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Checklist of the earthworm fauna (Oligochaeta: Lumbricidae) of Uzbekistan

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Abstract. *Abdullaev I, Bekchanova M, Gandjaeva L, Kholmatov B, Raxmatullayev A, Tajiyev Z, Razzakov K, Matyakubov Z, Doschanova M, Ruzmetov R. 2023. Checklist of the earthworm fauna of Uzbekistan (Oligochaeta: Lumbricidae). Biodiversitas 24: 4392-4401.* This article presents a checklist of the earthworm fauna (Lumbricidae) of Uzbekistan based on published records and the authors' data. This is the first checklist for Uzbekistan, which contains complete information on the ecological category, habitat, type of distribution and distribution of 28 species of earthworms in 4 regions of Uzbekistan. The currently known, based on our research, earthworm fauna of Uzbekistan, includes 23 species, 5 subspecies belonging to 9 genera. Of them, 3 species (*Perelia persiana, Perelia turcmenica, Lumbricus rubellus*) are new to Uzbekistan. *Perelia* is the species-richest genus (12 species). These earthworms are distributed Kyzylkum desert region along river banks, in the mountainous regions of Pomiro Alai and Tien Shan biogeographic region, which is mostly covered with forest or autochthonous flora. The earthworm fauna is more diverse in forests of the northern and in the mountains of the southern parts of Uzbekistan. Literature data and our present study showed that there are no earthworms in the Ustyurt Plateau, due to the fact that the soils of the Ustyurt Plateau are gypsum, saline, and infertile.

Keywords: Earthworm, Lumbricidae, Oligochaeta, Uzbekistan

INTRODUCTION

Earthworms are members of phylum Annelida and class Oligochaeta, living in different strata of soil. More than 4400 species of earthworms are found worldwide (Sharma and Garg 2018; Singh et al. 2019). About 33 lumbricid species have become naturalized around the world, but the bulk of the species are in the Holarctic region. The region of Central Asia with the adjacent areas is one of the partially researched regions of CIS (Commonwealth of Independent States) as far as the lumbricid fauna is concerned (Abukenova 2013). According to Juginisov et al. 2022, Uzbekistan represents one of the earthworm biodiversity hotspots in Central Asia. In Uzbekistan, studies of the fauna and ecology of earthworms are scarce. Only very few reports are available on Uzbekistan's arable lands (Hackenberger and Hackenberger 2013; Atabak et al. 2021). These studies mainly deal with the influence of chemical and organic fertilizers on the population dynamics of earthworms and their role in plant productivity (Rakhmatullaev 2022). Indiscriminate flood irrigation with poor drainage facilities, deep plowing of marginal and naturally saline soils, overexploitation of groundwater, recycling of drainage outflows for irrigation, and mono-cropping of high water consumptive crops (e.g., cotton) are the major factors accelerating secondary soil salinization in the Central Asian region of Uzbekistan. In 1990, about 48% of the total irrigated lands were suffering from soil salinity. By 2000, salinity had increased to 64% of the total irrigated lands (Rakhmatullaev 2022).

The research on earthworms in Uzbekistan started at the beginning of the 20th century (Atabak et al. 2021). For the first time, earthworms were collected by Fedchenko in 1871 (Rakhmatullaev 2022). Collected materials were processed and systematically analyzed by Michaelsen Perel, who developed a systematic classification of lumbricid of six orders; one suborder was based on new taxonomic characters (Szederjesi et al. 2014; Latif et al. 2017). The diversity and distribution of earthworms in Uzbekistan were reported in studies by Juginisov et al. (2022). Furthermore, Rakhmatullaev (2022) established a total of 9 new species and 2 subspecies for Uzbekistan Rakhmatullaev et al. (2010) have compiled all available literature data from various authors and added their results in an extensive monograph on earthworms in the southern part Uzbekistan. There are 21 earthworm species distributed in Uzbekistan soils (Rakhmatullaev 2022). In subtropical and tropical regions, there is a wider variation in species rather than species richness (Zhang et al. 2014; Nguyen et al. 2016). Eleven species have been reported from cultivated, non-cultivated, grassland, and garden soils (Mounpria et al. 2015). A total of 10 number of endemic species are in our republic, which in turn may be related to the region's different soil and climatic conditions (Rakhmatullaev 2022).

The species P*erelia arnoldiana, Perelia umbrophila* and *Perelia ophiomorpha* are endemic to Uzbekistan (taxo.drilobase.org; gbif.org). The poor diversity of earthworms in Uzbekistan soils may be attributed to climatic conditions, as well as soil properties of the region, since Uzbekistan climate is hot and dry (arid), and the texture of the soil in this arid region is primarily clay. Lee (1985) and Nguyen et al. (2016) reported earlier that earthworms are generally absent or rare in soils with coarse texture, probably due to the susceptibility of such soils to drought.

Rakhmatullaev and Mavlanov studied the distribution of 5 dominant species of earthworms (*Aporrectodea caliginosa caliginosa, Aporrectodea c. trapezoides, Aporrectodea jassyensis, Dendrobaena byblica,* and *Octolasion lacteum*) under lucerne in serozem soils of Uzbekistan. Species of earthworms such as *Perelia taschkentensis, Perelia kaznakovi, Perelia graciosa, Dendrobaena byblica, A. caliginosa trapezoides, A. caliginosa caliginosa, Aporrectodea rosea, Dendrodrilus veneta, Eisenia fetida, Eiseniella tetraedra,* and *Octolasion lacteum* are distributed in the mountain areas of the north eastern part of Uzbekistan. *A. jassyensis* was present only in valleys and lowland areas where soil was characterized as calcareous serozem (Rakhmatullaev et al. 2010; Latif et al. 2017).

