

Formation Trends of the Algoflora in the Fish Farms of the Republic of Karakalpakstan

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How to cite this paper: Aitbayeva, K.K. (2026) Formation Trends of the Algoflora in the Fish Farms of the Republic of Karakalpakstan. *American Journal of Plant Sciences*, 17, 272-283. <https://doi.org/10.4236/ajps.2026.173018>

Received: December 6, 2025

Accepted: March 21, 2026

Published: March 24, 2026

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Abstract

The article presents a comprehensive analysis of the composition of aquatic vegetation (algae and higher aquatic plants), the formation processes of flora, and the primary taxa in a series of fish farming enterprises located within the territory of the Republic of Karakalpakstan. Distinctive as well as shared characteristics of the floras across the studied water bodies have been identified. It is substantiated that the formation of flora in each individual water basin is fundamentally determined by external environmental factors and the specific sources of nutrient.

Keywords

Fish Farming Ponds Aquatic Vegetation, Taxa, Similar Species, Ecological Factors

1. Introduction

As emphasized by A.M. Muzafarov [1] and A.E. Ergashev [2], the composition of the algal flora in artificial water bodies used for fish farming in Central Asia exhibits considerable variation among individual reservoirs. This differentiation is largely attributable to a combination of factors, including the size and volume of the basin, the concentration of minerals in the water, the sources of nutrient enrichment, and the dominance patterns of species within the algal flora. In aquatic algae, as in higher plants, the dispersal of organisms occurs through various diaspores (diverse types of spores, thalli fragments, etc.). Through such dispersal mechanisms, the range (areal) occupied by the species expands, and the number of individuals increases. When algae are transported to another water body by various factors and successfully adapt to the environmental conditions of the new habitat, this process can lead to the emergence of

new intraspecific forms or even contribute to speciation events. The dispersal and migration of algae are primarily governed by the following key ecological factors: wind, water currents, soil (sediment transport), animals, and human activity [2].

Among these factors, anthropogenic influence represents the most recent but, at the same time, currently the most active vector of algal dispersal. In recent decades, the establishment of artificial water bodies created by human activity—including reservoirs, irrigation and drainage canals, fish-rearing ponds, multipurpose artificial lakes, and biological treatment ponds—has resulted in markedly distinct patterns of phytoplankton and phytobenthos cenosis formation. These differences are, in turn, determined by the previously mentioned ecological factors, as well as by the age (time since construction) of the water body and the specific purpose for which it is being utilized.

To date, the specific features of algoflora formation in the fish-rearing ponds of the Republic of Karakalpakstan have not been systematically investigated. The resolution of these issues constitutes one of the key factors that can significantly contribute to the further sustainable development and intensification of aquaculture in the region. Analysis of the results obtained from previous studies conducted in the area clearly demonstrates that, given the substantial differences in the ecological characteristics of fish ponds—particularly with respect to the trophic status of the water, climatic conditions, and soil-ground substrate properties—an individualized approach is required for the management and optimization of algoflora in each specific locality and pond system.

Studies conducted by Sh.Sh. Shernazarov [3]-[6] and Y.Sh. Tashpulatov [7] [8] on the algoflora of several fish farming enterprises in Samarkand Region have shown that the primary role in the formation of algal communities in the investigated fish ponds is played by the algal flora present in the water of the Zarafshan River. This is explained by the fact that the Zarafshan River constitutes the principal and virtually the only source of water supply for the fish farms in this region. Other large or small watercourses from the surrounding area are practically not introduced into the studied ponds. In the study area, the formation of algoflora in fish farming enterprises is, to a large extent, intrinsically linked to and determined by the algal composition of the Amu Darya River water.

2. Materials and Methods

Due to the Republic of Karakalpakstan's large area, part of it belongs to the Central Kazakhstan Province, while the rest belongs entirely to the Turan Plain Province. According to the soil-climate system, the Khorezm Region and the Republic of Karakalpakstan belong to the Lower Amu Darya soil-climate region. During 2022-2024, the algal flora of reservoirs was studied in a total of 7 fish farms (**Figure 1**), located mainly in the Nukus (Nukus agro-fish farm, Kuvanchbek-Gulziba, Zhenisbek-Gulshod), Khojali (Amur-Sazan, Khojali fishing industry, Khojali fish farm) and Takhiatash (Zamirbek-Takhiatash) districts, where commercial fish

farming has been carried out for several years.

