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Algae of the Ob' River and the Novosibirsk Water Supply

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The Ob' is one of the largest rivers of the plains of the Soviet Union. Its waters are used extensively by the population for drinking purpos s, including for the Novosibirsk water supply.

The creation of the Novosibirsk Reservoir brought about considerable changes in the hydrological and biological regimes of the section of river adjacent to the city, which confronted the water works of the city with a number of new problems. Specifically, after damming the river water began to contain phytoplankton which came here from the Reservoir, to a greater extent than before the damming.

The author's task was to make clear the basic composition and quantity of the Ob' River phytoplankton in the water downstream from the dam, the degree to which it was retained by the filters of the city [illegible] and its content in the city water supply system.

Samples for analysis were taken in 1959 every month from February to October and in 1960 in May, July and August. At the same time, three samples of water were taken, each of a volume of three liters: river water which entered the left- and right-bank water pipelines of the city, water supplied by the water works before entrance into the water supply system, and water from the city water supply system. In 1960, in the right-bank portion of the city water samples from the aqueduct were taken at two points: in the main aqueduct and in a remote section from it, a blind end.

Immediately after taking it, the water was passed through membrane prefilters and fixed with four percent formalin. The algae were counted in a Nageotte chamber (the number of cells per liter of water was determined). On examination of the sample the state in which the algae were fixed (presence of contents, chromatophores) attracted attention. The empty valves of diatomaceous algae were counted separately. In all, 82 samples were collected and examined.

Rhythm with Which Phytoplankton Enters the Water Works of Novosibirsk and its Basic Composition

Fig 1 a, b, gives an idea of the quantity of river phytoplankton coming to water purification structures in different seasons.

In March 1959, the phytoplankton of the Ob' River, still blocked up with ice, was very poor and consisted of occasionally found diatoma-

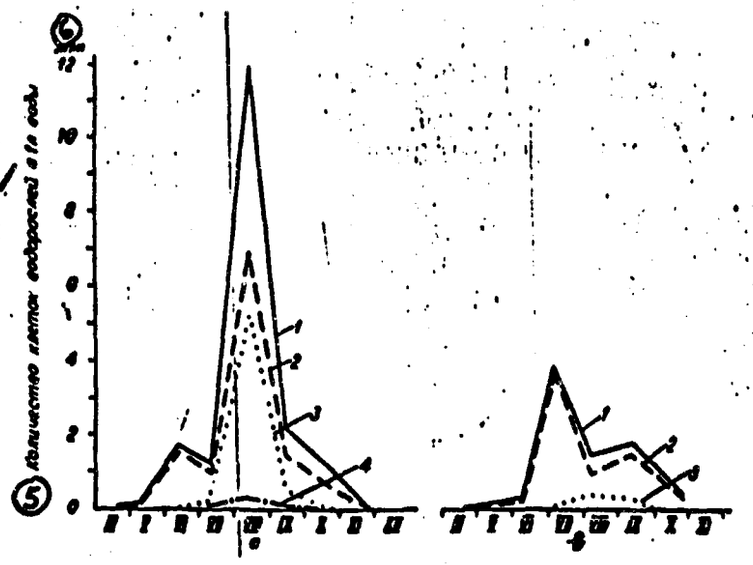

Fig 1. Phytoplankton Census of the Ob' River at Water Collection Points on the Left-Bank (a) and Right-Bank (b) Water Works. 1. Total number of algae; 2. Diatomaceous algae; 3. Blue-green algae; 4. Other groups; 5. Number of algal cells per liter of water; 6. Millions.

ceous algae, among which Cyclotella sp., Stephanodiscus sp., Asterionella gracillima, Synedra sp. were obtained more often than the others. Aside from the typical plankton forms, occasionally the bottom-dwelling Gomphonema olivaceum, Amphora sp., and Surirella ovata were encountered. In the March plankton Protococcales were found in small numbers: Scenedesmus quadricauda, Coelastrum microporum, Actinastrum hantzschii.

