

## NOTES ON THE BENTHIC MARINE ALGAE OF THE CANARY ISLANDS

Julio AFONSO-CARRILLO, Susana PINEDO and Yáel ELEJABEITIA

Departamento de Biología Vegetal (Botánica), Universidad de la  
Laguna, E-38271 La Laguna, Canary Islands, Spain.

**ABSTRACT** - Eight new records of marine algae from the Canary Islands are described: *Anadyomene saldanhae* Joly et Oliveira-Filho, *Pseudolithoderma adriaticum* (Hauck) Verlaque, *Zanardinia prototypus* (Nardo) Nardo, *Cystoseira mauritanica* Sauvageau, *Coelothrix irregularis* (Harvey) Børgesen, *Lophosiphonia cristata* Falkenberg, *Hildenbrandia occidentalis* Setchell and *Gelidiella antipai* Celan. The *Petrocelis cruenta* J. Agardh phase of *Mastocarpus stellatus* (Stackhouse) Guiry is also reported. Data concerning ecological conditions, geographical distribution, morphology, anatomy and phenology are presented.

**RÉSUMÉ** - Les auteurs signalent huit espèces et une phase nouvelle pour la flore des algues marines des Iles Canaries: *Anadyomene saldanhae* Joly et Oliveira-Filho, *Pseudolithoderma adriaticum* (Hauck) Verlaque, *Zanardinia prototypus* (Nardo) Nardo, *Cystoseira mauritanica* Sauvageau, *Coelothrix irregularis* (Harvey) Børgesen, *Lophosiphonia cristata* Falkenberg, *Hildenbrandia occidentalis* Setchell, *Gelidiella antipai* Celan et la phase *Petrocelis cruenta* J. Agardh de *Mastocarpus stellatus* (Stackhouse) Guiry. Pour chaque espèce sont données les conditions écologiques et la distribution géographique, ainsi que les observations morphologiques, anatomiques et phénologiques.

**KEY WORDS** : seaweeds, distribution, Canary Islands.

### INTRODUCTION

The first general account of the seaweed flora of the Canary Islands was given by Børgesen (1925-30). Later, Gil-Rodríguez & Afonso-Carrillo (1980) and Afonso-Carrillo & Sansón (1989) have summarized floristic data. More recently, Sansón *et al.* (1991) have reported new records of Florideophyceae.

The present investigation was prompted by the collection at Tenerife of several previously unreported marine algae.

### MATERIAL AND METHODS

Specimens were collected between 1990 and 1991 at Puerto de la Cruz and Punta del Hidalgo, in the N and NE of Tenerife (Canary Islands) respectively and were deposited at TFC. Permanent slides for anatomical studies were prepared from specimens preserved in 4% formalin in sea water, sectioned by hand with a razor blade and mounted in 20% aqueous "Karo" dextrose. Camera lucida drawings and

photomicrographs were obtained with the use of a Zeiss microscope. Herbarium abbreviations follow Holmgren *et al.* (1981).

## RESULTS AND DISCUSSION

### *Anadyomene saldanhae* Joly et Oliveira-Filho (Anadyomenaceae, Chlorophyta) (Fig. 1)

Eight species of *Anadyomene* are known from the Atlantic Ocean, with only one species, *Anadyomene stellata* (Wulfen) C. Agardh, previously reported from the Eastern Atlantic (Littler & Littler, 1991).

*Anadyomene saldanhae*, generally considered a deep-water species, was originally described from material dredged from 85 m in the Brazilian coast (Joly & Oliveira-Filho, 1969) and later collected in deep-water habitats at different Caribbean localities from Bermuda to Brazil (Norris & Olsen, 1991). This species has also been recently reported as growing on mangrove roots at the intertidal areas in Belize (Littler & Littler, 1991).

Plants examined have foliose blades up to 30 mm tall and agree with previous accounts of the species. According to Littler & Littler (1991) the most distinctive characters of *A. saldanhae* (Fig. 1) are the absence of overlappings cells within the eperforate blade, the random arrangement of interstitial cells following repeated polychotomous divisions, and the outer margin composed of small spherical cells.

*A. saldanhae* was collected in the intertidal at Puerto de la Cruz and Punta del Hidalgo (Tenerife) growing epilithic in the middle eulittoral under low light intensity habitats or in tide pools as an epiphyte of *Galaxaura rugosa* (Ellis et Solander) Lamouroux [TFC (Phyc) 5840, 6826, 6866, 6985].