The difference in the number of species between Rakhmatullaev's work and the current checklist is the result of several issues. Firstly, the collection activities in the past were not equally distributed and were not sampled in some parts of Uzbekistan; therefore, it was reasonable to expect new species. This was confirmed with our work. Firstly, based on our own previously unpublished data, *Perelia persiana* Michaelsen, *Perelia turcmenica* Malevic, *Lumbricus rubellus* Hoffmeister are new for Uzbekistan. Secondly, in this work, we have updated the lumbricid nomenclature to 23 species, 5 subspecies according to Rakhmatullaev (Rakhmatullaev et al. 2010; Atabak et al. 2021). The current checklist integrates published data related to the Uzbekistan territory and the authors' records. Each species is provided with information on its specific habitat, notation on the ecological group, species' zoogeographical type of distribution and distribution in Uzbekistan. The data presented in this paper is useful not only for agronomists and biologists but also for agencies and decision-makers about natural resource issues, especially land use farms, climate change, and pollution.

MATERIALS AND METHODS

Study area

The distribution of species in Uzbekistan is generally described according to the presence of species in biogeographic regions current in Uzbekistan: Ustyurt Plateau, Kyzylkum desert, Pomiro Alai, Tien Shan (Figure 1). The Republic of Uzbekistan is located between the Amudarya and Syrdarya Rivers, and its total area is 448,900 km^2. The territory of the republic is 1,425 km from east to west and 930 km from north to south. 1/5 of the territory of the republic is made up of mountain and sub-mountain regions.

The eastern region consists of medium and high mountain relief. The country includes the slopes of the Western Tien-Shan (Ugam, Pskem, Chatkal, and Kurama mountain ranges) and Pamir-Alai (Zarafshan, Turkestan, Hisar, Kohitangtog, and Boysuntog mountain ranges) mountains. The study area is included in the "continental mountainous", irrigation and steppe zone of Uzbekistan. The northeast of Uzbekistan is between the western part of the Tien Shan mountains and the Syrdarya River. Most of the territory of the Tashkent region is an alluvial bench. In the north and northeast-the Western Tien Shan ranges up to 4299 m high. The region borders the north and northwest of Kazakhstan, the northeast of Kyrgyzstan, the east of the Namangan region, the south of Tajikistan, and the southwest of the Syrdarya region. The Northeast biogeographic regional part of Uzbekistan is situated between the western part of the Tien Shan Mountains and the Syrdarya River.

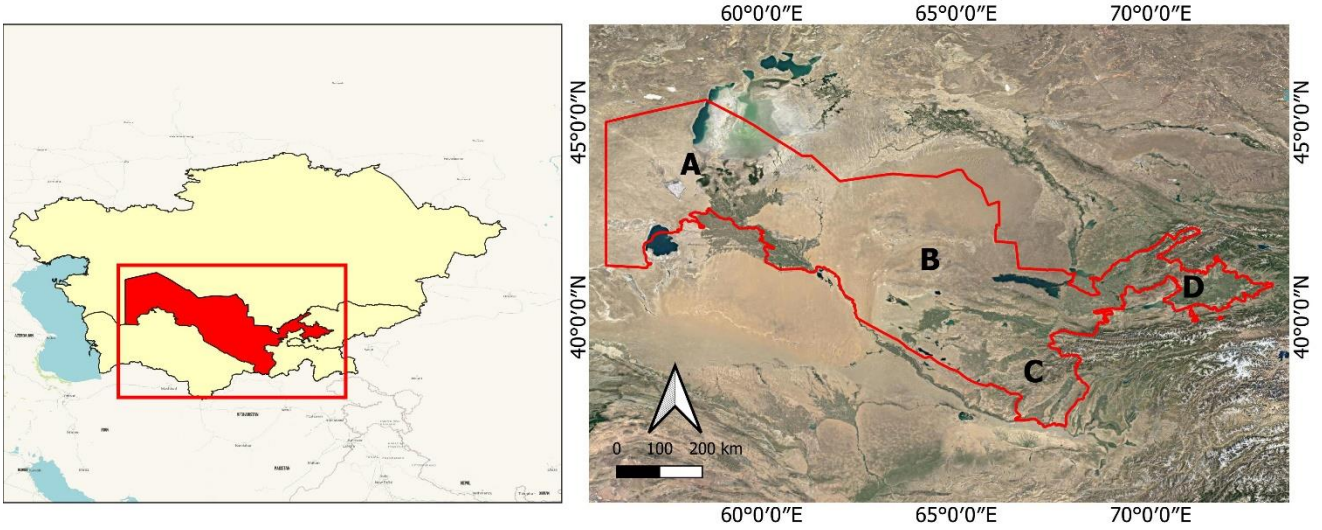

Figure 1. Biogeographic regions in Uzbekistan (UNDP 2015). A. Ustyurt Plateau, B. Kyzylkum desert, C. Pomiro Alai, D. Tien Shan

The northwestern biogeographic region covers the northern part of Uzbekistan (The Republic of Karakalpakistan and Khorezm region) and is characterized by a continental climate with hot summers and cold winters. A high percentage of this region is covered with natural (steppe, desert) and semi-natural habitat species. The area is a lowland located in the northwestern part of Uzbekistan, along the lower reaches of the Amudarya River, between 60'-61' longitude and 41'-42' latitude, at 113-138 m above sea level. The vegetation period of plants is 200-210 days. The climate is extremely continental, with an average annual precipitation of 80-90 mm. The average temperature is -14.8°C in January and +30.2°C in July. Meadow, meadow-marsh, marsh-sandy, and traditional alkali soils predominate (Khamraev et al. 2007; Abdullaev et al. 2020; Ruzmetov et al. 2020). The deserts of Kyzyl-Kum and Kara-Kum greatly influence the climate of the oasis. The region is in the steppe zone, in the western part of the Khorezm oasis and the southern part of the Aral Sea, 100 m above sea level. The relief consists of a low plain. It is the old Amu-Darya Delta and it consists of river sediments. The western and southwestern parts of the region connecting with Kara-Kum are covered with sand (Abdullaev et al. 2002; Ruzmetov et al. 2022).

