ZooKeys 1163: 121–142 (2023)
doi: 10.3897/zookeys.1163.99414
https://zookeys.pensoft.net

REVIEW ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

A zoogeographical analysis of true bugs (Insecta, Heteroptera) from Uzbekistan

Lola Gandjaeva[1,2], Ikram Abdullaev[1,2], Abdulla Iskandarov[2], Komila Allabergenova[2], Saodat Yusupova[3], Gulkhayo Narimanova[1], Erkinboy Yusupboev[1], Sohiba Ibragimova[1,2], Sanjar Begliev[1], Khulkar Bobojonova[2]

1 *Khorezm Mamun Academy, Markaz Str., 1, Khiva, Uzbekistan* **2** *Urgench State University, Khamid Alimjan Str., 14, Urgench, 220100, Uzbekistan* **3** *The Academic Lyceum of the Urgench branch of the Tashkent Medical Academy, Khamid Alimjan str., 14, Urgench, 220100, Uzbekistan*

Corresponding author: Lola Gandjaeva (tulipa_83@mail.ru)

Academic editor: Jader Oliveira | Received 30 December 2022 | Accepted 21 April 2023 | Published 22 May 2023

https://zoobank.org/D2E4ADEF-014D-4A12-9490-D7973AB73B33

Citation: Gandjaeva L, Abdullaev I, Iskandarov A, Allabergenova K, Yusupova S, Narimanova G, Yusupboev E, Ibragimova S, Begliev S, Bobojonova K (2023) A zoogeographical analysis of true bugs (Insecta, Heteroptera) from Uzbekistan. ZooKeys 1163: 121–142. https://doi.org/10.3897/zookeys.1163.99414

Abstract

The purpose of this study is to perform a zoogeographic analysis of terrestrial true bugs (Heteroptera) in the Lower Amudarya Territory, Uzbekistan. According to the findings of a literature review, there are 149 species of terrestrial hemipterans in the Territory. All hemipteran species, with the possible exception of five, have most likely been misidentified. Until now, reliable information on the zoogeography of true bug species in Uzbekistan's north-western region has not been published. The composition of species, diversity, and the proportion of endemism vary greatly across the country's zoogeographic regions. The Heteroptera fauna of the Khorezm and Karakalpakstan can be divided into four groups: most species belonging to the Palaearctic region, with 125 species constituting 83.89% of the fauna; the second group of Holarctic origin is characterized by no more than ten species, which constitutes 6.71%; the third consists of endemics, 13 species or 8.72%; and one species (0.67%) is cosmopolitan. Much more research is needed to investigate distributions in a more northern climate. The introduction of invasive Heteroptera to the north-western part of Uzbekistan will increase and deserves further consideration.

Keywords

Abundance, distribution, faunistics, geography range, Karakalpakstan, Khorezm, Lower Amudarya, occurrence

Introduction

Heteroptera or true bugs are a large group with more than 40,000 species in approximately 50 families distributed across the world (Weirauch and Schuh 2011; Henry 2017a). In Russia, 760 species in 285 genera, and 35 families, are recorded (Vinokurov et al. 2010), however, more than 1250 species are distributed in Central Asia (Esenbekova 2013), and 700 species of true bugs are distributed in Uzbekistan (Animal World of Uzbekistan 2023).

The study of the fauna of true bugs by Central Asia region has been occurring for more than 170 years (Saprykin 2013). Many individuals have studied regional true bugs from 1995–2013 using the large, published Catalogue of Palaearctic Heteroptera (Catalogue of Palaearctic true bugs 2013).

The geographical distribution of Heteroptera from around the world has always been of interest to researchers (Latreille 1810; Leach 1815; Panizzi and Grazia 2015; Schuh and Weirauch 2020). Many research papers have been published recently, including Chandra and Kushwaha (2013); Samra et al. (2015); Vinokurov et al. (2015); Yasunaga (2016); Drapolyuk (2017); Henry (2017b); Oh et al. (2017); Kim and Jung (2018); Kuzhuget and Vinokurov (2018); Gapon (2019); Yazici (2020); Gandjaeva (2011, 2012a, b, 2020); Gandjaeva and Abdullaeva (2022a, b); Gandjaeva and Allabergenova (2022); Gandjaeva et al. (2019, 2020a, b, c, d, e, 2021, 2022a, b, c); Abdullaev et al. (2020a, b); Allabergenova and Gandzhaeva (2022); Yusupova and Gandjaeva (2022);Yusupova et al. (2022); Iskandarov et al. (2022).

Since the second half of the 19th century, new descriptions of Central Asian species have been published regularly in the works of Yakovlev (1890); Oshanin (1891) and others. These researchers conducted route surveys in the Fergana Valley, Turkestan Ridge, Alay Range, and Alay Valley, as well as in Samarkand and Djizzakh. Approximately 384 species of true bugs were identified during expeditions, and their zoogeography was studied in Central Asia by prominent zoologists such as Oshanin (1891), who was the first scientist to investigate Heteropteran zoogeography and listed more than 530 species. In the 21st century, many American scientists studied regional Heteroptera including Rider (2006, 2016); Hoebeke and Carter (2003); Bundy and McPherson (2018); Schuh and Weirauch (2020).

The literature on the fauna of terrestrial true bugs in different habitats of the Republic of Uzbekistan is meager. This lack of study also includes true bugs of Central Asia, mainly in the southern regions, which cover the territories of Samarkand, Bukhara, Tashkent, Andijan, Fergana, Kashkadarya, and Surkhandarya.

The purpose of the current paper is to explain database entries for the Lower Amudarya Heteroptera species, including brief geographic histories and original references. Every database should be a living document, with the ability to track changes regularly. Additional information on newly studied species is being added continuously (Gandjaeva 2011, 2012a, b, 2020; Gandjaeva et al. 2019, 2020a, b, c, d, e, 2021, 2022a, b, c; Abdullaev et al. 2020a, b; Allabergenova and Gandzhaeva 2022; Gandjaeva and Abdullaeva 2022a, b; Gandjaeva and Allabergenova 2022; Iskandarov et al. 2022; Yusupova and Gandjaeva 2022; Yusupova et al. 2022).

The goals of this study include classifying species ranges and conducting a zoogeographical analysis of the nation's actual true bug fauna, as well as determining species compositions and distributions in various belts of the Khorezm region and Karakalpakstan Republic.

Materials and methods

The study was conducted in a lowland area in the northwestern part of Uzbekistan along the lower sections of the Amudarya River: between 60' and 61' longitude and 41' and 42' latitude, at an altitude of 113–138 m above sea level. The vegetative cycle of plants lasts 200–210 days. The climate is continental, with an average annual precipitation of 80–90 mm, and average temperature ranges from -5 °C in January to 40 °C in July. The climate has been changing, and the temperature has risen in summer, reaching 50 °C in July (Gandjaeva 2019; Abdullaev et al. 2022; Ruzmetov et al. 2022). The usual alkali soils are meadow, meadow–marsh, and marsh–sandy. The area is located in the steppe zone, as well as in the southern portion of the Aral Sea and the western part of the Khorezm oasis. The historic Amudarya delta is made up of river sediments. Sand can be found on the sections connecting with Karakum in the west and southwest. Minerals include limestone, sand, clay, and other building materials (Khamraev 2003).

For the analysis, we used zoogeographical categories of the heteropteran species that had been recorded earlier. Approximately 180 specimens of Heteroptera indexed in the territory of the Lower Amudarya River and were identified to 149 species in 89 genera, and two infraorders. These species were deposited in the Zoological collections of the Zoology Institute (**ZIN**) of the Academy of Sciences of the Republic of Uzbekistan.

The study was carried out between 2007 and 2020 (see Gandjaeva 2011, 2012a, b, 2020; Gandjaeva et al. 2019, 2020a, b, c, d, e, 2021, 2022a, b, c; Abdullaev et al. 2020a, b; Allabergenova and Gandzhaeva 2022; Gandjaeva and Abdullaeva 2022a, b; Gandjaeva and Allabergenova 2022). Terrestrial Heteroptera were collected from various fields, including the agricultural farms "Odilbek," "Amir Temur," "Gulrukhbegim," and "Oltin Kal'a" located in the Urgench district, "Dildora Bojimon" and "Buz Os Yep" agricultural farms, as well as the educational-experimental station of UrSU named "Uchkhoz" in Yangibazar district, "Ziroat-21" agricultural farm of Kushkupir district, "Raximbergan Xoji Anbar" in Khiva district, "Otabek garchak" and "Gulkand Istikbolli bog'i" in Khanka district and natural landscapes in the Khorezm region, as well as "Zaripboy," "Kilchinok," and "Yangiyer" agricultural farms in Ellikkala district of the Republic of Karakalpakstan and "Badai Tugai Nature Reserve," Karatau mountain in the Beruniy district of the Republic of Karakalpakstan (Gandjaeva et al. 2021). The geographical locations of the sites are shown in Fig. 1.

The zoogeographic analysis of identified species in the Lower Amudarya was based on zoogeographical nomenclature by Emelyanov (1974). In brief, geographic longitude was used to establish the zone along its meridional boundaries.

