BULLETIN OF THE IRAQ NATURAL HISTORY MUSEUM
Iraq Natural History Research Center & Museum, University of Baghdad
https://jnhm.uobaghdad.edu.iq/index.php/BINHM/Home
 Online ISSN: 2311-9799-Print ISSN: 1017-8678

Bull. Iraq nat. Hist. Mus.
(2022) 17 (2): 229-250. https://doi.org/10.26842/binhm.7.2022.17.2.0229

ORIGINAL ARTICLE

ECOLOGY OF LEECHES AND GASTROPODS OF THE LOWER AK-BUURA RIVER, FERGANA VALLEY,UZBEKISTAN

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Received Date: 24 Aug. 2022, Accepted Date: 26 Oct. 2022, Published Date: 20 December 2022

ABSTRACT

This study was conducted on species composition, morphology, ecological characteristics, biotope distribution, ecological groups, biodiversity indicators and zoogeography of leeches and gastropods distributed in the lower Ak-Buura River. According to the results, it was found that 7 species of leeches belonging to 4 families and 6 genera and 10 species of fresh-water gastropods belonging to 3 families and 6 genera live in the lower Ak-Buura River. In the river, it was observed that leeches are mainly distributed in muddy biotopes, and gastropods are widespread in muddy, stony and sandy biotopes with a lot of plants. Biodiversity indices of leeches and gastropods in the Ak-Buura River were analyzed using the Shannon index. As a result, it was determined that the biodiversity index of the Ak-Buura river is lower than other rivers in the Fergana valley (H' = 0.81-1.17). This is mainly due to the eutrophication of some parts of the river and the instability of the water hydro-regime. Most of the leeches distributed in the river are carnivores, and gastropods are phytophages. According to the zoogeographical analysis, it was found that leeches are Holarctic, Palearctic, Western Palearctic, and gastropods are composed of European-Siberian, Palearctic and Central Asian species.

Keywords: Ak-Buura River, Biodiversity, Ecology, Gastropod, Leech, Uzbekistan.

INTRODUCTION

In water bodies, invertebrates have an enormous ecological role, they occupy the main positions in the food chain. If we see this as an example of Fergana Valley rivers, the most common hydrobionts among them are leeches and molluscs (Mukhamediev, 1969; Lukin, 1976; Umarov and Pazilov, 2020; Pazilov and Umarov, 2021a, b). Leeches and gastropods, being the main elements of biodiversity, are important in biocenoses. Most leeches are ectoparasites that feed on the blood of mammals, birds, amphibians and fish. Some leeches attack and feed on fresh-water gastropods in the hydroecosystem (Siddall *et al*., 2005). Gastropods are intermediate hosts of helminths (Giannelli *et al*., 2015). When the soft bodies of molluscs serve as food for other aquatic organisms, the calcium element accumulates in their shells (Suzuki and Nagasawa, 2013; Sudarshan and Akhila, 2021).

Over the past 50 years, the construction of large canals receiving water from the Ak-Buura River, changes the water regime, and the increased anthropogenic influence on the river have led to a change in the ecological environment of the water (Mamajanov and Aliev, 2022). Even a slight disturbance of the ecological environment does not leave its impact on living organisms (Dillon, 2000). For this reason, the study of hydrobionts of the Ak-Buura River from the faunistic and ecological points of view remains a difficult mission. Although many hydrobiological studies have been carried out in the reservoirs of the Fergana Valley (Zhadin, 1952; Mukhamediev, 1967, 1969; Izzatullaev, 2015), the ecology of leeches and gastropods of the Ak-Buura River has been barely studied. Faunal research for the river was carried out mainly during 1966-1970 (Mukhamediev, 1967, 1969; Omarov, 1973). Omarov (1973) studied the fauna of invertebrates in the Ak-Buura River and their patterns of distribution by altitude regions. In this river *Physa acuta* Draparnaud, 1805; *Radix lagotis* (Schrank, 1803); *Radix auricularia* (Linnaeus, 1758) species of gastropods and species of leeches belonging to the subclass Hirudinea were recorded. After 1970, studies on invertebrate fauna and ecology were not conducted in the Ak-Buura River.

Very little studies have been done on leeches in Uzbekistan; fresh-water gastropods research appears to be fragmented. These data do not give unambiguous conclusions about the leeches and gastropods of Uzbekistan. This study aimed to determine the faunal composition of leeches and gastropods distributed in the lower part of the Ak-Buura River and to study their ecological characteristics.

MATERIALS AND METHODS

Research area

Ak-buura is a river in the south-east of the Fergana Valley, its length is 148 km. This river begins at the confluence of Chal-Kuyruk and Sari-Koy rivers on the northern slope of the Little Alay ridge in Kyrgyzstan. These rivers are formed by the melting of snow and glaciers in the mountains. The river begins in Ak-Djilga Village of Kyrgyzstan and flows to Andijan region of Uzbekistan. Then it flows into the Shakhrikhansoy canal. The area of the water basin is 2540 km^2, average annual water consumption is 21.4 m^3/sec. The river has constant water, 16.6-17.7% of annual water flows in June and July. Most of the river water is used for the irrigation of agricultural crops (Mamajanov and Aliev, 2022).

According to Omarov (1973), studying Ak-Buura river was devided into five parts: glacial part, melted ice part, upper mountain stream section, middle flow part and lower part. Altitude compared to sea level was taken into account as it is the main factor in dividing the river into parts. The material was collected in May till July 2020 from the lower part of Ak-Buura River at 650-950 m above sea level (Map 1, Pl. 1).