Methods

The species composition of earthworms of steppe, forest, and mountain ecosystems in Uzbekistan was assessed according to modern research. Quantitative collections were carried out according to the generally accepted method. Earthworms were collected by the formaldehyde dilution method Raw (Farhadi et al. 2013) and complemented with digging and hand-sorting. Earthworms appearing on the soil surface with the formalin applications were placed in 20% alcohol for approximately 5 minutes to be anesthetized and killed. The earthworms were thereafter preserved in 4% formaldehyde. In the TSBF and larger monolith samples, the earthworms were hand-sorted from the soil. In the laboratory, adult earthworms were identified to the genus (immatures) or the species level; identification at the species level was made using a stereoscopic microscope of 100× magnification. The samples were analyzed according to the methodology described by Raij (Nguyen et al. 2017). The specimens collected were killed in 4% formalin, then transferred into 75% ethanol and deposited in the earthworm collection of the Institute of Zoology (CZIUz) of the Academy of Sciences of the Republic of Uzbekistan and earthworm collection Khorezm Academy Mamun (CMAUz). In addition, new materials collected in various regions of Uzbekistan (Amu-Darya Delta, etc.) were also examined. Apart from literature data, habitat characterization was also made according to personal field observations.

All data, both literature and authors' records, were georeferenced and the species distribution maps (Figures 2A, B, and 3-6) were made using the GIS software (Hijmans et al. 2020). The data on synonymies of genus and species were taken from Atabak et al. (2021), Rakhmatullaev (2022) and DriloBASE 2023. The source of habitat data of each species was taken from our data.

RESULTS AND DISCUSSION

Results

In the course of excavations and route studies in 4 regions of Uzbekistan (mountainous regions, intrazonal relict mounds, oases, as well as anthropogenic biotopes and other regions), we found out that 28 types of earthworms are distributed in 3 regions of Uzbekistan. (Figures 2-7); 3 species (*Perelia persiana, Perelia turcmenica, Lumbricus rubellus*) are new to fauna Uzbekistan. Identified 28 species of earthworms are new to the fauna of the northwestern part of Uzbekistan. All the found species belong to 9 genera *(Perelia, Aporrectodea, Eisenia, Eiseniella, Octolasion, Dendrobaena, Dendrodrilus, Bimastos, Lumbricus*). The genus *Perelia (Allolobophora)* is one of the most ancient groups among the Lumbricidae, which took shape as early as the Mesozoic period (Marchán et al. 2021). Many endemic species distributed in South Uzbekistan belong to it (DriloBASE 2023).

Species composition of earthworm fauna of Uzbekistan

Class: Oligochaeta

Family: Lumbricidae

Genus: *Perelia* (Easton 1983)

Synonyms: *Allolobophora (Svetlovia)* Perel, 1976: *Alpodinaridella (Alpodinaridella)* Mrsic, 1987: *Alpodinaridella (Dinaridella)* Mrsic, 1987.

Species: ***Perelia taschkentensis*** *(Michaelsen 1900)*

Synonyms: *Allolobophora taschkentensis* Michaelsen, 1900: 8.

Climate zone: N/A (Not Assessed, or No Answer)

Habitat: N/A (http://taxo.drilobase.org); Synanthropic species, anthropogenic soils, gardens (Our research and literature data).

Distribution: Tien Shan region. (CZIUz) 2 ex., In Tashkent region, Bustonlik District, Chimyan. Sirdaryo region, leg (Omodeo 1959; Rakhmatullaev et al. 2010; Rakhmatullaev 2022; Asirovic 2011)

Species: ***Perelia kaznakovi*** *(Michaelsen 1910)*

Synonyms: *Helodrilus kaznakovi* Michaelsen, 1910: 16; *Eophila asiatica* Malevic, 1949: 123; *Helodrilus (Eophila) kaznakovi* Perel, 1976: 173; *Perelia kaznakovi* Easton, 1983: 181.

Climate zone: N/A

Habitat: N/A (http://taxo.drilobase.org); agrocenosis, anthropogenic soils, gardens (Our research and literature data).

Distribution: Tien Shan region. (CZIUz) 4 ex., In Tashkent region, Bustonlik District, Sidjak, Bildirsoy, Oksakota, Chotkol (Csuzdi and Pavlicek 2005; Rakhmatullaev et al. 2010; Rakhmatullaev 2022; Asirovic 2011).

Species: ***Perelia ferganae*** *(Malevic 1949)*

Synonyms: *Eophila ferganae* Malevic, 1949: 399; *Allolobophora ferganae* Malevic, 1949: 312.

Climate zone: N/A

Habitat: N/A (http://taxo.drilobase.org); agrocenosis, anthropogenic soils, gardens (Our research and literature data).

Distribution: Tien Shan region. (CZIUz) 11 ex., In Tashkent region, Chirchik District, Bustonlik District Korjantag, Ugam, Humson, Chorvok, Fergana region, Fergana mountains, Namangan region, Chortok, Turakurgan, Pop districts, Andijan region, Balikchi, Chinobod districts, leg. (Rakhmatullaev et al. 2010; Rakhmatullaev 2022; Asirovic 2011)

Species: ***Perelia arnoldiana*** *(Perel 1971)*

Synonyms: *Eophila arnoldiana* Perel, 1971: 1323; *Allolobophora arnoldiana* Perel, 1971: 121.

Climate zone: N/A

Habitat: N/A (http://taxo.drilobase.org); Forest, anthropogenic soils, gardens (Our research and literature data).

Distribution: Kyzylkum desert region. (CMAUz) 3 ex., In Khorezm region, Khanka and Tuprakkal'a districts, Bukhara region, Gazli District, Uch uchak, leg. (Rakhmatullaev et al. 2010; Bekchanova and Abdullaev 2022)

Species: ***Perelia chlorocephala*** *(Perel 1977)*

Synonyms: *Allolobophora chlorocephala* Perel, 1977: 497.

Climate zone: N/A

Habitat: N/A (http://taxo.drilobase.org); agrocenosis, tukay, anthropogenic soils, gardens (Our research and literature data).

Distribution: Kyzylkum desert, Pomiro Alai regions. (CMAUz) 4 ex., In Karakalpakstan Republic, Beruniy District, Khorezm region, Khiva District, Bukhara region, Olat District, Navoi region, Nurota District, leg. (Rakhmatullaev et al. 2010; Bekchanova and Abdullaev 2022).

