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Biodiversity of Helminths in genera of *Bufotes* and *Pelophylax*, Uzbekistan

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Abstract: Between 2000 and 2022, a study in Uzbekistan examined 1822 amphibians (624 *Bufotes* genus, 1198 *Pelophylax* genus) to assess helminth biodiversity. Species studied included Perrin's Green Toad, Pewzow's Toad, Turan Toad, Terentiev Water Frog, *Pelophylax* sp., and *Pelophylax terentievi* × *Pelophylax* sp. hybrid. The study revealed the presence of 66 species of parasitic helminths, including those from the classes Cestoda, Trematoda, Acanthocephala, and Nematode, in Uzbekistan's amphibians. Notably, the genus *Bufotes* and the genus *Pelophylax* were newly identified as hosts for 14 helminth species in the country. The biological diversity of amphibian helminths in Uzbekistan consists of 66 species, with varying distribution: 42 in the North-Eastern region, 40 in the Eastern region, 38 in the Southern region, 25 in the Central region, and 17 in the North-Western region.

Keywords: Amphibian, dominance index, cestoda, trematoda, acanthocephalan, nematoda.

Introduction

This study presents the current literature on parasites in five species and one hybrid form of amphibians from Uzbekistan. The findings of this study provide an updated understanding of the helminths found in these hosts.

The genus *Bufotes* (Rafinesque, 1815) is distributed in Western Europe, Eastern Europe, Western Asia, and Southeast Asia. On the other hand, the genus *Pelophylax* (Fitzinger, 1843) has a broader distribution, including Western Europe, Northern Europe, Central Europe, Eastern Europe, Southern Europe, the Middle East, Asia Minor, and West Asia (Budak & Göçmen 2014).

Bufotes viridis (Laurenti, 1768) and *Pelophylax ridibundus* (Pallas, 1771) are two frog species with extensive geographic distributions. These species have been the subject of numerous scientific studies abroad investigating their helminth fauna (Yıldırımhan et al. 1996, 1997, Yıldırımhan 1999, Yıldırımhan et al. 2005, Düşen & Öz 2006, Sağlam & Arıkan 2006, Düşen & Oğuz 2008, 2010, Düşen 2011, Düşen & Öz 2013, Düşen et al. 2010, Koyun et al. 2015).

Independent lineages of *B. viridis* and *B. latastii* have undergone intercrossing, resulting in the formation of at least six triploid and tetraploid hybrid forms found in Central Asia (Stock et al. 2006, Litvinchuk et al. 2012, Betto-Colliard et al. 2018). Recently described, *Bufotes perrini* is a diploid species distributed in northern (Karakalpak), central (Navoiy), and western (Bukhara) regions of Uzbekistan. *B. pewzowi* (Bedriaga, 1898), a tetraploid species of hybrid origin (Dufresnes et al. 2019), primarily inhabits mountainous areas in the central (Samarkand, Jizzakh), northeastern (Tashkent, Syrdarya), and eastern (Fergana Valley) parts of Uzbekistan. *Bufotes turanensis* (Hemmer, Schmidtler & Böhme, 1978) is distributed along the Amudarya River and primarily inhabits the southern regions of Uzbekistan (Surkhandarya, Kashkadarya) (Dufresnes et al. 2019; Litvinchuk et al. 2021).

The Eurasian water frogs (*Pelophylax*) comprise a minimum of 20 species and multiple hybrid forms (Frost 2022). Within this complex, approximately twelve lineages have been observed (Plötner et al. 2012). Mazepa (2013) documented the presence of the Terentiev Water Frog *Pelophylax terentievi* (Mezhzherin 1992) in the northern and southern regions of Uzbekistan, alongside genetically distinct *Pelophylax sp*. populations in the northeastern and eastern regions. Hybrid forms resulting from the crossbreeding of *Pelophylax terentievi* and *Pelophylax sp*. were identified in the central regions of Uzbekistan (Mazepa 2013). Additionally, Ualiyeva et al. (2022) identified two lineages of *Pelophylax sp. novum* (Syr Darya and Balkhash lineages) in Kazakhstan based on mitochondrial characteristics.

The objective of this study was to provide an updated understanding of the biodiversity of amphibian helminths in Uzbekistan, focusing on Perrin's Green Toad *Bufotes perrini* (Rafinesque, 1815), Pewzow's Toad *Bufotes pewzowi* (Bedriaga, 1898), *Bufotes turanensis* (Hemmer, Schmidtler & Böhme, 1978), Terentiev Water Frog *Pelophylax terentievi* (Mezhzherin, 1992), *Pelophylax sp* and hybrid forms of *P. terentievi* and *Pelophylax sp.*

Materials and methods

The study on amphibian helminths in Uzbekistan encompassed various data sources, including literature and fieldwork conducted between 2000 and 2019. Amphibians were collected from the Surkhandarya and Kashkadarya regions in the south, as well as the lowland of Karakalpakstan in the west. Additionally, samples were gathered from wetlands, watershed areas in the Bukhara and Navoiy oases, and diverse biotopes in the Jizzakh, Syrdarya, and Tashkent regions. From 2019 to 2022, further sampling took place in the Fergana Valley, eastern regions of Uzbekistan, covering wetlands, agro-landscapes, and urbanized areas (see Figure 1).

The specimens used in this study were helminths collected from Perrin's Green Toad *Bufotes perrini* (Rafinesque, 1815), Pewzow's Toad *Bufotes pewzowi* (Bedriaga, 1898), Turan Toad *Bufotes turanensis* (Hemmer, Schmidtler & Böhme, 1978), Terentiev Water Frog *Pelophylax terentievi* (Mezhzherin, 1992), *Pelophylax sp*, and hybrid form of *P. terentievi* and *Pelophylax sp*. These amphibians were captured from various habitats across Uzbekistan (refer to Figure 2).

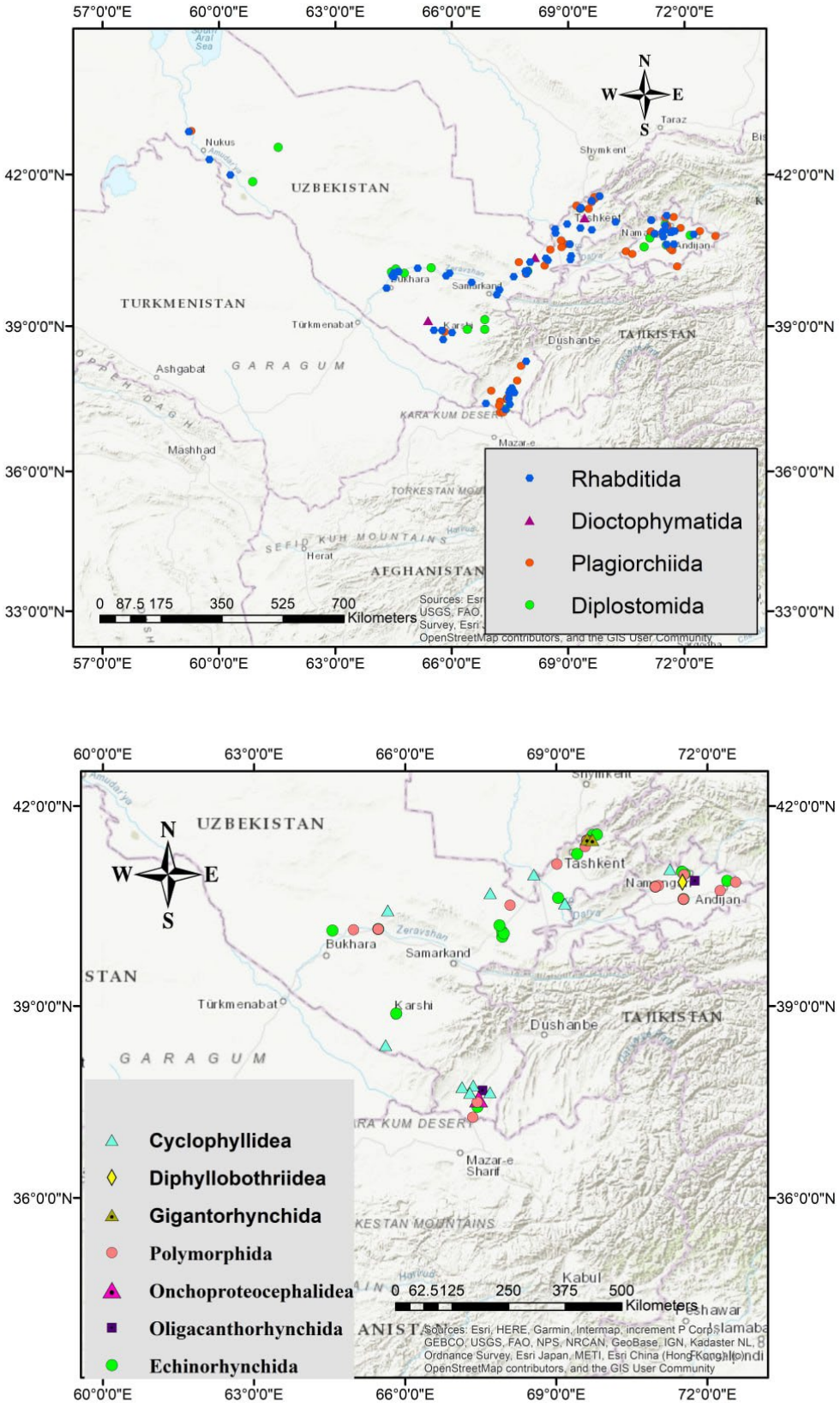

Figure 1. The Cyclophyllidea, Diphyllobothriidea, and Onchoproteocephalidea are orders belonging to the Cestoda class. The Echinorhynchida and Polymorphida are orders of the Palaeacanthocephala class. The Gigantorhynchida and Oligacanthorhynchida are orders of the Archiacanthocephala class. The Plagiorchiida and Diplostomida are orders of the Trematoda class. The Rhabditida and Dioctophymatida are orders of the Nematoda class.

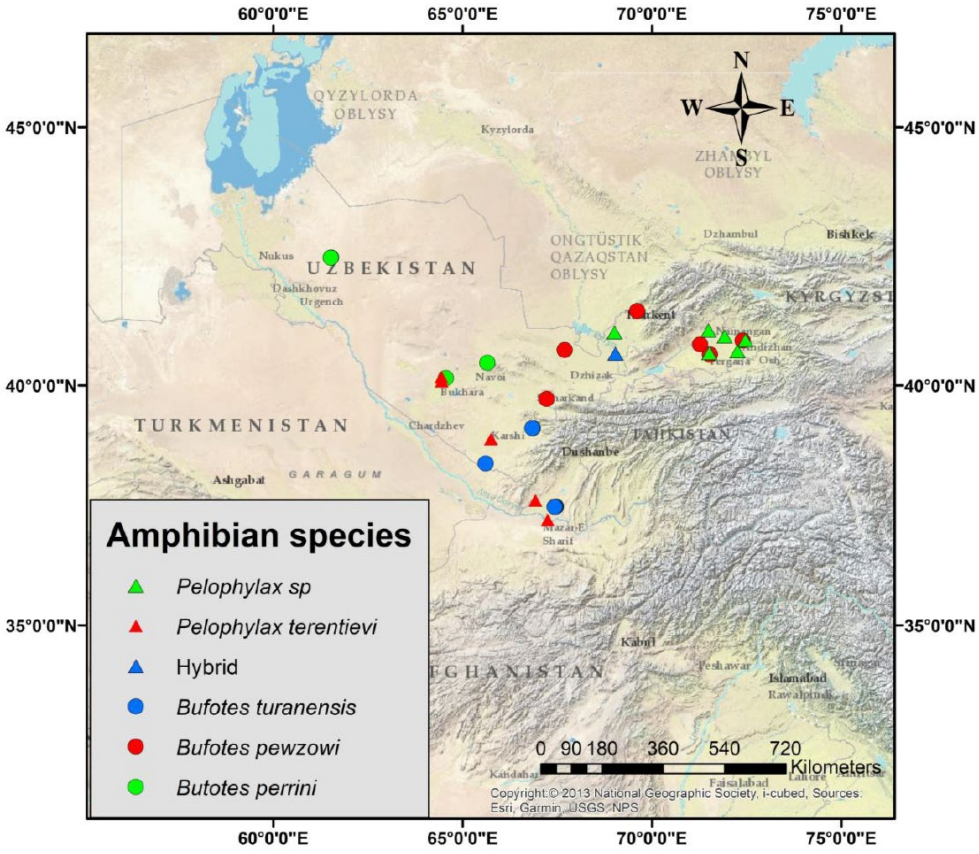

Figure 2. Amphibian species collected from different habitats of Uzbekistan.

