DUDRESNAYA PATULA SP. NOV., AN UNUSUAL DEEP-WATER RED ALGA FROM FLORIDA

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ABSTRACT

Dudresnaya patula *sp. nov. is described from 30–60 m depth on the east coast of Florida. The plant grows to a height of at least 10 cm, has flattened axes and main branches to 2 cm wide and 3 mm thick, and has unusually long female reproductive branches. The new species is compared to other* Dudresnaya *species in habitat, vegetative structure, and reproductive morphology.*

Key index words: Cryptonemiales; deep-water algae; Dudresnaya; Dudresnaya patula *sp. nov.; Dumontiaceae; Florida; Rhodophyta.*

The genus *Dudresnaya* P. et H. Crouan (1835) (Dumontiaceae; Cryptonemiales) contains nine species which are distributed in warmer seas of the world (Table 1). The largest number of these species has been found in the Pacific Ocean. *D. colombiana* Taylor (1945) was described from Colombia and reported from California (Mower and Widdowson 1969, Abbott and Hollenberg 1976) and the Gulf of California (Norris and Bucher 1976). *D. hawaiiensis* Lee (1963) and *D. lubrica* Littler (1974) occur in Hawaii. *D. minima* Okamura (1932) and *D. japonica* Okamura (1908) are found in Japan. A single species is found in southern Australia, *D. australis* J. Agardh (1899) (see also Mitchell 1966). Two taxa are known from the tropical and subtropical western Atlantic. *D. crassa* Howe (1905) was described from Bermuda (Taylor 1950, 1961) and subsequently reported from Puerto Rico (Almodovar 1970), Belize (Norris and Bucher 1981) and North Carolina (Schneider and Searles 1973). *D. bermuden-*

TABLE 1. *Habitat and vegetative comparison of* Dudresnaya *species.*

Species	Habitat	Habit	Axial cells	Assimilatory filaments	Distribution
D. patula sp. nov.	deep subtidal, 30–60 m, current >30 cm/s	erect, axis flat, smaller branches terete	75 μm diam.	dichotomous, cells cylindrical	Florida
D. lubrica (Littler 1974)	subtidal, 7 m	cylindrical, narrow, irregularly branched	100 × 550 μm	12 × 100 μm, distal cells rounded and larger	Hawaii
D. crassa (Taylor 1950, 1961)	subtidal, to 3 m	terete, radially branched	135–165 μm diam. 200–430 μm long	cylindrical, length 2–5 times diam.	Belize, Bermuda, Bahamas, N.C.
D. bermudensis (Setchell 1912)		complanate, distichous		cylindrical in center, moniliform at surface	Bermuda, Bahamas
D. colombiana (Norris & Bucher 1976)	intertidal to 23 m	cylindrical to slightly compressed	12–20 μm diam.	tapered at tips, distal cells shorter, oval, 4–7 μm diam. cylindrical	California, Gulf of California, Colombia
D. verticillata (Bornet & Thuret 1876, Littler 1974)				elongate	Europe
D. australis (Mitchell 1966, Setchell 1912)		irregularly radially branched			Southern Australia
D. hawaiiensis (Lee 1963)	4 m	dense, branchlets slightly flattened	10–16 × 30–40 μm	infrequently branched	Hawaii
D. japonica (Okamura 1908)		cylindrical, lower portion can be compressed, irregularly branched			Japan
D. minima (Hasegawa 1949, Kawashima 1959)		terete, irregularly branched to 5 orders		cylindrical, 8.3–11.3 μm, tips with unicellular colorless hairs, 50–60(–220) μm long	Japan

sis Setchell (1912) from Bermuda is also reported in the Bahamas (Collins and Hervey 1917, Taylor 1960). The type species for the genus, *D. coccinea* (C. Agardh) P. et H. Crouan (1835), is a taxonomic synonym of *D. verticillata* (Withering) Le Jolis (1863) [basionym: *Ulva verticillata* Withering (1796)] (see Silva 1950, 1952). This species is known in Europe from the Mediterranean, the Adriatic, Ireland, England and France (Lee 1963). One other little known species, *D. nodulosa* Ercegovic (1949) has been transferred to *Gulsonia* Harvey (Feldmann and Feldmann 1967). Finally, *D. canescens* J. Agardh (1899) is listed by Taylor (1960) as an uncertain record from Florida. Howe (1905) examined the Agardh specimen and concluded it was not a *Dudresnaya.*

