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GEORGE CLAUS

Contributions to the Knowledge of the Blue-Green Algae of the Salzlackengebiet in Austria[1])

Contents

In the summer of 1958 Prof. KARL HÖFLER of Vienna sent the author seven samples of living algae from the Salzlackengebiet of Burgenland (Austria). The samples sent by airmail did not arrive in the best condition probably due to the warm temperature. In order to make proper determinations of the blue-green algae it was necessary to cultur the samples.

My identifications are thus based partly on the original material worked over immediately after their arrival, partly on the forms cultured from Prof. HÖFLER's material. Because my task was to identify only the blue-green algae, other forms observed were not included in the list below. A total of 60 species or lower categories were found, 9 of which are new to science.

During the last few years several works appeared concerning the flora and fauna of the Salzlackengebiet (HUSTEDT, 1959c, LÖFFLER, 1957, 1959, HÖFLER et FETZMANN 1959).

The locations of the collected material treated in this paper can be found on the sketch published in LÖFFLER's work (1959). The numbers used in this paper to designate the collections are equal to the following ones employed by LÖFFLER (1959) and HUSTEDT (1959c).

No. 3: *Enteromorpha*-Graben, about 1 km east from Apetlon.
No. 7: Southern part of Fuchslochlacke. Floating pads amongst *Puccinellia* = No. 26 in LÖFFLER (1959) and HUSTEDT (1959c).
No. 9: Small pond infront of the „Unterer Stinker". Brownish-red deposit = No. 54 (ibid.).
No. 12: Unterer Stinker. Tufts of Oscillatoriaceae. = No. 36 (ibid.).

[1]) This study was supported by a grant from the U. S. Public Health Service No. A-2360 (C 2).

No. 14: Albersee. Tufts of Oscillatoriaceae. = No. 39 (ibid.).
No. 15: Albersee. Deposit. = No. 39 (ibid.).
No. 15c: Albersee. = No. 39 (ibid.).

The systematic enumeration of the determined forms is as follows: (the numbers after the name of the organism are identical with that of the collecting vials.) In Table I. the taxa are enumerated in alphabetical order and their occurrences are noted in the samples.

Chroococcales[1]) [2])

Chroococcaceae

1. *Microcystis marginata* (MENEGH.) KÜTZ.	15c.
2. *Microcystis flos-aquae* (WITTR.) KIRCHN.	15c.
3. *Microcystis holsatica* LEMM.	12, 15c.
4. *Aphanothece pallida* (KÜTZ.) RABH.	3.
5. *Chroococcus turgidus* (KÜTZ.) NAEG.	3, 14.
6. *Chroococcus minutus* (KÜTZ.) NAEG.	7, 9.
7. *Gomphosphaeria lacustris* CHODAT.	15c.
8. *Gomphosphaeria aponina* KÜTZ.	14, 15c.
9. *Coelosphaerium pallidum* LEMM.	14.
10. *Coelosphaerium kützingianum* NAEG.	15c.
11. *Synechococcus aeruginosus* NAEG.	15.

Hormogonales

Rivulariaceae

12. *Calothrix brevissima* G. S. WEST. 3.

Filaments epiphytic on *Cladophora*, very short: 23—55 μ long, 4.5—6 μ wide, not or very slightly tapering towards the end. Sheath firm, narrow, $\pm$ cylindrical, colorless; blue coloration with chlor zinc iodide. Trichomes short: 16—50 μ long, only very slightly tapering towards the end, or not tapering at all, with conically rounded ends, at the crosswalls constricted; dark olive green. Cells at the base 3—5 μ wide, shorter than wide, 1.5—2 μ long; at the ends 1—1.5 μ long. End cell conically rounded; no hair formed. Heterocysts basal, solitary, $\pm$ spherical with a diameter of 2.5—4 μ (Fig. 1, 1a).

According to GEITLER (1932. p. 624.) „Epiphytisch auf alten Pflanzenstengeln in Victoria-Nyanza-See, Africa. — Vermutlich nur ein Jugendstadium; wäre am besten zu streichen." I cannot agree with GEITLER that this species is a juvenile

[1]) I did not follow the corresponding part of the newest American system of the coccoid blue-green algae — published by DROUET and DAILY (1956) because the species' conception of these authors is still debated and in my opinion the system proposed by GEITLER (1932) — by taking into consideration the newer results of HOLLERBACH ET AL. (1953) and SKUJA (1948, 1956) is even today the most satisfactory system available for the determination of the blue-green algae.

[2]) For the same reason I did not use *Diplocystis* TREVIS, the name preferred by KOMAREK, (1958, p. 46) instead of *Microcystis*. Even the author himself is in favor of using *Microcystis*, which should become a „nomen conservandum" (p. 47).

Table I

Name of Organism	Numbers of Samples						
	3	7	9	12	14	15	15c
Anabaena minutissima LEMM.	+						
Anabaena sp. (sterile)	+						
Anabaenopsis raciborskii WOŁOSZ.					+		
Aphanothece pallida (KÜTZ.) RABENH.	+						
Calothrix brevissima G. S. WEST	+						
Chroococcus minutus (KÜTZ.) NAEG.		+	+				
Chroococcus turgidus (KÜTZ.) NAEG.	+				+		
Coelosphaerium kützingianum NAEG.							+
Coelosphaerium pallidum LEMM.					+		
Dasygloea höfleriana nov. spec.				+			
Gomphosphaeria aponina KÜTZ.					+		+
Gomphosphaeria lacustris CHOD.							+
Lyngbya biebeiana nov. spec.				+	+		+
Lyngbya borgertii LEMM.					+		+
Lyngbya distincta (NORDST.) SCHMIDLE							+
Lyngbya epiphytica HIERON.							+
Lyngbya erebii W. et G. S. WEST var. *thermalis* CLAUS							+
Lyngbya kossinskajae ELENK. var. *gracilis* nov. var.	+						+
Lyngbya lagerheimii (MOEB.) GOM.							+
Lyngbya limnetica LEMM.	+						+
Lyngbya martensiana MENEGH.		+					
Lyngbya martensiana MENEGH. fa.				+	+	+	+
Lyngbya norgardhii WILLE	+						+
Lyngbya norgardhii WILLE fa. *schirschoviana* ELENK.							+
Lyngbya pusilla (RABENH.) HANSG.	+						
Microcystis flos-aquae (WITTR.) KIRCHN.							+
Microcystis holsatica LEMM.				+			+
Microcystis marginata (MENEGH.) KÜTZ.							+
Nostoc minutissimum KÜTZ.			+				+
Nostoc sp. (sterile) probably *commune*							+
Oscillatoria acuiformis SKUJA fa.							+
Oscillatoria amphigranulata VAN GOOR							+
Oscillatoria animalis AG.		+	+	+			
Oscillatoria articulata GARDNER	+						
Oscillatoria brevis (KÜTZ.) GOM. fa. *brevis*		+	+				
Oscillatoria brevis (KÜTZ.) GOM. fa. *acuminata* fa. nova		+					
Oscillatoria brevis (KÜTZ.) GOM. fa. *capitata* fa. nova		+					
Oscillatoria coerulescens GICKELH.							+
Oscillatoria meslinii FRÈMY fa.				+	+		
Oscillatoria neglecta LEMM.	+						
Oscillatoria pseudogeminata G. SCHMID	+	+		+	+		+
Oscillatoria redekeii VAN GOOR							+
Oscillatoria subbrevis SCHMIDLE			+	+			

Table I

Name of Organism	Numbers of Samples						
	3	7	9	12	14	15	15c
Oscillatoria subtilissima Kütz.	+		+				
Oscillatoria trichoides Szafer	+		+				
Phormidium antarcticum W. et G. S. West			+				
Phormidium bigranulatum Gardner fa.							+
Phormidium dimorphum Lemm.			+				
Phormidium foveolarum Gom.	+	+	+	+	+	+	+
Phormidium lignicola Frèmy							+
Phormidium luridum (Kütz.) Gom.		+			+		+
Phormidium molle Gom.		+	+	+	+		
Phormidium subtruncatum Woronich. var. *constrictum* nov. var.						+	
Phormidium tenue (Menegh.) Gom.	+						
Phormidium tenuissimum Woronich.							+
Phormidium treleasei Gom. fa. *breviarticulata* fa. nova							+
Romeria austriaca nov. spec.						+	
Schizothrix bosniaca (Hansg.) Geitl.							+
Schizothrix rupicola Tilden					+		
Synechococcus aeruginosus Naeg.						+	
Total: 60	16	10	11	10	13	5	31
Addendum-Bacteriophyta:							
Thiothrix nivea (Rabenh.) Winogr.							+

form. There are many other small epiphytic *Calothrix* species which were not considered as juvenile forms. If he thinks the lack of hair is a determining factor in this case, he contradicts himself, when he characterizes the family Rivulariaceae (1932. p. 565): „Trichome ... nur sehr selten ohne deutliches Haar (*Calothrix*-Arten).“ Some typical *Calothrix* species do not have a hair through out their whole life cycle. My opinion is that the mentioned species is a well circumscribed, distinct one which because of its epiphytic mode of life probably shows a reduction of its shape. (Similar reduction is observable on the *Lyngbyae* of the section of Heteroleibleinia).

The question becomes more problematic at this point whether the trichomes are constricted at the cross walls or not. In his original diagnosis West (1907. p. 180.) states that they are not constricted — the same opinion is to be found in Geitler's work — yet one can observe marked constrictions on some of his drawings. According to Hollerbach (1953. p. 349.): „Trichomes ... at the location of the crosswalls are either constricted or not constricted.“ (Translated from the Russian). Because the specimens which I observed were in full agreement with those represented by West's figures, but were always constricted at the crosswalls I would favor the modified description of Hollerbach.

From the time of its first description as a tropical species, *Calothrix brevissima* has been found in many different habitats throughout the Soviet Union. Hollerbach (loc. cit.): „In standing or moving water, epiphytic on aquatic plants, Ukraine, mountains of Central Asia.[1]“)

Nostocaceae

13. *Anabaenopsis raciborskii* WOŁOSZ. 14.

Filaments solitary amongst other algae, straight or wavily-curved, 2.2—2.4 μ wide; slightly constricted at the hardly visible crosswalls, faint bluish-green. Cells somewhat longer than wide: 2.4—3.6 μ long; do not contain gas vacuoles; walls give no reaction with chlorzinciodide. Heterocysts at the ends of the filaments, ovoid with sharply pointed end; as wide as the filament and 4.4 μ long. Arthrospores absent (Fig. 33).

According to WOŁOSZYNSKA (in GEITLER 1932. p. 809.) the cells are 2.5—4 μ wide and 5—7 μ long. She attributes this latitude in the measurements to the existence of „younger" and „older" individuals. In this case the specimens which I have examined correspond to the „younger" form. GEITLER (loc. cit.) writes in connection with this question: „Auffallend sind die sehr verschiedenen Breiten der Trichome; . . . Ein so starkes Schwanken ist ungewöhnlich; vielleicht liegen zwei verschiedene Arten vor". The fact that I never found in my cultures filaments wider than 2.4 μ (also the „older" forms were apparently absent) seems to confirm the opinion of GEITLER, and it is very probable that WOŁOSZYNSKA found two distinct but only slightly differing species. If this suggestion is confirmed, then I would like to propose the name *Anabaenopsis woloszynskae* for the „older" forms (4 μ wide trichomes) of WOŁOSZYNSKA's *A. raciborskii*.

The species first was described from the Rawa Demaugan lake of Jawa. Later it was found by SKUJA (1937) in a lake at Kastoria in Macedonia (Greece). KOMAREK has doubt about its validity (1958. p. 154.): „Steht nach der Art *A. tanganyikae* nahe."

In the last 25 years about 15 species of the genus were described from world-wide extra-tropical habitats.

14. *Nostoc sp.* (sterile, probably *commune*) 15c.

