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ON SOME BRAZILIAN SPECIES OF TRENTEPOHLIACEAE

By

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The contribution to our knowledge of the freshwater algae of Brazil already furnished by many authors since the later part of eighteenth century *viz.* WILLE (1884) [4], NORDSTEDT (1877, 1889) [4], SCHMIDLE (1901) [4], DROUET (1939) [6], TIFFANY (1937) [21] and *et. al.* Recently, studies on the taxonomy of the freshwater algae of this region have been carried out by several workers. HUSTEDT (1965) [12] described some new taxa of Bacillariophyceae from Amazonian district, FORSTER (1966) [9] and BICUDO, C. M. B. (1969) [4] described several new taxa and many of the new records from the state of São Paulo, BICUDO, R. M. T. (1969) [3] reported several Brazilian Characeae, and SKVORTZOV and NODA (1968-1-2) [19,20] studied especially on the flagellated genera belonged ot Chlorophyta, Euglenophyta, Chloromonadophyta, Pyrrophyta and the certain colourless algal members. There has been quite few paper reported on the soil and aerial algae of this area.

Recently, through the kindness of Dr. B. V. SKVORTZOV of Instituto de Botanica, São Paulo, the author had an opportunity to study of the aerial and terrestrial algae (mostly Trentepohliacean algae) of São Paulo, Brazil and herein he wishes to report on the taxonomy of these algae.

The author wishes to express his cordial thanks to Professor Emeritus Dr. Yukio YAMADA of Hokkaido University and Professor Dr. Hiroyuki HIROSE of Kobe University for their criticism and encouragement.

Particular thanks are also to be offered to Dr. B. V. SKVORTZOV of Instituto de Botanica of São Paulo who was kindly supplying the materials used in this study.

Remarks

The members belonged to the family Trentepohliaceae are strictly aerial algae which are especially abundant in the tropics both of the northern and the southern hemisphere [6,8,13,18] but which at times are found in temperate regions [1,2,10,14]. And these algae mostly grow on the bark of trees, on the surface of leaves, and the certain member grows as a subcuticular or as an intercellular parasite of leaves of seed plants. Morphologically, the members of this family characterized by the presence of swallen, somewhat specialized cells for zoosporangia or gametangia. Vegetative cells are usually brick-or rusty-red in colour due to an abundance of haematochrome which complately masks the chlorophyll. A number of discoidal or in sometimes band-shaped chromatophores are present in each cell, however the pyrenoids are absent. The organization of each genus belonging to this family is well developed, *viz.* the branches may be

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wholly free from one another in *Trentepohlia*, or wholly united to form a flattened discoidal thallus in *Cephaleuros* and *Phycopeltis*. Sometimes the thallus is differentiated into two systems of prostrate and erect filaments, and has long multicellular setae.

The family is composed of four genera as follows ;

Key to the genera of Trentepohliaceae

1. Thallus composed of uniseriate freely branched filaments..... 2
1. Thallus composed of pseudoparenchymatous tissure or discoidal expansion of densely compacted branches..... 3
2. Thallus composed of several cells..... *Stomatochroon*
2. Thallus composed of many cells..... *Trentepohlia*
3. Thallus without erect filaments (multicellular setae).... *Phycopeltis*
3. Thallus bearing with erect setae-like filaments..... *Cephaleuros*

The Brazilian Trentepohliaceae examined in this study includes two genera which are *Trentepohlia* and *Phycopeltis*.

According to the previous investigation [10,13,15,16], as the taxonomic criteria on the specific level are mostly based on such characteristics as vegetative cell shape and size (length and width), the presence of hair-like cells, branching pattern (dichotomous, opposite, lateral or irregular), feature of cell wall (colour, smooth or scaled, presence of pectose cap), shape and size of sporangium, type of sporangium (sessile, stalked, funnel-shaped, presence or absence of certain type of sporangium), location of sporangium (terminal, intercellular, sessile), type of cell division (presence or absence of budding), aplanospore formation and *et. al.*

However some of the above mentioned characteristics have an instable feature relating with an ecological condition especially on the seasonal change. According to HOWLAND (1929)[11], in *Trentepohlia*, shorter cells are formed in damp and warm weather, when growth is more rapid, however the width of the apical cell is greatest in spring and least in autumn, independently of meteorological conditions. Such a seasonal variation of the length of hair-like cell which is one of the most important criterion in delimiting the certain species belonging to the *Nylandera* section of *Trentepohlia* also has been observed in the Japanese materials by AKIYAMA (1962) [1].