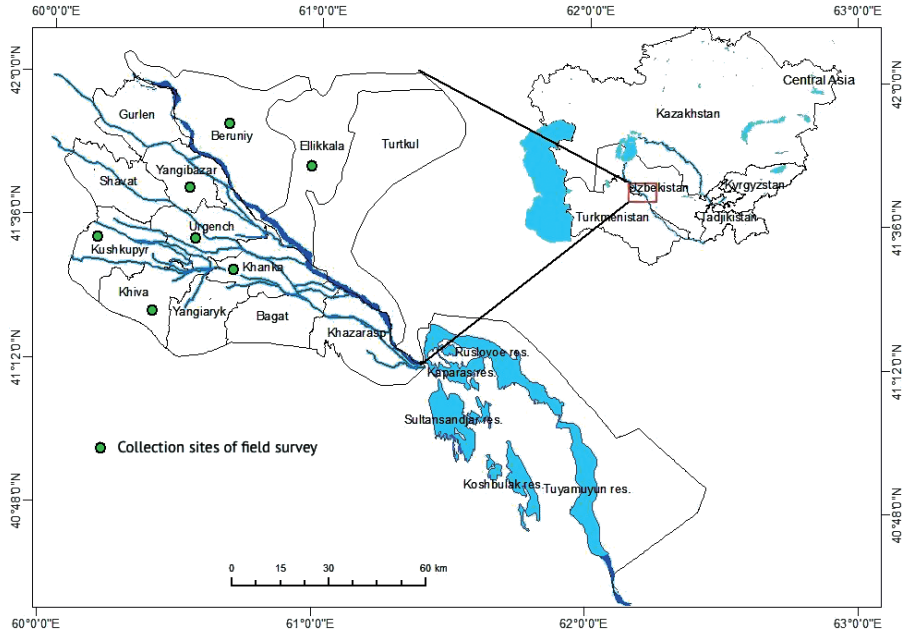

Figure 1. Geographical locations of the collection sites of terrestrial Heteroptera specimens in the Lower Amudarya Territory.

The descriptive area nomenclature utilized in this work uses the concepts of physical geography and applies two axis coordinates: the latitudinal axis runs from north to south and is critical because it is used to determine climatic conditions of the distributed species, especially temperature; the longitudinal axis runs from west to east. In some species, the range coincides with the boundaries of the landscape zone and is labeled as Arctic (polar deserts, tundra), boreal (taiga), subboreal (broad-leaved forests), subtropical and tropical (evergreen forests) (Lopatin and Meleshko 2016).

We used the basic data on the geographic distribution of these species from the Catalogue "Heteroptera of the Palaearctic" Volumes I–VI, published by the Netherlands Entomological Society, Amsterdam (NES) (1995–2013) (Catalogue of Palaearctic true bugs 2013) to describe the analysis of the zoogeographic areas of terrestrial Heteroptera (Aukema et al. 2013) the database is continually updated.

An analysis of the occurrence and abundance of species on cultivated and wild plants were carried out by observing 50–100 plant specimens every day along the diagonal of the fields. The number of adult bugs, larvae of all ages, and egg clutches was recorded (Gandjaeva et al. 2021).

The number of species and their occurrence was calculated using the formula devised by Dajoz (2000):

$$F(\%) = 100 \times (Pi/P)$$

where Pi refers to the species that was found; P is an absolute number.

Species are divided into four groups based on their frequency of occurrence:

Constantly occurring species: $F \geq 50\%$
Often occurring species: $25\% < F < 50\%$
Additional occurring species: $5\% \leq F < 25\%$
Rarely occurring species: $F < 5\%$

The dynamics of the abundance of species was calculated using the formula of Zaime and Gautier (1989):

$$Ar(\%) = 100 \times (Ni/N)$$

where Ni is the coefficient of special observable species; N is the absolute number of all observable species.

The analyses of the dynamics of the numbers of species are also divided into four groups:

Abundant: $Ar \geq 10$
Frequent: $5 \leq Ar < 10$
Some: $1 \leq Ar < 5$
Few: $Ar < 1$

Results and discussion

Checklists of Heteroptera for the Khorezm region and Karakalpakstan Republic were published more than 20 years ago. Khamraev (2003) and Kulumbetova (1998a, b, c, 1999) listed several species found to the north of Uzbekistan and, respectively, but some species have yet to be discovered while others are rare or migratory.

We carried out a comparative analysis of the lists of regional faunas using the data from Khamraev (2003) in the Khorezm Region and Kulumbetova (1998a, b, c, 1999) in the Republic of Karakalpakstan, which allowed us to determine regional features of the fauna in the Lower Amudarya (Table 1). Based on taxonomic distribution, this method enables the collection of data about species complexes with various zoogeographical characteristics (Table 1; Fig. 2). To classify the areas of the Lower Amudarya, information from Gandjaeva et al. (2021) was used (Fig. 2).

Entomologists (Kulumbetova 1998a, b, c, 1999; Khamraev 2003) discovered five new species: *Tarajala brevicornis* (Reuter, 1879), *Emblethis dilaticollis* (Jakovlev, 1874), *Aethus nigronervosus* (Melichar, 1906), *Microporus virgata* (Fabricius, 1974), and *Sciocoris helferi* (Fieber, 1851), which were indexed between 1998–2003 (Kulumbetova 1998a, b, c, 1999; Khamraev 2003) for the Lower Amudarya. These could be rare or migratory species, or are probably misidentified. These five species, shaded in Table 1, have not yet been verified and these records are not used in the distributional and zoogeographical analyses of the group; they are only mentioned in the checklist of the heteropterans found in the Khorezm region and Karakalpakstan.

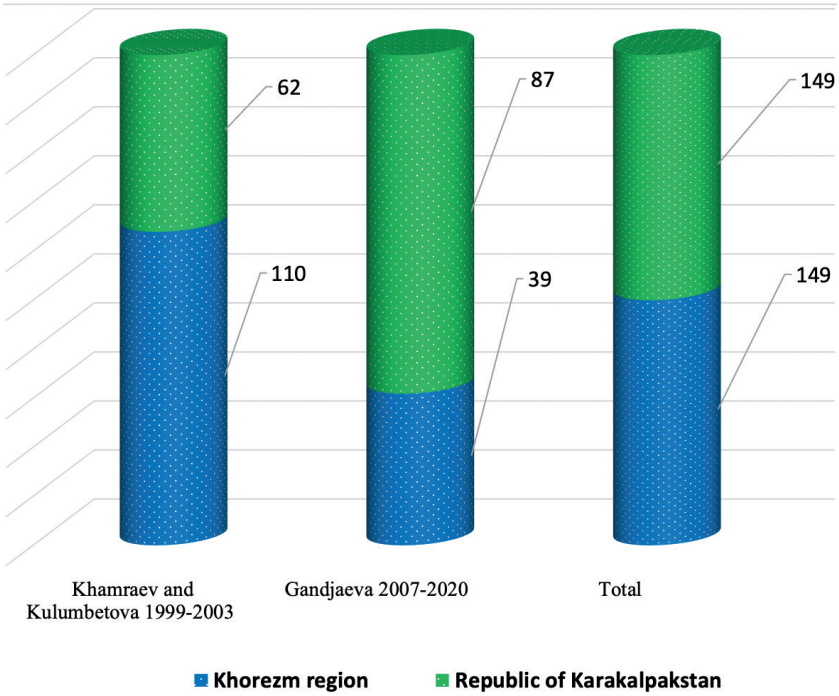

Figure 2. Numbers of terrestrial Heteroptera recorded in the regions of the northern part of Uzbekistan.

Table 1. Checklist of the terrestrial Heteroptera from the Lower Amudarya (2007–2020).

	Taxon	Family	Occurrence	Abundance	Distribution	Zoogeographic categories	References
1	*Anthocoris pilosus* (Jakovlev, 1877)	Anthocoridae Fieber, 1837	+	F	***	SA	Khamraev (2003); Gandjaeva et al. (2021)
2	*Orius niger* (Wolff, 1811)		++	FR	o	TP	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
3	*Orius ribauti* (Wagner, 1952)		+	F	***	P	Khamraev (2003); Gandjaeva et al. (2021)
4	*Orius albidipennis* (Reuter, 1884)		+	S	**	TP	Kulumbetova (1999); Gandjaeva et al. (2021)
5	*Nabis ferus* (Linnaeus, 1758)	Nabidae Costa, 1852	++	FR	o	TP	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
6	*Nabis palifer* (Seidenstücker, 1954)		+	F	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
7	*Nabis viridis* (Brullé, 1839)		+	F	***	SA	Khamraev (2003); Gandjaeva et al. (2021)
8	*Nabis rugosus* (Linnaeus, 1758)		++	FR	***	SA	Khamraev (2003); Gandjaeva et al. (2021)
9	*Nabis remanei* (Kerzhner, 1962)		+	F	**	ChCA	Kulumbetova (1999); Gandjaeva et al. (2021)
10	*Nabis sareptanus* (Dohrn, 1862)		+	F	***	TP	Khamraev (2003); Gandjaeva et al. (2021)
11	*Prostemma sanguineum* (Rossi, 1790)		+	F	**	PA	Kulumbetova (1999); Gandjaeva et al. (2021)

