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Laurencia viridis sp. nov. (Ceramiales, Rhodomelaceae) from the Macaronesian Archipelagos

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Abstract

Laurencia viridis sp. nov. (Ceramiales, Rhodomelaceae) is described from specimens collected around the Canary Islands and herbarium examples from Azores Islands, Madeira Islands, Salvage Islands and Cape Verde Islands. Vegetative fronds, sporophytes and gametophytes (male and female) arise from stoloniferous axes.

Characteristics of this new species include the following: a distinct green colour of both vegetative and fertile plants, with pinkish apical regions; presence of secondary pit-connections between adjacent cortical cells; terete branches radially arranged; spermatangial receptacle of determinate position, cup-like and with a clear central axis; tetrasporangia in parallel abaxial rows. This species is placed in the genus *Laurencia* Lamouroux, subgenus *Laurencia* Saito, section *Laurencia* Saito. Ecological data are presented.

We compare the *L. viridis* from the Macaronesian Archipelagos with the green species of *Laurencia* from other parts of the world.

Introduction

The genus *Laurencia* Lamouroux (Rhodomelaceae) includes about 140 species (McDermid 1989) of small to medium-sized red algae, distributed worldwide except in the Arctic and Antarctic. Members of this genus are abundant in warm waters, however, and often constitutes a conspicuous part of subtropical and tropical floras (Saito 1969, McDermid 1988, Vandermeulen *et al.* 1990).

Several species are present in the Macaronesian Archipelago, where they are a conspicuous component of the intertidal vegetation. Thirteen species were reported from Canary Islands area by Gil-Rodríguez and Haroun (1992) and fifteen species in a further publication by Gil-Rodríguez (1992). One of these species, for which fertile material was lacking, was designated as *Laurencia* sp. 1 (grex *obtusa*). Fertile specimens have subsequently been collected in various localities around Tenerife, La Palma, Hierro, Lanzarote, Montaña Clara and herbarium specimens examined from Azores (Santa María), Madeira Islands (Porto Santo), Salvage Islands (Fora and Salvage Pequeña) and Cape Verde Islands (Sao Vicente, Santiago, Branco and Sal). The plant is now described as a new species, *Laurencia viridis*.

Material and Methods

The description of this new species is based chiefly on plants collected intertidally in the Canary Islands and herbarium specimens (L!) from Azores Islands, Madeira Islands, Salvage Islands and Cape Verde Islands. Anatomical studies were made on both fresh specimens and plants fixed in 4% formalin in sea water. Slide preparations were mounted in 80% corn syrup (Karo®) after staining for 5–10 min with 1% aqueous aniline blue (Womersley 1984). Dried material of sterile plants, sporophytes and gametophytes is deposited at TFC Phyc. (Herbario de la Universidad de La Laguna, Departamento de Biología Vegetal, Botánica, Tenerife, Islas Canarias):

Tenerife: Punta del Hidalgo (10-1980, TFC Phyc. 732; 10-06-1986, TFC Phyc. 4289; 16-06-1986, TFC Phyc. 4288; 20-06-1986, TFC Phyc. 7177; 30-06-1986, TFC Phyc. 7203; 22-10-1988, TFC Phyc. 7183; 5-11-1988, TFC Phyc. 7207; 12-12-1988, TFC Phyc. 7188; 12-01-1989, TFC Phyc. 7202; 22-01-1989, TFC Phyc. 7189; 22-02-1989, TFC Phyc. 7206; 7-05-1989, TFC Phyc. 7200; 6-06-1989, TFC Phyc. 7204; 13-06-1989, TFC Phyc. 7185; 3-03-1990, TFC Phyc. 7174; 3-05-1990, TFC Phyc. 7182). Bajamar (3-06-1990, TFC Phyc. 7179). Las Caletillas (08-1979, TFC Phyc. 1789; 5-07-1985, TFC Phyc. 7208). Güimar-Playa del Socorro (28-04-1983, TFC Phyc. 175; 27-01-1987, TFC Phyc. 7209). Porís de Abona (03-1989, TFC Phyc. 7175). Tajao (11-06-1986, TFC Phyc. 4293; 10-03-1989, TFC Phyc. 7190; 12-04-1989, TFC Phyc. 7201). El Palmar (8-02-1989, TFC Phyc. 7181). Callao Salvaje (22-10-1979, TFC Phyc. 788; 3-05-1983, TFC Phyc. 7186; 13-05-1983, TFC Phyc. 174; Paraíso Floral (5-02-1989, TFC Phyc. 7180; 30-01-1990, TFC Phyc. 7173).

La Palma: Fajana de Barlovento (15-06-1983, TFC Phyc. 3044).

Hierro: El Verodal (3-04-1989, TFC Phyc. 7184). Tacorón (6-04-1989, TFC Phyc. 7187). La Restinga (5-04-1989, TFC Phyc. 7205).

Lanzarote: Timanfaya-Playa del Cochino (11-08-1987, TFC Phyc. 5204). Montaña Clara (31-03-1983, TFC Phyc. 7178).

Additional material examined from Rijksherbarium Leiden (L).

