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Chylocladia schneideri sp. nov. (Champiaceae, Rhodophyta) from Puerto Rico, Caribbean Sea

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Abstract — *Chylocladia schneideri* sp. nov., a diminutive species of *Chylocladia* (Rhodymeniaceae, Rhodophyta), is described from a shallow-water mangrove channel habitat in Puerto Rico, Caribbean Sea. The new species was collected as an epiphyte of *Avrainvillea longicaulis* (Kütz.) G. Murray & Boodle, *Halimeda incrassata* (J. Ellis) J.V. Lamour and *Thalassia testudinum* Banks ex Koenig. The primarily prostrate-growing alga has branches that measure to 2.0 cm in length with a maximum diameter of only 0.6 mm. Tetrasporangia are cut off internally and measure 40 – 55 µm in diameter. Cystocarps are nearly spherical, measure to 450 µm in diameter, and lack an ostiole. *Chylocladia schneideri* is among the smallest species of the genus, and, prior to this account, no *Chylocladia* species were recognized in the western Atlantic.

Caribbean / Champiaceae / *Chylocladia schneideri* / Puerto Rico / Rhodymeniales / Rhodophyta

Résumé — *Chylocaldia schneideri* sp. nov. (Champiaceae, Rhodophyta) de Puerto Rico, mer des Caraïbes. *Chylocladia schneideri* sp. nov., une toute petite espèce du genre *Chylocladia* (Rhodymeniaceae, Rhodophyta), a été trouvée en eau peu profonde dans une mangrove à Puerto Rico, mer des Caraïbes. Cette nouvelle espèce a été récoltée en épiphyte sur *Avrainvillea longicaulis* (Kütz.) G. Murray & Boodle, *Halimeda incrassata* (J. Ellis) J.V. Lamour. and *Thalassia testudinum* Banks *ex* Koenig. Les rameaux de l'algue, à croissance prostrée essentiellement, mesurent jusqu'à 2 cm de longueur avec un diamètre maximal de seulement 0,6 mm. Les tétrasporocystes sont isolés à l'intérieur du thalle et mesurent 40-55 µm de diamètre. Les cystocarpes sont presque sphériques, sans ostiole, avec un diamètre de 450 µm. *Chylocladia schneideri* est parmi les plus petites espèces de ce genre et, avant la présente description, aucune espèce de *Chylocladia* n'avait été reconnue dans l'ouest Atlantique. (Traduit par la Rédaction)

Caraïbes / Champiaceae / *Chylocladia schneideri* / Puerto Rico / Rhodymeniales / Rhodophyta

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INTRODUCTION

The generic name *Chylocladia* was first used by Greville in Hooker (1833). Schmitz (1889) later lectotypified the genus with *C. kaliformis* (Gooden. *et* Woodw) Grev., but Bliding (1928) subsequently pointed out that *C. kaliformis* was a taxonomic synonym of *Fucus verticillatus* Lightf. (1777), and thus *C. verticillatus* (Lightf.) Bliding is the accepted name of the type species. As with the closely related genera *Champia* and *Gastroclonium*, *Chylocladia* species are separated on the basis of size, branching pattern, degree of flattening, degree of segment constriction, cortex structure, and whether longitudinal filaments are peripheral or scattered through the diaphragms (Reedman & Womersley, 1976; Irvine & Guiry, 1983; Millar, 1998). *Chylocladia* and *Gastroclonium* have been separated from *Champia* on the basis of lacking an ostiolate pericarp and carposporangia being cut off directly from the fusion cell in the former two genera (Kylin, 1931; Irvine & Guiry, 1983). However, in the three genera, gonimoblast cells are cut off from the auxiliary cell, and in *Chylocladia* a large fusion cell bears sessile gonimoblasts. The fusion cell in *Chylocladia* expands rapidly and the gonimoblast cells transform quickly into carposporangia, wrongly giving the appearance of being cut off directly from the fusion cell (Fredericq, personal communication). *Gastroclonium* differs from *Chylocladia* in possessing a solid stipe and in possessing polysporangia in addition to tetrasporangia (Kylin, 1931; Irvine & Guiry, 1983). Stegenga *et al*. (1977), however, discounted the importance of polysporangia in distinguishing these genera. They referred polysporangiate material previously mis-identified as *Gastroclonium reflexum* (Chauv.) Kütz. to *Chylocladia capensis* Harv.

