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Fast Track Article

Biodiversity of Trentepohliales (Ulvophyceae, Chlorophyta) in Gabon, Central Africa

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With 24 figures

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Abstract: The distribution and diversity of the algae of the order Trentepohliales were studied from field collections made in Gabon, central Africa. Both forest and urban environments were examined for the presence of trentepohlialean taxa. Based on these field collections fourteen taxa of *Trentepohlia* and *Printzina* were recorded: *Printzina bosseae* (De Wildeman) Thompson & Wujek, *Printzina lagenifera* (Hildebrand) Thompson & Wujek, *Printzina* sp., *Trentepohlia abietina* (Flotow) Hansgirg, *Trentepohlia abietina* var. *corrugata* (Leighton) Cribb, *Trentepohlia arborum* (C.Agardh) Hariot, *Trentepohlia aurea* (Linnaeus) Martius, *Trentepohlia chapmanii* Rindi & López-Bautista, *Trentepohlia dusenii* Hariot, *Trentepohlia* cfr. *flintii* Sarma, *Trentepohlia minima* Schmidle, *Trentepohlia peruana* (Kützing) Printz, *Trentepohlia rigidula* (J.Müller) Hariot, *Trentepohlia umbrina* (Kützing) Bornet. Among these taxa, five are reported here for the first time from Africa: *P. bosseae*, *T. abietina* var. *corrugata*, *T. chapmanii*, *T. minima* and *T. peruana.* An undescribed *Printzina* species was collected from "Les Monts de Cristal" forest for which more collections and an assessment based on molecular data are needed to assess the identity in detail. These findings suggest that microbial diversity in Africa is still grossly understudied, and future biodiversity surveys of subaerial algae may lead to the discovery of new and undescribed trentepohlialean species.

Key words: Africa, Chlorophyta, Gabon, terrestrial algae, Trentepohliales.

Introduction

The order Trentepohliales consists exclusively of terrestrial algae classified in the mainly marine class Ulvophyceae (as demonstrated by molecular studies by López-Bautista & Chapman 2003 and Cocquyt et al. 2010). Representatives of this order are widespread around the world both in temperate and tropical regions. Their abundance,

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however, is typically higher in tropical regions with humid climates. Trentepohlialean algae are usually found growing on a wide range of substrata, such as rocks, tree barks, leaves, and various man-made constructions (Chapman 1984, Ettl & Gartner 1995, Thompson & Wujek 1997, Lopez-Bautista et al. 2007, Rindi & Lopez-Bautista 2008, Rindi et al. 2008). They have also been found growing on animals such as spiders (Cribb 1964) and hair of sloths (Suutari et al. 2010). Although these organisms are green algae, they usually show different colors due to the abundance of carotenoid pigments that color the thallus in orange, red, or even yellow (Geitler 1923). This group is characterized by several unique characteristics, in particular a sporangial branch called sporangiate lateral, formed by a zoosporangium borne at the top of an enlarged cell with a bent neck, the so-called suffultory cell (see fig. 6 in López-Bautista et al. 2002: http://ucjeps.berkeley.edu/constancea/83/lopez_etal/trent_fig6.html). Previous studies dealing with Trentepohliales diversity have mainly focused on Europe and some parts of Asia (Lopez-Bautista et al. 2007). Studies for tropical regions have a very uneven coverage, and not until recently some investigators have looked at these algae in North and Central America (Rindi et al. 2008, Thompson & Wujek 1997), in South America (Akiyama 1971 and Rindi et al. 2007, 2008), and the Hawaiian Islands (Rindi et al. 2005).

Since the Trentepohliales are one of the major components of the subaerial microbial flora in tropical regions (Fritsch 1907, Islam 1960, Gaylarde et al. 2006), and considering that tropical rainforests have been shown to be centers of algal biodiversity in South America and Asia (Lopez-Bautista et al. 2007, Neustupa & Škaloud 2008, 2010, Neustupa et al. 2011, Eliáš et al. 2010, Němcová et al. 2011), the tropical rainforests of central Africa can be expected to host a high trentepohlialean diversity. Africa is the least studied continent with regard to subaerial green algae, and records of African Trentepohliales are scattered in the fragmentary literature. Some species were described by early authors based on collections from Africa (e.g., Montagne 1846, Massalongo 1861, Reinsch 1877, Wittrock & Nordstedt 1893). Since these early reports, however, there was only a single major study by Printz (1921). This author investigated subaerial algae from South Africa, reporting several *Phycopeltis* and *Trentepohlia* species with detailed morphological descriptions. More recently, other records of Trentepohliales from South Africa and neighboring countries were documented by Rindi et al. (2006), who recorded some species previously unreported in Africa. The remaining information is limited to some studies on terrestrial algae from Algeria, Congo, Morocco and South Africa, which added occasional records of *Trentepohlia* species (Hariot 1891, 1913, Gauthier-Lievre 1954, Joska & Bolton 1996) without further taxonomic or morphological details.

In the course of a recent fieldtrip to Gabon, one of us (HAA) had the opportunity to make large collections of Trentepohliales. This country is situated on the equator in the central-western region of Africa. Gabon is characterized by a hot and humid climate, and is home to a rich and diverse tropical rainforest that covers about 80% of the country's total surface area (Alonso et al. 2006). It was therefore considered a good candidate area to host a rich and diverse trentepohlialean flora. We present here the results of the survey, which led to many interesting records, some new for the whole African continent.