15. *Nostoc minutissimum* KÜTZ. emend. *mihi* 9, 15c.

incl. *N. ellipsoideum* GARDNER

Stratum aut fusco viride aut spadix aut olivacaeum; primo parvum, globosum, cum diametro minusquam 1 mm; deinde planum; aut mucosum aut cartilaginosum; cuius forma irregularis, mensura ad 3 mm. Thalli, cum dimensionibus microscopicis, globosi cum lamina fusco-lutea apud perimetros. Aut densa aut laxe congesta filamenta. Ad septa perconstricta: 1.0—1.8 micra lata; olivacaea. Vagina maxime confluxa; chlorozincico iodurato non colorata. Cellulae quadratae aut 2.2 plo longitudinis quam latitudinis: fere 2.0 micra longae. Protoplasma aut homogeneum aut delicatissime in chromatoplasmate granulatum. Heterocystae globosae aut eandem aut duplicem latitudinem cellularum vegitativarum (ad 2.8 micra latitudinem) habent. Arthrosporae subellipticae: 2.0—4.0 micra latae; 5.4—6.0 micra longae; cum superficie levi et fusca.

Stratum dark green, olive-green, or brownish, at first small, spherical, with a diameter less than 1 mm. later flattened mucilagineous or cartilagineous with an ir-

[1]) I did not take into consideration FAN's newest *Calothrix* monograph (1956, pp. 154--178.) because of the debated „species concept" of the author. FAN being a student of DROUET tries to establish species monsters without giving any evidence to support his theories. He even omitted from his work the list of synonyms, reserving it for a later publication.

regular shape up to 3 mm large. Microscopically-small thalli spherical with a firm, yellowish-brown sheath on the periphery. Filaments densly or loosly congested, at the crosswalls markedly constricted, 1—1.8 μ wide, olive-green. Sheaths mostly confluent, with chlorzinciodide no reaction. Cells quadrate or 2.2 times longer than wide, usually 2 μ long. Protoplasm homogeneous or with very fine granules in the chromatoplasm. Heterocysts spherical, as wide as the vegetative cells or two times wider (up to 2.8 μ in width.) Arthrospors subellipsoid, 2—4 μ wide, 5.4—6 μ long with smooth, brown walls (Figs. 2, 2a).

Kützing described the species in his Phycologia Generalis (1843. p. 204.) where, however, he cites his earlier work: Actien 1836. Unfortunately, I was unable to find any further information about this presumably first description. Forti (in de Toni 1907. p. 412.) also accepts as the original diagnosis that of 1843, but in this work Kützing does not give a drawing of the species and the first figures appear only 6 years later (Fig. 2b) in his Tabulae Phycologicae (Vol. II. Tab. 1. fig. 1. 1849). In his very short description Kützing states: "filaments densly entangled, 1—1.2 μ wide; cells spherical; arthrospores 2 times wider than the vegetative cells." He makes no mention of the arthosporelength nor does he speak about the heterocysts. Therefore Geitler writes: (1932. p. 851.) „Unvollständig beschrieben — an der geringen Zellgröße vielleicht kenntlich." The specimens in Rabenhorst's Exiccata (No. 2245), collected and identified by Richter as *N. minutissimum* have ellipsoid cells which are 4—4.6 μ wide, 5.6—6.2 μ long and spherical heterocysts with a diameter of 6.8—7.2 μ. Arthrospores could not be detected. Although Richter states on his label that the cells are 1/810''' = (2.7 μ) wide, even if this would be the case the exiccata specimen cannot be identical with Kützing's species. Elenkin in 1938 (in Hollerbach 1953. p. 17.) wants to include Kützing's species in *Nostoc coeruleum*, from which it is quite distinct, as already pointed out by Hollerbach. But the latter author follows Elenkin in dividing the genus *Nostoc* into four different genera and thus *N. minutissimum* would be transferred by Kossinskaja into the genus *Sphaeronostoc* (*Sphaeronostoc minutissimum* (Kütz.) Kossink.). This seems to me to be a very unfortunate division; therefore I treated the species under its original name.

Gardner (1927, p. 64) described a new *Nostoc* species from Puerto Rico, under the name of *N. ellipsoideum*, which has moderatly tortuous, not densly congested filaments. Cells 1.4—1.8 μ wide, quadrate or 2.2 times longer than wide. Heterocysts dolioform 2.4—2.8 μ wide. Arthrospors cca. 3 μ wide, 6 μ long. Geitler (1932, p. 863) in connection with this species writes: „Ist wohl mit *N. minutissimum* identisch ... ungenügend beschrieben und wohl schon bekannt ... (ist) zu streichen." The description of Gardner is much more detailed than that of Kützing and can hardly be considered as incomplete, but unfortunately he fails to give illustrations. As yet I have been unable to examine Gardner's type material because of renovation operations at the New York Botanical Garden.

The specimens which I have found have „punktförmig" or microscopically small, spherical thalli (in this latter case cca. 300 μ in diameter) with a firm yellowish-brown sheath on the periphery. Filaments loosely congested ± flexuous, markedly constricted at the crosswalls. Sheats confluent do not react with chlorzinciodide. From the above points it is more closely related to Gardner's form. Cells 1.8 μ wide subellipsoid, 2.0—2.2 μ long. Heterocysts spherical with a diameter (2 μ) somewhat greater than the width of the vegetative cells. Arthrospores 5.4 μ long, subglobous or subellipsoid; cca. 4 μ wide with smooth brown walls.

In my opinion all three forms are very closely related to each other and from many points the specimens which I found form a definite transitus between KÜTZING's and GARDNER's species. Therefore it seems to be most reasonable to unite all three under the name *N. minutissimum* KÜTZ.

In the following table the characteristics of the three forms are summarized:

Characteristics:	*N. minutissimum* (KÜTZ.)	*N. ellipsoideum* GARDNER	*N. species*found by me
Shape of stratum	Very small, spherical	Flattened, up to 3 mm	Very small, spherical
Arrangement of filaments	Densely congested	Loosely congested	Loosely congested
Shape of cells	Nearly spherical	Cylindric, elliptical	Cylindric, subellipsoid
Width of cells	1—1.2 μ	1.4—1.8 μ	1.8 μ
Length of cells	?	1.4—3 μ	2—2.2 μ
Shape of heterocysts	?	Dolioform	Spherical
Width of heterocysts	?	2.4—2.8 μ	2 μ
Length of heterocysts	?	?	2 μ
Shape of arthrospores	?	Elliptical	Subglobous, subellipsoid
Cellwall of arthrospores	?	Brown, smooth	Yellowish-brown, smooth
Width of arthrospores	2.4 μ	3 μ	4 μ
Lenght of arthrospores	?	6 μ	5.4 μ

The species is most probably cosmopolitan. This is confirmed by the long list of occurrancies compiled by FORTI. Although many authors have noticed it I could not find any satisfactory illustration.

16. *Anabaena sp.* (sterile) 3.

17. *Anabaena minutissima* LEMM. 3.

Oscillatoriaceae

18. *Romeria austriaca* nov. spec. *mihi* 15.

Filamenta solitaria aut hemicyclica aut paulo flexa; ad septa inarticulata; 2.3 micra lata. In hoc, inter terminos spatium circa 9 micra perspicitur; in illo, longitudo 8.0—10.0 micra videri potest. Trichomata, tenuissima vagina diffluente circumdata, chlorozincico iodurato non affecta, brevia sunt, paucas cellulas — plerumque sex — habentia, in apice rotunda. Quae aut quadratae aut latitudinis plures; quam longitudinis sunt; 1.8—2.3 micra longae. Colore subglaucescenti-viridi protoplasma aut homogenum aut nonnumquam in centroplasmate corpus volutinum magnum; cellulae apicales late rotundae. Lente ad dextram se volvunt. A speciei *R. chlorina* BÖCHER mensura aliarum *Romeriarum* ad septa inarticulata, differt.

Filaments solitary, semicircularly curved or only slightly bent, not constricted at the crosswalls, 2.3 μ wide. In the previous form there is cca. 9 μ distance between the ends, while the latter are 8—10 μ long. Thrichomes surrounded with a very thin diffluent sheath, which becomes visible only in India ink preparations and does not give a reaction with chlorzinciodide. They are short, consisting only of a few, —

usually 6 — cells; ends rounded. Crosswalls in living material hardly, or not visible at all, but after staining with LUGOL's solution they become apparent. Cells quadrate or somewhat shorter than wide; 1.8—2.3 μ long. Protoplasm pale bluish-green, homogeneous or sometimes with one big volutine body in the centroplasm; end cells broadly rounded. A scarcely observable dexterorotation was noticed resembling those of *Spirulina,* but it was much slower; rotation toward right (Fig. 3). The trichomes of the species in contrast to the other *Romeriae* are not constricted at the crosswalls, and from this point it segregates sharply with *R. chlorina* BÖCHER from all of the remaining species of the genus, while from BÖCHER's form it differs in its shape and measurements. There is some habital resemblance between *R. austriaca* and the undeveloped individuals of *Spirulina curta* (LEMM.) GEITL. and of *Spirulina abbreviata* LEMM. From the former it differs in its minor width and in its unconstricted filaments, while the latter has sharply pointed end cells and longer trichomes. Finally, from the immature individuals of the *Rhaphidiopsis* genus it differs in its measurements and in its rounded ends.

19. *Oscillatoria subbrevis* SCHMIDLE emend. mihi 9. 12.
incl. *O. fracta* CARLSON.

Trichomata solitaria; plusminusve recta; relative brevia, fere 100—120 micra longa; non constricta ad septa quae inconspicua, sed saepe granulata: 5.0—7.0 micra lata; nec attenuata nec ad apices flexa, sed e contra late rotundata. Longitudo cellularum ½—$^1/_3$—$^1/_5$ plo latitudinis: 1.0—2.0 (—3.0) micra. Protoplasma colore luteo-glaucescente viride; cellulae apicales late rotundatae; calyptra caret.

Trichomes solitary, $\pm$ straight, relatively short, usually 100—120 μ long, not constricted at the crosswalls which are very faint, but often granulated, 5—7 μ wide, not tapering and not bent towards the ends, but widely rounded. Cells (½)—$^1/_3$—$^1/_5$ times longer than wide, 1—2—(3) μ long with a bluish-green protoplasm bearing a yellow tint, endcells widely rounded, without calyptra (Fig. 4).

SCHMIDLE described the species in 1901 from the therma: Nakwikmi in Northern Africa and in contrasting it with *Oscillatoria brevis* (KÜTZ.) GOM. he emphasizes the following: 1. not tapering end of thrichomes, 2. thermal habitat, and 3. the moniliform shape of the cells, (of which only No. 1 has some systematic value; even SCHMIDLE points out that the moniliform shape of the cells is probably due to the preservation in alcohol). In his description he stresses (1901, p. 243): „Scheidewände nicht granuliert, schwer sichtbar", of which characteristic GEITLER does not make mention. I reproduced SCHMIDLE's original drawing (Fig. 5), the one published in GEITLER's work (1932, p. 946, fig. b) is somewhat different and is probably a redrawing.

In 1913 CARLSON reported a new *Oscillatoria* from the Antarctica, as *O. fracta.* It is very similar in every detail to the above described one. The thrichomes separated very easily into smaller pieces and from this characteristic feature the organism acquired its specific name. (CARLSON illustrates this peculiar behavior of the alga. I have reproduced his illustration under Fig. 6.) This feature, however, has no systematic value. CARLSON himself admits that the material was kept more than 10 years in the preserving medium, before he received it for identification and it is known that some of the more sensitive Oscillatoriaceae spontaneously fall apart even to cells under the influence of the preserving material. For instance, I could observe the same procedure in *Oscillatoria okenii, Lyngbya aestuarii* and *L. maiuscula.* Therefore, it is not very probable that in this case homogonium formation was observed, as GEITLER suggests (1932, p. 946). Apart from this behavior of the filaments the differences between SCHMIDLE's and CARLSON's forms are: 1. in the shape of the endcells (CARLSON's species has a more widely rounded end); 2. in the presence of granules at the crosswalls in *Oscillatoria fracta*, of which CARLSON states, that because of the relative invisibility of the crosswalls one can separate them only by the arrangement of these granules; and 3. in their habitats.

The specimens observed in my material have a ± widely rounded endcell and the crosswalls which are rather hard to see were in the same thrichome sometimes granulated or not granulated. In the following table the characteristics of the three forms are summarized.