While Mazé & Schramm (1870-1877) reported four species of *Chylocladia* from Guadeloupe, French West Indies, these have been transferred to *Champia* and *Coelothrix*. Thus, the genus is presently considered not to be represented in the Caribbean (Taylor, 1960; Wynne, 1998). To date all *Chylocladia* species are known from the eastern Atlantic and Mediterranean, Indian Ocean and Australia, with six species recognized in Algae Base (Guiry & Nic Dhonncha, 2003): *C. verticillata*, *C. pelagosae* Erceg. (1956), *C. capensis* Harv. (1849), *C. rigens* (C.Agardh) J. Agardh (1851), *C. perpusilla* Weber van Bosse (1913) and *C. grandis* Reedman & Womersley (1976). Two additional species, *Chylocladia unistratosa* Erceg. (1956) and *Chylocladia phalligera* J. Agardh (1842), were considered to be of "dubious" status by Guiry & Nic Dhonncha (2003).

MATERIALS AND METHODS

Specimens were collected by snorkeling and were preserved in 10 % Formalin/seawater. Transections (30-40 µm thick) were made with an American Optical Cryo-Cut freezing microtome. Microscope slide preparations were mounted in 60 % Karo® syrup, and photomicrographs were taken using Kodak Pan Technical black and white film through an Olympus BMAX light microscope. Voucher slides stained with 1 % acidified aniline blue have been deposited in MICH, MSM and US. Herbarium abbreviations follow Holmgren *et al*. (1990) and authority designations are in accordance with Brummitt & Powell (1992).

RESULTS

Chylocladia schneideri sp. nov. Figs 1-12

Description

Plantae usque ad 4 axes teretes ab hapterone discoideo producentes, usque ad 2.0 cm longi et decumbescentes productione affixionum secondariorum et rhizoidealium; axes plantarum 0.3-0.6 diametro; cortex thalli crassus 1 cellulam; cellulae corticales in segmentis vetioribus rectangulares, 60-110 mm longae × 25-35 mm latae; cellulae corticales parvae et solitariae et atre tingentes, usque ad 12 mm, irregulares, inter cellulas corticales maiores positae; filamenta longitudinalia et interna per internam parietem cavitatis et per regionem thalli centralem praesentia, 12 mm diametro, atque glandicellulas sphaericas usque ad ovatas, 13 mm diametro, abscindentia; tetrasporangia (35) 40-65 (75) mm diametro et in cavitatem projecta; algae dioeciae; carposporophyta 1-3 fere sphaerica et sessilia in segmentis fecundis producta, usque ad 450 mm diametro; carposporangia deltata aut triangularia, usque ad 110 mm longa; fasciculi spermatangiorum segmenta fecunda tegentena vel plura spermatangia, ab cellulis spermatangiorum matricalibus usque ad 7 mm longis et elongatis, abscissa.

