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THE MARINE BENTHIC FLORA OF SOUTHERN AUSTRALIA

Part IIID

by

H.B.S. WOMERSLEY

Flora of Australia Supplementary Series Number 18

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FLORA OF AUSTRALIA SUPPLEMENTARY SERIES
NUMBER 18

THE MARINE BENTHIC FLORA OF SOUTHERN AUSTRALIA

RHODOPHYTA — Part IIID

Ceramiales – Delesseriaceae, Sarcomeniaceae, Rhodomelaceae

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CONTENTS OF PART IIID

INTRODUCTION 4
ACKNOWLEDGEMENTS 5
NEW TAXA AND NEW COMBINATIONS 6
SYNOPSIS OF FAMILIES, TRIBES (GROUPS) AND GENERA 8
ABBREVIATIONS USED IN FIGURES (LINE DRAWINGS) 11
DELESSERIACEAE 13
SARCOMENIACEAE 148
RHODOMELACEAE 167
APPENDIX 499
REFERENCES 501
GLOSSARY 518
INDEX 525

INTRODUCTION

Part IIID of this Marine Benthic Flora of southern Australia completes the account of the marine algae of this region. The present author will not be attempting an account of the Cyanophyta (blue-green algae, Cyanobacteria, Cyanoprokaryota) since this group requires a different approach and many years of study.

Part IIID is arranged similarly to previous parts, of which Part I included introductory chapters and Parts I, II and IIIA included locality maps of the region; localties are listed from west to east.

The following co-authors assisted as indicated:

Dr Murray J. Parsons, 242A Main Road, Moncks Bay, Christchurch 8, New Zealand (Lophothalieae).
Dr Gerald T. Kraft, Dr Sarah M. Wilson and **Dr Louise E. Phillips**, School of Botany, University of Melbourne, Victoria (certain genera of the Amansieae).

The layout of Part IIID is similar to that of previous Parts. In descriptions, ranges of dimensions apply to mature parts, and cell dimensions include the cell wall or sheath; in citing specimens the standard herbarium abbreviations (Holmgren *et al.* 1990) are used; most of these are listed in Part II. Unless otherwise stated in the captions, all figures are by the author (H.B.S.W.) with herbarium photographs mostly taken by Carolyn Ricci or Sarah Hotchkiss.

All papers referenced give descriptions or locality data, but references not giving such information (e.g. many in De Toni 1924) are not included, nor are ones just cited in ecological papers.

Keys apply only to the southern Australian taxa.

Part I (1984) of this Marine Flora gave an estimate (p. 54) of the species numbers for southern Australia as Chlorophyta 123, Phaeophyta 203 and Rhodophyta about 800. These numbers can now be updated to Chlorophyta 123 (plus 3 unrecorded in Part I), Phaeophyta 231 (plus 6–8 unrecorded in Part II) and *Vaucheria* 5 and Rhodophyta 778 (plus about 40 unrecorded), giving a total of 1137 recorded species and about 50 still to be described. The unrecorded species are known only from inadequate vegetative or reproductive material; a list of these has been deposited in AD.

A number of species in all phyla are regarded as probable adventives; these are listed in the Appendix.

Sets of "Marine Algae of southern Australia" continue to be distributed from the State Herbarium to herbaria listed in Part II (p. 11).

Identification of many Rhodophyta is far from easy. As well as abundant collections of good reproductive specimens (at least of female-cystocarpic and tetrasporangial plants) and good microscopic facilities, experience, time and patience are necessary. The similarity in form of many species in different tribes is often confusing, and details of their reproduction requires careful study; many tribes in families of the Ceramiales are separated on details of the female reproductive systems. Only rarely can certain identifications be made on general appearance and form, or on sterile material.

Due to these difficulties, keys to tribes (groups), and often genera, are frequently not fully comprehensive and have to be modified as knowledge develops. This Flora is (as previous parts) a step forward in our understanding of the Rhodophyta, and much research is still necessary as indicated in the accounts of many taxa; in particular, differences between some of the tribes merit further study.

ACKNOWLEDGEMENTS

Gratitude is expressed to the Director and Board of the Botanic Gardens and State Herbarium, the Department for Environment and Heritage and the Plant Biodiversity Centre and its Managers, for providing facilities for research on the Rhodophyta since 1989; previous research was conducted in the Department of Botany, University of Adelaide.

The author's research has been supported by the Australian Research Grants Scheme (to 1988) and since then (to 2000) by the Australian Research Council. I am also grateful for financial assistance from the Sir Mark Mitchell Research Foundation, from SARDI Aquatic Sciences, and from the National Parks & Wildlife SA. Grants provided have permitted assistance for research by Carolyn Ricci (since 1986) and by Sarah Hotchkiss (1996-2000), to whom appreciation is expressed for technical assistance, especially herbarium curating, slide preparation, manuscript and herbarium checking, and photographic processing.

Collections on which this Flora is based have been contributed by many SCUBA divers, especially by Dr S.A. Shepherd and the late Kevin Branden of SARDI, Aquatic Sciences, by Mr John Lavers (Penneshaw, Kangaroo Island), by Dr Jan Watson (Essendon, Victoria) and by Dr Graham Edgar (Department of Zoology, University of Tasmania). Directors of Australian Herbaria (especially MEL, MELU, NSW and HO) have permitted consultation of their algal collections, and Mrs Doris Sinkora (MEL) has provided extensive collections for AD.

Much of the manuscript of Rhodomelaceae has been commented on by Dr Gerald Kraft (University of Melbourne) who has assisted in various ways especially with specimen contributions, and for Delesseriaceae by Dr Michael Wynne (University of Michigan), and Dr Bill Woelkerling and Dr Paul Silva have assisted in literature matters.

The text of Part IIID was set up on word-processor by Miss Tina Eadsforth and the Latin diagnoses were provided by Mrs Mary Marlow, both of whom are sincerely thanked. Illustrations are by the author unless otherwise stated. Some illustrations have been re-used from journals as stated in the captions, and permission for this has been obtained in each case.

H.B.S. Womersley

NEW TAXA AND NEW COMBINATIONS

		Page
Delesseriaceae	*Hypoglossum harveyanum* (J. Agardh)Womersley & Shepley var. *fimbriatum* Womersley, *var. nov.*	50
	Haraldia australica Womersley, *sp. nov.*	67
	Nitospinosa Womersley, *gen. nov.*	83
	Nitospinosa pristoidea (Harvey)Womersley, *comb. nov.*	85
	Nitospinosa tasmanica Womersley, *sp. nov.*	87
	Nitospinosa littledipensis Womersley, *sp. nov.*	89
	Robea Womersley, *gen. nov.*	91
	Robea costata Womersley, *sp. nov.*	93
	Platyclinia crenulata Womersley, *sp. nov.*	102
	Platyclinia ramosa Womersley, *sp. nov.*	105
	Myriogramme cartilaginea (Harvey) Womersley, *comb. nov.*	111
	Schizoseris bombayensis (Børgesen)Womersley, *comb. nov.*	112
	Schizoseris hymenena (Zanardini)Womersley, *comb. nov.*	114
	Schizoseris perriniae (Lucas)Womersley, *comb. nov.*	117
	Hymenena endiviaefolia (Hooker & Harvey) Womersley, *comb. nov.*	141
Sarcomeniaceae	Sarcomeniaceae Womersley, *fam. nov.*	148
Rhodomelaceae		
Polysiphonieae	*Alleynea* Womersley, *gen. nov.*	216
	Alleynea bicornis Womersley, *sp. nov.*	219
	Tolypiocladia penningtonensis Womersley, *sp. nov.*	220
	Perrinia Womersley, *gen. nov.*	229
	Perrinia ericoides Womersley, *comb. nov.*	230
Lophothalieae	*Veleroa adunca* (J. Agardh)Womersley & Parsons, *comb. nov.*	240
	Endosiphonia spinulosa (Harvey)Womersley & Parsons, *comb. nov.*	251
	Micropeuce glomerulifera Womersley & Parsons, *sp. nov.*	257
	Micropeuce proxima (Harvey)Womersley & Parsons, *comb. nov.*	259
	Erythrostachys strobilifera (J. Agardh)Womersley & Parsons, *comb. nov.*	263
	Doxodasya hirta (J. Agardh)Womersley & Parsons, *comb. nov.*	272
Heterocladieae	*Heterocladia umbellifera* (Zanardini)Womersley, *comb. nov.*	286

Herposiphonieae	*Herposiphoniella* Womersley, *gen. nov.*	299
	Herposiphoniella plurisegmenta Womersley, *sp. nov.*	299
	Tiparraria Womersley, *gen. nov.*	301
	Tiparraria aurata (Harvey)Womersley, *comb. nov.*	303
	Dipterosiphonia australica Womersley, *sp. nov.*	308
	Gredgaria Womersley, *gen. nov.*	314
	Gredgaria maugeana Womersley, *sp. nov.*	315
Amansieae	*Amansia serrata* (Harvey)Womersley, *comb. nov.*	394

SYNOPSIS OF FAMILIES, TRIBES (GROUPS) AND GENERA

			Page
DELESSERIACEAE			13
Delesserioideae			
	Claudea group	*CLAUDEA*	16
	Caloglossa group	*TAENIOMA*	20
		CALOGLOSSA	21
	Sympodophyllum group	*SYMPODOPHYLLUM*	28
	Dicroglossum group	*DICROGLOSSUM*	28
	Hemineura group	*HEMINEURA*	32
	Delesseria group	*APOGLOSSUM*	35
	Hypoglossum group	*HYPOGLOSSUM*	41
		CHAUVINIELLA	59
		PHITYMOPHORA	63
Nitophylloideae			
	Phycodrys group	*HARALDIA*	67
		HETERODOXIA	69
		PHYCODRYS	71
		HALICNIDE	73
		WOMERSLEYA	77
		CRASSILINGUA	79
	Nitospinosa group	*NITOSPINOSA*	83
		ROBEA	91
	Martensia group	*MARTENSIA*	95
	Myriogramme group	*PLATYCLINIA*	98
		MYRIOGRAMME	107
	Schizoseris group	*SCHIZOSERIS*	111
	Nitophyllum group	*NITOPHYLLUM*	119
		HARALDIOPHYLLUM	125
	Cryptopleura group	*ACROSORIUM*	129
		HYMENENA	133
		BOTRYOGLOSSUM	144
SARCOMENIACEAE			148
		MALACONEMA	150
		COTTONIELLA	152
		SARCOTRICHIA	155
		PLATYSIPHONIA	158
		SARCOMENIA	165
RHODOMELACEAE			167
Polysiphonieae		*POLYSIPHONIA*	170
		LOPHURELLA	214
		ALLEYNEA	216
		TOLYPIOCLADIA	220
		ECHINOTHAMNION	222
		DIPLOCLADIA	227
		PERRINIA	229
		PITYOPHYCOS	231
		CHIRACANTHIA	233
Lophothalieae		*BRONGNIARTELLA*	237
		VELEROA	240
		HAPLODASYA	242
		LOPHOCLADIA	248

	ENDOSIPHONIA	250
	MICROPEUCE	253
	HOLOTRICHIA	259
	ERYTHROSTACHYS	261
	DOXODASYA	264
	LOPHOTHALIA	274
	GONATOGENIA	279
Heterocladieae	*HETEROCLADIA*	282
Herposiphonieae	*HERPOSIPHONIA*	289
	HERPOSIPHONIELLA	299
	TIPARRARIA	301
	DIPTEROSIPHONIA	304
	DITRIA	310
	HERPOPTEROS	312
	GREDGARIA	314
Polyzonieae	*DASYCLONIUM*	318
	CLIFTONAEA	325
	ECHINOSPORANGIUM	328
Lophosiphonia group	*LOPHOSIPHONIA*	332
	OPHIDOCLADUS	335
Pterosiphonieae	*PTEROSIPHONIA*	338
	SYMPHYOCLADIA	340
	HETEROSTROMA	341
	DICTYOMENIA	344
	POLLEXFENIA	351
Placophora group	*PLACOPHORA*	359
Bostrychieae	*BOSTRYCHIA*	362
	STICTOSIPHONIA	367
Sonderelleae	*SONDERELLA*	370
Amansieae	*PROTOKUETZINGIA*	374
	KUETZINGIA	376
	NANOPERA	378
	LENORMANDIA	380
	AMANSIA	390
	VIDALIA	395
	EPIGLOSSUM	401
	OSMUNDARIA	404
Chondrieae	*ACANTHOPHORA*	409
	COELOCLONIUM	409
	CLADURUS	417
	HUSSEYA	420
	CHONDRIA	422
Laurencieae	*JANCZEWSKIA*	452
	LAURENCIA	455
	CHONDROPHYCUS	481

GENERA OF UNCERTAIN POSITION	*WILSONAEA*	489
	HALYDICTYON	492
	CHAMAETHAMNION	495
	TYLOCOLAX	497

ABBREVIATIONS USED IN LINE DRAWINGS

1, 2, 3, 4 cells of carpogonial branch

1, 2, 3, 4 pericentral cells in sequence of formation.

ab co abaxial cover cell

ad co adaxial cover cell

ab p c abaxial pericentral cell

ab pp c abaxial pseudopericentral cell

ad p c adaxial pericentral cell

adv f adventitious filament

aux auxiliary cell

ax axial cell

b st gr basal sterile group

c carpogonium

c ad p c central adaxial pericentral cell

c b carpogonial branch

c c central cell

co cover cell

cort c corticating cell

f ax fertile axial cell

f c flanking cell

f c d flanking cell derivative

f p fertile pericentral cell

fu fusion cell

l p c lateral pericentral cell

l st gr lateral sterile group

pc pericarp

po co post-sporangial cover cell

pr co pre-sporangial cover cell

s ad pc side adaxial pericentral cell

sp spermatium

sp i spermatangial initial

spm spermatangium

st c sterile cell

st gr sterile group

stk stalk cell

st p sterile pericentral cell

su supporting cell

t *tetrasporangium*

tr trichogyne

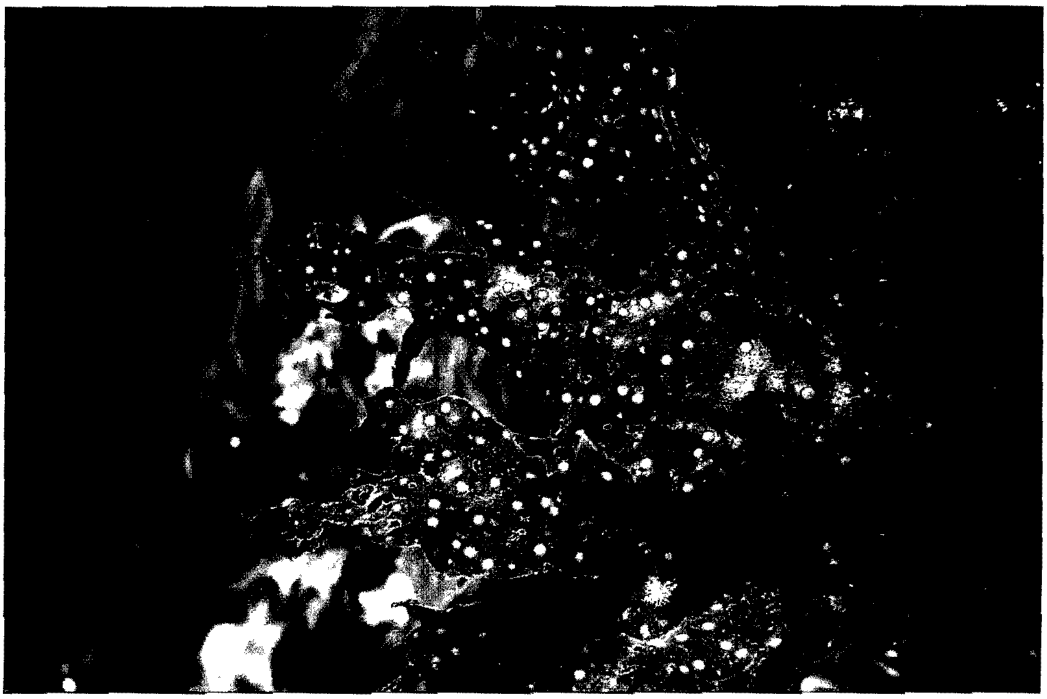

PLATE 1 fig. 1. *Myriogramme gunniana* at Charlotte Cove, Tas. Cystocarpic. (AD, A64313)
Photograph — G.Edgar.

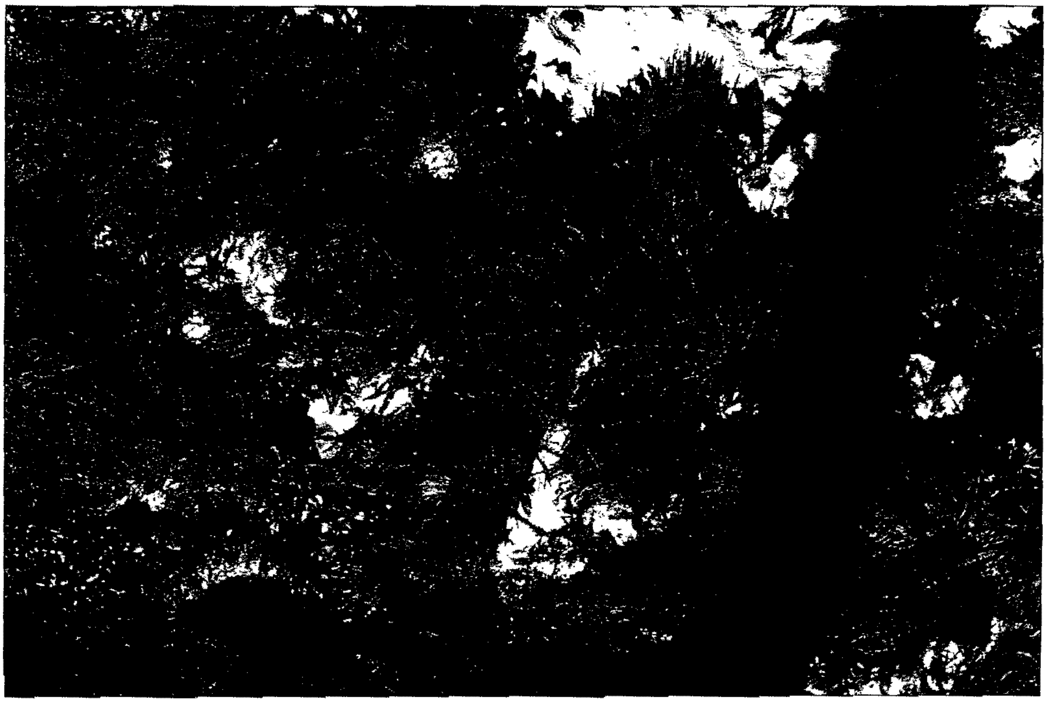

PLATE 1 fig. 2. *Lophurella periclados* at Back Beach, Little Dip Conservation Park, S.A., in shallow pools. (AD, A68511)
Photograph — H.B.S.Womersley.

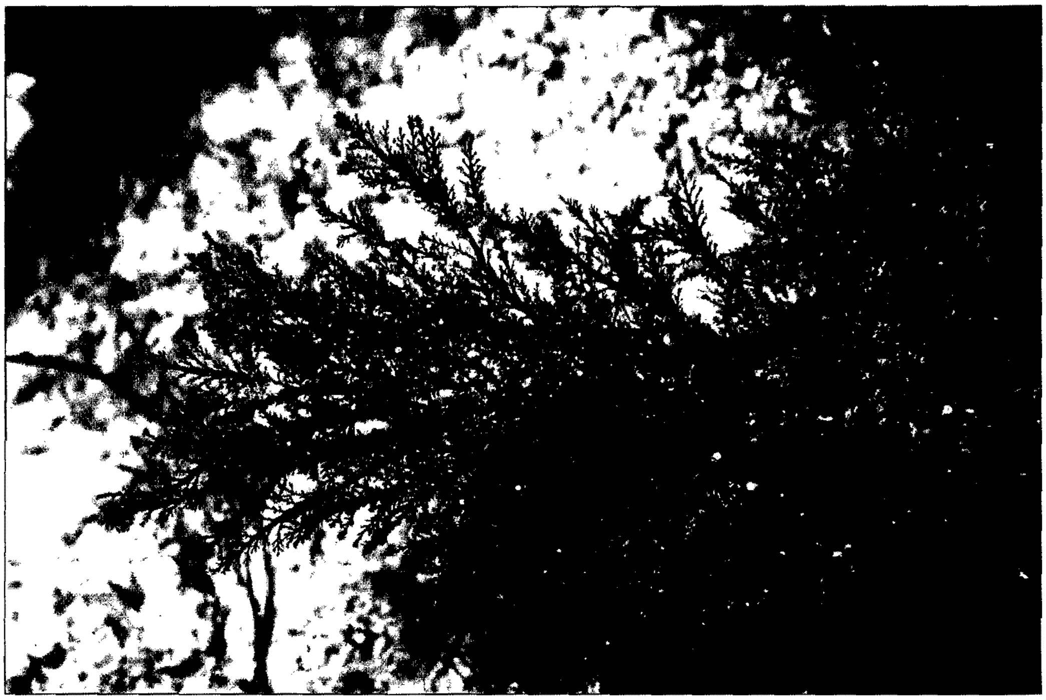

PLATE 2 fig. 1. *Dictyomenia harveyana* at Cloudy Lagoon, Tas. (AD, A64236)
Photograph — G.Edgar.

PLATE 2 fig. 2. *Epiglossum proliferum* at Back Beach, Little Dip Conservation Park, S.A. (AD, A68543)
Photograph — H.B.S.Womersley.

FAMILY DELESSERIACEAE Bory 1828: 181

by H. B. S. Womersley

Thallus mostly epilithic or epiphytic, some genera minute and parasitic, fronds strongly compressed to flat or foliose, almost entire to much branched from the midrib or the blade margins. Branching endogenous or exogenous, sometimes adventitious. Blades monostromatic to polystromatic, entire to lobed or divided, in a few genera forming a network. Midrib and veins present or absent. Older axes usually stipe-like by loss of lateral blade or wings, attached by a discoid or fibrous rhizoidal holdfast. *Structure*. Growth (Delesserioideae) by means of a dome-shaped or obconical apical cell segmenting to give an axial filament and 2 lateral pericentral cells followed by 2 transverse pericentral cells, the lateral pericentral cells developing second-order cell rows from which third-order cell rows (and often some fourth-order rows) arise abaxially, all or not all cells forming cell rows and all or not all rows reaching the blade margin, or (Nitophylloideae) growth by apical cells at the branch apices or on the margins or by means of marginal cells at the branch apices dividing by oblique divisions with 2 cutting faces, forming a flat membrane one or a few cells thick, with frequent intercalary divisions. Midrib and lateral veins present or absent, the midrib corticated or not, primary cells of blades corticated or not. Cortical cells equivalent to the primary cells in dimensions, or half or less (dimidiate) of the primary cells. Mature cells usually multinucleate. Rhodoplasts discoid, sometimes becoming elongate or ribbon-like in larger cells.

Reproduction. Reproductive organs formed on or in the blades or bladelets.

Gametophytes dioecious. Procarps produced on transverse pericentral cells near apices (Delesserioideae) or scattered over the blades (Nitophylloideae), with or without an anterior pericentral (cover) cell and with the supporting cell (pericentral or surface cell) forming 1 or 2 sterile groups and one or two 4-celled carpogonial branches. Post-fertilization the auxiliary cell is diploidised via a connecting cell or process from the carpogonium, and the carposporophyte develops usually a basal fusion cell, much branched gonimoblast filaments and single or chains of terminal carposporangia. Cystocarps ovoid and stipitate to immersed in the thallus, ostiolate, pericarp 1–5 cells thick with cells of the blade cortex in some genera forming erect filaments which may cut off outer cortical cells. Spermatangia develop in sori on the blade, often in linear patches on elongate blades, or irregularly scattered, with primary or cortical cells cutting off initials by periclinal then anticlinal divisions, which then produce several spermatangia.

Tetrasporangia produced in sori usually on both sides of blades, cut off from primary or inner cortical cells and lying in a single layer or 2 irregular layers, covered by a small-celled cortex, subspherical and tetrahedrally divided.

Type genus: Delesseria Lamouroux 1813: 122, *nom. cons.*

A family of some 95 genera (Wynne 1983, 1996), arranged in several groups which are considered equivalent to tribes by some authors; however, few tribes have been formally described [*e.g.* Dicroglosseae by Millar & Huisman (1996), Myriogrammeae by Hommersand & Fredericq (1997a), Schizoserideae by Hommersand & Fredericq (1997b) and Hemineureae by Lin *et al.* (2001)]. Referral of the genera to groups, as in Kylin (1924), was followed by Wynne in his numerous publications and his 1996 key to the genera*. Use of groups is followed here, since recognition of tribes has little advantage, and some of the characters used to separate them need further study, e.g. the absence or presence of veins in the blades; in *Hymenena multipartita* the veins are often very faint and scarcely recognisable, and in *H. curdieana* the veins are 2–4 cells broad in contrast to the veins in *H. affinis* which are only one cell broad. The nature of carposporangia also merits further study. While in some taxa they are clearly terminal only, in other taxa the next lower gonimoblast cell matures rapidly when the upper one is shed, and if this happens before shedding then they occur in short chains; this difference appears slight. In *Platyclinia* however, distinct rows of 3–5 carposporangia occur, with broad joint walls separating them. Use at generic level of gonimoblast cell fusions with cells of the primary cell plate on the cystocarp floor also needs

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* However, very recently Wynne (2000b) has recognised and formally described all the tribes of the Delesseriaceae.

caution. Such fusions are often extensive in *Haraldiophyllum* but occur close to the fusion cell in several genera (e.g. *Cryptopleura*, Kylin 1956, fig. 339B) and more extensively in *Crassilingua* and *Platyclinia*.

Some 27 genera occur on southern Australian coasts, with the richest representation on the cooler coasts of SE Australia and Tasmania.

The *Sarcomenia* group, due largely to the alternating (rhodomelaceous) order of pericentral cell formation, was referred to the Rhodomelaceae by Womersley & Shepley (1959), this difference being at that time considered an important basic separation between the Delesseriaceae and Rhodomelaceae. Other authors, following Papenfuss (1961), considered that other features ally the group more with the Delesseriaceae. Relationships of the *Sarcomenia* group have been clarified by DNA sequencing studies and the group is here regarded as a separate family (see below).

KEY TO GENERA OF DELESSERIACEAE

The following key applies only to southern Australian taxa.

1. Growth of blades from a single apical cell; no intercalary divisions in the primary cell row; midrib with descending rhizoids; procarps (and cystocarps) restricted to primary cell rows .... Delesserioideae 2
1. Growth by transversely dividing apical cells or obliquely dividing marginal initials with mainly anticlinal walls; intercalary divisions present in primary cell rows; midrib, if present, without descending rhizoids; procarps (and cystocarps) scattered over blade surface .... Nitophylloideae 11

2. Thallus net-like due to anastomoses of branches of one order with those of the previous order .... (*Claudea* group) CLAUDEA
2. Thallus not net-like, without such anastomoses 3

3. Branching exogenous at blade apices, often endogenous or adventitious below; tetrasporangia in a single layer, produced only from primary (second- or third-order) cells .... (*Caloglossa* group) 4
3. Branching endogenous (exogenous near apices in *Dicroglossum*); tetrasporangia usually in 2 irregular layers, produced from primary and/or cortical cells (in a single layer in *Sympodophyllum*, *Hypoglossum protendens* and *H. dendroides*) 5

4. Blades with 3 free monosiphonous filaments at their apices .... TAENIOMA
4. Blades without free monosiphonous apical filaments .... CALOGLOSSA

5. Thallus sympodially branched; lateral microscopic veins formed by second-order cell rows; tetrasporangia in a single layer, cut off from second-order row cells .... (*Sympodophyllum* group) SYMPODOPHYLLUM
5. Thallus monopodially branched (except *Hypoglossum revolutum*); lateral microscopic veins present or (usually) absent; tetrasporangia mostly in 2 irregular layers, produced from primary and/or cortical cells 6

6. Branching exogenous by new apices arising from end cells of second-order rows or from apical cells of marginal spinous outgrowths 7
6. All branching endogenous from axial cells of midrib 8

7. Apical branching by some second-order cell rows developing into new branches, resulting in subdichotomous main veins........... (*Dicroglossum* group) DICROGLOSSUM
7. Branching marginal and exogenous; short microscopic to faint central veins present in the marginal lobes but not extending back to the central midrib in older parts .... (*Hemineura* group) HEMINEURA

8. Not all third-order cell rows reaching the blade margins; third- and fourth-order rows often short, fitting within the other cell rows to form an irregular cell arrangement; microscopic lateral veins present .... (*Delesseria* group) APOGLOSSUM

8. All second- and third-order cell rows reaching the blade margin; cell rows regularly arranged; microscopic lateral veins absent .... (*Hypoglossum* group) 9

9. Blades monostromatic apart from the midrib .... HYPOGLOSSUM
9. Blades polystromatic, with smaller cortical cells overlying the primary cells; cells irregularly arranged in transverse section 10

10. All second-order row cells bearing third-order rows .... CHAUVINIELLA
10. Not all second-order row cells bearing third-order rows .... PHITYMOPHORA

11. Growth by means of 1 to several usually distinct apical cells terminating each axis or blade and dividing transversely; second-order rows producing third-order cells or rows abaxially (and often adaxially) .... (*Phycodrys* group) 12
11. Growth marginal, meristematic cells with anticlinal divisions or also with few to frequent spines with distinct transversely dividing apical cells; without distinct axial and second- or third-order rows 17

12. Blades monostromatic (apart from midrib and veins) at least when young; branched veins or a midrib and opposite lateral veins present or absent 13
12. Blades polystromatic; midrib absent or unbranched, lateral veins absent 16

13. Midrib and veins absent, blades monostromatic throughout .... HARALDIA
13. Midrib and lateral veins present; blade midribs polystromatic 14

14. Midrib branched as thallus branches; lateral veins not in pairs; tetrasporangia on small proliferations from midrib .... HETERODOXIA
14. Midrib not branched as thallus branches, bearing pairs of lateral veins; tetrasporangia on the blades or on marginal proliferations 15

15. Lateral veins faint; marginal and surface filaments absent; tetrasporangia on blade surface or on marginal segments .... PHYCODRYS
15. Lateral veins prominent; thallus margin and surface profusely covered with spinous, simple or branched, filaments; tetrasporangia on marginal proliferations ...... HALICNIDE

16. Midrib absent; tetrasporangial sori subterminal on lobes of blade. WOMERSLEYA
16. Midrib present; tetrasporangial sori forming raised ridges on both sides of midrib .... CRASSILINGUA

17. Growth by few to frequent distinct apical cells of marginal spines, also with few to frequent marginal cells dividing by anticlinal walls (probably separate group, *Nitospinosa*) 18
17. Growth marginal, cells with 2 dividing faces and anticlinal walls; without distinct apical cells except in some taxa on occasional lateral spines 19

18. Thallus monostromatic only when young, soon tri- to polystromatic; apical cells on prominent marginal spines, without or with few marginal cells dividing anticlinally; carposporangia in short chains .... NITOSPINOSA
18. Thallus mostly monostromatic, with a prominent midrib; apical cells on slight marginal projections or level with other marginal cells, marginal cells often dividing anticlinally by 2 cutting faces; carposporangia single, terminal .... ROBEA

19. Fronds with a distinct network above a non-perforate membranous base, with a membranous upper margin .... (*Martensia* group) MARTENSIA
19. Fronds not forming networks 20

20. Carposporangia in chains .... (*Myriogramme* group) 21
20. Carposporangia single, terminal 23

21. Blades polystromatic except near apices; cortical cells dimidiate or equivalent; carposporophyte a radiating weft producing erect filaments of 3–5 carposporangia .... PLATYCLINIA
21. Blades largely monostromatic, becoming polystromatic in oldest parts (but without a small-celled cortex); carposporangia in short chains on an erect carposporophyte 22

22. Blades usually much branched or lobed, without midribs or veins .... MYRIOGRAMME
22. Blades deeply divided or laciniate, usually with dichotomous central midribs or macroscopic veins .... SCHIZOSERIS

23. Midrib and microscopical veins absent .... (*Nitophyllum* group) 24
23. Microscopic veins present .... (*Cryptopleura* group) 25

24. Procarps with the central cell producing a cover cell and a supporting cell with one group of sterile cells and a carpogonial branch .... NITOPHYLLUM
24. Procarps with the central cell producing a cover cell and a supporting cell with two groups of sterile cells and a carpogonial branch .... HARALDIOPHYLLUM

25. Only microscopic veins present; basal midrib absent; thallus largely monostromatic .... ACROSORIUM
25. Microscopic and often macroscopic veins present, in some species with a basal midrib; thallus becoming tri- to polystromatic 26

26. Tetrasporangial sori scattered over blade surface .... HYMENENA
26. Tetrasporangial sori on marginal or surface proliferations, arising mostly from cortical cells .... BOTRYOGLOSSUM

Genus CLAUDEA Lamouroux 1813: 121

Thallus with net-like fronds, unilaterally placed on short or long stipes developed from the "midrib" of the nets. Holdfast discoid to conical, pseudoparenchymatous; epilithic or epiphytic. *Structure*. Apices of fronds with a dome-shaped apical cell segmenting to give an axial filament, each cell with 4 pericentral cells, 2 lateral cells cut off first followed by 2 transverse pericentral cells; lateral pericentral cells developing second-order rows with their inner cells forming third-order rows, with all second and third-order rows reaching the blade margin; fourth-order rows occasionally present marginally. The lateral pericentral cells develop wings 1–2 mm broad. The upper (adaxial) transverse pericentral cells each produce a secondary blade with similar apical development, of which each adaxial transverse pericentral cell produces a row of cells which connect to the lower (abaxial) transverse pericentral cells of the secondary frond above, with all cells except the apical adherent one developing flat blades as in primary and secondary axes. These tertiary blades and their interstices form the network of the fronds and similar branching of the tertiary blades forms quaternary blades with smaller networks. Cortication of the axes commences some distance below the apices and becomes thick on lower axes from which the wings are lost.

Reproduction. Gametophytes dioecious. Procarps (in *C. multifida*) borne on abaxial transverse pericentral cells, usually on successive cells, with 2 sterile groups and a 4-celled carpogonial branch. Carposporophyte with a basal fusion cell, much branched gonimoblast, and clavate to ovoid terminal carposporangia. Cystocarps dome-shaped to ovoid, borne singly on distinct pedicels; pericarp ostiolate, corticate. Spermatangial sori formed on tertiary or quaternary blades, with sterile midribs and margins, with initials cut off from second- and third-order rows producing an outer layer of spermatangia.

Tetrasporangial sori formed on tertiary and quaternary blades, with tetrasporangia cut off from second-order cells in a single (or displaced to two) layer (from cortical cells also in *C. multifida*), with cover cells on each side of the blade dividing to form a continuous cortical layer; tetrasporangia subspherical, tetrahedrally divided.

Type species: *C. elegans* Lamouroux 1813: 121.

A genus of 3 species, the type, *C. multifida* Harvey (1854, p. 145) from the northern Indian Ocean and *C. batanensis* Tanaka (1967, p. 18, figs 6–8) from the Philippines. Papenfuss (1937) gave a detailed description of the structure and reproduction of *C. multifida*.

Claudea elegans Lamouroux 1813: 121, pl. 8 figs 2–4. J. Agardh 1863: 1275; 1879: pl. 32 figs 30–33. De Toni 1900: 748. Guiler 1952: 100. Harvey 1844a: 408, pl. xx; 1844b: 430; 1846: 378; 1847: 15; 1855a: 537; 1858: pl. 1; 1859b: 294. 1863, synop.: xiv.

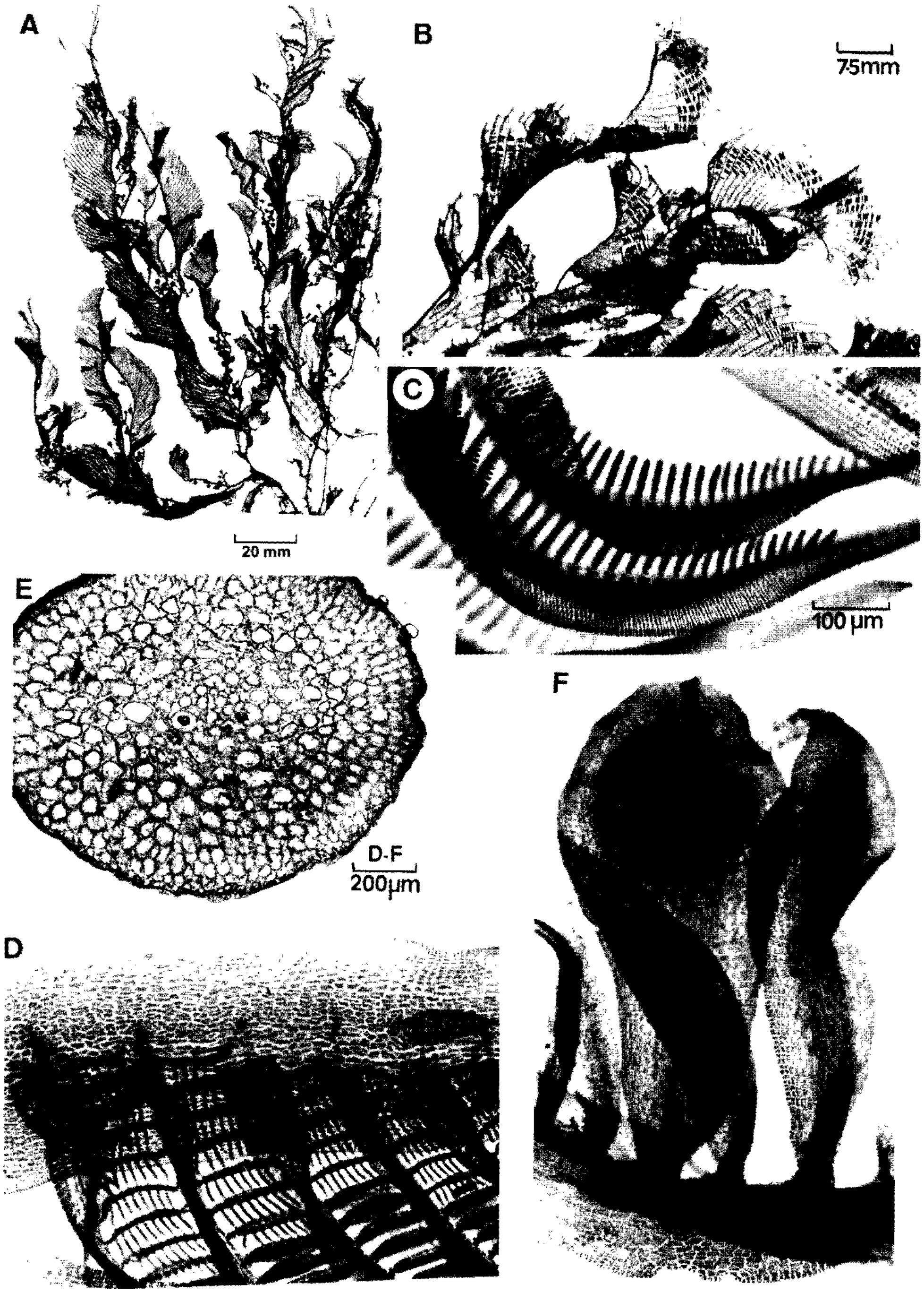

Fig. 1. *Claudea elegans* (**A**, AD, A35830; **B**, AD, A59980; C, D, AD, A64859; **E**, AD, A33054; **F**, AD, A22533). **A**. Habit, cystocarpic plant. **B**. Fronds with tetrasporangial sori. **C**. Young blades with filaments from the upper transverse pericentral cells. **D**. Blade with wings and secondary, tertiary and quaternary blades. **E**. Transverse section of lower axis. **F**. Blades with young cystocarps.

Hooker & Harvey 1847: 307. Huisman 1997: 200. Kützing 1843: 451; 1849: 888; 1869: 21, pl. 55. Kylin 1956: 437, figs 329B–D, 348C. Lucas 1909: 37; 1929a: 20. Lucas & Perrin 1947: 237, fig. 101. May 1965: 395. Mazza 1908: No. 257. Norris 1987a: 311, figs 1–6. Oliveira 1977: 118. Schmitz & Hauptfleisch 1897: 416. Shepherd & Womersley 1981: 366. Silva *et al.* 1996: 453. Sonder 1853: 696; 1880: 30. Wilson 1892: 164. Womersley 1950: 183. Wynne 1983: 443; 1996: 179; 1998: 40.

Lamourouxia elegans C. Agardh 1817: xiv.

Oneillia elegans (Lamouroux)C. Agardh 1822: 170; 1824: 253.

Fucus claudei Turner 1819: 108, pl. 243, *nom. illegit.*

FIGS 1, 2, 6A, B

Thallus (Fig. 1A, B) rose-red to grey-red, (10-) 20–40 cm high, with several axes usually basally branched and becoming 2–3 mm thick basally. Axes with upper net-like fronds (Fig. 1B) usually 5–15 cm long and 1–3 cm broad, tapering apically, unilaterally placed on narrow "mid-ribs" with membranous wings opposite the nets and rectangular interstices (Fig. 1D); apices of fronds usually curved abaxially, with frond margins dentate (Fig. 1B) due to the apices of second-order filaments; axes becoming thickened (Fig. 1E) and denuded below. Holdfast discoid, formed of spreading rhizoids, becoming pseudoparenchymatous; epilithic or on shells. *Structure.* Apical cells of blades dome-shaped, segmenting after 4–7 cells to form first 2 lateral pericentral cells, followed by lower (abaxial) and upper (adaxial) transverse pericentral cells. The lateral pericentral cells cut off 2 flanking cells, the upper (anterior) one forming a second-order row with most of the inner cells forming third-order rows; the lower (posterior) flanking cell develops as an unbranched third-order row also. Short fourth-order rows may develop from cells near the margin, and all rows reach the thallus margin. The wings developed from the lateral pericentral cells become 1–2 mm and many cells broad on the primary axes (Fig. 1D). The upper (adaxial) transverse pericentral cells produce secondary blades from successive segments, branched as above but smaller, lying in a plane at right angles to the parent blade, 80–120 μm and 6–10 cells broad. These secondary blades produce filaments (Fig. 1C) (4-) 6–10 cells long from the upper transverse pericentral cells which extend to and unite with the lower (abaxial) transverse pericentral cells of the secondary blade above them. As the frond expands, these filaments develop into tertiary blades (with their apical cell adherent above) which repeat the blade development (Fig. 1D). Apices of the secondary blades project as the dentations on the frond margins (Fig. 1B). Cortication of the midrib and lateral cells of primary blades commences some distance below the apices and becomes relatively thick below as the wings and blades are lost from older parts. Cells mostly multinucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps borne in series (Fig. 6A) on the lower (abaxial) side of primary and secondary blades close to apices, without development of the next order of branches near the procarps. The abaxial pericentral cell becomes the supporting cell, cutting off two sterile groups and a 4-celled carpogonial branch (Fig. 6B). Carposporophyte with a basal fusion cell, much branched gonimoblast (Fig. 2A) with broadly clavate to ovoid terminal carposporangia 50–90 μm in diameter, replaced from subterminal cells. Cystocarps (Fig. 1F) on slender stalks 2–5 mm long, single or in small clusters of adjacent stalks developed from the midrib and narrow wings, ovoid, 1–2 mm in diameter, with a slight neck only. Pericarp with an outer cortical layer of irregular but closely adjacent cells. Spermatangial sori (Fig. 2B) covering tertiary and quaternary blades of the nets, derived from lateral pericentral cells and inner cells of second and third-order rows, leaving the transverse pericentral cells and marginal (often also submarginal) cells sterile (Fig. 2C), with the primary cells dividing anticlinally and cutting off initials which each produce several spermatangia.

Tetrasporangial stichidia (Fig. 2D, E) developed from tertiary branches of the nets (which then lack further branches); the lateral pericentral cells form only a single second-order row of elongate cells, apart from division into 2 flanking cells (and later more third-order rows) at the margins. Stichidia ovate, 1–1.5 mm long and 500–700 μm broad, with the tetrasporangia cut off from 3–5 cells of the single rows from the lateral pericentral cells, essentially in a single layer (Fig. 2E) but usually pushed into 2 layers, with occasional further tetrasporangia cut off from the primary cells; the oldest tetrasporangia are situated centrally in the sorus (both longitudinally and near the midrib) and are subspherical, 50–120 μm in diameter.

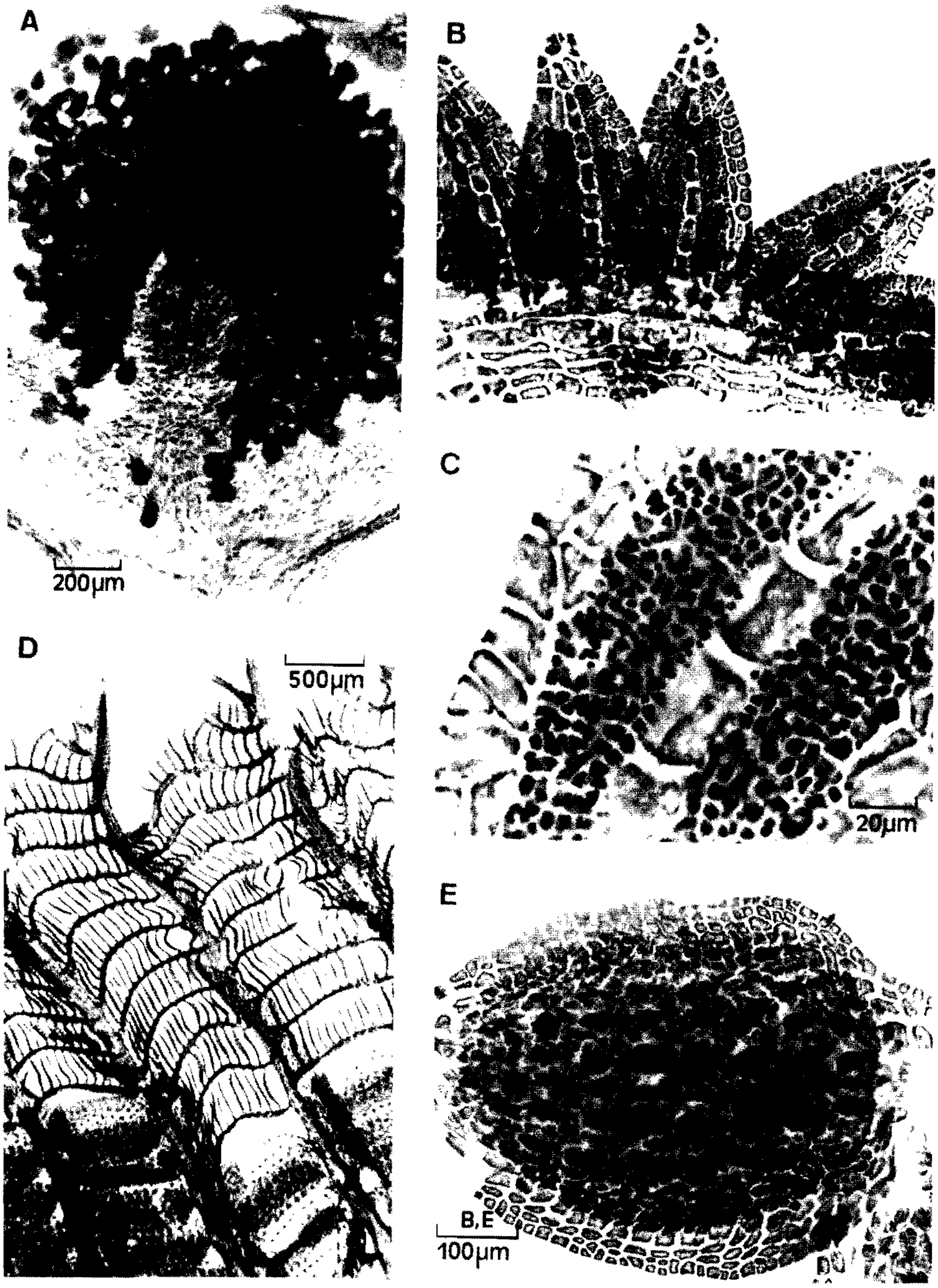

Fig. 2. *Claudea elegans* (**A**, AD, A34308; **B**, **C**, AD, A29501; **D**, AD, A64859; **E**, AD, A44755). **A**. Carposporophyte. **B**. Spermatangial sori on blades of the network. **C**. Spermatangial sori. **D**. Thallus with tetrasporangial blades. **E**. Tetrasporangial blade with tetrasporangia cut off from lateral pericentral cells.

Type from "Nouv. Holl." (*Peron*) – locality uncertain; holotype in Herb. Lamouroux, CN.

Distribution: Fremantle, W. Aust., to Walkerville, Vic., and N Tasmania.
India, Pakistan, Natal and Brazil (Oliveira 1977, p. 118).

Selected specimens: Hopetoun, W. Aust., 3–4 m deep (*Kraft* 7006 & *Ricker*, 16.viii.1979; MELU and AD, A50714). Nuyts Reef, S. Aust., 28–30 m deep (*Shepherd*, 26.iii.1980; AD, A52320). Ward I., S. Aust., 18–23 m deep (*Shepherd*, 3.iii.1980; AD, A50901). Elliston, S. Aust., 7 m deep in bay (*Shepherd*, 21.x.1970; AD, A37357). Hopkins I., S. Aust., 33 m deep (*Branden*, 8.i.1989; AD, A59980). Tapley Shoal (Edithburg), S. Aust., 18 m deep (*Shepherd*, 2.ii.1969; AD, A33447). Off Troubridge Light, Gulf St Vincent, S. Aust., 17 m deep (*Shepherd*, 4.ii.1969; AD, A33415—"Marine Algae of southern Australia" No. 109). Investigator Strait, S. Aust., 31 m deep (*Watson*, 23.i.1971; AD, A41094). Bay of Shoals, Kangaroo I., S. Aust., 3 m deep in channel (*Womersley*, 5.i.1990; AD, A60121). Snapper Point, Penneshaw, Kangaroo I., S. Aust., 20 m deep (*Lavers*, 24.iii.1996; AD, A64859). Pennington Bay, Kangaroo I., S. Aust., drift (*Womersley*, 4.i.1948; AD, A6567). Hastings, Western Port, Vic., 20 m deep (*Plant*, 18.v.1959; AD, A22533). Crawfish Rock, Westernport Bay, Vic., 6–8 m deep (*Watson*, 10.xi.1968; AD, A33054), 7 m deep (*Watson*, 5.iv.1970; AD, A35830), 3–4 m deep (*Watson* & *Womersley*, 26.iv.1964; AD, A34308) and 4 m deep (*Watson* & *Womersley*, 16.i.1974; AD, A44755). Walkerville, Vic., drift (*Sinkora* A2037, 20.ii.1975; MEL and AD, A48340). West Point, Erith I., Bass Strait, 28 m deep (*Shepherd* & *Lewis*, 10.v.1974; AD, A45116). Currie R., Tas. (*Perrin*, Nov. 1938; AD, A29501).

Claudea elegans has been recorded from India and Pakistan (see Silva *et al.* 1996, p. 453) and from Natal by Norris (1987a, p. 311); the latter specimen has a thick, possibly perennial, lower axis, much thicker than seen in Australian specimens.

Genus TAENIOMA J. Agardh 1863: 1256

Thallus turf-like or within turf, with prostrate, ecorticate, terete axes attached by uniseriate rhizoids, producing short assurgent indeterminate branches 1–4 mm high bearing determinate laterals with 1–5 persistent apical hairs. Determinate laterals flat, with the lateral pericentral cells each producing 2 flanking cells which remain undivided or form short 2–3-celled chains. *Structure*. Apical cells of prostrate axes dome-shaped, segmenting to axial cells with 4 pericentral cells; erect branches monopodial with exogenous branching, when mature bearing basally meristematic apical hairs in pit-connection with the axial cells.

Reproduction. Gametophytes rare, usually dioecious. Procarps produced on indeterminate axes, with a pericentral (supporting) cell bearing a 4-celled carpogonial branch and 2 sterile groups. Carposporophyte with a basal fusion cell and short chains of ovoid carposporangia, surrounded by an urceolate pericarp of erect filaments with outer pericentral cells and usually cortical cells on the lower pericarp. Spermatangia formed in sori on both sides of slightly broader flat determinate blades, with the primary cells cutting off initials which produce spermatangia.

Tetrasporangia produced on determinate laterals in 2 rows, from the lateral pericentral cells which each cut off 2 post-sporangial cover cells; tetrasporangia sub-spherical, tetrahedrally divided.

Type species: *T. perpusillum* (J. Agardh)J. Agardh 1863: 1257.

A genus of 3 species, the type with 3 monosiphonous apical filaments on the determinate branches, *T. nanum* (Kützing)Papenfuss (1952, p. 179) with 2 such filaments, recorded from Queensland by Cribb (1983, p. 100), and *T. dotyi* Hollenberg (1967b, p. 1202, fig. 4) from the Hawaiian Islands, which differs in that the flanking cells form chains of 2–3 cells and there are (3-) 4–5 apical filaments. Some authors (e.g. Hollenberg 1967b, p. 1203) suggest that *T. nanum* is only a variant of the type species.

Taenioma perpusillum (J. Agardh)J. Agardh 1863: 1257. Abbott 1999: 348, fig. 101A–E. De Toni 1900: 732; 1924: 358. Huisman 1993: 12; 2000: 153. Krishnamurthy & Varadarajan 1990: 107, figs 19–24. Kylin 1956: 435, fig. 347A. May 1965: 377. Millar & Kraft 1993: 49. Papenfuss 1944: 193, pls 23, 24; 1964a: 159, figs 1–10. Silva *et al.* 1996: 467. Stegenga *et al.* 1997: 493, pl. 202. Womersley & Shepley 1959: 205. Wynne 1996: 182.

Polysiphonia perpusilla J. Agardh 1847: 16.

FIG. 3

Thallus (Fig. 3A) usually within mats or turfs with other algae, with prostrate ecorticate terete axes (Fig. 3C) 100–250 µm in diameter, attached by long unicellular rhizoids cut off from pericentral cells mostly 1–4 segments apart; erect branches (Fig. 3A, B) 2–4 mm high, indeterminate but bearing determinate laterals 0.5–1.5 mm long with flat blades 500–800 µm long and 80–120 µm broad, terminated by 3 long hairs. Epilithic or epiphytic on turf-forming algae. *Structure*. Prostrate axes (Fig. 3C) with 4 pericentral cells formed in opposite order with the dorsal cells producing erect branches and the lower cells producing rhizoids, polysiphonous segments L/D 0.5–1. Erect branches monopodial with exogenous branching of subapical cells, determinate branchlets (Fig. 3D) 5 cells broad including the lateral pericentral cells which cut off 2 flanking cells (interpreted as an upper second-order row of 2 cells and a single celled third-order row), apical hairs uniseriate, basally meristematic, cells 20–40 µm in diameter and L/D 20–50; axial and pericentral cells 10–15 µm in diameter and L/D 1.5–2, flanking cells 7–12 µm in diameter and L/D 1–2, laterally elongate when young and becoming isodiametric. Cells multinucleate; rhodoplasts discoid to elongate, ribbon-like in larger cells.

Reproduction. (Gametophytes not observed in southern Australian material.) Gametophytes (Papenfuss 1964a) dioecious. Procarps produced on terete indeterminate axes, usually singly, with a pericentral (supporting) cell cutting off a 4-celled carpogonial branch and initials of 2 sterile groups. Carposporophyte branched, with a basal fusion cell and chains of ovoid carposporangia. Pericarp of erect filaments developed from vegetative cells around the supporting cell, each filament cell cutting off 2 outer pericentral cells, with the cystocarp urceolate and ostiolate. Spermatangia produced on both sides of determinate branchlets where the flanking cells form 4–5-celled chains, with the primary cells between the axile and marginal cells each cutting off several initials in short chains, which then cut off spermatangia.

Tetrasporangia in determinate branchlets (Fig. 3E), produced in 2 rows from the lateral pericentral cells, with small post-sporangial cover cells cut off on both surfaces; tetrasporangia subspherical, 30–40 µm in diameter.

Type from San Augustin, Mexico (*Liebmann*); holotype in Herb. Agardh, LD, 43343.

Distribution: Widespread in tropical and subtropical oceans, extending into cool temperate regions.

In southern Australia, from the west coast of Western Australia (Huisman 1993, p. 12) eastwards to Normanville, S. Australia; Lord Howe I. (Millar & Kraft 1993, p. 49).

Selected specimens: Strickland Bay, Rottnest I., W. Aust., on reef top (*Woelkerling*, 12.ii.1978; AD, A49300). Scott Bay, just W of Fowler Bay, S. Aust., reef pools (*Womersley*, 27.i.1951; AD, A14992). Pondalowie Bay, Yorke Pen., S. Aust., upper sublittoral (*Woelkerling*, 31.xii.1976; AD, A47877). Troubridge Point, Yorke Pen., S. Aust., lower eulittoral, shaded (*Womersley*, 7.ii.1969; AD, A33837—"Marine Algae of southern Australia" No. 122). Lady Bay, Normanville, S. Aust., on *Heterozostera* in reef pools (*Skinner*, 4.iv.1977; AD, A47982).

Taenioma perpusillum usually occurs as a mat on rock just above or below low tide level. It is easily overlooked and is probably more widespread than the above records indicate.

Genus CALOGLOSSA (Harvey)Martens 1869: 234, 237

Thallus forming loose entangled mats, main branches bearing alternate, exogenous indeterminate lateral branches, with endogenous and adventitious proliferous branches from the nodes and margins. Blades of flat, linear to clavate internodes and narrower, more or less terete, nodes, attached by uniseriate rhizoids usually from the nodal pericentral cells. *Structure*. Apical cells dome shaped, axial cells cutting off lateral pericentral cells, then ventral (lower) and dorsal (upper) pericentral cells, the lateral cells functioning as the first cells of second-order rows which produce third-order rows from their inner cells. Lateral cell rows 2–20 cells long, forming monostromatic wings to the blades which have a central mid-rib 3 cells thick; secondary pit-connections usually numerous between wing cells.

Reproduction. Gametophytes usually dioecious. Procarps borne on axial cells, usually in series with only one developing post-fertilization. Fertile pericentral (supporting) cell forming first a cover cell by an anterior division, then a 4-celled carpogonial branch; post-fertilization the carpogonium fuses with the auxiliary cell via a connecting cell, and the fusion cell

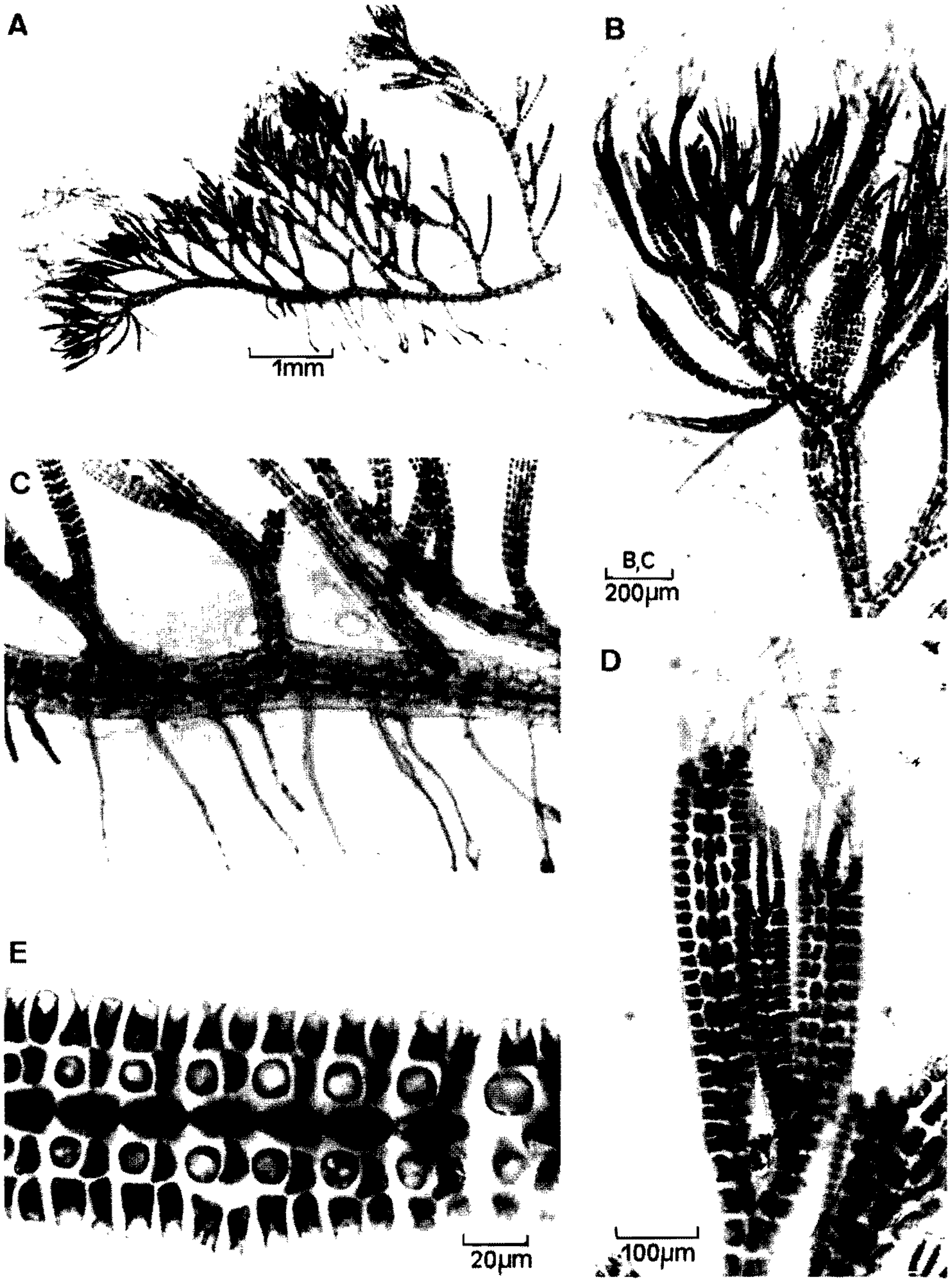

Fig. 3. *Taenioma perpusillum* (AD, A33837). **A**. Thallus with prostrate axis attached by rhizoids and bearing erect branches. **B**. An erect branch with determinate branchlets each with 3 terminal hairs. **C**. Prostrate terete axis with rhizoids and erect branches. **D**. Determinate branchlets with hairs. **E**. Part of a determinate branchlet with immature tetrasporangia.

produces branched gonimoblast filaments bearing short chains of ovoid carposporangia. Cystocarps ovoid, ostiolate, sessile on the blades, pericarp of 8–10 erect filaments with each cell cutting off 2 outer pericentral cells and the lower cells also forming cortical cells. Spermatangial sori covering the blades between the midrib and the margins, on both surfaces, with a layer of initials each cell of which produces several spermatangia.

Tetrasporangial sori develop below the blade apices from second- and third-order cells, each cell cutting off adaxially a tetrasporangium and then cover cells on both surfaces; tetrasporangia normally tetrahedrally divided, cover cells often irregularly lobed.

Type species: *C. leprieurii* (Montagne)Martens 1869: 234, 237.

Authorship of *Caloglossa* is discussed by Silva *et al.* (1996, p. 449), and the genus was monographed most recently by King & Puttock (1994), who recognise 8 species. While mainly a tropical-subtropical genus, *C. leprieurii* is a widespread species from tropical to cool temperate waters, and the tropical *C. ogasawaraensis* also occurs in southern Australia.

KEY TO SPECIES OF *CALOGLOSSA*

1. Thallus branches mostly 0.6–2 (-3) mm broad, markedly constricted at the nodes, internodes 20–40 cells broad; branching of main axes exogenous, also endogenous from central axial cells at the nodes .... 1. *C. leprieurii*
1. Thallus branches slender, 100–200 (-300) µm broad with only slightly constricted nodes, internodes 3–7 (-8) cells broad; branching exogenous near apices and adventitious from pericentral cells .... 2. *C. ogasawaraensis*

1. **Caloglossa leprieurii** (Montagne)Martens 1869: 234, 237. J. Agardh 1876: 499; 1898: 228–236. Beanland & Woelkerling 1982: 98. Davey & Woelkerling 1980: 59. De Toni 1900: 729; 1924: 357. Guiler 1952: 101. Kamiya *et al.* 1995: 81, figs 1–26. Kendrick *et al.* 1990: 51. King & Puttock 1994: 112. King *et al.* 1971: 123. Kylin 1956: 431, figs 312A–E, 344A, B. Lucas 1909: 37; 1929a: 20. Lucas & Perrin 1947: 233. May 1965: 395. May *et al.* 1978: 97. Millar & Kraft 1993: 45. Papenfuss 1961: 8, figs 1–30. Silva *et al.* 1996: 450. Sonder 1880: 24. Tisdall 1898: 509. Wynne 1996: 178. Wynne & Kraft 1985: 16, figs 20–23.

Delesseria leprieurii Montagne 1840a: 196, pl. 5 fig. 1. J. Agardh 1852: 682. Harvey 1859b: 311; 1863, synop.: xxxi. Sonder 1855: 522.

Caloglossa beccarii Zanardini *sensu* De Toni & Forti 1923: 34.

FIGS 4, 5A–C, 6C, D

Thallus (Fig. 4A) red-brown, forming loose entangled mats 5–20 mm thick, composed of arching, flat, linear, monopodial main branches attached at the constricted nodes by uniseriate rhizoids which become clumped and form basal stipes up to 4 mm high and 400–800 µm in diameter, base of stipe discoid, bearing apically clusters of branched fronds 10–20 mm long, branches (0.5-) 1–2 (-3) mm broad, linear with internodes usually 2–8 mm long separated by nodal constrictions; epiphytic on mangroves or epilithic, usually lower to mid eulittoral. *Structure*. Growth apical, with a dome-shaped apical cell (Figs 4C, 6C) and the axial cells cutting off first 2 lateral pericentral cells (Fig. 6D), then ventral and dorsal pericentral cells, the lateral pericentral cells each developing a second-order cell row which produces abaxially third-order rows 10–20 cells long (Fig. 4B, C) and which reach the blade margin (Figs 4C, 6C) and sometimes cut off fourth-order cells; secondary pit-connections numerous. Blades monostromatic apart from the central midrib, ecorticate, margins entire, more or less flat. Branching of main blades exogenous near apices with adventitious proliferations arising mainly from nodal pericentral cells. Cells mostly multinucleate; rhodoplasts discoid to elongate.

Reproduction. Gametophytes dioecious. Procarps borne in series on dorsal pericentral (supporting) cells, with usually a single cystocarp developing per branch. Fusion cell branched and incorporating lower gonimoblast cells, carposporophyte (Fig. 4D) much branched with short chains of ovoid to angular carposporangia 20–28 µm across. Cystocarps (Fig. 4D) ovoid, ostiolate, 500–750 µm in diameter; pericarp with 8–10 erect filaments, each cell cutting off outer pericentral cells and cortical cells near the base, with the outer pericarp cells becoming irregular in shape and position. Spermatangial sori (Fig. 4E) on both sides of blades apart from over and near the mid-rib and along the margins, with the primary cells cutting off several initials which each produce several spermatangia (Fig. 4F).

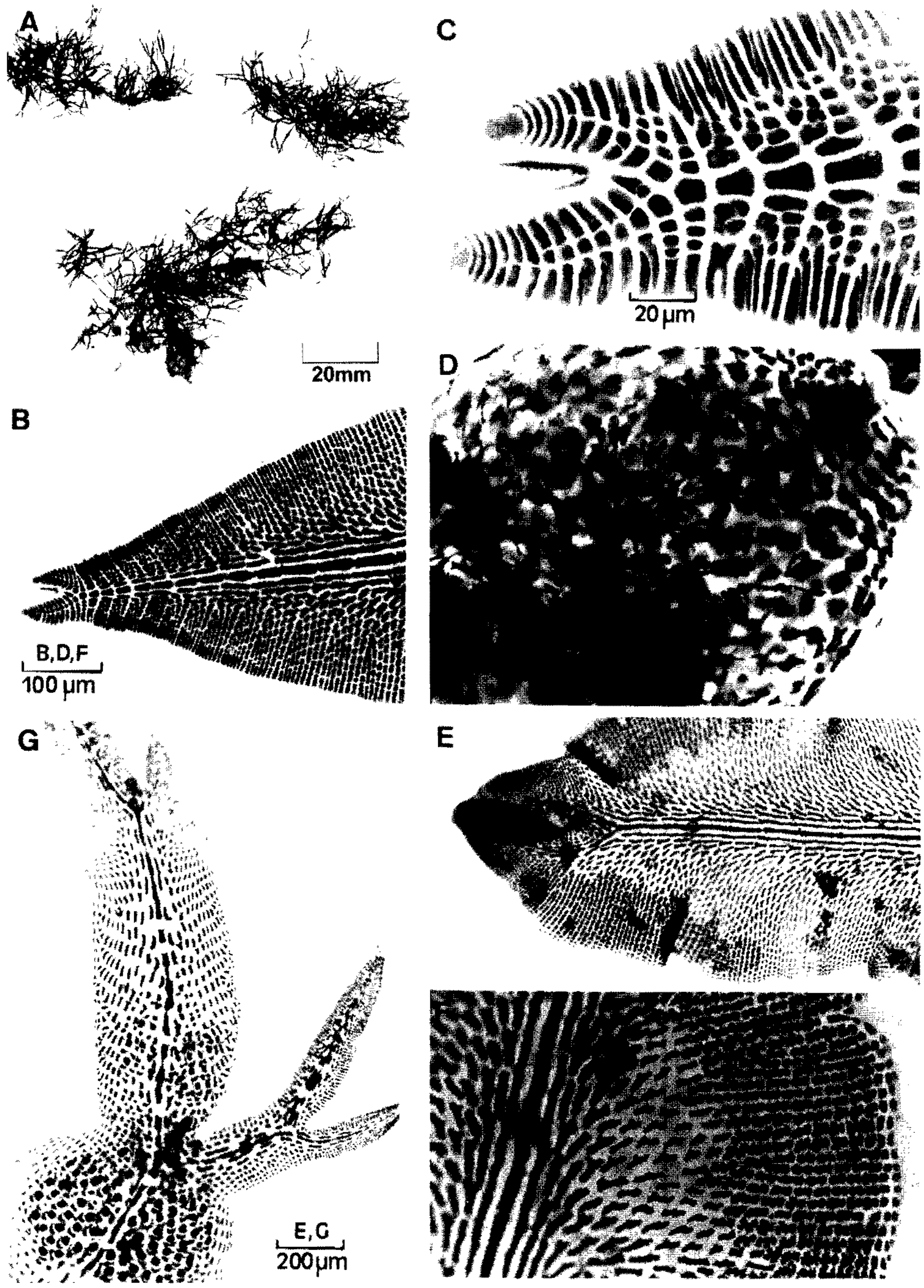

Fig. 4. *Caloglossa leprieurii* (**A**, AD, A53007; **B–F**, AD, A22593; **G**, AD, A23961). **A**. Habit. **B**. Apex of frond showing second- and third-order cell rows. **C**. Details of B, enlarged. **D**. Cystocarp with carposporophyte and short chains of young carposporangia. **E**. Spermatangial sori at blade apex. **F**. Outer cell rows with spermatangia. **G**. Upper frond branches producing tetrasporangia.

Tetrasporangia formed in sori (Figs 4G, 5A) near branch tips, cut off from second- and third-order cells and lying in regular rows (Fig. 5B), with the stalk cell then cutting off a cover cell on each surface, cover cells (Fig. 5C) becoming irregularly lobed; tetrasporangia subspherical, 30–45 µm in diameter.

Type from Cayenne, French Guiana, S. America (*Leprieur*, 20.xi.1841); holotype in PC.

Distribution: Widespread in tropical to cool temperate oceans.

In southern Australia, from Wallaroo eastwards, on *Avicennia* trunks and pneumatophores, and on rock and jetty piles, in calm localities through Victoria, N and E Tasmania, and around N Australia (King & Puttock 1994); extending upstream in fresh-water in some localities.

Selected specimens: Opposite Bird I., SW of Wallaroo, S. Aust., on *Avicennia* mangroves mid eulittoral (*Womersley*, 23.xi.1991; AD, A61508). Garden I., Port Adelaide, S. Aust., on *Avicennia* mangroves, mid eulittoral (*van den Hoek*, 1.x.1981; AD, A52646). Goolwa, S. Aust., mid eulittoral on rocks outside barrage (*Womersley*, 10.iv.1982; AD, A53007). American R. inlet, Kangaroo I., S. Aust., mid eulittoral on rocks S of Muston (*Womersley*, 23.viii.1963; AD, A27005). Nelson Lagoon, Vic., lower eulittoral on rock (*Beauglehole*, 10.v.1959; AD, A23961). Westernport Bay, Vic., on *Avicennia*, mid eulittoral (*Womersley*, 10.iv.1959; AD, A22593). Low Head, Tas., on jetty piles, mid eulittoral (*Womersley*, 28.i.1949; AD, A10308). Dover, Tas., on jetty piles (*Wollaston*, 20.viii.1965; AD, A29539). Stewarts Bay, Port Arthur, Tas., upper eulittoral, shaded (*Womersley*, 31.x.1982; AD, A55782). Triabunna, Tas. (*Cribb* 42.3, 18.iii.1950; AD, A16070).

2. **Caloglossa ogasawaraensis** Okamura 1897: 13, figs A–D; 1908: 183, pl. 37 figs 1–11. De Toni 1900: 730. King & Puttock 1994: 107, fig. 3C. Millar & Kraft 1993: 46. Oliveira 1977: 117. Silva *et al.* 1996: 452. Tanaka & Kamiya 1993: 113, figs 1–23. West 1991: 460, figs 4–9. Wynne 1998: 40.

Caloglossa bombayensis Børgesen 1933a: 127, figs 10–12. May 1965: 395.

FIG. 5D–F

Thallus (Fig. 5D) brown-red, forming loose entangled mats 5–10 mm thick, composed of slightly arching, flat, linear branches 100–200 (-300) µm broad, internodes 1–4 mm long between slightly constricted nodes; attached by uniseriate rhizoids from nodal pericentral cells; epiphytic on *Avicennia* pneumatophores or on mud below mangroves. *Structure*. Growth apical, with a dome-shaped apical cell cutting off axial cells and lateral and transverse pericentral cells, the lateral cells each producing 2 flanking cells (Fig. 5E), dividing once more in broader blades giving blades 5–7 (-9) cells broad (Fig. 5F) in the internodes; secondary pit-connections frequent. Blades monostromatic apart from the midrib, ecorticate, margins entire. Branching of blades exogenous near apices, with adventitious proliferous blades (Fig. 5E) arising from nodal pericentral cells.

Reproduction (from Tanaka & Kamiya 1993 - South Australian specimens sterile). Gametophytes dioecious. Carpogonial branches cut off from transverse pericentral (supporting) cells after formation of a sterile cell, with a second sterile cell produced later. Gonimoblast much branched, with a basal fusion cell and chains of ovoid carposporangia. Cystocarps central on branch internodes, sessile, ovoid, with a pericarp 2–4 cells thick. Spermatangial sori produced on both sides of the blades, between the sterile midrib and margin, with spermatangia cut off from initials on the primary cells.

Tetrasporangial sori 6–18 axial cells long, arising from second- and third-order cell rows, 1–4 cells broad on each side of the midrib including the lateral pericentral cells and submarginal cells; tetrasporangia subspherical, 35–50 µm in diameter.

Type from Ogasawara-jima, Bonin Is, Japan (*Yatabe*, March 1879); holotype in TI.

Distribution: SE Asia, W Africa, Brazil, Peru, western Pacific, W subtropical Atlantic, eastern Australia.

In southern Australia, known only from Barker Inlet, Port Adelaide, S. Aust., on *Avicennia* pneumatophores (Brock, 28.i.1982; AD, A52909, 15.vii.1999; AD, A68323 and 26.x.1999; AD, A68391) and Garden I., Port Adelaide, S. Aust., on mud under *Avicennia* (Parsons, 10.iii.1982; AD, A52982) and mid eulittoral on a hulk (Brock, 2.iv.1999; AD, A68077).

The above specimens are sterile but agree well vegetatively with the species. They occurred in an area subject to warmer water from a power station outfall, and may be adventive in this locality.

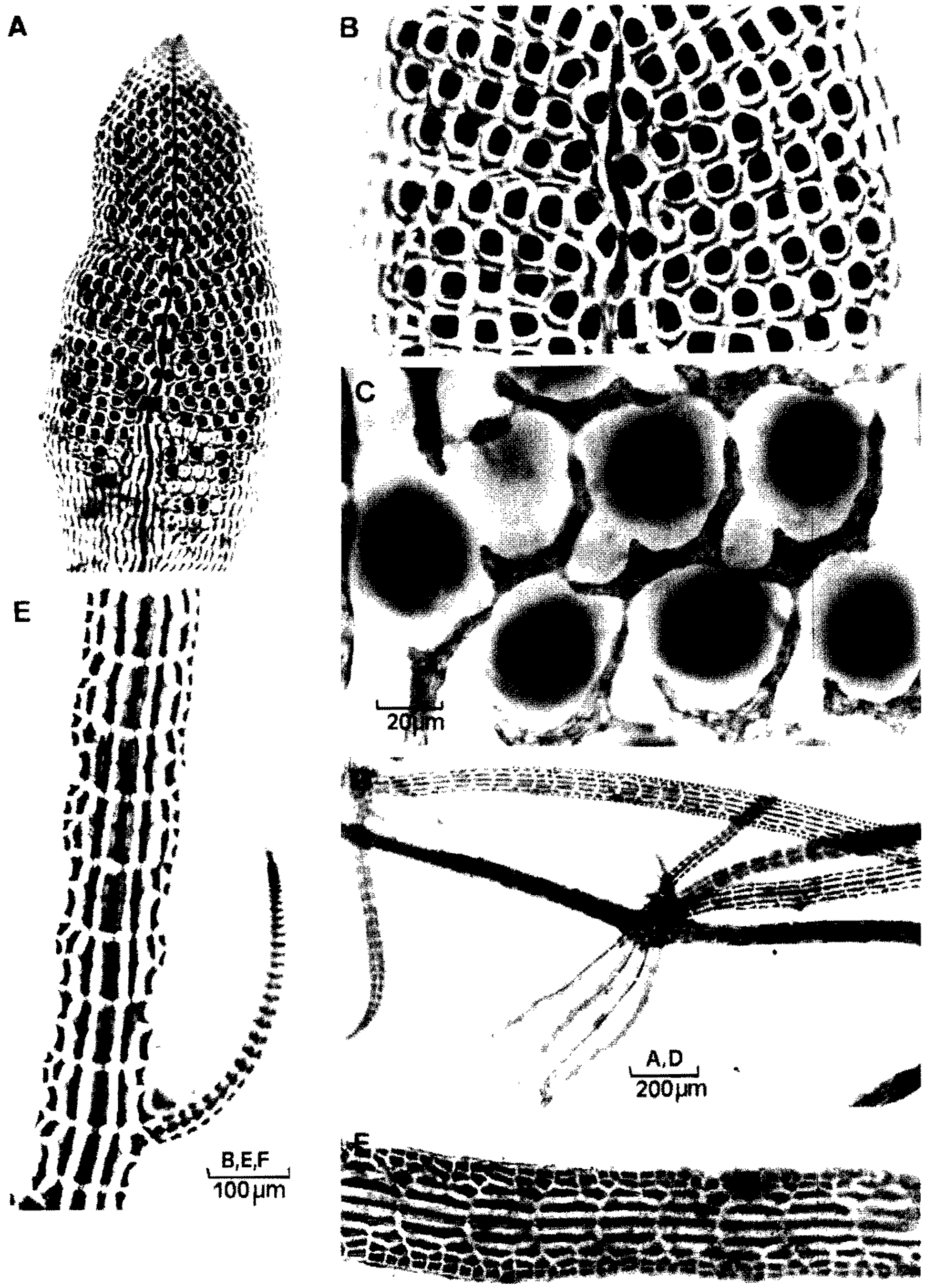

Fig. 5. A–C. *Caloglossa leprieurii* (AD, A61508). **A.** Tetrasporangial sorus. **B.** Tetrasporangia cut off from second-order rows and some from transverse pericentral cells. **C.** Cover cells lying outside the tetrasporangia. **D–F.** *Caloglossa ogasawaraensis* (**D**, **F**, AD, A52909; **E**, AD, A52982). **D.** Thallus with prostrate axis bearing nodal rhizoids and erect branches. **E.** Branch with lateral pericentral and flanking cells and an adventitious lateral branch. **F.** An older branch 9 cells broad.

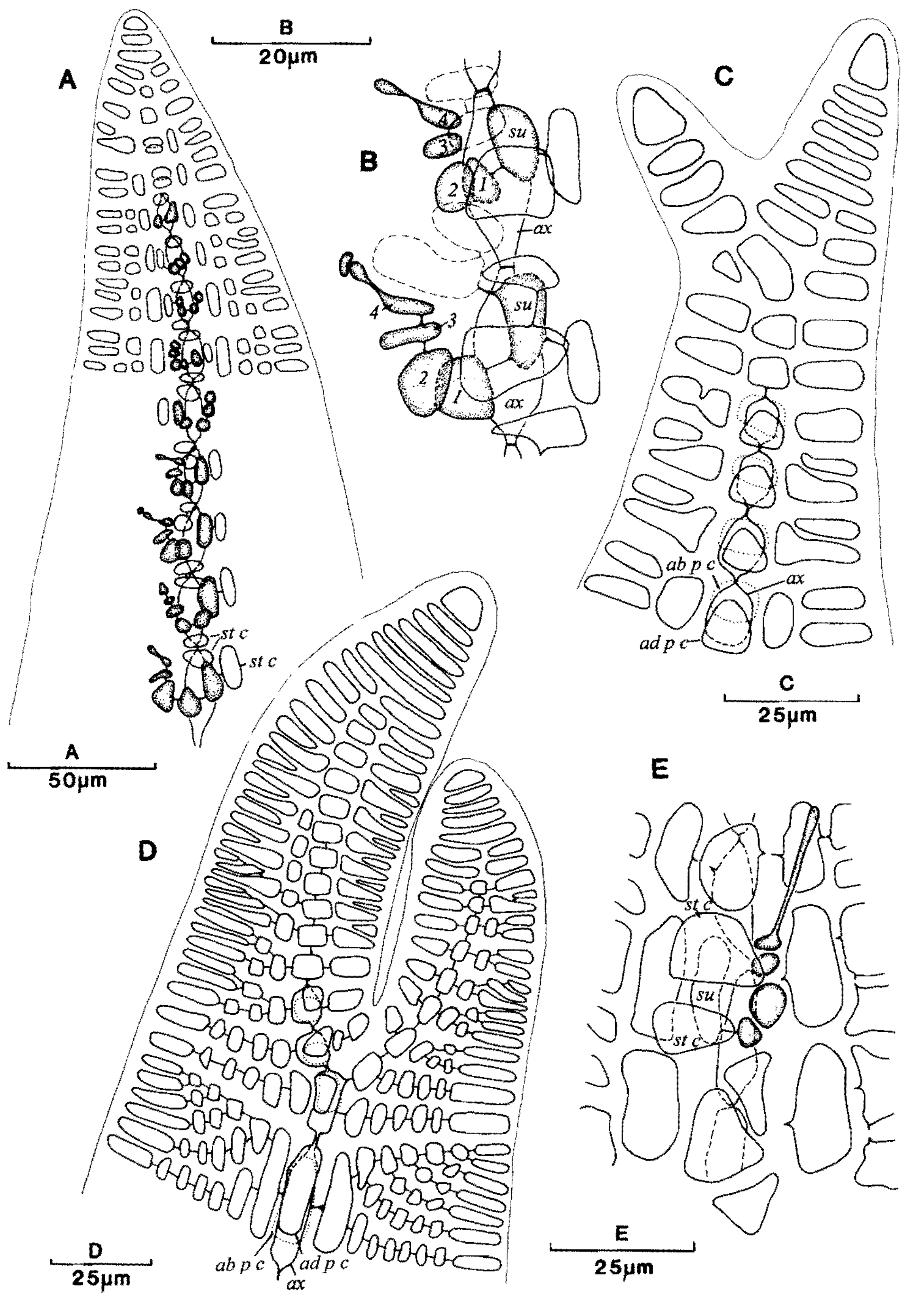

Fig. 6. A, B. *Claudea elegans* (AD, A29501). **A**. Apex of branch with procarps on each segment. **B**. Two procarps. **C, D**. *Caloglossa leprieurii* (AD, A16070). **C**. Apex showing exogenous branching, lateral pericentral cells and later-formed transverse pericentral cells. **D**. Apex of a blade with second- and third-order cell rows. (A–D by Ann Shepley.) **E**. *Apoglossum spathulatum* (AD, A63805). Procarp.

Genus **SYMPODOPHYLLUM** Shepley & Womersley 1960: 386

Thallus erect, with an upright terete axis bearing small, concave, ovate blades apparently sympodially developed and, arranged alternately in 2 ranks; attached by small holdfasts, epiphytic. *Structure*. Apical cell of blades segmenting to give an axial filament with 4 pericentral cells, 2 lateral ones and later 2 transverse ones, with the lateral pericentral cells forming second-order cell rows each cell of which forms third-order rows abaxially, but only the outer few third-order rows reaching the blade margin; end cells of the third-order rows elongate when young, isodiametric on maturity. Cortication of blades with up to 3 layers of cells, cortication of axis by small cells.

Reproduction. Gametophytes unknown.

Tetrasporangial sori on the concave blades, tetrasporangia cut off from second-order row cells in a single layer, covered by a 2–3-celled cortex.

Type (and only) *species*: *S. reinboldii* Shepley & Womersley 1960: 386.

A monospecific genus, apparently very rare and in need of further investigation.

Sympodophyllum reinboldii Shepley & Womersley 1960: 386, pl. 76 figs 1–7. May 1965: 399. Wynne 1996: 181.

FIGS 7, 9C

Thallus (Figs 7A, 9C) to 4 cm high, with an erect axis 0.5–1.5 mm in diameter bearing small, incurved, axis-clasping ovate blades 1.5–3 mm long, arranged alternately in 2 ranks. Attachment by a small holdfast; epiphytic on rhizoids of *Dictyota radicans**. *Structure*. Apex of axes not observed. Blades apparently arising sympodially and endogenously from the midrib of young blades on their adaxial side. Blades concave (Fig. 7B), edges partly inrolled. Apical cells (Fig. 7C) dome-shaped, segmenting to give an axial filament with 2 lateral pericentral cells and soon after 2 transverse pericentral cells, the lateral pericentral cells forming second-order rows (Fig. 7C) with each cell cutting off abaxially a third-order row but only the outer 2 or 3 third-order rows (as well as the second-order rows) reaching the blade margin (Fig. 7D, E); when young, the end cells of third-order rows are elongate but when mature and not dividing they become isodiametric (Fig. 7E); inner blade cells are isodiametric to slightly elongate and 20–30 µm across. In mature blades the cells of second-order rows enlarge and form microscopic lateral veins (Fig. 7B). Cortication of the blades commences early and up to 3 layers of cortex develop on each side. Cortication of the axis also commences early with slender rhizoids, appearing in section as small cells of uniform size surrounding a central core of larger cells. Rhodoplasts discoid.

Reproduction. Gametophytes unknown.

Tetrasporangial sori (Fig. 7F) on blades, with tetrasporangia cut off from cells of second-order rows, forming only a single layer in the thallus, covered by a cortex 1–3 cells thick; tetrasporangia subspherical, 40–60 µm in diameter.

Type from Pondalowie Bay, S. Aust., on *Dictyota radicans*, drift (*Womersley & Wollaston*, 24.iv.1955; AD, A19887).

Known specimens: Only known from the type and Investigator Strait, S. Aust. (*Davey* 272; HBG, fragment AD, A19862).

This distinctive but apparently very rare species has never been found since the 1955 collections. It is highly desirable that the apical development and apparent sympodial nature of the axis should be further investigated.

Genus **DICROGLOSSUM** Millar & Huisman 1996b: 128

Thallus complanately and subdichotomously branched, with a subdichotomous midrib and straight to strongly crisped margins, with proliferous bladelets arising from the midrib. Holdfast

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* As *D. prolifera* Lamouroux in Womersley 1987, p. 190; De Clerk & Coppejans (1996, p. 418) suggest this is a tropical species from northern Australia, and not the same as the southern *D. radicans*

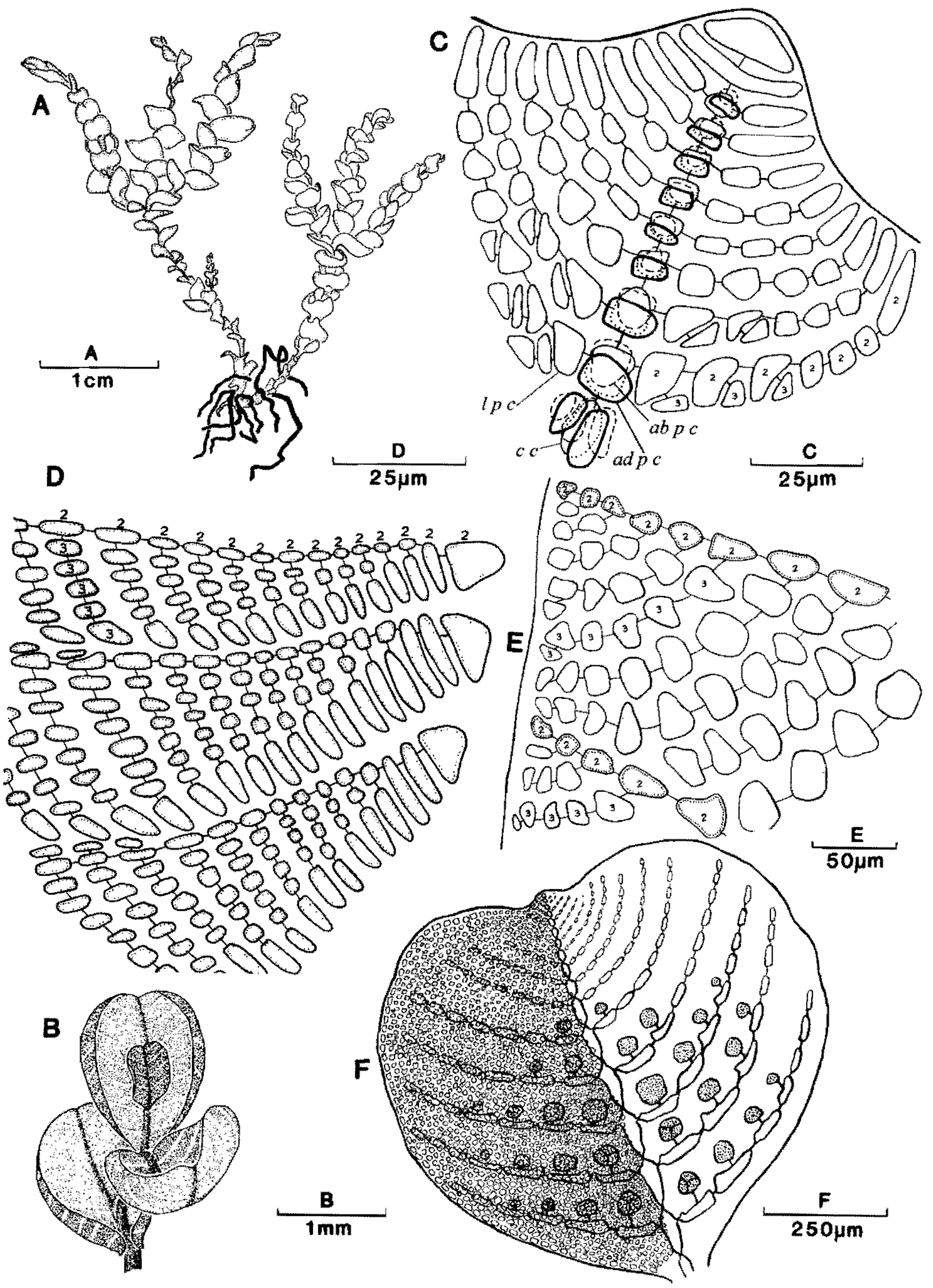

Fig. 7. *Sympodophyllum reinboldii* (AD, A19887). **A**. Habit of plant, on rhizoids (black) of *Dictyota*. **B**. Young leaflets showing midrib and lateral veins. **C**. Apical segmentation with second-order rows producing third-order cells. **D**. Part of a blade with second-order rows producing young third-order rows with elongate apical cells. **E**. Primary cells near the margin of a mature blade showing third-order rows at the surface and abutting second-order rows; cortical layers omitted; in **C**, **D**, and **E**, numbers indicate cells of the second and third order rows. **F**. Tetrasporangial blade, cortication omitted on right side. (As in Shepley & Womersley 1960, courtesy of Nova Hedwigia.)

discoid, usually epiphytic. *Structure.* Apical cells segmenting to an axial filament, and 2 lateral and later 2 transverse pericentral cells, with the lateral pericentral cells forming second-order rows of which some but not all cells form third-order rows, with nearly all rows reaching the blade margins; the subdichotomies arise by continued growth of a third-order row, just below the apex, to form a new apex and blade. Blades monostromatic, but cortication of midribs and adjacent wings of older blades occurs by slender rhizoidal filaments.

Reproduction. Reproductive structures borne mostly on ovate bladelets endogenous and proliferous from central axial cells of the midrib, but also on the subdichotomous blades.

Gametophytes dioecious. Procarps borne on transverse pericentral cells on both sides of blades, with the supporting cell bearing 2 carpogonial branches and one sterile group. Carposporophytes with a basal, branched, fusion cell and short terminal chains of carposporangia. Cystocarps sunken, situated on the midrib of blades, ostiolate with a pericarp 2–3 cells thick. Spermatangial sori on blades or bladelets, on either side of the sterile midrib, with cortical initials cutting off elongate spermatangia.

Tetrasporangial sori mainly on the bladelets, ovate, with 2 layers of tetrasporangia cut off from cortical initials and with outer small cortical cells.

Type (and only) *species*: *D. crispatulum* (Harvey)Millar & Huisman 1996b: 128.

Dicroglossum is characterised by the exogenous marginal and subdichotomous branching of the thallus, plus endogenous production of bladelets which become reproductive, and also by the formation of 2 carpogonial branches on each supporting cell. It was placed in its own tribe (group) by Millar & Huisman. The subdichotomous branching originates by a third-order cell row near the apex developing into a new lateral branch (see Millar & Huisman 1996, fig. 12).

Dicroglossum crispatulum (Harvey)Millar & Huisman 1996b: 128, figs 1–34. Silva *et al.* 1996: 455.

Delesseria crispatula Harvey 1855a: 548; 1863: pl. 268, synop.: xxxi. J. Agardh 1876: 495. Sonder 1880: 24.

Membranoptera crispatula (Harvey)Kuntze 1891: 904.

Hydrolapatha crispatula (Harvey)Kuntze 1898: 410.

Hypoglossum crispatulum (Harvey)J. Agardh 1898: 185. De Toni 1900: 688. Lucas 1909: 36.

Branchioglossum crispatulum (Harvey)Kylin 1924: 8, fig. 2b; 1956: 432. Ducker *et al.* 1977: 87. May 1965: 401. Millar & Wynne 1992b: 237. Wagner 1954: 283. Wynne 1989a: 517.

FIGS 8, 9A, B

Thallus (Fig. 8A) erect, medium red, 2–4 cm high, complanately branched with subdichotomous branches 1–3 (-5) mm broad, margins straight to strongly crispate (Fig. 8C), with a central midrib (no microscopical veins), blades monostromatic. Holdfast small, discoid, stoloniferous; usually epiphytic (on *Amphibolis* and various algae). *Structure.* Apical cell (Fig. 8B) transversely ovoid to obpyriform, segmenting to give axial cells and lateral pericentral cells which produce second-order rows, with only some cells producing third-order rows (Fig. 8B); most (but not all) rows reach the blade margin; the transverse pericentral cells remain undivided. Branching at the apex is exogenous (or marginal) with a lateral pericentral cell forming a third-order row which develops as a new apex, thus forming a subdichotomy which is shown by branching of the midrib in lower parts (Fig. 8C, D). Cortication of the midrib occurs by slender rhizoidal filaments, spreading to the adjacent wings on older thalli. Cells probably multinucleate; rhodoplasts discoid.

Reproduction. Reproductive structures (see also Millar & Huisman 1996) are borne both on the blades and on small determinate bladelets arising from the central axial cells (Fig. 9A).

Gametophytes dioecious. Procarps occur on the transverse pericentral cells on both sides of the blades, in series on consecutive segments, each with two 4-celled carpogonial branches and one sterile group. Carposporophyte with a branched basal fusion cell and short terminal chains of subspherical to ovoid carposporangia 12–25 µm in diameter. Cystocarps (Fig. 8E) sunken within the blades, ostiolate; pericarp 3–4 cells thick. Spermatangial sori (Fig. 8F) on both sides of the blades and the midrib, elongate, with the primary cells cutting off initials which each produce several anticlinally elongate spermatangia.

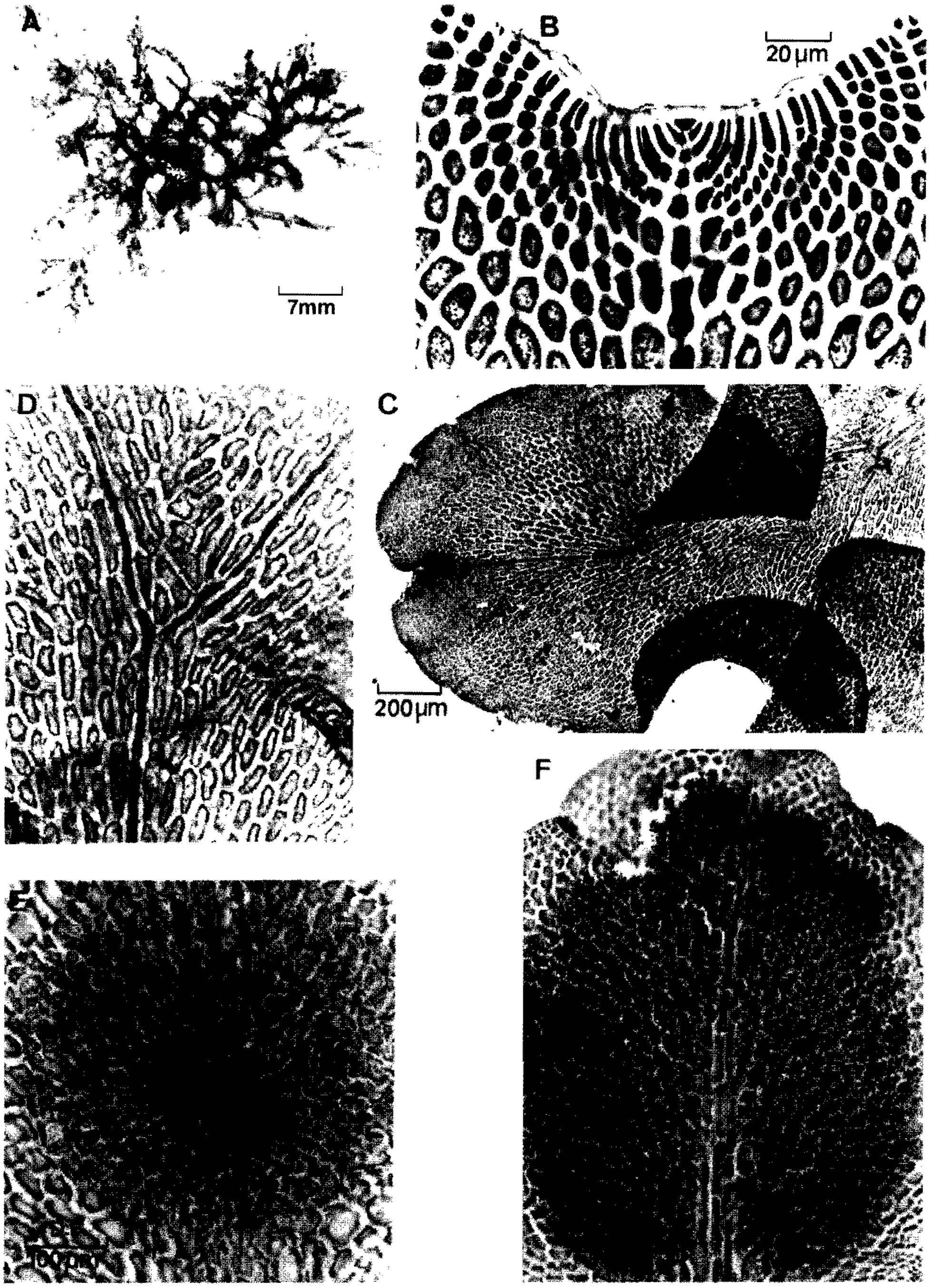

Fig. 8. *Dicroglossum crispatulum* (**A**, AD, A19285; **B–D**, AD, A50526; **E**, **F**, AD, A10718). **A**. Habit. **B**. Apex of blade showing segmentation. **C**. Upper blade showing crispate margins and axis subdichotomy. **D**. Subdichotomy of axial filament. **E**. Young cystocarp on the midrib. **F**. Blade with spermatangial sori.

Tetrasporangial sori (Fig. 9A, B) produced mostly on determinate bladelets from the midrib, the sorus covering the central blade but with a sterile margin; tetrasporangia cut off from cortical cells arising from the primary cells, in 2 layers in cross section, covered by smaller outer cortical cells, subspherical, 35–50 µm in diameter.

Type from Fremantle, W. Aust., (*Clifton*); holotype (Trav. Set 129) in Herb. Harvey, TCD.

Distribution: Fremantle, W. Aust., to Vivonne Bay, Kangaroo I., S. Australia.

Selected specimens: Penguin I., Safety Bay, W. Aust., on *Ptilophora prolifera*, *Amphiroa* and *Rhodopeltis*, 12 m deep (*Millar & Huisman*, 9.ii.1994; NSW, 293016–293030). Cape Leeuwin, W. Aust. on *Amphibolis*, drift (*Kraft*, 12.xii.1971; MELU and AD, A50526). 16 km E of Eucla, S. Aust., drift (*Womersley*, 3.ii.1954; AD, A19285). Vivonne Bay, Kangaroo I., S. Aust., epiphytic, drift (*Womersley*, 2.i.1949; AD, A10718).

Genus **HEMINEURA** Harvey 1849a: 116, pl. 45

Thallus erect, largely complanately branched with elongate flat axes bearing numerous short, flat, marginal proliferations, the main blades and marginal proliferations with a midrib but not connecting between them. Holdfast discoid to fibrous. *Structure*. Apical cells segmenting to form axes with each cell cutting off 2 lateral and then 2 transverse pericentral cells, the lateral cells forming second-order rows with occasional cells cutting off third-order cells or short rows; transverse intercalary divisions occur in cells of second- and third-order rows, and only the second-order rows and outermost third-order rows reach the blade margins, with the surface cell arrangement within the blade becoming irregular. Lateral blades arise marginally and exogenously from end cells of slight dentations, which divide as in main axes and develop a midrib which is then separated from the midrib of the parent blade by the wings of the latter. Cortication of the midrib occurs and a cortical layer (becoming 2 cells thick) of small cells covers each side of the blade wings, the transverse section showing dimidiate, regularly arranged, cells.

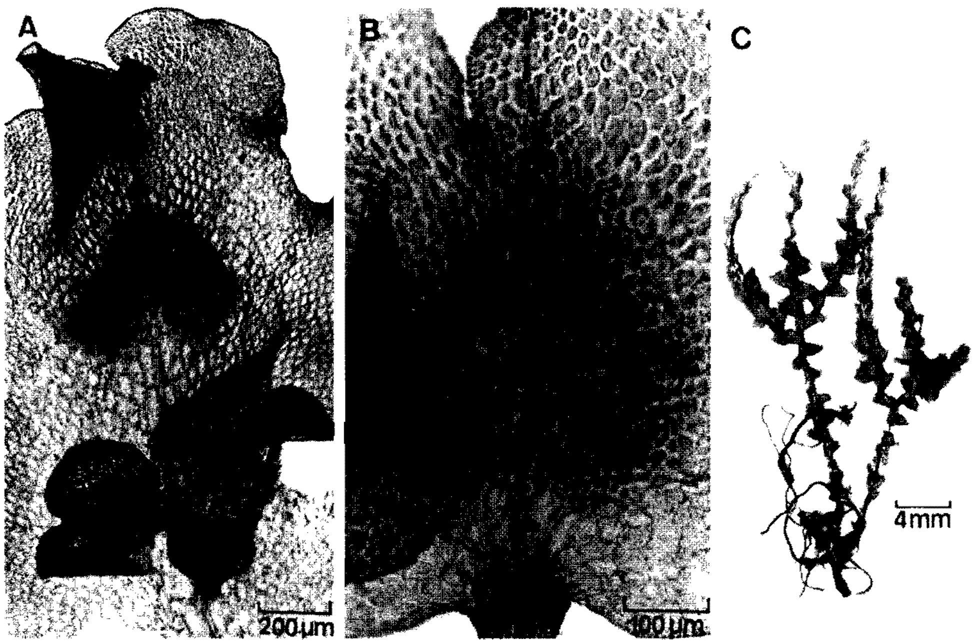

Fig. 9. A, B. *Dicroglossum crispatulum* (AD, A19285). **A.** Blade with crispate margins, proliferations from midrib, and a tetrasporangial sorus. **B.** Tetrasporangial sorus. **C.** *Sympodophyllum reinboldii* (AD, A19887). Habit.

Reproduction. Gametophytes dioecious. Procarps in series below apices, on transverse pericentral (supporting) cells on both sides of young blades, with each supporting cell cutting off 2 sterile cells and two 4-celled carpogonial branches. Carposporophyte with a basal branched fusion cell, much branched gonimoblast and short terminal rows of carposporangia maturing sequentially. Cystocarps single on the midrib, hemispherical, ostiolate, with a pericarp several cells thick. Spermatangial sori scattered on the blades, small to extensive, with spermatangia cut off from cortical initials.

Tetrasporangial sori scattered to extensive and linear between midrib and margins, with 2 irregular layers of tetrasporangia of varying ages, cut off from cortical cells and with an overlying cortex of small cells.

Type species: *H. frondosa* (Hooker & Harvey)Harvey 1849a: 116.

Hemineura was established by Harvey in 1849, having been suggested by Hooker & Harvey in 1847 in describing the species.

Hemineura is a distinctive genus, characterised by its habit with marginal exogenous branching when outer cells of small dentations develop further as apical cells of lobes, cutting off axial and pericentral cells, and thus resulting in a region of wing cells of the parent blade lying between the midrib of the latter and the midrib of the new marginal blade. The presence of 2 carpogonial branches and 2 sterile groups on each supporting cell, as well as the presence of only few third-order cells or rows and the irregular surface cell arrangement of the blades are also distinctive. Some of these features occur also in *Dicroglossum crispatulum*, which differs in habit, midrib arrangement and origin of laterals.

H. frondosa is probably the only species of *Hemineura*. *H. schmitziana* De Toni & Okamura has been placed by Yoshida (1974) in *Marionella*, and *H. hassleri* Taylor in a new genus *Austrofolium* by Wynne (1988), which includes also *H.? howellii* Taylor. *Hemineura* has been placed in a separate tribe, the Hemineureae, by Lin *et al.* (2001).

Hemineura frondosa (Hooker & Harvey)Harvey 1849a: 116, pl. 45. J.Agardh 1898: 180. De Toni 1900: 719. Fuhrer *et al.* 1981: pl. 32. Guiler 1952: 101. Huisman 1997: 201; 2000: 148. Huisman & Walker 1990: 429. Kylin 1924: 6, fig. 1; 1956: 434. Lin *et al.* 1997: 64; 2001: 135, figs 1–37. Lucas 1909: 37; 1929a: 20; 1929b: 50. Lucas & Perrin 1947: 232, fig. 95. May 1965: 400. Schmitz & Hauptfleisch 1897: 412. Shepherd & Womersley 1970: 135; 1981: 366. Silva *et al.* 1996: 456. Sonder 1853: 691. Womersley 1950: 183. Wynne 1985a: 77; 1996: 179.

Delesseria (*Hemineura*) *frondosa* Hooker & Harvey 1847: 403. J. Agardh 1852: 689; 1876: 485; 1879: 187, pl. 26 figs 18, 19; 1898: 180. Harvey 1859b: 312; 1860: pl. 179; 1863, synop.: xxxi. Reinbold 1897: 14. Sonder 1880: 24. Tate 1882a: 20. Tisdall 1898: 509. Wilson 1892: 174.

Hypoglossum frondosum (Hooker & Harvey)Kützing 1849: 876.

Hemineura crispata Harvey 1855a: 549. Silva *et al.* 1996: 456.

Hemineura wilsonis J. Agardh 1898: 180. De Toni 1900: 720. Guiler 1952: 101. Kylin 1924: 6. Lucas 1909: 37; 1929a: 20. May 1965: 400.

FIGS 10, 11

Thallus (Fig. 10A, B) medium red to red-brown, 5–40 cm high, complanate, usually irregularly branched with elongate axes and main branches 0.5–2 cm broad bearing marginal proliferations, sometimes foliose and 4–10 cm broad with crispate margins; marginal proliferations elongate-ovate to lanceolate, 5–10 (-20) mm long and usually 2–4 mm broad. Midrib present in all blades, not extending to that in the parent blade, becoming corticated; wings 120–250 µm thick, present to near base of the thallus, lost from a short stipe. Holdfast discoid to lacerate and fibrous, 1–5 (-20) mm across; epilithic or occasionally epiphytic or epizoic. *Structure*. Apical cells (Fig. 10D) broadly obconical, segmenting to axial cells each with 2 lateral pericentral cells and later 2 transverse ones, the lateral pericentral cells forming second-order rows with only occasional cells forming third-order cells or short rows; transverse intercalary divisions occur in second- and third-order rows, with only the second-order rows and outermost third-order cells reaching the blade margin; the surface cell arrangement of the blade becomes irregular (Fig. 10C). The blade margin has some cells projecting as slight dentations and dividing (Fig. 10C), some of which recommence growth to form new marginal exogenous blades with apical cells dividing as in the main blades, but

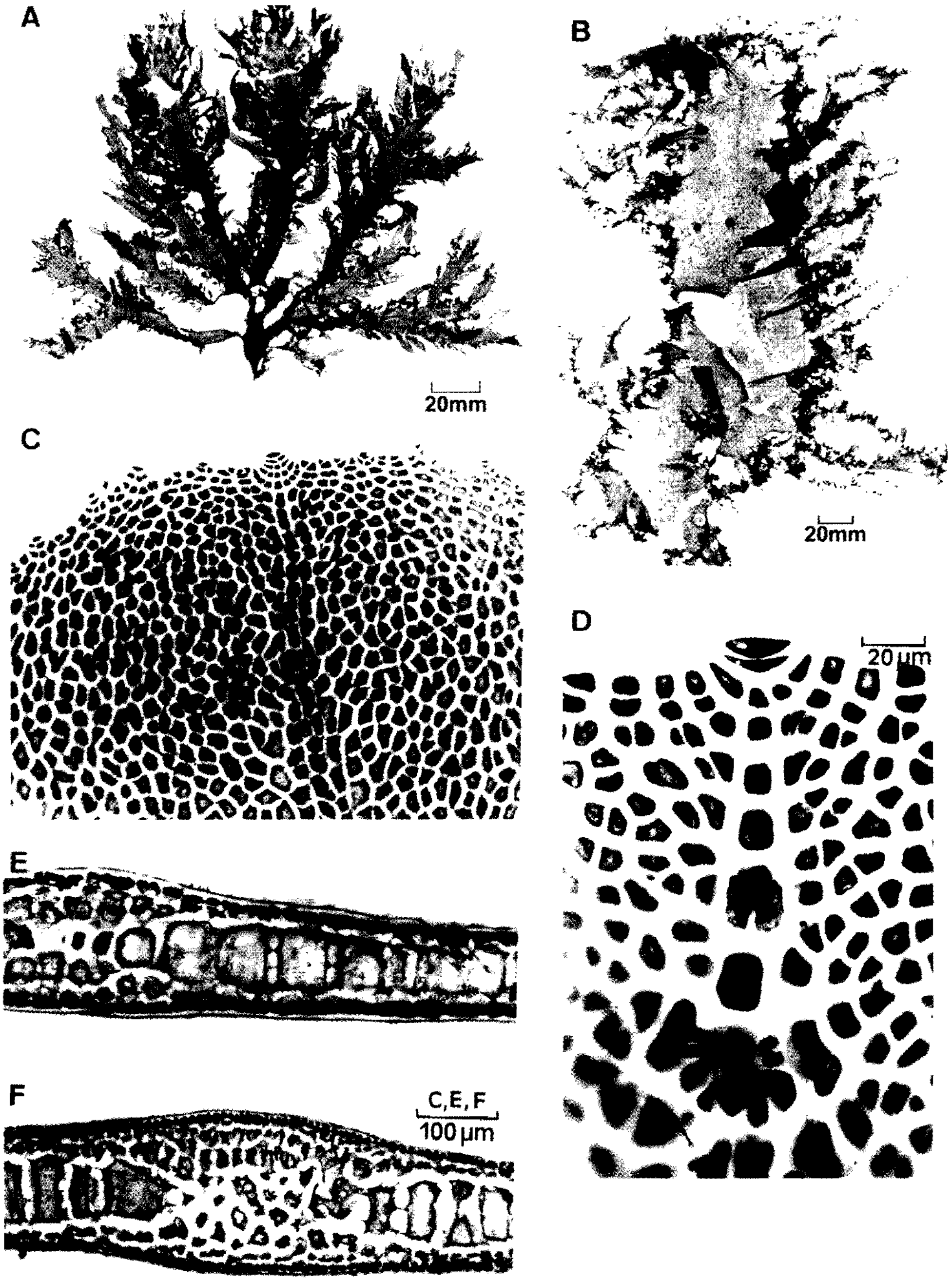

Fig. 10. *Hemineura frondosa* (**A**, AD, A35634; **B**, AD, A41637; **C**, **D**, AD, A67115; **E**, **F**, AD, A64262). **A**. Habit of typical plant. **B**. Habit of very broad plant. **C**. Apex of blade. **D**. Apex of blade showing segmentation and carpogonial branches. **E**. Transverse section of young blade. **F**. Transverse section of older blade.

without the new midrib connecting back to that in the parent blade (Fig. 11F). Cortication occurs first over the midrib from the transverse pericentral cells, and the cells of the wings cut off a layer of smaller cortical cells on both sides; in older parts the cortex becomes 2 cells thick and 3–4 cells thick over the midrib; transverse sections (Fig. 10E, F) show a regular arrangement of a central layer of large, shortly obloid cells 60–120 (-150) µm across and cortical layers of small, dimidiate, cells 20–35 µm across. Mature cells multinucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps (Fig. 11A) developed in series from transverse pericentral cells on both sides of the blades, with each supporting cell forming 2 sterile cells (groups) and two 4-celled carpogonial branches. Carposporophytes (Fig. 11C) with an elaborate, branched, fusion cell, much branched gonimoblast and short terminal rows of clavate to ovoid carposporangia 35–50 µm in diameter, maturing sequentially. Cystocarps (Fig. 11B) situated on the midrib, single, hemispherical, 0.8–2 mm across, ostiolate, with a beaked pericarp 4–8 cells thick. Spermatangia in small to extensive sori (Fig. 11D) on both sides of the wings, forming rounded to elongate-oblong patches, with spermatangia cut off from cortical initials.

Tetrasporangial sori (Fig. 11E, F) scattered, becoming extensive between the midrib and margins, 250–300 µm thick, with tetrasporangia in 2 irregular layers (Fig. 11G) of mixed ages, cut off mainly from inner cortical cells, with an overlying cortex of small cells; tetrasporangia subspherical, 40–90 µm in diameter.

Type from Tasmania (*Gunn*); lectotype in BM.

Distribution: Houtman Abrolhos, W. Aust., to Gabo I., Vic., and around Tasmania.

Selected specimens: White I., Houtman Abrolhos, W. Aust., 7–19 m deep (*Kraft, Saunders & Strachan*, 10.xi.1995; MELU, K10798; AD, A67978). Point Peron, W. Aust., drift (*Parsons*, 15.xi.1968; AD, A34292). Elliston, S. Aust., 7 m deep (*Shepherd*, 21.x.1970; AD, A37570). Price I., Point Avoid, S. Aust., 21 m deep (*Branden*, 6.i.1989; AD, A59973). Toad Head, West I., S. Aust., 22–26 m deep (*Shepherd*, 15.i.1966; AD, A30145). Middleton, S. Aust., drift (*Womersley*, 14.xi.1965; AD, A29690). Vivonne Bay, Kangaroo I., S. Aust., drift (*Womersley*, 24.i.1946; AD, A3313). Robe, S. Aust., drift (*Womersley*, 15.iv.1994; AD, A63547). Stinky Bay, Nora Creina, S. Aust., drift (*Womersley*, 26.x.1996; AD, A67115). Blackfellows Caves, SE S. Aust., drift (*Hotchkiss*, 3.xi.1997; AD, A67613). Cape Northumberland, S. Aust., shaded lower eulittoral depressions (*Womersley & Ricci*, 1.xi.1993; AD, A63257). "The Fort", S Channel, Port Phillip, Vic., 12 m deep (*Battershill*, 9.ii.1990; AD, A60144). Crawfish Rock, Westernport Bay, Vic., 5–10 m deep (*Watson*, 10.xi.1968; AD, A33056). Walkerville, Vic., drift (*Sinkora* A2115, 28.ii.1975; AD, A48416). Gabo I., Vic., 26 m deep (*Millar & O'Brien*, 4.xii.1996; NSW, 438978). Low Head, Tas. (*Perrin*, 8.x.1950; AD, A49593). Sarah I., Bathurst Ch., SW Tas., 2–5 m deep (*Edgar*, 11.iii.1995; AD, A64262). Two Mile Creek, St Patricks Head, E Tas., 6 m deep (AIMS-NCI, Q66C 3717-H, 26.ii.1990; AD, A60386). Marion Bay, Tas., 6 m deep (*Shepherd*, 13.ii.1970; AD, A35634). Surveyors Cove, Port Arthur, Tas., 13–19 m deep (*McGeary-Brown*, 29.x.1986; AD, A57421). Arch Rock, Ninepin Point, Tas., 5–12 m deep (*Sanderson*, 21.x.1994; AD, A63879). Taroona, Tas., 0–10 m deep (*Shepherd*, 4.ii.1970; AD, A35575). Fluted Cape, Bruny I., Tas., 7–10 m deep (*Shepherd*, 10.ii.1972; AD, A41461) and 1–10 m deep (*Andrews*, 21.x.1994; AD, A63903). Satellite I., D'Entrecasteaux Ch., Tas., 12 m deep (*Shepherd*, 17.ii.1972; AD, A41637).

Hemineura frondosa is highly variable in habit, especially in width of the main frond and laterals, and coarseness of the midrib.

Hemineura crispata Harvey (lectotype from Rottnest I., W. Aust., in Trav. Set 312, Herb. Harvey, TCD) is based on small and young specimens of *H. frondosa*, whereas *H. wilsonis* J. Agardh (lectotype in Herb. Agardh, LD, 31427) from Port Phillip Heads, Vic., is based on older specimens of *H. frondosa*.

Genus APOGLOSSUM J. Agardh 1898: 190

Thallus erect, much branched endogenously from the axial cells of the midrib, blades monostromatic apart from the corticated midrib, with lateral microscopic veins; holdfast discoid or stoloniferous. *Structure.* Apical cell segmenting to give first 2 lateral (later 2 transverse) pericentral cells with the second-order row producing third-order rows abaxially from each cell, with intercalary cells cutting off laterally short rows of fourth-order cells which are arranged irregularly in the monostromatic wings. Second- and outer third-order rows

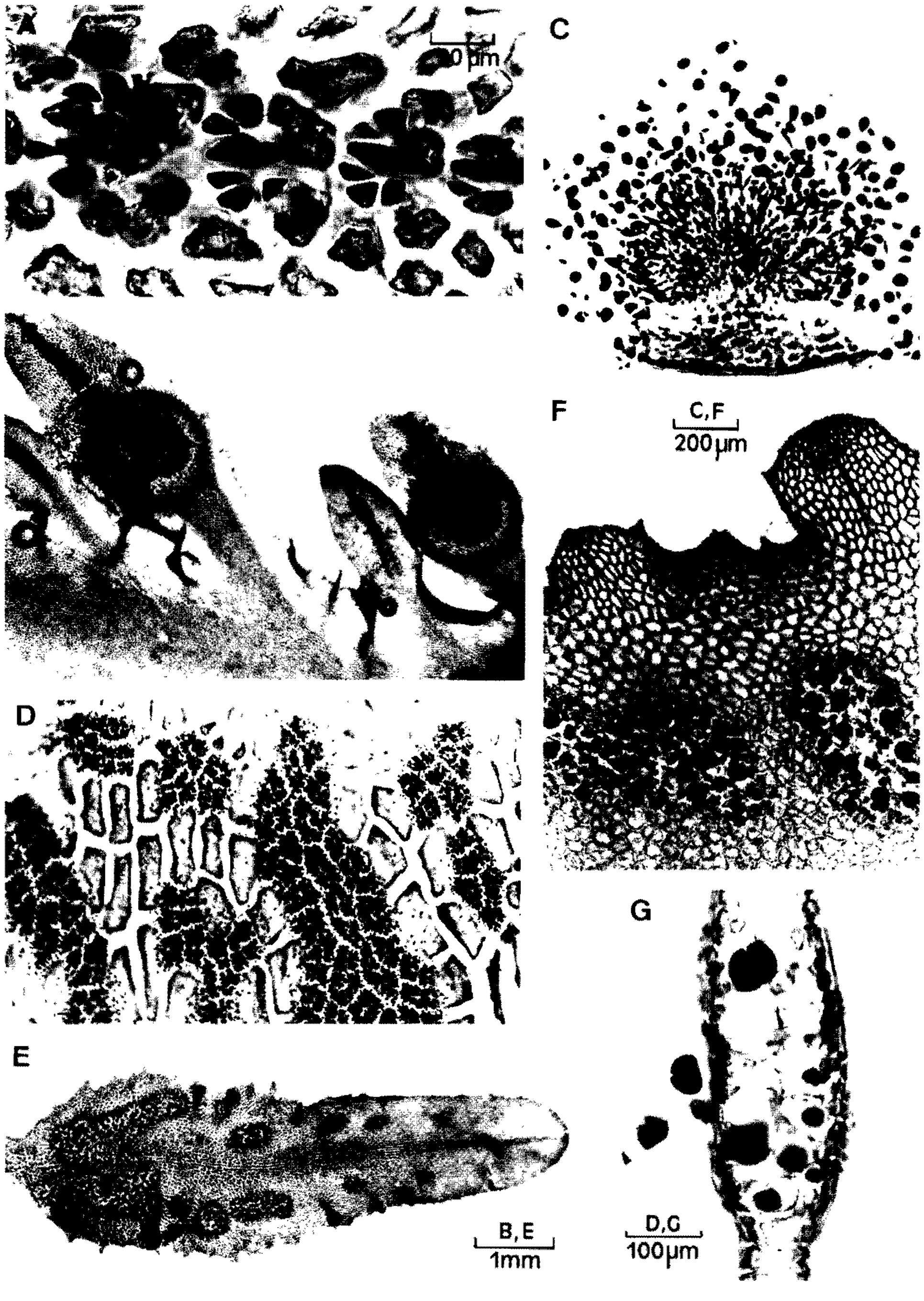

Fig. 11. *Hemineura frondosa* (**A**, AD, A35575; **B**, **C**, AD, A60386; **D**, AD, A63903; **E**, AD, A67613; **F**, **G**, AD, A60144). **A**. Twin carpogonial branches on successive axial segments. **B**. Cystocarps. **C**. Carposporophyte. **D**. Spermatangial sori. **E**. Blade with tetrasporangial sori. **F**. Tetrasporangial sori, lobes with midribs. **G**. Transverse section of tetrasporangial sorus.

only reaching the blade margin, with second-order cells (sometimes third-order cells) enlarging and the rows forming the microscopic lateral veins. Cortication of the midrib by cells cut off the transverse pericentral cells, later from the lateral pericentral cells, forming descending rhizoids, with the axial and pericentral cells remaining clear in transverse section of older midribs.

Reproduction. Gametophytes dioecious. Procarps developed on transverse pericentral cells on both sides of bladelets, with 2 sterile cells and a 4-celled carpogonial branch. Carposporophytes with a basal fusion cell, much branched gonimoblast, and terminal carposporangia that mature sequentially. Cystocarps ovoid to hemispherical, ostiolate, with or without a neck, pericarp 3–5 cells thick. Spermatangial sori on both sides of bladelets, with or without a sterile midrib, in striae between the lateral veins or spreading over the bladelet, with the primary cells cutting off initials with outer spermatangia.

Tetrasporangial sori on both sides of bladelets, with or without a sterile midrib, with tetrasporangia cut off from second- and third-order cells and later from inner cortical cells, with a cortex 2 cells thick.

Lectotype species: *A. ruscifolium* (Turner)J. Agardh 1898: 190. See Kylin 1923: p. 83, figs 53–60; Maggs & Hommersand 1993: 203, fig. 65.

A genus of some 7 species, the type, *A. spathulatum* (Sonder)Womersley & Shepley from southern Australia, *A. unguiculescens* Millar (1990, p. 425, fig. 51E–H) from N.S.W., *A. minimum* Yamada (1944, p. 13) from Japan, *A. gregarium* (Dawson)Wynne (1985b, p. 169) from the Gulf of California, southern California and the Hawaiian Is, and *A. montagneanum* (J. Agardh)J. Agardh and *A. oppositifolium* (Harvey)J. Agardh from New Zealand (see Adams 1994, p. 280).

Apoglossum spathulatum (Sonder)Womersley & Shepley 1982: 329. Huisman & Walker 1990: 429. Millar & Kraft 1993: 45. Silva *et al.* 1996: 447. Wynne 1984a: 141, figs 16–26.

Delesseria spathulata Sonder 1845: 57; 1848: 194; 1881: 105. J. Agardh 1852: 698; 1872: 58. Harvey 1855a: 548; 1863, synop.: xxxi. Kützing 1869: 5, pl. 12c–e.

Hypoglossum spathulatum (Sonder)Kützing 1849: 877.

Delesseria tasmanica Mueller *ex* Harvey 1859b: 311, pl. 190B; 1863, synop.: xxxi. J. Agardh 1872: 58; 1876: 494. Kützing 1869: 4, pl. 11a, b. Reinbold 1897: 14. Sonder 1880: 24. Tisdall 1898: 509.

Apoglossum tasmanicum (Mueller)J. Agardh 1898: 194. De Toni 1900: 702. Guiler 1952: 100. Kylin 1924: 23. Lucas 1909: 37; 1929a: 20; 1929b: 50. Lucas & Perrin 1947: 231, fig. 94. May 1965: 399. Shepherd & Womersley 1976: 190; 1981: 366. Womersley 1950: 183.

Delesseria ruscifolia (Turner)Lamouroux *sensu* Harvey 1849a: 115 (Tasmanian record); 1863, synop.: xxxi. Sonder 1880: 24.

Apoglossum ruscifolium (Turner)J. Agardh *sensu* Guiler 1952: 100. Lucas 1909: 37; 1929a: 20. May 1965: 399.

FIGS 6E, 12, 13

Thallus (Fig. 12A) medium to dark red, (2-) 4–14 cm high, much branched from the midrib with irregular rows of monostromatic (apart from the midrib) blades or bladelets on both sides, blades flat, mostly 1–5 cm long and 2–7 mm broad, with distinct lateral microscopic veins; bladelets ovate, 2–4 mm broad, margins straight to somewhat crispate; all branches with a midrib, becoming corticated and on older axes denuded of the wings leaving more-or-less terete stipes 0.5–1.5 mm in diameter. Holdfast small, discoid; epilithic or epiphytic (on *Amphibolis* or various algae). *Structure.* Apical cell (Fig. 12B) obconical, segmenting to give an axial filament with first 2 lateral and later 2 transverse pericentral cells; the lateral pericentral cells (not dividing transversely) form second-order rows with each cell forming an abaxial third-order row but only the second-order and outer third-order rows reaching the blade margins; many intercalary third-order cells divide laterally to form short fourth-order (or later) rows which lie between the other rows in an irregular arrangement (Fig. 12B). Cells of the second-order rows enlarge to form the lateral microscopic veins (Fig. 13A–D), the cells becoming 8–15 µm in diameter and 20–100 µm long, with each cell corresponding to 3–9 of the adjacent rounded cells; in larger blades, some third-order rows also become veins; wing cells adjacent to the midrib often enlarged. Cortication of the midrib commences a few

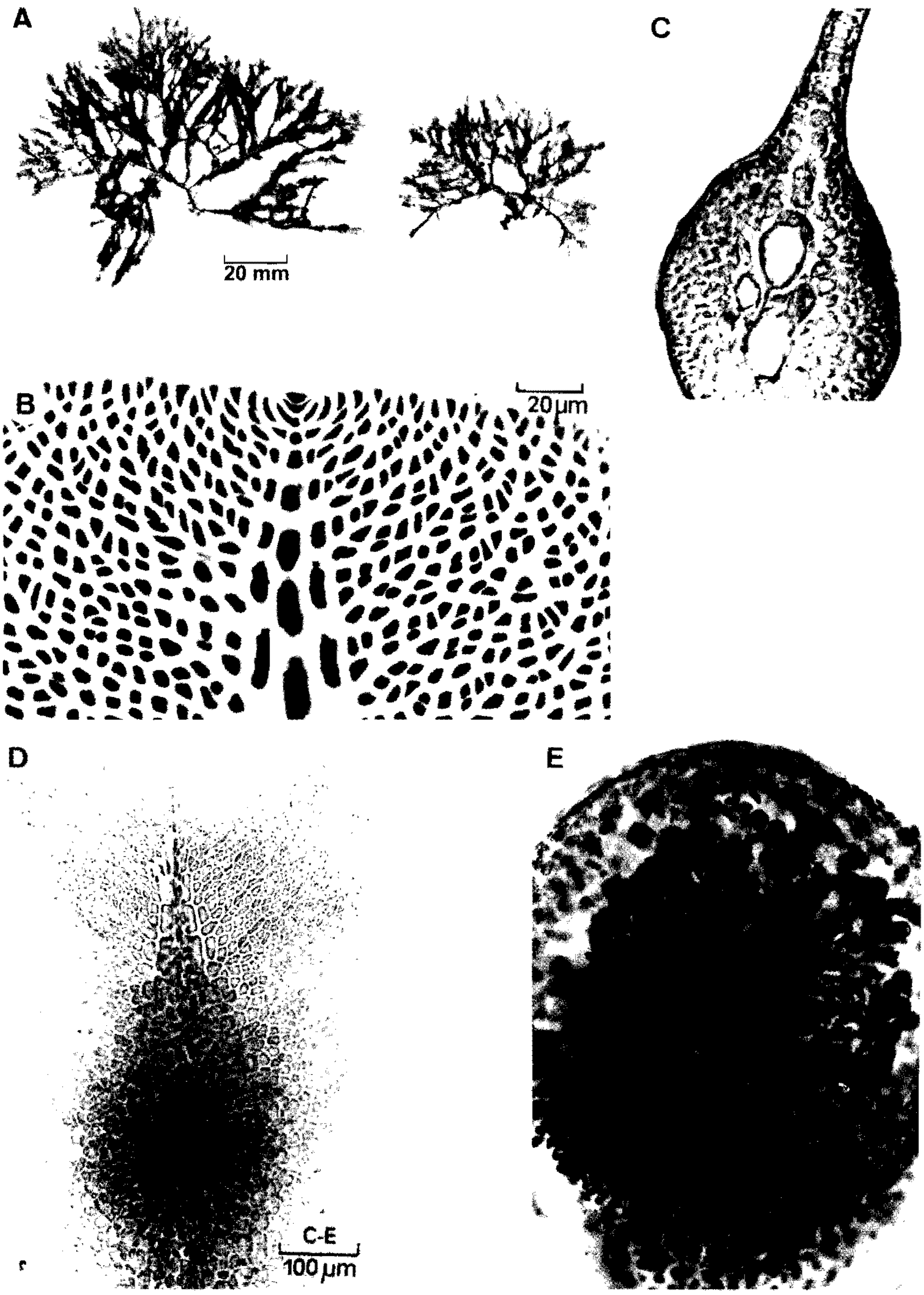

Fig. 12. *Apoglossum spathulatum* (**A**, AD, A50909; **B**, AD, A43375; **C**, AD, A35187; **D**, AD, A50324; **E**, AD, A60489). **A**. Habit. **B**. Blade apex showing segmentation. **C**. Transverse section of midrib of blade showing enlarged pericentral cells. **D**. Apex with young cystocarp, pericentral cells darkly staining. **E**. Cystocarp with carposporophyte and carposporangia.

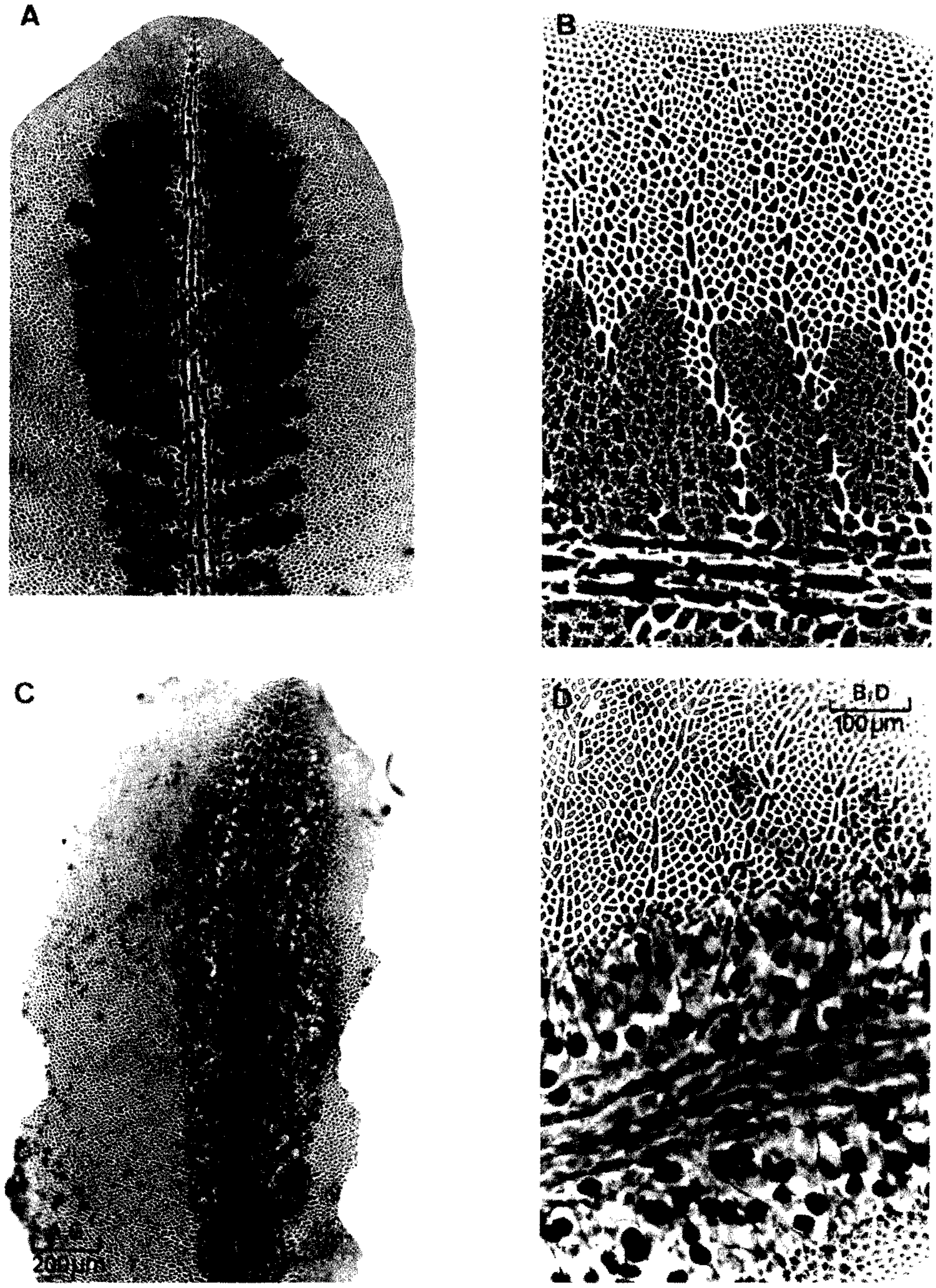

Fig. 13. *Apoglossum spathulatum* (**A**, **B**, AD, A43375; **C**, **D**, AD, A60489). **A**. Blade with spermatangial sori. **B**. Spermatangial sori between lateral veins. **C**. Blade with tetrasporangial sorus. **D**. Sorus with tetrasporangia cut off from inner cells of second- and third-order rows.

segments from the apices, by cells cut off from the transverse and later the lateral pericentral cells, covering the midrib but with the pericentral cells conspicuous in transverse sections (Fig. 12C). Branching is endogenous from axial cells of the midrib, at irregular intervals. Mature cells multinucleate; rhodoplasts discoid to elongate.

Reproduction. All reproductive organs borne on the ovate bladelets. Gametophytes dioecious. Procarps (Fig. 6E) borne on the transverse pericentral cells, in series but on alternate pericentral cells on each side of the bladelet, with 2 sterile cells and a 4-celled carpogonial branch, the third cell distinctly larger than the other 3. Post-fertilization the adjacent axial and lateral pericentral cells become darkly-staining (Fig. 12D), the carposporophytes (Fig. 12E) having a basal fusion cell, much branched gonimoblast and clavate to ovoid terminal carposporangia 20–25 µm in diameter, maturing sequentially from lower cells. Cystocarps sessile, broad based and hemispherical, 700–1200 µm in diameter, with an ostiolate pericarp developed from 10–14 erect filaments and becoming 3–4 cells thick. Spermatangial sori (Fig. 13A, B) on both sides of bladelets, usually with a sterile midrib and outer wings, sometimes in patches separated by the lateral veins; each primary cell cutting off several initials which develop outer spermatangia.

Tetrasporangial bladelets (Fig. 13C) usually with a sterile midrib and outer margin, the tetrasporangia cut off from inner cells of second and third-order rows (Fig. 13D) but lying to either side of the blade, later also from inner cortical cells, with a continuous cortical layer 1–2 cells thick covering the sorus which contains tetrasporangia of different ages; tetrasporangia subspherical, 25–50 µm in diameter.

Type from Georgetown, Tas. (*Harvey*); lectotype (Alg. Aust. Exsicc. 272 I), in Herb. Harvey, TCD.

Distribution: Rottnest I., W. Aust., to Gabo I., Vic., and around Tasmania; Lord Howe I. (Millar & Kraft 1993, p. 45).

India, Indonesia, South Africa (see Wynne 1984a, pp. 141, 144 and Silva *et al.* 1996, p. 447).

Selected specimens: Hillarys Boat Harbour, Sorrento, W. Aust., 9 m deep (AIMS-NCI, Q66C 2623-R, 12.iii.1989; AD, A59624). Twin Rocks, Head of Great Australian Bight, S. Aust., 20–22 m deep (*Branden*, 19.i.1991; AD, A61130). Pearson I., S. Aust., 20–23 m deep (*Shepherd & Turner*, 29.iii.1982; AD, A53032). Ward I., S. Aust., 18–23 m deep (*Shepherd*, 3.iii.1980; AD, A50909). Elliston, S. Aust., 10–12 m deep in bay (*Shepherd*, 24.x.1969; AD, A34946). Investigator Strait, S. Aust., 35 m deep (*Watson*, 14.i.1971; AD, A38208). Toad Head, West I., S. Aust., 23–27 m deep (*Shepherd*, 15.i.1966; AD, A30153). Vivonne Bay, Kangaroo I., S. Aust., in shaded pool, S side Ellen Point (*Womersley*, 29.viii.1950; AD, A15455). Robe, S. Aust., 1–2 m deep near jetty (*Mitchell*, 10.ii.1973; AD, A42982). Nora Creina, S. Aust., in bay (*Owen*, 17.i.1971; AD, A37808). Stinky Bay, S. Aust. (Nov. 1965; AD, A50324). 1.3 km off Cape Northumberland, S. Aust., 15 m deep (*Shepherd*, 1.ii.1978; AD, A55267). Double Corner Beach, Portland, Vic., drift (*Beauglehole*, 22.vi.1952; AD, A21609). Crawfish Rock, Westernport Bay, Vic., 10 m deep (*Watson*, 25.iv.1969; AD, A34375) and 2 m deep (*Shepherd*, 1.i.1970; AD, A35187). Gabo I., Vic., on *Plocamium angustum*, 1–3 m deep (*Shepherd*, 15.ii.1973; AD, A43375). Georgetown, Tas. (*Perrin*, 26.ii.1948; AD, A16443). Bicheno, Tas., 8–12 m deep (*Edgar*, 23.x.1994; AD, A63805). Arch Rock, Ninepin Point, Tas., 5–12 m deep (*Sanderson*, 21.x.1994; AD, A63881). Great Taylor Bay, Bruny I., Tas., 19 m deep (*Shepherd*, 14.ii.1972; AD, A42163). Tasman I., Tas., on sponge, 20 m deep (*Riddle*, 1.iii.1990; AD, A60489).

Apoglossum spathulatum is very variable in size and especially in width of the blades, which is greatest in Tasmanian and deeper water plants. Most specimens from the western part of its distribution tend to be smaller plants with narrow blades. Early records of the European *A. ruscifolium* from Australia probably all apply to *A. spathulatum*.

A. spathulatum is closely related to *A. ruscifolium* but is generally a smaller species, differing also in having hemispherical, broad based cystocarps in contrast to subspherical, beaked, ones in the latter, and also the spermatangial sori being more continuous over the blades, compared to separated striae in *A. ruscifolium* (Maggs & Hommersand 1993, p. 205; Wynne 1984, p. 144).

Genus **HYPOGLOSSUM** Kützing 1843: 444

Thallus usually erect, mostly 5–20 cm high, with flat (usually), elongate blades arising from the midrib of older blades, monopodially developed (sympodial in *H. revolutum*), monostromatic apart form the midrib; lateral veins absent; holdfast discoid, usually epilithic. *Structure.* Apical cells obconical, segmenting to form an axial filament of cells with 2 lateral pericentral cells followed by 2 transverse pericentral cells, the lateral cells forming second-order cell rows with all or some cells forming third-order rows, with all rows reaching the blade margin. Blade margin with or without fourth-order rows, entire or serrate, or with fimbriate uniseriate extensions. New branches arise endogenously from the axial cells. Midrib becoming corticated and forming a subterete stipe below as the blade wings are lost.

Reproduction. Gametophytes dioecious. Procarps borne on transverse pericentral (supporting) cells on both sides of the blades, with 2 sterile groups and a 4-celled carpogonial branch. Carposporophyte with a basal fusion cell, much branched gonimoblast, and short chains of ovoid carposporangia maturing sequentially. Cystocarps ovoid to urceolate, sessile to stipitate, ostiolate and sometimes with a conspicuous neck; pericarp formed by erect filaments with 1–3 layers of outer cortical cells. Spermatangial sori on both sides of young blades, usually with sterile midrib and margin, with the primary cells cutting off initials each of which produce several spermatangia.

Tetrasporangial sori on smaller blades, with tetrasporangia cut off from several inner second- and third-order cells, occasionally from lateral (or even transverse) pericentral cells, and often from cortical cells, the sorus containing sporangia of different ages and covered by a cortex 1–2 cells thick.

Lectotype species: *H. woodwardii* Kützing 1843: 444 [= *H. hypoglossoides* (Stackhouse) Collins & Hervey 1917: 116]. See Kylin 1923, p. 81, fig. 52; Maggs & Hommersand 1993, p. 195, fig. 63.

A genus of about 25 species (Wynne 1989a), with 6 on southern Australian coasts, monographed by Womersley & Shepley (1982).

KEY TO SPECIES OF *HYPOGLOSSUM*

1. Branching of the thallus regularly sympodial, mainly from the adaxial (convex) side of revolute branches. Development of third-order cell rows within the tetrasporangial sorus suppressed compared with vegetative blades .... 1. *H. revolutum*
1. Branching of the thallus monopodial, irregularly abaxial or opposite. Development of third-order cell rows within the tetrasporangial sorus similar to that of vegetative blades (except *H. dendroides*) 2

 2. Mature blades with all second-order cells producing third-order cell rows. Tetrasporangia not formed by transverse pericentral cells but often by cortical cells 3
 2. Mature blades with only the inner second-order cells producing third-order cell rows. Tetrasporangia commonly formed by transverse pericentral cells, but not by cortical cells 5

3. Mature blade margin smooth or undulate, without serrations .... 2. *H. heterocystideum*
3. Mature blade margin distinctly serrate or with long cellular projections 4

 4. Margin with regular spines or cellular projections, reflexed towards blade apex, derived from outgrowth of second-order cell rows .... 3. *H. harveyanum*
 4. Margin with irregular spines (often becoming branched) derived from outgrowth of third- and fourth-order cell rows .... 4. *H. armatum*

5. Branching of thallus mainly abaxial; all blades of similar structure; margins with the outer 2 or 3 cells markedly smaller than inner cells and often produced in pairs from submarginal cells .... 5. *H. protendens*

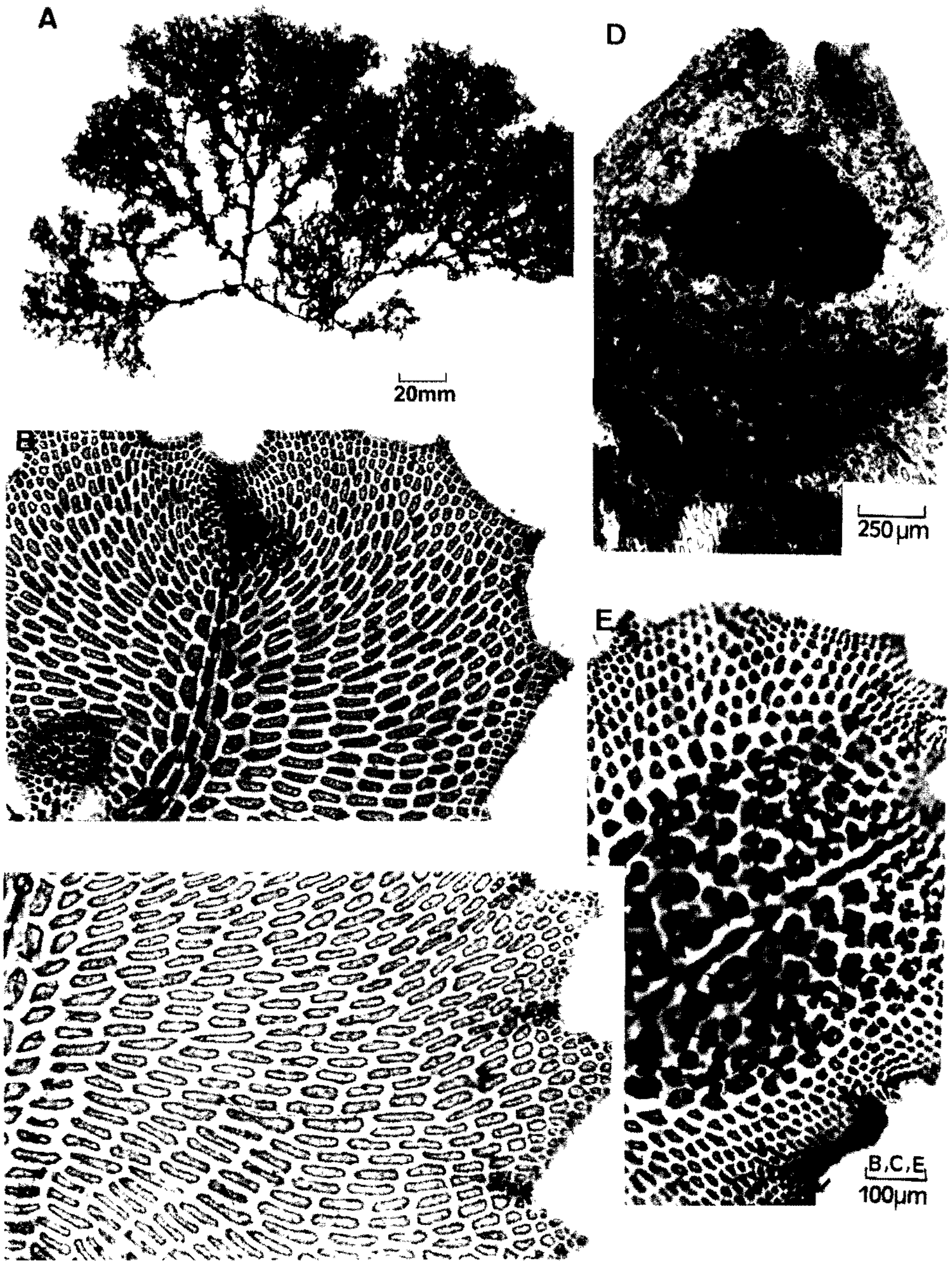

Fig. 14. *Hypoglossum revolutum* (**A**, AD, A50738; **B–D**, AD, A35017; **E**, AD, A37809). **A**. Habit. **B**. Apex of bladelet showing segmentation. **C**. Bladelet with second- and third-order rows and marginal dentations. **E**. Tetrasporangial sorus with tetrasporangia on second-order cells. (**B–E** as in Womersley & Shepley 1982, courtesy of Aust. J. Bot.)

5. Branching of thallus mainly opposite; ultimate blades usually considerably narrower and with fewer second-order cells than in earlier formed blades; margins with outer cells produced singly from submarginal cells and only slightly smaller than inner cells .... 6. *H. dendroides*

1. **Hypoglossum revolutum** (Harvey)J. Agardh 1898: 188. De Toni 1900: 692. Huisman 1997: 201. Huisman & Walker 1990: 430. Kylin 1924: 9. Lucas 1909: 36. Lucas & Perrin 1947: 228, fig. 91. Shepherd & Womersley 1971: 166; 1981: 366. Silva *et al.* 1996: 459. Womersley 1950: 183. Womersley & Shepley 1982: 323, figs 1A, 3. Wynne 1989a: 514.

Delesseria revoluta Harvey 1855a: 548; 1860: pl. 170; 1863, synop.: xxxi. J. Agardh 1872: 57; 1876: 490. Sonder 1880: 24. Tate 1882a: 20. Tisdall 1898: 509. Wilson 1892: 174.

Delesseria denticulata J. Agardh 1894: 66, *nom. illegit.* [NON *D. denticulata* Harvey 1855a: 548 = *Heterodoxia denticulata* (Harvey)J. Agardh. NEC Montagne 1849: 290 = *Membranoptera denticulata* (Montagne)Kylin.]

Hypoglossum denticulatum J. Agardh 1898: 188. De Toni 1900: 693. Kylin 1924: 9. Lucas 1929b: 50.

?*Placophora? cucullata* J. Agardh 1892: 175.

FIGS 14, 16A

Thallus (Fig. 14A) medium red to greenish brown, forming spreading clumps of one to a few axes with only very short stipes, attached by discoid primary (and often secondary) holdfasts. Branching entirely sympodial with new blades (often in clumps of 2–4) arising from some distance below the apex of parent blades on their adaxial (convex) side, with the ends of all blades being typically revolute. Mature blades 3–5 mm broad, with a distinct corticated midrib 300–600 µm across, and wings convolute with margins irregularly coarsely spinous. Holdfast 0.5–1 mm across; epiphytic on various algae. *Structure.* All second-order cells producing third-order rows (Figs 14B, C, 16A) with the outermost 2 or 3 cells much smaller than inner blade cells (Fig. 14B), produced singly or occasionally in pairs and in some plants extending as short 2- or 3-celled spinous projections, at first comprising second-order rows extending beyond the anterior third-order rows but later composed mainly of extended adjacent posterior third-order rows which usually cut off fourth-order cells both anteriorly and posteriorly (Figs 14B, 16A). Cortication of the midrib commences in young blades, and in mature blades extends almost to their apices; several layers of corticating cells form a broadly ovate to almost round midrib in section, but the lateral parts of the blades remain as wings throughout the thallus. Corticated midribs of older blades, either at their apices or below, often develop rhizoidal outgrowths which form secondary holdfasts. Mature cells multinucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps develop from the abaxial pericentral (supporting) cell, with a 4-celled carpogonial branch. Prior to fertilisation, the supporting cell cuts off an outer sterile cell which in turn produces a smaller sterile cell posteriorly. Several procarps may form in sequence, but usually on any blade only one procarp develops further. Carposporophyte with much branched gonimoblast filaments, with carposporangia developing terminally and sequentially but usually with chains of 2 or 3 maturing rapidly; subapical cells also produce carposporangia laterally. Carposporangia ovoid to pyriform, 25–45 µm in diameter. Cystocarps (Fig. 14D) develop on the abaxial (concave) side of young blades, becoming subspherical to slightly urceolate, not or only slightly basally constricted, 0.5–1.5 mm in diameter, with a small ostiole. Pericarp moderately corticated, 4–6 cells thick.

Spermatangia not observed.

Tetrasporangia develop in broad sori (Fig. 14E) at the revolute apices of young blades. No third-order cell rows form within the sorus although they are present outside the sorus. Tetrasporangia arise first from the lateral pericentral cells and each second-order cell within the sorus, and at an early stage from the first-formed corticating cells so that the sorus contains tetrasporangia of varying ages. Just prior to initiation of the sporangium, 1 or 2 corticating cells are cut off from the second-order cells and 2 or 3 outer corticating cells are usually produced from the first-formed ones; tetrasporangia 50–80 µm in diameter.

Type from King George Sound, W. Aust.; lectotype in Herb. Harvey, TCD (Trav. Set 311).

Distribution: Houtman Abrolhos, W. Aust. to Portland Bay, Victoria.

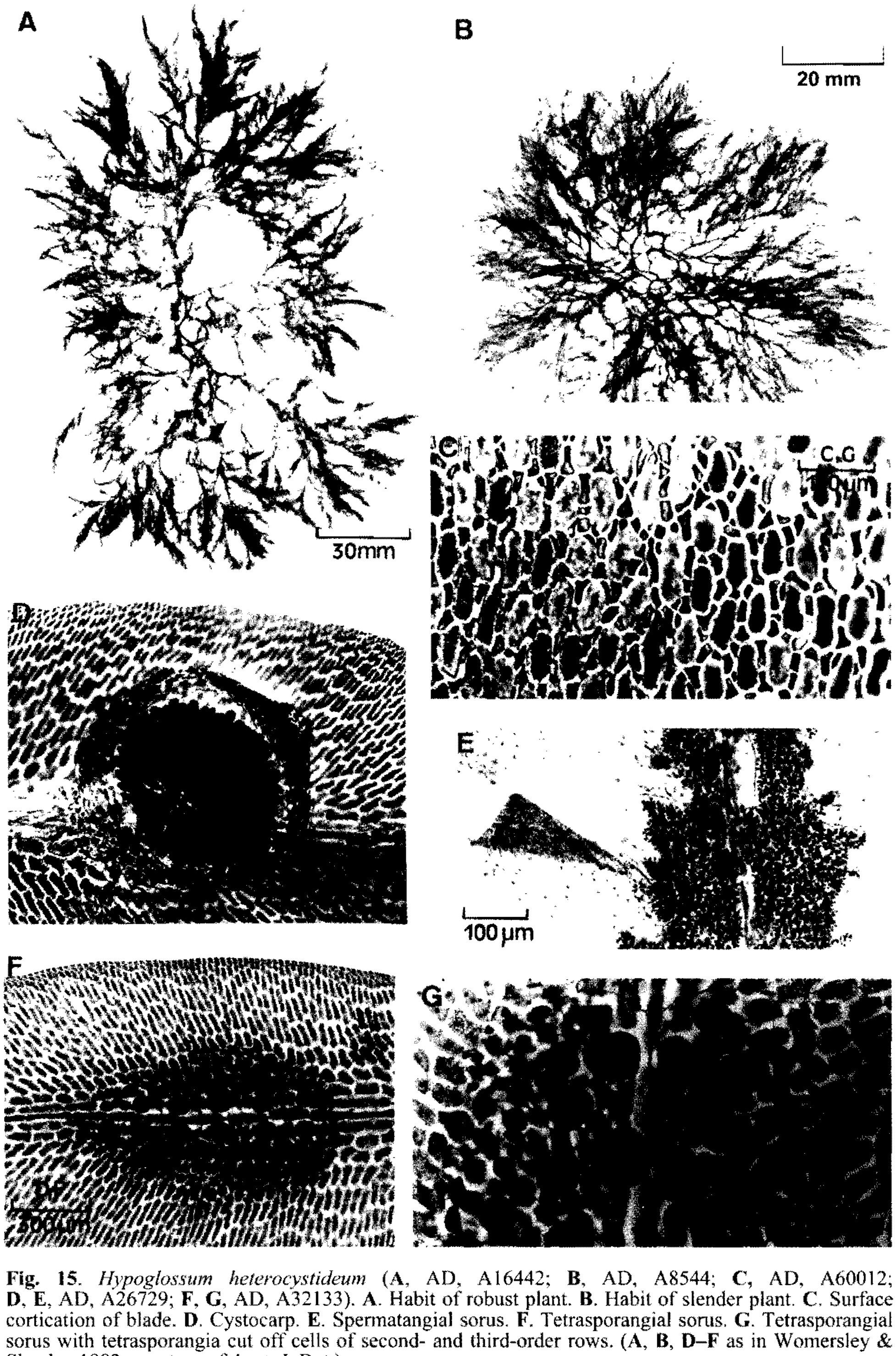

Fig. 15. *Hypoglossum heterocystideum* (**A**, AD, A16442; **B**, AD, A8544; **C**, AD, A60012; **D**, **E**, AD, A26729; **F**, **G**, AD, A32133). **A**. Habit of robust plant. **B**. Habit of slender plant. **C**. Surface cortication of blade. **D**. Cystocarp. **E**. Spermatangial sorus. **F**. Tetrasporangial sorus. **G**. Tetrasporangial sorus with tetrasporangia cut off cells of second- and third-order rows. (**A**, **B**, **D–F** as in Womersley & Shepley 1982, courtesy of Aust. J. Bot.)

Selected specimens: Safety Bay, W. Aust. (*Womersley*, 26.viii.1979; AD, A50738). Elliston, S. Aust., 10–11 m deep in bay (*Shepherd*, 20.x.1969; AD, A35017) and outside bar, 25 m deep (*Shepherd*, 25.x.1971; AD, A42568). Muston, Kangaroo I., S. Aust., 2–3 m deep (*Mitchell*, 21.xi.1968; AD, A32135). Nora Creina, S. Aust., (*Owen*, 17.i.1971; AD, A37809) and uppermost sublittoral in shaded caverns (*Womersley*, 19.xii.1971; AD, A41162).

Hypoglossum revolutum is readily recognised by the sympodial branching and revolute apices. *H. denticulatum* (J. Agardh)J. Agardh is based on Harvey's Alg. Aust. Exsicc. 279B of *H. revolutum*, from King George Sound, W. Aust. The type is in Herb. Agardh (LD, 31570). The characters on which J. Agardh separated *H. denticulatum* (more prominent midrib and marginal teeth) are variable within *H. revolutum*.

Recorded from 2–50 m deep.

Placophora cucullata J. Agardh, from Fremantle, W. Aust., holotype in Herb. Agardh, LD, 42935, is a fragment 5–6 mm high of a *Hypoglossum*, possibly *H. revolutum*.

2. **Hypoglossum heterocystideum** (J. Agardh)J. Agardh 1898: 187. De Toni 1900: 691. Coppejans & Millar 2000: 330. Guiler 1952: 101. Huisman &Walker 1990: 430. Huisman *et al.* 1990: 95. Kendrick *et al.* 1990: 51. Kraft *et al.* 1999: 21. Kylin 1924: 9. Lucas 1909: 36; 1913: 58; 1929a: 20. Millar 1990: 427, fig. 57E–G. Millar & Kraft 1993: 46. Silva *et al.* 1996: 458. Tisdall 1898: 509.

Delesseria heterocystidea J. Agardh 1885: 71. Wilson 1890: 490; 1892: 174.

Delesseria hypoglossoides Harvey 1855a: 548; 1859a: pl. 87; 1863, synop.: xxxi. J. Agardh 1872: 57; 1876: 489. Kützing 1869: 5, pl. 13a–c. Sonder 1880: 24.

Hypoglossum hypoglossoides (Harvey)Womersley & Shepley 1982: 326, fig. 4. Kendrick *et al.* 1988: 204. [NON *H. hypoglossoides* (Stackhouse)Collins & Hervey 1917: 116.]

Membranoptera hypoglossoides (Harvey)Kuntze 1891: 904.

Delesseria spathulata sensu Kützing 1869: 5, pl. 12 d, e (not c). [NON *D. spathulata* Sonder 1845: 57; 1848: 194. Harvey 1855a: 548. Kützing 1869: 5, pl. 12 c ≡ *Apoglossum spathulatum* (Sonder)Womersley & Shepley [syn. *A. tasmanicum* (Mueller *ex* Harvey)J. Agardh].

Hypoglossum spathulatum sensu J. Agardh 1898: 186. Cribb 1983: 96, pl. 42 figs 1, 2? De Toni 1900: 689. Guiler 1952: 101. Kylin 1924: 9. Levring 1946: 225? Lucas 1909: 36. Lucas & Perrin 1947: 227. Shepherd & Womersley 1971: 166. Womersley 1950: 183. [NON *H. spathulatum* (Sonder)Kützing 1849: 877 ≡ *Apoglossum spathulatum* (Sonder)Womersley & Shepley 1982: 329.]

Delesseria hypoglossum sensu Harvey 1863, synop.: xxxi.

Delesseria undulata J. Agardh 1894: 66.

Hypoglossum undulatum (J. Agardh)J. Agardh 1898: 188. De Toni 1900: 692. Kylin 1924: 9. Lucas 1909: 36.

Hypoglossum marginatum J. Agardh 1898: 189. De Toni 1900: 695. Kylin 1924: 9. Lucas 1909: 36.

FIGS 15, 16B, C

Thallus (Fig. 15A, B) pale grey-red to medium red, usually 3–6 (-10) cm high, with one to several much branched main axes, usually becoming densely tufted, branching irregular. Mature blades (1-) 2–5 (-8) mm broad, usually tapering gradually above to pointed apices (which become rounded when mature), margins entire and straight to convolute. Cortication usually slight, becoming moderate on lower midribs of larger plants. Marginal cells near apices occasionally fuse and develop outgrowing rhizoids (probably for attachment). Holdfast small, discoid; epiphytic on *Posidonia*. *Structure*. All second-order cells produce third-order rows (Fig. 16B, C) with the cells becoming elongate apart from the marginal (and often 1 or 2 submarginal) isodiametric cells (Figs 15F, 16C); the margin remains relatively linear. Cortication commences on older parts of lesser blades by rhizoidal filaments from the transverse pericentral cells, lying over the longitudinal margins of the pericentral cells and on older blades covering the pericentral cells (Fig. 15C) and becoming several layers thick on older midribs of larger plants. Cells uninucleate when small, 2–4 nucleate when larger; rhodoplasts discoid, becoming chained.

Reproduction. Gametophytes dioecious. Procarps single or few per blade, with 2 sterile groups (one 2-celled and one 1-celled) and a 4-celled carpogonial branch. Carposporophytes much branched from the basal fusion cell, with terminal elongate-ovoid to slightly pyriform carposporangia 20–50 µm in diameter; maturing singly and sequentially, and arising also from subapical cells. Cystocarps (Fig. 15D) maturing on medium to larger blades, subspherical, basally constricted, not urceolate, (0.5-) 1–1.5 mm in diameter; pericarp relatively thin, 2 or 3 cells thick. Spermatangial sori rounded, elongate or irregular (Fig. 15E), on both sides of the midrib of linear blades, usually separated by sterile areas but becoming confluent, arising from cells of the lateral cell rows and occasionally from the lateral pericentral cells.

Tetrasporangial sori rounded to elongate (Fig. 15F), on young blades with normal cell development. Tetrasporangia arise following production of cortical cells, first from the lateral pericentral cells (rarely from transverse pericentral cells) and later from adjacent cells of second- and third-order rows (Fig. 15G), occasionally (sometimes frequently) from corticating cells in older sori, usually producing a regular gradation of maturity, 50–100 µm in diameter.

Type from Port Phillip, Vic. (*Wilson*); lectotype in Herb. Agardh, LD, 31561.

Distribution: Port Denison, W. Aust., around southern Australia and Tasmania to Port Stephens, N.S.W. and possibly to Brisbane (Levring 1946, p. 225) and the southern Great Barrier Reef (Cribb 1983, p. 96), usually in shallow water but extending to 22 m deep.

N Papua New Guinea (Coppejans & Millar 2000, p. 330). Philippines (Kraft *et al.* 1999: 21).

Selected specimens: Salmon Bay, Rottnest I., W. Aust., drift (*Parsons*, 12.xi.1968; AD, A32138). Elliston, S. Aust., 10–11 m deep (*Shepherd*, 20.x.1969; AD, A35006). Hopkins I., S. Aust., 33 m deep (*Branden*, 8.i.1989; AD, A60012). Tapley Shoal, S. Aust., 13 m deep (*Shepherd*, 2.ii.1969; AD, A33525). Saunders Beach, Eastern Cove, Kangaroo I., S. Aust., drift (*Mitchell*, 25.viii.1963; AD, A26729 and 21.xi.1968; AD, A32133). American R. inlet, Kangaroo I., S. Aust., upper sublittoral (*Womersley*, 17.viii.1948; AD, A8544). Muston, American R. inlet, Kangaroo I., S. Aust., 2–3 m deep (*Kraft*, 7.iv.1972; AD, A42412). Low Head, Tas. (*F. Perrin*, Nov. 1949; AD, A16442).

Following use of *H. hypoglossoides* by Womersley & Shepley (1982, p. 326) for the Australian species, Wynne (1984b) pointed out that this combination had been used for the type species by Collins & Hervey (1917, p. 116).

H. heterocystideum varies considerably in size and robustness. Western and South Australian specimens are generally slender, less than 5 cm high and have only slight cortication. Some Tasmanian specimens reach 10 cm in height, the blades are slightly broader (5–8 mm), and the midrib becomes more heavily corticated below. Otherwise they are very similar in blade development and reproductive structures. Specimens from Pearson I., S. Aust., 22 m deep (*Shepherd*, 12.i.1969; AD, A34061) show unusual development of filaments of small rhizoidal cells lying over the blade cells out from the midrib. These specimens are relatively robust (branches 5–10 mm broad) and are provisionally placed under *H. heterocystideum* until better and fertile material is available. Similar rhizoidal cortication of the blade cells occurs in older blades of *H. harveyanum* (see below), but the Pearson I. specimens have the entire margin characteristic of *H. heterocystideum* rather than the regularly spinous margin of *H. harveyanum*.

H. heterocystideum is most closely related to the type species (*H. woodwardii*) of all the Australian species, but differs in that tetrasporangia are (in most plants) only occasionally produced from cortical cells and generally from cells of the second- and third-order rows, giving a more regular sorus than in *H. woodwardii*.

Two later species of J. Agardh are placed in synonymy with *H. heterocystideum* which, as shown above, is a rather variable species.

H. undulatum (J. Agardh)J. Agardh (lectotype in Herb. Agardh, LD, 31565) is based on a specimen of Harvey's Alg. Aust. Exsicc. 281B from King George Sound, W. Aust., distributed by Harvey as *D. spathulata*. The margin is undulate, as often occurs in *H. heterocystideum*.

H. marginatum J. Agardh (lectotype in Herb. Agardh, LD, 31636) is also based on a specimen of Harvey's Alg. Aust. Exsicc. 281A, from Fremantle, W. Aust., distributed as *D. spathulata*. This is a small specimen 2–3 cm high with rounded apices, growing on *Posidonia* and in all features it agrees well with *H. heterocystideum*.

D. spathulata Sonder was recorded from Brazil by several authors, but these records are now referred by Oliveira (1977, p. 121) to *H. tenuifolium* var. *carolinianum* Williams. *Hypoglossum spathulatum* has been recorded from the Red Sea (Nasr 1947, p. 145), the

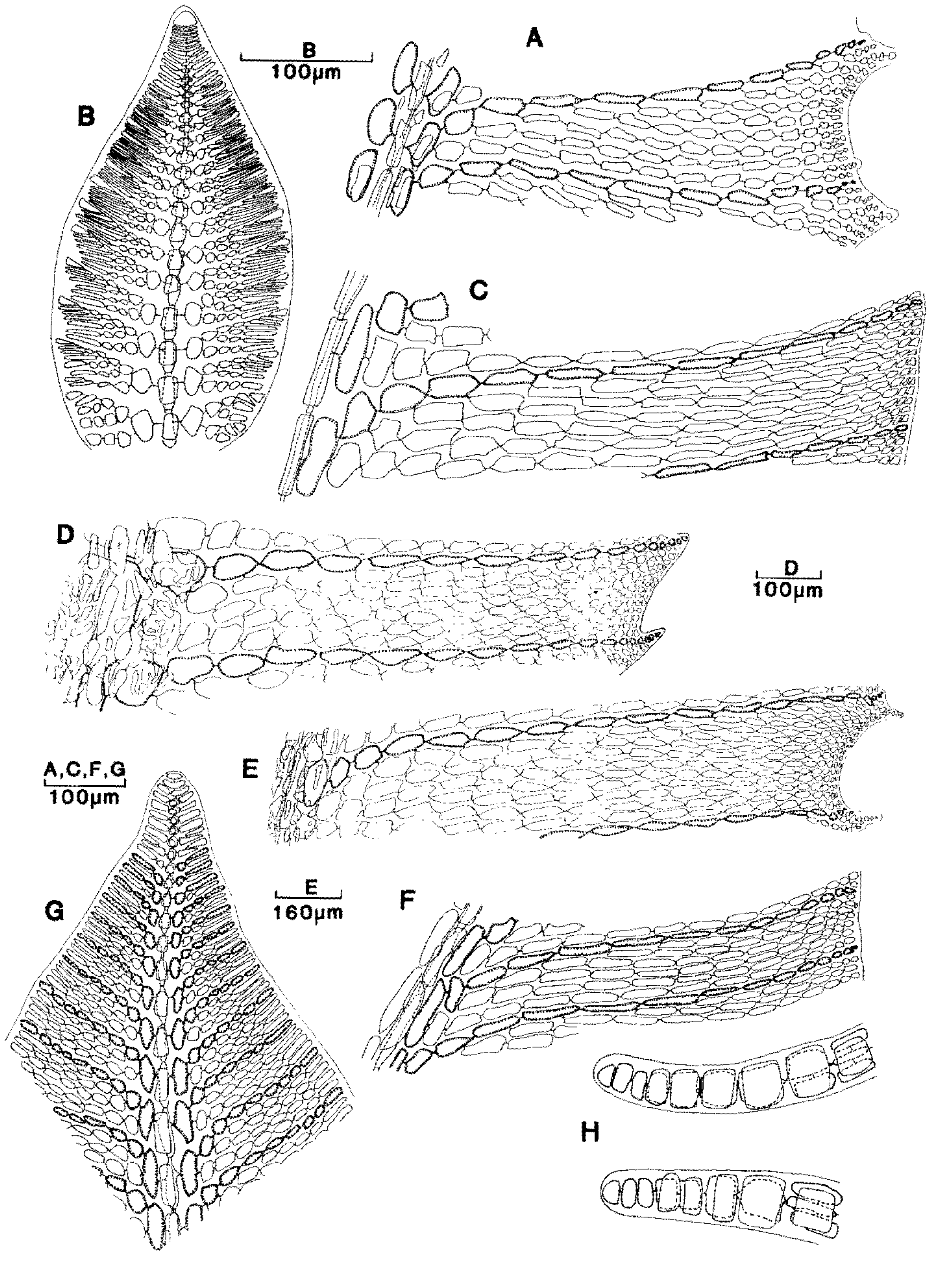

Fig. 16. A. *Hypoglossum revolutum* (AD, A37017)). Cell lineages, cells of second-order rows stippled. **B, C.** *Hypoglossum heterocystideum* (AD, A32138). **B.** Juvenile blade. **C.** Cell lineages, mid blade. **D.** *Hypoglossum harveyanum* (AD, A49090). Cell lineages, mid blade. **E.** *Hypoglossum armatum* (AD, A49380). Cell lineages, mature blade. **F.** *Hypoglossum protendens* (AD, A42964). Cell lineages, mid blade. **G, H.** *Hypoglossum dendroides* (AD, A37557). **G.** Blade apex. **H.** Sectional views of apices and formation of transverse pericentral cells (as in Womersley & Shepley 1982, courtesy of Aust. J. Bot.).

Persian Gulf (Nizamuddin & Gessner 1970, p. 12), India (Børgesen 1932, p. 128) and Indonesia (W.v. Bosse 1923, p. 389) but none of these references provides adequate detail to verify the species. The Weber-van Bosse specimens from Indonesia have recently been described as a new species, *H. annae* Wynne & De Clerck (2000: 118, figs 18–22).

"*Delesseria crispa* Sond.", listed by Harvey (1849a, p. 116), is based on Sonder (1848, p. 194) who remarked only that *Del. spathulata* had affinity with *Delesseria crispa* Zanardini.

3. **Hypoglossum harveyanum** (J. Agardh)Womersley & Shepley 1982: 330, figs 1D, 5, 6. Lewis 1984: 46. Millar 1990: 426, fig. 57A–D. Millar & Kraft 1993: 46. Silva *et al.* 1996: 458. Wynne 1989a: 514, fig. 2B.

Delesseria harveyana J. Agardh 1872: 57; 1876: 490. Sonder 1880: 24.

Delesseria serrulata Harvey 1858: pl. 59; 1863, synop.: xxxi. [NON *D. serrulata* Harvey 1857: 331 from Japan.]

Hypoglossum serrulatum (Harvey)J. Agardh 1898: 186. De Toni 1900: 690. Kylin 1924: 9. Lucas 1909: 36.

FIGS 16D, 17, 18

Thallus (Fig. 17A) light to medium red, 10–40 cm high, usually profusely branched to four or five orders, with a single main axis often (0.2-) 0.5–1 cm broad with a prominent corticate midrib 1–2 mm broad, giving rise to long laterals from both surfaces of the main blade. Main laterals usually 5–20 cm long, branched on both sides, but tertiary branches arising mainly abaxially. Cortication commences close to the apices, with the first three orders of branches in mature plants with a thick, corticated midrib, and the lower main axes and branches often becoming denuded. In older branches, where the midrib is moderately or heavily corticated, corticating filaments develop between the cells of the lamina of the blades, at first adjacent to the midrib and later spreading over the whole surface of the blades. Margins of young blades regularly and prominently serrate, often denuded below. Holdfast small, discoid; probably epilithic. *Structure.* All second-order cells (except marginal spine cells) produce third-order cell rows (Figs 16D, 17B, D), in both vegetative and fertile blades. At the margin of the blade (Fig. 16D), 1–3 subapical second-order cells remain undivided and, together with the third-order rows derived from several adjacent second-order cells, project beyond the older third-order cell rows and provide the regular serrations. In var. *fimbriatum* (see below), the second-order rows on older (lower) parts of the blades extend as uniseriate rows of 5–20 (-25) cells. Such fimbriate blades may occur on non-fimbriate parent blades, and variations from the normal spinous blades to fimbriate ones occur in the limited range of plants observed. Cells multinucleate; rhodoplasts discoid becoming chained.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes dense, with numerous much branched gonimoblast filaments producing terminal and lateral carposporangia maturing sequentially and often forming short chains with only the terminal 2 or 3 mature at any time, subspherical to ovoid or pyriform, 30–50 (-100) µm in diameter. Cystocarps developing abaxially (occasionally adaxially) close to the apices of ultimate and penultimate blades, often with two cystocarps on one blade. Mature cystocarps (Fig. 17C) 500–800 µm in diameter, not basally constricted but forming a prominent protrusion abaxially on the blade with only a slight bulge on the adaxial surface, ostiolate with a neck 100–250 µm long (Fig. 17C, arrow). Pericarp lightly corticated, 2 or 3 cells thick, with internal, slender, rhizoidal filaments. Spermatangial sori (Fig. 17D, E) on ultimate and penultimate blades extending 0.5–0.75 of the distance from midrib to margin, and often with sterile second-order cell rows within the sorus.

Tetrasporangial sori (Fig. 17F) on the ultimate and penultimate blades, with the sorus occupying about one-third of the blade width and up to three-quarters of the blade length. In penultimate blades several sori may develop in sequence. The lateral pericentral cells cut off, at much the same time, a tetrasporangial initial anteriorly and a corticating cell outwardly. This corticating cell divides rapidly to form a further outer layer of 2–4 corticating cells and in many cases cuts off anteriorly a darkly-staining incipient tetrasporangial initial. The tetrasporangia attached to the lateral pericentral cells and cells of the second- and third-order rows develop and mature most rapidly, but older sori contain tetrasporangia of mixed ages. The transverse pericentral cells produce corticating cells but only rarely do they produce functional tetrasporangia. Mature tetrasporangia are 55–100 µm in diameter. In older blades many marginal and near-marginal proliferations may develop and bear tetrasporangial sori.

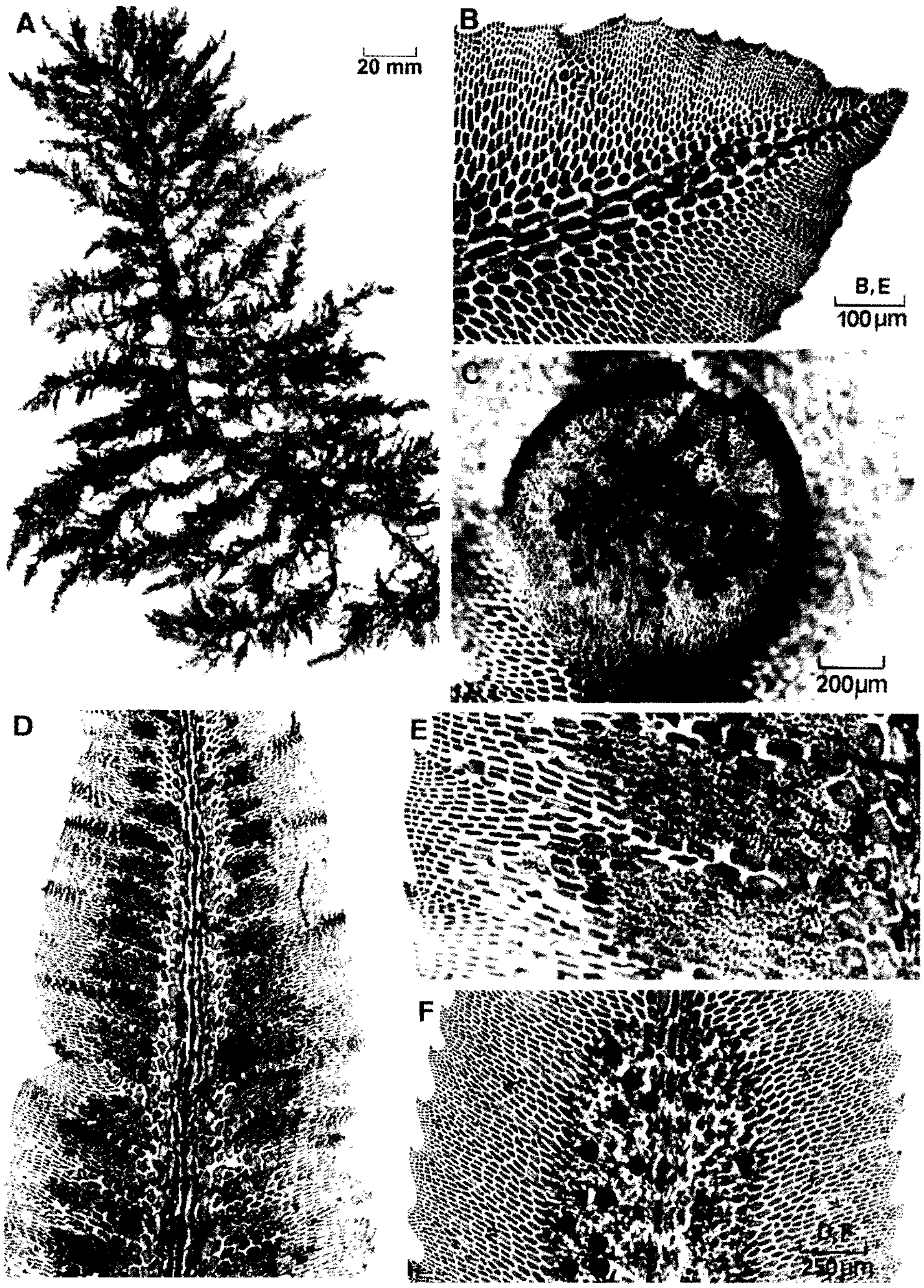

Fig. 17. *Hypoglossum harveyanum* (from N.S.W.) (**A**, AD, A38745, **B–F**, AD, A49090). **A**. Habit. **B**. Apex showing segmentation. **C**. Cystocarp with neck (arrow). **D**. Blade with spermatangial sori. **E**. Detail of spermatangial sori. **F**. Blade with a tetrasporangial sorus. (**A**, **B**, **D–F** as in Womersley & Shepley 1982, courtesy of Aust. J. Bot.)

Type from Port Jackson, N.S.W. (*Moore*) (Harvey, Alg. Aust. Exsicc. 277L); lecotype Herb. Agardh, LD, 31545.

Distribution: Known from Port Jackson and Botany Bay, N.S.W., Mary R. heads and Gladstone, Qld, 1–8 m deep. Var. *fimbriatum* (see below) from Port Turton, S. Aust., and Saunders Beach, Kangaroo I., S. Aust.

Selected specimens: Port Jackson, N.S.W. (*Harvey*, Alg. Aust. Exsicc. 277L; BM). Botany Bay, N.S.W. (*Lucas*, Jan. 1905; AD, A38745, and 30 sheets collected between June 1909 and Jan. 1912 in NSW). Off Carters I., Georges R. estuary, Botany Bay, N.S.W., 3 m deep on shells (*Larkum*, 12.i.1978; AD, A49090). Mary R. Heads, Qld (*McKeon*, 4.viii.1959; AD, A23289). Kite I., Calliope R., Gladstone, Qld, 1 m deep (*Moverly*, 25.viii.1977; AD, A50523).

Delesseria harveyana J. Agardh is based on Harvey's Alg. Aust. Exsicc. 277L from Port Jackson, N.S.W. The two specimens in TCD are labelled 'Paramatta R., C. Moore', and Harvey (1858, pl. 59) stated the only specimens he had were from Charles Moore. The specimens probably came from the Paramatta R. estuary which flows into Port Jackson; this probably was a comparable habitat to the Carters I. locality. Harvey (1857b, no. 277) first named the species '*D. serrata*', this name appearing on the C. Moore sheets, with the later addition of '*D. serrulata*'. Harvey (1858, pl. 59) referred to the species as *D. serrulata*, presumably because of the earlier *D. serrata* Postels & Ruprecht, which is now recognised as *Membranoptera serrata* (Postels & Ruprecht)Zinova (see Wynne 1970, p. 99).

However, *Delesseria serrulata* Harvey was first described by Harvey (1857a, p. 331), based on material from Hakodate, Japan, and Harvey in 1858 mistakenly considered the Port Jackson material the same species. J. Agardh (1872) realised the Australian material was distinct from the Japanese, and renamed the former *D. harveyana*. J. Agardh (1872, p. 58) also renamed the Japanese taxon *D. violacea*, but this is invalid and the Japanese taxon is correctly known as *Delesseria serrulata* Harvey (see Yoshida 1998, p. 971).

H. serrulatum was recorded from the Indonesian region by W. v. Bosse (1923, p. 389), but without adequate details to verify the species.

3a. **Hypoglossum harveyanum** var. **fimbriatum** Womersley, *var. nov.*

FIG. 18

Morphology and cell lineages as in the species, but with second-order rows extended into uniseriate projections 5–20 cells long, and cystocarps surmounted by long and broad necks, 500–1500 μm long and 200–400 μm in diameter, often flared at their tips.

Diagnosis: Morphologia ut in specie sed series secundae ordinis extensae in proiectiones uniseriatas 5–20 cellulas longas et in cystocarpia collis latis 500–1500 μm longis et 200–400 μm diametro, apicibus saepe effusis.

Type: from Saunders Beach, Kangaroo I., S. Aust., drift (*Shepley*, 25.viii.1963; holotype in AD, A29500).

Distribution: Known from Point Turton and Saunders Beach, Kangaroo I., S. Australia.

Selected specimens: Point Turton, S. Aust., 3–5 m deep on rock and jetty piles (*Kraft*, 17.ix.1973; AD, A44156) and 8–9 m deep (*Kald*, 8.vi.1968; AD, A33094).

This variety (Fig. 18A) is of distinctive morphology with the second-order cell rows in the smaller blades extended into uniseriate projections 5–20 cells long, which give these blades a fimbriate appearance (Fig. 18B–D). However, in the development of the blades, the further development of the second-order rows, and cortication of older blades, they show the essential features of *H. harveyanum*, though often the blades remain somewhat narrower. Older blades are typically those of *H. harveyanum*.

The tetrasporangial sori (Point Turton plants only) appear essentially similar to those of New South Wales plants, though the first corticating cells are cut off distinctly before the tetrasporangium, but the cystocarps of the single Saunders Beach fimbriate plant are remarkable. The cystocarp size is rather greater (1000–1500 μm in diameter), but it is surmounted by a very long and broad neck 500–1500 μm long and 200–400 μm in diameter that is slightly narrowed near its base and expanded above, often flared outwards at its tip (Fig. 18E). The carposporangia of this plant are also somewhat larger than in New South Wales plants.

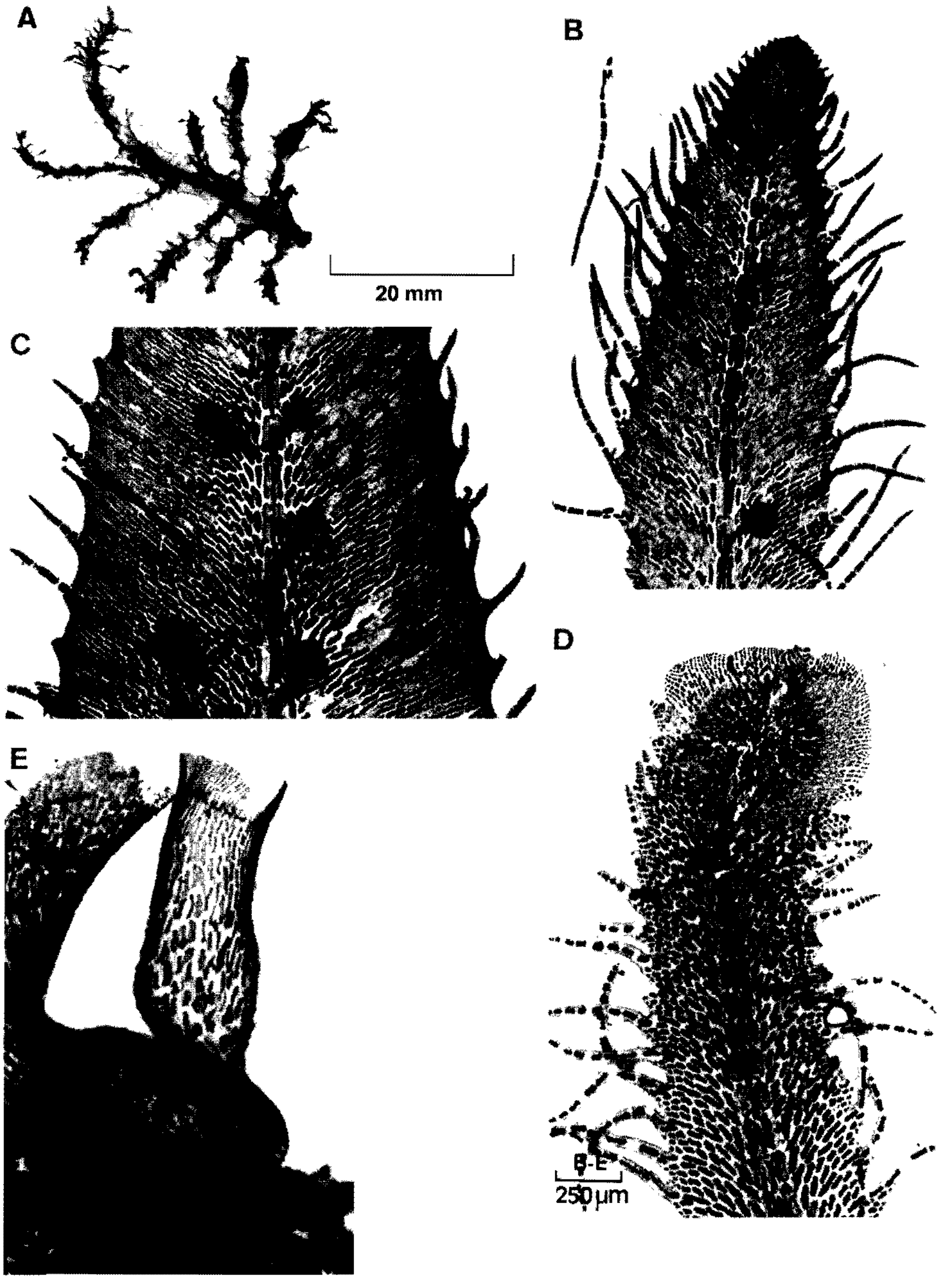

Fig. 18. *Hypoglossum harveyanum* var. *fimbriatum* (**A**, AD, A44156; **B**, **C**, AD, A33094; **D**, **E**, AD, A29500). **A**. Habit. **B**. Apex of blade with fimbriate margins. **C**. Older blade with fimbriate margins and proliferations from midrib. **D**. Blade with young terminal cystocarp. **E**. Cystocarp with extended neck. (All as in Womersley & Shepley 1982, courtesy of Aust. J. Bot.)

These South Australian records are well outside the geographical range of typical *H. harveyanum*, which is otherwise confined to the central New South Wales and southern Queensland coasts. It is noteworthy, however, that the Queensland collections show longer 'spines' to the second-order rows than the New South Wales plants, but usually not as extensively developed as in the South Australian plants. However, AD, A50523 from Gladstone, Qld (*Moverley*, 25.viii.1977), has marginal spines up to 25 cells long.

This variety was previously regarded (Womersley & Shepley 1982, p. 334, fig. 6); as a fimbriate form, but it now appears best, with the limited collections available, to regard the South Australian plants as a variety of the N.S.W. species. Study of further collections is necessary, especially of the thallus development and cystocarps and their variation, to assess the status of these plants. The Queensland plants also warrant further study on their variation.

4. **Hypoglossum armatum** (J. Agardh)J. Agardh 1898: 189. De Toni 1900: 693. Kylin 1924: 9. Lucas 1909: 36. Womersley & Shepley 1982: 335, figs 2A, 7. Wynne 1989a: 514, fig. 2C.

Delesseria armata J. Agardh 1894: 67.

Delesseria microdonthum J. Agardh 1898: 186. De Toni 1900: 691. Kylin 1924: 9. Lucas 1909: 36. Lucas & Perrin 1947: 228.

FIGS 16E, 19

Thallus (Fig. 19A, B) light to medium red, erect, usually 10–25 cm high, much branched above and often denuded below. Branching is largely abaxial, mature blades 2–5 mm in width, the midrib becoming corticated on older branches. Holdfast hapteroid to 2 cm across with a perennial stipe 2–4 mm thick, often branched, bearing fronds from its apices; epilithic. *Structure*. All second-order cells produce third-order rows (Figs 16E, 19C, D), and the margins of the blades are usually irregularly and variably dentate with spinous projections resulting from the development of outer third-order rows which usually cut off a few fourth-order cells (Fig. 16E). Some blades have very slight or virtually no spines (Fig. 19C). One of the third-order cell rows, derived from a second-order cell near the thallus margin, takes over further lateral development and gives rise to short rows of fourth-order cells, at first anteriorly and then often posteriorly (Fig. 16E). Older blades may show short, tapering, spinous outgrowths from any of the marginal cells of the blade. Slight cortication of the midrib commences about half-way along young vegetative blades and at their base the midrib area is completely covered by small elongate corticating cells. Cortication increases as the blades mature and in old blades may occupy 0.2–0.25 of the blade width before the wings of the blade are lost and the midrib remains as the terete stipe of the thallus. Cells uninucleate when small, multinucleate when larger; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes probably dioecious. Procarps not observed. Carposporophyte with a fusion complex and much branched gonimoblast filaments, with carposporangia developing terminally and sequentially, sometimes in short chains; carposporangia subspherical to ovoid or slightly pyriform, 50–90 µm in diameter. Cystocarps (Fig. 19E) develop adaxially near the tips of blades, subspherical to slightly urceolate, 1.5–2.5 mm in diameter, with a small ostiole (70–140 µm in diameter), basally constricted and subsessile on the parent blade, the midrib of which persists as a longer stalk to the cystocarp. Pericarp heavily corticated, 5–9 cells and 200–300 µm thick. Spermatangia not observed.

Tetrasporangia develop in sori (Fig. 19F) on young blades which lack midrib cortication, derived first from the lateral pericentral cells and later from cells of the second- and third-order rows, rarely from cortical cells. Tetrasporangia mature acropetally and then outwards from the midrib, producing 8–10 tetrasporangia across the blade, until the sorus occupies about two-thirds of the blade width; tetrasporangia 110–150 µm in diameter.

Type from Port Phillip Heads, Vic. (*Wilson*, 29.xii.1891); holotype in Herb. Agardh, LD, 31575; isotypes in MEL, 10057 and BM.

Distribution: Recherche Archipelago, W. Aust., to Port Phillip, Victoria.

Selected specimens: York I., Recherche Arch., W. Aust., 5–6 m deep (*Royce*, 8.ii.1960; PERTH, 2285/6). Anxious Bay (off Waldegrave I.), S. Aust., 23 m deep (*Shepherd*, 25.ii.1978; AD, A49380). Encounter Bay, S. Aust., drift (Alg. Muell., MEL, 10055). Pennington Bay, Kangaroo I., S. Aust., drift (*Womersley*, 4.i.1948; AD, A6590). Investigator Strait, S. Aust., 33 m deep (*Watson*, 24.i.1971; AD,

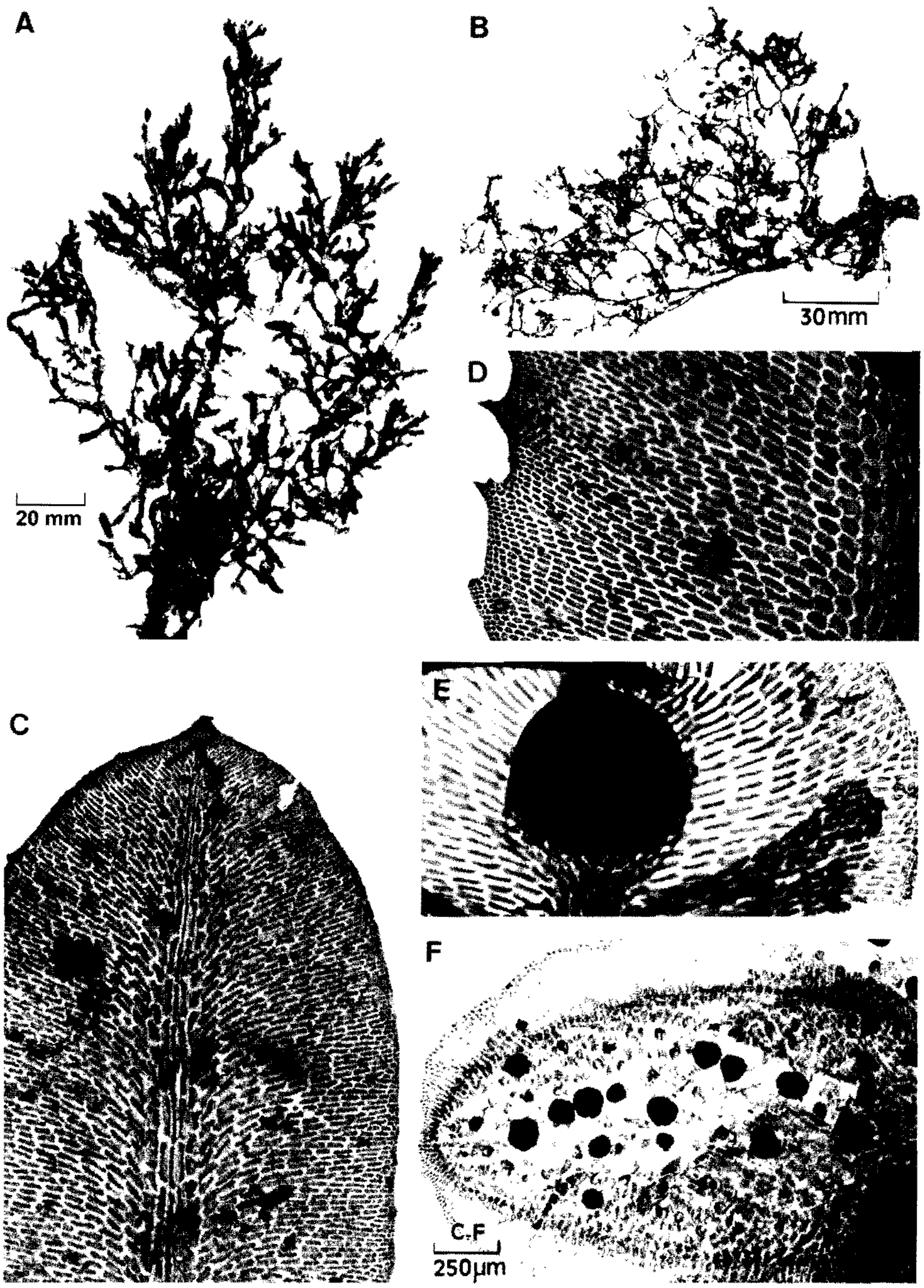

Fig. 19. *Hypoglossum armatum* (**A**, AD, A1072; **B–E**, AD, A49380; **F**, AD, A41086). **A**. Habit. **B**. Habit, cystocarpic plant. **C**. Apex of blade with only slight marginal spines. **D**. Blade with prominent marginal spines. **E**. Blade with young cystocarp. **F**. Tetrasporangial sorus. (All as in Womersley & Shepley 1982, courtesy of Aust. J. Bot.)

A41086). Gulf St Vincent, S. Aust., 40 m deep (AD, A1072). Port Phillip (West Channel), Vic., 14 m deep (*Wilson*, 28.xii.1883; MEL, 10031).

In size and general habit *H. armatum* resembles *H. harveyanum* and *H. protendens* but is distinguished from these by the cell development of the blade and marginal outgrowths. In contrast with *H. protendens* where only the inner 6–8 second-order cells form third-order rows, in *H. armatum* each second-order row cell forms a third-order row, and prominent but somewhat blunt and often irregularly developed spines occur. In contrast with *H. harveyanum* where the spines are formed by projecting second-order rows, in *H. armatum* the end of the second-order rows becomes inactive and the outermost third-order row extends out to form the spine, usually cutting off a few fourth-order cells.

Only a few cystocarpic and tetrasporangial plants have been seen and reproductive stages need further studies.

H. microdonthum J. Agardh is based on material from Port Elliot, S. Aust. (*Hussey*, Mar. 1898; holotype in LD, 31556), which agrees well with *H. armatum*. Other specimens from this area show marginal spines to be less developed than some of the specimens from further east (e.g. Port Phillip, Vic.), but of similar construction.

A consistent feature in all examined specimens of this species is the heavy growth of encrusting coralline algae over the blades, more so than on other Australian species of *Hypoglossum*.

The known range of distribution of this species is similar to that of *H. protendens* and records suggest that both are plants from deep water (usually 20–35 m), possibly with strong water movement.

5. **Hypoglossum protendens** (J. Agardh)J. Agardh 1898: 189. De Toni 1900: 693. Kylin 1924: 9. Lucas 1909: 36. Shepherd & Womersley 1970: 135. Silva *et al.* 1996: 459. Womersley & Shepley 1982: 336, figs 2B, 8.
Delesseria protendens J. Agardh 1894: 67.

FIGS 16F, 20

Thallus (Fig. 20A) medium red, 5–20 cm high, with one to several main axes, usually widely spreading and much branched, mainly abaxially. Base of plant (holdfast and about 1 cm of upright stipe below the point of branching) probably perennial. Main blades becoming denuded below, leaving the heavily corticated midrib as an axis. Mature blades 3–5 mm broad throughout and often with upper curved ends; young blades (Fig. 20B) narrower and tapering to a conical apex, becoming rounded when mature. Holdfast small, discoid; epilithic. *Structure.* Apical development with only the inner (3-) 4–8 second-order cells producing third-order cell rows (Fig. 16F), the mature blades with up to 25 elongate (L/D about 5) cells between midrib and margin. Second- and third-order cell rows run obliquely (about 45° to midrib) across the blade. Margin of mature blade smooth to undulate (Fig. 20B, C), usually with 2 or 3 rows of small isodiametric marginal cells often cut off in pairs from larger submarginal cells; some of the small marginal cells extend to 2 or 3 cells long and project irregularly along the margin (Fig. 20D, G). Midrib becoming corticate on the lower half of the youngest blades by a central band of 6–10 longitudinal corticating filaments. Mature cells multinucleate; rhodoplasts discoid, becoming chained.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophyte with carposporangia formed terminally and usually singly from the sequentially maturing cells of the gonimoblast, ovoid to pyriform, 50–100 μm in diameter. Cystocarps (Fig. 20E) develop on either surface of the smaller blades, hemispherical when young, becoming massive, depressed globular and basally constricted, 1.2–3 mm across with virtually no neck and a small ostiole; pericarp 5 or 6 cells thick. Spermatangial sori (Fig. 20F) covering the blades on either side of the midrib but with sterile areas of varying width along the margins and adjacent to midrib; sterile rows or patches also usually occur within the spermatangial area, running from midrib to margin, especially as sori develop.

Tetrasporangial sori well defined, ovate to elongate and tapering (Fig. 20G), covering the midrib and up to half the marginal width, and with a coherent layer (becoming 2 or 3 cells thick) of cortical cells over the whole sorus. Cortical cells are present when tetrasporangia are initiated. Tetrasporangia first develop acropetally from the lateral pericentral cells, giving two distinct rows of sporangia, then spread laterally from other second- or third-order cells, also developed from both abaxial and adaxial residual transverse pericentral cells though only

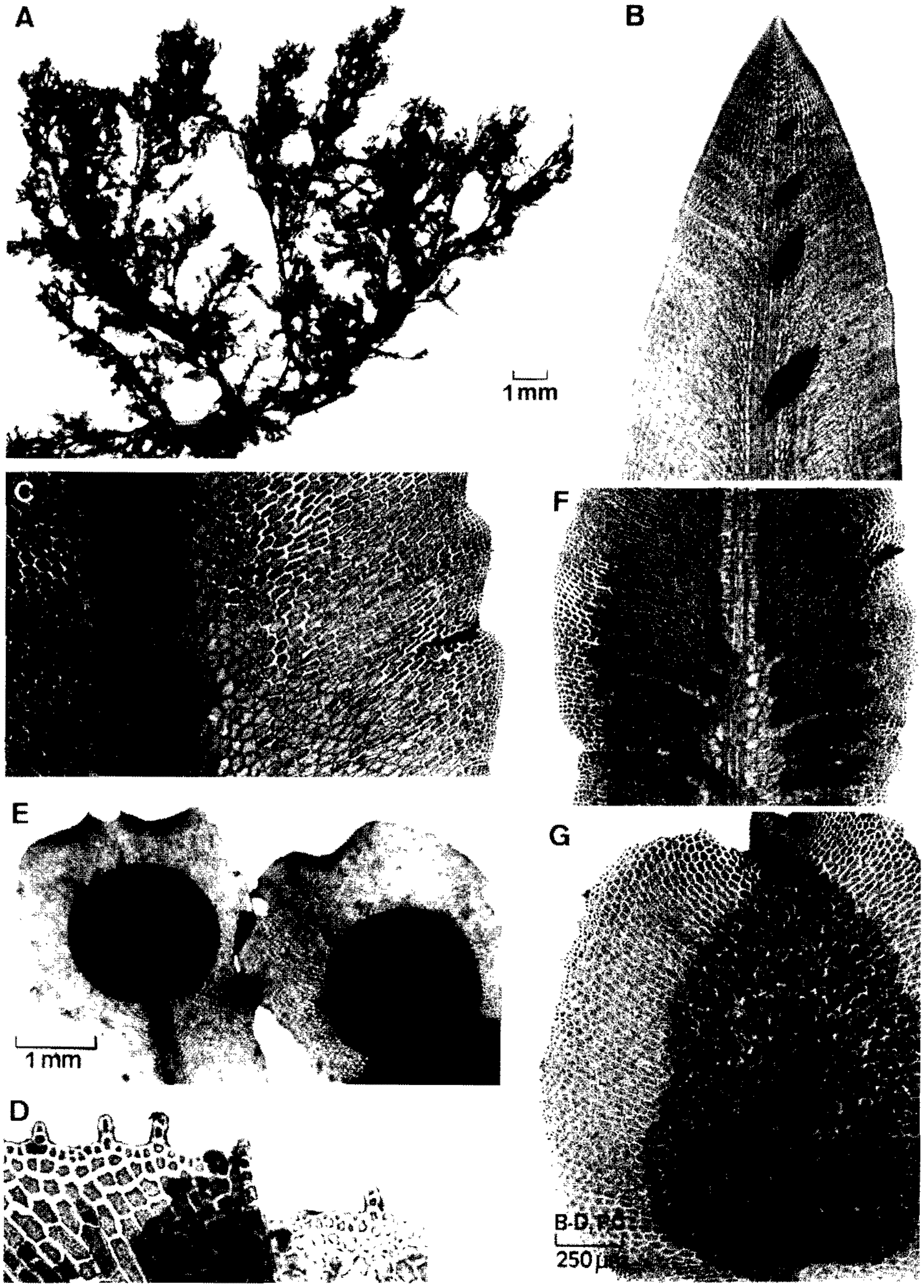

Fig. 20. *Hypoglossum protendens* (**A**, **D**, **G**, AD, A38209; **B**, **C**, **F**, AD, A30812; **E**, AD, A42964). **A**. Habit. **B**. Blade with apex and young blades from midrib. **C**. Part of a mature blade. **D**. Margin of blade with 1–2-celled outgrowths. **E**. Blades with cystocarps. **F**. Blade with spermatangial sori. **G**. Blade with a tetrasporangial sorus. (**A–D**, **F**, **G** as in Womersley & Shepley 1982, courtesy of Aust. J. Bot.)

occasional tetrasporangia mature in these positions. Tetrasporangia do not originate from cortical cells and are usually regularly arranged in the sorus, but sometimes differ in their degree of maturity; tetrasporangia 100–180 µm in diameter.

Type from Port Phillip Heads, Vic. (*Wilson*); lectotype in Herb. Agardh, LD, 31572.

Distribution: Fremantle and the Recherche Arch., W. Aust., to Port Phillip Heads, Victoria.

Selected specimens: Fremantle, W. Aust. (*H. Yabu*, 15.xii.1965; AD, A30634). Oedipus Point, West I., S. Aust., 16 m deep (*Shepherd*, 8.x.1966; AD, A30812—"Marine Algae of southern Australia" No. 403). Seal Rock, West I., S. Aust., 25 m deep (*Shepherd*, 15.iv.1967; AD, A31952). Amphitheatre Rock, West I., S. Aust., 20–22 m deep (*Shepherd*, 1.i.1969; AD, A33246). West I., S. Aust., 25 m deep (*Shepherd*, 29.i.1973; AD, A42964). Investigator Strait, S. Aust., 35 m deep (*Watson*, 14.i.1971; AD, A38209). Port Phillip Heads, Vic. (*Wilson*, 13.i.1883; MEL, 31572 and 11.i.1884; MEL, 10034).

Hypoglossum protendens is based on Wilson specimens from Port Phillip Heads, Vic., which J. Agardh (1894, p. 67) had first referred to as *D. revoluta major* ?

H. protendens agrees with other species of *Hypoglossum* in that all third-order cell rows reach the thallus margin, but differs from most other species in that only the inner (3-) 4–8 second-order cells form third-order rows. The thallus margins are also characteristic, with small isodiametric cells, often two from each of the larger inner cells, and some of these small cells form short 1–3-celled outgrowths (Fig. 20D). The tetrasporangial sori are particularly well defined with a cortex becoming 2 or 3 cells thick and a coherent outer layer of cortical cells; no clear cases have been seen of tetrasporangia originating from cortical cells. Tetrasporangia derived from the transverse pericentral cells do not always mature.

H. protendens resembles *H. dendroides* (see below) in that not all second-order cells form third-order rows, and in the formation of tetrasporangia from the transverse pericentral cells as well as second-order and third-order cells but not from cortical cells. However, *H. protendens* differs clearly from *H. dendroides* in having typical thallus development in fertile blades, whereas the latter taxon bears only single rows of cells from the lateral pericentral cells in female and tetrasporangial blades.

6. **Hypoglossum dendroides** (Harvey)J. Agardh 1898: 186. De Toni 1900: 690. Huisman & Walker 1990: 430. Kylin 1924: 9. Lucas 1909: 36. Shepherd & Womersley 1971: 166; 1981: 366. Silva *et al.* 1996: 458. Womersley & Shepley 1982: 341, figs 2C, D, 9. Wynne 1989a: 514, 515, fig. 1A.

Delesseria dendroides Harvey 1855a: 548; 1860: pl. 137; 1863, synop.: xxxi. J. Agardh 1872: 58; 1876: 491. Sonder 1880: 24.

Membranoptera dendroides (Harvey)Kuntze 1891: 904.

Hydrolapatha dendroides (Harvey)Kuntze 1898: 410.

FIGS 16G, H, 21

Thallus (Fig. 21A) medium to dark red, erect, 5–30 cm high, profusely branched to five or six orders with a heavily corticated, subterete, simple or furcate stipe to 10 cm long and 4–5 mm in diameter. The stipe is developed from the thickened lower midrib and is probably perennial since new fronds arise, often in a cluster, from its upper end. Annual fronds to 25 cm long, the primary blades up to 10 mm broad, bearing opposite pairs of secondary blades. This branching is repeated to the fifth order, all laterals being paired except the ultimate branchlets which are all developed abaxially. Branchlets elongate-ovoid to lanceolate, margins smooth or with irregular cellular projections formed by the simple elongation of occasional marginal cells. Holdfast lacerate or hapteroid, 0.5–1.5 cm across; epilithic. *Structure*. The lateral pericentral cells are formed within 3–5 segments of the apex (Fig. 16G). The transverse pericentral cells are formed 6–9 segments from the apex, being cut off almost simultaneously, but the adaxial one has been observed to form first (Fig. 16H). Only the innermost five or six cells of the second-order cell row produce third-order rows (Figs 16G, 21B, C) and different patterns of development are shown in later-formed blades, changing from the wide primary blades with 20–30 cells in cell rows between the midrib and margin to the narrow ultimate blades where there may be only two large lateral cells associated with each central cell. Near the apices of blades when growth is less active, the lateral pericentral cells form only one row of lateral cells, i.e. there are no third-order rows. The ultimate branches may show marginal (exogenous) branching or proliferation, but only of a very few

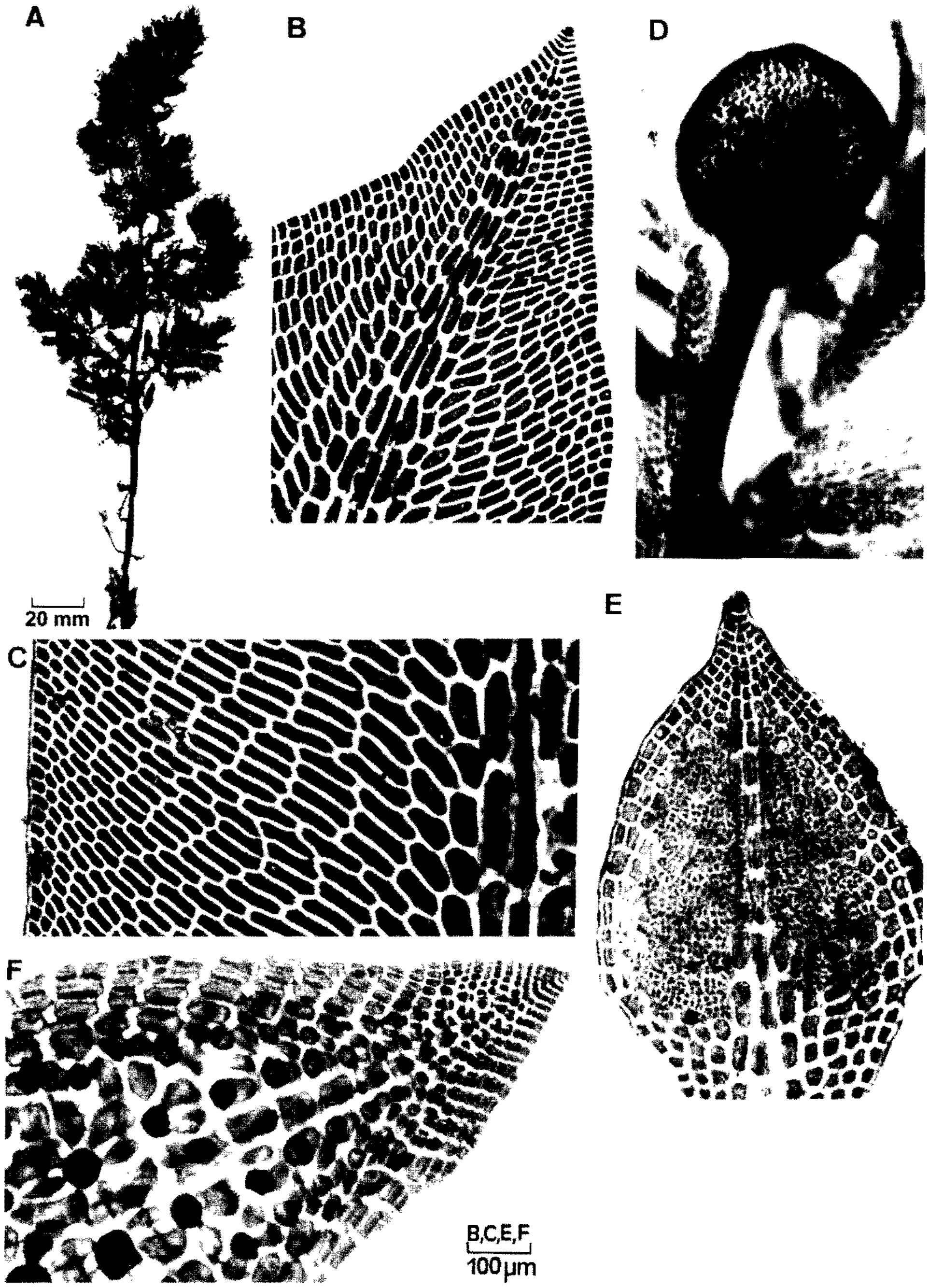

Fig. 21. *Hypoglossum dendroides* (**A**, A13547; **B**, **F**, AD, A37557; **C**, **E**, AD, A46906; **D**, AD, A34435). **A.** Habit. **B.** Blade apex showing segmentation. **C.** Blade with second- and third-order cell rows. **D.** Cystocarp. **E.** Blade with spermatangial sori. **F.** Upper part of tetrasporangial blade. (All as in Womersley & Shepley 1982, courtesy of Aust. J. Bot.)

cells. Midrib cortication is very heavy in the older blades but is variable between the orders of blades and ultimate blades are without midrib cortication. New blades arise from the central cells, but the initiation of a new lateral is preceded by formation of a corticating cell from the transverse pericentral cell; this is the first indication of new blade development. Cells mostly multinucleate; rhodoplasts discoid, in slight chains in larger cells.

Reproduction. Gametophytes dioecious. Procarps are developed on many successive segments of the blade, mainly abaxially, but a few segments near the tip of the blade may have procarps formed from both transverse pericentral cells. The procarp consists of one carpogonial branch of four cells and two groups of sterile cells (one 2-celled, one 1-celled) cut off from the supporting cell. Carposporophyte with a massive fusion complex, carposporangia elongate-clavate, 20–35 µm in diameter, formed singly from the cells of the much branched gonimoblast, maturing sequentially. In the fertile areas of the cystocarpic blades only one lateral cell row develops from each lateral pericentral cell. Cystocarps (Fig. 21D) form abaxially near the tips of penultimate blades. Mature cystocarps 800–1200 µm in diameter, ostiolate, subspherical with a thickened stalk that develops from the heavily corticated lower portion of the fertile blade. The tip of the fertile blade remains visible as a short 'spine' projecting backwards parallel with the stalk of the cystocarp. Pericarp of 2 (-3) layers of cells, the outermost rounded in outline and irregularly arranged; ostiole rim bounded by irregularly shaped cells, not sharply outlined. Spermatangia (one small blade only on AD, A46906 observed) form a central sorus (Fig. 21E) on both sides of blade, with transverse pericentrals, occasionally the lateral pericentrals, and several outer lateral cells undivided. Near the apices of the male blade the lateral pericentral cells produce only one row of cells, but two in fertile regions.

Tetrasporangia develop in regular sori (Fig. 21F) in the smaller blades and each lateral pericentral cell within the tetrasporangial region produces normally only a single row of cells, except occasionally near the margin of the blade. Tetrasporangia are cut off very soon after the two corticating cells (which may later subdivide) and develop in acropetal sequence from the lateral pericentral cells and later from the 1 or 2 adjacent lateral cells (occasionally also from abaxial pericentral cells). The cortical cells remain as a single layer and no corticating cells subsequently form tetrasporangia; thus the tetrasporangia lie in a regular pattern (Fig. 21F). Within the sorus the adaxial pericentral cell remains undivided while the abaxial pericentral cell cuts off first at least one cortical cell and then the tetrasporangial initial; tetrasporangia 50–80 (-180) µm in diameter.

Type from Fremantle, W. Aust., (*Clifton*); holotype in Herb. Harvey, TCD (Trav. Set 269).

Distribution: Fremantle and Rottnest I., W. Aust., to Point Avoid, Eyre Peninsula, S. Australia. A deeper water species, known from 6–38 m deep.

Selected specimens: Eyre, W. Aust., drift (*Parsons*, 22.xi.1968; AD, A34435). Elliston, S. Aust., drift (*Womersley*, 13.i.1951; AD, A13547) and 7 m deep (*Shepherd*, 21.x.1970; AD, A37557). Pearson I., S. Aust., 18 m deep (*Shepherd*, 10.i.1969; AD, A34120). Point Avoid, Eyre Peninsula, S. Aust., drift (*Womersley*, 2.xii.1975; AD, A46906). 15 km SE of Cape Willoughby, Kangaroo I., S. Aust. 38 m deep (*Bone*, 13.iii.1989; AD, A59864).

Harvey (1860, pl. 137) and J. Agardh (1876, p. 491) recognised two varieties of *H. dendroides*. The first, α *lancifolia*, is typical of the species whereas the second, ß *oblongifolia*, is probably not distinct.

H. dendroides is a distinctive species, especially in its regularly opposite branching, restricted number of third-order cell rows and the restriction of lateral cell row development in fertile areas of the blades. The formation, in these areas of both cystocarpic and sporangial blades, of normally only a single lateral cell row in each segment (i.e. third-order rows are absent) separates it from all other species except *H. revolutum*. Other distinctive features are the limited lateral blade development in the final orders of blades (frequently reduced to only the lateral pericentral cell and two 'flanking cells') and the occasional presence of irregular marginal branching in these younger blades.

While *H. dendroides* shows distinctive differences from one or more of the other species of *Hypoglossum*, each feature is shared by at least one other species, e.g. the restricted number of third-order rows in vegetative blades occurs in *H. protendens*, as does the restriction of tetrasporangia to the primary cells and also their formation from transverse pericentral cells. Restriction of third-order rows in fertile blades is also shown in *H. revolutum*. When the similarities in habit, blade development and most reproductive features are considered, it seems best to retain all the above species in *Hypoglossum*.

Genus CHAUVINIELLA Papenfuss 1956: 159

Thallus branched from the midrib, branches more-or-less linear with obtuse apices, becoming heavily corticated; holdfast discoid, becoming fibrous. *Structure*. Apical cells segmenting to give an axial filament and 4 pericentral cells, the lateral ones producing second-order rows (sometimes visible as faint veins) each cell of which forms a third-order row with all rows reaching the blade margin. Transverse section of blades showing irregular arrangement of cortical cells, with large and small cells and rhizoids intermixed.

Reproduction. Reproductive organs borne on small bladelets arising from the midrib. Gametophytes probably dioecious. Procarps on successive transverse pericentral cells, with 2 sterile groups and a carpogonial branch; carposporophytes with a basal fusion cell and few carposporangia. Cystocarps ovoid, sessile and sunken on the midrib of blades, with a thick pericarp and basal and surrounding network tissues, with a conspicuous peripheral space, around the carposporophyte. Spermatangial sori not observed.

Tetrasporangial sori on the small proliferous bladelets, tetrasporangia cut off from mid cortical cells and covered by small outer cortical cells, subspherical, tetrahedrally divided.

Type species: *C. coriifolia* (Harvey)Papenfuss 1956: 159.

A genus of 2 species, the type from Australia and *C. jadinii* (Børgesen)Papenfuss (1956, p. 159) from Mauritius. Both species merit further detailed study.

Confusion involving the names *Chauvinia* Harvey, *Chauvinia* Bory, *Phitymophora* J. Agardh and *Vinassaella* G. de Toni was discussed by Papenfuss (1956), who renamed the genus *Chauviniella*.

Chauviniella coriifolia (Harvey)Papenfuss 1956: 159. Huisman & Walker 1990: 429. May 1965: 399. Shepherd & Womersley 1981: 366. Silva *et al.* 1996: 453. Wynne 1989a: 522, fig. 7A–E; 1996: 179.

Delesseria coriifolia Harvey 1855a: 548; 1860: pl. 150. J. Agardh 1876: 495. Reinbold 1898: 47. Sonder 1880: 24. Tate 1882a: 20.

Chauvinia coriifolia (Harvey)Harvey 1862: comments with pl. 240; 1863, synop.: xxx. J. Agardh 1898: 152. De Toni 1900: 696. Kylin 1924: 13, fig. 6a, b. Lucas 1909: 36; 1929b: 50. Lucas & Perrin 1947: 230, fig. 93. Womersley 1950: 183.

Membranoptera coriifolia (Harvey)Kuntze 1891: 904.

Hydrolapatha coriifolia (Harvey)Kuntze 1898: 410.

Vinassaella coriifolia (Harvey)G. de Toni 1936: 5. Kylin 1956: 432.

Sarcomenia delesserioides ? sensu Harvey 1847: 21.

FIGS 22, 23

Thallus (Fig. 22A) medium to dark red, 10–30 cm high, much branched from the midrib with flat, more-or-less linear branches 2–8 cm long and 4–12 mm broad, with obtuse apices; blades 100–200 μm thick. Axes and lower branches becoming heavily corticated, stipes compressed to subterete, 1–3 mm across. Holdfast discoid, becoming fibrous, 2–10 mm across; epilithic. *Structure*. Apical cells dome-shaped, segmenting (Fig. 22C) to produce first 2 lateral pericentral cells then 2 transverse pericentral cells, the lateral cells producing second-order cell rows (sometimes visible as faint veins) with each cell producing a third-order row, all of which reach the blade margin (Fig. 22D). Cortication (Fig. 22F, G) of the midrib and blades commencing early, becoming 2–3 cells thick, cells irregularly placed (Fig. 22E) with larger and smaller cells and rhizoids, outer cells more or less isodiametric, 4–6 μm across; stipes pseudoparenchymatous, cells and rhizoids intermixed (Fig. 23A). Cells multinucleate; rhodoplasts discoid.

Reproduction. Reproductive organs borne in small clustered bladelets arising on the midrib (Fig. 22B).

Gametophytes dioecious. Procarps formed on successive transverse pericentral cells on one side of blades, each with 2 sterile groups and a 4-celled carpogonial branch. Carposporophytes with a basal network of separated cells and surrounded by a lesser network

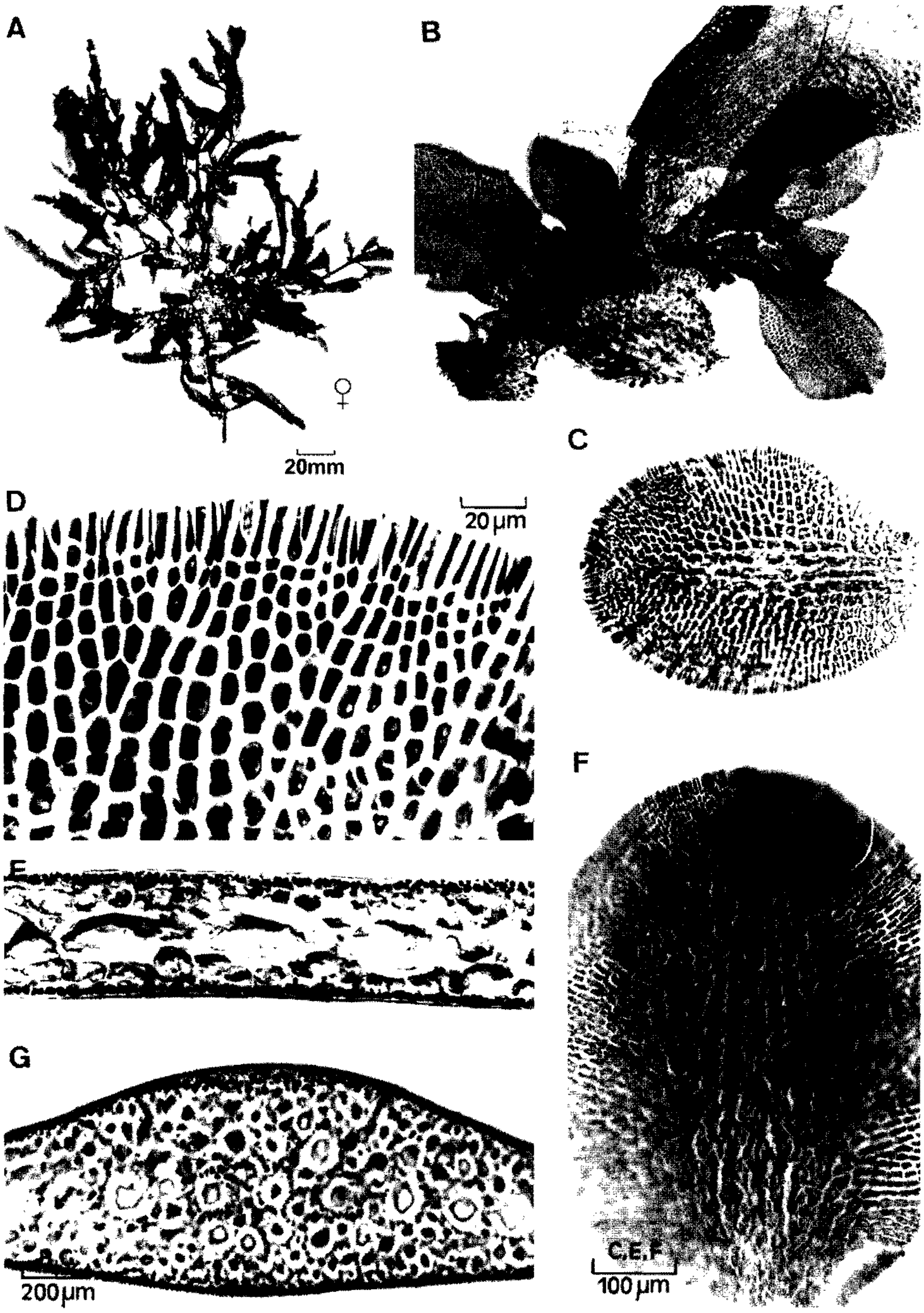

Fig. 22. *Chauviniella coriifolia* (**A**, **B**, AD, A42424; **C**, **D**, **F**, AD, A29272; **E**, AD, A30521; **G**, A67901). **A**. Habit. **B**. Proliferations from midrib. **C**. Young proliferation showing segmentation. **D**. Second-order rows with each producing a third-order row. **E**. Transverse section of young thallus with irregular cells. **F**. Blade with corticated central region. **G**. Transverse section of midrib region.

of elongate, mostly anticlinal, cells which extend to the surface of the blade around the ostiole (Fig. 23B); this lesser network is surrounded by a conspicuous space as seen in sectional view (Fig. 23B); carposporophytes themselves (Fig. 23B) little branched, with a basal fusion cell and few carposporangia. Cystocarps sunken within the swollen blade, ovoid, with a pericarp several cells thick (such cystocarps doubtfully mature). Spermatangia not observed.

Tetrasporangial sori round to ovate, covering most of small proliferous bladelets (Fig. 23C), cortex 3–4 cells thick, tetrasporangia cut off from mid cortical cells (Fig. 23D), with an outer cortical layer of small cells; tetrasporangia subspherical, 45–65 μm in diameter.

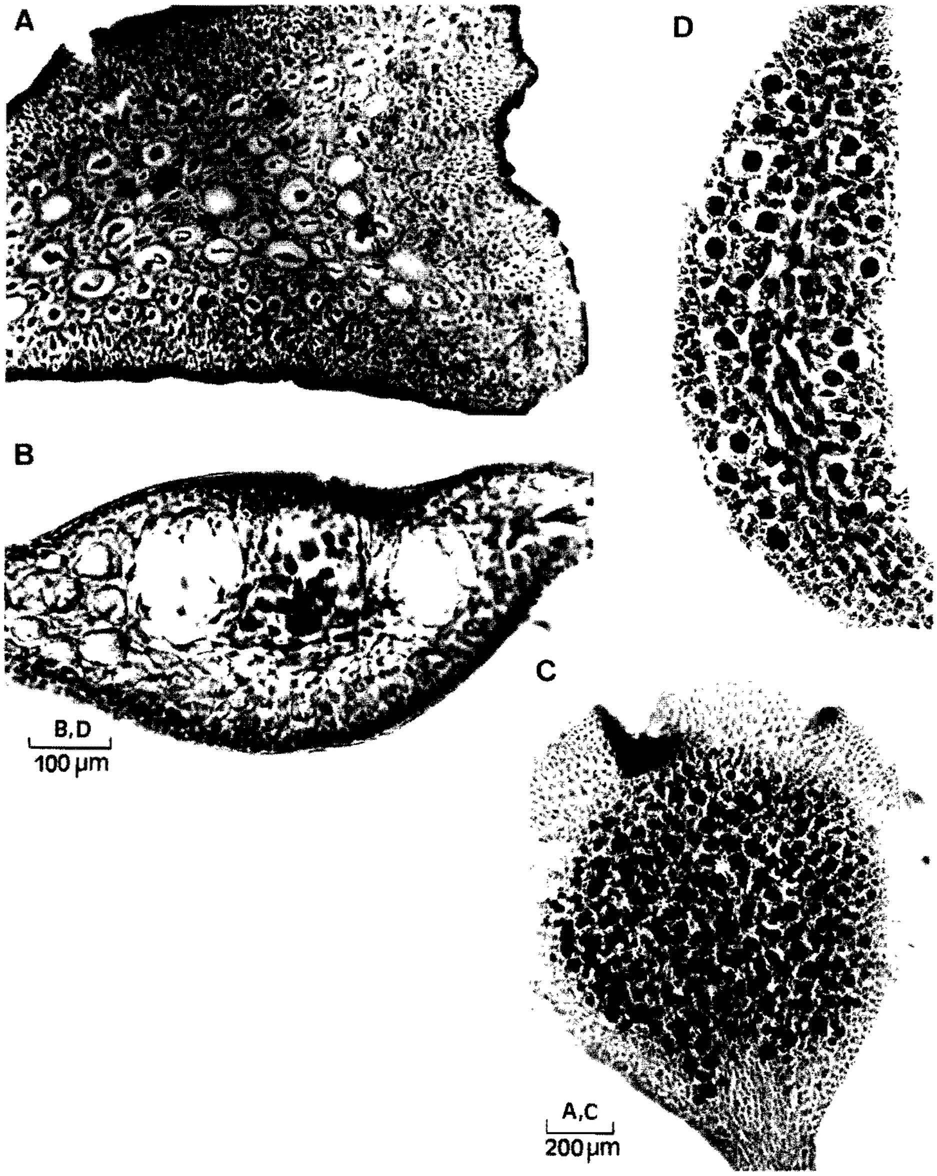

Fig. 23. *Chauviniella coriifolia* (**A**, **B**, AD, A42424; **C**, AD, A67901; **D**, AD, A29272). **A**. Transverse section of stipe. **B**. Cross section of cystocarp. **C**. Tetrasporangial bladelet. **D**. Section of bladelet with irregularly placed tetrasporangia.

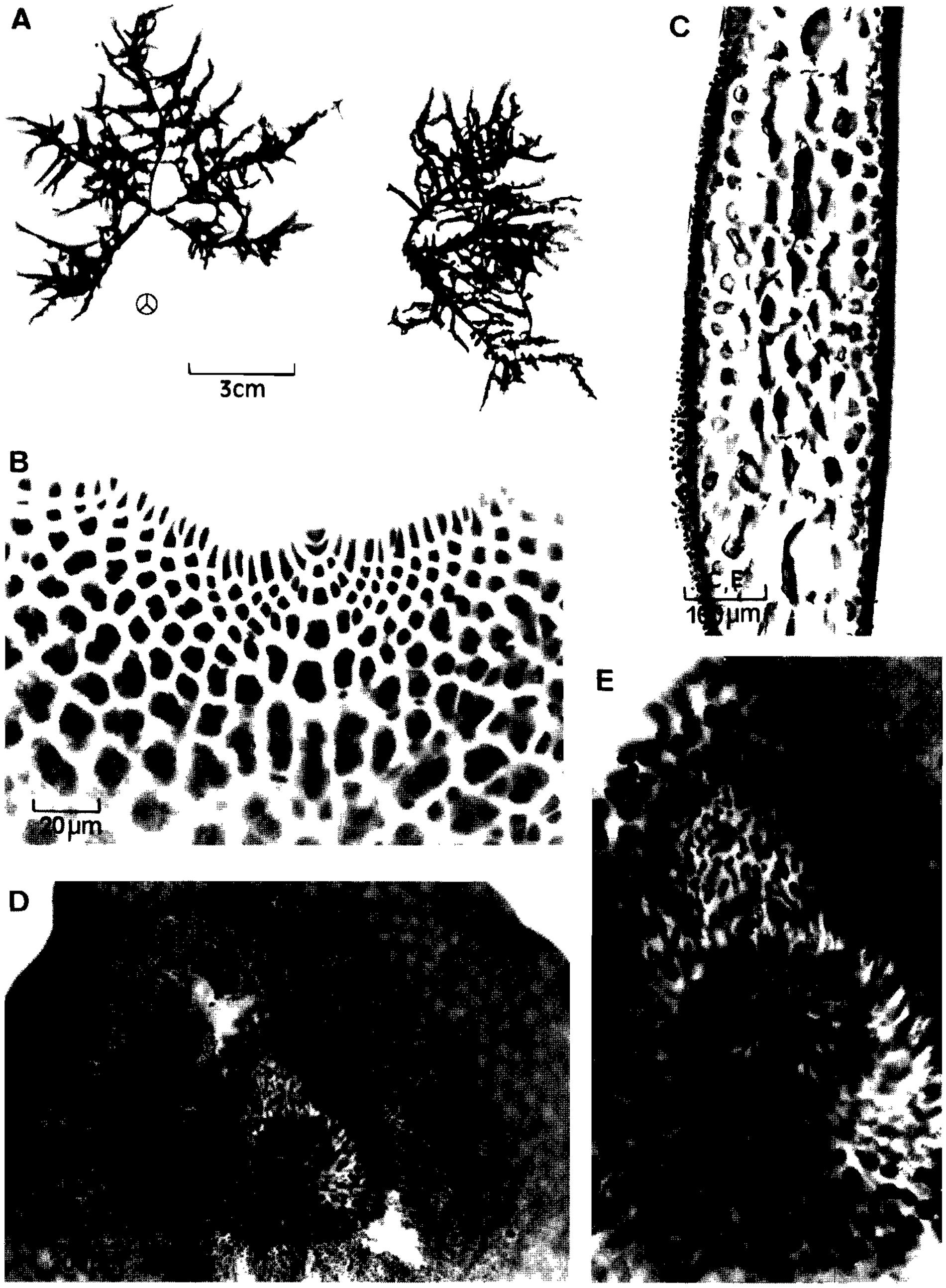

Fig. 24. *Phitymophora amansioides* (**A**, AD, A66667; **B**, **D**, **E**, AD, A57077; **C**, AD, A42970). **A**. Habit. **B**. Apex of blade showing segmentation. **C**. Transverse section of central region with irregular cells. **D**. Cystocarp. **E**. Carposporophyte with central fusion cell and peripheral carposporangia.

Type from Garden and Rottnest Is, W. Aust. (*Harvey*, Trav. Set 279); such specimens missing from Harvey's Trav. Set and in TCD; specimen from Fremantle selected as lectotype (1952).

Distribution: Port Denison, W. Aust., to Port Fairy, Victoria.

Selected specimens: Port Denison, W. Aust., drift (*Kraft* 4130, 14.xii.1971; AD, A41788). Safety Bay, W. Aust., drift (*Womersley*, 23.viii.1947; AD, A5825). Eyre, W. Aust., drift (*Gordon*, 22.xi.1968; AD, A34253). Elliston, S. Aust., 7 m deep (*Shepherd*, 22.v.1998; AD, A67901). Avoid Bay, S. Aust., drift (*Womersley*, 30.xi.1975; AD, A46829) and (*Ricci*, 12.ii.1994; AD, A63340). Price I., Point Avoid, S. Aust., 21 m deep (*Branden*, 6.i.1989; AD, A59975). Stenhouse Bay, S. Aust., drift (*Womersley*, 9.iv.1950; AD, A16093). Port Elliot, S. Aust., drift (*Mitchell*, 19.v.1966; AD, A30521). Seal Bay, Kangaroo I., S. Aust., drift (*Kraft*, 6.iv.1972; AD, A42424). Stanley Beach, Kangaroo I., S. Aust., drift (*Womersley*, 6.ii.1957; AD, A20920). Boatswain Point, Guichen Bay, S. Aust., drift (*Womersley*, 17.v.1965; AD, A29272). Robe, S. Aust., drift (*Womersley*, 15.iv.1959; AD, A23018). Port Fairy, Vic. (MEL, 10044).

The carposporophyte and surrounding tissues clearly merit further study in more mature specimens and may be distinctive for the Delesseriaceae.

Genus PHITYMOPHORA J. Agardh 1898: 173

Thallus branched from the midrib, with more-or-less linear, corticated, secondary and tertiary branches bearing central rows of numerous small, ovate bladelets on both sides; holdfast discoid; usually epiphytic. *Structure*. Apical cells segmenting to give an axial filament and 4 pericentral cells, the lateral cells producing second-order rows with the inner cells and occasional outer cells (but not all) forming third-order rows, with all rows reaching the blade margin. Transverse sections of blades show intermixed large and small cells and rhizoids.

Reproduction. Reproductive organs borne on the small, ovate, bladelets on the midrib. Gametophytes dioecious. Procarps borne in series on transverse pericentral cells, with 2 sterile groups and a carpogonial branch; carposporophyte with a basal fusion cell and short terminal chains of carposporangia. Cystocarps ovoid, sessile on the midrib of bladelets, with a corticated pericarp. Spermatangial sori covering both sides of the bladelets, spermatangia cut off from outer cortical cells.

Tetrasporangia in sori on both sides of the bladelets, cut off from inner cortical cells in 2 irregular layers, subspherical, tetrahedrally to decussately divided.

Lectotype species: *P. imbricata* (Areschoug)J. Agardh 1898: 174 [= *P. amansioides* (Sonder)Womersley].

A genus of 3 species, the type and *P. hypoglossum* from Australia, and *P. linearis* (Laing)Kylin (1924, p. 13) from New Zealand, described in detail by Wagner (1954, p. 291, figs 37–57).

KEY TO SPECIES OF *PHITYMOPHORA*

1. Thallus slender but firm, much branched with frequent proliferations, branches 2–3 (-5) mm broad and (80-) 100–140 μm thick, midrib slight .... 1. *P. amansioides*
1. Thallus relatively robust, cartilaginous, with occasional proliferations, branches 3–6 mm broad and (140-) 200–300 μm thick, midrib prominent.......................... 2. *P. hypoglossum*

1. **Phitymophora amansioides** (Sonder)Womersley 1965: 436. Ducker *et al.* 1977: 87. King *et al.* 1971: 123. Millar & Kraft 1993: 48. Saenger 1974: 81. Silva *et al.* 1996: 464. Wynne 1989a: 525, fig. 8A–D. Wynne & Scott 1989: 25. Wynne 1996: 181.
Delesseria amansioides Sonder 1853: 690.
Delesseria imbricata Areschoug 1854: 346. J. Agardh 1872: 59; 1876: 494. Reinbold 1897: 54. Sonder 1880: 24. Tate 1882a: 20. Tisdall 1898: 509. Wilson 1892: 174.
Chauvinia imbricata (Areschoug)Harvey 1862: pl. 240; 1863, synop.: xxxi. J. Agardh 1898: 150. Schmitz & Hauptfleisch 1897: 414.
Phitymophora imbricata (Areschoug)J. Agardh 1898: 174. De Toni 1900: 698. Guiler 1952: 101. Kuehne 1946: 35, figs 8, 13, 14. Kylin 1924: 13; 1956: 432, fig.

314B. Lucas 1909: 37; 1913: 58;1929a: 20; 1929b: 50. Lucas & Perrin 1947: 230. May 1965: 399. Womersley 1950: 183; 1966: 153.
Delesseria rigida Kützing 1869: 4, pl. 10c–e.

FIGS 24, 25

Thallus (Fig. 24A) medium to dark red, 5–10 (-15) cm high, much branched from the midrib with linear, corticated, secondary and tertiary branches 1–8 cm long and 2–3 (-5) mm broad, bearing central rows of numerous small, ovate, bladelets 1–2 mm long, with short terete stipes, and which bear the reproductive organs. Holdfast discoid, 1–3 mm across; usually epiphytic on stems of *Amphibolis*. *Structure*. Apical cells obconical, segmenting (Fig. 24B) to give an axial row with each cell cutting off first 2 lateral pericentral cells then 2 transverse ones, the lateral cells forming second-order rows with the inner 2–4 cells of the upper rows forming third-order rows and some (but not all) of the outer second-order rows also forming third-order rows; all rows reaching the blade margins. Cortication commencing early and becoming complete over the whole blade, 3–4 cells thick over the wings (thicker with elongate cells over the midrib), with large and small cells and rhizoids intermixed (Fig. 24C); inner (primary) cells becoming 80–100 μm across, more or less isodiametric, with the outer cortical cells angular and mostly 10–15 μm across. Cells uni- to multinucleate; rhodoplasts discoid.

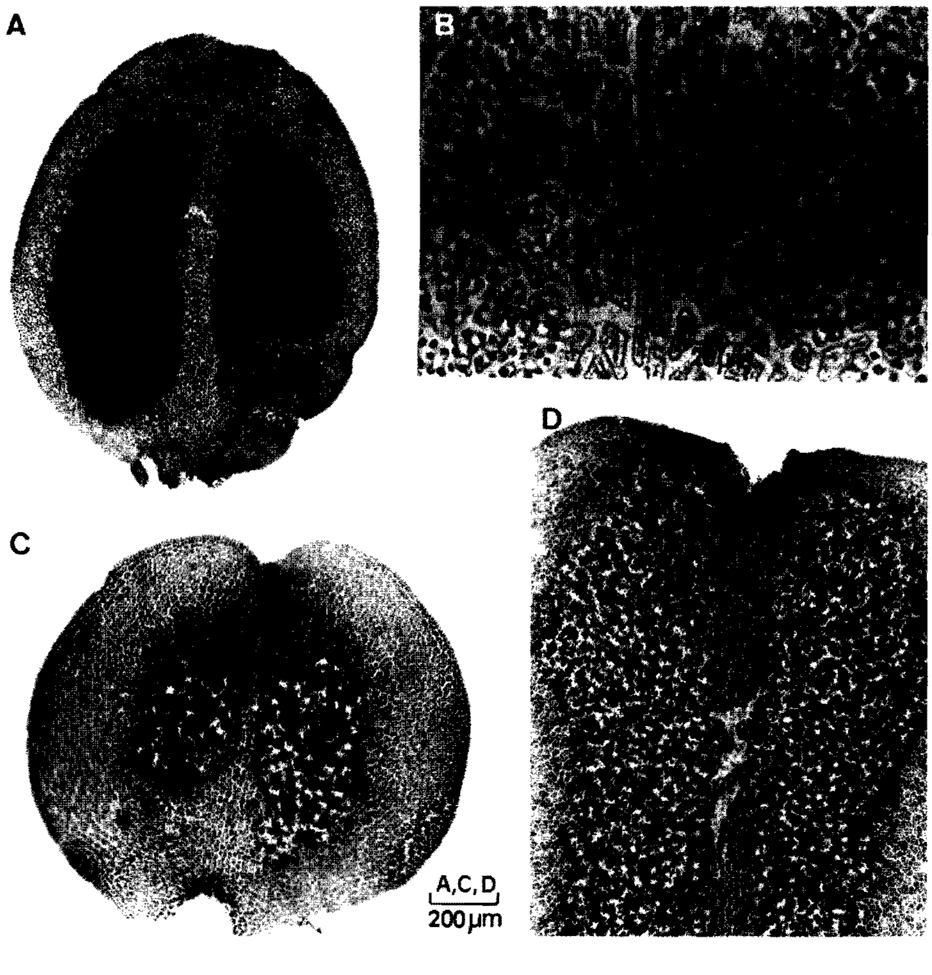

Fig. 25. *Phitymophora amansioides* (AD, A54297). **A**. Spermatangial bladelet. **B**. Spermatangial sori on sides of midrib. **C**. Tetrasporangial bladelet. **D**. Tetrasporangial sori.

Reproduction. All reproductive organs borne on the small ovate blades on the midrib.

Gametophytes dioecious. Procarps borne in series on transverse pericentral (supporting) cells, with 2(?) sterile groups and a 4-celled carpogonial branch. Carposporophyte (Fig. 24E) much branched with a basal fusion cell and short terminal chains of ovoid carposporangia 15–25 µm in diameter. Cystocarps (Fig. 24D) hemispherical, 0.7–1 mm across, with corticated pericarp 4–5 cells thick and a small ostiole. Spermatangial sori (Fig. 25A, B) covering both sides of the small bladelets, sometimes spreading over the midrib, with spermatangia cut off from outer cortical cells.

Tetrasporangial sori (Fig. 25C, D) on both sides of the bladelets, usually adjacent to the sterile midribs and sterile outer half or more of the bladelets, tetrasporangia cut off from inner cortical cells in 2 irregular layers of differing ages, with smaller outer cortical cells; tetrasporangia subspherical, 30–45 µm in diameter, tetrahedrally to decussately divided.

Type from Encounter Bay, S. Aust. (*Mueller*); holotype (tetrasporangial) in MEL, 4389, syntypes (cystocarpic) in MEL, 4388, 4390.

Distribution: Waterloo Bay, S. Aust. to Walkerville, Victoria, and to Twofold Bay, N.S.W.
Ile Amsterdam, S Indian Ocean (Wynne & Scott 1989).

Selected specimens: Waterloo Bay, S. Aust., 4 m deep (*Shepherd*, 26.ii.1978; AD, A54984). Port Elliot, S. Aust., on *Amphibolis*, drift (*Hussey*, Nov. 1898; AD, A36074). Seal Bay, Kangaroo I., S. Aust., drift (*Kraft*, 4.xii.1971; AD, A41432). Pennington Bay, Kangaroo I., S. Aust., sublittoral fringe (*Womersley*, 5.i.1947; AD, A4385). 600 m off Middle Point, Cape Northumberland, S. Aust., 5 m deep (*Shepherd & Johnson*, 19.iii.1974; AD, A44923). Robe, S. Aust., on *Amphibolis* near jetty, 1–2 m deep (*Womersley*, 11.ii.1973; AD, A42970; 12.ix.1983; AD, A54297) and 0.5–1 m deep (*Reimers*, 22.ii.1986; AD, A57077). Blackfellows Caves, S. Aust., on *Amphibolis*, drift (*Womersley*, 29.ix.1996; AD, A66667 and 20.xi.1998; AD A68038—"Marine Algae of southern Australia" No. 405). Whalers Point, Portland, Vic., on *Amphibolis*, drift (*Muir*, 17.i.1950; AD, A15718). Point Lonsdale, Vic., drift (*Sinkora* A1013, 14.xi.1970; AD, A62695). Walkerville, Vic., on *Amphibolis*, drift (*Sinkora* A2111, 28.ii.1975; AD, A48402).

P. amansioides is a common and distinctive species, usually on stems of *Amphibolis*.

The type of *D. rigida* Kützing is in MEL, 4384, based on a Harvey, Alg. Aust. Exsicc. 276E from Port Phillip Heads, Vic.; it is typical *P. amansioides*.

2. **Phitymophora hypoglossum** (J. Agardh)Womersley & Phillips *in* Phillips (2002a: 200, figs 12–14)

Lenormandia hypoglossum J. Agardh 1890: 66. De Toni 1903: 1114. Lucas 1909: 46. Lucas & Perrin 1947: 300. May 1965: 397.

FIG. 26

Thallus (Fig. 26A) dark red, 10–25 cm high, with a main axis bearing from the prominent midrib on both sides linear lateral branches 1–5 cm long, with occasional shorter proliferations; blades 3–6 mm broad and (140-) 200–300 µm thick, corticated, margins entire, slightly undulating when dried, basally constricted to a short terete stipe, apically rounded (Fig. 26B). Holdfast discoid, 3–5 mm across. *Structure*. Apical cell segmenting to give an axial row with 2 lateral and 2 transverse pericentral cells, the lateral cells forming 2 second-order rows with the upper rows producing third-order rows (Fig. 26C, D) from some but not all cells, all rows reaching the thallus margin. Surface view of blades show two rows of larger rectangular cells alongside the axial row of the midrib (Fig. 26B) and small, irregular cortical cells over both the wings (Fig. 26G) and the midrib (Fig. 26D); sectional views of the margins show a row of large central cells with a cortex 1–2 cells thick (Fig. 26E, F), with the thicker midrib consisting of irregular large and small cells. Rhodoplasts discoid.

Reproduction. Only cystocarps known, on short proliferations arising from the midrib.

Type from Geographe Bay, W. Aust. (*Irvine*); lectotype in Herb. Agardh, LD, 42692, with isolectotypes; isolectotype in MEL, 657594; AD, A18278.

Distribution: Also known from Hamelin Bay, W. Aust. (*White*, July 1898; Herb. Bastow, MEL, 657595, 657596).

Determination of *L. hypoglossum* as a member of the Delesseriaceae and not a species of *Lenormandia* was first recognised by Louise Phillips of the Melbourne University Botany

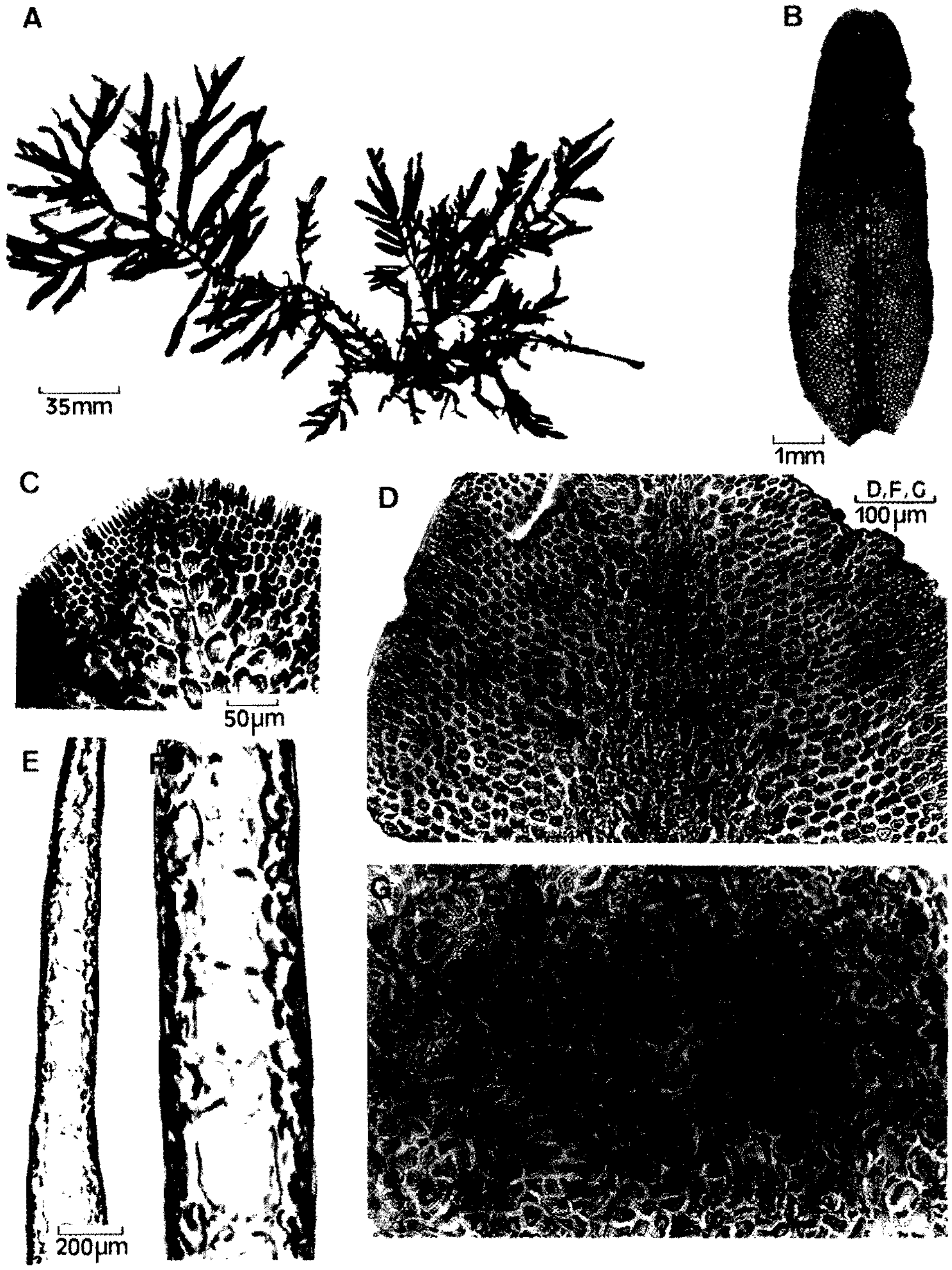

Fig. 26. *Phitymophora hypoglossum* (**A**, LD, 42692, lectotype; **B**, **C**, MEL, 657594, by L. Phillips; **D–G**, AD, A18278, isolectotype fragment). **A**. Habit. **B**. Blade, showing midrib and wing cells. **C**. Blade apex with corticated midrib and ecorticate second and third-order rows. **D**. Near apex of blade with first to third order cell rows. **E**. Transverse section of young blade. **F**. Transverse section of older blade. **G**. Surface pattern of cortication.

School, who was monographing the genus *Lenormandia*. While reproductive material is little-known (cystocarpic only), it agrees in apical development, cortication, and branching from the midrib with *Phitymophora*, but is a distinctly more robust and less regularly proliferous species than *P. amansioides*.

Genus HARALDIA J. Feldmann 1939: 5, figs 1–3.

Thallus slender, complanately and irregularly marginally branched, branches flat, more or less linear, margins usually spinose; holdfast uncertain. *Structure.* Growth from terminal and marginal apical cells which segment transversely, the derivative cells dividing laterally with frequent intercalary divisions but without clear axial cells or lateral rows, the blades monostromatic with irregular cell arrangement in surface view; cells relatively large, multinucleate.

Reproduction. Gametophytes probably dioecious (but not well known). Procarps scattered, undescribed except for *H. australica* (see below) which has a cover cell group, a 4-celled carpogonial branch and a sterile group, carposporophytes with a basal fusion cell, moderately branched gonimoblast and large terminal carposporangia, and ostiolate hemispherical cystocarps with a thin, large-celled, pericarp. Spermatangial sori (in the type) scattered, inadequately described.

Tetrasporangial sori scattered, mostly centrally on the branches, ovate to elongate, with tetrasporangia probably in 2 layers (in the type) or in one layer (in *H. australica*), covered by outer cortical cells.

Type species: *H. lenormandii* (Derbès & Solier)J. Feldmann 1939: 5.

A genus of 3 species, the type, *H. tenuis* Oliveira (1969, p. 97) from Brazil, and a newly described species, *H. australica*, from Kangaroo Island. *Haraldia prostrata* Dawson *et al.* (1960, p. 25) from Baja California, was transferred by Wynne (1990, p. 330) to *Myriogramme*. Reproductive features of the type species are poorly known, especially the gametophytic plants, but the thallus structure with terminal and lateral apical cells segmenting transversely to give an irregularly arranged monostromatic blade lacking any veins appears characteristic.

Haraldia australica Womersley, *sp. nov.*

FIGS 27, 41A

Thallus (Fig. 27A) rose-red, tufted, 5–12 cm high, much branched laterally from the margins and more or less complanately, branches 2–5 mm broad, tapering slightly to 2–3 mm broad near the apices, margin with small, spinous, irregularly spaced laterals each with an apical cell; veins absent; blades monostromatic. Holdfast unknown; probably epilithic. *Structure.* Growth from small but distinct apical cells (Fig. 27B, C) which segment with a curved to straight wall, the derivative laterally elongate cell then dividing transversely to give 2–4 cuboidal cells; no axial filament is apparent and the lateral cells do not form distinct rows (Fig. 27B), but intercalary divisions occur in the immediate and lateral derivatives. Mature cells angular, often in longitudinal lines, 30–60 µm across and L/D 1–2; marginal cells isodiametric, 15–25 µm across. Cells multinucleate; rhodoplasts discoid, becoming chained.

Reproduction. Gametophytes probably dioecious. Procarps (Fig. 41A) scattered, each with a 2-celled cover-cell group, a 4-celled carpogonial branch and a 3-celled sterile group, the carpogonial branch lying between the 2 groups (Fig. 27D). Carposporophytes with a basal fusion cell and moderately branched gonimoblast with large, clavate to ovoid, terminal carposporangia (Fig. 27E, F) 45–110 µm in diameter. Cystocarps scattered, 0.5–1 mm across, hemispherical; pericarp ostiolate, 2–3 cells thick, cells relatively large, 30–50 µm across. Spermatangial thalli unknown.

Tetrasporangial sori (Fig. 27G) scattered, mostly just within the margins or near the base of laterals, ovate, 350–650 µm across, with tetrasporangia cut off from the primary cells and lying between them more or less in one layer of mixed ages, covered on each side by an adherent layer of cortical cells; tetrasporangia subspherical, (50-) 80–150 µm in diameter.

Diagnosis: Thallus caespitosus, 5–12 cm altus, ramosissimus ad marginem et complanate, rami 2–5 mm lati, margo parvis et spinosis lateralibus; nervi absentes, laminae monostromaticae. Crescens ex cellulis apicalibus segmententibus muro exigue curvato, cellula

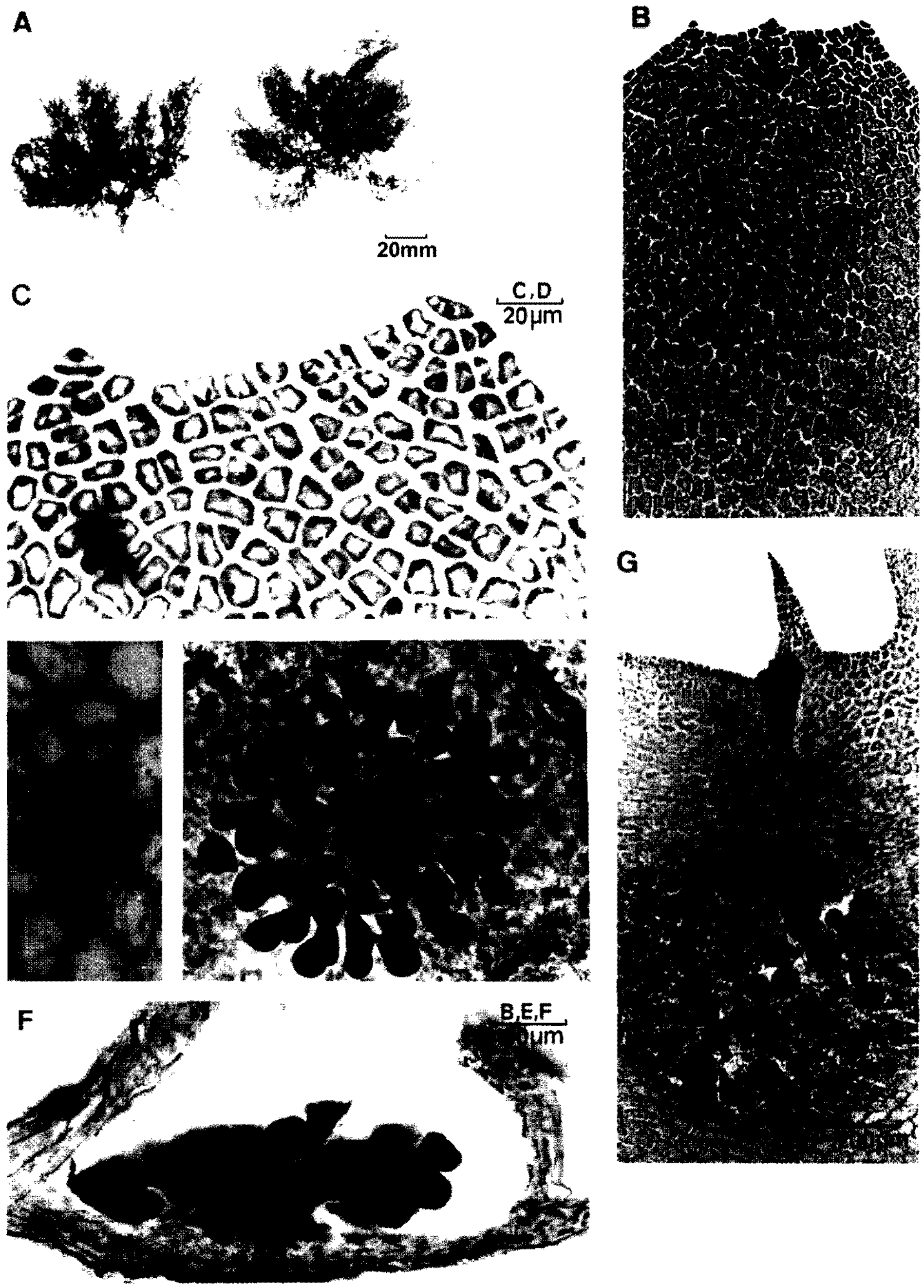

Fig. 27. *Haraldia australica* (**A–D**, **G**, AD, A30838; **E**, **F**, AD, A15370). **A**. Habit. **B**. Branch apex with apical cells. **C**. Apical cells and segmentation. **D**. Procarp with a 3-celled sterile cell group (on left), a 4-celled carpogonial branch and a 2-celled cover cell group (on right). **E**. Cystocarp with large terminal carposporangia, from above. **F**. Cystocarp, sectional view. **G**. Tetrasporangial sorus.

oriunda dividens transverse in 2–4 cellulas sine filamento manifesto axiali nec cellulis lateralibus in serie distincta; divisiones intercalares praesentes.

Procarpia dispersa, omnia turma bicellari tecta et turma tricellari sterili; carposporangia terminalia, clavata ad ovoidea; cystocarpia dispersa, 0.5–1 mm lata, pericarpium 2–3 cellulas crassum. Spermatangia non nota. Sori tetrasporangiales admodum intra margines dispersi, ovati, 350–650 µm lati, tetrasporangia ex cellulis primariis abscissa, interiecta in strato singulari varii aetatis, tecta cellulis corticalibus (50-) 80–150 µm diametro.

Type from American R. inlet, Kangaroo I., S. Aust., drift at jetty (*Womersley*, 31.x.1966); holotype in AD, A30838.

Distribution: Only known from American R. inlet, Kangaroo I., S. Australia; not collected recently.

Selected specimens: Muston, American R. inlet, Kangaroo I., S. Aust., upper sublittoral (*Womersley*, 2.xi.1947; AD, A6129, 29.xii.1949; AD, A12912, 27.viii.1950; AD, A15370, 27.viii.1950; AD, A15374, and 22.viii.1963; AD, A26977).

Haraldia australica differs from the type species and *H. tenuis* in habit, being more irregularly branched.

Genus HETERODOXIA J. Agardh 1898: 127

Thallus complanately and marginally branched with flat branches alternately positioned, margins with irregular dentations, with a well developed midrib connected throughout the thallus; holdfast fibrous. *Structure*. Apical cells segmenting to give an axial filament and lateral and transverse pericentral cells, the lateral ones forming second-order cell rows with some cells cutting off adaxial and abaxial cells which form a broad blade of irregularly arranged primary cells; margin with short, simple or branched, outgrowths forming the dentations. Young blades monostromatic between the veins. Cortication of the midrib by anticlinal filaments of small cells and of the blade by 1 (-3) layers of cells, inner cortical cells dimidiate, outer cells then equivalent.

Reproduction. Gametophytes dioecious. Procarps scattered on the blades or on small leaflets from the midribs, with a 4-celled carpogonial branch and sterile groups; carposporophytes with a basal fusion cell and branched gonimoblast filaments with terminal chains of carposporangia. Cystocarps sunken in the blade, ostiolate, with a thick pericarp of anticlinal filaments of cells. Spermatangial sori on the blade surface, with the cortical cells cutting off initials with outer spermatangia.

Tetrasporangial sori scattered, with tetrasporangia cut off from inner cortical cells on both sides of the blade, with short anticlinal rows of outer cortical cells.

Type (and only) *species*: *H. denticulata* (Kuntze)J. Agardh 1898: 131.

Silva *et al.* (1996, p. 456) discuss the authorship of the type species, treating *Membranoptera delicatula* Kuntze as a new name.

Heterodoxia denticulata (Kuntze)J. Agardh 1898: 131. De Toni 1900: 697. Fuhrer *et al.* 1981, pl. 31. Huisman 1997: 201; 2000: 149. Huisman & Walker 1990: 429. Kylin 1924: 45, fig. 35b; 1956: 441. Lucas 1909: 36. May 1965: 401. Mazza 1926: No. 884. Shepherd & Womersley 1981: 366. Silva *et al.* 1996: 456. Wynne 1989a: 522, fig. 7F; 1996: 179.

Delesseria denticulata Harvey 1855a: 548, nom. illegit; 1863, pl. 244, synop.: xxxi. J. Agardh 1872: 59; 1876: 495. Reinbold 1897: 54. Sonder 1880: 24.

Membranoptera denticulata Kuntze 1891: 904.

Hydrolapatha denticulata (Kuntze)Kuntze 1898: 410.

Hypoglossum denticulatum J. Agardh *sensu* Lucas 1929b: 50; Lucas & Perrin 1947: 229, fig. 92.

FIGS 28, 29A–D

Thallus (Fig. 28A) medium red to dark red-brown, (5-) 10–20 cm high, complanately and alternately marginally branched with well-developed midribs, branches 3–8 mm broad with delicate, slightly ruffled, wings with finely and irregularly dentate margins; wings lost below leaving a branched, subterete to compressed stipe 1–3 mm thick developed from the midrib. Holdfast fibrous, much branched, 5–15 mm across; epilithic. *Structure*. Growth by means of an obconical apical cell segmenting to give axial cells and within 1 or 2 segments lateral and transverse pericentral cells, the lateral pericentral cells forming second-order rows with the cells cutting off adaxial and abaxial cells or rows which develop rapidly to form a blade which overarches the apical cell (Fig. 28B); some marginal cells develop further to form the irregular, simple or branched, slender dentations. Cortication of the midrib (Fig. 28C) commences early, becoming many cells thick with anticlinal rows of small isodiametric cells 12–18 µm in diameter, overlying the central layer of larger cells 40–60 µm across; blades at first monostromatic but cortication also commencing early, becoming 3 cells thick generally and 5 cells thick near the midribs (primary cells angular, 20–35 µm across), with the inner

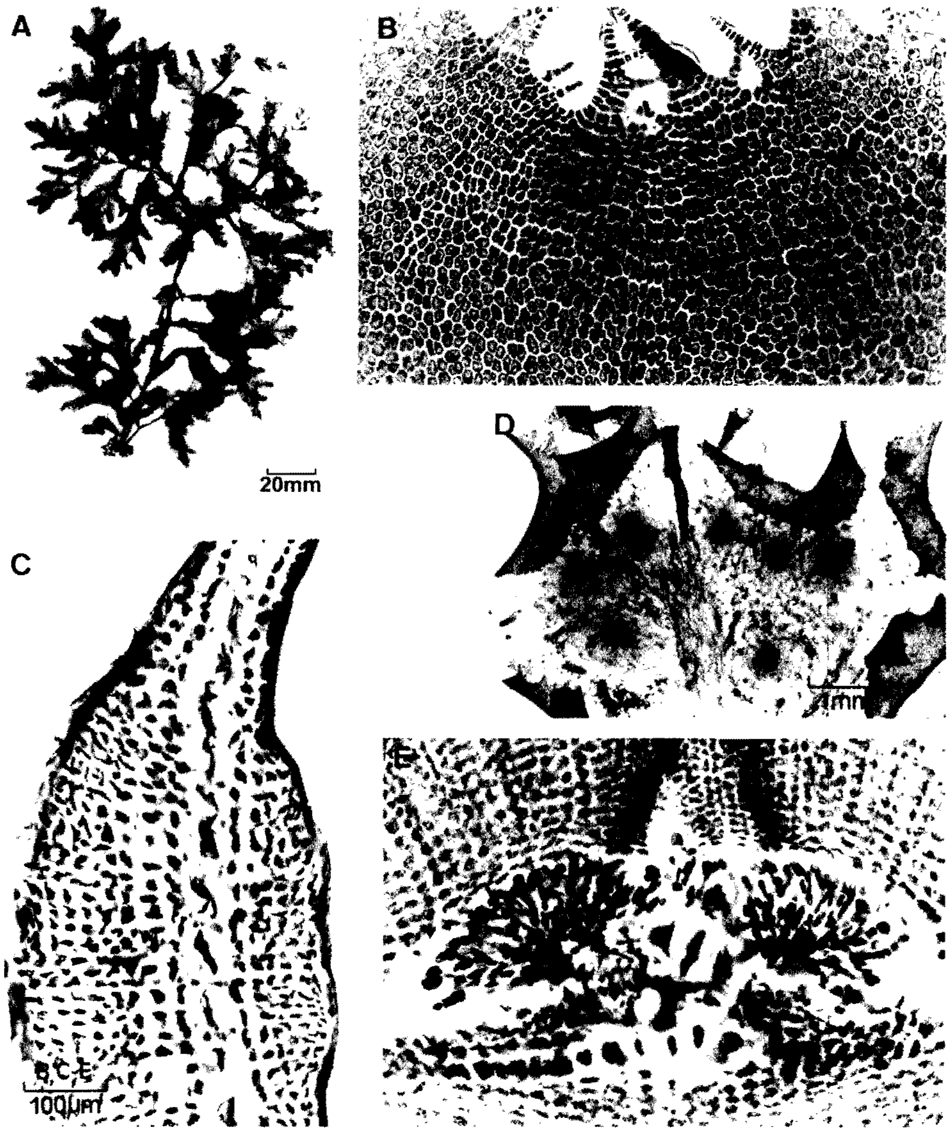

Fig. 28. *Heterodoxia denticulata* (**A**, **D**, **E**, AD, A59567; **B**, AD, A34945; **C**, AD, A34295). **A**. Habit. **B**. Blade apex with midrib and marginal spines. **C**. Transverse section of midrib and blade. **D**. Blade with cystocarps. **E**. Transverse section of cystocarp, showing fusion cell and chains of carposporangia.

cortical cells dimidiate, then outer layers equivalent, regularly arranged. Branching occurs by apical cells developing on the blade margins. Mature cells multinucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps scattered, often densely, over young blades or leaflets, usually opposite on both sides, with a 4-celled carpogonial branch and probably 2 sterile groups. Carposporophytes (Fig. 28E) with a basal, often 2-armed, fusion cell with branched gonimoblast filaments bearing chains of ovoid carposporangia 15–20 µm in diameter, maturing sequentially. Cystocarps (Fig. 28D) scattered, few to several per blade, sunken within the blade and convex to hemispherical above, 1.5–2.5 mm across, ostiolate; pericarp thick, of anticlinal rows 10–15 cells long. Spermatangial sori (Fig. 29A) on both sides of the midrib and the blade or on small leaflets, with several initials by division of the outer cortical cells, each producing 2–4 spermatangia (Fig. 29B).

Tetrasporangial sori (Fig. 29C) scattered on blades or on small leaflets arising from the midribs, 120–180 µm thick at sori, with tetrasporangia cut off from inner cortical cells on both sides of the blade (Fig. 29D), with outer cortical cells in anticlinal rows of 2–5 cells; tetrasporangia subspherical, 45–65 µm in diameter.

Type from Rottnest I., W. Aust. (*Harvey*); holotype (Trav. Set 235) in Herb. Harvey, TCD.

Distribution: Houtman Abrolhos, W. Aust. to Nora Creina, S. Australia.

Selected specimens: 7 mile Beach, Dongara, W. Aust., drift (*Kraft*, 9.viii.1979; MELU, K7090a). North Beach, Perth, W. Aust., drift (*Norris* 1733, 27.iii.1959; AD, A22261). Point Peron, W. Aust., drift (*Parsons* 15.xi.1968; AD, A34295). Mangles Bay, Point Peron, W. Aust., 2.5–3.5 m deep (*Kraft & Borowitzka*, 11.xii.1984; MELU). Eyre, W. Aust., drift (*Gordon*, 22.xi.1968; AD, A34252). Twin Rocks, Head of Great Australian Bight, S. Aust., 20–22 m deep (*Branden*, 19.i.1991; AD, A61143). Elliston, S. Aust., 10–12 m deep in bay (*Shepherd*, 24.x.1969; AD, A34945). 6 km N of Pondalowie Bay, S. Aust., drift (*Womersley*, 13.iv.1963; AD, A26339).). Port Elliot, S. Aust., drift (*Hussey*, May 1898; AD, A36059) and (*Baldock*, 4.v.1963; AD, A30968). Pennington Bay, Kangaroo I., S. Aust., drift (*Womersley*, 11.ii.1956; AD, A20124). Cape Jaffa, S. Aust., drift (*Womersley*, 25.iv.2000; AD, A68502). Robe, S. Aust., drift (*Womersley*, 2.iv.1999; AD, A68096). Nora Creina, S. Aust., 1 m deep in crevice (*Cenko*, 19.iv.1989; AD, A59567).

The vein system of *Heterodoxia* is laterally rather than dichotomously branched, the tetrasporangial sori occur on the main branches as well as on small leaflets, and the older blade becomes tri-polystromatic (c.f. Wynne 1996, p. 176).

Genus **PHYCODRYS** Kützing 1843: 444

Thallus erect to decumbent, complanately branched with flat primary blades bearing lateral blades marginally, borne on slender pedicels, monostromatic apart from veins; all blades with a midrib and paired lateral veins (often faint); holdfast discoid, base often stoloniferous. *Structure*. Apical cell segmenting to give an axial filament and 2 lateral and 2 transverse pericentral cells, the lateral cells forming second-order rows which reach the thallus margin with their cells cutting off third-order cells or rows irregularly and mainly abaxially which fill up the spaces between the second-order rows; transverse intercalary divisions occur in the axial cells, then separating the second-order rows. Margin of blades with short dentations, those terminating second-order rows sometimes developing into lateral blades. Midrib becoming heavily corticated, second-order rows (and adjacent primary cells) becoming lightly corticated.

Reproduction. Gametophytes dioecious. Procarps scattered on monostromatic blades, on opposite sides or not, with a 4-celled carpogonial branch and 2 sterile groups; carposporophytes with a basal fusion cell and branched gonimoblast with terminal chains of carposporangia. Cystocarps swollen on one or both sides of blades, ostiolate, with a pericarp 3–8 cells thick of anticlinal cell rows. Spermatangial sori on both sides of blades between midrib and margins, with a layer of cortical cells on both sides and each cell producing 2–4 spermatangia.

Tetrasporangial sori on blades between midrib and lateral veins, with tetrasporangia in 2 layers, produced laterally from inner cortical cells and covered by a layer of outer cortical cells.

Type species: *P. sinuosa* (Goodenough & Woodward)Kützing (1843: 444) = *P. rubens* (Linnaeus)Batters. See Kylin 1923: 64, figs 43–51; Maggs & Hommersand 1993: 215, fig. 68.

A genus of 6 or 7 species, of which *P. australasica* is the only Australian species.