Details of female reproductive structures and post-fertilization development are known for the type species, *Dudresnaya verticillata* (Littler 1974; as *D. coccinea*: Bornet and Thuret 1876, Kylin 1928), *D. crassa* (Taylor 1950, 1961), *D. hawaiiensis* (Lee 1963), *D. japonica* (Hirose 1949, Umezaki 1968), *D. lubrica* (Littler 1974), *D. minima* (Hasegawa 1949, Kawashima 1959) and *D. colombiana* (Norris and Bucher 1976).

All previously known *Dudresnaya* species have terete to compressed axes. For those where the reproductive morphology is known (Table 2) the carpogonial branches have 5–10 cells and auxiliary cell branches of 5–20 cells. These species are found only from shallow to moderately deep subtidal waters. A new species with flattened axes and compressed branches, more or less rounded apices, very long carpogonial (13–20 cells) and auxiliary cell (27–43 cells) branches, and apparently restricted to depths of more than 30 m in the type locality is described below.

MATERIALS AND METHODS

Plants were collected at depths of 32–58 m east of Singer Island, Palm Beach County, Florida, U.S.A., by divers from Johnson-Sea-Link submersibles; collection number with the prefix JSL

TABLE 2. *Reproductive comparison of* Dudresnaya *species.*

Species	Sexual plants	Spermatia	Tetraspores	Carpogonial branch	Auxiliary cell branch	Cystocarp
D. patula sp. nov.	dioecious	in groups of 1–3, terminal		13–20 cells, unbranched, straight, trichogyne inflated, often spiral	27–43 cells, 2(–6) cells enlarged, a.c. discoid	250 μm diam. spherical
D. lubrica	dioecious	on upper 2–3 cells of lateral branches		6–10 cells, branched, curved	branched, 10–16 cells, 4–6 enlarged, a.c. round	to 430 μm diam., carpospores to 24 μm diam., rounded
D. crassa	dioecious	at or near ends of cortical cells	irregularly zonate, terminal	6–10 cells, curved, trichogyne inflated or forked	(5–)6–9(–13) cells, 5–13 enlarged (–20), a.c. ½ diam. of enlarged cells	130–165 μm diam.
D. bermudensis		terminal			a.c. same size as adjacent cells	112–126 μm diam.
D. colombiana	monoecious, dioecious	terminal clusters			8–17 cells	120–180 μm diam.
D. verticillata	as in *D. colombiana*	on upper 2–3 cells of lateral branches	zonate	5–8 cells, branched	a.c. flattened, not distinct	carpospores angular, 11 μm diam.
D. australis	monoecious		terminal, zonate 18 × 45 μm		15 cells	reniform, 60–75 μm diam.
D. hawaiiensis	monoecious	terminal, whorled		7–11 cells, long trichogyne	10–16 cells, a.c. enlarged, flattened 5–9	195 μm diam.
D. japonica	dioecious	on upper cells of lateral branches		10 cells	5–9 cells	
D. minima	dioecious			(5–)6–7(–8) cells; long trichogyne, straight, 100–180(–220) μm long	(5–)6–9(–10) cells	80–150 μm diam.

refers to the dive number of the submersible I or II. Temperature was measured by thermometers on the submersible. Light was measured by a submersible quantum irradiance meter (Eiseman and Holt 1979). Plants were preserved in 5% buffered formalin-seawater. Preserved material was stained with aniline blue (Papenfuss 1937). Specimens studied, accompanying microscope slides and preserved portions are deposited in the U.S. National Herbarium, Smithsonian Institution (US), and in the Harbor Branch Foundation Herbarium (HBFH).

