

Features of New Blue-Green Types for the Adjacent Lakes of the Mezhdurechchina Reservoir

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Abstract: The article presents the results of a study (2003-2021) of the composition of algae in the Mezhdurechinsky reservoir. The average content of dissolved oxygen, bicarbonates, sulfate ions of chlorides and other metals in the water of the reservoir was determined. The water mineralization of lakes Koshpeli Aidyn, Autel and Baltaketken is maximum within the reservoir and ranges from 2500.3 to 4372.6 mg/l. Of the biogenic elements in the water of the reservoir, the readings of silicon, iron, phosphates, nitrates, and ammonium were determined.

Keywords: Blue-green, biodiversity, analysis, water salinity, biogenic elements, water salinity.

Introduction. Mezhdurechinsky reservoir: built on the basis of three fairly large former natural lakes like Koku, Shegekul and Zakirkul, located in the lower reaches of the delta of the Amudarya and Akdarya rivers, and also small lakes joined them: Koshpeli aydin, Autel, Baltaketken, Nogay uzyak, Shuak uzyak, Zhideli Uzyak, Rametulla Uzyak, Koz Zharma, Aiteke, Ilmurat Salma. The main goal is the constant supply of drinking water to the population of the region and fish farming in the lower water bodies of the Aral Sea basin. The water level here is not constant due to the unstable supply of water to the river. Amu Darya. The depth of the reservoir is 0.5-5.0 m, but more than 30% of the entire water area is occupied by shallow water. The water temperature in summer rises to 30-32°C, in winter its surface freezes, covered with ice 37-40 cm thick. The reservoir receives water from the Amu Darya. In shallow water, due to often standing strong winds, the water sometimes mixes with the soil layer. In this regard, we were set goals - to study the current state and biodiversity of the species composition and systematic analysis of algae of the Mezhdurechinsky reservoir.

The tasks are:

- Collection of algological samples from the Mezhdurechinsky reservoir and study of species composition, as well as systematic analysis of algae;
- Compilation of a systematic list of blue-green algae in this reservoir;
- determination of the average content of dissolved oxygen and other chemical indicators in the waters of the reservoir.
- determination of the average salinity of waters in the reservoir;

The study of algae of the Amudarya River and its delta:

The algae of the Amudarya delta were studied by A.M. Muzafarov [17]. He studied the algal flora of the Amudarya River from the source to the mouth of the river, also studied the algal flora of some lakes of the Amudarya delta, such as Korpkul, Birkazankul, etc. A.E. Elmuratov studied the algal flora of the southern part of the Aral Sea [9-13].

The works of Zh.F. Adiyatova (1966), M.I. Novozhilova (1973) [1, 19] are devoted to the floristic composition and distribution, as well as the total number and biomass of microorganisms in the Aral Sea.

The number of microorganisms, according to these authors, ranges from 26.2-710 thousand cells / ml in spring, 77.4-571.0 thousand cells / ml in summer, and 127.2-205.0 thousand cells in autumn /ml The average biomass of microorganisms for the entire sea in spring is 26.7 mg/l, in summer - 32.0 mg/l, in autumn - 31.2 mg/l.

Data on the higher aquatic vegetation of the Aral Sea can be found in many works (L.S. Berg, 1908; K.V. Dobrokhotov, 1954; R.S. Denginina, 1954; A.M. Muzafarov, 1960; E.A. Yablonskaya , 1960, 1964; A.E. Elmuratov, 1981, etc.) [2, 7-9, 22].

Materials and research methods. Sampling in the studied areas was carried out along the coasts, in bays, small kultuks, puddles and lagoons, etc. Samples were taken through each layer of water depth to the bottom with a Nansen bathometer. The fixed samples were allowed to stand for 15 days, concentrated, and examined for further analysis under a light microscope of the CarlZeiss type (made in GDR) [4]. Further study of the species composition and the establishment of the systematic belonging of algae was carried out by a number of methods: algological, microbiological and hydrobiological studies [4, 21]. In the course of the study, we collected more than 300 samples using the Gaz No. 78 plankton net, prepared temporary and permanent preparations of five replicates from each sample collected from each observation station (SN or MS) of the reservoir. When determining the species composition and taxonomy of the species, the determinants written by domestic and foreign authors [5, 6, 9-13, 16, 18, 21], also the determinants of the algae of Karakalpakstan [10-13], were used.