Species: ***Perelia microtheca*** *(Perel 1977)*

Synonyms: *Allolobophora (Svetlovia) microtheca* Perel, 1977: 495.

Climate zone: N/A

Habitat: N/A (http://taxo.drilobase.org); Tukay, agrocenosis, anthropogenic soils, gardens (Our research and literature data).

Distribution: Kyzylkum desert, Pomiro Alai, Tien Shan regions. (CMAUz) 4 ex., In Karakalpakstan Republic, Turtkul District, Khorezm region, Urgench and Khazarasp districts, Navoi Region, Karmana District, leg. (Rakhmatullaev et al. 2010; Bekchanova and Abdullaev 2022)

Species: ***Perelia graciosa*** *(Perel 1977)*

Synonyms: *Allolobophora (Svetlovia) graciosa* Perel, 1977: 498.

Climate zone: N/A

Habitat: N/A (http://taxo.drilobase.org); synanthropic species, forest, gardens (Our research and literature data).

Distribution: Tien Shan region. (CZIUz) 8 ex., In Tashkent region, Bustonlik and Parkent districts Chotkol, Korjantag, Ugam, Humson, Sidjak, Chorvok, Bildirsoy, Oksakota, leg. (Rakhmatullaev et al. 2010; Rakhmatullaev 2022).

Species: ***Perelia umbrophila*** *(Perel 1977)*

Synonyms: *Allolobophora (Svetlovia) umbrophila* Perel, 1977: 499.

Climate zone: N/A

Habitat: N/A (http://taxo.drilobase.org); synanthropic species, anthropogenic soils, forest (Our research and literature data).

Distribution: Tien Shan region. (CZIUz) 6 ex., In Tien Shan region. Tashkent region, Bustonlik District, Korjantag, Ugam, Humson, Sirdaryo region, Havas District, Fergana region, Fergana mountains, Namangan region, Pop districts, leg. (Rakhmatullaev et al. 2010; Rakhmatullaev et al. 2022).

Species: ***Perelia ophiomorpha*** *(Perel 1977)*

Synonyms: *Allolobophora ophiomorpha* Perel, 1977: 499; *Allolobophora ophimorpha* Rakhmatullaev and Egamberdieva 2010: 12.

Climate zone: N/A

Habitat: N/A (http://taxo.drilobase.org); agrocenosis, synanthropic species, anthropogenic soils, gardens (Our research and literature data).

Distribution: Kyzylkum desert, Tien Shan regions. (CMAUz) 1 ex., In Khorezm region, Yangibazar districts, leg. (Bekchanova and Abdullaev 2022); (CZIUz) 4 ex., In Tien Shan region. Tashkent region, Parkent district, Chatkal Ridge (Suqoq), Namangan region, Chortok, Turakurgan, Andijan region, Chinobod District, leg. (Rakhmatullaev et al. 2010; Rakhmatullaev 2022).

Species: ***Perelia stenosoma*** *(Perel 1977)*

Synonyms: *Allolobophora (Svetlovia) stenosoma* Perel, 1977: 500.

Climate zone: N/A

Habitat: N/A (http://taxo.drilobase.org); tukay, anthropogenic soils, gardens (Our research and literature data).

Distribution: Kyzylkum desert, Tien Shan regions. (CMAUz) 1 ex., In Khorezm region, Gurlan districts, leg. (Bekchanova and Abdullaev 2022); (CZIUz) 4 ex., In Tien Shan region. Tashkent region, Parkent District, leg. (Csuzdi and Pavlicek 2005; Rakhmatullaev et al. 2010; Rakhmatullaev 2022).

New species: ***Perelia persiana*** *(Michaelsen 1900)*

Synonyms: *Allolobophora persiana* Michaelsen, 1900: 216.

Climate zone: N/A

Habitat: N/A (http://taxo.drilobase.org); synanthropic species, anthropogenic soils, gardens (Our research and literature data).

Distribution: Kyzylkum desert region. (CMAUz) 2 ex., In Karakalpakstan Republic, Beruniy District, Khorezm region, Hazarasp districts, leg. (Asirovic 2011; Bekchanova and Abdullaev 2022).

New species: ***Perelia turcmenica*** *(Malevic 1941)*

Synonyms: *Octolasium turcmenicum* Malevic, 1941: 221; *Allolobophora turcmenicum* Malevic, 1945: *Perelia turcmencum* Qiu and Bouche, 1998q: 191.

Climate zone: N/A

Habitat: N/A (http://taxo.drilobase.org); Synanthropic species, anthropogenic soils, gardens (Our research and literature data).

Distribution: Kyzylkum desert region. (CMAUz) 3 ex., In Khorezm region, Shovot District, Bukhara region, Romitan District. leg. (Asirovic 2011; Bekchanova and Abdullaev 2022).

Genus: *Aporrectodea* (Orley 1885)

Synonyms: *Enterion* Savigny, 1820: *Enterium* Louis Agassiz, 1846: *Eiseniona* Omodeo, 1956: *Nicodrilus* Bouche, 1972: *Rhodonicus* Bouche, 1972: *Creinella* Mrsic, 1986: *Koinodrilus* Qiu and Bouche, 1998:

Species: ***Aporrectodea caliginosa*** *(Savigny 1826)*

Subspecies: *Aporrectodea caliginosa caliginosa* (Perel 1977)

Synonyms: *Enterion caliginosum* Savigny, 1826: 180; *Allolobophora turgida* Eisen, 1874: 129; *Nicodrilus cuendeti* Qiu and Bouche, 1998: 276.

Climate zone: Boreal, temperate, mediterranean and sub-tropical

Habitat: Forests, Meadows, Croplands, Urban areas (http://taxo.drilobase.org); Synanthropic species, common in pastures, anthropogenic soils, gardens, forests (Our research and literature data).

Distribution: Kyzylkum desert, Pomiro Alai, Tien Shan regions. (CZIUz) 3 ex., Spread all over Uzbekistan except for the Ustyurt Plateau (Omodeo 1959; Rakhmatullaev et al. 2010; Rakhmatullaev 2022; Bekchanova and Abdullaev 2022).

