

New records of marine benthic algae from the Lagon Sud-Ouest of New Caledonia, South Pacific

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SUMMARY

As part of an ongoing project to substantially increase knowledge of the marine algal flora of the French Pacific territory of New Caledonia, a survey of the Nouméa region was conducted that has resulted in the discovery of 41 previously unrecorded species of macroalgae, including 1 Chlorophyta, 1 Phaeophyceae (Heterokontophyta) and 39 Rhodophyta. Among the biogeographically interesting new records are the green macroalga *Rhipilia penicilloides* N'Yeurt et Keats (previously endemic to the islands of Fiji some 1000 km east of new Caledonia) and the brown alga *Cutleria mollis* Allender et Kraft (originally described from Lord Howe Island some 1000 km to the south). The red alga *Gloiophloea articulata* Weber-van Bosse, known only from its initial discovery in 1928 from the Mascarene Islands in the western Indian Ocean, is now recorded in the deep-water channels of the Nouméa region of New Caledonia. The widely distributed Indian Ocean species *Corynomorpha prismatica* (J. Agardh) J. Agardh has its easternmost distribution record from this area, and *Dotyella hawaiiensis* (Doty et Wainwright) Womersley et Shepley is recorded for the first time outside its central-Pacific distribution. These new discoveries represent a 12% increase in the total number of species (377) that are reliably known from New Caledonia.

Key words: biogeography, New Caledonia, new records, Macroalgae, taxonomy.

INTRODUCTION

The marine benthic algae of New Caledonia have been sporadically documented since the first records appeared as part of Kützinger's (1863a,b, 1865, 1866, 1867, 1868, 1869) comprehensively illustrated 20-volume *Tabulae Phycologicae*, in which he describes 66 new species from New Caledonia based on specimens collected by Eugène Vieillard during the years 1855–1867. The type specimens on which these records are based have recently been critically re-examined, the result of which has been many name changes and new

combinations for species that have been unwittingly redescribed by later authors (Millar & Prud'homme van Reine 2005). Collections, by presumably amateur collectors, were also published by Sauvageau (1901). The German amateur phycologist Grunow was the first algal specialist to actually collect in New Caledonia (in 1884), but because he never held a formal scientific position, he sent his specimens to others, often with suggested names. His findings were issued first by Murray and Boodle (1888) on green algae and, much later, by Kuckuck (1929) on brown algae. Many of these records were long considered unverifiable in the mistaken belief that Grunow's herbarium was destroyed during the WWII bombing of Berlin (Garrigue & Tsuda 1988), but Prud'homme van Reine (pers. comm., 2004) has discovered some of Grunow's collections in the National History Museum of Vienna.

Species lists and several descriptive works have been published since (Gepp 1922; Catala 1950; May 1953, 1966; Denizot 1965, 1968; Valet 1966, 1968, 1969, 1972, 1976). The most recent addition to the marine flora of New Caledonia is the conspicuous deep-water green alga *Struvea thoracica* Kraft and Millar (2005), whereas the most up-to-date catalog of all the macroalgae previously recorded is that of Garrigue and Tsuda (1988), which lists 335 species from New Caledonia including the nearby island of Ile des Pins.

A particularly noteworthy but hitherto obscure New Caledonian collection was made by Mrs R. Catala in the early 1950s. This consisted of 478 algal specimens that were studied and identified as 122 species by Valerie May (May 1953, 1966). In a similar vain to the New Caledonian specimens thought to be destroyed from the Grunow herbarium, the Catala collection was

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also thought to have been lost (Garrigue & Tsuda 1988). Fortunately, however, this latter collection has now been discovered among the liquid-preserved holdings of the National Herbarium of New South Wales at the Royal Botanic Gardens in Sydney, Australia. The extant specimens consist of 478 numbered small bottles, the liquid contents of which have mostly dried out and evaporated and the algal material has mostly deteriorated beyond re-soaking. Although some of the material has responded well to re-hydration (e.g. *Callophycus serratus* (Harvey ex Kuetzing) Silva), most of it is completely unrecoverable.

The marine benthic algae of the south-western Pacific have been receiving increased attention from a cohort of active phycologists over the past 20 years, and the floras of several of the islands and regions have been at least preliminarily, if not intensively, studied. These include New Zealand (Adams 1994), the New South Wales (NSW) coast of eastern Australia (Millar 1990; Millar & Kraft 1993, 1994a,b), Lord Howe Island (references summarized in Kraft 2000), Norfolk Island (Millar 1999a), Herald Cays in the Coral Sea (Millar 1999b), Papua New Guinea (Millar *et al.* 1999; Coppejans & Millar 2000), the southern Great Barrier Reef (Cribb 1983; Price & Scott 1992; Kraft & Millar 2005), Three Kings Islands (Adams & Nelson 1985), the Kermadec Islands (Nelson & Adams 1984), Wallis (N'Yeurt & Payri 2004), Fiji (N'Yeurt 2001; South & Skelton 2003), Rotuma (N'Yeurt 1996), Samoa (Skelton & South 2002), the Solomon Islands (Womersley & Bailey 1970) and Micronesian algae (Tsuda & Wray 1977; Lobban & Tsuda 2003). Through these surveys, it is becoming increasingly clear that this broad south-central Pacific region is very rich in macroalgae, although much more collecting needs to be done to reveal the full dimension of that diversity.

During September 2002, the authors were able to conduct brief subtidal survey around reefs of the Lagon Sud-Ouest area of Nouméa (Fig. 1). Although only one dive was conducted at each of 10 different sites, the discovery of 41 new records from just this limited area suggests that much more work remains to be done in this island nation if we are to better understand the full extent and diversity of its marine flora.

MATERIALS AND METHODS

All collections were made by scuba between 11–20 September 2002 from the islands and reefs around the Nouméa region, locally named Lagon Sud-Ouest of New Caledonia ('Grande Terre', Fig. 1). Station numbers represent those of the IRD (Institut de Recherche pour le Développement). Most specimens were sorted and pressed fresh (not formalized) at the IRD, Nouméa, with subsamples of some taxa dried in silica for later DNA extraction or preserved in a 4% formalin/seawater solu-

tion for critical anatomical studies. Slide material was stained in an aniline-blue solution composed as described by Millar and Wynne (1992a), the resulting permanent slides being housed in NSW. Photographs were taken on either a Wild Photomakroscop M400, a Wild Leitz MPS51 Ortholux II system using Kodak EPY (Ektachrome 64T Professional) positive film, an Olympus CH-2 with Nikon Coolpix 4500 digital camera, or an Olympus BH2 microscope with a Spot RT digital camera. Images were produced electronically following the methods of Millar and Kraft (2001). Herbarium and liquid-preserved vouchers are deposited in NSW and IRD with the silica-gel-dried collection held at the Center for Marine Science, University of North Carolina at Wilmington (CMS-UNCW). Herbarium abbreviations follow Holmgren *et al.* (1990).

RESULTS AND OBSERVATIONS

Phylum: Chlorophyta

Order: Bryopsidales

Family: Udoteaceae

Rhipilia penicilloides N'Yeurt and Keats (1997): 172, figs 1–16. (Fig. 2)

Type locality: Sand Bank, Suva Barrier Reef, Fiji.

Distribution: Known only from Fiji and, now, New Caledonia.

Vouchers: North of Passe Dumbea (IRD Station 196), 43 m on steeply sloping outer reef edge, A. J. K. Millar et D. W. Freshwater, 16.ix.2002, NSW 611762, NSW 611749.

Remarks: Millar and Kraft (2001) discuss this species in relation to *Rhipilia pusilla* and *Rhipilia fungiformis* that also lack a complanate flabelum and have few tenaculæ. The creeping stolon so noticeable in this species is also shared by *sinuosa sinuosa* and, less frequently, *sinuosa orientalis*. Neither of these species have siphon cortication by branched lateral rhizoids, a feature characteristic of *R. penicilloides*.

Phylum: Heterokontophyta

Order: Cutleriales

Family: Cutleriaceae

Cutleria mollis Allender and Kraft (1983): 122, figs 28, 29. (Fig. 3)

Type locality: Neds Beach, Lord Howe Island.

Distribution: From Lord Howe Island, Australia northwards to Norfolk Island and New Caledonia.