Results and discussion of studies.Over the years of research, the average content of dissolved oxygen in the water of the reservoir was noted to be quite high. During the year, the fluctuation of its amplitude is not the same, but despite this, it turned out to be quite sufficient to provide for the hydrobionts living in it (Table 1).

Table 1. Average content of dissolved oxygen (mg/l) in water
 Mezhdurechinsky reservoir for 2017-2021

Area	IV	V	VI	VII	IX	X
Cocsu	5,33-0,40	8,39-13,10	7,32-12,69	6,00-8,11	9,54-10,55	6,54-8,60
Shegekul	4,05-8,72	9,20-12,83	6,70-11,83	5,61-8,06	9,06-10,50	6,71-8,43
Zakirkul	4,07-8,64	7,98-12,54	6,70-11,67	5,66-7,92	8,76-10,05	6,09-8,46
Aydin koshpeli	5,40-9,36	8,01-12,60	7,85-11,75	6,12-8,00	8,90-10,57	6,63-8,55
Outel	2,52-7,45	3,86-7,03	3,77-6,58	3,47-6,56	3,40-6,35	3,04-5,52
Baltaketken	3,70- 7,80	3,88-7,75	4,00-6,80	4,01-7,11	3,54-7,30	3,20-5,52
Nogayuzyak	4,81-7,77	5,79-13,00	7,13-12,05	7,84-10,68	8,03-10,21	7,76-9,90

According to the content of chemical components, the water in the section of Lake Shuak Uzyak, which is located above the reservoir, differs somewhat from the water of Lake Zakirkul (Table 2), which is explained by the influence of river waters.

Table 2. Average salinity of waters (in ‰) for the areas of the Mezhdurechinsky reservoir for 2017-2021

Area	IV	V	VI	VII	IX	X
Cocsu	0,30-0,43	0,34-0,40	0,45-0,55	0,40-0,80	0,32-0,49	0,40-0,47
Shegekul	1,06-1,33	0,70-1,08	0,65-1,40	0,77-1,26	0,60-1,25	0,83-1,19
Zakirkul	0,40-0,78	0,36-1,31	0,80-1,46	0,83-1,27	0,73- 0,96	0,65-0,90
Aydin koshpeli	1,60-2,00	1,80-2,05	0,63-1,90	0,45-1,40	0,70-1,32	0,87-1,76
Outel	3,50-6,30	3,66-5,00	4,77-5,53	3,21-5,90	3,55-7,04	3,33-5,09
Baltaketken	2,40-3,70	2,67-4,03	2,07-3,00	2,30-4,13	2,68-3,85	2,55-3,90
Nogayuzyak	1,35-2,87	1,28-2,66	1,05-2,00	1,52-1,89	1,26-2,05	1,46-2,00

Lake water Koksul and Shegekul are poorly mineralized - 53.7-104.8 mg/l. According to the ionic composition, it belongs to the hydrocarbonate class (up to 90% equivalent of ions), in the calcium group, alkali metals were possessing cations (up to 67% equivalent of ions). Especially the chemical composition of water in the upper part of the Koksul and Shegekul is probably influenced by the tributaries of the Shuak. In other parts of the above reservoirs, the content of bicarbonates increases significantly and amounts to 107.9-300.5 mg/l, sulfate ions 0.76-10.73, chlorides 18-6.7 mg/l. The concentration of calcium is 6.5-10.2 mg/l, magnesium 1.5-2.8, alkali metals 0.8-9.8 mg/l.

The mineralization of water in Koshpeli Aydin, Autel and Baltaketken is maximum within the reservoir and ranges from 2500.3 to 4372.6 mg/l. Of the anions, hydrocarbonates predominate - 42-53-eq. (49.3-73.0 mg/l); share of sulfate ion 26.5-38.4, chlorides 19.0-42.5-eq. Cationic composition (%): calcium - 60.9, magnesium - 11, alkali metals - 3-22; Water pH varies within 7.3-8.4 and is characterized by a maximum in summer.

Of the biogenic elements in the water of the reservoir are present (mg / l): silicon - 0.002-0.950, total iron - 0.01-0.19, phosphates - 0.001-0.426, nitrates - 0.010-0.076, ammonium - 0.02-0, 04, nitrates - up to 0.011. Hereinafter, the concentrations of nitrates, nitrites, ammonium are given in terms of nitrogen, phosphates - for phosphorus, silicon dioxide - for silicon (Table 3). Permanganate oxidizability varies within 2.0-6.7 mg O/l

Table 3.