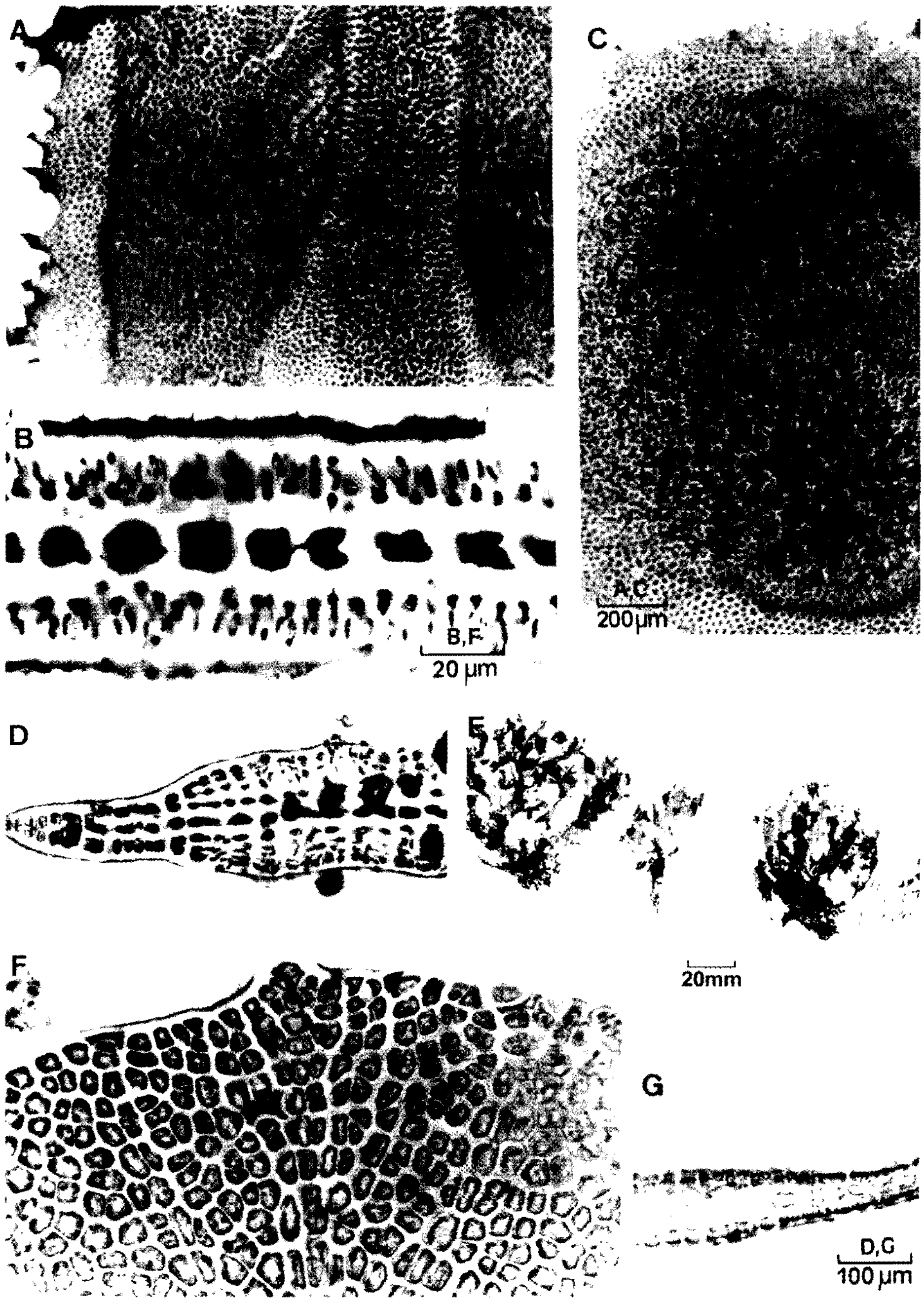

Fig. 29. A–D. *Heterodoxia denticulata* (**A**, **B**, AD, A61143; **C**, **D**, AD, A68096). **A**. Spermatangial sori on either side of midrib. **B**. Transverse section of a spermatangial sorus. **C**. Bladelet with a tetrasporangial sorus. **D**. Transverse section of a spermatangial sorus. **E–G**. *Phycodrys australasica* (**E**, **F**, AD, A37900; **G**, AD, A34369). **E**. Habit. **F**. Apex of blade showing segmentation. **G**. Transverse section of blade with midrib.

Phycodrys australasica Millar 1990: 423, fig. 56; 1999: 519. Millar & Kraft 1993: 48. Silva *et al.* 1996: 464.

FIGS 29E–G, 30

Thallus (Fig. 29E) medium red-brown, decumbent to more-or-less erect, 3–8 cm high, densely tufted with complanately branched primary and main blades 3–5 mm broad, bearing marginally lateral blades (1-) 2–4 mm broad with slender, compressed to terete, basal constrictions 200–500 µm broad; blades linear to gently tapering, flat, apices acute to rounded, margins with short, blunt, dentations; all blades with a central midrib and relatively faint, paired, lateral veins (Fig. 30A). Attachment by small discoid holdfasts bearing 1–3 fronds, often with a stoloniferous base giving rise to further erect fronds; epiphytic, epizoic (e.g. on bryozoans) or epilithic. *Structure.* Apical cell conical, segmenting rapidly (Fig. 29F) to an axial row (which soon becomes corticated) and lateral and transverse pericentral cells, the lateral cells producing second-order rows reaching the blade margin and from which third-order cells or short rows are cut off abaxially and adaxially in an irregular manner, giving a monostromatic blade (apart from the veins – Fig. 29G) of compact, isodiametric, irregular cells 20–30 µm across in surface view; lateral veins with central primary cells and a cortex 1 (-2) cells thick; transverse intercalary divisions occur in the axial cells so that the second-order rows become separated by 2–5 axial cells as they develop into the lateral paired veins, with further lateral divisions of the daughter axial cells and the second- and third-order cells forming the expanded blade. The margins of the blade bear short dentations 30–50 (-200) µm long, the larger ones corresponding to the vein endings and occasionally developing as lateral blades. Mature cells multinucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps scattered on both sides of blades, probably with a 4-celled carpogonial branch and 2 sterile groups. Carposporophytes with a small basal fusion cell and chains of ovoid carposporangia 15–30 µm in diameter. Cystocarps (Fig. 30B) 300–700 µm across, few per blade, protruding mainly on one side of the blade, ostiolate; pericarp 90–140 µm and 5–8 cells thick, thicker around the ostiole (Fig. 30C). Spermatangial sori (Fig. 30D) on both sides of blades between midrib and margins, covering the lateral veins, with each primary cell covered by 8–10 cortical cells each of which produces 2–4 spermatangia.

Tetrasporangial sori (Fig. 30E) scattered, often close to margins, with tetrasporangia in 2 layers (Fig. 30F), cut off from inner cortical cells and covered with a layer of small outer cortical cells, subspherical and 30–50 µm in diameter.

Type from Gellibrand Light, northern Port Phillip Bay, Vic.; holotype in MELU, A35185, with isotypes.

Distribution: Hamelin Bay, W. Aust., Port Noarlunga, S. Aust., Port Phillip Bay and Westernport Bay, Vic., and N.S.W. and Norfolk and Lord Howe Is.

Selected specimens: Port Noarlunga, S. Aust., upper sublittoral on reef (*Wollaston*, 26.x.1965; AD, A29711). Gloucester Reserve, Williamstown, Vic. 2–4 m deep (*Kraft & Saunders*, 6.ii.1995; MELU). Point Lonsdale, Vic., on sponge 1–4 m deep (*Kraft & Saunders*, 27.ii.1992; MELU, K8946). Crawfish Rock, Westernport Bay, Vic. (*Watson*, Nov. 1968; AD, A32138), 3–6 m deep (*Watson*, 15.ix.1965; AD, A32823), 6 m deep (*Watson*, 26.iv.1969; AD, A34369), 15 m deep (*Watson*, 5.iv.1970; AD, A35833), 5–10 m deep (*Watson*, 29.viii.1971; AD, A39370), 6 m deep (*Shepherd*, 4.ii.1971; AD, A37900), 10 m deep (*Shepherd*, 4.ii.1971; AD, A37940), 6 m deep (*Watson*, 16.i.1974; AD, A44854), and 10 m deep (*Watson*, 28.v.1974; AD, A45432).

P. australasica is a common alga in Port Phillip Bay and at Crawfish Rock, Westernport Bay, Vic., present throughout the year, and is probably more generally distributed in suitable localities than the other scattered collections indicate.

Genus HALICNIDE J. Agardh 1898: 201

Thallus complanately and marginally branched, with flat primary blades bearing ovate to elongate lateral blades with slender basal stipes, all blades with marginal, simple or branched, multicellular spines, older blades also with surface spines; blades with well-developed vein systems of a midrib and paired, opposite, lateral veins; holdfast becoming stoloniferous. *Structure.* Apical cell segmenting to give an axial filament and 2 lateral and 2 transverse pericentral cells, the lateral cells forming second-order rows the cells of which cut off occasional third-order cells both abaxially and adaxially, forming a blade of compact,

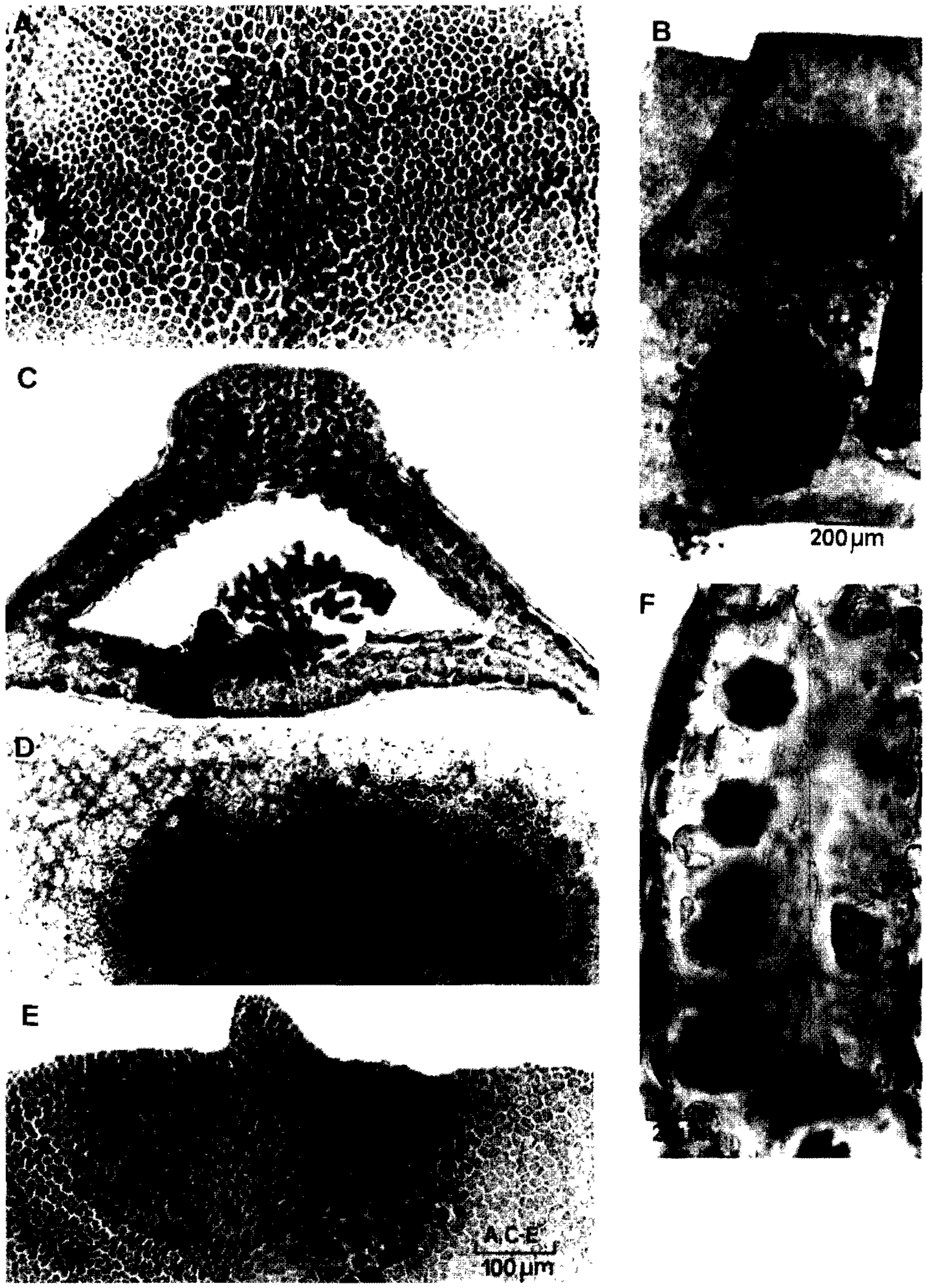

Fig. 30. *Phycodrys australasica* (**A**, **E**, AD, A35833; **B**, AD, A45432; **C**, AD, A34369; **D**, AD, A44854; **F**, AD, A39370). **A**. Surface view of blade with midrib and paired opposite veins. **B**. Two cystocarps. **C**. Cross section of a cystocarp. **D**. Part of a spermatangial sorus. **E**. Tetrasporangial sori near blade margin. **F**. Transverse section of tetrasporangial sorus.

irregularly arranged cells. Original second-order rows become separated by 2–4 axial cells due to intercalary divisions near the apex, then becoming corticated to form the opposite lateral veins, and terminating at the margin in the multicellular spines, which arise also from any marginal cell. The blade between the veins remains monostromatic when young but becomes tristromatic with cortical cells on both sides, and surface cells of older blades also form spines (mostly simple).

Reproduction. Gametophytes dioecious. Procarps scattered on blades, detailed structure not observed; carposporophytes with a basal fusion cell and terminal chains of ovoid carposporangia. Cystocarps swollen on both sides of blades, ostiolate, with a thick pericarp of anticlinal rows of cells, bearing short surface spines. Spermatangial sori on both sides of blades, with cortical cells subdividing and producing an outer layer of spermatangia.

Tetrasporangial sori on small, compressed, marginal leaflets also with surface spines, cut off from inner cortical cells on both surfaces, covered by small outer cortical cells.

Type species: *H. similans* (J. Agardh)J. Agardh 1898: 206.

Halicnide is a distinctive genus with the prominent midrib bearing well-developed opposite lateral veins and marginal and surface spines over the blades. However, only the young blade areas between the veins remain monostromatic and the tetrasporangial blades are distinctly compressed and not "spherical" (c.f. Wynne 1996, p. 176).

Halicnide similans (J. Agardh)J. Agardh 1898: 206; 1899: pl. 2 fig. 13. De Toni 1900: 724. Guiler 1952: 101. Kylin 1924: 45, fig. 35a; 1956: 441. Lucas 1909: 37; 1929a: 20. May 1965: 401. Shepherd & Womersley 1870: 135. Silva *et al.* 1996: 455. Wynne 1996: 179.

Delesseria similans J. Agardh 1872: 56; 1876: 488. Sonder 1880: 24. Tisdall 1898: 509. Wilson 1892: 174.

Delesseria lyallii sensu Harvey 1859b: 311; 1863, synop.: xxxi. [NON *D. lyallii* Hooker & Harvey *in* Hooker 1847: 471, pl. 176 from the Falkland Is and Kerguelen I. = *Cladodonta lyallii* (Hooker & Harvey)Skottsberg 1923: 38, fig. 16.]

FIG. 31

Thallus (Fig. 31A) light red to dark red-brown, 3–14 cm high, complanately branched usually with a single main blade (0.5-) 1–3 (-4) cm broad, bearing from the margins flat lateral blades (0.5-) 1–4 cm long and 3–10 mm broad, all blades basally constricted to a short stipe (0.2-) 0.5–1 mm in diameter; midrib becoming heavily corticated, bearing opposite lateral veins (Fig. 31B), blade margin and the older surface bearing short, spinous, multicellular filaments (Fig. 31B). Holdfast discoid, becoming stoloniferous and fibrous; epilithic. *Structure.* Growth by means of a dome-shaped to obconical apical cell (Fig. 31C), segmenting within 1 or 2 segments to lateral and transverse pericentral cells, the lateral cells forming second-order rows with some cells dividing irregularly to cut off third-order cells both abaxially and adaxially, forming a compact but irregular cell pattern. Original second-order rows become 2–4 axial cells apart due to intercalary divisions and form the opposite lateral veins which become heavily corticated, with the blade between veins remaining monostromatic (Fig. 31D) or becoming 3 cells thick with cortical cells on each side; thallus sectional view regular. Second-order cell rows project beyond the blade margin as prominent, branched, tapering spines (Fig. 31B) 200–300 µm long, base 80–200 µm and 3–5 (-10) cells across with corticating cells, the upper 4–8 cells uniseriate and 15–20 µm in diameter, cells isodiametric. Smaller but similar spines are formed from any marginal cells, and the veins and surface cells of older blades form, sparsely to densely, simple or occasionally basally branched, uniseriate spines mostly 90–200 (-500) µm and 6–25 cells long, 15–30 µm in diameter. Mature cells multinucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps scattered on blades. Carposporophytes (Fig. 31E, F) with a basal fusion cell and branched gonimoblast filaments with terminal chains of 3–5 ovoid carposporangia 15–20 µm in diameter. Cystocarps few per blade, 1–1.5 mm across, markedly swollen on both sides of the blade; pericarp (Fig. 31F) 250–350 µm thick, with compact anticlinal rows of isodiametric cells 15–20 µm in diameter, the surface cells often projecting as a short uniseriate spine. Spermatangial sori (Fig. 31G) extensive, covering most of the blades on both sides, with cortical cells dividing further and each cell producing several spermatangia.

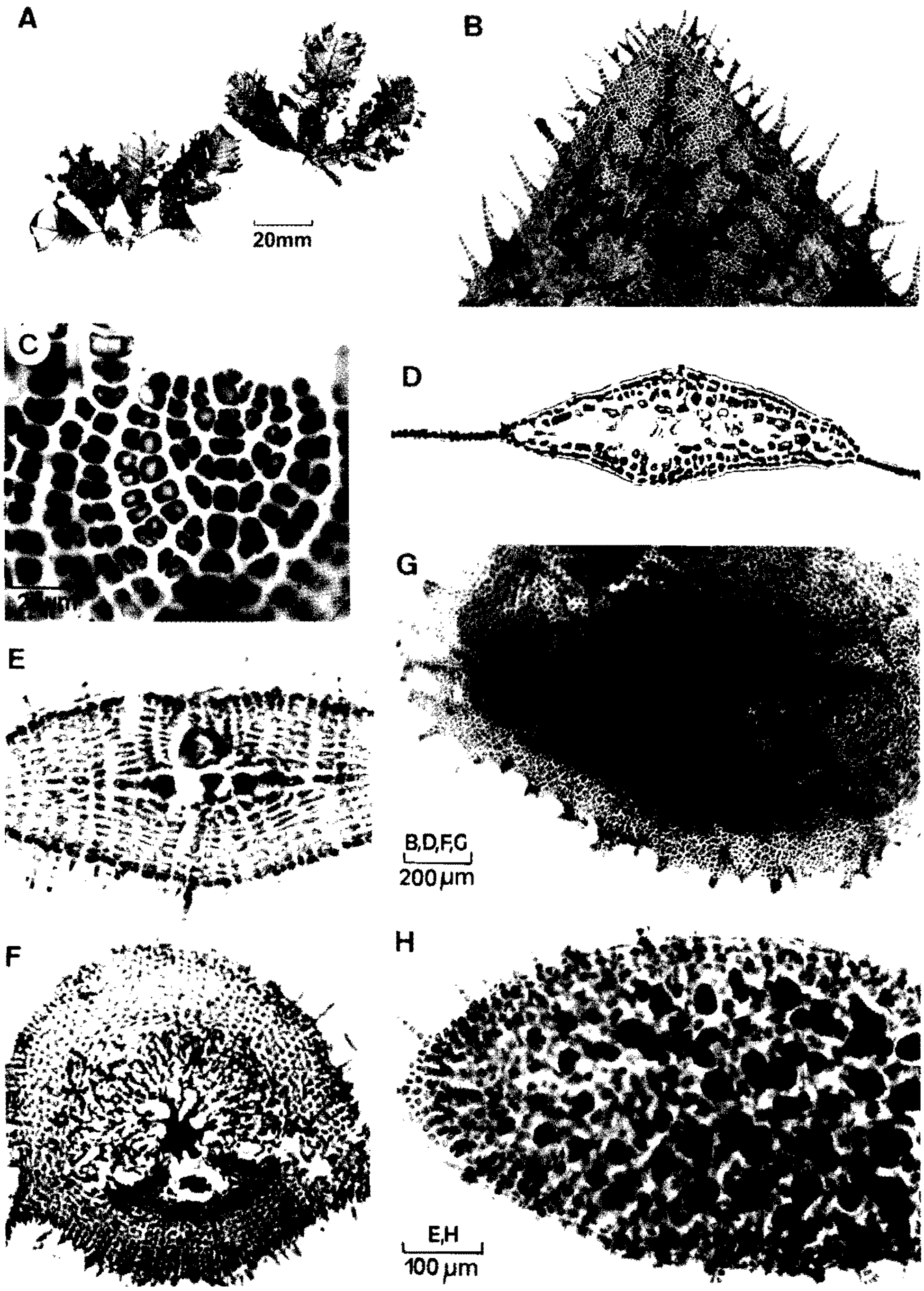

Fig. 31. *Halicnide similans* (**A**, AD, A63829; **B**, **D**, **H**, AD, A64793; **C**, AD, A33012; **E**, **F**, AD, A63811; **G**, AD, A60492). **A**. Habit. **B**. Apex of frond with midrib, opposite lateral veins and marginal and surface spines. **C**. Apex showing segmentation. **D**. Transverse section of midrib with monostromatic blades. **E**. Transverse section of young carposporophyte in thickened blade. **F**. Transverse section of cystocarp. **G**. Bladelet with spermatangial sorus. **H**. Bladelet with a tetrasporangial sorus.

Tetrasporangial sori (Fig. 31H) in small, compressed and ovate, marginal leaflets which develop profuse surface spines; tetrasporangia cut off from inner cortical cells on both sides, covered by smaller outer cortical cells, subspherical, 30–40 μm in diameter, with varying ages in the sorus.

Type from Georgetown, Tas. (*Harvey*, Alg. Aust. Exsicc. 271 I); holotype in Herb. Agardh, LD, 31740.

Distribution: Penguin I., Safety Bay, W. Aust., and Pearson I., S. Aust., to Point Hicks, E Vic., and E and S Tasmania. Millar & Kraft (1993, p. 63) have excluded *Halicnide similans* from N.S.W.

Selected specimens: Penguin I., Safety Bay, W. Aust., 5–6 m deep (*Kraft & Borowitzka*, 13.xii.1984; MELU, K7760). Pearson I., S. Aust., 10–15 m deep (*Shepherd*, 28.iii.1982; AD, A53051). Gulf St Vincent, S. Aust., 40 m deep (AD, A1086). Whale Point, West I., S. Aust., 25 m deep (*Shepherd*, June 1966; AD, A30616). Oedipus Point, West I., S. Aust., 21–25 m deep (*Shepherd*, 8.x.1966; AD, A30820). 13 km S of Vivonne Bay, Kangaroo I., S. Aust., 50–70 m deep (*Latz*, 24.xi.1968; AD, A33012). 13 km off Cape Northumberland, S. Aust., 61 m deep (*Shepherd*, 7.v.1975; AD, A46290). 16 km NW of Cape Bridgewater, Vic., 80–100 m deep (*Johnstone & Watson*, 16.v.1969; AD, A34489). Lighthouse Reef, Wilsons Prom., Vic., 2–12 m deep (*O'Brien*, 5.ii.1979; MELU, K6870). Point Hicks, E Vic., 18–21 m deep (*Kraft & Watt*, 8.ii.2001; MELU). Sarah I., Bathurst Ch., SW Tas., 2–5 m deep (*Edgar*, 11.iii.1995; AD, A64259). N end Governor I., Bicheno, Tas., 8–16 m deep (*Edgar*, 23.x.1994; AD, A63829). Waubs Bay, Bicheno, Tas., 8–12 m deep (*Edgar*, 23.x.1994; AD, A63811). Pirates Bay, Eaglehawk Neck, Tas., 9–12 m deep under kelp (*Gowlett-Holmes*, 31.x.1994; AD, A64058). Fortescue Bay, Tasman Pen., Tas, 2–3 m deep under kelp (*Gowlett-Holmes*, 22.vi.1995; AD, A64419). Charlotte Cove (Ninepin Point), Tas., 5–10 m deep (*Edgar*, 31.iii.1996; AD, A64793). Great Taylor Bay, Bruny I., Tas., 19 m deep (*Shepherd*, 14.ii.1972; AD, A42164). Tasman I., Tas., 20 m deep (*Riddle*, 1.iii.1990; AD, A60492).

H. similans is a very distinctive alga in habit, the paired lateral veins, and the spinous filaments covering the blade margins and the surface of older blades. It is a deep-water species, most common in Tasmania where it also occurs in shallower but shaded situations; the West Australian record is of small, juvenile plants. Such juvenile plants (1–2 cm high) have basal stolons producing the erect blades which may be bare of surface spines but usually have marginal spines and relatively faint opposite veins.

Genus **WOMERSLEYA** Papenfuss 1956: 160.

Thallus complanately and marginally branched, with irregular lateral and alternate, often proliferous blades, surface and margins smooth, arising from prostrate blades attached by discoid haptera; epiphytic. *Structure*. Apical cells to blades only just recognisable, segmenting to give an axial cell row and indistinct second-order rows which reach the blade margin with their cells cutting off third-order cells or rows irregularly, abaxially and also adaxially. Transverse intercalary divisions occur in axial cells and later formed cells, and the blade width increases by marginal growth by small, obscure apical cells. The blades soon become polystromatic throughout with larger central cells and smaller dimidiate cortical cells on both sides.

Reproduction. Gametophytes dioecious. Procarps scattered on the blades, with the cortical cells functioning as supporting cells bearing a single sterile group and two 4-celled carpogonial branches. Fusion cell with an apical group of sterile, conical cells and two gonimoblast groups. Carposporophytes with a prominent basal fusion cell and gonimoblast filaments bearing short chains of ovoid carposporangia. Cystocarps few per blade, ostiolate, swollen, with a thick pericarp of anticlinal rows of cells. Spermatangial sori on both sides of blades, with the cortical cells functioning as initials which cut off elongate spermatangia.

Tetrasporangial sori scattered, with tetrasporangia cut off laterally from cortical cells, in 2 layers, covered by a layer of smaller outer cortical cells.

Type (and only) *species*: *W. monanthos* (J. Agardh)Papenfuss 1956: 161.

Womersleya is distinguished within the *Phycodrys* group by having only just-recognisable apical cells, with marginal growth from other slight apical cells, by lack of veins in the blades which are polystromatic throughout, and by scattered procarps with 2 carpogonial branches on each supporting cell.

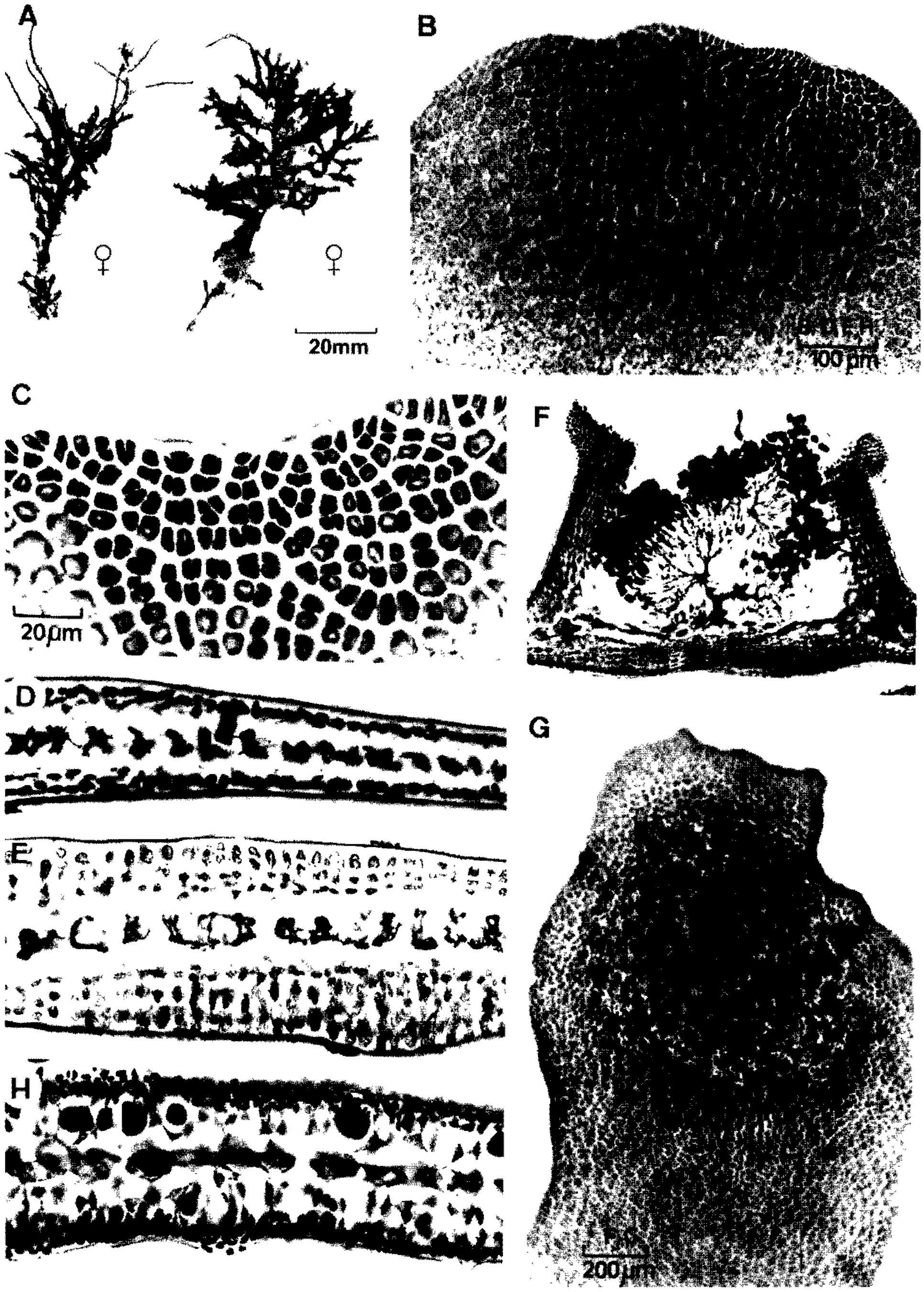

Fig. 32. *Womersleya monanthos* (**A**, **D**, **G**, AD, A42027; **B**, **C**, **E**, AD, A42928; **F**, AD, A41938; **H**, AD, A30677). **A**. Habit, epiphytic. **B**. Blade apex with very slight lines of cells from apices. **C**. Apex showing segmentation. **D**. Transverse section of young blade. **E**. Transverse section of older blade. **F**. Section of cystocarp. **G**. Tetrasporangial sorus. **H**. Transverse section of tetrasporangial sorus.

Womersleya monanthos (J. Agardh)Papenfuss 1956: 161. Lin & Kraft 1996: 173, figs 1–37. May 1965: 407. Wynne 1996: 182.

Nitophyllum monanthos J. Agardh 1852: 655; 1872: 50; 1876: 466; 1898: 46. De Toni 1900: 637; 1924: 324. Harvey 1863, synop.: xxxii. Kützing 1869: 4, pl. 9d–l. Lucas 1909: 35; 1926: 599, pl. 39 fig. 2. Sonder 1855: 522; 1880: 23. Tisdall 1898: 509.

Chondrophyllum monanthos (J. Agardh)Kylin 1924: 51, fig. 42a–c; 1956: 442, fig. 354A–C.

FIG. 32

Thallus (Fig. 32A) medium to dark red, erect to recumbent from prostrate blades, 1–4 cm high, complanately and irregularly laterally branched from the margins, branches (1-) 2–4 (-10) mm broad and 90–140 µm thick, slightly narrower basally and ends rounded; small proliferations frequent near apices otherwise margins smooth. Midrib and veins absent apart from slight lines of cells just below apices (Fig. 32B). Attachment by small discoid haptera from prostrate parts of branches; epiphytic on various algae (e.g. *Acrocarpia*, *Gelidium asperum*). *Structure*. Branch apices (Fig. 32B, C) with a just recognisable obconical apical cell, segmenting to form lateral pericentral cells producing indistinct second-order rows (Fig. 32C), the cells of which divide irregularly to form a broad blade which rapidly becomes corticated with smaller cells on both sides; transverse intercalary divisions frequent in cells of the scarcely recognisable rows. Marginal cells develop also as just recognisable apical cells cutting off cells which contribute to the blade width. Transverse pericentral cells not recognisable as such, blades polystromatic (Fig. 32D) throughout with a central layer of larger more or less isodiametric cells 30–80 µm across with 1–2 cortical layers of smaller dimidiate isodiametric cells 10–20 µm across, extending below (Fig. 32E) to a cortex of anticlinal filaments 5–15 cells long. Mature cells multinucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps scattered on both sides of blades, with the cortical cells functioning as supporting cells bearing a single sterile group (cells of which divide and enlarge) and 2 carpogonial branches, with adjacent primary cells enlarging and forming a nutritive tissue. Fusion cell with an apical group of elongate sterile conical cells and lateral gonimoblasts; carposporophytes (Fig. 32F) developing a prominent basal fusion cell and much branched filaments with short chains of ovoid carposporangia 30–40 µm in diameter. Cystocarps scattered, few per blade, 1–1.5 mm across, bulging mainly on one surface; pericarp (Fig. 32F) ostiolate, 90–130 µm and 8–10 cells thick, with a thicker collar around the ostiole. Spermatangial sori irregular, on both sides of the blade, with the cortical cells cutting off elongate spermatangia which produce terminal spermatia.

Tetrasporangial sori (Fig. 32G) scattered on blades, with tetrasporangia cut off laterally in 2 layers (Fig. 32H) from cortical cells and covered by a layer of 1 (-2) smaller outer cortical cells; tetrasporangia subspherical, 35–60 µm in diameter.

Type from Port Fairy, Vic.; holotype in Herb. Agardh, LD, 30446 (Harvey, Alg. Aust. Exsicc. 299D).

Distribution: Margaret Brock Reef, Cape Jaffa, S. Aust., to Gabo I., Vic. and SE Tasmania.

Selected specimens: Margaret Brock Reef, Cape Jaffa, S. Aust., on *Gelidium asperum*, 4–5 m deep in caves (*R. Lewis*, 29.xi.1972; AD, A42928). 1.3 km off Cape Northumberland, S. Aust., 15 m deep (*Shepherd*, 26.x.1977; AD, A55261). Port MacDonnell, S. Aust., on *Acrocarpia*, drift (*Mitchell*, 21.viii.1966; AD, A30677). Gabo I., Vic., 18 m deep (*Shepherd*, 17.ii.1973; AD, A43502). Fluted Cape, Bruny I., Tas., 23 m deep and on *Gelidium asperum*, 10 m deep (*Shepherd*, 12.ii.1972; AD, A41938 and A42027 resp.) See Lin & Kraft (1996, p. 174) for further Victorian localities.

W. monanthos appears to be a deep-water alga, epiphytic on various larger algae on rough-water coasts. It is distinguished by the just-recognisable apical cells, transverse intercalary cell divisions, lack of veins, polystromatic blades, presence of 2 carpogonial branches on each supporting cell, and carposporangia in short chains.

Genus CRASSILINGUA Papenfuss 1956: 160

Thallus much branched marginally and proliferously from within the margins, branches linear, margin smooth, all branches with a broad midrib but without lateral veins; holdfast fibrous, usually epilithic. *Structure.* Apical cells indistinct, segmenting to axial cells and lateral pericentral cells (transverse pericentral cells not recognisable) which produce second-order cell rows reaching the margin, the cells cutting off third-order cells and rows irregularly to form blades of compact, irregular cells. Transverse intercalary divisions frequent in axial and other cells. Cortication commencing early, with the blades polystromatic throughout and becoming (3-) 5 (-7) cells thick, with broad corticated midribs covering several primary cells, with anticlinal rows of cortical cells, and the blade margins thicker than other blade tissue.

Reproduction. Gametophytes dioecious. Procarps scattered between midribs and margins. Carposporophytes with a basal fusion cell and gonimoblast filaments with terminal chains of ovoid carposporangia. Cystocarps few per blade, ostiolate, swollen with a thick pericarp of anticlinal rows of cells. Spermatangial sori on both sides of blades, with the cortical cells functioning as initials which cut off elongate spermatangia.

Tetrasporangial sori elongate, between midrib and margin, thicker than adjacent sterile blade, with the cortical cells producing filaments of 4–7 cells surrounding short filaments bearing ovoid terminal tetrasporangia.

Type species: *C. husseyana* (J. Agardh)May 1965: 352, 400. [= *C. marginifera* (J. Agardh)Papenfuss 1958, p. 104.]

There is probably only a single species of *Crassilingua*; names within the genus are discussed below. It is characterised by the habit, indistinct apical cell, transverse intercalary divisions of axial cells, broad midrib and polystromatic blades, with distinctive linear tetrasporangial sori.

Crassilingua marginifera (J. Agardh)Papenfuss 1958: 104. May 1965: 352, 400. Shepherd & Womersley 1970: 135; 1981: 366. Silva *et al.* 1996: 454.
Delesseria marginifera J. Agardh 1885: 70. Tisdall 1898: 509. Wilson 1892: 174.
Pachyglossum marginiferum (J. Agardh)J. Agardh 1898: 126. De Toni 1900: 683. Kylin 1924: 50, fig. 41; 1956: 442, fig. 353. Lucas 1909: 36. Papenfuss 1956: 160.
Pachyglossum husseyanum J. Agardh 1894: 65; 1898: 127. De Toni 1900: 684. Kylin 1924: 51; 1956: 442. Lucas 1909: 36; 1929b: 50. Lucas & Perrin 1947: 226. Papenfuss 1956: 160. Reinbold 1897: 54.
Crassilingua husseyana (J. Agardh)May 1965: 352, 400. Wynne 1996: 179.
Nitophyllum proliferum J. Agardh 1894: 63; 1899, pl. 3 figs 1–3. De Toni 1900: 636. Lucas 1909: 35; 1926: 599, pl. 38 figs 3, 4, pl. 39 fig. 1.
Pachyglossum proliferum (J. Agardh)Kylin 1924: 50. Papenfuss 1956: 160.
Crassilingua prolifera (J. Agardh)May 1965: 352, 400.
Pachyglossum engelhardtii J. Agardh 1898: 126. De Toni 1900: 683. Kylin 1924: 50. Lucas 1909: 36; 1929b: 50. Lucas & Perrin 1947: 226. Papenfuss 1956: 160.
Crassilingua engelhardtii (J. Agardh)May 1965: 352, 400.
Pachyglossum ovale J. Agardh 1898: 127. De Toni 1900: 684. Kylin 1924: 50. Lucas 1909: 36.

FIGS 33, 34

Thallus (Fig. 33A) medium to dark red-brown, 5–20 (-30) cm high, irregularly much branched with linear laterals borne marginally or proliferously from within the margin. Main branches 3–6 (-8) mm broad, lesser branches 2–4 mm broad, with short constricted stipes, apices rounded; all branches with a broad, central midrib but no lateral veins. Holdfast divided, fibrous with rhizoids, 2–5 (-10) mm across; epilithic or rarely epiphytic. *Structure.* Apical cell (Fig. 33B, C) obconical but indistinct, segmenting to an axial filament and 2 lateral pericentral cells which form second-order cell rows reaching the thallus margin, with the cells cutting off irregularly third-order cells or rows both abaxially and adaxially (Fig. 33C); transverse pericentral cells not recognisable as such. Transverse intercalary divisions occur in axial and other cells, giving a compact but irregular cell arrangement in surface view. Cortication commencing close to apices, with the blades soon becoming polystromatic (Fig. 33D) and 120–160 μm thick, with a central layer of large, isodiametric to ovoid, cells 35–60 μm across and usually 2 layers of smaller, isodiametric and angular cells 10–15 μm across; margins 250–300 μm thick due to slight separation of the 5 layers of cells. Midrib broad, with 4–8 cell layers over 10–20 primary cells in transverse section. Mature cells multinucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps scattered on blades between midrib and margins, details not observed. Fusion cell with an apical group of sterile conical cells (Fig. 33E). Carposporophytes (Fig. 34A) with a prominent basal fusion cell and much branched gonimoblast with short terminal chains of ovoid carposporangia 15–20 µm in diameter. Cystocarps scattered between midrib and margins, 1–1.5 mm across, ostiolate, swollen on both sides of the blade; pericarp thick, with anticlinal chains of 8–10 cells. Spermatangial sori (Fig. 34B, C) elongate-ovate, between midrib and margins, with inner cortical cells dividing anticlinally to form a layer of initials, each cutting off several elongate spermatangia (Fig. 34D).

Tetrasporangial sori elongate, between midrib and margins (Fig. 34E), 300–350 µm thick, with the outer cortical cells forming anticlinal filaments (paraphyses) 80–100 µm and

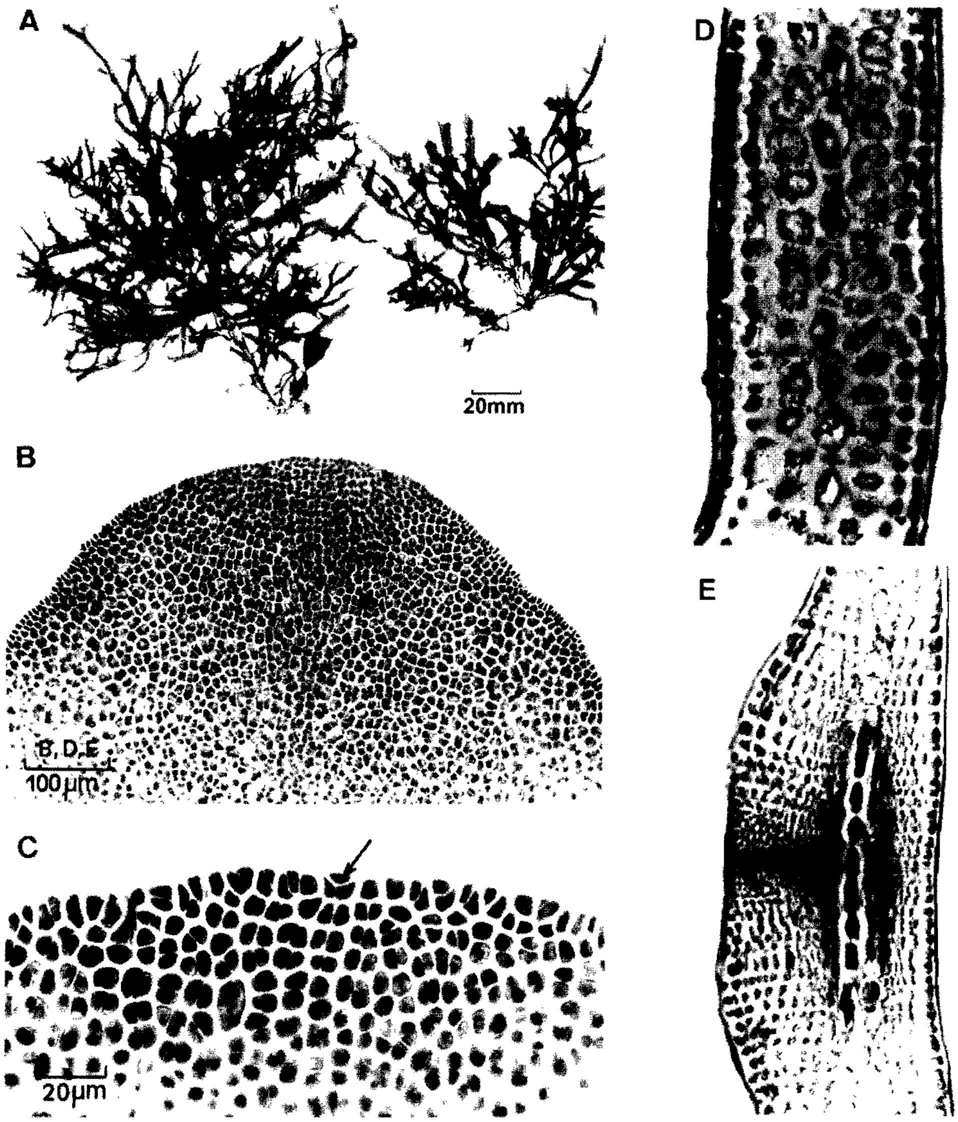

Fig. 33. *Crassilingua marginifera* (**A**, AD, A23020; **B**, **C**, AD, A21105; **D**, **E**, AD, A22089). **A**. Habit. **B**. Apex of blade. **C**. Apex with apical cell (arrow) and showing segmentation. **D**. Transverse section of blade. **E**. Transverse section of young cystocarp with central group of sterile conical cells.

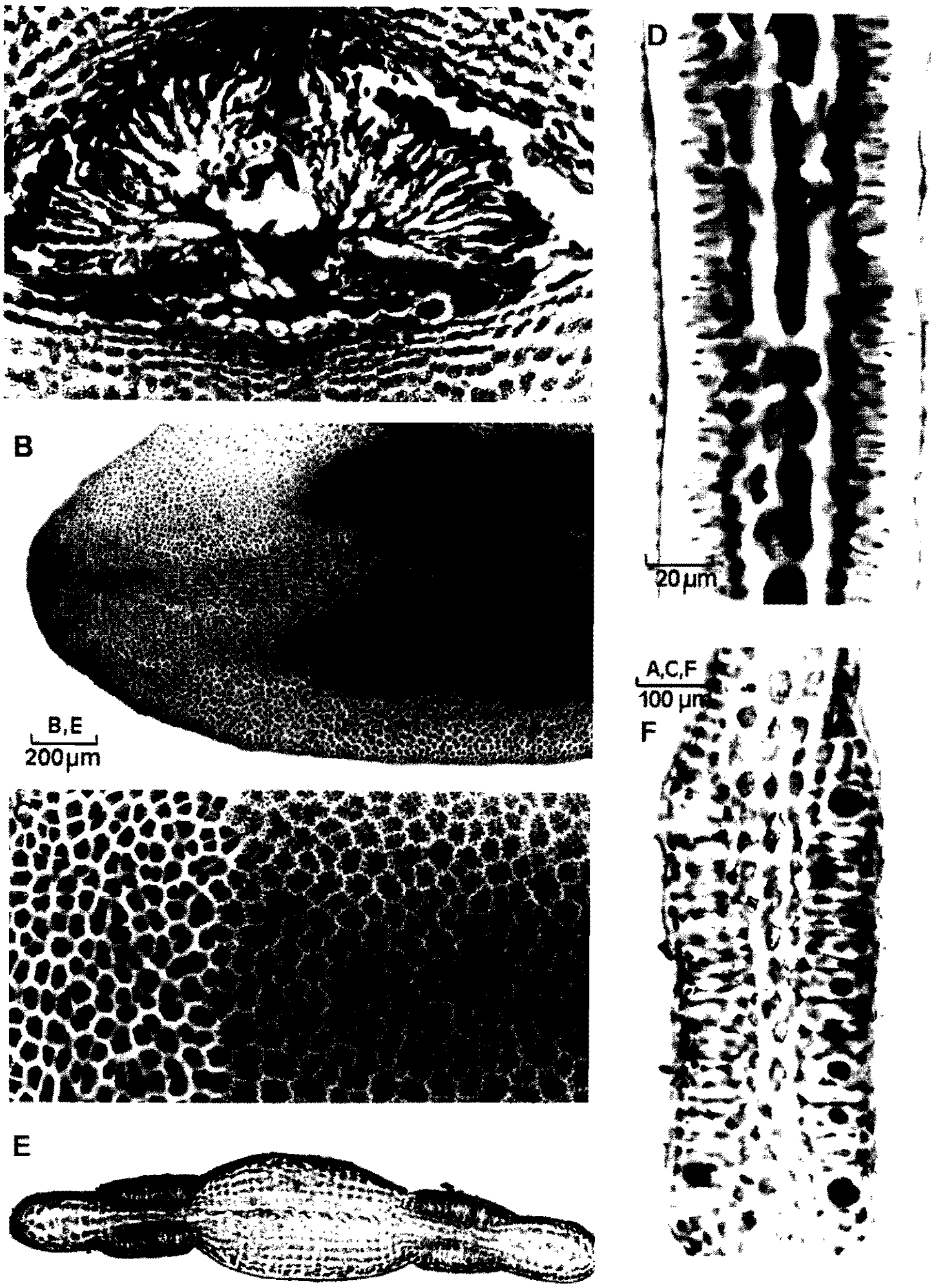

Fig. 34. *Crassilingua marginifera* (**A**, AD, A38684; **B**, AD, A21105; **C**, **D**, AD, A41849; **E**, AD, A30583; **F**, AD, A68102). **A**. Section of a cystocarp. **B**. Spermatangial sori on sides of midrib. **C**. Spermatangial sorus margin. **D**. Transverse section of spermatangial sorus. **E**. Transverse section of blade with linear tetrasporangial sori on each side of midrib. **F**. Transverse section of a tetrasporangial sorus.

4–7 cells long, surrounding the ovoid tetrasporangia (Fig. 34F), 30–40 µm in diameter, which are borne terminally on 2–4-celled filaments.

Type from "oras occid. Aust." (see below); lectotype in Herb. Agardh, LD, 31467.

Distribution: Western Australia(?) and Elliston, S. Aust., to Gabo I., Vic., and SE Tasmania.

Selected specimens: Elliston, S. Aust., 17 m deep outside bar (*Shepherd*, 12.v.1971; AD, A38684). Wanna, S. Aust., drift (*Shepley*, 19.ii.1959; AD, A22236). Whale Point, West I., S. Aust., 13 m deep (*Shepherd*, June 1966; AD, A30583). Port Elliot, S. Aust., drift (*Womersley*, 17.v.1960; AD, A24371). Middleton, S. Aust., drift (*Womersley*, 12.vi.1950; AD, A13078). N of Cape Thomas, Guichen Bay, S. Aust., drift (*Womersley*, 24.viii.1960; AD, A24391). 23 km NW of Robe, S. Aust., 40 m deep (*Shepherd*, 20.xi.1968; AD, A33105). Robe, S. Aust., drift (*Womersley*, 15.iv.1959; AD, A23020 and 2.iv.1999; AD, A68102) and 1–3 m deep on jetty piles (*Gilbert*, 21.ii.1986; AD, A56970). Stinky Bay, Nora Creina, S. Aust., on *Ballia callitricha*, drift (*Womersley*, 19.viii.1957; AD, A21105) and (*Shepley*, 2.ix.1958; AD, A22089). 1.3 km off Cape Northumberland, S. Aust., 15 m deep (*Shepherd*, 13.ii.1976; AD, A47019 and 26.x.1977; AD, A55276). Warrnambool, Vic., drift (*Womersley*, 13.iv.1959; AD, A22952). Port Phillip Heads, Vic., 30–32 m deep (*Saunders et al.*, 20.ii.1995; MELU, K10520). Gabo I., Vic., 13 m deep (*Shepherd*, 14.ii.1973; AD, A43342). North Point, Eaglehawk Neck, Tas., 16–21 m deep (*Kraft*, 12.xii.1993; MELU, K9663). Fluted Cape, Bruny I., Tas., 16 m deep (*Shepherd*, 14.ii.1972; AD, A41849). Great Taylor Bay, Bruny I., Tas., 4 m deep (*Shepherd*, 14.ii.1972; AD, A42030).

C. marginifera occurs mainly in deep water or shallow but shaded positions on rough water coasts.

The original description of *C. marginifera* gave only "occid. Aust." as locality, and the lectotype in Herb. Agardh is accompanied by a drawing with "Merrifield" and also "West Australia" on the sheet. The species is not otherwise known from Western Australia.

Pachyglossum husseyanum J. Agardh (1894, p. 65) is based on a specimen from Port Elliot, S. Aust. (*Hussey*); the lectotype in Herb. Agardh, LD, 31490, is identical with *C. marginifera*.

Nitophyllum proliferum J. Agardh (1894, p. 63) is based on a specimen from Port Phillip Heads, Victoria (*Wilson*); the holotype in Herb. Agardh, LD, 30432, is irregularly proliferous from the edge of the relatively broad (0.5–1 cm wide) main blades, with tetrasporangial sori in a straight line just within the margins. These differences are probably within the habit range of the species.

Pachyglossum engelhardtii J. Agardh (1898, p. 126) is based on a specimen of Engelhardt, probably from SE South Australia; the lectotype in Herb. Agardh, LD, 31475, has rather pointed branches, mainly but not entirely marginal, and is probably only a young plant of the species.

Pachyglossum ovale J. Agardh (1898, p. 127) is based on specimens of Wilson from Port Phillip, Vic., and, as Kylin (1924, p. 50) noted, are the same as *P. proliferum* (= *C. marginifera*).

Genus NITOSPINOSA Womersley, *gen. nov.*

Thallus erect, complanately branched with much branched laterals or foliose and lobed, with or without a distinct midrib. Margins with few to numerous short spinous dentations; holdfast fibrous. *Structure.* Growth partly to mainly from the numerous marginal spines, each with a distinct apical cell segmenting transversely but with recognisable axial and second-order cell rows only within the base of the spines; between the spines, some to most marginal cells divide by anticlinal walls; cell divisions below irregular and intercalary, cell rows not recognisable. Blades monostromatic when young, soon tristromatic and centrally polystromatic; cortical cells equivalent. Cells multinucleate.

Reproduction. Gametophytes dioecious. Procarps scattered, with the primary (supporting) cell bearing a sterile cell (often subdivided) and a 4-celled carpogonial branch. Carposporophyte with a basal, branched, fusion cell and much branched gonimoblast bearing short terminal chains of maturing ovoid carposporangia. Cystocarps scattered, swollen to hemispherical, ostiolate, pericarp of anticlinal rows of cells. Spermatangial sori scattered, with a layer of initials on each side of the primary cells, producing outer elongate spermatangia.

Tetrasporangial sori scattered with tetrasporangia in 2 layers, cut off from inner cortical cells and covered by outer cortical cells.

Diagnosis: Thallus erectus, complanate ramosus lateralibus ramosis aut foliosus costa praesente aut absente; margines paucis aut multis dentationibus, omnes cellula distincta apicali transverse dividente, serie axiali et cellulis ordinis secundae praesente solum intra basin dentationium, ceteris cellulis marginalibus muris anticlinalibus dividentibus; cellulae inferiores irregulariter et intercalariter dividentes sine serie manifesta. Laminae primo monostromaticae, cito tristromaticae, centrale polystromaticae, cellulae corticales aequales.

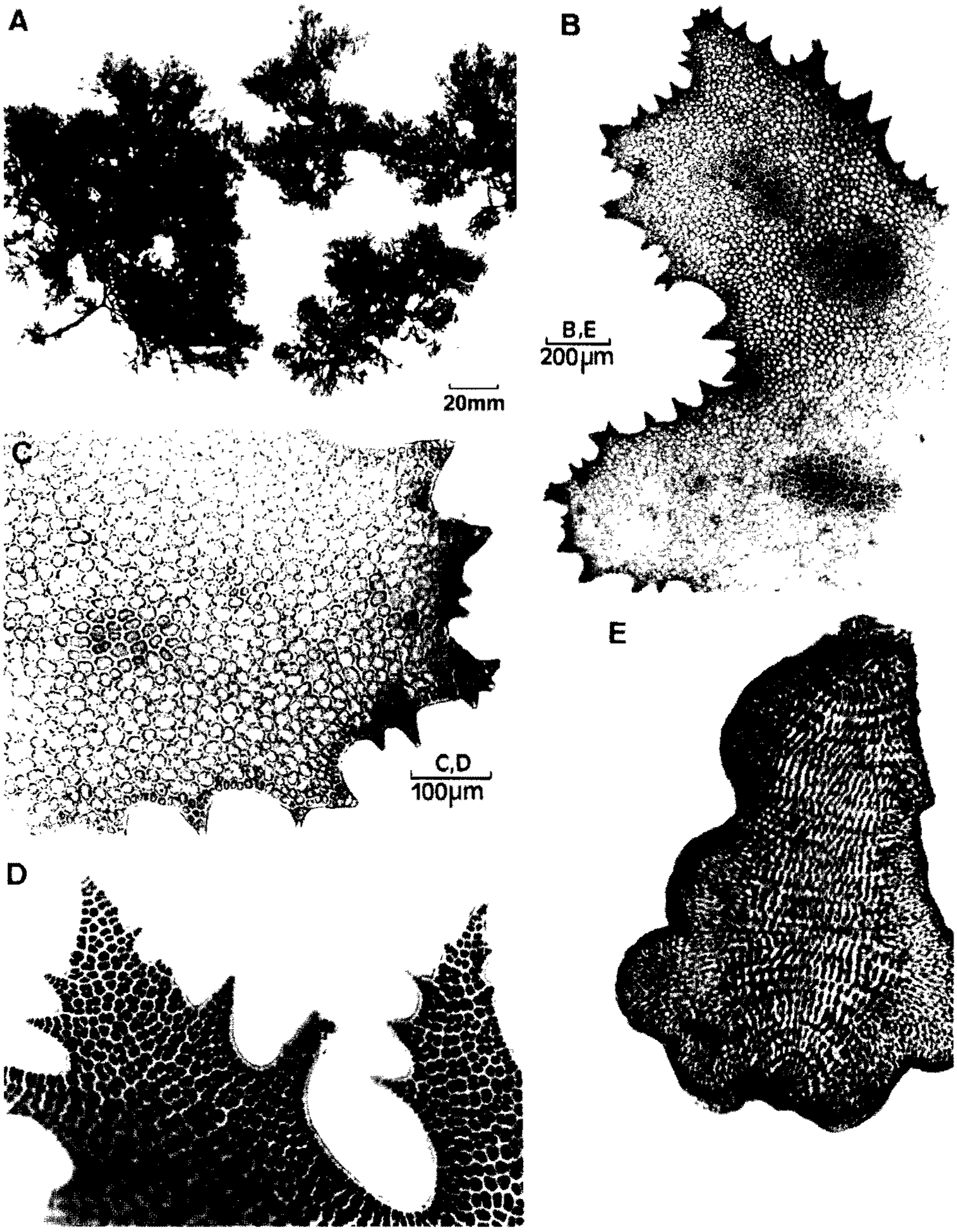

Fig. 35. *Nitospinosa pristoidea* (**A–C**, AD, A64761; **D**, **E**, AD, A68122). **A**. Habit. **B**. Branch apices with marginal spines. **C**. Branch apex with spines and irregular cell arrangement. **D**. Branch apex with actively developing spines. **E**. Transverse section of stipe.

Gametophytes dioeci. Procarpia dispersa, cellula sustens cellula sterili (saepe divisa). Carposporophytum catenis brevibus terminalibus carposporangiis ovoideis. Cystocarpia dispersa, tumida ad hemisphericalia, praecarpium serie anticlinali. Sori spermatangiales dispersi, initiis in quoque latere cellularum primariarum. Sori tetrasporangiales dispersi, tetrasporangia bis strata, ex cellulis interioribus abscissa et cellulis exterioribus corticalibus tecta.

Type species: *N. pristoidea* (Harvey)Womersley, *comb. nov.*

A genus of 3 species, the type, *N. tasmanica* and *N. littledipensis*, distinguished by the frequent to occasional spinous, apical cell-bearing, dentations on the margins, with few to many marginal cells dividing by anticlinal walls, and with cell divisions irregular below the base of the spines where axial and cell rows are not recognisable. The carposporangia mature terminally and subterminal cells then mature rapidly; thus short chains of carposporangia may occur, especially in *N. littledipensis*. While some species credited to *Myriogramme* [e.g. *M. prostrata* (Dawson *et al.*)Wynne 1990, p. 330, figs 8–13] have small marginal spines, the marginal apices are generally smooth and develop by predominantly anticlinal divisions in the marginal cells. *Myriogramme* also has carposporangia in chains.

Nitospinosa is closely related to *Papenfussia* Kylin (1938, p. 15) from South Africa, differing in being monostromatic for some distance from the apices, in having equivalent cortical cells (dimidiate in *Papenfussia*) and in having only oval tetrasporangial sori with tetrasporangia cut off from adjacent inner cortical cells; in *Papenfussia laciniata* (the type species) sori are linear and near the blade margins and are less well defined, with tetrasporangia separated by sterile inner cortical cells. Comparison of female plants cannot be made since these are inadequately described in *Papenfussia**.

Nitospinosa and *Robea* (see below) are probably closely related and belong to a separate group.

Nitospinosa is named from the numerous spines on and near the apices and its nitophylloid relationships.

KEY TO SPECIES OF *NITOSPINOSA*

1. Thallus profusely branched, branches 0.5–2 mm broad, lower branches with a midrib .... 1. *N. pristoidea*
1. Thallus slightly to moderately branched, main branches mostly over 5 mm broad, lower thallus without a midrib or centrally thickened 2

    2. Thallus 5–15 cm high, with branches or lobes 4–15 mm broad, mid parts foliose and 0.5–8 cm broad, often perforate, without a midrib .... 2. *N. tasmanica*
    2. Thallus 3–5 cm high, (3-) 5–10 mm broad throughout, irregularly marginally branched, with a central thickened midrib region below .... 3. *N. littledipensis*

1. **Nitospinosa pristoidea** (Harvey)Womersley, *comb. nov.*

Nitophyllum pristoideum Harvey 1862: pl. 229; 1863, synop.: xxxii. J. Agardh 1876: 460. De Toni 1900: 640. Lucas 1909: 35; 1926: 601; 1929b: 50. Lucas & Perrin 1947: 222, fig. 86. Reinbold 1897: 54. Sonder 1880: 23. Tate 1882a: 20. Tisdall 1898: 509. Wilson 1892: 175.

Aglaophyllum pristoideum (Harvey)Kützing 1869: 2, pl. 6a, b.

Myriogramme pristoidea (Harvey)Kylin 1924: 61, fig. 46d–f. May 1965: 400. Shepherd & Womersley 1981: 366. Womersley 1950: 184.

Nitophyllum serrulatum J. Agardh 1898: 51. De Toni 1900: 639. Lucas 1926: 600. May 1965: 400.

Myriogramme serrulata (J. Agardh)Kylin 1924: 61.

FIGS 35, 36, 41B, C

Thallus (Fig. 35A) dark red-brown, 6–25 cm high, profusely branched with compressed axes 0.5–2 mm broad bearing laterals marginally and complanately at intervals of 1–3 mm, the laterals 0.5–2 mm broad, margins irregularly serrate (Fig. 35B). Lower axes developing a thicker midrib; microscopic veins absent. Holdfast becoming much divided and fibrous, 2–10 mm across; epilithic or epiphytic on larger algae, especially on the underside of

* Reasons for using *Papenfussia* and not *Pollexfenia* for the South African plant are given under *Pollexfenia*.

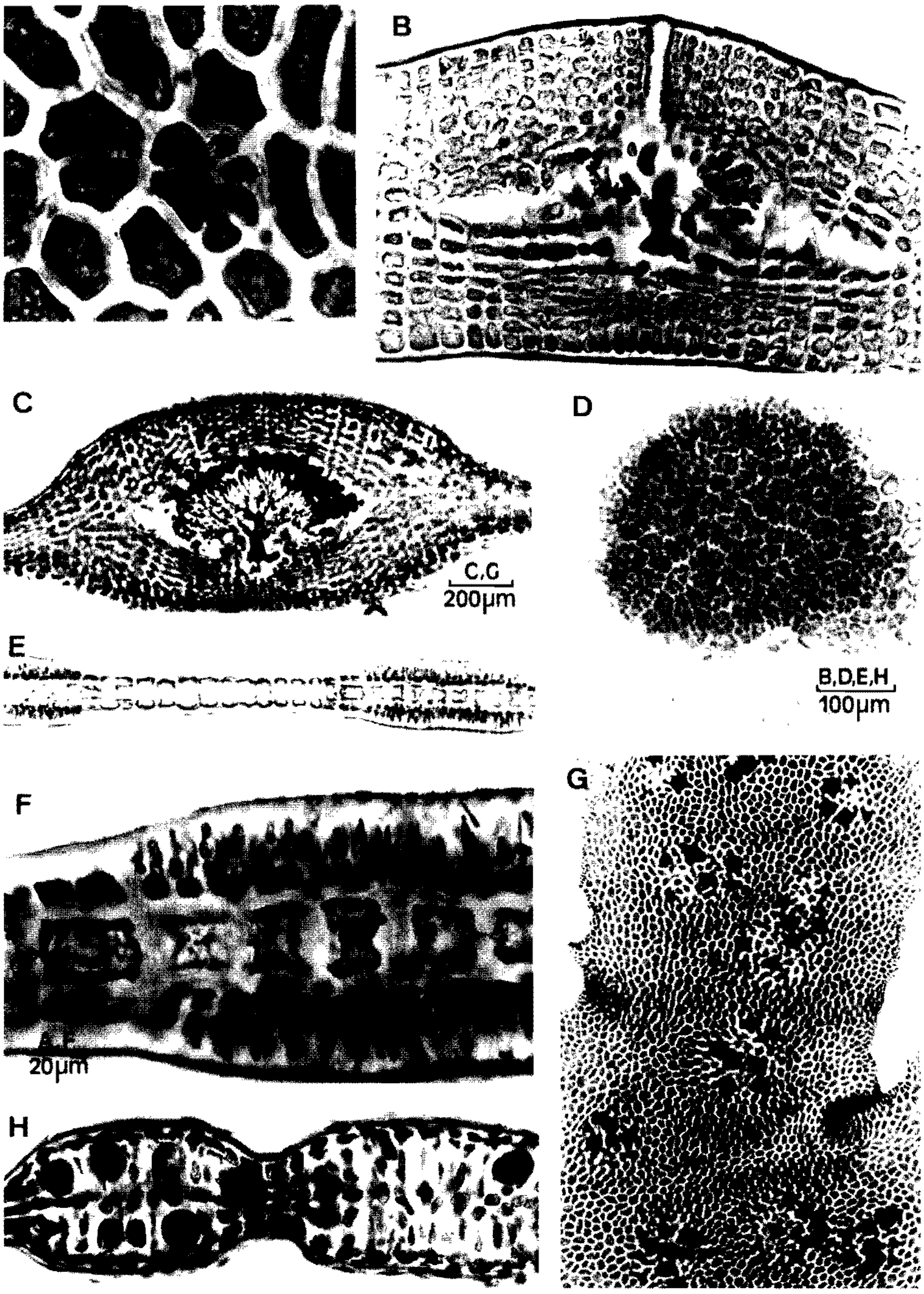

Fig. 36. *Nitospinosa pristoidea* (**A**, **C**, **G**, **H**, AD, A68122; **B**, **D–F**, AD, A64761). **A**. Procarp with carpogonial branch alongside 2 sterile cells. **B**. Young carposporophyte with developing gonimoblast. **C**. Section of mature cystocarp, carposporophyte with erect, basal, fusion cells and gonimoblast with terminal carposporangia. **D**. Spermatangial sorus. **E**. Section of spermatangial sori. **F**. Detail of spermatangial sorus section. **G**. Branch with tetrasporangial sori. **H**. Sectional view of tetrasporangial sori.

Sonderopelta. *Structure*. Growth marginal from short spinous outgrowths with apical cells (Fig. 35C, D), some marginal cells between the spines dividing anticlinally with irregular intercalary divisions giving a flat blade of irregularly arranged cells (Fig. 35C). Fronds monostromatic only when young, 35–55 µm thick, soon tristromatic and 55–75 µm thick, becoming polystromatic and 200–400 µm thick in the midrib (Fig. 35E) and where reproductive, with corticating cells equivalent and similar in size to the primary cells, sometimes subdividing. Blade cells in surface view (Fig. 35C) isodiametric to ovoid, 15–20 µm across and L/D 1–2. Cells multinucleate, nuclei central or on periclinal walls; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps (Fig. 41B, C) scattered on young blades, with a primary (supporting) cell bearing 2 sterile cells and a 4-celled carpogonial branch (Fig. 36A). Carposporophytes (Fig. 36B, C) with a basal fusion cell and much branched spreading gonimoblast filaments (Fig. 36C) bearing terminal chains of 2–3 ovoid carposporangia 15–35 µm in diameter, the sub-terminal cells maturing rapidly as carposporangia. Cystocarps scattered, 1–1.5 mm across, hemispherical; pericarp ostiolate, 180–300 µm thick, with anticlinal rows of 6–12 isodiametric cells. Spermatangial sori (Fig. 36D) scattered, more or less ovate, 400–1000 µm across and 60–100 µm thick, covering much of the upper branches, with a layer of cortical initials and each cell producing several elongate spermatangia (Fig. 36E, F) in blocks corresponding to the primary cells.

Tetrasporangial sori (Fig. 36G) scattered, swollen, ovate, 300–400 µm across and 160–240 µm thick, with sporangia in 2 layers (Fig. 36H) cut off from inner cortical cells, with cortical filaments of 3–5 cells surrounding subspherical tetrasporangia 40–65 µm in diameter.

Type from Port Fairy, Vic. (*Harvey*); lectotype Alg. Aust. Exsicc. 292D in TCD.

Distribution: Elliston, S. Aust., to Walkerville, Victoria.

Selected specimens: Elliston, S. Aust., 7 m deep (*Shepherd*, 21.x.1970; AD, A37603) and on *Osmundaria*, 7 m deep (*Shepherd*, 22.v.1998; AD, A67904). Point Avoid, S. Aust., drift (*Womersley*, 2.xii.1975; AD, A46944). West Cape, Yorke Pen., S. Aust., 15 m deep (*Edyvane*, 26.x.1993; AD, A66329). Encounter Bay, S. Aust. (*Cleland*; AD, A3646). West Bay, Kangaroo I., S. Aust., drift (*Womersley*, 6.i.1946; AD, A3210). Seal Bay, Kangaroo I., S. Aust., drift (*Mitchell*, 29.x.1966; AD, A30970). Cape Jaffa, S. Aust., drift (*Womersley*, 5.iv.1999; AD, A68077). 22 km NW of Robe, S. Aust., 40 m deep on limestone (*Shepherd*, 20.xi.1968; AD, A64761). Robe, S. Aust., drift (*Womersley*, 2.iv.1999; AD, A68122—"Marine Algae of southern Australia" No. 406). Stinky Bay Point, Nora Creina, S. Aust., drift (*Womersley*, 21.xi.1998; AD, A67944). 400 m off Cape Buffon, S. Aust., 5 m deep (*Collings*, 25.i.1991; AD, A61234). 1.3 km off Middle Point, Cape Northumberland, S. Aust., 13 m deep (*Shepherd*, 19.iii.1974; AD, A44945). Port MacDonnell, S. Aust., drift (*Womersley*, 15.iv.1959; AD, A22995). Bridgewater Bay, Vic., drift (*Beauglehole*, 21.vii.1951; AD, A21603). Lighthouse Point, Queenscliff, Vic., 12–14 m deep (*Goldsworthy*, 9.ii.1990; AD, A60157), Walkerville, Vic., drift (*Sinkora* A2600, 31.iii.1979; MEL and AD, A61009).

N. pristoidea is a common species on south eastern Australian coasts, with much branched, slender, narrow fronds which are marginally serrate.

M. serrulata (J. Agardh)Kylin appears to be only a sterile plant of *N. pristoidea*; the holotype sheet in LD, 30497, from Swan I. (prob. NE Tas.), *Baudinet*, was also labelled by J. Agardh "Nitoph. pristoidea Harv.?"

2. **Nitospinosa tasmanica** Womersley, *sp. nov.*

FIG. 37

Thallus (Fig. 37A) medium to dark red-brown, 5–15 cm high, foliose with mid parts 0.5–8 cm broad, bearing smaller branches or ovate lobes 4–15 mm broad from the upper margin; margins dentate (Fig. 37B), with frequent short spines mostly 50–200 µm long; veins absent but mid thallus often perforate with small holes (from grazing?); lower thallus narrower and centrally slightly thickened, becoming stipe-like basally. Holdfast fibrous, 2–6 mm across; epilithic. *Structure*. Growth from the marginal dentations each with a transversely dividing apical cell (Fig. 37C), with axial and second-order cell rows recognisable only to the base of the spines; between the spines, some marginal cells divide by anticlinal walls; below the spines, cell rows scarcely recognisable (Fig. 37B, C), intercalary divisions frequent giving an irregular cell arrangement. Young blades monostromatic (Fig. 37D) and 40–55 µm thick, soon becoming tristromatic and centrally polystromatic (Fig. 37D) and then 130–180 µm thick;

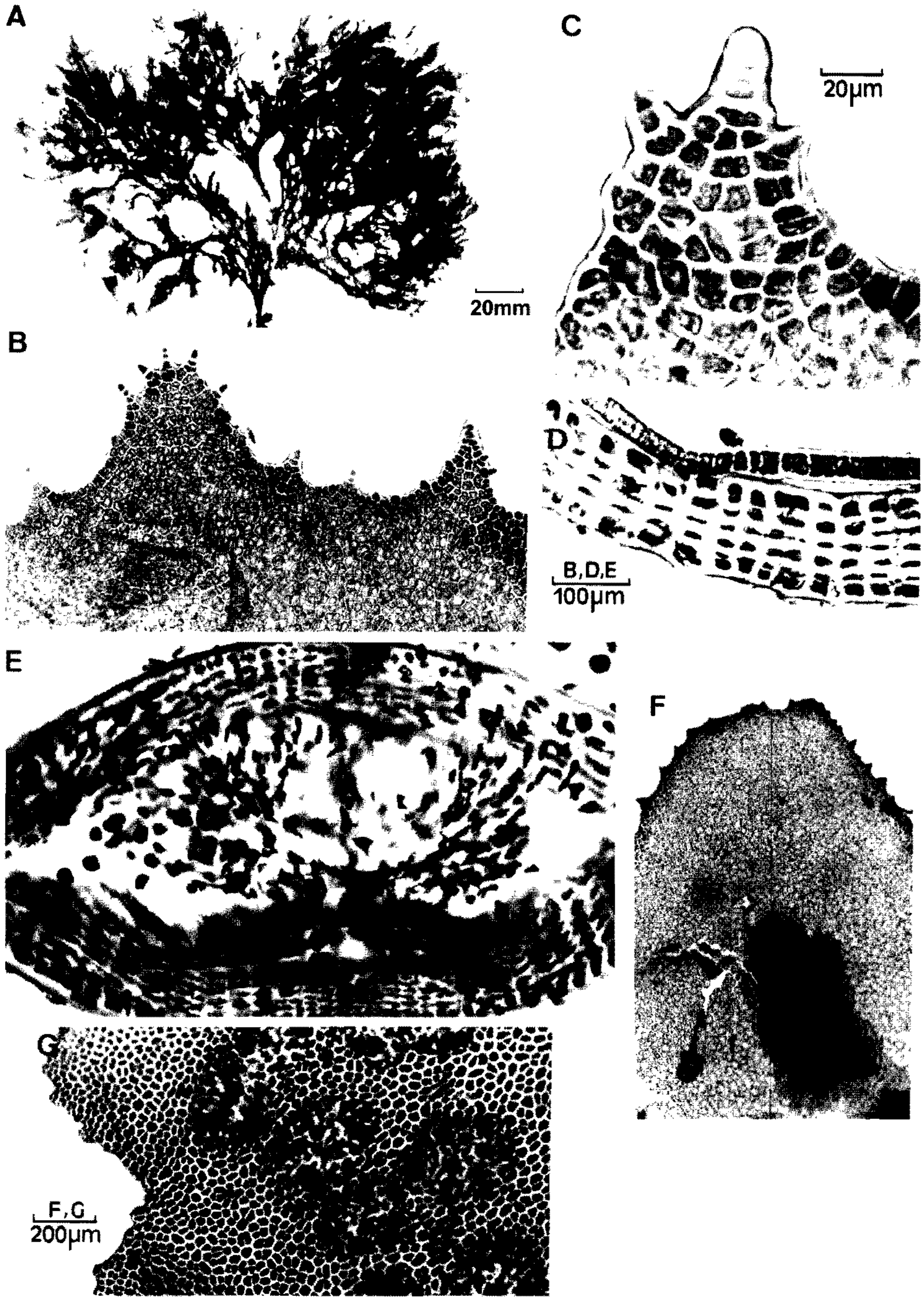

Fig. 37. *Nitospinosa tasmanica* (**A**, **B**, **D**, **G**, AD, A63908; **C**, AD, A63969; **E**, AD, A68223; **F**, AD, A10359). **A**. Habit. **B**. Apex of frond with frequent spines. **C**. A spine with apical cell and segmentation below. **D**. Transverse sections of young and older thallus. **E**. Section of cystocarp. **F**. Spermatangial sori. **G**. Blade with tetrasporangial sori.

surface cells angular, 20–40 µm across and L/D 1–2, with the cortical cells equivalent to the slightly thinner primary cells. Cells multinucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps scattered, details not observed. Carposporophytes with a basal, erect, fusion cell and much branched gonimoblast with ovoid to shortly clavate terminal carposporangia 30–60 µm in diameter, the subterminal cells maturing rapidly to give short chains. Cystocarps (Fig. 37E) scattered, swollen, 1–1.5 mm across; pericarp ostiolate, 100–180 µm and 6–8 cells thick, cells tiered. Spermatangial sori (Fig. 37F) irregular in shape, 200–600 µm across, with the primary cells producing on each side a layer of initials which cut off elongate spermatangia.

Tetrasporangial sori (Fig. 37G) ovate, scattered, 200–450 µm across and 160–200 µm thick, with tetrasporangia in 2 layers, cut off from inner cells of 2–3-celled cortical filaments and covered by the outer cells; tetrasporangia subspherical, 45–75 µm in diameter.

Diagnosis: Thallus 5–15 cm altus, foliosus, partes mediae 0.5–8 cm latae, ferens margine ramos aut lobos ovatos 4–15 mm latos, margines dentationibus crebris 50–200 µm longae; nervi absentes, rami inferiores parum in centro incrassati. Omnes dentationes cellula apicali transverse dividente sed series axiales et ordinis secundae praesentes solum ad basin dentationium; cellulae marginales inter dentationes per muros anticlinales dividentes. Laminae iuvenes monostromaticae postea tri- ad polystromaticae, cellulae corticales aequales.

Gametophyta dioica. Procarpia dispersa. Carposporophytes carposporangiis terminalibus ovoideis ad clavata, in catenis brevibus maturescentibus. Cystocarpia dispersa, turgida, pericarpium 6–8 cellulas crassum, stratum. Sori spermatangiales irregulares, 200–600 µm lati, initiis in quoque latere cellularum primariarum. Sori tetrasporangiales dispersi, ovati, 200–450 µm lati et 160–200 µm crassi, tetrasporangia distromatica, abscissa e cellulis interioribus corticalibus et cellulis exterioribus tecta, 45–75 µm diametro.

Type from Arch Rock, off Ninepin Point, SE Tasmania, 1–10 m deep (*Andrews*, 21.x.1994); holotype in AD, A63908.

Distribution: Port Phillip Heads and Crawfish Rock, Westernport Bay, Vic., Low Head, N Tas., and Ninepin Point and Arch Rock, SE Tasmania.

Selected specimens: The Rip, Port Phillip Heads, Westernport Bay, Vic., 16–21 m deep (*Saunders, Strachan & Kraft*, 5.iv.1995; MELU, K10623a and AD, A68265). Crawfish Rock, Westernport Bay, Vic., 5–10 m deep (*Watson*, 29.viii.1971; AD, A39375). West Point, Erith I., Bass Strait, 28 m deep (*Shepherd & R. Lewis*, 10.v.1974;AD, A45236). Low Head, Tas. (*Perrin*, 5.x.1950; AD, A16440). Bombay Rock, Tamar Est., Tas., upper sublittoral (*Womersley*, 27.i.1948; AD, A10359). Ninepin Point, Tas., 7–12 m deep (*Edgar*, 1.v.1999; AD, A68223). Arch Rock, E of Ninepin Point, SE Tas., 8–12 m deep (*Barrett*, 23.x.1994; AD, A63969, A63970). Charlotte Cove, near Ninepin Point, SE Tas., 3–6 m deep (*Edgar*, 6.x.1999; AD, A68327—"Marine Algae of southern Australia" No. 408).

Nitospinosa tasmanica is distinct from *N. pristoidea* in morphology but shows the characteristic marginal dentations on young apices; these are often lost from older parts.

N. tasmanica is named from its occurrence mainly in Tasmania.

3. **Nitospinosa littledipensis** Womersley, *sp. nov.*

FIG. 38

Thallus (Fig. 38A, B) medium red, upper parts often bleached, 3–5 cm high, complanately and irregularly marginally branched with lower and mid thallus (3-) 5–10 mm broad, 60–120 µm thick, margin usually crenulate or with small irregular dentations, apical margin (Fig. 38C) usually entire; lower blades centrally thickened, base of blades stipe-like, 1–2 mm broad. Holdfast discoid to slightly branched, 1–3 mm across; epilithic. *Structure.* Growth marginal (Fig. 38D) with occasional short dentations with apical cells on young apices, segmenting with transverse walls but second-order rows apparent only for 2–4 cells below the apical cells; most marginal cells divide anticlinally, intercalary divisions frequent within the margins; surface cells irregular in shape, 20–45 µm across and L/D 1–2. Blades monostromatic and 45–60 µm thick only near the apices or margins, soon tristromatic (Fig. 38E) and 70–100 µm thick, becoming polystromatic and 80–120 µm thick, developing a central midrib region 120–400 µm and 6–16 cells thick (Fig. 38F). Cortical cells equivalent to central cells and only slightly larger. Cells probably multinucleate; rhodoplasts discoid.

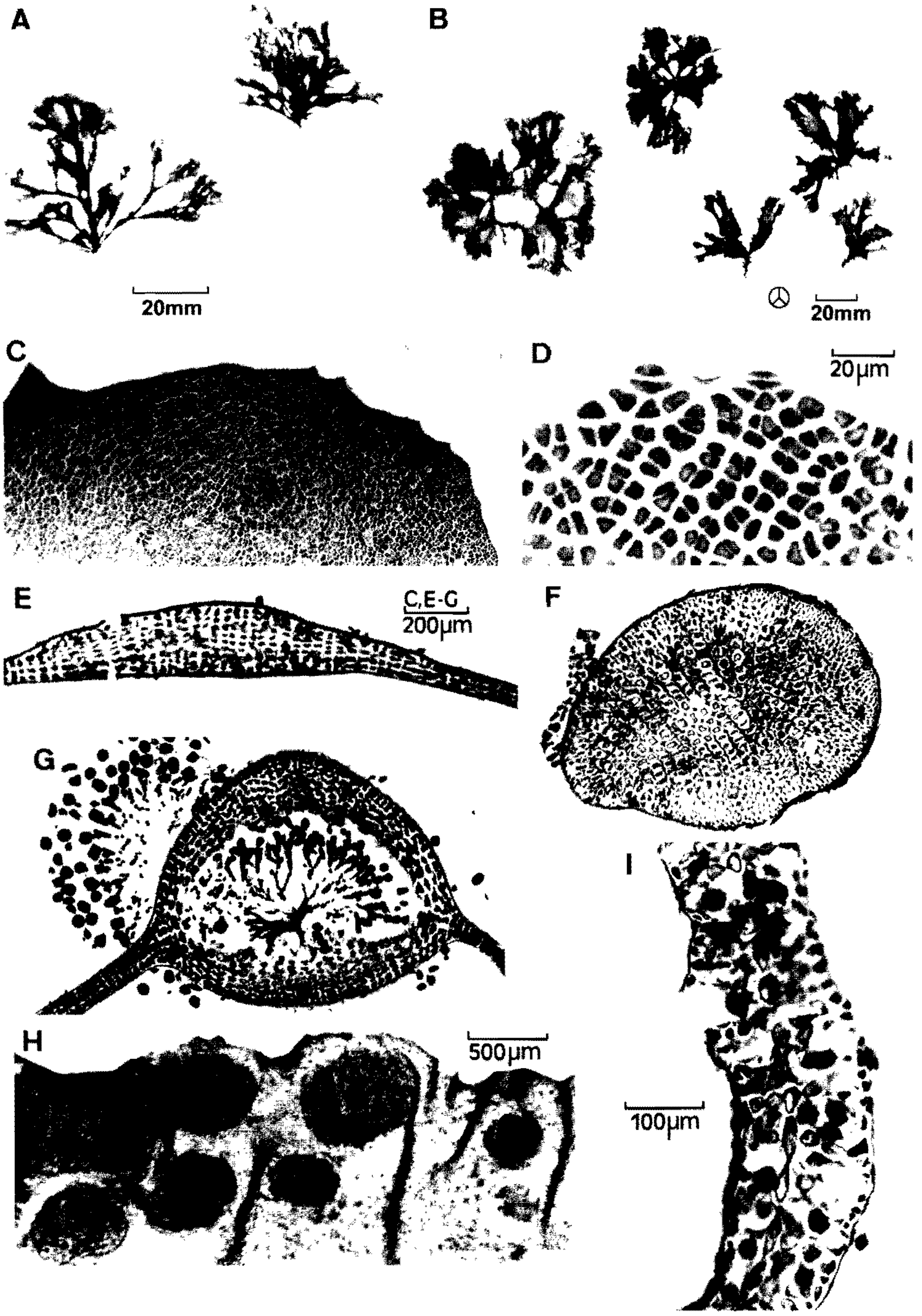

Fig. 38. *Nitospinosa littledipensis* (**A**, **D**, **E**, **G**, AD, A68375; **B**, **C**, **F**, **H**, **I**, AD, A63227). **A**. Habit of type. **B**. Habit, tetrasporangial plants. **C**. Apex of frond. **D**. Frond apex with apical cells and segmentation. **E**. Transverse section of thallus. **F**. Transverse section of stipe. **G**. Section of Cystocarp with chains of carposporangia. **H**. Tetrasporangial sori near thallus margin. **I**. Transverse section of tetrasporangial sorus.

Reproduction. Gametophytes probably dioecious. Procarps scattered on young blades, with a primary (supporting) cell bearing 2–3 sterile cells and a 4-celled carpogonial branch. Carposporophytes with a prominent, branched, basal fusion cell, and a much-branched gonimoblast with terminal, unbranched, chains of carposporangia (Fig. 38G), the end 3–5 cells mature, ovoid, and 35–55 µm in diameter. Cystocarps scattered, few per blade, 1.0–1.3 mm across, protruding mainly on one side of blade; pericarp ostiolate, 3–6 cells thick, slightly beaked or thickened (10–12 cells thick) around the ostiole. Spermatangial plants unknown.

Tetrasporangial sori (Fig. 38H) more or less ovate, usually submarginal, 0.5–2 mm across and 180–260 µm thick, tetrasporangia of irregular age, in 2 layers (Fig. 38I), cut off from inner cortical cells and covered by outer cortical cells, subspherical, 40–75 µm in diameter.

Diagnosis: Thallus 3–5 cm altus, complanate et in margine irregulariter ramosus, rami inferiores (3-) 5–10 mm lati, 60–120 µm crassi, margo crenulatus dentationibus parvis et irregularibus, margo apicalis integer; rami inferiores ad centrum incrassati. Crescens e cellulis apicalibus in dentationibus; series axialis et ordinis secundae clara per aliquot cellulas solum, sed plurimae cellulae marginales anticliniter dividentes, crebris divisionibus intercalaribus infra. Laminae prope margines monostromaticae mox tri- ad polystromaticas, cellulae aequales.

Procarpia sparsa, cellula sustinens 2–3 cellulis sterilibus; carposporophytes catenis terminalibus carposporangium ovoideorum, in extremo 2–3 matura. Cystocarpia dispersa, in uno latere thalli protrudentia, pericarpium 3–6 cellulas crassum, ostiolum rostratum. Spermatangia non nota. Sori tetrasporangiales ovati, submarginales, 0.5–2 mm lati, 180–260 µm crassi, tetrasporangia distromatica, abscissa e cellulis interioribus corticalibus et tecta per cellulas exteriores, 40–74 µm diametro.

Type from Back Beach, Little Dip Conservation Park, SE S. Aust., in shallow wave-washed pools (*Womersley*, 25.xi.1999); holotype (cystocarpic) in AD, A68375. Paratype (tetrasporangial) from the same locality (*Womersley*, 31.x.1993; AD, A63227).

Distribution: Known only from the above material.

N. littledipensis is known from only 2 collections and is named from the type locality. It is characterised by form of the thallus and by the chains of ovoid carposporangia.

Genus ROBEA Womersley, *gen. nov.*

Thallus erect, complanately and marginally branched, branches more or less linear, margins linear to convolute, apices usually rounded, with occasional surface bladelets, blades with a distinct midrib arising below the apices and forming a short basal stipe; microscopical veins absent; holdfast of clumped rhizoids; epiphytic. *Structure*. Apices of blades with or without small apical cells, level with the margin or slightly protruding and with only occasional cells dividing by anticlinal walls, with frequent irregular intercalary divisions but usually without recognisable axial or lateral cell rows. Blades monostromatic when young, becoming tristromatic and polystromatic near the base and in the midrib, with cortical cells equivalent and primary layer cells of similar size to cortical cells; cells multinucleate.

Reproduction. Gametophytes dioecious. Procarps scattered, with the primary cell cutting off two elongate cells parallel to blade length, one forming a group of cover cells and the other producing a 4-celled carpogonial branch and a group of 2 sterile cells, with the carpogonial branch lying between the groups of cover cells and sterile cells. Carposporophyte with a small basal fusion cell and a moderately branched gonimoblast with large terminal carposporangia. Cystocarps hemispherical, ostiolate, pericarp 4–7 cells thick usually with no collar. Spermatangial sori scattered, ovate, with the primary cells producing a layer of initials with outer elongate spermatangia.

Tetrasporangial sori ovate, scattered on blade wings, with tetrasporangia in 2 layers, cut off from inner cells of cortical chains 4–6 cells long.

Diagnosis: Thallus erectus, complanate et marginaliter ramosus, rami lineares, margines saepe convolati, apices rotundati, costa distincta et stipe brevi; nervi absentes. Apices cellulis parvis planis margine aut exigue protrudentibus, aliquot cellulis anticliniter dividentibus, infra divisionibus irregularibus et intercalaribus sed sine serie axiali et laterali. Laminae monostromaticae iuvenales, infra tristromaticae, costa polystromatica, cellulae aequae.

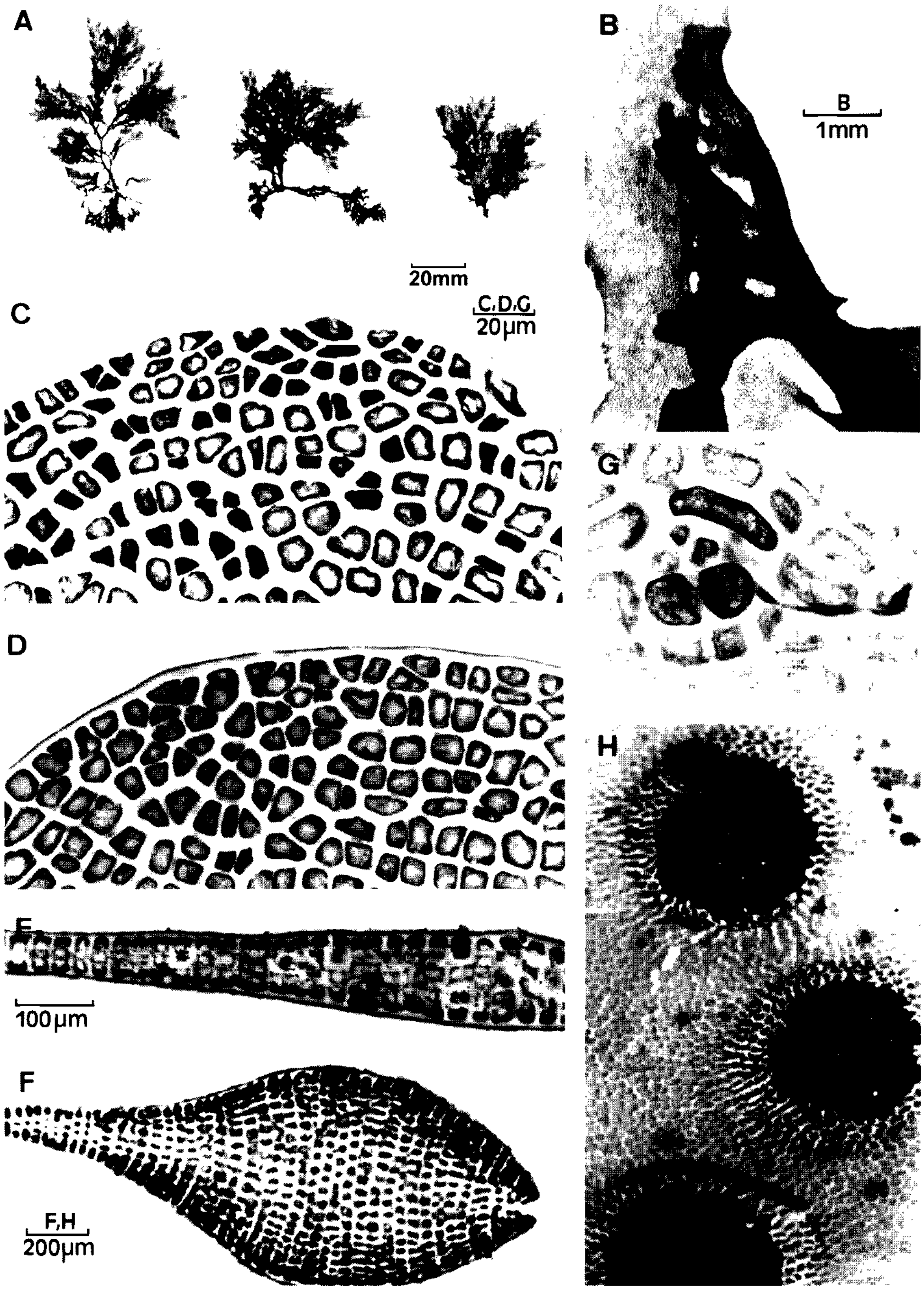

Fig. 39. *Robea costata* (**A**, **C–G**, AD, A68095; **B**, AD, A68099; **H**, AD, A29710). **A**. Habit of type on *Nitospinosa pristoidea*. **B**. Fibrous holdfast. **C**. Apex, with an apical cell almost level with margin. **D**. Apex without clear apical cells. **E**. Transverse section of blade, thicker centrally. **F**. Transverse section of midrib. **G**. Procarp with an undivided cover cell (above) and 2 sterile cells (Below). **H**. Cystocarps, surface view.

Gametophytes dioeci. Procarpia dispersa, cellula princeps 2 cellulas elongatas producens, altera cellulas tegentes faciens, altera ramum carpogonialem et 2 cellulas steriles. Carposporophyta carposporangiis terminalibus. Cystocarpia hemisphericalia, pericarpa 4–7 cellulis crassa. Sori spermatangiales dispersi, ovati, cellulis principibus stratum initiorum producentibus. Sori tetrasporangiales dispersi, ovati, tetrasporangia bistrata, abscissa e cellulis interioribus, compositis ex filis corticalibus 4–6 cellulatis.

Type species: *R. costata* Womersley, *sp. nov.*

Robea is characterised by the branch apices which usually do not have distinct protruding apical cells, but occasionally these are present. However, only few marginal cells dividing by anticlinal walls occur, and cells below the apical cells or the marginal apices divide in an irregular manner, and cell rows (whether axial or lateral) are not recognisable. These features probably place *Robea* (and *Nitospinosa*) as a separate group, related to the *Phycodrys* and *Valeriemaya* [Millar & Wynne (1992a)] groups which do show distinct axial and second-order cell rows. *Valeriemaya* also has a single apical cell to each blade and the blades are monostromatic except at the midrib. In reproductive features, *Robea* is similar to *Nitophyllum* and its allies, especially in the procarps, but also differs in having a strongly developed midrib; it is also similar to *Valeriemaya* reproductively, though carposporangia for this genus are not described.

Robea is named for the township of Robe, which is central to its distribution.

Robea costata Womersley, *sp. nov.*

FIGS 39, 40, 41D, E

Thallus (Figs 39A, 40A) erect, delicate, medium to dark red, 3–10 cm high, much branched marginally and more or less complanately, most branches (2-) 3–8 (-15) mm broad, margins linear to convolute with rounded to pointed apices and occasional small proliferations, developing a distinct midrib, wings lost near the base leaving a short stipe; veins absent. Holdfast of clumped rhizoids, becoming fibrous (Fig. 39B); epiphytic, commonly on *Nitospinosa pristoidea* and *Phacelocarpus peperocarpos*. *Structure*. Growth marginal (Fig. 39D), with occasional distinct apical cells (Figs 39C, 40B, C) but many branches with marginal growth from sunken apical cells and with some cells dividing anticlinally; cell divisions intercalary and irregular, without distinct axial or second-order cell rows; surface cell arrangement irregular but cells often in longitudinal lines (though not forming veins), cells angular, 20–45 μm broad and L/D 1–2. Blades monostromatic and 45–120 μm thick, the midrib (Fig. 39E) tristromatic and 90–200 μm thick and then polystromatic (Fig. 39F) and 250–300 μm thick; cortical cells equivalent, of similar size to primary cells. Cells multinucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps (Fig. 41D, E) scattered, developing on opposite sides of the blade from a primary cell which cuts off 2 elongate cells more or less parallel to the branch length, one dividing into 2 as a group of cover cells and the other (supporting) cell bearing a carpogonial branch and a 2-celled sterile group, these and the cover cells lying on each side of the 4-celled carpogonial branch (Figs 39G, 40D). Carposporophyte (Fig. 40E) with a small basal fusion cell and moderately branched gonimoblast of short cells with large, clavate to ovoid, terminal carposporangia 35–65 μm in diameter, replaced from below. Cystocarps (Fig. 39H) scattered, hemispherical, 0.7–1.3 mm across, ostiolate; pericarp 90–110 μm and 4–7 cells thick, with no or very slight collar. Spermatangial sori (Fig. 40F) on blades, elongate-ovate, (200-) 400–1000 μm across, with the primary cells producing a layer of initials which cut off outer elongate spermatangia.

Tetrasporangial sori (Fig. 40G) ovate, scattered, mainly on lateral blades or wings, rounded to elongate, (300-) 500–1200 μm across and 180–360 μm thick, with tetrasporangia in 2 layers, cut off from inner cells (Fig. 40H) of cortical chains 4–6 cells long and covered by outer cortical cells, subspherical, 60–110 μm in diameter.

Diagnosis: Thallus 3–10 cm altus, ramosissimus margine et complanate, rami (2-) 3–8 (-15) mm lati, margines lineares ad convolutos, apices rotundati ad acutos, interdum prolificantes; costa distincta, alae prope basin absentes; nervae absentes, epiphyticus in *N. pristoidea et Phacelocarpus peperocarpos*. Crescens margine, e cellulis interdum distinctis apicalibus et cellulis anticliniter dividentibus infra divisionibus intercalaribus, sed sine serie axiali vel

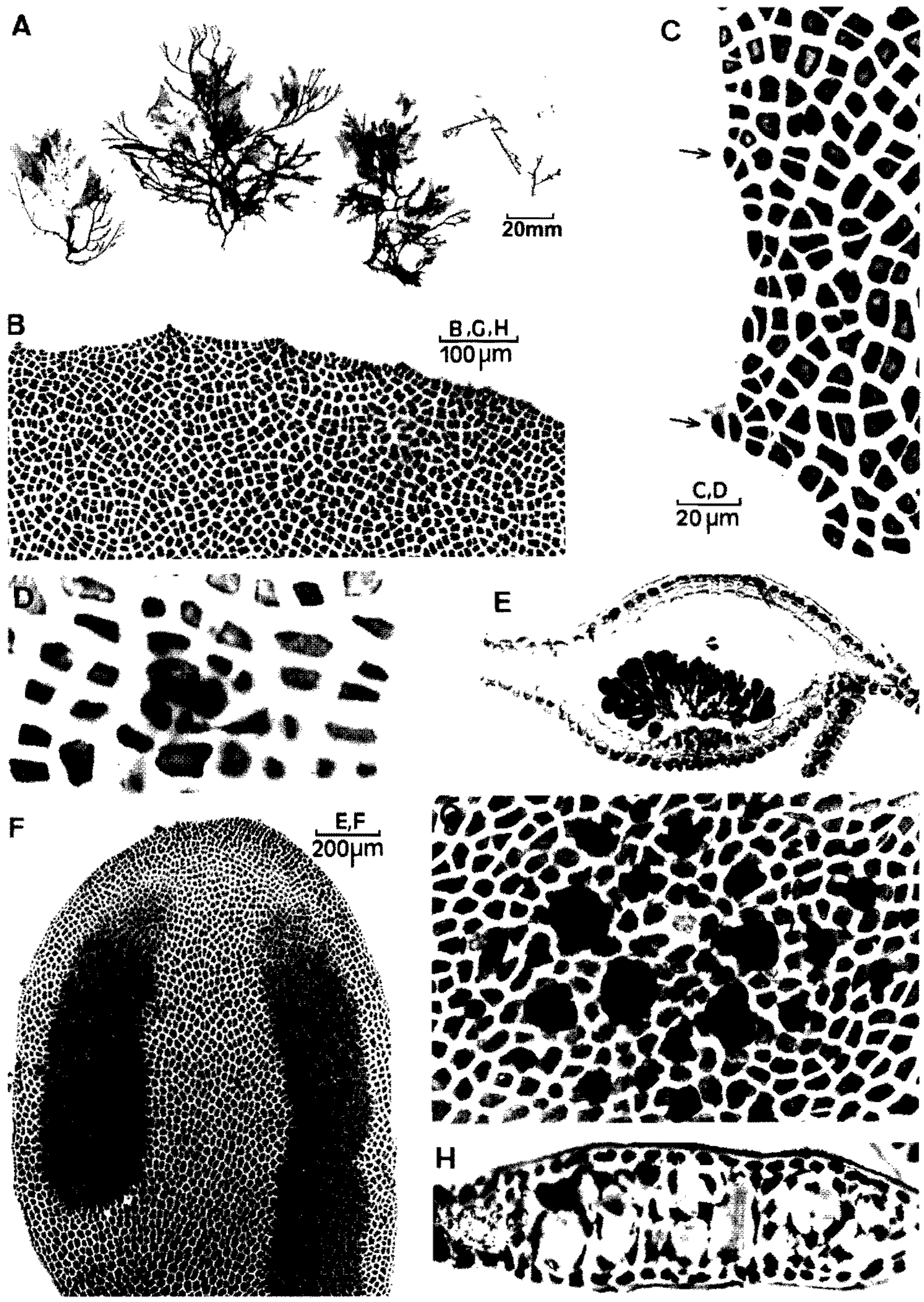

Fig. 40. *Robea costata* (**A–E**, **G**, AD, A64063; **F**, **H**, AD, A68149). **A**. Habit on *Phacelocarpus*. **B**. Branch apex with minute spines with apical cells. **C**. Frond margin with apical cells (arrows), one on a small spine. **D**. Procarp with a carpogonial branch and cover sterile cells (out of focus). **E**. Section of a cystocarp. **F**. Blade with spermatangial sori. **G**. Tetrasporangial sorus. **H**. Transverse section of tetrasporangial sori.

secundae ordinis. Laminae monostromaticae, 45–120 μm crassae, infra tristromaticae, costa polystromatica, cellulae aequivalentes.

Reproductio ut in genere.

Type from Port MacDonnell, S. Aust., on *Nitospinosa pristoidea*, drift (*Womersley*, 4.iv.1999); holotype in AD, A68095.

Distribution: Cape Thomas, Guichen Bay, to Cape Northumberland, S. Aust; Crawfish Rock, Westernport Bay, Vic., and SE Tasmania.

Selected specimens: N of Cape Thomas, Guichen Bay, S. Aust., on *Nitospinosa pristoidea*, drift (*Womersley*, 24.viii.1960; AD, A24389). Robe, S. Aust., on *Ballia callitricha*, drift (*Womersley*, 29.viii.1949; AD, A10913) and on *N. pristoidea*, drift (*Womersley*, 2.iv.1999; AD, A68099). Stinky Bay, Nora Creina, S. Aust, on *N. pristoidea*, drift (*Womersley*, 19.viii.1957; AD, A21274) and (*Mitchell*, Nov. 1965; AD, A29710). 2 km NW of Blackfellows Caves, S. Aust., on *N. pristoidea*, drift (*Womersley*, 24.xi.1992; AD, A61777). 1.3 km off Middle Point, Cape Northumberland, S. Aust., on *Phacelocarpus peperocarpos*, 15 m deep (*Shepherd*, 13.ii.1976; AD A47018). Crawfish Rock, Westernport Bay, Vic., on hydroid(?), 8 m deep (*Watson*, 26.iv.1969; AD, A34372). Pirates Bay, Eaglehawk Neck, Tas., on *P. peperocarpos*, 9–12 m deep (*Gowlett-Holmes*, 31.x.1994; AD, A64063). Cathedral Cave, Waterfall Bay, Tas., on *P. peperocarpos*, 6–15 m deep (*Archer*, 3.iv.1999; AD, A68149). Crayfish Point, Taroona, Tas., on *P. peperocarpos*, 0–6 m deep (*Sanderson*, 29.v.1992; AD, A61758).

Robea costata is named for the prominent costa shown by most plants.

Genus MARTENSIA Hering 1841: 92, *nom.cons.*

Thallus foliose, with broad fronds with lower solid membranous blades and upper perforate nets or meshes terminated by a continuous terminal membrane, smooth or dentate. Holdfast usually discoid, with a terete stipe; epilithic. *Structure*. Growth marginal from the terminal membrane, with submarginal intercalary cells dividing numerous times and the filaments separating and forming largely monostromatic segments several cells broad, lying at right-angles to the fronds; secondary lateral segments connect the primary segments forming an interconnected net or mesh; in some species the marginal membrane may give rise to secondary nets.

Reproduction. Gametophytes dioecious. Procarps scattered on the segments of the nets, with a 4-celled carpogonial branch and probably sterile groups. Carposporophytes usually with a basal fusion cell and large lower gonimoblast cells, decreasing in size to the ovoid terminal carposporangia. Cystocarps on the net segments, ovoid, ostiolate, with a thick pericarp of anticlinal cell rows. Spermatangial sori on the net segments, with small cortical cells each cutting off several elongate spermatangia.

Tetrasporangial sori scattered on the net segments or the lower membrane, rounded, with tetrasporangia transformed directly from or cut off from primary cells and covered by smaller cortical cells, subspherical, tetrahedrally divided.

Type species: *M. elegans* Hering 1841: 92.

Martensia includes 5 or 6 species, with probably a single species on southern Australian coasts but 2 or 3 other species on warmer water eastern and western coasts (see Millar 1990, p. 416). Records of *M. denticulata* and *M. elegans* from southern coasts (e.g. Huisman & Walker 1990, p. 430; Lucas 1909: 135; Lucas & Perrin 1947, pp 216–218; May 1965, p. 466) probably apply to *M. australis*.

Neomartensia [*N. flabelliformis* (Harvey)Yoshida & Mikami from Japan] has recently been separated by Yoshida & Mikami (1996) from *Martensia* on account of having carposporangia in chains and membranes with transverse sections showing irregular cells. This species occurs in the central to southern-eastern Pacific, including Lord Howe I.

Martensia australis Harvey 1855a: 537; 1858: pl. 8; 1863, synop.: xiv. J. Agardh 1863: 827; 1885: 87, fig. 7. Coppejans & Millar 2000: 330. De Toni 1900: 615. Huisman 1997: 202. Huisman & Walker 1990: 430. Kraft *et al.* 1999: 21. Kützing 1869: 22, pl. 58. Lucas 1909: 35; 1929a: 19. May 1965: 406. Millar 1990: 416, fig. 52; 1999: 519. Millar & Kraft 1993: 47. Shepherd & Womersley 1981: 366. Silva *et al.* 1996: 459.

M. palmata see (... may be the same.

Sonder 1880: 31. Svedelius 1908: 43, figs 7, 40. Tisdall 1898: 512. Wilson 1892: 168. Yoshida 1998: 981. Yoshida & Mikami 1996: 103, figs 19–24.
Capraella australis (Harvey)G. De Toni 1936: 3.
Mesotrema australis (Harvey)Papenfuss 1942: 449. Guiler 1952: 102.
Martensia sp. Harvey 1859b: 294. J. Agardh 1863: 832.
Martensia gigas Harvey 1863, synop.: xiv. De Toni 1900: 620. Lucas 1909: 35; 1929a: 19. Sonder 1880: 31.
Mesotrema gigas (Harvey)Papenfuss *ex* Guiler 1952: 102, *nomen invalid.*

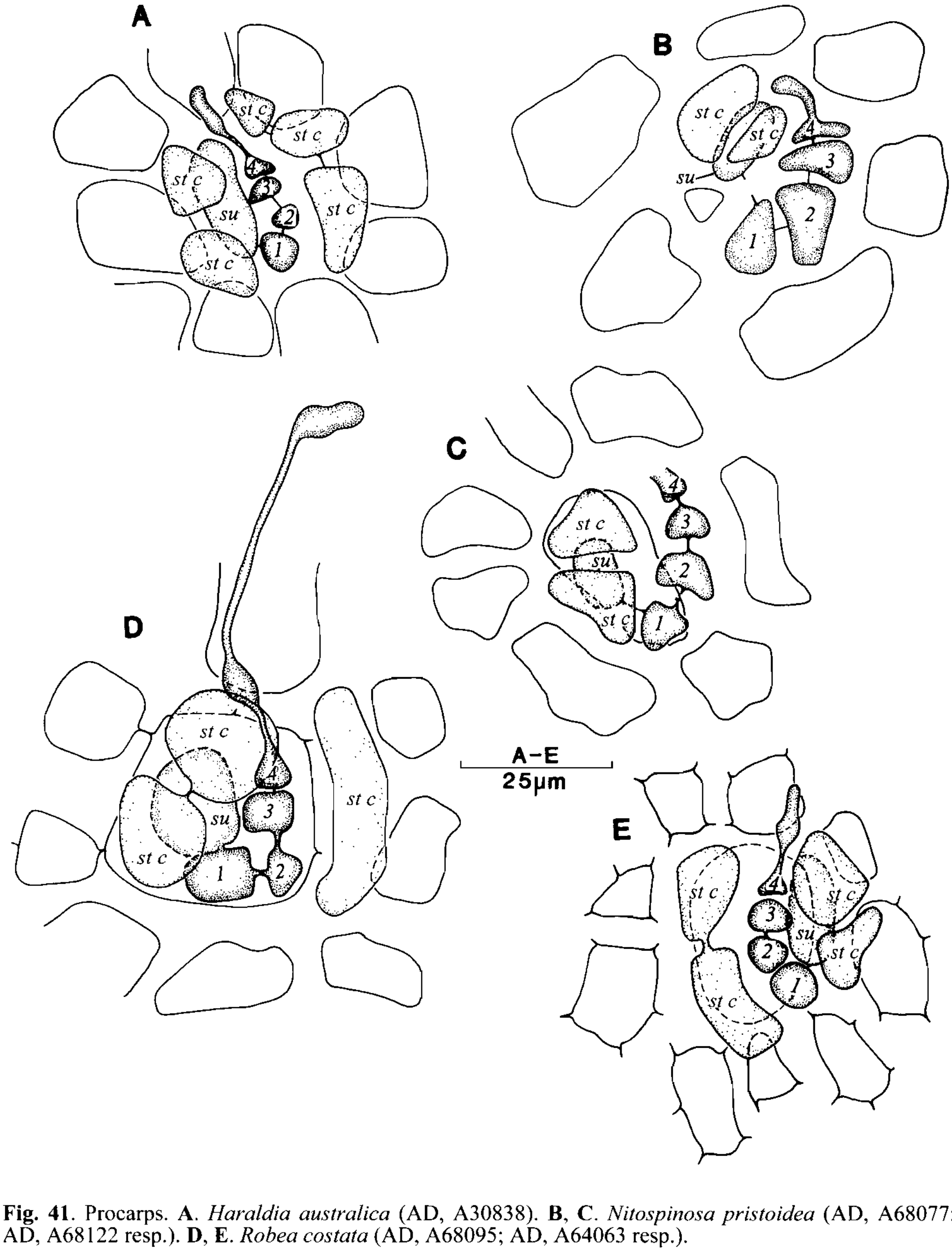

Fig. 41. Procarps. **A**. *Haraldia australica* (AD, A30838). **B**, **C**. *Nitospinosa pristoidea* (AD, A68077; AD, A68122 resp.). **D**, **E**. *Robea costata* (AD, A68095; AD, A64063 resp.).

FIGS 42, 43

Thallus (Fig. 42A) medium to dark red-brown (the net usually darker than the lower membrane), 5–20 cm high, foliose with a frequently divided frond 10–25 cm broad, borne on a single stipe usually 1–2.5 cm long and 1–2 mm in diameter; lower solid membrane 2–8 cm high and broad, mostly 150–200 µm thick, entire or lacerate or subdivided, with the upper mesh (1-) 5–15 cm high and as much or more across, radial and tangential membranes orientated at right-angles to the blades, mostly monostromatic, perforations elongate-rectangular (Fig. 42B), enlarging to 2–3 mm long and 200–400 µm wide; continuous marginal membrane (often lost) 1–3 mm across, with prominent, simple or branched, blunt spines 0.6–2 (-3) mm long (Fig. 42B). Secondary nets usually absent (see below). Holdfast discoid, 1–4 mm across; epilithic. *Structure*. Growth of marginal membrane (Fig. 42C) from numerous marginal cells dividing irregularly, with submarginal cells dividing to form radial chains of cells which separate laterally and undergo extensive intercalary divisions to form the main radial segments of the net, becoming linked tangentially by lateral segments; this process continues extensively to form the relatively coarse mesh, with segments 500–800 µm and 14–18 cells broad. Lower membrane 200–400 µm and 4–6 cells thick (Fig. 42D), cell arrangement regular in section. Stipe (Fig. 42E) becoming many cells thick, cells in tiers, equivalent. Mature cells multinucleate; rhodoplasts discoid, becoming chained.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes (Fig. 43B) with a basal pad of ovoid, darkly staining, cells below a basal rounded to erect fusion cell bearing a gonimoblast of several large, basal, clavate cells with branched filaments of progressively smaller cells and ovoid terminal carposporangia 15–35 µm in diameter. Cystocarps (Fig. 43A) on the radial segments, globose, 1–1.5 mm across; pericarp ostiolate, 200–450 µm and 5–15 cells thick, cells in tiers. Spermatangial sori (Fig. 43C) rounded to elongate, on the mesh segments, with small cortical initials each cutting off several elongate spermatangia (Fig. 43D).

Tetrasporangial sori (Fig. 43E) rounded, scattered on the mesh segments or on the lower solid membrane, 200–400 µm across, each with several tetrasporangia (Fig. 43F) developed from primary cells and covered on each side by a layer of smaller cortical cells (Fig. 43G), tetrasporangia subspherical, 50–80 µm in diameter.

Type from King George Sound, W. Aust., lectotype Alg. Aust. Exsicc. 111B in Herb. Harvey, TCD (Trav. Set 88 missing in 1952).

Distribution: Houtman Abrolhos ? (Huisman 1997, p. 202) and Rottnest I., W. Aust. (Huisman & Walker 1990, p. 430) to Coffs Harbour, N.S.W. (Millar 1990, p. 417) and N Tasmania (*M. gigas*).

N Papua New Guinea (Coppejans & Millar 2000: 330). Philippines (Kraft *et al.* 1999: 21). Japan and China (see Millar 1990, p. 417).

Selected specimens: Elliston, S. Aust., 3–4 m deep (*Shepherd*, 22.x.1970; AD, A37525) and 4 m deep (*Shepherd*, 22.x.1970; AD, A37512). Sheringa Bay, Eyre Pen., S. Aust., 3–6 m deep, shaded (*Shepherd*, 22.x.1969; AD, A35143). Hopkins I., S. Aust., 25 m deep (*Branden*, 17.xi.1990; AD, A60846). Aldinga, S. Aust., 17 m deep in cave (*F. Mitchell*, 3.xii.1958; AD, A22057) and 16 m deep (*F. Mitchell*, 15.xi.1959; AD, A23964 and 22.xi.1959; AD, A23966 and A23967). Amphitheatre Rock, West I., S. Aust., 16 m deep (*Watson*, 31.viii.1969; AD, A34487). Vivonne Bay, Kangaroo I., S. Aust., 5 m deep on jetty piles (*Kraft & Min Thein*, 4.xii.1971; AD, A41402). Alex Lookout, E of Penneshaw, Kangaroo I., S. Aust., 10 m deep (*Lavers*, 25.xi.1996; AD, A66835). Margaret Brock Reef, Cape Jaffa, S. Aust., 3–5 m deep (*Lewis*, 29.xi.1972; AD, A42905). Lady Julia Percy I., Vic., 19 m deep (*Shepherd*, 4.i.1968; AD, A32444). Cape Nelson, Vic., 7–10 m deep (*Shepherd*, Jan. 1967; AD, A31624). 5 km off Surry R. mouth, Portland, Vic., 20 m deep (*Watson*, 28.xi.1981; AD, A52807). San Remo, Vic., drift (*Sinkora* A1906, 30.xi.1974; AD, A53462). Gabo I., Vic., 22 m deep (*Millar & O'Brien*, 4.xii.1996; NSW, 439078).

M. australis is a deep-water species, usually in shade when in shallow depths. It is characterised by its large fronds (when mature) with a coarse mesh, marginal membrane with prominent spines, and distinct, terete, stipe. Collections from deep water off Aldinga reef, S. Aust., are typical in these respects, but AD, A23966 has developed secondary nets, as does *M. fragilis* Harvey (see Millar 1990, p. 418); however, since the margin does show prominent spines, for the present this is regarded as an unusual variant in *M. australis*.

M. gigas was named by Harvey in 1863, having been previously recorded (1859b, p. 294) as *Martensia* sp. The type is from Georgetown, Tas. (*Gunn* and *Fereday*) and the lectotype (*Gunn*) in Herb. Harvey, TCD is a large frond (mesh) fragment of *M. australis*.

Genus PLATYCLINIA J. Agardh 1898: 103

Thallus complanately and irregularly branched, margin entire to crisped or spinous; veins absent but central thallus slightly thicker than wings; holdfast discoid, becoming divided. *Structure.* Growth marginal, without distinct apical cells, intercalary divisions frequent, blades monostromatic near apices, soon tristromatic and polystromatic, especially in centre of blades, with first and second cortical layers equivalent or dimidiate.

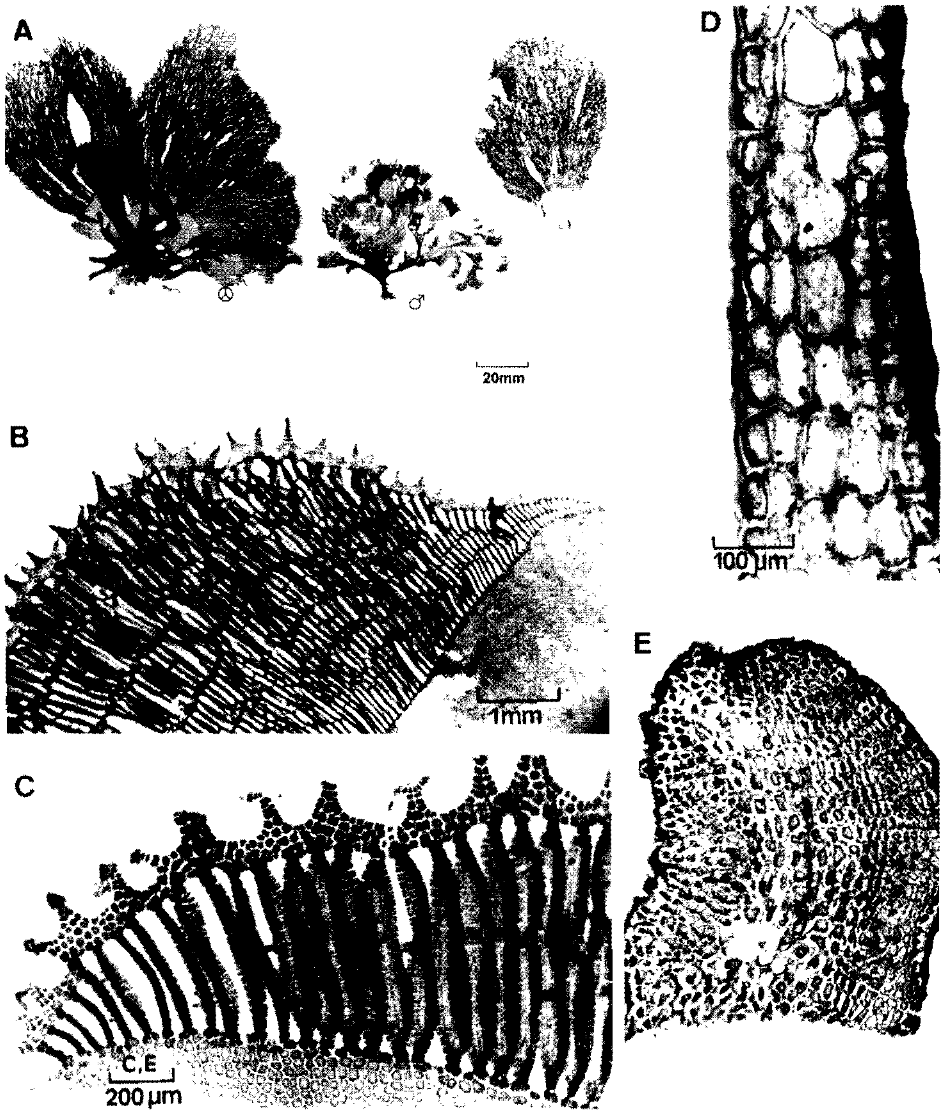

Fig. 42. *Martensia australis* (**A–C**, **E**, AD, A35143; **D**, AD, A31624). **A**. Habit. **B**. Net, with terminal and lower solid membranes. **C**. Detail of net and terminal membrane. **D**. Cross section of lower solid membrane. **E**. Transverse section of stipe.

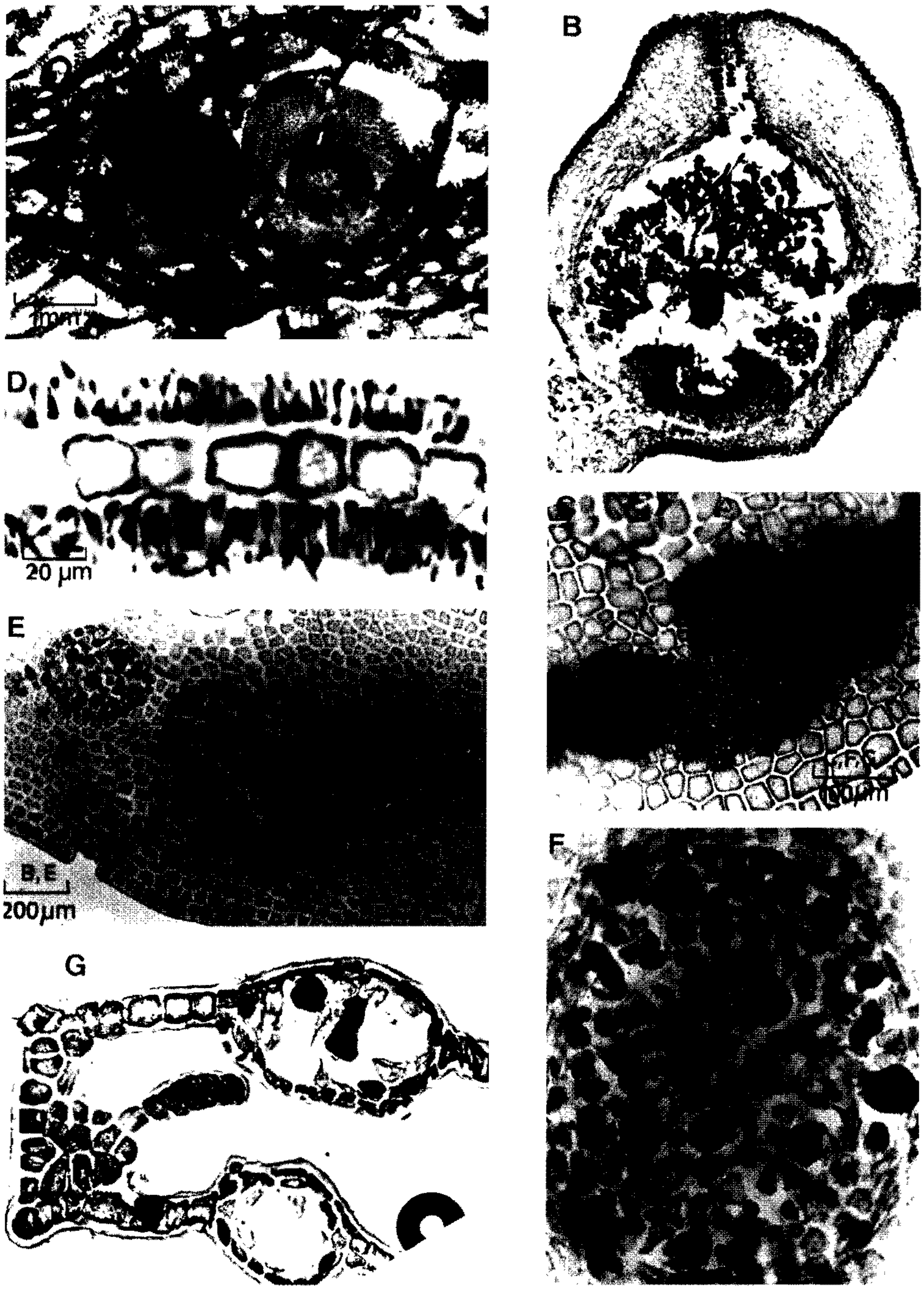

Fig. 43. *Martensia australis* (**A**, **C**, **D**, **G**, AD, A35143; **B**, AD, A37512; **E**, **F**, AD, A41402). **A**. Cystocarps within the net. **B**. Section of a cystocarp and carposporophyte. **C**. Spermatangial sorus on mesh segment. **D**. Transverse section of a spermatangial sorus. **E**. Tetrasporangial sori on a mesh segment. **F**. A tetrasporangial sorus. **G**. Sections of tetrasporangial sori.

Reproduction. Gametophytes dioecious. Procarps scattered, with the primary cells cutting off a cover cell and supporting cell with a 4-celled carpogonial branch and 2 sterile cells. Carposporophyte with a weft of slender radiating filaments (with cells fusing) over the layer of primary cells, producing numerous erect filaments of 3–5 carposporangia. Cystocarps slightly protuberant, pericarp thick, ostiolate. Spermatangial sori scattered, with the outer cortical cells producing initials with elongate spermatangia.

Tetrasporangial sori scattered, raised, with cortical cells producing paraphyses 3–4 cells long and tetrasporangia laterally from their lower cells.

Lectotype species: *P. stipitata* J. Agardh 1898: 106.

Wynne (1983, p. 446) discussed the type species of *Platyclinia*, advocating lectotypification of the genus on *P. stipitata*, on which the generic description is largely based.

Platyclinia is characterised by habit, sectional view of regular dimidiate or equivalent cortical cells, and especially by the carposporophyte in which a weft of slender, radiating filaments (with cells fusing) spreads over the layer of primary cells in the cystocarp, producing numerous erect filaments with clusters or rows of 3–5 carposporangia which mature simultaneously. While further detailed studies are needed, this structure appears distinctive within the Delesseriaceae.

KEY TO SPECIES OF *PLATYCLINIA*

1. Thallus branches 5–15 mm broad; cortex where polystromatic dimidiate ..... 1. *P. stipitata*
1. Thallus lateral branches 2–6 mm broad; cortex with cells equivalent to primary cells 2

    2. Margins and apices crenulate with frequent projecting cells; tetrasporangial sori linear (or in lines) between centre and margin of blades.................. 2. *P. crenulata*
    2 Apices and margins not crenulate; tetrasporangial sori ovate and scattered ....3. *P. ramosa*

1. **Platyclinia stipitata** J. Agardh 1898: 106. De Toni 1900: 669. Guiler 1952: 102. Kylin 1924: 64, fig. 49. Lucas 1909: 36; 1929a: 20. Lucas & Perrin 1947: 226. May 1965: 402. Wynne 1983: 446; 1996: 181; 1997: 330.

Platyclinia purpurea J. Agardh 1898: 109. De Toni 1900: 670. Kylin 1924: 66, fig. 51. Lucas 1909: 36. Lucas & Perrin 1947: 226. May 1965: 402.

Nitophyllum crispatum sensu J. Agardh 1898: 110 (NON Hooker & Harvey *in* Harvey & Hooker 1845: 185, pl. LXXI fig. 1).

Neuroglossum ?crispatum (J. Agardh)J. Agardh 1899: pl. 2 fig. 8.

Platyclinia crispata (J. Agardh)J. Agardh *ex* De Toni *sensu* Kylin 1924: 66, fig. 52. Lucas 1909: 36. May 1965: 402. [NON De Toni 1900: 670 = *Myriogramme crozieri* (Hooker & Harvey)Kylin 1924: 59 from southern S. America.]

Platyclinia kylinii Papenfuss 1967: 102.

FIGS 44, 45A–C, 54A

Thallus (Fig. 44A) complanately and irregularly laterally branched, 10–30 cm high, branches tapering to apices and mostly basally constricted, 5–15 (-50) mm broad and 180–350 µm thick, margin entire and wavy to slightly or strongly crisped (Fig. 44B) or with branched spinous clusters, especially on the lower thallus; midrib and lateral veins absent. Holdfast discoid, becoming divided, 0.5–1 mm across; epiphytic (on *Heterozostera* and various algae) or epilithic. *Structure.* Growth marginal, without distinct apical cells, intercalary cell divisions frequent, thallus monostromatic near apices, soon becoming polystromatic. Cross section of thallus (Fig. 44C) with regular cell arrangement, a central layer of large cells 40–110 µm thick, overlain by 1–2 (-3) layers of smaller cortical cells (slightly thicker centrally in branches), inner 2 cortical layer cells usually dimidiate, the inner cortical cells 35–55 µm across, outer cells (10-) 15–30 µm across, isodiametric to L/D 2. Mature cells multinucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps (Fig. 54A) scattered on both sides of blades, with the primary cell cutting off a cover cell and a supporting cell which produces 2 sterile cells and a 4-celled carpogonial branch. Carposporophytes (Fig. 44D) with radiating filaments of cells forming a weft on the floor of the cystocarp, connected to the plate of

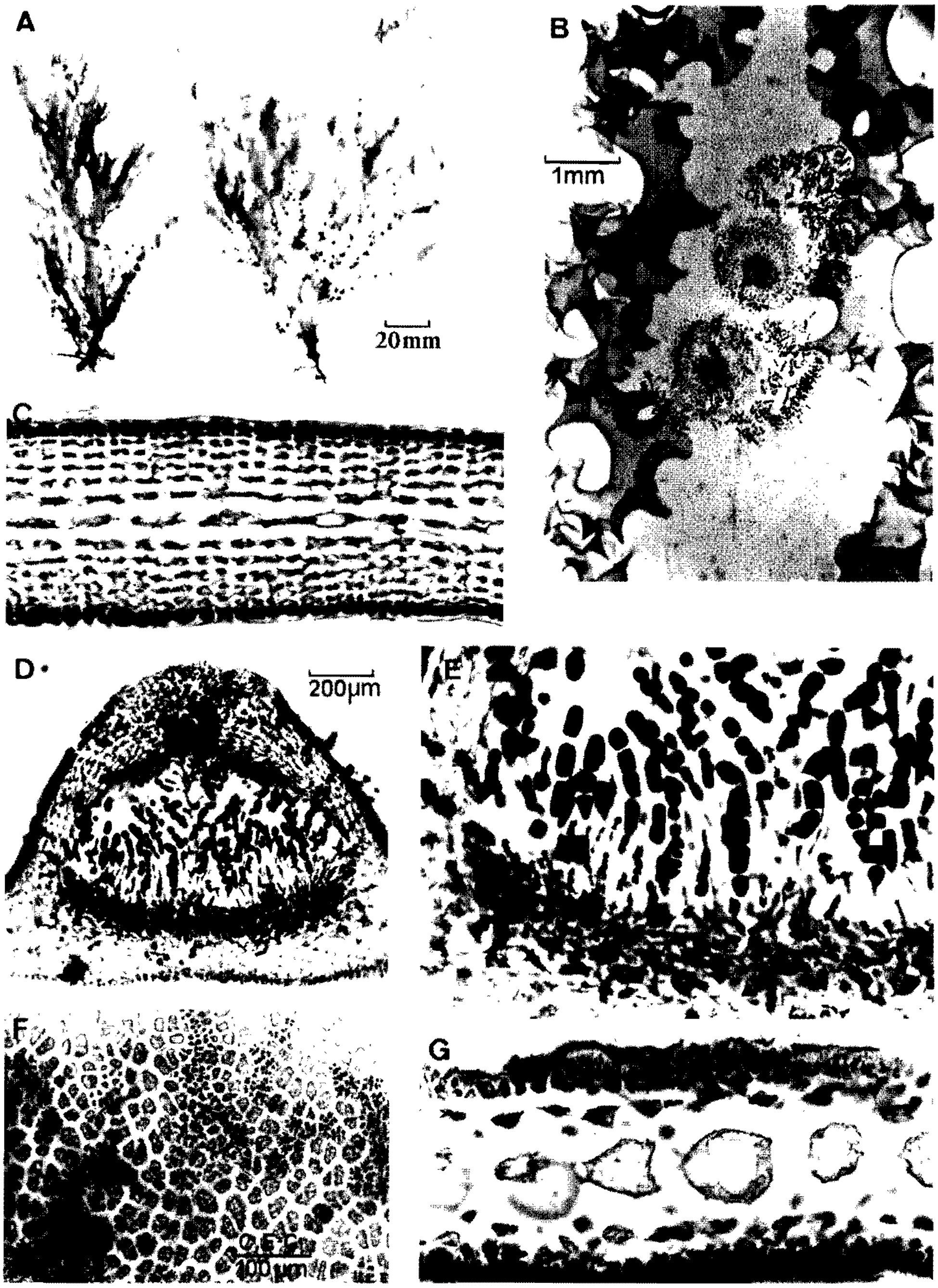

Fig. 44. *Platyclinia stipitata* (**A**, AD, A46946; **B**, AD, A30966; **C**, AD, A22167; **D–F**, AD, A22232; **G**, AD, A21288). **A**. Habit. **B**. Branch with ruffled margins and cystocarps. **C**. Transverse section of mature thallus. **D**. Section of a cystocarp. **E**. Carposporophyte with erect chains of carposporangia arising from gonimoblast filaments on floor of cystocarp. **F**. Spermatangial sori. **G**. Transverse section of spermatangial sorus.

primary cells by prominent pit-connections, and producing erect filaments (Fig. 44E) bearing chains of 3–5 ovoid to isodiametric carposporangia 25–45 µm in diameter, maturing together. Cystocarps (Fig. 44B) scattered, swollen and protuberant on one side of the blade, 1–1.5 mm across; pericarp ostiolate, 5–8 cells thick on sides, with a thicker collar 10–12 cells thick around the ostiole. Spermatangial sori (Fig. 44F) vague, scattered, slightly raised, with the cortical cells producing initials each cutting off several elongate spermatangia (Fig. 44G).

Tetrasporangial sori (Fig. 45A, B) small, circular to oval and 0.5–1 mm across, scattered but closely adjacent, slightly raised with the cortical cells producing paraphyses 3–4 cells long with terminal cells ovoid to obconical and 12–20 µm across. Tetrasporangia cut off from lower cells of paraphyses (Fig. 45C), subspherical to ovoid, 45–75 µm in diameter.

Lectotype from Port Elliot, S. Aust. (*Hussey*); in Herb. Agardh, LD, 31103.

Distribution: Elliston, S. Aust., to Bridgewater Bay, Victoria.

Selected specimens: Waterloo Bay (Elliston), S. Aust., on *Metagoniolithon*, 4 m deep (*Shepherd*, 26.ii.1978; AD, A54992). Elliston, S. Aust., drift (*Womersley*, 27.ii.1959; AD, A22167). Point Avoid, S. Aust., drift (*Womersley*, 2.xii.1975; AD, A46946). Wanna, S. Aust., on *Callophyllis*, drift (*Shepley*, 19.ii.1959; AD, A22232) and (*Ricci*, 13.ii.1994; AD, A63360). West Bay, Kangaroo I., S. Aust., on *Sargassum*, drift (*Womersley*, 6.i.1946; AD, A2230). Seal Bay, Kangaroo I., S. Aust., drift (*Mitchell*, 29.x.1966; AD, A30966). Pennington Bay, Kangaroo I., S. Aust., drift (*Womersley*, 27.i.1946; AD, A2885). Young Rocks, S of Kangaroo I., S. Aust., 16–30 m deep (*Branden*, 18.vi.1991; AD, A61443). Robe, S. Aust., on *Heterozostera*, drift (*Womersley*, 18.viii.1957; AD, A21288). Blackfellows Caves, SE S. Aust., epiphytic, drift (*Womersley*, 26.xi.1999; AD, A68373—"Marine Algae of southern Australia" No. 409). Port MacDonnell, S. Aust., on *Laurencia filiformis*, drift (*Kraft*, 1.xii.1991; MELU, K8749). Bridgewater Bay, Vic., drift (*Womersley*, 14.iv.1959; AD, A22617).

Platyclinia stipitata appears to be a rare species confined to rough-water coasts. The margins vary from slightly crispate to strongly so, becoming dentate with branched outgrowths on lower parts; this is well shown in A46946 and A68373 where upper parts are largely entire. Some plants (e.g. A30966, some of A68373) have entirely crispate-dentate margins as described for *N. crispatum sensu* J. Agardh (*Platyclinia kylinii* Papenfuss 1967, p. 102), type from "Australia", in Herb. Agardh, LD, 31124. *Platyclinia purpurea* J. Agardh [type from Port Elliot, S. Aust. (*Hussey*), in Herb. Agardh, LD, 31119] appears to be only part of a larger plant. Wynne (1983, p. 446) discusses *P. stipitata* and (1997, p. 330) the authorship of the species. "*P. purpurea*" from New Zealand is, as Adams (1994, p. 282) suggested, a distinct species.

When describing *P. stipitata*, J. Agardh (1898, p. 106) cited "*Nitophyllum stipitatum* Harvey (1859b, p. 312)". The latter species is distinct from J. Agardh's type of *P. stipitata* from Port Elliot, S. Australia, and is probably not a *Platyclinia* since the blades are 1 to 3 cells thick with cortical cells equivalent to the primary cells. Harveys tetrasporangial specimen is inadequate for determination, but the name is invalidated by *Nitophyllum stipitatum* Suhr (1841, p. 281).

2. **Platyclinia crenulata** Womersley, *sp. nov.*

Nitophyllum pulchellum sensu Lucas 1926: 596, pl. 37 fig. 1 (NON Harvey)

Myriogramme pulchella (Harvey)Millar 1990: 422, in part (see under *Nitophyllum pulchellum*).

FIGS 45D–F, 46

Thallus (Fig. 46A, B) rose-red, fading to grey-red, 4–12 cm high, much branched complanately and marginally, branches (2-) 3–6 mm broad below, (1-) 2–3 mm broad above, more or less linear, margins smooth near apices, becoming convolute below, with a broad midrib present from near apices of main branches, prominent below; veins absent. Holdfast fibrous; epiphytic (on *Nitospinosa pristoidea*), possibly epilithic. *Structure.* Growth marginal without distinct apical cells, with frequent but irregular intercalary divisions; many marginal cells around apices and along margins slightly elongate with rounded ends giving a crenulate appearance (Fig. 46C). Mature cells irregular in surface shape, often angular, (15-) 20–30 µm across and L/D 1–2 (-3); marginal crenulate cells 10–20 µm high, only basally conjoined. Blades monostromatic near apices, soon tristromatic and polystromatic in midrib region (Fig. 46D); cortical cells equivalent to the larger primary cells. Cells multinucleate; rhodoplasts discoid.

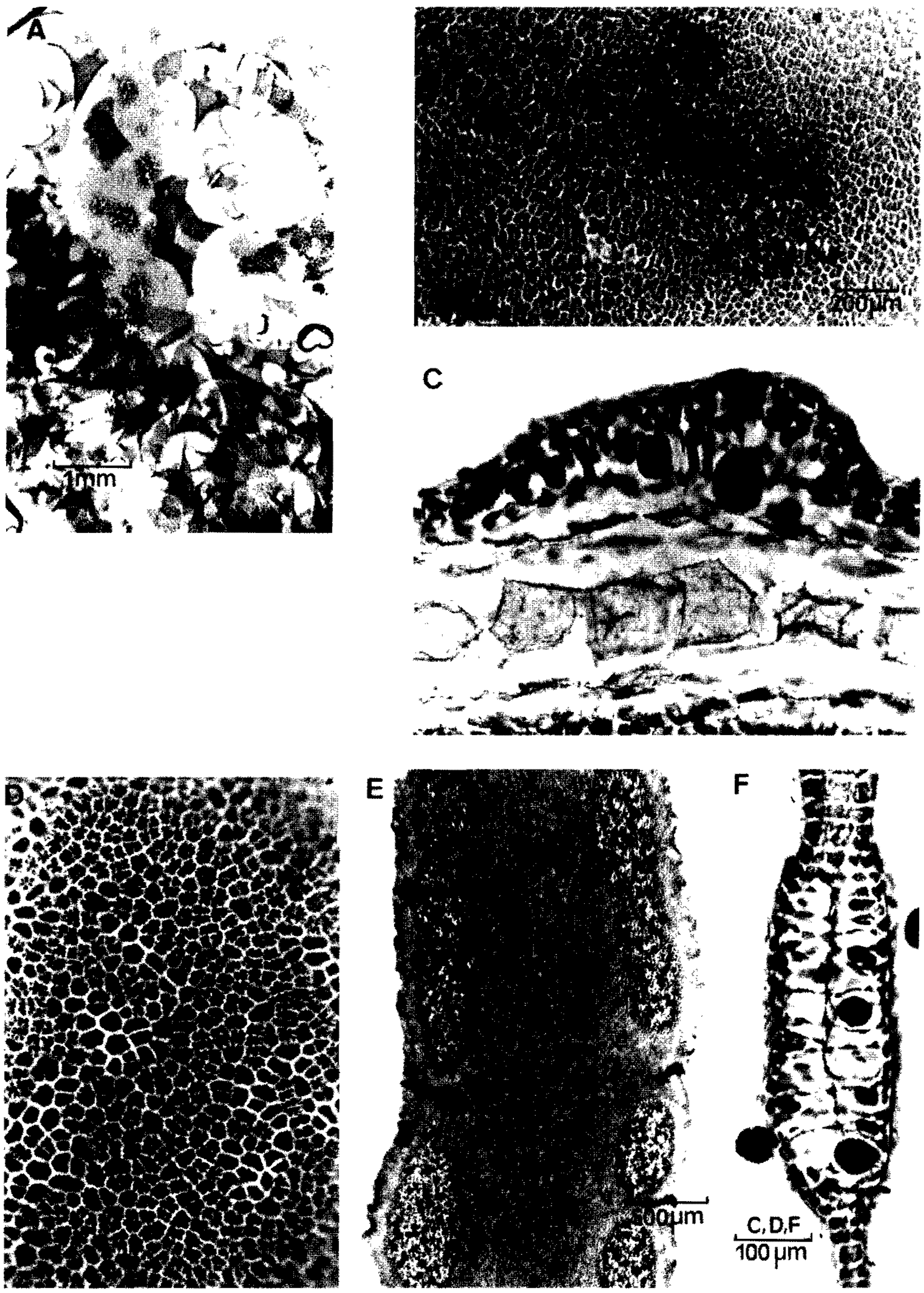

Fig. 45. A–C. *Platyclinia stipitata* (**A**, AD, A30966; **B**, AD, A22167; **C**, AD, A21288). **A**. Blade with tetrasporangial sori. **B**. Tetrasporangial sorus. **C**. Transverse section of tetrasporangial sorus. **D–F**. *Platyclinia crenulata* (AD, A68118). **D**. Spermatangial sori. **E**. Tetrasporangial sori. **F**. Transverse section of tetrasporangial sorus.

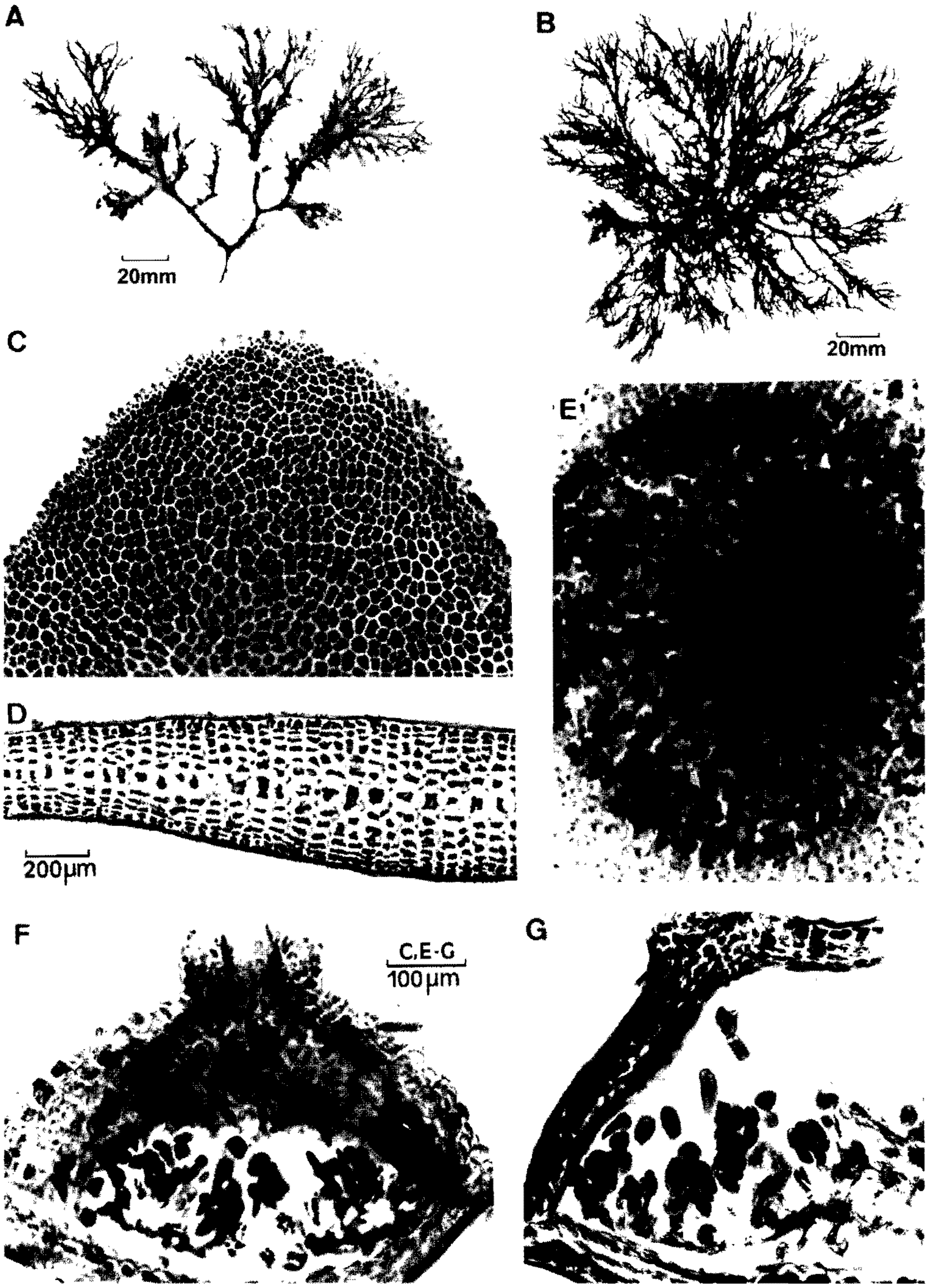

Fig. 46. *Platyclinia crenulata* (**A**, **G**, AD, A19922; **B–D**, AD, A68118; **E**, **F**, AD, A21273). **A**. Habit, holotype specimen. **B**. Habit. **C**. Apex of a branch, with crenulate margin. **D**. Transverse section of older branch. **E**. Surface view of cystocarp showing radiating gonimoblast filaments. **F**. Section of cystocarp. **G**. Carposporophyte with radiating gonimoblast filaments on cystocarp floor, producing erect clusters of carposporangia.

Reproduction. Gametophytes dioecious. Procarps scattered on blades, structure unknown. Carposporophytes with a central fusion cell and radiating filaments over the cystocarp floor (Fig. 46E, F), cells of filaments fusing, producing erect, branched, clusters (Fig. 46G) of carposporangia which mature together (often in short rows), when mature ovoid to pyriform and 20–30 µm in diameter. Cystocarps usually near the margin of blades, mostly 500–800 µm in diameter; pericarp ostiolate with a distinct collar (Fig. 46F) or slight beak, wall 45–90 µm and 4–6 cells thick. Spermatangial sori (Fig. 45D) small, diffuse and irregular in shape, scattered on wings of blades, 50–300 µm across, with the primary cells producing a layer of initials which bear elongate spermatangia.

Tetrasporangial sori (Fig. 45E) ovate to (usually) linear, 400–600 µm broad, lying between the margins and centre of blades, 160–220 µm thick with 2 layers (Fig. 45F) of tetrasporangia cut off from inner cells of cortical filaments 3–4 cells long, outer cells small and covering subspherical tetrasporangia 45–70 µm in diameter.

Diagnosis: Thallus roseus 4–12 cm altus, ramosissimus complanate et marginaliter, rami (2-) 3–6 mm infra lati, (1-) 2–3 mm supra lati, lineares, margines apice leves, infra convoluti, costa prominens, lata, nervae absentes. Hapteron fibrosum. Crescens margine, sine cellulis distinctis et apicalibus, divisionibus crebris intercalaribus; multae cellulae marginales elongatae, aspectu crenulatae, 10–20 µm altae. Laminae monostromaticae apud apices mox tristromaticae et costa polystromaticae, cellulae aequivalentes.

Gametophytes dioeci. Procarpia dispersa. Carposporophytes cellula centrali coalescente, fila radiantia et fasciculi erecti ramosi carposporangiorum simul maturescentes. Cystocarpia prope margines laminae 500–800 µm diametro, pericarpium collo ostiolari, murus 4–6 cellulas crassus. Sori spermatangiales parvi, forma irregulares, 50–300 µm lati. Sori tetrasporangiales ovati ad lineares, 400–600 µm lati, iacentes inter margines et centrum laminarum, 160–220 µm crassi, 2 strata tetrasporangiorum 45–70 µm diametro.

Type from Robe, S. Aust., drift (*Wollaston*, 13.iii.1955); holotype in AD, A19922.

Distribution: Robe, S. Aust., to Port Phillip Heads, Victoria.

Selected specimens: Robe, S. Aust., drift (*Womersley*, 2.iv.1999; AD, A68118). Stinky Bay, Nora Creina, S. Aust., drift (*Womersley*, 19.viii.1957; AD, A21273). Port MacDonnell, S. Aust., drift (*G. & R. Kraft* 8879b, 19.ii.1992; MELU and AD, A68267). Warrnambool, Vic., drift (*G. & L. Kraft* 7589, 10.viii.1984; MELU and AD, A68016). Port Phillip Heads, Vic. (*Wilson*, 10.i.1894; MEL, 676687).

P. crenulata is named from the crenulate margins at the apex and below, due to elongate marginal cells with rounded apices; while variable in prevalence, these seem to be a feature of all specimens. MEL, 676687, previously as *Nitophyllum pulchellum* shows this feature and typical carposporophyte structure.

P. crenulata is closely related to *P. ramosa*, differing in habit, thallus dimensions, much greater prevalence of crenulate cells, and in having linear tetrasporangial sori (or ovate ones borne in lines) rather than scattered ovate sori as in *P. ramosa*.

3. **Platyclinia ramosa** Womersley, *sp. nov*

FIG. 47

Thallus (Fig. 47A) light to medium red to yellow-red, 4–10 cm high, much branched marginally, main axes 5–15 mm broad, laterals 3–6 mm broad, tapering to 1–2 mm broad, margins crisped to convolute, apices rounded; veins absent. Base of main axes tapering to a short, slender stipe. Holdfast discoid; epiphytic. *Structure.* Growth marginal with numerous very small apical cells (Fig. 47B, C), segmenting to irregularly arranged cells with frequent intercalary divisions (Fig. 47C), mature cells angular, isodiametric to slightly elongate, 20–35 µm across; blades monostromatic near margins, becoming tristromatic and 30–90 µm thick, cortical cells equivalent, polystromatic near the base. Cells multinucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps scattered, details not observed. Carposporophytes (Fig. 47D) with a central fusion cell and a weft of gonimoblast filaments over the cystocarp floor, producing numerous erect chains of 2–4 ovoid carposporangia 20–40 µm in diameter. Cystocarps scattered, 1–1.5 mm across, hemispherical and with a collar; pericarp ostiolate, 3–5 cells thick, thicker at the collar. Spermatangial sori (Fig. 47E) scattered, relatively small and irregular in shape, some becoming confluent, with cortical initials producing elongate spermatangia in blocks corresponding to the primary cells.

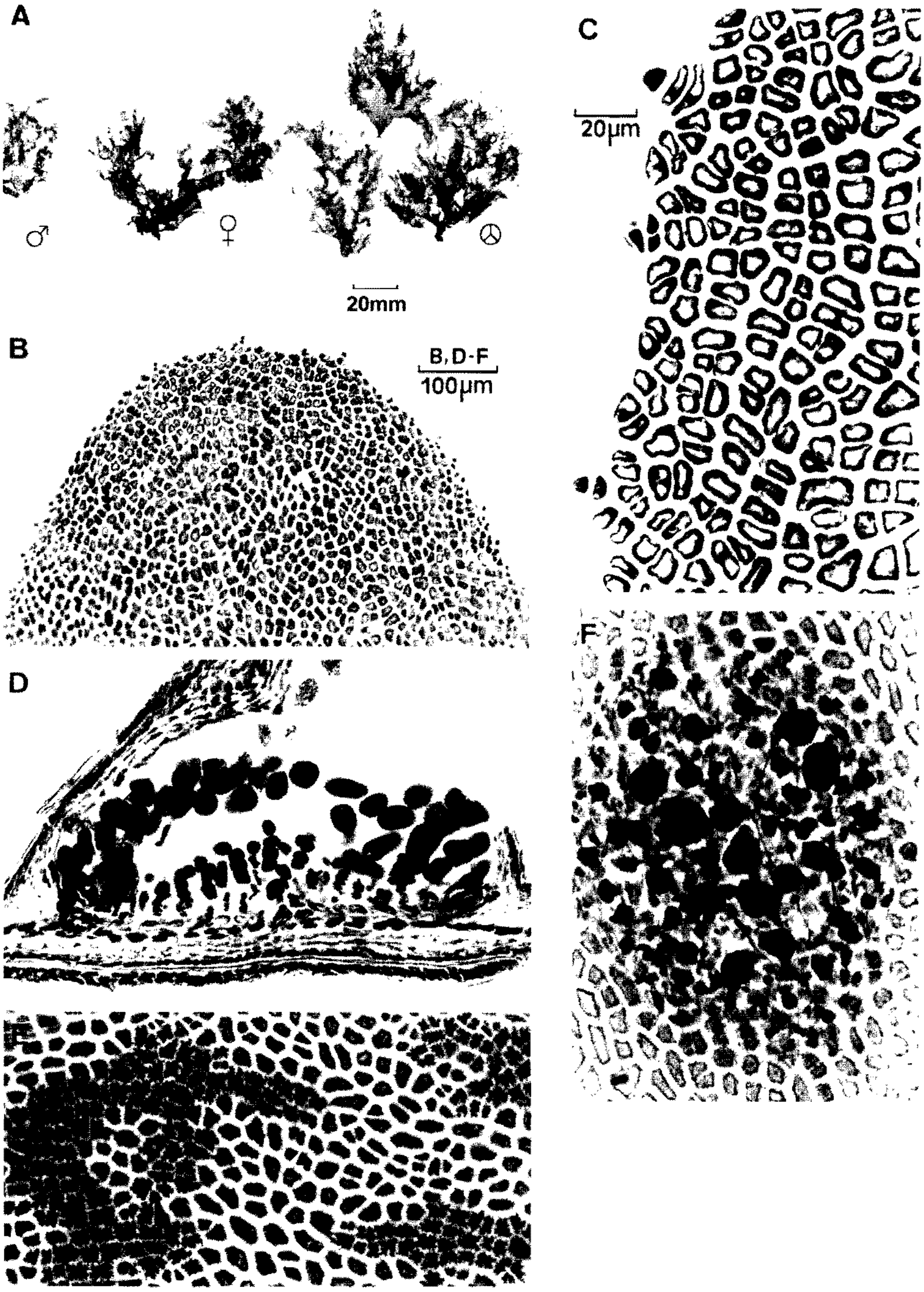

Fig. 47. *Platyclinia ramosa* (AD, A42565). **A**. Habit, type sheet. **B**. Apex of a branch. **C**. Apex of a branch showing slight apical cells and segmentation. **D**. Section of a cystocarp, carposporophyte with erect chains of carposporangia. **E**. Spermatangial sori. **F**. Tetrasporangial sorus.

Tetrasporangial sori (Fig. 47F) scattered, ovate, with tetrasporangia cut off from primary cells and lying largely in one layer of mixed ages, with outer cover cells; tetrasporangia subspherical, 40–70 μm in diameter.

Diagnosis: Thallus roseus ad rubrum, 4–10 cm altus, margine ramosissimus, axes principales 5–15 mm lati, laterales 3–6 mm lati, contracti ad 1–2 mm lati; margines crispi ad convolutum; nervae absentes; stipes brevis, gracilis. Hapteron discoideum. Crescens ad marginem multis cellulis apicalibus, cellulae maturae irregulariter dispositae, angulares, 20–35 μm latae; laminae monostromaticae apud margines, postea tristromaticae et 30–90 μm crassae, apud basin polystromaticae; cellulae aequivalentes.

Gametophytes dioeci. Procarpia dispersa. Carposporophytes cellula centrali coalescente et filis in fundo cystocarpii effusis, catenis erectis 2–4 carposporangiorum. Cystocarpia 1–1.5 mm lata hemisphericalia, pericarpium 3–5 cellulas crassum, ostiolum cum collo. Sori spermatangiales dispersi, parvi, irregulares. Sori tetrasporangiales dispersi, ovati, tetrasporangia abscissa e cellulis primariis plerumque in uno strato, 30–70 μm diametro.

Type from Elliston, S. Aust., 25 m deep outside bar (*Shepherd*, 25.x.1971); holotype in AD, A42565.

Distribution: Only known from Point Peron, W. Aust., Elliston, and Point Avoid, Yorke Pen., S. Australia.

Selected specimens: Point Peron, W. Aust., drift (*Kraft* 7473, 7.xii.1980; MELU). Elliston, S. Aust., drift (*Womersley*, 13.i.1951; AD, A13537) and 5 m deep in bay (*Shepherd*, 13.v.1971; AD, A38682). Point Avoid, S. Aust., drift (*Womersley*, 2.xii.1975; AD, A46948 and A46949).

P. ramosa (named from the much branched thallus compared to the type species), has the distinctive carposporophyte of *Platyclinia* but differs from *P. stipitata* in habit, dimensions, and in having equivalent cortical cells. It is closely related to *P. crenulata*, as is discussed under the latter species.

Genus MYRIOGRAMME Kylin 1924: 55

Thallus foliose to irregularly and profusely branched, often with a midrib or central thickened area near the base but without microscopic veins, monostromatic becoming tri- or polystromatic; holdfast discoid or fibrous. *Structure.* Growth marginal and intercalary, without apical cells, tri- or polystromatic parts with cells equivalent. Cells multinucleate.

Reproduction. Gametophytes dioecious. Procarps scattered, often on both sides of a primary cell which bears a cover cell and fertile pericentral cell with 2 sterile groups and a 4-celled carpogonial branch. Carposporophyte with an extensive basal fusion cell and much branched gonimoblast bearing terminal chains of carposporangia, sometimes with lateral clusters also. Cystocarps domed; pericarp ostiolate, several cells thick. Spermatangial sori scattered, with the primary cells bearing a layer of cortical initials which produce elongate spermatangia.

Tetrasporangial sori scattered, with 2–3 layers of cortical cells, tetrasporangia produced from the primary cells and often from inner cortical cells.

Type species: *M. livida* (Hooker & Harvey) Kylin 1924: 58.

The type species has been investigated in detail by Hommersand & Fredericq (1997a), who established the tribe Myriogrammeae for the group of Kylin (1924, p. 53). They consider the tribe to also include *Gonimiocolax* Kylin, *Haraldiophyllum* Zinova and *Hideophyllum* Zinova.

Myriogramme is a large genus of 10–15 species, but most members need study in relation to the type species. Specimens from Tasmania attributed to the Antarctic and New Zealand *M. multinervis* (Hooker & Harvey)Kylin by Harvey (1859b, p. 313) were not located and this record remains uncertain.

KEY TO SPECIES OF *MYRIOGRAMME*

1. Thallus usually 10–20 cm high, irregularly branched, branches 1–3 (-5) cm broad .... 1. *M. gunniana*

1. Thallus 4–8 cm high, irregularly subdichotomous, branches 2–6 mm broad .... 2. *M. cartilaginea*

1. **Myriogramme gunniana** (Hooker &Harvey)Kylin 1924: 60. Guiler 1952: 102. Levring 1946: 225. May 1965: 400. Shepherd & Womersley 1981: 366. Womersley 1966: 152.
Nitophyllum gunnianum Hooker & Harvey 1847: 403. J. Agardh 1852: 663; 1872: 49; 1876: 456; 1879: 60, pl. 27 fig 13; 1898: 44. De Toni 1900: 634. Harvey 1849a: 120, pl. 47; 1859b: 312; 1863: pl. 241, synop.: xxxii. Lucas 1909: 35; 1926: 597; 1929a: 19; 1929b: 50. Lucas & Perrin 1947: 220, fig. 84. Reinbold 1897: 54. Sonder 1853: 690; 1880: 23. Tisdall 1898: 509. Wilson 1892: 174.
Aglaophyllum gunnianum (Harvey)Kützing 1849: 868; 1866: 14, pl. 40.
Nitophyllum obscurum J. Agardh 1876: 452. Lucas 1926: 597. Sonder 1880: 23. Tisdall 1898: 509. Wilson 1892: 174.

PLATE 1 fig. 1; FIGS 48, 49A, B, 54B

Thallus (Fig. 48A) dark red-brown, (5-) 10–20 (-30) cm high, foliose and usually irregularly divided or lacerate, branches mostly 1–3 (-5) cm broad, terminally rounded, margins entire to very slightly dentate, surface often irregularly perforate (from grazing). Lower parts developing a central midrib, becoming stipe-like below by loss of lateral blades; microscopic veins absent. Holdfast becoming much divided and fibrous, 2–10 mm across; epilithic. *Structure*. Growth marginal with irregular intercalary submarginal divisions producing blades (Fig. 48C) with irregularly arranged cells 15–35 (-45) µm across and L/D 1–2 in surface view; occasional small marginal spines with small apical cells occur. Fronds monostromatic when young and 50–70 µm thick, soon tristromatic (Fig. 48B) and 90–120 µm thick, becoming polystromatic in the midrib and where reproductive, with corticating cells equivalent and similar in size to the primary cells. Cells multinucleate, nuclei on anticlinal walls; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps (Fig. 54B) scattered (Fig. 48C), with primary cells bearing a cover cell and a fertile pericentral cell with sterile cells and a 4-celled carpogonial branch (Fig. 48D). Carposporophytes (Fig. 48E, F) with a basal fusion cell and much branched gonimoblast with short terminal chains of ovoid carposporangia 25–35 µm in diameter, maturing sequentially. Cystocarps scattered, 1–1.6 mm across, hemispherical; pericarp ostiolate, thick, with anticlinal filaments of isodiametric cells. Spermatangial sori ovate to elongate, 200–500 µm across and 80–100 µm thick (Fig. 48G) with primary cells producing a layer of cortical initials with blocks of elongate spermatangia corresponding to the primary cells.

Tetrasporangial sori (Fig. 49A) scattered, ovate, 200–450 µm across and 150–250 µm thick, with tetrasporangia in 2 layers (Fig. 49B) cut off from inner cortical cells (Fig. 48B) and covered by smaller outer cortical cells; tetrasporangia subspherical, 45–65 µm in diameter.

Type from Georgetown, Tas. (*Gunn*); holotype in Herb. Harvey, TCD, labelled "original specimen from herb. Hooker."

Distribution: Probably from Whitford Beach, Perth, W. Aust., and Flinders I., S. Aust.; mainly from Port Elliot, S. Aust., to Walkerville, Vic., and around Tasmania.

Selected specimens: [Probable records: Whitford Beach, Perth, W. Aust., 4–5 m deep (*Lipkin*, 6.ii.1982; AD, A52958). The Hotspot, Flinders I., S. Aust., 25 m deep (*Branden*, 23.i.1991; AD, A61223)]. Port Elliot, S. Aust., drift (*Woelkerling*, 15.i.1968; AD, A50316). Stinky Bay, Nora Creina, S. Aust., drift (*Womersley*, 16.iv.1959; AD, A23069). 1.3 km off Cape Northumberland, S. Aust., 15 m deep (*Shepherd*, 1.ii.1978; AD, A55251). Queenscliff, Vic., drift (*Womersley*, 8.iv.1959; AD, A22874). Crawfish Rock, Westernport Bay, Vic., 5 m deep (*Shepherd*, 31.i.1970; AD, A35223) and 8 m deep (*Watson & Womersley*, 16.i.1974; AD, A45018—"Marine Algae of southern Australia" No. 155). San Remo Back Beach, Western Port, Vic., drift (*Sinkora* A674, 11.vii.1970; AD, A62721). Walkerville, Vic., drift (*Sinkora* A2273, 6.iii.1976; AD, A48275). West Cove, Erith I., Bass Strait, 28 m deep (*Shepherd & R. Lewis*, 10.v.1974; AD, A45258). Low Head, Tas. (*Perrin* 1219, 4.xi.1950; AD, A49612). Blackmans Bay (Hobart), Tas., drift (*Tyler*, 17.x.1973; AD, A44235). Charlotte Cove, SE Tas., 8 m deep (*Edgar* 12, 19.vi.1995; AD, A64313). Satellite I., D'Entrecasteaux Ch., Tas., 10 m deep (*Shepherd*, 18.ii.1972; AD, A41779). Bruny I., (opposite Gordon), Tas., 2–3 m deep (*Brown*, 10.x.1986; AD, A57826).

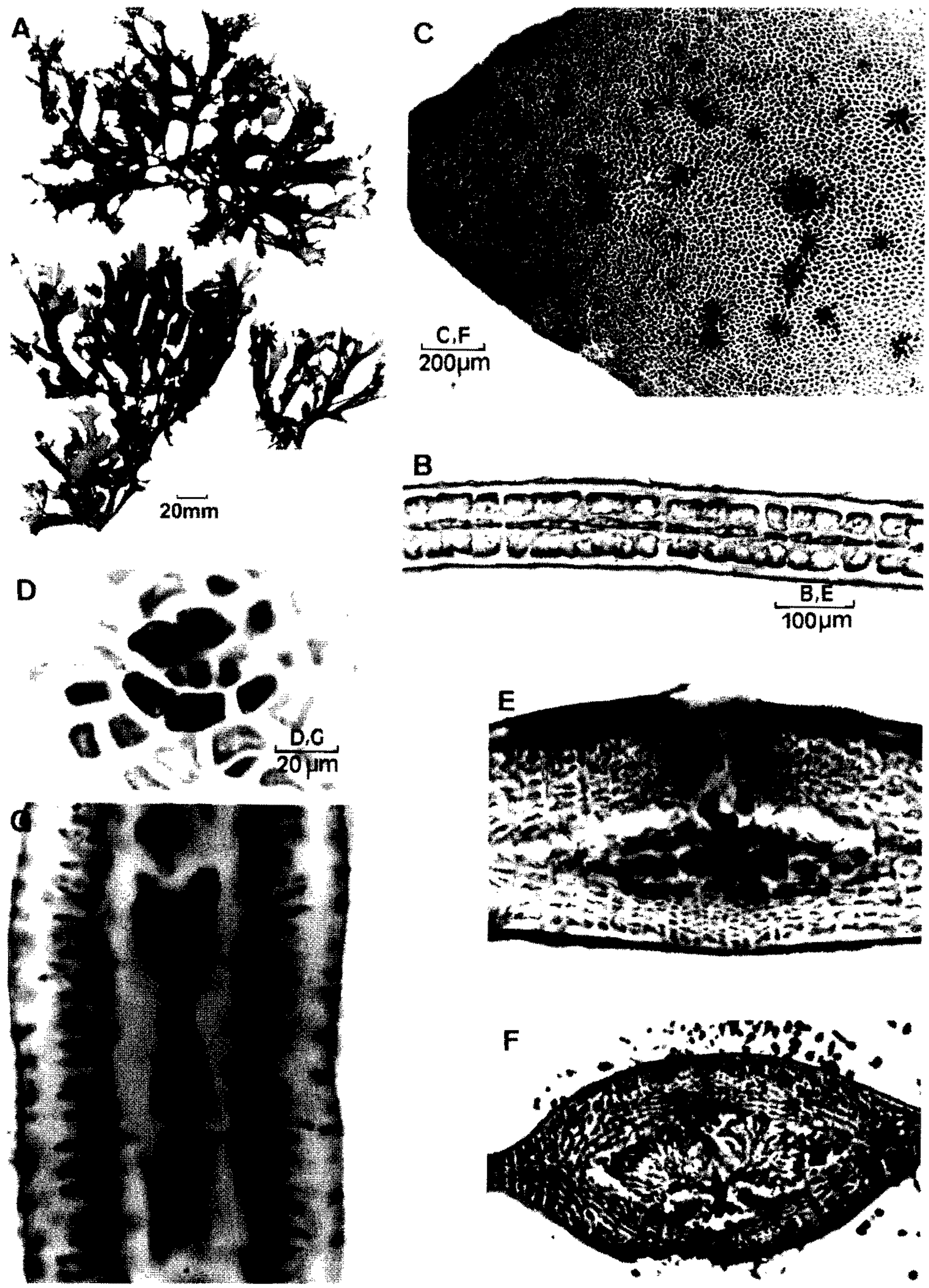

Fig. 48. *Myriogramme gunniana* (**A**, **E**, AD, A45018; **B**, AD, A35223; **C**, **D**, AD, A57826; **F**, AD, A64313; **G**, AD, A55251). **A**. Habit. **B**. Transverse section of thallus. **C**. Apex of branch with procarps. **D**. Procarps with 2 sterile cover cells (above), a carpogonial branch, and 3 sterile cells (below). **E**. Section of a young cystocarp. **F**. Section of a mature cystocarp with basal fusion cell and gonimoblast with short chains of carposporangia. **G**. Transverse section of spermatangial sorus.

M. gunniana is a common species on SE Australian coasts, with probable records as far west as Whitford Beach, Perth, W. Australia.

Nitophyllum obscurum J. Agardh, type from Tasmania (not located in 1952), is probably not distinct from *M. gunniana*. J. Agardh did not mention it in his later publications and may have realised that it was not distinct.

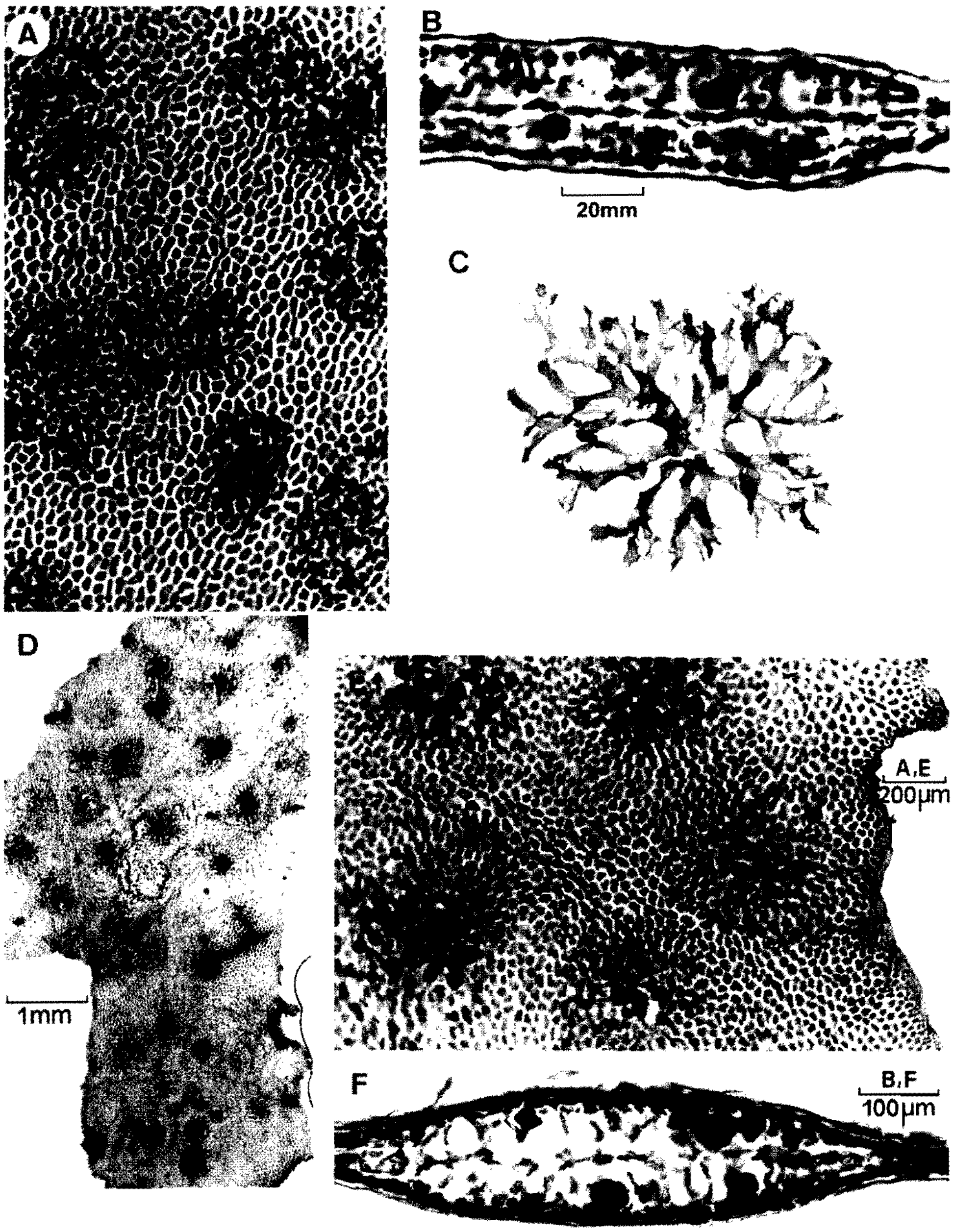

Fig. 49. A, B. *Myriogramme gunniana* (AD, A45018). **A.** Tetrasporangial sori. **B.** Transverse section of tetrasporangial sorus. **C–F.** *Myriogramme cartilaginea* (**C**, isolectotype in TCD; **D**, **E**, AD, A18533; **F**, AD, A67903). **C.** Habit of isotype. **D.** Branch with tetrasporangial sorus. **E.** Tetrasporangial sori. **F.** Transverse section of tetrasporangial sorus.

2. **Myriogramme cartilaginea** (Harvey)Womersley, *comb. nov.*

Nitophyllum cartilagineum Harvey 1855a: 549; 1863, synop.: xxxii. J. Agardh 1872: 50; 1876: 459; 1898: 44. De Toni 1900: 634. Kylin 1924: 96. Lucas 1909: 35; 1926: 598, pl. 38 fig 2. May 1965: 402. Silva *et al.* 1996: 463. Sonder 1880: 23.

Scutarius cartilagineus (Harvey)Kuntze 1891: 920.

FIG. 49C–F

Thallus (Fig. 49C) erect, dark red-brown, 4–8 cm high, cartilaginous, more-or-less complanately branched with irregularly alternate branches at intervals of 5–10 mm, branches of relatively uniform width of 4–6 mm from base to just below apices, apices rounded, margins irregular to crispate or with short, blunt, appendages; midrib and veins absent. Holdfast discoid, rhizoidal; epiphytic? *Structure.* Growth marginal, with distinct apical cells; marginal cells small, mature surface cells irregular, angular, 30–50 µm across and L/D 1–1.5 (-2). Blades monostromatic when young, soon tristromatic and polystromatic centrally, cortical cells equivalent to primary cells, central (primary) layer not distinct. Rhodoplasts discoid.

Reproduction. Gametophytes unknown.

Tetrasporangial sori (Fig. 49D, E) scattered, round to ovate, 400–800 µm across and 160–200 µm thick, tetrasporangia in 2 layers (Fig. 49F), cut off from inner cortical cells, with 2 layers of smaller outer cortical cells; tetrasporangia subspherical, 45–75 µm in diameter.

Type from Garden I., W. Aust.; lectotype in Herb. Harvey, TCD (Trav. Set 131).

Distribution: Only known from Garden I., W. Aust., "Swan River., W. Aust." (Harvey, Alg. Aust. Exsicc. 294a—fragment in AD, A18533), and Elliston, S. Aust., on *Osmundaria* ?, 7 m deep (*Shepherd*, 22.v.1998; AD, A67903).

M. cartilaginea is a little known species, and placement in *Myriogramme* is uncertain in the absence of cystocarps. The Elliston specimens are tetrasporic and agree well with the type in thallus morphology and structure.

Genus SCHIZOSERIS Kylin 1924: 67

Thallus foliose to divided and lacerate, monostromatic in young parts and often throughout but becoming tri- to polystromatic near the base and in the macroscopic veins. Macroscopic veins prominent, mostly subdichotomous, with or without lesser lateral veins; microscopic veins absent. *Structure.* Growth diffuse, marginal and intercalary, without conspicuous apical cells; mature cells multinucleate, nuclei lying in a plate across the cell centre in young cells, dispersed in mature cells; rhodoplasts single per cell, parietal to ribbon like, or several and discoid.

Reproduction. Gametophytes dioecious. Procarps scattered on either side of blades, with the supporting cell bearing a large-celled lateral sterile group, a 4-celled carpogonial branch and a small-celled basal sterile group. Carposporophyte first developing unilaterally, later radiating, with an extensive basal fusion cell and simple or branched chains of carposporangia. Cystocarps protuberant, ostiolate but often off-centre; pericarp thick, usually of anticlinal rows of 4–6 cells. Spermatangial sori ovate or aggregated, on young parts of blades, with spermatangia cut off from cortical cell initials.

Tetrasporangial sori with 2 layers of tetrasporangia cut off mainly from inner cortical cells and surrounded by cortical filaments.

Type species: *S. laciniata* Kylin 1924: 67 [= *S. condensata* (Reinsch)Ricker 1987, p. 283], from the Strait of Magellan, Chile.

A genus of about 10 species, mainly subantarctic in distribution. Hommersand & Fredericq (1997b) have described the tribe Schizoserideae to include *Schizoseris*, *Neuroglossum* Kützing, *Abroteia* J. Agardh and *Polycoryne* Skottsberg, of which only the former occurs in southern Australia, with the recently described *S. tasmanica* and 2 other species (*S. hymenena* and *S. perriniae*) here transferred to *Schizoseris* from *Nitophyllum*. These, together with a fourth species, *S. bombayensis*, need further detailed study on their morphology, reproduction and seasonal development. Their main area of distribution appears to be in SE Tasmania, where a further possible species (S of Huon I., 25 m deep, *Edgar*, 3.vii.2000; AD, A68829) occurs.

Schizoseris is characterised vegetatively by the relatively large (except *S. bombayensis*), foliose to lacerate thalli, monostromatic in young parts, with (usually) conspicuous dichotomous macroscopic veins but no microscopic veins.

KEY TO SPECIES OF *SCHIZOSERIS*

1. Thallus 1–5 cm high, veins slight but usually distinct .... 1. *S. bombayensis*
1. Thallus usually 10–25 cm high, veins very faint or prominent 2

  2. Dichotomous veins very faint, present only in lower thallus ....2. *S. tasmanica*
  2. Dichotomous veins prominent, extending throughout the thallus 3

3. Base of thallus not stipe-like, short, veins subdichotomous from the base .... 3. *S. hymenena*
3. Base of thallus with branched stipes 1–5 cm long and 2–3 mm in diameter; vein system with a central thicker "midrib" and alternate, lateral, subdichotomous veins .... 4. *S. perriniae*

1. **Schizoseris bombayensis** (Børgesen)Womersley, *comb. nov*

Myriogramme bombayensis Børgesen 1931a: 23, fig. 15, pl. II fig. 4; 1935: 57, figs 24, 25. Abbott 1999: 345, fig. 99F. Cribb 1954: 26; 1983: 98, pl. 30 fig. 1. May 1965: 400. Millar & Kraft 1993: 47. Silva *et al.* 1996: 461. Wynne 2001a: 397.

FIGS 50, 54C

Thallus (Fig. 50A) medium to red-brown, 1–5 cm high, foliose to irregularly branched or lacerate between the macroscopic veins, branching complanate, 4–12 mm broad when young, branches of older plants 1–3 (-4) mm broad, apices rounded, margins entire to irregular or ruffled, with occasional tufts (Fig. 50D) of long-celled rhizoids (for attachment?); macroscopic veins (Fig. 50A) more-or-less distinct from the base to close to apices, subdichotomous to laterally branched. Holdfast discoid to fibrous; epiphytic, epizoic or epilithic. *Structure.* Apical growth marginal without (Fig. 50B) distinct apical cells, marginal cells 3–6 μm in diameter and L/D 1–2, with submarginal intercalary divisions, mature cells in irregular lines, 6–10 μm across and L/W 1–2; young blades monostromatic, becoming irregularly 2 or 3 cells thick below and between reproductive areas, 25–35μm thick; veins polystromatic (Fig. 50C) with larger primary cells and dimidiate inner cortical layers, outer cells equivalent. Cells probably multiinucleate; rhodoplasts discoid to lobed.

Reproduction. Gametophytes probably dioecious. Procarps (Fig. 54C) scattered, with a sterile cell and a 4-celled carpogonial branch, soon becoming covered by a plate of 4–12 sterile cells. Carposporophytes (Fig. 50E) with a conspicuous, broad, basal fusion cell and an extensive, spreading, much branched gonimoblast bearing terminal chains of irregularly ovoid carposporangia 12–20 μm in diameter. Cystocarps swollen, scattered but usually not on the veins, 400–750 μm across, ostiolate; pericarp 60–90 μm and 4–5 cells thick, usually with a slight ostiolar collar. Spermatangial sori not observed.

Tetrasporangial (Fig. 50F) sori on upper blades often just below apices, irregular in shape and 0.2–2 mm across, 130–180 μm thick, with tetrasporangia in 2 layers (Fig. 50G), cut off from inner cortical cells and covered by outer cortical cells, subspherical, 25–60 μm in diameter.

Type from Malabar Hill, Bombay, India; holotype (?) in C.

Distribution: India, Oman, Japan, Korea, Gulf of California, Hawaiian Is.

In Australia, known from the southern Great Barrier Reef and Redcliffe, Qld. (Cribb) and from NSW (Millar & Kraft) and Lord Howe I. (Kraft, in MELU). Also from Williamstown, Port Phillip, Vic., and SE Tasmania.

Selected Specimens: Gloucester Reef, Williamstown, Vic., 3–4 m deep (*Kraft & Drews*, 5.vii.1992; MELU, 9032, on rock), (*Kraft & Williams*, 27.x.1992; MELU, 9468, on rock), (*Kraft*, 10.iv.1994; MELU, 10235, on crustose corallines) and (*Kraft & Saunders*, 3.iii.1995; MELU, 10548 and AD, A68032, on sponges and crustose corallines). Bicheno, Tas., 19–21 m deep (*Kraft*, 18.xii.1992; MELU, 9398 and AD, A68028). Charlotte Cove, SE Tas., 9–11 m deep (*Edgar*, 6.x.1999; AD, A68330).

Southern Australian records and their determination are due largely to Dr Gerry Kraft and his associates, following the earliest record of Cribb (1954, p. 26). These records suggest that

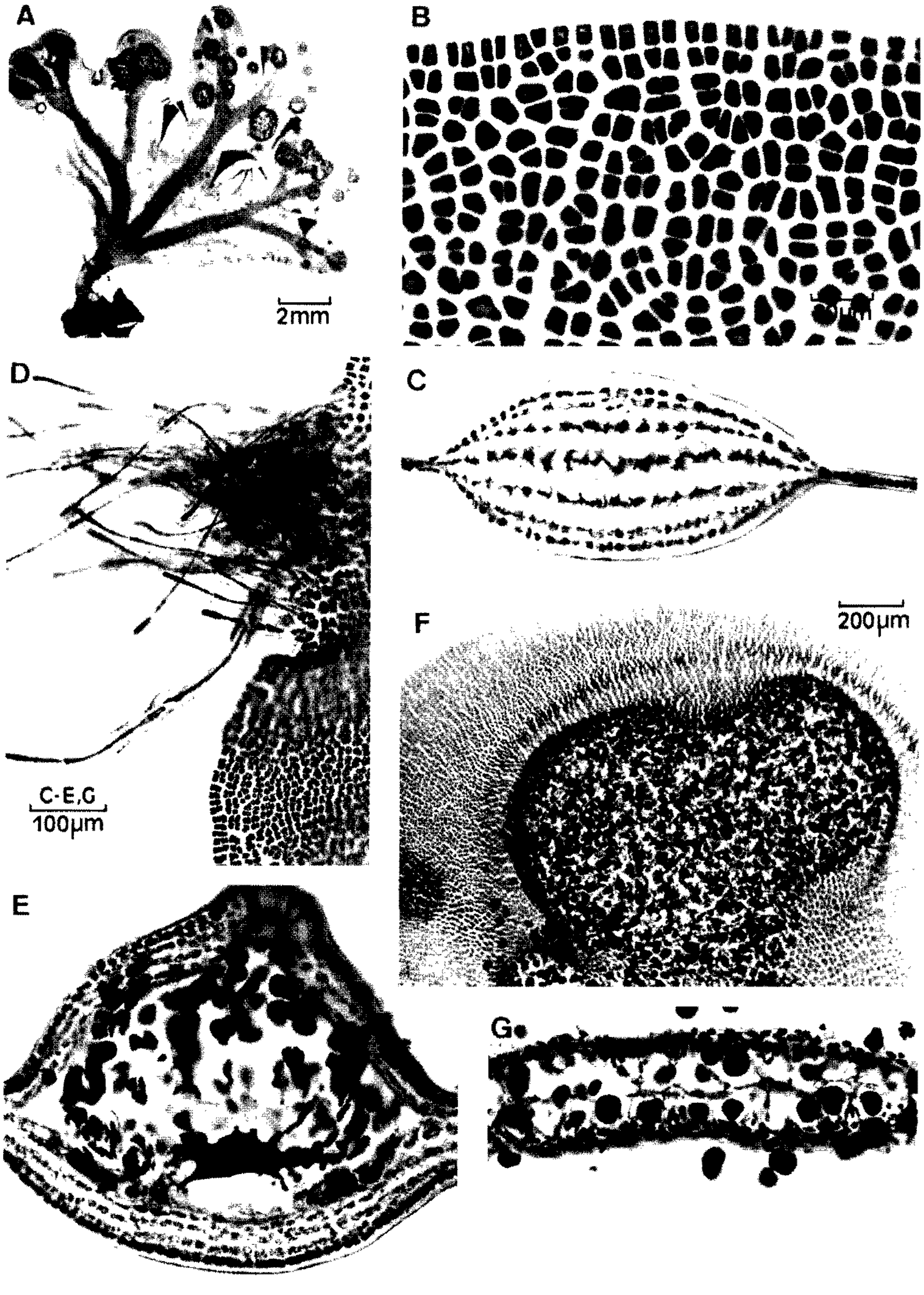

Fig. 50. *Schizoseris bombayensis* (AD, A68032). **A.** Habit, tetrasporangial plant. **B.** Marginal apex. **C.** Transverse section through polystromatic vein and monostromatic blade. **D.** Clump of marginal rhizoids. **E.** Cross section of cystocarp. **F.** Tetrasporangial sorus near branch apices. **G.** Transverse section of tetrasporangial sorus.

S. bombayensis may be widespread around the Australian coast. The Lord Howe I. collections in MELU include some plants that are slightly larger and of greater breadth than in the above description.

The features of *S. bombayensis* agree better with *Schizoseris* than with *Myriogramme*, following the studies of the type specimens of these genera by Hommersand & Fredericq (1997a and b). The plastid structure, subdichotomous macroscopic veins, procarp and carposporphyte structure, and origin of tetrasporangia from inner cortical cells, all indicate the genus *Schizoseris*.

As Millar & Kraft (1993, p. 47) suggest, *Schizoseris pygmaea* Dawson (1950, p. 157, figs 16, 17; 1962, p. 80, pl. 35 figs 3, 4) is probably a synonym of *S. bombayensis*, where Abbott (1999, p. 345) places it, along with *S. subdichotoma* (Segawa)Yamada from Japan.

2. **Schizoseris tasmanica** Lin & Kraft 1999: 128, figs 1–39.

FIG. 51

Thallus (Fig. 51A) foliose, usually simple, rose-red to dark purple, 10–35 cm high and 5–20 cm broad, margins smooth to densely ruffled, with a slender, simple or branched, stipe 1–2 (-4) cm long and 0.5–1 mm broad; macroscopic veins very faint, simple or subdichotomous, present for 5–10 cm above the stipe, 0.5–2 mm broad. Holdfast discoid, lobed; epizoic on gastropods or bivalves. *Structure.* Growth of young blades by apical cells of marginal dentations, later by vague marginal meristems, with scattered intercalary divisions. Blades monostromatic except for veins (Fig. 51B) and reproductive areas, cells more-or-less isodiametric, 20–60 μm across in surface view. Veins developed by periclinal divisions of linear series of cells, followed by anticlinal and further periclinal divisions, mature veins 20–25 cells thick. Cells multinucleate, nuclei in a medial horizontal layer; rhodoplasts one to a few per cell, lobed, often ribbon like.

Reproduction. Gametophytes dioecious. Procarps scattered, with the primary cells cutting off pericentral cells (usually on both sides of the blade) which act as supporting cells, bearing 2 one-celled sterile groups and a 4-celled carpogonial branch, but without a cover cell. Carposporophyte(Fig. 51C) developing a massive, branched, fusion cell and much branched gonimoblast bearing pyriform terminal carposporangia 40–65 μm in diameter, with lower cells also maturing as carposporangia. Cystocarps protuberant, 0.5–0.8 mm across; pericarp ostiolate (often slightly eccentric), 40–75 μm and 2–4 cells thick. Spermatangial sori (Fig. 51D) scattered, usually minute, irregular in shape, sometimes coalescing, with the primary cells dividing once periclinally, then anticlinally to form a group of initials each of which cuts off 2–4 spermatangia.

Tetrasporangial sori scattered, ovate, 200–550 μm across and 180–220 μm thick, with tetrasporangia in 2 layers (Fig. 51E), cut off from inner cortical cells, subspherical (Fig. 51F), (45-) 90–120 μm in diameter.

Type from Ninepin Point, SE Tasmania, 9–12 m deep (*Kraft & Sanderson*, 22.xii.1992; holotype MELU, K9167 (cystocarpic), syntype K9135 (tetrasporangial). Isotypes in MELU and in AD, A68023, A68024.

Distribution: Only known from the type locality and nearby Arch Rock and from 2 km N of Satellite I., D'Entrecasteaux Ch., Tasmania.

Selected specimens: Ninepin Point, Tas., 9–15 m deep (*Kraft & Sanderson*, 4.i.1993; MELU, 42219, K9197). Arch Rock, Tas., 6–15 m deep (*Kraft & Scott*, 16.xii.1993; MELU, K9855). 2 km N of Satellite I., D'Entrecasteaux Ch., Tas., on gastropod *Maoricolpus*, 15 m and 12 m deep (*Shepherd*, 17.ii.1972; AD, A41663 and A41668 resp.)

S. tasmanica is a particularly fine species known mainly from an extensive suite of specimens collected by Kraft & Sanderson from Ninepin Point.

3. **Schizoseris hymenena** (Zanardini) Womersley, *comb. nov.*

Nitophyllum hymenena Zanardini 1874: 497. J. Agardh 1876: 472. De Toni 1900: 664. Guiler 1952: 102. Lucas 1909: 36; 1926: 601, pl. 41 fig. 4. Sonder 1880: 23.

Nitophyllum gattyanum J. Agardh 1876: 454; 1897: 41; 1898: 59. De Toni 1900: 647. Lucas 1909: 35; 1926: 601, pl. 40 fig. 2, pl. 41 figs 1–3; 1929a: 19. Sonder 1880: 23. Tisdall 1898: 509. Wilson 1892: 174.

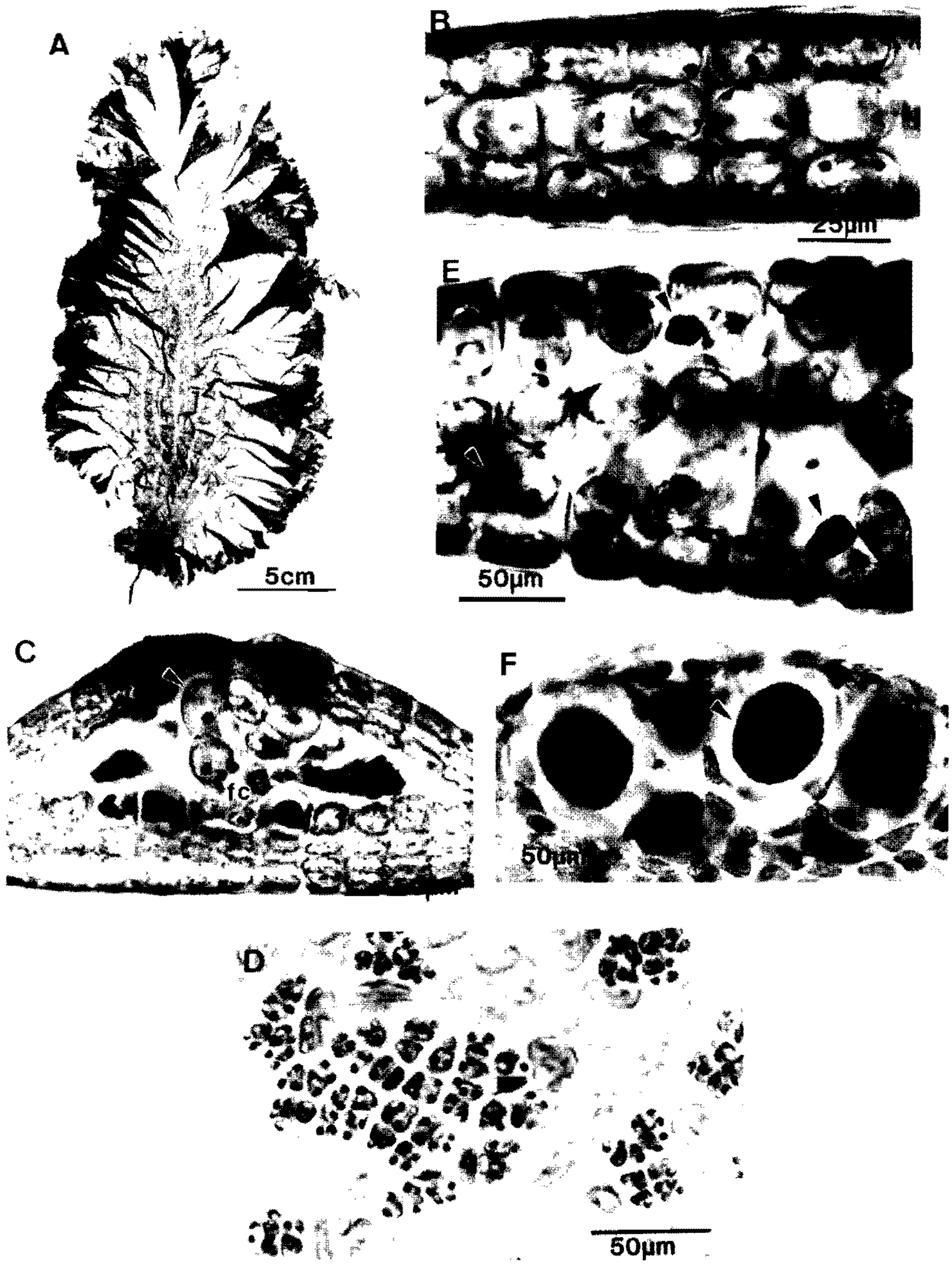

Fig. 51. *Schizoseris tasmanica* (**A**, **B**, MELU, K9167; **C**, MELU, A42219; **D**, MELU, K9855; **E**, **F**, MELU, K9197). **A**. Holotype specimen. **B**. Transverse section of thallus through a vein showing tiers of central and cortical cells. **C**. Cross section of an immature cystocarp with gonimoblast and carposporangia to the right and remnant sterile group to the left (arrow head). **D**. Spermatangial sorus. **E**. Transverse section of tetrasporangial sorus with tetrasporangia cut off from subsurface cells (arrow heads). **F**. Section of a tetrasporangial sorus, showing sporangium attached laterally to a subsurface cells (arrow head). (All as in Lin & Kraft 1999, courtesy of Phycologia.)

Myriogramme gattyana (J. Agardh) Kylin 1924: 60; 1929: 9, pl. 5 fig. 12. Guiler 1952: 102. May 1965: 400.

Nitophyllum multinerve sensu Harvey 1859b: 313. Sonder 1881: 105. [NON Hooker & Harvey 1845: 255 from Cape Horn = *Schizoseris dichotoma* (Hooker & Harvey) Kylin.]

FIG. 52

Thallus (Fig. 52A) medium red-brown, 10–20 cm high, foliose, with one to several fronds from short, slender stipes 2–10 mm long, fronds with entire but strongly undulate to convolute margins, veins (Fig. 52A, B) macroscopic, prominent, subdichotomous and extending throughout the fronds, basally 0.5–1.5 mm broad, decreasing gradually to 100–200 μm broad near the frond apex; midribs and microscopic veins absent. Holdfast discoid, possibly stoloniferous; epiphytic. *Structure.* Growth marginal without apical cells, marginal cells isodiametric to elongate 8–12 μm long, enlarging to angular mature blade cells, 30–50 μm

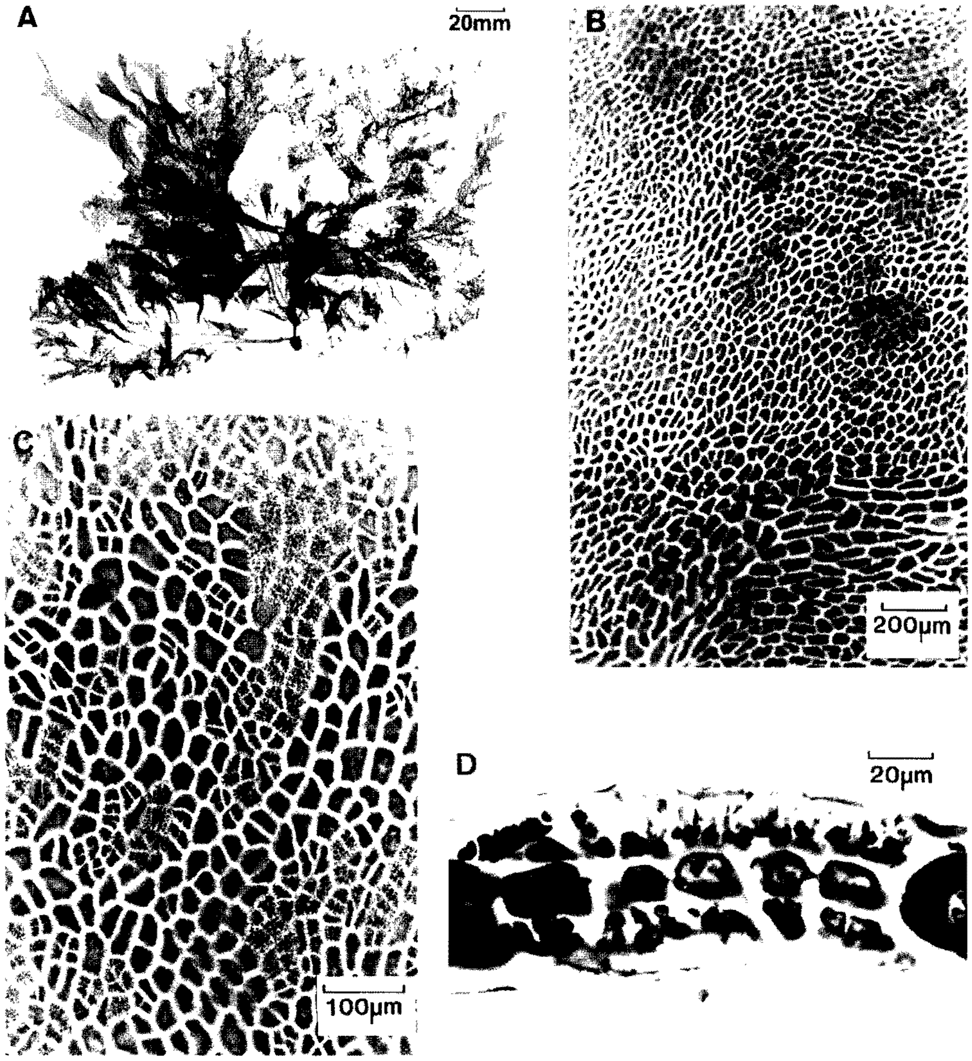

Fig. 52. *Schizoseris hymenena* (**A**, AD, A49610; **B–D**, AD, A64398). **A**. Habit. **B**. Blade showing cell arrangement and a microscopic vein (below). **C**. Blade with spermatangial sori. **D**. Transverse section of a spermatangial sorus.

across and L/D 1–2; young veins 1–3 cells broad, cells L/D 2–4, older veins (Fig. 52B) 6–10 cells broad, basally many cells broad. Blades monostromatic and 40–50 µm thick, polystromatic at veins and reproductive structures. Cells multinucleate; rhodoplasts discoid (?).

Reproduction. Gametophytes dioecious. Procarps scattered, probably with sterile groups and a 4-celled carpogonial branch. Carposporophytes with a large, laterally ovoid, fusion cell, and a moderately branched gonimoblast with terminal or short chains of ovoid to clavate carposporangia 30–40 µm in diameter. Cystocarps hemispherical, 1–1.5 mm across, pericarp ostiolate, 4–6 cells thick. Spermatangial sori (Fig. 52C) scattered, small and irregular in shape, 50–200 µm across, with the primary cells cutting off cortical initials (Fig. 52D) which produce elongate spermatangia in blocks corresponding to the primary cells.

Tetrasporangial sori scattered, ovate to elongate, 200–1000 µm across, tetrasporangia subspherical, 45–65 µm in diameter.

Type from Hobart, Tas. (in Herb Zanardini, V; "paratype" labelled "River Derwent, H. Town, near the Butts. Sam Hannaford").

Distribution: SE Tasmania.

Selected Specimens: Cloudy Lagoon, SE Tas., 4–5 m deep (*Edgar*, 30.vi.1995: AD, A64398). Blackmans Bay (S of Hobart), Tas., drift (*Tyler*, 17.x.1973; AD, A44236). Adventure Bay, Bruny I., Tas. (*Perrin*, 16–20.ix.1948; AD, A49610).

The type specimens of *Nitophyllum hymenena* Zanardini (1874, p. 497) and *N. gattyanum* J. Agardh (1876, p. 454) are both from the Derwent Estuary, Tasmania, and are very similar, marked by dichotomising macroscopic vein systems showing they are best referred to *Schizoseris*, though reproductive details need further investigation.

Kylin (1929, p. 9), followed by Adams (1994, p. 286), recorded *Myriogramme gattyana* from New Zealand, but this record probably applies to *S. dichotoma* (syn. *M. multinervis*).

Schizoseris hymenena is closely related to the New Zealand *S. dichotoma* (Hooker & Harvey) Kylin (1924, p. 68) and detailed comparisons are needed. *S. dichotoma* appears to differ in having a more dichotomous thallus and stronger vein system.

4. **Schizoseris perriniae** (Lucas)Womersley, *comb. nov.*

Nitophyllum (*Myriogramme*?) *perriniae* Lucas 1931: 408, pl. 24. Guiler 1952: 102.
Myriogramme perriniae (Lucas) May 1965: 352, 400.

FIG. 53

Thallus (Fig. 53A) rose-red, 8–20 cm high, with thick, branched stipes (possibly perennial) 2–8 cm long and 1–3 mm thick, continuing as a coarse central vein in blades (3-) 5–15 cm long and 2–8 cm broad, foliose and lobed with undulate wings, margins entire; central vein bearing alternate, lateral, subdichotomous veins (Fig. 53B, C) usually visible until close to the blade apices. Holdfast probably conical; epilithic. *Structure.* Growth marginal (Fig. 53D), without apical cells, marginal cells small and irregularly shaped, 4–6 µm broad, enlarging to angular mature blade cells, 25–45 µm across and L/D 1–1.5 (-2); young veins 1–3 cells broad, cells L/D 2–5, older veins 6–10 cells broad, basally many cells broad, stipes (Fig. 53F) with cells in tiers. Blades (Fig. 53E) monostromatic and 35–55 (-80) µm thick, cells in tiers in veins, polystromatic where reproductive. Cells multinucleate; rhodoplasts discoid.

Reproduction. Unknown.

Type from Georgetown, Tamar Est., Tas., 8–16 m deep (*Perrin & Lucas*, Jan. 1928), lectotype and isotypes in Herb. Lucas (currently in NSW), isotypes (?) in AD, A12241, A49609.

Distribution: Georgetown, N Tas., SW and SE Tasmania.

Selected specimens: Known from the type and Sarah I., Bathurst Ch., SW Tas., 2–5 m deep (*Edgar* 17, 11.iii.1995; AD, A64256). South Blackmans Bay, SE Tas., 2–10 m deep *Sanderson*, 4.xii.1999; AD, A68723). Trumpeter Bay, Bruny I., Tas., 31 m deep (*Edgar*, 18.iii.1999; AD, A68058).

Whereas *S. hymenena* has subdichotomous veins throughout, *S. perriniae* has a well developed basal stipe and a strong central main vein bearing lateral subdichotomous veins. However, *S. perrinae* is a little-known species and this difference and its reproduction need further study; it may be older, possibly second-year, plants of *S. hymenena*.

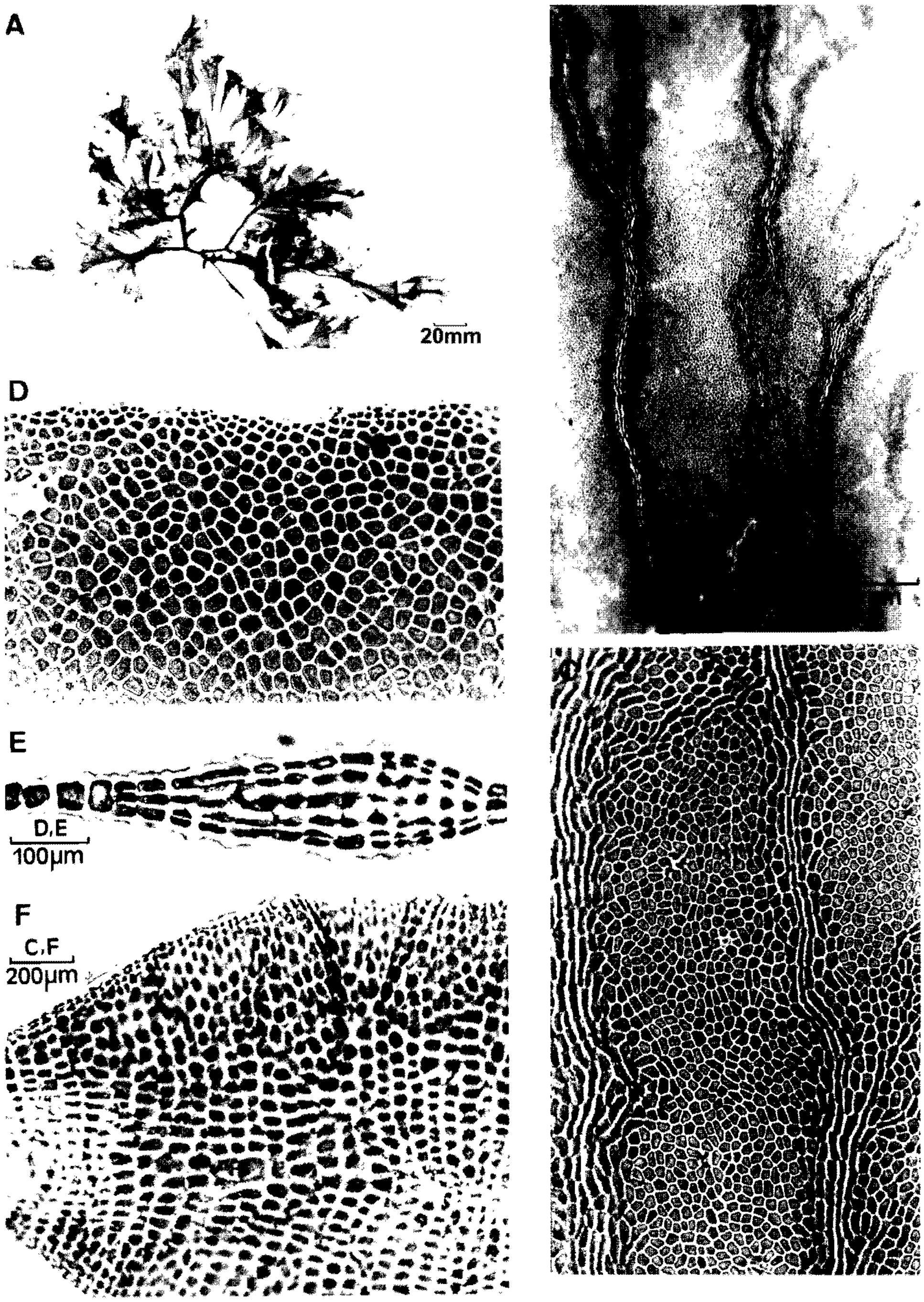

Fig. 53. *Schizoseris perriniae* (AD, A64256). **A**. Habit. **B**. Branch showing macroscopic veins. **C**. Detail of macroscopic veins. **D**. Marginal apex of frond. **E**. Transverse section of young vein and monostromatic blade. **F**. Transverse section of basal stipe.

Genus NITOPHYLLUM Greville 1830: xlvii, 77

Thallus foliose to deeply dissected, membranous, without midrib or veins, monostromatic above, becoming tri- or polystromatic below; holdfast discoid or fibrous. *Structure.* Growth apical when very young, otherwise marginal and intercalary. Cells equivalent when polystromatic. Cells multinucleate.

Reproduction. Gametophytes dioecious. Procarps scattered, formed usually in opposite pairs, the primary cell cutting off a cover cell and a supporting cell bearing a single, 1-celled, lateral sterile group and a 4-celled carpogonial branch. Carposporophyte with a small basal fusion cell and much branched gonimoblast bearing terminal (often sequential) clavate carposporangia, occasionally in chains. Cystocarps hemispherical, ostiolate; pericarp 3–4 cells thick. Spermatangial sori scattered, with primary cells bearing a layer of cortical cells which cut off elongate spermatangia.

Tetrasporangial sori scattered, with cortical filaments and tetrasporangia cut off from primary cells or inner cortical cells and covered by the outer cortex.

Lectotype species: *N. punctatum* (Stackhouse) Greville 1830: 79, pl. 12 – see Maggs & Hommersand 1993: 259, fig. 81.

A genus of numerous species (3 provisionally recorded from southern Australia), most of which need detailed investigation, especially of the procarp structure and origin of tetrasporangia.

KEY TO SPECIES OF *NITOPHYLLUM*

1. Thallus foliose to much branched or lobed, usually 10–25 cm high, lobes 5–15 mm across .... 1. *N. crispum*
1. Thallus laterally or subdichotomously branched, 3–12 cm high, branches 3–6 mm broad 2

 2. Tetrasporangial sori marginal, elongate to lunate .... 2. *N. fallax*
 2. Tetrasporangial sori scattered, rounded .... 3. *N. pulchellum*

1. **Nitophyllum crispum** (Kützing)J. Agardh 1852: 662; 1872: 48; 1876: 448; 1898: 39. De Toni 1900: 629. Guiler 1952: 102. Harvey 1859b: 312; 1863, synop: xxxii. Kylin 1924: 75. Levring 1946: 225. Lucas 1909: 35; 1926: 596, pl. 37 fig. 3, pl. 38 fig. 1; 1929a: 19. Lucas & Perrin 1947: 218, fig. 83. May 1965: 402. Shepherd & Womersley 1981: 366. Sonder 1853: 690; 1880: 23. Tisdall 1898: 509. Wilson 1892: 174.
Nitophyllum crispum var. *prolificans* Zanardini 1874: 498.
Aglaophyllum crispum Kützing 1849: 868; 1866: 14, pl. 39.
Nitophyllum punctatum sensu Harvey 1844b: 446; 1849a: 119; 1849b: 153. Hooker & Harvey 1847: 403.
Nitophyllum stipitatum Harvey 1859b: 312; 1863, synop.: xxxi. J. Agardh 1876: 472. Sonder 1880: 23. [NON *N. stipitatum* Suhr 1841: 281, pl. 2 fig. 4 from Tangier.]
Scutarius stipitatus (Harvey)Kuntze 1891: 920.
Platyclinia crozieri J. Agardh 1898: 107; 1899: pl. 3 figs 7, 8. Kylin 1924: 64, fig. 50. Lucas 1909: 36. May 1965: 402. [NON *Nitophyllum crozieri* Hooker & Harvey 1845a: 254 from Cape Horn].
Platyclinia agardhii Papenfuss 1967: 102.

FIGS 54D, 55

Thallus (Fig. 55A) medium red to yellow-red or red-brown, 10–25 (-50) cm high and 10–30 cm across, membranous, foliose and usually much branched with marginal lobes for 2–3 orders, complanate but the lobes often convolute or ruffled, lesser lobes 5–15 mm across, apices rounded; veins absent. Stipe 2–15 mm long, slender. Holdfast small, discoid becoming fibrous; epiphytic on seagrasses (*Posidonia* and *Amphibolis*) or larger algae. *Structure.* Growth marginal and intercalary (Fig. 55B), without or with occasional (Fig. 55C) apical cells, primary cells becoming irregularly placed or more-or-less in rows, angular, isodiametric to slightly elongate, 20–30 μm across, blades mostly monostromatic, 35–50 μm thick, becoming polystromatic below, cortical cells equivalent; margin of blades smooth or with slight dentations. Cells multinucleate; rhodoplasts discoid, becoming chained.

Reproduction. Gametophytes dioecious. Procarps (Figs 54D, 55D) scattered, on opposite sides of the thallus from one primary cell which cuts off a cover cell which divides into 2 (-3) and a supporting cell which produces a 4-celled carpogonial branch and a 2–3-celled sterile group, with the carpogonial branch lying between the cover cells and the sterile group (Fig. 55D). Carposporophyte with a small basal fusion cell and much branched gonimoblast with clavate to pyriform terminal carposporangia 30–45 µm in diameter. Cystocarps (Fig. 55E) 1–1.5 mm across, slightly swollen with a slight collar; pericarp ostiolate, 3–5 cells thick, cells in regular tiers. Spermatangial sori (Fig. 55F, G) scattered, elongate, 0.4–1 mm

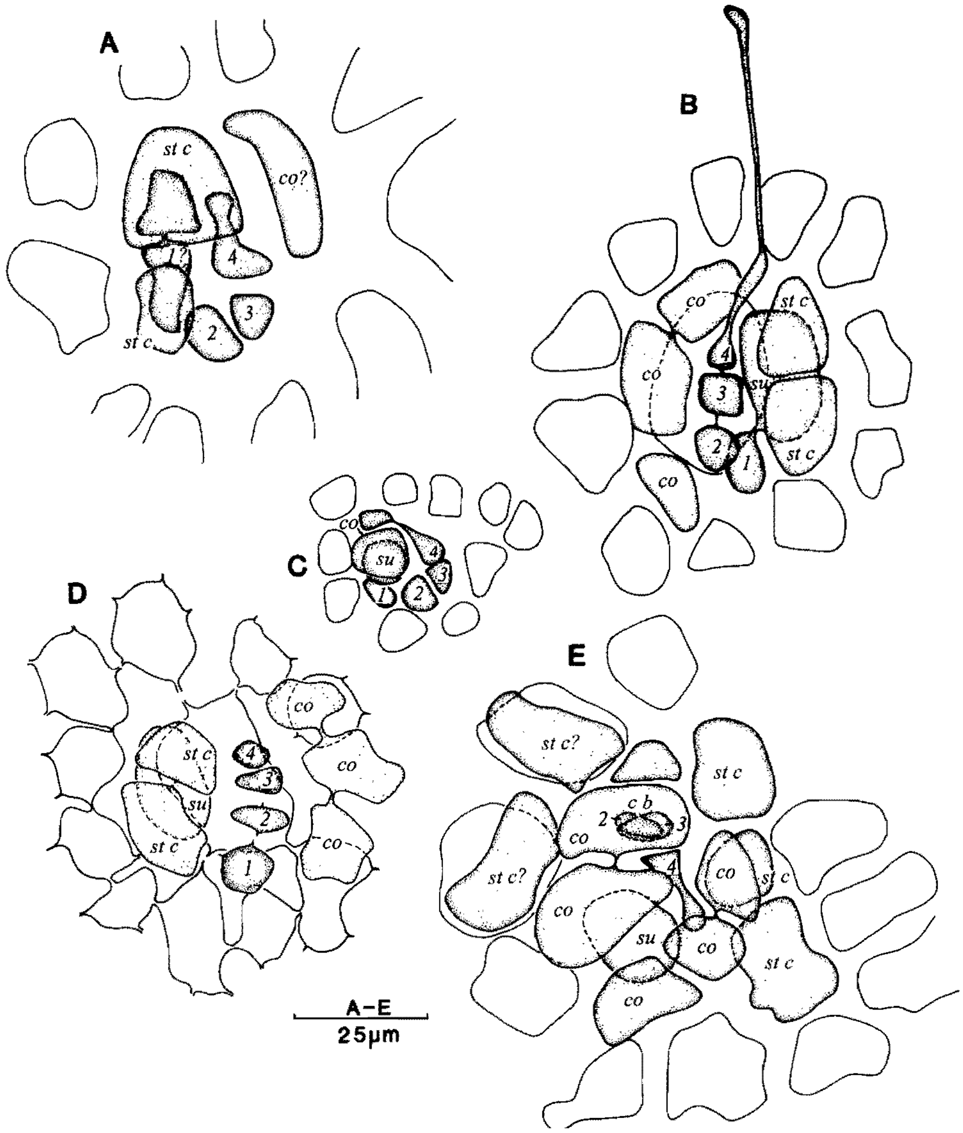

Fig. 54. Procarps. **A**. *Platyclinia stipitata* (AD, A61443). **B**. *Myriogramme gunniana* (AD, A57826). **C**. *Schizoseris bombayensis* (AD, A68032). **D**. *Nitophyllum crispum* (AD, A57770). **E**. *Haraldiophyllum nottii* (AD, A46142).

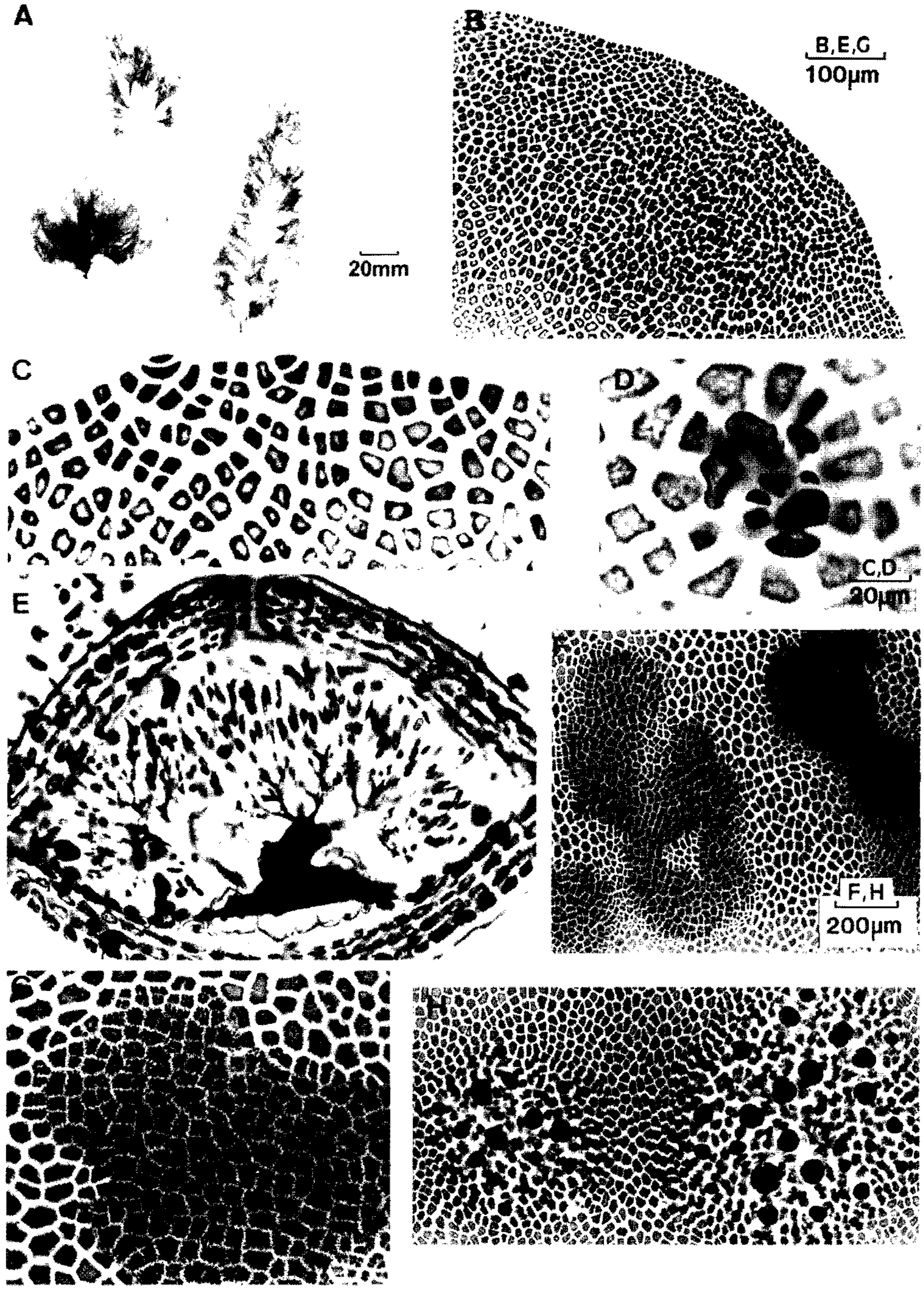

Fig. 55. *Nitophyllum crispum* (**A–D**, **F–H**, AD, 64796; **E**, AD, A61527). **A**. Habit. **B**. Marginal apex. **C**. Marginal apex with an apical cell. **D**. Procarp with 3 sterile cells (above), a carpogonial branch, and 2 cover cells (below). **E**. Section of cystocarp. **F**. Spermatangial sori. **G**. Detail of a spermatangial sorus. **H**. Tetrasporangial sori.

across, with the primary cells producing a layer of cortical initials which cut off elongate spermatangia, often in blocks corresponding to the primary cells.

Tetrasporangial sori (Fig. 55H) scattered, ovate, 0.2–1 mm across, with tetrasporangia cut off from the primary cells and lying in gaps between these cells, more-or-less in one layer; tetrasporangia subspherical, 45–90 µm in diameter.

Type from Georgetown, Tas. (*Gunn* 1269); holotype in Herb. Kützing, L, 941, 181...288.

Distribution: N and E coasts of Tasmania, probably also from Port Elliot, S. Aust., and Seaholme to Point Hicks, Victoria.

Selected specimens: The Rip, Port Phillip Heads, Vic., on *Cephalocystis furcellatus*, 16–23 m deep (*Kraft* 10710a *et al.*, 10.v.1995; MELU and AD, A68019, 68270). Point Hicks, E Vic., on *Carpomitra*, 18–21 m deep (*Kraft* & *Watt*, 8.ii.2001; MELU). Hebe Reef, off Georgetown, Tas., 6 m deep (*Edgar*, 22.x.1995; AD, A64796). Low Head, Tas. (*Perrin* 1199 & *Lucas*, Jan. 1931; AD, A49603; *Perrin* 1204, 8.x.1950; AD, A49606; and *Perrin* 1205, Nov. 1950; AD, A49607). Pilot Station, Low Head, Tas., drift (*Womersley*, 23.x.1986; AD, A57770). Taroona, Tas., uppermost sublittoral (*Sanderson*, 24.xi.1991; AD, A61527). Great Taylor Bay, Bruny I., Tas., on the gasteropod *Maoricolpus*, 10–16 m deep (*Shepherd*, 7.ii.1970; AD, A35151).

Probable specimens: Port Elliot, S. Aust., drift (*Womersley*, 10.viii.1957; AD, A21113). Seaholme, Vic., drift (*Hansen*, Oct. 1955; AD, A20464).

Nitophyllum crispum is mainly a Tasmanian species, with many fine past collections from Low Head, Tas., by Mrs F. Perrin. The Port Elliot and Seaholme specimens are small but probably referable to this species.

Nitophyllum crispum was first referred by Harvey to the European *N. punctatum* with which it is closely related, differing in being a larger and much more branched species, with smaller tetrasporangial sori (0.5–1 mm across compared to 0.3–3.5 mm long and 0.2–1 mm broad in *N. punctatum* – Maggs & Hommersand 1993, p. 259).

Var. *prolificans* Zanardini (1874, p. 498), also from Georgetown, Tas. (type in Herb. Zanardini, Venice), is a typical plant of *N. crispum* and not worth recognising.

Millar (1990, p. 422) suggested *N. crispum* may belong to *Haraldiophyllum*, but the procarps are typical of *Nitophyllum*.

Both the misapplied names *N. stipitatum* Harvey (1859b, p. 312), based on a Gunn specimen from East coast, Tas., and *Platyclinia crozieri* J. Agardh (1898, p. 107), based on a Wilson specimen from Port Phillip Heads, Vic. and renamed *Platyclinia agardhii* by Papenfuss (1967, p. 102), appear to belong to the variable *N. crispum*.

2. **Nitophyllum fallax** J. Agardh 1898: 48. De Toni 1900: 638. Kylin 1924: 97. Lucas 1909: 35; 1926: 600, pl. 40 fig. 1. Tisdall 1898: 509. Wilson 1892: 174, *nomen nudum*.

FIG. 56

Thallus (Fig. 56A) erect, medium red-brown, 8–12 cm high, irregularly laterally and complanately branched from the margins, branches (3-) 4–6 mm broad throughout, tapering only slightly above, apices and axils rounded, margins slightly undulate (mainly where sori present). Midrib slight, remaining as a narrower stipe below where wings are lost; veins absent. Holdfast 2–6 mm across, fibrous; epilithic. *Structure*. Growth marginal (Fig. 56B), without apical cells. Mature cells ovoid in surface view, 8–15 (-20) µm across, irregularly arranged. Blades monostromatic near the margins and 25–35 µm thick, soon tristromatic and 50–60 µm thick, becoming polystromatic centrally, cortical cells equivalent. Cells multinucleate; rhodoplasts discoid.

Reproduction. Gametophytes unknown.

Tetrasporangial sori (Fig. 56C–E) marginal, elongate to lunate, 600–1300 µm long, 300–600 µm broad, and 160–200 µm thick, with tetrasporangia in 2 layers (Fig. 56F), cut off from inner cells of cortical filaments 4–6 cells long and covered by outer cortical cells; tetrasporangia 35–55 µm in diameter.

Type from Port Phillip Heads, Vic. (*Wilson*); lectotype in Herb. Agardh, LD, 30478.

Distribution: Only known from the type and from 1.3 km off Cape Northumberland, S. Aust., 15 m deep (*Shepherd*, 7.vii.1977; AD, A48136 and 1.ii.1978; AD, A55030). Port Phillip Hds, Vic. (*Wilson*, 26.i.1886; MEL, 691948—appears sterile).

N. fallax is a rare species, known only from the two localities and from tetrasporangial plants; placement in *Nitophyllum* is hence provisional. It is characterised by habit and the marginal tetrasporangial sori. J. Agardh originally described semilunate marginal sori (probably tetrasporangial), but Kylin (1924, p. 97) stated that the LD specimens were all sterile, as did Lucas (1926, p. 600) for MEL specimens.

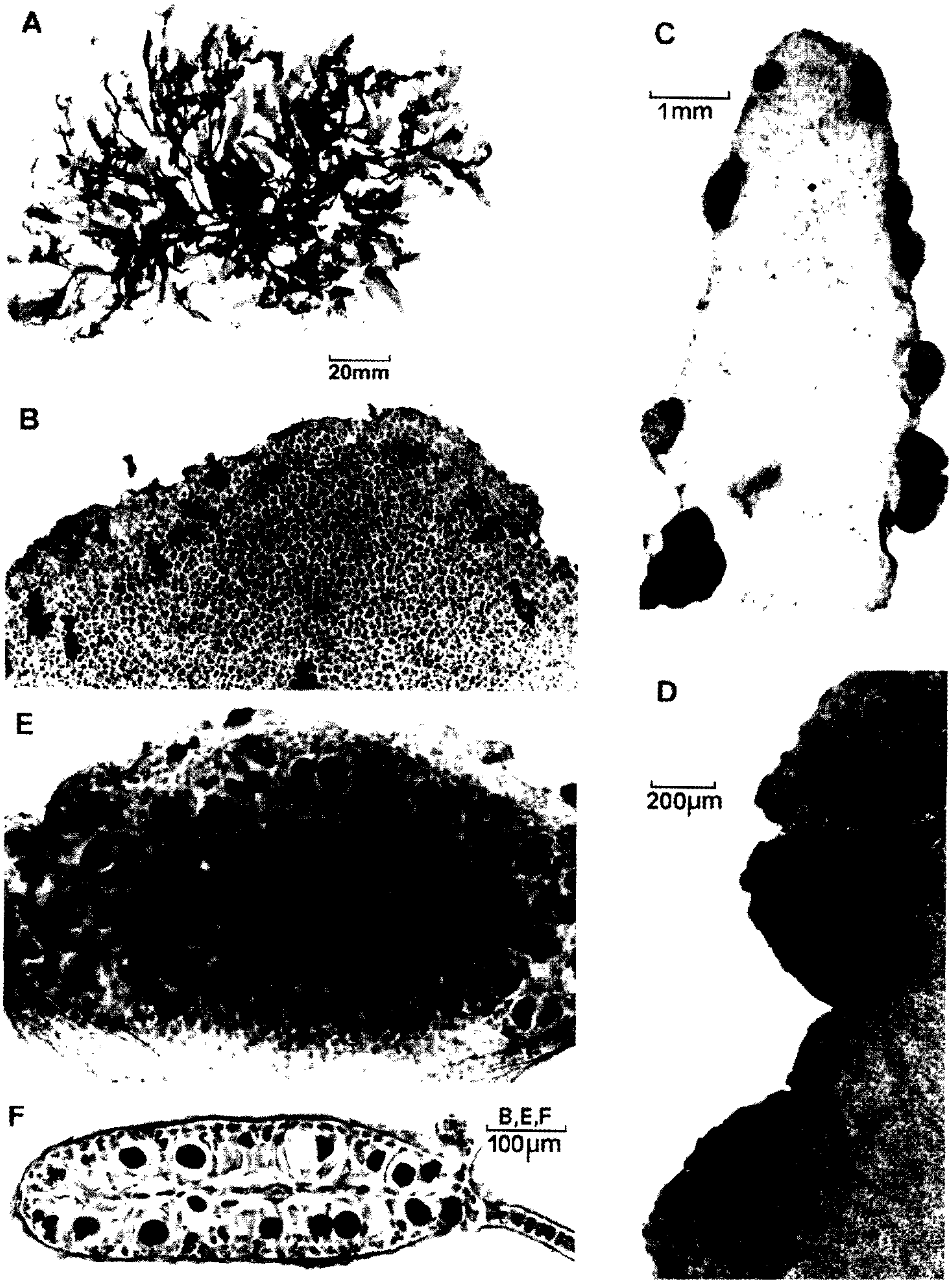

Fig. 56. *Nitophyllum fallax* (AD, A48136). **A.** Habit. **B.** Marginal apex of branch. **C.** Branch with marginal tetrasporangial sori. **D.** Tetrasporangial sori. **E.** Tetrasporangial sorus. **F.** Transverse section of tetrasporangial sorus and monostromatic blade.

3. **Nitophyllum pulchellum** Harvey 1855a: 549; 1863, synop.: xxxii. J. Agardh 1872: 48; 1876: 447; 1898: 38. DeToni 1900: 627. Huisman & Walker 1990: 431. Kylin 1924: 96. Lucas 1909: 35; 1926: 596, pl. 37 fig. 2 (excluding cystocarps). May 1965: 402. Sonder 1880: 23. Wilson 1892: 175.

Scutarius pulchellus (Harvey)Kuntze 1891: 920.

Myriogramme pulchella (Harvey)Millar 1990: 462. Silva *et al.* 1996: 462. [NON cystocarpic Victorian specimens cited by Miller.]

Aglaophyllum pulchellum (Harvey) Kützing 1869: 2, pl. 5a, b.

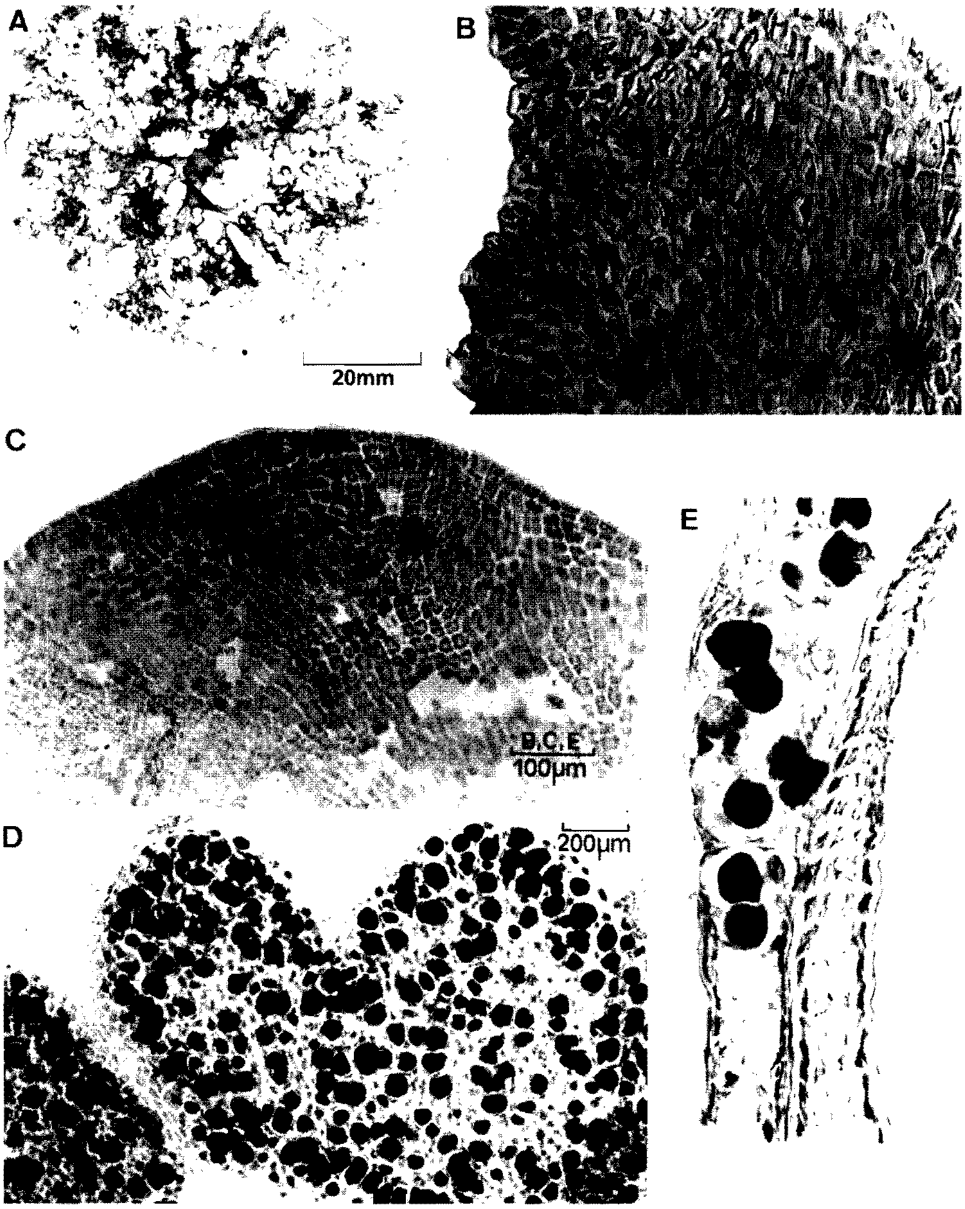

Fig. 57. *Nitophyllum pulchellum* (**A**, **B**, AD, A18302, isolectotype; **C–E**, AD, A68279). **A**. Habit. **B**. Surface view of blade. **C**. Apex and margin of blade. **D**. Tetrasporangial sori. **E**. Transverse section of blade and tetrasporangial sorus.

FIG. 57

Thallus (Fig. 57A) medium red, tufted, 3–5 cm high, subdichotomously and complanately branched with branches of even width, 3–6 mm broad, 2–5 mm apart, with strongly crispate to convolute margins, axils rounded; veins absent. Holdfast probably discoid; epiphytic. *Structure.* Growth marginal (Fig. 57C) without apical cells; mature cells (Fig. 57B) angular in surface view, isodiametric to slightly elongate, 35–55 µm across, often in transverse rows. Blades mostly tristromatic, polystromatic basally, cortical cells equivalent (Fig. 57E). Cells multinucleate; rhodoplasts discoid.

Reproduction. Gametophytes unknown.

Tetrasporangial sori (Fig. 57D, E) scattered, rounded, 0.5–1.5 mm across, with tetrasporangia subspherical to ovoid, 50–90 µm across.

Lectotype from King George Sound, W. Aust. (*Harvey*); in TCD (Harvey, Trav. Set 60); isolectotypes Alg. Aust. Exsicc. 295B, in TCD, MEL, 584158, NSW, 8645, 8646 and AD, A18302.

Distribution: King George Sound and Rottnest I., W. Aust. (*Harvey*).

Selected specimens: King George Sound, W. Aust., (*Harvey*) and Ocean Reef Marina, Perth, W. Aust., 6 m deep (*O'Brien & Millar*, 9.xii.1980; AD, A68279 and in MELU).

The above description is based on Harvey's type specimens from King George Sound, W. Aust. and on AD, A68279, which is probably *N. pulchellum.* The species is otherwise little known, but in form is similar to *Haraldiophyllum nottii* from SE Australia, which differs in having entire, straight, margins in contrast to the strongly crispate margins of *N. pulchellum.* Further collections and study of *N. pulchellum* are clearly desirable to place it generically.

Millar (1990, p. 422) referred *N. pulchellum* to *Myriogramme*, on the basis of a cystocarpic specimen of Wilson in MEL (676687) from Port Phillip Heads, Vic., 10.i.1894. This specimen, however, has crenulate apices and margins and carposporophytes typical of *Platyclinia;* while slightly different in habit, it is now placed under *Platyclinia crenulata* Womersley.

Genus HARALDIOPHYLLUM Zinova 1981: 12

Thallus erect, foliose, laciniate, subdichotomous or lobed, with short stipes; midrib and veins absent; margins entire, dentate, or with spinous processes. Holdfast discoid, from stolons in some species. *Structure.* Growth marginal and diffuse, without distinct apical cells. Young blades monostromatic, becoming tristromatic in reproductive areas and polystromatic near the base, cells in vertical rows, cortical cells equivalent.

Reproduction. Gametophytes dioecious. Procarps scattered on both sides of blades, with the primary blade cell cutting off a cover cell (group) apically, followed by a fertile supporting cell which bears a 1–2-celled lateral sterile group on one side, a 4-celled carpogonial branch on the other side, and a single-celled basal sterile group. Carposporophyte with a basal fusion cell and radiating gonimoblast filaments over the cystocarp floor, together with erect filaments, bearing terminal carposporangia replaced from cells below; the fusion cell occurs above the layer of primary cells of the blade, the cells of which are connected by broadened and partly fused pit-connections. Cystocarps swollen, ostiolate; pericarp 3–5 cells thick, cells in anticlinal rows, scarcely thickened around ostiole. Spermatangial sori on both sides of blades, with cortical cells dividing anticlinally to groups of initials which cut off elongate spermatangia.

Tetrasporangial sori ovate, with tetrasporangia in 1 or 2 layers cut off from the central (primary) cells and deflected alternately or from the inner cortical cells, covered by an outer layer of cortical cells.

Type species: *H. bonnemaisonii* (Kylin)Zinova 1981: 13. See Maggs & Hommersand 1993: 242, fig. 76.

A genus of some 6 species, the type from the British Isles (Maggs & Hommersand 1993, p. 242) and N Europe and 3 species from Australia (Millar & Huisman 1996a: 67).

Haraldiophyllum differs from *Nitophyllum* in procarp structure (*Nitophyllum* having one group of cover cells, whereas *Haraldiophyllum* has two groups) and in the carposporophyte where cells of radiating gonimoblast filaments both fuse laterally and also fuse with vegetative cells on the cystocarp floor. However, this latter character is shown to a varying degree by numerous species in other genera and cannot be used as a distinguishing feature. The difference between *Nitophyllum* and *Haraldiophyllum* is hence slight and may not be satisfactory.

KEY TO SPECIES OF *HARALDIOPHYLLUM*

1. Branch margins fringed with branched spinous processes .... 1. *H. erosum*
1. Branch margins entire, smooth ....2. *H. nottii*

1. **Haraldiophyllum erosum** (Harvey)Millar & Huisman 1996a: 62, figs 1–14. Huisman 1997: 201.

Nitophyllum erosum Harvey 1859a: pl. 94; 1863, synop.: xxxi. J. Agardh 1872: 50; 1876: 460; 1898: 50. De Toni 1900: 639. De Toni & Forti 1923: 33. Lucas 1909: 35; 1926: 600; 1929b: 50. Lucas & Perrin 1947: 219, 221, fig. 85. Mazza 1926: No. 862. Reinbold 1898: 46. Sonder 1880: 23. Tate 1882a: 20. Tisdall 1898: 509. Wilson 1892: 174.

Aglaophyllum erosum (Harvey)Kützing 1869: 2, pl. 6c, d.

Scutarius erosus (Harvey)Kuntze 1891: 920.

Myriogramme erosa (Harvey)Kylin 1924: 61. Huisman & Walker 1990: 431. May 1965: 400. Silva *et al.* 1996: 461. Shepherd & Womersley 1981: 366. Womersley 1950: 184.

Nitophyllum fimbriatum Harvey 1855a: 549, *nomen illegit.* [NON Greville 1833: 447.]

FIGS 58, 59A–C

Thallus (Fig. 58A) medium to dark red to red-brown, 5–13 cm high, subdichotomously to laterally complanately branched with branches 6–12 mm broad, reaching 25 mm broad at branchings; margins fringed with multicellular branched spinous processes (Fig. 58B, C) 200–600 µm long, corticated basally, each with a single apical cell; midribs and veins absent. Holdfast discoid, with a short stipe; epilithic or epiphytic. *Structure.* Growth marginal but vague (Fig. 58C), with intercalary divisions, blades monostromatic and 25–60 µm thick apart from the base and reproductive areas, cells 25–35 µm across and L/D 1–2 (-4).

Reproduction. Gametophytes dioecious. Procarps scattered over both surfaces, with primary cells cutting off 2 cells on each surface, becoming fertile on one side only with the distal cell developing as a cover cell group (Fig. 58D) and the proximal cell acting as a supporting cell which produces a distal sterile cell and a 4-celled carpogonial branch, followed by a second sterile cell from the supporting cell. Carposporophytes (Fig. 58F, G) with a basal fusion cell incorporating gametophytic cells on the cystocarp base, much branched gonimoblast and clavate to ovoid terminal carposporangia 20–35 µm in diameter. Cystocarps (Fig. 58E) 0.6–1.5 mm in diameter, swollen to hemispherical, ostiolate; pericarp 60–200 µm and 6–7 cells thick, bearing branched processes in the ostiolar side. Spermatangial sori (Fig. 59A) elongate, on both surfaces, with the primary cells producing cortical cells which divide anticlinally to 4 initials, each producing several spermatangia.

Tetrasporangial sori (Fig. 59B) ovate, scattered, 200–600 µm across and 90–130 µm thick, with 2 layers (Fig. 59C) of tetrasporangia cut off from inner cortical cells which also produce the outer layer of cover cells; tetrasporangia subspherical, 35–60 µm in diameter.

Type from Garden I., W. Aust., lectotype in Herb. Harvey, TCD (*Clifton*) bearing Harvey's name.

Distribution: Houtman Abrolhos, W. Aust., to Western Port, Victoria (Millar & Huisman 1996, p. 64).

Selected specimens: (see also Millar & Huisman 1996, p. 64): Pearson I., S. Aust., 20–23 m deep (*Shepherd & Turner*, 29.iii.1982; AD, A53047). Elliston, S. Aust., drift (*Womersley*, 13.i.1951; AD, A13566) and on *Euptilota*, 17 m deep (*Shepherd*, 12.v.1971; AD, A38681). Stenhouse Bay, S. Aust.,

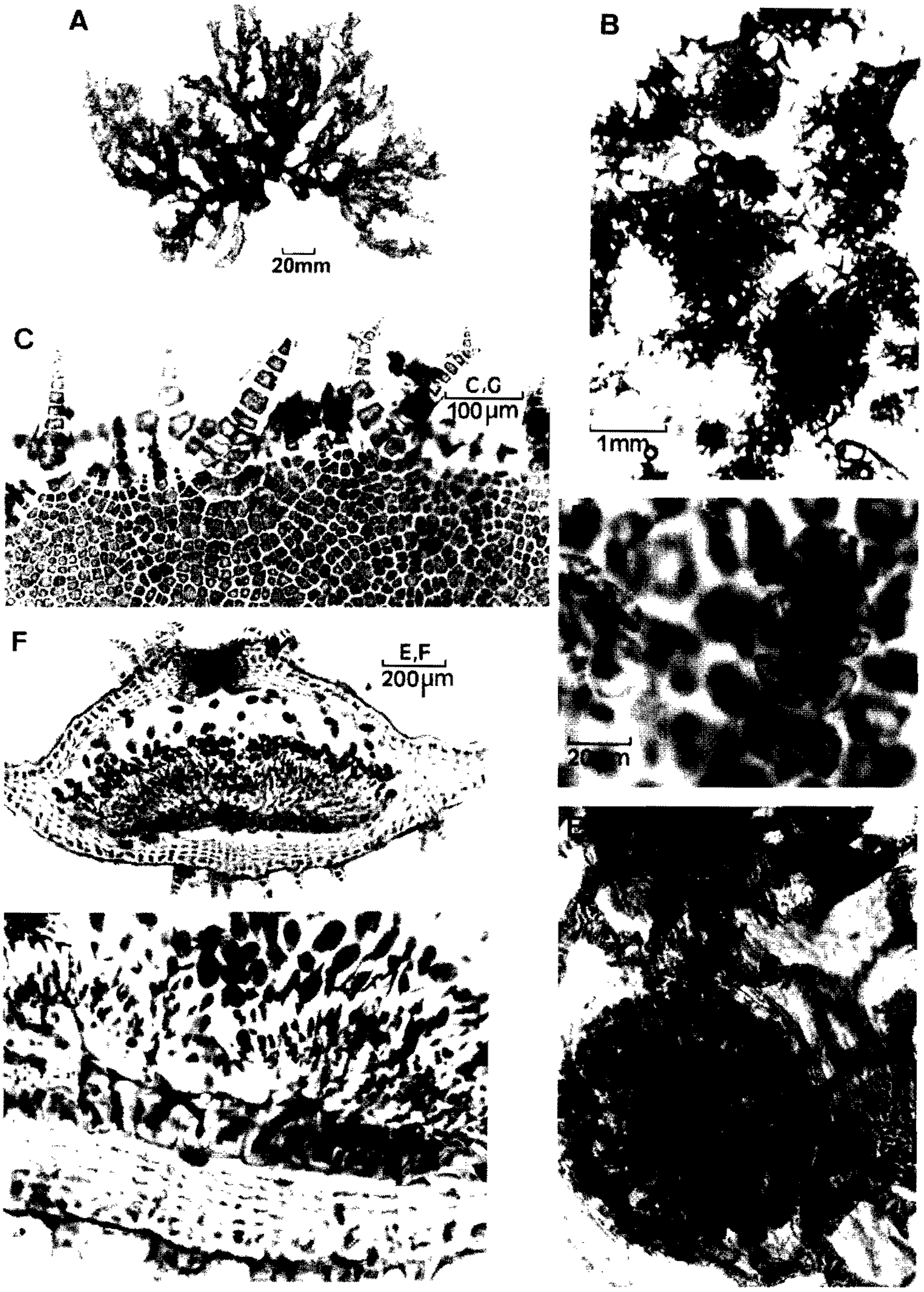

Fig. 58. *Haraldiophyllum erosum* (**A**, AD, A32951; **B**, **E–G**, AD, A27399; **C**, AD, A33011; **D**, AD, A13566). **A**. Habit. **B**. Branch with marginal tufts of spines and cystocarps. **C**. Marginal apex with spines. **D**. Procarps, with cover cells overlying the carpogonial branch. **E**. A cystocarp. **F**. Cross section of a cystocarp. **G**. Carposporophyte with terminal carposporangia.

drift (*Womersley*, 9.iv.1950; AD, A16092). Oedipus Point, West I., S. Aust., 26–30 m deep (*Shepherd*, 5.ii.1967; AD, A32382). West Bay, Kangaroo I., S. Aust., drift (*Womersley*, 6.i.1946; AD, A3212). Cape du Couedic, Kangaroo I., S. Aust., drift (*Womersley*, 13.i.1947; AD, A4185). 12 km S of Vivonne Bay, Kangaroo I., S. Aust., 50–70 m deep (*Latz*, 24.xi.1968; AD, A33011). Seal Bay, Kangaroo I., S. Aust., drift (*Mitchell*, 22.xi.1968; AD, A32951). Robe, S. Aust., drift (*Womersley*, 29.viii.1949; AD, A10911). Stinky Bay, Nora Creina, S. Aust., drift (*Womersley*, 19.viii.1957; AD, A21270 and 3.iv.1999; AD, A68070). Port MacDonnell, S. Aust., drift (*Womersley*, 28.i.1964; AD, A27399). Warrnambool, Vic., drift (*G. & R. Kraft* 10400, 2.i.1995; MELU and AD, A68252). Queenscliff, Vic., drift (*Norris*, 21.i.1963; AD, A25787).

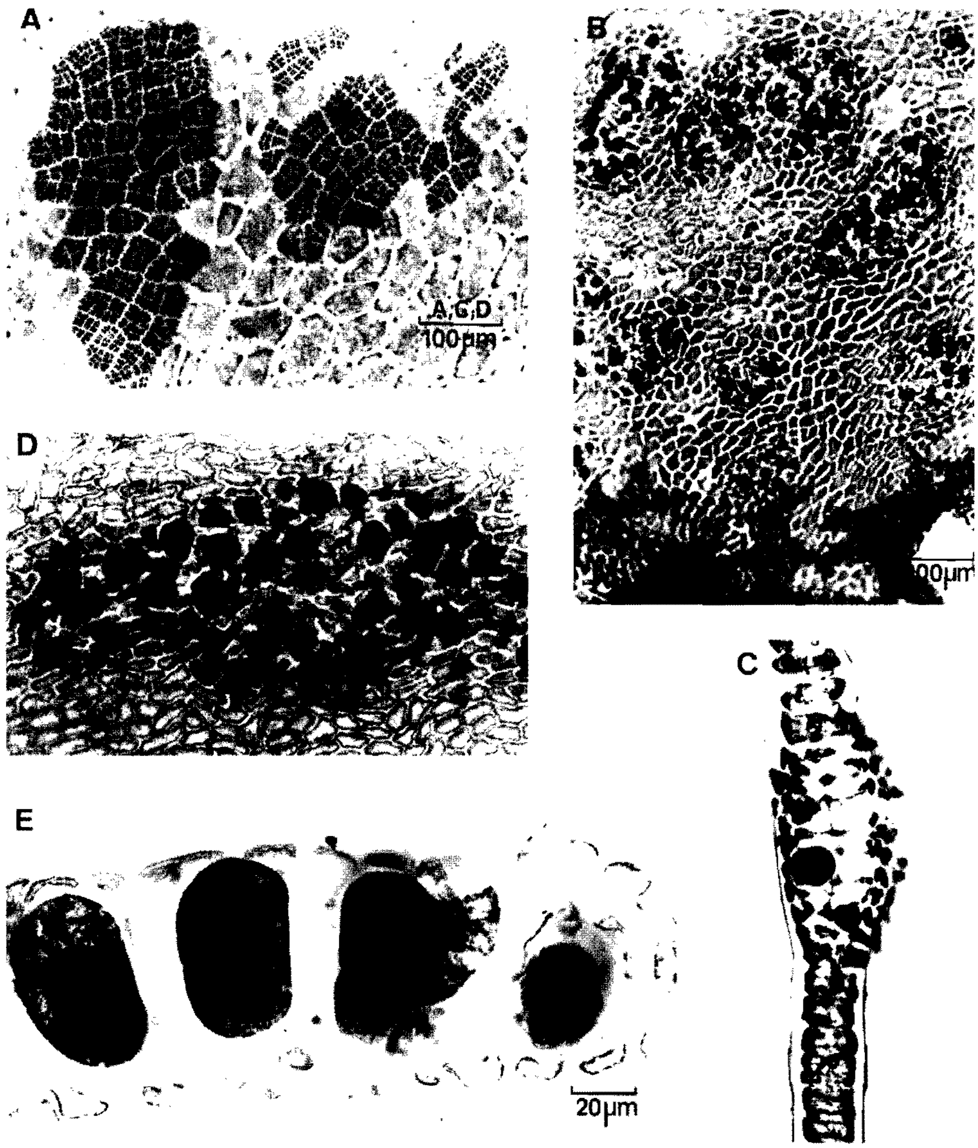

Fig. 59. A–C. *Haraldiophyllum erosum* (**A**, AD, A33011; **B**,**C**, AD, A68070). **A**. Spermatangial sori. **B**. Tetrasporangial sori. **C**. Transverse section of a tetrasporangial sorus. **D**, **E**. *Haraldiophyllum nottii* (AD, A46142). **D**. A tetrasporangial sorus. **E**. Transverse section of a tetrasporangial sorus.

2. **Haraldiophyllum nottii** (Norris & Wynne)Wynne 1983: 444.
Nitophyllum nottii Norris & Wynne 1968: 141, figs 1–8, 20, 22.

FIGS 54E, 59D, E, 60

Thallus (Fig. 60A) medium red, 2–7 cm high, complanately and subdichotomously branched, 3–8 (-10) mm broad, margins smooth, entire, axils usually rounded, apices rounded and not tapering, with very occasional slight spines; veins absent; stipe slender, 1–10 mm long, simple or branched. Holdfast discoid, 1–2 mm across; epilithic. *Structure.* Growth marginal (Fig. 60B, C), without distinct apical cells but with numerous intercalary divisions, cells irregularly arranged, mature cells 20–40 µm across, L/D (1-) 1.5–2 (-4), often in longitudinal lines; blades largely monostromatic where young, 50–75 µm thick, becoming tristromatic below and polystromatic near the base, cortical cells equivalent. Cells multinucleate; rhodoplasts discoid, becoming slightly chained.

Reproduction. Gametophytes dioecious. Procarps (Fig. 54E) scattered, with a cover cell group (Fig. 60D), one sterile cell group and a 4-celled carpogonial branch (Fig. 60E). Carposporophytes (Fig. 60F) with a basal fusion cell and spreading, much branched, gonimoblast with clavate terminal carposporangia 20–30 µm in diameter; lower gonimoblast cells often pit-connected to cells of the primary cell plate. Cystocarps domed, 600–1000 µm across; pericarp ostiolate, 4–5 cells thick, cells tiered. Spermatangial sori (Fig. 60G) scattered, irregular in shape but often slightly elongate, 100–600 µm across, with the primary cells producing a layer of cortical initials (Fig. 60H) which cut off spermatangia in blocks corresponding to the primary cells.

Tetrasporangial sori (Fig. 59D) scattered, ovate to elongate, 150–700 µm across, with tetrasporangia mostly in two layers, cut off from inner cortical cells but sometimes large tetrasporangia appear to lie in a single layer (Fig. 59E) probably due to lack of the opposing layer, with an outer layer of cortical cover cells; tetrasporangia subspherical, 35–55 µm in diameter.

Type from Hood Canal, Washington, U.S.A., 10 m deep (*Russell*, 18.xii.1967; WTU, 238051).

Distribution: Apollo Bay and Crawfish Rock, Westernport Bay, Vic., and SE Tasmania.
Washington State, U.S.A.

Selected specimens: Apollo Bay, Vic., 0.5–1 m deep on pipeline (*Parker & Womersley*, 21.viii.1988; AD, A59237). B.P. Refinery, Western Port, Vic., 0–6 deep (*Millar*, 29.iii.1979; MELU, 23925; AD, A63281). Crawfish Rock, Westernport Bay, Vic., 10 m deep (*Watson*, 25.iv.1969; AD, A34374), 5–10 m deep (*Watson*, 29.viii.1971; AD, A39374), and 6 m deep (*Watson*, 17.xi.1974; AD, A46250). Pirates Bay, Eaglehawk Neck, Tas., 9–12 m deep (*Gowlett-Holmes*, 31.x.1994; AD, A64065). Taroona, Tasmania, 2–3 m deep near jetty (*Shepherd*, 19.iii.1975; AD, A46142—"Marine Algae of southern Australia" No. 410).

These SE Australian specimens appear indistinguishable in habit and structure from *H. nottii* from Washington, U.S.A. (checked by the author and Dr M.J. Wynne). This name was first applied in Australia to a specimen from Westernport Bay, Vic. (MELU, 23925, now AD, A68281) by Dr Alan Millar.

H. nottii is morphologically similar to the little-known *N. pulchellum* from Western Australia, differing in having smooth, straight, margins to the branches instead of the strongly crispate margins of the latter. It is also similar to some forms of the European *N. punctatum* (e.g. Maggs & Hommersand 1993, fig. 81). However, the procarp structure is that of *Haraldiophyllum*.

The disparate occurrence of *H. nottii* suggests it may be an adventive species from one region to the other.

Genus ACROSORIUM Zanardini *ex* Kützing 1869: 4

Thallus basally prostrate or decumbent, becoming erect, membranous and delicate, more-or-less complanately branched with alternate to subdichotomous branches a few mm broad, tips rounded and, at least in the type species, often involute and recurved, margins entire to irregularly "ciliate" with clumped rhizoidal projections; slender branched veins present. Attachment by clumped rhizoids. *Structure.* Blades largely monostromatic, becoming tristromatic and polystromatic only near the base; cells uninucleate or multinucleate.

Reproduction. Gametophytes dioecious. Procarps scattered, with the primary (supporting) cell bearing a first sterile group, a 4-celled carpogonial branch, and a second sterile group.

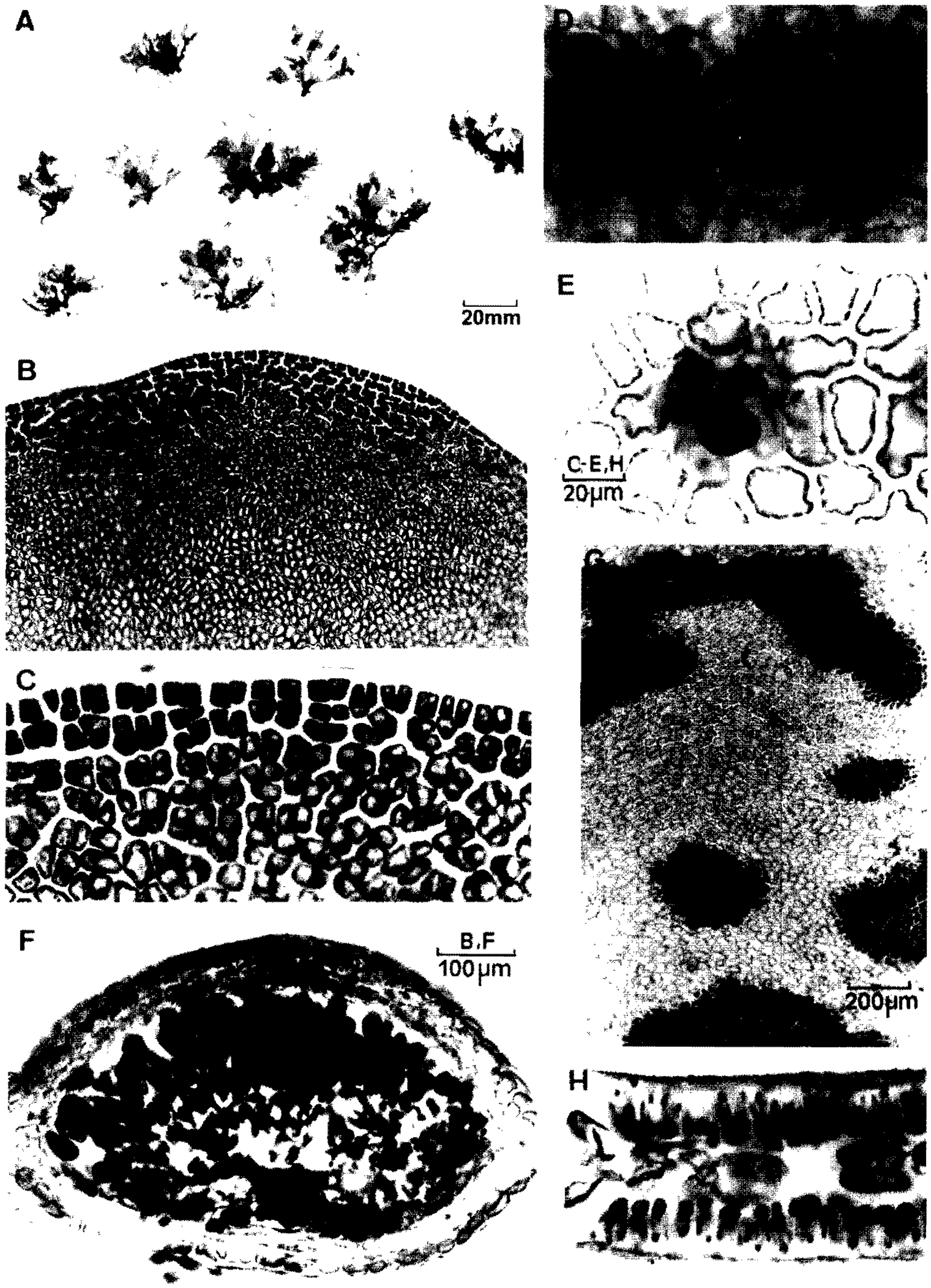

Fig. 60. *Haraldiophyllum nottii* (AD, A46142). **A**. Habit. **B**. Apex of branch. **C**. Apical meristem. **D**. Procarps with cover cell group in focus. **E**. The same procarp, with carpogonial branch partly in focus. **F**. Section of mature cystocarp. **G**. Spermatangial sori. **H**. Transverse section of spermatangial sorus.

Carposporophyte with a basal fusion cell and a much branched gonimoblast with terminal carposporangia, maturing in succession. Cystocarps ostiolate, with or without a collar, pericarp 3–6 cells thick. Spermatangial sori near branch tips.

Tetrasporangial sori usually single and relatively large near tips of branches, with tetrasporangia in 2 layers, of mixed ages, cut off from primary and/or inner cortical cells and covered by outer cortical cells.

Type species: *A. aglaophylloides* Zanardini *ex* Kützing 1869: 4, pl. 10a, b. [= *A. uncinatum sensu* Kylin 1924: 78, fig. 61, = *A. venulosum* (Zanardini)Kylin 1924: 77, fig. 60 = *A. ciliolatum* (Harvey)Kylin 1924: 78].

A genus of several recorded species, most of which need careful comparison with the type. The above description of cystocarpic stages is based mainly on Australian material of the type species (see below) and on Papenfuss (1939) who described the South African *A. acrospermum.*

Acrosorium ciliolatum is probably the only species on southern Australian coasts. *Acrosorium minor* (Sonder)Kylin (1924, p. 78) from the vicinity of Fremantle, W. Aust., is little known and may not be an *Acrosorium* (see below under "Species of uncertain status"). Kylin (1929, pp. 11, 14) considered it to be close to *A. decumbens* (J. Agardh)Kylin from New Zealand. Specimens in TCD under *A. minus* include 2 species; Harvey's 296a and Clifton from Fremantle are mostly tristromatic and may be a small *Hymenena*, while one of Clifton from "W. Aust." is probably a *Rhodophyllis.*

Acrosorium ciliolatum (Harvey)Kylin 1924: 78. May 1965: 403.

Nitophyllum ciliolatum Harvey 1855a: 549; 1863, synop.: xxxii. J Agardh 1876: 466; 1898: 66. De Toni 1900: 651; 1924: 326. Lucas 1909: 35; 1926: 602, pl. 42 fig. 3. Sonder 1880: 23.

Aglaophyllum ciliolatum (Harvey)Kützing 1869: 3, pl. 7a, b.

Acrosorium venulosum (Zanardini)Kylin 1924: 77, fig. 60; 1956: 447, fig. 358A, B. Adams 1994: 286. Kylin 1924: 77, fig. 60. Maggs & Hommersand 1993: 255, fig. 80. Millar 1990: 415, fig. 51D. Millar & Kraft 1993: 45. Silva *et al.* 1996: 446. Wynne 1989b: 249, figs 11–18; 1996: 178.

Nitophyllum venulosum Zanardini 1866: 143, pl. XLIX.

Nitophyllum uncinatum (Turner)J.Agardh 1852: 654; 1876: 465; 1898: 65. Guiler 1952: 102. Harvey 1863, synop.: xxxii. King *et al.* 1971: 123. Lewis 1983: 262. Lucas 1926: 602, pl. 42 figs 1, 2. Lucas & Perrin 1947: 223. Sonder 1880: 23. Tisdall 1898: 509. Wilson 1892: 175.

Acrosorium uncinatum (J. Agardh)Kylin 1924: 78, fig. 61; 1929: 10. Cribb 1983: 96, pl. 29 figs 2–4. Kuehne 1946: 31, figs 1–7, 10, 12, 20. Lewis 1983: 262. May 1965: 403. May *et al.* 1978: 97. Shepherd & Womersley 1970: 135; 1971: 166; 1981: 366. Womersley 1966: 152.

FIGS 61, 62A, B

Thallus (Fig. 61A) more-or-less erect from a prostrate base, light to medium red, 3–6 (-10) cm high, often clumped, branched more-or-less complanately with irregularly alternate branches of relatively uniform width but varying in different plants from 1–2 mm broad to 2–5 mm broad; usually with few to numerous uncinate branch ends (Fig. 61B, C) with recurved tips; axils rounded, apices rounded to acute, margins entire to irregularly and usually sparsely ciliate with short projections which may also arise from the surface of branches; veins (Fig. 61D) slender, branched and sometimes interconnected, mostly one cell broad. Attachment by rhizoidal pads, sessile or shortly stalked; epiphytic on *Posidonia* and various algae, probably also epilithic. *Structure.* Growth by marginal meristems with cells dividing by 2 faces, followed by irregular intercalary divisions. Blades monostromatic, 60–100 µm thick, cells in surface view irregularly angular, 25–40 µm across and L/D 1–2, marginal cells isodiametric and 6–12 µm across. Veins tristromatic, cells 10–25 µm broad and L/D (2-) 3–6 in surface view. Marginal "cilia" formed by clumps of elongate cells. Uncinate curved branch ends (Fig. 61C) with a band of elongate cells on the thicker inner concave side and squatter outer cells where blade monostromatic. Cells uni- to multinucleate; rhodoplasts discoid to elongate.

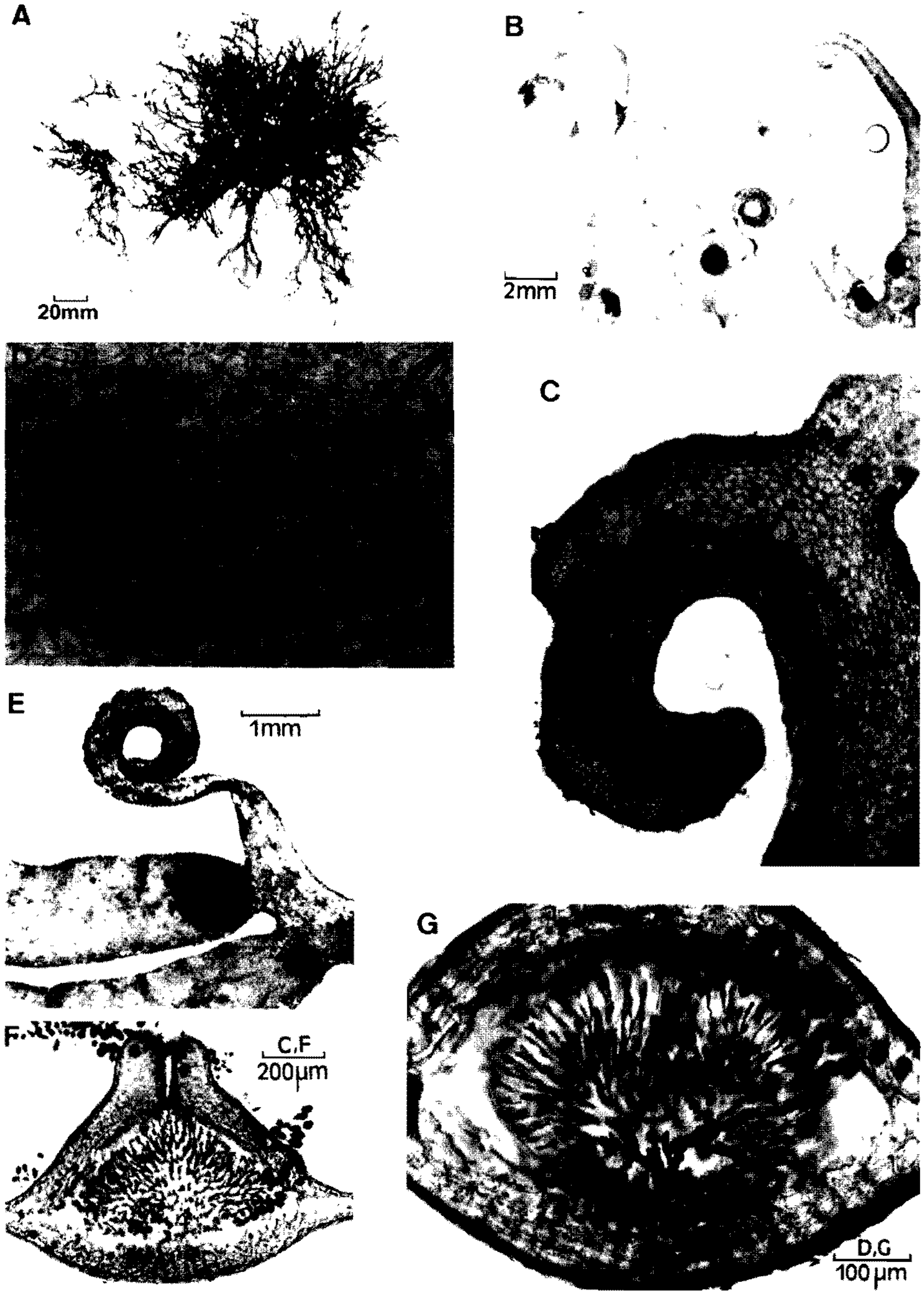

Fig. 61. *Acrosorium ciliolatum* (**A**, AD, A32136; **B–G**, AD, A31152). **A**. Habit. **B**. Branches with recurved branch ends and cystocarps. **C**. Recurved branch tip. **D**. Branch surface with microscopic veins. **E**. Branch with basal cystocarp. **F**. Cross section of a cystocarp. **G**. Section of a cystocarp, carposporophyte with basal, erect, fusion cell and gonimoblast with terminal carposporangia.

Reproduction. Gametophytes dioecious. Procarps scattered. Carposporophytes (Fig. 61G) with a basal, erect, fusion cell and much branched gonimoblast with ovoid to shortly clavate terminal carposporangia, 30–40 µm in diameter, probably replaced from below. Cystocarps (Fig. 61E, F) usually one per branch, 0.5–1 mm across, hemispherical with a thickened collar; pericarp ostiolate, 100–140 µm and 3–5 cells thick, cells somewhat irregular in section. Spermatangial sori usually single near branch apices.

Tetrasporangial sori (Fig. 62A) single, usually near branch apices and covering most of the branch width, ovate, 0.5–2 mm across and 160–200 µm thick, with tetrasporangia in 2 layers of mixed ages (Fig. 62B), cut off from inner cortical cells and covered by outer cortical cells, subspherical, 40–70 µm in diameter.

Type from King George Sound, W. Aust.; lectotype in Herb. Harvey, TCD (Alg. Aust. Exsic. 297B).

Distribution: Widespread in most oceans.

In southern Australia, from King George Sound, W. Aust., around Tasmania and to Queensland. Probably further west in W. Australia.

Selected specimens: Coffin Bay, S. Aust., 1–2 m deep (*P. Womersley*, 1.xii.1975; AD, A46795). N Spencer Gulf, S. Aust., 15 m deep (*Shepherd*, 7.ix.1973; AD, A44296). Wedge I., S. Aust., 5 m deep (*Edyvane*, 24.x.1993; AD, A65554). 4 km N of St Kilda, S. Aust., 1 m deep (*Steffensen*, 11.ix.1975; AD, A46528). Oedipus Point, West I., S. Aust., on *Gelidium australe*, 16 m deep (*Shepherd*, Dec. 1966; AD, A31152). Cape du Couedic, Kangaroo I., S. Aust., on *Pterocladia capillacea*, shaded pool (*Womersley*, 16.i.1965; AD, A28966). Muston, American R. inlet, Kangaroo I., S. Aust., 2–3 m deep (*Womersley*, 21.xi.1968; AD, A32136) and (*Kraft, Johnson & Wickes*, 16.iv.1973; AD, A43751). 1.3 km off Cape Northumberland, S. Aust., 15 m deep (*Shepherd*, 26.x.1977; AD, A55273). Nora Creina, S. Aust., on *Posidonia australis*, 1–2 m deep (*Owen*, 3.ix.1971; AD, A39581). Lady Julia Percy I., Vic., on *Plocamium angustum*, 8–10 m deep (*Shepherd*, 5.i.1968; AD, A32364). Lawrence Rock, Portland, Vic., on *Metagoniolithon radiatum*, 10–16 m deep (*Baldock*, 22.ix.1998; AD, A67898). Off Williamstown, Port Phillip, Vic., 5 m deep (*Macpherson*, 15.i.1961; AD, A28928). Crawfish Rock, Westernport Bay, Vic., 6–10 m deep (*Watson*, 15.ix.1968; AD, A32831). Gabo I., Vic., 24 m deep (*Shepherd*, 14.ii.1973; AD, A43313). Sarah I., Bathurst Ch., SW Tas., 2–5 m deep (*Edgar* 5, 11.iii.1995; AD, A64244). Sisters Rocks, Forestier Pen., Tas., on *Haliptilon roseum*, 25–30 m deep (*Gowlett-Holmes*, 15.x.1994; AD, A64016). Lady Bay, Southport, Tas, 7 m deep (*Brown & Kenchington*, 14.x.1986; AD, A57689). Fluted Cape, Bruny I., Tas., on *Gracilaria* ?, 16 m deep (*Shepherd*, 10.ii.1972; AD, A41579).

The type of *Acrosorium ciliolatum* has numerous short, slender, "cilia" on the margins and surface; these are particularly prevalent in the type but often occur on the margins or surfaces of other specimens (e.g. AD, A32138). As Kylin (1929, p. 13) considered, *A. ciliolatum* is not specifically distinct from *A. venulosum*, and is the earliest name for this *Acrosorium*.

Most descriptions under *Acrosorium venulosum* or *A. uncinatum* state "gametophytes unknown". However, a few southern Australian collections (e.g. AD, A31152) with typical uncinate branches and agreeing well with this species, do bear cystocarps, and the above description of female stages is based on these.

Acrosorium ciliolatum occurs mainly in sheltered situations in calm waters, or deeper water on rough-water coasts. It is often similar in habit to *Hymenena multipartita*, but characterised by more irregular branching, uncinate branch ends, large subterminal tetrasporangial sori, and largely monostromatic thalli.

Genus **HYMENENA** Greville 1830: xlviii

Thallus foliose to much branched, essentially complanate, erect and becoming stipitate or prostrate; holdfast rhizoidal or fibrous. Midribs absent or present, microscopical veins present. *Structure.* Growth marginal, without distinct apical cells. Young blades monostromatic, becoming tristromatic and polystromatic in central or older regions; cortical cells equivalent to primary cells, in anticlinal tiers where polystromatic. Stipes developed from thickened midribs, bare or with proliferations. Microscopic veins slender or coarse, 1–4 cells broad.

