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# ON THE STUDY OF FAUNA (MACROINVERTEBRATES, FISH, AMPHIBIANS, REPTILES, BIRDS AND MAMMALS) OF THE LOWER COURSE OF SHOKHDARA RIVER VALLEY IN PAMIR, MOUNTAIN BODAKHSHAN, TAJIKISTAN

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**On the Study of Fauna (Macroinvertebrates, Fish, Amphibians, Reptiles, Birds and Mammals) of the Lower Course of Shokhdara River Valley in Pamir, Mountain Bodakhshan, Tajikistan. Afanasyev, S. A., Marushchak, O. Yu., Lietytska, O. M., Abdulnazarov, A., Golub, O. O., Domashevsky, S. V. & Gavris, G. G.** — This paper contains information on the records of bottom macroinvertebrates, fish, amphibians, reptiles, birds and mammals collected during a field expedition in the valley of the Shokhdara River (in the vicinity of Khorog) near its mouth and confluence with the Panj River in autumn 2019–spring 2020. As a result of the study, 3 species of fish (Actinopterigii Cyprinidae — 2, Nemacheilidae — 1 were found in the Shokhdara River and 1 additional species was confirmed by local people. Five species of reptiles (Squamata, Colubridae — 2, Viperidae — 1, Agamidae — 1, Gekkonidae — 1) and 1 species of amphibians (Anura, Bufonidae — 1) were recorded. Twenty-four taxa of aquatic macroinvertebrates were recorded (89.7 % — Insecta): Simuliidae — 35.8 %, Ephemeroptera — 18.7 %, Chironomidae — 18 %, Trichoptera — 10.5 %, Oligochaeta — 6.5 %, Plecoptera — 2.8 %, Diptera — 2.5 %, Gastropoda — 2.5 %.

Nematoda, Turbellaria, Ostracoda, Copepoda, *Cyclops* spp., *Sphaerium* spp., Araneida, Acarina, Odonata, Heteroptera, Coleoptera, Neuroptera, Lepidoptera and Megaloptera represented only 2.7 % of the collected specimens of bottom invertebrates. Ninety-nine bird species (48 % of the avifauna of the study area) were recorded during the autumn/spring surveys. Among mammals, rare and internationally protected species such as Asian otter, snow leopard and Himalayan brown bear were confirmed to inhabit the areas adjacent to the surveyed river valley.
Key words: Tajikistan, Pamir, Shokhdara River valley, bottom macroinvertebrates, fish, herpetofauna, avifauna, teriofauna, mountain rivers.

**Introduction**

Animal groups such as aquatic macroinvertebrates, fish, reptiles and amphibians are highly vulnerable to habitat loss, pollution and anthropogenic modification due to their heavy dependence on water resources. Due to their relatively low mobility (lack of long-distance migration), these animal groups are particularly sensitive to the quantity and quality of water sources. Some populations may even become extinct before scientists have a chance to discover them. Ecosystems in mountainous regions and valleys are the most vulnerable and the best preserved. Yet they remain poorly understood (Afanasyev et al., 2013).

Global climate processes and increasing anthropogenic activities, including mining, recreation and human economic activities, have a significant impact on these watercourses, as noted in a number of studies in recent decades (Afanasyev, 2003; Afanasyev et al., 2014; Afanasyev et al., 2020; Marushchak et al., 2022). It is therefore crucial to collect as much data as possible from these areas to track and monitor biodiversity both locally and globally (Vasyliuk et al., 2022; Nekrasova & Marushchak, 2023; Nekrasova et al., 2021).

Regions that are difficult to reach due to their geographical location, especially those under intense anthropogenic pressure, pose a significant threat to native biodiversity (Milius, 2010; Keil et al., 2015; Bjorkland & Bjorkland, 2021). Some of these areas are potentially places of local endemism due to the geographical isolation of small territories, which prevents free gene flow and can lead to the development of new taxonomic groups (Noroozi et al., 2019; Yang et al., 2022; Polchaninova & Marushchak, 2023). In such areas, even more mobile animals, such as birds and mammals, deserve the attention of scientists. Faunistic studies of the mountain regions of Central Asia are scarce and usually do not present the modern status and distribution of many species (Klys & Lis, 2022).

The primary objective of this study is to document the fauna, including aquatic invertebrates, fish, amphibians, reptiles, birds and mammals, of a difficult-to-access region in the Pamir Mountains on the lower part of the Shokhdara River near its confluence with the Panj River on the border between Tajikistan and Afghanistan. These published data will provide valuable insights into seasonal population numbers and contribute to distribution maps of the fauna of Tajikistan.

**Material and Methods**

The field surveys were conducted in autumn (September 26–October 3) 2019 and in spring (May 16–30) 2020 (only bottom macroinvertebrates, birds, mammals and herpetofauna) along the valley of Shokhdara River and its inflow to the Panj River. Surveys covered the territory of the river's channel, banks and slopes of the surrounding mountain ridges from Khorog city to the village of Parzuj. Shokhdara is the river at South-West of Pamir in Tajikistan, left tributary of Gunt River. The catchment of the Shokhdara River is 4,190 km$^2$. Shokhdara is the biggest tributary of Gunt. The Shokhdara River has its source from a lake at the elevation of 4,668 m a. s. l. and enters Gunt River at the elevation of 2,105 m a. s. l. The total length of Shokhdara River is 142 km, total drop — 2,563 m, average slope — 18 ‰. The special feature of the river basin is a well-developed river network. The Shokhdara River has around 40 tributaries with lengths of more than 10 km. The biggest tributary is Badomdara River. The share of snow water in Shokhdara discharge is 39 %, ice melting — 20 % and groundwater r— 41 % (fig. 1).

