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Glony na wilgotnych skałach nadmorskich w Warnie (Bułgaria) — Algae on damp coastal rock at Warna (Bulgaria)

Mémoire présenté le 3 juin 1963 dans la séance de la Commission Biologique de l'Académie Polonaise des Sciences, Cracovie

The seacoast at Warna (Bulgaria) is composed in a certain area of sheer, precipitous calcareous rocks, bare for 2—4 m. from the level of the narrow shore and covered higher up with turf and bushy shrubs forming the seaside part of the municipal garden. Water seeps down from under the turf, constantly moistening the bare walls of the rocks. At the foot of the rocks there is a stony and sandy shore about 1—5 m. wide. However, sea water very seldom covers the entire shore and reaches the foot of the rocks only when the waves are very high. The rocks on the seacoast are therefore irregularly splashed with seawater, but constantly moistened with fresh water dripping down from the grassy slope.

In August, 1961 the damp rocks were entirely covered with large patches of orange-yellow, greenish-yellow, olive and reddish-brown algae. Besides these, clusters of mosses, hanging down from under the grassy slope, were sometimes covered with a brown coating of algae. This is shown in the photograph (Plate I, a) on which the numbers of collected samples are indicated. The photograph shows a fragment about 12 m. long of the rocky shore; to the right the rocks were more than 3 m. high and to the left 2—2,5 m. high. Samples 5 and 6 were collected in places directly exposed to the sun and covered with an uniform coating of algae, the colour of which ranged from pale yellow (the colour of straw) to an orange hue. Samples 1 and 1a were collected in places not directly exposed to the sun that were shaded by overhanging shrubs. Samples 3 and 4 were collected in places exposed only for short periods to the sun and remaining mostly in partial shadow. In these places the algae formed a gelatinous coating usually of a reddish-brown, olive-green, or greenish-yellow colour. Samples 2 and 2a were collected from agglomerations of moist mosses. Analysis of the samples was carried out in the laboratory of the Hydrobiological Chair of the Jagellonian University in Kraków. The samples were fixed on the spot in formalin.

The principal mass of algae covering the damp rocks at Warna was composed of blue-green algae, species from the genus *Gloeocapsa* dominating. The yellow, orange-yellow, sometimes brownish-yellow colour of algal patches derived from the species *G. turgina* fo. *turicensis*. This colour was especially intensive in full sunshine. In the shade or in partly shady places streaks or larger greenish-yellow, olive-yellow or brown patches were visible. They were formed, among others, by the species *G. helvetica, G. varia, G. dermochroa,* and *Microcystis muscicola*. The green hue was mostly caused by green algae, such as *Oocystis solitaria, Mesotaenium chlamydosporum* and *Cosmarium laeve*. On relatively small sods of wet mosses brown coatings encrusted with calcium carbonate were visible containing agglomerations of threads of *Calothrix parietina* surrounded by brown sheaths. Everywhere among gelatinous thalli of the unicellular and colonial blue-green algae mentioned above, filamentous blue-green algae: *Plectonema nostocorum, Schizothrix lateritia* and other species, *Microcoleus delicatulus* and some *Oscillatoria* and *Lyngbya* species appeared separately or in small agglomerations. Diatoms were common occupying in number the second place after the blue-green algae. On all six stands the species composition was fundamentally similar, so that the communities of algae on damp rocks at Warna were in great measure homogeneous. Nearly all species were in the good condition; their cells divided and did not show any degenerative symptoms even when they were exposed to sunshine throughout the day.

A complete list of species determined is presented in table I. It contains, for individual stands: the amount estimated according to a scale of 5 degrees and a number representing the index of coverage, being the result of multiplying the amount by the size estimated by means of an accepted scheme *. The index of coverage characterizes the role of the species in the community and presents, as it were, the common mass of individuals of the same species in comparison with the mass of individuals of another species appearing in the same sample. In this manner the position of each species in the community and the relation to its companions is clearly defined.

*) Estimation of amount: + very rare, the organism appears singly and not in every preparation. 1 single — organisms appear in numbers from 1—6 in a preparation. 2 few — 7—16 specimens of the organism in a preparation. 3 mean amount — 1—3 specimens of the organism in nearly all fields of vision of the preparation. 4 numerous — 4—7 specimens in nearly all fields of vision of the preparation. 5 very numerous — the organism dominates positively and appears in numbers greater than 7 individuals in each field of vision.

Estimation of size:

5 — diameter 300 μ and more;	coefficient of calculation of size	— 16
4 — diameter 200—300 μ;	coverage index	— 11
3 — diameter 100—200 μ;	„ „	— 7
2 — diameter 40—100 μ;	„ „	— 3

List of species

Stand: Steep calcareous wall near the seashore at Warna (Bulgaria)

Habitat: Damp rocks moistened with water trickling from under vegetal turf in a seaside park. The wall of rock is partly in shade and partly exposed to total insolation

Character of the coatings: Gelatinous sheaths light yellow and orange-yellow in the light, yellowish-brown, in places green in the shade. In shady spots patches of mosses are also visible.