Subspecies: *Aporrectodea caliginosa trapezoides* (Dugesi 1828)

Synonyms: *Lumbricus trapezoides* Duges, 1828: 289; *Allolobophora caliginosa trapezoides* Rosa, 1893: 328; *Helodrilus (Allolobophora) caliginosus trapezoides* Michaelsen, 1900: 132; *Dendrobaena samarigera var. graeca* Cernosvitov, 1938: 87;

Climate zone: Boreal, temperate, mediterranean and sub-tropical.

Habitat: Forests, Croplands (http://taxo.drilobase.org); Synanthropic species, common in pastures, anthropogenic soils, gardens, forests (Our research and literature data).

Distribution: Kyzylkum desert, Pomiro Alai, Tien Shan regions. (CZIUz) 3 ex., Spread all over Uzbekistan except for the Ustyurt Plateau (Rakhmatullaev et al. 2010; Rakhmatullaev 2022; Bekchanova and Abdullaev 2022).

Species: ***Aporrectodea rosea*** *(Savigny 1826)*

Synonyms: *Enterion roseum* Savigny, 1826: 182; *Allolobophora dairenensis* Kobayashi, 1940: 261; *Allolobophora Allolobophora prashadi* Mihailova, 1964: 167; *Eisenia hataii* Huang et al., 2006: 18.

Climate zone: Boreal, temperate and mediterranean.

Habitat: Forests, Meadows, Croplands, Urban areas (http://taxo.drilobase.org); Synathropic species common in pastures, gardens, meadows and forests. More abundant in moist soils (Our research and literature data).

Distribution: Kyzylkum desert, Pomiro Alai, Tien Shan regions. (CZIUz) 3 ex., Spread all over Uzbekistan except for the Ustyurt Plateau (Omodeo 1959; Rakhmatullaev et al. 2010; Rakhmatullaev 2022; Bekchanova and Abdullaev 2022).

Species: ***Aporrectodea jassyensis*** *(Michaelsen 1891)*

Synonyms: *Allolobophora jassyensis* Michaelsen, 1891: 83; *Allolobophora jassyensis* Rosa, 1893: *Helodrilus sotschiensis* Michaelsen, 1902: 50; *Allolobophora jassyensis f. orientalis* Omodeo, 1956: 333; *Aporrectodea jassyensis jassyensis* Valchovski, 2014: 3.

Climate zone: Temperate, mediterranean.

Habitat: Forests, meadows, croplands, urban areas (http://taxo.drilobase.org); Forests, meadows and cultivated soils, croplands (Our research and literature data).

Distribution: Kyzylkum desert, Pomiro Alai, Tien Shan regions. (CZIUz) 3 ex., Spread all over Uzbekistan except for the Ustyurt Plateau (Rakhmatullaev et al. 2010; Rakhmatullaev 2022; Bekchanova and Abdullaev 2022)

Genus: *Eisenia* (Malm 1877)

Synonyms: *Notogama* Rosa, 1893

Species: ***Eisenia fetida*** *(Savigny 1826)*

Synonyms: *Enterion fetidum* Savigny, 1826; 182. *Lumbricus foetidu* Duges, 1837; 143, *Allolobophora foetida* Eisen, 1874; Benham, 1899; 497; *Lumbricus annulatus* Hutton, 1877; 352; *Helodrilus (Eisenia) foetidu* Michaelsen, 1910; 381.

Climate zone: Boreal, temperate, mediterranean, sub-tropical.

Habitat: Forests, croplands, urban areas (http://taxo.drilobase.org); forests, croplands, urban areas (Our research and literature data).

Distribution: Kyzylkum desert, Pomiro Alai, Tien Shan regions. (CZIUz) 3 ex., Spread all over Uzbekistan except for the Ustyurt Plateau (Omodeo 1959; Rakhmatullaev et al. 2010; Rakhmatullaev 2022; Bekchanova and Abdullaev 2022)

Species: ***Eisenia nordenskioldi*** *(Eisen 1879)*

Subspecies: *Eisenia nordenskioldi nordenskioldi* (Eisen 1879)

Synonyms: *Eisenia nordenskioldi* Eisen, 1879; 243; *Eisenia nordenskjoldii* Eisen, 1879; (misspelling); 256; *Eisenia nordenskioeldii* Eisen, 1879; (misspelling); 247.

Climate zone: Boreal, temperate

Habitat: N/A (http://taxo.drilobase.org); tukay, anthropogenic soils, gardens (Our research and literature data).

Distribution: Kyzylkum desert region. (CMAUz) 2 ex., In Karakalpakstan Republic, Beruniy District, Khorezm reg, Hazarasp and Tuprakkal'a districts, Bukhara region, Gazli leg. (Rakhmatullaev et al. 2010; Asirovic 2011; Bekchanova and Abdullaev 2022).

Subspecies: *Eisenia nordenskioldi acystis* *(Michaelsen 1903)*

Synonyms: *Eisenia nordenskioldi* Eisen, 1879; 126.

Climate zone: Boreal, temperate.

Habitat: N/A (http://taxo.drilobase.org); tukay, anthropogenic soils, gardens (Our research and literature data).

Distribution: Kyzylkum desert region. (CMAUz) 2 ex., In Karakalpakstan Republic, Xojayli District, Khorezm region, Bagat and Tuprakkal'a districts, Bukhara region, Gazli leg. (Asirovic 2011; Bekchanova and Abdullaev 2022).

Genus: *Octolasion* (Orley, 1885)

Synonyms: *Alyattes* Kinberg, 1867: 123; *Octalosion* Ribaucourt, 1896: 107; *Octolasia* Rosa, 1896: 54; *Octolasium* Michaelsen, 1900: 76; *Octalasion* Cognetti de Martiis, 1905: 109; *Incolore Octolasium* Omodeo, 1952: 75.

Species: ***Octolasion lacteum*** *(Orley 1885)*

Synonyms: *Lumbricus terrestris* var. *lacteum* Orley, 1881: 584; *Allolobophora profuga* Rosa, 1884: 47; O*ctolasium lacteum* Cernosvitov, 1932: Mihailova, 1966: Sapkarev, 1978: Zicsi, 1982: 431.