Macroinvertebrates were sampled according to the European Union (EU) "kick and sweep" method (Schmidt-Kloiber, 2006) using the "AQEM/STAR" software. Based on the samples collected, the specifics of the invertebrate composition of each of the three studied rivers were identified to the taxon level of family or higher (Afanasyev & Lietytska, 2019; Marushchak et al., 2022). To identify large and rare forms of invertebrates, we conducted qualitative sampling in microhabitats (underwater branches, cut arms, small tributaries). Quantitative sampling was also carried out by washing out stones at selected sites measuring 0.5 × 0.5 m. These sites were chosen to be representative of the most typical habitats. Macroinvertebrate samples were collected from 9 sites (table 1). Comparison of the main groups of invertebrates recorded in the study sites was made using the Sørensen-Dice coefficient (Sørensen, 1948).

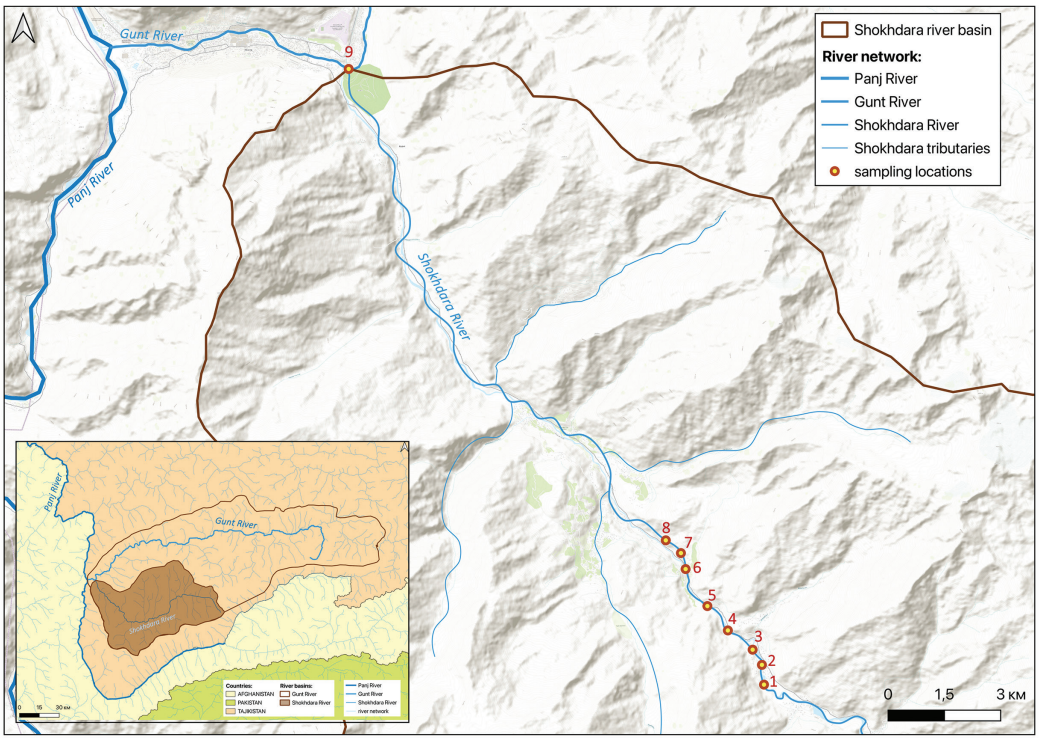


Fig. 1. Study area and sampling station.

Fish surveys were conducted at several sites along the rivers in the study area. Fish were caught in the field using non-lethal capture devices: fishing rod, 20 mm mesh casting net and 20 mm mesh fish landing net. Each fish caught was measured for size (height and length), identified to species, sex and age, and immediately released back into the wild. We also conducted interviews with local people used to interacting with the river (fishermen, local farmers, etc.). A total of 53 traps were used, 9 with ichthyological nets, and 3 baskets. All these devices are non-lethal. A total of 167 fish were caught. After measurements, the fish were released back into the river.

The registration of herpetofauna (amphibians and reptiles) took place in the Shokhdara River valley. Particular registrations made by local residents in spring 2020 are also included in the results of the survey. Investigation area included the near-water areas of the river, adjacent mountain slopes, areas adjacent to the banks along the road. For all representatives of the herpetofauna found on the routes, the registration points were recorded (using GPS-recording in Maps. Me mobile app v. 4.3.0) and then visualised in Google Earth 7.1.8.3036 (32-bit). All animals were studied in vivo using the route method (the width of the counting trail was 4 m (2 m on the right + 2 m on the left). The animals were photographed using an Olympus SP570UZ digital camera and released at the place of capture. Animals were registered visually, by their remnants (road kills, shed skin) and as a result of survey of the local people with demonstrations of the animals' pictures. Species were identified according to the published morphological keys (Bannikov et al., 1977; Kuzmin, 2012). It is important to mention that as the surveys were conducted at the end of September, some of the expected species were hard to identify, because this is the time of reduction of life activity of herpetofauna and preparation for wintering. All the animals were found only at the right bank of Shokhdara, because it receives more sunlight than the left bank, which has no light

**Table 1. Survey sites for macroinvertebrates**

| Site # | Coordinates | Elevation a.s.l., m |
|---|---|---|
| 1 | 37.3346 N 71.7140 E | 2,567 |
| 2 | 37.3374 N 71.7128 E | 2,563 |
| 3 | 37.3409 N 71.7120 E | 2,560 |
| 4 | 37.3459 N 71.7029 E | 2,529 |
| 5 | 37.3519 N 71.6969 E | 2,502 |
| 6 | 37.3609 N 71.6907 E | 2,453 |
| 7 | 37.3636 N 71.6876 E | 2,443 |
| 8 | 37.3678 N 71.6994 E | 2,429 |
| 9* | 37.3071 N 71.7576 E | 2,580 |

*Only macroforms of invertebrates washed off stones and wood from the riverbed without count.

starting from 16:00 local time. So, the animals at the right bank have more time to get warmer and stay active longer. Reduction of snake activities in this season was also confirmed in the interviews with local people.