Average content of biogenic elements (mg/l) in the Mezhdurechinsky reservoir for 2017–2021

Area		IV	V	VI	VII	IX	X
Cocsu	Si	0,016	0,007	0,063	0,009	0,002	0,033
	P	0,020	0,017	0,006	0,090	0,074	0,030
	N	0,015	0,020	0,107	0,020	0,085	0,052
Shegekul	Si	0,182	0,135	0,144	0,190	0,82	0,196
	P	0,134	0,133	0,106	0,198	0,126	0,119
	N	0,245	0,205	0,198	0,253	0,185	0,300
Zakirkul	Si	0,006	0,108	0,111	0,193	0,080	0,200
	P	0,003	0,001	0,026	0,074	0,010	0,023
	N	0,052	0,005	0,035	0,103	0,054	0,089
Aydin koshpeli	Si	0,102	0,104	0,098	0,126	0,093	0,129
	P	0,131	0,200	0,112	0,200	0,145	0,208
	N	0,100	0,100	0,089	0,235	0,134	0,273
Outel	Si	0,175	0,163	0,140	0,187	0,160	0,193
	P	0,277	0,252	0,246	0,328	0,241	0,426
	N	0,605	0,411	0,400	0,704	0,606	0,732
Baltaketgen	Si	0,307	0,231	0,173	0,265	0,195	0,950
		0,277	0,206	0,171	0,190	0,200	0,178
	P	0,540	0,356	0,300	0,498	0,330	0,500
	N						
Nagayozyak	Si	0,140	0,125	0,117	0,200	0,322	0,273
	P	0,165	0,156	0,104	0,187	0,163	0,200
	N	0,127	0,100	0,099	0,244	0,199	0,286
shuakozyak	Si	0,043	0,076	0,090	0,110	0,017	0,102
	P	0,102	0,080	0,207	0,211	0,038	0,200
	N	0,040	0,093	0,160	0,092	0,079	0,155

Dissolved silicon is present in river water in a smaller amount - 0.10-1.33 mg / l, and during the ice-free period, its minimum is observed in summer. The interval of change in the concentration of mineral phosphorus is higher - from traces to 0.070 mg/l. The amount of nitrates in the water is 0.009-0.045 mg/l, their slight increase is noted after the flood and a decrease in the warm season. The content of ammonium is 0.01-0.10 mg/l, its change is similar to the change in nitrates. Nitrites were found in an amount not

exceeding 0.024 mg/l. The permanganate oxidizability of water is low, it increases during high water (3.6-5.2 mg/l) and decreases in summer (2.0-2.4 mg O/l). The content of dissolved oxygen in water is close to normal saturation - 89-124% (table 1). Its maximum concentration is observed in early autumn. The amount of free carbon dioxide varies from 0.6 to 3.1 mg/l, decreasing from spring to summer.

Further in this article, information will be given on some blue-green algae that live in the lakes of the Mezhdurechinsky reservoir.

1. *Synechocystis endobiotica* Elenk. Et Hollerb*. - C.

In the lake Shegekul and Koksus, in the central regions, in summer and early autumn, at a depth of 3 m - singly; at water temperature - 22-29°C and salinity - 0.5-2.7‰, pH - 7.7-7.9; O₂ - 4.9 -12.5 mg/l; CO₂ - 8.0-14.5 mg/l; NH₄ - 0.34-3.18 mg/l; NO₂ - 0.001-0.04 mg/l; NO₃ - 0.01-0.06 mg/l; PO₄ - 0.001-0.009 mg/l, α-mesosaprob.

2. *Dactylococcopsis acicularis* Lemm*.

In the lake Koksus and Shegekul, everywhere, in summer, at a depth of 1-4 m - singly; at water temperature - 20-29 ° C and salinity - 0.6-3.8‰, pH - 7.6-8.1; O₂ - 7.4 -11.8 mg/l; CO₂ -12.0-22.1 mg/l; NH₄ - 0.44-3.21 mg/l; NO₂ - 0.001-0.04 mg/l; NO₃ - 0.01-0.06 mg/l; PO₄ - 0.001-0.009 mg/l. α-β-mesosaprob.