On 25 April the River was completely cleared of ice, and on 18 May at a water temperature of 8.4° and a transparency of four centimeters as against 30 centimeters in March, the phytoplankton census was low (87,000-125,000 cells per liter). Pyrophyte species were added to the algae mentioned above.

Beginning with June the number of algae in the Ob' River begins to increase gradually. This is particularly noticeable along the left bank (1,675,000 cells per liter). There was less phytoplankton on the right side (318,000 cells per liter), which was evidently associated with the influence of a tributary, the Inya River, on this part of the Ob'. In

the June plankton diatomaceous algae continued to be predominant: Cyclotella sp., Stephanodiscus sp., Asterionella gracillima. However, now in appreciable quantity Melosira granulata was noted; Protococcales were in second place, the species distribution of which was considerably richer than in May (Scenedesmus quadricauda, Ankistrodesmus sp., Dictyosphaerium pulchellum var. ovatum, Scenedesmus quadricauda var. setosus, Sc. bijugatus, Sc. acuminatus var. biseriatus, Pediastrum duplex). In addition, occasionally euglenids were encountered: Trachelomonas patelifera, T. volvocina, Euglena oxyuris, Euglena sp., Trachelomonas planctonica; of the blue-green algae, Aphanizomenon flos-aquae was found.

The richest phytoplankton was observed in July and August. The mean monthly water temperature at this time was 20-21°. The maximum phytoplankton census was noted on the left side of the Ob' River on 3 August (12, 576, 000 cells per liter); on the right side, on 8 July (3, 886, 000 cells per liter). This period is characterized by a change in the combination of prevalent forms of spring into summer plankton. The main mass is made up of Melosira granulata, Melosira granulata var. angustissima with a constant admixture of Cyclotella kützingiana var. radiosa and Stephanodiscus sp. There was a marked increase in the census of blue-green algae (Anabaena hassalii, A. scheremetievi, Aphanizomenon flos-aquae); the species content of green algae became richer. Coelastrum microporum, Crucigenia quadrata, Eudorina elegans, Scenedesmus arcuatus, Sc. acuminatus var. biseriatus, Actinastrum hantzschii, Tetraedron trigonum var. gracilis and Pediastrum boryanum became common in the plankton. In the previous content there had been euglenids, and Mallomonas sp. was occasionally encountered.

In September, at a water temperature of 14° the census of algae along the left bank amounted to only 18 percent of the August plankton. On the right bank the September phytoplankton formed a second maximum, which was still much lower than the July peak. At both points, with the exception of Melosira granulata, Fragilaria crotonensis and Melosira varians were noted in considerable numbers. There was an appreciable impoverishment of the group of blue-green algae.

On 21 October the water temperature dropped to 4. 3°. The phytoplankton became even poorer. Among the diatoms there was still a predominance of Melosira granulata. The presence of a large number of empty cells of this form in the water (348, 000 cells per liter) speaks for the extinction of this prevalent form of summer plankton.

In the first few days of November, when the period of the stable ice on the open water began, the phytoplankton of the Ob' River assumed a winter nature. Blue-green algae and Melosira dropped out of the group of plankton entirely; the place of the latter was again occupied by Cyclo-

tella sp., Stephanodiscus sp., although in very small quantities. Representatives of the other groups were encountered occasionally.

The indices of three investigations of phytoplankton made in 1960 were very close to the figures for the previous year. Only August should be noted as an exception, at which time the quantity of algae in the plankton of the water downstream from the dam was considerably higher at both points than in the previous year.

Content of Phytoplankton in the Water after Purification

An analysis of samples of purified water made it possible to judge the degree to which the algae were retained by the water works.