### *Pseudolithoderma adriaticum* (Hauck) Verlaque (Lithodermataceae, Phaeophyta)

This species has been reported to be found in the Adriatic Sea as well as in the Eastern and Western shores of the Mediterranean Sea (Athanasiadis, 1985; Verlaque, 1988). According to Verlaque (1988) the report from the French Atlantic (Hamel, 1931-39) correspond "sans aucun doute to *Pseudolithoderma roscoffense* Loiseaux.

Sterile plants collected in the Canary Islands agree with the description given by Athanasiadis (1985, as *Lithoderma adriaticum* Hauck) and Verlaque (1988).

Fletcher (1987) has pointed out that *P. roscoffense* Loiseaux from the British Isles and Brittany (France) appears to show a marked similarity with the description given by Hamel (1931-39) of *Pseudolithoderma adriaticum* (as *Lithoderma*). According to Verlaque (1988), *P. adriaticum* is only differentiated by the thinner crust and the barely bigger cell dimensions. It seems possible that *P. roscoffense* is conspecific with *P. adriaticum*, but further studies are needed before this matter can be firmly settled.

*P. adriaticum* was collected at Puerto de la Cruz and Punta del Hidalgo growing epilithic in exposed habitats of the middle and low eulittoral [TFC (Phyc) 6979, 6981, 7083].



Fig. 1 - *Anadyomene saldanhae* Joly et Oliveira-Filho. Habit.

***Zanardinia prototypus* (Nardo) Nardo (Cutleriaceae, Phaeophyta)**

This species has been recorded to be found from the Eastern North Atlantic from the British Isles down to Tangier (Morocco), as well as in Azores and the Western Mediterranean Sea (Ardré, 1970).

The Canarian material agrees with previous accounts of this taxon (see Ardré, 1970; Fletcher, 1987). In section, the medulla of thick-walled cells is surrounded by an upper cortex of up to 5 cells arranged in vertical rows and a lower cortex of 1-2 cells.

*Z. prototypus* was collected at Puerto de la Cruz, growing epilithic in low light intensity habitats under *Gelidium canariense* (Grunow) Seoane-Camba, *G. arbuscula* Bory ex Børgesen and *Pterocladia capillacea* (Gmelin) Bornet et Thuret in exposed tide pools. Antheridial plants were collected in May [TFC (Phyc) 5854].

***Cystoseira mauritanica* Sauvageau (Cystoseiraceae, Phaeophyta) (Fig. 2)**

This is a poorly known species only previously reported in Mauritania (Sauvageau, 1912) and the Spanish South Western Mediterranean shore (Oliveras-Plá & Gómez-Garreta, 1989).

The Canarian material examined (Fig. 2) is in good agreement with the description given by Sauvageau (1912) and with the type material housed at PC (Gómez-Garreta, pers. com.). Plants are up to 30 cm in height, usually solitary, non caespitose and attached by a conical disc. The axis is cylindrical, unbranched and bearing ovoid, smooth, dark-brown tophules. Lateral branch systems radial, up to 20 cm long, with bluish iridescence, repeatedly branched and bearing spine-like appendages "*Cystoseira abies-marina* type". Receptacles were not observed.

*C. mauritanica* was collected at Punta del Hidalgo growing in tide pools [TFC(Phyc) 6935, 6988].

***Coelothrix irregularis* (Harvey) Børgesen (Champiaceae, Rhodophyta) (Figs 3, 4)**

According to Van den Hoek (1982), this species is world wide spread found in tropical and warm temperate coasts. In the North Eastern Atlantic this species has been only recorded in Portugal (Ginsburg-Ardré, & Palminha, 1964). The paucity of recording of this species from the Eastern Atlantic is possibly due, as it was pointed out by Taylor (1960) and Ginsburg-Ardré & Palminha (loc. cit.), to misidentifications of taxa with similar habits, as *Wurdemannia miniata* (Draparnaud ex A.P. De Candolle) Feldmann et Hamel and *Gigartina acicularis* (Roth) Lamouroux.