Climate zone: Temperate.

Habitat: Croplands, forests, meadows, wetlands (http://taxo.drilobase.org); forests, meadows, croplands, wetlands (Our research and literature data).

Distribution: Kyzylkum desert, Pomiro Alai, Tien Shan regions. (CZIUz) 3 ex., Spread all over Uzbekistan except for the Ustyurt Plateau (Rakhmatullaev et al. 2010; Rakhmatullaev 2022; Bekchanova and Abdullaev 2022).

Species: ***Octolasion cyaneum*** *(Savigny 1826)*

Synonyms: *Enterion cyaneum* Savigny, 1826: 181; *Allolobophora profuga* Rosa, 1884: 47; *Dendrobaena jeanneli* Pop, 1948: 244; *Dendrobaena (Dendrobaena) jeanneli* Bouche, 1972: 404.

Climate zone: Boreal, temperate.

Habitat: N/A (http://taxo.drilobase.org); tukay, anthropogenic soils, gardens (Our research and literature data).

Distribution: Kyzylkum desert region. (CMAUz) 2 ex., In Karakalpakstan Republic, Xojayli District, Khorezm region, Tuprakkal'a districts leg. (Omodeo 1959; Bekchanova and Abdullaev 2022).

Genus: *Dendrobaena* (Eisen 1873)

Synonyms: *Dedrobaena* Rosa, 1897: 56; *Omodeoia* Kvavadze, 1994: 108.

Species: ***Dendrobaena byblica*** *(Rosa 1893)*

Synonyms: *Allolobophora (Dendrobaena) byblica* Rosa, 1893: 4; *Eisenia schelkovnikovi* Michaelsen, 1907h: 87; *Eiseniella oltenica* Pop, 1938: 135; *Dendrobaena byblica var. ganglbaueri* Cernosvitov, 1940: 446; *Dendrobaena platyura* Michalis, 1976: 161.

Climate zone: Temperate, mediterranean.

Habitat: Forests, meadows (http://taxo.drilobase.org); forests, meadows (Our research and literature data).

Distribution: Kyzylkum desert, Pomiro Alai, Tien Shan regions. (CZIUz) 2 ex., In Tashkent region: Kibray, Keles, Angren districts; In Pomiro Alai, region: Samarkand region: Oktepa, zarafshan, Urgut districts; Kashkadaryo region: Guzor, Bishkent, Chim, kasbi districts; (CMAUz) 2 ex., In Kyzylkum desert region. Karakalpakstan Republic, Nukus District, Khorezm region, Hazarasp and Tuprakkal'a districts; leg. (Omodeo 1959; Rakhmatullaev et al. 2010; Rakhmatullaev 2022; Bekchanova and Abdullaev 2022)

Species: ***Dendrobaena octaedra*** *(Savigny 1826)*

Synonyms: *Enterion octaedrum* Savigny, 1826: 183; *Dendrobaena flaviventris* Leuckart, 1849: 159; *Dendrobaena boeckii* Eisen, 1874: 53; *Dendrobaena octaedra quadrivesiculata* Pop, 1938: 1949; 487; Qiu and Bouche, 1998n: 155; *Dendrobaena octaedra* Mrsic, 1991: 607; Csuzdi and Pop, 2008b: 148; Pop et al., 2012: Csuzdi & Zicsi, Pedozool. Hung., 1: 121.

Climate zone: Boreal, temperate, mediterranean.

Habitat: N/A (http://taxo.drilobase.org); forest, meadows under fallen leaves, fallen trunks (Our research and literature data).

Distribution: Kyzylkum desert, Pomiro Alai, Tien Shan regions. (CZIUz) 2 ex., In Tashkent region: Kibray, Keles, Angren districts; In Pomiro Alai, region: Samarkand region: Oktepa, Zarafshan, Urgut districts; Kashkadaryo region: Guzor, Bishkent, Chim, Kasbi districts; Andijan region: Balikchi district; (CMAUz) 2 ex., In Kyzylkum desert region. Karakalpakstan Republic, Nukus District, Khorezm region, Hazarasp and Tuprakkal'a districts; leg. (Asirovic 2011; Rakhmatullaev 2022; Bekchanova and Abdullaev 2022).

Species: ***Dendrobaena veneta*** *(Rosa 1886)*

Synonyms: *Allolobophora veneta* Rosa, 1886: Atti. Ist. Veneto, 4: 674; *Dendrobaena caucasica* Kulagin, 1889: 13; *Dendrobaena bogdanowii* Kulagin, 1889: 14; *Dendrobaena austriaca* Michaelsen, 1936: 35; *Dendrobaena svetlovia* Grieb, 1948; 12.

Climate zone: Boreal, temperate, mediterranean.

Habitat: N/A (http://taxo.drilobase.org); Forest, meadows under fallen leaves, fallen trunks (Our research and literature data).

Distribution: Pomiro Alai, Tien Shan regions. (CZIUz) 2 ex., In Tashkent region: Kibray, Bostonlik districts; Jizzakh region: Gallaoral, Zami districts; leg. (Rakhmatullaev et al. 2010; Rakhmatullaev 2022; Asirovic 2011).

Genus: *Dendrodrilus* (Omodeo 1956)

Species: ***Dendrodrilus tenuis*** *(Savigny 1826)*

Subspecies: *Dendrodrilus rubidus tenuis* (Rakhmatullaev et al. 2010)

Synonyms: *Dendrodrilus rubidus norvegicus* Eisen, 1974: 182; *Dendrodrilus rubidus rubidus* Savigny, 1826: 31: 263; *Dendrodrilus rubidus subrubicundus* Mršić, 1991: Acad. Sci. Art. Slov. (Hist. Nat.), 31: 267; *Dendrodrilus rubidus subrubicundus* Csuzdi & Zicsi, 2003: Pedozool.

Hung., 1: 136; *Dendrodrilus rubidus tenuis* Eisen, 1974: 132; *Dendrodrilus rubidus tenuis* Savigny, 1826: 183.

Climate zone: Boreal, temperate, mediterranean and sub-tropical.