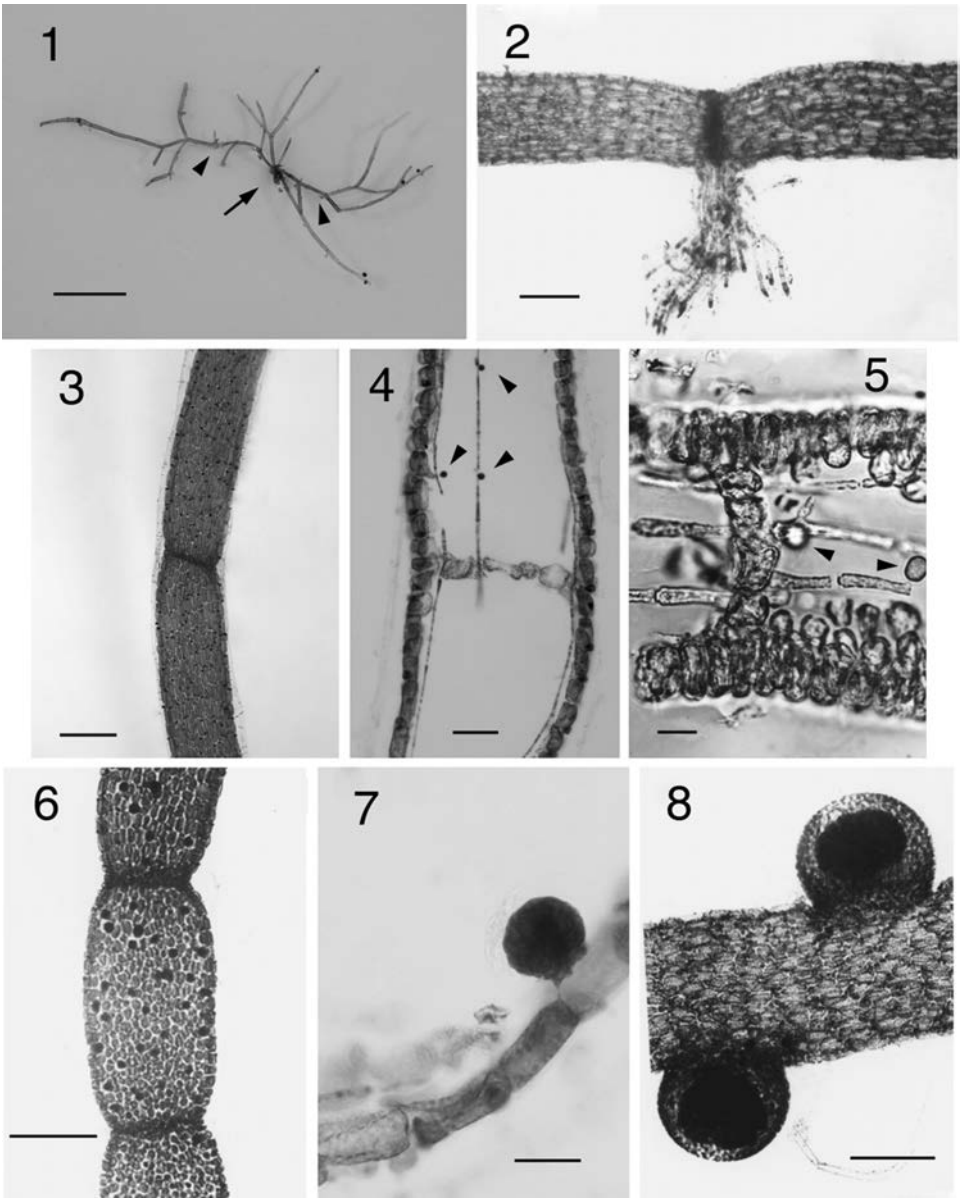
Holotype: *D.L. Ballantine 5906*, leeward Guayacan Island, La Parguera, epiphytic on *Halimeda incrassata* (J.Ellis) J.V. Lamour, 1.0 m, 30.vii.2003 (Alg. Coll. # US-208908).

Paratypes: *D.L.B. 5451*, leeward Guayacan Island, La Parguera, epiphytic on *Avrainvillea longicaulis* (Kütz.) G. Murray & Boodle, 1.0 m, 14.×.2000; *D.L.B. 5522*, *ibid*., 1.ii.2001; *D.L.B. 5604*, *ibid*., 22.×.2001; *D.L.B.. 5838, ibid.,* 15.i.2003; *D.L.B. 5861*, *ibid*., 28.ii.2003.

Etymology: The new species is named in honor of Dr. Craig W. Schneider, Trinity College, Hartford, Connecticut, and recognizes his substantial contributions to the systematics of western Atlantic marine algae.