A total of 1822 individuals of amphibians were collected and analyzed. To euthanize amphibians, 20% benzocaine hydrochloride was injected into the ventral abdomen. This procedure was performed in accordance with the AVMA Euthanasia Guidelines (AVMA Guidelines for the Euthanasia, 2020). And the helminthological materials were dissected from the amphibians by the complete helminthological autopsy method (Skrjabin 1928). The collected helminths were fixed in 70% ethanol and properly labeled for further processing.

The taxonomy of parasites is available on the Global Biodiversity Information Facility website (https://www.gbif.org/).

The identification of the detected helminths was conducted using the methodology outlined by Ryzhikov et al. (1980). The helminth dominance index was calculated using the formula proposed by Balogh (1958):

$$Di = \frac{ni}{N} \cdot 100$$

The dominance index (ID) reflects the ratio of the number of individuals (ni) of a species to the total number of species (N) in a biocenosis. Other abbreviations used in the text are as follows; EI: extensiveness of invasion and II: intensity of invasion.

Ethical statement: Fieldwork conducted in the inland waters of Uzbekistan adhered to the current Uzbek environmental legislation, specifically the Law of the Republic of Uzbekistan 'On the protection and use of wildlife' (No. 545-I 26.12.1997; https://lex.uz/docs/-31719). The research also followed the ethical guidelines outlined in the 'Guidelines for the Use of Live Amphibians and Reptiles in field and laboratory research' (2004) (Section 6) published by the American Society of Ichthyologists and Herpetologists (ASIH) (https://asih.org/animal-care-guidelines/), ensuring the ethical treatment of the studied animals.

Results

As a result of this study on amphibian helminths in Uzbekistan, a total of 66 species of parasitic worms belonging to the classes Cestoda, Trematoda, Acanthocephala, and Nematoda were identified and documented. The comprehensive list of these species is as follows:

Phylum: Platyhelminthes Schneider, 1873
Class: Cestoda Rudolphi, 1808
Order: Cyclophyllidea van Beneden in Braun, 1900
Family: Nematotaeniidae Lühe, 1910
Genus: *Nematotaenia* Lühe, 1910

Nematotaenia dispar
(Goeze, 1782)

Definitive host: Perrin's Green Toad - *Bufotes perrini*, Turan Toad - *Bufotes turanensis*, Pewzow's Toad - *Bufotes pewzowi*, Terentiev Water Frog – *P. terentievi, Pelophylax* sp. and hybrid form *P. terentievi* × *Pelophylax* sp.

Localization: Intestines.

Infection rates: In Perrin's Green Toad - EI 7.2%; II 2-6 copies; ID 0.14 (52 copies), in Turan Toad - EI 9.6%; II 2-4 copies; ID 0.12 (46 copies), in Pewzow's Toad - EI 8.6%; II 2-9 copies; ID 0.30 (116 copies), in Terentiev Water Frog - EI 1.0%; II 1-3 copies; ID 0.015 (6 copies), in *Pelophylax sp.* - EI 1.9%; II 2-3 copies; ID 0.08 (31 copies) and hybrid form - EI

1.4%; II 1-4 copies; ID 0.03 (15 copies).

Place of detection: Navoi, Jizzakh, Sirdarya, Kashkadarya, Surkhandarya regions and the Ferghana Valley and Tashkent city (Vashetko & Siddikov 1999, Ikromov et al. 2004, Ikromov 2011).

Family: Dipylidiidae Mola, 1929

Genus: *Joyeuxiella* Funrmann, 1935

Joyeuxiella echinorhynchoides
(Sonsino, 1889),
larvae

Definitive host: Predatory mammals.

We found the larval form of this type of cestoda in a Turan Toad – *B. turanensis*.

Localization: Body cavity.

Infection rates: EI 1.0%; II 2-3 ind.; ID 0.013 (5 copies).

Place of detection: Surkhandarya region - Sherabad region (Ikromov & Azimov 2004, Ikromov 2019).

Family: Mesocestoididae Poirier, 1897

Genus: *Mesocestoides* Vailland, 1863

Mesocestoides lineatus
(Goeze, 1782),
larvae

Definitive host: Predatory mammals and birds.

We found the larval form of this type of cestoda in a Turan Toad – *B. turanensis* and Pewzow's Toad – *B. pewzowi*.

Localization: Body cavity.

Infection rates: In Turan Toad - EI 7.5%; II 1-12 copies; ID 0.24 (92 copies) and in Pewzow's Toad - EI 8.6%; II 2-4 copies; ID 0.13 (49 copies).

Place of detection: Syrdarya, Samarkand, Kashkadarya, Namangan regions (Ikromov et al. 2004, Ikromov 2011, 2019).

Order: Diphyllobothriidea Kuchta, Scholz, Brabec et Bray, 2008

Family: Diphyllobothriidae Lühe, 1910

Genus: *Spirometra* Müller, 1937

Spirometra erinaceieuropaei
(Rud., 1819),
larvae

Definitive hosts: Carnivorous mammals.

We found the larval form of this species of cestoda in a *Pelophylax* sp.

Localization: body cavity and in the femoral muscles.

Infection rates: EI 0.47%; II 1-3 copies; ID 0.01 (4 copies).

Place of detection: Namangan region (Ikromov et al. 2004, Ikromov 2011, 2019).

Order: Onchoproteocephalidea Caira, Jensen, Waeschenbach, Olson & Littlewood, 2014

Family: Proteocephalidae La Rue, 1911

Genus: *Ophiotaenia* La Rue, 1911

Synonym: *Batrachotaenia* Rudin, 1917

Ophiotaenia (Batrachotaenia) ranae
(Yamaguthi, 1938)

Definitive host: Terentiev Water Frog – *P.terentievi*.

Localization: Intestines.

Infection rates: EI 4.3%; II 2-6 copies; ID 0.15 (59 copies).

Place of detection: Surkhandarya region.

Class: Trematoda Rudolphi, 1808

Order: Diplostomida Olson, Cribb, Tkach, Bray et Littlewood, 2003

Family: Diplostomidae Poirier, 1886.

Genus: *Alaria* Schrank, 1788

Alaria alata
(Goeze, 1782),
larvae

Definitive host: Predatory mammals.

We found the larval form of this species of trematoda in Perrin's Green Toad – *B. perrini*, in Pewzow's Toad – *B. pewzowi,* in *Turan Toad – B. turanensis,* in Terentiev Water Frog – *P. terentievi*, *Pelophylax* sp. and hybrid form *P. terentievi* × *Pelophylax* sp.

Localization: Muscles, body cavity.

Infection rates: In Perrin's Green Toad - EI 17.0%; II 5-16 copies; ID-0.63 (237 copies) in Pewzow's Toad - EI 15.5%; II 2-12 copies; ID-0.71 (268 copies), in Turan Toad - EI 14.5%; II 2-18 copies; ID-0.75 (284 copies), in Terentiev Water Frog - EI 8.0%; II 2-6 copies; ID-0.36 (138 copies) and *Pelophylax* sp.- EI 10.2%; II 2-8 copies; ID 0.8 (302 copies), hybrid form - EI 7.5%; II 2-6 copies; ID 0.35 (132 copies).

Place of detection: Everywhere (Ikromov 2006a, 2011, 2015, 2019).

Genus *Codonocephalus* Diesing, 1850

Codonocephalus urnigerus
(Rud., 1819) Lühe, 1909,
larvae

Definitive host: Birds.

We found the larval form of this species of trematoda in Perrin's Green Toad – *B. perrini*, in Pewzow's Toad – *B. pewzowi,* in *Turan Toad – B. turanensis,* in Terentiev Water Frog – *P. terentievi*, *Pelophylax* sp.and hybrid form *P. terentievi* × *Pelophylax* sp.

Localization: abdominal cavity, muscles, various internal organs.

Infection rates: In Perrin's Green Toad - EI 6.2%; II 2-4 copies; ID-0.08 (32 copies) in Pewzow's Toad - EI 7.3%; II 2-8 copies; ID-0.49 (185 copies), in Turan Toad - EI 7.5%; II 2-8 copies; ID-0.17 (64 copies), in Terentiev Water Frog - EI 16.0%; II 2-12 copies; ID-1.06 (401 copies) and *Pelophylax* sp.- EI 9.8%; II 1-22 copies; ID 0.47 (177 copies), hybrid form - EI 17.1%; II 2-7 copies; ID 0.93 (352 copies).

Place of detection: Everywhere (Ikromov & Azimov 2004, Ikromov et al. 2004, Ikromov 2006a, 2011, 2015, 2019).

Family: Strigeidae Railliet, 1919

Genus: *Strigea* Abildgaard, 1790

Strigea strigis
(Schrank, 1788) Abildgaard, 1790,
larvae

Definitive host: Birds.

We found the larval form of this species of trematoda in a Turan Toad – *B. turanensis* and in Terentiev Water Frog – *P. terentievi*.

Localization: Muscles, body cavity.

Infection rates: in Turan Toad - EI 15.6%; II 2-5 copies; ID 0.43 (163 copies) and in Terentiev Water Frog - EI 5.4%; II 1-14 copies; ID 0.6 (227 copies).

Place of detection: Surkhandarya (village Sherabod) and Kashkadarya (Kitab district) regions.

Order: Plagiorchiida La Rue, 1957
Family: Diplodiscidae Skrjabin, 1949
Genus: *Diplodiscus* Diesing, 1836

Diplodiscus subclavatus
(Pallas, 1760)

Definitive host: Pewzow's Toad – *B. pewzowi*, Terentiev Water Frog – *P. terentievi* and *Pelophylax* sp. and hybrid form *P. terentievi* × *Pelophylax* sp.

Localization: Intestines, rectum, cesspool.

Infection rates: in Pewzow's Toad - EI 7.7%; II 1-8 copies; ID 0.28 (109 copies), in Terentiev Water Frog - EI 3.5%; II 3-8 copies; ID 0.19 (75 copies), in *Pelophylax* sp. - EI 5.2%; II 2-6 copies; ID 0.25 (97 copies) and in hybrid form -EI 3.8%; II 1-3 copies; ID 0.1 (38 copies)

Place of detection: Tashkent, Jizzakh, Surkhandarya, Ferghana regions, the cities of Karshi and Tashkent (Belyaev et al. 1938, Vashetko & Siddikov 1999, Ikromov 2006a, 2011, 2015, 2019).

