

Diversity and ecology of molluscs (Gastropods) in mountain streams, Nurota mountain range, Uzbekistan

JASUR KUDRATOV^{1,2,*}, ABDUVAEIT PAZILOV^{1,2}, ZOKIR MAXAMMADIYEV¹, RA'NO URAZOVA², BEKZOD OTAKULOV³, BAXRITDIN BAZAROV⁴, KHUDOYOR KELDIYAROV⁵, ZARINA SOATOVA⁶, XULKAR URINOVA⁷

¹Department of Biology, Gulistan State University, Gulistan City 4-microdistrict, 120101 Gulistan, Uzbekistan. Tel.: +998-672-250-275, Fax.: +998-672-254-042, *email: kudratovzasur484@gmail.com

²Department of Zoology, Samarkand State University named after Sharof Rashidov, University Boulevard 15, 140104 Samarkand, Uzbekistan

³Department of Ecology and Life Safety, Samarkand State University named after Sharof Rashidov, University Boulevard 15, 140104 Samarkand, Uzbekistan

⁴Department of Human and Animal Physiology and Biochemistry, Samarkand State University named after Sharof Rashidov, University Boulevard 15, 140104 Samarkand, Uzbekistan

⁵Department of Plant Physiology and Microbiology, Samarkand State University named after Sharof Rashidov, University Boulevard 15, 140104 Samarkand, Uzbekistan

⁶Department of Zoology, Termiz State University, Street Barkamol Avlod (former F.Khodjayev) 43, 190101 Termiz, Surkhandarya, Uzbekistan

⁷Department of Life Safety, Navoi State Mining and Technology University, Street Galaba 76V, 210100 Navoi, Uzbekistan

Manuscript received: 30 March 2023. Revision accepted: 28 April 2023.

Abstract. Kudratov J, Pazilov A, Maxammadiyev Z, Urazova R, Otakulov B, Bazarov B, Keldiyarov K, Soatova Z, Urinova X. 2023. Diversity and ecology of molluscs (Gastropods) in mountain streams, Nurota mountain range, Uzbekistan. *Biodiversitas* 24: 2402-2408. Characterization of the faunal biodiversity of the regions is one of the important tasks in today's era when the influence of the anthropogenic factor has increased, and the natural ecosystems are undergoing drastic changes. Therefore, the faunal composition analysis of molluscs as a part of the natural food chain, the development of measures related to their protection, the disclosure of bioecological features, and the substantiation of scientific solutions are of great scientific and practical importance. This study provides information on the species composition of gastropod molluscs in the streams of the Nurota Mountains of Uzbekistan. Sampling was carried out at 11 stations from April to November 2019. Molluscs include 4 families (*Belgrandiellidae*, *Lymnaeidae*, *Physidae* and *Planorbidae*), 5 genera, and 15 species. The dominant family in the malacofauna of the study area is *Lymnaeidae*, one genus and eight species belonging to this family are found in the area. Most molluscs are found on rocky, sandy substrates around plants. This article describes the biological diversity of animals in streams in the Nurota Mountains of Uzbekistan.

Keywords: Diversity, gastropods, molluscs, mountain streams

INTRODUCTION

Due to the increase in the number of people worldwide, drastic environmental changes under the influence of anthropogenic factors are causing the loss of biological diversity and a decrease in the diversity of natural resources, including animal resources. In particular, due to the wide use of low-lying mountains near populated areas as pastures, the spread and diversity of existing flora and fauna are negatively affected (Pazilov et al. 2022). Here, the taxonomic structure, distribution, and importance of gastropod molluscs in the regions where natural ecosystems are undergoing drastic changes, determining their modern ecological status and improving the methods of preserving their populations are of great scientific importance (Abdurasulova et al. 2021).

Molluscs are animals that have the potential to be able to monitor species stability and also the environment; they can also be bioindicators of ecosystem changes (Isoni et al. 2023). Molluscs are a common group of macrozoobenthic invertebrates in aquatic ecosystems. They are found in

shallow water, streams, rivers, ponds, and lakes. They have significant functions in food webs and ecosystem equilibrium, such as nutrient cycling, biofiltration, and storage (Fateme et al. 2019). Mollusca is the second most diverse animal phylum occurring in all major environments except the aerospace (Strong et al. 2008). The biggest class of Mollusca is Gastropods, comprising 80% of this phylum (Islamy et al. 2020).

It is known that the biological diversity of plants and animals in mountain regions uniquely differs from other biotopes, and the number and variety of species are different (Narzullayev 2022; Alikulov et al. 2022a, 2022b). One of the areas with a high probability of changes due to anthropogenic influence is the Nurota mountain range and its adjacent areas (Khalimov 2020).