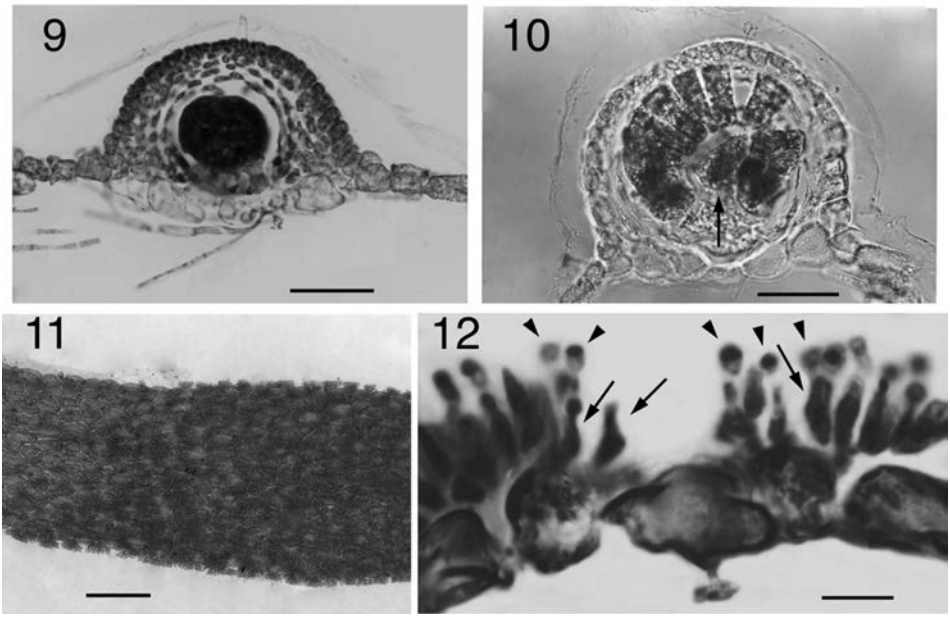
Observations

Specimens of *Chylocladia schneideri* were collected subtidally from depths of 1.0 to 1.5 m growing epiphytically on *Avrainvillea longicaulis*, *Halimeda incrassata* and *Thalassia testudinum* Banks ex Koenig. Algae develop up to four terete axes from a discoid holdfast (Fig. 1). These are up to 2.0 cm long with limited branching and become decumbent by production of secondary rhizoidal attachments from nodal regions (Fig. 2). Plant axes measure 0.3 to 0.6 mm in diameter. The thallus cortex is 1 cell thick. Cortical cells in older segments are rectangular in surface view (Fig. 3), measuring 60 to 110 µm long by 25 to 35 µm. Small solitary darkly staining cortical cells, round to ovate and measuring to 12 µm in largest dimension, are positioned irregularly between the larger cortical cells (Fig. 3). Lower and prostrate segments measure from 4 to 7 diameters in length with minimal constriction at the diaphragms, although they appear to be constricted after treatment with Karo® syrup. The segments decrease in length-to-breadth ratio distally. Diaphragms are a single cell thick (Figs 4, 5). Internal longitudinal filaments occur along the inner surface of medullary cells as well as through the central region of the thallus and measure to 12 µm in diameter (Figs 4, 5). The longitudinal filaments cut off spherical to obovoid gland cells (Figs 4, 5), which measure to 13 µm in diameter. Tetrasporangia are visible through the cortex (Fig. 6) and measure (35) 40–55 (70) µm in diameter. They are cut off on the inner medullary margin and project into the thallus cavity (Fig. 7). Gametophytic



plants are dioecious. One to three nearly spherical and sessile carposporophytes are produced on fertile segments (Figs 8, 9), measuring to 450 μm in diameter and lacking an ostiole. Carposporangia are deltoid in shape and measure 80 to 110 μm in longest dimension. They appear as if cut off directly from the large central fusion cell (Fig. 10). Spermatangia occur in dense clusters, which mostly cover fertile segments (Fig. 11). The clusters extend to 30 μm above the thallus surface. Spermatangial mother cells originate from small cells cut off on the outer faces of

◀ Figs 1-8. *Chylocladia schneideri* sp. nov. — Fig. 1. Habit of the holotype specimen (*D.L.B. 5906*). Arrow denotes principal attachment site and arrowheads show secondary attachments. Scale bar = 5.0 mm. — Fig. 2. Rhizoidal mass produced from nodal region (*D.L.B. 5522*). Scale bar = 500 µm. — Fig. 3. Cortex showing large rectangular cortical cells plus smaller spherical cells (*D.L.B. 5604*). Scale bar = 250 µm. — Fig. 4. Longitudinal section through nodal diaphragm showing longitudinal medullary filaments along cortical wall as well as through the central cavity. Arrowheads denote gland cells (*D.L.B. 5861*). Scale bar = 100 µm. — Fig. 5. Longitudinal section through nodal diaphragm showing longitudinal medullary filaments through the central cavity. Arrowheads denote gland cells (*D.L.B. 5604*) Scale bar = 25 µm. — Fig. 6. Portion of tetrasporangial thallus (*D.L.B. 5861*). Scale bar = 500 µm. — Fig. 7. Transection through tetrasporangial plant showing undivided tetrasporangia pit connected to cortical cell (*D.L.B. 5861*). Scale bar = 50 µm. — Fig. 8. Portion of female gametophyte showing two spherical cystocarps borne on same segment (*D.L.B. 5604*). Scale bar = 250 µm.