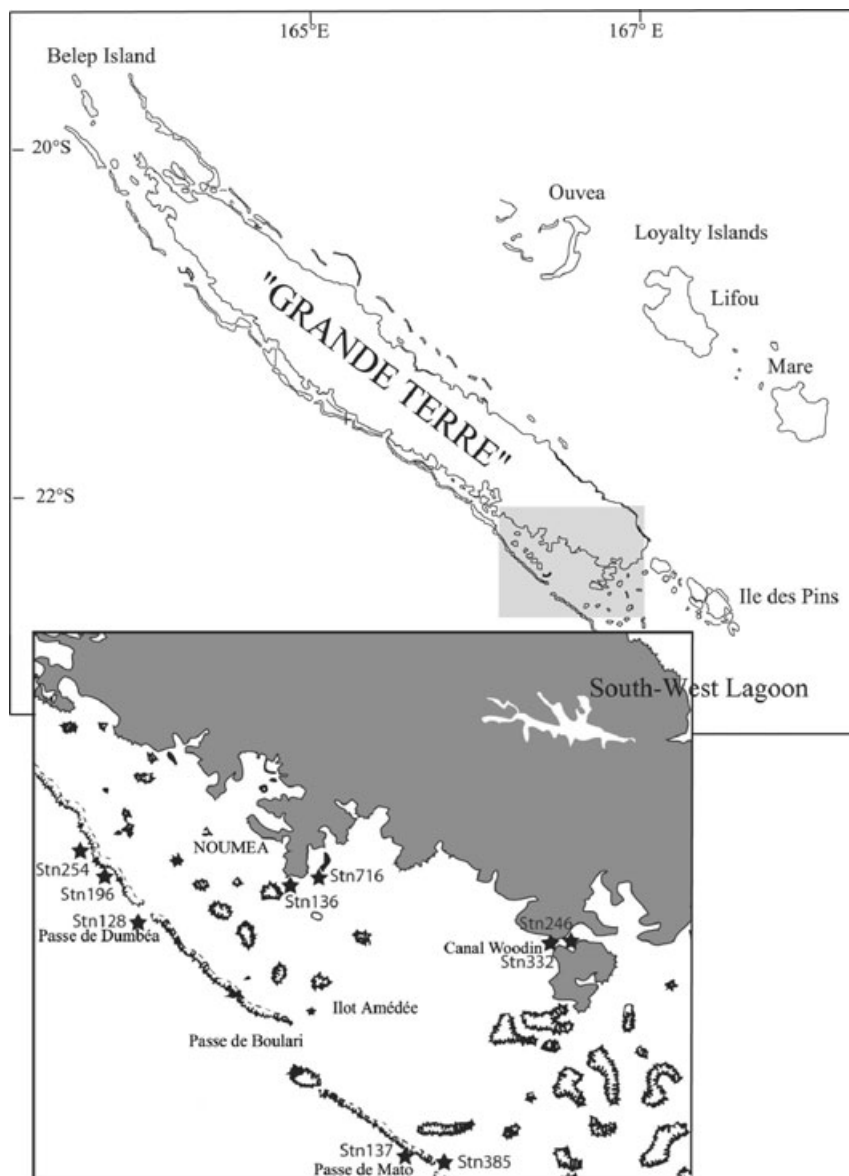


Fig. 1. Map of New Caledonia and the Lagon Sud-Ouest region near Noumea showing Institut de Recherche pour le Développement station numbers.

Vouchers: Ile Ndo, Baie de Sainte Marie (IRD Station 716), 9 m on flat seabed with isolated rocks and shells, A. J. K. Millar et D. W. Freshwater, 14.ix.2002, NSW 611823.

Remarks: A species originally described from Lord Howe Island in 1983, it is now known from New Zealand (Adams 1994), Norfolk (Millar 1999a) and now New Caledonia.

Phylum: Rhodophyta

Order: Nemaliales

Family: Scinaiceae

Scinaia tsinglanensis Tseng (1941): 106. (Fig. 4)

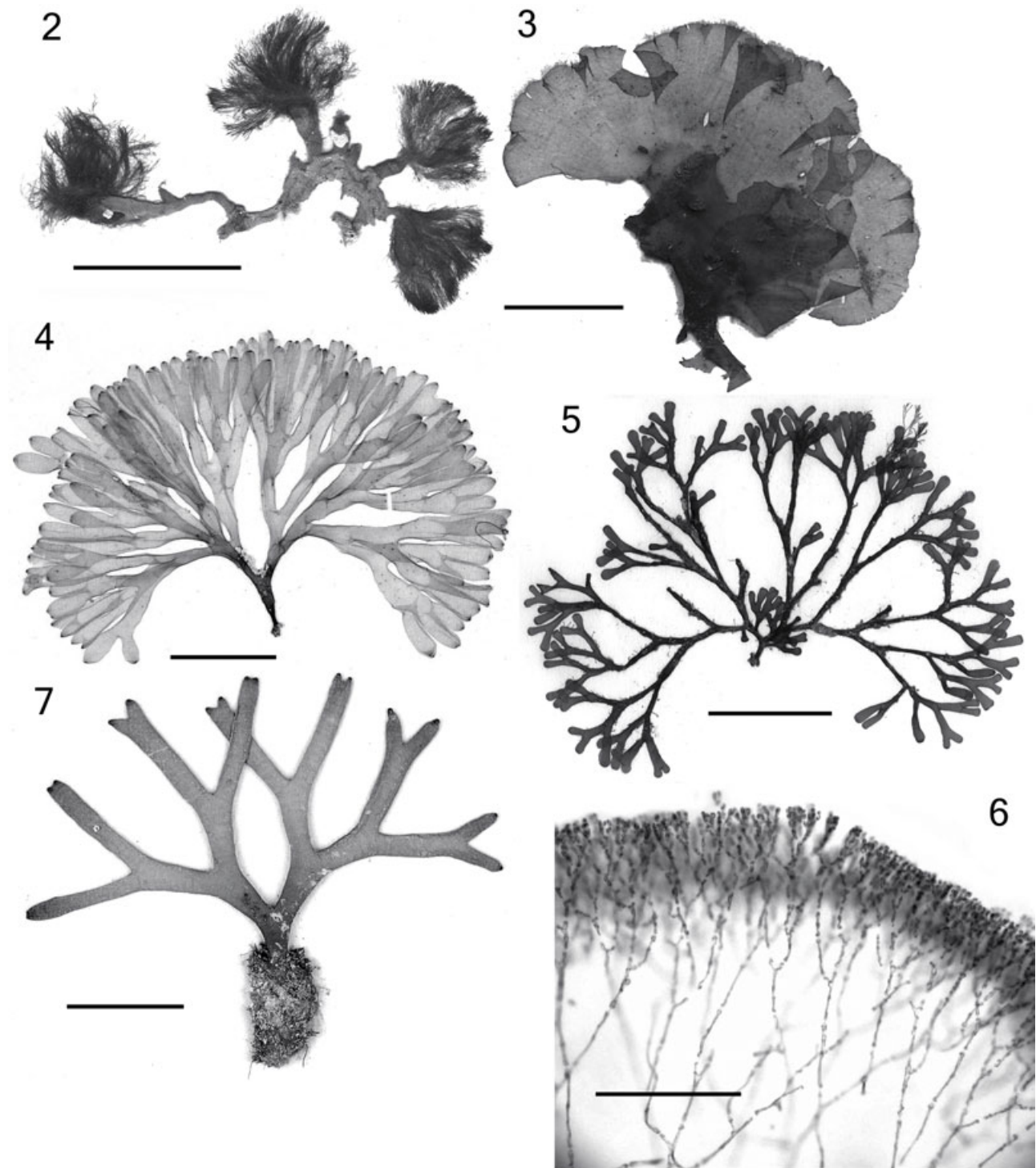
Type locality: Hainan, China.

Distribution: Around the entire coast of Australia, including Lord Howe Island and Norfolk Island. Also New Caledonia and Papua New Guinea.

Vouchers: Inside reef channel at Passe Mato (IRD Station 385), 26 m on sides of steeply sloping wall, A. J. K. Millar, J.- L. Menou, D. W. Freshwater, 12.ix.2002, NSW 611734.

Remarks: Huisman (1986) describes and discusses this species and its relationships with other species in the genus in detail. Although the presence or absence of constrictions along the terete branches is variable in this species, almost all Tasman Sea and mainland Australian populations display branches that are unconstricted as do the New Caledonian plants.