Sterile plants collected in the Canary Islands are in good agreement with previous accounts of the species (Børgesen, 1915-20; Taylor, 1960). Plants are 1-3 cm high, bluish-iridescent and with hollow terete branches (Fig. 3-4) frequently interadherent and fusing.

*C. irregularis* was collected at Puerto de la Cruz growing epilithic in tide pools, as an epiphyte of *Padina gymnospora* (Kützinger) Sonder and in low light habitats from the eulittoral entangled with *Griffithsia opuntioides* J. Agardh, *Hypoglossum hypoglossoides* (Stackhouse) Collins et Hervey and *Gastroclonium reflexum* (Chauvin) Kützinger [TFC(Phyc) 5789, 7239].

***Lophosiphonia cristata* Falkenberg (Rhodomelaceae, Rhodophyta) (Fig. 5)**

This species has been commonly reported from the Western Mediterranean Sea (Falkenberg, 1901; Coppejans & Boudouresque, 1976; Cormaci et al., 1979; Bal-

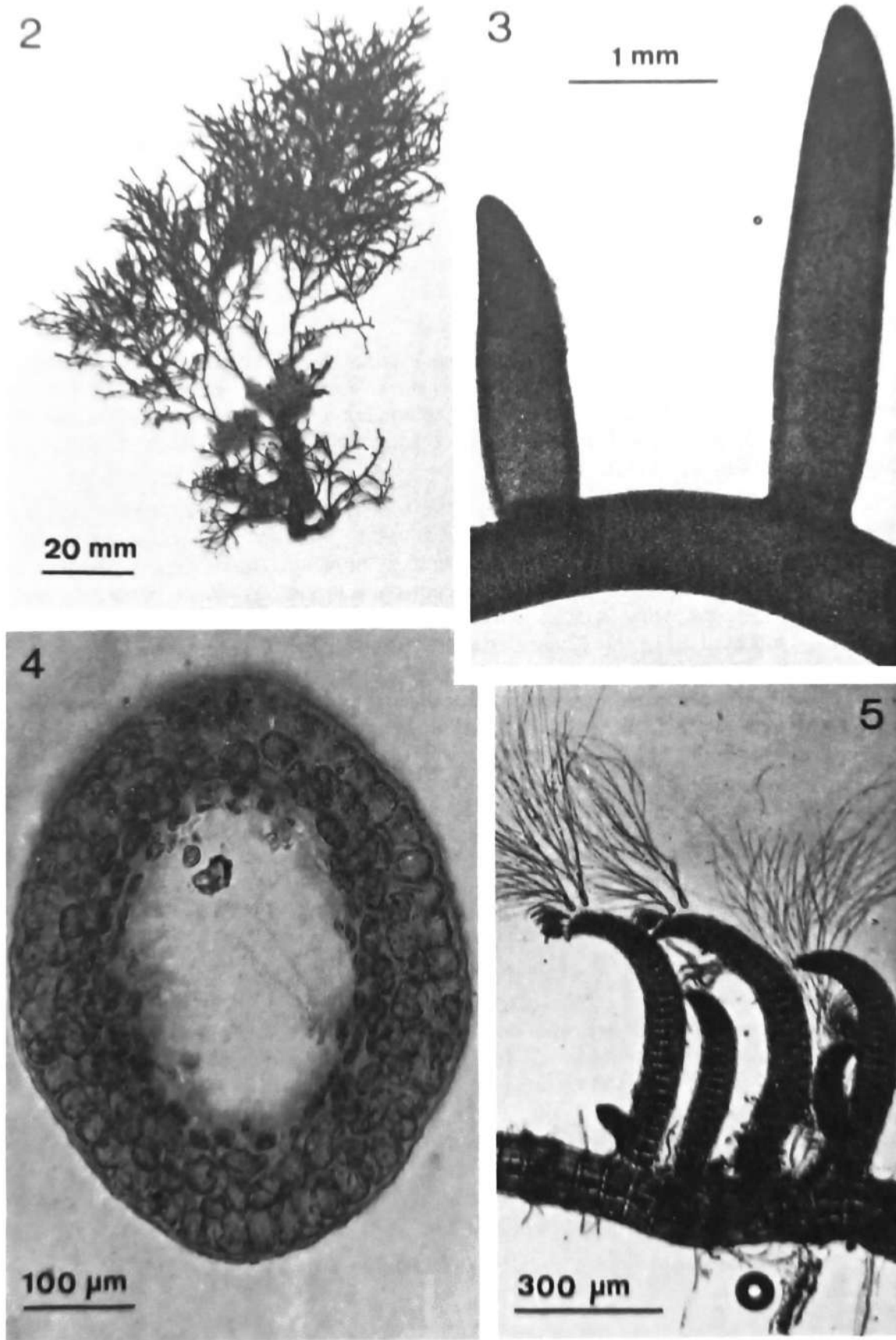


Fig. 2-5 - Fig. 2: *Cystoseira mauritanica* Sauvageau. Habit. Figs 3-4: *Coelothrix irregularis* (Harvey) Børgesen. Fig. 3: Detail of the habit. Fig. 4: Transverse section of branch. Fig. 5: *Lophosiphonia cristata* Falkenberg. Detail of the habit.