Dudresnaya patula sp. nov.

Plantae ad 10 cm altae, ab stipes brevis et hapteron discoideus afixa, textus maxime molliter gelatinosus, uniaxialis, axis principalis (et magnirami) complanatus, ad 2 cm lata, ad 3 mm crassa, rami parvi subcylindracei, 3–4 mm diam. filium axiale 75 μm diam. filia lateralia compluriens dichotomoramosa, cellula distalibus cylindracea, 2–3 μm diam. ca. 25 μm longis. Planta dioecia, rami carpogonii cum 13–20 cellulae, unramosa, interius dichotoma filia lateralia subcorticalia portati, rami auxiliarii cum 27–43 cellulae, interius dichotoma filia lateralia subcorticalia portati. Spermatia in rami lateralis planta mascula, terminalis; tetrasporangia ignota. Distinctissima axe complanato et ramis reproductiviis longis.

Holotypus: a M.O. Hall et E. Melton, JSL I-517, 8 June 1978, ad locum Singer Island, Palm Beach Co., Florida, U.S.A. dictum 26°45.5′ lat. sept. 79°59.5′ long, occid. lectus; numero US-072305.

Plants light pink, to 10 cm tall, attached by a short stipe and discoid holdfast, extremely soft-gelatinous in texture, main axis and larger branches flattened, to 2 cm wide and 3 mm thick, the distal branches nearly cylindrical, 3–4 mm diam. (Fig. 1). Growth uniaxial (Fig. 2), the uniaxial nature becoming obscure in older portions of the plant, axial filaments to 75 μm diam. giving rise to dichotomously branched laterals of several orders, cells of the ultimate cortical filaments 2–3 μm diam. and cylin-

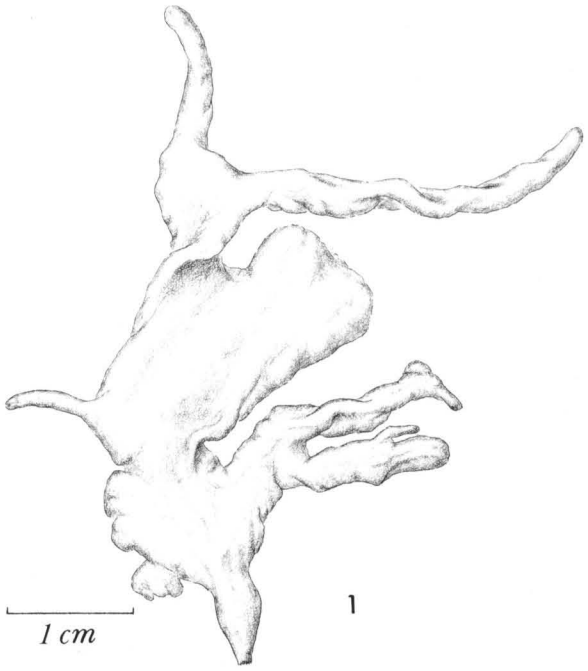
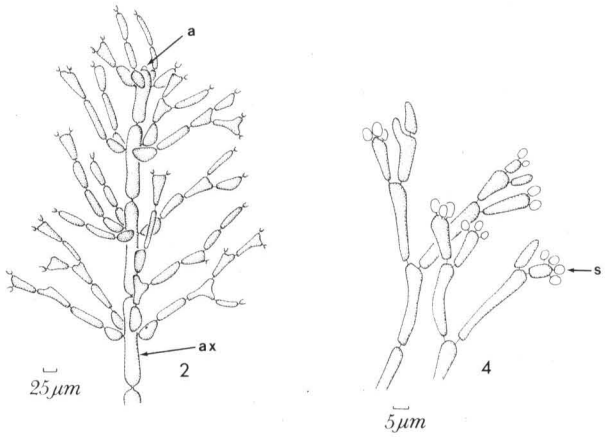
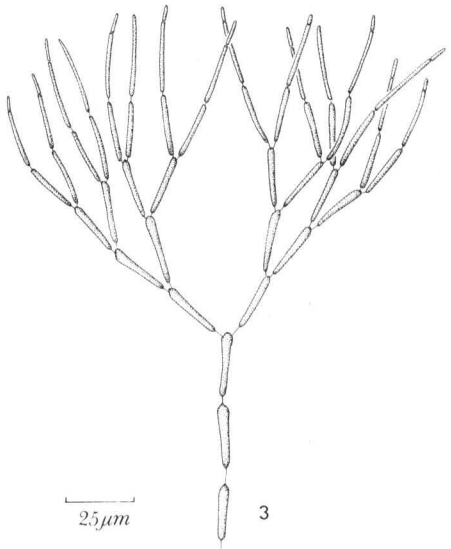