Thus, the Nurota mountain range continues the Turkestan mountain range to the northwest, and the Zarafshan river stretches 250 km along the right bank. The highest point is 2169 meters above sea level. The Nurota ridge is asymmetrically structured; the southern slope is long and wide and gradually descends to the Nurota basin.

The northern slope is short and steeply descends to Mirzachul, forming parallel low mountains. The geographic location of the Nurota mountain range, air masses blowing from the north and west, and the earth's surface structure are important in forming the region's climate. Since the northern and western sides of the Nurota ridge are flat, cold, dry air masses blowing from the Arctic and Siberia, and moist air masses blowing from the Atlantic Ocean easily enter. Since it is located very far from the oceans, the air temperature in summer and winter is very different. In the lower parts of the mountain, summer is dry and hot, and winter is not so cold. At higher altitudes, summers are cool and short, and winters are cold and long. The climate is dry continental, which caused the formation of unique flora and fauna in this region. Several studies have proven the distribution of animals (Khalimov 2020; Zokirova et al. 2022) and plants (Alikulov et al. 2023; Jurakulov et al. 2023) in this area is of high biological diversity and importance. However, information on the taxonomy and biocological characteristics of gastropods of the streams of the Nurota mountain range

(Uzbekistan) is practically rare in scientific literature and sources, which indicates that no in-depth research has been conducted in this regard.

Therefore, our research aimed to determine the biological diversity, ecology, and zoogeographical groups of gastropods in the streams of the Nurota mountain range (Uzbekistan).

MATERIALS AND METHODS

Study area

The selection of sampling stations is based on differences in environmental conditions, including humidity, lighting, and temperature. The research area comprises 11 streams: Sentob, Mojirum, Uxum, Uchma, Baland Osmon, Egizbulok, Kukala, Gujim, Garasha, Kurum, and Savruk in the Nurota Mountains of Uzbekistan. A complete description of the sampling station is shown in Figures 1-2 and Table 1.

Table 1. Sampling site of molluscs (Gastropods) in mountain streams, Nurota mountain range, Uzbekistan

Location	Name of location	Coordinate	Height above sea level, meters
Station I	Sentob	40°37'41.15"N, 66°40'22.66"E	1200-1300
Station II	Mojirum	40°35'31.94"N, 66°44'41.69"E	1300-1400
Station III	Uxum	40°35'20.82"N, 66°46'45.15"E	1400-1450
Station IV	Uchma	40°28'8.61"N, 67° 03'39.56"E	1200-1300
Station V	Baland osmon	40°22'20.98"N, 67°16'44.75"E	700-800
Station VI	Egizbulok	40°20'49.58"N, 67°23'53.91"E	650-750
Station VII	Kukala	40°16'16.47"N, 66°45'58.35"E	800-900
Station VIII	Gujim	40°19'11.94"N, 66°50'50.28"E	850-950
Station IX	Garasha	40°17'42.14"N, 66°56'58.97"E	850-950
Station X	Kurum	40°14'43.85"N, 67° 03'36.34"E	800-900
Station XI	Savruk	40°10'21.66"N, 67°16'38.05"E	800-850