Additionally, most of the species of *Trentepohlia* have a wide variability on cell shape and cell size in a same natural population. For this reason, it is necessary for observation of Trentepohliacean algae to carefully take the data statistically.

The variation of cell size of Brazilian Trentepohliaceous species examined is shown in the text-figures 1-3. Figure 1 shows a scattered diagram of the cell size of four species of *Trentepohlia* composed of cylindrical vegetative cells. As will be seen from the figure, this apparently indicates that *T. rigidula* clearly differ from one another in the cell size of thallus. Although, the value of diameter of the cells of *T. aurea* and *T. arborum* overlaps each other, but it is evidently separated into different group in their cell length. Additionally those species distinctly differ from each other in the status of location of pedicellate sporangia. On the contrary, *T. calamicola* and *T. abietina* are not distinguished by their cell size, however, there is a distinction in the colorization of cell wall. Figure 2 shows a scattered diagram of the cell size of two, small, epiphytic species of *Trentepohlia* composed of few-celled short filaments. There is scarcely no differences of the status of the variation of the cell size of main filame-

nts between *T. peruana* and *T. diffracta* with the exception of the cellular dimorphism in the former species.

The cellular dimorphism found in the section *Nylandera* is one of the most important criterion of this group. The most part of hair-like cell or setae are usually composed of a single narrow cell with or without a pectose cap. As already noted, it has been observed that there is a wide variability in the length of the hair-like cells of Japanese

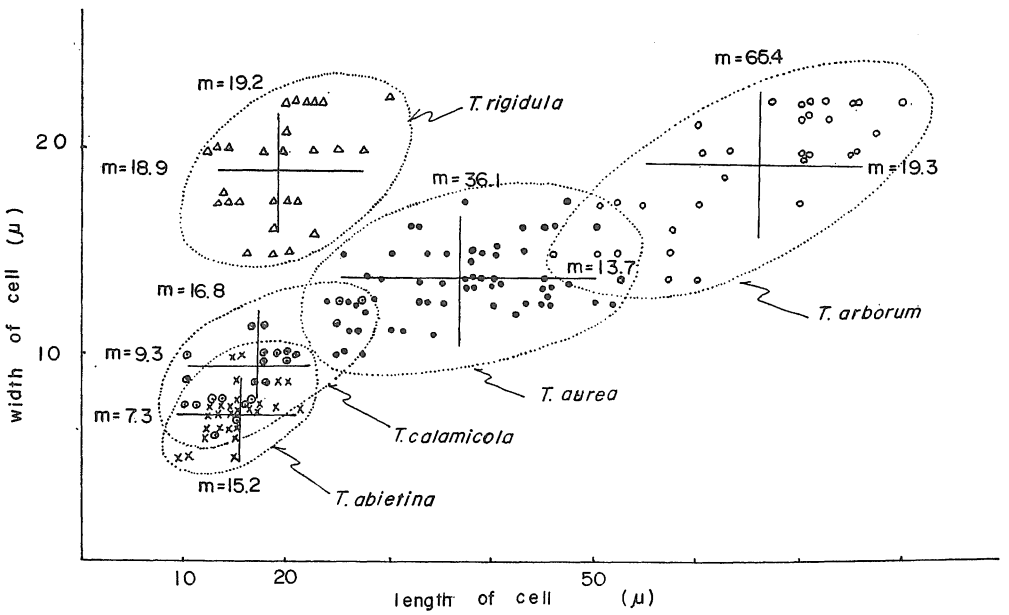

Fig. 1. Scattered diagram of cell size in *T. rigidula*, *T. abietina*, *T. calamicola*, *T. aurea* and *T. arborum*.

