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New and interesting records of *Trentepohlia* (Trentepohliales, Chlorophyta) from French Guiana, including the description of two new species

FABIO RINDI* AND JUAN M. LÓPEZ-BAUTISTA

Department of Biological Sciences, The University of Alabama, PO Box 870345, 425 Scientific Collections Building, Tuscaloosa, AL 35487-0345, USA

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Four species of the genus *Trentepohlia* were collected from French Guiana, including two new to science. *Trentepohlia chapmanii* sp. nov. formed orange coatings on bamboo reeds and consisted of a thick and compact, pseudoparenchymatous prostrate part on which numerous thin and unbranched erect axes were borne. *Trentepohlia infestans* sp. nov. produced dark red discolorations on many concrete walls and consisted of crustose masses formed by globular or elliptical cells, from which numerous cylindrical erect axes, supporting sporangiate laterals, arose. Regeneration of sporangiate laterals on the same erect axes was frequently observed. *Trentepohlia dusenii*, a little-known species, was collected from a metal surface in a forest environment and characterized morphologically. Sporangiate laterals were first observed in this species, and the collection from French Guiana represented its first record for the Americas. *Trentepohlia diffracta* var. *colorata* was collected from tree bark in rain forest, representing the second record since the original description from Queensland.

KEY WORDS: Chlorophyta, French Guiana, New species, Subaerial algae, *Trentepohlia*, Trentepohliales

INTRODUCTION

Of all algal groups, terrestrial eukaryotic microalgae are presently among the most understudied and least known (López-Bautista *et al.* 2007). The knowledge of their taxonomy and systematics is still relatively poor, largely because the study of these organisms is made difficult by several aspects of their biology. This is especially true for terrestrial algae of tropical regions, which have not been studied as in detail as those of temperate regions. Still today, collections of microalgae in tropical environments lead frequently to the discovery of new species (e.g. Neustupa & Sejnohová 2003; Neustupa 2005; Rindi *et al.* 2006a).

Green algae of the order Trentepohliales are among the most diverse and widespread in the subaerial vegetation of tropical regions (Chapman 1984; López-Bautista *et al.* 2002). As presently circumscribed, the order includes five genera: *Cephaleuros* Kunze *ex* Fries 1832, *Phycopeltis* Millardet 1870, *Printzina* Thompson & Wujek 1992, *Stomatochroon* Palm 1934 and *Trentepohlia* Martius 1817. *Trentepohlia* is the most species rich. Members of this genus consist of uniseriate branched filaments, which in some species may be densely intertwined and produce compact, almost crustose masses. Species of *Trentepohlia* occur on tree bark, leaves and rock, and in some regions with humid climate (e.g. Singapore and western Ireland), they are well-known pests, forming orange or red discolorations on artificial surfaces. *Printzina* was proposed by Thompson & Wujek (1992) for nine species formerly belonging to *Trentepohlia*. The extent of the prostrate system relative to the erect system (well developed in *Printzina*, limited in *Trentepohlia*) and the shape of the zoosporangia (globular to reniform in *Printzina*, ovoid in *Trentepohlia*) are the two main features on which Thompson & Wujek (1992) based the separation of the two genera. The validity of this separation, however, is dubious; an examination of reliable descriptions of many species shows that a complete range of intermediate forms exists between the typical *Printzina* and *Trentepohlia*, and no clear-cut delimitation can be traced. It is also contradictory that, for a genus in which the prostrate system is well developed and distinct from the erect parts, Thompson & Wujek designated as generitype *Printzina lagenifera* (Hildebrand) Thompson & Wujek, a species in which there is no clear distinction between erect and prostrate parts (Printz 1939; Nakano & Handa 1984; Rindi & Guiry 2002). Furthermore, recent SSU rRNA gene analyses have not supported the separation of *Printzina* from *Trentepohlia* (López-Bautista *et al.* 2006).

The information available on the terrestrial algal flora of French Guiana is scant and limited to a few fragmentary remarks reported as part of more general contributions (e.g. Montagne 1850; Hariot 1889, 1890; Sarthou *et al.* 1995). We visited this region during two recent field trips in the course of which large collections of Trentepohliales were made. These surveys led to the collection of not less than 28 trentepohliacean taxa. A detailed account of their diversity and distribution will be presented separately; here we report on some of the most interesting records obtained, and we describe two new species. Because of the extensive development of the prostrate parts, the morphology of these algae agrees with *Printzina* as described by Thompson & Wujek (1992). However, in consideration of the dubious

* Corresponding author (frindi@bama.ua.edu)

taxonomic validity of *Printzina*, as discussed above, we consider preferable to describe them as species of *Trentepohlia*.

MATERIAL AND METHODS

Collections were made during two field trips (15–23 July 2005 and 18 June–1 July 2006); details of sampling dates and locations are reported separately for the three taxa described. The algae were visually recognized as orange, red or green patches growing on different surfaces. Samples were collected by removing the algae from the substratum with a sharp knife; the material was kept dry in sealable plastic bags until examination in the laboratory. When conserved in this way, trentepohliacean algae remain usually viable for several weeks. Although some specimens were beginning to show signs of damage (i.e. carotenoid pigment tending to concentrate in few, large drops), at the time of microscopic examination the material was generally still in good condition, and the characters considered taxonomically significant were not affected by the time spent in transit. Microphotographs were taken with an Olympus BX51 microscope equipped with DIC and a QColor 3 digital camera and mounted in plates using Adobe Photoshop CS2. Voucher specimens were deposited in US, GALW, PC, and UNA.

RESULTS AND DISCUSSION

Trentepohlia diffracta var. *colorata* A.B. Cribb

This alga was recorded from a single site, the bark of an unidentified tree in primary rain forest near the Floramazone Lodge (4°33.578′N; 52°12.459′W), on the Montagne de Kaw (collections were made on 21 and 30 June 2006). It formed a dense, bright orange fur on the bark of the tree.