Reproduction. Gametophytes dioecious. Procarps scattered, with the supporting (cortical) cells producing 2 sterile cells and a 4-celled carpogonial branch, surrounded by pericarp initials. Carposporophytes with a basal fusion cell and much branched gonimoblast with terminal carposporangia, replaced from below in some species. Cystocarps swollen on both

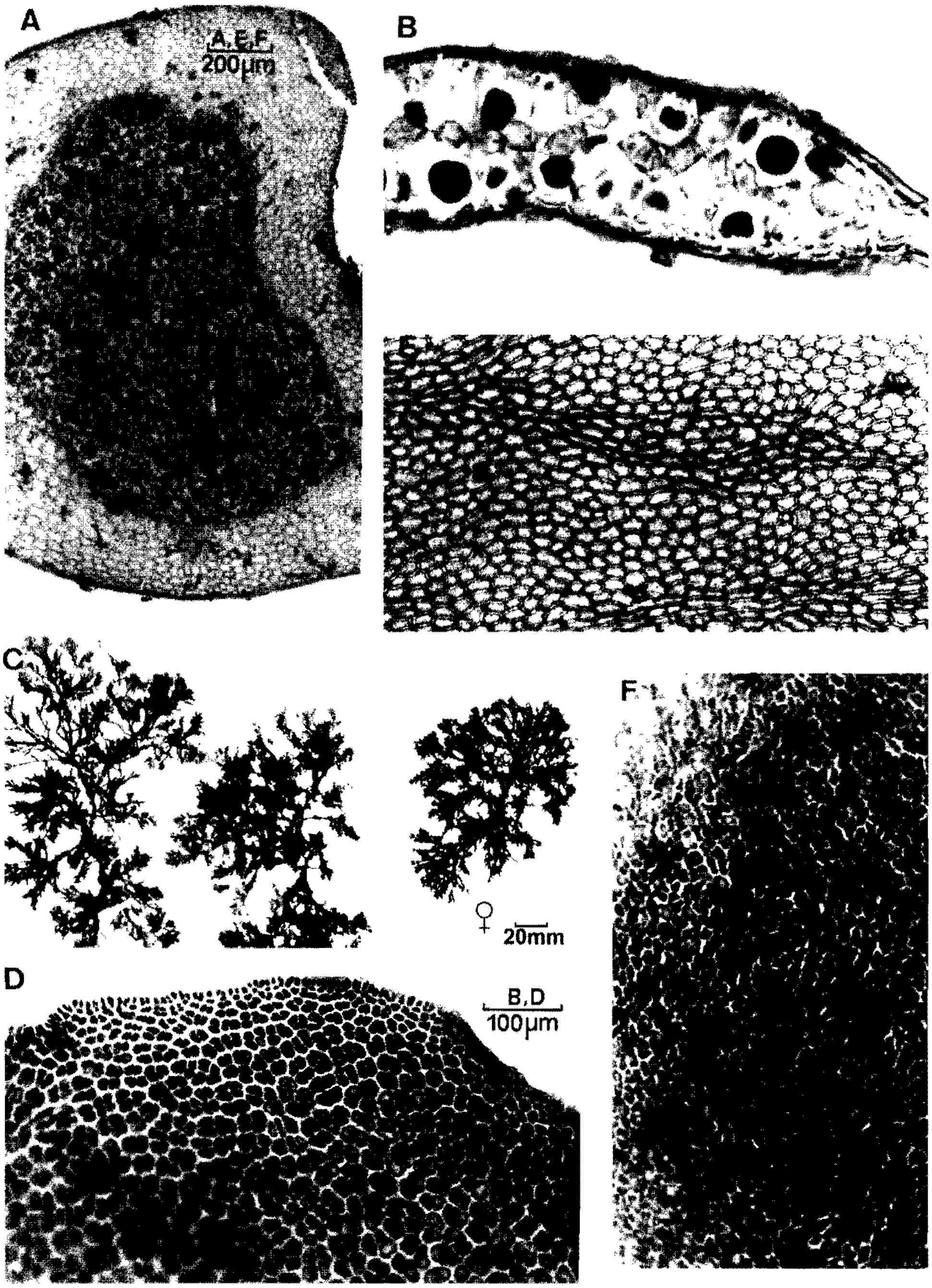

Fig. 62. A, B. *Acrosorium ciliolatum* (**A, B**, AD, A31152). **A**. A tetrasporangial sorus. **B**. Transverse section of tetrasporangial sorus. **C–F**. *Hymenena curdieana* (**C, D, F**, AD, A68087; **E**. AD, A68125). **C**. Habit. **D**. Apex of branch. **E**. Surface view of frond with broad veins. **F**. Broad veins and procarps.

surfaces usually with a short neck; pericarp ostiolate, thick, with anticlinal rows of cells. Spermatangial sori on branch ends, with a layer of initials producing groups of elongate spermatangia.

Tetrasporangial sori on branches, usually ovate, with inner cortical cells producing 2 layers of tetrasporangia laterally, covered by outer cover cells; tetrasporangia tetrahedrally divided.

Type species: *H. fissa* Greville 1830: xlviii = *H. venosa* (Linnaeus)Krauss 1846: 209.

A genus of some 20 species, with 3 species (including several synonyms) on southern Australian coasts. The type species was investigated by Wagner (1954, p. 321, figs 176–188, 191, 193–199).

Hymenena is characterised by the presence of microscopic veins and by single terminal carposporangia. These veins are slender and 1 cell broad in most species, but in *H. curdieana* are relatively coarse and 2–4 cells broad.

KEY TO SPECIES OF *HYMENENA*

1. Thallus usually 8–20 (-25) cm high, erect and complanately branched, mid and lower branches usually 4–10 mm broad 2
1. Thallus usually 5–10 cm high, densely tufted, branches 1–2 (-3) mm broad 3

    2. Lower axis usually well developed, covered with small proliferous bladelets; microscopic nerves coarse, usually 2–4 cells broad .... 1. *H. curdieana*
    2. Lower axis weakly developed, without proliferous bladelets; microscopic veins slender, one cell broad .... 2. *H. affinis*

3. Branches more-or-less complanate, midrib slight .... 3. *H. multipartita*
3. Upper branches convolute, developing midribs shortly below the apices .... 4. *H. endiviaefolia*

1. **Hymenena curdieana** (Harvey)Kylin 1924: 79. Fuhrer *et al.* 1981: pls 29, 30. Guiler 1952: 101. Levring 1946: 226. Lucas & Perrin 1947: 223. May 1965: 401. Shepherd & Womersley 1981: 366. Womersley 1950: 184.

Nitophyllum curdieanum Harvey 1860: pl. 151; 1863, synop.: xxxii. J. Agardh 1872: 50; 1876: 458; 1898: 78. De Toni 1900: 658. Lucas 1909: 36; 1926: 606, pl. 45 fig. 2; 1929a: 19; 1929b: 50. Lucas & Perrin 1947: 223, figs 89, 90. Reinbold 1899: 46. Sonder 1880: 23. Tate 1882a: 20. Tepper 1883: 66. Tidall 1898: 509.

Cryptopleura curdieana (Harvey)Kützing 1869: 1, pl. 3.

Nitophyllum polyanthum J. Agardh 1876: 461; 1898: 77. De Toni 1900: 657. Guiler 1952: 102. Lucas 1909: 35; 1926: 606, pl. 45 fig. 1; 1929a: 19; 1929b: 50. Lucas & Perrin 1947: 223. Reinbold 1897: 54. Sonder 1880: 23. Tate 1882a: 20. Tisdall 1898: 509. Wilson 1892: 175.

Nitophyllum caulescens J. Agardh 1898: 70. De Toni 1900: 653. Lucas 1909: 35; 1926: 605.

Nitophyllum validum J. Agardh 1898: 78. De Toni 1900: 658. Lucas 1909: 36; 1926: 606; 1929b: 50. Lucas & Perrin 1947: 223.

Hymenena valida (J. Agardh)Kylin 1924: 79, fig. 62. May 1965: 401.

FIGS 62C–F, 63

Thallus (Fig. 62C) light to dark red-brown, 10–20 (-25) cm high, much branched irregularly marginally and more-or-less complanately, upper branches alternately lobed, (2-) 4–10 mm broad but narrower basally, with rounded apices and margins usually slightly crispate, developing a thickened main axis and lower lateral branches, lower axes 2–4 mm broad, becoming covered with small proliferous bladelets; microscopic veins (Fig. 62E) coarse, irregularly branched, with the blade (especially on drying) becoming longitudinally corrugate between the veins. Holdfast 2–12 mm across, fibrous, branches compressed; epilithic. *Structure*. Growth marginal (Fig. 62D), without obvious apical cells, marginal cells 3–5 µm in diameter and L/D 1–2. Blades monostromatic near margins, becoming mostly 3 cells thick, cells 20–40 µm broad and L/D 1–2, with a broad midrib (Fig. 63A) developing below, 11–15 cells thick (cortex 5–7 cells thick, cells in anticlinal rows, similar in width).

Microscopic veins (Fig. 62E) mostly 2–4 cells broad and 3–5 cells thick, cells 25–35 μm in diameter and L/D 2–4 (-8). Cells multinucleate; rhodoplasts discoid to elongate.

Reproduction. Gametophytes dioecious. Procarps scattered (Fig. 62F) on both sides of blades, with the supporting (cortical) cell bearing 2 sterile cells and a 4-celled carpogonial branch. Carposporophytes (Fig. 63B) with a small basal fusion cell, and a much branched, small-celled gonimoblast with clavate terminal carposporangia 25–40 μm in diameter. Cystocarps (Fig. 63B) 1–1.5 mm across, bulging on both sides of the blade (more so on the

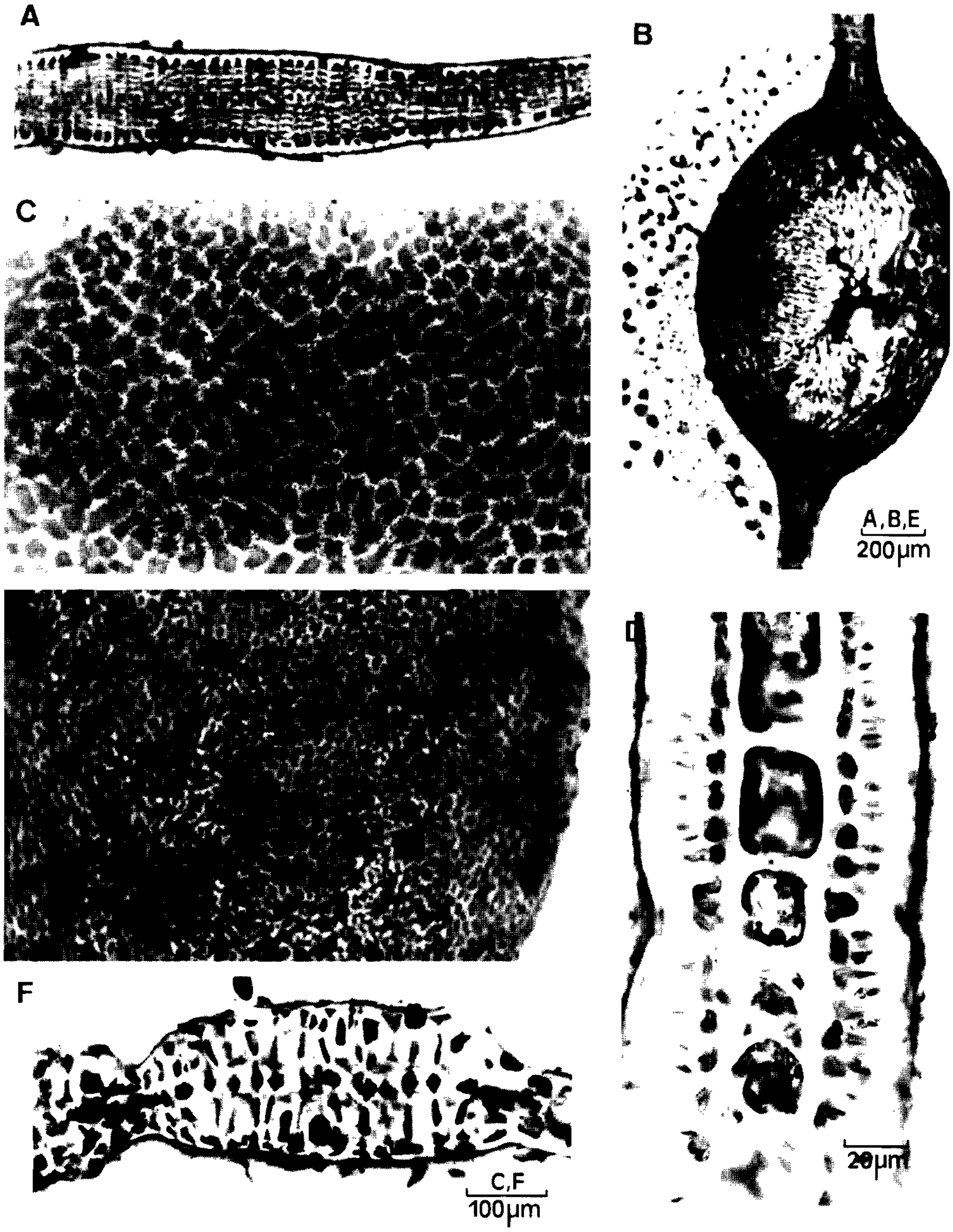

Fig. 63. *Hymenena curdieana* (**A**, AD, A68079; **B–F**, AD, A68087). **A**. Transverse section of lower thallus. **B**. Section of cystocarp, carposporangia mostly lost. **C**. Spermatangial sorus. **D**. Transverse section of spermatangial sorus. **E**. Tetrasporangial sori. **F**. Transverse section of tetrasporangial sorus.

ostiolate side). Pericarp 160–250 μm and 5–8 cells thick, cells in anticlinal rows. Spermatangial sori (Fig. 63C) on both sides of blades, more-or-less ovate, 0.7–1.2 mm across, 90–120 μm thick, with the cortical cells producing a layer of initials which cut off elongate spermatangia (Fig. 63D).

Tetrasporangial sori (Fig. 63E) ovate, 200–400 μm across and L/W 1–2 (-3), 130–200 μm thick, with 2 layers of tetrasporangia (Fig. 63F) cut off from inner cortical cells, and with outer cover cells which usually divide laterally; tetrasporangia subspherical, 45–55 μm in diameter.

Lectotype from S. Australia (*Curdie*); in Herb. Harvey, TCD.

Distribution: Elliston, S. Aust., to Point Lonsdale, Victoria.

Selected specimens: Elliston, S. Aust., drift (*Womersley*, 13.i.1951; AD, A13550—"Marine Algae of southern Australia" No. 110) and 7 m deep (*Shepherd*, 21.x.1970; AD, A37571). Gunyah Beach, Point Avoid, S. Aust., drift (*Ricci*, 12.ii.1994; AD, A63339). Port Elliot, S. Aust., drift (*Womersley*, 24.vii.1949; AD, A11140 and 10.viii.1957; A21153). Vivonne Bay, Kangaroo I., S. Aust., drift (*Womersley*, 2.i.1949; AD, A10622). Seal Bay, Kangaroo I., S. Aust., drift (*Mitchell*, 22.xi.1968; AD, A32950). 30 km SE of Cape Willoughby, Kangaroo I., S. Aust., 38 m deep (*Bone*, 13.iii.1989; AD, A59867). Cape Jaffa, S. Aust., drift (*Womersley*, 5.iv.1999; AD, A68079). Robe, S. Aust., drift (*Womersley*, 2.iv.1999; AD, A68125). Stinky Bay, Nora Creina, S. Aust., drift (*Womersley*, 21.xi.1998; AD, A67945). 1.3 km off Cape Northumberland, S. Aust., 15 m deep (*Shepherd*, 1.ii.1978; AD, A55280). Port MacDonnell, S. Aust., drift (*Womersley*, 4.iv.1999; AD, A68087—"Marine Algae of southern Australia" No. 110a). Narrawong Beach, Portland Bay, Vic., drift (*Beauglehole*, 15.v.1949; AD, A12092). Point Lonsdale, Vic., drift (*Hansen*, Jan 1955; AD, A20466).

Hymenena curdieana is a common deep-water species on south-eastern coasts of South Australia, usually frequent in the drift. It is variable in habit but characterised by the lower thickened axes with proliferous bladelets on the surface, and especially by the coarse microscopic veins 2–4 cells broad.

H. curdieana has been recorded from New Zealand (see Adams 1994, p. 288). However Lindauer, Alg. Nova-Zel. Exsicc. 297, is doubtfully *H. curdieana*, differing in habit and the relatively slight veins.

Nitophyllum polyanthum J. Agardh [lectotype from Waterloo Bay, S. Aust., (*O'Halloran*) in Herb. Agardh, LD, 30877] and *N. caulescens* J. Agardh (lectotype from Encounter Bay, S. Aust., in Herb. Agardh, LD, 30809) are not separable from *H. curdieana*, as Kylin (1924, p. 29) considered. *N. validum* J. Agardh [*H. valida* (J. Agardh)Kylin], type from Port Phillip Heads, Vic. (*Wilson*, 27.i.1883, lectotype in Herb. Agardh, LD, 30580) is also within the range of *H. curdieana*.

2. **Hymenena affinis** (Harvey)Kylin 1924: 79; 1929: 11, pl. 9 fig. 21. Guiler 1952: 101. Lucas & Perrin 1947: 223. May 1965: 401. Shepherd & Womersley 1981: 366. Silva *et al.* 1996: 457. Womersley 1966: 152.

Nitophyllum affine Harvey 1844b: 447; 1849a: 119; 1849b: 153; 1859b: 312; 1863, synop.: xxxii. J. Agardh 1852: 657; 1876: 456; 1898: 68. De Toni 1900: 652. DeToni & Forti 1923: 32. Hooker & Harvey 1847: 403. Lucas 1909: 35; 1926: 604, pl. 43 figs 1, 2; 1929a: 19; 1929b: 50. Lucas & Perrin 1947: 223, figs 87, 88. Reinbold 1897: 54; 1898: 47. Sonder 1880: 23. Tisdall 1898: 509. Wilson 1892: 174.

Aglaophyllum affine (Harvey)Kützing 1849: 869; 1869: 3, pl. 8.

FIG. 64

Thallus (Fig. 64A) medium to dark red-brown, 8–20 (-25) cm high, much branched marginally and complanately with alternately pinnate lobes (2-) 4–8 mm broad, apices rounded, margins entire and flat, main lower axes 5–10 mm broad, only slightly thickened centrally and near the thallus base often 2–4 mm broad where wings are lost; microscopic veins slender. Holdfast fibrous, 2–10 mm across; epilithic, epiphytic or epizoic. *Structure*. Growth marginal, without obvious apical cells, marginal cells short, 6–10 μm across. Blades mostly monostromatic with some cells or small patches becoming 3 cells thick, 70–100 μm thick, cells angular to ovoid, 35–50 μm broad and L/D 1–1.5; central lower blade 300–450 μm and 13–19 cells thick, cells in anticlinal rows. Microscopic veins (Fig. 64B) mostly slender, one cell broad, cells 20–25 μm broad and L/D 1.5–3 (-5). Cells with discoid to elongate rhodoplasts.

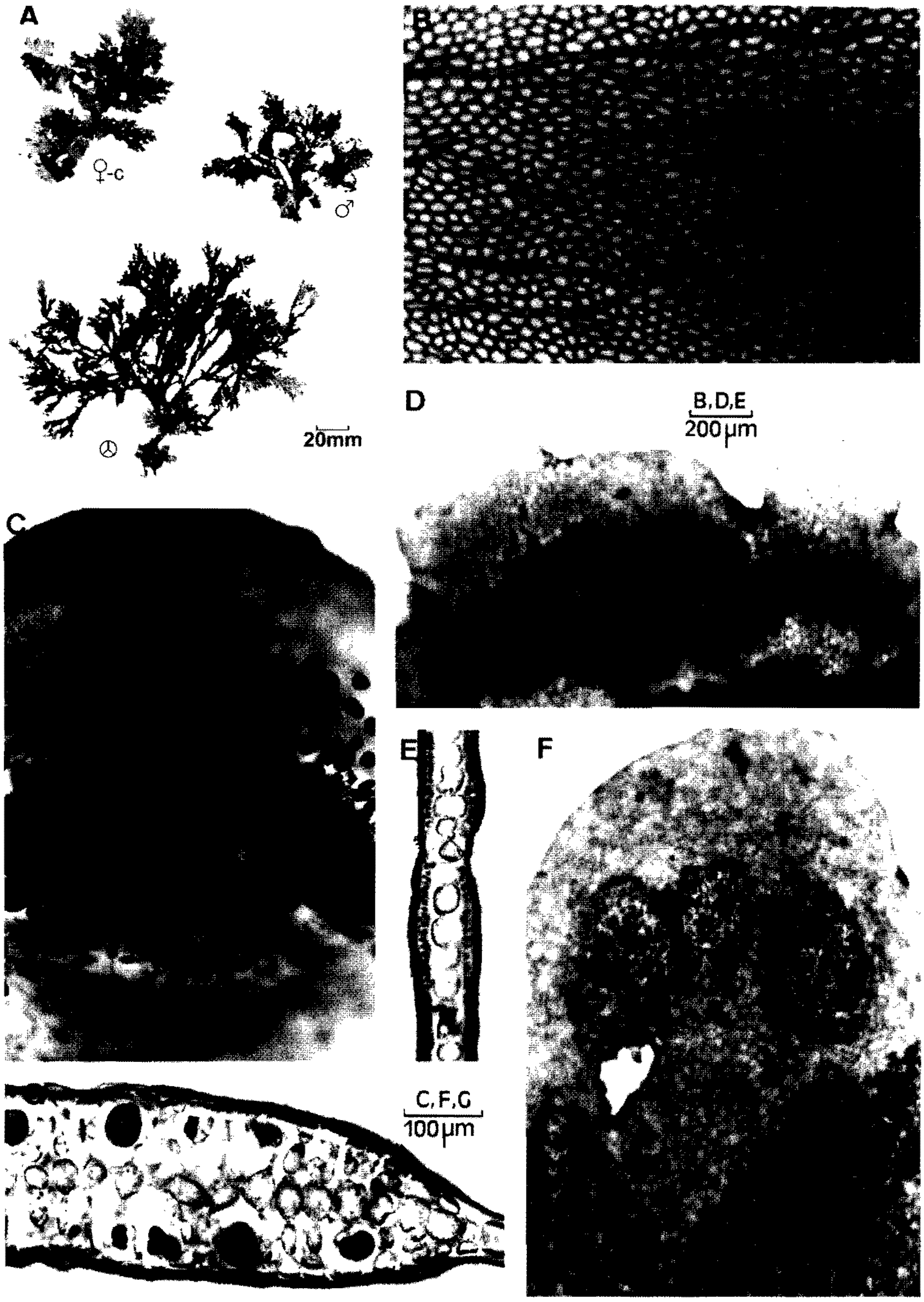

Fig. 64. *Hymenena affinis* (**A**, **D–G**, AD, A35261; **B**, **C**, AD, A41850). **A**. Habit. **B**. Slender veins (1 cell broad). **C**. Section of cystocarp. **D**. Branch with spermatangial sori. **E**. Transverse section of spermatangial sorus. **F**. Tetrasporangial sori. **G**. Transverse section of tetrasporangial sorus.

Reproduction. Gametophytes dioecious. Procarps scattered on both sides of blades, usually with supporting (cortical) cells on both sides producing 2 sterile groups and a 4-celled carpogonial branch, surrounded by the pericarp initials. Carposporophytes (Fig. 64C) with a small to moderate basal fusion cell and a much branched gonimoblast, short-celled basally but larger-celled upwards, with clavate terminal carposporangia 25–45 µm in diameter, replaced from below. Cystocarps 1–1.5 mm across, bulging on both sides, especially the ostiole side; pericarp 130–250 µm and 4–7 cells thick (cells in anticlinal rows) with a short thick neck. Spermatangial sori (Fig. 64D) on apical lobes with the cortical cells dividing anticlinally to form a plate of initials (Fig. 64E), each of which cuts off 2–4 spermatangia.

Tetrasporangial sori (Fig. 64F) on upper lobes, ovate to irregular and often merging, 0.5–1.5 mm across, 180–320 µm thick, with 2 layers of tetrasporangia (Fig. 64G) cut off laterally from inner cortical cells which also bear the outer layer of cover cells; tetrasporangia subspherical, 50–75 µm in diameter.

Type from Georgetown, Tas. (*Gunn* 1272); lectotype, labelled "original specimen", in Herb. Harvey, TCD. (*Gunn* 1272 not located in 1952).

Distribution: Elliston, S. Aust., to Bemm Reef, E Vic., and around Tasmania.

H. affinis has been recorded also from New Zealand (Kylin 1929, p. 11; Adams 1994, p. 305) and from Amsterdam I. and St Paul I. (see Silva *et al.* 1996, p. 457).

Selected specimens: Elliston Bay, S. Aust., 10–11 m deep (*Shepherd*, 20.x.1969; AD, A35011) and on *Muellerena*, 7 m deep (*Shepherd*, 22.v.1998; AD, A67902). 1.3 km off Cape Northumberland, S. Aust., 15 m deep (*Shepherd*, 9.ii.1977; AD, A55286). Sandringham, Port Phillip, Vic. (*Lucas*, Jan. 1900; AD, A1110). Crawfish Rock, Westernport Bay, Vic., 5–10 m deep (*Watson*, 10.xi.1968; AD, A33055) and 5 m and 6 m deep (*Shepherd*, 31.i.1970; AD, A35230 and A35261). Walkerville, Vic., drift (*Sinkora* A1554, 23.ii–9.iii.1972; AD, A42321). Bemm Reef, E Vic., 15–17 m deep (*Foard & Kraft*, 8.ii.2001; MELU). Georgetown, Tas., upper sublittoral (*Womersley*, 29.i.1949; AD, A10259). Piersons Point, Tinderbox, SE Tas., on sponge, 14 m deep (AIMS-NCI Q66C 5040-T, 13.ii.1991; AD, A61364). Fluted Cape, Bruny I., Tas., 10 m deep (*Shepherd*, 12.ii.1972; AD, A42029) and 16 m deep (*Shepherd*, 14.ii.1972; AD, A41850).

Hymenena affinis is closely related to *H. multipartita*, especially in the slender microscopic veins, differing essentially in habit having a broader thallus, especially basally, and less regular branching.

H. affinis is essentially an eastern species, frequent in Tasmania and Westernport Bay, Victoria, but it does extend westwards to Elliston Bay, S. Australia. It lacks the fairly distinct lower axis of *H. curdieana* and differs essentially from the latter in having slender microscopic veins mostly only one cell broad.

3. **Hymenena multipartita** (Hooker & Harvey)Kylin 1924: 79; 1929: 11, pl.8 fig. 20. Adams 1994: 305? Guiler 1952: 101. May 1965: 401. Papenfuss 1964b: 53?. Shepherd & Womersley 1970: 135; 1971: 166. Silva *et al.* 1996: 457.

Nitophyllum multipartitum Hooker & Harvey 1847: 404. J. Agardh 1852: 664; 1872: 50; 1876: 457; 1898: 69. De Toni 1900: 653. DeToni & Forti 1923: 33. Harvey 1849a: 121; 1859b: 312; 1863, synop.: xxxii. Lucas 1909: 35; 1926: 604, pl. 44 figs 1, 2; 1929a: 19. Sonder 1853: 690; 1880: 23. Tisdall 1898: 509. Wilson 1892: 174.

Aglaophyllum multipartitum (Hooker & Harvey)Kützing 1849: 868; 1869: 3, pl. 7c, d.

Nitophyllum obsoletum Zanardini 1874: 498. J. Agardh 1876: 472. DeToni 1900: 664. Guiler 1952: 102. Lucas 1909: 36. Sonder 1880: 23.

Nitophyllum parvifolium J. Agardh 1876: 457; 1898: 69. De Toni 1900: 653. Kylin 1929: 14. Lucas 1909: 35; 1926: 605, pl. 44 fig. 3; 1929b: 50. Reinbold 1897: 54. Sonder 1880: 23. Wilson 1892: 174. Womersley 1966: 152.

FIGS 65, 66A, B

Thallus (Fig. 65A, B) medium to dark red-brown, 5–10 (-12) cm high, usually densely tufted, more-or-less complanately branched with alternate, marginal, flat branches 1–4 (-10) mm apart, all branches 1–2 (-3) mm broad, apices rounded, margins entire, smooth, older axes becoming denuded of laterals below and 0.5–2 mm broad. Holdfast rhizoidal, becoming fibrous; epilithic or epizoic. *Structure.* Growth marginal (Fig. 65C), without obvious apical cells, marginal cells 6–10 µm across. Blades mostly monostromatic (Fig. 66B) and 50–90 µm thick, older parts 3 cells and 90–120 µm thick, cells angular to ovoid and 25–45 µm across,

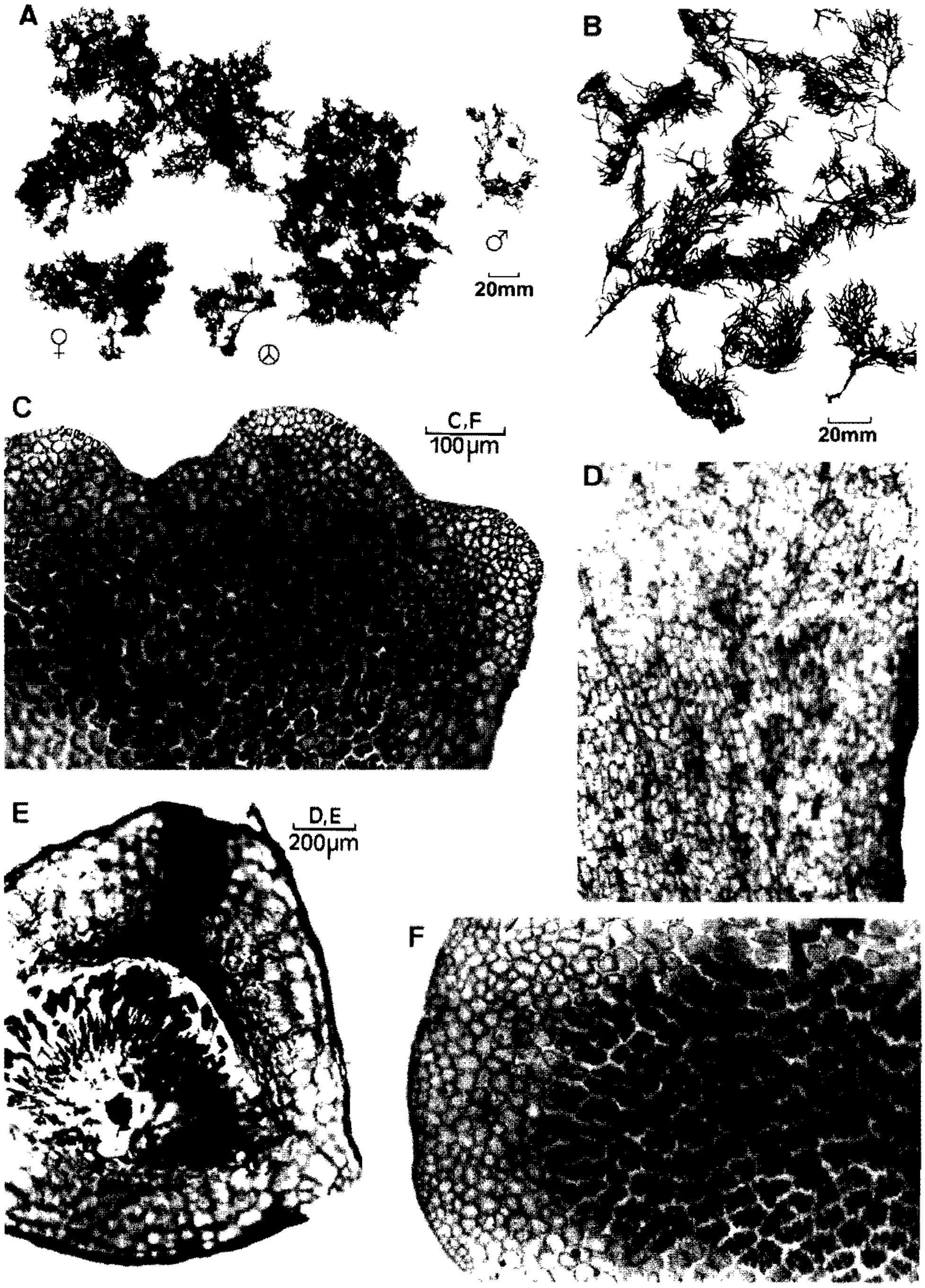

Fig. 65. *Hymenena multipartita* (**A**, **C**, **F**, AD, A68015; **B**, **D**, **E**, AD, A60358). **A**. Habit. **B**. Habit of more loosely branched plant. **C**. Apex of a branch. **D**. Branch with slender veins. **E**. Section of a cystocarp. **F**. Branch apex with a spermatangial sorus.

L/D 1–2. Central lower branches 200–500 µm and 7–14 cells thick, cells in anticlinal rows. Microscopical veins (Fig. 65D) slight to prominent, slender, 1 cell broad, cells 20–30 µm in diameter and L/D 1.5–3.5 (-5). Cells with discoid to elongate rhodoplasts.

Reproduction. Gametophytes dioecious. Procarps scattered on both sides of blades, with supporting cell bearing 2 sterile cells and a 4-celled carpogonial branch, surrounded by pericarp initials. Carposporophytes with a small basal fusion cell and much branched gonimoblast with clavate to ovoid carposporangia 25–40 µm in diameter. Cystocarps (Fig. 65E) 700–1500 µm across, bulging on both sides especially the ostiolar side with a short, coarse neck; pericarp 200–400 µm and 6–8 cells thick, cells in anticlinal rows. Spermatangial sori (Fig. 65F) covering ends of branches, cortical cells dividing anticlinally to form plates of initials each producing 2–4 elongate spermatangia.

Tetrasporangial sori (Fig. 66A) on branches, often near apices, 1 (-3) per branch width, ovate, 200–500 µm across and 180–230 µm thick, with 2 layers (Fig. 66B) of tetrasporangia cut off laterally from inner cortical cells which also produce the outer cover cells; tetrasporangia subspherical, 50–80 µm in diameter.

Lectotype from Georgetown, Tas. (*Gunn* 1273); in BM; syntype from Sullivan Cove, Tas. (*Hooker*) also in BM.

Distribution: Topgallant I., S. Aust., to Gabo I., Vic., and around Tasmania.

New Zealand (Kylin 1929, p.11). Andaman and Nicobar Is (see Silva *et al.* 1996, p. 457).

Selected specimens. Topgallant I., S. Aust., 35 m deep (*Branden*, 2.vii.1987; AD, A57557). Elliston, S. Aust., drift (*Womersley*, 13.i.1951; AD, A13540) and 7 m deep in bay (*Shepherd*, 22.v.1998; AD, A67900). Pearson I., S. Aust., 50 m deep (*Shepherd*, 9.i.1969; AD, A33914). Brown Beach, York Pen., S. Aust., drift (*Womersley*, 13.iv.1963; AD, A26638). Bashams Beach, Port Elliot, S. Aust., drift (*Womersley*, 7.iii.1999; AD, A68015). Oedipus Point, West I., S. Aust., 26–30 m deep (*Shepherd*, 5.ii.1967; AD, A32381). Pennington Bay, Kangaroo I., S. Aust., sublittoral fringe (*Womersley*, 16.i.1948; AD, A6481). 30 km SE of Cape Willoughby, Kangaroo I., S. Aust., 38 m deep (*Bone*, 13.iii.1989; AD, A59865). Margaret Brock Reef, Cape Jaffa, S. Aust., 3–5 m deep (*R. Lewis*, 29.xi.1972; AD, A42926). Robe, S. Aust., drift (*Womersley*, 29.viii.1949; AD, A10925). Back Beach, Little Dip Conservation Park, SE S. Aust., upper sublittoral shallow pods (*Womersley*, 25.xi.1999; AD, A68377—"Marine Algae of southern Australia" No. 412). Stinky Bay, Nora Creina, S. Aust., drift (*Womersley*, 21.xi.1998; AD, A67943). Port MacDonnell, S. Aust., drift (*Womersley*, 28.i.1964; AD, A27402). Point Roadknight, Vic., drift (*Sinkora* A1430, 29.xi.1971; AD, A43186). Point Lonsdale, Vic., drift (*Sinkora* A1029, 14.xi.1970; AD, A62692). Walkerville, Vic., drift (*Sinkora* A1549, 23.ii.–9.iii.1972; AD, A42305). Gabo I., Vic., 28 m deep (*Shepherd*, 14.ii.1973; AD, A43352). Currie R. mouth, N. Tas., drift (*Cribb* 75.5, 17.ix.1951; AD, A16306). Marion Bay, Tas., 10–12 m deep (*Shepherd*, 13.ii.1970; AD, A35653). Bicheno, Tas., 16 m deep (AIMS NCI Q66C 3722M, 26.ii.1990; AD, A60358) and 17 m deep (*McCauley*, 26.ii.1990; AD, A60414). Fluted Cape, Bruny I., Tas., 16 m deep (*Shepherd*, 10.ii.1972; AD, A41578).

The type of *N. parvifolium* J. Agardh, from Port Phillip, Vic. (*Mueller*), in Herb. Agardh, LD, 30805, is as Kylin (1924, p. 79) suspected, followed by May (1965, p. 401), only a depauperate plant of *H. multipartita*.

Hymenena multipartita is closely related to *H. affinis*, differing in habit and narrower branches. In the microscopic veins and reproduction they are very similar. It also shows similarity to species of *Acrosorium*. New Zealand records need checking with Australian plants.

One collection (A68377) of dense, profuse, tufts in shallow pools, had some plants, or their upper parts, slender with uncinate ends as in *Acrosorium ciliolatum*, but with several tetrasporangial sori near branch ends and the branches mainly tri- to polystromatic; only tetrasporangial plants were found.

The type of *Nitophyllum obsoletum* Zanardini (1874, p. 498), in Herb. Zanardini, Venice, has conspicuous but slender veins and appears to be a relatively robust plant of *H. multipartita*.

4. **Hymenena endiviaefolia** (Hooker & Harvey)Womersley, *comb. nov.*

Delesseria endiviaefolia Hooker & Harvey 1847: 403. J. Agardh 1852: 697. Harvey 1849a: 115; 1859b: 312; 1863, synop.: xxxi. Kützing 1869: 4, pl. 11 c–e.

Nitophyllum endiviaefolium (Hooker & Harvey)J. Agardh 1872: 50; 1876: 461; 1898: 47. De Toni 1900: 637. Lucas 1909: 35; 1926: 599, pl. 39 fig. 3; 1929a: 19. Sonder 1880: 23. Tisdall 1898: 509. Wilson 1892: 174.

Hypoglossum endiviaefolium (Hooker & Harvey)Kützing 1849: 876.

Cryptopleura endiviaefolia (Hooker & Harvey)Kylin 1924: 91. Guiler 1952: 101. May 1965: 401. Shepherd & Womersley 1971: 166; 1981: 366. Womersley 1950: 184.

FIGS 66C, D, 67

Thallus (Fig. 66C) medium red to dark red-brown, 5–15 cm high, much branched with lobed and convolute upper branches, developing midribs shortly below the apices, losing the wings below leaving compressed to terete axes to the main branches and main axis, 0.5–1.5 mm in diameter; upper branch lobes 0.7–1 mm broad with rounded apices; microscopic veins distinct on some branches, absent on others. Holdfast fibrous, 2–8 mm across; epilithic or epiphytic on larger algae (especially *Acrocarpia*). *Structure*. Growth marginal, without distinct apical cells, intercalary divisions frequent. Blade lobes monostromatic, 35–70 µm thick, cells ovoid, 20–30 µm across, L/D 1–2, soon becoming tristromatic with cortical cells equivalent to primary cells. Midrib (Fig. 66D) with several large central cells surrounded by a broad parenchymatous tissue of anticlinal rows of small cells. Veins one cell broad, cells longer than adjacent cells, often indistinct. Cells multinucleate; rhodoplasts discoid.

Reproduction. Reproductive organs borne on upper lobes of thallus. Gametophytes dioecious. Procarps scattered (Fig. 67A), the supporting cell bearing sterile groups and a 4-celled carpogonial branch (Fig. 67B). Carposporophytes (Fig. 67C) with a prominent basal fusion cell bearing much branched gonimoblast filaments with 2–4 terminal cells maturing,

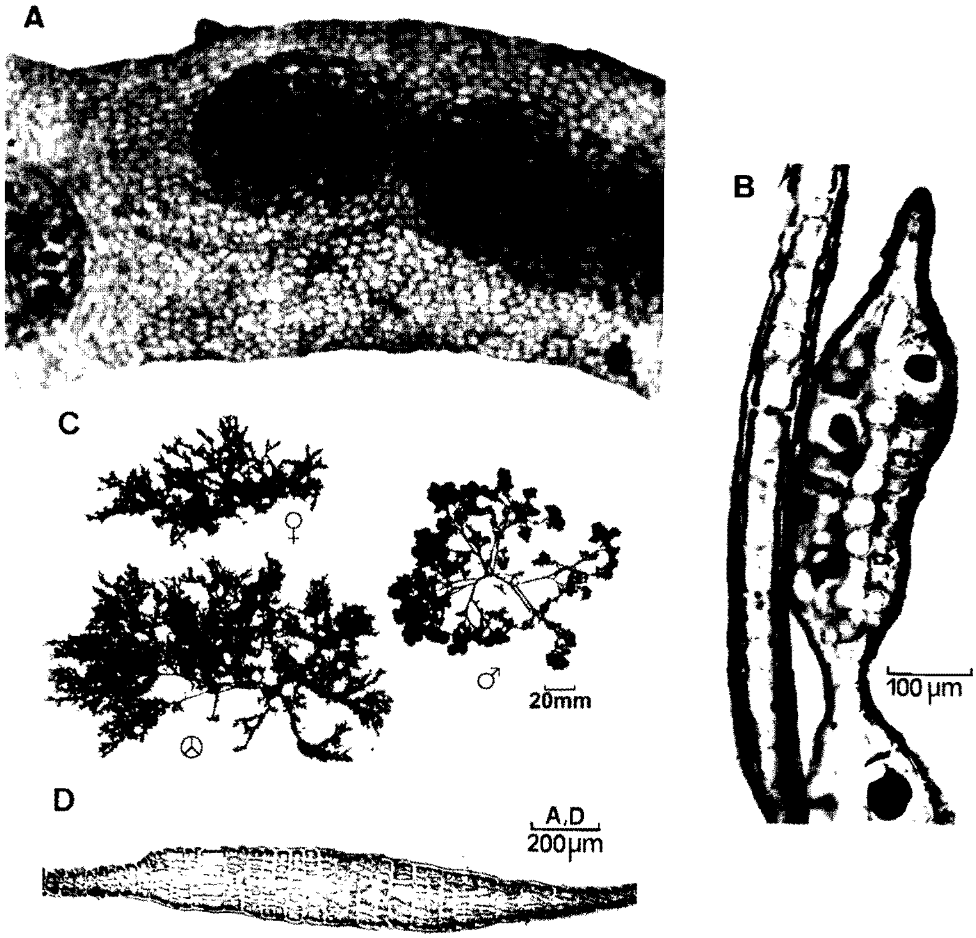

Fig. 66. **A**, **B**. *Hymenena multipartita* (AD, A60358). **A**. Branch with tetrasporangial sori. **B**. Transverse sections of tetrasporangial sorus and monostromatic blade. **C**, **D**. *Hymenena endiviaefolia* (AD, A68086). **C**. Habit. **D**. Transverse section of thallus.

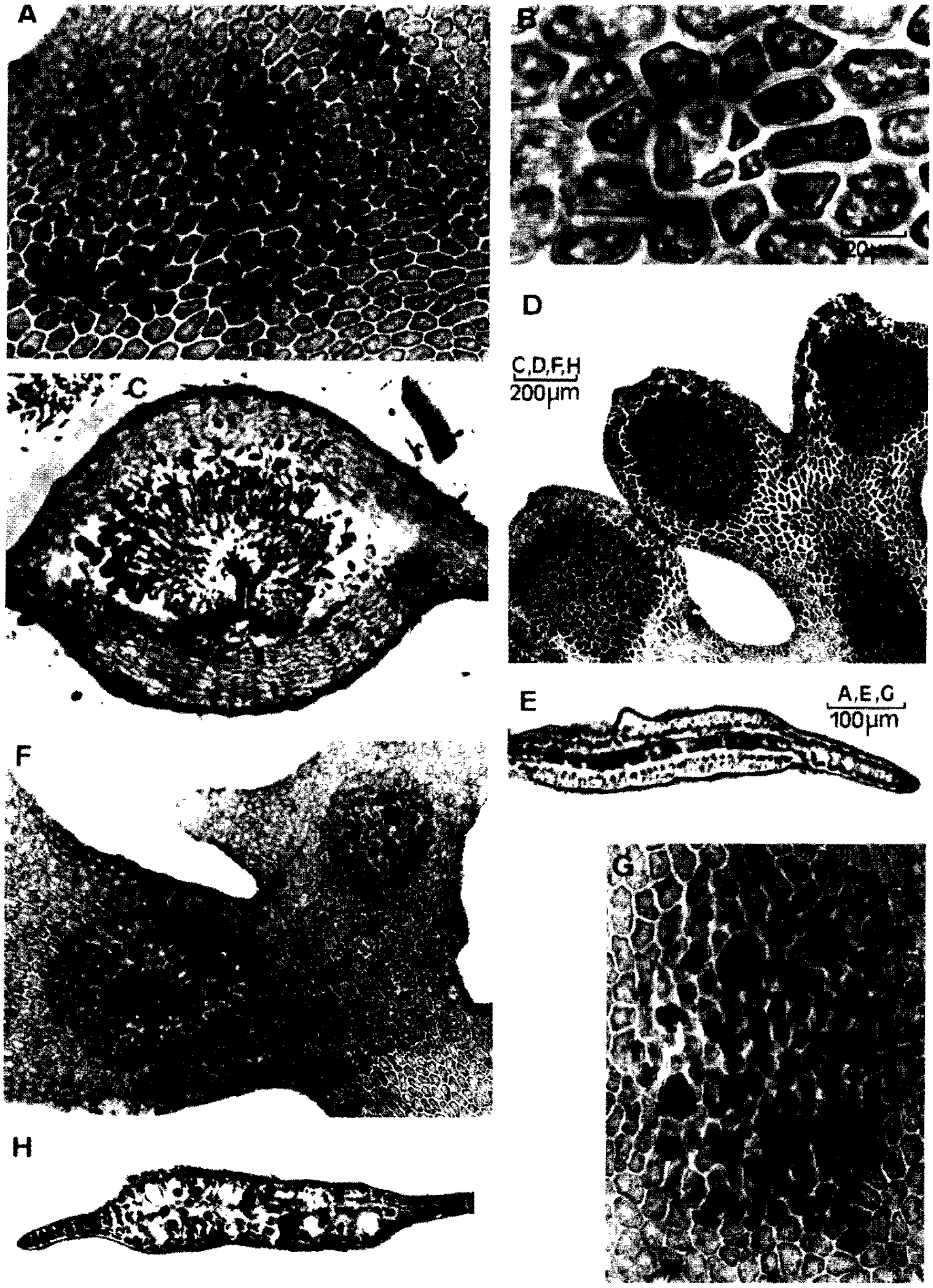

Fig. 67. *Hymenena endiviaefolia* (AD, A68086). **A.** Frond with scattered procarps. **B.** Procarp with carpogonial branch. **C.** Section of cystocarp. **D.** Branches with spermatangial sori. **E.** Transverse section of spermatangial sorus. **F.** Branch with tetrasporangial sori. **G.** Tetrasporangial sorus. **H.** Transverse section of tetrasporangial sorus.

successively, into clavate to ovoid terminal carposporangia 20–45 µm in diameter. Cystocarps 1–1.5 mm across, swollen, with a domed ostiolar neck; pericarp 5–8 cells and 120–200 µm thick, cells in tiers, 12–15 thick at the domed neck. Spermatangial sori (Fig. 67D) on the lobes, ovate, 300–500 µm across and 90–150 µm thick, with the cortical cells dividing anticlinally into several initials which cut off groups of 3–5 elongate spermatangia (Fig. 67E).

Tetrasporangial sori (Fig. 67F, G) scattered, on monostromatic lobes, ovate, 350–600 µm across and 200–300 µm thick, with tetrasporangia in 2 layers (Fig. 67H), cut off from inner cortical cells with an outer layer of cover cells; tetrasporangia subspherical, 45–70 µm in diameter.

Type from Georgetown, Tas. (*Gunn*); lectotype in Herb. Hooker, BM.

Distribution: Pearson Is, S. Aust., to Western Port, Vic., and the N coast of Tasmania.

Selected specimens: Pearson Is, S. Aust., 8 m deep (*Shepherd*, 7.i.1969; AD, A33673). Elliston, S. Aust., 11 m deep (*Shepherd*, 19.iv.1970; AD, A35862). Port Elliot, S. Aust., drift (*Womersley*, 23.v.1953; AD, A18733). West Bay, Kangaroo I., S. Aust., drift (*Cruickshank*, 26.i.1945; AD, A2626). Seal Bay, Kangaroo I., S. Aust., drift (*Woelkerling*, 20.xi.1967; AD, A32192). Blackfellows Caves, SE S. Aust., drift (*Loo*, 3.xi.1997; AD, A67612). 1.3 km off Cape Northumberland, S. Aust., 15 m deep (*Shepherd*, 8.ii.1977; AD, A55260). Port MacDonnell, S. Aust., drift (*Womersley*, 16.x.1985; AD, A57005 and 4.iv.1999; AD, A68086—"Marine Algae of southern Australia" No. 407); on *Acrocarpia*, drift (*G. & R. Kraft*, 9.vii.1994; MELU, K10323). Point Roadknight, Vic., drift (*Womersley*, 6.vi.1953; AD, A18803).

This species has been known mainly as *Cryptopleura endiviaefolia*.

Cryptopleura Kützing (1843, p. 444), based on *C. lacerata* (Gmelin)Kützing [= *C. ramosa* (Hudson)Kylin *ex* Newton; see Maggs & Hommersand 1993, p. 246, figs 77, 78], is characterised by tetrasporangial (and sexual) sori usually formed on small marginal leaflets (see Maggs & Hommersand 1993, p. 246, figs 77, 78; Wynne 1999, p. 199). In contrast, *Hymenena endiviaefolia* has tetrasporangial sori borne on lobes of branches and appears better placed in *Hymenena*, where it is close to some forms of *H. multipartita*, differing in having a strongly developed midrib and convolute, lobed, lateral branches.

Genus **BOTRYOGLOSSUM** Kützing 1843: 446.

Thallus erect, irregularly divided into long branches more-or-less linear or expanding upwards, 4–20 mm broad, margin entire or irregular; midrib present or indistinct; microscopic veins present or absent. Holdfast fibrous. *Structure*. Growth marginal, without distinct apical cells, blades monostromatic at first, soon becoming tristromatic and polystromatic in older parts or midribs, with cortical cells equivalent to primary cells which remain as a distinct central layer.

Reproduction. Reproductive organs borne in small proliferous bladelets on the surface or margins of the branches. Gametophytes dioecious. Procarps scattered on both surfaces, with 2 fertile pericentral (supporting) cells, one on each surface, with two sterile groups and a 4-celled carpogonial branch; carposporophyte with a basal fusion cell and much branched gonimoblast filaments bearing terminal carposporangia. Cystocarps scattered, swollen, ostiolate, pericarp of anticlinal tiers of cells. Spermatangial sori on both sides of the bladelets, with cortical cells dividing anticlinally to a plate of small initials, each producing several elongate spermatangia.

Tetrasporangial sori with two layers of tetrasporangia, cut off mainly from inner cortical cells and covered irregularly by further cortical cells.

Type species: *B. platycarpum* (Turner)Kützing 1843: 446.

A genus of 2 or 3 species (Wagner 1954, p. 325), the type from South Africa and *B. cartilagineum* mainly from Western Australia. *B. farlowianum* from Pacific N. America was regarded as a synonym of *Cryptopleura ruprechtiana* by Wynne (1987, p. 225).

The above generic description is based largely on Wagner's (1954) account of the type species.

The Australian species differs from the type in not having microscopical veins, and is also unknown for gametophytes; clearly it merits fuller investigation.

Botryoglossum cartilagineum (Harvey & Greville)Papenfuss 1942: 447. May 1965: 401. Silva *et al.* 1996: 448. Wagner 1954: 325.

Pollexfenia cartilaginea Harvey & Greville *in* Harvey 1847: 23. J. Agardh 1892: 165. De Toni 1903: 981.

Rhodoseris cartilaginea (Harvey & Greville)Harvey 1863, synop.: xvii. J. Agardh 1876: 476; 1898: 115; 1899: pl. 3 fig. 6. De Toni 1900: 622. Kylin 1924: 97; 1956: 448. Lucas 1909: 35. Schmitz & Hauptfleisch 1897: 411. Sonder 1880: 24.

FIG. 68

Thallus (Fig. 68A) medium to dark red-brown, 8–15 cm high, complanately and irregularly branched usually 5–20 mm apart, with elongate branches increasing in width upwards from 2–5 mm broad basally to 6–15 mm broad near the rounded apices, margins entire, smooth. Midrib inconspicuous above, thickened near the base and 2–3 mm broad; microscopic veins absent. Holdfast fibrous, 2–8 mm across; epilithic. *Structure.* Growth marginal, without conspicuous apical cells, with smaller cells marginally increasing to irregularly arranged angular cells 10–25 (-30) µm across and L/D 1–1.5 (-2). Blades soon tristromatic, later polystromatic (3–7 cells) and 35–55 µm thick, with corticating cells tiered (Fig. 68B) and equivalent in size to central layer which is not distinctive; midrib areas many cells thick.

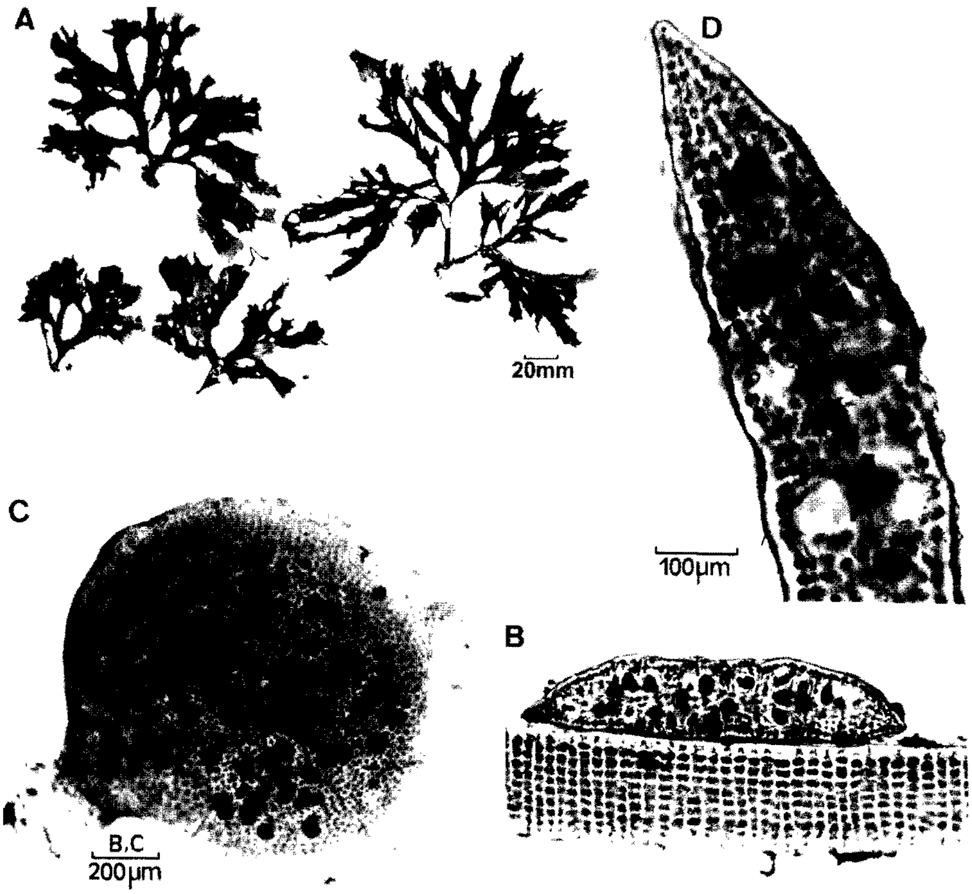

Fig. 68. *Botryoglossum cartilagineum* (A, AD, A61145; **B–D**, AD, A50326). **A.** Habit. **B.** Transverse section of a branch and tetrasporangial bladelet. **C.** A tetrasporangial bladelet. **D.** Section of a tetrasporangial bladelet.

Reproduction. Gametophytes unknown.

Tetrasporangial sori on ovate marginal leaflets (Fig. 68C) 1–3 mm across, several cells (Fig. 68B, D) and 300–400 μm thick, with short terete stipes, arising on the blade surface; tetrasporangia occupying most of the leaflet, of varying ages, cut off from cortical cells, subspherical and 45–75 μm in diameter.

Type from "Swan R. colony", W. Aust. (*Mylne*); holotype in Herb. Harvey, TCD.

Distribution: Dongara to the Swan R. region, W. Aust., and Head of the Great Australian Bight, S. Australia.

Selected specimens: Dongara, W. Aust., drift (*Kraft* 1797, 7.vii.1966; AD, A50326). Twin Rocks, Head of Great Australian Bight, S. Aust., 20–22 m deep (*Branden*, 19.i.1991; AD, A61145).

B. cartilagineum is apparently a rare, deep-water species, inadequately known reproductively.

The Twin Rocks collection is the only one from southern Australia.

SPECIES OF UNCERTAIN STATUS

The following species are uncertain, based on inadequately known material, lack of the type specimen, or an isolated record.

Delesseria crassinervia Montagne 1842b: 3; 1845: 164, pl. 8 fig. 1. Adams 1994: 279, pl. 98 lower left. Harvey 1959b: 311. Harvey & Hooker 1845: 184. Hooker & Harvey 1847: 403. Kylin 1929: 7, pl. 2 fig. 6. Papenfuss 1964b: 51. Sonder 1880: 105.

FIG. 69A–D

Type from the Auckland Islands (*D'Urville*).

Recorded from Sullivan Cove, Tas. (*Lyall*) by Harvey (1859b, p. 311), repeated by Sonder (1880, p. 105). Lyall's specimen was not found in TCD in 1952, but may be in the BM ("No. 135, V.D. Land. Dr Lyall"). Also a specimen (Fig. 69A) from "Kangaroo Point, Tasmania, 1856, ex coll. Mrs C. Eardley Wilmot," (previously identified as *Delesseria dendroides*, more recently as *Delesseria crassinervia* by Ann Mitchell), presented to Herb. Kew (now in BM), photo in AD, A48823, appears to be this species, agreeing in habit and thallus structure with a specimen from Ringa Ringa, Stewart I., N.Z., drift (*Womersley*, 4.i.1966; AD, A29801). The Kangaroo Point specimen shows branching from the midrib for several orders, apical and lateral row development (Fig. 69B, C) typical of *Delesseria*, and linear sori of tetrasporangia (Fig. 69D) alongside the midrib.

Either this is a very rare or extinct species in Tasmania, or very occasional drift specimens reach here from New Zealand; the latter appears unlikely in view of the distance and the delicate nature of the species.

Delesseria lacepedeana Reinbold 1898: 47. De Toni 1924: 346. Millar & Huisman 1996b: 127. Millar & Wynne 1992d: 111.

Hypoglossum lacepediana (Reinbold)Lucas 1929b: 50. Lucas & Perrin 1947: 229.

Reinbold's description translates as "Frond subcartilaginous, costa thick, evanescent below the apices, veins absent, subdichotomous-pinnate, laterals proliferating sparsely from the margin or rarely within the margin from the costa, oval or lanceolate; segments with entire margins and rounded apices, about 4–5 mm broad; antheridial sori on the laterals, oblong to rotund, tetrasporangia … cystocarps … . Scarcely adherent to paper. (II, 204). Lacepede Bay. leg. Dr. Engelhart."

"This species resembles in habit *D. denticulata*, but is on the whole narrower and essentially differs from this in the smooth margins of the segments. The proliferations, which are scattered and without definite order, also probably arise from the damaged apices of the segments, sprouting exceptionally from the small laterals, so that the branching develops solely from part of the lamina. The whole plant throughout has a fairly uniform width. The length is about 15 cm."

Type from Lacepede Bay, S. Aust.; not located.

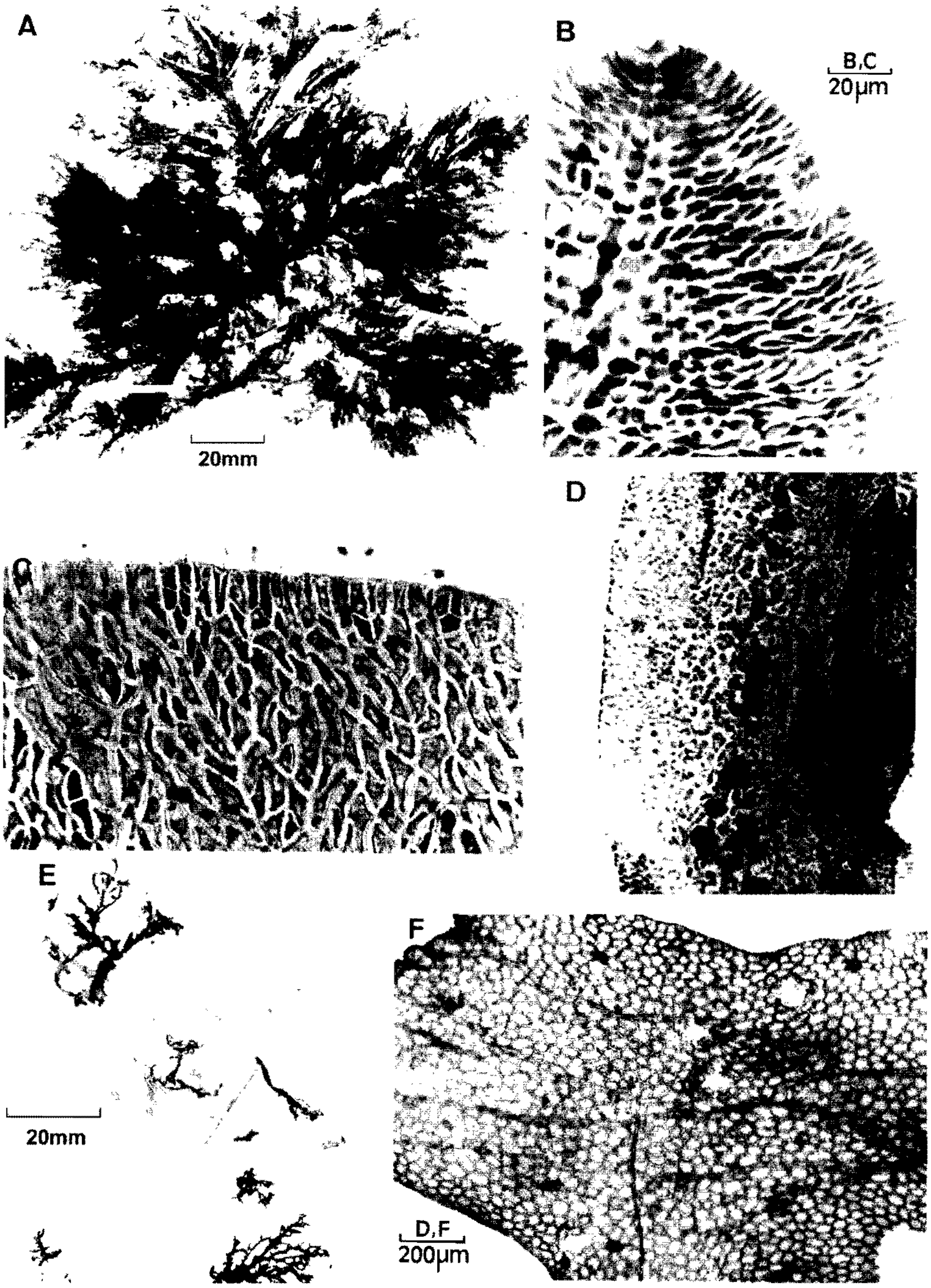

Fig. 69 A–D. *Delesseria crassinervia* (AD, A48823). **A**. Habit. **B**. Apical segmentation. **C**. Mature margin and blade. **D**. Blade with tetrasporangia (all from dried material). **E**, **F**. *Acrosorium minus* (Type, MEL, 603107). **E**. Fragments in type folder. **F**. Surface view of frond with veins.

This name must remain a *nomen dubium* until the type specimen can be located. No specimens have been found in M or L, or in other herbaria (pers. comm. also from M. Wynne).

It is possible it may be an older name for *Robea costata* or *Platyclinia crenulata*, but this is uncertain from the description.

Acrosorium minus (Sonder)Kylin 1924: 78. Huisman & Walker 1990: 428. May 1965: 403. Silva *et al.* 1996: 446.

Cryptopleura minor Sonder 1845: 57; 1848: 194. Kützing 1849: 870; 1866: 10, pl. 26a, b.

Nitophyllum minus (Sonder)Harvey 1849a: 119; 1855a: 549; 1863, synop.: xxxii. J. Agardh 1852: 655; 1876: 467; 1898: 66. De Toni 1900: 651. De Toni & Forti 1923: 33. Lucas 1909: 35; 1926: 603, pl. 42 figs 4, 5; 1929b: 50. Lucas & Perrin 1947: 223. Sonder 1880: 23. Tate 1882a: 20.

Scutarius minor (Sonder)Kuntze 1891: 920.

FIG. 69E, F

The type of *Acrosorium minus* is in MEL, 603107, and consists of an envelope labelled *Cryptopleura minor* Sond. pl. Preiss. Nov. Holl. occid. legt Preiss, with *Nitophyllum minus* Sond. above Sonder's original name. Inside are several fragmentary specimens (Fig. 69E), two about 3 cm long, some on mica. These specimens are complanately and alternately branched, branches 1–2 mm broad, mainly tristromatic and with fine veins (Fig. 69F), but do not show any uncinate branch ends. Harvey's Alg. Aust. Exsicc. 296a specimens, from the Swan R., and Clifton's from Fremantle, regarded as *N. minus* by Harvey, are mostly the same species (one sheet, AD, A18217, is a *Rhodophyllis*) as do specimens of Huisman from Penguin I., W. Aust., 12 m deep (*Huisman*, 9.ii.1994; MURU, JH585). However, Sonder's and most of Harvey's specimens are sterile, but JH585 and a few others have sparse tetrasporangial sori scattered on the upper branches.

A. minus has been recorded from numerous localities in southern Australia, as far east as Port Phillip, Victoria. In habit, the specimens are usually similar to small and slender *Hymenena multipartita*. Characterisation of *A. minus* depends on new collections of the species from the Fremantle region, including at least tetrasporangial specimens, to judge whether it is best placed in *Acrosorium* or *Hymenena* and its relationship to *H. multipartita*. Kylin (1929, pp 11, 14) considered *A. minus* was close to the New Zealand *A. decumbens* (J. Agardh)Kylin (1929, p. 10, fig. 18).

FAMILY SARCOMENIACEAE Womersley, *fam. nov.*

Thallus erect, much branched, branches terete or compressed, usually gelatinous and decaying rapidly. Apical cells prominent, protruding, axial cells with 4 pericentral cells cut off in alternating sequence with the first-formed transverse pericentral cells lying in a linear row. The slightly larger lateral pericentral cells each cut off 2 half-length flanking cells (only associated with reproduction in *Malaconema*) which produce rows of cells in some genera. Branching endogenous (except for monosiphonous filaments in *Dotyella* and *Sarcotrichia*). Trichoblasts absent, but some genera with simple, monosiphonous, rhodoplastic filaments from the pericentral or flanking cells, arising well below the apices, or endogenous from axial cells (in *Cottoniella*).

Reproduction. Gametophytes dioecious. Procarps borne on the adaxial transverse pericentral cells, with a 4-celled carpogonial branch and 2 sterile cells; carposporophytes with a basal fusion cell and much branched gonimoblast with clavate terminal carposporangia, replaced from lower cells*; cystocarps external to branches, ovoid to urceolate, pericarp arising post-fertilization, ostiolate, with numerous erect filaments developed from adjacent pericentral cells, each cell cutting off 2–3 outer pericentral cells, corticated or not. Spermatangia borne in sori on the surface of shorter, compressed, lateral blades.

* As pointed out previously (Womersley 1965, p. 448) branching of the gonimoblast is not sympodial (which implies regular and repeated replacement of a terminal apex by a lower lateral) and is best described as carposporangia being replaced from below after being shed.

Tetrasporangia in stichidia, cut off from lateral pericentral cells, in 2 longitudinal, distichous, rows, in a single layer, with post-sporangial cover cells on both sides.

Diagnosis: Thallus erectus, ramosissimus, rami teretes aut compressi, plerumque gelatinosi et celeriter putrescentes. Cellulae apicales manifestae et protrudentes, cellulae axiales cum 4 cellulis pericentralibus abscissis in serie alternatim cellulis primis transverticalibus pericentralibus seriatim iacentibus. Cellulae exigue maiores laterales pericentrales, omnes abscidentes 2 semilongas cellulas in latere (solum consociatae cum reproductione in *Malaconema*) producentes series cellularum in aliquot generibus. Ramificatio endogena (praeter filamenta monosiphonia in *Dotyella* et *Sarcotrichia*). Trichoblasti absentes, sed aliquot genera filamentis simplicibus monosiphonibus rhodoplasticis ex cellulis pericentralibus aut lateralibus, multum infra apices orientibus aut ex cellulis axialibus endogenis (in *Cottoniella*).

Gametophyta dioica. Procarpia in cellulis adaxialibus transversis pericentralibus portata cum ramo carpogoniali 4-cellulari et 2 cellulis sterilibus; carposporophyta cum cellula basin coniuncta et cum gonimoblasto ramosissimo, carposporangio terminali clavato ex cellulis inferioribus oriente, cystocarpia externa e ramis, ovoidea ad urceolata, pericarpium post fecundationem, ostiolatum multis filamentis erectis, orientibus ex cellulis adiacentibus pericentralibus, omnes cellulae abscindentes 2–3 exteriores cellulas pericentrales, aut corticatas aut non corticatas. Spermatangia portata in soris in pagina laminarum breviorum compressarum lateralium. Tetrasporangia in stichidiis, abscissa ab cellulis lateralibus pericentralibus in distichis longitudinalibus, in strato singulari, et in utroque latere cellulis post sporangialibus tegentibus.

Type genus: Sarcomenia Sonder 1845: 56.

The "*Sarcomenia* group" was studied in detail by Womersley & Shepley (1959) who concluded (p. 218) that the group "shows so many features which are characteristic of either the Delesseriaceae or the Rhodomelaceae that it must be recognised as forming an intermediate or linking group between the two families. It could be placed as a subfamily, the Sarcomenioideae, of either family or even recognised as an independent family." They considered it best placed as a subfamily of the Rhodomelaceae.

Following this account, Papenfuss (1961), Hommersand (1963) and Wynne (1969) supported retention of the Sarcomenia group within the Delesseriaceae, but (the first two) without knowledge of *Sonderella* (Womersley 1965), a distinctive member of the Rhodomelaceae.

While Womersley & Shepley had used the well-accepted (e.g. Papenfuss 1944, p. 200) feature of the order of pericentral cell formation in relating the *Sarcomenia* group to the Rhodomelaceae, the above 3 authors considered that because of the apparent delesseriaceous features of the group that this distinguishing feature could no longer be used. Other features they used (especially Hommersand 1963, p. 328) need to be reconsidered in light of the study on *Sonderella*, which has 4 pericentral cells (5 in female and tetrasporangial segments), the lateral pericentral cells form two "flanking" cells each producing a row of cells, trichoblasts are absent and procarps and spermatangia occur on the blade surface, the procarps from the central of 3 pericentral cells on the adaxial side. The origin of tetrasporangia before the cover cells in the *Sarcomenia* group, as in the Delesseriaceae, differs from that in *Sonderella* which agrees with the reverse situation in the Rhodomelaceae.

In their catalogue of Indian Ocean algae, Silva *et al.* (1996) placed most of the sarcomenioid algae in the Delesseriaceae, but included *Malaconema* (p. 526) in the Rhodomelaceae. Discovery of a cystocarpic plant of *Malaconema* (see below) supports its position within the Sarcomeniaceae.

The relationships of the *Sarcomenia* group have been clarified by molecular studies by Professor Gary W. Saunders, of the University of New Brunswick, Canada, and colleagues* who have found that, based on sequencing data from *Platysiphonia victoriae*, the group allies somewhat weakly to the Rhodomelaceae and is far more likely to belong there than to the Delesseriaceae. Lin, Fredericq & Hommersand (2001) using sequencing data have found (their Fig. 1) that *Sarcomenia delesserioides* is closest to the Rhodomelaceae, but in their Figs 2 and 3 is closer to tribes of the Delesseriaceae; clearly this is an untenable situation. They

* Choi, H-G, Kraft, G.T., Lee, I.K. & Saunders, G.W. (manuscript). Phylogenetic analyses of anatomical and nuclear SSU r DNA sequence data indicate that the Dasyaceae and Delesseriaceae (*Ceramiales*, *Rhodophyta*) are polyphyletic.

conclude (p. 893) that the position of *Sarcomenia* was ambiguous and its taxonomic position remains problematic.

It now seems preferable to regard the *Sarcomenia* group as a family with a suite of characters shared by both the Rhodomelaceae (R) and Delesseriaceae (D), but most closely related to the former. The distinctive features of the Sarcomeniaceae are:

1. Pericentral cells 4 (D, some R), cut off in alternating sequence (R).
2. Flanking cells from the lateral pericentral cells (D and Sonderelleae), in some genera producing lateral rows of cells.
3. Absence of trichoblasts (D, Sonderelleae, some R).
4. Reproductive cells (female and male) borne on surface cells (D, Sonderelleae, some Polyzonieae).
5. Pericarp ovoid, based on erect filaments (R), developed post-fertilization (D).
6. Tetrasporangia cut off before the cover cells (D), in two longitudinal rows (some D and R).

KEY TO GENERA OF SARCOMENIACEAE

1. Thallus without flanking cells from the lateral pericentral cells of vegetative (indeterminate) branches, but these present in stichidia and where carpogonial branches develop .... MALACONEMA
1. Thallus with flanking cells from the lateral pericentral cells 2

    2. Free monosiphonous filaments present 3
    2. Free monosiphonous filaments absent 4

3. Monosiphonous filaments formed endogenously from the central cells anterior to the adaxial transverse pericentral cell .... COTTONIELLA
3. Monosiphonous filaments formed exogenously from the anterior flanking cells of each segment and in *S. tenera* from the transverse pericentral cells .... SARCOTRICHIA

    4. Flanking cells not dividing further in the vegetative thallus ...... PLATYSIPHONIA
    4. Flanking cells dividing further, the anterior one producing 2 chains of cells, the posterior one a single chain of cells, which remain laterally adherent giving a strongly compressed thallus .... SARCOMENIA

Genus MALACONEMA Womersley & Shepley 1959: 210.

Thallus erect, slender, much branched irregularly, branches terete to slightly compressed, with flanking cells only near where carpogonial branches develop or in stichidia; holdfast rhizoidal, discoid. *Structure.* Apical cell hemispherical, axial cells cutting off 4 pericentral cells in alternating sequence, slightly corticated below; branching endogenous; cells uni- to multinucleate.

Reproduction. Carpogonial branches borne on transverse pericentral cells, with the adjacent lateral pericentral cells cutting off flanking cells. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia. Cystocarps sessile, ovoid; pericarp ostiolate, 2 cells thick, outer cells transversely elongate.

Tetrasporangial stichidia formed from ends of lateral branches, fertile segments forming flanking cells; tetrasporangia cut off from lateral pericentral cells, protected by cover cells on each side and the curved flanking cell.

Type species: *M. roeana* (Harvey)Womersley & Shepley 1959: 210.

Malaconema contains 2 species, the type and *M. minimum* Hollenberg (1963, p. 169) from the central Pacific, placed in the Sarcomeniaceae largely due to the structure of the stichidia with flanking cells, carpogonial branches with associated flanking cells and cystocarps, separated from other genera by the absence of flanking cells, in vegetative branches. The genus was included within the Rhodomelaceae by Silva *et al.* (1996, p. 526), separate from other genera of the Sarcomeniaceae (which they placed in the Delesseriaceae), but its apical development, cystocarp structure and reproduction clearly ally it with other genera of the Sarcomeniaceae (see also Abbott 1999, p. 342).

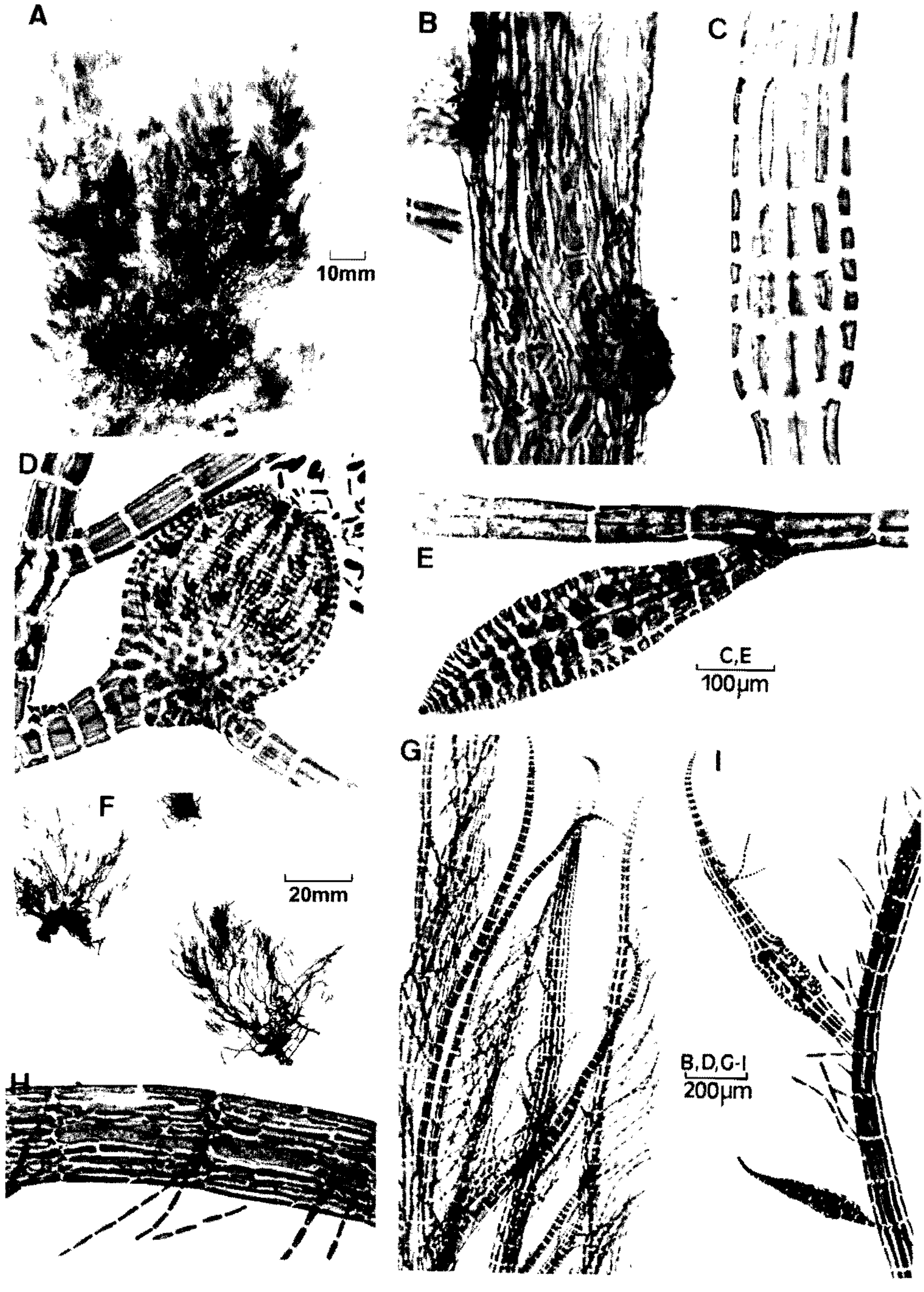

Fig. 70. **A–E**. *Malaconema roeanum* (**A**, **B**, **E**, AD, A30828; **C**, **D**, AD, A68849). **A**. Habit. **B**. Corticated branch with rhizoids. **C**. Branch with a carpogonial branch and associated flanking cells. **D**. A mature cystocarp. **E**. A stichidium. **F–I**. *Cottoniella fusiformis* (**F**, AD, A56845; **G–I**, AD, A58633). **F**. Habit. **G**. Branches with curved apices and paired monosiphonous filaments. **H**. Corticated branch with paired monosiphonous filaments. **I**. Tetrasporangial branches.

Malaconema roeanum (Harvey)Womersley & Shepley 1959: 210. May 1965: 378. Silva *et al.* 1996: 526. Womersley 1966: 153. Wynne 1996: 180.

Polysiphonia roeana Harvey 1855a: 540; 1858: pl. 35; 1863, synop.: xx. J. Agardh 1863: 967; De Toni 1903: 877. Kützing 1864: 20, pl. 55a–c. Lucas 1909: 40. Lucas & Perrin 1947: 267. Segi 1966: 512, pl. XXIIG. Sonder 1880: 34. Womersley & Shepley 1959: 204, figs 106–110, pl. 5 fig. 1.

Vertebrata roeana (Harvey)Kuntze 1891: 929.

FIGS 70A–E, 71A–D

Thallus (Fig. 70A) medium to dark red-brown, often with a greyish iridescence, becoming rose-red to grey-red and decomposing rapidly, erect, 5–20 cm high, much branched with slender branches distinctly but slightly laterally compressed (Fig. 71D) and without flanking cells in vegetative parts; axes 200–500 (-900) µm broad, tapering to 30–40 µm broad near the apices. Attachment by rhizoids with multicellular haptera, arising from cortical cells; epiphytic, possibly epilithic. *Structure.* Apical cell (Fig. 71A–C) hemispherical with axial cells cutting off 4 pericentral cells in alternating sequence, with slightly larger lateral pericentral cells; flanking cells absent in vegetative branches. Segments L/D 1–1.5 above, increasing to L/D 1.5–3 below; slight cortication (Fig. 70B) by longitudinal rows of small elongate cells occurs, but no monosiphonous filaments occur. Branching endogenous, largely adaxial. Cells uninucleate, larger cells multinucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Carpogonial branches borne on the adaxial transverse pericentral cell, with the lateral pericentral cells of several adjacent segments bearing flanking cells (Fig. 70C). Carposporophytes with an elongate basal fusion cell and much branched gonimoblast with clavate terminal carposporangia 30–40 µm in diameter. Cystocarps (Fig. 70D) sessile, ovoid; pericarp ostiolate, 2 cells thick, ecorticate, outer cells transversely elongate. Spermatangia unknown.

Tetrasporangial stichidia (Figs 70E, 71C) apparently rare, formed from ends of lateral branches with the upper 8–12 segments bearing tetrasporangia. Typical flanking cells develop on fertile segments, remaining undivided, with tetrasporangia in 2 longitudinal rows cut off from the lateral pericentral cells. Adaxial and abaxial cover cells partly protect the tetrasporangia, with the flanking cells becoming elongate and curved; tetrasporangia 40–70 µm in diameter.

Type from Fremantle, W. Aust. (*Harvey*); lectotype Harvey Alg. Aust. Exsicc, 169A in TCD.

Distribution: Only known from the type and from Torrens "Strait"(Outer Harbor) and American R. inlet and Penneshaw, Kangaroo I., S. Aust., and Port Phillip, Victoria.

Selected specimens: Torrens Strait (Torrens I.), Outer Harbor, S. Aust. (Dec. 1887; AD, A1459). American R. inlet, Kangaroo I., S. Aust., drift (*Shepley*, 18.viii.1954; AD, A19787—"Marine Algae of southern Australia" No. 119) and (*Womersley*, 25.viii.1963; AD, A26727 and 31.x.1966; AD, A30828). Near Muston, American R. inlet, Kangaroo I., S. Aust., on *Posidonia australis*, 2–3 m deep (*Kraft*, 17.vii.1972; AD, A42526). Ironstone Point, Penneshaw, Kangaroo I., S. Aust., on *Glossophora*, 15 m deep (*Lavers*, 29.ii.2000; AD, A68849). St Leonards, Port Phillip, Vic., on *Heterozostera*, 1–3 m deep (*Womersley*, 9.viii.1959; AD, A23084). Port Arlington, Port Phillip, Vic., 0–2 m deep (*Womersley*, 9.viii.1959; AD, A23118).

M. roeana is characterised by its habit, rapid disintegration, thallus structure and presence of flanking cells only in fertile segments. It occurs in calm water situations.

Genus COTTONIELLA Børgesen 1919: 333.

Thallus erect, slender, much branched, branches compressed, with slender monosiphonous filaments; attached by rhizoids from basal parts. *Structure.* Apical cell dome shaped, axial cells producing 4 pericentral cells, the abaxial first, followed by 2 lateral cells and last the adaxial pericentral cell; the lateral cells each cut off 2 flanking cells, from some or all segments, resulting in compressed branches. Monosiphonous unbranched filaments endogenous from the axial cells, 1 or 2 from each or some of the axial cells. Older branches lightly corticate by rhizoids from the pericentral cells. Lateral branches arising endogenously, the basal, segments usually without flanking cells. Cell uninucleate.

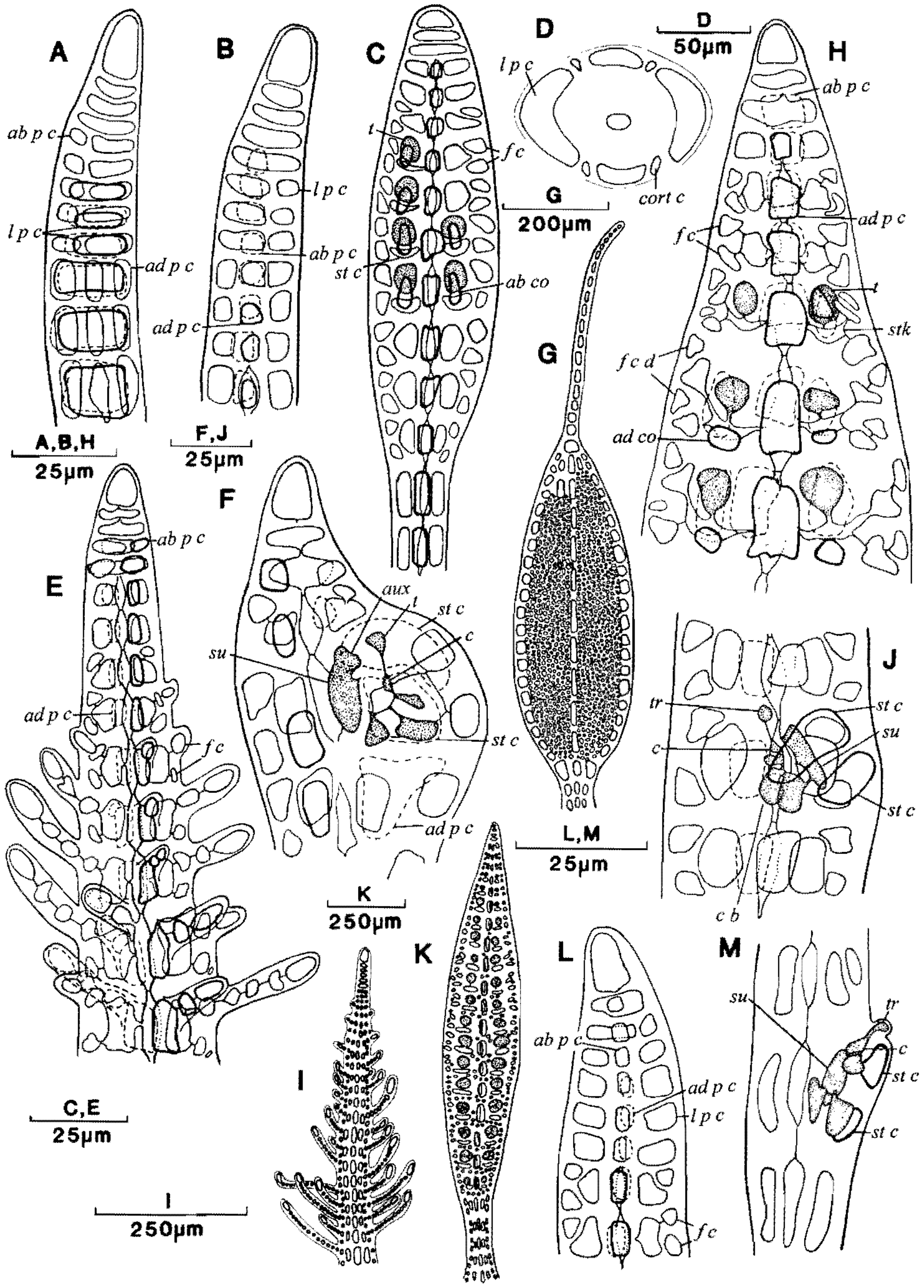

Fig. 71. A–D. *Malaconema roeanum* (**A**, **B**, **D**, AD, A19787; **C**, AD, A1459). **A**. Side view of compressed branch apex. **B**. Face view of a branch apex. **C**. Face view of a stichidium. **D**. Transverse section of a compressed branch, with slight cortication. **E–H**. *Sarcotrichia tenera* (AD, A16097). **E**. Branch apex with developing lateral and transverse monosiphonous filaments. **F**. Procarp with division of supporting cell to an auxiliary cell. **G**. A spermatangial blade. **H**. Apex of a stichidium, adaxial view. **I–K**. *Sarcotrichia dolichocystidea* (AD, A19788). **I**. Branch apex, with monosiphonous filaments only from the flanking cells. **J**. Branch with a mature procarp. **K**. A stichidium. **L**, **M**. *Platysiphonia delicata* (AD, A12914). **L**. Branch apex showing segmentation. **M**. Branch with a mature procarp. (All as in Womersley & Shepley 1959, courtesy of Aust. J. Bot.).

Reproduction. Gametophytes unknown apart from *C. triseriata* Hollenberg (1967b: 1199, fig. 9).

Tetrasporangial stichidia lateral on lesser branches which may continue growth, with 2 rows of tetrasporangia cut off the lateral pericentral cells which bear a cover cell on each side, and the flanking cells each divide and curve slightly around the stichidium edge.

Type species: *C. arcuata* Børgesen 1919: 334, figs 334–336.

A genus of probably 4 species (Hollenberg 1967b, p. 1201).

Cottoniella is a distinctive genus, including (as well as the type species) *C. filamentosa* (Howe)Børgesen (1920, p. 477) and *C. fusiformis* Børgesen (1930, p. 144, figs 58, 59), both of which have flanking cells on each segment. The latter is often regarded (e.g. Cormaci *et al.* 1978, p. 256; Cormaci & Furnari 1987, p. 756) as a variety of *C. filamentosa*, together with var. *algeriensis* (Schotter)Cormaci & Furnari (1987, p. 756). *C. filamentosa* has monosiphonous filaments singly from each axial cell, whereas *C. fusiformis* has usually, but not always, two from each axial cell. Variation in position of filaments is considerable in *C. fusiformis*, and otherwise they are identical.

The type species, *C. arcuata*, has only occasional flanking cells and single monosiphonous filaments per segment, flexed to alternate sides on successive segments.

Cottoniella fusiformis Børgesen 1930: 144, figs 58, 59. Hollenberg 1967b: 120.

Cottoniella arcuata var. *fusiformis* (Børgesen)Schotter 1951: 292.

Cottoniella filamentosa var. *fusiformis* (Børgesen)Cormaci *et al.* 1978: 256. Cormaci & Furnari 1987: 756. Huisman 1997: 201. Silva *et al.* 1996: 454.

FIG. 70F–I

Thallus (Fig. 70F) medium to dark red-brown, erect, 1–6 cm high, with numerous slender branches for 3–4 orders from one to several slightly corticated, compressed, main branches 0.5–1 mm broad, branch apices curved with monosiphonous filaments on the concave (adaxial) side. Attachment by multicellular rhizoids with branched, digitate ends, arising from the flanking cells of basal or decumbent branches; epiphytic and epilithic? *Structure.* Apical cells domed to elongate, cutting off 4 pericentral cells, the abaxial transverse one first, followed by 2 lateral cells and lastly the adaxial transverse pericentral cells, with the lateral cells each producing 2 flanking cells within 12–15 cells of the apices. Young branches (Fig. 70G) 30–50 μm broad, mature lateral branches slightly fusiform and compressed with the basal 2 segments without flanking cells and hence constricted, 250–500 μm broad. Monosiphonous filaments (Fig. 70G, H) rhodoplastic, unbranched, formed endogenously anterior to the adaxial transverse pericentral cell, at first singly per axial cell but soon, and usually, in pairs; filaments 0.5–1.5 mm long, tapering only slightly, 12–25 μm in diameter, cells L/D mostly 2–5. Cortication (Fig. 70H) by cells cut off the lower ends of transverse pericentral cells, producing descending rhizoidal filaments lying between the pericentral cells, later spreading to form a slight overall cortex. Lateral branches adaxial, arising endogenously from axial cells. Cells uninucleate with 2 iridescent bodies; rhodoplasts discoid to elongate, becoming chained in larger cells.

Reproduction. Gametophytes unknown.

Tetrasporangial stichidia (Fig. 70 I) lateral on lesser branches, 0.5–1 mm long with 5–10 fertile segments, 90–150 μm broad; tetrasporangia 30–40 μm in diameter, in 2 longitudinal rows, cut off from lateral pericentral cells with a short cover cell on the abaxial side and a longer one adaxially; the flanking cells each divide, with the lower cell becoming curved around the edge of the stichidium.

Type from Playa de Santa Catalina (Las Palmas), Gran Canaria, Canary Is; presumably in C.

Distribution: Canary Islands, Pakistan.

In southern Australia, known only from eastern Gulf St Vincent, S. Australia.

Selected specimens: Off Grange, S. Aust., on artificial tyre reef, 20 m deep (*Branden*, 7.iii.1985; AD, A56422). Seacliff, S. Aust., 12 m deep (*Rowland*, 2.ii.1986; AD, A57029). Port Stanvac, S. Aust., 13 m deep (*Rowland*, 6.iii.1988; AD, A58633). Port Noarlunga, S. Aust., on *Sargassum*, 8 m deep (*Gordon-Mills*, 26.iii.1987; AD, A56845).

These records, all from the coast adjacent to Adelaide, are spread over some 30 km of coast and from summer months of 4 years. They probably represent an adventive occurrence, but it is not known whether it has persisted.

Genus SARCOTRICHIA Womersley & Shepley 1959: 209.

Thallus moderately branched, with flat linear branches tapering to narrow apices, branches arising endogenously, becoming corticate and terete below, with long monosiphonous filaments in 2 or 4 rows; holdfast branched. *Structure.* Apical cells hemispherical to slightly elongate, axial cells cutting off an abaxial pericentral cell, then 2 lateral pericentral cells and last the adaxial pericentral cell, with the lateral cells each forming 2 flanking cells, thus forming flat blades. The upper flanking cells, and in *S. tenera* the transverse pericentral cells, produce long, slender, monosiphonous filaments in 2 or 4 rows, these being relatively persistent but lost from older corticated branches. Cells uni- to multinucleate.

Reproduction. Gametophytes dioecious. Procarps arising on the adaxial pericentral cells, with 2 sterile cells and a 4-celled carpogonial branch. Carposporophytes with an erect fusion cell and branched gonimoblast filaments with terminal carposporangia. Cystocarps ovoid, pedicellate; pericarp ostiolate, of erect filaments with each cell cutting off 2 cells outwardly, thus 2 cells thick. Spermatangial blades elongate-ovoid with sterile bases and an apical row, with spermatangia derived from the lateral pericentral cells, the flanking cells and transverse pericentral cells remaining sterile.

Tetrasporangial stichidia with the lateral pericentral cells each cutting off a tetrasporangium and 2 cover cells, the flanking cells becoming curved and protective.

Type species: *S. tenera* (Harvey)Womersley & Shepley 1959: 209.

The genus includes 2 species on southern Australian coasts, differing in the number of rows of the slender monosiphonous filaments.

KEY TO SPECIES OF *SARCOTRICHIA*

1. Monosiphonous filaments in 4 rows, formed by the flanking cells and the transverse pericentral cells .... 1. *S. tenera*
1. Monosiphonous filaments in 2 rows, formed only by the flanking cells .... 2. *S. dolichocystidea*

1. **Sarcotrichia tenera** (Harvey)Womersley & Shepley 1959: 209. May 1965: 377. Shepherd & Womersley 1981: 367. Silva *et al.* 1996: 466. Wynne 1996: 181.
Dasya tenera Harvey 1855a: 543; 1863, pl. 257. Kützing 1865: 1, pls 1c–d, 2.
Sarcomenia tenera (Harvey)J. Agardh 1863: 1264; 1896: 136; 1899: 145. De Toni 1900: 740. De Toni & Forti 1923: 35, pl. 5 figs 2–4. Guiler 1952: 101. Harvey 1863, synop.:xvii. Lucas 1909: 37; 1929b: 50. Lucas & Perrin 1947: 234, fig. 99. Mazza 1908: No. 253. Reinbold 1899: 46. Sonder 1880: 33. Tisdall 1898: 513. Wilson 1892: 164. Womersley 1950: 184. Womersley & Shepley 1959: 188, figs 57–71, pl. 4 fig. 1.
Sarcomenia secundata J. Agardh 1899: 144, 147. De Toni 1924: 361.

FIGS 71E–H, 72A–E

Thallus (Fig. 72A) greyish-red to red-brown, mucilaginous and rapidly disintegrating when detached, usually 10–30 cm high with stout but soft, branched, axes 1–2 (-3) mm in diameter and much branched, villose, upper parts bearing monosiphonous filaments. Holdfast small, rhizoidal; epiphytic. *Structure.* Apical cells (Fig. 71E) dome shaped with axial cells cutting off 4 pericentral cells, the abaxial first followed by 2 lateral cells and lastly the adaxial cell, with the lateral cells each cutting off 2 flanking cells. Monosiphonous filaments (Fig. 72B, C), up to 25 cells long, arise from the anterior flanking cells and also from the transverse pericentral cells, thus forming 4 rows along the branches; filaments 16–28 μm in diameter, mid cells L/D 2–3 (-4), simple or occasionally becoming branched, caducous some distance below branch apices. Cortication (Fig. 72B) commencing 15–20 segments from apices,

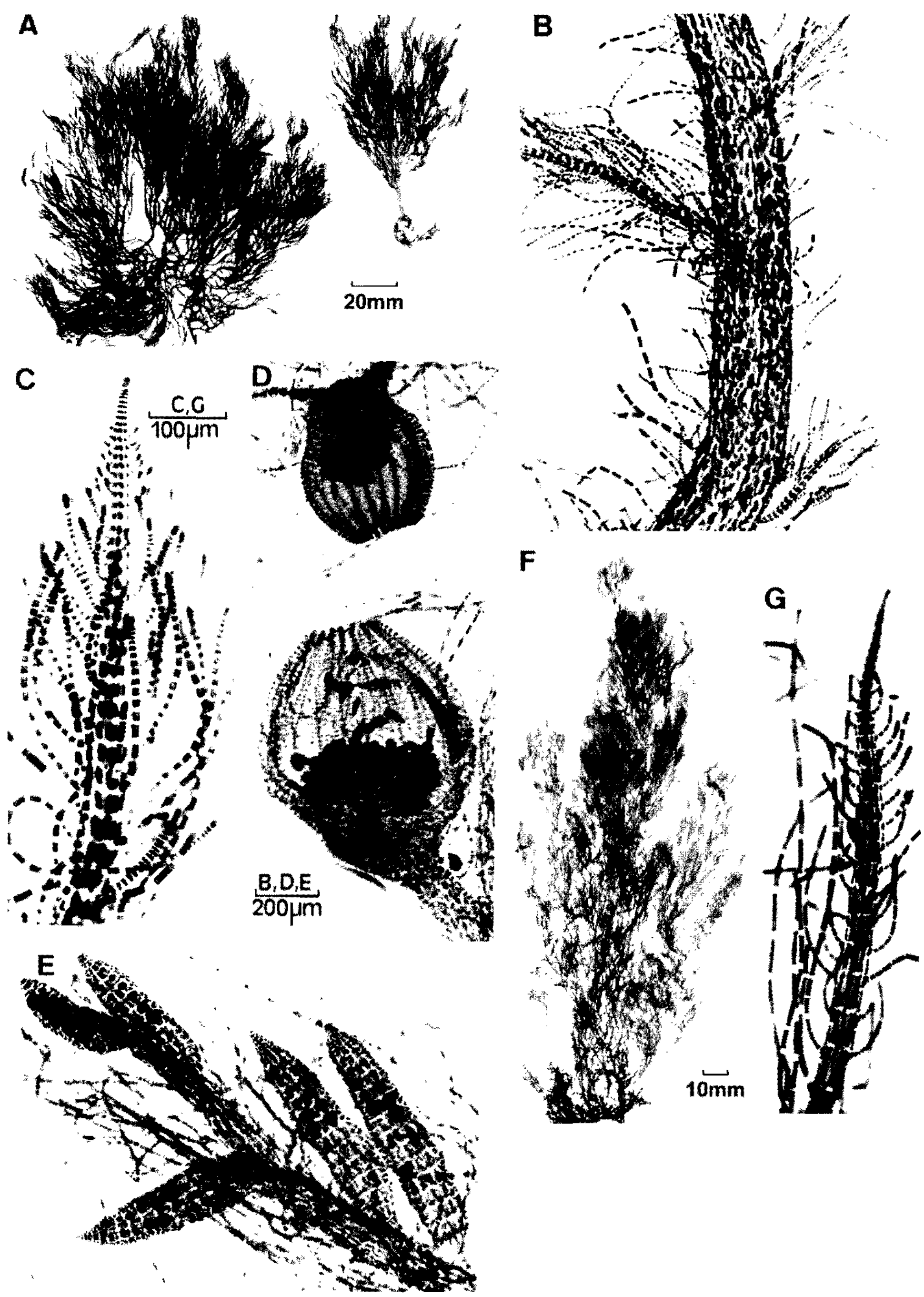

Fig. 72. **A–E**. *Sarcotrichia tenera* (**A**, AD, A62987; **B**, **C**, AD, A57774; **D**, **E**, AD, A26781). **A**. Habit. **B**. Corticate branch with ecorticate laterals. **C**. Young branch with monosiphonous filaments from flanking cells and transverse pericentral cell. **D**. Cystocarps. **E**. Branch with stichidia. **F**, **G**. *Sarcotrichia dolichocystidea* (AD, 26728). **F**. Habit. **G**. Branch with monosiphonous filaments only from flanking cells.

becoming heavy on lower terete axes. Lateral branches endogenous. Cells uni- or binucleate in filaments, multinucleate in larger pericentral cells; rhodoplasts discoid, becoming chained.

Reproduction. Gametophytes dioecious. Procarps (Fig. 71F) near the tip of laterals with the adaxial pericentral cell cutting off a first sterile cell, then the initial of the carpogonial branch, then a second sterile cell lying over the carpogonial branch. Carposporophyte with an erect fusion cell and branched gonimoblast filaments bearing clavate to ellipsoid terminal carposporangia 25–40 μm in diameter. Cystocarps ovoid, (500-) 800–1000 μm in diameter, sessile on branchlets which form a short stalk; pericarp ostiolate, with about 20 erect filaments, each cell cutting off 2 transversely elongate outer cells. Spermatangial blades (Fig. 71G) clustered on main branches, 400–700 μm long and 80–140 μm broad, with a terminal awn and sterile marginal and transverse pericentral cells, with the lateral pericentral cells producing a layer of initials cutting off outer spermatangia.

Tetrasporangial stichidia (Fig. 72E) 500–1500 μm long and 150–200 μm broad, produced from the adaxial surface of mature corticated branches, with the lateral pericentral cells each cutting off a tetrasporangium and abaxial and adaxial cover cells (Fig. 71H), the sporangia protected also by curved flanking cell derivatives; tetrasporangia 35–55 μm in diameter; slight cortication may occur on older stichidia.

Type from Fremantle, W. Aust. (*Harvey*); holotype Trav. Set 78, Herb. Harvey, TCD.

Distribution: Fremantle, W. Aust., to Western Port, Vic., and the N coast of Tasmania.

Selected specimens: Lucky Bay, Cape Le Grand, W. Aust., on *Amphibolis antarctica*, upper sublittoral (*Womersley*, 4.x.1979; AD, A51164). Anxious Bay, S. Aust., on *Laurencia* sp., drift (*Parsons*, 24.viii.1967; AD, A31935). Waterloo Bay, S. Aust., on *Metagoniolithon radiatum*, 4.5 m deep (*Turner*, 28.iv.1983; AD, A54154). Sturt Bay, S. Aust., on *Amphibolis*, drift (*Davey*, April 1897; AD, A1140). Marion Bay, S. Aust., drift (*Womersley*, 8.iv.1950; AD, A16097). Stenhouse Bay, S. Aust., on *Polysiphonia decipiens*, 3–4 m deep on jetty piles (*Cannon*, 15.x.1988; AD, A59176). Outside Tapley Shoal (Edithburg), S. Aust., on *Posidonia sinuosa*?, 15 m deep (*Shepherd*, 2.ii.1969; AD, A33504). Henley Beach, S. Aust., on *Heterozostera*, drift (AD, A1139). D'Estrees Bay, Kangaroo I., S. Aust., drift (*Womersley*, 23.viii.1963; AD, A26781). Nora Creina, S. Aust., drift (*Womersley*, 4.x.1970; AD, A37345). Port MacDonnell, S. Aust., drift (*Womersley*, 26.ix.1992; AD, A62987). Double Corner Beach, Portland, Vic., on *Sargassum*, drift (*Beauglehole*, 14.vii.1951; AD, A21611). Shoreham, Westernport Bay, Vic., drift (*Sinkora* A1686, 16.xi.1972; AD, A53405). Low Head, Tas., drift at Pilot Station (*Womersley*, 23.x.1986; AD, A57774). Bruny I. (opposite Gordon), Tas., 14 m deep (*Brown*, 10.x.1986; AD, A57812).

2. **Sarcotrichia dolichocystidea** (J. Agardh)Womersley & Shepley 1959: 210. May 1965: 377. Womersley 1966: 153.

Sarcomenia dolichocystidea J. Agardh 1896: 135; 1899: 145. De Toni 1900: 740. Lucas 1909: 37. Womersley & Shepley 1959: 192, figs 72–82, pl. 4 fig. 2.

FIGS 71I–K, 72F, G

Thallus (Fig. 72F) medium red to red-brown, when detached rapidly disintegrating, mucilaginous, 2–20 cm high, slender, much branched irregularly to unilaterally, with older terete axes and branched upper parts bearing 2 rows of monosiphonous filaments, lost from lower parts. Holdfast rhizoidal, spreading, discoid; epiphytic. *Structure.* Apical development as in *S. tenera* but with only the lateral flanking cells producing monosiphonous filaments (Figs 71 I, 72G), at first alternately from each upper flanking cell, later from both sides of each segment; filaments 14–20 μm in diameter, cells L/D 3–6. Lateral branches endogenous. Cortication commences many segments below the apices, becoming heavier on the terete lower axes. Cells uni- or binucleate in filaments, multinucleate in larger cells; rhodoplasts discoid, becoming chained.

Reproduction. Gametophytes dioecious. Procarps (Fig 71J) produced as in *S. tenera*, with the adaxial pericentral cell producing 2 sterile cells and the 4-celled carpogonial branch, the carposporophyte and cystocarp identical with those of *S. tenera.* Spermatangial blades also similar in structure to *S. tenera.*

Tetrasporangial stichidia (Fig. 71K) slightly longer and more corticated than in *S. tenera*, otherwise identical in structure; tetrasporangia 65–90 μm in diameter.

Type from Brighton Beach, Port Phillip, Vic. (*Harvey*, Alg. Aust. Exsicc. 209F); holotype in Herb. Agardh, LD, 43444.

Distribution: King George Sound, W. Aust., to Westernport Bay, Vic., and N Tasmania.

Selected specimens: Arno Bay, S. Aust., on *Sargassum*, drift (*Kraft* 4210, 12.xi.1971; AD, A42249). Port Turton, S. Aust., 8–10 m deep (*Kald*, 5.ix.1970; AD, A37253). American R. inlet, Kangaroo I., S. Aust., drift (*Womersley*, 25.viii.1963; AD, A26728) and (*Shepley*, 18.viii.1954; AD, A19788—"Marine Algae of southern Australia" No. 121), and near Muston, 2–3 m deep (*Womersley*, 22.viii.1963; AD, A26998). Port Arlington, Port Phillip, Vic., on *Zostera*? and jetty piles, 0–2 m deep (*Womersley*, 9.viii.1959; AD, A23109). Crawfish Rock, Westernport Bay, Vic., 2 m deep (*Watson*, 28.v.1974; AD, A45383). Dover, Tas., drift (*Wollaston*, 20.viii.1965; AD, A29558).

S. dolichocystidea usually occurs in more sheltered situations than *S. tenera* and is generally more slender. They differ essentially in the formation of 2 rows of monosiphonous filaments in the former and 4 in the latter. This might possibly be an environmental effect but distinct intermediates have not been observed.

Genus PLATYSIPHONIA Børgesen 1931b: 8.

Thallus much branched, decomposing readily, with compressed branches, usually heavily corticated on lower terete axes; holdfast branched or prostrate with rhizoids. *Structure.* Apical cells hemispherical, axial cells cutting off 4 periaxial cells in alternating sequence, the lateral pericentral cells each forming 2 flanking cells which do not divide further in vegetative parts. Cortication slight in some species to heavy in others. Lateral branches endogenous from central cells. Cells uni to multinucleate.

Reproduction. Gametophytes dioecious. Procarps borne on the adaxial pericentral cells, which cut off a sterile cell, a 4-celled carpogonial branch, then a second sterile cell. Carposporophyte with an erect, basal fusion cell and much branched gonimoblast filaments bearing terminal carposporangia, often replaced from below. Cystocarps ovoid to urceolate; pericarp ostiolate, of erect filaments with each cell cutting off 2 outer pericentral cells, becoming corticated below in some species. Spermatangial blades with sterile bases and tips and sterile transverse pericentral cells and flanking cells.

Tetrasporangial stichidia formed from lateral branches with the lateral pericentral cells each cutting off a tetrasporangium and cover cells on both sides of the blade, with the flanking cells in most (but not all) species each dividing into 2 and becoming curved around the edge of the stichidium.

Type species: *P. miniata* (C. Agardh)Børgesen 1931b: 8 [= *P. delicata* (Clemente)Cremades *in* Cremades & Perez-Cirera 1990: 492].

A genus of some 10 species. As well as the 3 southern Australian species described below, the heavily corticated and tendril bearing *P. hypneoides* (Harvey)Womersley & Shepley (1959, p. 209) occurs on the Western Australian coast from Rottnest I. northwards, *P. marginalis* Wynne, Millar & Kraft (1984, p. 273) occurs on the eastern Australian and Western Australian coasts (Rottnest I. northwards), and *P. intermedia* (Grunow)Wynne (1983, p. 446) from Western Australia; the latter 2 species have stichidia in which the flanking cells remain undivided.

KEY TO SPECIES OF *PLATYSIPHONIA*

1. Thallus 0.5–1.5 (-3) cm high, not or slightly basally corticate .... 1. *P. delicata*
1. Thallus 6–40 cm high, heavily corticate below 2

  2. Thallus slender, branches corticate only near their base .... 2. *P. mutabilis*
  2. Thallus robust, axes 1–2 mm in diameter below, usually corticate from close to apices .... 3. *P. victoriae*

1. **Platysiphonia delicata** (Clemente)Cremades *in* Cremades & Perez-Cirera 1990: 492. Huisman 1997: 202. Lawson *et al.* 1995: 104. Miller & Kraft 1993: 48. Silva *et al.* 1996: 464. Wynne 1998: 41.
Conferva delicata Clemente y Rubio 1807: 322
Hutchinsia miniata C. Agardh 1828: 94.

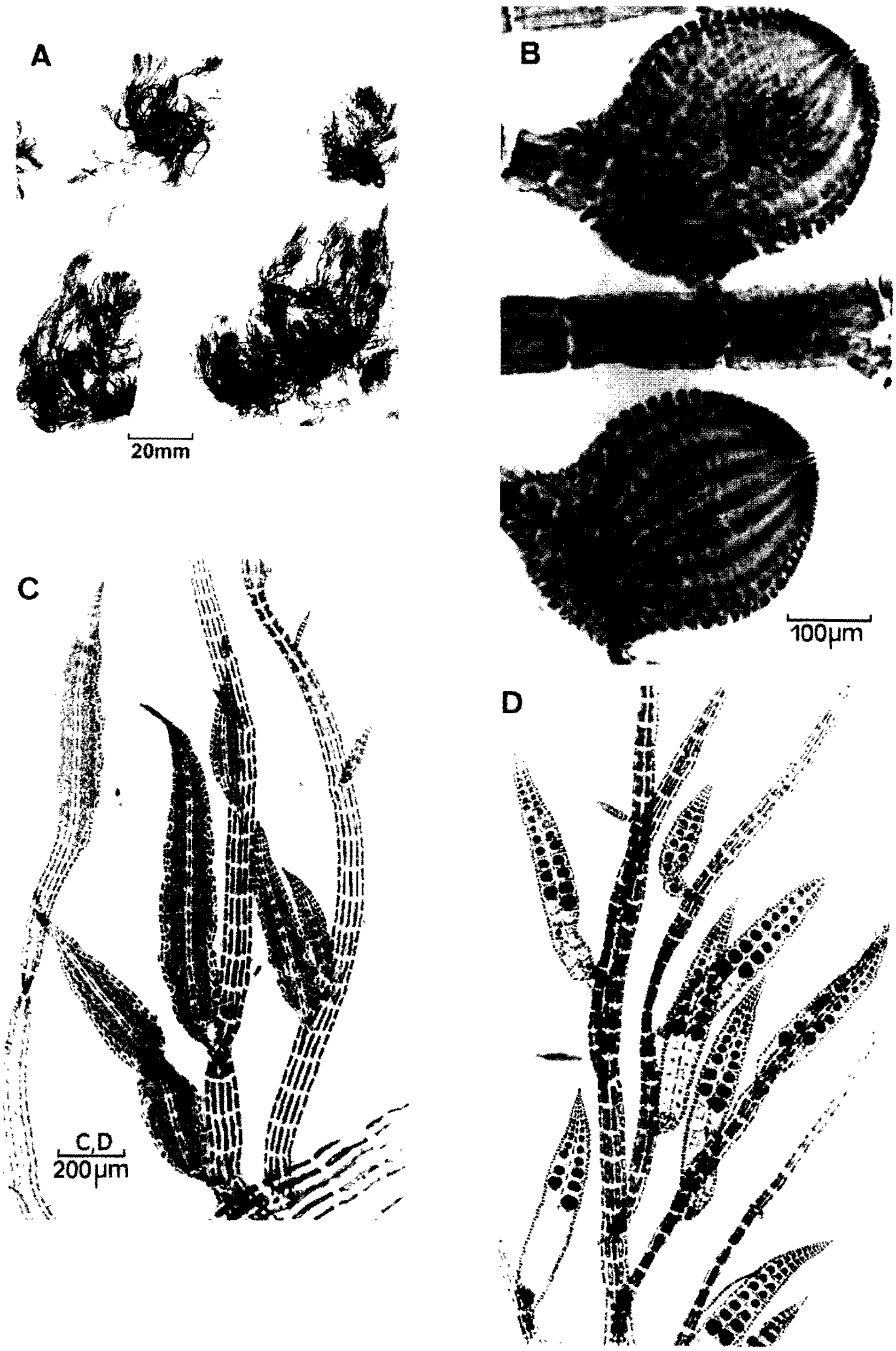

Fig. 73. *Platysiphonia delicata* (**A**, AD, A67123; **B**, AD, A50484; **C**, AD, A55546; **D**, AD, A27990). **A**. Habit. **B**. Cystocarps. **C**. Spermatangial branches. **D**. Stichidia.

Polysiphonia miniata (C. Agardh)Kützing 1849: 820.
Sarcomenia miniata (C. Agardh)J. Agardh 1863: 1260; 1896: 133. Børgesen 1931a: 20, fig. 13. De Toni 1900: 735; 1924: 359. Lucas 1909: 37. Lucas & Perrin 1947: 233. Weber van Bosse 1896: 281, pl. 359.
Platysiphonia miniata (C. Agardh)Børgesen 1931b: 1, figs 1–5. Cribb 1956a: 187. Huisman *et al.* 1990: 96. Kendrick *et al.* 1988: 204; 1990: table 1. Krishnamurthy & Varadarajan 1990: 109, figs 25–41. Kylin 1956: 436. May 1965: 377; 1981: 342; 1982: 101. May *et al.* 1978: 97. Silva & Cleary 1954: 251. Womersley & Shepley 1959: 194, 208, figs 83–99. Wynne 1996: 181.

FIGS 71L, M, 73

Thallus (Fig. 73A) medium to dark red-brown 0.5–1.5 (-3) cm high, erect or forming a turf-like mat in the uppermost sublittoral, with basal prostrate branches producing erect, moderately to much divided, branches. Attachment by rhizoidal holdfasts or by stout unicellular rhizoids with multicellular haptera, arising from the flanking cells of prostrate filaments; epilithic or epiphytic on *Posidonia* or various algae. *Structure.* Apical cell (Fig. 71L) hemispherical, forming first the abaxial pericentral cell, followed by 2 lateral pericentral cells (each forming 2 flanking cells) and last the adaxial pericentral cell. Mid branches 80–100 µm broad, segments L/D 0.8–1. Lower thallus ecorticate or very lightly corticate, 150–200 µm broad. Cells uninucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps (Fig. 71M) occur on the adaxial surface of young lateral branches which develop further rapidly, with the adaxial pericentral cell producing at first a sterile cell and a 4-celled carpogonial branch followed by a second cell. Carposporophyte moderately branched, with a relatively slight basal fusion cell and clavate terminal carposporangia 20–25 µm in diameter. Cystocarps (Fig. 73B) sessile, ovoid to urceolate, 300–500 µm across; pericarp ostiolate, arising after fertilisation, with about 15 erect filaments, each cell cutting off 2 outer transversely elongate pericentral cells only, thus 2 cells thick. Spermatangial blades (Fig. 73C) developed from small lateral branches, with initials and spermatangia cut off from lateral (and sometimes transverse) pericentral cells, but usually with sterile transverse pericentral cells and flanking cells, 0.5–1 mm long and 120–200 µm broad.

Tetrasporangial stichidia (Fig. 73D) developed as lateral branches, ecorticate with 2 longitudinal rows of tetrasporangia cut off from the lateral pericentral cells, followed by the abaxial cover cell and lastly the adaxial cover cell, with the flanking cells dividing horizontally into 2 cells which become curved and partly protect the tetrasporangia which are subspherical and 40–65 µm in diameter.

Type from Salúcar de Barrameda (Cadiz), Spain; lectotype in MA, Algae 1873.

Distribution: Spain; tropical eastern Atlantic Ocean; tropical Indian Ocean; Queensland.

In southern Australia, from Rottnest I. (and Houtman Abrolhos), W. Aust., to Walkerville, Vic., and N Tasmania, extending through NSW and Queensland.

Selected specimens: Rottnest I., W. Aust., on *Posidonia australis* (*Harvey* "Poly. B"; TCD and AD, A18316). Redcliff Point, N Spencer Gulf, S. Aust., on *P. australis*, 10 m deep (*Johnson*, 26.v.1976; AD, A50484). Christies Beach, S. Aust., upper sublittoral pools on reef (*Womersley*, 14.x.1968; AD, A32862—"Marine Algae of southern Australia" No. 120b). Vivonne Bay, Kangaroo I., S. Aust., low eulittoral pools in bay (*Womersley*, 4.i.1950; AD, A12914). American R. inlet, Kangaroo I., S. Aust., 2–4 m deep near Muston (*Kraft*, 2.xii.1971; AD, A41132). Robe, S. Aust., low eulittoral (*Womersley*, 25.x.1996; AD, A67123). Point Lonsdale, Vic., on *Codium galeatum*, drift (*Womersley*, 21.xi.1990; AD, A60802). Walkerville, Vic., lower eulittoral (*Sinkora* A1517, 22.ii.1972; AD, A42329). Crawfish Rock, Westernport Bay, Vic., on *Caulocystis cephalornithos* at low tide (*Watson*, 28.v.1974; AD, A45341). Rocky Cape, NW Tas., lower eulittoral pool (*Womersley*, 17.x.1982; AD, A55546). Bridport, Tas., upper sublittoral sandy pools (*Wollaston* & *Mitchell*, 4.iii.1964; AD, A27990—"Marine Algae of southern Australia" No. 120a).

2. **Platysiphonia mutabilis** (Harvey) Womersley & Shepley 1959: 209. May 1965: 377. Millar & Kraft 1993: 48. Shepherd 1983: 83. Silva *et al.* 1996: 465.
Polysiphonia mutabilis Harvey 1855a: 540. Kützing 1864: 20, pl. 55 d–g.
Sarcomenia mutabilis (Harvey)J. Agardh 1863: 1261; 1896: 134. Børgesen 1931b: 8. De Toni 1900: 736. Harvey 1863, synop.: xvii. Lucas 1909: 37.; 1929b: 50. Lucas & Perrin 1947: 234. Reinbold 1899: 46. Sonder 1880: 33. Tisdall 1848: 513. Womersley 1950: 184. Womersley & Shepley 1959: 187, figs 55, 56, pl. 3 fig. 2.

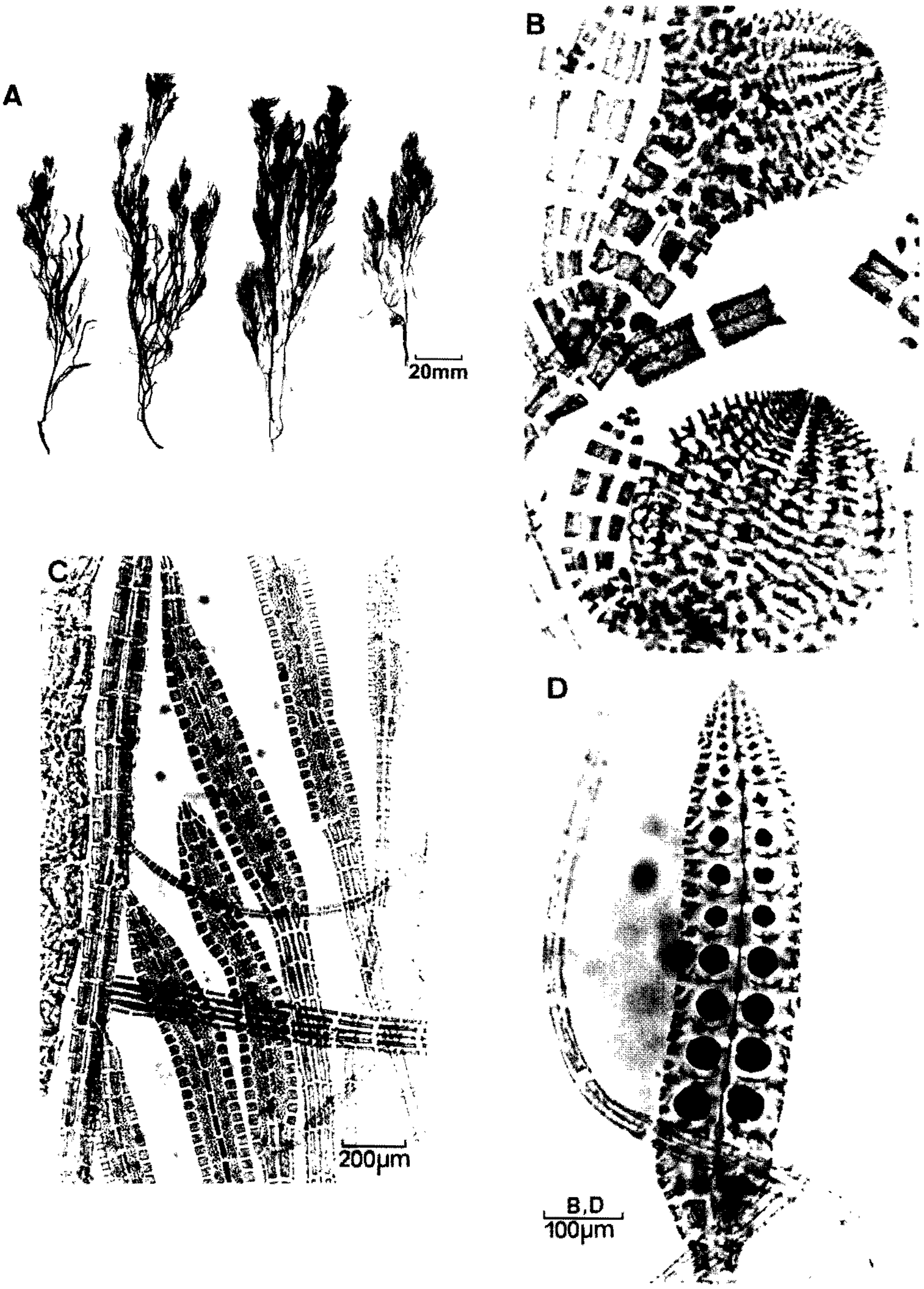

Fig. 74. *Platysiphonia mutabilis* (**A**, AD, A44226; **B–D**, AD, A29697). **A**. Habit. **B**. Cystocarps. **C**. Spermatangial branches with corticated branch on left. **D**. A stichidium.

FIG. 74

Thallus (Fig. 74A) medium to dark red-brown, 4–10 cm high, much branched with slender branches corticated only near their base. Attachment by a rhizoidal holdfast; epiphytic. *Structure.* Apical cell hemispherical, with axial cells producing 4 pericentral cells, the abaxial one first, followed by the lateral cells then the adaxial pericentral cell, with each lateral cell cutting off 2 flanking cells giving a compressed branch 5 cells broad. Mid blades 80–140 µm broad, segments L/D 0.6–1. Lower corticated axes 0.7–1.5 mm thick. Branches arise endogenously from the axial cells, with their basal 1–2 segments usually lacking flanking cells. Cortication (Fig. 74C) is slight above by small cells cut off from pericentral cells and becomes complete and moderate only on lower parts of older branches. Cells uni- to multinucleate; rhodoplasts discoid, becoming chained.

Reproduction. Gametophytes dioecious. Procarps adaxial on lateral branches, with the adaxial pericentral cell cutting off sterile cells and a 4-celled carpogonial branch. Carposporophytes with a small basal fusion cell and branched gonimoblast filaments bearing elongate-ovoid to clavate terminal carposporangia 16–22 µm in diameter. Cystocarps (Fig. 74B) sessile, ovoid, 500–700 µm in diameter. Pericarp with about 16 erect filaments, each cell producing 2 transversely elongate outer cells, slightly corticated only at the base. Spermatangia (Fig. 74C) covering the lower part of laterals, the fertile part 1–1.5 mm long and 180–220 µm broad, with spermatangia produced from the lateral pericentral cells, the transverse pericentral cells and flanking cells remaining sterile.

Tetrasporangia (Fig. 74D) borne in lateral blades 0.5–1.2 mm long and 100–180 µm broad, with 2 rows of tetrasporangia derived from the lateral pericentral cells which form a cover cell on each side, with each flanking cell dividing horizontally into 2; tetrasporangia 30–45 µm in diameter.

Type: From Fremantle, W. Aust., on "*Zostera*" (= *Posidonia*); lectotype in Herb. Harvey, TCD (Alg. Aust. Exsicc. 116A).

Distribution: Yanchep, W. Aust., to Port Stephens, NSW and N Tasmania.

Selected specimens: Yanchep, W. Aust., on *Amphibolis*, drift (*Womersley*, 22.ix.1979; AD, A51272). Safety Bay, W. Aust., on *Amphibolis*, drift (*Womersley*, 29.ix.1979; AD, A50737—"Marine Algae of southern Australia" No. 208). N Spencer Gulf, S. Aust., 11 m deep (*Shepherd*, 5.ix.1973; AD, A44226). Sturt Bay, S. Aust., on a fucoid alga (*Davey*; AD, A1137). Seal Bay, Kangaroo I., S. Aust., in pools on outer reef (*Womersley*, 29.x.1966; AD, A30848). Stinky Bay, Nora Creina, S. Aust., on *Codium galeatum*, drift (*Abbott*, 7.xi. 1965; AD, A29697). Shoreham, Western Port, Vic., drift (*Sinkora* A1306, 29.x.1971; AD, A62753). Low Head, Tas., drift (*Perrin*, Nov. 1949; AD, A16465).

Børgesen (1931b, p. 8) first stated that *S. mutabilis* could be referred to *Platysiphonia*, but did not validate the transfer.

3. **Platysiphonia victoriae** (Harvey *ex* J. Agardh)Womersley & Shepley 1959: 209. May 1965: 378. Shepherd & Womersley 1981: 362.

Sarcomenia victoriae Harvey *ex* J. Agardh 1863: 1262; 1896: 135; 1899: 145. De Toni 1900: 739; 1924: 359. Guiler 1952: 101. Harvey 1863, synop.: xvii. Lucas 1909: 37. Lucas & Perrin 1947: 234, fig. 97? Sonder 1880: 33. Tisdall 1898: 513. Wilson 1892: 164. Womersley & Shepley 1959: 176, figs 20–42, pls 1 fig. 2, 2 fig. 1.

Polysiphonia victoriae (Harvey)Kützing 1864: 20, pl. 56.

Sarcomenia dasyoides J. Agardh 1863: 1263; 1896: 134; 1899: 141. De Toni 1900: 738; 1924: 359. Guiler 1952: 101. Harvey 1863, synop.: xvii. Lucas 1909: 37; 1929a: 20. Lucas & Perrin 1947: 234, fig. 96. Sonder 1880: 33. Tisdall 1898: 513. Wilson 1892: 164. Womersley 1950: 183.

Sarcomenia opposita J. Agardh 1899: 142, 146. De Toni 1924: 359.

Sarcomenia wilsonis J. Agardh 1899: 142. De Toni 1924: 360.

Platysiphonia corymbosa (J. Agardh)Womersley & Shepley 1959: 209. Huisman 1997: 202. May 1965: 377.

Sarcomenia corymbosa J. Agardh 1896: 134. De Toni 1900: 737. Guiler 1952: 101. Lucas 1909: 37. Lucas & Perrin 1947: 234, fig. 98. Shepherd & Womersley 1981: 367. Womersley & Shepley 1959: 182, figs 43–50, pl. 2 fig. 2.

FIG. 75A–D

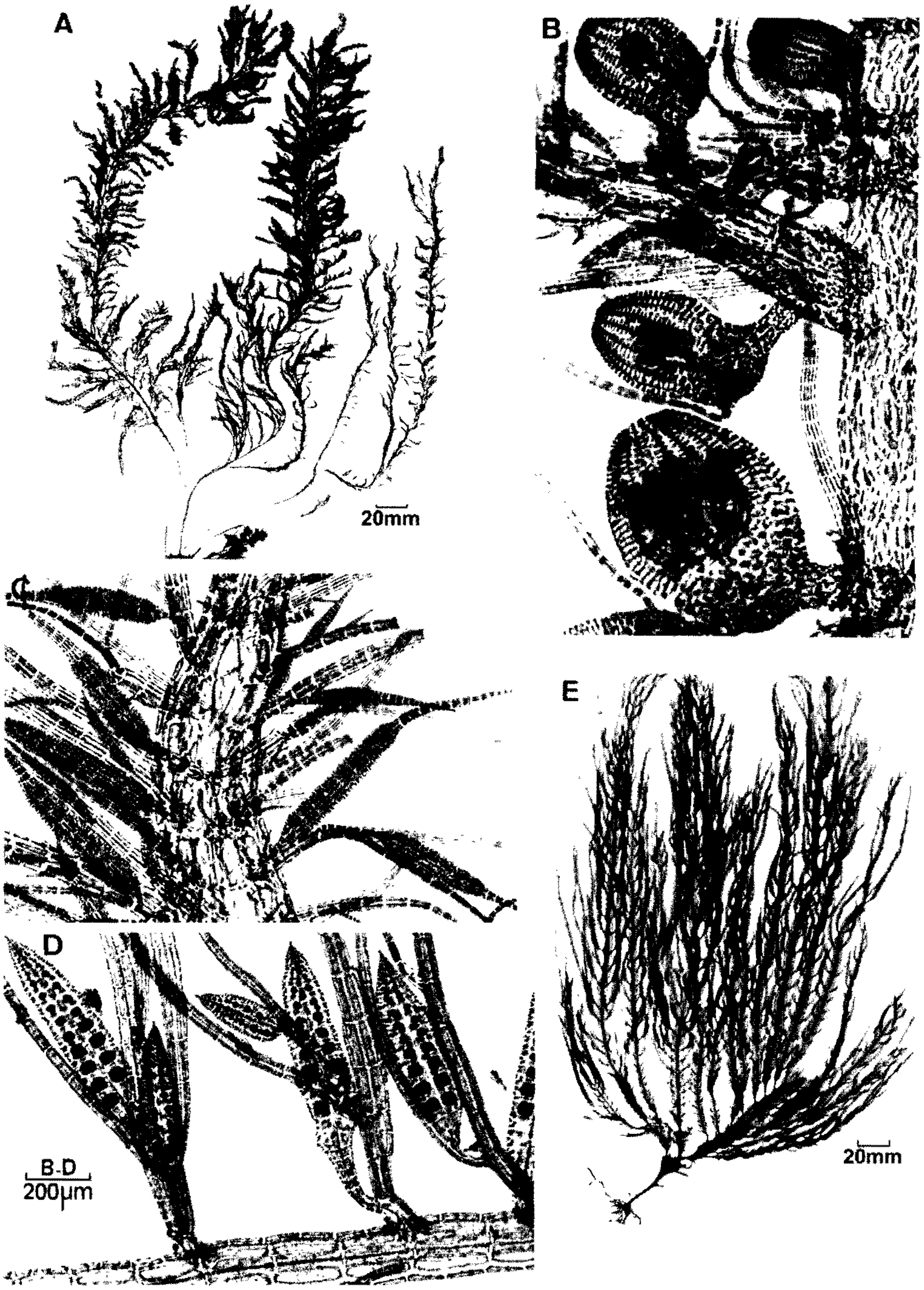

Fig. 75. A–D. *Platysiphonia victoriae* (**A**, AD, A20274; **B**, **C**, AD, A67967; **D**, AD, A64567). **A**. Habit. **B**. Corticated and ecorticate branches with cystocarps. **C**. Spermatangial branches. **D**. Branch with stichidia. **E**. *Sarcomenia delesserioides* (AD, A61614). Habit.

Thallus (Fig. 75A) red-brown with a greyish iridescence, when detached becoming rose-red and decomposing rapidly, 20–35 cm high, much branched with slender, compressed laterals of several orders, uncorticated branches (25-) 40–90 µm broad with segments L/D 1–1.5 (-2), becoming corticated with lower axes terete, 1–3 mm in diameter; branching irregular, largely adaxial from the centre of blades, with irregular to flat-topped and corymbose upper branch systems. Holdfast discoid, 1–5 (-10) mm across with 1 to several axes; epilithic or rarely epiphytic. *Structure.* Apical cell dome-shaped, with axial cells cutting off first the abaxial pericentral, then the 2 lateral pericentral cells and last the adaxial pericentral cell, and the lateral cells each cutting off 2 flanking cells half as long as the parent cells and resulting in a compressed branch; no further divisions of the flanking cells occur in the vegetative branches apart from cortication of all cells as the branch matures. Lateral branches arise endogenously from the anterior ends of axial cells. Cells multinucleate; rhodoplasts discoid to elongate, linear in larger cells.

Reproduction. Gametophytes dioecious. Procarps occur on the adaxial pericentral cells near the base of young blades, cutting off first a sterile cell, then the 4-celled carpogonial branch and then the second sterile cell. The carposporophyte develops an erect basal fusion cell and much branched gonimoblast filaments with ovoid to clavate terminal carposporangia 20–30 µm in diameter. Cystocarps (Fig. 75B) sessile, ovoid, 500–1000 µm in diameter; pericarp ostiolate with about 15 erect filaments arising from pericentral and flanking cells around the procarp, with each cell of the erect filaments cutting off 2 outer, transversely elongate, cells, with cortical cells on the pericarp base and the stalk, Spermatangial blades (Fig. 75C) 0.5–1 mm long and 80–130 µm broad, with the lateral pericentral cells each cutting off 2–4 cortical cells which divide anticlinally to form a plate of about 16 initials, each then forming 3–4 elongate spermatangia; the transverse pericentral cells and flanking cells remain sterile, and the spermatangial blades have a long sterile apex.

Tetrasporangial stichidia (Fig. 75D) 400–1200 µm long and 130–180 µm broad, occurring in dense masses on lateral branches, each with 2 regular rows of tetrasporangia. The lateral pericentral cells cut off, in rapid succession, the tetrasporangium and 2 cover cells, and the flanking cells elongate horizontally on the edge of the stichidium and each divides to give a further horizontal cell and later cut off small cortical cells at their ends; following loss of the tetrasporangia, the cover cells divide further; tetrasporangia subspherical, 50–100 µm in diameter.

Type from Port Phillip, Vic. (*Harvey*); holotype in Herb. Agardh, LD, 43373 (Harvey, Alg. Aust. Exsicc. 188F).

Distribution: Houtman Abrolhos (Huisman 1997, p. 202) and Israelite Bay, W. Aust., to Walkerville, Vic., and the N coast of Tasmania.

Selected specimens: Israelite Bay, W. Aust., drift (*Wells*, 10.xii.1974; AD, A46096). Elliston, S. Aust., in reef pools, south head (*Womersley*, 13.i.1951; AD, A13518, and 9.i.1976; AD, A46763—"Marine Algae of southern Australia" No. 181). Point Avoid, Eyre Pen., S. Aust., drift (*Womersley*, 2.xii.1975; AD, A46879). Pondalowie Bay, Yorke Pen., S. Aust., drift (*Womersley*, 9.xi.1980; AD, A51857). Tapley Shoal, Gulf St Vincent, S. Aust., 15 m deep (*F.J. Mitchell*, May 1961; AD, A28098). Witton Bluff (Port Noarlunga), S. Aust., drift (*Clarke & Engler*, 23.xi.1978; AD, A53956). Port Elliot, S. Aust., drift (*Parsons*, 3.xi.1967; AD, A32026). West Bay, Kangaroo I., S. Aust., drift (*Womersley*, 6.i.1946; AD, A3285). Seal Bay, Kangaroo I., S. Aust., pools on outer reef (*Womersley*, 29.x.1966; AD, A30849). Pennington Bay, Kangaroo I., S. Aust., upper sublittoral, reef edge (*Womersley*, 20.xii.1990; AD, A60839). Penneshaw, Kangaroo I., S. Aust., 6–7 m deep (*Lavers*, 27.ix.1997; AD, A67784). Cape Jaffa, S. Aust., drift (*Womersley*, 7.xii.1995; AD, A64567 and 22.xi.1998; AD, A67967). Nora Creina, S. Aust., drift (*Womersley*, 6.xii.1995; AD, A64749). Stinky Bay, Nora Creina, S. Aust., on *Acrocarpia*, drift (*Shepley*, 14.xi.1955; AD, A20274). Queenscliff, Vic., drift (*Norris*, 21.i.1963; AD, A27477). Flinders, Vic., drift (*Sinkora* A1733, 6.xi.1972; AD, A53441). Walkerville, Vic., drift (*Sinkora* A2348, 7.iii.1977; AD, A48505). Low Head, Tas., drift (*Perrin*, 24.ii.1942; AD, A49615).

The types of *Sarcomenia dasyoides* (a Harvey specimen) in Herb Agardh, LD, 43398, of *S. opposita* (in Herb Agardh, LD, 43381) and of *S. wilsonis* (in Herb Agardh, LD, 43406) are all within the range of *P. victoriae.* Previously (Womersley & Shepley 1959, p. 182) *P. corymbosa* had been kept separate from *P. victoriae*, though their similarity had been noted. Further study of their variation indicates that *P. corymbosa* differs only slightly in habit and features now regarded as within the range of *P. victoriae.*

Genus **SARCOMENIA** Sonder 1845: 56.

Thallus much branched with flat axes and laterals arising between midrib and margins, more or less linear, tapering to acute apices, decomposing rapidly on death; holdfast fibrous. *Structure.* Apical cell hemispherical, axial cells cutting off first an abaxial transverse pericentral cell, then 2 lateral pericentral cells, followed by the adaxial transverse pericentral cell. Lateral pericentral cells forming 2 flanking cells, the upper cutting off 2 cells and each of these 3 cells developing a row of cells to form the flat blades, with the whole blade becoming corticated. Lateral branches arise endogenously from the axial cells and become displaced to between the midrib and margin. Cells uni- to multinucleate.

Reproduction. Gametophytes dioecious. Procarps on the adaxial transverse pericentral cells which form the supporting cell, cutting off a sterile cell then the 4-celled carpogonial branch, followed by a second lateral sterile cell. Carposporophyte with a basal, erect, fusion cell and much branched gonimoblast bearing terminal carposporangia. Cystocarps ovoid to urceolate, pedicellate; pericarp ostiolate, of erect filaments with each cell cutting off 2 cells outwardly, the wall becoming 3–4 cells thick. Spermatangial blades developed laterally on older blades, with the lateral pericentral and outer cells producing a plate of initials which cut off elongate spermatangia, covering most of the blade except for transverse pericentral cells and marginal (or near) cells.

Tetrasporangial blades single or clustered, originating from axial cells, with the lateral pericentral cell derivatives only dividing horizontally to form protective, curved, marginal cells; lateral pericentral cells each cutting off a tetrasporangium followed by 2 cover cells, so that the blade bears 2 rows of tetrasporangia, maturing basally.

Type species: *S. delesserioides* Sonder 1845: 56.

Sarcomenia contains only a single species.

Sarcomenia delesserioides Sonder 1845: 56; 1848: 194; 1853: 697; 1880: 33. J. Agardh 1863: 1266; 1896: 137; 1899: 140. De Toni 1900: 742; 1924: 361. Harvey 1847: 21; 1855a: 537; 1860, pl. 121; 1863, synop.: xvii. Huisman 1997: 202; 2000: 152. Kützing 1849: 880. Kylin 1956: 436. Lucas 1909: 37. Lucas & Perrin 1947: 236, fig. 100. May 1965: 378. Mazza 1908: No. 255. Schmitz & Hauptfleisch 1897: 415. Shepherd & Womersley 1971: 166; 1981: 367. Silva *et al.* 1996: 466. Tate 1882a: 22. Tisdall 1893: 513. Wilson 1892: 164. Womersley 1950: 183. Womersley & Shepley 1959: 171, 208, figs 1–19, pl. 1 fig. 1. Wynne 1996: 181.

Hypoglossum muelleri Kützing 1866: 5, pl. 11a–f.

FIGS 75E, 76

Thallus (Fig. 75E) when living grey-red and usually iridescent, becoming rose-red on death and decomposing rapidly, 20–50 cm high, much branched with flat laterals positioned on both surfaces between the midrib and margins, older laterals 2–3 cm broad and 10–30 cm long, decreasing gradually to younger blades 5–10 mm broad and mostly 0.5–5 cm long, margins entire, smooth. Some plants with curved, tendril-like branch ends with blades becoming constricted. Holdfast 1–3 cm across, of spreading branched fibres 0.5–1 mm thick; epilithic or occasionally epiphytic. *Structure.* Growth (Fig. 76A) from a hemispherical apical cell, with axial cells cutting off first an abaxial transverse pericentral cell (Fig. 76B), followed by 2 lateral pericentral cells, then an adaxial transverse pericentral cell. The lateral pericentral cells each cut off 2 flanking cells, the upper of which divides again, and each of these 3 cells forms a row of cells (Fig. 76A), the outermost cell elongate, forming the flat blade, with secondary pit-connections between adjacent cells. Cortication of the transverse and then the lateral pericentral cells commences early, and the whole blade becomes corticated when mature. Lateral branches arise endogenously from the axial cells, and become displaced to between the midrib and margin. Cells uni- to multinucleate; rhodoplasts discoid to elongate, ribbon like in larger cells.

Reproduction. Gametophytes dioecious. Procarps (Fig. 76C) occur on the adaxial transverse pericentral cells of small blades which show only limited division of the 3 laterals in each segment, with the fertile pericentral (supporting) cell cutting off first a sterile cell, then a 4-celled carpogonial branch, followed by a second lateral sterile cell. Carposporophyte with a basal fusion cell, and much branched gonimoblast filaments with ovoid to clavate terminal

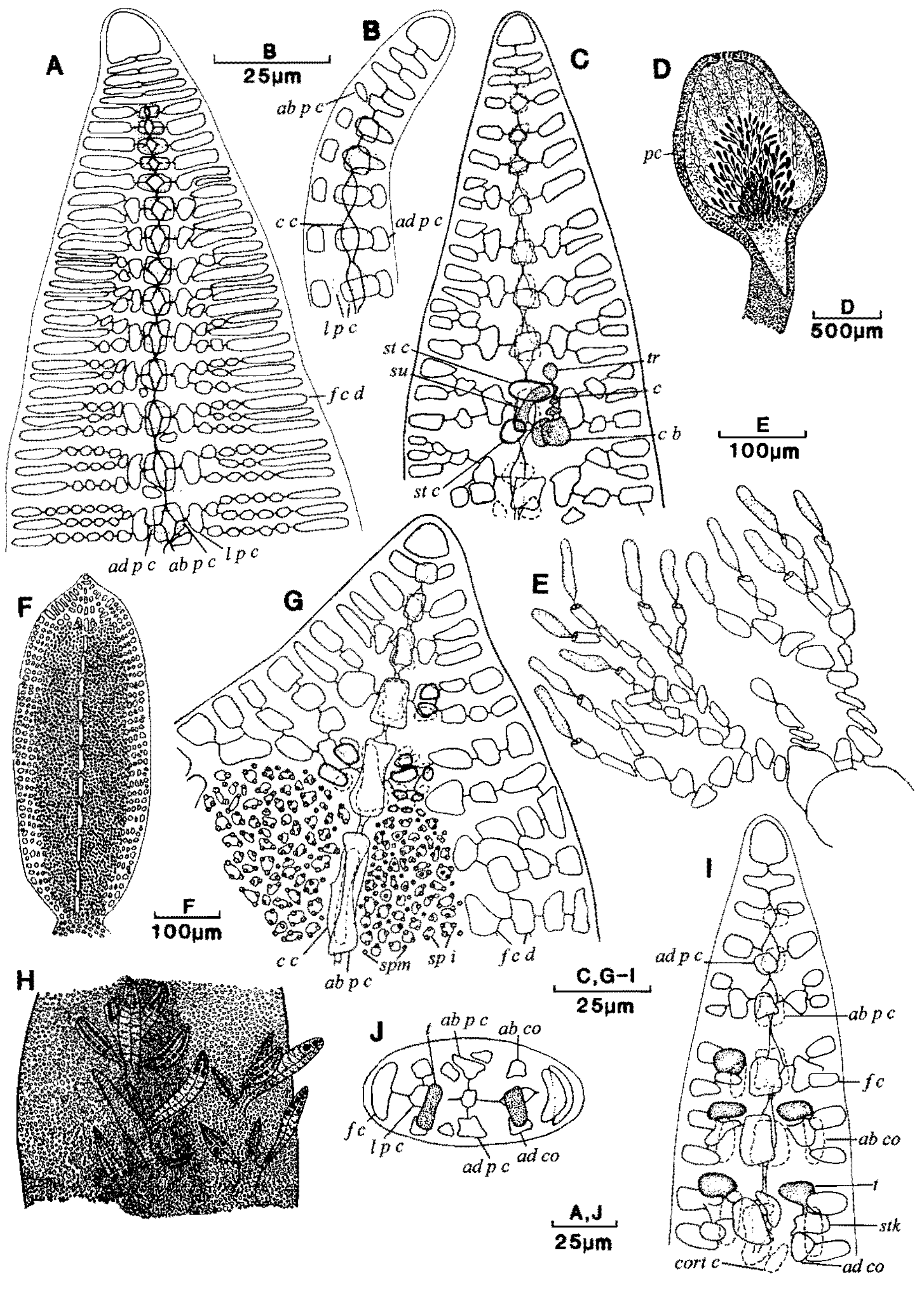

Fig. 76. *Sarcomenia delesserioides* (**A**, **B**, **H–J**, AD, A19016; **C**, **F**, **G**, AD, A19870; **D**, **E**, AD, A21394). **A**. Branch apex showing segmentation. **B**. Sectional view of apex with adaxial and abaxial pericentral cells. **C**. Young female blade, with a procarp and two sterile cells. **D**. Sectional view of a mature cystocarp. **E**. Carposporophyte with terminal carposporangia. **F**. Mature spermatangial blade. **G**. Tip of spermatangial blade showing initials and spermatangia. **H**. Part of thallus bearing stichidia. **I**. Upper part of a stichidium, showing tetrasporangia and cover cells. **J**. Transverse section of a stichidium. (All as in Womersley & Shepley 1959, courtesy of Aust. J. Bot.).

carposporangia (Fig. 76E) 20–30 µm in diameter. Cystocarps (Fig. 76D) sessile on short branchlets, ovoid to slightly urceolate, pedicellate, 0.5–1 mm in diameter; pericarp ostiolate, with about 20 erect filaments, cells each cutting off 2 cells outwardly and becoming corticated, especially basally where 3–4 cells thick. Spermatangial blades (Fig. 76F) positioned laterally on older blades but arising endogenously from axial cells, with limited development from the lateral pericentral cells forming short lateral cell-rows each of which cuts off cortical cells by periclinal divisions and which divide anticlinally to form a plate of about 16 spermatangial initials (Fig. 76G) which cut off elongate spermatangia, covering most of the blade from the transverse pericentral cells outwards.

Tetrasporangial blades (Fig. 76H) occur singly or in clusters, originating as do lateral blades but with derivatives of the lateral pericentral cells not dividing further apart from each dividing horizontally to form curved protective cells on the margin; the lateral pericentral cells each cut off a tetrasporangium and 2 cover cells in close succession (Fig. 76 I, J), probably the sporangium first, with the stichidia bearing 2 distinct rows (Fig. 76 I) of subspherical tetrasporangia 30–65 µm in diameter, maturing towards the base where after release further cortical cells may develop.

Type: from W. Aust. (*Preiss* 2618); type (fragment?, 5–6 cm high, tetrasporangial, in MEL, 503820.

Distribution: Houtman Abrolhos (Huisman 1997, p. 202) and Fremantle, W. Aust., to Western Port, Victoria.

Selected specimens: Hamelin Bay, W. Aust., drift (*Royce* 721, 21.vi.1950; AD, A15468). Elliston, S. Aust., 6 m deep near bay entrance (*Shepherd*, 24.x.1969; AD, A34782) and 7 m deep in bay (*Shepherd*, 21.x.1970; AD, A37548). Ward I., S. Aust., 18–23 m deep (*Shepherd*, 3.iii.1980; AD, A50902). Point Avoid, S. Aust., drift (*Womersley*, 2.xii.1975; AD, A46880). Wanna, S. Aust., drift (*Shepley*, 19.ii.1959; AD, A22231). Victor Harbor, S. Aust., drift (*Womersley*, 22.vii.1951; AD, A16126). Vivonne Bay, Kangaroo I., S. Aust., 6–7 m deep on jetty piles (*Kraft*, 15.vii.1972; AD, A42541). Seal Bay, Kangaroo I., S. Aust., drift (*Womersley*, 29.x.1966; AD, A30839). Pelorus I., S of Kangaroo I., S. Aust., 10–30 m deep (*Branden*, 19.vi.1991; AD, A61385). Robe, S. Aust., drift (*Shepley*, 14.iii.1955; AD, A19870). Nora Creina, S. Aust., drift (*Shepley*, 14.xi.1955; AD, A21394) and (*Womersley*, 18.viii.1953; AD, A19016). Stinky Bay, Nora Creina, S. Aust., drift (*Womersley*, 19.viii.1957; AD, A21212). Blackfellows Caves, SE S. Aust., drift (*Womersley*, 24.ii.1992; AD, A61614). Double Corner Beach, Portland, Vic., drift (*Beauglehole*, 14.vii.1951; AD, A21613). Queenscliff, Vic., 14 m deep (AIMS–NCI, Q66C 3331–M, 9.ii.1990; AD, A60349). Flinders, Western Port, Vic., drift (*Sinkora* A783, 16.viii.1970; AD, A57305).

Sarcomenia delesserioides is a distinctive species, recognisable when living by the iridescent fronds. It is essentially a deep water (or shaded) species on rough-water coasts.

FAMILY RHODOMELACEAE Areschoug 1847: 260, *nom. cons.*

Thallus usually erect and much branched, in some genera foliose and/or prostrate, branches terete, compressed or flat, all erect branches similar or with indeterminate branches bearing determinate laterals of limited growth; adventitious branching in some genera. Holdfast discoid or fibrous, or basal attachment by rhizoids. *Structure*. Growth monopodial, by transverse or oblique divisions of apical cells, the transverse divisions followed by longitudinal divisions to give pericentral cells and the oblique divisions giving rise to laterals; primary branching exogenous, in some genera later branching endogenous from axial cells or pericentral cells within the cortex, or adventitious. Apices either radial or dorsiventral in symmetry. Pericentral cells 4–24, cut off in alternating order, ecorticate or corticate, in some genera dividing transversely; cortex parenchymatous or rhizoidal, or with rhizoids separating the pericentral or cortical cells; pseudopericentral cells present in some genera. Trichoblasts usually present on subapical cells, in some genera on pericentral or cortical cells, colourless or containing rhodoplasts in some genera. Cells uni- or multinucleate; rhodoplasts usually discoid, often chained in larger cells.

Reproduction. Gametophytes usually dioecious; mixed phases known in some genera. Procarps borne on lower cells of trichoblasts or directly on thallus branches, consisting of a supporting cell (a fertile pericentral cell or its derivative cell) and a (3-) 4-celled carpogonial branch, together with a lateral sterile group; auxiliary cell cut off from the supporting cell after fertilization. Carposporophytes developing from the auxiliary and adjacent cells which usually form a basal fusion cell bearing a usually much-branched gonimoblast with clavate terminal carposporangia replaced from lower cells (i.e. not strictly sympodial branching). Cystocarps ovoid to subspherical, occasionally urceolate; pericarp produced pre-fertilization from cells adjacent to the supporting cell, consisting of erect filaments, each cell with 2–3 outer pericentral cells, ecorticate or corticate, with a narrow to broad ostiole. Spermatangial organs usually borne on branches of trichoblasts or replacing the whole trichoblast, terete or as flat plates and with a monosiphonous stalk, or borne directly on lesser branches of the thallus; the axial cells cut off 2–5 pericentral cells which form a layer of initials which produce an outer layer of spermatangia.

Tetrasporangia produced in polysiphonous, terete, lateral branches or in compressed to flat specialised branches, usually regarded as stichidia, cut off pericentral cells or in some genera from cortical cells, usually with 2–3 presporangial cover cells from the fertile pericentral cell and occasionally a post-sporangial cover cell, with or without a cover of cortical cells. Tetrasporangia tetrahedrally divided, usually subspherical, single per segment and spirally arranged or in a straight row, or twinned and distichously or decussately arranged, or verticillate and 4–6 per segment.

KEY TO TRIBES (GROUPS) OF RHODOMELACEAE

While tribes of the Rhodomelaceae are generally recognised, Kylin (1956) recognised *groups* and his *Lophosiphonia* and *Placophora* groups have not been designated as tribes (with Latin descriptions). There are also several genera doubtfully placed in tribes or unplaced (described below after the tribes/groups), and it may be that recognition of groups is more appropriate for the present state of knowledge of the family. Several species have been placed in *Rhodomela* or *Rytiphloea* but are now referred to other genera (see index) of *Rhodomelaceae*, apart from *Rhodomela preissii* Sonder 1848: 182 (from W. Aust., holotype in MEL, 45895 – a small inadequate specimen which may be a *Hypnea*.)

1. Thallus terete or compressed, filaments free or laterally fused, segments of pericentral cells usually clear to well below apices, ecorticate or corticated; apical cell filament protruding, not in a depression (occasionally within a flat cleft), subapical cells usually with trichoblasts; pericentral cells usually clear at least near branch apices, forming a clear, well-defined ring in transverse section, sometimes becoming obscured; tetrasporangia cut off only from pericentral cells, single, paired or whorled 2

1. Thallus parenchymatous, without segments of pericentral cells; apical filament erect in an apical depression, with trichoblasts on subapical cells within the depression or becoming external to it; pericentral cells clear or obscured; tetrasporangia cut off from pericentral or cortical cells but rather obscurely so 12

    2. Thallus usually terete and radially branched; apices radially and not dorsiventrally developed (see *Wilsonaea* related to the Bostrychieae) 3

    2. Thallus terete to flat, bilaterally or unilaterally branched; apices usually dorsiventrally developed 5

3. Thallus branches terete, pericentral cells 4–20; trichoblasts non-rhodoplastic, with non-adherent walls at branchings, usually caducous .... POLYSIPHONIEAE

3. Thallus branches terete or occasionally basally compressed; pericentral cells usually 4, 5 or 7, trichoblasts rhodoplastic, with adherent or non-adherent walls at branchings, caducous or often relatively persistent 4

    4. Branches terete, ecorticate or corticate; pericentral cells 4, 5 or 7 (rarely 6); trichoblasts with non-adherent walls at branchings; tetrasporangia single and spirally arranged, or opposite per segment .... LOPHOTHALIEAE

    4. Branches terete or compressed, heavily corticated; pericentral cells 4, dividing to form a ring of 7–8, becoming obscure in a rhizoidal medulla; trichoblasts with adherent walls at branchings; tetrasporangia single and spirally arranged in corticated branches bearing trichoblasts .... HETEROCLADIEAE

5. Branches terete, discrete (or in some genera congenitally laterally fused); pericentral cells not transversely divided (except some Pterosiphonieae); tetrasporangia usually single (paired in *Ophidocladus*) per segment 6
5. Branches terete and discrete, compressed or flat; pericentral cells transversely divided or not; tetrasporangia regularly 2 or more per segment 10

   6. Thallus radially or bilaterally branched, with indeterminate and determinate laterals in defined regular sequences 7
   6. Thallus bilaterally branched but indeterminate and determinate laterals not in defined sequences 8

7. Indeterminate axes with radial or bilateral determinate laterals; indeterminate apices dorsiventral and usually curved, with 4–16 pericentral cells; trichoblasts present on most determinate laterals .... HERPOSIPHONIEAE
7. Branching bilateral, determinate laterals regularly branched usually adaxially, branches discrete or fused; indeterminate apices dorsiventral, with 6 (or 7) pericentral cells; determinate laterals with no or 3 pericentral cells, arising exogenously usually in 2 ranks; trichoblasts present only on determinate laterals .... POLYZONIEAE

   8. Thallus with prostrate indeterminate, terete, branches bearing erect, terete, determinate laterals endogenously; indeterminate apices curved, dorsiventrally organised; pericentral cells 4–20, ecorticate; tetrasporangia single or paired per segment .... LOPHOSIPHONIA Group
   8. Thallus with bilateral discrete terete branches or flat with branches congenitally fused; apical arrangement of pericentral cells dorsiventral or not; pericentral cells in some genera (e.g. *Pollexfenia*) dividing transversely; tetrasporangia single per segment 9

9. Thallus usually erect, with terete, bilateral determinate branches or flat with polysiphonous branches congenitally fused; 4 or 6 pericentral cells, pericentral cell arrangement at apices not dorsiventral, pericentral cells in some genera dividing transversely .... PTEROSIPHONIEAE
9. Thallus prostrate, flat, with polysiphonous branches congenitally fused; 5 pericentral cells dorsiventrally arranged with 3 dorsally and 2 ventrally, pericentral cells not dividing transversely .... PLACOPHORA Group

   10. Branches terete, usually slender with curved apices, dorsiventral or radial; pericentral cells 4–9, dividing transversely to form tiers of 2–5 per axial cell; tetrasporangia in whorls of 4–6 .... BOSTRYCHIEAE
   10. Branches compressed to flat or foliose; apices flat or recurved, pericentral cells 4–6, with or without pseudopericentral cells; lateral pericentral cells dividing to form wings 1 or 2 cells thick, ecorticate or corticate; tetrasporangia in opposite pairs 11

11. Thallus branches flat, linear, apical cell protruding, pericentral cells 4 (5 in fertile segments) with 2 pseudopericentral cells; wings one cell thick, ecorticate; trichoblasts absent; all reproductive cells formed on the thallus surface .... SONDERELLEAE
11. Thallus branches linear, compressed to foliose; apical cell protruding or within an apical cleft, pericentral cells 5, with or without pseudopericentral cells, or 6; trichoblasts usually present, formed apically or adventitiously on the blade surface; sexual reproductive cells usually originating on reduced or normal trichoblasts .... AMANSIEAE

   12. Apical cells protruding or in an apical depression; 5 pericentral cells; central axis usually discernible, pericentral cells clear; spermatangia borne on flat, discoid plates with sterile marginal cells, on trichoblasts; tetrasporangia cut off singly from pericentral cells, spirally arranged (rarely 2–3 from a segment) .... CHONDRIEAE
   12. Apical cell always in an apical depression; 2 or 4 pericentral cells; central axis and pericentral cells becoming obscure; spermatangia borne laterally and singly on trichoblasts in the apical depressions or on filaments in subapical pits; tetrasporangia cut off from pericentral cells or from cortical cells .... LAURENCIEAE

Tribe POLYSIPHONIEAE Schmitz 1889: 447

Thallus usually erect, branching radial on all sides (rarely becoming bilateral) with all branches indeterminate or also with lateral determinate branches; apical cells protruding, trichoblasts usually present, colourless (non-rhodoplastic), caducous; trichoblasts and lateral branches usually produced spirally from successive segments.

Reproduction. Gametophytes usually dioecious. Procarps borne on a lower cell of trichoblasts. Spermatangial branches terete, produced as branches of trichoblasts.

Tetrasporangia single (rarely double) per segment in ordinary branches of the thallus, in spiral or straight rows.

Type genus: *Polysiphonia* Greville 1823: lxvii, 230, *nom. cons.*

A tribe of about 20 genera (Hommersand 1963, p. 347), of which 7 occur on southern Australian coasts.

KEY TO GENERA OF POLYSIPHONIEAE

1. Lateral branches essentially similar to main branches, not reduced to short determinate laterals .... POLYSIPHONIA
1. Lateral branches forming short determinate laterals moderately to densely covering the long indeterminate branches 2

    2. Determinate laterals corticate to close to apices 3
    2. Determinate laterals ecorticate or slightly corticate 4

3. Thallus with 4 pericentral cells, determinate laterals closely radially arranged, usually simple .... LOPHURELLA
3. Thallus with 6 pericentral cells, determinate laterals distant, spirally arranged, more or less complanately and subdichotomously branched with bicornate ends .... ALLEYNEA

    4. Short determinate laterals radially branched 5
    4. Short determinate laterals distichously branched 8

5. Four pericentral cells, indeterminate branches heavily corticated or ecorticate 6
5. Seven or 6–12 pericentral cells, all branches ecorticate 7

    6. Indeterminate branches ecorticate .... TOLYPIOCLADIA
    6. Indeterminate branches heavily corticate .... ECHINOTHAMNION

7. Seven pericentral cells, trichoblasts abundant, branched; tetrasporangia single per segment .... DIPLOCLADIA
7. Eleven–13 (-15) pericentral cells, trichoblasts rare; tetrasporangia paired per segment .... PERRINIA

    8. Determinate laterals mostly coupled, the upper compressed and pinnate, alternately distichously branched, with 3–5 branches on each side, each branch bearing a branched, caducous, trichoblast; the lower determinate lateral simple and terete .... PITYOPHYCOS
    8. Determinate laterals compressed, with 3–4 basal branches, each tapering to a single apical cell, the apex without trichoblasts but sometimes forming a monosiphonous filament .... CHIRACANTHIA

Genus **POLYSIPHONIA** Greville 1823: lxvii, 308, *nom. cons.*

Thallus erect, radially branched with progressively slenderer branches towards the apices but without differentiation into indeterminate and determinate branches, with basal rhizoidal holdfasts or prostrate axes attached by unicellular or multicellular rhizoids cut off or not from the pericentral cells. *Structure.* Growth apical, monopodial, with trichoblasts usually present and arising exogenously from every or many subapical cells; trichoblasts colourless (non-rhodoplastic), spirally arranged, usually caducous leaving a basal scar cell. Pericentral cells

4–24 (rarely 5), the same length as the central cell, relatively constant in number within a species, the first cut off below the trichoblast, the others in alternating sequence, ecorticate or corticated by descending filaments. Lateral branches borne on basal cell of trichoblasts or replacing them, or adventitious (cicatrigenous) from the central cell of older branches. Cells mostly uninucleate.

Reproduction. Gametophytes usually dioecious, rarely monoecious, occasionally with mixed phases.

Procarps on the fifth pericentral cell arising on the supra-basal segment of a trichoblast, with a 2-celled lateral sterile group, a (3-) 4-celled carpogonial branch and a 1-celled basal sterile group. Fertilization is followed by diploidization of the auxiliary cell via a connecting cell, with formation of a single gonimoblast initial, then a basal fusion cell and a branched carposporophyte with clavate terminal carposporangia, replaced from sub-apical cells. Cystocarps globular to urceolate, with or without a neck; pericarp arising pre-fertilization, from pericentral cells adjacent to the procarp, developing 12–14 axial filaments each with 2 outer pericentral cells and often corticated. Spermatangia borne on modified trichoblasts, as a single or several terete branches, usually with a basal sterile and often apical cells; axial cells with 4 pericentral cells, dividing anticlinally and periclinally to form 2 (-3) layers, with a surface layer of spermatangia.

Tetrasporangia produced in lateral branchlets, one per segment, usually spirally arranged (occasionally in linear series), tetrahedrally divided, covered by 2 pre-sporangial cover cells and sometimes a third, basal, post-sporangial cover cell.

Type species: *P. urceolata* (Dillwyn)Greville (1824, p. 309), *type cons.* [= *P. stricta* (Dillwyn)Greville 1824, p. 309].

A genus of very many species, common on most coasts of the world, with some 26 species on southern Australian coasts. The type species has been redescribed in detail by Kim *et al.* 2000, and Kim & Lee (1999) have described a related genus, *Neosiphonia*, from Korea; several species of *Polysiphonia* are transferred to *Neosiphonia*.

KEY TO SPECIES OF *POLYSIPHONIA*

1\. Pericentral cells 4 2
1\. Pericentral cells 5–12 18

2\. Thallus ecorticate throughout or with only slight cortication near the base of older axes 3
2\. Thallus corticate at least over most of the main branches 16

3\. Thallus epiphytic on *Haplodasya urceolata*, less than 2 mm high, attached by a cellular disc .... 1. *P. haplodasyae*
3\. Thallus usually well over 2 mm high, not epiphytic on *Haplodasya urceolata*, with normal attachment rhizoids 4

4\. Rhizoids not cut off from (ie. protoplast in open connection with) the parent pericentral cells 5
4\. Rhizoids cut off by a pit connection from the parent pericentral cells 8

5\. Trichoblasts or scar cells normally on every segment, attachment tendrils present .... 2. *P. shepherdii*
5\. Trichoblasts or scar cells only occasionally present, tendril branches absent 6

6\. Thallus usually less than 2 cm high (rarely to 4 cm), prostrate system well developed, forming spreading mats on low intertidal rock, occasionally epiphytic; branches of similar diameter (80–120 µm) throughout; male branches without sterile tip cells .... 3. *P. scopulorum*
6\. Thallus usually over 2 cm high, prostrate system slight compared with the much-branched erect systems; branches tapering to upper parts, usually over 120 µm in diameter below; male branches with a sterile tip of 5–7 cells 7

7. Thallus slender, upper branches 40–60 μm in diameter, lower branches 70–180 μm in diameter with segments L/D 1.5–2, all lateral branchlets non-spinous .... 4. *P. subtilissima*
7. Thallus moderately robust, upper branches 100–150 μm in diameter, lower branches 180–250 μm in diameter with segments L/D 4–10, branchlets spinous-tipped and of relatively limited growth .... 5. *P. senticulosa*

 8. Pericentral cells throughout thallus broader than long, thallus under 0.5 cm high (epiphytic on *Codium*) .... 6. *P. brevisegmenta*
 8. Pericentral cells in most of thallus longer than broad, thallus usually over 2 cm high (except *P. amphibolis*) 9

9. Thallus rarely over 1 cm high, forming a tangled felt on the stems of *Amphibolis*; rhizoids with multicellular pads .... 7. *P. amphibolis*
9. Thallus normally over 2 cm high, epilithic or epiphytic; rhizoids unicellular with lobed, digitate pads 10

 10. Branches originating from the basal cells of trichoblasts 11
 10. Branches originating in place of trichoblasts 13

11. Thallus usually with a single erect basal axis, with slight basal cortication on older axes, 250–500 μm in diameter below; often epiphytic .... 8. *P. mollis*
11. Thallus with several to numerous axes from prostrate basal filaments, ecorticate, with either slender axes 70–150 μm in diameter below or long (20–30 cm) axes with segments becoming 250–400 μm in diameter and L/D 6–12 (-18); epilithic or epiphytic 12

 12. Thallus with entangled, prostrate basal filaments producing numerous erect filaments 70–150 μm in diameter below; usually epilithic .... 9. *P. sertularioides*
 12. Thallus with several robust erect axes from prostrate basal filaments, 250–400 μm in diameter below and becoming L/D 6–12 (-18); epiphytic or epilithic .... 10. *P. perriniae*

13. Lower branches usually under 300 μm in diameter, upper branchlets 50–80 μm in diameter, with numerous patent laterals often markedly slenderer than parent branches .... 11. *P. infestans*
13. Lower branches usually over 300 μm in diameter, upper branchlets over 100 μm in diameter, with few if any slender patent laterals 14

 14. Thallus with fasciculate lateral branchlets, attachment tendrils, and ovoid, multicellular propagules, branch segments broader than long . 12. *P. propagulifera*
 14. Thallus subdichotomous with few laterals, without tendrils or propagules, segments often as long as or longer than broad 15

15. Base erect and becoming slightly corticated, usually epiphytic, apices involute .... 13. *P. succulenta*
15. Base prostrate, ecorticate, apices straight .... 14. *P. blandii*

 16. Lesser branches basally constricted, mainly cicatrigenous .... 15. *P. crassiuscula*
 16. Lesser branches not basally constricted, mainly apical with some cicatrigenous 17

17. Branches near apices arising from basal cell of trichoblasts; pericentral cells isodiametric; branches usually patent; basal axis single .... 16. *P. daveyae*
17. Branches near apices replacing trichoblasts; ecorticate pericentral cells usually longer than broad; branches fastigiate; basal axes usually several from a common holdfast .... 17. *P. australiensis*

 18. Pericentral cells normally 5 or 6 19
 18. Pericentral cells 7 or more 21

19. Pericentral cells normally 5; most segments, at least in mid parts of thallus, longer than broad .... 18. *P. abscissoides*
19. Pericentral cells usually 6; segments L/D usually less than 1 20

20. Thallus to 1 cm high, with prostrate filaments producing numerous erect branches with few laterals; pericentral cells elongate .... 19. *P. teges*
20. Thallus to 5 cm high, base erect, subdichotomously to laterally branched above; pericentral cells isodiametric .... 20. *P. forfex*

21. Pericentral cells 7 (-8), ecorticate or corticate 22
21. Pericentral cells 9–12 (rarely 7 or 8, see *P. isogona*), ecorticate 24

22. Thallus ecorticate 23
22. Thallus corticate except on upper branchlets .... 21. *P. brodiei*

23. Branching fastigiate, branches markedly basally constricted .... 22. *P. constricta*
23. Branching mostly patent, short laterals frequent, not basally constricted ... 23. *P. decipiens*

24. Thallus with prostrate entangled base and slender, erect, fastigiate branches less than 300 μm in diameter 25
24. Thallus with a single, erect, axis, and coarse patent branches usually over 300 μm in diameter .... 24. *P. atricapilla*

25. Pericentral cells usually 10–11 (-12); rhizoids not cut off from pericentral cells; spermatangial branches replacing whole trichoblast .... 25. *P. adamsiae*
25. Pericentral cells usually 9 (8–10); rhizoids cut off from pericentral cells; spermatangial branches developing as basal branch of trichoblast .... 26. *P. isogona*

1. **Polysiphonia haplodasyae** Womersley 1979: 465, fig. 1A–D.

FIG. 77A–D

Thallus (Fig. 77A) brown-red, 0.5–1.5 (-2) mm high, forming minute, densely branched tufts; epiphytic on *Haplodasya urceolata*. *Structure.* Basal attachment by a cellular disc on the corticated axes of *Haplodasya*, with elongate cells of epiphyte and host cells intermingling, but without distinct rhizoids; erect axis from the basal attachment short, 100–150 (-300) μm in diameter with segments L/D 0.5–0.7, branching every few segments with mid branches 70–100 (-200) μm in diameter with segments L/D 0.5–0.75 (-1), tapering to 30–60 μm in diameter and segments L/D 0.3–0.5 shortly below the straight apices; trichoblasts occasional to profuse; lateral branches replacing trichoblasts, cicatrigenous branches absent. Pericentral cells 4, L/D 1–1.5 (-2) (Fig. 77D), ecorticate except for slight cortication by odd cells near the base; trichoblasts (Fig. 77D) formed on every segment, with a divergence of 1/4, relatively robust and 12–25 μm in diameter in lower cells, simple to 3 times furcate, scar cells prominent, round in surface view. Rhodoplasts discoid, scattered.

Reproduction. Gametophytes dioecious. Carposporophyte with a small basal fusion cell and branched gonimoblast with clavate terminal carposporangia 15–20 μm in diameter. Cystocarps (Fig. 77A, B) short stalked, globular to ovoid, not or slightly urceolate, 150–300 (-400) μm in diameter; pericarp 2 cells thick, with enlarged ostiolar cells, outer cells isodiametric, angular. Spermatangial branches (Fig. 77C) developing as one basal branch of a trichoblast, elongate-ovoid to gently tapering from the base, 80–130 μm long and 35–60 μm in diameter, without or with a prominent sterile apical cell when mature.

Tetrasporangia (Fig. 77D) formed in spiral series in branches, usually extending below 1–3 branchings, slightly to moderately distorting the branch, subspherical to ovoid, 25–60 μm in diameter.

Type from Pennington Bay, Kangaroo I., S. Aust., epiphytic on *Haplodasya urceolata* (Harvey)Parsons, on *Cystophora intermedia* J. Agardh, sublittoral fringe (*Parsons*, 17.xi.1967); holotype in AD, A31892.

Distribution: Only known from the south coast of Kangaroo I., S. Australia.

Selected specimens: (All on *Haplodasya urceolata*). The type; Pennington Bay, Kangaroo I., S. Aust., sub-littoral fringe (*Mitchell*, 20.viii.1963; AD, A26993) and (*Womersley*, 19.i.1965; AD, A28922). Bales Beach, Kangaroo I., S. Aust., drift (*Womersley*, 29.xii.1999; AD, A68436).

This minute species, only known as an epiphyte on *Haplodasya urceolata* on the south coast of Kangaroo I., shows all the essential characters of *Polysiphonia*. It is radially branched at the apices, with exogenous apical branching, and has the normal occurrence of reproductive

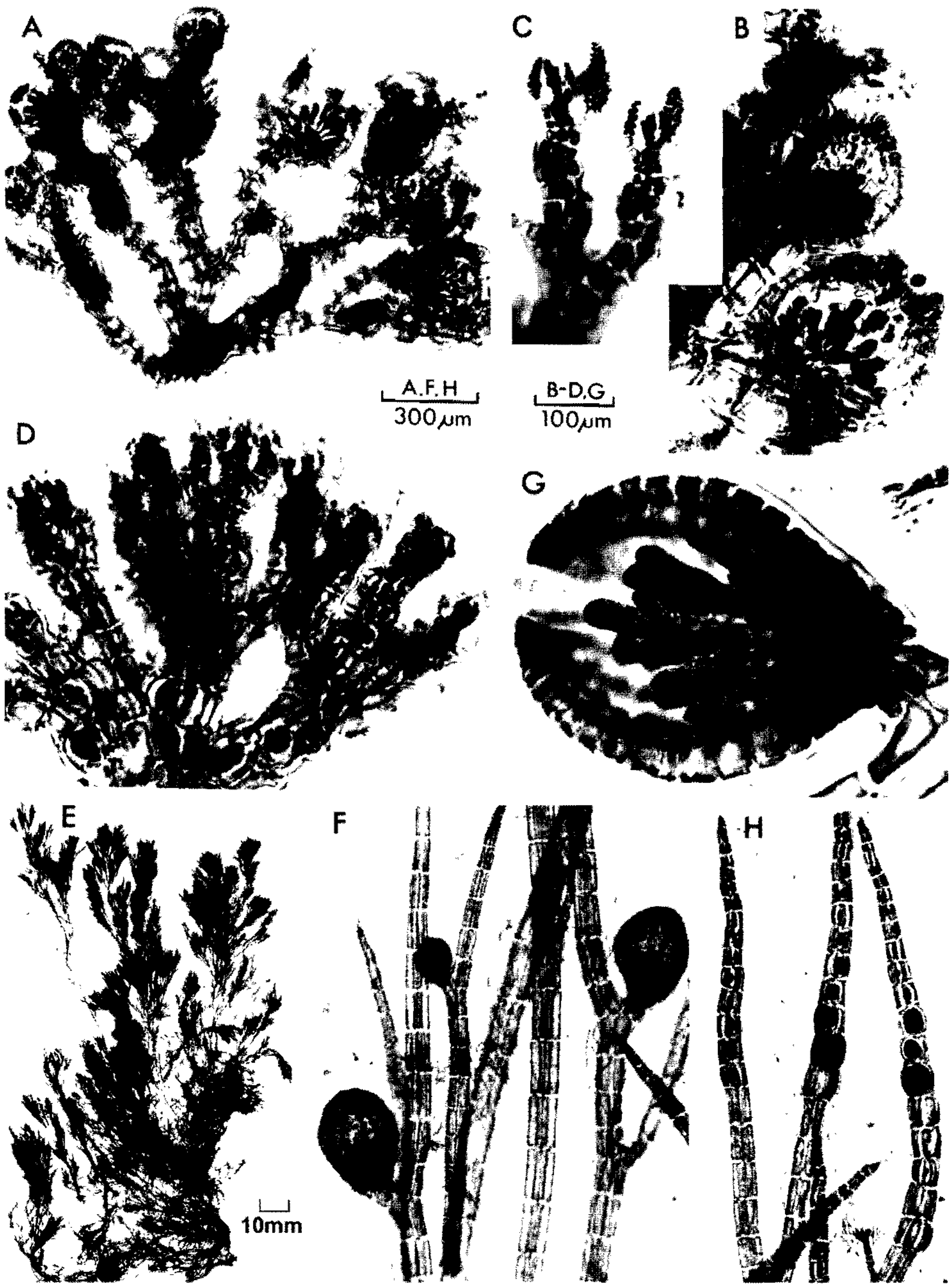

Fig. 77. A–D. *Polysiphonia haplodasyae* (**A**, **B**, **D**, AD, A31892; **C**, AD, A68436). **A**. A complete cystocarpic plant. **B**. Immature and mature cystocarps. **C**. Spermatangial branches (young?). **D**. A tetrasporangial plant. **E–H**. *Polysiphonia shepherdii* (AD, A33838). **E**. Habit. **F**. Branches with cystocarps. **G**. Median view of mature cystocarp. **H**. Tetrasporangial branches. (All as in Womersley 1979, courtesy of Aust. J. Bot.)

organs for the genus. Amongst southern Australian species, it is unusual in having a pad of cells as the attachment organ rather than distinct elongate rhizoids. Each plant of *Haplodasya* bore numerous plants of the *Polysiphonia*, virtually all of which were fertile.

2. **Polysiphonia shepherdii** Womersley 1979: 466, fig. 1E–H.

FIG. 77E–H

Thallus (Fig. 77E) dark red-brown, 10–18 cm high, with slight prostrate basal filaments and numerous erect, profusely branched tufts with some percurrent filaments, upper branchlets fastigiate, with occasional small lateral branchlets forming recurved tendrils. Recurved tendrils small, usually less than 1 mm across, formed from about 20 segments at branch ends, present on prostrate and lower branches. *Structure.* Basal prostrate filaments 250–300 μm in diameter with segments L/D about 1, attached by unicellular rhizoids which are not cut off from the pericentral cells and by hooked tendrils; erect axes 200–250 μm in diameter with segments L/D 3–6 (-8), decreasing in lesser branches to 100–150 μm in diameter with segments L/D 1–1.5 and to 50–80 μm in diameter with segments L/D 0.6–1 close to the apices; apices straight, shortly pointed, trichoblasts profuse; lateral branches replacing trichoblasts; occasional cicatrigenous branches present. Pericentral cells 4, elongate throughout the thallus, ecorticate (Fig. 77F); trichoblasts (or scar cells) formed on every segment, with a divergence of 1/4, relatively slender but often persistent for many segments from the apices. Rhodoplasts discoid, scattered or chained.

Reproduction. Carposporophytes with a small basal fusion cell and short, branched gonimoblast with clavate terminal carposporangia 25–50 μm in diameter. Cystocarps (Fig. 77F, G) short stalked, ovoid to slightly pyriform, non-urceolate, 300–400 μm in diameter; pericarp ostiolate, 2 cells thick, outer cells isodiametric, angular. Spermatangial branches unknown.

Tetrasporangia (Fig. 77H) in subulate branch ends or short laterals, gently spirally arranged and usually with a regular size gradation to the tip, mature sporangia occupying most of the width of the branch but scarcely distorting it, subspherical, 80–120 μm in diameter, tetrahedrally divided.

Type from 3 km SE of Troubridge I. S. Aust., 24 m deep (*Shepherd*, 5.ii.1969); holotype in AD, A33838.

Distribution: Only known from near the type locality, Waldegrave I. and Investigator Strait, S. Australia.

Selected specimens: Off Waldegrave I., S. Aust., 21 m deep (*Shepherd*, 30.x.1983; AD, A54507). Off Troubridge Light, S. Aust., 18 m deep (Shepherd, 4.ii.1969; AD, A33568). Edge of Tapley Shoal, S. Aust., 13 m deep (*Mitchell*, May 1961; AD, A28103). Investigator Strait, S. Aust., 33 m deep (*Watson*, 20.i.1971; AD, A38584).

P. shepherdii is a deep-water species characterised by the rhizoids not being cut off from pericentral cells, by profuse trichoblasts on every segment, by the small hooked tendril branches, and by the dimensions and habit of the thallus. It is a large species, distinct from the other species with such rhizoids in size and robustness (c.f. *P. scopulorum* and *P. subtilissima*) or in branch morphology (*P. senticulosa*), as well as in forming trichoblasts on every segment.

3. **Polysiphonia scopulorum** Harvey 1855a: 540; 1863, synop.: xx. Abbott 1999: 425, fig. 125C–F. Adams 1994: 317. J. Agardh 1863: 940. Beanland & Woelkerling 1982: 98. Cordeiro-Marino & Oliveira 1970: 45, figs 1–9. Cribb 1983: 132, pl. 70 figs 1, 2. De Toni 1903: 1065. Hollenberg 1968a: 79, figs 6F, 30, 31, 33, 36. Huisman & Walker 1990: 440. Huisman *et al.* 1990: 98. Kendrick *et al.* 1988: 204; 1990: 52. Kützing 1864: 12, pl. 37a–c. Lewis 1984: 65. Lucas 1909: 45. Millar 1990: 445, fig. 65E–G; 1999: 524. Millar & Kraft 1993: 58. Segi 1959: 262, pl. 13E, F, fig. 3, (excl. Japan specimens). Silva *et al.* 1996: 545. Sonder 1880: 34. Womersley 1979: 467, fig. 2A–E.
Vertebrata scopulorum (Harvey)Kuntze 1891: 929.
Lophosiphonia scopulorum (Harvey)Womersley 1950: 188. Ardre 1970: 215, pl. 28 fig. 1, pl. 29 figs 1–4. Cribb 1956b: 138, pls 1, 2 figs 8–12. May 1965: 380.

FIG. 78A–E

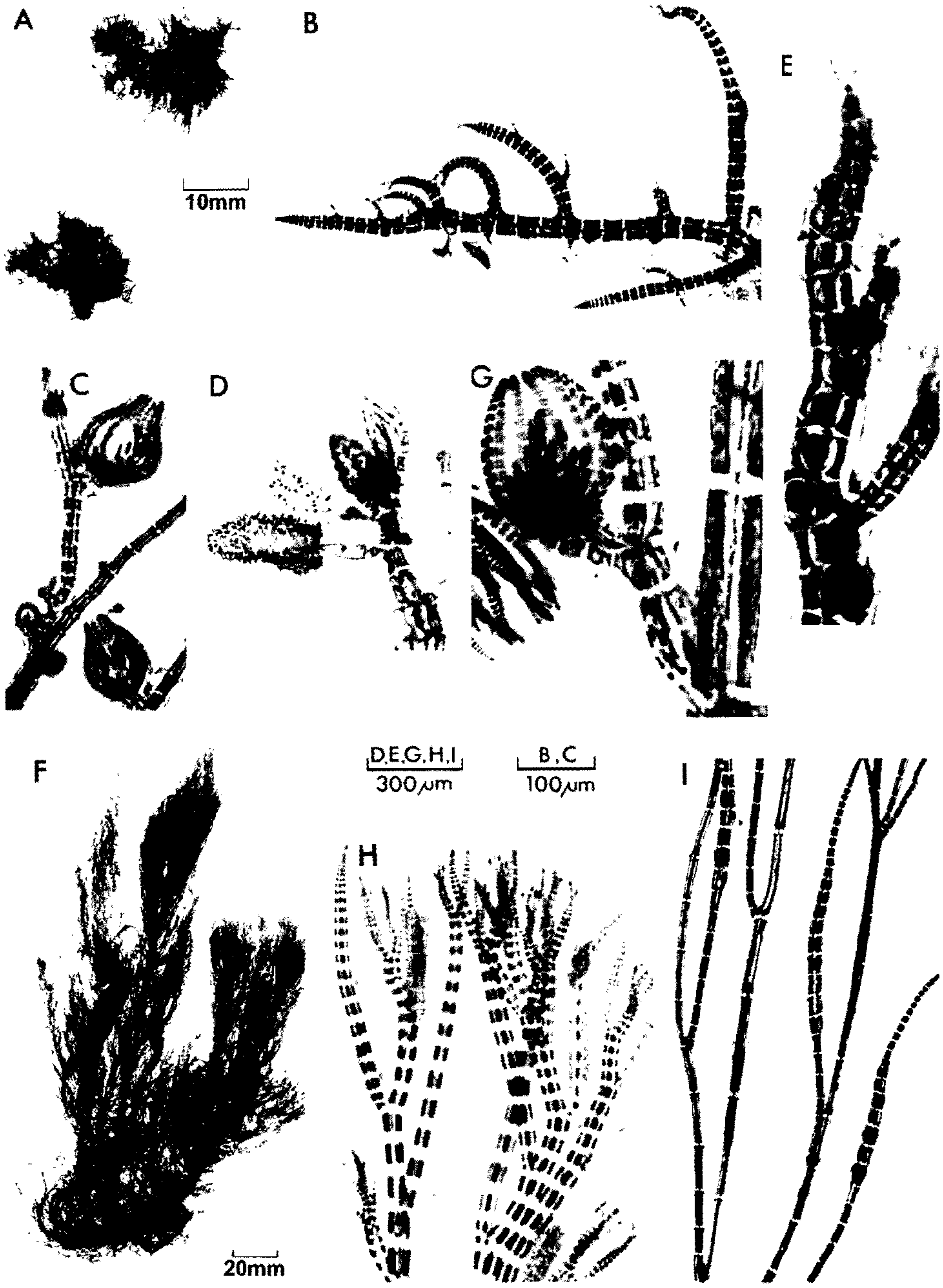

Fig. 78. A–E. *Polysiphonia scopulorum* (**A**, AD, A32910; **B–E**, AD, A46072). **A**. Habit. **B**. Prostrate axis with erect branches. **C**. Cystocarps. **D**. Spermatangial branches. **E**. Tetrasporangial branch. **F–I**. *Polysiphonia subtilissima* (**F**, AD, A44593; **G**, **H**, AD, A42717; **I**, AD, A36031). **F**. Habit. **G**. Cystocarp. **H**. Spermatangial branches. **I**. Tetrasporangial branches. (All as in Womersley 1979, courtesy of Aust. J. Bot.)

Thallus (Fig. 78A, B) dark red-brown, 5–15 (-40) mm high, usually forming spreading mats on rock platforms just emergent at low tide, sometimes as dense tufts, normally with an extensive and relatively prominent prostrate basal system bearing erect branches, simple or usually with few laterals (occasionally moderately branched). Attachment by rhizoids from prostrate filaments; epilithic, occasionally epiphytic (on *Scaberia* and *Amphibolis*). *Structure.* Prostrate filaments (Fig. 78B) 80–130 µm in diameter with segments L/D 0.5–1.5, attached by scattered rhizoids in open connection with pericentral cells, with actively developing apices and producing adventitious erect branches usually arising several segments from the apices; erect branches 80–120 (-140) µm in diameter with segments L/D 0.5–1.5, often slightly narrower towards their base, bearing a few lateral branches of similar diameter and arising independently of trichoblasts, probably mainly cicatrigenously. Pericentral cells 4, ecorticate (Fig. 78B, C); trichoblasts and scar cells occasional only on lower parts of erect branches, more frequent and sometimes on every segment with a phyllotaxis of 1/4 near well-developed apices; trichoblasts slender, several times furcate. Rhodoplasts discoid, scattered.

Reproduction. Gametophytes dioecious. Carposporophytes with a small basal fusion cell and branched gonimoblast with clavate terminal carposporangia 20–30 µm in diameter. Cystocarps (Fig. 78C) short-stalked, globular to slightly urceolate, 300–400 µm in diameter; pericarp 2 cells thick, outer cells isodiametric, angular. Spermatangial branches (Fig. 78D) developed commonly from both basal branches of a trichoblast and thus appearing paired, sometimes replacing whole trichoblast, 120–200 µm long and 40–50 µm in diameter, without sterile tip cells.

Tetrasporangia (Fig. 78E) forming slightly spiral series in upper laterals, slightly swelling and distorting the lateral (100–200 µm in diameter), sporangia 50–60 (-70) µm in diameter.

Type from Rottnest I., W. Aust. (*Harvey*); holotype and isotypes in TCD (Trav. Set 187).

Distribution: Dampier Archipelago, W. Aust. (Huisman & Walker 1990, p. 440), to Barwon Heads, Victoria, N.S.W. and southern Queensland. Variety *villum* (J. Ag.)Hollenberg is widely recorded from subtropical and temperate countries (NZ, Brazil, Portugal, Indo-Pacific). South Africa.

Selected specimens: Point Sinclair, S. Aust., lower eulittoral, shaded (*Gordon*, 3.xi.1968; AD, A34124). NE end Boston I., Port Lincoln, S. Aust., on *Scaberia*, 3–4 m deep (*Womersley*, 28.ii.1959; AD, A22517). Whyalla, S. Aust., in channel (*Harbison*, 30.v.1994; AD, A63576). Point Riley, S. Aust., on *Scaberia*, sublittoral (*Gill*, 24.xi.1974; AD, A46072). Christies Beach, S. Aust., sandy pools (*Womersley*, 14.x.1968; AD, A32873). Picnic Point, American R. inlet, Kangaroo I., S. Aust., upper sublittoral (*Womersley*, 30.viii.1950; AD, A15333). Pennington Bay, Kangaroo I., S. Aust., rear (lower) eulittoral (*Womersley*, 21.xi.1968; AD, A32910 and 27.x.1995; AD, A64610). Cape Lannes, S. Aust., lower eulittoral (*Womersley*, 22.iv.1990; AD, A60176—"Marine Algae of southern Australia" No. 346). Barwon Heads, Vic., mid eulittoral (*Gordon-Mills*, 4.xii.1983; AD, A55442).

P. scopulorum occurs mainly on rough-water rock platforms or in relatively calm localities, usually lower eulittoral, occasionally sublittoral on older axes of *Scaberia*. It is a distinctive species in its typical form, with the strongly developed prostrate system attached by rhizoids in open connection with the pericentral cells, the erect filaments of short segments with few branches, scar cells and trichoblasts rare or occasional on lower branches but present on every segment of well-developed apices, and the spermatangial branches either replacing the whole trichoblast or both basal arms of a trichoblast.

The characteristic lower eulittoral patches of *P. scopulorum* on rock platforms subject to strong wave action, along most of southern Australia, commonly have many apices removed by animal grazing, but some apices bear abundant trichoblasts. However, only the upper parts of well-grown erect filaments produce trichoblasts from every segment. Some specimens growing only under moderate wave action (e.g. AD, A32873, A64610) reach 25–40 mm in height with fairly numerous upper branches.

Branching of *P. scopulorum* appears to be largely cicatrigenous with some exogenous apical branching, and branching from prostrate filaments may be endogenous. However it is clear from the studies of Hollenberg (1942b, p. 536; 1968a, p. 56) that this species is best placed in *Polysiphonia* rather than *Lophosiphonia.*

Hollenberg (1968a, pp. 83, 85) described two varieties in addition to var. *villum* (J. Agardh) Hollenberg, from the tropical Pacific. While *P. scopulorum* may well be a fairly widespread species, varying elsewhere considerably from the southern Australian plants, some records are clearly incorrect [e.g. the Japanese record of Segi (1951, p. 200) is included by Yoshida (1998, p. 1073) under *P. yendoi* Segi].

4. **Polysiphonia subtilissima** Montagne 1840a: 199. Abbott 1999: 430, fig. 128A. Adams 1994: 318. J. Agardh 1863: 962. Allender 1981: 19, 20, 22. Beanland & Woelkerling 1982: 99. De Toni 1903: 874; 1924: 393. Harvey 1853: 34. Hollenberg 1968a: 92, fig. 19. Kützing 1849: 804; 1863: 10, pl. 28a–e. Lewis 1983: 263; 1984: 66. Menez 1964: 211, fig. 6D–G. Miller & Kraft 1993: 59. Segi 1959: 261, pl. 13C, D. Silva *et al.* 1996: 546. Womersley 1979: 469, fig. 2F–I. Yoon 1986: 13, fig. 5, pl. 3.

   Polysiphonia angustissima Kützing 1864: 17, pl. 47d–g. De Toni 1903: 960. Lucas 1909: 41. Lucas & Perrin 1947: 275 (descr. incorrect). Segi 1966: 504, pl. 2B.

   ? *Polysiphonia abscissa* Hooker & Harvey 1845a: 266. J. Agardh 1863: 974. De Toni 1903: 879; 1924: 394. Guiler 1952: 103. Harvey 1847: 43; 1859b: 299; 1863, synop.: xx. Hooker 1847: 480, pl. 183 fig. II. Howe 1914: 140. Kützing 1849: 817?; 1863: 22, pl. 70a–d. Lucas 1909: 41; 1929a: 21. Lucas & Perrin 1947: 267. Papenfuss 1964b: 62? Pujals 1963: 115. Segi 1951: 236, fig. 25, pl. 9 fig 4; 1960: 614, pl. 28D, E. Sonder 1880: 34. Tisdall 1898: 514.

FIG. 78F–I

Thallus (Fig. 78F) dark red-brown, (1-) 4–12 cm high, very slender, lax, much branched, arising from prostrate and entangled basal filaments. Attachment by rhizoids; epilithic (or on wood) or epiphytic. *Structure.* Prostrate filaments 100–180 µm in diameter with segments L/D 1–1.5 (-2), attached by scattered rhizoids in open connection with the pericentral cells, and with occasional endogenous branches; erect main filaments usually 70–180 µm in diameter with segments L/D 1.5–2 (-6) below, tapering gradually to 35–60 µm in diameter above with segments mostly L/D 1–2 (-3), irregularly branched but usually with terminal flat-topped branch systems (Fig. 78H); branches arising exogenously usually every 3–7 segments near apices, independent of trichoblasts, spirally arranged on a phyllotaxis of $^1/_3$ or $^1/_4$ usually continuing as indeterminate laterals; branches 15–25 µm in diameter several segments from the apices, segments L/D 0.5–1, apical cells relatively prominent. Pericentral cells 4, ecorticate (Fig. 78H, I); trichoblasts and scar cells rare to occasional in vegetative and tetrasporangial thalli, more frequent in sexual thalli; trichoblasts slender, lower cells 8–16 µm in diameter, simple to twice furcate. Rhodoplasts discoid, scattered or in chains.

Reproduction. Gametophytes dioecious. Carposporophytes with a small basal fusion cell and short branched gonimoblast with clavate terminal carposporangia 20–30 µm in diameter. Cystocarps (Fig. 78G) short-stalked, ovoid to slightly urceolate, 120–450 µm in diameter; pericarp ostiolate, 2 cells thick, outer cells isodiametric, angular. Spermatangial branches (Fig. 78H) 150–350 µm long and 30–65 µm in diameter, replacing the whole trichoblast and with a sterile tip 4–6 cells long.

Tetrasporangia (Fig. 78 I) forming a relatively uniform straight series in ultimate or subultimate slender branchlets 60–80 µm broad, swelling each segment slightly, 35–50 µm in diameter.

Type from Cayenne, French Guiana; holotype in Herb. Montagne, PC; isotype in BM.

Distribution: Tropical and subtropical eastern America; Korea; Hawaiian Is, Indian Ocean.

In southern Australia, from Swan R. estuary, W. Aust. (Allender 1981), to Port Phillip, Vic. and around Tasmania, and to Towra Point, Botany Bay, N.S.W.

Selected specimens: Princess Royal Harbour, Albany, W. Aust., upper sublittoral (*Womersley*, 21.viii.1979; AD, A51389). Entrance to Kellidie Bay, Coffin Bay, S. Aust., low eulittoral (*Womersley*, 22.viii.1967; AD, A31867). Port Lincoln, S. Aust., 1–2 m deep (*Womersley*, 13.v.1968; AD, A32499). St Kilda, S. Aust., on *Posidonia*, 1.5 m deep (*S. Lewis*, 23.viii.1972; AD, A42717). Port Noarlunga, S. Aust., 6 m deep (*Melville*, 18.xii.1996; AD, A66819). NE Ballast Head, Kangaroo I., S. Aust., 12 m deep (*Hone*, 5.xii.1996; AD, A66974). Muston, Kangaroo I., S. Aust., 2–3 m deep (*Kraft*, 17.vii.1972; AD, A42534). Robe, S. Aust., low eulittoral in boat harbour (*Womersley*, 24.viii.1973; AD, A44593). Port MacDonnell, S. Aust., drift (*Womersley*, 27.x.1996; AD, A66713). Apollo Bay, Vic., on rope in harbour, just sublittoral (*Engler*, 19.v.1980; AD, A51075). Kirk Point, Port Phillip, Vic., drift (*Womersley*, 11.viii.1970; AD, A36031). Bombay Rock, Low Head, Tas., on mud flat (*Cribb* 73.13, 15.ix.1950; AD, A16276). Taroona, Tas., 1–3 m deep (*Shepherd*, 19.iii.1975; AD, A46227). Towra Point, Botany Bay, N.S.W., drift (*Womersley*, 20.v.1978; AD, A49370).

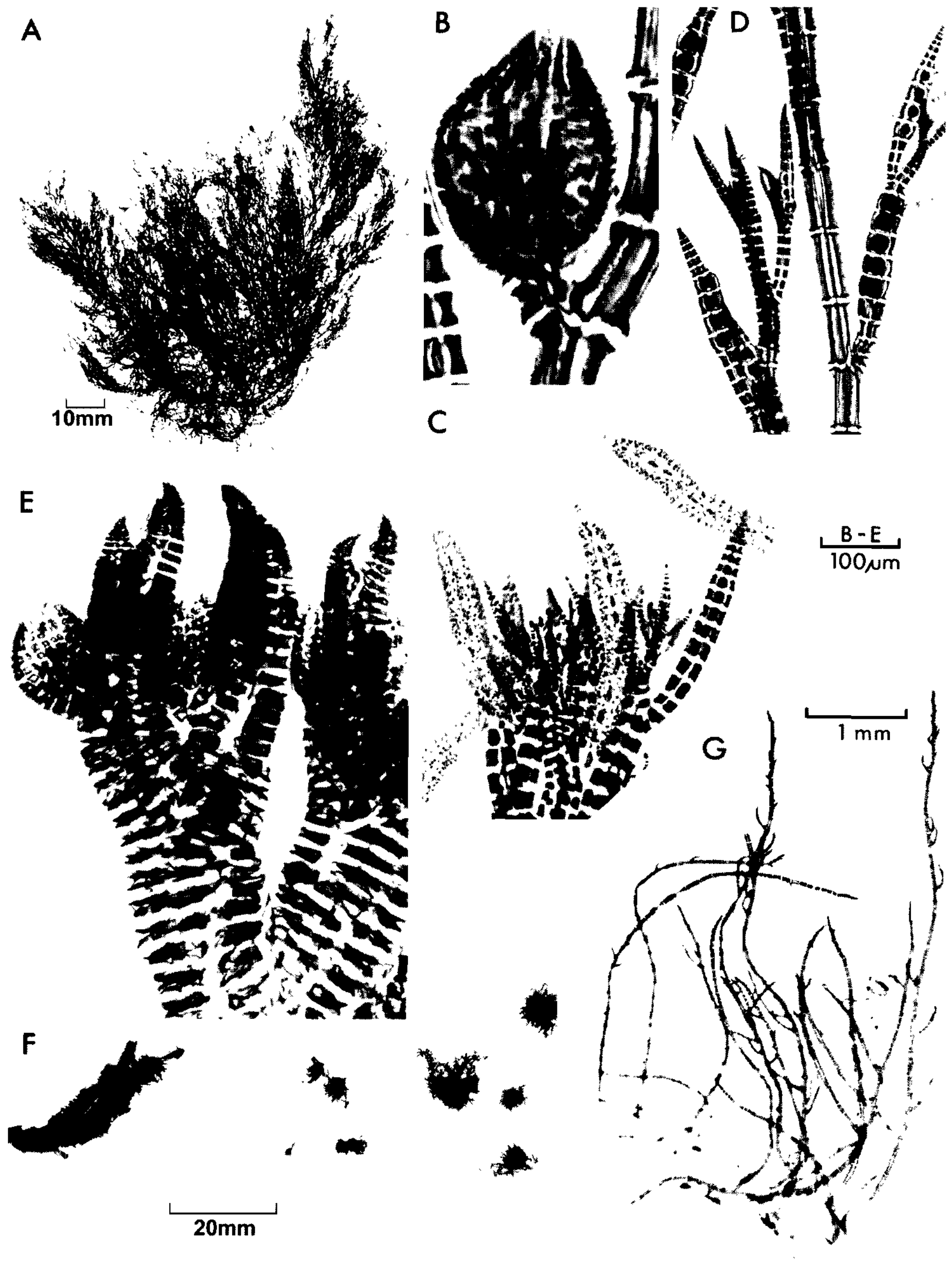

Fig. 79. A–D. *Polysiphonia senticulosa* (AD, A36032). **A.** Habit. **B.** Cystocarp. **C.** Spermatangial branches. **D.** Tetrasporangial branches. **E.** *Polysiphonia brevisegmenta* (AD, A32615). Branches bearing cystocarps. **F, G.** *Polysiphonia amphibolis* (**F**, AD, A32838; **G**, AD, A42525). **F.** Habit, on stems of *Amphibolis*. **G.** Thallus, with prostrate axes bearing erect branches. (All as in Womersley 1979, courtesy of Aust. J. Bot.)

P. subtilissima usually occurs in sheltered bays in shallow water or just intertidal.

Relationships of *P. subtilissima* with other Australian and southern hemisphere species were discussed in Womersley (1979, pp. 470–472).

5. **Polysiphonia senticulosa** Harvey 1862b: 169. J. Agardh 1863: 974. Kudo & Masuda 1988: 138, figs 1–9. Scagel *et al.* 1989: 235.

Polysiphonia pungens Hollenberg 1942a: 774, figs 1, 10. Lewis 1983: 262. Womersley 1979: 472, fig. 3A–D.

FIG. 79A–D

Thallus (Fig. 79A) dark red-brown, 5–18 cm high, slender and lax, much branched, arising from slight prostrate and entangled basal filaments. Attachment by rhizoids from prostrate filaments; epiphytic and probably epilithic. *Structure.* Prostrate filaments 250–350 μm in diameter with segments L/D 0.4–1, with scattered rhizoids in open connection with the pericentral cells; erect main filaments 180–250 μm in diameter with segments L/D 4–12 below, tapering gradually to 100–150 μm in diameter above with segments mostly L/D 1–3 (-4), irregularly branched; branches near apices arising exogenously prior to pericentral cell formation and usually every 2–7 segments, independent of trichoblasts, spirally arranged on a phyllotaxis of about 1/4, with most remaining as simple, determinate, gently tapering and acuminate (Fig. 79D) branchlets (30-) 50–100 (-120) μm in diameter, with segments L/D 0.5–1 which when mature are usually markedly shorter than segments of the parent branch; some branchlets continuing as indeterminate apices; accessory indeterminate branches also occasionally arising endogenously in branch axils from the first axial cell of the branch, or rarely from other axial cells. Pericentral cells 4, ecorticate; trichoblasts and scar cells absent or usually very rare in vegetative and tetrasporangial thalli; in sexual plants trichoblasts bear the reproductive organs, slender, with 1–3 branches. Rhodoplasts discoid to lobed or ribbon like, irregularly arranged.

Reproduction. Gametophytes dioecious. Carposporophytes with a small basal fusion cell and short gonimoblast bearing clavate terminal bearing carposporangia 20–40 μm in diameter. Cystocarps (Fig. 79B) short-stalked, ovoid to urceolate, with the neck prominent and spreading when mature, 200–570 μm in diameter; pericarp 2 cells thick, outer cells isodiametric to slightly transversely elongate. Spermatangial branches (Fig. 79C) 250–350 μm long and 40–50 μm in diameter, replacing the whole trichoblast and with a sterile tip 5–7 cells long.

Tetrasporangia (Fig. 79D) forming a straight series in lesser branchlets, swelling the branch evenly above the sterile basal segments, 60–90 μm in diameter.

Type from Orcas I., Washington, U.S.A. (*Lyall*); holotype in BM.

Distribution: In southern Australia from harbours in Victoria.

NW North America. Japan (Yoshida 1999, p. 1071).

Selected specimens: Apollo Bay, Vic., on *Sargassum vestitum* on pipeline (just subsurface) in dock (*Owen*, 1.ix.1971; AD, A39494). Kirk Point, Port Phillip, Vic., drift (*Womersley*, 11.viii.1970; AD, A36032 and 30.viii.1971; AD, A39519). Williamstown, Vic., lower eulittoral (*King*, 28.viii.1969; AD, A39493, MEL, 45986 and MELU, 4613). Breakwater Pier, Hobsons Bay, Vic., on mussels (*J. Lewis*, 3.ix.1976; AD, A49786). Ricketts Point, Port Phillip, Vic., lower eulittoral (*King*, 30.ix.1969; MEL, 45988 and MELU, 4697).

Kudo & Masuda (1988) have shown that *P. pungens* Hollenberg is synonymous with *P. senticulosa* Harvey. Kylin (1941, p. 35, pl. 11 fig. 33) placed the latter as the type of a new genus, *Orcasia*, due to the endogenous origin of accessory branches (see also Kylin 1956, p. 503). The genus *Orcasia* has not been recognised by other authors (e.g. Scagel *et al.* 1989) but the endogenous axillary branching may well be a distinctive feature.

The disparate distribution, and the occurrence in Australia mainly in the harbour of Port Phillip, indicates it may be an adventive, spread by shipping.

6. **Polysiphonia brevisegmenta** Womersley 1979: 473, fig. 3E. Millar & Kraft 1993: 57. Shepherd & Womersley 1981: 367.

FIG. 79E

Thallus (Fig. 79E) dark red-brown, 3–5 mm high, occurring as small erect tufts. Attachment by a basal tuft of rhizoids; epiphytic on *Codium capitulatum*. *Structure.* Rhizoids relatively coarse, simple or occasionally branched, cut off from pericentral cells near the base of erect axes which are subdichotomously branched several times. Lower axes 400–550 µm in diameter, tapering slightly until close to apices, then decreasing more abruptly from 150–200 µm in diameter to the pointed apices; segments L/D throughout thallus about 0.2, with all mature pericentral cells laterally elongate (Fig. 79E); laterals arising close to apices, apparently replacing trichoblasts, with occasional laterals from near the base. Pericentral cells 4, ecorticate throughout most of thallus but with slight cortication near the base of the erect axes; trichoblasts and scar cells on every segment, with a divergence of 1/4; trichoblasts slender, several times furcate, scar cells prominent, elongate radially to thallus. Rhodoplasts discoid, scattered.

Reproduction. Gametophytes dioecious. Carposporophytes with a small basal fusion cell and short gonimoblast with clavate carposporangia 30–40 µm in diameter. Cystocarps (Fig. 79E) subsessile, ovoid, 300–500 µm in diameter; pericarp ostiolate, 2 cells thick, outer cells isodiametric, angular. Spermatangial branches replacing whole trichoblast, 150–300 µm long and 100–200 µm in diameter, with a single dome shaped, sterile apical cell.

Tetrasporangia unknown.

Type from Elliston, S. Aust., on *Codium capitulatum* in shaded areas within south point of bay, about low tide level (*Gordon*, 16.v.1968); holotype in AD, A32615.

Distribution: Only known from the type, and reported from Lord Howe I. (Millar & Kraft 1993, p. 57).

Although still only known in southern Australia from the single type collection of a few sexual plants, *P. brevisegmenta* appears to be a distinctive though diminutive species. It is, however, very similar in most characteristics to *P. forfex*, differing in having only 4 pericentral cells compared with 6 in the latter. The closest species with 4 pericentral cells in southern Australia is *P. succulenta* Harvey, which differs in size, filament dimensions, and in having both segments and pericentral cells distinctly longer than in *P. brevisegmenta.*

7. **Polysiphonia amphibolis** Womersley 1979: 474, figs 3F, G, 4A–C. Huisman *et al.* 1990: 97. Kendrick *et al.* 1988: 204; 1990: 52. Lewis 1984: 63. Silva *et al.* 1996: 536.
Polysiphonia implexa sensu Harvey 1855a: 540; 1863, synop.: xx. J. Agardh 1863: 945 (in part?). Kützing 1864: 12, pl. 36g, h. Lucas 1909: 41. Lucas & Perrin 1947: 268. Sonder 1880: 34. [NON *P. implexa* Hooker & Harvey 1845b: 538; Harvey 1847: 44. De Toni 1903: 889. Kützing 1849: 806.]

FIGS 79F, G, 80A–C

Thallus (Fig. 79F, G) dark brown-red, forming intricate tufts or a felt, usually not more than 1 cm high but occasionally with branches extending from the felt and up to 2 cm high. Attachment by rhizoids from prostrate filaments; epiphytic on the stems of *Amphibolis*, occasionally on *Corallina* or *Chiracanthia*. *Structure.* Prostrate filaments 70–120 (-160) µm in diameter, tapering gradually to the pointed apices, with segments L/D 0.8–1.5, attached by scattered rhizoids cut off from the pericentral cells and with relatively massive multicellular haptera; axes branching irregularly spirally every (1-) 2–5 segments, producing laterals cicatrigenously and with occasional simple or once branched trichoblasts or single trichoblast cells or scar cells present on every segment. Lateral branches (from prostrate axes) more or less erect (Fig. 79G), mostly 50–130 µm in diameter with segments L/D (0.8-) 1.5–2.5 (-3), tapering gradually to pointed apices, irregularly spirally branched every 1 or 2 segments with branches replacing trichoblasts and developed to varying extents, with many remaining simple. Pericentral cells 4, ecorticate; trichoblasts and scar cell generally present on every segment of erect branches, trichoblasts on well developed apices several times furcate, basal cells 20–30 µm in diameter. Rhodoplasts discoid or commonly ribbon-shaped, irregular or often orientated transversely in the pericentral cells.

Reproduction. Gametophytes dioecious. Carposporophytes with a slight fusion cell and short, branched gonimoblasts with clavate terminal carposporangia 20–25 µm in diameter. Cystocarps (Fig. 80A) short-stalked, ovoid and orientated parallel to parent branch, becoming slightly urceolate when mature, 250–500 µm in diameter; pericarp ostiolate, 2 cells thick, outer cells isodiametric. Spermatangial branches (Fig. 80B) replacing the whole trichoblast, 70–90 µm long and 35–60 µm in diameter, apically pointed, with a 1–2-celled sterile base and usually a small, sterile apical cell.

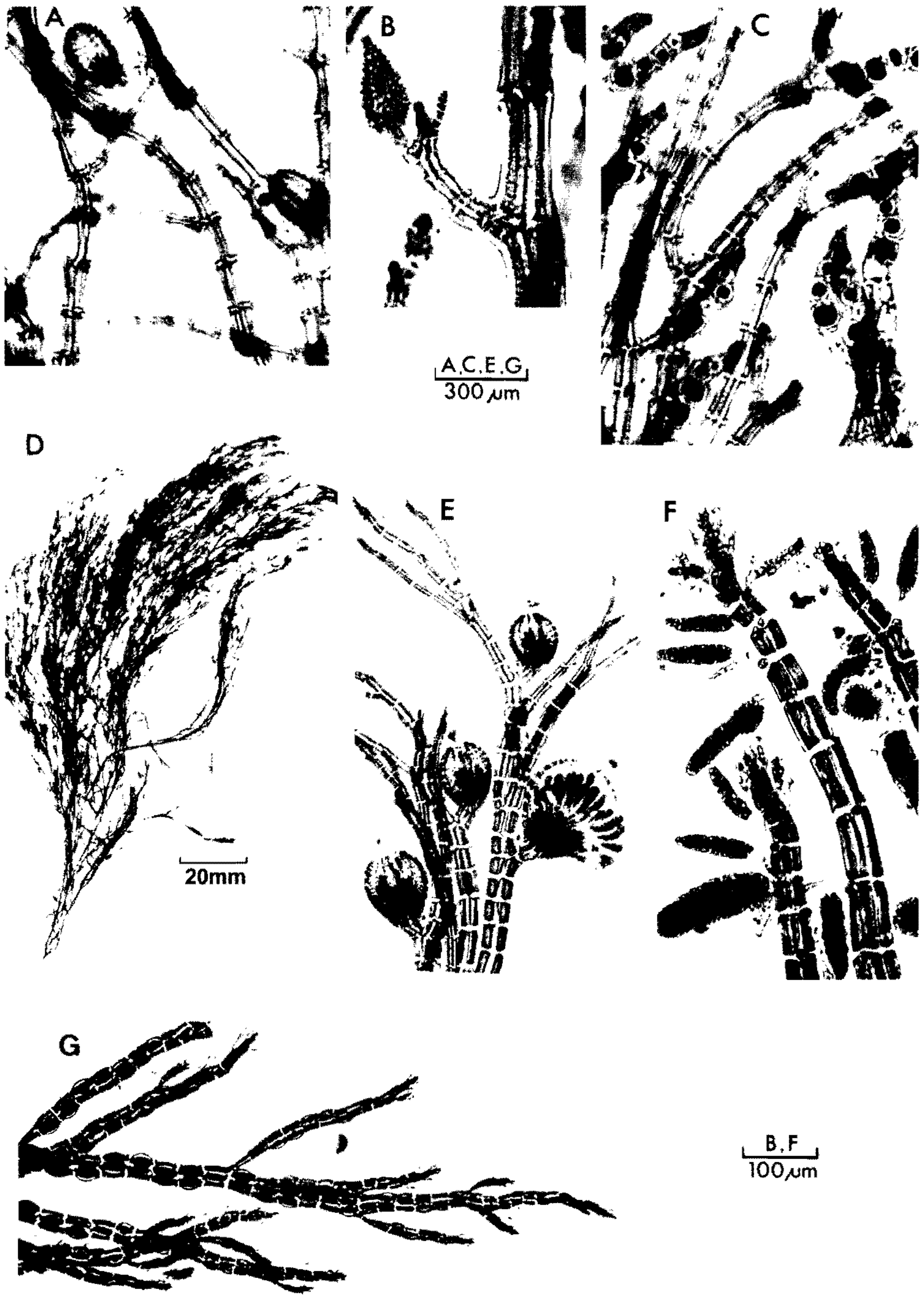

Fig. 80. A–C. *Polysiphonia amphibolis* (AD, A32838). **A.** Branches with cystocarps. **B.** Spermatangial branches. **C.** Tetrasporangial branches. **D–G.** *Polysiphonia mollis* (AD, A32929). **D.** Habit. **E.** Branches with cystocarps. **F.** Spermatangial branches. **G.** Tetrasporangial branches. (All as in Womersley 1979, courtesy of Aust. J. Bot.)

Tetrasporangia (Fig. 80C) forming a slightly spiral, short series (3–8) in the lesser branches, markedly swelling the segments above the sterile basal ones, 45–70 μm in diameter.

Type from West Beach, S. Aust., on *Amphibolis*, drift (*Gordon*, 4.x.1968); holotype in AD, A32838.

Distribution: Shark Bay, W. Aust. (Huisman *et al.* 1990, p. 97) to Marino, Gulf St Vincent, S. Aust. mainly on *Amphibolis*; also recorded on *Corallina* and *Chiracanthia*. Incorrectly reported from Lord Howe I. by Lewis (1984, p. 63) – see Millar & Kraft (1993, p. 57).

Selected specimens: Cliff Head, W. Aust., on *Amphibolis*, 5–6 m deep (*Kirkman & Joll*, 18.ix.1979; AD, A51195). King George Sound, W. Aust., (*Harvey*, Alg. Aust. Exsicc. 179B; AD, A18270 and MEL, 1006721). NE Boston I., Port Lincoln, S. Aust., on *Haliptilon*?, 3–4 m deep (*Womersley*, 28.ii.1959; AD, A22516). Yatala Harbour, N Spencer Gulf, S. Aust., 10 m deep (*Johnson*, 29.v.1976; AD, A54926). Tiparra Reef, S. Aust., on *Amphibolis*, 5 m deep (*Shepherd*, 17.vi.1971; AD, A39181). Off St Kilda, S. Aust., on *Amphibolis*, 3 m deep (*S. Lewis*, 28.viii.1972; AD, A42742). Glenelg, S. Aust., on *Amphbolis*, 18 m deep (*Glover*, 20.iv.1961; AD, A24849). Emu Bay, Kangaroo I., S. Aust., on *Haliptilon*, 3–4 m deep (*Kraft*, 6.iv.1972; AD, A42431). Muston, American R. inlet, Kangaroo I., S. Aust., on *Chiracanthia*, 2–3 m deep (*Kraft*, 17.vii.1972; AD, A42525).

The habitat, habit, morphology, the multicellular rhizoidal pads and the common transverse arrangement of rhodoplasts clearly characterise *P. amphibolis*. It is not uncommon on *Corallina* and is a common epiphyte on the stems of *A. antarctica*, where it may be directly associated with the common crustose coralline epiphytes on this seagrass. The single collection on *Chiracanthia* may also be associated with crustose corallines.

8. **Polysiphonia mollis** Hooker & Harvey *ex* Harvey 1847: 43; 1855a: 539; 1859b: 299; 1863, synop.: xx. J. Agardh 1863: 968. De Toni 1903: 877; 1924: 394. Guiler 1952: 103. Hooker & Harvey 1847: 399. Huisman & Walker 1990: 440. Kützing 1849: 823; 1863: 27, pl. 88a–c. Lucas 1909: 41; 1929a: 21; 1929b: 51. Lucas & Perrin 1947: 267. Mazza 1909: No. 284. Menez 1964: 213, fig. 3? Reinbold 1897: 57. Silva *et al.* 1996: 543. Sonder 1853: 701; 1855: 524; 1880: 34. Tisdall 1898: 514. Wilson 1892: 167. Womersley 1956: 82, 83; 1979: 476, fig. 4D–G.
Polysiphonia flavescens Zanardini 1874: 490. De Toni 1903: 955; 1924: 402. Guiler 1952: 103. Lucas 1909: 41; 1929a: 21. Lucas & Perrin 1947: 270.

FIG. 80D–G

Thallus (Fig. 80D) red-brown, usually 4–20 cm high, with a single, erect, basal axis (occasionally a slight prostrate part) and profusely branched above (often denuded below in older plants) subdichotomously to laterally to form dense, fastigiate to spreading, soft tufts. Holdfast discoid, small; commonly epiphytic on *Posidonia*, *Heterozostera*, *Halophila* or larger algae. *Structure*. Basal axis 300–700 μm in diameter with segments L/D 0.3–1, attached by unicellular rhizoids cut off from the lower pericentral cells; branches above the basal axis 250–500 μm in diameter with segments L/D 1–4 (-8), decreasing in lesser branches to 100–150 μm in diameter with segments L/D 0.7–3 and to 30–50 μm in diameter with segments L/D about 1 close to the apices; apices straight, apical cell and trichoblasts prominent; lateral branches arising close to apices from the basal cell of trichoblasts, with the trichoblast usually remaining lateral to the new branch rather than outside it; cicatrigenous branches often present below. Pericentral cells 4, elongate throughout the thallus except within a few segments of apices; ecorticate except for slight cortication in older parts near the base of the erect axis by filaments of relatively short cells originating from the corners of the pericentral cells and lying lengthwise over the junction; trichoblasts (or scar cells) formed on every segment, with a divergence of 1/4, relatively slender, basal cells 8–12 μm in diameter. Rhodoplasts discoid to angular; scattered or commonly in irregular chains.

Reproduction. Gametophytes dioecious. Carposporophytes with a slight basal fusion cell and short, branched, gonimoblast with shortly clavate terminal carposporangia 25–50 μm in diameter. Cystocarps (Fig. 80E) short-stalked, globular to ovoid, not or slightly urceolate, 250–400 μm in diameter; pericarp ostiolate, 2 cells thick, outer cells isodiametric, angular. Spermatangial branches (Fig. 80F) developing as one branch of a trichoblast, elongate-ovoid to cylindrical, (80-) 120–200 μm long and 35–50 μm in diameter, without a sterile apical cell, or with an inconspicuous one.

Tetrasporangia (Fig. 80G) forming gently spiral series in upper branches (often extending below one to several laterals), slightly to prominently swelling and distorting the branch, subspherical to ovoid, 50–70 μm in diameter.

Type from Tasmania, on larger algae (*Gunn*); lectotype in BM.

Distribution: Rottnest I., W. Aust., around southern Australia and Tasmania to Port Phillip, Victoria.

Indian Ocean (see Silva *et al.* 1996: 543); Pacific Ocean? (Abbott & Hollenberg 1976: 688).

Selected specimens: Salmon Bay, Rottnest I., W. Aust., on *Sargassum*, drift (*Parsons*, 12.xi.1968; AD, A33387). Muston, American R. inlet, Kangaroo I., S. Aust., 2–3 m deep (*Womersley*, 21.xi.1968; AD, A32929) and 4–5 m deep (*Shepherd*, 29.xii.1977; AD, A48954). Taroona, Tas., 1–3 m deep (*Shepherd*, 19.iii.1975; AD, A46226).

The type material of *P. mollis* in BM consists of a sheet with two specimens, both 'Gunn 1316'. The lower is selected as lectotype; the upper isolectotype is attached to a *Eucalyptus* leaf. Another specimen from V.D.L. is labelled '*Polysip. mollis* var'. Two features that are not convincingly shown in the type are the single erect base and the origin of the lateral branches. However, Harvey in his original description referred to 'Root scutate. Fronds erect, solitary, or approximating' and in the recent material examined the erect basal axis attached by a cluster of rhizoids is a general feature. The origin of branches from trichoblasts is a difficult feature to discern in herbarium specimens, but a careful examination of the type shows that almost certainly branches do originate from the basal cell of trichoblasts, as they clearly do in fresh collections which in other features agree well with the type.

P. mollis is characterised by the erect base and branches which taper from 300 μm or more near the base to 30–50 μm in diameter close to the apices, the branching associated with the trichoblasts, and the soft, readily disintegrating nature of the thallus. It is a common epiphyte in relatively calm situations or where a current flows.

P. mollis has been recorded (often doubtfully) from many parts of the tropical Indian and Pacific Oceans, e.g. from Japan by Yendo (1916b, p. 261), now placed under *P. japonica* Harvey by Yoshida (1998, p. 1067); from Sri Lanka by Durairatnam (1961, p. 70) on the basis of a sterile specimen ; from Mauritius by Børgesen (1945, p. 30) but see Silva *et al.* (1996, p. 543); from Bangladesh by Islam (1976, p. 64); from the central Pacific and from Mexico by Hollenberg (1961, p. 359, pl. 4 fig. 2; 1968a, p. 69, fig. 43) but referred by Abbott (1999, p. 432) to *P. tongatensis* Harvey *ex* Kützing; and from Queensland by Askenasy (1894, p. 13, pl. 3 fig. 13, pl. 4 figs 20–22) and by Cribb (1956b, p. 131, pl. 4 figs 1–4, pl.5). However, it appears unlikely that *P. mollis* occurs outside southern Australia.

An isotype of *P. flavescens* Zanardini from Georgetown, Tas. (*Goodwin*), in Herb. Zanardini, Venice, is identical with *P. mollis* and comes from the same type locality.

9. **Polysiphonia sertularioides** (Grateloup)J. Agardh 1863: 969. Adams 1994: 319. De Toni 1903: 870; 1924: 390. Falkenberg 1901: 122, pl. 1 figs 1–16. Funk 1955: 134, pl. 23 figs 7, 8. Huisman & Walker 1990: 440. Huisman *et al.* 1990: 98. Kendrick *et al.* 1990: 52. Lauret 1967: 350, pls 2, 3 figs 1, 2. Lewis 1984: 65. Millar & Kraft 1993: 58. Shepherd & Womersley 1981: 367. Silva *et al.* 1996: 545. Womersley 1979: 478, fig. 5A–D.

Ceramium sertularioides Grateloup 1806: (unnumbered page), fig. IV.

Polysiphonia havanensis sensu Harvey 1855a: 539; 1863, synop.: xx. Lucas & Perrin 1947: 269. Sonder 1880: 34 (in part). Tate 1882a: 23. [NON *P. havanensis* Montagne]

? *Polysiphonia macrarthra* Zanardini 1874: 490. Cribb 1954a: 25, 37. De Toni 1903: 955. Guiler 1952: 103. Lucas 1909: 41; 1913: 59; 1929a: 21. Lucas & Perrin 1947: 271.

? *Polysiphonia flaccidissima* Hollenberg 1942a: 783, fig. 8; 1961: 351, pl. 2 fig. 2; 1968a: 63, figs 2A, 11. Abbott 1999: 414, fig. 121A, B. Abbott & Hollenberg 1976: 688, figs 634, 635.

Polysiphonia flaccidissima var. *smithii* Hollenberg. Cribb 1956b: 134, pl. 4 fig. 5.

FIG. 81A–D

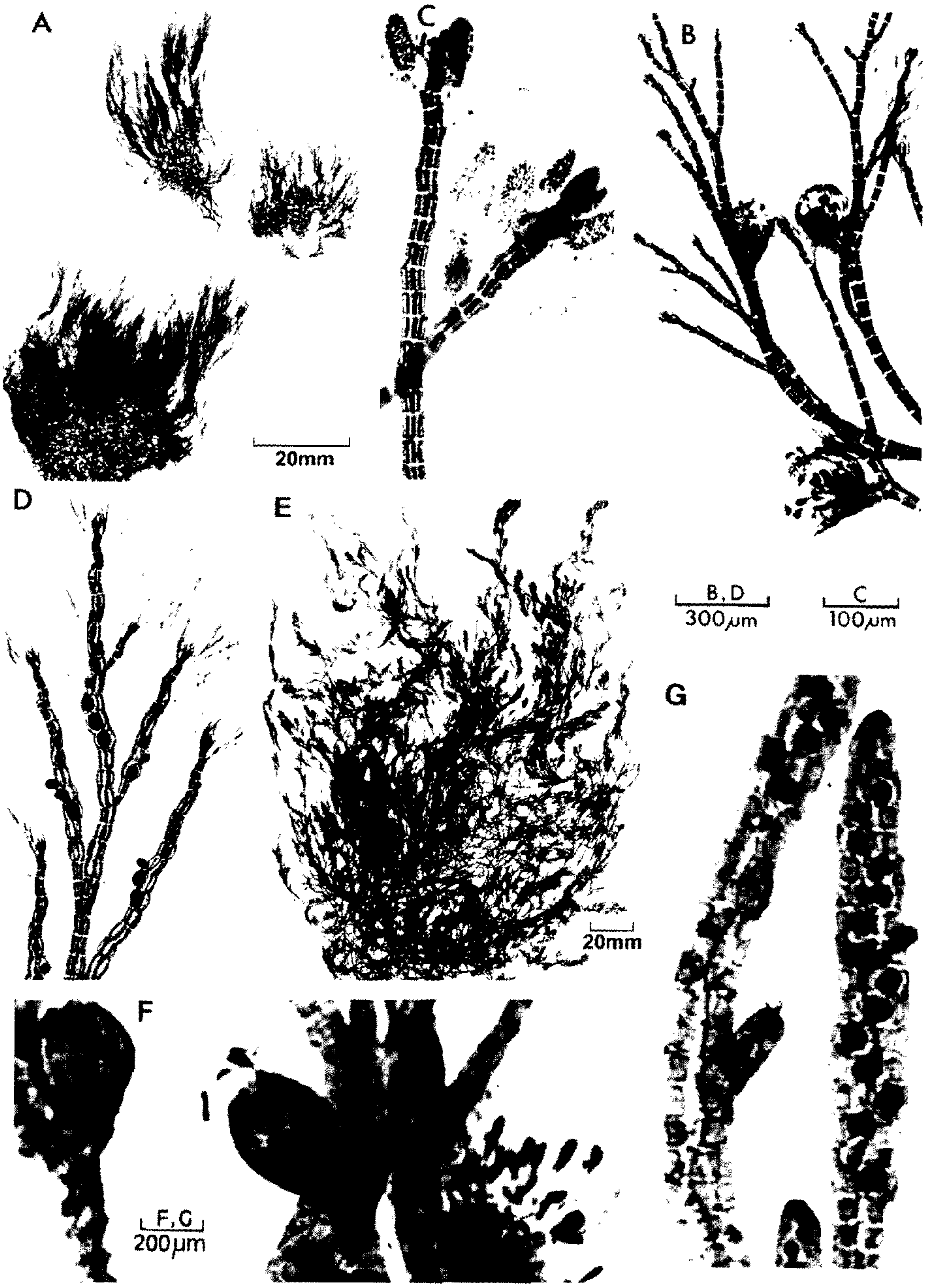

Fig. 81. A–D. *Polysiphonia sertularioides* (**A**, AD, A41531; **B–D**, AD, A49286). **A**. Habit. **B**. Branches with cystocarps. **C**. Spermatangial branches. **D**. Tetrasporangial branches. **E–G**. *Polysiphonia perriniae* (**E**, AD, A9004; **F**, G, AD, A64191). **E**. Habit. **F**. Cystocarps. **G**. Branches with tetrasporangia. (**A**, **B**, **D**, **E** as in Womersley 1979, courtesy of Aust. J. Bot.)

Thallus (Fig. 81A) dark red-brown, 2–8 (-14) cm high, usually in dense, soft and somewhat gelatinous tufts or masses, with a tangle of prostrate filaments producing very numerous erect, slender, fastigiate, much-divided branches. Attachment from prostrate filaments; epilithic, occasionally epiphytic. *Structure.* Prostrate filaments 100–130 (-250) µm in diameter with segments L/D 1–2, attached by scattered unicellular rhizoids with digitate haptera, cut off from the proximal end of pericentral cells. Erect branches (Fig. 81B, D) 70–150 (-200) µm in diameter with segments L/D (0.8-) 1–3 (-4), occasionally extending to L/D up to 12 in mid and lower parts of long branches, decreasing gradually to 25–50 µm in diameter and segments L/D 0.5–1.5 shortly below the apices; apices straight, with fairly prominent apical cells and usually profuse trichoblasts; lateral branches arising close to apices from the basal cell of a trichoblast (Fig. 81D) which remains simple or once furcate; cicatrigenous branches occasionally arise from lower parts. Pericentral cells 4, elongate throughout the thallus, ecorticate throughout; trichoblasts (or scar cells) formed on every segment with a divergence of 1/4, relatively slender, (1-) 2–3 (-4) times furcate. Rhodoplasts discoid, scattered or in chains.

Reproduction. Gametophytes dioecious. Carposporophytes with a slight basal fusion cell and short gonimoblast with pyriform to clavate terminal carposporangia 25–40 µm in diameter. Cystocarps (Fig. 81B) stalked, subspherical to slightly urceolate, 150–300 µm in diameter; pericarp ostiolate, 2 cells thick, outer cells elongate, L/D 1.5–2 when mature. Spermatangial branches (Fig. 81C) developing as one branch of a trichoblast, cylindrical and tapering slightly, 120–250 µm long and 30–60 µm in diameter, without a sterile apical cell when mature.

Tetrasporangia (Fig. 81D) forming regular, slightly spiral to almost straight, prominent series in upper branches, occasionally in isolated rows of 3–6, when in laterals with the lower few segments sterile and narrower, often extending below a branch, slightly to considerably but evenly swelling the branch with the mature sporangia occupying most of the branch width, subspherical to ovoid, 35–65 µm in diameter, tetrahedrally (often subcruciately) divided.

Type from Cette, Golfe du Lion, France; location unknown.

Distribution: Mediterranean, New Zealand.

In Australia, the Dampier Archipelago and from Rottnest I. and North Beach (Perth), W. Aust., along the southern coast to Western Port, Vic., (probably to Queensland) and around Tasmania.

Selected specimens: Rottnest I., W. Aust., uppermost sublittoral in sand (*Woelkerling*, 10.xi.1968; AD, A33236). Cape Le Grand, Esperance, W. Aust., lower eulittoral (*Woelkerling*, 28.i.1978; AD, A49286). Point Sinclair, S. Aust., lower eulittoral (*Womersley*, 7.ii.1954; AD, A19580). Kellidie Bay entrance, Coffin Bay, S. Aust., upper sublittoral (*Womersley*, 22.viii.1967; AD, A31815). Ethel Bay, Yorke Pen., S. Aust., rear eulittoral pools (*Womersley*, 13.iv.1963; AD, A26347). Port Pirie, S. Aust., 9 m deep (*Branden*, 15.ix.1987; AD, A59326). Off St Kilda, S. Aust., 3 m deep (*Womersley*, 18.iii.1972; AD, A41531). Pennington Bay, Kangaroo I., S. Aust., reef pool (*Womersley*, 16.i.1948; AD, A7029). Muston, Kangaroo I., S. Aust., on *Halophila*, 2–3 m deep (*Womersley*, 21.xi.1968; AD, A32925). Cape Lannes, S. Aust., rear reef pool (*Womersley*, 13.ii. 1978; AD, A49155). Port Fairy, Vic., low eulittoral (*Womersley*, 24.i.1967; AD, A31185). Breakneck Point, Sisters Beach, N Tas., mid eulittoral (*Womersley*, 16.x.1982; AD, A55568). Devonport, Tas., drift (*Gordon*, 18.i.1966; AD, A29995). Great Taylor Bay, Bruny I., Tas., on *Thamnoclonium dichotomum*, 4 m deep (*Shepherd*, 14.ii.1972; AD, A42025).

Southern Australian specimens vary somewhat in robustness, filament diameter and segment length but agree in all the basic characteristics of *P. sertularioides* as described by the above authors. The southern Australian plants occur in similar ecological situations to *P. sertularioides* in the Mediterranean, usually just above or below low tide level on rough-water coasts.

This is probably a widely distributed species, for which J. Agardh (1863, p. 969) and De Toni (1903, p. 870) cite numerous synonyms. Also, no satisfactory differences are apparent between it and *P. flaccidissima* Hollenberg from the Pacific coast of North America and the tropical Pacific. The upper branches of *P. sertularioides* are similar to those of *P. mollis*, but whereas the former occurs as dense tufts with entangled bases, *P. mollis* has a single, erect, basal axis.

P. macracartha Zanardini is probably the same as *P. sertularioides* as judged from a photograph of the type; confirmation of this has not been possible since the type in Herb. Zanardini, Museo Civico, Venice has not been available on loan.

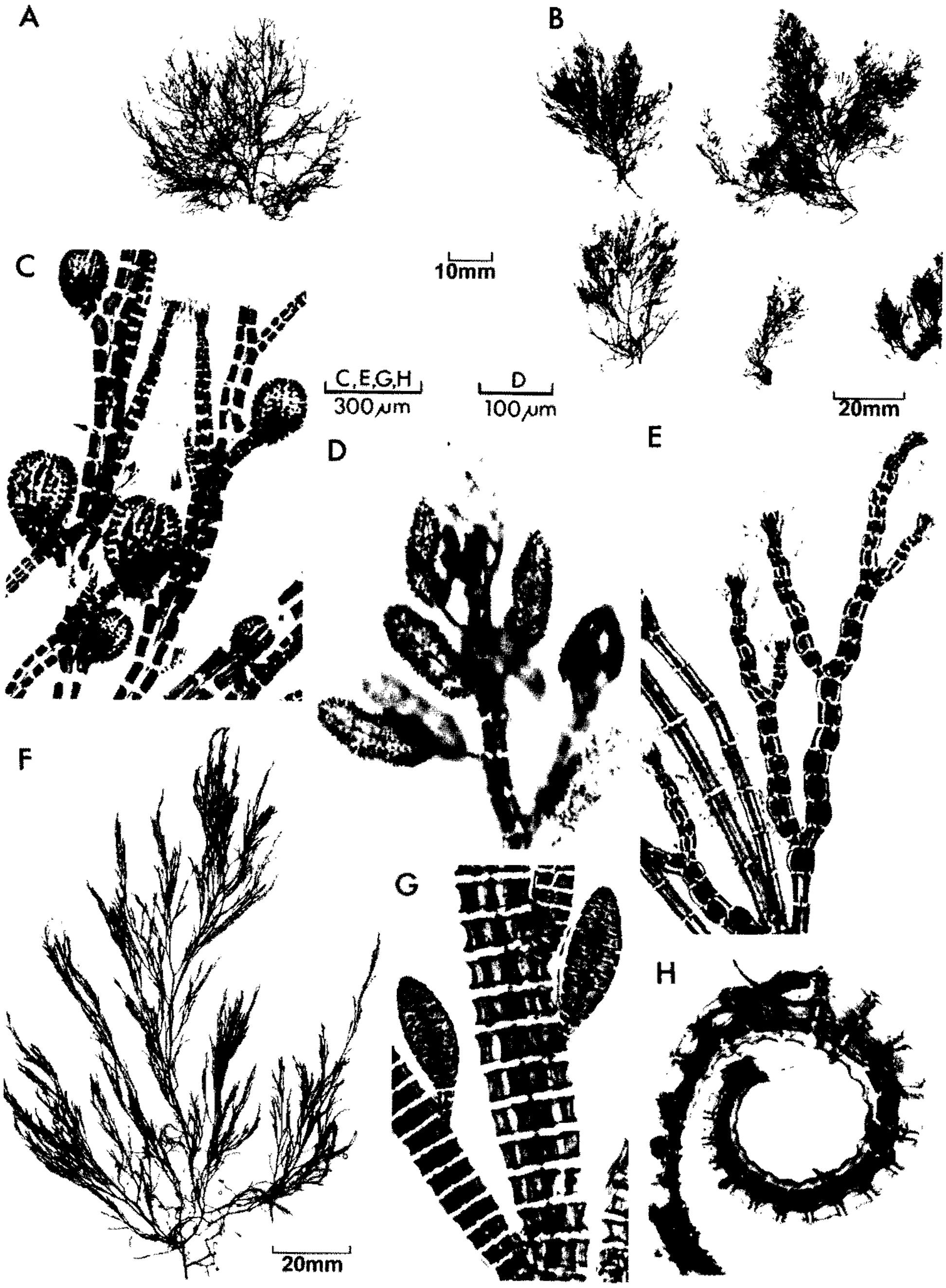

Fig. 82. A–E. *Polysiphonia infestans* (**A**, AD, A18284; **B**, AD, 32917; **C**, AD, A49147; **D**, **E**, AD, A32905). **A**. Habit of isotype. **B**. Habit. **C**. Branches with cystocarps. **D**. Spermatangial branches. **E**. Tetrasporangial branches. **F–H**. *Polysiphonia propagulifera* (**F**, **G**, AD, A33804; **H**, AD, A38222). **F**. Habit. **G**. Branches with propagules. **H**. Tendril. (All as in Womersley 1979, courtesy of Aust. J. Bot.)

10. **Polysiphonia perriniae** Womersley 1979: 479, fig. 5E.
Polysiphonia laxa Harvey 1859b: 300; 1863, synop.: xx. J. Agardh 1863: 984. De Toni 1903: 883. Guiler 1952: 103. Lucas 1909: 41; 1929a: 21. Lucas & Perrin 1947: 268. Segi 1966: 509, pl. 15A. Sonder 1880: 34. Tisdall 1898: 514. Wilson 1892: 167. [NON *P. laxa* Kützing 1843: 427; 1849: 827; 1864: 2, pl. 3a–c, from Venice.]

FIG. 81E–G

Thallus (Fig. 81E) dark red-brown, 15–40 cm high, with one to several axes from a clumped base with slight prostrate parts; branching profuse and irregular with long, often denuded, main branches and fasciculate tufts of lesser branches. Attachment by rhizoids from prostrate branches; host uncertain. *Structure.* Lower axes 200–350 μm in diameter with segments L/D 0.5–1, rhizoids robust, unicellular, 40–80 μm in diameter and cut off from the pericentral cells; branch axes 250–400 μm in diameter, with segments becoming L/D 6–12 (-18) in mid parts of larger plants, decreasing to 100–200 μm in diameter and segments L/D 0.6–3 in lesser branches and to 50–100 μm in diameter and L/D 0.5–1 close to the apices, then tapering to straight apices; branches apparently arising on basal cell of trichoblasts close to apices, with few cicatrigenous branches. Pericentral cells 4, elongate near apices, very long in mid parts and almost isodiametric near the base, ecorticate throughout; trichoblasts or scar cells present on every segment, with a divergence of 1/4. Rhodoplasts discoid, irregularly crowded.

Reproduction. Gametophytes dioecious. Carposporophytes with a slight basal fusion cell and short, branched gonimoblast with clavate terminal carposporangia 25–55 μm in diameter. Cystocarps (Fig. 81F) short-stalked, ovoid to obpyriform, not or scarcely urceolate, 300–600 μm in diameter; pericarp ostiolate, 2 cells thick, outer cells isodiametric, irregular. Spermatangial branches developing as one branch of a trichoblast, 200–300 μm long and 50–100 μm in diameter, apparently without a sterile apical cell when mature.

Tetrasporangia (Fig. 81G) forming spiral series in upper branchlets, not to slightly distorting the branch, 80–100 μm in diameter.

Type from Low Head, Tas. (*Perrin*, Aug. 1948); holotype in AD, A9004.

Distribution: Port Phillip Heads, Victoria, and N and E Tasmania.

Selected specimens: Port Phillip Heads, Vic. (*Wilson*, 17.xi.1889; MEL, 45486). Low Head, Tas. (*Perrin*, June 1939; AD, A16491) and (*Perrin* 1285, Nov. 1949; BM and AD, A49625). Currie R., Tas. (*Perrin*, Jan. 1938; MEL, 45491). Kangaroo Point, Derwent R., Tas. (*Sullivan*, Dec. 1871; MEL, 45492). Earlham Lagoon, E coast, Tas., unattached (*Heather*, 23.ii.1995; AD, A64191). Lewisham, Tas. (*Olsen*, 15.xi.1950; AD, A16210).

P. perriniae, though known from few specimens, appears distinct from other ecorticate southern Australian species with 4 pericentral cells both in habit and in the dimensions of the lower segments, both their diameter and relatively great lengths.

11. **Polysiphonia infestans** Harvey 1855b: 539; 1863, synop.: xx. J. Agardh 1863: 959. Beanland & Woelkerling 1982: 98. Cribb 1983: 131, pl. 69 figs, 1, 2. De Toni 1903: 891. Huisman 2000: 177. Huisman & Walker 1990: 439. Huisman *et al.* 1990: 98. Kendrick *et al.* 1990: 52. Kützing 1864: 14, pl. 40e–g. Lewis 1983: 262; 1984: 64. Lucas 1909: 41. Lucas & Perrin 1947: 268. Millar & Kraft 1993: 58. Silva *et al.* 1996: 542. Sonder 1880: 34. Womersley 1979: 481, fig. 6A–E.
Polysiphonia abscissa sensu Womersley 1947: 245; 1948: 150, 152,156; 1950: 184; 1956: 83. [NON *P. abscissa* Hooker & Harvey 1845a: 266.]
Polysiphonia zostericola Lucas 1919: 177. De Toni 1924: 395. Lucas & Perrin 1947: 271.

FIG. 82A–E

Thallus (Fig. 82A, B) dark red-brown, 2–6 (-10) cm high with a single erect, basal axis or with several clustered axes, occasionally with slight prostrate basal parts; axes percurrent, much branched and often fastigiate above when fertile, with patent and irregular (often short) laterals in central and lower parts of thallus, often denuded below. Attachment by rhizoids from base of clumped axes; epilithic or commonly epiphytic on other algae or seagrasses. *Structure.* Basal axes (180-) 250–300 (-700) μm in diameter with segments L/D 0.5–1 (-1.5), attached by unicellular rhizoids cut off from the lower pericentral cells; mid parts of axes (150-) 200–400 μm in diameter with segments L/D 1–2 (-8), decreasing to 50–80 μm and segments L/D (0.5-) 0.7–1.5 (-2) in lesser branchlets which, as lower laterals, are often markedly slenderer and usually with shorter segments than the parent branch; apices straight, trichoblasts usually prominent; lateral branches replacing trichoblasts, with frequent cicatrigenous branches. Pericentral cells 4, elongate throughout the mature thallus, ecorticate throughout (in old axes in some plants, a very few corticating cells are cut off on segments close to the base), with the filaments often slightly contracted between the ends of each segment; outer wall of older branches thick, often with numerous adherent diatoms and other minute epiphytes; trichoblasts, scar cells or branches present on every segment, with a divergence of 1/4, trichoblasts moderately robust, basal cells 15–25 µm in diameter. Rhodoplasts discoid, dense and irregularly scattered.

Reproduction. Gametophytes dioecious. Carposporophytes with a small basal fusion cell and short, branched, gonimoblast bearing clavate terminal carposporangia 20–40 µm in diameter. Cystocarps (Fig. 82C) stalked, ovoid (sometimes distinctly basally broader), not or only slightly urceolate, 150–300 (-400) µm in diameter; pericarp ostiolate, 2 cells thick, outer cells isodiametric, angular. Spermatangial branches (Fig. 82D) developing as one basal branch of a trichoblast, cylindrical, 100–220 (-300) µm long and 35–90 µm in diameter, usually with a subspherical, sterile apical cell.

Tetrasporangia (Fig. 82E) forming a spiral series in upper branchlets 60–130 µm in diameter, usually distorting the branchlet, subspherical to ovoid and 45–80 µm in diameter.

Type from Princess Royal Harbour, King George Sound, W. Aust. (*Harvey*), on *Polyphysa peniculus;* holotype in Herb. Harvey, TCD (Trav. Set 22), probable isotypes (Alg. Aust. Exsicc. 180B) in BM, MEL, 1006715, and AD, A18284.

Distribution: Shark Bay, W. Aust., to Walkerville, Vic. and N and E Tasmania. Also known from N.S.W. (Millar & Kraft 1993, p. 58) and Queensland (Cribb 1983, p. 131).

Selected specimens: Nanarup, W. Aust. on *Laurencia*, upper sublittoral (*Gordon*, 19.xi.1968; AD, A33996). Princess Royal Harbour, Albany, W. Aust., uppermost sublittoral (*Womersley*, 21.viii.1979; AD, A51385—"Marine Algae of southern Australia" No. 211b.) West Beach, Esperance, W. Aust., low eulittoral (*Wollaston*, 21.ii.1957; AD, A32557). Greenly Beach (60 km N of Coffin Bay), S. Aust., in mid eulittoral pools (*Parsons*, 15.v.1968; AD, A32559). Flour Cask Bay, Kangaroo I., S. Aust., rear reef pools (*Womersley*, 23.xii.1968; AD, A32917). Pennington Bay, Kangaroo I., S. Aust., in upper eulittoral pool (*Womersley*, 21.xi.1968; AD, A32905). Robe, S. Aust., on *Codium fragile*, low eulittoral near slipway (*Womersley*, 13.ii.1978; AD, A49147—"Marine Algae of southern Australia" No. 211a). Point Lonsdale, Vic., low eulittoral (*Womersley*, 12.x.1982; AD, A55353—"Marine Algae of southern Australia" No. 211c). Crawfish Rock, Westernport Bay, Vic., uppermost sublittoral (*Womersley*, 29.viii.1971; AD, A39445). Walkerville, Vic., drift (*Sinkora* A2397, 27.ii.1978; AD, A53587). Low Head, Tas. (*Perrin*, 27.viii.1948; AD, A49569). Green Point, Marrawah, NW Tas., lower eulittoral (*Womersley*, 17.x.1982; AD, A55562). Arch Rock, E of Ninepin Point, Tas., 1–10 m deep (*Andrews*, 21.x.1994; AD, A63907). Isthmus Bay, Bruny I., Tas., lower eulittoral (*Womersley*, 12.x.1986; AD, A57765).

P. infestans is common in intertidal rock pools or where just covered at low tide on rock platforms on rough-water coasts, extending less frequently to coasts of moderate water movement. It grows on both rock and on a variety of other larger algae such as *Laurencia.*

Harvey's type specimens were recorded as growing on *Acetabularia* (*Polyphysa*) *peniculus* in Princess Royal Harbour (Albany) in King George Sound; however, no specimen of Harvey's has been seen attached to *Polyphysa.* The habitat is more sheltered than is typical for the species, but the type material agrees well as far as can be ascertained with the above concept of the species; however the nature of the branching in replacing trichoblasts has not been observed clearly in the type material.

P. infestans is characterised by its habit, with erect axes and patent branching with many laterals (usually cicatrigenous) much slenderer than the parent branch, the short segments (L/D rarely greater than 1.5), by the dimensions, by the branches replacing the trichoblasts, and by the irregularly swollen and distorted tetrasporangial branchlets. Slight basal cortication occurs in some larger, presumably older, plants (e.g. AD, A49147).

Some specimens from Victoria (AD, A39445) and Tasmania (AD, A49569) are larger, relatively slender below, and with considerably longer mid to lower segments (L/D 4–8) than in most forms. Such plants are often growing under considerable currents rather than strong wave action. Otherwise they are identical with the more usual forms of *P. infestans*, and it seems best to place them within this species. It is clear, however, that there is considerable variation in the above features in *P. infestans* as recognised here.

P. zostericola Lucas was described from Botany Bay, N.S.W. (type in Herb. Lucas, NSW; isotype AD, A12234), forming a dense fringe on the leaves of *Zostera*. A recent collection from Nowra Point, Botany Bay, low eulittoral on *Zostera capricorni* (*Womersley*, 20.v.1978; AD, A49353), of plants smaller but otherwise the same as the type collection, agrees well with the above features of *P. infestans*.

P. infestans is somewhat similar to *P. mollis* in dimensions, but differs in habit in having numerous patent, slender branches (which are generally lacking in *P. mollis*), in the origin of branches, in having generally shorter segments which are often medially constricted, and in the more distorted tetrasporangial branchlets. Whereas *P. mollis* appears to be a plant of sheltered waters (though often subject to a current) and epiphytic on *Posidonia* and occasionally on other algae, *P. infestans* occurs in moderate water movement and in pools, either epilithic or epiphytic on various other algae but usually not seagrasses.

P. infestans is doubtfully recorded from New Zealand by Laing (1927, p. 167) and Naylor (1954, p. 661); this requires confirmation.

12. **Polysiphonia propagulifera** Womersley 1979: 483, fig. 6F–H.

FIG. 82F–H

Thallus (Fig. 82F) brown-red, 6–22 cm high, with slight prostrate parts attached by rhizoids and also with recurved tendrils (Fig. 82H) from lower parts of the thallus; branching profuse, irregularly lateral and fastigiate above from percurrent main axes, partly denuded below; attachment by rhizoids; substrate unknown. *Structure.* Basal prostrate axes 500–800 µm in diameter with segments L/D 0.3–0.7, with unicellular rhizoids cut off from the pericentral cells; lower erect branches 300–600 µm in diameter with segments L/D 0.5–0.8 (-1), decreasing gradually to about 200 µm in diameter with segments L/D 0.3–0.5 in lesser branchlets and then tapering evenly to pointed, straight, apices; apical cells small, trichoblasts slender and apparently readily caducous; branches apparently replacing trichoblasts, with a few cicatrigenous branches below. Pericentral cells 4, square to slightly elongate in surface view of lower parts and upper branches, to twice as long as broad in mid parts of main branches, ecorticate; trichoblasts or scar cells present on every segment, with a divergence of 1/4, relatively slender. Rhodoplasts discoid, scattered or in chains. Tendrils (Fig. 82H) present on lower parts of thallus, developed from the terminal 20–30 segments of a branch by enlargement of pericentral cells on one side of branch; rhizoids often developed from pericentral cells on the concave side. Propagules (Fig. 82G) frequent, developing cicatrigenously, borne on a short stalk 4–5 segments long, elongate-ovoid with a rounded apex, 400–500 µm long by 170–250 µm in diameter, with usually 9–12 segments and the 4 pericentral cells slightly broader than long, the junctions slightly alternately staggered as seen in surface view.

Reproduction unknown, apart from propagules.

Type from off Troubridge I., S. Aust., 23 m deep (*Shepherd*, 4.ii.1969); holotype in AD, A33804.

Distribution: Only known from the type and from Investigator Strait, S. Aust., 34 m deep (*Watson*, 20.i.1971; AD, A39218) and 33 m deep (*Watson*, 24.i.1971; AD, A38222) and Penneshaw reef, Kangaroo I., S. Aust., 11 m deep (*Lavers*, 5.xi.1999; AD, A68927).

Although normal reproductive structures are unknown, *P. propagulifera* appears to be a distinctive species, restricted to deep water. It is marked by its dimensions and very short segments throughout with pericentral cells mostly square in surface view, and the distinctive propagules. However, collections of a seemingly distinct species, also from deep water and which bear propagules are known from Satellite I., D'Entrecasteaux Ch., Tas., 12 m deep (*Shepherd*, 17.ii.1972; AD, A41654) (see Womersley 1979, p. 478) and from 3–4 km E of Lakes Entrance, Vic., 20–30 m deep (*G. North*, 6.xii.1997; AD, A6774). These specimens, which appear similar, are distinctly more slender than *P. propagulifera* and the propagules are about half as long and broad as those of the latter. Further collections of such plants may permit description of a new species.

Tuberous structures which may act as propagules have been recorded in *P. tuberosa* Hollenberg (1968a, p. 93, fig. 39), and Kapraun (1977) has described specialised asexual propagules, borne on the trichoblasts, in *P. ferulacea* J. Agardh.

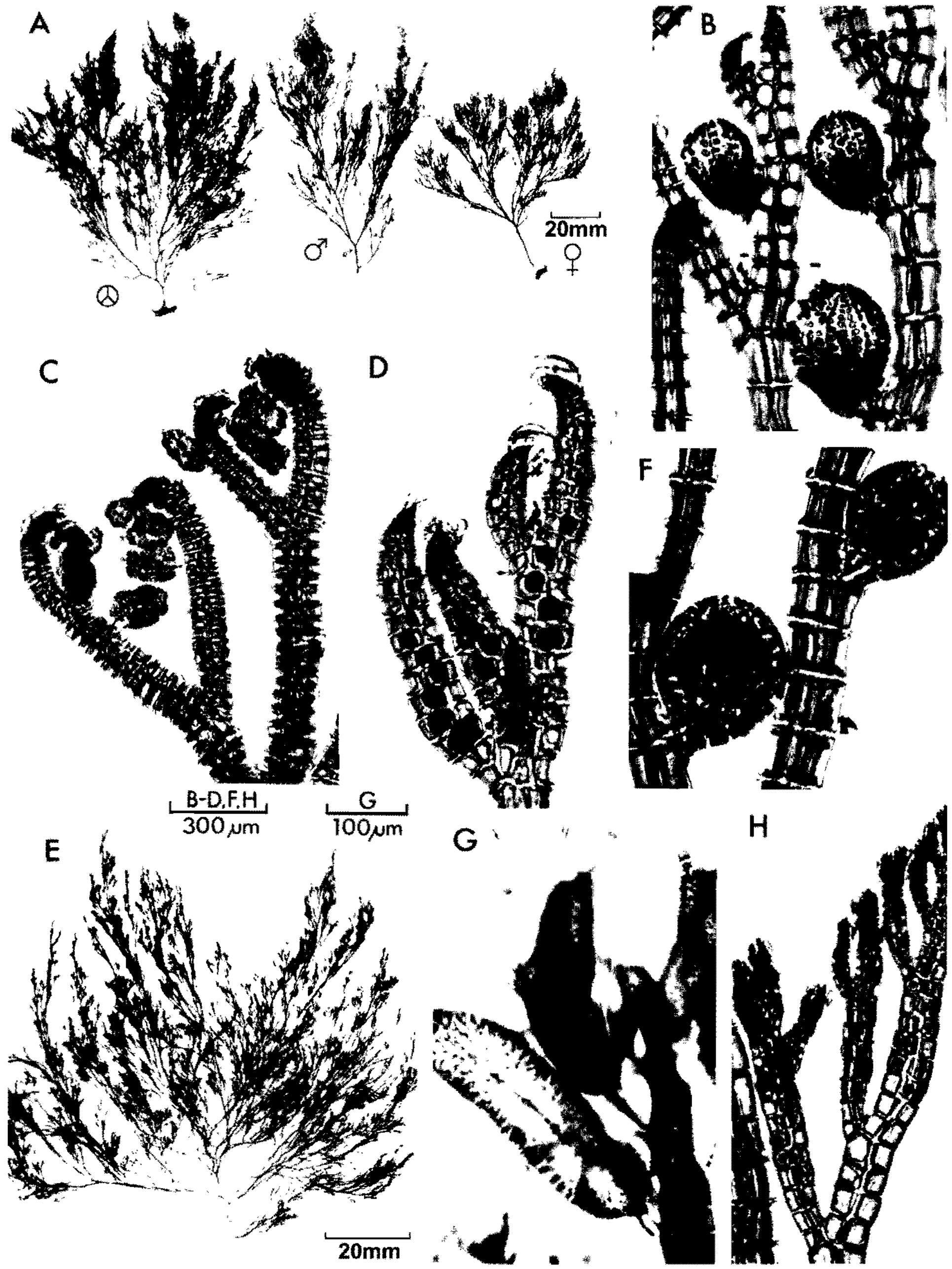

Fig. 83. A–D. *Polysiphonia succulenta* (AD, A32930). **A.** Habit. **B.** Cystocarps. **C.** Spermatangial branches. **D.** Tetrasporangial branches. **E–H.** *Polysiphonia blandii* (**E**, isotype in BM; **F**, **G**, AD, A48950; **H**, AD, A26342). **E.** Habit. **F.** Cystocarps. **G.** Spermatangial branches. **H.** Branches with young tetrasporangia. (All as in Womersley 1979, courtesy of Aust. J. Bot.)

13. **Polysiphonia succulenta** Harvey 1859b: 300; 1863, synop.: xx. J. Agardh 1863: 968. De Toni 1903: 879. Garnet 1971: 97. Guiler 1952: 103. Lucas 1909: 41; 1929a: 21. Lucas & Perrin 1947: 267. Segi 1966: 513, pl. 24B. Shepherd & Womersley 1971: 166. Silva *et al.* 1996: 546. Sonder 1880: 34. Tisdall 1848: 514. Womersley 1950: 185; 1956: 82, 83; 1979: 485, fig. 7A–D.

Polysiphonia spinuligera Zanardini 1874: 490. De Toni 1903: 955. Guiler 1952: 103. Lucas 1909: 41; 1929a: 22. Lucas & Perrin 1947: 271. Tisdall 1898: 514. Wilson 1892. 167.

FIG. 83A–D

Thallus (Fig. 83A) grey-brown to red-brown, usually 5–12 (-20) cm high with a single erect base and lower axis, branching subdichotomously (to laterally) to form a dense, fastigiate to spreading tuft. Holdfast of clumped rhizoids from lower cells of erect axes; epiphytic, usually on *Posidonia australis*. *Structure.* Lower axes (400-) 500–1000 µm in diameter with segments L/D 0.2–0.5; rhizoids unicellular and cut off from the pericentral cells; branches above the basal axis 300–500 µm in diameter with segments L/D (0.5-) 0.8–1 (-1.5) decreasing gradually to 100–200 µm in diameter with segments L/D 0.3–0.8 close to the apices, then tapering fairly abruptly to pointed apices which are commonly slightly to markedly involute (Fig. 83C, D) and usually have a prominent apical cell; lateral branches developing close to apices, replacing trichoblasts, with occasional cicatrigenous branchlets from lower parts. Pericentral cells 4 (often 5 within 2–5 segments from base of a lateral branch), isodiametric near apices (Fig. 83B) and extending to twice (rarely 3 times) L/D below, ecorticate except for slight cortical development near the base in robust plants by elongate cells cut off laterally or from the corners of pericentral cells, never forming a complete layer; older cells not readily permeable (partially collapsing in Karo); trichoblasts or scar cells present on every segment, with a divergence of 1/4, trichoblasts relatively robust, basally several times furcate, with long, tapering ultimate branches 4–6 cells long. Rhodoplasts discoid to elongate and often in chains, irregularly arranged.

Reproduction. Gametophytes dioecious. Carposporophytes with a slight basal fusion cell and short, branched gonimoblast with clavate terminal carposporangia 25–60 µm in diameter. Cystocarps (Fig. 83B) short-stalked, globular to slightly ovoid, occasionally slightly urceolate, (300-) 400–700 µm in diameter; pericarp ostiolate, 2 cells thick, with the terminal ostiolar cells distinctly enlarged when mature, outer cells isodiametric, angular. Spermatangial branches (Fig. 83C) usually developing as one (rarely both) basal branch of a trichoblast with the sterile branch soon lost, sometimes replacing whole trichoblast, elongate-ovoid, 150–300 µm long and (60-) 100–180 (-200) µm in diameter, usually with a sterile dome-shaped apical cell and often a sterile subapical cell or single sterile cell borne laterally on the subapical cell.

Tetrasporangia (Fig. 83D) forming spiral series of 1/4 divergence in upper branches (often extending below a lateral), not or slightly distorting or swelling the branch, 80–120 µm in diameter.

Type from Georgetown, Tas. (*Gunn*); holotype in Herb. Harvey, TCD; isotype in BM, part of holotype.

Distribution: Cockburn Sound, W. Aust., to Western Port, Vic., and the N coast of Tasmania.

Selected specimens: Cockburn Sound, W. Aust., on *Posidonia australis* (*Cambridge*, 10.v.1972; AD, A47070). Lucky Bay, Cape le Grand, W. Aust., on *P. australis*, upper sublittoral (*Woelkerling*, 30.i.1978; AD, A49267). Billy Light Point, Port Lincoln, S. Aust., on *P. australis*, 4 m deep (*Shepherd*, 23.viii.1975; AD, A46554). Muston, American R. inlet, Kangaroo I., S. Aust., on *P. australis*, 2–3 m deep (*Womersley*, 21.xi.1968; AD, A32930—"Marine Algae of southern Australia" No. 127, and *Kraft*, 2.xii.1971; AD, A41197). San Remo backbeach, Vic., drift (*Sinkora* A536, 14.vi.1970: MEL, 504847, AD, A49488). "Seaweed Point", Tamar Est., Tas., on *P. australis* (*Perrin* & *Lucas*, Jan. 1931; AD, A49632).

P. succulenta is a distinctive species, characterised by the dimensions, short segments, erect base to the axes, abruptly tapering and usually involute apices, the tetrasporangial branches with the tetrasporangia usually occupying less than half the width of the branch and not distorting it, and by the rather short and thick spermatangial branches. The common presence of 5 pericentral cells for 2–5 segments above the base of a branch also may be distinctive for the species. It is normally epiphytic on *Posidonia australis* in calm bays and inlets; in American R. inlet on Kangaroo I. it is particularly common.

The type specimen of *P. spinuligera* Zanardini (in Museo Civico, Venice), as judged by the description and a photograph showing a specimen epiphytic on *Posidonia*, is identical with *P. succulenta.*

P. succulenta is closely related to *P. blandii* Harvey; comparisons are made under the latter species.

14. **Polysiphonia blandii** Harvey 1862a: pl. 184; 1863, synop.: xx. J. Agardh 1863: 976. Black 1971: 131. De Toni 1903: 899. De Toni & Forti 1923: 38. Huisman 2000: 177. Huisman & Walker 1990: 439. King *et al.* 1971: 124. Kützing 1864: 15, pl. 43a–c. Lewis 1984: 63. Lucas 1909: 41; 1929b: 51. Lucas & Perrin 1947: 269, fig. 123. Millar 1990: 441, fig. 64. Millar & Kraft 1993: 57. Reinbold 1898: 51. Segi 1966: 505, pl. 6A. Shepherd & Womersley 1981: 367. Silva *et al.* 1996: 537. Sonder 1880: 34. Tisdall 1898: 514. Wilson 1892: 167. Womersley 1966: 153; 1979: 486, fig. 7E–H.

Polysiphonia breviarticulata sensu Harvey 1855a: 539; 1859b: 299. [NON *C. breviarticulata* C. Agardh, from the Adriatic.]

Polysiphonia ferulacea Suhr *ex* J. Agardh 1863: 980 (Aust. records only). Cribb 1956: 134. De Toni 1903: 892 (Aust. records only). Guiler 1952: 103. Harvey 1863, synop.: xx. Lucas 1909: 41; 1929a: 21; 1929b: 51. Lucas & Perrin 1947: 269. Reinbold 1898: 51. Sonder 1880: 34. [NON *P. ferulacea* Suhr *ex* J. Agardh 1863: 980, from Mexico and Florida.]

FIG. 83E–H

Thallus (Fig. 83E) very dark red-brown, usually 5–10 cm high, arising from a prostrate basal system, with several erect, subdichotomous axes which become fibrilliferous above, especially when fertile. Attached by rhizoids from prostrate filaments; usually epilithic. *Structure.* Prostrate filaments 350–700 µm in diameter with segments L/D 0.3–1, with scattered unicellular rhizoids cut off from pericentral cells (1 or often 2 per cell), with most prostrate branches soon becoming erect; erect branches 300–550 µm in diameter with segments L/D (0.3-) 1–2 (-2.5), decreasing very gradually to 120–180 µm in diameter with segments L/D (0.2-) 0.5–1 shortly below the apices, then tapering to a pointed, erect (not involute) apices; upper branchlets often slightly basally constricted; lateral branches arising close to apices, replacing trichoblasts, with occasional cicatrigenous branches. Pericentral cells 4, ecorticate throughout, walls rigid, soon becoming light red-brown in colour and older cells not readily permeable (collapsing in Karo); trichoblasts and scar cells present on every segment, with a divergence of 1/4, trichoblasts prominent, 1–3 times basally furcate with tapering ultimate branches several cells long, light red in colour owing to wall pigment. Rhodoplasts discoid to irregular, scattered.

Reproduction. Gametophytes dioecious. Carposporophytes with a slight basal, fusion cell and short, branched, gonimoblast with clavate terminal carposporangia 25–50 µm in diameter. Cystocarps (Fig. 83F) short-stalked to subsessile, globular to ovoid but not urceolate, 250–500 µm in diameter; pericarp ostiolate, 2 cells thick, outer cells isodiametric, angular. Spermatangial branches (Fig. 83G) developed from one basal dichotomy of a trichoblast, light brown in colour, 200–600 µm long and 60–150 µm in diameter, with (1-) 2–3 short sterile cells at the apex.

Tetrasporangia (Fig. 83H) forming spiral series in upper branchlets (often extending below a lateral), slightly to moderately distorting the branchlet, 50–100 µm in diameter.

Type from Brighton, Port Phillip, Vic. (*Harvey*, Alg. Aust. Exsicc. 170F); lectotype in Herb. Harvey, TCD; isolectotype in BM.

Distribution: Geraldton, W. Aust. (De Toni & Forti) to Geographe Bay, W. Aust. and Elliston, S. Aust. to Walkerville, Vic.; N and E Tasmania; Kiama, N.S.W. to Noosa and Low I., Qld.

Selected specimens: Rottnest I., W. Aust. (*Harvey*, Alg Aust. Exsicc. 185a; TCD and AD, A18286). Elliston, S. Aust., 4 m deep near Salmon Point (*Shepherd*, 22.x.1970; AD, A37516). Ward I., S. Aust., 25–30 m deep (*Shepherd*, 31.iii.1982; AD, A53127). Reevesby, I., S. Aust., 10–11 m deep (*Baldock*, 13.xii.1977; AD, A48950). Ethel Bay, Yorke Pen., S. Aust., rear littoral pools (*Womersley*, 13.iv.1963;

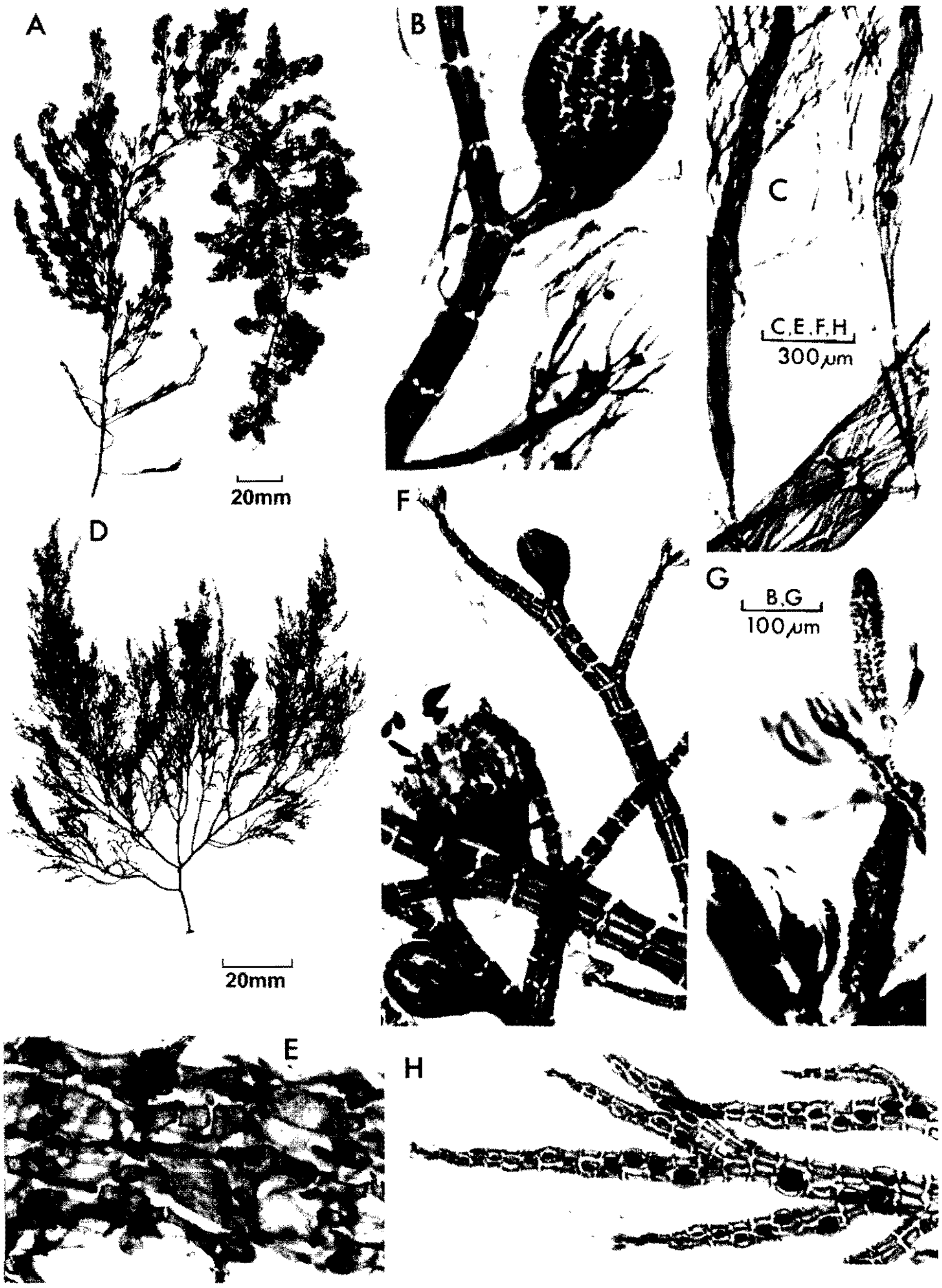

Fig. 84. A–C. *Polysiphonia crassiuscula* (**A**, AD, A37820; **B**, AD, A44459; **C**, AD, A46632). **A**. Habit. **B**. Branch with cystocarp. **C**. Branch with early cortication bearing tetrasporangial branchlets. **D–H**. *Polysiphonia daveyae* (**D–F**, AD, 32926; **G**, AD, A49183; **H**, AD, A26776). **D**. Habit. **E**. Early stage of cortication, with cicatrigenous branchlets. **F**. Branches with cystocarps. **G**. Spermatangial branches. **H**. Tetrasporangial branches. (All as in Womersley 1979, courtesy of Aust. J. Bot.)

AD, A26342). Wallaroo, S. Aust., 0.5–2.5 m deep on jetty piles (*Gill*, 9.xi.1980; AD, A51897). Port Noarlunga, S. Aust., 5 m deep on pebbles (*Hergstrom & Owen*, 19.vii.1970; AD, A35967). Vivonne Bay, Kangaroo I., S. Aust., 2–6 m deep inside Point Ellen (*F. Mitchell*, 21.viii.1963; AD, A26952). Pennington Bay, Kangaroo I., S. Aust., on reef surface (*Womersley*, 23.viii.1950; AD, A15403). Swan Bay, Port Phillip, Vic., 7 m deep (*Macpherson*, 4.iv.1963; AD, A28853). Crawfish Rock, Westernport Bay, Vic., 4 m deep (*Watson*, 17.xi.1974; AD, A46236). Walkerville, Vic., drift (*Sinkora* A1667, 23.ii.1972; AD, A43234). Port Sorell, Tas., drift (*Womersley*, 9.xi.1982; AD, A56232). Wine Glass Bay, Freycinet Pen., Tas., rock pools (*Wollaston & Mitchell*, 2.iii.1964; AD, A27897).

Harvey placed material from Western Port, Vic. [Alg. Aust. Exsicc. 170H, illustrated by Kützing (1864, pl. 43a–c) (now MEL, 1006719)] and from Kiama, N.S.W. (170N) under *P. blandii*. The latter locality needs verification since 170N in BM appears to be identical material (i.e. from the same collection) with the several specimens of 170F from Brighton, Vic.

Western Australian specimens were first referred by Harvey (1855a, p. 539) to *P. breviarticulata* C. Agardh from the Mediterranean, a species with slight cortication on lower branches (J. Agardh 1863, p. 1007). Harvey's Australian specimens were 'abundant on the reefs, near low water, Rottnest (188) – the latter number referring to his Travelling Set. Harvey (1859b, p. 299) later recorded it from Tasmania, but apparently did not realise he was describing the same or even a closely related plant when he described *P. blandii* in 1862. J. Agardh (1863, p. 980) referred Harvey's Australian records of *P. breviarticulata* to his newly described *P. ferulacea*, which was apparently based on specimens of Liebmann from Mexico and Harvey from Florida. J. Agardh ascribed the name to Suhr, but without quoting a Suhr specimen. J. Agardh considered the American (and Australian) specimens distinct from *P. breviarticulata* (C. Agardh)Zanardini from the Adriatic.

Harvey's Trav. Set 188 (also Alg. Aust. Exsicc. 185A, probably of the same collection) appear to be profusely branched and slightly more slender specimens of *P. blandii*. However, further studies on their variation are needed. Reinbold (1898, p. 51) commented on the close relationships of *P. blandii* and *P. ferulacea* as he recorded them from South Australia (see Womersley 1979, p. 487 for further comments on these species).

P. blandii is closely related to *P. succulenta* Harvey but differs in having somewhat longer segments (in central parts of well developed plants), always straight rather than involute apices, and prostrate basal filaments from which numerous erect filaments arise. *P. blandii* is entirely ecorticate, whereas the bases of old, erect axes of *P. succulenta* usually have slight cortication. *P. blandii* is usually readily distinguished by its very dark red-brown colour, which is largely due to the brown-coloured cell walls, this colouring extending to the trichoblasts. The branching of *P. blandii* is often more erect than in *P. succulenta* and the fertile (especially tetrasporangial) branches are more fastigiate or fibrilliferous, with more prominent trichoblasts. These two species also appear to differ consistently in habitat, *P. succulenta* being an epiphyte on the seagrass *Posidonia* in calm localities and only rarely on algae, while *P. blandii* is epilithic (and possibly epiphytic on algae) in stronger water movement.

However, while typical specimens of *P. succulenta* and *P. blandii* appear specifically distinct, some herbarium specimens appear intermediate, and some of the above distinctions may be ecological. Further comparisons of well-developed, complete and fertile specimens are desirable, and experimental studies could assist in assessing the distinctions.

Harvey (1862, pl. 284) commented that *P. blandii* was closely related to the European *P. fibrata*. The latter appears to be generally a slender, more branched plant and may differ in that the branches are associated with trichoblasts.

15. **Polysiphonia crassiuscula** Harvey 1859b: 299; 1863, synop.: xx. J. Agardh 1863: 986. De Toni 1903: 885. Guiler 1952: 103. Lucas 1909: 41; 1929a: 21; 1929b: 51. Lucas & Perrin 1947: 266. Reinbold 1897: 56. Segi 1966: 506, pl. 8A. Shepherd 1983: 83. Sonder 1880: 34. Womersley 1979: 488, fig. 8A–C.

FIG. 84A–C

Thallus (Fig. 84A) dark red-brown, usually 10–36 cm high, with a single basal axis and numerous laterals which may develop almost as strongly as the main axis, profusely branched on all sides with dense, often fastigiate, tufts of lesser branches with constricted bases, readily denuded leaving only the main branches. Holdfast of a cellular disc, 1–3 mm across, without formation of distinct rhizoids; usually epilithic. *Structure.* Lower main axes 0.5–1 (-4) mm in diameter, heavily corticated and usually denuded, mid branches commonly 0.5–1 mm in diameter, decreasing to 150–250 μm in diameter in slightly corticated branches with segments L/D (0.8-) 1.7–2.3; ecorticate branchlets 50–180 μm in diameter with segments L/D 1–1.5 (-2), usually distinctly basally constricted (Fig. 84C) and hence L/D often 2–4 in basal segments, tapering evenly to a somewhat pointed, straight, apex with profuse trichoblasts unless denuded; lateral branches arising from basal cell of trichoblasts but most branching cicatrigenous. Pericentral cells 4, elongate throughout the thallus, ecorticate in branchlets but soon becoming corticate, sometimes twisted; cortication commencing with short cells cut off usually from the posterior corners of the pericentral cells, then elongating and dividing to form rows of cells lying over the longitudinal walls of the pericentral cells, later extending to give complete coverage, and in older branches and the axis forming a cortex several to many cells thick. Trichoblasts light brown-red in colour due to rhodoplasts in the cells, slender, basal cells 15–30 (-40) μm in diameter, 2–4 times furcate, formed on every segment with a divergence of 1/4, often persistent for some distance behind the apices. Rhodoplasts discoid, densely aggregated.

