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The Current Environmental Status of the Tuyabuguz Reservoir

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ABSTRACT: The current ecological state of the Tuyabuguz reservoir is considered. The biodiversity of aquatic biota, the seasonal dynamics of the species composition, the abundance and biomass of phytoplankton, zooplankton, periphyton and zoobenthos organisms were studied. It was revealed that for all considered indicators a pronounced seasonal variation is characteristic.

KEY WORDS: Tuyabuguz water reservoir, environmental state, phytoplankton, zooplankton, periphiton, macrophytes.

I. INTRODUCTION

The role of reservoirs is growing in the sectors of the economy of the Central Asian countries: their water is increasingly used for irrigation, generating electricity, settlements water supply, recreation and other purposes [1].
The influence of anthropogenic factors affects the change in various aspects of the reservoirs natural complex. There is a change in the chemical composition of water, which in turn affects the living conditions of aquatic organisms, creates difficulties in water supply, and also causes pollution of groundwater.
This article discusses the ecological status of biocenoses of the Tuyabuguz reservoir located in the Tashkent region of the Republic of Uzbekistan.
The Tuyabuguz reservoir (Tashkent Sea) was built for the seasonal regulation of the Akhangaran Riverwater flow. The total volume of water mass is 250 millionm^3, the area of the water mirror is 20 km^2, length is 9 km, maximum width is 3 km, average width is 1,88 km, depth - maximum is 31,5 m, average is 16 m. The reservoir is used mostly for irrigation purposes, two irrigation channels leave the right and left-bank parts of the dam. Water consumption on the right-bank channel is 55 m^3/s, on the left-bank channel - 20 m^3/s [1].
The hydrochemical regime of the reservoir is directly affected by the hydrochemical regime of the tributaries of the Akhangaran and Burgalik rivers, as well as discharges from the Tashkent channel and the Gairat collector. It should be noted that the influx of water into the reservoir is carried out along the Akhangaranriveris from March to June, and in the remaining months there is practically no surface inflow. Water flow Akhangaranriverenters the reservoir by a groundwater flow in thick pebble deposits of the river floodplain, which also affects the dynamics and content of mineralization, ionic composition, gas regime, nutrients and organic matter of the water masses of the reservoir [2].
The Tuyabuguz reservoir is a multi-purpose reservoir, except for irrigation purposes, it is also used for recreational purposes, therefore its ecological status is very important. The main factors affecting the dynamics of the hydrochemical and hydrobiological regimes of the water of the Tuyabuguz reservoir are natural (physiographic and geological environmental conditions) and anthropogenic (discharges from agricultural fields, discharges of industrial enterprises above the reservoir, etc.) factors.

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Fig 1. Map of the location of the Tuyabuguz reservoir

II. MATERIALS AND METHODS

During complex seasonal expeditions to the Tuyabuguz reservoir in 2011-2012 and in 2018, material was collected phytoplankton, higher aquatic vegetation, zooplankton, periphyton and zoobenthos. Samples were taken and processed according to generally accepted methods using determinants.

Phytoplankton. Phytoplankton samples were taken with a one-liter Ruttner bathometer, merged 250 ml into 500 ml dishes, mixed. For high-quality collection of phytoplankton, a plankton network of silk gas was used; the samples were first fixed with a Lugol solution (1-2 ml), and then fixed with a 40% formalin solution (5-10 drops). Standard sampling horizons: 0 (surface); 0,5 m; 1,0 m; 2,0-2,5 m [1,4].

In the laboratory, subsequent concentration of phytoplankton samples was carried out by the sedimentary method. Quantitative processing of the material was carried out according to the generally accepted algological method in a Fuchs-Rosenthal chamber with a volume of 3,2 mm^3 using a MEIJI microscope. Phytoplankton biomass was determined by the generally accepted calculation method [2, 3, 8].

Zooplankton. Qualitative samples of zooplankton were taken by Apstein's conic planktonic network from various horizons (0,2-0,5 m), as well as on the Akhangaran riverbed in areas with a slowed flow of water, and were recorded with a 70% solution of ethyl alcohol. Determination of the species composition was carried out under a microscope using conventional determinants [1,3,7,9,10].

Periphyton. Fouling was collected from the surface of solid objects and macrophytes using a scalpel and tweezers. Sampling from the surface of leaves and stems of macrophytes was performed by washing off the growth with a soft brush. A small amount of material was placed in wide-neck samplers (0,5 L) with water [3,5,6].