	Taxon	Family	Occurrence	Abundance	Distribution	Zoogeographic categories	References
12	*Deraeocoris punctulatus* (Fallén, 1807)	Miridae Hahn, 1833	++	FR	o	P	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
13	*Deraeocoris serenus* (Douglas & Scott, 1868)		++	FR	** **	W	Gandjaeva et al. (2021)
14	*Adelphocoris lineolatus* (Coeze, 1778)		+++	A	o	TP	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
15	*Adelphocoris seticornis* (Fabricius, 1775)		+++	A	** **	W	Gandjaeva et al. (2021)
16	*Agnocoris rubicundus* (Fallen, 1807)		++	FR	***	TP	Khamraev (2003); Gandjaeva et al. (2021)
17	*Brachycoleus decolor* (Reuter, 1887)		++	FR	***	W	Khamraev (2003); Gandjaeva et al. (2021)
18	*Lygus pratensis* (Linnaeus, 1758)		+++	A	o	SA	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
19	*Lygus gemellatus* (Herrich-Schäffer, 1835)		+++	A	o	TP	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
20	*Lygus pachycnemis* (Reuter, 1879)		+++	A	***	TNT	Khamraev (2003); Gandjaeva et al. (2021)
21	*Lygus rugulipennis* (Poppius, 1911)		+++	A	** **	TP	Gandjaeva et al. (2021)
22	*Lygus punctatus* (Zetterstedt, 1838)		+++	A	** **	TP	Gandjaeva et al. (2021)
23	*Megacoelum brevirostre* (Reuter, 1879)		++	FR	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
24	*Orthops basalis* (Costa, 1853)		++	FR	***	SA	Khamraev (2003); Gandjaeva et al. (2021)
25	*Orthops kalmi* (Linnaeus, 1758)		++	FR	o	SA	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
26	*Polymerus vulneratus* (Panzer, 1806)		+++	A	o	TP	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
27	*Polymerus cognatus* (Fieber, 1858)		+++	A	**	TP	Kulumbetova (1999); Gandjaeva et al. (2021)
28	*Notostira elongata* (Geoffroy, 1785)		++	FR	** **	SA	Gandjaeva et al. (2021)
29	*Megaloceroea recticornis* (Geoffroy, 1785)		++	FR	** **	W	Gandjaeva et al. (2021)
30	*Stenodema calcaratum* (Fallen, 1807)		+++	A	o	TP	Khamraev (2003); Gandjaeva et al. (2021)
31	*Stenodema tripsinosa* (Reuter, 1904)		+++	A	***	TP	Khamraev (2003); Gandjaeva et al. (2021)
32	*Stenodema laevigata* (Linnaeus, 1758)		+++	A	***	PA	Khamraev (2003); Gandjaeva et al. (2021)
33	*Stenodema turanica* (Reuter, 1904)		++	FR	o	NC	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
34	*Trigonotylus ruficornis* (Geoffroy, 1785)		++	FR	o	PA	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
35	*Trigonotylus pulchellus* (Hahn, 1834)		++	FR	** **	P	Gandjaeva et al. (2021)
36	*Orthotylus eleagni* (Jakovlev, 1881)		++	FR	***	TS	Khamraev (2003); Gandjaeva et al. (2021)

	Taxon	Family	Occurrence	Abundance	Distribution	Zoogeographic categories	References
37	*Orthotylus flavosparsus* (Sahlberg, 1841)	Miridae Hahn, 1833	++	FR	***	TP	Khamraev (2003); Gandjaeva et al. (2021)
38	*Campylomma annulicorne* (Signoret, 1865)		++	FR	**	P	Kulumbetova (1999); Gandjaeva et al. (2021)
39	*Campylomma diversicornis* (Reuter, 1878)		+++	A	***	NS	Khamraev (2003); Gandjaeva et al. (2021)
40	*Campylomma verbasci* (Meyer-Dur, 1843)		+++	A	**	PA	Kulumbetova (1999); Gandjaeva et al. (2021)
41	*Camptotylidea alba* (Reuter, 1879)		++	FR	***	TNT	Khamraev (2003); Gandjaeva et al. (2021)
42	*Camptotylus meyeri* (Frey-Gessner, 1863)		++	FR	***	NS	Khamraev (2003); Gandjaeva et al. (2021)
43	*Europiella alpina* (Reuter, 1875)		++	FR	** **	TP	Gandjaeva et al. (2021)
44	*Heterocapillus tigripes* (Meyer & Dur, 1852)		+	F	*	SA	Gandjaeva et al. (2021)
45	*Macrotylus herrichi* (Reuter, 1873)		+	F	*	SA	Gandjaeva et al. (2021)
46	*Tuponia elegans* (Jakovlev, 1867)		++	FR	***	SA	Khamraev (2003); Gandjaeva et al. (2021)
47	*Tuponia pallida* (Jakovlev, 1867)		++	FR	***		Khamraev (2003); Gandjaeva et al. (2021)
48	*Tuponia roseipennis* (Reuter, 1889)		++	FR	***	ChCA	Khamraev (2003); Gandjaeva et al. (2021)
49	*Tarajala brevicornis* (Reuter, 1879)		–	–	–	–	Khamraev (2003)
50	*Monosteira discoidalis* (Jakovlev, 1883)	Tingidae Laporte, 1832	+	F	o	SA	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
51	*Stephanitis pyri* (Fabricius, 1775)		+	F	** **	P	Gandjaeva et al. (2021)
52	*Tingis leptochila* (Horvath, 1906)		+	F	***	ITCA	Khamraev (2003); Gandjaeva et al. (2021)
53	*Stenolemus bogdanovi* (Oshanin, 1896)	Reduviidae Latreille, 1807	+	F	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
54	*Coranus aegyptius* (Fabricius, 1775)		++	FR	***	SA	Khamraev (2003); Gandjaeva et al. (2021)
55	*Coranus subapterus* (De Geer, 1773)		++	FR	**	NS	Kulumbetova (1999); Gandjaeva et al. (2021)
56	*Rhynocoris monticola* (Oshanin, 1870)		++	FR	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
57	*Rhinocoris nigronitens* Reuter, 1881		++	FR	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
58	*Vachiria deserta* (Becker,1867)		+	F	** **	ITCA	Gandjaeva et al. (2021)
59	*Ectomocoris ululans* (Rossi, 1807)		+	F	***	ETPE	Khamraev (2003); Gandjaeva et al. (2021)
60	*Reduvius testaceus* (Herrich-Schäffer, 1845)		+	S	***	TS	Gandjaeva et al. (2021)
61	*Reduvius disciger* (Horváth, 1896)		+	F	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
62	*Reduvius christophi* (Jakovlev, 1874)		+	S	o	TS	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
63	*Reduvius fedtschenkianus* (Oshanin, 1871)		+	F	o	TNT	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)

	Taxon	Family	Occurrence	Abundance	Distribution	Zoogeographic categories	References
64	*Reduvius semenovi* (Jakovlev, 1885)	Reduviidae Latreille, 1807	+	F	***	TNT	Khamraev (2003); Gandjaeva et al. (2021)
65	*Reduvius elegans* (Jakovlev, 1885)		++	FR	***	TNT	Khamraev (2003); Gandjaeva et al. (2021)
66	*Oncocephalus brachymerus* (Reuter, 1882)		++	FR	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
67	*Oncocephalus termezanus* (Kiritshenko, 1914)		++	FR	**	ITCA	Kulumbetova (1999); Gandjaeva et al. (2021)
68	*Camptopus lateralis* (German, 1817)	Alydidae Amyot & Serville, 1843	+	F	o	SA	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
69	*Megalotomus ornaticeps* (Stål, 1858)		+	F	**	NS	Kulumbetova (1999); Gandjaeva et al. (2021)
70	*Centrocoris volxemi* (Puton, 1878)	Coreidae Leach, 1815	+	F	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
71	*Coreus marginatus* (Linnaeus, 1758)		+	S	***	TP	Khamraev (2003); Gandjaeva et al. (2021)
72	*Enoplops eversmanni* (Jakovlev, 1881)		+	F	***	T	Khamraev (2003); Gandjaeva et al. (2021)
73	*Bathysolen nubilus* (Fallen, 1807)		+	F	**	TS	Kulumbetova (1999); Gandjaeva et al. (2021)
74	*Bothrostethus annulipes* (Herrich-Schäffer, 1835)		+	S	**	TS	Kulumbetova (1999); Gandjaeva et al. (2021)
75	*Coriomeris vitticollis* (Reuter, 1900)		+	F	o	TS	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
76	*Brachycarenus tigrinus* (Schilling, 1829)	Rhopalidae Amyot & Serville, 1843	++	FR	o	TP	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
77	*Chorosoma schillingi* (Schilling, 1829)		++	FR	***	SA	Khamraev (2003); Gandjaeva et al. (2021)
78	*Corizus limbatus* (Rey, 1887)		+++	A	o	SA	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
79	*Corizus tetraspilus* (Horvath, 1917)		+++	A	**	NS	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
80	*Corizus hyoscyami* (Linnaeus, 1758)		+++	A	***	TP	Khamraev (2003); Gandjaeva et al. (2021)
81	*Maccevethus persicus* (Jakovlev, 1882)		++	FR	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
82	*Liorhyssus hyalinus* (Fabricius, 1794)		++	FR	o	C	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
83	*Rhopalus parumpunctatus* (Schilling, 1829)		++	FR	***	TP	Khamraev (2003); Gandjaeva et al. (2021)
84	*Rhopalus distinctus* (Signoret, 1859)		++	FR	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
85	*Stictopleurus unicolor* (Jakovlev, 1873)		++	FR	***	W	Khamraev (2003); Gandjaeva et al. (2021)
86	*Dicranocephalus marginatus* (Ferrari, 1874)	Stenocephalidae Dallas, 1852	+	F	o	TS	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
87	*Dicranocephalus ferghanensis* (Horváth, 1887)		+	F	o	TS	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)