C = constant number

$\frac{s}{n}$ = index of coverage

	F	V	1 Shade	2 Shade, mosses	3 Partial shade	4 Partial shade	5 Full sunlight	6 Full sunlight	C	$\frac{s}{n}$
1. Dominants										
Gloeocapsa turgida (Kütz.) Hollerb. f. turicensis (Nägeli)	⁂	●	1.7	4.28	4.28	4.28	2.14	5.35	V	23.3
G. varia (A.Br.) Hollerb.	⁂	●	1.11	1.3	1.3	1.7	3.48	1.16	V	14.6
G. helvetica (Nägeli) Starm.	⁂	●	2.6	4.12	4.12	5.15	5.15	4.12	V	12.0
Denticula elegans Kütz.	⁂	●	4.12	3.9	4.12	2.6	4.12	3.9	V	10.0
Gloeocapsa dermochroa Nägeli	⁂	●	1.7	1.7	2.14	3.21	-	-	IV	8.2
Calothrix parietina (Nägeli) Thur.	∿	●	1.7	2.22	-	1.11	+.07	-	IV	6,8
Microcystis muscicola (Menegh.) Elenk.	⁂	●	3.3	4.4	5.5	5.5	4.4	5.5	V	4.3
Cymbella affinis Kütz.	○	●	4.12	+.03	-	-	1.3	+.03	IV	2.3
Plectonema nostocorum Born.	∿	●	+.03	2.6	2.6	+.03	2.6	+.03	V	1.5
Cosmarium laeve Rabenh.	○	●	+.03	1.3	2.6	+.03	+.03	1.3	V	1.0
Oocystis solitaria Wittr.	⁂	●	+.03	1.3	1.3	1.3	1.3	+.03	V	0.9
Schizothrix lateritia (Kütz.) Gom.	∿	●	1.3	+.03	+.03	+.03	-	-	IV	0.4
Mesotaenium chlamydosporum De Bary	○	●	+.03	-	+.03	+.03	-	+.03	IV	0.2
2. Subdominants										
Rhabdoderma minimum Lemm.	⁂	?	+.01	-	-	+.01	-	-	II	0.03
R. lineare Schm. et Lauterb.	⁂	●	-	-	+.03	+.03	-	-	II	0.1
Microcystis pulverea (Wood.) Forti	⁂	●	-	-	+.03	+.03	-	-	II	0.1
M. pulverea f. parasitica (Kütz.) Elenk.	⁂	?	+.03	-	-	+.03	-	-	II	0.1
Aphanothece Castagnei (Bréb.) Rabenh.	⁂	?	+.03	-	+.03	+.03	-	-	III	0.2
A. elabens (Bréb.) Elenk. f. epilithica n. f.	⁂	●	-	+.03	-	+.03	-	-	II	0.1
A. saxicola Nägeli f. minutissima (W.West) Elenk.	⁂	?	1.1	+.01	-	-	-	-	II	0.2
A. globosa Elenk.	⁂	●	+.03	-	+.03	-	-	-	II	0.1
Gloeothece palea (Kütz.) Rabenh.	⁂	●	+.03	-	+.03	-	3.9	-	III	1.6
G. caldariorum (P.Richt.) Hollerb.	⁂	●	-	-	+.03	+.03	-	1.3	III	0.6
Oscillatoria acutissima Kuff.	∿	●	-	-	+.01	2.2	+.01	-	III	0.3
O. neglecta Lemm.	∿	●	-	1.3	+.03	-	-	-	II	0.5
Lyngbya perelegans Lemm.	∿	●	1.3	-	+.03	-	-	1.3	III	0.5
Schizothrix lardacea (Ces.) Gom.	∿	●	+.03	+.03	-	-	-	-	II	0.1
Microcoleus delicatulus W. et G.S.West	∿	●	-	-	-	-	+.03	+.03	II	0.1
Mastogloia elliptica Ag. var. dansei (Thwait.) Grun.	○	●	2.2	-	+.01	-	1.1	-	III	0.5
Navicula pupula Kütz.	○	●	1.1	-	-	-	+.01	-	II	0.1
N. cuspidata Kütz.	○	●	+.03	+.03	-	-	-	-	II	0,1
N. cryptocephala Kütz.	○	●	+.03	-	-	-	-	+.03	II	0.1
Amphora ovalis Kütz. var. pediculus Kütz.	○	●	+.01	-	-	+.01	-	-	II	0.03
Nitzschia palea (Kütz.) W.Smith	○	?	+.01	+.01	-	-	-	-	II	0.03
Asterocystis smaragdina Reinsch.	○	●	+.03	-	-	+.03	-	-	II	0.1
3. Adominants										
Synechococcus cedrorum Sauv.	○	●	+.01	-	-	-	-	-	I	0.02
Aphanothece saxicola Näg. f. endophytica (W. et G.S.West) Elenk.	⁂	?	-	-	-	-	-	+.01	I	0.02
A. saxicola f. longior (Naum.) Elenk.	⁂	●	-	-	-	+.01	-	-	I	0.02
Oscillatoria Redeckei Van Goor	∿	●	-	-	-	+.01	-	-	I	0.02
O. pseudogeminata G.Schmidt	∿	●	-	-	-	+.01	-	-	I	0.02
Symploca fuscescens (Kütz.) Rabenh.	∿	●	+.03	-	-	-	-	-	I	0.05
S. dubia (Näg.) Gom.	∿	●	+.03	-	-	-	-	-	I	0.05
Lyngbya Diguetii Gom.	∿	●	-	-	-	+.01	-	-	I	0.02
L. versicolor (Wartm.) Gom.	∿	●	-	-	-	+.01	-	-	I	0.02
L. amplivaginata Van Goor	∿	●	-	-	-	-	-	+.01	I	0.02
L. Lagerheimii (Möb.) Gom.	∿	?	-	-	-	-	+.01	-	I	0.02
L. bipunctata Lemm.	∿	?	-	-	-	-	+.01	-	I	0.02
Schizothrix fasciculata (Nägeli) Gom.	◿	●	-	-	-	+.03	-	-	I	0.05
S. coriacea (Ag.) Gom.	∿	●	+.03	-	-	-	-	-	I	0.05
S. tenuis Woron. f. tenuissima n.f.	∿	●	-	-	-	+.01	-	-	I	0.02
Trachelomonas irregularis Swir. var. minor Swir.	○	●	+.01	-	-	-	-	-	I	0.02
Diatoma vulgare Bory	○	●	+.01	-	-	-	-	-	I	0.02
Synedra ulna (Nitzsch) Ehrenb.	○	●	-	-	-	-	+.03	-	I	0.05
Achnanthes minutissimum Kütz.	○	●	1.1	-	-	-	-	-	I	0.16
Mastogloia Smithii Thwait. var. lacustris Gom.	○	●	+.01	-	-	-	-	-	I	0.02
Frustulia vulgaris Thwait.	○	○	+.01	-	-	-	-	-	I	0.02
F. vulgaris var. capitata Krasske	○	○	1.1	-	-	-	-	-	I	0.16
Neidium dubium (Ehr.) Cleve	○	●	-	-	-	-	1.3	-	I	0.5
Navicula gregaria Donkin	○	○	-	-	-	-	1.1	-	I	0.16
Pinnularia subsolaris (Grun.) Cleve	○	●	-	-	-	-	1.3	-	I	0.5
P. interrupta W.Sm. var. minutissima Hust.	○	○	1.1	-	-	-	-	-	I	0.16
Amphora coffeaeformis Ag.	○	○	+.01	-	-	-	-	-	I	0.02
Cymbella cymbiformis (Ag ?) V.Heurck	○	●	-	-	-	-	+.03	-	I	0.05
Gomphonema gracile Ehrb.	○	●	+.01	-	-	-	-	-	I	0.02
Rhopalodia gibba (Ehrb.) O.Müll.	○	●	-	-	-	-	+.03	-	I	0.05
Nitzschia communis Rabenh.	○	●	+.01	-	-	-	-	-	I	0.02
N. vitrea Normann	○	●	+.03	-	-	-	-	-	I	0.05

