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ECOLOGICAL CHARACTERISTICS OF THE PERIPHYTON COMMUNITY OF WATERMARKS OF THE UGAM-CHATKAL NATURAL STATE PARK OF UZBEKISTAN

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Annotation: The article presents the results of a study of water quality indicators and ecological condition in the winter-spring and summer-autumn periods of 2022 based on periphyton indicators of river ecosystems in protected natural areas of the Ugam-Chatkal Natural State National Park of Uzbekistan. In the periphyton of the studied watercourses of the UChNSNP, a total of 169 species of organisms were found, of which 152 species were from the group of producers, 17 species were from consumers and 5 were decomposers.

Keywords: Ugam-Chatkal natural state national park, periphyton, water quality, ecological status

Introduction

The Western Tien Shan region has always attracted the attention of researchers and many of them, especially during the period when the study of Central Asia began, sought to visit this region. Powerful chains of mountains with their foothill valleys are adjacent to oases developed by man, which then turn into vast areas of deserts [2].

Numerous and diverse water bodies form an integral part of the nature of the mountainous territory of the Central Asian region. Most of the water bodies of the Western Tien Shan, and in particular the Ugam-Chatkal Natural State National Park and the Chatkal Biosphere Reserve, which is part of it, organized in 1992 on the territory of the Tashkent region of Uzbekistan, cover all altitudinal zones within - Ugam, Pskem, Sandalash and Chatkal ranges [11].

The purpose of our research was to study and conduct monitoring observations of the taxonomic structure and species composition of hydrobionts in river ecosystems as part of a joint project with the Belarusian side on the topic: “Assess the ecological quality (ecological status) of river ecosystems and conduct a comparative analysis of their condition based on biotic indices using indicator groups of hydrobionts (macrozoobenthos) in protected natural areas in the conditions of Belarus and Uzbekistan.”

To carry out research work, the territory of the Ugam-Chatkal Natural State National Park of Uzbekistan (UCHSNP) was chosen, which covers almost all the mountain ranges of the Western Tien Shan within the Republic of Uzbekistan and the flat zone of the Tashkent region. The basins of the largest rivers in the region are located here - Pskem, Chatkal, Koksu, Akhangaran, Chirchik and their tributaries. A significant part of the UChNSNP is a single mountain ecosystem of the Chirchik River basin.

The park is included in the UNESCO World Heritage List and is the largest environmental complex in Uzbekistan. The area of the park is 574.6 thousand hectares, of which 56.4 thousand hectares are wooded zones, 177.3 are pastures and hayfields, 1.61 are irrigated lands, and, finally, 329.4 are mountainous, rocky areas [12].

Ugam-Chatkal Natural State National Park with its beautiful mountain slopes, rocks, caves, lakes, rivers and waterfalls has many opportunities for active recreation and tourism.

Material and research methods.

In watercourses of the region with a mountain type of nutrition and increased flow speed, the main priority biocenoses are periphyton (fouling) and macrozoobenthos (invertebrates), which are abundantly and diversely represented both in river ecosystems and in the littoral zone of mountain lakes in protected natural areas.

PERIPHYTON (the fouling) - communities of organisms living on a variety of underwater (living or dead) substrates raised above the bottom, regardless of their origin, which include representatives of three main functional groups: *autotrophic* organisms – producers (algae); *heterotrophic* organisms - consumers (protozoa, rotifers, worms and others) and *decomposer* organisms (zooglean, filamentous, rod-shaped, coccoid and other forms of bacteria and fungi).

Collection of field materials (fouling scrapings) was carried out using a scraper, scalpel and tweezers according to generally accepted methods [10, 13]. Desk work was carried out using a Meiji microscope; when identifying the species composition of periphyton, generally accepted identifications of freshwater algae were used in accordance with the analyzed group of aquatic organisms [1, 3, 5-9, 15-17, 19]. To assess the saprobity index (SI) of water, we used the method of indicator organisms of Pantle and Bucca, modified by Sladechek [18], as well as the Talskikh biotic periphyton index (BPI), developed for the fast-flowing regional characteristics of rivers in Central Asia [14] (Table 1).

