**Laurencia iridescens** sp. nov. (Rhodomelaceae, Ceramiales) from the Caribbean Sea

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*Laurencia iridescens* sp. nov. (Rhodophyta), a repent species, described from Guadeloupe (French West Indies) and Puerto Rico, is distinguished by the following set of characters: a perpendicular arrangement of its tetrasporangia, the presence of secondary pit connections between epidermal cells, the highly concrescent axes displaying a brilliant blue iridescence, and the absence of both ‘corps exercerise’ in the cortical cells and lenticular thickenings in the walls of the medullary cells.

**INTRODUCTION**

*Laurencia Lamouroux* (Rhodomelaceae, Rhodophyta) is a large genus containing numerous species that are well represented in tropical and temperate seas. Wynne (1986) listed 22 species as occurring in the western tropical and subtropical Atlantic. That list included two species described from Venezuela by Rodriguez de Rios (1981), *L. bolivarii* and *L. foldatsii*, and a species described from Colombia by Schnetter (1975), *L. minuscula*. A more recent account by Cordeiro-Marino & Fujii (1985) added *L. catari-nensis*, newly described from Brazil. Dawson (1962) reported *L. sinicola* Setchell et Gardner from the Atlantic coast of Costa Rica. Descriptions of additional new species from other parts of the world have appeared in the contemporary literature (Saito 1969; Saito & Womersley 1974; Ganzon-Fortes 1982; Tseng et al. 1982; Cribb 1983; McDermid 1989; Vandermeulen et al. 1990).

Saito (1966) has proposed two subgenera of *Laurencia*: subgenus *Laurencia*, in which longitudinal secondary pit connections are present between epidermal cells, and the tetrasporangia are arranged in a parallel manner relative to the longitudinal axis of the thallus; and subgenus *Chondrophycus*, in which secondary pit connections between epidermal cells are lacking, and tetrasporangia are arranged in a perpendicular manner relative to the longitudinal axis of the thallus. These two criteria effectively separated the many species of *Laurencia* from Japan (Saito 1967) and the central and western Pacific (Saito 1969).

In their study of southern Australian species of *Laurencia*, Saito & Womersley (1974) observed that the 16 species treated could all be clearly assigned to one or the other subgenus, with the exception of *L. botryoides* (Turner) Gail-lon. In the latter species, secondary longitudinal pit connections occurred between epidermal cells, but the tetrasporangia were ‘arranged apparently in the right-angle manner due to the very restricted development of the stichidia’ (Saito & Womersley 1974, p. 836). Although Zhang & Xia (1985) did not observe secondary pit connections in *L. parvipapillata* Tseng, Cribb (1983) observed a few secondary pit connections in this species, which has a tetrasporangial arrangement of the right-angle type (Tseng 1943), and thus it would be a further exception. Similarly, *L. crusi-formans*, a species recently described from Hawaii by McDermid (1989), also has secondary pit connections between epidermal cells, but shows a perpendicular arrangement of its tetrasporangia. We have collected an undescribed species of *Laurencia* in Guadeloupe (French West Indies) and Puerto Rico, which again possesses pit connections between epidermal cells (as in the subgenus *Laurencia*), and produces its tetra-
sporangia in a perpendicular arrangement (as in the subgenus *Chondrophyceae*). A brilliant blue iridescence is characteristic of living plants of the new species, which we describe here as *Laurencia iridescens* sp. nov.

**MATERIALS AND METHODS**

Specimens were preserved in 10% Formalin-seawater. Whole-mount slides were prepared following staining with 1% aniline blue (acidified with a few drops of HCl) in 60% Karo syrup. An Olympus stereo microscope with camera lucida was used to prepare the habit drawings. Isotype specimens of *Laurencia nana* Howe [= *L. caricibca* Silva] and *L. catarinensis* Cordeiro-Marinoc Fujii were borrowed from the Smithsonian Institution (US). Herbarium abbreviations follow those of Holmgren et al. (1981).

**OBSERVATIONS AND DISCUSSION**

*Laurencia iridescens* sp. nov.