Islands (Audiffred & Weisscher, 1984). Sterile plants collected in the Canary Islands agree with previous descriptions. From the creeping axes arise erect axes, of 6-12 pericentral cells, with the apices strongly curved and with a conspicuous crest of pseudo-dichotomous trichoblasts (Fig. 5). *L. cristata* was collected at Punta del Hidalgo growing in middle eulittoral caespitose communities with *Taenioma perpusillum* (J. Agardh) J. Agardh, *Sphacelaria tribuloides* Meneghini and *Ceramium codii* (Richards) Mazoyer [TFC(Phyc) 6920].

***Hildenbrandia occidentalis* Setchell (Hildenbrandiaceae, Rhodophyta) (Figs 6-8)**

This species has been reported to ground in California (the type locality), the Eastern Atlantic Ocean in Portugal (Ardré, 1959, 1970) and the Western Mediterranean (Ballesteros, 1990).

Plants collected in the Canary Islands form crusts dark purplish-red, nearly black when dry, 350-450  $\mu\text{m}$  thick; cells of erect filaments 3-4  $\mu\text{m}$  wide by 4-5  $\mu\text{m}$  high; conceptacles numerous in April-May, scattered to 150  $\mu\text{m}$  wide by to 300  $\mu\text{m}$  high (Fig. 6-7); tetrasporangia transversely zonately divided, 8-12  $\mu\text{m}$  wide by 25-40  $\mu\text{m}$  high (Fig. 8).