F – Form of growth
- ○ – single cells
- ⁂ – colonies
- ∿ – filaments
- ◿ – cushions

V – Vitality
- ● – live
- ○ – dead

The species were arranged in the table from the point of view of dominance. The species appearing in 60—100 per cent of investigated samples (phytosociological records) are considered as dominants, those present in 20—60 per cent of investigated samples as subdominants, and those appearing in 1—20 per cent of samples as adominants.

For better orientation frequency was calculated for every 6 records (each sample being considered as one phytosociological record) and represented in degrees of constancy and also the index of coverage, as the quotient of the sum of covering numbers of the given species in separate sociological records and of the number of these records. Although the number of samples is not very great, these calculations tend to bring out characteristic features of the community.

The communities of rock algae at Warna are composed of 13 dominants, 22 subdominants and 32 adominants. The sum indices of coverage amounts to 85.5 for dominants, 5.6 for subdominants and 1.5 for adominants. It can thus be considered, naturally with a certain approximation, that the dominating species occupy more than 90 per cent of the surface of investigated communities of algae.

The floristic spectrum of the community presented in table II has an interesting appearance.

Blue-green algae dominate and occupy the greatest area in the community. They are followed by diatoms and green algae. Red algae and euglenins play an insignificant role. The community of algae growing upon rocks is therefore a typical community of blue-green algae.

The biological spectrum, however, demonstrates a numerical preponderance of unicellular algae, mostly diatoms, but in sum they occupy only a small area (Tab. III).

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1 — diameter 4— 40 μ; coverage index — 1
— — diameter 0— 4 μ; „ „ — 0.1

When determining the size of the filaments, it was agreed that a filament with a length equal to the diameter of the field of vision of the microscope corresponds: when 1— 5 μ broad — to the scale of size 1
„ 5—20 μ „ „ „ „ „ „ 2
„ 20—40 μ „ „ „ „ „ „ 3
„ 40—60 μ „ „ „ „ „ „ 4
„ 60—80 μ „ „ „ „ „ „ 5

Filaments not longer than half the diameter of the field of vision in the microscope receive a directly lower degree.

The index of coverage was estimated by multiplying the amount (calculated by means of the scale) by the coefficient of calculation of size corresponding to individual numbers on the scale of size. The necessity for such a calculation derives from the fact that the degree of size 5 is not 5 times greater than degree 1; it corresponds to a mean coverage of 87.5 per cent or 350 μ, while degree 1 corresponds to a coverage of 5.5 per cent, or 22 μ. It was necessary, therefore, to determine a new series of numbers expressing the relation of the lowest degree to the consecutive higher ones, 1, 3, 7, 11, 16. The plus sign has the conventional value of 0.1.

As indicated by the table, the community is composed in the first place of colonial forms, the index of coverage of which is more than 60 per cent and is composed mostly of blue-green algae. Although unicellular forms have the greatest amount of species, they occupy a relatively small space and do not play a dominating role in the community.

Tab. II

Floristic spectrum

	Number of species	Sum of coverage indices
Cyanophyceae	38	76,15
Bacillariophyceae	24	14,32
Chlorophyceae	3	2,10
Rhodophyceae	1	0,10
Euglenophyceae	1	0,02

Tab. III

Biological spectrum

	Number of species	Sum of coverage indices
Separate cells	29	16,46
Threads	19	10,51
Colonies	18	65,66
Cushions	1	0,05

When the dominating species are arranged in order of the value indices of coverage, those that play the most considerable role in the community appear distinctly (Fig. 1). They are, in the first place, the characterized above all by the dominating species: *Gloeocapsa turgida* fo. *turicensis*, *G. varia*, *G. helvetica* and *Denticula elegans*.

The community of rock algae at Warna is therefore an association characterized above all by the dominating species: *Gloeocapsa turgida* fo. *turicensis* + *G. varia* + *G. helvetica* + *Denticula elegans*. There exists besides a whole series of condominants whose role is somewhat smaller.

The above-mentioned community covered, in August 1961, a compact surface of about 40 m.^{2} and was of a hue in which yellow shades prevailed. Differences in the composition of dominating species between places always in shade and those exposed to the sun for the greater part of the day, where the sunlight operated directly and strongly, were relatively small, so that a distinct photophilic or umbraphilic facia could not be established. The species *Calothrix parietina* is attached in the first place to shady places. The principal dominant *Gloeocapsa turgida* fo. *turicensis* appeared in smaller quantities, though not uncommonly, in places lying always in shade. The diatoms *Denticula elegans* and *Cymbella affinis* were surprisingly numerous both in light and shade.