Materials and methods

Samples of Trentepohliales were collected in Gabon (West Africa) in late May of 2008. Extensive collections were made at "Les Monts de Cristal" National Park at the Tchimbélé site (approximately 0°35'55.4"N, 10°25'14"E). Since its establishment as a national park in 2002 (by a presidential decree) the site has been a protected area and maintains many native areas in pristine conditions. The park is covered by a dense rainforest that has not been affected by major human impacts. Other samples were collected around the capital city Libreville (approximately 0°23'53"N, 9°26'39"E). All samples were removed with a plastic scrapper from different natural and artificial substrata where yellow, orange or red patches referable to Trentepohliales were observed by unaided eye. The substrata sampled included leaves, tree bark, rocks, concrete walls, and metal poles. After the collection, the samples were air-dried, placed into sealable plastic bags, and shipped back to the laboratory at The University of Alabama for further analyses.

Upon arrival, the samples were examined using both light and dissecting microscopes. The algae contained in the samples were identified morphologically using keys and descriptions available in the literature (i.e., Hariot 1889, De Wildeman 1900, Printz 1939, Cribb 1970, Rindi & López-Bautista 2007, Rindi et al. 2008). Photographic documentation was made with a CCD Q3 Digital camera mounted on an Olympus research microscope BX51 and an Olympus dissecting scope SZX7. Voucher specimens were deposited in the herbarium of the University of Alabama (UNA).

Results

Printzina bosseae (De Wildeman) Thompson & Wujek Figs 1–3

This alga forms a greenish-orange mat on tree bark. Erect axes are up to 700 μm tall, sparingly branched. The cells are cylindrical, 14–18 μm in width, 1.5–3 times as long as wide. The cell wall is thicker and colored brownish orange in the older parts. Sporangiate laterals are common; the zoosporangia are globular, 25–30 μm in diameter, with the ostiole opposite to the attachment. As typical of this species, growth restarts from the suffultory cell after the release of the zoosporangium. The apical cells are blunt, dome-shaped, devoid of pectic caps. Gamentangia are lateral and globular in shape. After the release, the gametangia leave some saucer-shaped scars on the main axes and branches.

The alga formed a greenish-orange fur on tree bark and was collected at "Les Monts de Cristal" National Park at the Tchimbélé site on 21 May 2008. This species is reported for the first time from Africa.

Printzina lagenifera (Hildebrand) Thompson & Wujek Fig. 4

This alga forms a dense and compact mat, in which individual filaments are densely mixed. The erect and prostrate parts cannot be distinguished. The cells are very variable in shape. In some cases they are perfectly cylindrical (7–10 μm in width), but more often they are elliptical or subglobular (8–12 μm in width). Presumptive gametangia (15–20 μm in diameter) are quite common and exhibit the morphology typical of this species. They are flask-shaped with the ostiole borne at the top of a neck, which is well developed in mature gametangia. They are usually produced in apical, lateral or intercalary position.

This alga was found forming orange coatings on a wooden wall in "Les Monts de Cristal" National Park at the Tchimbélé site on 21 May 2008. This species is one of

the most widespread in the genus, having been reported from different parts of the world ranging from temperate to tropical environments.

Reported in Europe by Hariot (1889) from the Czech Republic, Finland, Germany, Italy, and Sweden; also in South America in Guyana as *Trentepohlia lagenifera*. As *Printzina lagenifera*, it has been reported from Europe (Rindi & Guiry 2002) and the Pacific islands (Rindi et al. 2005). In Africa, it was reported previously by Rindi et al. (2006) from South Africa.

***Printzina* sp.** Fig. 5

This alga is found forming a bright green layer, very compact, strictly adherent to the substratum; the structure of the thallus is pseudoparenchymatic, formed by the encroachment of many entangled filaments. There is no clear distinction between prostrate and erect parts. The filaments are irregularly branched, strongly bent. The cells are elliptical, barrel-shaped or globular, rarely cylindrical usually 5–8 μm wide. Reproductive structures could not be observed.

This alga was collected on a tree bark at "Les Monts de Cristal" National Park at the Tchimbélé site on 24 May 2008.