Material selection and fixation

Materials were collected from the following coordinates: 40°34'52.7"N 72°45'16.6"E; 40°34'59.8"N 72°45'13.0"E; 40°35'09.6"N 72°45'05.4"E; 40°35'26.0"N 72°44'43.7"E; 40°35'43.8"N 72°44'16.4"E; 40°36'08.8"N 72°43'16.2"E; 40°36'30.5"N 72°42'06.4"E;

40°36'59.7"N 72°40'30.4"E. Generally accepted hydrobiological methods were used to collect leeches and gastropods (Zhadin, 1960; Lukin 1976, Kruglov, 2005; Izzatullaev, 2019).

The river temperature, flow rate, river depth, pH indicators and biotype were recorded. The total material was 600 leeches and more than 500 specimens of gastropods in 20 samples. Wild-caught leeches were first preserved in 10% ethanol and then fixed in 96% ethanol (Jovanović *et al*., 2021). Gastropods were first preserved in 45% ethanol, and after one day in 75% ethanol (Zhadin, 1960; Izzatullaev, 2018, 2019; Pazilov and Umarov, 2022).

Map (1): Research area: The lower Ak-Buura River. ★ – collection point for material.

Plate (1): Ak-Buura River, Khojaabad district, Republic of Uzbekistan (Photo by Farrukh U. Umarov).

Species identification and taxonomy

The leech samples were identified according to Nesemann and Neubert (1999), Lukin (1976), Govedich *et al*. (2019), while gastropods species were identified according to Starobogatov (2004), Kruglov (2005) and Izzatullaev (2018). Morphological characteristics such as body size, shape, surface, color, number and location of eyes and digestive organs of leeches were studied according to the methods of Lukin (1976) and Borda and Siddall (2004). Morphological characteristics of gastropod shells were analyzed according to the methods of Kruglov (2005) and Izzatullaev (2018). A ccording to Chiu *et al*. (2002), the standard indicators were used for the shell measurements: shell width (SW), shell height (SH) and aperture height (AH)

The taxonomies of Sawyer (1986), Tessler *et al*. (2018) and Izzatullaev (2018) were the basis for compiling the taxonomic list. International databases, GBIF Secretariat (2022) and MolluscaBase (2022) were used to write the latest accepted names of the species and determine their place in the families.

Defining biodiversity

The number of species, density of organisms (exam./m^2) and biodiversity index (*H'*) were used to characterize populations. Biodiversity index was determined by the Shannon (1948) 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* thespecies, 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.

Studies on leeches and gastropods were carried out using an MBS-9 stereomicroscope and an XPS-500E biological research microscope. Measurements were made on a digital Vernier calipers with 0.05 precision. Morphometric measurements of gastropod shells and leeches were performed using the statistical program "TIBCO Software Statistica 13.3".

RESULTS AND DISCUSSION

Species composition of leeches and gastropods

According to the results of the conducted research, it was found that 7 species of leeches belonging to the Glossiphoniidae, Piscicolidae, Hirudinidae, Erpobdellidae families and 10 species of gastropods belonging to the Lymnaeidae, Physidae and Planorbidae families live in the lower Ak-Buura River (Tab. 1).

Table (1): Faunal composition of leeches and gastropods of the Lower Ak-Buura River.

Family	Genus	Species
Annelida: Hirudinea		
Glossiphoniidae	*Alboglossiphonia* Lukin, 1976	*Alboglossiphonia hyalina* (Müller, 1774)
	Helobdella Blanchard, 1896	*Helobdella stagnalis* (Linnaeus, 1758)
Piscicolidae	*Piscicola* Blainville, 1818	*Piscicola geometra* (Linnaeus, 1761)
Hirudinidae	*Hirudo* Linnaeus, 1758	*Hirudo orientalis* Utevsky et Trontelj, 2005
	Haemopis Savigny, 1822	*Haemopis sanguisuga* (Linnaeus, 1758)
Erpobdellidae	*Erpobdella* Blainville, 1818	*Erpobdella octoculata* (Linnaeus, 1758)
		Erpobdella nigricollis (Brandes, 1900)
Mollusca: Gastropoda		
Lymnaeidae	*Lymnaea* Lamarck, 1799	*Lymnaea goupili* (A. Moquin-Tandon, 1856)
		Lymnaea subdisjuncta (G. Nevill, 1878)
		Lymnaea rectilabrum (Annandale et Prashad, 1919)
	Galba Schrank, 1803	*Galba truncatula* (O. F. Müller, 1774)
	Radix Montfort, 1810	*Radix auricularia* (Linnaeus, 1758)
		Radix bactriana (Hutton, 1849)
	Ampullaceana Servain, 1882	*Ampullaceana fontinalis* (Studer, 1820)
		Ampullaceana lagotis (Schrank, 1803)
Physidae	*Physella* Haldeman, 1842	*Physella acuta* (Draparuand., 1805)
Planorbidae	*Gyraulus* Studer, 1820	*Gyraulus acronicus* (J. B. Férussac, 1807)

Until now, the species composition of leeches and fresh-water gastropods of the lower Ak-Buura River had not been formed. However, Omarov (1973) mentioned that *Radix auricularia*, *Ampullaceana lagotis* and *Physella acuta* gastropods species and some leech species ccould be found in the river. However, the author did not specify which leech species were encountered.

Morphology and ecological characteristics of leeches

The results of research on the morphology and ecological characteristics of leeches of the lower Ak-Buura River are given below:

Family, Glossiphoniidae

Alboglossiphonia hyalina

A leech of small size; body length of adult 5-12 mm, width around 4-8 mm; body with a leaf-like shape at rest and edges toothed. Posterior sucker small; adheres very firmly to the substrate. Dorsal and ventral side almost yellowish-white (Pl. 2. A); although the dorsal surface appears to be smooth, there are many very small papillae; digestive organs can be seen with eye; crop caeca divided into 6 pairs. There are three pairs of eyes (Pl. 2. B), the front 1 pair is smaller, closer together. The next two pairs of eyes are larger, the distance between the eyes is larger and clearly visible (Solijonov and Izzatullaev, 2021).