In the winter, in the purified water, as was the case with the river water, occasional small forms of diatomaceous algae were found (see Fig 2, a, b). In May at both water works a very high percentage of retained algal cells was noted by comparison with the number coming in (see the Table). With enrichment of the river plankton the percentage of algae retained decreased somewhat in June. The qualitative composition of the algae in the purified water continued to be almost unchanged from the river water.

In July and August at both water works a high percentage of retained phytoplankton was noted. Thereby, it should be noted that in the purified water in July the numerical relationship between the phytoplankton components was of a somewhat different nature than in the incoming water. Relatively large filaments of Melosira granulata constituted 8.8 percent of the original number of cells in the river water, and narrower filaments of M. granulata var. angustissima constituted 30 percent. The figures were even lower for Anabaena, filaments of which form large balls, and therefore the number of them in purified water amounted to 5.2 percent. A number of authors has indicated different degrees of penetration of the algae through the filter pores depending on their size (3-5).

The percentage of retained algal cells given in the Table does not give any idea of their number in the purified water. Thus, in August 1959, at the left-bank water works, with retention of 77 percent of the algae by the filters 2,790,000 cells per liter were counted in the purified water, and in 1960, when the river plankton was richer than in the previous year, after retention of 75 percent of the algae by the filters 4,470,000 cells per liter still remained in the water.

The very low percentage of phytoplankton retained in September with the high content of algae in the incoming river water attracts attention. In October and November a considerably impoverished phytoplankton comes to the filter. Its census remained practically unchanged after

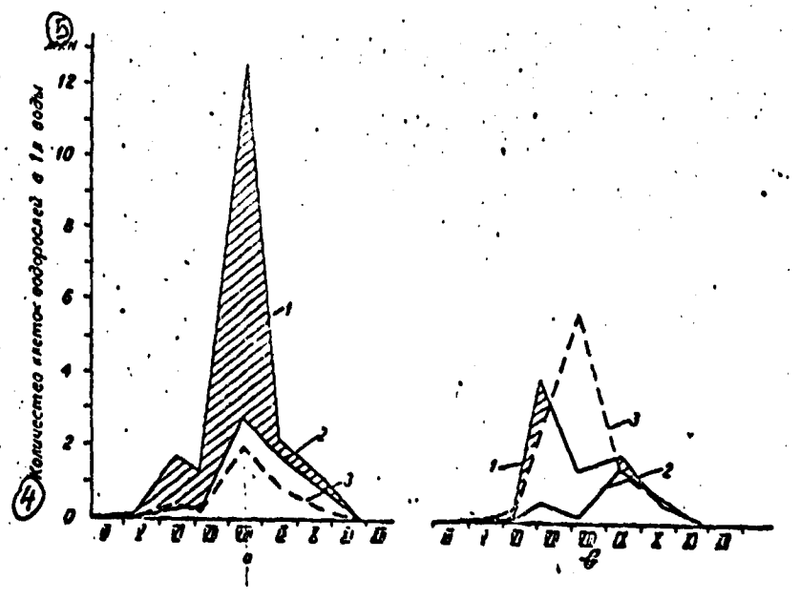

Fig 2. Comparison of the Quantity of Phytoplankton in the Ob' River with Its Content in the Purified Water on the Left Bank (a) and Right Bank (b) Water Works. 1. In the River; 2. Immediately following the filter; 3. In the city water pipeline; 4. Number of algal cells per liter of water; 5. Million.

going through the filters by comparison with the river water.

Water samples from the city water supply were taken for the determination of how the content of algae in the water supply system changes in the water main and in the side lines. The quantity of phytoplankton was always somewhat less in the water pipe water on the left bank than in the purified water, with the exception of June 1959, where the water in the water system was 11 percent richer than the water which came through the filters (Fig 2, a). The species content of algae remained the same as after coming through the filters.

