

Sublittoral and Deep-Water Red and Brown Algae New from the Canary Islands

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Nine species of sublittoral and deep-water red and brown algae are reported from the Canary Islands for the first time. The reports of the Western Atlantic species *Gloiocladia atlantica* (Searles) R. E. Norris and *Rosenvingea antillarum* (P. et H. Crouan) M. J. Wynne are the first from the Eastern Atlantic Ocean. The presence of *Feldmannophycus rayssiae* (J. et G. Feldmann) Augier et Boudouresque, *Fauchea repens* (C. Agardh) Montagne et Bory and *Halichrysis depressa* (J. Agardh) F. Schmitz, previously known from the Mediterranean Sea and the adjacent Atlantic coasts, place their southernmost known limit of distribution in the Canary Islands. *Stypopodium schimperi* (Buchinger ex Kützing) Verlaque et Boudouresque is reported for the first time in the Atlantic Ocean, although it is present in the Mediterranean Sea, probably as a Lessepsian species. The records of the widely distributed *Stylonema cornu-cervi* Reinsch, *Acrochaetium infestans* M. Howe et Hoyt and *Spatoglossum schroederi* (C. Agardh) Kützing were not unexpected. Data concerning morphology, habitat and geographical distribution of these species are presented. Observations on the scantily documented sublittoral species *Schimmelmannia schousboei* (J. Agardh) J. Agardh and *Dictyopteris plagiogramma* (Montagne) Vickers are also given. In the dioecious *Schimmelmannia schousboei*, which has been formerly accepted as a doubtful record for the Canary Islands, the reproductive morphology is described including the previously unreported spermatangia. *Dictyopteris plagiogramma* was recently included in a checklist of Canarian species of *Dictyopteris* and is discussed in detail here.

Introduction

The upper sublittoral and deep-water algal flora and vegetation of the Canary Islands have received a great deal of attention in recent years (Sansón *et al.* 1991, Ballesteros *et al.* 1992, Ballesteros 1993, Haroun *et al.* 1993, Reyes *et al.* 1993, González-Ruiz *et al.* 1995, Martín *et al.* 1996, Tabares *et al.* 1997, Afonso-Carrillo *et al.* 1998), increasing the number of recorded marine algae by more than 50 species. Recently, Afonso-Carrillo and Sansón (1999) have compiled the published information on the marine flora and have elaborated a synoptic key for the identification of the seaweeds, higher marine fungi and seagrasses of the Canary Islands. Nevertheless, several investigations carried out at sublittoral habitats during recent projects and expeditions have shown the presence of additional macroalgae in the Canary Islands' marine flora, some of them little-known worldwide.

The aim of this paper is to give an account of new records of sublittoral macroalgae from the Canary Islands, providing data concerning their habitats as well as the morphological and anatomical peculiarities of the Canarian plants, with the purpose of contributing to the knowledge of the sublittoral flora of this region, which is floristically dominated by red and brown algae.

Materials and Methods

Plants were collected between the years 1993 and

2000. Collections of sublittoral specimens were made by SCUBA diving at several localities from El Hierro, Tenerife and Fuerteventura (Fig. 1) and those from deep-waters by dredging carried out during several expeditions to the Marine Reserve of La Graciosa and several small islands (Alegranza, Montaña Clara and Roque del Este) at the north of Lanzarote (Fig. 1). Selected specimens were sorted out and preserved separately in 4 % Formalin in seawater. Permanent

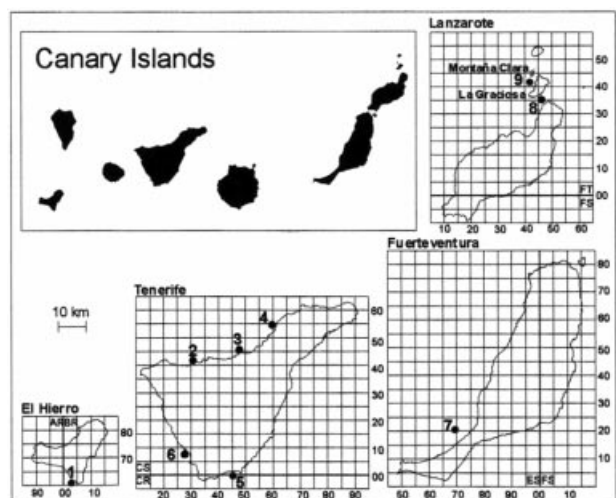


Fig. 1. Geographical location of sampling sites. 1. La Restinga. 2. Playa de San Marcos. 3. Puerto de la Cruz. 4. El Pris. 5. Agua Dulce. 6. Puerto Colón. 7. SW Fuerteventura. 8. El Río. 9. Between La Graciosa and Montaña Clara.

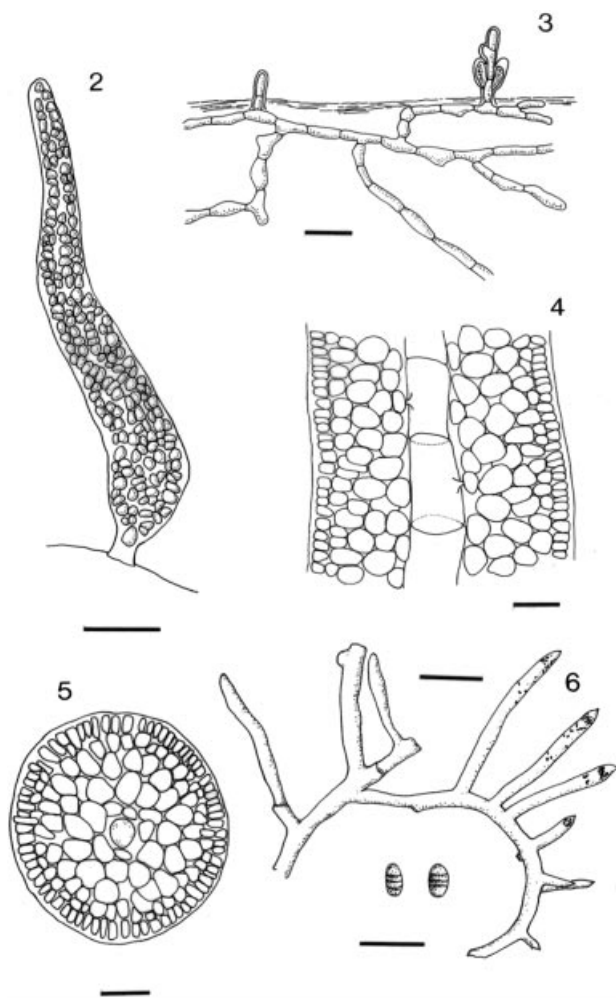
slides were prepared from selected fragments, and mounted in 20 % aqueous Karo-syrup. Camera lucida drawings were made with the aid of a Zeiss microscope. Voucher herbarium specimens have been lodged at TFC (Departamento de Biología Vegetal, Universidad de La Laguna, Islas Canarias).

Results

Rhodophyta

Stylonema cornu-cervi Reinsch (Porphyridiales)

Fig. 2



Figs 2–6.

Fig. 2. *Stylonema cornu-cervi* Reinsch. Plant showing cell arrangement. Scale = 100 μ m. Fig. 3. *Acrochaetium infestans* M. Howe *et* Hoyt. Branched prostrate and erect filaments, with young sporangia. Scale = 20 μ m. Figs 4–6. *Feldmannophycus rayssiae* (J. *et* G. Feldmann) Augier *et* Boudouresque. Fig. 4. Longitudinal section of a branch, showing the central filament and the formation of lateral filaments from the axial cells. Scale = 50 μ m. Fig. 5. Transverse section of a branch, with the central cell, the compact arrangement of medullary cells and the monostromatic cortex. Scale = 50 μ m. Fig. 6. Tetrasporophyte, with tetrasporangia grouped in nemathecium at the apices. Scale = 1 mm. Detail of two zonate tetrasporangia. Scale = 100 μ m.

Selected specimen: Canary Islands, Tenerife: Playa San Marcos, 02.06.1994, leg. J. Reyes, M. Sansón and E. Muñoz, TFC Phyc. 9595.

Distribution: Mediterranean (Ballesteros 1990, Cerecero *et al.* 1996), NE Atlantic, from the British Isles to N Spain (South and Tittley 1986), Pacific (Abbott and Hollenberg 1976, Abbott 1999, Yoshida *et al.* 2000), Australia (Womersley 1994).

Habitat: Plants were detected growing as minute epiphytes on different species of *Cladophora*, collected from the upper sublittoral down to 10 m depth.