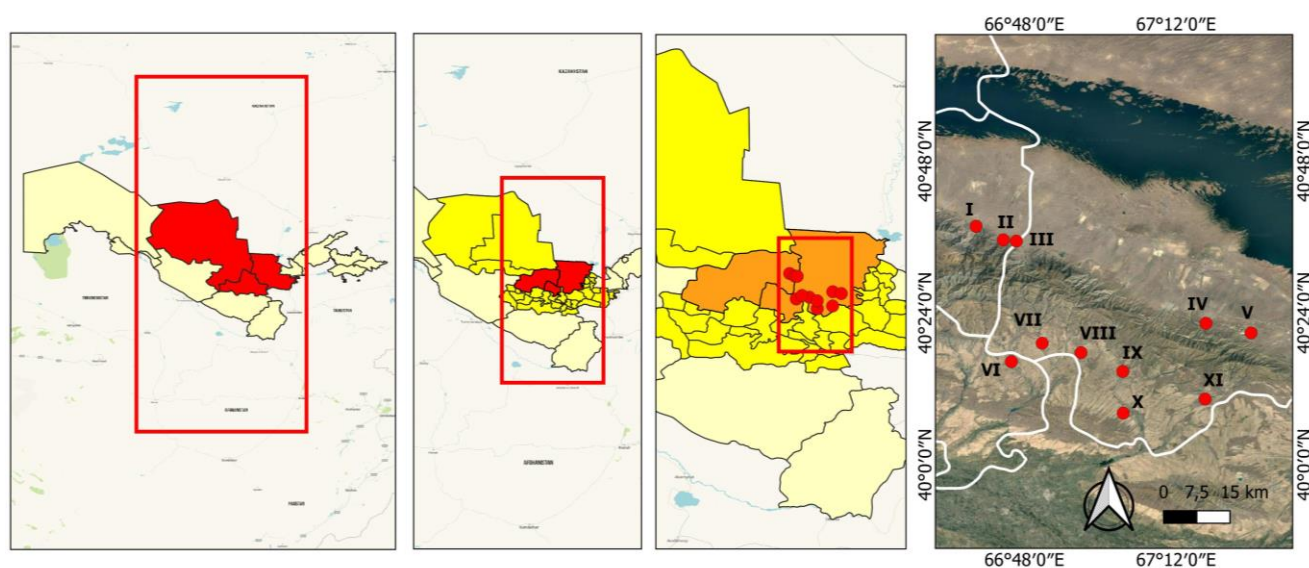


Figure 1. The sampling area in mountain streams, Nurota mountain range, Uzbekistan (I-XI - Stations; - collection points for material)



Figure 2. View of some research mountain streams, Nurota mountain range, Uzbekistan

Collection of samples

Material selection and processing were carried out using the method of Izzatullayev (2019) and Pazilov et al. (2021). The material was mainly collected from waters up to 1.5 meters deep with a hydrobiological scoop or matrap. Since molluscs were more abundant in shallow areas (0.05-0.4 m), they were collected by hand from the bottom and stems of algae. In some cases, plant branches and algae were taken in polyethylene bags, and molluscs were separated by washing them in a sieve in laboratory conditions. Finally, molluscs 1-2 mm in size were removed from the sand with a pipette or soft tweezers.

Their environment, pH, salinity, water clarity, and current speed were considered regardless of where and when the mollusks were collected. These data were recorded in the field notebook, indicating the month, date, and year in full. Fixation of molluscs is carried out with 70-75% alcohol. If it was impossible to fix with alcohol, it was fixed in 2% formalin, and soda (NaHCO_3) was added to the mixture to prevent the shell from dissolving. All the shells were kept dry in cardboard boxes of different sizes.

Identification molluscs

The keys of Starobogatov et al. (2004) and Izzatullayev (2019) were used to identify molluscs. After being photographed and identified, the sample is stored in the collection bottle. The methods used to identify mollusc

species consisted of morphological, anatomical, and taxonomic analysis. Identification of mollusc samples was carried out based on the morphology of mollusk shells and the structure of genital organs.

Population, ecological, and zoogeographic analysis

The mutual similarity of the species composition of the investigated streams was analyzed by the Neighbor-joining method (Yan et al. 2021) and described using the cluster prepared in the PAST 4.0 program (Pazilov et al. 2021). Determining ecological groups of molluscs in the studied streams was carried out according to the methods of Izzatullaev (2019) and the zoogeographical groups of Starobogatov (1970). The density of individuals in the population was determined by the method of Izzatullaev (2019). In this case, the samples were collected from plots with a size of 1 m².

RESULTS AND DISCUSSION

As a result of the research, more than 2,950 mollusc samples were collected from the streams of the Nurota mountain range. As a result of their morphological, anatomical, and taxonomic analysis, a malacofaunistic list was formed. According to this list, four families (*Belgrandiellidae*, *Lymnaeidae*, *Physidae*, *Planorbidae*), five genera (*Martinsamnicola*, *Bucharammicola*, *Lymnaea*, *Physella*, *Planorbis*) and 15 species of gastropod molluscs were found in the streams of the Nurota mountain range (Table 2, Figure 3). Furthermore, according to Table 2, representatives of the family *Lymnaeidae* (Rafinesque, 1815) dominate among gastropod molluscs in the study area. There are eight species belonging to this family in the region. When the malacofaunistic list was analyzed in the genus section, it was observed that eight species belong to *Lymnaea*, three species to *Planorbis*, two species to *Martinsamnicola*, one species each to *Bucharammicola* and *Physella*. A total of 5 species, including *Bucharammicola bucharica* (Shadin, 1952), *Lymnaea stagnalis* (Linnaeus, 1758), *Lymnaea thiessea* (Clessin, 1979), *Lymnaea subdisjuncta* (Nevill, 1878) and *Anisus ladacensis* (Nevill, 1878) Nurota mountain range meeting in the ridge was recorded by us for the first time.

