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## ALGOFLORA OF THE AKDARYA RESERVOIR AND FEATURES FORMATION OF ALGOFLORA WITH RELATIONSHIP TO ECOLOGICAL FACTORS

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**Annotation.** In the algoflora of the Akdarya reservoir, 83 species have been identified that belong to 4 divisions (Cyanoprocariota, Bacillariophyta, Euglenophyta, Chlorophyta). Algoflora is very abundant in the autumn period of the year, at this time there are 32 species and varieties, they make up 42.25%. The diversity of the species composition of algae in different periods of the year depends on temperature, water salinity and other factors.

**Keywords.** Algoflora, limiting factor taxa, freshwater, brackish species, euryhaline, stenohaline.

**Алгофлора Акдарьинского водохранилища и особенности формирования ее в зависимости экологических факторов**

**Аннотация**. В альгофлоре Акдарьинского водохранилища выявлено 83 вида, относящихся к 4 отделам (Cyanoprocariota, Bacillariophyta, Euglenophyta, Chlorophyta). Альгофлора очень обильна в осенний период года, в это время насчитывается 32 вида и разновидностей, они составляют 42,25%. Разнообразие видового состава водорослей в разные периоды года зависит от температуры, солености воды и других факторов.

**Ключевые** слова. Альгофлора, таксоны, лимитирующих факторов, пресноводные, солоноватоводные виды, эвригалин, стеногалин.

**Oqdaryo suv ombori algoflorasi va uning shakllananishini ekologik omillarga bog‘liqligi**

**Annotatsiya:** Oqdaryo suv ombori algoflorasi tarkibidan 83 tur aniqlangan bo‘lib, ular 4 bo‘limga (Cyanoprocariota, Bacillariophyta, Euglenophyta, Chlorophyta) mansub. Algoflora asosan kuz oylarida turlar soni bo‘yicha yetakchilik qilib, 32 turni tashkil etgan, bu jami florani 42,25% tashkil etadi. Suvo‘tlar turlar tarkibining xilma xilligi yil fasllaridagi suvning harorati, sho‘rlanish darajasi va boshqa omillarga bog‘liq.

**Kalit so‘zlar**. Algoflora, taksonlar, cheklovchi omillar, chuchuk suv, sho‘r suv suvo‘tlari, evrigalin, stenogalin.

### Introduction

Algae are considered very sensitive to changes in the ecological balance in the aquatic environment, their comprehensive study within a certain period of time allows monitoring the sanitary and ecological state of the aquatic ecosystem.

In the Akdarya reservoir, the floristic and ecological features of the algoflora have not yet been studied [1], [2]. In this area, ecological-floristic analyzes of algal flora have not yet been carried out. Therefore, the purpose of this article was to study the taxonomic composition of the algal flora of the Akdarya reservoir and carry out ecological and floristic analysis by seasons.

### Object and research methods.

The Akdarya reservoir is located in the middle reaches of the Zarafshan river basin, on the Akdarya river (right tributary of the Zarafshan river), which is located in the Ishtikhan district of the Samarkand region of the Republic of Uzbekistan, at 39º995'N and 066º382'E, at an altitude of 485 meters above sea level (Figure). Has been in operation since 1989. The volume of water is 131.8 million m3, the maximum height of the dam is 20 m, the water permeability is 70 m3 / s, the pH ranges from 6.5 to 7.0, the average salinity of the water is 511-612 mg / l.

More than 160 algological samples were collected (2016-2019) from the Akdarya reservoir and processed according to generally accepted algological methods. The collection of algological samples, fixation, labeling, and storage were carried out according to the method of collecting and studying

freshwater algae [3], [4]. Phytoplankton samples were collected by the sedimentation method (1 L of water was taken with subsequent settling) or by simple scooping of water (with the intensive development of algae). Fouling samples were taken together with the substrate or the top layer was scraped off from objects immersed in water. Phytobenthos were collected using a siphon, scraper, or spoon (with a sharpened side).

The chemical composition of the water was analyzed by the data of the Uzbek Hydrometeological Research Institute and other sources.

The species composition was determined using classical keys [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18].