The alga consisted of limited prostrate filaments on which well-developed erect axes, unbranched or little branched, up to 700 μm tall, were borne (Fig. 1). When pressed under a coverslip for microscopic examination, the erect axes were easily fragmented. The cells were cylindrical or slightly inflated, 11–15 μm wide (mainly 13–14), 1–1.5 times as long as wide (Figs 2–4). Apical cells were short, blunt and devoid of pectic caps. The cell wall was thick (2.5–3 μm), and in the older parts of the thallus it had a marked brown-orange colour. Plasmodesmata between adjacent cells were clearly visible throughout the thallus (Fig. 3). When present, lateral branches were borne on the top corner of axial cells; young branches arising from the central part of the cell, however, were also observed.

Presumptive gametangia were rare and were the only reproductive structures observed. They occurred in apical position on the erect axes and were globular, 18 μm in diameter, with the ostiole occurring at the top (Fig. 5).

The collection obtained in this study represents the second record of this taxon since the original description by Cribb (1968), based on material collected on Mount Hobwee, Queensland, Australia. The specimens from French Guiana are in very good agreement with the description and the illustrations of Cribb (1968), in particular for the two characters on the basis of which he erected the new variety: the brown colour of the cell wall and the width of the cells (lower than in the typical variety of *T. diffracta*, in which they are mostly 17.5–21.5 μm wide; Cribb 1968). The type of habitat, bark of tree in rain forest, is also the same as described by Cribb (1968). The present record suggests that the geographical distribution of this alga is much wider than was known so far. Its association with rainforest habitats has probably made it difficult to access and collect, and it is likely that careful searches in this type of environments will reveal a much larger distribution in tropical regions.

Trentepohlia chapmanii Rindi *et* López-Bautista, *sp. nov.*

DIAGNOSIS: *Alga crustosa, stratum tenue luteum formans. Thallus heterotrichus. Pars decumbens diffusa, pseudoparenchimatica, 10–50 μm crassa, multiplicibus stratis cellularum formata. Filamenti erecti e parte decumbente nascentes, 50–200 μm alti. Cellulae partis decumbentis ellipticae vel globosae, 7–10 μm latae; cellulae erectorum filamentorum cilindricae, 3.5–6 μm latae. Zoosporangia globosa, 10–15 μm lata, in apice breviorum erectorum filamentorum genita. Gametangia globosa, 10–12 μm lata, lateralia vel apicalia in erectis filamentis.*

Crustose alga, producing a thin orange layer. Thallus heterotrichous. Prostrate part spreading, pseudoparenchymatous, 10–50 μm thick, consisting of several layers of cells. Erect filaments arising from the prostrate parts, 50–200 μm tall. Cells of the prostrate part elliptic or globular, 7–10 μm wide; cells of the erect filaments cylindrical, 3.5–6 μm wide. Zoosporangia globular, 10–15 μm wide, produced at the apex of shorter erect filaments. Gametangia globular, 10–12 μm wide, lateral or apical on erect filaments.

HOLOTYPE: US. Material forming a thin orange crust on bamboo reeds facing sea, 10–15 m from shoreline, collected by Fabio Rindi at Fort Diamant, area of Rémire-Montjoly, French Guiana, on 25 June 2006.

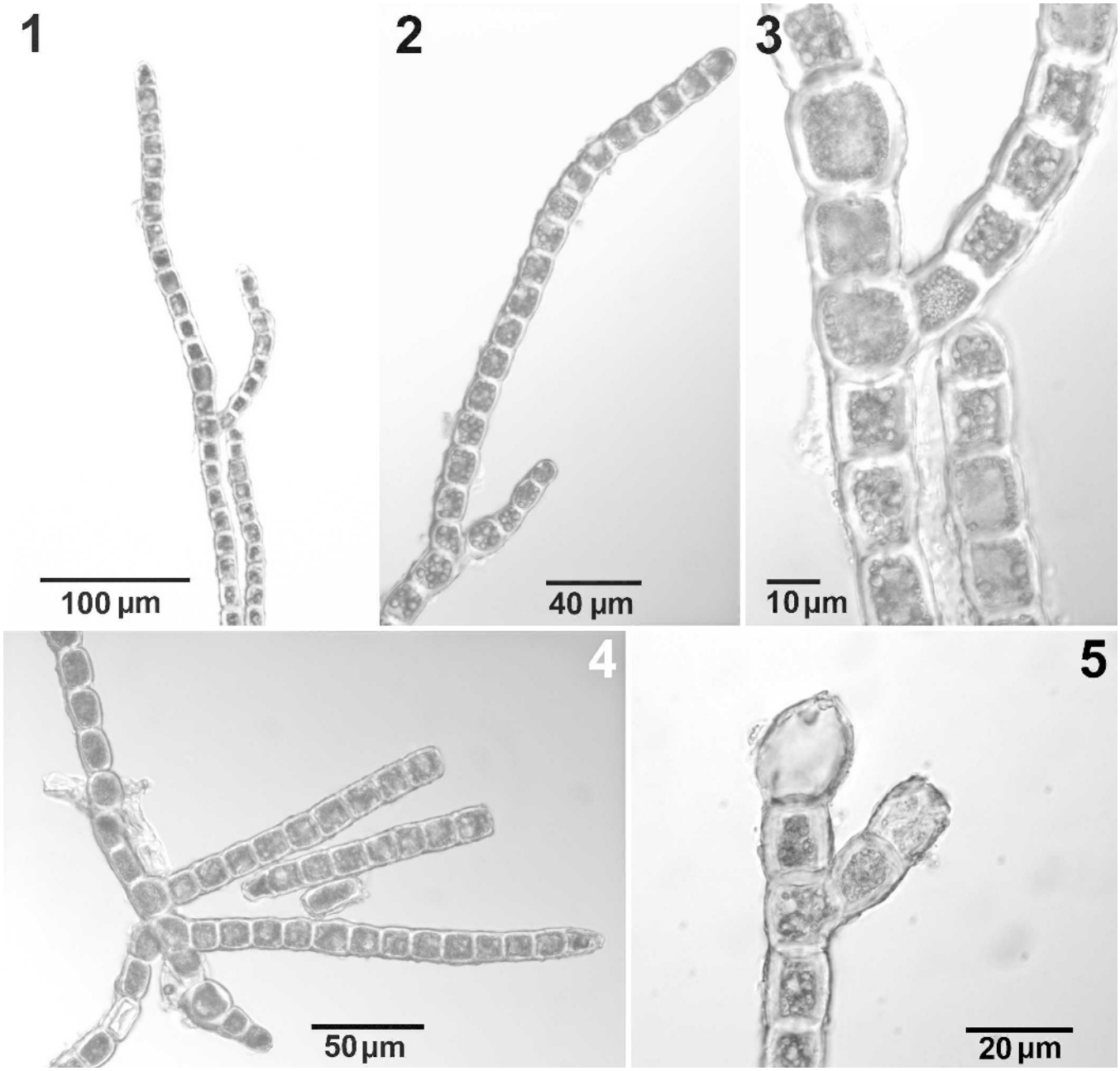
Isotype specimens deposited in GALW and PC.