Trentepohlia abietina (Flotow) Hansgirg Figs 6–7

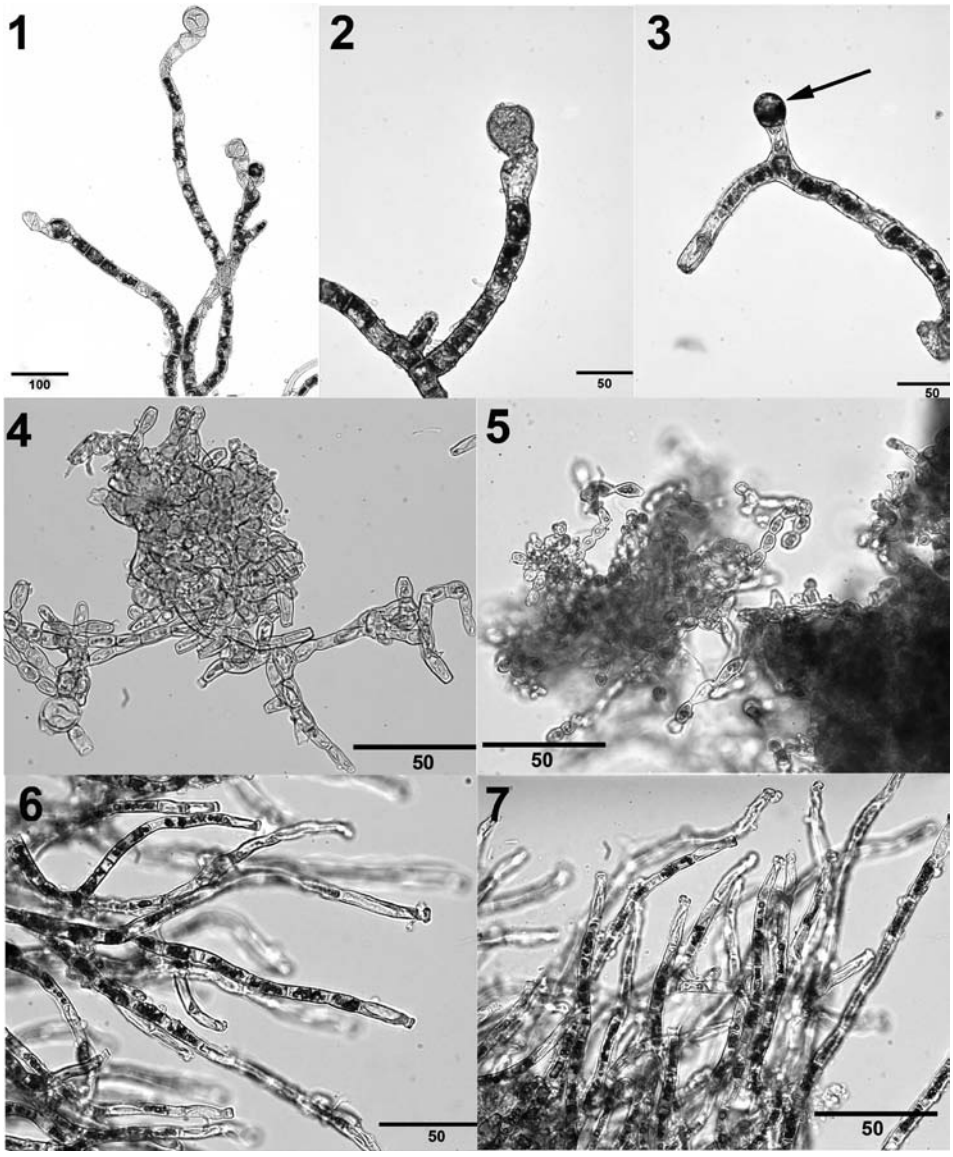
This species forms thin orange bushes on bark of trees. Erect axes are up to 250 μm tall, sparsely or not branched, arising from a limited prostrate system. The cells are variable in shape, sometimes cylindrical, sometimes swollen or barrel-shaped, 5–10 μm (mainly ~7.5) and 1–2 times as long as wide. The apical cells are usually longer and bear a small pectic cap. New branches arise from the upper part or the top corner of the cell. The cell wall is smooth. Reproductive structures were rarely observed. Some sporangiate laterals were observed at the top of some thicker erect axes. The zoosporangia are globular, 14–15 μm in diameter. A few globular or ovoid gametangia were observed borne apically or laterally on short branchlets, glorbular or subglobular, 15–20 μm in diameter.

This alga was common on tree barks in "Les Monts de Cristal" National Park at the Tchimbélé site and in Libreville, where it was collected at several sites in May of 2008.

This species represents another widespread entity in the genus. Originally described from central Europe, it has been widely recorded in the tropics (De Wildeman 1891, Cribb 1958, Islam 1960, Akiyama 1971, Islam 1972, Rindi et al. 2005, Rindi and Lopez-Bautista 2008), and was also reported growing on a spider (Cribb 1964). In Africa, it was reported for the first time by Rindi et al. (2006) in South Africa.

Trentepohlia abietina var. ***corrugata*** (Leighton) Cribb Figs 8–9

The cells are cylindrical or slightly swollen, 2–4 times as long as wide. The cell wall is densely covered by a thin spiral corrugation. The apical cells are slightly pointed or swollen, and pectic caps are often present. Presumptive gametangia are present but not abundant, globular, 12–15 μm wide; they are borne in lateral position along the main



Figs 1–7. 1. *Printzina bosseae.* Habit. 2. *Printzina bosseae.* Detail of a sporangiate lateral. 3. *Printzina bosseae.* Gametangium. 4. *Printzina lagenifera.* Habit. 5. *Printzina* sp. 6–7. *Trentepohlia abietina.* Habit.

axes or at the top of short lateral branches. Some sporangiate laterals are present. The zoosporangium is oval, 10–15μm in diameter; the ostiole is opposite to the attachment.

This alga was collected at "Les Monts de Cristal" National Park at the Tchimbélé site on 24 May 2008. It is reported for the first time for Africa after it was renamed by Cribb (1970) based on *Coenogonium corrugatum* Leighton (1870) from Sri Lanka.