Remarks: Until now, the genus *Stylonema* was only represented in the Canary Islands by *Stylonema alsidii* (Zanardini) Drew, a common epiphyte on numerous eulittoral and sublittoral macrophytes (Afonso-Carrillo and Sansón 1999). *Stylonema cornu-cervi*, the type species of the genus, is widespread in temperate seas (Womersley 1994) and its collection in the Canary Islands was not unexpected extending its known geographical range of distribution to the south in the Eastern Atlantic Ocean. The Canarian plants are in agreement with the description made by Womersley (1994). Plants examined are rose-red, simple to irregularly branched from near the base, up to 0.5 mm long and 100 μ m in diameter, and about 10 cells thick but distinctly unicellular at the apex and base (Fig. 2).

According to Womersley (1994), this small epiphyte is probably far more widespread than actual reports indicate.

Acrochaetium infestans M. Howe *et* Hoyt (Acrochaetiales)

Fig. 3

Selected specimen: Canary Islands, Tenerife: Puerto Colón, 28.09.1995, leg. M. Sansón, J. Reyes and J. Afonso-Carrillo, TFC Phyc. 10047.

Distribution: North Carolina, Bermuda, Sargasso Sea, British Isles, France, Mediterranean, Japan and Korea (Schneider and Searles 1991).

Habitat: Endozoic in hydroids, growing on floating moorings at 0–0.5 m depth in harbours, in association with *Blastophysa rhizopus* Reinke, *Chaetomorpha antennina* (Bory) Kützing and *Gymnophycus hapsiphorus* Huisman *et* Kraft.

Remarks: The Canarian plants agree with the descriptions given by Dixon and Irvine (1977) and Schneider and Searles (1991), both as *Audouinella infestans* (Howe *et* Hoyt) Dixon. Plants consist of intricate, irregularly branched, endozoic uniseriate filaments, with cells which are from cylindrical to irregular in outline, 9–30 μ m long and 4–6 μ m in diameter. Few emergent axes are formed from endozoic filaments (Fig. 3), are simple or irregularly branched, and up to 4–6 cells high. Lateral and terminal monosporangia were observed on emergent filaments (Fig. 3). They were sessile or on a one-celled pedicel, up to 13 μ m

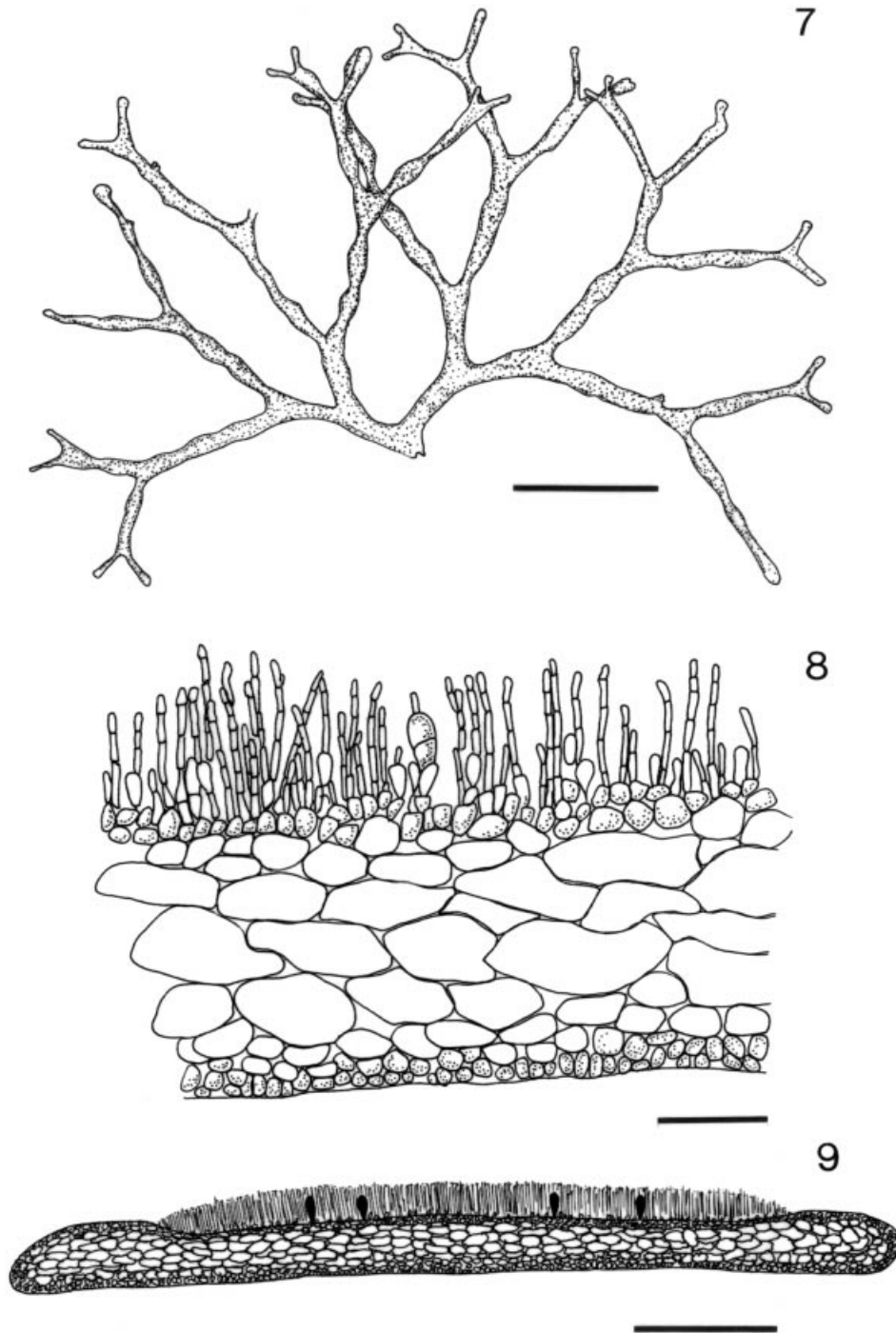
long and 5 μm in diameter. The presence of this species on the Canary Islands was not unexpected, since it seems to be a widely distributed species in the North Atlantic Ocean, although due to its small size and habitat is often overlooked.

Feldmannophycus rayssiae (J. et G. Feldmann) Augier et Boudouresque (Gigartinales) **Figs 4–6**

Selected specimen: Canary Islands, El Hierro: La Restinga, 02.08.1996, leg. J. Reyes, TFC Phyc. 9934.

Distribution: Mediterranean (Augier and Boudouresque 1971, Cecere *et al.* 1996), Salvage Islands (Audiffred and Weisscher 1984).

Habitat: Plants show a distinctive mat-like habit growing in shallow waters intermingled with other caespit-



Figs 7–9. *Faucheia repens* (C. Agardh) Montagne et Bory.

Fig. 7. Habit. Scale = 2 cm. Fig. 8. Detail of a transverse section of a branch. At the upper surface of the section, uniseriate filaments as well as sporangia are formed from the cortex. Scale = 50 μm . Fig. 9. Transverse section of a branch, with a nemathecium on the upper surface. Scale = 300 μm .

tose species, such as *Wurdemannia miniata* (Duby) J. Feldmann *et* Hamel and *Gelidium pusillum* (Stackhouse) Le Jolis.

Remarks: According to Augier and Boudouresque (1971), *Feldmannophycus rayssiae* mainly differs from *Caulacanthus ustulatus* (Mertens) Kützing, the type species of the genus in which it was originally placed (as *Caulacanthus rayssiae* J. *et* G. Feldmann), in the formation of one lateral filament from an axial cell (Fig. 4), the compact arrangement of medullary cells without inner lacunae (Fig. 5), and the distribution of tetrasporangia grouped in nemathecia at the end of branches (Fig. 6). All these attributes were evident in the tetrasporophytes collected on the Canary Islands. *Feldmannophycus rayssiae* appears to be less frequent than *Caulacanthus ustulatus* which has a similar habit. Although the presence of this species on the Canary Islands was expected since it had been previously reported from the nearby Salvage Islands, the great morphological resemblance to the very common species *Caulacanthus ustulatus* may be the probable cause of its late collection and identification.

Fauchea repens (C. Agardh) Montagne *et* Bory (Rhodymeniales) **Figs 7–9**

Selected specimen: Canary Islands, between La Graciosa and Montaña Clara at the north of Lanzarote, 29.09.1995, dredged, TFC Phyc. 9928.