Table 1 Classifier of the quality and ecological state of surface waters according to the values of the saprobity index (SI), biotic periphyton index (BPI)

Water of class	Water quality	Values IS	Values BPI	Ecological state of the biocenosis (desired / expert assessment)
I	very clean	< 1,0	10-9	Background (reference) – AB (F)
II	clean	1,1–1,5	8-7	Background (good) – AB
III	moderately polluted	1,6–2,5	6-5	Satisfactory – AB
IV	contaminated	2,6–3,5	4	Unsatisfactory – AB-Ab
V	dirty	3,6–4,0	3-2	Bad – Ab
VI	very dirty	> 4,0	1-0	Inadmissible - ab

The periphyton water quality class was determined based on the values of both indices, as well as taking into account the structure of the species composition, the presence of characteristic species of organisms in the dominant complex, and their ecological and geographical characteristics.

The above assessment methods using the IP and BPI indices are considered as basic indicators and their application reflects the true environmental picture.

Results.

The studies were carried out 4 times a year, seasonally: winter-autumn. Over the past period, 50 periphyton samples were collected and analyzed.

Figure 1 shows the places of collection of field material along the rivers of the Ugam-Chatkal Natural State National Park.

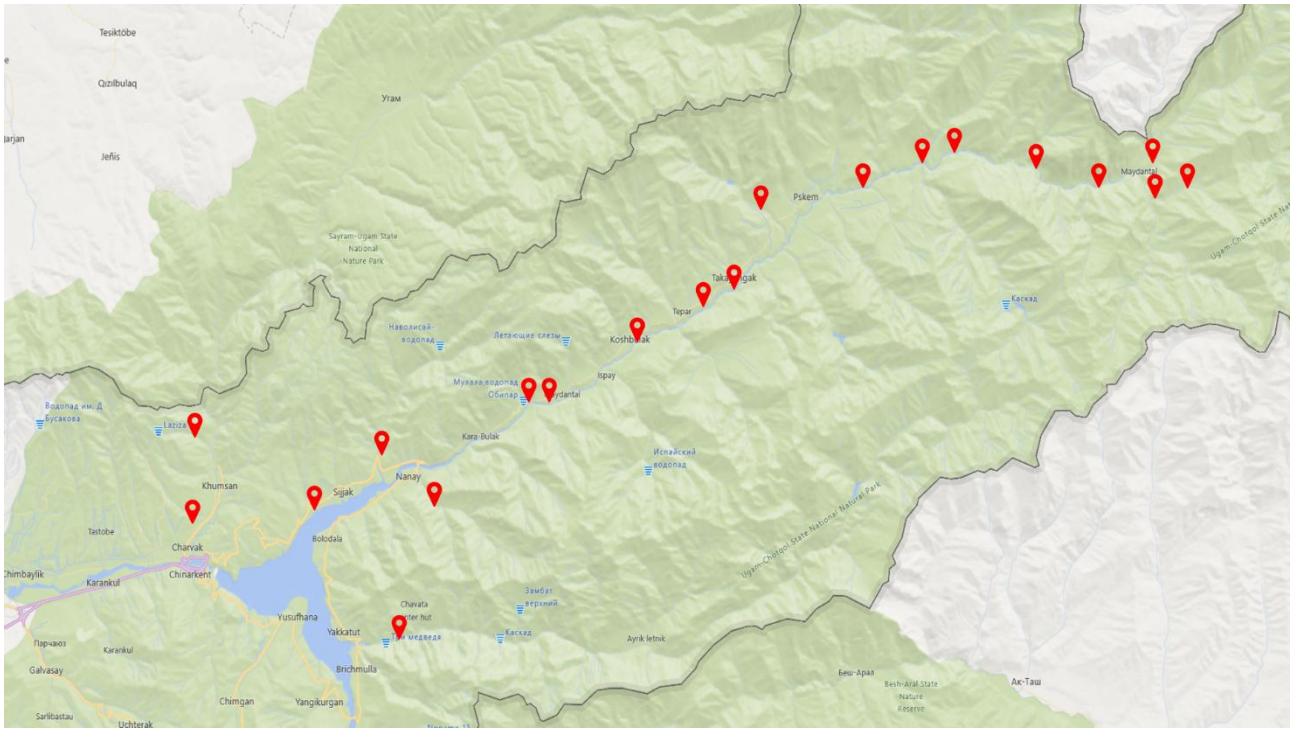


Figure 1. Schematic map of places where field material was collected by watercourses in the protected areas of UChNSNP for 2022.