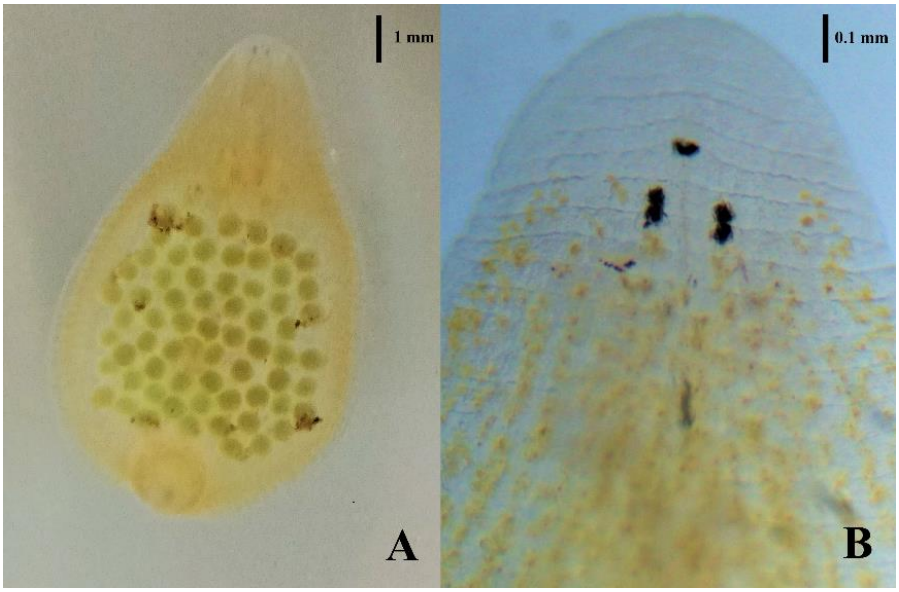

Plate (2): External morphology of the first recorded species of *Alboglossiphonia hyaline*; (A) Ventral side with cocoons, (B) Head part with three pairs of eyes. (Photo by Khayrulla Solijonov).

Thermophilic – warm water species. Flowing and almost stagnant aquatic environment live as benthos organisms; this species uses underwater rocks and other solid objects (bricks, under solid waste) as a substrate. *A. hyalina* participates in biotic relations with other species in the biocenosis in the form of "predator-prey". In particular, they attack and feed on small water gastropods such as *Galba truncatula*, *Physella acuta* and *Gyraulus acronicus*.

Helobdella stagnalis

Body length 12-16 mm; body width 2-3 mm, with an elongated oval shape; body edges with like saw teeth; dorsal side of body smooth (Pl. 3. A). Color of body yellowish-gray when stretched, green when shortened. The reason for this is the presence of dark green spots (dots) on the back surface of the body. *H. stagnalis* has a characteristic that distinguishes it from all Palearctic leeches. This is the presence of a posterior yellow chitinous scutum. The eyes are a

pair (Pl. 3. B); front part of body with snout for sucking hemolymph of invertebrates (Solijonov and Izzatullaev, 2021).

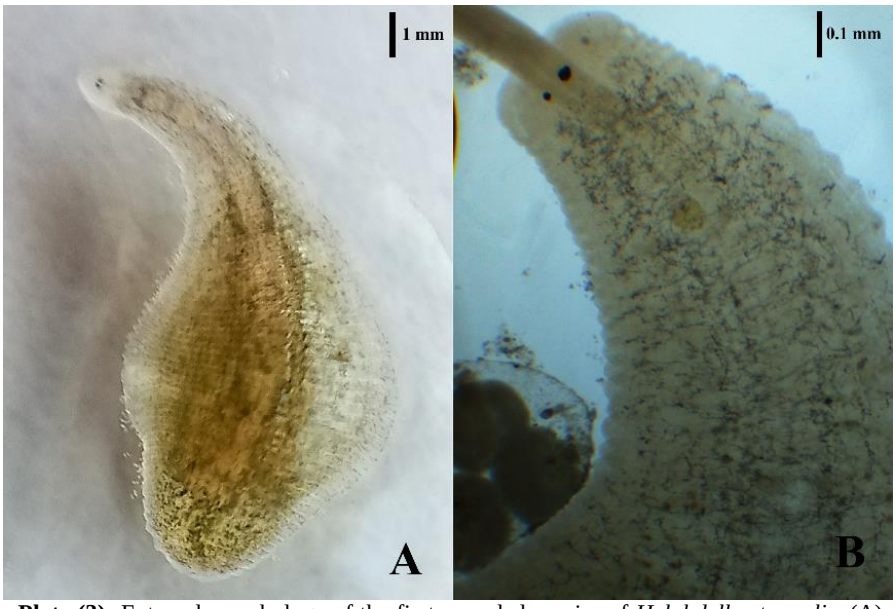

Plate (3): External morphology of the first recorded species of *Helobdella stagnalis*; (A) Dorsal side, (B) Head part with a pair of eyes. (Photo by Khayrulla Solijonov).