**Figs 1–11**

**Diagnosis:** Thallii e plurimis axibus confertim aggregatis constantes, multis organis affixionis secundariis inter axes contiguos atque axibus basilibus ad substratum affixis; in statu vivo thalli eyanei splendide iridescentes; iridescentes solum in superficiebus expositis aut dorsalibus; axes rigidi et cartilaginei et teretes sed axes vetustiores aliquot compressi; axes singuli horizontales, crescentse super axes vetustiores sed axes singuli non verticaliter extendentes super massam confertam; axes 2 cm longitudine attingentes; massa integra axium intertextorum 5–6 cm latitudine; series ultima ramorum brevis et paxilliformis, 1.0–1.3 cm diametro; ramificatio irregulatim radialis; foveo-colligationes longitudinalae secundariaeque (et paucae laterales) inter cellulas in superficie; cortex plerumque et duobus stratis cellularum constans; cellulae juvenes corticalesque quae apices circumvenient apiculatae sed minus signatae ut maturescentes; cellulae corticales radiate elongatae iuventute, plus isodiametricae maturitate, 28–40 μm lateae; ‘corps en cerise’ absens; cellulae medullolae elongatae, in sectione transversa 175–275 μm, in sectione longitudinali 330–475 μm: viscæ; nullæ incassations lenticulares in pariebus cellularum medullolorum; tetrasporangia in verticillum in ramos brevibus ultimis disposita, igitur in ordinatione perpendiculari ad axem longitudinalem; tetrasporangia matura 62–78 μm diametro; thalli sexuales non observati.

**Holotype:** Wynne 8278 [= Ballantine 2675] deposited in MICH.

**Isotypes:** AD, MEL, MELU, MICH, MSM, PC, UC, and US.

**Type Locality:** Les Alizes, southeast of Moule, Grande-Terre, Guadeloupe, French West Indies, collected by M.J. Wynne and D.L. Ballantine, 23. ii. 1987, in the mid-littoral zone on an exposed limestone pavement.

**Etymology:** The specific epithet refers to the strongly iridescent nature of this alga in the living condition. Latin *Iris* (stem: *irid-*) rainbow.

**Additional Specimens Examined:** Cabo Rojo Lighthouse, southwest corner of Puerto Rico, emergent limestone outcrop, at c. 30 cm depth (Ballantine 2663, 18.v.1987, MSM; Ballantine 2786, 30.viii.1987, MSM; Ballantine 3210, 27.i.1989, MSM; Ballantine = Wynne 9202, 19.iv.1990, MICH).

**Habit:** Thalli consist of a tightly concrescent aggregation of axes, with many secondary attachments between adjacent axes and with the most basal branches so strongly attached to the substratum that a knife was necessary to force a fused mat of axes from the substratum.

In the living condition, thalli display a brilliant blue iridescence, even when thalli are emersed, but this gradually fades when they are held out of the water. Under the microscope, shades of purple and green iridescence were also apparent. The iridescence is limited to the exposed or dorsal surfaces of the axes. Axes are rigid, cartilaginous and terete (Figs 1–3), but older axes can become somewhat compressed. Individual axes are generally oriented horizontally, growing over older axes and extending outward at the periphery; single axes do not extend vertically above the consolidated aggregation (Fig. 5). Axes reach 2 cm in length, the entire mass of intertwined axes reaching 5–6 cm in diameter.

**Vegetative Structure:** The growing points are located in apical depressions typical of the genus. The final-order branches are short peg-like structures (Fig. 1). Most axes are 1.0–1.3 mm in diameter, with irregularly radial branching. Longitudinal as well as some lateral secondary pit connections between epidermal cells are present (Fig. 9). The cortex consists of 1–3, usually two, layers of cells. Young cortical cells, i.e. those that surround the apices of ultimate branchlets, are prominently apiculate (Fig. 7), but this feature becomes less marked as cortical cells mature. Young cortical cells are radially elongate, but more isodiametric at maturity (Fig. 6), measuring 28–40 μm across. Cortical cells lack ‘corps en cerise.’ Medullary cells are elongate, measur-
ing 175–275 μm in cross section and 330–475 μm in longitudinal section. Lenticular thickenings in the walls of the medullary cells are absent (Fig. 8).