Characteristics	*O. subbrevis* SCHMIDLE	*O. fracta* CARLSON	*O. sp.* found by me
Length of the trichomes	?	100 μ (or 10 μ)	120 μ (or mre)
Width of the trichomes	5—6 μ	6—7 μ	6.—36.6 μμ
Length of the cells	1—2 μ	1.3—(3) μ	1—2 μ
Formation of crosswalls	hardly visible	hardly visible	hardly visible
Granulation at the crosswalls	absent	present	present or absent
Trichome at crosswalls	not constricted ?	not constricted	not constricted
Shape of endcell	rounded	widely rounded	widely rounded
Distribution	Thermal (Africa)	Snow (Antarctica)	Lake (Europe)

From this table it is clear, that, apart from the differences in the distribution, there are no systematic marks on the basis of which it would be possible to make any differentiation among the three forms.

Concerning the occurrences, one should consider the following: SCHMIDLE in the discussion of the North African thermal algal flora writes (1901, p. 240—241) „Man darf aus diesen Befunden wohl den Schluß ziehen, daß die tropische Thermalflora der untersuchten Quellen von der europäischen wenig verschieden ist.“ Consequently, the occurrence of the *O. subbrevis* in the investigated lake is therefore interesting only because here the plant does not live in a thermal habitat. But many Cyanphyceae which were first described as thermal algae, later were found in the most varying habitats. Probably the well-known wide ecological valency of the blue-green algae would give the explanation for its antarctic occurrence, too. For more detailed discussion of this problem see „final remarks“.

20. *Oscillatoria trichoides* SZAFER 3,9.

21. *Oscillatoria subtilissima* KÜTZ. 3,9.

22. *Oscillatoria coerulescens* GICKELHORN 15c.

23. *Oscillatoria meslinii* FRÈMY fa. 12, 14.

Trichomes solitary, freely floating or amongst the thalli of other algae, especially *Lyngbya*, vivid yellowish-green, 7—7.3 μ wide, at the crosswalls very moderately constricted, more or less loosely twisted in spirals throughout their length, not tapering and not bent towards the ends; ends rounded. Cells shorter than wide, 1.7—2 μ long at the crosswalls strongly granulated, endcell rounded, without calyptra (Fig 7).

It differs from the original type of FRÈMY in three characteristics:

1. The thrichomes are ± loosely twisted in spirals throughout their entire length and not only towards their end.

2. The thrichomes are not tapering towards their ends.
3. The thrichomes are very mildly constricted at the crosswalls.

All of these differences, however, are too small criteria on which to base a new variety or even a species.

The type is known from French Equatorial Africa.

24. *Oscillatoria articulata* GARDNER 3.
25. *Oscillatoria neglecta* LEMM. 3.
26. *Oscillatoria amphigranulata* VAN GOOR 15c.
27. *Oscillatoria redekeii* VAN GOOR 15c.

According to SKUJA (1956, p. 63) is probably identical with *Oscillatoria planctonica* WOŁOSZ.

28. *Oscillatoria pseudogeminata* G. SCHMID 3, 7, 12, 14, 15c.
29. *Oscillatoria acuiformis* SKUJA fa. 15c.

Trichomes solitary, freely floating among other algae, straight or slightly bent, not constricted at the crosswalls, tapering, but not or very slightly bending towards the ends, 0.8 μ wide. Cells quadrate or 2.5 times longer than wide, 0.8—2 μ long. Protoplasm pale bluish-green, homogeneous without visible differentiation of the chromatoplasm, crosswalls not granulated. Endcells elongated conical, in the form of a nail, sharply pointed, calyptra absent (Fig. 8).

It differs from the type in its shorter cells, in the absence of granulation at the crosswalls and in its habitat, i. e. it does not live as an endophyte in the mucus of other algae as SKUJA's form. There is a close relationship between this form and *O. deflexa* W. et G. S. WEST, but the latter is wider.

30. *Oscillatoria brevis* (KÜTZ.) GOM. fa. *brevis* = 7,9.
(*Oscillatoria brevis* (KÜTZ.) GOM. pro parte.)

Thalli olivegreen, adherent on the substrate or freely floating in form of loose bundles. Thrichomes $\pm$ straight, not constricted at the crosswalls, tapering and bent (very seldom not bending at the end) towards their ends, yellowish green, 5.4—6.3 μ wide. Cells shorter than wide, 1.3—1.8 μ long, at the crosswals heavily granulated. Endcell conically rounded (Fig. 9, 9a).

There is a rather uncertainity throughout the literature, concerning the type and its varieties and forms specially in the description of the shape of the endcell.

KÜTZING (p. 186. 1843) describes *Oscillaria brevis* with an: „apiculo attenuato, obtusiusculo, flexuoso.“ (In this first description he gives no illustration of the species. His first drawing appears later (Fig. 10) in the Tabulae Phycologicae — Vol. 1, p. 28, table 39, fig. VI. — in 1845. Other authors followed essentially KÜTZING's description, so GOMONT in his Monograph states: (p. 229, 1892): „apice haud capitata subacute et breviter attenuata uncinata vel tortuosa“, and his illustrations are in complete agreement with this opinion (loc. cit. table 7, fig. 14—15) (Reproduced as Fig. 11 here).

GEITLER actually copies GOMONT's description and figures (after TILDEN) when he writes: „Endzelle abgerundet-kegelig“ (p. 977, fig. 619a, 1932).

However, FORTI in DE TONI's Sylloge . . . already in 1907 widened our knowledge regarding the shape of the endcell. He describes (p. 180) filaments with: „apice haud capitatis, subacute et breviter attenuatis, uncinatis vel tortuosis.“ He gives as a reference the specimens in the RABENHORST's Exiccata . . . under numbers 30 and 2131. The latter (and this is mentioned by GEITLER too) was collected by LE JOLIS and the specimen actually has the name: *Oscillaria subuliformis* LE JOLIS. According to FORTI this species is a synonym of *O. brevis*. Upon investigating the named exiccata it was found that the material contains a wide variety of elements as regards the shape of their endcells. The majority have the conically rounded type, while the capitate and subacute forms are fewer. Approximately, each 100th specimen has an elongated, tapering and sharply pointed end. However, there are present forms with untapered and widely rounded ends, (these might be considered as freshly broken or immature filaments). The length of the cells in the exiccatum is 1.3—3.2 μ. (In measuring the widht of a filament in an exiccatum, special care must be taken because of the deformations — as was shown by JAAG (1943, pp. 16—33) — one usually gets either smaller or larger numbers than those corresponding to the natural state.)

Finally, according to HOLLERBACH (p. 450, 1953): „The filament is tapering towards the end and usually is $\pm$ bent, in the form of a hook." (Translated from the Russian.) His figure (p. 448, fig. 6) is only a magnification of that of GOMONT and not an original by KOSSINSKAJA as he states!

A further complication emerged in connection with another species described by KÜTZING in 1843 (p. 185) as *Oscillaria neapolitana*. The species was placed by GOMONT under *Oscillatoria brevis* as a variety of it (*var. neapolitana* (KÜTZ.) GOM.) with its only distinguishing feature being its marine occurrence. FORTI keeps it also as a separate variety but he adds to it LE JOLIS' *Oscillaria subuliformis* as a synonym. It was he, however, who already furnished evidence for the synonymity of *O. brevis* with *O. subuliformis*. Thus, FORTI implicitly acknowledges that the variety cannot be maintained (If a = b and c = b, than a = c).

Although according to GEITLER the variety is valid, looking through the quoted material, I could not find any significant difference between the species and the supposed variety which would confirm their separability. (The marine occurrence in the one case has no taxonomic significance amongst the Cyanophyceae.) In my opinion it would be best to eliminate this variety.

In 1922 after having investigated SVEN HEDIN's collection from Tibet, WILLE described an interesting *Oscillatoria* with peculiarly formed end-cells. He called it *O. brevis* var. *variabilis* (WILLE in SVEN HEDIN's Southern Tibet. p. 184, 1922). He stated that: „Die Fäden sind sehr verschieden zugespitzt, bald sind sie abgerundet, bald sind sie sehr spitzig." Unfortunately, WILLE neither gives a picture, nor names the place of the exiccatum. GEITLER felt that it would be best to eliminate the variety (p. 977, 1932): „da sie sich auf systematisch wertlosen Merkmalen aufbaut, (. . . verschiedene Zuspitzung der Thrichome)".

ELENKIN (see in HOLLERBACK p. 450, 1953) follows essentially WILLE's opinion when he recognizes the validity of the form but he changes its position, making a forma from the variety. (*O. brevis* f. *variabilis* (WILLE) ELENKIN). The fact that ELENKIN divides specimens with the most variously formed endcells into his "forma" is not in complete agreement with WILLE's description. "The endcells look partly like the typical form, and are partly bent and tapering, reaching up to 10 μ length (in HOLLERBACH p. 450, 1953, translated from the Russian). However, in the cited work on table 245 one can see capitate and subacute forms too (figs. 8, 9, 10, 11) of which neither ELENKIN nor HOLLERBACH make any mention. (I reproduce these drawings in Figs. 12, 12a—d.) Furthermore the authors seemingly do not take into consideration those very sharply pointed forms which, according to WILLE, show a great resemblance to *O. janthiphora* (FIOR.-MAZZ.) GOM. According to ELENKIN's description the filaments are sometimes constricted at the crosswalls and this is pictured both on POPOVA's and WORONICHIN's drawings (loc. cit.). This is a characteristic of which there is no mention in WILLE's original description; nor could I confirm this in my material. After all it seems to be justified to separate the two „Grenzvariationen" as two distinct formae: on the one hand those with a capitate endcell and on the other hand those bearing an elongated attenuated and sharply pointed encell. Both forms may occur intermingled with the main type, or may form distinct populations. Their descriptions are as follows:

31. *Oscillatoria brevis* fa. *capitata* fa. nova mihi = (*O. brevis* fa. *variabilis* (WILLE) ELENK. pro parte. = *Oscillaria subuliformis* LE JOLIS pro parte). 7.

Trichomata aut alias algas internexa aut libere nant plus minusve erecta; ad septa aut totaliter aut paene inarticulata; in apice et attenuata et late manata; colore luteoglaucescenti viridi; 5.4—6.3 micra lata. Longitudo cellularum minor latitudine; 1.3—1.8 micra longae; ad septa granulatae. Cellula apicalis capitata ad superficiem rotunda; calyptra caret. A typo, sua capitata, differt.

Trichomes intermingled with other algae, or freely floating, ± straight, at the crosswalls not, or very slightly constricted, tapering and bending towards the end, yellowish-green, 5.4—6.3 μ wide. Cells shorter than wide, 1.3—1.8 μ long, at the crosswalls granulated. Endcell capitate with broadly rounded outer surface, calypta absent.

Type material in LE JOLIS' collection from Cherbourg, intermingled with *O. brevis* (KÜTZ.) GOM. fa. *brevis*, under the name of *Oscillaria subuliformis*, (RABENHORST's Exiccata ... No. 2131) (Fig. 13).

It differs from the type by its capitate end, and from *O. koetlitzii* FRITSCH by its narrower thrichome.

32. *Oscillatoria brevis* fa. *acuminata* fa. *nova* mihi = (*O. brevis* fa. *variabilis* (WILLE) ELENK. pro parte.) 7.

Trichomata aut alias algas internexa aut libere nant plus minusve erecta; ad septa aut totaliter aut paene inarticulata. Quae in apice et attenuata et late manata, colore luteoglaucescenti viridi; 5.4—6.3 micra lata. Cellularum longitudo minor latitudine; 1.3—1.8 micra longae; ad septa granulatae. Cellula apicalis in conum producta, praeacuta; calyptra caret. A typo, sua ad apicem praeacuta, differt.

Trichomes intermingled with other algae, or freely floating, ± straight, not, or very slightly constricted at the crosswalls, towards the end tapering and bent, yellowish-green, 5.4—6.3 μ wide. Cells shorter than wide, 1.3—1.8 μ long, granulated at the crosswalls. Endcell elongated cones, sharply pointed, calyptra absent.

It differs from the type by its conically elongated, sharply pointed end, from *O. lloydiana* GOM. by its narrower trichome and from *O. janthiphora* (FIOR.-MAZZ.) GOM. by its shorter cells. Fig. 14.