Some more characteristic species of blue-green algae on rocks

1. *Gloeocapsa turgida* (Kütz.) Hollerb. fo. *turicensis* (Nägeli) Starmach comb. nova (= *Chroococcus turicensis* (Nägeli) Hansgirg; = *Chr. rufescens* var. *turicensis* Nägeli).

The author includes, after Hollerbach (1938), in the generic name of *Gloeocapsa* both the genus *Gloeocapsa* Kützing and the genus *Chroococcus* Nägeli for he considers the differences between these

genera as not significant. There is no reasonable cause (apart from habit, perhaps) for maintaining them artificially.

G. turgida in the characteristic and typical form of *turicensis* occupies the first place among the algae on damp rocks on the seashore at Warna. Cells and colonies of this species altogether correspond to the descriptions of the species *Chroococcus turicensis* as given by Hansgirg (1892, 2, p. 160) and Geitler (1932) and also by Nägeli (1849, p. 46) under the name of *Chroococcus rufescens* var. *turicensis*. From the morphological point of view it also corresponds to the form *G. turgida* fo. *luteola* (Woronichin) Hollerbach, differing only in the locality in which it appears. Woronichin gives this form as originating from the salt lake of Kiranskoje in Siberia (see Elenkin 1938). Hollerbach (in Elenkin 1938) did not take into consideration the species *Chroococcus turicensis* and placed it among the synonyms *Gloeocapsa turgida* fo. *typica* or *G. turgida* fo. *luteola*. This is not correct, as the form turicensis presents a homogenous material with no transition to the typical form. On the investigated stand only, besides orange-yellow cells, mostly enclosed in broad, soft sheaths, groups of cells are sometimes found, identical from the morphological point of view, but of a dirty violet or violet-blue colour, corresponding to the form *violacea* (W. West) Hollerbach. This form is described only on the basis of the colour of the cells, a feature of doubtful taxonomic value, and has, as can be seen from its appearance, ecological demands in accordance with the *turicensis* form.

The mass and extensive appearance of almost pure agglomerations of the *turicensis* form on rocks in full sunshine and partial shade, a lack of or *G. turgida* fo. *luteola*. This is not correct, as the form *turicensis* presents in similar places in other countries (as for example in Poland, in the Tatra Mountains) are proof of a considerable stability of features. It is easy to recognise by the characteristic shape of cells and sheaths, always colourless, broad, gelatinous, unstratified or indistinctly stratified, sometimes with layers that are not clean-cut but rather blurred. The differences between the typical form of *Gloeocapsa turgida* and the form *turicensis* are very distinct. It is also not excluded that these may be two distinct species, as accepted by former systematicians, but this can only be proved by further investigation.

The *Gloeocapsa turgida* fo. *turicensis* of Warna had cells with a diameter of 10—14 μ without the sheaths and 16—30 μ with the sheaths; its colonies were mostly composed of 2—4 cells, sometimes several of them clustered together. The sheaths were colourless, soft, with an indistinct stratification. The protoplast was finely granulated with separate large shiny grains (ectoplasts). The colour of the cells was yellow or orange-yellow, more rarely of a dirty blue or violet-blue hue. (Fig. 1, a; Plate I, b, c, d).

2. *Gloeocapsa helvetica* (Nägeli) Starmach nom. nov. (= *Chro-*

ococcus helveticus Nägeli, 1849, 46. Tabl. Ia; = *Gloeocapsa minuta* Kütz.) Hollerbach, 1938, 233 (pro parte)).

A species appearing abundantly with the previous one. It has characteristic cells and colonies distinctly differing from the typical forms of *G. minuta*, which are covered with homogeneous unstratified sheaths and appear in the plankton or sometimes in mixed algae masses free--floating in the water.

The cells are spherical, semi-circular before division, sometimes polygonal in young colonies, the sheaths being colourless, unstratified, or with an indistinct stratification. In colonies two or four cells are contained in their own sheaths and then enclosed in a common envelope. The cells are yellowish or yellowish-green, more rarely bluish-green, but with a yellowish hue. A typical appearance of a colony and of cells are shown in microphotographs (Plate I, e) and in Fig. 1, b.

Chroococcus helveticus and the species *Chr. pallidus* resembling it were considered by Hollerbach as identical with *Gloeocapsa* (*Chroococcus*) *minuta*, on the basis of the unstratified sheaths and dimensions of the cells comprised in the scale of dimensions for *G. minuta* (4—10 μ). However, these species differ from each other both as to shape and ecology. This can be distinctly seen from the figures presented by Hollerbach and partly executed after the original herbarium material of Wittrock and Nordstedt, and Hauck and Richter. The present author considers the species from damp walls in Warna as belonging to *Chr. helveticus* on account of its dimensions, which do not exceed locally 6 μ and lie within the limits 4—6 μ (4—7.5 μ in the diagnosis of Nägeli), while the dimensions of a similar *Chr. pallidus* species lie within the limits 5—11 μ. While *Chr. pallidus* (*G. minuta*) is distinctly dissimilar, the differences between *Chr. pallidus* and *Chr. helveticus* are rather small. Nägeli distinguished them according to the thickness of the sheaths, the colour of the cells, and the scale of dimensions. The first two features are not very important, but the dimensions of the cells are indeed included in a different scale and for this reason the present author does not, for the time being, integrate these two species. In accordance with the assumption of not considering further the generic name of *Chroococcus*, the described species are presented under the name of *Gloeocapsa helvetica*.

3. *Gloeocapsa varia* (A. Brun) Hollerbach (Fig. 1, c; Plate II, b).

This species appears often and almost exclusively in colonies composed of two or, more rarely, of four cells. The cells with no sheaths are usually 3—3.5 μ in diameter, 5—7 μ with sheaths. The sheaths are colourless or yellowish, homogeneous, refracting light strongly, especially in their external parts, and giving rise to a characteristic picture, darker near the periphery and lighter near the cells, of the gelatine. The cells are spherical or semi-spherical before division and of a pale bluish-green colour.