Watercourses of the Ugam-Chatkal Natural State National Park of Uzbekistan, cold-water oligotrophic rivers and streams/sai of varying power with a predominance of snow-glacial or snow-spring type of nutrition, which are characterized by low daily water temperature (1^{o}-4^{o}-15^{o}C) and a relatively low amplitude of its annual and daily fluctuations - high-mountain rivers, streams and tributaries of the Pskem, Maydantal, Oygaing rivers, the middle reaches of the Chatkal, Koksu, Ugam rivers, within the boundaries of protected and protected areas territories and are not subject to anthropogenic loads.

The second zone is the rivers of the mountain zone of the middle reaches: Chimgansay, Ugam, Aktashsay, Karakiyasay (tributaries of the Chirchik River), Aksarsay, Nauvalisay, Sidzhaksay, Akhalasai, Karakizsay, Urungachsay, Teparsay and other tributaries of the river. Pskem River is a mountain sai (river), the water content of which depends on the time of year.

During the period of active snow melting at altitudes above 2500 meters, the water level in the tributaries increases significantly, and mudflows are observed.

The third zone is the rivers of the foothill zone in the lower reaches of the boundaries of protected areas - tributaries of the river. Chirchik, flowing through villages and subject to partial anthropogenic loads. These are the mouth sections of the rivers Ugam, Kizilsu, Karakiyasay, Sidzhaksai, the Chirchik river - from the tailwater of the Charvak reservoir to the city of Gazalkent (above the city), a characteristic feature of which is higher amplitudes of annual and daily fluctuations in water temperature in the summer, when the water mass can warm up up to 21°-25°C.

The Chirchik River, the largest tributary of the Syrdarya, is the main water artery of the Tashkent region, with a length of 225 km (together with the Pskem tributary). Chirchik is formed from the confluence of several large rivers: Chatkal, Koksu, Pskem and Ugam. By nature, these rivers are mountainous and foothills almost until they flow into the Syrdarya. In the upper section (about 30 km) the Chirchik River flows in a mountain and foothill canyon, only the lowest reaches of the Chirchik River are actually close to flat conditions.

Visual and chemical characteristics.

In winter (February 2022), water samples were taken mainly in the coastal strip 1.0-1.6 from the shore or along the entire bed of the rivers Ugam, Karakiyasai, Koksu at depths from 0.2 m to 0.7 m, with water temperatures 3°C - 10°C.

Water transparency according to the Secchi disk corresponded to 0.3-0.6-1.0 m (to the bottom). The color of the water changed from clear to grayish-green and very turbid, and red-clay. The water transparency was 12 cm along the Sekki disk on the Chatkal and Chirchik rivers (above the city of Gazalkent). Bottom sediments are mainly stones, pebbles, sand mixed with dark gray silts.

In May, in the watercourses of the Ugam-Chatkal Natural State National Park, samples were taken mainly along the entire bed (1.5-3.0 m) of rivers/says or in the coastal strip 1.0-1.6 from the shore (Ugam, Karakiyasay, Koksu , Pskem), on gulfs from 0.10-0.70 m, at a water temperature of 8°-10° C and 15° -21° C.

The transparency of the water along the Secchi disk was visible to the bottom or corresponded to 0.15-0.70 m. The color of the water is transparent, but with a whitish tint on the Pskem River. Bottom sediments are mainly boulders, stones, pebbles, sand, and silt.

The water temperature in the high-mountain zone for the rivers Pskem, Chatkal, Ugam, Aksak-Ata was 1º-10ºC, in the mountain zone - 1º-15 ºC, in the foothills - 3º-19ºC.