TYPE LOCALITY: Fort Diamant (4°52.25′N; W 52°14.855′W), area of Rémire-Montjoly, French Guiana.

ETYMOLOGY: The specific epithet honours our friend and colleague Prof. Russell L. Chapman, in recognition of the outstanding contribution to the knowledge of the Trentepohliales that he has provided in many years of work.

This alga was collected on two separate occasions (21 July 2005 and 25 June 2006) from a dense bush of bamboo reeds, 10–15 m from shoreline, at Fort Diamant, in the area of Rémire-Montjoly. *Trentepohlia chapmanii* produced a thin orange layer, strictly adherent to the surface of the reeds. Apart for this population, no other specimens referable with certainty to this species were found in the course of the two surveys.

The thallus consisted of two distinct portions: a thick and compact prostrate part and an erect part formed by numerous thin, unbranched erect axes, producing a dense cover in surface view (Figs 6–9). The material collected was formed by many individual closely adhering thalli, and no



Figs 1–5. *Trentepohlia diffracta* var. *colorata* (GALW15562).
Fig. 1. An erect axis.
Fig. 2. Apical part of an erect axis.
Fig. 3. Detail of cells in erect axes; note plasmodesmata between adjacent cells.
Fig. 4. Detail of branching.
Fig. 5. Detail of presumptive gametangium.

juvenile specimens could be observed. Individual thalli appeared to consist primarily of a basal layer of cells with irregular shape that produced a spreading growth on the surface of the reeds colonized. Such basal layer was best observed by examining the thallus in underneath view; the cells were irregular in shape, usually polygonal (Figs 10, 11), 3–10 µm wide. No distinct individual filaments were recognizable, and the overall morphology of the basal layer was reminiscent of some species of *Phycopeltis* with irregular organization, in particular *Phycopeltis kosteriana* Cribb and *Phycopeltis irregularis* (Schmidle) Wille. Cell divisions taking place on the dorsal side of the basal layer produced the thick, pseudoparenchymatous prostrate part of the thallus, which had a very irregular organization and consisted of many densely intertwined filaments. This part was up to 50 µm thick (Fig. 6); its cells were elliptical, globular or barrel-shaped, 7–10 µm wide (Fig. 9). The erect axes arose from the superficial portion of the prostrate part (Fig. 9); they were up to 200 µm tall (Figs 6–8), mostly unbranched. The cells of the erect axes were cylindrical,

3.5–6 μm wide and 3–8 times as long as wide (Fig. 8). Apical cells were usually longer, slightly pointed, and were provided with a small pectic cap (Fig. 8). At strong magnification, very tiny spiral corrugations were observed on the cell walls of the erect axes.

Sporangiate laterals were the most common reproductive structures. They occurred at the top of short erect axes, usually 2–3 cells long, and consisted of a flask-shaped suffultory cell, 10–16 μm wide, supporting a globular zoosporangium, 10–15 μm in diameter (Figs 12–14). The neck of the suffultory cell was straight (Figs 12, 13) or slightly curved (Fig. 14). The position of the ostiole in the zoosporangium could not be observed. Gametangia were observed less frequently. They were globular or ovoid, 10–12 μm in diameter; they occurred in apical or lateral position on the erect axes (Fig. 15).

This alga is characterized by a combination of features that is not found in any other species of Trentepohliales currently known. In particular, the presence of numerous thin, cylindrical erect axes arising from a thick, pseudoparenchymatous prostrate part has never been reported for any member of this order. The separation between an erect and a prostrate system is the main morphological feature that Thompson & Wujek (1992) used to erect the genus *Printzina*. However, for all 11 taxa included by these authors in the genus, the original descriptions and other reliable records indicate that the prostrate part consists of a mixture of creeping axes adhering to the substratum, not producing a thick pseudoparenchymatous layer (Hildebrand 1861; De Wildeman 1888a, b, 1891; Wittrock & Nordstedt 1893; De Wildeman 1900; Printz 1920, 1939, 1964; Tiffany 1936; Cribb 1968; Thompson & Wujek 1992). Some species of *Trentepohlia* produce masses of globular cells, with almost pseudoparenchymatous structure; in these, however, erect axes clearly protruding from the thallus do not occur (see further details in discussion for *Trentepohlia infestans*). In underneath surface view, the basal layer of the thallus of *T. chapmanii* shows a habit similar to *P. kosteriana* Cribb and *P. irregularis* (Schmidle) Wille. Thalli of *P. kosteriana* consist of small discs up to 250 μm in diameter, produced by appressed radiating filaments with irregularly alternate branching; the cells are very irregular in shape, usually 1, 2 or 3-forked, (1.5) 2–3 (3.5) × (5) 7–12 (15) μm in size, more slender near the apices (Cribb 1967). Their habit is similar to the basal cells of *T. chapmanii* in habit and size; however, the thallus of *P. kosteriana* is entirely prostrate and does not produce tridimensional masses or erect axes (Cribb 1967). *Phycopeltis irregularis* is a very variable species, the habit of which can vary from a loose network of sparsely branched filaments to closed discs in which the cells are irregularly arranged (Printz 1939). In compact forms, the cells may show an irregular shape, similar to *T. chapmanii*; however, the production of a tridimensional pseudoparenchymatous portion has never been reported in *P. irregularis*.

