

On the occurrence of *Laurencia caraibica* (Ceramiales, Rhodophyta) in Atol das Rocas, Brazil

Presencia de *Laurencia caraibica* (Ceramiales, Rhodophyta) en Atol das Rocas, Brasil

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ABSTRACT

Laurencia caraibica P.C. Silva is being referred occurring in Atol das Rocas, a small island located about 147 miles off Brazilian northeastern coast. The specimens are characterized by the soft, reduced size thalli with four periaxial cells per each axial segment and tetrasporangia in parallel arrangement; presence of lenticular thickenings in the wall of the medullary cells; epidermal cells near the apex not projected beyond the surface of the thalli; presence of anastomose between branches and the occurrence of secondary pit connections between epidermal cells. In this paper, previously unknown detailed morphological characters are presented and compared to related species.

Key words: Atol das Rocas, Brazil, *Laurencia caraibica*, Rhodophyta, taxonomy

RESUMEN

Se registra por primera vez *Laurencia caraibica* P.C. Silva en Atol das Rocas, el cual es una pequeña isla localizada a 237 km fuera de la costa del noreste de Brasil. Los especímenes se caracterizan por tener talos suaves, pequeños en talla, con cuatro células pericentrales por cada segmento axial; tetrasporangios en arreglo paralelo; presencia de engrosamientos lenticulares en la pared de las células medulares; células corticales cerca del ápice no proyectadas en la superficie del talo; presencia de anastomosis entre las ramas y con uniones intercelulares secundarias entre las células corticales. En este trabajo, se detallan algunos caracteres morfológicos y se comparan con especies relacionadas.

Palabras clave: Atol das Rocas, Brasil, *Laurencia caraibica*, Rhodophyta, taxonomía.

INTRODUCTION

Atol das Rocas Reef is a marine biological reserve in Northeast Brazil, and is considered the only atoll in the South Atlantic (Kikuchi and Leão, 1996; Guerardi and Bosence 2001). The reef consists of a calcareous rock ring, measuring about 3 km in diameter and bathed by the Southern branch of the South Equatorial current, and is colonized by typical

members of tropical algae communities (Oliveira Filho and Ugadim 1976).

The benthic marine flora has been known mainly since 70's by Oliveira Filho (1972), Oliveira Filho and Menezes (1972), and Oliveira Filho and Ugadim (1974, 1976). In the latest reference 22 species of Chlorophyceae, 18 of Phaeophyceae, and 53 of Rhodophyceae are listed. Among members of *Laurencia*

complex (*Laurencia* J.V. Lamouroux, *Chondrophyucus* (Tokida et Saito) Garbary et J. Harper, *Osmundea* Stackhouse) only *L. decumbens* Kützing (as *L. pygmaea* Weber-van Bosse) and *Chondrophyucus papillosus* (C. Agardh) Garbary et J. Harper (as *Laurencia papillosa*) have been referred to Atol das Rocas (Oliveria Filho and Ugadim, 1974; 1976).

In the last two years, recent studies on the marine algae from the Atol das Rocas Reef are bringing out new information about the ecology and flora of this unique environment in Brazilian coast (Villaça *et al.*, 2001).

In this paper, *Laurencia caraibica* P.C. Silva is being added to the rhodophycean algal list from Atol das Rocas, and from Brazil. Previously unknown detailed morphological characters of the species are presented, compared to related species, and its geographical distribution is discussed.

STUDY AREA

Atol das Rocas is located in the Atlantic Ocean, at 30°51' S and 33°49' W, distant 150 miles from the city of Natal, Rio Grande do Norte State, in Northeast Brazil (Fig. 1). The atoll has an oval shape with an internal area of about 7.5 km². Its largest axis (E-W) is 3.7 km long, and the shortest (N-S) is 2.5 km long. An algal ridge limits the reef flat, which is dominated by a coralline algae-vermetid gastropods association growing as small linear ridges. Internally, the atoll is composed of two sand cays, a big sand plain, several pools of different sizes and depths, a permanent lagoon and an internal algal ridge (exposed at low tide).