	Taxon	Family	Occurrence	Abundance	Distribution	Zoogeographic categories	References
88	*Artheneis alutacea* (Fieber, 1861)	Artheneidae Stål, 1872	+	S	***	W	Khamraev (2003); Gandjaeva et al. (2021)
89	*Geocoris ater* (Fabricius, 1787)	Geocoridae Baerensprung, 1860	++	FR	**	TP	Kulumbetova (1999); Gandjaeva et al. (2021)
90	*Geocoris arenarius* (Jakovlev, 1867)		+	F	**	NS	Kulumbetova (1999); Gandjaeva et al. (2021)
91	*Geocoris dispar* (Waga, 1839)		++	FR	**	W	Kulumbetova (1999); Gandjaeva et al. (2021)
92	*Geocoris lapponicus* (Zetterstedt, 1838)		+	F	** **	P	Gandjaeva et al. (2021)
93	*Geocoris fedtschenkoi* (Reuter, 1885)		+	F	***	NS	Khamraev (2003); Gandjaeva et al. (2021)
94	*Geocoris scutellatus* (Montandon, 1907)		+	F	***	KNTIT	Khamraev (2003); Gandjaeva et al. (2021)
95	*Engistus salinus* (Jakovlev, 1874)		+	F	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
96	*Engistus exsanguis* (Stál, 1872)		++	FR	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
97	*Henestaris halophilus* (Burmeister, 1835)		+	F	***	W	Khamraev (2003); Gandjaeva et al. (2021)
98	*Lygaeus equestris* (Linnaeus, 1758)	Lygaeidae Schilling, 1829	++	FR	o	TP	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
99	*Spilostethus rubriceps* (Horvath, 1899)		+	F	o	TS	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
100	*Spilostethus pandurus* (Scopoli, 1763)		+	F	**	TS	Kulumbetova (1999); Gandjaeva et al. (2021)
101	*Nysius graminicola* (Kolenati, F.A., 1845)		++	FR	***	SA	Khamraev (2003); Gandjaeva et al. (2021)
102	*Oxycarenus pallens* (Herrich-Schäffer, 1850)		+	S	***	SA	Khamraev (2003); Gandjaeva et al. (2021)
103	*Ortholomus punctipennis* (Herrich-Schäffer, 1850)		++	FR	***	P	Khamraev (2003); Gandjaeva et al. (2021)
104	*Beosus quadripunctatus* (Muller, 1766)	Rhyparochromidae Amyot & Serville, 1843	++	FR	**	SA	Kulumbetova (1999); Gandjaeva et al. (2021)
105	*Bleteogonus beckeri* (Frey-Gessner, 1863)		+	F	**	TS	Kulumbetova (1999); Gandjaeva et al. (2021)
106	*Emblethis griseus* (Wolff, 1802)		+	F	o	SA	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
107	*Emblethis verbasci* (Fabricius, 1803)		+	F	o	SA	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
108	*Emblethis ciliatus* (Horváth, 1875)		+	F	o	SA	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
109	*Emblethis denticollis* (Horváth, 1878)		+	F	***	P	Khamraev (2003); Gandjaeva et al. (2021)
110	*Emblethis dilaticollis* (Jakovlev, 1874)		–	–	–	–	Kulumbetova (1999)
111	*Hyalocoris pilicornis* (Jakovlev, 1874)		+	S	o	TS	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
112	*Lamprodema maura* (Fabricius, 1803)		++	FR	o	W	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)

	Taxon	Family	Occurrence	Abundance	Distribution	Zoogeographic categories	References
113	*Aethus pilosulus* (Klug, 1845)	Cydnidae Billberg, 1820	+	F	o	TS	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
114	*Aethus nigronervosus* (Melichar, 1906)		–	–	–	–	Khamraev (2003)
115	*Byrsinus fossor* (Mulsant & Rey, 1866)		+	F	o	TP	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
116	*Microporus virgata* (Fabricius, 1794)		–	–	–	–	Khamraev (2003)
117	*Microporus nigrita* (Fabricius, 1794)		+	F	**	ETPE	Gandjaeva et al. (2021)
118	*Stibaropus hohlbecki* (Kiritshenko, 1912)		+	F	**	TNT	Kulumbetova (1999); Gandjaeva et al. (2021)
119	*Sehirus morio* (Linnaeus, 1761)		+	F	***	W	Khamraev (2003); Gandjaeva et al. (2021)
120	*Amaurocoris candidus* (Horváth, 1889)		+	F	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
121	*Aelia acuminata* (Linnaeus, 1758)	Pentatomidae Leach, 1815	+++	A	**	W	Kulumbetova (1999); Gandjaeva et al. (2021)
122	*Aelia furcula* (Fieber, 1868)		+++	A	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
123	*Aelia melanota* (Fieber, 1868)		+++	A	**	TS	Kulumbetova (1999); Gandjaeva et al. (2021)
124	*Brachynema germari* (Kalenati, 1846)		++	FR	o	TP	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
125	*Carpocoris pudicus* (Poda, 1761)		++	FR	***	P	Khamraev (2003); Gandjaeva et al. (2021)
126	*Carpocoris fuscispinus* (Boheman, 1851)		++	FR	o	W	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
127	*Palomena prasina* (Linnaeus, 1761)		+++	A	** **	SA	Gandjaeva et al. (2021)
128	*Dolycoris penicillatus* (Horváth, 1904)		+++	A	o	TS	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
129	*Desertomenida quadrimaculata* (Horváth, 1892)		+++	A	***	NS	Khamraev (2003); Gandjaeva et al. (2021)
130	*Desertomenida albula* (Kiritshenko, 1914)		+++	A	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
131	*Derula longipennis* (Oshanin, 1871)		+	F	** **	TP	Gandjaeva et al. (2021)
132	*Apodiphus integriceps* (Horváth, 1888)		+++	A	o	TS	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
133	*Cellobius abdominalis* (Jakovlev, 1885)		++	FR	***	NS	Khamraev (2003); Gandjaeva et al. (2021)
134	*Codophila varia* (Fabricius, 1787)		++	FR	***	SA	Khamraev (2003); Gandjaeva et al. (2021)
135	*Holcostethus nitidus* (Kiritshenko, 1914)		++	FR	***	TNT	Khamraev (2003); Gandjaeva et al. (2021)

	Taxon	Family	Occurrence	Abundance	Distribution	Zoogeographic categories	References
136	*Holcostethus strictus vernalis* (Wolff, 1804)	Pentatomidae Leach, 1815	++	FR	**	P	Kulumbetova (1999); Gandjaeva et al. (2021)
137	*Menaccarus deserticola* (Jakovlev, 1900)		++	FR	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
138	*Eurydema ornata* (Linnaeus, 1758)		+++	A	***	SA	Khamraev (2003); Gandjaeva et al. (2021)
139	*Eurydema oleracae* (Linnaeus, 1758)		+++	A	** **	SA	Gandjaeva et al. (2021)
140	*Eurydema wilkinsi* (Distant, 1879)		+++	A	*	NS	Gandjaeva et al. (2021)
141	*Eurydema ventralis* (Kolenati, 1846)		+++	A	** **	SA	Gandjaeva et al. (2021)
142	*Eurydema maracandica* (Oshanin, 1871)		+++	A	**	NS	Kulumbetova (1999); Gandjaeva et al. (2021)
143	*Graphosoma lineatum* (Linnaeus, 1758)		++	FR	***	SA	Khamraev (2003); Gandjaeva et al. (2021)
144	*Graphosoma consimile* (Horvath, 1903)		++	FR	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
145	*Tarisa elevata* (Reuter, 1901)		++	FR	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
146	*Tarisa subspinosa* (*Germar, 1839*)		++	FR	***	TP	Khamraev (2003); Gandjaeva et al. (2021)
147	*Tarisa virescens* (Herrich-Schäffer, 1851)		++	FR	***	NS	Khamraev (2003); Gandjaeva et al. (2021)
148	*Tarisa pallescens* (Jakovlev, 1871)		++	FR	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
149	*Sciocoris helferi* (Fieber, 1851)		–	–	–	–	Kulumbetova (1999)
150	*Eurygaster integriceps* (Puton, 1881)	Scutelleridae Leach, 1815	++	FR	o	P	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
151	*Odontotarsus impictus* (Jakovlev, 1886)		+	F	o	TS	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
152	*Odontotarsus angustatus* (Jakovlev 1883)		+	F	***	TS	Khamraev (2003); Gandjaeva et al. (2021)
153	*Scantius aegyptius* (Linnaeus, 1758)	Pyrrhocoridae Amyot & Serville, 1843	+	F	o	NS	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
154	*Pyrrhocoris apterus* (Linnaeus, 1758)		++	FR	o	W	Khamraev (2003); Kulumbetova (1999); Gandjaeva et al. (2021)
Total number of species: 154							

Symbols and abbreviations used in the table

Occurrence: constantly occurring species **(CO)**: **++++**; **o**ften occurring species **(OO)**: **+++**; additional occurring species **(AO)**: **++**; Rarely occurring species **(RO)**: **+**.