FIG. 1. *Dudresnaya patula* (JSL I-517). Habit of the holotype.





FIGS. 2–4. *Dudresnaya patula.* FIG. 2. Branch axis showing the apical cell and whorled laterals, characteristics of the genus (JSL I-650). FIG. 3. A cortical branch of long cylindrical cells (JSL I-517). FIG. 4. Distal filaments with terminal spermatangia (JSL I-507). a = apical cell, af = axial filament, s = spermatangium.

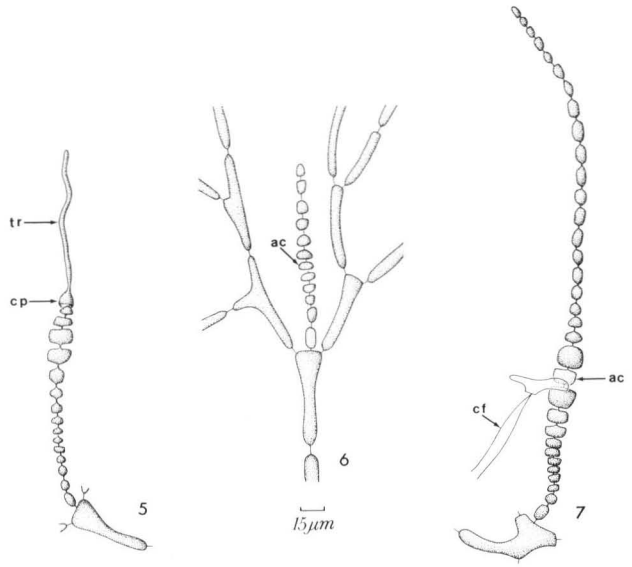
drical (Fig. 3). Dioecious; spermatangia terminal on the distal cells of the cortical filaments, usually three in a triangular arrangement, 1–3 μm diam. (Fig. 4); carpogonial branches 13–20 celled, unbranched, the distal 4–6 cells deeply staining, the carpogonium slightly recurved proximally, with a long trichogyne, borne within the dichotomies of subcortical lateral filaments (Fig. 5); auxiliary cell branches 27–43 celled, unbranched, borne in the dichotomies of lateral filaments (Figs. 6, 7); tetrasporangia not known.

The specimens studied were: JSL I-517, ♀, Holotype: (US-072305); JSL II-193 (HBFH), 5 May 1977, 40.9 m depth; JSL I-515 (US), 7 Jun 1978, 48.8 m; JSL I-518 (HBFH), ♀, 8 Jun 1978, 58 m depth; JSL I-650 (HBFH), 28 Mar 1979, 48.8 m; JSL I-797 (US), ♀, 2 Apr 1980, 33.5 m depth, and JSL I-799, 4 Apr 1980, 48.7 m depth (all from Singer Island, Palm Beach County, Florida, USA); JSL I-507 (US), ♂, east of St. Lucie Inlet, Martin County, Florida (27°10.3′ N; 80°0.00′ W), 5 Jun 1978, 42.1 m depth.