Moreover, when analyzing the composition of species in the stream section of Nurota Mountains, Mojirum (9 species), Ukhum and Egizbulok (8 species each), and Garasha (7 species) were species-rich found. In addition, Gujim, Kurum, and Savruk (4 each) species were noted to be relatively few streams (Table 3). The data in Table 3 confirm that in the investigated streams, 26.7% to 60.0% of the species are related to the area's total species. In particular, there are 5 species each: in Sentob, Uchma, and Kukala streams (33.3% of the total species in the area), 9 species (60%) in Mojirum stream, 8 species (53.3%) each in Uxum and Egizbulok streams, 6 species (40%) in Baland Osman stream, 4 species (26.7%) each in Gujim, Kurum and Savruk streams and 7 species (46.7%) in Garasha stream were found. The analyses showed that the species composition of the streams (I-VI) located on the North-

Eastern slopes of the Nurota Mountains is richer than that of the streams on the South-Western slopes. The situation is explained by the relatively mild climate and relatively high humidity on the North-Eastern slopes of the Nurota Mountains. The analyzes showed that *M. brevicula* and *M. hissarica* were the most dominant species in the study area. These species were found in 7 of the studied streams. The rarest species for the area are *P. planorbis* and *A. ladacensis*, which were found to be present in 3 streams.

Eight species, i.e., *M. brevicula*, *M. hissarica*, *B. bucharica*, *L. thiessea*, *L. truncatula*, *L. auricularia*, *L. oblonga*, *C. acuta* species of Nurota mountains were distributed in the streams on both sides. *L. stagnalis*, *L. subangulata*, *L. subdisjuncta*, *L. bactriana* and *P. tangitarensis* (5 species in total) were found only in streams on the North-Eastern slopes of the research area. Two species (*P. planorbis* and *A. ladacensis*) are distributed only in streams on the South-Western slopes.

Table 2. Checklist of molluscs (Gastropods) on mountain streams, Nurota mountain range, Uzbekistan

Family	Genus	Species
Belgrandiellidae (Radoman, 1983)	<i>Martensammicola</i> (Izzat, Sitn. et Star, 1985)	<i>Martensammicola brevicula</i> (Martens, 1874) <i>Martensammicola hissarica</i> (Shadin, 1950)
	<i>Bucharammicola</i> (Izzat., Sitn. et Star, 1985)	<i>Bucharammicola bucharica</i> (Shadin, 1952)
Lymnaeidae (Rafinesque, 1815)	<i>Lymnaea</i> (Lamarck, 1799)	<i>Lymnaea stagnalis</i> (Linnaeus, 1758)
		<i>Lymnaea thiessea</i> (Clessin, 1979)
		<i>Lymnaea truncatula</i> (Müller, 1774)
		<i>Lymnaea auricularia</i> (Linnaeus, 1758)
		<i>Lymnaea oblonga</i> (Puton, 1847)
		<i>Lymnaea subangulata</i> (Roffiaen, 1868)
		<i>Lymnaea subdisjuncta</i> (Nevill, 1878)
		<i>Lymnaea bactriana</i> (Hutton, 1849)
Physidae (Firzinger, 1833)	<i>Physella</i> (Haldeman, 1842)	<i>Costatella acuta</i> (Draparnaud, 1805)
		<i>Planorbis planorbis</i> (Linne, 1758)
Planorbidae (Rafinesque, 1815)	<i>Planorbis</i> (Geoffroy, 1767)	



Figure 3. Molluscs (gastropods) of mountain streams, Nurota mountain range, Uzbekistan

Table 3. The number of species in each sampling station (I-XI)

Species	Location										
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
<i>M. brevicula</i>	+	+	+	-	-	+	-	-	+	+	+
<i>M. hissarica</i>	+	+	+	-	-	+	-	-	+	+	+
<i>B. bucharica</i>	+	+	+	-	-	+	-	-	-	-	+
<i>L. stagnalis</i>	+	+	-	-	-	+	-	-	-	-	-
<i>L. thiessea</i>	-	+	+	-	-	+	-	+	+	-	-
<i>L. truncatula</i>	-	-	-	-	-	+	+	-	+	+	-
<i>L. auricularia</i>	-	-	-	-	+	-	-	-	+	+	+
<i>L. oblonga</i>	-	-	-	+	+	+	+	-	-	-	-
<i>L. subangulata</i>	-	+	+	+	+	-	-	-	-	-	-
<i>L. subdisjuncta</i>	-	+	+	+	+	-	-	-	-	-	-
<i>L. bactriana</i>	-	+	+	+	-	-	-	-	-	-	-
<i>C. acuta</i>	-	-	-	-	+	+	+	+	-	-	-
<i>P. planorbis</i>	-	-	-	-	-	-	+	+	+	-	-
<i>P. tangitarenensis</i>	+	+	+	+	+	-	-	-	-	-	-
<i>A. ladacensis</i>	-	-	-	-	-	-	+	+	+	-	-
Total species	5	9	8	5	6	8	5	4	7	4	4
Share of the total number of species in the area, %	33.3	60.0	53.3	33.3	40.0	53.3	33.3	26.7	46.7	26.7	26.7