Reproduction. Gametophytes dioecious. Carposporophytes with a small basal fusion cell and branched gonimoblast with ovoid to clavate terminal carposporangia 70–130 μm in diameter. Cystocarps (Fig. 84B) distinctly stalked, ovoid to globular and often broader than long when mature, non-urceolate, 280–450 (-700) μm in diameter; pericarp ostiolate, 2 cells thick, outer cells isodiametric, angular. Spermatangial branches developing as one branch of a trichoblast, cylindrical, 130–200 μm long and 50–75 μm in diameter, without a sterile apical cell when mature.

Tetrasporangia (Fig. 84C) in normally unbranched, acicular, cicatrigenous laterals, forming slightly spiral or almost straight rows decreasing regularly in size from the oldest sporangium, with mature sporangia almost as wide as and slightly bulging the branch, subspherical, ovoid, 80–230 μm in diameter when mature.

Type from East Coast, Tas. (*Gunn*); holotype in TCD; isotype in BM.

Distribution: N Spencer Gulf to Robe, S. Aust., and N and SE Tasmania.

Selected specimens: N Spencer Gulf, S. Aust., 12–15 m deep (*Shepherd*, 5 and 6.ix.1973; AD, A44211 and A44459). Investigator Strait, S. Aust., 22–32 m deep (*Watson*, 9.i.1971; AD, A38459 and 25.i.1971; AD, A38185). Off Troubridge I., S. Aust., 14 m deep (*Shepherd*, 4.ii.1969; AD, A33786). Holdfast Bay, S. Aust., 24 m deep (*Shepherd*, 30.xii.1966; AD, A31598). 20 km WSW of Outer Harbour, S. Aust., 22–25 m deep (*McFarlane*, 11.ix.1975; AD, A46632). Vivonne Bay, Kangaroo I., S. Aust., 1–4 m deep on jetty piles (*Kraft*, 6.iv.1972; AD, A42365). Stanley Beach, Kangaroo I., S. Aust., drift (*Womersley*, 27.i.1957; AD, A20851). Cape Jaffa, S. Aust., drift (*Womersley*, 22.xi.1998; AD, A67966). Robe, S. Aust., drift (*Womersley*, 15.xii.1970; AD, A37820). Rocky Cape, Tas., drift (*Gordon*, 18.i.1966; AD, A29964). Off Satellite I., D'Entrecasteaux Ch., Tas., 12 m deep (*Shepherd*, 17.ii.1972; AD, A41639).

P. crassiuscula is a distinctive species, characterised by its habit, the heavy cortication on lower branches, ecorticate and basally constricted branchlets, preponderance of cicatrigenous branches, and branching from the basal cell of trichoblasts. The type specimens of Gunn are very much denuded and virtually bare of branchlets; however the size and branching, heavy cortication of the larger branches and the few ecorticate branchlets agree well with the above collections in AD. The major branching is rather variable; in some specimens it is extensive near the base while in others there is a single percurrent axis. In one specimen (AD, A33786) this percurrent axis has apparently lasted for some time and is abnormally thick (up to 6 mm on the herbarium sheet, probably about 4 mm in life). Although the trichoblasts are slightly pigmented, sometimes with numerous rhodoplasts, all structural features agree well with those of *Polysiphonia*.

P. crassiuscula is clearly a deep-water species, and the type specimens were almost certainly rather old drift specimens.

16. **Polysiphonia daveyae** Reinbold 1899: 49. De Toni 1903: 913. Lucas 1909: 41; 1929b: 51. Lucas & Perrin 1947: 265. Shepherd & Womersley 1981: 367. Womersley 1948: 162; 1950: 185; 1956: 82; 1979: 490, fig. 8D–H.

FIG. 84D–H

Thallus (Fig. 84D) brown-red, 3–16 cm high with a single, erect basal axis, profusely irregularly branched on all sides with generally patent branching, more fastigiate above.

Attachment by numerous unicellular rhizoids cut off from pericentral and cortical cells, often aggregated to form a discoid holdfast; usually epiphytic (on *Posidonia*, *Codium galeatum* and other algae). *Structure.* Lower main axes 1–2 mm in diameter, moderately to heavily corticated, decreasing to 500–800 µm in diameter with segments L/D 0.3–0.5 (-0.8) in mid branches which are slightly to moderately corticated, then to 150–250 µm in diameter with segments L/D 0.3–0.8 (-1) in not or scarcely corticated branches, with ultimate branchlets 50–75 µm in diameter with mature segments L/D 0.5–1, and tapering evenly and markedly to a slender, erect apex; trichoblasts usually soon lost, branches arising from the basal cell of trichoblasts and often cicatrigenously from older branches. Pericentral cells 4, more or less isodiametric in surface view throughout the thallus but often 1.5–2 times as long as broad near the apices, becoming corticated from their corners (Fig. 84E) and cortication of short cells spreading around the pericentral cells as seen in surface view, becoming complete in older branches and several layers thick on old axes; trichoblasts (or scar cells) present on every segment with a divergence of 1/4, relatively slender (basal cells 20–25 µm in diameter), 2–4 times furcate. Rhodoplasts discoid and usually in chains.

Reproduction. Gametophytes dioecious. Carposporophytes with a small basal fusion cell and short gonimoblast bearing clavate terminal carposporangia 25–45 µm in diameter. Cystocarps (Fig. 84F) short-stalked, subspherical to ovoid, non-urceolate, 300–500 µm in diameter; pericarp ostiolate, 2 cells thick, outer cells angular, isodiametric. Spermatangial branches (Fig. 84G) developing as one branch of a trichoblast, cylindrical, 160–250 µm long and 50–80 µm in diameter, without a sterile apical cell when mature.

Tetrasporangia (Fig. 84H) forming gently spiral series in single branchlets, occasionally with a small lateral above, not or slightly bulging the segments and occupying about half the branch width when mature, subspherical to ovoid, 50–90 µm in diameter.

Type from Investigator Strait, S. Aust. (*Davey* 166); holotype (?) in Herb. Reinbold, M; isotype in AD, A1180.

Distribution: Frenchmans Bay, Albany, W. Aust., to Robe, S. Australia.

Selected specimens: Frenchmans Bay, Albany, W. Aust., drift (*Parsons*, 18.xi.1968; AD, A33229). Venus Bay, S. Aust., drift (*Womersley*, 12.ii.1954; AD, A19492). Tiparra reef, S. Aust., on *Lenormandiopsis*, 12 m deep (*Shepherd*, 13.v.1982; AD, A53324). American R. inlet, Kangaroo I., S. Aust., drift at jetty (*Womersley*, 25.viii.1963; AD, A26776). Muston, Kangaroo I., S. Aust., 2–3 m deep (*Womersley*, 21.xi.1968; AD, A32926). Strawbridge Point, Kangaroo I., S. Aust., drift (*Womersley*, 29.x.1995; AD, A64622). Seal Bay, Kangaroo I., S. Aust., on *Codium galeatum*, drift (*Womersley*, 29.x.1966; AD, A31036). Robe, S. Aust., drift on *Codium galeatum* (*Womersley*, 12.ii.1978; AD, A49183).

P. daveyae is a distinctive species marked by its form, isodiametric or short pericentral cells throughout and considerable cortication in the lower parts. It is most closely related to *P. australiensis*, but the latter differs in habitat and in having elongate pericentral cells. It usually occurs in moderately deep water off coasts with moderate to strong wave action.

17. **Polysiphonia australiensis** Womersley 1979: 491, fig. 9A–D. Huisman & Walker 1990: 439. Shepherd & Womersley 1981: 367. Silva *et al.* 1996: 537.
Polysiphonia dasyoides Zanardini *sensu* Womersley 1947: 245; 1948: 150, 157, 160; 1950: 184; 1953: 38. [NON *P. dasyoides* Zanardini 1874: 489. De Toni 1903: 954, from Georgetown, Tas. (probably *Echinothamnion hookeri*).]

FIG. 85A–D

Thallus (Fig. 85A) dark red-brown, 4–10 (-15) cm high, with one to several erect, percurrent axes from a clumped base, axes much branched above with fastigiate lateral branch systems usually not more than 1 cm long, often denuded below. Holdfast of tightly clumped rhizoids cut off from basal pericentral or cortical cells; epilithic or epiphytic on other algae. *Structure.* Lower axes 0.7–1.5 mm in diameter, heavily corticated, decreasing gradually to upper lightly corticated axes or branches 300–500 µm in diameter with segments L/D 0.3–0.8, within about 1 cm of branch apices; ecorticate branchlets 120–180 µm in diameter with segments L/D 0.7–1 (-1.3), decreasing to 70–100 µm in diameter with segments L/D 0.3–0.7 near the apices; trichoblasts usually profuse, branches replacing trichoblasts and commonly cicatrigenous from older branches. Pericentral cells 4, usually elongate with L/D (1-) 1.2–2 (-2.5) in ecorticate parts except near apices, becoming corticate from the sides or corners of

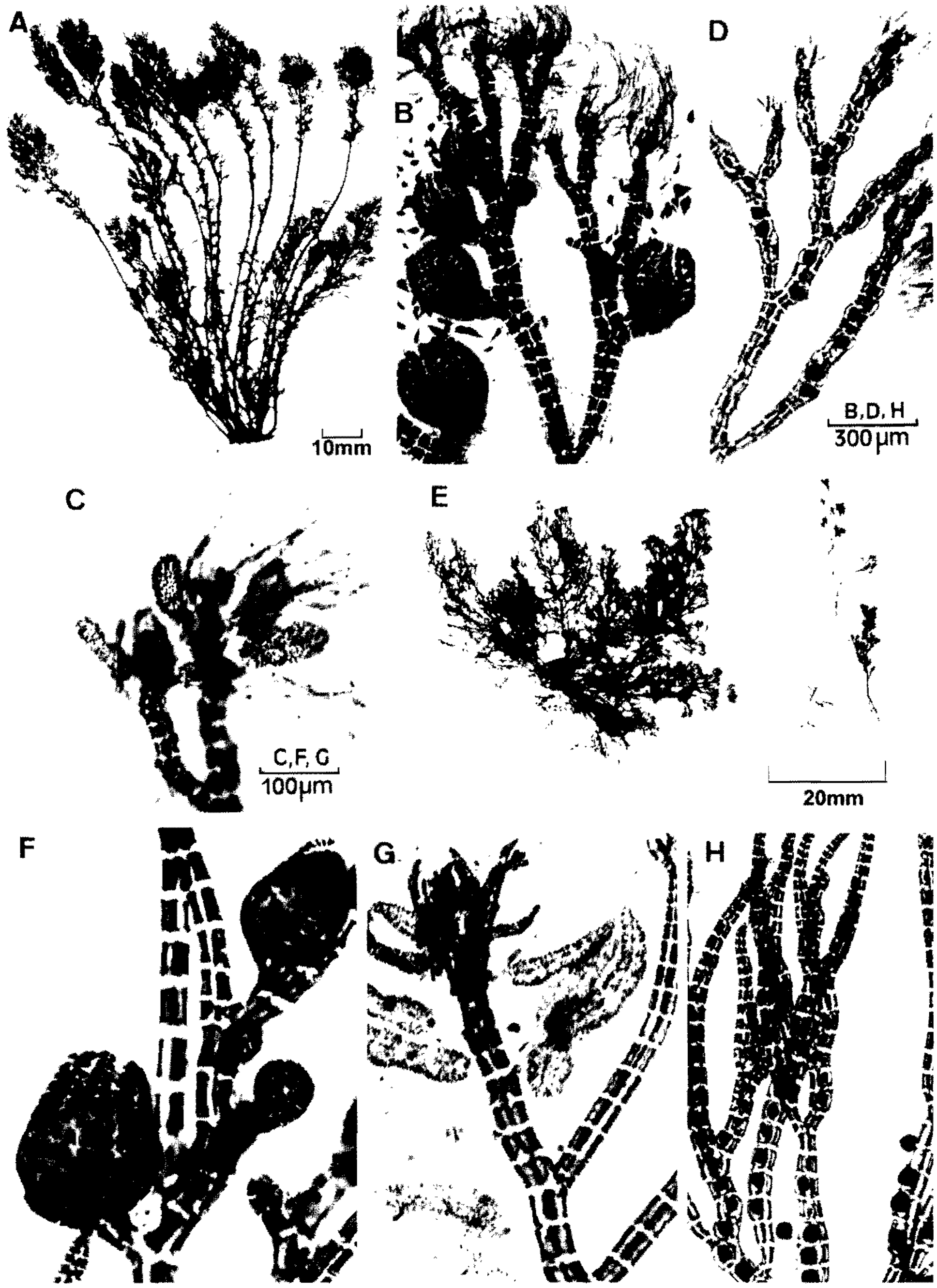

Fig. 85. A–D. *Polysiphonia australiensis* (**A**, **C**, **D**, AD, A32913; **B**, AD, A49278). **A.** Habit. **B.** Branches with cystocarps. **C.** Spermatangial branches. **D.** Tetrasporangial branches. **E–H.** *Polysiphonia abscissoides* (**E**, **F**, **H**, AD, A49188; **G**, AD, A47589). **E.** Habit. **F.** Branches with cystocarps. **G.** Spermatangial branches. **H.** Tetrasporangial branches. (All as in Womersley 1979, courtesy of Aust. J. Bot.)

pericentral cells with corticating filaments developing longitudinally between the pericentral cells, soon spreading as a complete surface layer, becoming several cells thick on older axes; trichoblasts or scar cells present on every segment with a divergence of 1/4, relatively robust (basal cells 35–45 µm in diameter), 2–3 (-4) times furcate. Rhodoplasts discoid, scattered.

Reproduction. Gametophytes dioecious. Carposporophytes with a small basal fusion cell and short gonimoblast bearing clavate terminal carposporangia 20–40 µm in diameter. Cystocarps (Fig. 85B) stalked, ovoid, usually becoming urceolate with a pronounced neck, 200–350 µm in diameter and 300–400 µm long (excluding stalk); pericarp ostiolate, 2 cells thick, outer cells isodiametric to elongate, angular, with the ostiolar cells considerably enlarged. Spermatangial branches (Fig. 85C) developing as one branch of a trichoblast, cylindrical to tapering, 150–300 µm long and 40–80 µm in diameter, with 1–2 sterile apical cells when mature.

Tetrasporangia (Fig. 85D) forming gently spiralling series in upper branchlets, usually extending below 1–3 branches, moderately distorting the segments and occupying 0.5–0.7 of the segment diameter when mature, subspherical, 40–60 µm in diameter.

Type from Vivonne Bay, Kangaroo I., S. Aust., mid eulittoral, south side Ellen Point (*Womersley*, 22.xi.1968); holotype in AD, A32913—"Marine Algae of southern Australia" No. 210.

Distribution: Rottnest I., W. Aust., to Curtis I., Bass Strait, Vic., and Three Hummock I, NW Tasmania.

Selected specimens: Rottnest I., W. Aust., on *Sargassum* (*Gordon*, 12.xi.1968; AD, A33131). Frenchmans Bay, Albany, W. Aust., upper sublittoral (*Woelkerling*, 2.ii.1978; AD, A49278). Twilight Corner, Esperance, W. Aust., on *Balanus*, lower eulittoral (*Woelkerling*, 29.i.1978; AD, A42989). Point Sinclair, S. Aust., lower eulittoral (*Womersley*, 26.i.1951; AD, A15225). Greenly Beach, Eyre Pen., S. Aust., lower eulittoral (*Parsons*, 15.v.1968; AD, A32558). Wanna, S. Aust., mid eulittoral pool (*Womersley*, 21.viii.1967; AD, A31865). Pennington Bay, Kangaroo I., S. Aust., in pool (*Womersley*, 21.xi.1968; AD, A32904). Back Beach, Little Dip Conservation Park, SE S. Aust., lower eulittoral on outer reef (*Womersley*, 24.iv.2000—"Marine Algae of southern Australia" No. 210a). Apollo Bay, Vic., (*McLennan*, Aug. 1951; AD, A16408). Blairgowrie, Vic., on *Laurencia*, at low tide level on ocean beach (*Sinkora* A2452, 23.xi.1978; AD, A60900). Curtis I., Bass Strait, Vic., lower eulittoral (*King*, ?; MEL, 20888; AD, A39446). Three Hummocks I., NW Tas., on *Laurencia*, low eulittoral (*Bennett*, 17.i.1954; AD, A19701).

P. australiensis is a distinctive species, largely confined to the lower and mid eulittoral zones on sloping rock on rough-water coasts; occasionally it is epiphytic in the same habitats. Of the southern Australian corticate species it is most closely related to *P. daveyae*, but differs in habit, in the branches replacing trichoblasts, in having elongate rather than isodiametric pericentral cells in ecorticate parts, in its habitat and in reproductive details such as the enlarged ostiolar cells of the pericarp, in having one or two sterile apical cells to the spermatangial branches, and in that the tetrasporangia usually extend below 2 or 3 branchings.

18. **Polysiphonia abscissoides** Womersley 1979: 492, fig. 9E–H. Adams 1994: 319, pl. 109, upper centre. Huisman *et al.* 1990: 97? Kendrick *et al.* 1988: 204; 1990: 52. Silva *et al.* 1996: 536.

Polysiphonia abscissa sensu Adams, Conway & Norris 1974: 236. [NON *P. abscissa* Hooker & Harvey 1845a: 266 (see under *P. subtilissima*).]

FIG. 85E–H

Thallus (Fig. 85E) dark red-brown, 4–12 cm high, densely tufted with numerous, much branched, slender, erect branches arising from prostrate filaments. Attachment by rhizoids from prostrate filaments; epilithic. *Structure.* Prostrate filaments (100-) 150–300 µm in diameter with segments L/D 1–1.5 (-2), with unicellular rhizoids cut off from pericentral cells; erect branches 100–175 (-200) µm in diameter with segments L/D 1.5–2 extending to 3–6 (-10) in mid parts, tapering gradually to 70–100 µm with segments L/D 1–1.5 in upper parts and (40-) 50–60 µm with segments L/D 0.5–1 near apices; apices straight to slightly curved, with fairly prominent apical cells and a few to numerous trichoblasts; lateral branches irregular and sparse but often 2–4 segments apart near apices, of limited growth and without trichoblasts; branches arising in place of trichoblasts; cicatrigenous branches absent (?) Pericentral cells 5 (occasionally 4), elongate except near apices, ecorticate throughout; trichoblasts (or scar cells) occasional in lower (older) parts, more plentiful near apices, simple or once furcate, basal cells 12–18 µm in diameter, sometimes plentiful and 2–3 times furcate in fertile plants. Rhodoplasts discoid, irregularly placed.

Reproduction. Gametophytes dioecious. Carposporophytes with a slight basal fusion cell and short gonimoblast bearing clavate terminal carposporangia 20–35 µm in diameter. Cystocarps (Fig. 85F) short-stalked, ovoid, becoming urceolate, 250–350 (-450) µm in diameter; pericarp ostiolate, 2 cells thick, outer cells isodiametric, angular. Spermatangial branches (Fig. 85G) developing as one branch of a trichoblast, cylindrical and gently tapering, (150-) 200–350 µm long and 50–75 µm in diameter, without a sterile apical cell when mature.

Tetrasporangia (Fig. 85H) forming regular, straight to gently spiral series in upper branches, often descending below 2–3 branchings, only slightly distorting the segments, subspherical, 50–75 µm in diameter.

Type from Swansea, Oyster Bay, Tas., mid eulittoral (*Skinner*, 22.ii.1978); holotype in AD, A49188.

Distribution: Shark Bay, W. Aust? (Huisman *et al.* 1990, p. 97) and SE Tasmania.
South I., New Zealand (see Womersley 1979, p. 493).

Selected specimens: Bruny I., Tas. (*White*, 1.ii.1937; AD, A16488). Dover, Tas., low eulittoral (*Wollaston*, 20.viii.1965; AD, A29543 and *Gordon*, 14.i.1966; AD, A30006). Point Puer, Port Arthur, Tas. (*Cribb* 152.2, 29.vi.1951; AD, A16383 and 26.vi.1951; AD, A21024). Kangaroo Point, Derwent R., Tas. (*Sullivan*, Dec. 1871; MEL, 45960–2). Akaroa, N.Z., mid and lower eulittoral (*Womersley*, 10.x.1976; AD, A47588 and AD, A47589). Thule, Stewart I., low eulittoral (*Womersley*, 5.i.1966; AD, A29902).

P. abscissoides is the only southern Australian species of *Polysiphonia* consistently with 5 pericentral cells. It is characterised also by the occasional scar cell in the lower parts of the thallus, though often trichoblasts occur on every segment in fertile and actively growing plants, and by the branches arising independent of the trichoblasts. The Tasmanian plants agree well with those from New Zealand, though the latter may often be better developed. The Shark Bay record is unlikely since it is from much warmer waters than the Tasmanian and N.Z. distribution.

In habit and filament dimensions *P. abscissoides* is very similar to *P. sertularioides* but is clearly differentiated on the number of pericentral cells and the trichoblasts. *P. abscissoides* appears to be essentially a low intertidal species confined to the south-east coasts of Tasmania and southern New Zealand, where it has been known as *P. abscissa* Hooker & Harvey. The latter, however, is from South America (see under *P. subtilissima*) and has 4 pericentral cells and rhizoids not cut off from pericentral cells, in contrast to *P. abscissoides* which usually has 5 pericentral cells and the rhizoids are cut off from the pericentral cells.

19. **Polysiphonia teges** Womersley 1979: 494, fig. 10A–C. Beanland & Woelkerling 1982: 99.

FIG. 86A–C

Thallus (Fig. 86A) dark brown-red, 1–2 cm high, forming dense mats on rock near low tide level, with prostrate filaments producing erect branches bearing several laterals. Attachment by rhizoids from prostrate filaments; epilithic. *Structure.* Prostrate filaments (Fig. 86B) 70–100 (-125) µm in diameter with segments L/D 0.5–1, with rhizoids 25–50 µm thick and in open connection with the pericentral cells; apices straight to curved, tapering fairly abruptly to the apical cell and with only occasional trichoblasts. Erect branches arising endogenously at irregular intervals, 60–120 µm in diameter with segments L/D 0.5–1 (-1.5), bearing a few lateral branches of similar diameter, tapering to 50–70 µm near the apices with segments L/D 0.3–0.8, with fairly prominent trichoblasts on actively growing apices; lateral branches probably arising independently of trichoblasts and cicatrigenously. Pericentral cells 6, ecorticate; scar cells absent on prostrate filaments, occasional only on erect branches, with trichoblasts 1–4 times furcate and usually several segments apart on actively growing apices. Rhodoplasts discoid, densely scattered.

Reproduction. Sexual reproduction unknown.

Tetrasporangia (Fig. 86C) scattered or in fairly long spiral series with a divergence of about 1/4 in erect branches, slightly distorting the segments, subspherical to ovoid, 50–65 µm in diameter.

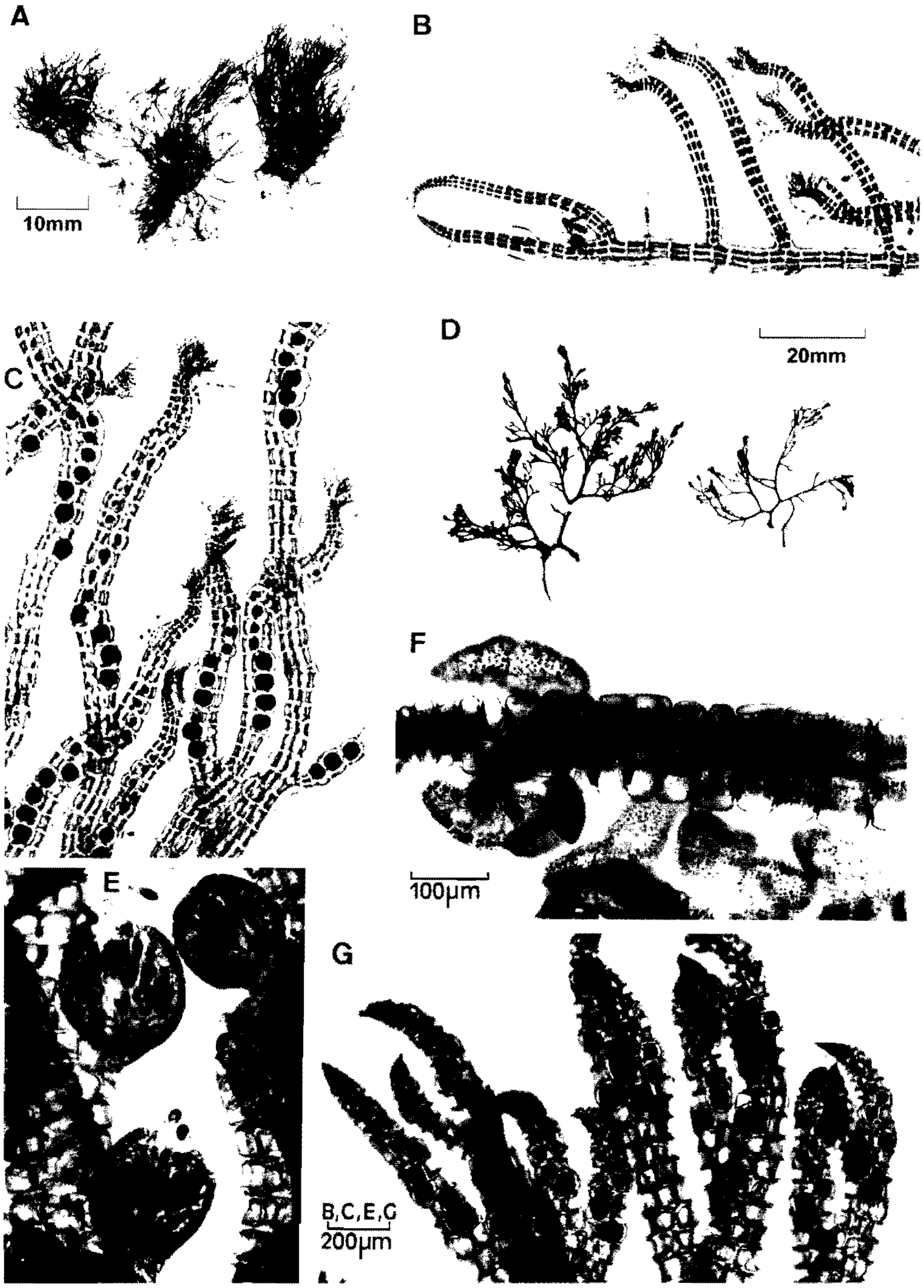

Fig. 86. A–C. *Polysiphonia teges* (AD, A49279). **A.** Habit. **B.** Prostrate axes with erect branches. **C.** Tetrasporangial branches. **D–G.** *Polysiphonia forfex* (**D**, MEL, 1006731, Alg. Aust. Exsicc. 171A; **E–G**, AD, A50697). **D.** Habit. **E.** Branches with cystocarps. **F.** Branch with spermatangial organs. **G.** Tetrasporangial branches. (**A–D** as in Womersley 1979, courtesy of Aust. J. Bot.)

Type from Frenchmans Bay, Albany, W. Aust., uppermost sublittoral on sand-covered rock (*Woelkerling*, 2.ii.1978); holotype in AD, A49279.

Distribution: Only known from the type and from Mangrove Point, N Spencer Gulf, S. Aust., uppermost sublittoral (*Womersley*, 31.xii.1950; AD, A13678).

P. teges is superficially very similar to *P. scopulorum* in habit, rhizoids, trichoblasts and tetrasporangia, but differs in having 6 pericentral cells throughout instead of 4 as in *P. scopulorum*.

20. **Polysiphonia forfex** Harvey 1859a: pl. 96; 1863, synop.: xxii. Huisman & Walker 1990: 439. Womersley 1979: 495, fig. 10D–G.

Polysiphonia forcipata Harvey 1855a: 541. J. Agardh 1863: 1024. De Toni 1903: 920. Kützing 1864: 15, pl. 44a–d. Lucas 1909: 41. Lucas & Perrin 1947: 272. Segi 1966: 508, pl. 12A. Sonder 1880: 35. [NON *P. forcipata* J. Agardh 1842: 127 from the Adriatic = *P. furcellata* (C. Agardh)Harvey].

FIG. 86D–G

Thallus (Fig. 86D) red-brown, 1–5 cm high, with an erect basal axis, subdichotomously to laterally branched with usually patent branches, sometimes fastigiate and unilateral above, usually with somewhat forcipate or involute apices. Holdfast 1–3 mm across, of clumped rhizoids; epiphytic on *Posidonia* or larger algae. *Structure.* Basal axis 300–700 µm in diameter with segments L/D 0.3–0.5, with rhizoids cut off from the pericentral cells or cortical cells of the basal segments; mid branches 300–500 µm in diameter with segments L/D 0.3–0.5, tapering to 100–150 µm in diameter with segments L/D 0.2–0.3 shortly behind the apices, then tapering abruptly to the involute apices (Fig. 86G), with relatively inconspicuous trichoblasts; lateral branches several to many segments apart, arising in place of trichoblasts; cicatrigenous branches occasional. Pericentral cells 6 occasionally 5 or 7, isodiametric to slightly broader than long in face view (Fig. 86G), and commonly in longitudinal rows but sometimes irregular, lightly corticate near the base of main axes with relatively large cells cut off from the sides of the pericentral cells; trichoblasts or scar cells on every segment, trichoblasts slender (basal cells 15–20 µm in diameter), 3–5 times furcate. Rhodoplasts elongate-ovoid to ribbon-like.

Reproduction. Gametophytes dioecious. Carposporophytes with a small basal fusion cell and short gonimoblast bearing clavate terminal carposporangia 35–50 µm in diameter. Cystocarps (Fig. 86E) short-stalked, subspherical to ovoid, 250–400 µm in diameter; pericarp ostiolate, 2 cells thick, outer cells angular, isodiametric, with the apical ostiolar cells becoming enlarged. Spermatangial branches (Fig. 86F) replacing the whole trichoblast, elongate-ovoid, 120–270 µm long and 70–120 µm in diameter.

Tetrasporangia (Fig. 86G) forming spiral series in upper branches, with a divergence of about 1/5 owing to irregularly placed pericentral cells, often descending below 1–2 branchings, not or very slightly distorting the segments and occupying only 0.3–0.5 the branch diameter, 55–110 µm in diameter.

Type from Rottnest I., W. Aust., on *Posidonia* (*Harvey*, Trav. Set 186 as *P. forcipata*); holotype in Herb. Harvey, TCD; isotype in BM.

Distribution: Coast near Fremantle, Rottnest I., Garden I. and King George Sound, W. Aust. Epiphytic on *Posidonia* and some robust algae.

Selected specimens: Fremantle, W. Aust. [*Harvey*, (Alg. Aust. Exsicc. 171A); MEL, 1006731)]. Whitford Beach, Perth, W. Aust., on *Sargassum*, 4 m deep (*Cook*, 20.viii.1979; AD, A50697). Rottnest I., W. Aust., drift on *Laurencia brongniartii* (*Cribb* 67.52, 9.viii.1950; AD, A13963) and on *Sargassum*, NW end (*Gordon*, 12.xi.1968; AD, A33132). Salmon Bay, Rottnest I., W. Aust., on *Sargassum*, drift (*Parsons*, 12.xi.1968; AD, A33385). Point Peron, W. Aust., upper sublittoral (*Womersley*, 24.ix.1979; AD, A51026).

Harvey (1859a, pl. 96) changed the name of his *P. forcipata* to *P. forfex*, recognising J. Agardh's earlier use of the former name. He recorded the species on *Zostera*, a name used by Harvey for *Posidonia australis*.

P. forfex occurs mainly on or near Rottnest I., but Harvey recorded it also from King George Sound. It is distinguished by its habit, normally 6 pericentral cells, and the very short

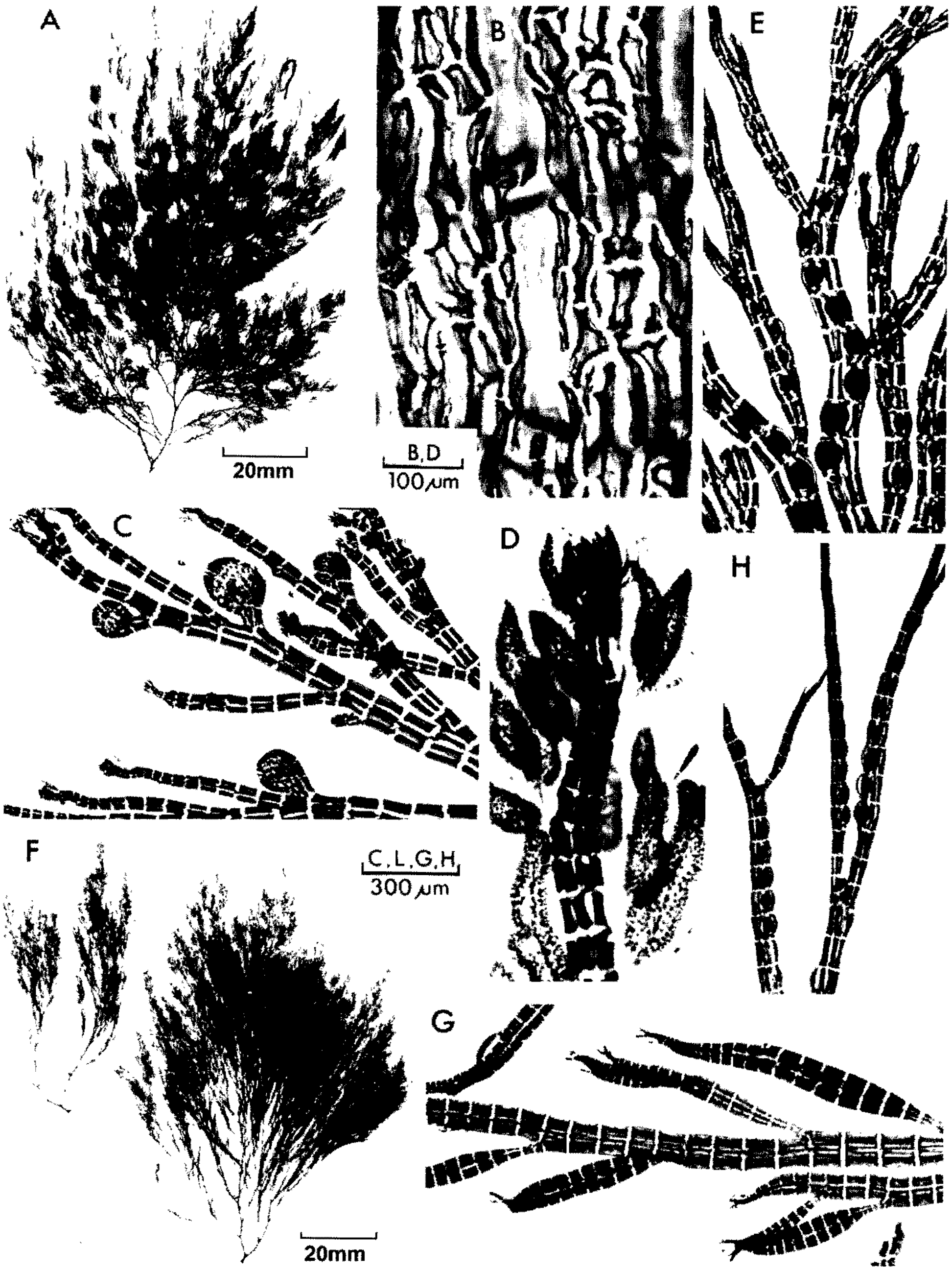

Fig. 87. A–E. *Polysiphonia brodiei* (**A**, **B**, **E**, AD, A49156; **C**, **D**, AD, A44594). **A**. Habit. **B**. Young cortication. **C**. Branches with cystocarps. **D**. Spermatangial branches. **E**. Tetrasporangial branches. **F–H**. *Polysiphonia constricta* (**F**, **G**, AD, A32927; **H**, AD, A42354). **F**. Habit. **G**. Branch with basally constricted laterals. **H**. Tetrasporangial branches. (All as in Womersley 1979, courtesy of Aust. J. Bot.)

segments throughout the thallus. Comparisons with *P. brevisegmenta* are made under the latter species.

P. forcipata Harvey was recorded from Japan by Segi (1951, p. 251, fig. 31, Pl. 13 fig. 1) but this record is referred to *P. fragilis* Suringar by Yoshida (1998, p. 1066). Yoon (1986, p. 36), followed by Silva *et al.* 1996, p. 542, places *P. forfex* as *P. japonica* var. *forfex*, but his description (presumably of Korean plants) differs from the Australian plants in referring to 4–6 pericentral cells (usually 6 in the latter) and is inadequate for comparisons. It seems unwise to follow Yoon for the present.

21. **Polysiphonia brodiei** (Dillwyn)Sprengel 1827: 349. Abbott & Hollenberg 1976: 694, fig. 642. Adams 1983: 2; 1994: 325, pl. 110, lower left. J. Agardh 1863: 993. Batten 1923: 303, pl. 24 figs 61–63. De Toni 1903: 947. Harvey 1848: pl. 195; 1855b: 230. Hollenberg 1944: 477. Lewis 1983: 262. Segi 1960: 623, fig. 15, pl. 34C, D. Maggs & Hommersand 1993: 314, fig. 95. Rosenvinge 1924: 430 figs 376–384. Silva *et al.* 1996: 537. Womersley 1979: 496, fig. 11A–E.
Conferva brodiaei Dillwyn 1809, pl. 107.

FIG. 87A–E

Thallus (Fig. 87A) dark-red brown, 4–12 (-17) cm high, profusely and irregularly branched from one or a few basal, erect axes (or slight prostrate parts), with several percurrent main branches, fastigiate above. Holdfast rhizoidal, 1–4 mm across; usually epilithic, occasionally epiphytic. *Structure.* Basal axis 0.5–1 mm in diameter, heavily corticate, attached by numerous rhizoids cut off from the pericentral or cortical cells; mid branches 300–500 µm in diameter with segments L/D 2–3 (-4) and moderately corticate, tapering to ecorticate upper branches and branchlets 100–200 µm in diameter with segments L/D 1–2, then to 50–75 µm in diameter with segments L/D 0.5–1 shortly behind the apices; young branchlets straight to slightly flexuous, with fairly prominent trichoblasts; lateral branches arising every few segments from the basal cells of trichoblasts, with occasional cicatrigenous branches below. Pericentral cells 7–8, elongate throughout, becoming corticate on branches about 200 µm in diameter with small cells cut off first from the posterior sides of the pericentral cells, forming filaments of ovoid to elongate cells lying over the longitudinal joins of the pericentral cells (Fig. 87B); a thin but fairly complete cortical layer is present on branches about 500 µm in diameter, and this becomes several cells thick on lower branches and axes; trichoblasts or scar cells on every segment, trichoblasts relatively slender (basal cell 10–15 µm in diameter, 2–4 times furcate). Rhodoplasts ovoid to irregular.

Reproduction. Gametophytes dioecious. Carposporophytes with a slight basal fusion cell and short gonimoblast bearing clavate terminal carposporangia 20–40 µm diameter. Cystocarps (Fig. 87C) stalked, subspherical to ovoid, sometimes slightly urceolate, 250–400 µm in diameter; pericarp ostiolate, 2 cells thick, outer cells angular, usually longitudinally elongate and L/D 1–2 (-3), often becoming irregularly lobed, sometimes with the ostiolar cells becoming enlarged. Spermatangial branches (Fig. 87D) developing as one branch of a trichoblast, cylindrical and gently tapering, 180–350 µm long and 50–75 µm in diameter, without a sterile apical cell when mature.

Tetrasporangia (Fig. 87E) forming gently spiral series in upper branches, often descending below several young lateral branches, with a divergence of $^1/_6$ to $^1/_7$, slightly distorting the segments and occupying when mature half to most of the segment diameter, subspherical to ovoid, 50–100 µm in diameter.

Type from Cork, Bantry Bay, Ireland (*Hutchins*). See Maggs & Hommersand (1993, p. 314).

Distribution: In southern Australia from Gulf St Vincent, S. Aust., to Port Phillip, Vic., and SE Tasmania.

Europe, Mediterranean, Atlantic Canada, NW U.S.A., Japan, Indian Ocean, New Zealand.

Selected specimens: Gulf St Vincent, S. Aust., 60 m deep (AD, A1209). American R. inlet, Kangaroo I., S. Aust., 1 m deep on buoys (*Lavers*, 22.x.1997; AD, A68242). Robe, S. Aust., on ramp in boat harbour, low tide level (*Womersley*, 24.viii.1973; AD, A44594) and on slipway reef, upper sublittoral (*Womersley*, 14.ii.1978; AD, A49156). Apollo Bay, Vic., 0.5–1 m deep on pipeline (*Parker & Womersley*, 21.viii.1988; AD, A59238—"Marine Algae of southern Australia" No. 324). Swan I. Naval Depot, Port Phillip, Vic., 0–0.5 m deep on barge (*Womersley*, 8.iv.1959; AD, A22608). Gellibrand Light, Port Phillip Bay, Vic., 0–2 m deep (*Kraft*, 28.i.1976; AD, 49792). Flinders, Western Port, Vic., drift

(*Sinkora* A1732, 16.xi.1972; AD, A53440). Bellerive, Tas. (*Perrin*, Nov. 1940; MEL, 46013) and (*Cribb* 47.7, 28.iii.1950; AD, A16005). Bicheno, Tas., on *Codium fragile*, lower eulittoral (*Skinner*, 22.ii.1978; AD, A49203). Blackmans Bay, Tas., drift (*Cribb* 76.9, 22.ix.1950; AD, A16248). Taroona, Tas., 1–3 m deep (*Shepherd*, 19.iii.1975; AD, A46224).

The Australian specimens agree well with material from Britain and, as in some other countries (e.g. California, see Hollenberg 1944, p. 477). The species is usually found in or near harbour areas and may be spread by shipping.

Silva *et al.* 1996, p. 537 commented on the spelling of "*brodiei*".

22. **Polysiphonia constricta** Womersley 1979: 497, fig. 11F–H. Adams 1983: 2; 1994: 325. Lewis 1983: 262. Millar 1990: 442, fig. 65A–D? Millar & Kraft 1993: 57.

FIG. 87F–H

Thallus (Fig. 87F) brown-red, 5–12 cm high, tufted, with an erect basal axis arising from a short prostrate filament, branched above subdichotomously to alternately with upper parts densely fibrilliferous to fastigiate. Attachment by rhizoids from prostrate base; probably epilithic. *Structure.* Prostrate base only a few mm long, 200–700 µm in diameter with segments L/D 0.3–0.7 (-1), attached by unicellular rhizoids cut off from pericentral cells; erect lower axis 300–800 µm in diameter with segments L/D 0.4–1, tapering gradually to 200–400 µm in diameter with segments L/D (0.3-) 0.5–0.8 (-1.8) in mid parts and to (60-) 75–100 µm in diameter with segments L/D 0.8–1 in branchlets; lateral branchlets, especially those unbranched or virtually so, usually markedly basally constricted (Fig. 87G), mostly 0.5–1 mm long and 70–150 µm in greatest diameter; apices straight, with few, inconspicuous trichoblasts; lateral branches arising from the basal cell of trichoblasts but remainder of trichoblast soon lost, with occasional cicatrigenous branchlets. Pericentral cells 7, elongate except close to apices, ecorticate throughout, much slenderer for 2–3 segments at base of constricted branchlets; trichoblasts and scar cells occasional, trichoblasts slender, often relatively undeveloped, 1–3 times furcate. Rhodoplasts discoid, scattered or in slight chains.

Reproduction. Sexual reproduction unknown.

Tetrasporangia (Fig. 87H) formed in linear series (usually adaxial) in lesser branchlets, often extending below 1–2 branchings, slightly but evenly distorting the segments on one side of the branchlet, subspherical to ovoid, 40–60 µm.

Type from Muston, American R. inlet, Kangaroo I., S. Aust., 2–3 m deep (*Womersley*, 21.xi.1968); holotype in AD, A32927.

Distribution: Coffin Bay, S. Aust. to Crawfish Rock, Westernport Bay, Victoria. N.S.W.? (see Millar 1990, p. 443 and Millar & Kraft 1993, p. 57).

New Zealand (Adams 1983, p. 2).

Selected specimens: Mt Dutton Bay, Coffin Bay, S. Aust, 5 m deep (*Womersley*, 1.xii.1975; AD, A46810). Tapley Shoal, Gulf St Vincent, S. Aust., 13 m deep (*Shepherd*, 5.ii.1969; AD, A33772). West Beach, S. Aust., drift (*Womersley*, 1.xii.1946; AD, A4513). Muston, Kangaroo I., S. Aust., 2–3 m deep (*Kraft*, 7.iv.1972; AD, A42411). American R. inlet, Kangaroo I., S. Aust., on outer black buoy (*Womersley*, 15.i.1948; AD, A9487). Bay of Shoals, Kangaroo I., S. Aust. (AD, A2634). 4 km off Seacliff, S. Aust., 13 m deep on shell (*Rowland*, 5.iii.1988; AD, A58637). Hobson Bay, Port Phillip, Vic., 0.5 m deep on power station water outlet (*Watson*, 2.v.1972; AD, A42354). Crawfish Rock, Westernport Bay, Vic., 2 m deep (*Watson*, 28.v.1974; AD, A45379).

P. constricta is a distinctive species in southern Australia, separated from the other species (*P. decipiens*) with 7 pericentral cells by its habit (without short patent laterals) and by the usual strong basal constriction of the young branchlets. The type and most specimens are sterile, but it is possible that the constricted, usually more densely protoplasmic branchlets could act as propagules. *P. constricta* is confined to very sheltered waters in bays and inlets.

Specimens from Coffin Bay, S. Aust. (AD, A46810) and Hobson Bay, Port Phillip, Vic. (AD, A42354 and MELU, L1065–6, L1073, L1086) agree well with *P. constricta* except for the absence of laterals with constricted bases. Of these, A42354 is tetrasporangial. Further study is needed on such specimens in relation to the type, but if they do prove to be the same species it is possible that sterile plants bear constricted laterals which can propagate the plants, while fertile plants do not bear such laterals. Further study is also needed of N.S.W. plants referred to this species.

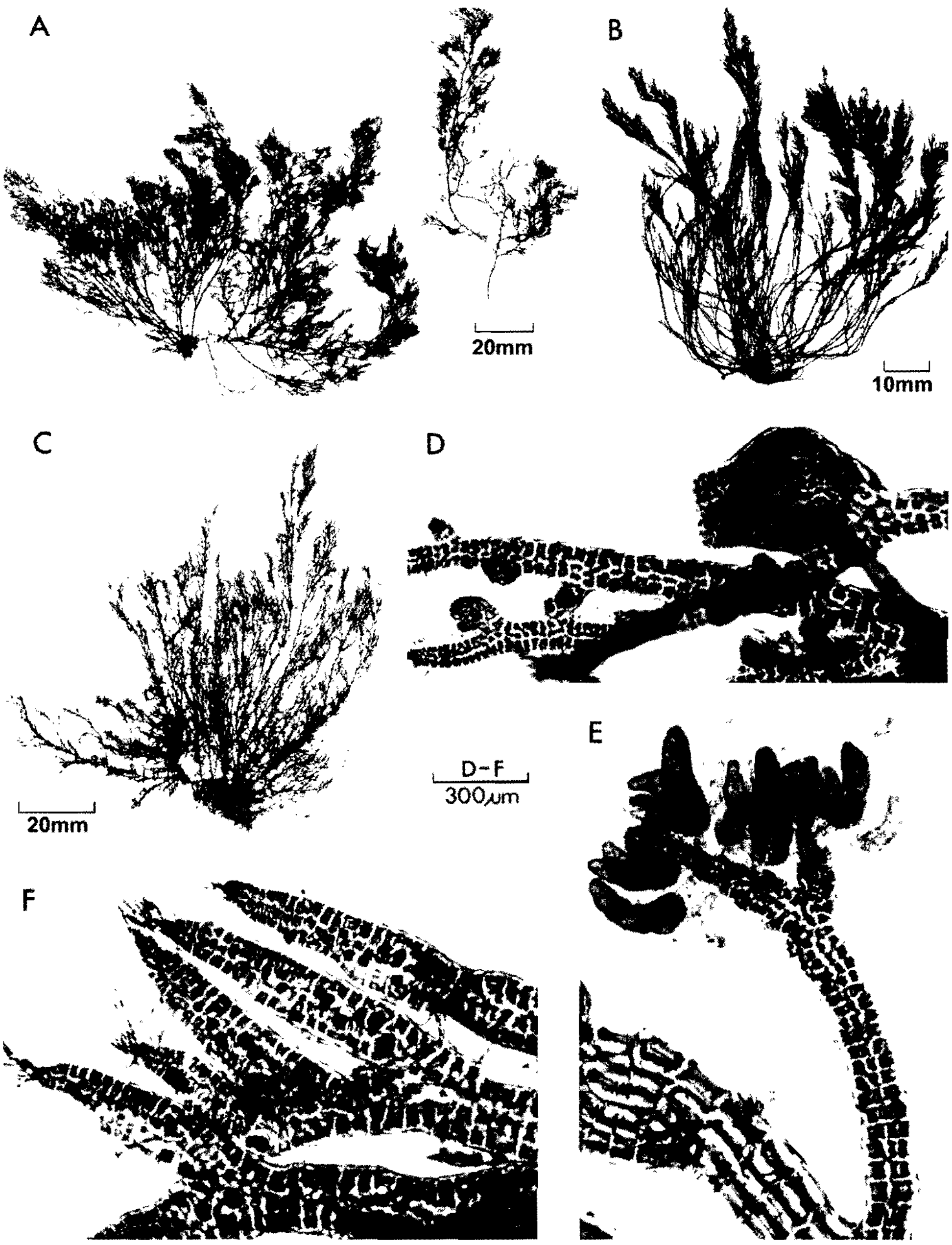

Fig. 88. *Polysiphonia decipiens* (**A**, **E**, AD, A37285; **B**, AD, A32914; **C**, AD, A46783; **D**, AD, A49204; **F**, AD, A32931). **A**. Habit of a subtidal epiphytic plant. **B**. Habit of rough-water reef plant. **C**. Habit of shallow and calmer water plant. **D**. Branches with young and mature cystocarps. **E**. Spermatangial branches. **F**. Tetrasporangial branches. (All as in Womersley 1979, courtesy of Aust. J. Bot.)

Some other specimens with 7 pericentral cells are at present referred to *P. isogona* Harvey (see below). These differ from *P. constricta* in being slenderer plants with numerous axes from prostrate entangled filaments, not having markedly constricted branch bases and in having more frequent trichoblasts or scar cells.

23. **Polysiphonia decipiens** Montagne 1842b: 5; 1845: 131. Adams 1994: 320, pl. 110 upper left. J. Agardh 1863: 1046; 1878: 29. Connolly 1911: 125, figs 1, 2, pl. 1. De Toni 1903: 927; 1924: 399. Harvey 1847: 50; 1855b: 230. Harvey & Hooker 1845: 184. Huisman 1997: 207. Huisman *et al.* 1990: 97. Huisman & Walker 1990: 439. Kendrick *et al.* 1988: 204; 1990: 52. Kützing 1849: 815; 1863: 21, pl. 65c–e. Millar & Kraft 1993: 57. Shepherd 1983: 83. Shepherd & Womersley 1981: 367. Womersley 1979: 499, fig. 12.

Polysiphonia frutex Harvey 1844b: 439; 1846: 426; 1847: 52; 1859b: 301; 1863, synop.: xxi. J. Agardh 1863: 1047. Cribb 1954a: 18, 35. De Toni 1903: 925; 1924: 399. De Toni & Forti 1923: 39. Guiler 1952: 103. Hooker & Harvey 1847: 399. Millar & Kraft 1993: 57. Kützing 1849: 815; 1863: 21, pl. 66d, e. Lucas 1909: 41; 1929a: 22. Lucas & Perrin 1947: 273. Segi 1966: 508, pl. 13F. Silva *et al.* 1996: 539. Sonder 1880: 35. Tate 1882a 23. Tisdall 1898: 514. Wilson 1892: 167. Womersley 1948: 151; 1950: 185.

Polysiphonia fuscescens Harvey 1844b 439; 1847: 52; 1849b 54; 1859b: 301; 1863, synop.: xxi. J. Agardh 1863: 1050. Cribb 1954: 15, 32, 35, 38. De Toni 1903: 925. Guiler 1952: 103. Hooker & Harvey 1847: 399. Kützing 1849: 816; 1863: 21, pl. 67a–d. Lucas 1909: 41; 1929a: 22. Lucas & Perrin 1947: 273. Sonder 1853: 702; 1880: 35. Tisdall 1898: 514. Womersley 1950: 185; 1956: 81, 82.

Polysiphonia cancellata Harvey 1844b 440; 1847: 51, pl. 15; 1849b 55; 1855a: 541; 1855b: 230; 1859b: 300; 1863, synop.: xxi. J. Agardh 1863: 1049; 1879: pl. 33 figs 7, 8. Ardissone 1888: 215. Black 1971: 131. Cribb 1954a 17, 36. De Toni 1903: 928; 1924: 399. De Toni & Forti 1923: 39. Ducker *et al.* 1977: 87. Guiler 1952: 103. Hooker & Harvey 1847: 399. Kützing 1849: 815; 1863: 21, pl. 66a–c. Levring 1946: 226. Lucas 1909: 41; 1929a: 22; 1929b: 51. Lucas & Perrin 1947: 273. Pujals 1963: 117. Reinbold 1897: 57; 1899: 50. Sonder 1853: 701; 1880: 35. Tate 1882a 23. Tisdall 1898: 514. Wilson 1892: 167. Womersley 1950: 184; 1956: 83; 1966: 153.

Polysiphonia rytiphlaeoides Hooker & Harvey 1845: 537. Raoul 1846: 6.

Polysiphonia nigrita Sonder 1845: 53; 1848: 181; 1853: 702; 1880: 35. J. Agardh 1863: 1048. De Toni 1903: 928. Guiler 1952: 103. Harvey 1847: 51; 1855a: 541; 1863, synop.: xxi. Kützing 1849: 816; 1863: 21, pl. 67e–h. Lucas & Perrin 1947: 274. Saenger 1974: 81. Shepherd 1974: 27. Shepherd & Womersley 1970: 135; 1971: 166; 1976: 190. Tate 1882a 23. Tisdall 1898: 514. Womersley 1948: 156, 160; 1950: 185.

Polysiphonia caespitula Sonder 1855: 524; 1880: 35. De Toni 1903: 960. Garnet 1971: 97. Guiler 1952: 103. Harvey 1863, synop.: xxii. Kützing 1864: 15, pl. 43d–g. Lucas 1909: 41; 1913: 58. Lucas & Perrin 1947: 274. Tisdall 1898: 514.

FIG. 88

Thallus (Fig. 88A–C) dark brown-red, drying very dark brown to almost black, 1–15 (-25) cm high, irregularly and densely branched (especially in rough-water forms) on all sides with one to a few or several clumped axes, bearing frequent, often short, patent, laterals, often fastigiate above when fertile; hooked branch ends occasionally present. Attachment by rhizoids from prostrate parts; epilithic or epiphytic on larger brown algae, seagrasses (*Posidonia*, *Amphibolis* and *Heterozostera*) and occasionally on red algae. *Structure.* Basal axis erect or with a very short prostrate part, with rhizoids cut off from the lower pericentral cells. Lower main axes 300–1000 (-1500) µm in diameter with segments L/D 0.2–0.3, decreasing to 250–750 (-1000) µm in diameter with segments 0.2–1 (-2) in mid parts and to (100-) 200–300 µm in diameter with segments L/D 0.2–0.5 in branchlets; lateral branchlets often markedly narrower and with shorter segments (Fig. 88E) than the parent branch, especially in robust forms; branchlets tapering fairly abruptly to pointed apices (Fig. 88F), often with profuse trichoblasts but commonly denuded in rough-water or older plants; lateral branches arising from basal cell of trichoblasts, with cicatrigenous branches below. Pericentral cells 7, rarely 8, ecorticate, subisodiametric and forming irregular segments in branchlets and often throughout most of the thallus in rough-water forms, becoming elongate (L/D 1.5–3) and forming regular segments in main branches of deeper- or calmer-water forms; trichoblasts formed on every segment with a divergence of about 1/4, up to 2 mm long, 2–4 (-6) times furcate, varying from moderately slender (basal cell 25–40 µm in diameter) to robust (basal cell 40–60 µm in diameter); scar cells prominent. Rhodoplasts discoid, scattered or in chains.

Reproduction. Gametophytes dioecious. Carposporophytes with a small basal fusion cell and short, gonimoblast with clavate terminal carposporangia 35–55 µm in diameter. Cystocarps (Fig. 88D) subsessile, globular to slightly ovoid (basally broadest), not or only slightly urceolate with small ostiolar cells, 350–700 µm in diameter; pericarp ostiolate, 2 cells thick, outer cells angular, isodiametric. Spermatangial branches (Fig. 88E) developing as one branch of a trichoblast, elongate ovoid to cylindrical, often basally broadest, 150–300 µm long and 50–100 µm in diameter, without sterile apical cells when mature.

Tetrasporangia (Fig. 88F) forming closely spiral series in upper, often elongate, branchlets, often extending below 2–3 branchings, formed from pericentral cells in successive segments and occupying 0.3–0.7 of the branchlet diameter when mature, 60–80 µm in diameter.

Type from the Auckland Is (*d'Urville*), on fuci; holotype in Herb. Montagne, PC; isotypes in TCD.

Distribution: Shark Bay and Geraldton, W. Aust., around southern Australia and Tasmania to Wilson Prom., Vic., and to Newcastle, N.S.W. (*Harvey*, Alg. Aust. Exsicc. 175M).

South I., Stewart I. and Auckland Is, New Zealand, and Tierra del Fuego.

Selected specimens: 7 Mile Beach, N of Dongara, W. Aust., drift (*Womersley*, 17.ix.1979; AD, A51355). Safety Bay, W. Aust., drift (*Womersley*, 18.viii.1979; AD, A50775). Head of Great Australian Bight, S. Aust., epiphytic, drift (*Woelkerling*, 4.xi.1968; AD, A34197). Coffin Bay, S. Aust., epiphytic, 2.5 m deep (*Womersley*, 4.xii.1975; AD, A46926). Crag Point, N Spencer Gulf, S. Aust., 3 m deep (*Shepherd*, 7.xi.1974; AD, A46032). Billy Lights Point, Port Lincoln, S. Aust., on rock, low eulittoral (*Taylor*, 3.xii.1975; AD, A46783). Tiparra Reef, Spencer Gulf, S. Aust., 5 m deep on *Amphibolis* (*Shepherd*, 30.ix.1970; AD, A37285). N of Aldinga reef, S. Aust., on *Posidonia*, 6 m deep (*Johnson*, 13.ii.1973; AD, A43918). Victor Harbor, S. Aust., on *Scytothalia*, drift (*Womersley*, 17.x.1948; AD, A9268). Pennington Bay, Kangaroo I., S. Aust., on *Cystophora* spp., sublittoral fringe (*Womersley*, 21.xi.1968; AD, A32912—"Marine Algae of southern Australia" No. 126) and on inner reef (*Womersley*, 21.xi.1968; AD, A32915—"Marine Algae of southern Australia" No. 125c). Muston, Kangaroo I., S. Aust., on *Sargassum*, 2–3 m deep (*Womersley*, 21.xi.1968; AD, A32931—"Marine Algae of southern Australia" No. 125). Stanley Beach, Kangaroo I., S. Aust., inner reef pools (*Womersley*, 21.xi.1968; AD, A32914—"Marine Algae of southern Australia" No. 125b). Stinky Bay Point, Nora Creina, S. Aust., 1–3 m deep (*Kildea*, 26.x.1996; AD, A66741). Point Lonsdale, Vic., drift (*Sinkora*, A1164, 8.xi.1970; MEL, 504865, AD, A49446). Crawfish Rock, Westernport Bay, Vic., 1 m deep (*Watson*, 25.xi.1971; AD, A42193). N end Waratah Bay, Vic., on *Cystophora retorta*, upper sublittoral (*Sinkora*, A2417, 3.iii.1978; AD, A53605). Georgetown, Tas., upper sublittoral (*Womersley*, 29.i.1949; AD, A10249). Bicheno, Tas., on *Phyllospora*, upper sublittoral (*Skinner*, 22.ii.1978; AD, A49204). Stapleton Point, Prosser Bay, Tas., 8–12 m deep (*Olsen*, 21.vi.1966; AD, A30544). Great Taylor Bay, Bruny I., Tas., 2–7 m deep (*Shepherd*, 7.ii.1970; AD, A35555).

P. decipiens is the commonest species of *Polysiphonia* on southern Australian coasts, usually epiphytic on *Amphibolis* and *Posidonia* or on larger algae. It occurs under varying conditions of wave action, from very calm to strong surf, generally in shallow water.

Plants from southern Australia and New Zealand with 7 (rarely 8, with some records of 8 probably due to inclusion of a scar cell) pericentral cells, ecorticate with mostly patent branches, short to very short segments, generally robust trichoblasts formed on every segment with a divergence of about 1/4, branches arising from the basal cell of trichoblasts and also cicatrigenously, and tetrasporangia in closely spiral series with a divergence of about 1/4, are all placed under the one species, *P. decipiens* Montagne. While agreeing well in these features and also in reproductive aspects, the species is variable in size, robustness and the diameter of the axes and main branches, and in length of the segments and surface shape of pericentral cells. Several of these last features correlate well with ecological conditions where the forms grow, and it appears that the names placed in synonymy above represent only ecological forms or may show some genetic variation but at a subspecific level. While the extremes (e.g. robust '*P. cancellata*' and slender '*P. fuscescens*') may appear specifically distinct, a virtually complete range of intergrades between them occurs.

The earliest name for this complex is *P. decipiens* Montagne, which is apparently only known from the original locality (Auckland Is) by the type specimen. Womersley (1979, p. 501) expressed doubt over the type locality, suggesting the specimen may have come from Tasmania.

P. decipiens appears to be widely distributed and often common along southern Australia, in New Zealand (South I., Stewart I., and Auckland Is) and possibly in southernmost South America (Ardissone 1888, p. 215, repeated by Pujals 1963, p. 117). *P. cancellata* was recorded from Japan by Yendo (1916a, p. 61), but the clearly distinct Japanese species has been described as *P. notoensis* by Segi (see Yoshida 1999, p. 1069).

24. **Polysiphonia atricapilla** J. Agardh 1863: 1054. De Toni 1903: 934. Harvey 1863, synop.: xxii. Lucas 1909: 41; 1929b: 51. Lucas & Perrin 1947: 274. Reinbold 1897: 56. Silva *et al.* 1996: 537. Womersley 1979: 502, fig. 13A–D.

FIG. 89A–D

Thallus (Fig. 89A) dark brown-red, 4–12 cm high, much branched on all sides and densely tufted above with frequent short, patent, branchlets, with a single erect, basal axis. Holdfast discoid, rhizoidal, commonly epiphytic on *Amphibolis*. *Structure.* Basal axis suberect to very shortly prostrate, with rhizoids cut off from the lower pericentral cells. Lower main axis 0.7–1 mm in diameter with segments L/D 0.3–0.5, decreasing gradually to 400–600 µm in diameter with segments L/D 0.3–1 in mid parts and to 200–300 µm in diameter with segments L/D 0.2–0.5 in branchlets, then tapering fairly evenly to straight apices, usually with profuse trichoblasts often extending well below apices; lateral branches arising from basal cells of trichoblasts, with some cicatrigenous branches below. Pericentral cells 10–12, elongate throughout most of thallus, ecorticate; trichoblasts relatively persistent, brown, formed on every segment with a divergence of 1/4 or 1/5, commonly 1–2 mm long with (2-) 3 (-4) furcations, basal cell 45–60 µm in diameter. Rhodoplasts ribbon-shaped.

Reproduction. Gametophytes dioecious. Carposporophytes with a small, erect, basal fusion cell and branched gonimoblast bearing ovoid to clavate terminal carposporangia 30–45 µm in diameter. Cystocarps (Fig. 89B) subsessile, globular to slightly ovoid, not or slightly urceolate and with small ostiolar cells, 400–500 µm in diameter; pericarp ostiolate, 2 cells thick, outer cells isodiametric, angular. Spermatangial branches (Fig. 89C) developing as one basal branch of a trichoblast, elongate-conical, tapering from near the base, 200–450 µm long and 100–150 (-200) µm in diameter, without a sterile apical cell when mature.

Tetrasporangia (Fig. 89D) forming spiral series with a divergence of about 1/5 in upper, simple, not or slightly swollen branchlets, not distorting the segments, occupying about 0.3 the branch diameter when mature, subspherical, 70–100 µm in diameter.

Type from King George Sound, W. Aust. (*Harvey*, Alg. Aust. Exsicc. 175B); holotype in Herb. Agardh, LD, 41629).

Distribution: King George Sound, W. Aust, to Guichen Bay, S. Australia.

Selected specimens: Tiparra Reef, Spencer Gulf, S. Aust., on *Amphibolis*, 11 m deep (*Shepherd*, 24.ii.1971; AD, A38235) and 6 m deep (*Shepherd*, 5.xi.1971; AD, A38349). Marion Bay, Yorke Pen., S. Aust., drift (*Gordon-Mills*, 24.v.1981; AD, A52198). Goldsmith Beach, Yorke Pen., S. Aust., on *Amphibolis*, drift (*Womersley*, 20.ix.1981; AD, A52942). Western Cove, Kangaroo I., S. Aust., on *Posidonia angustifolia*, 4 m deep (*Lavers*, 3.xii.1996; AD, A66834). Muston, American R. inlet, Kangaroo I., S. Aust., 2–3 m deep (*Womersley*, 2.xi.1947; AD, A6146 and 21.xi.1968; AD, A32932).

P. atricapilla is remarkably similar in habit to *P. decipiens* Montagne, and the type is one of Harvey's Alg. Aust. Exsicc. (175B) distributed as *P. cancellata*, a synonym of the latter name. *P. atricapilla* differs essentially in having 10–12 pericentral cells, whereas *P. decipiens* has 7–8. Most specimens of *P. atricapilla* are epiphytic on stems of *Amphibolis* or *Posidonia*, and the species may be largely confined to these hosts; however, *P. decipiens* also occurs on *Amphibolis*.

P. atricapilla was recorded by Askenasy (1888, p. 51) from St Paul I., but is described as having 12–18 pericentral cells and becoming corticated; it is not *P. atricapilla*.

25. **Polysiphonia adamsiae** Womersley 1979: 503, fig. 13E–H. Adams 1994: 325, pl. 110, centre left.

FIG. 89E–H

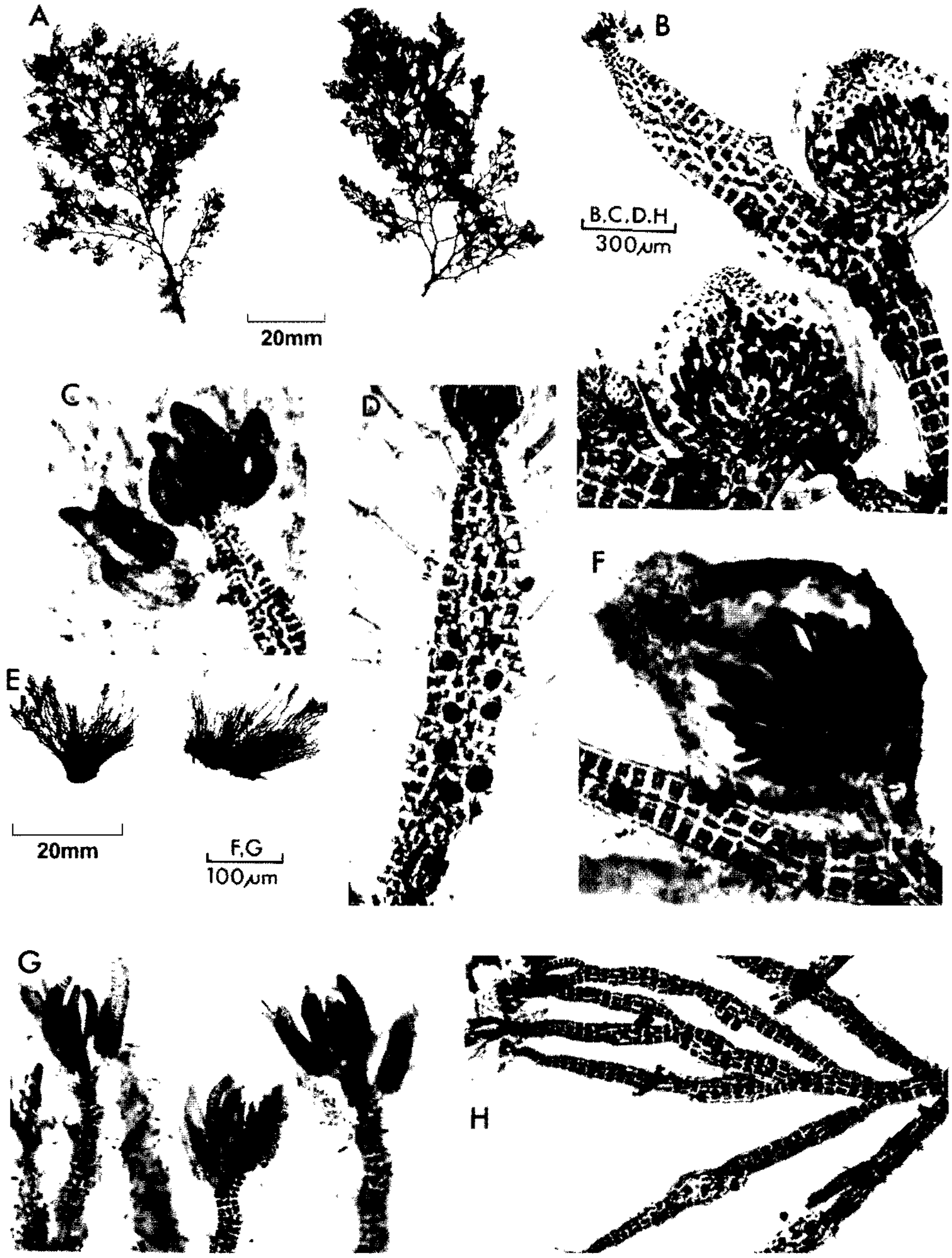

Fig. 89. A–D. *Polysiphonia atricapilla* (**A**, **C**, **D**, AD, A38349; **B**, AD, A38235). **A**. Habit. **B**. Branches with cystocarps. **C**. Spermatangial branches. **D**. Tetrasporangial branch. **E–H**. *Polysiphonia adamsiae* (AD, A35678). **E**. Habit. **F**. Cystocarp. **G**. Spermatangial branches. **H**. Tetrasporangial branches. (All as in Womersley 1979, courtesy of Aust. J. Bot.)

Thallus (Fig. 89E) dark brown-red, 0.5–3 cm high, usually forming dense mats on low intertidal rock, with densely entangled prostrate filaments producing numerous erect axes bearing simple to branched, fastigiate, laterals, often denser near the apices and denuded below, and often densely covered with microscopic epiphytes. Attachment by rhizoids from prostrate filaments; epilithic, occasionally epiphytic. *Structure.* Prostrate filaments densely entangled, 100–140 µm in diameter with segments L/D 0.5–1, with prominent apical cells, few trichoblasts and attached by unicellular rhizoids not cut off from the pericentral cells; erect axes 100–200 µm in diameter with segments L/D 0.5–1.5, and branchlets 60–100 µm in diameter with segments L/D 0.2–0.8; apices straight, with slender trichoblasts, soon lost; lateral branches arising in place of trichoblasts every few segments, with occasional cicatrigenous branches below. Pericentral cells 10–11 (-12), elongate except close to apices, ecorticate; trichoblasts from every segment near apices and scar cells usually present and prominent near apices, with a divergence of $^1/_7$–$^1/_{10}$, often absent from lower segments; trichoblasts slender (basal cells 20–30 µm in diameter), 1–3 times furcate. Rhodoplasts discoid, scattered.

Reproduction. Gametophytes dioecious. Carposporophytes with a small basal fusion cell and short gonimoblast bearing elongate-clavate terminal carposporangia 15–25 µm in diameter. Cystocarps (Fig. 89F) short-stalked, ovoid-urceolate, with sometimes enlarged or often subdivided ostiolar cells, 280–450 µm in diameter; pericarp ostiolate, 2 cells thick, outer cells isodiametric, angular. Spermatangial branches (Fig. 89G) replacing the whole trichoblast, cylindrical and slightly tapering, 120–200 µm long and 25–50 µm in diameter, usually without sterile apical cells when mature.

Tetrasporangia (Fig. 89H) forming gently spiral series in upper branches which are often slightly curved with the sporangia towards the outside, with a divergence of about $^1/_9$, often extending below a branch, only slightly swelling the segments and occupying 0.5–0.7 of the segment diameter when mature, subspherical, 30–50 (-60) µm in diameter.

Type from Orford, Prosser Bay, Tas. 0–3 m deep (*Shepherd*, 10.ii.1970); holotype in AD, A35678).

Distribution: SE Tasmania.
South I., New Zealand.

Selected specimens: Stingray Bay, Port Arthur, Tas., lower eulittoral (*Cribb* 160.23, 16.xi.1951; AD, A21047). Safety Cove, Port Arthur, Tas., lower eulittoral on *Cystophora torulosa* (*Skinner*, 21.ii.1978; AD, A49255). Bicheno, Tas., lower eulittoral (*Womersley*, 4.xi.1982; AD, A56457). Fortescue Bay, Tasman Pen., Tas., uppermost sublittoral (*Womersley*, 22.x.1994; AD, A64210). Lady Bay, Southport, Tas., lower eulittoral (*Womersley*, 28.x.1982; AD, A56542).

P. adamsiae is similar in form to *P. isogona* (see below) but is distinguished by the number of pericentral cells (most commonly 11), the rhizoids not being cut off from the pericentral cells and the spermatangial branches replacing the whole trichoblast.

26. **Polysiphonia isogona** Harvey 1855b: 231. Adams 1994: 320, pl. 110 centre left. De Toni 1903: 932. Lewis 1983: 262; 1984: 64. Millar & Kraft 1993: 58. Womersley 1979: 505, fig. 14.

Polysiphonia comoides Harvey 1855b: 231. De Toni 1903: 932.

Polysiphonia amoena Sonder 1855: 525; 1880: 35. De Toni 1903: 959. Harvey 1863, synop.: xxii. Lucas 1909: 41. Tisdall 1898: 514. [NON *P. amoena sensu* Kützing 1864: 13, pl. 40a–d. Lucas & Perrin 1947: 272, and Segi 1966: 504, pl. 2A; see Womersley 1979: 507.]

Polysiphonia neglecta Harvey *ex* J. Agardh 1863: 942. Harvey 1855a: 541; 1863, synop.: xxii (nomen nudum). Kützing 1864: 13, pl. 39d–g. Sonder 1880: 35.

Lophosiphonia neglecta (Harvey)De Toni 1903: 1071. Lucas 1909: 45. Lucas & Perrin 1947: 294.

Polysiphonia compacta Lucas 1913: 56. De Toni 1924: 399. Lucas & Perrin 1947: 276.

FIG. 90

Thallus (Fig. 90A, B) medium to dark red-brown, (1-) 3–15 (-20) cm high, forming densely and irregularly branched, lax, often fastigiate tufts with numerous axes (often partly denuded below) arising from prostrate, entangled filaments. Attachment by rhizoids from prostrate filaments; usually epilithic. *Structure.* Prostrate filaments (100-) 140–250 µm in diameter with segments L/D 0.5–1.2 (-3), with scattered unicellular rhizoids cut off from the proximal ends of pericentral cells; erect branches 125–250 (-300) µm in diameter with segments L/D (0.8-) 2–4, extending to L/D 6 in mid parts of long axes, decreasing gradually to 30–80 µm in diameter with segments L/D 0.7–1 near the straight apices with moderately prominent trichoblasts which are lost below the upper few segments; lateral branches arising from the side of the basal cell of trichoblasts, the latter usually soon lost; cicatrigenous branches usually absent. Pericentral cells (8-) 9–10, rarely 7 (see below), elongate throughout the thallus, ecorticate; trichoblasts or scar cells variable in position, from occasional on lower branches to every 2–4 segments above or sometimes on every segment with a divergence of 1/4 or 1/5, trichoblasts relatively slender and short, 1–3 times furcate, basal cells 12–20 µm in diameter. Rhodoplasts discoid, usually densely aggregated, occasionally in chains.

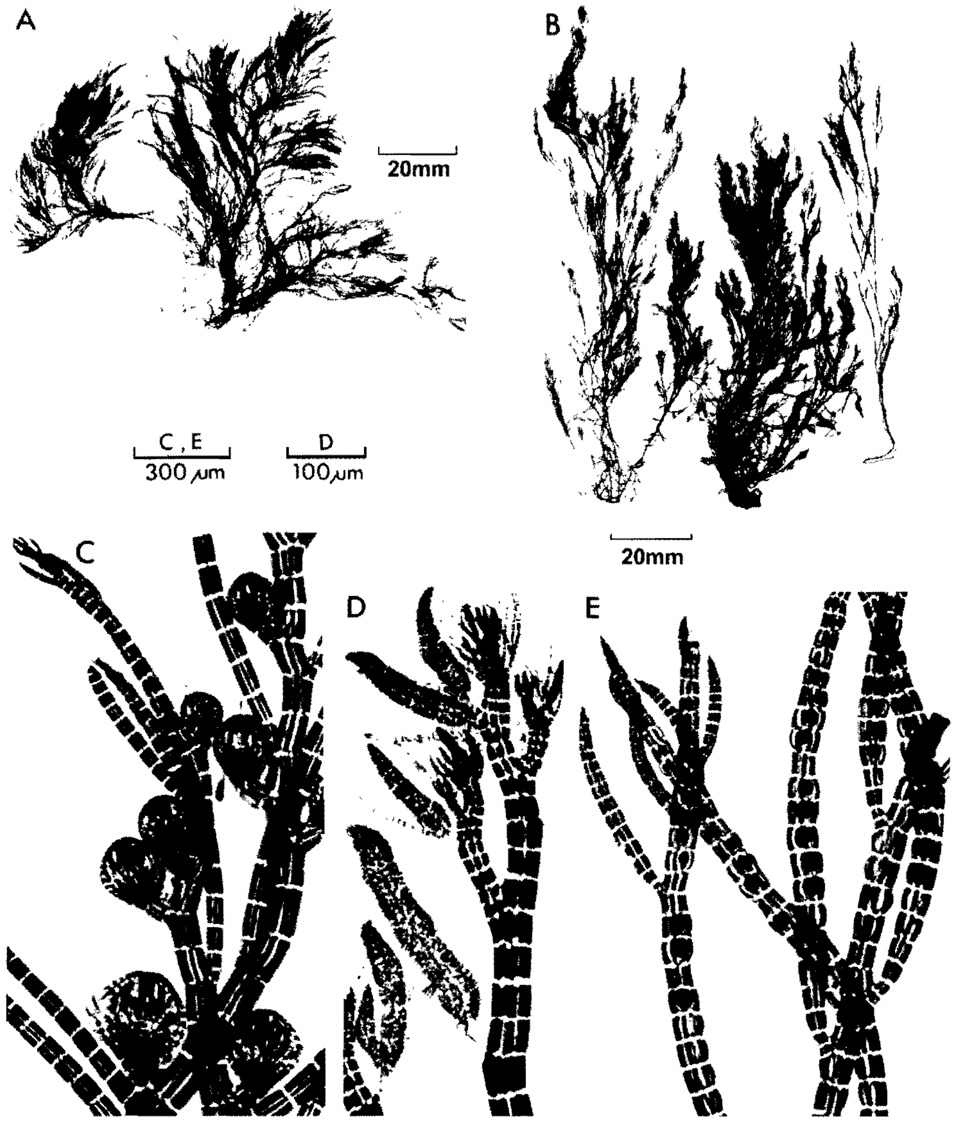

Fig. 90. *Polysiphonia isogona* (**A**, lectotype in BM; **B**, **D**, AD, A32684; **C**, **E**, AD, A42246). **A**. Lectotype. **B**. Habit. **C**. Branches with cystocarps. **D**. Spermatangial branches. **E**. Tetrasporangial branches. (All as in Womersley 1979, courtesy of Aust. J. Bot.)

Reproduction. Gametophytes dioecious. Carposporophytes with a slight basal fusion cell and short gonimoblast bearing clavate terminal carposporangia 25–45 µm in diameter. Cystocarps (Fig. 90C) stalked, subspherical or slightly conical to ovoid, (200-) 250–400 (-600) µm in diameter; pericarp ostiolate, 2 cells thick, outer cells angular, isodiametric, ostiolar cells not enlarged. Spermatangial branches (Fig. 90D) developing as one branch of a trichoblast, cylindrical, 150–220 (-310) µm long and 25–60 µm in diameter, commonly with 1–3 (-5) sterile apical cells when mature.

Tetrasporangia (Fig. 90E) forming long, gently spiralling series in upper branches with a divergence of 1/9, often extending below 1–3 laterals, slightly and evenly swelling the segments, occupying 0.5–0.8 the segment diameter when mature, subspherical to ovoid, 55–90 µm in diameter.

Type from Blind Bay, Cook Straits, New Zealand (*Lyall*); lectotype in BM, collected Aug. 1849; a similar specimen in TCD but dated Sept. 1850.

Distribution: New Zealand (widely distributed).

In southern Australia from King George Sound, W. Aust. to Tasmania and Port Jackson, N.S.W.; doubtfully from Queensland (Lewis, 1984, p. 64).

Selected specimens: Haslam, Streaky Bay, S. Aust., eulittoral (*Skinner*, 30.xi.1977; AD, A48875). Kellidie Bay entrance, Coffin Bay, S. Aust., lower eulittoral (*Womersley*, 22.viii.1962; AD, A31870). Sleaford Bay, S. Aust., low eulittoral (*Robertson*, 12.v.1968; AD, A32519). 4 km N of St Kilda, S. Aust., 1 m deep (*Steffensen*, 11.ix.1975; AD, A46529). Port Elliot, S. Aust., low eulittoral (*Woelkerling*, 1.iii.1968; AD, 32284). Pennington Bay, Kangaroo I., S. Aust., in shallow pools (*Prudhomme van Reine*, 26.ix.1988; AD, A59123). Robe, S. Aust., pools on slipway (*Womersley*, 9.ix.1968; AD, A32684—"Marine Algae of southern Australia" No. 124) and upper sublittoral pools (*Womersley*, 13.v.1972; AD, A42246). Bridgewater Bay, Vic., low eulittoral (*Womersley*, 25.i.1967; AD, A31783). Kirk Point, Port Phillip, Vic., drift (*Womersley*, 30.viii.1971; AD, A39520). Walkerville, Vic., lower eulittoral (*Sinkora* A2056, 23.ii.1975; MEL, 504904 and AD, A49496). Low Head, Tas. (*Perrin*, Aug. 1948; AD, A49963). Hope I., Dover, Tas., 2–5 m deep (*Sanderson*, 17.x.1994; AD, A64182). Blackmans Bay, Tas., low eulittoral (*Skinner*, 20.ii.1978; AD, A49201).

P. isogona is a widespread species on southern Australian and New Zealand coasts; synonymy and relationships were discussed by Womersley (1979, pp 506–508), who also commented on otherwise identical plants but with 7 pericentral cells; these were regarded as of uncertain relationships.

Usually growing as a turf, often amongst sand, at about low tide level under moderate to strong wave action, occasionally in calmer water.

SPECIES OF UNCERTAIN STATUS

Polysiphonia rutilans Kützing 1849: 806; 1863: 12, pl. 35a–c. J. Agardh 1863: 1065. De Toni 1903: 954. Lucas 1909: 41. Lucas & Perrin 1947: 272. Segi 1966: 512, pl. 22H. Womersley 1979: 508.

Type from "N. Holl."; in L, 941, 253...166.

As commented previously (Womersley 1979, p. 508), the type is inadequate for determination, though possibly close to *P. succulenta*; as suggested it is best rejected as a "nomen dubium".

Polysiphonia sphacelarioides J. Agardh 1885: 100. De Toni 1903: 890. Falkenberg 1901: 144. Lucas 1909: 41. Lucas & Perrin 1947: 268. Tisdall 1898: 514. Wilson 1890: 491; 1892: 167. Womersley 1979: 508.

Lectotype from Dromana Bay, Port Phillip, Vic. (*Wilson* 37, 1.ii.1884; LD, 39593), with isotypes in MEL, 1006734 and AD, A8297.

Womersley (1979, p. 508) commented that this species is probably not a *Polysiphonia*, but generic placement depends on collections of fertile material. The thallus consists of long slender axes, possibly prostrate, bearing short, mostly unbranched laterals from each segment, spirally arranged with a divergence of 1/4; the axial segments have 4 pericentral cells, and are

100–120 μm in diameter with L/D 1.5–2.2, and the segments of laterals are 40–60 μm in diameter and L/D 1–1.5.

Genus **LOPHURELLA** Schmitz *in* Schmitz & Falkenberg 1897: 440.

Thallus erect, tufted, with numerous axes arising from entangled prostrate branches, upper axes covered with radial, simple or branched, more-or-less determinate, short laterals. All branches corticated. *Structure.* Apical cells dome-shaped, subapical cells cutting off 4 pericentral cells which become corticated close to apices and heavily corticated below. Trichoblasts mainly on determinate laterals, branched, soon caducous.

Reproduction. Gametophytes dioecious. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia. Cystocarps sessile or short-stalked, ovoid; pericarp ostiolate, corticated. Spermatangial branches replacing whole trichoblasts, with sterile basal and apical cells.

Tetrasporangia in determinate laterals, single per segment, spirally arranged.

Type species: *L. periclados* (Sonder)Schmitz *in* Schmitz & Falkenberg 1897: 441.

A genus of about 4–6 species (Ricker 1987, p. 294), including *L. hookeriana* (J. Agardh)Falkenberg (1901, p. 158) from subantarctic S. America and New Zealand, *L. comosa* (Hooker & Harvey)Falkenberg (1901, p. 158) from the Falkland Is, and *L. caespitosa* (Hooker & Harvey)Falkenberg (1901, p. 155) from New Zealand.

The type species, *L. periclados*, has main axes bearing short, radial, determinate laterals, but the other species have less well defined laterals. The genus differs from *Polysiphonia* in this feature and in having all branches heavily corticated to close to the tips. From other Australian genera of the Polysiphonieae, it differs in having corticate determinate laterals (ecorticate in *Echinothamnion*, *Diplocladia*, and *Perrinia*) or in having terete laterals (compressed in *Chiracanthia* and *Pithyopsis*).

Lophurella periclados (Sonder)Schmitz *in* Schmitz & Falkenberg 1897: 441. De Toni 1903: 855; 1924: 387. De Toni & Forti 1923: 38. Falkenberg 1901: 154, pl. 19 figs 24–26. Guiler 1952: 102. King *et al.* 1971: 124. Kylin 1956: 501. Lucas 1909: 40; 1929a: 21. Lucas & Perrin 1947: 261. May 1965: 383; 1981: 332. Millar & Kraft 1993: 56. Womersley 1950: 184; 1966: 153.

Rhodomela periclados Sonder 1855: 523; 1880: 33. J. Agardh 1863: 878. Harvey 1858: pl. 28; 1859b: 296; 1863, synop.: xviii. Tisdall 1898: 513. Wilson 1892: 168.

Lophurella hookeriana sensu Guiler 1952: 102. Lucas 1909: 40? Lucas & Perrin 1947: 262? May 1965: 383?

Rhodomela simpliciuscula Harvey *in* Alg. Aust. Exsicc. No. 136, *nom. nudum.* Tisdall 1898: 513.

PLATE 1 fig. 2; FIG. 91

Thallus (Fig. 91A) very dark red-brown, drying almost black, 4–10 (-15) cm high, erect, tufted, usually with numerous terete axes (becoming denuded below) arising from entangled prostrate branches, upper axes densely covered with radial, becoming branched (mainly adaxially), more-or-less determinate laterals 1–3 (-4) mm long. Attachment by rhizoids on prostrate branches; epilithic or on mussels, occasionally epiphytic. *Structure.* Apices (Fig. 91B) surrounded by young determinate laterals, apical cells dome-shaped, segmenting transversely to slightly obliquely, producing 4 pericentral cells which become corticated within a few segments of apices, heavily corticated (Fig. 91C) below on axes. Trichoblasts mainly on determinate laterals, usually 2 axial cells apart but soon caducous, 200–400 μm long with 4–5 branches, lower cells 15–25 μm in diameter and L/D 1–2, tapering above with longer cells. Determinate laterals 100–200 μm in diameter, probably arising in place of trichoblasts. Axes 0.5–1 mm in diameter above, 1–2 mm in diameter below, prostrate branches 0.5–1 mm in diameter; outer cortical cells more-or-less in longitudinal lines, 10–20 μm across and L/D 1–2; rhizoids cut off from cortical cells, 25–50 μm in diameter, with digitate haptera. Rhodoplasts discoid, becoming ribbon-like in larger cells.

Reproduction. Gametophytes dioecious. Carposporophytes (Fig. 91D) with a basal fusion cell, branched gonimoblast and elongate-clavate terminal carposporangia 20–30 μm in diameter. Cystocarps sessile or short-stalked, ovoid, 300–600 μm in diameter; pericarp

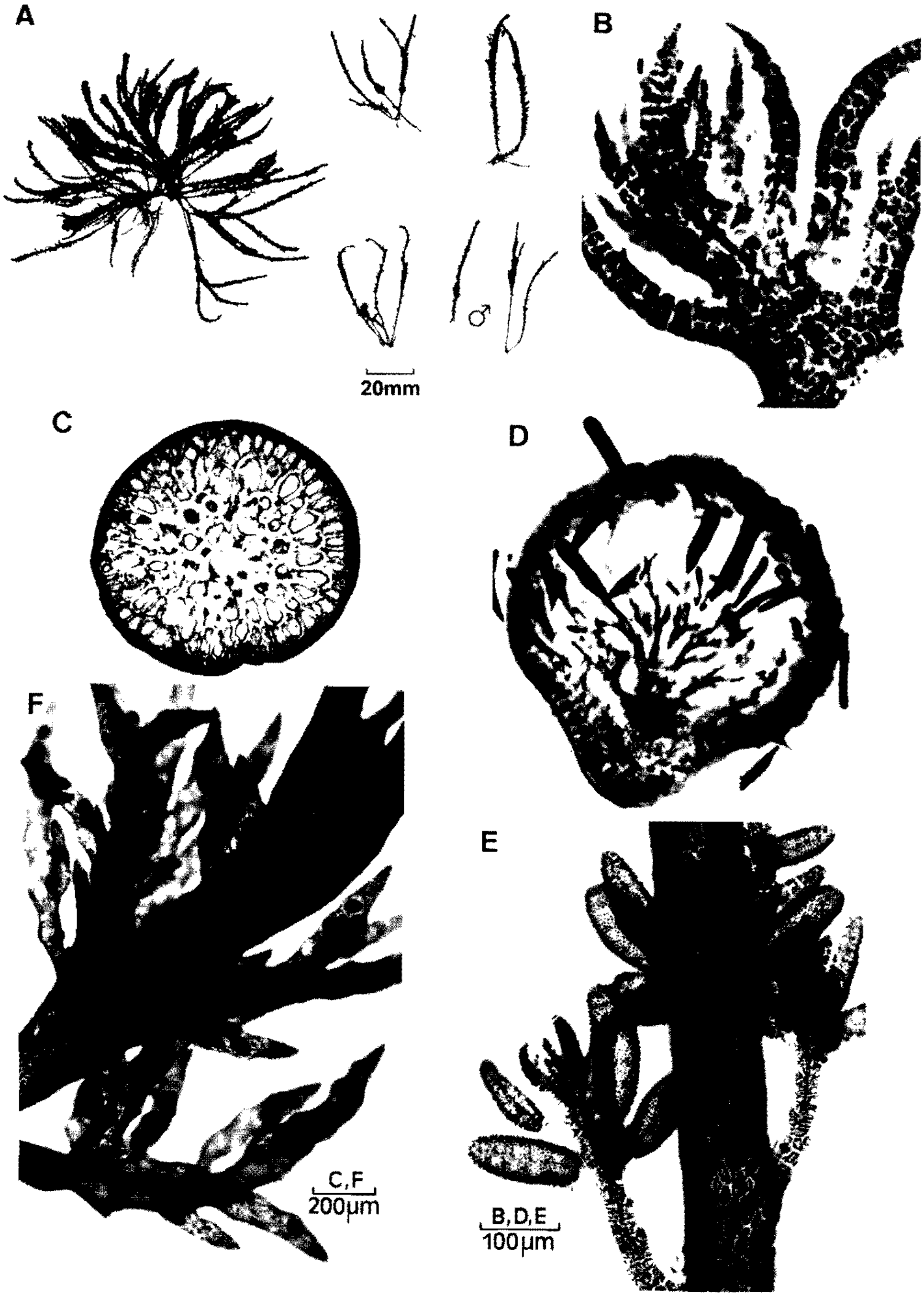

Fig. 91. *Lophurella periclados* (**A–C**, **E**, **F**, AD, A68511; **D**, AD, A68398). **A**. Habit, tetrasporophyte left, male plants right. **B**. Apex of indeterminate axis. **C**. Transverse section of indeterminate axis. **D**. Longitudinal section of cystocarp. **E**. Spermatangial branches. **F**. Determinate lateral branches with tetrasporangia.

ostiolate, without a neck, corticate and 2–3 cells thick. Spermatangial branches (Fig. 91E) usually replacing the whole trichoblast, with a sterile basal cell and 1 (-2) short apical cells, 150–200 µm long and 50–100 µm in diameter.

Tetrasporangia (Fig. 91F) in determinate lateral branches, extending over 1–2 mm, branches 100–150 µm thick, one per segment, spirally arranged, slightly swelling the branches, 40–75 µm in diameter.

Type from Port Phillip, Vic. (*Mueller*, 1.xi.1852); lectotype in MEL, 612898; isolectotypes MEL, 612897, 612899, 612900.

Distribution: Pennington Bay, Kangaroo I., S. Aust., to E Victoria and SE Tasmania; Stanwell Pk (S of Sydney), N.S.W. (Millar & Kraft 1993, p. 56).

New Zealand (Adams 1994, p. 330).

Selected specimens: Port Elliot, S. Aust., lower eulittoral (*Womersley*, 17.x.1948; AD, A9332). Pennington Bay, Kangaroo I., S. Aust., sublittoral fringe (*Womersley*, 6.i.1947; AD, A4445). Robe, S. Aust., sublittoral fringe in bay (*Womersley*, 30.viii.1949; AD, A11085). Back Beach, Little Dip Conservation Park, S. Aust., low eulittoral (*Womersley*, 24.iv.2000; AD, A68511—"Marine Algae of southern Australia" No. 411a). Cape Buffon, S. Aust., low eulittoral on mussels, N E side near jetty (*Womersley*, 26.xi.1999; AD, A68398—"Marine Algae of southern Australia" No. 411). Bridgewater Bay, Vic, sublittoral fringe (*Womersley*, 28.i.1964; AD, A27426). Warrnambool, Vic. Upper sublittoral (*Womersley*, 13.iv.1959; AD, A22901). Port Arlington, Port Phillip, Vic., 0–2 m deep (*Womersley*, 9.viii.1959; AD, A23107). Point Hicks, E Vic., 9–12 m deep (*Kraft & Watt*, 8.ii.2001; MELU and AD, A69084). Mallacoota, Vic. (*Harada*, 13.xi.1977; AD, A52507). Crayfish Point, Taroona, Tas, 0–6 m deep (*Sanderson*, 29.v.1992; AD, A61746).

L. periclados usually forms dense turfs at about low tide level (an unusual depth record from Point Hicks) on coasts of moderate to strong wave action. The Tasmanian specimens, from more sheltered coasts, are laxer, more elongate, plants.

Genus ALLEYNEA Womersley, *gen. nov.*

Thallus erect, with long indeterminate axes bearing short determinate laterals radially and spirally, determinate laterals branched 3–5 times subdichotomously and more-or-less complanately, ultimate branches short and bicornate; axes arising from an entangled, stoloniferous, base attached by multicellular compound rhizoids. *Structure*. Apical cells hemispherical to dome-shaped, segmenting transversely or obliquely. Pericentral cells 6, becoming corticate close to apices with an inner large-celled and outer small-celled cortex surrounding the central, clear, pericentral cells. Trichoblasts occasional only, on female plants, coarse.

Reproduction. Procarps on supra-basal cells of trichoblasts, with a 4-celled carpogonial branch and 2–3 sterile cells. Carposporophytes with short, branched, gonimoblast and elongate-clavate terminal carposporangia. Cystocarps ovoid; pericarp ostiolate, ecorticate. Spermatangial plants unknown.

Stichidia in branched clusters on determinate laterals, ecorticate, tetrasporangia in a gently spiral row, with 2 cover cells.

Diagnosis: Thallus erectus, cum axibus longis et indeterminatis, ferens laterales radialiter et spiraliter breves determinatos, ramosus subdichotome 3-plo – 5-plo (aliquantum complanatus), rami ultimi bicornes; hapteron stoloniferum, implicatum. Cellulae apicales, hemisphericales ad tholiformes; cellulae pericentrales 6, corticatae prope ad apices, cum cortice interiore magnis cellulis et exteriore parvis cellulis circum cellulas centrales conspicuas pericentrales; trichoblasti interdum in plantis femineis.

Reproductio. Procarpia in cellula suprabasali et 2–3 cellulis sterilibus. Carposporophyta cum gonimoblastio brevi et ramoso et cum carposporangio elongato-clavato terminali. Cystocarpia ovoidea; pericarpium ostiolatum, ecorticatum. Spermatangia non nota. Stichidia in fasciculis ramosis in lateralibus determinatis, ecorticata cum tetrasporangiis leniter spiratim dispositis, cum 2 cellulis tegentibus.

Type species: *A. bicornis* Womersley, *sp. nov.*

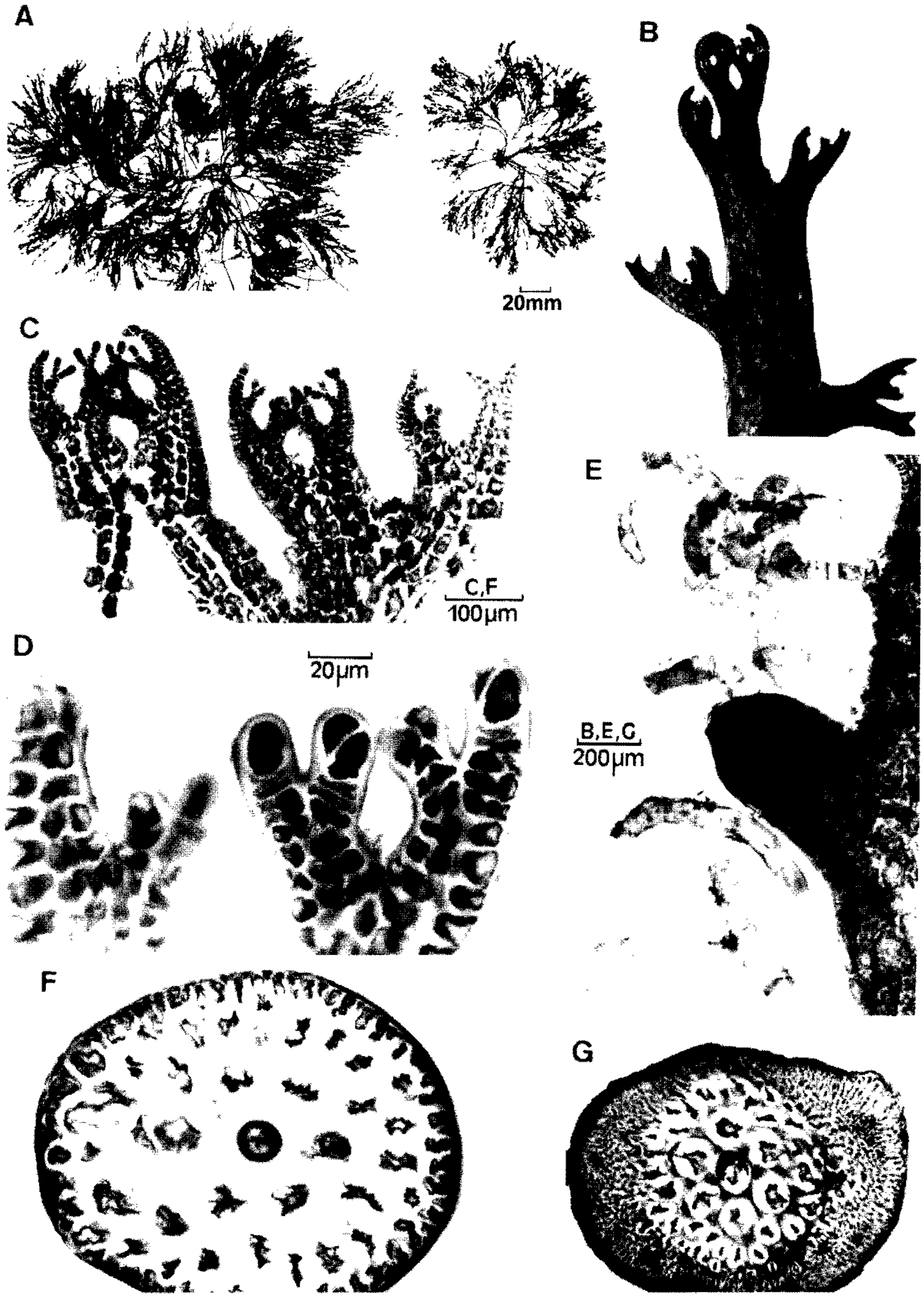

Fig. 92A–G. See caption next page.

Fig. 92. *Alleynea bicornis* (**A**, **F**, **G**, **J–M**, AD, A68425; **B–E**, AD, A42697; **H**, **I**, AD, A13583). **A**. Habit. **B**. Young axis with determinate laterals. **C**. Branch apices with apical cells. **D**. Segmentation of apices. **E**. Trichoblasts. **F**. Transverse section of young axis. **G**. Transverse section of older axis. **H**. Multicellular, clumped rhizoids. **I**. Procarps within early pericarps, trichogynes present. **J**. Young branches with juvenile cystocarps. **K**. Mature cystocarps. **L**. Branched cluster of stichidia. **M**. Stichidia with tetrasporangia.

Alleynea is provisionally placed in the Polysiphoniae (it merits comparisons also with the Pterosiphonieae), with the group of genera characterised by having indeterminate axes bearing short, determinate, laterals branched in various ways. The subdichotomous branching of the laterals, more-or-less complanately, separates it from genera such as *Chiracanthia* and *Pityophycos*.

Alleynea is named after my wife who has accompanied me on most field trips, including many when this alga was collected.

Alleynea bicornis Womersley, *sp. nov.*

FIG. 92

Thallus (Fig. 92A) dark brown-red, drying very dark, 10–30 cm high, with few to numerous erect, simple or branched, axes arising from an entangled, stoloniferous, base. Axes bear short determinate lateral branches (Fig. 92B) radially and spirally, 1–3 mm apart, 2–4 mm long, branched 3–5 times subdichotomously and more-or-less complanately, with prominent bicornate ends (Fig. 92H). Attachment by short branches and compound multicellular rhizoids with multicellular haptera (Fig. 92H) from stoloniferous branches; epilithic. *Structure.* Apical cells (Fig. 92D) of axes and laterals hemispherical to dome-shaped, 15–20 µm in diameter, segmenting transversely or obliquely to form a lateral and the ultimate bicornate ends (Fig. 92C, J) with pericentral cells cut off from the third to fifth axial cells. Pericentral cells 6 (Fig. 92F, G), clear in transverse section, developing from close to apices a large-celled inner cortex and small-celled outer cortex (Fig. 92G). Axes 700–1200 µm in diameter below, tapering gradually to 300–600 µm in diameter near apices. Determinate laterals 250–350 µm in diameter near their base, tapering gradually to 80–100 µm in diameter at base of bicornate ends, then abruptly to the apical cells. Trichoblasts (Fig. 92E) only seen on female plants, 300–600 µm long, coarse, basal cells 35–45 µm in diameter and L/D 1.5–2, upper cells 25–30 µm in diameter and L/D 2–3. Rhizoids cut off from pericentral cells. Cells uninucleate, larger cells multinucleate; rhodoplasts discoid, elongate and ribbon-like in larger cells.

Reproduction. Procarps (Fig. 92I) on the suprabasal cell of trichoblasts, with a 4-celled carpogonial branch and 2–3 sterile cells. Carposporophyte with a small basal fusion cell and short, branched gonimoblast filaments with elongate-clavate terminal carposporangia 35–50 µm in diameter. Cystocarps (Fig. 92J, K) ovoid, 400–600 µm in diameter; pericarp ostiolate, 2 cells thick, ecorticate, outer cells isodiametric and irregularly arranged. Spermatangial plants unknown.

Stichidia in irregularly branched clusters (Fig. 92L) on the determinate laterals, ecorticate, usually curved, 0.5–1 mm long and 90–120 µm in diameter, with tetrasporangia in gently spiral or almost straight rows (Fig. 92M), 50–100 µm in diameter, with 2 cover cells.

Diagnosis: Morphologia thalli ut in genere. Thallus hepaticus, 10–30 cm altus, axes 700–1200 µm diametro infra, decrescentes ad 300–600 µm supra, laterales determinati basi 250–350 µm diametro, 80–100 µm diametro basi extremorum bicornatorum, tum decrescentes abrupte ad cellulas apicales.

Reproductio. Ut in genere. Carposporangia 35–50 µm diametro; cystocarpia 400–600 µm diametro, cellulae exteriores pericarpii isodiametricae. Stichidia 0.5–1 mm longa et 90–120 µm diametro, plerumque curvata; tetrasporangia in serie leniter spirali vel paene stricta 50–100 µm diametro, cum 2 cellulis tegentibus.

Type from Chinamans Hat Island beach, Yorke Pen., S. Aust., drift (*Womersley*, 16.xii.1999); holotype in AD, A68425 (tetrasporangial), syntype (cystocarpic) and 2 isotypes (tetrasporangial).

Distribution: Hopetoun, W. Aust., to Yorke Pen. and Stanley Beach, Kangaroo I., S. Australia.

Selected specimens: Hopetoun, W. Aust., drift (*Wollaston*, 20.ii.1957; AD, A22100). Twilight Cove, Eyre, W. Aust., 6 m deep (*Kirkman*, 16.xii.1981; AD, A56690). Head of Great Australian Bight, S. Aust., drift (*Womersley*, 4.ii.1954; AD, A19230). Point Sinclair, S. Aust., drift (*Womersley*, 25.i.1951; AD, A13905). Seamount off Cannan Reefs, S. Aust., 22–30 m deep (*Branden*, 22.i.1991; AD, A61206). The "hotspot", near Flinders I., S. Aust., 25 m deep (*Branden*, 23.i.1991; AD, A61215). Elliston, S. Aust., drift (*Womersley*, 13.i.1951; AD, A13583—"Marine Algae of southern Australia" No. 418) and 9 m deep in bay (*Shepherd*, 27.x.1971; AD, A42697). Pearson Is, S. Aust., 36 m deep (*Shepherd*, 10.i.1969; AD, A34108). Point Avoid, S. Aust., drift (*Womersley*, 2.xii.1975; AD, A46915). Pondalowie

Bay, S. Aust., drift (*Womersley*, 9.xi.1980; AD, A51858). Cable Hut Bay, Yorke Pen., S. Aust., 2–3 m deep (*Kald*, 10.vi.1968; AD, A33067). South West R., Kangaroo I., S. Aust., 6 m deep (*F.J. Mitchell*, 24.viii.1963; AD, A26823). Vivonne Bay, Kangaroo I., S. Aust., drift (*Womersley*, 14.i.1948; AD, A6854). Pennington Bay, Kangaroo I., S. Aust., drift (*Womersley*, 27.i.1946; AD, A2877). Stanley Beach, Kangaroo I., S. Aust., drift (*Womersley*, 27.i.1956; AD, A20363).

Alleynea bicornis is a distinctive deep-water alga on the western coasts of South Australia. The epithet *bicornis* refers to the 2-horned branch apices, and was first used by Sonder as *Rytiphloea bicornis* on specimens from "between King George's Sound and Cape Lewin" now in MEL, 668479, on 2 sheets with Sonder's drawings. Sonder (1880, p. 35), also gave *Polysiphonia bicornis* as a *nomen nudum* and Shepherd & Womersley (1981, p. 368) listed it as *Pterosiphonia bicornis*.

Alleynea is characterised by the presence of radially and spirally arranged determinate laterals along the indeterminate axes, and 6 pericentral cells with cortication from close to the apices.

Genus TOLYPIOCLADIA Schmitz *in* Schmitz & Falkenberg 1897: 441.

Thallus more-or-less erect, irregularly branched, with indeterminate axes and main branches bearing, sparsely or densely, short determinate laterals, all branches ecorticate. *Structure.* Subapical axial cells cutting off 4 pericentral cells; determinate laterals spirally arranged with 1/4 divergence, branched, bearing simple or branched trichoblasts.

Reproduction. Gametophytes dioecious. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia. Cystocarps ovoid to urceolate; pericarp ostiolate, ecorticate. Spermatangial branches (where known) replacing whole trichoblast.

Tetrasporangia in determinate laterals, single per segment, spirally arranged.

Type species: *T. glomerulata* (C. Agardh)Schmitz 1897: 441.

Tolypiocladia includes 3 species from tropical seas (see Silva *et al.* 1996, p. 554) plus the following new species from southern Australia. The latter agrees with the type species in being ecorticate, with 4 pericentral cells, but differs (from the other species also) in having closely arranged, overlapping, determinate laterals and (see Kylin 1956, p. 504) in having branched trichoblasts.

Tolypiocladia penningtonensis Womersley, *sp. nov.*

FIG. 93

Thallus (Fig. 93A) dark brown-red, 2–5 cm high, erect, with one to several terete axial branches 2–4 mm broad, bearing 1–4 irregularly placed indeterminate laterals, consisting of a central ecorticate axis densely surrounded by radially and spirally arranged short determinate laterals. Attachment by rhizoids from prostrate branches; epiphytic on smaller entangled algae, possibly epilithic. *Structure.* Apices of indeterminate branches surrounded by young determinate laterals, apical cells dome-shaped, cutting off 4 pericentral cells (Fig. 93B) and determinate laterals on a 1/4 spiral sequence, all branches ecorticate. Axes (200-) 300–600 µm in diameter, segments L/D 0.5–1. Determinate laterals (Fig. 93C, E) 0.8–1.4 mm long, with 2–4 branches from near their base, branches 60–100 µm in diameter above their base, with 4 pericentral cells and segments L/D 0.5–1, with apical segments bearing branched trichoblasts, caducous on mature segments. Rhizoids on prostrate branches 100–500 µm in diameter, segments L/D 0.3–1, cut off from pericentral cells, unicellular with multicellular digitate haptera. Rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes probably dioecious. Carposporophytes with a small basal, fusion cell and branched gonimoblast with clavate to ovoid terminal carposporangia 20–35 µm in diameter. Cystocarps (Fig. 93C, D) urceolate, 300–400 µm in diameter, with a short neck 80–120 µm long; pericarp ostiolate, ecorticate, 2 cells thick, outer cells isodiametric, angular. Spermatangial thalli unknown.

Tetrasporangia (Fig. 93E) in determinate laterals, spirally arranged, one in each segment and slightly bulging the segments, (35-) 60–80 µm in diameter, with 2 cover cells.

Diagnosis: Thallus hepaticus, erectus, 2–5 cm altus, cum 1–complures ramis teretibus axialibus 2–4 mm latis, cum 1–4 lateralibus irregularibus indeterminatis, unus quisque cum axe ecorticato ferente radialiter et spiratim, breves determinatos laterales. Affixus per rhizoidea in ramis prostratis, epiphiticus fortasse epilithicus. Apices ramorum indeterminorum circumcincti lateralibus iuvenalibus determinatis in 1/4 spira, cellulae pericentrales 4, ecorticatae. Axes (200-) 300–400 µm diametro, segmenta L/D 0.5–1. Laterales determinati 0.8–1.4 mm longi, cum 2–4 ramis proximis basin 60–100 µm diametro; segmenta apicalia trichoblastos ferentia. Rhizoidea abscissa e cellulis pericentralibus cum hapteris multicellularibus.

Reproductio. Carposporophytia cum cellula parva basi coniungenti et gonimoblasto ramoso cum carposporangiis terminalibus 20–35 µm diametro clavatis ad ovoidea. Cystocarpia urceolata, 300–400 µm diametro; collum 80–120 µm longum; pericarpium ostiolatum,

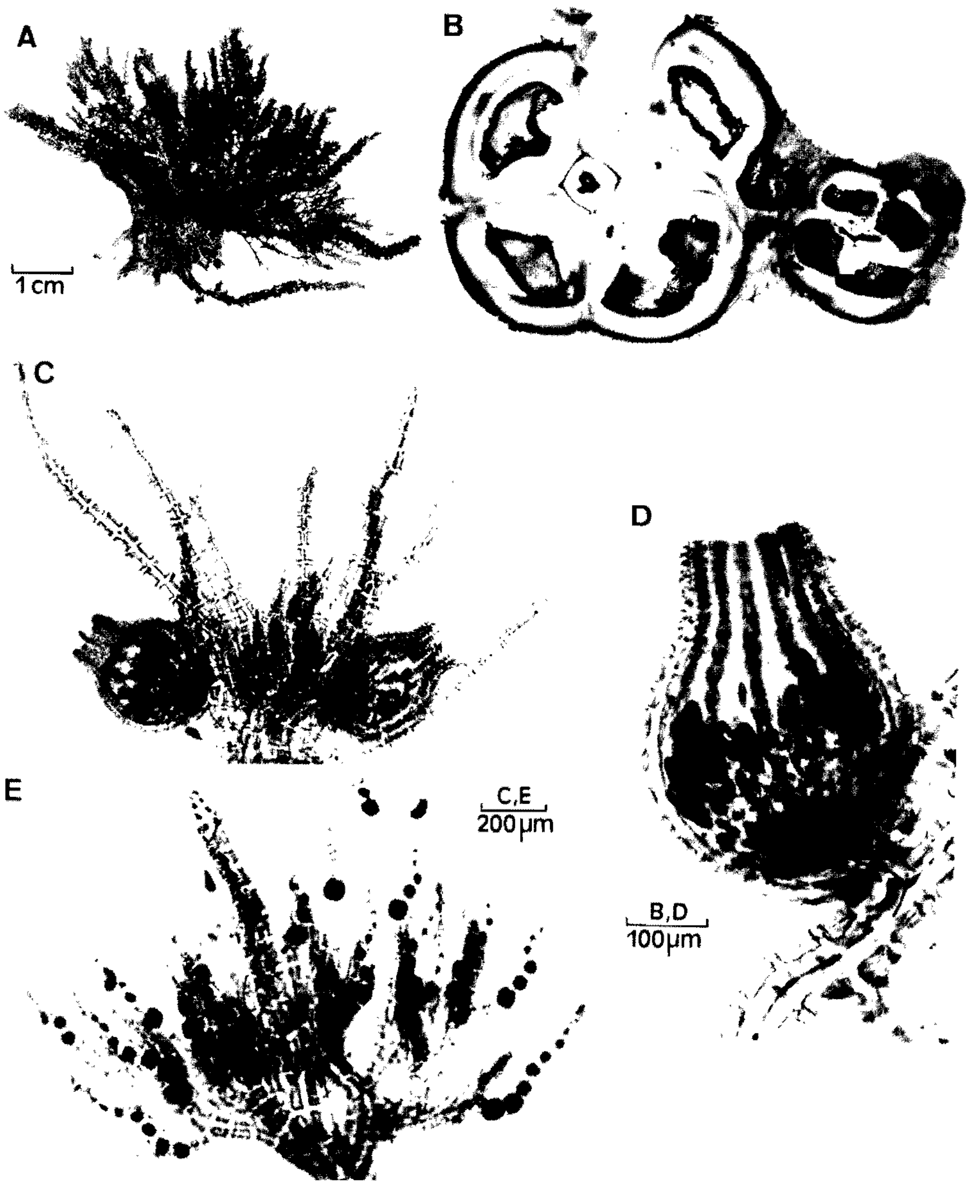

Fig. 93. *Tolypiocladia penningtonensis* (AD, A8736). **A.** Habit, holotype. **B.** Transverse section of axis and a determinate lateral. **C.** Determinate laterals with cystocarps. **D.** Cystocarp with carposporophyte. **E.** Determinate laterals with tetrasporangia.

ecorticatum, cellulae exteriores isodiametricae. Spermatangia non nota. Tetrasporangia in lateribus determinatis, spiratim disposita, unum per segmentum (35-) 60–80 μm diametro, cum 2 cellulis tegentibus.

Type from Pennington Bay, Kangaroo I., S. Aust., sublittoral fringe on main reef, probably epiphytic (*Womersley*, 29.viii.1948); holotype and isotypes in AD, A8736.

Distribution: Only known from Pennington Bay and nearby Stanley Beach, Kangaroo I., S. Australia.

Known specimens: Pennington Bay, Kangaroo I., S. Aust., sublittoral fringe (*Womersley*, 26.xii.1948; AD, A10465 and 19.i.1965; AD, A28924), also (*Kraft* & *Min-Thein*, 1.xii.1971; AD, A41375). Stanley Beach, Kangaroo I., S. Aust., drift (*Womersley*, 7.ii.1956; AD, A20085 and 27.i.1957; AD, A20852).

T. penningtonensis is a distinctive species known only from the Pennington Bay region of Kangaroo I. It probably occurs on similar rough-water coasts elsewhere but has been overlooked. Differences from the tropical species of *Tolypiocladia* are in habit and in having the determinate laterals closely adjacent to and covering the axis between them.

Genus ECHINOTHAMNION Kylin 1956: 506.

Thallus erect, loosely to densely branched, with few and irregular, or numerous, radial indeterminate laterals bearing short, branched, determinate laterals; holdfast fibrous. Axes and main laterals soon becoming heavily corticated, determinate laterals ecorticate. *Structure.* Apical cells dome-shaped, subapical cells cutting off 4 pericentral cells which soon become corticated on indeterminate branches but remain conspicuous in transverse section; ecorticate determinate laterals produced spirally from close to apices. Determinate laterals first simple, soon branched from near their base, with trichoblasts mainly on their branches, soon caducous.

Reproduction. Gametophytes dioecious. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia. Cystocarps sessile, slightly urceolate; pericarp ostiolate, 2 cells thick, ecorticate. Spermatangial branches replacing whole trichoblasts or as a basal branch, with sterile basal cells but usually no sterile apical cells.

Tetrasporangia in branches of determinate laterals, single per segment, spirally arranged.

Type species: *E. hystrix* (Hooker & Harvey)Kylin 1956: 506.

A genus of 3 or 4 species, characterised by the densely corticated main branches bearing short determinate tufts of basally branched ecorticate ramuli with 4 pericentral cells.

Echinothamnion mallardiae (Harvey)Kylin is based on two Colenso 227 type specimens from the East coast of New Zealand, in TCD. On these specimens, "*mallardiae*" is crossed out and "*lyallii*" is written over it. The first specimens Harvey ascribed to *P. mallardiae* (Hooker & Harvey 1845b, footnote pp. 533, 534) were ones of Mrs Mallard from Port Phillip, Victoria, and since then "*mallardiae*" has been a commonly used name for southern Australian specimens, all of which have 4 pericentral cells whereas the New Zealand species has 5 and is doubtfully an *Echinothamnion.* The variable but distinctive southern Australian species is here included in *E. hookeri* since there is no clear difference between this species and what has been referred to as "*mallardiae*".

KEY TO SPECIES OF *ECHINOTHAMNION*

1. Indeterminate branching irregular with long, simple or little-branched laterals of various lengths .... 1. *E. hystrix*
1. Indeterminate branching radial with laterals for 4 or 5 orders, gradually decreasing in length from the thallus base upwards .... 2. *E. hookeri*

1. **Echinothamnion hystrix** (Hooker & Harvey)Kylin 1956: 506. Adams 1994: 327, pl. 111 upper right. Fuhrer *et al.* 1981, pls 79, 80. Huisman 2000: 165. May 1965: 383. Shepherd 1983: 83. Shepherd & Womersley 1981: 367. Silva *et al.* 1996: 492.

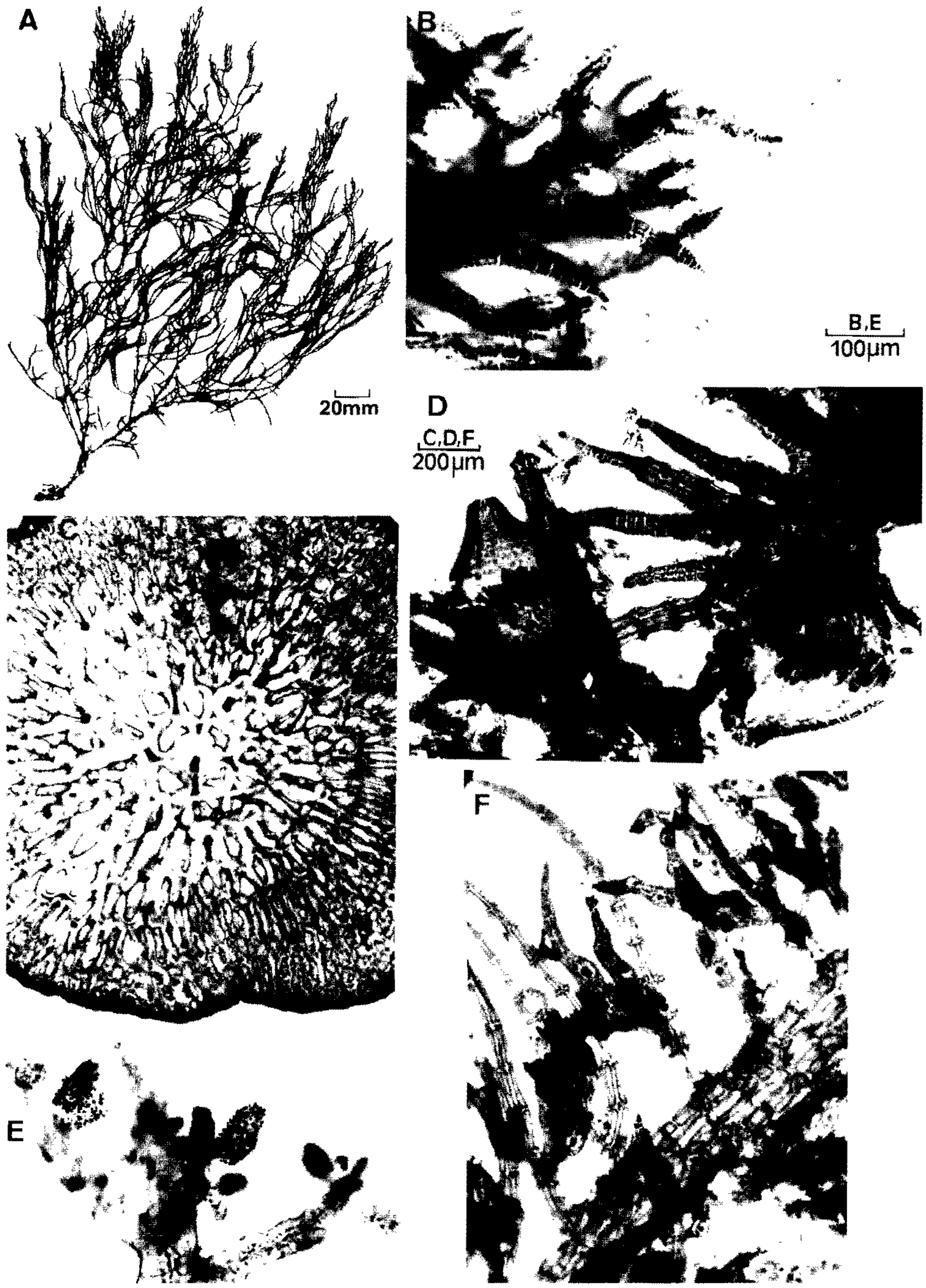

Fig. 94. *Echinothamnion hystrix* (**A**, AD, A33577; **B**, AD, A29986; **C**, AD, A64475; **D**, AD, A66910; **E**, AD, A28065; **F**, AD, A44460). **A**. Habit. **B**. Branch apices. **C**. Transverse section of axis. **D**. Cystocarps on determinate laterals. **E**. Spermatangial branches. **F**. Determinate laterals with tetrasporangia.

Polysiphonia hystrix Hooker & Harvey 1847: 398. J. Agardh 1863: 1017. De Toni 1896: 228; 1903: 906. De Toni & Forti 1923: 40. Falkenberg 1901: 138. Guiler 1952: 103. Harvey 1847: 41, pl. xiv; 1855a: 539; 1859b: 299; 1863, synop.: xix. Kützing 1849: 832; 1864: 6, pl. 18a–c. Levring 1946: 226. Lucas 1909: 41; 1929a: 22; 1929b: 51. Lucas & Perrin 1947: 265, fig. 120. Reinbold 1897: 56. Segi 1966: 509, pl. XIVC. Sonder 1853: 701; 1855: 524; 1880: 34. Tate 1882a: 23. Tisdall 1898: 514. Wilson 1892: 167. Womersley 1950: 185.

Polysiphonia polyphora Kützing 1849: 837; 1864: 11, pl. 32d–g. J. Agardh 1863: 1074.

FIG. 94

Thallus (Fig. 94A) dark brown-red, erect, 10–35 cm high, moderately branched with long, terete, heavily corticated main indeterminate branches bearing irregularly radial indeterminate laterals, all branches clothed with short tufts of ecorticate determinate laterals 1–2 (-3) mm long. Axes often denuded basally, 1–2 mm in diameter below, tapering gradually to 0.2–0.4 mm in diameter near apices. Holdfast fibrous 0.5–2 cm across; epilithic or epiphytic. *Structure.* Apical cells (Fig. 94B) of indeterminate branches dome-shaped, 8–10 µm in diameter, with 4 pericentral cells and producing spirally arranged determinate branches close to apices. Cortication commencing close to apices (especially in rough-water plants) with the pericentral cells remaining conspicuous in transverse section (Fig. 94C), outer cortical cells irregular in shape, mostly L/D 1–2. Determinate laterals first simple (remaining so near base of some plants), soon branched from near the base of their primary branch (Fig. 94F); lesser branches 0.5–1.5 mm long, 60–120 µm in diameter and tapering near their apices, segments L/D 1–2 (-2.5). Trichoblasts mainly on lateral branches of determinate laterals, 0.5–1 mm long, branched, soon caducous. Cells probably uninucleate; rhodoplasts discoid to elongate, becoming chained.

Reproduction. Gametophytes dioecious. Procarps on trichoblasts on young laterals of determinate branches, with a supporting cell bearing a 4-celled carpogonial branch surrounded by a pre-fertilization pericarp. Carposporophytes with a small basal fusion cell and short gonimoblast filaments bearing clavate terminal carposporangia 30–40 µm in diameter. Cystocarps (Fig. 94D) sessile, slightly urceolate with a short neck, 500–750 µm in diameter; pericarp ostiolate, 2 cells thick, outer cells isodiametric, angular. Spermatangial branches (Fig. 94E) on basal branches of trichoblasts, ovoid, 50–90 µm long and 30–45 µm in diameter, no sterile apical cell.

Tetrasporangia (Fig. 94F) in lateral branches of determinate branches, single per segment, spirally arranged and bulging the branch, 50–75 µm in diameter.

Type from Georgetown, Tas. (*Gunn*); lectotype in Herb. Hooker, BM.

Distribution: Nichol Bay, W. Aust., to Walkerville, Vic., and around Tasmania.

New Zealand ? (Adams 1994, p. 327).

Selected specimens: Nichol Bay, W. Aust., (1880; MEL, 45690). Port Denison, W. Aust., drift (*Kraft* 3987, 14.xii.1971; AD, A41733). Safety Bay, W. Aust., on *Posidonia*, drift (*Womersley*, 29.ix.1979; AD, A50734). Israelite Bay, W. Aust., epiphytic, drift (*Wells*, 10.xii.1974; AD, A46079). Marion Bay, S. Aust., drift (*Gordon-Mills*, 24.v.1981; AD, A52200). Investigator Strait, S. Aust., 27 m deep (*Watson*, 10.i.1971; AD, A38469). N Spencer Gulf, S. Aust., 10 m deep (*Shepherd*, 6.ix.1973; AD, A44460). Tiparra Reef, S. Aust., 11 m deep (*Shepherd*, 23.xii.1970; AD, A38273). Point Riley, Yorke Pen., S. Aust., 5 m deep (*Edyvane*, 17.vi.1995; AD, A64475). Off Troubridge Light, S. Aust., 18 m deep (*Shepherd*, 4.ii.1969; AD, 33577). 10 km W of Outer Harbor, S. Aust., on "John Robb" wreck, 22 m deep (*F. Mitchell*, 5.iv.1959; AD, A22253). Off Port Noarlunga, S. Aust., on scallops, 24 m deep (*Ottaway*, 3.ii.1981; AD, A52080). Penneshaw, Kangaroo I., S. Aust., on reef, 6 m deep (*Lavers*, 8.i.1997; AD, A66878). Robe, S. Aust., drift W of jetty (*Hotchkiss*, 2.xi.1997; AD, A67623). Port Campbell, Vic., drift (*Womersley*, 27.i.1964; AD, A28065). Dutton Bay, Portland, Vic., drift (*Womersley*, 13.iv.1959; AD, A22681). Point Lonsdale, Vic., drift (*Sinkora* A1036, 14.xi.1970; AD, A49456). Cat, Bay, Phillip I., Vic., drift (*Womersley*, 10.iv.1951; AD, A22726). Walkerville, Vic., drift (*Sinkora* A1838, 6.xii.1973; MEL, 504892, AD, A49465). Ulverstone, Tas., drift (*Gordon*, 18.i.1966; AD, A29986). Low Head, Tas. (*Perrin*, Feb. 1940; AD, A9003). Taroona, Tas., drift (*Westphalen*, 31.i.1997; AD, A66910). Fluted Cape, Bruny I., Tas., 16 m deep (*Shepherd*, 10.ii.1972; AD, A41503).

E. hystrix is a common species, varying considerably in robustness. Plants from sheltered habitats are generally slender, those from rough-water coasts usually relatively robust.

The type of *P. polyphora* Kützing (in L, 941, 240...157) is more likely *E. hystrix* rather than *E. hookeri*.

2. **Echinothamnion hookeri** (Harvey)Kylin *ex* Silva *in* Silva *et al.* 1996: 492; Kylin 1956: 506. May 1965: 383. Shepherd & Womersley 1981: 367.

Polysiphonia hookeri Harvey 1847: 40, pl. xii; 1859b: 299; 1863, synop.: xix. J. Agardh 1863: 1019; 1896: 110. De Toni 1903: 905. Falkenberg 1901: 141. Guiler 1952: 103. Hooker & Harvey 1847: 398. Kützing 1849: 832; 1864: 6, pl. 17. Lucas 1909: 41; 1929a: 22; 1929b: 51. Lucas & Perrin 1947: 263. Reinbold 1897: 57. Segi 1966: 509, pl. XIVB. Sonder 1853: 701; 1855: 524; 1880: 34. Tisdall 1898: 514. Wilson 1892: 167. Womersley 1950: 185.

Polysiphonia acanthophora Harvey 1844b: 441; 1849b: 56 (NON Kützing 1843: 424).

Polysiphonia mallardiae sensu Australian specimens (NON Harvey *in* Hooker & Harvey 1845b: 533 from New Zealand). J. Agardh 1863: 1020. De Toni 1903: 908; 1924: 397. Falkenberg 1901: 142. Guiler 1952: 103. Harvey 1847: 40, pl. xiii; 1855a: 539; 1859b: 299; 1863, synop.: xix. Huisman 2000: 165. Kützing 1849: 834; 1864: 8, pl. 22 c–e. Lucas 1909: 41; 1929a: 22; 1929b: 51. Lucas & Perrin 1947: 265. Reinbold 1898: 51. Segi 1966: 510, pl. XVIA? Silva *et al.* 1996: 492. Sonder 1880: 34. Tisdall 1898: 514. Wilson 1892: 167. Womersley 1950: 185.

Polysiphonia lyallii sensu Tisdall 1898: 514. Wilson 1892: 167.

Echinothamnion mallardiae (Harvey)Kylin *sensu* May 1965: 383.

Rhodomela mallardiae Harvey, footnote only in Hooker & Harvey 1845b: 333.

?*Polysiphonia dasyoides* Zanardini 1874: 489. De Toni 1903: 954. Lucas 1929a: 22. Lucas & Perrin 1947: 266.

FIG. 95

Thallus (Fig. 95A) dark brown-red, erect, 10–30 cm (-2 m) high, with radial, indeterminate, terete, heavily corticated branches for 3–4 orders, clothed with short tufts of ecorticate determinate laterals 2–4 (-5) mm long. Axes usually denuded basally, 1–2 (-3) mm in diameter below, tapering gradually to 200–400 µm in diameter near apices. Holdfast fibrous, 2–10 mm across; epilithic or epiphytic. *Structure.* Apical cells hemispherical, 8–10 µm in diameter, producing 4 pericentral cells (Fig. 95B) and determinate branches close to apices, spirally arranged. Cortication of indeterminate branches commences close to apices, the pericentral cells remaining conspicuous in section, outer cortical cells irregularly elongate, L/D 2–4. Determinate laterals first simple, 1–2 mm long, soon branched from near their base, lesser branches 0.2–1 mm long, 40–90 µm in diameter, tapering near their tips; segments L/D (0.5-) 0.8–2. Trichoblasts mainly on branches of determinate tufts, 0.2–1 mm long, branched, soon caducous, with scar cells on each segment in a 1/4 spiral. Cells mostly uninucleate; rhodoplasts discoid to elongate.

Reproduction. Gametophytes dioecious. Procarps on trichoblasts on determinate lateral branches, with a pre-fertilization pericarp. Carposporophytes with a small basal fusion cell and short gonimoblast filaments bearing elongate-ovoid terminal carposporangia 45–75 µm in diameter. Cystocarps (Fig. 95C) usually urceolate with a short neck and a distinct short basal stalk, 500–750 µm in diameter; pericarp ostiolate, 2 cells thick, outer cells isodiametric and angular. Spermatangial branches (Fig. 95D) replacing trichoblasts, with a sterile basal cell, elongate-ovoid, 90–180 µm long and 25–70 µm in diameter.

Tetrasporangia (Fig. 95E, F) in branches of the determinate tufts, few to a series per branch, single per segment and bulging the segments, 75–110 µm in diameter.

Type from Georgetown, Tas. (*Gunn*); holotype in Herb. Harvey, TCD (*Gunn* 1297, as *P. acanthophora*).

Distribution: Albany, W. Aust., to Walkerville, Vic., and around Tasmania.

Selected specimens: Middleton Beach, Albany, W. Aust., drift (*Wood*, 10.x.1960; AD, A24566). Elliston Bay, S. Aust., 10–12 m deep in centre of bay (*Shepherd*, 23.x.1969; AD, A34939). Avoid Bay, S. Aust., drift (*Womersley*, 30.xi.1975; AD, A46835). NE side Wedge I., S. Aust., 5 m deep (*Baldock*, 28.xii.1963; AD, A27332). Fitzgerald Bay, Point Lowly, S. Aust., on artificial tyre reef, 14 m deep (*Branden*, 13.ix.1987; AD, A59334). Off St Kilda, S. Aust., 6 m deep (*S. Lewis*, 4.ix.1972; AD, A42755). The Bluff, Victor Harbor, S. Aust., 8 m deep (*Clarke*, 16.vii.1982; AD, A60717). Muston, Kangaroo I., S. Aust., 2–3 m deep (*Womersley*, 21.xi.1968; AD, A32945). Vivonne Bay, Kangaroo I., S. Aust., drift (*Womersley*, 1.i.2000; AD, A68403). Seal Beach, Kangaroo I., S. Aust., drift (*Womersley*, 21.i.1965; AD, A28695). Pennington Bay, Kangaroo I., S. Aust., drift (*Womersley*, 7.i.1948; AD, A6697). Cape Jaffa, S. Aust., drift (*Womersley*, 25.iv.2000; AD, A68505). Robe, S. Aust., on *Amphibolis*

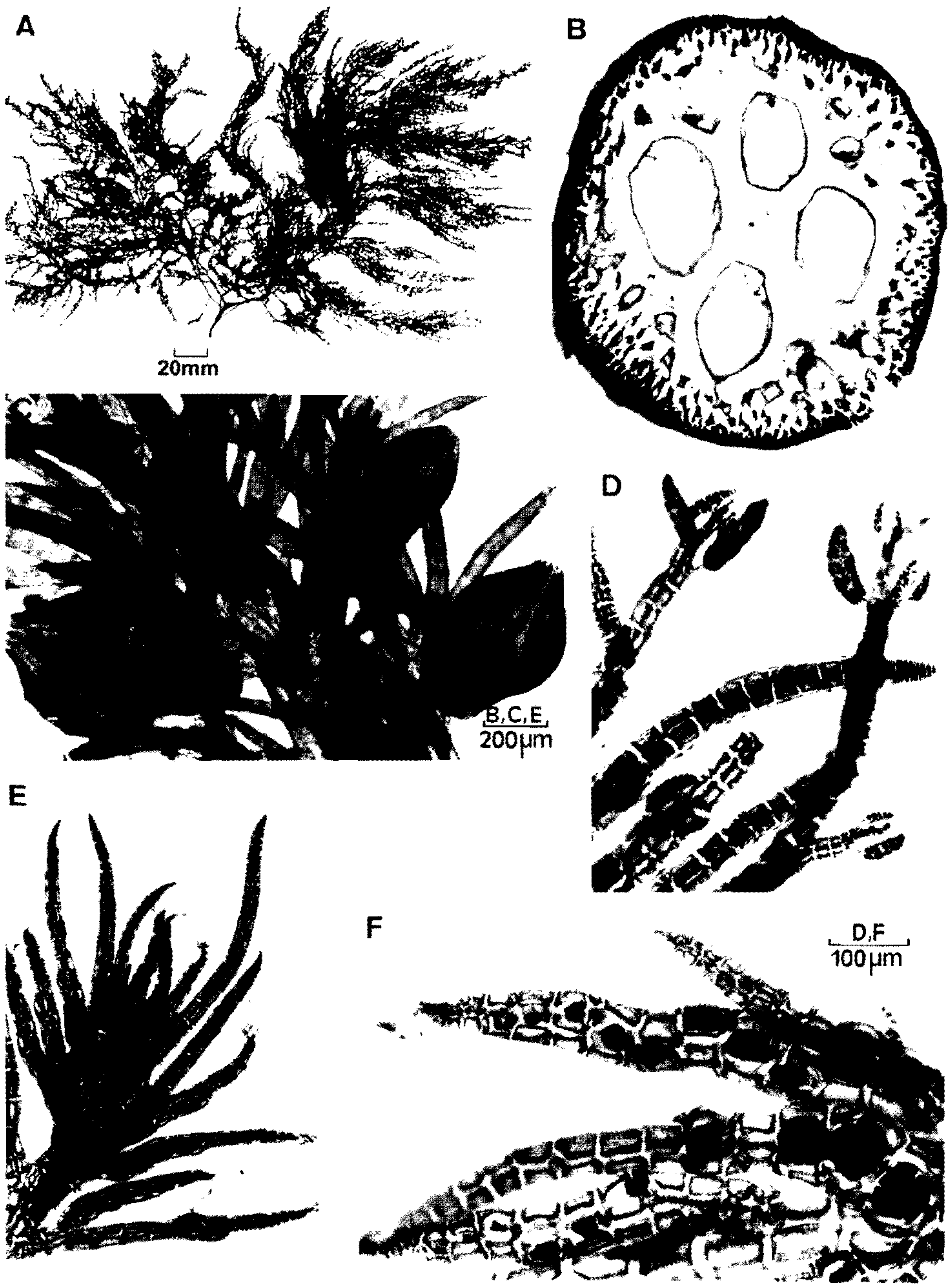

Fig. 95. *Echinothamnion hookeri* (**A**, **C**, **D**, AD, A68403; **B**, AD, A67092; **E**, AD, A32945; **F**, **G**, AD, A68505). **A**. Habit. **B**. Transverse section of indeterminate axis. **C**. Cystocarps on determinate laterals. **D**. Spermatangial branches on determinate laterals. **E**. Determinate laterals with tetrasporangia. **F**. Tetrasporangia in determinate laterals.

antarctica, 2 m deep (*Kildea*, 25.x.1996; AD, A67092). Port MacDonnell, S. Aust., drift in harbour (*Womersley*, 29.ix.1996; AD, A66630). Flinders, Vic., drift (*Womersley*, 25.x.1986; AD, A57844). San Remo back beach, Vic., drift (*Sinkora* A1980, 27.xi to 5.xii.1974; AD, A62712). North Walkerville, Waratah Bay, Vic., drift (*Sinkora* A1663, 23.ii to 9.iii.1972; AD, A43264). Rocky Cape, Tas., drift (*Gordon*, 18.1.1966; AD, A29963). Port Sorell, Tas., drift (*Womersley*, 9.xi.1982; AD, A56234). Taroona, Tas., drift (*Westphalen*, 31.i.1997; AD, A66912). Bruny I. (opposite Gordon), Tas., 2–3 m deep (*Brown*, 10.x.1986; AD, A57833).

E. hookeri differs from *E. hystrix* essentially in habit, having several orders of indeterminate branches compared to the irregular branches of the latter.

Genus **DIPLOCLADIA** Kylin 1956: 504.

Thallus erect or flaccid, densely branched with main axes bearing indeterminate laterals radially for 4–5 orders, all branches densely covered with short, branched determinate laterals; all branches ecorticate; attachment by rhizoids from base of axes. *Structure.* Apical cells dome-shaped, subapical cells cutting off 7 pericentral cells and determinate laterals spirally, determinate laterals first simple, becoming branched 4–5 times, bearing trichoblasts.

Reproduction. Gametophytes dioecious. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia. Cystocarps sessile or short-stalked, ovoid; pericarp ostiolate, 2 cells thick, with a slight cortex near the base. Spermatangial branches replacing the whole trichoblast, with a sterile basal cell only.

Tetrasporangia in branches of determinate laterals, single per segment, spirally arranged.

Type species: *D. patersonis* (Sonder)Kylin 1956: 504.

Diplocladia includes a single species, characterised by 7 pericentral cells and with all branches ecorticate. The differentiation of indeterminate branches and short determinate laterals is well defined.

Diplocladia patersonis (Sonder)Kylin 1956: 504. Beanland & Woelkerling 1982: 98. Davey & Woelkerling 1980: 59. May 1965: 383.

Polysiphonia patersonis Sonder 1855: 525; 1880: 35. Guiler 1952: 103. Harvey 1863: synop. xxi. Kützing 1864: 6, pl. 18 d–f. Tisdall 1898: 514. Womersley 1950: 185.

Brongniartella? patersonis (Sonder)De Toni 1903: 1011. Lucas 1909: 43; 1929a: 22. Lucas & Perrin 1947: 283.

Polysiphonia spinosissima Harvey 1859b: 301; 1860, pl. 155. J. Agardh 1863: 1045. Kützing 1864: 16, pl. 45 c–e. Tisdall 1898: 514. Wilson 1892: 167.

Brongniartella spinosissima (Harvey)Falkenberg 1901: 548, pl. 19 figs 11, 12.

FIG. 96

Thallus (Fig. 96A) dark brown-red to yellow-red, drying darker, erect, much branched with main axes bearing long laterals for 4–5 orders, arising from prostrate branches, and bearing radially relatively determinate lateral branchlets (Fig. 96B); all branches ecorticate. Attachment by rhizoids; epilithic or on shells. *Structure.* Apices with dome-shaped apical cells, cutting off 7 pericentral cells close to apices, with determinate laterals (Fig. 96B) arising spirally (usually at about 1/4 divergence), first simple, later branching 3–4 times and developing further apically but remaining limited in development; laterals (0.2-) 0.5–1 (-1.5) mm long, 70–150 µm in diameter with segments L/D 0.2–0.5. Axes 200–400 µm in diameter, segments L/D 0.2–0.5. Trichoblasts prominent on branches of determinate laterals, (0.4-) 1–1.5 mm long, lower cells 30–50 µm in diameter and L/D (2-) 6–15. Rhizoids 25–60 µm in diameter with digitate haptera usually cut off from pericentral cells. Rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Carposporophytes with a small basal fusion cell and branched gonimoblast with elongate-clavate terminal carposporangia 25–35 µm in diameter. Cystocarps (Fig. 96C) ovoid, 300–500 µm in diameter, sessile or short-stalked; pericarp ostiolate, with a slight neck, 2 cells thick with a slight cortex on lower parts. Spermatangial branches (Fig. 96D) replacing whole trichoblast, with a sterile basal cell 40–100 µm long but no sterile apical cells, 100–150 µm long and 50–90 µm in diameter, often slightly curved.

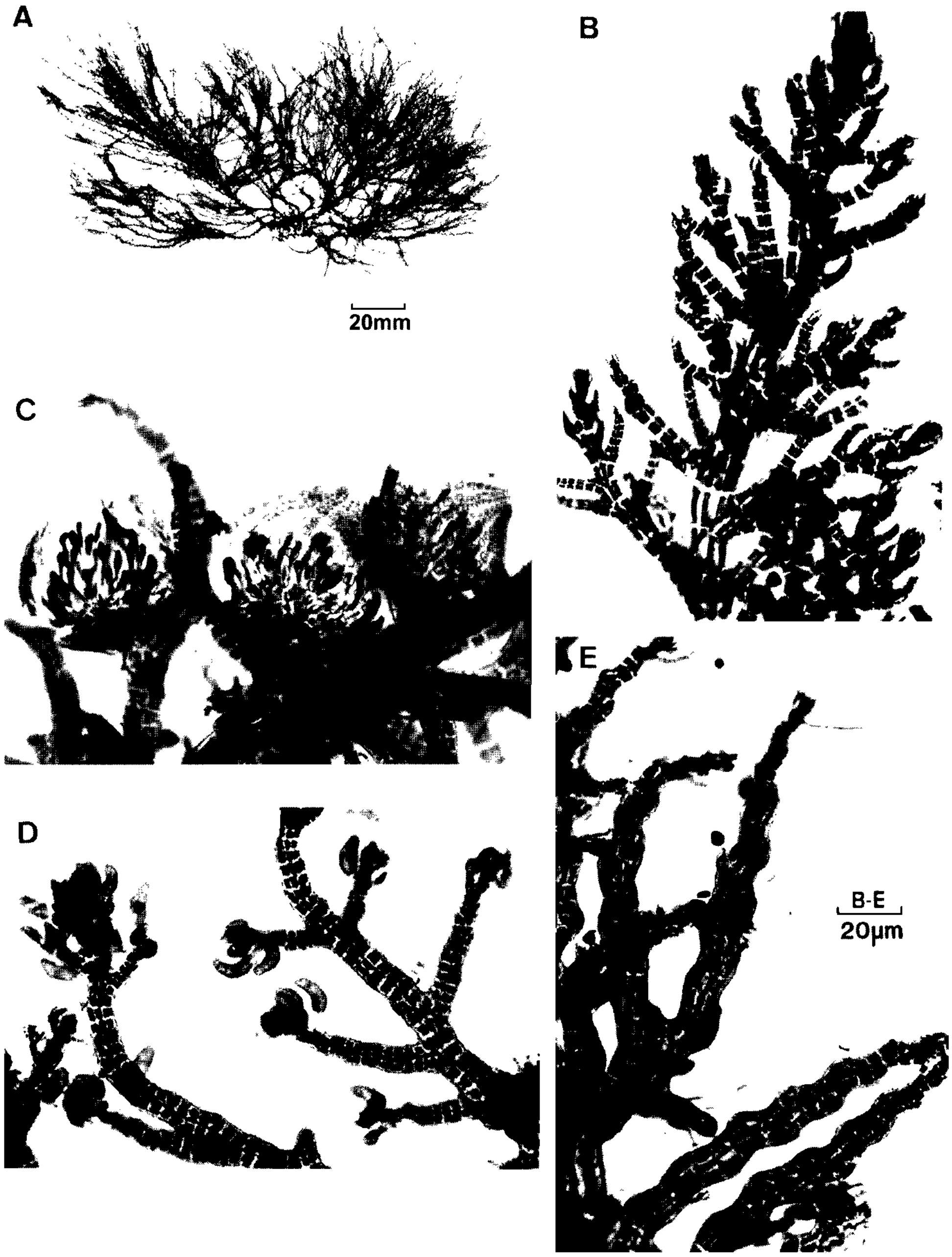

Fig. 96. *Diplocladia patersonis* (**A**, AD, A8695; **B**, **E**, AD, A68520; **C**, **D**, AD, A32514). **A**. Habit. **B**. Indeterminate axes with short, determinate laterals. **C**. Cystocarps and carposporophytes. **D**. Spermatangial branches on determinate laterals. **E**. Tetrasporangia in branches of determinate laterals.

Tetrasporangial branches (Fig. 96E) 0.7–1.5 mm long, simple or branched, with slightly undulate margins, 100–200 μm in diameter, tetrasporangia one per segment, spirally arranged, 40–80 μm in diameter.

Type from Cape Paterson, Vic. (*Mueller*, June 1853), lectotype in MEL, 45872, isolectotypes 45873–45875, 538237, 538238.

Distribution: Venus Bay, S. Aust., to Walkerville, Vic., and N coast of Tasmania.

Selected specimens: Venus Bay, S. Aust., low eulittoral on flats (*Womersley*, 17.i.1951; AD, A13761). Point Drummond, S. Aust., sheltered pool (*Womersley*, 11.i.1951; AD, A15023). Kellidie Bay, Coffin Bay, S. Aust., lower eulittoral (*Womersley*, 13.v.1968; AD, A32514—"Marine Algae of southern Australia" No. 123). Spalding Cove, Port Lincoln, S. Aust., lower eulittoral (*Womersley*, 25.viii.1975; AD, A46504). Aldinga, S. Aust., reef pools (*Womersley*, 12.vii.1968; AD, A32545). American R. inlet, Kangaroo I., S. Aust., lower eulittoral (*Womersley*, 26.viii.1948; AD, A8695) and 2–4 m deep near Muston (*Womersley*, 22.viii.1963; AD, A26887). Robe, S. Aust., low eulittoral (*Womersley*, 27.viii.1949; AD, A11074). Port MacDonnell, S. Aust., uppermost sublittoral pools at "Wagon Wheels" (*Womersley*, 23.iv.2000; AD, A68520—"Marine Algae of southern Australia" No. 123a). Point Lonsdale, Vic., in large mid eulittoral pool (*Sinkora* A2441, 22.iv.1978; AD, A60885). Shoreham, Westernport Bay, Vic., at low tide level (*Sinkora* A1358, 29.x.1971; MEL 504878; AD, A49481). Walkerville, Vic., in rockpools (*Sinkora* A1815, 4.xii.1973; AD, A53516). Low Head, Tas. (*Cribb* 73.14, 15.ix.1950; AD, A16289).

D. patersonis usually occurs in shallow water on tidal flats, occasionally under moderate water movement.

Brongniartella spinosissima was recorded by Papenfuss (1964b, p. 59) from the Auckland Is, based on a Rabenhorst record which is almost certainly incorrect.

Genus **PERRINIA** Womersley, *gen. nov.*

Thallus erect, tufted, with numerous indeterminate axes arising from prostrate basal stolons, the axes bearing determinate laterals more-or-less spirally; attachment by rhizoids from pericentral cells of stolons. *Structure.* Apical cells dome-shaped, subapical cells cutting off 11–13 (-15) pericentral cells close to apices, all branches remaining ecorticate. Trichoblasts usually prominent on determinate branches, on each segment or a few apart.

Reproduction. Gametophytes dioecious. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia. Cystocarps ovoid to urceolate, short-stalked; pericarp ostiolate, 2 cells thick, ecorticate. Spermatangial organs borne basally on trichoblasts, with a sterile basal cell only.

Tetrasporangia in branches of determinate laterals, usually 2 per segment (occasionally one), spirally arranged.

Diagnosis: Thallus erectus, caespitosus cum multis axibus indeterminatis orientibus ex stolonibus prostratis; axes ferentes laterales spiratim determinatos; affixus per rhizoidea ex cellulis stolonis pericentralibus, cellulae subapicales, abscissentes 11–13 (-15) cellulas pericentrales, ecorticatae. Trichoblasti in ramis determinatis.

Reproductio. Gametophyta dioecia. Carposporophyta cum cellula basi coniungenti et gonimoblasto cum carposporangibus clavatis et terminalibus. Cystocarpia ovoidea ad urceolata cum pedicella brevi; pericarpium ostiolatum, ecorticatum, 2 cellulas densum. Organa spermatangialia portata basi in trichoblastis. Tetrasporangia in ramis lateralium determinatorum plerumque 2 per segmenta spiratim disposita.

Type species: *P. ericoides* (Harvey *in* Hooker & Harvey 1847: 400)Womersley, *comb. nov.*

Perrinia ericoides clearly is not a species of *Bryocladia*, where it was placed by Schmitz, differing from the type species, *B. cervicornis*, in lacking endogenous branching, in having prominent trichoblasts, and in having usually two tetrasporangia per segment. The latter feature is found in *Leptosiphonia* Kylin (1956, p. 509), but this genus does not have differentiation into indeterminate axes and short determinate laterals shown by *Perrinia ericoides*.

Perrinia is named after Mrs Florence Perrin, who collected extensively in the Georgetown region of Tasmania and whose specimens enrich several Australian herbaria.

Perrinia ericoides (Harvey *in* Hooker & Harvey)Womersley, *comb. nov.*

Polysiphonia ericoides Harvey *in* Hooker & Harvey 1847: 400. Harvey 1847: 50; 1859b: 301; 1862a: pl. 185A; 1863, synop.: xxi. J. Agardh 1863: 956. Kützing 1849: 809. Sonder 1880: 35.

Bryocladia ericoides (Harvey *in* Hooker & Harvey)Schmitz *in* Falkenberg 1901: 169. Adams 1994: 316, pl. 108 upper left. De Toni 1903: 967. Guiler 1952: 102. Lucas 1909: 42; 1929a: 22. May 1965: 382.

Bryocladia cervicornis sensu De Toni & Forti 1923: 42? May 1965: 382?

Fig. 97. *Perrinia ericoides* (AD, A54520). **A**. Habit. **B**. Transverse sections of indeterminate axis and determinate lateral. **C**. Cystocarps. **D**. Tetrasporangia in branches of determinate lateral. **E**. Tetrasporangia in decussate pairs.

FIG. 97

Thallus (Fig. 97A) dark brown-red, drying brown-black, erect, 2–10 cm high, with several tufted axes from prostrate basal stolons, axes radially branched for 3–4 orders, narrow-pyramidal in outline, becoming denuded below apart from bases of laterals; all branches ecorticate. Attachment by rhizoids from pericentral cells of stolons; epilithic, epizoic (on mussels) or epiphytic (on coralline algae). *Structure.* Apical cells dome-shaped, cutting off 11–13 (-15) pericentral cells (Fig. 97B) close to apices, with determinate laterals arising more-or-less spirally, first simple, later with 1–3 branches, 1–3 mm long and 120–220 µm in diameter, segments L/D 0.3–0.5. Trichoblasts prominent, 250–1000 µm long, borne on each segment or a few segments apart, lower cells 40–50 µm in diameter and L/D (3-) 5–10, tapering above to 15–20 µm and cells L/D 6–10. Axes 500–900 µm in diameter, segments L/D 0.3–0.6. Rhizoids 40–80 µm in diameter with digitate haptera, cut off from pericentral cells. Rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Carposporophytes with a small fusion cell and branched gonimoblast with elongate-clavate terminal carposporangia 25–40 µm in diameter. Cystocarps (Fig. 97C) ovoid to urceolate, 250–500 µm in diameter, shortly stalked; pericarp ostiolate, 2 cells thick, outer cells angular, isodiametric. Spermatangial branches borne as a basal branch of trichoblasts, with a sterile basal cell but no sterile apical cells, 150–300 µm long and 35–55 µm in diameter.

Tetrasporangia (Fig. 96D) borne in simple or branched determinate laterals 1–3 mm long with smooth margins and 90–200 µm in diameter, in opposite decussate pairs (Fig. 97E), 50–70 µm in diameter.

Type from Tasmania (*Ewing*); lectotype in Herb. Harvey, TCD.

Distribution: Bridgewater Bay, Vic., and Three Hummocks I. and E Tasmania.
New Zealand.

Selected specimens: Bridgewater Bay, Vic., lower eulittoral (*Beauglehole*, 5.vi.1949; AD, A12079). Three Hummocks I., NW Tas., low eulittoral (*Bennett*, 17.i.1954; AD, A19700). Bicheno, Tas., lower eulittoral (*Womersley*, 4.xi.1982; AD, A56458). Tessellated Pavements, Eaglehawk Neck, Tas., lower eulittoral (*Womersley*, 30.x.1982; AD, A54520). Fortescue Bay, Tasman Pen., Tas., uppermost sublittoral (*Womersley*, 22.x.1994; AD, A64207). Port Arthur, Tas. (*Harvey*, AD, A18283 *ex* TCD).

P. ericoides is conspicuous in the eulittoral on SE Tasmanian coasts, under moderate wave action, and is known also from Bridgewater Bay in Victoria.

Genus PITYOPHYCOS Papenfuss 1958: 107

Thallus erect, with one to a few axes bearing long lateral indeterminate branches for 3–4 orders, upper branches clothed with short, coupled, determinate laterals, spirally arranged, the upper pinnate and the lower usually simple. Attachment by basal stoloniferous branches. *Structure.* Subapical axial cells cutting off 4 pericentral cells which become rapidly corticated, bearing spirally adjacent, short, determinate laterals in a 1/4 divergence; these laterals alternately distichously branched, polysiphonous from close to their apical cells and with branched trichoblasts.

Reproduction. Gametophytes little known. Cystocarps borne on pinnate determinate laterals, ovoid.

Tetrasporangia in branches of determinate laterals, single per segment, spirally arranged.

Type species: *P. tasmanica* (Sonder)Papenfuss 1958: 107.

Pityophycos is a little-known monotypic genus but seemingly distinct in the morphology of its determinate laterals, with an upper pinnate one and lower simple one, compared to *Chiracanthia* where they are branched and taper to an apical cell or monosiphonous filament.

Pityophycos tasmanica (Sonder)Papenfuss 1958: 107. May 1965: 384.

Acanthophora tasmanica Sonder 1853: 699. J. Agardh 1863: 816. Harvey 1859b: 296.
Polysiphonia tasmanica (Sonder)J. Agardh 1863: 1018. Harvey 1863, synop.: xx. Sonder 1880: 34. Tisdall 1898: 514.

Pithyopsis tasmanica (Sonder)Falkenberg *in* Schmitz & Falkenberg 1897: 441. De Toni 1903: 969. Falkenberg 1901: 181, pl. 14 figs 33–36. Guiler 1952: 102. Kylin 1956: 506, fig. 402. Lucas 1909: 42; 1929a: 22.

Dictyomenia myriacantha Kützing 1864: 33, pl. 94a–e. De Toni 1903: 988. Guiler 1952: 105. Lucas 1909: 42; 1929a: 22. May 1965: 395. Sonder 1880: 33.

FIG. 98

Thallus (Fig. 98A) dark red-brown, erect, 2–12 (-20) cm high, radially branched with one to few terete axes bearing long lateral branches for 3–4 orders, denuded below, upper branches clothed with short determinate laterals (Fig. 98B) often with a compressed, pinnate, upper one and a usually simple, terete, lower one, spirally arranged. Attachment by basal stoloniferous branches; probably epilithic or on coralline algae. *Structure.* Apices rapidly

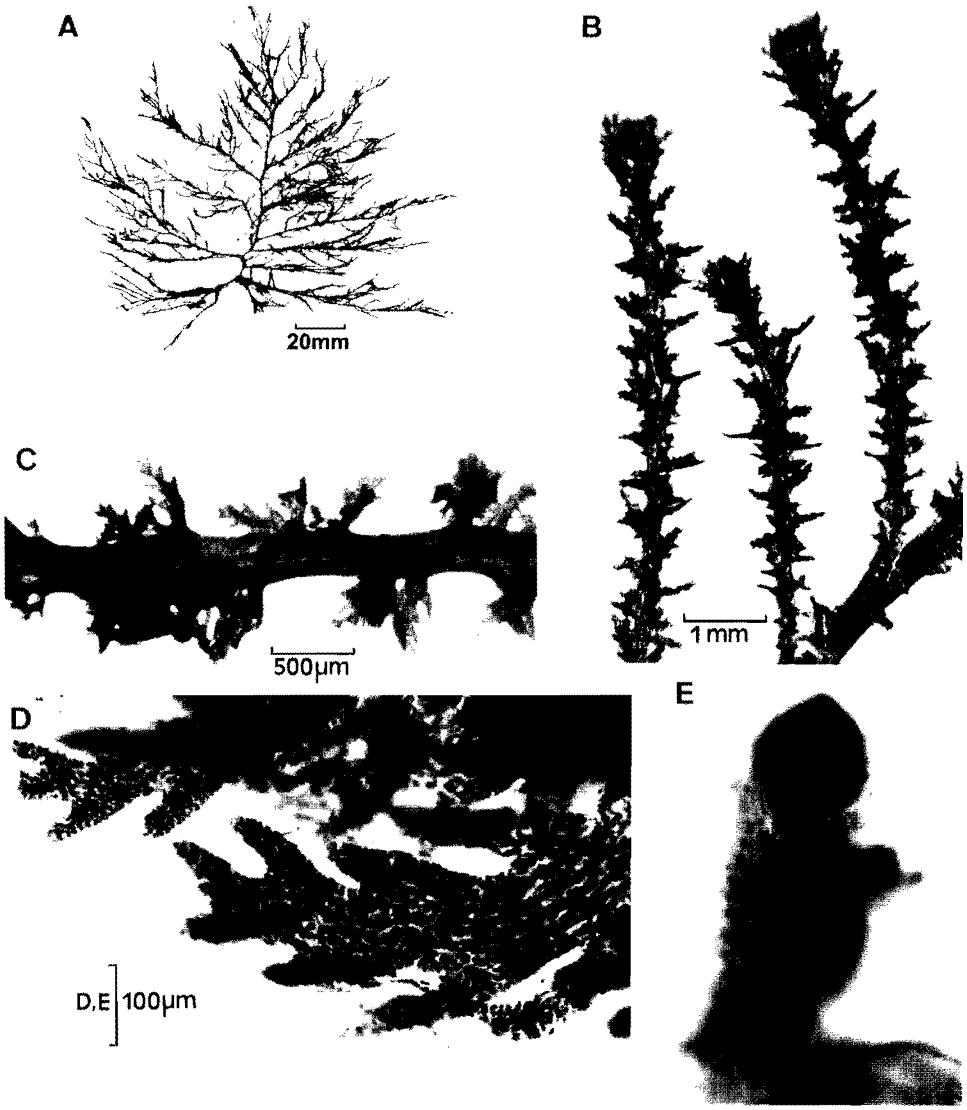

Fig. 98. *Pityophycos tasmanica* (**A**, MEL, 537395; **B**, MEL, 45614; **C**, **D**, AD, A16269; **E**, MEL, 45607). **A**. Habit, holotype. **B**. Indeterminate branches with pinnate and simple determinate laterals. **C**. Indeterminate branch with pinnate determinate laterals. **D**. Pinnate determinate laterals. **E**. Determinate lateral with a young cystocarp.

corticated, with 4 pericentral cells, bearing closely arranged, coupled, determinate laterals probably in 1/4 divergence; these laterals 0.5–1 mm long, the upper alternately distichously branched (Fig. 98C, D) with 3–5 branches on each side, polysiphonous from close to the apical cells and with branched trichoblasts; the lower one usually simple. Axes 0.5–1.2 mm in diameter, indeterminate laterals 0.3–0.5 mm in diameter, with the pericentral and inner cortical cells becoming thick walled. Rhodoplasts discoid.

Reproduction. Gametangial thalli little known. MEL, 45607 shows ovoid cystocarps (Fig. 98E) borne near the ends of the pinnate determinate laterals, some about 200 µm in diameter, with clavate terminal carposporangia borne on a short gonimoblast and a small basal fusion cell, with an ecorticate pericarp.

Tetrasporangia borne sparsely within the determinate laterals, single per segment, 25–40 µm in diameter.

Type from Georgetown, Tas. (*Stuart*); holotype in MEL, 537395, isotype MEL, 537396.

Distribution: Known only from the vicinity of Georgetown and Low Head, Tasmania, and from Port Phillip, Victoria.

Selected specimens: Port Phillip, Vic. (*Mueller*, MEL, 45607, 45681). Brighton, Port Phillip, Vic. (*Harvey*?, Trav. Set 479; MEL, 45614). Sorrento, Port Phillip, Vic. (*Wilson*, 29.i.1884; MEL, 45645). Georgetown, Tas. (*Harvey*, Alg. Aust. Exsicc. 165 I, fragment AD, A18443). Low Head, Tas. (*Cribb* 74.7, 16.ix.1952; AD, A16269). Currie R., Tas (*Jones*, 5.xii.1934; Tilden's South Pacific Plants, Series 2, No. 194, AD, A49949).

Pityophycos tasmanica is apparently a rare species, needing detailed study from fresh material to clarify the arrangement of the determinate laterals and reproduction. Although Falkenberg *in* Schmitz & Falkenberg (1897, p. 441), followed by May (1965, p. 384), recorded it from the coast of South Australia, the only mainland specimens are from Port Phillip, Victoria, collected in the mid 1800's. It has apparently never been collected in the last half century. The type of *Dictyomenia myriacantha* Kützing, from Georgetown Tasmania, in Herb. Sonder, MEL, is *Pityophycos tasmanica.*

Genus CHIRACANTHIA Falkenberg *in* Schmitz & Falkenberg 1897: 441.

Thallus erect to flaccid, with long axes and lateral indeterminate branches bearing short determinate laterals above, usually bare below. Holdfast discoid. *Structure.* Apices enclosed by determinate laterals, developing 4 pericentral cells and becoming heavily corticate. Determinate laterals ecorticate, with 3–4 basal branches lying in one plane, each tapering to a single apical cell sometimes extending to a monosiphonous filament.

Reproduction. Gametophytes dioecious. Carposporophytes with a branched gonimoblast bearing ovoid to clavate terminal carposporangia. Cystocarps sessile on determinate branchlets, ovoid; pericarp ostiolate, 2 (-3) cells thick, basally slightly corticate. Spermatangial branches replacing trichoblasts and terminating determinate branchlets, with sterile basal and apical cells.

Tetrasporangia in elongate determinate branchlets, single per segment, spirally arranged.

Type species: *C. arborea* (Harvey)Falkenberg *in* Schmitz & Falkenberg 1897: 441.

Chiracanthia is probably a monotypic genus, characterised by the habit, discoid holdfast, and the somewhat compressed determinate lateral branchlets.

Chiracanthia arborea (Harvey)Falkenberg *in* Schmitz & Falkenberg 1897: 441. De Toni 1903: 971. De Toni & Forti 1923: 42. Falkenberg 1901: 179, pl. 19 figs 18–23. Guiler 1952: 102. Kylin 1956: 507, fig. 403A, B. Lucas 1909: 42; 1929a: 22. Lucas & Perrin 1947: 277. May 1965: 384. Shepherd 1983: 83. Womersley 1950: 184.

Acanthophora arborea Harvey 1859b: 296; 1860: pl. 132; 1863, synop.: xvii. J. Agardh 1863: 822. Sonder 1880: 33. Tisdall 1898: 513. Wilson 1892: 168.

Polysiphonia valida J. Agardh 1896: 110. Reinbold 1898: 50.

Chiracanthia valida (J. Agardh)Falkenberg 1901: 733. De Toni 1903: 972. Guiler 1952: 102. Lucas 1909: 42; 1929b: 51. Lucas & Perrin 1947: 277. May 1965: 384. Silva *et al.* 1996: 479.

FIG. 99

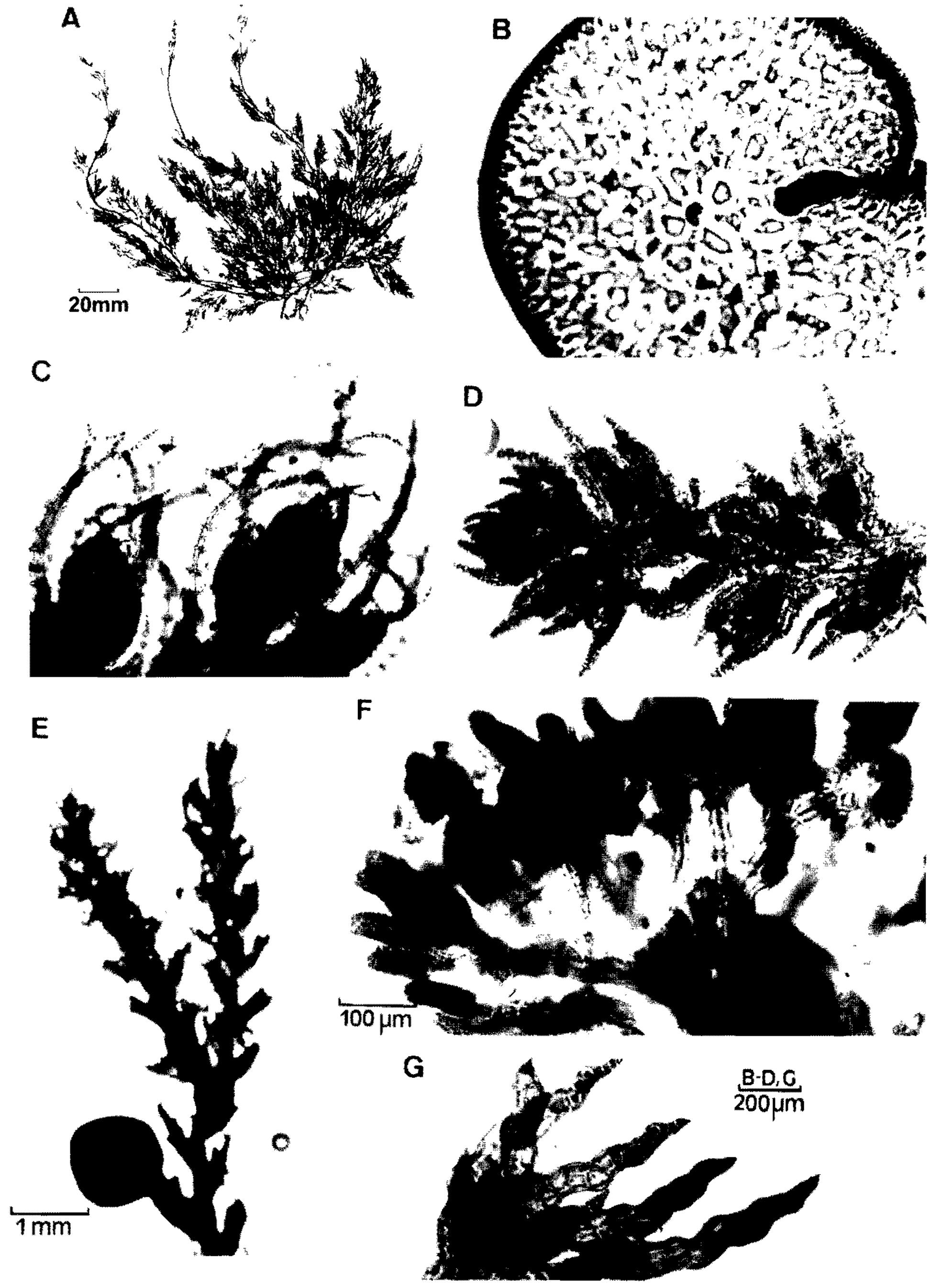

Fig. 99. *Chiracanthia arborea* (**A**, **B**, **G**, AD, A64623; **C**, **E**, **F**, AD, A41260; **D**, AD, A8587). **A**. Habit. **B**. Transverse section of indeterminate axis with darkly stained endophyte (on right). **C**. Determinate laterals with monosiphonous branch ends. **D**. Indeterminate axis with determinate laterals and darkly stained endophytes. **E**. Branches with a cystocarp. **F**. Cluster of spermatangial branches. **G**. Branches of determinate lateral with tetrasporangia.

Thallus (Fig. 99A) dark red-brown, 10–40 cm high, with a single or several axes bearing long main laterals irregularly radially, with lesser branches clothed sparsely to densely with short determinate laterals. Holdfast discoid, 2–8 mm across; epilithic, epiphytic, or on shells or jetty piles. *Structure.* Apex enclosed by determinate branchlets, forming 4 pericentral cells and becoming corticated (Fig. 99B) from close to apices. Axes 1–2 mm in diameter below, above 0.5–1 mm in diameter. Determinate branchlets (Fig. 99D) 0.8–2.5 mm long, ecorticate, with 3–4 basal branches each 0.5–1.5 mm long and 40–120 µm in diameter, tending to lie in one plane, with 4 pericentral cells and segments L/D 0.5–1.3, tapering to a single apical cell sometimes extended to a monosiphonous filament (Fig. 99C) 5–10 cells long; trichoblasts rare, caducous; a darkly-staining animal endophyte (Fig. 99B, D) frequent. Rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps borne on branches of determinate branchlets. Carposporophytes branched with elongate-ovoid to clavate terminal carposporangia 35–55 µm in diameter. Pericarp ostiolate, without a neck, 2 (-3) cells thick, basally slightly corticate. Cystocarps (Fig. 99E) sessile on determinate branchlets, ovoid, 0.5–1 mm in diameter. Spermatangial branches (Fig. 99F) terminating determinate branchlets, with monosiphonous pedicels 1–3 cells long and with 1–3 sterile apical cells, fertile parts 90–200 µm long and 40–90 µm in diameter.

Tetrasporangia (Fig. 99G) borne in elongate branches of determinate branchlets 0.5–1.4 mm long and 90–130 µm in diameter, with undulating margins due to the tetrasporangia which occur one per segment, spirally arranged, subspherical, 60–90 µm in diameter, with 2–3 rectangular cover cells.

Type from Georgetown, Tas. (*Harvey*); lectotype in Herb. Harvey, TCD (Alg. Aust. Exsicc. 140 I); isolectotypes MEL, 1554626 and elsewhere.

Distribution: Geographe Bay, W. Aust., to Port Phillip, Vic., and N Tasmania.

Selected specimens: Geographe Bay, W. Aust. (Herb. Agardh, LD, type of *C. valida*, and MEL, 504314–504322). N Spencer Gulf, S. Aust., 10 m deep (*Shepherd*, 6.ix.1973; AD, A44465). Investigator Strait, S. Aust., 23 m deep (*Watson*, 28.i.1971; AD, A41011). Outside Tapley Shoal (Edithburg), S. Aust., 15 m deep (*Shepherd*, 2.ii.1969; AD, A33511). Marino, S. Aust., drift (*Womersley*, 23.i.1972; AD, A41260). Bay of Shoals, Kangaroo I., S. Aust., 3 m deep (*Womersley*, 5.i.1990; AD, A60123). Strawbridge Point, Kangaroo I., S. Aust., drift (*Womersley*, 29.x.1995; AD, A64623—"Marine Algae of southern Australia" No. 392). Muston, Kangaroo I., S. Aust., channel edge (*Womersley*, 29.ix.1964; AD, A28223). Rocky Point, Kangaroo I., S. Aust., drift (*Womersley*, 21.viii.1948; AD, A8587). Kingston, S. Aust., drift (*Womersley*, 19.viii.1966; AD, A30663 and 8.ix.1968; AD, A32587). Swan Bay, Port Phillip, Vic., 0.5 m deep on jetty piles (*Watson*, 17.ix.1973; AD, A44135). Devonport, Tas., drift (*Womersley*, 9.xi.1982; AD, A56249). Currie R., Tas. (*Perrin*, Aug. 1950; AD, A49617).

Chiracanthia arborea is a distinctive species in habit and the determinate laterals. It is common in the Gulf of St Vincent region of South Australia, usually in moderately deep water, but extends throughout southern Australia. Many specimens bear an ovoid animal (?) in the axils of the determinate branchlets.

Chiracanthia valida (type from Geographe Bay, W. Aust; lectotype in Herb Agardh, LD, 40829) appears to apply to older, apically denuded plants of *C. arborea*. MEL, 504314–504322 are probably the same collection, with 504355 recorded as "Rhodomela muelleri Sond.", a *nomen nudum* in Sonder (1880, p. 105).

Tribe LOPHOTHALIEAE Schmitz & Falkenberg 1897: 445.

by H.B.S. Womersley & M.J. Parsons

Thallus erect, radially branched, branches clothed with rhodoplastic trichoblasts (usually persistent) developed on successive segments, spirally arranged; pericentral cells 4–7, ecorticate or becoming heavily corticated, in some genera with adventitious monosiphonous filaments from the pericentral or cortical cells. *Structure* monopodial, with trichoblasts produced close to apices, simple or branched with non-adherent or rarely adherent walls just above the branchings; adventitious filaments simple or branched, arising from pericentral or cortical cells, similar to trichoblasts in dimensions; pericentral cells formed in alternating sequence, undivided or divided in a few species.

Reproduction. Gametophytes dioecious. Procarps borne at base of trichoblasts, on the last formed of 5 pericentral cells, which cuts off a single group or two groups of sterile cells and a 4-celled carpogonial branch. Carposporophytes with a basal fusion cell and branched gonimoblast with terminal carposporangia, usually replaced from lower cells. Cystocarps ovoid or urceolate, ostiolate, with cells of the erect filaments producing 2 outer cells, corticated or not. Spermatangial organs borne as a branch of trichoblasts, axial cells with 3 pericentral cells producing a layer of initials and outer layer of spermatangia.

Tetrasporangia occur in lesser branches bearing trichoblasts or in discrete stichidia borne on the trichoblasts or adventitious filaments, with 4–5 pericentral cells, one, or two opposite ones, becoming fertile; tetrasporangia single, either in a longitudinal line or spirally arranged, or paired and opposite, pairs decussate, with 2 pre-sporangial and in most genera also 1 post-sporangial cover cells.

Type genus: *Lophothalia* (Harvey)Kützing 1849: 797.

Hommersand (1963, p. 346) listed 24 genera in the tribe, of which 11 occur on southern Australian coasts. However, Parsons (1975, p. 691) separated 6 genera in a separate tribe, the Brongniartelleae, based on their having trichoblasts branched in one plane, procarps with 2 sterile groups formed before and after the carpogonial branch, and the tetrasporangia with 2 or 3 pre-sporangial cover cells instead of 2 pre- and 1 post-sporangial cells.

Of these characters, the trichoblasts of some genera are branched largely in an upward curved plane, but this scarcely constitutes a tribal-based difference from those more irregularly branched in other genera. Similarly the difference in cover cells to the tetrasporangia (Brongniartelleae with 2–3 pre-sporangial and Lophothalieae with 2 pre- and 1 post-sporangial) appears to be slight, leaving the procarp sterile cell groups (1 in Lophothalieae and 2 in Brongniartelleae) as the most important feature.

It seems preferable to keep a single tribe for these genera which have persistent rhodoplastic trichoblasts. Alternatively, the genera could be separated on whether the tetrasporangia occur in normal branchlets (*Brongniartella*, *Veleroa*, *Endosiphonia*, *Micropeuce*, *Holotrichia*, *Erythrostachys*, *Doxodasya*, *Lophothalia* and *Gonatogenia*) or in specialised stichidia without trichoblasts (*Haplodasya*, *Lophocladia*).

KEY TO GENERA OF LOPHOTHALIEAE

1. Thallus totally ecorticate 2
1. Thallus corticate, at least basally 3

    2. Thallus with 7 pericentral cells, radially branched, trichoblasts irregularly and usually not complanately branched, often upwardly curved .... BRONGNIARTELLA
    2. Thallus with 4 pericentral cells, irregularly radially branched, trichoblasts radially arranged and more or less complanately branched, upwardly curved .... VELEROA

3. Branches with one tetrasporangium per segment 4
3. Branches with two opposite, decussately arranged, tetrasporangia per segment 9

    4. Tetrasporangia in a straight longitudinal line in the branch .... HAPLODASYA
    4. Tetrasporangia spirally arranged in the branch 5

5. Axial segments with 4 pericentral cells, stichidia and spermatangial organs with a monosiphonous pedicel 6
5. Axial segments with 5–7 pericentral cells, axes and branches becoming heavily corticated, tetrasporangial branches basally polysiphonous 7

    6. Spermatangial organs and stichidia without trichoblast branches; cortication on lower axes only .... LOPHOCLADIA
    6. Spermatangial organs and stichidia with frequent trichoblast branches; cortication from close to apices .... ENDOSIPHONIA

7. Axial segments with 5 pericentral cells .... MICROPEUCE
7. Axial segments with 7 pericentral cells 8

8. Cortex of branches, and/or the lax, simple, trichoblasts and adventitious monosiphonous filaments, with occasional to frequent "gland" cells; pericentral cells soon inconspicuous .... HOLOTRICHIA
8. "Gland cells" absent, monosiphonous filaments rigid, basally furcate, with isodiametric cells; pericentral cells conspicuous well below branch apices ....ERYTHROSTACHYS

9. Four pericentral cells present; trichoblasts simple or branched .... DOXODASYA
9. Five to 7 pericentral cells present; trichoblasts simple.. 10

10. Five or 7 pericentral cells present; trichoblasts (and monosiphonous filaments) unbranched, basal cells not markedly less in diameter than mid cells; reproductive organs on or in lesser branches .... LOPHOTHALIA
10. Five to 7 pericentral cells present; trichoblasts with 3–7 small basal cells; reproductive organs in axillary branch systems.......................... GONATOGENIA

Genus BRONGNIARTELLA Bory de St-Vincent 1822: 516.

Thallus erect from short prostrate axes, much branched irregularly, with 7 pericentral cells, ecorticate, each segment bearing a branched trichoblast; adventitious filaments absent; attachment by unicellular rhizoids. *Structure* monopodial, developing trichoblasts close to apices on a 1/7 spiral and pericentral cells in alternating sequence; trichoblasts rhodoplastic, basally branched. Cells multinucleate.

Reproduction. Gametophytes dioecious. Procarps borne on the second segment of trichoblasts which becomes polysiphonous, the last formed pericentral (supporting) cell bearing a first sterile cell group, the 4-celled carpogonial branch (with the basal cell dividing laterally), and a second sterile cell. Carposporophyte with a basal fusion cell and branched gonimoblast with terminal carposporangia, replaced from below. Cystocarps ovoid to urceolate, ostiolate, with the pericarp arising before fertilisation and becoming 2 cells thick with outer, isodiametric, cells on the erect filaments. Spermatangial organs ovoid, borne laterally on trichoblasts, with a sterile basal cell but no sterile apical cells.

Tetrasporangia in lesser branches or branch systems bearing trichoblasts, spirally arranged and one per segment, with 2 pre-sporangial cover cells, subspherical and tetrahedrally divided.

Type species: *B. elegans* Bory de St-Vincent (1822: 516) [= *B. byssoides* (Goodenough & Woodward)Schmitz 1893: 217.]

A genus of 2 species, the type and *B. australis* from Australasia, described in detail by Parsons (1980).

Brongniartella australis (C. Agardh)Schmitz 1893: 218. Adams 1994: 311, pl. 104, lower right. De Toni 1903: 1010. De Toni & Forti 1923: 44. Falkenberg 1901: 546, pl. 19 figs 6, 7. Guiler 1952: 103. Huisman & Walker 1990: 432. King *et al.* 1971: 123. Lucas 1909: 43; 1929a: 22; 1929b: 51. Lucas & Perrin 1947: 283, fig. 130. May 1965: 379. Parsons 1980: 278, figs 15–58, 61. Reinbold 1899: 48. Shepherd 1983: 83. Silva *et al.* 1996: 477. Womersley 1950: 185; 1966: 153.

Brongniartella australis f. *recurva* Parsons 1980: 287, figs 59, 62, 63.
Cladostephus australis C. Agardh 1824: 169.
Griffithsia australis (C. Agardh)C. Agardh 1828: 135.
Bindera australis (C. Agardh)Trevisan 1845: 63.
Polysiphonia australis (C. Agardh)J. Agardh 1863: 1044. Tisdall 1898: 514.
Lophothalia australis (C. Agardh)J. Agardh 1890: 59. Wilson 1892: 165.
Vertebrata australis (C. Agardh)Kuntze 1891: 928.
Polysiphonia byssoclados Harvey 1844b: 436; 1846: 423.
Bindera cladostephus Decaisne 1842: 358.
Polysiphonia cladostephus Montagne 1843: 302; 1845: 132, pl. 13 fig. 4. Harvey 1847: 45; 1855a: 541; 1859b: 301; 1860: pl. 154; 1863, synop.: xxi. Hooker & Harvey 1847: 400. Kützing 1849: 833; 1864: 6, pl. 19a–c. Sonder 1853: 701; 1880: 35. Tate 1882a: 23. Tisdall 1898: 514.

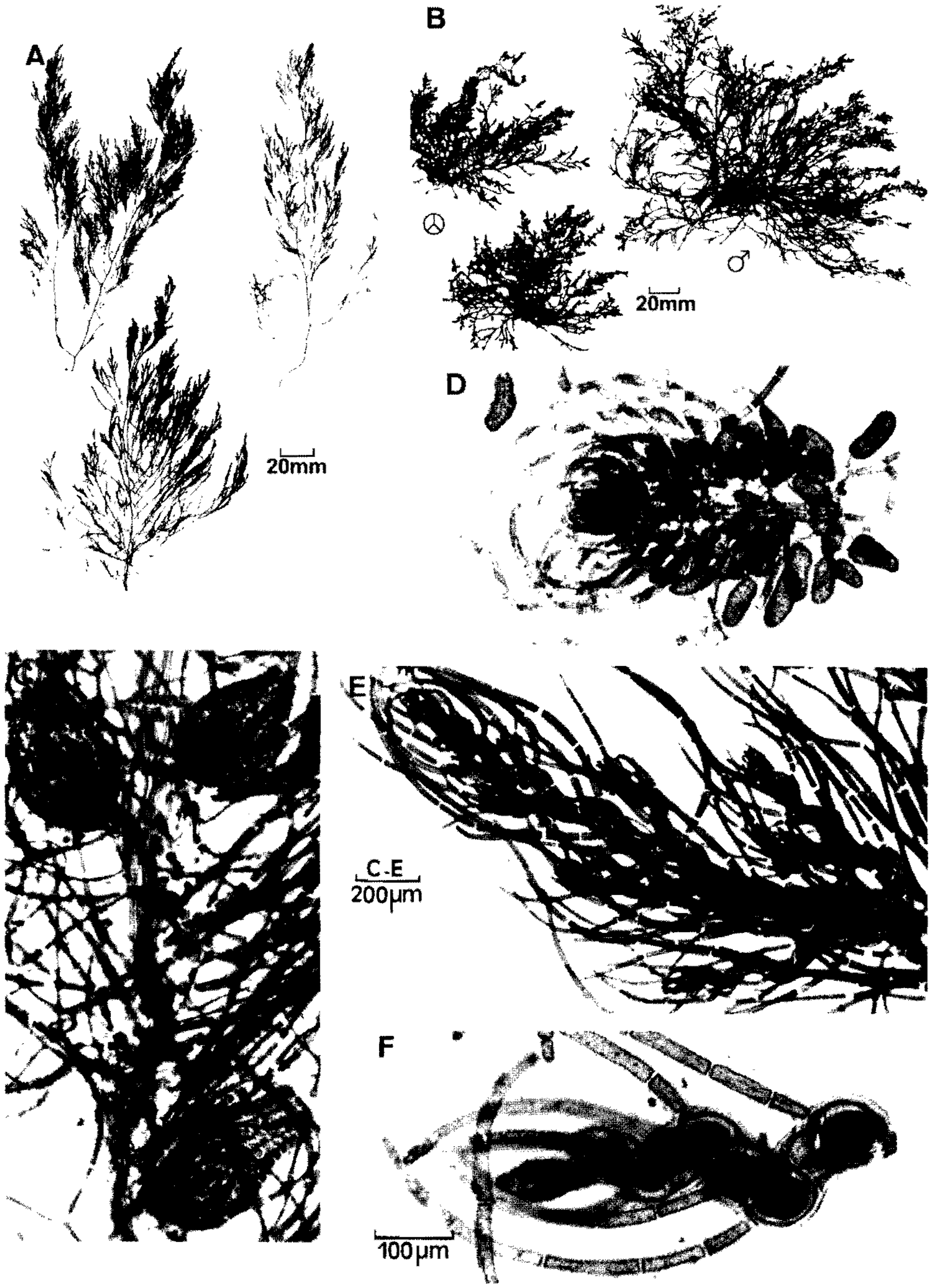

Fig. 100. *Brongniartella australis* (**A**, AD, A41143; **B**, AD, A64757; **C**, **E**, AD, A57834; **D**, **F**, AD, A67332). **A**. Habit, calm-water form. **B**. Habit, rough-water form. **C**. Branch with cystocarps. **D**. Branch with spermatangial organs. **E**. Compound branch with tetrasporangia. **F**. Tetrasporangia spirally arranged, segments with trichoblasts.

FIG. 100

Thallus (Fig. 100A, B) dark brown to purple, 10–50 cm high with short prostrate axes producing erect, irregularly branched, branches for 3–4 orders, main lateral branches 5–25 cm long, lax or dense, with 7 pericentral cells, ecorticate, densely clothed with branched rhodoplastic trichoblasts (Fig. 100E), denuded below. Attachment by rhizoids from the prostrate axes; epilithic or on shells, occasionally epiphytic. *Structure.* Monopodial, apical cells dome-shaped, trichoblasts arising from axial cells 3–9 on a 1/7 spiral, the pericentral cells cut off in alternating sequence from about segment 10. Young branches 60–150 µm in diameter, mature branches 0.4–1 mm in diameter, segments throughout L/D 0.2–0.8 (-1.2). Trichoblasts on each segment, 1–2 mm long, usually upwardly curved to recurved, basally branched 3–4 times, 1–2 cells apart, walls not adherent at branchings, tapering gradually to long unbranched ends, basal cells 50–90 µm in diameter and L/D 2–3, mid cells 40–60 µm in diameter and L/D 3–5, upper cells (12-) 16–35 µm in diameter and L/D (2-) 4–6 (-30). Rhizoids arising from pericentral cells, unicellular with digitate haptera. Lateral branches arising on basal cells of trichoblasts. Cells multinucleate; rhodoplasts discoid to elongate, becoming chained.

Reproduction. Gametophytes dioecious. Procarps arising on the second cell of trichoblasts, which develops 5 pericentral cells, the last formed bearing a sterile initial, a 4-celled carpogonial branch and a second sterile cell, with the basal carpogonial branch cell dividing laterally. Carposporophyte with a basal fusion cell and branched gonimoblast bearing clavate to ovoid terminal carposporangia 35–55 µm in diameter. Cystocarps (Fig. 100C) sessile, ovoid to slightly urceolate, 600–1000 µm in diameter, without or with a slight to distinct neck; pericarp ostiolate, of 10–12 erect filaments, each cell cutting off 2 outer, isodiametric, cells and hence 2 cells thick, ecorticate. Spermatangial organs (Fig. 100D) on the ultimate branches of trichoblasts, ovoid, 45–140 µm in diameter and L/D 1–2 (-2.5), with a sterile basal cell but no sterile apical cells, with 5 (-6) pericentral cells around each axial cell producing initials and outer spermatangia.

Tetrasporangia in lesser branches or branch systems (Fig. 100E) 0.5–1 (-2) mm long and 120–220 µm in diameter, bearing simple or once branched trichoblasts, sporangia in a close spiral row (Fig. 100F), one per segment and bulging the branch, 70–110 µm in diameter with 2 large pre-sporangial cover cells.

Type from "Novam Hollandiam" (probably W. Aust); lectotype in PC; isolectotype in Herb. Agardh, LD, 41993.

Distribution: Whitfords Beach, W. Aust., around southern Australia to Bemm Reef, E Vic., and around Tasmania.

New Zealand, from Wellington south to Stewart I. (see Parsons 1980, p. 279).

Selected specimens: Whitfords Beach, Perth, W. Aust., 4 m deep (*Cook*, 20.viii.1979; AD, A51081). Wanna, S. Aust., lower eulittoral (*Parsons*, 15.v.1968; AD, A32585). N Spencer Gulf, S. Aust., 10 m deep (*Shepherd*, 13.ix.1973; AD, A44321). Stenhouse Bay, S. Aust., 3–4 m deep on jetty piles (*Cannon*, 15.x.1988; AD, A59172). Tapley Shoal, Gulf St Vincent, S. Aust., 10 m deep (*Shepherd*, 2.ii.1969; AD, A33480). 20 km WSW of Outer Harbor, S. Aust., 22–25 m deep (*McFarlane*, 11.ix.1975; AD, A46628). Victor Harbor, S. Aust., 2 m deep (*Engler*, 25.x.1981; AD, A63174). Vivonne Bay, Kangaroo I., S. Aust., low eulittoral (*Womersley*, 7.x.1997; AD, A67332). American R. inlet, Kangaroo I., S. Aust., drift (*Womersley*, 30.x.1966; AD, A30898). Muston, Kangaroo I., S. Aust., 2–4 m deep (*Min-Thein*, 2.xii.1971; AD, A41143—"Marine Algae of southern Australia" No. 128). Robe, S. Aust., pools inside point (*Womersley*, 5.xii.1995; AD, A64757). Queenscliff, Vic., drift (*Wollaston*, 17.viii.1956; AD, A20554). Shoreham, Western Port, Vic., drift (*Sinkora* A1284, 29.x.1971; AD, A62696). Walkerville, Vic., upper sublittoral (*Sinkora* A2625, 19.xi.1979; AD, A61029). Sealers Cove, Wilsons Prom. Vic., (*Mueller*, MEL 45743–46). Bemm Reef, E. Vic., 15–17 m deep (*Kraft* & *Foard*, 8.ii.2001; MELU, 4119). Low Head, Tas., (*Perrin*, Jan. 1936; AD, A53625). Hope I., Dover, Tas., 2–4 m deep (*Sanderson*, 17.x.1994; AD, A64189). Bruny I., Tas., 2–3 m deep opposite Gordon (*Brown*, 10.x.1986; AD, A57834). Great Taylor Bay, Bruny I., Tas., 2–5 m deep (*Shepherd*, 14.ii.1972; AD, A42125).

Brongniartella australis is a common species on rough-water to sheltered coasts, ranging from low tide level to deep water. Its structure and reproduction were described by Parsons (1980), who described forma *recurva*, distinguished by having recurved trichoblasts; this feature however is often found in specimens of the species.

Genus VELEROA Dawson 1944: 335

Thallus with prostrate axes bearing erect branches, usually much branched irregularly radially, with 4 pericentral cells, ecorticate, each segment bearing a rhodoplastic trichoblast; attachment by rhizoids with multicellular haptera. *Structure* monopodial, developing trichoblasts and pericentral cells close to apices; trichoblasts simple or basally branched 1–3 times, with long unbranched ends, branched more or less in an upwardly curved plane; lateral branches arising on basal cell of trichoblasts. Cells uninucleate.

Reproduction. Gametophytes dioecious. Procarps borne on suprabasal cell of trichoblasts. Carposporophytes with a small basal fusion cell and branched gonimoblast with clavate terminal carposporangia. Cystocarps ovoid with a prominent neck; pericarp 2 cells thick, ecorticate. Spermatangial organs borne on lower or mid cells of trichoblasts, ovoid with a basal sterile cell but no upper sterile cells.

Tetrasporangia in lesser branch systems, with trichoblasts on each segment, spirally arranged with one per segment.

Type species: *V. subulata* Dawson 1944: 335, pl. 72 fig. 2.

A genus of 5 or 6 species, mainly subtropical in distribution.

Kylin (1956, pp 495, 511) distinguished his *Thaumatella* from *Veleroa* Dawson as having bilateral branching, though radial at the apices. This, however, is not true, *Thaumatella* having irregularly radial lateral branches throughout, though (especially on herbarium sheets) the lateral branches may appear somewhat bilateral. Hence *Thaumatella* is here synonymised with the earlier *Veleroa* Dawson, the species of which have been discussed by Saenger (1982) and Millar (2000a). *V. adunca* differs from the other species in size, branched trichoblasts with rounded apical cells, and rhizoid morphology.

Veleroa adunca (J. Agardh)Womersley & Parsons, *comb. nov.*

Dasya adunca J. Agardh 1890: 112. Lucas & Perrin 1947: 315.

Thaumatella disticha (Falkenberg)Kylin 1956: 511. May 1965: 379.

Brongniartella disticha Falkenberg 1901: 550, pl. 24 figs 20–22. De Toni 1903: 1015. Lucas 1909: 43. Lucas & perrin 1947: 285.

FIG. 101

Thallus (Fig. 101A, B) dark red-brown, 1–4 cm high, tufted, with prostrate axes bearing slender, moderately to densely branched, erect branches bearing rhodoplastic trichoblasts from each segment on a 1/4 spiral; pericentral cells 4, all branches ecorticate. Attachment by rhizoids (Fig. 101C) from prostrate branches; epiphytic on seagrasses or algae. *Structure* monopodial, with dome-shaped apical cells and trichoblasts cut off from subapical cells 4–6, with pericentral cells just below this; mature branches 90–140 (-170) µm in diameter, segments L/D 1–1.5. Trichoblasts 0.5–1.5 mm long, branched more or less in an upwardly curved plane, basally branched 1–3 times, 1–2 cells apart, tapering gradually with long, slender, unbranched ends (sometimes lost); basal cells 35–55 µm in diameter and L/D (1-) 1.5–2, mid cells 15–20 µm in diameter and L/D 2–4, and the slender ends 10–12 µm in diameter, cells L/D (1-) 1.5–3. Rhizoids arising from pericentral cells, 1–5 cells long, with multicellular haptera. Lateral branches arising irregularly radially, on basal cell of trichoblasts. Cells uninucleate; rhodoplasts discoid, sometimes chained.

Reproduction. Gametophytes dioecious. Procarps arising on suprabasal cell of trichoblasts, the segment becoming polysiphonous. Carposporophytes with a slight basal fusion cell and branched gonimoblast bearing clavate terminal carposporangia 20–30 µm in diameter. Cystocarps (Fig. 101D) almost sessile, ovoid, 300–500 µm in diameter, with a pronounced, usually flared, neck 80–140 µm long; pericarp ecorticate, with 12–16 erect filaments, each cell cutting off 2 outer isodiametric cells. Spermatangial organs (Fig. 101E) on lower to mid cells of trichoblasts, ovoid, 45–90 µm in diameter and L/D 1–2, with a sterile basal cell only, and 3–6 axial cells bearing lateral initials which divide and produce the outer layer of spermatangia.

Tetrasporangia in lesser branch systems (Fig. 101F) 1–2 mm long, with trichoblasts on each segment, spirally arranged and one per segment, slightly bulging the branch; tetrasporangia 50–80 µm in diameter, with cover cells.

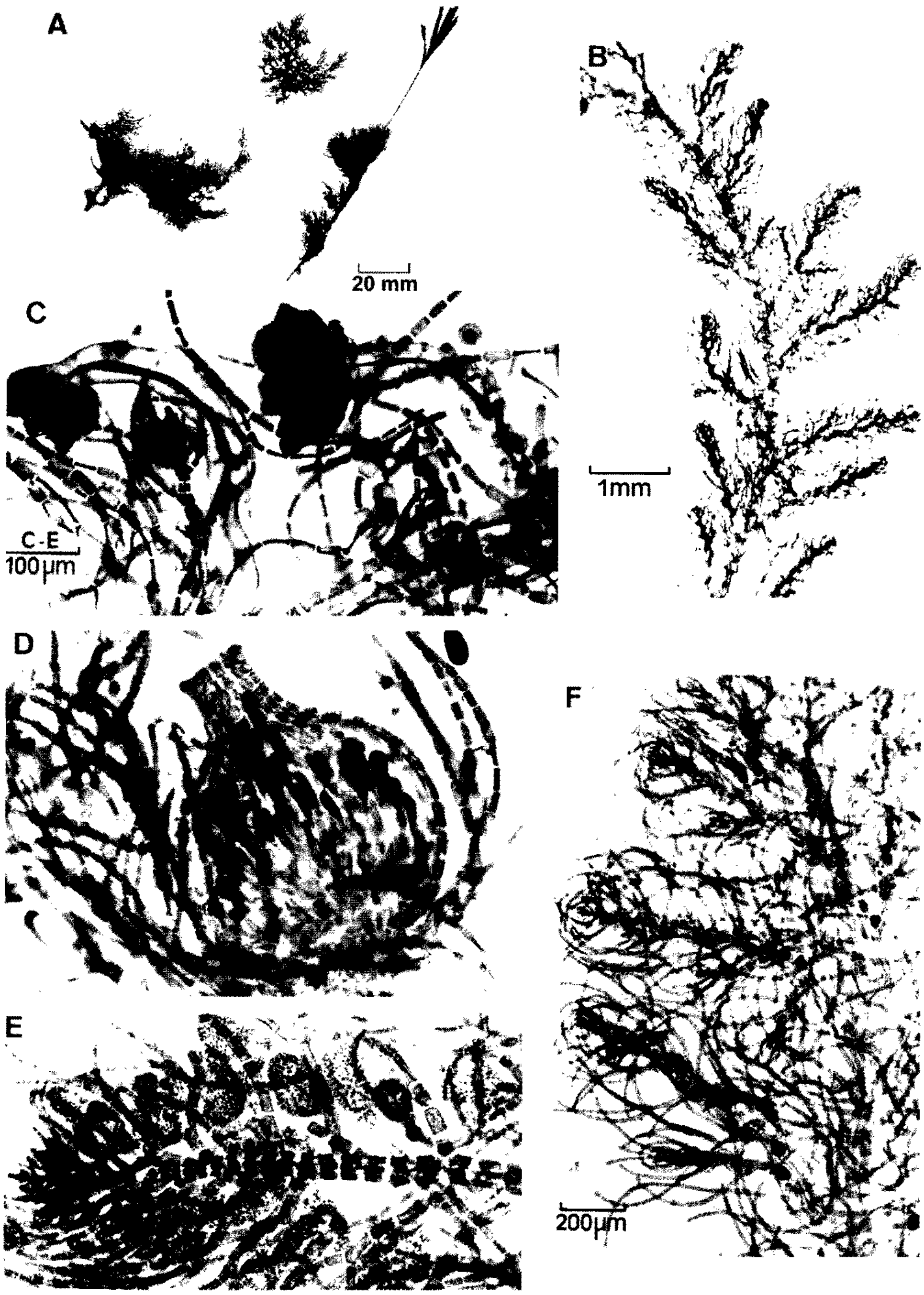

Fig. 101. *Veleroa adunca* (**A**, AD, A33312; **B**, **F**, AD, A45415; **C–E**, AD, A63900). **A**. Habit, on *Amphibolis*. **B**. Tetrasporangial branch with laterals and trichoblasts. **C**. Branch with two rhizoids with prominent haptera. **D**. Cystocarp. **E**. Branch with spermatangial organs. **F**. Branches with tetrasporangia.

Type from King George Sound, W. Aust; lectotype in Herb. Agardh, LD, 44372. Probable isolectotype in MEL, 1006689.

Distribution: King George Sound, W. Aust., to Westernport Bay, Vic., and SE Tasmania.

Selected specimens: Port Turton, Yorke Pen., S. Aust., 8–10 m deep (*Kald*, 5.ix.1970; AD, A37263). Port Victoria, S. Aust., on *Distromium flabellatum*, 3–4 m deep (*Kraft*, 20.ix.1973; AD, A44544). Off Semaphore, S. Aust., on *Heterozostera*, 15 m deep (*Shepherd*, 28.xii.1968; AD, A33312). West Beach, S. Aust., on *Amphibolis*, drift (*Parsons*, 4.x.1968; AD, A32599) and on *Posidonia*, 5 m deep (*Shepherd*, 13.xi.1970; AD, A37691). Port Stanvac, S. Aust., on *Ecklonia*, 6 m deep (*R. Lewis*, 14.vi.1972; AD, A42477). Aldinga, S. Aust., on *Posidonia*, 7 m deep (*Johnson*, 7.vii.1973; AD, A43884). Emu Bay, Kangaroo I., S. Aust., on *Acrocarpia*, 10–12 m deep (*Lavers*, 20.xii.1996; AD, A66899). Saunders Beach, Eastern Cove, Kangaroo I., S. Aust., drift (*Womersley*, 21.xi.1968; AD, A32895). Penneshaw, Kangaroo I., S. Aust., on *Cladurus*, 6 m deep (*Lavers*, 8.i.1997; AD, A66882). Crawfish Rock, Westernport Bay, Vic., on *Phycodrys*, 6 m deep (*Watson*, 28.v.1974; AD, A45415). Arch Rock, off Ninepin Point, SE Tas., epiphytic, 1–10 m deep (*Andrews*, 21.x.1994; AD, A63900). Great Taylor Bay, Bruny I., Tas., 2–5 m deep (*Shepherd*, 14.ii.1972; AD, A42112).

Veleroa adunca occurs in sheltered conditions, most commonly as an epiphyte on seagrasses.

Genus HAPLODASYA Falkenberg *in* Schmitz & Falkenberg 1897: 474

Thallus erect, radially branched either profusely or with occasional laterals, with terete, corticated branches from close to the apices. Pericentral cells 5 (rarely 4), formed in alternating sequence, each segment with a persistent, rhodoplastic monosiphonous trichoblast; cortical cells in *H. tomentosa* producing simple adventitious filaments. Attachment by cellular masses in the host conceptacles; epiphytic on species of *Cystophora* or *Carpoglossum*. *Structure* monopodial, developing trichoblasts close to apices on a $^{1}/_{5}$ spiral and pericentral cells in alternating sequence; trichoblasts basally branched, with long unbranched ends, adventitious filaments with small basal cells and upper cells similar to those of trichoblasts. Cells uninucleate.

Reproduction. Gametophytes dioecious. Procarps borne on segments (which become polysiphonous) at the base of trichoblasts or adventitious filaments, with the fifth pericentral cell producing a sterile group of cells and a 4-celled carpogonial branch; the fertilised carpogonium cuts off 2 connecting cells. Carposporophyte with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia. Cystocarps ovoid to urceolate; pericarp ostiolate with about 12 erect filaments, each cell cutting off outer cells and 1–2 cortical layers. Spermatangial organs borne on unbranched ends of trichoblasts or short adventitious filaments, with 1–2 sterile apical cells, without trichoblasts themselves, axial cells with 3 pericentral cells forming an inner layer of initials and outer of spermatangia.

Tetrasporangia borne in stichidia formed from unbranched ends of trichoblasts or the adventitious filaments, without bearing trichoblasts, with 4 pericentral cells (the second of which forms a tetrasporangium) which occur in a straight longitudinal row, with 2 pre-sporangial and 1 post-sporangial cover cells.

Type species: *H. reinboldii* Falkenberg (1897, p. 475) = *H. urceolata* (Harvey *ex* J. Agardh) Parsons 1975: 672.

A genus of 2 species, monographed by Parsons (1975). While reproductive features, especially the stichidia and spermatangial organs, are similar in both species, they differ significantly in that *H. tomentosa* produces abundant adventitious filaments but *H. urceolata* does not.

Silva *et al.* (1996, p. 440) include *Haplodasya* under the Dasyaceae, probably inadvertently as Parsons (1975) clearly showed its relationships are with the Lophothalieae.

KEY TO SPECIES OF *HAPLODASYA*

1. Thallus pyramidal, much branched, adventitious filaments absent from the cortex .... 1. *H. urceolata*
1. Thallus of elongate branches, adventitious filaments profuse on the cortical cells .... 2. *H. tomentosa*

1. **Haplodasya urceolata** (Harvey *ex* J. Agardh)Parsons 1975: 672, figs 34, 35, 47A. Silva *et al.* 1996: 440.

Dasya urceolata Harvey *ex* J. Agardh 1863: 1208; 1890: 106. De Toni 1903: 1209. Harvey 1863, synop.: xxiv. Lucas & Perrin 1947: 314. Womersley 1950: 182.

Haplodasya reinboldii Falkenberg *ex* Schmitz & Falkenberg 1897: 475. Falkenberg 1901: 628, pl. 18 figs 22–25. De Toni 1903: 1241. Lucas 1912: 159. Lucas & Perrin 1947: 320. May 1965: 380.

Sarcomenia rhizocarpa Harvey 1863, synop.: xvii. De Toni 1900: 736. Lucas 1909: 37. Sonder 1880: 33.

FIGS 102, 103

Thallus (Fig. 102A) light to dark red-brown, (1-) 5–15 cm high, with one to several erect axes laterally and radially branched for 3–4 orders, pyramidal in form, axes and branches terete, with 5 (rarely 4) pericentral cells, corticated from close to apices, clothed with branched rhodoplastic trichoblasts, denuded below. Attachment by a mass of tissue with the host receptacles; epiphytic on several species of *Cystophora* (*C. intermedia*, *C. subfarcinata*,

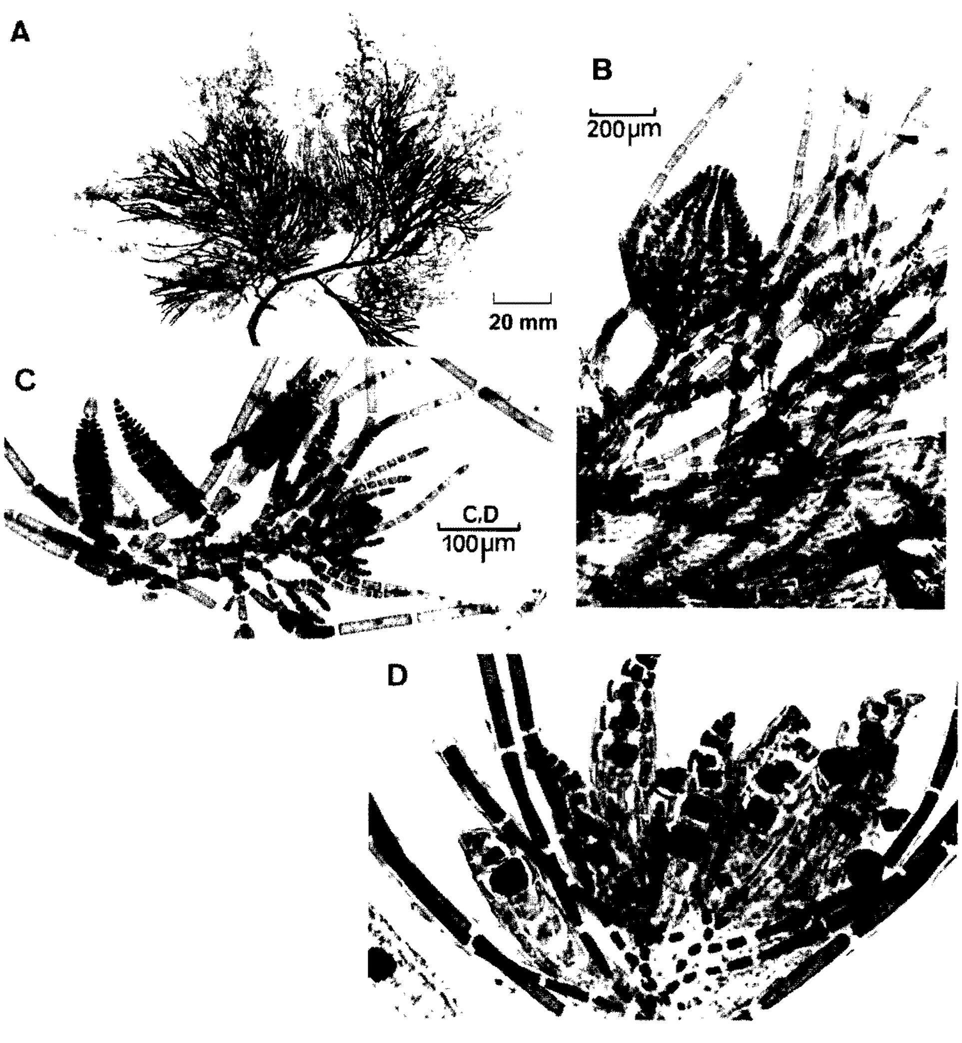

Fig. 102. *Haplodasya urceolata* (**A**, AD, A32057; **B**, AD, A67303; **C**, **D**, AD, A31857). **A**. Habit, epiphytic on *Cystophora*. **B**. Branch with young and mature cystocarps. **C**. Spermatangial organs. **D**. A cluster of stichidia.

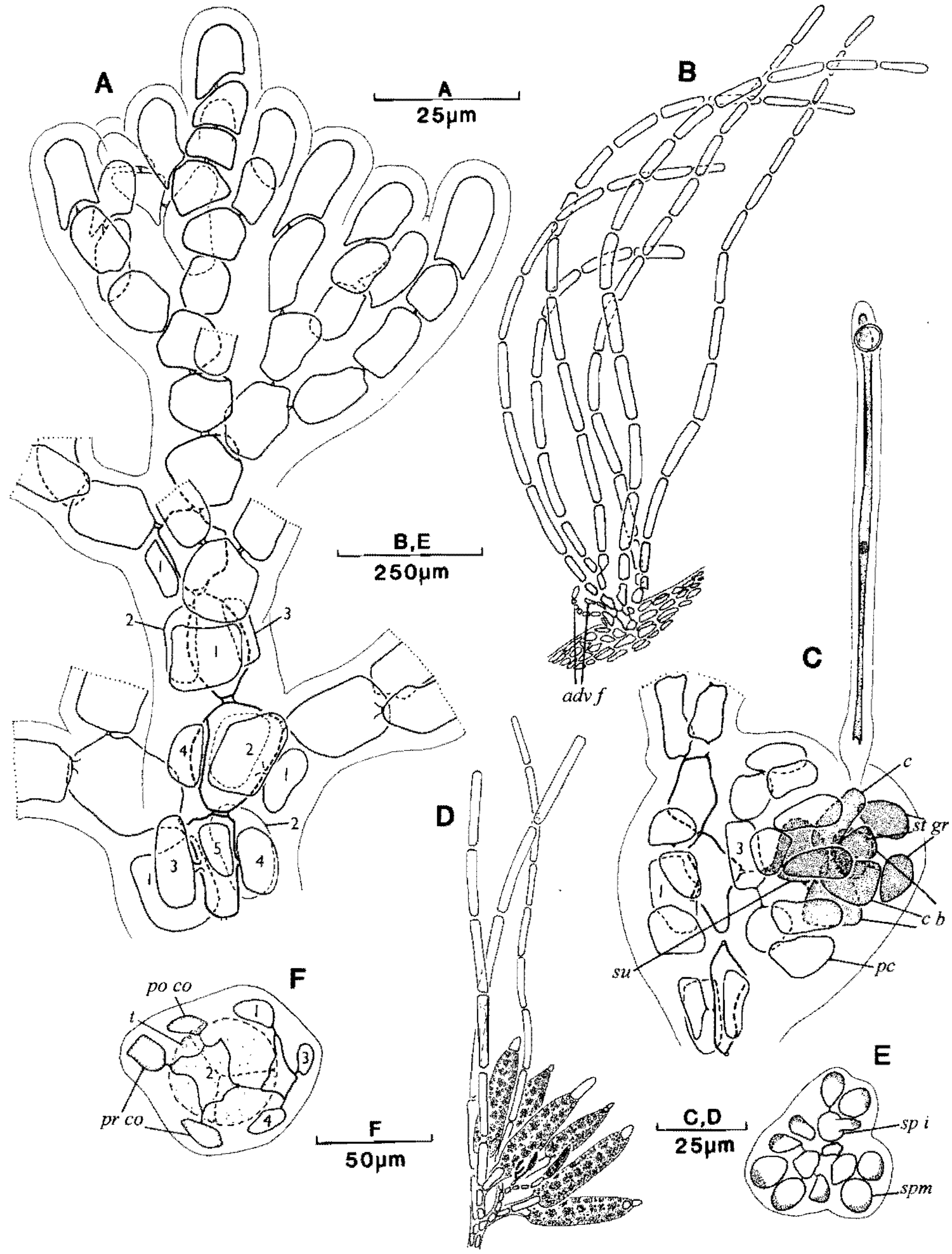

Fig. 103. *Haplodasya urceolata* (AD, A31857). **A**. Apex of axis showing pericentral cell formation. **B**. A short shoot with trichoblasts. **C**. A mature procarp. **D**. Mature spermatangial branches. **E**. Cross section of a spermatangial branch. **F**. Cross section of a stichidium. (All as in Parsons 1975, courtesy of Aust. J. Bot.)

C. moniliformis, *C. congesta*, *C. retorta*) and on *Carpoglossum confluens*, but not on *Cystophora siliquosa*. *Structure* monopodial (Fig. 103A), apical cells dome shaped, trichoblasts arising on a 1/4 or 1/5 spiral close to apices, with (usually) 5 pericentral cells cut off from 8–10 segments below apices in alternating sequence. Young branches 100–200 µm in diameter with segments L/D 0.8–1.2, mature corticated axes 200–600 µm in diameter. Trichoblasts (Fig. 102B) formed spirally, on each segment, 0.5–2 mm long, with spirally arranged branches, basally branched 2 or 3 times, 1–2 cells apart, with long unbranched ends (Fig. 103B), basal and mid cells 30–60 µm in diameter and L/D 2–7; tapering gradually to upper cells 15–30 µm in diameter and L/D 2–8; adventitious monosiphonous filaments absent apart from on basal cells of trichoblasts. Cortication commencing 15–20 segments from apices, becoming heavy on lower axes with inner cortical cells of similar size to pericentral cells, then decreasing to small outer cortical cells. Lateral branches arising from trichoblasts. Cells uninucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps (Fig. 103C) arising on the second or third segment of a trichoblast, which develops 5 pericentral cells, the last formed bearing a sterile cell group and a 4-celled carpogonial branch. Carposporophyte with a basal fusion cell and branched gonimoblast bearing clavate terminal carposporangia 25–35 µm in diameter. Cystocarps (Fig. 102B) sessile or short-stalked, urceolate, 350–650 µm in diameter, with a short, slightly flared neck; pericarp ostiolate, with about 12 erect filaments, each cell with 2 isodiametric outer cells and 1–2 layers of smaller cortical cells. Spermatangial organs (Figs 102C, 103D) borne as branches of trichoblasts, elongate–lanceolate, 100–250 µm long and 35–55 µm in diameter, with 1–2 basal and apical sterile cells, without trichoblasts themselves, with the axial cells bearing 3 pericentral cells (Fig. 103E) forming inner initials and an outer layer of spermatangia.

Tetrasporangial stichidia (Fig. 102D) borne as ultimate branches of trichoblasts or adventitious filaments, 180–550 (-700) µm long and 80–110 µm in diameter, with 1–4 sterile basal and 1–2 sterile apical cells, without trichoblasts themselves, with 4 pericentral cells (Fig. 103F) and 8–12 fertile segments, sporangia in a straight longitudinal row, 45–90 µm in diameter, with 2 pre-sporangial and 1 post-sporangial cover cells.

Type from Port Fairy, Vic., holotype in Herb. Agardh, LD, 44282 (*Harvey*, Alg. Aust. Exsicc. 217D).

Distribution: Cape Leeuwin, W. Aust., to Port Fairy, Victoria.

Selected specimens: Sarge Bay, Cape Leeuwin, W. Aust., on *Cystophora retorta*, drift (*Parsons*, 16.xi.1968; AD, A34203). Esperance, W. Aust., on *C. subfarcinata*, reef edge, 3rd Beach (*Parsons*, 21.xi.1968; AD, A33347). Head of Great Australian Bight, S. Aust., on *C. moniliformis*, drift (*Parsons*, 4.xi.1968; AD, A32943). Sleaford Bay, Port Lincoln, S. Aust., on *C. subfarcinata*, reef edge (*Womersley*, 20.viii.1967; AD, 31857). Wanna, S. Aust., on *C. moniliformis*, upper sublittoral (*Parsons*, 15.v.1968; AD, A32580). Rosetta Bay, Victor Harbor, S. Aust., on *Carpoglossum*, drift (*Womersley*, 3.xi.1997; AD, A67303). Victor Harbor, S. Aust., on *C. moniliformis*, drift (*Womersley*, 17.x.1948: AD, A9260). Seal Bay, Kangaroo I., S. Aust., on *Carpoglossum*, drift (*Parsons*, 22.xi.1968; AD, A 32957). Pennington Bay, Kangaroo I., S. Aust., on *C. intermedia*, sublittoral fringe (*Parsons*, 17.xi.1967; AD, A32057—"Marine Algae of southern Australia" No. 180) and on *C. moniliformis*, sublittoral fringe (*Womersley*, 9.x.1997; AD, A67287). Robe, S. Aust., on *C. moniliformis*, upper sublittoral, West Beach (*Parsons*, 15.v.1967; AD, A32068). Port MacDonnell, S. Aust., on *C. moniliformis*, upper sublittoral (*Parsons*, 11.ii.1968; AD, A32578).

H. urceolata is distinct in habit compared to *H. tomentosa* and also lacks the adventitious filaments of the latter, which also occurs only on *Cystophora siliquosa*.

2. **Haplodasya tomentosa** Parsons 1975: 679, figs 36, 37, 47B. Shepherd & Womersley 1981: 367.

FIGS 104, 105

Thallus (Fig. 104A) light to dark red-brown, fading to yellow-brown, mucilaginous, 5–15 (-20) cm high, with 1 to several corticated erect axes bearing few to many, irregularly radial, lateral branches for 1–2 orders, axes terete, 2–4 mm in diameter (including trichoblasts) densely clothed with branched rhodoplastic trichoblasts except close to the thallus base. Attachment by a mass of tissue within the host conceptacles; epiphytic on *Cystophora siliquosa*. *Structure* monopodial (Fig. 105A), apical cells dome-shaped, trichoblasts arising on a 1/5 spiral close to the apices with 5 pericentral cells cut off in alternating sequence from 6–8 segments below apices. Pericentral cells cut off from 9–12 segments below apices, divide transversely, the upper cell forming an adventitious filament. Young branches 35–60 µm in diameter with segments L/D 0.6–1, corticated branches 0.5–2 mm in diameter. Trichoblasts (1-) 2–3 mm long, on each segment in a 1/5 spiral, basally branched 1–2 times with long unbranched ends, developing into monopodial axes of short shoots bearing once furcate secondary trichoblasts (Fig. 105C), with 2–5 basal cells 15–20 µm in diameter and L/D 1.5–2, mid and upper cells 20–40 (-55) µm in diameter and L/D 4–10 (-15), tapering slightly above. Cortication commencing 18–20 segments from apices, becoming heavy with the pericentral cells lost in sectional view (Fig. 105B) and most outer cortical cells bearing simple

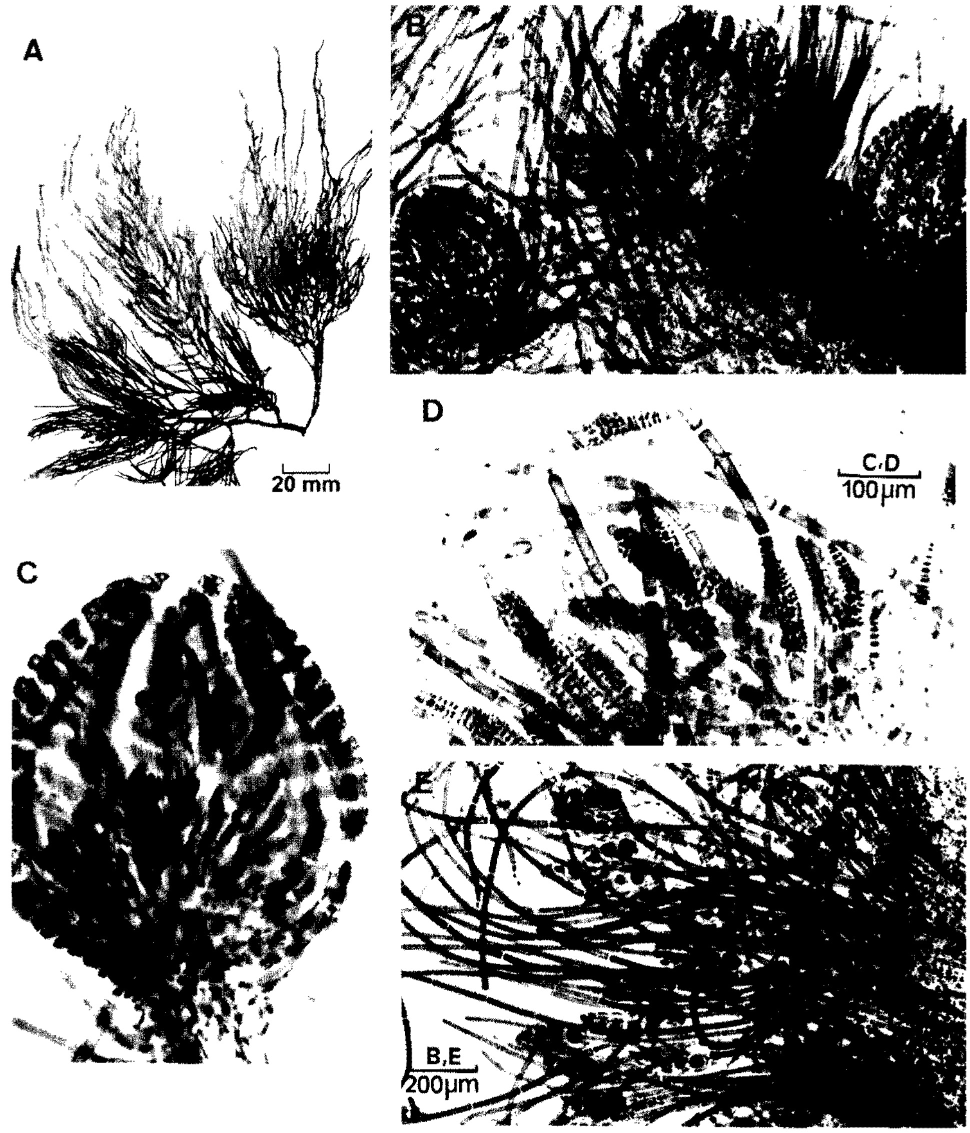

Fig. 104. *Haplodasya tomentosa* (**A**, AD, A22490; **B–E**, AD, A67286). **A**. Habit, epiphytic on *Cystophora*. **B**. Cystocarps among trichoblasts. **C**. Mature cystocarp. **D**. Spermatangial organs. **E**. Stichidia among trichoblasts.

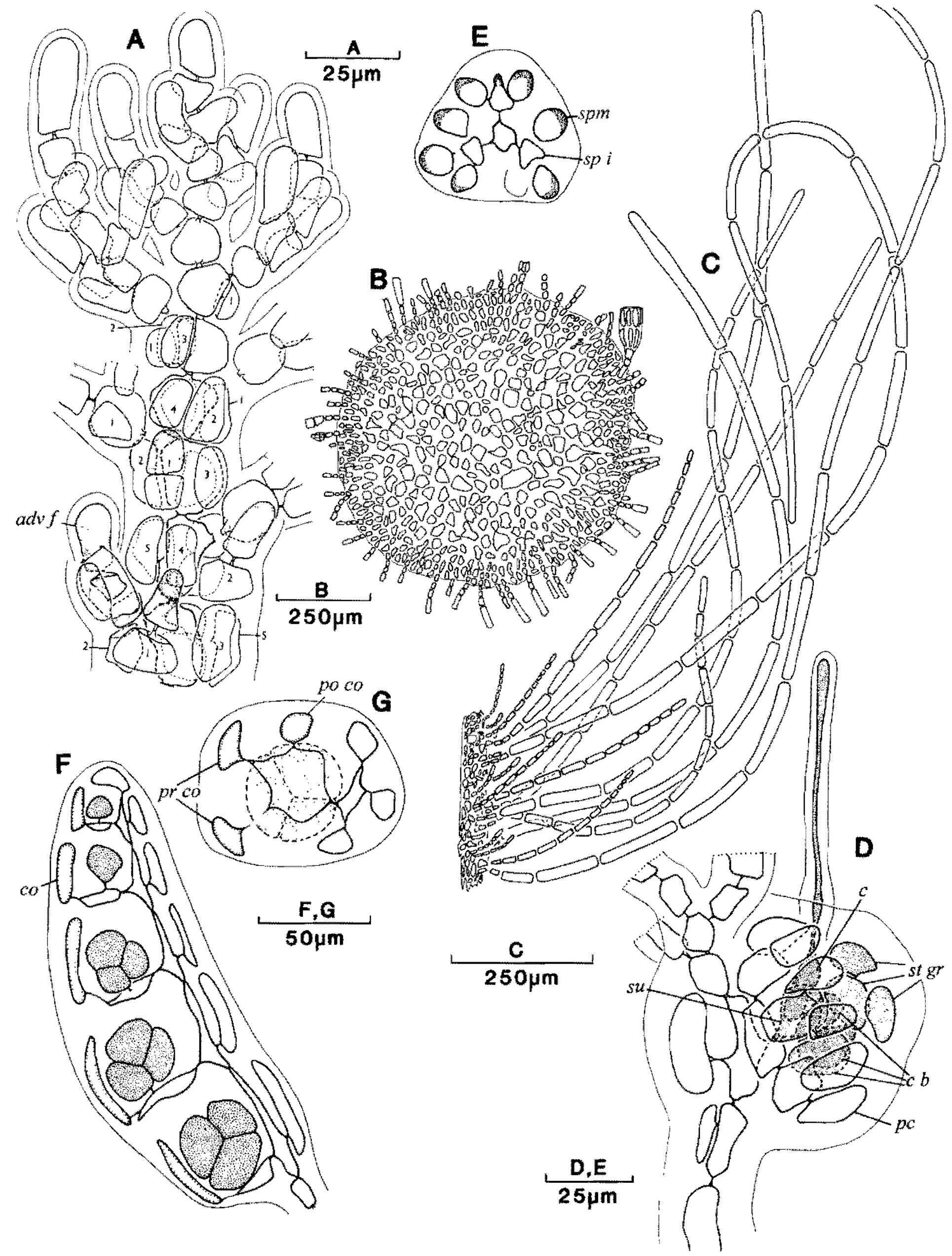

Fig. 105. *Haplodasya tomentosa* (AD, A31891). **A.** Apex of axis showing formation of pericentral cells and adventitious filaments. **B.** Transverse section of mature axis, with bases of adventitious filaments. **C.** Cortical surface with trichoblasts and adventitious filaments. **D.** A mature procarp. **E.** Cross section of a spermatangial branch. **F.** Longitudinal section of a stichidium. **G.** Cross section of a stichidium. (All as in Parsons 1975, courtesy of Aust. J. Bot.)

adventitious filaments with 2–5 small basal cells, upper cells of similar dimensions to trichoblasts. Lateral branches arising by further development of short shoots. Cells uni- or multinucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps (Fig. 105D) occur on segment 4 or 5 of adventitious filaments, with the fifth pericentral cell bearing a sterile group initial and a 4-celled carpogonial branch. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia 15–25 µm in diameter. Cystocarps (Fig. 104B, C) urceolate, sessile or short stalked, 450–700 µm in diameter, with a slight neck; pericarp ostiolate, with about 12 erect filaments, each cell cutting off 2 isodiametric outer cells and with a cortex 1–2 cells thick. Spermatangial organs (Fig. 104D) developed from branches of trichoblasts or the ends of short adventitious filaments, 90–220 µm long and 35–55 µm in diameter, with a 4–5 celled monosiphonous stalk and 1–2 sterile terminal cells; three pericentral cells (Fig. 105E) divide to form a layer of initials which cut off an outer layer of spermatangia.

Tetrasporangial stichidia (Fig. 104E) borne on the simple adventitious filaments, 180–350 µm long and 85–110 µm in diameter, with 4 pericentral cells (Fig. 105G), the second produced forming a straight row (Fig. 105F) of tetrasporangia each with 2 pre-sporangial and 1 post-sporangial cover cells (Fig. 105G); tetrasporangia 50–80 µm in diameter.

Type from Pennington Bay, Kangaroo I., S. Aust., on *Cystophora siliquosa*, sublittoral fringe (*Parsons*, 17.xi.1967); holotype in AD, A31891—"Marine Algae of southern Australia" No. 179a). Isotypes distributed under this number.

Distribution: Elliston, S. Aust., to Bridgewater Bay, Victoria.

Selected specimens: Elliston, S. Aust., on *Cystophora siliquosa*, 5 m deep (*Shepherd*, 28.x.1972; AD, A42838). Sleaford Bay, S. Aust., on *C. siliquosa*, sublittoral fringe (*Womersley*, 16.ii.1959; AD, A22490). Wanna, S. Aust., on *C. siliquosa*, upper sublittoral pools (*Womersley*, 19.ii.1959; AD, A22435). Vivonne Bay, Kangaroo I., S. Aust., drift (*Womersley*, 30.i.1956; AD, A20171). Pennington Bay, Kangaroo I., S. Aust., on *C. siliquosa*, sublittoral fringe (*Womersley*, 19.i.1965; AD, A28927—"Marine Algae of southern Australia" No. 179b) and on *C. intermedia*, sublittoral fringe (*Womersley*, 9.x.1997; AD, A67286). Bridgewater Bay, Vic., on *C. siliquosa*, upper sublittoral (*Beauglehole*, 26.xii.1950; AD, A15686).

H. tomentosa differs from *H. urceolata* in habit, in having numerous adventitious filaments produced from divided pericentral cells and cortical cells, and in growing mainly on *Cystophora siliquosa* whereas the latter occurs on other species of *Cystophora*.

Genus LOPHOCLADIA Schmitz 1893: 222

Thallus erect, radially branched, lightly corticated below, upper branches clothed with slender, basally branched, rhodoplastic trichoblasts; adventitious monosiphonous filaments usually absent; attachment by rhizoids with multicellular discs. *Structure* monopodial, axial cells each with a trichoblast and developing 4 pericentral cells which remain clear in transverse section within the slight cortex. Cells multinucleate.

Reproduction. Gametophytes dioecious. Procarps borne on basal cells of trichoblasts. Carposporophytes with a basal fusion cell and branched gonimoblast filaments bearing clavate terminal carposporangia. Cystocarps ovoid to urceolate, pericarp mostly 2 cells thick, corticated only basally. Spermatangial organs borne as a branch of a trichoblast, with sterile, monosiphonous pedicels and tips, without trichoblasts.

Tetrasporangial stichidia on basal cells of trichoblasts, with monosiphonous pedicels, without trichoblasts, slightly spirally twisted, with tetrasporangia one per segment in a spiral arrangement, with 3 elongate cover cells.

Type species: *L. trichoclados* (C. Agardh)Schmitz 1893: 223.

Lophocladia is distinguished by its slender habit and slight cortication, 4 pericentral cells, and spermatangial organs and tetrasporangial stichidia without trichoblasts and with monosiphonous pedicels. Apart from the rhodoplastic, longer lasting, trichoblasts, *Lophocladia* is very similar structurally and reproductively to *Polysiphonia*, and sequencing studies of their relationships would be of interest.

As well as the type species, *Lophocladia* includes *L. lallemandii* (Montagne)Schmitz from the Red Sea and the northern Indian Ocean, *L. kuetzingii* (Kuntze)Silva from Australia, *L. japonica* Yamada and *L. minima* Itono from Japan (the latter also from South Africa), and *L. kipukaia* Schlech (see Abbott 1999, p. 397) from the Hawaiian Is.

Lophocladia kuetzingii (Kuntze)Silva *in* Silva *et al.* 1996: 524. Coppejans & Millar 2000: 333. Millar 1999: 523.
Baillouviana kuetzingii Kuntze 1891: 885.
Dasya lallemandii sensu Harvey 1855a: 543; 1863, synop.: xxiv. Sonder 1880: 36.
Dasya lallemandii Montagne var. *gracilis* J. Agardh 1863: 1231.
Dasya harveyi Kützing 1864: 26, pl. 71 figs e, f, *nom. illegit.* (See Silva *et al.* 1996: 524.)
Lophocladia harveyi Schmitz 1893: 223. De Toni 1903: 1016; 1924: 413.

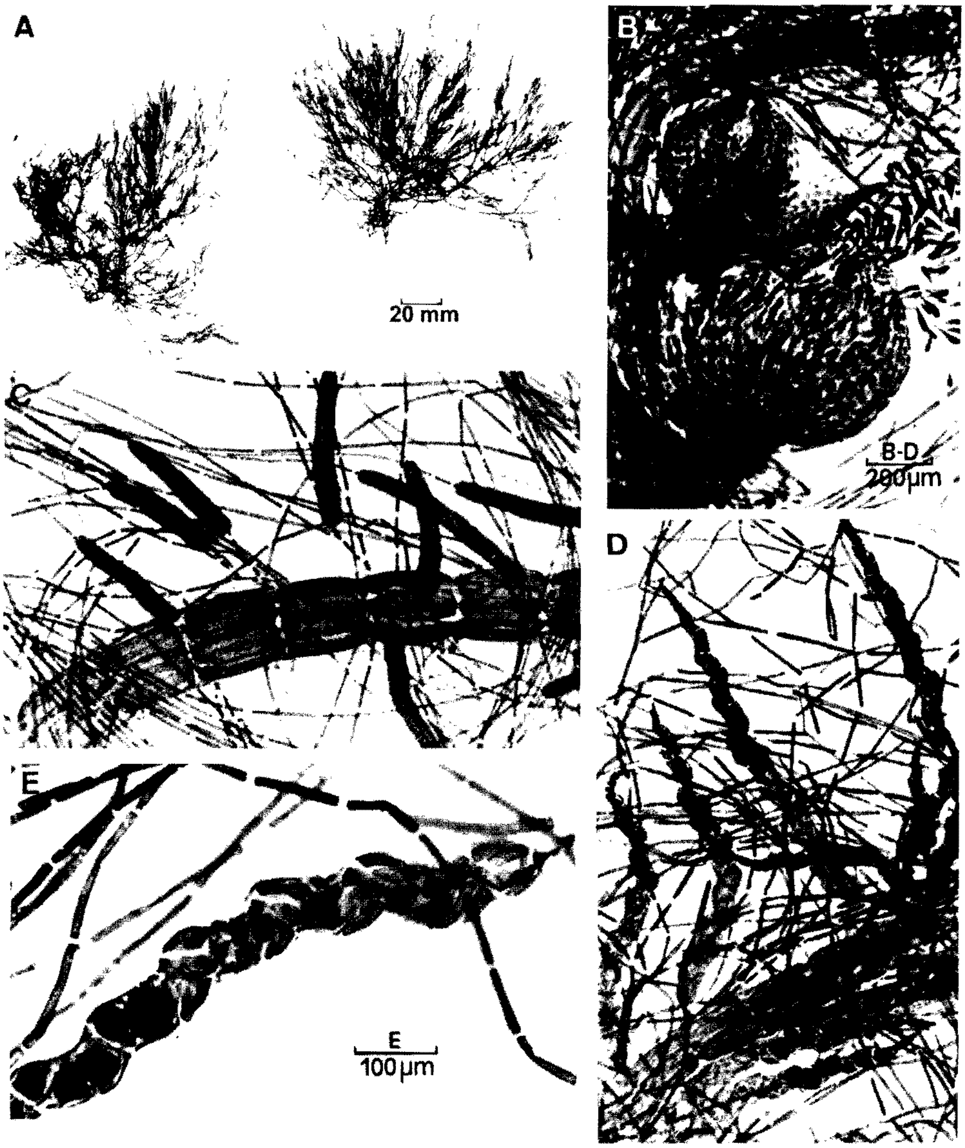

Fig. 106. *Lophocladia kuetzingii* (**A**, **C**–**E**, AD, A38174; **B**, AD, A41177). **A**. Habit. **B**. Cystocarps. **C**. Spermatangial organs on trichoblasts on axis. **D**. Stichidial branches and trichoblasts. **E**. Stichidium with spirally arranged tetrasporangia.

Falkenberg 1901: 553. Huisman 1997: 206. Huisman & Walker 1990: 438. Huisman *et al.* 1990: 97. Kendrick *et al.* 1990: 52. Levring 1946: 226. Lewis 1984: 62. Lucas 1909: 43. May 1965: 383. Millar & Kraft 1993: 56. Womersley 1950: 186.

FIG. 106

Thallus (Fig. 106A) medium to dark red-brown, 5–15 cm high, much branched irregularly radially with one to several axes or main branches, laterals mostly erect, upper and mid branches clothed with rhodoplastic trichoblasts (Fig. 106C), apices often congested. Attachment by rhizoids with multicellular discs, from prostrate or erect basal parts. *Structure.* Pericentral cells 4, branch axes 60–100 µm in diameter near apices, 300–600 µm in diameter in mid parts, and lower axes 0.5–1.5 mm in diameter. Trichoblasts 2–5 mm long, arising just below apices on a 1/4 spiral, irregularly basally branched (not complanately) 2–4 cells apart, slender, 15–25 µm in diameter, cells L/D (5-) 10–20; adventitious filaments absent. Lateral branches replacing trichoblasts. Cortication slight above around the large, clear, pericentral cells, becoming thicker on older axes. Cells multinucleate, few in trichoblast cells; rhodoplasts discoid, crowded.

Reproduction. Gametophytes dioecious. Procarps borne on the second segment (which becomes polysiphonous) of trichoblasts. Carposporophytes with a basal fusion cell and much branched gonimoblast with clavate terminal carposporangia 25–45 µm in diameter. Cystocarps (Fig. 106B) ovoid to urceolate, 600–800 µm in diameter, with a short, corticated, stalk and a very slight neck; pericarp ostiolate, 2 cells thick, corticated only near the base. Spermatangial organs (Fig. 106C) without trichoblasts, on monosiphonous pedicels with short sterile apical filaments, 180–650 µm long and 40–80 µm in diameter.

Tetrasporangial stichidia (Fig. 106D) slightly spirally twisted, without trichoblasts, occurring as a basal branch of a trichoblast with a monosiphonous pedicel 2–4 cells long, 400–1000 (-1500) µm long and 60–100 µm in diameter. Tetrasporangia one per segment, spirally arranged (Fig. 106E), 40–80 µm in diameter, with 3 elongate cover cells.

Type from Fremantle, W. Aust. (Harvey); type in Herb. Sonder, MEL, 608855.

Distribution: Warmer western and eastern coasts of Australia, and from American R. inlet on Kangaroo I., S. Australia. N Papua New Guinea.

Selected specimens: Port Denison, W. Aust., 0–5 m deep on jetty piles (*Kraft*, 14.xii.1971; AD, A41177). Lancelin, W. Aust., 4 m deep (AIMS-NCI, Q66C 2743-W, 18.iii.1989; AD, A59799). Thompson Bay, Rottnest I., W. Aust., 1–2 m deep on buoy (*Gordon-Mills*, 4.xii.1984; AD, A56625). American R. inlet, Kangaroo I., S. Aust., 4 m deep in channel (*Womersley*, 6.ii.1956; AD, A20323). Muston, American R. inlet, Kangaroo I., S. Aust., 4 m deep (*Owen*, 5.iii.1971; AD, A38174) and 2–3 m deep (*Kraft*, 7.iv.1972; AD, A42413).

Baillouviana kuetzingii Kuntze is a substitute name for *Dasya harveyi* Kützing, which was based on a Harvey specimen in Herb. Sonder (now MEL), transferred to *Lophocladia* by Silva (1996, p. 524).

L. kuetzingii appears to be confined to sheltered waters on the Australian coast. It appears to be closely related to *L. lallemandii* (Montagne)Schmitz and studies of their differences are desirable.

Genus ENDOSIPHONIA Zanardini 1878: 35

Thallus erect or entangled, much branched, branches rigid, drying cartilaginous, terete, with short, spinous, ultimate laterals; attachment by rhizoids or a fibrous holdfast. *Structure.* Apical cell segmenting transversely, subapical cells cutting off trichoblasts and 4 pericentral cells undivided transversely but forming a broad small-celled cortex. Trichoblasts probably also exogenous from epidermal cells, simple or basally branched, cells with rhodoplasts.

Reproduction. Gametophytes dioecious. Procarps borne on lower cells of trichoblasts, soon surrounded by 5 pericentral cells. Carposporophytes with a basal fusion cell and branched gonimoblast with terminal carposporangia. Cystocarps ovoid to slightly urceolate, ostiolate, with cells of the erect filaments cutting off 2 isodiametric outer cells and a cortex 1–2 cells thick. Spermatangia covering lower parts of trichoblasts, with a monosiphonous pedicel and emergent monosiphonous filaments.

Tetrasporangia produced in polysiphonous segments of trichoblasts, stichidia with a monosiphonous pedicel and simple filaments usually on each segment, developed from meristematic apices, with 2–3 cover cells.

Type species: *E. spinuligera* Zanardini 1878: 35 [= ?*E. spinulosa* (Harvey)Womersley, *comb. nov.*]

A genus of 5–8 species, the type from the Aru Islands of Irian Jaya, also known from northern Australia (Millar 1990, p. 453; Huisman 2000, p. 178) and the tropical Indo-Pacific. It appears probable that *E. spinulosa* (Harvey)Womersley & Parsons, *comb. nov.*, described below, is the same as the type and an older name.

Endosiphonia almost certainly includes *Spirocladia* Børgesen (1933b, p. 14, figs 1–10), the differences recognised by Kylin (1956, p. 496)— branching of trichoblasts and their presence or not on stichidia, presence or not of spines—are not satisfactory considering the account of Nasr (1938) of *E. clavigera* (Wollny)Falkenberg. *Spirocladia* includes the type, *S. barodensis* from India, *S. minor* Nasr (1939, p. 332, figs 1–8) from the Gulf of Suez, *S. loochooensis* (Yendo)Yoshida (1989, p. 272, figs 1, 2) from Japan, and *S. hodgsoniae* Abbott (see Abbott 1999, p. 438) from the Hawaiian Is.

Endosiphonia is characterised by having trichoblasts which become basally and spirally branched, with small basal cells and long, unbranched upper branches, by 4 pericentral cells becoming corticated, and by both spermatangial and tetrasporangial branches developed from trichoblasts, with monosiphonous pedicels and bearing simple filaments from each segment.

Endosiphonia spinulosa (Harvey)Womersley & Parsons, *comb. nov.*

Alsidium ?spinulosum Harvey 1855a: 538.

Rhodomela ?spinulosa (Harvey)Harvey 1860: pl. 130.

Rytiphlaea spinulosa (Harvey)Silva *in* Silva *et al.* 1996: 551.

Rytiphlaea aculeata C. Agardh *ex* J. Agardh 1841: 26 (*nomen nudum*); 1863: 1087. De Toni 1903: 1096. Harvey 1863, synop.: xviii. Lucas 1909: 46. May 1965: 397. Sonder 1880: 33.

?*Endosphonia spinuligera* Zanardini 1878: 35. Dawson 1956: 58, fig. 61. De Toni 1903: 1002. Falkenberg 1901: 571, pl. 13 fig. 12. Huisman 1997: 204; 2000: 166. May 1965: 377. Millar 1999: 521. Millar & Kraft 1993: 53. Silva *et al.* 1996: 494. Weber van-Bosse 1923: 354.

FIG. 107

Thallus (Fig. 107A) dark red-brown, 10–30 cm high, cartilaginous, much branched irregularly radially with 1 to several terete axes bearing 3–5 orders of lesser branches progressively shorter, giving a spiny appearance; axes 0.5–2 (-3) mm in diameter, grading to short spinous ultimate branches 1–3 mm long and (100-) 200–300 µm in diameter; trichoblasts rhodoplastic, not conspicuous on dried specimens; upper branches usually covered with non-geniculate coralline algae. Holdfast of coarse branching fibres, 1–3 cm across; epilithic. *Structure.* Apical cell elongate, 8–10 µm in diameter; growth monopodial, trichoblasts developed close to apices, followed by 4 pericentral cells (Fig. 107C), conspicuous in transverse section and with the basal trichoblast cell enlarged and interposed in the ring of pericentral cells. Trichoblasts 0.5–1.5 mm long, caducous, with 4–9 branches 1–2 cells apart, spirally arranged (Fig. 107B), lower cells where branched 8–12 µm in diameter and L/D 1–2, unbranched ends with 2–4 small basal cells then increasing suddenly to 12–22 µm in diameter and L/D 5–10 (-20). Cortication commencing close to apices, becoming extensive, with the pericentral cells remaining clear in section (Fig. 107C), surrounded by smaller cortical cells; epidermal cells mostly 10–15 µm in diameter and L/D 2–3, often rosette like over larger inner cells. Lateral branches developed from trichoblasts. Cells multinucleate; rhodoplasts discoid, becoming chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps developed on basal segments (becoming polysiphonous) of trichoblasts or at the base of their branches. Carposporophytes with a basal fusion cell and compact, branched, gonimoblast with clavate terminal carposporangia 16–35 µm in diameter. Cystocarps (Fig. 107D) sessile, ovoid to slightly urceolate, 0.7–1 mm in diameter, with a short neck; pericarp ostiolate, with about 12 erect filaments, each cell cutting off 2 isodiametric outer cells with 1–2 layers of cortical cells. Spermatangia (Fig. 107E) cover the basal part of trichoblasts, with protruding monosiphonous

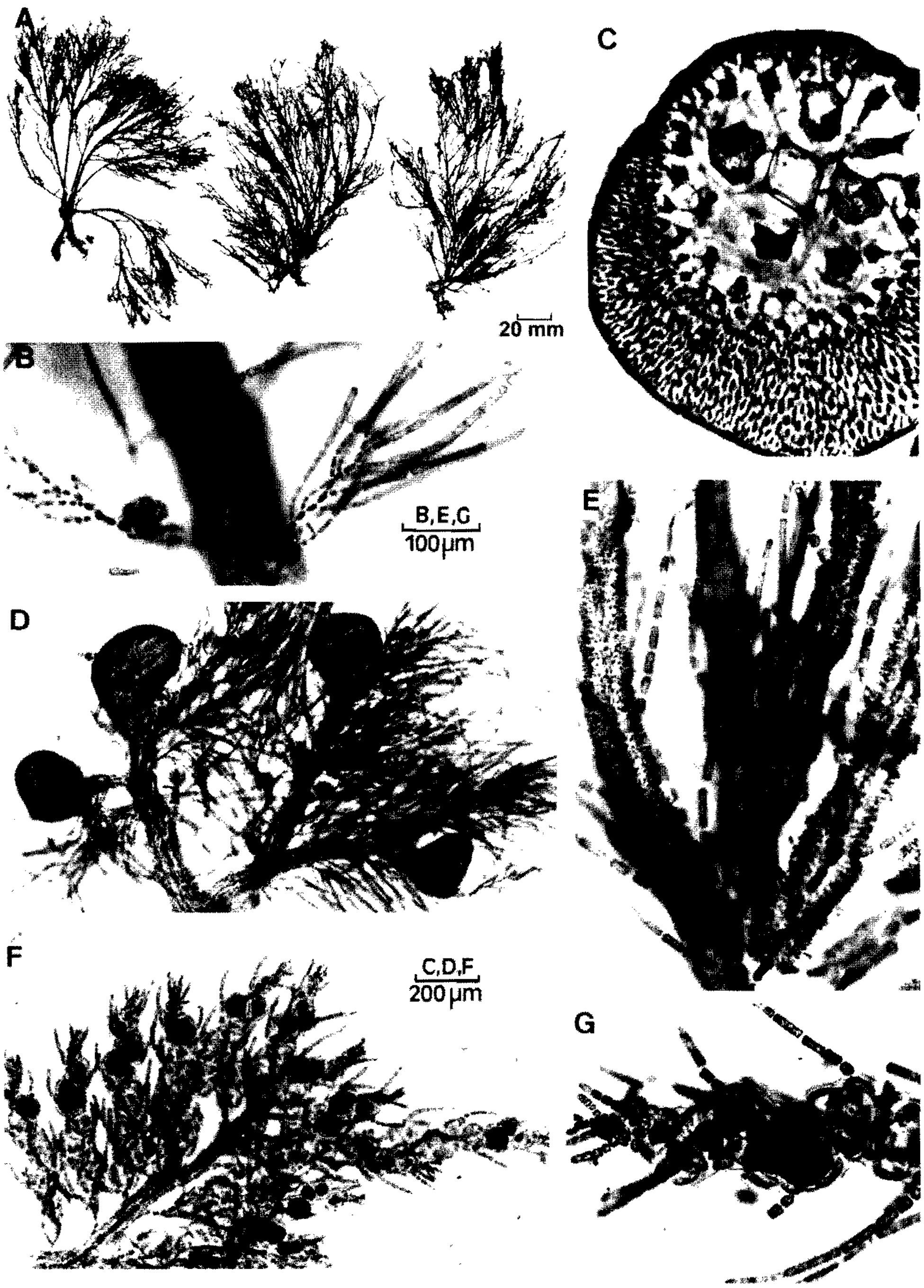

Fig. 107. *Endosiphonia spinulosa* (AD, A61438). **A**. Habit. **B**. Branch with spirally branched trichoblasts with small cells near their base. **C**. Transverse section of axis, cortex more developed on one side. **D**. Branch with cystocarps. **E**. Branched trichoblasts with spermatangial organs. **F**. Stichidia bearing trichoblasts. **G**. A stichidium with tetrasporangia and trichoblast branches from each segment.

filaments, fertile parts 300–800 μm long and 50–90 μm in diameter, borne on monosiphonous pedicels.

Tetrasporangia (Fig. 107F) in branched polysiphonous branches developed from trichoblasts, on monosiphonous pedicels and with apices producing unbranched monosiphonous filaments (Fig. 107G) on each segment, fertile parts 0.5–1 mm long and 100–140 μm in diameter; tetrasporangia spirally arranged, bulging the segments, 60–110 μm in diameter, with 2–3 cover cells.

Lectotype from "Garden I., Rottnest I. or Cape Riche, W. Aust." (*Harvey*, Trav. Set 180): to be chosen.

Distribution: N and W Australia, south to Thistle I., S. Aust., and from Lord Howe and Norfolk Islands.

New Guinea, Borneo, Philippines and the Marshall Is.

Selected specimens: Point Clune, Rottnest I., W. Aust., drift (*Kraft 7202, Ricker & Gabrielson*, 5.xii.1980; MELU), 11–13 m deep (*Ricker & Kraft*, 2.xii.1980; MELU and AD, A51957), and 13–14 m deep (*Walker*, 6.xii.1984; AD, A56641). Elliston, S. Aust., drift (*Womersley*, 13.i.1951; AD, A13477). Waterloo Bay (Elliston), S. Aust, 8 m deep near bar (*Turner*, 28.iv.1983; AD, A54156). Thistle I., S. Aust., 16 m deep (*Shepherd & Baldock*, 2.i.1964; AD, A27349). Avoid Bay, S. Aust., drift (*Womersley*, 30.xi.1975; AD, A46846). South West Rock, S of Kangaroo I., S. Aust., 15–36 m deep (*Branden*, 18.vi.1991; AD, A61438).

Genus MICROPEUCE J. Agardh 1899: 123

Thallus erect, radially branched, corticated, branches clothed with rhodoplastic, persistent, trichoblasts but usually without adventitious filaments; holdfast discoid. *Structure* monopodial, trichoblasts arising close to apices, with 5 pericentral cells formed in alternating sequence, remaining clear in transverse section of corticated branches. Trichoblasts branched several times in their lower part, branches more or less in an upwardly curved plane or irregular, rhodoplastic, walls of cells at branchings not adherent. Cells mainly uninucleate.

Reproduction. Gametophytes dioecious. Procarps borne on lower cells of trichoblasts which become polysiphonous. Carposporophytes with a basal fusion cell and branched gonimoblast with terminal carposporangia. Cystocarps globose to urceolate, pericarp ostiolate, corticated. Spermatangial organs developed as branches of trichoblasts.

Tetrasporangia produced in lesser branches, bearing trichoblasts, spirally arranged, one per segment and bulging the segments.

Type species: *M. strobilifera* J. Agardh 1899: 126 [= *M. feredayae* (Harvey)Kylin].

A genus of about 6 species, 4 from southern Australia (some of which are doubtfully distinct), *M. mucronata* (Harvey)Kylin from Atlantic N and S America, and *M. setosus* Abbott (see Abbott 1999, p. 405) from the Hawaiian Is.

Two southern Australian species are regarded as of uncertain status; they are dealt with after the following species.

KEY TO SPECIES OF *MICROPEUCE*

1. Main branches clothed with trichoblasts for up to 2 cm from apices, usually denuded below; trichoblasts 0.8–1.5 mm long; basal axes often covered with short, branched, processes 1–3 mm long .... 1. *M. feredayae*
1. Main branches bearing discrete, glomerulate, tufts 2–3 (-4) mm long, each tuft with 1–3 branched axes bearing trichoblasts; trichoblasts 500–800 μm long; lower branches bare .... 2. *M. glomerulifera*

1. **Micropeuce feredayae** (Harvey)Kylin *ex* P. Silva *in* Silva *et al.* 1996: 528. Kylin 1956: 511. May 1965: 379.

Dasya feredayae Harvey 1859b: 303; 1860: pl. 173 (habit only); 1863, synop.: xxiii. J. Agardh 1863: 1235. Sonder 1880: 36.

Dasya feredayae var. β *contractior* J. Agardh 1863: 1236.

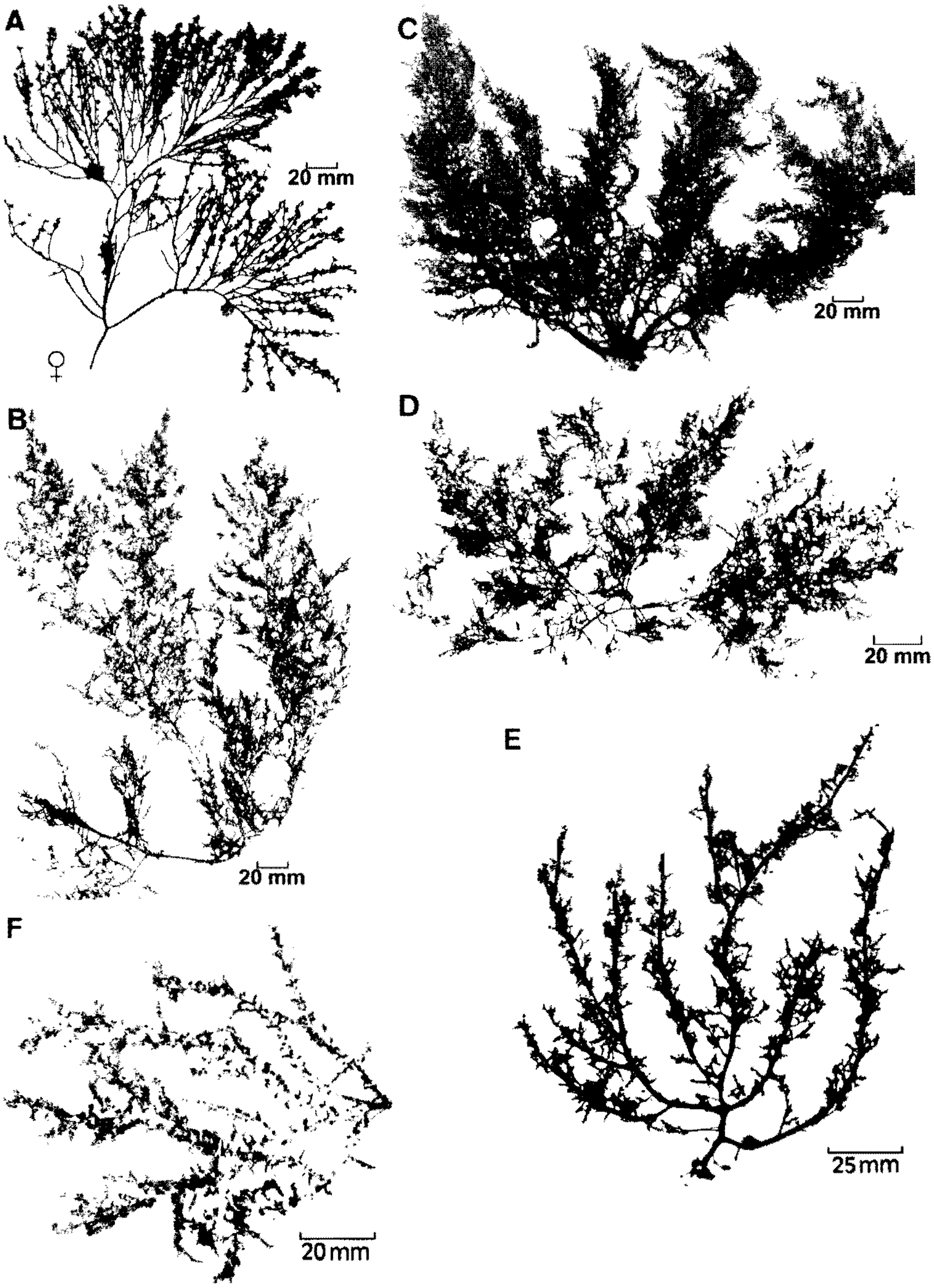

Fig. 108. **A.** *Micropeuce glomerulifera* (AD, A68356). Habit. **B–D.** *Micropeuce feredayae* (**B**, AD, A9033; **C**, AD, A67357; **D**, AD, A6663). **B.** Habit of a typical large plant, with processes on base of axis. **C.** Plant from a rough-water coast, with branched processes near the base of axes. **D.** Plant of the slenderer ("*strobiliferum*") form. **E.** *Micropeuce proxima* (holotype in Herb. Harvey, TCD). Habit. **F.** *Micropeuce sarcocaulon* (lectotype in Herb. Harvey, TCD). Habit.

Lophothalia feredayae (Harvey)J. Agardh 1890: 62. Wilson 1892: 165.
Brongniartella feredayae (Harvey)Schmitz 1893: 218. De Toni 1903: 1014. Guiler 1952: 104. Lucas 1909: 43; 1929a: 22. Womersley 1950: 186.
Micropeuce strobiliferum J. Agardh 1899; 126, pl. 1 fig. 4 (4a partly incorrect). De Toni 1903: 1127; 1924: 430. Falkenberg 1901: 683. Kylin 1956: 511. Lucas 1909: 47. Lucas & Perrin 1947: 306. May 1965: 378. Shepherd & Womersley 1981: 367.
Brongniartella strobilifera (J. Agardh)Schmitz 1893: 218.

FIGS 108B–D, 109

Thallus (Fig. 108B–D) dark red-brown, 8–30 (-50) cm high, much branched irregularly radially with a well developed, heavily corticated axis, usually branched in older plants, laterals branched for 2–4 orders, often proliferous from lower axes in larger plants. Upper branches clothed with trichoblasts for up to 2 cm from apices, denuded below, older axes smooth, 1–2 mm in diameter. Plants on rough-water coasts [var. β *contractior* J. Agardh (1863, p. 1236)] usually have the lower axes clothed with branched processes (Fig. 108C) 1–3 mm long, branches 100–300 μm in diameter. Holdfast discoid, 1–10 mm across; epilithic. *Structure* monopodial, trichoblasts cut off from segments 4–8 in spiral sequence, pericentral cells 5 (Fig. 109E), cut off from segments 8–15. Cortication commencing many segments below apices, with the pericentral cells remaining clear in transverse section and usually becoming thick walled, cortex small-celled. Trichoblasts rhodoplastic, 0.8–1.5 mm long, straight or often strongly incurved, branched several times 1–6 cells apart, tapering evenly from 30–50 μm in diameter below to 5–7 μm in subterminal cells (lost from older trichoblasts), basal cells L/D 1–1.5 (-2), mid cells L/D 2–3, upper cells L/D 4–10. Laterals arising on basal cells of trichoblasts. Cells uninucleate in trichoblasts; rhodoplasts discoid, becoming chained.

Reproduction. Gametophytes dioecious. Procarps on the next to basal cell of trichoblasts, which becomes polysiphonous. Carposporophytes with a basal fusion cell and much branched gonimoblast filaments with clavate terminal carposporangia 25–55 μm in diameter. Cystocarps (Fig. 109A) globose to urceolate, sessile, 600–1000 (-1200) μm in diameter, with a slight neck; pericarp ostiolate, 3–4 cells thick, corticated except on the neck. Spermatangial organs (Fig. 109B) on lower branches of trichoblasts, cylindrical, 100–220 (-300) μm long and 35–50 μm in diameter.

Tetrasporangia (Fig. 109D) borne in lesser branches (Fig. 109C) with trichoblasts, spirally arranged, one per segment, fertile parts (0.7-) 1–2 (-2.5) mm long and 150–300 μm in diameter; tetrasporangia 70–120 μm in diameter, with 3 cover cells.

Type from the Tamar, at Georgetown, Tas. (*Harvey*, Alg. Aust. Exsicc. 220); lectotype in BM.

Distribution: Eyre, W. Aust., to Western Port, Vic., and N Tasmania.

Selected specimens: Eyre, W. Aust., drift (*Parsons*, 22.xi.1968; AD, A34405). Head of Great Australian Bight, S. Aust., drift (*Parsons*, 4.xi.1968; AD, A32949). Fishery Bay, Eyre Pen., S. Aust., drift (*Parsons*, 21.viii.1967; AD, A31884). Port Victoria, S. Aust., 3–4 m deep (*Kraft*, 20.ix.1973; AD, A44550). Investigator Strait, S. Aust., 27 m deep (*Watson*, 10.i.1971; AD, A38463). 20 km WSW of Outer Harbor, S. Aust., 22–25 m deep (*McFarlane*, 11.ix.1975; AD, A46622). Brighton, S. Aust., drift (*Bienert*, 12.xi.1965; AD, A29665). Port Noarlunga, S. Aust., 24 m deep (*Ottaway*, 3.ii.1981; AD, A52082). Port Elliot, S. Aust., drift (*Womersley*, 17.x.1948; AD, A9405). Vivonne Bay, Kangaroo I., S. Aust., lower eulittoral, shaded, inside Point Ellen (*Womersley*, 4.i.1990; AD, A60111). Pennington Bay, Kangaroo I., S. Aust., drift (*Womersley*, 4.i.1948; AD, A6663) and upper sublittoral pools (*Womersley*, 27.x.1995; AD, A64607). Blackfellows Caves, SE S Aust., drift (*Loo*, 3.xi.1997; AD, A67357). Queenscliff, Vic., drift (*G. & R. Kraft*, 12.xi.1997; MELU, K10841). Point Leo, Western Port, Vic., drift (*Sinkora* A1370, 29.x.1971; AD, A55586). Walkerville, Vic., drift (*Womersley*, 11.xi.1982; AD, A55354). Bridport, Tas., drift (*Womersley & Parsons*, 6.xi.1982; AD, A54544). Currie R., Tas., 2–10 m deep (*G. &F. Perrin*, Jan. 1937; AD, A9033). Middleton, Tas., (*Perrin*, Sept. 1940; HO, 47699).

Harvey (1859b, p. 303) based his *Dasya feredayae* on his Alg. Aust. Exsicc. 220, of which there are 4 specimens in BM, two of which are tetrasporangial, one is sterile (these 3 are *Micropeuce*), and another is a young sterile plant of *Dasya haffiae*. There is a single specimen (*Micropeuce*) in LD (42070) which is tetrasporangial, but none in TCD. Harvey recorded his material as sterile.

Harvey (1859b, p. 303) also briefly described var. ß based on his Alg. Aust. Exsicc. 221. As Schmitz (1893, p. 218, footnote 3) realised, this variety is a true *Dasya* and was illustrated by Harvey (1860, pl. 173, figs 2, 4–6). Two specimens exist in TCD, but none in BM.

It appears clear that Alg. Aust. Exsicc. 220 is largely *Micropeuce* and 221 is mostly a *Dasya*, but some are the rough-water forms of *M. feredayae* which J. Agardh designated as var. β *contractior*.

M. feredayae shows considerable variation in habit, though the young branches and reproductive structures are consistent. Older plants develop thick axes, and *M. strobiliferum* [Type from Port Elliot, S. Aust., (*Hussey*); lectotype in Herb Agardh, LD, 38561] consists of

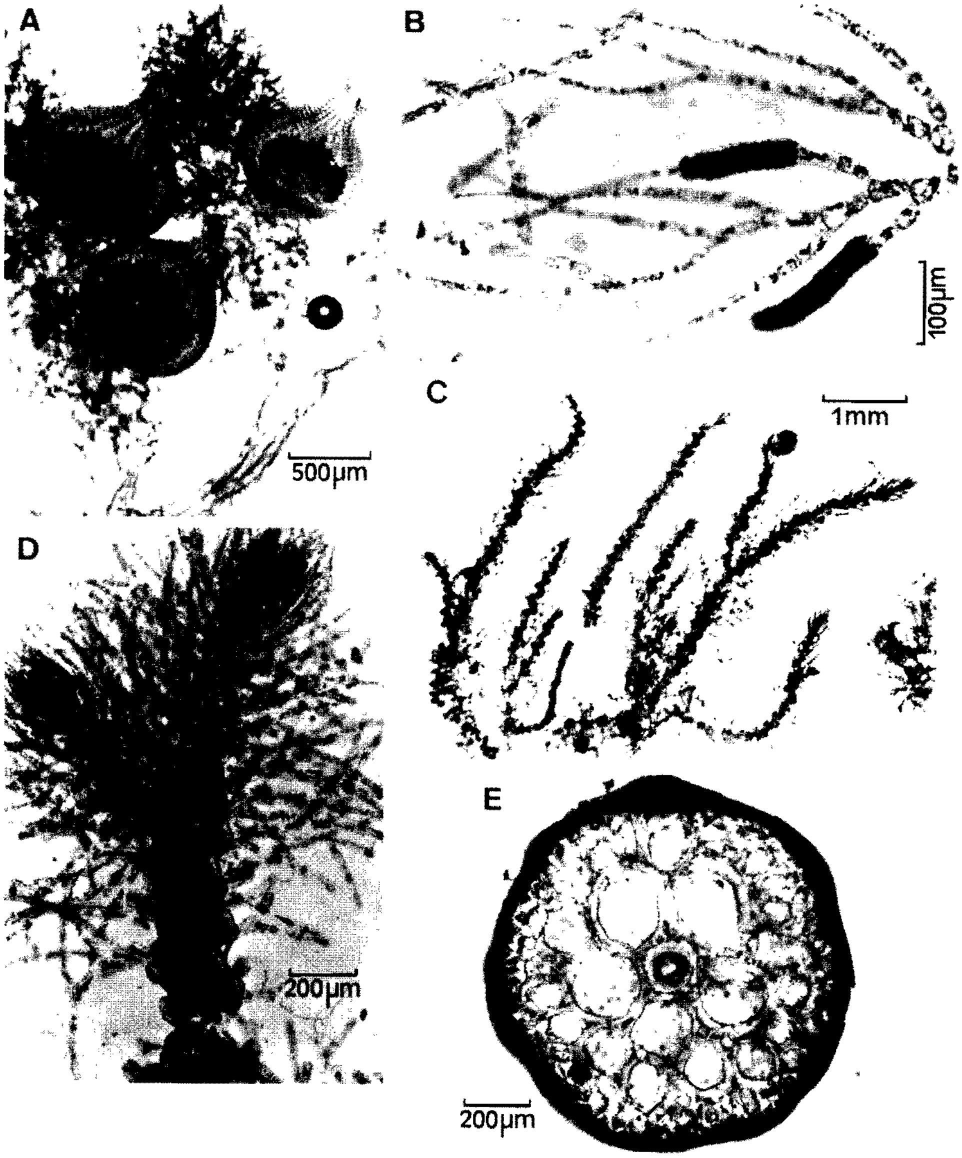

Fig. 109. *Micropeuce feredayae* (**A**, **E**, AD, A31884; **B**, **D**, AD, A34405; **C**, AD, A29665). **A**. Cystocarps. **B**. Spermatangial organs on a trichoblast. **C**. Branches with tetrasporangia. **D**. Branch with tetrasporangia. **E**. Transverse section of axis.

the slender, branched, laterals as often represented in drift specimens (Fig. 107D). Plants growing attached under turbulent conditions often display the short, lateral, appendages on the base of the axes.

2. **Micropeuce glomerulifera** Womersley & Parsons, *sp. nov.*

FIGS 108A, 110

Thallus (Figs 108A, 110A) medium to dark red-brown, 10–25 cm high, with one to a few branched, corticated, main axes 1–3 mm in diameter, with long laterals bearing short, probably proliferous, tufts (Fig. 110B, C) uniformly 2–3 (-4) mm long, each with 1–3 branched axes bearing trichoblasts. Holdfast discoid, 3–10 mm across; epilithic. *Structure* monopodial, trichoblasts cut off from segments 4–8, with 5 pericentral cells (Fig. 110D) produced from about segments 12–13. Trichoblasts rhodoplastic, 500–800 µm long, with 3–4 branches 1 (-2) cells apart and upper branched filaments 3–5 (-7) cells long; basal cells 40–60 µm in diameter and L/D 1–2, mid cells 20–30 µm in diameter and L/D 2–3, terminal cells 10–15 µm in diameter and L/D 2–3; young trichoblasts tapering to slender ends with cells 5–10 µm in diameter and L/D 6–10. Cortication commencing close to apices, with the pericentral cells remaining clear in transverse section, inner cortical cells only slightly smaller than pericentral cells (Fig. 110D), then grading to smaller outer cortical cells, with intermixed smaller rhizoidal cells (sometimes between pericentral cells). Cells uni- (-2) nucleate; rhodoplasts discoid or in slight chains.

Reproduction. Gametophytes dioecious. Procarps borne on the suprabasal segment of trichoblasts, with it and the basal cells becoming polysiphonous. Carposporophytes with a basal fusion cell and slender, branched, gonimoblast filaments with elongate-clavate terminal carposporangia 30–50 µm in diameter. Cystocarps (Fig. 110E, F) ovoid with a swollen base and short, scarcely constricted, neck, (300-) 500–1200 µm in diameter and 600–1200 µm long; pericarp ostiolate, corticated. Spermatangial organs (Fig. 110G) as mid branches of trichoblasts, lanceoid, 150–300 µm long and 20–70 µm in diameter.

Tetrasporangia (Fig. 110C) in polysiphonous branches of lateral tufts densely covered with trichoblasts, spirally arranged with 1 sporangium per segment, fertile parts 0.5–1 mm long and 150–250 µm in diameter; tetrasporangia bulging the segments, 80–140 µm in diameter with 3 cover cells.

Diagnosis: Thallus hepaticus, 10–25 cm altus, cum 1 vel paucis axibus ramosis et corticatis 1–3 mm diametro, cum lateralibus longis breves caespites 2–3 (-4) longos ferentibus, unus quisque cum 1–3 ramis trichoblastos ferentibus. Hapteron discoideum 3–10 mm latum, epilithicum. Structura monopodialis cum 5 cellulis pericentralibus corticatis prope apices; cellulae pericentrales manifestae in sectione transversa, cellulae corticales extrinsecus decrescentes cum cellulis mixtis rhizoidealibus.

Reproductio. Gametophyta dioecia. Procarpia in segmento suprabasali trichoblastorum portata. Carposporophyta cum cellula basi coniungenti et gonimoblasto graciliter ramoso cum carposporangiis 30–50 µm diametro elongatis et clavatis et terminalibus. Cystocarpia ovoidea basi turgida et collo brevi, (300-) 500–1200 µm diametro; pericarpium ostiolatum, corticatum. Organa spermatangialia sicut rami medio trichoblastorum, lanceoidea, 150–300 µm longa et 20–70 µm diametro. Tetrasporangia in ramis polysiphoneis caespitum lateralium, unum per segmentum, spiratim disposita, partes fertiles 0.5–1 mm longae et 150–250 µm diametro, tetrasporangia 80–140 µm diametro, cum 3 cellulis tegentibus.

Type from Stinky Bay, Nora Creina, S. Aust., drift (*Womersley*, 3.ix.1971); holotype in AD, A39555.

Distribution: Port Elliot, S. Aust., to Queenscliff, Vic., and SE Tasmania.

Selected specimens: Port Elliot, S. Aust., drift (*Womersley*, 25.x.1958; AD, A21888). Robe, S. Aust., drift (*Womersley*, 24.viii.1960; AD, A24440). Nora Creina, S. Aust., drift (*Womersley*, 4.ix.1958; AD, A21526). Warrnambool, Vic., drift (*G. & R. Kraft*, 11.vii.1997; MELU, K10654; AD, A68356). Queenscliff, Vic., drift (*Kraft & Doty*, 30.viii.1971; MELU, K3870). Charlotte Cove, SE Tas., 9 m deep (*Edgar*, 6.x.1999; AD, A68348).

M. glomerulifera differs from *M. feredayae* in habit, with the short glomerulate tufts scattered along the branches; the trichoblasts of the former are also shorter than those of *M. feredayae*.