Habitat: Forests, mountains (http://taxo.drilobase.org); forests, Sultan Uvays mountains (Our research and literature data).

Distribution: Kyzylkum desert, Pomiro Alai, Tien Shan regions. (CZIUz) 2 ex., In Tashkent region: Kibray, Keles, Angren districts; Jizzakh region: Farij, Jizzakh districts; In Pomiro Alai, region: Samarkand region: Kattakurgan, Pastdargom districts; (CMAUz) 2 ex., In Kyzylkum desert region. Karakalpakstan Republic, Nukus, Xujayli districts, Khorezm region, Khiva and Yangiarik districts; leg. (Rakhmatullaev et al. 2010; Rakhmatullaev 2022; Bekchanova and Abdullaev 2022).

Genus: *Bimastos* (Moore 1893)

Species: ***Bimastos parvus*** *(Eisen, 1874)*

Synonyms: *Allolobophora parva* Eisen, 1874: 46; *Eisenia parva* Eisen, 1874: 56; *Eisenia parvus* Pop, 1948: 123; *Bimastus parvus* Zicsi, 1959: 170; *Allolobophora (Allolobophora) parva* Perel, 1979: 187.

Climate zone: Boreal, temperate, mediterranean, sub-tropical, boreal.

Habitat: Forests (http://taxo.drilobase.org); wooded areas, gardens, under logs; habitats with high organic matter (Our research and literature data).

Distribution: Kyzylkum desert region. (CMAUz) 2 ex., In Karakalpakstan Republic, Nukus, Mahgit districts, Khorezm region: Urgench, Gurlan districts; Bukhara region: Gijdivan, Kagan districts. leg. (Omodeo 1959; Bekchanova and Abdullaev 2022).

Genus: *Eiseniella (*Michaelsen 1900)

Species: ***Eiseniella tetraedra*** *(Savigny 1826)*

Synonyms: *Enterion tetraedrum* Savigny, 1826: 184; *Lumbricus tetraedrus* Duges, 1837: 21; *Allurus tetraedrus* Eisen, 1874: Rosa, 1893: 12; *Eiseniella tetraedra f. typical* Michaelsen, 1900: 112; *Eiseniella intermedia* Jackson, 1931: 123.

Climate zone: Boreal, temperate, mediterranean and sub-tropical.

Habitat: Wetlands, meadows (our data).

Distribution: Kyzylkum desert region. (CMAUz) 2 ex., In Karakalpakstan Republic, Nukus, Mahgit districts, Khorezm region: Urgench, Gurlan districts; Bukhara region: Gijdivan, Kagan districts. leg. (Omodeo 1959; Rakhmatullaev et al. 2010; Bekchanova and Abdullaev 2022).

Genus: *Lumbricus* (Linnaeus 1758)

Synonyms: *Omilurus* Templeton, 1836: 134; *Lumbrikus* Schneidemuehl, 1896: 47.

New species: ***Lumbricus rubellus*** *(Hoffmeister 1843)*

Synonyms: *Lumbricus rubellus* Plisko, 1963; 483; Zicsi and Csuzdi, 1986; 120; Misirlioglu and Szederjesi, 2015; 100; Stojanovic et al. 2012; 9; Valchovski, 2014; 5; *Lumbricus campestris* Hutton, 1877; 351; *Allolobophora herculeana* Bretscher, 1899; 419; *Allolobophora ribaucourti* Bretscher, 1901; 220; *Allolobophora relictus* Southern, 1909; 169.

Climate zone: Boreal, temperate, mediterranea.

Habitat: Forests, meadows, croplands, polluted areas (http://taxo.drilobase.org); forests, meadows, croplands, tukay (Our research and literature data).

Distribution: Kyzylkum desert region. (CMAUz) 2 ex., In Karakalpakstan Republic, Mahgit, Beruniy districts, Khorezm region: Tuprakkal'a District. leg. (Gates 1972; Bekchanova and Abdullaev 2022).

Discussion

The most common and widespread earthworm species and subspecies in Uzbekistan are *Aporrectodea caliginosa trapezoides*, *Aporrectodea caliginosa caliginosa*, *Aporrectodea rosea*, *Aporrectodea jassyensis*, *Octolasion lacteum*, *Dendrobaena byblica* and *Eisenia fetida*, *Eiseniella tetraedra*. The 28 earthworm species listed for Uzbekistan in the present paper (Table 1) belong to 9 genera, with *Perelia* being the species-richest genus (12), followed by *Aporrectodea* (4), and *Dendrodrilus* (4).

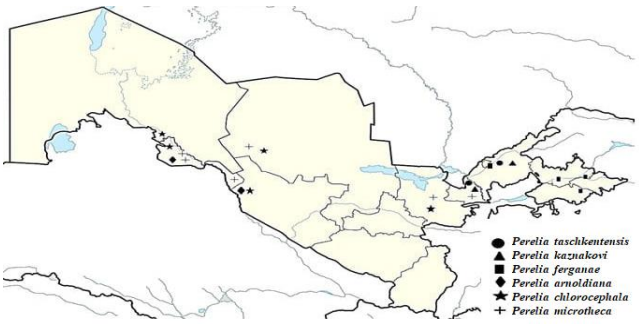

Figure 2. Distribution of earthworm species belonging to the genus *Perelia* in Uzbekistan