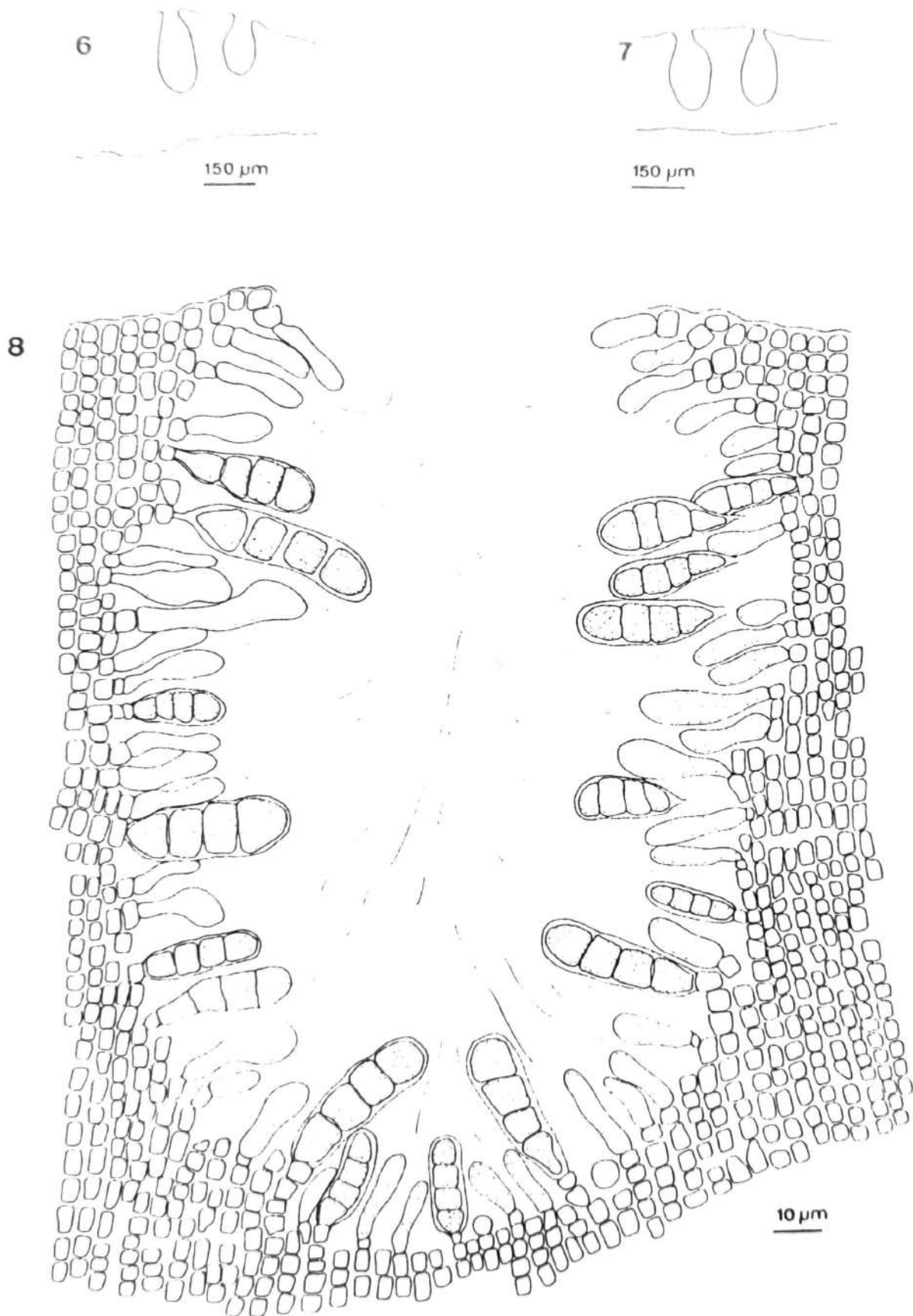
According to Denizot (1968) the criteria currently used for segregating species into *Hildenbrandia* are insufficient and are in need of revision. Species are mainly differentiated in basis to the type of tetrasporangia division (zonate versus irregular or obliquely cruciate), crust thickness and conceptacle morphology. *Hildenbrandia canariensis* Børgesen, the other species with tetrasporangia transversely zonately divided previously reported from the Canary Islands, differs from *Hildenbrandia occidentalis* mainly by the spherical chamber of the conceptacle and the well developed conceptacle roof with a smaller ostiole (see Børgesen, 1925, Fig. 5). *H. occidentalis* was collected at Puerto de la Cruz, growing epilithic in low light habitats in the middle and low eulittoral [TFC(Phyc) 7111].