Distribution: Mediterranean (Boudouresque and Perret 1977, Ballesteros 1990, Cabioch *et al.* 1992), NE Atlantic, near to Cadiz and Tangier (South and Tittley 1986, Cabioch *et al.* 1992), Maldives (Silva *et al.* 1996).

Habitat: Plants were epilithic on small rhodoliths of crustose coralline algae, principally *Lithothamnion corallioides* P. *et* H. Crouan, on organic sandy bottoms at 60 m depth. It grows together with *Stenogramme interrupta* (C. Agardh) Montagne *ex* Harvey, *Rhodymenia pseudopalmata* (Lamouroux) Silva, *Cryptoneimia seminervis* (C. Agardh) J. Agardh, *Halopteris filicina* (Grateloup) Kützing and *Zonaria tournefortii* (Lamouroux) Montagne.

Remarks: *Fauchea repens* seems to be a common species in the circa-littoral bottoms near Lanzarote and Fuerteventura (Canary Islands) growing in mäerl beds. Ballesteros (1993) showed that the Canarian mäerl beds have a high floristic resemblance with those situated in the warmer areas of the Western Mediterranean Sea, although they display a lower specific richness and a higher tropical character. In the Mediterranean Sea, *Fauchea repens* is commonly reported as a member of this community at between 20 and 120 m depth (Cabioch *et al.* 1992), and its presence in the Canarian mäerl beds supports the great affinity between these two areas.

The Canarian plants are partially prostrate, up to 7 cm long and 4 mm in diameter. They are dichoto-

mously branched, divaricate (Fig. 7), with smooth margins and slightly constricted. In transverse sections, the medulla is composed of 2–4 layers of large cells, up to 60 µm in diameter, while the cortex consists of small cells (up to 7 µm in diameter) in distinct short anticlinal filaments (Fig. 8). Only tetrasporophytes were detected, with tetrasporangia arranged in elongate nemathecia (Fig. 9).

Although Norris (1991) proposed to transfer several species of *Gloioderma* and *Fauchea* to *Gloiocladia*, he maintained the genus *Fauchea* for species with tetrasporangia in raised nemathecioid sori, as occurs in the type species *Fauchea repens*.

Gloiocladia atlantica (Searles) R. E. Norris (Rhodymeniales) **Figs 10–12**

Selected specimen: Canary Islands, Tenerife: Playa San Marcos, 17.06.1994, leg. J. Reyes, M. Sansón and E. Muñoz, TFC Phyc. 9930.

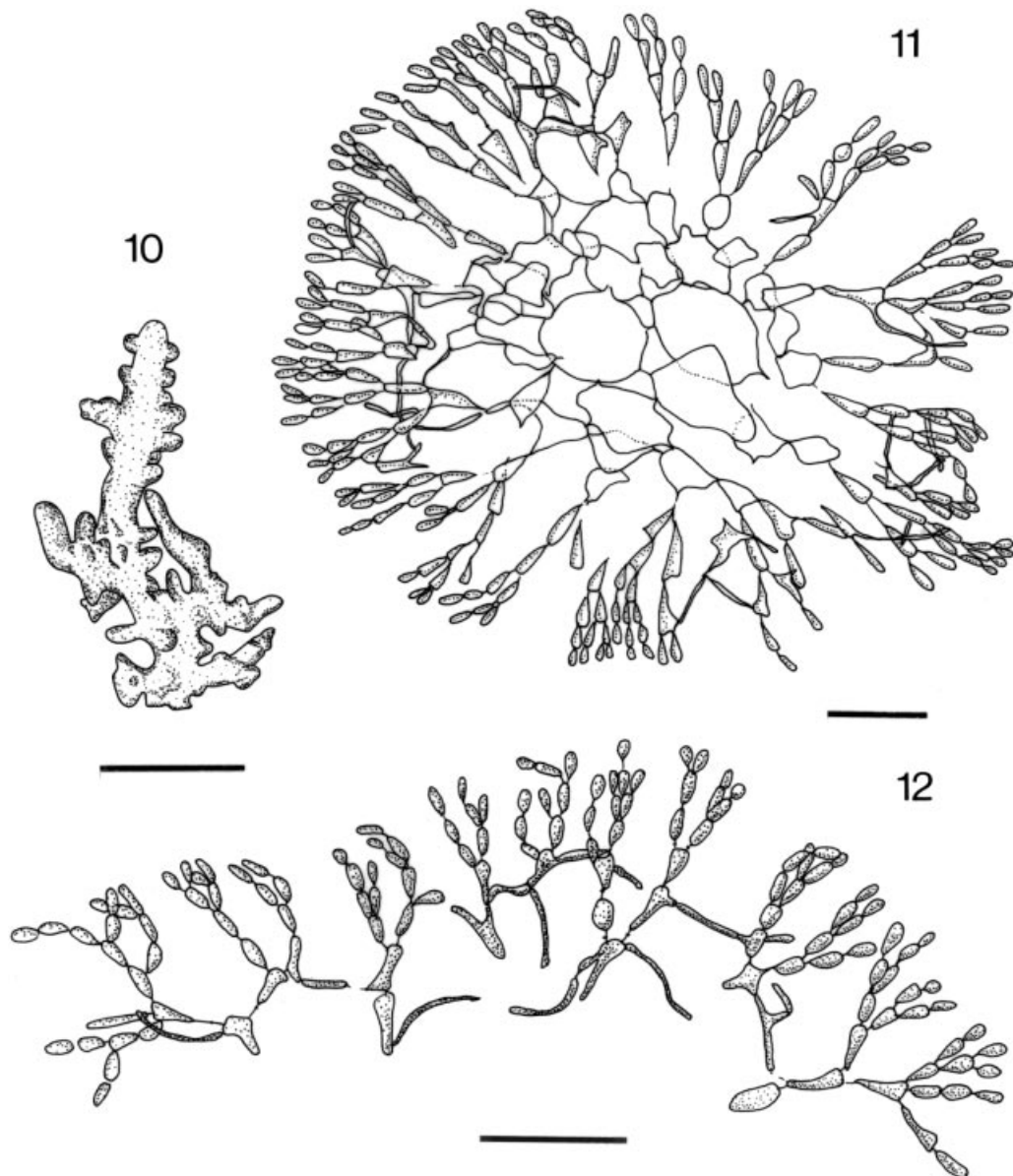
Distribution: Western Atlantic, at North Carolina, South Carolina, Florida, Bahamas, Puerto Rico and Bermuda (Schneider and Searles 1991, 1998a).

Habitat: Plants were collected at 6 m depth, growing on small rocks in a sandy-rocky habitat, in association with other seasonal red algae, such as *Dudresnaya canariensis* Tabares, Afonso-Carrillo, Sansón *et* Reyes, *Sebdenia rodrigueziana* (J. Feldmann) Codomier, *Scinaia complanata* (Collins) Cotton and *Naccaria wiggii* (Turner) Endlicher.

Remarks: The genus *Gloiocladia* includes about 15 species (Norris 1991), with a disjunct distribution along the Indo-Pacific and the Atlantic Oceans. Three of them [*Gloiocladia atlantica*, *G. blomquistii* (Searles) R. E. Norris and *G. rubrispora* (Searles) R. E. Norris] are known from the Atlantic coasts (Schneider and Searles 1991) and *Gloiocladia furcata* (C. Agardh) J. Agardh is recorded from the Mediterranean Sea (Boudouresque and Perret 1977).

On the Canary Islands, plants with radial branching and cell dimensions that characterise *Gloiocladia rubrispora* were recognized among herbarium sheets of *Helminthocladia* spp. sent in loan from Rijksherbarium (Leiden) and collected during an expedition to Lanzarote in May 1980. *Gloiocladia rubrispora* was growing at 40–50 m depth on sandy bottoms. Haroun *et al.* (1993) reported *Gloiocladia blomquistii* from the Canary Islands for the first time, dredged at 80 m depth near the southern coasts of Fuerteventura, and tentatively assigned to *Gloiocladia atlantica* an unidentified specimen with pinnate habit. The plants now studied are in agreement with the descriptions given by Searles (1972, as *Gloioderma atlanticum* Searles) and Schneider and Searles (1991), and confirm the presence of this species in the Eastern Atlantic Ocean.

Plants examined are erect and up to 1 cm long. They are mucilaginous, with a cylindrical to slightly com-



Figs 10–12. *Gloiocladia atlantica* (Searles) R. E. Norris.