Birds were identified visually and by voice. Photo camera with high resolution was used for the purposes of visual detection and further identification of species by photos. Other species were identified with the help of binoculars. Species abundance was identified at transects using the MacKinnon lists technique (a rapid assessment methodology designed for use in species rich environments).

The following methods were used to detect mammals: field registration of animals or signs of their presence (traces, excrements, food remains, etc.); night surveys; photo cameras using food baits; literature data and interviews with local residents (hunters).

## Results

### Macroinvertebrates

According to the data collected, 24 higher taxonomic groups of aquatic invertebrates were identified. Among them, the class Insecta was dominant (89.7 %).

Insecta: Ephemeroptera represented 18.7 % of the collected specimens of bottom invertebrates, Trichoptera — 10.5 %, Plecoptera — 2.8 %, Diptera Simuliidae — 35.8 %, Chironomidae — 18 %, other Diptera — 2.5 %, Mollusca Gastropoda — 2.5 %, Oligochaeta — 6.5 %, — others (Nematoda, Turbilaria, Ostracoda, Copepoda, Cyclops, Sphaerium, Araneida, Acarina, Odonata, Heteroptera, Coleoptera, Neuroptera, Lepidoptera and Megaloptera in total) — 2.7 % (fig. 2).

The distribution of taxa of aquatic invertebrates by sampling sites is shown in table 2. The results of the comparison of the main groups of invertebrates recorded in the study sites are highlighted in table 3.

There were no species of special conservation status among the large invertebrates in the Republic of Tajikistan.

We identified the following species of the mentioned macroinvertebrate families, which are typical for the region of Central Asia and the Pamirs.

**Mollusca Gastropoda** were represented by *Lymnaea auricularia* (Linnaeus, 1758). During the autumn period they got massively developed in the lateral arms at the sampling site No 1 and juvenile species — at the sampling site 3.

**Insect order Odonata** was represented just by one species *Aeshna grandis* Linnaeus, 1758, which was very abundant at the sampling site #1 and in lateral arms near this sampling site.

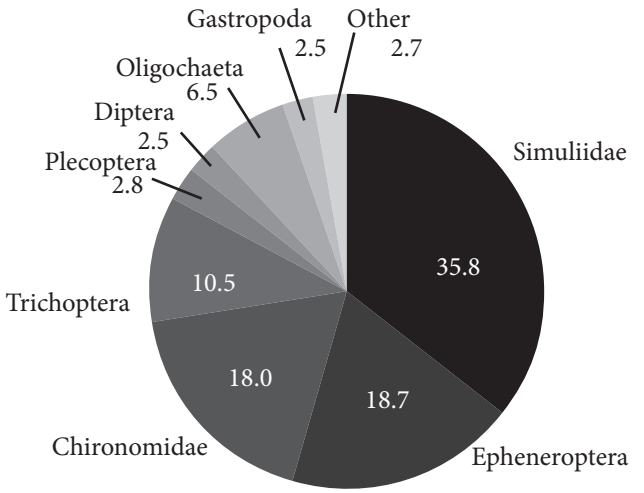


Fig. 2. Composition of invertebrates' communities within all studied monitoring stations.

**Order Ephemeroptera** was represented by 12 species, of which the nymphs of Baetidae were dominant in the whole study area. It is worth mentioning that in autumn most of the nymphs were at early instars, which made their identification difficult. The following species were identified *Cloeon tadjikistanicus* Brodsky, 1930 was seen along the whole study area; *Baetis* sp. ex gr. *muticus* (Linnaeus, 1758) was seen along

**Table 2. Number of recorded individuals and biomass of some indicator macroinvertebrate taxa in the survey sites (see Table 1)**

| Site # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Taxa | | | | | | | | |
| Turbellaria | 0 | 0 | 0 | + | 0 | + | + | + |
| Nematoda | + | 0 | + | 0 | 0 | + | + | + |
| Hirudinea | 0 | + | 0 | 0 | 0 | 0 | 0 | 0 |
| Oligochaeta | + | + | + | + | + | + | + | + |
| *Sphaerium* spp. | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gastropoda | + | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Ostracoda | + | 0 | + | 0 | + | 0 | + | + |
| Araneida | 0 | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Acarina | + | + | + | + | + | + | + | + |
| *Cyclops* spp. | 0 | 0 | 0 | + | 0 | 0 | 0 | + |
| other Copepoda | 0 | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Ephemeroptera | + | + | + | + | + | + | + | + |
| Odonata | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Plecoptera | + | + | + | + | + | + | + | + |
| Corixidae | 0 | 0 | + | 0 | 0 | 0 | 0 | 0 |
| other Heteroptera | + | + | + | + | + | + | + | + |
| Coleoptera | + | + | + | + | + | + | + | + |
| Megaloptera | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Trichoptera | + | + | + | + | + | + | + | + |
| Lepidoptera | + | 0 | + | + | + | + | 0 | + |
| Simuliidae | + | + | + | + | + | + | + | + |
| Chironomidae | + | + | + | + | + | + | + | + |
| Ceratopogonidae | 0 | 0 | + | 0 | 0 | 0 | 0 | 0 |
| other Diptera | + | + | + | + | + | + | + | + |
| Individuals | 12,600 | 6,170 | 14,160 | 9,300 | 7,840 | 16,300 | 9,210 | 8,740 |
| Biomass, mg | 11,840 | 5,970 | 14,750 | 8,950 | 7,160 | 9,800 | 8,750 | 8,100 |