33. *Oscillatoria animalis* AG. 7, 9, 12.

34. *Phormidium foveolarum* GOM. 3, 7, 9, 12, 14, 15, 15c.

Trichomes 0.9—1.4 μ wide, cells 0.8—1.2 μ long. The protoplasm after treatment with chlorzinciodide shows a brownish coloration!

35. *Phormidium molle* GOM. 7, 9, 12, 14.

36. *Phormidium dimorphum* LEMM. 9.

37. *Phormidium tenue* (MENEGH.) GOM. 3.

38. *Phormidium treleasei* GOM. fa. *breviarticulata* fa. *nova* mihi 15c.

Filamenta solitaria, parvis in fasciculis, alias algas, plerumque *Phormidia*, internexa; mucosa, saepe confluens, vagina; chlorozincico iodurato non colorata. Trichomata aut recta aut paulo flexa; ad septa inarticulata; 0.6—0.8 micra lata; in apice nec attenuata nec flexa. Cellulae quadratae, quarum longitudo minor latitudine: 0.4—0.8 micra longae. Cytoplasma homogeneum; colore subglaucescente viride; non granulatum. Cellula apicalis obtusa rotundaque; calyptra caret. A typo, suis cellulis brevioribus, differt.

Filaments solitary in smaller bundles amidst other algae, mostly *Phormidia*. Sheath mucilaginous, some time confluent, no blue coloration with chlorzinciodide. Trichomes staight or slightly bent, not constricted at the crosswalls, 0.6—0.8 μ wide, not tapering towards the end and not bending. Cells quadrate, shorter than wide, 0.4—0.8 μ long. Cytoplasm pale bluish-green, homogeneous no visible granules after staining. Endcell obtuse rounded, no calyptra. Differs from the type by shorter cells (Fig. 15).

The new form is quite distinct and well differentiated from other minute *Phormidia* closely related, by its homogenous protoplasm, short cells and typical endcell. There is a superficial resemblance to *Ph. glaciale* W. et G. S. WEST but it is smaller than that.

Further it resemblens COPELAND's Yellowstone *Phormidia* (*Ph. geysericola, subterraneum* and *bijahensis*) but it is wider than those.

39. *Phormidium bigranulatum* GARDN. fa. *brevicellulata* fa. *nova* mihi 15c.

Filamenta alias algas internexa; vagina tenuis, firma, postea mucosa; chlorozincico iodurato non colorata. Trichomata curvata, ad septa flexa, non constricta: 1.0 micron lata; in apice nec attenuata nec flexa. Cellularum longitudo plus minusve 4plo quam latitudo; 3.8—4.8 micra longae; ad septa granulum unum videri potest. Cytoplasma colore subglaucescenti viridi, quod, solutione LUGOLIS adhibita, minuta granula aeque distributa manifestat. Cellula apicalis obtusa, rotunda; calyptra caret. A typo, suis cellulis brevioribus ac modo vivendi non-endophytico, differt.

Filaments entangled, among other algae. Narrow, firm, later mucilagineous sheath, no blue coloration with chlorzinciodide. Trichomes curved, flexed not constricted at the crosswalls, 1 μ wide, not tapering and not bent towards the end. Cells approximately 4 times longer than wide, 3.8—4.8 μ long, with one granule at each crosswall. Cytoplasm pale bluish-green finely and evenly granulated after staining with LUGOL's solution. Endcell obtuse round, no calyptra. It differs from the type by having shorter cells and a non-endophytic mode of life (Fig. 16).

The new form resembles *Ph. laminosum* (AG.) GOM. although the latter usually contains more granules along the crosswalls, also resembles *Ph. tenue* (MENEGH.) GOM. var. *granuliferum* COPELAND which nevertheless, is constricted at the crosswalls with tapering and pointed endcell.

40. *Phormidium antarcticum* W. et G. S. WEST 9.

Filaments solitary amidst other algae, sheath hardly visible, confluent, mucilagenous, no coloration with chlorzinciodide. Trichomes $\pm$ regularly twisted in loose spirals 0.7 μ wide, height of turns: 6.5 μ, distance between them: 12.6 μ. Cells twice as long as wide, 1.4—1.5 μ long. Protoplasm pale bluish-green, homogeneous, not granulated at the crosswalls, endcell conically rounded, not tapering, no calyptra.

According to FRITSCH it is a *Lyngbya*, but WEST even in the original description states (1911, p. 292): "It need not be confused with any of the spirally twisted plankton species of *Lyngbya*. It has no definite sheath and is smaller and narrower than any of them. Some specimens showed slight indications of a sheath which had become diffluent . . ."

As can be seen from my illustration (Fig. 17) the sheath is either very thin or diffluent. In this latter case it becomes visible only in India ink preparations, but there it is very apparent. As far as I know, the species is known only from Antarctica; its presence in the Salzlackengebiet is astonishing; but not absurd. Other arctic or antarctic species, too, were later found in great abundance throughout the world. A striking example is *Ph. frigidum* FRITSCH. But about this problem I shall speak later.

41. *Phormidium tenuissimum* WORONICH. 15c.

Filaments in bundles or freely floating among other algae, straight, or slightly bent. Sheath thin, firm, colorless, no blue coloration with chlorzinciodide. Trichomes not constricted at the crosswalls, not tapering towards the end but rounded, 0.8 μ wide. Cells twice longer than wide, 1.6 μ long. Cytoplasm pale bluish-green, homogeneous, not granulated along the crosswalls, endcell widely rounded, no calyptra. Discovered originally in *Nostoc* (*Stratonostoc*) *commune* communities in the arctic regions of the Ural mountains. Its presence in the Salzlackengebiet is surprising (Fig. 18).

42. *Phormidium lignicola* FRÈMY 15c.

Filaments in dark black colonies, straight or bent, 1.5 μ wide. Sheath firm, tight or mucinous, no blue staining with chlorzinciodide. Trichomes not constricted at the crosswalls, not tapering or bending towards the end, but rounding, 1.4—1.5 μ wide. Cells three-four times longer than wide, with an average length of 5.2 μ. (On p. 1007 the data of GEITLER, — 1932 — are incorrect, probably because of a printing error: "Cells two-three times longer than wide, length: 4.5—7.5 μ"). Cytoplasm pale bluish-green, finely granulated, almost homogeneous, not granulated along the crosswalls. Endcell rounded, no calyptra. Originally described in French Equatorial Africa, its presence in the Salzlackengebiet is interesting (Fig. 19)

43. *Phormidium subtruncatum* WORONICH. var.
constrictum nov. var. mihi 15.

Thallus colore sordido-glaucescenti-viridi; filamenta plus minusve recta; vagina acolorata, tenuis, firma, chlorozincico iodurato non colorata. Trichomata ad septa perconstricta; nec attenuata nec flexa in apice, sed rotundata; 1.2 micra lata. Cellulae aut quadratae aut longitudinis plures quam latitudinis: 1.2—2.2 micra longae. Cytoplasma homogeneum, colore sublgaucescenti viridi; ad septa non granulatum. Cellula apicalis rotunda: calyptra caret. A typo, sua ad septa constricta et dimensionibus parvioribus, differt.

Colony dirty bluish-green. Filaments ± straight, sheath colorless, thin, firm, no staining with chlorzinciodide. Trichomes visibly constricted at the crosswalls, no tapering and no bending, but rounding at the end, 1.2 μ wide. Cells quadrate or longer than wide, 1.2—2.2 μ long. Cytoplasm pale bluish-green, homogeneous, not granulated along the crosswalls, endcell rounded, no calyptra. Differs from type in constrictions and smaller measurements (Fig. 20).

The new variety is closely related to *Ph. truncatum* LEMM. from which it differs by its constrictions and shorter cells. Actually the new variety deviates as much from its type as *Ph. truncatum* differs from *Ph. subtruncatum*. I am not sure that these species are really different. The only noticeable difference between them is the granulated protoplasm in the case of *Ph. truncatum*. This characteristic, however, varies greatly under different ecological influences. Because of this I did not want to create a new species. Further, since the protoplasm of my form is not granulated, I prefer to place it under *Ph. subtruncatum* as a variety. If my feeling about the identity of the two mentioned species is accepted, then according to priority, LEMMERMANN's species would be the valid one. Consequently, my variety must be placed under it.

44. *Phormidium luridum* (KÜTZ.) GOM. emend. mihi 7, 14, 15c.
(Incl. *Phormidium africanum* LEMM. + *Ph. subcapitatum* BOYE-PETERSEN.)

Thalli scortei et colore aut glaucescente- aut nigroviridi cum filamentis flexis. Vagina tenuis sed firma; chlorozincico iodurato aut vix aut non colorata; ad apicem nec attenuata necflexa, sed rotundata; 1.7—2.2 micra lata. Cellulae aut quadratae aut longitudinis plures quam latitudinis: 1.7—6.0 micra longae. Cytoplasma colore glaucescente-viridi; homogeneum; ad septa non granulatum. Cellula apicalis aut tonsa aut in conum producta. Calyptra aut absens aut minuta et difficiliter visa. A typo (GOMONTII) ita ut sua filamenta constringi et parvam calyptram adesse possint, differt.

Leather-like bluish or blackish green colonies with bent filaments. Sheath thin but firm, faint or no staining with chlorzinciodide. Trichomes lightly or deeply constricted at the crosswalls, not tapering or bending towards the end, but rounding, 1.7—2.2 μ wide. Cells quadrate or longer than wide, 1.7—6 μ long. Cytoplasm bluish-green homogeneous, not granulated along the crosswalls; endcell sheared off or conical, very poorly developed or no calyptra. Difference from the description of GOMONT (the type) is in the fact that the filaments could be highly constricted, and a small calyptra could be present.

The issue is highly confounded by the demonstrated illustration of GOMONT about *Ph. luridum* (Fig. 22) which shows markedly constricted trichomes. If the picture is correct instead of the description, there is only a color difference which is relatively unimportant. Furthermore, in this situation there is also a close resemblance to LEMMERMANN's *Ph. africanum* except that the small calyptra is visible on this species. (On p. 999, 1932. GEITLER mistakenly states that the sheath of *Ph. africanum* does not stain blue with chlorzinciodide. According to the original description it does !)

According to LEMMERMANN's implicit statement the description of GOMONT, is correct, but not his illustrations. This becomes evident from his differential diagnosis of the *Ph. africanum* against *Ph. luridum*, when he emphasizes that the filaments of the former are more constricted and that they have a small calyptra (LEMMERMANN: 1912, p. 89). Unfortunately, LEMMERMANN does not illustrate his new species.

According to GEITLER (1932, p. 999) the specimen, No. 528 of the Exiccata of WITTROCK-NORDSTETT is identical with *Ph. luridum*. This material, however, contains filaments with or without constrictions (which when present may be rather strongly pronounced) and with higher magnification sometimes a small calyptra is also observable. According to these findings *Ph. africanum* cannot be considered to be an independent species when the only difference from *Ph. luridum* is in the bluish-green color of its colonies and in the more or less pronounced positivity of the chlorzinciodide reaction. The former characteristic has also wide variations as seen in the case of FRÈMY's formae *violascens* (identical with the type) and *nigrescens* (= *Ph. luridum* fa. *nigrescens* FRÈMY) and according to my opinion is not enough for classifying it as an independent species.

If we want to maintain these separate formae (done so by COPELAND 1936, p. 179) as dictinct ones, then the *Ph. africanum* could be specified as the chlorescens form of *Ph. luridum* (= *Ph. luridum* fa. *chlorescens*). This form would correspond also with the forma I described above. The only difference from the Salszlacken form would be the presence of the poorly developed calyptra at LEMMERMANN. The whole problem could be solved if preserved material were obtained from the collection of LEMMERMANN, but he does not enumerate exiccata species.