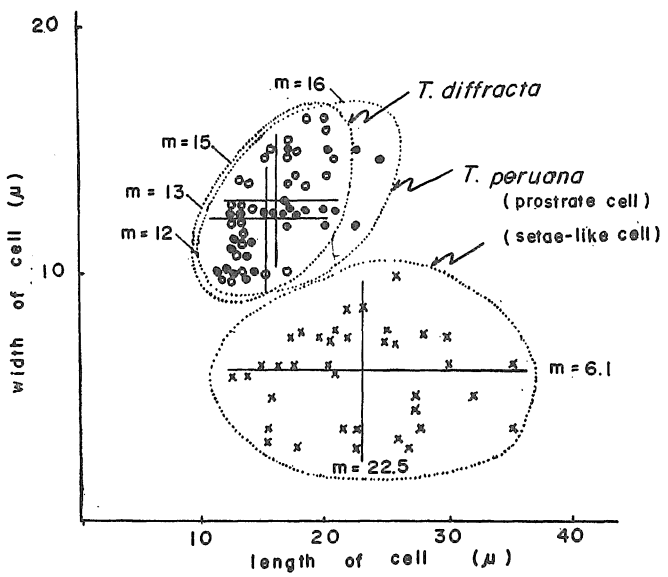

Fig. 2. Scattered diagram of cell size in *T. diffracta* and *T. peruana*.

species of *Trentepohlia* belonged to *Nylandera*. And in sometimes two-or three-celled setae have been recognized in Japanese materials. The scattered diagram of hair-like cells of *T. peruana* also shows a wide variability in length and width (Fig. 2).

The cellular multiplication in hair-like setae is also frequently observed in Brazilian materials (Pl. II Figs. 1~8). Additionally, the metamorphosis of such an intercalarlly produced cells transforming into large swallen cells often occurs in multicelled setae. This phenonenon must often accompany the cellular multiplication of hair-like cell or setae especially in *T. peruana*, and the formation of peculiar net-like organization of thallus of this species would be due to the presence of such a reason. The tendency of such a phenomenon in hair-like cell more or less has been recognized in another species belonging to *Nylandera*.

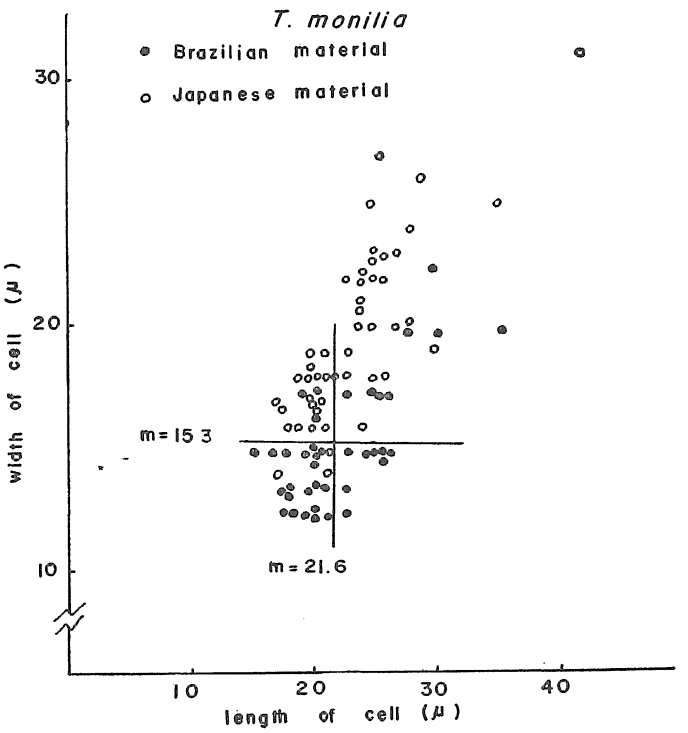

Fig. 3. Scattered diagram of cell size in *T. monilia*.

In the previous paper, the details of morphology of *T. monilia* found in the southern Japan was given by AKIYAMA and HIROSE (1967) [2]. The scattered diagram of cell size of *T. monilia* found in Brazil showing in figure 3 approximately coincited with that of Japanese material. This result may be taken to indicate that there is no specialized local variation in this species.

Ecologically, the most species of Brazilian Trentepohliaceae described here are epiphytes on barks of trees and leaves of such plants as Araceae, Marantaceae and large *Cactus*. And terrestrial status of algal population on the surfaces of red soil and muddy parts of termit nests are frequently observed. And the colonies of these algae

form both a single algal population and a complex population composed of two or three species of Trentepohliacean algae. In sometimes, such algae as *Zygogonium* sp., *Hormidium flaccidum*, *H. subtile*, *Mesotaenium* sp., *Cosmarium decedens* and *et. al.* often accompanied with Trentepohliacean communities.