Gloiophloea (?) *articulata* Weber-van Bosse (1914): 276, figs 1, 26, 27. (Figs 5,6)



Figs 2–7. Algae of New Caledonia. 2. *Rhipilia penicilloides*. New South Wales (NSW) 611749. Scale = 5 cm. 3. *Cutleria mollis*. NSW 611823. Scale = 2 cm. 4. *Scinaia tsinglanensis*. NSW 611734. Scale = 1 cm. 5. *Gloiophloea articulata* habit. NSW 611913. Scale = 5 cm. 6. *Gloiophloea articulata* internal structure. NSW Slide 29–2. Scale = 100 μ m. 7. *Dichotomaria australis*. NSW 611738. Scale = 1 cm.

Type locality: Cargados Carajos, Mascarene Group, Indian Ocean.

Distribution: Known only from the type collection and, now, New Caledonia.

Vouchers: Canal Woodin (IRD Station 332), 32 m deep on channel floor, J.-L. Menou, 18.ix.2002, NSW 611913; 26 m deep on channel sides, A. J. K. Millar, J.-L. Menou, W. Freshwater, 18.ix.2002, NSW 611800, NSW 611913, NSW Slide 29–2.

Remarks: This is an unusual red algae in that the translucent light-red branches are very firm and tough even though they are composed of a thin anticlinal cortex and a broad mucilaginous medulla of widely spaced fine filaments (Fig. 5). The branch apices are indented. Weber-van Bosse was unsure of the true generic placement of this species, and more recently Huisman (1987; 170) also questioned its position within the genus *Gloiophloea*, suggesting that it had features of the Gymnophloeaceae. Regrettably, all the plants we have collected were also sterile, although their habit and vegetative morphology match those illustrated by Weber-van Bosse (1914) and Huisman (1987, figs 7, 8). Attempts to sequence the small sub-unit gene by Wilson Freshwater (pers. comm, 2005) have been partially successful and suggest a possible affinity with the Dumontiaceae. Only the first and second halves of the gene, with no overlaps in the middle, have been sequenced. The first half suggests a genus related to *Gibsmithia* and *Kraftia* of the Dumontiaceae, but also with matches near *Rhodopeltis* of the Polydaceae, whereas the second half shows similarities with *Farlowia*, *Weeksia* and *Oriculifilum* all of the Dumontiaceae. Both the original Indian Ocean specimens and the present ones came from deep-water habitats (65–100 m and 32 m, respectively), which is a probable reason for the extreme scarcity of records of this species from the Indo-Pacific

Family: Galaxauraceae

Dichotomaria australis (Sonder) Huisman, Harper et Saunders 2004: 230. (Fig. 7)

Type locality: Wilsons Promontory, Victoria, Australia.

Distribution: South-western Pacific.

Vouchers: Outside reef at Kue (IRD Station 137), 39 m deep on steeply sloping reef wall, A. J. K. Millar et D. W. Freshwater, 12.ix.2002, NSW 611738.

Remarks: Until recently this species was widely but incorrectly known as *Galaxaura marginata* (Ellis et Solander) Lamarck. Huisman *et al.* (2004), argue on the basis of molecular evidence that the long-abandoned Lamarck genus of *Dichotomaria* should be reinstated to accommodate this former Pacific *Galaxaura* species, along with a close relative (*Dichotomaria tenera* (Kjellman) Huisman, Harper et Saunders) from

South Africa. *Galaxaura marginata* is now regarded as a later synonym of *Dichotomaria marginata* (Ellis et Solander) Lamarck, a species that might well be restricted to the Caribbean and northern Atlantic (Huisman *et al.* 2004). The New Caledonian plants match those reported by Womersley (1994; as *G. marginata*) from southern Australia.

Order: Halymeniales

Family: Halymeniaceae

Cryptonemia crenulata (J. Agardh) Agardh (1851): 225. (Fig. 8)

Type locality: Bahia, Brazil.

Distribution: Seemingly pantropical from the Western Atlantic, Papua New Guinea, Solomon Islands and New Caledonia to the Maldives in the Indian Ocean.

Voucher: Ile Ndo, Baie de Sainte Marie (IRD Station 716), 9 m on flat seabed with isolated rocks and shells, A. J. K. Millar et D. W. Freshwater, 14.ix.2002, NSW 611910.

Remarks: Millar *et al.* (1999) commented on the superficial similarity between this species and the southern-Australian species *Cryptonemia undulata* Sonder. The similarity consists in the overall size of plants, their prominent stipe, and upper broad blades. However, the stipe in the New Caledonian specimens never persists as a midrib into the upper blades as is the case for the latter species. Also, the blade margins in *C. crenulata* are irregularly toothed, whereas they are smooth in *C. undulata*. The New Caledonian plants match the descriptions and illustrations by Littler and Littler (2000).

Family: Corynomorphaceae

Corynomorpha prismatica (J. Agardh) Agardh (1876): 143. (Fig. 9)

Type locality: India.

Distribution: East Africa, Seychelles, India, Sri Lanka, Montebello Islands (Western Australia), Torres Strait, Papua New Guinea, and New Caledonia.

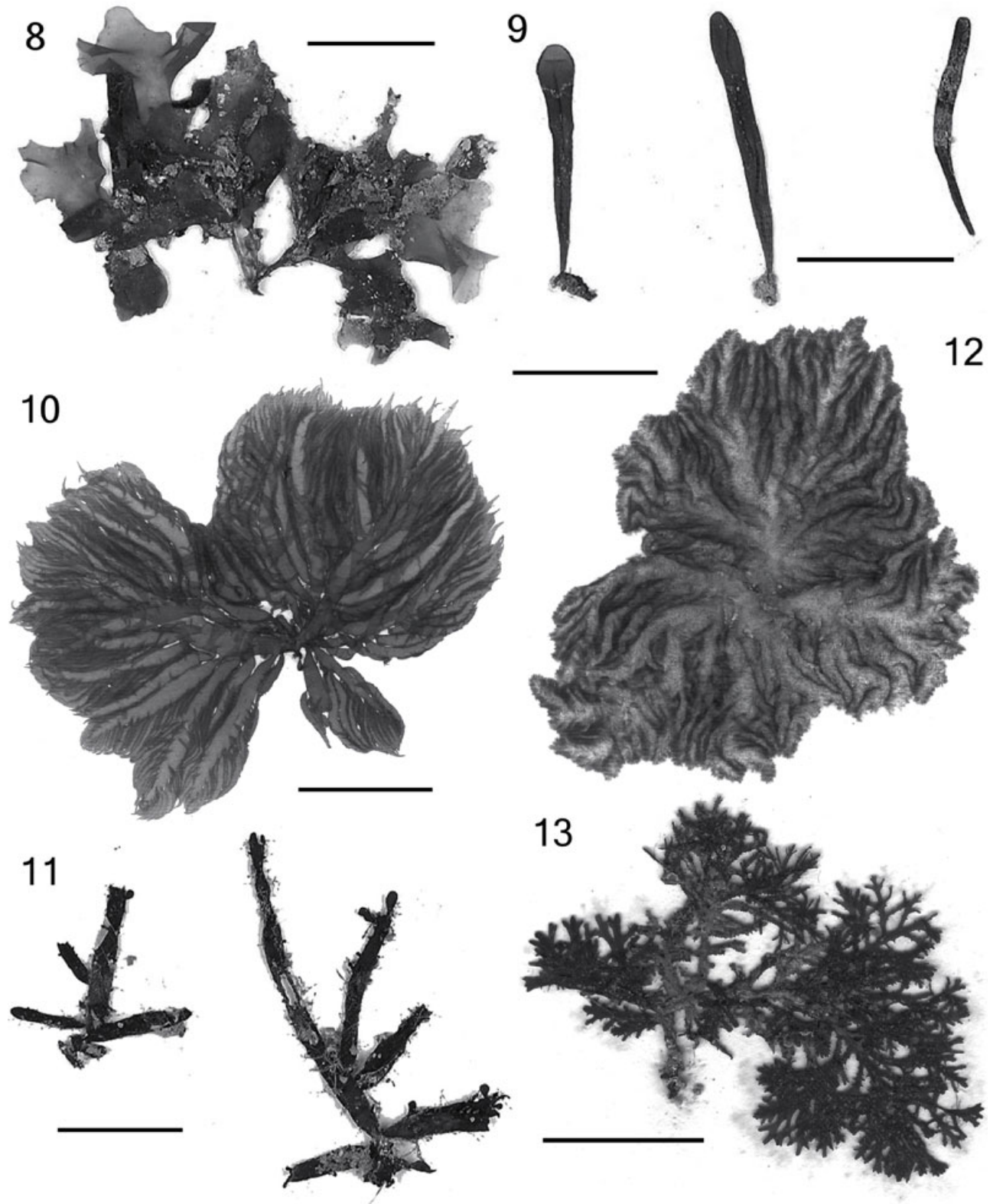
Voucher: Ile aux Canards (IRD Station 136), 22 m on flat sandy seabed, A. J. K. Millar, D. W. Freshwater and J.-L. Menou, 13.ix.2002, NSW 611917.