Further complication arises from the fact that BOYE-PETERSEN in 1923 desbribed a species from Iceland under the name of *Phormidium subcapitatum*, which according to the author (1923, p. 282) is closely allied to LEMMERMANN's *Ph. africanum* and is distinguishable from it by its sheath not staining blue with chlorzinciodide. (I took over BOYE-PETERSEN drawings under Fig. 23.) Although BOYE-PETERSEN considers the color of the colony to be very important and his plants occur in a colony with an „atro-aerugineo" shade, he does not consider this as a differential diagnostic distinction from the bright bluish-green color of *Ph. africanum*. (At least he does not mention it!) Nevertheless, if *Ph. africanum* is identical with *Ph. luridum* and we take into consideration the non-complete specificity of the chlorzinciodide reaction (as was already mentioned, the only distinguishing feature between *Ph. africanum* and *Ph. subcapitatum* is the blue staining of the sheath of the former) and upon this we base the identity of *Ph. africanum* with *Ph. subcapitatum*, then this latter must also be identical with *Ph. luridum*, i. e. with the *violascens* form of it described by FRÈMY which according to COPELAND is the species itself. And although FRÈMY does not mention a calyptra, its presence can be postulated for two reasons:

1. As described in the exiccata material, which I have seen calyptra were observed on several filaments of *Ph. luridum*.

2. Although BOYE-PETERSEN emphasized that the calyptra of *Ph. subcapitatum* are very hard to see, he nevertheless states that they are present (1923, loc. cit.): "In order to see it the finest optical facilities are needed."

Since neither GOMONT nor FRÈMY report the presence of calyptra nor did I myself find any in the specimens examined from the Salzlackengebiet, then it would seem that the development of the calyptra is dependent upon factors unknown and therefore cannot be considered to be a decisive mark for classification.

If, all these suggestions are correct (unfortunately, I could not obtain No. 297 vial of BOYE-PETERSEN's collection containing the type for *Ph. subcapitatum*) the description of *Ph. luridum* could be emended with the mentioning of the bluish-green, violaceous or blackish colour of the colonies, the marked or less pronounced constrictions of the trichomes, the sometimes positive chlorzinciodide reaction and the possible presence of a hardly visible calyptra.

In this instance, neither *Ph. africanum* nor *Ph. subcapitatum* can be considered as independent entities and they should be merged with *Phormidium luridum* (KÜTZ.) GOM.

Characteristics	*Ph. luridum* (KÜTZ.) GOM.	*Ph. luridum* f. *nigrescens* FRÉMY	*Ph. luridum* fa. found by me	*Ph. africanum* LEMM.	*Ph. subcapitatum* BOYE-PETERSEN
Color of colonies	Dark violaceous	Blackish-bluish	Bluish-green	Bluish-green	Dark bluish-green
and trichomes	Faint violaceous	Gray blue	Dull bluish-green	Bright bluish-green	Dark bluish-green
Sheath with chlorzinciodide	No staining	No staining	No staining	Weak staining !	No staining
Width of trichomes	1.7—2 µ	1.7—2 µ	1.8—2 µ	1.5—2 µ	1.8—2.2 µ
Trichomes at crosswalls	Constricted	Constricted	Highly constricted	Highly constricted	Constricted
Granulation at crosswalls	Absent	Absent	Absent	Absent ?	Absent ?
Length of cells	1.8—4.7 µ	1.8—4.7 µ	1.8—4.8 µ	1.5—4 µ	1.8—6 µ
Protoplasm	?	?	Homogeneous	?	?
Calyptra	Present ! ?	Absent	Absent	Very small	Hardly visible

In the following table (Table II) the characteristics of the three "species" and two "formae" are compiled. (*Ph. luridum* fa. *violascens* FRÈMY is omitted because it is considered to be identical with the type.)

45. *Lyngbya pusilla* (RABH.) HANSG.

46. *Lyngbya epiphytica* HIERON. 15c.

47. *Lyngbya norgardhii* WILLE 3, 15c.

48. *Lyngbya norgardhii* WILLE fa. *schirschoviana* ELENK. (Fig. 24). 15c.

49. *Lyngbya distincta* (NORDST.) SCHMIDLE 15c.

Cells 1.8 µ wide, 1.4 µ long.

The specimens occured always attached on debris but were never found on other algae or on higher aquatics. (Fig. 25).

The distinction between this species and *Lyngbya rigidula* (KÜTZ.) HANSG. is fluent and not satisfactory. They might be identical! I do not agree with ELENKIN when he classifies it under *L. kützingii* (KÜTZ.) SCHMIDLE as fa. *distincta* (NORDST.) ELENK. (See in HOLLERBACH p. 533. 1951.) Even the measurements given by ELENKIN are not in complete agreement with NORDSTEDT's data.

50. *Lyngbya lagerheimii* (MOEB.) GOM. 15c.

51. *Lyngbya limnetica* LEMM. 3, 15c.

Cells 1.8 µ wide, quadrate.

The distinction between this species and *Lyngbya subtilis* W. WEST is not clear cut. They might be identical!

52. *Lyngbya borgertii* LEMM. 14, 15, 15c.

Filaments solitary or several attached to each other, bent or straight. Sheath very thin, firm, colorless, no blue staining with chlorzinciodide, no constriction at the crosswalls; 2.5 µ wide. Ends not tapering and not bent but obtusly rounded. Cells longer than wide, 3.6 µ long. Pale bluish-green cytoplasm, single, rarely two-three large, irregularly shaped gas vacuols in centroplasm. In the chromatoplasm along the crosswalls one to three irregularly shaped granules visible. Since the first discovery in Ceylon this species was described from Europe and several parts of North America; probably cosmopolitan (Fig. 26).

53. *Lyngbya erebii* G. et W. S. West var. *thermalis* Claus 15c.

Colony thin, bluish-green, filaments bent, entangled. Sheath thin, firm colorless, no blue staining with chlorzinciodide. Trichomes markedly constricted at the crosswalls, 0.9—1.0 μ wide, with rounded ends. Cells shorter than wide, 0.6—0.8 μ long. Cytoplasm bright, bluish-green, scarcely granulated along the crosswalls, endcell widely rounded, no calyptra.

The type was described from Antarctica, the variety from the therma of Bükkszék, from Hungary, living in 37°C. water (Fig. 27).

54. *Lyngbya martensiana* Menegh. 7, 14.

Filaments 10.4 μ wide; trichomes 7.8 μ wide; cells 1.8—2.3 μ long; crosswalls granulated.

55. *Lyngbya martensiana* Menegh. fa. 12, 14, 15, 15c.

Colony bluish-green entangled (Fig. 28) filaments straight or slightly bent. Sheath thick, firm, mucilaginous or with cracked outer layer, no blue staining with chlorzinciodide. The encircling crack on the surface of the sheath demonstrates its spiral structure. Sometimes the entire sheatch is cracked along a spiral line (Figs. 28a, 28b). Similar structure was noted by Skuja in *Lyngbya stagnina*. Filaments 11—13 μ wide, trichomes 9.5 μ wide, dark bluish-green, readily moving up and down in the sheath, even sliding entirely out of it. (Figs. 28c, 28d.) In this case the forms having a slightly spiral structure float freely with a motion resembling that of *Oscillatoria*. (Fig. 28e). Between the cells wide concave spaces can be seen. (Not a systematic feature.) The sheathless filaments assume a yellow color under unfavorable circumstances (lack of nutrients ?) Cells shorter than wide, 0.5 μ long in fast growing cultures (Fig. 28f) but usually 2—2.2 μ long. Cytoplasm bright bluish-, or yellowish-green, strongly granulated, except along the crosswalls, where is no granulation. Endcell rounded, no calyptra.

In the material received for identification more sheathless than sheathed forms were found, presumably because of the heat and lack of O_2. These forms, however, were hardly mobile. After the samples were confined for two more days, the already sheathless forms became completely yellow and showed a vigorous motion, while those few forms which were still found in their sheath and had their original dark-green color were noted sliding out of their sheaths. Even if they were straight or only slightly bent when confined in their original sheath they assumed a $\pm$ regularly spiral form when freed from the sheath. This process could not be considered as a production of homogonia because of the considerable length of the nude filaments (achieving length more than 1000 μ) contradicts this possibility. These sheathless vigorously moving filamentous forms were in many cases indistinguishable from some *Oscillatoria* species.

Immediate cultures were prepared from one part of the material. In the Petri dishes sheathless specimens could also be found although less frequently than in the original bottles deprived of O_2. This indicates that the cause of the movement of the filament from its sheath in this species is neither the lack of O_2 nor the lack of nutrients. Nor can it be stated that the presence of O_2 would account for this phenomenon as was observed by Utermöhl in the case of *Lyngbya* (*Oscillatoria*) *lauter-*

bornii (SCHMIDLE) UTERM. The literature describes some *Lyngbya* species which leave their sheaths easily, for instance, *L. brachynema* SKUJA. The author writes (1948, p. 54): „Die Scheiden sind . . . in der Regel vorhanden, doch kriechen die Fäden verhältnismäßig leicht aus ihnen hinaus." Unfortunately, there is no mention as to whether or not these sheathless forms retain their motility. For *L. pseudovacuolata* VETTER fa. (SKUJA 1948, p. 55) he mentions: „Man findet auch scheidenlose Trichome . . . immer sind sie aber unbeweglich." Finally, the same author writes the following about *L. chlorospira* SKUJA, (1948, pp. 55—56): „. . . fehlt den Trichomen von *Lyngbya chlorospira* die Scheiden . . . sie sind immer unbeweglich." According to these statements some species of the *Lynbya* genus abandon their sheath but these naked filaments remain motionless.

The problem becomes somewhat more complicated by several observations like those of UTERMÖHL's or mine, namely, that the filaments have a slow or vigorous *Oscillatoria*-like motion in their sheathless state. Considering UTERMÖHL's observations, HUBER-PESTALOZZI concludes (1938, p. 250): „Die Leichtigkeit womit die Trichome von *L. lauterbornii* die Scheide verlassen erinnert an *Phormidium*, die systematische Stellung obiger Form erscheint noch nicht gesichert."

Further confounding of the issue is presented by the taxonomically uncertainly positioned *L. pseudospirulina* PASCHER. HUBER-PESTALOZZI considers this species more likely to be a *Phormidium*. This "*Lyngbya*" described by PASCHER, has a vigorous motion. Nevertheless, it has a considerably developed sheath, which sometimes is absent. Both the sheath and the motility have given rise to much discussion. All algalogist are in complete accord that *Lyngbya*-type-sheathed filament cannot move. But from the reports of PASCHER, GEITLER erronously concludes to the existence of moving sheathed filaments. Since their movement negates the possibility of a *Lyngbya*-type-sheath, he postulates a non-*Lyngbya*-type-sheathed filament. (1932, p. 1043). This, too, would seem to be going beyond the evidence, because as SKUJA already pointed out, (1948, p. 56): „. . . man weiß jedoch nicht ob auch bescheidete Trichome hier beweglich sind (was kaum anzunehmen ist.)". There is no actual mention in PASCHER's description whether the filaments are moving in sheated or sheathless form.

In opposition to GEITLER's non-*Lyngbya*-type-sheath, a more simple explanation presents itself. Several investigators have noticed that *Lyngbya* filaments can abandon their sheaths and in this case, the filaments can be either motile or immotile. This latter opinion is held by SKUJA, as shown above in his description of *L. chlorospira* SKUJA und *L. pseudovacuolata* VETTER fa. SKUJA. Further, when he does not employ the name proposed by PASCHER (*L. pseudospirulina*), but uses instead UTERMÖHL's synonym *Spirulina pseudovacuolata*, which genus contains only sheathless, motile forms, he implicitly states that even if a species of the *Lyngbya* genus abandons its sheath it must remain immotile. In the same way, he again contradicts UTERMÖHL' statements referring to *Lyngbya lauterbornii* (SCHMIDLE.) UTERM., namely: that there exist both sheathed and sheathless forms of which only the latter are actively moving, by using its older classification as *Oscillatoria*, and by writing the following about the motility of this species (1956, p. 64): „Die Fäden bewegen sich unter Rotation um die Längsachse zuweilen mit einer Geschwindigkeit bis 70 μ in der Minute, häufig sind jedoch keine Bewegungen festzustellen."

Conclusively, those forms, which are capable of performing active movement are condidered as either *Spirulina* or *Oscillatoria*, whether or not they have a firmly sheathed stage. Only those species would belong to *Lyngbya* which — even if they occured in a sheathless state — do not show any motility.