Cosmopolitan is an evribiont species. According to the results of the research, it was found that it is also widespread in organically polluted, eutrophicated water types (Kazanci *et al.*, 2015).This species, like most glosphonids, avoids light; mainly use stone, brick, solid waste, especially waste products containing polyethylene as a substrate. *H. stagnalis* feeds as a predator in the aquatic ecosystem, usually attacking the species of fresh-water gastropods: *Lymnaea stagnalis*, *L. subdisjuncta*, *Radix auricularia*, *Galba truncatula*, *Physella acuta*, *Gyraulus acronicus.*

Family, Piscicolidae

Piscicola geometra

Body length 18-24 mm, width 1-3 mm, and thin shaped; anterior sucker with disc-shaped, colored in the form of a plus (+),posterior sucker big; sucker with up to 14 radial lines of light color. This helps to adhere firmly to the substrate or host. Body color yellow, however the body color looks dark due to the presence of small spots of dark brown-black color, also with light-colored spots on back, which form 17-19 stripes (Pl. 4. A). Eyes have two pairs (Pl. 4. B), the front one pair larger, long linear in shape, back has two pair which smaller (Solijonov and Izzatullaev, 2021).

Plate (4): External morphology of the first recorded species of *Piscicola geometra*; (A) Lateral side, (B) Head part with two pairs of eyes. (Photo by Khayrulla Solijonov).

An oxyphilic species. That is, a species that lives in waters with a lot of oxygen gas. During the study, *Schizothorax intermedius* McClelland, 1842 was found in the body of the fish. Usually, this is an ectoparasite predominantly of cyprinids. The species uses underwater plants (*Myriophyllum verticillatum* L., *Typha latifolia* L., *Nasturtium officinale* R. Br., *Fissidens grandifrons* Brid.) and sometimes rocks as a substrate.

Family, Hirudinidae

Hirudo orientalis

This species was recorded for the first time by the authors from the region of Fergana Valley, It a large-sized leech that very similar in appearance to *H. Medicinalis*; average length of body about 80-130 mm, width around 8-14 mm; eyes with 5 pairs, crescent-shaped on front of body (Solijonov and Izzatullaev, 2021). body shape worm-shaped, back blistered and front flattened. Edges of body smooth; back sucker with medium size; body greenish-dark olive dorsally, with 4 rows of orange stripes running from head to anal (Pl. 5. A). They consist of a paramedial and paramarginal row, as in *H. medicinalis.* However, paramedial row without have small oval-shaped black spots, while paramarginal row has a large circular shape separated from each other. Body edges yellow. Ventral side dark green-elliptical, with large dark spots, which they densely located that made of abdominal side appear in black color (Pl. 5. B). Inside the anterior sucker, mouth similar to that of *H. medicinalis*, with 71-91 teeth on each of jaws (Kovalenko and Utevsky, 2015). Reproduction takes place through the cocoons. Puts them on beach soils or algae above water level.

Plate (5): External morphology of the first recorded species of *Hirudo orientalis*; (A) Dorsal side, (B) Ventral side. (Photo by Khayrulla Solijonov).

H. orientalis is thermophilic species. It can survive in the range of 7-43°C. The optimum temperature for it is 22-27°C. Leech samples were collected from waters with a temperature of 16-20°C. Studies have shown that leeches are found in pools where the surface of the water is warm and the bottom becomes cooler. This species is ectoparasite, blood-sucking on invertebrates: frogs, cattle, sheep and people. These leeches are used in medicine.

Haemopis sanguisuga

A large species leech; length 90-110 mm, width 10-15 mm. body worm-like shaped, front part thinner. Body surface smooth and soft. color black or brownish-black; ventral light, mostly gray; most have full or incomplete black wavy striped patterns on back surface. Posterior sucker small; mouth found inside the front sucker, which has 3 jaws. They have a total of about 50-60 blunt teeth that slightly sharp (Kovalenko and Utevsky, 2015); and having 5 pairs of eyes. genital orifice (anus) large, male organ very long, reaching 10-20 mm. Reproduction, like medical leeches, places oval cocoons between the soil and grass on the shore. However, the cocoons are smaller than those of medical leeches (10-15 mm), the top coating is not dense and there is no color whitish (Solijonov and Izzatullaev, 2021).

Amphibiont belongs to the ecological group and lives mainly in the coastal areas of slow-flowing or stagnant water bodies. They hide clay layer pores, stones and solid waste. In

addition to laying cocoons on land, it also comes out for food. It usually swallows small hairy worms and also attacks gastropods such as *Oxyloma elegans* (Shikov, 2011). This species is resistant to various environmental factors and survive in eutrophication processes.

Family, Erpobdellidae

Erpobdella octoculata

Body of this leech with medium-sized, 30-60 mm long and 3-9 mm wide; body flattened, worm-shaped with surface almost smooth; edges smooth;dorsal black, greenish-black, brownish-black, with white-yellow stripes along the transverse row. There are a large number of yellow spots parallel to the lines, abdomen with same color, gray, without spots. rear suckers with medium size, and having 4 pairs eyes and usually round in shape. Sticks the cocoons firmly to the substrate. They are transparent-yellow, brown in color, oval-shaped, 4-8 mm in size (Solijonov and Izzatullaev, 2021). It mainly lives in constantly flowing water bodies, clinging to rocks, solid waste and other various underwater substrates. It participates in biotic relations in the hydroecosystem as a "predator-prey" and feeds on aquatic larvae of insects, small crustaceans, and small hairy worms (Lukin, 1976). It is especially important in the natural management of mosquito populations.