Description

Key to the Brazilian species of *Trentepohlia*

1. Thallus composed of cylindrical or swallen cells without hair-like (one-celled or in sometimes several-celled) setae ..... 2.
1. Thallus composed of dimorphic elements of cylindrical or swallen cells and narrow hair-like setae ..... Sect. *Nylandera*... 9.
2. Thallus differentiated into erect and prostrate systems..... Sect. *Heterothallus* (not recognized in this survey)
2. Thallus not the above, without specialized basal system.....Sect. *Chroolepus* ... 3.
3. Thallus composed of inflated spherical cells ; cell division by means of budding ; asexual reproduction is mostly by a formation of aplanospores ..... **T. monilia**
3. Thallus composed of cylindrical cells ; cell division not the above, mostly by means of typical transverse division ; asexual reproduction is by a formation of zoospores .....4.
4. Diameter of cell mostly up to 10 μ ..... 5.
4. Diameter of cell broader than 10 μ ..... 6.
5. Cell wall yellowish brown in colour ..... **T. calamicola**
5. Cell wall smooth and colourless ..... **T. abietina**
6. Thallus forming a large macroscopic, cottony colony ; composed of many-celled and well developed filaments ..... 7.
6. Thallus forming a small, microscopic, patched colony, epiphytic on leaves and tree trunks, composed of few-celled short filaments ..... 8.
7. 2-5, pedicellate sporangia grouped at the apex of the terminal cell of a filament ..... **T. arborum**
7. A single pedicellate sporangium located at the apex of subterminal cell of a filament ..... **T. aurea**
8. Filament with a single terminal pedicellate sporangium ; cell wall scaled ..... **T. rigidula**
8. Filament with lateral or intercalar sessile sporangia ; cell wall smooth .... **T. diffracta**
9. Only one species belonging to this section is recognized ; Thallus composed of complicated net-like branched filament ..... **T. peruana**

Trentepohlia monilia DeWildemann

Printz, 1939, *Nytt Mag. Naturv.* 80 : 190, Taf. XXXII, A-C ; Skuja, 1949, *Nova Acta Reg. Soc. Sci. Ups.* Ser. IV, 14 : 77, Taf. XVI, F. 2 ; Islam, 1960, *Trans. Amer. Microsc. Soc.* LXXIX : 476, Pl. 3, F. 9-10 ; Bourrelly, 1966, Les Alg. d' Eau Douce Tome I : 333, Pl. 67, F. 8-10 ; Akiyama & Hirose, 1967, *Bull. Jap. Soc. Phycol.* 15 : 127-131, F. 2.

Syn. *Physolinum monilia* (Dewildm.) Printz

(Pl. I. Fig. 1.)

Thallus forming a minute colony, intermingled with other epiphytic or terrestrial Trentepohliacean algae ; filament very short, mostly 10-20-celled, freely but sparsely branched, without differentiation between main axis and branches ; cell spherical to

broadly elliptical ; each cell more or less of same shape, deeply constricted at the point of attachment, 12.5− (mean = 15.3) −22.5 μ in diameter, 15 − (m = 21.6) − 35 μ in length.

Trentepohlia calamicola (ZELLER) DE TONI et LEVI

HEERING, 1912, Chlorophyceae 3, in PASCHER's Süsswasserfl. H. 6 : 123, F. 177 ; PRINTZ, 1939, *Nytt Mag. Naturv.* 80 : 147, Taf. I, 0-P. Taf. II, A. ; PRINTZ, 1966, *Hydrobiologia* XXIV : 301, Tab. XCIII, F. 1-3.

(Pl. I. Fig. 2.)

Thallus forming a thin and compacted cushion-like colony epiphytic on tree trunks ; filament freely branched, somewhat differentiated into main axis and branches ; cell cylindrical, with slight constrictions at the cross walls, 6.3 − (m = 9.3) − 12.5 μ in diameter, 10 − (m = 16.8) − 27.5 μ in length ; cell wall yellowish brown in colour ; reproductive organ sessile, mostly spherical, 20-25 μ in diameter.

Trentepohlia abietina (FLOTOW) WILLE ?

