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A TAXONOMIC APPRAISAL OF *CALLOPHYLLIS* AND *EUTHORA* (RHODOPHYTA)

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Critical examination of the literature and specimens of the three described species of *Euthora* indicates that the acceptance of the northern species *E. cristata* (C. Ag.) J. Ag. and *E. fruticulosa* (Rupr.) J. Ag. has been based on lack of familiarity with the degree of variation normal within one species, and these two species should be united. The carpogonial branch system of this combined species is typical of that found in the genus *Callophyllis* within which it should therefore be included as *Callophyllis cristata* (C. Ag.) Kütz. The taxonomic position of the only other species of *Euthora*, *E. tristanensis* Baardseth, cannot be determined until information on the carpogonial structure is available.

The genus *Euthora* (Kallymeniaceae), has been considered (Kylin, 1956) to consists of three species: *Euthora cristata* (C. Ag.) J. Ag., the type species, occurring in the Arctic and North Atlantic Oceans, *E. fruticulosa* (Rupr.) J.Ag. in the North Pacific and *E. tristanensis* Baardseth from Tristan da Cunha. During the course of ecological and morphological studies of the first two species, it became evident that a reassessment of the genus was necessary.

J. Agardh (1847) erected the genus *Euthora*, including *E. cristata* and a number of other species which he subsequently removed (Agardh, 1852) when he added *E. fruticulosa* to the genus. Kützing (1849, 1867) first suggested the inclusion of *Euthora* in *Callophyllis* but this move was not accepted by his contemporaries. Not until the studies by Kylin (1923, 1930) was the affinity between the two genera demonstrated and widely accepted.

Recent detailed morphological studies of the Kallymeniaceae by Norris and his co-workers (Norris, 1957, 1961, 1964; Abbott & Norris, 1966; Womersley & Norris, 1971) are the basis of modern interpretations of genera within the family. Womersley & Norris (1971) briefly suggest that *Euthora* may fall within the circumscription of the genus. The following paper supports this suggestion.

MATERIALS AND METHODS

Herbarium specimens throughout the reported range of *Euthora* were made available by the institutions listed in the acknowledgements. These were rehydrated with distilled water or a weak detergent solution. Specimens have been collected by one of us (R.H.) from the British Isles; north-eastern North America, between Cape Cod and Labrador; and from Vancouver Island, British Columbia. These were preserved in 5% neutral formalin in seawater. Dr R. E. Norris provided specimens, preserved in 70% ethanol, from the San Juan Islands in Washington State.

Procarp and carposporophyte morphology were observed in squash preparations stained with Mayer's acid haemalin according to the method used by Norris (1957) or with 1% lactophenol cotton blue. Structural observations were made of sections through various parts of the plants, prepared either by hand or freezing microtome. Staining of sections was usually unnecessary.

NOMENCLATURE

Callophyllis cristata has long been recognised as a species, but its nomenclature as well as its taxonomic position have been the subject of considerable confusion. The Linnaean herbarium contains a sheet (No. 1247/69) labelled *Fucus cristatus*. Dixon & Parkes (1968) discovered that the generally accepted citation of the basionym is a nomen nudum, and that Turner's (1808) publication of the name is illegitimate because of Withering's (1796) earlier homonym. C. Agardh's (1817) inclusion of *Fucus cristatus* L. ex Turn. in the genus *Sphaerococcus* is therefore treated as a new name and not as a new combination. The type of *Sphaerococcus cristatus* C. Ag. is the type of *Fucus cristatus* L. ex Turn. The species was first transferred to the genus *Callophyllis* by Kützing, so the correct binomial and authority for this alga is *Callophyllis cristata* (C. Ag.) Kütz.

SYNONYMY

Callophyllis cristata (C. Ag.) Kütz. (1849, p. 747).

