

## *Compsopogon coeruleus*, a red alga newly reported for freshwater aquaria in Prague

*Compsopogon coeruleus*, sladkovodní ruducha žijící v pražských akváriích

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Examination of a dense growth of erect, bluish green filaments in some freshwater aquaria in Prague, Czechoslovakia, revealed that these thalli were a red algal species, *Compsopogon coeruleus* (BALBIS) MONTAGNE. Since this species is essentially tropical and subtropical and it has been rarely reported from Europe, the new locality constitutes an interesting extension of its known distribution. A diagnosis of this species as well as some details about its morphology and geographical distribution are given.

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### INTRODUCTION

A dense growth of blue to blue green colored algal filaments growing on stones, waterplants, and the bottom of some aquaria in Prague turned out to be a red algal species of the genus *Compsopogon*. This is an essentially world wide distributed mainly tropical and subtropical fresh and brackish water genus. According to the monograph of the genus by KRISHNAMURTHY (1962) and some additional papers the genus is represented in India (KRISHNAMURTHY 1957, DAS 1964), the Malayan Archipelago (WEBER-VAN BOSSE 1921—1928), the Antilles (TAYLOR 1960), Italy (MENECHINI 1840), Algeria (MONTAGNE 1846), France (BOILLOT 1958), and the southern U.S.A. (SMITH 1950). However, some *Compsopogon* species have also been reported from localities with a temperate climate, i.e. China (JAO 1941), Japan (OKAMURA 1915), the Northern U.S.A. (COLLINS 1916, SMITH 1950), Great Britain (WEISS et MURRAY 1909), Germany (FRIEDRICH 1966), and New Zealand (CHAPMAN et CAMERON 1967). The occurrence of the species in these localities which is thought to be due to transport by shipping, is often characterized by an influx of warm waste water.

First in 1961 by MÜLLER, and again in 1971 by HEYNIG a *Compsopogon* species was reported from Germany inhabiting warmwater aquaria. From their original habitats these species may have been introduced into Central Europe by the transfer of aquarium plants. Such a transfer of tropical plants is also held responsible for the invasion of the tropical green alga, *Pithophora* into Czech aquaria (ŠULA 1930, FOTT 1971).

The dimensions of the aquarium of Dr. Pecina in Prague were 70 × 34 × 32 cm. The alga was growing here before 1971. After that year the species disappeared suddenly for two years but has developed recently (in 1975) again. The bottom of the aquarium is partly covered by gravel which has not changed over the last five years and partly of isolated pieces of limestone which are deposited in the background of the aquarium. Here, some submerged plants belonging to the genus *Cryptocoryne* are growing on which the spores of *Compsopogon* germinate and develop as

germlings. The adult algae are usually up to 10 cm long and are not damaged by herbivorous fish, as long as the algae are alive and growing. Their habit is well adapted to the plantation of *Cryptocoryne* or other water plants. The alkalinity of the aquarium water measures 1.76 meq/l and the pH of the sample equilibrated with air was 7.9. The temperature of the water in summer is from 24 to 25° C, in winter it is not below 20° C. The aquarium was inhabited by a rather great amount of fish. Out of about 60 specimens of fish one third were adults belonging to the species *Poecilia melanogaster*, *Xiphophorus maculatus*, and *Girardinus metallicus*. The aquarium was not aerated.

#### MORPHOLOGY, REPRODUCTION, AND TAXONOMIC POSITION

The *Compsopogonaceae* occupy an unique position among the primitive red algae in that the erect axis consists of large colorless, axial cells surrounded by 2—4 layers of small, densely pigmented cortical cells (Pl. I : 2). With the exception of the *Compsopogonaceae* all other *Bangiophycidae* lack a cortical envelope.

Contrary to the observations by FAN (1960) studies with the electron microscope have shown that the cell walls of *Compsopogon* are without pit connections (NICHOLS, RIDGWAY et BOLD 1966). The openings seen in incompletely deposited cell walls are not similar to the pit connections in the *Florideophycidae*. However, in such cases cytoplasmatic connections between adjacent cells occur and typical cell organelles, including chloroplasts, are contained within the cytoplasm.

The blue green chloroplasts are parietal and so closely associated as to form irregularly winded, lobed, rosary shaped structures (Pl. I : 4). In older cells the chloroplasts are separated and no longer ensheathed by cytoplasmatic strands. In mature cells there is a great number of vacuoles but in young cells there is just a single large one. The nucleus is rather conspicuous and located on one side of the cell (Pl. I : 4). In older cells a dense accumulation of floridean starch grains fills the cells.

Normally, reproduction is by means of monospores (= macroaplano-spores). Any cortical cell of an old filament may become a monosporangium. Upon germination the monospores develop a prostrate system of branching filaments from which the erect, corticated filaments may arise. In some cases microaplano-spores may be formed (THAXTER 1900).

