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ON THE ECOLOGY AND SPECIES DIVERSITY OF THE FRESHWATER GASTROPODS OF SPRINGS IN ANDIJAN REGION, UZBEKISTAN

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ABSTRACT

This study examines the species composition, biodiversity, zoogeography, and ecology of freshwater gastropods of 12 springs in Andijan region of Uzbekistan. The study used generally accepted malacological, faunistic, ecological, analytical, and statistical methods. As a result of research in the springs, 14 species of freshwater gastropods belonging to 2 subclasses, 5 families, and 10 genera were recorded. 7 of them are endemic to Central Asia. When indicators of biodiversity of mollusks were analyzed according to the Shannon index, it was found that the highest value was recorded in the springs besides the hills. According to the biotope of distribution and bioecological features, they were divided into cryophilic, phytophilic, pelophilic, and eurybiontic ecological groups. The mollusks, which are common in the springs, were divided into 3 groups according to their faunal similarity. The contribution of the Central Asian and European-Siberian species to the formation of the malacofauna in the springs of the Andijan region was significant.

Keywords: Andijan, Biodiversity, Ecology, Freshwater Gastropods, Spring.

INTRODUCTION

Springs are one of the water basins in need of protection, because they were separated from the water basins, and allowed for the emergence of rare and endemic species; one of the most common organisms among them is Mollusca group (Izzatullayev *et al.*, 2013). Mollusks play an important role in the metabolism of substances in aquatic ecosystems and the processes of self-cleaning of water bodies (Leshko, 1998), as well as changes in the external environment; they are visible (Zhadin, 1952).

At present, the conservation of the diversity of mollusks in springs is based on faunistic analysis of the species, identification of distribution areas, the study of the transformation process under the influence of anthropogenic forces, and the development of measures to

protect rare species (Starobogatov, 1972). Based on these tasks, the study of the biodiversity and ecological properties of freshwater gastropods in the springs of the Fergana Valley is one of the current important issues (Umarov and Pazilov, 2020).

Russian malacologist Zhadin (1952) studied the fauna and ecology of mollusks distributed in fresh and brackish waters of the USSR. Based on the collections of Arkhangelsky (1933) from the Shohimardon springs in the Fergana Valley, he introduced a new species of *Valvatamnicola archangelskii* (Zhadin, 1952) to the science belonging to the *Hygrobeidae* family. These species are included in the Red Book of the Republic of Uzbekistan (2019). Mukhamediyev (1967, 1969, 1986) studied the hydrobionts of the Fergana Valley, at freshwater gastropods and recorded the following species in the springs: *Costatella acuta* (Draparnaud, 1805); *Planorbis planorbis* (Linnaeus, 1758); *P. tangitarensis* Germain, 1918; *Anisus ladacensis* (Nevill, 1878) and *Radix auricularia* (Linnaeus, 1758).

In recent years, Izzatullayev and Solijonov (2016), Izzatullayev (2018, 2019), Pazilov and Umarov (2020), Umarovs (2020) and Umarov and Pazilov (2020) studied aquatic mollusks of the Fergana Valley. However, according to literature data, although hydrobiological studies were carried out in the Fergana Valley, studies of aquatic mollusks in springs have not been sufficiently studied.

Taking into account the mentioned above, the present investigation aimed to study the biodiversity and ecological characteristics of freshwater gastropods in the springs of the Andijan region.

MATERIALS AND METHODS

Andijan region is located in the eastern part of the Fergana Valley; the western part consists of the plains, while the eastern part includes the Fergana and Alay ridges. Administratively, it is the most eastern region of the Republic of Uzbekistan. The region is at an altitude of 500-600 m above sea level, the proximity of groundwater to the surface in most areas, and the presence of rivers, hills, and mountains have allowed the emergence of more than 50 large and small springs (Mukhamediyev, 1967).

Twelve springs were selected for the present study. Their selection took into account the constant availability of spring water and its richness in hydrobionts. The existing springs in Andijan region can be divided into 3 groups (Mukhamediyev, 1967): at the bottom of the river cones (Uchbulak, Kajnarbulak, Tandirbulak, Kushmabulak, Ajdinbulak), besides the hills (Fozilman ota bulak, Alchalik bulak, Bibi Seshanba bulak, Kukbulak) besides the mountains (Shirmonbulak, Imam ota bulak, Shiraghanbulak). The water of all studied springs was fresh water, but there were differences in some of the environmental parameters (Tab. 1). Field work was carried out to study the malacofauna of 12 springs at Andijan region and their ecology during May-August 2020 (Map 1).