the whole study area and in the lateral arms; *B.* sp. cf. *gracilis* Bogoescu & Tabacaru, 1957 was seen along the whole study area, (in few numbers); *B.* sp. cf. *buceratus* Eaton, 1870 was seen throughout the study area; *B.* sp. cf. *kogistani* Novikova & Kluge, 1994 was seen in the lateral arms; *B.* sp. ex gr. *rhodani* (Pictet, 1843) was seen throughout the study area and in the lateral arms; *Rhodobaetis issyksuvensis* Brodsky, 1930 was seen throughout the study area and in the lateral arms; gen. sp. cf. *Heptagenia quadripunctata* Kluge, 1989 was seen along the whole surveyed area and in lateral arms; *Heptagenia* sp. cf. *perflava* Brodsky, 1930 was seen along the whole surveyed area and in lateral arms; *Rhithrogena* sp. cf. *eugeniae* Kluge, 1983 was seen along the whole surveyed area and in lateral arms as a single specimen; gen. sp. cf. *Epeorus bispinosus* Braasch, 1980 was seen along the entire survey area and in lateral arms as an individual; *Ephemerella* sp. cf. *kabulensis* Allen, 1973 was seen along the entire survey area and in lateral arms.

**Order Plecoptera** was represented by 8 species. It is worth mentioning that abundance of this group along the whole surveyed area was quite low during the both survey seasons. This can indicate that untreated wastewaters from settlements as well as cattle breeding affect water quality in the river. As for other groups of macroinvertebrates; most of specimens were nymphs at early instars, which made their identification complicated. We identified the following species: *Zhiltzovaia* sp. cf. *cachemirica* (Aubert, 1959) was seen along the whole surveyed

area and in lateral arms; *Perlodes amabilis* Jewett, 1958 was seen along the whole surveyed area; gen. sp. cf. *Kyphopteryx pamirica* Zhiltzova, 1972 (endemic for Bodakhshan) was seen along the whole surveyed area and in lateral arms; *Nemoura* sp. cf. *papilla* Okamoto, 1922 was seen along the whole surveyed area and in lateral arms; gen. sp. cf. *Mesonemoura tianshanica* (Zhiltzova, 1971) (endemic for Bodakhshan) was seen along the whole surveyed area and in lateral arms; *Illiesonemoura ornata* (McLachlan, 1875) (endemic for Bodakhshan) was seen along the whole surveyed area and in lateral arms; *Capnia prolongata* Zhiltzova, 1969 (endemic for Bodakhshan) was seen along the whole surveyed area and in lateral arms; *Capnia badakhshanica* (Zhiltzova, 1974) (endemic for Bodakhshan) was seen along the whole surveyed area and in lateral arms.

Among **Heteroptera** two families were identified, including Corixidae along the whole river.

Fauna of **Coleoptera** was presented by 2 families: Hydrophilidae — *Laccobius hindukuschi* Chiesa, 1966 at survey sites 1–3; Hydrochidae — *Hydrochus elongatus* (Schaller, 1783) at survey sites 4–8.

**Order Trichoptera** was represented by more than 19 species. Some species were represented by the juvenile specimen at 1–3 stage of development, which made their species identification very hard. However, we identified the following ones: *Himalopsyche* sp. cf. *gigantea* (Martynov, 1914) identified at the sampling sites 0 and 1 only; *H.* sp. cf. *todma* Schmid, 1963 in lateral arms; *Rhyacophila extensa* Martynov, 1928 was seen along the whole studied area and in lateral arms as individual specimen; gen. sp. cf. *R. kadaphes* Schmid, 1959 was seen along the whole studied area and in lateral arms; *R.* sp. cf. *obscura* Martynov, 1927 was seen along the whole study area and in lateral arms, (a few specimens); *Agapetus cocandicus* McLachlan, 1875 — commonly seen species, which was seen along the whole study area and in lateral arms; *Agapetus* sp. cf. *sindis* Kimmins, 1953 — dominating species among Trichoptera, was seen along the whole study area and in lateral arms; *Glossosoma shugnanica* Ivanov, 1992 — commonly occurring species, which was seen along the whole study area and in lateral arms; *Hydroptila sanghala* Schmid, 1960 was registered at the sampling sites 3 and 6; *Stactobia* sp. cf. *shahdara* Ivanov, 1992 was registered at the sampling site 5; *Dolophilodes ornatus* Ulmer, 1909 was registered only at the sampling site 8; *Cheumatopsyche* sp. cf. *capitella* (Martynov, 1927) was seen along the whole study area and in lateral arms; *Hydronema persica* Martynov, 1914 was seen along the whole study area and in lateral arms; *Hydropsyche* sp. cf. *ardens* R. McLachlan, 1875 was seen along the whole study area and in lateral arms; *H. kaznakovi* Martynov, 1915 was seen along the whole study area and in lateral arms; *H.* sp. cf. *asiatica* Ulmer, 1905 was registered at the sampling sites 7 and 8; *Astratodina* sp. cf. *inermis* Mosely, 1936 was seen along the whole study area and in lateral arms; *Dinarthrum* sp. cf. *badakschanicum* Schmid, 1963 was seen along the whole study area and in lateral arms; *D.* sp. cf. *lindbergi* Schmid, 1963 was seen along the whole study area and in lateral arms.

Among **Diptera order**, along the whole study area and lateral arms we have registered 10 families, including Athericidae, Blephariceridae, Deuterophlebiidae, Dixidae, Empididae, Ephydridae, Limoniidae, Psychodidae, Ptychopteridae, Tipulidae and were abundant.

**Actinopterygii**

A total of 3 fish species (Nemacheilidae — 1, Cyprinidae — 2) was recorded in the study area.

False osman, *Schizopygopsis stoliczkai* Steindachner, 1866, (IUCN status: Data Deficient) is a cyprinid fish with an average length of 18.3 to 49.6 cm. In Tajikistan they are found only in the Pamirs. They can reach a maximum length of 80–95 cm. Spawning (at the age of 2–

3 years) occurs in tributaries of the Panj, with fish migrating upstream from the Panj in spring and returning to the main river in late spring or summer, with juveniles following in autumn (Qi et al., 2015; Wanghe et al., 2017). The study shows the presence of false osman throughout the study area. The largest fish caught was 16.5 cm long (fig. 3), with a minimum of 3 cm. It is worth mentioning that this fish is dominant in the river (58 % of the total number of fish caught) (table 4).