Trentepohlia arborum (C.Agardh) Hariot Figs 10–11

This alga is found forming a fluffy filamentous thallus produced by erect axes up to 5mm tall, poorly or not branched. The cells are cylindrical, 14–24 μm wide and 3–4 times as long as wide, mainly about 3 times. The apical cells are blunt, devoid of pectic caps. The branching is irregular and branches arise both from the center and the corners of the cells.

Sporangiate laterals are common; zoosporangia are elliptical or ovoid, ~25 μm in width at maturity, borne in clusters at the top of the erect axes. Presumptive gametangia lateral on the erect axes, 25–40 μm in diameter, sometimes borne in couples or triples.

This alga was by far the most common species of Trentepohliales in Gabon at the time of the survey, being found growing on a wide range of substrata including tree bark, wooden fences and rocky cliffs around a waterfall at the Tchimbélé site in "Les Monts de Cristal" National Park. This species is usually reported from different types of substrata and is often the phycobiont in specimens of the common lichen genus *Coenogonium.*

This alga is one of the most widespread species of *Trentepohlia* and, more generally, one of the most common terrestrial algae in the tropics worldwide. It has been reported almost in every study that has concerned the Trentepohliales in tropical regions. In Africa it was previously reported from Democratic Republic of the Congo (formerly Zaire) by Sarma (1986).

Trentepohlia aurea (Linnaeus) Martius Figs 12–13

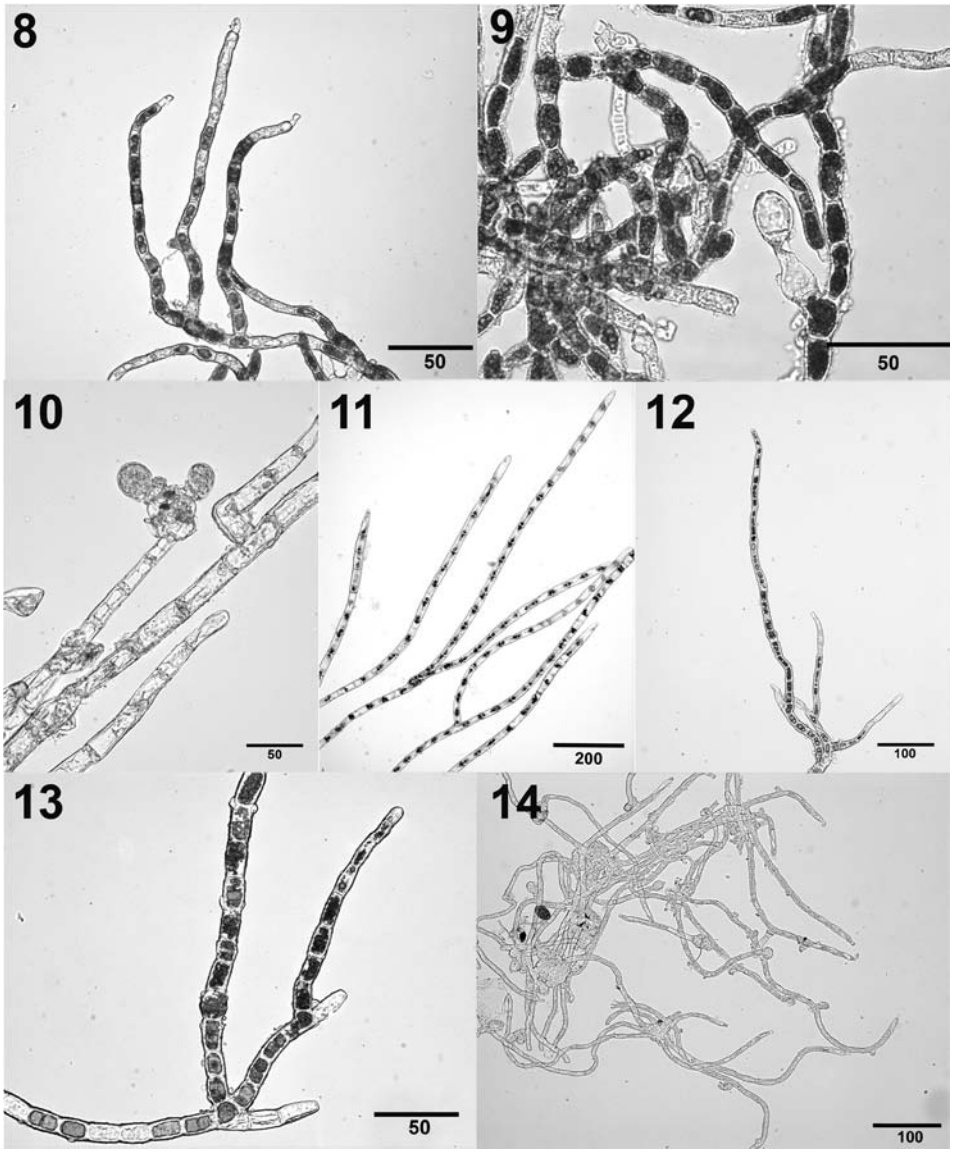
This alga consists of orange, dense tufts formed by erect axes irregularly branched. The cells are cylindrical (10–13μm wide), 1–3 times as long as wide. The apical cells are variable in shape, mostly with blunt tips, but occasionally pointed. The cell walls are variable in thickness and the septa are sometimes remarkably thick.