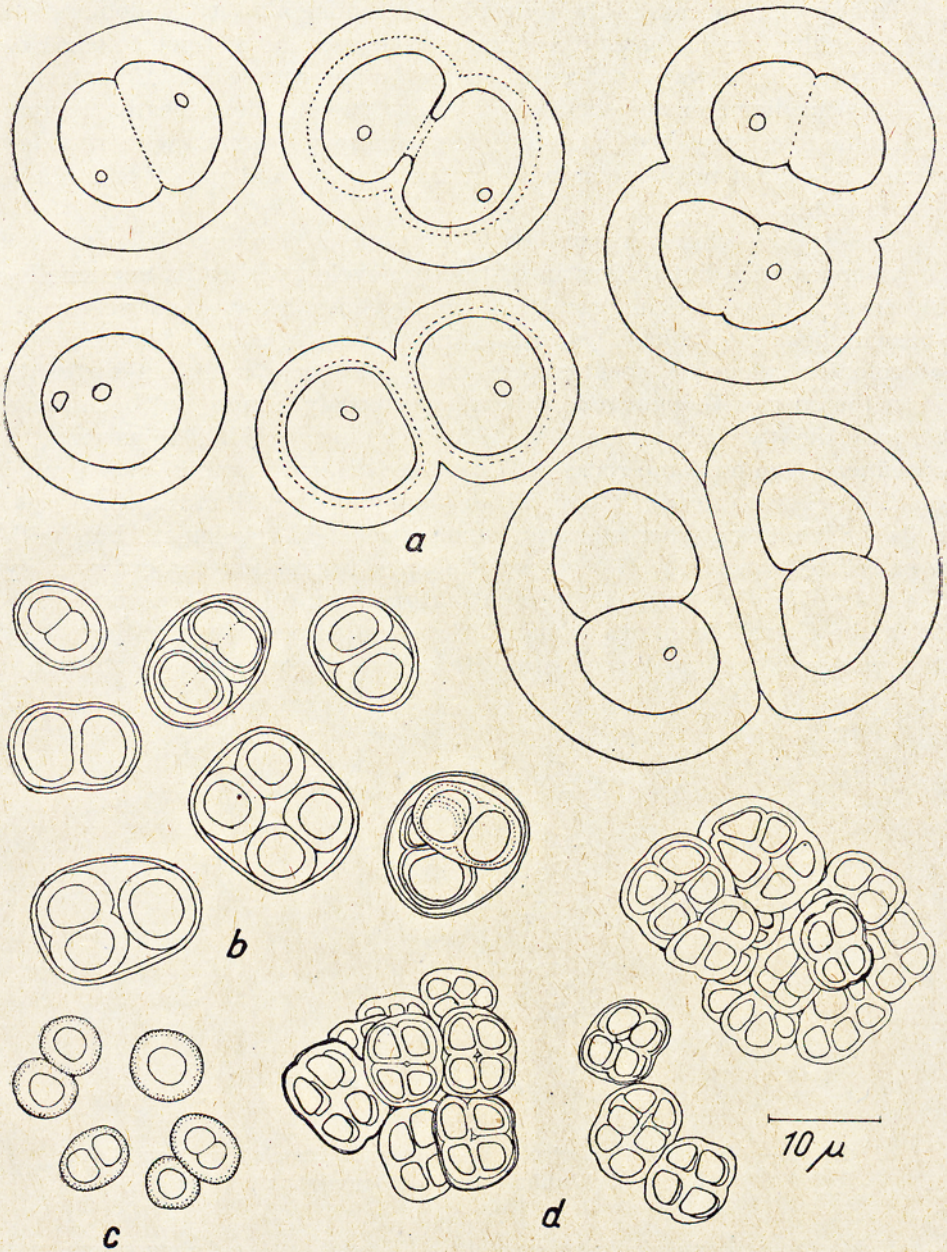


Fig. 1. a — *Gloeocapsa turgida* f. *turicensis;* b — *G. helvetica;* c — *G. varia;* d — *G. dermochroa.* Groups of colonies loosening under pressure

4. *Gloeocapsa dermochroa* Nägeli (Fig. 1, c; Plate II, a).

This species appears in the form of nests among a mixed agglomeration of other blue-green algae. It is mostly composed of distinct colonies of 4—8—16 cells, always concentrated in larger aggregates. Colonies of 10—20 μ in diameter are enclosed in yellow or colourless sheaths distinct and sometimes stratified. The cells are usually polygonal, with rounded corners, 2—2.5 μ in diameter without the sheaths, and rather pale olive-green in hue.

This species closely resembles *Gloeocapsa crepidinum* Thuret as to its appearance but differs in distinctly developed sheaths and smaller dimensions of cells. The transition from yellowish-olive and yellowish-brown sheaths to colourless ones is interesting; in some agglomerations of colonies colourless sheaths prevail. *G. dermochroa* differs distinctly from the species *G. punctata*, although previously efforts had been made to join the two (Ercegović 1925, Geitler 1932). However, the specimens seen on damp rocks at Warna also differ from those represented on Geitler's figure (1932, p. 99) in having, above all, mostly polygonal cells which form characteristic, small packet-like colonies, but with a structure typical for *Gloeocapsa*. Colonies resembling those drawn by Geitler are known to the present author from other places, especially from the Tatra Mountains (Poland). It is not impossible, therefore, that the species existing at Warna is a different form requiring separate study.

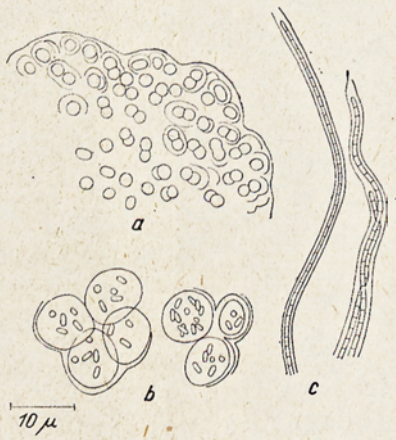


Fig. 2. a — *Microcystis muscicola;* b — *Aphanothece elabens* f. *epilithica;* c — *Schizothrix tenuis* f. *tenuissima*

5. *Microcystis muscicola* (Menegh.) Elenkin (= *Aphanocapsa muscicola* (Menegh.) Wille) (Fig. 2, a). This species forms large, sometimes widely spread colonies, appearing together with other blue-green algae. The cells are bluish-green, usually with a diameter of 2 μ, broadly elliptic before division and sometimes attaining a length of 3.5 μ. The special

sheaths are colourless. They are visible only on the borders of the colonies, and dissolve entirely in their central parts.