HEERING, 1914, Chlorophyceae 3 in PASCHER's Süsswasserfl. H. 6 : 122 ; PRINTZ, 1939, *Nytt Mag. Naturv.* 80 : 147 ; ISLAM, 1960, *Trans. Amer. Microsc. Soc.* LXXIX : 476, Pl. 3, F. 1-7 ; PRINTZ, 1964, *Hydrobiologia* XXIV : 301, Tab. XCIII, F. 4-7 ; BOURRELLY, 1966, Les Alg. d' Eau Douce Tome 1 : 331, Pl. 66, F. 6, 7, 9, 10.

(Pl. III. Figs. 4, 5.)

Thallus forming a thin cottony colony epiphytic on tree trunks ; filament freely branched and well developed but not differentiated into main axis and branches ; cell more or less cylindric or slightly inflated ; apical cell slightly tapering ; cell 5 − (m = 7.3) − 10 μ in diameter, 10 − (m = 15.2) − 20 μ in length ; reproductive organ both terminal and lateral, mostly sessile, spherical to subspherical, 13.8− (m = 17.7) −22.5 μ in diameter.

Trentepohlia arborum (C. AG.) HARIOT

PRINTZ, 1939, *Nytt Mag. Naturv.* 80 : 151, Taf. VI, A-H ; ISLAM, 1960, *Trans. Amer. Microsc. Soc.* LXXIX : 472, Pl. 1, F. 1-8 ; PRINTZ. 1964. *Hydrobiologia* XXIV : 302, Tab. XCIV, 2-6 ; BOURRELLY, 1966, Les Alg. d' Eau Douce Tome 1 : 333, Pl. 67, F. 1. 3.

(Pl. III. Fig. 3.)

Thallus forming a fuzzy or cottony colony epiphytic on tree trunks or attached to marginally epiphyllous, 2 - 3 cm in length ; filament well developed, freely or in sometimes laterally branched, differentiated into main axis and branches ; cell long cylindrical without constrictions at the cross walls ; cell wall smooth and colourless ; cell 13.8− (m = 19.3) −22.5 μ in diameter, 45− (m = 65.4) −80 μ in length ; reproductive organ both lateral and terminal with pedicle cell, spherical to elliptical, 12.5 − (m = 14.9) − 16.3 μ in diameter, 17.5 − (m = 23.4) − 27.5 μ in length ; 2-5 of pedicellate reproductive organs grouped at the apex of the swallen subterminal cell on the 2-or 3-celled, short side branch.

Trentepohlia aurea (L.) MARTIUS

HEERING, 1914, Chlorophyceae 3 in PASCHER's Süsswasserfl. H. 6 : 122, F. 173, 178 ; PRINTZ, 1939, *Nytt Mag. Naturv.* 80 : 153, Taf. VII, F. G-P ; PRESCOTT, 1951, Alg.

West. Great Lakes Area, 133, Pl. 67, F. 6-9. : ISLAM, 1960, *Trans. Amer. Microsc. Soc.* LXXIX : 474, Pl. F. 1-7 ; PRINTZ, 1964, *Hydrobiologia* XXIV : 304, Tab. XCIV, F. 7-13. ; BOURRELLY, 1966, Les Alg. d' Eau Douce Tome 1 : 333, Pl. 67, F. 4-7.

(Pl. I. Figs. 3-6.)

Thallus forming a cottony colony epiphytic on tree trunks or terrestrial on soil surfaces ; filament well developed, freely and irregularly branched, somewhat differentiated into main axis and branches ; cell cylindrical, with or without constrictions at the end walls, 10－(m＝13.7)－17.5 μ in diameter, 23.8－(m＝36.1)－52.5 μ in length ; reproductive organ both lateral and terminal with a pedicle cell, spherical to subspherical ; sessile reproductive organ 25-28.8 μ in diameter, pedicellate reproductive organ 15－(m＝17.5)－20 μ in diameter, 20－(m＝23.4)－28 μ in length.

Trentepohlia rigidula (MUELL.) HARIOT

PRINTZ, 1939, *Nytt Mag. Naturv.* 80 : 161, Taf. IX, F. B-E.

(Pl. I. Figs. 7, 8.)