Trentepohlia dusenii **Hariot**

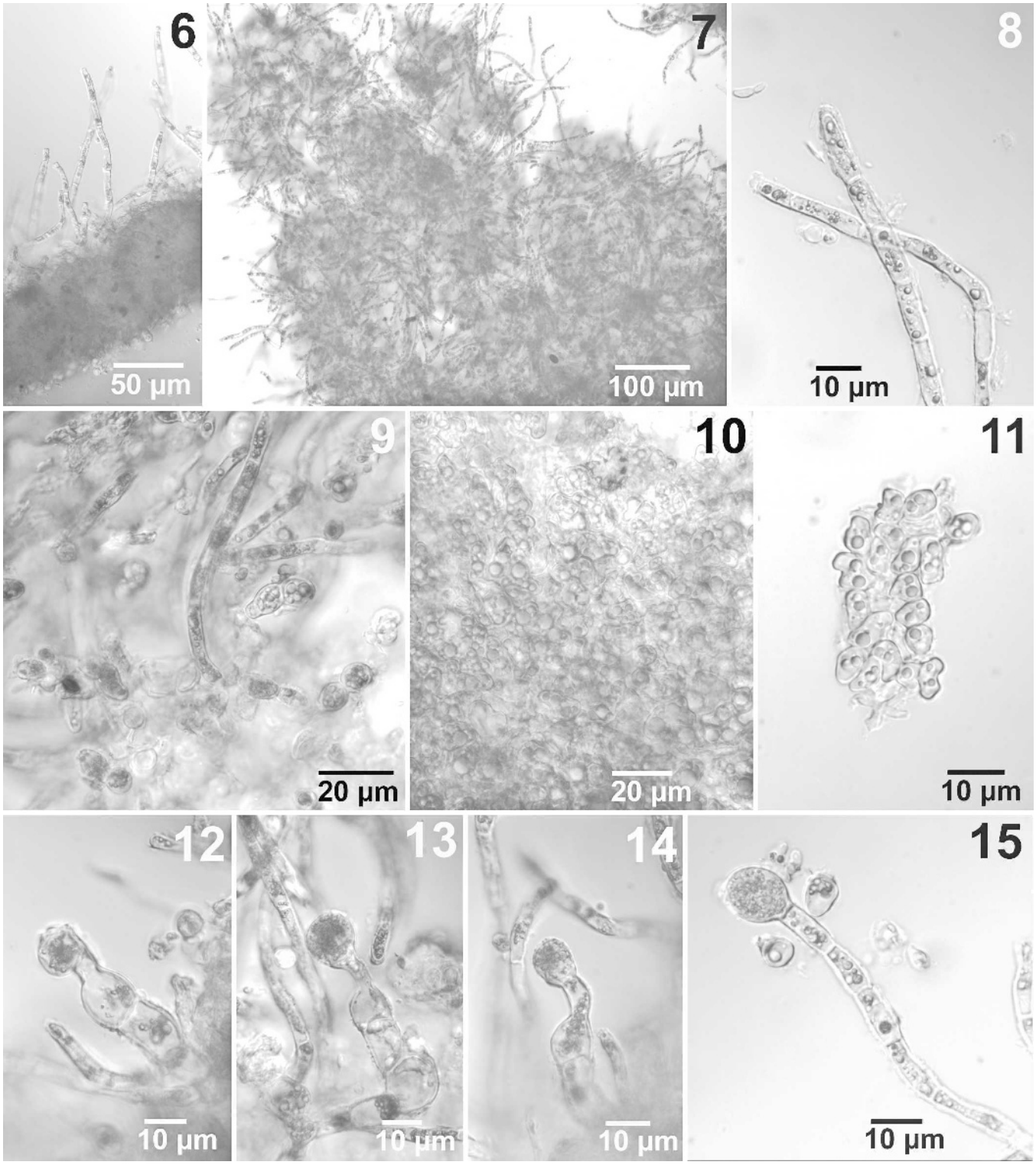
This alga was collected from metal and plastic parts of a post located in a shaded site near a stream, in the forest of Mont Rorota (4°53.724′N; 52°15.580′W), Montagne de Mahury, on 25 June 2006. It formed a dense grass-green mat, easily peeled from the substratum, covering a large portion of one of the metal poles holding the post. No other collections of this species were made.

The thallus was distinctly separated into a prostrate part and an erect part. The prostrate part consisted of a thick spongy layer formed by a system of creeping axes, densely branched and intricated. The cells varied in shape from cylindrical to globular or elliptical and were 6–9 μm wide. The erect part consisted of erect axes little or not branched, up to 350 μm tall (Fig. 16), sometimes joined in groups to form small bushes. Their cells were cylindrical, sometimes slightly enlarged or barrel-shaped, 1–4 times as long as wide (mainly 1.5) (Figs 17, 18). In the mats formed by the alga, erect axes of slightly different size were often noted. The thinner axes, corresponding to the gametophyte generation, were 4.5–7.5 μm wide (mainly 5.5–6); thicker axes, corresponding to the presumptive sporophyte generation, were 7–8.5 μm wide (mainly 7.5–8). The apical cells varied in shape from slightly pointed and bullet-shaped to blunt; no pectic caps were observed. Chloroplasts were well observable; one or a few parietal chloroplasts with lobed shape were present in each cell. In this alga, the carotenoid pigments occurred in very limited amounts (usually only one or two small droplets in each cell), and the colour of the thallus was bright green.