Figure 3. Distribution of earthworm genus *Perelia* in Uzbekistan

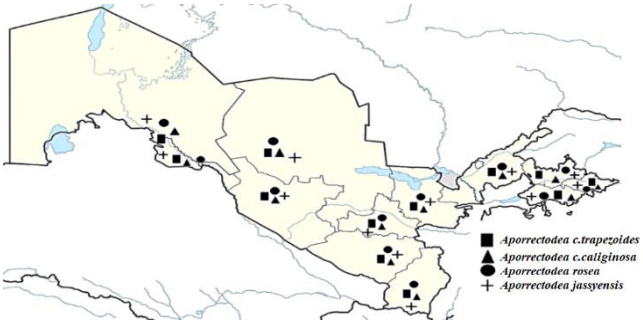

Figure 4. Distribution of earthworm species in Uzbekistan

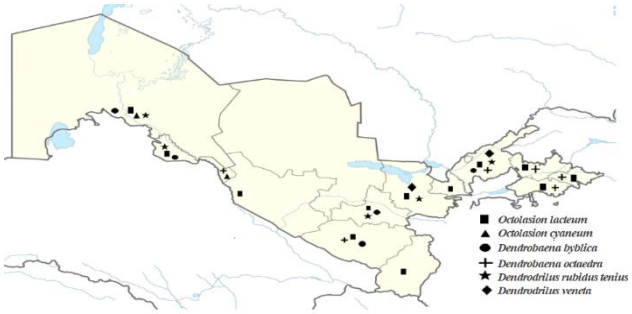

Figure 6. Distribution of earthworm species in Uzbekistan

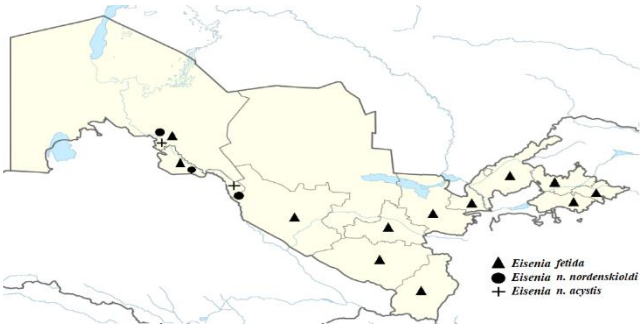

Figure 5. Distribution of earthworm species in Uzbekistan

Figure 7. Distribution of earthworm species in Uzbekistan

Table 1. List of earthworm species with a distribution type in Uzbekistan. Endemic: BR - broad-range, Uzbekistan and neighboring countries, NR-narrow range, Uzbekistan

Species	Geographical origin*	Ecological category	Distribution status**
Perelia taschkentensis	Central Asia	Epigeic	Cosmopolitan
Perelia kaznakovi	Central Asia	Epigeic	Cosmopolitan
Perelia ferganae	Central Asia	Epigeic	Cosmopolitan
Perelia arnoldiana	Uzbekistan	Epigeic	Endemic (NR)
Perelia chlorocephala	Central Asia	Epigeic	Cosmopolitan
Perelia microtheca	Central Asia	Epigeic	Cosmopolitan
Perelia graciosa	Central Asia	Epigeic	Cosmopolitan
Perelia umbrophila	Uzbekistan	Epigeic	Endemic (NR)
Perelia ophiomorpha	Uzbekistan	Epigeic	Endemic (NR)
Perelia stenosoma	Central Asia	Epigeic	Cosmopolitan
Perelia persiana	Western Asia	Epigeic	Cosmopolitan
Perelia turcmenica	Europe & N.Asia	Epigeic	Cosmopolitan
Aporrectodea caliginosa trapezoides	Europe & Asia	Endogeic, Aquatic	Cosmopolitan
Aporrectodea caliginosa caliginosa	Europe	Endogeic	Cosmopolitan
Aporrectodea rosea	Europe	Endogeic	Cosmopolitan
Aporrectodea jassyensis	Trans-Aegean	Endogeic	Cosmopolitan
Bimastos parvus	North America	Epigeic, Corticolous	Cosmopolitan
Eiseniella tetraedra	Europe	Aquatic, Epigeic	Cosmopolitan
Eisenia fetida	Europe	Epigeic, Epiendogeic	Cosmopolitan
Eisenia nordenskioldi nordenskioldi	North.Palearctic	Epigeic	Asiatic, typical shape
Eisenia nordenskioldi acystis	North.Palearctic	Epigeic	Asiatic, typical shape
Octolasion lacteum	Europe	Endogeic	Cosmopolitan
Octolasion cyaneum	Europe	Endogeic	Cosmopolitan
Dendrobaena byblica	C.Mediterranea	Epigeic	Cosmopolitan
Dendrobaena octaedra	Europe	Epigeic	Cosmopolitan
Dendrodrilus rubidus tenuis	Europe	Epigeic	Cosmopolitan
Dendrodrilus veneta	Europe	Epigeic	Cosmopolitan
Lumbricus rubellus	Europe, Russia	Epigeic, Epiendogeic	Cosmopolitan, Invasive

Note: *References to geographical origin: http://taxo.drilobase.org/index.php?title=Lumbricidae/List_of_species, **References to distribution status: Rakhmatullaev et al. (2010), Omodeo (1959), Asirovic (2011), Csuzdi and Pavlicek (2005)

Chronologically, these species can be allocated to 3 different types of distribution (Table 1). More than half of all species are either cosmopolitans (23 species, 82,15%), asiatic, typical shapes (2 species, 7,15%) and endemics (3 species, 10,7%). For the fauna of Uzbekistan, only 3 species *Perelia umbrophila, Perelia arnoldiana, Perelia umbrophila* (NR) are endemic with a narrow rangeThe chronological characterization reveals a high rate of endemism. Additionally, the high biodiversity of the earthworm fauna of Uzbekistan can be attributed to the presence of four distinct biogeographical regions (Ustyurt Plateau, Kyzylkum desert, Pomiro Alai and Tien Shan) in a small geographic area. The centers of earthworm endemism in Uzbekistan are mountains in the Tien Shan and Kyzylkum desert (Amudary River) bioregion. These species add to the importance of checklists like the one presented here for future conservation and protection purposes, as deforestation, tugay (forest), and soil pollution especially affect endemic earthworms that have narrower ecological ranges.

In conclusion, the earthworm fauna of Uzbekistan includes 23 species and 5 subspecies. The earthworm fauna is more diverse in forests of the northern and in the mountains of the southern parts of Uzbekistan. According to the literature data and our research, there are no earthworms found in the Ustyurt Plateau, due to the fact that the soils of the Ustyurt Plateau are gypsum, saline, and infertile. It has been established that earthworms do not occur in this area and the literature in the analyses. Based on the results of our research, it was noted that no earthworm species are found in Ustyurt Plateau of Uzbekistan (A).

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