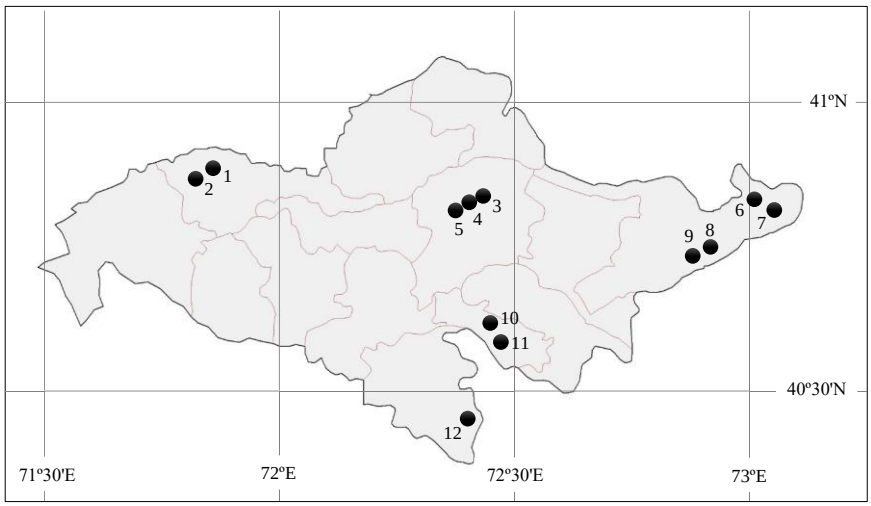
Hydrobiological net and tweezers were used to collect the mollusks; then collected specimens were first fixed in 70 %, and a day later - in 96 % ethyl alcohol (Izzatullayev,

2018). In total, more than 1300 mollusks were collected in 50 specimens. A 25 x 25 cm frame was used to determine the population density of mollusks (Zhadin, 1960). Also, water samples were taken for hydrochemical analysis; depth was measured, and general information about the spring biotope was recorded.

Table (1): Hydrochemical characteristics of spring water in Andijan region.*

No.	Name of springs	pH	O_2, mg/l	t, °C
1	Uchbulak	7.3	8.8	18.1
2	Kajnarbulak	7	12.8	13.2
3	Tandirbulak	7.2	9.1	16.3
4	Kushmabulak	7	11.3	18.4
5	Ajdinbulak	7.3	9.4	18.8
6	Fozilman ota bulak	7	10.2	13.2
7	Alchalik bulak	6.9	7.7	19.5
8	Bibi Seshanba bulak	6.9	15.9	16.7
9	Kukbulak	6.9	16.7	17.4
10	Shirmonbulak	7.1	13.8	15.1
11	Imam ota bulak	7	12.4	13.1
12	Shiraghanbulak	6.9	9.2	13.3

[*Note: During June-August 2020, the average was measured at 3 different times of the day].



Map (1): Andijan region, research area (Kholiqov, 2020); (1) Uchbulak (40°53'32.3"N 71°51'16.8"E), (2) Kajnarbulak (40°53'09.5"N 71°50'08.6"E), (3) Tandirbulak (40°51'13.9"N 72°22'19.4"E), (4) Kushmabulak (40°51'07.7"N 72°22'01.3"E), (5) Ajdinbulak (40°50'54.5"N 72°21'35.1"E), (6) Fozilman ota bulak (40°48'50.9"N 72°59'42.2"E), (7) Alchalik bulak (40°48'36.0"N 73°04'54.7"E), (8) Bibi Seshanba bulak (40°44'51.8"N 72°55'48.4"E), (9) Kukbulak (40°44'44.3"N 72°55'31.7"E), (10) Shirmonbulak (40°35'11.5"N 72°28'59.3"E), (11) Imam ota bulak (40°32'20.2"N 72°37'05.0"E), (12) Shiraghanbulak (40°26'29.7"N 72°24'06.6"E)[(Symbol: •) collection points for material].