The *Rhodophyta* form an ancient group of algae. Fossil records of possible red algae are known from the Paleozoic era which started about 600 million years ago. The division contains only one class, the *Rhodophyceae* which is subdivided into two subclasses, i.e. the more primitive *Bangiophycidae* and the higher developed *Florideophycidae*. According to SKUJA (1939) there are 7 families in the *Bangiophycidae*, one of which is the family *Compsopogonaceae*. In his monograph, KRISHNAMURTHY recognized two genera, *Compsopogon* and *Compsopogonopsis*. The former includes all algae with coarse axes exceeding 250  $\mu\text{m}$  in diameter and with rhizoidal outgrowths confined to the basal part of the thallus only.

#### DIAGNOSIS OF THE CZECH AQUARIUM SPECIMENS

Thallus bushy, soft but not gelatinous, sessile or free floating, green to bluish-violet green; sessile plants with small basal attachment cells from which uniseriate, 4—6  $\mu\text{m}$  wide rhizoids project into the substrate and from which usually one but sometimes 2—4 erect, well branched filaments arise; branches making a wide angle (usually over 70°) with the main axis; erect filaments variable in length but normally less than 10 cm long and up to 0.5 mm wide; older parts cylindrical but tapering to uniseriate branches with blunt tips; older parts 0.4—1 mm in diameter; uniseriate branches consisting of discoid cells which measure at the base 17—26  $\mu\text{m}$  wide  $\times$  10

to 18  $\mu\text{m}$  high and at the apices 4–7  $\mu\text{m}$  wide  $\times$  3–6  $\mu\text{m}$  high; older filaments and branches corticated; cortex usually forming more than one layer; cortical cells triangular to polygonal, outer cells 18–34  $\mu\text{m}$  wide and 12–21  $\mu\text{m}$  high; axial cells 126–175  $\mu\text{m}$  wide and 42  $\mu\text{m}$  high; monosporangia 21–25  $\mu\text{m}$  in diameter; monospores (only macro-aplanospores were seen) average 17  $\mu\text{m}$  in diameter.

## DISCUSSION

The measurements given in the diagnosis indicate that the Czech aquarium specimens have to be referred to *Compsopogon coeruleus* (BALBIS) MONTAGNE. The thallus is relatively short (shorter than in wild live specimens) and the erect axes are up to only 0.5 mm wide. Under the microscope, most impressive are the outstanding branches making an angle with the main axis of close to 90°. The dimensions of the cells of the uniseriate branches, of the cortical cells, and of the monosporangia agree with those of *C. coeruleus*. However, it is certainly true that the differences between *C. coeruleus* and *C. hookeri* MONTAGNE are relatively slight (CHAPMAN et CAMERON 1967). The other closely related species, *C. aeruginosus* (J. AGARDH) KÜTZING has smaller monospores being 9–13  $\mu\text{m}$  in diameter and the axes bear short spinous branches. Both characteristics are absent in our specimens.

*C. coeruleus* is the most widespread species of the genus. It has been recorded from all continents and from localities other than the tropics and subtropics. The species occurs in both fresh and brackish water, from sea level to 1200 meters above sea level. It has become a nuisance in some irrigation works (SMITH 1950). It is unlikely that this could happen in Czechoslovakia since the period of cold weather is too long for this alga to make survival possible. Because of the low winter temperatures it is also unlikely that the alga will become a permanent member of the Czech algal flora. In aquaria, *Compsopogon* if present in reasonable quantities, is certainly useful while releasing oxygen by photosynthesis.

*C. coeruleus* is the type species of the genus. The species was first described by MONTAGNE (1846) from a specimen collected in Algeria. Another specimen, mounted on the same herbarium sheet, is a specimen from the herbarium of Balbis and was collected in Puerto Rico. The former specimen is designated as the type, the second as co-type. The type specimen is present in the Muséum National d'Histoire Naturelle, Paris.