Remarks: This typically Indian Ocean species appears to be at its most easterly distribution at New Caledonia in the south-west Pacific. The New Caledonian plants match in all respects the anatomy and morphology of those from the western Australian coast of the Indian Ocean illustrated by Huisman (2000).

Order: Gigartinales

Family: Acrosymphytaceae

Acrosymphyton taylorii Abbott (1962): 845, figs 1–7. (Fig. 10)



Figs 8–13. Red algae of New Caledonia. 8. *Cryptonemia crenulata*. New South Wales (NSW) 611910. Scale = 2 cm. 9. *Corynomorpha prismatica*. NSW 611917. Scale = 2 cm. 10. *Acrosymphyton taylorii*. NSW 611726. Scale = 3 cm. 11. *Corynocystis prostrata*. NSW 611752. Scale = 2 cm. 12. *Dudresnaya capricornica*. NSW 611727. Scale = 3 cm. 13. *Callophycus densus*. NSW 611780. Scale = 3 cm.

Type locality: Oahu, Hawai'i.

Distribution: From the Houtman Abrolhos Islands to Rottnest Island in the west, southern Australia, NSW, Lord Howe Island, Norfolk Island, Great Barrier Reef, Herald Cays (Australia), New Caledonia, Papua New Guinea, Hawai'i.

Vouchers: Outside reef at Kue (IRD Station 137), 39 m deep on steeply sloping reef wall, A. J. K. Millar et D. W. Freshwater, 12.ix.2002, NSW 611723, NSW 611726. North of Passe Dumbea (IRD Station 196), 43 m on steeply sloping outer reef edge, A. J. K. Millar et D. W. Freshwater, 16 ix.2002, NSW 611744, NSW 611760. Fausse Passe, Uitoë (IRD Station 254), 30 m on sloping floor of canyon, A. J. K. Millar et D. W. Freshwater, 16.ix.2002, NSW 611783.

Remarks: Although the overall habit of the plants of this species can vary considerably, from fine and delicate to robust and broad, the internal anatomy is invariable (Millar & Kraft 1984).

Order: Gigartinales

Family: Corynecystaceae

Corynecystis prostrata Kraft in Kraft *et al.* (1999): 26, figs 45–60. (Fig. 11)

Type locality: Bulusan, Sorsogon Province, the Philippines.

Distribution: From Mauritius in the Indian Ocean, the Philippines and widespread in the Pacific (Wallis, Fiji, Tahiti, Papua New Guinea, Great Barrier Reef, New Caledonia).

Vouchers: North of Passe Dumbea (IRD Station 196), 43 m on steeply sloping outer reef edge, A. J. K. Millar et D. W. Freshwater, 16.ix.2002, NSW 611752.

Remarks: Although sterile, the specimens from New Caledonia match precisely those collected in the Philippines.

Family: Dumontiaceae

Dudresnaya capricornica Robins and Kraft (1985): 23, figs 90–129. (Fig. 12)

Type locality: One Tree Island, Great Barrier Reef, Queensland, Australia.

Distribution: In Australia from the Houtman Abrolhos Islands to Rottnest Island in the west, the NSW coast, Lord Howe Island, Norfolk Island, Great Barrier Reef and Papua New Guinea. Also Socotra, Yemen, Arabian Sea.

Voucher: Outside reef at Kue (IRD Station 137), 39 m deep on steeply sloping reef wall, A. J. K. Millar et D. W. Freshwater, 12.ix.2002, NSW 611727. Fausse Passe, Uitoë (IRD Station 254), 30 m on sloping floor of canyon, A. J. K. Millar et D. W. Freshwater, 16.ix.2002, NSW 611784.

Remarks: The New Caledonian plants match precisely those seen by the first author from Heron Island in the Capricorn group of islands on the southern Great Barrier Reef.

Dudresnaya australis J. Agardh ex Setchell (1912): 245, fig. 9.

Syntype localities: Port Phillip Bay and Western Port, Victoria, Australia.

Distribution: Southern coast of Australia from King Georges Sound, Western Australia to Western Port, Victoria, New Caledonia.

Voucher: Canal Woodin, side of channel (IRD Station 246), 25 m deep on gently sloping soft bottom, A. J. K. Millar, D. W. Freshwater and J.-L. Menou, 18.ix.2002, NSW 611815.

Remarks: These specimens are male gametophytes and this identification and record stands on the fact that in typical *D. australis*, the spermatangia are borne in terminal fascicles of short cells that are borne on the 2–3 outermost cortical cells (Robins & Kraft 1985, figs 32, 33). In *D. capricornica*, the spermatangia are borne in stichidial-like heads. We have not been able to successfully sequence the DNA of the New Caledonian plants and, therefore, cannot irrefutably claim that this otherwise southern Australian endemic occurs in warm tropical waters.

Family: Areschougaceae

Callophycus densus (Sonder) Kraft (1984a): 58, figs 17–32, 56. (Fig. 13)

Type locality: Cape York, Queensland, Australia.

Distribution: Great Barrier Reef and New Caledonia.

Voucher: Fausse Passe, Uitoë (IRD Station 254), 30 m on sloping floor of canyon, A. J. K. Millar et D. W. Freshwater, 16.ix.2002, NSW 611780.

Meristotheca procumbens Gabrielson and Kraft (1984): 241, figs 14–17. (Fig. 14)

Type locality: Neds Beach, Lord Howe Island, Australia.

Distribution: Lord Howe Island, Solitary Island (NSW mainland), Fiji, Rotuma and New Caledonia.

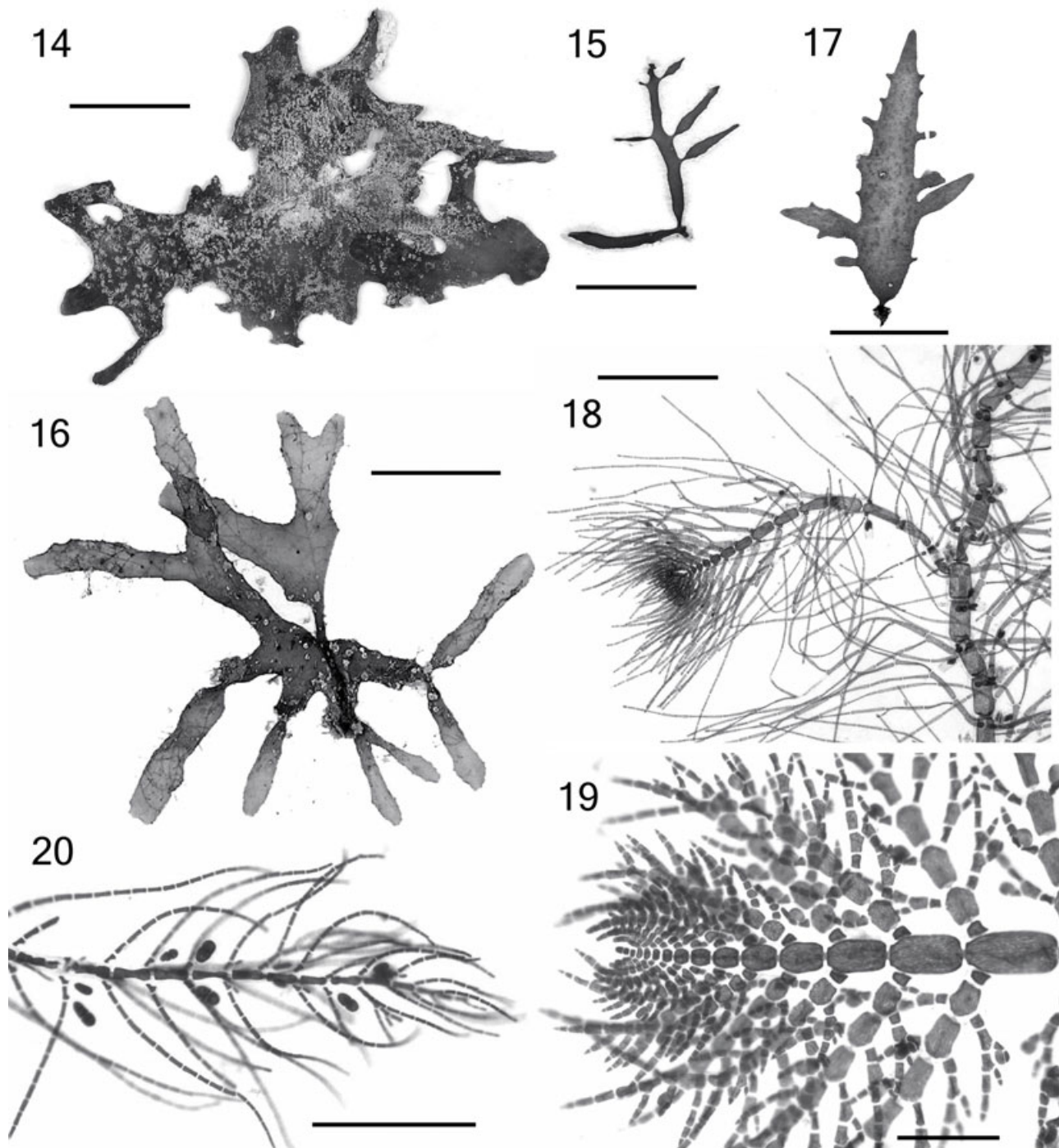
Voucher: Ile aux Canards (IRD Station 136), 22 m on flat sandy seabed, A. J. K. Millar, D. W. Freshwater and J.-L. Menou, 13.ix.2002, NSW 611944.