Presumptive gametangia are numerous and variable in shape and position. They are globular or flask-shaped, 20–25 μm wide at maturity; sometimes they bear a well-developed beak. They are borne apically or laterally; sometimes 2 or 3 gametangia occur adjacent to each other on adjacent segments.

This alga is the type species of the genus *Trentepohlia*. It was found growing on a bark of a tree in the Monts de Cristal national park on 22 May 2008, and in another collection it was also found growing on a cement pole. It has been reported previously from various parts of Africa (Congo, Morocco, South Africa, Democratic Republic of the Congo) by Sarma (1986).

Trentepohlia chapmanii Rindi & Lopez-Bautista Fig. 14

This species forms a spreading network on the bark of trees. There is a well-developed prostrate system from which erect axes arise. In the prostrate system there are groups



Figs 8–14. 8. *Trentepohlia abietina* var *corrugata*. Habit. 9. *Trentepohlia abietina* var *corrugata*. Detail of a sporangiate lateral. 10. *Trentepohlia arborum.* Sporangiate laterals in clusters. 11. *Trentepohlia arborum.* Habit. 12–13. *Trentepohlia aurea.* Habit. 14. *Trentepohlia chapmanii.* Habit

of globular or subglobular cells from which cylindrical axes spread laterally on the substratum, connecting with other globular cells. From the same globular cells the erect axes are also issued. The cells in the cylindrical axes are 5–8 μm wide, while the globular

cells are 10–20 μm. The apical cells of the erect axes are either flattened or pointed and usually bear a pectic cap. Reproductive structures were not clearly observable, but some globular cells gave the impression to be developing into gametangia.

This alga was collected from trees facing the sea close to the "Hotel Tropicana" in Libreville on 26 May 2008.

This species is reported for the first time outside of the Americas. It was described from French Guiana by Rindi & Lopez-Bautista (2007) and subsequently reported for Panama (Rindi et al. 2008).

Trentepohlia dusenii Hariot Figs 15–16

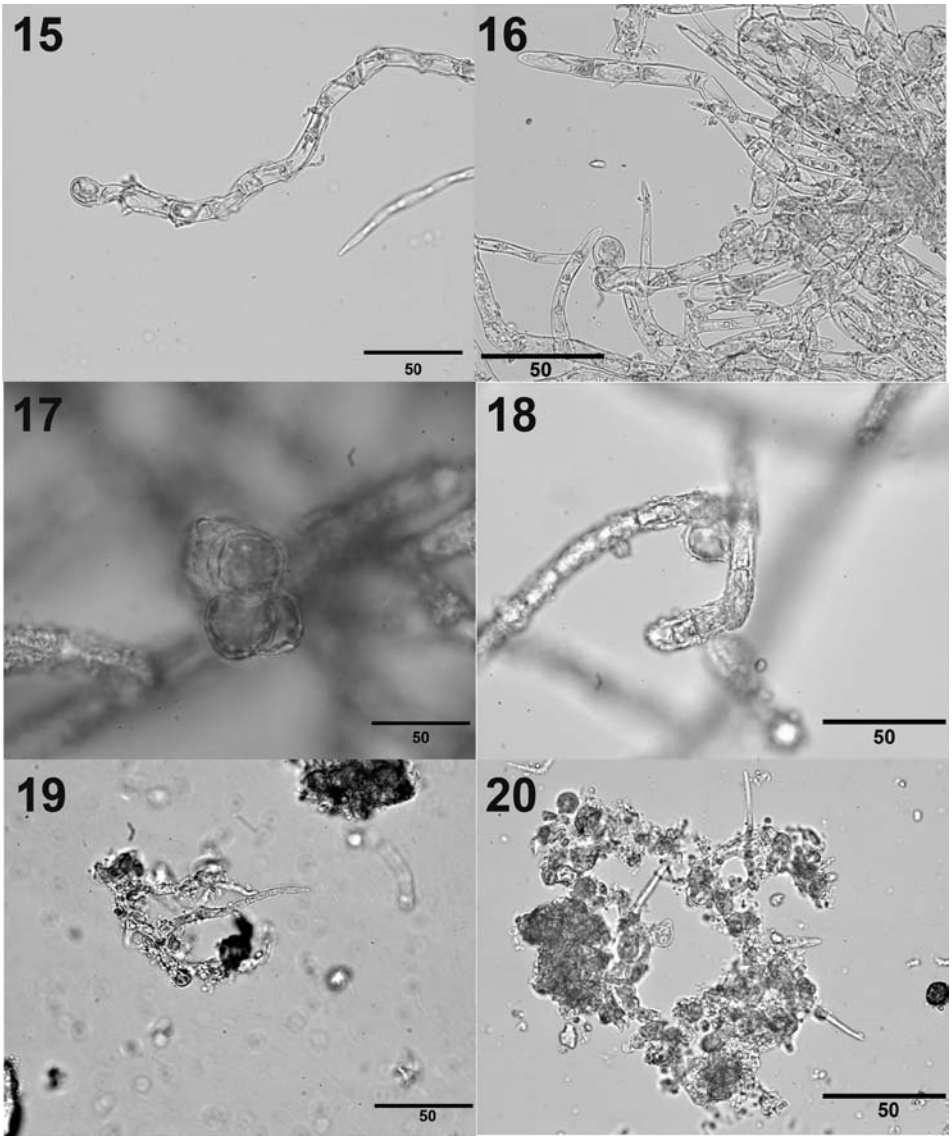
This alga has a thallus sharply separated in erect and prostrate parts. The cells are cylindrical throughout the thallus, but in the prostrate parts it forms a network in which a lot of debris and unicellular microchlorophytes get trapped. Initially the globular unicells compacted in aggregations may give the erroneous impression of being prostrate parts of *Trentepohlia*. The branching is very irregular; erect axes arise from the prostrate axes at 90° angle from the center of the cell. The cells are 2–4 times as long as wide, mainly 2.5–3 times. The apical cells are quite variable in shape, sometimes blunt but more often sharply pointed, devoid of pectic caps. The specimens examined bore numerous sporangiate laterals, which are produced singly at the top of the erect axes. The suffultory cell is characteristically tall, variably inflated and in some cases is considerably swollen. In other filaments it is not larger than a normal vegetative cell. The zoosporangium is elliptical and about 15 μm in width, and the ostiole occurs basally near the attachment. It is clear that in this species the growth of the erect axis can restart after the zoosporangium is shed; some enlarged intercalary cells are clearly suffultory cells from which the growth restarted (as seen in *Printzina bosseae*).