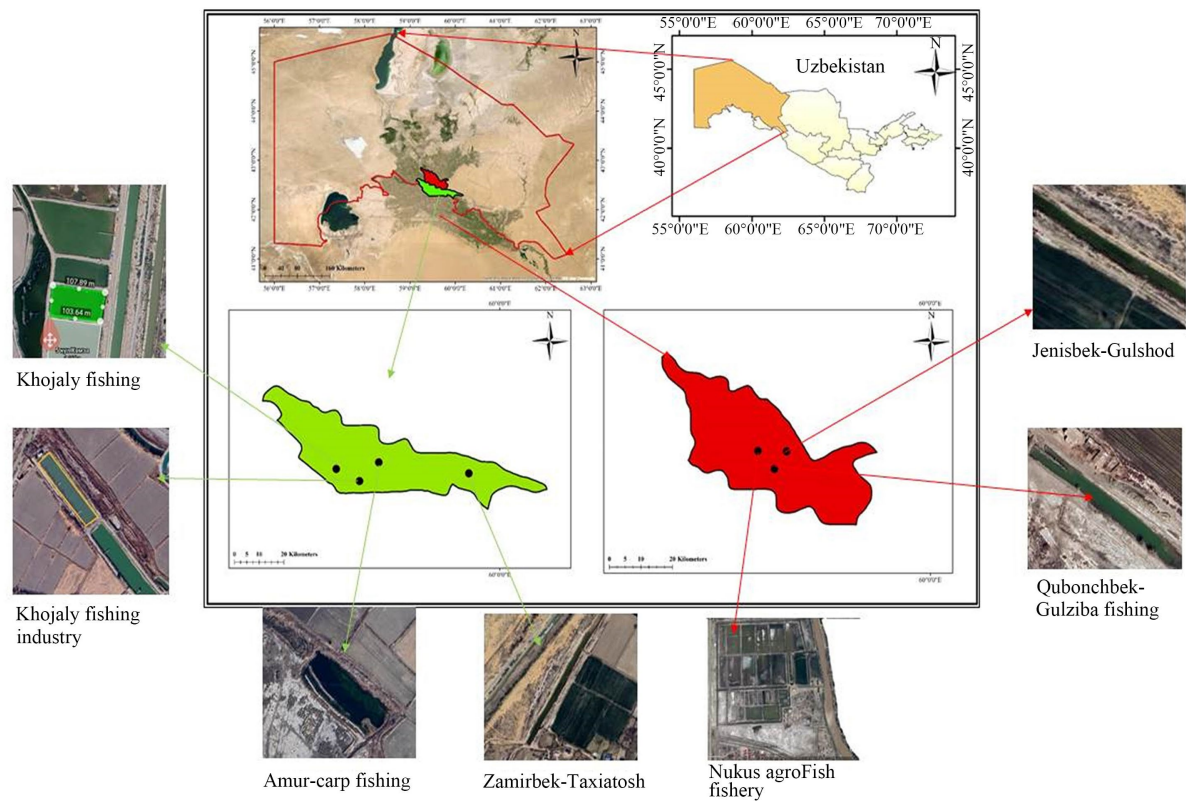


Figure 1. Map of the studied fish farms of the republic of Karakalpakstan.

Table 1. General data of the studied fish ponds.

Fish ponds	Coordinates		Average physical parameters of fish ponds			
	Norts	East	Water temperature, °C	pH	Mineralization, mg/l	Water transparency, cm
Zamirbek-Takhiatosh	42.344561	59.549551	23.5 ± 1.17	7.5	604.1 ± 30.2	20.5 ± 0.41
Khojayli fishing	42.355823	59.564214	24.1 ± 1.20	7.3	797.5 ± 39.8	16.8 ± 0.84
Khojayli fishing industry	42.360204	59.563464	24.2 ± 1.21	7.0	647.5 ± 32.3	28.5 ± 1.4
Amur sazan	42.381828	59.601331	24.3 ± 1.22	7.5	556.0 ± 27.8	18.6 ± 0.93
Nukus Agrofis	42.492533	59.584860	24.4 ± 1.22	7.6	573.3 ± 28.6	28.3 ± 1.4
Kuvanchbek-Gulziba	42.537506	59.579469	23.6 ± 1.18	6.8	1317.0 ± 65.8	24.6 ± 1.2
Zhenisbek-Gulshad	42.553708	59.592053	23.8 ± 1.19	7.2	642.5 ± 32.1	25.9 ± 1.3

Carp fish such as *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*, *Aristichthys nobilis*, *Cyprinus carpio*, *Silurus glanis*, *Abramis brama orientalis* are bred in ponds (Table 1).