**Figure 1.** General view of the Akdarya reservoir

Results and its discussion. In the period 2016-2019, only 83 species were identified in the Akdarya reservoir. They belong to 4 divisions (Cyanoprocariota, Bacillariophyta, Xantophyta, Chlorophyta), 8 classes, 24 orders, 36 families and 69 genera, which are shown in Table 1.

**Table 1.**

Taxonomic composition of the algoflora of the Akdarya reservoir

| Divisions | Class | Order | Family | Genus | species | |
|---|---|---|---|---|---|---|
| | | | | | Σ | % |
| Cyanoprocaryota | 1 | 5 | 8 | 12 | 26 | 31.3 |
| Euglenophyta | 1 | 1 | 1 | 1 | 1 | 1.2 |
| Bacillariophyta | 3 | 10 | 18 | 30 | 34 | 40.9 |
| Chlorophyta | 4 | 9 | 10 | 12 | 22 | 26.5 |
| Total: | 9 | 25 | 37 | 55 | 83 | 100 |

The average temperature in the spring in the reservoir was +10 +12ºC, the amount of minerals was 511-523 mg/l, the transparency of the water was 100-115 cm, pH was 6-6.5. During this period of the year, 30 species and varieties of algae were identified in the algal flora, this makes up 36.14% of the algal flora of the reservoir (Table 2). Here, 7 species and varieties (6 species, 1 form) were identified from the Cyanoprocariota section and 23 species from the Bacillariophyta section (18 species, 5 varietites).

From the department Cyanophyta, taxa were identified that belong to class 1 (Hormogoniophyceae), 2 orders (Nostocales (Geitl.) Elenk. Oscillatoriales Elenk.), 3 families (Nostocaceae Kuetz., Anabaenaceae Elenk.), 5 genera (*Nostoc* Adanson, *Anabaena* Bory, *Oscillatoria* Vauch., *Spirulina* Turp., *Formidium* Kuetz.).

Taxa belonging to 2 classes (Centricae, Pennatae), 3 orders (Discoidales, Araphinales Schütt, Raphinales), 5 families (Coscinodiscaceae Kuetz., Fragilariaceae (Kuetz.) D.T., Naviculaceae West., Nitzschiaceae, Surirellaceae (Kuetz.) Grun.), 10 genera (*Cyclotella* Kuetz., *Diatoma* DC, *Fragilaria*

Lingb., *Synedra* Ehr., *Navicula* Bory, *Neidium* Pfitz., *Amphora* Ehr., *Cymbella* Ag., *Nitzschia* Hass., *Surirella* Turp.).

The species *Nostoc zetterstedtii* Aresch., *Oscillatoria quadripunctulata* Brühl dominated in the spring algoflora of the Akdarya reservoir. et Biswas, *Oscillatoria limosa* Ag. f. *desperso-granulata* (Schkorb.) Elenk., *Oscillatoria rupicola* Hansg., *Spirulina jenneri* (Hass.) Kuetz. *f. jenneri*, *Spirulina gomontiana* (Setchell) Geitl. (from the division Cyanoprocariota), *Synedra ulna* (Nitzsch.) Ehr., *Navicula cryptocephala* var.*veneta* (Kuetz.) Grun. (Bacillariophyta).

15 species (50%) of algae identified in the spring are freshwater, 10 species (33.33%) are freshwater-brackish, 5 species (16.66%) are brackish algae (Table 3).

In summer, there is an increased vegetation of agricultural crops; a very large amount of water is taken from the Zarafshan River for irrigation. As a result, the water level in the reservoir drops sharply. Due to a significant decrease in the water level in the reservoir, an acceleration of water exchange occurs. In addition, fish farming is well developed in the reservoir, as a result of which breeding phytoplanktons are intensively eaten by young fish. In summer, an increase in air temperature (+ 30 + 36ºC) and water (+ 19 + 26ºC) is observed, the mineralization of water increases (556-601 mg/l), pH 6.0, water transparency increases (over 200 cm). In turn, all these factors have a significant impact on the algal flora of the reservoir. At this time, 25 species of algae were identified in the algal flora of the reservoir, which makes up 30.12% of the algal flora of the reservoir (Table 2). They belong to the divisions Cyanoprocariota (1 species), Bacillariophyta (20 species), and Xanthophyta (4 species).