This alga was collected from a metal pole in "Les Monts de Cristal" National Park at the Tchimbélé site forest on 22 May 2008. *Trentepohlia dusenii* is one of the least known in the genus (Rindi & Lopez-Bautista 2007). It was originally described from Cameroon by Hariot in Wittrock & Nordstedt (1893). However, this alga is not restricted to this area and has been reported also for Brazil (Lemes-da-Silva et al. 2009), French Guiana (Rindi & Lopez-Bautista 2007), India (Jose & Chowdary 1980), Panama (Rindi et al. 2008), and Queensland (Cribb 1963).

Trentepohlia cfr. ***flintii*** Sarma Figs 17–18

This alga produces orange tufts on cement poles. The thallus consists of differentiated prostrate and erect portions. The width of the cells in the erect axes is 15–17 μm, in the prostrate axes 24–30 μm. The cells of the erect axes are cylindrical, 2–4 times as long as wide (mainly 2.5–3 times). The cells of the prostrate parts are globular/subglobular, and they are larger and smoother than in the erect parts. The apical cells of the erect axes are slightly pointed. In the erect axes the wall is densely corrugated, to the extent of forming prominently spiny protrusions in the older cells.

Presumptive gametangia are common. They vary in shape from globular to elliptical. When globular, they often have a beak and are 24–28 μm wide. They also have a corrugated wall.



Figs 15–20. 15. *Trentepohlia dusenii*. Detail of a sporangiate lateral. 16. *Trentepohlia dusenii*. Habit. 17. *Trentepohlia* cfr. *flintii*. Some presumptive gamentangia. 18. *Trentepohlia* cfr. *flintii*. *Deta*il of an erect axis. 19. *Trentepohlia minima*. Detail of an erect axis. 20. *Trentepohlia minima*. Creeping filaments mixed with moss

This alga was found near a hydroelectric dam at Tchimbélé forest in "Les Monts de Cristal" National Park on 22 May 2008. Its morphology does not agree with any species of *Trentepohlia* currently known. For the marked corrugation of the cell walls it is close

to *T. flintii*, a species described by Sarma (1986) from the Piha area, Auckland, New Zealand; however, it differs from it for the distinction of erect and prostrate system, the range of cell width and the shape of the apical cells.

Trentepohlia minima Schmidle Figs 19–20

This species consists of creeping filaments from which some erect axes, up to 100 μm tall, arise. The erect axes are either branched near the base or not branched. They are 3–4 μm wide, have a pointed tip and become gradually tapered towards the apices. On some axes presumptive gametangia occur. They are borne laterally or on a short lateral branch, globular or elliptical, sometimes with a short beak at maturity, 5–7 μm in diameter. The cells of the erect axes are 3–5 times as long as wide.

This alga was growing epiphytically on a thick compact layer formed by an unidentified alga with pseudoparenchymatous structure on the bark of a tree and was collected in "Les Monts de Cristal" National Park on 24 May 2008.

This is the first record of this species in Africa. *Trentepohlia minima* was recorded previously only from the type locality in New Guinea (Schmidle 1897) and from Panama (Rindi et al. 2008).

Trentepohlia peruana (Kützing) Printz Figs 21–22

The thallus of this alga consists of prostrate axes irregularly branched and deeply entangled. The cells are barrel-shaped, subglobular or elliptical, rarely cylindrical, 8–10 μm wide. Cell wall thick and heavily corrugated. Numerous unicellular hairs are borne on the dorsal side of the cells; they are 4–5 μm wide and up to 60 μm tall. Only one gametangium was observed, and it was subglobular, 12 μm wide, borne laterally on a prostrate axis.