Fucus cristatus L. ex Turn. (1808, p. 48) nom. illeg., *Fucus coccineus* var. *pusillus* Wahlenberg (1812, p. 500), *Sphaerococcus cristatus* C. Ag. (1817, p. 300), *Rhodymenia cristata* (C. Ag.) Grev. (1830, p. 89), *Rhodomenia fabriciana* J. Ag. (1841, p. 15), *Chondrococcus cristatus* (C. Ag.) Kütz. (1847, p. 23), *Euthora cristata* (C. Ag.) J. Ag. (1848, p. 11), *E. fabriciana* (J. Ag.) J. Ag. (1848, p. 11), *Nereidea cristata* (C. Ag.) Rupr. (1851, p. 63 (255)), *N. fruticulosa* Rupr. (1851, p. 63 (255)), *E. fruticulosa* (Rupr.) J. Ag. (1852, p. 705). See also Taylor (1937, p. 275) and Dixon & Parkes (1968, p. 83).

REVISED DESCRIPTION OF *CALLOPHYLLIS CRISTATA*

Thallus (Figs 1–4) usually 20–120 (200) mm high, with branches essentially in one plane, although often twisted into bushy clumps; one to several axes attached by a small discoid holdfast; branching to five or more orders, the lower axes 0·4–5 (15) mm broad, usually branched in a subdichotomous manner; ultimate branchlets irregularly alternate to pinnate, terminating in acute apices, narrow marginal proliferations may be present; colour rose red, sometimes bleaching to pale greenish-yellow in summer; substance crisp to lightly cartilaginous.

Thallus (Figs 5, 6) usually 40–70 μm thick near apex, 150–200 μm through the main axes and 300–500 μm through the basal region of older plants; medulla of large, unpigmented, irregularly spaced, round or oblong cells, later becoming intermixed with slender rhizoidal filaments developing from primary medullary cells and inner cortical cells, filaments most abundant in basal regions and in older plants; cortex two-layered, the outer cortex of closely packed, small (3–9 μm), ovoid photosynthetic cells, inner cortex of larger (10–15 μm) pigmented cells, cortex thickest in older plants.

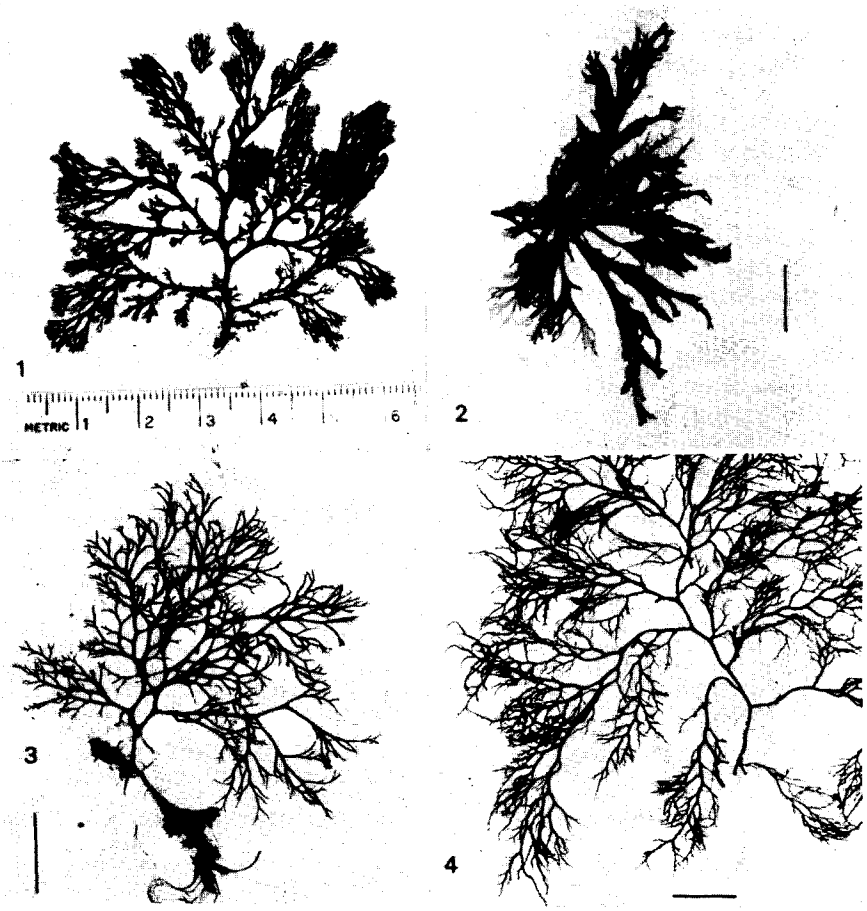
Sexual plants dioecious, carpogonial branch system (Fig. 7) formed in the inner cortex and outer medulla from primary cortical cells; monocarpogonial, carpogonial branch three-celled on supporting cell, with usually one subsidiary cell; supporting cell acting as auxiliary cell, fusion cell 45–60 μm, carposporophyte developing outwards producing numerous groups of 12–18 μm spherical carpospores separated by gonimoblast filaments; cystocarps marginal, 400–1200 μm, distinctly protuberant, with a single poorly developed ostiole when mature.

