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A new freshwater species of *Rhodochorton* (Rhodophyta, Nemaliales) from Venezuela

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A new freshwater species of *Rhodochorton, R. venezuelensis* (Nemaliales, Rhodophyta), is described from eastern Venezuela. The plants are up to 4 mm long and heterotrichous. The basal portion of erect filaments may or may not be covered by many septate, branched, downward rhizoids. Cells of erect filaments contain numerous small discoid to elongate parietal chromatophores without pyrenoids. Monosporangia were the only reproductive structures observed in the material studied.

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Introduction

The thallus of *Rhodochorton* (Acrochaetiaceae, Nemaliales) is generally small, up to a few mm long, and consists of branched uniseriate filaments. As construed by many workers (Papenfuss, 1945, 1947; Kylin, 1956; Taylor, 1957, 1960), each vegetative cell contains numerous, small, parietal chromatophores. Asexual reproduction is by means of mono-or tetraspores. Sexual reproduction has remained very imperfectly known until West (1969, 1970*b*), demonstrated by means of culture studies that the post-fertilization development in *R. purpureum* (Lightfoot) Rosenvinge is unique, *i.e.,* without formation of a typical carposporophyte, the tetrasporophyte developing from the gonimoblast cells.

All the described species of *Rhodochorton,* except *R. investiens* (Leonormand) Swale and Belcher (1963), are marine. *R. purpureum* sometimes grows in freshwater near the littoral (Conway and Knaggs, 1966) but is probably not a genuine freshwater form. Among the freshwater algal collections of eastern Venezuela made by one of us (L.G.D.), a new species of *Rhodochorton* was found, which forms the subject of this paper.

Material and Methods

Abundant material was collected on March 1, 1971 from Caño Juanico in Maturin, Monagas State (9°45′ Lat. N; 64°10′ Long. W.), a slow-moving freshwater stream. Microscopic observations of both living and fixed (3% formalin) material were made. The fixed material was stained with a 1% solution of Aniline blue in distilled water.

Observations

Rhodochorton venezuelensis grows attached to small pebbles forming dull green outgrowths up to a height of 4 mm. The plants are heterotrichous. The basal system consists of many cells of various shapes (Fig. 9), irregularly grouped together without forming a symmetrical disc.

The erect system consists of filaments which are generally abundantly, alternately or unilaterally branched (Fig. 1). However, opposite branching is not uncommon (Fig. 10). Cells of the erect filaments are 17–36μm broad and 50–110μm long. The basal portion of some adult erect filaments are covered by many septate, branched, downward growing rhizoids (Fig. 6, *R*). These rhizoids are 10-22μm in diameter and arise as outgrowths from the lower part of cells (Fig. 7, *R*), well above the middle region of the erect filaments. Formation of rhizoidal filaments does not appear to be a constant feature since many adult plants were devoid of them. Probably they are formed in very robust individuals as an additional support for the erect axis. Cells of the branches are 10–22μm broad and 28–55μm long. Apical cells are 10–20 (25)μm broad and 45–110μm long. Hairs are absent. In the apical cell and its most immediate derivatives, there are numerous, small, discoid to elongate parietal chromatophores (Fig. 3, 4, *C*). Careful observations have shown that, even in older