When identifying mollusks, the keys of Starobogatov *et al*. (2004) and Izzatullayev (2019) were used. The coordinates of the location of the materials collected for the study were determined using the Google Maps mapping service. The plural ratio of species was grouped on a 5-point logarithmic scale (Pesenko, 1982). Species with an abundance of 4 - 5 points are the most common (dominant), 3 points - common and 1 - 2 points - few. The biodiversity index of mollusks in springs was calculated using the Shannon (1948) method based on the following formula:

$$H' = -\sum_{i-1}^{s} p_i \ln(p_i)$$

Where, H' -the Shannon index value, p_i – the proportion of individuals found in i the species, ln - the natural logarithm, s – the number of species in the community. The levels of the Shannon Biodiversity Index (H'): $H' < 1.5$ – low; $1.5 < H' > 2.5$ - medium; $2.5 < H'$ – due to high character. Statistical analysis and diagrams of the data were performed using microsoft excel 2013 and TIBCO software statistica 13.5 for windows.

RESULTS AND DISCUSSION

Malacofauns of springs of Andijan region:

14 species of freshwater gastropods belonging to 10 genera, 5 families and 2 subclasses were recorded in the springs of the Andijan region. Their faunistic structures and taxonomy are given below:

(A) Subclass, Pectinibranchia Blainville, 1814
- **Family, Hydrobiidae** Stimpson, 1865
  - **Genus, *Bucharamnicola*** Izzatullayev, Sitnikova & Starobogatov, 1985
    - *Bucharamnicola bucharica* (Zhadin, 1952)
  - **Genus, *Martensamnicola*** Izzatullayev, Sitnikova & Starobogatov, 1985
    - *Martensamnicola brevicula* (von Martens, 1874)
    - *M. hissarica* (Zhadin, 1950)
  - **Genus, *Sogdamnicola*** Izzatullayev, Sitnikova & Starobogatov, 1984
    - *Sogdamnicola pallida* (von Martens, 1874)

(B) Subclass, Pulmonata Cuvier, 1814
- **Family, Acroloxidae** Thiele, 1931
  - **Genus, *Acroloxus*** Beck, 1838
    - *Acroloxus lacustris* (Linnaeus, 1758)
- **Family, Lymnaeidae** Rafinesque, 1815
  - **Genus, *Ampullaceana*** Servain, 1882
    - *Ampullaceana lagotis* (Schrank, 1803)
  - **Genus, *Lymnaea*** Lamarck, 1799
    - *Lymnaea bowelli* Preston, 1909
    - *L. tengriana* (Izzatullayev, Kruglov & Starobogatov, 1983)
  - **Genus, *Radix*** Montfort, 1810
    - *Radix auricularia* (Linnaeus, 1758)
- **Family, Physidae** Firzinger, 1833
  - **Genus, *Physella*** Haldeman, 1842
    - ***Physella acuta*** (Draparnaud, 1805)
- **Family, Planorbidae** Rafinesque, 1815
  - **Genus, *Gyraulus*** Charpentier, 1837
    - *Gyraulus acronicus* (Férussac, 1807)
    - *G. ladacensis* (Nevill, 1878)
  - **Genus, *Planorbis*** Müller, 1773

Planorbis tangitarensis Germain, 1918
P. planorbis (Linnaeus, 1758)

The malakofauna of the springs at Andijan region are characterized by the high density of species of *Lymnaeidae* and *Planorbidae* and the lowest one of *Hydrobiidae* and *Physidae* (Diag. 1). The most common species were *R. auricularia, A. lagotis, Ph. acuta, P. tangitarensis,* and *P. planorbis.*

The depth distribution of hydrobionts in lenticular water bodies has a great importance (Zhadin and Gerd, 1961). In springs such as Uchbulak, Kajnarbulak, Kushmabulak, Aydinbulak, and Kukbulak, where water is collected and forms a pool (diameter < 2 m, depth < 1.5 m), mollusks were observed mainly in the littoral zone. In the coastal littoral zones of spring ponds (0.1 – 0.5 m): *A. lacustris, L. lagotis, C. acuta, P. tangitarensis, P. planorbis, G. acronicus* and *G. ladacensis* and in the lower littoral zone (0.5 – 2 m): *R. auricularia, M. brevicula, M. hissarica,* and *B. bucharica* were widespread. Below the littoral zone, mainly in the profundal zone, the occurrence of mollusks was very low especially in pulmonate mollusks.