Zoobenthos.Zoobenthos samples were taken with a scraper from the bottom of the reservoir (fence of the upper soil layer) and by mowing higher aquatic vegetation. The soil was washed through a gas sieve (No. 36) and fixed with a 40% formalin solution. Subsequent processing of benthos samples was carried out in laboratory conditions using microscopes MBS-10 and MC-300X, electronic scales [3,4,8].

Higher aquatic vegetation. For high-quality collection of macrophytes from the bottom with a water depth not exceeding 2-3 m, water rakes were used. A small amount of all species of plants encountered was taken, samplers were placed in 0.5 L, water was added and fixed with 40% formalin solution (1 ml). For visual assessment of the overgrowing of a reservoir, we used the scheme - determining the degree of overgrowing of water bodies at different locations of vegetation in the coastal areas, where: + - single occurrence (1-2%), 2 - small (3-10%), 3 - medium (11-20%), 4 - large (21% -35%), 5 - very large (36-50%), + 5 - overgrowing, vegetation covers more than 50% of the area. Identification of macrophyte species was carried out in office conditions [5].

III. RESULTS AND DISCUSSION

The water quality of the Tuyabuguz reservoir was evaluated according to the results of our own research, as well as according to results of the Uzhydromethydrochemical monitoring. In the period 2011-2012, mineralization of water in the reservoir ranged from 197,9 to 646,95 mg/dm^3. The monthly average BOD5 values varied from 0,3 to 1,22mg/dm^3, COD-4,73-8,21 mg/dm^3, nitrate nitrogen 0,48-1,96 mg/dm^3, ammonium nitrogen 0,002-0,06 mg/m^3andnitrite nitrogen

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0,01-0,03 mg/dm^3, zinc-1,7-11,1 mg/dm^3, copper-0,23-4,54 mg / dm^3, cadmium up to 0,76 mg/dm^3 lead up to 0,24 mg/dm^3.

At the time of the study, in Tuyabuguz reservoir, the usual filling of the bowl of the reservoir was observed, the flow is not very fast, the color of the water is green, the transparency is 3,5 m (across the Secchi disk); the nature of bottom sediments along the coast is stones, pebbles, at the depth - gray silt. The thickness of the silt sediments is small – 0,15-0,20 m, under them lie the primary soils of the bottom bed. Soils are represented by alluvial deposits - sand, clay with loam.

During the study period, in 2011-2012 and 2018, 63 samples were taken and processed (15 phytoplankton, 12 zooplankton, periphyton 22, 12 zoobenthos, 12 macrophytes), in which 324 species of aquatic organisms were found, of which 246 species microdroplets from phytoplankton and periphyton communities, 27 - zooplankton, 39 - zoobenthos and 12 - macrophytes.

Communities of phytoplankton and periphyton. During the expeditionary survey of the Tuyabuguz reservoir, 246 species, varieties and forms of microalgae were found in phytoplankton and periphyton samples, of which 33 were blue-green (Cyanophyta), 159 were diatomic (Bacillariophyta), and green (Chlorophyta) 42 species, cryptophytic (Cryptophyta) - 2 species, dinophytic (Dinophyta) - 6 species, eugle (Euglenophyta) - 3 species, yellow-green - (Xanthophyta) - 1 species (Table 1).

Table 1 - The taxonomic structure of phytoplankton
Tuyabuguz reservoir

	falling into reservoir			middle reservoir			outflow from reservoir		
Taxon / Sample NO..	N. 1	NO. 2	NO. 3	NO. 4	NO. 5	NO. 6	NO. 7	NO. 8	NO. 9
Cyanophyta	11	11	12	9	9	6	7	5	8
Bacillariophyta	20	70	54	19	39	29	17	18	18
Cryptophyta	1	2	1	2	2	-	-	-	-
Euglenophyta	-	2	-	-	-	-	-	1	-
Dinophyta	-	-	4	2	3	2	-	2	3
Chlorophyta	7	11	5	14	13	8	10	12	6
Number of species	**39**	**96**	**76**	**46**	**66**	**47**	**34**	**38**	**35**

Note: No.1,4,7 - surface, depth 0,5m; No. 5, 8 – depth 1,0 m; No. 3, 6, 9 - depth 2,0-2,5 m.