Spermatia 1·5–2·5 μm; cut off from outer cortical cells, forming irregular superficial sori on the younger portions of male plants, present very briefly; probably only a few weeks per year.

Tetrasporangia 2–35 × 16–23 μm; formed from outer cortical cells which become embedded in the cortex as surrounding cortical cells continue growth, division cruciate or irregular; scattered in the cortex, often particularly abundant in marginal proliferations.

TAXONOMIC DISCUSSION

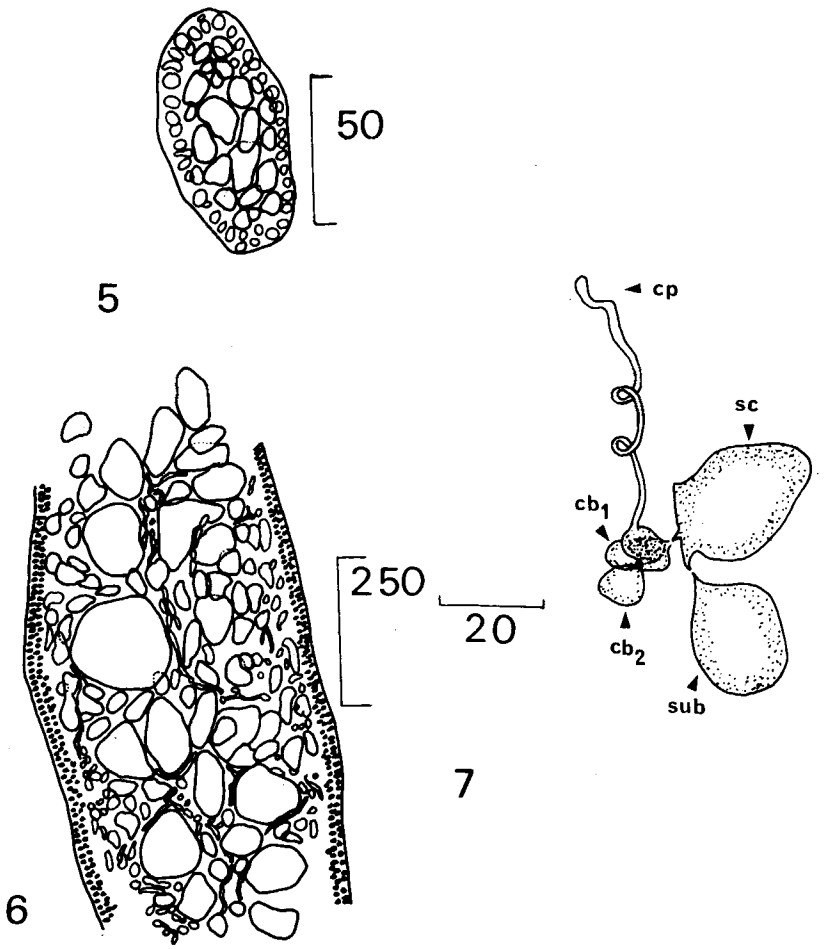
As is the case with other *Callophyllis* species on the Pacific Coast of North America studied by Abbott & Norris (1966), extreme morphological variability has led to much taxonomic confusion. Ruprecht (1851) tentatively erected his *Nereidea fruticulosa* from Kamchatka based on its terete and filiform appearance. At the time he expressed grave doubt whether it was truly distinct from his *N. cristata*. Subsequent workers (Setchell & Gardner, 1903), aware only of the extreme forms, have perpetuated Ruprecht's (1851) distinction. Kjellman (1889), however, one of the few phycologists familiar with *C. cristata*