Azores Islands: Cancap V (4805), STA 5K03. S. coast Santa Maria (29-5-1981) 987.276/051 (as *L. obtusa* var. *pyramidata*).

Madeira Islands: Cancap IV (4135), STA 4K27. Porto Santo (10-6-1980) 987.187/309 (as *L. obtusa* (Hudson) Lamouroux).

Salvage Islands: Cancap IV (3396). Isle do Fora (26-5-1980) 987.251/240 (as *L. obtusa* (Hudson) Lamouroux); Cancap IV (3373), STA 4DO7. Salvage Pequeña (26-5-1980) 987.251/363 (as *L. obtusa* (Hudson) Lamouroux).

Canary Islands: Cancap IV (3619), STA 4D12. La Palma (30/31-5-1980) 987.252/890 (as *Laurencia* sp.).

Cape Verde Islands: Cancap VI (7428), STA 6D11. Sao Vicente (Baia San Pedro, 20-6-1980) 988.111/243 (as *Laurencia* sp.); Cancap VI (6571), STA 6K07. Santiago (Baia de Santa Clara, 6-6-1982) 987.326/270 (as *L. obtusa*); Cancap VI (6564), *ibis*, 987.326/228 (as *Laurencia* sp.); Cancap VII (9712), STA 7K24. I. Branco (5-9-1986) 987.170/282 (as *Laurencia* sp.); Cancap VII (9689), *ibid*, 987.170/439 (as *Laurencia* sp.); Cancap VII (9672), *ibid*, 987.170/175 (as *Laurencia* sp.); Cancap VII (9292), STA 7D08. Sal (29-8-1986) 987.170/216 (as *L. obtusa*); Cancap VII (9291), *ibid*, 987.170/218 (as *L. obtusa*); Cancap VII (9189), STA 7K16. I. do Sal Rei (28-8-1986) 987.170/319 (as *Laurencia* sp.); Cancap VII (8848), STA 7K10. Santiago (21-8-1986) 987.117/719 (as *L. obtusa*); Cancap VII (8847), *ibid*, 987.118/703 (female plant) (as *L. obtusa*); Cancap VI (6432), STA 6K06. Santiago (4/5/6/11-6-1982) 987.326/397 (as *L. obtusa*); Cancap VI (6434), *ibid*, 987.326/365 (as *Laurencia* sp.).

Results

Diagnosis

Laurencia viridis *Gil-Rodríguez* et *Haroun* sp. nov.

Thallus annus erectus, cartilagineus, papyro non adhaerens, colore viridi propio. Axes principales erecti, 2–(4–8)–15 cm alti, rami clavati, colori viridi, apicibus rosaceis; aliqui axes surgunt ab axibus qui substrato per rhizoidea se adhaerent. Ramificatio alternata vel irregularis et generaliter tantum in partibus superioribus, in inferioribus sine ramificatione.

Spermatangia cupuliformia, in quoque ramo varia, 1,5–2–(3) mm longa et 1–1,5 mm lata. Cystocarpi urceolati sessiles, 1,(3–n) in quoque ramo, 11,5(2) mm longi × 0,5–1–(1,5) mm late. Tetrasporangia disposita parallele axi ramli, abaxialia.
Habit: frequens in locis valde expositis fluctibus.

Holotype. Tetrasporangial plants collected at Punta Hidalgo-Baja Negra (northern part of Tenerife, Canary Islands) in the lower intertidal zone mixed with other algae, 8 May 1989, leg. M. C. Gil-Rodríguez, TFC Phyc. 7176. (Fig. 1A)

Isotypes. Tetrasporangial plants collected at the same locality as the holotype, 8 May 1989 (BM, P, L, C, SAP, MA, UC and TFC Phyc.).

Etymology: The specific name *Laurencia viridis* draws attention to the distinctive greenish colour of this alga.

Thallus annual, erect, cartilaginous, not adhering to paper, dark green. Erect axes 2–(4–8)–15 cm high; arising from stoloniferous axes that are attached to substrate by rhizoids. Branches are clavate and green but with punkish tips. Branching is alternate or helicoid and occurs only in the upper ⅔ of the thallus.

Spermatangia ovoid, produced on repeatedly branched trichoblasts 1,5–2–(3) mm high × 1–1,5