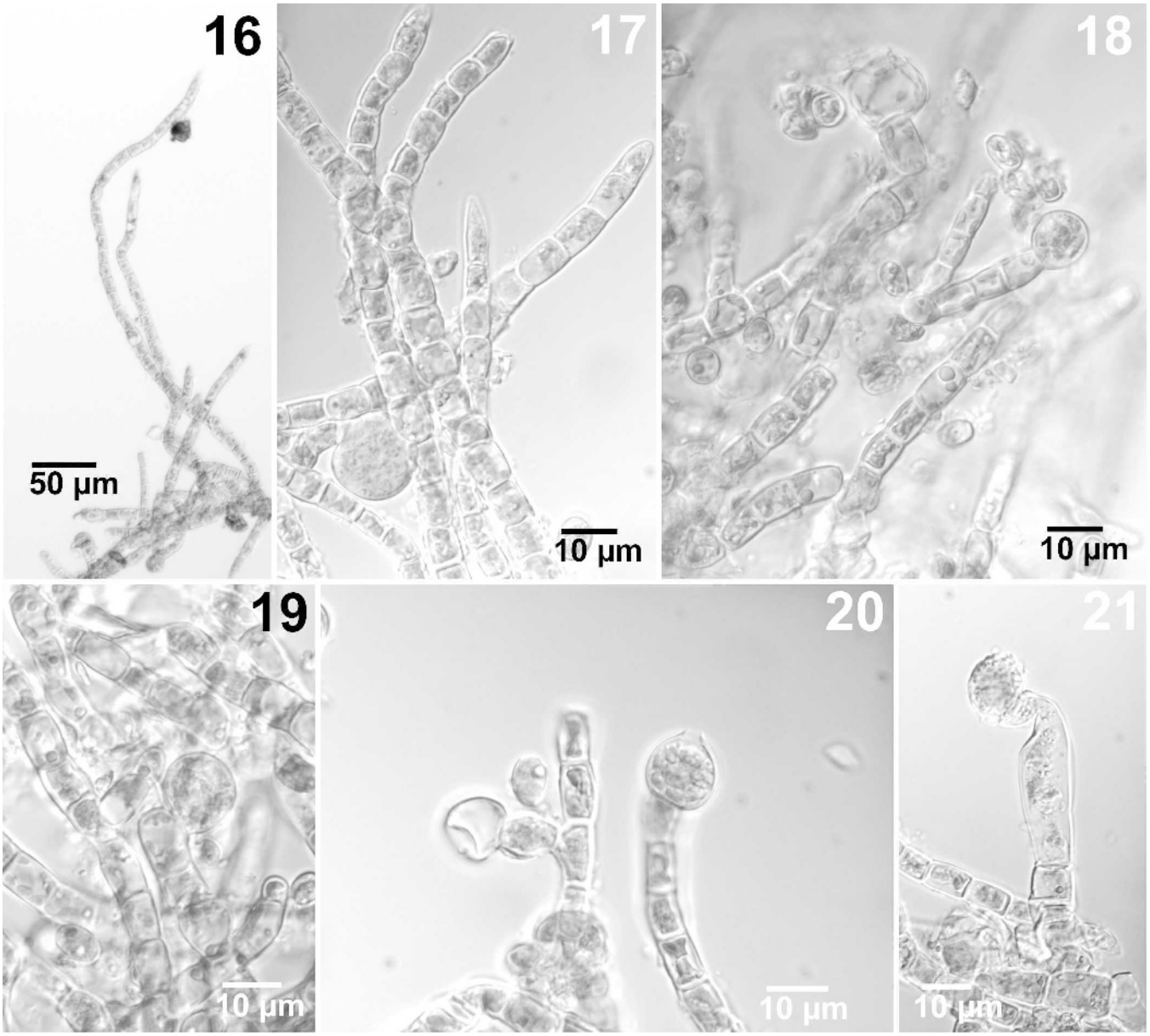
Presumptive gametangia were the most common reproductive structures. They were borne on the erect axes, in apical, lateral or intercalary position (Figs 17–20). At maturity, they were globular or ovoid, 10–15 μm in diameter; in some gametangia, the ostiole occurred at the top of a short beak (Fig. 20). Sporangiate laterals were infrequent; they were produced singly at the top of the erect axes (Fig. 21). The suffultory cell was long, only slightly enlarged, with a neck bent at approximately a 90-degree angle. The zoosporangium was elliptical, 10–13 × 14–16 μm in size; the escape pore was adjacent to the connection between zoosporangium and suffultory cell.

This species was described by Hariot in Wittrock & Nordstedt (1893, p. 193) for material collected by P. Dusén from tree leaves near Bonge, Cameroon. Thompson & Wujek (1992) transferred it to *Printzina*; the new combination, however, was invalid because Thompson & Wujek (1992) failed to cite the correct reference for the publication of the basionym.

Trentepohlia dusenii is one of the least-known species of the genus. Its morphological characterization has been difficult mainly because no illustrations were supplied with the original description. Because of the scarcity of descriptions and illustrations available in the literature, in order to confirm the identification of our material, we examined an authentic specimen that was part of the original collection used by Hariot for the description of the species. The specimen PC0110846 (marked as syntype) consists of several fragments of leaves on which *T. dusenii* produced green mats covering several cm^2. The thallus consisted of a compact basal layer, easily peeled from the surface of the leaves, from which numerous erect axes arose. The basal layer was formed by numerous prostrate axes, densely intricated and branched. Size and shape of the cells were identical to those of the material from our collection. Gametangia occurred at the top of some erect axes and



Figs 6–15. *Trentepohlia chapmanii* (GALW15561 – syntype specimen).
Fig. 6. View of thallus in cross section.
Fig. 7. Thallus in surface view.
Fig. 8. Detail of apical part of erect axes.
Fig. 9. Detail of surface of thallus, showing erect axes borne on globular cells of the prostrate part.
Fig. 10. Detail of thallus in underneath view, showing the basal layer.
Fig. 11. Fragment of the basal layer, showing detail of cells.
Figs 12–14. Detail of sporangiate laterals.
Fig. 15. A presumptive gametangium.