REPRODUCTION: Tetrasporangial thalli produce tetrasporangia in a perpendicular arrangement relative to the longitudinal axis (Figs 3, 4). The tetrasporangia appear to comprise a single whorl on ultimate branchlets when viewed from above. Saito (1967, p. 70) referred to this arrangement as the ‘right angle type’ as opposed to the ‘parallel type’, in which tetrasporangia are cut off parallel to the bearing axis. Nevertheless, their arrangement would appear to be a function of growth of the branchlet, giving rise to the tetrasporangia after the sporangia are cut off. When a longitudinal section of the earliest appearance of tetrasporangial primordia is viewed, it can be seen that they are cut off parallel to the growing axis, although over a short distance. However, these
ultimate branchlets remain short and peg-like and, upon maturation, the tetrasporangia become arranged in a whorl, resulting in a right-angled or perpendicular arrangement (Fig. 10). The tetrasporangia, formed only in the final-order branchlets, are cut off adaxially from the bearing cell. Mature tetrasporangia (Fig. 11) are tetrahedrally divided, measuring (40–) 62–78 (–90) μm in diameter. Gametophytic thalli were not observed.

REMARKS: Iridescence occurs sporadically in a number of marine brown and red algae. Certain species of Dictyota are conspicuous because of their bluish-green iridescence (Jaasund 1970b). In cortical cells of D. dichotoma (Hudson) Lamouroux, iridescent bodies have been reported to originate from dictyosomes (Feldmann & Guglielmi 1972). The fucoïd Cystoseira tamarensis (Hudson) Papenfuss is an iridescent member of the genus (Robert 1970). Among the Rhodophyta iridescence is displayed in such disparate genera as Iridaea (Gerwick & Lang 1977), Ochttodes (Littler et al. 1989), Gastroclonium (Feldmann 1970b), Martensia and Dotyella (Magruder & Hunt 1979), and Chondria (Feldman 1964, 1970a). Some species of Laurencia have been described as iridescent, or sometimes iridescent, such as L. obtusa (Hudson) Lamouroux, the type of the genus, and L. pinnatifida (Hudson) Lamouroux (Dangeard 1940). These iridescent Laurencia species are easily separated from the proposed species on the basis of their parallel arrangement of tetrasporangia (Saito 1982). Another feature that distinguishes L. obtusa is the presence of ‘corps en cerise’, or elaioplasts, in its epidermal cells, a cytological feature that is recognized in a limited number of species in the genus (Feldmann & Feldmann 1950; Diannelidis & Höfler 1959; Young et al. 1980). Taylor (1928, p. 179) referred to submerged L. corallopsis (Montagne) Howe as being ‘frequently highly iridescent’. However, that species can be distinguished from L. iridescens, since it is a member of the section Palisadae and lacks secondary pit connections between epidermal cells (Rodriguez de Rios & Saito 1982). When submerged, the upright axes of L. crustiformans often have ‘iridescent rings’ (McDermid 1989).

Features attributed to Laurencia distichophylla J. Agardh by Jaasund (1970a, 1976) appear to be strongly indicative of the new Caribbean alga. Jaasund referred to his East African alga as having a blue iridescence and consisting of stiff, cartilaginous axes adpressed to coral rock; its branching pattern also strongly resembles that of the alga under discussion. Jaasund’s identification may be incorrect in the light of Saito & Womersley’s (1974) account of L. distichophylla (a species based on a New Zealand type) from southern Australia. The data on L. distichophylla provided by Saito & Womersley permit us to eliminate it from further consideration, viz. the parallel arrangement of its tetrasporangia, the medullary cells having occasional lenticular thickenings, and the largely complanate main axes. Furthermore, L. distichophylla lacks the highly concrescent habit of L. iridescens, and there is no mention of iridescence in this alga.

The clump-forming habit of Laurencia concreta Cribb, with attachment by holdfasts at numerous points and with contiguous branches becoming interlinked (Cribb 1983), bears a strong similarity to that of L. iridescens, but the Australian species can be distinguished because its epidermal cells have a palisade-type arrangement and lack secondary pit connections.