Erpobdella nigricollis

Body of the species with a small and medium-sized, 15-25 mm long, 2-4 mm wide; with flattened shape body of a leech, front of which is cylindrical; smoothly surface, edges of body also smooth. Body color brownish-green, but due to the thinness of the tissues covering the skin, head nerve node and abdominal nerve chain visible. Back sucker medium size. There are 4 pairs of eyes, you can easily see them, analyze their location. cocoons transparent-yellow, small brown, oval in shape, and adhere firmly to the dried leaves and other substrate in water. They differ from other herpobdelids by their small size and small number of eggs (3-5). Propagation processes take place from April to September (Lukin, 1976). Biotopes are springs with constant or almost no flow. This species hides under stones, solid waste and other substrates. The feeding habits are similar to those of *Erpobdella octoculata*.

Shell morphology and ecological characteristics of gastropods

The results of research on shell morphology and ecological characteristics of the lower Ak-Buura River gastropods are given below:

Family, Lymnaeidae

Lymnaea goupili

Shell dimensions: SH 9.6 ± 0.36 mm; SW 5 ± 0.32 mm; AH 4.6 ± 0.51 mm. Shell small with oval shape, thick-walled, horn-colored; convex whorls number 5 to 6; suture between whorls deep; aperture narrow, oval, with an impenetrable rim on upper side; the edges of the aperture are sharp, not twisted. The species mainly lives in biotopes close to the shore of the river. The species could be found in drying mud and increases in number in May to June. The total life cycle is 1 year.

Lymnaea subdisjuncta

Shell dimensions: SH 18 ± 0.91 mm; SW 11 ± 0.56 mm; AH 12 ± 0.38 mm; medium in size and oval shaped, thin-walled, pale-horn colored and having 5-6 whorls. This species distinguish from other gastropods by the height of the whorls. Among the river's vegetation thickets and muddy biotopes live. It is also found in agricultural ditches. This species can also live in a slightly brackish water environment (Izzatullaev, 2018). The number of this species increases in May – June. Life expectancy is more than 1.5 years. This species was observed to co-occur more with *Radix auricularia* and *R. bactriana.*

Lymnaea rectilabrum

Shell dimensions: SH 10.6 ± 0.52 mm, SW 6.2 ± 0.34 mm, AH 6.7 ± 0.27 mm. shell dome shaped and distinguished by sharpness compared to other species that belong to the same genus. shell with yellowish-horn color, and having 3-3.5 whorls. It lives among the plants that grow in the flowing and stagnant areas of the river. They reproduction in April-June. Lives for more than 1.5 years.

Galba truncatula

Shell dimensions: SH 6.5 ± 0.32 mm; SW 3.3 ± 0.21 mm; AH 3.1 ± 0.18 mm, with dome shell that high-peaked and horn-like in color; having 5 whorls; aperture oval in shape. This species lives mainly in dry, small springs and mud. It is more common on the banks of the river. Increases in March-June. It usually lives for 1 year. Densely populated. According to Gorokhov (1978), this species is well adapted to the new area.

Radix auricularia

Shell dimensions: SH 22 ± 0.72 mm; SW 18 ± 0.44 mm; AH 16 ± 0.48 mm. shell large, ear-shaped, and having 4 whorls with unevenly rotated; last whorl is very wide and it covers the umbillicus; sutures shallow; dome low but sharp. It is a phytophilous species, living among algae and sand-mud in slow-flowing parts of the river. It is usually rare in the fast-flowing part of the river. They reproduction in March-June. Lives 1.5-2 years (Kruglov, 2005). In our research, it was revealed that the artificial increase and decrease of river water in spring and summer (4-5 times a week) is the cause of many deaths of *R. auricularia.* This species was identified by us for the first time in the Ak-Buura River. In our research, it was found that the shape of the mollusk shell has changed compared to the information presented in the literature, that is, it has become slightly spherical. The reason for such a change was the expansion of the shell aperture under strong waves. As a result, it became spherical (Andreyeva *et al*., 2010).

Radix bactriana

Shell dimensions, SH 18.5 ± 0.61 mm; SW 14.2 ± 0.66 mm; AH 15 ± 0.31 mm; shell similar in shape to that of *R. auricularia*. Last whorl of shell large and wide; with 4 whorls. This species is common in river biotopes rich in plants. It also lives in the pond waters near the river. They reproduction in August; the total period of stay is 2 years. This species has been found to live in both warm and brackish waters (Izzatullaev, 2018).

Ampullaceana fontinalis

Shell dimensions: SH 18.2 ± 0.55 mm; SW 16±0.11 mm; AH 14.1 ± 0.85 mm; shell variable in shape, with whorl relatively low and, yellow; body has 4 whorls; aperture wide oval shape. They reproduction in June. It lives by clinging to vegetation, rocks and other hard substrates in the river. They can also be found in ponds with a relatively high temperature near the river. The total life expectancy is 1.5 years.

Ampullaceana lagotis

Shell dimensions: SH 12 ± 0.78 mm; SW 7.5 ± 0.57 mm; AH 8 ± 0.22 mm. shell medium in size, ovoid and thick-walled. shell elongate, its body whorl is ½ times smaller than height of aperture, with 4 whorls. Aperture oval shaped, edges slightly curved. Phytophilic and telmatophilic species. They reproduction in May-August. It is found in permanent and non-permanent water bodies. It is known to live at a depth of 2-3 m. Shells of this species can be variable in water bodies with different environmental conditions (Gorokhov, 1978). It was observed that it is more common in the stagnant waters of the Ak-Buura River. It turned out that young individuals of the species live mainly in mudflats near the coast. The total period of residence is not more than 1.5 years.

Family: Physidae

Physella acuta

Shell dimensions: SH 11.5 ± 0.56 mm; SW 8.4 ± 0.46 mm; AH 8.6 ± 0.51 mm. Shell twisted to left, walls thick, long oval in shape; tip of shell sharp; aperture wide; with 5 whorls. This gastropod breeds in April-May.