Thallus forming a minute colony, intermingled with other epiphytic Trentepohliacean algae ; filament very short, 20-30-celled, sparcely branched, without differentiation into main axis and branches ; cell cylindrical, somewhat inflated, constricted at the cross wall ; cell wall thick, roughly scaled, 12.5－(m＝18.9)－22.5 μ in diameter, 12.5－(m＝19.2)－27.5 μ in length ; reproductive organ pedicellate, a single, spherical to subspherical cell connected with a bottle-shaped pedicle cell at the neck of the cell ; reproductive organ 20-25 μ in diameter, pedicellate cell 30-40 μ in length.

Trentepohlia diffracta (KREMP.) HARIOT

PRINTZ, 1939, *Nytt Mag. Naturv.* 80 : 161, Taf. XII, F. C-E.

(Pl. III. Figs. 1, 2.)

Thallus forming a thin, compacted, epiphytic colony on tree trunks ; filament very short, 20-30-celled, freely and irregularly branched, without differentiation between main axis and branches ; cell more or less inflated, 10－(m＝13)－16.3 μ in diameter, 12.5 － (m＝15.7) － 20 μ in length ; cell wall thick and smooth ; reproductive organ sessile or on short lateral branches, spherical to subspherical, 13.8－(m＝17.3)－22.5 μ in diameter.

Trentepohlia peruana (KUETZ.) PRINTZ

PRINTZ, 1939, *Nytt Mag. Naturv.* 80 : 167 ; BOURRELLY, 1966, Les Alg. d' Eau Douce Tome 1 : 335, Pl. 68, F. 1, 2.

(Pl. II. Figs. 1-8.)

Thallus forming a thin, compacted, epiphytic colony on tree trnnks or on surfaces of leaves ; filament very short, 20-30-celled, freely branched and complicated with one another, composed of dimorphic cell elements, *viz.* hair-like cell (setae-like cell) and more or less of inflated and thick walled cell ; hyaline, hair-like filament mostly composed of one to two long narrow cells with thin, smooth cell wall, in sometimes intercalarly cell division accompanied with metamorphosis of such newly produced cells into thick walled inflated cells occurs in the filament ; cell of hair-like filament 3－(m＝6.1) －10 μ in diameter, 12.5 － (m＝22.5)－35 μ in length ; cell of burly filament cylindrical to elliptical, with thick, and irregularly scaled walls, 10－(m＝12)－12.5 μ

in diameter, 11.3−(m = 16) − 22.5 μ in length ; reproductive organ sessile or on short lateral branches, spherical to subspherical, 12.5−(m = 18) −20 μ in diameter.

Phycopeltis arundinacea (MONT.) DE TONI

PRINTZ, 1939, *Nytt Mag. Naturv.* 80 : 171, Taf. XIX, F. A-C ; ISLAM, 1960, *Trans. Amer. Microsc. Soc.* LXXIX : 478, Pl. 2, F. 8.

(Pl. III. Figs. 6, 7.)

Thallus composed of regularly, dichotomously branched filaments, forming a small, discoidal expansion, up to 2-3 mm in diameter, epiphytic on the leaves of some seed plants ; cell elongate quadrate to polygonal, 4.5−(m = 6.3) −8.8 μ in diameter, 10−(m = 13.1) −18.8 μ in length ; reproductive organ produced intercalarly, sccattered, spherical to subspherical, 12−15 μ in diameter.

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Plates with Explanations.

Explanation of Plate I.

Fig. 1. *Trentepohlia monilia* DE WILDEMANN.