Table 4. Distribution of common species of the studied area by ecological groups

Species	Ecological groups			
	Phytophil	Crenophil	Telmatophil	Phytoreophil
<i>M. brevicula</i>	(-)	(20-25)	(-)	(-)
<i>M. hissarica</i>	(-)	(25-30)	(-)	(-)
<i>B. bucharica</i>	(-)	(25-35)	(-)	(-)
<i>L. stagnalis</i>	(40-45)*	(-)	(-)	(-)
<i>L. thiessea</i>	(-)	(-)	(8-10)	(-)
<i>L. truncatula</i>	(-)	(-)	(4-6)	(-)
<i>L. auricularia</i>	(-)	(-)	(-)	(10-12)
<i>L. oblonga</i>	(-)	(-)	(-)	(12-14)
<i>L. subangulata</i>	(-)	(40-60)	(-)	(-)
<i>L. subdisjuncta</i>	(-)	(35-40)	(-)	(-)
<i>L. bactriana</i>	(25-35)	(-)	(-)	(-)
<i>C. acuta</i>	(18-20)	(-)	(-)	(-)
<i>P. planorbis</i>	(20-25)	(-)	(-)	(-)
<i>P. tangitarenensis</i>	(25-30)	(-)	(-)	(-)
<i>A. ladacensis</i>	(12-14)	(-)	(-)	(-)
Total species	6	5	2	2
Share of the total number of species in the area, %	40,0	33,2	13,4	13,4

Note: *Density (ind/m²)

Moreover, through analysis of characteristics of mutual proximity and similarity of species composition of streams in the Nurota mountain range, it is observed that Sentob (I) and Egizbulok (VI) streams are important in the formation of species composition (Figure 4). Therefore, according to the principle of mutual affinity, species in the area can be divided into two groups: species formed from Sentobsoy (1) and species from Egizbulok (2). Based on the dendrogram, the malacofauna of Mojirum and Uxum, Uchma and Balandosmon, Kukala and Gujim, Kurum, and Savruk streams are the closest to each other.

During our research, ecological groups and distribution (density) of gastropod molluscs in streams of the Nurota Mountains were determined. According to the results of the research, 6 (40%) gastropod molluscs distributed in the area were classified as phytophilic, 5 (34%) - crenophilic, 2

(13%) - telmatophilic and 2 (13%) - phytophilic (Table 4, Figure 5). Among the molluscs belonging to the phytophilic group, the species with the highest distribution density were *L. stagnalis* (40-45 ind/m²), *L. bactriana* (30-35 ind/m²) and *P. tangitarenensis* (25-30 ind/m²). *L. subangulata* (40-60 ind/m²), *L. subdisjuncta* (35-40 ind/m²) and *B. bucharica* (25-35 ind/m²) were recorded as species with the highest distribution density among molluscs belonging to the crenophilic group. It was observed that the distribution density of gastropod molluscs belonging to the telmatophilic and phytophilic groups was much lower than the initial group. The distribution density of *L. thiessea*, the largest species of the telmatophilic group, is 8-10 ind/m², while this indicator is 12-14 ind/m² in *L. oblonga*, belonging to the phytoreophilic group.

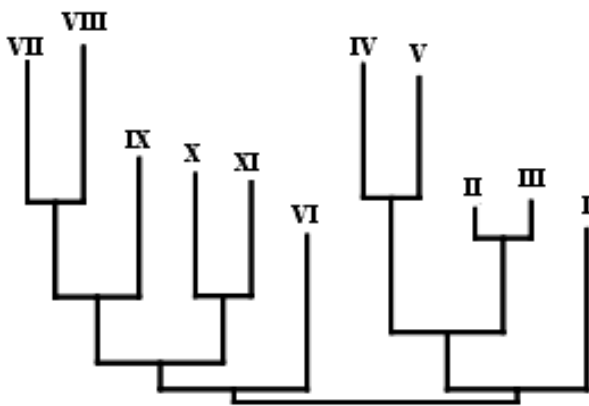


Figure 4. Dendrogram of faunistic similarity of gastropods of mountain streams, Nurota mountain range, Uzbekistan