Fig. 10. Habit. Scale = 3 mm. Fig. 11. Transverse section of a branch, showing subglobose to irregular medullary cells from which fascicles of subdichotomous cortical filaments are formed. Scale = 50 µm. Fig. 12. Detail of adjacent fascicles of cortical filaments, connected by a network of filaments. Scale = 50 µm.

planate main axis, to 1.5 mm broad, with numerous short distichous to irregular lobes (Fig. 10). In transverse sections, the medulla is composed of isodiametric to irregular-shaped cells (Fig. 11), up to 65 µm in diameter. The cortex consists of dichotomously branched filaments of ellipsoidal cells, the outermost up to 13 µm long and 5 µm in diameter. At the base of the cortical fascicles, a network of filaments parallel to the surface is formed (Fig. 12). Only female gametophytes were detected, with globose ostiolate cystocarps, without horns, arranged at the distal ends of short lateral branches.

Although according to Norris (1991), *Gloiocladia atlantica* may be a synonym of *Gloiocladia iyoensis*

(Okamura) Norris, comparative studies on variations in habit and branching (from pinnate-distichous to radial and irregular) as well as the presence or absence of horn-like outgrowths on cystocarps in plants of different regions are required before they can be synonymized.

Halichrysis depressa (J. Agardh) F. Schmitz (Rhodymeniales)

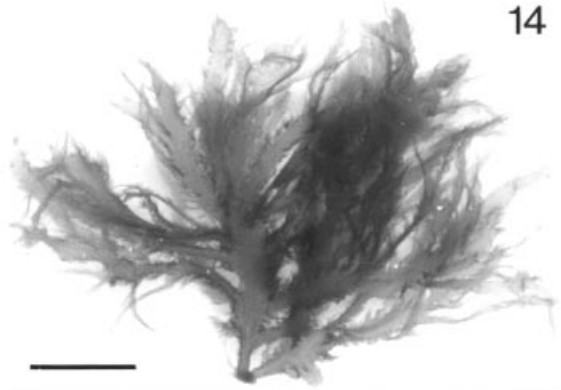
Figs 13, 19–20

Selected specimens Canary Islands, Tenerife: Playa San Marcos, 16.06.1994, leg. J. Reyes, M. Sansón and E. Muñoz, TFC Phyc. 9638; Puerto de la Cruz, 15.07.2000, leg. G. González and A. Sancho, TFC Phyc. 10048.

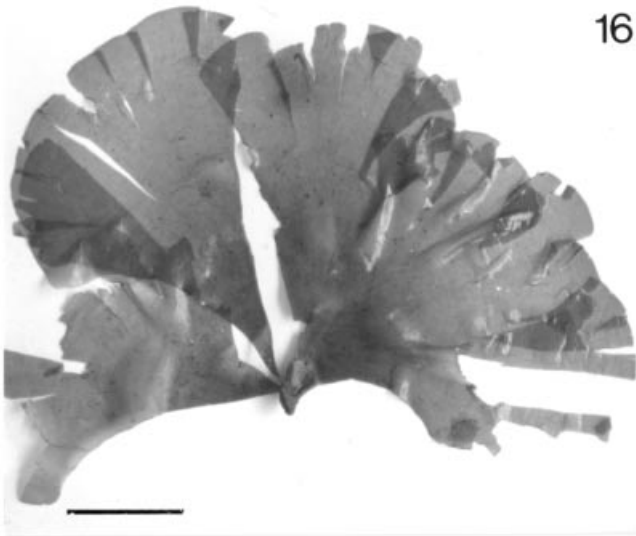
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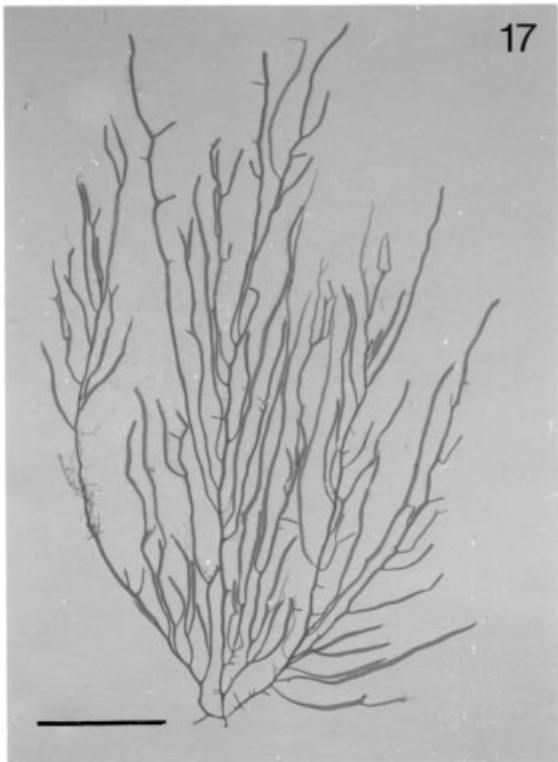
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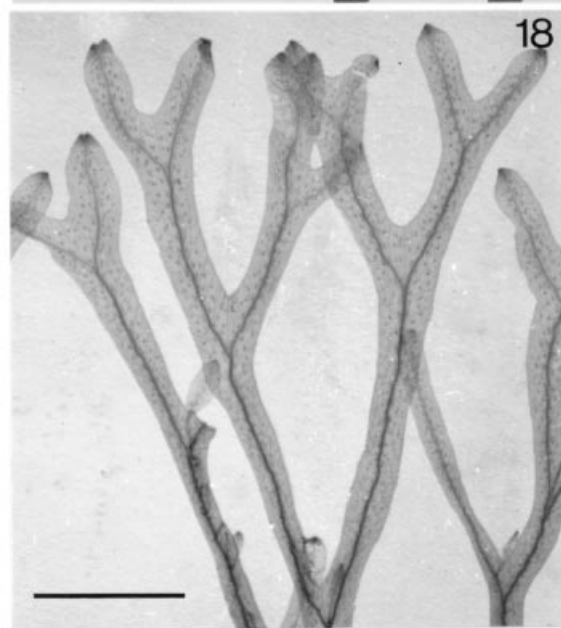
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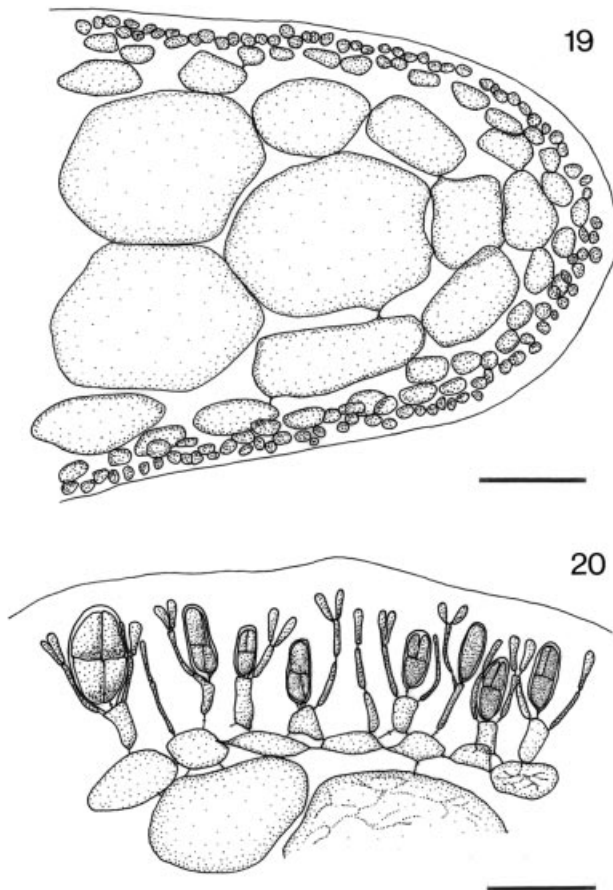


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Figs 19–20. *Halichrysis depressa* (J. Agardh) Schmitz.
Fig. 19. Detail of the transverse section of a branch.
Fig. 20. Detail of a tetrasporangial sorus, with cruciate tetrasporangia born among paraphyses. Both scales = 50 μ m.

Distribution: NE Atlantic, at Morocco, Azores and Ghana (Huvé and Huvé 1976, Lawson and John 1982, Neto 1994), Pakistan (Silva *et al.* 1996).

Habitat: Specimens were collected at the upper sublittoral (5–7 m depth) growing on rocks upon crustose coralline algae, together with *Zonaria tournefortii* (Lamouroux) Montagne, *Spyridia filamentosa* (Wulfen) Harvey, *Lophocladia trichocladus* (C. Agardh) Schmitz and *Dictyota paffii* Schmitter.