Remarks: Although first scientifically discovered and described in the 1980s from Lord Howe Island, the species has been used and eaten by Pacific Islanders for a long time (N'Yeurt 1996).

Solieria robusta (Greville) Kylin (1932): 18.

Type locality: probably near Fremantle, Western Australia.

Distribution: Throughout the Indian Ocean, the Philippines, around Australia including NSW mainland,



Figs 14–20. Red algae of New Caledonia. 14. *Meristotheca procumbens*. New South Wales (NSW) 611944. Scale = 2 cm. 15. *Solieria anastomosa*. NSW 611809. Scale = 2 cm. 16. *Asteromenia peltata*. NSW 611799. Scale = 2 cm. 17. *Chrysomenia ornata*. NSW 611803. Scale = 2 cm. 18. *Antithamnion delicatulum*. NSW Slide 29–3. Scale = 300 μ m. 19. *Antithamnion pectinatum*. NSW Slide 29–4. Scale = 100 μ m. 20. *Antithamnionella ternifolia*. NSW Slide 29–6. Scale = 300 μ m.

Lord Howe Island, Norfolk Island and Queensland. New Caledonia.

Voucher: Canal Woodin, side of channel (IRD Station 246), 25 m deep on gently sloping soft bottom,

A. J. K. Millar, D. W. Freshwater and J.-L. Menou, 18.ix.2002, NSW 611821.

Remarks: Although seemingly widely distributed throughout the Indo-Pacific oceans, current molecular

data suggests that the species might not in fact occur in the tropical Pacific (Saunders & Kraft, pers. comm., 2005). The New Caledonian specimens match those described and illustrated by Gabrielson and Kraft (1984) from Lord Howe Island.

Solieria anastomosa Gabrielson and Kraft (1984): 222, figs 1c–e, 2c–e, 3–5. (Fig. 15)

Type locality: Phillip Rock, Lord Howe Island.

Distribution: In Australia at Lord Howe Island, Norfolk Island and now New Caledonia.

Voucher: Canal Woodin, side of channel (IRD Station 246), 25 m deep on gently sloping soft bottom, A. J. K. Millar, D. W. Freshwater and J.-L. Menou, 18.ix.2002, NSW 611809.

Remarks: Millar (1999a) demonstrate that there are close links between Lord Howe and Norfolk Island's subtidal floras. The presence of this Lord Howe species in New Caledonia suggests that these biogeographic links might be broader than originally thought.

Order: Nemastomatales

Family: Nemastomataceae

Predaea weldii Kraft and Abbott (1971): 194, figs 1–15.

Type locality: Kaneohe Bay, Oahu, Hawai'i.

Distribution: In Australia at the Houtman Abrolhos Islands in the west and Lord Howe Island and the Great Barrier Reef in the east. Also Papua New Guinea, Wallis, Fiji, Hawai'i, eastern South Africa, Oman, Yemen, Venezuela and Puerto Rico.

Voucher: Outside reef at Kue (IRD Station 137), 39 m deep on steeply sloping reef wall, A. J. K. Millar et D. W. Freshwater, 12.ix.2002, NSW 611724.

Remarks: Kraft (1984b) and later Millar and Guiry (1989) characterize this species as having its gonimoblast initial formed terminally on the auxiliary cell. This is the case in the New Caledonia specimens and it is on this feature that the identification is based.

Predaea laciniosa Kraft (1984b): 11, figs 25–35.

Type locality: Heron Island, Great Barrier Reef, Queensland, Australia.

Distribution: In Australia from the Houtman Abrolhos Islands, and the Great Barrier Reef. Also Papua New Guinea, Wallis, Hawai'i, Tahiti, Oman and Yemen.

Voucher: Fausse Passe, Uitoe (IRD Station 254), 30 m on sloping floor of canyon, A. J. K. Millar et D. W. Freshwater, 16.ix.2002, NSW 611788.

Remarks: Both this species and *P. weldii* were two of the more common gelatinous species on the reef in approximately 30 m depths. *Trichogloea*, *Acrosymphyton* and *Dudresnaya* were more common in the shallower areas up to 20 m.

Order: Rhodymeniales

Family: Rhodymeniaceae

Asteromenia peltata (Taylor) Huisman and Millar (1996): 139: figs 1–17. (Fig. 16)

Type locality: Tortuga Island, Venezuela.

Distribution: Western Atlantic from North Carolina to Brazil, Indian Ocean from Maldiv Islands, Iran and Western Australia, and in the Pacific from Papua New Guinea, New Caledonia and Norfolk Island.

Voucher: Canal Woodin, side of channel (IRD Station 246), 25 m deep on gently sloping soft bottom, A. J. K. Millar, D. W. Freshwater and J.-L. Menou, 18.ix.2002, NSW 611799.

Remarks: Current molecular studies suggest this almost cosmopolitan species to be much more restricted in its distribution (Saunders & Kraft, pers. comm., 2005).

Chrysomenia ornata Kylin (1931): 10, 11, table 3, fig. 6. (Fig. 17)

Type locality: Port Jackson, Sydney, NSW.

Distribution: In the Pacific from NSW, Lord Howe and Norfolk Islands (Australia), New Caledonia, Solomon Islands, and in the Indian Ocean from the Houtman Abrolhos Islands, Western Australia.

Voucher: Canal Woodin, side of channel (IRD Station 246), 25 m deep on gently sloping soft bottom, A. J. K. Millar, D. W. Freshwater and J.-L. Menou, 18.ix.2002, NSW 611803.

Remarks: The New Caledonian plants are overall smaller than the more robust and larger southern NSW populations, but seem to match them in internal anatomy and vesicular cell disposition (Millar 1990).

Order: Ceramiales

Family: Ceramiaceae

Antithamnion delicatulum (Harvey) De Toni (1903): 1415. (Fig. 18)

Type locality: King George Sound, Western Australia.

Distribution: Southern Australia including Tasmania, Lord Howe Island, New Caledonia and South Africa.

Voucher: Ile aux Canards (IRD Station 136), 22 m on flat sandy seabed, A. J. K. Millar, D. W. Freshwater and J.-L. Menou, 13.ix.2002, NSW Slide 29–3.

Remarks: The records from South Africa and Lord Howe Island considerably extended the distribution of this species (Athanasiadis 1996: 155). We have examined the Lord Howe specimens and found them to be identical with New Caledonian populations, which are the most easterly distribution of the species.

Antithamnion pectinatum (Montagne) Brauner in Athanasiadis and Tittley (1994): 79. (Fig. 19)

Type locality: Auckland Island, New Zealand.

Distribution: In Australia from Portland to Gabo Island, Victoria, and south-east Tasmania, and now eastwards to New Caledonia. Also Korea, Japan, North-western Atlantic, Mediterranean and the Azores.

Voucher: Fausse Passe, Uitoe (IRD Station 254), 30 m on sloping floor of canyon, A. J. K. Millar et D. W. Freshwater, 16.ix.2002, NSW Slide 29-4.

