# UNUSUAL WAY OF REPRODUCTION OF LYNGBYA LAGERHEIMII (MÖB.) GOM. CYANOPHYTON

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*Szilvásvárad,* one of the pleasantest health resorts, is situated at the western slope of the *Bükk*-Mountains. In the park of the Workers' Holiday Home there is a little artificial pond which receives its water-supply from the springs of *Szalajka* Valley. The water of this pond has been drained off in September 1957. The surface of the slowly drying bed was soon overgrown with *Botrydium granulatum* (L.) Grey. Between 11th and 13th October I examined, among other things, the *Botrydium* covered soil of the bed-surface. I managed to examine the soil on the spot once more on 26th October. For subsequent examinations I took some soil samples on both occasions. At the end of October the number of the *Botrydium* individuals had decreased.

The observations both at the locality and at the laboratory resulted, apart from Bacteria and Bacillariophyceae, 22 kinds of microorganisms in the soil:

| | |
|---|---|
| Cyanophyta | 3 |
| Euglenophyta | 2 |
| Chrysophyta | 1 |
| Chlorophyta | 16 |

All of the Chlorophyta belonged to the class of Chlorophyceae. At present I will give an account of my observations, continued for several months, respecting the *Lyngbya Lagerheimii* (Möb.) Gom. bluealga. Before I commence, I want to give first a more detailed description of the plant in question, as my observations complete, especially concerning the end-cells, the diagnoses of GEITLER, HUBER-PESTALOZZI, and of POLJANSKIJ and his fellow-workers.

The trichomes are straight or curved, sometimes they may be quite rolled up, some parts of the trichome may even be regularely waved. The cells are covered with a thin, colourless hull, the diameter of which fluctuates between 1,6—2,8 μ. The filaments are always found single; they are light-blue to greenish-blue; their length varies from filaments consisting of only a few cells to filaments of several 100 μ. The cell contents are homogeneous; sometimes 1—4 cynaphycin granula are to be seen near to the transversal walls, especially at the poles.

The terminal cells are generally roundish, sometimes a little longer than those behind them and in these cases they are somewhat thinner. Exceptionally they even may terminate in a blunt point (spicule) or have in cross section the form of a rectangular triangle. I wish to emphasize this statement because GEITLER (p. 1044), HUBER-PESTALOZZI (p. 247) and even the newest descriptions, e. g. SKUJA's (p. 69), say that the terminal cells of the filaments are rounded up, they do not elongate. In the material from *Szilvásvárad* this is also the usual and characteristic form of terminal cells, but, though rarely, some stretched, blunt-pointed, and even triangle-form endcells are to be seen. Short filaments are able to move, creeping lively; even the longer ones can bend semicircularly and in a short time straighten out again. *Figure 1.* shows the changes of form, accomplished by a singular filament during only one minute. Cells divide at a rapid rate. Heterocystes, spores there are none; hormogonia are frequent.

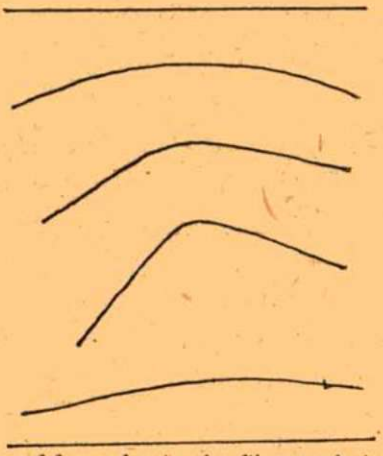

Fig. 1. Changes of form of a singular filament during one minute

I could observe many individuals of this *Lyngbya* on the drying soil of the pond in the park of the Workers' Holiday Home in *Szilvásvárad* from 11th to 13th October and on 26th October as well. From the surface of the soil-sample, taken on 26th October, I put as much as a pin-point on a slide, added a little water, covered it and closed the lid with wax. I wanted to supply the plants with a tiny environment, similar to the natural one. This could be done but partly, as the organisms were transferred to a place of perfect quiet where no motion of water was possible. The light conditions were also modified, as instead of getting natural light the culture was illuminated every day for some hours from below with the 15 W lamp of the Lumipan microscope, supplying the necessary light for assimilation. There was also the light of a 40 W electric bulb, standing about 35 cm from the preparation. The organisms were living in a laboratory with a normal and practically unvaried temperature of 17—24 C°. In the artificial environment the necessary $CO_2$ for assimilation was furnished by the *Bacteria* and the animal organisms of the biocoenose. In this conditions, rendered more difficult, I observed the life of the imprisoned micro-collective more than a year long. This time I will give an account of the unusual way of reproduc-

tion of *Lyngbya Lagerheimii* only. About the life of the micro-collective I shall give a more particular report later on.

From October 1957 till March 1958 I did not observe any abnormal phenomena in the life of the blue-alga. The cells of the filaments were dividing intensively and, in consequence, the number of blue-alga-individua increased through hormogonious reproduction.