***Gelidiella antipai* Celan (Gelidiellaceae, Rhodophyta) (Figs 9-14)**

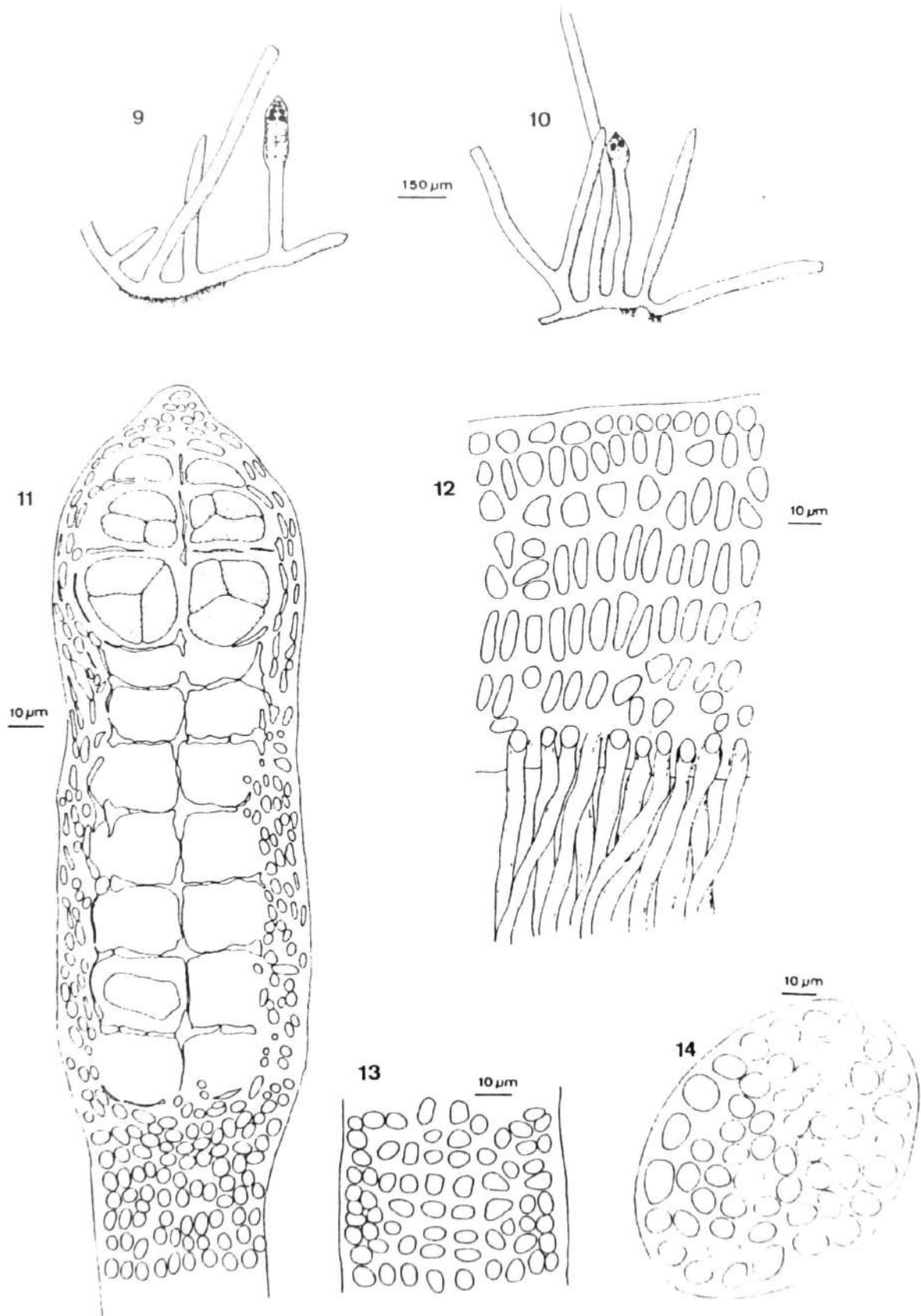
This species has been recorded from different localities in the Eastern and Western Mediterranean Sea (Boudouresque, 1972; Cormaci *et al.*, 1979; Athanasiadis, 1985). According to Boudouresque (1972). *Gelidiella stichidiospora* Dawson from the Mexican Pacific is morphologically identical to this species.

Plants collected in the Canary Islands agree with the description given by Boudouresque (1972). The minute thallus, the terminal cylindrical stichidia on erect axes and the production of tetrasporangia in two regular ranks (Fig. 9-11) distinguish this species from other members of the genus. Plants studied (Fig. 9-10) consist of creeping axes, 40-50  $\mu\text{m}$  in diameter attached to at intervals by groups of hialine rhizoids arising from cortical cells (Fig. 12), and erect axes with similar diameter, 1 mm tall. In surface view, erect axes show rounded cortical cells fairly widely spaced (Fig. 13), nevertheless, creeping axes show cortical cells transversely elongated (Fig. 12). Transverse section of axes show a medulla of widely spaced rounded cells, without rhizines, surrounded by morphologically similar cortical cells (Figs. 14).

*G. antipai* was collected at Punta del Hidalgo growing on the surface of undetermined crustose coralline algae from exposed habitats in the lower eulittoral [TFC(Phyc) 6939].



Figs 6-8: *Hildenbrandia occidentalis* Setchell. Figs 6-7: Transverse sections showing conceptacles. Fig. 8: Section of conceptacle with tetrasporangia.



Figs 9-14: *Gelidiella antipai* Celan. Figs 9-10: Habit. Fig. 11: Detail of stichidium showing tetrasporangia in two regular ranks. Fig. 12: Detail of creeping axis showing hialine rhizoids. Fig. 13: Surface view of erect axis. Fig. 14: Transverse section of erect axis.