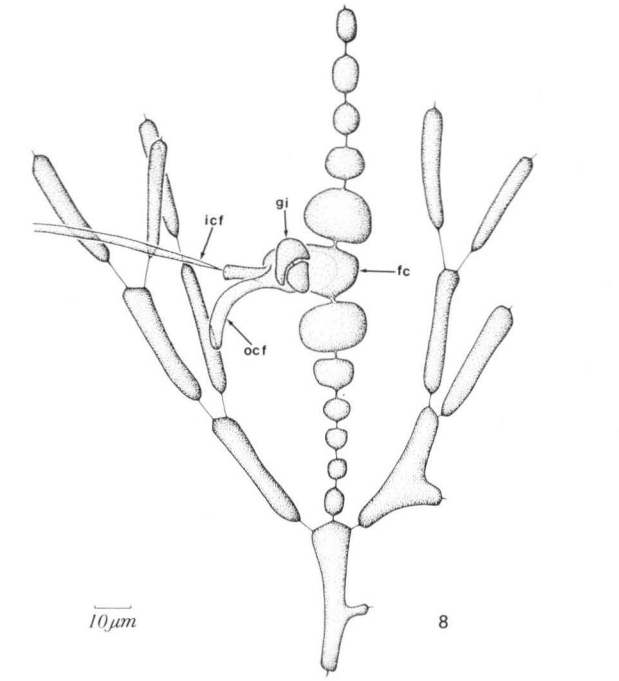
OBSERVATIONS

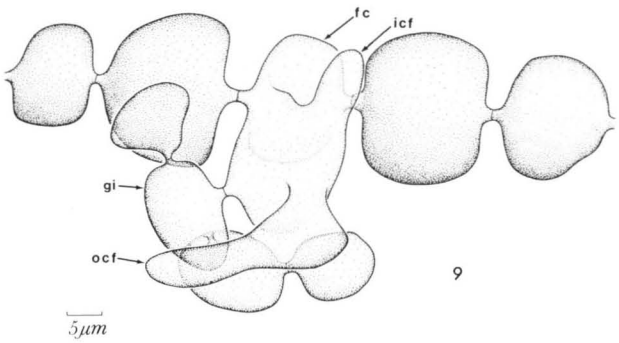
Habitat. The plants were found growing at 32–58 m depths on calcareous rubble interspersed with coarse calcareous sand and shell hash. Bottom relief was only a few centimeters. About 240 species of red, green, and brown algae were collected at these stations. Dictyotales, siphonous Chlorophyta, *Peyssonnelia rubra* (Greville) J. Agardh, *Halymenia* spp. and members of the Rhodymeniaceae and Delesseriaceae were particularly abundant. Hydroids, bryozoans, ascidians and sponges were also common on the rubble and small annelids, amphipods, and decapods were common in the crevices in the rocks and among the fronds of the foliose algae. Bryozoa are commonly found on the surface of the larger algae (Winston and Eiseman 1980). The typical temperature range at these stations was 18–27° C, with occasional lower temperatures (to 9° C) when upwelling occurred. Mean light intensity (June 6–8, 1978) was 9.6×10^5 μEin·d^{-1} at 53 m and 8.8×10^5 μEin·d^{-1} at 58 m; photoperiod on these days was 13.2 h at 43 m and 13.1 h at 58 m (Eiseman and Holt 1979).

Vegetative structure. Dudresnaya patula is uniaxial in structure but this is obvious only in newly formed branches. The apical cell is hemispherical and minute and is surrounded by outward growing assim-



FIGS. 5–7. *Dudresnaya patula* (JSL I-517). FIG. 5. A carpogonial branch, borne in the dichotomy of lateral filaments. FIG. 6. An immature auxiliary cell branch, shown within a dichotomy. FIG. 7. A mature auxiliary cell branch with a connecting filament. ac = auxiliary cell, cf = connecting filament, cp = carpogonium, tr = trichogyne.





