The discovery of viruses lysing blue-green algae in the Dneprovsk reservoirs.

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Viruses, which are characterised by a relative simplicity of chemical composition, are involved with all the groups of the animal and plant world. The discovery of viruses of lower organisms has special interest. Along with the already known viruses lysing bacteria and actinomycetes, viruses have been discovered in recent years which lyse algae. N.B. Zavarzina (Zavarzina and Protsenko 1958, Zavarzina, 1961, 1962, 1964) had discovered a virus of green algae which causes the lysis of cultures of Chlorera pyrenoidosa Pringsh.* Safferman and Morris (1963, 1964, Safferman 1964) made known from sewerage a virus of blue-green algae concerned with the genera Lyngbya, Plectonema and Phormidium. Lysis set in 3-4 days after infection of a culture. From the lysate was extracted a DNA-containing virus (Schneider, Dienes, Safferman 1964). However, the role of the species of algae mentioned in water blooms is negligible. During investigations of water from water-bloom patches** and of mud taken from zones of massive accumulation of blue-green algae in the Dneprovsk reservoirs, we obtained viruses lysing algae (Goryushin and Chaplinskaya 1966).

The revealing of viruses producing lysis of blue-green algae, which one could use in the control of water-blooms, has the greatest interest. With this aim, samples of water were collected from various zones of water-bloom patches in the Kremenchug, Dneprovsk and Kukhov reservoirs. The addition of moderate amounts of water from the water-bloom patches to unialgal*** cultures of Microcystis aeruginosa Kütz., M. pulverea f. incerta (Lemm.) Elenk., M. muscicola (Menegh.) Elenk., grown on the liquid medium of Fitzgerald in a luminostat (temperature 25 , illumination 4000 lux) caused their lysis. The cells of the algae were decolourised, the culture became transparent from green. The more of such water added, the sooner lysis set in. Young cultures were lysed quicker than old ones. The cells of M. aeruginosa Kütz. and M. muscicola (Menegh.) Elenk. lysed notably better than those of M. pulverea f. incerta (Lemm.) Elenk. Only young colonies of the last species are lysed, whereas older colonies continue to live.

A similar picture of lysis was observed also in laboratory conditions with the addition of water from water-bloom patches to outwardly healthy algae (M. aeruginosa Kütz.) from Kremenchug reservoir. The observed infectious basis fits well****.

*Translator's note - 'Pringsh.' probably is a mistake for Chick.
**Literally - 'spots of flowering'.
***Literally - algologically pure.
****This does not make sense but I do not know the meaning of 'passiruet' sya and 'nachalo' may have several meanings. 'infectionnoe nachalo' can also mean 'the infectious principle'.

I have kept to a literal translation. Where I use inverted commas, the author does so.
Lysis also took place with the addition of water from water-bloom patches, which had been filtered through the bacteriological filter G-5, to a unialgal culture of *M. aeruginosa* Kütz., although it set in somewhat later (20-25 days). In the latter case, the later lysis, apparently, was caused by partial adsorption of the lytic agent on the bacteriological filter. It is not excluded that the lytic agent - virus - utilises some bacterium which pierces the mucilaginous capsule in order to penetrate into the cell. Thus, with investigations in the electron microscope of normal and lysed cultures of *M. aeruginosa* Kütz., we obtained bacteria of the *Caulobacter* group. In this connection one should note the observations of N.B. Zavarzina (1961), who showed that growth of the bacterium *Caulobacter vibrioides* Henrici and Johnson in cultures of *Chlorella pyrenoidosa* Pringsh. promoted lysis of this species of alga under the influence of virus infection, although lysis took place also without bacteria (Zavarzina 1964).

Approximately two months later, after the complete lysis of *M. aeruginosa* Kütz. caused by the virus, other species of algae began to multiply in the flasks (*Scenedesmus acuminatus* (Lagerh.) Chod., *Nostoc* sp. etc.), scattered cells of which were present in the water from the water-bloom patches.