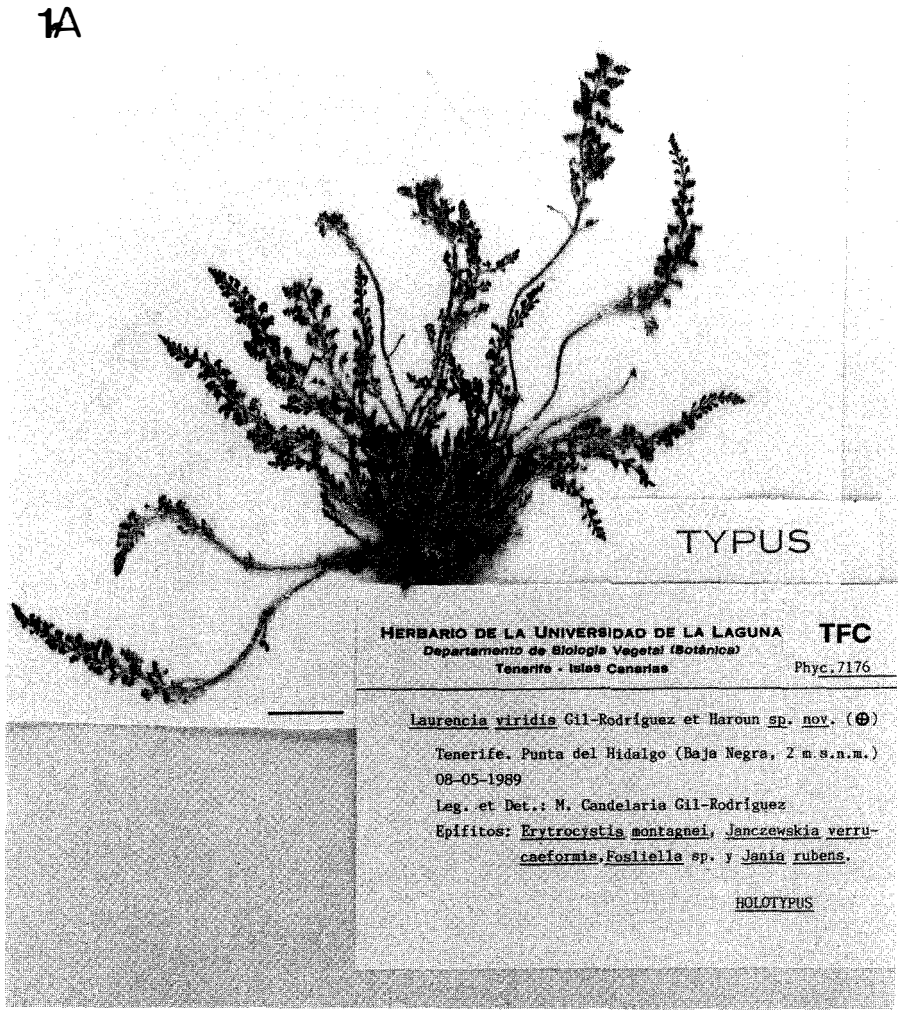
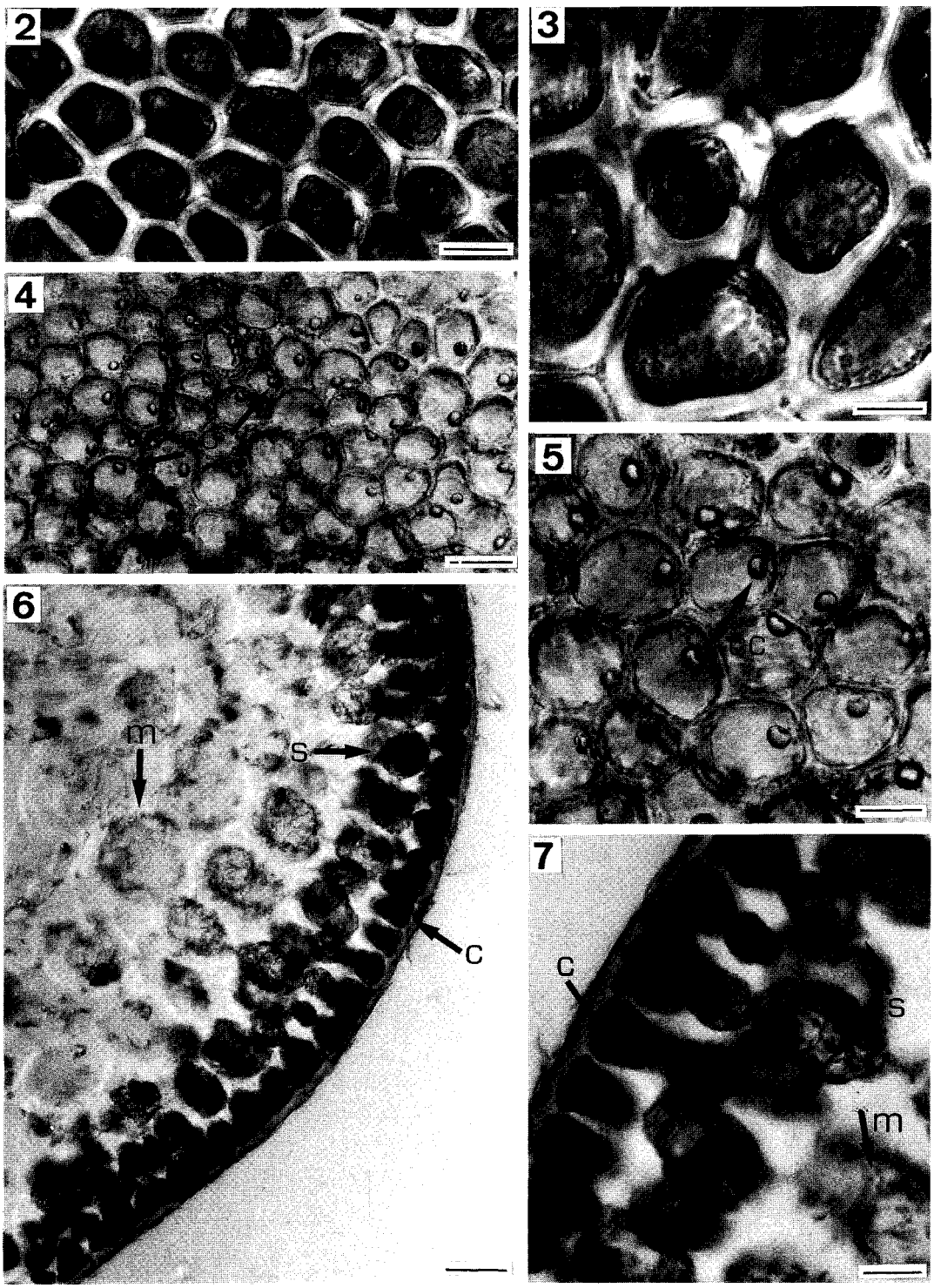