FIGS. 8–9. *Dudresnaya patula* (JSL I-517), post-fertilization stages. FIG. 8. Auxiliary cell branch (32 cells in length) with incoming and outgoing connecting filaments, and the gonimoblast initial. FIG. 9. Detail of the fusion cell with probable incoming and outgoing connecting filaments. fc = fusion cell, gi = gonimoblast initial, icf = incoming connecting filament, ocf = outgoing connecting filament.

ilatory filaments from the first axial cell below it (Fig. 2). Each cell of the axial filament gives rise to a whorl of four lateral branches. These are probably produced distally on newly formed axial cells but are found in a median position in mature axial cells. The lateral whorl branches are repeatedly dichotomously branched to form the body of the plant. As a branch matures and thickens, the axial structure becomes so deeply buried that the uniaxial character of the plant is virtually impossible to detect in squash preparations, even of the apex. The axial filaments also lost almost all affinity for aniline blue stain at maturity and can only rarely be seen in older axes.

Reproduction. The carpogonial branch has a supporting cell which is distinct from the other cells of the branch (Fig. 5). This gives rise to a chain of globose cells terminating with the carpogonium and trichogyne. The trichogyne may be inflated and spiral. The four cells proximal to the carpogonium and the carpogonium and trichogyne stain deeply with aniline blue. The third and fourth cells from the carpogonium are slightly enlarged and stain more deeply than the first and second cells. These are presumably nutritive cells as have been found in several other species by the authors cited above. We have not observed connecting filaments issuing from the carpogonial branch. However, an outgrowth was observed on one carpogonium which appears to be a filament initial, further indicating the placement of this species in the genus *Dudresnaya*. The carpogonium is recurved towards the base of the branch but cells 2, 3 and 4 are not displaced from the branch axis as reported for *D. crassa* (Taylor 1950).

The auxiliary cell is differentiated early in branch development. It is discoid in form and is typically (6–)9–10(–12) cells from the base of the branch. The two cells adjacent to the auxiliary cell are enlarged and stain darkly with aniline blue (Fig. 6). Frequently additional cells adjacent to these may be somewhat enlarged and may stain more darkly than the rest of the filament but are not so abruptly enlarged as those adjacent to the auxiliary cell.

Gonimoblast development appears to begin on the connecting filament which enlarges after fusing with the auxiliary cell (Figs. 7–9) as in *D. lubrica*. At

maturity the carpospore mass nearly surrounds the auxiliary cell filament although the auxiliary cell and adjacent enlarged cells can be clearly distinguished in properly oriented specimens. The distal portion of the filament remains attached in almost all cases.

DISCUSSION

Dudresnaya patula differs from the other species of the genus in a number of respects, the most obvious being the flattened axes and main branches (the specific epithet, *patula,* refers to the broad, spreading nature). The carpogonial and auxiliary cell branches are also much longer (i.e. with more cells) than any of the other species for which reproduction is known. The cylindrical nature of the terminal cells of the filaments is shared only with *D. verticillata.* The habitat depth is unusually deep for the genus and perhaps unique to this species.

Dudresnaya patula may also be distinguished from other species on reproductive characters other than the length of the branches. The carpogonial and auxiliary cell branches of *D. patula* are borne within the dichotomies of the lateral filaments. In *D. crassa* they are in a lateral position, sometimes opposite a small branch (Taylor 1950). In *D. verticillata,* Bornet and Thuret (1876) show the carpogonial branch on the basal cell of the dichotomy but not within it. No branching or lateral proliferation of the carpogonial branch has been observed in *D. patula.* Further comparisons can be made using Tables 1 and 2.

We gratefully acknowledge Candy Feller (Smithsonian Institution) for preparing the illustrations and thank Dr. Isabella A. Abbott for examining our material and the drawings, Dr. Dan H. Nicolson for discussion of valid publication of the taxa names, and Katina E. Bucher for comments on the manuscript. This is contribution No. 210 from the Harbor Branch Foundation, Inc.

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