**"*Petrocelis cruenta* J. Agardh" phase (Gigartinaceae, Rhodophyta)**

Guiry & West (1983) showed that *Mastocarpus stellatus* (Stackhouse) Guiry (as *Gigartina*) growing in the North Atlantic exhibited two basic types of life history: (1) a heteromorphic-type in which dioecious plants alternate with crustose plants bearing tetrasporangia (*Petrocelis*-like tetrasporophyte) and, (2) a direct-type in which carpospores give rise to foliose plants, and tetrasporangia are not formed, and consequently reduced *Petrocelis cruenta* to a synonym of *Mastocarpus stellatus*.

According to Guiry *et al.* (1984) *M. stellatus* is found in the Eastern Atlantic from Northern Russia to Portugal and from Morocco possibly to Rio de Oro, Mauritania.

Gametic plants of *M. stellatus* have been reported in the Canary Islands by Afonso-Carrillo & Gil-Rodríguez (1980). Nevertheless, at this moment, the sporophyte were unreported. Sterile plants of "*Petrocelis cruenta*" studied agree with the description given by Dixon & Irvine (1977). These plants were collected at Puerto de la Cruz in pebbles at 2 m depth growing on *Spongites wildpretii* Afonso-Carrillo [TFC(Phyc) 5871].

## ACKNOWLEDGEMENTS

We are grateful to Dr A. Gómez-Garreta for her assistance in the identification of *Cystoseira mauritanica*. This work has been supported by the PB 89-0601 project from the Spanish DGICYT.

## REFERENCES

- AFONSO-CARRILLO J. & GIL-RODRIGUEZ M.C., 1980 - Datos para la flora marina de la isla de Fuerteventura. *Vieraea* 10: 147-170.
- AFONSO-CARRILLO J. & SANSÓN M., 1989 - *Clave para la determinación de los macrófitos bentónicos marinos de las Islas Canarias*. Departamento de Biología Vegetal. Universidad de La Laguna. 55 p.
- ARDRÉ F., 1959 - Un intéressant *Hildebrandtia* du Portugal. *Rev. Algol., N.S.* 4: 227-237.
- ARDRÉ F., 1970 - Contribution à l'étude des algues marines du Portugal. I - La Flore. *Portug. Act. Biol. (B)* 10: 137-555.
- ATHANASIADIS A., 1985 - North Aegean marine algae. I. New records and observations from the Sithonia Peninsula, Greece. *Bot. Mar.* 28: 453-468.
- AUDIIFRED P.A.J. & WEISSCHER F.L.M., 1984 - Marine algae of Selvagem Grande (Salvage Islands, Macaronesia). *Bol. Mus. Mun. Funchal* 36: 5-37.
- BALLESTEROS E., 1990 - Check list of benthic marine algae from Catalonia (North-Western Mediterranean). *Treballs de l'Institut Botànic de Barcelona* 13: 5-52.
- BØRGESEN F., 1915-1920 - The marine algae of the Danish West Indies. III. Rhodophyceae. *Dansk. Bot. Ark.* 3: 1-498.
- BØRGESEN F., 1925-1930 - Marine algae from the Canary Islands, especially from Teneriffe and Gran Canaria. I - Chlorophyceae, II - Phaeophyceae, III - Rhodophyceae, part 1, 2, 3. *K. Danske Vidensk. Selsk. Biol. Medd.* 5(3): 1-123 (1925); 6(2): 1-112 (1926); 6(6): 1-97 (1927); 8(1): 1-97 (1929); 9(1): 1-159 (1930).
- BOUDOURESQUE C.-F., 1972 - Végétation marine de l'île de Port Cros (Parc National). IX. Sur *Gelidiella antipai* Marie Celan (Gelidiales). *Bull. Soc. Phycol. Fr.* 17: 1-8.