I noticed the first strange occurrences in the first days of March. On 14th March some of the filaments were conspicuously swelled, their colour was heightened. The swollen cells were wider than the normal ones. *Table 1. figures 1.—5.* show parts of normally developped filaments, on *figure 6.* swollen cells are to be seen beside normal ones. Figure 6 shows an exemplar, observed on 25th March. The day before, on 24th March, I laid down three strange filament formations on *figures 10—12. Figure 10 shows* a filament which is split in two at a stretch of 11 cells length and has become waved on this stretch in consequence of more vigorous cell-division. In both details of the filament the cells do not differ in form, dimension, and inner construction from those before and after the bifurcation.

The filament detail on *figure 11* represents an extraordinary, striking formation. The one-line-cell trichome has repeatedly split in two; in every trichomebranch a very energetic cell-division has taken place and caused the egg-formed swelling, consisting of spiral trichomes.

*Figure 12* shows the largest sized phenomenon, observed up to now. The swelling began to develop at the beginning of March. On March 24 it reached the length of 130 μ. The lower big swelling resembles the former figure, but it shows a more advanced stage. It does not lead into a one-line-cell filament but into a two-line-cell one; this branches again and the peculiar formation thickens again in its upper part. Then it suddenly becomes normal and turns into a one-line-celled trichome. The text-photo (*Fig. 2.*) shows the state of two days later,

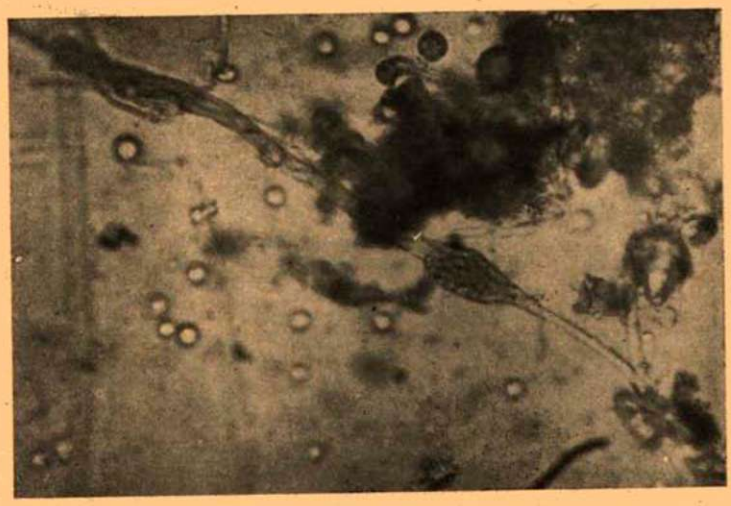

Fig. 2. *Lyngbya Lagerheimii.* The unusual way of reproduction

on 26th March. It is clearly distinguishable that through intensive cell-fission the lower swelling has become more powerful, the section after the egg-formed thickening has twisted and the end of the swelling has also continued to grow.

*Figures 7—9* have been made on 4th June. All three of the abnormal trichome formations occurred on one and the same filament! In *figure 7* three swollen cells have divided in longitudinal direction, but the progeny cells were more or less different in size. This is especially well marked in the bottom cell, the left side of which is nearly 3 times as big as the other. With the two cells above the bottom cell the situation is the same, though in a lesser degree. The upper part of the cell below the lowest cell pair is wider than its basis, as if it was going to divide. In *figure 8*, seven cells have dividded in longitudinal direction. In the new part of the filament the form of the cells is not the same as that of the corresponding cells of the old part. It seems that the tendences of developping and dividing deviate. In *figure 9*, I could observe the splitting of the filament on a stretch of 67 μ. On this stretch the filament pairs have become waved in consequence of the more vigorous division.

The cells of *Lyngbya Lagerheimii* divided in the closed living space during about 7 months very lively; until March 1958, they have brought forth filaments of several 100 μ length. The filaments may be quite straight, a little bent or in a high degree curved, and at the same time spirally whirled or completely intertwined. *Figure 13* shows some filament forms. This blue-alga is a very resistant, extreme conditions well enduring organism; *Oscillatoria limosa* Ag. and *Oscillatoria nigra* Vauch., which also existed in the micro-biotop at the beginning of the observations, perished after a few weeks and after that time only this one organism represented the Cynophyta. During the first weeks the division of cells was not striking, but from the third month onwards the intensity of cell-division increased. In the fifth month, in March, I could observe the above related unusual way of reproduction. From the seventh month the rythm of cell-division slackened very much and came to a perfect standstill a year later. I think this must have been due principally to the hindering effect of the great mass of accumulated metabolism-products. The unusual reproduction in March was due to extraordinary atmospheric influences. AUJESZKY gave me the following information, respecting the extraordinary atmospheric phenomena:

„On 3rd March a powerful prefrontal state prevailed since the early morning hours and lasted in *Budapest* till 5 p. m., at which time the passage of a strongly developped front occurred. This was followed at 8 p. m. by a new advancing front, in the course of which a violent storm was raging, maximal speed 22 m/second.

On 4th March another front, coming from North-East, was standing at the frontier of the country. The storm that came with it reached its top-speed at 4 a. m. with a maximum value of 21 m/second.