Fig. 1A–B. *Laurencia viridis sp. nov.*
1A.: Holotypus (Scale bar = 2 cm). 1B.: General morphology (Scale bar = 1.5 cm).

mm wide, arising from cup-like depressions at the apex of branches. Cystocarps urceolate, sessile, 1–(3–n) per branch; 0,5–1–(1,5) mm wide × 1–1,5(2) mm high. Tetrasporangia arranged in rows parallel to the axis of the branch, abaxial.

Vegetative structure

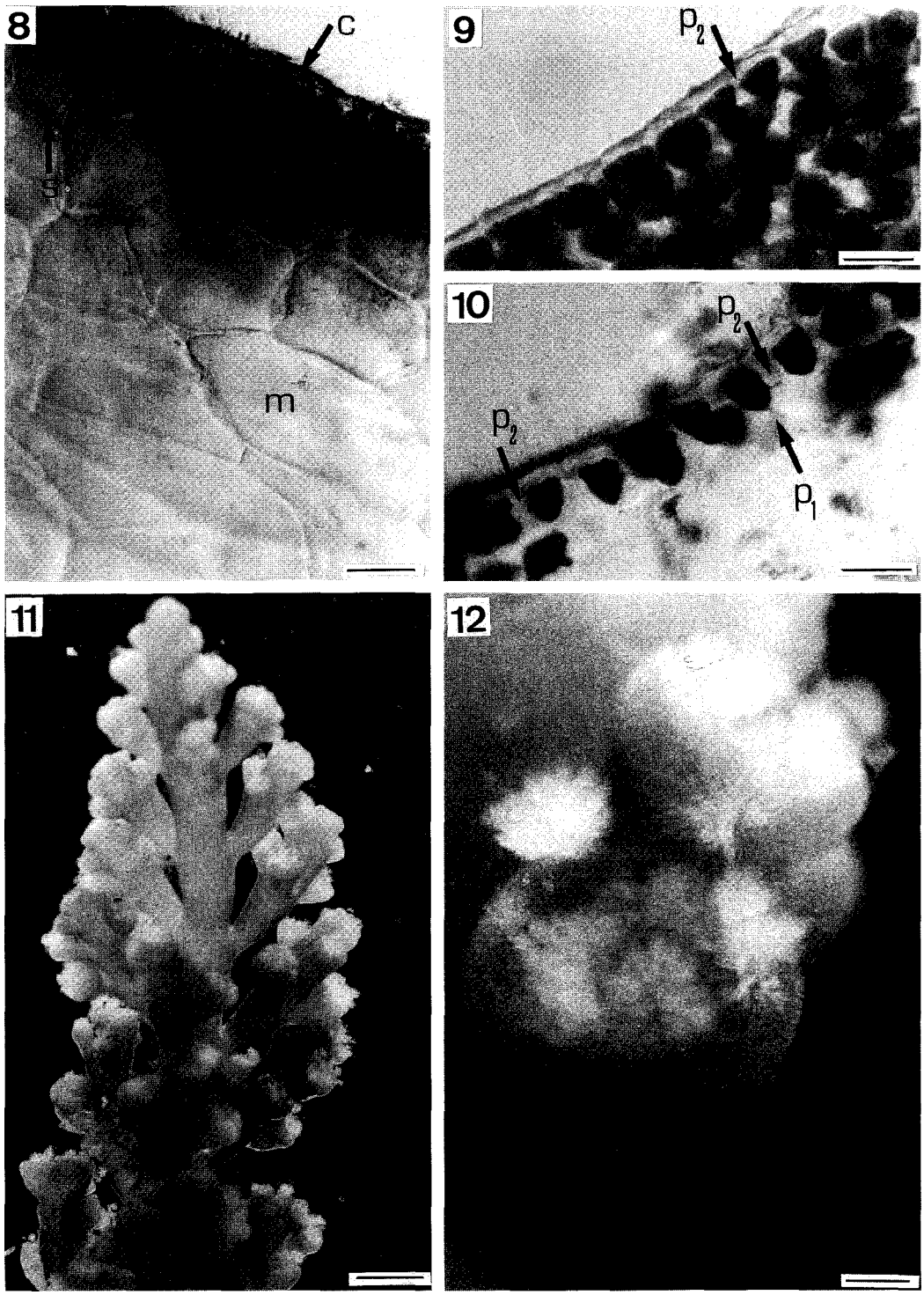
The plant consists of annual, erect (Fig. 1B), cartilaginous, dark green, thalli arising from stoloniferous axes that are attached to the substrate by mean of