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## SOUHRN

*Compsopogon* MONTAGNE 1846 je rod sladkovodních ruduch, obsahující 6 druhů (KRISHNA-MURTHY 1962), které jsou kosmopolitně rozšířeny v teplých vodách trópů a subtropů. Jeden druh, řazený původně do rodu *Lemanea*, je znám i z jižní Evropy z okolí města Pisy v Itálii. Nejrozšířenější druh *Compsopogon coeruleus* (BALBIS) MONTAGNE se počíná v posledních 20 letech šířit i do chladnějších částí Evropy. První nález byl v umělém toku Reddish Canal u města Manchester v Anglii. Kanál se vyznačuje zvýšenou teplotou vody po celý rok a byla v něm již dříve objevena jiná tropická sladkovodní zelená řasa *Pithophora*. Další nálezy ruduchy jsou z teplých odpadních vod v NSR (FRIEDRICH 1966) a z akvárií v NDR (HEYNYG 1971). V Praze ji ve svém akváriu poprvé našel dr. P. Pecina v r. 1971 a dal nám materiál k prostudování. Vedle rodu *Pithophora*, která ve sterilním stavu se sotva dá rozlišit od r. *Cladophora*, je to druhý obyvatel tropických vod zdomácený v našich akváriích. V mládí má *Compsopogon* podobu krátkých, jednořadých vláken modrozelené, našedlé barvy, rostoucích na akvarijních rostlinách. Později vyroste keříčkovitě větvená stélka, několik centimetrů velká (v přírodě až 20 cm, v našich akváriích asi 9 cm), která se může oddělit od podkladu a volně vzplývat ve vodě. Na průřezu stélkou vidíme sloupec vel-

kých osních buněk, obklopený parenchymatickou korou drobných buněk. Plastidy v buňkách obsahující asimilační pigmenty nejsou červené, jak bychom u ruduchy očekávali, nýbrž šedo-modré. Modrý fykocyanin převládá nad malým množstvím červeného fykoerythrinu. Na rozdíl od ostatních řas, znečišťujících stěny a rostliny akvárií, dá se *Compsopogon* snadno odstranit a v přiměřeném množství zásobuje akvariijní vodu vydatně kyslíkem. Rozmnožuje se tvorbou nepohlavních spor, tzv. monospor. Potvrdili jsme elektronoptická pozorování (NICHOLS et al. 1966), že zrněčka škrobu jako u všech ruduch se tvoří v cytoplasmě a hromadí se zvláště kolem elipsoidního jádra, které se následkem toho podobá pyrenoidu (Pl. I : 4).

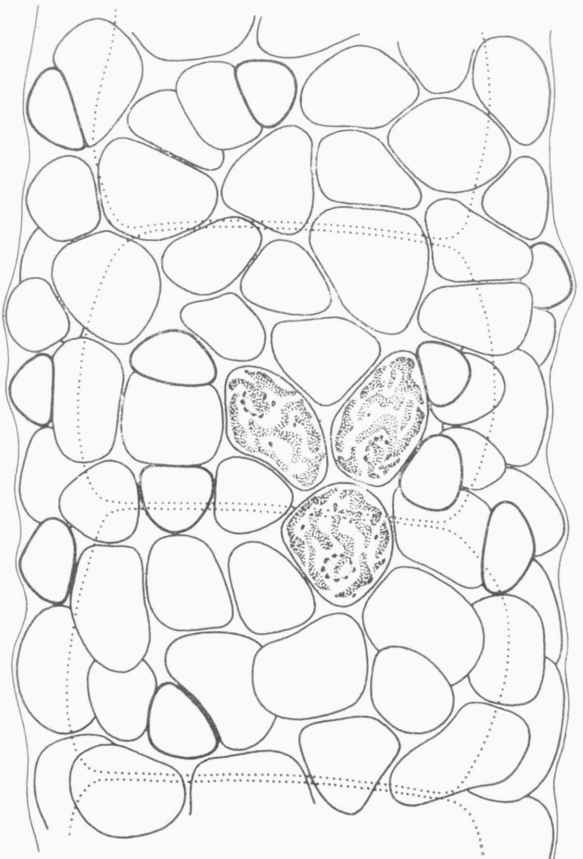
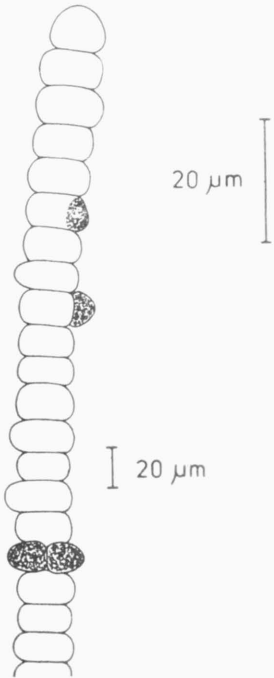
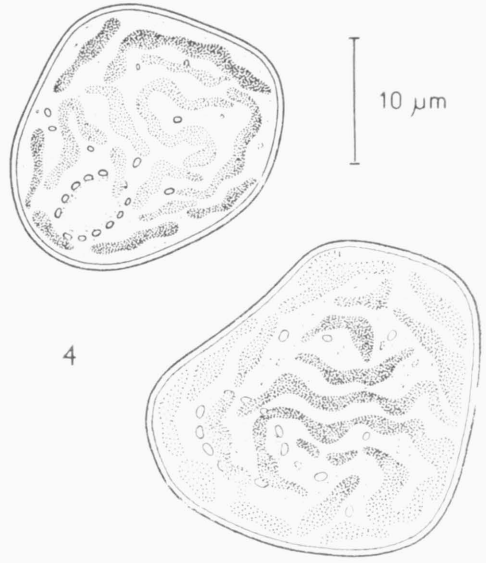
#### REFERENCES