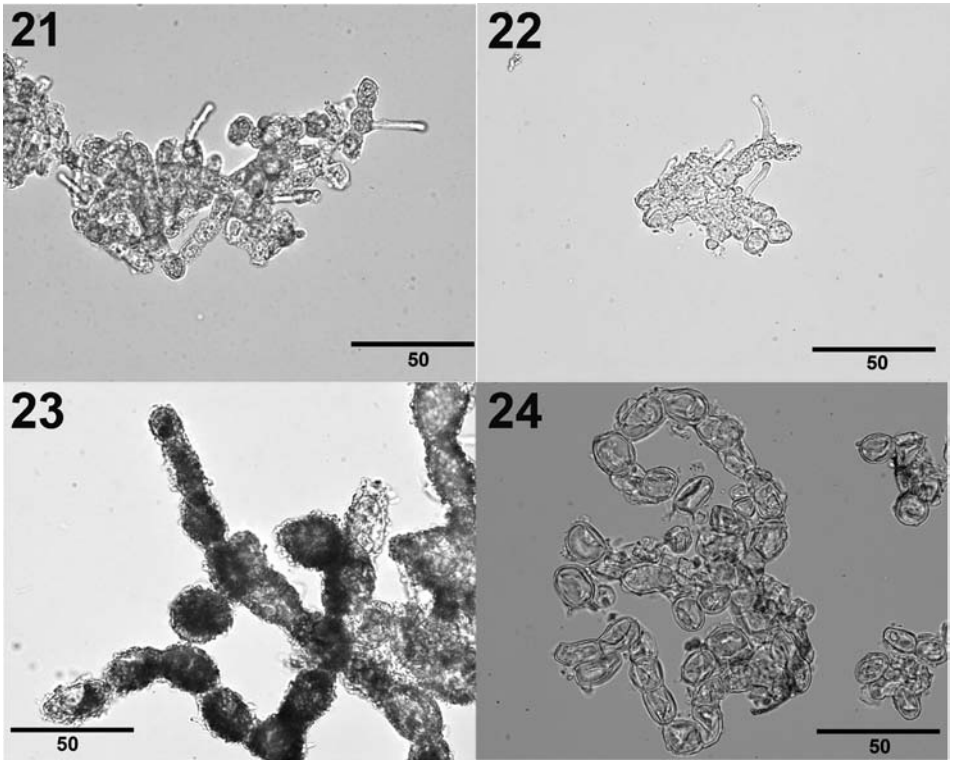
This alga was found forming a thin, compact layer on tree bark. It was collected at the "Tchimbélé" forest on 21 May 2008. This species has been previously reported from Indonesia and Japan as *Trentepohlia bogoriensis* De Wildeman (Ettl & Gärtner 1995), and as *Trentepohlia peruana* in Asia, the Caribbean Islands, New Zealand, North and South America (Sarma 1986). This is the first record for Africa.

Trentepohlia rigidula (J.Müller) Hariot Fig. 23

Filaments of this alga are deeply entangled with irregular habit, mostly prostrate or decumbent. The cell wall appears to be strongly hydrophobic; the alga is very resistant to rewetting. The cells are globular, subglobular, barrel-shaped or sometimes almost cylindrical, 1–3 times as long as wide (18–22 μm wide). The cell wall is heavily corrugated and covered by numerous small scales. The reproductive structures are not readily observable, but it is possible that some larger cells occurring in intercalary position are gametangia in development.

This alga formed a velvety thin orange mat on the bark of a tree in the "Monts de Cristal" National Park. It was collected on 22 May 2008.

Trentepohlia rigidula is widely distributed in tropical regions. Cribb (1970) concluded that another common tropical trentepohlialean alga, *Trentepohlia monilia* De Wildeman



Figs 21–24. 21. *Trentepohlia peruana*. Unicellular hairs. 22. *Trentepohlia peruana*. habit. 23. *Trentepohlia rigidula.* Detail of filaments. 24. *Trentepohlia umbrina.* Habit of thallus.

(=*Physolinum monile* (De Wildeman) Printz) is conspecific with *T. rigidula*, so records of *T. monilia* should also be refereed to this species. This is the second record of this species for Africa after the report from Congo by Sarma (1986).

Trentepohlia umbrina (Kützing) Bornet Fig. 24

This alga is found forming a compact mass where no distinction between erect and prostrate parts is observable. Cells are variable in shape from globular to cylindrical, but mostly elliptical or more or less swollen; the cell width is 10–17μm. The individual filaments are deeply entangled, easily broken off when pressed under the coverslip. No reproductive structures could be observed.

This alga was found forming red crusts on roof tiles and concrete walls of a factory in a dam at the Tchimbélé forest on 22 May 2008. This species is widespread and has been reported from almost all regions of the world including temperate and tropical. In Africa, it has been reported from South Africa and Tanzania (Rindi et al. 2006).