I am accord with SKUJA in disagreeing with the opinion of HUBER-PESTALOZZI that those species which can more or less easily abandon their sheath should be classified as *Phormidium*, because in this genus the formation of the sheath is more characteristic than the capacity of the filament to move in it or to slide out of it. However I disagree with SKUJA in another respect. I am convinced that the species which abandon their originally solid sheath and still retained their motility should be considered *Lyngbya*. For this reason I have placed the above mentioned forma of mine under *Lyngbya martensiana*; and also favor *Lyngbya pseudospirulina* PASCHER in preference to *Spirulina pseudovacuolata*, the synonym of UTERMÖHL preferred by SKUJA.

The inconsistant importance of motion as a useful mark of classification within the Oscillatoriacea family was pointed out by SKUJA on the different formae of *Oscillatoria trichoides* SZAFER. He writes the following about a forma observed in 1927 (1948, p. 48): „Die Fäden sind ohne Scheide und immer unbeweglich." Later he mentions another forma found in 1926 (1956, p. 64): „Gewöhnlich erscheinen die Fäden bewegungslos und nur selten gelingt es, eine sehr langsame Gleitbewegung festzustellen.

Another example is given by GEITLER (1932, p. 1026.) who writes the following concerning *Phormidium uncinatum* GOM.: „Drehrichtung nach links." Therefore in the differentiation among the three closely related genera (*Oscillatoria, Phormidium, Lyngbya*) the motility of the filaments is only a quantitative mark and the most stable systematic characteristic is still the formation of the sheath. It is naturally very difficult to determine correctly *Phormidium* or *Lyngbya* when only sheathless forms are oberserved. Sometimes ist is impossible or missleading and in these instances culture experiments are unavoidable.

On the basis of the above, one must consider that the new forma described is a *Lyngbya* which has both motile and immotile sheathless states. Therefore the diagnosis of the genus *Lyngbya* (described by AGARDH and more accurately determined by GOMONT) has to be completed with the statement that under certain conditions the filaments have the capability — at least in certain species — to abandon their sheaths, and that these forms cannot be considered as hormogonia. Regarding this GEITLER states (1932, pp. 18—19): „Obwohl die Scheide auf die Tätigkeit der Trichomzellen zurückgeht, also eine gemeinsame Membranbildung aller Zellen ist, besitzt das Trichom innerhalb der Scheide weitgehende Selbständigkeit. Es kann bei plötzlichen und kräftigen Wachstum die Scheide sprengen und sie im Homogonium Stadium überhaupt verlassen", but there is no mention of whole trichomes abandoning their sheaths. These nude forms are either immotile or moving about with a longitudinal circumaxial rotation resembling closely that of *Oscillatoria*.

The newly described forma differs from the type in that there is never granulation along the crosswalls and that under certain circumstances it can easily abandon its sheath and move subsequently with *Oscillatoria* like motion.

56. *Lyngbya biebliana*[1]) spec. nov. *mihi* 12, 14, 15c.

Thallus colore glaucescento viridi, filamenta sese intermixa, aut recta aut paulo flexa. Vagina et crassa et salebrosa, sed non pannosa; firma, acolorata, chlorozincico

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[1]) The species was named honoring the outstanding Austrian algologist-physiologist Professor RICHARD BIEBL.

iodurato non colorata; filamenta 9 micra lata. Trichomata ad septa non constricta, quae in apice nec attenuata nec flexa, sed in conum rotundata; 6.3—6.5 micra lata. Cellulae latitudinis plures quam longitudinis: 1.7—2.0 micra longae. Cytoplasma colore luteoglaucescenti viridi; homogeneum; minutissime granulatum; septa aut non granulata. Cellula apicalis in conum rotundata; in terminis cum plasmatis operculo distincto tecta. Filamenta facile de vagina desistunt, deinde sicut *Oscillatoria* movent; ad dextram se volvunt. Ad speciem, *Lyngbya antarctica* GOM., proxime accedit; quae, autem, et ad apicem attenuata et capitata et ad septa granulata.

Colony bluish-green, filaments entangled, straight or slightly bent. Sheath thick, uneven, but not frayed, firm, colorless, no blue staining with chlorzinciodide, filaments 9 μ wide. Trichomes not constricted at the crosswalls, ends not tapering, not bent, but conically rounded, 6.3—6.5 μ wide. Cells shorter than wide, 1.7—2 μ long. Cytoplasm yellowish-greenish-blue, homogenous, finely granulated but no granules along the crosswalls. Endcell conically rounded with well developed plasma cap at the end. Filaments easily abandon sheath, subsequently, moving with *Oscillatoria* like motion; rotation to right. (These characteristics are described above in detail, see: *Lyngbya martensiana* fa.) (Fig. 29a, 29b, 29c).

Its closet resemblance is to *Lyngbya antarctica* GOM., which however, tapers towards the end and is capitate; furthermore its crosswalls are granulated.

There is certainly a great resemblance between this new species and *Phormidium ambiguum* GOM. Examining the exiccata specimens of *Ph. ambiguum* (the RABENHORST' Exiccata No. 75 referred to by GEITLER as a synonym was a mistake, because it is a green alga — but the other numbers are correct) I found filaments which differed from the original description in a fow characteristics: e. g. their width is not 6 μ but 6.45 μ — this might be the result of drying and flattening —; the sheath was never found to be confluent but frequently frayed; only one part of the filaments gave the chlorzinciodide reaction. Because I could not detect the type, and according to my findings the description of *Phormidium ambiguum* is in fact ambiguous (actually the structure and development of the sheath in the exsiccata species refer them to the *Lyngbya*) therefore, I find insufficient proof to associate my new species with this *Phormidium*.

Besides the above inconsistences to *Ph. ambiguum*, there are other characteristics which serve to distinguish the two species: e. g. the presence of the sheath in the new species definitely aligns it with *Lyngbya*; its filaments are never constricted at the crosswalls, which are never granulated; moreover the sheath never stains blue with chlorzinciodide; finally the sheathed trichomes are wider than those of *Phormidium ambiguum*.

57. *Lyngbya kossinskajae* ELENK. var. *gracilis* var. nov.
mihi 3, 15.

Filamenta ad 200 micra longitudinem tendunt; quae ad substratum termino fixa; numquam libere nant; aut flexa aut recta; 1.5 micra lata; colore subglaucescenti viridi. Vagina tenuis, firma, non-striata, acolorata, chlorozincico iodurato paene colorata. Trichomata 1.2—1.3 micra lata; quorum tenua septa in vivo inconspicua, tantum effectu chlorozincico iodurato apparent. Cellularum longitudo plus (bis-ter) quam latitudo: 2.5—3.6 micra longae. Protoplasma subglaucescens cum 1—3 granulis. Rotundata cellula apicalis; basalis nondum specifice formata. A typo, sua gracili forma, differt.

Filaments up to 200 μ length, attached to the substrate (*Cladophora*) with one end and never freely floating; variably bent or erect, 1.5 μ wide, pale bluish-green. Sheath narrow, tight, firm, without layers, colorless, very weak blue staining with chlorzinciodide. Trichomes 1.2—1.3 μ wide, crosswalls hardly visible in living condition, very thin and become apparent only after staining with chlorzinciodide (when they show a slight cellulose reaction). Cells 2—3 times longer than wide, 2.5—3 6 μ long. Protoplasma faint bluish-green with 1—3 granules in it. Endcell rounded, basal cell not specifically differentiated, like those at some species belonging to the Heteroleibleinia sectio. (Figs. 30, 30a.) By the lack of this the variety is well differentiated from the unripe members of the *Sokolovia* genus, too. Epiphytic together with *L. pusilla* and *L. norgardhii* on *Cladophora*.

The new variety differs from the type by its more graceful appearence. It is closely related to *L. kützingii* (Kütz.) Schmidle var. *minor* Gardner from which it differs by its longer cells. It, is also distinct from *L. kützingii* fa. *woronichinae* Elenk. (which is very probably identical with *L. subtilis* W. West), in that the filament is narrower and it gives a positive chlorzinciodide reaction.

Actually it is very hard to give a complete differential diagnosis in this case, because the taxonomy of these minute *Lyngbya* is not at all satisfactory and a revision of the more than 30 accepted species below 3 μ width is absolutely necessary, but this task is beyond the scope of this study.

58. *Schizothrix bosniaca* (Hansg.) Geitl. emed mihi 15c.

Filamenta sese internexa usque ad 22 micra lata crescunt; quae thallos non efficiunt. Vagina firma, transparens, acolorata; marginibus salebrosis; chlorozincico iodurato non colorata. Trichomata in vagina: basalia (aut 2 aut 3 aut 5); apicalia et solitaria; ad septa valde articulata; 3.8—4.0 micra lata; quorum apex et attenuatus et in conum rotundatus. Cellularum longitudo plus quam latitudo: 5.2—6.3 micra longae. Cytoplasma colore subglaucescente viridi; homogeneum. Cellula apicalis in conum rotundata. Inter alias algas, saepissime *Cladophora*, invenitur.

Filaments entangled, no colony formation; up to 22 μ wide. Sheath firm, transparent, colorless with uneven borders, no blue staining with chlorzinciodide. Trichomes 2—3—5 at the base and solitary at the top in the sheath, markedly constricted at the crosswalls, 3.8—4—4.8 μ wide, end tapering off and conically rounded. Cells longer than wide, 5.2—6.3 μ long. Cytoplasm dull bluish-green, homogeneous, endcell conically rounded. Amidst other algae, mostly *Cladophora*. (Fig. 31, 31a).

The type species was originally described by Hansgirg as *Lyngbya bosniaca* (1891, p. 348), later classified by Forti (in de Toni, 1907, p. 339) as a *Hypheothrix* and it was transferred by Geitler (1933, p. 1083) into the *Schizothrix* genus. From the original diagnosis of Hansgirg it does not become clear whether the trichomes are constricted at the crosswalls or not. This could be the basis for Geitler's remark: ,,Kaum identifizierbar.“

Drouet reexamining Hansgirg's original collection has found that *Lyngbya bosniaca* is identical with *Amphithrix janthiana* (Mont.) Born. et Flah. (Drouet 1957, p. 51). Although I have not seen the original material of Hansgirg, I am reluctant to accept the statement of Drouet for several reasons:

1. Drouet gives the original description as appeared in: ,,SB. Böhm. Ges. Wiss., math.-nat. Cl. 1. 1891, (1), p. 448; 1891.“ (Incidentally the year is 1892 and not 1891.) However, Hansgirg noted this species for the first time as a nomen nudum in 1890 on the 131st. page of the same periodical, in which he also mentioned: ,,. . . Lager

stellenweise fast goldgelb gefärbt war ...", whereas the *Amphithrix* is always violaceous.

2. According to DROUET the type locality is: „Bosnia: Duboj", however, HANSGIRG in his 1890 description gave the type locality as „in Spalato bei Kuin, Castell Vecchio, Clissa, Pisano." Only in his second description does he mention „in der Bosna und Jala bei Doboj ..." (Duboj may be a misspelling ?)

3. Generally accepted fact is that the width of the filaments of *Amphithrix janthiana* is from 1.5 μ to 2.25 μ, (the width of the species in the RABENHORST Exiccata No. 1580. varies from 1.3 to 1.8 μ) while the species described by HANSGIRG is 3—4 μ rarely 5 μ; therefore 2—3 times as wide as the filaments of the *Amphithrix*. FORTI who also reexamined the original collection of HANSGIRG (see Preface in DE TONI) did not mention that the trichomes of the *Lyngbya-Hypheothrix bosniaca* were narrower than the measurements given by HANSGIRG.

4. Finally, it is hard to assume that a plant of a *Lyngbya* character could be mistaken for an *Amphithrix*.

One possible conclusion is that the specimen DROUET saw was not the original of HANSGIRG (the lectotype), because he himself makes the remark about HANSGIRG's collection (1957, p. 41): "Both the packets of dried material and the slides are chiefly without annotations as to the taxa included" and he continues (p. 42): "it proved to be essentially a routine method to identify the algae which his descriptions indicate."