Remarks: Seven species have so far been assigned to *Halichrysis* (Huvé and Huvé 1976, Eiseman and Moe 1981, Millar 1990, Norris 1991). From the Canary Islands, this genus was only known for plants reported

as *Halichrysis peltata* (W. R. Taylor) P. Huvé *et al.* H. Huvé (Haroun *et al.* 1993). Huisman and Millar (1996) proposed the new genus *Asteromenia* to accommodate *Fauchea peltata* W. R. Taylor, as *Asteromenia peltata* (W. R. Taylor) Huisman *et al.* Millar, and commented that the record of Haroun *et al.* (1993) from the Canary Islands was probably based on a misidentification.

Plants of *Halichrysis depressa*, the type species of the genus, collected from the Canaries agree with the detailed description given by Huvé and Huvé (1976) of specimens collected in Tangier, in which all stages of reproduction were extensively studied and illustrated. This scarcely reported species is mainly characterized by its partially prostrate, foliose and cartilaginous habit. The irregularly lobed blades have several points of anastomoses between blades and markedly wavy edges (Fig. 13). The plants show flashy golden iridescence with metallic reflections. In transverse sections, the medulla is 5–6 cells thick, with large inner cells decreasing outwards, and the cortex is composed of 1–2 small isodiametric cells (Fig. 19). Tetrasporophytes and female gametophytes were detected. Tetrasporophytes form tetrasporangia, up to 96 μ m long and 68 μ m in diameter, born among paraphyses in immersed sori (Fig. 20). Female gametophytes show uniporate cystocarps which are hemispherical, up to 2 mm in diameter and when mature protrude from the surface of the blades.

Schimmelmannia schousboei (J. Agardh) J. Agardh (Gigartinales) **Figs 14, 21–30**

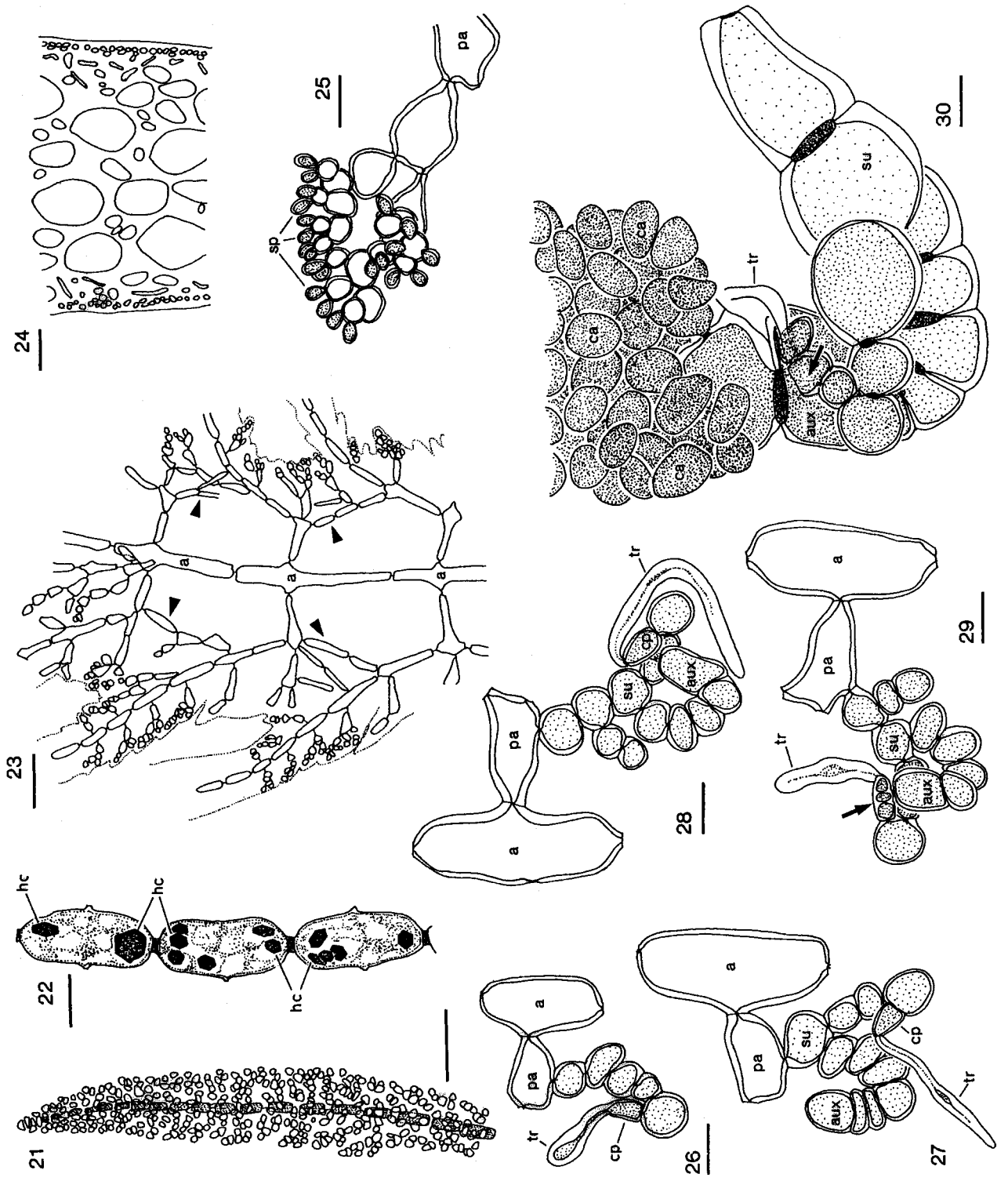
Selected specimens: Canary Islands, Tenerife, Playa San Marcos, 13. 06. 1994, leg. J. Reyes, M. Sansón and E. Muñoz, TFC Phyc. 9712; Playa San Marcos, 14. 06. 1994, leg. J. Reyes, M. Sansón and E. Muñoz, TFC Phyc. 9713; Playa San Marcos, 25. 05. 1995, leg. J. Reyes, M. Sansón and E. Muñoz, TFC Phyc. 9714.

Distribution: Western Mediterranean (Giaccone *et al.* 1985); NE Atlantic: France (Kyllin 1930), N Spain (Gorostiaga and Santolaria 1992, Granja *et al.* 1992, Díez *et al.* 1996), Azores (Neto 1994), Tangier (Bornet 1892).

Habitat: Plants collected were epilithic in the sublittoral, on rocks established in sandy bottoms, at 3–6 m depth, growing together with *Zonaria tournefortii* (Lamouroux) Montagne.

Figs 13–18.

Fig. 13. *Halichrysis depressa* (J. Agardh) Schmitz. Habit. Scale = 1 cm. Fig. 14. *Schimmelmannia schousboei* (J. Agardh) J. Agardh. Habit. Scale = 2 cm. Fig. 15. *Spatoglossum schroederi* (C. Agardh) Kützinger. Habit. Scale = 4 cm. Fig. 16. *Stypopodium schimperi* (Buchinger ex Kützinger) Verlaque *et* Boudouresque. Habit. Scale = 2 cm. Fig. 17. *Rosenvingea antillarum* (P. *et* H. Crouan) Wynne. Habit. Scale = 2 cm. Fig. 18. *Dictyopteris plagiogramma* (Montagne) Vickers. Detail of the habit, showing the subdichotomous branching and the fine oblique lateral veins from the midrib. Scale = 1 cm.



Remarks: The genus *Schimmelmannia* was established by Kützing (1849) based on plants collected by Schousboe in Tangier (Morocco) and described as *Schimmelmannia ornata* Kützing, an illegitimate name used to replace the previously described *Sphaerococcus schousboei* J. Agardh (1841). Although six species of *Schimmelmannia* are currently recognized, most of them have been infrequently reported and are poorly known. *Schimmelmannia bollei* Montagne from the Cape Verde Islands (Eastern Atlantic Ocean), *S. elegans* Baardseth from Tristan da Cunha (South Atlantic Ocean), *S. frauenfeldii* Grunow from St Paul Island (Indian Ocean) and *S. dawsonii* Acleto from Peru appear to have distributions restricted to the type localities (Acleto 1972). The remaining species have a wider distribution: *S. plumosa* (Setchell) Abbott has been reported from California, Chile and Japan (Santelices 1989, Yoshida *et al.* 2000), and the type species *S. schousboei* has been documented for several localities of the warm temperate Eastern Atlantic Ocean.