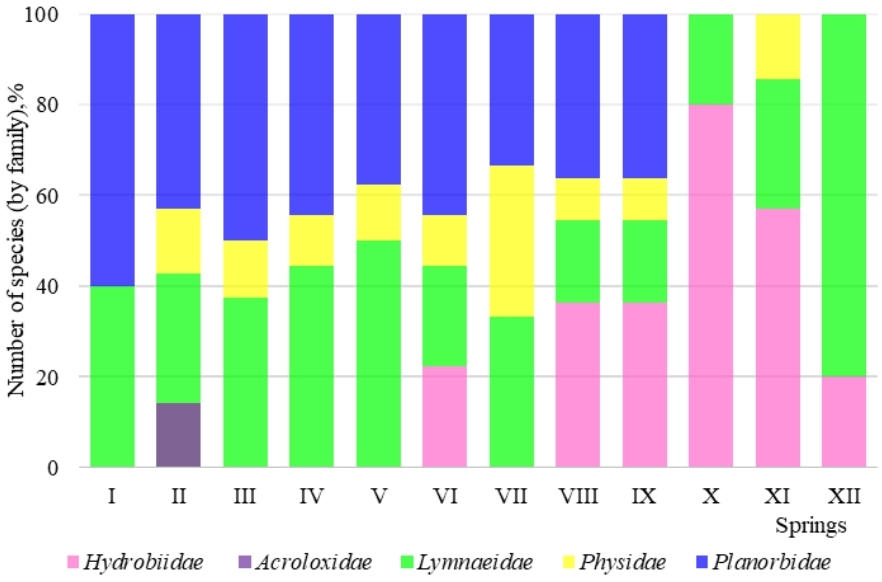


Diagram (1): Taxonomic structure of freshwater gastropods in the springs of Andijan region; (I) Uchbulak, (II) Kajnarbulak, (III) Tandirbulak, (IV) Kushmabulak, (V) Ajdinbulak, (VI) Fozilman ota bulak, (VII) Alchalik bulak, (VIII) Bibi Seshanba bulak, (IX) Kukbulak, (X) Shirmonbulak, (XI) Imam ota bulak, (XII) Shiraghanbulak.

The variation in density of mollusks in the studied springs can be attributed to the hydrochemical composition of water, aquatic plants, pH, temperature, minerals, and other

environmental factors. The amount of oxygen dissolved in water also affects the variation in the density of mollusks. For example, in Kokbulak, where the dissolved oxygen was 16.7 mg / l, the density of aquatic mollusks was 200-300 individuals per $1m^2$. While, the amount of dissolved oxygen in the Alchalik bulak was 7.7 mg / l, and the density was similarly low, that is 10-20 individuals / m^2.

Biodiversity of freshwater gastropods from springs of the Andijan region:

The malacofauna of the studied springs was 5 to 11 species (Tab. 2). There were 9-11 species of mollusks in the Bibi seshanba and Kokbulak springs. The share of dominant species in these springs is 17-19%, while the rest 2-12%. *G. acronicus* and *G. ladacensis* species were relatively rare and were characterized by a score of 2-3 on the plural ratio.

In Uchbulak, Kaynarbulak, Shirmonbulak, Imam ota bulak and Shiraghanbulak, the number of species is less than that of other springs and were 5-7. However, the percentage of dominant mollusk species among them was high, in particular, *R. auricularia* that accounted of about 53.3% in Uchbulak, *A. lacustris* in Kaynarbulak 31.1%, and *B. bucharica* in Shirmonbulak 37.2%. Dominant species are characterized by 4-5 points on the plural ratio. Among them is Kainarbulak, the only biotope of *A. lacustris*, which the only species similar to a hat mollusks of the malacofauna of the Fergana Valley (Pazilov and Umarov, 2020); this species usually lives only in ecologically clean unpolluted fresh water. Unlike springs in the cones of the lower reaches of the river, prosobranch gastropods were common in springs at the foot of the hills (Fozilman ota bulak, Bibi Seshanba bulak, Kukbulak) and foothill springs (Shirmonbulak, Imam ota bulak). For instance, in Shirmonbulak at the foot of the Chilustun mountains, *B. bucharica* was numerous and dominant; with a percentage of 37.2%.

Table (2): Species composition and abundance ratio of freshwater gastropods of springs of Andijan Region.