Until further elucidation of this problem the *Schizothrix bosniaca* (HANSG.) GEITL. species has to be considered valid. If, however, furhter investigations prove this species to be identical with some of the already known Cyanophycea, then the species described above originating from the Salzlackengebiet should be considered a new species and will have to be redescribed.

The form found by me has some resemblance to *Schizothrix lamyi* GOM., but is distinguished from it by several criteria of which the most important are: the sheath though wide, never reaches the measurements of that of *Sch. lamyi* and is never layered; the trichomes are markedly constricted at the crosswalls; finally, the endcell is conically rounded.

59. *Schizothrix rupicola* TILDEN 14.

60. *Dasygloea höfleriana* nov. spec. mihi.[1])

Plantae solitariae; filamenta ramosa et flexa; vagina lata, homogenea, ad limina non conflucta, sed crassiore firmiore que salebroso externo strato, parvis granulis globosis crustato. Quae libere ad apicem aperta, ad curvaturas plicata; colore chlorozincico iodurato non colorata; ad filamenti partem basalem fere 100 micra; ad mediam circa 60 micra; post bifurcationem, 22—30 micra tantum; totaliter 3000—4500 micra longa. Trichomata inaequaliter locata, maxime inter se in vagina distant. Quae et in parte basali et mediali 5—6 numerant; post ramificationem, unicum, raro duo, inveniri potest. Trichomata brevia; 2.7 micra lata; ad septa paulo constricta et ad apicem non attenuata. Cellularum longitudo aliquantulum plus quam latitudo; 3.6—4.0 micra longae. Septa percrassa. Cytoplasma bene dividitur in chromatoplasma fuscum-glaucescentis-viride et centroplasma pallidum glaucescentis viride; quorum neuter granulatum. Cellula apicalis hebetiter rotunda. Trichomata nec in apicem in basim dividuntur, cum filamenta mature sic dividantur. Reproductio a

[1]) This species was named in honor of Professor KARL HÖFLER the illustrious Austrian plant physiologist.

hormogoniis, quae 3—5 cellulas tenent. Cuius generis duo species inveniuntur: *Dasygloea amorpha* THWAITES et *D. yellowstoniensis* COPELAND. Ab hoc, suis parvioribus mensuris, ab illo et suis mensuris et vagina non striata et septis valde crassis, novus differt.

Plants solitary, filaments branching, bent, (Fig. 32). Sheath wide, homogeneous, not confluent at its borders, but with a thicker and firmer uneven external layer with incrustations of small round granuls, freely opens at the end (Fig. 32a), plicated at the curvatures (Fig. 32b), not staining blue with chlorzinciodide, at the base of the filament approximately 100 μ, at midpart cca. 60 μ, after branching only 22—30 μ wide. Full length 3000—4500 μ. Trichomes situated irregularly, wide apart in sheath, generally at the base and midpart 5—6 past branching only one, rarely two can be found (Fig. 32c). Trichomes short, 2.7 μ wide, slightly constricted at the crosswalls and not tapering towards the end. Cells somewhat longer than wide, length 3.6—4 μ, crosswalls conspicously thick (giving the impression at first sight of largly constricted trochomes). Cytoplasm well differentiated into a dark dull bluish-green chromato, — and a lighter, pale bluish-green centroplasm, neither of them contain granules. End-cells bluntly rounded, no differentiation of the trichomes into base and top can be observed, although the fully developed filament shows such differentiation. Reproduction by hormogonia consisting of 3—5 cells. (Fig. 32d) Infrequently, longer trichomes can also slide out from the sheath — homogonia ? —, which, however, are always immobile. Further development of the homogonia, i. e. trichome parts could unfortunately not be observed.

Two species of this genus have been known: *Dasygloea amoprha* THWAITES and *D. yellowstoniensis* COPELAND. The new species differs from the first by its smaller measurements; from the latter — apart from the measurements — in the fact that its sheath is not layered and the crosswalls are considerably thicker.

GEITLER remarks in reference to *D. amorpha* (1932, p. 991): „Vielleicht nur ein Entwicklungsstadium einer anderen Gattung (*Microcoleus*)!" I do not share his opinion because I have found several younger or older specimens but none of them showed the characteristic crowded filament arrangement of *Microcoleus*. Not a single *Microcoleus* specimen was found in the material which could have been the developmental stage of the *Dasygloea*, although during the culture experiments if this species had been only a developmental form it could have been transformed into the typical *Microcoleus*.

Some resemblance could be found among the new species and some *Schizothrix* species, (e. g. *Sch. vaginata* GOM.). However, there is a quantitative difference in the widely scattered irregular arrangement of the trichomes in the very wide sheath. If the quantitative differences of the distinct genera of the Cyanophyceae should be changed, then the whole system of classification would undergo several transformations.

Additionally, it should be mentioned that sample No 15c contained *Thiothrix nivea* (RABENH.) WINOGR. a filamentous epiphytic bacterium.

Concluding remarks

The presence of arctic, antarctic, tropical and thermal species of Cyanophyta from a single area raises some interesting points for consideration.

1. The presence of polar species

When a species is well known in Europe and is described from the polar regions it is not considered unusual. However, when a species originally described from the arctic is later found in Europe, this usually requires an explanation. In reality there is no difference between the two processes. For instance, *Phormidium frigidum* FRITSCH was described first from Antarctica, later it was found in the High Tàtra, then from several rivers in the Soviet Union, SKUJA demonstrated this in the plankton of lakes in Uppland, GAYRAL observed it on the sea coast of Marocco and I have found it in caves in Hungary and in several rivers of the United States. This species is therefore certainly cosmopolitan and this is probably true for all the other polar Cyanophyceae.

GEITLER (1932, p. 84) has the same opinion: „Meiner Meinung nach sind wohl die allermeisten Blaualgen Kosmopoliten. Daß dies ohne jede Ausnahme zutrifft ist gewiß unwahrscheinlich. Vielleicht gehören zu diesen Ausnahmen einige *Anabaenopsis*-Arten, die nur in afrikanischen Seen vorzukommen scheinen. Im allgemeinen beweist es nichts, wenn eine Art nur an einer Stelle gefunden wurde." As to the tropical i. e. especially the *Anabaenopsis* species, this supposition of GEITLER did not hold true: during the past 25 years about 15 *Anabaenopsis* species were discovered throughout Europe and North America.

2. The presence of thermal species

According to the statements of SCHMIDLE quoted earlier, there is no decisive difference between the African and European thermal Cyanophyceae-flora. The situation is similar to the thermae of the American Yellowstone Park (disregarding naturally some endemic species). COPELAND in 1936 described numerous species (hitherto known only in the tropics) from Yellowstone. Because of the conventional consept that thermal organisms are only those species which live in water with a temperature above 65 °C (COPELAND p. 216) and all others below that temperature range are facultative thermal species, it would be expected that the latter are also to be found in waters with more normal temperatures. This has proven to be true in many instances. Because of this it becomes impossible to properly differentiate between a thermal and a non thermal Cyanophyceae-flora. It is concluded that when a species is first described in a thermal water this does not mean — unless the temperature is very high — that it cannot occur in cold water. Even such characteristic thermal organisms as *Mastigocladus laminosus*, *Oscillatoria okenii*, *O. angustissima*, *Phormidium laminosum* etc. were detected in non thermal waters. All these data support the postulate accepted in other branches of biology that in the study of the distribution of the Cyanophyceae the absence of a certain species in a given ecological condition is not a determining factor in itself, or vice versa, which in this case means that a negative proof is no proof at all.

3. The presence of new taxa

Referring to the relatively numerous new taxa I have to mention the 15c collection which is a special conglomerate of the thin and very thin Oscillatoriaceae, thus providing an excellent opportunity to study contemporaneously all these complicated closely related species and their life.

W. LOUB in his recent study about the algae communities of the Neusiedler See found 350 "surely identified" species, among them 40 blue-green algae, which number even if it is not too high is impressive. More important, however, is the fact, that he was able to differentiate among a surprisingly big number of biocoenoses (1955, p. 105): „Diese reiche Abstufung innerhalb der Biozönose, die beträchtlichen Unterschiede in den ökologischen Bedingungen, sprechen wohl sehr dafür, den Neusiedler See nicht als Weiher zu bezeichnen, sondern als Steppensee den Seen vom Normaltypus gegenüber zu stellen." If this statement is true for one lake it must certainly be true for the many smaller or bigger ponds and lakes of the Salzlackengebiet.

I conclude this paper with a quote from Prof. SCHILLER who recently published a highly important work about the Dinoflagellates of the Neusiedler See (more than 400 new taxa), but which could be applied to the whole Salzlackengebiet (1955, p. 60): „Es ist der einzige Steppensee Mitteleuropas... und erwies sich geradezu als eine biologische Goldgrube."

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▶

Table I.

1 Calothrix brevissima G. S. WEST, solitary well developed filament, 600 ×; *1a* same as above, filaments attached on *Cladophora*, 600 ×; *2 Nostoc minutissimum* KÜTZ. emend. CLAUS, small colony, 60 ×; *2a* same as above, solitary filament, 1200 ×; *2b, c Nostoc minutissimum* according to KÜTZING; *3 Romeria austriaca* CLAUS, 1200 ×; *4 Oscillatoria subbrevis* SCHMIDLE emend. CLAUS, 600 ×; *5 Oscillatoria subbrevis* according to SCHMIDLE, 360 ×; *6 Oscillatoria fracta* according to CARLSON, 720 ×; *7 Oscillatoria meslinii* FRÈMY fa., 600 ×; *8 Oscillatoria acuiformis* SKUJA fa., 1800 ×; *9 Oscillatoria brevis* (KÜTZ.) GOM. fa. *brevis*, 600 ×; *9a* same as above. Rare not bending form, 600 ×; *10 Oscillaria brevis* according to KÜTZING; *11 Oscillatoria brevis* acccording to GOMONT, 360 ×; *12 Oscillatoria brevis* (KÜTZ.) GOM. fa. *variabilis* (WILLE) ELENK. according to WORONICHIN, 600 × cca.; *12a—d* same as above. According to POPOVA, 600 × cca.; *13 Oscillatoria brevis* (KÜTZ.) GOM. fa. *capitata* CLAUS, 600 ×; *14 Oscillatoria brevis* (KÜTZ.) GOM. fa. *acuminata* CLAUS, 600 ×.

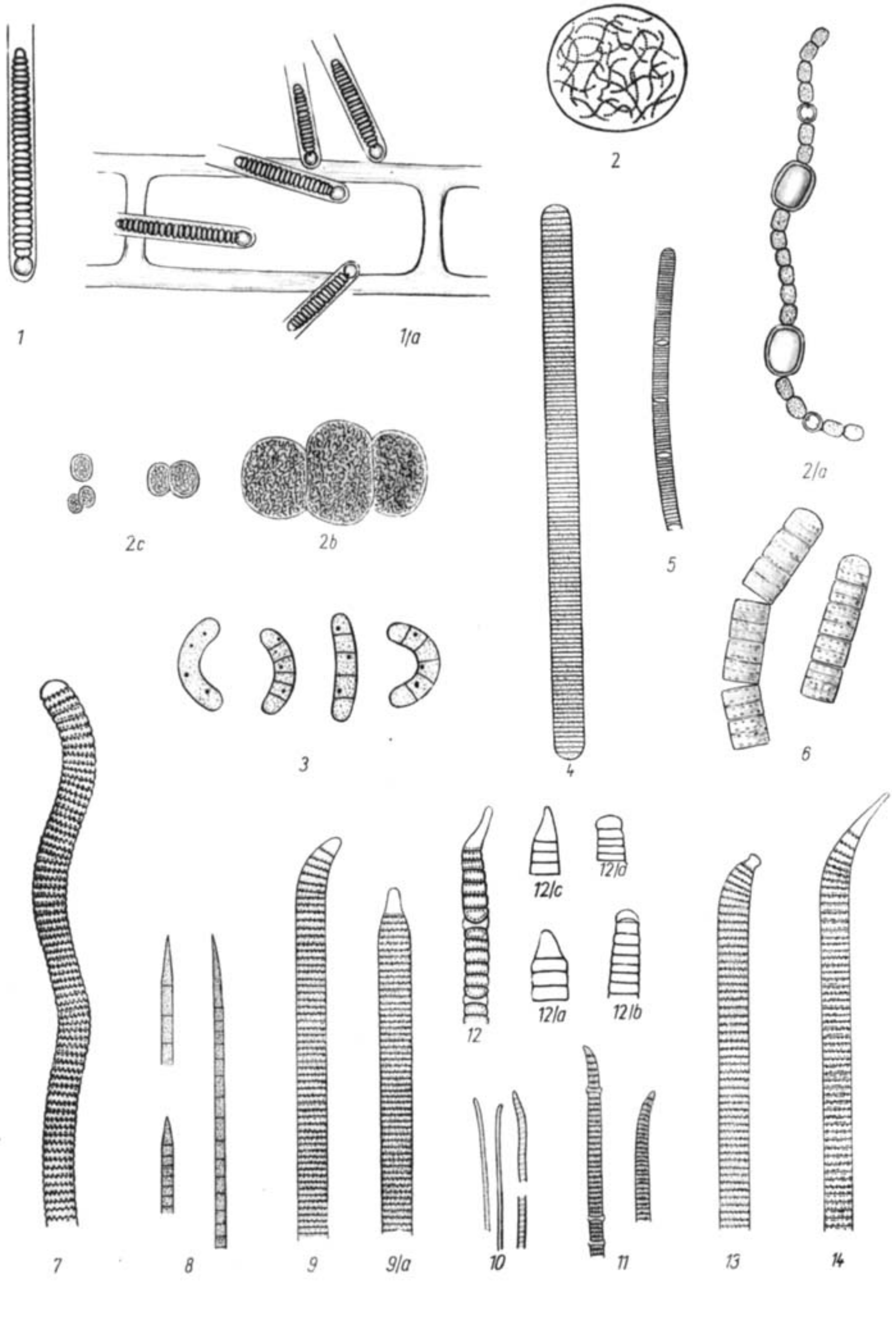
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Table II