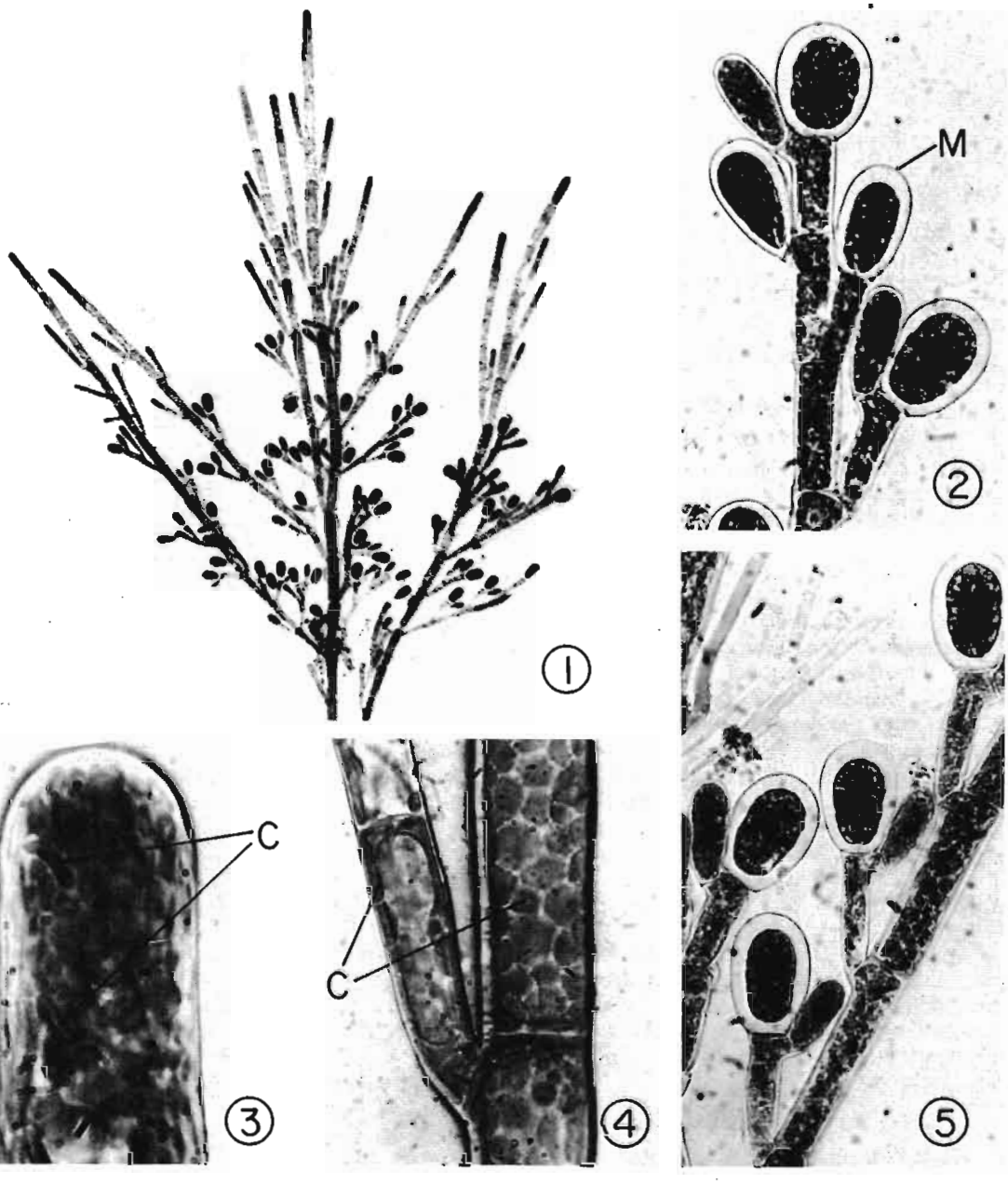

FIG. 1–5. *Rhodochorton venezuelensis* sp. nov. FIG. 1. Part of an erect filament showing mode of branching and disposition of monosporangia; ×94. FIG. 2. A branchlet showing monosporangia in different positions; ×492. FIG. 3. Apical cell showing elongate chromatophores; ×1473. FIG. 4. Part of an erect filament with a branch cell showing the numerous discoid to elongate chromatophores; ×921. FIG. 5. Monosporangia in unilateral series; ×500. Figures 3 and 4 are photographs of living material.

cells where plastids are very closely packed, the limit of each plastid may be clearly seen. The plastids are devoid of pyrenoids. Observations on plastid morphology were based on living material. Primary pit-connections between sister cells are prominent (Fig. 8, *P*).

Monosporangia were the only reproductive structures in the material examined. These are oval-ovate in shape, borne on one to many celled laterals on the branches and branchlets. Rarely, they are also rounded, sessile (Fig. 2) or in small secund series (Fig. 5). Monosporangia are 17–23 μm broad and 30–40 μm long. Monospores are 14–16 μm broad and 23–30 μm long.