Figs 2–7. *Laurencia viridis sp. nov.*
Fig. 2. Surface view, formalin preserved plant (scale bar = 15 µm). Fig. 3. Surface cell, formalin preserved plant (scale bar = 8 µm). Fig. 4. Surface cell with single "corps à cérise", fresh plants (scale bar = 25 µm). Fig. 5. "corps à cérise" (scale bar = 18 µm). Figs 6–7. Transverse sections, in the apical region of axes: cortical cells (c), subcortical cells (s) and medullary cells (m) (Fig. 6 scale bar = 35 µm and Fig. 7 scale bar = 30 µm).

rhizoids. The plants have a distinct pit enclosing several deciduous trichoblasts at the apex of each branch. The trichoblasts are subdichotomously branched to 5 or 6 orders. Each cell of the trichoblast possesses a single clear, refringent body ('corps à cérise').

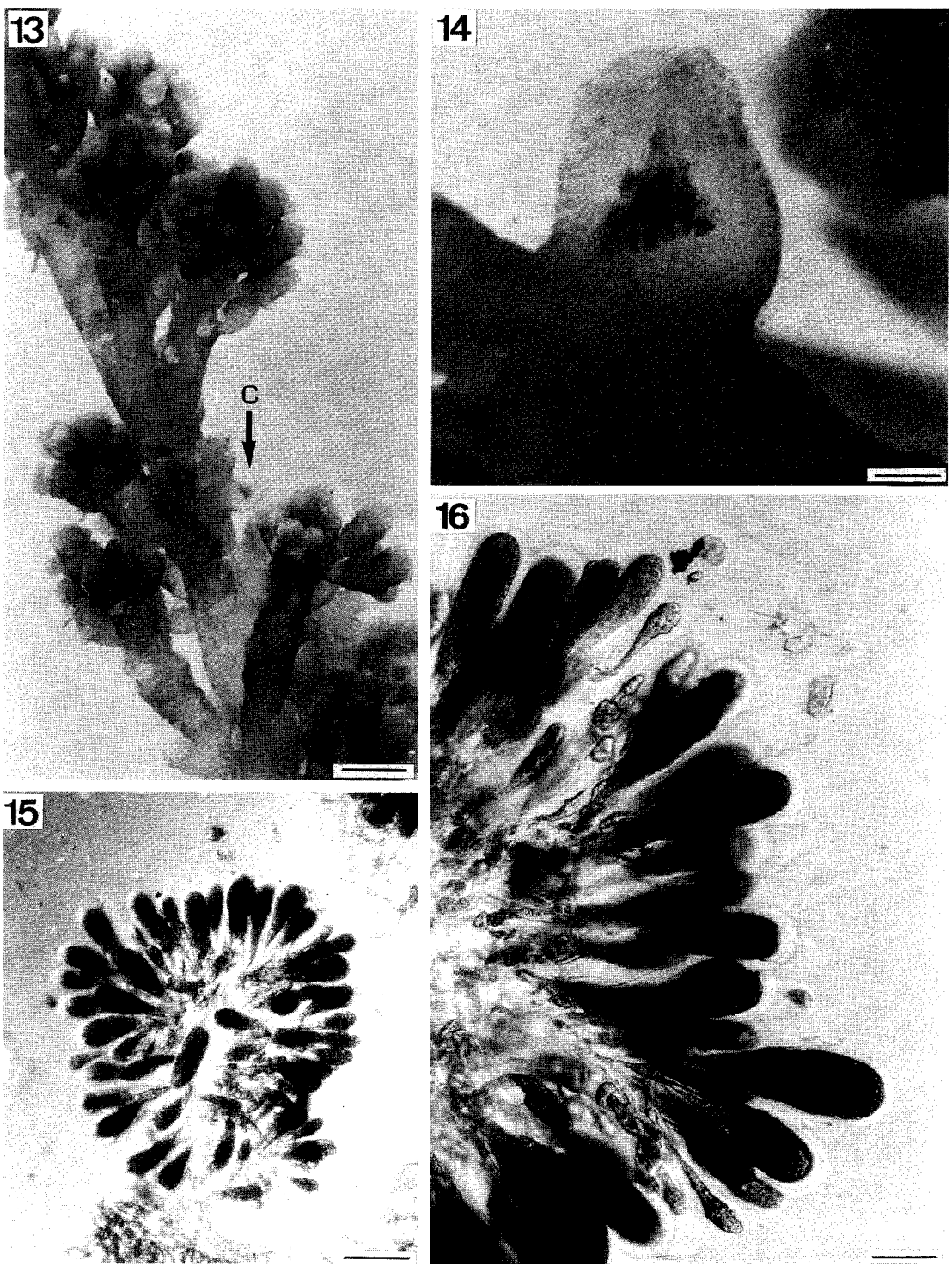
Erect axes are 2–(4–8)–15 cm high and are 900–(920–980)–1050 µm in diameter basally, 1200–(1300–1400)–1500 µm in median parts and 1100–(1150–1180)–1250 µm near the apex. Primary branches of the erect axes are 600–(830–920)–950



Figs 8–12. *Laurencia viridis sp. nov.*
Fig. 8. Longitudinal section of axis, cortical cells (c), subcortical cells (s) and medullary cells (m) (scale bar = 35 µm). Figs. 9–10. Sections to show cortical cells connected longitudinally (p1) and laterally (p2) (scale bar = 30 µm). Fig. 11. Male gametophyte with spermatangial branches and sterile trichoblasts (scale bar = 0.25 cm). Fig. 12. Detail of spermatangial cup-like branches (scale bar = 0.25 mm).