But besides the influence of the fronts other atmospherical powers must also have been at work. In the forenoon of 3rd March, the relatively rare *phenomenon of* MÖGEL—DOLLINGER *short-wave fade-out* occurred. In the lower part of the ionosphere (the so-called D-layer) *ionisation of abnormal degree took place* and in consequence of it the short-wave radio-connection with the far off parts of the Earth was completely cut. The radio-station of our institute (the National Central Meteorological Institute; note of the Author), as well as the

other radio stations working in *Budapest*, could not receive any material on the 37,5—60 meter band while the fade-out lasted. The magnometers indicated a *strong magnetic commotion* (the magnetic character number for March 3 attained the unusually high value of 3°). Deducting the conclusions of these symptoms, a *vigorous ultra-violet solar eruption* must have taken place in the forenoon of 3rd March." (Underlinings from the Author.)

AUJESZKY informs me in his letter, that on 3rd and 4th March human meteoropathy also sent a lot of reports about „a very great deal of exceptional phenomena" to the Meteorological Institut: „Neuralgics occurred and during the night between March 3 and 4 complaints about meteoropathic insomnia, uncommonly early awakening, as well as disturbed sleep because of bad dreams (cauchemar) arose."

It is surprising that the above described unusual cell-divisions and swellings should have taken place just at the beginning of March.

Why do I think these atmospheric influences so significant an inducing agent? Before March there have also been front passings above the territory of our fatherland and this unwonted way of reproduction of the LYNGBYA species has not occurred.

From the above report it is evident that a ternary front influence was at work at the beginning of March. The powerful prefrontal and frontal influence, the MÖGEL—DOLLINGER short-wave fade-out, the abnormal ionisation, and the vigorous magnetic commotion worked together as bio-stimulators. So, besides the front influences we have to take into consideration ther atmospheric factors as well!

At the same time, under the same unusual atmospheric conditions, the colonies of the green-alga *Scenedesmus soli* Hortob. were showing intensive production of auto-spores in company with *Lyngbya Lagerheimii*. I think it worth while to emphasize once more that the atmospheric influences have come into full display in a closed room, on a preparation in the miscroscop, the lid of which was framed in with wax so that the plants were completely isolated!

How is this occurrence to be interpreted? The single cells of the filament, as shown on *figure 6*, begin to swell with energy, the plasma grows, the colour material gets richer, the colour of the cells grows darker than that of normal cells. Then they divide simultaneously, not in diagonal but in longitudinal direction, along their axis. So we can not speak of real branching but must take it for a new type of it which we may perhaps call „island-like" branching. This island-like branching is single, but it may also be plural as you see in *figures 11* and *12*. The latter happens if one or the other of the filament pairs, or both, form new islets by branching again through repeated longitudinal cell-division. The cells of the filament pairs are the same in form, but they may also be deviating, as the vigour of division may be different in the cells of the filaments as well. If the cell-division is very energetic, some characteristical swellings may appear in which the filaments, built of intensively dividing cells, settle down spirally as you can see in *figures 11* and *12*. On the plate *figures 6—12*, showing the states of evolution, show as well the chronological order of the succession of the evolution-states.

For the Oscillatoriaceae family, to which the *Lyngbya* genus belongs, the presence of hormogonia and the lack of heterocystes and akinetes is character-

istic, as GEITLER, HUBER—PESTALOZZI, GOLLERBACH, KOSINSKAJA, POLJANSKIJ state it. The form, the dimensions, the habit of the cell, the hormogonious reproduction ranks the alga from *Szilvásvárad* among the *Lyngbya* genus. The swelling of cells, on the other hand, shows its relationship to the form with akinetes. H. SKUJA mentioned in his work, published in 1956, in the genus *Achroonema* some similar swollen cells and the drawings of them are very like our *figure 6* (p. 83—91, Plate VIII, fig. 14; Plate IX, fig. 1). Concerning this he writes on p. 83 of his book „. . . bei einer Art sind auch interkalar gebildete Dauerzellen bekannt, bei einer anderen sind solche im Anfangsstadium beobachtet worden." On the ground of my observations and SKUJA's statement I take the cell-swelling and the corresponding filament-swelling to be an atavistic but simplified producing of akinetes which happened under constraint in consequence of the difficult outer conditions and the additional uncommon atmospheric phenomena (front passings, abnormal ionisation). I take it for an atavistic symptom because the genera, the reproduction of which is hormogonious, hormocystous, are thought by the authors of systematic orders to be higher developped than the genus whose reproduction lacks hormogonium. I think it to be a phenomenon, caused by pressure and constraint, because it happened under the influence of unusual conditions. We have to take it to be a simplified way of producing akinetes, as it jumps the state of standstill and begins immediately to produce new trichomes.

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*Table 1.*

Fig. 1.—5. Normally formed filaments of *Lyngbia Lagerheimii*
Fig. 6. Part of filament with swollen cells
Fig. 7.—10. „Island-like" branching part of filaments in different states of development
Fig. 11.—12. Filament swellings
Enlarged: 1000 times

*Table I.*