In the studied samples of phytoplankton, a moderately good development of blue-green (*Cyanophyta*) algae was noted in the summer-autumn period 33 species or 13,41% of the total number of algae. They are represented mainly by the widespread freshwater-brackish-water colonial and filamentous forms from the genera *Microcystis, Dactylococcopsis, Aphonothece, Gloeocapsa, Gomphosphaeria, Oscillatoria, Phormidium, Lyngbya*. The abundance of blue-green algae ranges from 4018,750 * 10^3 cells/L to 41481,250 * 10^3 cells/L The weakest qualitative and quantitative development of blue-green algae was noted at a depth of 2,0-2,5 m (the middle of the Tuyabuguz reservoir). The biomass of the latter was only 0.0345 mg/ml.
According to taxonomic diversity, diatoms (Bacillariophyta) dominate in the phytoplankton of the studied areas of the Tuyabuguz reservoir (159 species or 64,63%) and are represented as widespread freshwater-brackish-water forms of the algae of the genera *Cyclotella, Melosira, Cocconeis, Diatoma, DiatomaFragilaria, Achnanthes, Navicula, Diploneis*, as well as brackish water species characteristic of water bodies with low water salinity (*Bacillariaparadoxa, Cymbellapusilla, Naviculaspicula, N.Kolbei, Gyrosigmaacuminatum, Nitzschiacapitellata, MastogloiaSmithii*and its variation,*Entomoneispaludosa, SurirellaCapronii*and etc.). In the summer, diatoms of both the above genera and the genera *Cymbella, Eunotia, Denticula, Caloneis, Synedra, Gomphonema, Gyrosigma, Amphora, Nitzschia*,, many of which are simultaneously characteristic of eutrophic reservoirs, as well as species characteristic of biotopes from accumulation of plant detritus (*Synedra ulna, Amphora ovalis, Naviculacryptocephala*and with variations, *Nitzschiapalea*and etc.).
During the entire period of research, there was a massive development of planktonic forms of diatoms *Melosiravarians, Cyclotellameneghiniana, C.comta, C.caspia, C. kuetzingii*, etc. The number of diatoms varies from 1156,250 *10^3 cells / l to 4056,250*10^{3}cells / l, and biomass, respectively, from 0,9913 mg / ml to 2,5225 mg / ml.

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Green algae (Chlorophyta) in the studied areas developed moderately well 42 species (17,07%) and are mainly represented by the genera *Oocystis, Chlorocococcus, Chlorella, Dictyosphaerium, Tetraedron, Carteria, Cosmarium, Coelastrum, Closterium, Pediastrum, Scenedesmus*. At the height of the so-called "biological summer" (August-September), the species diversity of green algae increases, of which individual species are pronounced gallophils (*Oocystisborgii, O.marssonii, Scenedesmusguadricauda, Cosmariumformulosum*, etc.). The number of green algae in the samples ranges from 156,250*10^3 cells/L to 2412,500*10^3cells/L, and the biomass, respectively, from 0,0693 mg/ml to 0.3569 mg/ml.

Dinophyta algae (Dinophyta) of 6 species (2,44%) are most representative of species from the genera *Peridinium, Glenodium,Ceratium*. In September sample No. 3, abundant development of *Ceratiumhirundinella* was noted. The number of dinophytic algae ranges from 12,500*10^3cells / liter to 206,250*10^3cells / liter, the biomass of the latter was respectively – 0,0259 mg / ml to 0,1581 mg / ml.

Euglena algae (Euglenophyta) with a low abundance (1-2 species) were recorded only in the summer period in the coastal part at the confluence and in the outflow from the Tuyabuguz reservoir. The number of euglena algae was 6,250*10^3 cells/L and 18,750*10^3 cells/L, biomass, respectively, 0,0080-0,0241 mg/ml.

Thus, based on the obtained, qualitative and quantitative indicators, it can be noted that the summer-autumn (August, September 2011-2012 and 2018) period of the phytoplankton of the studied sections of the Tuyabuguz reservoir is represented mainly by blue-green, diatom, green and dinophytic microalgae, where the leading role was played by diatomsin the phytoplankton in the studied period.

The highest quality development of microalgae was observed in the summer-autumn period in areas near the coast at the "confluence of the reservoir" and in the middle part of the reservoir. At the so-called endpoint, the "outflow", phytoplankton developed moderately. The greatest quantitative development of microalgae was noted in the surface layers, where planktonic colonial and filamentous microalgae from the genera *Microcystis, Aphanothece,Oscillatoria, Phormidium, Lyngbya, Cyclotella, Melosira, Synedra, Fragillaria*and others reached mass development. Most of the detected species are widely distributed. to reservoirs with increased trophicity and having a wide ecological valency. The increased abundance at a depth of 1,0-2,5 m was created mainly by representatives of filamentous blue-green algae of the Oscillatoriaceae family.

In the seasonal aspect, the greatest development of phytoplankton algae is observed in the studied areas, both in qualitative and quantitative terms in the summer-autumn (August-September) period.