μm in diameter and secondary branches (400–(526–600)–800 μm in diameter. In surface view the cells are polygonal, 15–20 μm wide × 20–28 μm high (Figs 2–3). They are irregularly arranged and with a single 'corps à cérise', in fresh plants (Figs 4–5).

The surface cells are not protuberant. In transverse sections of the axis in the apical region the cortical cells are triangular or subquadrate (Figs 6–7), 12–(15–22)–30 μm wide × 15–(17–25)–35 μm high. Those in median parts of of the axis are 22–(25–28)–30 μm wide × 28–(30–33)–40 μm high, while those in the basal area are 20–(23–27)–30 μm wide × 27–(28–30)–37 μm high. Subcortical cells are ovoid to sub-spherical (Figs 6–7), 25–(30–35)–40 μm wide × 32–(35–45)–50 μm high, with less pig-

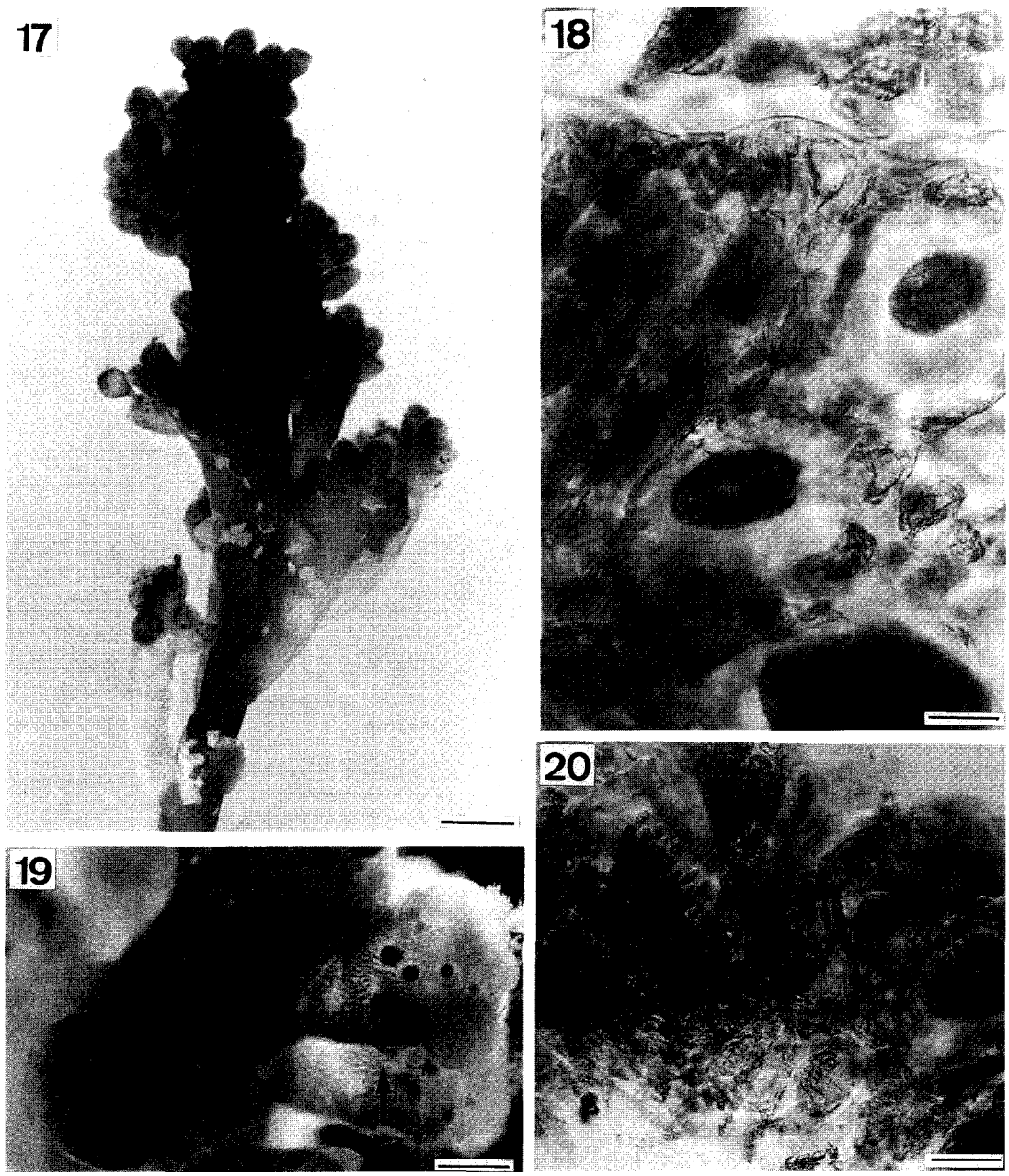


Figs 13–16. *Laurencia viridis sp. nov.*
Fig. 13. Female plants with cystocarp (c) (scale bar = 0.25 cm). Fig. 14. Mature cystocarp (scale bar = 0.35 mm). Figs 15–16. Detail of carposporangia (Fig. 15 scale bar = 100 μm and Fig. 16 scale bar = 25 μm).