Figs 16–21. *Trentepohlia dusenii* (GALW15563).
Fig. 16. Detail of some erect axes.
Fig. 17. Detail of cells in erect axes.
Fig. 18. Thallus in surface view, showing with some presumptive gametangia.
Fig. 19. Detail of a presumptive gametangium borne laterally.
Fig. 20. Presumptive gametangia borne in apical position.
Fig. 21. Detail of sporangiate lateral.

were more or less globular, 10–15 µm in diameter. The only noticeable difference between this specimen and our collection from French Guiana was the more robust development of the prostrate part in our material, in which a thick spongy layer of globular cells was produced (not or scarcely visible in the authentic specimen). Otherwise, the morphological correspondence between the two samples is excellent, and we have no hesitation to refer our material from French Guiana to *T. dusenii*.

The unusual colour of this species – bright, grass-green, instead of the yellow, orange or red typical of *Trentepohlia* – makes it prone to be overlooked and confused with mosses or other terrestrial green algae. We suspect that this is the main reason why, after the original description, *T. dusenii* has rarely been recorded. Springbrook, Queensland, Australia (Cribb 1963), and Calcutta, India (Jose & Chowdary 1980, citing the unpublished PhD thesis of Chowdary), are the only other localities for which this species has been reported; our collection from French Guiana represents the first record for the Americas. Since gametangia were the only reproductive structures reported for all previous collections, our material has also provided the first documented collection of sporangiate laterals for this species.

Trentepohlia infestans* Rindi *et* López-Bautista, *sp. nov.

DIAGNOSIS: *Alga crustosa, maculas rubras ad muros formans. Pars decumbens crustosa, pseudoparenchimatica, multiplicibus mixtis filamentis formata. Filamenti erecti breves, 3–6 cellulis formatis, 50–200 μm alti. Cellulae partis decumbentis ellipticae vel globosae, 10–13 μm latae; cellulae erectorum filamentorum cilindricae, 7–12.5 μm latae. Zoosporangia globosa, 15–22 μm lata, in apice erectorum filamentorum genita. Gametangia non visa.*

Crustose alga, forming red patches on walls. Prostrate part crustose, pseudoparenchymatous, formed by many mixed filaments. Erect axes short, consisting of 3–6 cells, 50–200 μm tall. Cells of the prostrate part elliptical or globular, 10–13 μm wide; cells of the erect axes cylindrical, 7–12.5 μm wide. Zoosporangia globular, 15–22 μm wide, produced at the top of the erect axes. Gametangia not observed.

HOLOTYPE SPECIMEN: US. Material forming dark red patches at the base of a painted concrete wall, near external fan of air-conditioning system on the back of building; collected by Fabio Rindi in the Zone Industrielle, Collery Marengo, French Guiana, on 21 June 2006.

Isotype specimen deposited in GALW.

TYPE LOCALITY: Zone Industrielle, Collery Marengo, French Guiana (4°53.944′N, 52°19.634′W)

ETYMOLOGY: The specific epithet (*infestans* = infesting, pest-like) refers to the extensive red discolorations formed by this species on walls of buildings in French Guiana, as observed at the time of the survey.

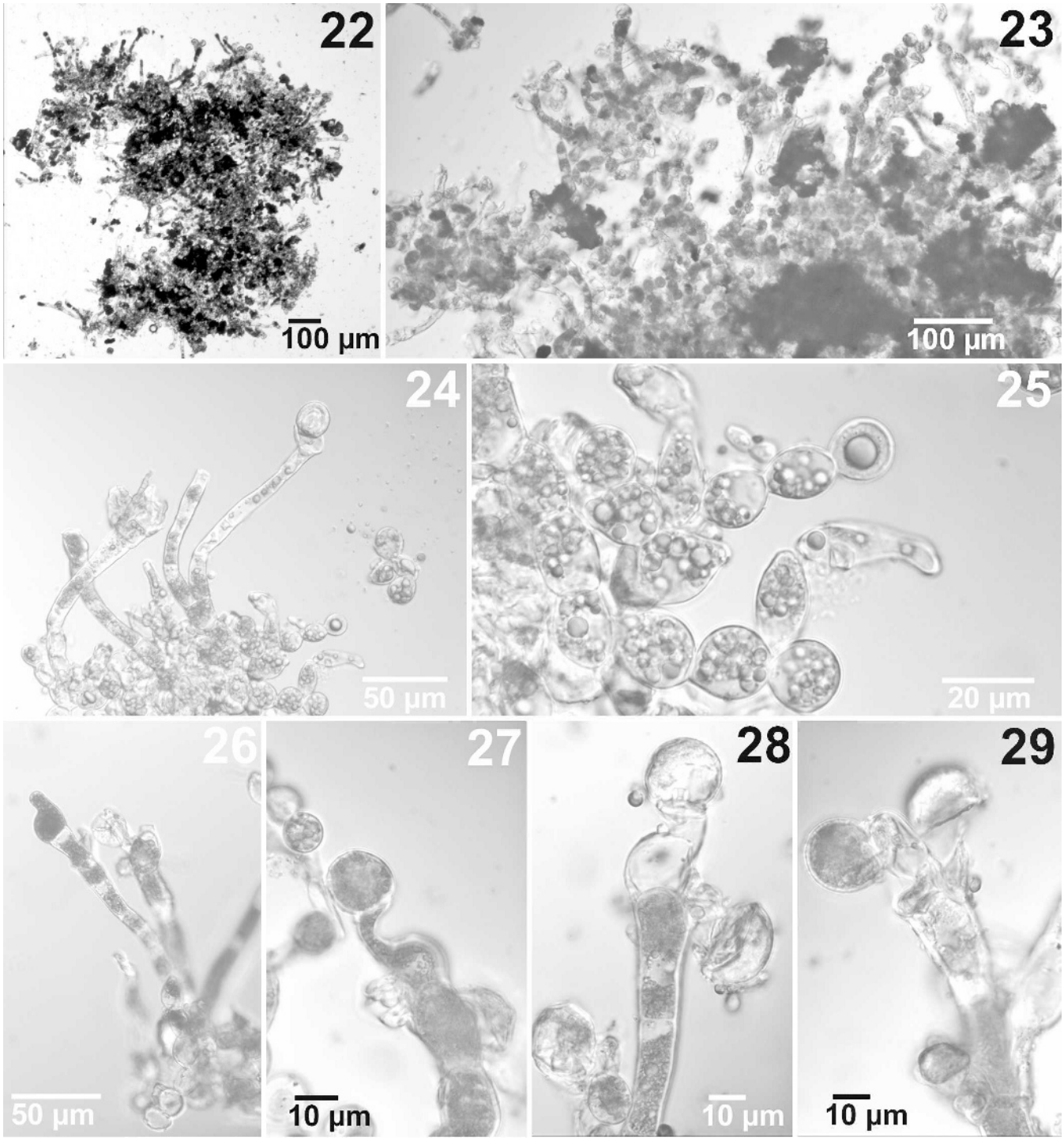
At the time of the survey *T. infestans* appeared to be common in Cayenne and surrounding areas, where it produced large populations on concrete walls. Recently established populations produced dark red streaks with the habit of appearing as more or less vertical stripes; in older populations that formed extensive growths, the alga often resembled a uniform layer of red paint. The red streaks produced by this species are easily observable and recognizable from a long distance. Although samples could be collected only from a relatively limited number of sites, it is likely that similar red growths observed on other walls were also produced by this species.