Common marinka or Dapeghat snow trout, *Schizothorax curvifrons*, Heckel, 1838, (IUCN status: Least Concern) is the most widespread species of marinkas. It lives in the river basins of Syrdarya, Talas, rivers coming from the Karatau ridge, in Kyzylkol Lake. It reaches maturity at the age of 3–4 years with the body length: females — 20 cm, males — 16 cm. Spawning takes place in rivers on sand-gravel sediments or in reeds. Spawning begins in the second half of March — early April, when the water temperature is +5–7 °C (Talwar & Jhingran, 1991). We caught only 3 specimens of this fish: one specimen with the length of 9.5 cm (fig. 4) and two fish with the length of 2.7 and 2.9 cm respectively (table 4).

**Table 3. Sørensen-Dice coefficients as a result of pairwise comparison of key macroinvertebrate taxa recorded in 8 survey sites (see Table 1)**

| Site | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1 | | 0.77 | 0.87 | 0.76 | 0.89 | 0.83 | 0.86 | 0.87 |
| 2 | 0.77 | | 0.71 | 0.80 | 0.83 | 0.80 | 0.83 | 0.77 |
| 3 | 0.87 | 0.71 | | 0.71 | 0.83 | 0.77 | 0.80 | 0.81 |
| 4 | 0.76 | 0.80 | 0.71 | | 0.84 | 0.86 | 0.81 | 0.90 |
| 5 | 0.89 | 0.83 | 0.83 | 0.84 | | 0.85 | 0.88 | 0.89 |
| 6 | 0.83 | 0.80 | 0.77 | 0.86 | 0.85 | | 0.89 | 0.90 |
| 7 | 0.86 | 0.83 | 0.80 | 0.81 | 0.88 | 0.89 | | 0.93 |
| 8 | 0.87 | 0.77 | 0.81 | 0.90 | 0.89 | 0.90 | 0.93 | |

**Table 4. Quantitative distribution of the caught fish per survey site (see Table 1)**

| Site | *Schizopygopsis stoliczkai* | *Schizothorax curvifrons* | *Nemachilus stoliczkai* |
|---|---|---|---|
| 1 | 52 | 0 | 39 |
| 3 | 29 | 3 | 21 |
| 4 | 11 | 0 | 11 |
| 8 | 5 | 0 | 5 |
| Total | 97 | 3 | 67 |
| Total ,% | 58 | 2 | 40 |

Fig. 3. Caught specimens of the false Osman (*S. stoliczkai*).

Tibetan stone loach, *Nemachilus stoliczkai* (Steindachner, 1866), (IUCN status: Least Concern) is widespread in Central Asia, in the river basins of the Tarim, the Balhash and the Alakol. The average size of the Tibetan stone loach is 9–10 cm, very rarely up to 15 cm (fig. 5). The maximum size is 15.5 cm. The Tibetan Stone Loach spawns in portions from the end of March through the summer, sticking the eggs in the sand. The fish mature at the age of 2–3 years with a body length of 5–7 cm (Talwar & Jhingran, 1991). It is the second most abundant fish species (after false osman). It has been caught throughout the study area. The largest specimen was 12.5 cm long and the smallest was 2.5 cm long (table 4).

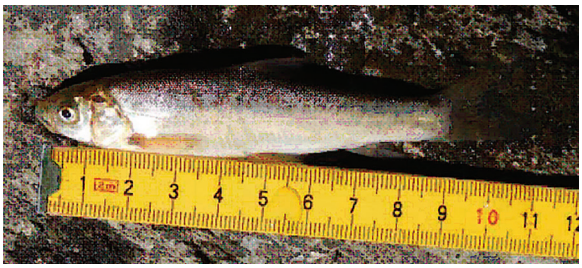

Fig. 4. Caught specimen of common marinka (*S. curvifrons*).

Fig. 5. Caught Tibetan stone loach *N. stoliczkai.*

Turkestan catfish *Glyptosternum* sp. was not caught during this field study. However, local people in the village of Sebzor confirmed its presence. This non-migratory fish is difficult to access as it hides under the stones. The Tukrkestan catfish was also not caught during the spring expedition in the study area. However, on 12 July 2020, 3 individuals of the Turkestan catfish were caught by local fishermen in the Shokhdara River, in the area where it flows into the Gunt River. Geographical coordinates of the place where the catfish was caught: 37.482222 N 71.591389 E, 1200 m a. s. l. The maximum size is 22.5 cm. According to local fishermen who have been fishing in the Shokhdara River for many years, the Turkestan catfish is not found further up the river except in its lowest part.

**Amphibia**

Only 1 species of amphibian (Anura, Bufonidae — 1) was recorded in the study area.

The green toad, *Bufotes viridis* (Laurenti, 1768) aggr., (IUCN status: Least Concern (LC)) is a typical synanthropic species that lives near households, in bushes, usually quite far from the river in habitats with soft soils. It does not seem to go further than irrigation canals, preferring to stay in shallow lowlands (Kuzmin, 2012). In autumn, one specimen (mature male) was found killed on the road leading to the slope, about 1 km downstream of the intake (Appendix 1, fig. 6). We observed mass movements of juvenile green toads in Khorog on the banks of the Panj (fig. 7). In spring 2020, tadpoles and juveniles were observed in large numbers in the lower reaches of the Shokhdara and near its confluence with the Gunt River.

Fig. 6. *B. turanensis,* road kill, village of Sebzor.

According to Dufresnes et al. (2019) the populations in the project area should belong to *Bufotes turanensis* (Hemmer, Schmidtler & Böhme, 1978) (https://amphibiaweb.org/species/7084). However, further studies using molecular and genetic analysis are required to clarify position of Pamir populations. This species has the same conservation status as the green toad and is also synanthropic.