Remarks: The New Caledonian plants show a superficial similarity to *Antithamnion amphigeneum* from the mainland coast of Australia (Millar 1990). Typical of *A. pectinatum*, however, is that new axes replace a branch in a pair or develop adventitiously from periaxial cells. In *A. amphigeneum*, new axes have no opposite branch even though they can also have adventitious development.

Antithamnionella ternifolia (Hooker et Harvey) Lyle (1922): 350. (Fig. 20)

Type locality: St Martins Cove, Cape Horn, Chile.

Distribution: South Africa, South America, New Zealand, New Caledonia, southern Ocean and Europe. In Australia from Shark Bay, Western Australia to Jervis Bay, NSW, Lord Howe Island.

Voucher: North of Passe Dumbea (IRD Station 196), 43 m on steeply sloping outer reef edge, A. J. K. Millar et D. W. Freshwater, 16.ix.2002, NSW Slide 29-6.

Remarks: At least within Australian collections, this species was formerly known as *Antithamnionella tasmanica*, until Athanasiadis (1996) compared type material and demonstrated that they were conspecific. Athanasiadis (1996) quotes Maggs (pers. comm., 1996) as saying that Australian and British populations are closely related at the molecular level.

Ceramium borneense Weber-van Bosse (1923): 329

Type locality: Borneo Bank.

Distribution: Great Barrier Reef, New Caledonia, Solomon Islands, Marshall Islands, Ryukyu Archipelago (Japan).

Voucher: Outside reef at Kue (IRD Station 137), 20–39 m on wall of drop off, A. J. K. Millar, D. W. Freshwater, J.-L. Menou, 12.ix.2002, NSW Slide 29-14.

Remarks: The New Caledonian plants match perfectly in all anatomical details with the description and illustrations of *Ceramium sympodiale* Dawson (1957: 121) from the Great Barrier Reef plants by Price and Scott (1992). Abbott (1999) examines the type material of that species and *C. borneense* and decides that the two species are conspecific.

Dotyella hawaiiensis (Doty et Wainwright) Womersley and Shepley (1959): 210. (Figs 21,22)

Type locality: Oahu, Hawai'i.

Distribution: Hawai'i and New Caledonia.

Voucher: Fausse Passe, Uitoe (IRD Station 254), 30 m on sloping floor of canyon, A. J. K. Millar et

D. W. Freshwater, 16.ix.2002, NSW 611777, NSW Slide 29-7.

Remarks: This appears to be the first record of the genus and species outside of Hawai'i and, therefore, considerably extends its known distribution.

Dasyphila plumarioides Yendo (1920): 7. (Fig. 23)

Type locality: Hung-t'ou Island, Taiwan.

Distribution: Western Pacific from the Ryukyu Islands, Japan to Eastern Australia Heron Island, Great Barrier Reef, Queensland, New Caledonia, and Fiji.

Voucher: Fausse Passe, Uitoe (IRD Station 254), 30 m on sloping floor of canyon, A. J. K. Millar et D. W. Freshwater, 16.ix.2002, NSW Slide 29-9.

Remarks: Kraft and Wilson (1997) describe and illustrated female gametophytes for the first time, and demonstrate the species' distribution as clearly western Pacific. The New Caledonian plants were sterile. Fiji represents the most easterly record for this species (South *et al.* 1993).

Euptilota articulata (J. Agardh) Schmitz (1896): 7. (Figs 24,25)

Type locality: Western Australia.

Distribution: In Australia from the Houtman Abrolhos Islands, around southern Australia to Coffs Harbour and Lord Howe Island, NSW. Also India, Japan and New Caledonia.

Voucher: Fausse Passe, Uitoe (IRD Station 254), 30 m on sloping floor of canyon, A. J. K. Millar et D. W. Freshwater, 16.ix.2002, NSW 611773, NSW Slide 29-8.

Remarks: The New Caledonian plants agree well with those the first author has collected from Rottnest Island in Western Australia.

Haloplegma duperreyi Montagne (1842): 248, pl. 7, fig. 1.

Type locality: Martinique, West Indies.

Distribution: Seemingly widespread in the Indian, Pacific and Atlantic oceans.

Vouchers: Canal Woodin, side of channel (IRD Station 246), 25 m deep on gently sloping soft bottom, A. J. K. Millar, D. W. Freshwater and J.-L. Menou, 18.ix.2002, NSW 611813, NSW 611820.

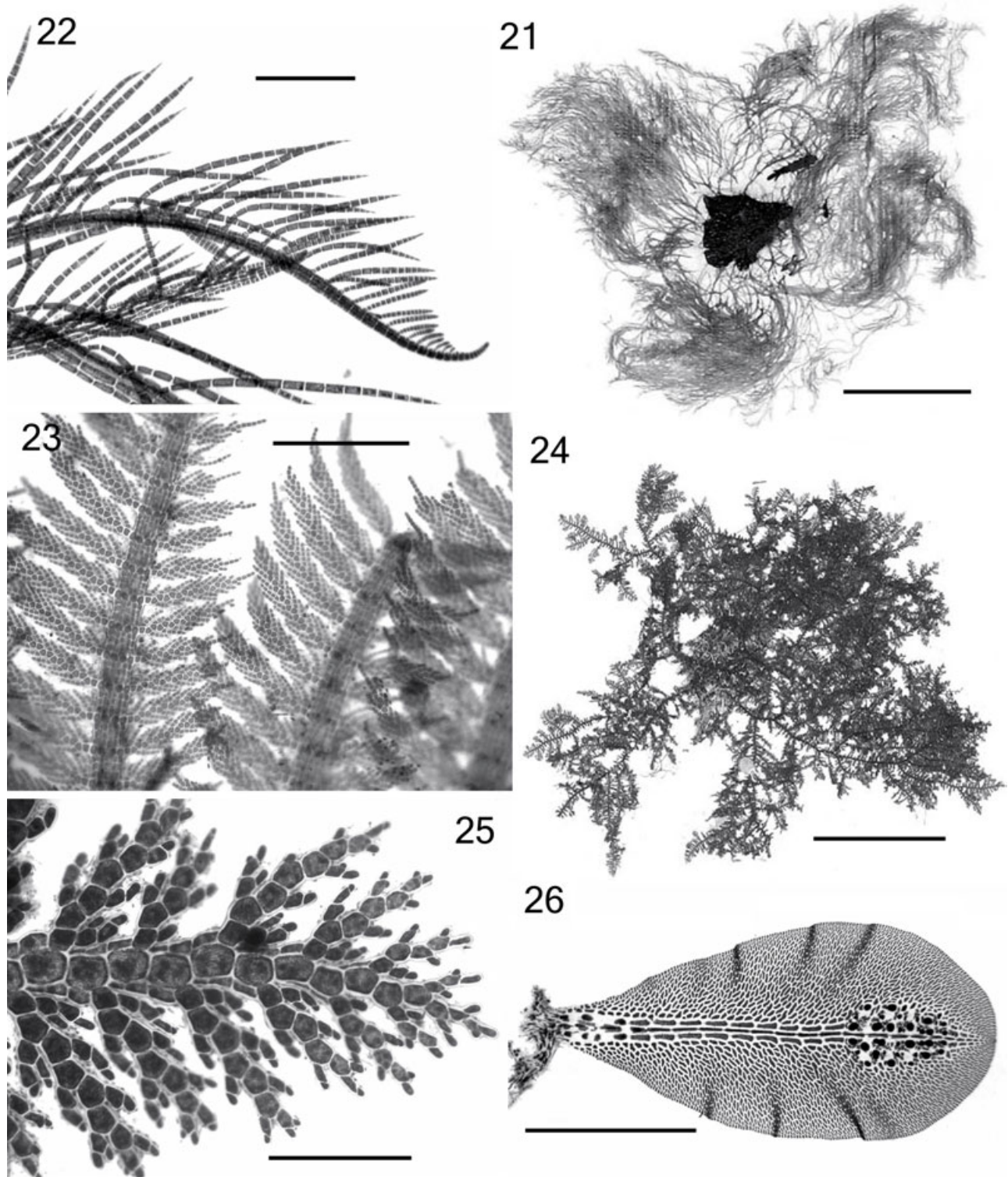
Ptilocladia yuenii Abbott in Abbott and Norris (1993): 452, figs 6–10.

Type locality: Necker Island, NW Hawaiian Islands.