Water mineralization is low and varied from 197.7-211.8 mg/l in the mountain zone to 179.0-377.8 mg/l in the foothill zone of the Chirchik river.

The rivers Pskem, Chimgansay, Ugam, Aktashsay (tributaries of the Chirchik River) are background watercourses and there is no significant anthropogenic impact on them. The water of all these rivers is characterized by low mineralization and is fixed at the level of 0.2 MAC (Maximum Permissible Concentrations). The concentration of copper salts is at the level of 0.9–1.9 μg/dm3 (0.9–1.9 MAC). The content of phenols was 0.0008 - 0.0025 mg/dm3 (0.8-2.5 MAC). The oxygen regime of the watercourse in the reporting year was satisfactory, the content of dissolved oxygen was at the level of 9.21-9.61 mgO2/dm3. DDT, its metabolites and HCH (γ-isomer of hexachlorocyclohexane) isomers were not detected.

In terms of WPI (Hydrochemical index of water pollution), the water quality in all these rivers corresponds to class II clean waters [4].

Periphyton. The composition of periphyton fouling includes representatives of three main functional groups of organisms: 1 – autotrophic organisms (producers) - algae; 2 - heterotrophic organisms (consumers): protozoans, rotifers, ciliates, crustaceans, cyclops, daphnia, sponges, bryozoans, worms, bivalves and others; 3 - decomposer organisms: filamentous, coccoid, rod-shaped, zooglean and other bacteria, fungi (Table 1).

Table 1. Quantitative diversity of the main periphyton groups of the Ugam-Chatkal Natural State National Park for 2022

Group/season	Winter	Spring	Summer	Autumn
Producers	158	178	152	180
Consumers	17	20	17	24
Decomposers	4	3	-	1
Total organisms	**179**	**201**	**169**	**205**

The dominant complex of periphyton communities of the studied period was represented, first of all, by producers, the greatest development and diversity among which are diatoms (Bacillariophyta), blue-green (Cyanophyta) and green algae (Chlorophyta). Golden (Chryzophyta), euglenoid (Euglenophyta), yellow-green (Xanthophyta), dinophyta (Dinophyta) and red (Rhodophyta) algae are found with small diversity (1-3 species) (Table 2).

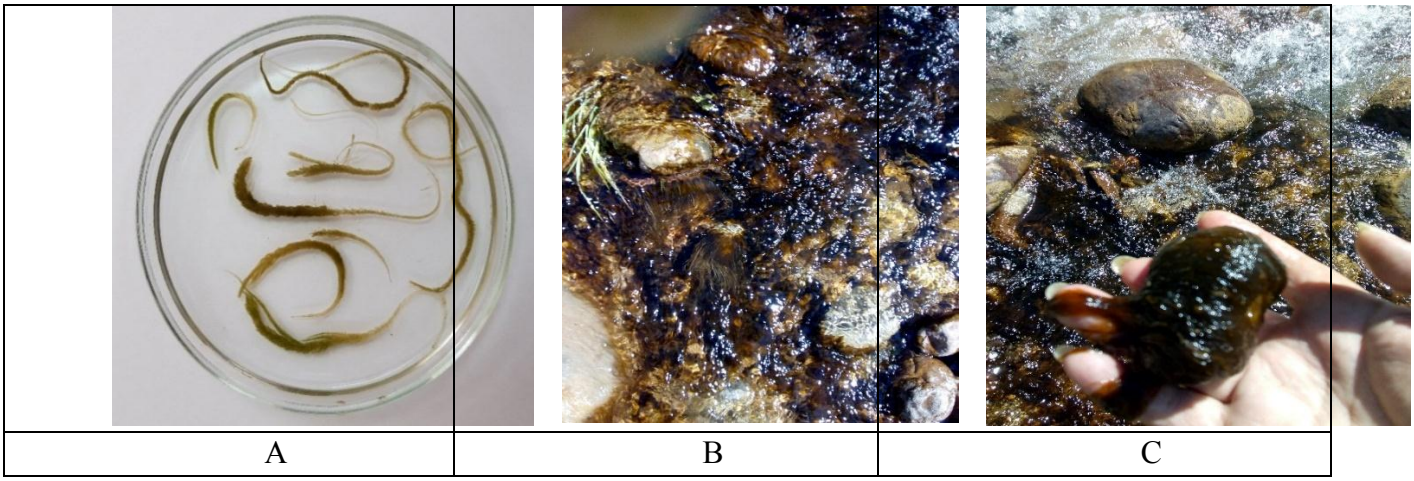
Table 2. Taxonomic structure of periphyton of river ecosystems of UChNSNP Tashkent region for 2022