No.	Species	Springs								
		Uchbulak			Kajnarbulak			Tandirbulak		
		N, cop.	*Ia*, %	, *B* ball	*N*, cop.	*Ia*, %	*B*, ball	*N*, cop.	*Ia*, %	*B*, ball
1	*M. brevicula*	–	–	–	–	–	–	–	–	–
2	*M. hissarica*	–	–	–	–	–	–	–	–	–
3	*B. bucharica*	–	–	–	–	–	–	–	–	–
4	*S. pallida*	–	–	–	–	–	–	–	–	–
5	*A. lacustris*	–	–	–	50	31.1	4	–	–	–
6	*L. tengriana*	–	–	–	–	–	–	8	7.55	3
7	*L. bowelli*	–	–	–	–	–	–	12	11.32	3
8	*R. auricularia*	40	53.33	5	15	9.3	3	10	9.43	3
9	*A. lagotis*	12	16.0	3	22	13.7	3	–	–	–
10	*Ph. acuta*	–	–	–	35	21.7	4	17	16.04	3
11	*P. tangitarensis*	10	13.33	3	–	–	–	9	8.49	3
12	*P. planorbis*	–	–	–	15	9.3	3	28	26.42	4

13	*G. acronicus*	6	8.0	2	11	6.8	3	12	11.32	3
14	*G. ladacensis*	7	9.33	3	13	8.1	3	10	9.43	3
	General	75	100		161	100		106	100	
Number of species (S)		5			7			8		

Continuation of Table (2)

No.	Species	Springs								
		Kushmabulak			Ajdinbulak			Fozilman ota bulak		
		N, cop.	I_d, %	*B* ball,	*N*, cop.	I_d, %	*B*, ball	*N*, cop.	I_d, %	*B*, ball
1	*M. brevicula*	–	–	–	–	–	–	20	17.09	3
2	*M. hissarica*	–	–	–	–	–	–	–	–	–
3	*B. bucharica*	–	–	–	–	–	–	18	15.38	3
4	*S. pallida*	–	–	–	–	–	–	–	–	–
5	*A. lacustris*	–	–	–	–	–	–	–	–	–
6	*L. tengriana*	12	6.82	2	4	4.76	2	–	–	–
7	*L. bowelli*	14	7.95	2	6	7.14	2	–	–	–
8	*R. auricularia*	30	17.05	3	12	14.29	3	12	10.26	3
9	*A. lagotis*	18	10.23	3	8	9.52	3	21	17.95	3
10	*Ph. acuta*	10	5.68	2	6	7.14	2	14	11.97	3
11	*P. tangitarensis*	25	14.2	3	10	11.9	3	10	8.55	2
12	*P. planorbis*	30	17.05	3	–	–	–	8	6.84	2
13	*G. acronicus*	19	10.8	3	20	23.81	4	6	5.13	2
14	*G. ladacensis*	18	10.23	3	18	21.43	4	8	6.84	2
	General	176	100		84	100		117	100	
Number of species (S)		9			8			9		

Continuation of Table (2)

No.	Species	Springs								
		Alchalik bulak			Bibi Seshanba bulak			Kukbulak		
		N, cop.	I_d, %	*B* ball,	*N*, cop.	I_d, %	*B*, ball	*N*, cop.	I_d, %	*B*, ball
1	*M. brevicula*	–	–	–	12	7.55	2	10	4.81	2
2	*M. hissarica*	–	–	–	14	8.81	3	8	3.85	1
3	*B. bucharica*	–	–	–	16	10.06	3	12	5.77	2
4	*S. pallida*	–	–	–	10	6.29	2	11	5.29	2
5	*A. lacustris*	–	–	–	–	–	–	–	–	–
6	*L. tengriana*	–	–	–	–	–	–	–	–	–
7	*L. bowelli*	–	–	–	–	–	–	–	–	–
8	*R. auricularia*	–	–	–	10	6.29	2	38	18.27	3
9	*A. lagotis*	12	30	4	8	5.03	2	23	11.06	3
10	*Ph. acuta*	8	20	4	19	11.95	3	17	8.17	3
11	*P. tangitarensis*	–	–	–	22	13.84	3	35	16.83	3
12	*P. planorbis*	–	–	–	16	10.06	3	40	19.23	4
13	*G. acronicus*	20	50	5	14	8.81	3	8	3.85	1
14	*G. ladacensis*	–	–	–	18	11.32	3	6	2.88	1