Distribution: Hawai'i and Torres Strait, North Queensland (Australia).

Voucher: North of Passe Dumbea (IRD Station 196), 43 m on steeply sloping outer reef edge, A. J. K. Millar et D. W. Freshwater, 16 ix.2002, NSW Slide 29-17.

Remarks: The description and illustrations of Hawaiian plants by Abbott (1999) match those we have collected from New Caledonia.



Figs 21–26. Red algae of New Caledonia. 21. *Dotyella hawaiiensis* habit. New South Wales (NSW) 611777. Scale = 2 cm. 22. *Dotyella hawaiiensis* branch detail. NSW Slide 29–7. Scale = 300 µm. 23. *Dasyphila plumarioides*. NSW Slide 29–9. Scale = 200 µm. 24. *Euptilota articulata* habit. NSW 611773. Scale = 2 cm. 25. *Euptilota articulata* cellular detail. NSW Slide 29–8. Scale = 200 µm. 26. *Apoglossum unguiculescens* NSW Slide 29–5. Scale = 500 µm.

Ptilothamnion schmitzii Heaydrich (1893): 75, pl. 22, figs 1–6.

Type locality: Bay of Islands, New Zealand.

Distribution: In Australia from Eucla, WA around southern Australia including Tasmania. New Caledonia is clearly its northernmost record.

Voucher: North of Passe Dumbea (IRD Station 196), 43 m on steeply sloping outer reef edge, A. J. K. Millar et D. W. Freshwater, 16 ix.2002, NSW Slide 29–18.

Remarks: The New Caledonian plants are tetrasporic and match the illustrations of southern Australian plants by Womersley (1998, fig. 102f).

Family: Delesseriaceae

Apoglossum unguiculens Millar (1990): 425, figs 51e–h. (Fig. 26)

Type locality: Muttonbird Island, Coffs Harbour, NSW (Australia).

Distribution: NSW coast of eastern Australia, New Caledonia and east coast of South Africa (Millar, pers. obs., 2005).

Voucher: North of Passe Dumbea (IRD Station 196), 43 m on steeply sloping outer reef edge, A. J. K. Millar et D. W. Freshwater, 16 ix.2002, NSW Slide 29–5.

Remarks: This is the northernmost record of this species, which appears to tolerate cold-temperate conditions (Twofold Bay, southern NSW) to tropical conditions.

Hypoglossum simulans Wynne *et al.* (1989): 31, figs 12–26. (Fig 27)

Type locality: Ilet de Pidgeon, Malendure, Guadeloupe, French West Indies.

Distribution: Western Atlantic, throughout the Pacific, including in Australia the Great Barrier Reef and Lord Howe Island and now, New Caledonia.

Vouchers: Passe Dumbea (IRD Station 128), 20–48 m on vertical reef wall, A. J. K. Millar, D. W. Freshwater and P. Laboute, 17.ix.2002, NSW 611908, NSW Slide 29–10.

Remarks: The New Caledonian plants display the characteristic lateral branches arising from the basal segment of other lateral branches. One feature the New Caledonian plants do not share with typical material from the Caribbean Sea is that the procarps are borne precisely every five segments along the entire length of main and lateral blades. This might ultimately define this as a new species in the genus.

Martensia fragilis Harvey (1854): 145.

Type locality: Belligam Bay, Sri Lanka.

Distribution: Tropical to warm temperate Indian, Pacific and Atlantic Oceans.

Voucher: Passe Dumbea (IRD Station 128), 20–48 m on vertical reef wall, A. J. K. Millar, D. W. Freshwater and P. Laboute, 17.ix.2002, NSW Slide 29–16.

Remarks: There is a possibility that the previous New Caledonian records of *Martensia elegans* by May (1953) and Denizot (1963) actually represent this species, because *M. elegans* is a cold water species (Millar, pers. obs., 2006), whereas *M. fragilis* is mostly tropical to warm temperate.

Vanvoorstia spectabilis Harvey (1854): 144, pl. V. (Fig. 28)

Type locality: Belligam, Sri Lanka.

Distribution: Throughout the Indian and Pacific oceans, but seemingly absent from the Atlantic.

Voucher: Inside reef channel at Passe Mato (IRD Station 385), 26 m on sides of steeply sloping wall, A. J. K. Millar, J.-L. Menou, D. W. Freshwater, 12.ix.2002, NSW 611737.

Family: Dasyaceae

Dasya pilosa (Weber-van Bosse) Millar (1990): 433, Fig. 59d–g.

Type locality: Waru, Seram, Moluccas, Indonesia.

Distribution: Through the Indian and Pacific Oceans. No records exist from the Atlantic.

Voucher: North of Passe Dumbea (IRD Station 196), 43 m on steeply sloping outer reef edge, A. J. K. Millar et D. W. Freshwater, 16 ix.2002, NSW 611747.

Remarks: This species has been considered, with varying degrees of certainty, to be synonymous with the earlier described *Dasyopsis anastomosans* Weber-van Bosse (Abbott 1999; Wynne 2002). Unlike *Dasyopsis pilosa*, which Millar (1990) clearly demonstrates to be a member of the genus *Dasya* based on tetrasporic and female reproductive features, *Dasyopsis anastomosans* remains unstudied in these regards.

Dasya naccarioides Harvey (1844): 432.

Type locality: Georgetown, Tasmania, Australia.

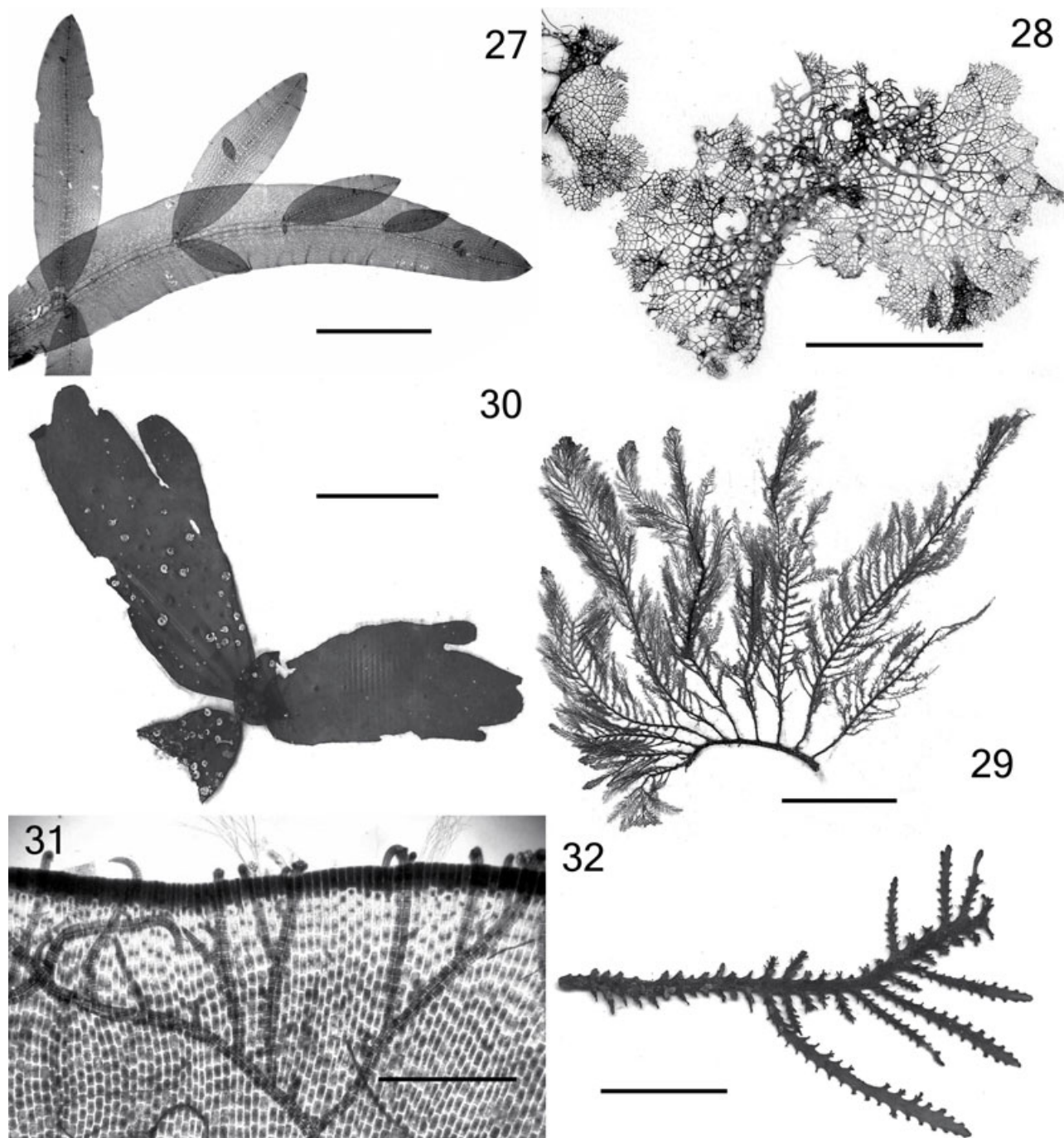
Distribution: From Albany, Western Australia around southern Australia, including Tasmania to Coffs Harbour and Lord Howe Island, NSW. New Caledonia.