taxa	Winter	Spring	Summer	Autumn
Cyanophyta	19	35	39	29
Bacillariophyta	123	116	98	120
Euglenophyta	1	-	-	-
Chryzophyta	1	1	1	1
Xanthophyta	2	2	-	-
Dinophyta	-	1	-	1
Chlorophyta	11	20	12	29
Rhodophyta	2	3	2	-
Total species of microalgae	**159**	**178**	**152**	**180**

The fouling of watercourses in the protected area of the Ugam-Chatkal Natural State National Park (without sharp seasonal fluctuations in qualitative and quantitative indicators) is dominated by boreal-alpine and mountain cryophilic species - indicators of x-, x-o-, o- and o-β-mesosaprobic conditions from diatoms *Diatoma hiemale* (Lyngb.) Heib., *D.hiemale var.mesodon* (Ehr.) Grun., *Meridion circulare* Ag., *Achnanthes linearis* (W.Sm.) Grun., *Ach.lanceolata и ее варианта*, *Fragilaria bicapitata* A.Mayer., *Fr.construens v.venter*, *Fr.construens v.subsalina*, *Cymbella hebridica* (Greg.) Grun., *C.Stuxbergii* Cl., *C.delicatula v.sibirica* Kütz., *Synedra amphicephala*

Kütz., *S.Goulardii* (Breb.) Grun., *S.Vaucheria* Kütz., as well as species from the genera *Cyclotella, Tabellaria, Fragillaria, Navicula* etc.

In the periphyton, a massive development of cryophilic xeno-saprobic conditions of diatoms was noted *Melosira arenaria* Moore, *Didymosphenia geminata* (Lyngb.) Schmidt. and golden algae *Hydrurus foetidus* (Villars) Trevisan, which dominate mainly in the cold winter-spring period, forming characteristic brownish slimy, visually visible fouling on underwater rocks. Massive development of green filaments of *Ulothrix zonata* (Web.et Mohr) Kütz., *Ul. tenuissima* Kütz. was also observed. (Fig. 2).



A B C

Figure 2. Appearance of periphyton fouling of the studied watercourses on stones in the protected area of UCHNSNP: golden algae *Hydrurus foetidus* Kirchn.: A – "fox tails" of *hydrurus*; B - r. Ugam, Khumsan village, above the bridge, 05.16.2022; S – r. Kizilsu, 05.17.2022.

In the spring, the massive development of green filamentous algae Spirogyra sp., Cladophora glomerata (L.) Kütz., and golden algae Hydrurus foetidus (80-95% of the projective bottom cover) was observed almost everywhere. On individual rivers of the mountain zone studied, dark green slimy tuberculate formations of the blue-green algae Noctoc and cotton wool-like brownish slimy formations of diatoms were noted (Fig. 3).

A Б C

Figure 3. Appearance of periphyton on the stones of the second zone: A - r. Kurgansai, green tender filament and blue-green algae Noctoc verricosum Vaucher, 05.17.2022; B - r. Teparsay, individual representatives of *Nostoc*, 05.17.2022; C – channel Khumsan, below Khumsan village, slimy, cotton wool-like formations of diatoms *Didymosphenia geminata*, 10.14.2022.

In the periphyton of the mountain rivers of the middle reaches of Chatkal, Koksu, Ugam, Karakiyasay, the Chirchik River (above the city of Gazalkent), boreal-alpine and mountain cryophilic species also predominate in winter - indicators x-, x-o-, o- and o-β- mesosaprobic conditions characteristic of background watercourses of the UCHNSNP from diatoms of the genera *Diatoma, Ceratoneis, Achnanthes, Cymbella, Synedra, Didymosphenia, Hydrurus foetidus* (golden algae), from green filaments *Ulothrix, Cladophora*.