	General	40	100		159	100		208	100	
Number of species (S)		3			11			11		

Continuation of Table (2)

No.	Species	Springs								
		Shirmonbulak			Imam ota bulak			Shiraghanbulak		
		N, cop.	I_d, %	*B* ball	*N*, cop.	I_d, %	*B*, ball	*N*, cop.	I_d, %	*B*, ball
1	*M. brevicula*	25	22.12	4	3	6.25	2	–	–	–
2	*M. hissarica*	28	24.78	4	4	8.33	2	–	–	–
3	*B. bucharica*	42	37.17	4	6	12.5	3	–	–	–
4	*S. pallida*	8	7.08	2	5	10.42	3	28	34.15	4
5	*A. lacustris*	–	–	–	–	–	–	–	–	–
6	*L. tengriana*	–	–	–	–	–	–	18	21.95	4
7	*L. bowelli*	–	–	–	–	–	–	14	17.07	3
8	*R. auricularia*	10	8.85	2	8	16.67	3	12	14.63	3
9	*A. lagotis*	–	–	–	10	20.83	4	10	12.2	3
10	*Ph. acuta*	–	–	–	12	25.0	4	–	–	–
11	*P. tangitarensis*	–	–	–	–	–	–	–	–	–
12	*P. planorbis*	–	–	–	–	–	–	–	–	–
13	*G. acronicus*	–	–	–	–	–	–	–	–	–
14	*G. ladacensis*	–	–	–	–	–	–	–	–	–
	General	113	100		48	100		82	100	
Number of species (S)		5			7			5		

[Note: N - number of collected mollusk individuals, cop.; I_d – percentage of collected mollusk individuals, %; *B* – plurality ratio on a 5-point logarithmic scale (Pesenko, 1982)].

The faunistic composition of mollusks of springs at the Andijan region was compared to each other for similarity and according to the results of cluster analysis, they were divided into three main groups (Diag. 2); the first group includes Uchbulak, Kajnarbulak and Tandirbulak, whose malacofauna is closely related (5-6 species). The second group includes Kushmabulak, Ajdinbulak and Fozilman ota bulak (8 species), and the third group includes Alchalik bulak, Imam ota bulak, Shiraghanbulak, Shirmonbulak and Kukbulak, in which the species composition of mollusks is similar (3-5 species).

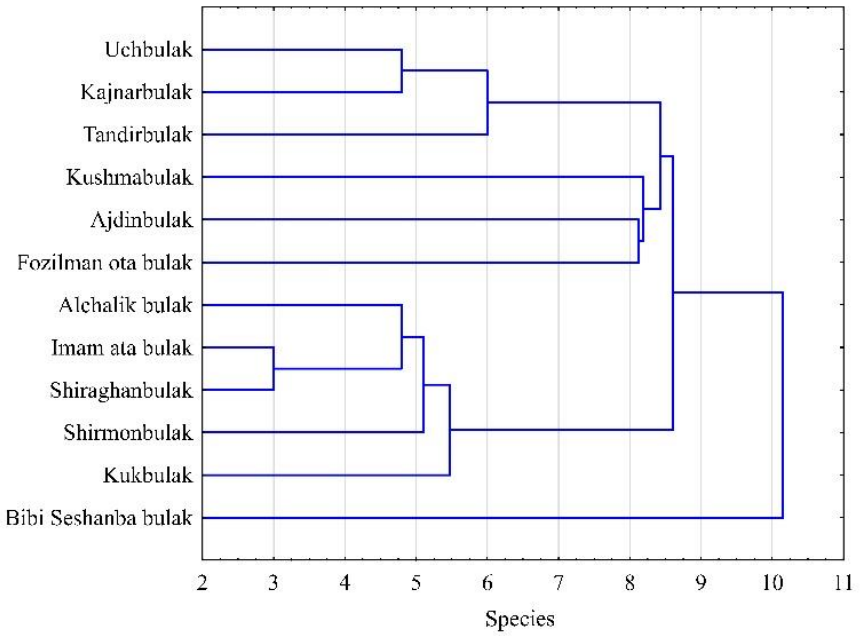


Diagram (2): Dendrogram of faunistic similarity of freshwater gastropods from the springs of the Andijan region.