The above observations were based on field collected material. The complete life-cycle has not been observed under controlled laboratory culture.

Diagnosis

Rhodochorton venezuelensis D'Lacoste *et* Ganesan sp. nov.

Plantae heterotrichae, ad 4 mm altae. Portio basalis constat cellulis variis formis. Filamenta erecta in ramis alternis et oppositis, 17–37 μm lata atque 51–110 μm longae; cellulae ramorun 10–22 μm latae atque 28–55 μm longae, atque cellulae apicales 10–20 (25) μm latae atque 45–118 μm longae; pili nulli; basis filamentorum erectorum operta multis saeptis, ramosi rhizoides deorsum crescentes 10–22 μm; monosporangia oval ovate insidentia terminaliter vel lateralieter lateralibus univel pluricellularibus in ramis atque ramusculis, raro sessilia atque unilateralis; monosporangia 17–23 μm lata atque 30–40 μm longa.

Habitat: Super parvis lapillis in rivo aquae dulcis Caño Juanico appellato, Maturin, Status Monagas, Venezuela.

HOLOTYPUS: L.G.D. 6 (1.iii.1971) depositus in "Ficoteca Venezolana", Instituto Oceanográfico, Universidad de Oriente, Cumaná, Venezuela.

ISOTYPUS: L.G.D. 7 (1.iii.1971) depositus in Herbarium, University of California, Berkeley, California, U.S.A.

Discussion

Classification proposals for genera of acrochaetioid algae are in a notable state of flux (Drew, 1928; Papenfuss, 1945, 1947; Kylin, 1956; Feldmann, 1962; Woelkerling, 1971), and it is outside the scope of the present paper to deal elaborately with these papers. The Venezuelan plants are considered by us as a *Rhodochorton* species mainly by the presence of numerous small discoid to elongate chromatophores in each cell. In doing so, we have followed the circumscription proposed by Papenfuss (1945, 1947) and Kylin (1956), which is also used in floristic treatises (Taylor, 1957, 1960).

Rhodochorton is distinguished from the 2 closely related genera *Audouinella* and *Acrochaetium* essentially by plastid morphology. *Acrochaetium* has 1–3 parietal plate-like or lobed chromatophores usually with pyrenoids, while *Audouinella* has 1 to few chromatophores in the form of irregular spiral bands lacking pyrenoids. However, after a monographic study of acrochaetioid algae of South Australia, Woelkerling (1971) considers that plastid shape and number are unreliable for distinguishing genera and that pyrenoids may be found to have generic significance. Woelkerling recognizes only 2 genera, *Audouinella* (including *Rhodochorton, Acrochaetium, Balbiania, Chromastrum,* and *Grania*) for species with sexual reproduction and *Colaconema* for species unknown in the sexual state. In our opinion, Woelkerling's proposal of reducing *Rhodochorton* under *Audouinella* is somewhat questionable for the following reason. It appears that the author himself did not examine plastids in living material of *R. purpureum,* the type species of *Rhodochorton.* His conclusion that the number of chloroplasts per cell and their shape vary in *R. purpureum* is based on the observations of Kuckuck (1897) and Drew (1928), who evidently examined preserved material. It has been shown by West (1968) that true plastid morphology of genera belonging to the Acrochaetiaceae is distinct only in living plants and once treated with standard fixatives their shape is obscured unless individual plastids are widely separated. It is also interesting to point out here that Drew (1928) indicated a single lobed or reticulate parietal plastid in *R. concrescens.* However, basing his observations on living material of the same species, West (1970*a*) demonstrated that there are numerous parietal, discoid to elongate plastids, which are most obvious in the apical cells and its derivatives. He also showed that in specimens of the cultured clone treated with standard alcohol or formalin fixatives the chloroplasts lose their identity and appear very much like a single parietal plastid.