Family: Encyclometridae Mehra, 1931
Genus: *Encyclometra* Baylis & Cannon, 1924

Encyclometra colubrimurorum
(Rud., 1819),
larvae

Definitive host: Snakes.

We found the larval form of this species of trematoda in a Terentiev Water Frog – *P. terentievi*.

Localization: Body cavity, internal organs.

Infection rates: EI 1.6%; II 5-14 copies; ID 0.12 (48 copies).

Place of detection: Surkhandarya (Sherabod and Termez regions) region (Ikromov 2006a, 2011, 2015, 2019).

Family: Gorgoderidae Looss, 1901
Genus: *Gorgodera* Looss, 1899

Gorgodera cygnoides
(Zeder, 1800)

Definitive host: Pewzow's Toad – *B. pewzowi* and *Pelophylax* sp.

Localization: Bladder.

Infection rates: in Pewzow's Toad - EI 4.0%; II 2-6 copies; ID 0.11 (42 copies) and in *Pelophylax* sp. - EI 17.9%; II 3-11 copies; ID 1.37 (516 copies)

Place of detection: Tashkent city and Tashkent region (Humson village) (Belyaev et al. 1938, Vashetko & Siddikov 1999, Ikromov et al. 2004, Ikromov 2006a, 2011, 2015, 2019).

Gorgodera asiatica
Pigulevsky, 1945

Definitive hosts: Terentiev Water Frog – *P. terentievi* and *Pelophylax* sp.

Localization: Bladder.

Infection rates: Terentiev Water Frog - EI 9.2%; II up to 5 copies; ID 0.53 (201 copies) and in *Pelophylax* sp.- EI 12.9%; II 2-8 copies; ID 1.07 (405 copies)

Place of detection: Jizzakh, Tashkent, Surkhandarya, Namangan and Ferghana regions and the Republic of Karakalpakstan (Ikromov 2006a, 2011, 2019, Shakarboev 2007).

Gorgodera dollfusi
Pigulewsky, 1945

Definitive host: hybrid form P. *terentievi* × *Pelophylax sp.*

Localization: Bladder.

Infection rates: EI 7.9%; II up to 7 copies; ID 0.49 (185 copies).

Place of detection: Syrdarya region (Ikromov 2011, 2015).

Gorgodera media
Strom, 1940

Definitive hosts: Terentiev Water Frog – *P. terentievi*, *Pelophylax* sp. and hybrid form *P. terentievi* × *Pelophylax* sp.

Localization: Bladder.

Infection rates: Terentiev Water Frog - EI 4.9%; II 2-5 copies; ID 0.15 (57 copies), in *Pelophylax* sp. - EI 5.0%; II 2-8 copies; ID 0.24 (93 copies) and in hybrid form - EI 6.2%; II 2-10 copies; ID 0.4 (154 copies)

Place of detection: Tashkent, Surkhandarya, Jizzakh and Syrdarya regions (Muminov et al. 1984, Ikromov et al. 2004, Ikromov 2006a, 2011, 2015).

Gorgodera pagenstecheri
Ssinitzin, 1905

Definitive hosts: Pewzow's Toad – *B. pewzowi* and *Pelophylax* sp.

Localization: Bladder.

Infection rates: in Pewzow's Toad - EI 5.3%; II 2-6 copies; ID 0.39 (147 copies), in *Pelophylax* sp. - EI 4.95%; II 3-11 copies; ID 0.15 (58 copies).

Place of detection: Tashkent and Namangan regions (Shakarboev 2007, Ikromov 2011, 2015, 2019).

Genus *Gorgoderina* (Looss, 1902)

Gorgoderina orientalis
Strom, 1940

Definitive hosts: *Pelophylax* sp. and hybrid form *P. terentievi* × *Pelophylax* sp.

Localization: Bladder.

Infection rates: in *Pelophylax* sp.- EI 2.87%; II 4-9 copies; ID 0.21 (79 copies) and in hybrid form - EI 3.38%; II 2-3 copies; ID 0.09 (35 copies)

Place of detection: Chinaz district of Tashkent region and Zamin district of Jizzakh region (Shakarboev 2007, Ikromov 2011, 2015).

Gorgoderina vitelliloba
(Olsson, 1876)

Definitive hosts: Terentiev Water Frog – *P. terentievi* and *Pelophylax* sp.

Localization: Bladder.

Infection rates: in Terentiev Water Frog - EI 9.5%; II 1-8 copies; ID 0.56 (211 copies) and in *Pelophylax* sp.- EI 5.0%; II 2-4 copies; ID 0.18 (69 copies).

Place of detection: Nurata district of Navoiy region, Pap district of Namangan region, Bostonlyk district of Tashkent region, as well as Tashkent city (Belyaev et al. 1938, Ikromov 2011, 2015).

Family: Haematoloechidae Freitas & Lent, 1939

Genus: *Haematoloechus* Looss, 1899

Haematoloechus (Pneumonoeces) variegatus
(Rud., 1819)

Definitive hosts: Perrin's Green Toad – *B. perrini*, Pewzow's Toad – *B. pewzowi,* Turan Toad – *B. turanensis,* Terentiev Water Frog – *P. terentievi*, *Pelophylax* sp. and hybrid form *P. terentievi* × *Pelophylax* sp.

Localization: Lungs.

Infection rates: In Perrin's Green Toad - EI 12.9%; II 2-12 copies; ID 0.56 (212 copies) in Pewzow's Toad - EI 15.5%; II 2-8 copies; ID 0.52 (198 copies), in Turan Toad - EI 9.6%; II 2-8 copies; ID 0.25 (96 copies), in Terentiev Water Frog - EI 73.1%; II 2-8 copies; ID 1.57 (593 copies), *Pelophylax* sp. - EI 85.4%; II 3-12 copies; ID 4.92 (1852 copies) and hybrid form - EI 76.0%; II 1-6 copies; ID 3.54 (1335 copies).

Locations of detection: everywhere (Ikromov et al. 2004, Ikromov 2006a, 2011, 2015, 2019).

Haematoloechus variegatus abbreviatus
Bykhovsky, 1932

Host: *Pelophylax* sp.

Localization: Lungs.

Infection rates: EI 5.0%; II 2-7 copies; ID 0.27 (104 copies).

Place of detection: Trematodes *P. v. abbreviatus* were found in the Lake frog from the coasts of Buvaida district of the Fergana region and the headwaters of the Mingbulak district of the Namangan region (Ikromov et al. 2004, Ikromov 2006a, 2011).

Family: Plagiorchiidae Lühe, 1901

Genus *Haplometra* Looss, 1899

Haplometra cylindracea
(Zeder, 1800).

Definitive host: *Pelophylax* sp.

Localization: Lungs.

Infection rates: EI 4.54%; II 2-4 copies; ID 0.12 (47 copies).

Place of detection: Besharyk district of Ferghana region (Ikromov 2006a, 2011, 2015).

Genus: *Plagiorchis* Lühe, 1899

Plagiorchis elegans
(Rud., 1802),
larvae

Definitive host: Birds.

We found the larval form of this species of trematoda in a Terentiev Water Frog – *P. terentievi*.

Localization: Intestines.

Infection rates: EI 2.9%; II 1-3 copies; ID 0.06 (23 copies).

Place of detection: Sherabad district of Surkhandarya region (Ikromov 2011, 2015).

Genus: *Skrjabinoeces* Sudarikov, 1950

Skrjabinoeces similis
(Looss, 1899)

Definitive host: *Pelophylax* sp.

Localization: Lungs.

Infection rates: EI 31.0%; II from 2-7 copies; ID 1.14 (429 copies).

Place of detection: on the banks of the Kasansay River of Turakurgan district, Namangan region, Yazyavan region, Ferghana and Syrdarya regions (Ikromov & Azimov 2004, Ikromov et al. 2004, Ikromov 2006a, 2011, 2015, 2019).

Skrjabinoeces minimus
Shevchenko, 1965

Definitive host: *Pelophylax* sp.

Localization: Lungs.

Infection rates: EI 9.5%; II 1-4 copies; ID 0.27 (102copies).

Place of detection: Namangan and Ferghana regions (Ikromov et al. 2004, Ikromov 2006a, 2011, 2015).

Family: Pleurogenidae Looss, 1899

Genus: *Pleurogenoides* Travassos, 1921

Pleurogenoides medians
Olsson, 1876

Definitive hosts: Terentiev Water Frog – *P. terentievi* and *Pelophylax* sp.

Localization: Intestines.

Infection rates: In Terentiev Water Frog - EI 6.2%; II 2-8 copies; ID 0.31 (119 copies) and in *Pelophylax* sp. - EI 3.8%; II 1-4 copies; ID 0.11 (45 copies)

Place of detection: Karakalpakstan (Beruni district), Ferghana and Surkhandarya regions (Ikromov &Azimov 2004, Ikromov 2006a, 2011, 2015).

Family: Telorchidae Looss, 1898

Genus: *Dolichosaccus* Johnston, 1912

Dolichosaccus rastellus
(Olsson, 1876)

Definitive host: *Pelophylax* sp.

Localization: Intestines.

Infection rates: EI 4.3%; II 1-3 copies; ID 0.09 (35 copies).

Place of detection: in the rice fields of the Altinkul district of Andijan region and near the Kasansay River of the Kasansay district of Namangan region (Ikromov &Azimov 2004, Ikromov et al. 2004, Ikromov 2011, 2015).

Genus: *Opisthioglyphe* Looss, 1899

Opisthioglyphe ranae
(Froelich, 1791)

Definitive hosts: Perrin's Green Toad – *B. perrini*, Pewzow's Toad – *B. pewzowi,* Turan Toad – *B. turanensis,* Terentiev Water Frog – *P. terentievi*, *Pelophylax* sp. and hybrid form *P. terentievi* × *Pelophylax* sp.

Localization: Intestines, body cavities, lungs and livers.

Infection rates: In Perrin's Green Toad - EI 9.8%; II 2-6 copies; ID 0.19 (73 specimens) in Pewzow's Toad - EI 8.5%; II 2-8 copies; ID 0.33 (126 copies), in Turan Toad - EI 7.6%; II 1-6 copies; ID 0.13 (51 copies), in Terentiev Water Frog - EI 68.3%; II 6-32 copies; ID 3.31 (1246 copies), *Pelophylax* sp. - EI 56.9%; II 5-24 copies; ID 5.07 (1907 copies) and hybrid form - EI 76.0%; II 1-6 copies; ID 2.51 (947 copies).

Place of detection: recorded in all sites (Muminov et al. 1984, Ikromov et al. 2004, Ikromov 2006a, 2011, 2015, 2019).

Opisthioglype koisarensis
Dunganova, 1974

Definitive host: *Pelophylax* sp.

Localization: Intestines.

Infection rates: EI 8.6%; II 2-7 copies; ID 0.46 (174 copies).

Place of detection: the coast of lakes, springs and rice fields of the Yangikurgan and Mingbulok districts of Namangan region and the Bostonlyk district of Tashkent region (Ikromov & Azimov 2004, Ikromov et al. 2004, Ikromov 2006a, 2011, 2015, 2019).

Genus: *Telorchis* Lühe, 1899

Telorchis assula
(Dujardin, 1845),
larvae

Definitive hosts: Common and water snakes, yellowfin, common and steppe vipers.

We found the larval form of this species of trematoda in the tadpoles of a Terentiev Water Frog – *P. terentievi* and *Pelophylax* sp.