Between 2022 and 2024, 125 algae samples (80 plankton, 45 benthos) were collected from the ponds of the aforementioned fisheries along the route in spring, summer, and fall. Freshwater algae collection and analysis methods were used to collect, record, label, and store the algae samples. The sample was fixed with 4%

formalin. Non fixed and fixed samples were transported to the lab in the ice box, and investigated in soft and permanent slides under Microscopes «Leitz BioMed», Motic BA 300 [9] [10] and current taxonomic literature. The list of identified species was arranged alphabetically according to modern taxonomy cited in Guiry and Guiry [11]. The chemical analysis of the water was carried out in the university laboratory, the remaining physical data was obtained during sample collection. The ecological characteristics of the revealed species were obtained from the database compiled for freshwater algae from multiple analyses of algal biodiversity [12] [13] with additions [14] according to substrate preference, temperature, streaming and oxygenation, pH, salinity and trophic states.

3. Result and Discussions

The algal flora of fish ponds in the Republic of Karakalpakstan includes 45 species of cyanophytes and 192 species of algae. These species belong to 5 divisions (Dinophyta, Chrysophyta, Bacillariophyta, Euglenophyta, Chlorophyta), 13 classes, 22 orders, 47 families, and 82 genera (Table 2).

Table 2. Taxonomic composition of algal flora of fishing ponds.

Department of Algae	Number of taxonomic units						
	Classes	Orders	Families	Genera	Species	Total	%
Cyanoprocarvota	3	4	14	17	45	45	18.99
Dinophyta	1	2	3	4	9	9	3.80
Chrysophyta	1	1	2	2	5	5	2.11
Bacillariophyta	2	6	15	33	126	126	53.16
Euglenophyta	1	1	1	3	6	6	2.53
Chlorophyta	5	8	12	23	46	46	19.41
Total	13	22	47	82	237	237	100

Taxonomic analysis of the algaeflora in the fish-rearing ponds of the investigated fish farming enterprises in the Republic of Karakalpakstan revealed a markedly uneven distribution of algal taxa across the studied water bodies. According to the results of the analysis, the sequence of fish farming enterprises ranked by the relative richness of their algaeflora is presented in the following table (Table 3). The data indicate that the highest number of algal species—144 taxa—was identified in the ponds of the “Khojayli fishing industry” fish farming enterprise. These 144 taxa constitute 60.76% of the total algaeflora recorded across all investigated ponds. They belong to 6 divisions, 13 classes, 21 orders, 41 families, and 65 genera. The next positions were occupied by the ponds of “Amur-Sazan” (141 taxa—59.49%) and “Nukus AgroFish” (141 taxa—59.49%). Lower richness was recorded in the following enterprises: “Quvonbek-Gulziba” with 119 taxa (50.21%), “Khojali fish” with 110 taxa (46.41%), “Jenisbek-Gulshod” with 92 taxa (38.82%), and “Zamirbek-Takhiatash” with 82 taxa (34.60%) (Table 3).

Table 3. Taxonomic composition of algoflora in the studied fish farming ponds.

Fish farming enterprise	Division	Class	Order	Family	Genus	Species	%
Khojayli fishing industry	6	13	21	41	65	144	60.76
Amur-Sazan	6	12	19	42	64	141	59.49
Nukus-AgroFish	6	13	21	43	69	141	59.49
Quvonbek-Gulziba	6	11	17	36	61	119	50.21
Khojayli fish	6	12	19	39	56	110	46.41
Jenisbek-Gulshod	6	11	17	37	53	92	38.82
Zamirbek-Takhiatash	6	8	16	32	48	82	34.60

The species diversity of algoflora in the fish farming ponds of the Republic of Karakalpakstan is contingent upon a series of factors, including the duration of the enterprise's operational history, the degree of water stagnation in the ponds, the substrate structure, the extent of coverage by higher aquatic plants along the shorelines, the depth of the ponds, the sources of nutrient enrichment, as well as the ecological characteristics of the water (temperature, transparency level, mineralization, pH, and the concentration of biogenic substances).