MATERIAL AND METHODS

Voucher specimens and materials for morphological studies were fixed in 4% Formalin/seawater or pressed as herbari-

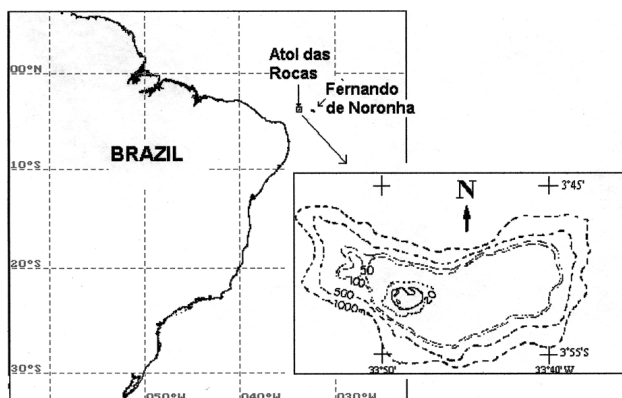


Figure 1. Study area: Atol das Rocas, Brazil.

um sheets. The specimens were collected manually on an internal ridge during low tide. Longitudinal and transverse hand sections were made with a stainless steel razor blade under a stereoscopic dissection microscope, and stained with 0.5% aqueous aniline blue solution, acidified with dilute HCl or in aqueous ruthenium red (ca. 0.02%). Photomicrographs were taken with an Olympus BH-2 microscope. Voucher specimens are housed at the herbarium of the Instituto de Botânica at São Paulo, Brazil (SP). Herbarium abbreviations are as given in Holmgren *et al.*, (1990).

RESULTS

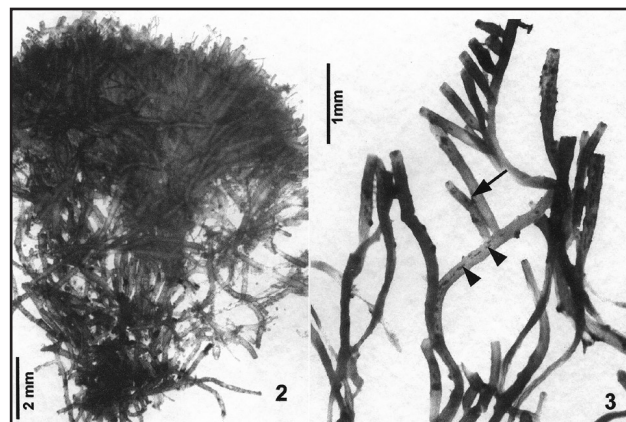
Laurencia caraibica P.C. Silva 1972: 205. Figures 2-11

Basionym: *Laurencia nana* Howe in Britton and Millspaugh 1920: 566, nom. illeg.

Type locality: Mariguana (Mayaguana), Bahamas. Type: Howe 5393. Isotype: US 68437!

Habit: Plants heavily entangled forming cushion-like tufts, fixed to the substratum by mean of discoid holdfast or with numerous holdfasts originated by prostrate branches. Thalli are erect or decumbent, cylindrical, up to 1.6 cm high and 0.16-0.21 mm in diameter, soft in texture, adhering well to herbarium paper when dried. Color is pinkish-purple to garnet-brown. Branching is unilateral to irregularly alternate, bearing long unramified or shortly ramified ultimate branchlets, up to 6 mm long and 120-200 μ m in diameter. Branches slightly constricted at the basis and with truncate apex. Anastomose between branches are frequent (Figs. 2-3).

Vegetative Structures: In surface view, epidermal cells in the middle region of the thalli are elongate-polygonal, 37-



Figures 2-3. *Laurencia caraibica*. 2. Habit. 3. Detail of tetrasporangial branches, with arrow indicating anastomosis and arrowheads the lenticular thickenings.

57 µm long x 20-26 µm wide, connected to one another by longitudinally oriented secondary pit connections (Fig. 4). Living material was not observed to check the occurrence of "*corps en cerise*". In cross-section of the thallus a layer of pigmented epidermal cells and three-four layers of medullary cells (Fig. 5). Epidermal cells neither radially elongated nor arranged like palisade, 18-21 µm long and 20-26 µm wide. Secondary pit connections present between adjacent epidermal cells (Figs. 4, 6). Medullary cells are large and slightly flattened. Each vegetative axial segment cuts off four periaxial cells, 26-32 µm in diameter, which are slightly larger than cells of surrounding layer (Fig. 5). Lenticular thickenings are abundant in the walls of the medullary cells (Figs. 3, 7). In median longitudinal sections through a branchlet, the outer walls of the epidermal cells do not project beyond the surface (Fig. 8).

Reproductive Structures: Tetrasporangial branches are clavate with truncate apex, simple, 1-6 mm long. X 0.2 mm wide (Figs. 3, 9). Tetrasporangia are 53-76 µm in diameter, and display parallel arrangement on the fertile branches (Figs. 3, 9-11). Male and female plants were not found.