Abundance: Abundant: **A**; frequent: **FR**; some**: S;** few: **F**.

Distribution: o – species presence;

– species presence not confirmed

* – previously unregistered species for Uzbekistan;

** – previously unregistered species for the Khorezm region;

*** – previously unregistered species for the Republic of Karakalpakstan;

** ** – previously unregistered species for the Khorezm region and the Republic of Karakalpakstan.

Zoogeographical categories

C – Cosmopolitan; **TP –** Trans-Palaearctic; **P –** Pancontinental; **ETPE –** Ethiopia – Trans-Palaearctic – Eastern; **SA –** Super-Atlantic; **W –** The Western; **PA –** Pan-Atlantic; **NC –** Narrow continental; **NS –** The North Seitan; **TS –** Tethyan-Siberian; **ChCA –** Chinese-Central Asian endemics; **TNT –** Turkestanian-Northern Turanian endemics; **ITCA –** Irano-Turanian-Central Asian endemics; **KNTIT –** Kazakh-Northern Turanian, Irano-Turanian; **T –** Turanian endemics.

Khamraev (2003) identified 110 species for the Khorezm, and Kulumbetova (1998a, b, c, 1999) 62 species for the Republic of Karakalpakstan.

The analysis of terrestrial Heteroptera in the Lower Amudarya by Gandjaeva (2007–2020) represented 39 species, which were first studied for the fauna of the Khorezm region and 87 species for the Republic of Karakalpakstan. According to the data, there are currently 149 species of terrestrial Heteroptera recorded in the Lower Amudarya (Fig. 2).

During 2007–2020, 149 species of terrestrial heteropterans were recorded in the Lower Amudarya territory as represented in Table 1.

From the surveys, it has been established that approximately 30 species are abundant and numerous. Sixty-two species are frequent, eight are sometimes encountered, and 49 were recorded as few. They belong to 17 families, 89 genera and the most numerous are Miridae – 37 species and Pentatomidae – 28 species, followed by Reduviidae – 15; Rhopalidae – 10; Geocoridae – 9; Rhyparochromidae – 8; Nabidae – 7; Coreidae, Lygaeidae, Cydnidae – 6, Anthocoridae – 4. Other families are represented by not more than two or three species (Table 2).

Recorded species belong to 11 types according to sector ranges, and 28 groups of areas according to belt ranges (Table 3). The Lower Amudarya's hemipteran species were divided into four large groups: Wide Areas, Holarctic Areas, Palaearctic Areas, and Endemic Areas (Fig. 3).

– Broad areas – extend beyond the Holarctic;
– Cosmopolitan areas – occur on at least three continents;
– Holarctic areas – cover the Palaearctic and the Nearctic region;
– Palaearctic areas – cover parts of Europe, Asia, and North Africa;
– Nearctic areas – cover North America, Mexico, and Greenland;
– The Ethiopia – Trans-Palaearctic – Eastern areas – this complex combines the Palaearctic, Ethiopia and Eastern regions;
– Trans-Palaearctic areas – cover the entire Palaearctic;
– Super-Atlantic areas – cover from the Atlantic sectors to the Eastern transitional sectors;
– The Western areas – cover the part of the Palaearctic Realm from the Eastern Atlantic to the Western Eucontinental sectors;
– Pan-Atlantic areas – encompass the Atlantic sector as well as the western subcontinental subsectors;
– Pancontinental areas – located from the sub-Atlantic to the eastern continental sectors inclusive;
– Narrow Continental areas – cover the Sahara-Gobi Desert area, the Mediterranean and the Irano-Turanian sub-areas.
– The North-Setian areas – cover the Trans-Scythian, the Western-Scythian, and the Eastern-Scythian sub-regions;
– Tethyan-Siberial areas – cover the Tethyan Subkingdom, Scythian, Setian, and European, Mediterranean, and Irano-Turanian subregions;
– Endemic areas – occur only in a certain area and nowhere else.

Table 2. Distribution of the number of genera, species within families, as well as their percentage (%) in the fauna of terrestrial heteropterans.

Family	Number of genera	%	Number of species	%
Anthocoridae	2	2.27	4	2.68
Nabidae	2	2.27	7	4.70
Miridae	20	21.59	37	24.16
Tingidae	3	3.41	3	2.01
Reduviidae	7	7.95	15	10.07
Alydidae	2	2.27	2	1.34
Coreidae	6	6.82	6	4.03
Rhopalidae	7	7.95	10	6.71
Stenocephalidae	1	1.14	2	1.34
Artheneidae	1	1.14	1	0.67
Geocoridae	3	3.41	9	6.04
Lygaeidae	5	5.68	6	4.70
Rhyparochromidae	5	5.68	8	5.37
Cydnidae	6	6.82	6	4.03
Pentatomidae	15	17.05	28	18.79
Scutelleridae	2	2.27	3	2.01
Pyrrhocoridae	2	2.27	2	1.34
Total:	**89**	**100**	**149**	**100**

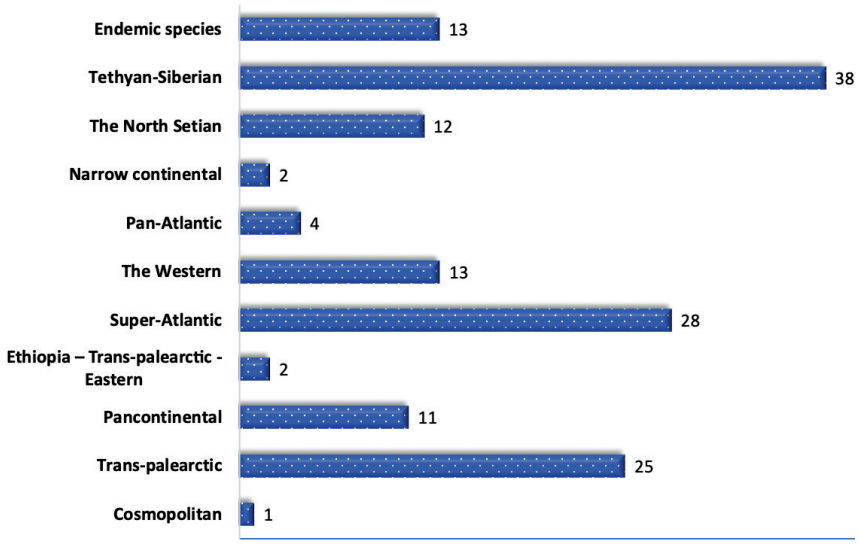

Figure 3. Species numbers of true bugs by area grouping.

In the northern part of Uzbekistan, only one species (0.67%) is cosmopolitan. The group of the Holarctic range is characterized by no more than ten species, which constitutes 6.71% of the total, and most species belong to the Palaearctic group, which is most diverse. The group contains 125 species (83.89%), with 38 from the Tethyan-Siberian type constituting 25.50%. Approximately 15 species account for 10.07% of the Irano-Turanian range, while ten species constitute 6.71% of the Euro-Mediterranean-Turanian range. In the Super-Atlantic range, 28 species account for 18.79%, with eight

Table 3. Percentage of the terrestrial Heteroptera by area grouping.