In spring 2020 these toads (yearlings from 2019 and tadpoles from 2020) were observed in large numbers in the lower reaches of the Shokhdara River and near its confluence with the Gunt River.

Fig. 7. *B. turanensis,* toadlet, Khorog City, near Panj River.

**Reptilia**

A total of 5 species of reptiles (Squamata, Agamidae — 1, Colubridae — 2, Gekkonidae — 1, Viperidae — 1) were recorded during the study period.

The dice snake, *Natrix tessellata* (Laurenti, 1768), (IUCN status: LC) (Colubridae). In autumn 2019, one mature male (fig. 8) was found on the Shokhdara bank and one yearling was found killed on the road 1 km downstream from the first site. The preferred habitat for this species is shallow water with little or no current. According to local people, it is quite abundant in the study area.

Fig. 8. *N. tessellata* specimen found near Shokhdara River.

Fig. 9. Young individual of spotted whip snake, road kill, Sebzor village.

The spotted whip snake, *Hemorrhois ravergieri* (Ménétries, 1832), (IUCN status: LC) was recorded in the study areas as individuals killed on the road (Appendix 1, fig. 9). At an elevation of 2,600 m a. s. l., near the irrigation canal, we found shed skin of an older species with a length of about 60 cm. It is worth mentioning that this snake is quite aggressive, although not poisonous. Its preferred habitats are rocks and stony rip-raps between bushes. It hides under stones, in cracks and holes of other animals and is often seen along rivers and in human settlements (Bannikov et al., 1971; Said-Aliev, 1979). Due to its aggressive behaviour, it is often killed by local people, and therefore special measures need to be taken to protect this species in the study area.

Blunt-nosed viper, *Macrovipera lebetinus* (Linnaeus, 1758), (IUCN status: LC; Red Book of Tajikistan status: Vulnerable) (Viperidae); 1 juvenile was spotted crossing the road downhill from Hidorjev village.

The Himalayan agama, *Paralaudakia himalayana* (Steindachner, 1867), (IUCN status: LC) (Agamidae). In autumn, 2 juveniles were found near the bridge in the village of Ridjist on stony rip-raps, and 1 on the slopes near the bend in the Shokhdara River leading to the Pamir Botanical Garden (Appendix 1, fig. 10). In spring, they were observed in large numbers basking along the irrigation channels from 11:30 to 16:00–17:00. Normally, they are active from the morning until midday when the temperature is above +20 °C (Ananjeva & Tuniev, 1994; Bannikov et al., 1971; Said-Aliev, 1979). These animals like mountains with few plants and live on rocks, stony rip-raps, cracks and piles of stones — key areas for their conservation. According to local people, this species is quite abundant in the study area.

*Mediodactylus russowii* (Strauch, 1887) (IUCN status: LC) (Gekkonidae). In May 2020 they were recorded in the study sites to be surprisingly numerous study areas. The records are additionally highlighted in the table "A list of records of batracho- and herpetofauna in the field survey" (Appendix 1, fig. 11). At night they stick to walls near lamps (2–4 geckos

Fig. 10. Himalayan agamas spotted along the rocks and mountain slopes along the course of Shokhdara River.

Fig. 11. Grey thin-toed geckos registered within the study area.

near each lamp) and hunt for nocturnal insects. According to the interviews with the locals, they are not afraid of geckos and do not threaten them, but they are afraid of possible gecko bites. The grey thin-toed gecko is a typical representative of arid deserts, sandy and clay deserts and semi-deserts. In the mountains, it can be found up to 2000 m above sea level. Its typical habitats are saxaul shrubs in the valleys of desert rivers, steep slopes and stony rip-raps. It hides in crevices, between stones, in tree holes, in former ant hills or in holes made by small rodents. This species easily becomes synanthropic and lives in human houses (Bannikov et al., 1971; Ananjeva et al., 2004; Ananjeva et al., 2006; Bauer et al., 2013; Shcherbak & Golubev, 1996). It is not listed in the Red Book of Tajikistan.

*Pelophylax ridibundus* (Pallas, 1771), *Asymblepharus alaicus* (Elpatjevsky, 1901) and *Elaphe dione* (Pallas, 1773) recorded by Bannikov et al. (1971) and Said-Aliev (1979) were not found during the surveys (fig. 12).

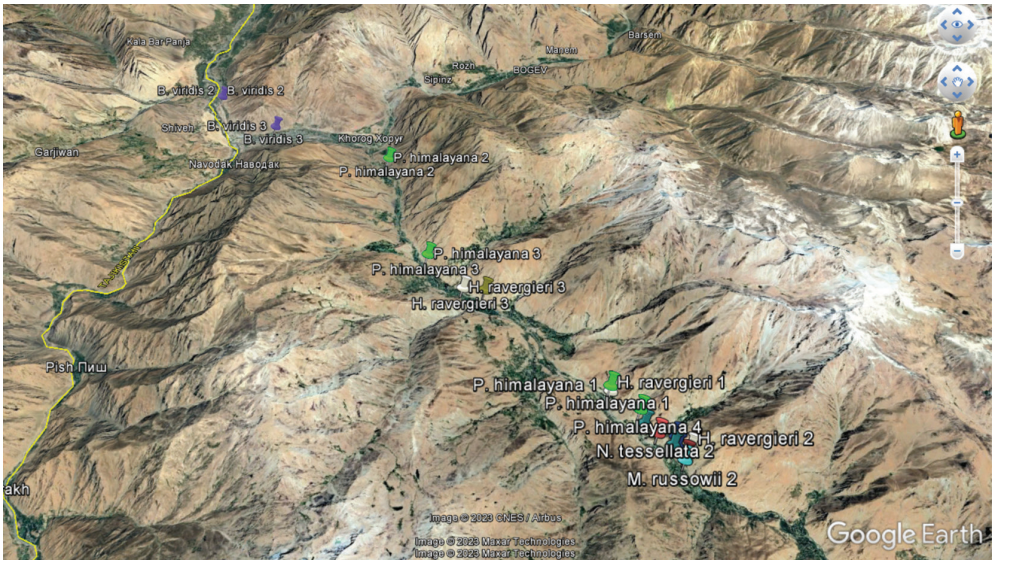


Fig. 12. Scheme of the findings of amphibians and reptiles at the study area.