The Diagram (2) shows that the fauna of the Bibi Seshanba bulak stands out. This is because all mollusk species except *A. lacustris, L. Tengriana* and *L. bowelli* are found in this spring. Such groupings are based on the similarities or differences of their biotopes and ecological environments. For instance, the ecological environment of Shirmanbulak and Imam ata bulak springs in the mountains included in the Alay ridge is similar. They also have little difference in the hydrochemical characteristics of the water. This similarity can also be observed in the species composition of mollusks. Both have *M. brevicula, M. hissarica, B. bucharica, S. pallida,* and *A. lacustris* species. There were 2 species that differ from each other, namely *A. lagotis* and *Ph. acuta* are present in the springs of Imam ota bulak, but are not found in Shirmonbulak.

According to the results of the present investigation, the biodiversity index of mollusks in the springs of Andijan region was determined; the high value was recorded in the Bibi Seshanba bulak (*H'*= 2.38), and the lowest - in the Alchalik bulak spring (*H'* = 1.03) (Diag. 3). Based on the differences in the biodiversity of mollusks in springs, it was observed that the hydrochemical properties of the spring depend on the aquatic vegetation cover and the degree of anthropogenic impact.

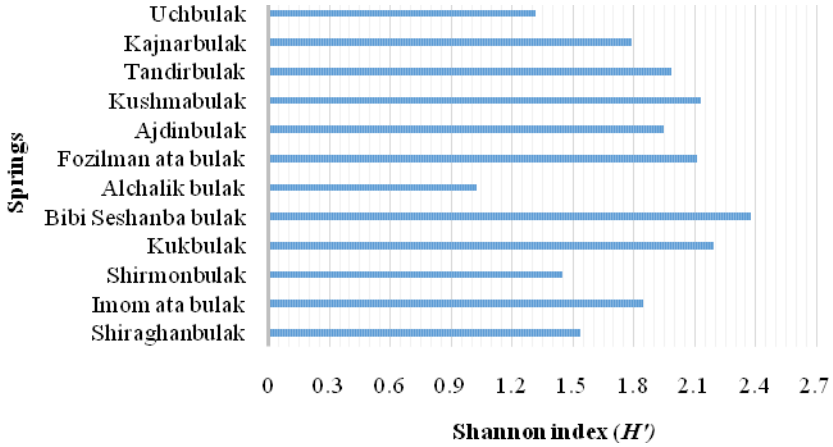


Diagram (3): Biodiversity of the Shannon index (H') of freshwater gastropods from the springs of the Andijan Region.

According to the Shannon index, the biodiversity index of mollusks in Uchbulak, Alchalik bulak, Shirmonbulak, and Shiraghanbulak is low ($H' < 1.5$) and the average in all other springs is $1.5 < H' > 2.5$. High levels ($2.5 < H'$) of biodiversity were not found in any of the springs. However, it was found that the general biodiversity index of freshwater gastropods in the studied springs was high ($H' = 2.53$).

Ecological groups of mollusks, distribution of species by biotope:

Mollusks can be divided into several ecological groups according to their distribution in different aquatic biotopes: crenophil (Izzatullayev, 2018), phytophil, pelophil and eurybiont (Leshko, 1998). It was observed that in the springs of Andijan region there were species of mollusks belonging to all the above ecological groups (Diag. 4).

According to habitat biotopes, some mollusks are only distributed in springs. Such mollusks are crenophilic organisms. In the present study, it was observed that *M. brevicula*, *M. hissarica*, *B. bucharica*, *S. pallida*, *L. tengriana*, and *L. bowelli* species live only in springs. The bottom of the springs, formed in the downstream cones of the river, was mainly muddy and sandy, which allowed the pelophilic mollusk species to live. Representatives of the genus *Lymnaea* are common in these springs. It was found that the main reason for the prevalence of mollusks in the littoral zones of springs, where water is collected and forms a pool, is the diversity of biotopes in this area and the abundance of high aquatic plants on the shores. Of all the mollusks we studied, *A. lacustris*, *Ph. acuta*, *P. tangitarensis*, *P. planorbis*, *G. acronicus*, and *G. ladacensis* were found to belong to the phytophilic ecological group.

Diagram (4): Ecological groups of freshwater gastropods are common in the springs of the Andijan Region.

The fauna of besides the hills and mountains springs are slightly different from each other; the springs Bibi Seshanba bulak and Kukbulak, which are part of the sources at the foot of the hills, have different aquatic biotopes, therefore, in nix, you can find mollusks belonging to all ecological groups. However, phytophilous mollusk species are less common due to the lack of high aquatic plants in mountain springs. During our studies, it was observed that although *R. auricularia* is a phytophilic, unlike other mollusks, it is known that it lives in all springs except Alchalik bulak spring.