Type area	The sector and belt range	Number of species	Species	Percentage
I. Groups of wide areas	**I.1. Cosmopolitan**	**1**	*Liorhyssus hyalinus*;	**0.67**
II. Holarctic	**II.1. Trans-Palaearctic**	**9**		**6.04**
	a) Extratropical, Nearctic	3	*Lygus rugulipennis*, *Orius albidipennis*, *Derula longipennis*;	2.01
	b) Boreal-subtropical, Nearctic	3	*Agnocoris rubicundus*, *Lygus punctatus*, *Polymerus cognatus*;	2.01
	c) Boreal-subtropical	2	*Polymerus vulneratus*, *Orthotylus flavosparsus*;	1.34
	d) Boreal – subboreal	1	*Stenodema tripsinosa*;	0.67
	II.2. Pancontinental	**1**		**0.67**
	a) Extratropical	1	*Deraeocoris punctulatus*;	0.67
III. Palaearctic	**III.1. Ethiopia – Trans-Palaearctic – Eastern**	**2**		**1.34**
	a) Southern	2	*Ectomocoris ululans*, *Microporus nigrita*;	1.34
	III.2. Trans-Palaearctic	**16**		**10.74**
	a) Extratropical	1	*Europiella alpina*;	0.67
	b) Arctic	3	*Brachynema germari*, *Byrsinus fossor*, *Tarisa fraudatrix*;	2.01
	c) Boreal	2	*Nabis ferus*, *Nabis sareptanus*;	1.34
	d) Boreal-subtropical	9	*Orius niger*, *Adelphocoris lineolatus*, *Lygus gemellatus gemellatus*, *Stenodema calcaratum*, *Geocoris ater*, *Coreus marginatus*, *Brachycarenus tigrinus*, *Corizus hyoscyami hyoscyami*, *Rhopalus parumpunctatus*;	6.04
	e) Boreal-subboreal	1	*Lygaeus equestris*;	0.67
	III.3. Super-Atlantic	**28**		**18.79**
	a) Arcto-Subboreal	7	*Tuponia elegans*, *Tuponia pallida*, *Coranus aegyptius*, *Nysius graminicola graminicola*, *Emblethis griseus*, *Emblethis verbasci*, *Corizus limbatus*;	4.70
	b) Boreal-subboreal	1	*Orthops basalis*;	0.67
	c) Boreal-subtropical	7	*Lygus pratensis*, *Notostira elongata*, *Eurydema ornata*, *Eurydema oleracae*, *Palomena prasina*, *Orthops kalmi*, *Chorosoma schillingi*;	4.70
	d) Subboreal	8	*Nabis rugosus*, *Nabis viridis Brullé*, *Heterocapillus tigripes*, *Macrotylus herrichi*, *Monosteira discoidalis*, *Beosus quadripunctatus*, *Codophila varia*, *Camptopus lateralis*;	5.37
	e) Subboreal-subtropical	2	*Eurydema ventralis*, *Graphosoma lineatum*;	1.34
	f) Southern	3	*Anthocoris pilosus*, *Oxycarenus pallens*, *Emblethis ciliatus*;	2.01
	III. 4. The Western	**13**		**8.72**
	a) Boreal	2	*Deraeocoris serenus*, *Adelphocoris seticornis*;	1.34
	b) Boreal-subtropical	5	*Lamprodema maura*, *Stictopleurus unicolor*, *Sehirus morio*, *Aelia acuminata*, *Carpocoris fuscispinus*;	3.36
	c) Boreal-subboreal	2	*Pyrrhocoris apterus*, *Megaloceroea recticornis*;	1.34
	d) Subboreal	3	*Artheneis alutacea*, *Brachycoleus decolor*, *Geocoris dispar*;	2.01
	e) Southern	1	*Henestaris halophilus*;	0.67
	III. 5. Pan-Atlantic	**4**		**2.68**
	a) Boreal-subtropical	2	*Stenodema laevigata*, *Campylomma verbasci*;	1.34
	b) Boreal-subboreal	1	*Trigonotylus ruficornis*;	0.67
	c) Subboreal-subtropical	1	*Prostemma sanguineum*;	0.67
	III. 6. Pancontinental	**10**		**6.71**
	a) Northern	1	*Geocoris lapponicus*;	0.67
	b) Boreal-subtropical	5	*Ortholomus punctipennis*, *Emblethis denticollis*, *Holcostethus strictus vernalis*, *Carpocoris pudicus*, *Trigonotylus pulchellus*;	3.36
	c) Subboreal	1	*Orius ribauti*;	0.67
	d) Subboreal-subtropical	1	*Eurygaster integriceps*;	0.67
	e) Southern	2	*Campylomma annulicorne*, *Stephanitis pyri*;	1.34

Type area	The sector and belt range	Number of species	Species	Percentage
	III. 7. Narrow Continental	**2**		**1.34**
	a) Eastern Mediterranean Gobian	1	*Stenodema turanica*;	0.67
	b) Mediterranean-Irano-Turanian	1	*Geocoris fedtschenkoi*;	0.67
	III. 8. The North Setian	**12**		**8.05**
	a) Trans-Scythian	1	*Geocoris arenarius*;	0.67
	b) Western Scythian	3	*Coranus subapterus*, *Campylomma diversicorne*, *Camptotylus meyeri*;	2.01
	c) Eastern Scythian	8	*Corizus tetraspilus*, *Megalotomus ornaticeps*, *Desertomenida quadrimaculata*, *Cellobius abdominalis*, *Eurydema wilkinsi*, *Eurydema maracandica*, *Tarisa virescens*, *Scantius aegyptius*;	5.37
	III. 9. Tethyan-Siberian	**38**		**25.50**
	a) Western-Scythian-Saharo-Gobian	1	*Stenolemus bogdanovi*;	0.67
	b) Euro-Mediterranean – Turanian	10	*Spilostethus pandurus*, *Tarisa pallescens*, *Reduvius testaceus*, *Centrocoris volxemi*, *Bathysolen nubilus*, *Coriomeris vitticollis*, *Rhopalus distinctus*, *Engistus exsanguis*, *Aelia furcula*, *Graphosoma consimile*;	6.71
	c) Irano-Turanian-Gobian	4	*Megacoelum brevirostre*, *Orthotylus eleagni*, *Oncocephalus brachymerus*, *Bothrostethus annulipes*;	2.68
	d) Irano-Turanian	15	*Reduvius disciger*, *Reduvius christophi*, *Engistus salinus*, *Tarisa elevata*, *Desertomenida albula*, *Odontotarsus impictus*, *Odontotarsus angustatus*, *Amaurocoris candidus*, *Aelia melanota*, *Dolycoris penicillatus*, *Apodiphus integriceps*, *Menaccarus deserticola*, *Maccevethus corsicus persicus*, *Dicranomerus marginatus*, *Dicranomerus ferghanensis*;	10.07
	e) Kazakh-Northern Turanian, Irano-Turanian	6	*Nabis palifer*, *Rhynocoris monticola monticola*, *Rhynocoris nigronitens*, *Spilostethus rubriceps*, *Bleteogonus beckeri*, *Geocoris scutellatus*;	4.03
	f) Tethys-Ethiopian	2	*Hyalocoris pilicornis*, *Aethus pilosulus*;	1.34
IV. Endemics	**IV. Endemics**	**13**		**8.72**
	a) Chinese-Central Asian	2	*Nabis remanei*, *Tuponia roseipennis*;	1.34
	b) Chinese-Irano-Central Asian	1	*Reduvius fedtschenkianus*;	0.67
	c) Turkestanian-Northern Turanian	6	*Stibaropus hohlbecki*, *Holcostethus nitidus*, *Lygus pachycnemis*, *Camptotylidea alba*, *Reduvius semenovi*, *Reduvius elegans*;	4.03
	d) Irano-Turanian-Central Asian	3	*Vachiria deserta*, *Tingis leptochila*, *Oncocephalus termezanus*;	2.01
	e) Turanian	1	*Enoplops eversmanni*;	0.67
Total:		**149**		**100**

species making up 5.37% of subboreal and seven species accounting for 4.70% of boreal-subtropical species recorded. Sixteen Trans-Palaearctic species (10.74%) have been recorded, followed by 13 Western (8.72%), 12 North Setian (8.05%), ten Pancontinental (6.71%), and four Pan-Atlantic (2.68%) species. The number of species with Ethiopia-Trans-Palaearctic-Eastern distributions and Narrow Continental is only two for each area or 1.34%. It can be seen that the prevailing part of the group,125 species (83.89%), were found in wider areas of the Holarctic, and 13 are endemic species (8.72%).

The endemics are divided into Chinese-Central Asian, Chinese-Irano-Central Asian, Turkestanian-Northern Turanian, Irano-Turanian-Central Asian, and Turanian (found in Central Asia only). For the assessment of any territory, endemics have a high conservation value since they indicate the distinctive nature of the fauna.

Conclusions

In this study, we collected new 39 species for the Khorezm region and 87 species for the Republic of Karakalpakstan during 2007–2020. In addition, we compare our collections with reports of Khamraev (2003) and Kulumbetova (1998a, b, c, 1999) and a total of 154 species (17 families) of terrestrial Heteroptera (Fig. 2, Table 1) were analyzed.

Khamraev (2003) identified 110 species for the Khorezm, and Kulumbetova (1998a, b, c, 1999) 62 species for the Republic of Karakalpakstan. There are currently 149 species of terrestrial Heteroptera in the Lower Amudarya. The results show that 62 species are highly abundant at the site, divided into 17 families and 89 genera, with the Miridae and Pentatomidae having most species (37 and 28, respectively), followed by Reduviidae (15), Rhopalidae (10), Geocoridae (9), Rhyparochromidae (8), Nabidae (7), Coreidae, Lygaeidae, Cydnidae (6 each) (Table 2).

The Heteroptera fauna of Khorezm and Karakalpakstan can be divided into four groups: Cosmopolitan with one species (0.67%); Holarctic, with no more than ten species, or 6.71%; Palaearctic, with most of species (125 species, or 83.89%); and endemic with 13 species, or 8.72%.

An understanding of the fauna is important, as the productivity of crops is currently being negatively impacted by invasive species from neighboring countries. For example, recently we recorded (Gandjaeva et al. 2022b) the brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) (Heteroptera: Pentatomidae) from Uzbekistan for the first time. Several adults and immatures were found in the Khorezm and Ferghana provinces. This species is native to East Asia (China, Korea, Japan, and Taiwan) (Rider et al. 2002; Hoebeke and Carter 2003; Rider 2006, 2016) and is a dangerous pest of many agricultural plants. Therefore, more study is required to examine the impacts of dispersion in a northern environment. In the north-western region of Uzbekistan, an increase in the number of invasive Heteroptera is expected, which will require careful monitoring.

Acknowledgements

The authors express their warm gratitude to Dr. M. Ahmed for checking the English version of the manuscript, to Dr. M. Sultonov for producing the map of the study area and sampling locations, and to the team from the Zoology Institute (ZIN) of the Uzbekistan Academy of Sciences (UAS) for their assistance.