A phytophilous and evribiont species. Lives in both fast and slow flowing parts of the river. It is usually more common on the banks and among the vegetation in the swamps. It is active from the beginning of March to the end of November, and breeds in April-May. Life expectancy is 2-3 years (Izzatullaev, 2018). During our research, some areas of the lower Ak-Buura River were eutrophicated. That is, cases of excessive reproduction of plankton and algae in the water ecosystem were found. This situation leads to a decrease in oxygen in the water and has a negative effect on organisms. The artificial origin of eutrophication is caused by the discharge of sewage, many nutrients and other waste water into natural water bodies (Pazilov and Umarov, 2021a). Local residents say that this situation may be caused by the discharge of waste water from the Osh (a city in the Kyrgyz Republic) water treatment plant into the river. *Ph. acuta* is the dominant gastropods species in the river because it is resistant to eutrophication and multigenerational (Wethington and Dillon, 1993; Laenko, 2012). The average density of the *Ph. acuta* population in the Ak-Buura River is 280 ex./m^2.

Family, Planorbidae

Gyraulus acronicus

Shell dimensions: SH 1.5 ± 0.14 mm; SW 5 ± 0.23 mm; AH 1.5 ± 0.11 mm; shell clearly distinguished by its small size and shape; last whorl 2.7 times wider than previous one. color of the shell is horn-like. A phytophile-evrybiont species. It lives in the river and nearby canals, ditches, ponds and ponds, in underwater vegetation, on stones at the edge of the banks.

This species prefers slow-flowing and calcium-rich water bodies (Killeen and McFarland, 2004). During our research, it was observed that *G. acronicus* was abundantly distributed in the parts of the river where the water is constantly changing and the flow speed is 0.1 m/s on average.

Distribution and ecological groups of leeches and gastropods by biotopes:

Distribution of leeches and gastropods in the river by biotopes depends on their morpho-anatomical structure, physiological capabilities, nutrition, reproduction stages. In particular, molluscs with large (*R. auricularia*) and relatively small (*G. acronicus*) shells are widely distributed in the slow-flowing parts of the river, while medium-sized species (*Ph. acuta*) are adapted to live in fast-flowing biotopes. Leeches sticking their cocoons to the substrate (*E. octoculata*, *E. nigricollis*) are found in fast-flowing water biotopes. However, some species (*H. orientalis* and *H. sanguisuga*) are common in slow-flowing or stagnant biotopes and reproduce by placing their cocoons under the soil.

As a result of our research, the Ak-Buura River was divided into biotopes according to underwater rocks (Filippenko, 2012), which was found that leeches and gastropods live in five different biotopes: sandy-loam (B1), silt (B2), silt-clay (B3), stony (B4) and sandy (B5). Differences in number and density of leeches and gastropods are observed in biotopes (Tab. 2). The uneven distribution of species in biotopes was influenced by their lifestyle and adaptability to environmental factors.

Table (2): Ecological indicators of leeches and gastropods in different biotopes in the lower Ak-Buura River.

№	Species	Widespread biotope*	Density, ex/m^2	Ecological group
	Annelida: Hirudinea			
1.	*Alboglossiphonia hyalina*	B2, B4	24±5.5	phytophile
2.	*Helobdella stagnalis*	B1, B4	230±24.2	lithophile
3.	*Piscicola geometra*	B2	0.4±0.1	phytophile
4.	*Hirudo orientalis*	B2, B3	0.3±0.1	pelophile
5.	*Haemopis sanguisuga*	B2, B3	8±3.3	pelophile
6.	*Erpobdella octoculata*	B4	10±4.8	lithophile
7.	*E. nigricollis*	B4	9±2.7	lithophile
	Mollusca: Gastropoda			
1.	*Lymnaea goupili*	B2	5±1.5	madicol
2.	*L. subdisjuncta*	B2, B3, B1	6±2.5	pelolimnophile
3.	*L. rectilabrum*	B4, B5	4±2.0	phytophile
4.	*Galba truncatula*	B1, B2	51±10.1	madicol
5.	*Radix auricularia*	B1, B2	3±1.4	phytophile
6.	*R. bactriana*	B2, B3	3±1.6	phytophile
7.	*Ampullaceana fontinalis*	B1, B2, B4	5±2.1	phytophile
8.	*A. lagotis*	B1, B5	4±3.1	eurybiont

9.	*Physella acuta*	B1, B2, B3, B4	280±26.3	eurybiont
10.	*Gyraulus acronicus*	B4, B2	35±8,6	phytophile

* – *abbreviations are given in the text.*

The analysis revealed that muddy (B2) biotope is very favorable for leeches of Glossiphoniidae and Hirudinidae families. Piscicolidae, Erpobdellidae family leeches are common in stony (B4) biotopes. *H. stagnalis* was recorded as the dominant species in the river (Diag. 1). Among the gastropods, *R. auricularia* lives in sandy-muddy, *L. subdisjuncta* muddy places, and *A. lagotis* species can be found in slow-flowing, vegetated parts of the river. It was found that representatives of the Lymnaeidae family live in relatively small numbers in the fast-flowing parts of the river. It was observed that *Ph. acuta* species from the Physidae family mainly live in rocky biotopes and are dominant among gastropods distributed in the river (Diag. 2). *G. acronicus* from the Planorbidae family can be found more often among the vegetation of the river near the shore, with mud and mud.