During the development of the cells of *M. aeruginosa* Kütz., *M. pulverea* f. incerta (Lemm.) Elenk. and *M. muscicola* (Menegh.) Elenk. on the solid medium proposed by B.V. Gromov (1964), into which was put a lysate obtained under laboratory conditions, there appeared the negative colonies characteristic of a virus of the phage type.

Virus particles were observed (fig. I) in the electron microscope during investigations of the obtained lysates of algae. In some of them, as in the majority of known bacteriophages, an appendix was clearly seen (fig. 3).

Along with the viruses observed in the water from the water-bloom patches, an infectious principle was disclosed in the superficial bottom deposits in the Kremenchug and Dneprovsk reservoirs in zones of massive accumulation, of algae.

Figure 1. Negative colonies produced by the virus, extracted from the green zone of a water-bloom patch, during cultivation of *Microcystis aeruginosa* Kütz., emend. Elenk. on an agar medium.

Figure 2. Negative colonies produced by the virus, extracted from the superficial bottom deposits, during cultivation of *Microcystis aeruginosa* Kütz., emend. Elenk. on an agar medium.

Figure 3. Virus particles discovered in the lysate after addition of water from a water-bloom patch to a culture of *Microcystis pulverea* f. incerta (Lemm.) Elenk. x60000.
Figure 4. Virus-like particles obtained in an outwardly normal culture of *Microcystis aeruginosa* Kütz. x75000.

The agent discovered in the mud, like the virus from water-bloom patches, on addition to cultures in liquid medium produced lysis of *M. aeruginosa* Kütz., *M. pulverea* f. *incerta* (Lemm.) Elenk. and *M. muscicola* (Menegh.) Elenk. However, in the character of the negative colonies developed on solid medium (fig. 2), in the time of their appearance and in the temperature of inactivation, the lysing infectious principle revealed in the mud differed somewhat from the virus found in the water from the water-bloom patches.

On the basis of this one can suppose that lysis of cultures of blue-green algae of the genus *Microcystis* can be brought about by two different viruses. Taking into account that a virus lysing *M. aeruginosa* Kütz. was discovered in the mud in the very same points of Kremenchug reservoir at the end of October 1965 and also in March and May 1966, that is in the period of the year when the algae are concentrated mainly in the mud, one can suppose that viruses of blue-green algae 'winter' on the bottom of the reservoir together with the algae. A.E. Protsenko (1966) advanced a hypothesis concerning the existence of saprophytic (free-living) 'viruses'. Protsenko's basic argument in favour of such a viewpoint was the discovery of virus-like particles in the electron microscope during the investigation of mud taken from the bottom of a pond. It is more logical to suppose that, in this case also, in the mud where algae had sedimented were found also their viruses.

The first data obtained concerning the presence of viruses of blue-green algae of the genus *Microcystis* in various positions in the Kremenchug reservoir and also in the Dneprodzerzhinsk, Dneprovsk and Kakhovsk reservoirs speak in favour of the relatively wide distribution of viruses lysing blue-green algae in the Dneprovsk reservoirs. There is not excluded also the existence of latent viruses of algae. Thus, during investigation in the electron microscope of culture fluid of various species of outwardly normal algae, in many cases virus-like particles have been found (fig. 4).

The fact that the viruses of algae which are known up to now do lyse algae, brings them close to the bacteria, among which the viruses of bacteria - bacteriophages - also cause lysis. For viruses lysing algae we propose the name - 'algophages'. Along with the existence of viruses of algae of the phage type, one cannot deny the possibility of the existence of viruses of another type, multiplying in the cells of algae and causing their virus illnesses. With this aim we are investigating a series of species of 'sick' algae. In this connection one should mention that virus-like structures (Ueda 1965) were found recently in Japan in the cells of the blue-green algae *Oscillatoria princeps*.

References.


*In Ukrainian. The journal is Ukrainian too.

The references are given as in the text and are not therefore necessarily as in the World List of Scientific Periodicals.


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