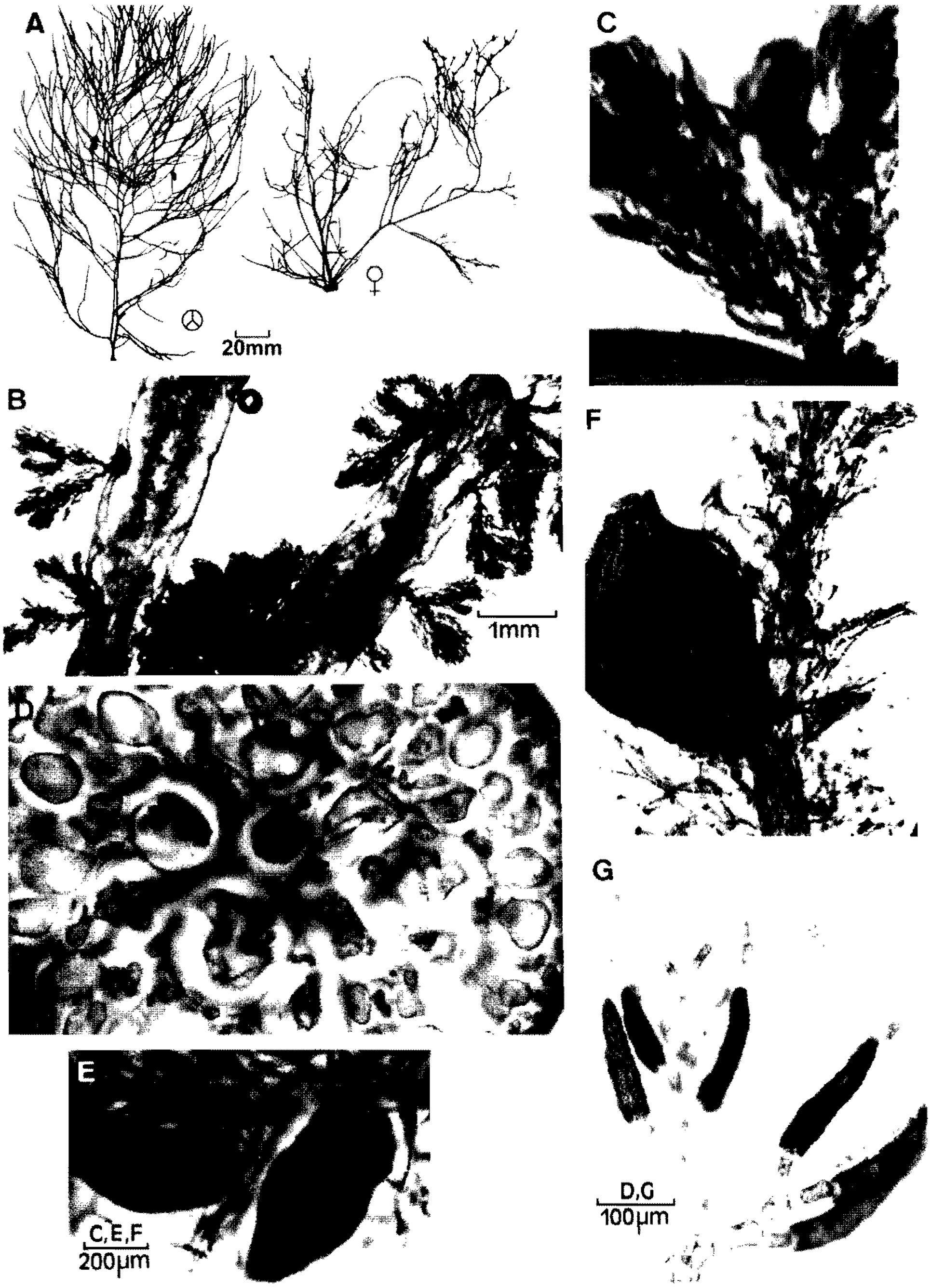

Fig. 110. *Micropeuce glomerulifera* (**A–E**, AD, A39555; **F**, AD, A24440; **G**, AD, A21888). **A**. Habit of partly denuded plants. **B**. Axes with glomerulate tufts. **C**. A glomerulate tuft, with tetrasporangia. **D**. Transverse section of axis with 5 pericentral cells. **E**. Young cystocarps. **F**. A mature cystocarp. **G**. Spermatangial organs on a trichoblast.

SPECIES OF UNCERTAIN STATUS

Micropeuce proxima (Harvey)Womersley & Parsons, *comb. nov.*
Dasya proxima Harvey 1855a: 542; 1863, synop. xxiii. J. Agardh 1863: 1218. De Toni 1903: 1197.

FIG. 108E

Type from Middleton Bay, King George Sound, W. Aust. (*Harvey*); holotype in Herb. Harvey, TCD.

This species is represented by a single sheet in TCD, labelled "336. KGS", as shown in Fig. 108E. The trichoblast branches do not show adherent walls (as in *Dasya*) so it is probably a *Micropeuce*, with 5 pericentral cells. In form it is similar to *M. feredayae*, but its identity needs to be established on the basis of similar collections from the King George Sound region.

Micropeuce sarcocaulon (Harvey)Kylin *ex* Silva *in* Silva *et al.* 1996: 528. Kylin 1956: 511. May 1965: 378.
Dasya sarcocaulon Harvey 1863, pl. 278. De Toni 1903: 1216. Sonder 1880: 36.
Lophothalia sarcocaulon (Harvey)J. Agardh 1890: 62. Reinbold 1897: 57.
Brongniartella sarcocaulon (Harvey)Schmitz 1893: 218. De Toni 1903: 1013. De Toni & Forti 1923: 44. Guiler 1952: 104. Lucas 1909: 43; 1929a: 22; 1929b: 51. Lucas & Perrin 1947: 285. Womersley 1950: 186.

FIG. 108F

Type from Fremantle, W. Aust., (*Clifton*, Aug. 1858); lectotype in Herb. Harvey, TCD.

The lectotype (Fig. 108F) in Herb. Harvey, may be only a form of *M. feredayae*, but appears to be a softer, more mucilaginous, plant. *M. sarcocaulon* has been recorded from other parts of southern Australia, and such specimens are here regarded as forms of *M. feredayae.* Fresh collections from the Fremantle region are needed to clarify the status of *M. sarcocaulon.*

Genus HOLOTRICHIA Schmitz *in* Schmitz & Falkenberg 1897: 450

Thallus erect, radially branched, heavily corticated below, upper branches clothed with simple trichoblasts and adventitious monosiphonous filaments; holdfast massive, of coarse, branched, fibres. *Structure* monopodial, axial cells each with a rhodoplastic trichoblast and developing 7 pericentral cells, some dividing transversely, soon obscured in transverse section among similar inner cortical cells and rhizoids. "Gland cells" present in trichoblasts and also in the outer or inner cortical cells. Cells probably uninucleate.

Reproduction. Gametophytes dioecious. Procarps borne on basal (or near) cells of trichoblasts. Carposporophytes with a basal fusion cell and branched gonimoblast filaments bearing clavate terminal carposporangia. Cystocarps ovoid, without a neck, pericarp ostiolate, lightly corticated. Spermatangial organs developed on trichoblasts.

Tetrasporangia produced in lesser branches with normal trichoblasts, spirally arranged, one per segment, with 3 cover cells.

Type species: *H. comosa* (Harvey)Schmitz *in* Schmitz & Falkenberg 1897: 450.

The single species of *Holotrichia* is distinguished by 7 pericentral cells, some dividing transversely, with a thick cortex on lower axes and massive holdfasts, by simple trichoblasts and adventitious filaments, by the presence of "gland" cells in the trichoblasts and cortex, and by having spirally arranged tetrasporangia in lesser branches.

Holotrichia comosa (Harvey)Schmitz *in* Schmitz & Falkenberg 1897: 450, fig. 252 B, C. De Toni 1903: 1145. Falkenberg 1901: 566, pl. 24 figs 12, 13. Huisman & Walker 1990: 435. Kylin 1956: 516, fig. 408C, D. Lucas 1909: 47. May 1965: 378. Silva *et al.* 1996: 500.
Alsidium comosum Harvey 1863, pl. 270, synop.: xviii. J. Agardh 1896: 113. Schmitz 1893: 230 (in part). Sonder 1880: 34. Tisdall 1898: 513. Wilson 1892: 168.
Maschalostroma fastigiata sensu Guiler 1952: 104. Lucas 1909: 39. Lucas & Perrin 1947: 253, fig. 112.

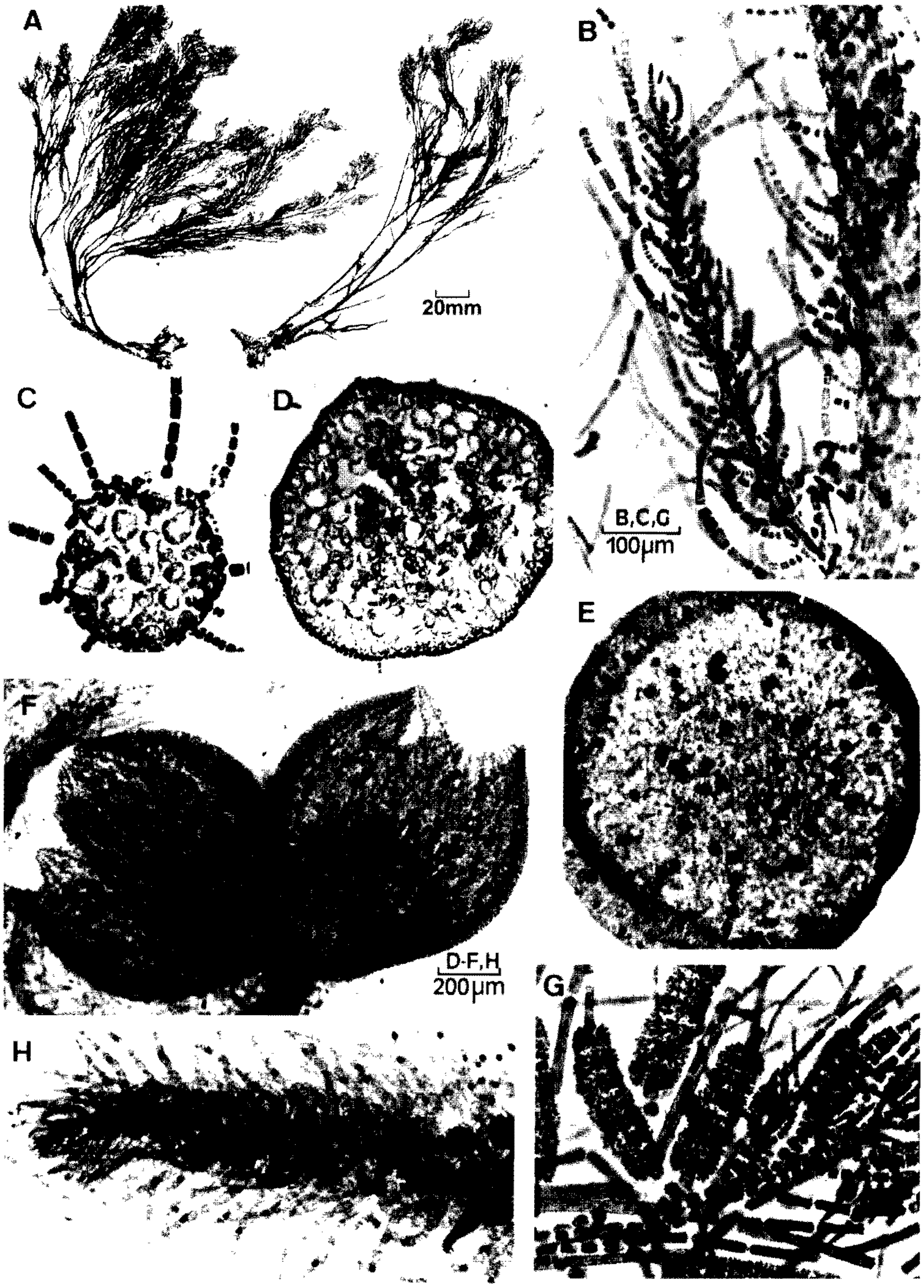

Fig. 111. *Holotrichia comosa* (**A**, **F**, AD, A37635; **B–D**, AD, A57265; **E**, **H**, AD, A56437; **G**, AD, A66939). **A**. Habit. **B**. Branch apex and trichoblasts. **C**. Transverse section of young branch with adventitious trichoblasts. **D**. Transverse section of older branch. **E**. Transverse section of old branch with darkly stained ("gland") cell contents. **F**. Cystocarps. **G**. Spermatangial organs. **H**. Branch with tetrasporangia, trichoblasts with "gland" cells.

FIG. 111

Thallus (Fig. 111A) medium to dark red-brown, 10–35 cm high, with robust, cartilaginous, branched lower axes (probably perennial) 2–10 mm in diameter, bearing plumose upper branches 5–20 cm long, branched for 3–4 orders and profusely covered with rhodoplastic trichoblasts and adventitious filaments; axes corticated, well defined, 0.5–1.5 mm in diameter, upper branches radial, tapering to 20–60 µm in diameter shortly below apices. Holdfasts (Fig. 111A) relatively massive, perennial, coarsely fibrous, 1–3 cm across. *Structure* monopodial (Fig. 111B) with trichoblasts arising from third or fourth axial cells, maturing rapidly, and pericentral cells (usually 7, Fig. 111C) cut off from segments 6–10, with some pericentral cells dividing transversely into 2, the trichoblast attached to the upper cell. Trichoblasts (Fig. 111B) simple, arising spirally 1/4, 0.2–1 mm long when mature, 16–24 µm in diameter, tapering gently, basal cells L/D 0.5–1, mid cells L/D (2-) 4–8 (-10). "Gland" cells part way along (Fig. 111H) some trichoblasts (and probably adventitious filaments), usually single, formed following division of a cell to give an isodiametric, angular, cell 8–30 µm in diameter, with a small cell above; one of these 2 cells usually darkly staining. Adventitious monosiphonous filaments frequent, similar to trichoblasts (or slightly slenderer), arising from pericentral cells and later from cortical cells. Cortication (Fig. 111D) commencing well below apices, becoming thick, with cells with darkly staining contents ("gland" cells) rare to abundant (Fig. 111E), on the surface or within the cortex, outer cortical cells 5–10 µm across and L/D 1–2 (-4), angular and in rows. Pericentral cells soon lost (Fig. 111D) in transverse section among inner cortex cells of similar size and abundant rhizoids. Laterals arising on basal cell of trichoblasts. Cells probably uninucleate; rhodoplasts discoid, becoming chained.

Reproduction. Gametophytes dioecious. Procarps on basal (or near) cell of trichoblasts. Carposporophytes with a small basal fusion cell and branched gonimoblast filaments with clavate terminal carposporangia 35–55 µm in diameter, replaced from below. Cystocarps (Fig. 111F) ovoid, 700–1500 µm in diameter, sessile, with no neck; pericarp ostiolate, 3–4 cells thick, with 10–25 erect filaments cutting off outer pericentral cells and an outer layer of small cortical cells. Spermatangial organs (Fig. 111G) on mid cells of trichoblasts with sterile basal and apical filaments, 200–300 µm long and 60–80 µm in diameter.

Tetrasporangia in lesser branches (Fig. 111H), fertile parts 1–2 mm long and 120–180 µm in diameter, with trichoblasts and adventitious filaments from each segment, one tetrasporangium per segment, spirally arranged, (35-) 50–130 µm in diameter, each with 3 cover cells.

Type from "The Vasse" (near Busselton), W. Aust., holotype in Herb. Harvey, TCD.

Distribution: Rottnest I., W. Aust., to Glenelg, S. Australia.

Selected specimens: Cavenagh Reef, Cervantes, W. Aust., 5 m deep (*Edgar*, 2.xi.1999; AD, A68384). Point Clune, Rottnest I., W. Aust., 12 m deep (*Kraft & Ricker*, 5.xii.1980; MELU, K7203a). Between Backstairs Passage and Troubridge I., S. Aust. (AD, A16139). Tiparra Reef, S. Aust., 5 m deep (*Shepherd*, 30.ix.1970; AD, A37282), 11 m deep (*Shepherd*, 31.x.1970; AD, A37635—"Marine Algae of southern Australia" No. 130) and 10–12 m deep (*Shepherd*, 16.iii.1985; AD, A56437). Off Outer Harbor, S. Aust., 17 m deep (*Shepherd*, 26.vii.1969; AD, A35110). Glenelg, S. Aust., on tyre reef, 18 m deep (*Reimers*, 9.x.1986; AD, A57265). NE of Ballast Head, Kangaroo I., S. Aust., 12 m deep (*Hone*, 13.ii.1997; AD, A66939).

Holotrichia comosa occurs in relatively deep water in areas of moderate water movement.

Genus ERYTHROSTACHYS White *in* Ewart *et al.* 1912: 257

Thallus erect, with robust, corticated, cartilaginous axes bearing lateral, branched, tufts with lightly corticated branches, probably proliferous; holdfast divided, with thick branches. *Structure* monopodial, trichoblasts and pericentral cells cut off close to apices. Pericentral cells 7, remaining clear in transverse section around the axial cell and within the smaller celled cortex. Trichoblasts rigid, basally furcate once (rarely twice), with adherent basal walls at the furcations, cells rhodoplastic, more or less isodiametric, terminal cells acute; adventitious filaments absent. Cells uninucleate.

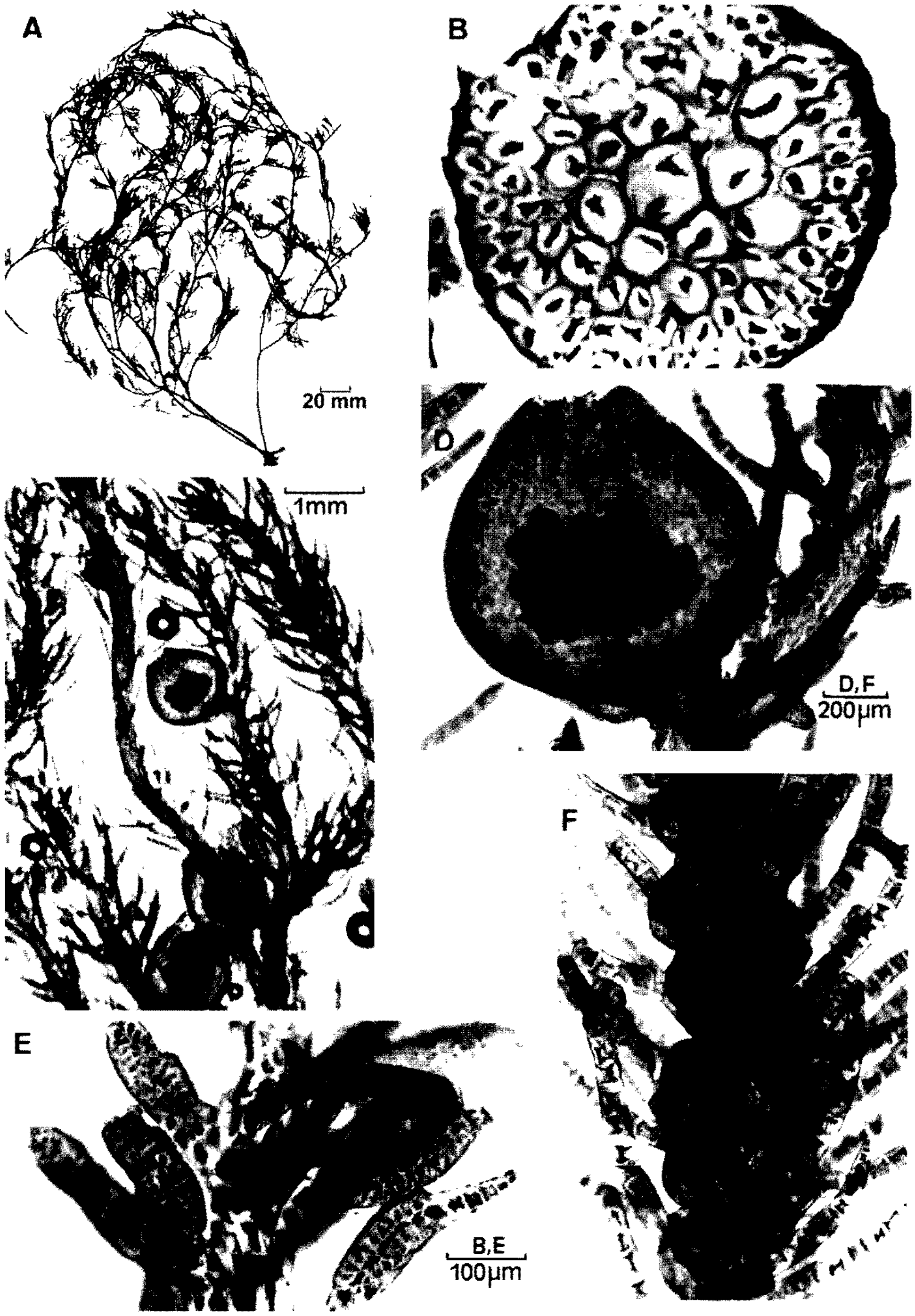

Fig. 112. *Erythrostachys strobilifera* (**A**, **E**, AD, A25430; **B**, **F**, AD, A26311; **C**, **D**, AD, A32070). **A**. Habit. **B**. Transverse section of axis. **C**. Branches with coarse trichoblasts and cystocarps. **D**. A cystocarp. **E**. Spermatangial organs. **F**. Branch with trichoblasts and tetrasporangia.

Reproduction. Gametophytes dioecious. Procarps borne on a lower cell of trichoblasts at a furcation. Carposporophytes with a basal fusion cell, short, slender gonimoblast filaments and large terminal carposporangia. Cystocarps ovoid, without a neck; pericarp ostiolate, corticated. Spermatangial organs developed on branches of trichoblasts.

Tetrasporangia produced in lateral, corticated, branches bearing trichoblasts, spirally arranged, one per segment.

Type species: *E. prolifera* White [= *E. strobilifera* (J. Agardh)Womersley & Parsons, *comb. nov.*]

Erythrostachys was described as *E. prolifera* White *in* Ewart *et al.* (1912) in a rather obscure publication on the basis of a specimen seen and named by J. Agardh, who had (unknown to White) described it (1890, p. 60) as *Lophothalia strobilifera.* Kylin (1956, p. 510) erected the genus *Rhodolphia* for it, being unaware of the earlier *Erythrostachys.*

Erythrostachys is a distinctive genus, with 7 pericentral cells, heavily corticated axes, short, rigid trichoblasts which are basally furcate, and spirally arranged tetrasporangia.

Erythrostachys strobilifera (J. Agardh)Womersley & Parsons, *comb. nov.*

Lophothalia strobilifera J. Agardh 1890: 60.

Brongniartella strobilifera (J. Agardh)Schmitz 1893: 218. De Toni 1903: 1012. Lucas 1909: 43. Lucas & Perrin 1947: 283.

Erythrostachys prolifera White *in* Ewart *et al.* 1912: 257, pl. 52 figs 3–7.

Rhodolophia strobilifera (J. Agardh)Kylin 1956: 510. May 1965: 379. Shepherd & Womersley 1981: 367.

FIG. 112

Thallus (Fig. 112A) dark red-brown, 10–40 cm high, with robust, branched, corticated, cartilaginous axes 0.5–2 mm in diameter, bearing lateral, branched tufts 1–3 (-7) cm long with lightly corticated branches, covered with rhodoplastic trichoblasts, probably proliferous. Holdfast discoid, soon becoming divided, 5–15 mm across, branches 400–800 µm thick; epilithic. *Structure* monopodial, apical cells hemispherical, subapical cells 10–20 µm in diameter, bearing trichoblasts from axial cells 3–8. Pericentral cells 7 (Fig. 112B), cut off from segments just below the apical cell. Trichoblasts (Fig. 112C, F) rigid, 700–1250 µm long, basally once (occasionally twice) furcate with adherent basal walls at the dichotomy, branches straight or slightly curved, 60–100 µm in diameter with cells L/D 0.8–1.2 below, tapering slightly until near their tips, subterminal cells 25–30 µm in diameter, terminal cell acute; adventitious filaments absent. Cortication commencing 8–10 segments from apices, remaining slight except on main branches and axes; pericentral cells remaining clear (Fig. 112B) in transverse section, with small outer cortical cells. Cells probably uninucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps borne on a basal cell of a trichoblast or the cell just above a furcation. Carposporophyte with a basal fusion cell producing relatively slender gonimoblast filaments with shortly clavate to ovoid terminal carposporangia 90–140 µm in diameter. Cystocarps (Fig. 112C, D) ovoid, 0.7–1.2 mm in diameter, sessile, with no neck; pericarp ostiolate, 4 cells thick, lightly corticated. Spermatangial organs (Fig. 112E) on branches of trichoblasts, with sterile basal and apical cells, 100–300 µm long and 60–80 µm in diameter, with initials cutting off an outer layer of spermatangia.

Tetrasporangia occur on corticated branches bearing normal trichoblasts (Fig. 112F), fertile parts 2–5 mm long and 400–600 µm in diameter(including the torulose tetrasporangia), strongly torulose with the large sporangia, one per segment and spirally arranged, 180–230 µm in diameter, lightly corticated.

Type from "Adelaide", S. Aust.; lectotype (tetrasporangial) in Herb. Agardh, LD, 42047, isolectotype (cystocarpic) LD, 42943.

Distribution: Eyre, W. Aust., to Port Elliot, S. Australia.

Selected specimens: Eyre, W. Aust, drift (*Parsons*, 22.xi.1968; AD, A35128). Elliston, S. Aust., drift (*Womersley*, 13.i.1951; AD, A13528). Wanna, S. Aust., drift (*Womersley*, 19.ii.1959; AD, A22411). Victor Harbour, S. Aust., drift (*Womersley*, 16.ii.1963; AD, A26311). Port Elliot, S. Aust., drift (*Womersley*, 26.xi.1961; AD, A25430 and (*Parsons*, 15.i.1968; AD, A32070). Vivonne Bay, Kangaroo I., S. Aust., drift (*Womersley*, 2.i.1949; AD, A10621). Seal Bay, Kangaroo I., S. Aust., drift (*Womersley*, 21.i.1965; AD, A28701).

The holotype of *Erythrostachys prolifera* White is in MEL, 608416, from Encounter Bay, *Hussey*, (an Algae Muellerianae specimen, det. by J. Agardh), accompanied with notes of Reinbold and drawings published by White.

E. strobilifera is apparently a deep-water species on rough water coasts, known only from occasional drift specimens. Further study is needed to clarify reproductive details.

Genus DOXODASYA (Schmitz)Falkenberg 1901: 537.

Thallus erect, radially branched, corticated, branches clothed with rhodoplastic, relatively persistent trichoblasts and in some species with adventitious monosiphonous filaments; holdfast fibrous. *Structure* monopodial, trichoblasts rhodoplastic, cut off from axial cells close to apices, with 4 pericentral cells developed from axial cells in alternating sequence, remaining clear in transverse section of corticated branches. Trichoblasts simple or with 1–4 branches, dichotomies with or without adherent basal walls. Cells usually uninucleate.

Reproduction. Gametophytes dioecious. Procarps borne on lower cells of trichoblasts, on the last of 5 pericentral cells, developing a sterile cell group and a 4-celled carpogonial branch. Carposporophyte with a basal fusion cell and branched gonimoblast filaments with clavate terminal carposporangia. Cystocarps globose to urceolate, with or without a neck, pericarp ostiolate, corticated or not. Spermatangial organs developed on branches of trichoblasts.

Tetrasporangia produced in lesser branches, sometimes stichidioid, usually with normal trichoblasts, in decussate pairs with 2–3 cover cells.

Type species: *D. bolbochaete* (Harvey)Falkenberg 1901: 538, pl. 13 figs 21, 22.

Doxodasya was first described by Schmitz (1893, p. 220) as a subgenus of *Lophothalia*, and elevated to a genus by Falkenberg.

The genus now comprises 4 species, 3 recognised by Schmitz (1893, p. 220) and *Dasya hirta* J. Agardh here transferred to *Doxodasya*. *Doxodasya lenormandiana* and *D. hirta* are both much less common species than the other two; they agree with *Doxodasya* in essential features but differ in having more robust, branched, trichoblasts with adherent basal walls to cells above the dichotomies (as in Dasyaceae), and *D. lenormandiana* is distinctive in having very slender, branched filaments on cells of the trichoblasts.

KEY TO SPECIES OF *DOXODASYA*

1. Trichoblasts mostly simple, occasionally basally branched, 12–25 µm in diameter with mid cells L/D 3–8; branch walls not adherent at dichotomies where branched 2
1. Trichoblasts with 1–4 branches, lower cells 20–80 µm in diameter and L/D 1–2.5; branch walls adherent at dichotomies 3

    2. Branches bearing discrete, tufted, short shoots with trichoblasts, adventitious filaments absent .... 1. *D. bolbochaete*
    2. Branches densely covered with short shoots and adventitious filaments .... 2. *D. lanuginosa*

3. Trichoblasts rigid, lower cells 60–80 µm in diameter, terminal cells mucronate, some cells bearing branched slender filaments 5–8 µm in diameter, adventitious filaments absent .... 3. *D. lenormandiana*
3. Trichoblasts rigid below, with long lax ends, lower cells 20–30 µm in diameter, terminal cells pointed; adventitious filaments frequent on lower branches .... 4. *D. hirta*

1. **Doxodasya bolbochaete** (Harvey)Falkenberg 1901: 538, pl. 13 figs 21, 22. De Toni 1903: 1021. Guiler 1952: 104. Huisman 1997: 204. Kylin 1956: 512, fig. 405B. Lucas 1909: 43; 1929a: 22. Lucas & Perrin 1947: 286, fig. 131. May 1965: 378. Parsons 1975: 659, figs 30, 31, 46A. Shepherd 1983: 83. Shepherd & Womersley 1981: 367. Silva *et al.* 1996: 491. Womersley 1950: 186.

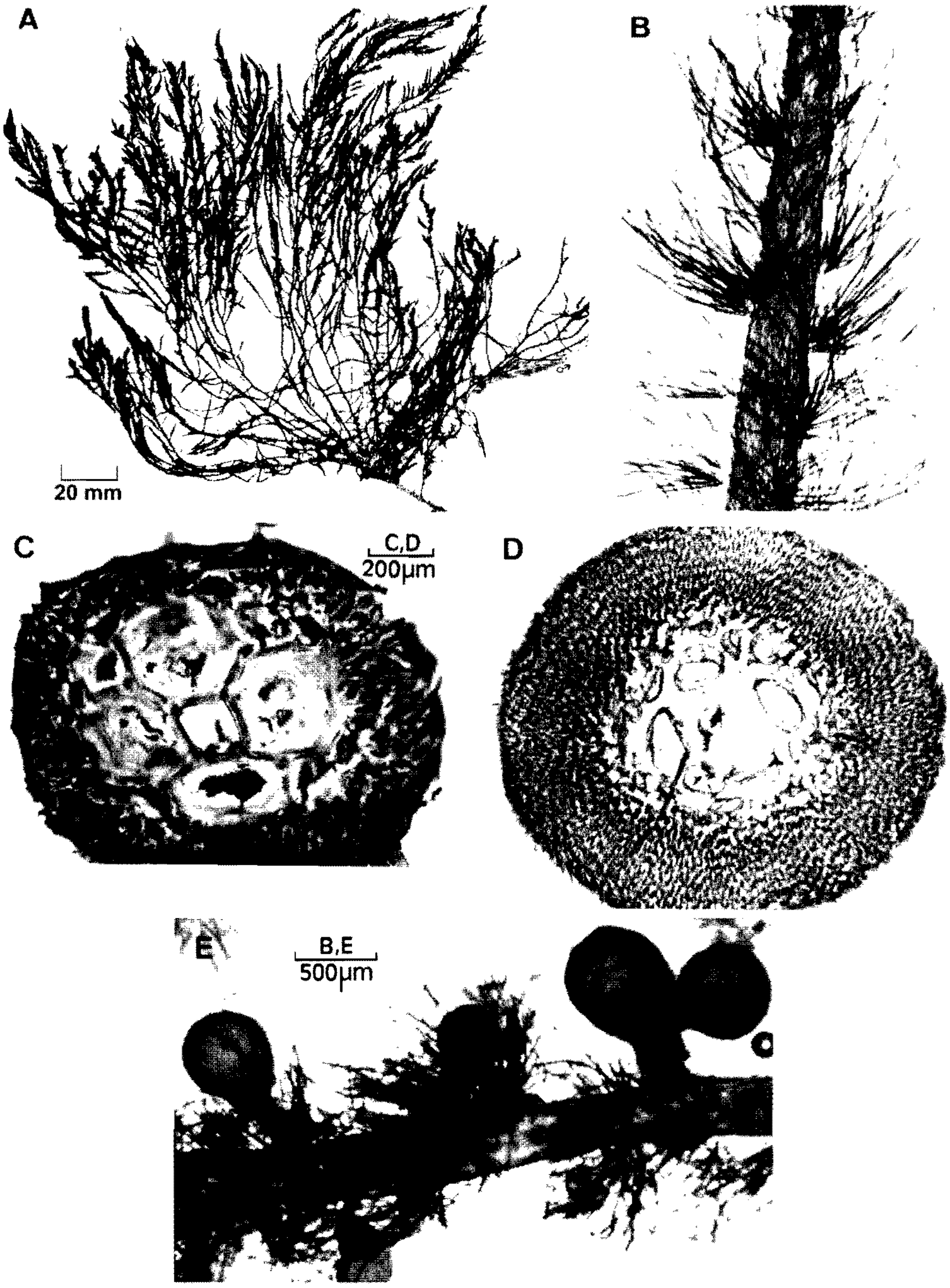

Fig. 113. *Doxodasya bolbochaete* (**A**, AD, A35005, **B**, **D**, AD, A67968; **C**, **E**, AD, A60000). **A**. Habit. **B**. Branch with discrete tufts of trichoblasts. **C**. Transverse section of young axis. **D**. Transverse section of old axis. **E**. Branch with cystocarps.

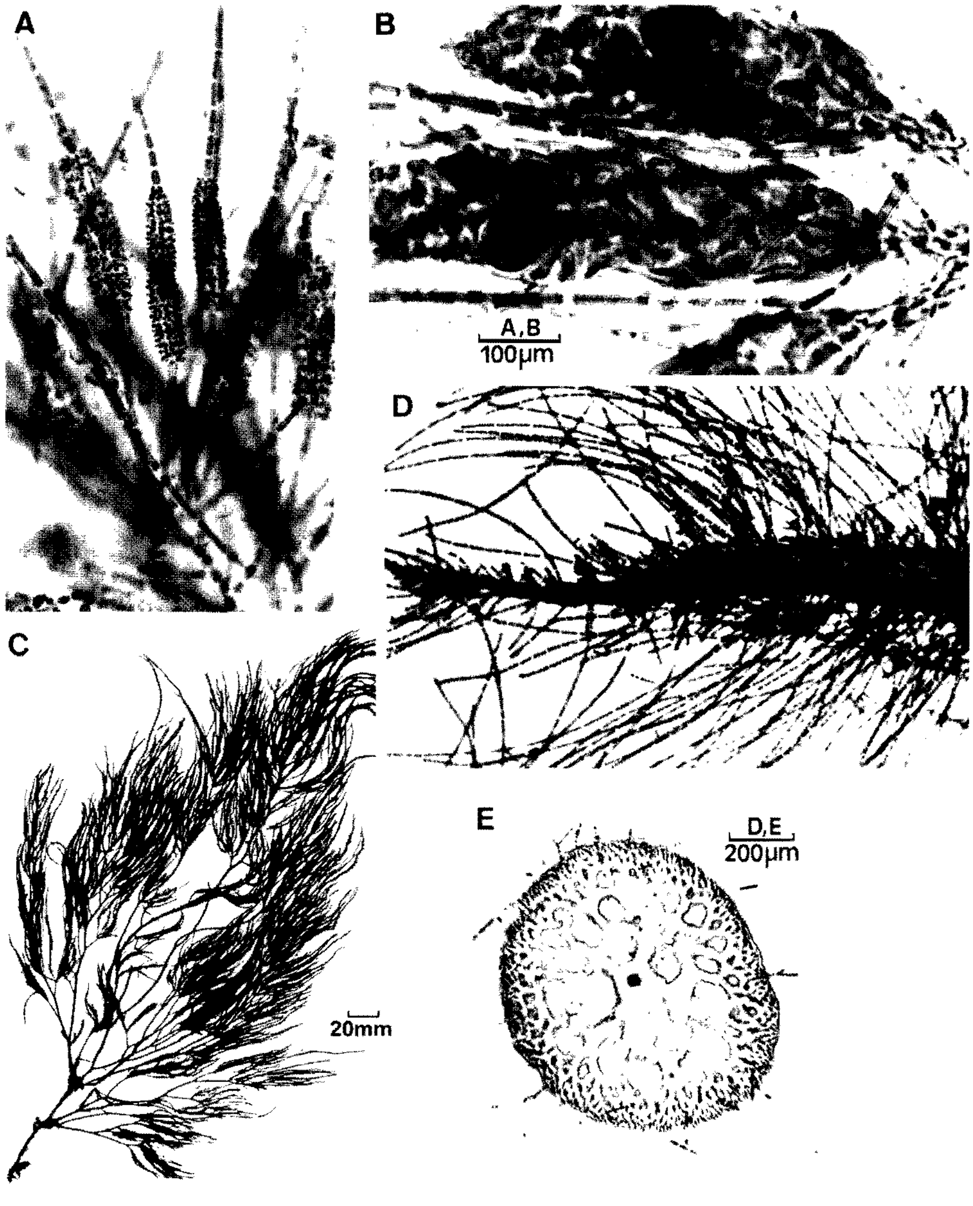

Fig. 114. A, B. *Doxodasya bolbochaete* (**A**, AD, A60000; **B**, AD, A32946). **A**. Spermatangial organs. **B**. Tetrasporangial stichidia. **C–E**. *Doxodasya lanuginosa* (**C**, **E**, AD, A62208; **D**, AD, A32205). **C**. Habit. **D**. Branch apex with trichoblasts and monosiphonous filaments. **E**. Transverse section of branch.

Dasya bolbochaete Harvey 1844b: 434; 1846: 421; 1849a: 65, pl. 25; 1859b: 304; 1863, synop.: xxiv. J. Agardh 1863: 1233. Kützing 1849: 797; 1864: 23, pl. 65a–c. Sonder 1853: 703; 1880: 36.

Lophothalia bolbochaete (Harvey)J. Agardh 1890: 63. Schmitz 1893: 220. Wilson 1892: 165.

Polysiphonia longissima J. Agardh 1896: 109. De Toni 1903: 906. Guiler 1952: 103. Lucas 1909: 41. Lucas & Perrin 1947: 265.

FIGS 113, 114A, B, 115

Thallus (Fig. 113A) light to dark red-brown, 10–70 cm high, with denuded, branched, cartilaginous main axes 1–2 (-3) mm in diameter, bearing irregularly (often clustered) laterals 10–20 cm long, branched for 1–3 orders, upper and mid branches clothed with small discrete branch systems (Fig. 113B) of short, quadrifarous, shoots bearing rhodoplastic trichoblasts spirally. Cortication commences about 50 segments from apices, first with rhizoidal filaments lying outside and between the pericentral cells and later covering the branch and becoming heavy on lower axes; the 4 pericentral cells (sometimes with 1–2 more interposed cells) remain clear in transverse section (Fig. 113C, D), and the outer cortex is of elongate cells. Holdfast discoid, 1–3 mm across; epilithic. *Structure* monopodial (Fig. 115A), with 4 pericentral cells formed in alternating sequence 20–27 segments below apices, each axial segment bearing a simple (or basally branched) trichoblast (Fig. 115B), spirally arranged with the sub-basal cell forming a short shoot; adventitious filaments absent. Short shoots 1–4 mm long, with an axis of 15–30 small isodiametric cells bearing spirally arranged trichoblasts; these short shoots give a characteristic appearance to the branches. Trichoblasts slender, 2–4 mm long, 12–25 µm in diameter and scarcely tapering, basal cell short (L/D about 1), mid and upper cells L/D (3-) 4–8, terminal cell tapering with a rounded tip. Cells uninucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps (Fig. 115C) occur 2–3 cells from base of a trichoblast on a short shoot, developing 5 pericentral cells with the fifth bearing a sterile group of 4 cells and a 4-celled carpogonial branch. Carposporophytes with a basal fusion cell bearing erect gonimoblast filaments with clavate terminal carposporangia 25–40 µm in diameter, replaced from below. Cystocarps (Fig. 113E) ovoid to globose, 0.8–1.5 mm in diameter, with a stalk 0.5–2 mm long but no neck; pericarp ostiolate, several cells thick with small cortical cells. Spermatangial organs (Figs 114A, 115D) on trichoblasts of short shoots, with several sterile basal and apical cells, 100–400 µm long and 40–65 µm in diameter, with 10–15 fertile segments of 3 pericentral cells (subdividing to 5–6) cutting off an outer layer of spermatangia (Fig. 115E).

Tetrasporangial stichidia (Figs 114B, 115F) formed from axes of the short shoots, 0.3–1 (-1.6) mm long and 200–250 µm in diameter, the tetrasporangia formed in decussate pairs with 2 pre-sporangial and 1 post-sporangial cover cells (Fig. 115G); tetrasporangia 70–110 µm in diameter.

Type from Georgetown, Tas. (*Gunn*); holotype in Herb. Harvey, TCD (*Gunn* 1264)

Distribution: Houtman Abrolhos, W. Aust., around southern Australia to Walkerville, Vic., and the N coast of Tasmania.

Selected specimens: Houtman Abrolhos, W. Aust., 50 m deep between Rat and Pelsart Groups (P. Sladen Exp. Nov.1915; UWA, A904). Port Denison, W. Aust., drift (*Kraft* 3994, 14.xii.1971; AD, A41725). Cliff Head, W. Aust., drift (*Womersley*, 18.ix.1979; AD, A51244). Eyre, W. Aust., drift (*Parsons*, 22.xi.1968; AD, A34406). Head of Great Australian Bight, S. Aust., drift (*Parsons*, 4.xi.1968; AD, A32946). Elliston, S. Aust., 10–11 m deep in bay (*Shepherd*, 20.x.1969; AD, A35005). Hopkins I., S. Aust., 33 m deep (*Branden*, 8.i.1989; AD, A60000). N Spencer Gulf, S. Aust., 10 m deep (*Shepherd*, 5.ix.1973; AD, A44223). Off Troubridge Light, S. Aust., 17 m deep (*Shepherd*, 4.ii.1969; AD, A33445). 5 km W of Port Noarlunga, S. Aust., 21 m deep (*Ottaway*, 8.xii.1980; AD, A52135). Port Elliot, S. Aust., drift (*Parsons*, 15.i.1968; AD, A32207). Stanley Beach, Kangaroo I., S. Aust., drift (*Womersley*, 7.ii.1956; AD, A20101). Ironstone Point, E of Penneshaw, Kangaroo I., S. Aust., 15 m deep (*Lavers*, 1.ii.1996; AD, A64629). Cape Jaffa, S. Aust., drift (*Womersley*, 22.xi.1998; AD, A67968). Robe, S. Aust., drift (*Womersley*, 11.xii.1969; AD, A34874). Walkerville, Vic., drift (*Sinkora* A2541, 9.iii.1979; AD, A60966). Devonport, Tas., drift (*Womersley*, 23.x.1986; AD, A57455). Georgetown, Tas. (*Perrin*, 29.i.1949; AD, A16454).

D. bolbochaete was described in detail by Parsons (1975, p. 659).

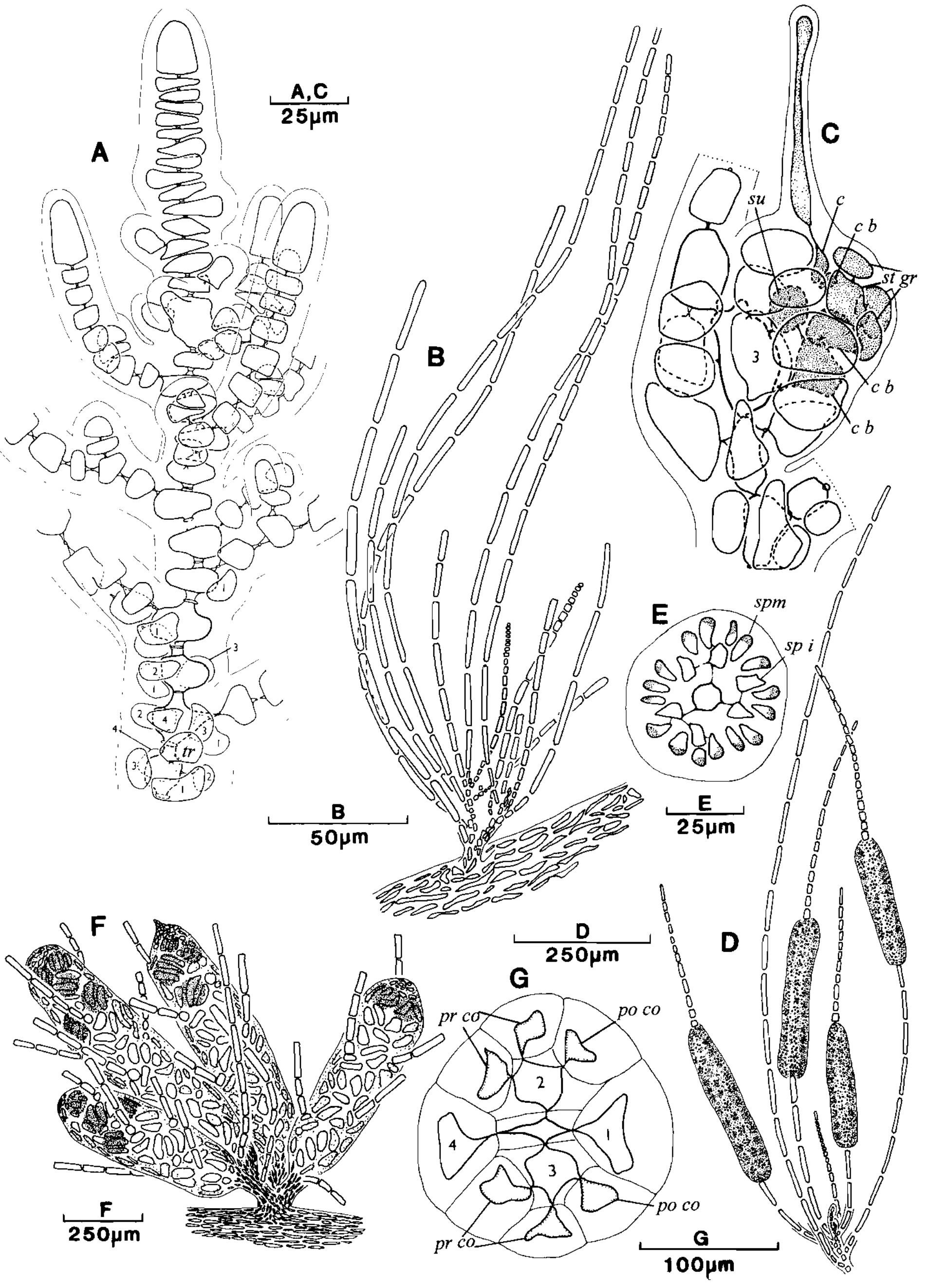

Fig. 115. *Doxodasya bolbochaete* (**A–C**, AD, A32946; **D**, **E**, AD, A35005; **F**, **G**, AD, A34406). **A**. Apex of a branch. **B**. Short shoot with trichoblasts. **C**. A procarp. **D**. Spermatangial organs. **E**. Transverse section of a spermatangial organ. **F**. Stichidia. **G**. Transverse section of a stichidium (lacking tetrasporangia at 2 and 3). (All as in Parsons 1975, courtesy of Aust. J. Bot.)

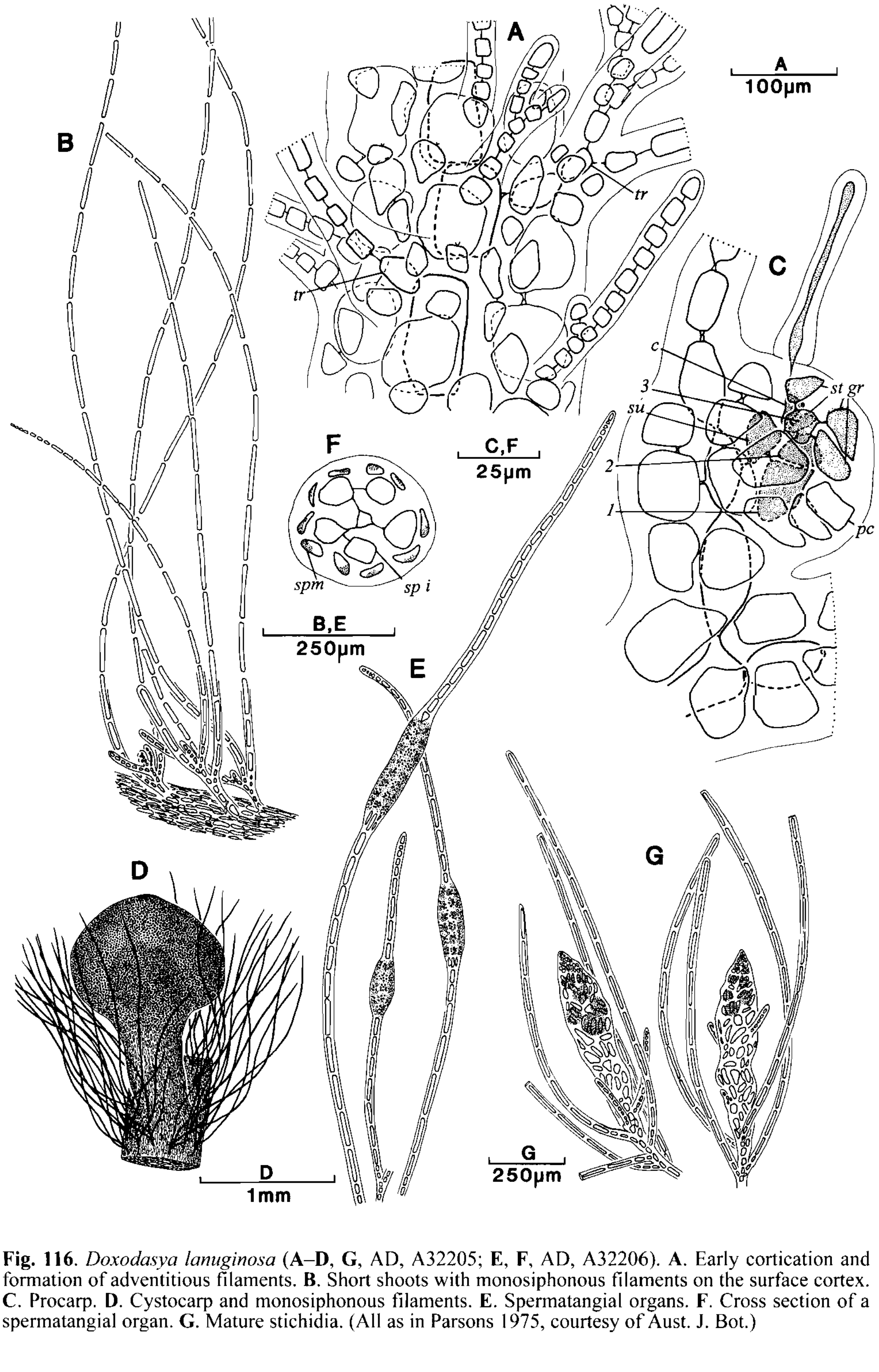

Fig. 116. *Doxodasya lanuginosa* (**A–D**, **G**, AD, A32205; **E**, **F**, AD, A32206). **A**. Early cortication and formation of adventitious filaments. **B**. Short shoots with monosiphonous filaments on the surface cortex. **C**. Procarp. **D**. Cystocarp and monosiphonous filaments. **E**. Spermatangial organs. **F**. Cross section of a spermatangial organ. **G**. Mature stichidia. (All as in Parsons 1975, courtesy of Aust. J. Bot.)

2. **Doxodasya lanuginosa** (J. Agardh)Falkenberg 1901: 541, pl. 13 fig. 23. De Toni 1903: 1022. Lucas 1909: 43; 1929b: 51. Lucas & Perrin 1947: 287, fig. 132. May 1965: 378. Parsons 1975: 665, figs 32, 33, 46B. Shepherd & Womersley 1981: 367.
Lophothalia lanuginosa J. Agardh 1890: 64, pl. 2 fig. 3. Reinbold 1898: 50. Schmitz 1893: 220.

FIGS 114C–E, 116

Thallus (Fig. 114C) dark red-brown, (10-) 20–70 cm high, with a single main axis bearing denuded, corticated, lower branches 1–2 mm in diameter, with clustered upper branches 10–40 cm long, branched for 2–3 orders, densely and evenly clothed (Fig. 114D) with rhodoplastic trichoblasts and monosiphonous filaments 1–3.5 mm long. Holdfast at first discoid, soon becoming fibrous and 1–2 cm across; epilithic. *Structure* monopodial, with trichoblasts arising 1–3 axial cells apart and 4 pericentral cells cut off in alternating order 20–25 axial cells below apices. Adventitious monosiphonous filaments arise (Fig. 116A) from pericentral and cortical cells and develop a short determinate axis of 6–12 isodiametric cells bearing trichoblasts (Fig. 116B) spirally, with short basal cells, mid and upper cells 15–25 µm in diameter and L/D 3–7, terminal cells shorter with rounded ends; these short shoots with trichoblasts densely and evenly clothe the branches, some becoming indeterminate and developing into long lateral branches. Cortication starting about 40 segments from apices and becoming heavy on lower branches, with the 4 pericentral cells (Fig. 114E) remaining clear in transverse section, surrounded by larger inner and small outer cortical cells. Cells multinucleate; rhodoplasts discoid, becoming chained or ribbon like.

Reproduction. Gametophytes dioecious. Procarps (Fig. 116C) developed 2–3 cells from base of a trichoblast, with 5 pericentral cells, the fifth producing a sterile group of 4 cells and a 4-celled carpogonial branch. Carposporophyte with a basal fusion cell and erect, branched, gonimoblast filaments with clavate terminal carposporangia 25–40 µm in diameter, replaced from below. Cystocarps (Fig. 116D) subglobose, 1–1.5 mm in diameter, with a stalk 0.5–2 mm long and no neck; pericarp ostiolate, 5–7 cells thick with small outer cortical cells. Spermatangial organs (Fig. 116E) developed on trichoblasts, with long, sterile basal and terminal filaments, 200–300 µm long and 30–50 µm in diameter, each segment with 3 pericentral cells (Fig. 116F), dividing to 5, producing initials and an outer layer of spermatangia.

Tetrasporangial stichidia (Fig. 116G) developed from axes of short shoots with few trichoblasts, on a monosiphonous base, 300–600 (-1000) µm long and 60–160 µm in diameter, with 4 pericentral cells producing decussate pairs of tetrasporangia 45–75 µm in diameter, each with 2 pre-sporangial and 1 post-sporangial cover cells.

Lectotype from Encounter Bay, S. Aust. (*Hussey*); in Herb. Agardh, LD, 42150.

Distribution: Esperance, W. Aust., to Lady Bay (Warrnambool), Vic. and NE Tasmania.

Selected specimens: Esperance, W. Aust., drift (*Burbidge*, 30.iii.1937; UWA, A844). Golden I., Avoid Bay, S. Aust., 22 m deep (*Hone*, 28.ix.1989; AD, A59810). Elliston, S. Aust., drift (*Woelkerling*, 28.xii.1976; AD, A47870). Port Elliot, S. Aust., drift (*Parsons*, 15.i.1968; AD, A32205—"Marine Algae of southern Australia" No. 129b, and AD, A32206). Seal Bay, Kangaroo I, S. Aust., drift (*Womersley*, 21.i.1965; AD, A28676—"Marine Algae of southern Australia" No. 129a). Robe, S. Aust., drift (*Womersley*, 26.i.1967; AD, A31213). Stinky Bay, Nora Creina, S. Aust., drift (*Womersley*, 16.v.1982; AD, A55541). 2 km N of Blackfellows Caves, S. Aust., drift (*Womersley*, 24.xi.1992; AD, A62208). Lady Bay, Vic., (March 1857; MEL 106625). Mussleroe Bay, NE Tas. (*G. & F. Perrin*, Mar. 1937; HO, 47650, 47651).

D. lanuginosa was described in detail by Parsons (1975, p. 665). It differs from *D. bolbochaete* in having a denser and more even cover of trichoblasts and short shoots over the branches.

3. **Doxodasya lenormandiana** (J. Agardh)Schmitz 1893: 220. De Toni 1903: 1022. Lucas 1909: 43. Lucas & Perrin 1947: 287. May 1965: 378.
Dasya lenormandiana J. Agardh 1863: 1238. Sonder 1880: 36.
Lophothalia lenormandiana (J. Agardh)J. Agardh 1890: 63. Schmitz 1893: 220.

FIG. 117

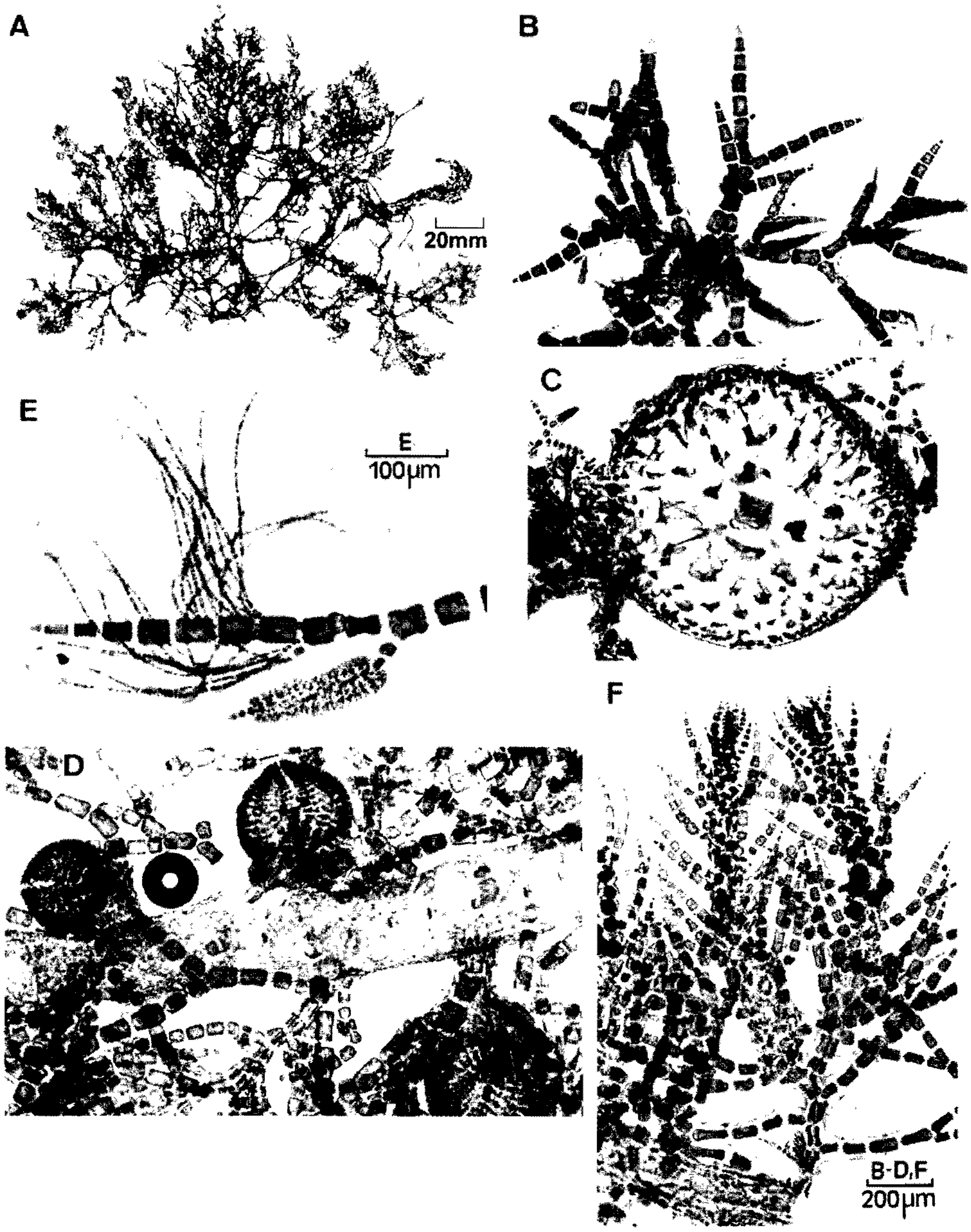

Fig. 117. *Doxodasya lenormandiana* (**A**, AD, A28843; **B**, AD, A68090; **C**, AD, A68044; **D**, **F**, AD, A57012; **E**, AD, A66623). **A**. Habit. **B**. Rigid, mucronate, trichoblasts. **C**. Transverse section of axis. **D**. Axis, rigid trichoblasts and cystocarps. **E**. Trichoblast with slender filaments and a spermatangial organ. **F**. Branches with tetrasporangia.

Thallus (Fig. 117A) dark red-brown, 5–25 cm high, radially and irregularly much branched with several relatively slender main axes or branches 0.5–1 mm in diameter, laterals laxly branched for 2–3 orders with lesser branches covered with short shoots 2–3 mm long, bearing rhodoplastic trichoblasts 0.5–1 mm long. Cortication commencing shortly below apices but usually slight, becoming thicker on main branches, with the pericentral cells remaining clear in transverse section (Fig. 117C). Holdfast of slender fibres, bearing short, branched, processes; epilithic or epiphytic. *Structure* monopodial with a conical apical cell, axial cells 3 or 4 below apices producing trichoblasts spirally from each segment, with 4 pericentral cells formed from about the sixth axial cell. Trichoblasts rigid (Fig. 117B, F), with 1–4 branches in varying planes and 1–4 cells apart near their base, 0.5–1 mm long, lower cells 60–90 μm in diameter and L/D 1–1.5 (-2), tapering to subterminal cells 20–30 μm in diameter and L/D 1–1.2, terminal cell mucronate (Fig. 117B); dichotomies with basally adherent walls (as in *Dasya*). Many trichoblasts bear, sparsely to prolifically, from their mid cells small tufts 0.5–1.5 mm long (Fig. 117E) of slender, lax, filaments, each with a rounded basal cell then filaments branched 2–6 times, 5–8 μm in diameter, mature cells L/D 8–12. Lateral branches arising from basal cells of trichoblasts. Cells multinucleate; rhodoplasts discoid to chained.

Reproduction. Gametophytes dioecious. Procarps borne on the supra-basal cells of trichoblasts, this and the basal segment becoming polysiphonous and corticated. Carposporophytes with a basal fusion cell and branched gonimoblast filaments bearing clavate terminal carposporangia, 25–35 μm in diameter, replaced from below. Cystocarps (Fig. 117D) urceolate, 600–800 μm in diameter, short stalked, with a distinct neck 180–250 μm long; pericarp ostiolate, 4–5 cells thick. Spermatangial organs (Fig. 117E) on branches of trichoblasts, usually with a sterile basal cell and tip of 5–8 cells, fertile parts 120–200 μm long and 35–55 μm in diameter.

Tetrasporangial stichidia (Fig. 117F) with simple or once branched trichoblasts and decussate pairs of tetrasporangia, 400–800 μm long and 70–130 μm in diameter; tetrasporangia (25-) 40–70 μm in diameter.

Type from Glenelg R. mouth, Vic.; holotype in Herb. Lenormand, CN, fragment thereof in Herb. Agardh, LD, 42095.

Distribution: Seal Bay, Kangaroo I., S. Aust., to the Glenelg R. mouth, Victoria.

Selected specimens: Seal Bay, Kangaroo I., S. Aust., drift (*Womersley*, 21.i.1965; AD, A28843). Pennington Bay, Kangaroo I., S. Aust., drift (*Womersley*, 11.ii.1956; AD, A20139). Blackfellows Caves, SE S. Aust., drift (*Womersley*, 20.xi.1998; AD, A68043). Port MacDonnell, S. Aust., drift (*Womersley*, 21.viii.1966; AD, A30697, on *Laurencia filiformis*, 16.x.1985; AD, A57012, and 29.ix.1996; AD, A66623 and 4.iv.1999; AD, A68090).

Doxodasya lenormandiana is apparently not a common species, known only from drift on rough-water coasts. It is characterised by habit and the rigid, large-celled, trichoblasts which bear tufts of very slender filaments.

4. **Doxodasya hirta** (J. Agardh)Womersley & Parsons, *comb. nov.*

Dasya hirta J. Agardh 1894: 82. De Toni 1903: 1193. Lucas 1912: 157. Lucas & Perrin 1947: 311.

FIG. 118

Thallus (Fig. 118A) dark red-brown, 2–10 cm high, much branched radially and irregularly with long, slender, main branches bearing alternate laterals for 4 or 5 orders. Larger branch axes 400–500 μm in diameter, tapering to 30–40 μm in diameter just below apices, clothed throughout (Fig. 118B) with rhodoplastic trichoblasts and similar adventitious filaments 200–300 μm long. Cortication commencing many segments below apices, moderate on lower branches, with the pericentral cells remaining clear (Fig. 118C) and thick walled in transverse section. Holdfast fibrous, small; probably epilithic. *Structure* monopodial, with a domed apical cell and axial cells (from 4–5 below apices) cutting off trichoblasts in spiral order; the 4 pericentral cells are cut off shortly below. Trichoblasts (Fig. 118D) rigid but with lax, long, ends, 300–1000 μm long with 2–5 branches in varying planes and usually 1–2 cells apart near the base, then with long, unbranched ends; lower and mid cells (10-) 20–30 μm in diameter and L/D (1-) 1.5–2.5, tapering evenly to upper cells 5–7 μm in diameter and L/D 3–6, terminal cell pointed; branch dichotomies with adherent lower walls (as in *Dasya*).

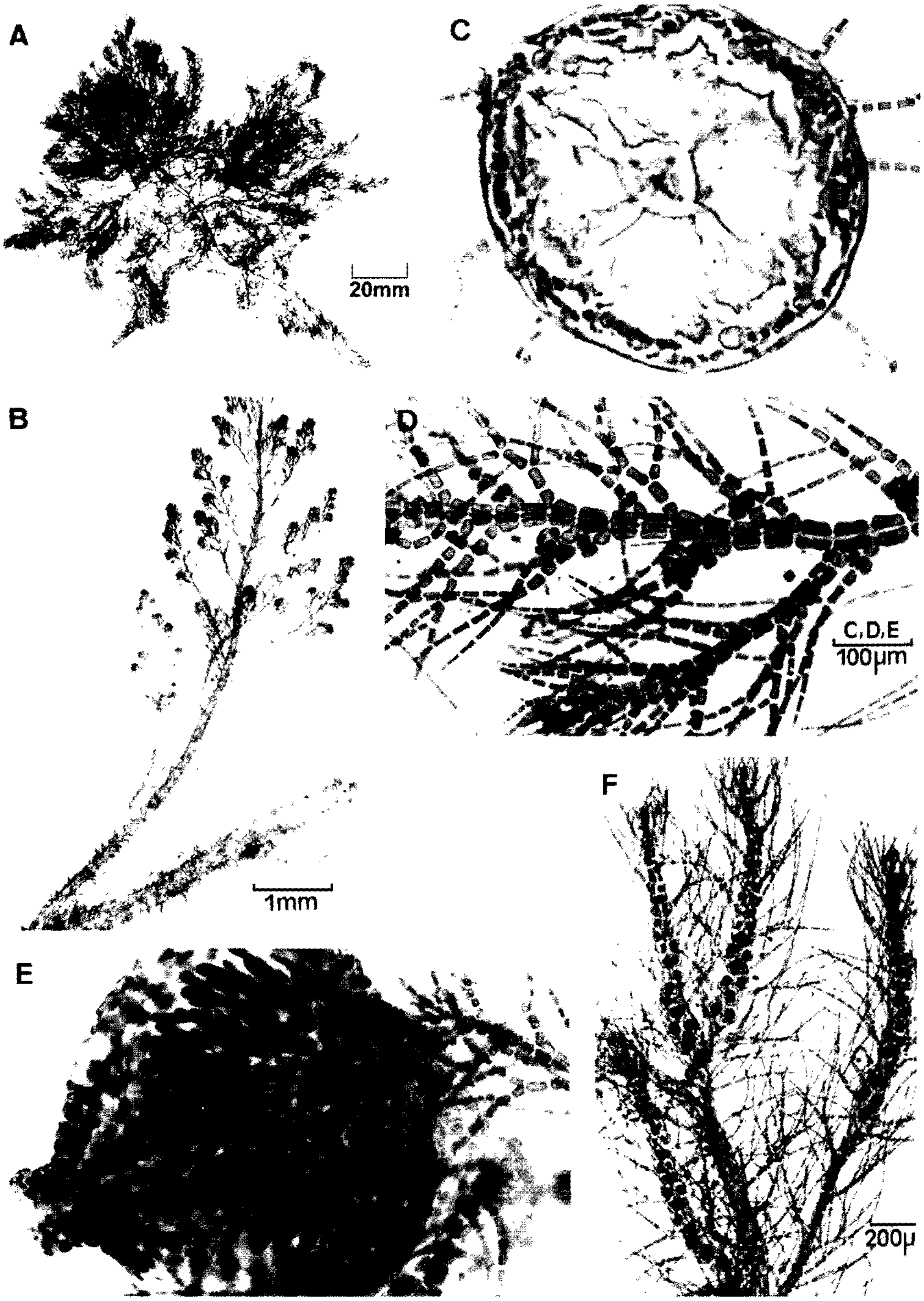

Fig. 118. *Doxodasya hirta* (**A**, **C–F**, AD, A57442; **B**, AD, A42704). **A**. Habit. **B**. Axis and lateral branches with trichoblasts and adventitious filaments. **C**. Transverse section of axis with bases of adventitious filaments. **D**. Upper branch with trichoblasts bearing procarps on their suprabasal segment. **E**. Cystocarp. **F**. Branches with paired, decussate, tetrasporangia.

Adventitious filaments similar to trichoblasts, arising from cortical cells and sparse to prolific on lower branches. Lateral branches arise from base of trichoblasts. Cells uninucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps (Fig. 118D) developed on second cell of trichoblasts, with 5 pericentral cells, the adaxial one developing a carpogonial branch and probably sterile cells. Carposporophytes with a small basal fusion cell and branched gonimoblast filaments with clavate terminal carposporangia 20–30 µm in diameter, replaced from below. Cystocarps (Fig. 118E) urceolate, base globose and 400–600 µm in diameter, with a short but distinct neck; pericarp ostiolate, 2–3 cells thick. Spermatangial organs on lower branches of trichoblasts, with a sterile basal cell and upper sterile filament, 40–100 µm long and 20–35 µm in diameter (possibly juvenile).

Tetrasporangia in lesser branches (Fig. 118F) with normal trichoblasts, fertile parts 0.5–1 mm long and 80–110 µm in diameter, with paired decussate tetrasporangia 30–55 µm in diameter, each with 2–3 cover cells.

Type from Port Phillip Heads, Vic. (*Wilson*, 25.i.1893); holotype in Herb. Agardh, LD, 43932, isotype in MEL, 1006687).

Distribution: Only known from Port Phillip Heads, Vic., and eastern coast of Gulf St Vincent, S. Australia.

Selected specimens: Port Stanvac, S. Aust., 3 m deep on jetty pylon (*R. Lewis*, 19.ix.1972; AD, A42704). Port Noarlunga, S. Aust., 19 m deep on tyre reef (*Branden*, 26.iii.1987; AD, A57442).

Genus **LOPHOTHALIA** (Harvey)Kützing 1849: 797.

Thallus erect, radially branched, corticated, branches clothed with rhodoplastic, relatively persistent, trichoblasts, in some species also with adventitious monosiphonous filaments from the pericentral or cortical cells; holdfast discoid or fibrous. *Structure* monopodial, trichoblasts cut off from axial cells close to apices, with 5 to 7 pericentral cells developed in alternating sequence, clear or obscured in transverse section. Trichoblasts and adventitious filaments unbranched, slender. Cells multinucleate.

Reproduction. Gametophytes dioecious. Procarps developing on a lower cell of trichoblasts which becomes polysiphonous. Carposporophytes with a basal fusion cell and branched gonimoblast filaments with clavate terminal carposporangia. Cystocarps globular or urceolate, with or without a slight neck; pericarp ostiolate, usually not corticated. Spermatangial organs covering lower cells of trichoblasts with sterile basal and terminal cells.

Tetrasporangia formed in lesser branches, usually with trichoblasts, in decussate pairs each with 3 cover cells.

Type species: *L. verticillata* (Harvey)Kützing 1849: 797.

Lophothalia was established as a subgenus of *Dasya* by Harvey (1847, p. 64) and elevated to genus by Kützing (1849, p. 797). It differs from *Doxodasya* essentially in the number of pericentral cells, 5–7 compared to 4 in the latter genus.

KEY TO SPECIES OF *LOPHOTHALIA*

1. Trichoblasts more or less whorled on each segment, with frequent adventitious monosiphonous filaments from the cortex; pericentral cells 5, remaining clear in transverse section; trichoblasts 30–50 (-60) µm in diameter .... 1. *L. verticillata*
1. Trichoblasts single from each segment, adventitious filaments absent or rare; branches usually infected with a hydroid (*Halecium sp.*); pericentral cells 6 or 7, becoming inconspicuous in transverse section of older branches; trichoblasts 50–130 µm in diameter .... 2. *L. hormoclados*

1. **Lophothalia verticillata** (Harvey)Kützing 1849: 797; 1864: 30, pl. 86. J. Agardh 1890: 61. De Toni 1903: 1018. Falkenberg 1901: 534, pl. 13 figs 24–28. Guiler 1952: 104. Kylin 1956: 511. Lucas 1909: 43; 1929a: 22; 1929b: 51. Lucas & Perrin 1947: 285. May 1965: 378. Parsons 1975: 653, figs 28, 29, 41B. Reinbold 1897: 57. Schmitz 1893: 219. Wilson 1892: 166. Womersley 1966: 153.

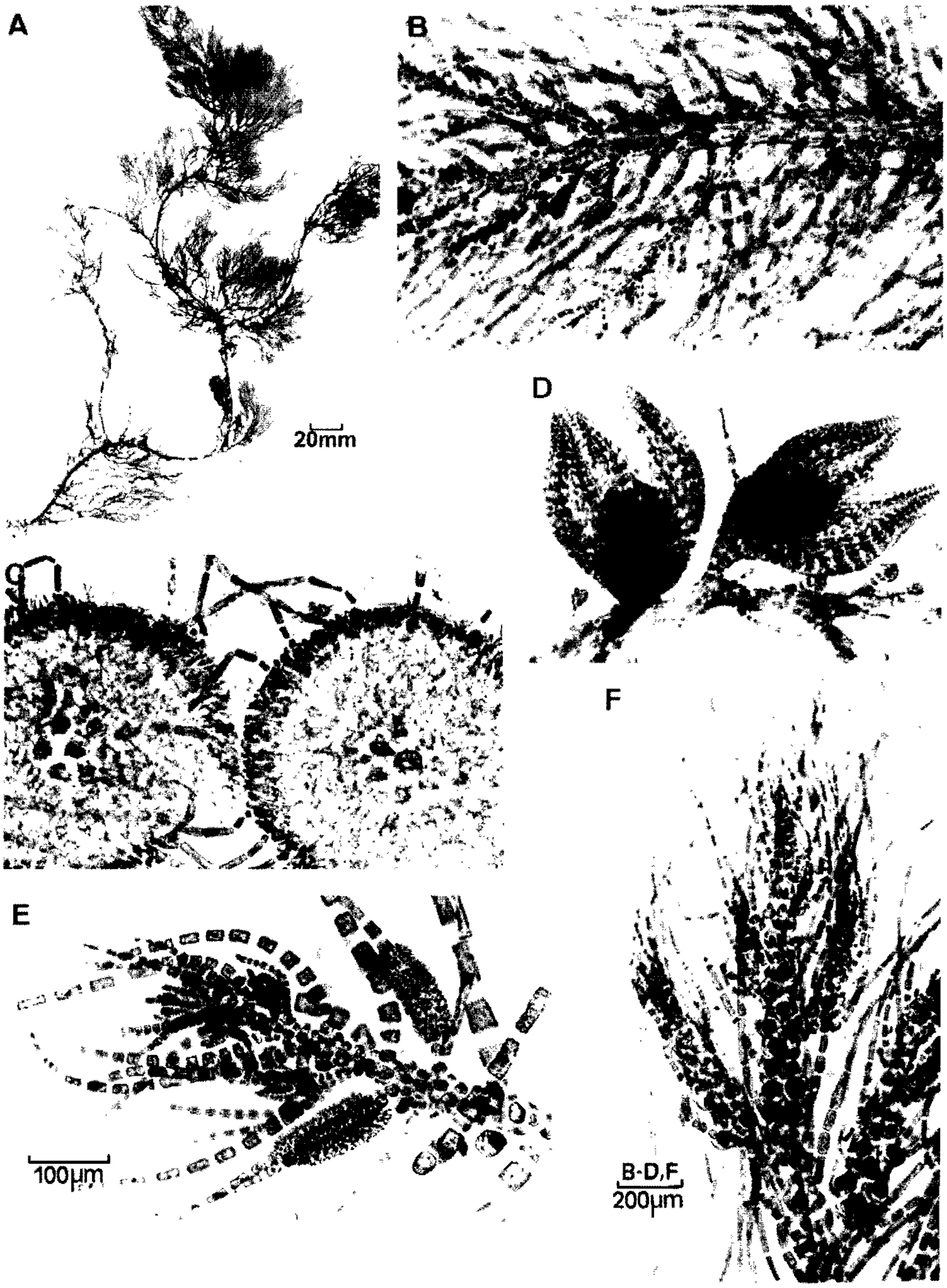

Fig. 119. *Lophothalia verticillata* (**A**, **B**, AD, A41396; **C**, AD, A33500; **D**, AD, A23095; **E**, AD, A66795; **F**, AD, A53198). **A**. Habit. **B**. Branch with trichoblasts and adventitious filaments. **C**. Transverse sections of axes. **D**. Cystocarps. **E**. Branch with spermatangial organs. **F**. Branches with paired, decussate, tetrasporangia.

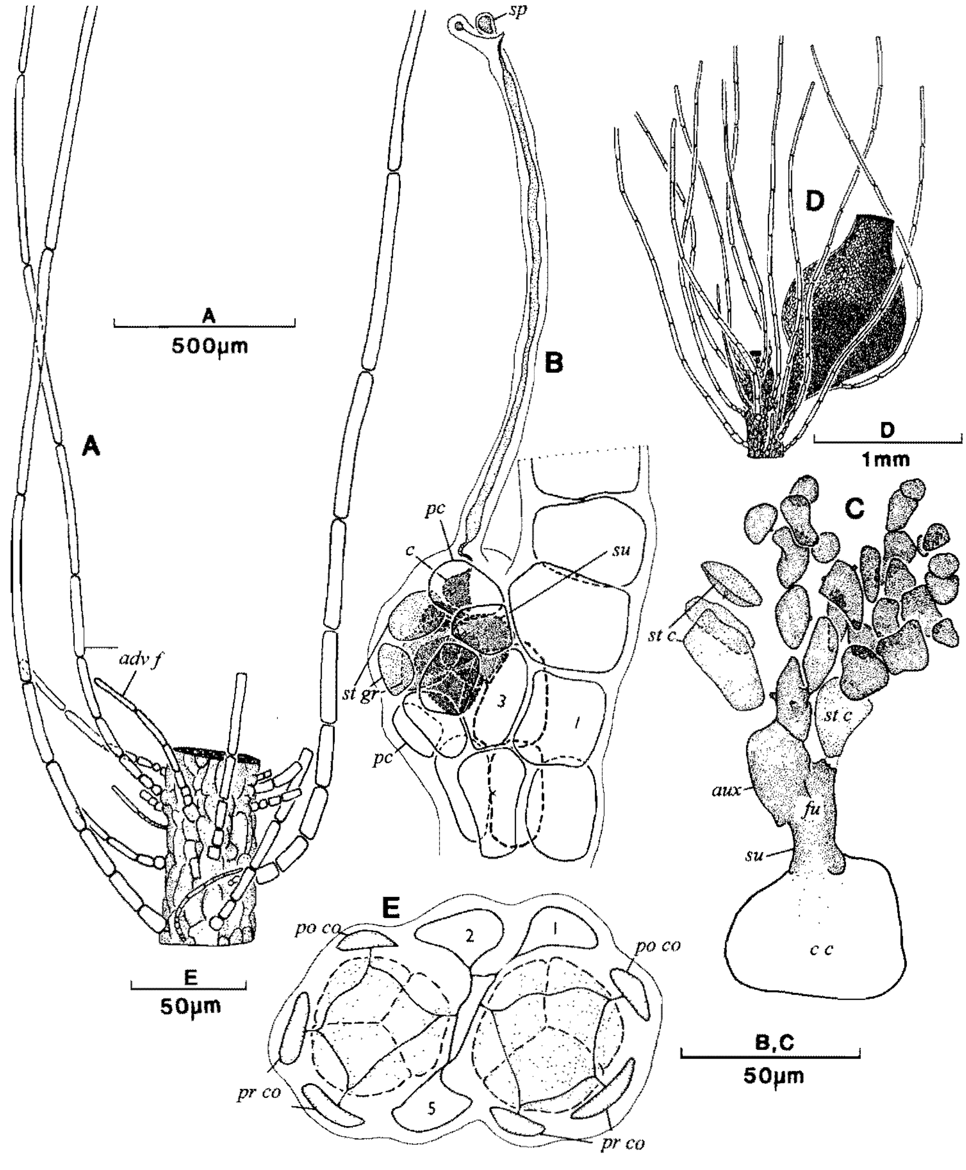

Fig. 120. *Lophothalia verticillata* (**A–D**, AD, A30712; **E**, AD, A23095). **A**. Young axis with trichoblasts and adventitious filaments. **B**. Procarp. **C**. Carposporophyte with basal fusion cell and gonimoblast. **D**. Mature cystocarp. **E**. Cross section of a stichidium with paired tetrasporangia. (All as in Parsons 1975, courtesy of Aust. J. Bot.)

Dasya verticillata Harvey 1844b: 434; 1846: 422; 1847: 64, pl. 24; 1859b: 304; 1863, synop.: xxiv. J. Agardh 1863: 1234; 1890: 61. Sonder 1853: 702; 1880: 36.

FIGS 119, 120

Thallus (Fig. 119A) medium to dark red-brown, fading to grey-red, 10–30 (-50) cm high, much branched with robust, cartilaginous, usually branched main axes (1-) 2–3 mm in diameter, bearing delicate, slender, irregular, terete laterals for 3–5 orders, basally 0.5–1 mm in diameter, tapering to 50–100 µm in diameter below apices; cortication commencing near apices but slight on laterals, becoming thick and dense on axes. Laterals clothed throughout (Fig. 119B) with slender, simple, rhodoplastic trichoblasts (one per axial cell) and monosiphonous adventitious filaments (Fig. 120A) arising from the pericentral cells more or less in a whorl. Holdfast divided, fibrous, 3–10 (-15) mm across; epilithic or on jetty piles. *Structure* monopodial, with axial cells producing 5 pericentral cells in alternating sequence, sometimes with 1 or 2 further intercalated cells, pericentral cells usually clear in transverse section (Fig. 119C). Trichoblasts 30–50 (-75) µm in diameter with basal cells L/D 1–2, increasing above to L/D 3–8 (-20); adventitious filaments similar but slightly more slender. Lateral branches arising on lower cells of trichoblasts. Cells uninucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps (Fig. 120B) arising 4–7 cells from base of trichoblasts, with 5 pericentral cells, the last-formed cutting off a sterile group initial (becoming 3-celled) then the initial of the 4-celled carpogonial branch. Carposporophyte (Fig. 120C) with a broad to erect fusion cell with short, branched, gonimoblast filaments bearing clavate terminal carposporangia 30–45 µm in diameter, replaced from lower cells. Cystocarps (Figs 119D, 120D) urceolate with a short stalk and slight neck, 1–1.5 mm in diameter; pericarp ostiolate, 2 cells thick. Spermatangial organs (Fig. 119E) covering the basal part of the trichoblasts with a sterile upper filament, elongate, 180–250 µm long and 30–50 µm in diameter.

Tetrasporangial stichidia (Fig. 119F) transformed from vegetative branches, 0.5–1.5 mm long and 100–180 µm in diameter, bearing trichoblasts, with decussate pairs (Fig. 120E) of tetrasporangia 50–80 µm in diameter, each with 2 pre-sporangial and 1 post-sporangial cover cells.

Type from Georgetown, Tas.; holotype Gunn 1306 in BM.

Distribution: Tapley Shoal, S. Aust., to San Remo, Vic., and N Tasmania.

Selected specimens: Outside Tapley Shoal (Edithburg), S. Aust., 15 m deep (*Shepherd*, 2.ii.1969; AD, A33500). Aldinga, S. Aust., drift (*Womersley*, 17.ix.1966; AD, A30712–data in Parsons 1975, p. 653 incorrect). Granite I. causeway, Victor Harbor, S. Aust., 7–10 m deep (*Edyvane*, 8.viii.1982; AD, A53198). Vivonne Bay, Kangaroo I., S. Aust., 2–4 m deep on jetty pylons (*Kraft & MinThein*, 4.xii.1971; AD, A41396). Penneshaw, Kangaroo I., S. Aust., on rope on jetty, 7 m deep (*Lavers*, 16.ix.1996; AD, A66795). Stinky Bay Point, Nora Creina, S. Aust., 3–5 m deep (*Miller*, 28.x.1996; AD, A67205). St Leonards, Port Phillip, Vic., 1–3 m deep (*Womersley*, 9.viii.1959; AD, A23095). Port Phillip, Vic., 17 m deep, N bay (*Macpherson*, 18.x.1959; AD, A24659). San Remo, Vic. drift on outer beach (*Sinkora* A1964, 27.xi.1974; AD, A55598). Low Head, Tas. (*Perrin*, 11.xi.1950; AD, A16496). Bridport, Tas., drift (*Womersley & Parsons*, 6.xi.1982; AD, A54547). Mussleroe Bay, Tas. (*Perrin*, Mar. 1950; AD, A49964).

L. verticillata was described in detail by Parsons (1975, p. 653). It differs from *L. hormoclados* in developing whorled trichoblasts and copious adventitious filaments and in their distinctly smaller cells.

2. **Lophothalia hormoclados** (J. Agardh)J. Agardh 1890: 59. De Toni 1903: 1019. Falkenberg 1901: 537. Kylin 1956: fig, 405A. Lucas 1909: 43; 1929a: 22. Lucas & Perrin 1947: 286. May 1965: 378. Schmitz 1893: 219. Shepherd 1983: 83. Wilson 1892: 166.
Dasya hormoclados J. Agardh 1841: 32; 1863: 1188. Harvey 1849a: 65, pl. 26; 1863, synop.: xxiv. Sonder 1880: 36.
Eupogonium (?) *hormoclados* (J. Agardh)Kützing 1849: 799.

FIG. 121

Thallus (Fig. 121A) medium to dark red-brown, fading to grey-red, 20–50 cm high, much branched with denuded, cartilaginous, branched axes 1–3 (-4) mm in diameter bearing apically and laterally (proliferous on older axes) dense, soft, tufts 2–5 cm long of slender, terete, laterals, irregularly radially branched for 3–5 orders, basally 200–500 µm in diameter and tapering to 100–200 µm in diameter below apices; cortication (Fig. 121C) commencing

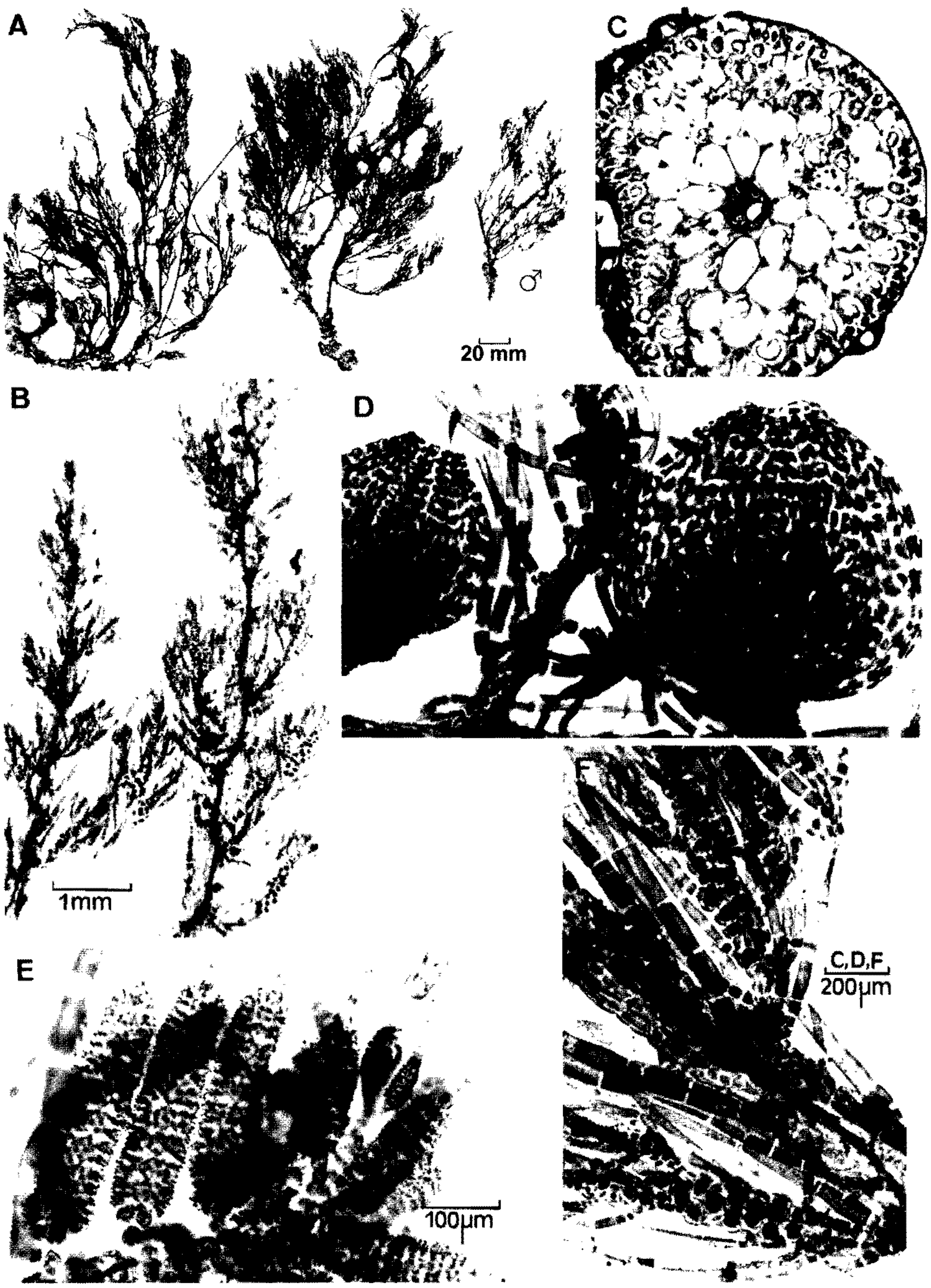

Fig. 121. *Lophothalia hormoclados* (**A**, **C**, AD, A62826; **B**, **F**, AD, A26651; **D**, **E**, AD, A56804). **A**. Habit. **B**. Branches with tetrasporangia and dark line of the endophytic hydroid. **C**. Transverse section of axis. **D**. Cystocarps. **E**. Spermatangial organs. **F**. Branch bearing trichoblasts and with decussate tetrasporangia.

close to apices but slight above, becoming thick on axes. Laterals clothed with simple, relatively robust rhodoplastic trichoblasts (Fig. 121B) arising singly from each segment, adventitious filaments absent or rare. Axes and laterals usually infested with a hydroid (*Halecium* sp.) (Fig. 121B). Holdfast discoid, becoming fibrous and 1–3 cm across; epilithic or on jetty piles. *Structure* monopodial with 6 or 7 pericentral cells which become separated by smaller cells and inconspicuous in transverse section of older branches. Trichoblasts tapering gradually throughout or more so apically, 50–130 µm in diameter below with basal cells L/D 1–1.5, increasing to L/D 3–4 (-8) in mid and upper cells, then tapering to subterminal cells 15–20 µm in diameter, terminal cells pointed. Cells multinucleate; rhodoplasts discoid, becoming chained.

Reproduction. Gametophytes dioecious. Procarps developing on a lower cell of trichoblasts, this and lower cells becoming polysiphonous. Carposporophytes with a basal fusion cell and branched gonimoblast filaments with clavate terminal carposporangia 30–45 µm in diameter, replaced from below. Cystocarps (Fig. 121D) globular, 700–1000 µm in diameter, with a short stalk and no (or slight) neck; pericarp ostiolate, 2 cells thick. Spermatangial organs (Fig. 121E) densely aggregated, covering lower cells of trichoblasts with 1–3 basal sterile cells and a terminal sterile filament; fertile parts 200–400 µm long and 40–90 µm in diameter.

Tetrasporangia (Fig. 121F) occur in lesser ultimate branch systems 1–2 mm long and 90–180 µm in diameter, bearing a trichoblast from each segment; tetrasporangia in decussate pairs, 60–120 µm in diameter, with 3 cover cells.

Type from "Nov. Holl" (Herb. Binder); holotype in Herb. Agardh, LD, 42012. Probable isotype in Herb. Sonder, MEL, 1005957 (ex Herb. Binder).

Distribution: Fowlers Bay, S. Aust., to Bemm reef, Vic., and around Tasmania.

Selected specimens: Fowlers Bay, S. Aust., 15 m deep (*Edyvane*, 19.vi.1994; AD, A64433). Ward I., S. Aust., 18–23 m deep (*Shepherd*, 3.iii.1980; AD, A50908). Schnapper Point, Port Lincoln, S. Aust., 6–8 m deep (*Baldock*, 1.i.1964; AD, A27094). N Spencer Gulf, S. Aust., 11 m deep (*Shepherd*, 4.ix.1973; AD, A44108). Tiparra reef, S. Aust., 7 m deep (*Shepherd*, 12.i.1978; AD, A49397). Investigator Strait, S. Aust., 33 m deep (*Watson*, 24.i.1971; AD, A41077). Outside Tapley Shoal, Edithburg, S. Aust., 15 m deep (*Shepherd*, 2.ii.1969; AD, A33495). Off Outer Harbor, S. Aust., 16 m deep (*Loan*, 9.viii.1963; AD, A26651). Off Grange, S. Aust., on tyre reef, 20 m deep (*Branden*, 5.x.1985: AD, A56804—"Marine Algae of southern Australia" No. 421). Aldinga, S. Aust., drift (*Womersley*, 7.ix.1986; AD, A57138). Granite I., Encounter Bay, S. Aust., eastern side of causeway, 7–10 m deep (*Edyvane*, 8.viii.1982; AD, A53199). Pennington Bay, Kangaroo I., S. Aust., drift (*Womersley*, 22.viii.1954; AD, A19762). Gypsum Wharf, Ballast Head, Kangaroo I., S. Aust., on jetty piles, 0–5 m deep (*Kraft*, 16.vii.1972; AD, A42454). Penneshaw, Kangaroo I., S. Aust., 7 m deep on jetty (*Lavers*, 14.ix.1996; AD, A66784). Robe, S. Aust., on jetty piles, 3 m deep (*Collings & Hotchkiss*, 26.ix.1992; AD, A62826). Nelson, Vic., drift (*Womersley*, 29.xii.1981; AD, A52864). Off Redcliffe, Phillip I., Vic., 5 m deep (AIMS-NCI Q66C-3382-R; 12.ii.1990; AD, A60364). Walkerville, Vic., drift (*Sinkora* A2290, 6.iii.1976; AD, A48445). Bemm reef, E Vic., 15–17 m deep (*Kraft & Foard*, 8.ii.2001; MELU, K11096). Low Head, Tas. (*Perrin*, 25.x.1937; AD, A9031). Charlotte Cove, SE Tas, 9 m deep (*Edgar*, 6.x.1999; AD, A68349).

Genus GONATOGENIA J. Agardh 1896: 115.

Thallus erect, radially and irregularly branched, usually denuded of trichoblasts except near apices, cartilaginous and heavily corticated; holdfast discoid. *Structure* monopodial, trichoblasts simple, rhodoplastic, cut off from axial cells near apices, each with 3–7 small, isodiametric, basal cells with upper cells distinctly longer. Pericentral cells cut off from subapical axial cells, 5–7 which become separated by small cells and indistinct in larger branches. Cells multinucleate.

Reproduction. Reproductive organs borne on small branch systems in axils of upper lateral branches.

Gametophytes dioecious. Procarps developing on a small basal cell of trichoblasts which becomes polysiphonous. Carposporophytes with a large basal fusion cell producing gonimoblast filaments with clavate terminal carposporangia. Cystocarps ovoid to globular, without a neck; pericarp ostiolate, with small outer cortical cells. Spermatangial organs developed on trichoblasts.

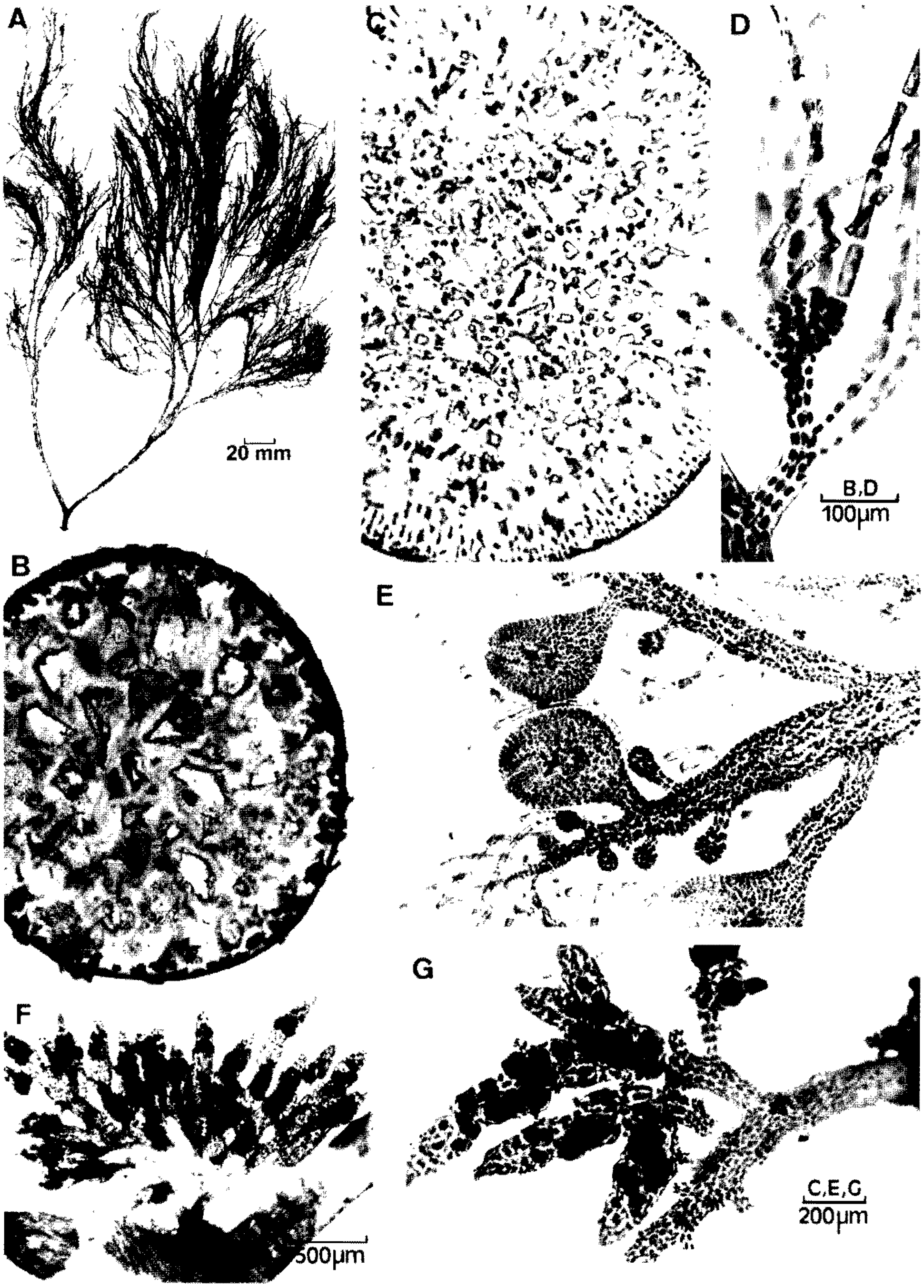

Fig. 122. *Gonatogenia subulata* (**A**, **D**, **E**, AD, A38640; **B**, AD, A64815; **C**, AD, A67006; **F**, **G**, AD, A59295). **A**. Habit. **B**. Transverse section of young branch. **C**. Transverse section of older branch. **D**. Young branch with simple trichoblasts with minute basal cells. **E**. Branch with young cystocarps. **F**. Axillary cluster of stichidia. **G**. Stichidia with decussate pairs of tetrasporangia.

Stichidia developed from axillary branch systems, bearing trichoblasts on their upper segments, with tetrasporangia in decussate pairs.

Type species: *G. subulata* J. Agardh 1896: 118.

Gonatogenia is characterised by habit, the variable number of pericentral cells (5–7), by the caducous simple trichoblasts each with a row of small basal cells, and by the reproductive organs borne on branch systems in the axils of upper laterals. *Spirophycus* Millar (2000b) has very similar trichoblasts to *Gonatogenia* but the thallus is ecorticate and the tetrasporangia single per segment.

Maschalostroma Schmitz *in* Schmitz & Falkenberg (1897, p. 435), with type *M. fastigiatum* Falkenberg, is based on a denuded form of *Alsidium comosum sensu* J. Agardh (1890, p. 52) [referred to by Schmitz (1893, p. 230) and Falkenberg (1901, p. 231) as forma *denudata*] as is *Gonatogenia subulata*.

Gonatogenia subulata J. Agardh 1896: 118. Kylin 1956: 512, fig. 406. May 1965: 379. Shepherd & Womersley 1981: 367. Silva *et al.* 1996: 494.

Maschalostroma fastigiatum Falkenberg *ex* Schmitz & Falkenberg 1897: 435. De Toni 1903: 816.

Maschalostroma scoparium Schmitz *ex* Hauptfleisch 1897: 570 (*nomen nudum*). Falkenberg 1901: 233, pl. 22 figs 24, 25. Lucas 1929b: 51. Reinbold 1898: 50.

Alsidium ? *comosum sensu* J. Agardh 1890: 52, pl. 2 fig. 2.

FIG. 122

Thallus (Fig. 122A) medium to dark red-brown, fading to yellow-brown, 20–60 (-100) cm high, cartilaginous, much branched irregularly with thickened main axes 1–3 mm in diameter below and long laterals (0.5–1 mm in diameter, becoming progressively shorter and slenderer, ultimate laterals usually 1–2 cm long and 100–200 μm in diameter; all branches terete, bare of trichoblasts below the apices. Holdfast discoid, 1–4 (-8) mm across; epilithic. *Structure* monopodial, with subapical cells cutting off 5–7 pericentral cells (Fig. 122B), soon becoming corticated, pericentral cells becoming separated by smaller irregular cells and indistinct in older branches (Fig. 122C). Trichoblasts rhodoplastic, only present near apices, simple, with 3–7 small, isodiametric, basal cells (Fig. 122D), then increasing rapidly to (15-) 20–35 (-50) μm in diameter and L/D 3–8 (-12). Cells multinucleate; rhodoplasts discoid.

Reproduction. Reproductive organs borne on small branch systems (Fig. 122F) in axils of upper laterals.

Gametophytes dioecious. Procarps developing on a small basal cell of the trichoblasts which then become polysiphonous. Carposporophytes with a large basal fusion cell producing erect, clavate, terminal carposporangia. Cystocarps (Fig. 122E) ovoid, becoming globular, 1–2 mm in diameter, short-stalked, without a neck; pericarp ostiolate, thick, with outer small cortical cells. Spermatangial organs 150–250 μm long and 35–45 μm in diameter.

Stichidia (Fig. 122F, G) in axillary, basally branched (or from the primary branch) tufts 1–2 mm long, fertile branches 600–1000 μm long and 150–350 μm in diameter, with trichoblasts on the upper segments, tetrasporangia in decussate pairs, 100–180 μm in diameter.

Lectotype from Port Phillip (Heads) or Western Port, Vic. (*Wilson*, 7.iv.1893); in Herb. Agardh, LD, 42240. Selection of a lectotype is uncertain but should be based on a specimen labelled "Port Phillip Heads *or* Western Port" and labelled "TYPUS" in LD. J. Agardh referred to several locations in his protologue, but not to Western Port.

Distribution: Flinders I., S. Aust. to Walkerville, Victoria. Not known in Western Australia as inferred by Silva *et al.* 1996, p. 494.

Selected specimens: "The Hotspot", W of Flinders I., S. Aust., 32 m deep (*Branden*, 21.vi.1988; AD, A59295). Elliston, S. Aust., 11 m deep in bay (*Shepherd*, 14.v.1971; AD, A38640). Off Troubridge Light (Edithburg), S. Aust., 18 m deep (*Shepherd*, 4.ii.1969; AD, A33567). Victor Harbor, S. Aust, drift (*Womersley*, 22.iv.1951; AD, A15505). Cape Jervis, S. Aust., 15 m deep (*Shepherd*, 5.xii.1985; AD, A56953). Pennington Bay, Kangaroo I., S. Aust., drift (*Womersley*, 22.viii.1954; AD, A19767). Ironstone Point, E of Penneshaw, Kangaroo I., S. Aust., 6 m deep (*Lavers*, 13.iii.1996; AD, A64815) and 10–15 m deep (*Lavers*, 12.i.1997; AD, A67006). Kingston, S. Aust., drift (*Womersley*, 9.viii.1961; AD, A24870). Robe, S. Aust., drift (*Womersley*, 23.ix.1986; AD, A57204). Double Corner Beach, Portland, Vic., drift (*Beauglehole*, 22.vi.1952; AD, A21536). Point Leo, Western Port, Vic., drift (*Wollaston*, 19.viii.1956; AD, A20576). Walkerville, Vic., drift (*Sinkora* A2345, 5.iii.1977; AD, A48389).

Gonatogenia subulata is characterised by its habit, denuded of trichoblasts except close to apices, by the row of 3–7 small cells at the base of the simple trichoblasts, and by the occurrence of reproductive organs on branched axillary systems. The number of pericentral cells varies from 5 to usually 6 or 7, which especially in dried specimens are often not clear.

In describing *G. subulata*, J. Agardh (1896, p. 118) based it on his mis-interpretation (as f. *denudata* according to Schmitz & Falkenberg 1897, p. 435) of *Alsidium comosum* Harvey (now *Holotrichia comosa*) and he referred to f. *comosa* and f. *subulifera*. Schmitz *in* Schmitz & Falkenberg (1897, p. 435) described *Maschalostroma fastigiata* Falkenberg, based on the same J. Agardh mis-interpretation, and Falkenberg (1901, p. 233) used the name *M. scoparium* for the same species. Kylin (1956, p. 512) realised these names applied to the one taxon, and the forms appear to be only growth states.

Tribe HETEROCLADIEAE Falkenberg 1901: 731

Thallus erect, irregularly radially branched, with or without divergent basal and upper parts, branches heavily corticated, terete or compressed, upper branches usually with prominent rhodoplastic trichoblasts. *Structure* monopodial, apical cells distinct, with 4 pericentral cells formed in alternating sequence and dividing longitudinally to form a ring of 7–8 cells around the axial cell, then cutting off outer cortical cells which show both longitudinal and transverse divisions; rhizoidal filaments developed abundantly from the inner cells, separating and obscuring the pericentral cells. Trichoblasts produced exogenously at apices from each segment, cells with abundant rhodoplasts.

Reproduction. Gametophytes dioecious. Procarps on lower trichoblast cells (usually the second) with the supporting cell bearing a 4-celled carpogonial branch and a single sterile group of 3 cells. Carposporophytes with a basal fusion cell, and branched gonimoblast with clavate terminal carposporangia. Cystocarps stalked to subsessile, ovoid, pericarp ostiolate, corticated, 4–5 cells thick. Spermatangial organs developed on branches of trichoblasts, with sterile apical cells, axial cells with 4 pericentral cells, cutting off initials which produce an outer layer of spermatangia.

Tetrasporangia in swollen branchlets bearing numerous trichoblasts, spirally arranged, single per segment, the stichidium corticated.

Type genus: *Heterocladia* Decaisne 1842: 359.

Genus HETEROCLADIA Decaisne 1842: 359

Description as for the tribe Heterocladieae.

Type species: *Heterocladia australis* Decaisne 1842: 359.

Heterocladia has been recently monographed by Phillips, Choi, Saunders & Kraft (2000), who have shown that *Trigenia* Sonder (1845, p. 54) is not generically distinct and *Heterocladia* then contains 3 species.

KEY TO SPECIES OF *HETEROCLADIA*

1. Axes terete to compressed, laterals irregular, much branched; lower part compressed, upper branches terete .... 1. *H. australis*
1. Axes terete, bearing short and dense or more-or-less clustered and umbellate laterals 2
    2. Determinate laterals dense and irregular on axes, terete, usually 5–15 mm long and 300–500 µm in diameter .... 2. *H. caudata*
    2. Laterals irregularly to umbellately arranged on axes, terete to slightly compressed, usually 2–8 cm long and 600–900 µm in diameter .... 3. *H. umbellifera*

1. **Heterocladia australis** Decaisne 1842: 359. (1841: 177, 178, pl. V figs 18–22, without specific name). J. Agardh 1863: 1250; 1897: 90, pl. 2 figs 6, 7? De Toni 1903: 1126. Falkenberg 1901: 588, pl. 12 figs 16–21. Harvey 1863, synop.: xviii. Hommersand 1863: 338. Kylin 1956: 556, fig. 443B. Lucas 1909: 47. May 1965: 399. Phillips *et*

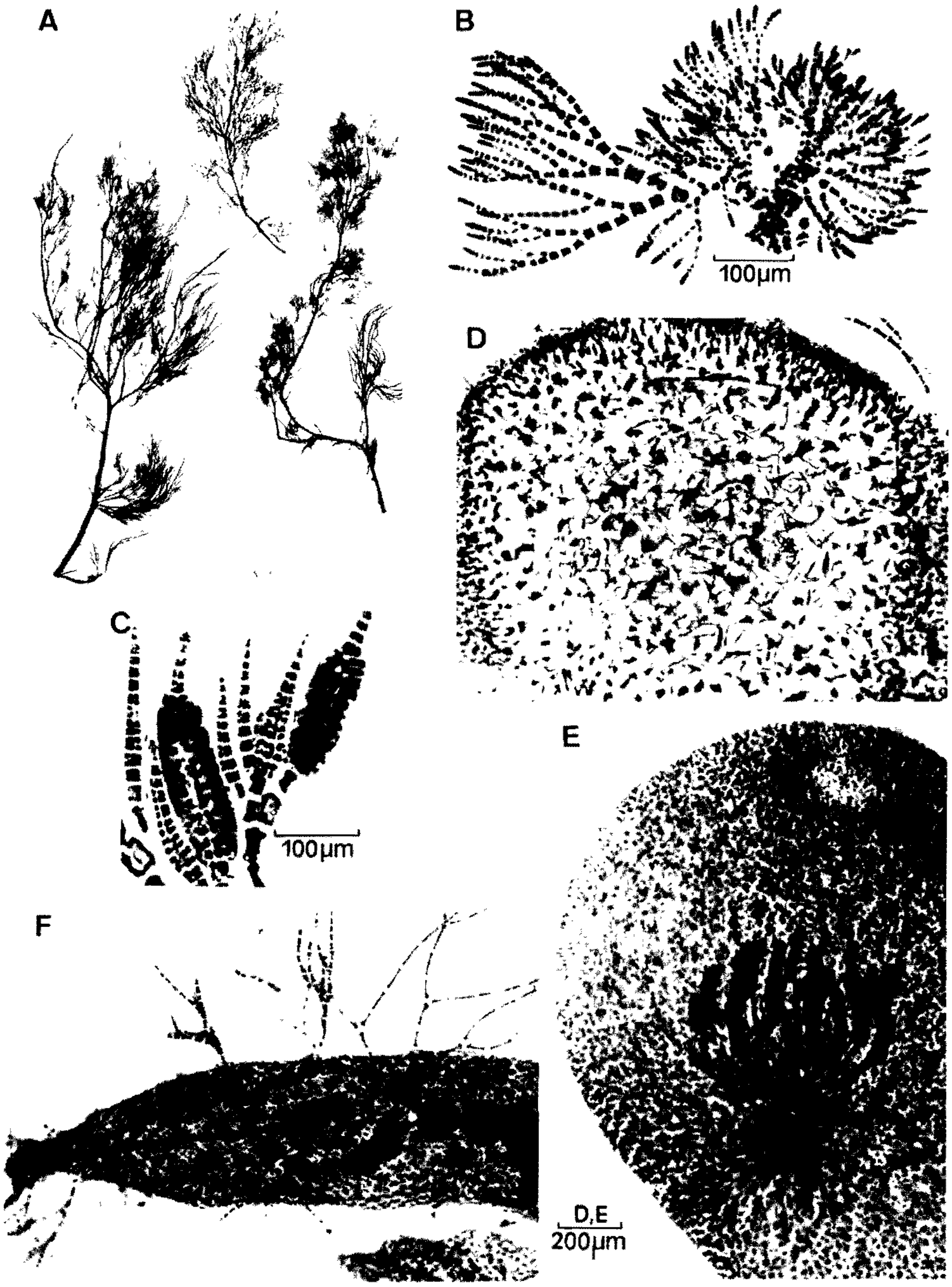

Fig. 123. *Heterocladia australis* (**A**, **E**, **F**, AD, A34227; **B**, **D**, AD, A42573; **C**, MELU, K9985, by L.E. Phillips). **A**. Habit. **B**. Apex with trichoblasts. **C**. Spermatangial organs on trichoblasts. **D**. Transverse section of branch. **E**. Cystocarp with carposporophyte. **F**. Branch with tetrasporangia and trichoblasts.

al. 2000: 203, figs 2–35. Schmitz 1889: 447. Schmitz & Falkenberg 1897: 454, fig. 255. Silva *et al.* 1996: 500. Sonder 1880: 33.

Heterocladia prolifera Decaisne *ex* Kützing 1849: 879, *nom. illegit.*; 1866: 3, pl. 7a–f.

Coeloclonium gracilipes J. Agardh 1897: 47.

Dolichoscelis gracilipes (J. Agardh)J. Agardh 1899: 120. De Toni 1903: 828. Falkenberg 1901: 215. Gordon-Mills & Womersley 1987: 561. Kylin 1956: 551. Lucas 1909: 40. Lucas & Perrin 1947: 257. May 1965: 383. Silva *et al.* 1996: 491.

FIG. 123

Thallus (Fig. 123A) erect, medium to dark red-brown, (10-) 20–50 cm high, with a prominent, terete to slightly compressed main axis 1–3 (-5) mm broad, bearing irregularly but usually densely lateral branches 2–15 cm long with compressed lower parts 0.5–3 cm long and 2–6 (-14) mm broad, surmounted by terete, irregularly branched, upper parts 4–14 cm long, often profusely covered with trichoblasts. Holdfast discoid, 3–6 mm across, often fibrous; epilithic or on calcareous algae. *Structure.* Growth apical (Fig. 123B), monopodial, apical cell dome-shaped 30–40 µm in diameter (with thick walls), axial cells with 4 pericentral cells, rapidly and extensively corticated with rhizoidal filaments (Fig. 123D) from the pericentral and inner cells, pericentral cells soon obscured, inner cortical cells large, outermost small. Trichoblasts from each segment below apices, 1–3 mm long, branched from each lower cell with the walls adherent at each dichotomy, lower cells 30–55 µm in diameter and L/D 2–3, rhodoplastic. Cells multinucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps usually on the second cell of trichoblasts, the supporting cell bearing a 4-celled carpogonial branch and a sterile 3-celled group. Carposporophyte (Fig. 123E) with a basal fusion cell and a short, branched, gonimoblast with clavate terminal carposporangia 80–150 µm in diameter. Cystocarps stalked, ovoid, 1–2.5 mm in diameter; pericarp ostiolate, corticated, 4–5 cells thick. Spermatangial organs (Fig. 123C) on branches of trichoblasts, elongate-ovoid, 50–70 µm in diameter and 150–200 µm long, with 4 pericentral cells and a 3–4-celled sterile apex.

Tetrasporangia (Fig. 123F) borne in lesser, simple or compound, corticated, branches, bearing abundant trichoblasts, spirally arranged and single per tier, 150–270 µm in diameter.

Type from "cotes occidentale Nova Hollandiae" (*Leschenault*); holotype in PC.

Distribution: Geraldton, W. Aust., to Gulf St Vincent, S. Australia.

Selected specimens: Geraldton, W. Aust., drift (*G. & R. Kraft*, 9.x.1990; MELU, K9985; AD, A67880). Eyre, W. Aust., drift (*Gordon*, 22.xi.1968; AD, A34227). Elliston, S. Aust., drift (*Womersley*, 27.ii.1959; AD, A22221) and 25 m deep outside bar (*Shepherd*, 25.x.1971; AD, A42573). 3 km SE of Troubridge I., S. Aust., 24 m deep (*Shepherd*, 5.ii.1969; AD, A33890). Gulf St Vincent, S. Aust., 20 fathoms (40 m) deep (AD, A1224, A16141).

Heterocladia australis is a rare, deep-water alga most common in the Geraldton region of Western Australia. The unusual type specimen and the species morphology and variation have been discussed by Phillips *et al.* 2000, p. 203.

2. **Heterocladia caudata** Phillips, Choi, Saunders & Kraft 2000: 218.

Trigenia australis Sonder 1845: 54; 1848: 181; 1880: 33. J. Agardh 1863: 1248; 1890: 116; 1894: 83–87; 1899: 122. De Toni 1903: 1124. Falkenberg 1901: 583. Harvey 1847: 37; 1855a: 538. Hommersand 1963: 338. Kützing 1849: 841; 1866: 20, pl. 57a–e. Kylin 1956: 556. Lucas 1909: 47. Lucas & Perrin 1947: 305 (in part). May 1965: 384. Phillips *et al.* 2000: 208, figs 36–52. Schmitz 1889: 446. Schmitz & Falkenberg 1897: 454. Silva *et al.* 1996: 555. Tate 1882a: 22. Tisdall 1898: 513.

Rhodomela trigenia Harvey 1860: pl. 126; 1863, synop.: xviii. Tisdall 1898: 513.

FIG. 124A–C

Thallus (Fig. 124A) dark red-brown, erect, 20–60 cm high, with a terete to slightly compressed main axis bearing a few similar main lateral branches 5–20 cm long, all bearing a dense cover of terete, determinate, simple or occasionally branched, laterals 0.5–1.5 cm long and 300–500 µm in diameter, some bearing trichoblasts; axes denuded below, cartilaginous, 2–5 mm in diameter. Holdfast discoid with fibrous outgrowths, 2–10 mm across; epilithic. *Structure.* Apices tapering, apical cell dome-shaped, thick walled, axial cells cutting off 4 pericentral cells, rapidly corticated and producing abundant rhizoidal filaments from inner cells obscuring the pericentral cells; older axes have a medulla largely of entangled rhizoids (Fig. 124B) with a thin outer cortex of small cells. Trichoblasts are produced apically from each segment, 300–900 µm long, below branched 2 cells apart with adherent walls at the branchings, lower cells 35–70 µm in diameter and L/D mostly 1–1.5, rhodoplastic. Cells uni- or multinucleate; rhodoplasts discoid to elongate.

Reproduction. Procarps usually on the second cell of trichoblasts, with the supporting cell bearing a 4-celled carpogonial branch and a sterile group of 3 cells. Carposporophytes with a basal fusion cell and a short, branched, gonimoblast with clavate terminal carposporangia

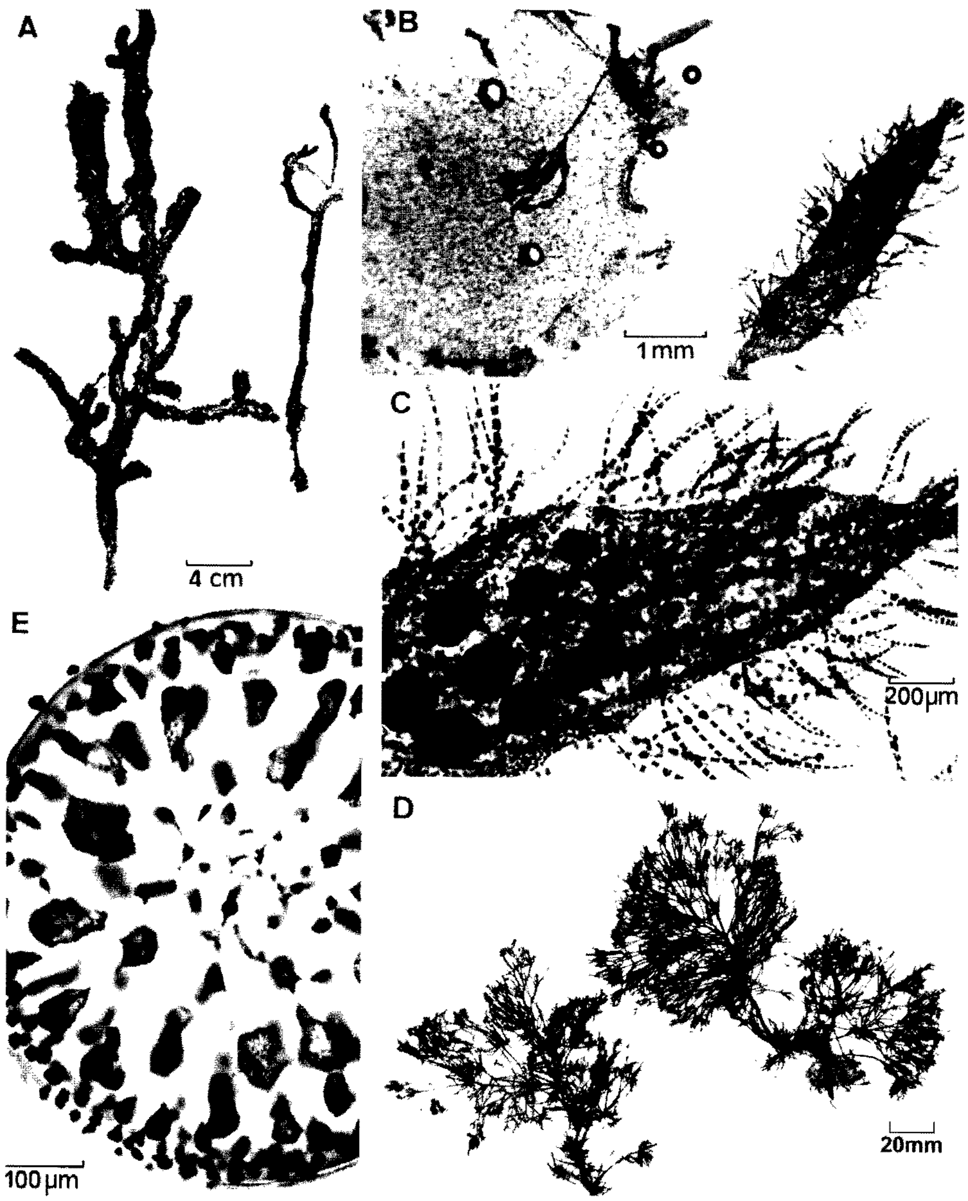

Fig. 124. A–C. *Heterocladia caudata* (**A**, AD, A34169; **B**, **C**, AD, A33214). **A**. Habit. **B**. Transverse section of branch and tetrasporangial branch. **C**. Branch with tetrasporangia and trichoblasts. **D**, **E**, *Heterocladia umbellifera* (AD, A68393). **D**. Habit. **E**. Transverse section of young branch.

50–150 µm in diameter. Cystocarps stalked or subsessile, ovoid, 800–1200 µm in diameter; pericarp ostiolate, corticated, 4–5 cells thick. Spermatangia unknown.

Tetrasporangia (Fig. 124C) borne in simple or branched, corticated, determinate laterals bearing trichoblasts, spirally arranged, single per tier, 120–250 µm in diameter.

Type from "occid. Novae Hollandiae"; holotype in MEL, 537394.

Distribution: Geraldton to Hopetoun, W. Australia.
Auckland Is? (Papenfuss 1964b: 64).

Selected specimens: Geraldton, W. Aust., drift (*Kraft & Herrington*, 9.x.1990; MELU, K9984). Port Denison, W. Aust., drift (*Kraft* 3971, 14.xii.1971; MELU and AD, A41738), and (*Woelkerling*, 8.xi.1968; AD, A33214). Cliff Head, W. Aust., drift (*Womersley*, 18.ix.1979; AD, A51231). Hopetoun, W. Aust., drift (*Gordon*, 20.xi.1968; AD, A34169).

Heterocladia caudata is only known from drift specimens and appears to be largely restricted to the west coast of Australia; the Hopetoun specimen may have been transported in an easterly current from the west coast.

Many specimens of *H. umbellifera* have been misidentified as *Trigenia australis* (*H. caudata*), and any of the references to *T. australis* referring to localities east of Western Australia are probably incorrect. Some Kangaroo I. specimens in AD had been tentatively identified as *T. australis* but are now referred to *H. umbellifera*. True *H. caudata* appears to not occur east of Hopetoun, W. Australia.

3. **Heterocladia umbellifera** (Zanardini)Womersley, *comb. nov.*

Corallopsis? *umbellifera* Zanardini 1874: 498. De Toni 1900: 461.

Trigenia umbellata J. Agardh 1890: 116; 1899: 122, pl. 2 figs 1–6. De Toni 1903: 1125. Falkenberg 1901: 583, pl. 12 figs 14, 15. Lucas 1909: 47; 1929b: 51. Lucas & Perrin 1947: 305, fig. 145. May 1965: 384. Phillips *et al.* 2000: 211, figs 53–72. Reinbold 1897: 56. Shepherd & Womersley 1981: 369. Wilson 1892: 164. Womersley 1950: 190.

Trigenia australis sensu Reinbold 1898: 50.

Heterocladia umbellata (J. Agardh)Phillips *et al.* 2000: 218.

Chondriopsis cartilaginea J. Agardh 1892: 160.

Chondria cartilaginea (J. Agardh)De Toni 1903: 848. Gordon-Mills & Womersley 1987: 558.

FIGS 124D, E, 125

Thallus (Fig. 124D) medium to dark red, erect, 5–40 cm high, with a terete to slightly compressed main axis, 2–4 mm in diameter, bearing similar main lateral branches irregularly, 5–15 cm long, all with radial and irregularly positioned (but often clustered and appearing somewhat umbellate), more or less determinate, branched laterals 2–8 cm long and 600–900 µm in diameter, bearing trichoblasts; axes denuded below. Holdfast discoid, 2–6 mm across; epilithic. *Structure*. Apices tapering, apical cell dome-shaped, thick walled, 25–35 µm in diameter, axial cells cutting off 4 pericentral cells, rapidly corticated (Fig. 124E) and older branches with abundant rhizoidal filaments forming a largely rhizoidal medulla with the pericentral cells obscured (Fig. 125A), and a small-celled cortex. Trichoblasts (Fig. 125B) produced apically from each segment, 600–900 µm long, basally branched from usually every second cell, basal walls adherent, lower cells 40–80 µm in diameter and L/D 1–1.5, rhodoplastic. Cells probably uninucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps on a lower cell of trichoblasts (Fig. 125B), with the supporting cell bearing a 4-celled carpogonial branch and a sterile group of 3 cells, rapidly pericarpic. Carposporophytes (Fig. 125C) with a basal fusion cell and short, branched, gonimoblast with clavate terminal carposporangia 90–150 µm in diameter. Cystocarps stalked, ovoid, 1–2 mm in diameter; pericarp ostiolate, corticated, 5–7 cells thick. Spermatangial organs (Fig. 125D, E) on branches of trichoblasts, 90–120 µm in diameter and L/D (2-) 3–5, with 4 pericentral cells and 4–8 fertile segments, with a sterile apex 2–4 cells long.

Tetrasporangia (Fig. 125F) borne in simple or branched, corticated, determinate laterals bearing trichoblasts, spirally arranged, single per tier, borne adaxially (upwards) from the 4 pericentral cells, 180–320 µm in diameter.

Type from Port Phillip, Vic. (*Mueller*); lectotype in Herb. Zanardini, Venice.

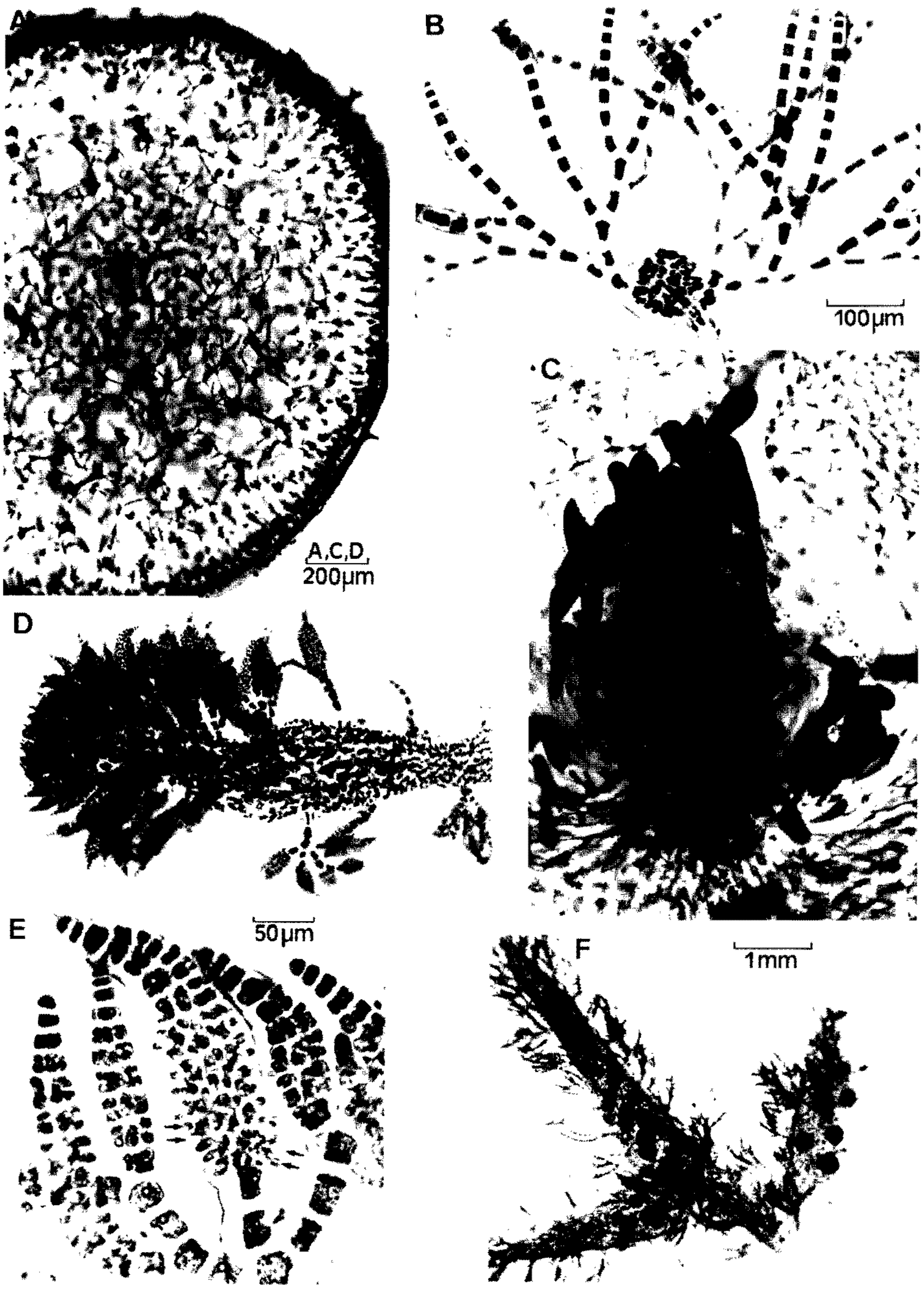

Fig. 125. *Heterocladia umbellifera* (**A**, **F**, AD, A68393; **B**, AD, A66631; **C**, AD, A68097; **D**, AD, A38659; **E**, MELU, K10663, by L.E. Phillips.) **A**. Transverse section of older branch. **B**. Trichoblasts with juvenile cystocarp. **C**. Carposporophyte. **D**. Spermatangial organs on trichoblasts. **E**. Spermatangial organs with initials producing 2 spermatangia (arrows). **F**. Branches with tetrasporangia and trichoblasts.

Distribution: Eyre, W. Aust., to Cape Patterson, Victoria.

Selected specimens: Eyre, W. Aust., drift (*Woelkerling*, 22.xi.1968; AD, A34244). Head of Great Australian Bight, S. Aust., drift (*Womersley*, 4.ii.1954; AD, A19224). Off Waterloo Bay, S. Aust., 18–20 m deep (*Shepherd*, 24.iv.1999; AD, A68107). Elliston, S. Aust., 17 m deep outside bar (*Shepherd*, 12.v.1971; AD, A38659). Top Gallant I., S. Aust., 35 m deep (*Branden*, 2.vii.1987; AD, A57553). Bashams Beach, Port Elliot, S. Aust., drift (*Womersley*, 18.ix.1999; AD, A68393). West Bay, Kangaroo I., S. Aust., drift (*Womersley*, 14.i.1965; AD, A28938). Robe, S. Aust., drift (*Womersley*, 2.iv.1999; AD, A68097). Cape Lannes, S. Aust., drift (*Womersley*, 25.iv.2000; AD, A68530). Stinky Bay, Nora Creina, S. Aust., drift (*Womersley*, 22.iv.2000; AD, A68534). Port MacDonnell, S. Aust., drift (*Womersley*, 29.ix.1996; AD, A66631). Warrnambool, Vic., drift (*G, R. & L. Kraft*, 13.vii.1997; MELU, K10663). Port Phillip Heads, Vic. (*Wilson*, 12.iv.1887; MEL, 659552). Cape Patterson, Vic., drift (*Ducker*, 18.v.1972; MELU, 21426).

This species has been generally known as *Trigenia umbellata*, but an older epithet is *umbellifera* of Zanardini, hence the new combination *Heterocladia umbellifera* is here made. It is common in the drift in South Australia and western Victoria and has been collected *in situ* from 3 to 35 m deep.

Heterocladia umbellifera is closely related to *H. caudata*, differing in form and arrangement, length, branching and diameter of the determinate laterals. Some specimens from the west of South Australia (e.g. A28938, A34244, A68107) have compressed determinate laterals, but otherwise agree with *H. umbellifera*; their relationship with *H. australis* also needs investigation. Unfortunately, these specimens are sterile and do not bear trichoblasts.

Tribe HERPOSIPHONIEAE Schmitz & Falkenberg 1897: 457

Thallus completely to partially prostrate, often with erect or free upper parts. Branching exogenous, with defined sequences of indeterminate and determinate lateral branches, the determinate laterals simple or becoming slightly to regularly branched. Indeterminate axes compressed or subterete, bilaterally or radially developed, apices usually dorsiventrally developed, often curved upwards (dorsally), axes attached by rhizoids from ventral or lateral pericentral cells. Pericentral cells 4 to 16, not divided transversely, usually ecorticate (slightly corticate in *Gredgaria*). Trichoblasts usually present on determinate laterals, often rare.

Reproduction. Gametophytes dioecious, occasionally monoecious. Procarps borne on basal cells of trichoblasts, the fertile axial cells soon becoming polysiphonous. Carposporophytes with a basal fusion cell, branched gonimoblast and clavate terminal carposporangia. Cystocarps ovoid to urceolate, lateral on determinate laterals; pericarp ostiolate, usually ecorticate. Spermatangial organs ovoid to lanceoid, on trichoblasts, usually with sterile basal and apical cells.

Tetrasporangia in straight to curved determinate laterals, single per segment, in straight to slightly curved rows, with 2–3 cover cells.

Type genus: *Herposiphonia* Nägeli 1846: 238.

The tribe includes some 9 genera, 7 on southern Australian coasts including 3 newly described below, distinguished by the defined but varied patterns of branching involving regular sequences of indeterminate and determinate laterals or of determinate lateral and branch initials only; the indeterminate laterals may remain only slightly developed or may grow into longer lateral axes, whereas the determinate ones usually remain short, simple or slightly branched. The branching patterns of the new genera are usually regular and ally them with other Herposiphonieae, such as *Ditria* and *Womersleyella* described by Hollenberg (1967a). The branching patterns of several genera have been analysed by Schneider & Walde (1992).

KEY TO GENERA OF HERPOSIPHONIEAE

1. Axes with 3 or 5–7 (-13) simple, determinate laterals between each indeterminate lateral 2
1. Axes with single or paired determinate laterals on alternate sides of the indeterminate axes 3

2. Axes with 3 simple determinate laterals between each indeterminate lateral .... HERPOSIPHONIA
2. Axes with 5–7 (-13) simple determinate laterals between each indeterminate lateral .... HERPOSIPHONIELLA

3. Prostrate axes with erect branches 1–3 cm high; successive axial segments with a long semi-determinate branch, a short indeterminate branch, and no branch on 1 (-3) segments .... TIPARRARIA
3. Prostrate axes with distichously arranged and largely prostrate lateral branches; determinate laterals paired or single 4

4. Determinate laterals appearing paired from successive segments on alternate sides of axes 5
4. Determinate laterals single on alternate sides of axes 6

5. Determinate lateral pairs on successive segments of axes .... DIPTEROSIPHONIA
5. Determinate lateral pairs usually separated by one segment with only a small cell cut off from the axial cell .... DITRIA

6. Determinate laterals pinnately branched, each alternate pair separated by an axial segment with only a cell formed by division of a dorsal pericentral cell; cortication absent .... HERPOPTEROS
6. Determinate laterals simple, becoming pinnate, separated by a single segment and with small clusters of corticating cells lying over the end walls of the pericentral cells, later spreading .... GREDGARIA

Genus HERPOSIPHONIA Nägeli 1846: 238

Thallus prostrate or with erect, free, lateral indeterminate axes bearing determinate laterals, from a few mm to several cm high. Branching pattern of 3 determinate laterals on consecutive segments, separated from the next group of 3 by one indeterminate lateral, occasionally developed as a long lateral axis; determinate laterals usually more-or-less erect from alternate sides of successive segments of axes, in some species pectinately or distichously arranged. Indeterminate axes terete to slightly compressed, determinate laterals terete. Pericentral cells 6–16, ecorticate. Trichoblasts absent on indeterminate axes but usually present subterminally on determinate laterals. Attachment by rhizoids cut off from ventral pericentral cells, with digitate haptera; usually epiphytic.

Reproduction. Cystocarps lateral on determinate laterals, ovoid. Spermatangial organs on branches of trichoblasts.

Tetrasporangia in determinate laterals, single per segment, with 2–3 cover cells.

Lectotype species: *H. tenella* (C. Agardh)Ambronn 1880: 197.

A genus of 20–30 species found on most coasts, with 6 species recorded below from southern Australia. Several other species probably occur there but descriptions await collection of more adequate material. Species of *Herposiphonia* are not easy to categorise or separate and the degree of variation in many is uncertain. The account below deals only with recognised and previously named species. Comparisons with species from other regions (e.g. the tropical Pacific – Hollenberg 1968b; Abbott 1999, pp. 368–378) are needed in a more extensive monographic study.

KEY TO SPECIES OF *HERPOSIPHONIA*

1. Prostrate axes extensive, attached for most of their length, with simple, erect, determinate laterals 1–3 mm high .... 1. *H. calothrix*
1. Prostrate axes of limited extent, with extensive erect indeterminate branches 1–12 cm long, bearing shorter determinate laterals 2

2. Thallus relatively robust, axes usually over 200 µm in diameter and determinate laterals over 100 µm in diameter 3

2. Thallus slender, axes usually less than 200 µm in diameter and determinate laterals less than 100 µm in diameter 4

3. Branching of indeterminate axes irregular, with determinate laterals variously orientated; axes 200–600 µm in diameter, determinate laterals 100–200 µm in diameter; colour often orange-brown .... 2. *H. versicolor*
3. Branching of indeterminate axes usually pectinate with determinate laterals mostly abaxial; axes usually 300–450 µm in diameter, determinate laterals 100–150 µm in diameter; colour red .... 3. *H. rostrata*

4. Erect branches 1–2 cm high, branching dense, determinate laterals not pectinate; axial segments 90–140 µm in diameter, L/D 1–2 (-3), determinate lateral segments, L/D 1–2 (-3) .... 4. *H. filipendula*
4. Erect branches usually 3–6 cm high, branching open with pectinate determinate laterals; axes 160–260 or 80–110 µm in diameter, determinate lateral segments L/D 1–1.6 or 3–4 5

5. Axes 160–260 µm in diameter, segments L/D 0.8–1.2, determinate laterals 50–90 µm in diameter, segments L/D 1–1.6; tetrasporangia markedly swelling segments .... 5. *H. monilifera*
5. Axes 80–110 µm in diameter, segments L/D 2–4, determinate laterals 45–60 µm in diameter, segments L/D 3–4; tetrasporangia unknown .... 6. *H. pectinella*

1. **Herposiphonia calothrix** (Harvey)Womersley, *comb. nov.*

Polysiphonia calothrix Harvey 1855a: 541; 1862a: pl. 185C; 1863, synop.: xxi. J. Agardh 1863: 942. Askenasy 1888: 50, pl. 10 figs 14–17. Kützing 1864: 13, pl. 38f, g. Sonder 1880: 35.

Lophosiphonia? calothrix (Harvey)De Toni 1903: 1071. Lucas 1909: 45. Lucas & Perrin 1947: 294. May 1965: 380; 1970: 82. Millar & Kraft 1993: 56.

FIG. 126

Thallus (Fig. 126A, B) forming low mats, with extensive prostrate axes bearing simple, erect, 1–2 mm high, determinate laterals on 3 consecutive segments (Fig. 126A), separated by short indeterminate laterals, some developing into lateral axes (Fig. 126B) adherent to the substrate. Attachment by rhizoids; epilithic or epiphytic on *Corallina* and *Codium*. *Structure.* Apices of indeterminate axes dorsally revolute (Fig. 126A), apical cells hemispherical, 10–15 µm in diameter. Axes 100–220 (-250) µm in diameter, segments L/D 0.6–1 (-2), with 8–9 (-12) pericentral cells; determinate laterals (Fig. 126C) arising dorsally, 70–100 µm in diameter, segments L/D (0.6-) 1–2, with 7–8 (-9) pericentral cells. Trichoblasts near ends of determinate laterals, 0.5–1 mm long, much branched, lower cells 12–18 µm in diameter. Rhizoids cut off from ventral pericentral cells, unicellular with digitate haptera (branch ends often cut off as separate cells). Cells multinucleate; rhodoplasts discoid to elongate, then often in parallel stacks.

Reproduction. Gametophytes dioecious. Procarps with a 4-celled carpogonial branch. Cystocarps (juvenile) ovoid; pericarp arising prefertilization, 2 cells thick with small corticating cells. Spermatangial organs (Fig. 126D) replacing trichoblasts on mid to upper parts of determinate laterals, lanceoid, 100–550 µm long and 50–120 µm in diameter, with a sterile basal cell and terminal row of 2–5 sterile cells.

Tetrasporangia (Fig. 126E) in straight series in determinate laterals, one per segment, 50–75 µm in diameter, with 2–3 cover cells.

Type from King George Sound, W. Aust., on mid-tide rocks; lectotype Harvey, Alg. Aust. Exsicc. 178B (Trav. Set 337 missing in 1952).

Distribution: Dirk Hartog I. and Sorrento, W. Aust., to Encounter Bay, S. Australia. Botany Bay and Long Reef, N.S.W. (May 1970, p. 82).

Selected specimens: Hillary Boat Harbour, Sorrento, W. Aust., 6 m deep on reef (AIMS-NCI Q66C 2603-U, 11.iii.1989; AD, A59631). Vlaming Head, Rottnest I., W. Aust., on limpets on reef (*Woelkerling*, 8.ii.1978; AD, A49301). Frenchman Bay, King George Sound, W. Aust., mid eulittoral on rock (*Womersley*, 29.viii.1979; AD, A51657) and on *Corallina*, lower eulittoral (*Womersley*, 29.viii.1979; AD, A51658). Scott Bay (W of Fowler Bay), S. Aust., reef pools (*Womersley*, 27.i.1951; AD, A14989). Elliston, S. Aust., on *Codium pomoides*, shaded lower eulittoral (*Womersley*, 15.i.1951;

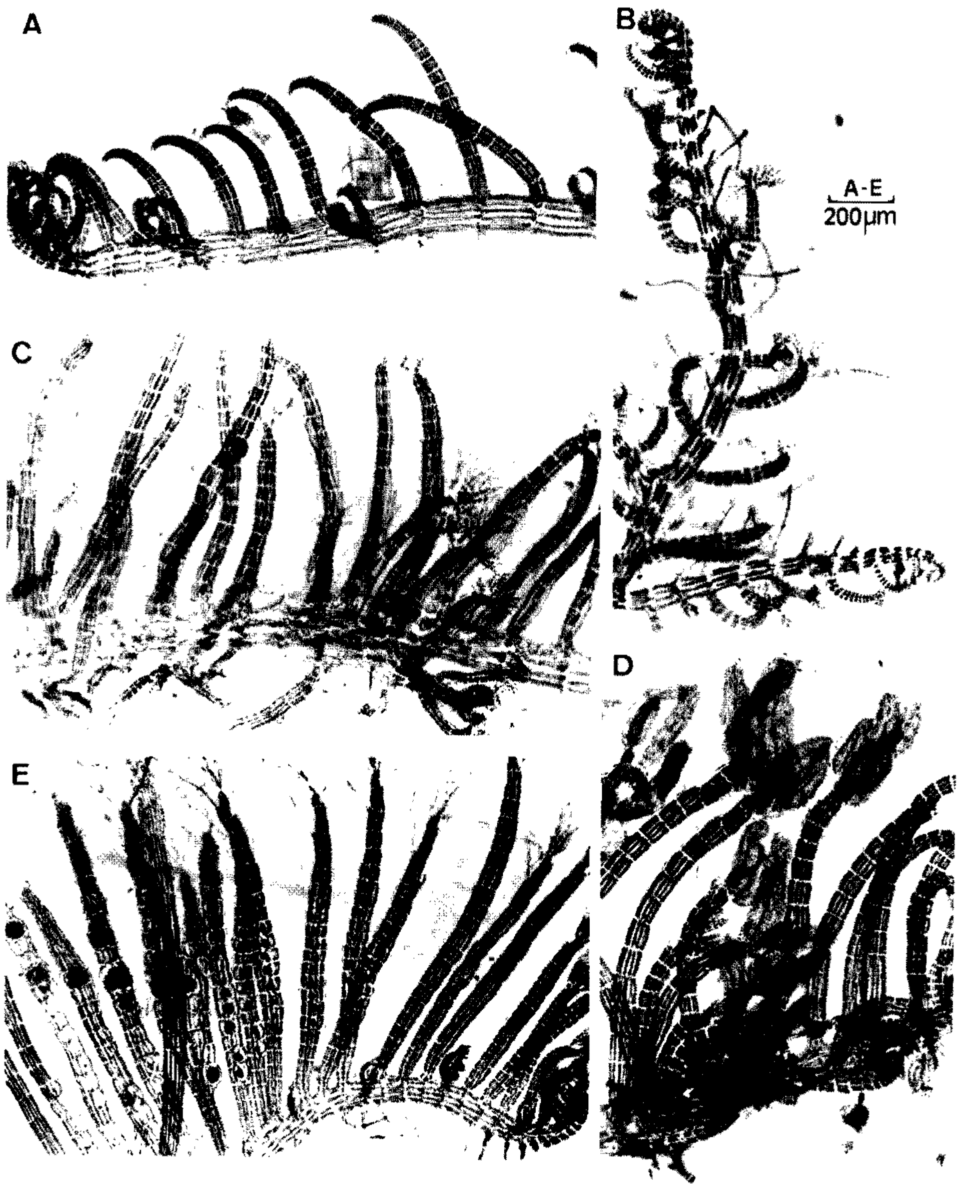

Fig. 126. *Herposiphonia calothrix* (**A**, **D**, AD, A32493; **B**, AD, A51658; **C**, AD, A51657; **E**, AD, A49301). **A**. Indeterminate branch with apex and young indeterminate laterals separated by 3 determinate laterals. **B**. Older axis showing branching pattern and determinate laterals with trichoblasts. **C**. As for **B**, in more detail. **D**. Spermatangial organs on determinate laterals. **E**. Determinate laterals with tetrasporangia.

AD, A14956) and on *C. capitulatum*, low eulittoral in shade (*Woelkerling*, 16.v.1968; AD, A32493). Point Westall, S. Aust., on *Codium capitulatum*, shaded pool (*Womersley*, 19.i.1951; AD, A13803). Wright I., Encounter Bay, S. Aust., lower eulittoral (*Womersley*, 15.iv.1978; AD, A49260).

Material from the type locality clearly shows that this species is a *Herposiphonia*, occurring mainly in the lower intertidal.

H. calothrix is distinct from other species in its mat-like habit with entirely prostrate indeterminate axes.

2. **Herposiphonia versicolor** (Hooker & Harvey)Reinbold 1899: 50. De Toni 1903: 1056; 1924: 419. De Toni & Forti 1923: 45. Ducker *et al.* 1977: 87. Falkenberg 1901: 315. Guiler 1952: 106. Lucas 1909: 44; 1929a: 23, 1929b: 51. Lucas & Perrin 1947: 293, fig. 138. Shepherd 1983: 83. Shepherd & Womersley 1971: 166; 1981: 368.

Polysiphonia versicolor Hooker & Harvey 1847: 399. J. Agardh 1863: 922; 1896: 111. Harvey 1847: 48, pl. 16; 1855a: 541; 1859b: 301; 1863, synop.: xxi. Kützing 1849: 805; 1863: 11, pl. 31a–c. Reinbold 1897: 57. Sonder 1853: 701; 1855: 524; 1880: 35. Tate 1882a: 23. Tisdall 1898: 514. Wilson 1892: 167.

Polysiphonia argus Kützing 1864: 17, pl. 48. De Toni 1903: 960. Lucas & Perrin 1947: 275.

FIG. 127

Thallus (Fig. 127A) dark red-brown to orange-red, largely erect, tufted and densely branched, 2–12 cm high, basally attached with free, terete, more or less pinnate branches with 3 (rarely 4) simple determinate laterals between each indeterminate branch, more or less spirally arranged. Attachment by rhizoids; epiphytic on various hosts, probably also epilithic. *Structure*. Apices surrounded by dense curved branches (Fig. 127B); apical cells hemispherical, 10–18 µm in diameter. Pericentral cells (Fig. 127B) 8–10, axes 200–600 µm in diameter, segments L/D 0.4–0.8 (-1), determinate laterals mostly 1–3 mm long, 100–200 µm in diameter, segments L/D 1–1.5 (-2). Trichoblasts profuse on determinate laterals, 1–2 mm long, much branched, lower cells 25–35 µm in diameter, L/D 1–2 (-5), elongate when mature. Rhizoids cut off from pericentral cells, unicellular with digitate haptera. Cells multinucleate; rhodoplasts discoid to elongate, becoming chained.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with an inconspicuous fusion cell and short, densely branched, gonimoblast with clavate terminal carposporangia 20–35 µm in diameter. Cystocarps (Fig. 127C) sessile or short-stalked, lateral on determinate laterals, ovoid to slightly urceolate, 300–600 µm in diameter; pericarp ostiolate, 2 cells thick, ecorticate, outer cells rounded. Spermatangial organs (Fig. 127D) replacing trichoblasts, with 1–2 sterile basal cells and a sterile terminal filament 2–several cells long, 35–65 µm in diameter and 150–220 µm long.

Tetrasporangia (Fig. 127E) in straight rows in determinate laterals, single per segment, 60–90 (-120) µm in diameter, with 3 cover cells.

Type from Tasmania (*Gunn*), probably N coast; lectotype in BM.

Distribution: Yanchep, W. Aust., to San Remo, Vic., and around Tasmania.

Selected specimens: Yanchep, W. Aust., drift (*Womersley*, 22.ix.1979; AD, A51263). Frenchman Bay, Albany, W. Aust., drift (*Parsons*, 18.xi.1968; AD, A33230). Pearson Is, S. Aust., 8 m deep (*Shepherd*, 12.i.1968; AD, A33659). N Spencer Gulf, S. Aust., 10 m deep (*Shepherd*, 5.ix.1973; AD, A44228). Tiparra Reef, S. Aust., on *Amphibolis griffithii*, 11 m deep (*Shepherd*, 13.xii.1971; AD, A41218). Dany Beach, Corny Point, S. Aust., on *Amphibolis antarctica*, drift (*Womersley*, 13.x.1989; AD, A59905). Marion Bay, Yorke Pen., S. Aust., on *Cystophora monilifera*, drift (*Womersley*, 9.x.1998; AD, A67939). 3 km SE of Troubridge I., S. Aust., 24 m deep (*Shepherd*, 5.ii.1969; AD, A33894). Brighton, S. Aust., on *Amphibolis antarctica*, drift (*Bienert*, 12.xi.1965; AD, A29670). Granite I., Encounter Bay, S. Aust., on *Gelidium australe*, 7–10 m deep (*Edyvane*, 8.viii.1982; AD, A60620). Seal Bay, Kangaroo I., S. Aust., drift (*Womersley*, 29.x.1966; AD, A31087). Strawbridge Point, Kangaroo I., S. Aust., drift (*Womersley*, 29.x.1995; AD, A64614). Robe, S. Aust., drift (*Womersley*, 11.xii.1969; AD, A34869). Blackfellows Caves, SE S. Aust., drift (*Womersley*, 20.xi.1998; AD, A68042). Double Corner Beach, Portland, Vic., drift (*Beauglehole*, 22.vii.1951; AD, A21571). San Remo, Vic., drift (*Sinkora* A1917, 5.xii.1974; AD, A49476, MEL, 504898). Low Head, Tas., drift (*Perrin*, Jan. 1937; AD, A9025). Bridport, Tas., drift (*Womersley*, 23.x.1986; AD, A57794). White Rock, E of Ninepin Point, SE Tas., 0–5 m deep (*Sanderson*, 14.xii.1999; AD, A68691).

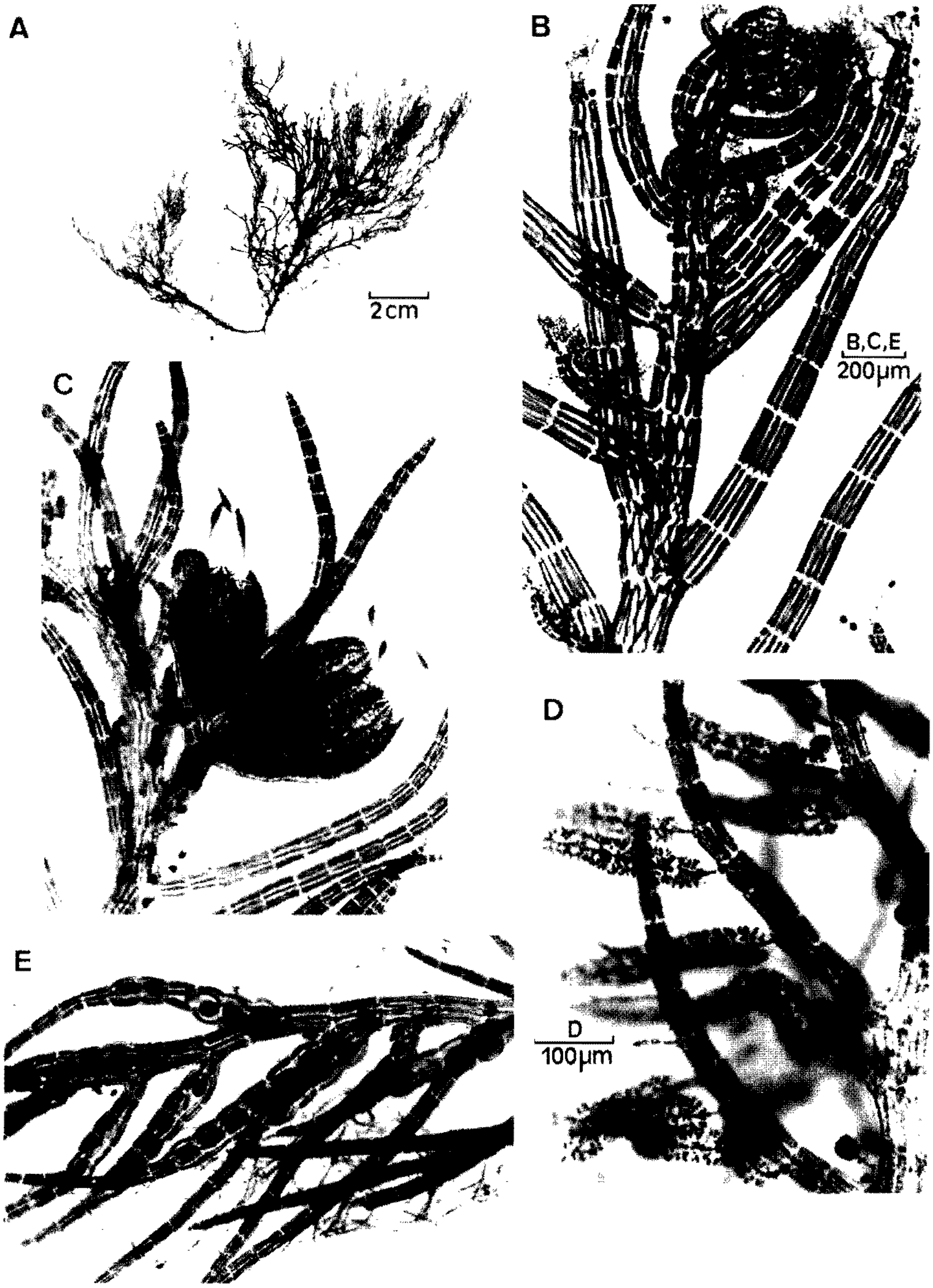

Fig. 127. *Herposiphonia versicolor* (AD, A57794). **A**. Habit, slender plant. **B**. Apex of branch with indeterminate and determinate laterals. **C**. Branches with cystocarps. **D**. Spermatangial organs on determinate laterals. **E**. Tetrasporangia in determinate laterals.

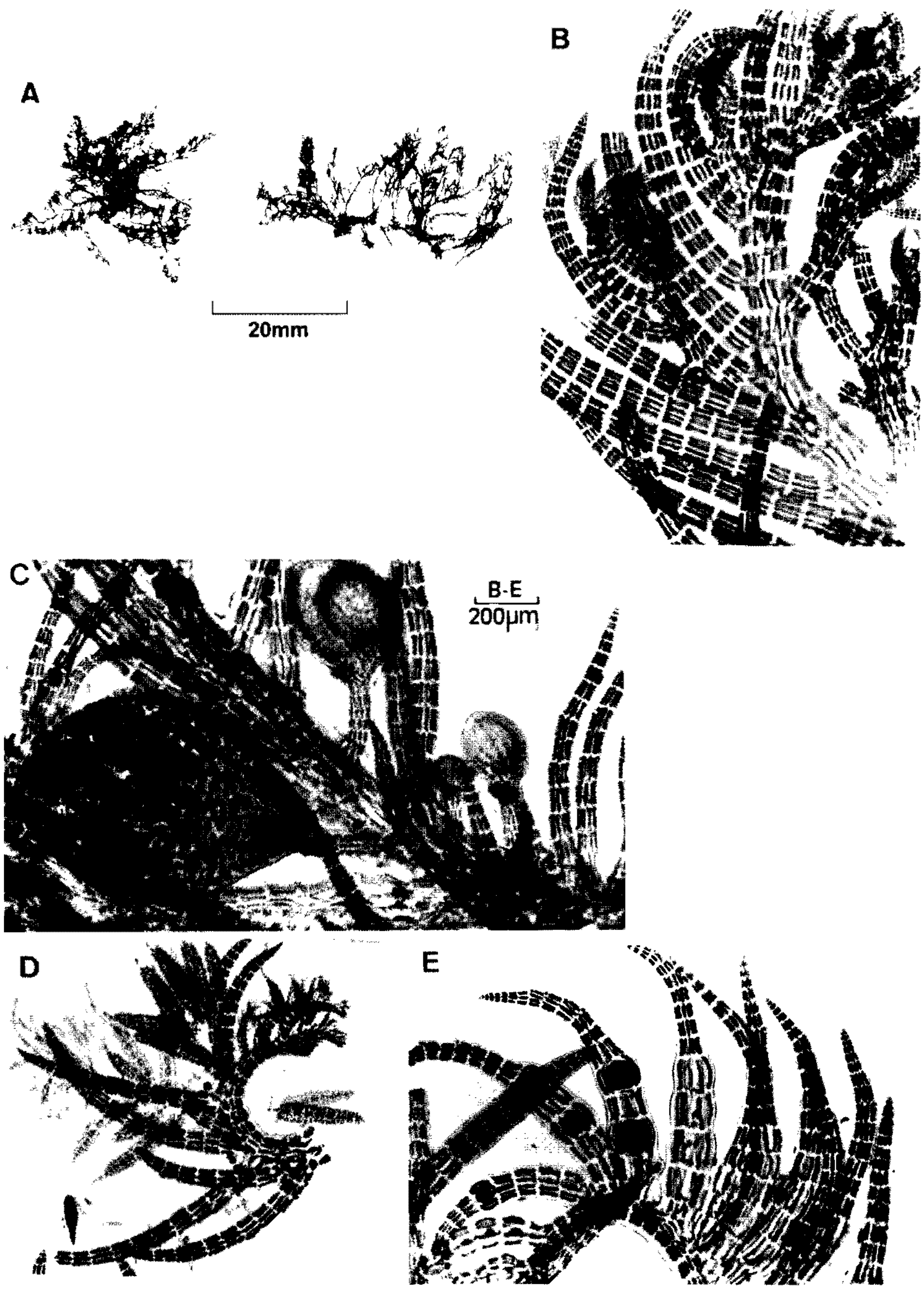

Fig. 128. *Herposiphonia rostrata* (**A**, AD, A18239; **B–E**, AD, A50739). **A**. Habit. **B**. Branch apex with indeterminate and determinate laterals. **C**. Branches with cystocarps. **D**. Spermatangial organs on determinate laterals. **E**. Tetrasporangia in determinate laterals.

Herposiphonia versicolor is a large species for the genus and rather variable in robustness. More robust plants in particular show the orange-red colour, especially when dead. Relationships with *H. rostrata* are described under this species.

Polysiphonia argus Kützing is based on a Harvey, Alg. Aust. Exsicc. 197H specimen from Western Port, Vic., holotype in MEL, 45813, isotypes Trav. Set 354, in MEL, 45821 and 1006754; they are robust specimens of *H. versicolor*.

3. **Herposiphonia rostrata** (Sonder)Reinbold 1899: 50. De Toni 1903: 1053. Falkenberg 1901: 311, pl. 3 fig. 19. Huisman & Walker 1990: 434. Lucas 1909: 44; 1929b: 51. Lucas & Perrin 1947: 292. Silva *et al.* 1996: 499.
Polysiphonia rostrata Sonder 1845: 53; 1848: 180; 1880: 35. J. Agardh 1863: 926. Harvey 1847: 49; 1855a: 541; 1863: pl. 242, synop.: xxi. Kützing 1849: 809; 1863: 14, pl. 43c, d. Reinbold 1897: 57. Tisdall 1898: 514. Wilson 1892: 167.
Vertebrata rostrata (Sonder)Kuntze 1891: 929.

FIG. 128

Thallus (Fig. 128A) medium red, with prostrate axes producing erect axes 2–6 cm high, bearing laterally relatively short indeterminate axes with simple determinate laterals mostly pectinately and abaxially arranged, the indeterminate laterals separated by usually 3 segments bearing determinate laterals (Fig. 128B). Attachment by rhizoids; epiphytic, on *Amphibolis* and various algae. *Structure*. Apices revolute with determinate laterals on the convex side, apical cells hemispherical, 12–15 μm in diameter. Pericentral cells 12–14 in axes, (10-) 11 (-12) in determinate laterals; axes (250-) 300–450 μm in diameter, segments L/D 0.5–0.8, determinate laterals 1.0–2.5 mm long, 100–150 μm in diameter, segments L/D 0.8–1.2. Trichoblasts on upper segments of determinate laterals, 200–1000 μm long, basal cells 10–20 μm in diameter and L/D 1–2. Rhizoids cut off from pericentral cells, unicellular with digitate haptera. Cells uni- to multinucleate; rhodoplasts discoid to elongate.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with an inconspicuous basal fusion cell and short gonimoblast with clavate terminal carposporangia 30–60 μm in diameter. Cystocarps (Fig. 128C) ovoid, 300–900 μm in diameter; pericarp ostiolate, 2 cells thick, ecorticate, outer cells isodiametric, irregular in shape. Spermatangial branches (Fig. 128D) replacing trichoblasts or basal branches thereof, 100–330 μm long and 40–80 μm in diameter, with 1–2 sterile basal cells and a sterile apical filament of 2–several cells.

Tetrasporangia (Fig. 128E) in straight or curved series of 2–6 in determinate laterals, 70–130 μm in diameter, with 2–3 cover cells, swelling the segments to 150–220 μm in diameter.

Type from W. Aust., (probably near Fremantle); holotype in MEL, 45839.

Distribution: Yanchep, W. Aust., to Westernport Bay, Victoria.

Selected specimens: Yanchep, W. Aust., on *Amphibolis*, drift (*Womersley*, 22.ix.1979; AD, A51260). Swan R., W. Aust. (*Harvey*, Alg. Aust. Exsicc. 196a; AD, A18239). Safety Bay, W. Aust., on *Amphibolis*, drift (*Womersley*, 29.ix.1979; AD, A50739). Anxious Bay, S. Aust., on *Amphibolis*, drift (*Parsons*, 24.viii.1967; AD, A31936). Tiparra Reef, S. Aust., on *Amphibolis antarctica*, 5 m deep (*Shepherd*, 20.viii.1971; AD, A39463) and on *A. griffithii*, 12 m deep (*Shepherd*, 27.vii.1970; AD, A36005). Sturt Bay, S. Aust., on *Amphibolis* (*Davey*; AD, A1352). Off West Beach, S. Aust., on *Amphibolis*, 6 m deep (*Shepherd*, 13.xi.1970; AD, A37696). Vivonne Bay, Kangaroo I., S. Aust., on *Amphibolis*, drift (*Womersley*, 29.viii.1950; AD, A15309). Double Corner Beach, Portland, Vic.; on *A. antarctica*, drift (*Beauglehole*, 22.vii.1951; AD, A21567). Port Phillip Heads, Vic., epiphytic (*Wilson*, 17.i.1888; MEL, 45844). Cruiser Point, Westernport Bay, Vic., drift (*Sinkora* A1305, 29.x.1971; AD, A49469, MEL, 504874).

Herposiphonia rostrata is, as Harvey commented, closely related to *H. versicolor*, differing in colour, in having the determinate laterals mostly pectinately arranged, and in the larger number of pericentral cells. Further studies of these differences are needed.

4. **Herposiphonia filipendula** (Harvey *ex* J. Agardh)Falkenberg *ex* De Toni 1903: 1058. Falkenberg 1901: 317. Lucas 1909: 45. Lucas & Perrin 1947: 294. Silva *et al.* 1996: 497.
Polysiphonia filipendula Harvey *ex* J. Agardh 1863: 920. Harvey 1863, synop.: xxi. Kützing 1864: 13, pl. 38a–e. Sonder 1880: 35. Tisdall 1898: 514.

FIG. 129

Thallus (Fig. 129A) dark red-brown, with prostrate indeterminate axes bearing erect, assurgent branches (Fig. 129B) 1–2 cm high, with usually 3 determinate laterals between lateral indeterminate branches, the determinate laterals irregularly placed but tending to be on one side (Fig. 129C). Attachment by rhizoids; epilithic and occasionally epiphytic. *Structure.* Apex with recurved determinate laterals, apical cells hemispherical to dome-shaped, 12–15 µm in diameter. Pericentral cells 8–9 (-10), prostrate axes 100–220 µm in diameter, segments L/D 1–2, erect indeterminate axes 90–140 µm in diameter, segments L/D 1–2 (-3), determinate laterals 1–3 (-6) mm long, 45–80 µm in diameter, segments L/D 1–2 (-4). Trichoblasts on upper segments of determinate laterals, 0.5–1 mm long, basal cells 15–20 µm in diameter, short, then elongate. Rhizoids cut off from pericentral cells, unicellular with digitate haptera. Cells uninucleate, larger multinucleate; rhodoplasts discoid.

Reproduction. Procarps not observed. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia 30–55 µm in diameter. Cystocarps (Fig. 129C) lateral on determinate laterals, subsessile, ovoid, 400–600 µm in

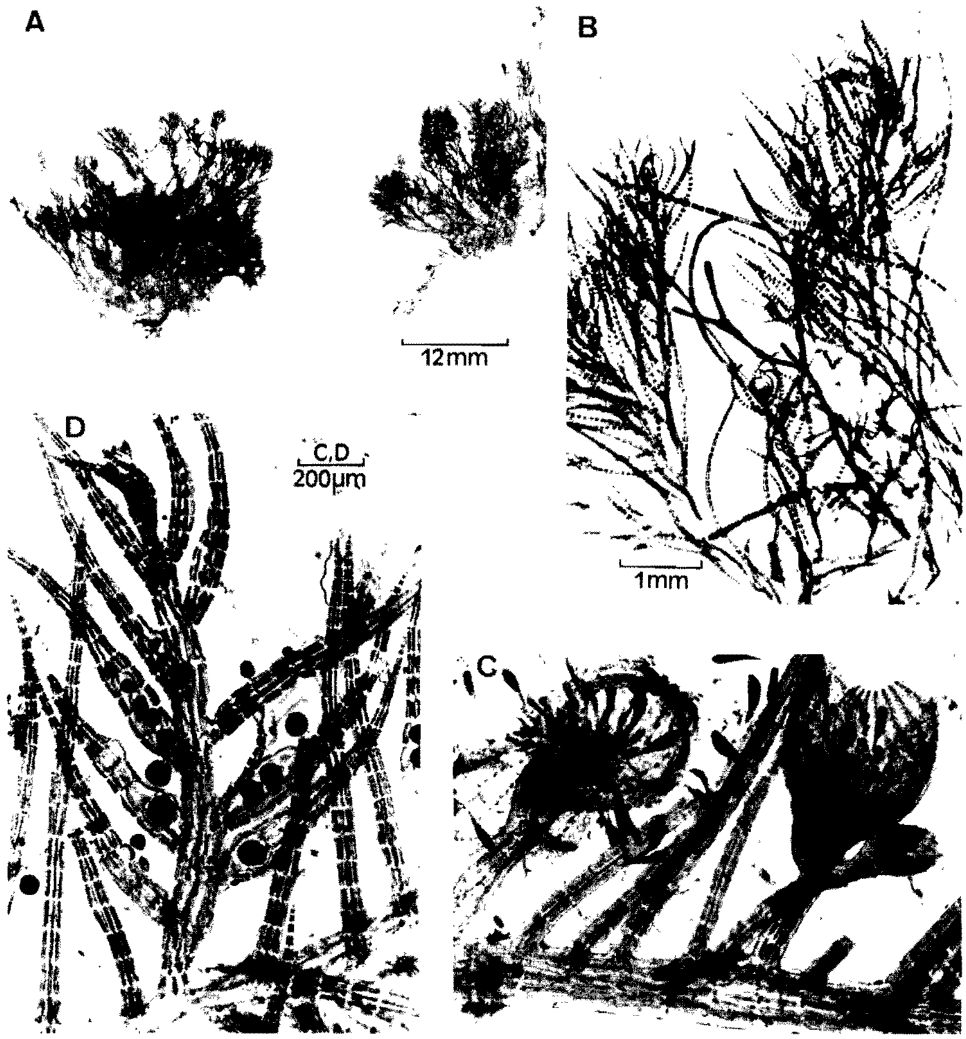

Fig. 129. *Herposiphonia filipendula* (**A**, **B**, AD, A59122; **C**, **D**, AD, A33781). **A**. Habit. **B**. Branches. **C**. Determinate laterals with cystocarps. **D**. Determinate laterals with tetrasporangia.

diameter; pericarp ostiolate, 2 cells thick, ecorticate, outer cells isodiametric, angular. Spermatangia unknown.

Tetrasporangia (Fig. 129D) in series of 1–6 in determinate laterals, in fairly straight rows, one per segment, 60–80 μm in diameter, with 3 cover cells.

Type from Port Fairy, Vic.; lectotype Harvey, Alg. Aust. Exsicc. 193D, in Herb. Agardh, LD, 39142; isolectotype in MEL, 45810.

Distribution: Port Lincoln, S. Aust., to Westernport Bay, Victoria.

Selected specimens: Port Lincoln, S. Aust., 0.5–2 m deep on jetty piles (*Womersley*, 13.v.1968; AD, A32496). Off Troubridge I., S. Aust., on *Chiracanthia arborea*, 14 m deep (*Shepherd*, 4.ii.1969; AD, A33781). Pennington Bay, Kangaroo I., S. Aust., in shallow pools (*Prud'homme van Reine*, 26.ix.1988; AD, A59122). Sorrento, Vic., 5–6 m deep (*Kraft & Drews*, 8.vi.1992; MELU, K9023, AD, A69079). Crawfish Rock, Westernport Bay, Vic., 0 m deep (*Watson*, 28.v.1974; AD, A45363).

H. filipendula is a little-known species, and further study of material from the type locality is needed.

The species combination is usually ascribed directly to Falkenberg (1901, p. 317), but he did not cite the original reference of J. Agardh and also stated that it doubtfully belonged to *Herposiphonia*. De Toni (1903, p. 1058) was the first author to correctly make the transfer, ascribing it to Falkenberg.

The specimen first designated as *P. filipendula* by Harvey, from W. Australia (*Clifton*), is distinct from that described by J. Agardh. It is probably a slender form of *H. versicolor*.

5. **Herposiphonia monilifera** (Hooker & Harvey)Falkenberg 1901: 315. De Toni 1903: 1056. Guiler 1952: 106. Lucas 1909: 44; 1929a: 23. Shepherd & Womersley 1971: 166.
Polysiphonia monilifera Hooker & Harvey 1847: 399. J. Agardh 1863: 927. Harvey 1847: 49, pl. 16; 1859b: 301; 1863, synop.: xxi. Kützing 1849: 812. Sonder 1880: 35.

FIG. 130A, B

Thallus (Fig. 130A) medium red-brown, slender, largely erect, 2–8 cm high, with determinate laterals pectinately arranged, 3 between the indeterminate branches, basal prostrate axes attached by rhizoids; epiphytic, especially on *Posidonia*. *Structure*. Apices more-or-less unilaterally branched, apical cells hemispherical, 10–15 μm in diameter. Pericentral cells 10–12 in axes, 8–10 in determinate laterals, axes 160–300 μm in diameter with segments L/D 0.8–1.2, determinate laterals 1–2 mm long, 50–110 μm in diameter and tapering gently, with segments L/D 1–1.6. Trichoblasts (juvenile) present on determinate laterals, 0.5–1 mm long, basal cells 10–12 μm in diameter. Rhizoids cut off from pericentral cells, unicellular with digitate haptera. Cells probably multinucleate; rhodoplasts discoid.

Reproduction. Gametophytes unknown.

Tetrasporangia (Fig. 130B) in prominent moniliform series of 2–8 in determinate laterals, 90–140 μm in diameter and swelling the diameter of the lateral to 130–180 μm.

Type from Tas. (*Gunn*), probably near Georgetown.

Distribution: Albany, W. Aust. to N Tasmania, but apparently rare.

Selected specimens: Middleton Beach, Albany, W. Aust., drift (*Wood*, 10.x.1960; AD, A24574). Redbanks, Kangaroo I., S. Aust., drift (*Womersley*, 25.viii.1950; AD, A15331). Werribee Sewage Farm, Port Phillip, Vic., drift (*Kraft*, 17.xi.1993; MELU, K9623).

This little-known species needs further study. It is apparently distinguished by its slender habit and pectinate branching and segment dimensions, with moniliform rows of tetrasporangia. The above description is based largely on AD, A24574.

6. **Herposiphonia pectinella** (Harvey)Falkenberg 1901: 315. De Toni 1903: 1055. Huisman & Walker 1990: 434. Lucas 1909: 44. Lucas & Perrin 1947: 292. Silva *et al.* 1996: 498.
Polysiphonia pectinella Harvey 1855a: 541; 1863, synop.: xxi. J. Agardh 1863: 918. Sonder 1880: 35. Tisdall 1898: 514. Wilson 1892: 167.
Polysiphonia pectinata Harvey *ex* Kützing 1864: 13, pl. 39a–e.

FIG. 130C–E

Thallus (Fig. 130C) light red-brown, slender, erect but flaccid, 1–6 cm high, determinate laterals radially to pectinately arranged with 3 between indeterminate branches (Fig. 130D),

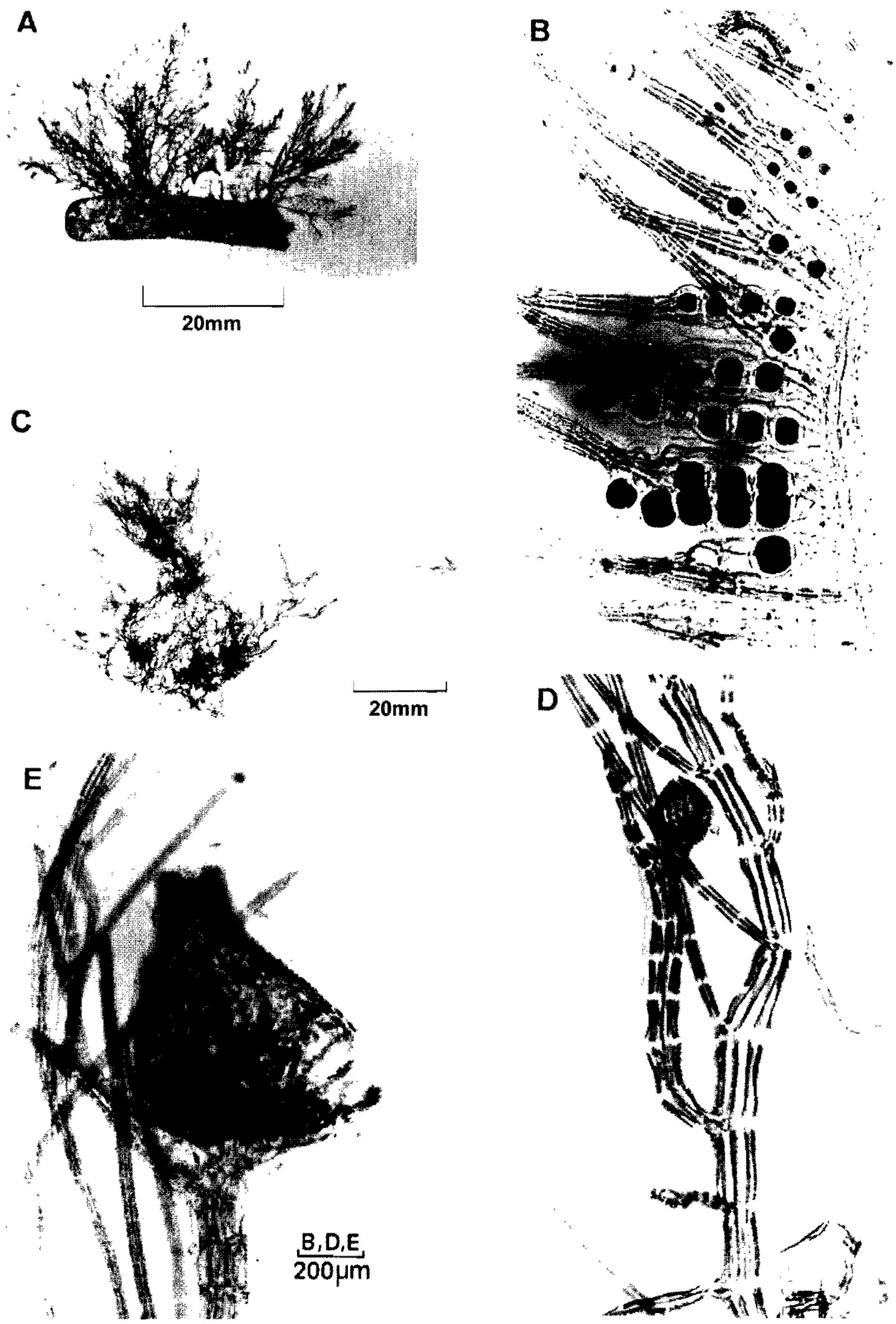

Fig. 130. A, B. *Herposiphonia monilifera* (**A**, AD, A15331; **B**, AD, A24574). **A**. Habit, on *Posidonia*. **B**. Determinate laterals with tetrasporangia. **C–E**. *Herposiphonia pectinella* (AD, A34114). **C**. Habit. **D**. Branches with a juvenile cystocarp. **E**. A mature, damaged, cystocarp.

lower axes attached by rhizoids; epiphytic. *Structure*. Pericentral cells 6–8 (-9), axes 80–110 µm in diameter with segments L/D 2–4, determinate laterals 2–4 mm long, 45–60 µm in diameter, segments L/D (2-) 3–4. Trichoblasts (juvenile) on determinate laterals. Rhizoids cut off from pericentral cells, unicellular with digitate haptera. Cells multinucleate; rhodoplasts discoid to elongate.

Reproduction. Procarps on a lower cell of trichoblasts, with a 4-celled carpogonial branch. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia 30–40 µm in diameter. Cystocarps (Fig. 130D, E) borne on determinate laterals 150–220 µm in diameter, slightly urceolate, 400–800 µm in diameter; pericarp ostiolate, 2 cells thick, ecorticate, outer cells isodiametric, irregularly shaped. Spermatangial organs unknown.

Tetrasporangia unknown.

Type from King George Sound, W. Aust.; holotype in Harvey, Trav. Set. 38, TCD.

Distribution: King George Sound, W. Aust., to Western Port, Victoria. Record from Rottnest I., W. Aust. (*Harvey* 1855a, p. 541) doubtful.

Selected specimens: Pearson I., S. Aust., 36 m deep (*Shepherd*, 10.i.1969; AD, A34114). BP Refinery pier, Western Port, Vic., 0–1 m deep (*Millar*, 3.v.1979; MELU, 23945).

Herposiphonia pectinella is probably closely related to *H. monilifera*, differing in having longer segments and fewer pericentral cells. *H. pectinella* was distributed by Harvey (Alg. Aust. Exsicc. 194B) as *Polysiphonia pectinata*, but described as *pectinella*. It is a little-known species needing further study. The above description is based largely on AD, A34114 which was collected from 36 m deep, in contrast to the type collection from intertidal mud.

Genus HERPOSIPHONIELLA Womersley, *gen. nov.*

Thallus basally prostrate, above largely free of the host, complanately branched with indeterminate axes bearing 5–7 (-13) alternate, distichous, simple determinate laterals between indeterminate laterals. Attachment by rhizoids. *Structure*. Apical cells segmenting transversely, subapical cells obliquely to form a lateral. Axes with 11 pericentral cells, determinate laterals with 8 pericentral cells. Trichoblasts present subapically on determinate laterals. Rhizoids cut off from pericentral cells, with digitate haptera.

Reproduction. Unknown.

Diagnosis: Thallus basaliter prostratus, supra magnopere ex hospite discretus, complanate ramosus cum axibus indeterminatis, ferens laterales alternatos distichos simplices determinatos inter laterales indeterminatos. Affixus per rhizoidea. Structura. Cellulae apicales transversim dividentes, cellulae subapicales oblique dividentes lateralem facientes. Axes cum 11 cellulis pericentralibus, lateres determinati cum 8 cellulis pericentralibus. Trichoblasti in lateralibus determinatis subapicaliter praesentes. Rhizoidea ex cellulis pericentralibus abscissa cum hapteris digitatis.

Reproductio: non nota.

Type species: *H. plurisegmenta* Womersley

Herposiphoniella differs from *Herposiphonia* in having 5–7 (-13) determinate laterals between the indeterminate laterals, in contrast to 3 in the latter genus. It is named for its close relationship to *Herposiphonia*.

Herposiphoniella plurisegmenta Womersley, *sp. nov.*

FIG. 131

Thallus (Fig. 131A) red-brown, 1–4 cm long, largely free from the host, complanately branched with indeterminate axes irregularly branched and bearing 5–7 (-13) alternate, distichous, simple, determinate laterals 600–800 µm long between short indeterminate laterals (Fig. 131B–D). Attachment of the basal axes by rhizoids; epiphytic on *Pterocladia capillacea*, *Laurencia filiformis* and *Dictyota*. *Structure*. Apical cells hemispherical to conical, 15–20 µm in diameter, segmenting transversely and the subapical cells obliquely, with each segment bearing an indeterminate or determinate lateral. Axial segments 140–270 µm broad with 11

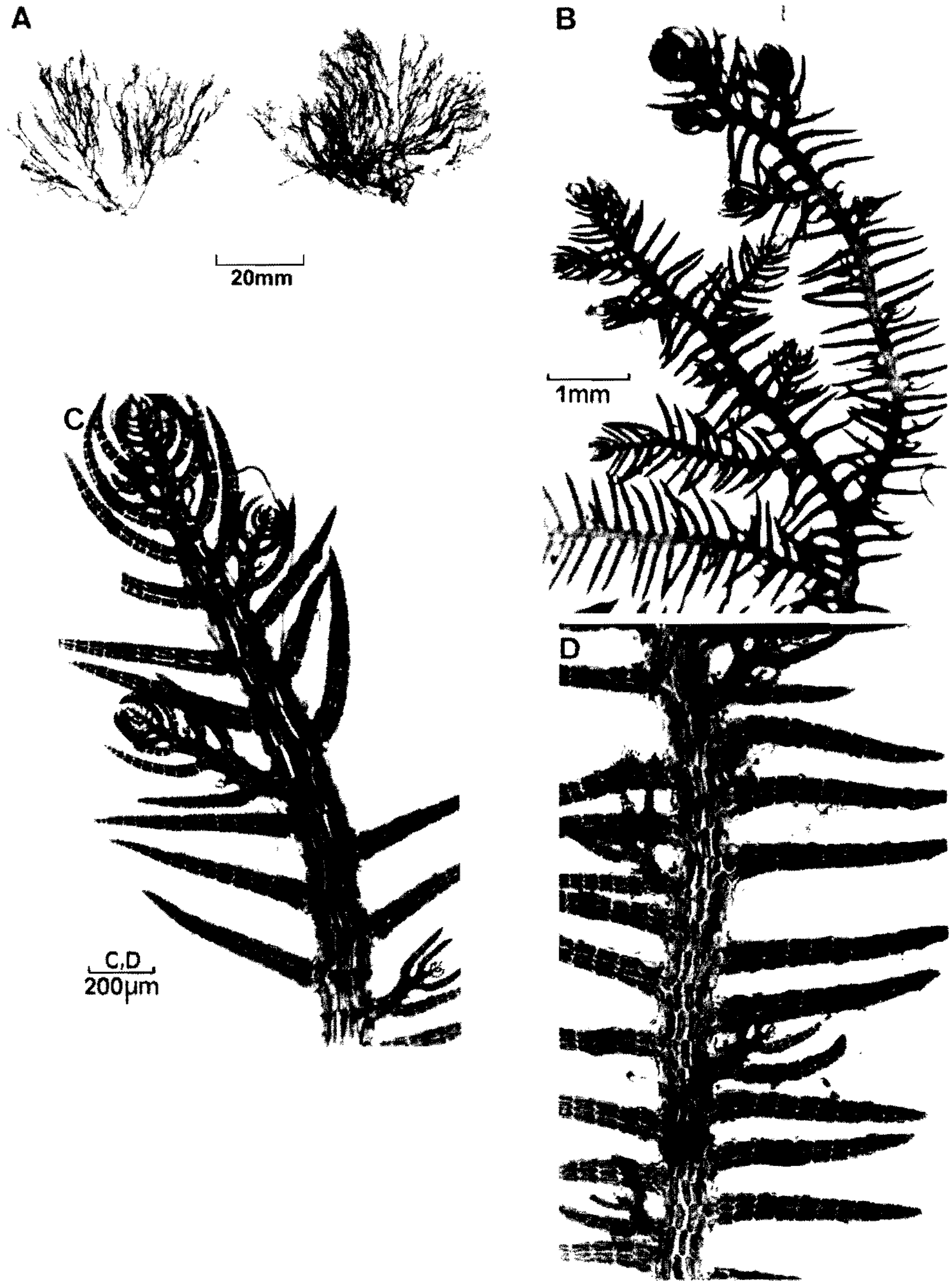

Fig. 131. *Herposiphoniella plurisegmenta* (**A**, AD, A47822; **B–D**, AD, A38022). **A**. Habit. **B**. Branches with indeterminate laterals separated by usually 5 determinate laterals. **C**. As for **B**. **D**. Branching pattern at higher magnification.

pericentral cells, L/D (0.3-) 0.5–0.8, ecorticate; segments of determinate laterals 110–140 μm broad basally, tapering gradually, with 8 pericentral cells, L/D 0.5–0.9, basal segment shorter with 4 isodiametric pericentral cells. Lateral axes developed by continued growth of indeterminate laterals. Trichoblasts present near apices of young determinate laterals, 0.5–1.5 mm long, branched, basal cells 20–30 μm in diameter and L/D 1–2. Rhizoids cut off from pericentral cells, unicellular, with digitate haptera. Cells uninucleate, larger cells probably multinucleate; rhodoplasts discoid, ribbon like in larger cells.

Reproduction unknown.

Diagnosis: Thallus hepaticus, 1–4 cm longus, magnopere ex hospite discretus, complanate ramosus cum axibus indeterminatis irregulariter ramosis et ferentibus 5–7 (-13) laterales alternatos, distichos, simplices, determinatos 600–800 μm longos inter laterales breves et indeterminatos. Axes basales affixi per rhizoidea; epiphyticus in *Pterocladia capillacea* et *Laurencia filiformis* et *Dictyota*. Structura. Cellulae apicales hemisphaericales ad conicas, 15–20 μm diam., dividentes transverse et cellulae subapicales oblique, omnia segmenta lateralem indeterminatum aut determinatum ferentia. Segmenta axilia 140–270 μm lata cum 11 cellulis pericentralibus, L/D (0.3-) 0.5–0.8, ecorticata; segmenta lateralium determinatorum 110–140 μm basaliter lata, paulatim deminuta cum 8 cellulis pericentralibus L/D 0.5–0.9, segmentum basale breviora cum 4 cellulis isodiametris pericentralibus. Axes laterales per crescentiam continuam lateralium indeterminatorum. Trichoblasti apud apices lateralium iuvenium determinatorum, 0.5–1.5 mm longi ramosi, cellulae basales 20–30 μm diam. et L/D 1–2. Rhizoidea abscissa ex cellulis pericentralibus, unicellaria, cum hapteris digitalibus. Cellulae uninucleatae, cellulae maiores probabiliter multinucleatae, rhodoplasti discoidei, in cellulis maioribus taeniformes.

Reproductio: non nota.

Type from N side Althorpe Is, S. Aust., on *Pterocladia capillacea*, 10–12 m deep (*Baldock*, 4.i.1964); holotype and isotype in AD, A27321.

Distribution. Near Fremantle, W. Aust., to Cape Northumberland, S. Australia.

Selected specimens: W. Aust. (*Clifton*; Herb. Harvey, TCD; AD, A18168). Seamount off Cannon Reefs, S. Aust., on *Dictyota*, 22–30 m deep (*Branden*, 22.i.1991; AD, A61204). Masillon I., Isles of St Francis, S. Aust., epiphytic, 13–18 m deep (*Shepherd*, 5.i.1971; AD, A38022). Pearson I., S. Aust., on *Laurencia*, 35 m deep (*Shepherd*, 7.i.1969; AD, A34034). 1.3 km off Cape Northumberland, S. Aust., 15 m deep (*Shepherd*, 26.xi.1976; AD, A47822).

H. plurisegmenta appears to be a deep-water epiphyte on the west coast of Eyre Peninsula and from Cape Northumberland, S. Australia. It is also known from a Clifton collection in Herb. Harvey, probably from near Fremantle, W. Australia.

The species is named for the larger and variable number of determinate laterals between the indeterminate ones.

Genus TIPARRARIA Womersley, *gen. nov.*

Thallus with basal attached axes but largely free from the host, prostrate axes usually bearing from successive segments a long, branched, indeterminate lateral, a short, slightly-developed, branched lateral, and no lateral on 1 (-3) segments, this sequence then repeated; erect indeterminate laterals bearing usually 2 branches from successive segments separated by 1–8 unbranched segments. Erect laterals bearing trichoblasts. Attachment by rhizoids. *Structure*. Pericentral cells (9-) 11–13, ecorticate. Rhizoids cut off from pericentral cells, unicellular with digitate haptera. Cells multinucleate.

Reproduction. Gametophytes dioecious. Carposporophytes with a basal fusion cell and gonimoblast bearing clavate terminal carposporangia; Cystocarps ovoid, pericarp ostiolate, ecorticate. Spermatangial organs on trichoblasts, with an apical sterile filament.

Tetrasporangia in branches of erect laterals, single per segment.

Diagnosis: Thallus cum axibus basaliter affixis sed magnopere ex hospite discretus, axes prostrati plerumque ferentes ex segmentis successivis lateralem longum ramosum indeterminatum tum lateralem brevem leviter evolutum ramosum tum lateralem nullum in 1 (-3) segmentis, iterum atque iterum-laterales erecti indeterminati ferentes plerumque 2 ramos ex

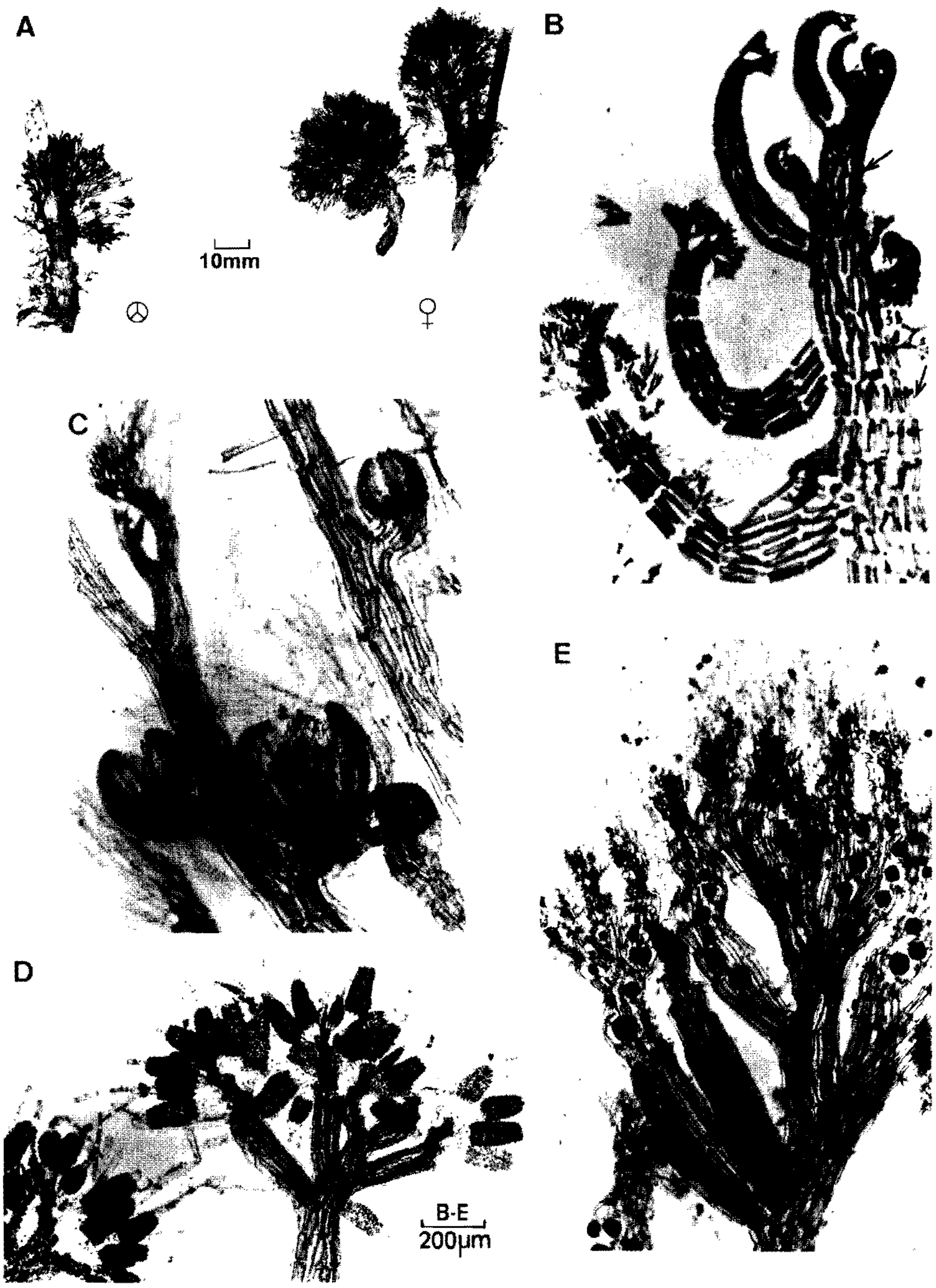

Fig. 132. *Tiparraria aurata* (**A–D**, AD, A41227; **E**, AD, A50700). **A**. Habit, on *Amphibolis* leaves. **B**. Apex, showing segments with a short indeterminate lateral, a large determinate lateral and no lateral (arrow). **C**. Branches with cystocarps. **D**. Branches bearing spermatangial organs. **E**. Branches with tetrasporangia.

segmentis separatis per 1–8 segmenta sine ramis. Laterales erecti trichoblastos ferentes. Affixus per rhizoidea. Structura. Cellulae pericentrales (9-) 11–13 ecorticae. Rhizoidea ex cellulis pericentralibus, unicellaria cum hapteris digitalibus. Cellulae multinucleatae.

Reproductio. Gametophyta dioecia. Carposporophyta cum cellula basali coalescenti et cum gonimoblasto carposporangia clavata terminalia ferente. Cystocarpia ovoidea, pericarpium ostiolatum, ecorticatum. Organa spermatangialia in ramis lateralium erectorum, unum per segmentum. Tetrasporangia in ramis lateralium erectorum, unum per segmentum.

Type species: *T. aurata* (Harvey)Womersley.

Tiparraria is distinguished by the branching sequence of prostrate and erect indeterminate laterals. It is particularly common around Tiparra Reef, South Australia, and is named from this locality.

Some species from other regions, presently retained in *Herposiphonia* (e.g. Abbott 1999), may be more related to *Tiparraria*.

Tiparraria aurata (Harvey)Womersley, *comb. nov.*

Polysiphonia aurata Harvey 1855a: 541; 1863, synop.: xxii.. J. Agardh 1863: 1026. De Toni 1903: 933. Lucas 1909: 41. Lucas & Perrin 1947: 275. Segi 1966: 505, pl. V B. Shepherd & Womersley 1981: 367. Sonder 1880: 35.

FIG. 132

Thallus (Fig. 132A) orange-brown, (1-) 2–3 cm high, largely free from the host, with prostrate filaments bearing from successive segments a long, branched, indeterminate lateral, a short, slightly developed, branched lateral, and no lateral (Fig. 132B) on 1 (-3) segments, this sequence (with slight variation) then repeated on the next 3 segments. Erect indeterminate laterals becoming branched apically (especially when fertile), 5–10 (-20) mm long, branched usually from successive segments and each pair separated by 1–8 unbranched segments. Attachment by rhizoids; epiphytic on *Posidonia* and *Amphibolis*. *Structure*. Indeterminate apices upwardly recurved, apical cells hemispherical, 10–15 µm in diameter, segmenting transversely and subapical cells obliquely. Segments ecorticate, with (9-) 11–13 pericentral cells, 200–300 µm in diameter and L/D 0.7–1.2 in axes and 150–250 µm in diameter in lesser branches with L/D 1–1.5. Branches of erect indeterminate laterals bearing prominent trichoblasts, much branched, 1–2 mm long, basal cells 80–100 (-110) µm in diameter, short when immature, L/D 2–5 when mature. Rhizoids cut off from pericentral cells, unicellular with digitate haptera (becoming multicellular with ends of haptera branches cut off as terminal cells). Cells multinucleate; rhodoplasts discoid, becoming chained in older cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a basal fusion cell and short gonimoblast with clavate terminal carposporangia 30–45 µm in diameter. Cystocarps (Fig. 132C) short-stalked, ovoid, 350–750 µm in diameter; pericarp ostiolate, 2 cells thick, ecorticate, outer cells irregular, angular. Spermatangial organs (Fig. 132D) replace usually the second cell of trichoblasts, 70–110 µm in diameter and L/D 1.5–2, with a sterile basal cell and 2 to several sterile apical cells.

Tetrasporangia (Fig. 132E) in upper branches of indeterminate laterals, spirally arranged, single per segment, 60–100 µm in diameter, with 3 cover cells.

Type from King George Sound, W. Aust. (*Harvey*, Trav. Set. No. 307); lectotype in Herb. Harvey, TCD.

Distribution: Cliff Head, W. Aust., to Kingston, S. Aust., and N Tasmania.

Selected specimens: Cliff Head, W. Aust., on *Amphibolis antarctica*, drift (*Womersley*, 18.ix.1979; AD, A51245). Eucla, W. Aust., on *A. griffithii*, drift (*Womersley*, 5.x.1979; AD, A50700). Elliston, S. Aust., on *A. antarctica*, 3 m deep (*Shepherd*, 20.x.1970; AD, A37533). Murray Point, Port Lincoln, S. Aust., on *Posidonia australis*, uppermost sublittoral (*Womersley*, 6.i.1976; AD, A46780). Tiparra Reef, S. Aust., on *A. griffithii*, 11 m deep (*Shepherd*, 31.x.1970; AD, A37645 and 13.xii.1971; AD, A41227). Dany Beach, Corny Point, S. Aust., on *A. antarctica*, drift (*Womersley*, 15.x.1989; AD, A59902). Middle River, Kangaroo I., S. Aust., on *Amphibolis*, drift (*Womersley*, 8.i.1946; AD, A3425). Muston, Kangaroo I., S. Aust., on *Posidonia australis*, 2–4 m deep (*Womersley*, 22.viii.1963; AD, A26885). Kingston, S. Aust., on *A. antarctica*, 6–7 m deep (*R. Lewis*, 28.xi.1972; AD, A42866). Bridport, Tas., on *Amphibolis*, drift (*Womersley & Parsons*, 6.xi.1982; AD, A54555).

Genus **DIPTEROSIPHONIA** Schmitz & Falkenberg 1897: 463.

Thallus entirely or largely prostrate, with indeterminate axes bearing determinate laterals in alternate pairs on successive segments, laterally placed or more or less erect and free, the anterior one usually branched similarly to the axes and sometimes extending as an indeterminate lateral, the posterior one usually simple. Attachment by rhizoids; usually epiphytic. *Structure.* Pericentral cells 4–10, ecorticate. Trichoblasts or determinate laterals. Rhizoids cut off from pericentral cells, unicellular with multicellular haptera. Cells uninucleate.

Reproduction. Gametophytes monoecious or (usually) dioecious. Procarps on basal cell of trichoblasts. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia. Cystocarps ovoid to urceolate, pericarp ostiolate, ecorticate. Spermatangial organs replacing whole or branches of trichoblasts.

Tetrasporangia in determinate laterals, single per segment.

Type species: *D. dendritica* (C. Agardh)Schmitz *in* Schmitz & Falkenberg 1897: 464.

Dipterosiphonia is a widely distributed genus characterized by the branching pattern of alternate pairs of determinate laterals on successive indeterminate segments.

KEY TO SPECIES OF *DIPTEROSIPHONIA*

1. Prostrate axes with erect, mostly simple, crowded, determinate laterals 1–2 mm long .... 2. *D. prorepens*
1. Prostrate axes with prostrate or short, separated, simple or branched determinate laterals 100–800 μm long 2
    2. Upper of the paired determinate laterals simple or little branched, free from the host .... 3. *D. australica*
    2. Upper of the paired determinate laterals pinnately branched, the lower one simple, prostrate on the host .... 1. *D. dendritica*

1. **Dipterosiphonia dendritica** (C. Agardh)Schmitz *in* Schmitz & Falkenberg 1897: 464. Børgesen 1918: 292, figs 290, 291; 1924: 303. De Toni 1903: 1047. Falkenberg 1901: 324. Joly *et al.* 1965: 25, pls 1–6. Kylin 1956: 533. Lucas 1909: 44. Lucas & Perrin 1947: 291. May 1965: 380. Oliveira 1977: 138. Silva *et al.* 1996: 491.
Hutchinsia dendritica C. Agardh 1824: 146; 1828: 104.
Polysiphonia dendritica (C. Agardh)J. Agardh 1863: 916; 1885: 98. Harvey 1847: 47; 1863, synop.: xxi. Sonder 1880: 37. Tisdall 1898: 514.
Polysiphonia heteroclada J. Agardh 1885: 98.
Dipterosiphonia heteroclada (J. Agardh)Falkenberg 1901: 320, pl. 3 figs 1–3. Adams 1994: 313, pl. 106, lower. De Toni 1903: 1046. Millar 1990: 448, fig. 62A–C. Millar & Kraft 1993: 52. Schmitz & Falkenberg 1897: 464.

FIG. 133

Thallus (Fig. 133A) dark red-brown, 2–10 mm long, prostrate on and adherent to the host, complanately branched with occasionally branched compressed axes, with paired determinate laterals from adjacent segments on alternate sides (Fig. 133B), the anterior of each pair 250–600 μm long, flexed forward from the axial cell and branched as in the axes but of limited development, the posterior one simple, emitted directly from the axial cell, and 100–200 μm long. Lateral branches of axes occur by continued growth of the anterior determinate lateral. Attachment by rhizoids; epiphytic on various algae. *Structure.* Apical cells hemispherical, 10–15 μm in diameter. Axes with 5–6 pericentral cells (3–4 in face view), terete determinate laterals with 5 (-6) pericentral cells, axial segments L/D 0.5–0.8. Trichoblasts occur on end segments of determinate laterals or their branches, 200–1000 μm long, much branched with basal cells 15–25 μm in diameter and L/D 1–2, upper cells longer and slenderer. Rhizoids cut off from lateral pericentral cells of axes, unicellular with multicellular haptera. Cells uninucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes monoecious (AD, A15431, Fig. 133C), probably also dioecious. Procarps probably on basal cell of trichoblasts on determinate laterals, rapidly

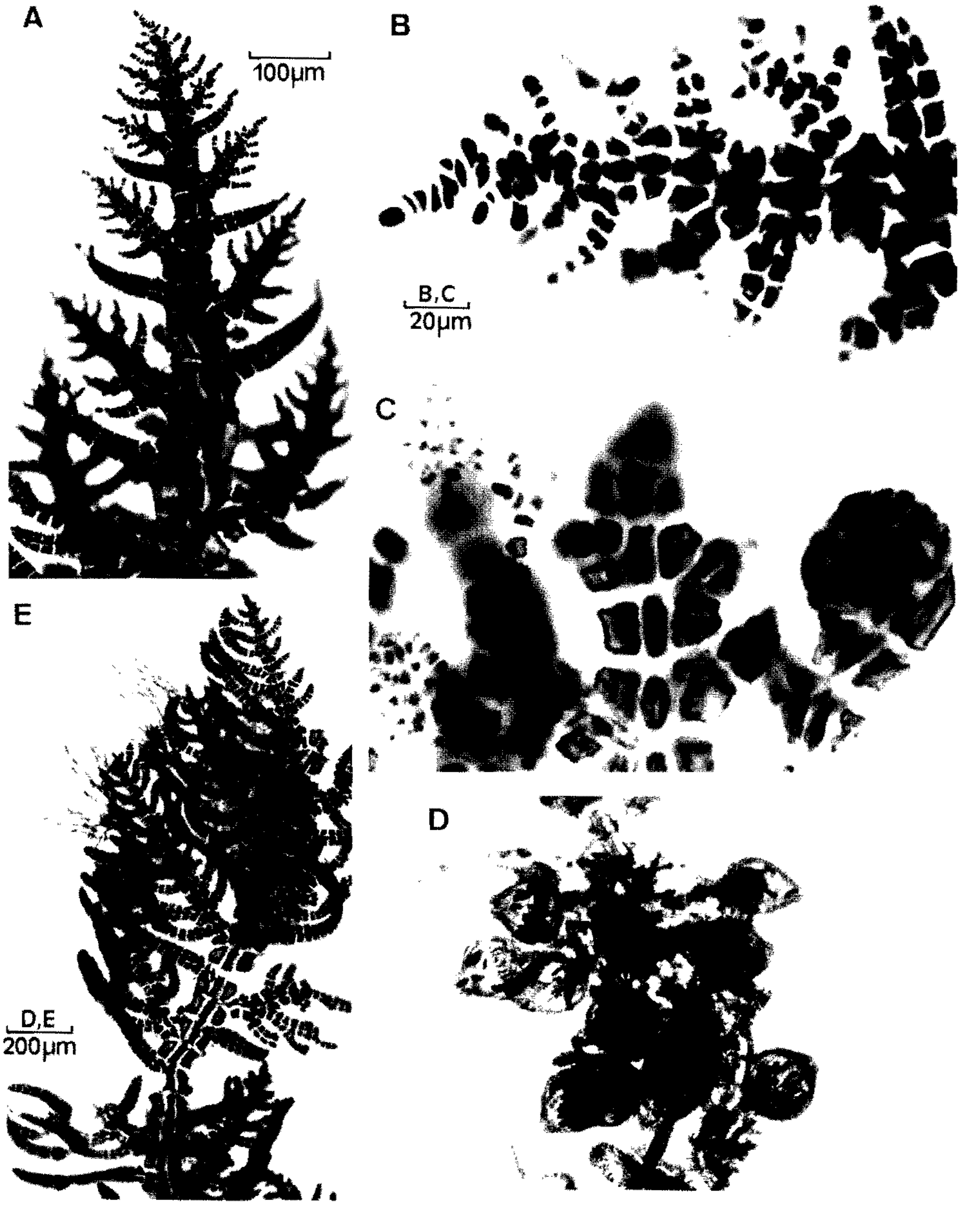

Fig. 133. *Dipterosiphonia dendritica* (AD, A15431). **A.** Prostrate axis showing branching. **B.** Branch apex with alternate pairs of anterior branched and posterior simple determinate laterals. **C.** Branch with a juvenile cystocarp (right) and juvenile spermatangial organs (left) on one plant. **D.** Mature cystocarps. **E.** Branches bearing trichoblasts and tetrasporangia.

polysiphonous. Carposporophytes with a small basal fusion cell and short, branched, gonimoblast with clavate terminal carposporangia 10–18 µm in diameter. Cystocarps (Fig. 133D) ovoid to slightly urceolate, 200–300 µm in diameter; pericarp ostiolate, 2 cells thick, ecorticate, outer cells angular, L/D about 1 (-2). Spermatangial organs lanceoid, 80–180 µm long and 35–55 µm in diameter, with 1 (-2) basal sterile cells and 2–3 sterile apical cells.

Stichidia developed from determinate laterals, curved, free from host and more or less erect, with tetrasporangia (Fig. 133E) in a fairly straight row, 30–45 µm in diameter, with 2 cover cells.

Type from Brazil, on *Vidalia obtusiloba*; holotype in Herb. Agardh, LD, 39124.

Distribution: In southern Australia, from Yanchep, W. Aust., to Phillip I., Victoria and N Tasmania. N.S.W. (*Millar & Kraft* 1993: 52).

Widespread in the temperate southern hemisphere, extending into the northern hemisphere.

Selected specimens: Yanchep, W. Aust., on *Erythroclonium muelleri*, drift (*Womersley*, 22.ix.1979; AD, A51278). Point Drummond, S. Aust., on *Laurencia filiformis*, mid eulittoral pool (*Womersley*, 11.i.1951; AD, A15138). Yatala Harbour, N Spencer Gulf, S. Aust., on *Posidonia sinuosa*, 10 m deep (*Johnson*, 27.vi.1978; AD, A54933). Troubridge Point, S. Aust., on *Haliptilon roseum*, 2–5 m deep (*Shepherd*, 7.ii.1969; AD, A33835). D'Estrees Bay, Kangaroo I., S. Aust., on *Laurencia filiformis*, sublittoral fringe pools (*Womersley*, 24.viii.1950; AD, A15431). Pennington Bay, Kangaroo I., S. Aust., on *Chaetomorpha coliformis*, upper sublittoral (*Womersley*, 26.i.1956; AD, A20118). Brighton, Port Phillip, Vic. (*Harvey*, Trav. Set 480; MEL, 45859). Phelans Bluff, Phillip I., Vic., on *Metagoniolithon stelliferum*, drift (*Sinkora*, A559, 15.vi.1970; AD, A62709, MEL, 2010413). Emu Bay, N Tas., on *Botryocladia obovata* (1880; herb. Sonder; MEL, 45856).

J. Agardh (1885, p. 98) in describing *P. heteroclada*, based on New Zealand material, separated it from *P. dendritica* in having branches secundarily erect. The basic branching pattern in both is identical and the erect parts largely apply to the tetrasporic branches. There appears to be little difference between them, based on the description of Brazilian material by Joly *et al.* (1965), and *P. heteroclada* is here regarded as a synonym of *P. dendritica*.

2. **Dipterosiphonia prorepens** Falkenberg 1901: 328. De Toni 1903: 1050. May 1965: 380?

Polysiphonia prorepens sensu Harvey 1855a: 541; 1862a; pl. 185B; 1863, synop.: xxi. J. Agardh 1863: 917. Kützing 1864: 12, pl. 36a–f. Sonder 1880: 35.

Herposiphonia prorepens sensu Lucas 1909: 45. Lucas & Perrin 1947: 293, fig. 136.

FIG. 134

Thallus (Fig. 134A) dark red-brown, densely clothing the host for up to several cm, 2–6 mm high (thick) with prostrate axes producing alternate pairs of determinate laterals (Fig. 134B) which soon become more or less erect and closely adjacent on the axes, with the branches of the anterior laterals developing as well as the posterior laterals; the anterior laterals are flexed forward on the axes and the posterior one emitted more directly. Attachment by rhizoids; epiphytic, especially on the stems of *Amphibolis*. *Structure*. Axial apical cells hemispherical, 12–20 µm in diameter, segmenting transversely and the subapical cells obliquely in the pattern of the genus, with the anterior determinate lateral branched and the posterior simple (Fig. 134B), all soon flexed upwards and free from the substrate (Fig. 134E). Axes and laterals with (7-) 8 pericentral cells, axes 130–200 µm in diameter with segments L/D 0.3–0.5, determinate laterals terete, 50–120 µm in diameter with segments L/D 0.2–0.5 (-0.8), tapering slightly throughout. Trichoblasts arising from subapical cells of determinate laterals, 300–1000 µm long, much branched, basal cells 16–30 µm in diameter, L/D 1–2, longer and slenderer above. Rhizoids cut off from axial pericentral cells, unicellular with multicellular haptera. Cells uninucleate; rhodoplasts discoid to elongate, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps on subrabasal cell of trichoblasts, soon polysiphonous. Carposporophytes with a small basal fusion cell and a much branched gonimoblast with clavate terminal carposporangia 20–30 µm in diameter. Cystocarps (Fig. 134C) lateral on determinate laterals, short-stalked, ovoid, 450–650 µm in diameter; pericarp ostiolate, 2 cells thick, ecorticate, outer cells angular, isodiametric. Spermatangial organs (Fig. 134D) replacing trichoblasts, tapering, 80–180 µm long and 35–55 µm in diameter, with a sterile basal cell and usually 2–3 sterile apical cells.

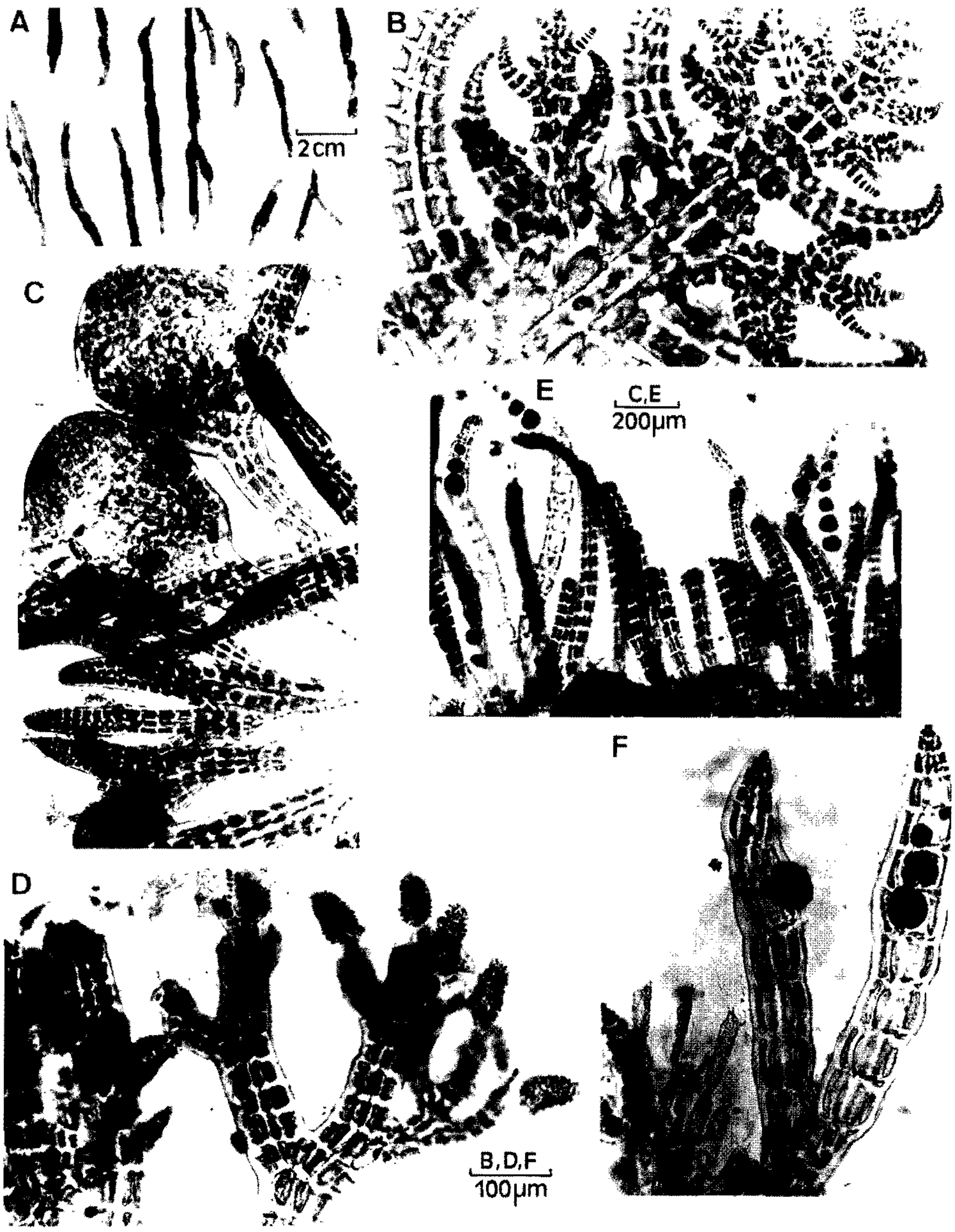

Fig. 134. *Dipterosiphonia prorepens* (**A**, **C**, **D**, **F**, AD, A19161; **B**, **E**, AD, A50696). **A**. Habit, on stems of *Amphibolis*. **B**. Branching pattern of apex. **C**. Cystocarps on determinate branches. **D**. Erect branches with spermatangial organs. **E**. Erect determinate laterals with tetrasporangia. **F**. Tetrasporangia in determinate laterals.

Tetrasporangia (Fig. 134E, F) in determinate laterals, usually in straight series, not or slightly swelling the segments, 40–80 μm in diameter, with 2–3 cover cells.

Type from King George Sound, W. Aust., on *Dicranema revolutum*; lectotype Alg. Aust. Exsicc. No. 181, in Herb. Harvey, TCD.

Distribution: Kalbarri, W. Aust., to Kingston, S. Australia.

Selected specimens (all on stems of *Amphibolis*): Red Bluff, Kalbarri, W. Aust., upper sublittoral pools (*Womersley*, 15.ix.1979; AD, A51293—"Marine Algae of southern Australia" No. 404). Eucla, W. Aust., drift (*Womersley*, 5.x.1979; AD, A50696). Head of Great Australian Bight, S. Aust., upper sublittoral (*Womersley*, 4.ii.1954; AD, A19161). Tiparra reef, Spencer Gulf, S. Aust., 5 m deep (*Shepherd*, 24.ix.1971; AD, A39720). Goolwa, S. Aust., drift (*Ricci*, 19.v.1997; AD, A67080). D'Estrees Bay, Kangaroo I., S. Aust., outer reef pool (*Womersley*, 11.i.1950; AD, A12691). 3 km SW of Kingston, S. Aust., 6–7 m deep (*R. Lewis*, 28.xi.1972; AD, A42867).

The indeterminate apices show typical *Dipterosiphonia* structure, but this is obscured by the dense arrangement of the erect determinate laterals. *D. prorepens* is largely restricted to the stems of the seagrass *Amphibolis*, occasionally on other algae.

D. prorepens is ascribed to Falkenberg as a newly described species, distinct from *Polysiphonia prorepens* [= *Herposiphonia prorepens* (Harvey)Schmitz] from South Africa. Falkenberg (1901, p. 329) considered the illustration of Harvey (1862, pl. 185B) included both Australian and South African plants, but Wynne (1984c, p. 172) doubted this and it seems that pl. 185B is based entirely on the Australian species.

3. **Dipterosiphonia australica** Womersley, *sp. nov.*

FIG. 135

Thallus (Fig. 135A) dark brown-red, densely clothing the host for 1–3 cm, 3–5 mm high (thick) with compressed prostrate axes producing alternate pairs of determinate laterals, the anterior often becoming indeterminate, free and more or less erect (Fig. 135B), 2–7 mm long, with anterior and posterior determinate laterals terete and mostly simple. Attachment by rhizoids; epiphytic, mainly on the axes of *Acrocarpia paniculata*. *Structure*. Apical cells hemispherical, 15–20 μm in diameter, segmenting transversely and obliquely in the pattern of the genus, with the anterior determinate lateral branched and the posterior simple, the anterior frequently becoming indeterminate with determinate laterals 400–800 μm long, mostly simple and 35–70 μm in diameter, segments L/D 0.2–0.4. Axes and determinate laterals with usually 6 pericentral cells, axes 90–140 μm broad, segments L/D 0.4–0.8. Trichoblasts occasional, on determinate laterals, branched, 400–800 μm long, basal cells 15–20 μm in diameter and L/D 1–1.5, slenderer above. Rhizoids cut off from axial pericentral cells, unicellular with multicellular haptera. Cells uninucleate; rhodoplasts discoid to elongate.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a small basal fusion cell and branched gonimoblast with clavate terminal carposporangia 20–30 μm in diameter. Cystocarps (Fig. 135C) lateral on determinate laterals, sub-sessile, ovoid to very slightly urceolate, 300–400 μm in diameter; pericarp ostiolate, 2 cells thick, ecorticate, outer cells angular, isodiametric. Spermatangial organs (Fig. 135D) replacing trichoblasts, lanceoid, 80–140 μm long and 35–55 μm in diameter, with a single basal and 2–3 apical sterile cells.

Tetrasporangia in determinate laterals (Fig. 135E), the ends curved to recurved and 400–1000 μm long; fertile segments 60–90 μm in diameter, tetrasporangia in a curved line, 35–65 μm in diameter with 2–3 cover cells.

Diagnosis: Thallus rubiginosus, hospitem ad 1–3 cm dense investiens, 3–5 mm crassus, cum axibus compressis et prostratis producentibus para alternata lateralium determinatorum, anticus saepe indeterminatus, liber et plus minusve erectus, 2–7 mm longus, cum lateralibus anticis et posticis determinatis teretis plerumque simplicibus. Affixus per rhizoidea; epiphyticus praecipue in axibus *Acrocarpia paniculata*. Structura. Cellulae apicales hemisphaericae, 15–20 μm diam., dividentes transverse et oblique ut in ordinatione generis, cum laterale antico ramoso et postico simplici, antico saepe indeterminato cum lateralibus determinatis 400–800 μm longis plerumque simplicibus 35–70 μm diam., cum segmentis L/D 0.2–0.4. Axes et laterales determinati cum plerumque 6 cellulis pericentralibus, axes 90–140 μm lati, segmenta L/D 0.4–0.8. Trichoblasti interdum, in lateralibus determinatis, ramosis, 400–800 μm longis, cellulae basales 15–20 μm diam. et L/D 1–1.5, supra graciliores.

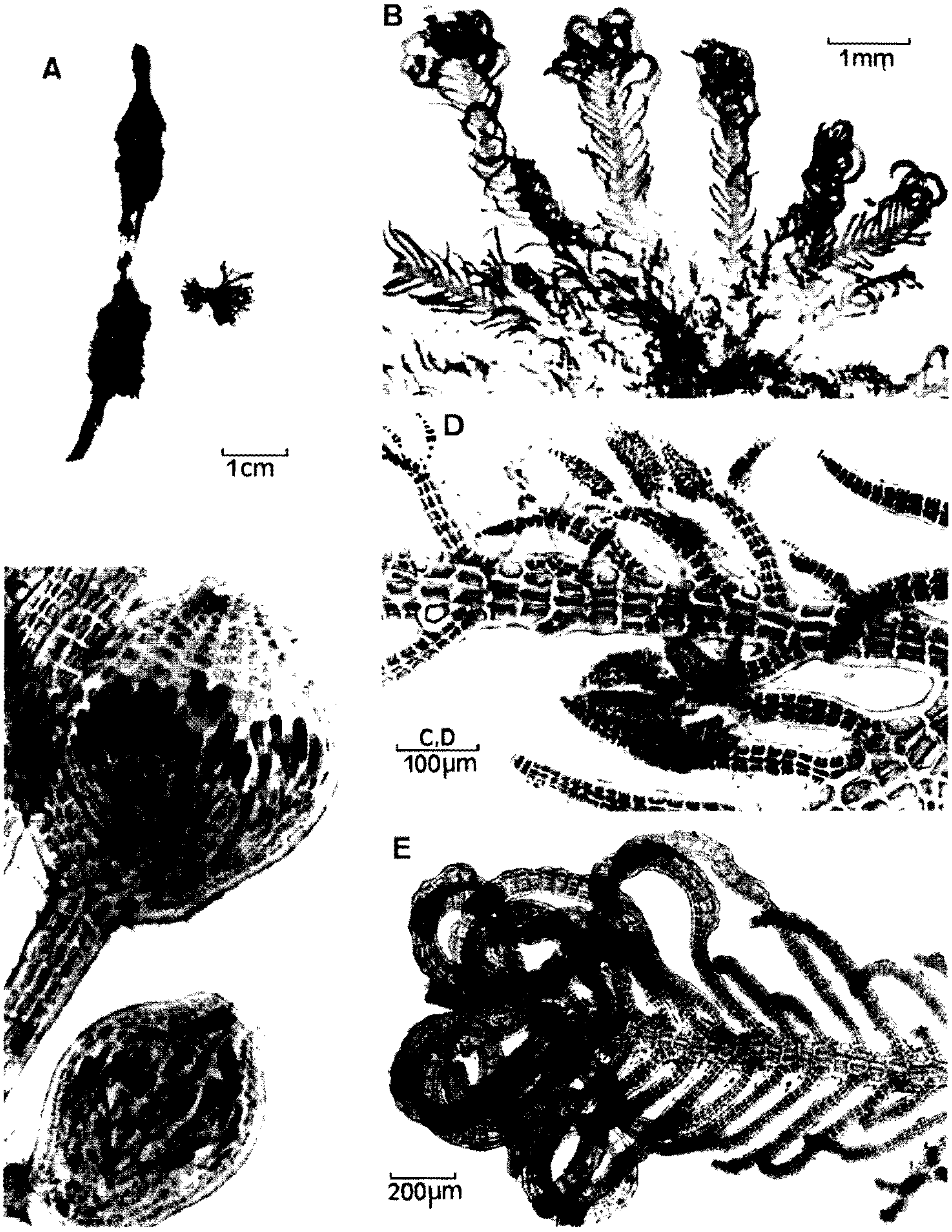

Fig. 135. *Dipterosiphonia australica* (AD, A20888). **A**. Habit, on *Acrocarpia*. **B**. Erect indeterminate branches with alternate pairs of determinate laterals. **C**. Cystocarps. **D**. Spermatangial organs on determinate laterals. **E**. Tetrasporangial branches (determinate laterals).

Rhizoidea ex cellulis axialibus pericentralibus abscissa, unicellularia cum hapteris multicellularibus. Cellulae uninucleatae; rhodoplasti discoidei ad elongatos.

Reproductio. Gametophyta dioecia. Carposporophyta cum cellula parva basali coalescente et cum gonimoblasto ramoso cum carposporangiis terminalibus clavatis 20–30 μm diam. Cystocarpia lateralia in lateribus determinatis, subsessilia, ovoidea ad leviter urceolata 300–400 μm diam.; pericarpium ostiolatum crassum ecorticatum, cellulae exteriores angulares isodiametrae. Organa spermatangialia vice trichoblastorum, lanceoidia, 80–140 μm longa et 35–55 μm diametro, cum una cellulis basali et 2–3 cellulis apicalibus sterilibus. Tetrasporangia in lateralibus determinatis, extrema curvata aut recurvata, 400–1000 μm longa; segmenta fertilia 60–90 μm diam.; tetrasporangia in curvamine posita 35–65 μm diam., cum 2–3 cellulis tegentibus.

Type from Stanley beach, S coast Kangaroo I., S. Aust., on *Acrocarpia paniculata*, drift (*Womersley*, 2.ii.1957); holotype in AD, A20888.

Distribution: South coast of Kangaroo I., S. Aust. to San Remo, Victoria. Probably more widely distributed than the few records.

Selected specimens: Vivonne Bay, Kangaroo I., S. Aust., on *Myriodesma harveyanum* (*Womersley*, 1.i.1996; AD, A13039). Pennington Bay, Kangaroo I., S. Aust., reef edge (*Kraft 4323*, 4.iv.1972; AD, A42452). Stanley Beach, Kangaroo I., S. Aust., on *Acrocarpa*, drift (*Womersley*, 7.ii.1956; AD, A20094). Point Lonsdale, Vic., on tunicate, 2.5–4 m deep (*Kraft*, 1.iii.1989; MELU). San Remo, Vic., on *Laurencia*, drift (*Sinkora* A2009, 22.xi.1974; AD, A19568; MEL, 2010984).

D. australica is distinguished by the similarity of the simple anterior and posterior determinate laterals and the largely free nature of the indeterminate branches; it appears to be epiphytic on larger brown algae and not *Amphibolis*. The specific name is based on its Australian distribution.

Genus **DITRIA** Hollenberg, 1967a: 206

Thallus entirely prostrate, with dorsi-ventral indeterminate axes bearing in spiral sequence, singly or in pairs, simple determinate laterals flexed to alternate sides, separated usually by an unbranched segment which bears only a single dorsal cell cut off the axial cell. *Structure*. Pericentral cells 5, ecorticate, axes compressed, determinate laterals terete with trichoblasts on upper segments. Rhizoids cut off from ventral pericentral cells, unicellular with multicellular haptera. Cells uninucleate.

Reproduction. Gametophytes dioecious. Procarps borne on trichoblasts, with a 4-celled carpogonial branch and 2 sterile groups; carposporophyte with a basal fusion cell and gonimoblast with clavate terminal carposporangia; cystocarps terminal on determinate laterals, ovoid, ostiolate, pericarp ecorticate. Spermatangial organs replacing trichoblasts on determinate laterals, lanceoid, with sterile basal and terminal cells.

Tetrasporangia in ends of determinate laterals, single per segment.

Type species: *D. reptans* Hollenberg 1967a: 208, fig. 4.

A genus of 3 species, the type, *D. zonaricola* (Okamura)Yoshida & Yoshida (1983) from Japan, and *D. expleta* Huisman. The type and *D. zonaricola* have dormant ventral lateral initials whereas in *D. expleta* these form one determinate lateral of each pair. This results in a striking difference between *D. expleta* and the other 2 species, which might be considered of generic status.

Ditria expleta Huisman 1994: 2, figs 1–13; 1997: 204; 2000: 164. Silva *et al.* 1996: 491.

FIG. 136

Thallus (Fig. 136A) brown-red, entirely prostrate on the host, axes 2–6 mm long, dorsiventrally organised with pairs of simple, terete, determinate laterals 300–800 μm long, usually separated by a dorsal segment bearing only a single cell. Attachment by rhizoids from ventral pericentral cells; epiphytic on *Lobophora variegata* and *Zonaria* sp. *Structure*. Apical cells hemispherical, 14–18 μm in diameter, segmenting transversely to give short axial cells, subapical cells dividing obliquely to cut off in a spiral sequence initials of determinate laterals which lie in alternate pairs separated usually by a segment with only a single dorsal cell

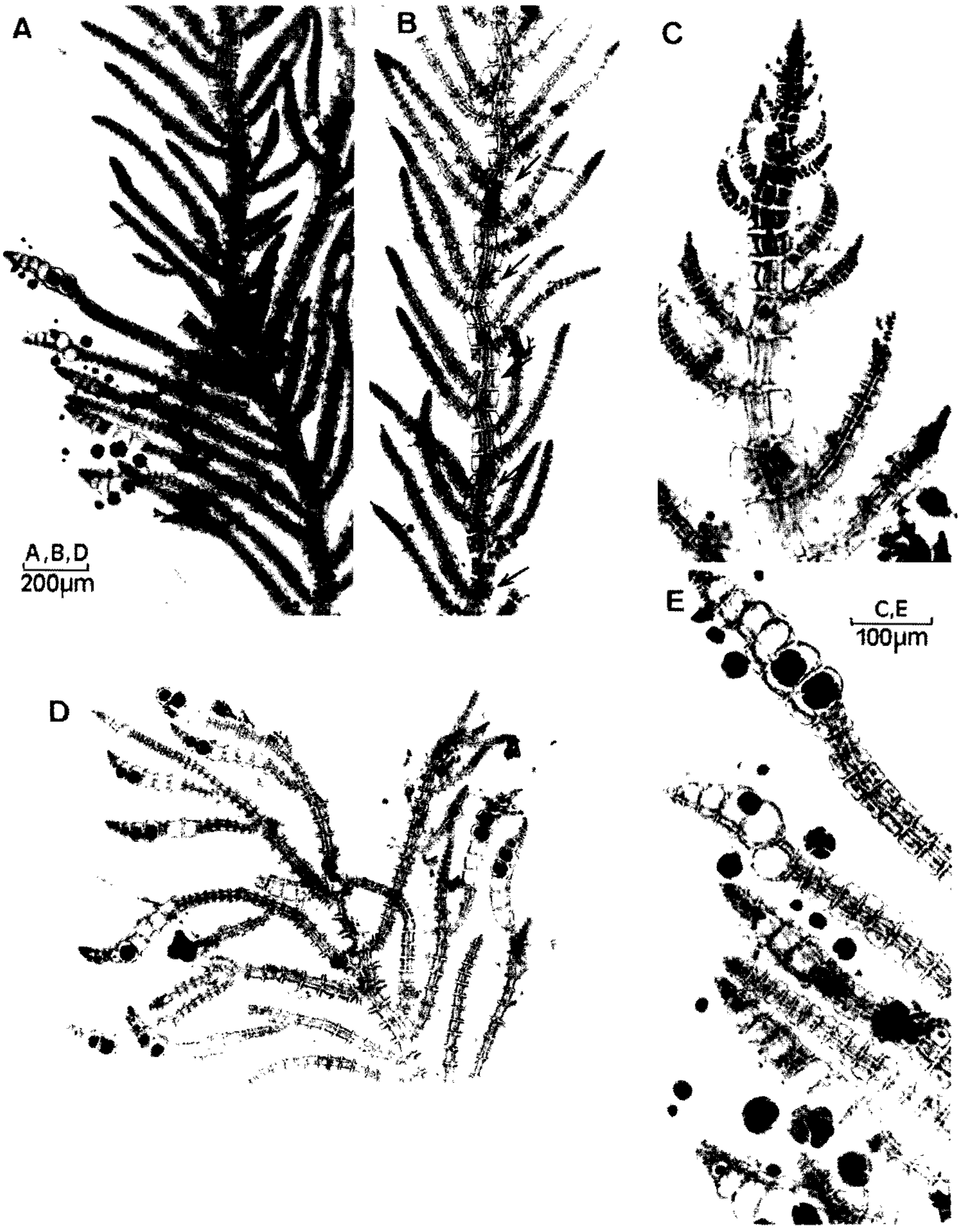

Fig. 136. *Ditria expleta* (AD, A46955). **A.** Part of tetrasporangial thallus showing branching pattern. **B.** Indeterminate branch with alternate pairs of determinate laterals usually separated by an unbranched segment (arrow) bearing a primordial cell. **C.** Apex showing branching pattern. **D.** Determinate laterals with tetrasporangia. **E.** Tetrasporangia in upper segments of determinate laterals.

(Fig. 136B, C, arrows), occasionally lacking the latter. Pericentral cells 5, ecorticate. Axes compressed, (50-) 70–110 μm broad, segments L/D 0.6–1.0 (-1.5), determinate laterals 15–20 segments long, (40-) 50–85 μm in diameter, segments L/D 0.5–0.8. Lateral axes developed by continued growth of determinate laterals. Trichoblasts on occasional upper segments of determinate laterals, 400–1000 μm long, branched, basal cells 25–35 μm in diameter, L/D 2–5. Rhizoids cut off from pericentral cells, unicellular with multicellular haptera. Cells uninucleate; rhodoplasts discoid to elongate, often transversely orientated in axial cells.

Reproduction. Gametophytes dioecious (Huisman 1994). Procarps borne on the second cell of trichoblasts on apices of determinate lateral branches, with a 4-celled carpogonial branch and 2 sterile branches. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia. Cystocarps terminal on determinate laterals, ovoid; pericarp ostiolate, ecorticate. Spermatangial organs arise on trichoblasts on determinate laterals, lanceolate, mostly 180–300 μm long and 35–45 μm in diameter, with 1–2 basal and 1–4 apical sterile cells.

Tetrasporangia (Fig. 136D, E) in linear series in swollen and often curved ends of determinate laterals, fertile segments 70–90 μm in diameter; 40–110 μm in diameter, with 3 cover cells.

Type from Goss Passage, Wallabi Group, Houtman Abolhos, W. Aust., on *Lobophora variegata*, 15 m deep (*Huisman*, 13.vii.1993; Murdoch HA313a).

Distribution: Houtman Abrolhos and Rottnest I., W. Aust., and from Cootes Hill, Sturt Bay, Yorke Pen., to Sellicks reef, and Rocky Point, Kangaroo I., S. Aust., but probably more widespread.

Selected specimens: Cootes Hill, Yorke Pen., S. Aust., on *Lobophora*, 5 m deep (*Edyvane*, 30.x.1993; AD, A66541). Edithburg, S. Aust., on *Lobophora*, 3–4 m deep on jetty piles (*Kay*, 26.v.1975; AD, A46955). Port Noarlunga, S. Aust., on *Lobophora*, 1.5–3 m deep (*Kraft* 3015 & *Womersley*, 3.xii.1970; MELU and AD, A69075). Sellicks reef, S. Aust., on *Zonaria*, 5 m deep (*O'Leary*, 20.iii.1994; AD, A63383). Emu Bay, Kangaroo I., S. Aust., on *Lobophora*, upper sublittoral on jetty piles (*Womersley*, 10.ii.1956; AD, A20151). Rocky Point, Kangaroo I., S. Aust., on *Lobophora*, drift (*Womersley*, 4.vi.1947; AD, A5696).

D. expleta is an inconspicuous alga, being entirely prostrate on *Lobophora* and *Zonaria*, and is probably more widely distributed on southern Australian coasts.

Genus HERPOPTEROS Falkenberg *in* Schmitz & Falkenberg 1897: 460

Thallus entirely prostrate, with compressed indeterminate axes bearing alternate determinate laterals from successive segments, with the next segment unbranched but with the dorsal pericentral cell dividing to give a small isodiametric cell. *Structure*. Pericentral cells 10–12, 6–7 in face view, ecorticate. Determinate laterals alternately pinnate, lower branches bearing a trichoblast. Rhizoids cut off from the marginal pericentral cells of axes, unicellular with multicellular haptera. Cells uninucleate.

Reproduction. Gametophytes dioecious. Procarps unknown. Carposporophytes with a branched gonimoblast and terminal carposporangia. Cystocarps ovoid, sessile, pericarp ecorticate. Spermatangial organs replacing trichoblasts.

Tetrasporangia in simple stichidia replacing determinate laterals, in a straight row, one per segment.

Type species: *Herpopteros fallax* Falkenberg *in* Schmitz & Falkenberg 1897: 461.

Herpopteros is characterized by the alternate, single, branched, determinate laterals on successive segments, the next segment having only a divided dorsal pericentral cell (not a single cell from the axial cell, as in *Ditria*).

Herpopteros fallax Falkenberg *in* Schmitz & Falkenberg 1897: 461, fig. 259. Falkenberg 1901: 333, pl. 2 figs 24–26, pl. 3 figs 21–23. De Toni 1903: 1061. Guiler 1952: 106. Kylin 1956: 532, fig. 425. Lucas 1909: 45; 1929a: 23. Lucas & Perrin 1947: 294. May 1965: 381. Saenger 1974: 81. Shepherd & Womersley 1981: 368.

FIG. 137

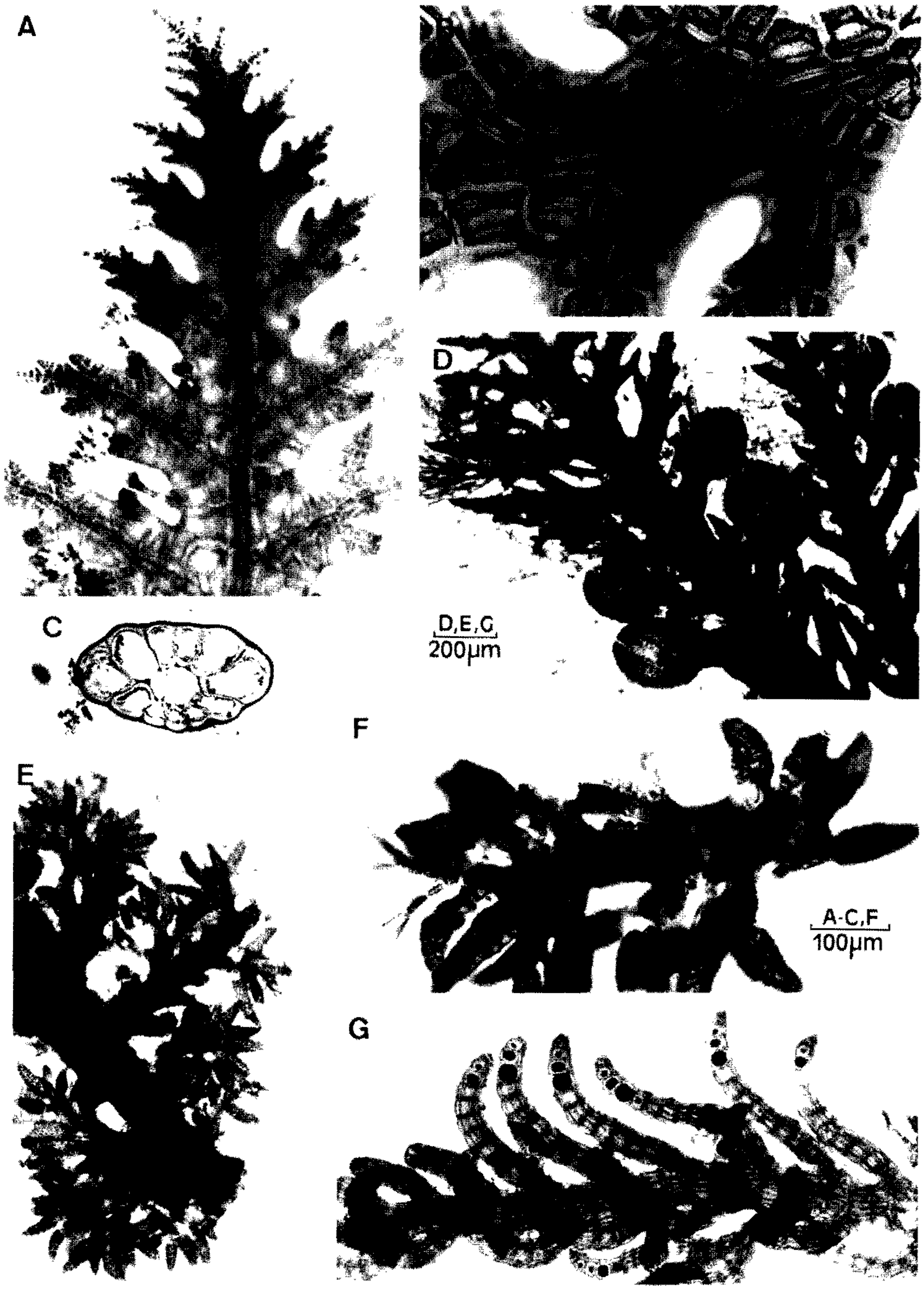

Fig. 137. *Herpopteros fallax* (AD, A59903). **A.** Habit of frond apex. **B.** Indeterminate branch showing small isodiametric cell (arrow) cut off anterior end of dorsal pericentral cell. **C.** Transverse section of indeterminate axis. **D.** Branches with cystocarps. **E.** Branch with spermatangial organs. **F.** Spermatangial organs. **G.** Determinate laterals with tetrasporangia.

Thallus prostrate, 1–10 (-15) mm long, entirely adherent to the host, axes compressed and irregularly branched, bearing alternate determinate laterals on successive segments (Fig. 137A) with the next segment producing only a single additional cell by transverse division of the central dorsal pericentral cell (Fig. 137B, arrows). Attachment by rhizoids; epiphytic on cartilaginous axes of various hosts. *Structure*. Apical cells protruding, dome-shaped, 10–20 µm in diameter, segmenting transversely and obliquely to cut off the sequence of determinate laterals. Axes with 10 (-12) pericentral cells, with 2–3 central narrower ones and larger edge ones (Fig. 137C), in face view often appearing 6–7 across (Fig. 137B) due to the compressed nature of the axis but the lateral cells not laterally divided; axes 130–250 µm broad, L/D 0.3–0.8, with the pericentral cells 20–30 (-40) µm in diameter and L/D 2–3. Determinate laterals 600–1000 µm long, alternately pinnate (as in the axes), with the lower branches bearing a trichoblast (Fig. 137A). Trichoblasts 1–1.5 mm long, branched mainly adaxially below, basal cell isodiametric and 20–40 µm across, lower cells elongate and 20–45 µm in diameter. Rhizoids produced by and cut off from the marginal cells of the axes, reflexed to the underside, unicellular with multicellular haptera. Cells uninucleate; rhodoplasts discoid to elongate, often chained.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophyte (young) with a basal fusion cell and branched gonimoblast. Cystocarps (Fig. 137D–juvenile) ovoid, 150–200 µm in diameter, sessile on branches of determinate laterals; pericarp ostiolate, 2 cells thick, ecorticate. Spermatangial organs (Fig. 137E, F) in position of trichoblasts, elongate-ovoid and tapering, 90–190 µm long and 35–55 µm in diameter, with sterile basal and apical cells.

Stichidia (Fig. 137G) occur in place of determinate laterals, simple, usually curved, 400–900 µm long and 80–100 µm in diameter, with tetrasporangia in an almost straight row, 45–65 µm in diameter, with 2 elongate cover cells.

Type from Port Phillip and Western Port, Vic. (lectotype to be selected); presumably in Herb. Falkenberg, Naples.

Distribution: Elliston, S. Aust., to Western Port, Victoria.

Selected specimens: Elliston, S. Aust., on *Heterosiphonia lawrenciana*, 7–8 m deep (*Shepherd*, 27.x.1971; AD, A42446). Tiparra Reef, S. Aust., on *Amphibolis*, 10–12 m deep (*Shepherd*, 16.iii.1985; AD, A56446). Hardwicke Bay, S. Aust., on *Protokuetzingia*, drift (*Gordon-Mills*, 26.v.1981; AD, A52190). Dany Beach, Corny Point, S. Aust., on *Laurencia*, drift (*Womersley*, 15.x.1989; AD, A59903). Aldinga, S. Aust., on *Posidonia*, 7 m deep (*Johnson*, 7.vii.1973, AD, A43803). Port Elliot, S. Aust., on *Gracilaria cliftonii*, drift (*Womersley*, 23.v.1953; AD, A18758), and on *Laurencia*, drift (*Ricci*, 26.ix.1966; AD, A66664). Robe, S. Aust., on *Laurencia*, drift (*Womersley*, 23.viii.1960; AD, A24457).

H. fallax is an inconspicuous but not uncommon epiphyte on cartilaginous red algae or on *Amphibolis*.

Genus GREDGARIA Womersley, *gen. nov.*

Thallus basally attached but with free upper parts, axes branched, bearing simple or branched, alternate, distichous, determinate laterals separated by a single unbranched segment. Attachment by clumped rhizoids. *Structure*. Pericentral cells 8, 2 larger on each face and 2 slightly smaller on each margin, the latter sometimes dividing transversely; corticating cells occur in irregular clusters on each side of the axes, lying over the ends of pericentral cells and on the margins. Trichoblasts apparently absent. Rhizoids cut off from adjacent pericentral cells and hence clumped, individually unicellular with multicellular haptera.

Reproduction. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia. Cystocarps ovoid; pericarp ostiolate, ecorticate. Spermatangial organs unknown.

Tetrasporangia in determinate laterals, spirally arranged, one per segment.

Diagnosis: Thallus basaliter affixus sed cum partibus superioribus liberis, axes ramosi ferentes laterales simplices aut ramosos, alternos, distichos determinatos, separatos per unum segmentum sine ramis. Affixus per rhizoidea fasciculata. Structura. Cellulae pericentrales 8, 2 maiores in utraque facie et 2 leviter minores in utroque margine; haec interdum transverse dividentes, cellulae corticatae in fasciculis irregularibus in utroque latere axium, iacentes super extrema cellularum pericentralium et in marginibus. Trichoblasti absentes. Rhizoidea ex cellulis adiacentibus pericentralibus abscissa et ita fasciculata, unicellularia cum hapteris multicellularibus.

Reproductio. Carposporophyta cum cellula basali coalescente et cum gonimoblasto ramoso et cum carposporangiis clavatis terminalibus. Cystocarpia ovoidea; pericarpium ostiolatum ecorticatum. Organa spermatangialia non nota. Tetrasporangia in lateralibus determinatis, spiratim disposita, unum per segmentum.

Type species: *G. maugeana* Womersley, *sp. nov.*

Gredgaria is characterised by the pattern of branching, pericentral cells and corticating cell clusters, and clumped rhizoids. It is named after Dr Graham Edgar, whose extensive collections off Tasmania coasts (in particular) have contributed to our knowledge of the algae of this region.

Gredgaria maugeana Womersley, *sp. nov.*

FIG. 138

Thallus (Fig. 138A, B) dark brown-red, (0.5-) 1–2 cm long, basally attached with free, lax, upper parts, axes frequently branched and bearing simple or branched, alternate, distichous, determinate laterals along its length (Fig. 138C), the laterals separated by one unbranched segment (Fig. 138C, D, arrows). Attachment by rhizoids, usually clumped (Fig. 138F) from cells of adjacent segments; epiphytic on various hosts, epizoic, and possibly epilithic. *Structure.* Apical cells dome-shaped, 15–20 µm in diameter, cutting off by oblique walls alternate laterals a cell apart. Axes compressed, with 8 pericentral cells, usually arranged with 2 slightly larger ones on each face and 2 slightly smaller ones (which may divide transversely) on each margin (Fig. 138D); smaller corticating cells occur in irregular clusters on each side, lying over the ends of the pericentral cells (Fig. 138E) and on the margins. Determinate laterals 0.5–2 mm long, simple or branched as in the axes, 60–100 (-140) µm broad, segments L/D 0.4–1.2. Axes 160–300 µm broad, segments L/D (0.2-) 0.5–1. Trichoblasts apparently absent. Rhizoids cut off from adjacent pericentral cells, unicellular with multicellular haptera. Cells probably uninucleate; rhodoplasts discoid to elongate.

Reproduction. Procarps not observed. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia 25–40 µm in diameter. Cystocarps (Fig. 138G) almost sessile, ovoid, 250–400 µm in diameter; pericarp ostiolate, ecorticate, 2 cells thick, outer cells isodiametric. Spermatangial organs not observed.

Tetrasporangia in branched determinate laterals, swelling the segments, spirally arranged, one per segment, 35–70 µm in diameter, with probably 2 cover cells.

Diagnosis: Thallus ferrugineus, (0.5-) 1–2 cm longus, affixus basaliter cum partibus superioribus laxis liberis, axes ramosi ferentes laterales simplices aut ramosos alternatos distichos determinatos secum longitudinem, laterales uno segmento sine ramis separati. Affixus per rhizoidea plerumque fasciculata ex cellulis segmentorum adiacentium, epiphyticus in hospitibus variis, epizoicus et probabiliter epilithicus. Structure. Cellulae apicales tholiformes, 15–20 µm diam. abscissentes per muros obliquos laterale alternatos una cellula separatos. Axes compressi, cum 8 cellulis pericentralibus plerumque dispositi cum 2 leviter maioribus in quaque superficie et 2 minoribus (fortasse transverse dividentibus) in quoque margine; cellulae minores corticantes in fasciculis irregularibus in quoque latere, iacentes supra extrema cellularum pericentralium et in marginibus. Laterales determinati 0.5–2 mm longi, simplices aut ramosi sicut in axibus, 60–100 (-140) µm lati, segmenta L/D 0.4–1.2. Axes 160–300 µm lati, segmenta L/D (0.2-) 0.5–1. Trichoblasti apparenter absentes. Rhizoidea ex cellulis adiacentibus pericentralibus abscissa, unicellularia cum hapteris multicellularibus. Cellulae probabiliter uninucleatae; rhodoplasti discoidei ad elongatum.

Reproductio. Carposporophyta cum cellula basali coalescente et gonimoblasto ramoso cum carposporangiis clavatis et terminalibus 25–40 µm diam. Cystocarpia fere sessilia, ovoidea, 250–400 µm diam., pericarpium ostiolatum, ecorticatum, 2 cellulas crassum, cellulae exteriores isodiametricae. Organa spermatangialia non visa. Tetrasporangia in lateralibus ramosis et determinatis, segmenta tumescentia, spiraliter disposita, unum per segmentum 35–70 µm diam., cum probabiliter 2 cellulis tegentibus.

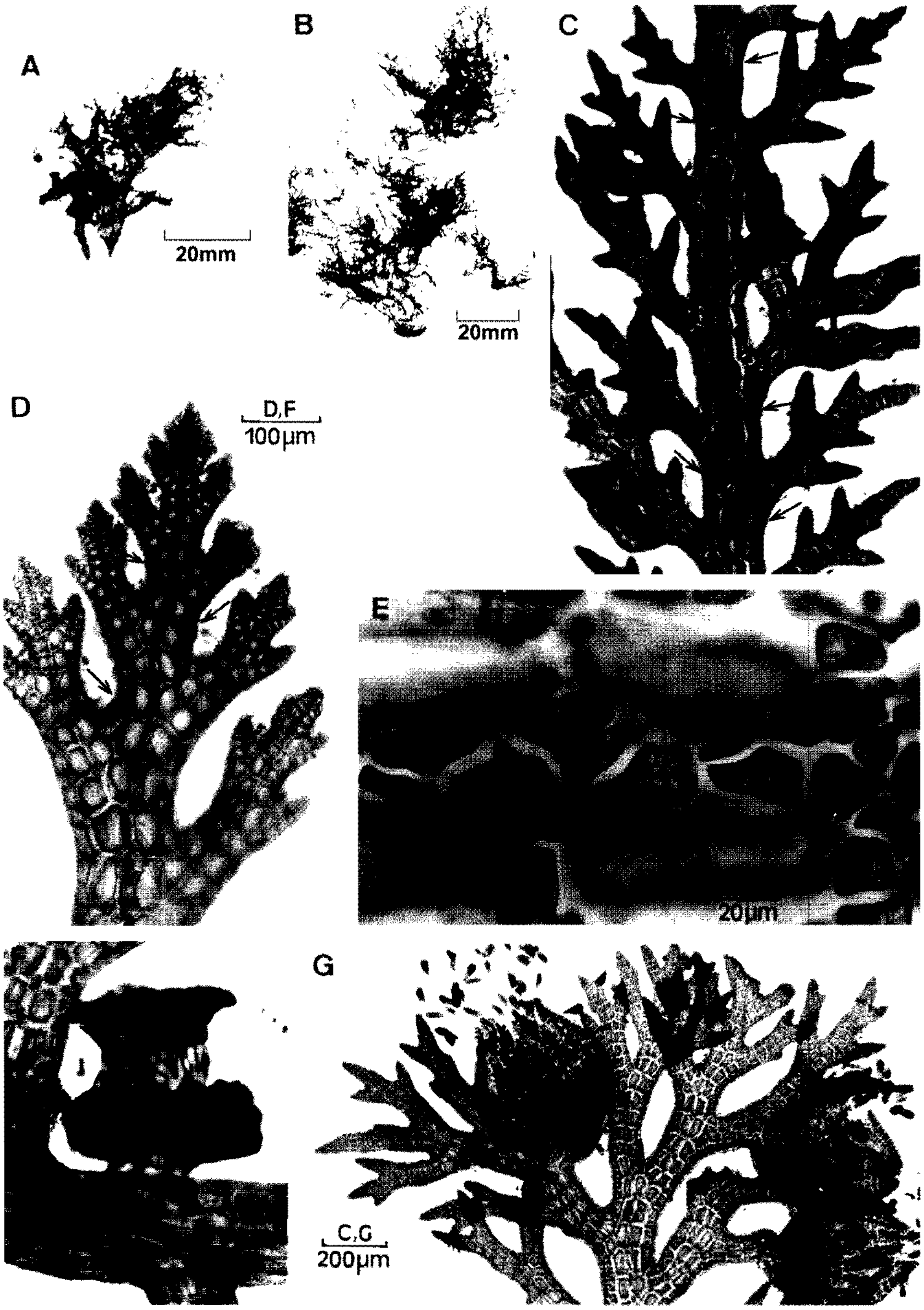

Fig. 138. *Gredgaria maugeana* (**A**, **C–E**, AD, A43353; **B**, AD, A68568; **F**, **G**, AD, A43512). **A**. Habit, type. **B**. Habit, larger specimen. **C**. Indeterminate axis bearing branched determinate laterals (arrows to unbranched segments). **D**. Apex of indeterminate axis with determinate laterals (arrows to unbranched segments). **E**. Pattern of cortical cells lying over the pericentral cells. **F**. Clumped rhizoids (two, one above the other). **G**. Branches with cystocarps.

Type from Gabo I., Vic. on *Rhodymenia*, 24 m deep (*Shepherd*, 14.ii.1973); holotype in AD, A43353; syntype Gabo I., Vic., on *Epymenia*, 18 m deep (*Shepherd*, 17.ii.1973) in AD, A43512.

Distribution: E Victoria and SE Tasmania.

Selected specimens: Point Lonsdale, Vic., pool on reef flat (*Tolmer & Kraft*, 5.x.2001; MELU, K11097, AD, A69229). Cape Woolamai, Vic., on tunicate *Herdmania momus*, 15–18 m deep (*Sorokin*, 16.ii.1990; AD, A60202). Point Hicks, E Vic., 18–21 m deep on "Satisfaction reef" (*Kraft & Watt*, 8.ii.2001; MELU, 3820, 3827; AD, A69077). Gabo I., Vic., epiphytic, 1–3 m deep (*Shepherd*, 15.ii.1973; AD, A43378) and on *Rhodymenia*, 28 m deep (*Shepherd*, 19.ii.1973; AD, A43539). Huon I., off Ninepin Point, SE Tas., 8–14 m deep (*Edgar*, 31.iii.2000; AD, A68568). Great Taylor Bay, Bruny I., Tas., on *Thamnoclonium*, 1–2 m deep (*Shepherd*, 14.ii.1972; AD, A42144). Port Arthur, Tas., upper sublittoral (*Cribb* 37.4, 6.iii.1950; AD, A16342).

The specific name is based on the eastern Australian distribution of this alga, within the Maugean subprovince.

Tribe POLYZONIEAE Schmitz & Falkenberg 1897: 461.

Thallus partly or largely prostrate, or erect, with indeterminate axes bearing determinate laterals in a regular pattern, these laterals often foliose and jungermanniaceous. Indeterminate apices dorsiventrally organised, with a large, usually curved, apical cell, with 6 (7 in *Leveillea*) pericentral cells; ecorticate or becoming corticated below; determinate laterals with three pericentrals, in some species absent. Determinate laterals arise exogenously, usually from alternate segments of the axes and in 2 slightly displaced ranks, and may be simple, branched, or foliose. Lateral indeterminate axes arise endogenously and subapically, at regular intervals or not. Trichoblasts absent or present on the determinate laterals. Attachment by rhizoids (usually paired, not cut off the parent cells, and with digitate haptera) or by fibrous holdfasts.

Reproduction. Procarps borne on basal cells of trichoblasts or directly on determinate laterals; carposporophytes with terminal carposporangia; cystocarps on determinate laterals, ovoid, pericarp ecorticate or corticate. Spermatangial organs spoon-shaped or tri-radiate, developed from determinate laterals, with marginal sterile cells to the flanges.

Tetrasporangia occur in the indeterminate axes or in special lateral indeterminate branches, cut off from lateral pericentral cells, relatively large, with 3 cover cells which divide to form a corticating layer over the tetrasporangia.

Type genus: *Polyzonia* Suhr 1834: 739.

The tribe includes 5 genera, *Polyzonia* Suhr, *Leveillea* Decaisne, *Dasyclonium* J. Agardh, *Cliftonaea* (Harvey)Harvey and *Echinosporangium* Kylin, of which the last 3 occur on southern Australian coasts (and *Leveillea* only on warmer northern coasts). *Polyzonia elegans* Suhr was incorrectly ascribed to Australia by Lucas (1909, p. 44); Lucas & Perrin (1947, p. 289) and May (1965, p. 380).

Falkenberg (1901) and Scagel (1953 and 1962) have dealt comprehensively with some genera of the tribe.

KEY TO GENERA OF POLYZONIEAE

1. Indeterminate axes terete, ecorticate, without a keel, determinate laterals terete, branched; attachment by rhizoids .... DASYCLONIUM
1. Indeterminate axes with a flat monostromatic keel, becoming heavily corticated below, determinate laterals terete or flat and scalpelliform; attachment by holdfasts 2
    2. Determinate laterals terete, arising alternately from each axial segment; corticating cells over the tetrasporangia without cellular prolongations .... CLIFTONAEA
    2. Determinate laterals flat, scalpelliform, arising alternately from each second axial segment; corticating cells over the tetrasporangia have short cellular prolongations .... ECHINOSPORANGIUM

Genus DASYCLONIUM J. Agardh 1894: 80.

Thallus prostrate or largely erect, with indeterminate axes bearing distichously determinate laterals from each second segment; determinate laterals exogenous, with exogenous branches pectinately or digitately arranged, simple or themselves branched, free or basally united to varying degrees. Lateral indeterminate axes arise endogenously, separated by 3 determinate laterals. Attachment by paired rhizoids from adjacent pericentral cells, not cut off and with digitate haptera. *Structure.* Indeterminate axes with 6 pericentral cells, determinate laterals with 3 pericentral cells, upper parts 3 cells broad, polysiphonous to near the mucronate apical cell or with monosiphonous ends. Trichoblasts absent. Cells uni- or multinucleate.

Reproduction. Gametophytes dioecious. Procarps borne on a lower segment of the basal branch of determinate laterals; carposporophytes with a short gonimoblast and terminal carposporangia; cystocarps ovoid, pericarp ostiolate, ecorticate. Spermatangial organs usually triradiate, developed from the lower part of branches of the determinate laterals, the flanges with marginal sterile cells.

Tetrasporangial branches arising endogenously from the segment above the determinate laterals, developing short outgrowths, with tetrasporangia in straight series of 2–25, each with 3 cover cells which usually subdivide.

Type species: *D. incisum* (J. Agardh)Kylin 1956: 534.

Scagel (1953 as *Euzoniella*; 1962) recognised 2 groups in *Dasyclonium*, the Incisate group (7 species) with branches of the determinate laterals free, and the Cuneifoliate group (3 species) with them united laterally into a foliose structure.

The 3 southern Australian species are in the Incisate group. While *D. harveyanum* appears to be distinct, relationships between *D. incisum* and *D. flaccidum* are less clear and warrant further study.

KEY TO SPECIES OF *DASYCLONIUM*

1. Basal branch of determinate laterals itself branched .... 3. *D. harveyanum*
1. Basal branch of determinate laterals simple 2

    2. Determinate laterals 0.5–1.2 (-1.6) mm long, polysiphonous to the terminal mucronate cell, determinate laterals less than 120 µm in diameter, segments L/D 0.1–1, with pericentral cells usually isodiametric (L/D usually 1–1.5); indeterminate axes (110-) 150–200 µm in diameter .... 1. *D. incisum*
    2. Determinate laterals usually 1–2 mm long, branch ends often monosiphonous for several segments to the terminal mucro, determinate laterals often over 120 µm in diameter with pericentral cells elongate and L/D (1.5-) 2–3; indeterminate axes (130-) 250–400 µm in diameter .... 2. *D. flaccidum*

1. **Dasyclonium incisum** (J. Agardh)Kylin 1956: 534. Adams 1994: 314, pl. 107 upper. Ducker *et al.* 1977: 87. Fuhrer *et al.* 1981: pl. 76. Huisman 1997: 203; 2000: 162. Huisman & Walker 1990: 433. Millar 1990: 458; 1999: 521. Millar & Kraft 1993: 52. Norris & Aken 1985: 62, fig. 28. Scagel 1962: 1026, figs 5, 20–28. Shepherd & Womersley 1971: 166; 1981: 368. Silva *et al.* 1996: 487. Womersley 1966: 154.
Polyzonia incisa J. Agardh 1841: 24; 1863: 1165; 1878: 32. Harvey 1849a: 71; 1858: pl. 42A; 1859b: 299; 1863, synop.: xv. Hooker & Harvey 1845: 535; 1847: 398. Kützing 1865: 3, pl. 5e, f. Reinbold 1897: 56. Sonder 1853: 703; 1855: 527; 1880: 31. Tate 1882a: 22. Tisdall 1898: 513. Wilson 1892: 166.
Euzoniella incisa (J. Agardh)Falkenberg 1901: 361, pl 5 figs 2–8, 11, pl. 14 figs 28–32. Cuogi Constantini 1912: 183, figs 1–3. De Toni 1903: 1028. De Toni & Forti 1923: 45. Ewart 1907: 91. Guiler 1952: 106. Levring 1946: 226. Lucas 1909: 44; 1929a: 22; 1929b: 51. Lucas & Perrin 1947: 287, fig. 133. May 1949: 296; 1965: 379. Oltmanns 1922: 330, figs 539 (2–5), 544 (3–5). Scagel 1953: 70, figs 13, 14. Womersley 1950: 189.
Polyzonia incisa var. *sonderi* J. Agardh 1863: 1166.

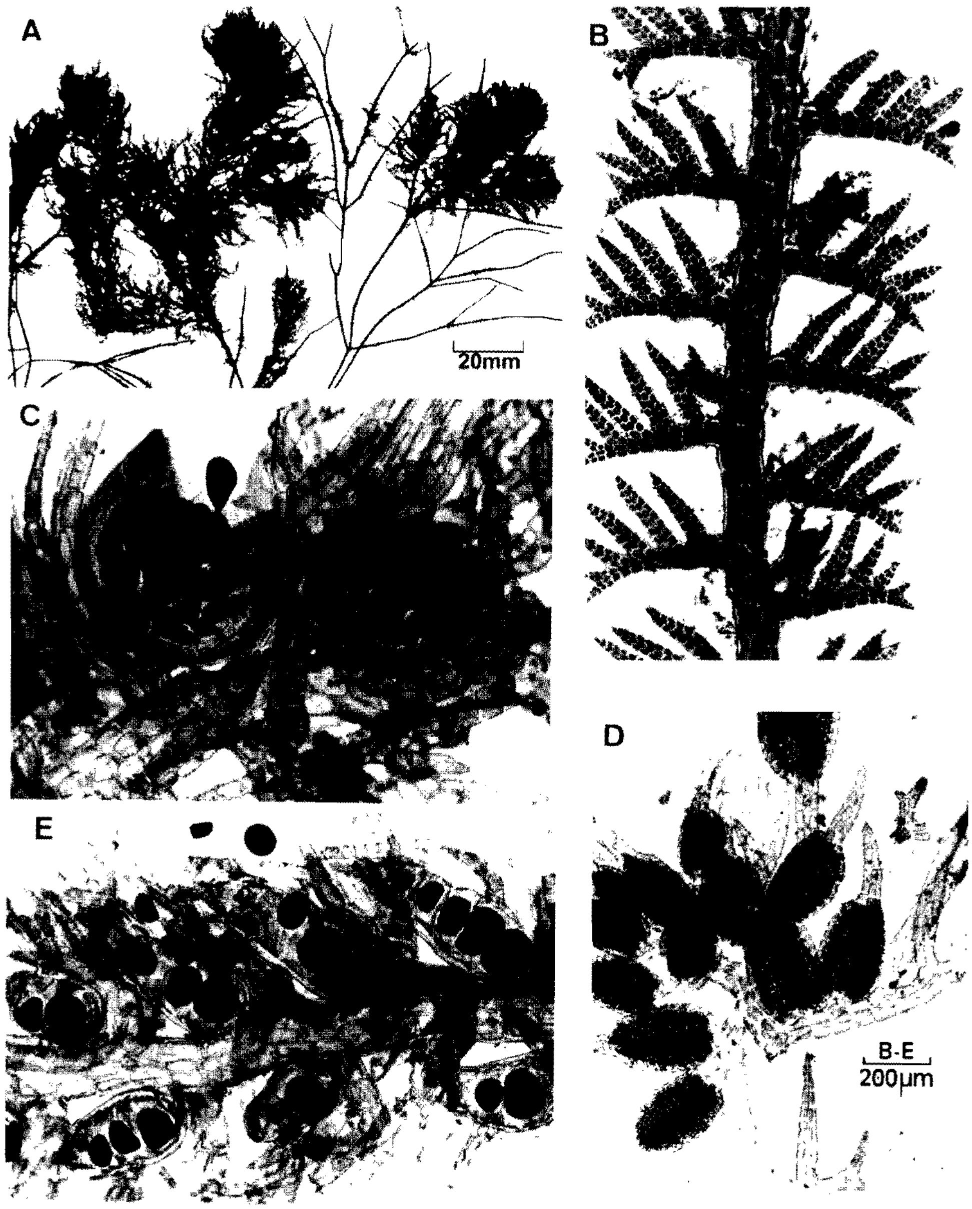

Fig. 139. *Dasyclonium incisum* (**A**, AD, A44940; **B**, AD, A43354; **C–E**, AD, A67329). **A**. Habit, on *Gelidium asperum*. **B**. Axis with pectinate determinate laterals and short indeterminate laterals. **C**. Cystocarps on determinate laterals. **D**. Spermatangial organs. **E**. Tetrasporangial branches arising from the segment above determinate laterals.

Dasyclonium acicarpum J. Agardh 1894: 81.
Polysiphonia inversa Sonder 1845: 53; 1848: 180. Kützing 1849: 823; 1863: 27, pl. 87d, e.
Polysiphonia pecten Areschoug 1854: 345. J. Agardh 1863: 918. De Toni 1903: 1066. Harvey 1863, synop.: xxi. Lucas 1909: 45. Lucas & Perrin 1947: 295.
Polyzonia sonderi Harvey 1849a: 72; 1855a: 539; 1863, synop.: xv. Sonder 1880: 31. Tate 1882a: 22. Tisdall 1898: 513.
Polyzonia colensoi Hooker & Harvey *ex* Harvey 1849a: 71.
Polyzonia elegans var. *incisa* Kützing 1849: 882.
Polyzonia australis Lenormand *ex* Kützing 1865: 3, pl. 6a–c.

FIG. 139

Thallus (Fig. 139A) medium to dark red-brown, lower to mid parts attached to host, above free and 0.5–5 (-10) cm long, indeterminate axes irregularly branched and bearing distichously, alternate, determinate laterals 0.5–1.2 (-1.6) mm long from each second segment; determinate laterals (Fig. 139B) pectinate, curved downwards, complanately branched with simple, exogenous, branches from each second cell, all polysiphonous to the end cells. Lateral indeterminate axes (Fig. 139B) arising endogenously from a segment above a determinate lateral, separated usually by 3 determinate laterals, occasionally developing into longer axes. Attachment by rhizoids; epiphytic on a variety of cartilaginous brown and red algae, occasionally epizoic. *Structure.* Apex usually slightly curved, apical cells dome-shaped, 15–20 µm in diameter. Indeterminate axes with 6 pericentral cells, (110-) 150–250 (-350) µm in diameter, segments L/D 0.7–1. Determinate laterals with 3 pericentral cells, lower branches 200–600 (-900) µm long, 45–120 (-200) µm in diameter in mid and lower parts. Segments L/D 0.4–0.8 (-1) with the cells often slightly displaced (terminally with only 2 pericentral cells and then compressed in section), tapering to a single (-2) apical cell, mucronate. Trichoblasts absent. Rhizoids usually in pairs from adjacent axial pericentral cells and within a common sheath, not cut off, with digitate haptera, ends cut off as cells. Cells uninucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps borne on the second segment of the basal (and sometimes next) branch of determinate laterals. Carposporophytes with a small basal fusion cell and short gonimoblast with large, ovoid, terminal carposporangia 60–100 µm in diameter. Cystocarps (Fig. 139C) sessile, ovoid, 350–600 µm in diameter; pericarp ostiolate, ecorticate, 2 cells thick, outer cells angular and mostly L/D 1–2. Spermatangial organs (Fig. 139D) tri-radiate, developed on the lower half of the lower 1–2 branches of determinate laterals, 180–270 µm across and 250–500 (-750) µm long, each flange with a marginal row of isodiametric sterile cells.

Tetrasporangial branches (Fig. 139E) arising endogenously from the indeterminate segment above each determinate lateral, lying in the same plane, older branches developing short, cellular, outgrowths, with tetrasporangia in a straight series of 2–9, 120–180 µm in diameter with 3 cover cells each usually divided.

Type from "Nov. Holl"; holotype in Herb. Agardh, LD, 43036.

Distribution: Houtman Abrolhos, W. Aust., around southern Australia and Tasmania to Byron Bay, N.S.W.

New Zealand, South Africa.

Selected specimens: Port Denison, W. Aust., on *Sargassum*, inner reef pools (*Gordon*, 8.xi.1968; AD, A33225). Yanchep, W. Aust., on *Amphibolis*, drift (*Womersley*, 22.ix.1979; AD, A51257). Point Peron, W. Aust., on *Amphibolis*, drift (*Womersley*, 18.viii.1979; AD, A51013). Elliston, S. Aust., on *Pterocladia*, 28 m deep (*Shepherd*, 23.x.1970; AD, A37475). Wanna, S. Aust., on *Acrocarpia* in pools (*Womersley*, 19.ii.1959; AD, A22450). Oedipus Point, West I., S. Aust., on *Gelidium asperum*, 16 m deep (*Shepherd*, Dec. 1966; AD, A31156). Vivonne Bay, Kangaroo I., S. Aust., on *Acrocarpia*, drift (*Womersley*, 7.x.1997; AD, A67329). Kangaroo Head, Kangaroo I., S. Aust., on *Sargassum*, 6 m deep (*Lavers*, 9.xii.1996; AD, A66833). Stinky Bay, Nora Creina, S. Aust., drift (*Womersley*, 26.x.1996; AD, A67113). 600 m off Middle Point, Cape Northumberland, S. Aust., on *Gelidium asperum*, 5 m deep (*Shepherd & Johnson*, 19.iii.1974; AD, A44940). Warrnambool, Vic., on *G. asperum*, drift (*Womersley*, 13.iv.1959; AD, A22915). Gabo I., Vic., on *Rhodymenia*, 28 m deep (*Shepherd*, 14.ii.1973; AD, A43354). Currie R., Tas., on *Cystophora*, drift (*Cribb* 75.3, 17.ix.1950; AD, A21026). Stapleton Point, Prosser Bay, Tas., on *Carpoglossum*, 3–6 m deep (*Shepherd*, 10.ii.1970; AD, A35744). Fluted Cape, Bruny I., Tas., on *G. asperum*, 10 m deep (*Shepherd*, 11.ii.1972; AD, A41797). Byron Bay, N.S.W., on *Amphiroa anceps*, 8 m deep (*Silvester*, 18.viii.1973; AD, A43980).

The type in LD is a small specimen in an envelope labelled "*Polyzon. incisa* J. Ag. in Linnaea".

The type of *D. acicarpum* J. Agardh, from Port Phillip Heads, Vic. (*Wilson*, 31.xii.1981) is in Herb. Agardh, LD, 38160, and is *D. incisum*. The type of *Polysiphonia pecten* in S, from Port Adelaide, consists of mica mounts of *D. incisum*, and the type of *Polysiphonia inversa* Sonder, from "Nov. Holl. austro occid" (*Preiss*) is in MEL, 1523853.

Scagel (1953) gave a detailed account of the structure and reproduction of *D. incisum* (as *Euzoniella*).

2. **Dasyclonium flaccidum** (Harvey)Kylin 1956: 534. Adams 1994: 315. Scagel 1962: 1024, figs 4, 32–34. Huisman 1997: 203. Huisman & Walker 1990: 433. Huisman *et al.* 1990: 97. Kendrick *et al.* 1990: 52. Shepherd & Womersley 1981: 368. Silva *et al.* 1996: 487. Yoshida 1998: 1020.

Polyzonia flaccida Harvey 1855a: 539; 1858: pl. 42B; 1863, synop.: xv. J. Agardh 1863: 1165. Sonder 1880: 31. Tisdall 1898: 513. Wilson 1892: 166.

Euzoniella flaccida (Harvey)Falkenberg 1901: 365, pl. 5 fig. 10. De Toni 1903: 1029. Lucas 1909: 44. Lucas & Perrin 1947: 288, fig. 134. May 1949: 296; 1965: 379. Scagel 1853: 81. Womersley 1950: 189.

Dasya archeri Harvey 1859b: 304. J. Agardh 1863: 1197; 1890: 83. Parsons & Womersley 1998: 479.

Heterosiphonia archeri (Harvey)De Toni 1903: 1219.

FIG. 140

Thallus (Fig. 140A) medium to dark red-brown, basally attached to host (or rock?), above free and 1–15 cm long; indeterminate axes irregularly branched and bearing distichous, alternate, determinate laterals (0.6-) 1–2 mm long from each second segment (Fig. 140B); determinate laterals pectinate (Fig. 140B, C), main branch usually curved downwards, complanately branched with simple, exogenous branches from each second cell, these branches with monosiphonous ends 5–12 cells long or sometimes entirely monosiphonous. Lateral indeterminate axes arising endogenously from a segment above a determinate lateral, separated usually by 3 determinate laterals, occasionally developing into longer axes. Attachment by rhizoids; epiphytic on various algae, occasionally epilithic. *Structure.* Apex slightly curved, apical cells dome-shaped, 15–30 µm in diameter. Indeterminate axes with 6 pericentral cells, 130–350 µm in diameter, segments L/D 0.4–1. Determinate laterals below with 3 pericentral cells, 60–150 µm in diameter below with segments L/D 0.4–1.2; pericentral cells L/D (1.5-) 2–3, monosiphonous parts 35–100 µm in diameter with cells L/D 1–5, end cell mucronate. Trichoblasts apparently absent. Rhizoids usually in pairs from adjacent axial pericentral cells, not cut off, with digitate haptera. Cells uninucleate, larger cells multinucleate; rhodoplasts discoid to slightly elongate.