FIGS 1–4. Fig. 1. Typical specimen of *Callophyllis cristata*. Fig. 2. Broad specimen from an exposed location; Logy Bay, Newfoundland. Fig. 3. Narrow specimen from a sheltered location; Bonne Bay, Newfoundland. Fig. 4. Narrow specimen from Lopez Island, Washington State. Scales of Figs 2–4, 10 mm.

throughout its range, regarded all of his Bering Sea material as belonging to this species. He erected a new form, f. *pinnata*, for one specimen with pinnate ultimate branchlets, but regarded the terete habit as perfectly normal for the species. In fact every form found in the Pacific is readily paralleled in the Atlantic in comparable habitats. Much variation is apparently due to environmental influence. The most flattened, broad forms (Fig. 2) occur in severely exposed localities while the narrow, more sparsely branched forms occur in deeper and more sheltered habitats (Figs 1, 3, 4). The lack of reports of extremely wide forms in the Pacific may be due to confusion between *C. cristata* and the closely related *C. flabellulata* Harvey, or to genetically based differences across the wide geographical range of the species.

The narrow forms of the species have been commonly, though incorrectly, known (Taylor, 1937, 1957) as var. *angustata* (Lyngb.) Kjellm. The type specimen



FIGS 5–7. Fig. 5. Transverse section near apex of thallus. Fig. 6. Section at base of old plant. Fig. 7. Procarp of *C. cristata*. cb_1, first cell of carpogonial branch; cb_2, second cell of carpogonial branch; cp, carpogonium; sc, supporting cell; sub, subsidiary cell. Scales of Figs 5–7 in μm.

of *Sphaerococcus cristatus β angustatus*, held by the Botanical Museum, University of Copenhagen, has the typical form of *C. cristata*, but is an old apically damaged plant showing narrow, young, secondary growth from the apices. Such plants are common in the winter and spring (January to March) and are totally distinct from the terete, sheltered-water plants. Until the causes of the variations are better understood, and in view of the variability of form found within any one population, it does not seem desirable to maintain or erect any formae.

The description of *C. cristata*, earlier in the paper, falls well within the present-day concepts of the genus *Callophyllis* (Womersley & Norris, 1971). Kylin (1956) felt the single or very rarely two side branches on the supporting cell of

Euthora were significant in distinguishing it from *Callophyllis*. Subsequent investigation of *Callophyllis* species (Norris, 1957, 1964; Abbott & Norris, 1966; Womersley & Norris, 1971) has shown the numbers of carpogonial branches and subsidiary cells to be extremely variable. Kylin (1930, 1956) mistakenly attributes *C. cristata* with uniaxial construction. In fact, development is clearly multiaxial in all but the narrowest branchlets where an apparent single apical cell may be observed. Therefore *Euthora* cannot be considered distinct on these grounds.

Callocolax, a closely related parasitic genus, contains species which occur widely on a number of other *Callophyllis* species. A new species (Hooper, unpublished) occurs on *C. cristata*, suggesting a close relationship with other species of *Callophyllis*.

The only other species placed in the genus *Euthora*, *E. tristanensis*, is known only from the original collections of Baardseth (1941). None of the type or isotype material possesses procarps. Determination of the proper taxonomic placement of this species is impossible until fertile material is available for study.

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