Localization: Intestines.

Infection rates: In Terentiev Water Frog - EI 0.54%; II 1-2 copies; ID 0.007 (3 copies) and *Pelophylax* sp. - EI 0.71%; II 1-4 copies; ID 0.015 (6 copies)

Place of detection: in the territory of Surkhandarya (Sherabad region) and Andijan (Pakhtabad region) regions (Ikromov & Azimov 2004).

Type: Acanthocephala Rudolphi, 1808
Class: Palaeacanthocephala (Meyer, 1931)
Order: Echinorhynchida Southwell & Macfie, 1925
Family: Echinorhynchidae Cobbold, 1879
Genus: *Acanthocephalus* Koelrenther, 1771

Acanthocephalus falcatus
(Frolich, 1788)

Definitive hosts: Pewzow's Toad – *B. pewzowi* and Turan Toad – *B. turanensis*

Localization: Intestines

Infection rates: Pewzow's Toad - EI 31.0%; II 2-6 copies; ID 1.16 (437 copies), Turan Toad - EI 23.1%; II 2-4 copies; ID 0.35 (135 copies)

Place of detection: Tashkent, Jizzakh, Namangan, Surkhandarya regions and Karshi city (Vashetko & Siddikov 1999, Ikromov & Azimov 2004).

Acanthocephalus ranae
(Schrank, 1788)

Definitive hosts: Perrin's Green Toad – *B. perrini*, Pewzow's Toad – *B. pewzowi,* Turan Toad – *B. turanensis*, Terentiev Water Frog – *P. terentievi, Pelophylax* sp. and hybrid form *P. terentievi* × *Pelophylax* sp.

Localization: Intestines.

Infection rates: In Perrin's Green Toad - EI 47.1%; II 2-9 copies; ID 1.54 (582 copies) in Pewzow's Toad - EI 32.2%; II 1-4 copies; ID 0.55 (209 copies), in Turan Toad - EI 39.7%; II 1-6 copies; ID 0.8 (301 copies), in Terentiev Water Frog - EI 8.4%; II 2-3 copies; ID 0.2 (77 copies), *Pelophylax* sp. - EI 6.9%; II 1-3 copies; ID 0.14 (54 copies) and hybrid form -EI 6.0%; II 2-8 copies; ID 0.33 (126 copies).

Place of detection: Jizzakh, Surkhandarya, Kashkadarya, Tashkent, Syrdarya, Bukhara and Navoi regions (Muminov et al. 1984, Vashetko & Siddikov 1999).

Genus *Pseudoacanthocephalus* (Petrotschenko, 1956)

Pseudoacanthocephalus bufonis
(Shipley, 1903)

The definitive hosts: Perrin's Green Toad – *B. perrini*, Pewzow's Toad – *B. pewzowi*, Turan Toad – *B. turanensis* and Terentiev Water Frog – *P. terentievi*.

Localization: Intestines.

Infection rates: In Perrin's Green Toad - EI 38.8%; II 2-9 copies; ID 1.07 (403 copies) in Pewzow's Toad - EI 24.0%; II 1-4 copies; ID 0.45 (172 copies), in Turan Toad - EI 31.1 %; II 2-6 copies; ID 0.55 (208 copies), in Terentiev Water Frog - EI 2.9%; II 2-3 copies; ID 0.06 (26 copies).

Place of detection: In the territory of Tashkent, Kashkadarya, Navoi, Jizzakh regions, in the southern part of the Ferghana Valley, as well as the city of Tashkent and Karshi (Vashetko & Siddikov 1999, Ikromov et al. 2004, Ikromov 2019).

Pseudoacanthocephalus bufonincola
(Kostylew, 1941)

Definitive host: Pewzow's Toad – *B. pewzowi*.

Localization: thin section of the intestine.

Infection rates: EI 15.5%; II 1-5 copies; ID 0.31 (119 copies).

Place of detection: In Tashkent, Jizzakh, Namangan (near the village of Gurumsaroy) regions and Karshi city (Vashetko & Siddikov 1999).

Order: Polymorphida Petrochenko, 1956
Family: Centrorhynchidae Van Cleave, 1916
Genus: *Centrorhynchus* Lühe, 1911

Centrorhynchus globocaudatus
Zeder, 1800,
larvae

Definitive host: Birds

We found the larval form of this species of hybrid form *P. terentievi* × *Pelophylax* sp.

Location: Body cavity, mesentery.

Infection rates: EI 4.3%; II 2-7 copies; ID 0.22 (84 copies).

Place of detection: On the territory of the Jizzakh region (Ikromov 2006b).

Genus: *Sphaerirostris* (Golvan, 1956)

Sphaerirostris picae
(Rudolphi, 1819),
larvae
Synonym *Centrorhynchus (Sphaerirostris) teres*
(Westrumb, 1821)

Definitive host: Birds.

We found the larval form of this species in Pewzow's Toad – *B. pewzowi* and Terentiev Water Frog – *P. terentievi*.

Localization: Body cavity, mesentery.

Infection rates: Pewzow's Toad - EI 15.1%; II 1-5 copies; ID 0.32 (121 copies) and in Terentiev Water Frog - EI 7.3%; II 2-3 copies; ID 0.17 (64 copies).

Place of detection: This parasite was mainly recorded in the Pewzow's Toad and in the Terentiev Water Frog which live in near-water biotopes of the Tashkent, Surkhandarya, Navoi regions, as well as the southern parts of the Ferghana Valley (Ikromov & Azimov 2004, Ikromov et al. 2004, Ikromov 2019).

Family: Plagiorhynchidae Golvan, 1960
Genus: *Plagiorhynchus Lühe, 1911*

Plagiorhynchus transversus
(Rudolphi, 1819),
larvae

Definitive host: Birds.

We found the larval form of this species in the Terentiev Water Frog – *P. terentievi* and hybrid form *P. terentievi* × *Pelophylax* sp.

Location: Body cavity, mesentery.

Infection rates: In Terentiev Water Frog - EI 1.3%; II 1-4 copies; ID 0.03 (13 copies), hybrid form - EI 0.7%; II 1-2 copies; ID 0.01 (4 copies).

Place of detection: Foothill zone of Tashkent, Surkhandarya, Navoi regions, as well as the southern parts of the Ferghana Valley (Ikromov & Azimov 2004, Ikromov et al. 2004, Ikromov 2006b).

Class: Archiacanthocephala (Meyer,1931)
Order: Gigantorhynchida Southwell & Macfie, 1925
Family: Gigantorhynchidae Hamann, 1892
Genus: *Mediorynchus* Van Cleave, 1916

Mediorhynchus papillosus
Van Cleave 1916,
larvae

Definitive host: Birds (passerines).

We found the larval form of this species in the *Pelophylax* sp.

Location: Body cavity.

Infection rates: EI 1.9%; II 2-3 copies; ID 0.03 (14 copies).

Place of detection: Khumsan and Bostonlyksky districts, Tashkent region (Ikromov 2006b, 2019).

Order: Oligacanthorhynchida Petrotchenko, 1956
Family: Oligacanthorhynchidae Southwell et Macfie, 1925
Genus: *Macracanthorhynchus* Travassos, 1915

Macracanthorhynchus catulinus
Kostylev, 1927,
larvae

Definitive hosts: Carnivorous mammals.

We found the larval form of this species in the Terentiev Water Frog – *P. terentievi* and hybrid form *P. terentievi* × *Pelophylax* sp.

Localization: Mesentery.

Infection rates: Terentiev Water Frog - EI 4.3%; II up to 5 copies; ID 0.11 (45 copies), hybrid form - EI 3.3%; II 1-4 copies; ID 0.09 (34 copies).

Place of detection: Sherabad district of the Surkhandarya region, as well as the Balykchinsky district of the Andijan region (Ikromov et al. 2004).

Type: Nemathelminthes Schneider, 1973
Class: Chromadorea Inglis, 1983
Order: Rhabditida Chitwood, 1933
Family: Acuariidae Railliet, Henry & Sisoff, 1912
Genus: *Agamospirura* Henry & Sisoff, 1913

Agamospirura magna
Sharpilo, 1963,
larvae

Definitive host: Unknown.

We found the larval form of this species of nematodes in a Pewzow's Toad – *B. pewzowi* and *Pelophylax* sp.

Localization: Intestine wall, mesentery.

Infection rates: In Pewzow's Toad EI 4.8%; II 2-7 copies; ID 0.15 (59 copies), *Pelophylax* sp. - EI 2.1%; II 1-6 copies; ID 0.1 (41 copies).

Place of detection: Near Yaz-Javan deserts in the territory of the Buvaidinsky district of the Ferghana region (Ikromov

et al. 2013, Ikromov 2019, Ikromov & Ikromov 2019).

Family: Ascarididae Baird, 1853
Genus: *Amplicaecum* Baylis, 1920

Amplicaecum schikhobalovi
Mosgovoy, 1950,
larvae

Definitive hosts: Terentiev Water Frog – *P. terentievi* and *Pelophylax* sp.

Localization: Body cavities, in the walls of internal organs.

Infection rates: In Terentiev Water Frog - EI 2.9%; II 2-5 copies; ID 0.09 (34 copies), *Pelophylax* sp. - EI 3.5%; II 1-3 copies; ID 0.07 (29 copies).

Place of detection: Bukhara, Samarkand, Syrdarya and Surkhandarya regions.

Family: Cosmocercidae (Railliet, 1916)
Genus: *Aplectana* Railliet et Henry, 1916

Aplectana acuminata
(Schrank, 1788)

Definitive hosts: Perrin's Green Toad – *B. perrini*, Pewzow's Toad – *B. pewzowi*, Turan Toad – *B. turanensis*, Terentiev Water Frog – *P. terentievi*, *Pelophylax* sp. and hybrid form *P. terentievi* × *Pelophylax* sp.

Localization: Intestines.

Infection rates: Perrin's Green Toad - EI 27.9%; II 1-6 copies; ID 0.53 (201 copies) in Pewzow's Toad - EI 25.3%; II 2-8 copies; ID 0.88 (331 copies), in Turan Toad - EI 21.5%; II 2-5 copies; ID 0.37 (142 copies), in Terentiev Water Frog - EI 8.4%; II 2-3 copies; ID 0.21 (82 copies), *Pelophylax* sp. - EI 5.7%; II 1-3 copies; ID 0.11 (45 copies) and hybrid form - EI 3.0%; II 2-4 copies; ID 0.1 (41 copies).

Place of detection: ubiquitous (Ikromov & Azimov 2001, Ikromov et al. 2004, Ikromov et al. 2013, Ikromov & Ikromov 2019).

Aplectana multipapillosa
Ivanitzky, 1940

Definitive hosts: Perrin's Green Toad – *B. perrini*, Pewzow's Toad – *B. pewzowi*, Turan Toad – *B. turanensis*, Terentiev Water Frog – *P. terentievi*, *Pelophylax* sp. and hybrid form *P. terentievi* × *Pelophylax* sp.

Localization: Rectum.

Infection rates: Perrin's Green Toad - EI 12.9%; II 3-8 copies; ID 0.39 (148 copies) in Pewzow's Toad - EI 16.0%; II 1-4 copies; ID 0.26 (99 copies), in Turan Toad - EI 18.8%; II 2-6 copies; ID 0.42 (158 copies), in Terentiev Water Frog - EI 10.3%; II 2-5 copies; ID 0.36 (137 copies), *Pelophylax* sp. - EI 8.8%; II 1-3 copies; ID 0.22 (86 copies) and hybrid form - EI 7.5%; II 2-7 copies; ID 0.4 (151 copies).