Analysis of the water samples from the water tower on the right bank showed that in March and in June the census of algae in the system was lower than after the filters; the rest of the time it was considerably higher than the figures for the purified water, and in August, even higher than the river water figures (see Fig 2, b). Beginning with September,

Retentive Power of Phytoplankton Filters at the Left- and Right-Bank Stations in 1959 and 1960

(1) Месяцы	(2) Задержано клеток фитопланктона фильт. зим., %			
	(3) левобережная н.-ф. с.		(4) правобережная н.-ф. с.	
	1959 г.	1960 г.	1959 г.	1960 г.
(5) Март	0	0	—	—
(6) Май	91,3	82	92	84
(7) Июнь	84,5	94,7	75	—
(8) Июль	75,4	—	87	78
(9) Август	77,7	75	89	70
(10) Сентябрь	20	—	15	—
(11) Октябрь	—	—	0	—
(12) Ноябрь	33,4	—	0	—

Note. No analyses were made.

1. Months; 2. Phytoplankton cells retained by the filters, percent; 3. Left-bank water works; 4. Right-bank water works; 5. March; 6. May; 7. June; 8. July; 9. August; 10. September; 11. October; 12. November.

the difference between the purified water after the filters and the water in the water system on the right bank decreased.

What was the reason for such unexpected results? It is known that the water works on the right bank operated arrhythmically, and there were frequently changes in water pressures. In the remote areas, in the side lines, this led to stagnation of the water and accumulation of suspension on the bottom of the pipe, and in the summer season, also the accumulation of algal cells. Water samples taken from the system in the water main and in the side lines in 1960 confirmed the idea that the side lines were becoming cluttered up. The figures for the quantity of phytoplankton in the side line were always higher than in the main. The algal cells in the water system were maintained in good condition and were the same in external appearance as the river plankton. There was no process of decay noted which could have had an influence on the taste properties of the water or particularly on its bacterial flora.

Conclusions

The phytoplankton of the Ob' River before damming was poor (4, 5). In it there was a maximum of 2, 500, 000-2, 700, 000 algal cells per

liter, among which there was a predominance of diatoms and green algae. After damming of the river the phytoplankton census in the portion of the river downstream from the dam of the Hydroelectric Power Station increased by four-six times, mainly because of an increase in diatoms; in the summer, this increase was because of the group of blue-green algae.

Ye. Ye. Raskina (6), studying the influence of phytoplankton on the operation of Leningrad water pipes, indicates that the filters begin to "feel" the algae when their content in the incoming water is 800,000 cells per liter of water. This quantity of algae appears in the Ob' River as early as June; in July-August the number of algae increases considerably.

In the period when the river is frozen there are few algae in it, and no measures are needed for retaining them.

In the period when navigation is possible, from May to August 1959, the filters of the left-bank water works retained an average of 82 percent; in 1960, 66 percent of the algae; the right-bank water works retained 71 and 54 percent, respectively. These figures are usual ones for the operation of fast filters (7), and only in September can the percentage of algae retained be called inadequate.

As is well known, the composition of mass organisms which can influence the taste of the water is of great importance. Under conditions of the Ob' River, these are chiefly Melosira granulata with its variety M. granulata var. angustissima; of the blue-green algae, Anabaena scheremetievi, A. hassalii f. tenuis, and Aphanizomenon flos-aquae. Melosira granulata is a very widespread organism, and its mass development can interfere with the operation of the filters at the water works (8). In the case of mass development of blue-green algae the water can acquire a grassy odor.

Even the first observations show that for the purpose of improving the operation of the Novosibirsk Water Works certain measures need to be taken. One of the measures contributing to reduction of algae in the water before coming to the filters is chlorination of it before the settling tanks, because it is well known that dead plankton is precipitated much more quickly than living plankton.

More rhythmical operation of the water works, particularly on the right bank, is the second condition for improving the quality of the tap water of the city.

The studies made in the area of the river below the dam of the Novosibirskaya Hydroelectric Power Station show the need for constant checking on the development of the river and reservoir phytoplankton and consideration of these data by the city water works.

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