The family Acrochaetiaceae is represented in freshwaters by 3 species of *Acrochaetium* (Raikwar, 1962; Patel, 1970; Khan, 1970),

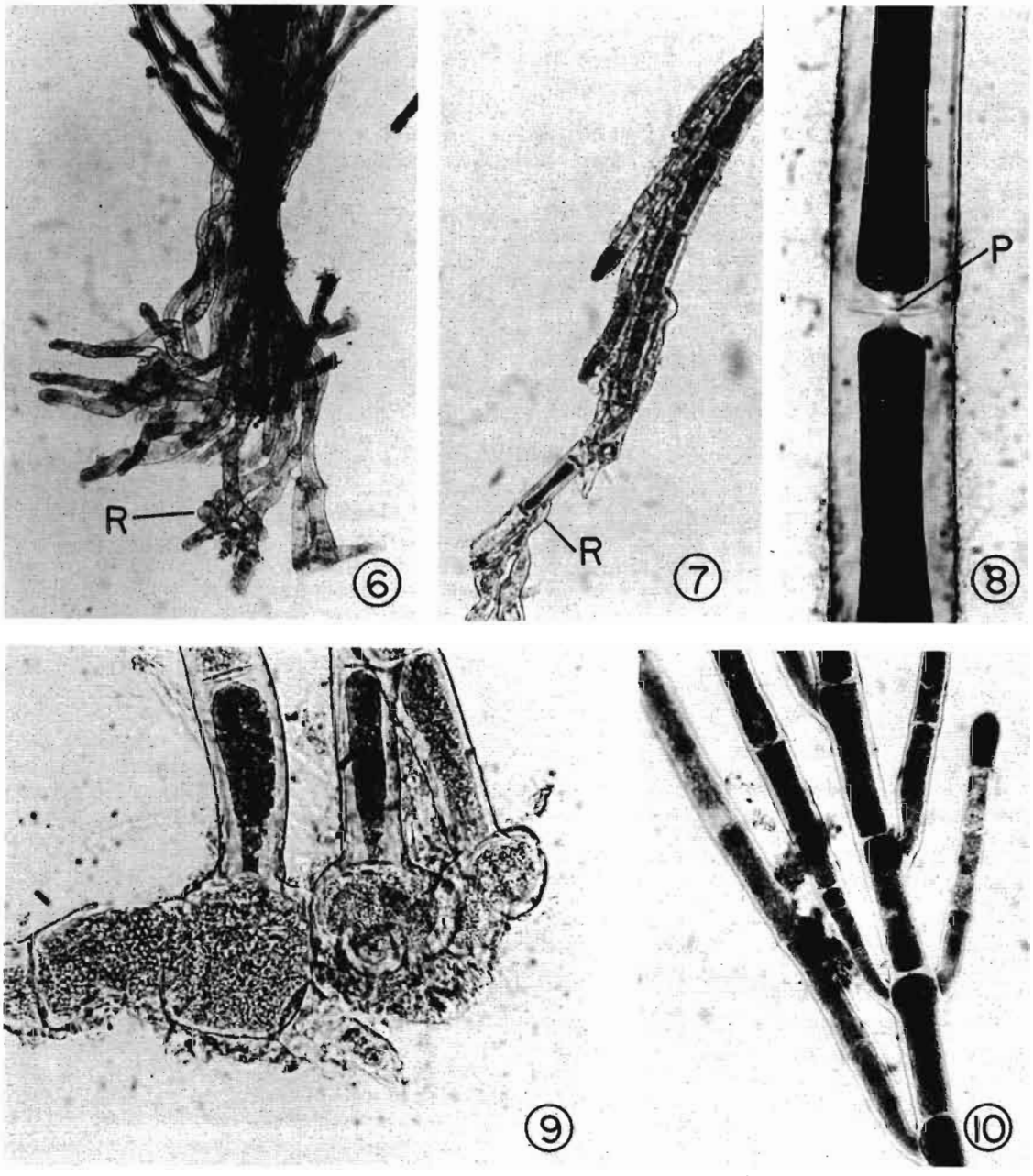

FIG. 6–10. *Rhodochorton venezuelensis* sp. nov. FIG. 6. Basal portion of an adult erect filament covered by abundant rhizoids (*R*); ×263. FIG. 7. Basal portion of an adult erect fllament showing origin of the rhizoids (*R*) from lower part of cells; ×186. FIG. 8. Two vegetative cells showing a pit-connection (*P*) between them; ×775. FIG. 9. Part of a basal system with three young erect filaments; ×515. FIG. 10. Part of an erect filament showing alternate and opposite branching; ×360.