References

Abdullaev II, Gandjaeva LA, Allabergenova KS, Kurbondurdiev ZJ, Razzakova RS (2020a) Biology and ecology of true bugs of the genus *Eurydema* Lap. Bulletin of the Khorezm Mamun Academy 10: 11–13. http://www.mamun.uz/bulletin/archive/2020/10 [In Russian]

Abdullaev II, Gandjaeva LA, Allabergenova KS (2020b) The cabbage bugs in the territory of the Amu Darya River (Heteroptera, Pentatomidae, *Eurydema*). Electronic Journal of Actual Problems of Modern Science. Education + Training 3: 266–278. http://khorezmscience.uz/public/upload/2020/3/26.pdf

Abdullaev U, Abdullaev I, Gandjaeva L (2020) The Social WASP Fauna of Riparian Tuqai Forest in Khorezm Region of Uzbekistan (Hymenoptera, Vespidae). International Journal of Current Research and Review 12 (14): 96–99. https://doi.org/10.31782/IJCRR.2020.121420

Abdullaev I, Gandjaeva I, Matyakubov Z, Doschanova M, Kholmatov B, Ruzmetov R, Iskandarov A, Otaev O, Ibragimov Sh, Atajanova Sh (2022) Survival of *A. ahngerianus* (Isoptera: Hodotermitidae) Under the Influence of External Factors (Relative Humidity and Temperature) and Use of Different Water Sources. WSEAS Transactions on Environment and Development 18: 1208–1215. https://doi.org/10.37394/232015.2022.18.113

Allabergenova KS, Gandzhaeva LA (2022) Mating, fecundity and egg development of the true bugs (Heteroptera, Pentatomidae). Scientific Review. Biological Sciences 3: 5–10. https://doi.org/10.17513/srbs.1288 [In Russian]

Animal World of Uzbekistan (2023) Animal World of Uzbekistan. http://www.orient-tracking.com/Fauna.htm [Accessed on 01.10.2023]

Aukema B, Rieger C, Rabitsch W (2013) Catalogue of the Heteroptera of the Palaearctic Region 6: Supplement. Netherlands Entomological Society, Amsterdam, 653 pp. https://www.pemberleybooks.com/product/catalogue-of-the-heteroptera-of-the-palaearctic-region-6-supplement/25071/

Bundy CS, McPherson JE (2018) Life history of *Mecidea major* with descriptions of nymphal instars (Hemiptera, Heteroptera, Pentatomidae). In: Wheeler Jr AG (Ed.) A Festschrift Recognizing Thomas J. Henry for a Lifetime of Contributions to Heteropteran Systematics. ZooKeys 796: 335–346. https://doi.org/10.3897/zookeys.796.21325

Catalogue of Palaearctic true bugs (2013) Catalogue of the palaearctic heteropteran. https://catpalhet.linnaeus.naturalis.nl [Accessed on 01.10.2023]

Chandra K, Kushwaha S (2013) Distribution and diversity of Hemiptera fauna of Singhori Wildlife Sanctuary, Raisen District, Madhya Pradesh, India. Munis Entomology & Zoology 8(2): 677–681. https://www.munisentzool.org/yayin/vol8/issue2/vol8issue2-431788.pdf

Dajoz R (2000) Précis d'écologie (7° edn.). Dumond, Paris, 615 pp. [In French]

Drapolyuk IS (2017) Ecological and zoogeographical analysis of capsid bug family (Insecta, Heteroptera, Miridae) of the Caucasus. South of Russia: ecology, development 12(1): 184–190. https://doi.org/10.18470/1992-1098-2017-1-184-190 [In Russian]

Emelyanov AF (1974) Proposals on classification and nomenclature of ranges. Entomological Review 53(3): 497–522. https://www.zin.ru/animalia/coleoptera/rus/palearct.htm [In Russian]

Esenbekova PA (2013) True bugs (Heteroptera) of Kazakhstan. Nur-Print, Almaty, 349 pp. https://zool.kz/wp-content/uploads/2020/04/esenbekova2013_poluzhestkokrylye_kz.pdf [In Russian]

Gandjaeva LA (2011) Geographical distribution of cruciferous bugs (*Eurydema maracandica* Osh. and *E. wilkinsi* Dist.). Scientific conference of the Institute of Zoology, Tashkent, 109–110. [In Russian]

Gandjaeva LA (2012a) Dynamics of the number of larvae of cruciferous bugs on cultivated and wild cruciferous plants. Actual problems of the humanities and natural sciences 4(39): 25–26. https://cyberleninka.ru/article/n/dinamika-chislennosti-lichinok-krestotsvetnyh-klopov-na-kulturnyh-i-dikih-krestotsvetnyh-rasteniyah [In Russian]

Gandjaeva LA (2012b) Influence of the feeding plant on the rate of puberty, fertility and lifespan of bugs. FAN-Science journal of scientific works, 11–12. [In Russian] https://www.elibrary.ru/item.asp?id=17844710

Gandjaeva L (2019) Effect of sowing date on yield of winter wheat cultivars Grom, Asr and Kuma in Khorezm region. Bulgarian Journal of Agricultural Science 25(3): 474–479. https://www.agrojournal.org/25/03-07.pdf

Gandjaeva LA (2020) Effect of temperature on embryonic development of the Central Asian Cabbage bug. I International Multidisciplinary Conference "Recent Scientific Investigation". Primedia E-launch LLC. Shawnee, USA, 6–9. https://www.internauka.org/authors/lola-gandjaeva

Gandjaeva LA, Abdullaeva SI (2022a) Species composition of cruciferous bugs on cabbage. Research of ways of improvement of scientific and technical potential of society in strategic period: Collection of articles of the International scientific-practical conference (Russia), May 2022. Magnitogorsk, Ufa, 22–24. https://os-russia.com/SBORNIKI/KON-436-2.pdf#page=24 [In Russian]

Gandjaeva LA, Abdullaeva SI (2022b) The cruciferous bugs (Miridae). Conceptions for sustainable development of science in modern conditions: Proceedings of the International Scientific and Practical Conference (Novosibirsk), Part 2. June 2022. Ufa, 15–17. https://os-russia.com/SBORNIKI/KON-437-2.pdf#page=15 [In Russian]

Gandjaeva LA, Allabergenova K (2022) Ecological groups of cruciferous bugs. Bulletin of the Khorezm Mamun Academy 7(1): 42–45. http://www.mamun.uz/bulletin/archive/2022/7 [In Russian]

Gandjaeva LA, Nurullaeva MSh, Jumanazarova NR, Ruzmatova MI, Boltaeva S (2019) Geographical distribution of cruciferous bugs (*E. maracandica* Osh. and *E. wilkinsi* Dist). Materials of the International Scientific and Practical Conference Actual issues of theory and practice of scientific research development, 4, Ufa, 61–63. https://www.elibrary.ru/item.asp?id=41576582 [In Russian]

Gandjaeva LA, Abdullaev II, Allabergenova K (2020a) Study of ranges of Cruciferous Bugs. Bulletin of the Khorezm Mamun Academy 8: 36–38. http://www.mamun.uz/bulletin/archive/2020/8 [In Russian]

Gandjaeva LA, Abdullaev II, Abdullaeva SB (2020b) Analysis of population dynamics of the Central Asian Bugs on agricultural crops in the territory of the Lower Amudarya River (Heteroptera, Pentatomidae, *Eurydema*). Scientific Review. Biological Sciences 3: 94–100. https://doi.org/10.17513/srbs.1203 [In Russian]

Gandjaeva LA, Abdullaev II, Razzakov KB (2020c) Characteristic of Identified Insect species on Cabbage in the Conditions of Khorezm Region. Scientific Review. Biological Sciences 4: 5–11. https://doi.org/10.17513/srbs.1206 [In Russian]

Gandjaeva LA, Abdullaev I, Razzakov K, Allabergenova K (2020d) Climate impact on the population dynamics of Cruciferae Bugs (Heteroptera, Pentatomidae, *Eurydema*). EurAsian Journal of BioSciences 14: 3349–3358. http://www.ejobios.org/download/climate-impact-on-the-population-dynamics-of-cruciferae-bugs-heteroptera-pentatomidae-eurydema-7940.pdf

Gandjaeva LA, Ismayilova I, Saidova S (2020e) The Central Asian Cabbage Bugs. Tendenze attuali della moderna ricerca scientifica: der Sammlung wissenschaftlicher Arbeiten «ΛΌΓΟΣ» zu den Materialien der internationalen wissenschaftlich-praktischen Konferenz. 2, Stuttgart, Germany, 122–123. https://doi.org/10.36074/05.06.2020.v2.50

Gandjaeva LA, Abdullaev II, Allabergenova K (2021) True Bugs in the Lower Amu Darya. Bulletin of the Khorezm Mamun Academy 5: 42–46. http://www.mamun.uz/bulletin/archive/2021/5 [In Russian]

Gandjaeva LA, Abdullayev II, Bobojonova XM, Iskandarov AI (2022a) Occurrence of the true bugs (Heteroptera) in a variety of habitats. Scientific Review. Biological Sciences 3: 10–15. https://doi.org/10.17513/srbs.1277 [In Russian]

Gandjaeva LA, Hudayberdieva MO, Abdullaev II, Mirzayeva GS, Yusupboev EK (2022b) First record of *Halyomorpha halys* (Heteroptera: Pentatomidae) from Uzbekistan. Zoosystematica Rossica 31(2): 329–331. https://doi.org/10.31610/zsr/2022.31.2.329

Gandjaeva LA, Yusupova SK, Doschanov JS (2022c) Trophic relationships of bread bugs (Heteroptera). Bulletin of the Khorezm Mamun Academy 7(1): 45–48. http://www.mamun.uz/bulletin/archive/2022/7 [In Russian]