3. *Dactylococcopsis irregularis* G.M.Smith

In the lake Shegekul, everywhere - rarely; in the lake Koksus, in the eastern, northern and central regions, at a depth of 1-3 m - singly; in the south - rarely; at water temperature - 21-29°C and salinity - 0.6-3.0‰, pH - 7.4-8.1; O₂ - 7.4 -11.8 mg/l; CO₂ - 12.0-22.1 mg/l; NH₄ - 0.44-3.21 mg/l; NO₂ - 0.001-0.04 mg/l; NO₃ - 0.01-0.06 mg/l; PO₄ - 0.001-0.009 mg/l. α-β-mesosaprobe

4. *Dactylococcopsis scenedesmoides* Nyg*.

In the lake Shegekul and Koksus, at a depth of 4 m, from May to August - singly; at water temperature - 20-29°C and salinity - 0.7-3.55‰, pH - 7.4-8.1; O₂ - 7.4 -11.8 mg/l; CO₂ - 12.0-22.1 mg/l; NH₄ - 0.44-3.21 mg/l; NO₂ - 0.001-0.04 mg/l; NO₃ - 0.01-0.06 mg/l; PO₄ - 0.001-0.009 mg/l. α-β-mesosaprob.

5. *Merismopedia punctata* Meyen. f. *arctica* Kossinsk

In the lake Koksus, in the southern and eastern coasts, near between reed bushes, from May to September - rarely; in the central and northwestern areas, at a depth of 2-3 m, in summer and early autumn - singly; In the lake Shegekul, everywhere, in summer plankton - rarely, in autumn - singly; at water temperature - 12-29.3 ° C and salinity - 0.5-3.4‰, pH - 7.0-8.1; O₂ - 4.0 - 11.5 mg/l; CO₂ - 7.0-13.5 mg/l; NH₄ - 0.30-3.04 mg/l; NO₂ - 0.001-0.03 mg/l; NO₃ - 0.01-0.04 mg/l; PO₄ - 0.001-0.006 mg/l.

8. *Gloeocapsa magma* (Breb.) Kutz. emend. Hollerb* [=Gl. Sanguinea (Ag.) Kutz., Chroococcus simmeri Schmidle и некоторые другие].

In the lake Shegekul, distributed everywhere, from May to September, but more abundant in July plankton; in the lake Koksus and Zakirkul, in the southern part and near the mouth of Shuak Uzyak, July-August, in coastal plankton - often; at water temperature - 15-29°C and salinity - 0.5-2.3‰, pH - 6.98-7.4, O₂ - 38-130%.

10. *Gloeocapsa compacta* Kutz.

In the lake Zhideli- and Nogai-uzyak, in the puddles of the valley, (June-July) - rarely; in the lake Koksus, in the southern and northern coasts, in the waters between reed beds, in summer - singly; in the lake Shchegekul, in the central region, in July plankton - rare; at temperature - 24-37°C and salinity - 0.5-3.2‰, pH - 7.7-8.0; O₂ - 7.5-11.8 mg/l; CO₂ - 8.6-13.4 mg/l; NH₄ - 0.30-3.04 mg/l; NO₂ - 0.001-0.04 mg/l; NO₃ - 0.01-0.05 mg/l; PO₄ - 0.001-0.007 mg/l. α-β-mesosaprob.

11. *Gloeocapsa rupestris* Kutz.

In the lake Shegekul, Koksus, Zakirkul, Koshpeli-aydin, are found everywhere, in the central region, from mid-May to September, at a depth of 1.0-4.3 m - singly; in coasts, on macrophytes and swamps, between other algae - rarely; in the southern drying shores, forms powder rafts, at a water temperature of 25-36 ° C and salinity - 0.5-2.5‰, pH - 7.0-7.6, O₂ - 30-67%, oxidizability - 1, 8-9.0 O₂/l.

15. *Woronichinia Naegeliana* (Ung.) Elenk*. - В. Нэгели

В оз. Шегекуль, Коксу, в прибрежном планктоне, летом - единично; в оз. Аутель, Балта-кеткен, Ногай-узяк; Шуак-озек, в планктоне и болотистом мелководье, на гниющих роголистниках - очень единично; при температуре воды - 12-32°C и солености - 0,3-2‰, pH - 6,8-8,0, O₂ - 110-126 %, CO₂ - 6,8 мг/л.