Sterile and tetrasporangial plants were collected in July 1999 and June 2000, over the hard bottom of an internal algal ridge and over small corals that link a reef flat section to the sand cay. The specimens were found in very intricate small turfs, heavily entangled with other macroalgae such as *Gelidiopsis intricata* (C. Agardh) Vickers, *Lomentaria rawitscheri* A.B. Joly, *Jania adhaerens* J.V. Lamouroux, and *Lophosiphonia obscura* (C. Agardh) Falkenberg.

Geographical Distribution: Atlantic ocean: Bahamas (Mariguana [=Mayaguana], type locality) (Howe 1920 as *L. nana*; Littler and Littler 2000); Belize (Norris and Bucher, 1982); Mexico (Senties and Fujii, 2002); Jamaica (Taylor, 1960 as *L. nana*); Puerto Rico (Ballantine and Norris, 1989); Antigua (Taylor, 1969 as *L. nana*); Greater Antilles, Lesser Antilles, Western Caribbean, Gulf of Mexico (Littler and Littler 2000); Colombia (Bula-Meyer, 1986); Brazil, Atol das Rocas, (Oliveira Filho and Ugadim, 1974; 1976, as *L. pygmaea* Weber-van Bosse). Indic Ocean: India (Silva *et al.*, 1986).

Material Examined: SPF 025561 (as *L. pygmaea*), Atol das Rocas, Feb. 1972, coll. E.C. Oliveira, det.: M.T. Fujii. SP 355383, Atol das Rocas, 21 Jul. 1999, coll.: R. Villaça, det.: M.T. Fujii. SP 355384, Atol das Rocas, 13 Jun. 2000, coll.: R. Villaça, det.: M.T. Fujii.

Additional Material Examined: US 68437 (isotype), on corals, near low-water mark, Abraham bay, Mariguana, Bahamas, 6 Dec. 1907, coll. M.A. Howe.

DISCUSSION

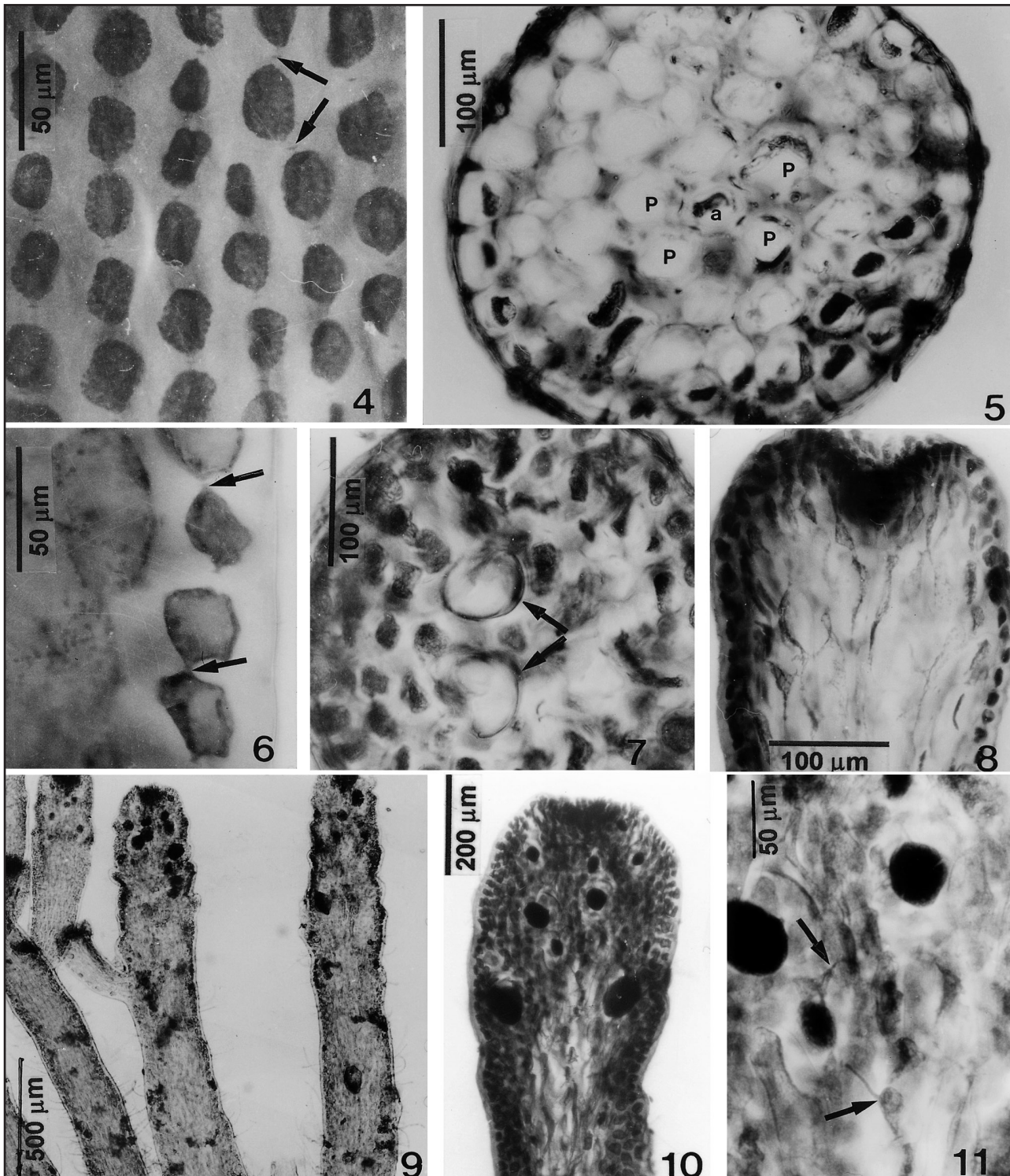
Laurencia nana was proposed by Howe (1920) to include species proceeding from Mariguana (=Mayaguana), Bahamas, characterized by having 1-2 cm high and densely caespitose to intricate thalli with 0.15-0.45 mm in diameter, but without lenticular thickenings in the walls of medullary cells.