ment or even colourless. They lack lenticular thickenings and intercellular spaces. Medullary cells are large and colourless (Figs 6–7), 40–(50–60)–74 µm wide × 45–(50–70)–85 µm high. In longitudinal section (Fig. 8), cortical cells are sub-ovate, 12–(16–19)–25 µm wide × 18–(20–22)–30 µm high. Subcortical cells are ovate, 30–(35–48)–52 µm wide × 40–(45–51)–54 µm high. Medullary cells are very long, subrectangular, 60–(74–85)–90 µm wide × 180–(210–250)–290 µm high. Cortical cells are interconnected both longitudinally and laterally by secondary pit-connections (Figs 9–10). Subcortical and medullary cells show similar interconnections. Lenticular thickenings are absent.

Reproductive structure

Male gametophytes are 2–(3–4)–5 cm high (Fig. 11). Spermatangia are formed in dense clusters of repeatedly branched filaments arising from cup-like depressions (pits) at the apex of terminal branches (Fig. 12). Spermatangial branches are very small, 1–1,5 mm wide × 1,5–2–(3) mm high. Spermatangial trichoblasts terminate in inflated, pyriform cells.



Figs 17–20. *Laurencia viridis sp. nov.*
Fig. 17. Tetrasporophytic plant (scale bar = 0.25 cm). Fig. 18 and 20. Abaxial tetrasporangia (Fig. 18 scale bar = 60 µm and Fig. 20 scale bar = 120 µm). Fig. 19. Tetrasporangia in parallel rows (scale bar = 0.35 mm).

Table I. Comparison of *Laurencia* spp from the Canaries which have been placed in the Subgenus *Laurencia* Saito

Taxon	Habit	Main axes	Cortical cells (Tranv. Sect.)	Lenticular thickenings	Tetrasporangial
L. obtusa	– Dense tufts intricate with stoloniferous branches or erect with erect axes from a discoid holfast. – Pink-green. – Irregular, alternate, opposite or subverticillate branching – 2–5 cm tall.	– Terete. – 0,5–0,9 mm diam.	– 2° pit-connection present. – Non-projecting. – Isodiametric. – 8–23 µm wide × 15–25 µm high. – 'Corps à cérise' 1–3.	– Absent.	– Abaxial. – Parallel.
L. majuscula	– Erect thallus. – Discoid holdfast. – Alternate or opposite branching. – Axes to 12 cm tall.	– Terete. – 1–2 mm. diam.	– 2° pit-connection present. – Projecting. – Subquadrate. – 20–35 µm wide × 25–40 µm high. – 'Corps à cérise' 2–3.	– Absent.	– Abaxial. – Parallel.
L. minuta	– Erect thallus very small. – Pink or red. – Discoid holdfast, stoloniferous absent. – 0,7–1 cm tall.	– Terete. – 0,3–0,7 mm diam.	– 2° pit-connection present. – Projecting. – Isodiametric. – 8–10 µm wide × 10–15 µm high. – 'Corps à cérise' 1	– Absent.	– Abaxial. – Parallel.
L. tenera	– Colonies intricate to 5–10 mm high. – Brown-red and yellow. – Discoidal haptera and secondary holdfast. – Dichotomous or subdichotomous branching. – 1 cm tall.	– Terete. – 0,3–0,8 mm diam.	– 2° pit-connection present. – Non-projecting. – Quadrate to subquadrate. – 18–22 µm wide × 20–25 µm high. – 'Corps à cérise' absent.	– Absent.	– Abaxial. – Parallel.
L. viridis sp. nov.	– Erect thallus. – Bright green. – Holdfast stoloniferous. – Alternate branching. – Axes to 15 cm tall.	– Terete. – 0,9–2 mm diam.	– 2° pit-connection present. – Non projecting. – Triangular o subquadrate. – 12–30 µm wide × 15–40 µm high. – 'Corps à cérise' 1.	– Absent.	– Abaxial. – Parallel.