Zoogeographic analysis of freshwater gastropods from the springs of the Andijan region:

According to the scheme of zoogeographic zoning of continental watersheds (Starobogatov, 1970) in the springs of the Andijan region, the species can be divided into the following zoogeographical zones: Central Asian – 57,1 %, European-Siberian – 21,4 %, Palaearctic – 14,3 % and Mediterranean – 7,1 % (Diag. 5). The most common Central Asian species of the studied springs are *M. Brevicula*, *M. hissarica*, *B. bucharica*, *S. pallida*, *L. tengriana*, *L. bowelli*, *P. tangitarensis*, and *G. ladacensis*, which are endemic to the regional malacofauna. From the European-Siberian species: *A. lacustris*, *A. Lagotis* and *P. planorbis*, and from the Palaearctic species: *R. auricularia*,and *G. Acronicus*; the proportion is relatively smaller. Of the Mediterranean species, only *Ph. acuta* has been found.

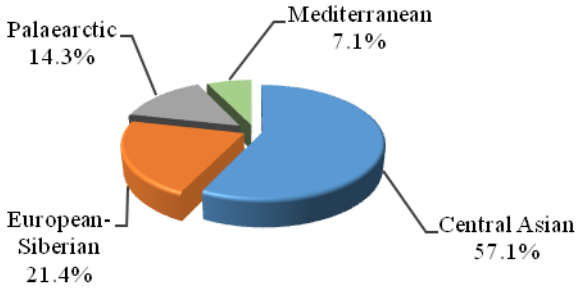


Diagram (5): Zoogeographic analysis of freshwater gastropods from the springs of the Andijan region.

CONCLUSIONS

According to the results of the study, 14 species of freshwater gastropods belonging to 2 subclasses, 5 families, and 10 genera were recorded in the springs of the Andijan region. 7 of them are endemic species and are distributed only in Central Asian watersheds. The fauna of mollusks is mainly of Central Asian, European-Siberian, Palearctic, and Mediterranean species. In most springs, the biodiversity of mollusks is moderate, however, it was observed to be higher than other water bodies in the study area. Mollusks are mainly distributed in the littoral zones of springs, and their survival in this zone was influenced by water-soluble oxygen, pH, temperature, and vegetation cover.

In recent years, as a result of the expansion of recreational use of Uchbulak, Fozilmon ota bulak, Bibi Seshanba bulak, Kokbulak, Shirmonbulak, and Imam ota bulak, there is a danger of extinction of rare and endemic hydrobionts. To preserve the biodiversity of springs in the Andijan region, it is advisable not to adversely affect their biotopes, and careful use of spring water.

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بيئة وتنوع بطنية الاقدام في ينابيع المياه العذبة لمنطقة أنديجان ، أوزبكستان

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الخلاصة

بحثت هذه الدراسة في تكوين الأنواع ، والتنوع البيولوجي ، والجغرافيا الحيوانية ، وبيئة بطنيات الأقدام في المياه العذبة في 12 ينبوعًا في منطقة أنديجان في أوزبكستان. استخدمت الدراسة أساليب ملاكولوجية وحيوانية وبيئية وتحليلية وإحصائية مقبولة بشكل عام. نتيجة للبحث في الينابيع ، سجل 14 نوعًا من بطنيات المياه العذبة تنتمي إلى 2 تحت صنف و 5 عائلات و 10 أجناس. 7 أنواع منها مستوطنة في وسط آسيا.

عند تحليل مؤشرات التنوع الحيوي للرخويات وفقًا لمؤشر شانون ، وجد أن أعلى قيمة سجلت في الينابيع بجانب التلال. وفقًا للنموذج الحيوي للتوزيع والسمات البيولوجية البيئية ، تم تقسيمها إلى عدة مجموعات هي cryophilic، phytophilic، pelophilic و eurybiontic؛ كما قسمت الرخويات الشائعة في الينابيع إلى 3 مجموعات حسب تشابه مجاميعها.

مساهمة الأنواع في وسط آسيا وأوروبا وسيبيريا في تكوين فونا النواعم لينابيع منطقة أنديجان كان كبيرا.