Place of detection: Tashkent, Bukhara, Surkhandarya, Syrdarya and Samarkand regions, Karakalpakstan (Ikromov & Azimov 2001, Ikromov et al. 2004, Ikromov et al. 2013, Ikromov & Ikromov 2019).

Genus: *Cosmocerca* Diesing, 1861

Cosmocerca commutata
(Diesing, 1851)

Definitive hosts: Perrin's Green Toad – *B. perrini*, Pewzow's Toad – *B. pewzowi,* Turan Toad – *B. turanensis*, Terentiev Water Frog – *P. terentievi, Pelophylax* sp. and hybrid form *P. terentievi* × *Pelophylax* sp.

Localization: Rectum.

Infection rates: In Perrin's Green Toad - EI 43.0%; II 2-8 copies; ID 1.79 (674 copies) in Pewzow's Toad - EI 37.1%; II 2-12 copies; ID 0.78 (294 copies), in Turan Toad - EI 32.2%; II 2-6 copies; ID 0.73 (276 copies), in Terentiev Water Frog - EI 14.4%; II 2-5 copies; ID 0.45 (172 copies), *Pelophylax* sp. - EI 11.9%; II 1-9 copies; ID 0.4 (154 copies) and hybrid form -EI 16.4%; II 2-8 copies; ID 0.9 (341 copies).

Place of detection: everywhere (Vashetko & Siddikov 1999, Ikromov & Azimov 2001, Ikromov et al. 2004, Ikromov et al. 2013, Ikromov 2019, Ikromov & Ikromov 2019).

Cosmocerca ornata
(Dujardin, 1845)

Definitive hosts: Terentiev Water Frog – *P. terentievi*, *Pelophylax* sp. and hybrid form *P. terentievi* × *Pelophylax* sp.

Localization: Rectum.

Infection rates: In Terentiev Water Frog - EI 23.7%; II 1-9 copies; ID 1.57 (594 copies), *Pelophylax* sp. - EI 17.7%; II 2-4 copies; ID 0.64 (244 copies), hybrid form - EI 14.5%; II 1-6 copies; ID 0.53 (202 copies).

Place of detection: Tashkent, Navoi, Jizzakh, Bukhara regions, as well as Karshi city and Tashkent (Vashetko & Siddikov 1999, Ikromov & Azimov 2001, Ikromov et al. 2013, Ikromov &Ikromov 2019).

Genus: *Cosmocercoides* Wilkie, 1930

Cosmocercoides skrjabini
(Ivanitzky, 1940)

Definitive hosts: Pewzow's Toad – *B. pewzowi* and *Pelophylax* sp.

Localization: Intestines.

Infection rates: in Pewzow's Toad - EI 4.0%; II 1-12 copies; ID 0.3 (116 specimens) and in *Pelophylax* sp. - EI 3.8%; II 2-4 copies; ID 0.13 (52 copies).

Place of detection: Mingbulak district of Namangan region (Ikromov et al. 2013; Ikromov & Ikromov 2019).

***Cosmocercoides* sp.**

Definitive host: Pewzow's Toad – *B. pewzowi*.

Localization: Intestines.

Infection rates: EI 2.8%; II 2-7 copies; ID 0.07 (29 copies).

Place of detection: Akhangaran district of Tashkent region (Ikromov et al. 2013, Ikromov & Ikromov 2019).

Genus: *Neoxysomatium* Ballesteros Marguez, 1945

Neoxysomatium brevicaudatum
(Zeder, 1800)

Definitive host: Pewzow's Toad – *B. pewzowi*.
Localization: Small intestine and rectum.
Infection rates: EI 15.1%; II 1-5 copies; ID 0.3 (113 copies)
Place of detection: Chinaz district of Tashkent region (Ikromov et al. 2013, Ikromov & Ikromov 2019).

***Neoxysomatium* sp.**

Definitive host: Pewzow's Toad – *B. pewzowi*.
Localization: Intestines.
Infection rates: EI 4.0%; II 2-3 copies; ID 0.05 (21 copies).
Place of detection: this nematode was found in the Chinaz district of Tashkent region (Ikromov et al. 2013, Ikromov & Ikromov 2019).

Genus: *Neoraillietnema* Ballesteros Marguez, 1945

Neoraillietnema praeputiale
(Skrjabin, 1916)

Definitive hosts: Perrin's Green Toad – *B. perrini* and Turan Toad – *B. turanensis*.
Localization: Rectum.
Infection rates: In Perrin's Green Toad - EI 19.6%; II 2-7 copies; ID 1.05 (398 copies), *B. turanensis* - EI 12.9%; II 2-5 copies; ID 0.64 (241 copies).
Place of detection: Northwest and southern regions of Uzbekistan (Ikromov & Azimov 2001, Ikromov et al. 2013, Ikromov & Ikromov 2019).

Genus: *Paraplectana* Rijikov, Sharpilo, Shevchenko, 1980

Paraplectana brumpti
(Travassos, 1931)

Definitive hosts: Pewzow's Toad – *B. pewzowi* and Turan Toad – *B. turanensis*.
Localization: Small intestine.
Infection rates: In Pewzow's Toad - EI 6.1%; II 1-5 copies; ID 0.14 (56 copies), Turan Toad -EI 3.2%; II 1-2 copies; ID 0.01 (5 copies).
Place of detection: Denovsky district of Surkhandarya region and Kasansay district of Namangan region (Ikromov et al. 2013, Ikromov & Ikromov 2019).

Family: Gongylonematidae Hall, 1916
Genus: *Gongylonema* Molin, 1857

Gongylonema pulchrum
(Molin, 1857),
larvae

Definitive hosts: Birds and mammals.
We found the larval form of this species of nematodes in Turan Toad – *B. turanensis* and Pewzow's Toad – *B. pewzowi*.
Localization: Stomach wall, liver and body cavity.
Infection rates: Turan Toad - EI 3.2%; II 2-6 copies; ID 0.05 (22 copies), Pewzow's Toad - EI 4.0%; II 2-3 copies; ID 0.06 (26 copies)
Place of detection: Surkhandarya, Andijan and Namangan regions and Tashkent city (Vashetko & Siddikov 1999, Ikromov et al. 2004, Ikromov 2006b, Ikromov et al. 2013, Ikromov 2019, Ikromov & Ikromov 2019).

Family: Kathlaniidae Lane, 1914
Genus: *Spironoura* Leidy, 1856

Spironoura govacus
Ikromov & Azimov, 2004

Definitive host: Pewzow's Toad – *B. pewzowi*,
Localization: Intestines.
Infection rates: EI 7.3%; II 2-4 copies; ID 0.15 (57 copies).
Place of detection: the village of "Serka Kirildi" of the Ohangaran district of the Tashkent region and the village of Gova of the Chust district of the Namangan region (Ikromov & Azimov 2003, Ikromov et al. 2013, Ikromov & Ikromov 2019).

Family: Molineidae Skryabin & Schulz, 1937
Genus: *Oswaldocruzia* Travassos, 1917

Oswaldocruzia filiformis
(Goeze, 1782)

Definitive hosts: Pewzow's Toad – *B. pewzowi*, Turan Toad – *B. turanensis*.
Localization: Small intestine.
Infection rates: In Pewzow's Toad - EI 22.8%; II 3-8 copies; ID 0.82 (311 copies), Turan Toad - EI 12.3%; II 1-4 copies; ID 0.16 (63 copies).
Place of detection: Tashkent, Jizzakh, Syrdarya regions and Karshi city (Ikromov & Azimov 2001, Vashetko & Siddikov 1999, Ikromov et al. 2013, Ikromov & Ikromov 2019).

Oswaldocruzia biolata
(Molin, 1880) Travassos, 1917

Definitive hosts: Perrin's Green Toad – *B. perrini*, Pewzow's Toad – *B. pewzowi*, Turan Toad – *B. turanensis*.
Localization: Intestines.
Infection rates: In Perrin's Green Toad - EI 7.3%; II 1-4 copies; ID 0.1 (41 copies), Pewzow's Toad - EI 5.3%; II 3-6 copies; ID 0.17 (64 copies), Turan Toad - EI 3.2%; II 1-2 copies; ID 0.02 (9 copies)
Place of detection: Tashkent, Bukhara, Surkhandarya region and Karshi city (Vashetko & Siddikov 1999, Ikromov & Azimov 2001, Ikromov et al. 2013, Ikromov & Ikromov 2019).

Family: Onchocercidae Leiper, 1911
Genus: *Foleyella* Seurat, 1917

Foleyella duboisi
(Gedoelst, 1916)

Definitive host: *Pelophylax* sp.
Location: Body cavity.

Infection rates: EI 2.3%; II 3-11 copies; ID 0.18 (71 copies).

Place of detection: Tashkent city (Vashetko & Siddikov 1999, Ikromov & Azimov 2001).

Family: Pharyngodonidae Travassos, 1919

Genus: *Gyrinicola* Yamaguti, 1938

Gyrinicola tba
Dinnik, 1930
Synonim *Thelandros tba*
(Dinnik, 1930) Volgar, 1959

Definitive hosts: Pewzow's Toad – *B. pewzowi* and *Pelophylax* sp.

Localization: Intestines.

Infection rates: in Pewzow's Toad - EI 5.7%; II up to 12 copies; ID 0.24 (91 copies) and in *Pelophylax* sp. - EI 4.0%; II 5-14 copies; ID 0.38 (145 copies).

Place of detection: The Kirghuli massif of Fergana city (Ikromov & Azimov 2001, Ikromov et al. 2013, Ikromov & Ikromov 2019).

***Gyrinicola* sp.**

Definitive host: *Pelophylax* sp.

Localization: Intestines.

Infection: EI 2.1%; II 2-4 copies; ID 0.05 (21 copies).

Place of detection: Altinkul district of Andijan region (Ikromov et al. 2004, Ikromov et al. 2013, Ikromov & Ikromov 2019).

Family: Quimperiidae Gendre, 1928 г.

Genus: *Subulascaris* Fraitas et Dobbin, 1957

***Subulascaris* sp.**

Definitive host: *Pelophylax* sp.

Localization: Intestines.

Infection rates: EI 3.3%; II 1-3 copies; ID 0.08 (33 copies).

Place of detection: Namangan and Syrdarya regions (Ikromov et al. 2013, Ikromov & Ikromov 2019).

Family: Rhabdiasidae Railliet, 1916

Genus: *Rhabdias* Stiles et Hassal, 1905

Rhabdias bufonis
(Schrank, 1788) Stiles & Hassall, 1905

Definitive hosts: Perrin's Green Toad – *B. perrini*, Pewzow's Toad – *B. pewzowi,* Turan Toad – *B. turanensis*, Terentiev Water Frog – *P. terentievi, Pelophylax* sp. and hybrid form *P. terentievi* × *Pelophylax* sp.

Localization: Lungs.

Infection rates: In Perrin's Green Toad - EI 67.3%; II 2-14 copies; ID 3.91 (1474 copies) in Pewzow's Toad - EI 72.2%; II 1-18 copies; ID 4.31 (1624 copies), in Turan Toad - EI 61.2%; II 2-16 copies; ID 2.59 (976 copies), in Terentiev Water Frog - EI 82.2%; II 5-24 copies; ID 4.76 (1792 copies), *Pelophylax* sp. - EI 77.0%; II 2-21 copies; ID 4.11 (1546 copies) and hybrid form - EI 66.8%; II 1-18 copies; ID 3.6 (1357 copies).