15 Phormidium treleasei GOM. fa. *breviarticulata* CLAUS, 1800 ×; *16 Phormidium bigranulatum* GARDN. fa. *brevicellulata* CLAUS, 1800 ×; *17 Phormidium antarcticum* W. et G. S. WEST 1200 ×; *18 Phormidium tenuissimum* WORONICH, 1800 ×; *19 Phormidium lignicola* FRÈMY, 1800 ×; *20 Phormidium subtruncatum* WORONICH. var. *constrictum* CLAUS 1800 ×; *21 Phormidium luridum* (KÜTZ.) GOM. emend. CLAUS, 600 ×; *22 Phormidium luridum* according to GOMONT, 480 ×; *23 Phormidium subcapitatum* according to BOYE-PETERSEN, 720 × cca.; *24 Lyngbya norgardhii* WILLE fa. *schirschowiana* ELENK. Habital picture of some filaments laying in their whole length on the surface of *Cladophora*, 300 ×; *25 Lyngbya distincta* (NORDST.) SCHMIDLE, 1800 ×; *26 Lyngbya borgertii* LEMM., 1200 ×; *27 Lyngbya erebii* G. et W. S. WEST var. *thermalis* CLAUS, 1800 ×; *28 Lyngbya martensiana* MENEGH. fa. Habital picture of a bundle of filaments, 60 ×; *27a* same as above; outside surface of sheath, showing the spiral structure of the encircling crack, 300 ×; *29b* same as above; the sheath is cracked along a spiral line, 300 ×; *28c* same as above; mature filament, 600 ×; *28d* same as above; entire trichome sliding out from the sheath, 600 ×; *28e* same as above; nude trichome assuming spiral structure and freely moving in water, 300 ×; *28f* same as above; fast dividing trichome with very short cells, 600 ×.

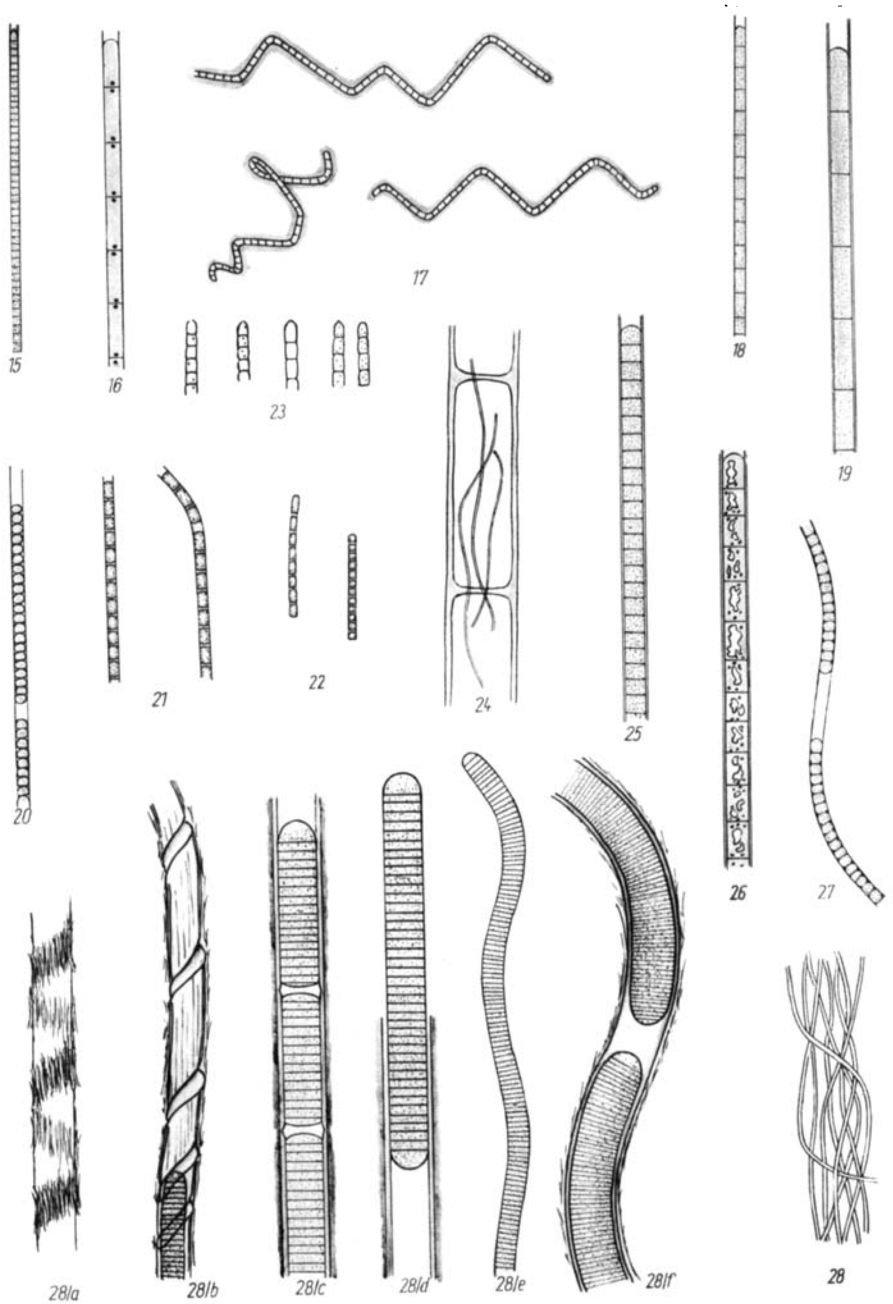
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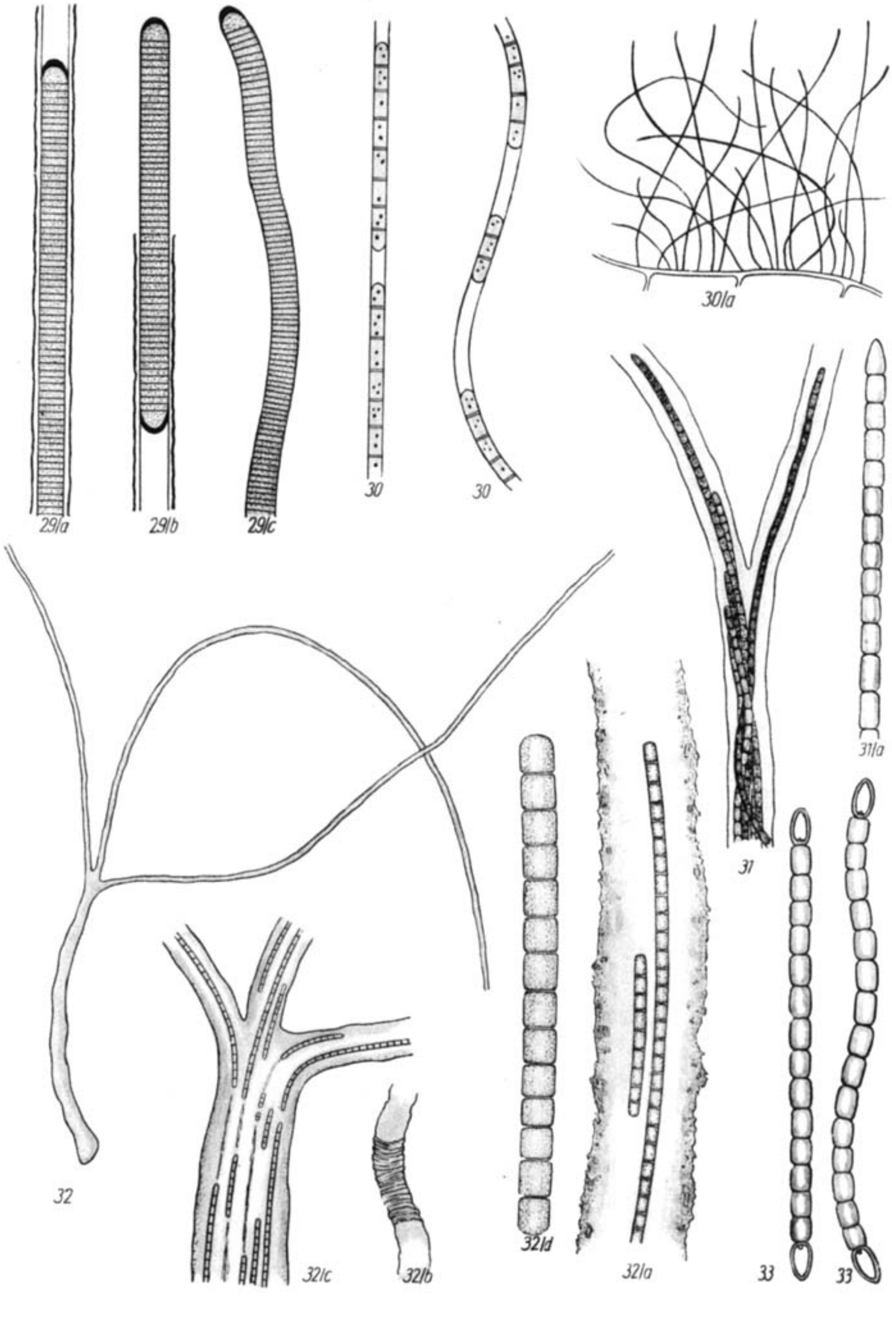
Table III

29a Lyngbya biebliana CLAUS, 600 ×; *29b* same as above; trichome sliding out of its sheath; 600 ×; *29c* same as above; nude trichome assuming spiral structure and freely moving in water, 600 ×; *30 Lyngbya kossinskajae* ELENK. var. *gracilis* CLAUS, 1200 ×; *30a* same as above; habital picture, filaments attached on *Cladophora*, 180 ×; *31 Schizothrix bosniaca* (HANSG.) GEITL. emend. CLAUS; habital picture of a plant, 300 ×; *31a* same as above; solitary trichome, 600 ×; *32 Dasygloea höfleriana* CLAUS, habital picture of a plant, 30 ×; *32a* same as above; filament after branching with freely opened end, 600 ×; *32b* same as above; outer surface of a side branch showing plicae at the curvatures, 180 ×; *32c* same as above; filament at site of branching, 180 ×; *32d* same as above; solitary trichome, 1800 ×; *33 Anabaenopsis raciborskii* WOŁOS, 1200 ×.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