A comparative analysis of the species composition of the studied algal flora in fish farms in the Republic of Karakalpakstan revealed that the algal flora of fish farms with the same food source, close to each other in territory, and with similar ecological characteristics is relatively similar. In particular, the greatest similarity was found in the flora of the Amur-Sazan and Nukus Agro-Fish (0.673), 6-Kuvonchbek-Gulziba, 7-Zhenisbek-Gulshad (0.671), and the Khojali fish and Khojali fishing industry (0.668). As noted above, the main reasons for the similarity in the flora of these fish farms are the fact that they primarily ate from the same food source, their territorial proximity, and the similarity of factors influencing the formation of algal flora (Figure 2).

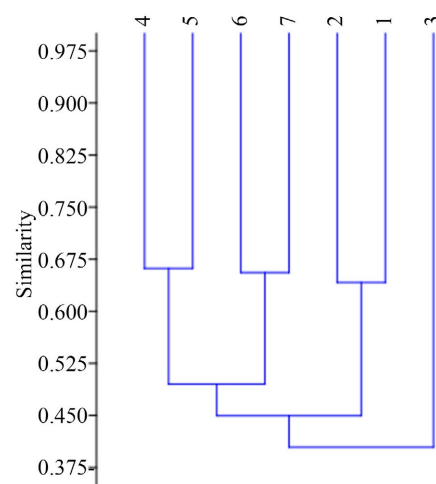


Figure 2. Fish farming enterprises: 1—Khojayli, 2—Khojayli Baliq Sanoat, 3—Zamirbek-Takhiatash, 4—Amur-Sazan, 5—Nukus-AgroFish, 6—Quvonchbek-Gulziba, 7—Jenisbek-Gulshad.

3.1. Features of Algoflora Formation in Fish Farming Ponds

Proceeding from the specific natural and climatic characteristics of the Central Asian region, the analysis of previously conducted research results clearly demonstrates that the formation of algoflora in water bodies of the same type within any particular sub-region of Central Asia is predominantly determined by one principal (or one dominant group of) source water body. The primary reasons for this strong dependence on a single (or dominant) source water body in Central Asia are rooted in the region's specific soil-climatic and hydrological conditions, namely.

At the same time, it has been noted that the formation of algoflora in water bodies across different sub-regions of Central Asia exhibits considerable variation, and the scope and intensity of influence exerted by individual ecological factors also differ significantly among these areas [2].

In the areas of the Republic of Karakalpakstan where our research was conducted, the fish farm ponds are primarily supplied with water from the Amu Darya River and its tributaries. This, in turn, indicates that the algoflora of these fish farms is predominantly influenced by and recruited from this particular water source. Previous algofloristic studies carried out in the territory of the Republic of Karakalpakstan have mainly focused on the western part of the region — specifically the Aral Sea and the various lakes surrounding it. The available data therefore largely reflect the soil and climatic conditions characteristic of that particular area. As is well known, the fish farms investigated in our study are located in the eastern part of the Republic of Karakalpakstan, predominantly in the vicinity of the city of Nukus.

3.2. Analysis of Taxon Ratios in Algoflora

During the course of the study, a quantitative analysis of the proportional ratios of algal taxa was conducted for the algoflora of the investigated fish farming ponds. Such analyses are considered highly appropriate and necessary for each individual water body.

This is because the ecological characteristics of any specific water basin are inherently unique, reflecting a distinctive set of hydrochemical, hydrological, morphometric, and anthropogenic conditions. These site-specific features directly influence the processes of algoflora formation, taxonomic structure, dominance patterns, and functional organization of algal communities. Consequently, examining the relative proportions of taxa (at the level of divisions, classes, orders, families, genera, and species) provides deeper insight into the adaptive strategies of algae, the prevailing ecological drivers, and the overall trophic and successional status of each pond [5] [15]-[18].

3.3. Analysis of the Number of Species and Taxonomic Groups in the Algoflora of the Studied Fish Farm Ponds

Among the investigated fish farm ponds, Khojali Fish Industry ponds ranked first

in terms of the total number of algal species, encompassing 60.75% of the overall algoflora recorded across all sites. The next positions were jointly occupied by Amur-Sazan (141 species—59.5%) and Nukus Agro Fish (141 species—59.5%), which showed identical proportions. The lowest number of species was recorded in Zamirbek-Takhiatam fish farm, with only 82 species, accounting for 34.6% of the total algoflora.

When the composition was analyzed at the level of taxonomic divisions/classes (higher taxa), the pattern appeared somewhat different. The richest division-level diversity was observed in Nukus Agro Fish, where 69 divisions/classes were recorded, representing 84.1% of all taxonomic groups identified in the study. This was followed by Khojali Fish Industry (65 divisions/classes—79.3%) and Amur-Sazan (64 divisions/classes—78.04%). The lowest taxonomic group diversity was again found in Zamirbek-Takhiatam, with only 48 divisions/classes, corresponding to 58.5% of the total recorded taxonomic spectrum.