**Table 2**

Distribution of algal flora by seasons years of the Akdarya reservoir

| Divisions | Of the total number of species (83) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Spring | % | Summer | % | Autumn | % | Winter | % |
| Cyanoprocariota | 7 | 8.43 | 1 | 1.20 | 7 | 8.43 | - | - |
| Bacillariophyta | 23 | 27.71 | 20 | 24.09 | 23 | 27.71 | - | - |
| Xantophyta | - | - | 4 | 4.82 | - | - | - | - |
| Chlorophyta | - | - | - | - | 2 | - | 2 | |
| Total: | 30 | 36.14 | 25 | 30.12 | 30 | 36.14 | 2 | 2.41 |

Occurring in the spring *Oscillatoria rupicola* Hansg. from the Cyanoprocariota division are also found in benthos in summer. The identified 20 taxa from the Bacillariophyta division belong to class 1 (Pennatae), 2 orders (Araphinales Schütt, Raphinales), 4 families (Fragilariaceae (Kuetz.) DT, Naviculaceae West., Nitzschiaceae, Surirellaceae (Kuetz.), Genera (*Synedra* Ehr., *Navicula* Bory, *Neidium* Pfitz., *Amphora* Ehr., *Cymbella* Ag., *Nitzschia* Hass., Surirella Turp.)

In the same period of the year, species of the division Xanthophyta were identified in the algoflora, which belong to 2 classes (Heterococcophyceae, Heterotrychphyceae), 2 orders (Heterococcales, Tribonematales), 2 families (Chlorotheciaceae, Tribonemataceae Pasch.), 2 genera (*Ophiocytium* Naeg., *Tribonema* Derb. et Sol.)

In the summer algal flora of the reservoir, such species as *Synedra tabulata* (Ag.) Kuetz., *Amphora ovalis* var. *gracilis* Ehr., *Nitzschia distans* var. *tumescens* Grun., *N. angularis* W. Sm., *N. acuta* Hantzsch. (Bacillariophyta), related to freshwater-brackish and *Ophiocytium gracillimum* Borzi em. Pasch., *Tribonema subtilissima* Pasch. (Xanthophyta), related to brackish algae, are more common than other species.

In the algal flora sampled in summer, 13 species (52%) were identified as freshwater, 6 species (24%) were freshwater-brackish and 6 species (24%) were brackish algae (Table 3).

In autumn, the water level in the reservoir remains almost unchanged. At this time, irrigation of autumn crops develops, the mineralization of water increases (average 570-612 mg/l) due to the filling of the river with sewage, a change in pH is recorded (6.5-7.0), the water temperature was +12 +18°C, but despite these factors, the number of species in the algal flora increased. This can be attributed to the fact that, due to the different reservoirs flowing to the reservoir (large and small canals, collectors, rice fields), saltwater and freshwater-saltwater algae appear. In addition, fish breeding in the reservoir become larger, because of this, they eat little phytoplankton.

In autumn, 30 species and varieties were identified, which make up 36.14% of the algal flora of the reservoir (Table 2). They belong to the divisions Cyanophyta (7 species), Bacillariophyta (23 species),

Chlorophyta (2 species). The identified species in the Cyanophyta division correspond to 7 taxa of 2 classes (Chroococcophyceae, Hormogoniophyceae), 2 orders (Chroococcales, Nostocales (Geitl.) Elenk.), 2 families (Merismopediaceae Elenk., Oscillatoriaceae (Meyen.) Elenk., *Oscillatoria* Vauch., *Spirulina* Turp., *Formidium* Kuetz.). Identified in the Bacillariophyta department correspond to 23 taxa of 2 classes (Centricae, Pennatae), 3 orders (Discoidales, Araphinales Schütt., Raphinales), 5 families (Coscinodiscaceae Kuetz., Fragilariaceae (Kuetz.) DT, Naviculaceae West.), 10 genera (*Cyclotella* Kuetz., *Fragilaria* Lingb., *Synedra* Ehr., *Caloneis* Cl., *Gyrosigma* Hass., *Amphora* Ehr., *Cymbella* Ag., *Nitzschia* Hass., *Cymatopleura* W. Sm., *Surirella* Turp. ).