**Aves**

Based on the results of the field surveys and analysis of literature resources, we found 205 bird species in the study area (Abdulnazarov, 2023). Of these, 21 species have a conservation status. However, the majority of bird species belong to synanthropic species or species that have adapted to anthropogenic factors, which is due to the presence of many settlements in this region. Among these species: nesting — 70 species; settled — 54 species; transit (registered during migration) — 86 species; wintering — 19 species; vagrant — 1 species (Abdulnazarov, 1999, 2013, 2017, 2021, 2022).

The period of autumn bird observation was from 26 September to 3 October 2019. During the autumn survey, we recorded 70 species, including: nesting — 32 species, sedentary — 32 species, transit — 13 species, overwintering — 2 species, vagrant — 1 species. The species' records are presented in the table "List of avifauna of the surveyed region" (Appendix 2).

The spring bird observation period was from 16 May to 30 May 2020. During the spring survey we recorded 75 species, including: nesting — 36 species; sedentary — 37 species; transit — 7 species (fig. 13).

It is worth mentioning that the sum by categories is higher than the actual number of registered birds (by 10), because some birds belong to several groups according to the character of their presence.

In the spring, we used spider nets to catch birds in order to determine their breeding behaviour according to the condition of the site. As a result, 42 birds belonging to 22 species were caught. Of these, 19 species have clear reproductive spots.

In total, during two surveys we identified 99 species of birds, which makes 48 % of the total avifauna of Tajikistan. Out of 21 species with protected status, 9 species were identified (43 % of all species with protected status as it is indicated in the table "List of avifauna of the surveyed region") (Appendix 2).

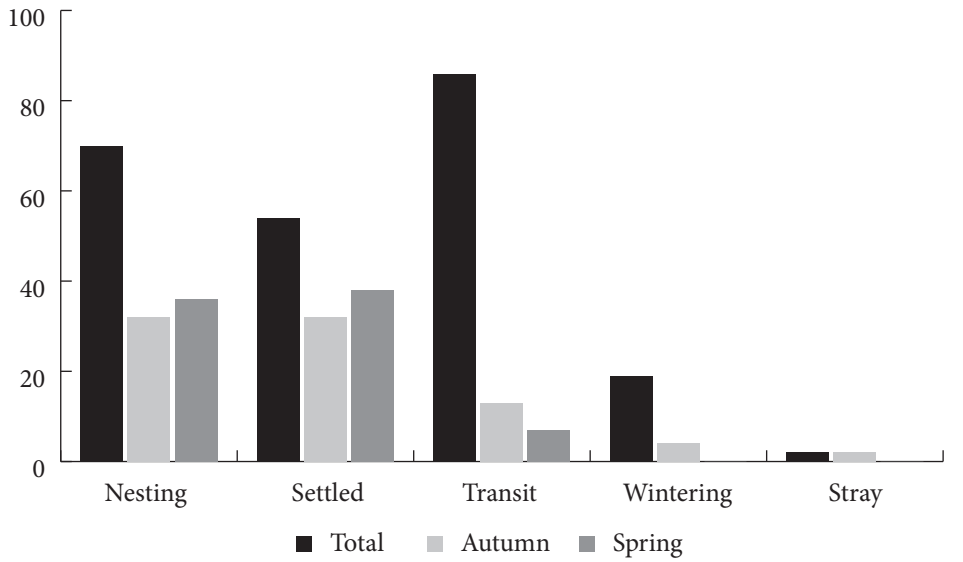


Fig. 13. Total avifauna list versa the actually registered species; note: some species may be included in more than 1 type of occurrence.

**Mammalia**

During the field surveys, 8 species of mammals were recorded either directly or as a result of secondary signs of their presence. The records are presented in the table "A list of mammals recorded in the field survey" (Appendix 3, figs 14–16).

Fig. 14. Grey draft hamster.

Fig. 15. Dr. Abdulnazarov with female of snow leopard in Pamir biological institute.

Fig. 16. Traces of Himalayan bear.

## Discussion

The first study of the biological resources of the Pamir begins with the expedition of V. P. Fedchenko to Central Asia in 1871 (Senkovskaya, 2009). This was followed by the expedition of N. A. Severtsov and I. V. Mushketov in 1877–1878 with the collections of A. A. Kushakevich, about the results of which Nikolai Severtsov wrote the following "The most vital scientific interest is the remarkably complete collections of the expedition from the Pamir, which was before us a terra incognita in the natural-historical sense, but which, according to the few reports by Voan-tsan and Marco-Polo about its completely peculiar biological conditions, has long aroused the strongest curiosity of the entire scientific world. The work of our expedition can satisfy this curiosity. The Pamirs, as a completely unknown country in terms of fauna and flora, immediately became one of the most researched areas in Asia" (Severtsov, 1879). This was followed by a series of expeditions, the most important of which was Lockhart's Chitral expedition, which was the first to describe the Panj River valley, to which the Shokhdara River belongs. At the same time, the zoological and zoogeographical expeditions of G. E. Grum-Grzhimailo made a great contribution to the study and knowledge of the fauna of the Pamirs.