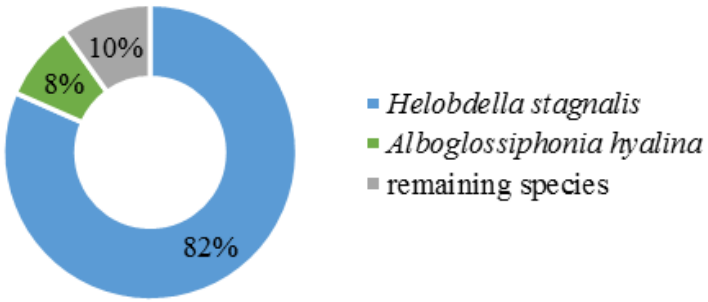

Diagram (1): Distribution coefficient of leeches in the lower Ak-Buura River.

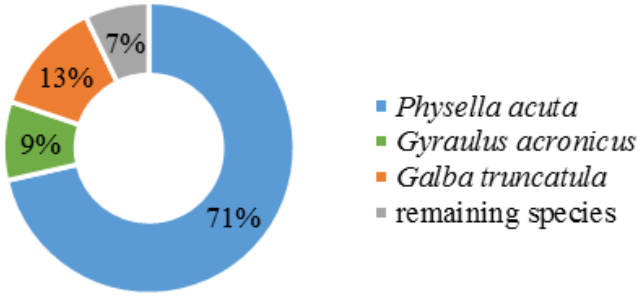

Diagram (2): Distribution coefficient of gastropods in the lower Ak-Buura River.

Biodiversity indicators of leeches and gastropods:

Biodiversity of leeches and gastropods of the lower Ak-Buura River was analyzed according to the Shannon index. Indicators were found to be equal to H' = 0.81 for leeches and H' =1.17 for gastropods. This indicator can be considered low. Due to the process of eutrophication in the river, the population of *Ph. acuta* (71%) is widespread, and *H. stagnalis*

(82%) is found accordingly. All other leeches and gastropods make up 1/3 of the total species. This situation has led to a low biodiversity index.

Feeding of leeches and gastropods

According to their diet, leeches are divided into 3 groups: carnivorous, blood-sucking and liquid-sucking groups (Sawyer, 1986; Lynggaard *et al*., 2022). The leeches we studied also belong to the above groups. *H. sanguisuga, E. octoculata and E. nigricollis* are carnivorous, attacking larval, less hairy worms and swallowing them whole. Blood-sucking feeders include *P. geometra* and *H. orientalis*, the first of which is mainly ectoparasitic on fish, while the second feeds on the blood of amphibians and warm-blooded animals. *H. orientalis* clings to livestock that come to water bodies to drink water or graze and suck blood from their bodies. *A. hyalina* and *H. stagnalis* leeches attach to gastropods and feed by sucking the hemolymph fluid of their bodies.

All identified gastropod species mainly belong to phytophagous trophic group. Among fresh-water gastropods, there are almost no highly specialized species in terms of nutrition (Tsikhon-Lukanina, 1987). Most of the gastropods in the Ak-Buura River can be included in the group of phytophages, because they feed mainly on algae and high plant residues. Members of the Lymnaeidae family feed on higher plants (50%), blue-green algae (17%), ferns (8%), detritus (8%), diatoms (8%) and bacteria (8%) (Tsikhon-Lukanina, 1987). While *Ph. acuta* feeds on some higher plant debris, it has been observed that its main diet is blue-green algae. *G.acronicus* was found to feed on dead remains of flowering plants and diatom algae.

Zoogeography of leeches and gastropods

Zoogeographic data of leeches of the Ak-Buura River (Lukin, 1976; Sket and Trontelj, 2008; Saglam *et al.*, 2016; Darabi-Darestani *et al.*, 2016; Baturina *et al.*, 2020; Fedorova and Kaygorodova, 2022) were analyzed. Most of the species identified from the research area (*H. sanguisuga, E. octoculata, E. nigricollis*) are Palearctic – 57%. However, *P. geometra, A. hyalina* and *H. stagnalis* Holarctic – 28%, while *H. orientalis* is distributed in Western Palearctic: Caucasus, Iran, Uzbekistan, Kazakhstan – 15% (Diag. 3).

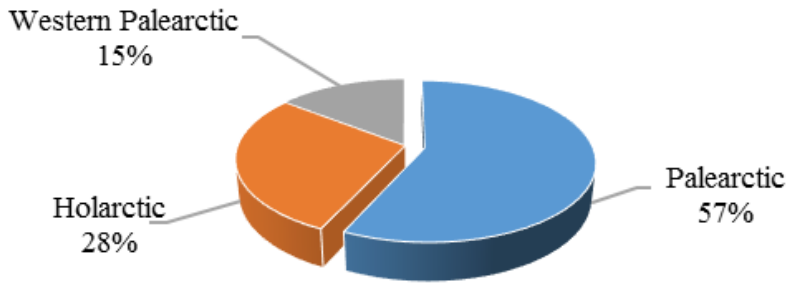

Diagram (3): Zoogeographic distribution of leeches in the lower Ak-Buura River.

According to Starobogatov (1970) scheme of zoogeographical zoning of terrestrial water bodies, species of gastropods of the Ak-Buura River can be divided into the following groups (Diag. 4): European-Siberian – 30 %, Palearctic – 20 %, Central Asian – 20 %. West-South European – 10 %, Anterior-Central Asian – 10 %, Mediterranean – 10 %.