Reproduction. Female plants unknown. Spermatangial organs (Fig. 140D) tri-radiate, developed from the lower parts of determinate lateral branches, with a single basal and 3–5 apical sterile segments 150–600 µm long and 130–230 µm across, each flange with a marginal row of isodiametric sterile cells.

Tetrasporangial branches (Fig. 140E) arising endogenously from the segment above each determinate lateral, curved upwards towards the axis and developing short cellular outgrowths; tetrasporangia in series of 4–6, 80–140 µm in diameter, with 3 (divided) cover cells.

Lectotype from King George Sound, W. Aust. (*Harvey*); lectotype Trav. Set 34 in Herb. Harvey, TCD.

Distribution: Houtman Abrolhos, W. Aust., to Robe, S. Aust., and N Tasmania. Japan.

Selected specimens: 7 mile Beach, N of Dongara, W. Aust., on *Amphibolis*, drift (*Womersley*, 17.ix.1979; AD, A51354). Port Denison, W. Aust., drift (*Kraft* 4005, 14.xii.1971; AD, A41713). Safety Bay, W. Aust. on *Amphibolis*, drift (*Womersley*, 18.viii.1979; AD, A50789). 4 km W of Waldegrave I., S. Aust., 30 m deep on limestone (*Branden*, 3.vii.1987; AD, A57583). Elliston, S. Aust., on *Distromium multifidum*, 7 m deep (*Shepherd*, 21.x.1970; AD, A37581) and on *Husseya*, 5 m deep (*Shepherd*, 24.x.1973; AD, A44282). Pearson Is, S. Aust., epiphytic, 48 m deep (*Shepherd*, 9.i.1969; AD, A33713).

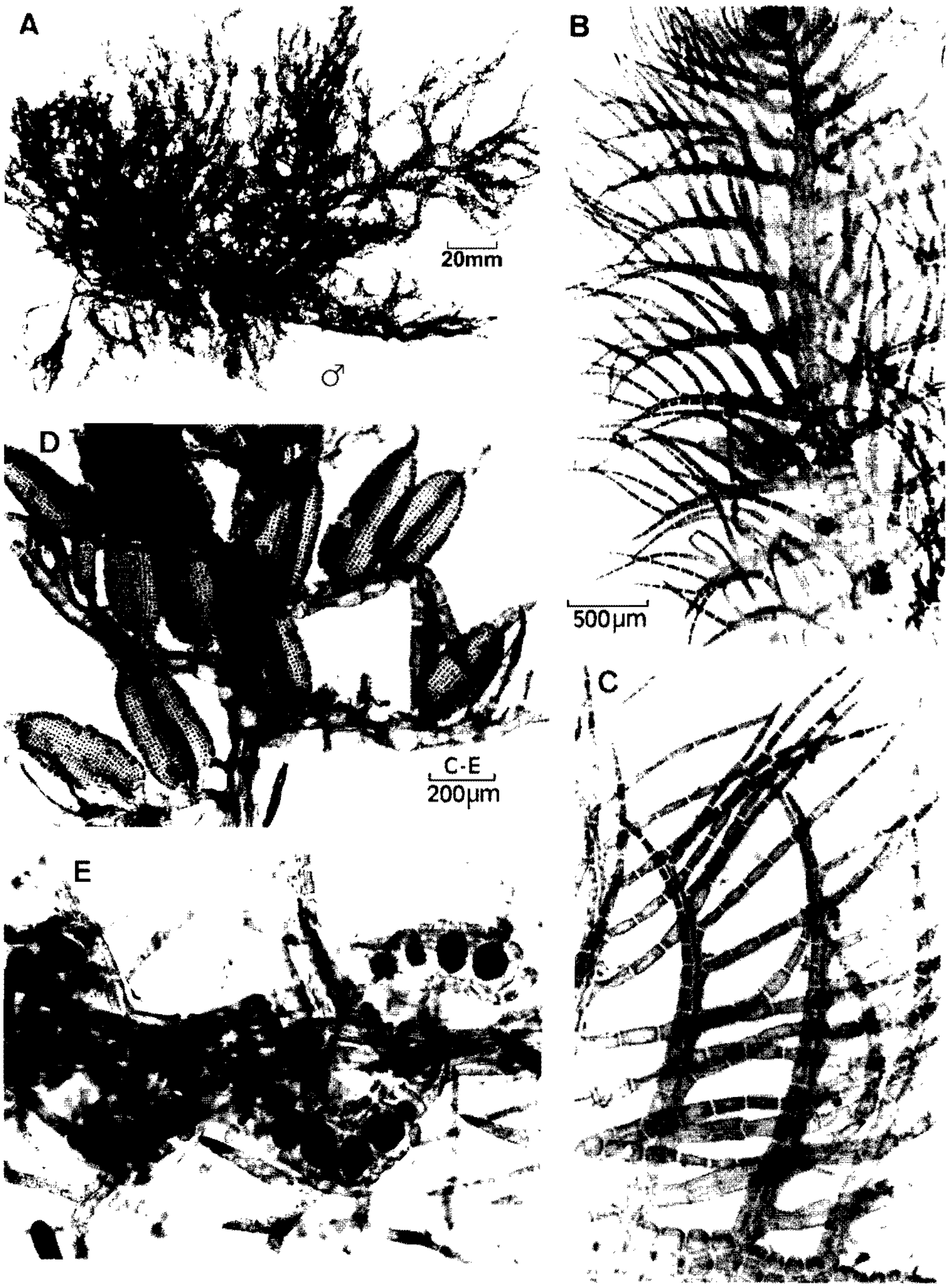

Fig. 140. *Dasyclonium flaccidum* (**A**, **D**, AD, A57583; **B**, **C**, AD, A44282; **E**, AD, A57788). **A**. Habit. **B**. Indeterminate branch with pectinate determinate laterals with monosiphonous branches. **C**. Detail from **B**. **D**. Triradiate spermatangial organs. **E**. Tetrasporangial branches arising from segments above determinate laterals.

Daly Head, Yorke Pen., S. Aust., drift (*Woelkerling*, 26.iii.1967; AD, A31407). Aldinga, S. Aust., on *Sargassum*, drift (*Womersley*, 17.ix.1966; AD, A30713). Victor Harbor, S. Aust., sublittoral (*Engler*, 8.v.1979; AD, A63179). Vivonne Bay, Kangaroo I., S. Aust., on *Myriodesma*?, drift (*Womersley*, 1.i.2000; AD, A68408). Penneshaw, Kangaroo I., S. Aust., on *Heterozostera*, 6 m deep (*Lavers*, 8.i.1997; AD, A66868). Robe, S. Aust., on *Sargassum*, drift (*Womersley*, 20.xii.1953; AD, A19113). Currie R., N Tas., on fucoid (*Perrin*, Jan. 1938; AD, A10158). Bridport, Tas., on *Cystophora grevillei*, drift (*Womersley*, 23.x.1986; AD, A57788).

The type of *Dasya archeri* Harvey (1859b, p. 304), from Georgetown, Tas. (*Archer*), in Herb. Harvey, TCD, is *Dasyclonium flaccidum*, the determinate lateral branches having frequent monosiphonous ends.

Dasyclonium flaccidum is a variable species as considered by Harvey and other authors, especially in the monosiphonous ends to the branches of the determinate laterals which vary from almost the complete length to only the terminal 2 or 3 cells. Nearly all specimens can be separated from *D. incisum* on the characters used in the key, but occasional intermediate plants occur. Further study is warranted.

3. **Dasyclonium harveyanum** (Decaisne *ex* Harvey)Kylin 1956: 534. Adams 1994: 314, pl. 107 top left. Scagel 1962: 1025, figs 18, 19, 41–44.

Polyzonia harveyana Decaisne *ex* Harvey 1849a: 72. Raoul 1846: 32, *nomen nudum*.

Polyzonia incisa var. *harveyana* (Decaisne *ex* Harvey)J. Agardh 1863: 1166.

Euzoniella harveyana (Decaisne *ex* Harvey)Falkenberg 1901: 366, fig. 7. De Toni 1903: 1030. Guiler 1952: 106. Lucas 1909: 44. May 1949: 297; 1965: 379. Scagel 1953: 82.

FIG. 141

Thallus (Fig. 141A) dark red-brown, largely prostrate or basally attached and free above, 0.5–2 cm long (to 6 cm in New Zealand), indeterminate axes occasionally branched, bearing distichously alternate determinate laterals 0.5–1.5 mm long from each second segment; determinate laterals (Fig. 141B, C) pectinate to digitate, more or less complanately branched with the lower 1–2 (-3) branches similarly branched. Lateral indeterminate axes arise endogenously from the segment above a determinate lateral and separated by (2-) 3 determinate laterals. Attachment by rhizoids (Fig. 141B); epiphytic, or epilithic? *Structure.* Apices relatively straight, apical cells dome-shaped, 15–20 μm in diameter. Indeterminate axes with 6 pericentral cells, 70–240 μm in diameter, segments L/D 0.6–1.2. Determinate laterals in lower segments with 3 pericentral cells, segments (60-) 80–120 μm in diameter and L/D 0.5–1, tapering above to 3 cells broad, polysiphonous to the 1 (-3) terminal cells, mucronate. Trichoblasts absent. Rhizoids in pairs from adjacent pericentral cells, not cut off, with a common sheath and digitate haptera. Cells uni- to multinucleate; rhodoplasts discoid.

Reproduction. Procarps on a lower segment of the basal branch of a determinate lateral. Carposporophytes with a small basal fusion cell and short gonimoblast with clavate terminal carposporangia, 50–90 μm in diameter. Cystocarps (Fig. 141D) ovoid to slightly urceolate, 500–750 μm in diameter, sessile on determinate laterals; pericarp 2 cells thick, ecorticate, outer cells angular, L/D 1–2. Spermatangia unknown.

Tetrasporangial branches (Fig. 141E) arising from the axial segment above a determinate lateral, 0.9–2 mm long and 100–180 μm in diameter, simple or with lower branches, bearing branched spinous determinate laterals from each second segment, more or less distichously. Tetrasporangia in long rows of 8–25, occupying most of the segment width, 70–130 μm in diameter, with 3 (divided) cover cells.

Type from New Zealand, on *Pterocladia lucida* (*Raoul*); lectotype in Herb. Harvey, TCD? Adams (1994, p. 314) suggests the type probably came from Akaroa.

Distribution: In southern Australia, from Cape Woolamai, Vic., and SE Tasmania.
New Zealand.

Selected specimens: Cape Woolamai, Vic., on *Hildenbrandia*, 13 m deep (*Riddle*, 17.ii.1990; AD, A60084). Stapleton Point, Prosser Bay, Tas., on *Sonderophycus*, 6–8 m deep (*Shepherd*, 10.ii.1970; AD, A35752). Port Arthur, Tas., on *Hildenbrandia expansa*, 10 m deep (*McKenna*, 1.iii.1990; AD, A60433). Safety Cove, Port Arthur, Tas., on non-geniculate coralline, 7 m deep (*Brown & Kenchington*, 16.x.1986; AD, A57727). Fluted Cape, Bruny I., Tas., on non-geniculate coralline, 23 m deep (*Shepherd*, 12.ii.1972; AD, A41927).

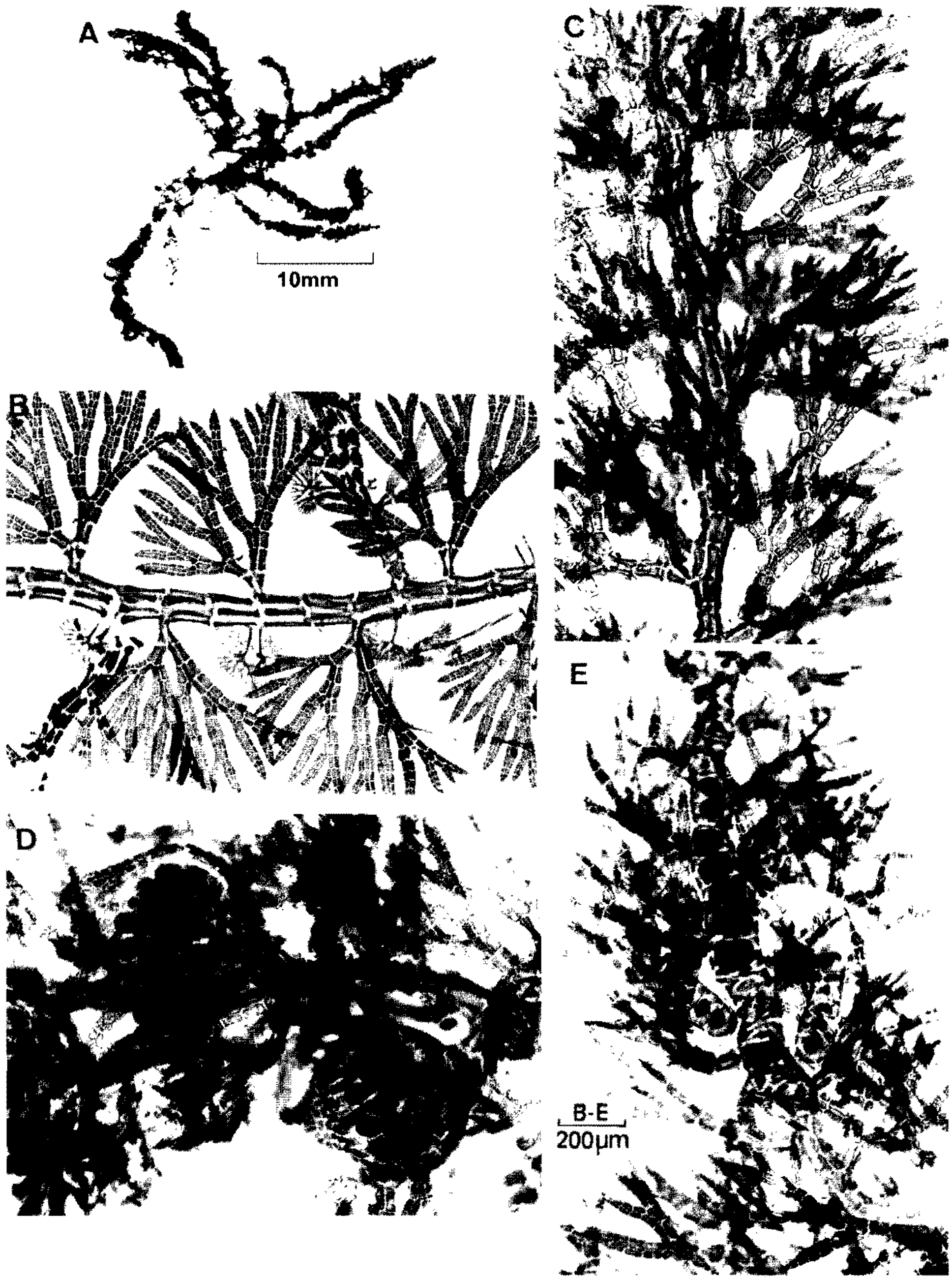

Fig. 141. *Dasyclonium harveyanum* (**A**, AD, A57727; **B**, AD, A60433; **C–E**, AD, A41927). **A**. Habit. **B**. Indeterminate branch with rhizoids and determinate laterals with branched basal branches. **C**. As in **B**. **D**. Cystocarps. **E**. Tetrasporangia within an indeterminate branch bearing determinate branches.

This New Zealand species occurs also in SE Australia, mainly on cartilaginous algae or corallines. It is clearly distinguished from the other species of *Dasyclonium* by the branched lower branches on the determinate laterals, and also the long series of tetrasporangia.

Polyzonia harveyana was first mentioned (as a *nomen nudum*) in Raoul 1846—"Choix de Plantes de la Nouvelle-Zelande", a publication which Harvey (1849, p. 72) referred to as "Pl. Nov. Zeal." (M.J. Parsons, pers. comm.).

Genus CLIFTONAEA (Harvey)Harvey 1863: pl. 279.

Thallus erect, irregularly branched, with revolute apices developing an axis bearing a membranous, monostromatic keel and 2 adjacent rows of alternating, simple, terete, determinate laterals, pectinately arranged; holdfast discoid. *Structure*. Indeterminate axes ecorticate with 6 pericentral cells, dorsal and ventral and 2 lateral ones on each side; the dorsal ones form the keel and the 2 ventral lateral cells form the determinate laterals from alternate segments. Indeterminate branches arise endogenously and occur adjacent to the keel. Trichoblasts adaxial from each segment of the determinate laterals.

Reproduction. Gametophytes dioecious. Procarps in series on the second trichoblast cell on the next to basal segment of determinate laterals; carposporophytes with terminal carposporangia; cystocarps ovoid, pericarp corticated. Spermatangial organs replacing trichoblasts, flat or tri-radiate, with sterile marginal cells.

Tetrasporangia in long series in the axes or in proliferous branch clusters, cut off from the lateral pericentral cells opposite to those bearing a determinate lateral, large and covered by a layer of corticating cells.

Type species: *C. pectinata* Harvey 1859a: pl. 100.

A monospecific genus following referral of *C. semipennata* to *Echinosporangium* Kylin, which is, however, closely related.

Cliftonia Harvey (1859a: pl. 100) was changed to *Cliftonaea* by Harvey (1863, pl. 279) due to the earlier *Cliftonia* Banks *ex* Gaertner.

Cliftonaea pectinata Harvey 1859a: pl. 100; 1863, synop.: xv. J. Agardh 1863: 1160; 1879: pl. 32 fig. 22; 1897: 86, pl. 2 figs 8–18. De Toni 1903: 1039. Falkenberg 1901: 375, pl. 5 figs 17–25, pl. 10 figs 1–4, pl. 24 fig. 3. Huisman 2000: 160. Huisman & Walker 1990: 432. Kylin 1956: 536, figs 381A, C, 426B, 429F, 430G. Lucas 1909: 44. Lucas & Perrin 1947: 289, fig. 135. May 1965: 395. Oltmanns 1922: 331, figs 540 (1–3), 597 (4). Scagel 1953: 50. Schmitz & Falkenberg 1897: 460, fig. 258B. Shepherd 1983: 83. Shepherd & Womersley 1971: 166; 1976: 191. Silva *et al.* 1996: 486. Sonder 1880: 31. Tisdall 1898: 512. Wilson 1890: 491; 1892: 166. Womersley 1950: 188.

FIGS 142, 143

Thallus (Fig. 142A) medium to dark red-brown, 10–20 cm high, much branched irregularly, branches with revolute apices (Fig. 142B) and below a membranous axial keel 0.5–2 mm broad and bearing terete, pectinate, determinate laterals 2–4 mm long, closely arranged in 2 slightly divergent rows, alternating from successive segments. Holdfast discoid, bearing several axes; epilithic. *Structure*. Apices revolute ventrally (on the side of the determinate laterals), apical cells dome-shaped, 15–20 μm in diameter, axial cells cutting off 6 pericentral cells (Fig. 142D) with dorsal and ventral cells and 2 lateral ones on each side, the dorsal cells dividing longitudinally to form the keel and the 2 ventral lateral cells forming the determinate laterals from alternate segments. The keel is 1 cell thick and 6–12 cells broad, cells 30–60 μm in diameter and L/D 3–4. The determinate laterals are 120–180 μm in diameter with 3 pericentral cells, segments L/D 0.6–1.3. Small corticating cells may be cut off from the pericentral cells. Branching is endogenous from the axial cells, emitted laterally from near the keel. Trichoblasts (Fig. 142C) adaxial on each segment of the determinate laterals, 1–2 mm long, branched, basal cells 15–20 μm in diameter, L/D 2–3. Cells multinucleate; rhodoplasts discoid to elongate, chained in larger cells.

Reproduction. Gametophytes probably dioecious. Procarps in extensive series (Fig. 142E) on the second cell of the trichoblast on the next to basal segment of determinate laterals, with 4-celled carpogonial branches. Carposporophytes with a basal, branched, fusion cell and

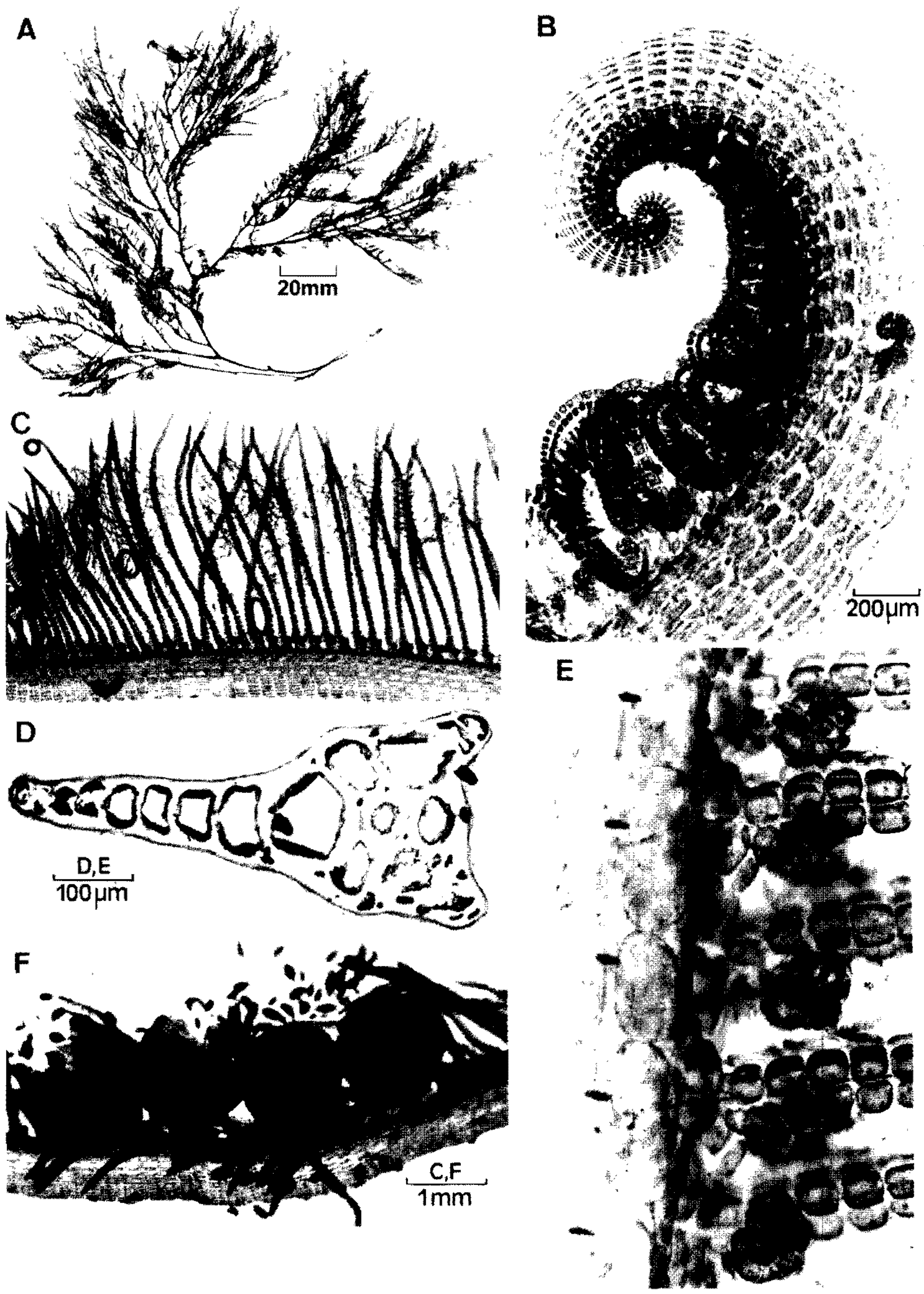

Fig. 142. *Clifonaea pectinata* (**A–C**, **E**, AD, A34111; **D**, AD, A68245; **F**, AD, A59995). **A**. Habit. **B**. Revolute branch apex with membranous keel and pectinate laterals. **C**. Terete determinate laterals on keel, with procarps on their bases and bearing trichoblasts. **D**. Transverse section of axis with keel (left) and 2 determinate laterals (right). **E**. Determinate laterals on keel, with procarps on their second segment. **F**. Cystocarps.

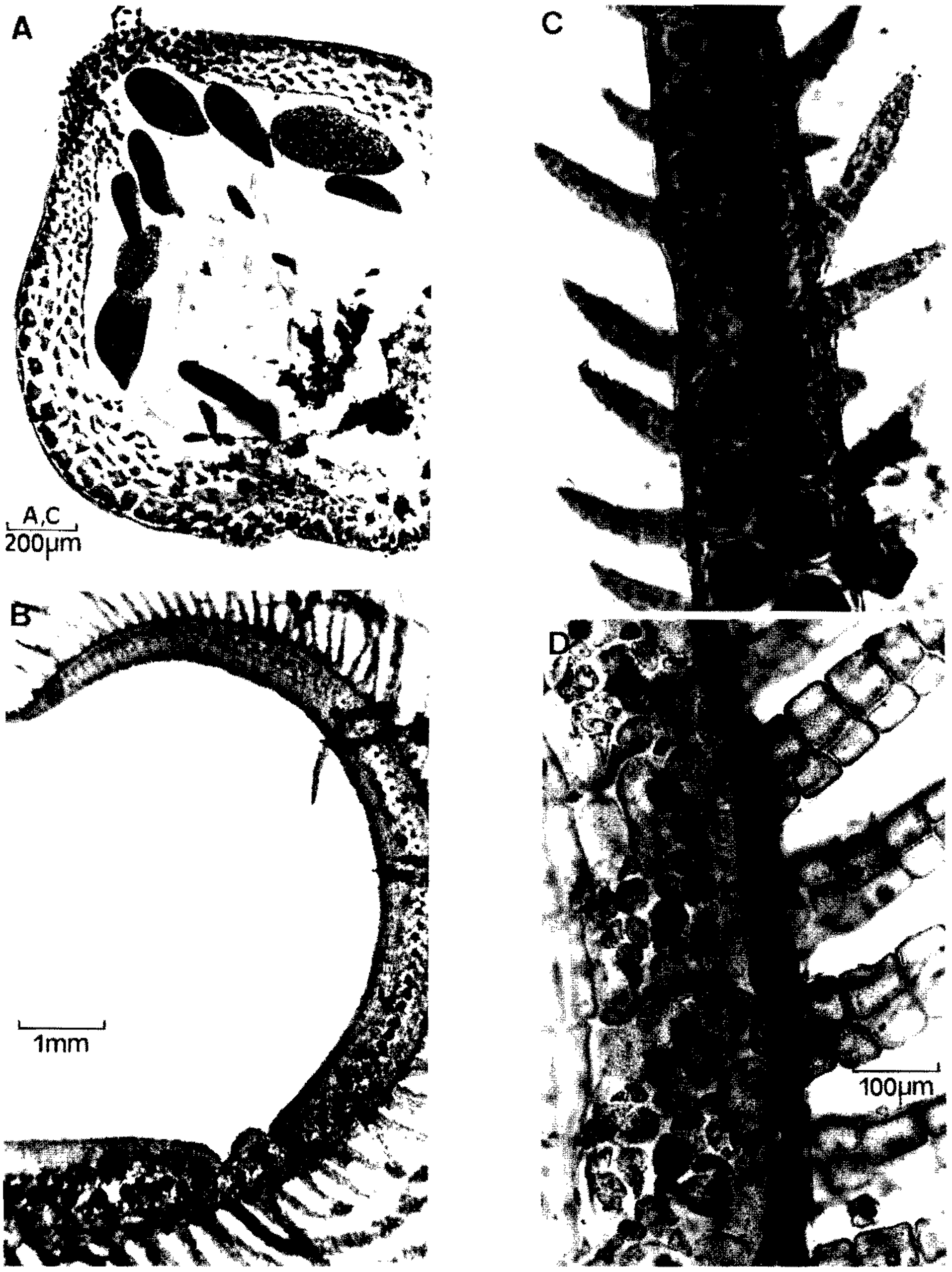

Fig. 143. *Cliftonaea pectinata* (**A**, AD, A68880; **B**, **D**, AD, A68877; **C**, AD, A59995). **A**. Section of cystocarp. **B**. Branch bearing tetrasporangia. **C**. Tetrasporangia cut of alternately from lateral pericentral cells (view from keel). **D**. Corticating cells covering alternate tetrasporangia.

branched gonimoblast with ovoid terminal carposporangia 90–180 µm in diameter. Cystocarps (Fig. 142F) ovoid to slightly urceolate, 1.3–2 mm in diameter, short stalked; pericarp (Fig. 143A) ostiolate, corticated and 4–5 cells thick. Spermatangial organs (Falkenberg 1901, pl. 24 fig. 3) replacing trichoblasts, flat to tri-radiate, shown with sterile marginal cells.

Tetrasporangia in long rows (Fig. 143B) in the axes or in small, proliferous, branch clusters arising endogenously from the axes, cut off alternately (Fig. 143C) from the lateral pericentral cells opposite to those bearing a determinate lateral and hence in 2 slightly displaced rows, 150–450 µm in diameter, becoming covered by corticating cells (Fig. 143D) cut off the adjacent pericentral cells.

Type from Garden I., W. Aust., (*Clifton*); lectotype in Herb. Harvey, TCD.

Distribution: Geelvink Channel, W. Aust., to Port Phillip Heads, Victoria.

Selected specimens: Geelvink Ch., 21 km W of Geraldton, W. Aust., 5 m deep (*France*, Feb. 1979; AD, A51707). Point Clune, Rottnest I., W. Aust., 13–15 m deep (*Kraft 7173 & Ricker*, 5.xii.1980; AD, A68359). Eyre, W. Aust., drift (*Woelkerling*, 22.xi.1968; AD, A34241). Point Fowler, S. Aust., 18 m deep (*Shepherd*, 28.iii.1980; AD, A52242). Masillon I., Isles of St Francis, S. Aust., 13–18 m deep (*Shepherd*, 5.i.1971; AD, A38005). Waldegrave I., S. Aust., 22 m deep (*Shepherd*, 23.x.1970; AD, A37397). Pearson I., S. Aust., 36 m deep (*Shepherd*, 10.i.1969; AD, A34111). Hopkins I., S. Aust., 33 m deep (*Branden*, 8.i.1989; AD, A59995). Wedge I., S. Aust., 8–10 m deep (*Baldock*, 29.xii.1963; AD, A27248). N Spencer Gulf, S. Aust., 15 m deep (*Shepherd*, 5.ix.1973; AD, A44216). Point Turton, S. Aust., drift (*Womersley*, 16.x.1988; AD, A59131—"Marine Algae of southern Australia" No. 131a). Off Troubridge Light, Gulf St Vincent, S. Aust., 18 m deep (*Shepherd*, 4.ii.1969; AD, A33566—"Marine Algae of southern Australia" No. 131). Investigator Strait, S. Aust., 34 m deep (*Watson*, 20.i.1971; AD, A39221). Off Grange, S. Aust., 18 m deep (*Shepherd*, 7.xii.1968; AD, A33300). Port Elliot, S. Aust., drift (*Womersley*, 20.i.1960; AD, A23992). Vivonne Bay, Kangaroo I., S. Aust., drift (*Womersley*, 14.i.1948; AD, A6852). Ironstone Point, Kangaroo I., S. Aust., 15 m deep (*Lavers*, 20.xi.1997; AD, A68245) and 14 m deep (*Lavers*, 11.vii.1999; AD, A68877). Cable Hut reef, Penneshaw, Kangaroo I., S. Aust., 22 m deep (*Lavers*, 1.ii.2000; AD, A68880). Outside Port Phillip Heads, Vic., 22 m deep (*Watson*, 29.iii.1985; AD, A57047).

Cliftonaea pectinata is a deep-water species, common on the western coasts of South Australia.

Genus **ECHINOSPORANGIUM** Kylin 1956: 537.

Thallus erect, irregularly branched, with robust perennial axes below; apices revolute, developing axes with a dorsal, membranous keel and 2 adjacent rows of flat, ventral, determinate laterals, arising 2 segments apart; older axes heavily corticated and covered with slender, branched appendages; holdfast massive, becoming branched. *Structure*. Indeterminate axes with 6 pericentral cells, ecorticate, dorsal and ventral ones and 2 lateral ones on each side; the dorsal ones form the largely monostromatic keel and the ventral lateral cells form the alternate determinate laterals, separated by a single unbranched cell; determinate laterals scalpelliform, with a posterior margin 3 cells thick, otherwise monostromatic apart from close to the indeterminate axis. Indeterminate branches arise endogenously. Trichoblasts arise from alternate lower to mid segments of the posterior margin of determinate laterals.

Reproduction. Gametophytes probably dioecious. Procarps on the second cell of the lower 1 (-3) trichoblasts on determinate laterals; carposporophytes with terminal carposporangia; cystocarps ovoid, pericarp heavily corticated. Spermatangia unknown.

Tetrasporangia in series in the midrib adjacent to the keel, cut off from the ventral pericentral cell, large and covered by corticating cells which develop outward prolongations 1–3 cells long, with rounded ends.

Type species: *E. semipennatum* (Lamouroux *ex* Poiret)Kylin 1956: 537.

Echinosporangium contains only a single species, since *C. imbricata* J. Agardh is synonymous.

Echinosporangium is very similar to *Cliftonaea* in morphology, structure and reproduction, differing in having the determinate laterals flat rather than terete and arising from each second segment instead of every segment, and in having the corticating cells over the tetrasporangia producing short, 1–3 celled, filaments with rounded ends (not "echino"). They are clearly closely related and may be better placed within the one genus.

Echinosporangium semipennatum (Lamouroux *ex* Poiret)Kylin 1956: 537, fig. 430K. May 1965: 394. Silva *et al.* 1996: 492.

Amansia semipennata Lamouroux *ex* Poiret 1810: 310. C. Agardh 1822: 195; 1824: 248. J. Agardh 1841: 25. Decaisne 1841: 173, pl. 5 fig. 27. Harvey 1847: 24. Kützing 1849: 883; 1865: 2, pl. 3e, f. Lamouroux 1813: 270, pl. 11 figs 4, 5.

Cliftonaea semipennata (Lamouroux *ex* Poiret)J. Agardh 1863: 1160; 1897: 96. De Toni 1903: 1039. Lucas 1909: 44; 1929b: 51. Lucas & Perrin 1947: 289. Reinbold 1899: 48.

Cliftonaea imbricata J. Agardh 1885: 115. May 1965: 394.

Clifton(i)aea lamourouxii Harvey 1859a: text for pl. 100 (as *Cliftonia*); 1863: pl. 279, synop.: xv. Falkenberg 1901: 382, pl. 5 figs 26–31, pl. 10 fig. 5, pl. 24 figs 4–11. Sonder 1880: 31.

FIGS 144, 145

Thallus (Fig. 144A) medium to dark red-brown, 10–30 cm high, probably perennial, with robust branched axes 2–7 mm in diameter, bearing lesser branches with revolute apices developing a membranous, dorsal keel 1–2 mm broad and flat, ventral, determinate laterals (Fig. 144B) 1–2 mm long, in 2 slightly divergent rows, alternating 2 segments apart; old axes heavily corticated, denuded but covered with irregularly branched, terete to compressed, appendages. Holdfast massive, first discoid but becoming branched, 3–30 mm across; epilithic. *Structure.* Apices (Fig. 144C) revolute ventrally (towards the determinate laterals), apical cells dome-shaped, 15–20 μm in diameter, axial cells cutting off 6 pericentral cells, with dorsal and ventral cells and 2 lateral ones on each side; the dorsal cells divide longitudinally to form the keel and the 2 ventral lateral cells form the alternate determinate laterals separated by a single, unbranched cell. The keel is mostly 1 cell thick but may become 2 cells thick, and 17–22 cells broad with cells 35–75 μm in diameter and L/D 3–4. Determinate laterals are scalpelliform, terminally pointed, medially 10–14 cells broad, tapering to the acute tip, 1 cell thick apart from close to the indeterminate axis and the posterior margin which is 3 cells thick (Fig. 144E) with alternate segments each bearing a trichoblast (absent near the tip). Trichoblasts (Figs 144D, 145A) become 2–3 mm long, branched, basal cells 20–35 μm in diameter and L/D 1–2. Old axes become heavily corticated (Fig. 144F) with parenchymatous cells surrounding the 6 pericentral cells, and often covered with much branched, slender appendages 2–6 mm long, denuded near their base. Cells multinucleate; rhodoplasts discoid, becoming chained.

Reproduction. Gametophytes probably dioecious. Procarps (Fig. 145A) on the second cell of the basal (and sometimes up to third) trichoblast on the determinate laterals. Carposporophytes (Fig. 145B) with a small basal fusion cell and short gonimoblast with large, shortly clavate carposporangia 150–200 μm in diameter. Cystocarps subsessile, ovoid, 1–2 mm in diameter; pericarp ostiolate, heavily corticated, 5–8 cells thick. Spermatangia unknown.

Tetrasporangia occur in series in the midrib (Fig. 145C) adjacent to the keel, cut off from the ventral pericentral cells, covered by cortical cells (Fig. 145D, E) which develop outward prolongations 1–3 cells and 80–130 μm long, 40–65 μm in diameter with rounded ends; tetrasporangia 250–500 μm in diameter.

Type from "Nouv. Holl." (*Peron*); holotype in Herb. Lamouroux; isotype in PC.

Distribution: Eyre, W. Aust., to Port Elliot, S. Australia.

Selected specimens: Eyre, W. Aust., drift (*Woelkerling*, 22.xi.1968; AD, A34239). St Francis Isles, S. Aust., 37 m deep (*Symonds*, 23.x.1973; AD, A44251). Waldegrave I., S. Aust., 22 m deep (*Shepherd*, 23.x.1970; AD, A37398). Marion Bay, S. Aust., drift (*Womersley*, 9.x.1998; AD, A67932). Investigator Strait, S. Aust., 22 m deep (*Watson*, 11.i.1971; AD, A39294), 32 m deep (*Watson*, 20.i.1971; AD, A41017), and 33 m deep (*Watson*, 20.i.1971; AD, A38558—"Marine Algae of southern Australia" No. 132). Gulf St Vincent, S. Aust., 40 m deep (AD, A1361). Off Port Elliot, S. Aust., dredged (*Verco*, Jan. 1896; MEL, 643088).

Cliftonaea imbricata J. Agardh is based on a specimen from Israelite Bay, W. Aust. (*Brooke*), holotype in LD, 44401. It is identical with *E. semipennatum*.

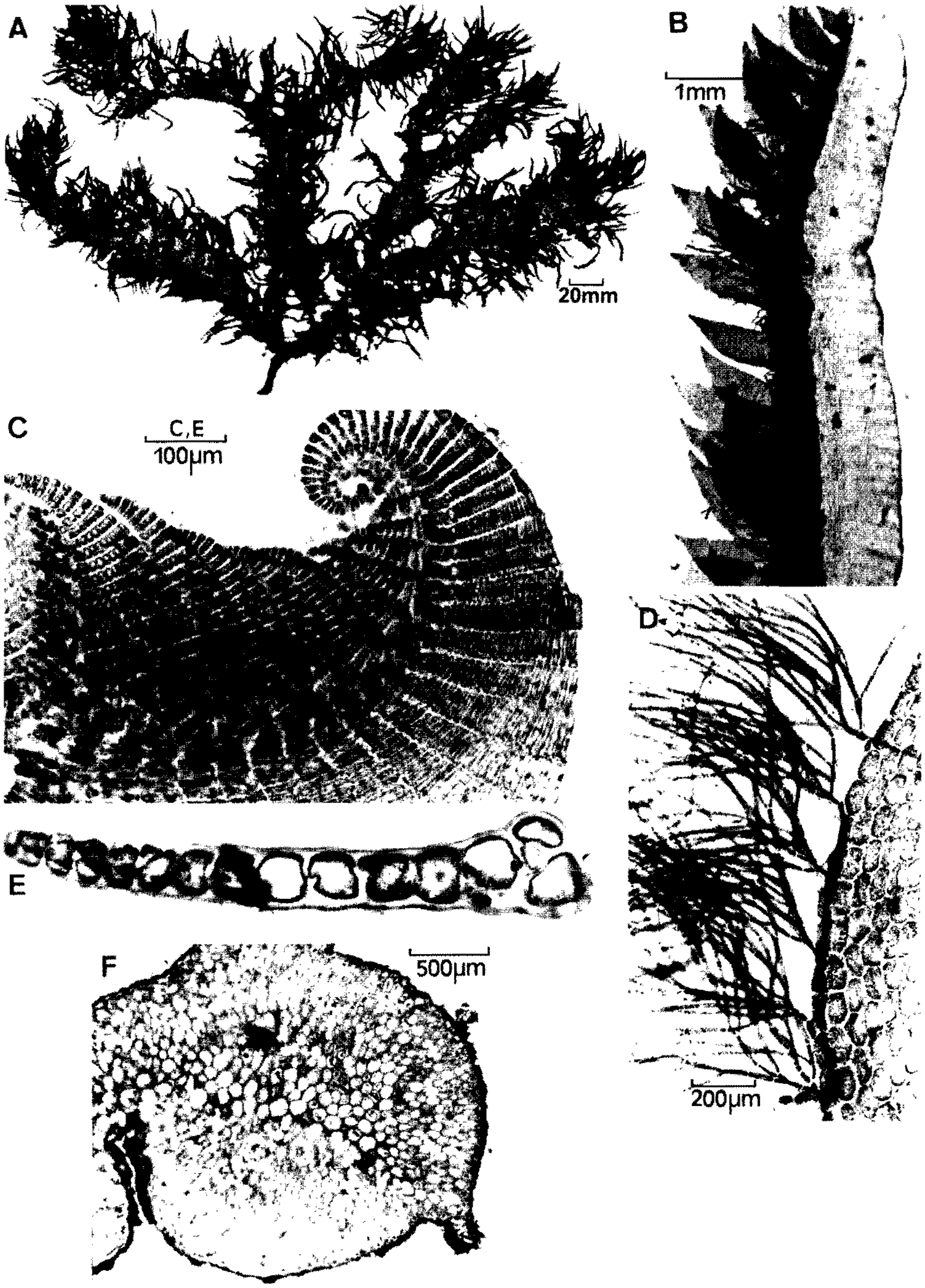

Fig. 144. *Echinosporangium semipennatum* (AD, A67932). **A.** Habit. **B.** Branch with keel and flat determinate laterals. **C.** Revolute apex of keel with flat determinate laterals. **D.** Trichoblasts on posterior margin of a determinate lateral. **E.** Transverse section of a determinate lateral. **F.** Transverse section of mature axis.

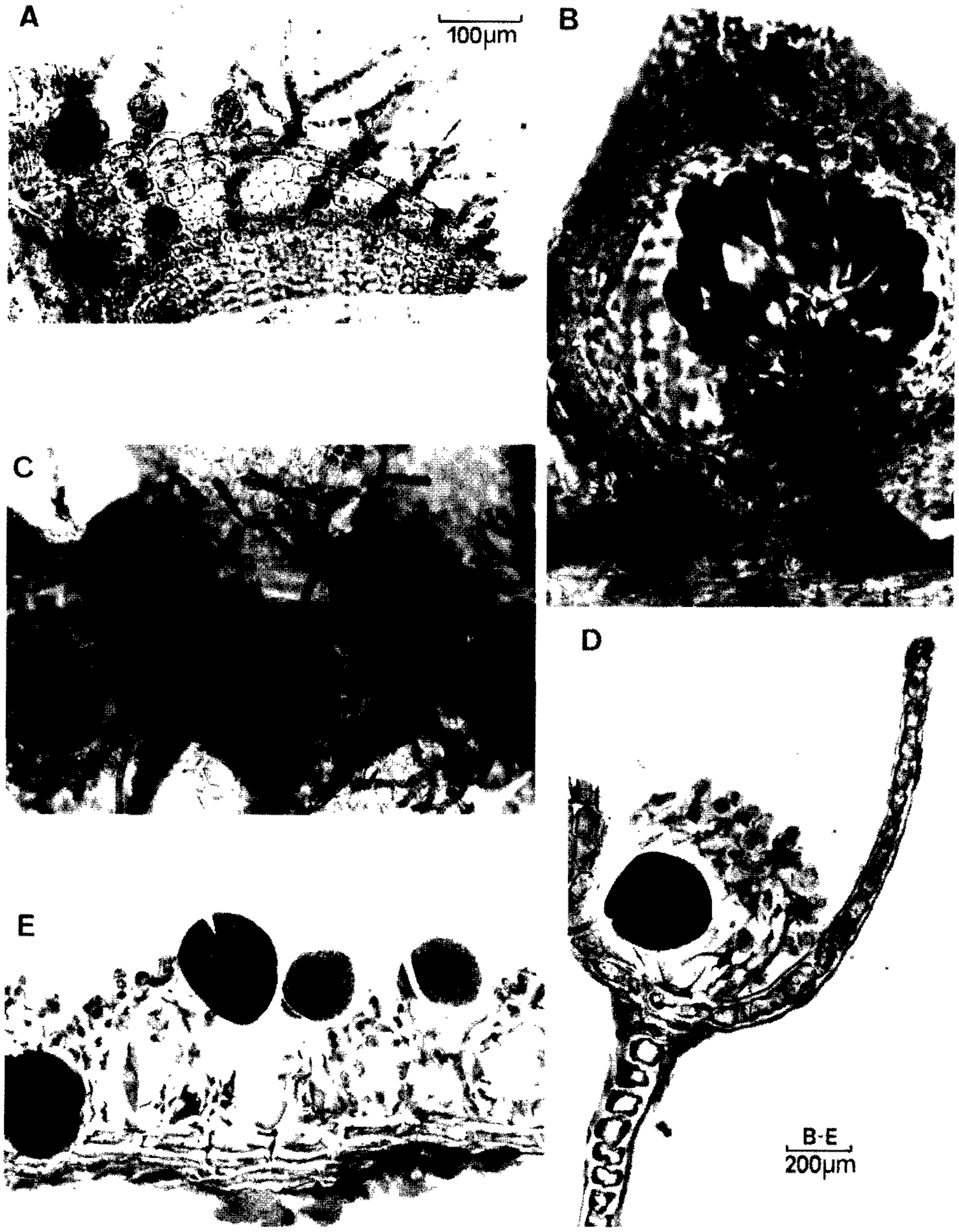

Fig. 145. *Echinosporangium semipennatum* (**A**, **B**, AD, A39294; **C–E**, AD, A67932). **A**. Determinate lateral with procarps on lower posterior trichoblasts. **B**. Section of cystocarp. **C**. Tetrasporangia in the midrib along the keel. **D**. A tetrasporangium covered by cortical cells with prolongations, in transverse section (keel below, determinate lateral to right (and left). **E**. Tetrasporangia and cortical cells in longitudinal section of keel.

Group LOPHOSIPHONIEAE Kylin 1956: 538.

Thallus prostrate with decumbent to erect determinate laterals, or largely erect, with indeterminate and determinate laterals arising endogenously and not in regular sequences. Trichoblasts usually present on determinate laterals. Prostrate axes attached by rhizoids. *Structure*. Apices usually curved, dorsiventrally orientated. Pericentral cells 4–20, ecorticate in most genera. Rhizoids cut off or not from pericentral cells.

Reproduction. Gametophytes dioecious. Procarps borne on basal cells of trichoblasts. Carposporophytes with a branched gonimoblast and terminal carposporangia. Cystocarps ovoid, lateral on determinate laterals; pericarp ostiolate, ecorticate. Spermatangial organs borne on trichoblasts.

Tetrasporangia single or paired per segment.

Type genus: *Lophosiphonia* Falkenberg *in* Schmitz & Falkenberg 1897: 459.

A group credited with 5 or 6 genera (Kylin 1956, p. 538; Hommersand 1963, p. 348), two of which occur on southern Australian coasts.

Lophosiphonia, when first described by Falkenberg in Schmitz & Falkenberg (1897, p. 459), was placed in the Herposiphonieae, but Falkenberg (1901, p. 726) later separated it from this tribe. Kylin (1956, p. 538) placed it in the *Lophosiphonia* group and this was followed by Hommersand (1963, p. 348). However, the *Lophosiphonia* group was amalgamated with the Herposiphonieae by Maggs & Hommersand (1993, p. 381) and Millar (1990, p. 452), for unstated reasons.

The Herposiphonieae are distinguished by defined but varied patterns of branching involving regularly alternating sequences of indeterminate and determinate exogenous laterals, whereas the *Lophosiphonia* group does not show this regular sequence and also has endogenous branching.

KEY TO GENERA OF LOPHOSIPHONIA GROUP

1. Pericentral cells 4 or 6; tetrasporangia single per segment .... LOPHOSIPHONIA
1. Pericentral cells 12–22; tetrasporangia in opposite pairs in each segment .... OPHIDOCLADUS

Genus **LOPHOSIPHONIA** Falkenberg *in* Schmitz & Falkenberg 1897: 459.

Thallus of prostrate, polysiphonous, ecorticate, indeterminate axes with curved apices, bearing irregularly more or less erect, simple or branched, determinate laterals often bearing trichoblasts; attachment of indeterminate axes by rhizoids; epiphytic or epilithic. *Structure*. Apices of indeterminate axes dorsiventrally organised, apical cells dome-shaped, dividing slightly obliquely resulting in a curved apex to the axes, filaments with 4, 6 or up to 20 pericentral cells. Lateral indeterminate axes or determinate laterals arising endogenously. Rhizoids cut off or not from pericentral cells.

Reproduction. Gametophytes dioecious. Procarps developing on lower cells of trichoblasts; carposporophytes with a short, branched, gonimoblast with terminal carposporangia. Cystocarps ovoid to urceolate, borne on determinate laterals, pericarp ecorticate. Spermatangial organs replacing trichoblasts or branches thereof.

Tetrasporangia borne in erect determinate laterals, one per segment.

Type species: *L. obscura* (C. Agardh)Falkenberg *in* Schmitz & Falkenberg 1897: 460.

Lophosiphonia, a genus of several species, is characterised by its habit of prostrate indeterminate axes with relatively short, erect, determinate laterals arising endogenously, the apices of indeterminate axes being dorsiventrally organised; rhizoids are usually not cut off from the pericentral cell. Some species of *Polysiphonia* (e.g. *P. scopulorum*) superficially resemble *Lophosiphonia* but differ in having radial apices and exogenous laterals.

Two southern Australian species, *L. obscura* and *L. prostrata*, belong to the genus.

KEY TO SPECIES OF *LOPHOSIPHONIA*

1. Pericentral cells 4, epiphytic on Zonarieae ....1. *L. prostrata*
1. Pericentral cells 6, epiphytic on mangroves ....2. *L. obscura*

1. **Lophosiphonia prostrata** (Harvey)Falkenberg 1901: 501. Abbott 1999: 399, fig. 117D, E. Adams 1994: 317. Cribb 1956b: 139, pl. 2 figs 1–7. De Toni 1903: 1070. Hollenberg 1968: 77, fig. 3. Huisman 1993: 13; 1997: 206. Lucas 1909: 45. May 1965: 380; 1981: 342. May & Larkum 1981: 456. Millar 1990: 452, fig. 69F. Millar & Kraft 1993: 56. Silva *et al.* 1996: 526.

Polysiphonia prostrata Harvey 1855a: 540; 1863, synop.: xx. J. Agardh 1863: 915. Sonder 1880: 34.

Falkenbergiella prostrata (Harvey)Kylin 1938: 21. Pocock 1953: 44.

FIG. 146

Thallus (Fig. 146A) prostrate on the host surface, 2–8 (-20) cm long, with filaments extending and branching over the host length and their apices free and curled over the host growing margin (Fig. 146B); erect filaments few and short, associated with reproduction. Attached by rhizoids; epiphytic on *Lobophora* and *Distromium*. *Structure*. Apical cells hemispherical or shortly conical, 10–20 µm (including the thick sheath) in diameter, axial cells with 4 pericentral cells; filaments of uniform width (Fig. 146B), 55–90 µm in diameter, segments L/D 0.5–1 (-1.5). Branching endogenous from the axial cells. Trichoblasts variable in abundance, on subapical segments of short free branches, 200–500 µm long, branched, basal cells 20–25 µm in diameter. Rhizoids unicellular, not cut off from pericentral cells. Cells uninucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes (Fig. 146D) with a small basal fusion cell and short branched gonimoblast with clavate terminal carposporangia 20–35 µm in diameter. Cystocarps (Fig. 146C, D) on branches of short erect laterals, short-stalked, ovoid to slightly urceolate, 200–300 µm in diameter; pericarp 2 cells thick, ecorticate, outer cells angular, isodiametric. Spermatangial organs (Fig. 146E) replacing trichoblasts, 35–55 in diameter and 90–180 µm long, with a sterile basal and 1 (-2) sterile apical cell.

Tetrasporangia (Fig. 146F) in curved, sub-erect branches near recurved apices, the branches 300–500 µm long and 60–100 µm in diameter, tetrasporangia one per segment, 50–75 µm in diameter, with 3 cover cells.

Type from Fremantle, W. Aust. (on *Lobophora*); holotype in TCD (*Harvey*, Trav. Set).

Distribution: Rottnest I., W. Aust., to Aldinga, S. Australia; N.S.W. (Millar & Kraft 1993, p. 56); Qld (Cribb 1956b, p. 139).

New Zealand. Central Pacific (Abbott 1999, p. 400). South Africa ?(Silva *et al.* 1996, p. 526).

Selected specimens: Point Clune, Rottnest I., W. Aust., on *Zonaria*, 13–14 m deep (*Kraft & Ricker*, 2.xii.1980; MELU, A35527). Pearson I., S. Aust., on *Distromium multifidum*, 20–23 m deep (*Shepherd & Turner*, 29.iii.1982; AD, A53045). Port Victoria, Yorke Pen., S. Aust., on *D. flabellatum*, 3–4 m deep (*Kraft*, 20.ix.1973; AD, A44541). Tiparra Reef, S. Aust., on *D. flabellatum*, 5–6 m deep (*Shepherd*, 24.vi.1970; AD, A35938). Troubridge Point, S. Aust., on *D. multifidum*, 5 m deep (*Baker*, 31.x.1993; AD, A66392). Somerton, S. Aust., on *Lobophora*, drift (*Womersley*, 4.iii.1944; AD, A1605). Marino, S. Aust., on *D. flabellatum*, drift (*Womersley*, 18.iv.1960; AD, A24357). Aldinga, S. Aust., on *D. flabellatum*, drift (*Womersley*, 14.vii.1963; AD, A26531) and on *D. multifidum* (*Womersley*, 14.vii.1963; AD, A26521). Middle R., Kangaroo I., S. Aust., on *Lobophora*, drift (*Womersley*, 8.i.1946; AD, A3402).

Lophosiphonia prostrata has a remarkably wide distribution as an epiphyte on zonarioid algae. It is distinctive in that the apices of filaments curl over the growing margin of the host, the growth of both being closely co-ordinated.

Stegenga & Vroman (1988, p. 307, figs 24–26, 29–31) recorded a "form" of *Polysiphonia scopulorum* epiphytic on *Lobophora* from Curacao. Their figures 29–31 indicate clearly that this form is actually *Lophosiphonia prostrata*. However, the figures (8–12) of Norris (1992) are most unlikely to be of *L. prostrata*.

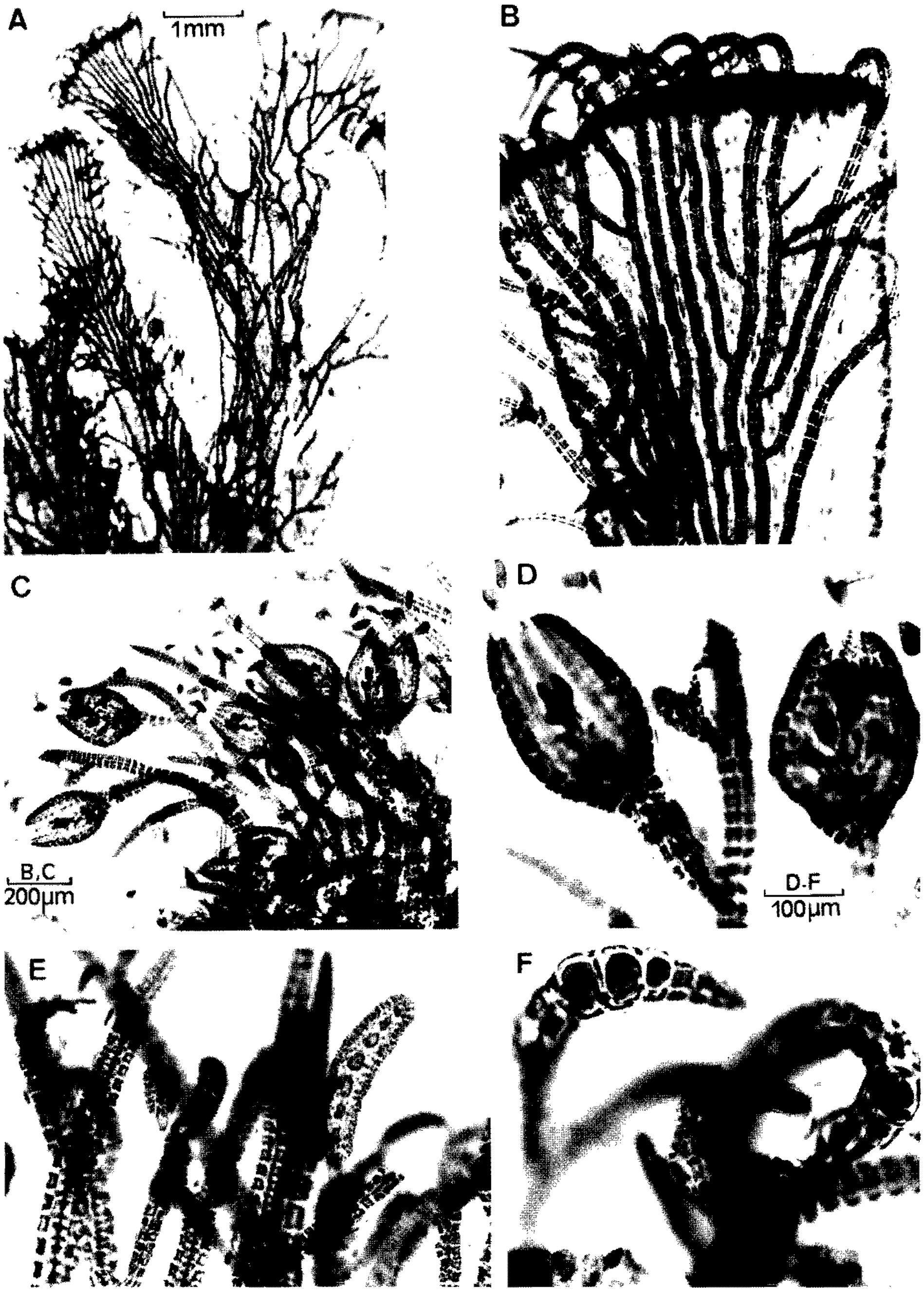

Fig. 146. *Lophosiphonia prostrata* (**A–E**, AD, A53045; **F**, AD, A26531). **A**. Habit, on *Distromium multifidum*. **B**. Closer view of **A**. **C**. Cystocarps on erect branches. **D**. Cystocarps. **E**. Spermatangial organs replacing trichoblasts on erect branches. **F**. Tetrasporangia in erect branches.

2. **Lophosiphonia obscura** (C. Agardh)Falkenberg *in* Schmitz & Falkenberg 1897: 460. Silva *et al.* 1996: 525. Wynne 1998: 44.
Hutchinsia obscura C. Agardh 1828: 108.
Polysiphonia subadunca Kützing 1843: 418; 1849: 805; 1863: 11, pl. 32a–c. J. Agardh 1863: 1064.
Lophosiphonia subadunca (Kützing)Falkenberg 1901: 496, pl. 9 figs 21–24. Beanland & Woelkerling 1982: 98. Børgesen 1939: 132. Cribb 1956b: 139. De Toni 1903: 1067. Silva *in* Silva *et al.* 1996: 921.

FIG. 147A–C

Thallus (Fig. 147A) of prostrate filaments with upwardly curved apices, bearing dorsally terete erect branches 1–2 cm high, simple or with few branches, with few apical trichoblasts. Attachment by rhizoids; epiphytic on mangrove pneumatophores. *Structure.* Apical cells dome-shaped, 20–25 µm in diameter, axial cells cutting off 6 pericentral cells (Fig. 147C), ecorticate. Prostrate and erect filaments 80–100 µm in diameter, segments L/D 0.6–1. Erect branches arise endogenously. Rhizoids (Fig. 147B) not cut off from the parent cell, 35–45 µm in diameter, with divided (probably multicellular) haptera. Cells with discoid rhodoplasts.

Reproduction. Not observed in Australian collections and apparently rare elsewhere. Female plants little known (Falkenberg 1901, p. 498). Spermatangial organs borne on trichoblasts, lanceoid (Falkenberg 1901, pl. 9 figs 23, 24).

Tetrasporangia borne in upper segments of erect branches, spirally arranged, one per segment, 50–80 µm in diameter (Børgesen 1939, p. 132).

Type from Cadiz, Spain; in Herb. Agardh, LD.

Distribution: Wallaroo, S. Australia.

Mediterranean and Atlantic Europe, NW Indian Ocean. W subtropical Atlantic. Queensland.

Southern Australian specimen: 5 km S of Wallaroo, S. Aust., on *Avicennia marina* pneumatophores (*Beanland*, 15.vi.1981; LTD, 12376 and AD, A69062).

Use of the name *L. obscura* follows Silva *in* Silva *et al.* (1966, p. 921). Cribb (1956b, p. 140) considered that Kützing (1863, pl. 32C) showed a rhizoid cut off from the pericentral cell; this figure, however, is at best vague on this feature.

The above collection is the only record of the species from southern Australia.

Genus **OPHIDOCLADUS** Falkenberg *in* Schmitz & Falkenberg 1897: 461.

Thallus of prostrate, polysiphonous, ecorticate, indeterminate axes with upwardly curved apices, bearing irregularly erect, simple or branched, determinate laterals usually bearing trichoblasts; attachment of indeterminate axes by unicellular rhizoids; epilithic. *Structure.* Apices of indeterminate axes dorsiventral, filaments with 12–22 pericentral cells, lateral branches arising endogenously. Rhizoids cut off from pericentral cells, with digitate haptera.

Reproduction. Gametophytes dioecious. Procarps developing on a lower cell of trichoblasts; carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia. Cystocarps ovoid, sessile on determinate laterals, pericarp ecorticate. Spermatangial organs borne on trichoblasts.

Tetrasporangia borne in upper determinate branches, two per segment and forming two longitudinal rows.

Type species: *O. simpliciusculus* (Crouan & Crouan)Falkenberg *in* Schmitz & Falkenberg 1897: 461.

Ophidocladus probably includes only a single species according to Saenger (1971), distinguished from *Lophosiphonia* by bearing two tetrasporangia per segment.

Ophidocladus simpliciusculus (Crouan & Crouan)Falkenberg *in* Schmitz & Falkenberg 1897: 461. De Toni 1903: 1072. Falkenberg 1901: 488, pl. 9 figs 16–20. Kylin 1956: 541, fig. 433A–D. May 1965: 381. Saenger 1971: 291, figs 1–8. Silva *et al.* 1996: 531.

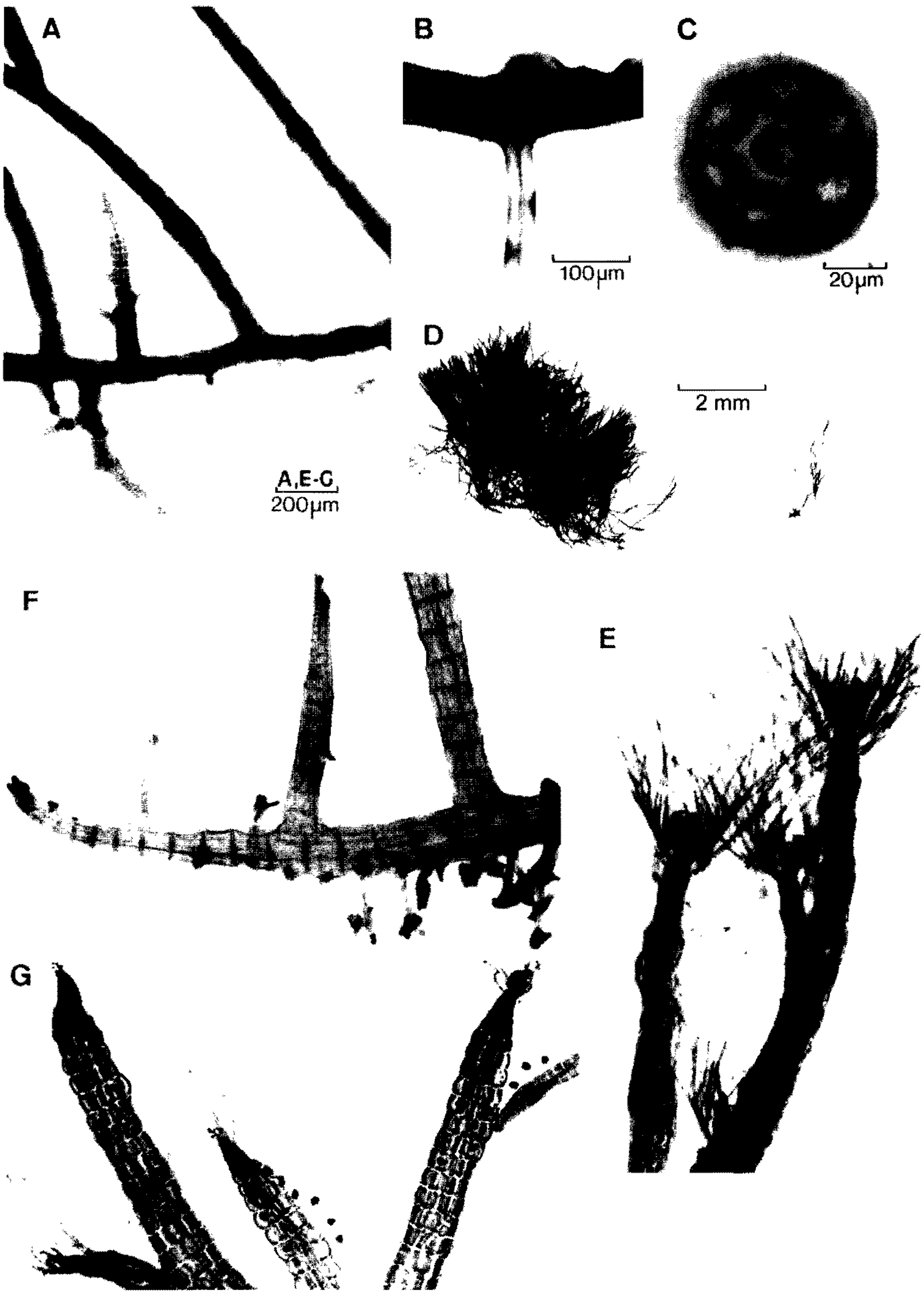

Fig. 147. A–C. *Lophosiphonia obscura* (AD, A69062). **A.** Indeterminate (horizontal) branch with 2 juvenile indeterminate branches, all bearing determinate laterals. **B.** Indeterminate branch with a rhizoid. **C.** Transverse section of branch with 6 pericentral cells. **D–G.** *Ophidocladus simpliciusculus* (**D**, AD, A48870; **E**, AD, A32907; **F**, **G**, AD, A42969). **D.** Habit. **E.** Apices of erect branches with trichoblasts and tetrasporangia. **F.** Apex of indeterminate prostrate axis with erect branches and rhizoids. **G.** Erect branches with opposite tetrasporangia.

Polysiphonia simpliciuscula Crouan & Crouan 1852; no. 302; 1867: 157, pl. 31, no. 199, 1–5. J. Agardh 1863: 944. Harvey 1863, synop.: xxii. Sonder 1880: 35.
Polysiphonia obscura Harvey 1855a: 541.

FIG. 147D–G

Thallus (Fig. 147D) dark brown-red, 2–4 cm high, forming dense mats usually on low-intertidal rock, with prostate indeterminate filaments (Fig. 147F) bearing erect, simple or branched, ecorticate, determinate filaments (Fig. 147E). Attachment of indeterminate filaments by unicellular rhizoids. *Structure.* Apices of indeterminate filaments curved upwards, dorsiventral, apical cell 25–30 μm in diameter, axes cutting off 10–18 pericentral cells and becoming 130–180 μm in diameter with segments L/D 0.5–1. Erect laterals with conical apical cells 16–28 μm in diameter (including thick walls), producing trichoblasts (Fig. 147E) several segments apart and more-or-less in 2 rows, with 12–22 pericentral cells 12–16 μm broad, surrounding axial cells 40–50 μm broad and L/D 0.8–1.2; filaments (100-) 120–200 μm in diameter, segments L/D (0.3-) 0.5–0.8 (-1). Branching endogenous, frequent from indeterminate filaments, usually sparse from erect filaments. Trichoblasts 0.5–1 mm long, branched from 3–4 basal cells 30–40 μm in diameter and L/D 1–2 (-3), upper cells long. Rhizoids with digitate haptera, cut off from pericentral cells. Cells multinucleate; rhodoplasts discoid to elongate, chained in larger cells.

Reproduction. Gametophytes dioecious, unknown in Australian collections but described by Saenger (1971) from southern Africa. Procarps on the third segment of trichoblasts, developing 5–7 pericentral cells with one (the supporting cell) cutting off a basal and 2 lateral sterile cells and a 4-celled carpogonial branch. Carposporophyte with a basal fusion cell and a branched gonimoblast with clavate terminal carposporangia. Cystocarps ovoid, sessile; pericarp ostiolate, probably ecorticate. Spermatangial organs on lower cells of trichoblasts, reported as 60–300 μm broad.

Tetrasporangia (Fig. 147G) in upper branches, in 2 longitudinal rows of opposite pairs over 6–10 segments, 30–65 μm in diameter, with 2 cover cells similar to pericentral cells.

Type from Anse du Minou, Finistère, France; holotype(?) in Herb. Crouan, CO; isotype (Crouan 302) in PC.

Distribution: In southern Australia, from King George Sound, W. Aust., to Port Elliot, S. Aust.
Western Europe, California, South Africa, Seychelles.

Selected specimens: Middleton Bay, King George Sound, W. Aust., on sand-covered rocks (*Harvey*, Feb. 1854; Herb. Harvey, TCD and AD, A18312). Venus Bay, S. Aust., low eulittoral (*Womersley*, 12.ii.1954; AD, A19513). Cape Carnot, S. Aust., eulittoral (*Skinner*, 4.xii.1977; AD, A48870). Wanna, S. Aust., low eulittoral (*Gordon*, 15.v.1968; AD, A32632). Port Elliot, S. Aust., low eulittoral inside breakwater (*Venning*, 4.ii.1973; AD, A42969). Pennington Bay, Kangaroo I., S. Aust., reef surface (*Wickes*, 14.iv.1973; AD, A43579). Stanley Beach, Kangaroo I., S. Aust., inner reef (*Womersley*, 21.xi.1968; AD, A32907).

Ophidocladus simpliciusculus appears to be a rare alga on southern Australian coasts, confined to lower eulittoral rock.

Tribe PTEROSIPHONIEAE Falkenberg 1901: 261

Thallus erect (often with a prostrate base) or largely prostrate, branching bilateral with discrete, alternate, terete to compressed, distichous laterals, or flat and elongate with short marginal determinate laterals, or branched with foliose rounded apices. Branches one cell thick with a small-celled cortex, or 2 cells thick and ecorticate, with or without a midrib. *Structure.* Apical cells dividing transversely to form axial cells, with the subapical cells dividing obliquely to form alternate distichous laterals. Frond apices with a single apical cell or a margin of several to numerous apical cells, each forming polysiphonous systems congenitally fused at their base to the axis, or fused along their whole length to form flat fronds; pericentral cells 4 to numerous, in some genera transversely divided. Trichoblasts rare and associated only with sexual reproduction, or frequent on the thallus surface or margin. Cells generally uninucleate.

Reproduction. Gametophytes usually dioecious. Procarps with a 4-celled carpogonial branch and sterile cells, surrounded by a pericarp prior to fertilization; carposporophyte with a basal fusion cell and branched gonimoblast with terminal carposporangia. Cystocarps usually ovoid, pericarp ecorticate or lightly corticate. Spermatangial organs replacing trichoblasts or branches thereof.

Tetrasporangia in terete lateral branches or in stichidia associated with trichoblast tufts on the thallus margin or surface, spirally arranged and single per segment.

Type genus: *Pterosiphonia* Falkenberg *in* Schmitz & Falkenberg 1897: 443.

The Pterosiphonieae include about 10 genera (Hommersand 1963, p. 347), all showing bilateral apical development but not primary dorsiventrality.

KEY TO GENERA OF PTEROSIPHONIEAE

1. Thallus slender, pinnately branched with discrete determinate lateral branches arising alternately 2–4 axial segments apart, with their bases congenitally fused with the axis for a few segments only .... PTEROSIPHONIA
1. Thallus broad or foliose, prostrate or erect, with one or usually many apical cells producing alternate lateral branches congenitally fused for all or most of their length 2

    2. Thallus prostrate to assurgent, 0.5–4 cm long, little branched or regularly pinnate and spinous 3
    2. Thallus erect, robust, (3-) 5–40 cm high and 3–20 mm broad 4

3. Thallus prostrate, 0.5–4 cm long, 2–4 mm broad, foliose and slightly branched .... SYMPHYOCLADIA
3. Thallus assurgent, pinnate with alternate, spinous, marginal branches .... HETEROSTROMA

    4. Fronds branched, linear, axes corticated, with a midrib and regularly spinous margins, axial cells with 6 pericentral cells, remaining undivided transversely; thallus mostly 1 cell thick plus a small-celled cortex........ DICTYOMENIA
    4. Fronds foliose, ecorticate, with or without a midrib, axial cells with 4 pericentral cells, dividing transversely; thallus 2 cells thick .... POLLEXFENIA

Genus PTEROSIPHONIA Falkenberg *in* Schmitz & Falkenberg 1897: 443.

Thallus erect from terete prostrate filaments, bilaterally branched with simple or branched indeterminate axes bearing alternate, distichous, simple or branched, terete or compressed, determinate laterals 2–3 segments apart, with their bases coalescing with the main axis over one to a few segments. Trichoblasts usually absent apart from those bearing sex organs. Attachment by rhizoids on prostrate filaments. *Structure.* Apical cells single on indeterminate branches, dividing transversely or obliquely to form alternate laterals every 2–3 segments; pericentral cells 4–12 (5–9 in face view of compressed axes), ecorticate or corticate. Cells uninucleate.

Reproduction. Gametophytes dioecious, rarely with mixed phases. Procarps on modified trichoblasts; carposporophyte with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia; cystocarps on determinate laterals, ovoid, pericarp ecorticate or corticate. Spermatangial organs borne on modified trichoblasts.

Tetrasporangia in determinate laterals, spirally arranged, single per segment, with 2 pre-sporangial and 1 post-sporangial cover cells.

Type species: *P. cloiophylla* (C. Agardh)Falkenberg *in* Schmitz & Falkenberg 1897: 443.

A genus of some 19 species, the type studied in detail by Hommersand (1963, p. 261, figs 38–43). *Pterosiphonia* is characterised by its pinnate habit with the determinate laterals coalescing with the indeterminate axes over only a very few segments.

Only one species occurs on southern Australian coasts.

Pterosiphonia pennata (C. Agardh)Sauvageau 1897: 287 (reprint p. 18). Abbott 1999: 435, fig. 130A–D. Ardre 1967: 43, pl. 6 figs 1–3; 1970: 194, pl. 25 figs 4, 5. De Toni 1903: 998. Falkenberg 1901: 263, pl. 2 figs 1, 2. Lewis 1983: 262. Lucas 1909: 43.

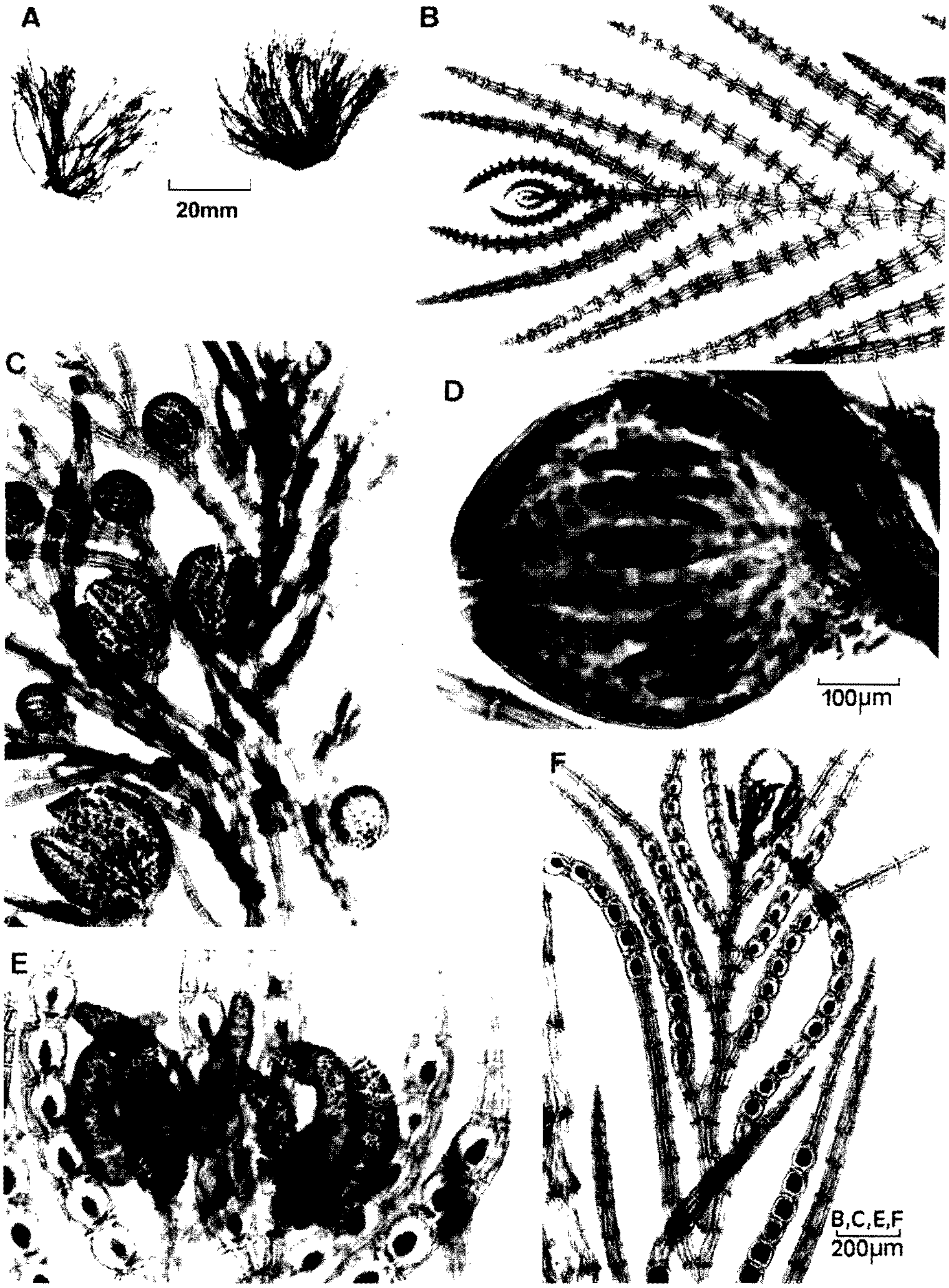

Fig. 148. *Pterosiphonia pennata* (**A**, **C–F**, AD, A57125; **B**, AD, A49281). **A**. Habit. **B**. Branch apex. **C**. Cystocarps. **D**. Cystocarp with carposporangia. **E**. Mixed phase plant with spermatangial organs and tetrasporangia. **F**. Determinate laterals with tetrasporangia.

Maggs & Hommersand 1993: 377, fig. 118. May 1965: 382; 1981: 343. Millar 1990: 455, fig 69C, D. Millar & Kraft 1993: 59. Silva *et al.* 1996: 549.
Hutchinsia pennata C. Agardh 1824: 146.
Polysiphonia pennata (C. Agardh)J. Agardh 1842: 141. Harvey 1855a: 541; 1863, synop.: xxi. Sonder 1880: 35. Tisdall 1898: 514. Wilson 1892: 167.

FIG. 148

Thallus (Fig. 148A) dark red-brown, forming dense tufts or turfs 2–4 (-6) cm high with numerous erect axes from prostrate, branched, filaments; erect axes simple or occasionally branched, with pinnate, alternate, determinate laterals (Fig. 148B), the axis linear in outline and 2–3 mm broad, the laterals simple, 1–2 mm long; attachment by rhizoids from prostrate filaments; epilithic. *Structure.* All axes and laterals ecorticate. Prostrate filaments terete, 120–160 µm in diameter with segments L/D 0.8–1.4 (-2), branching 2–4 segments apart, with 7–8 pericentral cells; rhizoids unicellular, cut off from pericentral cells, with multicellular discoid haptera. Erect axes slightly compressed, 180–230 µm broad, segments L/D 0.8–1.2, with 8–10 pericentral cells, 5–6 visible in side view. Determinate laterals straight or incurved when young, linear and tapering apically to a small apical cell, coalesced with axes over 1–1.5 (-2) segments, 16–25 segments long, segments L/D (0.3-) 1–1.5. Trichoblasts usually absent, Cells uninucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious; one case of mixed phases (male on tetrasporophyte – Fig. 148E) known. Procarps probably borne on short trichoblasts, segments soon polysiphonous. Carposporophyte (Fig. 148D) with a small basal fusion cell, short gonimoblast filaments and clavate terminal carposporangia 30–45 µm in diameter. Cystocarps (Fig. 148C, D) ovoid, short-stalked, 300–800 µm in diameter; pericarp ostiolate, ecorticate, 2 cells thick, outer cells isodiametric. Spermatangial organs (Fig. 148E) near apex of axes, elongate-ovoid to clavate and often curved, 45–120 µm in diameter and 130–350 µm long, with 1–2 sterile basal and apical cells.

Tetrasporangia (Fig. 148F) in determinate laterals in straight rows in 6–10 successive segments, subspherical to slightly ovoid, 35–60 µm in diameter, with 2 elongate cover cells.

Type from the Mediterranean (not specified); lectotype in Herb. Agardh, LD, 39271.

Distribution. Widely distributed in Atlantic and Pacific Oceans.

In southern Australia, from Bunbury, W. Aust., to Byron Bay, N.S.W. and Taroona, Tas. (see Millar & Kraft 1993, p. 59).

Selected specimens: Bunbury, W. Aust., low eulittoral (*Woelkerling*, 5.ii.1978; AD, A49281). Middleton Bay, King George Sound, W. Aust. (*Harvey* 12, in TCD). Cape Carnot, S. Aust., low eulittoral (*Skinner*, 4.xii.1977; AD, A48871). Christies Beach, S. Aust., upper sublittoral in sandy pools (*Womersley*, 14.x.1968; AD, A32863—"Marine Algae of southern Australia" No. 388). Port Noarlunga, S. Aust., lower eulittoral (*Ladd*, 25.vi.1986; AD, A57125). Bales Bay, Kangaroo I., S. Aust., low eulittoral (*Womersley*, 6.i.1990; AD, A60125). Pennington Bay, Kangaroo I., S. Aust., upper sublittoral pool (*Womersley*, 27.x.1995; AD, A64594—"Marine Algae of southern Australia" No. 388a). Apollo Bay, Vic. (*McLennan*, viii.1957; AD, A16498). Walkerville, Vic., uppermost sublittoral (*Sinkora* A1884, 9.xii.1973; AD, A49485). Portsea, Vic., on jetty pilings, 2–4 m deep (*Kraft & Phillips*, 3.ii.1997; MELU, K10514). Bemm reef, E Vic., 15–17 m deep (*Kraft & Foard*, 8.ii.2001; MELU, 4115). Taroona, Tas., drift (*Kildea*, 31.i.1997; AD, A68452). Byron Bay, N.S.W., 6 m deep (*Millar & Richards*, 29.vii.1992; NSW, A11615).

Pterosiphonia pennata forms mats or turfs close to low tide level under moderate wave action, rarely in deep water (e.g. at Bemm reef, Vic.). Fertile thalli are not uncommon, whereas they are unknown in the British Isles (Maggs & Hommersand 1993, p. 377). The latter authors clarify differences between *P. pennata* and related species, as did Ardre (1967, p. 51).

Genus SYMPHYOCLADIA Falkenberg *in* Schmitz & Falkenberg 1897: 443.

Thallus prostrate to more-or-less erect, flat, to a few cm long and a few mm broad, often marginally lobed, with numerous apical cells on the growing margin producing axial systems which remain congenitally laterally attached. Thallus mostly 2 cells thick, ecorticate or corticated, with branched trichoblasts arising marginally close to dormant apical cells. Attachment by rhizoids from the ventral surface. *Structure.* Apical cells dividing transversely, subapical cells obliquely to form laterals and cutting off 5 or 8 pericentral cells, 3 or 4 on each side of thallus, pericentral cells remaining undivided; lateral axial branches usually 2 cells apart.

Reproduction. Reproductive organs borne on margins of thalli. Procarps borne on basal cells of trichoblasts; cystocarps ovoid, sessile on polysiphonous stalks, pericarp 2 cells thick, with few cortical cells. Spermatangial organs on trichoblasts.

Stichidia borne marginally, basally to largely fused, tetrasporangia spirally to linearly arranged, one per segment, in the fused basal parts or the upper free parts.

Type species: *S. marchantioides* (Harvey)Falkenberg.

A genus of 4 species, the type (from New Zealand and widespread in the western Pacific) and 3 further species from Japan (Yoshida 1998, p. 1083; Uwai & Masuda 1999).

Transverse section of the thallus show similar cell arrangement on both sides, i.e. not dorsiventral. *Symphyocladia* has been discussed by Ardre (1973) and Kraft & Wynne (1992, p. 31).

Symphyocladia marchantioides (Harvey)Falkenberg *in* Schmitz & Falkenberg 1897: 444. Abbott 1999: 440, fig. 131G–I. Adams 1994: 313, pl. 105, lower right. Ardre 1973: 20, pls 1–5, figs 1–15. De Toni 1903: 989. Falkenberg 1901: 277, pl. 2 figs 18–23, pl. 4 figs 20–24. Kylin 1956: 524. Lewis 1984: 67. Lucas 1909: 43. May 1965: 403; 1981: 342. Millar 1990: 456, fig. 69E. Millar & Kraft 1993: 59. Norris & Aken 1985: 62, fig. 29. Shepherd & Womersley 1981: 368. Silva *et al.* 1996: 554.
Amansia? marchantioides Harvey 1855b: 223.

FIG. 149A–E

Thallus (Fig. 149A) brown-red, 1–2 cm long and 2–4 mm broad, prostrate with a main branch bearing occasional to frequent similar but shorter and slenderer marginal branches. Attachment by rhizoids from basal parts; epilithic or epiphytic. *Structure*. Growth from apical cells 6–10 µm in diameter which divide transversely, the subapical cells cutting off 6 or 8 pericentral cells (Fig. 149D), 3 or 4 on each side, without transverse subdivision of these cells; thallus usually 2 (-3) cells thick; apical cells and derivative segments remain laterally attached congenitally (Fig. 149B), with the axial cells branching laterally 2–5 cells apart; mature pericentral cells 90–120 µm long, the lateral (outer) ones 25–45 µm in diameter, the transverse ones 15–20 µm in diameter. Rhizoids unicellular, cut off from pericentral cells, with multicellular haptera. Trichoblasts (Fig. 149C) arising from dormant apical cells on margins of branches, branched, becoming 600–1000 µm long, lower cells 20–30 µm in diameter. Cells uninucleate; rhodoplasts discoid.

Reproduction. Gametophytes not seen in the only southern Australian collection. AD, A52223 from Long Reef, N.S.W. (*Harada*, 21.x.1978) is a good female plant.

Tetrasporangia (Fig. 149E) borne in laterally fused stichidia, in straight rows, one per segment, 60–90 µm in diameter.

Type from Cape Kidnappers, Hawkes Bay, New Zealand (*Colenso*); holotype in Herb. Harvey, TCD. (Harvey gave "Cape Kidnapper and Hawke's Bay; however the Cape is at the southern extremity of Hawkes Bay and it appears that this is the only type locality).

Distribution: In southern Australia, known from Edithburg, S. Aust., to Point Hicks E Vic., and from eastern Australia (see Millar & Kraft 1993, p. 59).

New Zealand, N of Banks Pen; western Pacific Ocean; Azores; eastern and western Australia; South Africa; Japan.

Selected specimens: Edithburg, S. Aust., 1–4 m deep in swimming pool (Prud'homme van Reine, 14.x.1988; AD, A59223). Nora Creina, S. Aust., drift (*Kraft* 5986a, 15.i.1977; MELU and AD, A69070). Aireys Inlet, Vic. (*Kraft & Watts*, 15.x.1978; MELU, K6615). Point Lonsdale, Vic., on shell, 2–4 m deep (*Kraft* 9565, 28.v.1993; MELU and AD, A69067). Point Hicks, E Gippsland, Vic., 1.5 m deep (*Kraft & Watts*, 7.ii.2001; MELU).

Genus **HETEROSTROMA** Kraft & Wynne 1992: 17.

Thallus with prostrate blades bearing assurgent fronds alternately pinnate 3–4 times, complanately branched, branches flat, ecorticate, margins regularly serrate with pointed determinate laterals, each with a protruding apical cell, some becoming indeterminate.

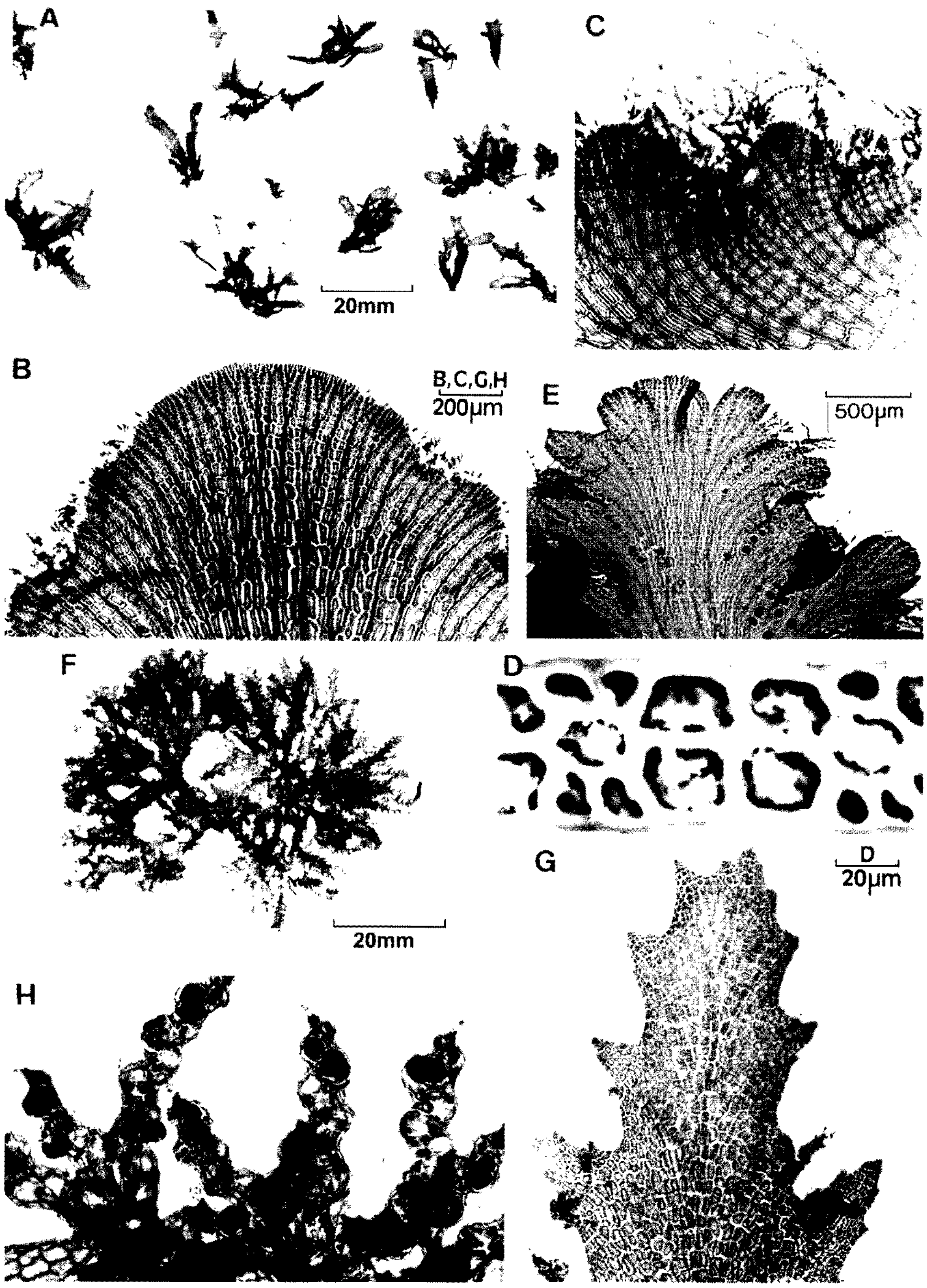

Fig. 149. **A–E**. *Symphyocladia marchantioides* (**A–C**, AD, A59223; **D**, MELU, K6615, slide; **E**, AD, A69070). **A**. Habit. **B**. Flat branch apex with congenitally fused polysiphonous filaments, showing vein system. **C**. Margin of branch with trichoblasts. **D**. Transverse section of branch showing 8 pericentral cells. **E**. Branch with tetrasporangia. **F–H**. *Heterostroma nereidiis* (AD, A34969). **F**. Habit. **G**. Branch apex with alternate spinous determinate laterals. **H**. Stichidia on blade margin.

Attachment by clumped rhizoids. *Structure*. Subapical axial cells cutting off 4 pericentral cells, 2 on each surface, the dorsal pericentral cells dividing transversely and longitudinally to form short cells covering the larger ventral pericentral cells which divide only longitudinally. Axial cells usually branching alternately every 2 cells and also producing unicellular primordia from alternate cells on alternate sides. Trichoblasts only associated with reproductive structures. Rhizoids unicellular, cut off from pericentral cells, haptera multicellular.

Reproduction. All reproductive organs borne on short marginal processes with 5 pericentral cells. Gametophytes dioecious. Procarps on suprabasal cell of trichoblasts, with a 4-celled carpogonial branch and 2 sterile groups; cystocarps ovoid, ostiolate. Spermatangial organs borne as a basal branch of trichoblasts, elongate-ovoid, axial cells with 3 pericentral cells bearing initials and a surface layer of spermatangia.

Tetrasporangial stichidia marginal, bearing trichoblasts, tetrasporangia spirally arranged, one per segment of 5 pericentral cells, with 3 cover cells.

Type (and only) *species*: *H. nereidiis* Kraft & Wynne 1992: 18, figs 2–36.

Heterostroma was described in detail by Kraft & Wynne, who compared it with other flat, congenitally united, blade-like Rhodomelaceae, concluding that it has no close relatives but vegetatively is most similar to *Aphanocladia* and *Jeannerettia*. The latter genus is shown below to be correctly named *Pollexfenia*. *Heterostroma* is closest to *Pollexfenia* in thallus construction and reproduction and is provisionally placed in the Pterosiphonieae. It differs from *Pollexfenia* mainly in having only the pericentral cells on the dorsal surface dividing transversely (on both sides in *Pollexfenia*), and in the alternately spinous margins.

Heterostroma nereidiis Kraft & Wynne 1992: 18, figs 2–36.

FIG. 149F–H

Thallus (Fig. 149F) medium to dark brown-red, with decumbent fronds 1–4 cm long arising from prostrate, imbricate to expanded, bases to 280 μm thick. Fronds complanately and pinnately branched for 3–4 orders, branches (1-) 2–3 (-4) mm broad and 60–130 μm thick, margins irregularly serrate with alternate, pointed, determinate laterals (Fig. 149G), all with distinct apices and some becoming indeterminate. Attachment by clumped rhizoids from the ventral surface; epilithic or epiphytic on *Amphibolis* or on encrusting corallines on larger algae. *Structure*. Apical cells short-conical to dome-shaped, 15–20 μm in diameter, subapical cells cutting off first lateral branch initials then 4 pericentral cells with 2 lying on each of the dorsal and ventral surfaces which become heteromorphic by different divisions but remain ecorticate. The axial cells branch alternately laterally every 2 cells and also produce unicellular primordia from alternate cells on alternate sides; however, inner parts of secondary laterals may be branched 4–7 axial cells apart. Dorsal pericentral cells divide transversely and longitudinally to produce angular cells 15–30 μm across and L/D 1–2, lying over the larger ventral cells which divide only longitudinally, remaining 40–75 (-140) μm in diameter and L/D (2-) 3–4. Trichoblasts occur only associated with reproductive organs but are well developed, branched and 0.5–1.5 mm long. Rhizoids unicellular, cut off from the pericentral cells and with multicellular haptera.

Reproduction. All reproductive organs borne on short terete marginal processes with 5 pericentral cells and trichoblasts. Gametophytes dioecious. Procarps on the second cell of trichoblasts, with a 4-celled carpogonial branch and 2 sterile groups. Cystocarps (juvenile) ovoid; pericarp ostiolate, with about 11 erect filaments, probably ecorticate. Spermatangial organs borne as one basal branch of trichoblasts, elongate-ovoid, 130–200 μm long and 50–60 μm in diameter, with 7–9 fertile segments each with 3 pericentral cells, producing a layer of initials and a surface layer of spermatangia.

Tetrasporangial stichidia (Fig. 149H) occur marginally, single or grouped and bearing terminal trichoblasts, irregularly twisted or distorted by the sporangia, stichidia (0.25-) 0.5–1.2 mm long and 150–200 μm in diameter, each segment with 5 pericentral cells and a single tetrasporangium, spirally arranged, 50–100 μm in diameter, with 3 cover cells.

Type from Yanchep, W. Aust., on stems of *Amphibolis antarctica*, drift (*G., L. & J. Kraft*, 20.ix.1990); holotype MELU, K17001, isotypes K17002–17004.

Distribution. Houtman Abrolhos to Rottnest I., W. Aust., and Elliston, S. Australia.

Selected specimens: Point Clune, Rottnest I., W. Aust., on *Zonaria*, 13–14 m deep (*Kraft & Ricker*, 2.xii.1980; MELU, A35328 and AD, A69069). Elliston, S. Aust., 10–12 m deep on limestone in centre of bay (*Shepherd*, 24.x.1969; AD, A34969).

Heterostroma nereidiis has a wide distribution on western and southern Australian coasts but is apparently a rare alga, easily overlooked. The Elliston specimen is tetrasporangial and agrees well with the type description.

Genus DICTYOMENIA Greville 1830: 1.

Thallus erect, irregularly to pinnately branched with relatively long, linear, flat, indeterminate branches (1-) 2–6 (-7) mm broad, with short, marginal, determinate laterals 1–3 mm long and 1–3 mm apart; branches with a distinct midrib and conspicuous (usually) lateral veins (of the determinate laterals), the midrib denuded of the wings below. Trichoblasts occur on determinate laterals near branch apices or arise on the surface above the lateral veins. Holdfast fibrous. *Structure*. Apical cells segmenting transversely or obliquely usually 2–4 axial cells apart to form the determinate laterals, with the axial cells conspicuous throughout the thallus. Indeterminate branches have 6 pericentral cells, 2 larger lateral ones and 2 smaller ones on each surface, the lateral ones dividing laterally to give 3–6 cells between the veins but not dividing transversely; the terete determinate branches have pericentral cells of similar size. Blades with a single layer of larger cells and corticated by a single layer of small cells, thicker over the midribs. Cells generally uninucleate.

Reproduction. Reproductive organs occur on trichoblasts or branch clusters on the surface or the margins; propagules occur in *D. harveyana*.

Gametophytes dioecious. Procarps on surface or marginal trichoblasts. Cystocarps ovoid, pericarp corticated or not. Spermatangial organs on trichoblasts, with sterile basal cells and 1 to several sterile apical cells.

Stichidia in clusters on surface or margins of branches, terete, with mature tetrasporangia in short series, one per segment, spirally arranged, with 2 cover cells.

Type species: *D. tridens* (Mertens *ex* Turner)Greville 1830: li.

A genus of about 7 species in southern Australia and South Africa. As well as the species and synonymy recognised below from southern Australia, *D. myriacantha* is now placed as a synonym of *Pityophycus tasmanica*.

The original spelling of *Dictyomenia* has often been given as *Dictymenia* in later lists.

KEY TO SPECIES OF *DICTYOMENIA*

1. Main branches bi- to tripinnate; determinate laterals profuse and much branched on margins of main branches; reproductive organs on marginal determinate laterals...... 4. *D. harveyana*
1. Main branches irregularly and sparsely laterally branched; determinate laterals with few branches; reproductive organs in branch clusters on surface of indeterminate branches, situated over veins of determinate laterals.. 2
    2. Main branches 4–5 (-6) mm broad, branch apices of several congenitally fused apical systems .... 3. *D. sonderi*
    2. Main branches 1–3 mm broad, branch apices single, not fused with others........... 3
3. Thallus moderately densely branched, lateral branches separated by few determinate laterals 1–2 mm long .... 1. *D. tridens*
3. Thallus sparsely branched, lateral branches separated by 2 to many determinate laterals 2–3 (-5) mm long.. 2. *D. angusta*

1. **Dictyomenia tridens** (Mertens *ex* Turner)Greville 1830: li. J. Agardh 1841: 27; 1863: 1081; 1885: 105; 1897: 60. De Toni 1903: 985. De Toni & Forti 1923: 43. Falkenberg 1901: 287. Fuhrer *et al.* 1981: pl. 34. Guiler 1952: 105. Harvey 1855a: 538; 1863, synop.: xviii. Hooker & Harvey 1847: 397. Huisman 1997: 204; 2000: 163. Huisman & Walker 1990: 434. King *et al.* 1971: 124. Kützing 1849: 848; 1864: 33, pl. 94 f, g. Kylin 1956: 525. Lewis 1984: 53. Lucas 1909: 42; 1929b: 51. Lucas & Perrin 1947: 281, fig. 128. May 1965: 396. Millar & Kraft 1993: 52. Reinbold

1898: 48. Schmitz & Falkenberg 1897: 445. Shepherd & Womersley 1971: 166; 1981: 367. Silva *et al.* 1996: 489. Sonder 1853: 697?; 1880: 33. Tate 1882a: 22. Tisdall 1898: 513. Wilson 1892: 167. Womersley 1950: 188.
Fucus tridens Mertens *ex* Turner 1819: pl. 255.
Rhodomela tridens (Mertens *ex* Turner)C. Agardh 1822: 373; 1824: 197.

FIG. 150

Thallus (Fig. 150A) dark brown-red, erect, 10–40 cm high, complanately and irregularly marginally branched, with flat indeterminate branches 2–3 mm broad, above with a central midrib and reticulate surface pattern, bearing marginally short determinate branches 1–2 mm long, alternately positioned 1–3 mm apart, each with a broader base and tapering to 2–3 slender upper branches. Indeterminate lateral branches develop by continued growth of determinate laterals. Older indeterminate branches become denuded of the wings and the midrib thickened. Holdfast fibrous, 5–20 mm across, with terete branches; epilithic. *Structure.* Apical cell dome-shaped, 8–18 μm in diameter, segmenting transversely, with determinate laterals (2-) 3–4 cells apart (Fig. 150B), axial cells remaining conspicuous throughout the thallus. Indeterminate branches with 6 pericentral cells (Fig. 150C, D), 2 large lateral ones and 2 smaller ones on each surface, with the large lateral pericentral cells dividing laterally to form the flat branch and becoming corticated early between the pericentral cells and their derivatives (i.e. over the wings), more so over the midrib (Fig. 150D), especially below. Determinate laterals of clusters terete, with 5 (-6) pericentral cells, corticated. Trichoblasts occur near apices of determinate branches but readily caducous, branched, 1–2 mm long, basal and mid cells 20–30 μm in diameter and L/D (1-) 2–3. Cells uninucleate; rhodoplasts discoid.

Reproduction. Reproductive organs borne on branch clusters arising above lateral veins on the surface of main branches or as continued development of determinate laterals near apices.

Gametophytes dioecious. Procarps not observed. Carposporophytes with a small basal fusion cell and short, branched, gonimoblast filaments bearing elongate-clavate terminal carposporangia 30–55 μm in diameter. Cystocarps (Fig. 150E) ovoid to slightly urceolate, 800–1200 μm in diameter; pericarp ostiolate, corticated on mid and lower parts. Spermatangial organs (Fig. 150F) ovoid to elongate, 90–140 μm in diameter and 140–350 μm long, with 1–2 sterile basal cells and a uniseriate sterile apex 5–7 cells and 180–350 μm long.

Tetrasporangia (Fig. 150G) in the branched clusters on branch surface, branches terete, 180–230 μm in diameter, with segments L/D 0.5–1. Tetrasporangia in short series, one per segment, spirally arranged, 140–200 μm in diameter, with 2 cover cells.

Type from "Coast of New Holland" (Péron): probably from SE Australia; holotype in BM (illustrated by Turner).

Distribution: Houtman Abrolhos, W. Aust., to San Remo, Vic., Deal I., Bass Strait, and Twofold Bay, N.S.W. (Millar & Kraft 1993, p. 52); doubtfully further north (Lewis 1984, p. 53).

Selected specimens: 7 mile beach, N of Dongara, W. Aust., drift (*Womersley*, 17.ix.1979; AD, A51377). Watermans, 20 km N of Perth, W. Aust., drift (*Womersley*, 20.viii.1979; AD, A50994). Head of Great Australian Bight, S. Aust., drift (*Womersley*, 4.ii.1954; AD, A19228). 4 km W of Waldegrave I., S. Aust., 30 m deep (*Branden*, 3.vii.1987; AD, A57605). Tapley Shoal, S. Aust., 10 m deep (*Shepherd*, 2.ii.1969; AD, A33481). Semaphore, S. Aust., 10 m deep (*Branden*, 19.vi.1975; AD, A46349). Victor Harbour, S. Aust., drift (*Womersley*, 24.vii.1949; AD, A11151). Bashams Beach, Port Elliot, S. Aust., drift (*Womersley*, 15.v.1985; AD, A56607 and 15.viii.1999; AD, A68324). Vivonne Bay, Kangaroo I., S. Aust., drift (*Womersley*, 14.i.1948; AD, A6898). D'Estrees Bay, Kangaroo I., S. Aust., drift (*Womersley*, 23.viii.1963; AD, A26784). Robe, S. Aust., drift (*Culic*, 20.vii.1974; AD, A45365). Lawrence Rock, Portland, Vic., 20 m deep (*Watson*, 14.v.1969; AD, A34431). Port Phillip Heads, Vic., 22 m deep (*Watson*, 29.iii.1985; AD, A57046). San Remo, Vic., drift (*Sinkora* A1982; 27.xi.1974; AD, A62707). East Cove, Deal I., Bass Strait, 15 m deep (*Shepherd* & *R. Lewis*, 7.v.1974; AD, A45104).

Dictyomenia tridens is a deep-water alga on rough-water coasts along most of southern Australia.

2. **Dictyomenia angusta** J. Agardh 1897: 60. De Toni 1903: 987. Lucas 1909: 42; 1929b: 51. Lucas & Perrin 1947: 282. May 1965: 395. Reinbold 1898: 48. Silva *et al.* 1996: 488.

FIG. 151H

Thallus (Fig. 151H) dark brown-red, erect, 10–25 cm high, complanately and irregularly branched with indeterminate branches 1–2 mm broad and separated by 3 to many determinate

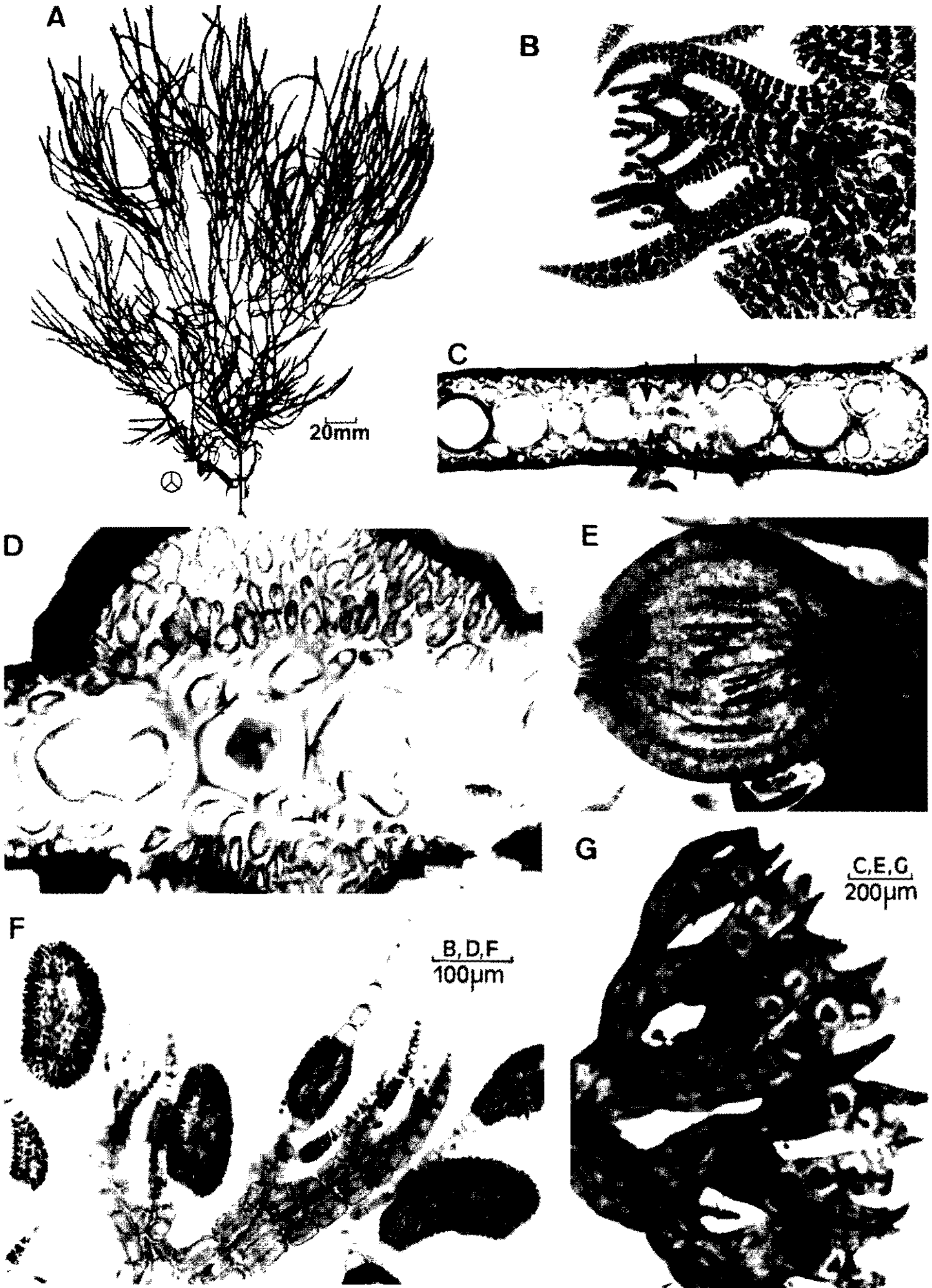

Fig. 150. *Dictyomenia tridens* (**A**, AD, A56607; **B**, **F**, AD, A45365; **C**, **G**, AD, A68324; **D**, AD, A46349; **E**, AD, A50994). **A**. Habit. **B**. Apex of indeterminate branch with determinate laterals. **C**. Transverse section of young thallus showing axial and 6 pericentral cells (arrows to 4 smaller cells). **D**. Transverse section of central region of older axis. **E**. Cystocarp. **F**. Spermatangial organs on trichoblasts. **G**. Branches with tetrasporangia.

laterals on each side. Determinate laterals 2–3 (-5) mm long, slender, usually with 2–3 apical branches, 2–5 mm apart on each side of indeterminate branches, denuded near the thallus base. Holdfast probably fibrous (inadequately seen). *Structure.* Apical structure not observed. Axial cells moderately conspicuous, branching to the determinate laterals every 3–4 cells. Indeterminate branches with 6 pericentral cells, corticated from near the apices; indeterminate laterals corticated. Trichoblasts not observed.

Reproduction. Only tetrasporangial branch clusters seen, situated on the surface over lateral veins of determinate laterals, much branched; tetrasporangia immature.

Type from "occidentales, tum australes Novae Hollandiae"; lectotype from Port Elliot, S. Aust. (*Hussey*); in Herb. Agardh, LD, 42315.

Distribution. Port Elliot, S. Aust., and Walkerville, Victoria. J. Agardh placed similar specimens from Geographe Bay, W. Aust., under this species.

Known specimens: Port Elliot, S. Aust. (*Hussey*, Feb. 1898; AD, A36058). Walkerville, Vic., drift (*Sinkora* A2108, 28.ii.1975; AD, A48308 and A2292, 6.iii.1976; AD, A48466, and A2553, 10.iii.1979; AD, A60972).

D. angusta is known from only few herbarium specimens and needs detailed study from fresh material. While seemingly distinct in habit, it is closest to *D. tridens*, differing in much sparser branching and longer and more widely spaced determinate laterals. It may, however, be an unusual form of *D. tridens*.

3. **Dictyomenia sonderi** Harvey 1858: pl. 21; 1863, synop.: xvii. J. Agardh 1863: 1082; 1885: 105. De Toni 1903: 986. De Toni & Forti 1923: 43. Falkenberg 1901: 285, pl. 19 figs 13–16. Huisman 1997: 204; 2000: 163. Huisman & Walker 1990: 434. Kützing 1864: 34, pl. 96. Kylin 1956: (525), figs 378E, F, 418. Lewis 1984: 53. Lucas 1909: 42. Lucas & Perrin 1947: 280, fig. 127. May 1965: 396. Schmitz & Falkenberg 1897: 445, fig. 248. Shepherd & Sprigg 1976: 170. Shepherd & Womersley 1981: 367. Silva *et al.* 1996: 489. Sonder 1880: 33.

Dictyomenia fimbriata Greville *sensu* Harvey 1855a: 538.

Dictyomenia sonderiana J. Agardh 1897: 59.

FIG. 151A–G

Thallus (Fig. 151A) medium to dark red-brown, erect, 10–40 cm high, complanately and marginally branched with regularly to irregularly pinnate lateral branches, linear and (3-) 4–6 (-7) mm broad, with regular marginal fringes of branched determinate laterals 1–2 (-3) mm long. Main branches (Fig. 151B) with a well defined midrib and prominent alternate lateral veins, midrib thickened below and remaining as a subterete stalk 1–1.5 (-2) mm thick where the lateral membrane is lost. Branch blades corticated from close to apices. Holdfast fibrous, branched, 1–2 cm across; epilithic. *Structure.* Apical cell (Fig. 151C) of branches dome-shaped, 7–15 µm in diameter, with the axial cells branching on alternate sides every 2 cells to originate determinate laterals and cutting off 6 pericentral cells (Fig. 151D, E), 2 larger lateral ones and 2 smaller ones on each side. The determinate laterals remain active for some time, cutting off the 6 pericentral cells and the lateral pericentral cells forming chains of 2–3, resulting in (3-) 5–6 large inner cells between the lateral veins; the determinate laterals fuse congenitally (Fig. 151B) to form the 4–6 mm broad main branches, with the apices of the determinate laterals forming the marginal fringe; trichoblasts occur as dense tufts on the end branches of the determinate laterals. Cortication generally 1 (-2) cells thick over the blades, heavier over the midrib. Cells probably uninucleate; rhodoplasts discoid.

Reproduction. Reproductive organs borne on branched clusters arising over the lateral veins on the branch surface.

Gametophytes dioecious. Procarps not observed. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia 35–90 µm in diameter. Cystocarps (Fig. 151F) subspherical to slightly ovoid, 700–1500 µm in diameter; pericarp ostiolate, corticated. Spermatangial organs with 1–2 sterile basal cells, no sterile apical cells, ovoid to slightly tapering, 60–90 µm in diameter and 100–150 µm long.

Stichidia (Fig. 151G) in much-branched clusters 1–2 mm high, branches 100–180 µm in diameter with segments L/D 0.4–0.8, tetrasporangia single per segment, in short series maturing acropetally, 130–200 µm in diameter.

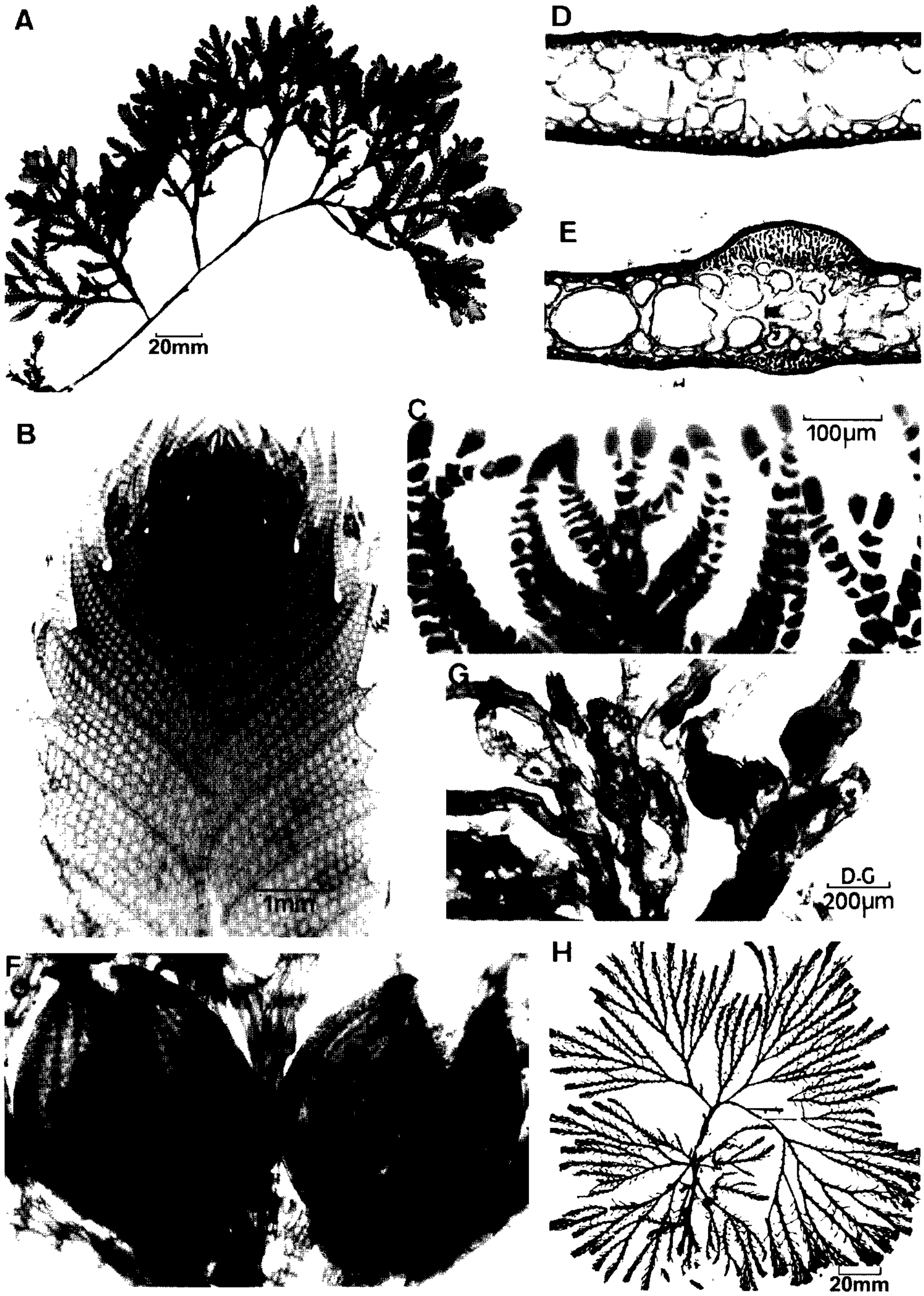

Fig. 151. A–G. *Dictyomenia sonderi* (**A**, AD, A47866; **B**, AD, A33211; **C**, **F**, AD, A19572; **D**, **E**, **G**, AD, A64431). **A.** Habit. **B.** Indeterminate branch with marginal determinate laterals. **C.** Apex of indeterminate branch with determinate laterals. **D.** Transverse section of young branch with axial and 6 pericentral cells. **E.** Transverse section of older branch with thickened midrib. **F.** Cystocarps. **G.** Branches with tetrasporangia. **H.** *Dictyomenia angusta* (type, LD, 42315). Habit.

Type from Garden I., W. Aust.; lectotype in Herb. Harvey, TCD. (Harvey, Alg. Aust. Exsic. 122a).

Distribution: N of Dongara, W Aust., to Backstairs Passage, S. Australia; doubtfully N Australia (Lewis 1984, p. 53).

Selected specimens: 7 mile beach, N of Dongara, W. Aust., drift (*Womersley*, 17.ix.1979; AD, A51359). Port Denison, W. Aust., drift (*Gordon*, 8.xi.1968; AD, A33211). Point Peron, W. Aust., drift (*Royce* 932, 22.ii.1951; AD, A14180). Penguin I., W. Aust., drift (*Wollaston*, 3.ii.1957; AD, A22126). Eyre, W. Aust., drift (*Woelkerling*, 22.xi.1968; AD, A34232). Head of Great Australian Bight, S. Aust., drift (*Womersley*, 4.ii.1954; AD, A19222). W of Cape Adieu, S. Aust., 15 m deep (*Edyvane*, 21.vi.1994; AD, A64431). Point Sinclair, S. Aust., drift (*Womersley*, 7.ii.1954; AD, A19572). Elliston, S. Aust., drift (*Woelkerling*, 28.xii.1976; AD, A47866). Off Troubridge I., S. Aust., 23 m deep (*Shepherd*, 4.ii.1969; AD, A33528). Backstairs Passage, S. Aust. (no data; AD, A1318).

4. **Dictyomenia harveyana** Sonder 1853: 698; 1855: 523; 1880: 33. J. Agardh 1863: 1079; 1885: 104; 1897: 62. De Toni 1903: 983. Falkenberg 1901: 283, pl. 19 fig. 17. Guiler 1952: 105. Harvey 1859b: 295; 1863, synop.: xviii. Kützing 1864: 33, pl. 95a, b. Levring 1946: 226. Lucas 1909: 42; 1929a: 22; 1929b: 51. Lucas & Perrin 1947: 282, fig. 129. May 1965: 395. Reinbold 1897: 56. Shepherd 1983: 83. Shepherd & Womersley 1981: 367. Silva *et al.* 1996: 488. Tate 1882a: 22. Tisdall 1898: 513. Wilson 1892: 167. Womersley 1950: 188; 1966: 154.

Dictyomenia harveyana var. *flabelligera* Harvey 1863, synop.: xviii.

Dictyomenia tridens sensu Harvey 1844b: 430; 1846: 381; 1847: 28, pl. 7. J. Agardh 1863: 1081 (in part).

Dictyomenia spinulosa Kützing 1864: 34, pl. 97c–e. De Toni 1903: 988. Lucas 1909: 42. Lucas & Perrin 1947: 282. May 1965: 395. Silva *et al.* 1996: 489. Sonder 1880: 33.

? *Dictyomenia interstincta* J. Agardh 1885: 105; 1897: 61. De Toni 1903: 985. Lucas 1909: 42. Lucas & Perrin 1947: 281. May 1965: 395. Silva *et al.* 1996: 489.

PLATE 2 fig. 1; FIG. 152

Thallus (Fig. 152A) medium to dark brown-red, erect, 10–40 cm high, complanately and usually regularly pinnately branched for 3 or 4 orders, with flat main axes (1-) 2–5 mm broad bearing lateral branches 2–15 mm apart, the lesser branches (Fig. 152B) with alternate determinate laterals (bearing trichoblasts), 2–3 mm long and 2–3 mm apart, with branches more-or-less terete. Midrib of main branches present but not conspicuous, lateral veins also inconspicuous. Main branches corticated, heavily so near thallus base where blades are lost, giving a subterete stalk 1–3 mm thick. Holdfast branched or fibrous, 5–15 mm across; epilithic or on shells. *Structure*. Apical cell hemispherical to dome-shaped, 12–16 μm in diameter, with the axial cells branching alternately distichously 2–4 cells apart, cutting off 6 pericentral cells with 2 larger lateral ones and 2 smaller ones on each side, but of equal size in the terete branches of the ecorticate determinate laterals (which can become indeterminate). Lateral pericentral cells of the indeterminate branches divide laterally to form rows of 4–6 cells in the 2–5 mm broad branches (fewer in slender thalli) which become lightly corticated from close to the apices. Determinate branches 60–270 μm in diameter, with segments L/D (0.6-) 0.8–1.5, with trichoblasts from each segment near their apices, branched, 1–2 mm long, lower cells 20–30 μm in diameter and L/D 3–4 (basal cells isodiametric). Cells uninucleate; rhodoplasts discoid.

Reproduction. Propagules (Fig. 152C) often formed abundantly and terminally on determinate branches, flat, ovate, 1–1.5 mm long, 400–600 μm broad, with 3–4 short spinous laterals and with a dormant apex, borne on a slender terete stalk.

All reproductive organs occur on the marginal determinate laterals.

Gametophytes dioecious. Procarps borne on the second cell of trichoblasts, which rapidly cuts off 5 pericentral cells, with the supporting cell cutting off a 4-celled carpogonial branch and a group of sterile cells. Carposporophytes with a basal fusion cell and branched gonimoblast with elongate-ovoid to clavate terminal carposporangia 40–80 μm in diameter. Cystocarps (Fig. 152D) on branches of determinate laterals, short stalked, subspherical to ovoid, 500–1200 μm in diameter; pericarp ostiolate, 3 cells thick, corticated. Spermatangial organs (Fig. 152E) replacing trichoblasts, elongate and tapering apically with 1 (-2) sterile basal cells and a sterile apical cell, 40–80 μm in diameter and 180–360 μm long.

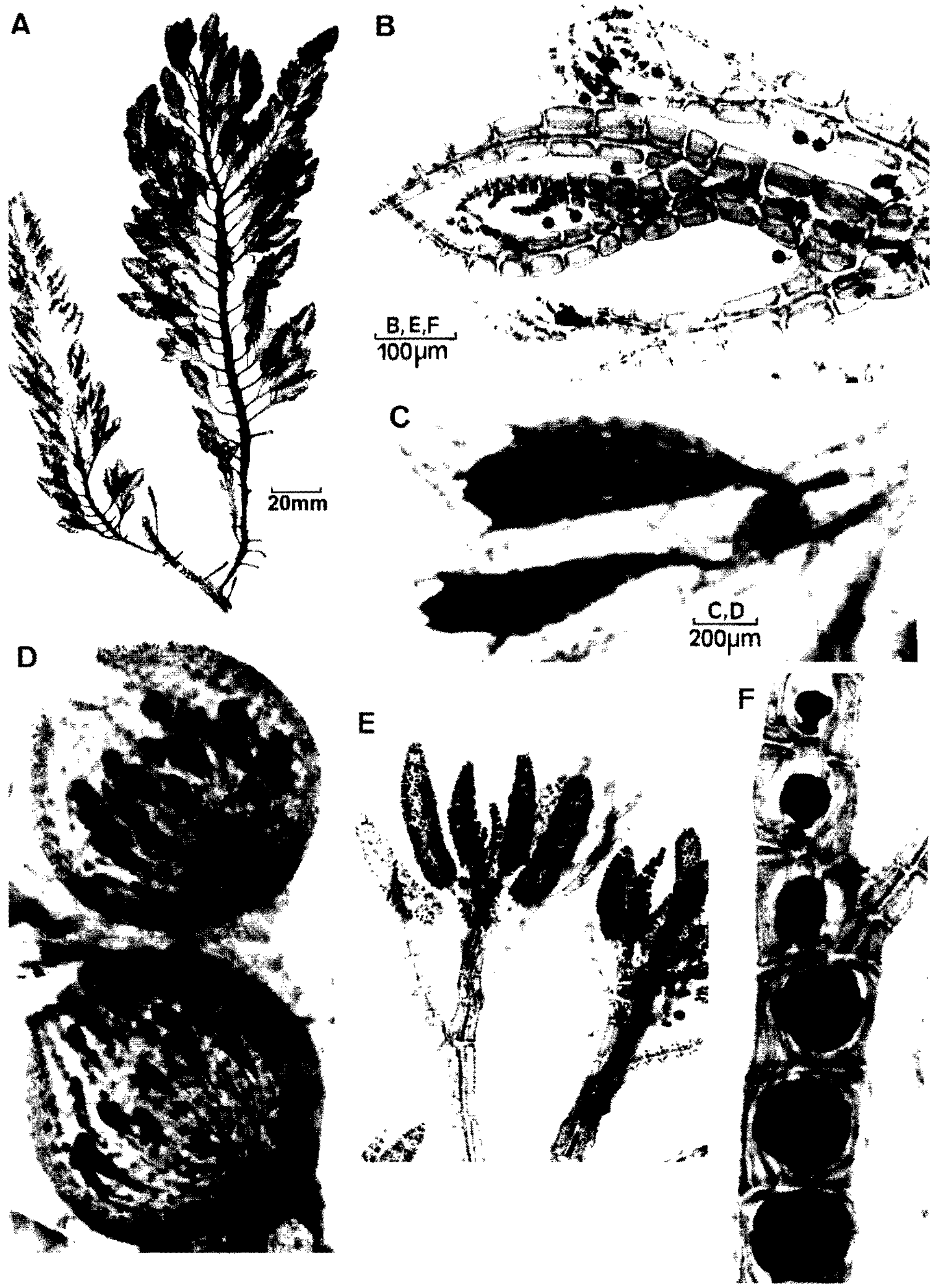

Fig. 152. *Dictyomenia harveyana* (**A**, AD, 9258; **B**, **E**, AD, A44302; **C**, AD, A20834; **D**, AD, A32947; **E**, AD, A57312). **A**. Habit. **B**. Apex of indeterminate axis with determinate laterals (dark spots are protozoans). **C**. Flat propagules. **D**. Cystocarps. **E**. Spermatangial organs. **F**. Branch with tetrasporangia.

Tetrasporangia (Fig. 152F) in terete branches of the determinate laterals, single per segment, in slightly spiral rows with 1–4 mature, 120–180 μm in diameter, with 2 cover cells.

Lectotype from Lefevre Pen., S. Aust. (*Mueller*, July 1952) in Herb. Sonder, MEL, 653127 (lower of 2 sheets); isolectotypes MEL, 653124–653130. Syntype from VDL, MEL, 653123.

Distribution. Port Denison, W. Aust., to Green Cape, N.S.W., and around Tasmania.

Selected specimens: Port Denison, W. Aust., drift (*Kraft*, 14.xii.1971; MELU, K4160). Yanchep, W. Aust., drift (*Womersley*, 22.ix.1979; AD, A51266). Nuyts Reef, S. Aust., 28–30 m deep (*Shepherd*, 26.iii.1980; AD, A52321). Elliston, S. Aust., 7 m deep in bay (*Shepherd*, 20.x.1970; AD, A37631). N Spencer Gulf, S. Aust., 10 m deep (*Shepherd*, 6.ix.1973; AD, A44486) and 16 m deep (*Shepherd*, 7.ix.1973; AD, A44302). Tiparra Reef, S. Aust., 11 m deep (*Shepherd*, 24.ix.1971; AD, A39714). Investigator Strait, S. Aust., 33 m deep (*Watson*, 24.i.1971; AD, A41075). Port Noarlunga, S. Aust., 24 m deep 5 km offshore (*Ottaway*, 3.ii.1981; AD, A52087). Gulf St Vincent, S. Aust., 15–19 m deep (*R. Lewis*, 3.xii.1986; AD, A57312). Victor Harbor, S. Aust., drift (*Womersley*, 17.x.1948; AD, A9258). Muston, Kangaroo I., S. Aust., 2–3 m (*Womersley*, 21.xi.1968; AD, A32947) and 4–5 m deep (*Shepherd*, 29.xii.1977; AD, A48964—"Marine Algae of southern Australia" No. 419). Seal Bay, Kangaroo I., S. Aust., drift (*Womersley*, 29.x.1966; AD, A31023). Stanley Beach, Kangaroo I., S. Aust., drift (*Womersley*, 27.i.1957; AD, A20834). Cape Jaffa, S. Aust., drift (*Womersley*, 22.xi.1998; AD, A67965). Double Corner Beach, Portland, Vic., drift (*Beauglehole*, 14.vii.1951; AD, A21596). San Remo, Vic., drift (*Sinkora* A671, 11.vii.1970; AD, A62702). Crawfish Rock, Westernport Bay, Vic., 4–5 m deep (*Watson*, 26.iv.1969; AD, A34305). Walkerville, Vic., drift (*Sinkora* A1841, 6.xii.1973; AD, A53533). Gabo I., Vic., 22 m deep (*Millar & O'Brien*, 4.xii.1996; NSW, 438953). Port Sorell, N Tas., drift (*Womersley*, 9.xi.1982; AD, A56241). Georgetown, Tas. (*Perrin & Lucas*, Jan. 1931; AD, A50192). Cloudy Lagoon, SE Tas., 1–3 m deep (*Edgar*, 12.ii.1995; AD, A64236). Arch Rock, Ninepin Point, Tas., 5–8 m deep (*Sanderson*, 21.x.1994; AD, A63930). W of Green Cape Lighthouse, Disaster Bay, N.S.W., 28 m deep (*Miller et al.*, 28.i.1996; NSW, 395777).

Dictyomenia harveyana is a variable species in width of the axes and main branches, depending on degree of water movement and depth; broader, more robust plants occur on rough-water coasts and slender ones in calmer waters (A44486 has broad axes and A44167 narrow axes, both from N Spencer Gulf, S. Aust.). It is mostly a deep-water species, though in shallow water on Tasmanian coasts.

This species is characterised by the reproductive organs occurring on the marginal determinate laterals (not on surface clusters as in *D. tridens* and *D. sonderi*) and the branches are derived from a single apex, not from congenitally fused ones as in *D. sonderi.*

D. spinulosa Kützing (1864, p. 34, pl. 97c–e), type from Tasmania ("VDL") in Herb. Kützing, L, 940, 347...122, appears to be a profusely cystocarpic specimen of *D. harveyana.*

D. interstincta appears to be based on a specimen with normal vegetative lower parts and slender, much divided, fertile upper branches. The type is a Harvey, Alg. Aust. Exsicc. 12a specimen from Fremantle, W. Aust., placed by Harvey as *D. tridens.* This variation is shown in other plants of *D. harveyana* (e.g. AD, A48964) which have reproductive organs developed in the marginal determinate branchlets.

Genus POLLEXFENIA Harvey 1844b: 431

Thallus erect, membranous, complanately branched, usually with lobed, flat, terminally rounded lateral branches, with fine, branching veins within the laterals. Holdfast discoid or clasping on the host (usually *Amphibolis*) or epilithic. *Structure.* Branch apices with numerous apical cells producing congenitally fused systems, the axial cells cutting off 4 pericentral cells, 2 on each surface, and branching usually every two cells, with unicellular (becoming multicellular) primordia cut off alternately on each side between the axial branches. Pericentral cells dividing transversely on both dorsal and ventral sides so that on maturity 2–8 cells correspond to each axial cell in length. Thallus mostly 2 cells thick, with or without a defined midrib. Trichoblasts in tufts on the thallus surface above the axial cells, arising mainly from the primordia, or on the margins.

Reproduction. Reproductive structures associated with the surface or marginal trichoblast tufts.

Gametophytes dioecious. Procarps with a 4-celled carpogonial branch; carposporophytes with a basal fusion cell, branched gonimoblast and clavate terminal carposporangia; cystocarps ovoid, pericarp ecorticate. Spermatangial organs on branches of trichoblasts.

Stichidia in tufts on thallus surface or margin, with tetrasporangia in a close spiral, single per segment, with 2–3 cover cells.

Type species: *P. pedicellata* Harvey 1844b: 431.

A genus of 3 or 4 species, confined to southern Australia, characterised especially by habit, 4 pericentral cells, and transverse division of the pericentral cells. Apical development is similar on both sides, i.e. not dorsiventral or heteromorphic.

There has been considerable confusion concerning the names *Pollexfenia* Harvey (1844b, p. 431) and *Papenfussia*, which Kylin (1938, p. 15) used for the South Africa plant (Delesseriaceae) on the basis that *Pollexfenia* was a southern Australian genus of the Rhodomelaceae.

Harvey (1844b, p. 431), in describing *Pollexfenia* in his "Algae of Tasmania", described *P. pedicellata* first, following which he characterised the South African *P. laciniata*. He also (and in 1846, p. 382) stated that the genus was "founded on a plant from the Cape of Good Hope". In view of this comment, Papenfuss (1942, p. 446) considered *P. laciniata* should be the type species, quoting Harvey's comment, but omitting Harvey's (1847, p. 22) later comment referring to *P. pedicellata*, *viz*. "The first, to which the name *Pollexfenia* will be preserved, is distinguished by its delicate substance being traversed internally by a system of pellucid, branching striae, and by having stichidia". Kylin (1956, p. 444) considered *Pollexfenia* should be retained for the Australian genus and *Papenfussia* for the South African plant (with the older name *laciniata* replacing his *elegans*). Neither Papenfuss nor Kylin commented on Harvey's protologue for *Pollexfenia*, which agrees very largely with *pedicellata* and not with *laciniata*. Since the ICBN (Art. 9.13(b), 10.5) states clearly that the type must not be in conflict with the protologue, it is clear that *P. pedicellata* from southern Australia must be the type species of *Pollexfenia*, and the South African taxon is correctly known as *Papenfussia laciniata*. *Papenfussia* includes 2 South African species (Stegenga *et al*. 1997, p. 493) and probably also "*Pollexfenia*" *japonica* Yoshida & Mikami (1990, p. 200, figs 1–26; Yoshida 1998: 992) from Japan.

Pollexfenia Harvey (1844b, p. 431) now includes and replaces *Jeannerettia* Hooker & Harvey in Harvey (1847, p. 20).

KEY TO SPECIES OF *POLLEXFENIA*

1. Thallus 2–5 cm high, 2–4 mm broad, epiphytic on *Amphibolis*; reproductive structures on the thallus margins .... 3. *P. crispata*
1. Thallus usually 10–25 cm high, branches mostly 8–15 mm broad, on seagrasses or epilithic; reproductive structures on the thallus surface 2
    2. Thallus with numerous laterals or lobes, without a midrib; mature pericentral cell derivatives 70–180 µm long, L/D mostly 1.5–2; stichidia ecorticate .... 1. *P. pedicellata*
    2. Thallus with long main branches with few lobes; midrib present, wings denuded below; mature pericentral cell derivatives 30–60 (-90) µm long, L/D mostly 1–1.5; stichidia corticated .... 2. *P. lobata*

1. **Pollexfenia pedicellata** Harvey 1844b: 431; 1846: 382; 1847: 22, pl. 5; 1855a: 537; 1859b: 295; 1863, synop.: xvii. J. Agardh 1863: 834. De Toni 1896: 228; 1903: 979. De Toni & Forti 1923: 43. Falkenberg 1901: 291, pl. 4 figs 14–19. Garnet 1971: 95. Hooker & Harvey 1847: 398. Kützing 1849: 874; 1866: 4, pl. 9a–c. Kylin 1956: 529. Lucas 1909: 42; 1929a: 22; 1929b: 51. Lucas & Perrin 1947: 278, fig. 124. Mazza 1909: No. 302. Oltmanns 1922: 329, figs 538 (4, 6), 597 (5). Reinbold 1898: 48; 1899: 48. Schmitz & Falkenberg 1897: 455. Sonder 1853: 697; 1855: 523; 1880: 32. Tate 1882a: 22. Tisdall 1898: 513. Wilson 1892: 168.

Jeannerettia pedicellata (Harvey)Papenfuss 1942: 448. Ducker *et al*. 1977: 87. Fuhrer *et al*. 1981: pl. 35. Guiler 1952: 105. Huisman 1997: 205. Huisman & Walker

1990: 435. May 1965: 399. Shepherd 1983: 83. Shepherd & Womersley 1981: 368. Silva *et al.* 1996: 502. Womersley 1950: 188; 1966: 154.

Pollexfenia nana J. Agardh 1892: 164. De Toni 1903: 981. Lucas 1909: 42. Lucas & Perrin 1947: 280. Tisdall 1898: 513. Wilson 1892: 168.

Jeannerettia nana (J. Agardh)Papenfuss 1942: 448. May 1965: 399.

?*Pollexfenia crenata* J. Agardh 1892: 165. De Toni 1903: 980. Lucas 1909: 42. Lucas & Perrin 1947: 279. Tisdall 1898: 513. Wilson 1892: 168.

?*Jeannerettia crenata* (J. Agardh)Papenfuss 1942: 448. May 1965: 399.

FIG. 153

Thallus (Fig. 153A) erect, red-brown, 5–20 cm high, membranous, complanately branched, main branches with lobed to elongate lateral branches, 5–12 mm broad in plants on rough-water coasts and 2–4 mm broad in some plants (Fig. 153B) on sheltered coasts; branch apices rounded. Holdfast an expanding, clasping, pad; usually epiphytic on *Amphibolis*, occasionally on *Posidonia*, possibly epilithic. *Structure.* Branch apices (Fig. 153C) with numerous apical cells producing congenitally fused systems, the axial cells cutting off 4 pericentral cells, 2 on each surface; axial cells branched usually 2 cells apart, with unicellular primordia (becoming multicellular) cut off from the alternate cells on alternate sides of the thallus; apical cells squat, 8–16 µm in diameter, the axial cells branching every few cells. Mature pericentral cell dividing transversely (Fig. 153D) with 4–8 derivatives corresponding to each axial cell in length, 30–80 (-100) µm in diameter and 70–180 µm long, L/D mostly 1.5–2. Thallus 2 cells thick and without a defined midrib. Trichoblasts in branched tufts, above and arising from the axial primordia, on alternate sides of the thallus. Cells probably uninucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Reproductive structures are associated with the trichoblast tufts on the axial primordia.

Gametophytes dioecious. Procarps on a branch of the trichoblasts, with a 4-celled carpogonial branch. Carposporophytes with a basal fusion cell and much branched gonimoblast with clavate terminal carposporangia 25–40 µm in diameter. Cystocarps (Fig. 153E) ovoid, short-stalked, 700–1000 µm in diameter; pericarp 2 cells thick, ecorticate, outer cells isodiametric (20-) 45–60 µm across. Spermatangial organs (Fig. 153F) as a branch of trichoblasts, elongate-ovoid, 80–150 µm in diameter and 120–270 µm long, with usually single basal and apical sterile cells, spermatangia ovoid, 8–10 µm in diameter.

Stichidia (Fig. 153G) in tufts associated with trichoblasts, 180–300 µm in diameter and 400–700 µm long, ecorticate, with tetrasporangia in a close spiral, one per segment, 50–90 µm in diameter, with 2–3 cover cells.

Type from Georgetown, Tas.; lectotype (*Gunn* 1272) in Herb. Harvey, TCD.

Distribution. Houtman Abrolhos, W. Aust., to Walkerville, Vic., and around Tasmania; doubtfully Queensland (Lewis 1984, p. 55).

Selected specimens: Yanchep, W. Aust., drift (*Womersley*, 22.ix.1979; AD, A51261). Safety Bay, W. Aust., drift (*Womersley*, 18.viii.1979; AD, A50772). Eucla, W. Aust., on *Amphibolis*, drift (*Womersley*, 5.x.1979; AD, A50702). N Spencer Gulf, S. Aust., 10 m deep (*Shepherd*, 6.ix.1973; AD, A44485). Dany Beach, Corny Point, S. Aust., on *Amphibolis antarctica*, drift (*Womersley*, 15.x.1989; AD, A59901). West Cape, Yorke Pen., S. Aust., 5 m deep (*Baker*, 26.x.1993; AD, A66348). Off Adelaide, Gulf St Vincent, S. Aust., 15–19 m deep (*R. Lewis*, 3.xii.1986; AD, A57311). West Beach, Gulf St Vincent, S. Aust., on *Posidonia*, 5 m deep (*Shepherd*, 13.xi.1970; AD, A37698). Wright I., Victor Harbor, S. Aust., on *Amphibolis*, 3 m deep (*Hone*, 25.x.1989; AD, A66962). Point Tinline, Kangaroo I., S. Aust., drift (*O'Leary*, 5.xi.1990; AD, A60778). Rocky Point, Kangaroo I., S. Aust., on *Posidonia*, drift (*Womersley*, 4.vi.1947; AD, A5694 and 23.viii.1963; AD, A26771). Muston, Kangaroo I., S. Aust., channel edge (*Womersley*, 29.ix.1964; AD, A28225). Antechamber Bay, Kangaroo I., S. Aust., on *Amphibolis*, drift (*Womersley*, 18.viii.1948; AD, A8684). Robe, S. Aust., on *Amphibolis*, drift near jetty (*Hotchkiss*, 2.xi.1997; AD, A67760). Double Corner Beach, Portland, Vic., on *Amphibolis*, drift (*Beauglehole*, 14.vii.1951; AD, A21592). Point Lonsdale, Vic., drift (*Sinkora* A1128, 8–12.xi.1970; AD, A62726). St Leonards, Port Phillip, Vic., 1–3 m deep (*Womersley*, 9.viii.1959; AD, A23099). Walkerville, Vic., drift (*Sinkora* A2650; 23.xi.1979; AD, A61048). Low Head, Tas. (*Perrin*, Nov.1949; AD, A49611). Bombay Rock, Tamar Est., Tas., upper sublittoral (*Womersley*, 27.i.1949: AD, A10367). Bridport, Tas., on *Amphibolis*, drift (*Womersley*, 23.x.1986; AD, A57791). Great Taylor Bay, Bruny I., Tas., 10 m deep (*Shepherd*, 7.ii.1970; AD, A35291).

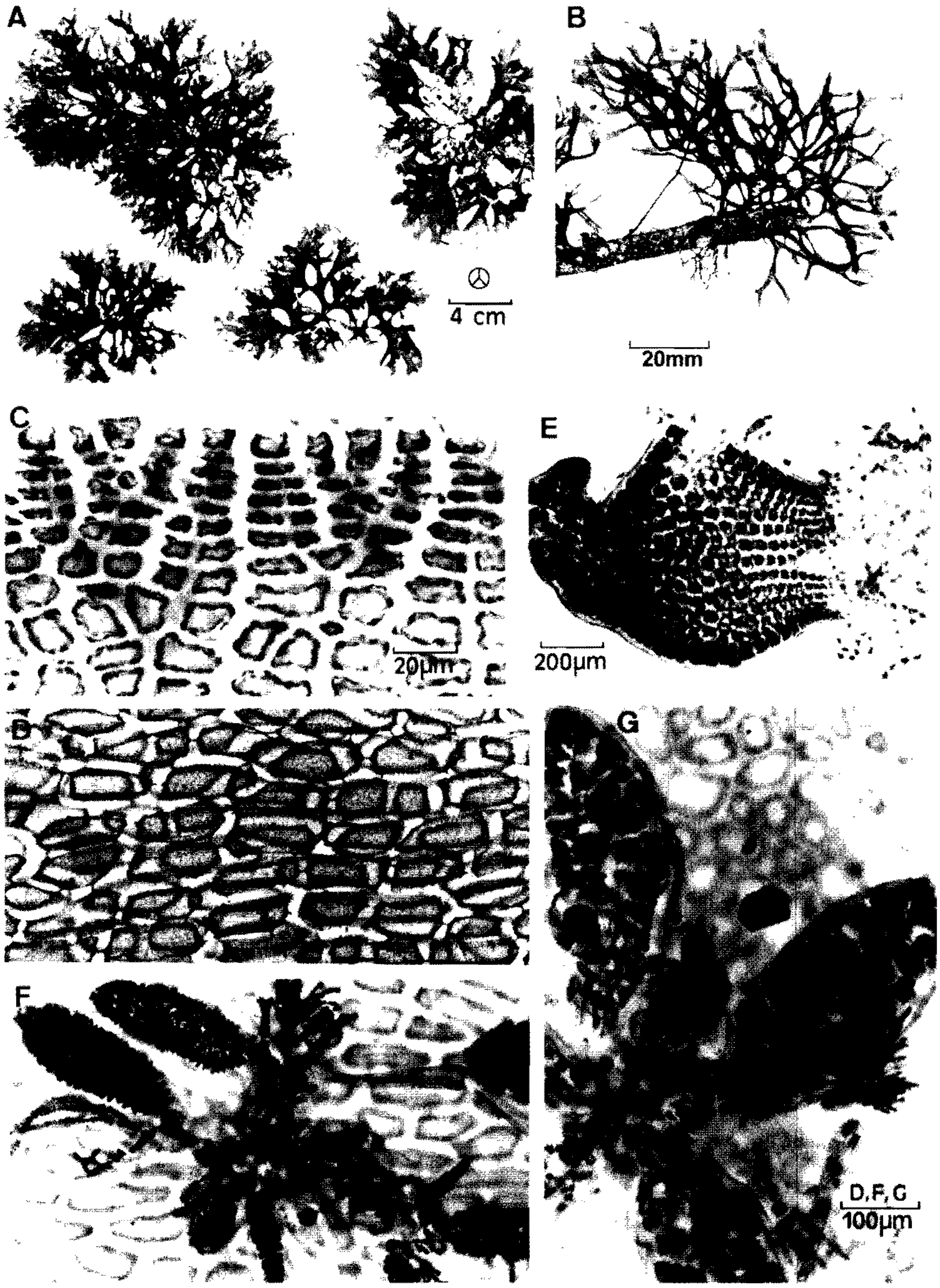

Fig. 153. *Pollexfenia pedicellata* (**A**, **C**, **E**, AD, A67760; **B**, AD, A5694; **D**, **F**, **G**, AD, A26771). **A**. Habit, rough-water plant. **B**. Habit, on *Posidonia* in sheltered habitat. **C**. Growing margin of thallus. **D**. Surface view of thallus showing transverse division of some pericentral cells. **E**. Cystocarp. **F**. Spermatangial organs on trichoblasts. **G**. Stichidia.

Pollexfenia pedicellata is a common and distinctive alga, varying considerably in branch width, broad on rough-water and moderate coasts to slender in calm conditions.

Pollexfenia nana J. Agardh (holotype in Herb. Agardh, LD, 38118) from Port Phillip Heads, is a small fragment of the narrow form, similar to var. *angustata* Harvey *ex* Sonder (1853, p. 697; 1855, p. 523), which is not here recognised as a distinct entity.

Pollexfenia crenata J. Agardh is placed under *P. pedicellata* with some doubt. It is only known from collections from Port Phillip Heads, Vic. (lectotype *Wilson* 18/89, 9.i.1889; LD, 38122). These are small plants characterised by a dentate margin, but are regarded as unusual forms of *P. pedicellata*.

Placophora ?cucullata J. Agardh (1892, p. 175) is not a synonym of *Pollexfenia pedicellata* as Falkenberg (1901, p. 295) suggested but is a poor, minute, specimen of *Hypoglossum* (see under *H. revolutum*).

P. pedicellata was recorded by Martens (1868, p. 32) from Zamboanga, Philippines, but this almost certainly applies to a different alga.

2. **Pollexfenia lobata** (Hooker & Harvey) Falkenberg 1901: 295. De Toni 1903: 979. Lucas 1909: 42; 1915: 57; 1929a: 22; 1929b: 51. Lucas & Perrin 1947: 278, fig. 125.

Jeannerettia lobata Hooker & Harvey *in* Harvey 1847: 20, pl. 4. J. Agardh 1863: 837; 1879: 198, pl. 33 figs 20–23. Fuhrer *et al.* 1981, pl. 36. Guiler 1952: 105. Harvey 1858: pl. 33; 1859b: 295; 1863, synop.: xvii. Hooker & Harvey 1847: 398. Huisman 1997: 205. Kützing 1866: 2, pl. 4e, f. May 1965: 399. Papenfuss 1942: 448. Reinbold 1898: 48. Shepherd & Womersley 1981: 368. Silva *et al.* 1996: 502. Sonder 1853: 697; 1880: 32. Tate 1882a: 22. Tisdall 1898: 513. Wilson 1892: 168. Womersley 1950: 188; 1966: 154.

Botryoglossum lobatum (Hooker & Harvey)Kützing 1849: 881.

Jeannerettia frondosa Harvey 1855a: 537.

Jeannerettia latifolia Kützing 1866: 2, pl. 6.

FIG. 154

Thallus (Fig. 154A) erect, red-brown, 10–30 cm high, membranous, complanately branched, main branches (0.5-) 1–1.5 (-2) cm broad, with irregularly positioned laterals of similar or lesser width, branch apices rounded, margins smooth to irregular, with a central, prominent, midrib commencing from near apices to well down the thallus; fronds denuded below leaving the thickened midrib as a stalk 1–2 mm thick, often with small proliferous blades. Holdfast discoid, 2–5 mm across; epilithic. *Structure*. Branch apices with numerous apical cells producing congenitally fused systems (Fig. 154B), with the axial cells cutting off 4 pericentral cells (Fig. 154D), 2 on each side; apical cells hemispherical to conical, 7–12 µm in diameter, axial cells branching usually 2 cells apart, with unicellular primordia (some becoming multicellular and branched) cut off from the alternate cells on alternate sides of the thallus. Mature fronds have the apical margins apparently non-functional and coloured brown for 6–10 cells deep, this margin often split (Fig. 154C). The pericentral cells divide laterally giving 3–5 between adjacent veins (Fig. 154B), and also show transverse divisions with 6–10 corresponding to each mature axial cell; mature surface (derivative) cells are mostly 35–45 µm in diameter and 30–60 (-90) µm long, L/D mostly 1–1.5, and become irregularly arranged in surface view. Fronds 2 cells thick, with the midrib (Fig. 154D) formed by proliferation of cortical cells from the pericentral cell derivatives. Trichoblasts much branched, situated on the thallus surface above the axial cells, with the basal part becoming polysiphonous. Cells probably uninucleate; rhodoplasts discoid to elongate.

Reproduction is associated with the trichoblast tufts.

Gametophytes dioecious. Procarps on lower trichoblast cells, with 4-celled carpogonial branches. Carposporophytes branched, with clavate terminal carposporangia 20–40 µm in diameter. Cystocarps (Fig. 154E) ovoid, short-stalked, 800–1200 µm in diameter; pericarp ostiolate, 2 cells thick, ecorticate, outer cells isodiametric, 50–90 µm across. Spermatangial organs (Fig. 154F) on branches of trichoblasts, their stalks becoming polysiphorous, 90–160 µm in diameter and 200–400 µm long, ends rounded or tapering, with single sterile apical and basal cells, spermatangia ovoid, 5–7 µm in diameter.

Stichidia (Fig. 154G) on the basal, polysiphonous, part of trichoblasts, 120–200 µm in diameter and 500–750 µm long, corticated, with tetrasporangia in a close spiral, one per segment, 70–110 µm in diameter, with 2 cover cells.

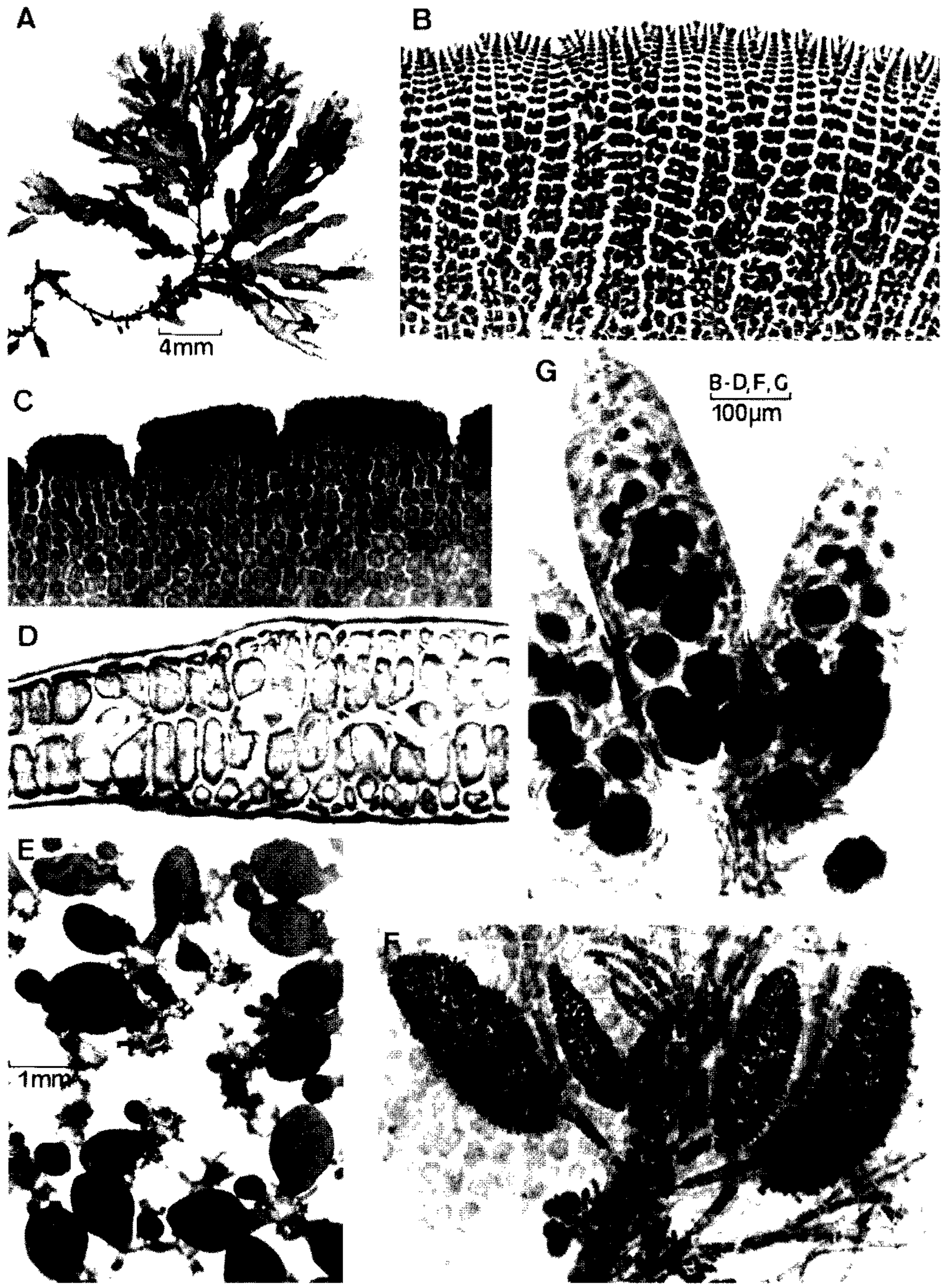

Fig. 154. *Pollexfenia lobata* (**A**, **B**, **D**, AD, A64075; **C**, **E**–**G**, AD, A68341). **A**. Habit. **B**. Growing margin of thallus. **C**. Thickened and split margin of older thallus. **D**. Transverse section of central thallus. **E**. Cystocarps on thallus surface. **F**. Spermatangial organs. **G**. Stichidia.

Type from Port Arthur, Tas. (*Jeannerett*); holotype in BM.

Distribution. Houtman Abrolhos, W. Aust., to Walkerville, Vic., and around Tasmania; doubtfully Queensland (Lewis 1984, p. 55).

Selected specimens: 7 mile beach, N of Dongara, W. Aust., drift (*Womersley*, 17.ix.1979; AD, A51357). Cottesloe, W. Aust., drift (*Royce* 1037, 12.vi.1951; AD, A16222). Waldegrave I., S. Aust., 30 m deep (*Branden*, 3.vii.1987; AD, A57589). Point Avoid, Eyre Pen., S. Aust., drift (*Womersley*, 2.xii.1975; AD, A46895). Off Troubridge Light, S. Aust., 18 m deep (*Shepherd*, 4.ii.1969; AD, A33559). Port Elliot, S. Aust., drift (*Womersley*, 23.v.1953; AD, A18718). Vivonne Bay, Kangaroo I., S. Aust., 3–4 m deep on jetty piles (*Latz*, 22.xi.1968; AD, A33025). Pennington Bay, Kangaroo I., S. Aust., drift (*Womersley*, 22.viii.1954; AD, A19758). Robe, S. Aust., in shaded pool (*Womersley*, 27.viii.1949; AD, A11077). 600 m off Middle Point, Cape Northumberland, S. Aust., 5 m deep (*Shepherd & Johnson*, 19.iii.1974; AD, A44944). Port MacDonnell, S. Aust., drift (*Womersley*, 19.viii.1953; AD, A18974). Gardens Beach, Portland, Vic., drift (*Beauglehole*, 18.viii.1951; AD, A21593). Point Lonsdale, Vic., drift (*Sinkora* A1127, 8–12.xi.1970; AD, A62727). Walkerville, Vic., drift (*Sinkora* A2097, 27.ii.1975; AD, A48301). Bombay Rock, Tamar Est., Tas., upper sublittoral (*Womersley*, 27.i.1949; AD, A10411). Stapleton Point, Prosser Bay, Tas., 4–10 m deep (*Shepherd*, 10.ii.1970; AD, A35720). Taroona, Tas., 5 m deep (*Brown*, 24.x.1982; AD, A55778). Taroona, Tas., 2–5 m deep, unattached (*Westphalen*, 31.i.1997; AD, A66903). Safety Cove, Port Arthur, Tas., shaded lower eulittoral pool (*Womersley*, 21.x.1994; AD, A64075—"Marine Algae of southern Australia" No. 420). Charlotte Cove, SE Tas., 3–6 m deep (*Edgar*, 6.x.1999; AD, A68341).

Some deep-water and broad specimens from Investigator Strait appear similar to *P. lobata* in that they have midribs in lower fronds and in habit, but the pericentral cells are longer than usual and they are inadequately fertile. These specimens include AD, A38467 and A39331, from 27 m and 19 m deep, collected by Jan Watson on 10 and 11.i.1971.

3. **Pollexfenia crispata** (Zanardini)Falkenberg *in* Schmitz & Falkenberg 1897: 455, fig. 256. Falkenberg 1901: 296. De Toni 1903: 980. Kylin 1956: fig. 421. Lucas 1909: 42. Lucas & Perrin 1947: 279, fig. 126. Tisdall 1898: 513.
Melanoseris crispata Zanardini 1874: 489. Sonder 1880: 32. Tisdall 1898: 513. Wilson 1892: 168.
Jeannerettia crispata (Zanardini)Papenfuss 1942: 448. May 1965: 399.

FIG. 155

Thallus (Fig. 155A) erect, medium to dark brown red, 2–5 cm high, with flat branches 2–4 mm broad, margins linear but crispate with elongate polysiphonous papillae (Fig. 155C), situated mostly at the end of veins; apices rounded or tapering slightly. Holdfast a clasping disc; epiphytic on stems of *Amphibolis*. *Structure*. Apices with numerous apical cells producing congenitally fused systems (Fig. 155B), apical cells ovoid to conical, 12–18 µm in diameter, axial cells branching 2 to several cells apart, cutting off 4 pericentral cells, 2 on each surface, and occasional primordia which usually remain unicellular. Pericentral cells dividing transversely, with 2 (-3) corresponding to each axial cell and becoming irregular in position, mature derivative cells angular, irregularly isodiametric and mostly 35–65 µm across, L/D 1–1.5. Thallus mostly 2 cells thick, without a midrib. Trichoblasts near thallus apices or on polysiphonous papillae (Fig. 155C). Cells probably uninucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Reproductive organs marginal, associated with the papillae.

Gametophytes dioecious. Procarps not observed. Carposporophytes with a basal fusion cell and much branched gonimoblast with clavate terminal carposporangia 30–45 µm in diameter. Cystocarps (Fig. 155D) ovoid, 1–1.3 mm in diameter; pericarp ostiolate, 2 cells thick, outer cells compact, irregularly arranged, isodiametric and 45–75 µm across. Spermatangial organs (Fig. 155E) on ends of marginal papillae, on short trichoblasts, ovoid, 80–110 µm in diameter and 130–180 µm long, with 1–2 sterile basal cells and a single sterile apical cell.

Stichidia (Fig. 155F) robust, developed from marginal papillae, (0.3-) 0.5–1.5 mm long and 250–350 µm in diameter, corticated, tetrasporangia spirally arranged, one per segment, 70–110 µm in diameter.

Type from Port Phillip, Vic., on *Amphibolis antarctica* (*Mueller*); holotype in Herb. Zanardini, Venice.

Distribution. Tiparra Reef, S. Aust., to Port Phillip, Victoria.

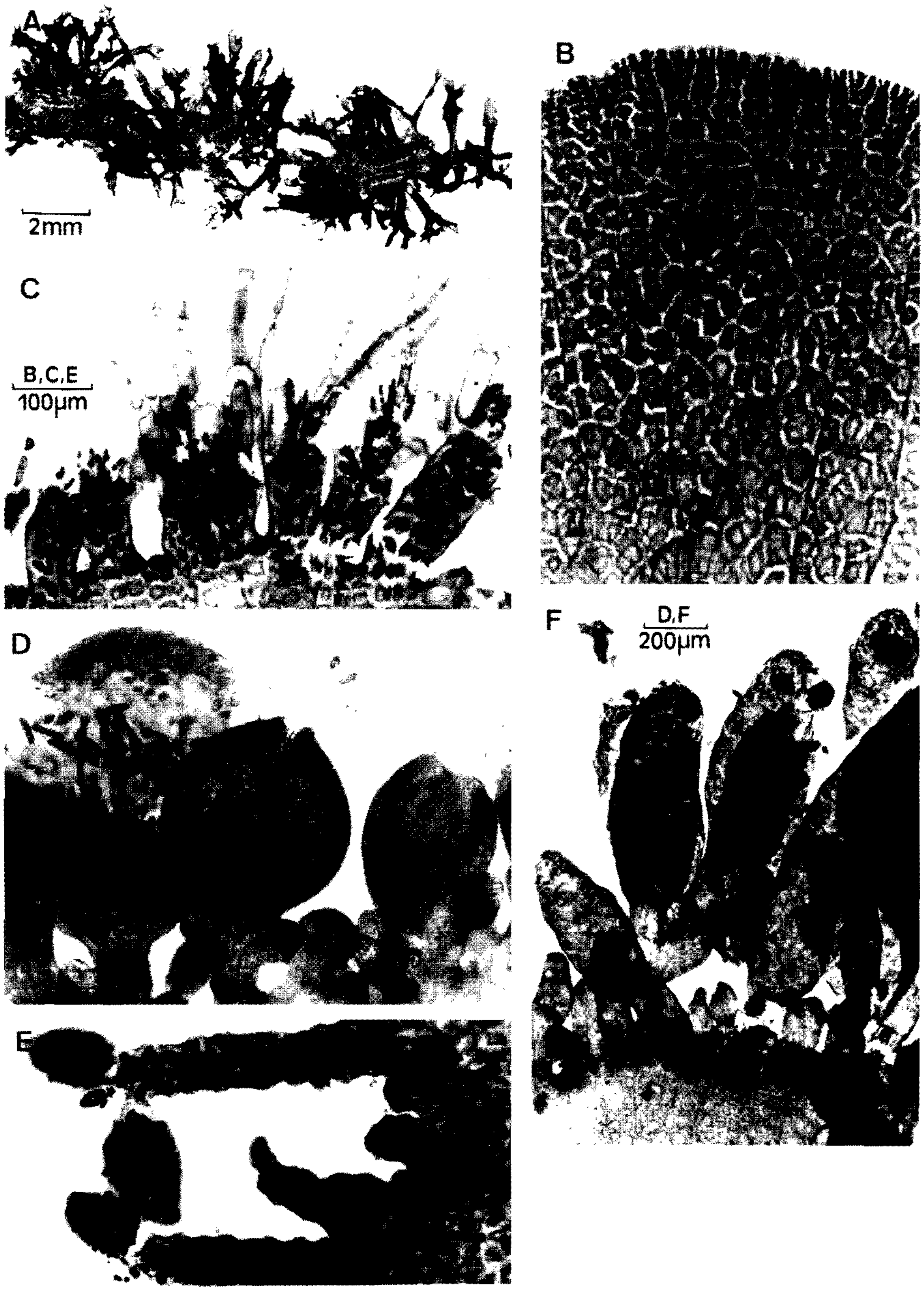

Fig. 155. *Pollexfenia crispata* (AD, A36013). **A**. Habit, on *Amphibolis* stem. **B**. Growing margin of thallus. **C**. Thallus margin with papillae and trichoblasts. **D**. Cystocarps. **E**. Spermatangial organs on marginal papillae. **F**. Stichidia on margin of thallus.

Selected specimens (all epiphytic on *Amphibolis* stems): Tiparra Reef, S. Aust., 12 m deep (*Shepherd*, 27.vii.1970; AD, A36013). Semaphore, S. Aust., drift (*Harris*, vii.1943; AD, A1971). Marino, S. Aust., drift (*Womersley*, 30.vi.1963; AD, A26464). Encounter Bay, S. Aust., drift (*Cleland*; AD, A3720). Kingston, S. Aust., 6–7 m deep (*R. Lewis*, 28.xi.1972; AD, A42868). Dutton Bay, Portland, Vic., drift (*Womersley*, 13.iv.1959; AD, A22701).

Pollexfenia crispata agrees well with the genus but differs from the other species in habit and in having marginal papillae with which the reproductive organs are associated.

Pollexfenia ciliaris J. Agardh in Tate 1882b: 93 and Tepper 1883: 66, from Hallett Cove, S. Aust., is a *nomen nudum*, probably *P. crispata*.

PLACOPHORA GROUP

Thallus prostrate, flat and foliose, simple or branched irregularly, usually less than a few cm long, apices rounded. Attachment by ventral rhizoids. *Structure*. Apices of branches formed by numerous polysiphonous filaments congenitally laterally attached, each with an apical cell and 5 pericentral cells, 3 on the dorsal side and 2 ventrally, the apex of each filament hence dorsiventrally organised. Thallus ecorticate, mostly 2 cells thick; rhizoids cut off from ventral pericentral cells, unicellular or multicellular.

Reproduction. Reproductive organs on short, free, polysiphonous branches on thallus margin, or (*Amplisiphonia* tetrasporangia) in flat lobes of the thallus.

Gametophytes dioecious. Procarps on the basal or next cell of short trichoblasts, with a 4-celled carpogonial branch and 2 sterile cells; carposporophytes with clavate terminal carposporangia; cystocarps ovoid, pericarp ostiolate, ecorticate. Spermatangial organs on trichoblasts, elongate, with sterile basal and apical cells.

Tetrasprangia in marginal stichidia or in thallus lobes, with 5–7 pericentral ells (not dorsiventrally arranged), single per segment and lying in longitudinal series, each with 2 cover cells.

The *Placophora* group includes *Placophora* J. Agardh (1863, p. 1137) and *Amplisiphonia* Hollenberg (1939, p. 380); Hollenberg & Wynne (1970), distinguished by primary dorsiventrality of the pericentral cell arrangement.

Placophora was first related to the *Amansia* group by J. Agardh (1863, p. 1138), placed in the Pollexfenieae by Schmitz (1893, p. 448), in the Polyzonieae by Schmitz & Falkenberg (1897, p. 428) and in the Herposiphonieae by Falkenberg (1901, p. 727) and by Scagel (1953, pp. 23, 95). Kylin (1956, p. 497, 528) recognised the "Placophora group" for *Placophora*, *Amplisiphonia*, *Periphykon* Weber-von Bosse (1929, p. 255) and *Pollexfenia* Harvey (1844b, p. 431), of which only *Placophora* and *Amplisiphonia* have dorsiventally arranged pericentral cells and are here retained in the *Placophora* group. Hommersand (1963, p. 348) placed *Placophora* in an expanded Polysiphonieae, but commented, (p. 341) that it is "quite different from the dorsiventral Polysiphonieae ..."

Placophora is here retained as the only southern Australian genus of the *Placophora* group, which is characterised by the primary dorsiventrality of the pericentral cells. *Pollexfenia*, which does not show this feature, is placed in the Pterosiphonieae.

Genus **PLACOPHORA** J. Agardh 1863: 1137

Thallus prostrate, flat, foliose, simple or branched, a few mm broad, and mostly 2 cells thick, epiphytic on *Codium* and other algae. *Structure*. Marginal apical cells terminating branched axial filaments, the axial cells cutting off 3 dorsal and 2 ventral pericentral cells (hence primarily dorsiventral), with the filaments laterally fused to give the flat thallus; trichoblasts absent from prostrate axes. Branching of the main axial filaments in alternate pairs of cells, of the lateral axes one to several cells apart. Rhizoids cut off from ventral pericentral cells.

Reproduction. Reproductive organs formed on short, free, polysiphonous branches on thallus margin; gametophytes dioecious. Procarps on the basal cell of short trichoblasts, with a 4-celled carpogonial branch and 2 sterile cells; carposporophyte with clavate terminal carposporangia; cystocarps ovoid, pericarp ostiolate, 2 cells thick, ecorticate. Spermatangial organs on branches of trichoblasts, elongate, with 3–4 sterile apical cells.

Stichidia with 5–7 pericentral cells, with tetrasporangia single per segment, lying in a longitudinal series, each with 2 cover cells.

Type species: *P. binderi* (J. Agardh)J. Agardh 1863: 1138.

A genus of 2 species originally described from South Africa, the type now known to be relatively widespread in the southern hemisphere, and *P. eckloniae* Pocock only known from South Africa. Adams (1994, p. 333, pl. 115 lower right) describes an un-named species from New Zealand, needing verification as a *Placophora*.

The most detailed description of *Placophora binderi* and *P. eckloniae* is by Scaegel (1953).

Placophora binderi (J. Agardh)J. Agardh 1863: 1138; 1885: 111. Adams 1994: 333? De Toni 1903: 1044. Falkenberg 1901: 338, pl. 4 figs 1–13. Huisman 1997: 207. Huisman & Walker 1990: 438. Kylin 1956: 528. Scagel 1953: 25, figs 1–4. Schmitz & Falkenberg 1897: 462. Shepherd & Womersley 1981: 368. Silva *et al.* 1996: 535. Stegenga *et al.* 1997: 542, pl. 228. Yoshida 1998: 1060.

Amansia binderi J. Agardh 1841: 26.

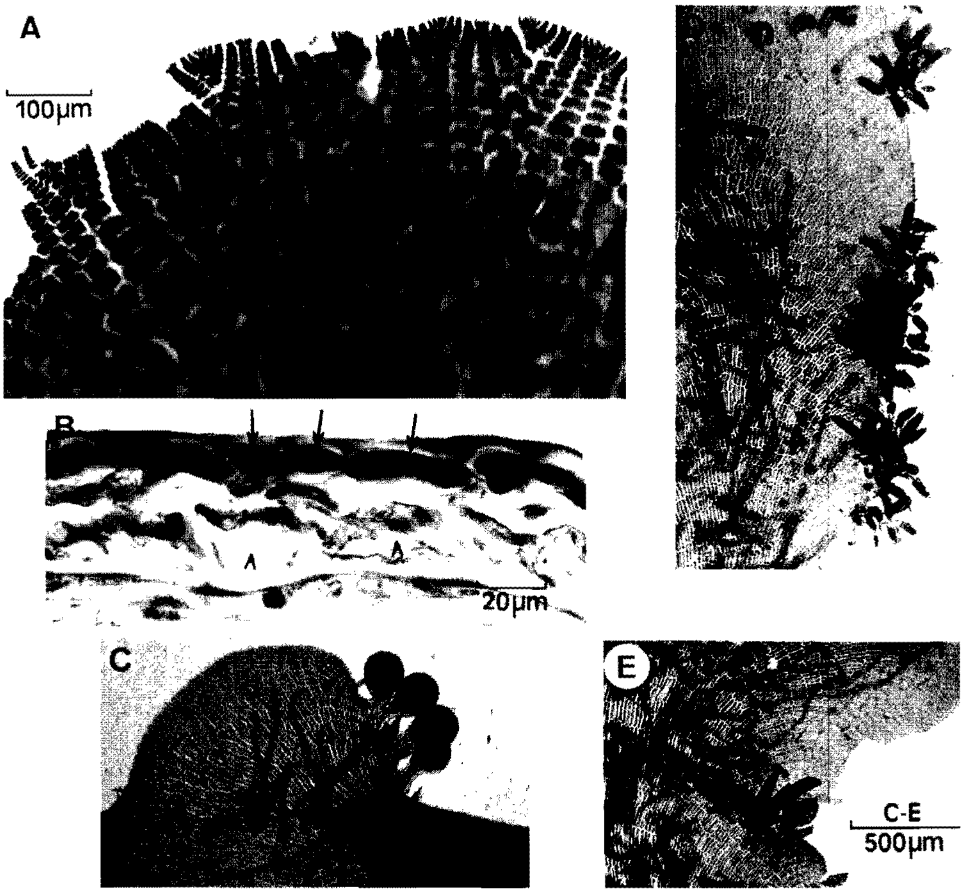

Fig. 156. *Placophora binderi* (**A**, **B**, AD, A15017; **C–E**, AD, A47998, from Umkomaas, South Africa, on *Codium*, low intertidal (*Ducker & Norris*, Jan. 1977). **A**. Growing margin, ventral side with rhizoids. **B**. Transverse section of thallus, with 3 dorsal pericentral cells (arrows) and 2 ventral (arrow heads) pericentral cells. **C**. Cystocarps on blade margin. **D**. Clusters of spermatangial organs on blade margin. **E**. Cluster of stichidia.

FIG. 156

Thallus prostrate, flat, dark brown-red, 1–2 cm long and 3–6 mm broad, apex rounded, simple or branched, epiphytic on *Codium*, attached by rhizoids from the ventral pericentral cells. *Structure*. Margin of numerous apical cells terminating polysiphonous filaments laterally united in the broad thallus apex (Fig. 156A), without trichoblasts (apart from sexual plants). Apical cells squat, flat-topped, 10–16 µm broad and 10–12 µm long, axial cells cutting off 5 pericentral cells dorsiventrally, 3 dorsally and 2 ventrally (Fig. 156B); mature pericentral cells 15–25 µm in diameter and L/D (2-) 3–5. Branching of the main axial cells in alternate pairs, in lateral axes one to several cells apart. Rhizoids cut off from the ventral pericentral cells, 20–30 µm in diameter, penetrating between the *Codium* utricles. Cells with discoid rhodoplasts.

Reproduction. Unknown in Australian material (the following based on AD, A47998 from Umkomaas, South Africa, on *Codium*, low eulittoral, Jan. 1977, Coll. Ducker & Norris). Gametophytes dioecious; reproductive organs on short, free, polysiphonous branches bearing trichoblasts, on the thallus margins. Cystocarps (Fig. 156C) ovoid, 180–250 µm in diameter (immature); pericarp ostiolate, ecorticate, 2 cells thick, outer cells isodiametric. Spermatangial organs (Fig. 156D) on trichoblasts, clustered, ovoid-lanceoid, 90–150 µm long and 40–65 µm in diameter, with 3–4 sterile apical cells.

Stichidia (Fig. 156E) in small clusters, cylindrical, 180–360 µm long and 50–70 µm in diameter, with tetrasporangia in a straight row, one per segment, 30–50 µm in diameter, with 2 cover cells.

Type from the Cape of Good Hope, S. Africa; holotype in Herb. Agardh, LD, 42945.

Distribution. Elliston, S. Australia.

South Africa, Mozambique, Timor? (see Silva *et al.* 1996, p. 535). New Zealand.

Selected specimen: Elliston, S. Aust., on *Codium pomoides* lower eulittoral; shaded, just inside bay (*Womersley*, 15.i.1951; AD, A15017).

The above record is the only confirmed one from southern Australia. *Placophora*, especially when only sterile material is available, has to be observed carefully to separate it from the superficially similar *Symphyocladia*, the thallus of which is not dorsiventral in section and frequent trichoblasts are present.

Placophora binderi is most commonly epiphytic on *Codium*, but Seagel (1953, p. 25) records it as epiphytic on several other firm-surfaced algae in South Africa.

Tribe BOSTRYCHIEAE Falkenberg 1901: 504

Thallus apices dorsiventrally developed, with polysiphonous indeterminate axes bearing polysiphonous and monosiphonous determinate laterals usually at regular intervals; trichoblasts absent; axes attached by clumped rhizoids. Branching mostly exogenous. Polysiphonous branches with 4–9 pericentral cells dividing transversely into 2–5 tiers; ecorticate or corticated.

Reproduction. Procarps formed on 2–6 or more successive polysiphonous segments, each segment with 1–4 procarps each with the fertile pericentral (supporting) cell, a lateral sterile group of 2–6 cells and a (3-) 4-celled carpogonial branch; carposporophyte with a branched gonimoblast bearing terminal carposporangia; cystocarps with a post fertilization pericarp of 6–14 longitudinal filaments, each cell cutting off 2 (-3) outer pericentral cells, usually corticated. Spermatangia forming an outer layer on polysiphonous determinate laterals.

Tetrasporangial stichidia on determinate laterals, each segment with 4–5 pericentral cells and whorled tetrasporangia, protected by cover cells.

The Bostrychieae includes the two genera *Bostrychia* Montagne and *Stictosiphonia* Hooker & Harvey. The features of the tribe have been emphasised most recently by Hommersand (1983) and Maggs & Hommersand (1993), who consider the tribe distinct from all the other tribes of the Rhodomelaceae, especially in its female reproduction. The tribe is distinguished in particular by complete absence of trichoblasts, pericentral cells dividing into 2–5 tiers, procarps borne on successive segments in ordinary branches and containing only one sterile group, pericarp formation only post-fertilization, and spermatangia formed on polysiphonous branchlets, not on trichoblasts.

KEY TO GENERA OF BOSTRYCHIEAE

1. Pericentral cells dividing transversely into 2 tiers .... BOSTRYCHIA
1. Pericentral cells dividing transversely into (3-) 4–5 tiers .... STICTOSIPHONIA

Genus BOSTRYCHIA Montagne 1842a: 39, *nom. cons.*

Thallus dorsiventrally developed, apices straight or usually curved to circinnate, with prostrate and erect indeterminate axes bearing simple or branched determinate laterals usually at regular intervals. Attachment by rhizoidal haptera borne terminally on special branches ("cladohaptera") or as clusters from pericentral or cortical cells ("peripherohaptera"); epiphytic or epilithic. *Structure.* Apical cells prominent, with thick walls. Pericentral cells 4–9, each dividing transversely into 2 tiers, the basal cell remaining pit-connected with the axial cell; ecorticate or corticate. Branching exogenous, rarely endogenous. Trichoblasts absent.

Reproduction. Gametophytes monoecious or (usually) dioecious. Procarps formed in series on polysiphonous determinate branches, with 1–4 per segment, each procarp with a single sterile group and (3-) 4-celled carpogonial branch. Carposporophyte with a short, branched gonimoblast bearing clavate terminal carposporangia. Cystocarps subterminal, ovoid to subspherical; pericarp initiated post-fertilization, with 6–14 longitudinal filaments, corticated. Spermatangia superficial on corticated polysiphonous determinate laterals with or without a sterile tip.

Tetrasporangia whorled, borne in stichidia on determinate laterals, up to 25 segments long, fertile segments with 4–5 pericentral cells and tetrasporangia, each protected by 2–3 cover cells which are often subdivided.

Lectotype species: *B. scorpioides* (Hudson)Montagne (Kützing 1849: 839).

A genus of numerous species, differing from *Stictosiphonia* in having pericentral cells dividing transversely into only 2 tiers instead of 4–5. The Australian species were described by King & Puttock (1989) and their account is followed here.

KEY TO SPECIES OF *BOSTRYCHIA*

1. Thallus with corticated indeterminate axes .... 2. *B. harveyi*
1. Thallus with ecorticate indeterminate axes 2

    2. Determinate laterals polysiphonous to within 2–8 cells of their apices .... 1. *B. tenuissima*
    2. Determinate laterals with long monosiphonous branches 20–50 cells long .... 3. *B. moritziana*

1. **Bostrychia tenuissima** King & Puttock 1989: 18, figs 7d, 8. Adams 1994: 311. Millar & Kraft 1993: 51.

Bostrychia rivularis sensu J. Agardh 1863: 855. Harvey 1860: pl. 176B; 1863, synop.: xix. Sonder 1880: 34. Tisdall 1898: 514.

Bostrychia simpliciuscula sensu Guiler 1952: 104. Lucas 1909: 47. Lucas & Perrin 1947: 306. King & Wheeler 1985: 102. May 1965: 376. Womersley 1950: 186.

Bostrychia tenuis f. *typica* Post 1936: 22.

Bostrychia radicans sensu Davey & Woelkerling 1980: 58. De Toni & Forti 1923: 50. Beanland & Woelkerling 1982: 98. May 1965: 376.

FIG. 157A–D

Thallus (Fig. 157A) forming moderate to dense turfs 2–10 (-20) mm high, brown-red to purple, with branched prostrate indeterminate axes 5–40 mm long, bearing determinate laterals 2–3 axial cells apart and 2–6 mm long, simple or branched for 1–2 orders. Attachment by peripherohaptera (Fig. 157B) near branching of indeterminate axes; epilithic, on mud, or epiphytic on mangroves, mid to upper eulittoral, usually shaded. *Structure.* Apices straight or curved (Fig. 157C), apical cells dome-shaped to conical, 30–40 µm in diameter. Pericentral cells 5–7, each dividing into 2 tiers, ecorticate apart from odd cells on older axes, polysiphonous throughout apart from the end 2–8 cells of determinate laterals. Indeterminate

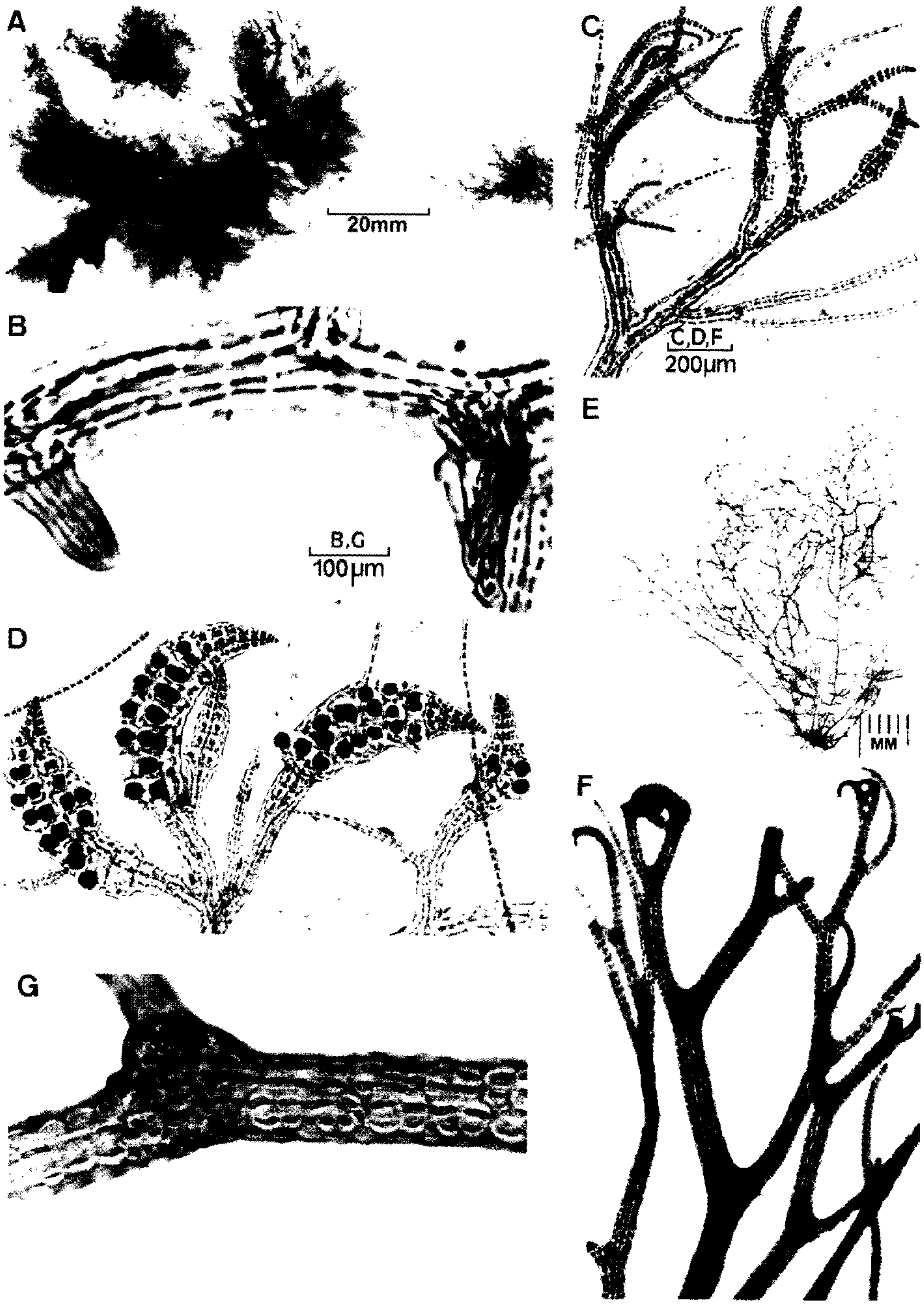

Fig. 157. **A–D**. *Bostrychia tenuissima* (**A**, AD, A54391; **B**, AD, A61506; **C**, **D**, AD, A56448). **A**. Habit. **B**. Prostrate axis with peripherohaptera. **C**. Upper branches with stichidia. **D**. Stichidia with 4 tetrasporangia per whorl. **E–G**. *Bostrychia harveyi* (AD, A21367). **E**. Habit. **F**. Upper branches with curved apices. **G**. Branch with swelling due to extra cortication adjacent to branch.

axes 70–180 µm in diameter, axial cells 80–250 µm long; determinate laterals 40–80 µm in diameter. Cells uninucleate, often binucleate in larger cells; rhodoplasts discoid, chained in larger cells.

Reproduction. Female plants unknown. Spermatangial organs 80–100 µm in diameter, 1000–1200 µm long, involving 9–15 axial cells of ultimate lateral branches, with 5 pericentral cells in 2 tiers, 1–2 layers of cortical cells and an outer layer of spermatangia.

Stichidia (Fig. 157C, D) subapical or intercalary on determinate or indeterminate branches, 100–200 µm in diameter, 500–1500 µm and 4–10 (-25) axial cells long, with 4 pericentral cells and tetrasporangia per whorl; tetrasporangia 70–85 µm in diameter, with 3 cover cells which cut off small cortical cells.

Type from Port Fairy, Vic. (*Harvey*, Alg. Aust. Exsicc. 174D); holotype in MEL, 672236.

Distribution: Head of Great Australian Bight, S. Aust., around SE Australia and Tasmania to southern Queensland.
New Zealand.

Selected specimens: Head of Great Australian Bight, S. Aust., supralittoral (*Womersley*, 4.ii.1954; AD, A19314). Point Sinclair, S. Aust., shaded, mid eulittoral (*Parsons*, 3.xi.1968; AD, A32939). Venus Bay, S. Aust., mid eulittoral, shaded (*Womersley*, 17.i.1951; AD, A14951). Proper Bay, Port Lincoln, S. Aust., upper eulittoral, shaded (*Womersley*, 7.i.1951; AD, A15064). Opposite Bird I., SW of Wallaroo, S. Aust., mid eulittoral on *Avicennia* pneumatophores (*Womersley*, 23.xi.1991; AD, A61506—"Marine Algae of southern Australia" No. 338a). Port Adelaide, S. Aust., mid eulittoral on log (*Brock*, 18.x.1974; AD, A45977). Head of Lagoons, American R. inlet, Kangaroo I., S. Aust., mid eulittoral under samphires (*Womersley*, 21.xi.1987; AD, A58387—"Marine Algae of southern Australia" No. 338). Nora Creina, S. Aust., mid eulittoral, shaded (*Womersley*, 18.viii.1953; AD, A19072). "The Blowholes", Cape Bridgewater, Vic., in pool 30 m above sea level, very rough-water coast (*Womersley*, 21.viii.1953; AD, A19067). E side Westernport Bay, Vic., on *Avicennia* pneumatophore (*Womersley*, 10.iv.1959; AD, A56448). Orford, Tas., upper eulittoral in reeds (*Womersley*, 3.xi.1982; AD, A54391).

Bostrychia tenuissima was usually referred to as *B. simpliciuscula* Harvey *ex* J. Agardh until distinguished by King & Puttock as a separate species, differing from the latter in not having monosiphonous lateral branches. However, while King & Puttock consider the lateral branches of *B. tenuissima* as "polysiphonous", most specimens have the terminal 2–8 cells of determinate laterals monosiphonous, but never as long as the much longer monosiphonous branches of true *simpliciuscula* from the tropical Pacific.

2. **Bostrychia harveyi** Montagne 1852: 317. J. Agardh 1863: 865; 1897: 80. DeBerg 1949: 500, fig. 1. De Toni 1903: 1163. Guiler 1952: 104. Harvey 1859b: 299; 1863: pl. 292, synop.: xix. King & Puttock 1989: 13, figs 2d, 4a, 6, 7a–c. Kützing 1865: 8, pl. 22a–c. Lucas 1909: 47; 1929a: 23. Lucas & Perrin 1947: 307, fig. 146. Millar & Kraft 1993: 50. Silva *et al.* 1996: 473. Sonder 1880: 34. Tisdall 1898: 514.
Bostrychia australasica Sonder 1855: 527.
Bostrychia scorpioides sensu Davey & Woelkerling 1980: 58. Entwisle & Kraft 1984: 251. May 1965: 377. Prud'homme van Reine & Sluiman 1980: 325, fig. 2.
Bostrychia distans Harvey 1855b: 226. Harvey 1859b: 299.

FIG. 157E–G

Thallus (Fig. 157E) matted to erect, often clumped, dark brown-red, 0.5–4 cm high, with branched indeterminate axes 3–8 cm long, bearing determinate laterals 5–10 mm long with 2–3 orders of branches. Attachment by peripherohaptera from indeterminate axes; epilithic or epiphytic, often with fresh water influence. *Structure*. Apices strongly curved to circinnate (Fig. 157F), apical cells hemispherical to conical, 20–25 µm in diameter. Pericentral cells 6–8 in axes, 4–6 in lesser branches, dividing into 2 tiers and axes becoming corticate (2–3 cells thick) throughout; polysiphonous from close to apices. Indeterminate axes 200–600 µm in diameter, axial cells 200–800 µm long; determinate laterals 2–5 axial cells apart, slightly corticate, 70–110 µm in diameter, ultimate branches many segments long, with straight to curved apices. Swellings (Fig. 157G) due to extra cortical cells occur on the indeterminate axes adjacent to determinate laterals and the peripherohaptera. Cells uninucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps borne on 2–6 consecutive axial cells of polysiphonous determinate laterals, with 1 (-2) per axial cell; carpogonial branches (2-) 3 cells long, with a pre-fertilization group of 2–3 sterile cells, and a group of 2–3 cells from the

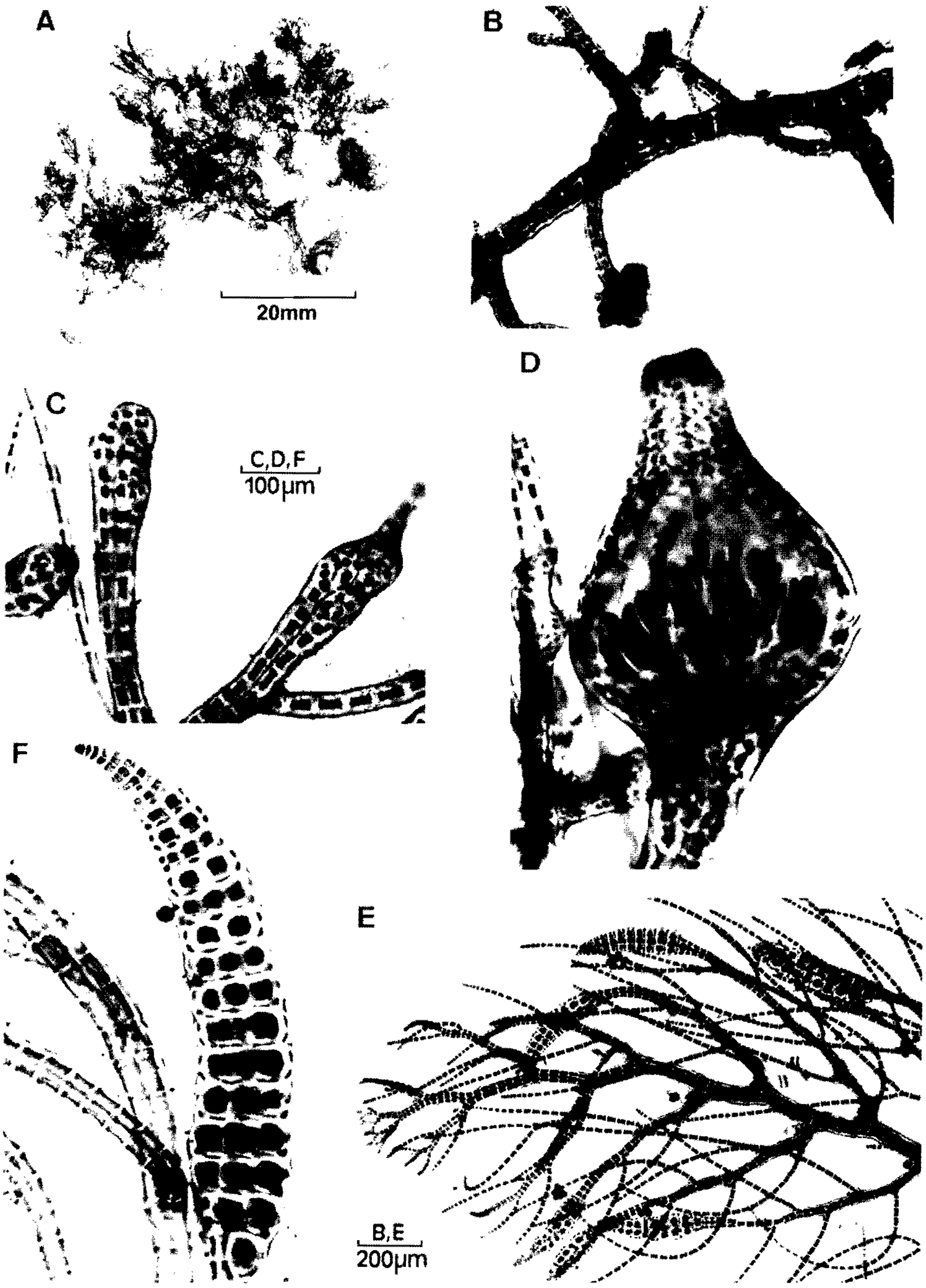

Fig. 158. *Bostrychia moritziana* (**A**, **F**, AD, A51854; **B–D**, AD, A22592; **E**, AD, A68392). **A**. Habit. **B**. Prostrate axis with cladohaptera. **C**. Upper branches with procarps. **D**. Cystocarp. **E**. Indeterminate axis bearing monosiphonous determinate laterals with stichidia. **F**. Stichidium with whorls of 4 tetrasporangia.

adjacent pericentral cell. Carposporophyte with a short, branched, gonimoblast and clavate terminal carposporangia 15–25 (-35) µm in diameter. Cystocarps ovoid to subspherical, 450–600 µm in diameter; pericarp ostiolate, with 12–14 longitudinal filaments and 1–2 orders of cortical cells. Spermatangial organs involving 24–60 axial cells, 150–180 µm in diameter and 1.3–2.8 mm long, with 5 pericentral cells and 1–2 cortical cells plus outer spermatangia.

Stichidia terminating branches of determinate laterals, 100–185 µm in diameter and 8–16 (-20) axial cells and 400–800 µm long, with 5 pericentral cells and tetrasporangia per whorl; tetrasporangia 35–45 µm in diameter, with 3 cover cells which divide.

Type locality: Corral, Chile (*Lechler*); lectotype in PC.

Distribution. Cool temperate southern hemisphere.

In Australia, from St George R. to Sealers Cove, Vic., and SE Tasmania.

Selected specimens: Gordon R., 3–4 km up from Macquarie Harbour, Tas. (*McLachlan*, 19.x.1981; AD, A52697). Dover, Tas., in creek (*Cribb* 77.12, 23.ix.1950; AD, A16297). Huonville, Tas., on banks of Huon R. (*Curtis*, 5.iii.1958; AD, A21367).

B. harveyi is apparently not a widespread species in southern Australia, occurring mainly under fresh-water influence in central Victoria and SE Tasmania.

Prud'homme van Reine & Sluiman (1980, p. 325, fig. 2) maintained *B. harveyi* as a synonym of *B. scorpioides*, but King & Puttock (1889, p. 12, 18) kept the latter separate largely on account of the indeterminate axis swellings at branchings.

3. **Bostrychia moritziana** (Sonder *ex* Kützing)J. Agardh 1863: 862; 1897: 77. Adams 1994: 310. Beanland & Woelkerling 1982: 97. Davey & Woelkerling 1980: 58. De Toni 1903: 1158. Kendrick *et al.* 1990: 52. King & Puttock 1989: 29, figs 1a, 13, 14. May 1965: 376. Millar & Kraft 1993: 50. Silva *et al.* 1996: 474. West & Zuccarello 1999: 115.

Polysiphonia? *moritziana* Sonder *ex* Kützing 1849: 838. J. Agardh 1863: 862.

FIG. 158

Thallus (Fig. 158A) forming dense mats or turfs 1–3 cm high, brown-red to purple, with indeterminate main axes 2–4 (-6) cm long bearing determinate laterals 2–5 (-10) axial cells apart and 2–3 mm long. Attachment by cladohaptera (Fig. 158B) from indeterminate axes; epilithic or epiphytic on mangroves and salt marsh plants. *Structure.* Apices straight, apical cells dome-shaped and 20–25 µm in diameter (including thick walls), producing determinate laterals with monosiphonous branches mostly 20–50 cells long. Pericentral cells 4–5 (-6), each dividing into 2 tiers, ecorticate. Indeterminate axes 60–100 µm in diameter, axial cells 80–160 µm long; determinate laterals basally 35–60 µm in diameter, monosiphonous branches 25–40 µm in diameter, cells L/D (1-) 1.5–3. Cells uninucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps (Fig. 158C) borne on 3–6 consecutive axial cells of polysiphonous parts of determinate laterals, with 1 (-2) per axial cell; carpogonial branches (2-) 3 cells long, with a prefertilization group of 2–4 sterile cells and a group of 3–4 cells from an adjacent pericentral cell. Carposporophyte with a short branched gonimoblast and clavate terminal carposporangia 20–25 µm in diameter. Cystocarps (Fig. 158D) on determinate laterals, ovoid to subspherical or slightly urceolate, 500–550 µm in diameter; pericarp ostiolate, with 6 longitudinal filaments, 3 cells thick, outer cells irregular. Spermatangial organs involving 4–12 axial cells of determinate laterals, 30–50 µm in diameter and 100–200 µm long, with 5 pericentral cells, a layer of cortical cells, and an outer layer of spermatangia.

Stichidia (Fig. 158E) subapical or intercalary on determinate laterals, with polysiphonous stalks, 100–140 µm in diameter and 5–12 (-17) axial cells and 800–1200 µm long, with 4 pericentral cells and tetrasporangia per whorl (Fig. 158F); tetrasporangia 50–60 µm in diameter, with 2 cover cells.

Type material from Venezuela, St Lucia and French Guiana; lectotype from Cumana, Venezuela (*Moritz* 142), in MEL, 672271.

Distribution. Widely distributed in tropical and temperate seas.

In Australia from Western Australia around southern coasts and Tasmania to Queensland.

Selected specimens: Opposite Bird I., SW of Wallaroo, S. Aust., mid eulittoral on *Avicennia* pneumatophores (*Womersley*, 23.xi.1991; AD, A61507). Port Arthur, Gulf St Vincent, S. Aust., lower eulittoral on pneumatophores (*Womersley*, 9.xi.1980; AD, A51856). Port Clinton, S. Aust., lower eulittoral on pneumatophores (*Womersley*, 8.xi.1980; AD, A51854—"Marine Algae of southern Australia" No. 402). Garden I., S. Aust., lower eulittoral on hulks & mangroves (*Brock*, 26.x.1999; AD, A68392 and 8.ii.2000; AD, A69009). E side Westernport Bay, Vic., on mangrove pneumatophores (*Womersley*, 10.iv.1959; AD, A22592). Crawfish Rock, Westernport Bay, Vic., mid eulittoral (*Womersley*, 29.viii.1971; AD, A39447).

B. moritziana occurs in calm, sheltered, localities, often under fresh-water influence. It is distinguished by the long, monosiphonous branches of the determinate laterals. Life cycles within the species have been analysed by West & Zuccarello (1999).

Genus STICTOSIPHONIA Hooker & Harvey *in* Hooker 1847: 483

Thallus dorsiventrally developed, apices usually curved, with prostrate and erect indeterminate axes bearing determinate laterals usually at regular intervals. Attachment by cladohaptera or peripherohaptera; epilithic or epiphytic. *Structure*. Apical cells prominent, pericentral cells 4–8, each dividing to form (3-) 4–5 tiers of cells, ecorticate or corticated. Branching mainly exogenous.

Reproduction. Gametophytes dioecious. Procarps formed in series of 3–9 on unspecialised polysiphonous determinate branches, with (4-) 5–6 pericentral cells per whorl, one (the supporting cell) bearing a (2-) 3-celled carpogonial branch and a group of 2–6 sterile cells, with the adjacent pericentral cells also producing a group of sterile cells. Carposporophyte with a short, branched gonimoblast and terminal carposporangia. Cystocarps subterminal, ovoid to subspherical, pericarp initiated post-fertilization, with 8–12 longitudinal filaments, becoming corticated. Spermatangia superficial on polysiphonous determinate branches, covering 5–50 or more axial cells.

Tetrasporangial stichidia on determinate laterals, 2–20 axial cells long, with 4–5 pericentral cells and tetrasporangia, protected by 2–3 cover cells which divide.

Lectotype species: *S. hookeri* (Harvey)Hooker & Harvey [= *S. intricata* (Bory)Silva].

A genus of some 6 species, distinguished from *Bostrychia* by the pericentral tiers of 4–5 cells rather than 2.

Stictosiphonia intricata (Bory)Silva *in* Silva *et al.* 1996: 552.

Scytonema intricatum Bory 1828: 225.
Bostrychia intricata (Bory)Montagne 1852: 317. J. Agardh 1863: 866. Davey & Woelkerling 1980: 58. De Toni 1903: 1166. Kützing 1865: 9, pl. 23d–f. May 1965: 377.
Bostrychia hookeri Harvey *in* Hooker & Harvey 1845a: 269. J. Agardh 1863: 857; 1897: 73. De Toni 1903: 1148. Falkenberg 1901: 509, pl. 11 figs 19–24. Harvey 1849a: 69. Kützing 1849: 840; 1865: 8, pl. 21a–c. Millar & Kraft 1993: 59.
Stictosiphonia hookeri (Harvey)Harvey *in* Hooker 1847: 483, pl. 186 fig. II. Adams 1994: 309. King & Puttock 1989: 44, figs 2a, 17, 18a, b.
Bostrychia mixta Hooker & Harvey 1845a: 270; 1845b: 536. J. Agardh 1863: 858; 1897: 72. De Toni 1903: 1150. Falkenberg 1901: 511. Guiler 1952: 104. Harvey 1849a: 70; 1859b: 298; 1860: pl. 176A; 1863: pl. 176A, synop.: xix. Kützing 1849: 840; 1865: 8, pl. 20d–f. Lucas 1909: 47; 1929a: 23. Shepherd & Womersley 1981: 368. Sonder 1853: 703; 1880: 34. Tate 1882a: 23. Womersley 1950: 186.
Amphibia mixta (Hooker & Harvey)Kuntze 1891: 881.

FIG. 159

Thallus (Fig. 159A) forming dense turfs 5–15 mm high, purple to red-brown, with prostrate and erect indeterminate axes 5–10 (-30) mm long, bearing simple or subdichotomous determinate laterals. Attachment by peripherohaptera (Fig. 159B) on the prostrate axes, usually opposite erect axes; epilithic or epiphytic on mangroves, upper eulittoral. *Structure*. Apices straight or curved, apical cells dome-shaped, 30–40 µm in diameter (including a very thick wall). Pericentral cells 5–7 (-8), each dividing to (3-) 4–5 tiers (Fig. 159C) per axial cell, ecorticate apart from odd corticating cells on older axes. Prostrate indeterminate axes 60–150 µm in diameter, axial cells 90–200 µm long, erect indeterminate axes 30–120 µm in diameter,

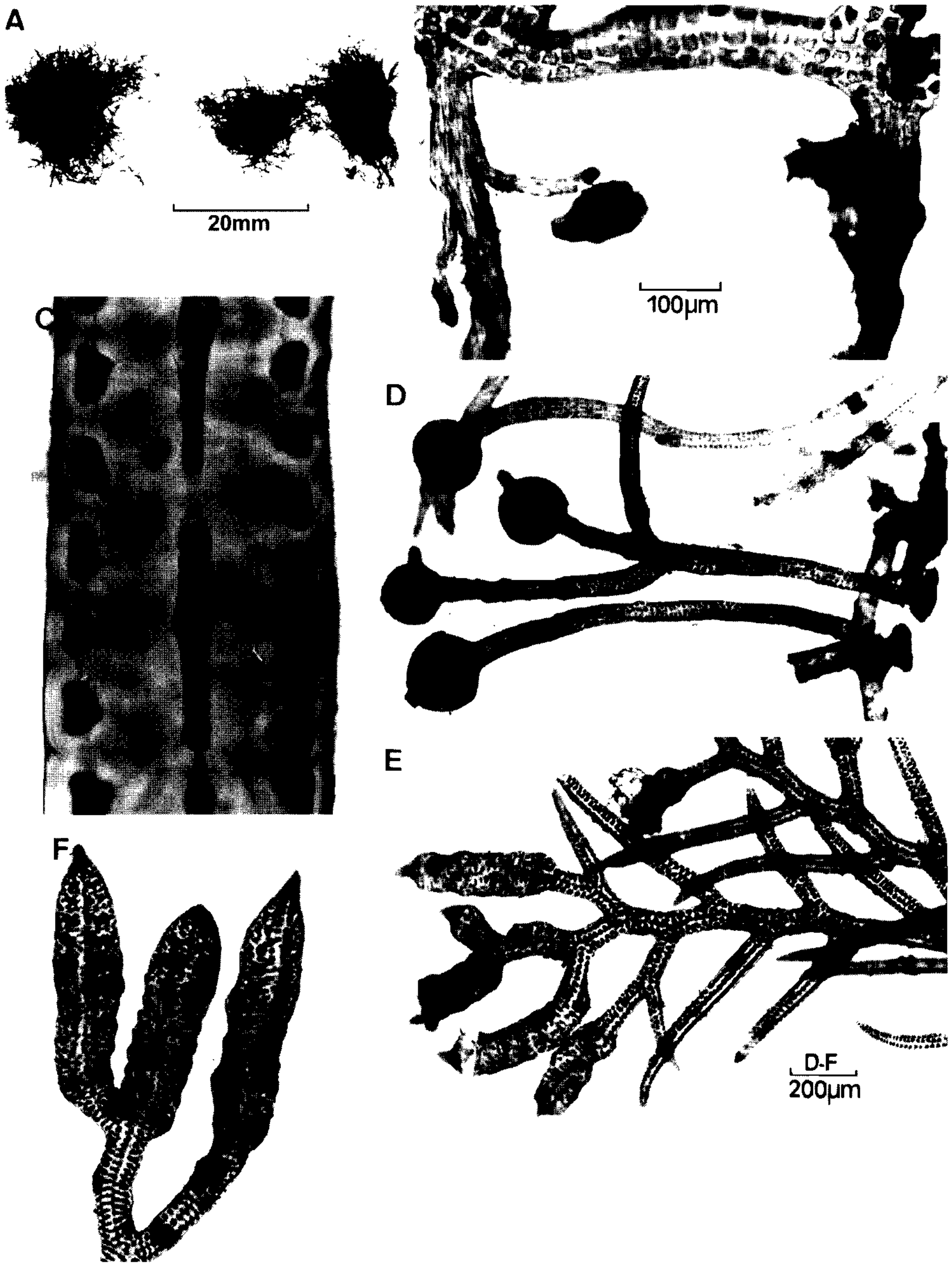

Fig. 159. *Stictosiphonia intricata* (**A**, AD, A39448; **B–E**, AD, A9459; **F**, AD, A59556). **A**. Habit. **B**. Prostrate axis with peripherohaptera. **C**. Longitudinal view of axis with 4 tiers of divided pericentral cells. **D**. Erect filaments with cystocarps. **E**. Indeterminate axis with stichidia on determinate laterals. **F**. Stichidia with 4–5 tetrasporangia per whorl.

bearing determinate laterals 2–3 axial cells apart, tapering, lower segments 60–90 µm in diameter. Cells uninucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious, rare. Procarps on 3–6 consecutive segments of determinate laterals, with 1 (-2) per axial cell, the supporting cell with a sterile group of 2–3 cells before fertilization and the adjacent sterile pericentral with a group of 3–4 cells; carpogonial branch 4 cells long (King & Puttock 1989, fig. 18a). Carposporophyte with a short, branched, gonimoblast and ovoid to clavate terminal carposporangia 30–45 µm in diameter. Cystocarps (Fig. 159D) subapical on determinate laterals, ovoid to subspherical, 400–550 µm in diameter; pericarp ostiolate, with 8 longitudinal filaments, each cell with 2 (-3) pericentral cells and becoming 2–3 cells thick, outer cells irregular. Spermatangial organs including 6–9 axial cells of determinate laterals, 60–75 µm in diameter and 400–1000 µm long, with an outer layer of spermatangia.

Stichidia (Fig. 159E) subapical or intercalary on determinate laterals, 150–250 µm in diameter, (300-) 600–1200 µm and 4–10 (-22) axial cells long, with 4–5 pericentral cells and tetrasporangia per whorl (Fig. 159F); tetrasporangia 50–80 µm in diameter, with 2 cover cells dividing 2 (-3) times and forming odd cortical cells.

Lectotype from Falkland Is; in PC.

Distribution. Widespread in temperate waters of the Southern Hemisphere.

In Australia, from Point Sinclair, S. Aust., to SE Tas., and Manly, N.S.W. (see King & Puttock 1989, p. 46).

Selected specimens: Point Sinclair, S. Aust., shaded under overhang (*Parsons*, 3.xi.1968; AD, A32937). Elliston, S. Aust., mid eulittoral, shaded (*Womersley*, 15.i.1951; AD, A14949). Ethel Bay, Yorke Pen., S. Aust., upper eulittoral, shaded (*Womersley*, 13.iv.1963; AD, A26341). Pennington Bay, Kangaroo I., S. Aust., upper eulittoral, shaded (*Womersley*, 29.viii.1948; A9459 and 6.i.1949; AD, A10791). Point Nepean, Vic., lower eulittoral (*Brown*, 22.vii.1981; AD, A59556). Crawfish Rock, Westernport Bay, Vic., mid eulittoral, shaded (*Womersley*, 29.viii.1971; AD, A39448). Mersey Bluff, Devonport, Tas., mid eulittoral (*Womersley*, 29.x.1994; AD, A63856—"Marine Algae of southern Australia" No. 380, as *S. hookeri*). Long Bay, Port Arthur, Tas., mid to lower eulittoral (*Gribb* 115.10, 22.i.1951; AD, A16207).

This species, with synonymy and references, is discussed in detail by King & Puttock, (1989, p. 44) as *S. hookeri*, and the nomenclature clarified by Silva *et al.* (1996, p. 552).

Tribe SONDERELLEAE L.E. Phillips 2001: 498

Thallus erect, branched from the midrib or margins, branches flat, linear, monostromatic. Apices with an apical cell in a slight cleft, dorsiventral with the axial cells producing 3 or 4 pericentral cells (5 in fertile segments), 2 lateral and 1 or 2 adaxial, with a pseudopericentral cell from each lateral cell; lateral pericentral cells each forming 2 chains of wing cells. Branching adventitious from the midrib or exogenous from the margin. Trichoblasts absent.

Reproduction. Gametophytes dioecious, reproductive cells borne directly on thallus surface. Procarps borne in series on the central adaxial pericentral cells, carposporophyte with terminal carposporangia, cystocarps usually single per blade. Spermatangial blades ovate, with sterile axial and marginal cells.

Stichidia borne on the midrib, linear, compressed, corticated, with 2 rows of tetrasporangia cut off from opposite lateral pericentral cells, with 4 (-6) pre-sporangial cover cells.

The Sonderelleae now includes the monospecific *Sonderella* and *Lembergia*; it was presaged by Womersley (1965, p. 449) who showed that *Sonderella* was more related to the Rhodomelaceae than the Delesseriaceae, probably to the Amansieae, and suggested it should be "placed in a group of its own". The tribe Sonderelleae has been established by L.E. Phillips (2001, p. 498) to include also the New Zealand *Lembergia*.

The Sonderelleae is distinguished by the apical development with 3–4 (or 5) pericentral cells plus 2 pseudopericentral cells, complete lack of trichoblasts, and formation of sexual reproductive cells directly on the blade surface. The vegetative development and stichidia relate it most closely to the Amansieae.

Genus SONDERELLA Schmitz *in* Schmitz & Hauptfleish 1897: 415.
[Schmitz 1889: 446, *nomen nudum*]

Thallus erect, branched from the midrib, branches monostromatic, flat, linear, entire, 2–4 mm broad. Holdfast rhizoidal; epiphytic. *Structure*. Apical cell in a slight apical cleft, apices dorsiventral, the axial cell cutting off 4 pericentral cells (5 in fertile segments), 2 larger lateral cells and 2 smaller adaxial ones, with each of the lateral pericentral cells cutting off a pseudopericentral cell; lateral pericentral cells each forming 2 chains of wing cells; blades ecorticate, midrib corticate below. Branching adventitious from the pericentral or pseudopericentral cells. Trichoblasts absent.

Reproduction. Gametophytes dioecious, reproductive cells formed directly on the thallus surface. Procarps borne in series on the central of 3 adaxial pericentral cells, the supporting cell bearing 2 sterile cells and a 4-celled carpogonial branch. Carposporophyte with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia. Cystocarps usually single per blade, ovoid, pericarp ostiolate, (3-) 4 cells thick. Spermatangial blades flat, ovate, with sterile axial and marginal cells, with a plate of initials producing elongate spermatangia.

Stichidia borne on the midrib, linear, compressed, corticated, with 2 rows of tetrasporangia cut off from opposite lateral pericentral cells.

Type (and only) *species*: *S. linearis* (Harvey)Schmitz 1897: 415.

Schmitz (1889, p. 446) first used the name *Sonderella* but without giving a description; he validated it in 1897.

Sonderella linearis (J. Agardh)Schmitz *in* Schmitz & Hauptfleish 1897: 415. De Toni 1900: 744. Falkenberg 1901: 708, 710, 712. Guiler 1952: 101. Kylin 1956: 436. Lucas 1909: 37; 1929a: 20; 1929b: 50. Lucas & Perrin 1947: 237. May 1965: 396. Mazza 1908: No. 256. Phillips *et al.* 2000: 217. Phillips 2001: 493, figs 35–40. Reinbold 1898: 47. Schmitz 1889: 446 (*nomen nudum*). Womersley 1965: 435, figs 1–16, pls 1–3. Womersley & Shepley 1959: 169.

Amansia linearis Harvey 1859a: pl. 108; 1863, synop.: xv. Kützing 1869: 20, pl. 54a–c. Sonder 1880: 31. Tate 1882a: 22. Tisdall 1898: 512.

Lenormandia linearis (Harvey)J. Agardh 1863: 1102; 1879: 148, pl. 33 figs 17, 18.

FIGS 160, 161

Thallus (Fig. 160A) medium red to red-brown, 4–8 (-16) cm high, moderately branched with flat, linear, entire branches 2–4 mm broad, longer branches bearing irregular shorter ones, all from the midrib. Holdfast rhizoidal, clasping the host axes and 2–7 mm long; epiphytic on *Ballia callitricha* (rarely on *B. mariana*). *Structure*. Apical cell dome-shaped to laterally elongate, often in a slight apical cleft, axial cell (Fig. 161A), cutting off 4 pericentral cells (5 in fertile segments), 2 larger lateral cells and 2 smaller adaxial cells, with the larger cells each cutting off a pseudopericentral cell on the abaxial side; apices hence dorsiventral; the lateral pericentral cells divide to form 2 chains (Fig. 160B), extending apically, of wing cells which become hexagonal and 70–110 µm across. Blades ecorticate, midrib becoming corticate below with descending rhizoids. Trichoblasts absent. Branching adventitious from the pericentral or pseudopericentral cells. Cells probably multinucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious, reproductive cells formed on thallus surface. Procarps borne on up to 10 successive segments, on the central of the 3 adaxial pericentral cells, on the adaxial face of the blade, with the central (supporting) cell bearing 2 sterile cells and a 4-celled carpogonial branch. Carposporophyte (Fig. 161C) with a basal, erect, fusion cell and much-branched gonimoblast with clavate terminal carposporangia 50–75 µm in diameter. Cystocarps (Fig. 161B, C) usually single per branch, ovoid to slightly urceolate, 0.5–1 mm in diameter; pericarp originating prefertilisation, ostiolate, (3-) 4 cells thick. Spermatangial (Figs 160C, 161D) blades flat, ovate, 0.5–1 (-2.5) mm broad, with sterile central and marginal cells, the wing cells cutting off small initials which form a horizontal plate, each cell of which cuts off 1–4 elongate spermatangia.

Stichidia (Fig. 160D) are borne on the midrib on both sides of the blades, linear, compressed, 0.5–1 mm broad and 2–6 mm long, with tetrasporangia in 2 rows, borne from the lateral adaxial pericentral cells (Fig. 161E); the lateral pericentral cells divide laterally only 1–2 times but cut off smaller cover (corticating) cells on the stichidium surface; tetrasporangia 80–140 µm in diameter, released mainly through splits on the adaxial side.

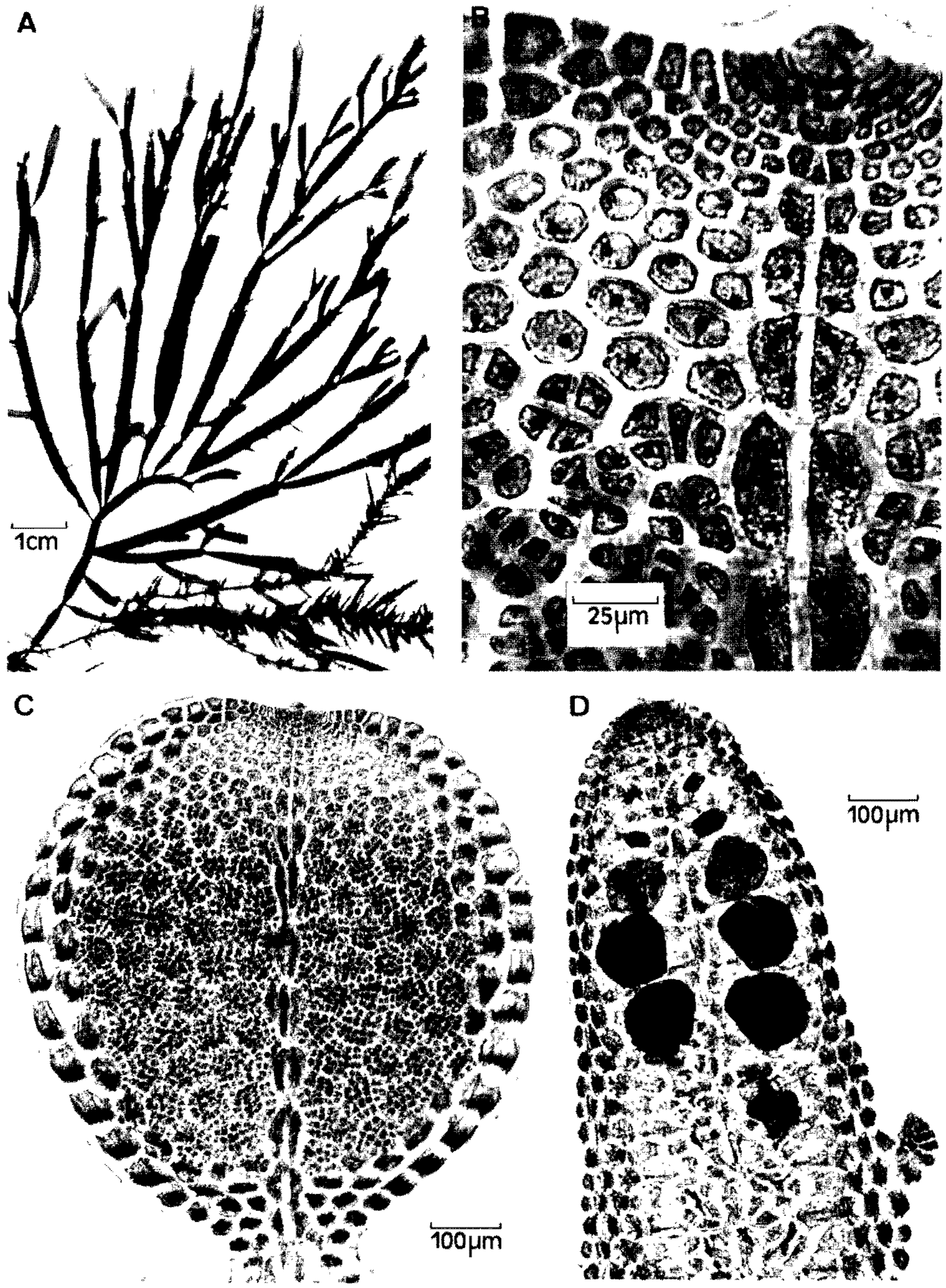

Fig. 160. *Sonderella linearis* (**A**, **C**, **D**, AD, A27971; **B**, AD, A21107). **A**. Habit. **B**. Apex of branch showing segmentation. **C**. A spermatangial blade. **D**. Stichidium with paired tetrasporangia. (All as in Womersley 1965, courtesy of Aust. J. Bot.)

Lectotype from Port Fairy, Vic. (*Harvey*, Alg. Aust. Exsicc. 118D); in Herb, Harvey, TCD.

Distribution: Robe, S. Aust., to Cape Paterson, Victoria.

Selected specimens: Guichen Bay, S. Aust., on *Ballia callitricha*, 10–16 m deep (*Womersley*, 1.ix.1949; AD, A10962). Robe, S. Aust., on *B. callitricha*, drift (*Womersley*, 18.v.1964; AD, A27971—"Marine Algae of southern Australia" No. 135) and on *Ballia mariana*, drift (*Womersley*, 18.v.1964; AD, A27843). Stinky Bay, Nora Creina, S. Aust., on *B. callitricha*, drift (*Womersley*, 19.viii.1957; AD, A21107). Warrnambool, Vic., on *B. callitricha*, drift (*Womersley*, 13.iv.1959; AD, A22941). Queenscliff, Vic., on *B. callitricha*, drift (*Womersley*, 8.iv.1959; AD, A22862). Cape Paterson, Vic. (*Ducker*, 8.iv.1973; MELU, 21720).

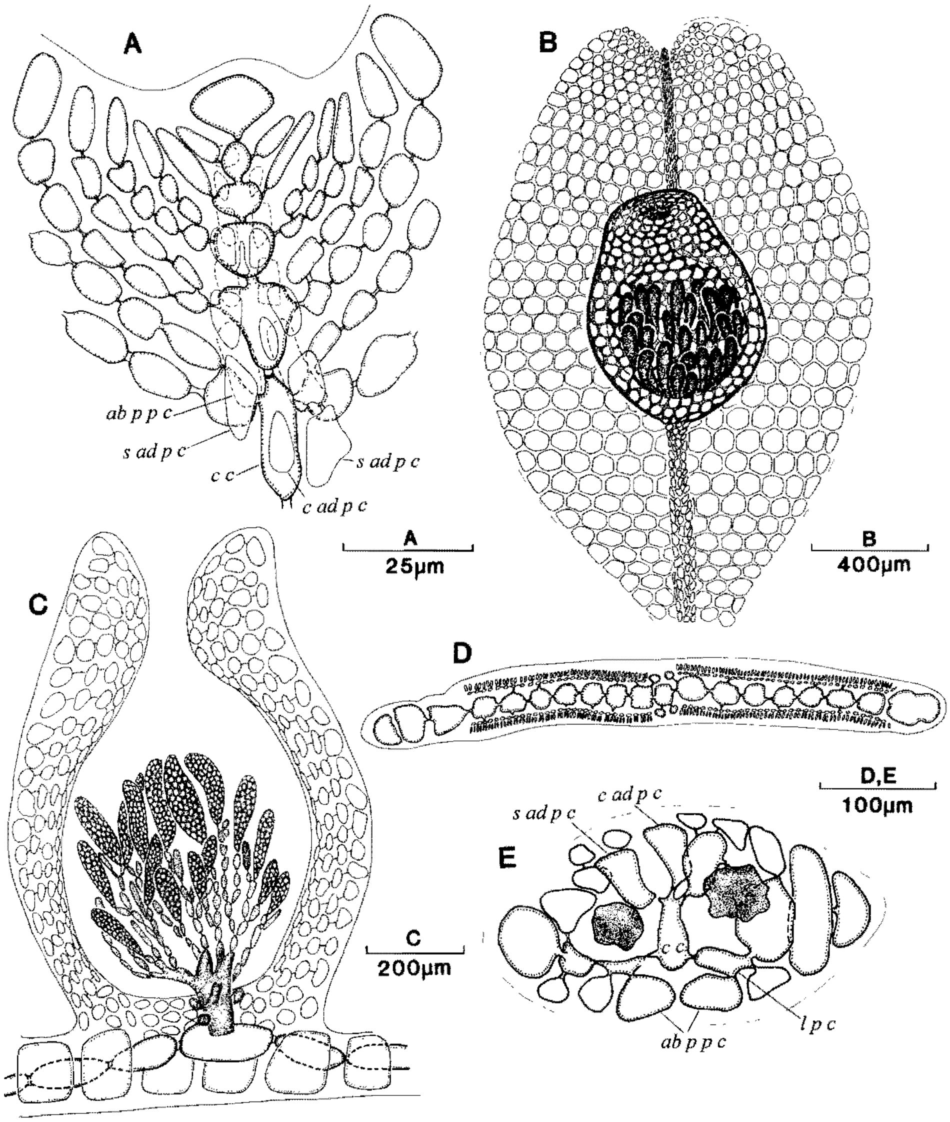

Fig. 161. *Sonderella linearis* (**A–C**, AD, A21107; **D**, **E**, AD, A27971). **A**. Apical segmentation, with 3 adaxial pericentral cells and 2 abaxial pseudopericental cells (broken lines). **B**. Blade with a mature cystocarp. **C**. Longitudinal section of a cystocarp with carposporophyte. **D**. Cross section of a spermatangial blade. **E**. Transverse section of a stichidium, with undivided sporangia cut off from the two lateral adaxial pericentral cells. (All as in Womersley 1965, courtesy of Aust. J. Bot.)

Sonderella linearis has rarely been collected since the mid 1960's, when material permitted Womersley (1965) to clarify the relationships of this distinctive alga.

Silva *et al.* (1996, p. 493) discuss the authorship of this species, which should be credited to (J. Agardh)Schmitz *in* Schmitz & Hauptfleisch 1897: 415.

Tribe AMANSIEAE Schmitz 1889: 447

Thallus erect, usually much branched, branches compressed to flat or foliose, usually with a conspicuous midrib and lateral wings, margins entire or dentate, blades ecorticate or corticate. Apices dorsiventral and bilateral, straight or often revolute to varying degrees, with a single apical cell, protruding or not, segmenting usually transversely to an axial filament cutting off 5 or 6 pericentral cells, with or without pseudopericentral cells (cut off laterally from the pericentral cells and lying in the ring of pericentral cells), the lateral pericentral cells dividing to form the wings of the blades. Medulla 1–3 cells thick, cells in some taxa in layers or interposed to form (surface view) chevrons or rhombic areolation; cortex 1–2 cells broad, surface bare or covered with short, dense, proliferations. Branching usually endogenous from the midrib or wings, or adventitious from the cortex. Trichoblasts apical or arising adventitiously from cortical cells, or absent apart from much reduced and associated with reproduction.

Reproduction. Gametophytes dioecious, usually with short, erect, fertile processes. Procarps arising on reduced trichoblasts (soon polysiphonous), carpogonial branches 4-celled; carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia; cystocarps ovoid, usually stalked; pericarp ostiolate, several cells thick. Spermatangial organs on short, polysiphonous, processes on the blades, ovoid and with 1–2 sterile basal cells.

Tetrasporangial stichidia on the blade surface or on short processes, corticated, compressed, with paired tetrasporangia per segment, in longitudinal rows.

Type genus: *Amansia* Lamouroux 1809a: 332.

The Amansieae includes some 13 genera, distributed in the tropics and Pacific – Indian Oceans in particular, with 8 genera (6 endemic) known from southern Australia.

Several genera show the presence of pseudopericentral cells but the number and occurrence of these is variable and their presence or not must be used with caution to characterise particular species.

In addition to the genera described below, *Adamsiella chauvinii* (Harvey)Phillips & Nelson *in* Phillips probably occurs on southern Australian coasts. Phillips (2002b, p. 220) considers it is restricted to New Zealand, though Harvey in his original description (1855, p. 222) referred to it as a "Native of New Holland" and stated "Our first specimens of this plant were received from M. Chauvin, who obtained them from New Holland." Wilson (1892, p. 166) recorded it from Port Phillip Heads, but no recent collections are known from here. A specimen from Oedipus Point, West I., S. Australia, 21–25 m deep (*Shepherd*, 8.x.1966; AD, A30861) appears to be this species, but further collections are needed for confirmation.

KEY TO GENERA OF AMANSIEAE

1. Axes with 6 pericentral cells 2
1. Axes with 5 pericentral cells 3

    2. Branches slightly compressed, mostly 0.5–1.5 mm broad... PROTOKUETZINGIA
    2. Branches flat, (2-) 3–5 (-6) mm broad .... KUETZINGIA

3. Axes with 5 pericentral cells and without pseudopericentral cells 4
3. Axes with 5 pericentral cells and 2–3 pseudopericentral cells 5

    4. Thallus bipinnate, branches 1–2 mm broad, opposite, determinate laterals linear-lanceolate, apices initially curved; branching endogenous, surface without areolations, reproductive organs on short shoots in axils of determinate laterals .... NANOPERA

4. Thallus irregularly branched, 5–100 cm broad, apices flat (not circinnate), branching absent or adventitious, surface showing rhombic areolation; reproductive organs marginal or on blade surface........................ LENORMANDIA

5. Branches ecorticate (except for midrib).. AMANSIA
5. Branches corticate throughout...6

6. Branches with regular, alternate, marginal dentations, midrib with alternate, lateral veins.. VIDALIA
6. Branches without prominent marginal dentations and midrib obscure or slight, lateral veins absent or inconspicuous. 7

7. Apex recurved, surface cells in chevrons, reproductive organs borne on midrib or blade surface .... EPIGLOSSUM
7. Apex straight, surface cells in straight rows; reproductive organs mostly marginal .... OSMUNDARIA

Genus PROTOKUETZINGIA Falkenberg *in* Schmitz & Falkenberg 1897: 469

By H.B.S. Womersley, S.M. Wilson & G.T. Kraft

Thallus erect, oppositely branched, branches endogenous, slender, linear, compressed, less than 1.5 mm broad; lower axis with a slight secondary cortex; holdfast discoid or tendril-like. *Structure*. Apices revolute, apical cell protruding, axial filament with 6 pericentral cells, 2 lateral, 2 dorsal and 2 ventral, cortex 1–2 cells thick, trichoblasts frequent, prominent.

Reproduction. Gametophytes dioecious. Procarps on lower trichoblast cells on short, endogenous, lateral branchlets, soon polysiphonous and pericarpic. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia. Cystocarps ovoid, short-stalked; pericarp ostiolate, 3–5 cells thick. Spermatangial organs on trichoblasts, globose to ovoid, with 1 (-3) sterile basal cells.

Tetrasporangial stichidia first inrolled, later lanceolate, marginal or submarginal, single or grouped, compressed, corticated, with two rows of tetrasporangia paired in each segment.

Type species: *P. australasica* (Montagne)Falkenberg *in* Schmitz & Falkenberg 1897: 469.

Protokuetzingia is probably a monotypic genus, since the other species (*P. schottii*, from Columbia and Brazil) has been transferred to *Enantiocladia* by Wilson & Kraft (2000, p. 338). It is distinguished by the slender, opposite branches and 6 pericentral cells, with stichidia and sexual reproductive organs, typical of the tribe.

Protokuetzingia australasica (Montagne)Falkenberg *in* Schmitz & Falkenberg 1897: 469. De Toni 1903: 1076. De Toni & Forti 1923: 46. Ducker *et al.* 1977: 87. Falkenberg 1901: 475, fig. 8B, pl. 9 fig. 6. Guiler 1952: 106. Huisman 1997: 207. Huisman & Walker 1990: 440. King *et al.* 1971: 124. Kylin 1956: 542. Lucas 1909: 45; 1929b: 51. Lucas & Perrin 1947: 295, fig. 139. May 1965: 384. Reinbold 1899: 48. Shepherd 1983: 83. Shepherd & Womersley 1981: 368. Silva *et al.* 1996: 548. Wilson & Kraft 2000: 360, figs 25–27. Womersley 1950: 189.

Rhodomela australasica Montagne 1840: 154.

Rytiphlaea australasica (Montagne)Harvey 1847: 32; 1855a: 538; 1858: pl. 27; 1863, synop.: xviii. J. Agardh 1863: 1092. Sonder 1880: 33. Tate 1882a: 23. Tisdall 1898: 513. Wilson 1892: 166.

Rytiphlaea australis (Montagne)Endlicher 1843: 48. Harvey 1859b: 298. Sonder 1853: 700.

Halopithys australasica (Montagne)Kützing 1849: 841; 1865: 10, pl. 27e–g.

Lophura australasica (Montagne) Kützing 1849: 851.

FIG. 162

Thallus (Fig. 162A) medium to dark red-brown, 5–15 cm high, spreading, oppositely but irregularly branched by loss of laterals, branches linear, compressed, endogenous, 0.5–1.5 mm broad, apices revolute (Fig. 162B), with a slight midrib, some axes with tendril-like ends. Holdfast discoid or tendril-like; epiphytic on *Amphibolis* or algae, or epilithic. *Structure*.

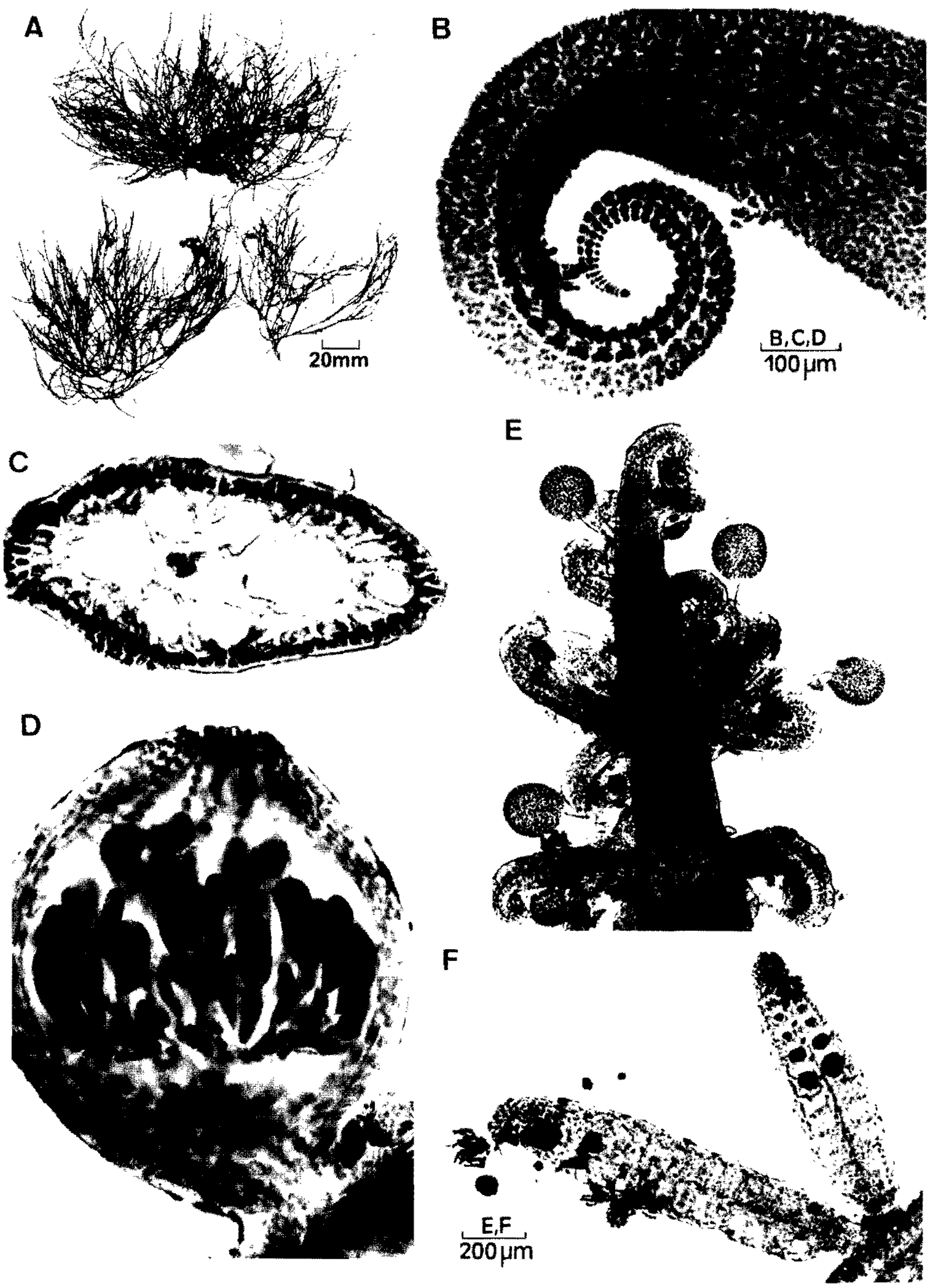

Fig. 162. *Protokuetzingia australasica* (AD, A64617). **A**. Habit. **B**. Revolute apex of branch. **C**. Transverse section of branch with 6 pericentral cells. **D**. Cystocarp with carposporophyte. **E**. Branch with spermatangial organs. **F**. Stichidia with paired tetrasporangia.

Apical cell dome-shaped, 20–25 µm in diameter (including thick walls), cutting off 6 pericentral cells (Fig. 162C), 2 lateral, 2 dorsal and 2 ventral, with frequent abaxial trichoblasts from each segment near apices and occasionally on the margins. Cortex present from near apices, 2–3 cells broad on edges and 1–2 cells thick on faces of branches. Cells uni- or multinucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps on the lower cells of trichoblasts, with a 4-celled carpogonial branch, borne abaxially on short marginal or submarginal involute branchlets. Carposporophytes with a basal fusion cell and short, branched gonimoblast with clavate to obovoid terminal carposporangia. Cystocarps (Fig. 162D) ovoid, short-stalked, 500–700 µm in diameter; pericarp ostiolate, 3–5 cells thick. Spermatangial organs (Fig. 162E) on branches of trichoblasts borne on short lateral branchlets, globose to shortly ovoid, 180–220 µm in diameter, with 1 (-3) sterile basal cells 30–50 µm in diameter and L/D 2–4.

Tetrasporangial stichidia (Fig. 162F) marginal or submarginal, in groups of 1–3, terminally involute, lanceolate, compressed, corticated, 0.9–1.6 mm long and 250–300 µm broad, with tetrasporangia paired, in two longitudinal rows, 80–120 µm in diameter; adaxial trichoblasts often present near apices of stichidia.

Type from Tasmania [probably Storm Bay, Tas. (*Labillardiere*)]; holotype in Herb. Montagne, PC.

Distribution: Port Denison, W. Aust., to San Remo, Vic., and around Tasmania.

Selected specimens: Port Denison, W. Aust., drift (*Kraft* 4007, 14.xii.1971; AD, A41712). Point Peron, W. Aust., drift (*Mitchell*, 22.ix.1966; AD, A30759). Head of Great Australian Bight, S. Aust., drift (*Woelkerling*, 4.xi.1968; AD, A34198). Elliston, S. Aust., 7 m deep in bay (*Shepherd*, 20.x.1970; AD, A37627). N Spencer Gulf, S. Aust., 12 m deep (*Shepherd*, 6.ix.1973; AD, A44452). Tiparra Reef, S. Aust., on *Amphibolis griffithii*, 11 m deep (*Shepherd*, 24.ii.1971; AD, A38232). Marino, S. Aust., on *A. antarctica*, 3 m deep (*Owen*, 27.i.1972; AD, A47229). Port Elliot, S. Aust., drift (*Womersley*, 17.x.1948; AD, A9424). Strawbridge Point, Kangaroo I., S. Aust., drift (*Womersley*, 29.x.1995; AD, A64617). Pennington Bay, Kangaroo I., S. Aust., sublittoral fringe (*Womersley*, 31.xii.1949; AD, A12807). Port MacDonnell, S. Aust., drift (*Womersley*, 27.x.1996; AD, A66727). Point Lonsdale, Vic., drift (*Sinkora* A1050, 14.xi.1970; AD, A62764). San Remo, Vic., drift (*Sinkora* A2023, 27.xi.1974; AD, A62763). Port Sorell, N Tas., drift (*Womersley*, 9.xi.1982; AD, A56240). Lady Bay, Southport, Tas., 3–5 m deep (*Brown* & *Womersley*, 28.x.1982; AD, A56530).

Protokuetzingia australasica is not uncommon in shallow water on calm to rough-water coasts along most of southern Australia.

Genus KUETZINGIA Sonder 1845: 54

by H.B.S. Womersley, S.M. Wilson & G.T. Kraft

Thallus erect, complanately and oppositely to irregularly branched, branches flat, linear, corticated, the apices and margins inrolled or flat, midrib present, secondary thickened below; holdfast discoid to conical. *Structure*. Apex inrolled, pericentral cells 6, 2 large lateral cells and 2 smaller dorsal and 2 ventral cells, with or without 1–4 pseudopericentral cells. Medulla of a single layer of large cells, cortex 2–3 cells thick.

Reproduction. Gametophytes dioecious where known. Procarps formed on short determinate branchlets on branch margins or surfaces; cystocarps in similar positions. Spermatangial organs borne on unbranched trichoblasts on similar determinate branchlets, ovoid with a sterile basal cell.

Tetrasporangial stichidia single or clustered on margins at ends of paired endogenous lateral axes or on branch surfaces on outgrowths from endogenous laterals, linear, with 2 rows of paired tetrasporangia.

Type species: *K. canaliculata* (Greville)Sonder 1845: 54.

An Australian endemic genus of 2 species, the type and *K. angusta* Harvey (1855a, p. 538; 1860, pl. 177) from Western Australia (Rottnest I. to Geraldton). *K. natalensis* J. Agardh from South Africa and *K. pectinella* (Harvey)Falkenberg (1901, p. 454) were placed in a new genus *Plectrophora* by Wilson & Kraft (2000), a name replaced by *Kentrophora* Wilson & Kraft *in* Henderson *et al.* 2001).

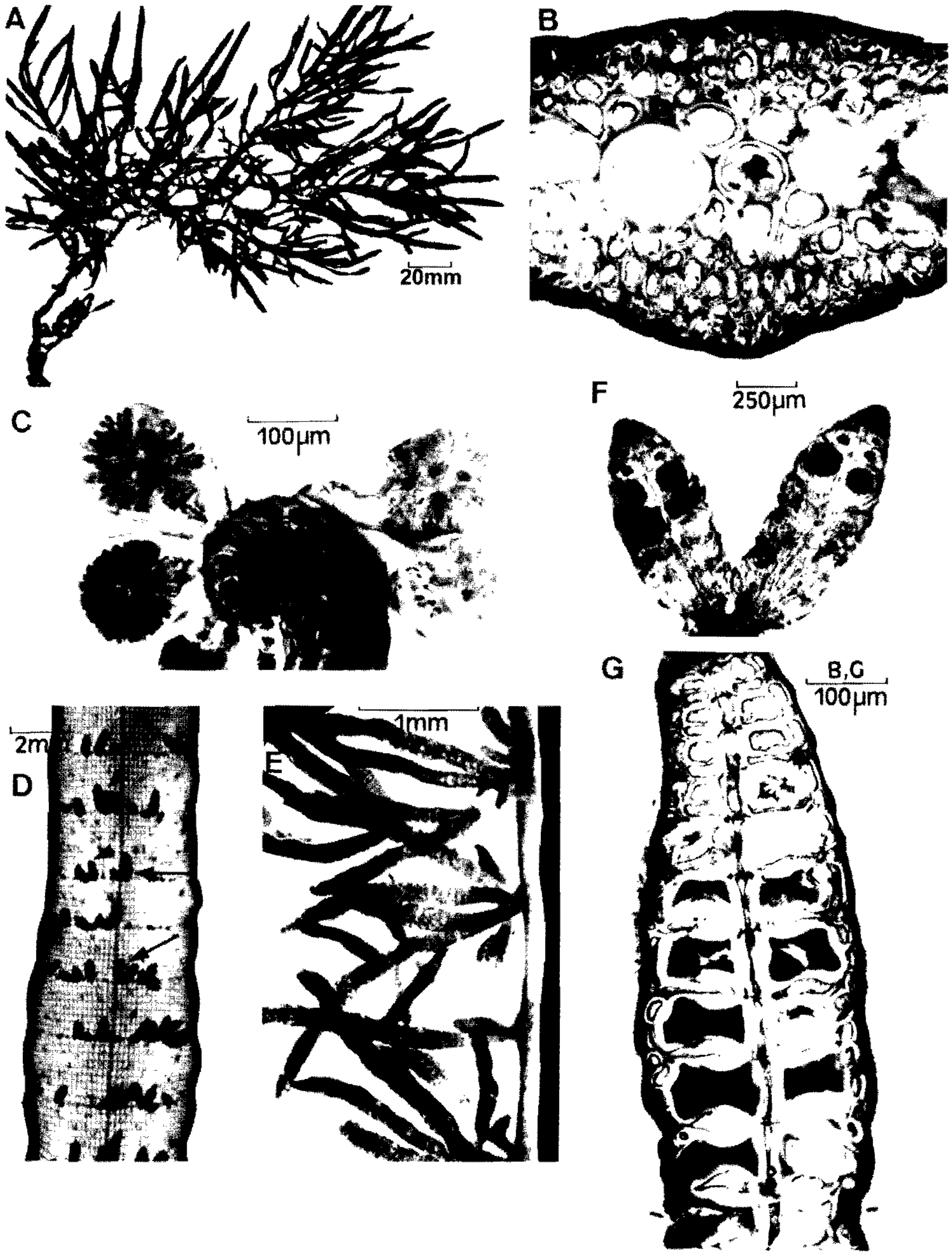

Fig. 163. *Kuetzingia canaliculata* (**A**, AD, A50638; **B**, **G**, AD, A50687; **C–F**, MELU, K6946 by G.T. Kraft). **A**. Habit. **B**. Transverse section of branch with 6 pericentral cells, 2 large lateral, 2 dorsal and 2 ventral plus 1 pseudopericentral cells. **C**. Spermatangial organs. **D**. Stichidia on the ventral surface and a few on the dorsal surface (arrows) of a branch. **E**. Simple and branched stichidia submarginal on the ventral side of a branch. **F**. Stichidia with paired tetrasporangia. **G**. Longitudinal section of a stichidium. (**C–F**, as in Wilson & Kraft 2000, courtesy of Aust. Syst. Botany.)

Kuetzingia is characterised by the opposite branching and endogenous laterals, 6 pericentral cells and single layer of larger medullary cells, and clustered marginal and submarginal stichidia.

Kuetzingia canaliculata (Greville)Sonder 1845: 54; 1848: 184. J. Agardh 1863: 1097. De Toni 1903: 1078. De Toni & Forti 1923: 46. Falkenberg 1901: 451, pl. 7 figs 30–36. Harvey 1847: 23, pl. 9; 1855a: 538; 1862a: pl. 232; 1863, synop.: xvi. Huisman 1997: 205; 2000: 169. Huisman & Walker 1990: 435. Kützing 1849: 846; 1865: 4, pl. 10. Kylin 1956: 542. Lucas 1909: 45. May 1965: 396. Schmitz & Falkenberg 1897: 470. Silva *et al.* 1996: 503. Sonder 1848: 184; 1880: 32. Wilson & Kraft 2000: 344, figs 12, 13.

Rytiphlaea canaliculata Greville 1831: 149, pl. iv, figs 1–4 (upper).

FIG. 163

Thallus (Fig. 163A) dark red-brown, 10–50 cm high, complanately branched with fairly regular (unless broken) opposite branches for 2–3 orders, branches 2–15 mm apart, axils broad, ultimate branches (1-) 2–6 cm long, branches flat, linear, (2-) 3–5 (-6) mm broad, corticated, midrib present, apices rounded with a slight notch, apex and often margins inrolled. Axes thickened and denuded below, 2–4 mm broad. Holdfast discoid-conical, 4–10 mm across; epilithic. *Structure.* Apex inrolled, with a dome-shaped apical cell. Pericentral cells (Fig. 163B) 6, 2 large lateral cells, 2 smaller dorsal and 2 (smallest) ventral cells, often with 1–4 interposed pseudopericentral cells. Wings with a single central layer of large cells and a small-celled cortex 2–3 cells broad, with a secondary cortex over the midrib. Opposite, endogenous, lateral filaments (Fig. 163D) arise every (2-) 4–10 axial cells. Trichoblasts occur at the ends of the endogenous lateral filaments. Cells uni- or multinucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps occur on terete marginal and surface laterals. Carposporophytes and cystocarps little known. Spermatangial heads (fig. 163C) subspherical, 100–150 µm in diameter, borne on large basal cells of unbranched trichoblasts in dorsal series on laterals.

Tetrasporangial stichidia (Fig. 163D–G) occur in clusters at the ends of the endogenous filaments, submarginally or from the surface on both surfaces, linear, compressed, 0.5–2 mm long and 200–400 µm broad, with 2 rows of paired tetrasporangia (Fig. 163F, G) 150–200 µm in diameter.

Type from "coast of Swan R. settlement", W. Aust. (*Fraser*); holotype in E.

Distribution: Dongara to Point D'Entrecasteaux, W. Aust., and Wanna, S. Australia.

Selected specimens: 7 mile beach, N of Dongara, W. Aust., drift (*Womersley*, 17.ix.1979; AD, A51367). Port Denison, W. Aust., 8–12 m deep (*Kraft & Allender*, 9.viii.1979; MELU, K6946). Cowaramup Bay, W. Aust., drift (*Royce* 655, 5.vi.1950; AD, A15491). Gnarabup Beach, W. Aust., in reef pools (*Womersley*, 1.ix.1979; AD, A50687). Flinders Bay (Augusta), W. Aust., drift (*Womersley*, 1.ix.1979; AD, A50638). Point D'Entrecasteaux, W. Aust., drift (*Smith*, 30.iii.1946; AD, A4551). Wanna, S. Aust., drift (*Womersley*, 19.ii.1959; AD, A22413).

Kuetzingia canaliculata extends from the north along the south-west coast of Western Australia within the southern Australian region, and one specimen is known from Wanna in South Australia. The species is not adequately known, especially as cystocarpic plants.

Genus NANOPERA Wilson & Kraft 2000: 340.

by H.B.S. Womersley, S.M. Wilson & G.T. Kraft

Thallus erect, pinnately branched, with slender axes bearing opposite determinate laterals which may become indeterminate as a further order of branching. Laterals and axes compressed, axes secondarily thickened below; holdfast discoid. *Structure.* Apices tapering, curved, pericentral cells 5, 2 lateral, 2 dorsal and 1 ventral, the lateral and dorsal cells forming a 2-layered medulla, with a cortex 2–3 cells thick. Trichoblasts short, branched, at apices of determinate laterals.

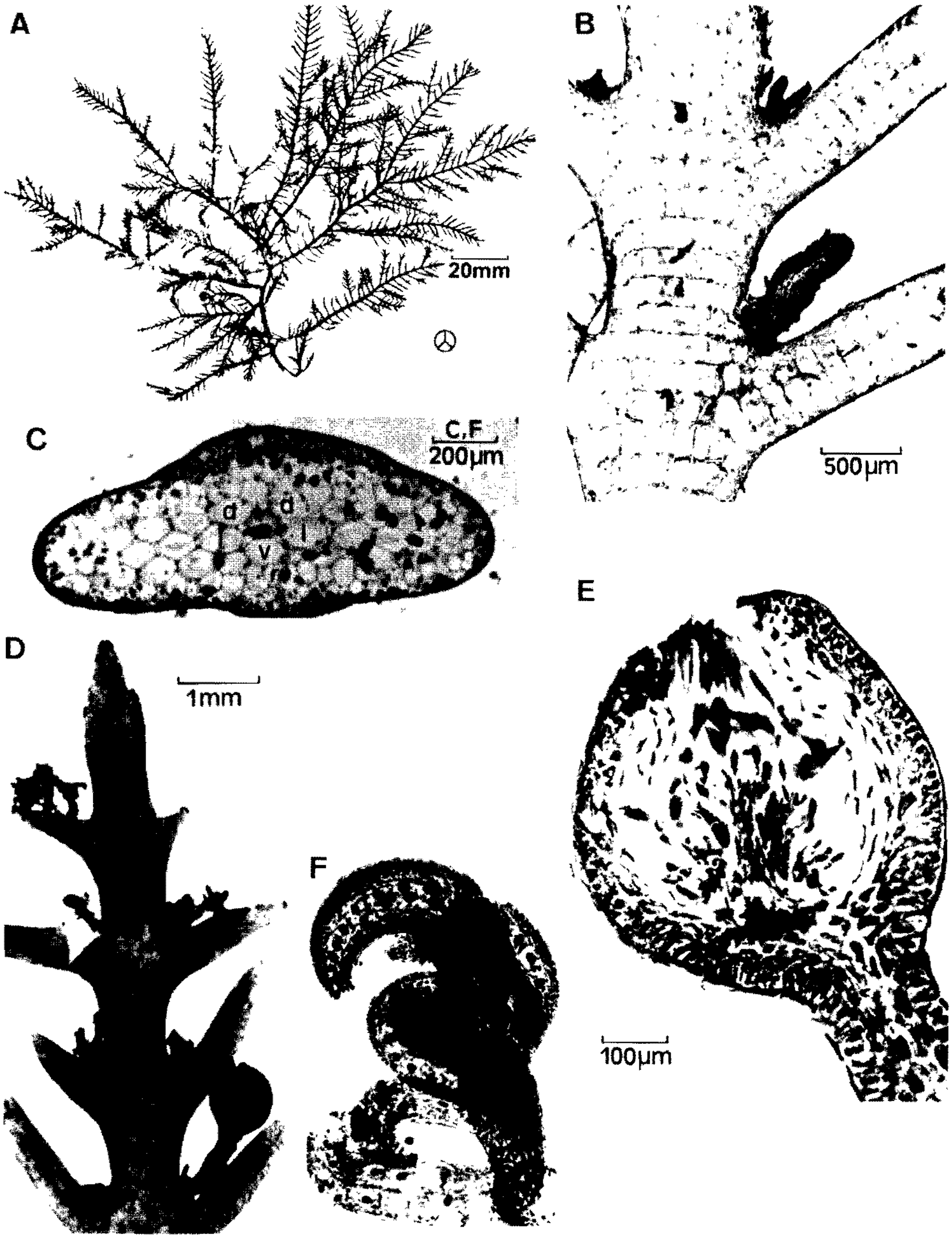

Fig. 164. *Nanopera merrifieldiae* (AD, A31044). **A**. Habit. **B**. Longitudinal section of branch with opposite laterals and axillary shoots. **C**. Transverse section of branch with 5 pericentral cells (2 dorsal, 2 lateral and 1 ventral). **D**. Branch with cystocarpic shoots in axils of opposite determinate laterals. **E**. Section of cystocarp. **F**. Stichidia.

Reproduction. Reproductive structures borne on short, branched shoots in the axils of determinate laterals. Procarps probably on rudimentary trichoblasts, soon on polysiphonous shoots and pericarpic; carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia; cystocarps globose, pericarp ostiolate, thick-walled. Spermatangial organs unknown.

Tetrasporangial stichidia in clusters on axillary shoots, linear but curved, corticated, with 2 rows of paired tetrasporangia.

Type (and only) *species*: *N. merrifieldiae* (J. Agardh)Wilson & Kraft 2000: 341.

Nanopera is characterised by the habit, with opposite, pinnate, branches, by the presence of 5 pericentral cells, and especially by the formation of reproductive organs on short, branched, shoots in the axils of the determinate laterals. However, it is a little-known genus and further study is warranted.

Nanopera merrifieldiae (J. Agardh)Wilson & Kraft 2000: 341, figs 7–10.

Rytiphlaea merrifieldii J. Agardh 1885: 107. De Toni 1903: 1098. Lucas 1909: 46. May 1965: 397. Silva *et al.* 1996: 551.

Enantiocladia axillaris Falkenberg 1901: 442, pl. 7 fig. 27. De Toni 1903: 1093. Lucas 1909: 46. Lucas & Perrin 1947: 298. May 1965: 397.

FIG. 164

Thallus (Fig. 164A) dark brown-red, 6–20 cm high, axes (1–2 mm broad) branched for 2–3 orders and bearing opposite, determinate, pinnate, tapering laterals (Fig. 164B) 3–6 mm long and 400–800 µm broad, axes and laterals compressed; some laterals becoming indeterminate as a further order of branching. Apices initially curved, later flat. Holdfast discoid; epilithic. *Structure.* Apices curved, tapering. Axial cells with 5 pericentral cells (Fig. 164C), 2 dorsal, 2 lateral and 1 ventral, the dorsal and ventral cells dividing to form a 2-layered medulla of uniform cells, with a cortex 2–3 cells thick. Secondary cortex occurs centrally on older axes. Short, branched trichoblasts occur at apices of young pinnate laterals. Cells uni- or multinucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Reproductive organs occur on short, branched, shoots in the axils of the pinnate laterals (Fig. 164B, D). Procarps with 4-celled carpogonial branches, soon on polysiphonous shoots and pericarpic. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia 30–50 µm in diameter. Cystocarps (Fig. 164D, E) globose, stalked, 500–800 µm in diameter; pericarp ostiolate, 5–6 cells thick. Spermatangial organs unknown.

Tetrasporangial stichidia (Fig. 164F) clustered on axillary short shoots, 600–1500 µm long, curved, compressed, corticated, 300–550 µm broad, with two rows of opposite tetrasporangia 100–150 µm in diameter.

Type from King George Sound, W. Aust. (*Merrifield*); holotype in Herb. Agardh, LD, 42497.

Distribution: Geraldton (*Wilson & Kraft*) to King George Sound, W. Australia.

Selected specimens: Geraldton, W. Aust., drift (*G. & R. Kraft*, 8.x.1990; MELU, K9970). Flat Rocks, 40 km S of Geraldton, W. Aust. (*Mitchell*, 17.ix.1966; AD, A31044).

Nanopera merrifieldiae is apparently a rare alga, extending from the west coast around to King George Sound (the type locality). Further study of fresh collections is desirable.

Genus LENORMANDIA Sonder 1845: 54, *nom. cons.*

by H.B.S. Womersley and L.E. Phillips

Thallus foliose, simple or branched from margins, surface or midrib, blades 1–20 cm broad, ovate to linear, apices rounded, apical cells conical, thick-walled, sunk within a distinct apical cleft. Axial cells cutting off 5 pericentral cells (pseudopericentral cells largely absent), 2 lateral ones on each side and a ventral pericentral cell, the lateral cells forming the 2–3-cell thick medulla of the wings, with a small-celled cortex 1–2 cells thick. Axial cells forming a clear midrib in most species, blade surfaces showing rhombic areolation due to regularly arranged medullary cells overlain by cortical cells, this appearance sometimes obscured on older parts. Trichoblasts present from surface cells or projections in some species.

Reproduction. Gametophytes dioecious. Procarps borne on reduced trichoblasts, rapidly polysiphonous, in scattered clusters on blade surface or margin, with a supporting cell bearing a 4-celled carpogonial branch and a lateral and a basal sterile cell group. Carposporophytes with a basal fusion cell and branched gonimoblast bearing clavate terminal carposporangia. Cystocarps ovoid, stalked, pericarp ostiolate and corticated (5–10 cells thick). Spermatangial organs on branches of trichoblasts, ovoid to elongate, in scattered clusters on blades.

Tetrasporangial stichidia on margin or surface of blade, single or clustered, ovoid to elongate-cylindrical, slightly compressed, each segment producing two opposite tetrasporangia, corticated and probably with cover cells.

Type species: *L. spectabilis* Sonder 1845: 54.

A genus of 5 species, all mainly confined to southern Australia (see Phillips 2002a).

KEY TO SPECIES OF *LENORMANDIA*

1. Thallus without lateral branches, ovate, usually 10–20 cm broad, occasionally with small lateral blades from the stipe; midrib absent or inconspicuous .... 5. *L. latifolia*
1. Thallus branched from the margins, surface or midrib, branches mostly 1–4 cm broad; midrib usually distinct 2

   2. Primary and secondary branches mostly 2–4 cm broad; thallus usually over 20 cm high 3
   2. Primary and secondary branches mostly 1–2 cm broad; thallus usually 5–15 cm high 4

3. Branches arising from face of blades between the slight midrib and the margin, or on the margin, with only a short, basally constricted, stipe; midrib only slightly thickened .... 1. *L. spectabilis*
3. Branches confined to the prominent midrib, with stipes 1–10 cm long; midrib becoming heavily thickened .... 2. *L. muelleri*

   4. Branches and reproductive organs mostly marginal; marginal dentations present near apices .... 3. *L. marginata*
   4. Branches and reproductive organs arising from surface of blades; margin entire .... 4. *L. pardalis*

1. **Lenormandia spectabilis** Sonder 1845: 54; 1848: 183; 1880: 32. J. Agardh 1863: 1106. De Toni 1903: 1117. Ducker *et al.* 1977: 87. Falkenberg 1901: 467, pl. 8 fig. 17. Fuhrer *et al.* 1981: pl. 39. Harvey 1847: 18; 1855a: 537; 1862a: pl. 181; 1863, synop. xvi. Huisman & Walker 1990: 437. Kützing 1849: 849; 1865: 3, pl. 8a–e. Kylin 1956: 547. Lucas 1909: 46. Lucas & Perrin 1947: 301. May 1965: 397. Phillips 2002a: 189, figs 2–5. Shepherd & Womersley 1981: 368. Silva *et al.* 1996: 522. Womersley 1950: 189.

Lenormandia spectabilis var. *enervis* Harvey 1863, synop. xvi. Silva *et al.* 1996: 522.

Lenormandia spectabilis var. *angustifolia* Harvey 1863, synop.: xvi. Silva *et al.* 1996: 522.

FIG. 165

Thallus (Fig. 165A) dark red-brown, fading to grey, 10–40 cm high, membranous, sparsely branched with branches usually 4–25 cm long and (1-) 2–4 (-6) cm broad, branches arising at or from within the margin of the parent blade, basally constricted into a short stipe, broadest half way or more along their length and tapering slightly to a rounded apex, margins entire, midrib slight. Holdfast discoid, 2–5 mm across; epilithic or epiphytic on *Amphibolis* and *Acrocarpia paniculata*. *Structure*. Apices cleft (Fig. 165B), apical cell conical, 50–60 μm in diameter (including very thick walls), axial cells cutting off 5 pericentral cells, the dorsal lateral cell larger than the ventral lateral cell, and the ventral pericentral cell, with the medulla 1–2 cells thick (thicker marginally) and a cortex 1–2 cells thick; surface view of blades showing rhombic areolation (Fig. 165B), cortical cells angular, irregular, 10–18 μm across and L/D 1–2.

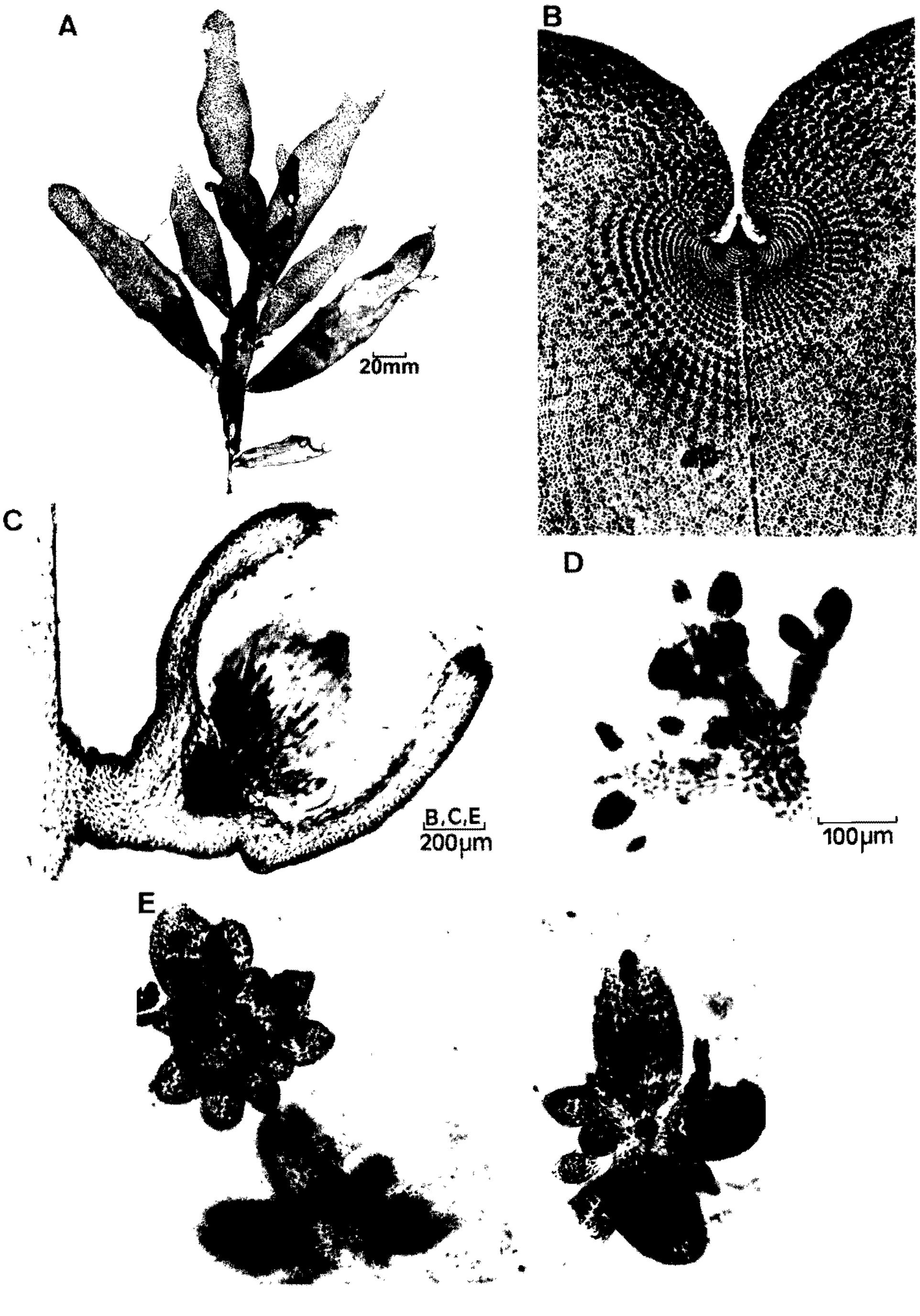

Fig. 165. *Lenormandia spectabilis* (**A**, AD, A44254; **B**, **E**, AD, A50769; **C**, AD, A31077; **D**, AD, A35889). **A**. Habit. **B**. Apex of blade, showing apical cleft and segmentation. **C**. Section of a cystocarp. **D**. Spermatangial organs on trichoblasts. **E**. Clusters of stichidia.

Trichoblasts present on blade surfaces associated with reproductive organs. Cortical cells uninucleate, medullary cells multinucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps on branches of reduced trichoblasts, with a supporting cell bearing a 4-celled carpogonial branch and a single basal cell and a lateral 2-celled sterile group, with a pre-fertilisation pericarp. Carposporophytes with a basal fusion cell and much branched gonimoblast with clavate terminal carposporangia 25–40 μm in diameter. Cystocarps (Fig. 165C) single (occasionally clustered) on blade surfaces, globose to ovoid, short stalked, 0.5–1 mm in diameter; pericarp ostiolate, 5–8 cells thick. Spermatangial organs (Fig. 165D) in dense clusters on blade surfaces, on branched polysiphonous shoots, with a sterile basal cell, ovoid, 35–55 μm in diameter and L/D 1.2–1.6.

Tetrasporangial stichidia in scattered clusters (Fig. 165E) on blade surfaces, ovoid, 300–900 μm long and 150–300 μm in diameter, slightly compressed, corticated, with tetrasporangia paired in 2–4 segments, 60–100 μm in diameter.

Type from "Nov. Holl. Occid." (*Preiss*); lectotype in HBG (no type material in MEL).

Distribution: Geraldton, W. Aust., to Robe, S. Australia.

Selected specimens: Flat Rocks, 40 km S of Geraldton, W. Aust., drift (*Mitchell*, 17.ix.1966; AD, A31077). Dongara, W. Aust., drift (*Kraft* 7090 & *Allender*, 9.viii.1979; MELU). Point Peron, W. Aust., on *Amphibolis antarctica*, drift (*Ducker*, 8.viii.1973; MELU, A21746). Safety Bay, W. Aust., drift (*Womersley*, 18.viii.1979; AD, A50769). Israelite Bay, W. Aust., drift (*Wells*, 10.xii.1974; AD, A46081). Isles of St Francis, S. Aust., 37 m deep (*Symonds*, 23.x.1973; AD, A44254). Waldegrave I., S. Aust., 22 m deep (*Shepherd*, 17.iv.1970; AD, A35889). Point Drummond, S. Aust., on *Acrocarpia*, drift (*Shepherd*, 19.x.1970; AD, A37404). Wanna, S. Aust., drift (*Womersley*, 19.ii.1959; AD, A22405). Encounter Bay, S. Aust., drift (*Harris*, Dec. 1943; AD, A1909). Seal Bay, Kangaroo I., S. Aust., drift (*Womersley*, 21.i.1965; AD, A28690). Stanley Beach, Kangaroo I., S. Aust., drift (*Womersley*, 6.ii.1957; AD, A20938). Robe, S. Aust., on *Amphibolis*, drift (*Womersley*, 30.x.1993; AD, A63214).

L. spectabilis is characterised by its robust dimensions and by daughter blades arising mostly within the margin of the parent blade and with a very short stipe. It is a deep-water species on rough-water coasts.

2. **Lenormandia muelleri** Sonder 1853: 696; 1855: 523; 1880: 32. J. Agardh 1863: 1105. De Toni 1903: 1116. De Toni & Forti 1923: 49. Falkenberg 1901: 467, pl. 8 figs 13–16. Fuhrer *et al.* 1981: pl. 40. Garnet 1971: 95. Guiler 1952: 106. Harvey 1858: pl. 45; 1863, synop.: xvi. Kützing 1869: 6, pl. 15a, b. Lucas 1909: 46; 1929b: 51. Lucas & Perrin 1947: 300, fig. 142. May 1965: 397. Phillips 2002a: 197, figs 2, 9, 10. Reinbold 1897: 55. Shepherd & Womersley 1971: 166. Tate 1882c: 22. Tisdall 1898: 513. Wilson 1892: 166. Womersley 1950: 189.