16. *Chroococcopsis gigantea* Geitl.

In the lake Koksuk and Shegekul, distributed in the coastal part, in the bottom plankton, on the stems and leaves of the underwater part of the common reed - rarely; on swampy soil, among fouling - singly; In the lake Nogay-Uzyak, Balta-ketken, Autel, in shallow waters, on the surface of *Meriophyllum* and *Potamogeton*: *lucens*, *perfoliatus*, rarely in summer; at water temperature - 24-33 ° C and 0.5-2.5‰, pH - 7.0-7.2, O₂ - 80-110%, CO₂ - 6.1-6.2 mg / l.

17. *Xenococcus chroococcoides* F.E.Fritsch*.

In the lake Zakirkul, Koshpeli Aidyn, Autel and Nogayuzyak, in the coasts on swampy soils and on the keels of submerged boats, leaves and stems of the underwater part of reed thickets, twisted with threads of *Spirogyra*, *Cladophora* and *Zygnema*, from April to October - singly; at a water temperature of 6-14 ° C and a salinity of 0.5-2.0‰ pH - 6.9 - 7.3; O₂ - 110-120%, CO₂ - 6.9 mg/l.

18. *Endonema moniliforme* Pasch*.

In the lake Shegekul, in the area of Uyrek aydin, in summer plankton, in the northwestern coast, on the leaves of the underwater part near reed thickets - rare; in the northeastern region, close to the shores of the lake. Zakirkul, on the surface of chernozem-loamy soil, between other algae, from July to August - very rarely; at water temperature - 24-29 ° C and salinity - 0.5-1.7‰ o, pH - 6.8-7.1, O₂ - 105-126%, CO₂ - 5.0-6.8 mg / l.

20. *Sphaeronostoc coeruleum* (Lyngb.). Elenk.

The floodplain terrace of the lake. Uzyak lived, 2 km north of the Uyrek Aidyn pool, in July to August - once; lake Aidyn and Baltaketken coshpels, in summer, in the surface layer near bottom sediments - rare; at water temperature - 24-32°C and salinity - 0.5-1.5‰ o, pH - 6.9-7.4; O₂ - 67-126%, CO₂ - 6.5 mg/l.

21. *Anabaena Volzii* Lemm.

In the lake Shegekul, Zakirkul, Zhideli and Shuak Uzyak, in summer, in plankton and on sandy-silty ground, together with other blue-greens - once; at water temperature - 24-31 ° C and salinity - 0.5-1.6‰ o, pH - 6.8-7.4, O₂ - 90-12.6%, CO₂ - 6.2 mg / l.

23. *Oscillatoria angustissima* W. Et G.S. West.

In the lake Baltaketken, Nogay and Zhideliuzyaki, on water-immersed macrophytes and marshy shores, rarely in summer; in the lake Shegekul and Koksuk, in the central part, at a depth of 1-3 m, from June to mid-September - singly; in coastal swamps - rarely; at water salinity - 0.5-3.6‰ o, pH - 7.8-8.0; O₂ - 4.8-12.4 mg/l; CO₂ - 6.7-17.5 mg/l; NH₄ - 0.34-3.18 mg/l;

Conclusion. During the study of the Mezhdurechinsky reservoir, we registered 392 species and intraspecific taxa of algae belonging to 108 genera, 58 families, 30 orders, 20 classes belonging to 8 divisions. Of these, the Bacillariophyta division is 135 species and varieties, or 34.43% of the total number of algae, Chlorophyta - 102 (25.76%), Cyanophyta - 81 (20.66%), Euglenophyta - 30 (7.65%), Dinophyta - 28 (7.14%), Xanthophyta - 12 (3.06%), Chrysophyta - 3 (0.76%), Cryptophyta - 2 species (0.51%). Their systematic lists have been compiled.

In the plankton of the reservoirs of the Mezhdurechinsky Reservoir, four ecological groups of algae have been identified, which differ in the dynamics of abundance and in relation to temperature: a) eurythermal species (they are present in plankton all year round and have two abundance maxima in spring-first half of summer and late summer-autumn); b) spring-summer species (peak numbers in late spring-early summer); c) summer species (they reach their maximum number during the period of the greatest warming of the water column); d) summer-autumn species (the maximum number is observed in late summer-early autumn). Taxonomic diversity increases with increasing temperature, reaching its maximum in summer.

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