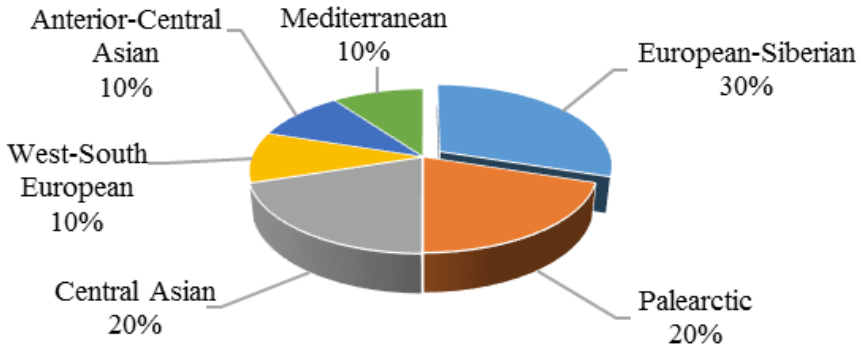

Diagram (4): Zoogeographic distribution of gastropods in the lower Ak-Buura River.

According to the diagram, only 20% of the gastropods of the Ak-Buura River are unique to the region, and the remaining gastropods come from other regions.

CONCLUSIONS

In conclusion, it can be said that 7 species of leeches and 10 species of fresh-water gastropods are currently distributed in the Lower Ak-Buura River. Among the identified leeches, *Alboglossiphonia hyalina*, *Helobdella stagnalis*, *Haemopis sanguisuga*, *Erpobdella octoculata* and *Erpobdella nigricollis* leech species participate in biotic relationships in the form of predator-prey in the hydroecosystem. Among the leeches, *Piscicola geometra* is a fish parasite. By studying the population and distribution areas of these ichthyoparasites, it is possible to prevent the spread of diseases in fish farms. *Hirudo orientalis* is an ectoparasite of livestock. However, local people use this species in hirudotherapy.

Freshwater gastropods are bioindicators of water purity. In particular, *Physella acuta* and *Galba truncatula* species are common in eutrophicated areas. As a result of the increase in the number of these species in the Ak-Buura River, the diversity of other hydrobionts has decreased.

In the lower reaches of the river compared to the upper reaches, the slow flow of water and the abundance of nutrients caused the diversity of leeches and gastropods. According to the underwater rocks of the Ak-Buura River, leeches and gastropods live in sandy-mud, mud, mud-swamps, stony and sandy biotopes. According to analytical data, leeches are mainly found in muddy biotopes and gastropods are widespread in muddy, stony and sandy biotopes rich in vegetation. Leeches belonging to the lithophile (43 %) ecological group and mollusks belonging to the phytophile (50 %) ecological group are mainly distributed in the lower Ak-Buura River. In the river, the biodiversity index of leeches is equal to H' = 0.81 and the

biodiversity of gastropods is equal to $H' = 1.17$, which is low compared to other rivers of the valley. Due to the eutrophication of some parts of the river, the population of *Ph. acuta* is widespread and, accordingly, *H. stagnalis* is abundant. It is important to reduce the pollution of the river and ensure its stability in preserving the species of leeches and gastropods present in the lower Ak-Buura River.

CONFLICT OF INTEREST STATEMENT

We declare that there is no conflict of interest between the authors. We confirm that all the pictures in the manuscript belong to us, and note in this study that there is no conflict of interest regarding the use of the laboratory of Andijan State University.

ACKNOWLEDGMENTS

We are grateful to our scientific supervisors Prof. Dr. Z. Izzatullaev of Samarkand State University and Prof. Dr. A. Pazilov of Gulistan State University for their scientific advice.

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BULLETIN OF THE IRAQ NATURAL HISTORY MUSEUM

Ecology of leeches and gastropods

Bull. Iraq nat. Hist. Mus.
(2022) 17 (2): 229-250.

بيئة العلق و بطنية الاقدام في نهر أك-بورا السفلي ، وادي فيرجانا، أوزبكستان

خير الله سوليجونوف وفاروخ عمروف

جامعة أنديجان الحكومية ، مدينة أنديجان ، جمهورية أوزبكستان.

تأريخ الاستلام: 2022/8/24، تأريخ القبول: 2022/10/26، تأريخ النشر: 2022/12/20

الخلاصة

أجريت هذه الدراسة على تكوين الأنواع، والتشكل، والخصائص البيئية، و توزيع الكائنات الحية، والمجموعات البيئية، ومؤشرات التنوع البيولوجي والجغرافيا الحيوانية للعلقات وبطنيات الأرجل الموزعة في نهر أك بورا السفلي. وفقًا للنتائج، وجد أن 7 أنواع من العلقات تنتمي إلى 4 عائلات و 6 أجناس و 10 أنواع من بطنيات المياه العذبة تنتمي إلى 3 عائلات و 6 أجناس تعيش في نهر Ak-Buuraالسفلي. في النهر، لوحظ أن العلقات تتوزع بشكل أساسي في البيئات الموحلة، وتنتشر بطنيات الأقدام في البيئات الموحلة والحجرية والرملية التي بها الكثير من النباتات. تم تحليل مؤشرات التنوع البيولوجي للعلقات وبطنيات الأرجل في نهر Ak-Buura بأستخدام مؤشر Shannon نتيجة لذلك، تم تحديد أن مؤشر التنوع البيولوجي لنهر Ak-Buura أقل من الأنهار الأخرى في وادي فرغانة (H '= 0.81-1.17)؛ يرجع ذلك أساسًا إلى إغناء بعض أجزاء النهر بالمغذيات وعدم استقرار النظام المائي. معظم العلق الموزعة في النهر من الحيوانات آكلة اللحوم، وبطنيات الأرجل هي نباتات نباتية. وفقًا لتحليل علم الحيوان الجغرافي، وجد أن العلقات في مناطق Holarctic ، Palearctic، Western Palearctic، وتتكون بطنيات الأقدام من أنواع أوروبية- سيبيريا ، المنطقة القطبية القديمة و وسط آسيا.