Lenormandia grevilleana J. Agardh *ex* Tisdall 1898: 513, *nom. nud.*

FIG. 166

Thallus (Fig. 166A) dark brown-red, 20–50 (-80) cm high, probably perennial, much branched with 3–4 orders of elongate-ovate blades all with distinct stipes 1–10 cm long, the lower axis denuded and secondarily thickened and usually several cm long, compressed to terete and 1–2 mm broad; blades simple, ovate to elongate, arising from the midrib of older blades, margins entire, smooth to undulating, 5–20 cm long and (1-) 2–4 (-8) cm broad, midrib distinct, becoming heavily thickened in the stipes. Holdfast discoid, becoming branched, 2–20 mm across; epilithic or epiphytic (on *Osmundaria*). *Structure.* Apices cleft (Fig. 166C), apical cell conical, 30–50 μm in diameter (including very thick wall), axial cells cutting off probably 5 pericentral cells (Fig. 166B) but these soon indistinct in transverse section; medulla irregular, 2–3 cells broad, cortex 2–3 cells broad, cells in surface view irregular, angular, 8–15 μm across, L/D 1–1.5, with clear rhombic areolation in young blades. Trichoblasts on midrib of young blades and associated with reproductive organs, 0.5–1 mm long, basal cell 40–60 μm in diameter, L/D 1–2. Cortical cells uninucleate, medullary cells probably multinucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps on reduced trichoblasts, becoming polysiphonous as short, branched, outgrowths scattered on the blade surface. Carposporophytes with a basal fusion cell and much branched gonimoblast with clavate terminal carposporangia 40–60 μm in diameter. Cystocarps (Fig. 166D) usually single, stalked, ovoid, 1–1.5 mm in diameter; pericarp ostiolate, 7–12 cells thick. Spermatangial

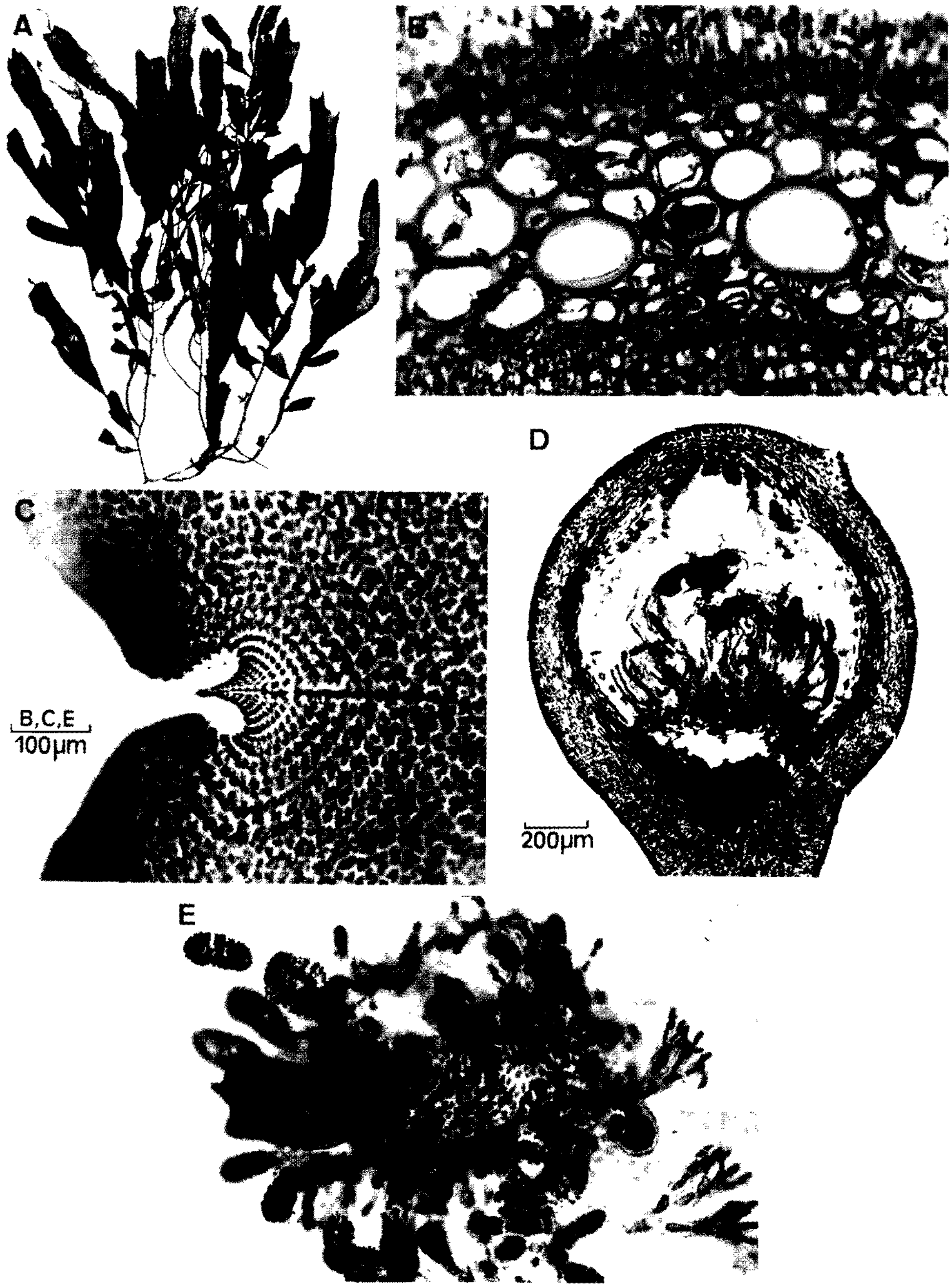

Fig. 166. *Lenormandia muelleri* (**A**, **B**, **D**, AD, A21286; **C**, **E**, AD, A61240). **A**. Habit. **B**. Transverse section of older branch showing axial and pericentral cells and midrib cortication. **C**. Apical cleft and segmentation. **D**. Section of cystocarp. **E**. Spermatangial organs on trichoblasts.

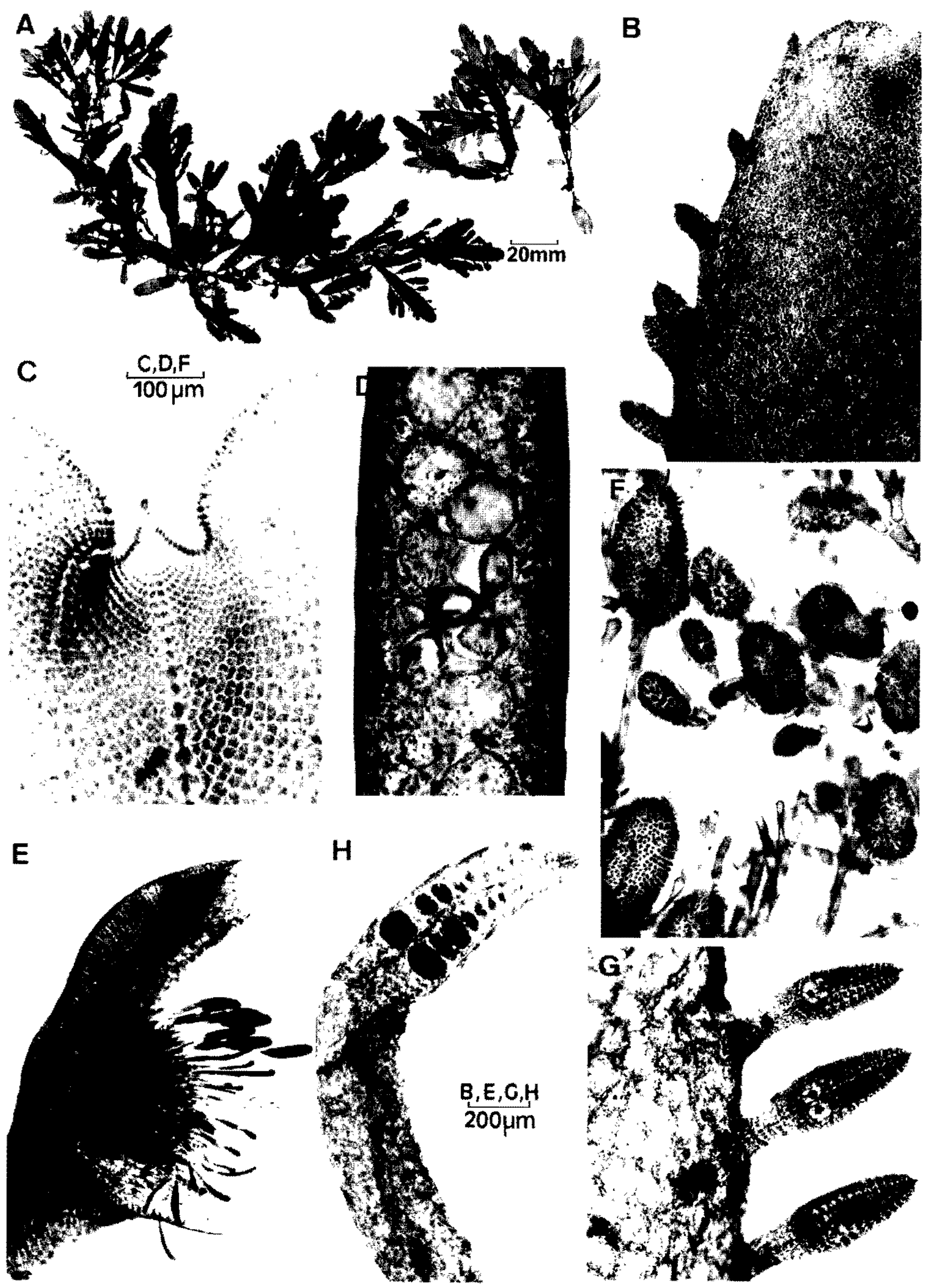

Fig. 167. *Lenormandia marginata* (**A**, AD, A64059; **B**, AD, A68549; **C**, **G**, AD, A63853; **D**, AD, A18775; **E**, **H**, AD, A68218; **F**, AD, A63832). **A**. Habit. **B**. Apex of branch with dentations. **C**. Apical cleft and segmentation. **D**. Transverse section of young branch with axial and 5 pericentral cells. **E**. Section of cystocarp (part) and carposporophyte. **F**. Spermatangial organs on trichoblasts. **G**. Stichidia on margin of branch. **H**. Stichidium with paired tetrasporangia.

organs (Fig. 166E) in dense clusters on branches of trichoblasts at the base of short, flat, proliferations on branch surfaces, 40–80 μm in diameter and L/D 1–2.5.

Tetrasporangial stichidia clustered, scattered on blade surface, often mainly on one surface, slightly compressed, 1–2 mm long and 200–400 μm broad, corticated, with tetrasporangia in opposite pairs, 60–80 μm in diameter.

Type from Rivoli Bay, S. Aust.; holotype in Herb. Sonder, MEL, 657622.

Distribution: Port Elliot, S. Aust., to Wilsons Prom., Victoria and Bruny I., Tasmania. Auckland Is ? (Papenfuss 1964b, p. 60).

Selected specimens: Port Elliot, S. Aust., drift (*Hussey*, May 1898; AD, A1382). Robe, S. Aust., drift (*Shepley*, 27.iii.1959; AD, A22972). Stinky Bay, Nora Creina, S. Aust., drift (*Womersley*, 19.viii.1957; AD, A21286). Off Cape Buffon, S. Aust., 5 m deep (*Collings*, 25.i.1991; AD, A61240 –"Marine Algae of southern Australia" No. 354). 1.35 km off Middle Point, Cape Northumberland, S. Aust., 15 m deep (*Johnson*, 20.iii.1974; AD, A45013). Lawrence Rock, Portland, Vic., 24–30 m deep (*Owen*, 2.ix.1971; AD, A39662). Warrnambool, Vic., drift (*Kraft* 7594, 10.viii.1984; MELU) and (*Kraft* 7992 & *Herrington*, 6.xi.1989; MELU). Point Roadknight, Vic., drift (*Womersley*, 6.vi.1953; AD, A18801). Wilsons Promontory, Vic., drift (*Wilson*; MEL, 657626). Hen & Chickens Rocks, Bruny I., Tas., sublittoral (*Sanderson*, 3.i.1988; AD, A68744).

L. muelleri is distinguished by its dimensions, coarse thickened stipes below the blades and branching from the stipes. It is a deep-water species on eastern southern Australian coasts.

3. **Lenormandia marginata** Hooker & Harvey *in* Harvey 1847: 19, pl. 20; 1859b: 295; 1862a; pl. 235; 1863, synop.: xvi. J. Agardh 1863: 1107. De Toni 1903: 1115. Falkenberg 1901: 461, pl. 8 figs 7–12. Fuhrer *et al.* 1981: pls 37, 38. Guiler 1952: 106. Hooker & Harvey 1847: 398. Kützing 1849: 849; 1865: 4, pl. 8d–h. Kylin 1956: fig. 435E. Levring 1946: 226. Lucas 1909: 46; 1929a: 23. Lucas & Perrin 1947: 304, fig. 144. May 1965: 397. Phillips 2002a: 195, figs, 2, 8. Schmitz & Falkenberg 1897: 471. Sonder 1853: 696; 1880: 32. Tisdall 1898: 513. Wilson 1892: 166.

FIG. 167

Thallus (Fig. 167A) medium to dark red-brown, 5–15 (-20) cm high, erect, complanately and marginally branched, usually bipinnate with primary and secondary blades 4–10 cm long and 5–17 (-20) mm broad centrally, basally narrow and tapering to rounded apices; midrib distinct to inconspicuous; tertiary blades borne irregularly marginally, mostly 5–20 mm long and 2–6 mm broad; young blade margins usually with minute dentations (Fig. 167B), absent from older blades. Holdfast discoid, 1–3 mm across; epilithic. *Structure*. Apices cleft (Fig. 167C), apical cell hemispherical, 30–40 μm in diameter (including thick walls), axial cells cutting off 5 pericentral cells (Fig. 167D), 2 lateral ones on each side (one larger than the other) and a ventral cell; pseudopericentral cells generally absent, but occasionally one cut off from the dorsal pericentral cell and inserted into the ring, with the lateral cells dividing to form the medulla mostly one cell broad (3–4 cells broad at the margins) in the wings; cortex 1 (-2) cells thick. Surface appearance of the blades showing rhombic areolation of the medullary cells, overlain by angular cortical cells, irregularly arranged and 14–30 μm across. Trichoblasts occasional, adventitious from surface cortical cells, much branched, 1–1.5 mm long, basal cells 30–40 μm in diameter and L/D 1–2, greatly reduced when associated with sexual organs. Cortical cells uninucleate, medullary cells multinucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps borne on reduced adventitious trichoblasts associated with the marginal dentations, occasionally also on the blade surface. Carposporophytes with a basal fusion cell, much branched gonimoblast and elongate-clavate carposporangia 20–35 (-40) μm in diameter. Cystocarps (Fig. 167E) short stalked, globose to ovoid, single or in small marginal groups, occasionally on the surface, 700–1100 μm in diameter; pericarp 5–10 cells thick, with a small ostiole. Spermatangial heads (Fig. 167F) on the blade surface on reduced trichoblasts, with unicellular pedicels, ovoid, 70–100 μm in diameter and L/D 1–2.

Tetrasporangial stichidia (Fig. 167G, H) marginal, single, occasionally to frequently on the blade surface, 1–2 (-3) mm long and 250–360 μm broad, slightly compressed, corticated, with sporangia in 2 longitudinal rows, 2 per segment, 70–100 μm in diameter.

Type from mouth of the Tamar, Tasmania (*Gunn*); lectotype in TCD; a specimen in BM labelled "n. sp.", from "V.D. Land" may be the holotype but is not labelled "mouth of the Tamar".

Distribution: Waterloo Bay, S. Aust., to Gabo I., Vic., and around Tasmania.

Selected specimens: Waterloo Bay (Elliston), S. Aust., 13 m deep (*Shepherd*, 26.ii.1978; AD, A55004). West Point, Eyre Pen., S. Aust., 10–12 m deep (*Shepherd*, 25.x.1969; AD, A34927). Port Elliot, S. Aust., drift (*Womersley*, 24.vii.1949; AD, A11101). Nora Creina, S. Aust., 3–6 m deep (*Kraft* 4951, 18.ii.1974; MELU and AD, AD46024). 13 km off Cape Northumberland, S. Aust., 61 m deep (*Shepherd*, 7.v.1975; AD, A46288). Point Roadknight, Vic., drift (*Womersley*, 6.vi.1953; AD, A18775). Gabo I., Vic., 13 m deep (*Shepherd*, 14.ii.1973; AD, A43336). Barrel Rock, Georgetown, Tas., 12–16 m deep (*Edgar*, 19.x.1994; AD, A63853). Pirates Bay, Eaglehawk Neck, Tas., 9–12 m deep (*Gowlett-Holmes*, 31.x.1994; AD, A64059). Painted Cliffs, Maria I., Tas., 6–8 m deep (*Edgar*, 22.iii.2000; AD, A68549). N end Governor I., Bicheno, Tas., 8–16 m deep (*Edgar*, 23.x.1994; AD, A63832). Tinderbox, Tas., 7–10 m deep (*Kraft & Sanderson*, 20.xii.1990; MELU, K9246). Ninepin Point, Tas., 7–12 m deep (*Edgar*, 1.v.1999; AD, A68218).

4. **Lenormandia pardalis** J. Agardh 1894: 80. De Toni 1903: 1119. Lucas 1909: 46. Lucas & Perrin 1947: 302. May 1965: 397. Phillips 2002a: 192, figs, 2, 6, 7. Shepherd & Womersley 1981: 368.
Lenormandia marginata sensu Huisman & Walker 1990: 437. Silva *et al.* 1996: 522.
Lenormandia pusilla Sonder 1880: 32 (*nom. nud.*)

FIG. 168

Thallus (Fig. 168A) medium to dark brown-red, 5–10 cm high, membranous, erect, irregularly branched from the frond surface, primary and secondary blades 3–7 cm long and 4–9 mm broad, ovate to oblong but basally constricted and with rounded apices, margins entire and sometimes slightly involute; midrib faint to distinct; tertiary blades smaller, ovate. Holdfast discoid to fibrous, 2–3 mm across; epilithic or epiphytic. *Structure.* Apices cleft, apical cells conical, 40–60 µm in diameter (including thick walls), axial cells cutting off 5 pericentral cells, 2 lateral ones on each side and a ventral cell, with the lateral cells becoming interposed to form the mainly one-cell broad medulla, with a cortex 1 (-2) cells thick. Surface appearance clearly rhombic areolate, cortical cells irregularly arranged, 15–40 µm across, L/D 1–2. Trichoblasts adventitious, scattered on the surface, arising from cortical cells, much branched, 0.7–1.2 mm long, basal cells 16–25 µm in diameter, L/D 1–2. Cortical cells uninucleate, medullary cells multinucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps (Fig. 168B) occur in clusters on trichoblasts on the blade surface, soon on polysiphonous branches. Carposporophytes with a basal fusion cell, much branched gonimoblast and clavate carposporangia 50–90 µm in diameter. Cystocarps (Fig. 168C) stalked, globose, 500–800 µm in diameter; pericarp ostiolate, 4–7 cells thick. Spermatangial organs (Fig. 168D, E) in dense clusters on branches of surface trichoblasts, ovoid, 45–75 µm in diameter, L/D 1.5–2.

Tetrasporangial stichidia (Fig. 168F) in clusters on blade surfaces, 300–600 µm long and 200–300 µm broad, ovoid, slightly compressed, corticated, with 2 tetrasporangia per segment, 70–120 µm in diameter.

Type from Port Elliot, S. Aust. (*Hussey*); lectotype in Herb. Agardh, LD, 42768; isotypes in MEL, 657638, 657639.

Distribution. Yanchep, W. Aust., to Gabo I., Vic. and Deal I., Bass Strait.

Selected specimens: Yanchep, W. Aust., drift (*G. & R. Kraft*, 29.ix.1990; MELU, K8561). Point Peron, W. Aust., drift (*Kraft*, April 1966; MELU, K1507). Hamelin Bay, W. Aust., 2–10 m deep (*O'Brien*, 12.i.1978; MELU, 22743). Nuyts Reef, S. Aust., 30 m deep (*Shepherd*, 27.iii.1980; AD, A52345). Elliston, S. Aust., drift (*Womersley*, 13.i.1951; AD, A13564). Port Elliot, S. Aust., drift (*Womersley*, 10.viii.1957; AD, A21119). Seal Bay, Kangaroo I., S. Aust., drift (*Womersley*, 22.xi.1968; AD, A32973). Pennington Bay, Kangaroo I., S. Aust., on *Codium galeatum*, drift (*Womersley*, 12.i.1944; AD, A2707). Stanley Beach, Kangaroo I., S. Aust., drift (*Womersley*, 7.ii.1956; AD, A20087 and 6.ii.1957; AD, A20936). Robe, S. Aust., drift (*Womersley*, 20.xii.1953; AD, A19115). Gabo I., Vic., on *Epiglossum smithiae*, 18 m deep (*Shepherd*, 17.ii.1973; AD, A43505). Little Squally Cove, Deal I., Bass Strait, 30 m deep (*Shepherd & Lewis*, 3.v.1974; AD, A45212).

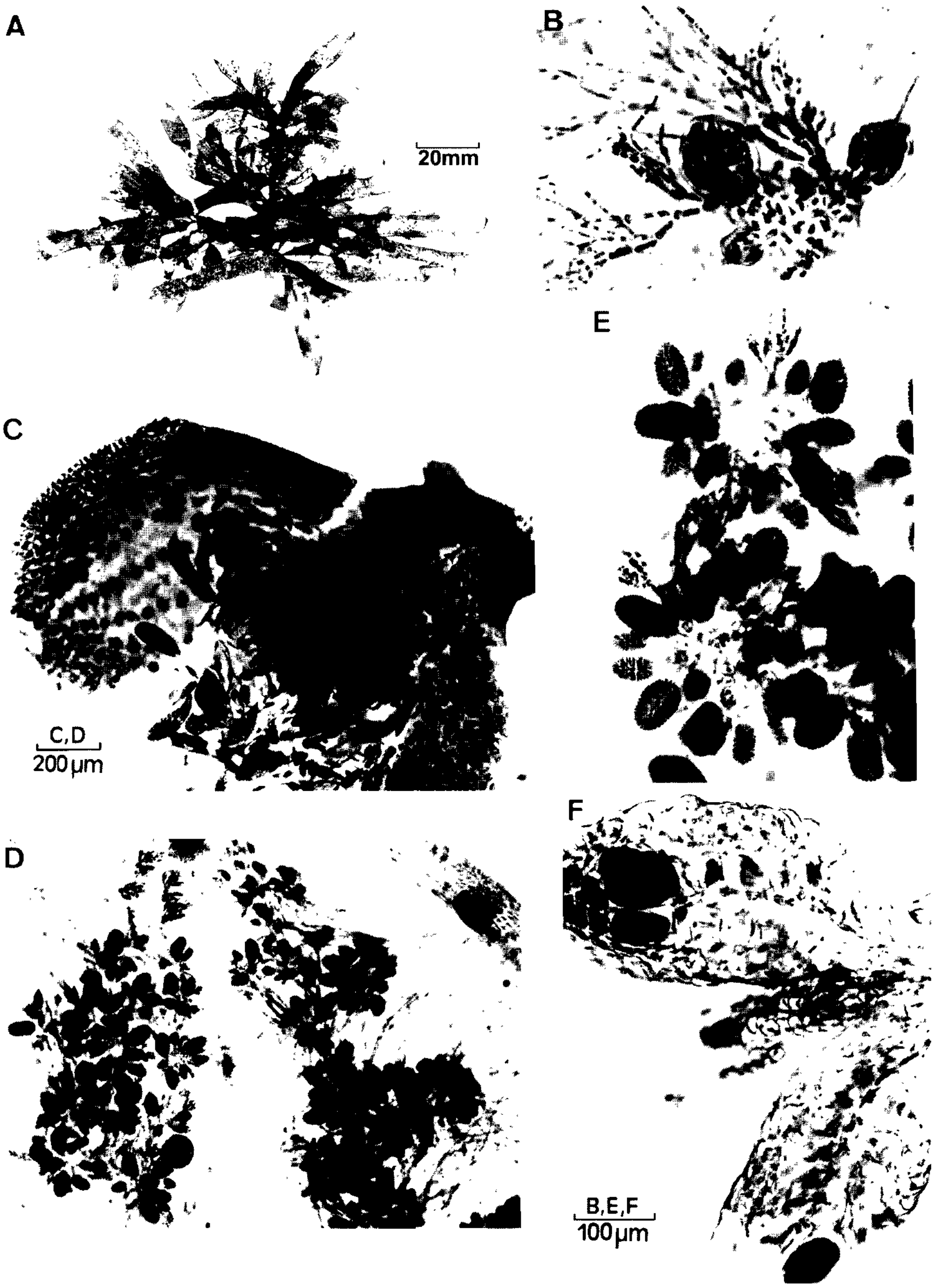

Fig. 168. *Lenormandia pardalis* (**A**, AD, A2707; **B**, **C**, AD, A20936; **D**, **E**, AD, A32973; **F**, AD, A20087). **A**. Habit. **B**. Mature procarps developed on trichoblast cluster on branch surface. **C**. Cystocarp (broken). **D**. Spermatangial organs on trichoblasts on branch surface. **E**. Spermatangial organs on trichoblasts. **F**. Stichidia.

5. **Lenormandia latifolia** Harvey & Greville *in* Harvey 1847: 19. J. Agardh 1890: 67; 1892: 169. Lucas 1929b: 51. Phillips 2002a: 199, figs 2, 11.

Lenormandia spectabilis var. *latifolia* (Harvey & Greville)Harvey 1863, synop.: xvi. *Aneuria latifolia* (Harvey & Greville) De Toni 1924: 429. May 1965: 397. Womersley 1950: 189.

Lenormandiopsis latifolia (Harvey & Greville)Papenfuss 1967: 103. Ducker *et al.* 1977: 87. Huisman 1997: 206; 2000: 172. Norris 1987b: 82, figs 12–15. Shepherd & Womersley 1981: 368. Silva *et al.* 1996: 522.

FIG. 169

Thallus (Fig. 169A) medium red to dark red-brown, with one (occasionally a few small lateral blades from the stipe) unbranched blade from a short stipe, blades usually 20–60 (-80) cm long and (5-) 10–20 cm broad, ovate to elongate, expanding from the short stipe upwards and broadest at half or more of the length, margin smooth, apex broadly tapering and rounded; midrib slight, not apparent in older blades, faintly visible in some young fronds. Holdfast discoid to divided, 2–5 mm across; usually epiphytic on Osmundaria, occasionally on

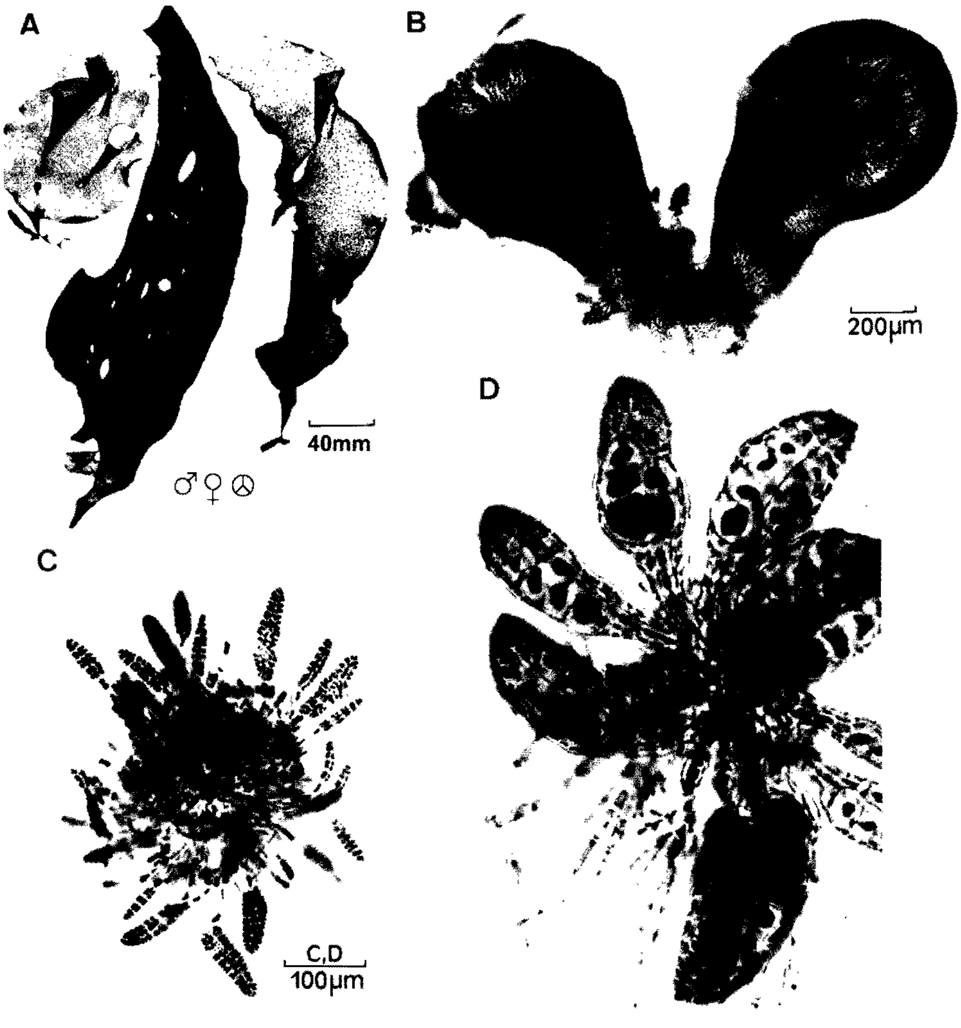

Fig. 169. *Lenormandia latifolia* (**A–C**, AD, A44207; **D**, AD, A68869). **A**. Habit. **B**. Cystocarps. **C**. Spermatangial organs on cluster of trichoblasts. **D**. Stichidia.

Epiglossum smithiae, possibly also epilithic. *Structure*. Apices usually lost from mature plants, axial cells with 5 pericentral cells, clear only close to the apex; midrib; medulla 2–3 cells thick, cells irregularly arranged, cortex 1–2 cells thick with surface cells angular, more-or-less isodiametric and 12–30 µm across in surface view. Rhombic areolation apparent only near apices of young blades. Trichoblasts scattered on thallus surface, 1–2.5 mm long. Rhodoplasts discoid, often becoming chained.

Reproduction. Gametophytes dioecious. Procarps on lower cells of exogenous trichoblasts on the blade surface, the branchlets soon becoming polysiphonous. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia 25–50 µm in diameter. Cystocarps (Fig. 169B) ovoid to pyriform with a thick stalk, 0.5–1 mm in diameter; pericarp ostiolate, corticated, 4–6 cells thick, often with a side bulge. Spermatangial organs (Fig. 169C) clustered on branches of surface trichoblasts, elongate-ovoid, 25–50 µm in diameter and L/D 3–4, with 1–3 sterile basal cells.

Tetrasporangial stichidia (Fig. 169D) in dense clusters scattered on the blade surface, stalked, elongate-ovoid to cylindrical, 200–280 µm in diameter and L/D 2–4, corticated, with paired tetrasporangia 60–100 µm in diameter.

Type from Swan R. colony, W. Aust. (*Mylne*); holotype in Herb. Harvey, TCD.

Distribution: Yanchep, W. Aust., to Cape Northumberland, S. Australia.

Selected specimens: Yanchep, W. Aust., drift (*Womersley*, 22.ix.1979; AD, A51270). Point Peron, W. Aust., drift (*Huisman*, 25.viii.1999; MELU, 49). Israelite Bay, W. Aust., drift (*Wells*, 10.xii.1974; AD, A46082). Elliston, S. Aust., on *Osmundaria*, 10 m deep (*Shepherd*, 18.x.1973; AD, A44207). Avoid Bay, S. Aust., on *Osmundaria*, drift (*Womersley*, 30.xi.1975; AD, A46831). Investigator Strait, S. Aust., 19 m deep (*Watson*, 11.i.1971; AD, A38510). Port Elliot, S. Aust., on *Osmundaria*, drift (*Womersley*, 17.x.1948; AD, A9390). Point Tinline, Kangaroo I., S. Aust., on *Osmundaria*, drift (*O'Leary*, 5.xi.1990; AD, A60774). Monument Reef, Kangaroo Head, Kangaroo I., S. Aust., 12 m deep (*Lavers*, 14.ii.2000; AD, A68869). Cape Jaffa, S. Aust., drift (*Womersley*, 10.xii.1991; AD, A61561). 11 km off Cape Northumberland, S. Aust., on *Epiglossum smithiae*, 48 m deep (*Shepherd*, 6.v.1975; AD, A46321).

Lenormandia latifolia was returned to the genus *Lenormandia* by Phillips (2002a) since it differs from other species only in the blade being unbranched (apart from small lateral blades from the stipe). Also, young blades do show a central axis and rhombic areolation, both of which are not apparent in mature blades.

L. latifolia is common on rough-water coasts of most of southern Australia, but not on Victorian or Tasmanian coasts.

Genus AMANSIA Lamouroux 1809a: 332; 1809b: 132

Thallus erect, more-or-less pinnately and complanately branched, branches flat, linear to serrate with determinate pinnules, with horizontal tiers of elongate cells in surface view, wings ecorticate, midrib slight to prominent; apices circinnate. *Structure*. Apical cells in circinnate apices, axial cells cutting off 5 pericentral cells, 2 lateral on each side and one ventral, with the dorsal-lateral pericentral cells and occasionally the ventral cell each cutting off a pseudopericentral cell; the lateral pericentral cells divide rapidly to produce the distromatic wings, the elongate cells in surface view lying in horizontally aligned tiers and slightly overlapping at their ends.

Reproduction. Gametophytes dioecious. Reproductive organs borne on short, spinous, marginal shoots or the spinous pinnules. Procarps borne on reduced or normal trichoblasts which are soon polysiphonous and pericarpic. Carposporophytes with a basal fusion cell and much-branched gonimoblast with clavate terminal carposporangia. Cystocarps globose to ovoid, stalked; pericarp ostiolate, corticate and 3–6 cells thick. Spermatangial organs clustered on the determinate laterals, ovoid, with a sterile basal cell.

Tetrasporangial stichidia on the determinate laterals, elongate, curved to circinnate, compressed, with 2 rows of paired tetrasporangia.

Type species: *A. multifida* Lamouroux 1809a: 332, pl. 6 figs C–E.

Norris (1988a, p. 210) claimed that no pseudopericentral cells were present in the type species, *A. multifida*, and on this feature he segregated several species as a new genus

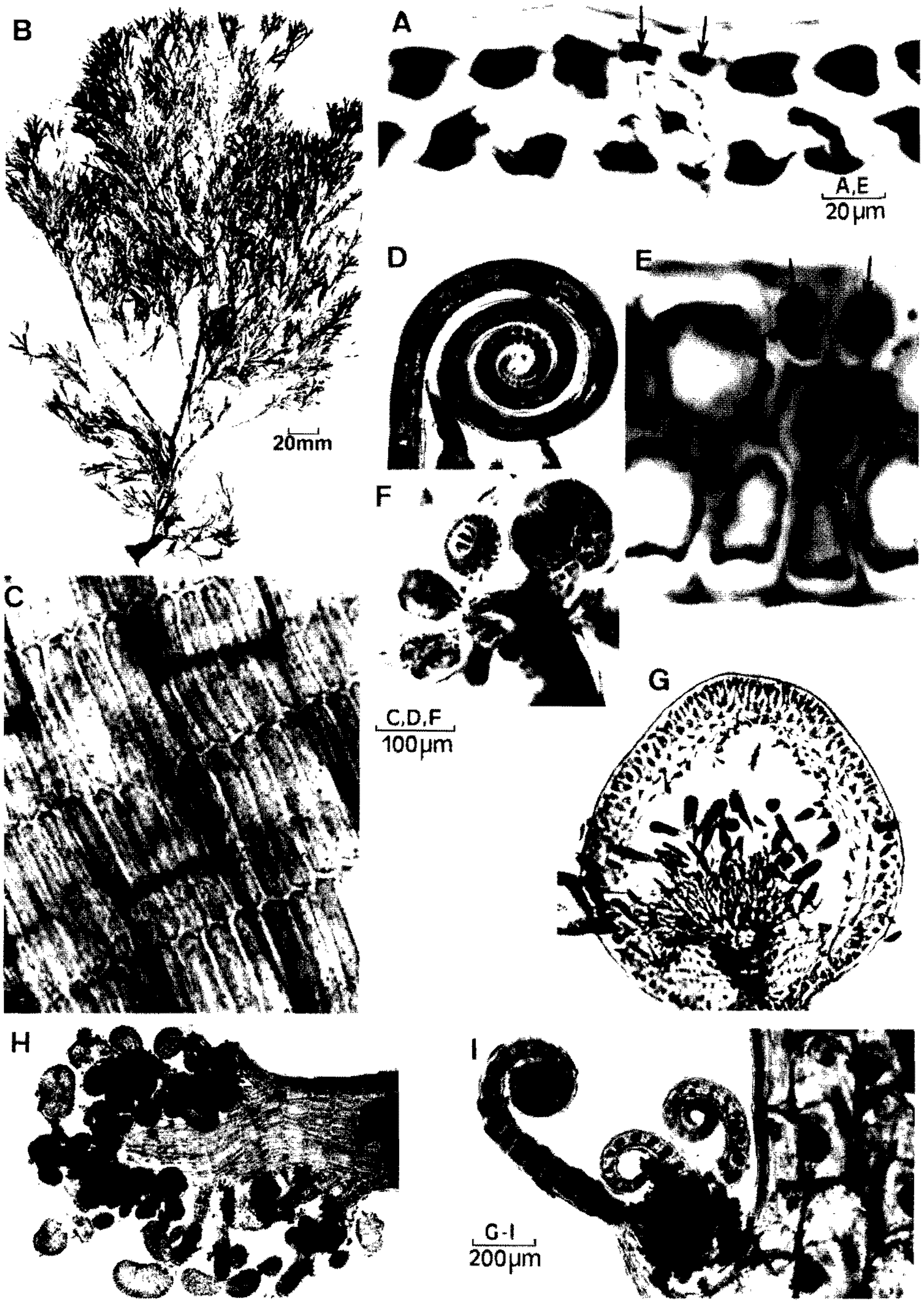

Fig. 170. **A**. *Amansia multifida* (Rocas, Santo Domingo; CIBIMA 7634, AD, A49316). Transverse section of blade showing 2 pseudopericentral cells (arrows) from the dorsal pericentral cells. **B–I**. *Amansia pinnatifida* (**B**, AD, A61792; **C**, **D**, **F**, **H**, AD, A68837; **E**, AD, A68457; **I**, AD, A68881). **B**. Habit. **C**. Surface pattern of transverse tiers of cells. **D**. Section of circinate apex. **E**. Transverse section of axial and pericentral cells, with 2 dorsal pseudopericentral cells (arrows). **F**. Procarps of various ages. **G**. Section of cystocarp. **H**. Spermatangial organs. **I**. Stichidia.

Melanamansia. However, study of *A. multifida* from Rocas, Santo Domingo (*Almodovar & Rivas*, 27 July 1977, CIBIMA 7634; AD, A49316) shows that pseudopericentral cells do occur (Fig. 170A). Other supposed differences are insignificant. Hence *Melanamansia* Norris should become a synonym of *Amansia*.

Amansia is characterised by its habit, ecorticate wings of 2 layers of elongate tiered cells, and axes with 5 pericentral cells plus usually 2 pseudopericentral cells. Besides the 3 southern Australian species described below, several other species occur on northern coasts of Australia.

KEY TO SPECIES OF *AMANSIA*

1. Branches mostly 6–8 mm broad; margins with regular, short, multicellular spines from each row of lateral wing cells .... 3. *A. mamillaris*
1. Branches mostly 2–4 mm broad, margin entire or with spinous pinnules on alternate rows of lateral wing cells 2

2. Branches linear with entire margins apart from short reproductive laterals .... 1. *A. pinnatifida*
2. Branches bipinnate, with short, marginal, alternate, determinate, spinous pinnules .... 2. *A. serrata*

1. **Amansia pinnatifida** Harvey 1862a: pl. 222; 1863, synop.: xv. J. Agardh 1863: 1114; 1885: 109; 1892: 172. De Toni 1903: 1090. Falkenberg 1901: 419. Lucas 1909: 45; 1929b: 51. Lucas & Perrin 1947: 296. May 1965: 396. Reinbold 1897: 55. Shepherd & Womersley 1971: 166. Tate 1882a: 22. Womersley 1950: 189.
Melanamansia pinnatifida (Harvey)Norris 1988a: 222. Silva *et al.*1996: 527.

FIG. 170B–I

Thallus (Fig. 170B) medium to dark red-brown, 10–40 cm high, much branched alternately marginally and complanately with flat, linear, branches (1.5-) 2–3 mm broad, slightly constricted basally and with ventrally circinnate apices (Fig. 170D), margins entire, midrib clear on dorsal side, the cells in surface view in transverse tiers (Fig. 170C) with the ends of the 2 layers overlapping alternately, ecorticate. The ventral surface of branches invariably bears an almost complete cover of the bryozoan *Bathypora nitens* (Hinks). Lower axes denuded of most laterals, 2–4 mm broad, the midrib secondarily thickened. Holdfast discoid-conical, 2–20 mm across; epilithic. *Structure*. Apex circinnate, apical cell hemispherical, 12–18 µm in diameter, axial cells cutting off 5 pericentral cells, 2 lateral on each side and 1 ventral, with the dorsal-lateral cells each cutting off a pseudopericentral cell (Fig. 170E) and the lateral cells dividing rapidly to produce the 2 cell-thick wings with mature cells 35–50 µm in diameter and L/D 5–6, ends dovetailing. The midrib develops secondary thickening first ventrally, spreading laterally and later also dorsally. Trichoblasts not observed. Cells multinucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Reproductive organs borne on short, spinous, marginal shoots. Procarps on reduced trichoblasts on these shoots, soon polysiphonous and pericarpic (Fig. 170F). Carposporophytes with a basal fusion cell and much branched gonimoblast with clavate terminal carposporangia 30–50 µm in diameter. Cystocarps (Fig. 170G) on margins, with a short, thick, stalk, globose to ovoid, 500–1200 µm in diameter; pericarp ostiolate, 4–6 cells thick. Spermatangial organs (Fig. 170H) clustered on short, branched, marginal laterals, with a basal sterile cell, ovoid, 90–180 µm in diameter.

Tetrasporangial stichidia (1–5) (Fig. 170 I) on short marginal spinous branchlets, curved to circinnate, compressed, corticated, 0.5–1.5 mm long and 150–300 µm broad, with 2 rows of paired tetrasporangia 70–110 µm in diameter.

Type from King George Sound, W. Aust. (*Harvey*); lectotype (*Harvey*, Alg. Aust. Exsicc. 119B) in Herb. Harvey TCD.

Distribution: King George Sound, W. Aust., to Robe, S. Australia.

Selected specimens: Eucla, W. Aust., drift (*Womersley*, 2.ii.1954; AD, A19356). Nuyts Reef, S. Aust., 9–10 m deep (*Shepherd*, 26.iii.1980; AD, A52211). Pearson I., S. Aust., 15 m deep (*Shepherd*, 8.i.1969; AD, A33933). Snapper Point, Port Lincoln, S. Aust., 6–8 m deep (*Shepherd*, 1.i.1964; AD,

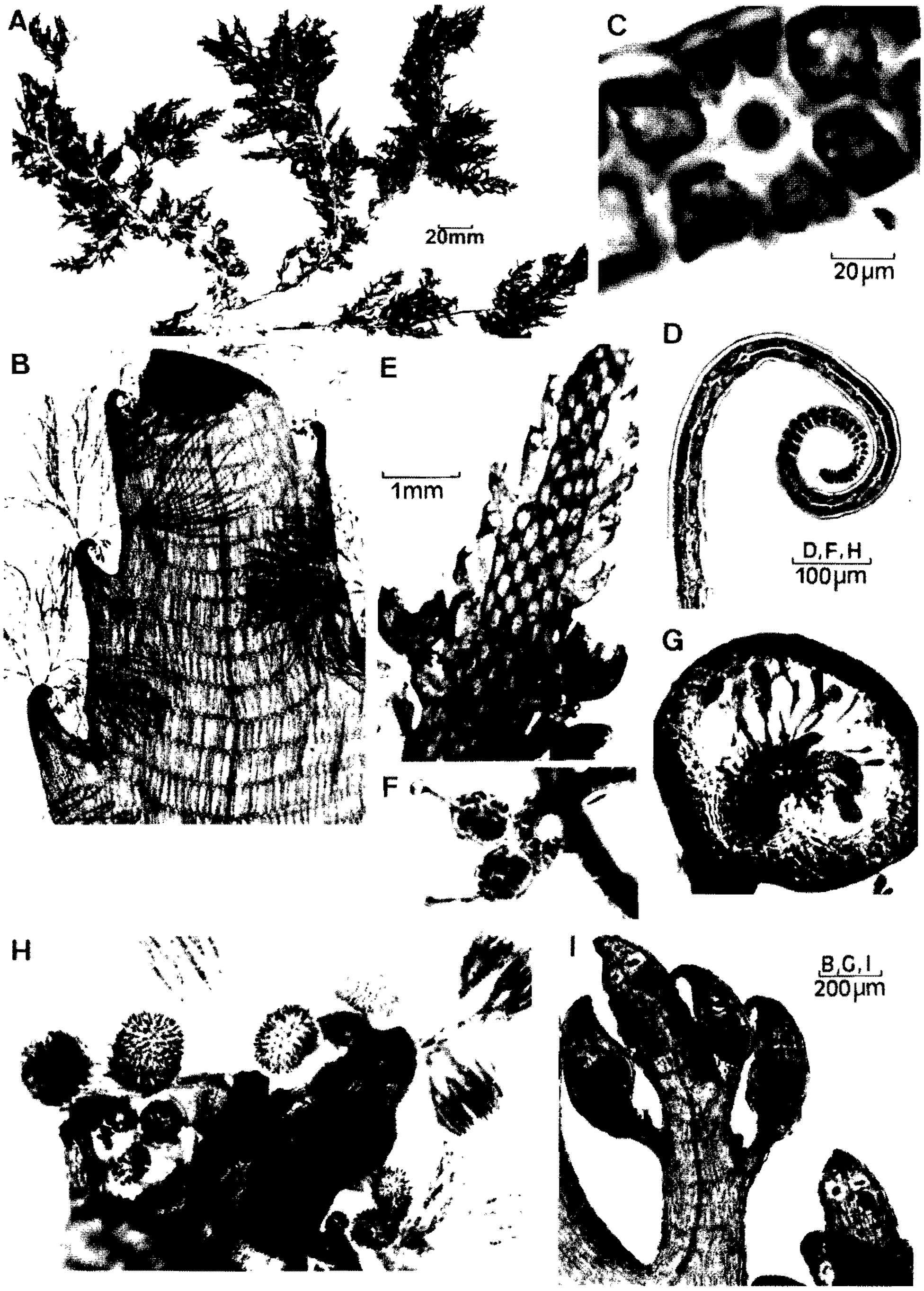

Fig. 171. *Amansia serrata* (**A**, **D**, **I**, AD, A68472; **B**, **C**, AD, A68838; **E**, AD, A20930; **F**, AD, A24848; **G**, AD, A68116; **H**, AD, A68902). **A**. Habit. **B**. Branch with spinous laterals and trichoblasts, showing cell arrangement. **C**. Transverse section of axial and pericentral cells, with 2 dorsal pseudopericentral cells (upper). **D**. Section of circinnate apex. **E**. Cover of a bryozoan or the branch surface. **F**. Procarps. **G**. Section of a cystocarp. **H**. Spermatangial organs. **I**. Stichidia.

A27087). Outside Tapley Shoal, Gulf St Vincent, S. Aust., 15 m deep (*Shepherd*, 2.ii.1969; AD, A33534). Investigator Str., S. Aust., 24 m deep (*Watson*, 9.i.1971; AD, A38449). Victor Harbor, S. Aust., 10 m deep (*Clarke & Engler*, 17.x.1979; AD, A63180). Cable Hut Reef, Penneshaw, Kangaroo I., S. Aust., 22 m deep (*Lavers*, 1.ii.2000; AD, A68837). Ironstone Point, Kangaroo I., S. Aust., 14 m deep (*Lavers*, 11.xii.1999; AD, A68881). Vivonne Bay, Kangaroo I., S. Aust., drift (*Womersley*, 29.xii.1999; AD, A68457). Pennington Bay, Kangaroo I., S. Aust., drift (*Womersley*, 22.i.1946; AD, A2937) and 0.5 m deep in channel (*Kraft*, 4.xii.1971; MELU, K4051 and AD, A69223). Cape Jaffa, S. Aust., drift (*Womersley*, 25.xi.1992; AD, A61792). Robe, S. Aust. (*Macklin*, Jan. 1926; AD, A1373).

Amansia pinnatifida is a deep water alga of distinctive habit.

2. **Amansia serrata** (Harvey)Womersley, *comb. nov.*

Kuetzingia serrata Harvey 1855a: 538.
Melanamansia serrata (Harvey)Norris 1988a: 222. Huisman 1993: 13; 2000: 174.
Amansia kuetzingioides Harvey 1858: pl. 51; 1863, synop.: xv. De Toni 1903: 1085. De Toni & Forti 1923: 47. Falkenberg 1901: 420, pl. 7, fig. 5. Huisman & Walker 1990: 431. Lucas 1909: 45. Lucas & Perrin 1947: 296, fig. 140. May 1965: 396. Sonder 1880: 31. Womersley 1950: 189.
Vidalia? kuetzingioides (Harvey)J. Agardh 1863: 1128.
Rytiphlaea kuetzingioides (Harvey)Sonder 1880: 33.
Euspiros kuetzingioides Kuntze 1891: 894.
Amansia hawkeri J. Agardh 1892: 173.

FIG. 171

Thallus (Fig. 171A) dark red-brown, 10–35 cm high, much branched more-or-less bipinnately with the flat pinnae 1–3 cm long and bearing short, alternate, determinate, spinous pinnules 1–2 mm long, with acute tips; main branches 2–4 mm broad with a central thickened midrib 1–2 mm broad, denuded below, wings 2 cells thick, ecorticate; determinate laterals 3–6 axial cells apart. Most fronds are covered on older axes with the bryozoan *Bathypora nitens* (Fig. 171E) or a didemnid ascidian, and frequently with a hydroid. Holdfast discoid-conical, becoming divided; epilithic. *Structure*. Apices circinnate (Fig. 171D), apical cell hemispherical, 15–20 µm in diameter. Axial cells with 5 pericentral cells, 2 lateral on each side and one ventral, with the dorsal-lateral cells each cutting off a pseudopericentral cell (Fig. 171C) and occasionally the ventral cell dividing laterally to form an additional pseudopericentral cell; lateral pericentral cells dividing rapidly to form the wings, with horizontal tiers of cells (Fig. 171B) slightly over-lapping in surface view and appearing as a tier of short cells, cells 40–50 µm in diameter and L/D (3-) 4–5. Midrib slender in upper branches, becoming corticated with irregular, thick-walled cells that spread laterally from the midrib. Trichoblasts (Fig. 171B) frequent and prominent at apices of the determinate pinnules, 0.5–1.5 mm long, Cells mostly multinucleate; rhodoplasts discoid.

Reproduction. Gametophytes dioecious. Procarps (Fig. 171F) borne on trichoblasts near apices of pinnules. Carposporophytes with a basal fusion cell and much-branched gonimoblast with clavate terminal carposporangia 35–55 (-90) µm in diameter. Cystocarps (Fig. 171G) borne on determinate pinnules, globose, 0.7–1 mm in diameter; pericarp ostiolate, corticated, 3–4 cells thick. Spermatangial organs (Fig. 171H) borne on lower branches of, or replacing, trichoblasts, ovoid, 80–140 µm in diameter, with a sterile basal cell.

Tetrasporangial stichidia (Fig. 171 I) converted from upper part of determinate pinnules, later with lateral stichidia also, elongate-ovoid to short-lanceolate, compressed, 200–300 µm broad and 450–750 µm long, with tetrasporangia in pairs for 4–7 segments (the older 1 or 2 mature), 60–140 µm in diameter, with cover cells but no further cortication.

Type from Rottnest I., W. Aust. (*Harvey*); holotype (Trav. Set 291) in Herb. Harvey, TCD.

Distribution: Flat Rocks, W. Aust., to Robe, S. Australia.

Selected specimens: Flat Rocks, 40 km S of Geraldton, W. Aust., drift (*Mitchell*, 12.ix.1966; AD, A31046). Point Peron, W. Aust., drift (*Gordon*, 15.xi.1968; AD, A34261). Israelite Bay, W. Aust., drift (*Wells*, 10.xii.1974; AD, A46080). Royston Head, S. Aust., 10 m deep (*Baker*, 28.x.1993; AD, A65526). Tiparra Reef, S. Aust., 5 m deep (*Shepherd*, 11.i.1978; AD, A49406). Investigator Strait, S. Aust., 31 m deep (*Watson*, 23.i.1971; AD, A41095). Norma wreck, off Outer Harbor, S. Aust., 15 m deep (*F. Mitchell*, 15.iii.1959; AD, A22419). Glenelg, S. Aust., 17 m deep (*Glover*, 20.iv.1961; AD, A24848). Port Noarlunga, S. Aust., 24 m deep (*Ottaway*, 3.ii.1981; AD, A52093). Cable Hut Reef, Penneshaw, Kangaroo I., S. Aust., 22 m deep (*Lavers*, 1.ii.2000; AD, A68838). Penneshaw, Kangaroo I., S. Aust., 10 m deep on breakwater (*Lavers*, 15.xi.1999; AD, A68902). Vivonne Bay, Kangaroo I., S. Aust., drift (*Womersley*, 1.i.2000; AD, A68472). Bales Beach, Kangaroo I., S. Aust., drift (*Womersley*, 31.xii.1999; AD, A68434). Point Renolds, Kangaroo I., S. Aust., drift (*Womersley*, 28.x.1995; AD, A64588). Stanley Beach, Kangaroo I., S. Aust., drift (*Womersley*, 6.ii.1957; AD, A20930). Cape Jaffa, S. Aust., drift (*Womersley*, 10.xii.1991; AD, A61581). Robe, S. Aust., drift (*Womersley*, 2.iv.1999; AD, A68116).

Amansia serrata, first described by Harvey in 1855 as *Kuetzingia serrata*, was invalidly changed to *A. kuetzingioides* by Harvey in 1858 and has been known under the latter name most frequently. The earlier combination of *A. serrata* was apparent to the author many years ago, and also to Dr Paul Silva (see Silva *et al.* 1996, p. 528) who had intended to publish it but was preempted by Norris (1988a, p. 222) who listed this combination as a synonym of his *Melanamansia serrata*, a combination which is here rejected (see generic comments). The combination *Amansia serrata* is now validly published.

3. **Amansia mamillaris** Lamouroux *ex* C. Agardh 1822: 193; 1824: 247. J. Agardh 1841: 25; 1863: 1113; 1890: 68; 1892: 172. De Toni 1903: 1089. Harvey 1863, synop.: xv. Kützing 1849: 883. Lucas 1909: 45. May 1965: 396. Norris 1988a: 222. Sonder 1880: 31. Wilson & Kraft 2000: 327.

FIG. 172

Thallus (Fig. 172A) medium to dark brown, 10–30 cm high, with corticated, more-or-less terete axes bearing alternately pinnate to bipinnate, complanately branched, basally constricted laterals 4–8 cm long, branches (4-) 6–8 (-10) mm broad, margins smooth to irregular, minutely crenulate (Fig. 172C, D). Holdfast unknown; probably epilithic. *Structure.* Apices circinnate, with the apical and subapical cells dividing rapidly to form a broad apex (Fig. 172B); axial cells cutting off 5 pericentral cells (Fig. 172E), 2 lateral on each side and probably one ventral, with 2 pseudopericentral cells cut off from the dorsal lateral pericentral cells and 1–3 cut off on the ventral side. Wings 2 cells thick, the layers overlapping at their ends, cells 35–60 µm in diameter and L/D 2–3, with the outermost cells producing multicellular spines 130–180 µm long (Fig. 172D). Midrib slight in upper branches, becoming corticated and 2–3 mm thick below. Trichoblasts scattered on surface of blades, 300–500 µm long. Cells multinucleate; rhodoplasts discoid, chained and reticulate in larger cells.

Reproduction. Procarps unknown. Carposporophytes with a basal fusion cell and short, branched, gonimoblast with elongate-clavate carposporangia 45–70 µm in diameter. Cystocarps (Fig. 172C, F) scattered on branch surface, stalked, ovoid, 0.7–1 mm in diameter; pericarp ostiolate, corticated, 4–5 cells thick. Spermatangia unknown.

Tetrasporangial stichidia (Fig. 172G) scattered on the branch surface between midrib and centre of wings, in groups of 1–5, ovate to slightly elongate, compressed, 300–450 µm broad, lightly corticated, tetrasporangia paired, 70–170 µm in diameter.

Type from "Nov. Holl." (*Lamouroux*), probably W. Aust.; holotype (a fragment) in Herb. Agardh, LD 42639; isotype in Herb. Lamouroux, CN.

Distribution: Port Denison to Eyre, W. Australia.

Selected specimens: Separation Point, Geraldton, W. Aust., drift (*Kraft & Gabrielson*, 15.xii.1980; MELU, 35485). Dongara, W. Aust., drift (*Kraft*, 7.vii.1966; MELU, K1819). Port Denison, W. Aust., drift (*Kraft*, 14.xii.1971; AD, A41791). Point Peron, W. Aust., drift (*Royce* 474, 28.i.1950; AD, A15496). Eyre, W. Aust., drift (*Woelkerling*, 22.xi.1968; AD, A34235).

Amansia mamillaris is a deep-water species from the west coast of Australia, with one collection from Eyre on the south coast; it is known only from drift collections and the habit suggests that larger plants may be perennial.

Further studies are needed on its relationships to other species of *Amansia*, especially in regard to the pericentral and pseudopericentral cell arrangement in young apices.

Genus **VIDALIA** Lamouroux *ex* J. Agardh 1863: 1117, *nom. cons.*

Thallus erect, much branched irregularly from the margin, branches flat and complanate or spirally twisted, usually 2–5 mm broad, with alternate marginal serrations; surface of branches smooth, without proliferous outgrowths apart from reproductive structures; branches

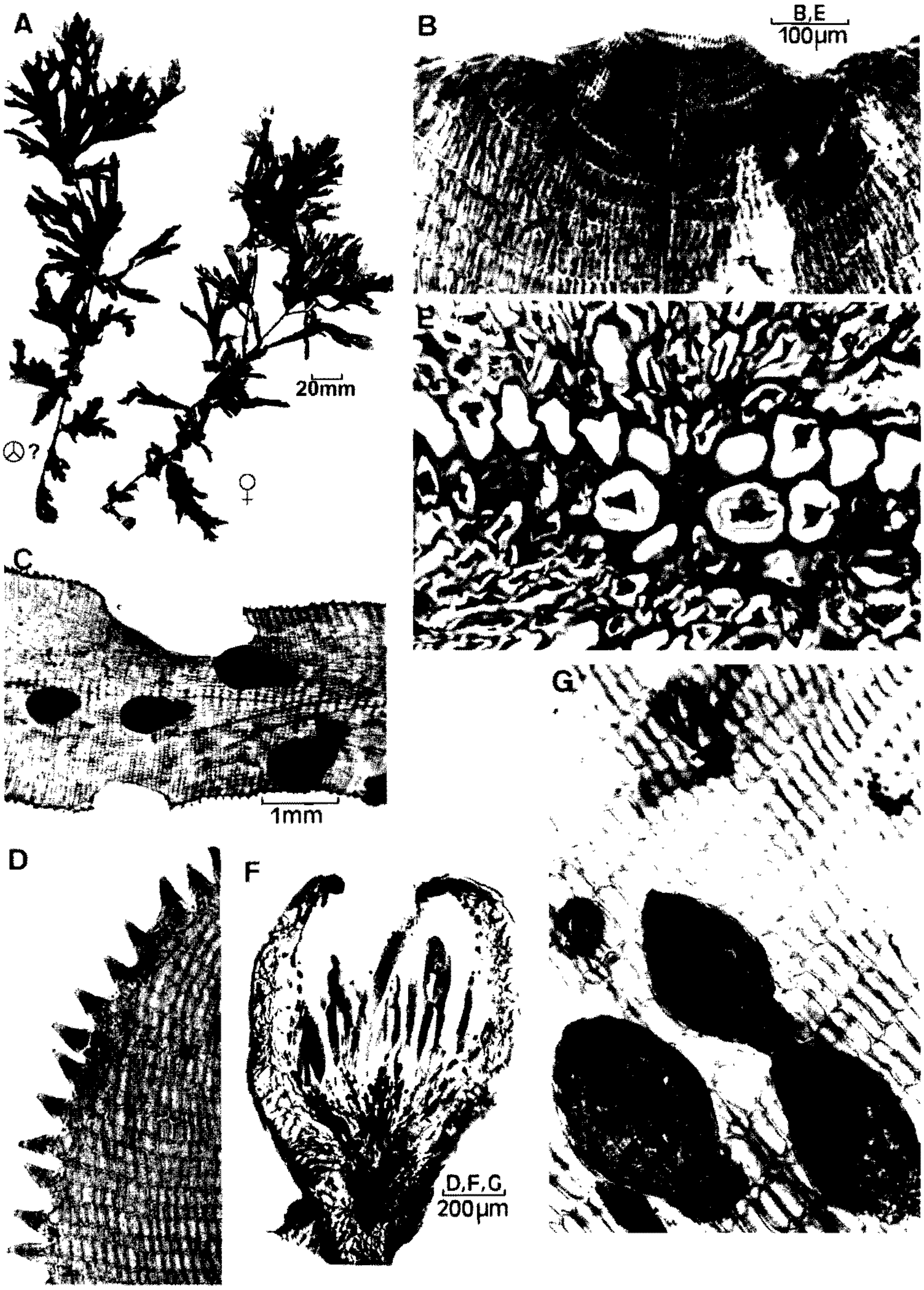

Fig. 172. *Amansia mamillaris* (**A**, **B**, **D**, **E**, **G**, AD, A34235; **C**, **F**, MELU, 35485; AD, A69038). **A**. Habit. **B**. Apex of branch. **C**. Lower part of branch showing cell pattern and cystocarps. **D**. Margin of branch with spines. **E**. Transverse section of branch with axial, pericentral and pseudopericentral cells (upper). **F**. Section of cystocarp. **G**. Stichidia on branch surface.

with a midrib and inconspicuous veins to the serrations. *Structure.* Apices revolute, axial filament with 5 pericentral cells, 2 lateral ones on each side and a ventral pericentral cell, together with a pseudopericentral cell cut off each of the dorsal lateral pericentral cells and sometimes a further pseudopericentral from the ventral pericentral cell. Thallus 2 medullary cells and 1–3 cortical cells thick, the midrib thickened by cortical cell proliferation. Trichoblasts present on marginal serrations and over the midrib.

Reproduction. Reproductive organs borne over the branch midrib or on the serrations. Procarps unknown. Carposporophytes with a basal fusion cell, branched gonimoblast and clavate terminal carposporangia. Cystocarps globular, stalked; pericarp ostiolate, several cells thick. Spermatangial organs borne on trichoblasts, subspherical to ovoid.

Tetrasporangial stichidia clustered on the midrib, elongate-ovoid to fusiform, compressed, with 2 rows of tetrasporangia, corticated.

Lectotype: *V. spiralis* (Lamouroux)Lamouroux *ex* J. Agardh 1863: 1126 (Schmitz 1889: 447).

A genus of about 9 species (see Norris 1991) here separated from the single species of *Osmundaria.*

Norris (1991) considered that *Vidalia* was a synonym of *Osmundaria*, based on study of the proliferous basal lateral shoots previously named by Falkenberg as *Vidalia gregaria*, agreeing with Harvey (1862a, pl. 188) who had considered them only young stages of the supposed host. Harvey and Norris are almost certainly correct, as is further supported by occasional small proliferous laterals (e.g. on AD, A69013) being partly bare and partly with surface proliferations (e.g. on one side only, or near the base only), the lack of any reproductive structures on the proliferations, and sections of the base of the proliferations on the heavily thickened *Osmundaria* base appearing to show that they involve only outgrowth from the thickened cortex.

However, this does not support union of *Vidalia* with *Osmundaria*, and based on the type species of both genera they differ as follows:

1. In habit, *Vidalia* having prominent alternate marginal dentations which *Osmundaria* lacks.
2. *Vidalia* having a smooth surface, *Osmundaria* branches being covered by abundant short, branched, spinous proliferations.
3. *Vidalia* having an alternate, lateral vein system leading to the marginal dentations, with the lateral pericentral cells not forming rows across the thallus as in *Osmundaria* which in general does not show such a lateral vein system.
4. Reproductive organs in *Vidalia* are borne centrally on the branches, above the midrib, in contrast to *Osmundaria* where they are marginal.

As well as the type species, *Vidalia* includes *V. intermedia* J. Agardh (1890, p. 69) from the central coast of Western Australia, which differs from *V. spiralis* in not being spirally twisted; its relationships with *V. spiralis* need further study.

Vidalia cliftonii Harvey 1863, synop.: xvi; De Toni 1903: 1107; Lucas 1909: 46. May 1965: 398; Sonder 1880: 32, transferred to *Osmundaria spiralis* as var. *cliftonii* (Harvey)Norris (1991: 20, fig. 23–fig. not this var.), followed by Silva *et al.* (1996, p. 533) has no relationship to *V. spiralis*, having 4 pericentral cells and an ecorticate thallus 2 cells thick. Until its reproduction is known, its relationships cannot be established, but it is probably generically distinct from *Vidalia.*

Vidalia spiralis (Lamouroux)Lamouroux *ex* J. Agardh 1863: 1126; 1879: 198, pl. 33 figs 26–29. De Toni 1903: 1106. De Toni & Forti 1923: 47. Falkenberg 1901: 428. Harvey 1863, synop.: xvi. Huisman & Walker 1990: 440. Huisman *et al.* 1990: 98. Kendrick *et al.* 1988: 204; 1990: 48, 52. Kylin 1956: 545. Lucas 1909: 46; 1929b: 51. Lucas & Perrin 1947: 298. May 1965: 398. Reinbold 1899: 48. Shepherd & Womersley 1981: 368. Sonder 1880: 32. Tate 1882a: 22. Womersley 1950: 190.

Delesseria spiralis Lamouroux 1813: 124, pl. 9 fig. 2.

Epineuron spirale (Lamouroux)Harvey 1847: 25, pl. 9. Kützing 1849: 848; 1864: 35, pl. 100a–c.

Dictyomenia spiralis (Lamouroux)Sonder 1848: 182. Harvey 1855a: 538.

Osmundaria spiralis (Lamouroux)Norris 1991: 17, figs 22, 26–31. Huisman 1993: 13; 1997: 207; 2000: 176. Silva *et al.* 1996: 533.

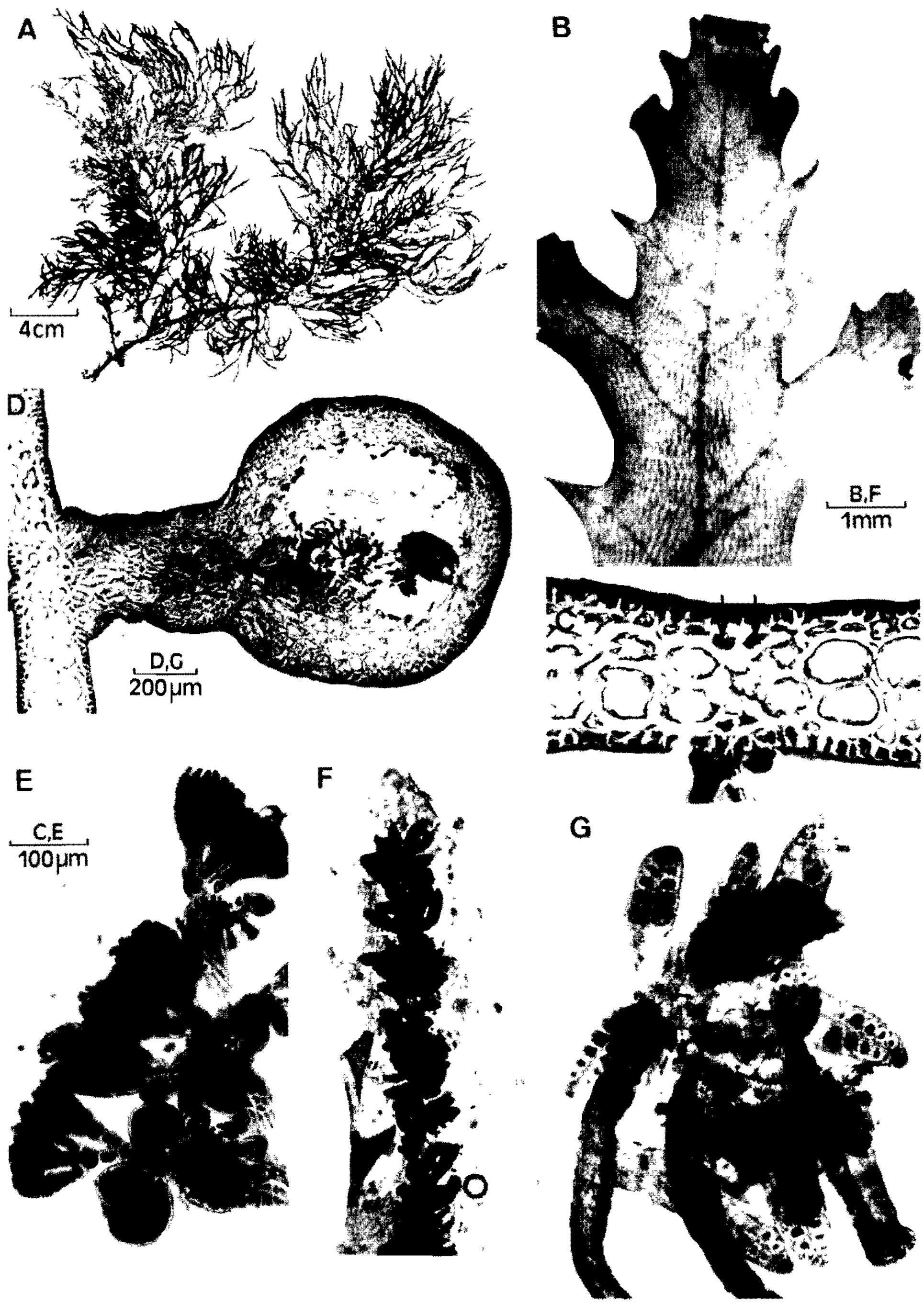

Fig. 173. *Vidalia spiralis* (**A**, **F**, **G**, AD, A38643; **B**, AD, A6960; **C**, **D**, AD, A68503; **E**, AD, A45057). **A**. Habit. **B**. Branch with revolute apex, vein system and marginal serrations. **C**. Transverse section of thallus with axial and pericentral cells, with 2 dorsal pseudopericentral cells (arrows). **D**. Section of cystocarp. **E**. Trichoblasts with spermatangial organs. **F**. Branch with crowded stichidia on midrib. **G**. Cluster of stichidia.

Euspiros spiralis (Lamouroux)Kuntze 1891: 894.
Rhodomela tridens var. *spiralis* (Lamouroux)C. Agardh 1822: 374; 1824: 197.
Rhodomela serrulata C. Agardh 1824: 197 (in part)
Epineuron backhousii Harvey *in* Hooker & Harvey 1845b: 532 (nomen). Kützing 1849: 849.

FIG. 173

Thallus (Fig. 173A) dark red-brown, 10–30 cm high, erect and much branched irregularly for 3–5 orders with ultimate branches 1–8 cm long, flat, 2–3 mm broad, with regularly spaced (1–2 mm apart) marginal serrations (Fig. 173B) 0.5–1 mm long, branches sparsely to frequently spirally twisted, apices dorsally revolute. Axes with a prominent midrib, denuded basally and 2–3 mm broad, 1–2 mm thick, serrations with a faint central vein. Lateral branches arising by continued growth of marginal serrations. Holdfast conical, becoming fibrous, 0.5–1 (-4) cm across; epilithic, *Structure*. Apices revolute (Fig. 173B), broad; axes with 5 pericentral cells, 2 lateral ones on each side and a ventral pericentral cell, with the dorsal lateral cells each cutting off a pseudopericentral cell (Fig. 173C); a ventral pseudopericentral cell sometimes also formed. The lateral pericentral cells form the wings of the branches, 300–500 µm thick, with a medulla of 2 larger cells and a cortex (1-) 2–3 cells thick, the midrib becoming thickened by proliferation from adjacent cortical cells. Marginal serrations occur 2–3 axial cells apart, have curved apices and are rapidly corticated. Trichoblasts occur subapically on marginal serrations and on short, dorsal, projections on the midrib, 0.5–1 mm long, basal cells 20–30 µm in diameter and L/D 1–1.5 with thick walls, upper cells 6–10 µm in diameter and L/D 6–10. Cells uni- or (larger) multinucleate; rhodoplasts discoid to elongate.

Reproduction. Reproductive organs produced mostly on the branch midrib. Gametophytes dioecious. Procarps not observed. Carposporophytes with a prominent basal fusion cell, much branched gonimoblast and clavate terminal carposporangia 30–50 µm in diameter. Cystocarps (Fig. 173D) short-stalked, globular, 1–2 mm in diameter; pericarp with a small ostiole, wall 6–10 cells and 200–300 µm thick, cells irregular in section. Spermatangial organs (Fig. 173E) clustered on branches of trichoblasts on marginal serrations or on the midrib, subspherical to ovoid, 80–130 µm in diameter.

Tetrasporangial stichidia (Fig. 173G) densely clustered on the midrib (Fig. 173F), sessile, compressed, elongate-ovoid to fusiform with curved apices, 180–220 µm broad and 0.4–1.5 mm long, with a narrow stalk, corticated, with 2 rows of tetrasporangia 50–90 µm in diameter.

Type from "Nouv. Holl."; not located in Herb. Lamouroux, CN.

Distribution: Houtman Abrolhos, W. Aust., to Port Phillip Heads, Victoria.

Selected specimens: Port Denison, W. Aust., drift (*Womersley*, 31.viii.1947; AD, A5853). Cliff Head, W. Aust., 5–6 m deep (*Kirkman & Joll*, 18.ix.1979; AD, A51185). Cowaramup Bay, W. Aust., 2–3 m deep (*Clarke & Engler*, 1.ix.1979; AD, A50669). Eucla, W. Aust., drift (*Womersley*, 2.ii.1954; AD, A19352). Smooth I., Isles of St Frances, S. Aust., 22 m deep (*Shepherd*, 29.iii.1980; AD, A52184). Elliston, S. Aust., 11 m deep in bay (*Shepherd*, 14.x.1971; AD, A38643). Sleaford Bay, S. Aust., shaded rear reef pools (*Womersley*, 16.ii.1959; AD, A22505). Between Hopkins & Thisle Is, S. Aust., 6–9 m deep (*Shepherd & Baldock*, 1.i.1964; AD, A27118). Victor Harbor, S. Aust., 6 m deep (*Clarke*, 22.iv.1978; AD, A59009). Goolwa, S. Aust., drift (*Ricci*, 19.v.1997; AD, A67078). Kingscote, Kangaroo I., S. Aust., drift (*Womersley*, 12.i.1948; AD, A6960). Vivonne Bay, Kangaroo I., S. Aust., 7 m deep at jetty (*Kraft*, 19.i.1974; AD, A45057) and in shaded pool (*Womersley*, 15.i.1947; AD, A4259). Cape Jaffa, S. Aust., drift (*Womersley*, 25.iv.2000; AD, A68503). Port Phillip Heads, Vic., drift (AD, A1410).

Vidalia spiralis is a common species in shallow but shaded situations to deep water on the western and southern coasts, characterised by the spirally twisted branches in mature plants, the reproductive organs borne mainly on the midrib, and the cross sectional arrangement of 5 pericentral cells with 2 pseudopericentral cells from the dorsal lateral pericentrals, sometimes with one also from the ventral pericentral cell. Sterile plants of *Vidalia spiralis* and *Dictyomenia tridens* can be superficially similar, but differ in lack of thallus spirality in the latter and arrangement and number of pericentral cells.

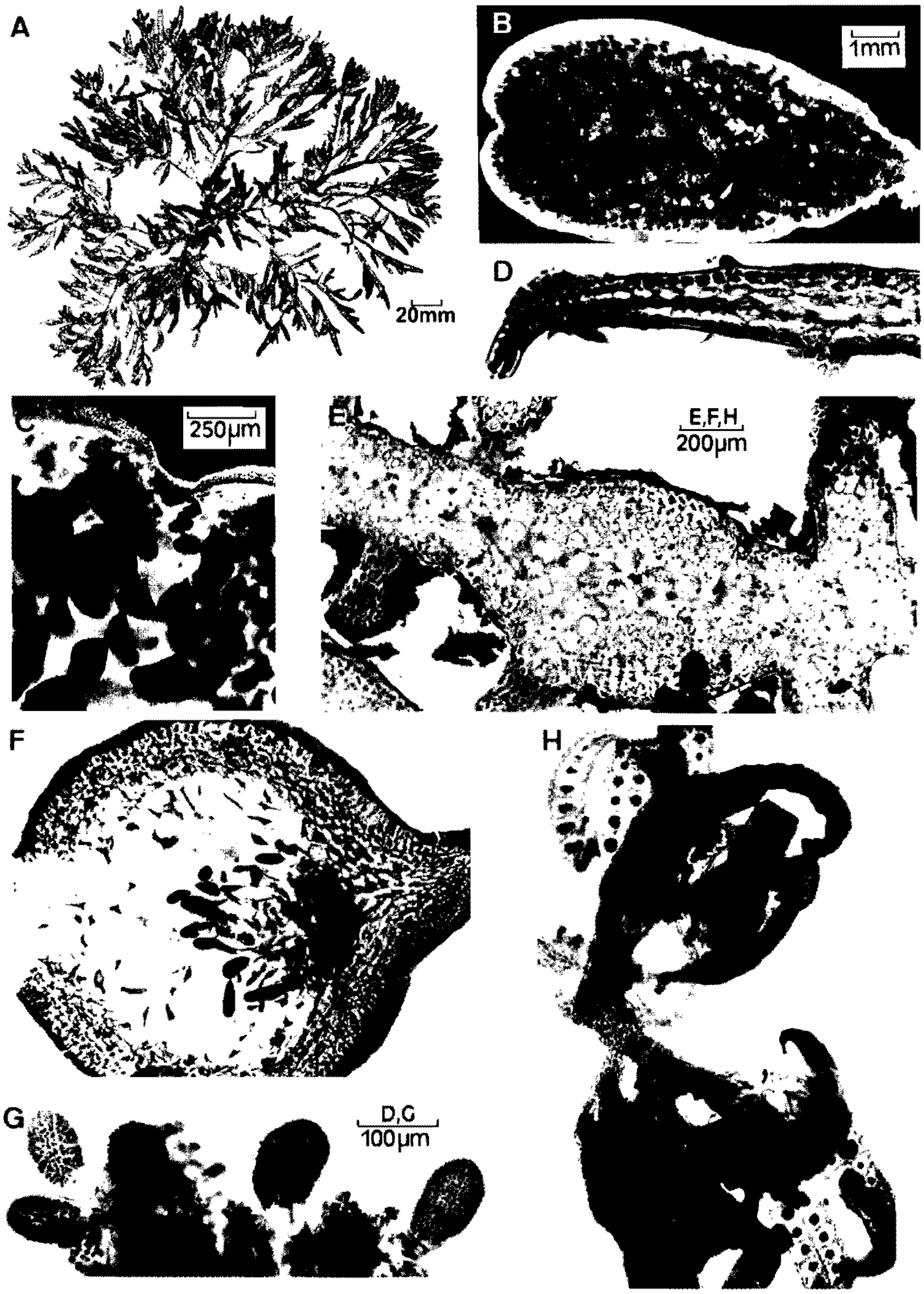

Fig. 174. *Epiglossum smithiae* (**A**, AD, A27116; **B**, **C**, MELU, 58/59; **D**, AD, A68103; **E**, **H**, AD, A65925; **F**, AD, A30661; **G**, AD, A21370). **A**. Habit. **B**. Blade with apical cleft and flat proliferations. **C**. Proliferations on blade. **D**. (**B**, **C**, by L.E. Phillips) Longitudinal section near apex. **E**. Transverse section through midrib, with proliferations. **F**. Section of cystocarp. **G**. Spermatangial organs. **H**. Stichidia with paired tetrasporangia.

Genus EPIGLOSSUM Kützing 1849: 878

by H.B.S. Womersley & L.E. Phillips

Thallus erect, much branched from the midrib for 3–5 orders, branches linear, flat, 2–5 (-9) mm broad, with an inconspicuous midrib, the surface bare or densely covered with short, ovate, flat, determinate proliferations; apex of branches rounded, recurved. Holdfast discoid to crustose. *Structure.* Apical cell exerted on the rounded apex or in a slight cleft, axial cells with 5 pericentral cells and 2–4 pseudopericentral cells, medulla 2–3 cells thick with larger central cells, cortex 1–2 cells thick, with secondary cortication over the midrib. Branching adventitious. Trichoblasts absent apart from reproduction.

Reproduction. Reproductive organs borne on short erect branches on the surface or on the midrib. Gametophytes dioecious. Procarps borne in series on reduced trichoblasts on erect shoots, rapidly polysiphonous and pericarpic. Carposporophytes with a basal fusion cell and much-branched gonimoblast with clavate terminal carposporangia. Cystocarps ovoid, stalked, pericarp ostiolate and corticated, 5–10 cells thick. Spermatangial organs on reduced trichoblasts, with a sterile basal cell, ovoid, clustered on erect shoots.

Stichidia on the erect shoots, simple, curved, compressed, with two tetrasporangia per segment, corticated.

Type species: *E. smithiae* (Hooker & Harvey)Kützing 1849: 878.

A genus of two species, resurrected by Phillips (2002b) as distinct from *Lenormandia* in apical structure, surface appearance (lacking rhombic areolation), and 18SrDNA sequences.

KEY TO SPECIES OF *EPIGLOSSUM*

1. Branch surface densely covered with small, flat, determinate proliferations; reproductive shoots on blade surfaces .... 1. *E. smithiae*
1. Branch surface devoid of proliferations; reproductive shoots borne mainly on the midrib .... 2. *E. proliferum*

1. **Epiglossum smithiae** (Hooker & Harvey)Kützing 1849: 878; 1866: 4, pl. 8a, b. Phillips 2002b: 221, figs 8, 10.

Polyphacum smithiae Hooker & Harvey *in* Harvey 1847: 17, pl. 3; 1859b: 295; 1863, synop.: xvi. J. Agardh 1863: 1132. Hooker & Harvey 1847: 398. Sonder 1880: 32. Tisdall 1898: 513. Wilson 1892: 166.

Osmundaria smithiae (Hooker & Harvey)Kuntze 1891: 909.

Lenormandia smithiae (Hooker & Harvey)Falkenberg 1901: 464, pl. 8 figs 18–21. De Toni 1903: 1120. Garnet 1971: 95. Guiler 1952: 106. Lucas 1909: 46; 1929a: 23. Lucas & Perrin 1947: 303, fig. 143. May 1965: 397. Womersley 1950: 189; 1966: 154.

Polyphacum intermedium J. Agardh 1892: 175.

FIG. 174

Thallus (Fig. 174A) dark red-brown, 10–20 (-27) cm high, cartilaginous, often with surface sponge, moderately to much branched for 3–5 orders from the midrib, branches linear, 3–5 (-9) mm broad and (1-) 2–10 cm long, lower axis denuded, 2–4 mm thick, apices rounded, basally constricted to a short stipe; midrib inconspicuous, margins slightly thickened, branch surfaces (Fig. 174B) densely covered (apart from a discrete marginal border) with short, flat, adventitious, determinate, proliferations (Fig. 174C). Holdfast discoid, 1–4 (-15) mm across; epilithic. *Structure.* Apices obcordate, margins slightly recurved adaxially (Fig. 174D); apical cell within a slight cleft but recurved, thick walled and 25–30 µm in diameter, axial cells cutting off 5 pericentral cells, with 2–4 pseudopericentral cells somewhat irregular in position; medulla irregular, 2–3 cells thick, cortex 1–2 cells thick, with secondary cortication over the midrib (Fig. 174E). Surface proliferations (Fig. 174C) directed forwards, flat, ovate to obcordate, 0.3–1 mm long, surfaces with short excrescences. Trichoblasts unknown apart from association with reproduction. Cells uni-nucleate; rhodoplasts discoid.

Reproduction. Reproductive organs borne on erect branch systems with a simple stalk, 1–2 mm high, borne on the branch surface (mainly near the margins) among the proliferations. Gametophytes dioecious. Procarps borne on upper branches of the systems, usually several in

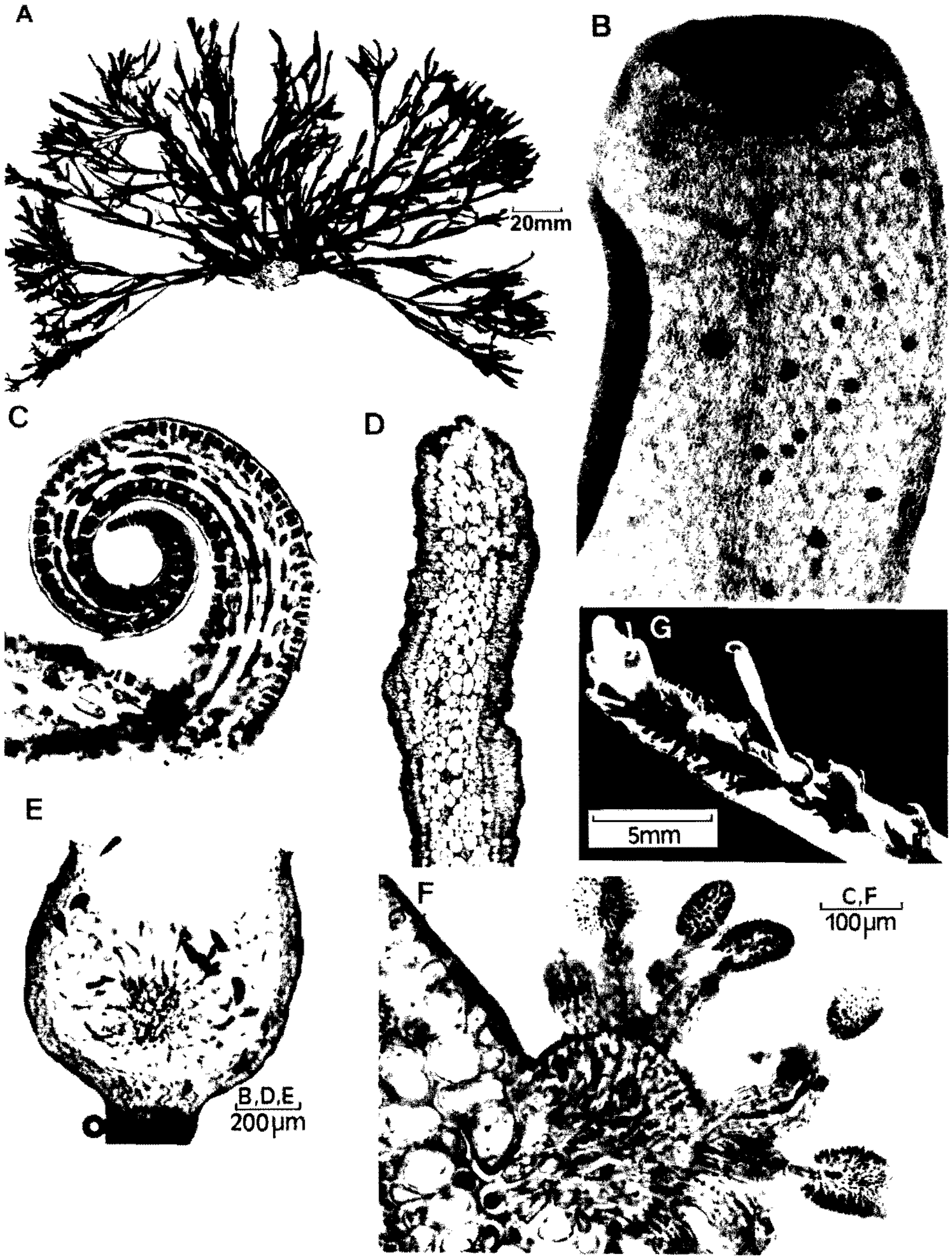

Fig. 175. *Epiglossum proliferum* (**A**, AD, A64770; **B–D**, **F**, AD, A68543; **E**, AD, A24398; **G**, MELU, 67). **A**. Habit. **B**. Branch with revolute apex. **C**. Longitudinal section of revolute apex. **D**. Transverse section of branch. **E**. Section of cystocarp. **F**. Spermatangial organs. **G**. Branch with stichidia and adventitious branchlets on the midrib (by L.E. Phillips).

a series, rapidly polysiphonous and pericarpic. Carposporophytes with a basal fusion cell and much-branched gonimoblast with clavate terminal carposporangia 40–70 µm in diameter. Cystocarps (Fig. 174F) stalked, ovoid, 1–1.6 mm in diameter; pericarp ostiolate, heavily corticated, 7–10 cells thick. Spermatangial organs (Fig. 174G) on much-branched heads of the stalks, ovoid, 80–110 µm in diameter, with a single basal sterile cell but no sterile apical cells.

Stichidia (4–10) terminating the stalk, curved, compressed, 0.5–1.2 (-2) mm long and 180–300 µm broad, corticated, with opposite pairs of tetrasporangia (Fig. 174H) 100–160 µm in diameter.

Type from Circular Head, N Tasmania (*Smith & Gunn*); holotype in TCD.

Distribution: Memory Cove, S. Aust., to Green Cape, N.S.W., and around Tasmania.

Selected specimens: Memory Cove, S. Aust., 40 m deep (*Shepherd*, 2.i.1964; AD, A27150). Between Hopkins & Thistle Is, S. Aust., 6–9 m deep (*Shepherd*, 1.i.1964; AD, A27116). Toad Head, West I., S. Aust., 20–30 m deep (*Owen*, 2.vii.1971; AD, A39232). Port Elliot, S. Aust., drift (*Womersley*, 12.iv.1958; AD, A21370). Vivonne Bay, Kangaroo I., S. Aust., drift (*Womersley*, 2.i.1949; AD, A10617). Penington Bay, Kangaroo I., S. Aust., drift (*Womersley*, 31.xii.1949; AD, A12846). Cable Hut reef, Penneshaw, Kangaroo I., S. Aust., 7–20 m deep (*Lavers*, 18.x.1999; AD, A68893). Hog Bay reef, Kangaroo I., S. Aust., 6–11 m deep (*Lavers*, 9.vi.1996; AD, A65925). Kingston, S. Aust., drift (*Womersley*, 19.viii.1966; AD, A30661). Robe, S. Aust., drift (*Womersley*, 2.iv.1999; AD, A68103). Dutton Bay, Portland, Vic., drift (*Womersley*, 13.iv.1959; AD, A22673). Queenscliff, Vic., drift (*Phillips*, 15.viii.1998; MELU 58/59). Port Phillip Heads, Vic., 16–18 m deep N of Quarantine Station (*Kraft et al.*, 5.iv.1995, MELU, K10638). Walkerville, Vic., drift (*Sinkora*, 11.iii.1978; AD, A60880). Gabo I., Vic., 28 m deep (*Shepherd*, 14.ii.1973; AD, A43351). W of Green Cape Lighthouse, N.S.W., 28 m deep (*Miller, Richards & Yee*, 24.ii.2000; NSW, 439064). Bicheno, Tas., 8–12 m deep (*Edgar*, 23.x.1994; AD, A63817).

Epiglossum smithiae is a deep-water alga often common in the drift around south eastern Australia, readily recognised by its habit with the linear branches covered by short, flat, proliferations somewhat similar to the terete proliferations of *Osmundaria prolifera*.

2. **Epiglossum proliferum** (C. Agardh)Phillips 2002b: 224, figs 8, 11, 12.

Amansia prolifera C. Agardh 1822: 194; 1824: 247.

Dictyomenia prolifera (C. Agardh)J. Agardh 1841: 27. Harvey 1847: 30. Kützing 1849: 848; 1864: 34, pl. 95c–f. Sonder 1855: 523.

Lenormandia prolifera (C. Agardh)J. Agardh 1863: 1103. De Toni 1903: 1119. Falkenberg 1901: 462. Guiler 1952: 106. Harvey 1863, synop.: xvi. King *et al.* 1971: 124. Lucas 1909: 46; 1929a: 23. Lucas & Perrin 1947: 302. May 1965: 397. Millar & Kraft 1993: 55. Saenger & Ducker 1971: 51, figs 1–12. Saenger *et al.* 1969: 59. Sonder 1880: 32. Tisdall 1898: 513. Wilson 1892: 166. Womersley 1966: 154.

Rytiphlaea simplicifolia Harvey 1859b: 298; 1863: pl. 246. J. Agardh 1863: 1095. Tisdall 1898: 513.

PLATE 2 fig. 2; FIG. 175

Thallus (Fig. 175A) dark brown, drying almost black, 5–15 (-25) cm high, cartilaginous, usually much branched for 3–4 orders from the midrib or proliferous from eroded apices, branches linear, flat, tapering basally and with rounded, recurved, apices, (2-) 3–5 mm broad and 240–300 µm thick, margins smooth, thickened, midrib inconspicuous, branch surfaces without proliferations. Holdfast discoid to crustose, 2–20 mm across; epilithic, just below low tide level or in deeper water. *Structure*. Apices rounded, recurved (Fig. 175B, C), apical cells within the recurved apices, conical, 15–20 µm in diameter, blade margins thickened. Apical cells cutting off probably 5 pericentral cells, with 2–4 pseudopericentral cells, forming an irregular medulla (Fig. 175D) 1–3 (-4) cells broad (the central cells largest) and a cortex 1–2 cells broad; secondary cortex formed over the midrib on older branches. Trichoblasts only associated with reproductive organs, reduced. Cells probably uninucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Reproductive organs borne on short, erect shoots over the midrib, rarely elsewhere. Gametophytes dioecious. Procarps formed in series on trichoblasts on polysiphonous branchlets on midribs. Carposporophytes with a basal fusion cell and much-branched gonimoblast with clavate terminal carposporangia 20–55 µm in diameter. Cystocarps (Fig. 175E) stalked, ovoid, 700–1000 µm in diameter; pericarp ostiolate, corticated, 4–5 cells thick. Spermatangial organs (Fig. 175F) on polysiphonous, simple or branched, erect shoots from a hemispherical base, ovoid, 70–110 µm in diameter, with a sterile basal cell and 3–5 fertile axial cells.

Stichidia (2–8) on proliferous shoots on the midrib (Fig. 175G), 0.5–1 (-4) mm long and 120–180 µm broad, compressed, corticated, sometimes with reduced trichoblasts, tetrasporangia in 2 rows, 50–80 µm in diameter.

Type from "N. Holl." (No. 24); holotype in LD, 42807; isotype in PC.

Distribution: Yallingup, W. Aust., to Walkerville, Vic., and around Tasmania; Twofold Bay, N.S.W. (Millar & Kraft 1993, p. 55).

Selected specimens: Torpedo Rocks, Yallingup, W. Aust., drift (*Royce* 590, 31.v.1950; AD, A8000). Esperance, W. Aust., drift (*Firman*, Dec. 1951; AD, A18952). Troubridge Hill, S. Aust., 5 m deep (*Edyvane*, 30.x.1993; AD, A66356). Port Elliot, S. Aust., drift (*Womersley*, 24.vii.1949; AD, A11125). E end D'Estrees Bay, Kangaroo I., S. Aust., sublittoral fringe pools (*Womersley*, 11.i.1950; AD, A12687). Pennington Bay, Kangaroo I., S. Aust., uppermost sublittoral (*Womersley*, 30.i.1946; AD, A3005). Robe, S. Aust., drift (*Womersley*, 24.viii.1960; AD, A24398) and upper sublittoral pools (*Womersley*, 18.v.1964; AD, A28071—"Marine Algae of southern Australia" No. 134), and upper sublittoral pools (*Womersley*, 5.xii.1995; AD, A64770). Back Beach, Little Dip Conservation Park, S. Aust., reef pools (*Womersley*, 24.iv.2000; AD, A68543—"Marine Algae of southern Australia" No. 134a). Snapper Point, Beachport, S. Aust. (*Phillips et al.*, 28.x.1998; MELU, 67). Point Bunbury, Apollo Bay, Vic., shaded pool (*Womersley*, 12.iv.1959; AD, A22642). Glaneuse Reef, Point Lonsdale, Vic., low eulittoral pools (*Phillips*, 4.xii.1998; MELU, 63). Walkerville, Vic., just below low tide (*Sinkora* A2145, 4.iii.1975; AD, A48567). Granville Harbour, W Tas., 3–10 m deep (*Blackman*, 28.i.1979; AD, A58506). Rocky Cape, N Tas., low eulittoral pools (*Wollaston & Mitchell*, 24.ii.1964; AD, A27650). Missionary Bay, Bruny I., Tas., 6–8 m deep (*Womersley*, 15.i.1949; AD, A10170). Dover, Tas., drift (*Wollaston*, 20.viii.1965; AD, A29555).

Epiglossum proliferum is a common species on rough-water platforms, often forming dense tufts just below low tide level; it also occurs to about 10 m deep.

Genus OSMUNDARIA Lamouroux 1813: 42

Thallus erect, cartilaginous, moderately branched with long, flat, ultimate branches with rounded apices, margins smooth to closely dentate, midrib inconspicuous, lateral veins absent or inconspicuous. Surface of branches covered with a felt of short, branched, multicellular proliferations up to 1 mm long and often with surface sponge, with bare proliferous branches from basal, thickened axes of some plants. Holdfast conical. *Structure*. Apical cells inconspicuous, axial cells cutting off 5 pericentral cells, 2 lateral on each side and one ventral, with a pseudopericentral cell cut off from each of the dorsal lateral pericentral cells; medulla 1–2 cells broad, cortex 1–3 cells broad, with the lateral pericentral cell derivatives forming horizontal lines across the thallus. Trichoblasts absent.

Reproduction. Procarps borne on short, polysiphonous laterals on marginal shoots near branch apices; carposporophytes with a prominent, branched, basal fusion cell, branched gonimoblast and clavate terminal carposporangia. Cystocarps stalked, ovoid to globular; pericarp with a small ostiole, several cells thick. Spermatangia unknown.

Tetrasporangial stichidia clustered on margins of upper branches, occasionally on the branch surface, elongate, compressed, with rows of 2 tetrasporangia per segment, corticated.

Type species: *O. prolifera* Lamouroux 1813: 43.

Osmundaria is a distinctive monospecific genus. Norris (1991) considered *Vidalia* Lamouroux not distinct from *Osmundaria* on the basis of the smooth-surfaced proliferous branches from the lower denuded branches, but the dense covering of mature surfaces with short, branched, proliferations and also the lack of alternate, lateral veins in marginal serrations clearly separate the two genera (see under *Vidalia*). Most if not all the species Norris placed in *Osmundaria* probably belong in *Vidalia*.

Osmundaria prolifera Lamouroux 1813: 42, pl. 7 figs 4–6. Decaisne 1846: 8, and 1848, pl. 3A. De Toni 1903: 1109. De Toni & Forti 1923: 48. Falkenberg 1901: 469, pl. 8 figs 24–26. Huisman 2000: 176. Kylin 1956: 547, fig. 436C. Lucas 1909: 46; Lucas & Perrin 1947: 299, fig. 141. May 1965: 398. Norris 1991: 7, figs 1–6. Reinbold 1899:

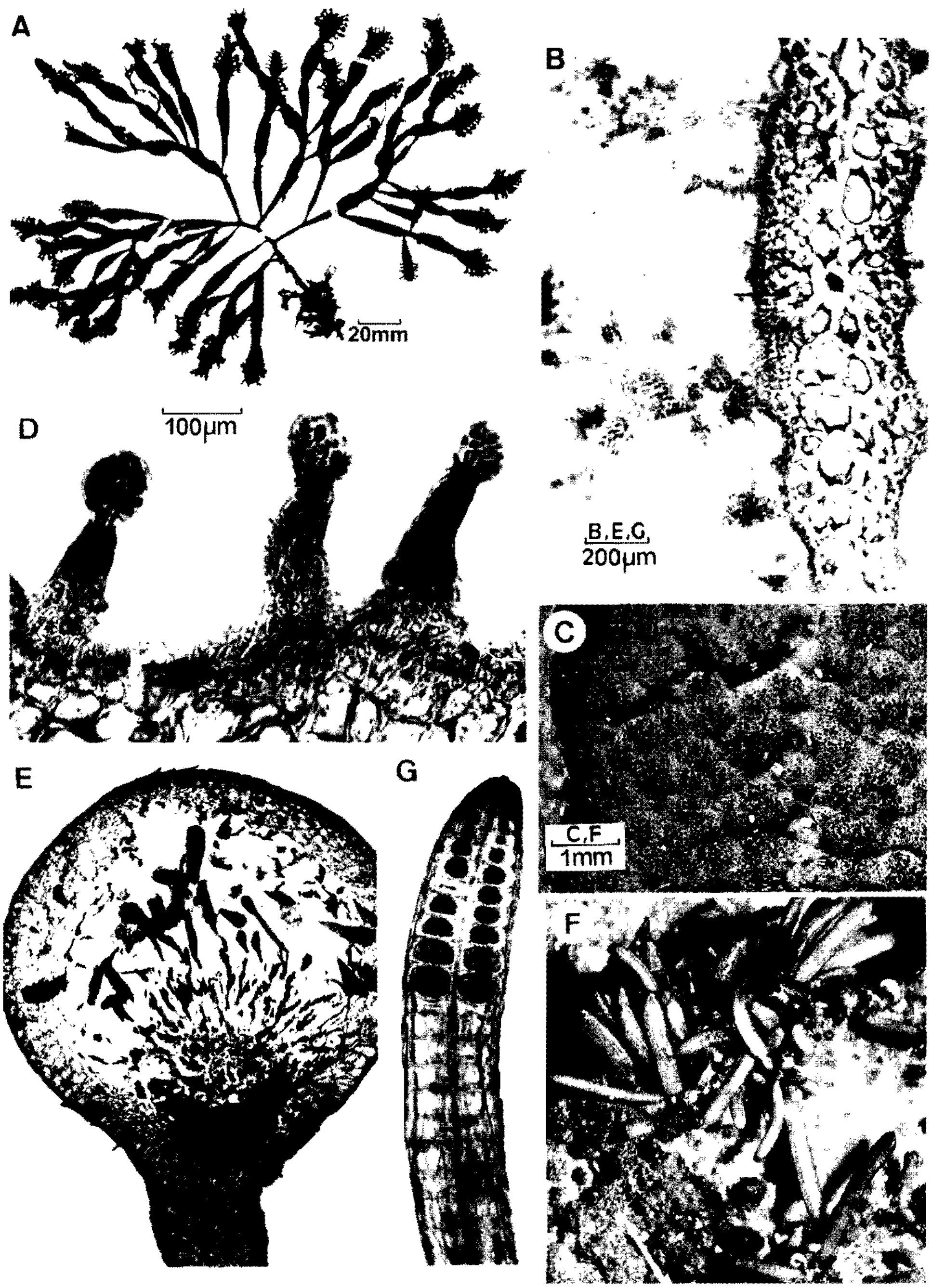

Fig. 176. *Osmundaria prolifera* (**A**, AD, A2928; **B**, **C–G**, AD, A69012; **D**, AD, A42957). **A**. Habit. **B**. Transverse section of branch showing axial, pericentral and pseudopericentral cells (arrows) and branched proliferations. **C**. Surface of branch with sponge between the proliferations. **D**. Short marginal shoots with developing procarps. E. Section of cystocarp. **F**. Stichidia on branch margin and surface. **G**. Stichidium with tetrasporangia. [**C** and **F** by R.N. Baldock.]

48. Saenger 1970: 305, figs 1, 2. Schmitz & Falkenberg 1897: 469, fig. 261C. Shepherd & Womersley 1970: 134; 1971: 166; 1976: 191; 1981: 368. Silva *et al.* 1996: 532. Womersley 1950: 189.

Polyphacum proliferum (Lamouroux)C. Agardh 1820: 106; 1824: 274. J. Agardh 1863: 1133. Harvey 1847: 17; 1855a: 537; 1859b: 295; 1862a: pl. 188; 1863, synop. xvi. Kützing 1849: 879; 1866: 3, pl. 7g–i, k, l. Reinbold 1897: 56. Sonder 1845: 54; 1848: 185; 1880: 32.

Vidalia gregaria Falkenberg 1901: 435, pl. 8 figs 22, 23. De Toni 1903: 1108. De Toni & Forti 1923: 47. Lucas 1909: 46. May 1965: 398.

Polyphacum intermedium J. Agardh 1892: 175.

Osmundaria intermedia (J. Agardh)De Toni 1903: 1110. Lucas 1909: 46. May 1965: 398. Silva *et al.* 1996: 531.

FIG. 176

Thallus (Fig. 176A) dark brown-red, 5–25 cm high, cartilaginous, erect, moderately branched especially near the base, usually with long ultimate branches 2–10 cm long, with narrow bases and rounded apices, branches flat, mostly 4–10 mm broad, margins smooth to closely dentate; midrib inconspicuous, lateral veins absent or inconspicuous. Surface of branches covered by a dense felt (Fig. 176C) of short, branched, proliferations (Fig. 176B) 0.5–1 mm long, apart from adventitious branches from lower, heavily corticated, denuded branches which remain mostly bare ("*V. gregaria*"). Base of branches usually denuded and thickened, 2–3 (-5) mm thick near the base. Holdfast irregularly conical, 5–30 mm high and 5–15 mm broad; epilithic. *Structure.* Apices of branches broad, with inconspicuous apical cells, forming transverse rows of cells across the branch, with the marginal cells forming short, closely adjacent, dentations 0.5–1.5 mm long and basally 0.5–1.5 mm broad; lateral, alternate, vein system (c.f. *Vidalia*) absent or inconspicuous. Pericentral cells 5, 2 lateral on each side and one ventral, with a pseudopericentral cell cut off each of the dorsal lateral pericentral cells (Fig. 176B); the medulla 1–2 cells broad, cortex 1–3 cells broad. Surface proliferations (Fig. 176B) multicellular, branched, some with spinous ends. Trichoblasts apparently absent. Smaller cells uninucleate, larger multinucleate; rhodoplasts discoid to elongate, becoming chained.

Reproduction. Procarps borne on short marginal shoots (Fig. 176D) near branch apices, usually several on polysiphonous laterals. Carposporophytes with a prominent basal, branched, fusion cell, branched gonimoblast and clavate terminal carposporangia 30–50 µm in diameter. Cystocarps (Fig. 176E) stalked, ovoid to globular, clustered on marginal outgrowths on upper fronds, 1.5–2 mm in diameter; pericarp with a small ostiole, 5–8 cells thick. Spermatangial organs unknown.

Tetrasporangial stichidia (Fig. 176F) clustered on margins of upper branches, occasionally on the branch surface, 1–3 mm long, compressed, 200–400 µm broad, corticated, with 2 tetrasporangia per segment (Fig. 176G).

Type from "Nouv. Holl." (probably W. Aust.); not located in Herb. Lamouroux, CN.

Distribution: Kalbarri, W. Aust., to Victor Harbor and Kangaroo I., S. Australia.

Selected specimens: Red Bluff, Kalbarri, W. Aust., 6–9 m deep (*Kraft & Ricker*, 15.xii.1980; MELU, 35348; AD, A69220). Point Moore, Geraldton, W. Aust., drift (*Womersley*, 17.ix.1979; AD, A51172). Israelite Bay, W. Aust., 7 m deep (*Kirkman*, 18.xii.1981; AD, A56670). Emu Beach, King George Sound, W. Aust., drift (*Mitchell*, 27.ix.1966; AD, A30815). Eucla, W. Aust., drift (*Womersley*, 2.ii.1954; AD, A19348). Point Sinclair, S. Aust., upper sublittoral under *Posidonia* (*Womersley*, 25.i.1951; AD, A13672). Pearson I., S. Aust., 20–25 m deep (*Shepherd*, 8.i.1969; AD, A33250). Snapper Point, Port Lincoln, S. Aust., 6–8 m deep (*Baldock*, 1.i.1964; AD, A27088). Balgowan reef, Yorke Pen., S. Aust., 3–8 m deep (*Kald*, 17.xii.1967; AD, A32187). Investigator Strait, S. Aust., 19 m deep (*Watson*, 11.i.1971; AD, A39330). Aldinga, S. Aust., drift (*Womersley*, 13.i.1973; AD, A42957—"Marine Algae of southern Australia" No. 163), and (*Womersley*, 23.xii.2000; AD, A69012). Victor Harbor, S. Aust., drift (*Womersley*, 17.x.1948; AD, A9248). Stokes Bay, Kangaroo I., S. Aust., upper sublittoral (*Womersley*, 15.i.1965; AD, A28939). Pennington Bay, Kangaroo I., S. Aust., drift (*Womersley*, 27.i.1946; AD, A2928). Stanley Beach, Kangaroo I., S. Aust., drift (*Womersley*, 6.ii.1957; AD, A20928).

While "*Vidalia gregaria*" appears to be only vegetative adventitious growth on lower corticated branches, most of which lacks the surface felt of proliferations, *Osmundaria* differs clearly from the type species of *Vidalia* (*V. spiralis*) in having the surface proliferations on all mature branches and also in the thallus construction, not having transverse rows of large cells in surface view and in lacking the alternate vein system of *Vidalia* (see also under *Vidalia*); reproductive organs are also marginal in *Osmundaria* but usually on the midrib in *Vidalia*.

Osmundaria intermedia (J. Agardh)De Toni, type from Champion Bay, W. Aust., in Herb. Agardh, LD, 42899, is a typical specimen of *O. prolifera* with surface clusters of stichidia.

Tribe CHONDRIEAE Schmitz & Falkenberg 1897: 432

Thallus erect, rarely prostrate, radially or occasionally bilaterally branched, branches with clear axial and pericentral cells surrounded by a broad, compact, cellular cortex (except in *Coeloclonium*). Apex rounded or depressed, with a short, monopodial, apical filament cutting off pericentral cells and trichoblasts. Pericentral cells 5, becoming elongate parallel to the axial cells (except in *Coeloclonium* and tetrasporangial branches of *Chondria*). Pericentral and inner cortical cells in many species with distinctive thickenings on the cell walls. Lateral branches arising on the basal cell of trichoblasts.

Reproduction. Gametophytes dioecious. Procarps borne on lower cells of trichoblasts, with the fifth-formed pericentral (supporting) cell bearing a 4-celled carpogonial branch and 2 sterile groups. Carposporophyte with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia. Cystocarps lateral, ovoid to slightly urceolate, pericarp ostiolate, ecorticate or corticate. Spermatangial organs developed from the whole or lower branches of trichoblasts, forming flat pates or discs with sterile-cell margins (except *Cladurus*, see below).

Tetrasporangia formed in lesser branches, sometimes in axillary clusters, cut off from pericentral or occasionally inner cortical cells, subspherical, tetrahedrally divided.

Type genus: *Chondria* C. Agardh 1817: xviii, *nom. cons.*

The Chondrieae contains 7 or 8 genera, of which one (*Cladurus*) probably belongs in a separate tribe since it does not have discoid spermatangial plates which are a distinctive feature of the tribe. Other features are the clear presence of pericentral cells throughout the thallus and tetrasporangia cut off mostly from the pericentral cells.

KEY TO GENERA OF CHONDRIEAE

1. Branches bearing short, stout spines .... ACANTHOPHORA
1. Branches without such spines 2

   2. Branches partly hollow or vesicular throughout most of thallus, basally constricted (sometimes also along branches); pericentral cells elongate at right angles to axial cells throughout the thallus .... COELOCLONIUM
   2. Branches parenchymatous and compactly cellular in mature parts, pericentral cells parallel to and of similar length to axial cells (except close to apices and where tetrasporic in *Chondria*) 3

3. Pericentral cells large, sharply separated from the small-celled cortex, branches showing transverse partitions corresponding to tiers of pericentral cells; spermatangial organs terete, borne as a branch on trichoblasts .... CLADURUS*
3. Pericentral cells surrounded by cells grading to the outer cortex, without surface partitions; spermatangial plates discoid, with sterile-cell margins 4

   4. Cortex in transverse section with rings of larger cortical cells separated by bands of rhizoids; cystocarps stalked; stichidia clustered in axils of lateral branches .... HUSSEYA
   4. Cortex in transverse section without rings of larger cortical cells separated by rhizoids; cystocarps sessile or short-stalked; tetrasporangia in lesser branches .... CHONDRIA

* *Cladurus* differs from all other Chondrieae in having terete spermatangial organs, not discoid, plate-like ones. It is almost certainly not a member of the Chondrieae, but whether it should be placed in any other tribe (e.g. Polysiphonieae) or as a separate tribe is uncertain.

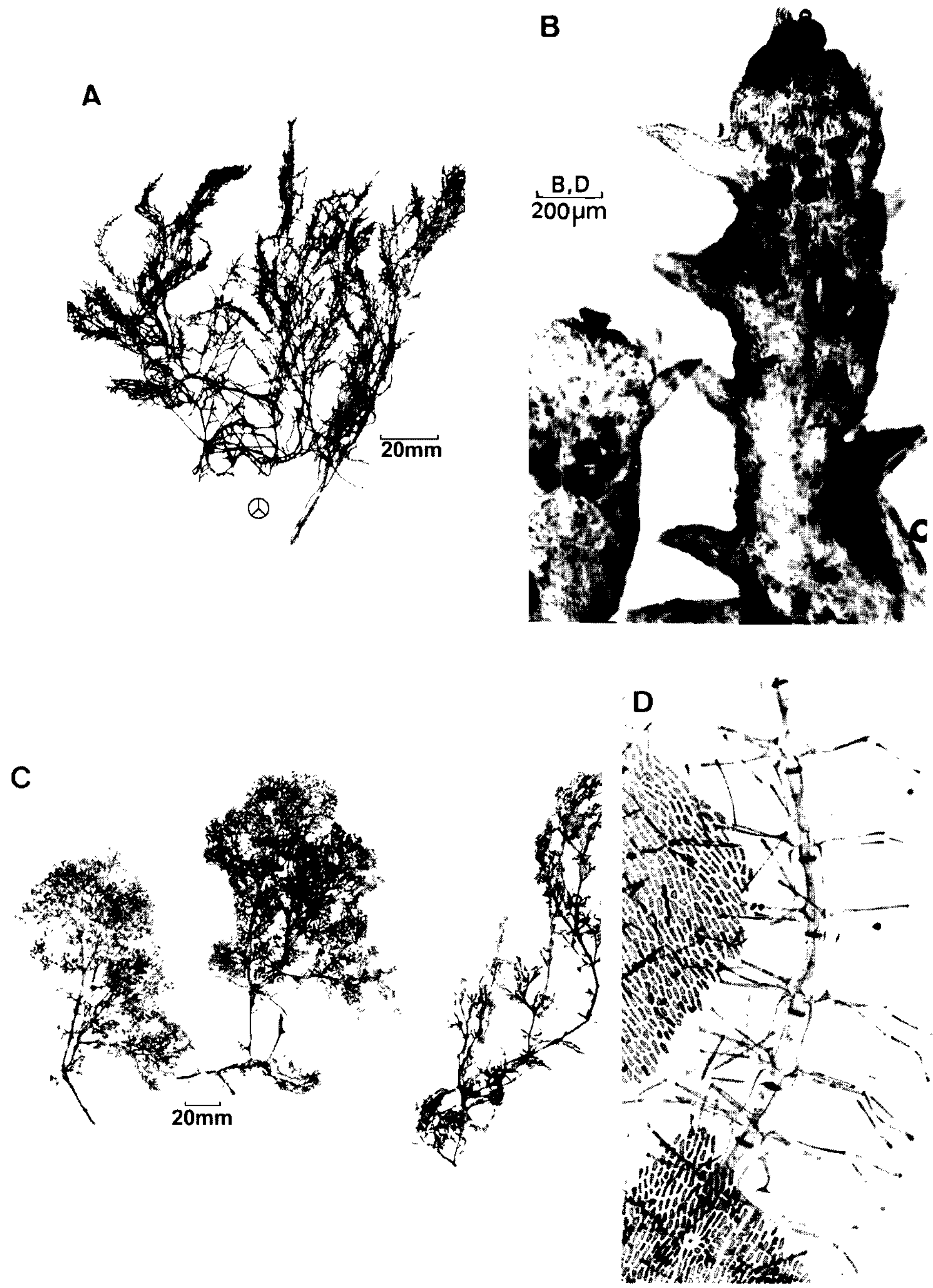

Fig. 177. A, B. *Acanthophora dendroides* (AD, A13658). **A.** Habit. **B.** Branch with short spines, and tetrasporangia. **C, D.** *Coeloclonium tasmanicum* (**C**, AD, A59189; **D**, AD, A53760). **C.** Habit. **D.** Axial filament with laterally elongate pericentral cells.

Genus ACANTHOPHORA Lamouroux 1813: 132

Thallus erect, much branched, branches terete or compressed, bearing spirally to irregularly arranged short spines. *Structure*. Apices of branches depressed or projecting, bearing trichoblasts. Pericentral cells 5, corticated, grading to outer small cells, with rhizoids around the axial and inner cells. Spines multicellular.

Reproduction. Gametophytes dioecious. Procarps on lower cells of trichoblasts. Carposporophytes with a basal fusion cell and branched gonimoblast with terminal carposporangia. Cystocarps ovoid, sessile, pericarp ostiolate, several cells thick. Spermatangial organs forming flat plates with sterile marginal cells, borne on trichoblasts.

Tetrasporangia formed in lateral branchlets bearing spines, cut off from pericentral cells, several per whorl.

Type species: *A. spicifera* (Vahl)Børgesen 1910: 201.

A genus of 7 species, mainly tropical-subtropical in distribution, characterised by the presence of short spines on the branches, recently monographed by de Jong *et al.* (1999). Only one record of *A. dendroides* from southern Australia exists.

Acanthophora dendroides Harvey 1855a: 538; 1863, synop.: xvii. J. Agardh 1863: 818. de Jong *et al.* 1999: 225, figs 9–14, 43. De Toni 1903: 820; 1924: 380. Huisman 1997: 203; 2000: 154. Huisman & Walker 1990: 431. Huisman *et al.* 1990: 97. Kendrick *et al.* 1990: 52. Kraft 1979: 124, 126, 128, fig. 7. Lewis 1984: 49. Lucas 1909: 39. Lucas & Perrin 1947: 254. May 1965: 384. Millar & Kraft 1993: 49. Silva *et al.* 1996: 468. Sonder 1880: 33.

FIG. 177A, B

Thallus (Fig. 177A) dark brown-red, 5–12 cm high, much branched irregularly radially for 3–4 orders, branches terete, main axes 1–1.5 mm in diameter, lesser branches 400–600 µm in diameter, all branches bearing short spines (Fig. 177B) irregularly spirally. Holdfast discoid, with spreading stolons; probably epilithic. *Structure*. Apices of branches rounded and depressed, with trichoblasts within the depressions. Pericentral cells 5, remaining clear in older branches and becoming thick-walled, with a compact cortex grading to an outer layer of longitudinally elongate cells; small cells and rhizoids developing around the axial cells and pericentral (and inner cortical) cells. Spines multicellular, 200–400 µm long, bases 100–300 µm broad.

Reproduction. Gametophyte plants not described from Australia. de Jong *et al.* (1999, p. 225) describe cystocarps as globose and sessile, and spermatangial plates as discoid, margins with large oblong cells.

Tetrasporangial stichidia (Fig. 177B) formed from smaller lateral branches, 1–2 mm long and 300–500 µm in diameter, usually bearing spines; tetrasporangia cut off from pericentral cells, several per whorl, (50-) 80–110 µm in diameter.

Type from Rottnest I., W. Aust. (*Harvey*); holotype in Herb. Harvey, TCD (Trav. Set 224).

Distribution. Western Australia, N.S.W. and Queensland; in southern Australia, only known from Denial Bay, S. Australia.

Widespread around the Indian Ocean (see de Jong *et al.* 1999, fig. 43, which omits the type locality).

Selected specimen: Denial Bay, S. Aust., upper sublittoral (*Womersley*, 23.i.1951; AD, A13658).

This species needs detailed study of its structure and reproduction, and search for further records from southern Australian coasts. De Jong *et al.* (1999, p. 223) key *A. dendroides* as having basally constricted determinate branches. Australian plants (including West Australian and an isotype specimen) do not show constricted laterals and they are scarcely "determinate".

Genus COELOCLONIUM J. Agardh 1876: 639

Thallus erect, usually much branched with lesser branches basally constricted and in some cases segmented, branches terete, with broad rounded apices, sometimes depressed, surmounted by a short apical filament bearing trichoblasts and cutting off 5 pericentral cells. Holdfast discoid or divided. *Structure*. Pericentral cells rapidly elongating at right angles to axial cells, becoming separated by spaces, branching apically tri- or quadrichotomously for 2–3 orders, then with an outer cortex of small, compact cells, 1–2 cells thick. Older branches usually with a rhizoidal inner cortex and in some species with rhizoids filling the spaces between the pericentral cells. Cells usually uninucleate.

Reproduction. Gametophytes dioecious. Carposporophytes with a basal cluster of filaments or slight fusion of lower cells and a branched gonimoblast with clavate terminal carposporangia. Cystocarps ovoid, sessile or short-stalked; pericarp with a broad ostiole, ecorticate to lightly corticate. Spermatangial organs (where known) flat, ovate discs, with a sterile margin.

Tetrasporangia borne on the pericentral cells or their derivatives, from none to few per whorl.

Lectotype species: *C. opuntioides* (Harvey)J. Agardh [= *C. tasmanicum* (Harvey)Womersley]

A genus of some 5 species, mainly southern Australian, distinguished from *Chondria* by the elongation of the pericentral cells at right angles to the axial cells. This is comparable to the term "periaxial cells" as applied by Min-Thein & Womersley (1976, p. 38) and contrasts with the usual orientation of pericentral cells in the Rhodomelaceae. However, they are here referred to as pericentral cells since they are rhodomelaceous.

KEY TO SPECIES OF *COELOCLONIUM*

1. Thallus usually 10–30 cm high, much branched irregularly with clavate segments which readily disintegrate; usually epilithic .... 1. *C. tasmanicum*
1. Thallus usually less than 10 (-15) cm high, branched verticillately, umbellately or only slightly, segments not readily disintegrating; epiphytic, usually on *Posidonia* or *Amphibolis* 2
   2. Thallus slender, 2–4 cm high, branches 0.5–1 mm in diameter, branching slight .... 2. *C. debile*
   2. Thallus usually 2–10 (-15) high, relatively robust, branching umbellate or mostly verticillate, branches 1–3 mm in diameter 3
3. Thallus 1–3 cm high with 2–3 successive umbells of synchronous branches; usually epiphytic on *Posidonia* (or *Amphibolis*) .... 3. *C. umbellula*
3. Thallus 5–15 cm high, much branched, verticillate or clustered, or singly and not synchronous; usually epiphytic on *Amphibolis* or algae .... 4. *C. verticillatum*

1. **Coeloclonium tasmanicum** (Harvey)Womersley, *comb. nov.*

Chylocladia tasmanica Harvey 1844b: 444; 1849a: 81.
Catenella major Sonder 1845: 57; 1848: 171. Kützing 1849: 724; 1866: 25, pl. 72a–c.
Coeloclonium major (Sonder)Silva *in* Silva *et al.* 1996: 486.
Rhabdonia sonderi J. Agardh 1851: 356. Sonder 1880: 28.
Chylocladia opuntioides Harvey 1855a: 556.
Chondria opuntioides (Harvey)Harvey 1859b: 297, pl. 189; 1863, synop.: xix. Tisdall 1898: 512.
Coeloclonium opuntioides (Harvey)J. Agardh 1876: 640. De Toni 1903: 825. Falkenberg 1901: 211, pl. 22 figs 32–34. Guiler 1952: 104. Huisman & Walker 1990: 433. King *et al.* 1971: 124. Kylin 1956: 549, fig. 439C. Lucas 1909: 40; 1929b: 51. Lucas & Perrin 1947: 256. May 1965: 383. Mazza 1922: No. 783. Reinbold 1898: 49; 1899: 48. Schmitz & Falkenberg 1897: 433, fig. 244C, D. Shepherd & Womersley 1981: 368. Sonder 1880: 29. Tate 1882a: 21. Tisdall 1898: 511. Wilson 1892: 170. Womersley 1950: 187; 1966: 154.

FIG. 177C, D, 178

Thallus (Fig. 177C) medium to dark red brown, fading to grey-red, 10–30 cm high, much branched irregularly with axes and main branches bearing lesser branchlets for 2–4 orders, these branchlets appearing as basally constricted segments with rounded apices, often in clusters of 2–4. Axes and main branches 2–4 (-10) mm in diameter, lesser branches clavate (Fig. 178D) to elongate-ovoid, (0.5-) 1–2 mm in diameter and 2–8 mm long. Holdfast discoid

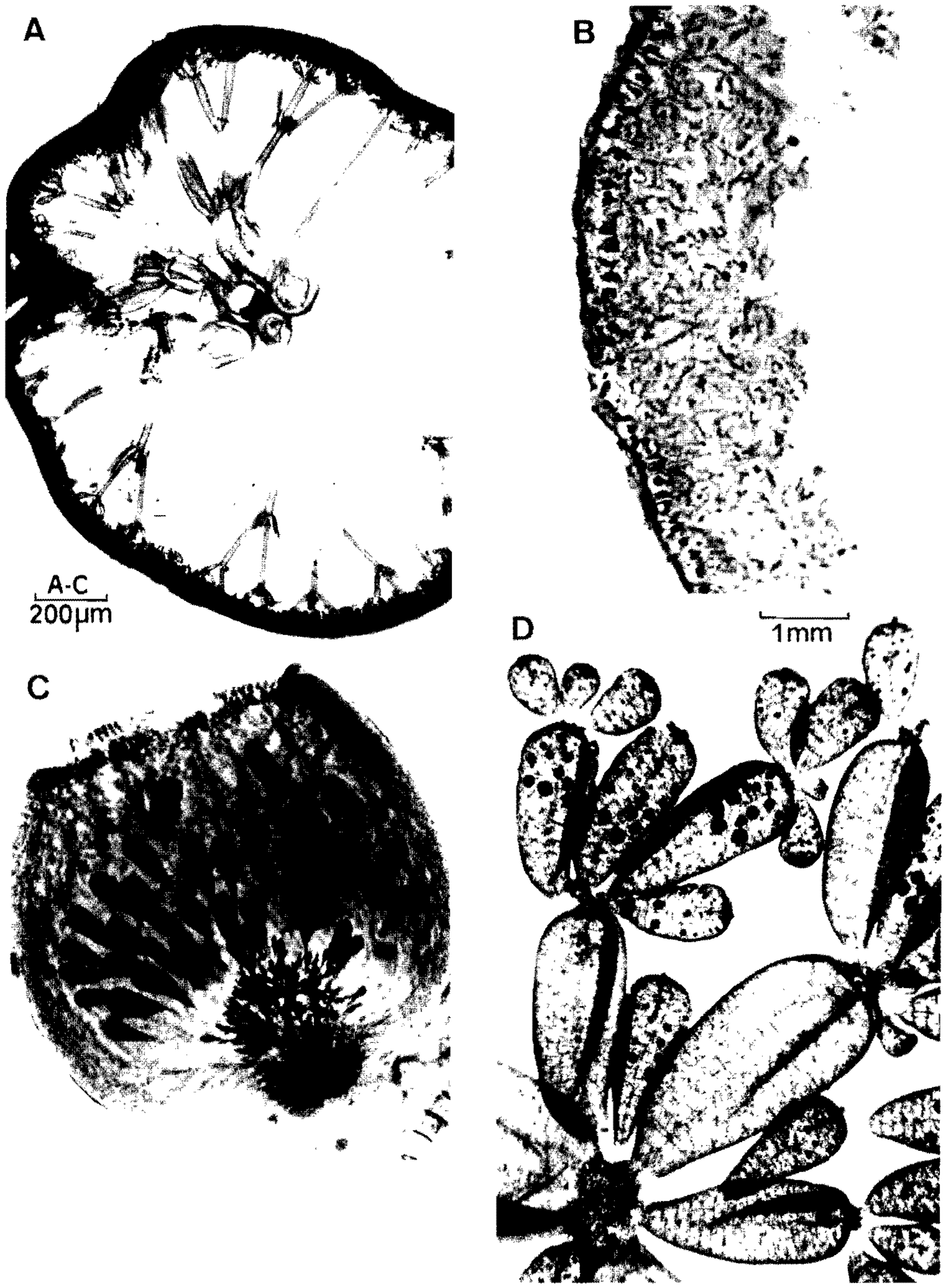

Fig. 178. *Coeloclonium tasmanicum* (**A**, **C**, AD, A59189; **B**, AD, A53760; **D**. AD, A64747). **A**. Transverse section of branch showing axial filament and laterally elongate pericentral cells (incomplete), separated by spaces. **B**. Transverse section of older rhizoidal cortex. **C**. Cystocarp with carposporophyte. **D**. Branches with tetrasporangia.

or divided; epilithic, occasionally epiphytic. *Structure.* Apical filaments 8–15 cells long, projecting above the broad rounded apices (due to rapid enlargement of the pericentral cells and their derivatives), apical cells hemispherical, 12–18 μm in diameter. Pericentral cells 5, rapidly elongating (Fig. 177D) at right angles to axial cells thus separated by spaces (Fig. 178A), becoming 90–130 μm in diameter and L/D (1.5-) 4–10, when older bearing short, ovoid cells laterally; pericentral cells apically branched tri- or quadrichotomously for 2–3 orders, cells elongate, with an outer cortex 1–2 cells thick, outer cells mostly ovoid and 10–20 μm in

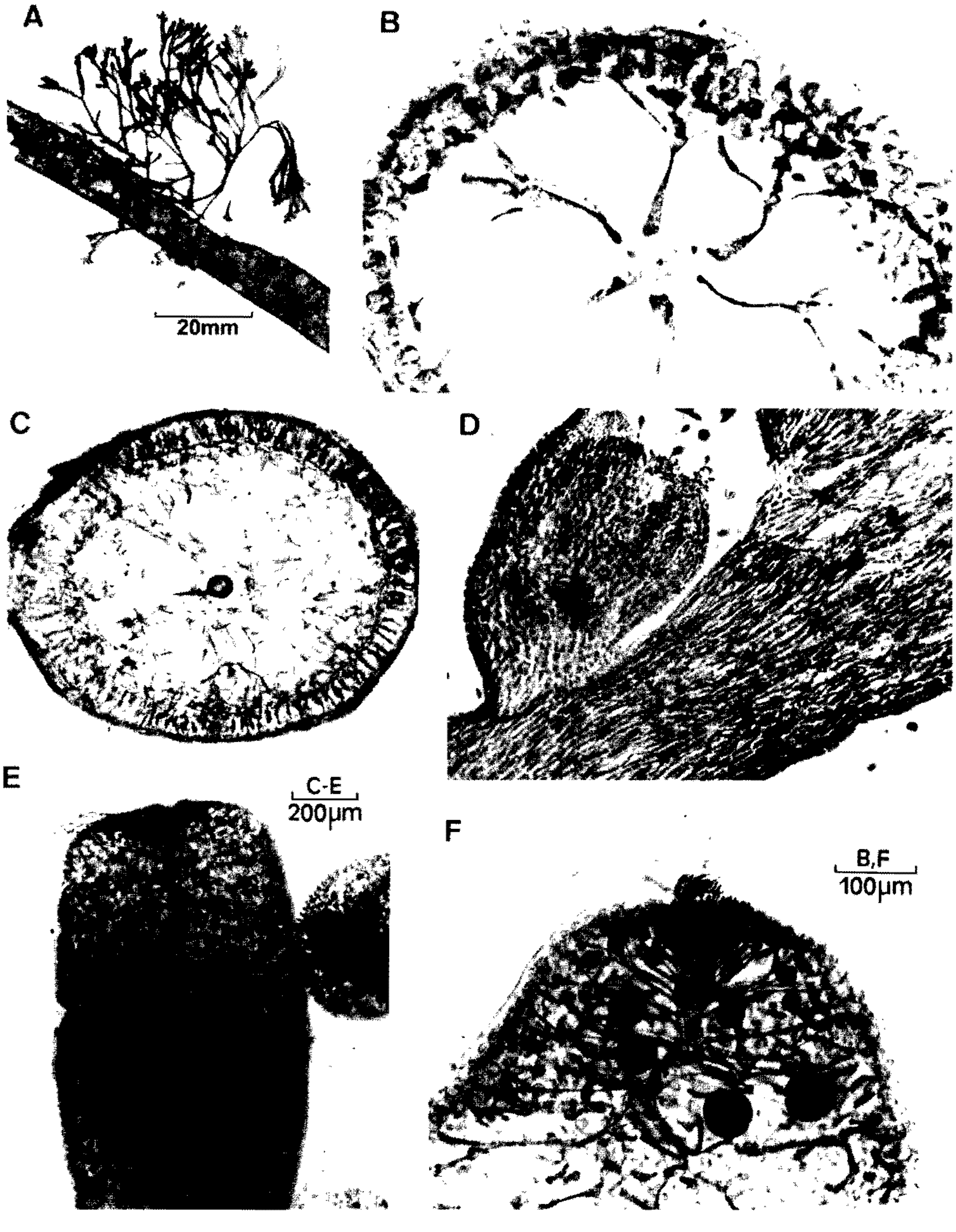

Fig. 179. *Coeloclonium debile* (**A**, **D**, AD, A41317; **B**, **C**, **E**, **F**, AD, A53373). **A**. Habit, on *Posidonia*. **B**. Transverse section of young branch. **C**. Transverse section of old branch. **D**. Cystocarp. **E**. Branch with tetrasporangia. **F**. Apex of tetrasporangial branch.

diameter, in longitudinal rows; older branches with an extensive inner cortex of rhizoids (Fig. 178B) cut off from the subcortical cells. Trichoblasts abundant at apices, 0.5–2 mm long. Cells uninucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a basal cluster of filaments and slight fusion of lower, branched gonimoblast cells, with clavate terminal carposporangia 60–90 μm in diameter. Cystocarps (Fig. 178C) ovoid, sessile, 1–1.5 mm in diameter, lateral on upper branches; pericarp several cells thick, with the erect filaments producing branched derivatives within the cellular cortex. Spermatangial plates not observed.

Tetrasporangia (Fig. 178D) borne on the pericentral cells or their derivatives, few to several per whorl, 120–220 μm in diameter.

Type from Georgetown, Tas. (*Gunn* 1295); lectotype in Herb. Harvey, TCD.

Distribution: N of Dongara, W. Aust., to Walkerville, Vic., and around Tasmania.

Selected specimens: 7 mile beach, N of Dongara, W. Aust., drift (*Womersley*, 17.ix.1979; AD, A51358). Safety Bay, W. Aust., on *Amphibolis*, drift (*Womersley*, 23.viii.1947; AD, A5826). Elliston, S. Aust., 4 m deep in bay (*Shepherd*, 22.x.1970; AD, A37507). Stenhouse Bay, S. Aust., 7 m deep on jetty piles (*Gilbert*, 15.x.1988; AD, A59189). Marino, S. Aust., drift (*Womersley*, 22.ix.1945; AD, A1974). Chiton Rocks, S. Aust., 6–10 m deep (*Edyvane*, 8.viii.1982; AD, A60642). Vivonne Bay, Kangaroo I., S. Aust., 3–4 m deep on jetty piles (*Latz*, 22.xi.1968; AD, A33029). Muston, Kangaroo I., S. Aust., 2–4 m deep (*Womersley*, 22.viii.1963; AD, A26857). Stinky Bay, Nora Creina, S. Aust., drift (*Womersley*, 6.xii.1995; AD, A64747) and 1-3 m deep (*Miller*, 26.x.1996; AD, A66748). Point Lonsdale, Vic., in pools (*Sinkora* A935, 8.xi.1970; AD, A62698). Crawfish Rock, Westernport Bay, Vic., 0 m deep (*Watson*, 29.v.1974; AD, A44418). Walkerville, Vic., in deeper pools (*Sinkora* A2631, 22.xi.1979; AD, A61031). Low Head, Tas. (*Perrin*, Jan. 1937; AD, A50200). Bridport, Tas., drift (*Parsons & Womersley*, 6.xi.1982; AD, A53760). Bruny I., Tas., 14 m deep (*Brown*, 10.x.1986; AD, A57808).

The type specimen of *Chylocladia tasmanica* in TCD is a poor specimen but recognisable, and Harvey's protologue while expressing reservations is quite recognisable as applying to this common species of *Coeloclonium*.

Coeloclonium tasmanicum is variable in robustness, the slender specimens occurring in sheltered waters and robust ones on rough-water coasts; it occurs from low tide level to 20 m deep.

2. **Coeloclonium debile** (Harvey)Gordon-Mills & Womersley 1987: 557

Chondria debilis Harvey 1863, synop.: xix. De Toni 1903: 847; 1924: 383. De Toni & Forti 1923: 37 (in part). Guiler 1952: 104? Lucas 1909: 40; 1929a: 21(?). Lucas & Perrin 1947: 260.

Chondriopsis debilis (Harvey)J. Agardh 1892: 155. Sonder 1880: 34. Tisdall 1898: 514. Wilson 1892: 168.

FIG. 179

Thallus (Fig. 179A) red-brown, slender, 2–4 cm high, irregularly branched, branches basally constricted, 2–5 mm long and 0.5–1 mm in diameter, apices rounded and slightly depressed. Holdfast discoid, 0.5–1 mm across; epiphytic on *Posidonia sinuosa* and *Dilophus*.

Structure. Apical filament short, bearing trichoblasts. Pericentral cells 5 (Fig. 179B), lengthening rapidly to form the broad branch apex, 20–40 (-100) μm in diameter and L/D (2-) 10–12, cortex 1 (-2) cells thick, outer cells ovoid to elongate, 20–35 μm in diameter and L/D 1–2 (-5), in longitudinal lines. Older axes with moderately abundant rhizoids (Fig. 179C) between the pericentral cells, cut off from these cells and their derivatives. Trichoblasts 300–700 μm long. Cells probably uninucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Procarps not observed. Carposporophytes with a small basal fusion cell and branched gonimoblast with clavate terminal carposporangia 40–120 μm in diameter. Cystocarps (Fig. 179D) ovoid, short-stalked, 1–1.5 mm in diameter; pericarp with a broad ostiole, ecorticate, 2 (-3) cells thick. Spermatangial plates not observed.

Tetrasporangia (Fig. 179E, F) borne on pericentral cells or their derivatives, one to few per whorl, 50–100 μm in diameter.

Type from King George Sound, W. Aust., on *Posidonia* (*Harvey*, Alg. Aust. Exsicc, 157B); lectotype in Herb. Harvey, TCD.

Distribution. King George Sound, W. Aust., to Tiparra Reef, S. Australia.

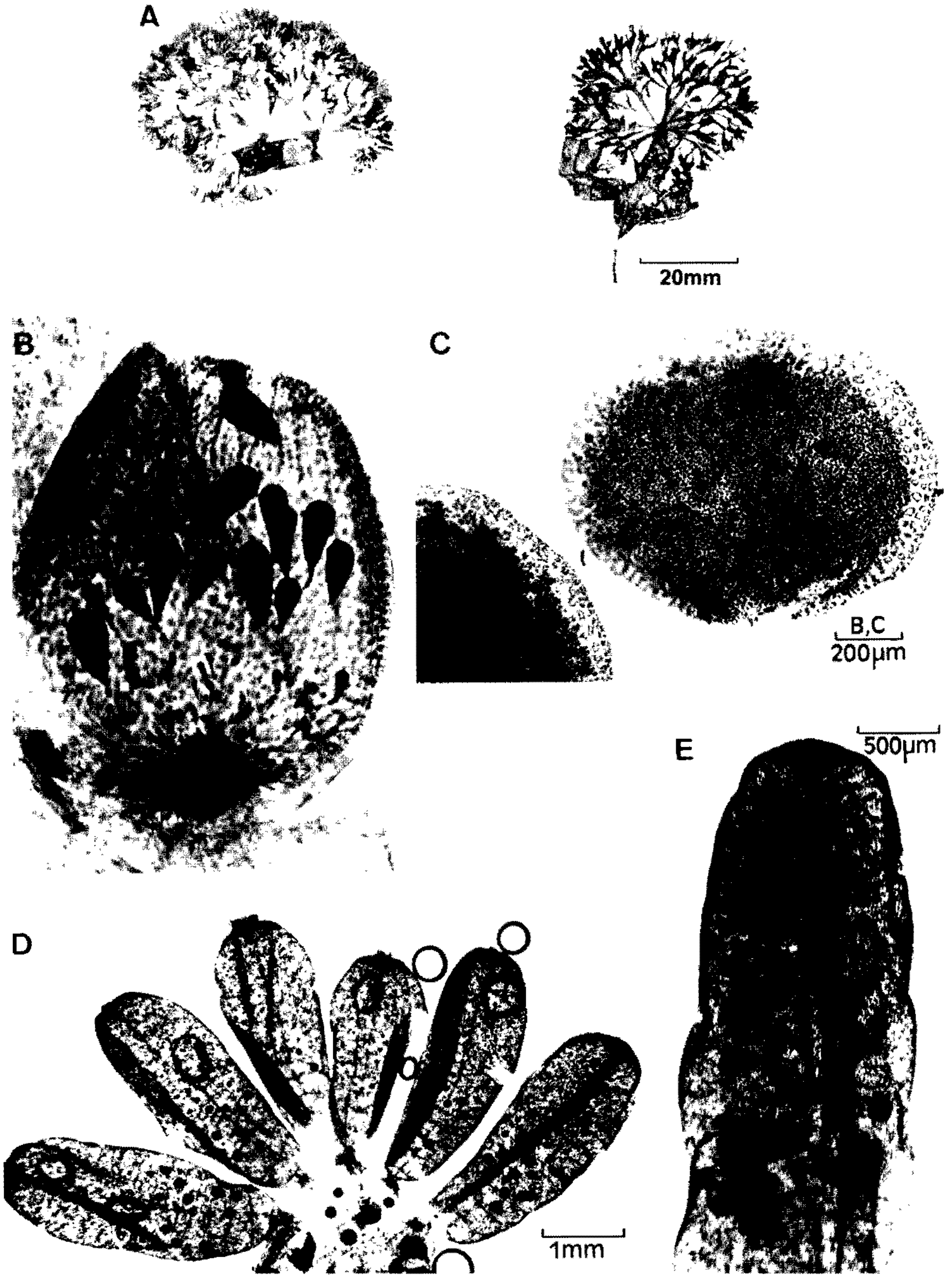

Fig. 180. *Coeloclonium umbellula* (**A**, AD, A44567; **B–E**, AD, A37309). **A**. Habit. **B**. Cystocarp. **C**. Spermatangial plates. **D**. Umbel of branches with tetrasporangia. **E**. Branch with tetrasporangia.

Selected specimens: Speeds Point, Sceale Bay, S. Aust., on *Dilophus*, 3–4 m deep (*Edyvane*, 30.ix.1982; AD, A53373). Tiparra Reef, S. Aust., on *Posidonia sinuosa*, 5 m deep (*Shepherd*, 19.v.1971; AD, A41317).

Coeloclonium debile is much smaller than the other species but agrees well in structure. It is apparently a rare species and further collections are desirable to clarify its structure.

3. **Coeloclonium umbellula** (Harvey)J. Agardh 1876: 640 (as "umbellata"). De Toni 1903: 824. Ducker *et al.* 1977: 87. Falkenberg 1901: 214. Huisman & Walker 1990: 433. Huisman *et al.* 1990: 97. Kendrick *et al.* 1988: 204; 1990: 52. Lucas 1909: 39; 1929b: 51. Lucas & Perrin 1947: 256, fig. 114. May 1965: 383 (as "umbellatum"). Reinbold 1898: 49; 1899: 48. Shepherd & Womersley 1981: 368. Silva *et al.* 1996: 486. Sonder 1880: 29.

Chondria umbellula Harvey 1855a: 539; 1860, pl. 147; 1863, synop.: xix.

FIG. 180

Thallus (Fig. 180A) medium red-brown, 1–3 cm high, with 2–3 successive umbels (Fig. 180D) of 5–10 elongate segments, synchronously developed to give the thallus a rounded outline; basal segments 5–8 (-12) mm long and 2–3 mm in diameter, upper segments mostly 2–4 mm long and 1.5–3 mm in diameter, with trichoblasts at the apices. Holdfast discoid, 1–2 (-3) mm across; epiphytic on leaves of *Posidonia* and *Amphibolis*. *Structure*. Apical filaments short, cutting off 5 pericentral cells which expand rapidly to form a broad summit to the upper segments, becoming elongate at right angles to the axial cells, 20–30 µm in diameter and very long, and bearing 2–3 clusters of derivative segments, all with an outer cortex of smaller cells 12–25 µm in diameter and L/D mostly 2–3. Trichoblasts 1–2 mm long, basal cells 20–40 µm in diameter and L/D 1–2 (-3). Cells uninucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes without a basal fusion cell, gonimoblast filaments basally branched with carposporangia supported on long slender strands, carposporangia clavate, 50–120 µm in diameter. Cystocarps (180B) sessile, ovoid, 1–1.5 mm in diameter; pericarp with a broad ostiole, ecorticate, 2 (-3) cells thick. Spermatangial plates (Fig. 180C) on ends of upper segments, replacing whole trichoblast, with a branched vein system, ovate, 1–2 mm across, with a sterile margin 3–4 cells broad.

Tetrasporangia (Fig. 180D, E) in upper segments, borne on pericentral or derivative cells, usually one to a few per whorl, 120–220 µm in diameter.

Lectotype from Garden I., W. Aust.; Harvey, Alg. Aust. Exsic. 161a, in Herb. Harvey, TCD.

Distribution: Rottnest I., W. Aust., to Portland, Victoria. Kendrick *et al.* (1988, p. 204) record it from Shark Bay, W. Australia.

Selected specimens: Yanerbie Bay, Sceale Bay, S. Aust., on *Posidonia*, 3–4 m deep (*Edyvane*, 30.ix.1982; AD, A60609). Elliston, S. Aust., on *Posidonia*, drift (*Parsons*, 23.viii.1967; AD, A31929). Coffin Bay, S. Aust., on *Posidonia*, 2.5 m deep (*Womersley*, 4.xii.1975; AD, A46941). Tiparra Reef, S. Aust., on *Posidonia sinuosa*, 5 m deep (*Shepherd*, 30.ix.1970; AD, A37309). Pondalowie Bay, S. Aust., drift (*Womersley*, 15.x.1988; AD, A59149). Stenhouse Bay, S. Aust., 3–7 m deep (*Kraft*, 18.ix.1973; AD, A44567). Aldinga, S. Aust., on *Posidonia*, 7 m deep (*Johnson*, 7.vii.1973; AD, A43833). Victor Harbor, S. Aust., on *Amphibolis*, drift (*Womersley*, 2.xi.1965; AD, A29631). Gardens Beach, Portland, Vic., drift (*Beauglehole*, 11.viii.1951; AD, A21582).

Coeloclonium umbellula is distinctive in habit and occurs mainly on the sea-grasses *Posidonia* and *Amphibolis*, though Harvey (1860, pl. 147) reported it on "smaller algae" at Garden Island.

4. **Coeloclonium verticillatum** (Harvey)J. Agardh 1876: 640. De Toni 1903: 824. Falkenberg 1901: 214. Guiler 1952: 104. Huisman 2000: 161. Huisman & Walker 1990: 433. Lucas 1909: 39; 1929a: 21; 1929b: 51. Lucas & Perrin 1947: 254, fig. 113. May 1965: 383. Reinbold 1897: 55; 1899: 48. Shepherd & Womersley 1981: 368. Silva *et al.* 1996: 487. Sonder 1880: 29. Tisdall 1898: 511. Wilson 1892: 170.

Chondria verticillata Harvey 1855a: 539; 1859a: pl. 102; 1859b: 297; 1863, synop.: xix.

FIG. 181

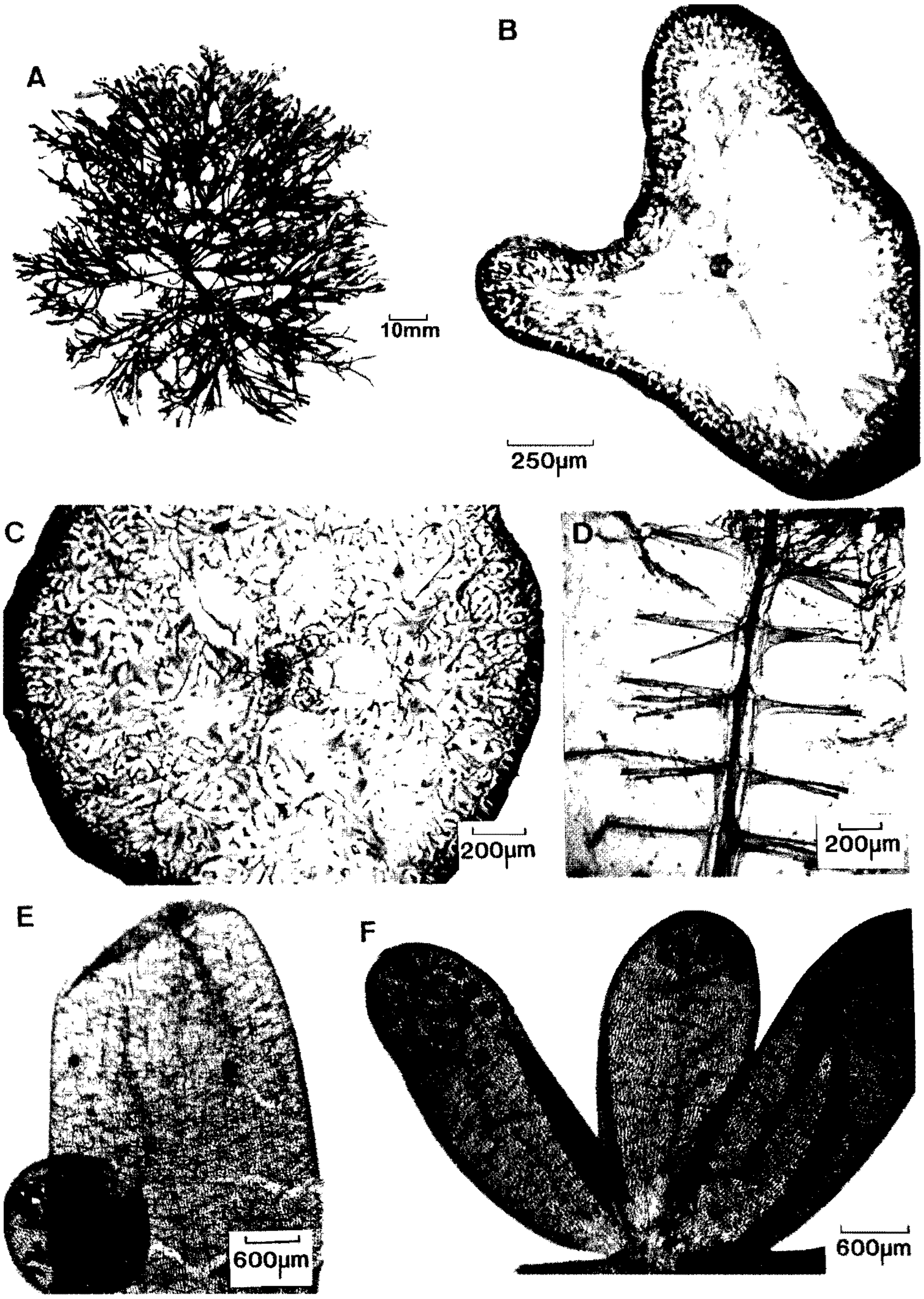

Fig. 181. *Coeloclonium verticillatum* (**A–C**, **F**, AD, A68089; **D**, **E**, AD, A53374). **A**. Habit. **B**. Transverse section of young branch. **C**. Transverse section of axis. **D**. Axial filament with laterally elongate pericentral cells. **E**. Branch with cystocarp. **F**. Segments with tetrasporangia. [**B–F**, by R.N. Baldock.]

Thallus (Fig. 181A) medium to dark brown-red, 5–15 cm high, densely branched with axes and branches bearing whorls (usually not synchronous) or clusters of lesser branches as well as single branches; axes 1–2 mm in diameter with 0.5–1.5 cm between whorls, lesser branchlets elongate-clavate to linear, basally constricted but not segmented, 5–10 mm long and 1–2 (-3) mm in diameter, apices rounded to slightly depressed. Holdfast discoid or divided, clasping host; usually epiphytic on *Amphibolis*, *Laurencia* and other algae. *Structure.* Apical filament short, on broad, rounded or slightly depressed apices, apical cell hemispherical, 12–18 µm in diameter. Pericentral cells 5 (Fig. 181B, C), transversely elongate (Fig. 181D), becoming 40–90 µm in diameter and L/D 4–6, with arms extending down along the axial cell and uniting with the lower pericentral cell, also producing further rhizoids. Pericentral cells branched tri- or quadrichotomously for 2–3 orders, with an outer cortex 1–2 cells thick, outer cells (20-) 30–40 µm in diameter and L/D 2–3 (-4), in longitudinal rows. Older branches becoming filled with rhizoids (Fig. 181C) between the pericentral and their derivative cells. Trichoblasts on apical filaments. Cells uninucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Procarps not observed. Carposporophytes with a basal filamentous cluster and branched gonimoblast with clavate terminal carposporangia 40–80 µm in diameter, borne on slender strands. Cystocarps (Fig. 181E) ovoid, sessile, 1.5–2 mm in diameter; pericarp with a broad ostiole, ecorticate, 2–3 cells thick. Spermatangial organs not observed.

Tetrasporangia (Fig. 181F) borne on the pericentral cells or their derivatives, one to few per whorl, 80–150 (-200) µm in diameter.

Type from Garden I., W. Aust.; lectotype (*Clifton*, W. Aust.) in Herb. Harvey, TCD. Trav. Set 273 from Garden I., was not located in TCD in 1952, so a Clifton specimen was selected as lectotype; a 273 from Port Fairy, Vic. is in TCD.

Distribution: Rottnest I., W. Aust., to Port Phillip Heads, Vic., and around Tasmania.

Selected specimens: Point Peron, W. Aust., drift (*Royce 942*, 22.ii.1951; AD, A14183). Point Sinclair, S. Aust., drift (*Womersley*, 25.i.1951; AD, A13881). Walker Rock, Anxious Bay, S. Aust., 8–10 m deep (*Edyvane*, 1.x.1982; AD, A53374). Tiparra Reef, S. Aust., on *Osmundaria*, 5 m deep (*Shepherd*, 2.ix.1970; AD, A36912). Cape Spencer, S. Aust. (*Davey*; AD, A1241). Stenhouse Bay, S. Aust., on *Amphibolis* on jetty piles, 3–4 m deep (*Cannon*, 15.x.1988; AD, A59178). Marion Bay, S. Aust., drift (*Kraft*, 18.ix.1973; AD, A44535). Off Troubridge Light, S. Aust., 17 m deep (*Shepherd*, 4.ii.1969; AD, A33427). Robe, S. Aust., drift (*Womersley*, 30.x.1993; AD, A63216). Port MacDonnell, S. Aust., on *Amphibolis*, drift (*Womersley*, 20.viii.1984; AD, A55714) and drift (*Womersley*, 4.iv.1999; AD, A68089). Point Nepean, Port Phillip Heads, Vic., on *Laurencia*, 5–7 m deep (*Borowitzka & Walker*, 3.xii.1983; AD, A55424). Alonnah, Bruny I., Tas., on *Laurencia*, upper sublittoral (*Wollaston & Mitchell*, 28.ii.1964; AD, A27922).

Coeloclonium verticillatum is widely distributed around southern Australia but is apparently not a common species. The thallus is relatively robust, especially the lower axis.

Genus CLADURUS Falkenberg *in* Schmitz & Falkenberg 1897: 435

Thallus erect, robust, irregularly radially branched; holdfast conical to divided. *Structure.* Apical cell surmounting a short, slender apex, with trichoblasts, then broadening suddenly by enlargement of pericentral cells; 5 (-6) pericentral cells, becoming relatively large and remaining conspicuous throughout the thallus, surrounded by a narrow single-celled cortex, later several cells thick; face view of branches showing clear segments corresponding to the tiers of pericentral cells; rhizoids surround the older axial and pericentral cells.

Reproduction. Gametophytes dioecious. Procarps probably borne on trichoblasts. Carposporophytes with a prominent, branched, fusion cell and branched gonimoblast with terminal carposporangia. Cystocarps borne on short axillary branchlets, ovoid, pericarp corticated, several cells thick. Spermatangial organs on branches of trichoblasts, terete and elongate.

Tetrasporangial stichidia in axils of lateral branches, elongate, corticated, tetrasporangia spirally arranged, cut off from pericentral cells.

Type (and only) *species*: *C. elatus* (Sonder)Falkenberg *in* Schmitz & Falkenberg 1897: 435.

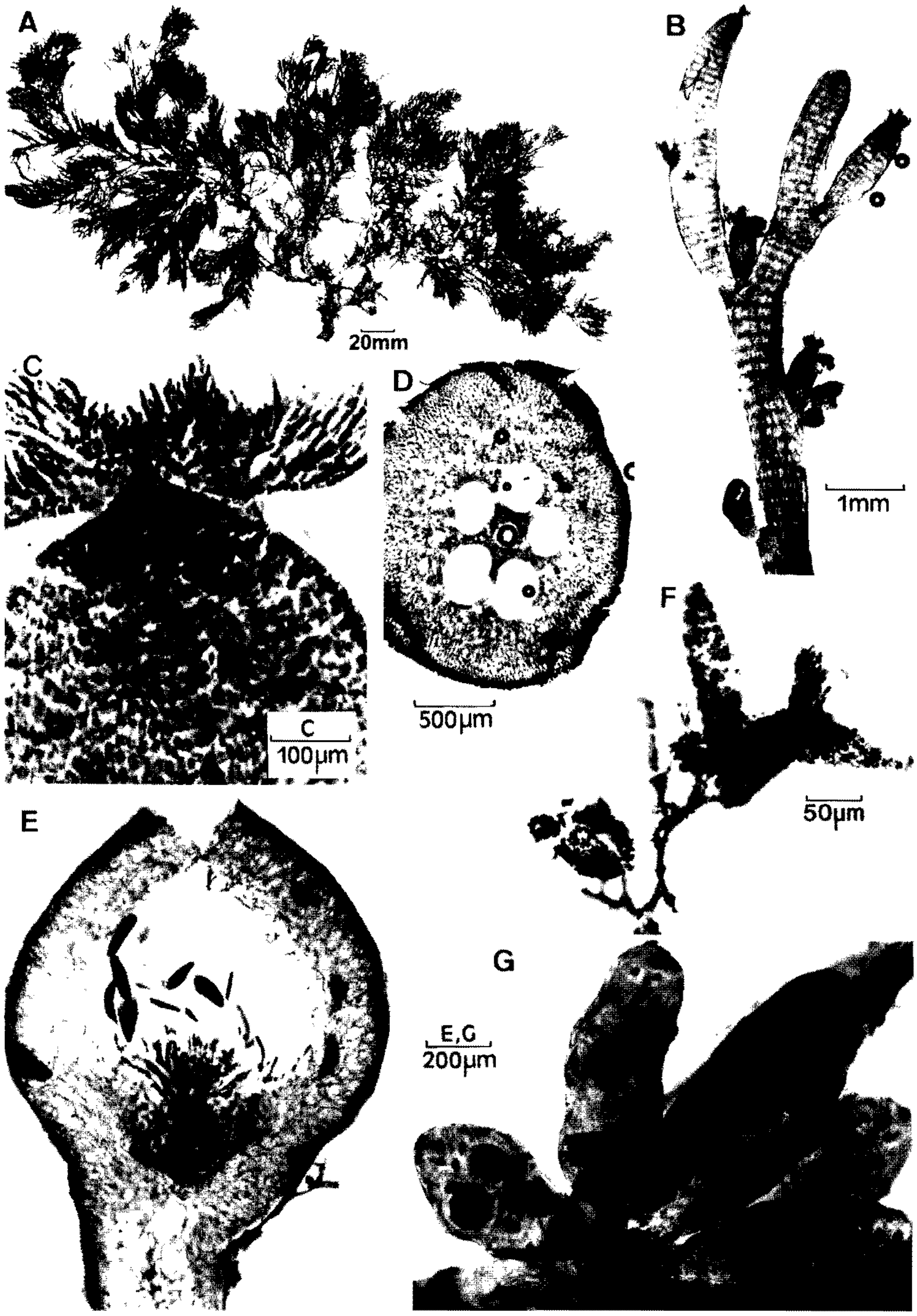

Fig. 182. *Cladurus elatus* (**A–D**, AD, A68856; **E**, **G**, AD, A57603; **F**, AD, A20850). **A**. Habit. **B**. Branch showing young laterals with trichoblasts and regular segmentation. **C**. Branch apex. **D**. Transverse section of branch with 5 large pericentral cells. **E**. Section of cystocarp. **F**. Spermatangial organs. **G**. Cluster of branches with tetrasporangia.

The name *Cladurus* was first used by Schmitz (1889, p. 448), credited to Falkenberg but without description.

Cladurus is distinguished by the relatively very large pericentral cells, compactly arranged with only a thin cortex; in face view the branches show clear segments corresponding to each tier of pericentral cells. The terete spermatangial organs, distinctly different to the plate-like organs of the Chondrieae, show that *Cladurus* is not a member of the Chondrieae (see Gordon Mills & Womersley 1987, p. 561), but its placement is uncertain and may be clarified by sequencing studies.

Cladurus elatus (Sonder)Falkenberg *in* Schmitz & Falkenberg 1897: 435. De Toni 1903: 814. Falkenberg 1901: 223, pl. 22 fig. 1. Guiler 1952: 104. Kylin 1956: 549. Lucas 1909: 39; 1929b: 51. Lucas & Perrin 1947: 251, fig. 111. May 1965: 384. Reinbold 1898: 50; 1899: 48. Shepherd & Womersley 1971: 166; 1981: 368. Silva *et al.* 1996: 485. Womersley 1950: 186; 1966: 154.

Rhodomela elata Sonder 1853: 699. J. Agardh 1894: 76.

Rytiphlaea elata (Sonder)Harvey 1855a: 538; 1862: pl. 236; 1863, synop.: xviii. J. Agardh 1863: 1088; 1885: 106. Sonder 1880: 33. Tate 1882a: 123. Tisdall 1898: 513. Wilson 1892: 166.

Halopithys elata (Sonder)Kützing 1865: 15, pl. 41.

Rytiphlaea umbellifera (*-ata*) J. Agardh 1894: 77. De Toni 1903: 1098. Tisdall 1898: 513. Wilson 1892: 166. Wilson & Kraft 2000: 330.

FIG. 182

Thallus (Fig. 182A) dark brown-red, drying almost black, 20–40 cm high, much branched irregularly radially with stout, terete, main axes or branches 2–5 mm in diameter, tapering to lesser branchlets 250–700 µm in diameter. Older branches usually covered with various encrusting animals. Holdfast robust, discoid to conical and divided, (0.4-) 0.6–1.5 cm across; epilithic. *Structure*. Apices (Fig. 182C) surmounting broad subapical branches, 8–12 segments long with hemispherical apical cells 10–12 µm in diameter, axial cells cutting off 5 (-6) pericentral cells which enlarge rapidly to 100–350 µm in diameter, becoming thick-walled and remaining conspicuous throughout the thallus (Fig. 182D), with an outer cortex at first 1, later 2–3 cells thick, outer cells elongate lengthwise and 8–18 µm broad, L/D 3–5. Face view of branches shows clearly marked segments (Fig. 182B), L/D usually 0.3–0.5. Rhizoids are cut off from pericentral cells and surround the axial and pericentral cells, later forming a broad band between the pericentral cells and cortex. Trichoblasts usually profuse below the apices, 0.5–2 mm long, basal cells 25–40 µm in diameter and L/D 1–2 (-4). Cells probably multinucleate; rhodoplasts discoid, elongate and chained in larger cells.

Reproduction. Gametophytes dioecious. Cystocarps formed on short, axillary branchlets. Procarps not observed. Carposporophytes with a prominent, erect, branched, fusion cell and branched gonimoblast with ovoid to clavate terminal carposporangia 50–90 µm in diameter. Cystocarps (Fig. 182E) ovoid, stalked, 1–1.5 mm in diameter; pericarp ostiolate, corticated, 4–5 cells thick. Spermatangial organs (Fig. 182F) on branches of trichoblasts at apices of longer lateral branches, terete, lanciform, 40–60 µm in diameter and 120–180µm long.

Tetrasporangial stichidia (Fig. 182G) in axils of lateral branches, usually clustered, 250–350 µm in diameter and 500–1000 µm long, tetrasporangia spirally arranged, cut off from pericentral cells, 80–200 µm in diameter.

Type from LeFevre Pen., S. Australia; holotype sheet (several specimens) in MEL, 612890, with Sonder's notes; lectotype MEL, 612891.

Distribution: Cliff Head, W. Aust., to Walkerville, Vic., and the N coast of Tasmania.

Selected specimens: Cliff Head, W. Aust., 5–6 m deep (*Kirkman & Joll*, 18.ix.1979; AD, A51212). Cowaramup Bay, W. Aust., 2–3 m deep (*Clarke & Engler*, 1.ix.1979; AD, A50657). "The Hotspot", W of Flinders I., S. Aust., 32 m deep (*Brandoen*, 21.vi.1988; AD, A59296). 4 km W of Waldegrave I., S. Aust., 30 m deep (*Branden*, 3.vii.1987; AD, A57603). Elliston, S. Aust., 7 m deep in bay (*Shepherd*, 20.x.1970; AD, A37630). Stenhouse Bay, S. Aust., drift (*Womersley*, 9.iv.1950; AD, A13209). Investigator Strait, S. Aust., 11 m deep (*Watson*, 20.i.1971; AD, A38383). Outside Tapley Shoal, S. Aust., 15 m deep (*Shepherd*, 2.ii.1969; AD, A33491). On "Norma" wreck, off Outer Harbor, S. Aust., 15 m deep (*Mitchell*, 15.iii.1959; AD, A22588). Glenelg, S. Aust., drift (*Womersley*, 14.iv.1948; AD, A8359). Port Elliot, S. Aust., drift (*Womersley*, 24.vii.1949; AD, A11100). Vivonne Bay, Kangaroo I.,

S. Aust., drift (*Womersley*, 2.i.1949; AD, A10692). E end D'Estrees Bay, Kangaroo I., S. Aust.; in deep pool (*Womersley*, 11.i.1950; AD, A12688). Stanley Beach, Kangaroo I., S. Aust., drift (*Womersley*, 27.i.1957; AD, A20850). Penneshaw, Kangaroo I., S. Aust., 7 m deep (*Lavers*, 27.i.2000; AD, A68856). Robe, S. Aust., 8 m deep (*P. Womersley*, 24.viii.1973; AD, A43963). Nora Creina, S. Aust., 12 m deep (*Mitchell*, 26.v.1963; AD, A26509). Dutton Bay, Portland, Vic., drift (*Womersley*, 13.iv.1959; AD, A22684). Walkerville, Vic., drift (*Sinkora* A2082, 26.ii.1975; AD, A48542). Pegleg Bay, Deal I., Bass Strait, 19 m deep (*Houridis*, 13.iii.1993; AD, A63327). Currie R., Tas. (*G. & F. Perrin*, Jan. 1937; AD, A8995).

Cladurus elatus is a common subtidal species on rough-water coasts of southern Australia, extending into moderate water movement.

Genus HUSSEYA J. Agardh 1901: 123, *nom. cons.*

Thallus erect, robust, cartilaginous, irregularly branched for 3–4 orders, branches terete; actively growing apices depressed, when mature rounded, with trichoblasts; holdfast discoid, becoming fibrous. *Structure.* Apical filament short, apex broadening rapidly; 5 pericentral cells, derivative cells forming 1–3 outer rings which become separated by bands of rhizoids; the young epidermis remains meristematic and on lower branches forms an extensive secondary cortex. Pericentral and some outer ring cells developing wall thickenings which come to almost fill the cells.

Reproduction. Procarps on lower cells of trichoblasts on short, usually axillary, branchlets; carposporophytes with a basal fusion cell and clavate terminal carposporangia; cystocarps ovoid, pericarp ostiolate, lightly corticated. Spermatangial organs unknown.

Tetrasporangia borne in axillary branchlets clustered in axils of larger lateral branches, cut off from pericentral cells.

Type (and only) *species*: *H. australis* J. Agardh 1901: 123 [= *H. rubra* (Harvey)Silva *in* Silva *et al.* 1996: 501].

The account of Gordon-Mills & Womersley (1984a) reaffirms the essential features of *Husseya*; this name has been accepted as a nomen conservandum over *Husseyella* Papenfuss (1958, p. 105), which was used in the extensive account of Gordon-Mills & Womersley. However, differences between *Husseya* and *Chondria* are relatively minor since some species of *Chondria* show to some degree the features distinguishing *Husseya*, e.g. outer rings of cortical cells (in *C. incurva*), and axillary branching in several species (e.g. *C. incurva*, *C. subfasciculata* and *C. curdieana*).

Husseya rubra (Harvey)Silva *in* Silva *et al.* 1996: 501

Chondria rubra Harvey 1863: pl. 280, figs 1, 2 (not figs 3, 4 = *Hypnea ramentacea*), synop.: xix. Falkenberg 1901: 209.

Rhododactylis rubra (Harvey)J. Agardh 1876: 568 (in part); 1897: 46 (in part). De Toni 1900: 486 (in part). Lucas 1909: 31. May 1965: 393.

Husseyella rubra (Harvey)Gordon-Mills & Womersley 1984a: 147, figs 1–24.

Chondriopsis corallorhiza J. Agardh 1885: 92; 1892: 153. Tisdall 1898: 514.

Chondria corallorhiza (J. Agardh)Falkenberg 1901: 720. De Toni 1903: 844. Lucas 1909: 40.

Rhodomela erinacea J. Agardh 1885: 96. De Toni 1903: 1133. Lucas 1909: 47. May 1965: 375.

Laurencia casuarina J. Agardh 1896: 109, in part. De Toni 1903: 781. Lucas 1909: 38; 1929b: 50. Lucas & Perrin 1947: 247. Reinbold 1898: 49. Saito & Womersley 1974: 848. Yamada 1931: 231, pl. 19b.

Husseya australis J. Agardh 1901: 123. De Toni 1924: 386. Kylin 1956: 549. Shepherd & Womersley 1981: 368. Svedelius 1911: 245.

Husseyella australis (J. Agardh)Papenfuss 1958: 105. May 1965: 384.

Rytiphlaea compressa J. Agardh 1885: 106. De Toni 1903: 1097. May 1965: 397.

FIG. 183

Thallus (Fig. 183A) dark brown-red, 15–30 cm high, irregularly branched for 3–4 orders, branches terete, lower axes 1.5–2 (-5) mm in diameter, grading to 0.5–1 mm in ultimate branchlets, axillary branchlets frequent; active branch apices depressed, when mature

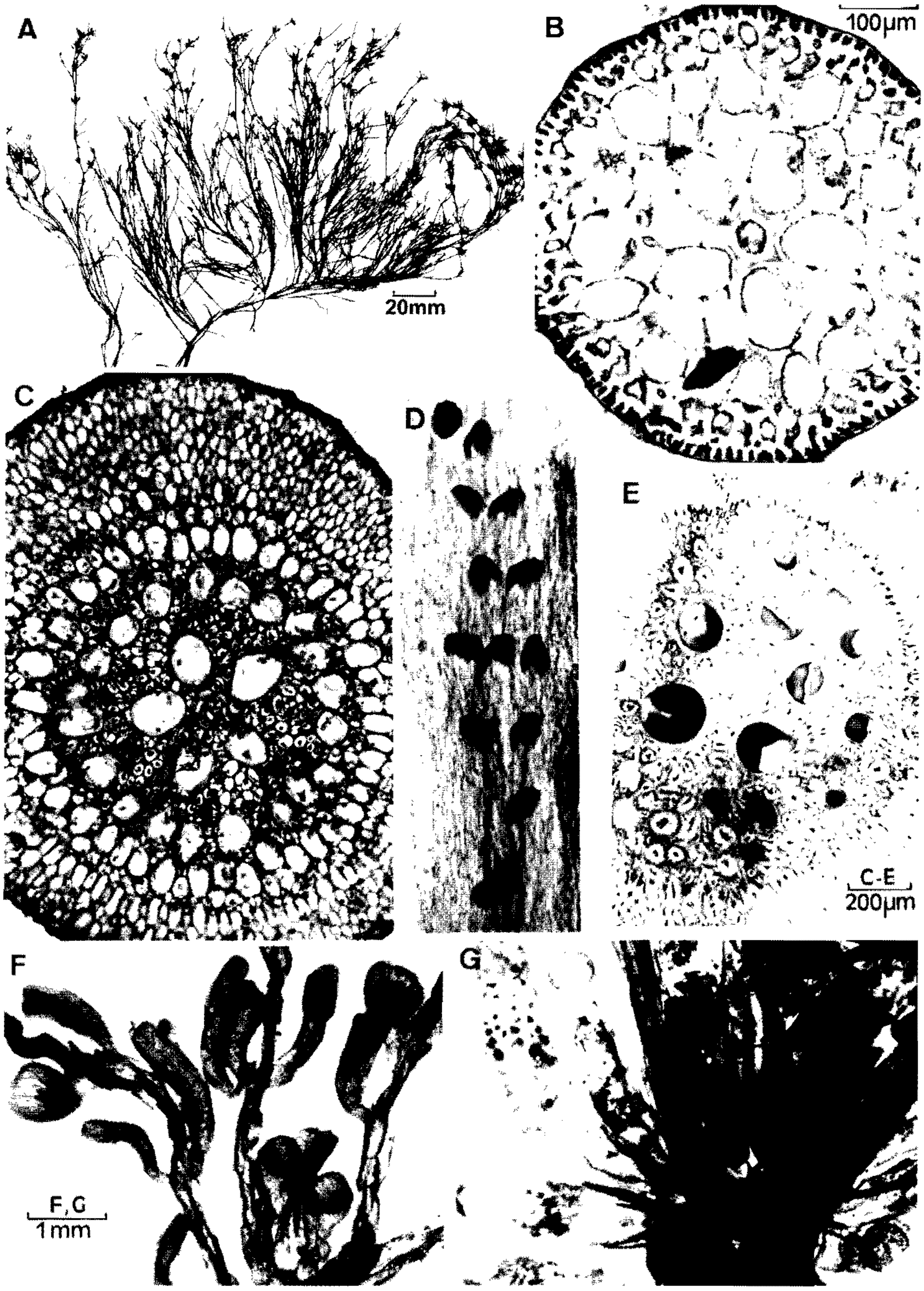

Fig. 183. *Husseya rubra* (**A**, **G**, AD, A67110; **B**, **C**, AD, A66316; **D**, **E**, AD, A19202; **F**, AD, A63008). **A**. Habit. **B**. Transverse section of young branch. **C**. Transverse section of older branch. **D**. Longitudinal branch view of cell wall thickenings. **E**. Transverse section showing thickenings in pericentral and larger inner cortical cells. **F**. Branches with cystocarps. **G**. Cluster of tetrasporangial branches.

rounded, with prominent trichoblasts when young. Holdfast discoid, 4–5 mm across, becoming fibrous; epilithic. *Structure.* Apical cells hemispherical, 15–20 µm in diameter, with a short apical filament then broadening suddenly. Pericentral cells 5 (Fig. 183B), equal in length to the axial cells, cortex broad and with 3–4 additional rings of larger cells (Fig. 183C) separated by abundant development of rhizoids; the epidermis remains meristematic forming an extensive secondary cortex of small cells, sometimes with apparent growth rings. Epidermal cells 25–50 µm in diameter, L/D 1–1.5 when young, later elongate and L/D 2–6; on secondary thickened axes, outer cells isodiametric and about 100 µm in diameter. Cell wall thickenings (Fig. 183D, E) present on the pericentral cells and sometimes cells of the next outer ring, increasing from strips to caps or rings, becoming massive and almost filling the cell (Fig. 183E). Trichoblasts 0.5–1 mm long. Cells with discoid to elongate rhodoplasts, chained in larger cells.

Reproduction. Procarps on the suprabasal cell of trichoblasts of short axillary branchlets. Carposporophytes with an erect fusion cell and short, branched gonimoblast with clavate terminal carposporangia 90–100 µm in diameter. Cystocarps (Fig. 183F) with short stalks, ovoid with a small basal protrusion, 1–1.4 mm in diameter; pericarp ostiolate, lightly corticated, 150–200 µm thick. Spermatangial organs unknown.

Tetrasporangial branches (Fig. 183G) in axillary clusters, 2–5 mm long and 700–1200 µm in diameter, tetrasporangia cut off from pericentral cells, 80–170 µm in diameter.

Type from W. Aust. (*Clifton*), probably near Fremantle; holotype in Herb. Harvey, TCD.

Distribution: W. Aust. (Fremantle? or Geographe Bay) to Cape Northumberland, S. Australia.

Selected specimens: Head of Great Australian Bight, S. Aust., drift (*Womersley*, 4.ii.1954; AD, A19202). Aldinga, S. Aust., drift (*Womersley*, 14.ix.1996; AD, A66316). Victor Harbor, S. Aust., drift (*Womersley*, 17.x.1948; AD, A9247). Stinky Bay, Nora Creina, S. Aust., drift (*Womersley*, 26.x.1996; AD, A67110). Blackfellows Caves, S. Aust., 1.5–2 m deep (*Welbourne*, 10.ix.1993; AD, A63008). 600 m off Middle Point, Cape Northumberland, S. Aust., 5 m deep (*Johnson & Shepherd*, 19.iii.1974; AD, A44950).

Husseya rubra (as *Husseyella*) was discussed by Gordon-Mills & Womersley (1984a), who clarified the numerous synonyms (mainly based on specimens from Geographe Bay, W. Aust., or Encounter Bay, S. Aust.).

Genus CHONDRIA C. Agardh 1817: xviii, *nom. cons.*

Thallus usually erect, rarely prostrate or free-floating, much branched irregularly radially or unilaterally, rarely sub-distichously, with or without one to a few percurrent axes; a few species with tendrils, axillary branches often present; branches terete or compressed, young branches basally constricted. Some species with swollen, bulbous, sterile storage organs. Attachment by discoid holdfasts or haptera from stolons; epilithic or epiphytic. *Structure.* Apices of branches depressed or rounded, or tapering, with an apical filament usually 10–20 cells long, the subapical cells cutting off 5 pericentral cells in alternating order and branched trichoblasts. Pericentral cells of similar length to axial cells except near apices of tetrasporangial thalli, producing 2–5 series of di- to quadrichotomous branchings, expanding rapidly to form the rounded ends of branches; pericentral cells remaining clear throughout the thallus, cortex of compact, ovoid cells with the epidermal cells ovoid or angular to elongate in surface view. Pericentral and often the inner cortical cells of most species developing wall thickenings of various forms often characteristic of the species. Rhizoids usually formed from pericentral and inner cortical cells, sparse to dense around these cells in larger branches. Secondary cortex absent or present on the lower axes by proliferation of the epidermis.

Reproduction. Gametophytes dioecious. Procarps borne on a lower cell of trichoblasts, with the fifth-formed pericentral (supporting) cell bearing a 4-celled carpogonial branch and lateral and basal sterile cell groups; auxiliary cell cut off post-fertilization or in some species the supporting cell acting as auxiliary cell. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia, replaced from lower cells. Cystocarps ovoid to slightly urceolate, in some species with a basal spur developed from trichoblast cells above the supporting cell; pericarp ostiolate, with 9–18 erect filaments arising pre-fertilization from adjacent pericentral cells, each cell with 2–3 outer pericentral cells and ecorticate or not. Spermatangial plates flat, discoid or slightly lobed, developed from the whole or a basal branch of a trichoblast, with the primary cells producing a layer of initials each cell of which cuts off 2–4 spermatangia, and with a sterile margin 1–3 cells broad.

Tetrasporangia developed in lesser branchlets, cut off singly from near the outer ends of 1–3 radially elongate pericentral cells per axial cell, covered by the outer cortex and epidermal cells.

Type species: *C. tenuissima* (Withering)C. Agardh 1817: xviii [= *C. capillaris* (Hudson)Wynne 1991: 317].

A genus of 40–50 species, well represented on southern Australian coasts with 15 species. This account is based on the revision by Gordon-Mills & Womersley (1987), which presented several taxonomic hypothesis for their separation, most of which need further testing.

Chondria is superficially similar to *Laurencia*, but differs in that the pericentral cells remain clear in transverse sections throughout the thallus, the flat spermatangial plates contrast with those of *Laurencia*, and the tetrasporangia are cut off from the pericentral cells only, not from the ends of pericentral cells or from outer cortical cells as occurs in *Laurencia*.

Gordon-Mills & Womersley (1984, 1987) have pointed out the importance of the cell wall thickenings, stained with 2×10^{-4}% aqueous ruthenium red, in distinguishing many of the species of *Chondria*.

Chondria dasyphylla was recorded from southern Australia by Harvey (1855a, p. 539) and later authors, but rejected as an Australian species by Gordon Mills (1987); Australian references to *C. dasyphylla* probably apply to several species, including *C. curdieana* and *C. harveyana*. Similarly, early records of *C. tenuissima* from Australia are usually uncertain.

KEY TO SPECIES OF *CHONDRIA*

1. Thallus largely prostrate, attached to host algae by multicellular haptera from the lower side of compressed axes; cystocarps with the adaxial wall adnate to the bearing branch .... 1. *C. infestans*
1. Thallus largely erect, epiphytic or epilithic; axes terete or compressed; cystocarps not adnate to the bearing branch 2

    2. Thallus branches terete throughout 3
    2. Thallus branches mostly compressed or compressed below 14

3. Lesser branches under 250 µm in diameter 4
3. Lesser branches mostly over 250 µm in diameter 5

    4. Apices pointed, branching radial; cystocarps with a pointed spur; spermatangial plates with few sterile marginal cells; thallus epiphytic or loose-lying .... 2. *C. angustissima*
    4. Apices slightly depressed, branching unilateral; cystocarps without a spur; spermatangial plates with a row of sterile marginal cells; epilithic or on artificial substrates .... 3. *C. arcuata*

5. Swollen storage organs present at base of axes or on upper branches .... 4. *C. bulbosa*
5. Swollen storage organs absent 6

    6. Epidermal cells short, L/D 1–1.5 (-2.5); thallus robust, ultimate branchlets 1–1.5 mm in diameter, axillary branches frequent .... 5. *C. incurva*
    6. Epidermal cells elongate, L/D 1.5–10 (-17); thallus robust or slender, ultimate branchlets less than 1 mm in diameter, axillary branches present or absent 7

7. Cell wall thickenings elaborate, forming circular branches with extensions, becoming highly lobed and almost reticulate .... 6. *C. hieroglyphica*
7. Cell wall thickenings present or absent, if present as apical caps or semicircular bands, occasionally lobed in lower axes but not reticulate 8

    8. Lateral branches mostly unilateral and adaxial .... 7. C. subsecunda
    8. Lateral branches irregularly radial 9

9. Thallus usually with ends of lateral branches forming curled tendrils; thallus epiphytic or loose lying .... 8. *C. capreolis*
9. Ends of lateral branches straight, not tendril-like 10

10. Apices attenuate to bluntly pointed; cell wall thickenings as discrete caps on both upper and lower ends of pericentral and inner cortical cells; spermatangial plates with a sterile margin 2–3 cells broad .... 9. *C. fusifolia*
10. Apices rounded or depressed; cell wall thickenings mainly as caps on the upper ends of pericentral and/or inner cortical cells; spermatangial plates with a sterile margin one cell broad 11

11. Axillary branching present; cell wall thickenings present; epidermal cells L/D mostly 2–5; cystocarps without a spur; spermatangial plates with a 2 (-3)-cell broad sterile margin; tetrasporangia 180–250 μm in diameter 12
11. Axillary branching absent or occasionally present; cell wall thickenings absent or as upper end caps; epidermal cells L/D (1.5-) 5–17; cystocarps with a spur; spermatangial plates with a single row of marginal sterile cells; tetrasporangia 120–150 μm in diameter 13

12. Axillary branches profuse; cell wall thickenings as caps on upper ends of pericentral and inner cortical cells, later as circular bands ...... 10. *C. subfasciculata*
12. Axillary branches moderate; cell wall thickenings as brands around pericentral and inner cortical cells, becoming hooked .... 11. *C. curdieana*

13. Thallus usually 10–40 cm high, loosely branched, dark red to brown-red, cell wall thickenings absent; epidermal cells 10–15 μm broad, L/D 9–17 .... 12. *C. harveyana*
13. Thallus usually 3–18 cm high, medium red to brown-red, cell wall thickenings absent or as caps on upper end of cells; epidermal cells (15-) 20–25 μm broad, L/D 1.5–7 (-12) .... 13. *C. succulenta*

14. Thallus 2–6 cm high; terete near apices, compressed in mid and lower parts, branches (300-) 500–800 μm broad .... 14. *C. lanceolata*
14. Thallus usually 5–30 cm high; compressed throughout (except at base), branches 0.8–3 mm broad 15

15. Apices usually pointed; main branches 0.8–1.5 mm broad; epidermal cells angular, 15–35 μm across .... 15. *C. foliifera*
15. Apices rounded, or depressed; main branches 1.5–2 (-3) mm broad; epidermal cells rounded, (20-) 30–60 (-85) μm across .... 16. *C. incrassata*

1. **Chondria infestans** (Lucas)Millar 1990: 460, fig. 72A–F, 73A–E. Millar & Kraft 1993: 51. Millar & Wynne 1992c: 428.
Laurencia infestans Lucas 1919: 174, pl. VI. De Toni 1924: 372.
Chondria myriopoda Gordon-Mills & Millar *in* Gordon-Mills & Womersley 1987: 552, figs 23I, J, 24F, 29.

FIG. 184

Thallus (Fig. 184A) largely prostrate with axes becoming free and erect by growing past the host apices up to 3.5 cm, axes compressed, 0.8–1 mm broad, bearing alternate lateral branchlets 1–3 mm long from their edges, at first terete but becoming compressed; longer lateral branches occur irregularly and axillary branchlets occur adaxially. Attachment by multicellular haptera (Fig. 184A, B) from the lower surface, 200–400 μm across; epiphytic on larger algae. *Structure*. Apices rounded to slightly depressed, with 5 pericentral cells and a thin cortex, epidermal cells 20–50 (-80) μm in diameter and L/D (1.5-) 2–4. Trichoblasts at apices, "pigmented" (Millar 1990, p. 460). Cells with discoid rhodoplasts, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a basal fusion cell and short branched gonimoblast bearing clavate terminal carposporangia 50–90 μm in diameter. Cystocarps (Fig. 184C) ovoid, sessile and adaxially adnate to the bearing branch, 700–1000 μm in diameter, without a spur; pericarp ostiolate, ecorticate. Spermatangial plates obcordate, with a single row of sterile marginal cells.

Tetrasporangia (Fig. 184D, E) in short, free, swollen, lateral branchlets, on 1–5 pericentral cells per axial cell, 120–200 μm in diameter.

Type from Manly Cove, Port Jackson, N.S.W. on *Ecklonia radiata* (*Lucas*, 28.ii.1914); holotype in NSW, 8122.

Distribution: In southern Australia, known from Portland and Gabo I., Victoria.
Manly to Coffs Harbour, N.S.W.

Selected specimens: Lawrence Rock, Portland, Vic., on *Polyopes* in rock pools (*Beauglehole*, 15.i.1960; AD, A24013 and A24795). Gabo I., Vic., on *Polyopes*, 2–5 m deep (*Shepherd*, 16.ii.1973; AD, A43368), 3–4 m deep (*Shepherd*, 19.ii.1973; AD, A43528) and on *Phyllospora*, 6 m deep (*Shepherd*, 15.ii.1973; AD, A43365). Arawatta Headland, N.S.W., on *Hormosira*, low intertidal (*Millar* 807, 10.i.1981; AD, A55691; MELU). Muttonbird I., Coffs Harbour, N.S.W., on *Dictyopteris acrostichoides*, 3–5 m deep (*Millar*, 10.i.1980; MELU, AM239).

Fig. 184. *Chondria infestans* (**A–C**, AD, A24795; **D**, **E**, AD, A43368). **A**. Prostrate axis showing lateral branches and ventral haptera. **B**. As for **A**, enlarged view. **C**. Cystocarp. **D**. Branch with tetrasporangial laterals. **E**. Branches with terminal tetrasporangia.

Chondria infestans appears to be an eastern Australian species, reaching to Gabo I. in Victoria with an isolated occurrence at Portland in Victoria. In habit it is quite distinctive.

2. **Chondria angustissima** Gordon-Mills & Womersley 1987: 531, figs 13D, 19. Millar & Kraft 1993: 51. Silva *et al.* 1996: 479.

FIG. 185

Thallus (Fig. 185A) brown-red, fading to yellow-red, 2–10 cm high, very slender, much branched radially for 3–4 orders, branches spreading and often entangled, terete; lower

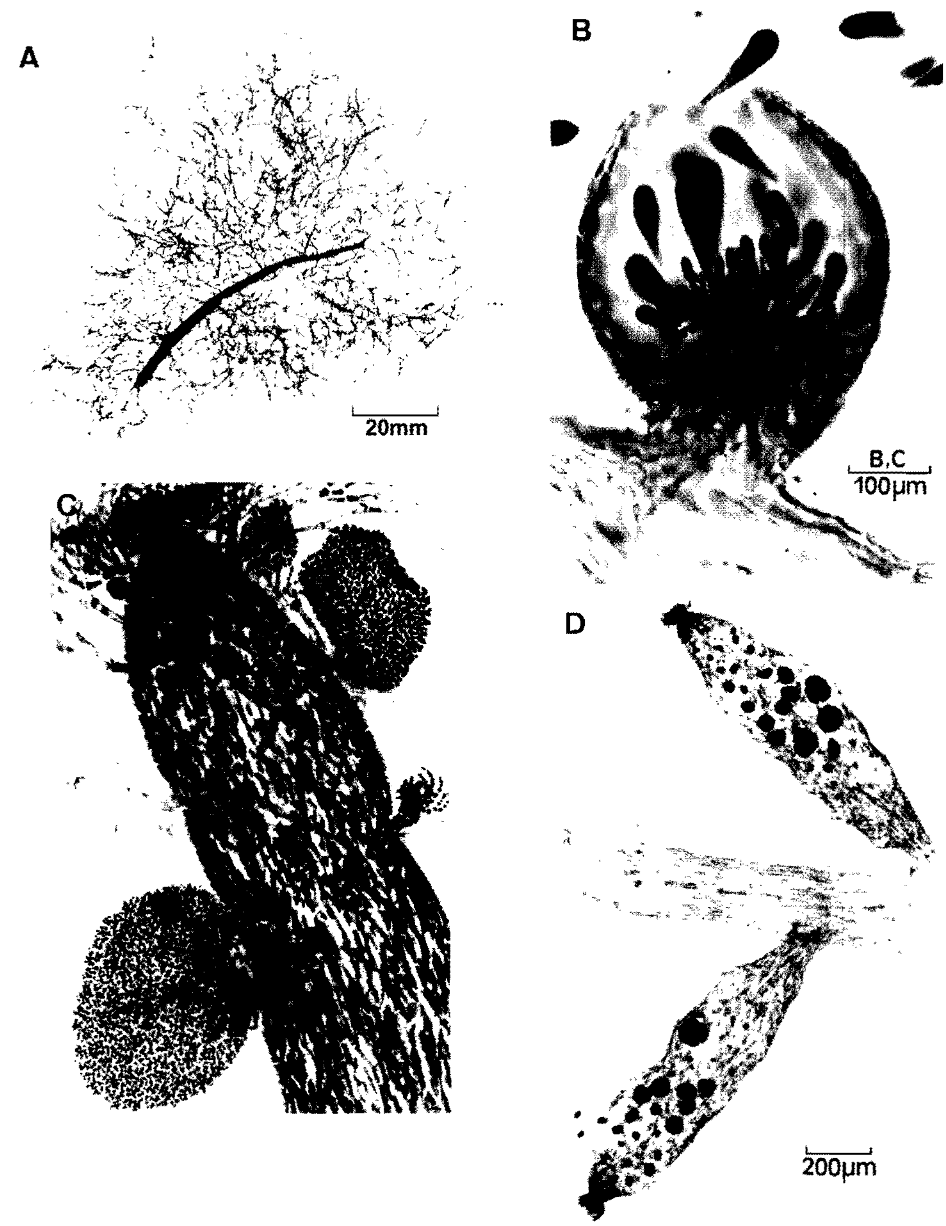

Fig. 185. *Chondria angustissima* (**A**, **C**, AD, A53797; **B**, **D**, AD, A52062). **A**. Habit, on *Zostera*. **B**. Cystocarp. **C**. Branch with spermatangial plates. **D**. Branches with tetrasporangia.

branches or axes 500–750 µm in diameter, grading to lesser branchlets 150–200 (-250) µm in diameter. Holdfast discoid, 200–500 µm across; epiphytic on *Zostera* or *Gracilaria*, or unattached, or epilithic, in sheltered estuarine conditions. *Structure*. Apices pointed, occasionally slightly rounded, with an apical filament 10–12 cells long, cortex becoming a few cells broad; epidermal cells 15–25 µm in diameter and L/D 5–12; rhizoids and cell wall thickenings absent. Trichoblasts profuse at and near branch apices, 1–2 mm long. Lateral branches arising from basal cells of trichoblasts. Cells multinucleate; rhodoplasts discoid to elongate.

Reproduction. Gametophytes dioecious. Procarps on a lower cell of trichoblasts. Carposporophytes with a branched, basal fusion cell and short branched gonimoblast with clavate terminal carposporangia 30–55 µm in diameter. Cystocarps (Fig. 185B) ovoid, short-stalked, 400–600 µm in diameter, with a short basal spur; pericarp ostiolate, with 10–14 erect filaments, 2 cells thick, ecorticate. Spermatangial plates (Fig. 185C) formed as a basal branch on trichoblasts, irregularly discoid to obcordate, 200–350 µm across, with sterile terminal cells to the trichoblast branches, but otherwise spermatangia formed by marginal cells.

Tetrasporangia (Fig. 185D) in swollen lesser branches 200–250 µm in diameter, on 2–3 pericentral cells per axial cell, 100–120 µm in diameter, with conspicuous cover cells.

Type from Onkaparinga Estuary, S. Aust., on *Zostera muelleri* (*Gordon-Mills & Robertson*, 9.ii.1984—"Marine Algae of southern Australia" No. 310); holotype and isotypes in AD, A53797, isotypes in the above distributed set.

Distribution: Leschenault Inlet, W. Aust., to Port Stevens, N.S.W.

Selected specimens: Leschenault Inlet, SW W. Aust., (*Walker*, 23.iv.1985; AD, A56818). Onkaparinga Est., S. Aust., 10 km downstream from Noarlunga (*Thomas*, 27.i.1977; AD, A47883), and on *Gracilaria* near mouth (*Gordon-Mills*, 10.xii.1981; AD, A52062). American R. inlet, Kangaroo I., S. Aust., 2–4 m deep near Muston (*Womersley*, 22.viii.1963; AD, A26871). Glenelg R. mouth, Vic., on rock (*Beauglehole*, 26.i.1952; AD, A21544). Mallacoota, Vic., floating in estuary lagoon (*Womersley*, 12.xi.1982; AD, A53693). Port Stevens, N.S.W. (*Wheeler & King*, 14.ix.1983; UNSW, 15067; AD, A55705).

Chondria angustissima is the most slender species of the genus in southern Australia, confined to sheltered estuarine conditions.

3. **Chondria arcuata** Hollenberg 1945: 447, figs 2–4. Abbott 1999: 357, fig. 103A. Abbott & Hollenberg 1976: 724, fig. 672, right. Adams 1994: 331, pl. 114, lower left. Dawson 1963: 442, pl. 167 figs 1–3. Gordon-Mills & Womersley 1987: 551, figs 24D, E, 27.

FIG. 186

Thallus (Fig. 186A) red-brown, 3–7 cm high, with numerous slender, erect, branches arising from prostrate stolons; erect branches irregularly radially or largely unilaterally branched, upper parts frequently curved; lower parts of branches 250–500 µm in diameter, terminal parts 200–250 µm in diameter. Attachment of stolons by small rhizoidal haptera; epilithic or on debris, or epiphytic. *Structure*. Apices slightly depressed, pericentral cells 5 (Fig. 186B), becoming surrounded by a thin cortex, without rhizoid development and without cell wall thickenings; epidermal cells 20–35 µm in diameter and L/D (1.5-) 3–8. Cells with rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a basal fusion cells and branched gonimoblast with clavate terminal carposporangia 30–45 µm in diameter. Cystocarps (Fig. 186C) ovoid, 600–900 µm in diameter, subsessile, without a spur; pericarp ostiolate, 2 cells thick, ecorticate. Spermatangial plates (Fig. 186D) discoid or slightly lobed, 300–600 µm across, with a single row (rarely 2 cells broad) of sterile marginal cells.

Tetrasporangia (Fig. 186E) near branch ends, on (1-) 3 pericentral cells per axial cell, 60–100 µm in diameter.

Type from Laguna Beach, Orange County, California, U.S.A. (*Hollenberg*, 29.x.1935); holotype in US, 61168.

Distribution: Port Noarlunga, S. Aust., to Port Phillip Bay, Victoria.
Southern California and Pacific Mexico.

Selected specimens: Port Noarlunga, S. Aust., on *Sargassum*, 2 m deep, outside of reef (*Gordon-Mills*, 26.iii.1987; AD, A56846). Apollo Bay, Vic., on pipeline in harbour (*Kraft & Owen*, 2.ix.1971; MELU, K3718a). Werribee, Port Phillip Bay, Vic. (*Brown*, 20.iv.1983; AD, A53792). Gellibrand Light, Port Phillip Bay, Vic., 4–6 m deep (*J. Lewis*, 25.xi.1976; MELU, L1036 and 23.xii.1976; MELU, L1037), 1–2 m deep (*J. Lewis*, 27.i.1977; MELU, L1039) and 6–8 m deep (*Kraft*, 9.xii.1975; MELU, K5695).

The above specimens agree well with the Californian species but are slightly longer and more branched. Gordon-Mills & Womersley (1987, p. 552) suggested they may be adventives, being found mainly in harbours.

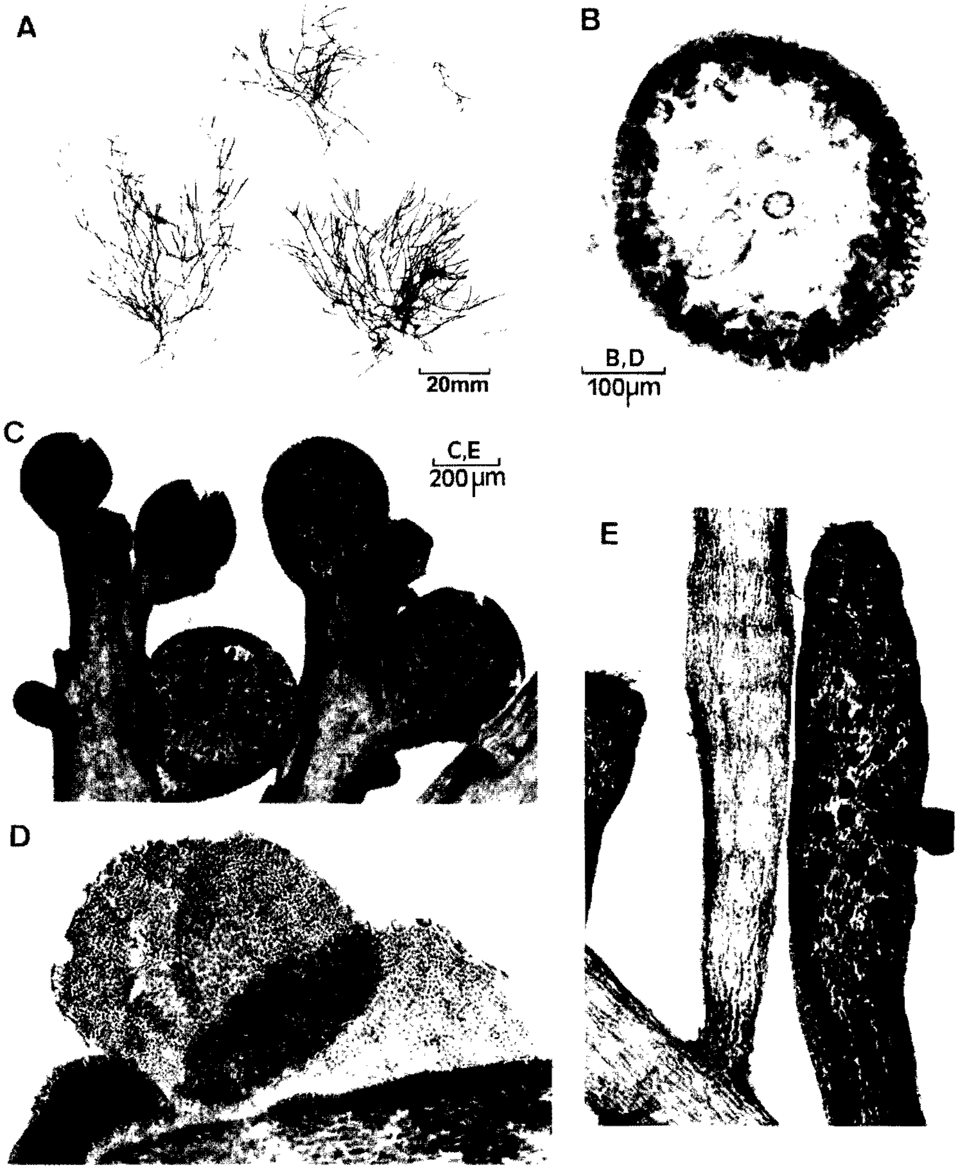

Fig. 186. *Chondria arcuata* (**A**, AD, A53792; **B**, MELU, K5695; **C**, MELU, L1036; **D**, MELU, L1039; **E**, MELU, L1037). **A**. Habit. **B**. Transverse section of branch. **C**. Cystocarps. **D**. Spermatangial plates. **E**. Branches with tetrasporangia.

4. **Chondria bulbosa** Harvey 1859b: 297; 1863, synop.: xix. Gordon-Mills & Womersley 1987: 526, figs 12G, H, 17C, D, 18. Reinbold 1898: 49. Silva *et al.* 1996: 480.
Rhododactylis bulbosa (Harvey)J. Agardh 1876: 568; 1892: 159. De Toni 1900: 487. Lucas 1909: 31. May 1965: 393.
Chondriopsis bulbosa (Harvey)J. Agardh 1890: 49.
Chondria suprabulbosa Gordon-Mills & Womersley 1987: 524, figs 12D–F, 15F–H, 16, 17A, B.

FIGS 187, 188A, B

Thallus (Fig. 187A, B) medium to dark red to red-brown, 10–30 cm high, with one to several erect axes irregularly radially branched for 3–4 orders, lower parts of axes often sparsely branched, upper often with long laterals; lower axes 0.8–2 mm in diameter, grading to lesser branchlets 200–600 µm in diameter; base of axes usually swollen to 3 mm in diameter and 5–15 mm long with starch-filled cells, and bulbous swellings (Fig. 187B, D) 0.6–1 (-2) mm in diameter often occur on upper branches in tetrasporangial plants. Holdfast discoid to conical, 1.5-4 (-10) mm across; epilithic, usually in deep water. *Structure.* Apices attenuate to slightly depressed, mature epidermal cells 20–30 µm in diameter and L/D (1.5-) 3–8; axes with slight to moderate rhizoid development around the pericentral and inner cortical cells; secondary cortex extensive on lower axes in some plants. Cells of the basal and upper swellings usually starch-filled (except the epidermis); these may act as storage organs or propagules. Cell wall thickenings absent or occurring as band-like caps or bands (Fig. 187E, F) around the centre of pericentral (and some inner cortical) cells. Cells with discoid rhodoplasts, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a basal fusion cell and short, branched, gonimoblast with clavate terminal carposporangia 35–50 µm in diameter. Cystocarps (Fig. 187G) broadly ovoid to slightly urceolate, 0.8–1.25 mm in diameter, short-stalked, without a spur; pericarp with a broad ostiole, 2 cells thick, ecorticate. Spermatangial plates (Fig. 187H) developed from a basal branch of a trichoblast, irregularly reniform, 500–750 µm across, with a sterile margin usually 1 (-2) cells broad.

Tetrasporangia (Fig. 188A, B) in lesser branchlets, on 2–3 pericentral cells per axial cell, 180–250 (-400) µm in diameter.

Type from E coast of Tasmania (*Gunn*); lectotype in Herb. Harvey, TCD (right hand part of specimen).

Distribution: Port Denison, W. Aust., to Cape Jaffa, S. Aust., and E Tasmania.

Selected specimens: Port Denison, W. Aust., 10–13 m deep (*Kraft* 7041 & *Allender*, 10.viii.1979; MELU). Pearson Is, S. Aust., 36 m deep (*Shepherd*, 10.i.1969; AD, A34113). Point Turton, Yorke Pen., S. Aust., 8–10 m deep (*Kald*, 5.ix.1970; AD, A37250) and drift (*Womersley*, 16.x.1988; AD, A59132—"Marine Algae of southern Australia" No. 320). Investigator Strait, S. Aust., 33 m deep (*Watson*, 24.i.1971; AD, A41070) and 34 m deep (*Watson*, 20.i.1971; AD, A39227). 10 km W of Outer Harbour, S. Aust., 23 m deep on "John Robb" wreck (*R. Lewis*, 10.ix.1972; AD, A42647). 20 km WSW of Outer Harbour, S. Aust., 22–25 m deep (*McFarlane*, 11.ix.1975; AD, A46636). Grange, S. Aust., 20 m deep on artificial reef (*Branden*, 4.ix.1985; AD, A56589). 5 km W of Port Noarlunga, S. Aust., 21 m deep (*Ottaway*, 8.xii.1980; AD, A52127). Saunders Beach, Kangaroo I., S. Aust., drift (*Womersley*, 25.viii.1963; AD, A26708). Cape Jaffa, S. Aust., drift (*Womersley*, 25.xi.1992; AD, A61788). Crawfish Rock, Westernport Bay, Vic., 0–3 m deep (*Watson*, 15.ix.1968; AD, A32767). Arch Rock, Ninepin Point, Tas., 5–8 m deep (*Sanderson*, 21.x.1994; AD, A63942). Great Taylor Bay, Bruny I., Tas., 19 m deep (*Shepherd*, 14.ii.1972: AD, A42161).

Chondria bulbosa is a deep-water species characterised by swollen, elongate, organs at the base of the axes and also by bulbous ones on the upper branches; they may be storage organs or even propagules.

Several plants (AD, A59132, A39227 and A61788) are now known which show both the elongate basal swellings and the upper bulbous ones, so the separation of *C. suprabulbosa* on the latter feature is no longer tenable. The only other significant difference was very large tetrasporangia in *C. suprabulbosa*, but these (in AD, A38453) appear to be lightly-staining and unusually large aberrant sporangia as occasionally found, and most mature (i.e. divided) tetrasporangia are within the range cited above.

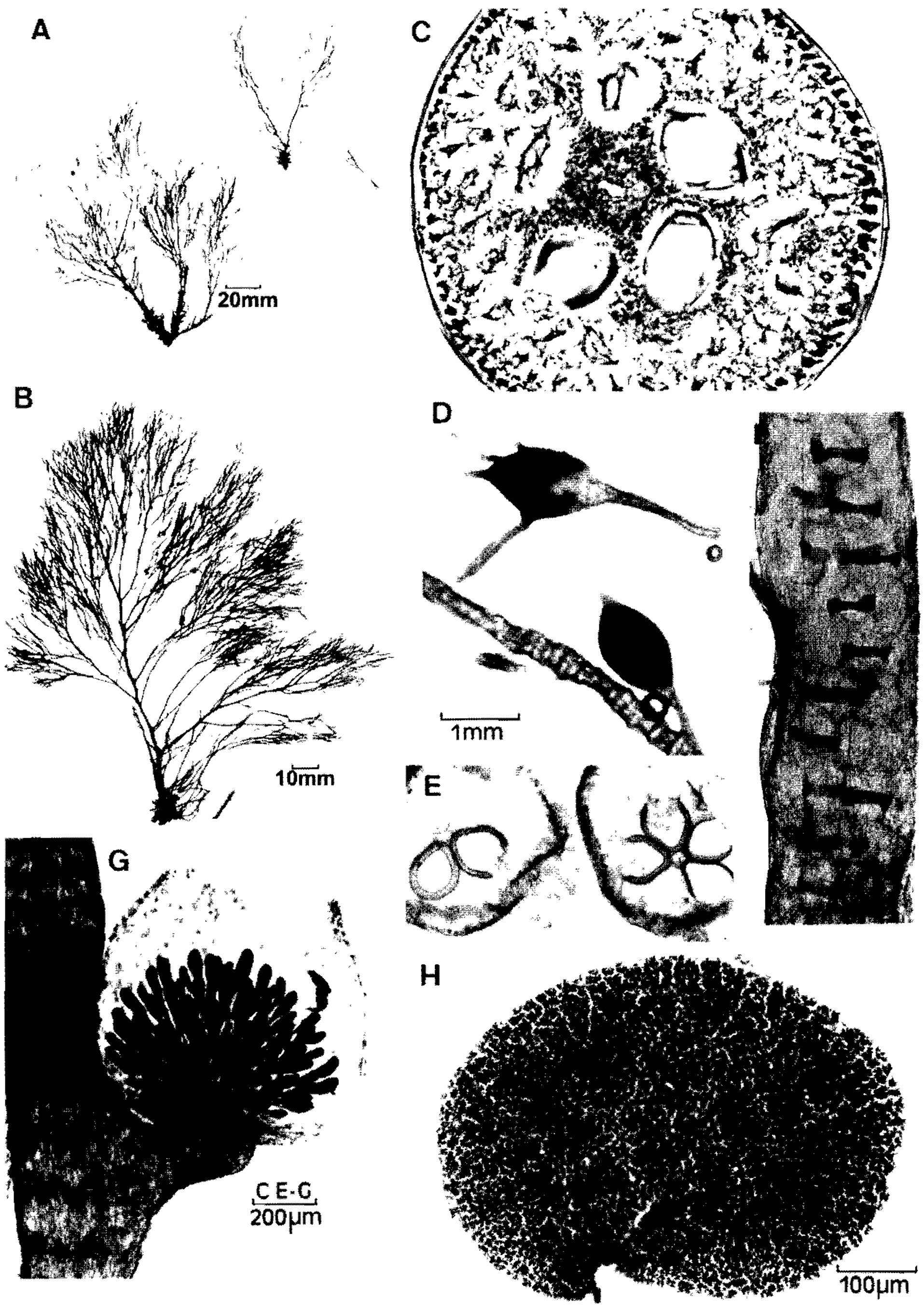

Fig. 187. *Chondria bulbosa* (**A**, AD, A39227; **B**, AD, A59132; **C**, AD, A52127; **D–F**, AD, A41070; **G**, AD, A42647; **H**, AD, A37250). **A**. Habit, plant with basal bulbous swellings. **B**. Habit, plant with basal and upper bulbous swellings. **C**. Transverse section of branch. **D**. Upper bulbous swellings. **E**. Transverse sections with wall thickenings. **F**. Longitudinal view with wall thickenings. **G**. Cystocarp. **H**. Spermatangial plate.

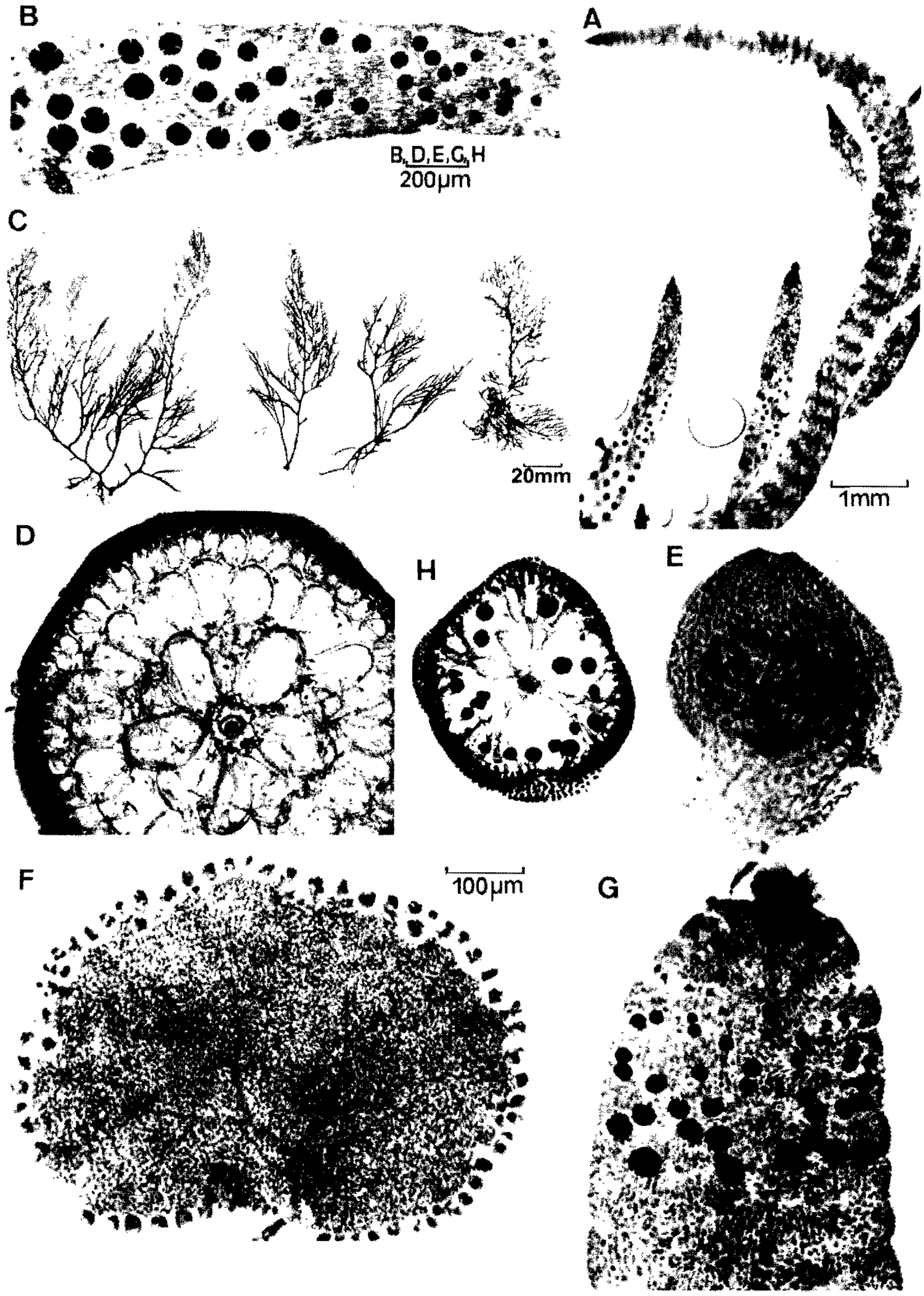

Fig. 188. **A**, **B**. *Chondria bulbosa* (AD, A37250). **A**. Branches with tetrasporangia. **B**. Branch with tetrasporangia. **C–H**. *Chondria incurva* (**C**, AD, A41407; **D**, **E**, AD, A53370; **F**, AD, A34967; **G**, AD, A37593; **H**, AD, A42363). **C**. Habit. **D**. Transverse section of branch. **E**. Cystocarp. **F**. Spermatangial plate. **G**. Branch apex with tetrasporangia. **H**. Transverse section with tetrasporangia.

5. **Chondria incurva** Gordon-Mills & Womersley 1987: 512, figs 8D, 10G–J, 11, 12A. Silva *et al.* 1996: 483.

FIG. 188C–H

Thallus (Fig. 188C) medium to dark red-brown, fading to yellow-red, 8–25 (-30) cm high, irregularly radially or unilaterally branched for 3–4 orders, branches terete, upper parts of branches frequently curved usually adaxially, with frequent axillary branches; lower axes 1–2 (-4) mm in diameter, grading to lesser branchlets 1–1.5 mm in diameter. Holdfast discoid, 1–10 mm across, frequently with basal stolons attached by haptera; epilithic or epiphytic on *Amphibolis* or algae, occasionally epizoic. *Structure.* Apices in a distinct depression, with 5 pericentral cells (Fig. 188E) and a broad cortex with epidermal cells 20–50 µm in diameter and L/D 1–1.5 (-2.5); axial cells often clear in side view of branches, 50–70 µm in diameter and L/D 1–1.5 (-2). Mature axes with distinct rings of pericentral and inner cortical cells, separated by rhizoids, and the lower axes developing a secondary cortex. Cell wall thickenings in mid to lower axes, forming patches or bands on the upper ends and sides of pericentral and inner cortical cells. Trichoblasts profuse at apices, 1–1.5 mm long. Cells with discoid to elongate rhodoplasts, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a large basal fusion cell and branched gonimoblast with clavate terminal carposporangia 30–40 µm in diameter. Cystocarps (Fig. 188E) ovoid, 1–1.2 mm in diameter; with a short stalk and a blunt, rounded spur; pericarp ostiolate, corticated, 3–4 cells thick. Spermatangial plates (Fig. 188F) discoid to slightly lobed, 700–800 µm across, with a sterile margin 1 (-2) cells broad.

Tetrasporangia (Fig. 188G, H) occur in lesser branches, borne singly on 2–3 pericentral cells per axial cell, 80–130 µm in diameter.

Type from Vivonne Bay, Kangaroo I., S. Aust., 0.5 m deep on jetty pile (*Kraft* & *Min-Thein*, 4.xii.1971); holotype sheet in AD, A41407.

Distribution: Port Denison, W. Aust., to San Remo, Vic.

Selected specimens: Port Denison, W. Aust., drift (*Kraft* 4006, 14.xii.1971; AD, A41729). Yanchep, W. Aust., drift (*Womersley*, 22.ix.1979; AD, A51277). Elliston, S. Aust., 7 m deep in bay (*Shepherd*, 21.x.1970; AD, A37593) and 10–12 m deep in bay (*Shepherd*, 24.x.1969; AD, A34967) and 9 m deep (*Edyvane*, 28.ix.1982; AD, A53370). Goldsmith Beach, Yorke Pen., S. Aust., drift (*Womersley*, 20.ix.1981; AD, A52073). Marino, S. Aust., drift (*Womersley*, 4.x.1964; AD, A28229). Vivonne Bay, Kangaroo I., S. Aust., 1–4 m deep on jetty piles (*Kraft*, 6.iv.1972; AD, A42363). Pennington Bay, Kangaroo I., S. Aust., drift (*Kraft* & *Min Thein*, 3.xii.1971; AD, A41391). Robe, S. Aust., inside Baudin Rocks, 8 m deep (*P. Womersley*, 24.viii.1973; AD, A43969). Nora Creina, S. Aust., drift (*Womersley*, 6.xii.1995; AD, A64746). Double Corner Beach, Portland, Vic., drift (*Beauglehole*, 22.vii.1951; AD, A21537). San Remo (back beach), Vic., drift (*Sinkora*, 27.xi.–5.xii.1974; AD, A55706, MEL, 608554).

Chondria incurva is a sublittoral species mainly found on rough-water coasts. It is similar to *Husseya rubra* in transverse section of axes but differs in having reproductive bodies on or in normal branchlets and shorter epidermal cells.

6. **Chondria hieroglyphica** Gordon-Mills & Womersley 1987: 521, figs 12B, C, 13A, B, 15A–E; 1984b: 226, figs 10–12.

FIG. 189

Thallus (Fig. 189A) medium to dark red-brown, 10–15 (-17) cm high, radially branched with divergent laterals for 3–4 orders, secondary and tertiary laterals mostly 0.5–1 cm apart, terete, lower branches or axes 1.5–2 mm in diameter, grading to lesser branchlets 300–500 µm in diameter, axillary branching absent. Holdfast unknown. *Structure.* Apices rounded or truncate, with or without a depression, mature epidermal cells 20–30 µm in diameter and L/D (2.5-) 3–8. Mid and lower axes have slight development of rhizoids between the pericentral cells (Fig. 189C), more so near the base; secondary cortex occurs near the base. Cell wall thickenings (Fig. 189B) occur in the pericentral cells, first forming semicircular to circular bands, subsequently further patches, bands and extensions occur, becoming highly lobed and almost reticulate. Cells with discoid rhodoplasts, chained in larger cells.

Reproduction. Procarps not observed. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia 30–45 µm in diameter. Cystocarps (Fig. 189D) ovoid, short-stalked, 1–1.5 mm in diameter, without a basal spur; pericarp broadly ostiolate, 3–4 cells thick, corticated. Spermatangia unknown.

Tetrasporangia (Fig. 189E) in lesser branches, probably borne on 2 pericentrals per axial cell, 100–150 μm in diameter.

Type from Walkerville, Vic., drift (*Sinkora* A1866, 6.xii.1973); holotype in AD, A53712; isotype in MEL, 608547.

Distribution: Port Phillip Heads to Walkerville, Victoria.

Known specimens: Apart from the type collection, known only from Port Phillip Heads, Vic. (*Wilson*, 27.i.1894; MEL, 608607) and Western Port, Vic. (*Wilson*, 9.i.1885; LD, 37786).

Chondria hieroglyphica is most closely related to *C. capreolis* and *C. bulbosa*, differing in the remarkable wall thickenings (after which the species is named) and also size of tetrasporangia. Further collections are highly desirable.

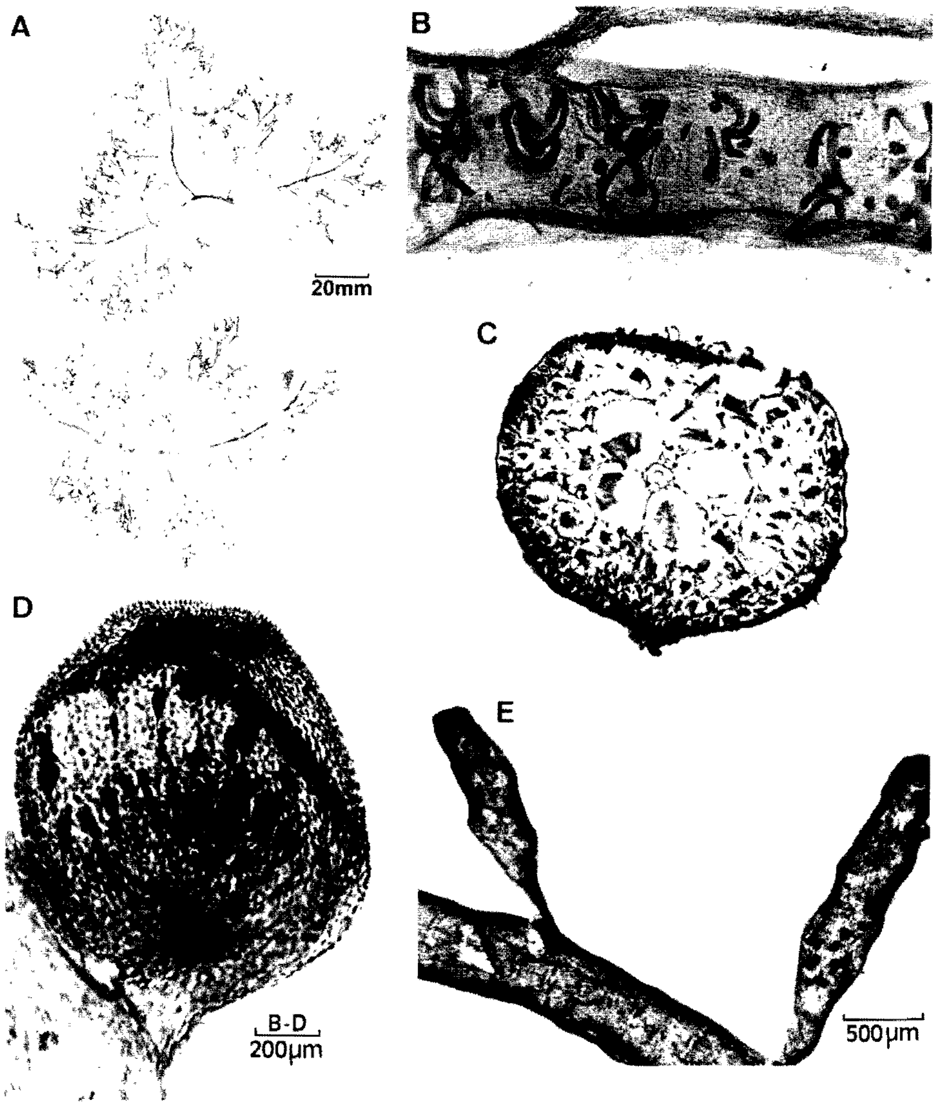

Fig. 189. *Chondria hieroglyphica* (**A–D**, AD, A53712; **E**, LD, 37786) **A**. Habit, holotype. **B**. Longitudinal view of branch with wall thickenings. **C**. Transverse section of branch. **D**. Cystocarp. **E**. Branches with tetrasporangia.

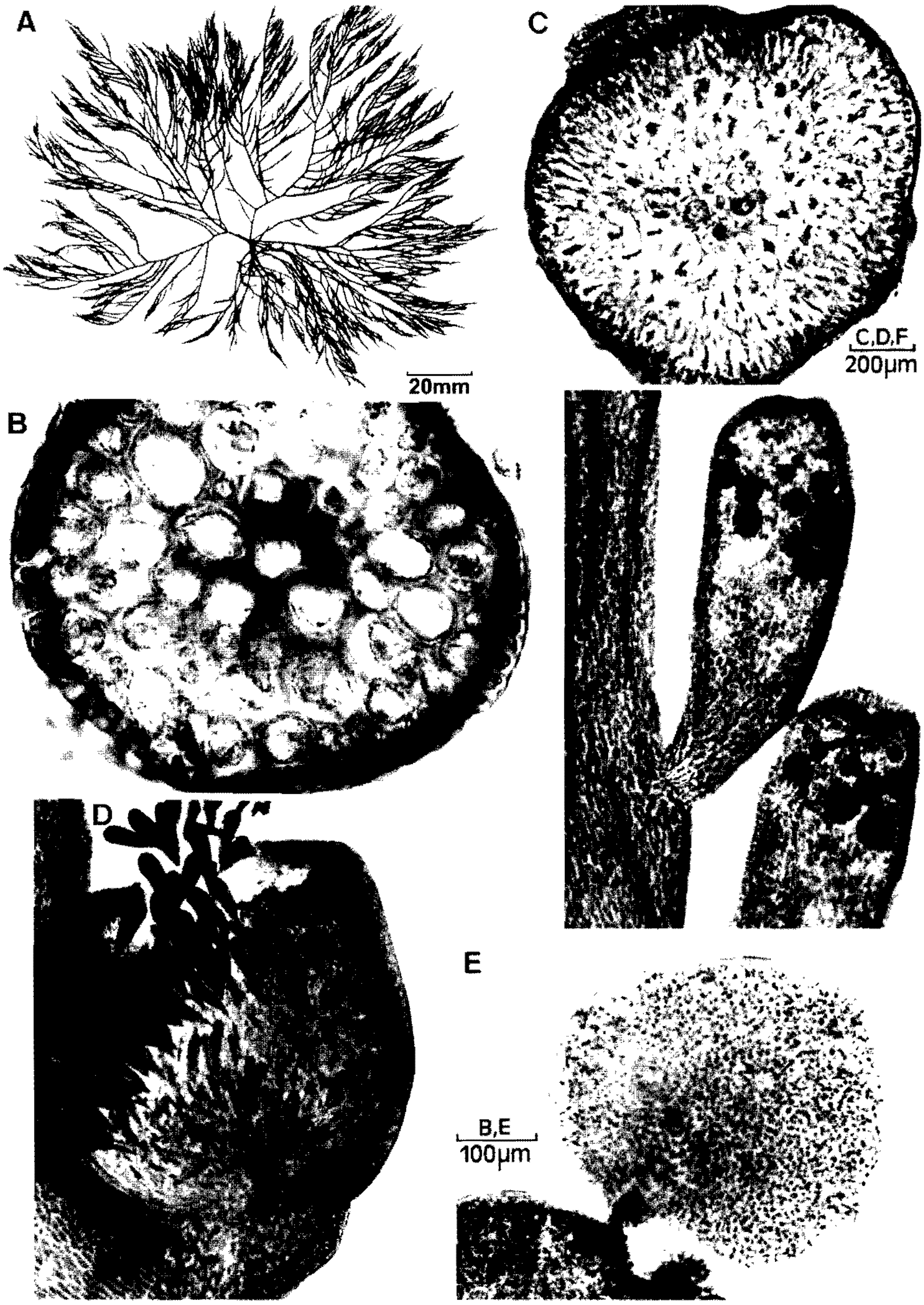

Fig. 190. *Chondria subsecunda* (**A**, **B**, **F**, AD, A56591; **C–E**, AD, A56844). **A**. Habit. **B**. Transverse section of young branch with wall thickenings in pericentral cells. **C**. Transverse section of older branch. **D**. Cystocarp. **E**. Spermatangial plate. **F**. Tetrasporangial branches.

7. **Chondria subsecunda** Gordon-Mills & Womersley 1987: 511, figs 8C, 10A–F.

FIG. 190

Thallus (Fig. 190A) light red, 6–10 cm high, with 2–4 (-5) terete erect axes bearing laterals mainly on one side, 1–6 mm apart, with further (third order) mainly adaxial laterals usually present; axes 1–2 mm in diameter, lesser laterals 500–700 µm in diameter. Holdfast discoid, 1–2 mm across; epiphytic (on *Acrocarpia*). *Structure*. Apices depressed to rounded, with mature epidermal cells 25–50 µm in diameter and L/D 1.5–3.5, axis with few rhizoids (Fig. 190C) and sometimes a slight secondary cortex. Cell wall thickenings (Fig. 190B) occur as 1–2 circular bands on pericentral and inner cortical cells, becoming massive and lobed or joined in lowermost axes. Cells with discoid to elongate rhodoplasts, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a basal fusion cell and much branched gonimoblast with clavate terminal carposporangia 40–75 µm in diameter. Cystocarps (Fig. 190D) ovoid, subsessile, 1–1.5 mm in diameter, with a basal swelling but not a spur; pericarp broadly ostiolate, 2 cells thick, ecorticate. Spermatangial plates (Fig. 190E) discoid, 350–500 µm across, with a sterile margin 1 (-2) cells broad.

Tetrasporangia (Fig. 190F) in lesser branchlets, borne adaxially on (1-) 2–3 pericentrals per axial cell, 90–180 µm in diameter.

Type from Warrnambool, Vic. on *Acrocarpia*, drift (*Kraft*, 10.vii.1984); holotype in MELU, K7587, isotypes MELU, K7589 and AD, A56591.

Distribution: Known only from the type locality and Port MacDonnell, S. Aust., on *Acrocarpia*, drift (*G. & L. Kraft*, 30.x.1986; MELU, and AD, A56844).

Chondria subsecunda is still known only from the above two collections. It is an elegant species distinguished by the largely secund branching.

8. **Chondria capreolis** Gordon-Mills & Womersley 1987: 505, figs 6Q–Z, 8A, B, 9; 1984b: 226, figs 8, 9 (*nom. nudum*).

Laurencia uncinata Kützing 1849: 852; 1865: 16, pl. 44a, b. J. Agardh 1863: 811. De Toni 1903: 808. [NON *L. uncinata* Zanardini 1847: 201.]

FIG. 191

Thallus (Fig. 191A) brown-red, fading to yellow-brown, (8-) 10–20 cm high, lower branches entangled and adhering by tendrils (Fig. 191B), upper branches irregularly radially branched for 3–4 orders, without axillary branches, branches terete, varying in robustness; lower branches 0.5–1 (-2) mm in diameter, grading to 0.3–1 mm in diameter in upper, basally constricted, branchlets. Attachment by tendrils and small holdfasts to host seagrasses or algae; mainly epiphytic, possibly epilithic. *Structure*. Apices slightly to distinctly depressed, with 5 pericentral cells (Fig. 191C) rapidly developing the cortex, mature epidermal cells 20–40 µm in diameter and L/D (1-) 2.5–6. Mature branches with no or few rhizoids. Cell wall thickenings (Fig. 191C, D) usually present, forming 2–3 (-4) circular bands around the wall, later becoming lobed but not hooked. Trichoblasts 1–2 mm long. Cells with discoid to elongate rhodoplasts.

Reproduction. Procarps as for the genus. Carposporophytes with a basal fusion cell and branched gonimoblast bearing clavate terminal carposporangia 50–90 µm in diameter. Cystocarps (Fig. 191E) ovoid, 1–1.2 mm in diameter, with a lower swelling but not a basal spur; pericarp ostiolate, with 12–16 erect filaments, two cells thick, ecorticate. Spermatangia unknown.

Tetrasporangia (Fig. 191F) in lesser branchlets, borne adaxially on 1 (-2) pericentral cells per axial cell, 200–250 µm in diameter.

Type from Tasmania; holotype in L, 941, 119...39.

Distribution: Point Turton, S. Aust., to Westernport Bay, Vic., and N and SE Tasmania.

Selected specimens: Wallaroo, S. Aust., on shallow reef (*Watson*, Jan. 1983; AD, A53755). Point Turton, S. Aust., on *Caulocystis*, 3–5 m deep (*Kraft*, 17.ix.1973; AD, A44018). American R. inlet, Kangaroo I., S. Aust., drift at jetty (*Womersley*, 25.viii.1963; AD, A26770). Muston, American R. inlet, Kangaroo I., S. Aust., upper sublittoral (*Womersley*, 27.viii.1950; AD, A15387). Port MacDonnell, S. Aust., drift (*Womersley*, 17.x.1983; AD, A53713) and just below low tide in harbour (*Womersley*, 16.x.1985; AD, A56809 —"Marine Algae of southern Australia" No. 309). Clifton Springs, Corio Bay, Vic., drift (*Sinkora* A1472, 29.xi.1971; AD, A43180; MEL, 608643). Sealers Cove, Vic. (*Mueller*, MEL, 608577). Greens Beach, N Tas., epiphytic, in pool (*Wollaston* & *Mitchell*, 4.iii.1964; AD, A27572). Low Head, Tas. (*Perrin*, 24.vi.1951; AD, A50199). Bridport, Tas., drift (*Parsons* & *Womersley*, 6.xi.1982; AD, A53757). Port Arthur, Tas., on *Zostera*, upper sublittoral (*Cribb*, 26.vi.1951; AD, A16325).

Chondria capreolis as a name replaced the invalid *Laurencia uncinata* Kützing 1849. It occurs in sheltered habitats as loosely attached entangled masses in shallow pools or on tidal flats, characterised by the presence of tendrils and the circular band-like wall thickenings. *C. capreolis* is closely related to both *C. dasyphylla* from Europe, and to *C. curdieana*.

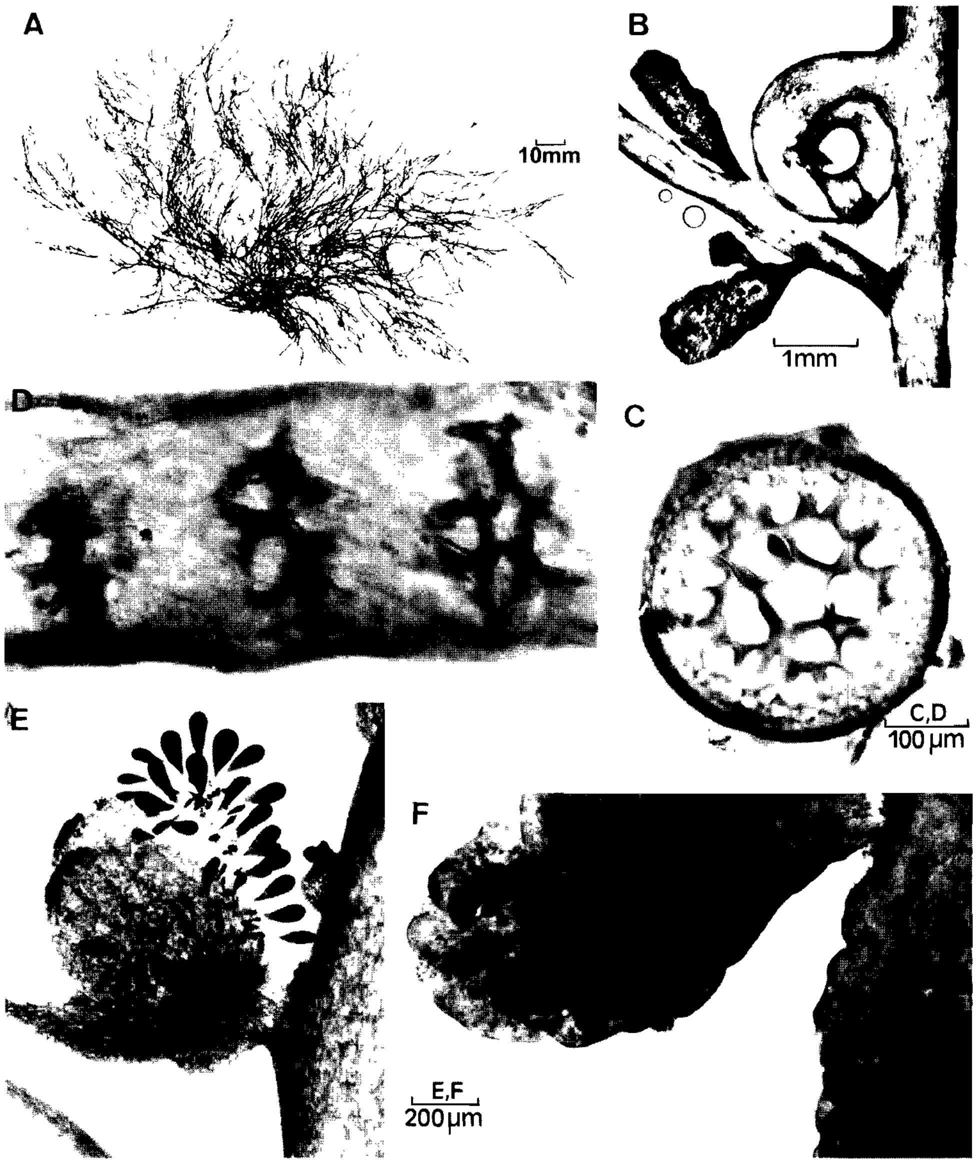

Fig. 191. *Chondria capreolis* (**A**, **F**, AD, A56809; **B**, AD, A27572; **C**, AD, A53755; **D**, AD, A15387; **E**, AD, A44018). **A**. Habit. **B**. Tendril on tetrasporangial plant. **C**. Transverse section of branch with cell wall thickenings. **D**. Longitudinal view of branch and cell wall thickenings. **E**. Cystocarp. **F**. Tetrasporangial branch, showing axial filament.

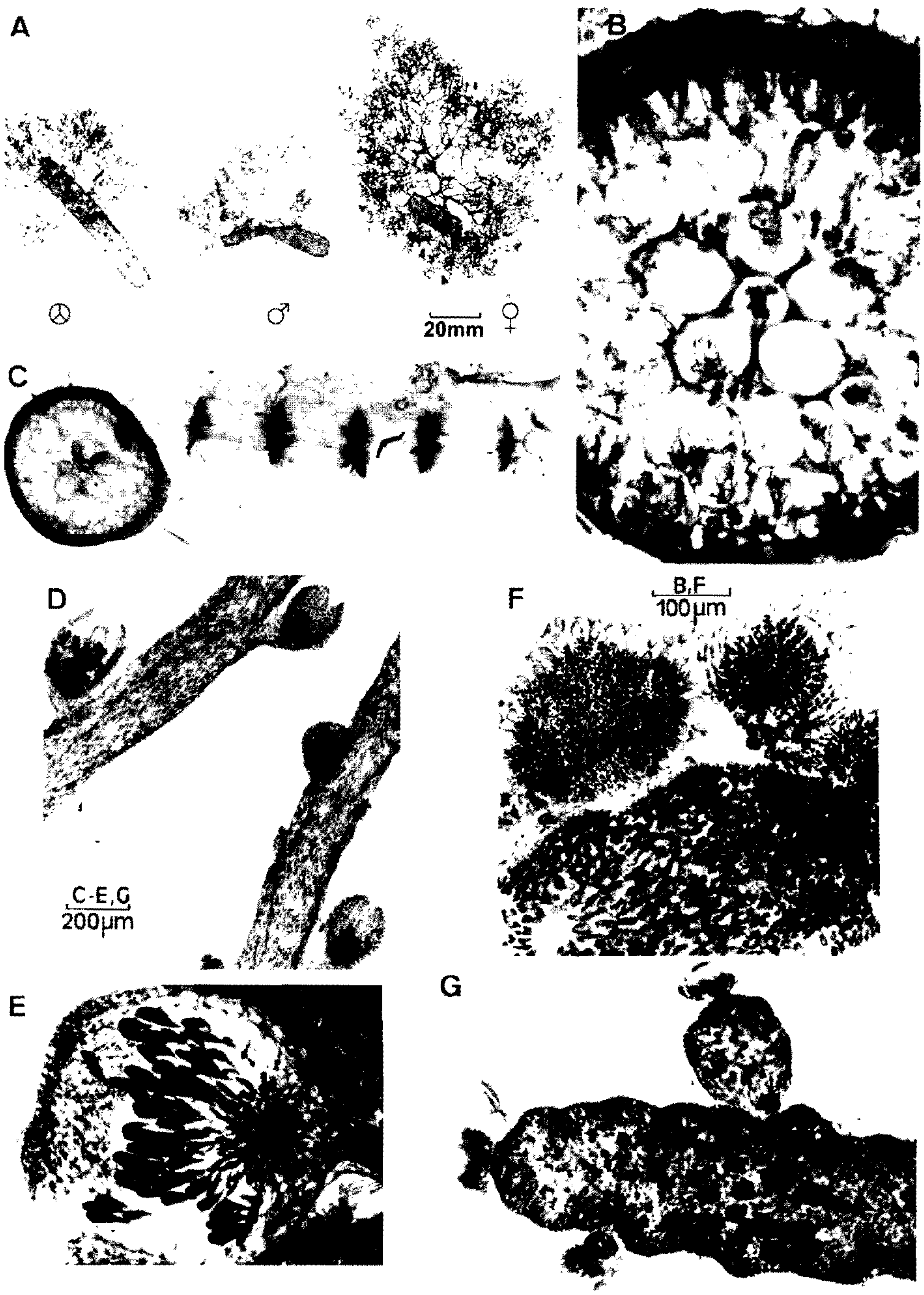

Fig. 192. *Chondria fusifolia* (**A**, **E**, **G**, AD, A46770; **B**, AD, A53796; **C**, AD, A53759; **D**, AD, A3152; **F**, AD, A35183). **A**. Habit, on *Posidonia*. **B**. Transverse section of branch. **C**. Transverse and longitudinal sections with cell wall thickenings. **D**. Branches with cystocarps. **E**. Cystocarp. **F**. Spermatangial plates. **G**. Branch with tetrasporangia.

9. **Chondria fusifolia** (Hooker & Harvey)Harvey 1859b: 298; 1863, synop.: xix. De Toni 1903:836. Gordon-Mills & Womersley 1987: 487, figs 1A, B, 2–4. Guiler 1952: 104. Lucas 1909: 40; 1927: 561, pls 46, 47(1); 1929a: 21. Lucas & Perrin 1947: 258, fig. 115(?).
   Laurencia fusifolia Hooker & Harvey 1847: 401. J. Agardh 1863: 811. Harvey 1849a: 86. Kützing 1849: 853.
   Chondriopsis fusifolia (Hooker & Harvey)J. Agardh 1892: 156. Sonder 1880: 34. Tisdall 1898: 513. Wilson 1892: 165.
   Laurencia tenuissima sensu Harvey 1844b: 444; 1849: 85. Hooker & Harvey 1847: 401.
   Chondria tenuissima sensu Lucas & Perrin 1947: 258.

FIGS 192, 193

Thallus (Fig. 192A) light to medium red-brown, fading to yellow-brown, (3-) 10–20 (-30) cm high, usually fairly robust, much-branched irregularly radially for 3–4 orders, branches terete, with one to several axes (0.5-) 1–1.5 mm in diameter, grading to lesser branches 2–5 mm long and (250-) 400–800 µm in diameter, basally constricted. Holdfast discoid, 2–4 mm across; epilithic or epiphytic, usually in shallow water. *Structure*. Apices bluntly pointed (Fig. 192G), with 9–14 axial cells bearing pericentral cells and trichoblasts. Pericentral cells 5 (Fig. 192B), producing outwardly 3–4 quadrichotomous series of cortical cells, epidermal cells becoming 10–25 µm in diameter and L/D 2–5 (-12). Mature axes with large cortical cells and intermixed rhizoids (Fig. 193A). Cell wall thickenings usually absent, when present forming caps on pericentral cells (Fig. 192C). Trichoblasts 1–1.5 mm long. Cells with rhodoplasts discoid, chained in largest cells.

Reproduction. Gametophytes dioecious. Procarps (Fig. 193B) on the suprabasal cell of trichoblasts, the fifth pericentral cell bearing a 4-celled carpogonial branch and lateral and basal sterile groups, each becoming multicellular. Carposporophyte with a basal, branched, fusion cell and branched gonimoblast bearing elongate-clavate terminal carposporangia 30–45 µm in diameter. Cystocarps (Fig. 192D, E) ovoid to slightly urceolate, 500–900 µm in diameter, with a slight basal spur (Fig. 193C, D); pericarp ostiolate, with 12–16 erect filaments, each cell producing outwardly 2 pericentral cells with slight cortication on the lower half. Spermatangial plates (Figs 192F, 193E–G) formed from a basal branch of a trichoblast, discoid, 250–350 µm across, with smooth or irregular margins 2 (-3) cells broad.

Tetrasporangia (Figs 192G, 193H) occur in lesser branches, borne adaxially (Fig. 193 I) near the distal end of pericentral cells which remain radially elongate, 100–130 µm in diameter.

Type from Sullivans Cove, Tas. (*Lyall*); lectotype in BM (lower specimen on type sheet).

Distribution: Albany, W. Aust., to Pittwater, N.S.W., and around Tasmania.

Selected specimens: Middleton Beach, Albany, W. Aust., on *Zostera*, drift (*Wood*, 10.x.1960; AD, A24572). Lucky Bay, Cape Le Grand, W. Aust., on *Posidonia*, upper sublittoral (*Womersley*, 4.x.1979; AD, A51166). Elliston, S. Aust., on *P. australis*, drift (*Womersley*, 9.i.1976; AD, A46770). Vivonne Bay, Kangaroo I., S. Aust., shaded pool, S side Ellen Point (*Womersley*, 29.viii.1950; AD, A15461). American R. inlet, Kangaroo I., S. Aust., on tidal flats (*Womersley*, 1.ii.1946; AD, A3152). Cape Thomas, S. Aust., drift (*Womersley*, 24.viii.1960; AD, A24397). Carpenter rocks, S. Aust., upper sublittoral (*Womersley*, 5.ii.1970; AD, A35183—"Marine Algae of southern Australia" No. 308). Sorrento, Vic., drift on outer coast ("back beach") (*Price*, 14.vii.1963; MELU, A658) and 0.5 m deep (*Gordon-Mills*, 9.xii.1983; AD, A53796). Shoreham, Western Port, Vic. (*King*, 17.iv.1971; MELU, 20907). Georgetown, Tas. (*Gunn* 1319, BM: AD, A52069). Bridport, Tas., drift (*Parsons & Womersley*, 6.xi.1982; AD, A53759). Dover, Tas., drift (*Cribb*, 21.iii.1950; AD, A16343). Isthmus Bay, Bruny I., Tas., lower eulittoral (*Womersley*, 12.x.1986; AD, A57767). Pittwater, N.S.W., on seagrass, 20 cm deep (*Harada*, 22.x.1975; AD, A52360).

Chondria fusifolia is closely related to *C. tenuissima* (Goodenough & Woodward)C. Agardh from N Europe; differences between them were discussed by Gordon-Mills & Womersley (1987, p. 497).

10. **Chondria subfasciculata** (J. Agardh)Gordon-Mills & Womersley 1987: 539, figs 20C, 22A–E, 23A–E.
   Chondriopsis succulenta var. *subfasciculata* J. Agardh 1892: 155.

FIG. 194

Thallus (Fig. 194A) brown-red, (8-) 25–45 cm high, much branched irregularly radially for 3–4 orders, branches erect or spreading, terete, axillary branches usually present; lower

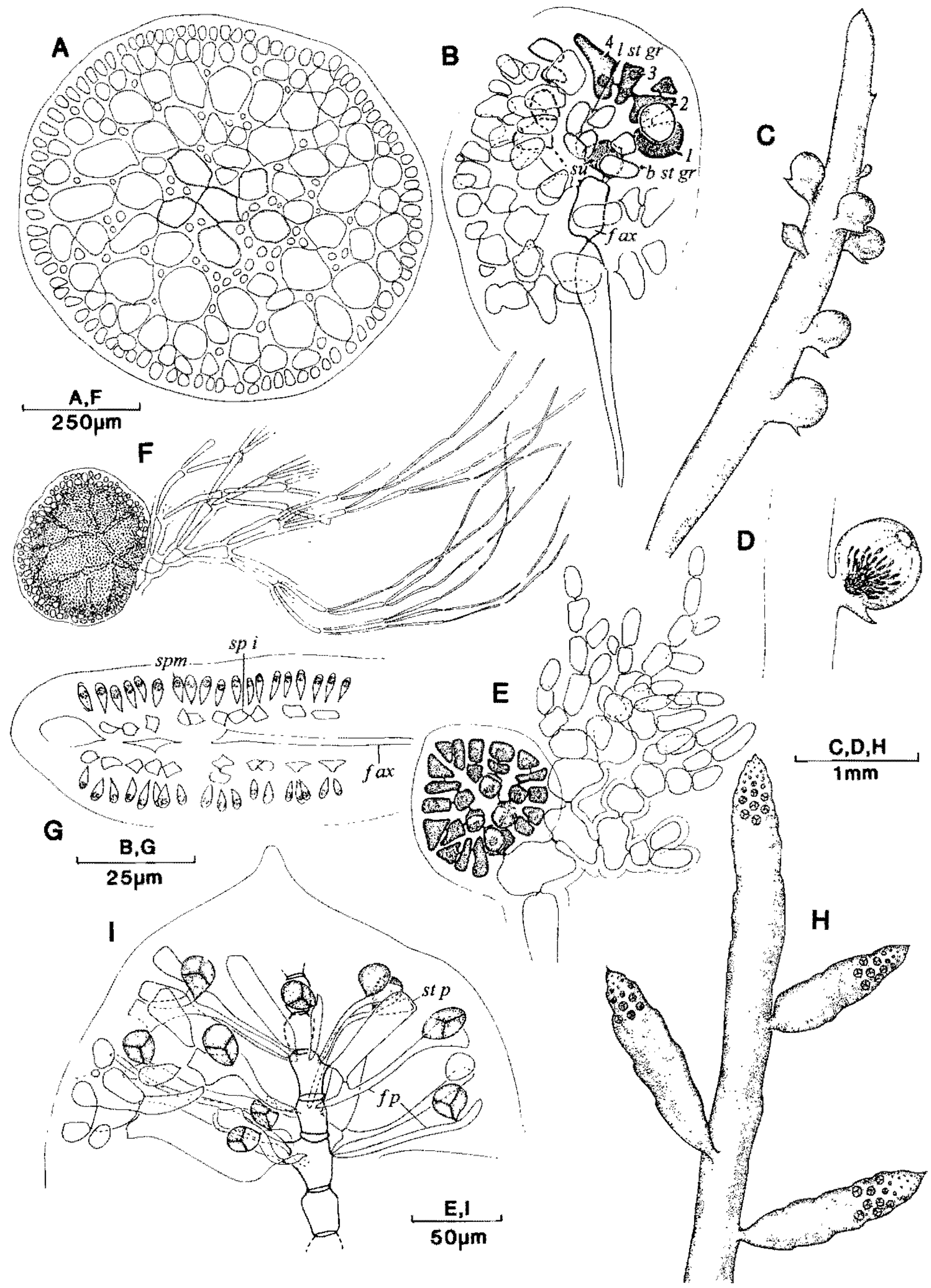

Fig. 193. *Chondria fusifolia* (**A**, MELU, A658; **B**, **F**, **G**, AD, A15461; **C**, **D**, AD, A52069; **E**, AD, A35183; **H**, **I**, AD, A16343). **A**. Transverse section of branch. **B**. Procarp with carpogonial branch and basal and lateral sterile groups, and with developing pericarp. **C**. Branch with cystocarps, each with a spur. **D**. Cystocarp with carposporophyte. **E**. Young spermatangial plate on base of a trichoblast. **F**. Mature spermatangial plate. **G**. Section of spermatangial plate. **H**. Branches with tetrasporangia. **I**. Part section of branch with pericentral cells bearing tetrasporangia. (All as in Gordon-Mills & Womersley 1987, courtesy of Aust. J. Bot.)

axes 1.2–2 mm in diameter, grading to lesser branchlets 500–700 µm in diameter. Holdfast discoid, 1–2 mm across; epiphytic (on *Amphibolis*) or epilithic. *Structure.* Apices slightly pointed or depressed, with 5 pericentral cells (Fig. 194B) and surrounding inner cortical cells often distinctly larger than the pericentral cells, with rhizoids around the axial and pericentral cells in the lower thallus; epidermal cells 20–30 µm in diameter, L/D 2–5 (-9); secondary cortex absent. Cell wall thickenings (Fig. 194B, C) initially as massive caps on the upper end of pericentral cells and larger cortical cells, later as circular bands on central outer and radial walls. Cells with discoid to elongate rhodoplasts, chained in larger cells.

Reproduction. Procarps not observed. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia 40–75 µm in diameter. Cystocarps (Fig. 194D) ovoid to slightly urceolate, 1–1.5 mm in diameter, short-stalked, without a spur; pericarp ostiolate, 3–4 cells thick, lightly corticate. Spermatangial plates unknown.

Tetrasporangia (Fig. 194E) in lesser branchlets, on (1-) 2–3 pericentral cells per axial cell, 180–220 µm in diameter.

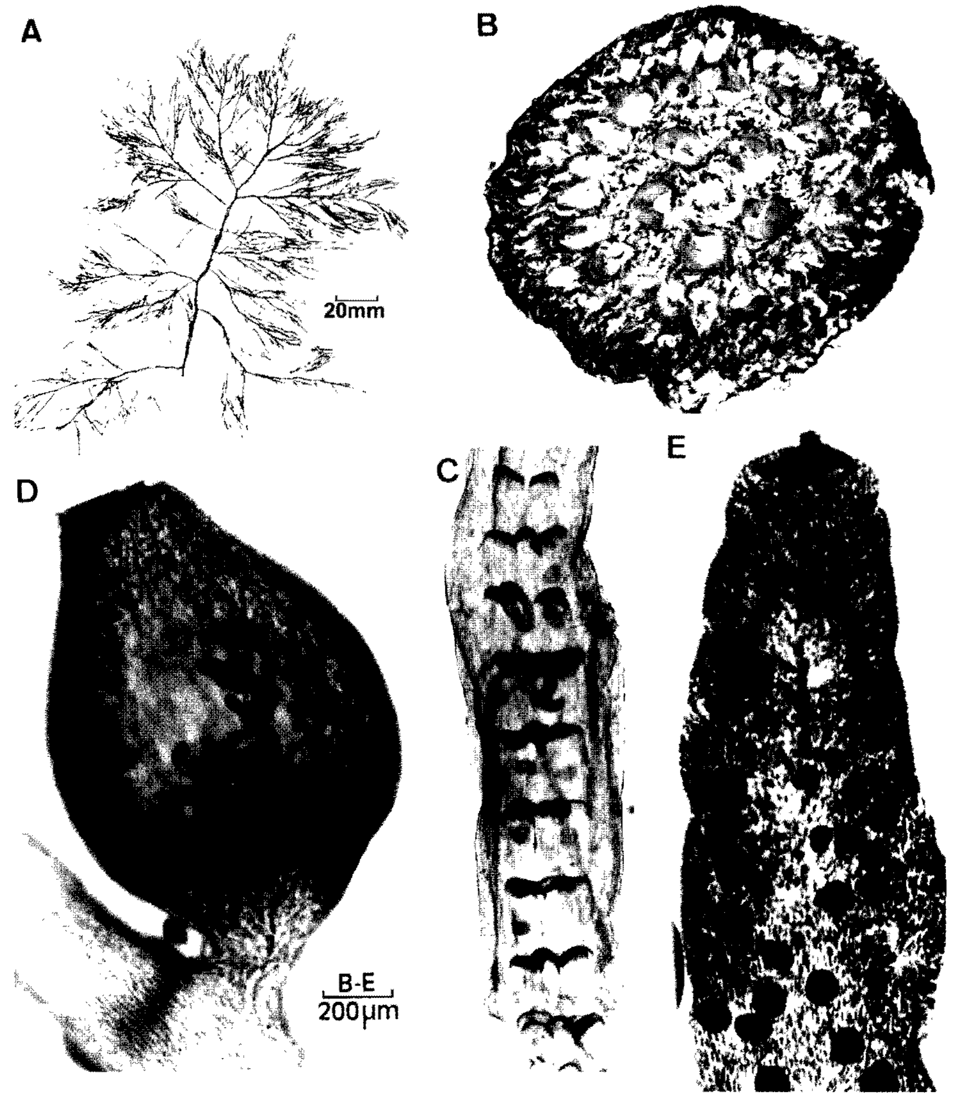

Fig. 194. *Chondria subfasciculata* (**A**, **B**, **E**, AD, A56587; **C**, **D**, AD, A53762). **A**. Habit. **B**. Transverse section of axis, with cell wall thickenings. **C**. Longitudinal view of branch, with cell wall thickenings. **D**. Cystocarp. **E**. Branch with tetrasporangia.

Lectotype from Symons Channel, Port Phillip Heads, Vic. (*Wilson* 52B, 9.i.1884); in Herb. Agardh, LD, 37785.
Distribution: Portland to San Remo, Vic., and N and SE Tasmania.

Selected specimens: Double Corner Beach, Portland. Vic., drift (*Beauglehole*, 14.vii.1951; AD, A21542). Flinders, Vic., drift (*Gordon-Mills*, 9.xii.1983; AD, A55303). San Remo, Vic., drift on "back beach" (*Sinkora* A2029, 27.xi.–5.xii.1974; AD, A56587; MEL, 608556). Bridport, Tas., drift (*Parsons & Womersley*, 6.xi.1982; AD, A53762). Gordon, Tas., drift (*Curtis*, 3.ii.1965; HO, 66097).

Chondria subfasciculata is closely related to *C. succulenta*, differing in having cell wall thickenings only on the pericentral cells (except in the lower thallus), in lacking a spur on the cystocarp, and in having larger tetrasporangia (180–220 μm in diameter compared to 120–150 μm in *C. succulenta*).

11. **Chondria curdieana** (Harvey *ex* J. Agardh)De Toni 1903: 844. Gordon-Mills & Womersley 1987: 497, figs 1C, D, 5–7. Huisman 1997: 203. Huisman & Walker 1990: 432. Lucas 1909: 40. Lucas & Perrin 1947: 260. Tisdall 1898: 512. *Silva et al.* 1996: 481. [NON Lucas 1913: 57 = *C. succulenta*.]
Chondriopsis curdieana Harvey *ex* J. Agardh 1892: 152.
Chondria dasyphylla var. *pyrifera* J. Agardh 1863: 810 (in part).
Chondriopsis dasyphylla sensu Tisdall 1898: 513.

FIG. 195

Thallus (Fig. 195A) red-brown, fading to yellow-brown, (2-) 5–12 (-17) cm high, much-branched irregularly radially for 3–4 orders, branches terete, often axillary in robust forms, lower branches 0.4–1 mm in diameter, ultimate branchlets 300–500 (-900) μm in diameter, basally constricted. Holdfast discoid, attachment often by small haptera 0.3–1 mm across on prostrate branches; epilithic or epiphytic on *Posidonia* or larger algae. *Structure*. Apices rounded or usually slightly depressed, with an apical filament cutting off 5 pericentral cells and trichoblasts, the pericentral cells rapidly producing usually 3 series of quadrichotomous cortical cells, epidermal cells becoming (15-) 20–25 (-30) μm in diameter and L/D (2-) 3–5 (-7). Mature axes with large cortical cells and rhizoids outside the pericentral cells. Cell wall thickenings (Fig. 195B, C) usually present in pericentral and inner cortical cells, on the inner walls or band-like around the cell and becoming hooked and lobed. Trichoblasts profuse at branch apices, 1–1.5 mm long. Cells multinucleate; rhodoplasts discoid to elongate, becoming chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps on the suprabasal cell of trichoblasts, with a 4-celled carpogonial branch and lateral and basal multicellular sterile groups. Carposporophyte with a branched basal fusion cell and short branched gonimoblast bearing lachrimiform to clavate terminal carposporangia 70–100 μm in diameter. Cystocarps (Fig. 195D) ovoid, subsessile, 1–2 mm in diameter, without a spur; pericarp ostiolate, with 10–12 erect filaments, 3–4 cells thick with slight cortication. Spermatangial (Fig. 195E) plates as a lower branch of a trichoblast, discoid, 400–600 μm across, margin smooth and 2 (-3) cells broad.

Tetrasporangia (Fig. 195F) occur in lesser branches, borne adaxially near the distal end of 1 (-2) pericentral cells per axial cell, 120–200 μm in diameter.

Type from "S. Australia" (Curdie), probably SE S. Australia; lectotype in LD, 377510.

Distribution: Houtmann Abrolhos, W. Aust., to Waratah Bay; Vic., and northern Tasmania.

Selected specimens: Nancy Cove, Rottnest I., W. Aust., on *Posidonia*, 1–2 m deep (*Gordon-Mills*, 7.xii.1985; AD, A55694). Point Peron, W. Aust., on *Posidonia*, drift (*Womersley*, 18.viii.1979; AD, A51016). Elliston, S. Aust., epiphytic, 7 m deep (*Shepherd*, 20.x.1970; AD, A37615). Pearson Is, S. Aust., upper sublittoral (*Specht*, 17.ii.1960; AD, A24544). Wanna, S. Aust., on *Spyridia dasyoides* in pools (*Womersley*, 19.ii.1959; AD, A22460). Chiton Rocks, Victor Harbor, S. Aust., 7–10 m deep (*Edyvane*, 8.viii.1982; AD, A52939). Vivonne Bay, Kangaroo I., S. Aust., 1–5 m deep on jetty pylon (*Kraft*, 19.i.1974; AD, A45046). Pennington Bay, Kangaroo I., S. Aust., on *Hormosira*, reef edge (*Womersley*, 19.i.1965; AD, A28937). Robe, S. Aust., on *Posidonia*, drift (*M. Robertson*, 12.ii.1978; AD, A49751) and (*Womersley*, 9.ii.1982; AD, A52071) and on *Amphibolis*, 1–2 m deep (*Womersley*, 12.ix.1983; AD, A53718). Cape Lannes, S. Aust., on *Sargassum decipiens*, low eulittoral (*Womersley*, 31.xii.1981; AD, A52065). Port MacDonnell, S. Aust., drift (*Womersley*, 20.viii.1984; AD, A55713). Double Corner Beach, Portland, Vic., drift (*Beauglehole* 473G, 22.vii.1951; AD, A21538). Shorham,

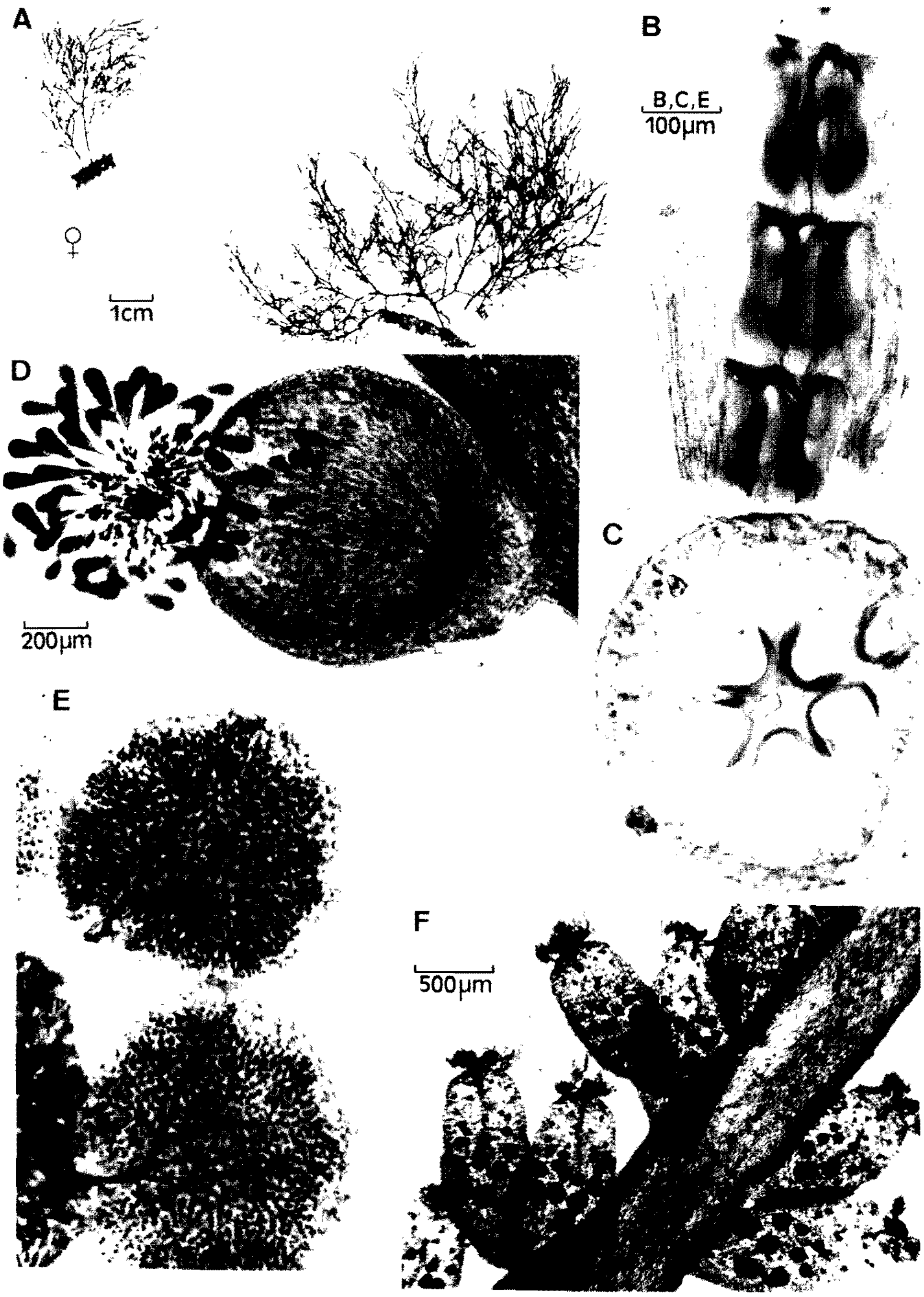

Fig. 195. *Chondria curdieana* (**A**, AD, A49751; **B**, **C**, **E**, AD, A52071; **D**, **F**, AD, A52065). **A**. Habit, on *Posidonia*. **B**. Longitudinal view of centre of branch with cell wall thickenings. **C**. Transverse section of branch with cell wall thickenings. **D**. Cystocarp with extruded carposporophyte. **E**. Spermatangial plates. **F**. Branches with tetrasporangia.

Western Port, Vic., drift (*Sinkora* A1258, 29.x.1971; AD, A55316). Bridport, Tas., drift (*Parsons & Womersley*, 6.xi.1982; AD, A53758). Edystone, Tas. (*Perrin*, Nov. 1944; AD, A55301; HO, 66016).

Chondria curdieana is common on rough-water coasts of south-eastern Australia, epiphytic on seagrasses and various algae, usually in shallow water; stouter plants occur under rougher water.

C. curdieana is related to the British *C. dasyphylla*, differing in the cell wall thickenings, in having larger tetrasporangia and in the margin of sterile cells in the spermatangial plates (see Gordon-Mills 1987 and Gordon-Mills & Womersley 1987, p. 505).

12. **Chondria harveyana** (J. Agardh)De Toni 1903: 847. Adams 1983: 1; 1994: 331, pl. 114 upper right. Gordon-Mills & Womersley 1987: 541, figs 20D, 22F–J. Guiler 1952: 104. Lucas 1909: 40; 1929a: 21. Shepherd 1983: 83.

Chondriopsis harveyana J. Agardh 1863: 808; 1892: 155. Sonder 1880: 34. Tisdall 1898: 513. Wilson 1892: 168.

Chondriopsis arborescens J. Agardh 1892: 158. Tisdall 1898: 514. Wilson 1892: 168.

Chondria arborescens (J. Agardh)De Toni 1903: 837. Lucas 1909: 40. Lucas & Perrin 1947: 259.

Chondria dasyphylla sensu Harvey 1859b: 297 (in part). Womersley 1950: 186.

Laurencia dasyphylla sensu Harvey 1844b: 444 (in part); 1849: 85. Hooker & Harvey 1847: 401. Sonder 1853: 695.

Bolboclinium rhytidophloeum J. Agardh 1894: 79, *nom. nudum*. Falkenberg 1901: 697.

FIG. 196

Thallus (Fig. 196A) dark red to brown-red, drying very dark, 10–40 (-120) cm high, irregularly radially branched for 3–4 orders, branches terete, usually with one to a few percurrent axes with often distant laterals, lower axes 0.7–1.5 (-2.5) mm in diameter, grading to lesser branchlets 300–500 µm in diameter. Holdfast discoid, becoming divided, 2–10 mm across, with lateral branchlets from the lowermost axis adhering by small haptera; epilithic or epiphytic on *Amphibolis*. *Structure*. Apices slightly pointed to just depressed, inner cortical cells often as a ring of larger cells (Fig. 196B) with surrounding rhizoids in older axes; epidermal cells 10–15 µm in diameter and L/D (5-) 9–17. Trichoblasts profuse in apical depressions, 0.5–1 mm long. Cell wall thickenings not observed. Cells with discoid rhodoplasts, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps situated several cells along trichoblasts. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia 35–60 µm in diameter. Cystocarps (Fig. 196C) ovoid to slightly urceolate, 0.8–1.5 mm in diameter, short-stalked with a prominent, curved, spur (Fig. 196D); pericarp ostiolate, mostly 2 cells thick, lightly corticate basally. Spermatangial plates (Fig. 196E) discoid to cordate, 350–750 µm across, with 1 (-2) sterile marginal cells.

Tetrasporangia (Fig. 196F) in lesser branchlets, on (2-) 3 pericentral cells per axial cell, 90–140 µm in diameter.

Type from Georgetown, Tas. (*Harvey*, Alg. Aust. Exsicc. 158 I); holotype in LD, 37833; isotypes NSW, A3660 and elsewhere.

Distribution: King George Sound, W. Aust., and Spencer Gulf, S. Aust., to Westernport Bay, Vic. and around Tasmania.

New Zealand (Adams 1983, p. 1).

Selected specimens: King George Sound, W. Aust., (*Harvey*, Trav. Set 293; Herb. Harvey, TCD). N Spencer Gulf, S. Aust., 15 m deep (*Shepherd*, 5.ix.1973; AD, A44219). Port Elliot, S. Aust., drift (*Womersley*, 16.v.1985; AD, A55693). American R. inlet, Kangaroo I., S. Aust., 4–6 m deep off jetty (*Womersley*, 22.viii.1963; AD, A26963). Muston, Kangaroo I., S. Aust., 2–3 m deep (*Womersley*, 21.xi.1968; AD, A32946). Portsea, Port Phillip, Vic., drift (*Lukey*, 12.i.1956; AD, A23252). Shoreham, Western port, Vic., drift (*Sinkora* A1257, 29.x.1971; AD, A55330; MEL, 608527). San Remo, Vic., drift (*Sinkora* A2027, 27.xi.1974; AD, A55678; MEL, 608555). Port Sorell, N Tas., drift (*Womersley*, 9.xi.1982; AD, A55686). Gordon, Tas. (*Perrin*, 25.ix.1937; AD, A8503; HO, 66127). Bruny I. (opp. Gordon), Tas., 2–3 m deep (*Brown*, 10.x.1986; AD, A57832).

Chondria harveyana is the longest, though moderately slender, species, confined largely to sheltered situations often where there is strong current flow.

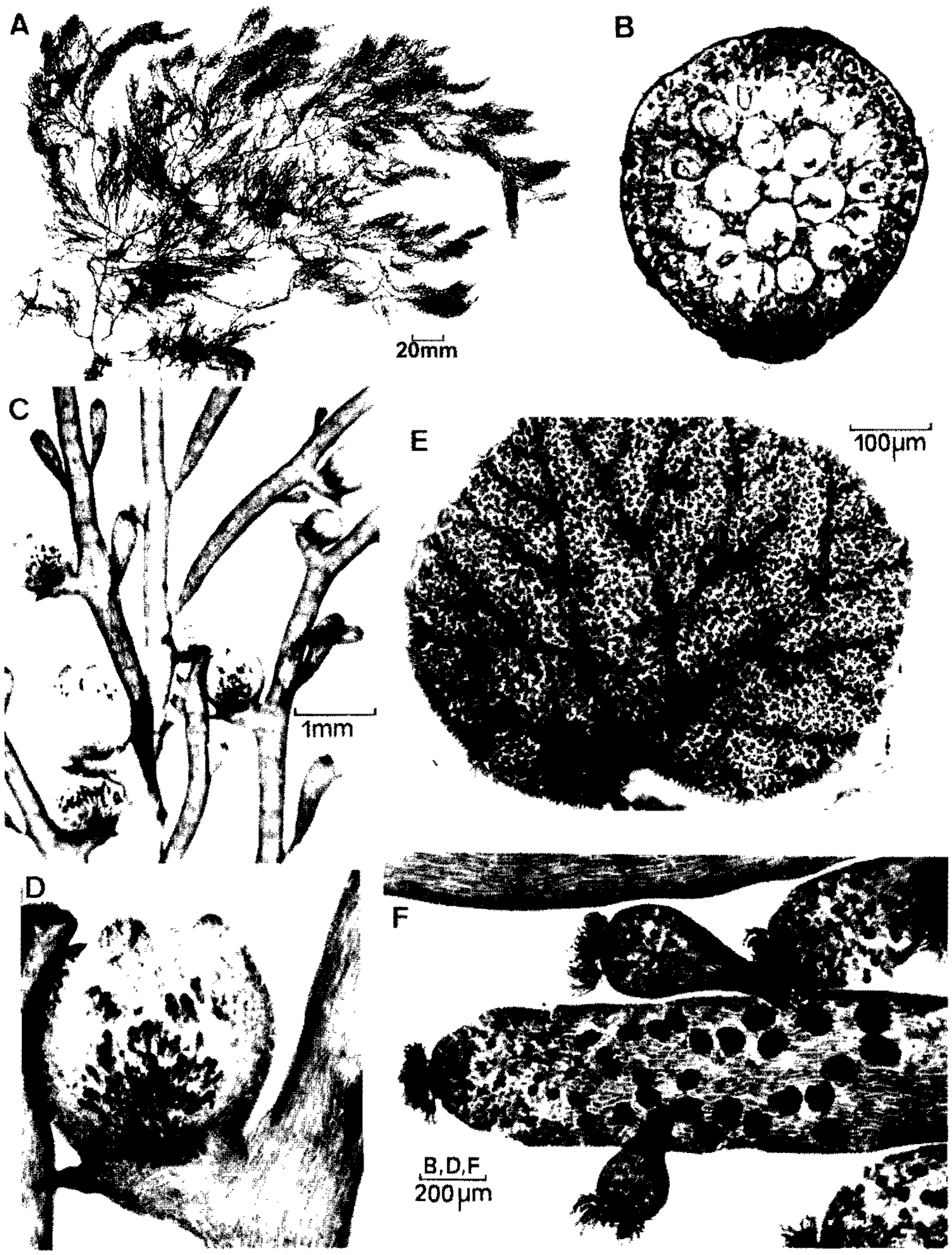

Fig. 196. *Chondria harveyana* (**A**, **F**, AD, A32946; **B**, **E**, AD, A55693; **C**, **D**, AD, A26963). **A**. Habit. **B**. Transverse section of branch. **C**. Branches with cystocarps with basal spurs. **D**. Cystocarp with prominent spur. **E**. Spermatangial plate. **F**. Branches with tetrasporangia.

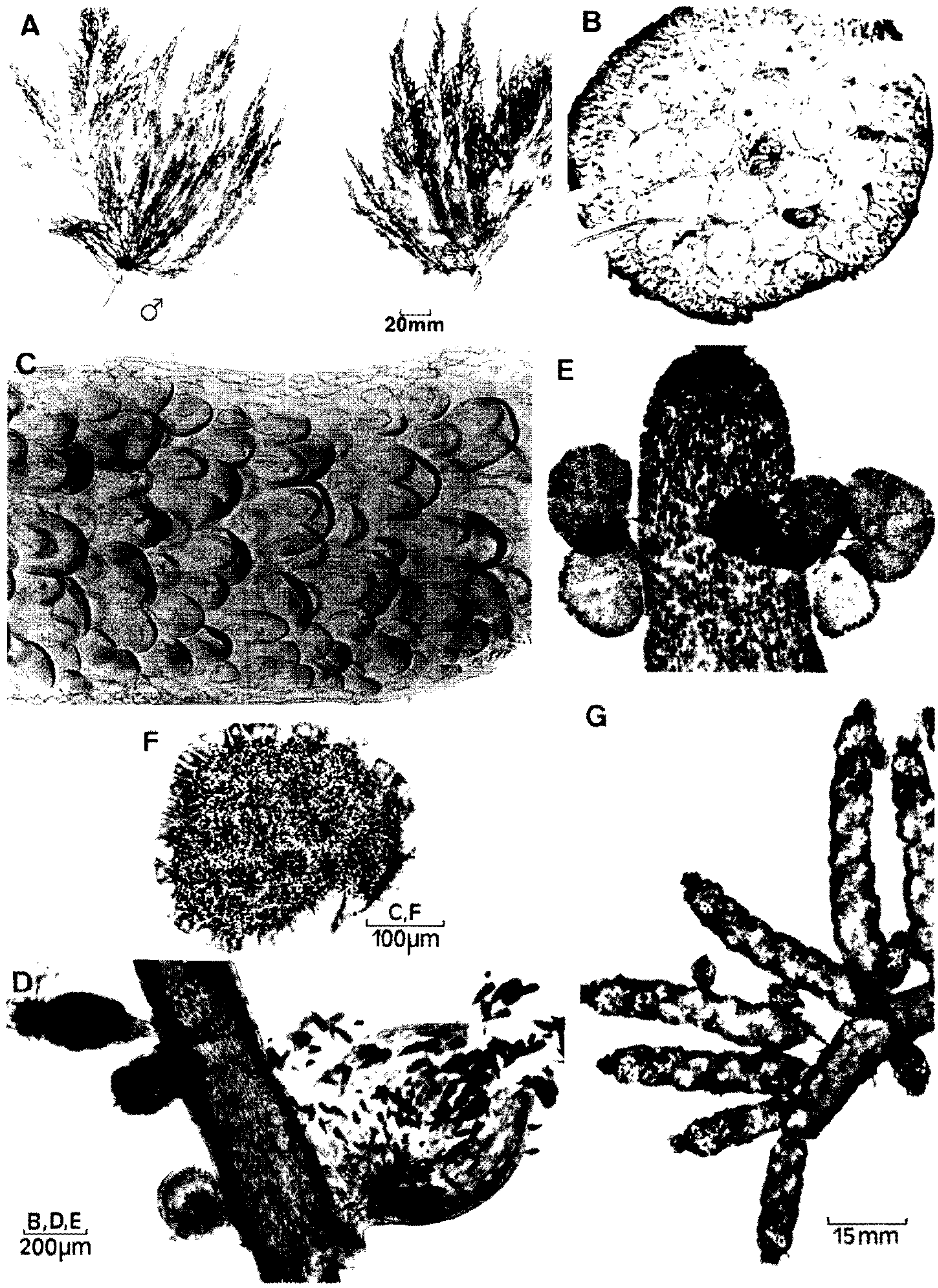

Fig. 197. *Chondria succulenta* (**A**, **E**, **F**, AD, A46814; **B**, AD, A41192; **C**, AD, A49750; **D**, **G**, AD, A53795). **A**. Habit. **B**. Transverse section of branch. **C**. Cell wall thickenings in longitudinal view. **D**. Cystocarps, basal spur on one to lower left. **E**. Branch with spermatangial plates. **F**. Spermatangial plate. **G**. Branches with tetrasporangia.