The thallus consisted primarily of a crustose, prostrate part, from which erect axes, unbranched or little-branched, arose (Figs 22, 23). The prostrate part was formed by many individual filaments, densely entangled to produce an almost pseudoparenchymatous mass. The cells of the prostrate part were globular, elliptical or barrel-shaped, 10–13 μm wide (Figs 24, 25). The erect axes arose in large numbers from the surface of the prostrate part. They were short (up to 200 μm tall, formed by 3–5 cells), unbranched or, less frequently, branched at the base (Fig. 24). The cells of the erect axes were cylindrical, 7–12.5 μm wide (mostly 8–10), 2–5 times as long as broad.

At maturity, most erect axes supported sporangiate laterals. The sporangiate laterals occurred at the top of the axes and consisted of a globular zoosporangium, 15–22 μm in diameter, borne on a more or less enlarged suffultory cell, 15–20 μm wide (Figs 26–29). In new sporangiate laterals, the neck of the suffultory cell was comparatively thin, variably bent and arose excentrically from the body of the suffultory cell (Fig. 27). Regeneration of a sporangiate lateral on the same erect axis was observed frequently. In some cases, this happened without shedding of the zoosporangium. The suffultory cell dried and got bleached without releasing the zoosporangium, and the apical cell of the erect axis produced a new sporangiate lateral, which displaced laterally the original (Figs 28, 29).

Gametangia were not observed.

The combination of a crustose prostrate part formed by globular cells, short erect axes formed by cylindrical cells and regeneration of sporangiate laterals on the same erect axes differentiates this alga from other similar species. *Trentepohlia umbrina* (Kützing) Bornet is one of the most widespread species of *Trentepohlia*, and, although originally described for corticolous material (Kützing 1843, as *Chroolepus umbrinum*), it has been reported from artificial substrata (John 1988; Rindi & Guiry 2002; Rindi *et al.* 2003). Its thallus consists of compact masses of irregularly branched, easily fragmented filaments, formed by globular or swollen cells similar to those of *T. infestans* (Printz 1939; Sarma 1986; Ettl & Gärtner 1995). However, no erect parts occur in *T. umbrina*, and the zoosporangia are not borne on axes morphologically differentiated from the rest of the thallus; the width of the cells is also generally larger in *T. umbrina* (Printz 1939; Sarma 1986; Ettl & Gärtner 1995; Thompson & Wujek 1997, as *Phycopeltis umbrina* [Kützing] Thompson & Wujek). *Trentepohlia iolithus* (Linnaeus) Wallroth and *Trentepohlia odorata* (Wiggers) Wittrock have been widely reported for tropical and temperate regions around the world. These species are characterized by a relatively large range of morphological variation, and compact crust-like forms occur in both of them (Hariot 1889; De Wildeman 1900; Printz 1939; Cribb 1963; Rindi & Guiry 2002). Both *T. iolithus* and *T. odorata* have also been recorded on artificial substrata, producing growths with habit identical to *T. infestans* (Wee & Lee 1980; Rindi & Guiry 2002). However, for these species no marked morphological differentiation occurs between prostrate parts and erect parts. When the erect axes are well developed, they are arranged with a parallel pattern and form a dense, compact mat (Hariot 1889; Printz 1939) not produced by the erect axes of *T. infestans*. The size of the cells in *T. iolithus* and *T. odorata* and the size of the zoosporangia in *T. iolithus* are larger than in *T. infestans* (Printz 1939, 1964; Ettl & Gärtner 1995; Rindi & Guiry 2002). In these species the shape of the cells is usually barrel-shaped or slightly constricted, rather than globular or elliptical (as it is most frequently the case for *T. infestans*). *Printzina lagenifera* (Hildebrand) Thompson & Wujek is widespread in tropical and temperate regions and was collected at sites different from *T. infestans* during the second field trip. It has cells similar in shape and size to those of the prostrate parts of *T. infestans* and may also produce compact thalli. However, the absence of differentiation between prostrate and erect parts is typical of *P. lagenifera*; zoosporangia have been rarely observed in this species, and, when present, they do not occur at the top of cylindrical erect axes (Printz 1939; Nakano & Handa 1984). *Printzina lagenifera* has been long known as a very poly-



Figs 22–29. *Trentepohlia infestans* (GALW15564 – syntype specimen).
Fig. 22. Habit of thallus.
Fig. 23. Detail of fragment of thallus.
Fig. 24. Detail of some erect axes and superficial part of prostrate thallus.
Fig. 25. Detail of cells of the prostrate part.
Fig. 26. Detail of a sporangiate lateral in which the zoosporangium has not yet been divided from the suffultory cell.
Fig. 27. Detail of a mature sporangiate lateral.
Figs 28, 29. Erect axes in which regeneration of the sporangiate lateral has taken place.

morphic organism showing a considerable range of variation in colour and branching pattern (Hariot 1889; Nakano & Handa 1984; Rindi & Guiry 2002; Rindi *et al.* 2005). Some algae described from tropical localities, such as *Trentepohlia gracilis* Iyengar in Brühl & Biswas, *Trentepohlia procumbens* De Wildeman, *Trentepohlia tenuis* (Zeller) De Toni and *Trentepohlia lagenifera* var. *africana* Printz, are close to *P. lagenifera* and have been treated as synonyms or subspecific taxa of this species (Printz 1939). Although a detailed taxonomic reassessment based on a modern approach is desirable for these taxa, none of their original descriptions (Zeller 1873; De Wildeman 1891; Printz 1920; Brühl & Biswas 1923) mentions the differentiation between erect and prostrate parts and the habit of sporangiate laterals that are the most striking features of *T. infestans*.