In autumn, species such as *Rhizoclonium profundum* Brand and *Closterium leibleinii* Kuetz appeared in the algal flora of the reservoir. (Chlorophyta) and *Ophiocytium gracillimum* Borzi em. Pasch., *Tribonema spirotaenia* Ettl., *T. affine* West., *T. subtilissima* Pasch. (Xanthophyta). These species are classified into 4 classes (Siphonocladophyceae, Conjugatophyceae, Heterococcophyceae, Heterotrychophyceae), 4 orders (Cladophorales, Desmidiales, Heterococcales, Tribonematales), 4 families (Cladophoralesgenera (*Chaetomorpha* Kuetz., *Closterium* Nitzsch, *Ophiocytium* Naeg., *Tribonema* Derb. et Sol.). These species are not found in the Akdarya River (right branch of the Zarafshan River) [1]. They can enter the reservoir from a variety of water sources such as lakes, sewers, canals, and rice paddies that are located around the reservoir.

During this period of the year, species such as *Merismopedia elegans* A.Br., *Oscillatoria quadripunctulata* Brühl dominated in the algal flora of the reservoir. et Biswas, *O. limosa* Ag. *f.despersogranulata* (Schkorb.) Elenk., *O. rupicola* Hansg., *Spirulina jenneri* (Hass.) Kuetz., *S. gomontiana* (Setchell) Geitl (Cyanophyta), *Fragilaria bicapitata* A. Mayer, *Caloneis alpestris* (*Groneis alpestris* (Gr.) Cl., *Gyrosigma distortum* (W. Sm.) Cl., *Amphora ovalis* Kuetz. var. *pediculus* Kuetz., *A. costulata* Skv., *Nitzschia sublinearis* Hust., *N. acicularis* W. Sm. (Bacillariophyta), *Rhizoclonium profundum* Brand., *Closterium leibleinii* Kuetz. (Chlorophyta).

Of the algae identified in the fall, 14 species (43.75%) belong to freshwater, 16 species (50%) to freshwater-brackish and 3 species (9.37%) to brackish algae (Table 3).

In winter, the water level in the reservoir drops sharply. Freezing was observed in the upper layer of water for some time. The water temperature dropped sharply (average +1+6ºC), the mineralization of the water was 520-561 mg/l, pH 6.5-7.5, water transparency 2.5 meters. The sharp drop in temperature influenced the spread and formation of algae, which was the main limiting factor. During this period, only cold-resistant species have been identified in the reservoir as *Oscillatoria rupicola* Hansg. (Cyanophyta), related to freshwater-saltwater and *Rhizoclonium profundum* Brand. (Chlorophyta) related to brackish algae.

In the collected samples of the observed algal flora of the Akdarya reservoir, the species *Oscillatoria rupicola* Hansg., Which occurs in all seasons, and the species *Synedra ulna* (Nitzsch.) Ehr., *Nitschia vermicularis* (Kuetz.) Grun., Occurring from spring to autumn, were identified. These species are considered eurybionts (eurytherm and euryhaline).

In the algal flora of the Akdarya reservoir, out of 83 identified species, 38 species (Cyanophyta-2, Bacillariohyta-32, Xantophyta-4) are considered freshwater algae, this makes up 45.78% of the total algal flora of the reservoir, 23 species (Cyanophyta-7, Bacillariohyta-14, Chlorophyta-2) freshwater brackish water (32.39%) and 9 species (Bacillariophyta-9) brackish water (12.67%).

This numerical value indicates that certain algae are half freshwater brackish and brackish algae. This is done by increasing the mineralization of the reservoir water in the summer and autumn months, as well as by running wastewater from irrigated areas. This condition at one time negatively affects the development of freshwater algae and favorably affects the development and distribution of freshwater-brackish and brackish algae.