However, with an increase in temperatures (+25°-28°C) in the summer-autumn period and low water flow of individual rivers/sai, there is a replacement of cold-loving species with widespread species of o-, o-β-, β- and β-α-mesosaprobic conditions characteristic for eutrophicated water bodies from the genera *Cymbella* (*C.prostrata*, *C.affinis*), *Synedra*, *Melosira*, *Navicula*, *Nitzschia*, etc.).

In small streams - tributaries with a higher trophic level, blue-green algae noticeably develop in the form of films, buns and crusts from the genera Anabaena, Lyngbya, Calothrix, Tolypothrix, spherical colonies of nostoc (Sphaeronostoc coeruleum (Lyngb.) Elenk, S.verrucosum Vaush.).

In samples of periphyton, in the estuaries of rivers in the foothill and lowland zones of the Tashkent region (Ugam, Karakiyasay, Sidzhaksay, Kizilsu, etc.) subject to anthropogenic loads, individual representatives of consumers of the genera Amoeba, Bodo, Chilodonella, Stylonichia, Rotaria, were constantly noted with low abundance. Colurella, Vorticella, Epistilis, Nematoda, Chironomida, Oligochaeta, Flagellata, etc. Also in the samples were found organisms from the group of decomposers Bacterium sp., Pelonema subtilissimum, Sphaerotilus dichotomus and fungi Micota sp.

Aquatic communities of periphyton of high-mountain streams in the protected area of the Ugam-Chatkal Natural State National Park are developing moderately well and are represented by cold-water, high-mountain and rheophilic species of organisms.

The water quality for mountainous background sections of rivers is rated I, I-II, II (very clean - clean water). The values of the biotic periphyton index (BPI) vary from 8-9-10 points, IP - 1.0-1.13-1.53.

The ecological state corresponds to - AB (F) - the background ecological state, in which biocenoses are in a state of metabolic and ecological progress and are represented by a complex of species reflecting the natural (undisturbed) gene pool of the region.

The water quality for the middle reaches of the mountain and foothill sections of the Navalisai, Ugam and Chirchik rivers (above the city of Gazalkent), the Khumsan channel corresponds mainly to I-II, II (clean waters). The values of the biotic periphyton index (BPI) vary from 7-9 points, the saprobity index (SI) – 1.29-1.44-1.74.

The ecological state corresponds to - AB (F) - the background ecological state. For the foothill lower estuary sections of rivers (Ugam, Karakiyasai, Sidzhaksai and others) subject to anthropogenic loads, depending on the season, the ecological state changes from AB (F) (winter-spring) to – AB (summer-autumn), i.e. satisfactory ecological state, characterized by the metabolic and ecological progress of biocenoses.

Conclusion.

Based on the results obtained, we can conclude that high/good water quality is typical for high-mountain background watercourses that are not subject to direct anthropogenic influence, for example, for the rivers of the Ugam-Chatkal natural state national park (Chatkal, Pskem, Maidantal, Oygaing, Koksu, etc.), where changes in hydrobiological parameters are of a natural nature and depend mainly on the dynamics of climatic factors.

The fouling of watercourses in the protected area of UCHNSNP is dominated by boreal-alpine and mountain cryophilic species - indicators of x-, x-o-, o- and o-β-mesosaprobic conditions of the diatoms Melosira arenaria, Didymosphenia geminata and the golden alga Hydrurus foetidus.

Constantly, with low abundance, certain types of consumers are present in fouling biofilms and turfs of water moss - naked and testate amoebae, ciliates, rotifers, nematodes, larvae of mayflies, stoneflies, larvae of chironomids, caddisflies, and bacopods.

The values of formal indices vary throughout the year depending on the season and the river section from IS - 1.0-1.74, BPI - 7-10 points, which corresponds to classes I, I-II and II (very clean - clean waters). The ecological status corresponds mainly to AB (F) - the background ecological state.

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