Two other species of Laurencia occurring in the tropical western Atlantic, viz L. caraibica Silva (formerly L. nana Howe) and L. catariensis Cordeiro-Marino et Fujii, resemble L. iridescens in having a repent or partially repent habit. A comparison of these three species is shown in Table 1. Both L. caraibica and L. iridescens occur in high-energy habitats, i.e. those that are subject to significant wave exposure. Laurencia caraibica is also reported to have a light bluish iridescence and concrescent branches (Ballantine & Norris 1989). Plants of L. caraibica are dichotomously or sub-dichotomously branched in the basal portions, and erect portions reach 2 cm in height (Howe 1920), whereas in L. iridescens the axes are not dichotomously

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Fig. 5. Holotype specimen of Laurencia iridescens, sp. nov. showing the repent habit and the concrescent nature of the axes.
Figs 6–11. Morphology and reproduction of Laurencia iridescent sp nov.
Fig. 6. Portion of cross-section of older axis, showing quadrate cortical cells.
Fig. 7. Apex in longitudinal section, showing apiculate cortical cells.
Fig. 8. Axis in cross-section, showing the absence of refractive wall thickenings in the medullary cells.
Fig. 9. Surface view of cortical cells (aniline-blue stained), showing both longitudinal and lateral secondary pit connections (arrowheads).
Fig. 10. Apical region of fertile axis, showing perpendicular arrangement of tetrasporangia.
Fig. 11. Various stages of maturing tetrasporangia.
Table 1. Repent or partially repent western Atlantic species of Laurencia

<table>
<thead>
<tr>
<th>Species</th>
<th>Habit</th>
<th>Confluence among branches</th>
<th>Main axis diameter</th>
<th>Lenticular thickenings among medullary cells</th>
<th>Apiculate cortical cells at apices</th>
<th>Apiculate pit connections between cortical cells</th>
<th>Tetrasporangial arrangement</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>L. caribica</em></td>
<td>Totally repent</td>
<td>Present</td>
<td>1.0-1.3 mm</td>
<td>Present</td>
<td>Present</td>
<td>Present but rare</td>
<td>Right angle</td>
</tr>
<tr>
<td><em>L. catarinensis</em></td>
<td>Partially repent, mostly erect</td>
<td>Present 2, 2, 2</td>
<td>0.9-1.2 mm 2</td>
<td>Absent 2, 2, 2, 2, 2</td>
<td>Absent 2, 2, 2, 2, 2, 2</td>
<td>Parallel</td>
<td></td>
</tr>
</tbody>
</table>

* Branched and remain tightly concrescent and prostrate, the entire mat approaching 1.5 cm in thickness. An examination of an isotype specimen of *L. caribica* revealed that epidermal cells near the apices of axes lack apiculate walls. Another difference from *L. iridescens* is that walls of the medullary cells have lenticular thickenings (Norris & Bucher 1984). Although the main axes of *L. catarinensis* are cushion-like and partially decumbent, they are not concrescent, and the tetrasporangial arrangement is of the parallel type (Cordeiro-Marino & Fuji 1985).

The description of *Laurencia iridescens* adds another species with a combination of characters that differs from the subgeneric circumscripton proposed by Saito (1966, 1967), i.e. species with a perpendicular arrangement of tetrasporangia and the presence of secondary pit connections between surface cells. Two other species showing this combination of characters are *L. botryoides* and *L. crustiformans*, neither of which is known from the Caribbean. Assigned to section Planae of subgenus *Laurencia*, *L. botryoides* can be distinguished from *L. iridescens* by its branching in one plane (Saito & Womersley 1974). *Laurencia crustiformans* has thalli consisting of little branched, non-interlocking erect axes arising from a spreading basal crust, and is distinguished by the presence of "corps en cerise" in the cortical cells (McDermid 1989).

A different group of species also conflicts with the subgeneric classification proposed by Saito (1966), in that its members show a parallel arrangement of tetrasporangia and the absence of secondary pit connections. These species include *L. pinnatifida* and *L. hybrida* (DeCandolle) Lecommand ex Duby (Saito 1982) and *L. platycephala* Kützing (Magne 1980).

It is evident from these observations that Saito's (1966) subgeneric classification of *Laurencia* is inadequate for the separation of the species on the basis of the criteria of tetrasporangial arrangement and presence or absence of secondary pit connections between epidermal cells. Other means of delineation are required.

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REFERENCES


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