6. *Aphanothece elabens* (Bréb.) Elenkin fo. *epilithica* **n. fo.** (Fig. 2, b; Plate II, c).

Spherical or almost round colonies, clustered together in groups of less or more than ten specimens, forming small, irregular thalli among other algae. The cells are bluish-green, clublike, 0.6—0.8 μ broad and 2—3 μ long.

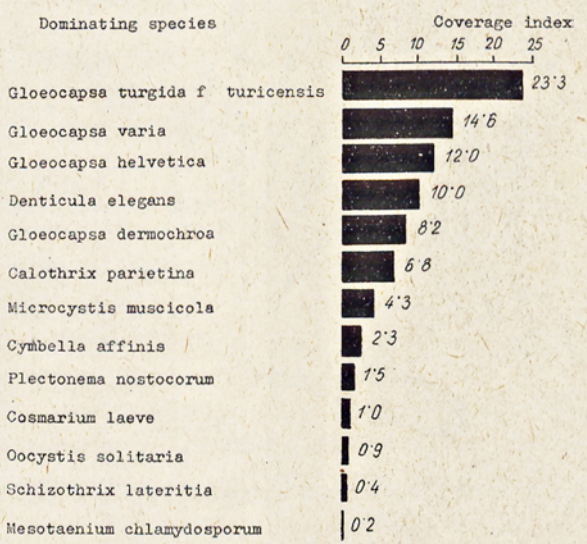
Aphanothece elabens (= *Microcystis elabens* Bréb.) is in substance a plankton species living in stagnant waters and having gaseous vacuoles. This form, to which the author has given the name of *epilithica,* has a structure of thalli and shape of cells conforming with those of *A. elabens,* but its cells are considerably smaller, it has no gaseous vacuoles, and it grows among various gelatinous algae on damp rocks. It occupies, therefore, an entirely different stand from the typical form. Few specimens were found.

7. *Calothrix parietina* (Nägeli) Thuret (Fig. 3; Plate II, d, e).

This species grows mostly in shady places, mainly on mosses, forming there small brown coatings, encrusted with lime to a greater or lesser degree. The filaments are twisted in a diverse manner, stretching upward, with or without branching, enclosed in sheaths of different breadth, distinctly stratified, the external strata being the most considerably thickened and fimbriated. The filaments are 8.5—12.7 μ wide at the base and 7.2—12.5 μ wide in the middle. The trichomes in the median part are