Place of detection: ubiquitous (Vashetko & Siddikov 1999, Kuchboev et al. 2002, Ikromov & Azimov 2004, Ikromov et al. 2004, Ikromov et al. 2013, Ikromov 2019, Ikromov &Ikromov 2019).

Rhabdias rubrovenosus
(Schneider, 1866)

Definitive hosts: Perrin's Green Toad – *B. perrini*, Turan Toad – *B. turanensis*.

Localization: Lungs.

Infection: In Perrin's Green Toad - EI 16.0%; II 4-7 copies; ID 0.48 (184 copies), in Turan Toad - EI 12.9%; II 2-6 copies; ID 0.36 (137 copies)

Place of detection: Bukhara, Kashkadarya and Surkhandarya regions (Kuchboev et al. 2002, Ikromov et al. 2013, Ikromov & Ikromov 2019).

Family: Spirocercidae Chitwood & Wehr, 1932

Genus: *Ascarops* Beneden, 1873

Ascarops strongylina
(Rud., 1819),
larvae

Definitive hosts: Mammals.

We found the larval form of this species of nematodes in Perrin's Green Toad – *B. perrini*, Pewzow's Toad – *B. pewzowi*.

Localization: Stomach wall and body cavity.

Infection rates: In Perrin's Green Toad - EI 7.3%; II 2-6 copies; ID 0.19 (74 copies), Pewzow's Toad - EI 4.8%; II 1-4 copies; ID 0.08 (32 copies).

Place of detection: In the Nurata district of the Navoiy region and Tashkent (Vashetko & Siddikov 1999, Ikromov 2006b, Ikromov 2019).

Genus: *Physocephalus* Diesing, 1861

Physocephalus sexalatus
(Molin, 1860),
larvae

Definitive hosts: Mammals.

We found the larval form of this species of nematodes in Turan Toad – *B. turanensis* and Pewzow's Toad – *B. pewzowi.*

Localization: Stomach wall, liver and body cavity.

Infection: In Turan Toad - EI 3.7%; II 2-6 copies; ID 0.09 (36 copies), Pewzow's Toad - EI 2.0%; II 1-5 copies; ID 0.03 (15 copies).

Place of detection: in the territory of Tashkent and Surkhandarya regions (Vashetko & Siddikov 1999, Ikromov 2006b, Ikromov 2019).

Genus: *Spirocerca* Railliet et Henry, 1917

Spirocerca lupi
(Rud. 1809),
larvae

Definitive hosts: Mammals.

We found the larval form of this species of nematodes in

Pewzow's Toad – *B. pewzowi*, Terentiev Water Frog – *P. terentievi*.

Localization: stomach wall, Intestines.

Infection rates: In Pewzow's Toad - EI 7.7%; II 3-11 copies; ID 0.4 (152 specimens) and in Terentiev Water Frog - EI 2.17%; II 2-4 copies; ID 0.06 (24 copies).

Place of detection: In the Namangan, Andijan and Surkhandarya regions (Ikromov et al. 2004, Ikromov 2006b, Ikromov et al. 2013, Ikromov 2019, Ikromov & Ikromov 2019).

Family: Strongyloididae Chitwood et Melntosh, 1934

Genus: *Strongyloides* Grassi, 1879

Strongyloides spiralis
(Grabda - Kazubska, 1978)

Definitive hosts: Pewzow's Toad – *B. pewzowi* and *Pelophylax* sp.

Localization: The mucous membrane of the rectum.

Infection rates: In Pewzow's Toad - EI 32.4%; II 4-37 copies; ID 1.68 (634 copies) and in *Pelophylax* sp. - EI 43.7 %; II 5-42 copies; ID 3.62 (1362 copies).

Place of detection: Syrdarya, Tashkent, Namangan, Andijan and Ferghana regions (Ikromov & Azimov 2001, Ikromov & Shakarbaev 2002, Ikromov et al. 2004, Ikromov et al. 2013, Ikromov 2019, Ikromov & Ikromov 2019).

***Strongyloides* sp. 1**

Definitive host: *Pelophylax* sp.

Localization: Small intestine.

Infection rates: EI 0.95%; II 1-2 copies; ID 0.015 (6 copies).

Place of detection: Pakhtabad district of Andijan region (Ikromov et al. 2004, Ikromov et al. 2013, Ikromov & Ikromov 2019).

***Strongyloides* sp. 2**

Definitive host: *Pelophylax* sp.

Localization: Small intestine.

Infection rates: EI 8.6%; II 2-5 copies; ID 0.25 (97 copies).

Place of detection: Buvaidinsky district of Ferghana region and Chinaz district of Tashkent region (Ikromov et al. 2013, Ikromov & Ikromov 2019).

Class: Enoplea Bezerra et al 2023

Order: Dioctophymatida Baylis & Daubney, 1926

Family: Dioctophymatidae Castellani & Chalmers, 1910

Genus: *Hystrichis* Dujardin, 1845

Hystrichis tricolor
Dujardin, 1845,
larvae

Definitive hosts: Birds.

We found the larval form of this species of nematodes in Terentiev Water Frog – *P. terentievi, Pelophylax* sp. and hybrid form *P. terentievi* × *Pelophylax* sp.

Localization: Intestinal mucosa.

Infection rates: In Terentiev Water Frog - EI 11.4%; II 1-5 copies; ID 0.36 (139 copies), *Pelophylax* sp. - EI 8.3%; II 2-6 copies; ID 0.38 (144 copies), hybrid form -EI 7.5%; II 2-3 copies; ID 0.22 (84 copies).

Place of detection: Tashkent, Jizzakh region and Karshi city (Vashetko & Siddikov 1999, Kuchboev et al. 2002, Ikromov 2006b, 2019, Ikromov & Ikromov 2019).

In total, 66 species (37606 individuals) of parasitic worms belonging to 5 classes have been registered in amphibians of Uzbekistan: Cestoda - 5 (3 at the larval stage), Trematoda - 23 (6 at the meta - and 1 - mesocercaria stage), Palaeacanthocephala - 7 (3 at the larval stage), Archiacanthocephala - 2 at the larval stages, Nematoda - 29 (7 at the larval stage) species. Of these, 16 species (Cestoda - 1, Trematoda - 4, Palaeacanthocephala - 2, Nematoda - 9) occur only in Perrin's Green Toad, 16 species (Cestoda - 1, Trematoda - 4, Palaeacanthocephala - 2, Nematoda - 9) in Pewzow's Toad, 32 species (Cestoda - 2, Trematoda - 7, Palaeacanthocephala - 5, Nematoda - 18) in Turan Toad, 22 species (Cestoda - 3, Trematoda - 5, Palaeacanthocephala - 3, Nematoda - 11) in Terentiev Water Frog, 28 species (Cestoda - 2, Trematoda - 13, Palaeacanthocephala - 4, Archiacanthocephala - 1, Nematoda - 8) in *Pelophylax* sp. 39 (Cestoda - 2, Trematoda - 19, Palaeacanthocephala - 1, Archiacanthocephala - 1, Nematoda - 16) in hybrid form and 19 (Cestoda - 1, Trematoda - 8, Palaeacanthocephala - 3, Archiacanthocephala - 1, Nematoda - 6) - in both amphibian species. 41 species are highly specific parasites of amphibians (Table.1)

As can be seen from Table 1, the species of helminths and the indicators of infection with them are not at the same level in amphibians. The largest number of 39 species of helminths is found in the amphibian *Pelophylax* sp., relatively less - 32 species to *B. pewzow*, less *P. terentievi* - 28, *B. turanensis* - 22 and Hybrid *P. terentievi* × *Pelophylax* sp. 19 species, the least 16 species belong to *B. perrini*. The analysis also showed great diversity in the degree of helminth infection of amphibians. Dominant species (over 70 percent) were not found at all among Cestodes and Acanthocephals. Among the trematodes, *Haematoloechus variegatus* and *Opisthioglyphe ranae*, and the nematode *Rhabdias bufonis* as the dominant species were noted to infect one or another amphibian.

The study identified new definitive and additional hosts for 18 helminth species in Uzbekistan. Notably, the *B. turanensis* was found to be the definitive and additional host for *Opisthioglyphe ranae, Joyeuxiella echinorhynchoides, larvae*, and the *B. pewzowi* was found to be the definitive host *Spironoura govacus, Pseudoacanthocephalus bufonincola, Mesocesdoides lineatus, Strongyloides spiralis, Aplectana multipapillosa, Cosmocercoides scrjabini, Neoxysomatium brevicaudatum*, and additional host for *Thelandros tba larvae*. The *P. terentievi* served as the definitive host for *Ophiotaenia (Batrachotaenia) ranae*, additional host for *Plagiorchis elegans, larvae*. The *Pelophylax* sp. served as the additional host for *Spirometra erinaceieuropaei, larvae, Mediorhynchus papillosus, larvae,* definitive host for *Sk. minimus, H. variegatus abbreviates, Haplometra cylindracea, O. koisarensis.*

Table 1. The composition of helminth species found in 5 species and 1 hybrid form of amphibians found in Uzbekistan and their damage levels. (D - Dominant species - 70%; Sub - Subdominant species 50%; C - Common species 30%; R - Rare species >10%; S - Very rare <10%. * - specific parasites of amphibians).

№	Species of helminths	Hosts					
		B. perrini	*B.pewzowi*	*B. turanensis*	P. terentievi	*Pelophylax* sp.	*Hybrid* P. terentievi × Pelophylax sp.
Cestoda							
1	*Nematotaenia dispar**	S	S	S	S	S	S
2	*Joyeuxiella echinorhynchoides, larvae*	-	-	S	-	-	-
3	*Mesocestoides lineatus, larvae*	-	S	S	-	-	-
4	*Spirometra erinaceieuropaei, larvae*	-	-	-	-	S	-
5	*Ophiotaenia (Batrachotaenia) ranae**	-	-	-	S	-	-
Trematoda							
6	*Alaria alata, larvae*	R	R	R	S	R	S
7	*Codonocephalus urnigerus, larvae*	S	S	S	R	S	R
8	*Strigea strigis, larvae*	-	-	R	S	-	-
9	*Diplodiscus subclavatus**	-	S	-	S	S	S
10	*Encyclometra colubrimurorum, larvae*	-	-	-	S	-	-
11	*Gorgodera cygnoides**	-	S	-	-	R	-
12	*G. asiatica**	-	-	-	S	R	-
13	*G. dollfusi**	-	-	-	-		S
14	*G. media**	-	-	-	S	S	S
15	*G. pagenstecheri**	-	S	-	-	S	
16	*Gorgoderina orientalis**	-	-	-	-	S	S
17	*G. vitelliloba**	-	-	-	S	S	
18	*Haematoloechus (Pn) variegatus**	R	R	S	D	D	D
19	*H. variegatus abbreviatus**	-	-	-	-	S	-
20	*Haplometra cylindracea**	-	-	-	-	S	-
21	*Plagiorchis elegans, larvae*	-	-	-	S	-	-
22	*Skrjabinoeces similis**	-	-	-	-	C	-
23	*Sk.minimus**	-	-	-	-	S	-
24	*Pleurogenoides medians**	-	-	-	S	S	-
25	*Dolichosaccus rastellus**	-	-	-	-	S	-
26	*Opisthioglyphe ranae**	S	S	S	Sub	Sub	D
27	*O. koisarensis**	-	-	-	-	S	
28	*Telorchis assula, larvae*	-	-	-	S	S	-
Acanthocephala							
29	*Acanthocephalus falcatus**	-	C	R	-	-	-
30	*Acanthocephalus ranae**	C	C	C	S	S	S
31	*Pseudoacanthocephalus bufonis**	C	R	C	S	-	-