3.4. Analysis of the Ratio of Families

In terms of the ratio of families, Amur-Sazan (43 families/91.4%) and Nukus Agro Fish (43 families/91.4%) showed identical and the highest values. They were followed by Khojali Fish Industry (41 families—87.2%) and Khojali Fish Farms (39 families—82.9%). The lowest number of families was recorded in Zamirbek-Takhiatam, with only 32 families, corresponding to 68.1%. According to the results of the analysis of the ratios of the main taxonomic levels — species, genera (divisions/classes), and families — in the algoflora, the leading positions were consistently occupied by the fish farms of Khojali Fish Industry, Amur-Sazan, and Nukus Agro Fish, whereas Zamirbek-Takhiatam fish farm demonstrated the lowest values across all these indicators. Analysis of the Mutual Ratios of the Main Taxonomic Levels in the Algoflora Composition of the Studied Fish Farms The results of the analysis of the interrelationships among the main taxonomic categories within the algoflora of the investigated fish farm ponds were examined. These analyses were performed based on the following indicators: the average number of species per genus (division/class), the average number of genera per family, and the average number of species per family.

In terms of the average number of species per genus (division/class), the fish farms of Khojali Fish Industry (2.20) and Amur-Sazan Khojali (2.20) clearly took the leading positions. These were followed by the ponds of Nukus Agro Fish (1.96) and Khojali (1.95). The lowest value for this indicator was recorded in the Zamirbek-Takhiatam fish farm ponds (1.71) (**Figure 3**).

In terms of the average number of species per family, Khojali Fish Industry (3.50) clearly took the leading position. It was followed by Quvonchbek-Gulziba (3.30) and Nukus Agro Fish (3.27) fish farms. The lowest value for this indicator was recorded in Amur-Sazan fish farm (2.28) (**Figure 3**).

Regarding the average number of genera (divisions/classes) per family, Quvonchbek-Gulziba fish farm demonstrated the highest value (1.69). The next

positions were occupied by Nukus Agro Fish (1.60), while the lowest values for this parameter were observed in the algoflora of Khojali (1.43) and Jenisbek-Gulshad (1.43) fish farms (Figure 2). According to the overall ratio of the main taxa present in the algofloras of the studied fish farm ponds in the territory of the Republic of Karakalpakstan, the algoflora of the Khojali Fish Industry ponds clearly occupied the leading position with a ratio of 2.43. The next positions were taken by the ponds of Quvonchbek-Gulziba (2.31) and Nukus Agro Fish (2.30). The lowest value was recorded for Jenisbek-Gulshad (1.87). From this it can be concluded that the algoflora of the Khojali Fish Industry fish farm ponds is considerably more stable compared to the other ponds, and all the ecological factors essential for the formation and development of the algoflora are present at optimal levels. In contrast, in the ponds of the Jenisbek-Gulshad fish farm, these factors are not balanced/are suboptimal.