Voucher: Ile Ndo, Baie de Sainte Marie (IRD Station 716), 9 m on flat seabed with isolated rocks and shells, A. J. K. Millar et D. W. Freshwater, 14.ix.2002, NSW 611911.

Remarks: This identification and record is based on similarities between the New Caledonian plants and those from the mainland NSW coast (see Millar 1990). The latter have not been confirmed at the molecular level as identical to southern Australian populations, and the genus as a whole requires DNA sampling to better understand the species.

Heterosiphonia crassipes (Harvey) Falkenberg (1901): 655. (Fig. 29)

Type locality: Rottnest Island, Western Australia.



Figs 27–32. Red algae of New Caledonia. 27. *Hypoglossum simulans*. New South Wales (NSW) Slide 29–10. Scale = 2 mm. 28. *Vanvoorstia spectabilis*. NSW 611737. Scale = 2 cm. 29. *Heterosiphonia crassipes*. NSW 611812. Scale = 3 cm. 30. *Lenormandopsis lorentzii*. NSW 611804. Scale = 2 cm. 31. *Lophosiphonia prostrata*. NSW Slide 29–11. Scale = 500 μ m. 32. *Osmundea spectabilis*. NSW 611816. Scale = 2 cm.

Distribution: In Australia from Rottnest Island around southern Australia, not including Tasmania, to Coffs Harbour and Lord Howe Island, Norfolk Island, and New Caledonia.

Voucher: Canal Woodin, side of channel (IRD Station 246), 25 m deep on gently sloping soft

bottom, A. J. K. Millar, D. W. Freshwater and J.-L. Menou, 18.ix.2002, NSW 611812, NSW 611908.

Remarks: The New Caledonian plants agree in all morphological respects with those from Rottnest island that the first authors has collected.

Family: Rhodomelaceae

Chondria simpliciuscula Weber-van Bosse (1914): 125, pl. 12, figs 9, 10.

Type locality: Passe Houareau, Aldabra Island, Maldives.

Distribution: Maldives, Great Barrier Reef, Norfolk Island, Ant Atoll, Micronesia, Wallis, Hawaii and New Caledonia.

Voucher: Passe Dumbea (IRD Station 128), 20–48 m on vertical reef wall, A. J. K. Millar, D. W. Freshwater and P. Laboute, 17.ix.2002, NSW Slide 29–15.

Remarks: Price and Scott (1992) first recorded this species from outside of its type locality, and since then, its discovery from islands throughout the northern, central and southern Pacific suggest that the type locality might actually be an outlying record of this Pacific species.

Chondria viticulosa Millar and Wynne (1992b): 422, figs 1–14.

Type locality: Ropers Shoal, Caloundra, Queensland, Australia.

Distribution: Mainland coast of Australia from Caloundra to Byron Bay, New Caledonia to Norfolk and Lord Howe Islands.

Vouchers: Passe Dumbea (IRD Station 128), 20–48 m on vertical reef wall, A. J. K. Millar, D. W. Freshwater and P. Laboute, 17.ix.2002, NSW Slide 29–12 and 29–13.

Remarks: Although initially thought to be endemic to the type locality, this distinctive flattened species of *Chondria* is proving to be widespread throughout the tropical Tasman and Coral Seas. The New Caledonian plants are tetrasporic, which are the first collections of this reproductive stage. Two to three tetrasporangia (to 140 µm diameter) develop on each fertile segment in distal parts of main and lateral branches, just as is seen in *Chondria infestans* (Lucas) Millar (see Gordon-Mills & Womersley 1987, fig. 29b, as *Chondria myriopoda*).

Lenormandiopsis lorentzii (Weber-van Bosse) Papenfuss (1967): 103. (Fig. 30)

Type locality: Thursday Island, Torres Strait, Australia.

Distribution: In the Indian Ocean from South Africa, India and Indonesia. In the Pacific from Japan, the Philippines, New Caledonia, Norfolk and Lord Howe Islands.

Voucher: Canal Woodin, side of channel (IRD Station 246), 25 m deep on gently sloping soft bottom, A. J. K. Millar, D. W. Freshwater and J.-L. Menou, 18.ix.2002, NSW 611804.

Remarks: Because the type species of the genus *Lenormandiopsis* Papenfuss, *L. latifolia* (Harvey et Greville) Papenfuss, has been found to belong to the earlier named genus *Lenormandia* Sonder (Phillips 2002), the

generic placement of this particular species remains in doubt.

Lophosiphonia prostrata (Harvey) Falkenberg (1901): 501. (Fig. 31)

Type locality: Fremantle, Western Australia.

Distribution: In Australia from the Houtman Abrolhos Islands, Western Australia to Coolangatta, Queensland. Also Lord Howe Island, Hawai'i, Tuamotu Archipelago and South Africa.

Voucher: North of Passe Dumbea (IRD Station 196), 43 m on steeply sloping outer reef edge, epiphytic on *Lobophora variegata*, A. J. K. Millar et D. W. Freshwater, 16 ix.2002, NSW Slide 29–11.

Remarks: The species appears to be an almost obligate epiphyte of species of the brown algal order Dictyotales.

Osmundea spectabilis (Postels et Ruprecht) Nam in Nam *et al.* (1994): 393, figs 9–25. (Fig. 32)

Type locality: Norfolk Sound, Alaska.

Distribution: From south-east Alaska to Baja California, Mexico. Papua New Guinea and New Caledonia.

Voucher: Canal Woodin, side of channel (IRD Station 246), 25 m deep on gently sloping soft bottom, A. J. K. Millar, D. W. Freshwater and J.-L. Menou, 18.ix.2002, NSW 611816.

Remarks: Millar *et al.* (1999, fig 6f) illustrate specimens from the Port Moresby region of Papua New Guinea that were identified as *Osmundea sinicola* (Setchell et Gardner) Nam. The New Caledonian specimens are precisely similar to those in habit and anatomy. Closer examination of the specimens from both New Caledonia and Papua New Guinea show them to have occasional secondary pit connections between adjacent epidermal cells and no lenticular thickenings. According to Nam *et al.* (1994), this would ally the specimens with *O. spectabilis* rather than to the similarly compressed species *Osmundea osmunda* and *Osmundea pinnatifida*. Although *O. sinicola* lacks lenticular thickenings and has compressed branches, that species is on the whole much smaller and the branches narrower than in *O. spectabilis*. The presence of an Alaskan species occurring in waters of New Caledonia is surprising, and although this species is reported from the warmer waters of Baja California, DNA analysis of the New Caledonian plants might well show them to be a different and possibly undescribed species.

DISCUSSION

The marine benthic flora of New Caledonia is proving to be extremely rich, even though the area of the islands that has been surveyed to any major extent is limited to the lagoon Sud-Ouest region near the town of Nouméa. Although Vieillard, back in the 1860s, made some minor, clearly intertidal collections from the west

and east coasts (Wagap, Balade and Gatope) the vast majority of the west, north and east coasts of New Caledonia is yet to be documented both intertidally and subtidally. Our short survey alone has added more than 12% to the species number and the 41 new records bring the total species count to 377. This figure is likely to be very much short of the actual total, because it does not include the crustose Corallinaceae nor the Liagoraceae that are being studied separately (Payri & Abbott pers. comm., 2006).

The New Caledonian marine flora has produced some surprising records, and perhaps the most intriguing are those of what were thought to be typically southern Australian, cool-temperate species. At least morphologically they are seemingly representatives of their southern populations, but further research might show these to be different on a molecular level (D. W. Freshwater pers. comm., 2006). Such cryptic species, although not unusual, might require more extensive morphological examination and ultimately their description as new species.

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