13. **Chondria succulenta** (J. Agardh)Falkenberg 1901: 205, pl. 22 figs 22, 23. De Toni 1903: 846. Gordon-Mills & Womersley 1984: 224, figs 6, 7; 1987: 534, figs 12 I–O, 20A, B, 21. Guiler 1952: 104. Huisman & Walker 1990: 432. Lucas 1909: 40; 1913: 58. Lucas & Perring 1947: 260. Millar 1990: 461, figs. 71C–G. Millar & Kraft 1993: 51. Reinbold 1898: 49. Silva *et al.* 1996: 485.

Chondriopsis succulenta J. Agardh 1892: 154. Tisdall 1898: 514. Wilson 1892: 168.
Chondria curdieana sensu Lucas 1913: 57.
Chondria sedifolia sensu Harvey 1855a: 539.
Chondria dasyphylla var. *sedifolia* Harvey 1863, synop.: xviii. J. Agardh 1863: 810.
Chondria iridescens Lucas 1927: 561, pl. 48.

FIG. 197

Thallus (Fig. 197A) red to brown-red, 3–18 (-30) cm high, much branched irregularly radially for 3–4 orders, usually with a main axis, branches terete, lateral branches initially constricted, axillary branching occasional; basal axes 0.6–2.5 mm in diameter, grading to lesser branchlets 500–800 µm in diameter. Holdfast discoid, 1–2 mm across, or attachment by haptera. *Structure.* Apices rounded or slightly depressed, with a protruding apical filament, pericentral cells relatively large, epidermal cells ovoid to elongate, (15-) 20–25 µm in diameter and L/D 1.5–7 (-12), with slight rhizoid development around the axial and pericentral cells (Fig. 197B) in lower parts of the thallus; secondary cortex absent or slight near the base. Cell wall thickenings absent or present as hemispherical caps (Fig. 197C) on upper ends of pericentral and inner cortical cells, the pericentral cells later also with a central band or girdle. Trichoblasts usually prominent. Cells with discoid to elongate rhodoplasts, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps on suprabasal cells of trichoblasts, with a 4-celled carpogonial branch and basal and lateral sterile groups. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia 35–65 µm in diameter. Cystocarps (Fig. 197D) ovoid to slightly urceolate, 0.7–1 mm in diameter, usually with a distinct basal spur; pericarp broadly ostiolate, 2 cells thick, ecorticate. Spermatangial plates (Fig. 197E, F) discoid to slightly lobed, 400–650 µm across, with a single row of sterile marginal cells.

Tetrasporangia (Fig. 197G) near ends of lesser branchlets, on 2–3 pericentral cells per axial cell, 80–140 µm in diameter.

Type from King George Sound, W. Aust. (*Harvey*, Alg. Aust. Exsicc. 157B); lectotype in Herb. Agardh, LD, 37802; isotypes LD, 37800, 37801, 37804, AD, A18280 and in other herbaria.

Distribution: Point Peron, W. Aust., to American R. inlet, Kangaroo I., S. Aust., probably Port Phillip, Vic., possibly N coast of Tasmania, and N.S.W.

Selected specimens: Point Peron, W. Aust., reef surface (*Gordon-Mills*, 8.xii.1984; AD, A55703). Crinolin Point, Coffin Bay, S. Aust., uppermost sublittoral (*Womersley*, 5.xii.1975; AD, A46814—"Marine Algae of southern Australia" No. 423). Moonta Bay, Yorke Pen., S. Aust., lower eulittoral pools (*Gordon-Mills*, 18.xii.1983; AD, A53795). Muston, American R. inlet, Kangaroo I., S. Aust., 2–3 m deep (*Kraft*, 2.xii.1971; AD, A41192) and 1–4 m deep (*Johnson*, 24.i.1978; AD, A49750). ?Sorrento, Port Phillip, Vic., 10 m deep (*Womersley*, 7.iv.1959; AD, A22870). Towra Point, Botany Bay, N.S.W., on cockles, low eulittoral (*Womersley*, 20.v.1978; AD, A49352). Port Stephens, N.S.W. (*Lucas*, March 1913 as *Chondria iridescens*; AD, A1996).

Chondria succulenta appears to be largely confined to sheltered inlets where there is strong current flow.

14. **Chondria lanceolata** Harvey 1855a: 539; 1862a: pl. 239; 1863, synop.: xix. Adams 1994: 332, pl. 114 mid left. J. Agardh 1863: 805. De Toni 1903: 837. Gordon-Mills & Womersley 1987: 544, figs 23F, 24A, B, 25. Huisman 1997: 203. Huisman & Walker 1990: 432. Lucas 1909: 40. Lucas & Perrin 1947: 259, fig. 117. Millar & Wynne 1992c: 428. Silva *et al.* 1996: 483.

Chondriopsis lanceolata (Harvey)J. Agardh 1892: 157. Sonder 1880: 34.

FIG. 198

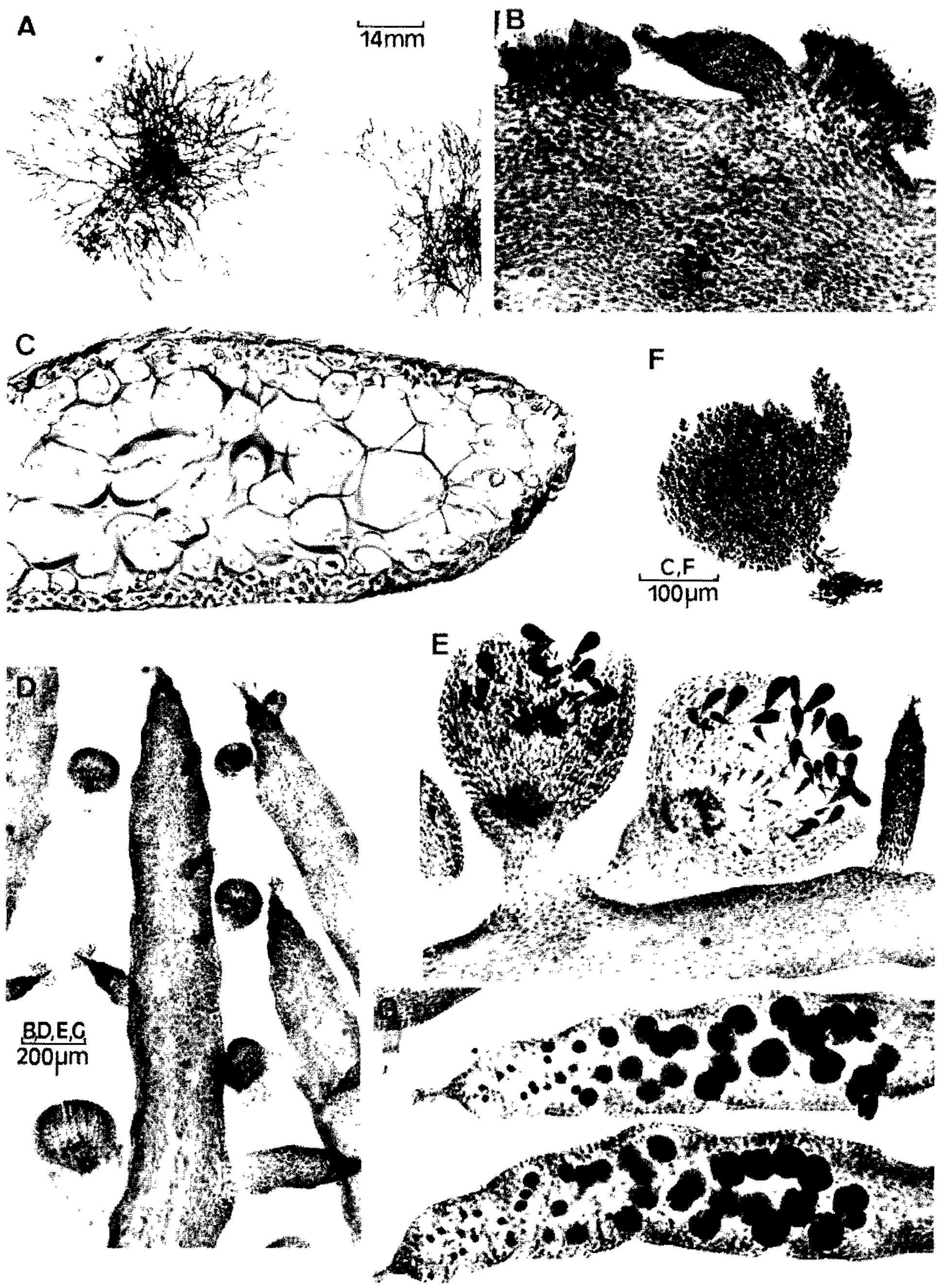

Fig. 198. *Chondria lanceolata* (**A–D**, AD, A51015). **A**. Habit, on *Posidonia*. **B**. Branch with short, discoid, holdfasts. **C**. Transverse section of branch. **D**. Branches with cystocarps. **E**. Cystocarps with carposporangia. **F**. Spermatangial plate. **G**. Branches with tetrasporangia.

Thallus (Fig. 198A) dark red-brown, 2–6 cm high, much branched irregularly radially for 3–4 orders, sometimes slightly distichous, branches terete near apices, compressed in mid and lower branches; lower branches 500–800 μm broad where compressed, grading to lesser branchlets 300–350 μm in diameter, young branchlets basally constricted but this soon lost. Holdfasts discoid, 0.2–0.8 mm across, or with short lateral branches attached by discoid haptera (Fig. 198B); epiphytic on *Posidonia* or epilithic. *Structure.* Apices (Fig. 198D, G) tapering gradually to an apical filament 8–10 cells long, apical cell dome-shaped, 8–10 μm in diameter, with 5 pericentral cells (Fig. 198C) not readily distinguished from inner cortical cells, cortex 2–3 cells broad, transversely and 5–7 cells laterally, epidermal cells 10–15 (-18) μm in diameter and L/D 1–3.5 (-6). Cell wall thickenings (Fig. 198C) lenticular to band-like, mainly on the outer and radial walls of the pericentral and inner cortical cells. Cells with discoid rhodoplasts.

Reproduction. Gametophytes dioecious. Procarps several cells up on trichoblasts. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia 35–65 μm in diameter. Cystocarps (Fig. 198D, E) ovoid, 700–1200 μm in diameter, with a short stalk and often a rounded basal protrusion; pericarp ostiolate, with 16–18 erect filaments, ecorticate or lightly corticate below. Spermatangial plates (one seen) discoid (Fig. 198F), 250–300 μm across, with a sterile margin one cell broad.

Tetrasporangia (Fig. 198G) in lesser branchlets, on 1–2 pericentral cells per axial cell, 60–140 μm in diameter.

Type from Rottnest I., W. Aust. (*Harvey*, Trav. Set 191); holotype in Herb. Harvey, TCD; probable isotypes in Alg. Aust. Exsicc. 156A.

Distribution: Houtman Abrolhos to Point Peron W. Aust., (*Huisman* 1997: 203) and probably from Scott Bay, S. Australia.

Selected specimens: Point Peron, W. Aust., on *Posidonia australis*, uppermost sublittoral (*Womersley*, 18.viii.1979; AD, A51015—"Marine Algae of southern Australia" No. 212, and 29.ix.1979; AD, A51027). Scott Bay, S. Aust., upper sublittoral pools (*Womersley*, 27.i.1951; AD, A15022).

The Scott Bay collection is of small, depauperate plants and is only provisionally referred to *C. lanceolata*. Typical *C. lanceolata* is characterised by habit and the compressed larger branches, together with the attenuate apices.

15. **Chondria foliifera** (J. Agardh)Falkenberg 1901: 206. De Toni 1903: 839. Gordon-Mills & Womersley 1987: 547, figs 23G, H, 24C, 26. Lucas 1909: 40. Lucas & Perrin 1947: 260. Millar & Wynne 1992c: 428.
Chondriopsis foliifera J. Agardh 1885: 90, fig. 8s–u; 1892: 159. Tisdall 1898: 514. Wilson 1890: 491; 1892: 168.

FIG. 199

Thallus (Fig. 199A) medium red, 5–15 cm high, irregularly but mostly alternately distichously branched for 3–4 orders from, or near to, the branch edges; most branches strongly compressed (Fig. 199B), with the base of the axes (Fig. 199C) becoming thickened and terete, 1–2 (-3) mm in diameter, possibly perennial; main branches 1–2.5 mm broad and 0.75–1 mm thick, lesser branchlets 0.8–1.5 mm broad and 70–100 μm thick. Holdfast discoid, 3–6 mm across; epilithic. *Structure.* Apices (Fig. 199C) tapering gradually, with a short apical filament, pericentral cells soon inconspicuous and separated by rhizoids, laterally with more and larger inner cortical cells, epidermal cells 20–30 μm in diameter and L/D 1–2 (-3), angular. Median and lower axes with rhizoids around the axial and pericentral cells, and a secondary cortex (Fig. 199C) develops near the base. Cell wall thickenings (Fig. 199D) occur as bands or patches on the upper ends and sides of pericentral cells. Cells with discoid rhodoplasts.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a basal fusion cell and short, branched gonimoblast with shortly-clavate to ovoid terminal carposporangia 50–100 μm in diameter. Cystocarps (Fig. 199E) usually on or near the edges of the branches, ovoid, 600–1400 μm in diameter, short-stalked, without a spur; pericarp ostiolate, 3–4 cells thick, corticated. Spermatangial plates (Fig. 199F) discoid to reniform, 250–400 μm across, with a single row of sterile marginal cells.

Tetrasporangia (Fig. 199G) in lesser branchlets, probably on 2–3 pericentral cells per axial cell, 120–200 μm in diameter.

Type from Port Phillip Heads, Vic. (*Wilson* 57, Jan. 1882); lectotype in Herb. Agardh, LD, 37947.

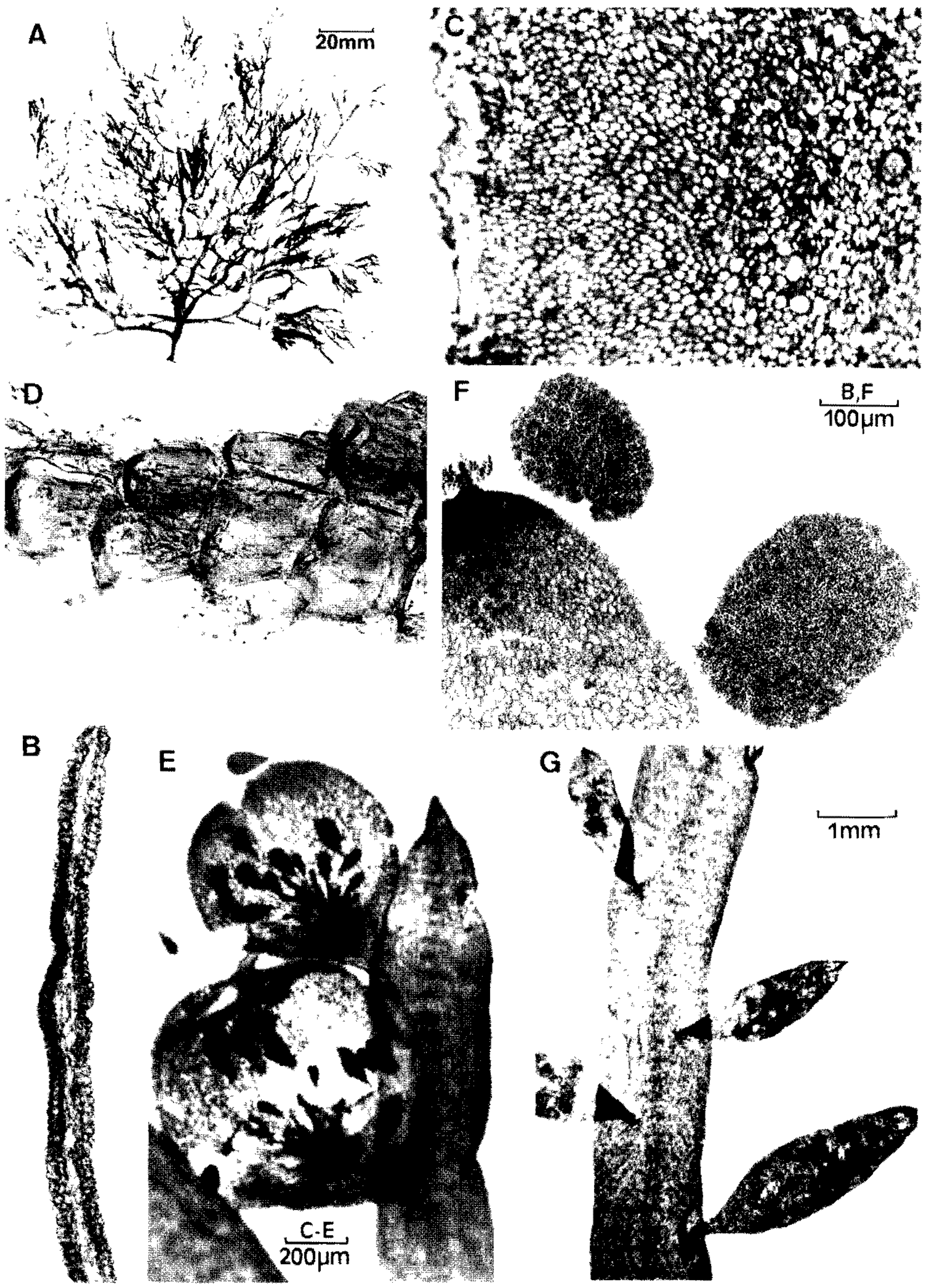

Fig. 199. *Chondria foliifera* (**A, D**, AD, A1083; **B**, **F**, AD, A30613; **C**, **G**, LD, 37947). **A**. Habit. **B**. Transverse section of compressed branch. **C**. Transverse section of basal stipe. **D**. Longitudinal view of pericentral cells with wall thickenings. **E**. Cystocarps. **F**. Spermatangial plates. **G**. Branches with tetrasporangia.

Distribution: Troubridge Light to West I., S. Aust., and Port Phillip Heads, Victoria.

Selected specimens: Troubridge Light, S. Aust., 18 m deep (*Shepherd*, 4.ii.1969; AD, A33569). Gulf St Vincent, S. Aust., 40 m deep (AD, A1083). Whale Point, West I., S. Aust., 26 m deep (*Shepherd*, June 1966; AD, A30613). Port Phillip Heads, Vic. (*Wilson*, 31.xii.1889; AD, A18155 and 7.i.1890; MEL, 608606).

Chondria foliifera is known from only a few, mainly dried, collections. It appears to be a rare deep-water species.

16. **Chondria incrassata** (J. Agardh)Gordon-Mills & Womersley 1987: 517, figs 13C, 14. Millar & Wynne 1992c: 428.

Coeloclonium incrassatum J. Agardh 1876: 641. De Toni 1903: 826. Guiler 1952: 104. Lucas 1909: 40; 1929a: 21; 1929b: 51. Lucas & Perrin 1947: 257. May 1965: 383. Reinbold 1898: 49. Sonder 1880: 29.

Chondria clavata β *dendroides* Harvey 1863, synop.: xviii (*nom. nudum*).

Chondriopsis ovalifolia J. Agardh 1890: 48; 1892: 159. Tisdall 1898: 514. Wilson 1892: 168.

Chondria ovalifolia (J. Agardh)De Toni 1903: 839. Guiler 1952: 104. Lucas 1909: 40. Lucas & Perrin 1947: 260.

Dolichoscelis disticha J. Agardh 1899: 120. De Toni 1903: 828. Lucas 1909: 40. Lucas & Perrin 1947: 257.

FIG. 200

Thallus (Fig. 200A) dark red-brown, robust, 10–30 (-40) cm high, with one to several strongly developed erect axes bearing often clustered laterals for 3–4 orders, branching first radial, later more-or-less distichous and often axillary from slightly compressed (Fig. 200B) parent branches, axes 2–4 (-5) mm broad (breadth/thickness 1.5–2), lesser branchlets terete, 0.8–2 (-2.5) mm in diameter. Holdfast discoid to lobed, 0.5–3 cm across; epilithic. *Structure*. Apices depressed, developing 5 pericentral cells and a broad cortex becoming more extensive laterally (Fig. 200B) as branches become compressed; epidermal cells (20-) 30–60 (-85) µm in diameter and L/D 1–1.5 (-2). Mature branches with rhizoids around the pericentral and inner cortical cells. Cell wall thickenings (Fig. 200C) usually present in lower main axes, as lenticular patches or slightly lobed bands. Trichoblasts profuse at apices. Cells multinucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a basal branched fusion cell and branched gonimoblast with clavate terminal carposporangia 80–120 µm in diameter. Cystocarps (Fig. 200D) ovoid to slightly urceolate, subsessile, 1–2 mm in diameter, sometimes with flared necks, without a spur; pericarp ostiolate, corticated, 3–5 cells thick, especially at the neck. Spermatangial plates (Fig. 200E) discoid, 500–800 µm across, with sterile margins mostly one cell broad.

Tetrasporangia (Fig. 200F) in lesser terete branchlets, on one pericentral per axial cell, 100–250 µm in diameter.

Type from Orford, Tas. (*Meredith*); lectotype in Herb. Agardh, LD, 36159, plus 4-isolectotypes.

Distribution: Elliston, S. Aust., to Walkerville, Vic., and around Tasmania.

Selected specimens: Elliston, S. Aust., 10–11 m deep in bay (*Shepherd*, 20.x.1969; AD, A35027). Port Elliot, S. Aust., drift (*Womersley*, 14.xii.1957; AD, A21326). Margaret Brock Reef, Cape Jaffa, S. Aust., 3–5 m deep (*R. Lewis*, 29.xi.1972; AD, A42904). Robe, S. Aust., drift (*Womersley*, 14.xi.1955; AD, A19992 and 6.xi.1965; AD, A29638). 1.3 km off Cape Northumberland, S. Aust., 15 m deep (*Shepherd*, 2.i.1978; AD, A50519). Port MacDonnell, S. Aust., drift (*Womersley*, 16.x.1985; AD, A56995). Port Phillip Heads, Vic. (*Wilson* 20, 5.ii.1886; LD, 37951). Walkerville, Vic., drift (*Sinkora* A1833, 6.xii.1973; AD, A53526 and MEL, 608649). Currie R., Tas. (*Perrin*, Sept. 1934; HO, 66136). Eddystone, Tas. (*Perrin*, Nov. 1944; AD, A53766 and HO, 66138). S Charlotte Cove, D'Entrecasteaux Ch., Tas., 3–4 m deep (*Pope*, 1.x.1983; AD, A55311). Fluted Cape, Bruny I., Tas., 23 m deep (*Shepherd*, 12.ii.1972; AD, A41928). Lady Bay, Southport, Tas., 1–5 m deep (*Brown & Womersley*, 28.x.1982; AD, A53691—"Marine Algae of southern Australia" No. 304).

Chondria incrassata is a distinctive and robust member of the genus, known from 1–23 m deep on rough-water coasts.

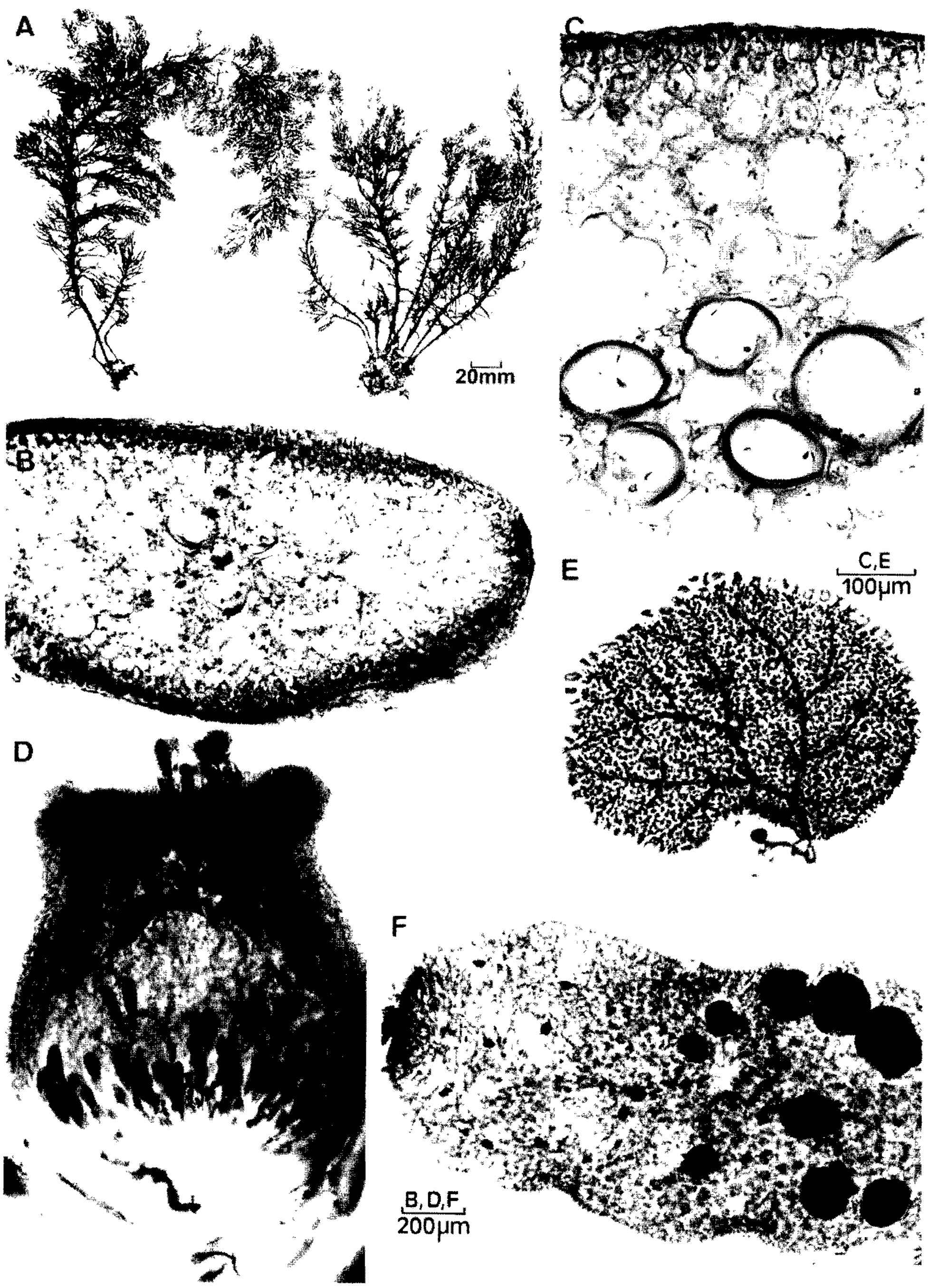

Fig. 200. *Chondria incrassata* (**A**, AD, A56995; **B**, AD, A50519; **C**, AD, A35027; **D**, AD, A41928; **E**, AD, A55311; **F**, AD, A21326). **A**. Habit. **B**. Transverse section of branch. **C**. Transverse section with wall thickenings in pericentral cells. **D**. Cystocarp. **E**. Spermatangial plate. **F**. Branch with tetrasporangia.

Tribe LAURENCIEAE Schmitz 1889: 447

Thallus pulvinate or erect and branched, radially or bilaterally, branches terminated by an apical depression surrounding an axial filament, with apical trichoblasts and 2 or 4 pericentral cells per axial cell; axial and pericentral cells obscure within the cortex shortly below the branch apex. Thallus epilithic, epiphytic or parasitic.

Reproduction. Gametophytes dioecious. Procarps borne on lower cells of trichoblasts, with a 4-celled carpogonium and 2 multicellular sterile groups. Carposporophyte with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia. Cystocarps ovoid, pedicellate, sessile or partly immersed, pericarp ostiolate, corticate and 3–6 cells thick. Spermatangia borne on apical trichoblasts or on filaments arising from epidermal cells within apical or adjacent depressions.

Tetrasporangia situated in the outer cortex, formed on the outer end of elongate pericentral cells or cut off from outer or epidermal cells, with 2 cover cells; tetrasporangia subspherical to ovoid, tetrahedrally or decussately divided.

Type genus: *Laurencia* Lamouroux 1813: 130.

The Laurencieae has included 4 genera (Kylin 1956, p. 552), *Laurencia* Lamouroux, *Rodriguezella* Schmitz and the parasitic *Riccardia* Derbès & Solier and *Janczewskia* Solms-Laubach, of which the first and last occur on southern Australian coasts.

The first genus, *Laurencia*, within which several subgenera and sections have previously been recognised (Saito 1967; Saito & Womersley 1974; has recently been separated into 3 genera (Garbary & Harper 1998; Nam 1999), viz.

Laurencia Lamouroux (1813), with 4 pericentral cells, epidermal cells connected laterally by secondary pit-connections and containing *corps en cerise*, spermatangia borne on trichoblasts in apical receptacles, and tetrasporangia cut off from pericentral cells usually in parallel arrangement, with horizontal cover cells.

Chondrophycus (Tokida & Saito *in* Saito 1967, p. 72) Garbary & Harper (1998, p. 194) with 2 pericentral cells, epidermal cells in most species without secondary pit-connections and *corps en cerise*, spermatangia borne on trichoblasts in apical receptacles, and tetrasporangia cut off from pericentral cells usually in right-angle arrangement, with horizontal cover cells. Nam (1999) considers that the only definite feature separating *Chondrophycus* and *Laurencia* is the number of pericentral cells.

Osmundea Stackhouse (1809), resurrected by Nam *et al.* (1994), with 2 pericentral cells, spermatangia borne on filaments arising from epidermal cells in pits near apices, and tetrasporangia produced laterally from epidermal cells with longitudinal cover cells.

Species of *Osmundea* apparently do not occur on southern Australian coasts.

KEY TO GENERA OF LAURENCIEAE

1. Thallus pulvinate to globose, less than 6 mm across, epiphytic on *Laurencia* spp. .... JANCZEWSKIA
1. Thallus erect, branched, 2–20 cm high 2

   2. Axes with 4 pericentral cells, epidermal cells with secondary pit-connections and *corps en cerise*, tetrasporangia in parallel arrangement .... LAURENCIA
   2. Axes with 2 pericentral cells, epidermal cells in most species without secondary pit-connections or *corps en cerise*, tetrasporangia usually in right-angle arrangement .... CHONDROPHYCUS

Genus **JANCZEWSKIA** Solms-Laubach 1877: 209

Thallus grey-white to pink, subspherical to pulvinate and a few mm across, with a basal parenchymatous cushion bearing surface tuberculate excrescences or elongate, terete, branches a few mm long. Attachment to host by rhizoids; parasitic on species of *Laurencia*, *Chondria*, and one species on *Cladhymenia*. *Structure.* Branches or excrescences with truncated apices and an apical depression around the axial filament which bears trichoblasts and pericentral cells (number uncertain, probably 2 in *J. tasmanica*); axial and pericentral

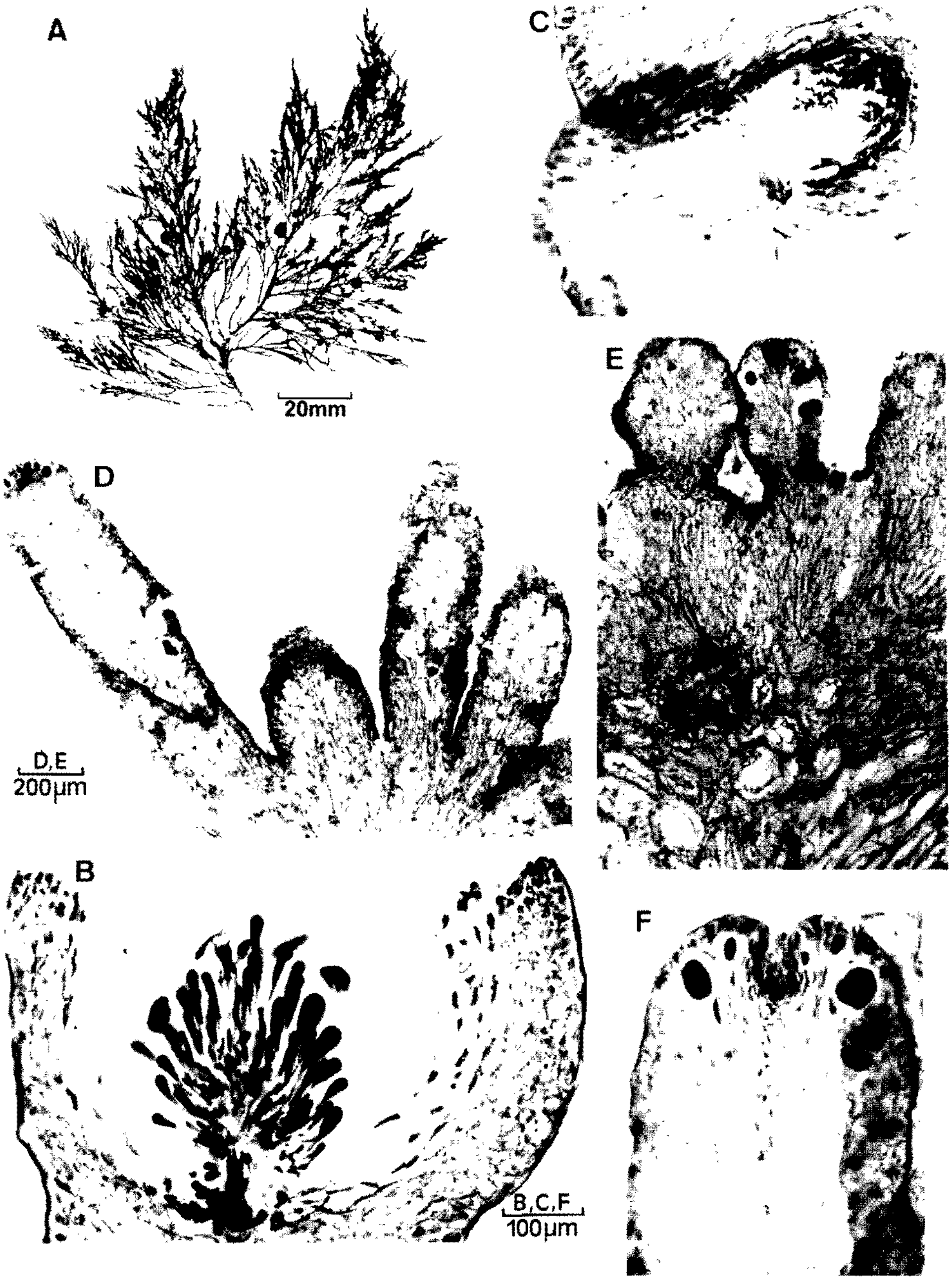

Fig. 201. *Janczewskia tasmanica* (**A**, AD, A63249; **B–F**, AD, A32091). **A**. Habit, on *Laurencia filiformis* f. *heteroclada*. **B**. Section of cystocarp. **C**. Section with spermatangial depression. **D**. Tetrasporangial branches. **E**. Thallus attached to host. **F**. Apex of tetrasporangial branch.

cells soon obscure in the cellular cortex, epidermal cells with secondary pit-connections. Cells with few, pale rhodoplasts.

Reproduction. Gametophytes dioecious. Procarps little known, borne on lower cells of apical trichoblasts. Carposporophytes with a basal fusion cell and branched gonimoblast bearing clavate terminal carposporangia. Cystocarps sunken in tubercles or on erect branches, sessile, ovoid; pericarp ostiolate, corticated, several cells thick. Spermatangia borne on modified trichoblasts in apical depressions.

Tetrasporangia situated in the outer cortex in parallel arrangement, cut off abaxially from the ends of elongate pericentral (or outer) cells, tetrahedrally or decussately divided.

Type species: *J. verrucaeformis* Solms-Laubach 1877: 209, pl. 3, described in detail by J. & G. Feldmann (1958).

A genus of about 8 species, most of which were included in the general account of Setchell (1914), most species parasitic on species of *Laurencia*, a few on species of *Chondria*, one on *Cladhymenia*.

The southern Australian *J. tasmanica* was the second species to be described, differing from the type species in having distinct outer, terete, branches.

One species occurs on southern Australian coasts, the crediting of the Mediterranean *J. verrucaeformis* to Australia by Goff (1982, p. 302) being incorrect.

Janczewskia tasmanica Falkenberg 1901: 257, pl. 24 figs 18, 19. De Toni 1903: 812; 1924: 378. Goff 1982: 302. Guiler 1952: 105. Lucas 1909: 39; 1929b: 50. Lucas & Perrin 1947: 250. May 1965: 385. Schmitz & Falkenberg 1897: 432, fig. 243C (*nomen nudum*). Setwchell 1914: 16. Shepherd & Womersley 1981: 368. Womersley 1950: 187.

Janezewskia australis? Falkenberg *ex* Reinbold 1899: 47 (*nomen nudum*). De Toni 1924: 379. Setchell 1914: 18.

FIG. 201

Thallus (Fig. 201A) grey-white, 3–6 mm across, subspherical, with a basal parenchymatous cushion 1–3 mm thick and upper, simple or once-branched, terete branches 1–3 mm long, 600–1000 µm in diameter in sexual thalli and 300–450 µm in tetrasporangial thalli (Fig. 201D). Attachment by rhizoids from cells of the cushion (Fig. 201E), growing between host cells; parasitic on species of *Laurencia* (especially *L. filiformis* f. *heteroclada*).

Structure. Branches with truncated and depressed apices, with axial filaments bearing trichoblasts and probably 2 pericentral cells, soon becoming obscure in older parts; cortical cells large, ovoid, epidermal cells compact, isodiametric and angular, 15–25 µm across in surface view, with secondary pit-connections. Cells uninucleate; rhodoplasts few, pale, discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes (Fig. 201B) with a prominent basal fusion cell and branched gonimoblast bearing clavate terminal carposporangia 20–30 µm in diameter. Cystocarps (Fig. 201B) lateral on erect branches, ovoid, sessile and broad-based, 700–800 µm in diameter; pericarp with a broad ostiole, corticated and 6–8 cells thick. Spermatangia borne on modified trichoblasts in apical depressions (Fig. 201C).

Tetrasporangia (Fig. 201F) situated in the outer cortex in parallel arrangement, cut off abaxially from near the ends of elongate pericentral cells (or outer cells), ovoid, 40–70 µm in diameter, tetrahedrally or decussately divided.

Type from Tasmania; in Herb. Falkenberg, Naples, Italy?

Distribution: Point Sinclair, S. Aust., to Cape Bridgewater, Vic., and Tasmania.

Selected specimens: Point Sinclair, S. Aust., on *Laurencia filiformis*, reef surface (*Womersley*, 26.i.1951; AD, A15231). Venus Bay, S. Aust., on *L. elata*, sublittoral fringe pools (*Womersley*, 12.ii.1954; AD, A19519). Elliston, S. Aust., on *L. shepherdii*, 1–2 m deep (*Shepherd*, 28.x.1972; AD, A42808). Horseshoe Bay, Port Elliot, S. Aust., on *L. filiformis*, upper sublittoral pools (*Womersley*, 1.xii.1967; AD, A32091—"Marine Algae of southern Australia" No. 136). Pennington Bay, Kangaroo I., S. Aust., on *L. elata*, sublittoral fringe (*Womersley*, 7.i.1948; AD, A6682) and on *L. filiformis* f. *heteroclada*, low eulittoral (*Womersley*, 23.viii.1950; AD, A13400). Cable Hut Reef, Penneshaw, Kangaroo I., S. Aust., on *L. filiformis*, 22 m deep (*Lavers*, 22.x.1996; AD, A66806). Robe, S. Aust., on *L. filiformis*, drift (*Womersley*, 21.ii.1985; AD, A56406). Cape Northumberland, S. Aust., on *L. filiformis*

f. *heteroclada*, lower eulittoral depressions (*Womersley*, 1.xi.1993; AD, A63249—"Marine Algae of southern Australia" No. 136a). Bridgewater Bay, Vic., on *L. botryoides*, low eulittoral (*Womersley*, 3.ix.1981; AD, A55404).

Janczewskia tasmanica is a common parasite on several species of *Laurencia* on SE Australian coasts. *J. australis* is certainly a synonym of *J. tasmanica*, both names involving *nomina nuda* when first mentioned.

Genus LAURENCIA Lamouroux 1813: 42, *nom. cons.*

Thallus erect, moderately to much branched radially or distichously for 2–5 orders, soft to firm, usually drying cartilaginous, branches with truncated apices with a depressed apical pit; holdfast discoid or stoloniferous, epilithic or epiphytic. *Structure*. Apical depression with a central, short, apical filament bearing well-developed trichoblasts and 4 pericentral cells per

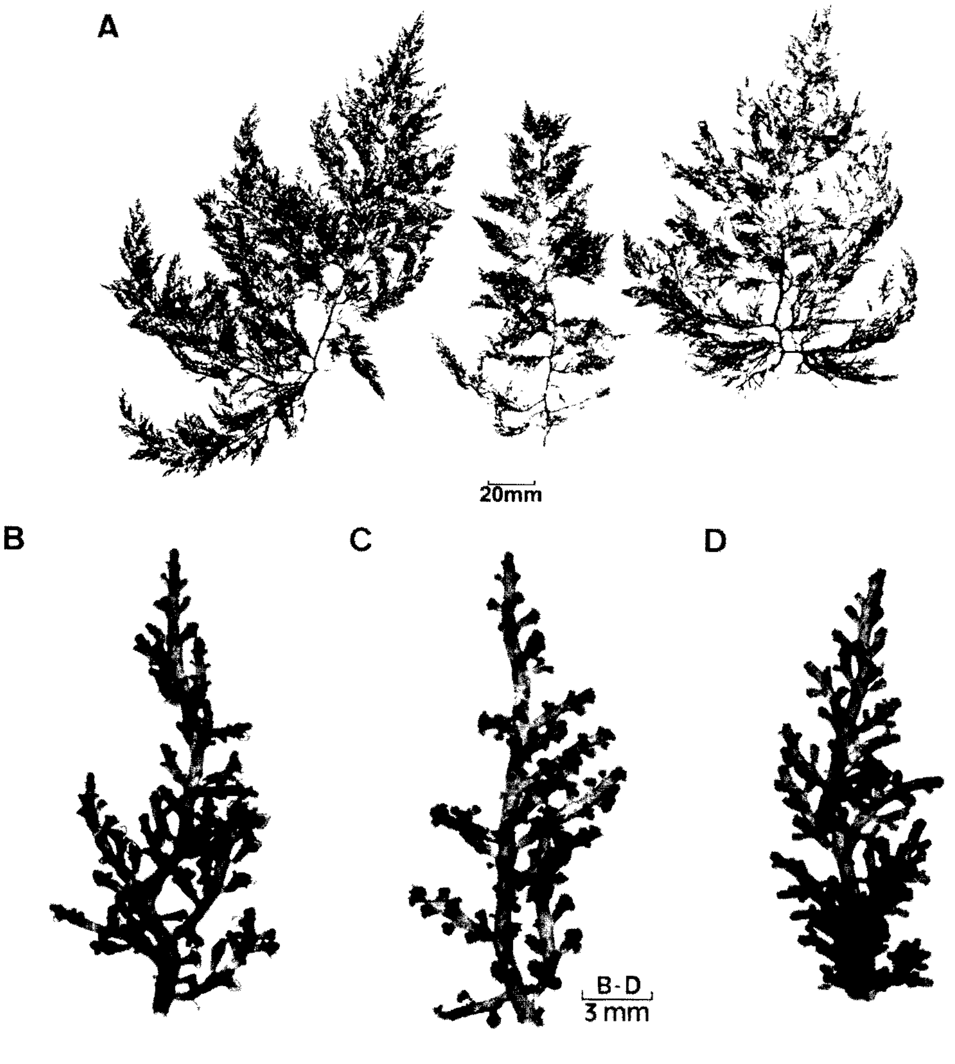

Fig. 202. *Laurencia majuscula* (**A**, AD, A41262; **B–D**, AD, A41231). **A**. Habit. **B**. Cystocarpic thallus. **C**. Spermatangial thallus. **D**. Tetrasporangial thallus. (**B–D**, as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

axial cell, axial cells short, these and the pericentral cells soon obscured and not recognisable in sections, cortex extensive with relatively large, ovoid, usually compact, irregular cortical cells and a small-celled epidermis with secondary pit-connections between the cells lengthwise to the branch and usually with *corps en cerise*; inner cortical cells often producing rhizoids and in some species with lenticular wall thickenings. Lateral branches arising from basal cells of trichoblasts. Cells uni- or multinucleate; rhodoplasts discoid to elongate, often chained in larger inner cells.

Reproduction. Gametophytes dioecious. Procarps formed on the fourth pericentral cells on the suprabasal cell of trichoblasts, consisting of a lateral sterile group of 4–6 cells, a 4-celled carpogonial branch and a basal sterile group of 2–3 cells. Carposporophytes with a basal fusion cell and branched gonimoblast bearing clavate terminal carposporangia, usually replaced from cells below when lost. Cystocarps usually lateral on branches, usually sessile, basally constricted or broad-based and in some species conical; pericarp arising pre-fertilization, ostiolate, corticated and 3–6 cells thick. Spermatangia borne in lateral whorls on cells of modified trichoblasts in the apical cup-like depressions, each axial cell with 4 pericentral cells and ultimate spermatangia, the filaments terminated by an enlarged globular cell.

Tetrasporangia borne, usually abaxially, on outer ends of laterally elongate pericentral cells or pit-connected to outer cortical cells, usually in "parallel" (down the branch) arrangement, tetrahedrally divided.

Type species: *L. obtusa* (Hudson)Lamouroux 1813: 42.

A genus of many species, common on most coasts, with some 12 species on southern Australian coasts. The genus in southern Australia was monographed by Saito & Womersley (1974), but details of number of pericentral cells, presence of *corps en cerise*, structure of procarps, spermatangial trichoblasts and origin of tetrasporangia still await description for nearly all species.

Old records frequently include *L. obtusa*, but the species involved remain uncertain.

KEY TO SPECIES OF *LAURENCIA*

1. Thallus irregularly radially branched, branches terete 2
1. Thallus complanately branched, branches slightly to strongly compressed 9

 2. Epidermal cells near apices with slightly projecting, convex, outer walls; thallus densely branched with many short laterals 3
 2. Epidermal cells near apices without distinctly convex outer walls; thallus loosely to densely branched 4

3. Thallus usually with percurrent axes mostly 1–2 mm in diameter .... 1. *L. majuscula*
3. Thallus without distinct percurrent axes, more-or-less entangled, branches slender, 400–600 µm in diameter .... 2. *L. aldingensis*

 4. Thallus usually less than 8 cm high, growing on *Posidonia*, with a single discoid holdfast and axis, branches subdichotomous; lenticular thickenings in cortical cells usually abundant .... 3. *L. forsteri*
 4. Thallus usually over 8 cm high, rarely on *Posidonia*, with one to several axes irregularly branched, lenticular thickenings absent or occasional 5

5. Thallus soft when young, not cartilaginous; branches often clavate, 0.5–1.5 cm long, distinctly or not basally constricted, with frequent spaces between outer cortical cells but without lenticular thickenings 6
5. Thallus firm, usually cartilaginous when dried, irregularly branched with small branchlets, not markedly basally constricted 7

 6. Laterals distinctly basally constricted with a narrow stalk; young branches appearing articulate, older branches terete with a thickened cortex; laterals often clustered at upper ends of segments .... 4. *L. clavata*
 6. Laterals not or only slightly basally constricted, often subopposite but rarely clustered .... 5. *L. shepherdii*

7. Thallus relatively slender, axes usually 0.7–1.5 mm in diameter, lesser ramuli 300–500 (-800) µm in diameter; stichidia in small dense clusters, individually 400–600 (-800) µm in diameter and 0.5–1 (-2) mm long .... 6. *L. arbuscula*
7. Thallus moderately to very robust, axes often over 2 mm in diameter, lesser ramuli usually about 1 mm in diameter; stichidia simple or branched, transformed from branchlet ends, usually 1–3 mm long 8

    8. Thallus robust, with percurrent axes bearing irregularly short laterals, cortical cells without lenticular thickenings .... 7. *L. tasmanica*
    8. Thallus slender to moderately robust, with or without percurrent axes, branching often distant and without short laterals, cortical cells often with lenticular thickenings .... 8. *L. filiformis*

9. Branches subterete to slightly compressed, main and lateral branches alternately distichous; stichidia (and spermatangial ramuli) in botryoidal clusters ....9. *L. botryoides*
9. Branches distinctly compressed, branching distichous or irregular; tetrasporangia in ramuli, not botryoidal 10

    10. Branching irregularly alternately distichous, rarely pinnate, with laterals usually distant; branches slightly to moderately compressed, usually over 750 µm thick; mature thallus usually 12–30 cm high .... 10. *L. elata*
    10. Branching regularly alternately pinnate, laterals closely arranged; branches strongly compressed, usually less than 700 µm thick; mature thallus usually 4–12 cm high 11

11. Thallus usually 5–18 cm high, branches 1.5–4 mm broad .... 11. *L. brongniartii*
11. Thallus usually 3–5 cm high, branches 0.5–1 mm broad .... 12. *L. distichophylla*

1. **Laurencia majuscula** (Harvey)Lucas 1935: 223. Cribb 1983: 120, pl. 37 fig. 3. Huisman 1997: 205; 2000: 171. Huisman & Walker 1990: 437. Huisman *et al.* 1990: 97. Kendrick *et al.* 1990: 48, 52. Lucas & Perrin 1947: 249. Millar & Kraft 1993: 54. Saito 1969: 149. Saito & Womersley 1974: 819, figs 1A, 6. Shepherd 1974: 27. Silva *et al.* 1996: 513. Womersley 1950: 188.
Laurencia obtusa sensu many authors, incorrect for southern Australian localities.
Laurencia obtusa var. *majuscula* Harvey 1863, synop.: xxvi.
Laurencia gracilis sensu Womersley 1950: 187.
Laurencia dendroides sensu Sonder 1880: 29.

FIG. 202, 205A

Thallus (Fig. 202A) grey red to red-purple, 5–20 cm high, much branched, relatively soft and adherent to paper, with one to several percurrent, usually bushy, axes, pyramidal to spreading; branching irregularly radial, branches terete, axes (0.7-) 1–2 mm in diameter, grading to ultimate ramuli 0.5–2 (-4) mm long and 0.2–0.5 mm in diameter; most branches less than 2 mm apart except where denuded. Holdfast discoid, 1–2 (-3) mm across, becoming stoloniferous; epilithic or epiphytic. *Structure.* Epidermal cells near apices (Fig. 205A) with convex, slightly projecting, outer walls, 15–25 µm in diameter near apices, extending to 35 (-50) µm broad and L/D 2–4 on lower axes, usually in longitudinal rows, with lateral pit-connections, *corps en cerise* present; in transverse section epidermal cells L/D 1–1.5, inner cells with intercellular spaces, but thickenings absent. Cells with discoid to elongate rhodoplasts.

Reproduction. Gametophytes dioecious. Carposporophytes with a basal fusion cell and short, branched gonimoblast with clavate terminal carposporangia 40–75 µm in diameter. Cystocarps (Fig. 202B) often clustered, sessile, subspherical to ovoid, 0.5–1 mm in diameter; pericarp ostiolate, corticated, with a slight neck. Spermatangial receptacles (Fig. 202C) single or clustered, 400–900 µm across, spermatangia borne on trichoblasts.

Tetrasporangial ramuli (Fig. 202D) simple or compound, terete, 150–300 (-500) µm in diameter and 0.2–0.8 (-2) mm long, cut off abaxially from cortical cells in parallel arrangment, tetrasporangia 70–100 µm in diameter.

Type from Rottnest I., W. Aust.; lectotype in Herb. Harvey, TCD (Alg. Aust. Exsicc. 236a).

Distribution: Widespread around Australia, usually in sheltered situations.
Widespread in the Indian Ocean (see Silva *et al.* 1996, p. 513).

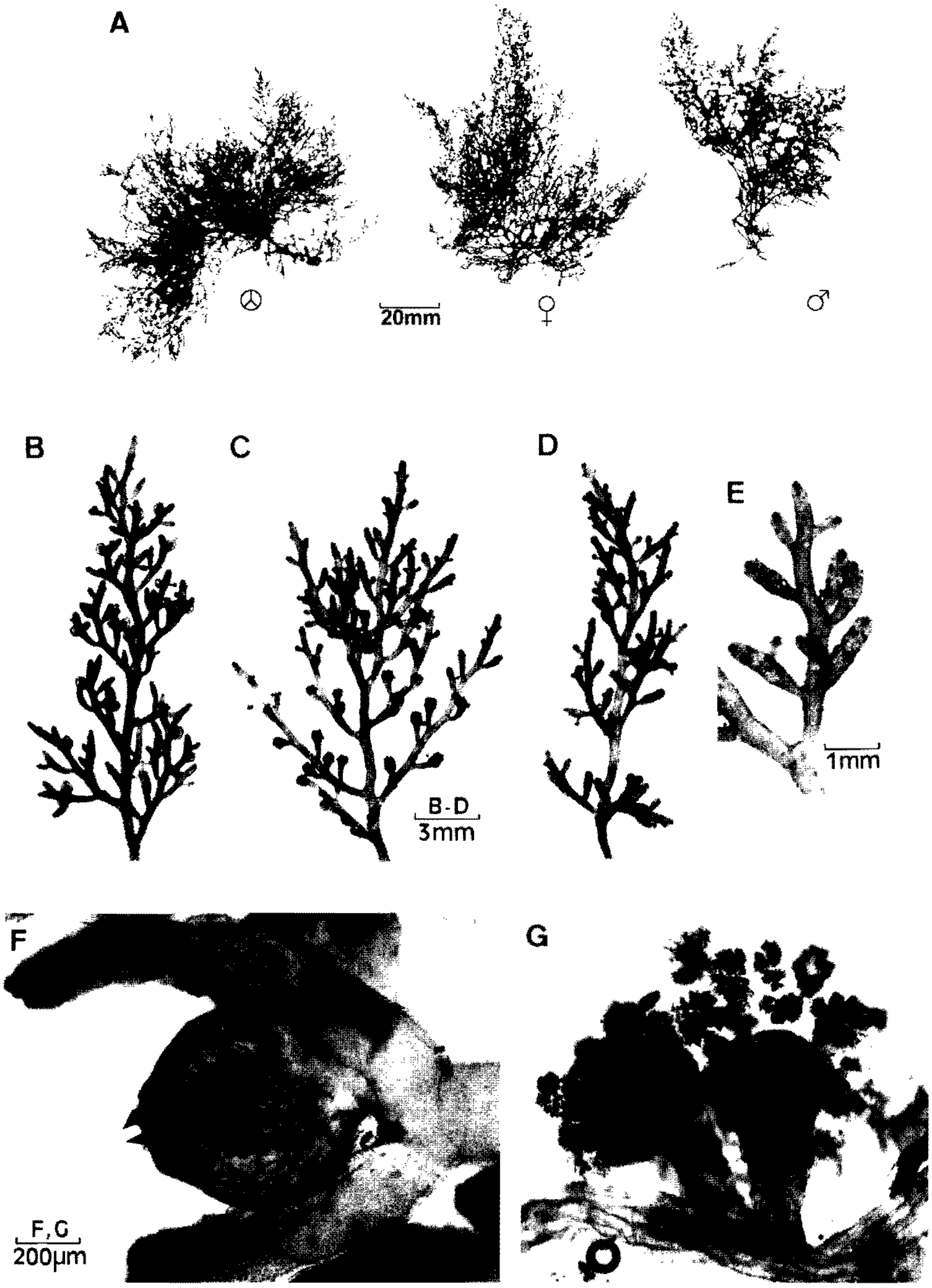

Fig. 203. *Laurencia aldingensis* (AD, A44448). **A**. Habit. **B**. Cystocarpic thallus. **C**. Spermatangial thallus. **D**, **E**. Tetrasporangial thalli. **F**. Cystocarp. **G**. Spermatangial receptacles. (**A–E**, as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

Selected specimens: Port Denison, W. Aust., drift (*Kraft*, 14.xii.1971; AD, A42016). Strickland Bay, Rottnest I., W. Aust., on *Sargassum*, reef surface (*Womersley*, 5.ix.1979; AD, A51084). D'Entrecasteaux Reef, S. Aust., 15–20 m deep, epiphytic (*Shepherd*, 27.iii.1980; AD, A52160). Coffin Bay, S. Aust., upper sublittoral (*Womersley*, 24.ii.1959; AD, A22565. Billy Lights Point, Port Lincoln, S. Aust., uppermost sublittoral (*Womersley*, 12.i.1984; AD, A54734—"Marine Algae of southern Australia" No. 316). Marino, S. Aust., drift (*Womersley*, 23.i.1972; AD, A41262). Aldinga, S. Aust., reef pools (*Womersley*, 16.i.1972; AD, A41231). American R. inlet, Kangaroo I., S. Aust., on shells, 2–3 m deep (*Saito*, 7.iv.1972; AD, A41966). Flinders, Western Port, Vic., drift (*Sinkora* A1731, 16.xi.1972; AD, A43905). Lady Barron, Flinders I., Bass Strait (*Perrin*, 12.vi.1949; AD, A50206). Crayfish Point, Taroona, Tas., 5 m deep (*Brown*, 24.x.1982; AD, A55773).

Laurencia majuscula is variable in habit, with some specimens being placed as var. *elegans* (Lucas)Saito & Womersley (1974, p. 821).

2. **Laurencia aldingensis** Saito & Womersley 1974: 821, figs 1B–D, 7.

FIGS 203, 205B

Thallus (Fig. 203A) medium red, often greenish below, tufted, 2–8 (-10) cm high and wide, cartilaginous, branching irregularly radial, dense, lower branches entangled, upper longer branches free, terete, slender, with fairly uniform diameter of 400–600 µm, ultimate branchlets 1–2 mm long, 1–3 mm apart. Attachment to host and itself by small pads and recurved branchlets; epiphytic on *Sargassum* and *Cystoseira*. *Structure*. Epidermal cells compact, outer walls (Fig. 205B) slightly convex near branch apices, isodiametric and 15–25 µm across near apices, 30–50 µm broad and L/D (1.5-) 2–3 (-4) below, with longitudinal secondary pit-connections; epidermal cells isodiametric in section, with *corps en cerise*, inner cells without lenticular thickenings. Cells uni- or multinucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a slight basal fusion cell and short branched gonimoblast with clavate carposporangia 30–55 µm in diameter. Cystocarps (Fig. 203B, F) borne just below apices of branchlets, ovoid or slightly urceolate, sessile, 500–800 µm in diameter, broad based or slightly constricted; pericarp ostiolate with a slight neck, several cells thick. Spermatangia (Fig. 203C, G) borne on trichoblasts in terminal pyriform branchlets 400–800 (-1000) µm across.

Tetrasporangia (Fig. 203D, E) borne in slightly broader, terete, simple or branched ramuli 300–500 (-600) µm in diameter and 0.7–1.5 (-2) mm long, in parallel arrangement, cut off adaxially or abaxially from outer part of pericentral cells, 80–120 µm in diameter.

Type from Aldinga reef, S. Aust., on *Sargassum decipiens* in shallow pools near reef edge (*Womersley*, 25.xi.1973); holotype and isotypes in AD, A44448—"Marine Algae of southern Australia" No. 167.

Distribution: Venus Bay to Aldinga, S. Australia; probably more widespread.

Selected specimens: Venus Bay, S. Aust., upper sublittoral (*Womersley*, 13.ii.1954; AD, A19482). Port Broughton, S. Aust., in deeper hole (*Womersley*, 1.xii.1963; AD, A27045). Port Turton, S. Aust., 3–5 m deep on piles (*Kraft*; 17.ix.1973; AD, A44016). Aldinga, S. Aust., outer reef pools (*Womersley*, 16.i.1972; Ad, A41230).

Saito & Womersley (1974, p. 823) compared *L. aldingensis* to *L. intricata* Lamouroux from the Antilles, suggesting that while probably distinct, further detailed comparisons are needed. Relationships with other slender species (e.g. *L. filiformis* f. *filiformis*) also need further study.

3. **Laurencia forsteri** (Mertens *ex* Turner)Greville 1830: lii. J. Agardh 1852: 744 (in part); 1876: 645. De Toni 1896: 227; 1903: 779. De Toni & Forti 1923: 36. Ducker *et al.* 1977: 87. Guiler 1952: 105. Harvey 1849a: 85; 1855a: 544; 1859b: 306(?); 1863, synop. xxv. Hooker & Harvey 1847: 401. Huisman & Walker 1990: 437. Kützing 1849: 854. Lucas 1909: 38 (in part); 1929a: 21; 1929b: 50. Lucas & Perrin 1947: 247 (in part). Saito & Womersley 1974: 823 figs 1E, 8. Reinbold 1899: 47? Saenger 1974: 81. Shepherd & Womersley 1971: 166. Silva *et al.* 1996: 511. Sonder 1848: 178 (f. *vera* only); 1853: 694; 1855: 523; 1880: 29. Tate 1882a: 22. Tepper 1883: 66. Tisdall 1898: 512. Wilson 1892: 169. Yamada 1931: 213, pl. 13a.

Fucus forsteri Mertens *ex* Turner 1809: 16, pl. 77.

Chondria forsteri (Mertens *ex* Turner)C. Agardh 1823: 343; 1824: 203.

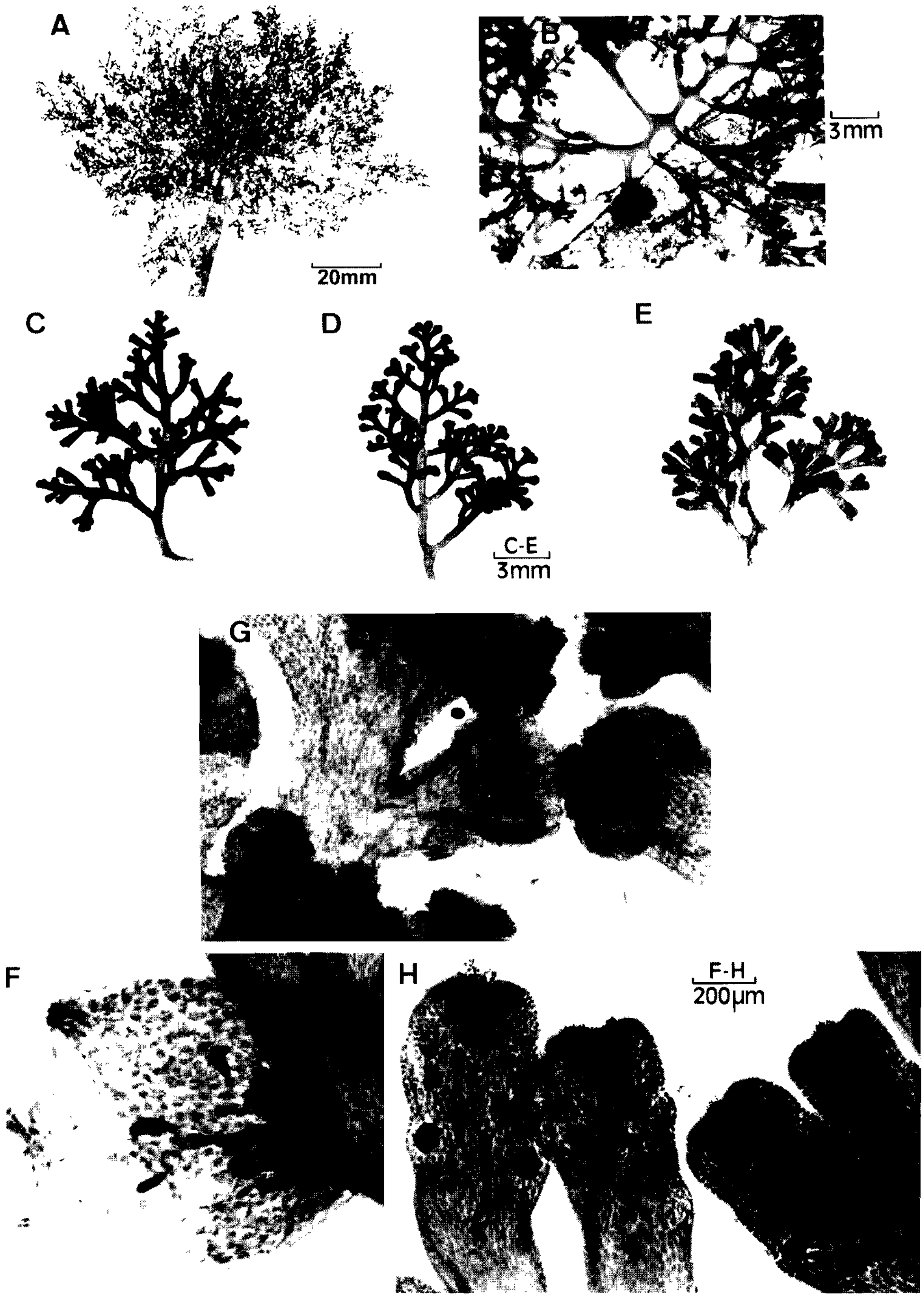

Fig. 204. *Laurencia forsteri* (**A–E**, AD, A41855; **F–H**, AD, A44323). **A**. Habit, on *Posidonia*. **B**. Base of thallus with discoid holdfast, on *Posidonia*. **C**. Cystocarpic thallus. **D**. Spermatangial thallus. **E**. Tetrasporangial thallus. **F**. Cystocarp. **G**. Spermatangial receptacles. **H**. Tetrasporangial branches. (**B–E**, as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

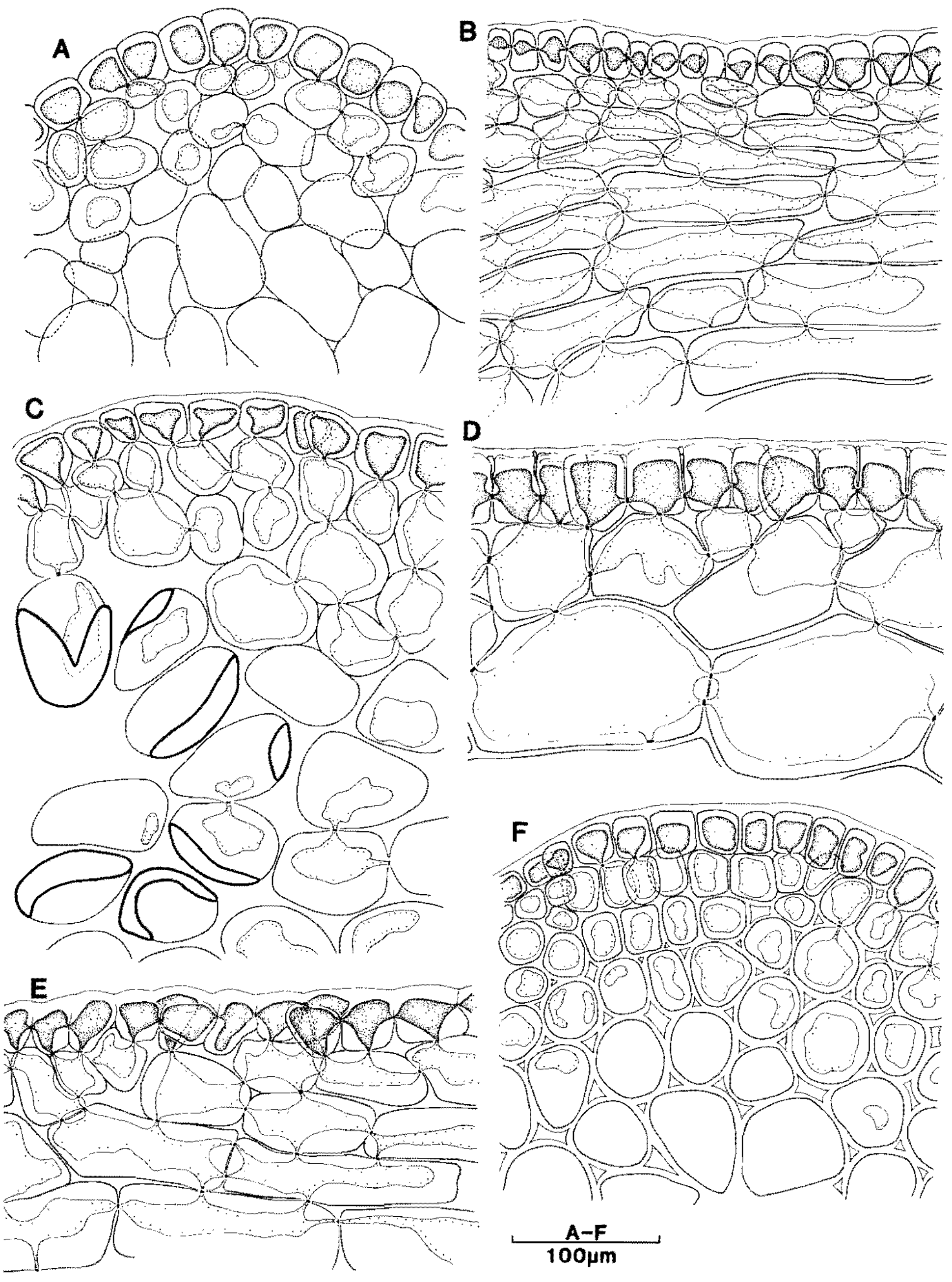

Fig. 205. A. *Laurencia majuscula* (AD, A41231). Transverse section. **B.** *Laurencia aldingensis* (AD, A44448). Longitudinal section. **C.** *Laurencia forsteri* (AD, A41855). Transverse section with lenticular thickenings. **D.** *Laurencia clavata* (AD, A42231). Longitudinal section. **E.** *Laurencia shepherdii* (AD, A42795). Longitudinal section. **F.** *Laurencia arbuscula* (AD, A42244). Transverse section. (All as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

FIGS 204, 205C

Thallus (Fig. 204A) red to red-brown, moderately soft, 2–6 (-8) cm high, slender, spreading with radial, terete branches at wide angles, mostly 2–5 mm apart; lower branches 0.5–1 mm in diameter, decreasing to 300–500 µm in branchlets. Holdfast (Fig. 204B) flat, discoid, 1–3 mm across; epiphytic on *Posidonia*, occasionally *Amphibolis*. *Structure.* Epidermal cells near apices (Fig. 205C) polygonal to slightly elongate, 15–20 µm across, enlarging below to 20–30 (-50) µm broad and L/D 3–5 (-8), with secondary pit-connections and *corps en cerise*; lenticular thickenings (Fig. 205C) usually abundant in inner cortical cells. Cells uninucleate, multinucleate in larger cells; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a small basal fusion cell and short branched gonimoblast bearing clavate carposporangia 30–60 µm in diameter. Cystocarps (Fig. 204C, F) sessile, globular and urceolate, with broad, slightly constricted bases, (300-) 500–1100 µm in diameter; pericarp ostiolate, 2–3 cells thick, with a distinct neck 100–150 µm high. Spermatangial receptacles (Fig. 204D) terminating clavate to pyriform branchlets, 300–700 µm across, spermatangia borne on trichoblasts.

Tetrasporangia (Fig. 204E, H) in simple or compound, clavate, branchlets 400–700 µm broad and 0.5–1 (-2) mm long, in parallel arrangement and cut off abaxially, 120–220 µm in diameter.

Type from "Coast of Australia" (probably King George Sound, W. Aust.), *Menzies*; holotype in BM.

Distribution: Houtmann Abrolhos, W. Aust., to Wilson Prom., Vic. (*Sonder*) and N Tasmania.

Selected specimens: Safety Bay, W. Aust., on *Posidonia sinuosa*, drift (*Cribb 68.4*, 14.viii.1950; AD, A13974). Lucky Bay, Cape LeGrand, W. Aust., on *Posidonia australis*, upper sublittoral (*Womersley*, 4.x.1979; AD, A51163). Coffin Bay, S. Aust., on *P. sinuosa*, 2.5 m deep (*Womersley*, 4.xii.1975; AD, A46937). Tiparra Reef, S. Aust., on *P. sinuosa*, 11 m deep (*Shepherd*, 29.i.1972; AD, A41853). Aldinga, S. Aust., on *P. sinuosa*, upper sublittoral (*Saito*, 27.ii.1972; AD, A41855); on *P. sinuosa*, 5–6 m deep (*Johnson*, 7.vii.1973; AD, A44323—"Marine Algae of southern Australia" No. 164); and on *Amphibolis* leaf (*Shepley*, 13.x.1954; AD, A20189). Second Valley, S. Aust., on *P. sinuosa*, 3–4 m deep (*Womersley*, 19.i.1973; AD, A42961). Emu Bay, Kangaroo I., S. Aust., on *P. sinuosa* (*Womersley*, 18.i.1945; AD, A2686). Muston, American R. inlet, Kangaroo I., S. Aust., on *P. australis*, 2–3 m deep (*Kraft*, 12.iv.1973; AD, A43712). Adelaide Bay, Flinders I., Bass Strait, on *Posidonia*, 0–2 m deep (*Blackman*, 30.i.1978; AD, A49235). Low Head, Tas., on *P. australis* (*Perrin*, 11.ix.1937; AD, A8993).

Laurencia forsteri is a distinctive species, confined largely to the leaves of *Posidonia* (occasionally *Amphibolis*) in conditions of moderate water movement. Probably some references to *L. forsteri* should apply to forms of *L. filiformis*.

The West Australian *L. cymosa* Kützing (1865, p. 21, pl. 57c, d), type in L, 941, 119 ...121 (a Preiss specimen), may be identical with *L. forsteri*. They are very similar in habit, and the comment of Saito & Womersley (1974, p. 825) that *L. cymosa* "completely lacks lenticular thickenings" is doubtfully true since some specimens (e.g. "Marine Algae of southern Australia" No. 213), distributed as *L. cymosa*, do have abundant wall thickenings.

4. **Laurencia clavata** Sonder 1853: 694. Falkenberg 1901: 251. Huisman & Walker 1990: 436. Nam & Choi 2001: 286, figs 1–20. Saenger 1974: 81. Saito & Womersley 1974: 825, figs 2A, B, 9. Shepherd & Womersley 1970: 135. Silva *et al.* 1996: 505. Womersley 1950: 187; 1966: 155. Yamada 1931: 228.
Chondria clavata (Sonder)Harvey 1862a: pl. 189; 1863, synop.: xviii.
Chondria clavata β *dendroides* Harvey 1863, synop.: xviii.
Chondria corynephora Harvey 1855a: 539. J. Agardh 1863: 812. Tisdall 1898: 512.
Corynecladia clavata (Sonder)J. Agardh 1876: 643. De Toni 1903: 810. Lucas 1909: 39. Lucas & Perrin 1947: 250. Sonder 1880: 29. Tate 1882a: 21.
Corallopsis australasica Sonder 1853: 687; 1855: 522. Kützing 1869: 10, pl. 28.
Corynecladia umbellata J. Agardh 1876: 643, *nom. illegit.* De Toni 1903: 810. De Toni & Forti 1923: 37. Guiler 1952: 105. Lucas 1909: 39; 1929b: 50. Lucas & Perrin 1947: 250. May 1965: 391. Reinbold 1897: 55. Tisdall 1898: 511. Wilson 1892: 169.
Corynecladia australasica (Sonder)Sonder 1880: 29. Tate 1882a: 21. Tisdall 1898: 511.

FIGS 205D, 206

Thallus (Fig. 206A) medium to dark red, 3–15 cm high, with a main axis irregularly radially branched, young branches soft and older branches drying cartilaginous, upper branches of elongate-clavate segments (1-) 1.5–2 mm in diameter and 1–1.5 (-3) cm long, di- to polychotomous for 3–4 orders, segments basally with a narrow pedicel; older thalli (Fig. 206A) with terete axes 2–3 mm in diameter, often denuded below or with subverticillate clusters (Fig. 206B) of branches. Holdfast discoid, 2–6 mm across, bearing 1 to several axes; epilithic. *Structure*. Epidermal cells (Fig. 205D) rounded to polygonal near apices, 20–50 μm across, scarcely elongating in older branches, with longitudinal secondary pit-connections; in transverse section epidermal cells isodiametric, intercellular spaces present between cortical cells, lenticular thickenings absent; *corps en cerise* present in epidermal cells. Cells with discoid rhodoplasts, chained in larger cells.

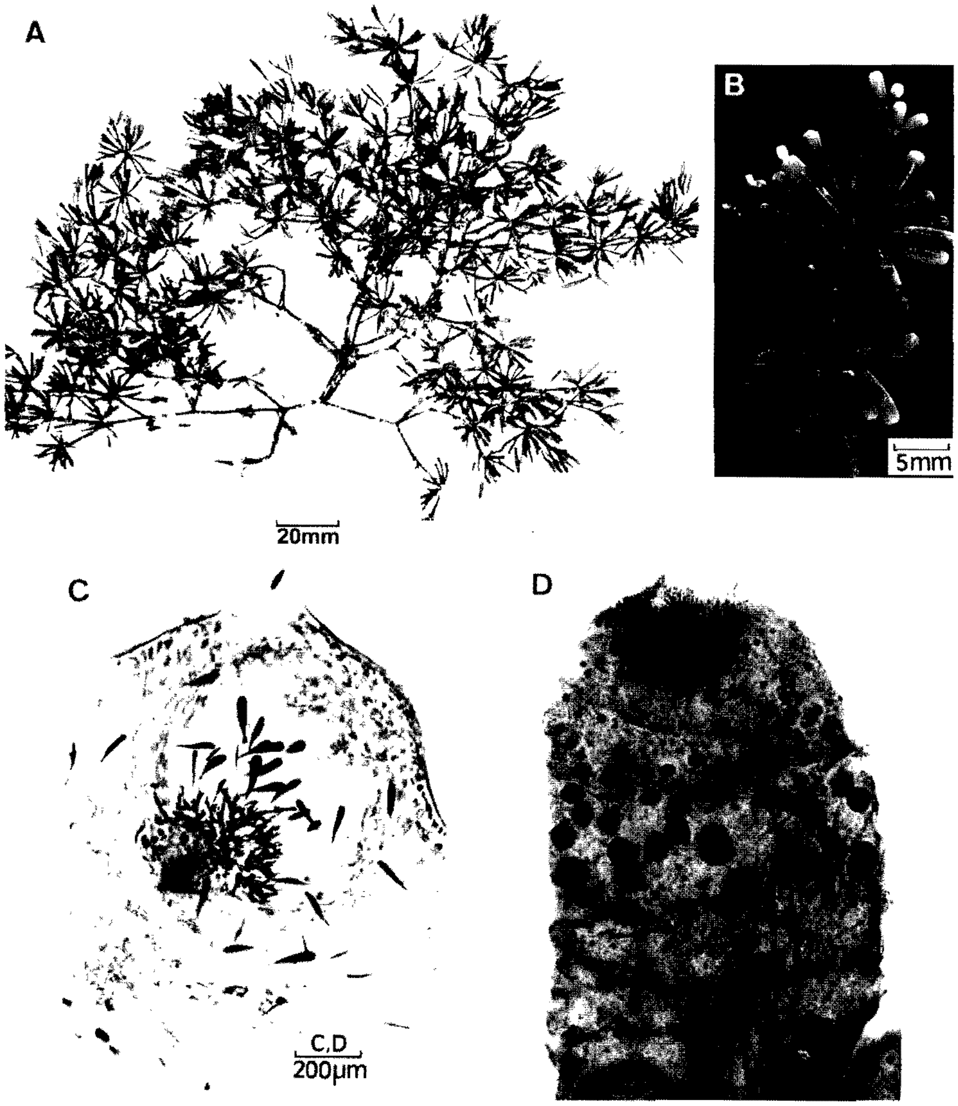

Fig. 206. *Laurencia clavata* (**A**, AD, A23032; **B**, AD, A42231; **C**, **D**, AD, A42453). **A**. Habit of an older plant. **B**. Clustered laterals on an older plant. **C**. Section of a cystocarp. **D**. Branch with tetrasporangia. (**A**, **B** as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a basal fusion cell and short, branched gonimoblast bearing clavate carposporangia 30–60 µm in diameter. Cystocarps (Fig. 206C) sessile, broad-based and not constricted, conical to hemispherical, (0.5-) 0.7–1.5 mm in basal diameter; pericarp ostiolate, 6–8 cells thick. Spermatangial thalli with short, clavate to pyriform, receptacles 1–2 mm across, spermatangia borne on trichoblasts.

Tetrasporangia (Fig. 206D) borne in simple clavate branchlets, in parallel arrangement, cut off abaxially from outer cells, 80–110 µm in diameter.

Type from LeFevre Pen., S. Aust. (*Mueller*); lectotype in MEL, 1006926, isolectotypes 1006927, 1006928.

Distribution: Port Denison, W. Aust., to Walkerville, Vic. and around Tasmania.

Doubtfully elsewhere (see references in Silva *et al.* 1996, p. 505).

Selected specimens: Port Denison, W. Aust., drift (*Kraft*, 14.xii.1971; AD, A42015). Safety Bay, W. Aust., drift (*Womersley*, 23.viii.1947; AD, A5819). Nuyts Reef, S. Aust., 28–30 m deep (*Shepherd*, 26.iii.1980; AD, A52325). Port Turton, S. Aust., on piles & rock, 3–5 m deep (*Kraft*, 17.ix.1973; AD, A44015). Port Noarlunga, S. Aust., 6 m deep (*Kraft*, 15.iii.1973; AD, A43046). Shell Rock, West I., S. Aust., 6–8 m deep (*Shepherd*, 28.xii.1965; AD, A30426). Port Elliot, S. Aust., drift (*Womersley*, 10.viii.1957; AD, A21124). South West R., Kangaroo I., S. Aust., 6 m deep (*Mitchell*, 24.viii.1963; AD, A26834). Little Rocky Pt, Eastern Cove, Kangaroo I., S. Aust., 2–4 m deep (*Womersley*, 22.viii.1963; AD, A26910). American R. inlet, Kangaroo I., S. Aust., 2–3 m deep near Muston (*Kraft*, 17.vii.1972; AD, A42453). Margaret Brock Reef, Cape Jaffa, S. Aust., 3–5 m deep (*R. Lewis*, 29.xi.1972; AD, A42899). Robe, S. Aust., drift (*Womersley*, 15.iv.1959; AD, A23032). Cape Lannes, S. Aust., drift (*Womersley*, 14.v.1972; AD, A42231). Stinky Bay, Nora Creina, S. Aust., drift (*Womersley*, 19.viii.1957; AD, A21287). Lawrence Rock, Portland, Vic., 8–11 m deep (*Larkum*, 2.ix.1971; AD, A39635). Walkerville, Vic., drift (*Sinkora* A1828, 5.xii.1973; AD, A53525). Sarah I., Bathurst Ch., SW Tas., 2–5 m deep (*Edgar*, 11.iii.1995; AD, A64247). Safety Cove, Port Arthur, Tas., 10 m deep (AIMS-NCI; Q66C-3832-I, 1.iii.1990; AD, A60377).

Laurencia clavata certainly needs detailed study as to its placement in *Laurencia*, especially as to the origin of tetrasporangia (which appear to be pit-connected to outer cortical cells). It is a distinctive species morphologically with the narrow pedicels to the relatively broad branchlets and the broadly conical cystocarps which taper from the broad base upwards.

5. **Laurencia shepherdii** Saito & Womersley 1974: 826, figs 2C, D, 10. Huisman *et al.* 1990: 97. Kendrick *et al.* 1990: 52. Shepherd & Womersley 1981: 369. Silva *et al.* 1996: 520.

FIGS 205E, 207

Thallus (Fig. 207A) red to red-purple, soft, radially branched, usually basally denuded, branches terete, laterals irregular to subopposite; axes 1.5–3 mm in diameter, decreasing to ramuli 0.7–1 (-1.5) mm in diameter and 1–3 mm long, slightly basally constricted and with truncate apices. Holdfast discoid, 3–5 mm across; epilithic or occasionally epiphytic on seagrasses or coralline algae. *Structure.* Epidermal cells rounded and 25–50 µm across near apices, elongating to L/D 2 on lower axes, with secondary pit-connections (Fig. 205E) and *corps en cerise*, with frequent intercellular spaces between cortical cells; lenticular thickenings absent. Cells with discoid rhodoplasts, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia 35–70 µm in diameter. Cystocarps (Fig. 207C, E) sessile, broad-based, conical to ovoid 0.8–1 (-1.2) mm in diameter; pericarp ostiolate, 5–6 cells thick. Spermatangial receptacles (Fig. 207D, F) on dense, short ramuli 1–1.2 mm in diameter, with broad apices.

Tetrasporangia in simple to clustered ramuli (Fig. 207D, G) 0.7–1 mm in diameter and 1–2 mm long, often subdistichous or subtristichous when young, in parallel arrangement, cut off abaxially, 80–130 µm in diameter.

Type from Elliston, S. Aust., 1–2 m deep inside bar (*Shepherd*, 28.x.1972); holotype in AD, A42795. Isotypes in "Marine Algae of southern Australia" No. 138.

Distribution: Shark Bay (Kendrick *et al.* 1990: 52), W. Aust., to San Remo, Victoria.

Selected specimens: Whitford Beach, Perth, W. Aust., 6 m deep on off shore reef (*Cook*, 20.viii.1979; AD, A50586). Hamelin Bay, W. Aust., drift (*Womersley*, 1.ix.1979; AD, A50601). Port

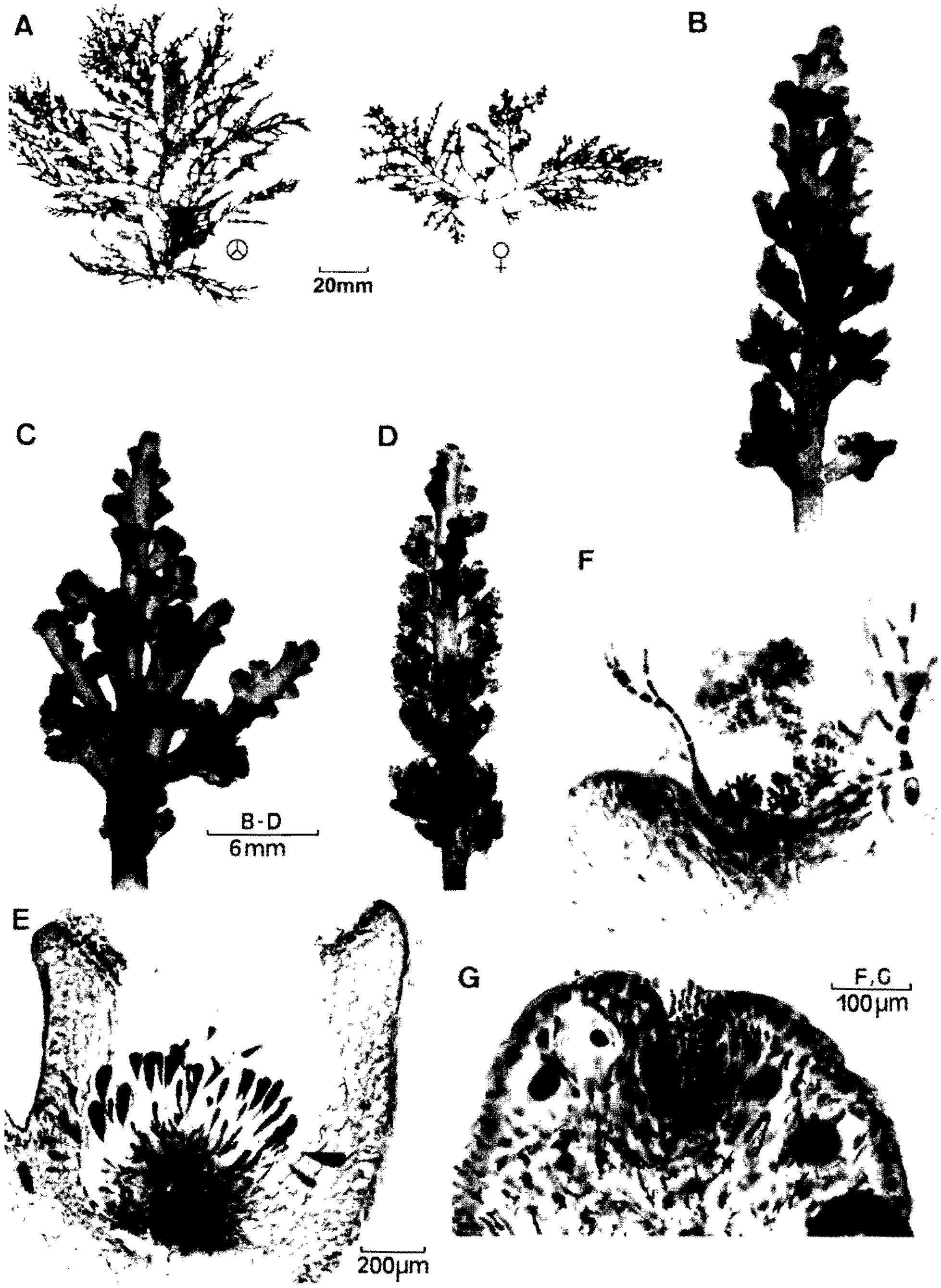

Fig. 207. *Laurencia shepherdii* (AD, A42795). **A.** Habit, the holotype. **B.** Cystocarpic branch. **C.** Spermatangial branch. **D.** Tetrasporangial branch. **E.** Section of cystocarp. **F.** Section of spermatangial receptacle. **G.** Section of tetrasporangial ramulus. (**A–D** as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

Turton, S. Aust., on piles and rock 3–5 m deep (*Kraft*, 17.ix.1973; AD, A69060). Investigator Strait, S. Aust., (*Davey*; AD, A1249). Off Port Adelaide, S. Aust., on wreck of "Norma", 12 m deep (*F. Mitchell*, 10.xi.1958; AD, A22006). Marino, S. Aust., drift (*Womersley*, 26.x.1975; AD, A46645). Off Aldinga, S. Aust., 3–4 m deep (*R. Lewis*, 7.xii.1972; AD, A42894). Victor Harbor, S. Aust., sublittoral (*Clarke & Engler*, 8.v.1979; AD, A63183). South West R., Kangaroo I., S. Aust., 6 m deep (*F. Mitchell*, 24.viii.1963; AD, A26886). Rocky Point, Kangaroo I., drift (*Womersley*, 26.viii.1950; AD, A13335). Cape Lannes, S. Aust., drift (*Womersley*, 7.x.1972; AD, A42778). Gardens Beach, Portland, Vic., drift (*Beauglehole*, 11.viii.1954; AD, A21546). Point Lonsdale, Vic., drift (*Sinkora* A1184, 8.xi.1970; AD, A41344). Crawfish Rock Westernport Bay, Vic., 0 m deep (*Watson*, 17.xi.1974; AD, A46221). San Remo, Vic., drift (*Sinkora* A696, 11.vii.1970; AD, A41359).

Laurencia shepherdii is a shallow sublittoral species on rough-water to sheltered coasts, characterised by habit, with frequent subopposite laterals, soft texture with frequent intercellular cortical spaces, and broad-based cystocarps.

6. **Laurencia arbuscula** Sonder 1845: 55; 1848: 177; 1880: 29. J. Agardh 1852: 769. Cordiero-Marino *et al.* 1983: 29, figs 1–29. Harvey 1849a: 83; 1855a: 544; 1863, synop.: xxvi. Huisman & Walker 1990: 436. Kützing 1849: 855; 1865: 25, pl. 72a, b. Saito & Womersley 1974: 828, figs 3A, 11, 12. Silva *et al.* 1996: 503. Tate 1882a: 22. Tisdall 1898: 512. Wynne 1998: 43.

Laurencia botryoides var. *minor* Harvey 1863, synop.: xxvi.

Laurencia obtusa var. *regia* Harvey 1863, synop. xxvi.

Laurencia regia (Harvey)Yamada 1931: 234, pl. 22a.

Laurencia rigida sensu Lucas 1909: 38. Levring 1946: 226(?). [NON J. Agardh 1876: 651.]

FIGS 205F, 208

Thallus (Fig. 208A) dark red-brown to red, firm, cartilaginous, 5–15 cm high, with one to several long axes developing long laterals, radially branched and usually pyramidal; all branches terete, with abundant short ramuli throughout, main axes (0.5-) 0.7–1.5 mm in diameter, decreasing to 0.7–1 mm in lateral branches and to 300–500 (-800) µm in diameter in the short ramuli. Holdfast discoid, with numerous axes, 2–5 mm across; epilithic. *Structure*. Epidermal cells (Fig. 205F) compact, isodiametric and (15-) 20–35 µm across; in surface view, elongating slightly below to L/D 1.5–2 (-3), with secondary pit-connections and *corps en cerise*; inner cortical cells compact, without lenticular thickenings. Cells with discoid rhodoplasts, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a basal fusion cell and short branched gonimoblast with clavate terminal carposporangia 30–55 µm in diameter. Cystocarps (Fig. 208B) on short stalks or subsessile, broad-based, ovoid-conical, 600–1000 µm in diameter; pericarp ostiolate, with no or a slight neck. Spermatangial receptacles (Fig. 208C) in summit of shortly clavate ramuli 500–900 µm across, spermatangia borne on trichoblasts.

Tetrasporangia in short, branched, often fastigiate, clusters of ramuli (Fig. 208D), each 300–600 (-800) µm in diameter and (0.5-) 3–4 mm long, cut off abaxially in parallel arrangement, 80–130 µm in diameter.

Type from W. Aust. (*Preiss*), probably near Fremantle; holotype in MEL, 1006897.

Distribution: Rottnest I., W. Aust., to Walkerville, Vic., and N Tasmania.

Subtropical western Atlantic (Wynne 1998, p. 43). Brazil (Cordiero-Marino *et al.* 1983).

Selected specimens: Point Valliant, Two People Bay, W. Aust., mid eulittoral pool (*Womersley*, 30.viii.1979; AD, A50973). Head of Great Australian Bight, S. Aust., low eulittoral (*Womersley*, 4.ii.1954; AD, A19151). Cape Carnot, S. Aust., mid eulittoral pool (*Womersley*, 26.viii.1975; AD, A46499). Crinolin Point, Coffin Bay, S. Aust., uppermost sublittoral (*Womersley*, 30.xi.1975; AD, A46813— "Marine Algae of southern Australia" No. 168). Marino, S. Aust., low eulittoral (*Womersley*, 13.viii.1972; AD, A42609). Petrel Cove, Victor Harbor, S. Aust., low eulittoral (*Saito*, 6.ii.1972; AD, A41951). Cape Jervis, S. Aust., just sublittoral (*Womersley*, 18.i.1973; AD, A42962). Vivonne Bay, Kangaroo I., S. Asut., uppermost sublittoral (*Kraft*, 6.iv.1972; AD, A42432). Robe, S. Aust., very low eulittoral, slipway reef (*Womersley*, 7.x.1972; AD, A42776). Cape Lannes, S. Aust., lower eulittoral pools (*Womersley*, 14.v.1972; AD, A42244). Port MacDonnell, S. Aust., uppermost sublittoral at "Wagon Wheels" (*Womersley*, 23.iv.2000; AD, A68521). Little Beach, Discovery Bay, Vic., lower eulittoral (*Beauglehole*, 14.i.1950; AD, A15612). Shoreham, Western Port, Vic., edge of rockshelf

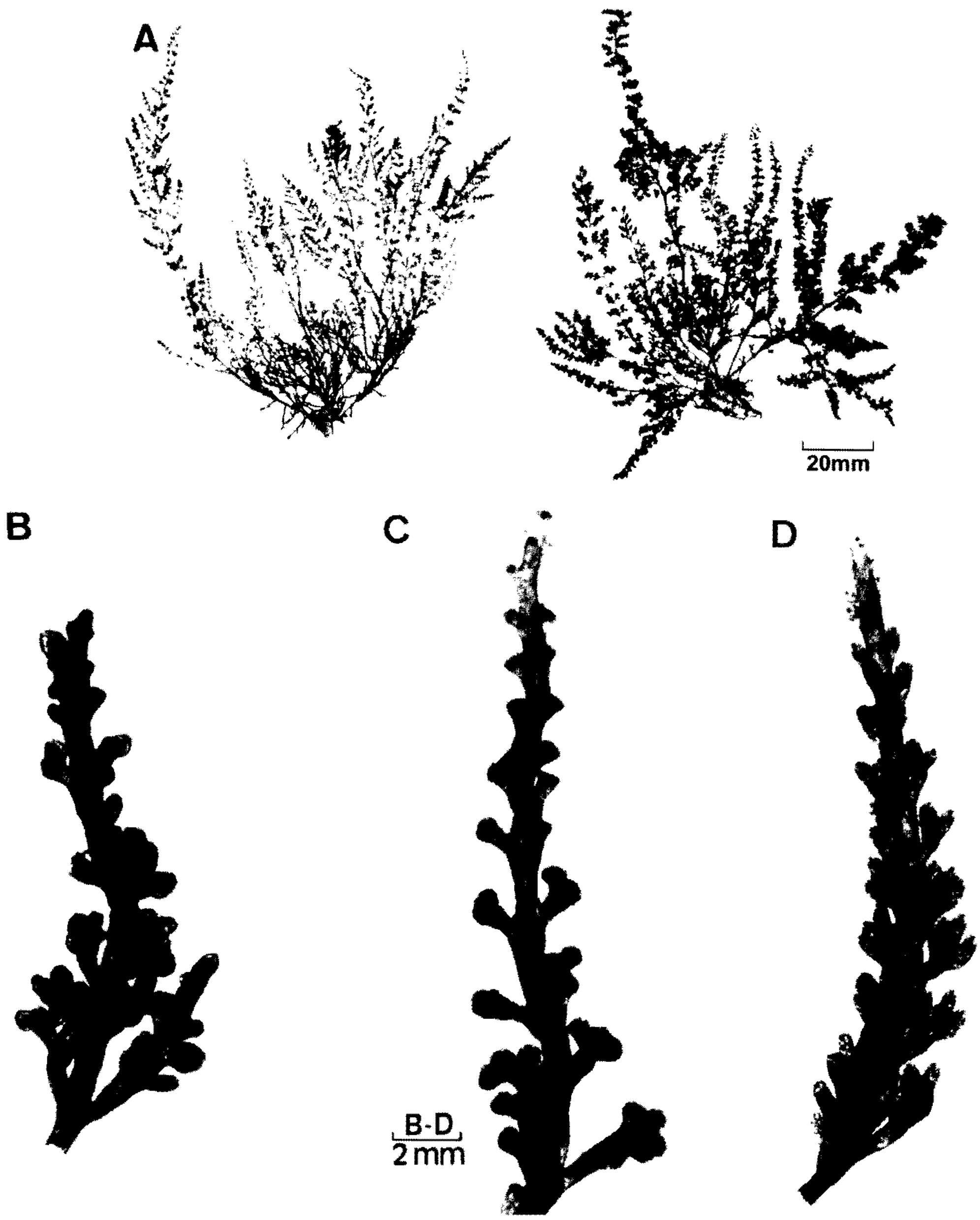

Fig. 208. *Laurencia arbuscula* (**A**, AD, A46813; **B–D**, AD, A42244). **A**. Habit. **B**. Cystocarpic branch. **C**. Spermatangial branch. **D**. Tetrasporangial branch. (**B–D**, as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

(*Sinkora* A1363, 29.x.1971; AD, A41348). San Remo, Vic., in deep pool (*Sinkora* A1900, 27.xi.1974; AD, A62732). Cape Liptrap, Vic., near low tide level (*Sinkora* A2200, 18.x.1975; AD, A48433). Walkerville, Vic., lower eulittoral (*Sinkora* A2386, 23.ii.1978; AD, A53577). West Head, Stanley, Tas., low eulittoral (*Bennett*, 30.i.1955; AD, A20585).

Laurencia arbuscula is a slender but rigid species, growing near to low tide level on somewhat sheltered coasts. In general form it resembles *L. tasmanica* but is considerably more slender; further detailed comparisons however are warranted.

7. **Laurencia tasmanica** Hooker & Harvey *ex* Harvey 1849a: 84; 1855a: 545; 1859b: 307; 1863, synop.: xxv. J. Agardh 1852: 755; 1876: 654. De Toni 1903: 795. Guiler 1952: 105. King *et al.*. 1971: 124. Lucas 1909: 39; 1929a: 21; 1929b: 50. Lucas & Perrin 1947: 249. Reinbold 1899: 47? Saito & Womersley 1974: 830, figs 3B, 13. Silva *et al.* 1996: 521. Sonder 1880: 30. Tate 1882a: 22. Womersley 1950: 188; 1966: 155. Yamada 1931: 234, pl. 21.

Laurencia papillosa sensu Hooker & Harvey 1847: 401 [NON *L. papillosa* (L. Agardh)Greville 1830: lii].

Laurencia excelsa Kützing 1865: 23, pl. 63c, d.

Laurencia botryoides sensu (in part) Womersley 1950: 187.

FIGS 209, 214A

Thallus (Fig. 209A) medium to dark brown-red, 10–25 cm high, robust, drying cartilaginous with one to several percurrent axes, pyramidal in outline, irregularly radially branched with clustered branched ramuli, branches terete; axes 2–3 mm in diameter, often denuded below, laterals 1–1.5 mm in diameter, decreasing to ultimate ramuli 0.5–1 (-2) mm long and (0.5-) 0.7–1 mm in diameter. Holdfast discoid, becoming stoloniferous; epilithic. *Structure*. Epidermal cells (Fig. 214A) isodiametric and 10–15 (-18) µm across near apices, enlarging to 15–30 µm broad and L/D 2–4 (-5) in older parts, with secondary pit-connections and *corps en cerise*; cortical cells compact, without lenticular thickenings. Cells with discoid rhodoplasts.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a basal fusion cell and much-branched gonimoblast with clavate terminal carposporangia 20–45 µm in diameter. Cystocarps (Fig. 209B) sessile, broad based or slightly constricted, ovoid, 600–1200 µm in diameter; pericarp ostiolate, without a neck, 5–6 cells thick. Spermatangial receptacles (Fig. 209C) ovoid to broadly clavate, 800–1200 (-1500) µm across; spermatangia on trichoblasts.

Tetrasporangial ramuli (Fig. 209D) simple, in branched clusters, clavate, 1–3 mm long and 0.5–1 mm broad, cut off abaxially in parallel arrangement, 100–140 µm in diameter.

Type from Tasmania (*Gunn*), probably near Georgetown; holotype in BM.

Distribution: Capel Beach, W. Aust., and American R. inlet, Kangaroo I., S. Aust., to San Remo, Vic., and around Tasmania.

Selected specimens: Capel Beach, W. Aust., at low water mark (*Royce* 362, 17.ix.1949; AD, A14164). Ballast Head, Kangaroo I., S. Aust., low eulittoral (*Womersley*, 31.x.1947; AD, A6109). Pelican Lagoon, American R. inlet, Kangaroo I., S. Aust., upper sublittoral (*Womersley*, 28.viii.1948; AD, A8641). Gardens Beach, Portland, Vic., drift (*Beauglehole*, 11.viii.1951; AD, A21551). Portarlington, Port Phillip Bay, Vic., in shallow water (*Sinkora* A1479, 29.xi.1971; AD, A41350). Point Lonsdale, Vic., in rock pools (*Sinkora* A925, 8.xi.1970; AD, A41338). San Remo, Vic., drift (*Sinkora* A479, 14.vi.1970; AD, A41355 and *Sinkora* A2004, 27.xi.1974; AD, A62743 and MEL, 2010979). Crawfish Rock, Westernport Bay, Vic., 0–3 m deep (*Watson*, 15.ix.1968; AD, A32774). Rocky Cape, NW Tas., in lower eulittoral pools (*Womersley*, 17.x.1982; AD, A55549). Low Head, Tas. (*Perrin*, 11.ix.1937; AD, A8991). Currie R., Tas. (*Perrin*, Aug. 1937; AD, A8992). Musselroe Bay, NE Tas. (*Perrin*, Aug. 1940; AD, A8990). Satellite I., D'Entrecasteau Ch., Tas., 1 m deep (*Shepherd*, 18.ii.1972; AD, A41518).

Laurencia tasmanica needs detailed study from fresh material; the above description is based on dried specimens. Relationships between the robust *L. tasmanica* and the slender but similar *L. arbuscula* also merit further studies.

8. **Laurencia filiformis** (C. Agardh)Montagne 1845: 125. J. Agardh 1852: 745; 1876: 644. De Toni 1903: 779. Ducker *et al.* 1977: 87. Fuhrer *et al.* 1981: pl. 87. Guiler 1952: 105. Harvey 1849a: 84; 1859b: 307; 1863, synop.: xxv. Huisman 1997: 205. Huisman & Walker 1990: 437. Huisman *et al.* 1990: 97. Kendrick *et al.* 1990: 52. Kützing 1849: 853. Levring 1946: 226. Lucas 1909: 38; 1929a: 21; 1929b: 50. Lucas & Perrin 1947: 247. May 1981: 342. Millar & Kraft 1993: 54? Reinbold 1897: 55. Saito & Womersley 1974: 832, figs 3C, D, 14–16. Shepherd & Womersley 1970: 135; 1981: 368. Silva *et al.* 1996: 508. Sonder 1853: 694; 1880: 29. Tate 1882a: 22. Womersley 1966: 155. Wynne 1998: 44. Yamada 1931: 226, pl. 18a.
Chondria filiformis C. Agardh 1822: 358; 1824: 208.
Gracilaria filiformis (C. Agardh)Greville 1930: liv.

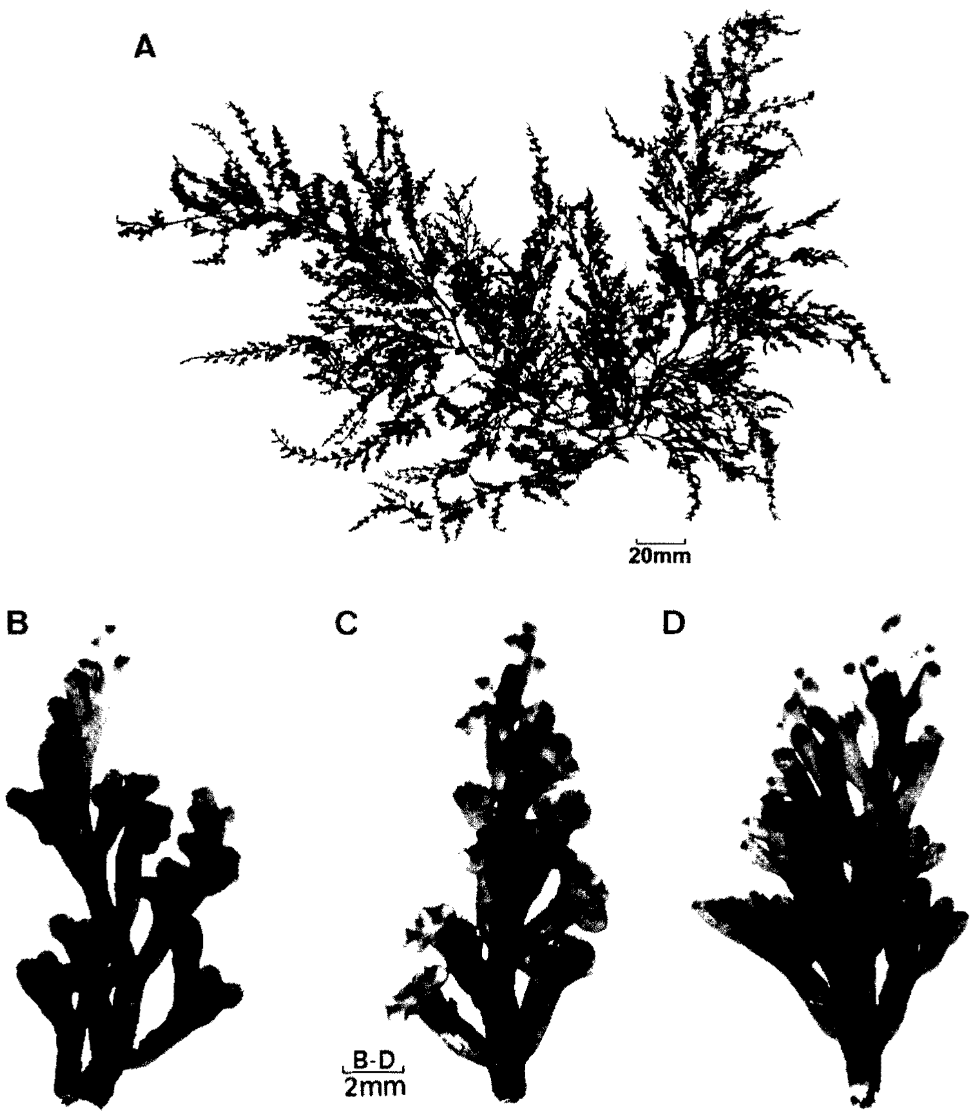

Fig. 209. *Laurencia tasmanica* (**A**, AD, A8992; **B–D**, AD, A41518). **A**. Habit. **B**. Cystocarpic branch. **C**. Spermatangial branch. **D**. Tetrasporangial branch. (All as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

Laurencia affinis Sonder 1845: 55; 1848: 178; 1853: 694; 1880: 29. J. Agardh 1852: 744; 1876: 646. De Toni 1903: 780. Harvey 1849a: 84; 1855a: 544; 1863, synop.: xxv. Kützing 1849: 854; 1865: 17, pl. 45c, d. Lucas 1909: 38. Sonder 1880: 29.
Laurencia fasciculata sensu Kützing 1865: 17, pl. 46a, b.
Laurencia forsteri sensu Womersley 1953: 38, and probably some other authors.
Laurencia forsteri f. *affinis* (Sonder)Yamada 1931: 214, pl. 13a.
Laurencia forsteri f. *delicatula, gracilis, elata* and *fragilis*, all of Sonder 1848: 178; 1880: 29. Kützing 1849: 854; 1865: 17, pls 47, 48. Reinbold 1897: 55.
Laurencia forsteri f. *dilatata* and *setacea* Kützing 1865, 18, pl. 48.
Laurencia forsteri f. *fasciculata, subpinnata* and *pyramidata* all of J. Agardh 1876: 645.
Laurencia gracilis sensu De Toni & Forti 1923: 37. Shepherd & Womersley 1971: 166. Womersley 1950: 187.
Laurencia heteroclada Harvey 1855a: 544; 1860: pl. 148; 1863, synop.: xxv. J. Agardh 1876: 647. De Toni 1903: 782; 1924: 370. Ewart 1907: 91. Garnet 1971: 97. Guiler 1952: 105. King *et al.* 1971: 124. Laing 1927: 164. Levring 1946: 226. Lucas 1909: 38; 1929a: 21. Lucas & Perrin 1947: 247. Saenger 1974: 81. Shepherd & Womersley 1971: 166. Tisdall 1898: 512. Womersley 1950: 187; 1966: 155. Yamada 1931: 238.
Laurencia filiformis f. *heteroclada* (Harvey)Saito & Womersley 1974: 834, fig. 15A. Millar & Kraft 1993: 54. Shepherd & Womersley 1976: 191; 1981: 368. Silva *et al.* 1996: 509.
Laurencia filiformis f. *dendritica* Saito & Womersley 1974: 834, fig. 16. Shepherd & Womersley 1976: 191; 1981: 368.
Laurencia obtusa sensu Shepherd & Womersley 1971: 166.
Coeloclonium claviferum J. Agardh 1897: 39.
Dolichoscelis clavifera (J. Agardh)J. Agardh 1899: 120. De Toni 1903: 827. Guiler 1952: 104. Lucas 1909: 40; 1929a: 21. Lucas & Perrin 1947: 257.

For further Indian Ocean references, see Silva *et al.* 1996: 508, 509.

FIGS 210, 211, 214B, C

Thallus (Figs 210A, B, 211A, F) medium to dark red, firm, drying cartilaginous, 6–15 cm high, to 30 cm in deep-water forms; f. *filiformis* (Fig. 210A, B) slender, branches spreading, irregularly radial; f. *heteroclada* (Fig. 211A) and f. *dendritica* (Fig. 211F) with one to several main axes, radially and usually densely branched, pyramidal in form; lower axes terete, 600–800 (-1000) µm in diameter in f. *filiformis*, 1.5–2 mm in f. *heteroclada* and 2–3 mm in diameter in f. *dendritica*, decreasing to upper branchlets 400–800 (-1000) µm in diameter in f. *filiformis*, 800–1200 µm in f. *heteroclada* and f. *dendritica*. Holdfast discoid, 1–3 mm across in f. *filiformis* when epiphytic usually on *Amphibolis*; discoid, becoming stoloniferous, and 3–10 mm across in f. *heteroclada* and f. *dendritica* which are epilithic. *Structure.* Epidermal cells (Fig. 214B, C) near apices isodiametric to slightly elongate, (15-) 20–40 (-50) µm across, L/D increasing to 2–3 below, with secondary pit-connections and *corps en cerise*; cortical cells with only small intercellular spaces, lenticular thickenings usually present (rare in f. *dendritica*). Cells with discoid to elongate rhodoplasts, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a basal fusion cell and short, branched gonimoblast bearing clavate terminal carposporangia 30–80 µm in diameter. Cystocarps (Figs 210C, 211B, C, G) sessile, not or slightly basally constricted, ovoid to slightly conical, 600–1000 (-1500) µm in diameter; pericarp broadly ostiolate, with or without a slight neck, 4–5 cells thick. Spermatangial receptacles (Figs 210D, 211D, H) ovoid to shortly clavate, becoming broad and cupulate, 0.8–1.5 mm across, spermatangia borne on trichoblasts.

Tetrasporangia in simple to compound ramuli (Figs 210E, 211E, I) 1–2 (-3) mm long and 400–800 µm in diameter, cut off abaxially in parallel arrangement, (70-) 100–150 µm in diameter.

Type (f. *filiformis*) from "occid. N. Holl.;" lectotype in LD, 36488, isotype in PC. Type of f. *heteroclada* from Rottnest I., W. Aust. (*Harvey*); lectotype in Trav. Set No. 210, Herb. Harvey, TCD. Type of f. *dendritica* from Vivonne Bay, Kangaroo I., S. Aust., 0–2 m deep on jetty piles (*Kraft*, 15.vii.1972); holotype in AD, A42549.

Distribution: Houtman Abrolhos, W. Aust., to Tilba, N.S.W., Qld? (Cribb 1983, p. 117), and around Tasmania.

New Zealand? Recorded from Indian Ocean localities (see Silva *et al.* 1996, p. 509) from Brazil (Oliveira 1969, p. 178), and from the western tropical Atlantic? (Wynne 1998, p. 44).

Saito & Womersley (1974, p. 834 and key) described 3 forms of *L. filiformis* on habit and ecological differences, commenting that further studies were necessary. These were:

f. *filiformis*. (Fig. 210) On rock or epiphytic on seagrasses (especially *Amphibolis*), under moderate water movement; thallus with one to a few axes from a discoid holdfast, branches moderately slender (usually under 1 mm in diam.), without or with only weakly developed percurrent axes, branching loose and relatively distant; lenticular thickenings (Fig. 214B) usually present, occasional (rarely plentiful) and massive, often clustered in 2–4 cells.

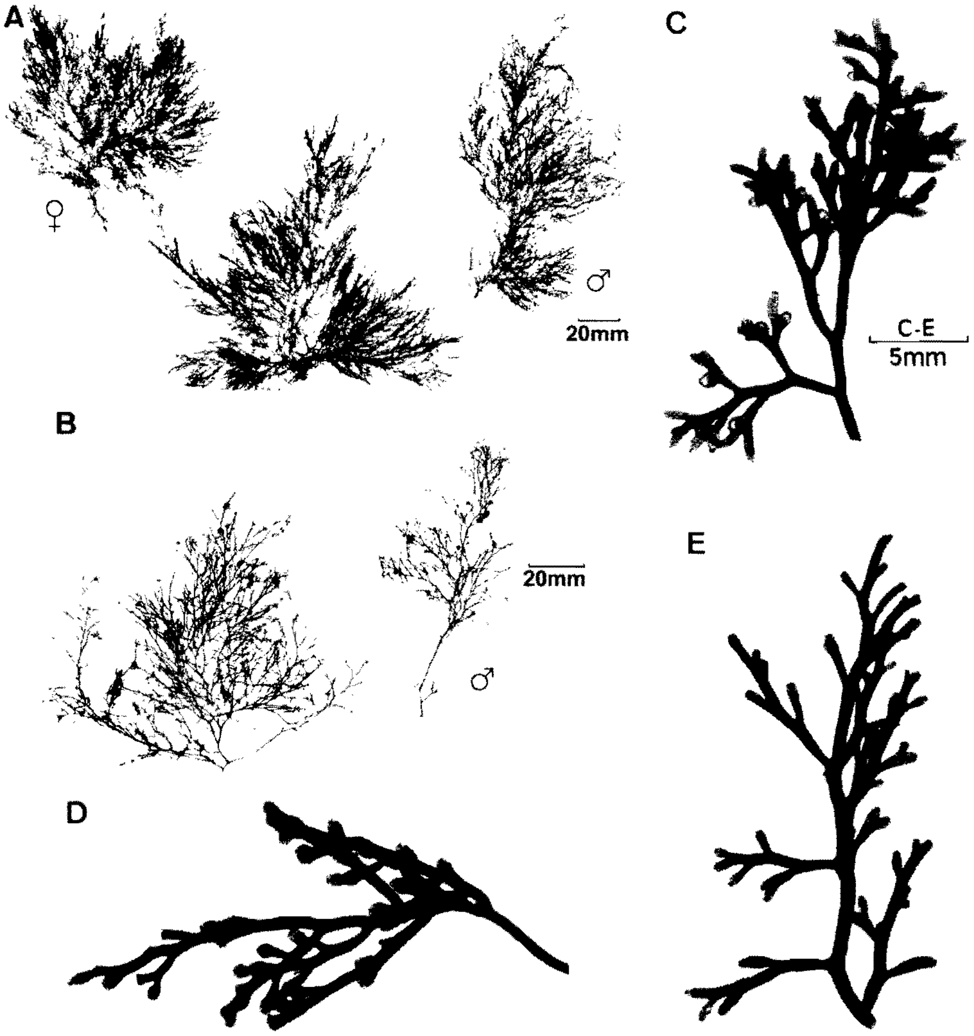

Fig. 210. *Laurencia filiformis* f. *filiformis* (**A**, AD, A42610; **B**, AD, A37680; **C–E**, AD, A41955). **A**, **B**, Habit. **C**. Cystocarpic branch. **D**. Spermatangial branch. **E**. Tetrasporangial branch. (**C–E**, as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

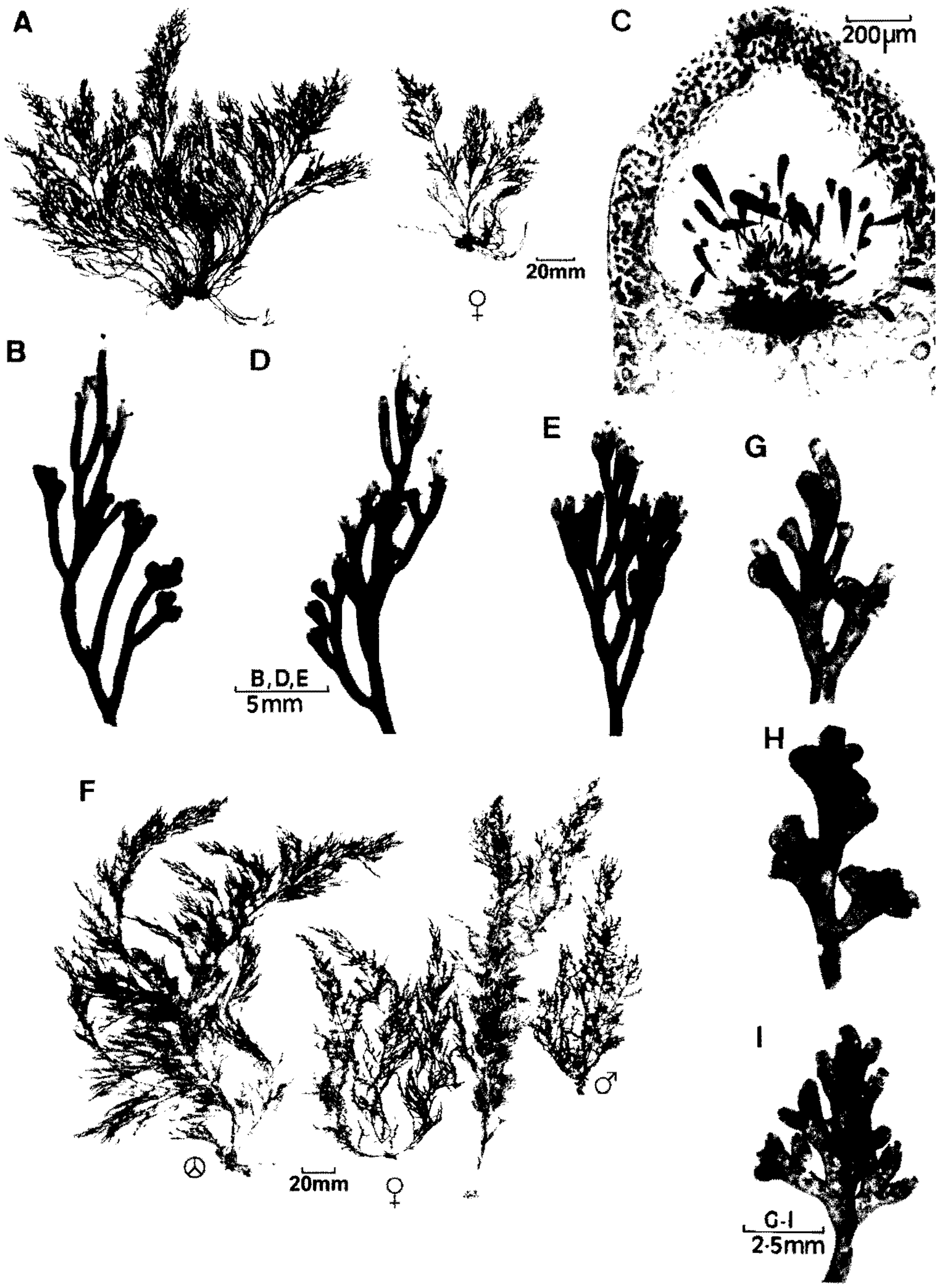

Fig. 211. A–E. *Laurencia filiformis* f. *heteroclada* (**A**, AD, A42780; **B**, **D**, **E**, AD, A41953; **C**, AD, A42548). **A**. Habit. **B**. Cystocarpic branch. **C**. Section of cystocarp. **D**. Spermatangial branch. **E**. Tetrasporangial branch. **F–I**. *Laurencia filiformis* f. *dendritica* (AD, A42549). **F**. Habit. **G**. Cystocarpic branch. **H**. Spermatangial branch. **I**. Tetrasporangial branch. (**B**, **D–I** as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

f. *heteroclada*. (Fig. 211A–E) On rock on rough-water coasts; moderately firm with numerous fastigiate axes from an entangled base, sparsely branched except in upper fertile parts; fertile fronds with percurrent axes and laterals becoming gradually more slender; lenticular thickenings present but occasional, or absent.

f. *dendritica*. (Figs 211F–I, 214C) On rock or jetty piles, on moderate to rough-water coasts; to 30 cm high with one to a few strongly developed percurrent axes, becoming 1.5–3 mm in diameter in lower parts, usually denuded below and much branched above; lenticular thickenings absent.

Selected specimens:

(f. *filiformis*). Port Denison, W. Aust., drift (*Kraft*, 14.xii.1971; AD, A42018). Safety Bay, W. Aust., drift (*Cribb* 68.33, 14.viii.1950; AD, A14001). Tiparra Reef, S. Aust., 11 m deep (*Shepherd*, 31.x.1970; AD, A37650). Great Australian Bight, S. Aust., 42 m deep (*Symond*, 5.v.1973; AD, A43520). Off Troubridge I., S. Aust., 23 m deep (*Shepherd*, 4.ii.1969; AD, A33805). West Beach, S. Aust., on *Amphibolis*, 6 m deep (*Shepherd*, 13.xi.1970; AD, A37680). Marino, S. Aust., uppermost sublittoral (*Womersley*, 13.viii.1972; AD, A42610) and drift (*Saito*, 23.i.1972; AD, A41955). Toad Head, West I., S. Aust., 10 m deep (*Shepherd*, 13.x.1968; AD, A32883). Pennington Bay, Kangaroo I., S. Aust., drift (*Womersley*, 24.v.1945; AD, A2674). American R. inlet, Kangaroo I., S. Aust., 2–3 m deep on shell (*Kraft*, 7.iv.1972; AD, A41989). Nora Creina, S. Aust., 3–6 m deep (*Kraft*, 13.v.1972: AD, A42236). Dutton Bay, Portland, Vic., drift (*Womersley*, 13.iv.1959; AD, A22690). San Remo, Vic., drift (*Sinkora* A490, 14.vi.1970; AD, A41357). Low Head, Tas. (*Perrin*, 8.x.1950; AD, A50205). Stapleton Point, Prosser Bay, Tas., 4–10 m deep (*Shepherd*, 10.ii.1970; AD, A35707).

(f. *heteroclada*). Port Denison, W. Aust., inner reef (*Womersley*, 30.viii.1947; AD, A5907). Belinda Beach, Middle I., Recherche Arch., W. Aust., low eulittoral (*Trudgen* 828, 23.xi.1973; PERTH and AD, A51703). Elliston, S. Aust., outer bar edge, 0.5 m deep (*Shepherd*, 28.x.1972; AD, A42797). Cable Hut Bay; Yorke Pen., S. Aust., 1.5 m deep (*Kald*, 10.vi.1968; AD, A33068). Petrel Cove, Victor Harbour, S. Aust., low eulittoral (*Saito*, 30.i.1972; AD, A41953). Vivonne Bay, Kangaroo I., S. Aust., 0–2 m deep on jetty piles (*Kraft*, 15.vii.1972; AD, A42548). Cape Lannes, S. Aust., uppermost sublittoral reef pools (*Womersley*, 7.x.1972; AD, A42780—"Marine Algae of southern Australia" No. 166). Koonya Bay, Mornington Pen., Vic., lower eulittoral (*Womersley*, 15.i.1974; AD, A44672). Fluted Cape, Bruny I., Tas, uppermost sublittoral (*Shepherd*, 10.ii.1972; AD, A41771).

(f. *dendritica*). Port Valliant, Two People Bay, W. Aust., 0–2 m deep (*Clarke & Engler*, 30.viii.1979; AD, A50970). Elliston, S. Aust., 7 m deep (*Shepherd*, 21.x.1970; AD, A37596). Margaret Brock Reef, Cape Jaffa, S. Aust., 3–5 m deep (*R. Lewis*, 29.xi.1972; AD, A42903). Nora Creina, S. Aust., 3–8 m deep (*Owen*, 3.ix.1971; AD, A39593). Lady Julia Percy I., Vic., 3–6 m deep (*Shepherd*, 4.i.1968; AD, A32433). Gabo I., Vic., 18 m deep (*Shepherd*, 17.ii.1973; AD, A43508). Stapleton Point, Prosser Bay, Tas., 4–10 m deep (*Shepherd*, 10.ii.1970; AD, A35708). Safety Cove, Port Arthur, Tas., 12 m deep (AIMS-NCI Q66C-3828-A, 1.iii.1990; AD, A60376).

Coeloclonium claviferum J. Agardh (1897, p. 39); *Dolichoscelis clavifera* (J. Agardh) J. Agardh (1899, p. 120) was based on Meredith 294 from Tasmania (LD, 36174) and is a slender form of *Laurencia filiformis*. However, J. Agardh's specimen under this name from Spencer Gulf (*O'Halloran*), LD, 36173 is *Laurencia clavata*.

9. **Laurencia botryoides** (C. Agardh)Gaillon 1828: 363. J. Agardh 1852: 759; 1876: 658. De Toni 1896: 228; 1903: 802. De Toni & Forti 1923: 36(?). Endlicher 1843: 43. Fuhrer *et al.* 1981: pl. 86. Guiler 1952: 105. Harvey 1844b: 444; 1849a: 82 (excl. S. Africa); 1849b: 58; 1859b: 307; 1862a, pl. 182; 1863, synop.: xxvi (excl. var. *minor*). Hooker & Harvey 1847: 401. King *et al.* 1971: 124. Kützing 1849: 857; 1865: 25, pl. 71. Lucas 1909: 39; 1913: 58; 1929a: 21. Lucas & Perrin 1947: 249, fig. 109. Saenger 1967: 171; 1974: 81. Saito & Womersley 1974: 835, figs 4A, B, 17. Silva *et al.* 1996: 504. Sonder 1848: 179?; 1853: 695; 1855: 523; 1880: 30. Tisdall 1898: 512. Yamada 1931: 230.

Chondria botryoides C. Agardh 1817: xviii; 1822: 346; 1824: 204.

Fucus botryoides Turner 1811: 104, pl. 178, *nom. illegit.* See Silva *et al.* (1996, p. 504) re authorship of this species.

FIGS 212, 214D

Thallus (Fig. 212A) dark red to red-brown, robust, firm, drying cartilaginous, 5–17 cm high, pyramidal in outline, with percurrent axes bearing distichous laterals similarly branched, all branches terete, (1-) 3–10 mm apart, with reproductive ramuli forming botryoidal clusters;

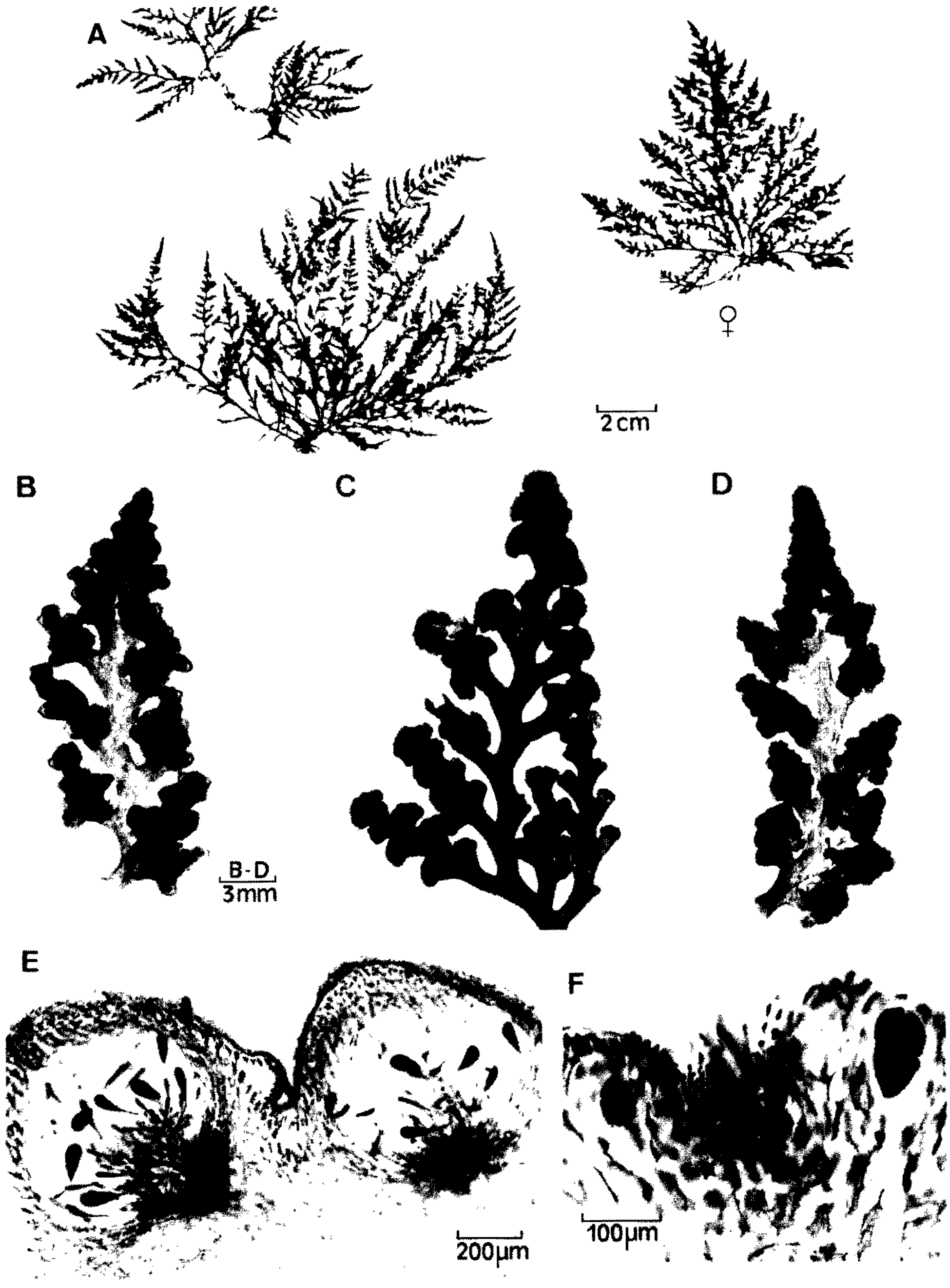

Fig. 212. *Laurencia botryoides* (AD, A42775). **A.** Habit. **B.** Cystocarpic branch. **C.** Spermatangial branch. **D.** Tetrasporangial branch. **E.** Section of cystocarps. **F.** Section with tetrasporangia. (**A–D** as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

axes 1.5–2 (-3) mm in diameter, decreasing to 0.5–1 mm in lesser branches. Holdfast stoloniferous; epilithic. *Structure*. Epidermal cells 20–50 µm broad, isodiametric near apices and extending to L/D 4–8 below, with secondary pit-connections and *corps en cerise*; in sectional view (Fig. 214D), epidermal cells L/D (1-) 1.5–2, with slight spaces between cortical cells, lenticular thickenings absent. Cells with discoid rhodoplasts, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a basal fusion cell and much-branched gonimoblast bearing clavate terminal carposporangia 30–60 µm in diameter. Cystocarps (Fig. 212B, E) crowded, sessile, ovoid to conical, 0.7–1 mm in diameter; pericarp ostiolate, 6–8 cells thick. Spermatangial ramuli (Fig. 212C) short, in botryoidal clusters.

Tetrasporangial ramuli (Fig. 212D) in compound, botryoidal, clusters, tetrasporangia (Fig. 212F) in right-angle arrangement, cut off abaxially, subspherical to ovoid, 60–100 µm in diameter, tetrahedrally or decussately divided.

Type from Kent I., Bass Strait, in shallow water (*Brown*); holotype in BM.

Distribution: Robe, S. Aust., to Cape Conran, Vic., Bass Strait islands and around Tasmania. Records from outside this range, especially Indian Ocean tropics, are doubtful (see Silva *et al.* 1996, p. 504). Askenasy (1888, p. 47) recorded it from Dirk Hartog I., W. Aust., almost certainly incorrectly.

Selected specimens: Robe, S. Aust., very low eulittoral in bay (*Womersley*, 7.x.1972; AD, A42775—"Marine Algae of southern Australia" No. 137). Nora Creina, S. Aust., uppermost sublittoral (*Kraft*, 13.v.1972; AD, A42233). Bridgewater Bay, Vic., low eulittoral (*Womersley*, 3.ix.1981; AD, A55403). Lawrence Rock, Portland, Vic., low rock pool (*Beauglehole*, 15.i.1960; AD, A24009). Point Lonsdale, Vic. in rock pools (*Sinkora* A924, 8.xi.1970; AD, A41337). Cape Conran, Vic. (*Ducker & King*, 15.xi.1971, MELU 20729). Remine, Tas., reef pools (*Wollaston & Mitchell*, 25.ii.1964; AD, A27514). Currie R, N Tas., at lowest tide (*Perrin*, Jan. 1937; AD, A8511). Musselroe Bay, NE Tas. (*Perrin*, Aug. 1940; AD, A8989). Bicheno, Tas., upper sublittoral (*Wollaston*, 11.viii.1965; AD, A29578). Tesselated Pavements, Eaglehawk Neck, Tas., lower eulittoral (*Womersley*, 30.x.1982; AD, A54519). Port Arthur, Tas. (*Cribb* 35.12, 2.iii.1950; AD, A16061). Lady Bay, Southport, Tas., low eulittoral (*Womersley*, 28.x.1982; AD, A56513—"Marine Algae of southern Australia" No. 137a).

Laurencia botryoides is a distinctive species, being distichously branched with short fertile ramuli in botryoidal clusters. It is confined to the cooler waters of south-eastern Australia, occurring just below low tide level or in pools.

10. **Laurencia elata** (C. Agardh)Hooker & Harvey 1847: 401. Adams 1994: 328, pl. 113, upper left. J. Agardh 1852: 766; 1876: 659; 1878: 26. De Toni 1903: 803. Ewart 1907: 91. Fuhrer *et al.* 1981: pl. 85. Guiler 1952: 105. Harvey 1849a: 81, pl. 33; 1855a: 545; 1855b: 233; 1959b: 307; 1863, synop.: xxvi. Huisman 2000: 171. Huisman & Walker 1996: 437. King *et al.* 1971: 124. Kützing 1849: 856; 1865: 24, pl. 67d–g. Laing 1927: 164. Levring 1946: 226. Lucas 1909: 39; 1929a: 21; 1929b: 50. Lucas & Perrin 1947: 249, fig. 110. Mazza 1909: No. 270. Millar & Kraft 1993: 54. Nam & Choi 2001: 289, figs 21–48. Patton 1937: 363. Reinbold 1899: 47. Saenger 1974: 81. Saito & Womersley 1974: 837, figs 3E, 18, 19. Shepherd & Womersley 1970: 135; 1971: 166; 1976: 191; 1981: 368. Silva *et al.* 1996: 508. Sonder 1880: 30. Tate 1882a: 22. Tisdall 1898: 512. Wilson 1892: 169. Womersley 1950: 187; 1966: 155. Yamada 1931: 241, pl. 26.

Chondria pinnatifida var. *elata* C. Agardh 1822: 340; 1824: 202.

Laurencia pinnatifida sensu Sonder 1880: 30.

Laurencia pinnatifida var. *elata* (C. Agardh)Sonder 1846: 177.

Laurencia elata var. (f.) *luxurians* Harvey 1863, synop.: xxvi. Yamada 1931: 242, pl. 27.

Laurencia luxurians (Harvey)J. Agardh 1876: 659. De Toni 1903: 804. Lucas 1909: 39. Sonder 1880: 30. Tate 1882a: 22. Yamada 1931: 242.

FIGS 213, 214E

Thallus (Fig. 213A) medium to dark red, firm, cartilaginous, 10–40 cm high, complanately branched, axes with 2–4 orders of alternate, usually erect, laterals at irregular distances apart, older axes basally denuded; all branches compressed except near holdfast, axes 2–4 mm broad and 0.7–1.5 mm thick, lesser branches (1-) 1.5–2.5 mm broad, about

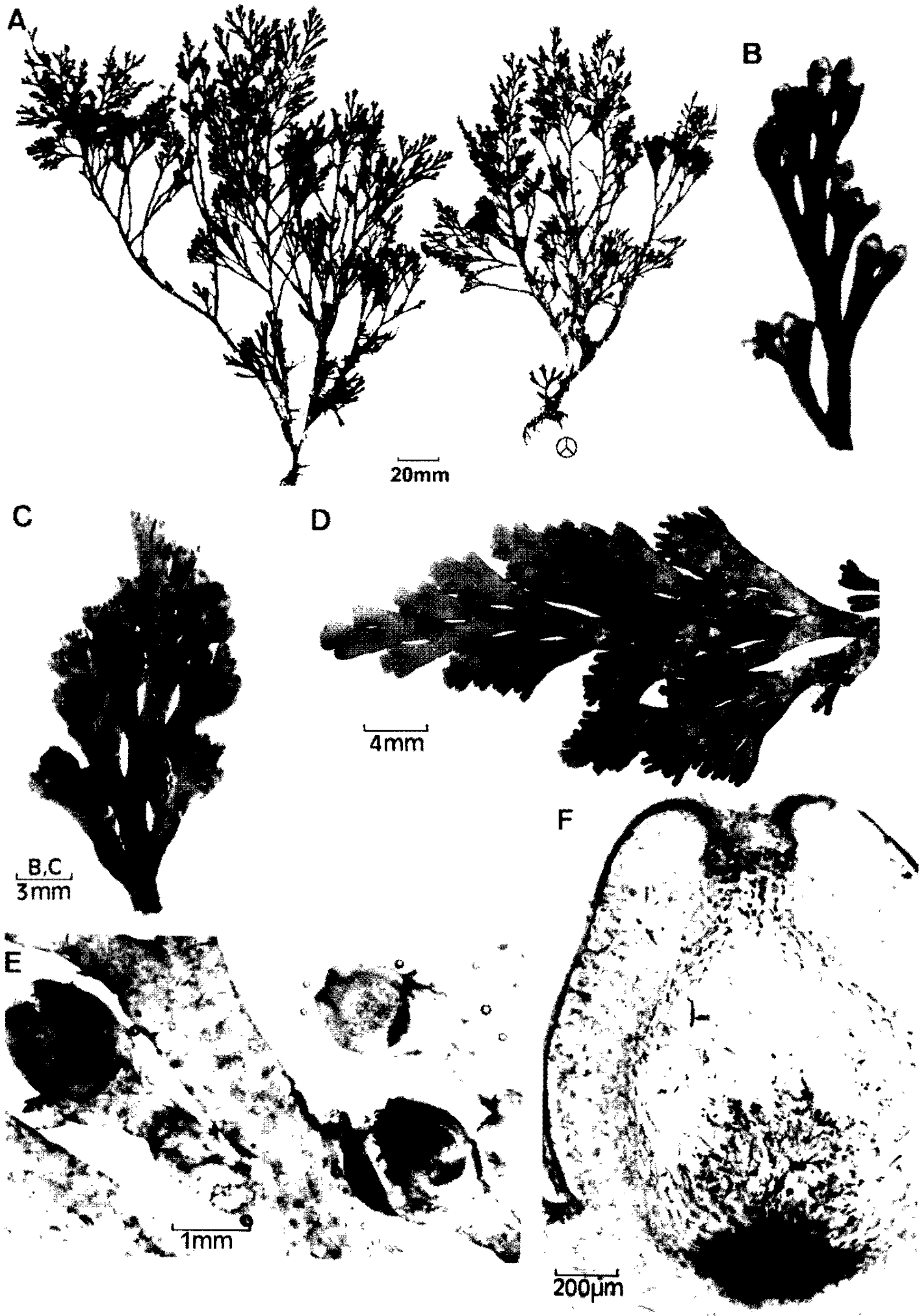

Fig. 213. *Laurencia elata* (**A**, **D**, AD, A42237; **B**, **E**, **F**, AD, A21091; **C**, AD, A41942). **A**. Habit. **B**. Cystocarpic branch. **C**. Spermatangial branch. **D**. Tetrasporangial branch. **E**. Cystocarps. **F**. Section of a cystocarp. (**A–D** as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

0.5 mm thick near the truncate apices. Holdfast discoid when young, becoming stoloniferous; epilithic. *Structure*. Epidermal cells (Fig. 216E) 15–30 µm across, isodiametric near apices and only slightly elongate below, with secondary pit-connections and *corps en cerise*; cortical cells more extensive laterally, inner cells with thickened walls and abundant, massive, lenticular thickenings (Fig. 216E). Cells with discoid rhodoplasts, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a basal fusion cell and much-branched gonimoblast bearing clavate terminal carposporangia 40–70 µm in diameter. Cystocarps (Fig. 215B, E, F) lateral and usually single on lesser branchlets, sessile, broad-based, ovoid, 1–2 mm in diameter; pericarp with a broad ostiole without or with a slightly thicker neck, 6–8 cells thick. Spermatangial branches (Fig. 215C) single, receptacles ovoid with broad apices 1–1.5 mm across.

Tetrasporangia in simple or branched, fastigiate, ramuli (Fig. 215D) (300-) 500–700 µm in diameter and 1–6 mm long; tetrasporangia cut off abaxially, in parallel arrangement, 100–140 µm in diameter.

Type from King I., Bass Strait; holotype in Herb. Agardh, LD, 37235. Isotype in PC.

Distribution: Port Denison, W. Aust., around southern Australia to Split Solitary I., N.S.W. (*Millar & Kraft* 1993, p. 54) and around Tasmania.

New Zealand. Other Indian Ocean localities (see Silva *et al.* 1996, p. 508) need verification.

Selected specimens: Port Denison, W. Aust., drift (*Kraft*, 14.xii.1971; AD, A41945). King Head, Rottnest I., W. Aust., 4–6 m deep (*Clarke & Engler*, 6.ix.1979; AD, A50801). Cannan Reefs, S. Aust., 20–25 m deep (*Branden*, 25.i.1991; AD, A61089). Pearson I., S. Aust., 20–25 m deep (*Shepherd*, 7.i.1969; AD, A33638). Elliston, S. Aust., 9 m deep outside bar (*Shepherd*, 28.x.1972; AD, A42815). Pondalowie Bay, S. Aust., 5–8 m deep (*Shepherd*, 14.iv.1963; AD, A26605). Port Elliot, S. Aust., drift (*Womersley*, 10.viii.1957; AD, A21091) and upper sublittoral pool (*Saito*, 30.i.1972; AD, A41942). Vivonne Bay, Kangaroo I., S. Aust., upper sublittoral (*Saito*, 6.iv.1972; AD, A41980). Pennington Bay, Kangaroo I., S. Aust., on reef (*Womersley*, 25.i.1944; AD, A2691). Nora Creina, S. Aust., 3–4 m deep (*Kraft*, 13.x.1972; AD, A42237). Port MacDonnell, S. Aust., outer reef pools (*Womersley*, 25.i.1967; AD, A31673). Lady Julia Percy I., Vic., 3–6 m deep (*Shepherd*, 4.i.1968; AD, A32430). San Remo, Vic., drift (*Sinkora* A2002, 27.xi.1974; AD, A62739; MEL, 2010977). Remine, Tas., reef pools (*Wollaston & Mitchell*, 25.ii.1964; AD, A27509). Bicheno, Tas., upper sublittoral (*Gordon*, 16.i.1966; AD, A30120). Satellite I., SE Tas., 0–2 m deep (*Shepherd*, 18.ii.1972; AD, A41517).

Laurencia elata is a distinctive, robust and common species, occurring from just below low tide level to 25 m deep.

11. **Laurencia brongniartii** J. Agardh 1841: 20; 1852: 768; 1876: 660. Abe *et al.* 1998: 231, figs 1–17. Cribb 1983: 114, pl. 36 fig. 4. De Toni 1903: 805. Huisman 1997: 205; 2000: 170. Huisman & Walker 1990: 436. Huisman *et al.* 1990: 97. Kendrick *et al.* 1990: 52. Kützing 1849: 856. May 1953: 60; 1981: 342. Millar 1990: 463. Millar & Kraft 1993: 53. Saito & Womersley 1974: 839, figs 4C, D, 20, 21. Shepherd & Womersley 1981: 368. Silva *et al.* 1996: 504. Taylor 1960: 628. Yamada 1931: 240, pl. 25.

Laurencia concinna Montagne 1842b: 6; 1845: 126, pl. 14 fig. 3. J. Agardh 1852: 764; 1876: 661. Cribb 1958: 162. De Toni 1903: 806. Harvey 1849a: 81. Kützing 1849: 857; 1865: 24, pl. 69a, b. Lucas 1909: 39; 1935: 223, pl. 9 fig. 1. Sonder 1880: 30.

Laurencia distichophylla sensu Harvey 1855a: 545; 1863, synop.: xxvi.

Laurencia grevilleana Harvey 1855a: 545; 1858: pl. 15; 1863, synop.: xxvi. J. Agardh 1876: 661. Cribb 1958: 162. De Toni 1903: 806. Lucas 1909: 39. Sonder 1880: 30. Tisdall 1898: 512. Wilson 1892: 169. Yamada 1931: 245.

FIGS 214F, 215

Thallus (Fig. 215A) medium red to red-brown, firm, drying cartilaginous, 5–18 cm high, with one to several axes, complanately and regularly pinnately branched; axes strongly compressed, 1.5–4 mm broad and 0.5–1 mm thick, decreasing to ultimate branchlets 0.5–1 (-1.5) mm broad, with truncated apices. Holdfast discoid, becoming branched and 2–12 mm across, sometimes stoloniferous; epilithic. *Structure*. Epidermal cells (Fig. 214F) 25–40 µm broad and slightly elongate near apices, increasing to 60–80 µm broad and L/D 2–2.5 below, with secondary pit-connections and *corps en cerise*, in section quadrate to L/D 3, occasionally

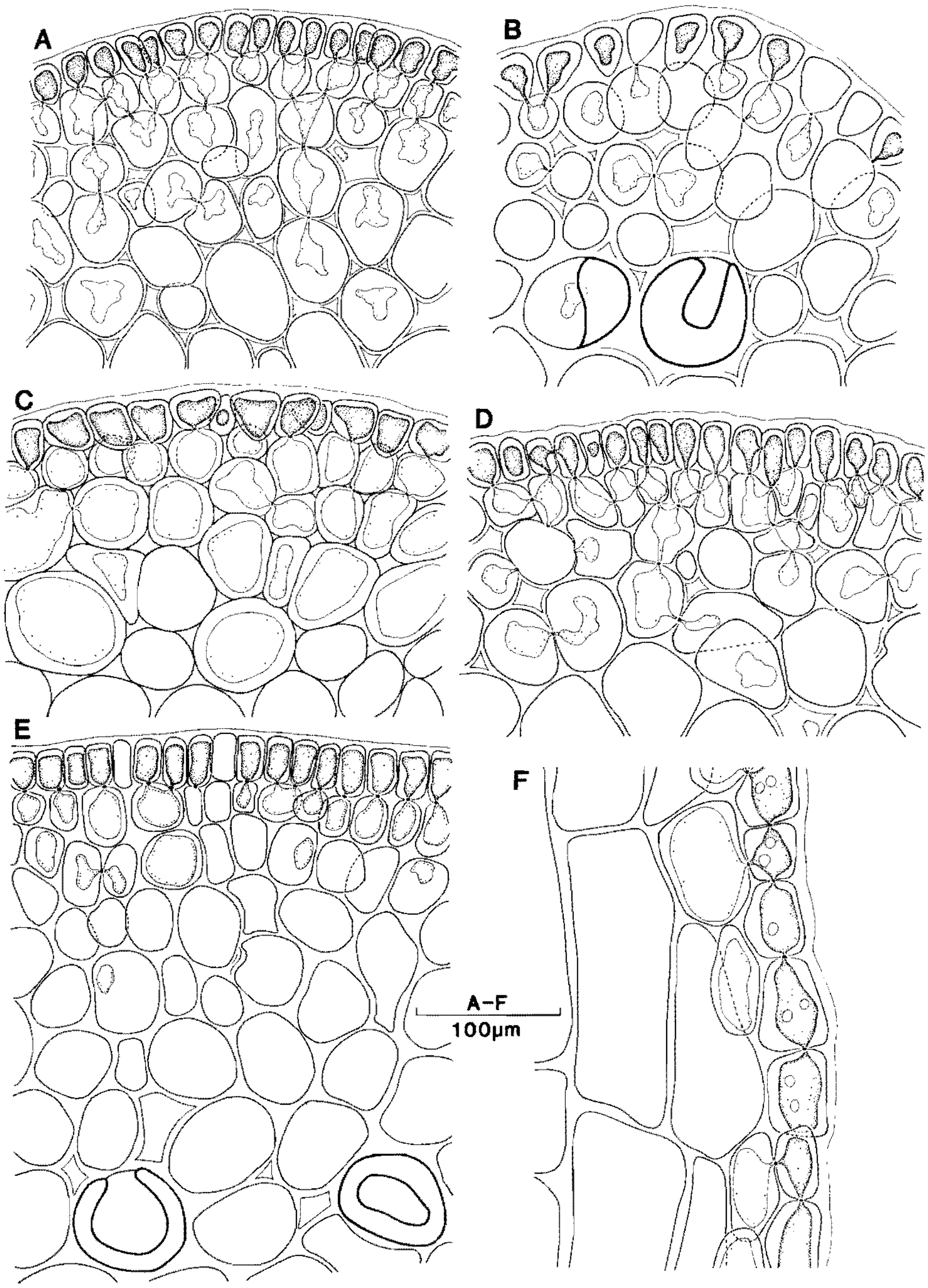

Fig. 214. **A**. *Laurencia tasmanica* (AD, A41518). Transverse section. **B**. *Laurencia filiformis* f. *filiformis* (AD, A41955). Transverse section, with lenticular thickenings. **C**. *Laurencia filiformis* f. *dendritica* (AD, A42549). Transverse section. **D**. *Laurencia botryoides* (AD, A42775). Transverse section. **E**. *Laurencia elata* (AD, A42237). Transverse section, with lenticular thickenings. **F**. *Laurencia brongniartii* (AD, A44591). Longitudinal section. (All as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

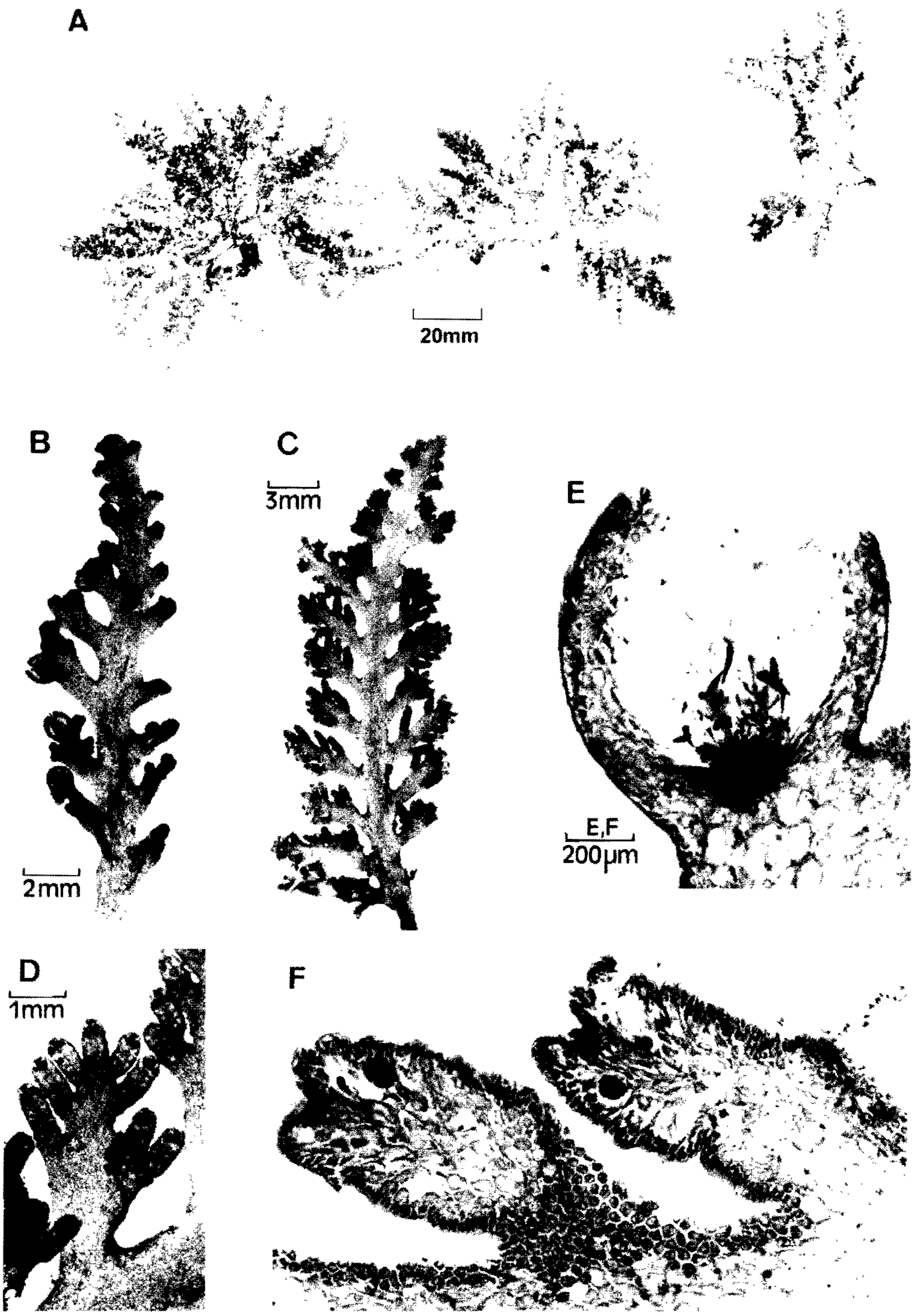

Fig. 215. *Laurencia brongniartii* (**A**, AD, A22079; **B–F**, AD, A44591). **A**. Habit. **B**. Cystocarpic branch. **C**. Tetrasporangial branch. **D**. Tetrasporangial ramuli. **E**. Section of cystocarp. **F**. Ramuli with tetrasporangia. (**A–D** as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

palisade-like; cortical cells compact, often with prominent lenticular thickenings. Cells (epidermal) binucleate; rhodoplasts discoid to elongate, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes with a small basal fusion cell and branched gonimoblast bearing clavate terminal carposporangia 30–70 μm in diameter. Cystocarps (Fig. 215B, E) lateral and usually single, broad based, globular to slightly ovoid, 600–1300 μm in diameter; pericarp ostiolate, without or with a slight neck, 4–5 cells thick. Spermatangial ramuli single or grouped, receptacles 600–800 μm broad.

Tetrasporangia in simple or clustered terete ramuli (Fig. 215C, D, F), 300–600 (-800) μm in diameter and (0.5-) 1–2 mm long, cut off abaxially in parallel arrangement, 70–120 (-135) μm in diameter, tetrahedrally or decussately divided.

Type from Martinique, West Indies; holotype in Herb. Agardh, LD, 37257; isotype in PC.

Distribution: Widespread in tropical and subtropical waters, including the entire coasts of N.S.W. (Millar & Kraft 1993, p. 53) and western Western Australia.

In southern Australia, isolated records from several localities (see below).

Selected specimens: Point Peron, W. Aust., reef pools (*Womersley*, 23.viii.1947; AD, A5831). King Head, Rottnest I., W. Aust., reef edge (*Womersley*, 6.ix.1979; AD, A50846). Hamelin Bay, W. Aust., 1–2 m deep (*Clarke & Engler*, 1.ix.1979; AD, A50620). Elliston, S. Aust., 10–12 m deep outside bar (*Shepherd*, 25.x.1971; AD, A42671). Port Noarlunga, S. Aust., 10 m deep (*Kraft*, 13.xii.1973; AD, A44591). Aldinga, S. Aust., 8–11 m deep (*F. Mitchell*, 4.i.1959; AD, A22079). Port Phillip Heads, Vic. (*Wilson*, 29.xii.1884; MEL, 1001034). Mallacoota, Vic. (*Ducker & King*, 15.ii.1970; MELU, 20667).

The synonymy of *L. brongniartii* was discussed by Saito & Womersley (1974, p. 840). It is largely a tropical species, extending into southern Australia as isolated occurrences.

12. **Laurencia distichophylla** J. Agardh 1852: 762; 1876: 656. Adams 1994: 328, pl. 113, upper right. De Toni 1903: 800; 1924: 373. Harvey 1855b: 234; 1863, synop.: xxvi?. Laing 1927: 164. Millar & Kraft 1993: 54. Saito & Womersley 1974: 841, fig. 22. Silva *et al.* 1996: 507. Yamada 1931: 235.

FIG. 216

Thallus (Fig. 216A) medium to dark red, drying cartilaginous, 2–5 cm high, with several complanately branched axes bearing closely pinnate laterals for 2–4 orders; axes compressed,

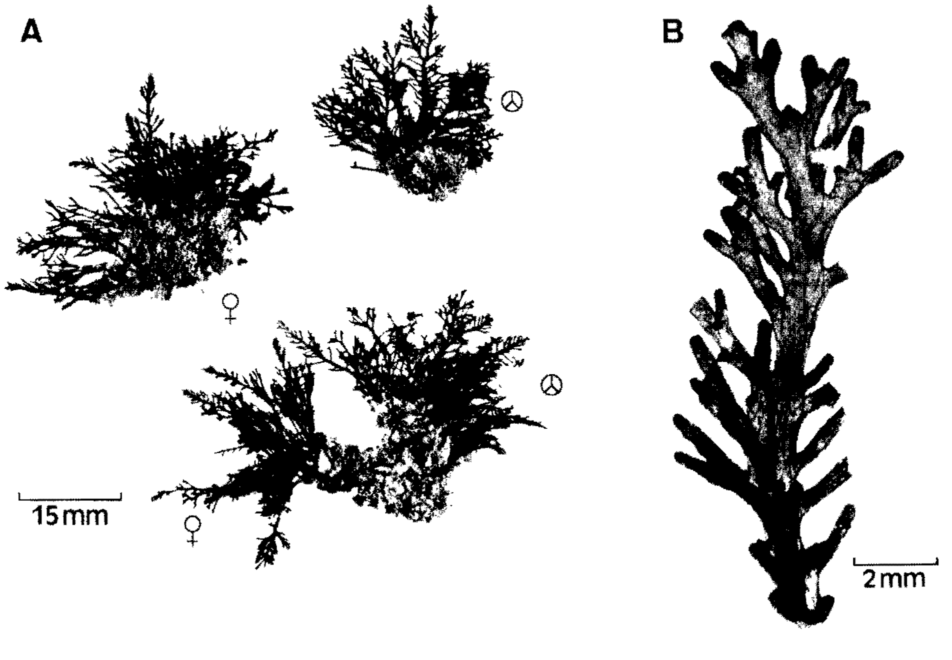

Fig. 216. *Laurencia distichophylla* (AD, A27906). **A**. Habit. **B**. Branch with tetrasporangia. (As in Saito & Womersley 1974, courtesy of Aust. J. Bot.]

0.5–1 mm broad, 200–300 µm thick, laterals 0.5–2 (-3) mm apart, ultimate branchlets (0.5-) 1–2 mm long, terete to slightly compressed, 300–500 µm broad. Holdfast stoloniferous; epilithic. *Structure*. Epidermal cells 15–30 µm broad near apices and L/D 1–1.5 (-2), below 25–40 µm broad and L/D 2–3 (-4) with secondary pit-connections, in section, epidermal cells quadrate, cortical cells with occasional lenticular thickenings. Cells with discoid to elongate rhodoplasts.

Reproduction. Procarps not observed. Carposporophytes with a basal fusion cell and much branched gonimoblast with clavate terminal carposporangia 30–70 µm in diameter. Cystocarps lateral and usually single, sessile, broad-based, ovoid, 600–1200 µm in diameter; pericarp ostiolate, 3–4 cells thick. Spermatangial thalli not recorded.

Tetrasporangial ramuli (Fig. 216B) simple or branched, terete, 1–2 (-3) mm long and 300–600 µm in diameter, tetrasporangia cut off abaxially, in parallel arrangement, 60–130 µm in diameter.

Type from New Zealand; holotype in Herb. Agardh. LD, 37171.

Distribution: In southern Australia, known only from Wine Glass Bay, Freycinet Pen., Tasmania. N.S.W. (Millar & Kraft 1993, p. 54).

New Zealand (N Island). Recorded from various tropical Indian Ocean localities (see Silva *et al.* 1996, p. 507).

Selected specimen: Wine Glass Bay, Freycinet Pen., Tas., in rock pools (*Wollaston & Mitchell*, 2.iii.1964; AD, A27906).

Laurencia distichophylla is a slender, pinnately branched, species, from the north island of New Zealand, known in southern Australia only from the above record of tetrasporangial and cystocarpic plants. Papenfuss (1952, p. 184) considered that it does not occur in South Africa, but Silva *et al.* (1996, p. 507) recorded it from widespread Indian Ocean localities. Yendo (1916b) and Yamada (1931, p. 235) recorded it from Japan, but it is not listed by Yoshida (1998).

Genus CHONDROPHYCUS (Tokida & Saito)Garbary & Harper 1998: 194

Thallus erect, radially to distichously branched for 2–5 orders, usually firm and drying cartilaginous, branches with truncated apices with a depressed apical pit; holdfast discoid or stoloniferous; epilithic or epiphytic. *Structure*. Apical depression with a central, short, apical filament bearing well-developed trichoblasts and each axial cell with 2 pericentral cells, axial and pericentral cells soon obscured in sectional view; cortex extensive with relatively large, ovoid, compact cortical cells and a small-celled epidermis without secondary pit-connections and without *corps en cerise*; inner cortical cells with or without lenticular thickenings and rhizoids. Lateral branches arising from basal cells of trichoblasts. Cells uni- or multinucleate, rhodoplasts discoid or elongate, often ribbon-like in larger cells.

Reproduction. Gametophytes dioecious. Procarps on a pericentral cell on the suprabasal cell of trichoblasts, consisting of a lateral sterile group, a 4-celled carpogonial branch and a basal sterile group. Carposporophytes with a basal fusion cell and branched gonimoblast bearing clavate terminal carposporangia, replaced from cells below. Cystocarps lateral on branches, sessile, basally constricted or broad-based and only slightly projecting; pericarp arising pre-fertilization, ostiolate, corticated and 3–6 cells thick. Spermatangia borne in lateral whorls on cells of modified trichoblasts in the apical, cup-like, depressions, the filaments terminated by an enlarged globular cell.

Tetrasporangia borne abaxially on the outer ends of laterally elongate pericentral cells, appearing in side view of axes in "right angle" (to the branch axis) arrangement, tetrahedrally or decussately divided.

Type species: *C. cartilagineus* (Yamada)Garbary & Harper 1998: 194.

A genus of 16–18 species, with 4 on southern Australian coasts. These species were included in subgenus *Chondrophycus* by Saito & Womersley (1974), and as for species of *Laurencia*, all 4 species need detailed study of the number of pericentral cells, origin of tetrasporangia, and other features.

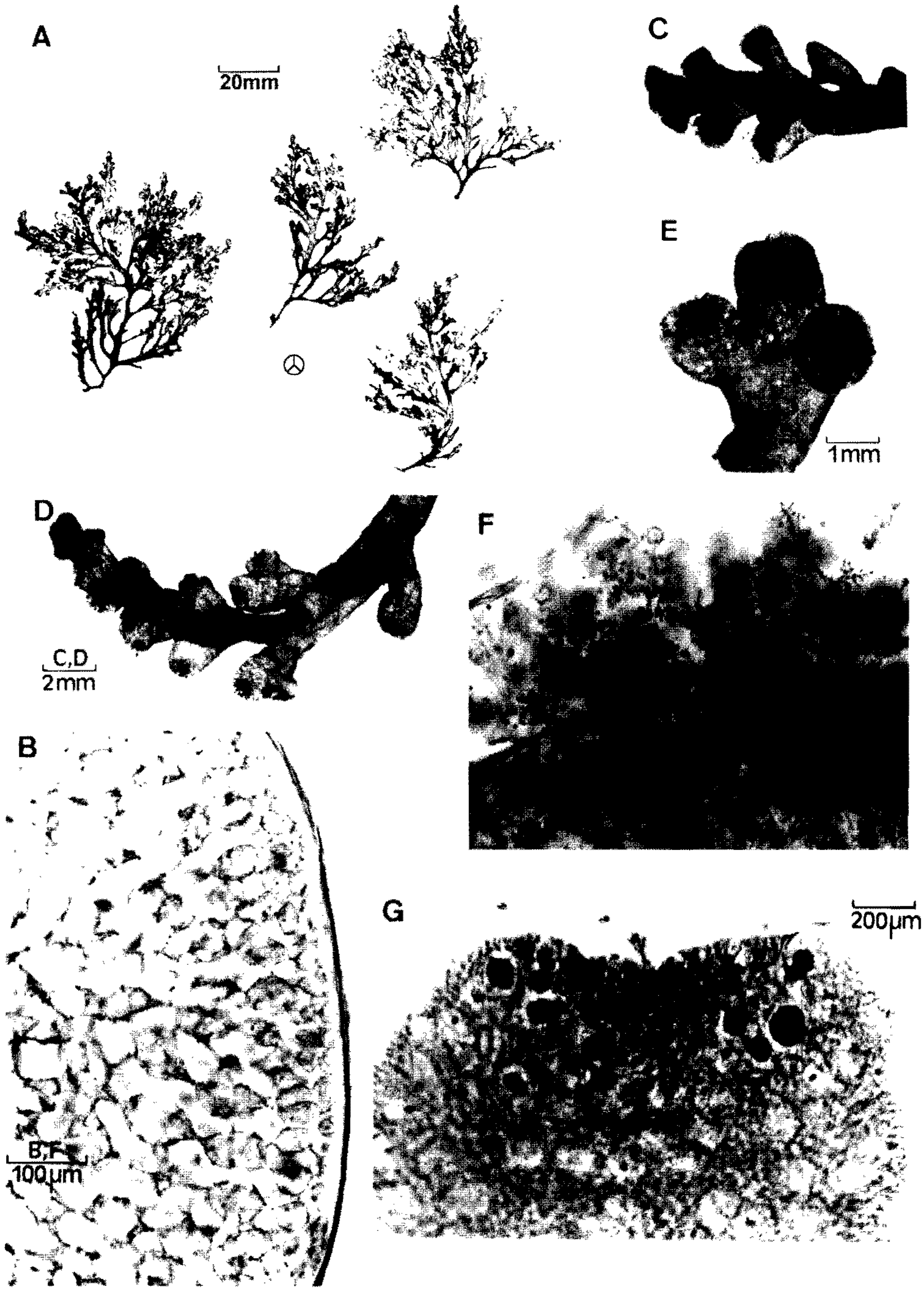

Fig. 217. *Chondrophycus brandenii* (AD, A44287). **A.** Habit. **B.** Transverse section of branch. **C.** Spermatangial branch. **D, E.** Tetrasporangial branches. **F.** Spermatangial trichoblasts in branch apex. **G.** Tetrasporangia in branch apex. (**A, C–E** as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

KEY TO SPECIES OF *CHONDROPHYCUS*

1. Thallus soft to moderately firm, not drying cartilaginous; epidermal cells not palisade-like but obconical in section of branches .... 1. *C. brandenii*
1. Thallus firm, drying cartilaginous; epidermal cells elongate and palisade-like in section of branches 2

2. Usually epiphytic on *Amphibolis*; thallus with divergent and relatively distant branches mostly 0.5–1 mm in diameter .... 2. *C. cruciatus*
2. Epilithic; branches small and prolific or swollen and 1–4 mm in diameter 3

3. Thallus with profuse, small, ultimate branchlets .... 3. *C. paniculatus*
3. Thallus with stout, swollen, branches; ultimate branchlets reduced to swellings on parent branch, with groups of tetrasporangia along the parent branch .... 4. *C. tumidus*

1. **Chondrophycus brandenii** (Saito & Womersley)Nam 1999: 463.

Laurencia brandenii Saito & Womersley 1974: 842, figs 5A, B, 23. Ducker *et al.* 1977: 87. Shepherd 1983: 83. Shepherd & Womersley 1981: 368. Silva *et al.* 1996: 504.

FIGS 217, 219A

Thallus (Fig. 217A) red to red-brown, soft, drying adherent to paper, 4–8 cm high, with one to several axes bearing laterals irregularly radially for 3–4 orders, branches terete to larger ones slightly compressed; axes 3–4 mm in diameter, laterals 1.5–2 mm and ultimate ramuli (0.8-) 1–1.5 mm in diameter. Holdfast discoid, 1–3 mm across; epilithic, on shells, or epiphytic on *Amphibolis*. *Structure*. Epidermal cells isodiametric and rounded, 15–25 µm across near apices, increasing to 45 µm across and L/D 1–2 below, without secondary pit-connections and *corps en cerise*; in section (Figs 217A, 219A), obconical to rounded, 20–35 µm across and long, with spaces below epidermal and between cortical cells which lack lenticular thickenings. Cells uninucleate, larger multinucleate; rhodoplasts discoid, ribbon-like in larger cells.

Reproduction. Female plants unknown. Spermatangial receptacles (Fig. 217C) shortly clavate, 1–1.5 mm across, spermatangia (Fig. 217F) borne on trichoblasts.

Tetrasporangial stichidia (Fig. 217D, E) simple, becoming compound, 0.7–1.5 mm broad and 1.5–3 mm long, tetrasporangia (Fig. 217C) cut off abaxially in right-angle arrangement, 80–150 µm in diameter, decussately to tetrahedrally divided.

Type from Elliston Bay, S. Aust., 5 m deep (*Branden & Shepherd*, 24.x.1973); holotype in AD, A44287.

Distribution: Elliston to Marino, S. Australia.

Known specimens: N Spencer Gulf, S. Aust., 10 m deep (*Shepherd*, 13.ix.1973; AD, A44291). South West R. mouth, Kangaroo I., S. Aust. (*Mitchell*, 24.viii.1963; AD, A26836). Marino, S. Aust., on *Amphibolis antarctica*, 3 m deep (*Owen*, 1.iv.1970; AD, 41906 and 1.x.1972; AD, A42774).

Chondrophycus brandenii is apparently a rare species. It has been recorded from India (see Silva *et al.* 1996, pl. 504) but these records need verification.

2. **Chondrophycus cruciatus** (Harvey)Nam 1999: 463.

Laurencia cruciata Harvey 1855a: 544; 1863, synop.: xxvi. J. Agardh 1876: 652. De Toni 1903: 790. Ducker *et al.* 1997: 87. Huisman 1997: 205. Huisman & Walker 1990: 436. Levring 1946: 226. Lucas 1909: 39. Millar 1990: 464, fig. 75. Millar & Kraft 1993: 54. Saito & Womersley 1974: 843, figs 5C, 24. Silva *et al.* 1996: 507. Sonder 1880: 30. Tate 1882a: 122. Tisdall 1898: 512. Womersley 1953: 38. Yamada 1931: 198, pl. 5a, fig. E.

FIGS 218, 219B

Thallus (Fig. 218A) dark brown-red, firm, cartilaginous, 2–7 cm high, with one to several main branches bearing irregularly radially lesser branches for 3 or 4 orders, mostly 2–6 mm apart, alternate to subopposite (then appearing "cruciate"), branched at wide angles (Fig. 218B), terete and of uniform diameter, 0.7–1 (-1.2) mm in main branches, 0.5–1 mm in lesser branches, with slightly broader, truncated apices. Holdfast small, discoid; usually epiphytic on *Amphibolis*. *Structure*. Epidermal cells rounded to oval near apices, 10–20 µm across with the gelatinous wall matrix often polygonal, elongating to L/D 2–5 below (Fig. 218C), without secondary pit-connections or *corps en cerise*; in section, epidermal cells compact (Fig. 219B), palisade-like and L/D 1.5–2 near apices, 2–5 (-8) in older parts; cortical cells compact with slight spaces, cells becoming thick walled with occasional massive thickenings. Cells with discoid to elongate rhodoplasts, chained in larger cells.

Reproduction. Female plants unknown. Spermatangial ramuli with terminal receptacles 0.7–1 mm across.

Stichidial branchlets short, simple, clavate, with broad truncated apices, tetrasporangia (Fig. 218D) cut off abaxially in right-angle arrangement, subspherical to ovoid, 90–120 µm in diameter, tetrahedrally to decussately divided.

Type from Rottnest I., W. Aust., on *Amphibolis antarctica* (*Harvey*); lectotype in Herb. Harvey, TCD (Trav. Set 209).

Distribution. Houtman Abrolhos, W. Aust., to Kingston, S. Aust., in isolated localities. N.S.W. Tropical Indian Ocean (see Silva *et al.* 1996: 507).

Selected specimens: Port Denison, W. Aust., drift (*Kraft*, 14.xii.1971; AD, A41615). Safety Bay, W. Aust., drift (*Womersley*, 18.viii.1979; AD, A50755). Goose I., Recherche Arch., W. Aust., drift (*Willis*, 23.xi.1950; AD, A15912). Outer Harbor, S. Aust., on *Amphibolis antarctica*, drift (*Womersley*, 16.vii.1950; AD, A13287). 5 km W of Port Noarlunga, S. Aust., 21 m deep (*Ottaway*, 8.xii.1980; AD, A52130). Kingston, S. Aust., on *Amphibolis antarctica*, 6–7 m deep (*R. Lewis*, 28.xi.1972; AD, A42850).

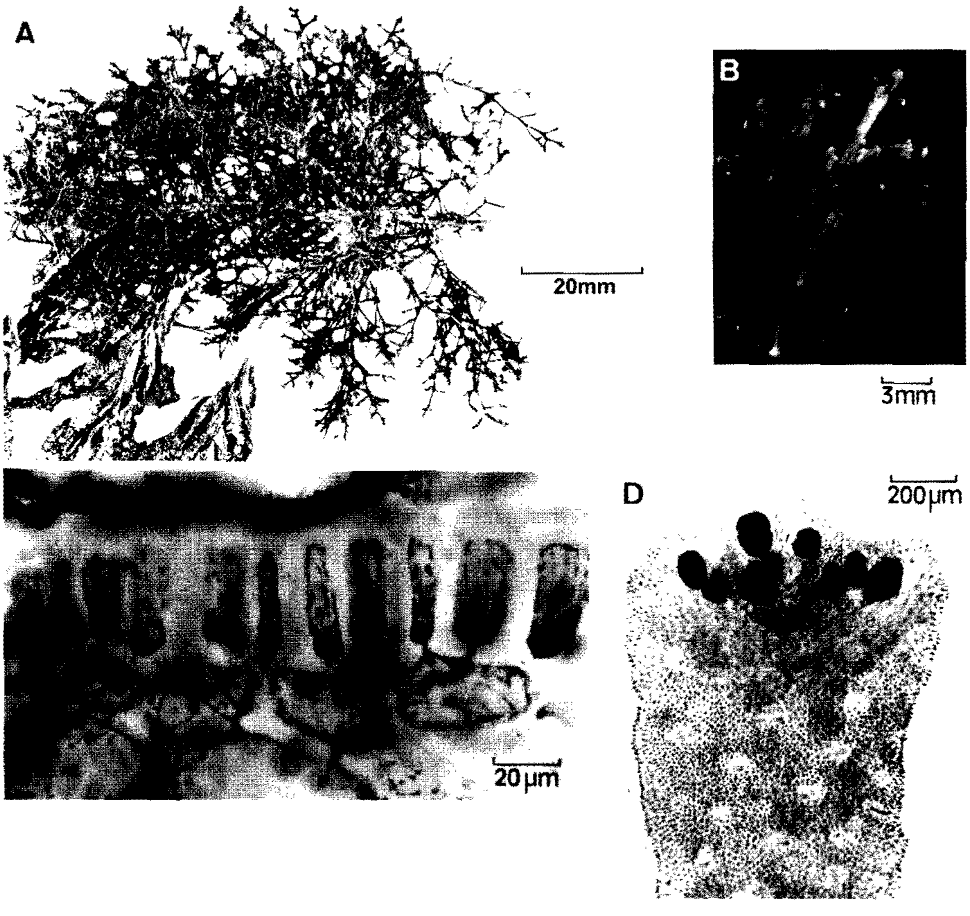

Fig. 218. *Chondrophycus cruciatus* (**A**, **B**, AD, A13287; **C**, AD, A42850; **D**, AD, A41615). **A**. Habit, on *Amphibolis*. **B**. Branches. **C**. Transverse section with elongate epidermal cells. **D**. Tetrasporangia in branch apex. (**B** as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

3. **Chondrophycus paniculatus** (C. Agardh)Furnari *in* Boisset *et al.* 2000: 393
Chondria obtusa var. *paniculata* C. Agardh 1822: 343.
Laurencia paniculata (C. Agardh)J. Agardh 1852: 755; 1876: 651. De Toni 1903: 788. Falkenberg 1901: 247. Saito 1969: 158. Saito & Womersley 1974: 845, figs 5D, 25. Shepherd & Womersley 1976: 191; 1981: 368. Yamada 1931: 192, pl. 3a.

FIGS 219C, 220

Thallus (Fig. 220A) dark red-brown, rigid, cartilaginous, 8–12 cm high, pyramidal in outline, becoming denuded below, profusely and closely radially branched (Fig. 220B) for 3–5 orders, branches terete; axes 1–1.5 mm in diameter, decreasing to branchlets 0.5–0.8 (-1) mm in diameter and 1–3 mm long, apices truncated and often slightly verrucose just below. Holdfast discoid, 2–10 mm across; epilithic. *Structure.* Epidermal cells polygonal, (12-) 15–25 (-35) µm across and L/D 1 (-2) near apices, scarcely elongating below, without secondary pit-connections or *corps en cerise*; in section, epidermal cells compact and palisade-like (Figs 219C, 220C), L/D (1-) 1.5–2 near apices, 2–3 (-4) in older branches; cortical cells compact, with few spaces and without lenticular thickenings. Cells with discoid to elongate rhodoplasts, ribbon-like and reticulate in cortical cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes (Fig. 220E) with a basal fusion cell and branched gonimoblast bearing clavate terminal carposporangia. Cystocarps (Fig. 220D) sessile, conical and broad-based, 0.7–1 mm in diameter; pericarp ostiolate and slightly operculate, 6–8 cells thick. Spermatangial ramuli short, with broad, truncated to concave receptacles 0.7–1.2 mm across, spermatangia borne on trichoblasts.

Tetrasporangial branchlets short, swollen, simple or basally branched, 800–1100 µm in diameter and 0.5–1.5 mm long, with tetrasporangia (Fig. 220F) cut off abaxially in right-angle arrangement, ovoid, 60–110 µm in diameter, tetrahedrally or decussately divided.

Type from Trieste, Adriatic Sea; lectotype in Herb. Agardh, LD, 36711.

Distribution: Widespread in the tropics and Mediterranean.

In southern Australia, from the Head of the Great Australian Bight, S. Aust., to Western Port, Victoria.

Selected specimens: Head of Great Australian Bight, S. Aust., upper sublittoral (*Womersley*, 4.ii.1954; AD, A19150). Scott Bay, S. Aust., upper sublittoral pool (*Womersley*, 27.i.1951; AD, A13894). Elliston, S. Aust., upper sublittoral, reef in bay (*Womersley*, 15.i.1951; AD, A13733). Aldinga, S. Aust.; just below low tide (*Saito*, 27.ii.1972; AD, A41935). Vivonne Bay, Kangaroo I., S. Aust., in large pool, S side Ellen Point (*Womersley*, 2.i.1949; AD, A10810). Robe, S. Aust., 1–2 m deep near jetty (*Saito*, 12.ii.1972; AD, A41614). Crawfish Rock, Westernport Bay, Vic., at low tide level (*Womersley*, 16.i.1974; AD, A44608—"Marine Algae of southern Australia" No. 165).

Chondrophycus paniculatus apparently occurs in scattered localities in southern Australia, usually just below low tide level.

4. **Chondrophycus tumidus** (Saito & Womersley)Garbary & Harper 1998: 195. Nam 1999: 466.
Laurencia tumida Saito & Womersley 1974: 846, figs 5E, F, 26, 27. Shepherd & Womersley 1981: 369.

FIGS 219D, 221

Thallus (Fig. 221A) dark brown-red, robust, firm, cartilaginous, (2-) 10–15 cm high, with one to several axes, little-branched when young, becoming much-branched radially for 2–3 orders and pyramidal in form when mature; branches terete, axes (1-) 1.5–2 (-3.5) mm in diameter, slightly tapering basally, lesser branches 1.5–2.5 mm in diameter. Holdfast discoid, thin, 2–10 mm across; epilithic. *Structure.* Epidermal cells 12–20 µm across, isodiametric to slightly elongate, compact, scarcely elongating below, without secondary pit-connections or *corps en cerise*; in section (Fig. 219D), epidermal cells elongate and palisade-like, L/D 1.5–2.5, cortical cells compact, without lenticular thickenings. Cells with elongate rhodoplasts, ribbon-like and reticulate in cortical cells.

Reproduction. Gametophytes dioecious. Procarps not observed. Carposporophytes (Fig. 221E) with a basal fusion cell and branched gonimoblast bearing clavate terminal carposporangia 20–40 µm in diameter. Cystocarps (Fig. 221B) largely immersed, forming slight to hemispherical mounds on lesser branches, 0.7–1 mm across; pericarp ostiolate, several cells thick near ostiole. Spermatangial ramuli (Fig. 221C) short, papillate to cushion-shaped on the branchlets, with inflated receptacles 1.5–2 (-2.5) mm across, spermatangia borne on trichoblasts (Fig. 221F).

Tetrasporangia in short verrucose papillae (Fig. 221D), appearing clustered in cavities corresponding to the apices of very short ramuli, cut off abaxially, in right-angle arrangement (Fig. 221G), 75–120 μm in diameter.

Type from Robe, S. Aust., low eulittoral on slipway reef (*Womersley*, 9.x.1972); holotype and isotypes in AD, A42777—"Marine Algae of southern Australia" No. 139a, as *Laurencia*.

Distribution: Elliston, S. Aust., to San Remo, Vic, and around Tasmania.

Selected specimens: Elliston, S. Aust., 0.5 m deep on bar (*Shepherd*, 28.x.1972: AD, A42798). Kellidie Bay, Coffin Bay, S. Aust., uppermost sublittoral at entrance (*Womersley*, 22.viii.1967; AD, A31855—"Marine Algae of southern Australia" No. 139b, as *Laurencia*). Wanna, S. Aust., sublittoral

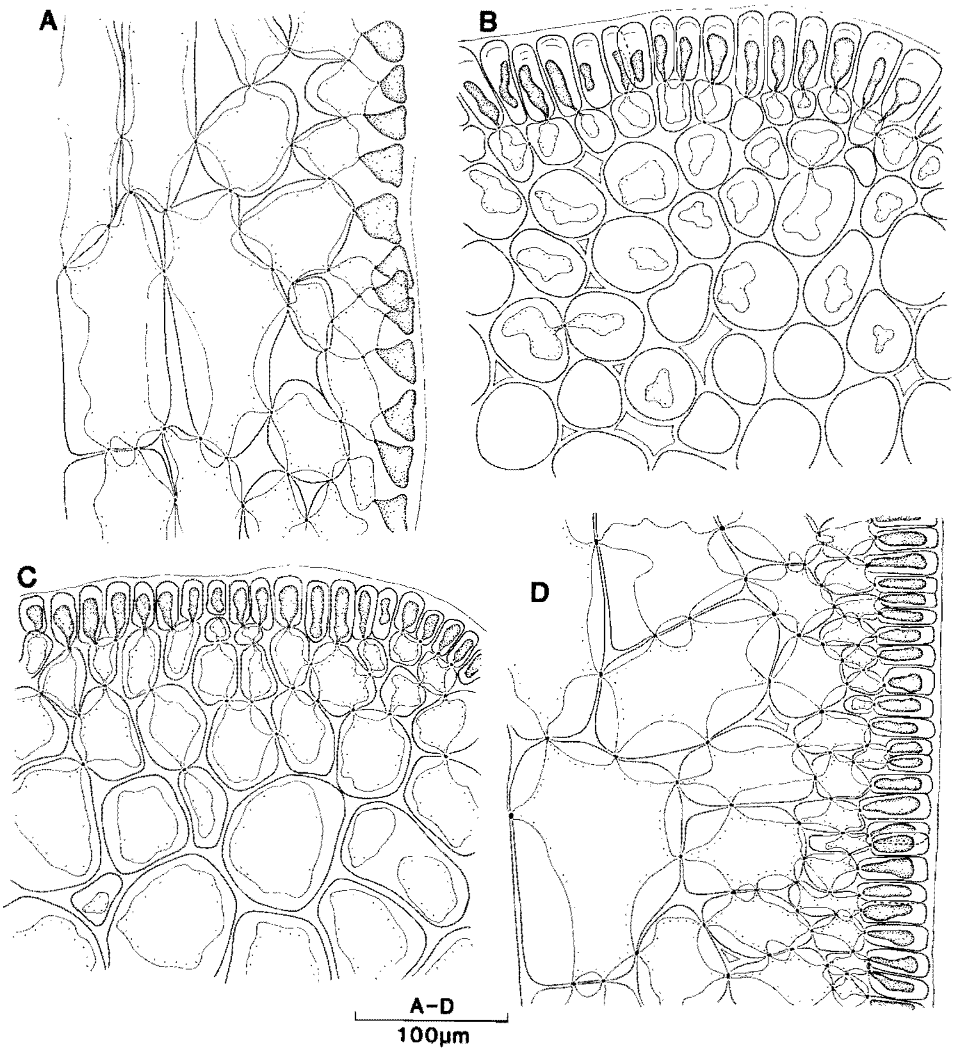

Fig. 219. **A**. *Chondrophycus brandenii* (AD, A44287). Longitudinal section. **B**. *Chondrophycus cruciatus* (AD, A13287). Transverse section. **C**. *Chondrophycus paniculatus* (AD, A41614). Transverse section. **D**. *Chondrophycus tumidus* (AD, A42777). Longitudinal section. (All as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

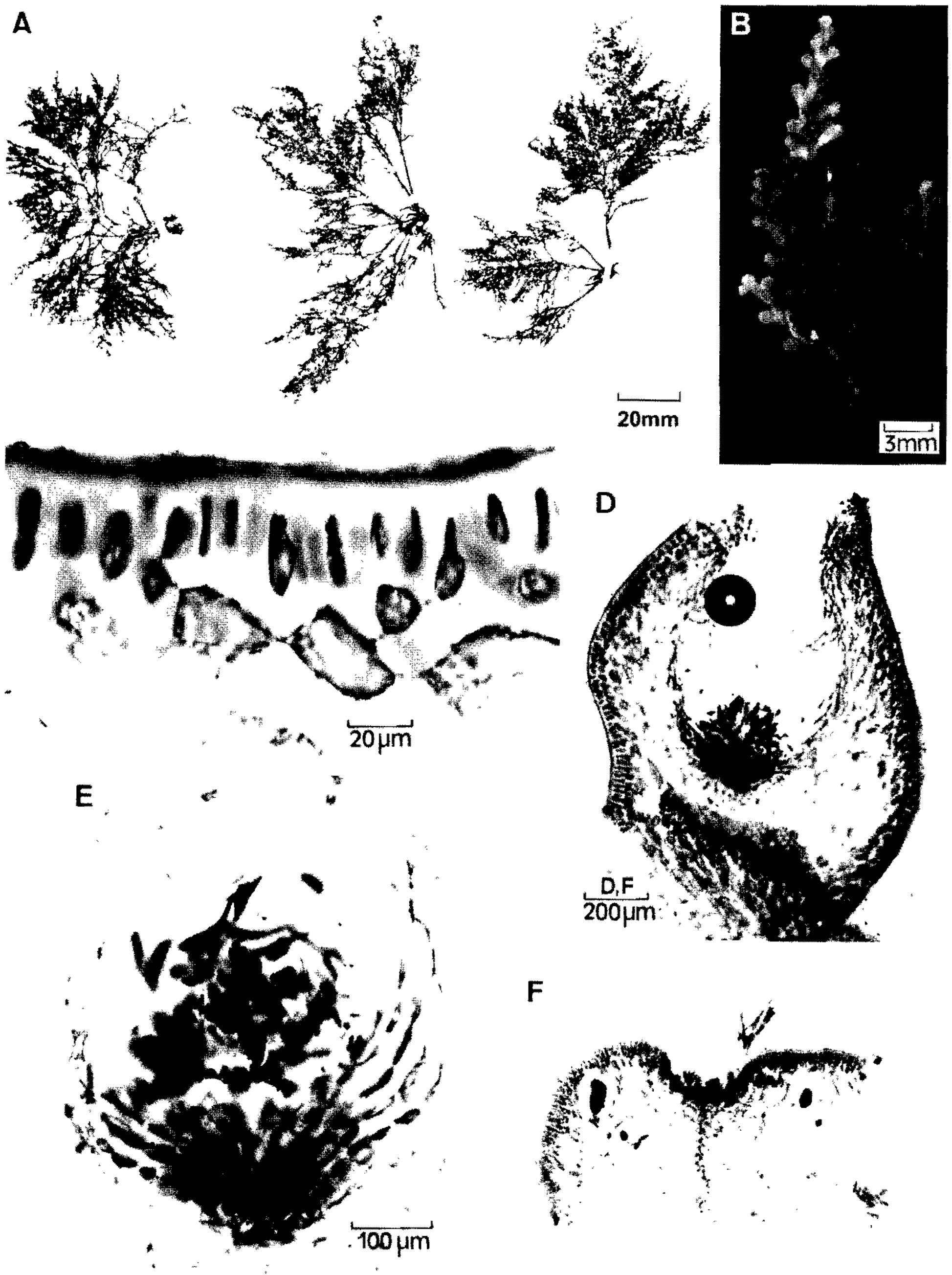

Fig. 220. *Chondrophycus paniculatus* (**A**, **B**, **F**, AD, A41614; **C–E**, AD, A13894). **A**. Habit. **B**. Branches. **C**. Transverse section of outer branch cells. **D**. Section of cystocarp. **E**. Carposporophyte. **F**. Branch apex with tetrasporangia. (**A**, **B**, as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

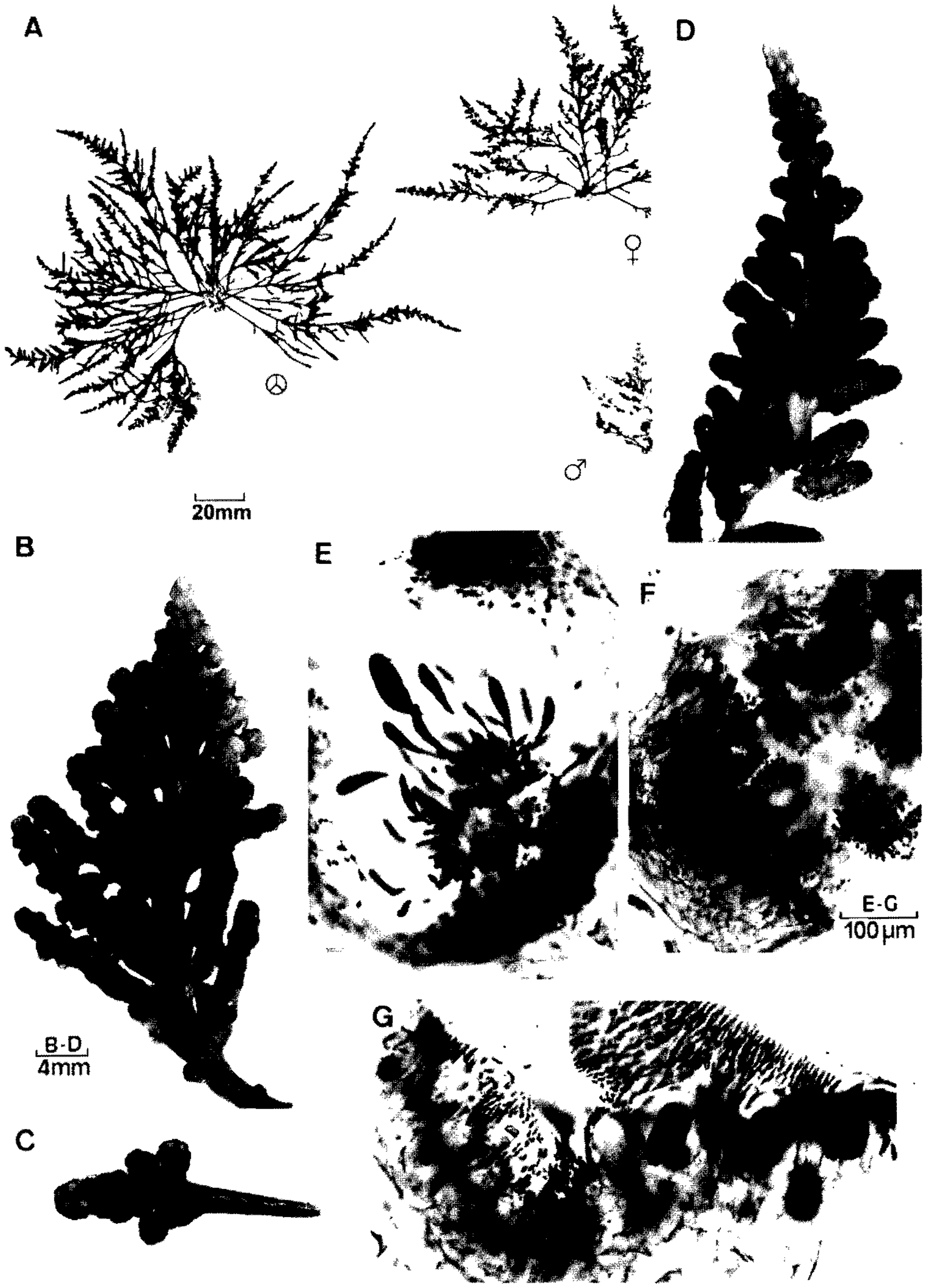

Fig. 221. *Chondrophycus tumidus* (**A–D**, **F**, **G**, AD, A42777; **E**, AD, A42547). **A**. Habit. **B**. Cystocarpic branch. **C**. Spermatangial branch. **D**. Tetrasporangial branch. **E**. Section of cystocarp with carposporophyte. **F**. Spermatangia on trichoblasts in section of apical pit. **G**. Tetrasporangia in section of branch apex. (**A–D** as in Saito & Womersley 1974, courtesy of Aust. J. Bot.)

fringe (*Kraft*, 11.xi.1971; AD, A42179). Edithburg, S. Aust., 1 m deep on jetty pylons (*Johnson*, 31.v.1984; A55527). Encounter Bay, S. Aust. (*Womersley*, 4.vi.1943; AD, A1777). "Gypsum wharf", Ballast Head, Kangaroo I., S. Aust., 0.5 m deep (*Kraft*, 16.vii.1972; AD, A42519). Vivonne Bay, Kangaroo I., S. Aust., lower eulittoral on jetty (*Kraft*, 15.vii.1972; AD, A42547). Pennington Bay, Kangaroo I., S. Aust. (*Saito*, 4.iv.1972; AD, A41971). Lawrence Rock, Vic., in rock pools (*Beauglehole*, 15.i.1960; AD, A24796). Warrnambool, Vic., on reef (*Shepherd*, 19.viii.1972; AD, A42627). Cape Nelson, Vic., mid eulittoral pool (*Womersley*, 2.ix.1971; AD, A39539). Crawfish Rock, Westernport Bay, Vic., 0 m deep (*Watson*, 17.xi.1974; AD, A46219). San Remo, Vic., drift (*Sinkora* A723, 15.viii.1970; AD, A41362). Mallacoota, Vic. (*Herada*, 13.xi.1977; AD, A52552). Rocky Cape, NW Tas., lower eulittoral pools (*Womersley*, 17.x.1982; AD, A55548). Low Head, Tas., upper sublittoral (*Cribb* 74.9, 16.ix.1950; AD, A16304). Tessellated Pavements, Eaglehawk Neck, Tas., low eulittoral (*Gordon*, 13.i.1966; AD, A30078).

Chondrophycus tumidus is a distinctive species occurring near to low tide level on coasts of moderate roughness, characterised by its robust thallus with extremely short branches bearing reproductive structures.

GENERA OF UNCERTAIN POSITION

The following 4 genera are regarded as ones which cannot be placed satisfactorily in one of the established groups or tribes.

Genus WILSONAEA Schmitz 1893: 231

Thallus erect, radially branched, branches bearing apical tufts of monosiphonous filaments but denuded below. *Structure*. Apices monopodial, with monosiphonous filaments several cells long, lower cells producing lateral monosiphonous branches in a 1/4 spiral and cutting off 4 (-5) pericentral cells each of which divides transversely into 2. Axes soon become corticated with rhizoids between the pericentral cells and an extensive parenchymatous cortex. The monosiphonous branches have adherent basal walls at the dichotomies and the lower segments become polysiphonous, and their cells are rhodoplastic.

Reproduction. Gametophytes dioecious. Procarps on several successive segments of special polysiphonous branches below terminal tufts, with a 4-celled carpogonial branch. Carposporophytes with a basal branched fusion cell and branched gonimoblast with terminal carposporangia. Cystocarps lateral and terminal on short branches, corticated. Spermatangia covering lower monosiphonous cells of the laterals, with an outer layer of spermatangia from a layer of initials produced by pericentral cells.

Stichidia robust, borne near ends of lesser branches, with whorls of 4–5 pericentral cells and 3–4 tetrasporangia, each with 3 cover cells and an outer cortical layer.

Type (and only) *species*: *W. dictyuroides* (J. Agardh)Schmitz 1893: 231.

The position of *Wilsonaea* was considered by Schmitz (1923, p. 231) as possibly closest to *Bostrychia*, which it resembles in the transversely divided pericentral cells, position of carpogonial branches and whorls of tetrasporangia. Falkenberg (1901, pp. 527–531) related it to both the Dasyaceae and *Bostrychia*. Kylin (1956, p. 555) considered it as probably a member of the Dasyaceae. The monopodial development, rhodoplastic monosiphonous filaments with adherent lower walls at the dichotomies (as in Dasyaceae, Heterocladieae, and some *Lophothalia* species), transversely divided pericentral cells, spermatangia covering cells of the filaments, and stichidia with whorls of 4–5 tetrasporangia are all distinctive features which point to a separate group or tribe for *Wilsonaea*.

Wilsonaea dictyuroides (J. Agardh)Schmitz 1893: 231. De Toni 1903: 1146. Falkenberg 1901: 527, pl. 12 figs 22, 23. Kylin 1956: 555. Lucas 1909: 47. Lucas & Perrin 1947: 306. May 1965: 379. Schmitz & Falkenberg 1897: 451. Shepherd & Womersley 1981: 367.

Dasya dictyuroides J. Agardh 1890: 111, pl. 3 fig. 5. Parsons & Womersley 1998: 479.

FIGS 222, 223

Thallus (Fig. 222A) medium to dark red-brown, 4–25 cm high, much branched irregularly radially, with a robust main axis 2–3 mm in diameter and laterals 0.5–1.5 mm in

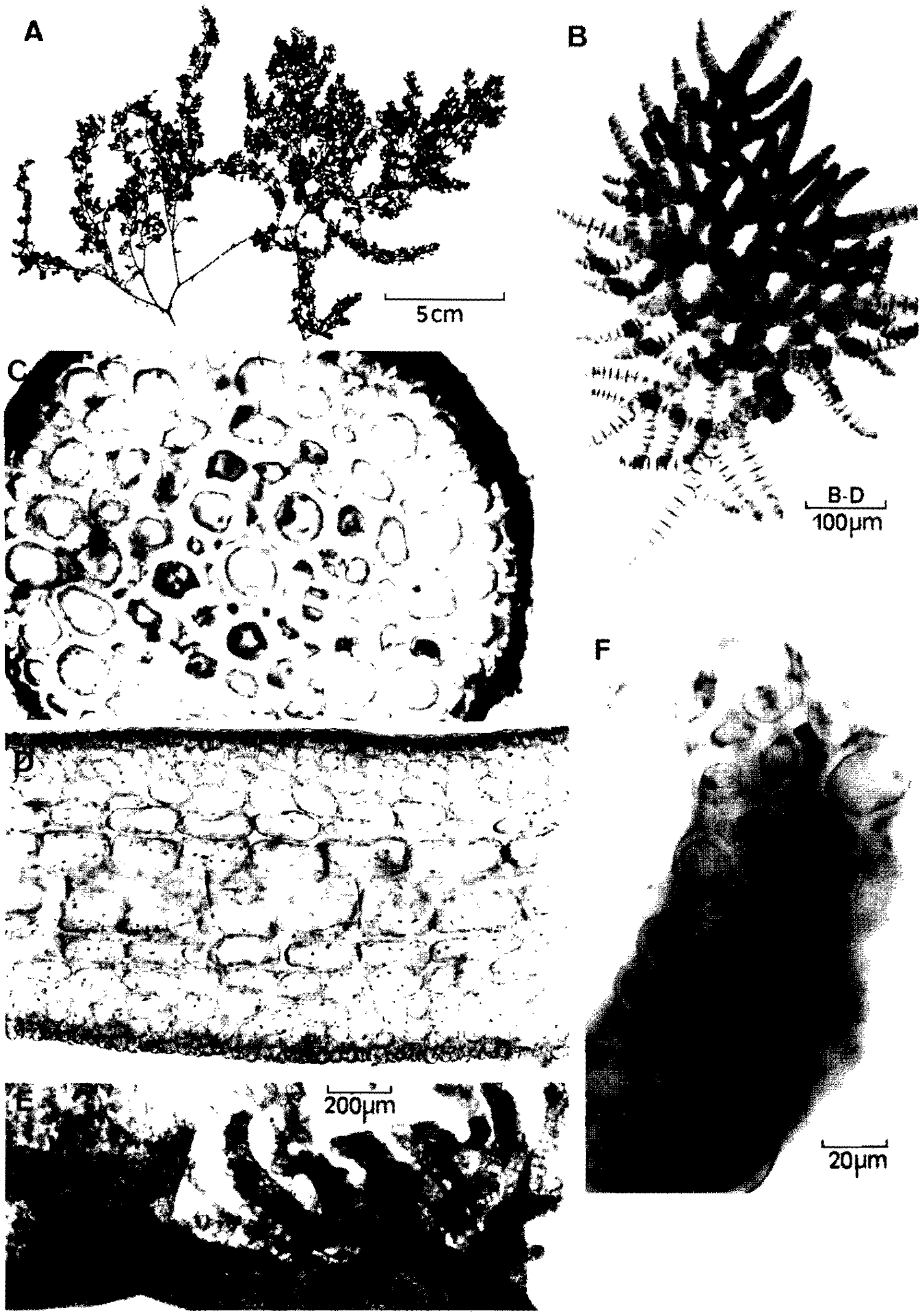

Fig. 222. *Wilsonaea dictyuroides* (**A**, **C**, AD, A68430; **B**, **D**, AD, A67935; **E**, **F**, AD, A34399). **A**. Habit. **B**. Apex of branch with monosiphonous laterals. **C**. Transverse section of axis with 5 pericentral cells and rhizoids. **D**. Longitudinal section of axis with 2 divided pericentral cells corresponding to each axial cell. **E**. Polysiphonous branches with procarp and a cystocarp (on left). **F**. Branch with carpogonial branches (darkly stained) on successive segments.

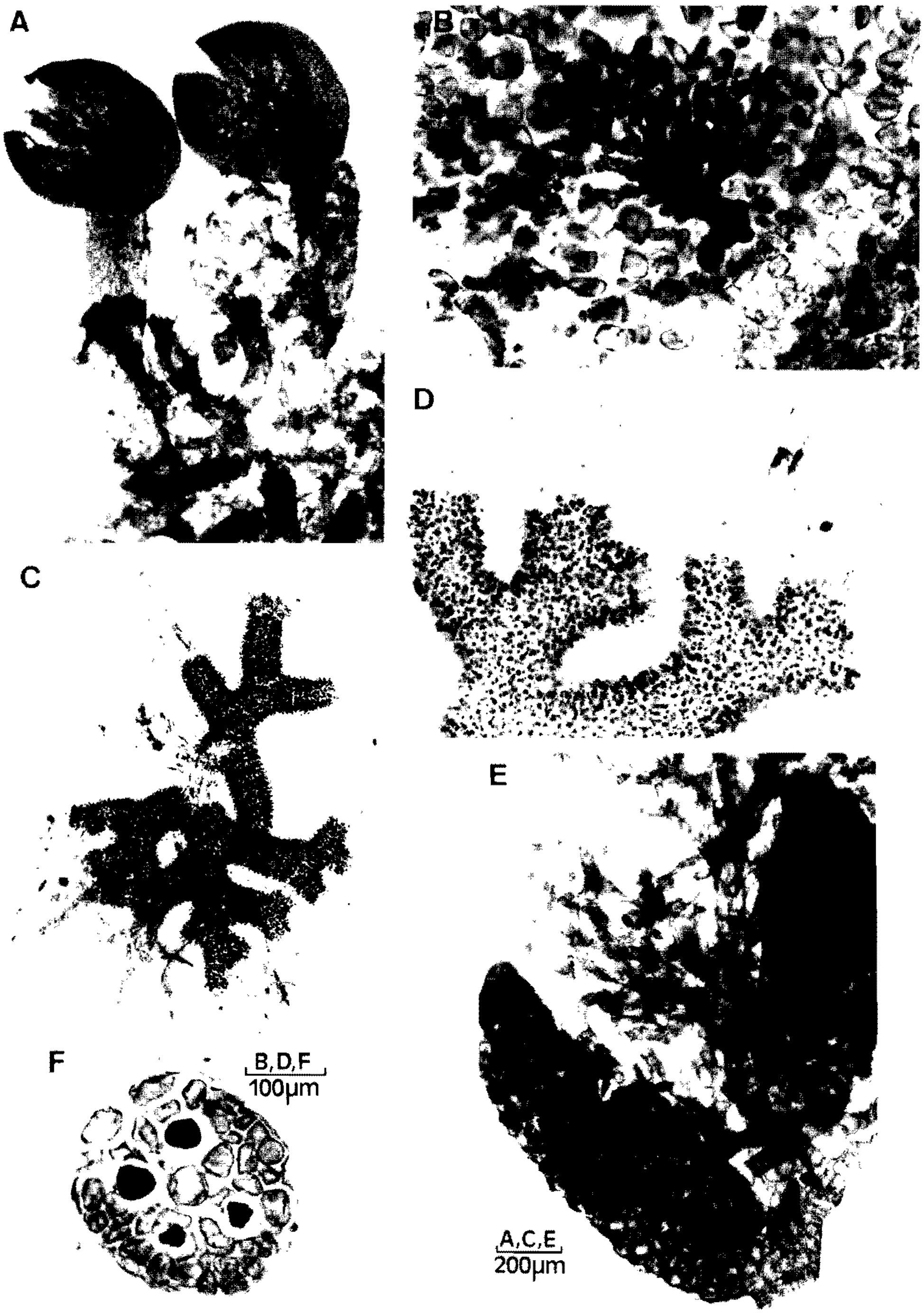

Fig. 223. *Wilsonaea dictyuroides* (**A**, **E**, **F**, AD, A34399; **B**, AD, A32962; **C**, **D**, AD, A33360). **A**. Cystocarps. **B**. Carposporophyte. **C**. Monosiphonous branches with spermatangia. **D**. As in **C**, enlarged. **E**. Stichidia. **F**. Transverse section of a stichidium, with a whorl of 4 tetrasporangia.

diameter, denuded below the apical tufts of monosiphonous laterals at the ends of lesser branches. Holdfast discoid-conical, 2–10 mm across; epilithic. *Structure*. Apices monopodial (Fig. 222B), apical cells dome-shaped, 14–20 μm in diameter with thin walls, monosiphonous and unbranched for 8–12 cells and below this cutting off exogenous lateral monosiphonous branches from each of 4–6 cells, with segments below this cutting off 4 (-5) pericentral cells (Fig. 222C) bearing monosiphonous lateral filaments which become basally polysiphonous; pericentral cells dividing transversely (Fig. 222D) into 2 irregular tiers and thus with 2 tiers between the monosiphonous lateral branches, and later becoming separated by rhizoidal cells and with a cortex becoming many cells thick below; the rhodoplastic monosiphonous laterals become branched at each cell in their lower parts (Fig. 222B), with adhering bases at the dichotomies, and the lower segments become polysiphonous; lower monosiphonous cells 50–75 μm in diameter and L/D (1-) 1.5–2.5, upper simple branches 5–12 cells long, tapering to terminal cells 20–30 μm in diameter and L/D (2-) 5–8, apices rounded. Cells uninucleate, larger ones multinucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Gametophytes dioecious. Procarps on special polysiphonous branches (Fig. 222E) below terminal tufts, on several successive segments (Fig. 222F), with a 4-celled carpogonial branch. Carposporophytes (Fig. 223B) with a basal branched fusion cell and branched gonimoblast with shortly clavate terminal carposporangia 30–45 μm in diameter; vegetative cells adjacent to the gonimoblast base becoming darkly staining. Cystocarps (Fig. 223A) lateral and terminal on short branches, more-or-less ovoid, 0.3–1 (-1.5) mm in diameter; pericarp ostiolate, with about 10 longitudinal filaments, corticated and 5–8 cells thick, outer cells isodiametric, irregularly placed. Spermatangia (Fig. 223C, D) cover lower monosiphonous cells of the laterals, with short pericentral cells branching and lying along the parent cell and producing an outer cortical layer then with outermost spermatangial initials.

Stichidia (Fig. 223E) robust, borne near base of lesser branches, lanceoid to elongate, 250–450 μm in diameter and 1–1.5 mm long, with whorls of 4–5 pericentral cells and 3–4 tetrasporangia (Fig. 223F) 70–120 μm in diameter, 3 cover cells and an outer layer of cortical cells.

Type from Western Port, Vic. (*Wilson* 66, 7.i.1885); holotype in Herb. Agardh, LD, 44358 (this is the only specimen in Herb. Agardh collected before 1890).

Distribution: Hopetoun, W. Aust., to Western Port, Victoria.

Selected specimens: Hopetoun, W. Aust., drift (*Parsons*, 20.xi.1968; AD, A33360—"Marine Algae of southern Australia" No. 118) and 3–4 m deep on rocks under jetty (*Kraft & Ricker*, 16.viii.1979; MELU, K6999). Eyre, W. Aust., drift (*Parsons*, 22.xi.1968; AD, A34399). Marion Bay, S. Aust., drift (*Womersley*, 9.x.1998; AD, A67935). Off Troubridge I., S. Aust., 23 m deep (*Shepherd*, 4.ii.1969; AD, A33830). Port Elliot, S. Aust., drift (*Gordon*, 8.x.1967; AD, A32961). Seal Bay, Kangaroo I., S. Aust., drift (*Womersley*, 22.xi.1968; AD, A32962). Bales Beach, Kangaroo I., S. Aust., drift (*Womersley*, 29.xii.1999; AD, A68430). Port Phillip Heads, Vic. (*Wilson*, 9.ii.1894; MEL, 584174).

Parsons & Womersley (1998, p. 479) commented briefly on *Wilsonaea dictyuroides*, considering that detailed studies were needed of its relationships.

Genus **HALYDICTYON** Zanardini 1843: 52

Thallus forming an irregularly expanding network, vaguely lobed or branched; usually epiphytic, attached by short processes. *Structure*. Growth from surface areas of small meristematic cells regularly arranged, forming square or polygonal cell meshes by union of lateral cells at the join of adjacent branches; cells expanding in size but not dividing below the meristematic surface area. Cells multinucleate.

Reproduction. Gametophytes monoecious (Coppejans 1975), female plants rare. Procarps borne on upper filaments, developing 4 pericentral cells, with a carpogonial branch. Cystocarps ovoid to urceolate, pericarp ecorticate. Spermatangial organs compressed, ovate, with sterile basal cell and marginal cells, the axial cells cutting off lateral pericentral cells which produce the sterile marginal cells and transverse cells which form plates of smaller cells which produce spermatangia.

Tetrasporangial stichidia compressed, ovate-pointed to elongate, with opposite tetrasporangia. Axial cells with 4 pericentral cells, the transverse ones remaining undivided

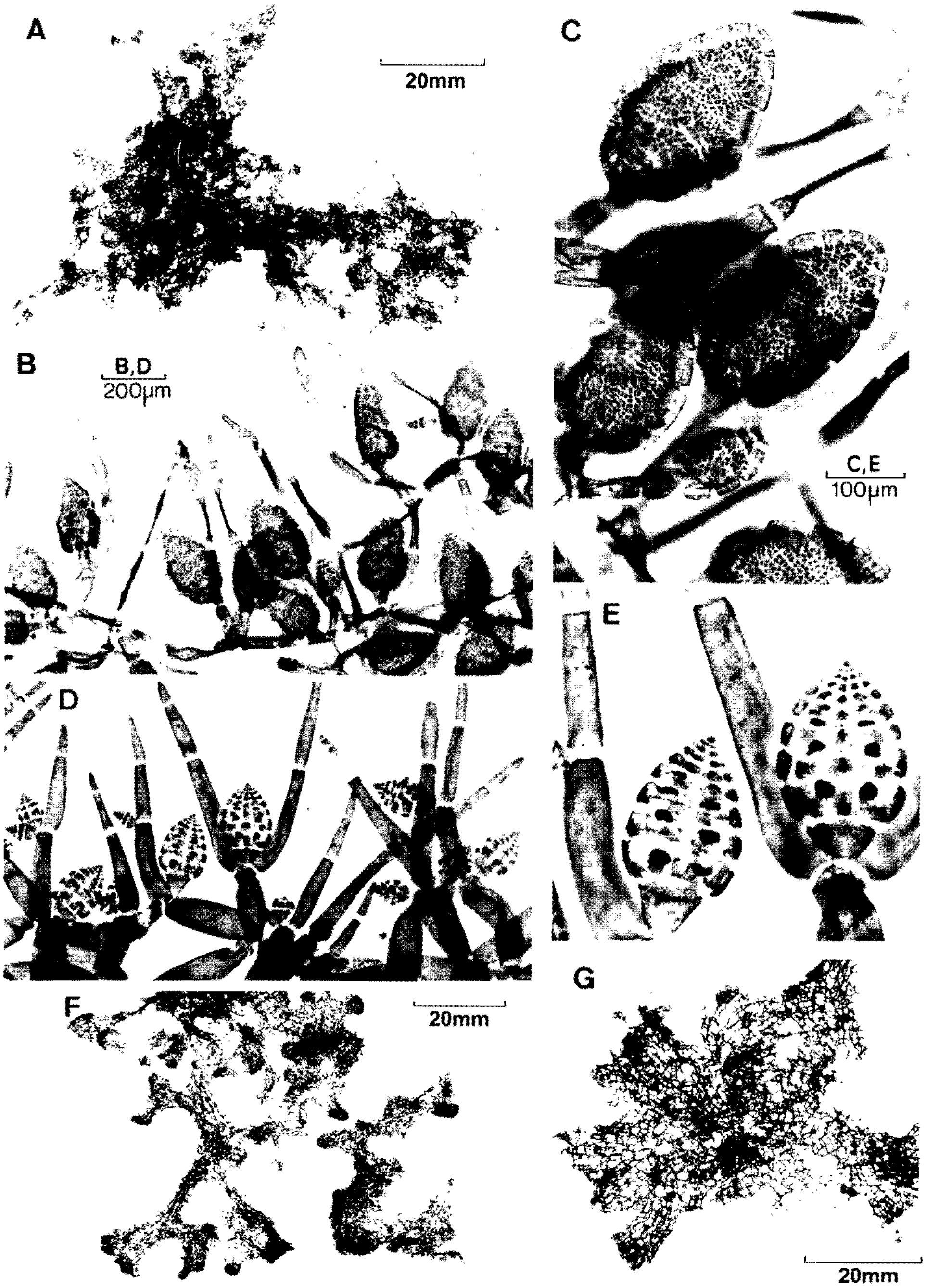

Fig. 224. A–E. *Halydictyon arachnoideum* (**A**, AD, A45257; **B**, **C**, AD, A56771; **D**, **E**, AD, A26655; **F**, AD, A1425; **G**, AD, A38160). **A**. Habit. **B**. Branches with spermatangial organs. **C**. Compressed spermatangial organs with sterile-cell margins. **D**. Branches with stichidia. **E**. Compressed stichidia with paired tetrasporangia. **F**. Habit of "robustum" form. **G**. Enlargement of part of robust thallus.

and the lateral ones cutting off marginal cells and a lateral cell on each side of the stichidium, then a tetrasporangium upwards; tetrasporangia subspherical, tetrahedrally divided.

Type species: *H. mirabile* Zanardini 1860: 17.

A genus of 3 or 4 species, one from southern Australia and *H. australe* (Sonder)Harvey (1859a, pl. 91), distinguished by its habit, the meshes forming branched terete fronds 4–6 mm broad and 5–15 cm high, occurring on the West Australian coast apparently from Rottnest I. north.

Halydictyon (incorrectly spelt *Halodictyon* – see Silva 1996, p. 495) is a little-known genus as to its female reproduction and taxonomic relationships; a polysiphonous structure occurs only in the reproductive organs. It has been placed in the Dasyaceae (e.g. Coppejans 1975) or the Rhodomelaceae (e.g. Silva *et al.* 1996, p. 495). Falkenberg (1901, p. 697) and Børgesen (1930, p. 143) relate it to the Delesseriaceae. From the reproductive organs it appears most likely to be rhodomelaceous but this should be clarified by detailed studies of the female structures and by protein sequencing.

Halydictyon arachnoideum (Harvey)Harvey 1858: pl. 37A. De Toni 1903: 1246. Falkenberg 1901: 693. Guiler 1952: 100. Lucas 1912: 159. Lucas & Perrin 1947: 322. May 1965: 360. Shepherd & Womersley 1971: 166.

Hanowia arachnoidea Harvey 1855a: 558. J. Agardh 1863: 1254. Sonder 1880: 31. Tisdall 1898: 512. Wilson 1892: 164.

Hanowia robusta Harvey 1855a: 558. J. Agardh 1863: 1254. Sonder 1880: 31. Tisdall 1898: 512. Wilson 1892: 164.

Halodictyon robustum (Harvey)Harvey 1858: pl. 37B. De Toni 1903: 1245. Falkenberg 1901: 693. Huisman & Walker 1990: 434. Lucas 1912: 159. Lucas & Perrin 1947: 323. May 1965: 360. Silva *et al.* 1996: 495.

Halodictyon velatum Reinbold 1897: 58; 1898: 48. De Toni 1903: 1246. Lucas 1912: 159. Lucas & Perrin 1947: 322. May 1965: 360.

FIG. 224

Thallus (Fig. 224A, F, G) forming an irregularly expanding net 1–12 cm high and broad, with more-or-less compressed lobes or branches 2–10 mm broad. Usually epiphytic on other algae, attached by small adherent branchlets or long rhizoidal branches. *Structure*. Growth from plate-like areas of small meristematic cells at the end of branches, the cells regularly positioned and producing laterals which join to adjacent filaments at their cross walls thus forming 4 cells (rarely 3 or 5) around square interstices. Young cells 20–60 µm in diameter and L/D 1–2, expanding to 80–200 µm in diameter and L/D (2-) 4–8 (-10), with the largest cells in the lower thallus 120–240 (-400) µm in diameter and L/D (3-) 4–10. Cells multinucleate; rhodoplasts discoid, chained in larger cells.

Reproduction. Female plants unknown. Spermatangial organs (Fig. 224B, C) ovate, compressed, 100–200 µm broad and 140–400 µm long with a single sterile basal cell and sterile marginal cells (Fig. 224C) 20–25 µm in diameter and L/D 1–2 (-3) surrounding spermatangial cells. Axial cells 4–7, each (except the terminal one) cutting off a lateral pericentral cell which produces a sterile marginal cell and a transverse cell forming a plate of initials each cell of which cuts off 3–4 spermatangia.

Tetrasporangial stichidia (Fig. 224D, E) compressed, 120–180 µm broad, when first fertile 200–300 µm long, later extending to 800–1000 µm long. Axial cells cutting off 4 pericentral cells, the transverse ones remaining undivided and the lateral cells (Fig. 224E) each cutting off a marginal cell, two lateral cells and a tetrasporangium which becomes 40–50 µm in diameter; cover cells uncertain, doubtfully present.

Type from King George Sound, W. Aust. (*Harvey*); lectotype in Herb. Harvey, TCD (Trav. Set 52).

Distribution: Cottesloe, W. Aust., to Deal I., Bass Strait and Coles Bay, Tasmania (Guiler 1952, p. 100).

Selected specimens: Cottesloe, W. Aust., drift (*Smith* A427, June 1964; AD, A28997). Fremantle, W. Aust. (*Harvey*, Alg. Aust. Exsicc. 342, TCD—type of *H. robusta*) and W. Aust. (*Clifton*; AD, A18257). Waterloo Bay (*Elliston*), S. Aust., 10 m deep (*Shepherd*, 2.v.1982; AD, A53134). Investigator Strait, S. Aust., 43 m deep (*Watson*, 27.i.1971; AD, A38160). Off Outer Harbor, S. Aust., 16 m deep

(*Loan*, 8.viii.1963; AD, A26655). Off Grange, S. Aust., on artificial reef, 20 m deep (*Branden*, 4.ix.1985; AD, A56771). Kingscote, Kangaroo I., S. Aust., 6 m deep at jetty (*Lavers*, 7.vii.1997; A67768). American R. inlet, Kangaroo I., S. Aust., drift (*Womersley*, 31.x.1966; AD, A30826) and (*L. Clark*, 20.viii.1954; AD, A19785). Muston, Kangaroo I., S. Aust., 0–3 m deep (*McKelvey*, 18.iv.1999; AD, A68247). Rocky Point beach, Kangaroo I., S. Aust., drift (*Womersley*, 21.viii.1948; AD, A8612). Stanley Beach, S coast Kangaroo I., S. Aust., drift (*Womersley*, 7.ii.1956; AD, A20078). Margaret Brock Reef, S. Aust., 3–4 m deep (*Ball*, 8.xii.1973; AD, A44589). Lacepede Bay, S. Aust. (*Engelhart*; AD, A1425, probably isotype of *H. velatum* Reinbold). West Cove, Erith I., Kent Group, Bass Strait, 20 m deep (*Shepherd & R. Lewis*, 10.v.1974; AD, A45257). East Cove, Deal I., Kent Group, Bass Strait, 10 m deep (*Shepherd & R. Lewis*, 7.v.1974; AD, A45100).

Both *Halydictyon arachnoideum* and *H. robustum* (type from Fremantle, W. Aust., Trav. Set 342 in Herb. Harvey, TCD) have been recognised on southern Australian coasts since Harvey (1855a) described them in the same publication. However the cell dimensions as the cells mature from the branch apices cover a wide range, and both species come within the ranges given above. Hence they are here combined under *H. arachnoideum* as the most suitable species name. *H. velatum* Reinbold [type from Lacepede Bay, S. Aust. (*Engelhart*), in Herb. Reinbold, M; isotype in AD, A1425] also comes within the species circumscription.

Apparently female plants have never been found, but one male plant (AD, A56771) is known.

Genus CHAMAETHAMNION Falkenberg *in* Schmitz & Falkenberg 1897: 449

Thallus epiphytic or parasitic on rhodomelaceous hosts, with a pseudoparenchymatous base and erect, simple or branched, branchlets 2–3 mm high, branchlets terete, with 5 pericentral cells and trichoblasts, ecorticate. Attachment by intermixing of parasite and host cells. Cells uninucleate; rhodoplasts absent or few.

Reproduction. Gametophytes dioecious. Procarps borne on a lower cell of trichoblasts, with a 4-celled carpogonial branch and sterile cells. Carposporophyte with a slight basal fusion cell and a branched gonimoblast with clavate carposporangia. Cystocarps ovoid, ostiolate, pericarp 2 cells thick, ecorticate. Spermatangial organs elongate-ovoid to sub-spherical.

Stichidia elongate, terete or compressed, bearing opposite tetrasporangia, with 2 cover cells.

Type species: C. schizandra Falkenberg *in* Schmitz & Falkenberg 1897: 449.

Chamaethamnion contains the type species from Australia and a second species, *C. pocockiae* Norris (1988b, p. 346) from Natal. It is the only parasitic (or largely so), tufted, genus with ecorticate erect branches and stichidia with opposite tetrasporangia.

Kylin (1956, p. 496) placed *Chamaethamnion* in his *Levringiella* group of parasitic genera, while Hommersand (1963, pp. 337, 338) placed it in the Lophothalieae; however, the trichoblasts are not rhodoplastic as in the latter group, and it is here regarded as of uncertain position.

Chamaethamnion schizandra Falkenberg *in* Schmitz & Falkenberg 1897: 449. De Toni 1903: 1007. Falkenberg 1901: 579, pl. 14 figs 9–17. Kylin 1956: 518. Lucas 1909: 43. May 1965: 379. Papenfuss 1968: 269. Silva *et al.* 1996: 479.

FIG. 225

Thallus (Fig. 225A, B, E) epiphytic (parasitic?) on *Polysiphonia decipiens* and *Micropeuce feredayae*, forming small, pale, subspherical thalli 1–3 mm across on the host branches. Attachment obscure, by rhizoids penetrating through the host cortex. *Structure.* Base of thallus pseudoparenchymatous, producing erect terete branches (Fig. 225A, D, E) 1–2 mm long and 60–120 µm in diameter, simple or occasionally branched apart from the trichoblasts. Apical cells dome-like, 8–10 µm in diameter, axial cells producing trichoblasts and 5 pericentral cells each 8–16 µm in diameter and L/D 2–4, ecorticate, segments L/D 0.4–0.8 (-1). Trichoblasts 200–400 µm long, branched, basal cells isodiametric and 30–40 µm in diameter, upper cells elongate and 6–8 µm in diameter. Cells uninucleate; rhodoplasts absent from most cells, occasionally present and elongate to ribbon-like.

Reproduction. Gametophytes dioecious. Procarps borne on a lower cell of trichoblasts, with a 4-celled carpogonial branch and a sterile branch, surrounded by a pre-fertilization pericarp. Carposporophyte (Fig. 225C) with a slight basal fusion cell and short, branched gonimoblast with elongate-clavate carposporangia 20–30 µm in diameter. Cystocarps (Fig. 225B, C) ovoid,

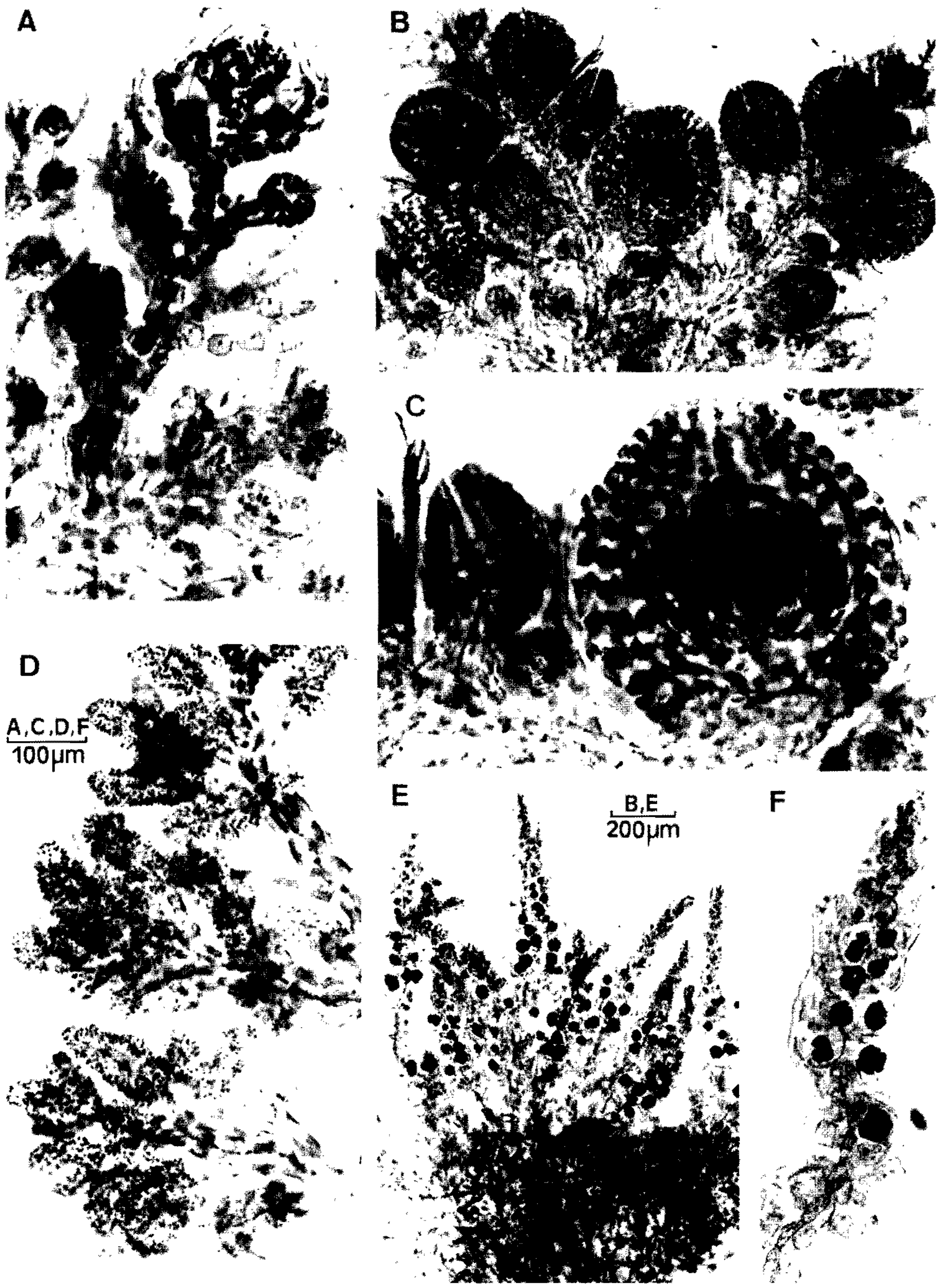

Fig. 225. *Chamaethamnion schizandra* (**A–D**, AD, A56426; **E**, **F**, AD, A29669). **A**. Branch with procarps and juvenile cystocarps. **B**. Branch with cystocarps. **C**. Cystocarp and carposporophyte. **D**. Branches with spermatangial organs. **E**. Thallus with basal cushion and erect tetrasporangial branches. **F**. Branch with opposite tetrasporangia.

400–700 μm in diameter; pericarp ostiolate, 2 (-3) cells thick, ecorticate apart from odd small cells, main outer cells isodiametric to laterally elongate, 20–25 μm across. Spermatangial organs (Fig. 225D) replacing trichoblasts, elongate-ovoid to lanceoid, 100–180 μm long and 50–80 μm in diameter, with 1–2 sterile basal cells but no sterile apical cell, and with 4–6 axial cells each with probably 3 pericentral cells cutting off outer spermatangia.

Stichidia (Fig. 225E, F) simple or occasionally branched, transformed from vegetative branches, terete, 0.5–1 mm long and 120–180 μm in diameter, bearing trichoblasts. Tetrasporangia opposite (Fig. 225F) in each segment, decussately arranged, 40–75 μm in diameter, with 2 cover cells.

Type from Australia. Falkenberg also gave South Africa in the protologue but not in 1901, and Papenfuss (1968, p. 269) excluded this locality. The precise type locality is unknown. Presumably the type is in Herb. Falkenberg, Naples.

Distribution. The E coast of Gulf St Vincent, S. Australia.

Selected specimens: Grange, S. Aust., on *Micropeuce* on tyre reef, 20 m deep (*Branden*, 7.iii.1985; AD, A56426). Brighton, S. Aust., on *M. feredayae*, drift (*Bienert*, 12.xi.1965; AD, A29669).

The above description is based on these two collections, which appear to agree well with Falkenberg's (1901) illustrations of what appears to be a rare species.

Genus TYLOCOLAX Schmitz *in* Schmitz & Falkenberg 1897: 478

Thallus forming small pustules on the host surface, each with a basal, hemispherical, pseudoparenchymatous cushion bearing erect, polysiphonous branches; attachment by short, often rhizoidal, cells to the host surface; epiphytic (parasitic?) on *Lenormandia spectabilis*. *Structure.* Erect branches mostly simple, with 5 (or 6?) pericentral cells, lightly corticated, with short apical trichoblasts.

Reproduction. Gametophytes probably dioecious. Procarps borne on trichoblasts, with a 4-celled carpogonial branch and sterile cells, soon covered by the pericarp. Carposporophyte with a basal fusion cell and branched gonimoblast bearing clavate terminal carposporangia. Cystocarps ovoid, short-stalked; pericarp ostiolate, 4–5 cells thick. Spermatangial organs borne on trichoblasts, with a sterile basal cell, ovoid.

Tetrasporangia (Schmitz) in stichidia in 2 longitudinal rows, from opposite pericentral cells, with 2–3 cover cells.

Type (and only) *species*: *T. microcarpus* Schmitz *in* Schmitz & Falkenberg 1897, p. 478.

Tylocolax is still a little-known genus (see below). Kylin (1956, p. 519) places *Tylocolax* in his *Levringiella* Group while Hommersand (1963, p. 348) retains it as of uncertain position. It is here kept as a genus of uncertain position.

Tylocolax microcarpus Schmitz *in* Schmitz & Falkenberg 1897: 478. De Toni 1903: 1251. Goff 1982: 304. Kylin 1956: 519, fig. 412C. Lucas 1912: 159. Lucas & Perrin 1947: 323. May 1965: 384.

FIG. 226

Thallus (Fig. 226A) forming pustules 1–2.5 mm across and 1–1.5 mm high on the host, *Lenormandia spectabilis*, with a basal, hemispherical pseudoparenchymatous tissue from which more-or-ess erect (Fig. 226A, B), polysiphonous branches 300–600 μm high arise. Attachment by smaller, rhizoidal, cells on the surface of the host. *Structure.* Erect branches mostly simple, with 5 (or 6?) pericentral cells, lightly corticated, 70–90 μm in diameter, segments L/D 0.3–0.5. Trichoblasts present at least with gametophytic organs.

Reproduction. Procarps with a 4-celled carpogonial branch and probably sterile cells, soon enclosed by the pericarp. Carposporophyte (Fig. 226C) with a basal fusion cell and branched gonimoblast with clavate terminal carposporangia 20–25 μm in diameter. Cystocarps ovoid (Fig. 226B, C), 400–500 μm in diameter, short-stalked; pericarp ostiolate, 4–5 cells thick, corticated. Spermatangial organs (Fig. 226D) ovoid, 45–75 μm long and 30–45 μm in diameter, with a sterile basal cell.

Tetrasporangia originally described as in 2 longitudinal rows.

Type from south coast of Australia, on *Lenormandia spectabilis*; location?

Distribution: Point Avoid to Stanley Beach, Kangaroo I., S. Australia.

Selected specimens: Point Avoid, S. Aust., drift (*Womersley*, 2.xii.1975; A46907). Wanna, S. Aust., drift (*Womersley*, 19.ii.1959; AD, A22408). Encounter Bay, S. Aust., drift (*Cleland*; AD, A3657). Vivonne Bay, Kangaroo I., S. Aust., drift (*Womersley*, 24.i.1946; AD, A3335 and 14.i.1948; AD, A68976). Stanley Beach, Kangaroo I., S. Aust., drift (*Womersley*, 27.i.1957; AD, A20877).

Tylocolax is still a little-known parasitic alga, having never been re-described since the original description of Schmitz, who gave only a general stylised drawing of the thallus, repeated by Kylin (1956, fig. 412C). The above description is based entirely on dried specimens growing on *Lenormandia spectabilis* and agrees in general with the description of Schmitz. However, tetrasporangia in two straight longitudinal rows have not been observed though some elongate, decussately divided, tetrasporangial cells, 30–45 µm long and 14–18 µm in diameter, have been observed within short upright excrescences on the basal cushion (in A20877).

Re-examination of good, fertile, liquid-preserved material of *Tylocolax* is needed.

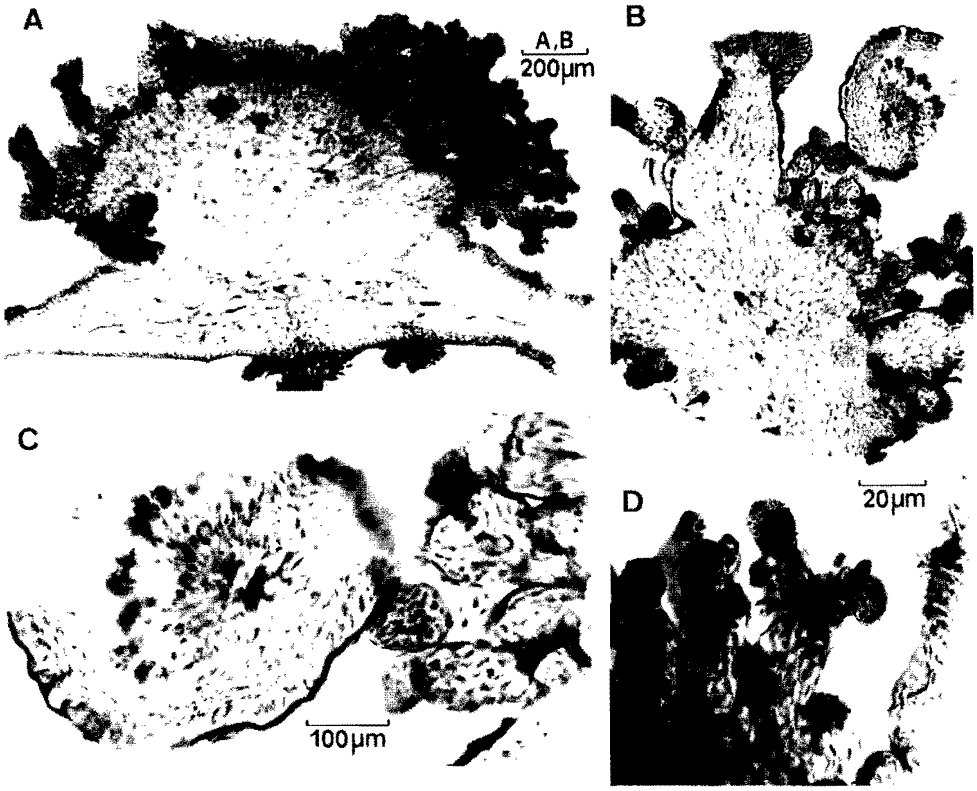

Fig. 226. *Tylocolax microcarpus* (**A**, **D**, AD, A68976; **B**, **C**, AD, A3335). **A**. Section of thallus on *Lenormandia*, with basal cushion bearing erect branches. **B**. Section of basal cushion with erect branches, one with a cystocarp. **C**. Section of cystocarp with carposporophyte. **D**. Erect branches with ovoid spermatangial organs.

APPENDIX

Adventive and Invasive Species

The following probable adventive species were included in the "Flora", and three invasive species have been found on southern Australian coasts since Parts I (Chlorophyta) and II (Phaeophyta) were published. Adventive species are usually found in restricted areas (commonly harbours) during relatively recent times, but their status is often uncertain.

There are also numerous species in all three phyla which are regarded as widely dispersed species rather than adventive ones. These include some species (such as *Polysiphonia brodiei*) which may be adventive, but they have been known to be present for a long time and are known from several localities. Species common to New Zealand and SE Australia are regarded as having this distribution rather than recent spread from one region to the other.

Some adventive species (eg. *Arthrocladia villosa*) have apparently not persisted in the southern Australian locality but invasive species such as *Codium fragile* ssp. *tomentosoides*, *Caulerpa taxifolia* and *Undaria pinnatifida* should be regarded as serious pests.

CHLOROPHYTA

Ulva taeniata (Setchell)Setchell & Gardner. Part I, p. 149.

Anadyomene stellata (Wulfen)C. Agardh. Part I, p. 217.

Codium fragile ssp. *tomentosoides* (van Goor)Silva. Recently (2002) found (common) in West Lakes, Adelaide, S. Aust. and earlier recorded by Campbell (1999) from bays on the Victorian coast. Recorded as a potential introduction by Furlani (1996). ["Marine Algae of southern Australia" No. 423.]

Caulerpa racemosa var. *laetevirens* f. *cylindracea* (Sonder)Weber van Bosse. Part I, p. 270. Recently found in the Port River estuary near Beacon 13, Outer Harbor, S. Aust., on artificial substrate, 2–3 m deep, 5.xii.2001, Coll. D. Wiltshire. An introduction from Western Australia.

Caulerpa taxifolia (Vahl)C. Agardh. A recent (2002) introduction to West Lakes, Adelaide, and the Port River, S. Aust., where it is common and regarded as a serious pest. An attempt to remove it completely from West Lakes by poisoning the whole lake with copper sulphate is planned by SARDI Aquatic Sciences in late 2002. ["Marine Algae of southern Australia" No. 422.] See Furlani (1996).

PHAEOPHYTA

Sorocarpus micromorus (Bory)Silva. Part II, p. 36.

Elachista orbicularis (Ohta)Skinner. Part II, p. 78.

Discosporangium mesarthrocarpum (Meneghini)Hauck. Part II, p. 146.

Sphacella subtilissima Reinke. Part II, p. 148.

Arthrocladia villosa (Hudson)Duby. Part II, p. 266.

Striaria attenuata Greville. Part II, p. 312.

Stictyosiphon soriferus (Reinke)Rosenvinge. Part II, p. 314.

Asperococcus compressus Griffiths *ex* Hooker. Part II, p. 318.

Undaria pinnatifida (Harvey)Suringar. First recorded in southern Australia from SE Tasmania (see Sanderson 1990) and now occurs from Bicheno to the northern end of D'Entrecasteaux Channel. It has also been found in Port Phillip Bay, Victoria.

RHODOPHYTA

Acrosymphyton taylorii Abbott. Part IIIA, p. 220.

Schottera nicaeensis (Lamouroux *ex* Duby)Guiry & Hollenberg. Part IIIA, p. 263.

Gymnogongrus crenulatus (Turner)J. Agardh. Part IIIA, p. 269.

Solieria tenera (J. Agardh)Wynne & Taylor [= *S. filiformis* (Kützing)Gabrielson]. Part IIIA, p. 343.

Antithamnion cruciatum (C. Agardh.)Nägeli. Part IIIC, p. 117.

Antithamnionella spirographidis (Schiffner)Wollaston. Part IIIC, p. 168.

Haraldiophyllum nottii (Norris & Wynne)Wynne. Part IIID, p. 129.

Cottoniella fusiformis Børgesen. Part IIID, p. 154.

Polysiphonia senticulosa Harvey. Part IIID, p. 180.

Chondria arcuata Hollenberg. Part IIID, p. 427.

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GLOSSARY

abaxial: on the side of the branch facing away from the axis.
adaxial: on the side of a branch facing the axis.
adventitious: an organ or structure arising in an abnormal position.
adventive (species): species introduced from other areas, persistent or not.
alternate: with branches arising at different levels along an axis, at regular intervals.
alternating sequence: the sequence of cutting off pericentral cells in the Rhodomelaceae, the second and later ones on alternate sides.
anastomosing: union of cells or filaments laterally to form a network (if extensive).
anterior: towards the front or apex of a structure.
anticlinal: cell division by a wall perpendicular to the surface of the tissue (usually the outer layer of the thallus).
apical: the tip of a branch or structure.
appendage: a part or process added to another.
areolation: a series of spaces on the surface of a structure.
articulate: jointed.
assurgent: inclined upwards (usually curved) from its origin.
auxiliary cell: a cell which produces the carposporophyte following transfer to it of the zygote nucleus or one of its diploid progeny.
awn: a tapering terminal appendage.
axial: pertaining to the axis or central core of a branch.
axile: situated on the axis of an organ.
axis: the main stem or a major branch of a thallus, usually bearing laterals.

bicornate: with two horn-like processes.
bilateral: arranged on opposite sides.
blade: the lamina or part of a flat frond.
bladelet: a small blade on a larger one.
botryoidal: form similar to a cluster of grapes.

caducous: dropping off early.
carpogonial branch: the uniseriate branch, usually four cells long (Ceramiales), which bears the terminal carpogonium.
carpogonium: the female reproductive cell (oogonium), usually bearing a trichogyne, in the Rhodophyta.
carposporangia: the reproductive cells produced by the carposporophyte, and which usually give rise to the tetrasporophyte.
carposporophyte: the post-fertilization diploid phase of the Florideophyceae, comprising fusion cell and gonimoblast filaments bearing carposporangia.
cartilaginous: firm and tough but somewhat flexible.
chevron: a figure or arrangement like an inverted V.
cicatrigenous: growth of a lateral organ from a residual scar cell (e.g. of a trichoblast).
circinnate: coiled into a ring or partly so.
clavate: club-shaped, broadest near the apex.
cleft: divided or split usually about half-way down.
complanate: flattened or branched in one plane.
compressed: flattened but not strongly so, with an ovate cross section.

congenitally: united together from an early stage.
connecting cell: a cell, through which the zygote nucleus is transferred from the carpogonium to the auxiliary cell.
convolute: rolled around.
"corps en cerise": spherical bodies found in the epidermal cells of *Laurencia*, best seen in fresh material.
cortex: the outer layer of smaller cells or tissue of a thallus, outside the medulla.
corymbose: a flat-topped cluster of branches.
corticate: covered with an outer layer, usually of smaller cells.
coupled: associated in pairs.
cover cell: a cell overlying the tetrasporangium (or carpogonial branch), cut off from the sporangium initial (or supporting cell).
crenulate: with small but regular marginal teeth.
crisped: with a curled and much divided edge or margin.
cystocarp: reproductive structure in Rhodophyta consisting of the carposporophyte and surrounding tissue (the pericarp).

decumbent: reclining or prostrate but with the apex or margin ascending.
decussate: divided into pairs alternately at right angles; a sporangium with cross walls in different planes.
dentate: with marginal teeth.
denuded: with branches or appendages lost with age.
determinate: having a fixed limit to growth.
dichotomous: branching into two equal parts by equal division at the apex.
digitate: branched like the fingers of a hand.
dimidiate: where daughter cells are paired or divide transversely (as in the cortex of some Delesseriaceae).
dioecious: having the male and female gametes produced on different plants.
diploid: the generation or cells with nuclei bearing 2N chromosomes.
discoid: forming a flattened disc with a rounded outline.
discrete: separate, not joined or coalescent.
distal: furthest from the point of attachment of an organ.
distichous: in two opposite rows along an axis or branch and thus lying in one plane.
divergence: turning or separating in different directions.
dorsal: the back or upper side of a structure, away from the substrate.
dorsiventral: a structure with distinct upper and lower surfaces.

ecorticate: without a cortex.
endogenous: arising from within another body, not from the surface.
entire: with an even, relatively straight, margin.
epilithic: living attached to rock or stones.
epiphytic: living attached to a plant, but not parasitic.
epizoic: living attached to an animal.
equivalent: where daughter cells are the same length as the parent cell, not transversely divided (as in the cortex of some Delesseriaceae).
eulittoral: the main intertidal zone between the sublittoral (usually dominated by large brown algae) and the littoral fringe (usually dominated by littorinid snails).

evanescent: soon disappearing.
excrescences: small outgrowths on the surface of an organ.
exogenous: arising from the outer layer of a structure, e.g. from the subapical axial cells before other cells are cut-off or from the outer pericentral or cortical cells.

fibrous: in the form of fibres, usually relatively long and often robust and multicellular.
filament: a long row of cells attached end to end, usually uniseriate.
fimbriate: with the margin bordered by long slender processes.
flange: slightly projecting longitudinal rims or edges on a branch.
flanking cells: the paired cells cut off from the lateral pericentral cells (e.g. in Sarcomeniaceae).
flared: spread out or broadened above the base.
flexuous: axes or branches with zig-zag development, usually with alternate branches on each side.
foliose: broadly flattened and leaf-like.
forcipate: forked like pincers.
frond: the thallus or a main branch thereof.
furcate: divided into two, usually fairly equally, but not strictly dichotomous.
fusiform: spindle shaped, thicker centrally and tapering to both ends.
fusion cell: an enlarged, often irregular, cell formed from the zygote by fusion with other adjacent cells.

gametophyte: the multicellular sexual (N) gamete-producing phase of the life history of a plant.
gland cell: a small, ovoid to subspherical, cell with highly refractive contents, usually darkly staining, which may function in secretion or storage.
globose (globular): nearly spherical.
glomeruliferous: bearing rounded clusters of filaments.
gonimoblast (filament): much-branched filaments, produced by the fusion cell and which produce the carposporangia.

habit: the morphological form of a plant.
hair: elongate, unicellular or multicellular and uniseriate, extensions, not or only slightly pigmented, tapering or cylindrical.
haptera: branched, often multicellular, attachment organs, often terminating rhizoids.
holdfast: a basal attachment organ.
holotype: the single specimen or sheet on which an author bases the description of a new taxon.

indeterminate: capable of unlimited growth.
initial: the cell from which other specialised cells originate.
intercalary: situation or growth occurring between the apex and base.
internode: the region between two nodes.
interstices: spaces between the cells of a net or mesh.
involute: rolled inwards.
isodiametric: with approximately equal diameters or dimensions.
isotype: a duplicate specimen to the holotype.

jungermanniaceous: with small, flat, more-or-less distichous appendages, similar to certain liverworts.

keel: a long ridge or flange on one side of a branch.

L/D: length divided by diameter.
lacerate: torn or irregularly cleft.
laciniate: divided into narrow lobes or divisions.
lanceoid: a solid form, lance-shaped; long and narrow, tapering to both ends, especially to the upper.
lateral: an appendage on the side of a branch.
layer: a distinct line of cells, like a layer of bricks.
lectotype: a specimen of the type collection selected as the basis of the taxon in the absence of a holotype.
lenticular: shaped as in a doubly-convex lens.
linear: narrow, with parallel sides and several times longer than broad.

macroscopic: structures seen clearly with the unaided eye.
medulla: the central region of a thallus, internal to the cortex.
membranous: delicate and often translucent.
meristem: a region of cells actively dividing.
microscopic: seen only with the aid of a microscope.
midrib: the central, differentiated and usually thicker, region of a structure.
mixed phases: when one plant bears both tetrasporangia and sexual structures.
monoecious: producing male and female gametes usually in separate structures but on the same individual.
monopodial: growth by means of a continuous apical growing point.
monosiphonous: a filament with a single row of cells.
monostromatic: single layered, usually only one cell thick.
mucilaginous (mucoid): slimy, with surface and/or internal mucilage.
mucro: a sharp terminal point.
mucronate: possessing a short, straight point.
multinucleate: with several to many nuclei in each cell.

neck: the upper, usually narrower, part of an organ (e.g. a cystocarp).
node: the position on an axis or branch where laterals arise.
nom. cons.: nomen conservandum, or a name conserved according to the International Code of Botanical Nomenclature.

obconical: reverse of conical, i.e. narrower at the base and expanding above.
obcordate: inversely heart shaped.
obovoid: egg-shaped, but broadest near the upper end (a three-dimensional term).
obpyriform: pyriform (pear-shaped) but attached at the larger end.
ostiole: the pore-like opening to a reproductive structure (e.g. in the pericarp of a cystocarp).
ovate: egg-shaped in outline, broadest near the base (a two-dimensional term).
ovoid: egg-shaped, often broadest near the base (a three-dimensional term).

palisade-like: rows or tiers of often laterally attached elongate cells, usually on the surface of tissues, with primary pit-connections on the short basal wall.
papillose: covered with papillae (soft protuberances).
paraphyses: sterile cellular filaments.
parasite: an organism growing on and dependent on the host for its nutrition.
parenchymatous: a tissue of thin-walled, more or less isodiametric cells, derived by division in different planes.
pectinate: with close-set lateral branches like the teeth of a comb.
pedicel: the stalk of a reproductive organ.
pedicellate: with a cellular stalk, usually applied at the microscopic level.
percurrent: extending from base to apex of a thallus as one or more well-developed axes.
perennial: a thallus or part thereof which lasts for several years.
perforate: with numerous more-or-less circular holes.
periaxial cell/filament: a cell or filament cut off from an axial cell but (shorter and) orientated obliquely or at right angles to it; this contrasts with pericentral.
pericarp: the protective tissue around or outside the carposporophyte, derived from the cortex.
pericentral cell: a cell cut off from an axial cell and remaining similar in size and orientation to the axial cell.
periclinal: cell division by a wall parallel to the surface of the tissue.
phyllotaxis: the arrangement of lateral appendages around an axis.
pinnate: with laterals, ramuli or segments arranged along each side of an axis or branch.
pinnule: a lateral of a pinnate branch.
pit-connection: a cytoplasmic strand connecting two adjacent cells through a pit in their wall.
polychotomous: division at one point into several subequal branches.
polysiphonous: a filament several cells broad, usually with 4 or more pericentral cells around an axial filament.
polystromatic: several to many cell layers thick.
procarp: the supporting cell, sterile cells, carpogonial branch, and auxiliary cell closely associated in the one branch system.
procumbent: lying along the substrate.
proliferous: bearing branchlets as irregularly placed offshoots.
propagules: accessory (vegetative) reproductive structures.
prostrate: lying flat on the substrate.
proximal: nearest to the point of attachment of an organ.
pseudoparenchymatous: parenchyma-like due to lateral adherence or interweaving of filaments but without cell divisions in all planes.
pseudopericentral cells: cells which occur in the ring of pericentral cells but are cut off laterally from pericentral cells (which are pit-connected to axial cells).
pulvinate: hemispherical or cushion-shaped, with a broad base.
pyriform: pear-shaped, attached at the narrower end.

radial: on the radii of the structure or around an axis.
recumbent: lying back on the substrate or branch.
reniform: kidney-shaped.
reticulum: in the form of a net.
revolute: rolled back from the margin or apex.

rhizoid: a single- or few-celled (without differentiation) attaching or absorptive structure or produced from inner cells.

rhodoplast: the photosynthetic plastid of the Rhodophyta, with single thylakoids which bear the phycobilin pigments.

scalpelliform: the form of a scalpel, with one straight edge and the other edge straight or curved.

secondary pit-connection: a pit-connection between cells of two adjacent filaments.

sequentially: formed in order of time or place.

serrate: marginally toothed with teeth pointing forwards.

sessile: attached directly to the substrate without a distinct holdfast and stipe; not stalked.

simple: unbranched or undivided.

sorus(-i): a cluster of reproductive organs, occurring as a surface patch or slightly raised group.

spermatangia: the cells which contain or cut off the male spermatia.

spine: a stiff, sharp-pointed projection on a cell or tissue.

sporophyte: the diploid (2N) spore-producing multicellular phase of a life history.

stichidium(-a): a specialised branch bearing tetrasporangia.

stipe: the stalk, lying between the holdfast and the blade or frond of the thallus, or bearing the primary branches.

stolon: a prostrate or creeping axis, lying on the substrate, from which erect branches arise.

stoloniferous: stolon-like or stolon-bearing.

striae: narrow, slender, more-or-less parallel markings or grooves.

subapical: shortly below the apex; one (or more) cells below the apex.

subdichotomous: almost dichotomous but not truly so.

sublittoral: the photic zone below the eulittoral region, from about mean low tide level to the lower limit of algal growth.

subspherical: almost spherical.

supporting cell: the cell which bears one or more carpogonial branches.

sympodial: branching of an axis where the apex is continually replaced by a lateral from below.

synchronous: simultaneous growth of branches.

syntype: one of the specimens used by the author when no holotype was designated, separate from one selected as lectotype.

tendril: a filiform appendage securing an organ to another structure, usually curved.

terete: cylindrical and usually slightly tapering.

terminal: the end cell (or tissue) of a chain.

tetrahedral: a four-sided figure, as in tetrahedrally divided tetrasporangia.

tetrasporangium: a meiosporangium containing four spores, usually in a distinctive arrangement.

tetrasporophyte: the diploid generation which produces tetrasporangia.

thallus: the relatively simple plant body of a non-vascular plant.

tiers: regular rows or layers of cells.

transverse: from the flat sides of a compressed structure.

trichoblast: a colourless or rhodoplastic, usually branched, hair-like appendage produced near branch apices (Rhodomelaceae).

truncated: cut off rather abruptly at the end.

type: the specimen on which a species (or lesser category) is based (see holotype, isotype), or the species name which provides the basis of the genus; similarly for higher taxa.

umbellate: with a cluster of branches from the same point.

uncinate: hook shaped.

unilateral: branched on one side of the axis or branch.

uniseriate: arranged in a single row or series, not more than one cell broad.

urceolate: shaped like an urn; hollow and contracted at the mouth.

ventral: the under or lower side of a structure.

verrucose: covered with small wart-like excrescences.

verticillate: structures (usually branchlets) arranged in a ring or whorl around an axis.

villose (branchlets): long, slender and soft branches.

weft: filaments interwoven to an irregular meshwork.

wing: the lateral, usually thinner, parts of a flat branch, on each side of the midrib.

INDEX TO GENERA AND SPECIES

Names of recognised genera and species are given in roman and synonyms in italics

ACANTHOPHORA 409
arborea 233
dendroides 409
tasmanica 231
ACROSORIUM 129
ciliolatum 131
minus 148
uncinatum 131
venulosum 131
Acrosymphyton
taylorii 500
Aglaophyllum
affine 137
ciliolatum 131
crispum 119
erosum 126
gunnianum 108
multipartitum 139
pristoideum 85
pulchellum 124
ALLEYNEA 216
bicornis 219
Alsidium
comosum 259
? comosum 281
? spinulosum 251
AMANSIA 390
binderi 360
hawkeri 394
kuetzingioides 394
linearis 370
mamillaris 395
marchantioides 341
pinnatifida 392
prolifera 403
semipennata 329
serrata 394
Amphibia
mixta 367
Anadyomene
stellata 499
Aneuria
latifolia 389
Antithamnion
cruciatum 500
Antithamnionella
spirographidis 500
APOGLOSSUM 35
ruscifolium 37
spathulatum 37
tasmanicum 37
Arthrocladia
villosa 499
Asperococcus
compressus 499

Baillouviana
kuetzingii 249
Bindera
australis 237
cladostephus 237
Bolboclinium
rhytidophloeum 443
BOSTRYCHIA 362
australasica 364
distans 364
harveyi 364
hookeri 367
intricata 367
mixta 367
moritziana 366
radicans 362
rivularis 362
scorpioides 364
simpliciuscula 362
tenuis
f. *typica* 362
tenuissima 362
BOTRYOGLOSSUM 144
cartilagineum 145
lobatum 355
Branchioglossum
crispatulum 30
BRONGNIARTELLA 237
australis 237
f. *recurva* 237
disticha 240
feredayae 255
patersonis 227
sarcocaulon 259
spinosissima 227
strobilifera 255, 263
Bryocladia
cervicornis 230
ericoides 230

CALOGLOSSA 21
beccarii 23
bombayensis 25
leprieurii 23
ogasawaraensis 25

Capraella
australis 96
Catenella
major 410
Caulerpa
racemosa
var. laetevirens
f. cylindracea 499
taxifolia 499
Ceramium
sertularioides 184
CHAMAETHAMNION 495
schizandra 495
Chauvinia
coriifolia 59
imbricata 63
CHAUVINIELLA 59
coriifolia 59
CHIRACANTHIA 233
arborea 233
valida 233
CHONDRIA 422
angustissima 426
arborescens 443
arcuata 427, 500
botryoides 473
bulbosa 429
capreolis 435
cartilaginea 286
clavata 462
β *dendroides* 450, 462
corallorhiza 420
corynephora 462
curdieana 441, 446
dasyphylla 443
var. *pyrifera* 441
var. *sedifolia* 446
debilis 413
filiformis 469
foliifera 448
forsteri 459
fusifolia 438
harveyana 443
hieroglyphica 432
incrassata 450
incurva 432
infestans 424
iridescens 446
lanceolata 446
myriopoda 424
obtusa
var. *paniculata* 485
opuntioides 410
ovalifolia 450
pinnatifida
var. *elata* 475
rubra 420
sedifolia 446
subfasciculata 438
subsecunda 435
succulenta 446
suprabulbosa 429
tenuissima 438
umbellula 415
verticillata 415
Chondriopsis
arborescens 443
bulbosa 429
cartilaginea 286
corallorhiza 420
curdieana 441
dasyphylla 441
debilis 413
foliifera 448
fusifolia 438
harveyana 443
lanceolata 446
ovalifolia 450
succulenta 446
var. *subfasciculata* 438
CHONDROPHYCUS 481
brandenii 483
cruciatus 483
paniculatus 485
tumidus 485
Chondrophyllum
monanthos 79
Chylocladia
opuntioides 410
tasmanica 410
Cladostephus
australis 237
CLADURUS 417
elatus 419
CLAUDEA 16
elegans 16
CLIFTONAEA 325
imbricata 329
lamourouxii 329
pectinata 325
semipennata 329
Codium
fragile
ssp. tomentosoides 499
COELOCLONIUM 409
claviferum 470
debile 413
gracilipes 284
incrassatum 450
major 410
opuntioides 410
tasmanicum 410

umbellula 415
verticillatum 415
Conferva
brodiaei 204
delicata 158
Corallopsis
australasica 462
? umbellifera 286
Corynecladia
australasica 462
clavata 462
umbellata 462
COTTONIELLA 152
arcuata
var. *fusiformis* 154
filamentosa
var. *fusiformis* 154
fusiformis 154, 500
CRASSILINGUA 79
engelhardtii 80
husseyana 80
marginifera 80
prolifera 80
Cryptopleura
curdieana 135
endiviaefolia 142
minor 148

Dasya
adunca 240
archeri 321
bolbochaete 267
dictyuroides 489
feredayae 253
var. β *contractior* 253
harveyi 249
hirta 272
hormoclados 277
lallemandii 249
lenormandiana 270
proxima 259
sarcocaulon 259
tenera 155
urceolata 243
verticillata 277
DASYCLONIUM 318
acicarpum 320
flaccidum 321
harveyanum 323
incisum 318
DELESSERIA
amansioides 63
armata 52
coriifolia 59
crassinervia 146
crispatula 30
dendroides 56
denticulata 43, 69
endiviaefolia 141
frondosa 33
harveyana 48
heterocystidea 45
hypoglossoides 45
hypoglossum 45
imbricata 63
lacepedeana 146
leprieurii 23
lyallii 75
marginifera 80
microdonthum 52
protendens 54
revoluta 43
rigida 64
ruscifolia 37
serrulata 48
similans 75
spathulata 37, 45
spiralis 397
tasmanica 37
undulata 45
DICROGLOSSUM 28
crispatulum 30
DICTYOMENIA 344
angusta 345
fimbriata 347
harveyana 349
var. *flabelligera* 349
? interstincta 349
myriacantha 232
prolifera 403
sonderi 347
sonderiana 347
spinulosa 349
spiralis 397
tridens 344, 349
DIPLOCLADIA 227
patersonis 227
DIPTEROSIPHONIA 304
australica 308
dendritica 304
heteroclada 304
prorepens 306
Discosporangium
mesarthrocarpum 499
DITRIA 310
expleta 310
Dolichoscelis
clavifera 470
disticha 450
gracilipes 284
DOXODASYA 264
bolbochaete 264

hirta 272
lanuginosa 270
lenormandiana 270

ECHINOSPORANGIUM 328
semipennatum 329
ECHINOTHAMNION 222
hookeri 225
hystrix 222
mallardiae 225
Elachista
orbicularis 499
Enantiocladia
axillaris 380
ENDOSIPHONIA 250
? spinuligera 251
spinulosa 251
EPIGLOSSUM 401
proliferum 403
smithiae 401
Epineuron
backhousii 399
spirale 397
ERYTHROSTACHYS 261
prolifera 263
strobilifera 263
Eupogonium
(?) *hormoclados* 277
Euspiros
kuetzingioides 394
spiralis 399
Euzoniella
flaccida 321
harveyana 323
incisa 318

Falkenbergiella
prostrata 333
Fucus
botryoides 473
claudei 18
forsteri 459
tridens 345

GONATOGENIA 279
subulata 281
Gracilaria
filiformis 469
GREDGARIA 314
maugeana 315
Griffithsia
australis 237
Gymnogongrus
crenulatus 500
HALICNIDE 73
similans 75
Halodictyon
robustum 494
velatum 494
Halopithys
australasica 374
elata 419
HALYDICTYON 492
arachnoideum 494
Hanowia
arachnoidea 494
robusta 494
HAPLODASYA 242
reinboldii 243
tomentosa 245
urceolata 243
HARALDIA 67
australica 67
HARALDIOPHYLLUM 125
erosum 126
nottii 129, 500
HEMINEURA 32
crispata 33
frondosa 33
wilsonis 33
HERPOPTEROS 312
fallax 312
HERPOSIPHONIA 289
calothrix 290
filipendula 295
monilifera 297
pectinella 297
prorepens 306
rostrata 295
versicolor 292
HERPOSIPHONIELLA 299
plurisegmenta 299
HETEROCLADIA 282
australis 282
caudata 284
prolifera 284
umbellata 286
umbellifera 286
HETERODOXIA 69
denticulata 69
Heterosiphonia
archeri 321
HETEROSTROMA 341
nereidiis 343
HOLOTRICHIA 259
comosa 259
HUSSEYA 420
australis 420
rubra 420
Husseyella
australis 420
rubra 420

Hutchinsia
dendritica 304
miniata 158
obscura 335
pennata 340
Hydrolapatha
coriifolia 59
crispatula 30
dendroides 56
denticulata 69
HYMENENA 133
affinis 137
curdieana 135
endiviaefolia 141
multipartita 139
valida 135
HYPOGLOSSUM 41
armatum 52
crispatulum 30
dendroides 56
denticulatum 43, 69
endiviaefolium 141
frondosum 33
harveyanum 48
var. fimbriatum 50
heterocystideum 45
hypoglossoides 45
lacepediana 146
marginatum 45
muelleri 165
protendens 54
revolutum 43
serrulatum 48
spathulatum 37, 45
undulatum 45

JANCZEWSKIA 452
australis? 454
tasmanica 454
Jeannerettia
? crenata 353
crispata 357
frondosa 355
latifolia 355
lobata 355
nana 353
pedicellata 352

KUETZINGIA 376
canaliculata 378
serrata 394

Lamourouxia
elegans 18
LAURENCIA 455
affinis 470
aldingensis 459
arbuscula 466
botryoides 468, 473
var. *minor* 466
brandenii 483
brongniartii 477
casuarina 420
clavata 462
concinna 477
cruciata 483
dasyphylla 443
dendroides 457
distichophylla 477, 480
elata 475
var. (f.) *luxurians* 475
excelsa 468
fasciculata 470
filiformis 469
f. *dendritica* 470
f. *heteroclada* 470
forsteri 459, 470
f. *affinis* 470
f. *elata* 470
f. *delicatula* 470
f. *dilatata* 470
f. *fasciculata* 470
f. *fragilis* 470
f. *gracilis* 470
f. *pyramidata* 470
f. *setacea* 470
f. *subpinnata* 470
fusifolia 438
gracilis 457, 470
grevilleana 477
heteroclada 470
infestans 424
luxurians 475
majuscula 457
obtusa 457, 470
var. *majuscula* 457
var. *regia* 466
paniculata 485
papillosa 468
pinnatifida 475
var. *elata* 475
regia 466
rigida 466
shepherdii 464
tasmanica 468
tenuissima 438
tumida 485
uncinata 435
LENORMANDIA 380
grevilleana 383
hypoglossum 65
latifolia 389

linearis ... 370
marginata ... 386, 387
muelleri ... 383
pardalis ... 387
prolifera ... 403
pusilla ... 387
smithiae ... 401
spectabilis ... 381
var. *angustifolia* ... 381
var. *enervis* ... 381
var. *latifolia* ... 389
Lenormandiopsis
latifolia ... 389
LOPHOCLADIA ... 248
harveyi ... 249
kuetzingii ... 249
LOPHOSIPHONIA ... 332
? calothrix ... 290
neglecta ... 211
obscura ... 335
prostrata ... 333
scopulorum ... 175
subadunca ... 335
LOPHOTHALIA ... 274
australis ... 237
bolbochaete ... 267
feredayae ... 255
hormoclados ... 277
lanuginosa ... 270
lenormandiana ... 270
sarcocaulon ... 259
strobilifera ... 263
verticillata ... 274
Lophura
australasica ... 374
LOPHURELLA ... 214
hookeriana ... 214
periclados ... 214

MALACONEMA ... 150
roeanum ... 152
MARTENSIA ... 95
australis ... 95
gigas ... 96
sp. ... 96
Maschalostroma
fastigiata ... 259
fastigiatum ... 281
scoparium ... 281
Melanamansia
pinnatifida ... 392
serrata ... 394
Melanoseris
crispata ... 357
Membranoptera
coriifolia ... 59
crispatula ... 30
dendroides ... 56
denticulata ... 69
hypoglossoides ... 45
Mesotrema
australis ... 96
gigas ... 96
MICROPEUCE ... 253
feredayae ... 253
glomerulifera ... 257
proxima ... 259
sarcocaulon ... 259
strobiliferum ... 255
MYRIOGRAMME ... 107
bombayensis ... 112
cartilaginea ... 111
erosa ... 126
gattyana ... 116
gunniana ... 108
perriniae ... 117
pristoidea ... 85
pulchella ... 102, 124
serrulata ... 85

NANOPERA ... 378
merrifieldiae ... 380
Neuroglossum
? crispatum ... 100
NITOPHYLLUM ... 119
affine ... 137
cartilagineum ... 111
caulescens ... 135
ciliolatum ... 131
crispatum ... 100
crispum ... 119
var. *prolificans* ... 119
curdieanum ... 135
endiviaefolium ... 141
erosum ... 126
fallax ... 122
fimbriatum ... 126
gattyanum ... 114
gunnianum ... 108
hymenena ... 114
minus ... 148
monanthos ... 79
multinerve ... 116
multipartitum ... 139
nottii ... 129
obscurum ... 108
obsoletum ... 139
parvifolium ... 139
perriniae ... 117
polyanthum ... 135
pristoideum ... 85
proliferum ... 80

pulchellum 102, 124
punctatum 119
serrulatum 85
stipitatum 119
uncinatum 131
validum 135
venulosum 131
NITOSPINOSA 83
littledipensis 89
pristoidea 85
tasmanica 87

Oneillia
elegans 18
OPHIDOCLADUS 335
simpliciusculus 335
OSMUNDARIA 404
intermedia 406
prolifera 404
smithiae 401
spiralis 397

Pachyglossum
engelhardtii 80
husseyanum 80
marginiferum 80
ovale 80
proliferum 80
PERRINIA 229
ericoides 230
PHITYMOPHORA 63
amansioides 63
hypoglossum 65
imbricata 63
PHYCODRYS 71
australasica 73
Pithyopsis
tasmanica 232
PITYOPHYCOS 231
tasmanica 231
PLACOPHORA 359
binderi 360
? cucullata 43
PLATYCLINIA 98
agardhii 119
crenulata 102
crispata 100
crozieri 119
kylinii 100
purpurea 100
ramosa 105
stipitata 100
PLATYSIPHONIA 158
corymbosa 162
delicata 158
miniata 160
mutabilis 160
victoriae 162
POLLEXFENIA 351
cartilaginea 145
? crenata 353
crispata 357
lobata 355
nana 353
pedicellata 352
Polyphacum
intermedium 401, 406
proliferum 406
smithiae 401
POLYSIPHONIA 170
abscissa 188, 199
? abscissa 178
abscissoides 199
acanthophora 225
adamsiae 209
amoena 211
amphibolis 181
angustissima 178
argus 292
atricapilla 209
aurata 303
australiensis 197
australis 237
blandii 193
breviarticulata 193
brevisegmenta 180
brodiei 204
byssoclados 237
caespitula 207
calothrix 290
cancellata 207
cladostephus 237
comoides 211
compacta 211
constricta 205
crassiuscula 195
dasyoides 197
? dasyoides 225
daveyae 196
decipiens 207
dendritica 304
ericoides 230
ferulacea 193
filipendula 295
flaccidissima
var. *smithii* 184
? flaccidissima 184
flavescens 183
forcipata 202
forfex 202
frutex 207
fuscescens 207

haplodasyae 173
havanensis 184
heteroclada 304
hookeri 225
hystrix 224
implexa 181
infestans 188
inversa 320
isogona 211
laxa 188
longissima 267
lyallii 225
? macrarthra 184
mallardiae 225
miniata 160
mollis 183
monilifera 297
moritziana 366
mutabilis 160
neglecta 211
nigrita 207
obscura 337
patersonis 227
pecten 320
pectinata 297
pectinella 297
pennata 340
perpusilla 20
perriniae 188
polyphora 224
propagulifera 190
prorepens 306
prostrata 333
pungens 180
roeana 152
rostrata 295
rutilans 213
rytiphlaeoides 207
scopulorum 175
senticulosa 180, 500
sertularioides 184
shepherdii 175
simpliciuscula 337
sphacelarioides 213
spinosissima 227
spinuligera 192
subadunca 335
subtilissima 178
succulenta 192
tasmanica 231
teges 200
valida 233
versicolor 292
victoriae 162
zostericola 188

Polyzonia
australis 320
colensoi 320
elegans
var. *incisa* 320
flaccida 321
harveyana 323
incisa 318
var. *harveyana* 323
var. *sonderi* 318
sonderi 320
PROTOKUETZINGIA 374
australasica 374
PTEROSIPHONIA 338
pennata 338

Rhabdonia
sonderi 410
Rhododactylis
bulbosa 429
rubra 420
Rhodolophia
strobilifera 263
Rhodomela
australasica 374
elata 419
erinacea 420
mallardiae 225
periclados 214
serrulata 399
simpliciuscula 214
? spinulosa 251
tridens 345
var. *spiralis* 399
trigenia 284
Rhodoseris
cartilaginea 145
ROBEA 91
costata 93
Rytiphlaea
aculeata 251
australasica 374
australis 374
canaliculata 378
compressa 420
elata 419
kuetzingioides 394
merrifieldii 380
simplicifolia 403
spinulosa 251
umbellifera 419

SARCOMENIA 165
corymbosa 162
dasyoides 162

delesserioides 59, 165
dolichocystidea 157
miniata 160
mutabilis 160
opposita 162
rhizocarpa 243
secundata 155
tenera 155
victoriae 162
wilsonis 162
SARCOTRICHIA 155
dolichocystidea 157
tenera.. 155
SCHIZOSERIS 111
bombayensis.. 112
hymenena 114
perriniae 117
tasmanica 114
Schottera
nicaeensis 500
Scutarius
cartilagineus 111
erosus 126
minor 148
pulchellus 124
stipitatus 119
Scytonema
intricatum 367
Solieria
tenera.. 500
SONDERELLA.................................... 370
linearis.. 370
Sorocarpus
micromorus 499
Sphacella
subtilissima 499
STICTOSIPHONIA 367
hookeri 367
intricata 367
Stictyosiphon
soriferus 499
Striaria
attenuata 499
SYMPHYOCLADIA 340
marchantioides 341
SYMPODOPHYLLUM 28
reinboldii 28

TAENIOMA 20
perpusillum 20
Thaumatella
disticha 240
TIPARRARIA....................................... 301
aurata.. 303
TOLYPIOCLADIA............................... 220
penningtonensis.................................. 220

Trigenia
australis...................................... 284, 286
umbellata.. 286
TYLOCOLAX 497
microcarpus.. 497

Ulva
taeniata 499
Undaria
pinnatifida 500

VELEROA 240
adunca 240
Vertebrata
australis.. 237
roeana 152
rostrata... 295
scopulorum... 175
VIDALIA 395
gregaria.. 406
? kuetzingioides 394
spiralis 397
Vinassaella
coriifolia.. 59

WILSONAEA 489
dictyuroides 489
WOMERSLEYA.................................... 77
monanthos 79