Due to the lack of specialists, the remoteness of the study area and the difficult conditions of the highlands, the study of the fauna of the Pamirs, and in particular its aquatic fauna, remained far from complete for a long time. It was only in the 1960s that the former Soviet Union began to make extensive use of lakes and artificial reservoirs, not only in the plains but also in the mountains. In this respect, the Tian Shan lakes in Kyrgyzstan, Sonkul, Chatyrkul and Issykkul, are relatively well studied. For example, the Presidium of the Academy of Sciences of the Republic of Tajikistan twice (1976–1980 and 1981–1985) included this topic in the comprehensive scientific and technical programme of the State Planning Commission of the Council of Ministers of the TSSR. In this connection, a study was carried out by Dr Firuz Akhrorov to study the benthic fauna and fish of the Pamir reservoirs and to determine the prospects for their fishery use to improve the economy. These works were mainly focused on the study of a number of benthic fauna and fish in various typical reservoirs of the Pamir — lakes, rivers, warm springs, residual reservoirs, etc. Unfortunately, these studies covered most of the lakes, but very few were carried out on the rivers (Akhrorov, 2001).

Literature review shows that bottom fauna is the main food base for fish. According to Dr Akhrorov's doctoral thesis "Bottom fauna of water courses of the Pamir: Biology, ecology, production and genesis", it is presented in water courses up to 3700–4200 m a. s. l. However, he mainly studied lakes and smaller rivers. There are no other works on aquatic invertebrates, so we can say that the Shokhdara River has not been studied until now. The only exceptions are the warm springs in the basin of the Shokhdara River, where several species of dragonflies, molluscs and chironomids belonging to the tropical and subtropical complex were found (Akhrorov, 2001).

According to our data obtained during the expeditionary studies for two seasons (autumn 2019 and spring 2020), 24 taxonomic groups of the highest rank were registered in the communities of benthic invertebrates in the studied section of the Shakhdara River, among which representatives of the class Insecta dominated (92 %) the total number of specimens. According to the results of the pairwise Sørensen dice coefficient, the containment of key macroinvertebrates (needed for the maintenance of local fish populations) tends to be poorer in the lower course of the river (sites 1–5) than in the upper parts (6–8), but the differences are not dramatic, with the highest coefficient (0.93) between sites 7 and

8 and the lowest (0.71) between sites 3 and 4. At the same time, there is a high degree of endemism. Amphibians and reptiles show a tendency to decrease their populations, sometimes with subsequent extinction of species due to habitat destruction, smuggling (Phillips, 1999), the spread of alien invasive species and pathogens (Pupina et al., 2018), climate change (Nekrasosa et al., 2021) and many other teratogenic factors (Alroy, 2015).

During this study, a population of *M. russowii* was found much further eastwards than the previously described natural range. The significance of this finding is that the eastern limit of its range is far to the North-East. This proves that the natural range of this species is much larger and its eastern boundary is much further to the East than previously thought (Bannikov et al., 1977). It is unclear how this species entered the project area. It was probably introduced as an invasive species on local transport and adapted to the local climate.

**Conclusions**

The work represents records of 24 taxonomic groups of higher aquatic macroinvertebrates dominated by class Insecta (89.7 %), 3 fish (and 1 additional species was confirmed only by local fishermen), 1 amphibian, 5 reptiles, 8 mammal species in the vicinity of the city of Khorog along the Shokhdara River and near its mouth. A total of 205 bird species were recorded as using this area for various purposes (migration, nesting, concentration, wintering). These records are of great importance for the study of the native biota of certain areas of the Pamir Mountains, which, due to their geographical site, tend to be so-called "blind spots" of biodiversity studies.

The fauna of aquatic macroinvertebrates is quite rich, with the dominant group of insects being mostly represented by species from the family Simuliidae (35.8 % of all Insecta species), while such groups as Nematoda, Turbellaria, Ostracoda, Copepoda, *Cyclops* spp, *Sphaerium* spp., Araneida, Acarina, Odonata, Heteroptera, Coleoptera, Neuroptera, Lepidoptera and Megaloptera together accounted for only 2.7 % of all finds. Despite its species richness, the aquatic macroinvertebrate fauna did not show any signs of species requiring special conservation measures in the Republic of Tajikistan. The same is true for fish species, which are represented by widely distributed examples of the Asian ichtyofauna. On the basis of the Sørensen-Dice coefficients, it was shown that the number of higher taxonomic ranks of recorded invertebrates is poorer in the upper course of the river than in its lower course. It can be concluded that species richness decreases as the river rises.

The herpetofauna is not very rich and mainly consists of common species with a wide distribution. Most of them are synanthropic (*B. turanensis, N. tessellata, M. russowii*) and thus well adapted to the conditions of different levels of anthropogenic transformation along the river. The presence of green frogs (*Pelophylax* sp.) requires separate confirmation and further studies, since these frogs usually do not inhabit mountain streams and rivers with strong currents (such as the Shokhdara River), but can be locally distributed by waterfowl and inhabit shallow reservoirs with stagnant water. New records of *M. russowii* are of particular interest as they have been made far to the east of its known easternmost range limits. This may be a consequence of the use of transport vehicles to disperse these geckos, and the parental population from which geckos in this population originate, using modern molecular techniques, is urgently needed.

The vast majority of the avian species known for the study area (37.4 %) appeared to be migratory, thus using the study area for migration-related purposes (feeding, con-

centration, resting), while nesting was confirmed for 30.5 % of the species. Taking this into account, it should be emphasised that the Shokhdara River valley is important for the maintenance of bird populations in the region.

The presence of rare mammal species such as the Eurasian otter, snow leopard and Himalayan brown bear during research makes the surrounding area important to these species. As a result, special local measures and activities are required to minimise contact with the local population and to avoid harmful effects on the animals, which are often hunted by local people

It can therefore be inferred that the presence of the faunal representatives spotted during the research makes a significant contribution to the conservation potential of the area. The registration of mountain fauna will not only help to update existing maps of species natural ranges in the country, but will also prove to be a valuable contribution to the data that can potentially be used in GIS modelling of species distributions in response to anticipated climate changes.

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