Rindi *et al.* (2006b) collected a *Printzina* from tree bark in Zanzibar (Tanzania) for which they did not propose a species-level attribution. This alga is morphologically similar to *T. infestans* in producing a crustose mat and in the size and shape of the cells. However, the erect axes are not clearly distinct from the prostrate parts, and their cells are comparatively shorter than in *T. infestans* (usually 1–2 times as long as wide); the zoosporangium is also notably smaller (10–16 μm in diameter).

Implications of the new records for the taxonomy of the Trentepohliales

Although the Trentepohliales have attracted the attention of many phycologists for over two centuries, the information available on the diversity and taxonomy of this group has a very irregular geographical coverage and in general is much better for Europe than for the other continents. For several reasons, our knowledge of the diversity and phylogeny of this group is unsatisfactory. At present, the genus- and species-level classification in the Trentepohliales is entirely based on gross morphology. Several species, however, are very polymorphic and show considerable morphological variation linked to environmental conditions (Hariot 1889; Printz 1939; Rindi & Guiry 2002; Rindi *et al.* 2005). Although in the typical form the habit of most species is characteristic and of straightforward identification, field specimens with intermediate morphology are frequently found and often cannot be identified unambiguously. A further problem is the fact that these algae are difficult to isolate in pure cultures; even when this is possible, their growth is slow, and no zoosporangia (which are a helpful character for species-level identification) are produced. Molecular data of good quality can be produced only from material free of contaminations, which is usually not possible to obtain from field collections. As a result, the first molecular data on the Trentepohliales have been published only recently (SSU rDNA and phragmoplastin gene sequences: López-Bautista & Chapman 2003; López-Bautista *et al.* 2003, 2006) and are not yet sufficient to support morphology-based investigations. López-Bautista *et al.* (2006) showed that the morphological criteria traditionally used for the circumscription of genera and species do not match phylogenetic patterns and that a new classification focused on different characters will probably be necessary. Subcuticular habit, heteromorphic life history, arrangement of the zoosporangia and position of the ostiole in the zoosporangium seem to be the morphological features phylogenetically most important, whereas other characters commonly used for species- and genus-level discrimination (shape and size of the cells, prostrate/erect habit, substratum colonized) have no phylogenetic relevance.

In consideration of the problems mentioned above, the description of new taxa of Trentepohliales should be based on well-supported evidence, on a very careful examination of the material collected and on a scrupulous comparison with all species currently attributed to the order. The morphology of the species described here is distinctive enough to prevent any possibility of overlap with other members of the Trentepohliales. The presence of numerous thin, cylindrical erect axes arising from a thick prostrate part consisting of globular cells, the habit of the basal layer in *T. chapmanii* and the habit of the sporangiate laterals in *T. infestans* provide a combination of characters that is unique to these species. Unfortunately, despite several attempts, it has not been possible to isolate these species in culture. This has precluded the generation of molecular data that might have helped to clarify their phylogenetic position within the order. It should be noted, however, that *T. chapmanii* shows a morphology that is somewhat intermediate between typical species of *Trentepohlia* with erect thallus and *Phycopeltis*. The erect axes of *T. chapmanii*, in particular, are very similar to thin and unbranched forms of *Trentepohlia abietina* (Flotow) Hansgirg, a corticolous species common in temperate and tropical regions (Printz 1939; Sarma 1986; Rindi *et al.* 2005, 2006b), including French Guiana (Rindi, unpublished observations). The basal layer of *T. chapmanii*, as mentioned above, has a similar habit to species of *Phycopeltis* (*P. kosteriana* and *P. irregularis*). Interestingly, in the phylogeny of López-Bautista *et al.* (2006), *T. abietina* occurred in the same clade with the only species of *Phycopeltis* sequenced, *P. arundinacea* (Montagne) De Toni. *Trentepohlia chapmanii* can be expected to be closely related to these species and occur in the same group.

Finally, the discoveries of this study underpin the great value of basic investigations on the taxonomy and diversity of the Trentepohliales. Although it is generally accepted that these algae have their centre of diversity in the tropics, detailed floristic accounts of this group are available only for few tropical regions, such the area of Bogor, Java, Indonesia (De Wildeman 1891, 1900); India and Bangladesh (Brühl & Biswas 1923; Saxena 1961; Randhawa & Venkataraman 1962; Islam 1972; Jose & Chowdary 1980; Panikkar & Sindhu 1993; Krishnamurthy 2000); and Queensland, Australia (Cribb 1958, 1963, 1967, 1968, 1970). At present, the information available for other regions of the Indo-Pacific area is fragmentary, and almost nothing is known for the rain forests of the Amazonian basin and equatorial Africa. These are regions where the diversity of this order may be considerable and on which our efforts are currently focused. Collections made during two field trips (Rindi & López-Bautista 2008) and literature data have indicated that the trentepohlialean flora of French Guiana consists of not less than 29 taxa, which

represents approximately 30% of the total number of species of Trentepohliales currently recognized. Considering the limited extent of the area surveyed, this is an impressive estimate and indicates that further intensive investigations will be necessary to reveal the full extent of the taxonomic and evolutionary diversity of the Trentepohliales distributed in the tropical regions of our planet.

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