According to Silva (1972), *L. nana* Howe is a later homonym of *L. nana* (C. Agardh) Greville (1830), previously described as *Chondria nana* C. Agardh (1827). This species, which was found at Trieste, Italy, was considered a small form of *L. paniculata* (C. Agardh) J. Agardh (1863). The epithet *Laurencia caraibica* was provided by Silva (1972) as a substitute name for *L. nana* Howe.

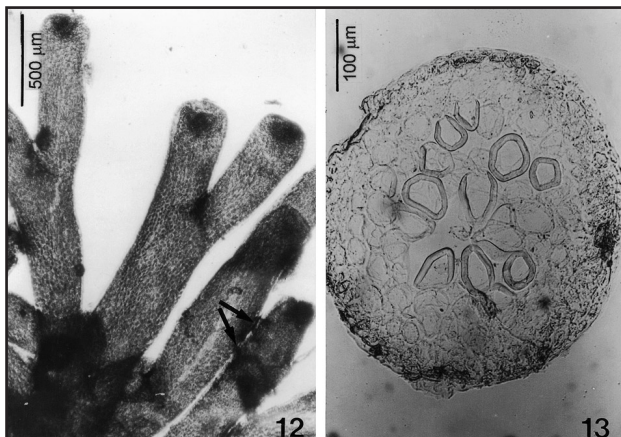
Laurencia caraibica is a typical member of the genus showing four periaxial cells per each axial segment, and tetrasporangia cut-off from a particular periaxial cell. The lenticular thickenings in the walls of the medullary cells were not reported either in the original description by Howe (1920) or later by Taylor (1960) in the specimens from Jamaica. However, lenticular thickenings were observed by Norris and Bucher (1982) and also by us in the isotype (US 68437) (Figs. 12-13). Norris and Bucher (1982), Ballantine and Norris (1989), and Senties and Fujii (2002) stated the occasional occurrence of lenticular thickening in the walls of the medullary cells in specimens proceeding from Belize, Puerto Rico, and Mexico, respectively. In specimens from Atol das Rocas reef, Brazil, lenticular thickenings are abundant in the walls of the medullary cells, and they are visible through the epidermal cells in surface view.

Mexican plants, reach up to 5 cm height and 1 mm in diameter of axis, resulting larger than our specimens. Senties and Fujii (2002) reported the presence of two (third and fourth) fertile periaxial cells per each axial segment producing tetrasporangia in specimens from Mexico. In Brazilian specimens, however, this feature is not clear enough but figure 11 suggests that only the fourth periaxial cell produces tetrasporangium as in *L. similis* Nam and Saito (1991) and occasionally in *L. brongiartii* J. Agardh (Nam and Sohn 1994) and *L. filiformis* (C. Agardh) Montagne (Fujii 1998). In Puerto Rican plants the secondary pit-connections between adjacent cortical cells are lacking and tetrasporangia display right-angle arrangement, suggesting that it could belong to another taxon.