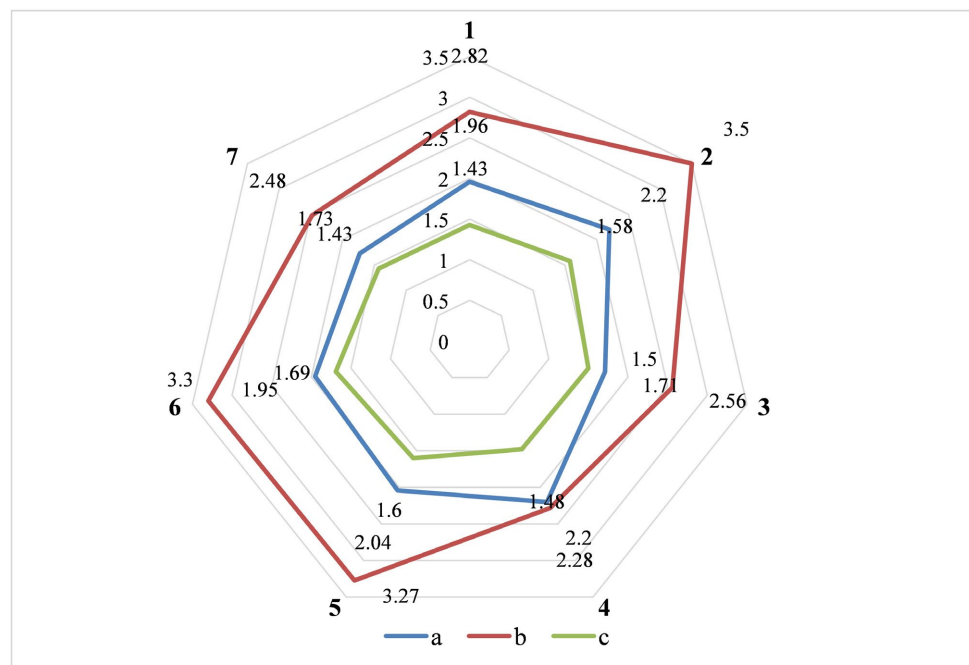


Figure 3. Interrelationships of taxa in the Algoflora composition. **Caption:** Fish farms: 1—Khojali, 2—Khojali Fish Industry, 3—Zamirbek-Takhiatam, 4—Amur-Sazan Khojali, 5—Nukus Agro Fish, 6—Quvonchbek-Gulziba, 7—Jenisbek-Gulshad; a—average number of species per genus (division/class), b—average number of species per family, c—average number of genera (divisions/classes) per family.

Figure 3. Interrelationships of taxa in the Algoflora composition.

3.5. Analysis of Species Activity in the Algoflora

The frequency of occurrence of algae in specific water bodies largely depends on the breadth of each species' distributional range (living diapason). The wider the range of environments in which a species occurs, the higher its morphological, physiological, and ecological tolerance is considered to be. According to the data presented by B. Dustov [15], who studied the algoflora of various water bodies in the Western Zarafshan Range, the analysis of species with broad distributional

ranges and the determination of their proportion within particular floras holds significant importance for understanding the specific characteristics of the flora. Based on the author's findings, 81 species were recorded in 5 or more water bodies — *i.e.*, in more than 50% of the studied aquatic habitats. These taxa, representing 32.37% of the total algae, are classified as wide-ranging (eurybiontic) species according to their distributional range [16]. Criteria for Assessing the Activity Level of Species Based on the Size of the Studied Area and the Number of Species in the Algoflora of the Investigated Water Bodies.

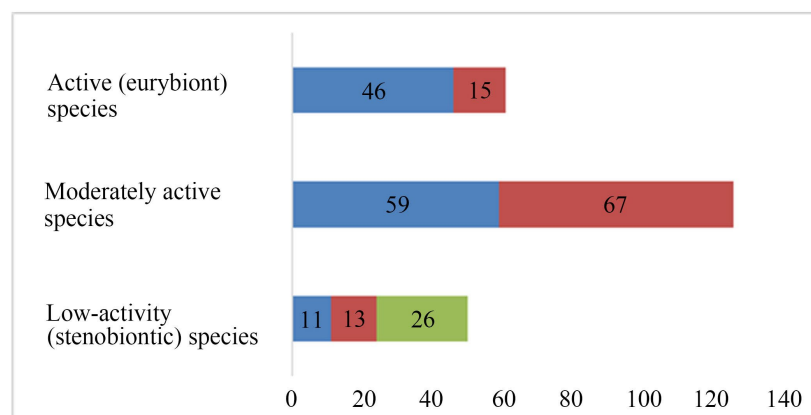
Given the scale of the studied territory and the number of species recorded in the algoflora of the investigated water bodies, it is appropriate to establish criteria for evaluating the activity level of species. Accordingly, in determining the activity level of species in the algoflora of fish farms in the Republic of Karakalpakstan, the following conditional classification was applied: Species occurring in 5 - 7 fish farm ponds were classified as highly active (eurybiontic), species occurring in 3 - 4 fish farm ponds were classified as moderately active, species occurring in 1 - 2 fish farm ponds were classified as low-activity (stenobiontic) species (Table 3). During our research, an analysis of the frequency of occurrence of species in the algoflora of the studied fish farm ponds was conducted. The analysis of the data revealed the following: The number of species occurring in all studied fish farm ponds was 11 species, which constitutes 4.64% of the total algoflora. Of these, 6 species belong to blue-green algae (Cyanobacteria), 3 species to diatoms (Bacillariophyta), and 2 species to green algae (Chlorophyta). The number of species occurring in 6 fish farm ponds was 13 species, accounting for 5.48% of the total algoflora. Among them, 6 species belong to blue-green algae, 1 species to dinoflagellates (Dinophyta), 3 species to diatoms, and 3 species to euglenoids (Euglenophyta). The number of species recorded in 5 fish farm ponds was 26 species, representing 10.97% of the total algoflora. Of these, 9 species belong to blue-green algae, 2 species to dinoflagellates, 10 species to diatoms, 1 species to euglenoids, and 4 species to green algae. The number of species recorded in 4 ponds is 59, which constitutes 24.89% of the total algoflora. Of these: 15 species belong to blue-green algae (Cyanoprocarota), 1 species to dinoflagellates (Dinophyta), 1 species to golden algae (Chrysophyta), 31 species to diatoms (Bacillariophyta), 1 species to euglenoids (Euglenophyta), 10 species to green algae (Chlorophyta). The number of species identified in 3 ponds is 67, accounting for 28.27% of the total algoflora. Of these: 6 species belong to blue-green algae, 2 species to dinoflagellates, 3 species to golden algae, 38 species to diatoms, 18 species to green algae.