Gametophytes examined are dioecious and no morphological differences occur between male and female plants. Plants are bushy, red wine to purple in colour, arising from a single discoid holdfast and consisting of several compressed main axes, up to 20 cm high and 1 cm broad. They are downy in outline, gelatinous but firm and distichously branched with pinnate to tripinnate lateral branches (Fig. 14). Lateral branches are lanceolate, constricted at the base and acuminate at the apex, with pinnae at their margins. The central filament and the apical hemispherical cell are evident at the younger region of branches (Fig. 21). Axial cells are cylindrical and often contain 1–5 hexagonal crystals (Fig. 22). Each axial cell produces a single whorl of up to 5 cortical filaments, one of which grows to form a lateral branch or pinna (Fig. 23). Cortical filaments are four to five times di- or trichotomously branched with cells subcylindrical at the base, becoming shorter and thinner upwards. The terminal cells are subspherical to obovoid, 4–9 µm in diameter. Basal cells of cortical filaments produce descending rhizoidal filaments that connect with cortical filaments formed below (Fig. 23) originating a characteristic network

that obscures the central axis in old regions of the plant (Fig. 24).

Spermatangia are ovoid, 2–3 µm broad, borne 2–3 on subspherical spermatangial mother cells, 3–4 µm in diameter, which arise from the terminal cells of the cortical filaments (Fig. 25). The carpogonial and auxiliary-cell branches occur in longitudinal series, in younger branches, arising acropetally and alternately to one side and the other along the axes. Each procarp is formed abaxially from a periaxial cell and consists of a 4-celled carpogonial branch, previously formed from a 5 to 7-celled auxiliary-cell branch which arises from a 1–3 proximal cell (Figs 26–28). After fertilization the carpogonium divides transversely twice (Fig. 29) and the central cell fuses with the auxiliary-cell (Fig. 30). Mature carposporophytes are subhemispherical, up to 190 µm in diameter, and consist of a mass of spherical to ovoid carposporangia, 8–15 µm in diameter (Fig. 30).

Species of *Schimmelmannia* have been mostly characterized on external attributes such as the shape of the axis (linear or complanate), the texture (cartilaginous or gelatinous) and the degree of branching of axes and pinnae (Acleto 1972). Axes which are compressed and gelatinous have been reported only in *S. bollei*, *S. dawsonii* and *S. schousboei*. The bushy appearance of the plants as a consequence of the development of several axes is accepted as an exclusive attribute of *S. schousboei* (Acleto 1972). On the contrary, the vegetative and reproductive morphology have been scantily documented in species of *Schimmelmannia* (Kylin 1930, Acleto 1972) preventing its use in species delineation.

The collection of spermatangial plants of *Schimmelmannia schousboei* has permitted us to document for the first time the spermatangia in this species. These show the general pattern of shape and arrangement exhibited by other Gloiosiphoniaceae (Kylin 1930, Tabares and Afonso-Carrillo 1998). Other notable attributes observed in *S. schousboei* are the size of both carposporophytes and carposporangia which show smaller dimensions than previously reported in the few species of *Schimmelmannia* where these features have been documented, and the common occurrence of hexagonal crystals in the axial cells.

Figs 21–30. *Schimmelmannia schousboei* (J. Agardh) J. Agardh.

Fig. 21. Surface view of the apex of a branch, showing the central filament and the prominent apical cell. Scale = 50 µm. Fig. 22. Hexagonal crystalline inclusions (hc) in axial cells. Scale = 10 µm. Fig. 23. Longitudinal view of a branch, showing the axial cells (a) and the fascicles of cortical filaments. Note the rhizoidal filaments (arrowheads) formed from periaxial cells forming a network between adjacent inner cortical filaments. Scale = 50 µm. Fig. 24. Transverse section at the basal region of a branch, with numerous rhizoidal filaments in the medulla. Scale = 50 µm. Fig. 25. Detail of a cortical filament bearing spermatangia (sp). Scale = 10 µm. Fig. 26. Young carpogonial branch, with carpogonium (cp) and trichogyne (tr), before the initiation of the auxiliary-cell branch. Note that it is formed abaxially from a periaxial cell (pa). Scale = 10 µm. Figs 27–28. Details of two mature procarps showing the location of the auxiliary cell (aux), the carpogonium (cp) and the supporting cell (su). Scale = 10 µm. Fig. 29. Detail of a procarp after presumed fertilization, with the twice transversely divided carpogonium (arrow). Scale = 10 µm. Fig. 30. Detail of the proximal portion of a mature carposporophyte with carposporangia (ca). Both cells of the procarp and their pit-connections are greatly enlarged. Only the central cell of the divided carpogonium (arrow) fuses with the auxiliary cell (aux). Scale = 10 µm.

These crystalline inclusions had not been previously reported in Gloiosiphoniaceae and are similar in shape to those observed in other red algae (Pueschel 1992). The usefulness of these characters in the determination of *Schimmelmanna* species may be high, as has been demonstrated in other gelatinous uniaxial red algae (Robins and Kraft 1985). However, in the absence of vegetative and reproductive information for most of the species of *Schimmelmanna*, the value of these attributes is difficult to assess at present.

The only previous records of *Schimmelmanna* in the Canary Islands were those of Schmitz and Hauptfleisch (1896–1897) who included the Canaries in the distribution of *Schimmelmanna bollei*, and Mazza (1903) who also included the Canaries in the distribution of *S. schousboei* (as *S. ornata*). Børgesen (1929) did not find specimens from the Canary Islands in the Botanical Museum of Berlin and considered both reports as doubtful. All the records compiled by Woelkerling *et al.* (1998) and accepted by Afonso-Carrillo and Sansón (1999) are based on these reports. Therefore, the present findings confirm the presence of *S. schousboei* in the Canary Islands and clarify the controversial records of the species of *Schimmelmanna* for this region.

Phaeophyta

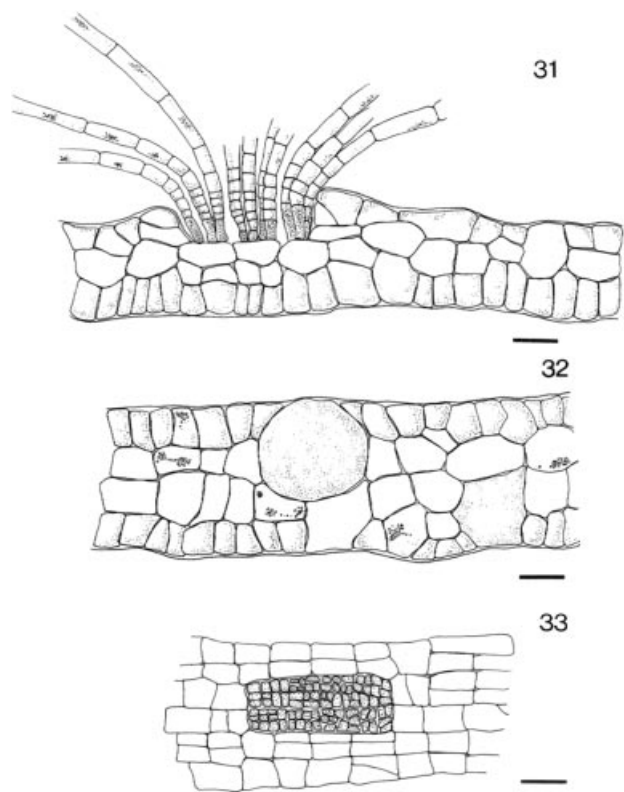
Spatoglossum schroederi (C. Agardh) Kützing (Dictyotales) **Figs 15, 31–33**

Selected specimen: Canary Islands, Tenerife: El Pris, 20.05.1996, leg. J.M. González, TFC Phyc. 10049.

Distribution: Western Atlantic, from North Carolina to Brazil (Schneider and Searles 1991), Eastern Atlantic, from Morocco to Cameroon (Price *et al.* 1978), Mediterranean (Ribera *et al.* 1992), Madagascar, Pakistan, Sri Lanka and Tanzania (Silva *et al.* 1996).

Habitat: Plants were collected growing at 20 m depth on rocks covered by organic sand, together with *Sargassum desfontainesii* (Turner) C. Agardh, *Cystoseira abies-marina* (Gmelin) C. Agardh and *Sargassum vulgare* C. Agardh, next to a rocky platform dominated by the sea urchin *Diadema antillarum* (Philippi).