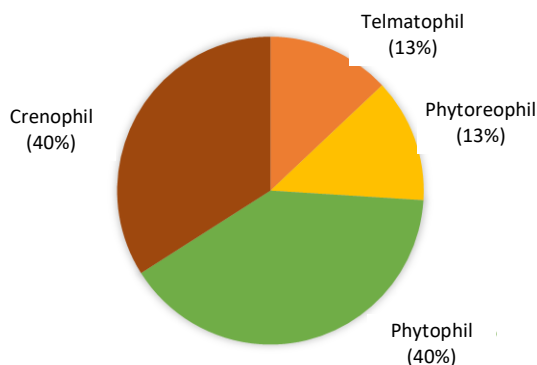


Figure 5. Ecological groups of gastropods of mountain streams, Nurota mountain range, Uzbekistan

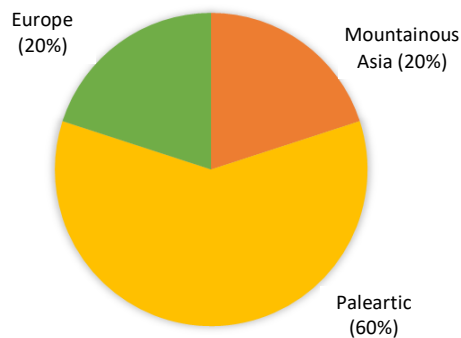


Figure 6. Zoogeographical groups of gastropods in mountain streams, Nurota mountain range, Uzbekistan

As a result of the research, water bodies inhabited by gastropod molluscs in the Nurota Mountains are divided into three groups, i.e., Group 1 - small water bodies: springs, springs and swamps; Group 2 - small streams and ponds that dry up from time to time; Group 3 was found to be between the stones in the places where the water of the stream flows. It was found that the water area of the first

habitat is composed of macrophytes, and there we can find species such as *L. thiessea*, *L. truncatula*, and *P. planorbis*. Also, the number of species increases as the depth of spring, and spring and swamp increases. The *M. brevicula*, *M. hissarica*, *B. bucharica*, and *L. subangulata* species are found there. Their population density is also high, and the transformation of the territory into permanent species was observed. In the second habitat, *L. truncatula*, *A. ladacensis* species, which are resistant to the drying up of water bodies, were distributed. In the third habitat of gastropod molluscs, the lake and river species *L. auricularia*, adapted to live in fast-flowing waters, was widespread. Chertoprud et al. (1996) classified freshwater gastropods according to their occurrence in different biotopes based on 370 specimens collected from central parts of Russia. According to them, the ecological species groups greatly influence the species composition of the water basin type and substrate. The significant relationship between species composition and water body type is significant.

During the research, zoogeographical groups of gastropod molluscs of streams of the Nurota mountains were determined. Gastropod molluscs in the area belong to the Palearctic (60%), European (20%), and Mountain Asian (20%) groups. Representatives of the Palearctic group included *L. stagnalis*, *L. auricularia*, *L. truncatula*, *L. thiessea*, *L. oblonga*, *L. subangulata*, *L. subdisjuncta*, *L. bactriana*, *C. Acuta*, *M. brevicula*, *M. hissarica*, *B. bucharica* are European species. In comparison, *A. ladacensis*, *P. planorbis*, *P. tangitarenis* are species belonging to the mountain Asian group (Figure 6). Furthermore, Anistratenko et al. (2012) noted that the distribution of molluscs in zoogeographical groups in the section of species is not uniform, as a result of researching zoogeographical groups of Middle Sarmatian gastropod molluscs.

In several studies in our country and abroad, the fauna of terrestrial and aquatic gastropod molluscs in certain regions has been studied in detail. Nedjoua et al. (2021) determined the variation of the diversity of gastropod molluscs in North-East Algeria depending on the composition of the external environment and soil factors. They showed that eight species belonging to 4 families are distributed in this area. Bae and Park (2020) determined that 31 species belonging to 11 families are distributed in the Han, Nakdong, Yeongsan, Seomjin, and Geum Rivers of South Korea. In this study, it is important to show the representatives of the families Lymnaeidae and Planorbidae found in the streams of the Nurota Mountains. Schilkeyko et al. (2017, 2020), emphasizing the diversity of the mollusk fauna of the Central Asian region, noted that the possibility of species new for science is high because the malacofauna in the region has not been studied in depth. Studies of malacofauna of the Kor River of Iran (Fatemeh et al. 2019), East Java and Indonesia (Isoni et al. 2023), Turkey and Greece (Peter et al. 2012), Repede Valley of Romania (Voichița et al. 2010) and other regions show that important features in the biological diversity and distribution of molluscs are directly related to their climates and regional-locations.