The number of species recorded in 2 ponds is 46, representing 19.40% of the total algoflora. Of these: 3 species belong to blue-green algae, 2 species to dinoflagellates, 33 species to diatoms, 8 species to green algae. The number of species recorded in only 1 pond is 15, which constitutes 6.33% of the total algoflora. Of these: 1 species belongs to golden algae (Chrysophyta), 6 species to diatoms (Bacillariophyta), 8 species to green algae (Chlorophyta).

Table 4. Analysis of the activity level of species in the Algoflora composition.

Active (eurybiont) species/%			Moderately active species/%		Low-activity (stenobiontic) species/%	
7	6	5	4	3	2	1
11/4.64	13/5.48	26/10.97	59/24.89	67/28.27	46/19.40	15/6.33
53/22.36			126/53.16		61/25.73	

Analysis of the data in **Table 4** shows that: highly active (eurybiontic) species total 53, accounting for 22.36% of the algoflora, moderately active species total 126, representing 53.16% of the total algoflora, low-activity (stenobiontic) species total 61, constituting 25.73% of the total algoflora (**Table 4, Figure 4**).



Caption: Highly active species: 11—species occurring in 7 water bodies, 13—species occurring in 6 water bodies, 26—species occurring in 5 water bodies; Moderately active species: 59—species occurring in 4 water bodies, 67—species occurring in 3 water bodies; Low-activity species: 46—species occurring in 2 water bodies, 15—species occurring in 1 water body.

Figure 4. Comparative analysis of species activity in the Algoflora.

4. Conclusions

The differences and similarities between the algal floras of the studied fish ponds are explained by their dependence on a number of factors, such as the structure of the pond soil, the degree of coverage of the banks with higher plants, the depth of the ponds, sources of saturation and the ecological characteristics of the water (temperature, transparency, mineralization, pH, amount of biogenic substances).

The comparative analysis of the species composition in the algoflora of fish farms studied in the territory of the Republic of Karakalpakstan revealed that fish farm ponds with the same water supply source, located in close geographical proximity, and possessing similar ecological characteristics also exhibit relatively close similarity in their algoflora. In particular, the highest degrees of similarity were observed between the floras of the following fish ponds: Amur-Sazan and Nukus Agro Fish (0.673), Quvonchbek-Gulziba (6) and Jenisbek-Gulshad (7) (0.671), as well as Khojali and Khojali Fish Industry (0.668). As noted above, the primary

reasons for this similarity are that these fish farms are mainly supplied from the same water source, are situated in close geographical proximity, and are influenced by similar environmental factors that shape the development of their algaeflora.

In the algaeflora composition of the studied fish farm ponds in the Republic of Karakalpakstan, moderately active species clearly predominated, accounting for more than half of all species recorded in the total algaeflora. This indicates a relatively stable formation of the algaeflora in the investigated fish farms.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