5 species of *Audouinella* (Kylin, 1956) and only one species of *Rhodochorton* (Swale and Belcher, 1963). *Rhodochorton purpureum,* generally a marine species, is also known to occur in fresh waters and in high level pools receiving both saline and fresh waters (Knaggs, 1967). The Venezuelan material is sufficiently different from both *R. purpureum* and *R. investiens* in the following features to be described as a new species, *R. venezuelensis* D'Lacoste and Ganesan *sp. nov.*

1) *Rhodochorton purpureum* is recorded so far in all but tropical latitudes (Knaggs, 1967; West, 1969). In his review of the world distribution and ecology of *R. purpureum,* Knaggs (1967) showed that in the southern hemisphere all the known records of *R. purpureum* with the exception of Tristan da Cunha lie to the south of latitude 45°. Hence, it appears that *R. purpureum* and *R. venezuelensis* are very different in geographical distribution as well as habitat.

2) Throughout its range, *R. purpureum* reproduces generally by tetraspores. Sexual reproduction under laboratory conditions has also been established for this species (West, 1969). *Rhodochorton venezuelensis* reproduces solely by monospores.

3) Cells of filaments of *R. investiens* are 30–90 μm long and 3–5 μm broad, while in *R. venezuelensis* they are 50–110 μm long and 17–36 μm broad.

4) In *R. investiens* there is a single parietal, band-shaped chromatophore, which usually forms a loose, irregular spiral, occupying only about half the space in the cell (Swale and Belcher, 1963, p. 283, fig. 3). In *R. venezuelensis* there are numerous small discoid to elongate chromatophores (Fig. 3, 4, *C*), which occupy almost the entire cell cavity. Plastid morphology in both these species is based on observations in living material.

5) Monospores of *R. investiens* are 16–18 μm long and 7–9 μm broad, while in *R. venezuelensis* monospores are 23–30 μm long and 14–16 μm broad. Sexual reproduction is also known in *R. investiens* (Swale and Belcher, 1963), while *R. venezuelensis* reproduces only by monospores.

It should also be mentioned here that there is some question as to the placement of *R. investiens* under the genus *Rhodochorton* (West, 1969, p. 17), since post-fertilization in *R. investiens* (Swale and Belcher, 1963) and the marine *R. purpureum* (West, 1969) are strikingly different. *Rhodochorton investiens* has a carposporophyte, which produces free carpospores. These carpospores give rise to tetrasporophytes, which are similar in vegetative morphology to the gametophytes. In *R. purpureum,* a typical carposporophyte is lacking and the tetrasporophyte develops from the gonimoblast cells. Sexual plants of *R. venezuelensis* are unknown. Since a freshwater species of *Rhodochorton* with a chromatophore morphology very similar to the marine species (*e.g. R. concrescens,* West, 1970*a*) is described here for the first time, the inclusion of *R. investiens* with its single parietal chromatophore in the form of an irregular spiral band under *Rhodochorton* appears to us somewhat questionable. *Rhodochorton investiens* may be better placed under *Audouinella,* as already suggested by Kylin (1956, p. 87).

Attention should also be drawn to the fact that during their life-cycles genera like *Batrochospermum, Lemanea,* and *Sirodotia* sometimes pass through a *Chantransia* stage with an acrochaetioid morphology (Israelson, 1942). Since there is little similarity either reproductively or vegetatively and no other red alga was observed in the river where *R. venezuelensis* was collected, we consider our plants an independent species.

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Resumen

Se describe una nueva especie dulciacuicola de *Rhodochorton, R. venezuelensis* (Nemaliales, Rhodophyta), del Oriente de Venezuela. Las plantas, heterotricas, alcanzan hasta 4 mm de altura. La porción

basal de los filamentos erectos puede o no estar cubierta por rizoides decurrentes, septados y ramificados. Las células de los filamentos erectos contienen numerosos cromatóforos parietales, disciformes hasta alargados, sin pirenoides. Los monosporangios fueron las únicas estructuras reproductoras observadas en el material estudiado.

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