- BOILLOT A. (1958): Sur la présence en France d'un *Compsopogon* (Rhodophyceae, Bangioideae). — Soc. Phycol. de France, Paris, Bull. 4.
- CHAPMAN V. J. et H. CAMERON (1967): *Compsopogon* in New Zealand. — New Zealand J. Bot., Wellington, 5 (4) : 548—552.
- COLLINS F. S. (1916): Notes from the Woods Hole Laboratory. 1915. — Rhodora, Boston, 18 : 90—92.
- DAS C. R. (1964): The *Compsopogonales* in India. — Proc. Nat. Inst. Sci. India, Alahabad, 29, B, No. 2 (1963) : 239—243.
- FAN K. C. (1960): On pit connections in the Bangiophyceidae. — Nova Hedwigia, Lehre, 1 : 305—307.
- FOTT B. (1971): Algenkunde, Ed. 2. — Jena.
- FRIEDRICH G. (1966): *Compsopogon hookeri* Montagne (Rhodophyceae, Bangiophyceidae) — neu für Deutschland. — Nova Hedwigia, Lehre, 12 : 399—404.
- HEYNIG H. (1971): Die Rotalge *Compsopogon* als Bewohner von Warmwasser-Aquarien. — Mikrokosmos, Stuttgart, 8 : 228—234.
- JAO C. C. (1941): Studies on the freshwater algae of China. VIII. A preliminary account of the Chinese freshwater Rhodophyceae. — Sinensia, Nanking, 12 : 245—290.
- KRISHNAMURTHY V. (1957): The early stages of development in four species of *Compsopogon*. — Phytomorphology, New Delhi, 7 : 398—403.
- (1962): The morphology and taxonomy of the genus *Compsopogon* Montagne. — J. Linn. Soc. (Bot.), London, 58 : 207—222.
- MENECHINI G. (1840): Lettera al Dott. Corinaldi a Pisa. — Padova.
- MONTAGNE C. (1846): Phycées. — In: J. B. BORY de St. Vincent et M. DUREUX: Flore d'Algérie, 1 : 154.
- MÜLLER J. (1960): Die Rotalge *Compsopogon aeruginosus* — ein neuer Aquarienbewohner? — Mikrokosmos, Stuttgart, 49 : 203—207.
- NICHOLS H. W., J. E. RIDGWAY et H. C. BOLD (1966): A preliminary ultrastructural study of the freshwater red alga *Compsopogon*. — Ann. Missouri Bot. Gard., St. Louis, 53 (1) : 17—27.
- OKAMURA K. (1915): Icones of Japanese algae, III, N. VII. — Tokyo.
- SKUJA H. (1939): Versuch einer systematischen Einteilung der Bangioideen oder Protofloridaen. — Acta Hort. Bot. Univ. Latv., Riga, 11—12 : 23—40.
- SMITH G. M. (1950): The freshwater algae of the United States. Ed. 2. — New York.
- ŠULA J. (1930): *Pithophora pragensis* n. sp., eine neue *Pithophora* aus Prager Aquarien. — Preslia, Praha, 9 : 22—25.
- TAYLOR W. R. (1960): Marine algae of the eastern tropical and subtropical coasts of the Americas. Ann Arbor.
- THAXTER R. (1900): Note on the structure and reproduction of *Compsopogon*. — Bot. Gaz., London, 29 : 259—267.
- WEBER-VAN BOSSE A. (1921—1928): Liste des algues de Siboga. II. Rhodophyceae, 2e. part., 59c : 311—392. — Leiden.
- WEISS F. E. et H. MURRAY (1909): On the occurrence and distribution of some aquatic plants in the Reddish Canal, near Manchester. — Mem. Proc. Manchester Lit. Phil. Soc. 53 (14) : 1—8.

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See also Plate I in the Appendix.

Plate I. — 1. — Habit of *Compsopogon coeruleus* (BALBIS) MONTAGNE from a freshwater aquarium in Prague. — 2. — Surface view of a portion of an adult erect filament. The axial cells (indicated by dotted lines) are surrounded by small, irregularly shaped polygonal cortical cells. — 3. — Uncorticated uniseriate filament showing some arising monosporangia. — 4. — Single cell structure showing irregularly shaped chloroplasts and floridean starch grains associated with the nuclear area of the cell and not with the chloroplasts. Starch grains are seldom in close proximity to the chloroplast.



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J. S. ZANEVELD, B. FOTT and M. NOVÁKOVÁ: *Compsopogon coeruleus*, a red alga newly reported for freshwater aquaria in Prague