- [1] Muzafarov, A.M. (1964) Materials for the Flora of Algae in the Reservoir of the River Zeravshan. In: *Publications of the Tashkent State University, New Series, Biological Sciences*, 235-249.
- [2] Ergashev, A.E. (1976) Patterns of Development and Distribution of Algaeflora in Artificial Reservoirs of Central Asia. Fan Publishing House, 360 p.
- [3] Shernazarov, S.S. and Tashpulatov, Y.S. (2020) Species Composition of Algae in the Food Tract of Common Silver Carp (*Hypophthalmichthys molitrix* Vab.) in Growing Conditions. *Bulletin of Pure & Applied Sciences—Zoology*, **39**, 338-343. <https://doi.org/10.5958/2320-3188.2020.00037.6>
- [4] Shernazarov, S.S. and Tashpulatov, Y.S. (2020) Algaeflora of the Akdarya Reservoir and Features of Its Formation in Relation to Ecological Factors. *Scientific Journal of Samarkand State University*, **5**, 109-114.
- [5] Shernazarov, S.S. (2020) Algaeflora of Fish Farms of Samarkand Region and Its Significance. Ph.D. Thesis, Samarkand State University, 46 p.
- [6] Shernazarov, S., Davronova, S., Tashpulatov, Y., Rakhmonov, V., Muminov, S. and Nurniyozov, A. (2024) The Importance of *Azolla* Aquatic Plants in Creating a Natural Sustainable Nutrient Environment in the Fisheries Industry. *E3S Web of Conferences*, **539**, Article ID: 02009. <https://doi.org/10.1051/e3sconf/202453902009>
- [7] Tashpulatov, Y.S. (2018) Taxonomic Analysis of Algaeflora of the Akdarya Reservoir (Basin of the Zarafshan River, Uzbekistan). *Hydrobiological Journal*, **54**, 50-55.
- [8] Tashpulatov, Y.S. and Shernazarov, S.S. (2021) Formation of Algaeceneses of Fish Ponds in Relation to Anthropogenic Impact on Water Bodies of the Samarkand Region. *Turkish Online Journal of Qualitative Inquiry (TOJQI)*, **12**, 814-819.
- [9] Krammer, K. (2004) Bacillariophyceae Teil: Achnanthaceae, Kritische Ergänzungen zu Navicula (Lineolatae), Gomphonema Gesamtliteraturverzeichnis. In: *Süßwasserflora von Mitteleuropa*, Vol. 2/4. Spektrum Akademischer Verlag, 468 p.
- [10] Lange-Bertalot, M. and Bak, A. (2011) Witkowski, Eunotia and Some Related Genera. In: *Diatoms of Europe*, Vol. 6, 747 p.
- [11] Guiry, M.D. and Guiry, G.M. (2015) AlgaeBase. World-Wide Electronic Publication, National University of Ireland. <http://www.algaebase.org>
- [12] Barinova, S. and Stenina, A. (2013) Diatom Diversity and Ecological Variables in the Arctic Lakes of the Kostyanoi Nos Cape (Nenetsky Natural Reserve, Russian North). *Plant Biosystems—An International Journal Dealing with all Aspects of Plant Biol-*

- ogy, **147**, 397-410. <https://doi.org/10.1080/11263504.2012.749956>
- [13] Barinova, S.S., Medvedeva, L.A. and Anissimova, O.V. (2006) Diversity of Algal Indicators in Environmental Assessment. Pilies Studio, 496 p. (In Russian)
- [14] Kharitonov, V.G. (2010) Summary of Diatom (Bacillariophyceae) Flora of the Northern Coast of the Okhotsk Sea. Institute of Biological Problems of the North Press, 189 p. (In Russian)
- [15] Dustov, B., Aitbayeva, K., Rakhmonov, V., Tashpulatov, Y. and Shernazarov, S. (2024) Floristic and Ecological Characteristics of Algotora of Different Types of Reservoirs of the West Zarafshan Ridge (Uzbekistan). *E3S Web of Conferences*, **510**, Article ID: 03003. <https://doi.org/10.1051/e3sconf/202451003003>
- [16] Dustov, B.S. and Tashpulatov, Y.S. (2023) Taxonomic Analysis and Ecological Features of the Algal Flora of the Water Bodies of the West Zarafshan Range. *American Journal of Plant Sciences*, **14**, 542-551. <https://doi.org/10.4236/ajps.2023.145037>
- [17] Kobulova, B.B., Yazdonov, U.T., Aitbayeva, K.K. and Tashpulatov, Y.S. (2023) Ecological Characteristics of Algotora of Lake Khadicha and Monitoring Water Quality. *IOP Conference Series: Earth and Environmental Science*, **1284**, Article ID: 012035. <https://doi.org/10.1088/1755-1315/1284/1/012035>
- [18] Kobulova, B.B. and Tashpulatov, Y.S. (2023) Bioresource Potential of Phytoplankton of Lake Khadicha (Bukhara, Uzbekistan). *IOP Conference Series: Earth and Environmental Science*, **1138**, Article ID: 012014. <https://doi.org/10.1088/1755-1315/1138/1/012014>