In summer samples, in comparison with spring species, the participation of blue-green (*Merismopedia, Gloeocapsa, Comphosphaeria, Oscillatoria*) and green algae increases. The dominant green algae complex is represented mainly by Protococcales and Desmidiales orders, namely, species of the genera *Oocystis, Scenedesmus, Ankistrodesmus, Tetraedron.*

In the periphyton communities (above and below the Tuyabuguz reservoir) organisms from the group of producers (164 species) and consumers (21 species) were noted, no reducers were found. The producers are represented by almost the same genera of blue-green, diatom, green, euglena and dinophytic algae, as are the phytoplankton communities of the reservoir. Also filamentous green and yellow-green algae (*Hydrodictionreticulatum, Enteromorphaintestinalis, Stigeocloniumlumbricum, S.tenue, Cladophoraglomerata, Ulothrixzonata, Spirogyra sp., S.porticalis, ZygnemastellinumиVaucheriageminata*).

Consonations are presented by protozoa (*Amoeba proteus, Aspidiscacostata, Bodo sp., Chilodonellauncinata, Trinemaenchelys, Stylonichiamytilis, Vorticella sp., V. convallaria*), rotifers (*Colurellacolurus, Cephalodella sp., Cephalodellagibba, Lecane sp., Lepadellaovalis, Rotariacitrina, Rotariarotatoria, Trichotria sp*.), Lower crustaceans (*Alonarectangula, Harpacticoida gen. sp., Eucyclopsserrulatus*), as well as chironomid larvae, roundworm nematodes, and tardigrades of the genus *Macrobiotis*. Organisms from the group of consumers reach the greatest development in the summer-autumn period in thickets of filamentous algae and macrophytes at shallow depths.

Zooplankton. During the study period, 27 species were found in zooplankton samples, of which Rotifera - 18, Cladocera - 4, Copepoda - 5 (Table 2).

Table 2 - The taxonomic structure of zooplanktonTuyabuguz reservoir

Taxon	falling into reservoir	middle reservoir	outflow from reservoir
Rotifera	8	6	10
Cladocera	3	-	3
Copepoda	5	-	2
Number of species	16	6	15

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Above the Tuyabuguz reservoir, zooplankton communities are represented by:*Cephalodella sp., Euchlanisdilatata, Lecaneluna, Lecanelunapresumpta, Rotaria sp., Trichocercarattuscarinata, Trichotria truncate aspinosa, Alonarectangula, Chydorussphaericus, Ilyocryptussp.*,Harpacticoida gen. sp., *Macrocyclopsalbidus, Eucyclopsserrulatus, Paracyclops sp., Acanthocyclopseinslei*,as well as copepodal and nauplial stages of cyclops development.

Below the reservoir, zooplankton communities are represented:*Cephalodella sp., Euchlanisdilatata, Lecane bulla diabolica, Lecanelunapresumpta, Lecanequadridentata, Lecaneungulata, Mytilinaventralis, Trichocercarattus, Trichotriapocillum, Trichotriatruncata, Alonarectangula, Chydorussphaericus, Scapholeberisrammneri*, Harpacticoida gen. sp., *Eucyclopsserrulatus*, as well as copepodal and nauplial stages of cyclops development.

Zooplankton in the middle of the reservoir is somewhat poor and is represented mainly by rotifers: *Euchlanisdilatata, Keratellacochlearis, Keratellacochlearistesta, Lecaneluna, Polyarthra major, Trichocercasimilis,* as well as copepodal and nauplial stages of cyclops development.

Zooplankton sampling points above and below the reservoir are places of not great depth (<0,3 m), respectively, well warmed up and heavily overgrown with both filament and macrophytes. Therefore, species that prefer temporary, highly eutrophic and overgrown reservoirs (species of the genus *Cephalodella* and *Rotaria*, *Lecane bulla diabolica, Macrocyclopsalbidus, Eucyclopsserrulatus, Paracyclops sp., Acanthocyclopseinslei*, etc.) predominate here. In the reservoir itself, mainly true planktonic species (species of the genus *Keratella*) are noted.

Zoobenthos. During the study, 39 species of organisms were recorded in the macrozoobenthos of the Tuyabuguz reservoir: dipterous larvae (Diptera) - 7 species, including 7 species of chironomids (Chironomidae), 7 species of oligochaetes, Coleoptera beetles and dragonfly larvae (Odonata) - 4 species each, Mayfly larvae (Ephemeroptera) - 3 species, mollusks (Mollusca), bugs (Heteroptera) and nematodes (Nematoda) - 2 species each, caddis flies (Hydropsyche), amphipods (Gammarus), shrimps (Decapoda) (table 3).