Figs 9-12. *Chylocladia schneideri* sp. nov. — Fig. 9. Longitudinal section through cystocarp (*D.L.B. 5604*). Scale bar = 100 µm. — Fig. 10. Transection through cystocarp showing large central fusion cell (arrow) (*D.L.B. 5604*). Scale bar = 100 µm. — Fig. 11. Spermatangial sori mostly covering a fertile segment (*D.L.B. 5604*). Scale bar = 10 µm. — Fig. 12. Longitudinal section through spermatangial sorus showing spermatangia (arrowheads) cut off from radially elongate spermatangial mother cells (arrows) (*D.L.B. 5604*). Scale bar = 10 µm.

cortical cells or from the small cortical cells. They give rise to other spermatangial mother cells, which are cut off in files of several cells and pit connected at their proximal ends. The spermatangial mother cells are oriented perpendicularly to the thallus surface and are elongate, 7 to 10 µm in length (Fig. 12). The mother cells may also branch distally, which contributes to the density of the spermatangial masses. The spermatangial mother cells typically cut off two spermatangia terminally (Fig. 12).

DISCUSSION

The new species is assigned to *Chylocladia* rather than to *Champia* on the basis of its possession of pericarps lacking ostioles and in its development of carposporangia that appear to be cut off directly from the fusion cell, and rather than to *Gastroclonium* on the basis of lacking polysporangia and lacking a solid stipe. Given the close morphological appearances, comparisons with *Champia* and *Gastroclonium* species that are reduced in size or grow with a prostrate habit are considered. Of the western Atlantic *Champia* species, *Champia parvula* (C. Agardh) Harv. var. *prostrata* L.G. Williams (1951) is small and grows repent (Schneider & Searles, 1991, 1997). It is nevertheless larger than the new species (to 0.8 mm diameter), is distinctly flattened and obviously constricted at the nodes. *Champia vieillardii* Kütz. grows at least partially prostrate, is substantially larger than the new species and also has a markedly compressed thallus (Lawson & John, 1982). *Champia laingii* Lindauer (1938) from New Zealand is another prostrate (procumbent) species that is small in size (2-4 cm long) with barely constricted segments (Chapman & Dromgoole, 1970). It differs from the new species in having anastomosing branches which become compressed in older plants. *Gastroclonium reflexum* possesses stolon-like branches that attach to the substratum with secondary attachment discs (Irvine & Guiry, 1983). Nevertheless *Gastroclonium reflexum* is larger in size, with markedly constricted branches to 60 mm in length and to 2 mm in diameter (Irvine & Guiry, 1983).

With two exceptions, *Chylocladia schneideri* is the smallest described species of the genus and may be separated from all other described species on the basis of its size. The only species of *Chylocladia* that might be confused with the new species are *C. perpusilla* and *C. pelagosae.* The former species was described as creeping on *Udotea* by Weber-van Bosse (1913) and has branch dimensions in the size range of the new species; it differs, however, in possessing tetrasporangia that are located in inflated branches (Weber-van Bosse, 1913). Due to the fact that *C. perpusilla* lacks diaphragms and given the fact that cystocarpic specimens were not observed (Weber-van Bosse, 1913), placement in *Chylocladia* must be regarded as doubtful. *Chylocladia pelagosae,* which was described from deep water in the Adriatic Sea (Ercegovíc, 1956), is a species with an erect habit and further differs from the new species in possessing only rare medullary filaments.

Among other *Chylocladia* species*, C. rigens* was described as being green and turf-like (Agardh, 1822). Agardh also indicated that its lower portions were repent; however, it becomes erect with pinnate branching. *Chylocladia grandis* is an erect (to 50 cm high) species with opposite or whorled lateral branches and may become 8 cells thick in older segments (Reedman & Womersley, 1976). *Chylocladia capensis* grows erect, is distinctly constricted at the septa, and has a two- to three-layered thallus wall (Stegenga *et al*., 1997). *Chylocladia verticillata* is also an erect species, reaching 30 (-55) cm in height with a two-layered thallus wall and with verticillate branching (Irvine & Guiry, 1983).

Of the species regarded as dubious by Guiry & Nic Dhonncha (2003), the name *Chylocladia unistratosa* has been recognized by some (Coppejans, 1979). This species was erected in an unusual nomenclatural manner, when Ercegovic (1956), assigned the status of "superspecies" to *Chylocladia kaliformis* and attempted to describe two species, *C. kaliformis unistratosa* Erceg. and *C. kaliformis bistratosa* Erceg. These species are to be considered invalid under Art. 23.6(c) (International Code of Botanical Nomenclature: Greuter *et al*., 1994); due to Ercegovíc's (1956) inconsistent use of the Linnaean system of binary nomen-

clature. The poorly known *Chylocladia phalligera* differs from the newly described species in being repeatedly di- trichotomously branched and in having a compressed thallus (Agardh, 1876).

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