(Table 1 – continued on the next page)

(Table 1 – continuation)

№	Species of helminths	Hosts					
		B. perrini	*B.pewzowi*	*B. turanensis*	P. terentievi	*Pelophylax* sp.	*Hybrid* P. terentievi × *Pelophylax* sp.
32	*Pseudoacanthocephalus bufonincola**	-	R	-	-	-	-
33	*Centrorhynchus globocaudatus, larvae*	-	-	-	-	-	S
34	*Sphaerirostris picae, larvae*	-	R	-	S	-	-
35	*Plagiorhynchus transversus, larvae*	-	-	-	S	-	S
36	*Mediorhynchus papillosus, larvae*	-	-	-		S	-
37	*Macracanthorhynchus catulinus, larvae*	-	-	-	S	-	S
Nemathelminthes							
38	*Agamospirura magna, larvae*	-	S	-	-	S	-
39	*Amplicaecum schikhobalovi, larvae*	-	-	-	S	S	
40	*Aplectana acuminata**	R	R	R	S	S	S
41	*A. multipapillosa**	R	R	R	R	S	S
42	*Cosmocerca commutata**	C	C	C	R	R	R
43	*C. ornata**	-	-	-	R	R	R
44	*Cosmocercoides skrjabini**	-	S	-	-	S	-
45	*Cosmocercoides* sp*	-	S	-	-	-	-
46	*Neoxysomatium brevicaudatum**	-	R	-	-	-	-
47	*Neoxysomatium* sp*	-	S	-	-	-	-
48	*Neoraillietnema praeputiale**	R	-	R	-	-	-
49	*Paraplectana brumpti*	-	S	S	-	-	-
50	*Gongylonema pulchrum, larvae*	-	S	S	-	-	-
51	*Spironoura govacus*	-	S	-	-	-	-
52	*Oswaldocruzia filiformis**	-	R	R	-	-	-
53	*O. biolata**	S	S	S	-	-	-
55	*Foleyella duboisi*	-	-	-	-	S	-
56	*Gyrinicola tba**	-	S	-	-	S	-
57	*Gyrinicola* sp*	-	-	-	-	S	-
58	*Subulascaris* sp	-	-	-	-	S	-
59	*Rhabdias bufonis**	Sub	D	Sub	D	D	Sub
60	*Rhabdias rubrovenosus**	R	-	R	-	-	-
61	*Ascarops strongylina, larvae*	S	S	-	-	-	-
62	*Physocephalus sexalatus, larvae*	-	S	S	-	-	-
63	*Spirocerca lupi, larvae*	-	S	-	S	-	-
64	*Strongyloides spiralis**	C	-	-	-	C	-
65	*Strongyloides* sp. 1*	-	-	-	-	S	-
66	*Strongyloides* sp. 2*	-	-	-	-	S	-
67	*Hystrichis tricolor, larvae*	-	-	-	R	S	S
Total		**16**	**32**	**22**	**28**	**39**	**19**

Discussions

Amphibians and their helminth fauna provide valuable insights into the state of an ecosystem within a region. The composition and infection indicators of helminths in amphibians are influenced by both biotic factors, such as the composition of flora and fauna, and abiotic factors, including the relief, microclimate, presence and characteristics of water bodies, illumination, and soil type. Studies by researchers such as Rohde (1979), Aho (1990), Hamann et al. (2013), and Chikhlyaev et al. (2018) have highlighted the significance of these factors in shaping the helminth fauna of amphibians.

The helminth fauna found in amphibians plays a crucial role as a component of the aquatic biocenosis, contributing to the overall species diversity and functioning of the ecosystem. The presence of parasites forms a distinct structural level within the ecosystem. As a biotic factor, the parasitic interactions influence the number of host species and have implications for the ecosystem's structure and functioning (Zaostrovtseva 2007).

It is important to note that certain helminth species found in amphibians can also pose health risks to humans and animals. For instance, *Alaria alata* (Goeze, 1782) is known to cause alariosis (Möhl et al. 2009), while cestodes like *Spirometra erinaceieuropaei* (Rudolphi, 1819) Mueller, 1937 can lead to diphyllobothriosis (Ikromov et al. 2020).

The initial data on the species composition of helminths in amphibians in Uzbekistan can be found in the work of Massino (Massino 1927). Subsequently, several studies were conducted on amphibian helminths in different biogeocenoses of Uzbekistan, including works by Belyaev et al. (1938), Kostylew (1941), Mozgovoy et al. (1956), Kogay (1961), Muminov et al. (1984), Siddikov & Vashetko (1994), Vashetko & Siddikov (1999), and Ikromov et al. (2004). However, it should be noted that the available data on amphibian helminths in Uzbekistan are fragmented and significantly outdated. These studies were conducted at different times and in various regions, resulting in limited coverage and incomplete information about the current helminth fauna of amphibians in the country.

The helminth fauna of the genus *Bufotes*, consisting mainly of larval and adult forms of nematodes, exhibits high infestation rates. This can be attributed to the terrestrial lifestyle of these amphibians, which exposes them to diverse and extreme habitat conditions (Ikromov & Azimov 2001, 2003, 2004, Ikromov 2006a, 2006b, 2019).

The helminth fauna of the genus *Pelophylax* is primarily composed of trematodes, encompassing both sexually mature and larval forms. The infection rates with these trematodes are notably high, which can be attributed to the aquatic lifestyle of the hosts and their broad dietary range (Ikromov & Azimov 2004, Ikromov et al. 2004, Ikromov 2006a, 2006b, Ikromov 2015, 2019, Ikromov & Ikromov 2019).

Based on the analysis of amphibian helminth fauna, it can be inferred that the invasion of helminths in amphibians is ecologically influenced and associated with their habitat preferences. *Pelophylax*, which primarily inhabits aquatic environments, exhibits a higher diversity of trematodes. On the other hand, Bufotes, which predominantly occupies terrestrial habitats, shows a higher prevalence of geohelminths, specifically nematodes. Thus, the type and intensity of helminth infections in amphibians are closely linked to their duration of stay in water or on land.

To date, the study of helminth fauna in tailless amphibians across adjacent territories of Uzbekistan remains fragmented. In Kazakhstan, for example, data is available only for the western and southern regions, where 14 helminth species have been documented between 1986 and 2012, including 7 trematodes, 2 acanthocephalans, and 5 nematodes (Tarasovskaya 2013). Similarly, studies by Ryzhikov et al. (1980) reported 9 helminth species in Kyrgyzstan, 20 species in Tajikistan, and 9 species in Turkmenistan.

When comparing the helminth fauna of amphibians in regions near and far from the study area, several helminth species were found in amphibians of the South Ural region: *Gorgodera varsoviensis* Sinitzin, 1905; *Gorgodera loossi* (Sinitzin, 1905); *Skrjabinoeces volgensis* Sudarikov, 1950; *Pleurogenes claviger* (Rudolphi, 1819); *Pleurogenes intermedius* Issaitchikow, 1926; *Brandesia turgida* (Brandes, 1888); *Prosotocus confusus* (Looss, 1894); *Strigea falconis* Szidat, 1928 (larvae); and *Strigea sphaerula* (Rudolphi, 1803) (larvae). In amphibians of Eastern Europe (Belarus), larvae of *Cathaemasia hians* (Rudolphi, 1819), *Astiotrema monticelli* Stossich, 1904, and *Paralepoderma cloacicola* (Luhe, 1909) were found. However, trematodes *Haematoloechus asper* (Looss, 1899) were not found in amphibians from Uzbekistan. These species are primarily trematodes, and their life cycle depends largely on the type and number of intermediate hosts, particularly molluscs (Zaripova et al. 2018, Ikromov et al. 2020).

The biological diversity of amphibian helminths in Uzbekistan comprises a total of 66 species. Among these, 42 species are found in the North-Eastern region, 40 species in the Eastern region, 38 species in the Southern region, 25 species in the Central region, and 17 species in the North-Western region. These findings indicate significant variation in helminth species composition across different regions of Uzbekistan.

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References

Aho, J.M. (1990): Helminth communities of amphibians and reptiles: comparative approaches to understanding patterns and processes. pp. 157-195. In: Parasite communities: patterns and processes. Esch G.W., Bush A.O., Aho J.M. (eds), Springer, Dordrecht.

Balogh, J. (1958): Lebensgemeinschaften der Landtiere, ihre Erforschung unter besonderer Berucksichtigung der zoozonologischen Arbeitsmetoden. Budapest.

Belyaev, K.V., Kovylkova, P., Kobaidova L. (1938): On the fauna of parasitic worms *Rana ridibunda* Pall. Suburbs of Tashkent. Proceedings of Asian University, Zoological sciences 32(12): 3-7.

Budak, A., Göçmen, B. (2014): Herpetology, 3rd Edition, Ege University Press, İzmir.

Betto-Colliard, C., Hofmann, S., Sermier, R., Perrin, N., Stock, M., (2018):

Profound genetic divergence and asymmetric parental genome contributions as hallmarks of hybrid speciation in polyploid toads. Proceedings of the Royal Society B 285: 2017-2667.

Chikhlyaev, I.V., Kirillova, N.Y., Kirillov, A.A. (2018): Ecological analysis of trematodes (Trematoda) of marsh frog Pelophylax ridibundus (Ranidae, Anura) from various habitats of the National Park «Samarskaya Luka» (Russia). Nature Conservation Research 3: 36–50.

Dufresnes, C., Mazepa, G., Jablonski, D., Caliari Oliveira, R., Wenseleers, T., Shabanov, D. A., Auer, M., Ernst, R., Koch, C., Ramírez-Chaves, H. E., Patrick Mulder, K., Simonov, E., Tiutenko, A., Kryvokhyzha, D., Wennekes, P. L., Zinenko, O. I., Korshunov, O. V., Al-Johany, A. M., Peregontsev, E. A., Masroor, R., Betto-Colliard, C., Denoël, M., Borkin, L. J., Skorinov, D. V., Pasynkova, R. A. Mazanaeva, L. F., Rosanov, J. M., Dubey, S., Litvinchuk, S. (2019): Fifteen shades of green: The evolution of Bufotes toads revisited. Molecular Phylogenetics and Evolution 106615. https://doi.org/10.1016/j.ympev.2019.106615.

Düşen, S., Öz, M. (2006): Helminths of the marsh frog, *Rana ridibunda* Pallas, 1771 (Anura: Ranidae), from Antalya Province, south-western Turkey. Comparative Parasitology 73: 121–129.

Düşen, S., Oğuz, M.C. (2008): Occurrence of *Pomphorhynchus laevis* (Acanthocephala) in the marsh frog (*Rana ridibunda* Pallas, 1771), from Turkey. Helminthologia 45: 154–156.

Düşen, S., Oğuz, M.C. (2010): Metazoan Endoparasites of Three Species of Anurans Collected from the Middle Black Sea Region of Turkey. Helminthologia 47 (4): 226-232.

Düşen, S., Oğuz, M. C., Barton D., P. Aral, A., Şulekoğlu, S., Tepe, Y. (2010): A Metazoan Parasitological Research of Three Species of Anurans Collected from the Çanakkale Province, Northwestern Turkey. North-Western Journal of Zoology 6 (1): 25-35.