Table II. Comparison of *Laurencia viridis* with species of *Laurencia* with a green thallus from another parts of the world

Taxon	Habit	Main axes	Cortical cells	Lenticular thickenings	Tetrasporangial
L. intricata (Australia: Cribb 1983)	– Erect axes densely tufted intricate. – 10 cm high. – Stoloniferous holdfast. – Alternate occasionally subopposite.	– Terete – 0,7–1,1 mm diam.	– 2° pit-connection present. – Occasionally projecting. – Non elongated radially. – Subquadrate. – 2 µm diam.	– Absent	– Parallel
L. flexilis (Australia: Cribb 1983)	– Erect axes. – 4–5 cm high. – Stoloniferous holdfast. – Alternate, irregulary branching.	– Terete – 0,5–1 mm diam.	– 2° pit-connection absent. – Non projecting. – Elongated radially. – Subquadrate. – 17 µm diam.	– Absent	– Right-angle
L. nidifica (Hawaii: McDermid 1988)	– Erect axes. – 3–8 cm high. – Stoloniferous holdfast. – Alternate-opposite branching.	– Terete – 0,5–1 mm diam.	– 2° pit-connection present. – Non projecting. – Non elongated radially. – Subquadrate. – 14 µm diam.	– Present	– Parallel
L. "green" (Hawaii: McDermid 1988)	– Erect axes. – 2–5 cm high. – Stoloniferous holdfast. – Alternate-branching.	– Terete – 0,7–1 mm diam.	– 2° pit-connection present. – Non projecting. – Non elongated radially. – Subquadrate. – 22 µm diam.	– Absent	– Parallel
L. okamurai (Japan: Saito 1965; China: Tseng 1983)	– Erect axes densely tufted. – 4–19 cm high. – Coalescing basal branches. – Alternate, opposite or verticillate branching.	– Terete – 0,8–1,2 cm diam.	– 2° pit-connection present. – Non projecting. – Non elongated radially. – Poligonal. – 14 µm long × 40 µm broad.	– Present	– Parallel
L. intermedia (Caribbean: Rodríguez-Rios & Saito 1982)	– Erect axes, loosely tufted. – 4–13 cm high. – Stoloniferous holdfast. – Alternate branching.	– Terete – 1–1,5 mm diam.	– 2° pit-connection absent. – Non projecting. – Elongated radially. – Poligonal. – 14 µm long × 17 µm broad.	– Absent	– Right-angle
L. viridis sp. nov. (Macaronesian Archipelago)	– Erect axes. – 2–15 cm high. – Stoloniferous holdfast. – Alternate branching.	– Terete – 0,9–2 mm diam.	– 2° pit-connection present. – Non projecting. – Non elongated radially. – Triangular or subquadrate. – 25 µm long × 22 µm broad.	– Absent	– Parallel

Female plants are 4–(5–6)–10 cm high (Fig. 13). The mature carposporophyte is partially immersed in the thallus. Cystocarps are urceolate, sessile, projecting 1–1,5–(2) mm above the thallus and 0,5–1–(1,5) mm in diameter (Fig. 14). Carposporangia are obovate, 15–35 µm in wide and 100–150 µm high (Figs 15–16). A delicate network of dichotomously branched filaments radiates from this complex of cells and lines the inner wall of the pericarp.

Tetrasporophytes are 3–(4–8)–15 cm high (Fig. 17). Tetrasporangia occur in parallel rows (Figs 17, 19) of 3–6 and are immersed at the tips of the terminal branches; the thallus continues to grow after tetrasporangial formation. Tetrasporangia are cut off abaxially (Figs 18, 20) from pericentral cells and cleave tetrahedrally. Mature tetrasporangia are 80–110 µm wide × 110–180 µm high.

Habitat

Laurencia viridis grows in the lower intertidal zone, intermingled with other turf algae. It occurs on exposed, overhanging rocks subject to strong wave-action. *Laurencia viridis* is an annual plant that grows rapidly during winter–spring months and decays in late summer. This species would therefore have an ephemerophycean life-form (Garbary 1976).

Epiphytes: *Erythrocystis*, *Janczewskia*, *Jania* and *Fosliella* are very often observed along the axes of this species (Figs 13–16).

Discussion and Conclusion

Several morphological and anatomical characteristics of *Laurencia viridis sp. nov.*, such as the branching pattern, general morphology and colour, are shared by previously described *Laurencia* species in the Canaries, which are compared in Table I.

In Table II we compare different green species of *Laurencia* from other parts of the world (Australia, Hawaii, Japan, China and Caribbean) with *L. viridis* from the Macaronesian Archipelagos. We have considered the following characters: habit, main axes, cortical cells, lenticular thickening and tetrasporangials. The cortical cells (secondary pit-connections present or absent, non elongated radially or elongate radially), lenticular thickenings and tetrasporangials are the more important characters in which to see the differences between these species.

Laurencia viridis sp. nov. is a distinct species that lies within the generic criteria of *Laurencia* as described by Kylin (1956), Saito and Womersley (1974), and McDermid (1988). The general vegetative and reproductive features of the genus are described by Saito (1967, 1969). The presence of secondary pit-connections between adjacent cortical cells and the parallel arrangement of mature tetrasporangia place *Laurencia viridis* in the subgenus *Laurencia* (Saito 1967, 1969; Saito and Womersley 1974).

Although *Laurencia* has been the subject of several studies over recent years (Yamada 1931, Tseng 1943, Cribb 1958, 1983, Saito 1967, Saito and Womersley 1974), many researchers are of the opinion that systematics of the genus need further investigation (Saito 1982, McDermid 1989). Gil-Rodríguez and Haroun (1992) and Gil-Rodríguez (1992) have discussed the problems of subgeneric placement of several *Laurencia* spp. from the Canaries.

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