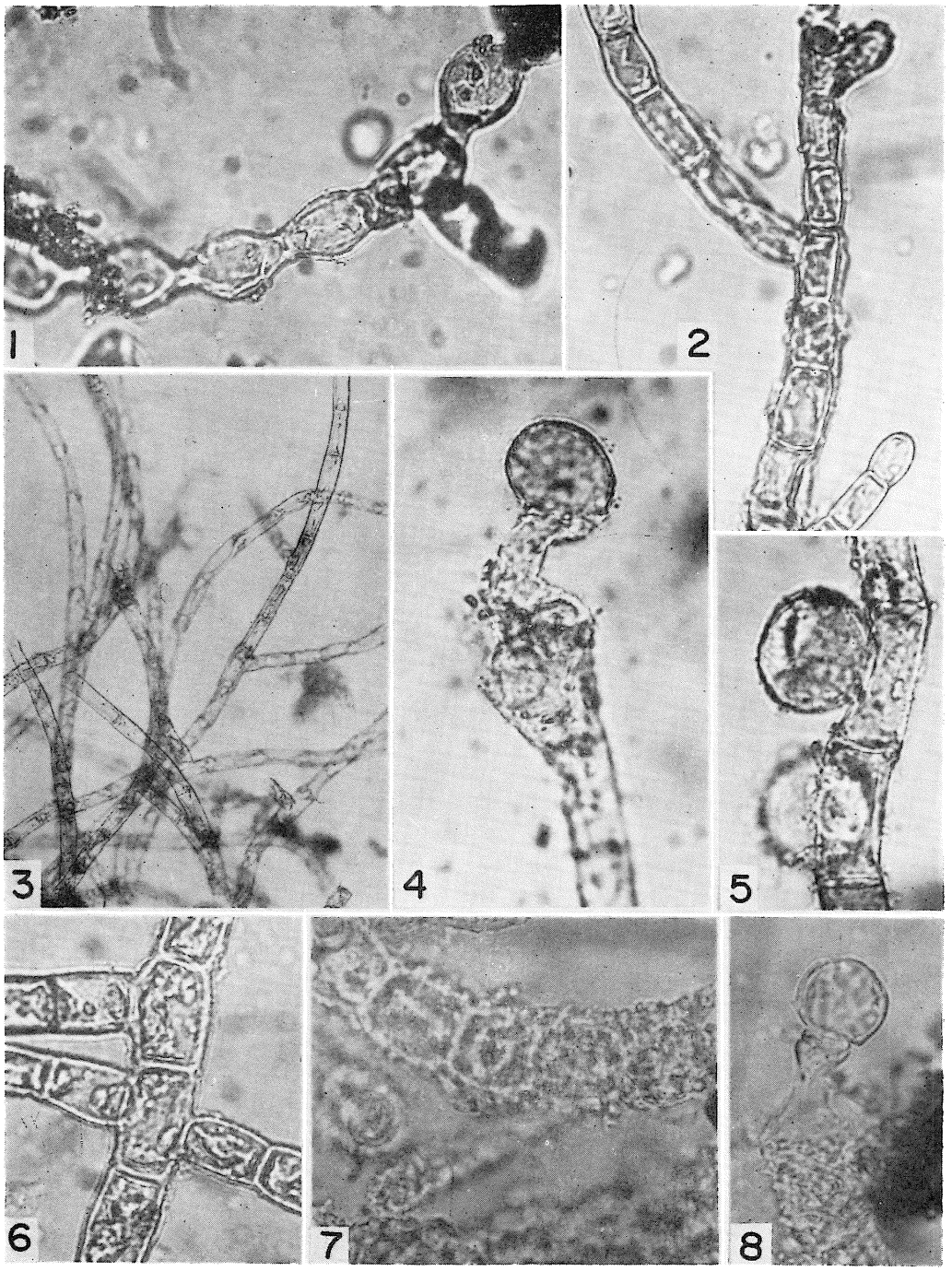
Fig. 2. *Trentepohlia calamicola* (ZELLER) DE TONI et LEVI.

Figs. 3-6. *Trentepohlia aurea* (L.) MARTIUS. 3. Vegetative filaments. 4. Pedicellate sporangium. 5. Sessile sporangia. 6. Vegetative cells.

Fig. 7, 8. *Trentepohlia rigidula* (MUELL.) HARIOT. 7. Vegetative filaments. 8. Pedicellate sporangium.

(1. ×450, 2, 4–8. ×550, 3. ×150)

Plate 1.