Tab. IV

Coverage indices of dominating species



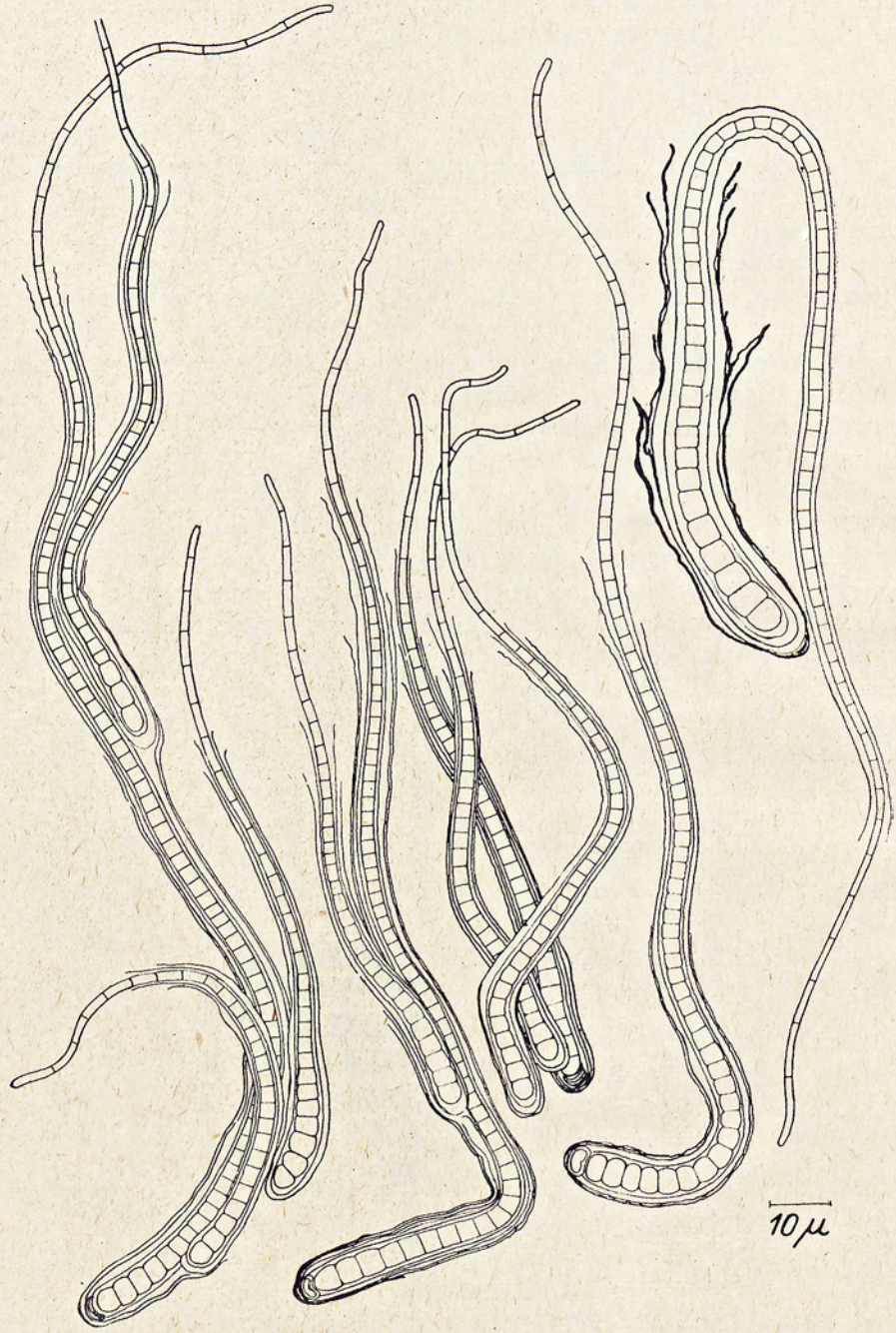


Fig. 3. *Calothrix parietina*. Threads without heterocysts are visible in balls

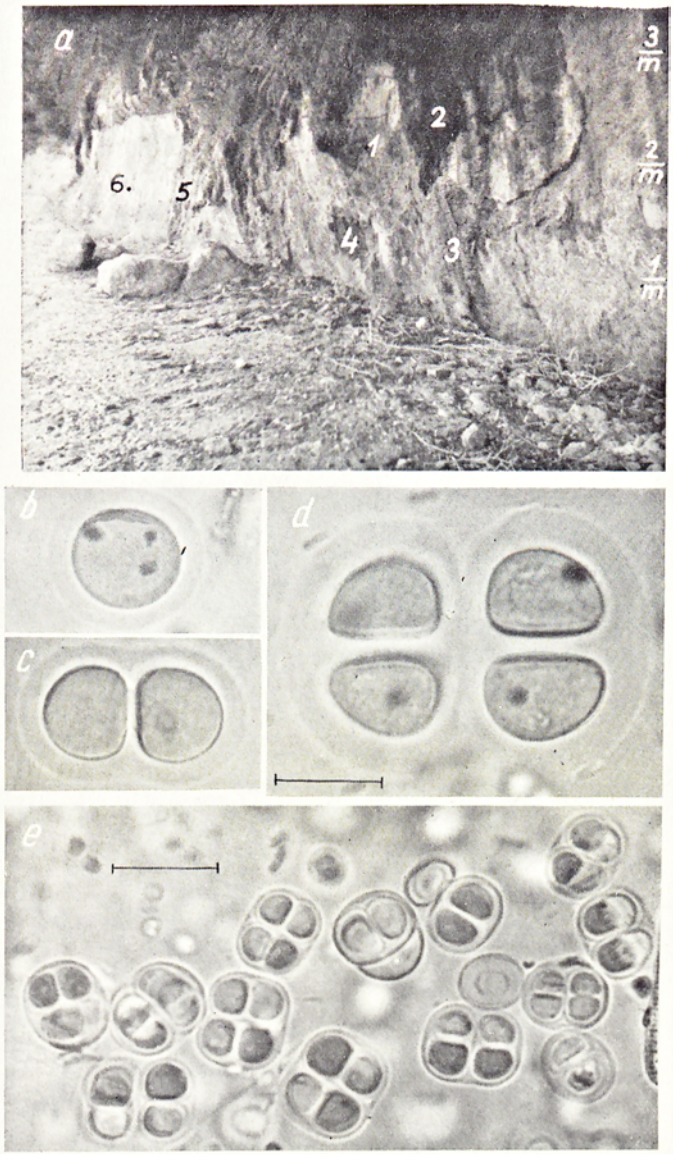


Plate I. A. View of a maritime rock covered with algae in Warna. The stands, on which algae were collected, are marked with numbers 1—6, and the height of the rock in metres is given at the side; B, C, D. *Gloeocapsa turgida* f. *turicensis;* E. *G. helvetica*