Baptista (1974) described *L. caraibica* (as *L. nana*) from Ilha dos Lobos, Rio Grande do Sul, Southern Brazil. Based on the habit, the larger size of thalli, and absence of lenticular thickenings in the walls of medullary cells, Baptista's specimens should be referred to as *L. intricata* J.V. Lamouroux. In the same paper, the author included an unidentified species of



Figures 4-11. *Laurencia caribica*. Vegetative and tetrasporangial structures. 4. Longitudinally oriented secondary pit-connections (arrows) between adjacent epidermal cells in surface view of the thallus. 5. Transverse section through the thallus showing an axial cell (a) producing four periaxial cells (p). 6. Longitudinal section through a thallus, showing detail of the epidermal cells with secondary pit-connections (arrows). 7. Transverse section of the branch with lenticular thickenings (arrows) in the walls of the medullary cells. 8. Longitudinal section through a young tetrasporangial branchlet showing the apical pit and epidermal cells near the apex not projected beyond the surface. 9-10. Details of tetrasporangial branches in surface view with parallelly oriented tetrasporangia. 11. Longitudinal section of the tetrasporangial axial segment showing a periaxial cell per each axial segment producing tetrasporangium (arrows).



Figures 12-13. *Laurencia caraibica*. Isotype specimen housed in the United States National Herbarium (US 68437). 12. Detail of the branches with anastomose (arrows). 13. Transverse section of the thallus with lenticular thickenings in the walls of the medullary cells.

Laurencia, which is referable to *L. caraibica* on the basis of the habit and morphological characteristics, except for the absence of the lenticular thickening in the medullary cell walls.

Baptista's (1974) *Laurencia* sp. corresponds to *L. oliveirana* Yoneshigue, an other dwarf species described from Rio de Janeiro, Brazil, by Yoneshigue (1985) and later also reported from São Paulo (Fujii 1990). *L. caraibica* differs from *L. oliveirana* in both the presence of lenticular thickenings in the medullary cells and anastomose between branches.

The presence or absence of lenticular thickening as a character to distinguish species within the genus *Laurencia* is somewhat controversial since this feature is not always easily detectable, although it has been used to characterize members of *Laurencia* included into the section *Forsterianae* Yamada (Saito 1967). In *L. caraibica*, however, the lenticular thickenings are visible through the epidermal cells in surface view and useful as diagnostic character.

Oliveira Filho and Ugadim (1974; 1976) described *L. decumbens* (as *L. pygmaea*) from Atol das Rocas, Brazil. From the study of last material (SPF 025561), however, it resulted that it showed all the characters of *L. caraibica*.

Laurencia pygmaea was originally described from Chagos archipelago, Diego Garcia, Indian Ocean, an specimens collected by Mr. J. Stanley Gardiner during the "Sealark expedition" (Weber-van Bosse 1913). Later, based on the morphological similarity *L. pygmaea* was considered synonym of *L. decumbens* described from New Caledonia, Pacific Ocean, but also found in Mauritius, India (Børgesen 1945).

Although the description of *L. decumbens* (as *L. pygmaea*) given by Weber-van Bosse (1913) has shown a great resemblance to

that of *L. caraibica* because both have small thalli growing as intricate tufts, according to Weber-van Bosse (1913), the branches of *L. decumbens* can be easily teased out under a pocket-lens, whereas in the case of *L. caraibica* this cannot be done without damaging the frond due to the presence of anastomose between contiguous branches (Weber-van Bosse, 1913; Oliveira Filho and Ugadim, 1974).

As concerns the geographical distribution, it should be noted that *L. decumbens* occurs in Pacific and Indian Oceans whereas *L. caraibica* is more related to Atlantic Ocean, especially in Caribbean region, although it was reported also from India (Silva *et al.*, 1996).

Considering the morphological characteristics combined with geographical distribution, we propose that *L. decumbens sensu* Oliveira Filho and Ugadim (1974; 1976) be recognized as *L. caraibica* P.C. Silva.

Other two species of *Laurencia* described from Brazil that possess reduced thalli are *L. catarinensis* Cordeiro-Marino et Fujii (1985) and *L. intricata* J. Agardh (Fujii, 1990). The former has greenish color and the latter is pink-rose. Both species develop in densely intricate tufts with unilaterally or radially branched thalli, but their final gross morphology and the size are different from the present species, and the lenticular thickenings are lacking in both species.

Laurencia caraibica was collected in well-illuminated habitats, emersed during the low tides, sometimes for a long period, but with no damages because of the closed association with other species of algae and some small invertebrates also supporting an internal wet environment. The reef section where *L. caraibica* was found is protected from direct wave impacts but it is regularly washed by the tide currents. *L. caraibica* is reported from some reefs in the Caribbean under the same environmental conditions (Littler and Littler, 2000).

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