Remarks: Eighteen species of *Spatoglossum* are known from warm temperate to tropical regions of the world, and also in cold-temperate regions of the Southern Hemisphere (Tanaka 1991). Two of them have been reported from the Eastern Atlantic Ocean, *Spatoglossum schroederi* and *S. solierii* (Chauvin) Kützing. Price *et al.* (1978) pointed out that *Spatoglossum solierii* is characterized by its entire and undulating margin and generally has a more northerly distribution (Mediterranean and the warmer Atlantic temperate coasts to Brittany). The Mediterranean Sea is the northern limit of distribution known for *Spatoglossum schroederi* which is distinguished by its irregular and dentate margins. Oosterbaan (1984) identi-

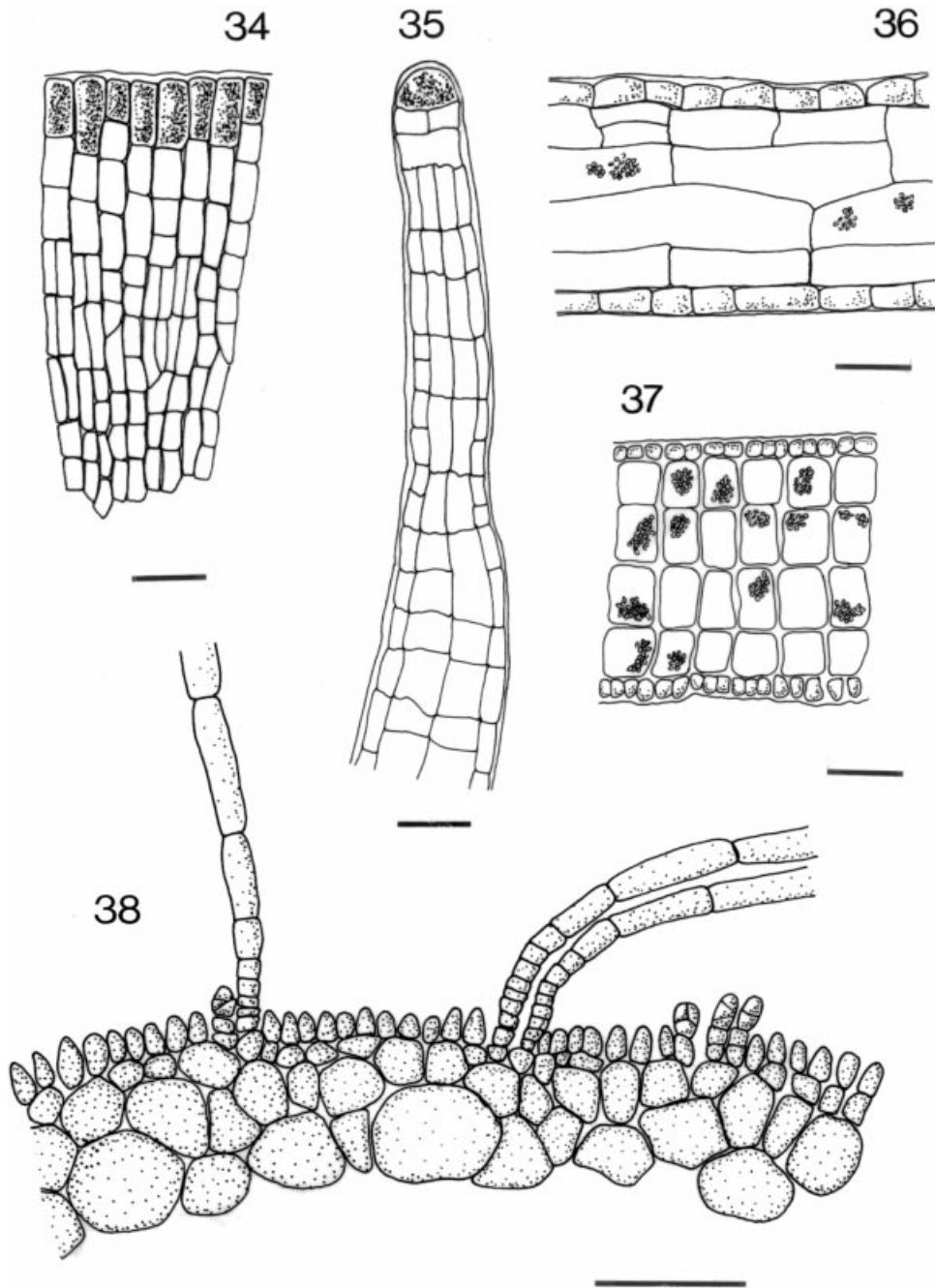


Figs 31–33. *Spatoglossum schroederi* (C. Agardh) Kützing. Fig. 31. Transverse section of a frond, with a tuft of phaeophyceyan hairs. Fig. 32. Transverse section of a sporophyte, with globose sporangia lying within the cortex. Fig. 33. Surface view of a frond, with a sorus of antheridia. All scales = 50 μ m.

fied sporophytes of *Spatoglossum solierii* in Lanzarote, but plants of *Spatoglossum schroederi* have not been detected in the Canary Islands previously.

The plants studied are relatively delicate in texture, complanate, irregularly branched or lacerate, up to 80 cm long (Fig. 15) and attached by a discoid rhizoidal holdfast. Margins are entire when young and also at the youngest region of mature plants, but are undulate, dentate or lacerate at the oldest regions. Fronds grow by a group of apical cells in a slightly depressed apex. In transverse sections, plants are (2–)4–6(–7) cells thick and are up to 300 μ m broad. The cortical cells usually subdivide once from larger medullary cells, the latter are irregularly placed and rounded to irregular in shape (Fig. 31). Hair tufts are scattered, persistent and with their bases sunk in the fronds (Fig. 31). Sporangia and antheridial sori were detected lying completely within the cortex on both surfaces of the fronds. Sporangia are subspherical to ovoid in transverse section, up to 204 μ m in diameter and 170 μ m long (Fig. 32). Antheridial sori are irregular in shape, with antheridia elongate and densely grouped and lacking paraphyses surrounding the sori (Fig. 33).

Stypodium schimperi (Buchinger *ex* Kützing) Verlaque *et* Boudouresque (Dictyotales) **Figs 16, 34–37**



Figs 34–38.

Figs 34–37. *Styopodium schimperi* (Buchinger ex Kützing) Verlaque *et* Boudouresque. Fig. 34. Surface view of marginal growth cells. Fig. 35. Longitudinal section showing segmentation from an active apical cell. Fig. 36. Longitudinal section at the middle region of the frond. Fig. 37. Transverse section at the middle region of the frond. Fig. 38. *Rosenvingea antillarum* (P. *et* H. Crouan) M. J. Wynne. Transverse section of a branch, with subglobose medullary cells, monostromatic cortex, phaeophycean hairs and plurilocular reproductive structures. All scales = 50 μ m.

Selected specimen: Canary Islands, at the SW of Fuerteventura: Cofete, 01.10.1997, dredged, TFC Phyc. 9932.

Distribution: Red Sea and Mediterranean (Verlaque and Boudouresque 1991, Verlaque 1994, Cabioch *et al.* 1992), Somalia (Silva *et al.* 1996).

Habitat: Plants were epilithic on small stones at bot-

toms dominated by organic sand, at 63 m depth. Plants were growing in association with *Zonaria tournefortii* (Lamouroux) Montagne, *Syringoderma floridana* Henry, *Halopteris filicina* (Grateloup) Kützing and *Peyssonnelia inamoena* Pilger.

Remarks: *Styopodium schimperi* was originally described from the Red Sea and it has been recently

found in some Mediterranean localities (Verlaque and Boudouresque 1991). Plants examined are thin and membranous, erect, flabellate, scarcely lacerate, up to 8 cm high and 12 cm broad (Fig. 16). They are stupose below with a matted rhizoidal holdfast. Fronds are broadest near their flabellate apices, tapering below, with a marginal row of apical growth cells (Fig. 34). Fronds are from 1–4 cells and 60 μm thick at the apical region (Fig. 35) to 5–7 cells and 165 μm thick at the basal region (Fig. 36). In transverse sections, subrectangular medullary cells are arranged in regular rows, with (2–) 3–4 cortical cells to each medullary cell (Fig. 37). Although the Canary Islands specimens are sterile, plants agree well with the description given by Verlaque and Boudouresque (1991). By its thin and translucent membranous habit and the less numerous and smaller medullary cells, *Styopodium schimperi* can be easily distinguished from the young plants of *Styopodium zonale* (Lamouroux) Papenfuss, the other species of the genus reported from the Canary Islands (Afonso-Carrillo and Sansón 1999).

Rosenvingea antillarum (P. et H. Crouan) M. J. Wynne (Scytosiphonales) **Figs 17, 38**

Selected specimens: Canary Islands, El Río (between Lanzarote and La Graciosa), 04.10. 1995, leg. J. Reyes, TFC Phyc. 10050, 10051.