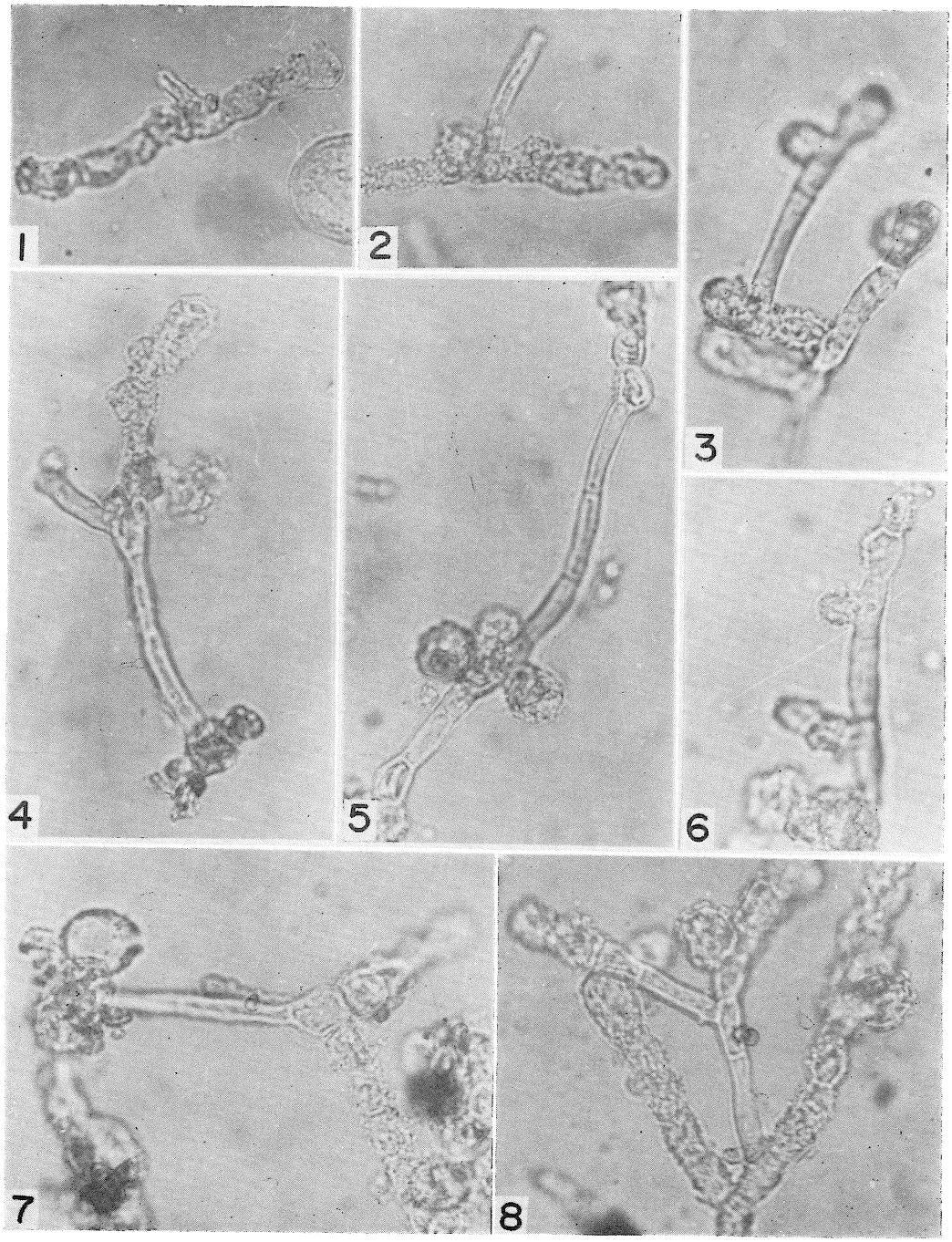
Explanation of Plate II.

Figs. 1-8. *Trentepohlia peruana* (KUETZ.) PRINTZ.

1, 2. Development of setae-like cell. 3. Cell division in setae-like cell accompanied with metamorphosis of newly produced cell. 4-6. Multi-celled setae-like filament bearing several metamorphosed cells. 7. Sessile sporangium. 8. Complicated thallus.

(1—8. ×550)

Plate 2.



Explanation of Plate III.

Figs. 1, 2. *Trentepohlia diffracta* (KREMP.) HARIOT. 1. Vegetative filaments. 2. Sessile sporangium.

Fig. 3. *Trentepohlia arborum* (C. AG.) HARIOT. Pedicellate sporangia.

Figs. 4, 5. *Trentepohlia abietina* (FLOTOW) WILLE? 4. Apical cells of vegetative filament. 5. Sessile sporangia.

Figs. 6, 7. *Phycopeltis arundinacea* (MONT.) DE TONI.

(1, 2, 4—7. ×650, 3. ×300)

Plate 3.