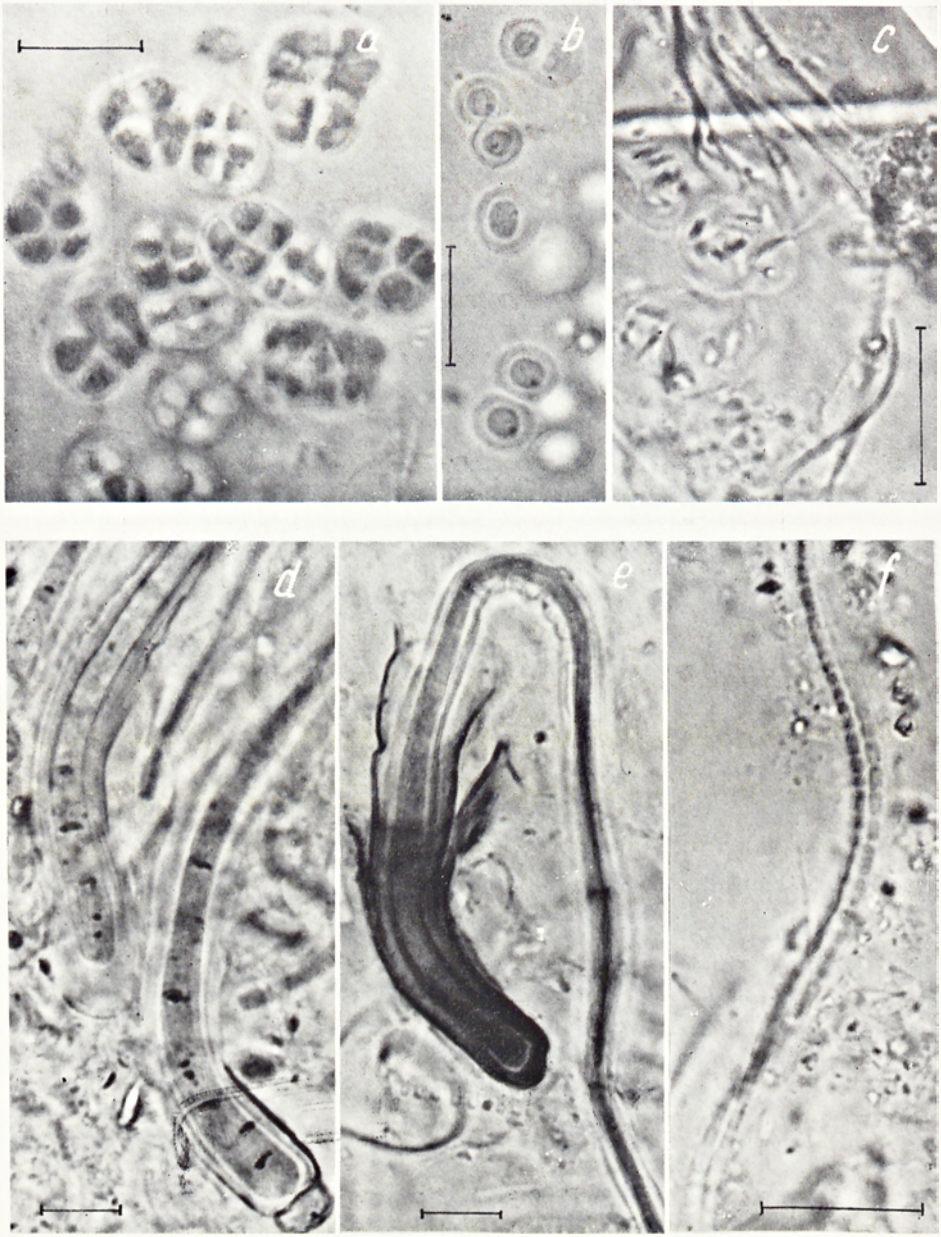


Plate II. A. *Gloeocapsa dermochroa;* B. *G. varia;* C. *Aphanothece elabens* f. *epilithica;* D, E. *Calothrix parietina,* there are visible two threads without heterocysts; F. *Schizothrix tenuis* f. *tenuissima.* — Magnification scale on the photographs corresponds to 10 μ.

built of cells that are nearly square, not constricted or only slightly constricted at the transversal walls. In the lower parts of the filaments the cells are often shorter than their breadth or as long as they are broad, strongly constricted at the transversal walls and sometimes nearly rounded. In the upper part the trichomes pass into a long filament, with cells longer than their breadth, often vacuolised or altogether deprived of content. The trichomes are 4—7 μ wide at the base and 3—3.5 μ wide in the centre. Heterocysts are semi-spherical or slightly flattened at the base of the filaments, sometimes broader than the cells at the base of the filaments. However, they are not always present.

There are agglomerations in which the greater part of the filaments have no heterocysts. This is an interesting phenomenon, demonstrating the artificiality of the division of the *Calothrix* and *Homoeothrix* genera, based only on the presence or absence of heterocysts. This division is maintained in systematics for practical purposes only. In previous approaches to the problem the genus *Homoeothrix* was considered as a section of the genus *Calothrix*. This is accepted by Bornet and Flahaut (1886); Kirchner (1900), however, divided the two genera. Lately, a tendency to incorporate the genus *Homoeothrix* into the *Calothrix* genus has again become manifested. This was expressed by Fan-Kung-Chu (1956) in his revision of the genus *Calothrix*, accomplished under the supervision of F. Drouet on the basis of investigation of herbarium material. According to the present author, the genus *Homoeothrix* should remain, as the lack of heterocysts constantly observed in separate species differentiates them in a natural manner from groups of species which always have them. The lack of heterocysts in a certain part of a population which possesses them constantly is no great hindrance in distinguishing the two species, as one and the other of them are found in the same preparation. In the marine *Calothrix* genera, especially as, for example in *C. contarenii* (Zanard.) Born. and Flah. and in *C. fusco-violacea* Crouan, it was previously observed that not all the filaments possess heterocysts (cf. also Elenkin 1948, p. 1004).

8. *Schizothrix tenuis* Woronichin fo. *tenuissima* **n. fo.** (Fig. 2, c; Plate II, f).

The filaments are twisted, enclosed in colourless sheaths. They appear singly or collected in small clusters and agglomerations situated between other colonial and filamentous algae. The filaments are 1.2 μ wide on the average, but the trichomes are very slender, 0.5 μ wide. Cells are 1.5—1.8 μ long, the apical cell is rounded. In the sheaths single trichomes appear most frequently, filaments containing at least 2 trichomes on a certain sector being seen more rarely.

It grows in small quantities in partial shade.

STRESZCZENIE

W lecie 1961 r. skały nadmorskie poniżej parku miejskiego w Warnie (Bułgaria) pokryte były w całości płatami glonów barwy pomarańczowożółtej, zielonożółtej, oliwkowej i czerwonobrunatnej. Masę glonów powlekających skały zwilżane wodą słodką ściekającą spod zadarnionego brzegu stanowiły głównie sinice. Tworzyły one wraz z innymi glonami zbiorowisko jednolite choć różnobarwne, rozciągające się na przestrzeni ok. 40 m². Oznaczono 38 gatunków sinic pokrywających ok. 76% powierzchni skał, a obok tego 24 gatunki okrzemek o pokryciu ok. 14%, 3 gatunki zielenic, 1 gatunek krasnorostów i 1 gatunek euglenin o nieznacznym pokryciu.

Dominowały bezwzględnie gatunki: *Gloeocapsa turgida* fo. *turicensis* Nägeli, *Gl. varia* (A. Br.) Hollerbach, *Gl. helvetica* Nägeli, *Denticula elegans* Kützing. Przeważająca barwa pomarańczowożółta pochodziła od gatunku *Gl. turgida* fo. *turicensis*.

Podano uzupełnienia do opisu niektórych gatunków oraz opisano nowe formy *Aphanothece elabens* fo. *epilithica* oraz *Schizothrix tenuis* fo. *tenuissima*.

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