Discussion and conclusions

This is the most detailed study on the diversity of the Trentepohliales available for Africa to date. The biogeographic significance of our results is high because this is the first extensive survey covering a tropical region of this continent. The tropics are the main repository of trentepohlialean diversity and detailed surveys focused on this group are available for tropical parts of Asia (De Wildeman 1981, 1900, Islam 1960, 1972, Jose & Chowdary 1980, Panikkar & Sindhu 1993, Neustupa 2003, 2005), Australia (Cribb 1958, 1963, 1964, 1968, 1970, 1993), central (Rindi et al. 2008) and South America (Rindi & López-Bautista 2008), and the Pacific Islands (Brooks 2004, Rindi et al. 2005). The availability of similar data for an African region fills in part an important biogeographic gap. The availability of floristic information for an African tropical area makes possible a comparison with other tropical regions, and it is of particular interest to compare the results of this study with a similar investigation carried out in French Guiana by Rindi & López-Bautista (2008). The eastern corner of South America was in contact with western Africa, fitting into the Gulf of Guinea, until the late Jurassic-early Cretaceous (150–140 mya). Therefore, the regions today corresponding to Gabon and French Guiana were in close geographical proximity until relatively recent geological times. It should be also remarked that the potential of dispersal of trentepohlialean algae is an almost unexplored field, but it is reasonable to postulate that these algae are capable to disperse on extremely long distances. The main dispersal structure of this group is represented by the zoosporangium, which is produced at the top of the suffultory cell. At maturity, following some complex ultrastructural modifications, the attachment of the zoosporangium to the suffultory cell is broken (Good & Chapman 1978) and the zoosporangium is carried by the wind for distances that may possibly reach hundreds or thousands of km. It is therefore possible that populations of Trentepohliales of eastern South America and western Africa are in fact genetically connected, although molecular data with resolution at population level would be necessary to confirm it. Not surprisingly, many entities that could be identified comfortably at the species level in Gabon in this study and in French Guiana by Rindi & López-Bautista (2008) are common to the two regions (*P. bosseae*, *P. lagenifera*, *T. abietina*, *T. arborum*, *T. aurea*, *T. chapmanii*, *T. dusenii*, *T. rigidula*). Molecular data (*rbc*L sequences) that we are currently producing for the Gabonese strains of some of these species should help to gain further insights.

Fourteen taxa of Trentepohliales were found in the tropical rainforests of Gabon and the city of Libreville. This figure is somewhat lower than for other tropical regions such as Queensland (31), the area of Bogor in Indonesia (30), French Guiana (29) and central Panama (24). We believe that this is partly due to logistical restrictions and the difficulty of obtaining collection and export permits, which limited the area that we could survey in Gabon. The possibility to sample additional areas of rainforest and other types of habitats would have probably increased the number of recorded taxa. It should be also kept in mind that recent molecular studies have shown that the genetic diversity of *Trentepohlia* and *Printzina* is higher than the morphology suggests (Rindi *et al.* 2009, Nelsen et al. 2011). Some common tropical morphospecies, such as *Printzina lagenifera* and *Trentepohlia arborum*, appear to be complexes of cryptic species rather than single taxa (Rindi et al. 2009). So, molecular data could also reveal

more diversity than expected for the Gabonese strains too. Five taxa are new records for Africa (*Printzina bosseae, Trentepohlia abietina* var. *corrugata, T. chapmanii, T. minima, and T. peruana*). *Printzina bosseae* and *Trentepohalia peruana* have been widely reported in other continents, and their presence in Africa was expected. For the other taxa, the lack of previous records is presumably due to other reasons: for *T. chapmanii*, the relatively recent description (Rindi & López-Bautista 2007); for *T. minima*, the small size, which make this species difficult to observe; for *T. abietina* var. *corrugata* the previous taxonomic treatment (presumably in many previous studies this taxon was not recognized at subspecific level and therefore not separated from *T. abietina*).

From an ecological point of view, the species of Trentepohliales recorded in Gabon show a more strict association with rainforest environments than in other regions. With the exception of the collections of *T. abietina* and *T. chapmanii* made in Libreville, all collections were made in habitats located at the margin or within rainforests. Interestingly, the specimens of *T. chapmanii* were collected from a type of habitat almost identical to that of the original description (bark of bamboo reeds facing the sea at Fort Diamant, French Guiana; Rindi & López-Bautista 2007). This suggests that this species may have a preference for sites subjected to maritime influence and perhaps benefit of salty spray; further records will be useful to understand more about its ecology. As in other tropical region, the occurrence of Trentepohliales on artificial substrata was common in Gabon. Five taxa (*Printzina lagenifera, Trentepohlia arborum, T. dusenii, T.* cfr. *flintii*, and *T. umbrina*) were found growing on artificial substrata, which included wooden fences, concrete, plastic, and metal poles. Collections on artificial substrata were also made in environments at the margins of rainforest. The occurrence of some of these taxa on artificial surfaces has been documented for other regions (Rindi & Guiry 2002). For *Trentepohlia dusenii*, collections from French Guiana examined by Rindi & López-Bautista (2007) were also made from a post in a rainforest.

Such association with rainforest environments involves important problems for the conservation of the Trentepohliales and other micro-organisms. Unfortunately, rainforests are disappearing at a fast rate in many regions of the world (Bulte &Van Kooten 2000, Williams et al. 2003, Fearnside & Laurance 2004), which might prevent future investigators from characterizing undescribed taxa from these environments. This is unfortunate since we are facing the fact that many species may become extinct before they can be described and catalogued. This is a problem that has also important potential repercussions from an applied point of view. The rainforests are considered very productive chemical factories, hosting numerous organisms capable to produce secondary metabolites with valuable bioactive properties. Loss of rainforests may therefore cause loss of biotechnologically valuable organisms and the benefits that these may provide from a biotechnological point of view.

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