Based on the discussed information and research results, we believe that the formation of biological diversity of gastropod molluscs in the streams of the Nurota Mountains took place depending on the dry continental character of the area.

In conclusion, 15 species of gastropod molluscs belonging to four families and five genera can be found in the mountain streams of the Nurota Mountains of Uzbekistan. Representatives of the *Lymnaeidae* family dominate among gastropod molluscs of the region. There are eight species belonging to this family in the region. The analyzes showed that *M. brevicula* and *M. hissarica* were the most dominant species in the study area. Gastropod molluscs of the region belong to four ecological (phytophilic, crenophilic, telmatophilic, phytophilic) and three zoogeographical (Palearctic (60%), European (20%) and Mountain Asian (20%)) groups. A total of five species, including *Bucharamnicola bucharica* (Shadin, 1952), *Lymnaea stagnalis* (Linnaeus, 1758), *Lymnaea thiessea* (Clessin, 1979), *Lymnaea subdisjuncta* (Nevill, 1878) and *Anisus ladacensis* (Nevill, 1878) Nurota mountain range collected upon the ridge were recorded by us for the first time.

ACKNOWLEDGEMENTS

The authors would like to thank Dr. B.Alikulov, associate professor of Samarkand State University, and Dr.B.Eshkuvvatov, associate professor of Samarkand State University, for their advice and recommendations on the selection of research methods for carrying out the research presented in the article.