Düşen, S. (2011): The helminth parasites of the bufonid toads, European Common Toad, *Bufo bufo* (Linnaeus, 1758) and European Green toad, *Bufo* (*Pseudepidalea*) *viridis* Laurenti, 1768 (Anura: Bufonidae), collected from Denizli Province, Inner-West Anatolia Region, Turkey. Helminthologia 48 (2): 101-107.

Düşen, S., Öz, M. (2013): Helminth fauna of the Eurasian marsh frog, *Pelophylax ridibundus* (Pallas, 1771) (Anura: Ranidae), collected from Denizli Province, Inner-West Anatolia Region, Turkey. Helminthologia 50 (1): 57-66.

Frost, D. (2022): Amphibian Species of theWorld: An Online Database. 2021. Available online: https://amphibiansoftheworld.amnh.org/

Hamann, M.I., Kehr, A.I., González, C.E. (2013): Biodiversity of trematodes associated with amphibians from a variety of habitats in Corrientes Province, Argentina. Journal of Helminthology 87(3): 286-300.

Ikromov, E.F., Azimov, D.A. (2001): Fauna and ecology of nematodes of amfibians in Uzbekistan. Russian Journal of Nematology 9(2): 144. [In Russian].

Ikromov, E.F., Shakarbaev, E. (2002): Detection of the nematode *Strongyloides spiralis* (Grabda-Kazubska, 1978) in the Lake Frog of Uzbekistan. Bulletin of chemical and biological sciences 1: 61-62 [In Russian].

Ikromov, E.F., Azimov, D.A. (2003): Two new species of nematodes found in amphibians and reptiles in the northern part of the Ferghana Valley of Uzbekistan. Parasitology 6: 512-516 [In Russian].

Ikromov, E.F., Azimov, D.A. (2004): Helminths of amphibians of the Ferghana Valley of Uzbekistan. Parasitology 38(1): 81-86 [In Russian].

Ikromov, E.F., Azimov, D.A., Cho M.R. (2004): The Helminth fauna of Lake frog *Rana ridibunda* Pallas, 1977 in Fergana valley of Uzbekistan. Journal of Asia-Pacific Entomology 7(2): 137-141.

Ikromov, E.F. (2006a): Trematodes of amphibians of the fauna of Uzbekistan. Bulletin of Karakalpak branch of Academy of Sciences of Uzbekistan 3: 28-29.

Ikromov, E.F. (2006b): The participation of amphibians and reptiles as intermediate and reservoir hosts for helminths in the host-parasite system. Vestnik NUUZ 1: 57-59.

Ikromov, E.F. (2011): A systematic review of helminths (Plathelminthes) of amphibians of Uzbekistan. Mathematical studies of the modern scientific-practical conference "Modern problems of biology and ecology", Makhachkala, 35-38 pp.

Ikromov, E.F, Ikromov, E.E., Egamberdiev, M. (2013): Taxonomic diversity of nematodes of amphibians of Uzbekistan. Materials of the scientific conference "Theoretical and applied problems of biodiversity of animals of Uzbekistan", Tashkent, 94-97 pp. [In Russian].

Ikromov, E.F. (2015): Trematodes lake Frog-*Rana ridibunda* Pall., 1770 Uzbekistan: fauna, distribution and ecology. Vesnik of Gulistan State University 57(2): 39-41. [In Russian].

Ikromov, E.F. (2019): Helminth fauna of amphibians, reptiles of Uzbekistan and factors of its formation. Bulletin of Karakalpak branch of UzAS 3: 40-43. [In Russian].

Ikromov, E.F., Ikromov E.E. (2019): Species and Ecological Diversity of Nematodes Amphibian Uzbekistan. International Journal of Science and Research 8(9): 1073-1075.

Ikromov, E.F., Ikromov E.E., Mikulich E.L. (2020): Geographical features of the helminth fauna of the lake frog in its two remote populations - Uzbekistan and Belarus. Scientific and Practical Journal of Animal Husbandry and Veterinary Medicine 36 (1): 50-54.

Kogay, E.S. (1961): On the fauna of intestinal helminths in the green toad (*Bufo viridis* Laurenti) of the Kzyl-Orda region and the seasonal dynamics of their development. DAN Uz SSR 2: 60-63 [In Russian].

Kostylew, N.N. (1941): A new species of acanthcephalus from the toads of Central Asia: Proceedings of the Military-Med. Acad. them -S.M. Kirov. A collection of works dedicated, 30th anniversary of scientific activist Acad, Pavlovsky 25: 341-345 [In Russian].

Koyun, M., Birlik, S., Sümer, N., Yıldırımhan, S.H. (2015): Helminth fauna of Eurasian marsh frog, *Pelophylax ridibundus* (Pallas, 1771) (Anura: Ranidae) from Bingol, Eastern Anatolia, Turkey. Biharean Biologist 2: 128–132.

Kuchboev, A.E., Shakarboev, E.B., Kucharova, I.S. (2002): Helminths of amphibians of Uzbekistan. Uzbek Biology Journal 1: 39-43 [In Russian].

Litvinchuk, S.N., Borkin, L.J., Skorinov, D.V., Mazepa, G.A., Pasynkova, R.A., Dedukh, D.V., Krasikova, A.V., Rosanov, J.M. (2012): Unusual triploid speciation in green toads Bufo viridis group in High-altitude Asia. pp. 160-165. In: Novitskiy, R.V. (Ed.), Problems of Herpetology. Minsk, Belarus.

Litvinchuk, S.N., Svinin, A.O., Dujsebayeva T.N. (2021): Morphological differentiation between diploid and polyploid species of green toads (Anura: Bufonidae: Bufotes) in Central Asia. Bonn Zoological Bulletin 70 (2): 361–371.

Massino, B.G. (1927): Ninth Allied helminthological expedition to old Bukhara. In: Activities of twenty-eight helminthols. Expedition in the USSR (1919-1925): Moscow, GIEV, 126–132 [In Russian].

Mazepa, G. (2013): Evolution of Water Frogs Pelophylax in Central Asia: How Hybridization and Mitochondrial Introgression among Ecologically Divergent Species Promote Occupation of Novel Environment. Master's Thesis, Uppsala University, Uppsala, Sweden. Available online: https://www.researchgate.net/publication/361727081 (accessed on 19 August 2022).

Mozgovoy, A.A., Ryzhikov, K.M., Sudarikov V.E. (1956): The work of the 289th allied helminthological expedition 1952-1953 in the areas of the Amu Darya delta and the Murghab basin. Tr. GELAN AN USSR. Moscow, 8: 38-39 [In Russian].

Möhl, K., Grobe, K., Hamedy, A., Wüste, T., Kabelitz, P., Lücker, E. (2009): Biology of *Alaria* spp. and human exposition risk to Alaria mesocercariae. Parasitology Research 105: 1–15.

Muminov, P.A., Sultanov, M.A., Mavlyanova, R.D. (1984): Helminths of reptiles. In: Ecology of animal parasites of the north-east of Uzbekistan. Tashkent.

Plötner, J., Baier, F., Akin, C., Mazepa, G., Schreiber, R., Beerli, P., Litvinchuk, S.N., Bilgin, C.C., Borkin, L., Uzzell, T. (2012): Genetic data reveal that water frogs of Cyprus (genus *Pelophylax*) are an endemic species of Messinian origin. Zoosystematics and Evolution 88(2): 261 - 283.

Rohde, K. (1979): A critical evaluation of intrinsic and extrinsic factors responsible for niche restriction in parasites. American Naturalist 114: 648-671.

Ryzhikov, K.M., Sharpilo, V.P., Shevchenko N.N. (1980): Helminths of amphibians of the fauna of the USSR. M.: Nauka. [In Russian].

Sağlam, N., Arıkan, H. (2006): Endohelminth fauna of the marsh frog *Rana ridibunda* from Lake Hazar, Turkey. Disease Aquatic Organism 72: 253–260.

Shakarboev, E.B. (2007): The distribution of vertebrate trematodes in Uzbekistan. Uzbek Biological Journal 5: 58-61 [In Russian].

Siddikov, B.H., Vashetko, E.V. (1994): On ecology of helminths of toads in Tashkent and vicinity. Eighth International Congress of Parasitology, İzmir-Turkey.

Skrjabin, K.I. (1928): The method of complete helminthological dissections of vertebrates, including humans. Publishing House of Moscow State University, Moskow. [In Russian].

Stock, M., Moritz, C., Hickerson, M., Frynta, D., Dujsbayeva, T., Eremchenko, V., Macey, J.R., Papenfuss, T.J., Wake, D.B. (2006): Evolution of mitochondrial relationships and biogeography of Palearctic green toads (Bufo viridis group) with insights in their genome plasticity. Molecular Phylogenetics and Evolution 41: 663-689.

Tarasovskaya, N.E. (2013): Seasonal dynamic of infection of moor frog by nematodes *Rhabdias bufonis* from flood-land landscapes of Irtysh river. Vestnik Kazakh National University 2(58): 99 – 105 [in Russian].

Ualiyeva, D., Ermakov, O.A., Litvinchuk, S.N., Guo, X., Ivanov, A.Yu., Xu, R., Li. J., Xu, F., Arifulova, I.I., Kaptyonkina, A.G., Khromov, V.A., Krainyuk, V.N., Sarzhanov, F., Dujsebayeva, T.N. (2022): Diversity, Phylogenetic Relationships and Distribution of Marsh Frogs (the Pelophylax ridibundus complex) from Kazakhstan and Northwest China. Diversity 14(10): 869. https://doi.org/10.3390/d14100869.

Vashetko, E.V., Siddikov, B.H. (1999): The effect of the ecology of toads on the distribution of Helminths. Turkish Journal of Zoology 1(23): 107-110.

Yıldırımhan, H.S., Uğurtaş, İ.H., Altunel, F.N. (1996): An investigation of helminths of *Rana ridibunda* Pallas, 1771 (marsh frogs). Turkısh Journal of

Parasitology 20: 113–130.
Yıldırımhan, H. S., Oğuz, M. C., Uğurtaş, İ. H. (1997): Bursa ve çevresinden yakalanan bazı kuyruksuz kurbağaların (*Rana ridibunda*, *Bufo bufo, Pelobates syriacus*) nematodları üzerine bir araştırma. Hacettepe Fen ve Mühendislik Bilimleri Dergisi 18: 45-58.
Yıldırımhan, H.S. (1999): Researches on parasitic helminths of *Bufo viridis* Laurenti, 1768 Anura: Amphibia). Turkish Journal of Zoology 23: 177–195.
Yıldırımhan, H.S., Karadeniz, E., Gurkan, E. and Koyun, M. (2005): Metazoon parasites of the marsh frog (*Rana ridibunda* Pallas, 1771; Anura) collected from the different regions in Turkey. Acta Parasitologica Turcica 29: 135-139.
Zaostrovtseva, S.K. (2007): Ecological and faunistic analysis of the parasitic fauna of fish of the Vistula Gulf, the Pregolya and Prokhladnoy rivers. Biological Sciences, Kaliningrad. [In Russian].
Zaripova F. F., Fayzulin A. I., Mikhailov R. A. (2018) On the fauna of helminths of tailless amphibians of the Southern Urals. Izvestiya Samarskogo nauchnogo tsentra Rossiyskoy akademii nauk, Bulletin of the Samara Scientific Center of the Russian Academy of Sciences 20 (5-4): 559-563 [In Russian].
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**** https://www.gbif.org/