Table 3 - The taxonomic structure of macrozoobenthos of the Tuyabuguz reservoir

Taxon	falling into reservoir.	middle reservoir	outflow from reservoir .
Ephemeroptera	+	-	+
Diptera	+	-	-
Orthocladiinae	+	+	+
Chironominae	+	+	+
Coleoptera	+	+	+
Heteroptera	-	-	+
Hydropsychidae	+	-	+
Odonata	+	+	-
Gammaridae	+	-	+
Mollusca	+	+	+
Decapoda	+	+	+
Oligochaeta	+	+	+
Nematoda	+	-	+

The benthic fauna complex of the Tuyabuguz reservoir is represented by widespread freshwater-brackish b-, b-a-, a-eurisaprobic species of mayfly larvae *Cloeondipterum, Caenismacrura, Baetistransiliensis*,dipterous larvae*Ceratopogonidae*gen.sp.,caddis flies*Hydropsychegracilis*,shrimp*Macrobrachiumnipponenseasper*,amphipods*Gammaruslacustris*,beetles of the genera *Haliplus, Gyrinus, Coelambus*,mollusks*Lemnaeaovata*, chironomids*Cricotopussilvestris*, oligochaetes*Naiscommunis, Stylarialacustris*, etc.

The predominant group of benthic communities of the Tuyabuguz reservoir is the true bottom fauna, represented in the bottom sediments by the Iloid forms of p-saprobic species of oligochaetes of the Tubificidae family and chironomid larvae, subspecies of the Chironomidae family (up to 60%), and phytophilous vegetation, highland vegetation, and represented by ba-saprobic species of oligochaeta p / family Naidinae, a-saprobic species of larvae of dragonflies of this. Coenagrionidae, chironomid of the genus *Tanytarsus*, a-p-saprobic species of *Physaacuta* mollusks, characteristic of eutrophic and moderately polluted waters.

Zoobenthos biomass, measured on silty soils, varied in different areas in the range of 1708-5351 mg/m^2.

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Downstream in the summer-autumn period, in the zoo benthos, with an increase in the level of water mineralization, the specific ratio of the eurisynus species and the noticeable quantitative development of the mollusk *Physaacuta* and theshrimp*Macrobrachiumnipponenseasper*, which prefer well-heated areas, especially shallow water with thickets of aquatic vegetation, increase.
During the year, phytophages, detritophage-gatherers, filtrators, and optional predators predominated in trophic dominants.
Thus, the zoobenthos communities of the Tuyabuguz reservoir are represented by rather diverse ecological groups of organisms that prefer silty soft soils and, to a lesser extent, overgrown aquatic vegetation, which is moderately or abundantly developed in the reservoir, depending on its accumulation.
Macroforms. During the period of the expeditionary studies, overgrowing by the higher aquatic vegetation of the reservoir was observed in places to a depth of 2-3 m from the highest water level in it. The upper sections (confluence) and bays, where the greatest accumulation of river sediments occurs, are especially heavily overgrown [11]. The abundant development of macrophyte associations was observed in the coastal area in summer (up to 80%), which were mainly represented by hydrophytes - curly sediments (*Potamogetoncrispus*) and comb (*P. pectinatus*), duckweed (*Lemna minor*), and moss (*Fontinalis)*. In the summer-autumn period, abundant development of chara (*Charafragilis*) and hornwort submerged (*Ceratophyllumdemersum*) was observed.
The dominant complex of higher aquatic vegetation of the Tuyabuguz reservoir is represented, first of all, by vines (*Potamogetoncrispus, P. pectinatus, P. perfoliatus*), spiked urut (*Meriophyllumspicatum*) and semi-submerged hornwort (*Ceratophyllumsubmersum*), most of which are diverse and comb. With a low abundance, vipers (*P. perfoliatus, P. nodosus*) were noted. In the coastal strip at the "inlet" of the studied sections of the reservoir, good development of common reed *(Phragmitescommunis*) and cattail (*Thypha*) was observed.
As a result of sharp fluctuations in the water level during the irrigation season and the uneven bottom in the reservoir, the associations of higher aquatic vegetation in the ecological order are inconsistent, one or another group falls out during the year and their change is mainly dependent on hydrological and hydrochemical conditions.

IV.CONCLUSION

Conducting comprehensive studies of aquatic biocenoses of the Tuyabuguz reservoir significantly increased the level of hydrochemical, hydrobiological, and general environmental studies in Uzbekistan.
Aquatic biocenoses are mainly represented by widespread species of organisms that undergo both qualitative and quantitative changes during the year. The greatest qualitative and quantitative development of fouling was observed at a depth of 0,5-1,0 m and in the bottom layers. By autumn, with an increase in the level of mineralization of water, the specific ratio of brackish-water species of organisms increases.

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