REFERENCES

- Abdurasulova S, Pazilov A. 2021. Nature of variability of *Candaharia levanderi* (Simroth, 1902) in the Ferghana and Surkhan - Sherabad Valleys, Uzbekistan. Bull Iraq Nat Hist Mus 16 (4): 547-555. DOI: 10.26842/binhm.7.2021.16.4.0535.
- Alikulov B, Gulboev D, Maxammadieva D, Tillaeva Z, Olimjonova S, Ismailov Z. 2023. Isolation and characterization of endophytic bacteria from some halophytes in saline desert regions of Uzbekistan. Biodiversitas 24: 1279-1288. DOI: 10.13057/biodiv/d240270.
- Alikulov B, Shurigin V, Davranov K, Ismailov Z. 2022a. Plant growth-promoting endophytic bacteria associated with *Halocnemum strobilaceum* (Pall.)M. Bieb and their plant beneficial traits. Plant Sci Today 9: 44-50. DOI: 10.14719/pst.1605.
- Alikulov BS, Shuryhin VV, Davranov KD, Ismailov ZF. 2022b. The halophytic plant *Halostachys belangeriana* (Moq.) Botsch as a source of plant growth-promoting endophytic bacteria. Microbiol J 4: 31-39. DOI: 10.15407/microbiolj84.04.030.
- Anistratenko O, Anistratenko V. 2012. Zoogeography and ecology of the Middle Sarmatian Gastropods of the Eastern Paratethys. Ruthenica 22 (2): 115-134. DOI: 10.35885/ruthenica.2021.30(2).5.
- Bae M-J, Park Y-S. 2020. Key determinants of freshwater gastropod diversity and distribution: The implications for conservation and management. Water 12 (7), 1908. DOI: 10.3390/w12071908.
- Chertoprud M, Udalov A. 1996. Ecological groups of freshwater gastropods in the central part of European Russia. The influence of the type of water body and substrate. J Zool 75 (5): 664-676.
- Fatemeh A, Sareh Y, Peter G, Mehrdad Z. 2019. Ecology and species composition of Molluscs in upstream of the Kor River System, with two new records for the Fars Province, Iran. J Wildl Biodivers 3 (2): 29-39. DOI: 10.22120/jwb.2019.105850.1062.
- Islamy RA, Hasan V. 2020. Checklist of mangrove snails (Mollusca: Gastropoda) in South Coast of Pamekasan, Madura Island, East Java, Indonesia. Biodiversitas 21 (7): 3127-3134. DOI: 10.13057/biodiv/d21073.
- Ironi W, Sari PDW, Sari LA, Daniel K, South J, Islamy RA, Wirabuana PYAP, Hasan V. 2023. Checklist of mangrove snails (Gastropoda: Mollusca) on the coast of Lamongan District, East Java, Indonesia. Biodiversitas 24: 1676-1685. DOI:10.13057/biodiv/d240341.
- Izzatullayev ZI. 2019. Fauna of The Molluscs of Water Ecosystems of Central Asia and The Contiguous Country Territories. Lesson-Press Pub., Tashkent.
- Jurakulov B, Tagaev I, Alikulov B, Axanbayev S, Akramov I, Ismailov Z. 2023. Population of *Halocnemum strobilaceum* (Pall.)M.Bieb in a dry salt lake of the Central Kyzylkum. Plant Sci Today 10 (2): 170-177. DOI: 10.14719/pst.2062.
- Khalimov F. 2020. Seasonal dynamics of dominant species of soil predators (Coleoptera: Carabidae, Staphylinidae) in agrolandscapes and their potential gluttony. Travaux du Muséum National d'Histoire Naturelle "Grigore Antipa" 63 (2): 175-187. DOI: 10.3897/travaux.63.e54116.
- Khalimov F. 2020. The ground beetles (Coleoptera, Carabidae) of the Karatepa and Chakilkalyan Mountains (west part of Zarafshan Mountains Range, Uzbekistan). Biosyst Divers 28 (3): 265-271. DOI: 10.15421/012035.
- Narzullayev SB. 2022. New data on the vertical distribution of nematode communities in mountain ecosystems of Mount Zarafshan, Uzbekistan. Biodiversitas 23: 3967-3975. DOI: 10.13057/biodiv/d230814.
- Nedjoua Z, Louiza D, and Amel H. 2021. Diversity and abundance of terrestrial gastropods in Skikda region (North-East Algeria): correlation with soil physicochemical factors. J Basic Appl Zool 82: 41. DOI: 10.1186/s41936-021-00239-6.
- Pazilov A, Umarov F. 2021. On the ecology and species diversity of the freshwater gastropods of springs in Andijan Region, Uzbekistan. Bull Iraq Nat Hist Mus 16 (3): 325-340. DOI: 10.26842/binhm.7.2021.16.3.0325.
- Pazilov A, Umarov F. 2022. Conchological variability of terrestrial mollusk *Chondrulopsina fedtschenkoi* (Ancey, 1886) (Gastropoda, Pulmonata, Enidae) from the Zarafshan Range, Uzbekistan. Bull Iraq Nat Hist Mus 17 (1): 103-113. DOI: 10.26842/binhm.7.2022.17.1.0103.
- Peter G, Dilian G. 2012. Three new gastropod species from Greece and Turkey (Mollusca: Gastropoda: Rissoidae) with notes on the anatomy of *Bythinella charpentieri cabirius* Reischütz 1988. North-West J Zool 8 (2): 278-282.
- Schilkeyko A, Pazilov A, Abdulazizova SH. 2017. A new genus of the Bradybaenidae family (Gastropoda, Pulmonata) from central Asia. Ruthenica 27 (1): 31-37. DOI: 10.35885/ruthenica.2017.27(1).3.
- Schilkeyko A, Pazilov A, Abdulazizova SH. 2020. One more surprise from *Bradybaenidae* (Gastropoda, Pulmonata). Ruthenica 30 (4): 217-221. DOI: 10.35885/ruthenica.2021.30(4).6.
- Starobogatov YI, Prozorova LA, Bogatov VV, Sayenko YM. 2004 Key to freshwater invertebrates of Russia and adjacent lands. Tsalolikhin SJ (ed). Molluscs, Polychaetes, Nemerteans. Nauka, Saint-Petersburg.
- Starobogatov YI. 1970. Molluscan fauna and zoogeographic zoning of continental water bodies of the world. Nauka, Leningrad.
- Strong EE, Gargominy O, Ponder WF, Bouchet P. 2008. Global diversity of gastropods (Gastropoda; Mollusca) in freshwater. Hydrobiol 95: 149-166. DOI: 10.1007/978-1-4020-8259-7_17.
- Voichița G. 2010. Terrestrial gastropod fauna of the repede river valley in the Rodna Mountains National Park (Transylvania-Maramureș, Romania). Transylv Rev Syst Ecol Res 9: 113-121.
- Yan H, Maozu G, Juan W. 2021. ENJ algorithm can construct triple phylogenetic trees. Mol Ther: Nucleic Acids 23: 286-293. DOI: 10.1016/j.omtn.2020.11.004.
- Zokirova D, Khalimov F. 2022. Morphometric features of the beetle *Acinopus (Acinopus) laevigatus* Menetries, 1882 (Coleoptera, Carabidae) in the mountain ecosystems of Uzbekistan. Bull Iraq Nat Hist Mus 17 (2): 141-153. DOI: 10.26842/binhm.7.2022.17.2.0141.