- COPPEJANS E. & BOUDOURESQUE C.-F., 1976 - Végétation marine de l'île de Port Cros (Parc National). XII. Sur *Acrochaetium molinieri* sp. nov. et *Lophosiphonia cristata* Falkenberg. *Giorn. Bot. Ital.* 110: 219-229.
- CORMACI M., FURNARI G. & SCAMMACCA B., 1979 - Ricerche floristiche sulle alghe marine della Sicilia Orientale. *Atti Acc. Gioenia Sc. Nat. ser. IV*, 13: 27-44.
- DENIZOT M., 1968 - *Les algues floridées encroustantes (à l'exclusion des Corallinacées)*. Paris. Muséum National d'Histoire Naturelle. 310 p.
- DIXON P.S. & IRVINE L.M., 1977 - *Seaweeds of the British Isles. I. Rhodophyta. Part I. Introduction, Nemaliales and Gigartinales*. London. British Museum (Natural History). 252 p.
- FALKENBERG P., 1901 - Die Rhodomelaceen des Golfes von Neapel, in Fauna und Flora des Golfes von Neapel. *Zool. Stat. Neapel* 26: 1-754.
- FLETCHER R.L., 1987 - *Seaweeds of the British Isles. Vol. III. Fucophyceae (Phaeophyceae). Part I*. London. British Museum (Natural History). 359 p.
- GIL-RODRIGUEZ M.C. & AFONSO-CARRILLO J., 1980 - *Catálogo de las algas marinas bentónicas (Cyanophyta, Chlorophyta, Phaeophyta y Rhodophyta) para el Archipiélago Canario*. Aula de Cultura de Tenerife. Santa Cruz de Tenerife. 47 p.
- GINSBURG-ARDRÉ F. & PALMINHA F., 1964 - Extension de l'aire de répartition de *Coelothrix irregularis* (Harvey) Börgesen (Rhodophyceae, Champiaceae). *Rev. Algol.*, n.s., 7: 325-331.
- GUIRY M.D. & WEST J.A., 1983 - Life history and hybridization studies on *Gigartina stellata* and *Petrocelis cruenta* (Rhodophyta) in the North Atlantic. *J. Phycol.* 19: 474-494.
- GUIRY M.D., WEST J.A., KIM D.-H. & MASUDA M., 1984 - Reinstatement of the genus *Mastocarpus* Kützinger (Rhodophyta). *Taxon* 33: 53-63.
- HAMEL G., 1931-1939 - *Phéophycées de France*. Paris. XLVII + 432 p. [fasc. I, pp. 1-80 (1931), fasc. II, pp. 81-176 (1935), fasc. III, pp. 177-240 (1937), fasc. IV, pp. 241-336 (1938), fasc. V, pp. 337-432, I-XLVII (1939)].
- HOEK C. van den, 1982 - The distribution of benthic marine algae in relation to the temperature regulation of their life histories. *Biol. J. Linn. Soc.* 18: 81-144.
- HOLMGREN P.K., KEUKEN W. & SCHOFIELD E.K., 1981 - *Index Herbariorum. Pt. 1. The Herbaria of the World*. Ed. 7, Bohn, Scheltema & Holkema. Utrecht [Regnum Vegetabile Vol. 106.]
- JOLY A.B. & OLIVEIRA-FILHO E.C. De, 1969 - Notes on Brazilian algae. II. A new *Anadyomene* of the deep water flora. *Phykos* 7: 27-31.
- LITTLER D.S. & LITTLER M.M., 1991 - Systematics of *Anadyomene* species (Anadyomenaceae, Chlorophyta) in the tropical western Atlantic. *J. Phycol.* 27: 101-108.
- NORRIS J.N. & OLSEN J.L., 1991 - Deep-water green algae from the Bahamas, including *Cladophora vandenhoekii* sp. nov. (Cladophorales). *Phycologia* 30: 315-328.
- OLIVERAS-PLÁ M.A. & GÓMEZ-GARRETA A., 1989 - Corología del género *Cystoseira* C. Agardh (Phaeophyceae, Fucales). *Anal. Jard. Bot. Madrid* 46: 89-97.
- SANSÓN M., REYES J. & AFONSO-CARRILLO J., 1991 - Contribution to the seaweed flora of the Canary Islands: new records of Florideophyceae. *Bot. Mar.* 34: 527-536.
- SAUVAGEAU C., 1912 - A propos de *Cystoseira* de Banyuls et de Guéthary. *Bulletin de la Station Biologique d'Arcachon* 14: 133-556.
- TAYLOR W.R., 1960 - *Marine algae of the Eastern tropical and subtropical coasts of the Americas*. University of Michigan Press, Ann Arbor. 870 p. Reprint 1967.
- VERLAQUE M., 1988 - Végétation marine de la Corse (Méditerranée). VII. Documents pour la flore des algues. *Bot. Mar.* 31: 187-194.