Distribution: Western Atlantic (Wynne 1997, 1998), Eastern Pacific [Abbott and Hollenberg 1976, as *Rosenvingea floridana* (W. R. Taylor) W. R. Taylor], Bangladesh (Silva *et al.* 1996, as *R. floridana*).

Habitat: Plants were collected at 8–13 m depth, growing on small stones and shells, on sandy bottoms dominated by patches of the seagrass *Cymodocea nodosa* (Ucria) Ascherson. *Rosenvingea antillarum* grows as isolated plants or small groups, together with *Sargassum desfontainesii* (Turner) J. Agardh, *Lophocladia trichoclados* (C. Agardh) Schmitz, *Hydroclathrus clathratus* (C. Agardh) Howe and *Lithothamnion corallioides* P. et H. Crouan.

Remarks: Wynne (1997) proposed the name *Rosenvingea antillarum* to replace the junior taxonomic synonym *Rosenvingea floridana*. Until now, two species of *Rosenvingea* were known from the Canary Islands: *R. sanctae-crucis* Børgesen and *R. intricata* (J. Agardh) Børgesen (Afonso-Carrillo and Sansón 1999). The finding of *Rosenvingea antillarum* in the Canary Islands extends its geographical distribution, being the first record known from the Eastern Atlantic coasts, and supports the amphiatlantic character of this genus.

Plants studied are yellow-brown, up to 12 cm high, consisting of cylindrical or slightly compressed axes, which are irregularly alternately branched and attached by a small basal disc (Fig. 17). Branches are long and slender, up to 1.5 mm in diameter, tapering to the base and apex. Branches are tubular except near

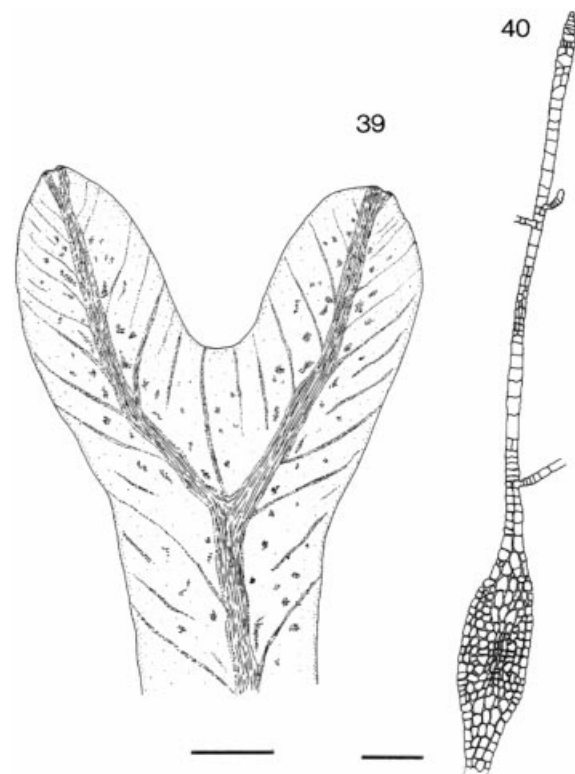
the base of the plant where rhizoidal filaments fill the central cavity. Walls of branches are 3–4(–5) cells thick, with large and colourless medullary cells, to 55 μm in diameter, and small and pigmented cortical cells, to 8 μm in diameter (Fig. 38). Hairs occur scattered or in small groups on the surface of branches. They are 13–14 μm in diameter (Fig. 38). Superficial sori with plurilocular reproductive structures, cylindrical to clavate, to 8 μm in diameter and 25 μm long, were observed (Fig. 38).

Dictyopteris plagiogramma (Montagne) Vickers (Dictyotales) **Figs 18, 39–40**

Selected specimens: Canary Islands, Tenerife, Agua Dulce, 16.07.1993, leg. J. Reyes, E. Ballesteros and J. Romero, TFC Phyc. 9925, 10052.

Distribution: Western Atlantic (Wynne 1998), Australia, Madagascar and Seychelles (Silva *et al.* 1996), NW Pacific (Yoshida *et al.* 2000).

Habitat: Plants collected were epilithic on the sublittoral, on small rocks occurring in organic sandy bottoms, shells and rhodoliths of encrusting corallines, at 20–30 m depth. They were growing in association with *Cymodocea nodosa* (Ucria) Ascherson, *Caulerpa prolifera* (Forsskål) Lamouroux, *Sargassum vulgare*



Figs 39–40. *Dictyopteris plagiogramma* (Montagne) Vickers. Fig. 39. Surface view of the apex of a branch, showing the central midrib, lateral veins and hair tufts. Scale = 2 mm. Fig. 40. Transverse section of a branch, showing the structure of the midrib and adjacent wing. Scale = 200 μm .

C. Agardh, *Lophocladia trichocladus* (C. Agardh) Schmitz and *Cottoniella filamentosa* (Howe) Børgeesen.

Remarks: The genus *Dictyopteris* includes some 20 species, widespread in tropical and temperate waters, characterized by a much branched habit with a distinct percurrent midrib (Womersley 1987). Four of these species, *Dictyopteris australis* (Sonder) Askenasy, *D. hoytii* Taylor, *D. serrata* (Areschoug) Hoyt and *D. plagiogramma* are readily recognized by the fine lateral veins at the wings of the fronds. Of them, *Dictyopteris plagiogramma* is the most widely distributed species, but it was unknown from the Eastern Atlantic Ocean. Recently, Afonso-Carrillo and Sansón (1999) included this species among the Canary Islands species of the genus *Dictyopteris*, based on the material now discussed here.

Plants studied are erect, up to 20 cm long, yellow-brown and translucent. They are profusely branched, with alternate or subdichotomous branching at regular intervals of 1–2.5 cm (Fig. 18) and are attached by a matted rhizoidal holdfast. Fronds are up to 4 mm broad, with a central midrib throughout from which pinnate fine lateral veins arise, obliquely to the margins (Fig. 39). The base of the fronds is often partly to largely denuded. In transverse section, the structure of the wing is 1–2(–4) cells thick while the midrib becomes pluristromatic, up to 12 or more cells thick (Fig. 40). Hair tufts occur in irregular, oblique rows beside the midrib, generally between the veins. No reproductive structures were detected.

Conclusion

Investigations on sublittoral, especially deep-water floras, are continuously revealing new discoveries at many biogeographical marine regions (Norris and Olsen 1991). In the Canary Islands, recent researches carried out at special sublittoral habitats between 10 and 50 m depth, such as the cobble substrata or the border of rocky bottoms just above sand flats, have discovered the presence of a rich ephemeral spring-summer annual flora (Tabares *et al.* 1997, Afonso-Carrillo *et al.* 1998). The species newly reported from the Canary Islands in this work are the result of the study of these habitats during the favorable spring-summer periods. The geographic location of the Canary Islands, suitable for settlement of seaweed species with different biogeographical affinities, has per-

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mitted the recent surprising enrichment of the Canarian sublittoral flora.

Of the eleven marine algae documented in this paper, *Gloiocladia atlantica*, *Rosenvingea antillarum*, *Dictyopteris plagiogramma* and *Stypopodium schimperi* are reported for the first time from the Eastern Atlantic Ocean. *Gloiocladia atlantica* was only previously known from the Western Atlantic coasts, and joins other amphi-Atlantic species with strictly warm-temperate zone distribution (Schneider and Searles 1998b). *Rosenvingea antillarum* and *Dictyopteris plagiogramma* had been found in the Western Atlantic Ocean and occasionally in the Indo-Pacific Ocean. *Stypopodium schimperi* deserves special mention, because Verlaque (1994) considered this species as an example of the Lessepsian migration process from the Red Sea to the Mediterranean Sea throughout the Suez Canal. Verlaque (1994) included this species among the macrophytes introduced in the Mediterranean Sea, and marked its western limit of distribution at Benghazi (Libya). The presence of *Stypopodium schimperi* in the Canary Islands extends the range of expansion of this species recorded now for the first time in the Atlantic Ocean.

Four species, *Feldmannophycus rayssiae*, *Schimmelmannia schousboei*, *Faucheia repens* and *Halichrysis depressa*, can be considered as characteristic of the warm temperate North Eastern Atlantic Region (Hoek 1984), although the last two species have also been reported from a locality in the Indian Ocean. The Canary Islands now constitute the southernmost known limit of their distribution.

Finally, the remainder of the algae newly reported from the Canary Islands (*Stylonema cornu-cervi*, *Acrochaetium infestans* and *Spatoglossum schroederi*) have been previously found in other localities from the Eastern Atlantic Ocean and their presence in the Canary Islands was not unexpected.

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