Gapon DA (2019) The brown marmorated stink bug Halyomorpha halys (Stål, 1855) (Heteroptera: Pentatomidae): expansion of its range in the European part of Russia, description of the imago and larvae, and the diagnostics of the species. Caucasian Entomological Bulletin 15(2): 241–247. https://doi.org/10.23885/181433262019152-241247

Henry TJ (2017a) Biodiversity of Heteroptera. In: Foottit RG, Adler PH (Eds) Insect Biodiversity. Science and Society (Vol. I. 2nd edn.). Wiley-Blackwell Press, Oxford, 904 pp. https://doi.org/10.1002/9781118945568.ch10

Henry TJ (2017b) First record of the Palaearctic plant bug *Rhabdomiris striatellus* (Fabricius) (Heteroptera: Miridae: Mirinae) in North America. Proceedings of the Entomological Society of Washington 119(4): 575–579. https://doi.org/10.4289/0013-8797.119.4.575

Hoebeke ER, Carter ME (2003) *Halyomorpha halys* (Stal) (Heteroptera: Pentatomidae): A polyphagous plant pest from Asia newly detected in North America. Proceedings of the Entomological Society of Washington 105: 225–237. https://www.cabdirect.org/cabdirect/abstract/20033040299

Iskandarov A, Abdullaev I, Gandjaeva L, Musaev D, Mirzayeva G, Kholmatov B, Jumanazarov H, Jangabaeva A, Razzakov K, Abdullaev U (2022) Updated Checklist of the Pentatomidea (*Heteroptera*: *Pentatomomorpha*) of Uzbekistan. WSEAS Transactions on Environment and Development 18: 1283–1295. https://doi.org/10.37394/232015.2022.18.121

Khamraev ASh (2003) Soil organisms and entomocomplexes in Khorezm and Karakalpakstan (Uzbekistan). Tashkent. ZEF Work Papers for Sustainable Development in Central Asia, 63 pp. https://www.zef.de/fileadmin/webfiles/downloads/projects/khorezm/downloads/Publications/wps/ZEF-UZ-WP06-Khamraev1.pdf [In Russian]

Kim J, Jung S (2018) Three new records of the subfamily Mirinae (Hemiptera: Heteroptera: Miridae) from the Korean Peninsula. Journal of Asia-Pacific Biodiversity 11(2): 255–258. https://doi.org/10.1016/j.japb.2018.04.003

Kulumbetova TT (1998a) Insects of the Southern Aral Sea (part 1). Bulletin of the Karakalpakstan 1: 66–68. [In Russian]

Kulumbetova TT (1998b) Insects of the Southern Aral Sea (part 2). Bulletin of the Karakalpakstan 4: 64–66. [In Russian]

Kulumbetova TT (1998c) Insects of the Southern Aral Sea (part 3). Bulletin of the Karakalpakstan 1: 37–39. [In Russian]

Kulumbetova TT (1999) Insects of the Southern Aral Sea (part 4). Bulletin of the Karakalpakstan 1: 62–69. [In Russian]

Kuzhuget SV, Vinokurov NN (2018) Types of areal of Heteroptera from Tuva, Russia. Evraziatskii Entomologicheskii Zhurnal 17(2): 103–109. https://doi.org/10.15298/euroasentj.17.2.05 [In Russian]

Latreille PA (1810) Ordre III. Hemipteres. Section Premiere. In: Heteropteres. Considerations generales des Crustaces, Arachnides et Insectes sur l'ordre naturel des animaux composant les classes des Crustaces des Arachnides et des Insectes, avec un tableau methodique de leurs genres, disposes en families. F. Schoell, Paris, 250–434. https://doi.org/10.5962/bhl.title.34917 [In French]

Leach WE (1815) Entomology. The Edinburgh Encyclopedia 9 (1): 57–172. https://zoobank.org/NomenclaturalActs/6B4353F6-7682-4CB6-97D0-8548009000D3

Lopatin IK, Meleshko JE (2016) Zoogeography (with electronic application). BSU, Minsk, 53–55. https://elib.bsu.by/handle/123456789/158509 [In Russian]

Oh M, Yasunaga T, Lee S (2017) Taxonomic review of *Phytocoris* Fallén (Heteroptera: Miridae: Mirinae: Mirini) in Korea, with one new species. Zootaxa 4232(2): 197–215. https://doi.org/10.11646/zootaxa.4232.2.4

Oshanin VF (1891) Zoogeographical character of the fauna of True bugs of Turkestan. Sankt-Peterburg 23(1): 116. [In Russian]

Panizzi AR, Grazia J (2015) Introduction to True Bugs (Heteroptera) of the Neotropics. In: Panizzi A, Grazia J (Eds) True Bugs (Heteroptera) of the Neotropics. Entomology in Focus, 2: 3–20. https://doi.org/10.1007/978-94-017-9861-7_1

Rider DA (2006) Family Pentatomidae Leach, 1815, 233–402. In: Aukema B, Rieger Ch (Eds) Catalogue of the Heteroptera of the Palaearctic Region. The Netherlands Entomological Society, 500–550.

Rider DA (2016) *Aeliavuori linnacostatus*, a new genus and species of Pentatomidae from the Democratic Republic of the Congo (Hemiptera: Heteroptera: Pentatomidae: Pentatominae: Carpocorini). Entomologica Americana 122(1–2): 212–219. https://doi.org/10.1664/15-RA-038

Rider DA, Zheng LY, Kerzhner IM (2002) Checklist and nomenclatural notes on the Chinese Pentatomidae (Heteroptera). II. Pentatomina. Zoosystematica Rossica 11(1): 135–153. https://doi.org/10.31610/zsr/2002.11.1.135

Ruzmetov R, Abdullaev I, Gandjaeva L, Matyakubov Z, Razzakov K, Iskandarov A, Otaev O, Ibragimov Sh (2022) Fundamentals of using Geographical Information Systems in predicting the distribution of *Helicoverpa armigera* (Lepidoptera: Noctuidae). Biodiversitas 23(6): 3251–3256. https://doi.org/10.13057/biodiv/d230653

Samra S, Ghanim M, Protasov A, Mendel Z (2015) Development, reproduction, host range and geographical distribution of the variegated caper bug *Stenozygum coloratum* (Hemiptera: Heteroptera: Pentatomidae). EJE 112(2): 362–372. https://doi.org/10.14411/eje.2015.041

Saprykin MA (2013) Ecological and faunistic analysis of water bugs and water striders (Heteroptera: Nepomorpha, Gerromorpha) of the Northwestern Caucasus. PhD thesis, Kuban State university, Krasnodar city, 253 pp. https://doi.org/10.13140/2.1.4042.7523

Schuh RT, Weirauch C (2020) True Bugs of the World (Hemiptera: Heteroptera): Classification and Natural History (2nd edn.). (Monographs Series, vol. 8). Siri Scientific Press, Manchester, 800 pp. https://www.nhbs.com/true-bugs-of-the-world-hemiptera-heteroptera-book

Vinokurov NN, Kanyukova EV, Golub VB (2010) Catalogue of true bugs insects (Heteroptera) of Asian part. Nauka, Novosibirsk, 317 pp. [In Russian]

Vinokurov NN, Golub VB, Zinovieva AN (2015) Plant bugs (Heteroptera, Miridae) of the South Urals State Natural Reserve. I. Bryocorinae, Deraeocorinae, Mirinae. Bulletin of Belgorod State University. Series Natural Sciences, BGNIU 15 (212): 84–93. https://cyberleninka.ru/article/n/klopy-slepnyaki-heteroptera-miridae-yuzhno-uralskogo-gosudarstvennogo-prirodnogo-zapovednika-i-bryocorinae-deraeocorinae-mirinae [In Russian]

Weirauch C, Schuh RT (2011) Systematic and Evolution of Heteroptera: 25 years of progress. Annual Review of Entomology 56(1): 487–510. https://doi.org/10.1146/annurev-ento-120709-144833

Yakovlev VE (1890) Fauna of True bugs of Russia and neighboring countries. Russian Entomology Society 24: 311–348. [In Russian]

Yasunaga T (2016) A new mirine plant bug genus (Heteroptera: Miridae: Mirinae: Mirini), with two confirmed species from Nepal and Taiwan. Tijdschrift voor Entomologie 159(3): 209–216. https://doi.org/10.1163/22119434-15903002

Yazici G (2020) Overview of the Zoogeographical Distribution of Aquatic and Semi-Aquatic Heteroptera (Hemiptera) in Turkey. Journal of Insect Biodiversity and Systematics 6(2): 135–155. https://doi.org/10.52547/jibs.6.2.135

Yusupova SK, Gandjaeva LA (2022) Species composition of bread bugs (Heteroptera) on triticale. Research of ways of improvement of scientific and technical potential of society in strategic period: Collection of articles of the International scientific-practical conference (Magnitogorsk), Part 2, May 2022. Ufa, 20–22. https://www.elibrary.ru/item.asp?id=48728365 [In Russian]

Yusupova SK, Gandzhaeva LA, Doschanov ZhS (2022) True bugs in triticale agrocenoses. Scientific Review. Biological Sciences 3: 57–62. https://doi.org/10.17513/srbs.1285 [In Russian]

Zaime A, Gautier JY (1989) Comparaison des régimes alimentaires de trois espèces sympatriques de Gerbillidae en milieu saharien au Maroc. Revue d'Ecologie (Terre et vie) 44(2): 153–163. https://hal.science/hal-01320881