**Table 3**

The ratio of algae to water mineralization in the algal flora of the Akdarya reservoir

| Division | of the total number of the form (83): | | | | | | of the total number of the form (83): | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | freshwater | % | freshwater-brackish | % | brackish | % | euryhaline | % | stenohaline | % |
| Cyanophyta | 2 | 2.41 | 7 | 8.43 | - | - | 7 | 8.43 | 2 | 2.40 |
| Bacillariophyta | 32 | 38.55 | 15 | 18.07 | 9 | 10.84 | 15 | 18.07 | 41 | 49.39 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Xantophyta | 4 | 4.82 | - | - | - | - | - | - | 4 | 4.82 |
| Chlorophyta | - | - | 2 | 2.40 | - | - | 2 | 2.41 | - | - |
| Total: | 38 | 45.78 | 24 | 28.91 | 9 | 1.94 | 24 | 28.91 | 46 | 56.62 |

Table 3 shows that freshwater-brackish and brackish algae make up a significant proportion of the algal flora. This is influenced by an increase in the degree of water mineralization from α-hypogalin (in spring) to β-oligogalin (from summer to winter).

As a result of the ecological-floristic study of the algal flora of the Akdarya reservoir, the analysis of the formation and properties of the algal flora was carried out. As mentioned above, the Akdarya reservoir is located directly on the course of the Akdarya river and the water of this reservoir directly regulates the water level in the river. This means that the formation of the algal flora of the Akdarya reservoir is closely related to the algal flora of the Akdarya river.

According to existing data [1], 129 species and varieties (92 species, 8 forms, 29 variations) have been identified in the algal flora of the Akdarya River. They consist of 5 divisions (Cyanoprocariota, Bacillariophyta, Euglenophyta, Dinophyta, Chlorophyta), 11 classes, 15 genera, 26 families and 48 species.

A comparative analysis of the algal flora of the Akdarya reservoir with the algoflora of the Akdarya river was carried out. In total, 33 species and varieties were found in the reservoir (2 species of Cyanoprocariota, 30 species of Bacillariophyta, 1 species of Chlorophyta), the presence of which corresponded to the algoflora of the Akdarya River. Of these, 22 species and varieties (66.66%) are considered freshwater algae. Along the length from the river to the reservoir, water salinity averaged 442-463 mg/l, this is α-hypogalin (freshwater). The similarity of the algal flora of the reservoir with the algal flora of the river was found, amounting to 46.47%. The remaining 38 species and varieties were not found in the Akdarya River, as well as in the currents between the reservoir and the river.

This means that the rest of the algal flora of the reservoir was formed by algae emerging from adjacent reservoirs, lakes and rice fields.

The Kattakurgan reservoir, located in the middle reaches of the Zarafshan River, is filled with water from the Zarafshan River. The algoflora of this reservoir was studied by A. Muzafarov and K. Musaev (1969). A comparative study established the similarity of 38 species of algal flora of the two reservoirs. Of these, 2 taxa belong to the Cyanoprocariota division, 35 taxa to the Bacillariophyta division, and 1 taxa to the Chlorophyta division. These data indicate that the predominantly large amount of minerals in the Zarafshan River creates a favorable condition for the spread and development of species of the Bacillariophyta family, as compared to species of other families. As a result, the dominance of species of the family Bacillariophyta is observed both in the Zarafshan River itself and in other water basins formed from this river.

**Conclusion**

The distribution, development of algae and the formation of the algal flora of the Akdarya reservoir are directly related to the complex effect of environmental factors (water temperature, degree of mineralization, pH, water transparency, impact of living organisms). During the year, the water of the reservoir changes from hypoghaline to oligogalin, which, as a result, leads to a change in the composition of the algal flora, where the species quantity of freshwater-brackish and brackish-water algae varies. In the algal flora of the reservoir, most of the algae are freshwater-brackish and brackish algae.

The similarity of 33 species (39.75%) in the composition of the algal flora of the Akdarya reservoir with the species of the algal flora of the Akdarya river was established. Due to the difference in the chemical composition of the waters flowing into this reservoir from various sources (collectors, large and small canals, rice fields), a kind of ecological condition has been formed. The rest (38 species, 45.78%) of the algal flora of the Akdarya reservoir was formed due to inflow from the surrounding sources (territory).

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