

Diversity of true bugs (Hemiptera: Heteroptera) of the Southern Aral Sea Region, Uzbekistan

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Abstract. Medetov MZH, Abdullaeva JK, Reymov A, Miratdinova AM, Seytmuratov AK, Tajibaeva JD, Kadirov RS, Utemuratov NA, Kimyonazarov SK, Kudratov J, Urazova RS, Keldiyorova XX, Uralov UB. 2025. Diversity of true bugs (Hemiptera: Heteroptera) of the Southern Aral Sea Region, Uzbekistan. *Biodiversitas* 26: 3125-3135. This article presents the results of a scientific study conducted in 2021-2023 on screening representatives of the order Heteroptera in various regions of the Southern Aral Sea, Uzbekistan, using modern zoological and ecological methods and the literature review of the available scientific sources. It was noted that the hemipterans in the Southern Aral Sea Region consist of 258 species belonging to 4 infraorders, 13 superfamilies, 25 families, 35 subfamilies, 35 tribes, 104 genera and 3 subgenera. According to the distribution of hemipterans in the Southern Aral Sea Region in terms of infraorders, 132 species belong to the infraorder Pentatomomorpha (51.2%), 106 species to Cimicomorpha (41.1%), 13 species to Nepomorpha (5.03%), 7 species to Gerromorpha (2.7%) and the infraorder Gerro-morpha made up the least numbers with 1 species (0.38%). 167 species identified in our research materials were found to be close to 124 species according to Khamraev's data in 2003, (KJ: 0.25), as well, 146 species according to Ganjaeva's data in 2021 (KJ: 0.30). According to the distribution of hemipterans in the Southern Aral Sea Region in landscapes, 89 species (34.5%) were identified in agro-biocenoses, 85 species (32.9%) in the Lower Amudarya Biosphere Reserve, 83 species (32.29%) in Kyzylkum desert areas, 19 species (7.36%) on water and water banks, as well, 100 species (38.7%) in Ustyurt. Based on the density and number of 167 species of hemipterans distributed in the natural and anthropogenic regions of the Southern Aral Sea, 13 species were recorded as very rare (7.8%), 25 species-rare (15%), 63 species-permanent (38%), 27 species-common (16.1%), and 39 species-very common (23.3%).

Keywords: Active periods, bugs, heteropterans, similarity coefficient, species composition

INTRODUCTION

The concept of heteropterans or true bugs was first introduced to science by the Swedish scientist Carl Linnaeus in 1758 (Randall et al. 1995). At present, more than 45,000 species of heteropterans belonging to 91 families and 6,000 genera are known worldwide (Cassis and Gross 2002). They belong to 8 infraorders and 37,000 species are estimated to belong to the Cimicomorpha and Pentatomomorpha infraorders (Panizzi 2015).

In various literature sources, more than 2,000 species of heteropterans are recorded in the Commonwealth of Independent States (CIS) countries, in particular, more than 2,000 species in Russia, Ukraine and Kazakhstan (Kerzhner et al. 2004; Esenbekova 2013), more than 760 species belonging to 35 families in Uzbekistan (Aukema 2018), and more than 150 species in Tajikistan (Oshanin 1891). According to the latest data, 25,000 species of heteropterans belonging to 7 large infraorders, 79 families, and about 3116 genera are listed in the Palaearctic Region (Aukema 2018).

The research on the species composition, biology, ecology, and significance of heteropterans and other

invertebrates in Central Asia began at the end of the 18th century (Kudratov et al. 2024; Medetov et al. 2024b). For the first time in 1869-1890, scientific research works under the leadership of Fedchenko were conducted to study the nature of the Turkiston (Delmar 1869). The study of heteropterans across Uzbekistan was carried out according to the general orders.

In 1998-1999, Kulumbetova (1999) conducted research on the fauna of heteropterans in the Karakalpakstan, and identified 87 species in this area, furthermore, 149 species were identified by Gandjaeva et al. (2023). In 2003, 128 species of heteropterans were identified in Khorezm Region by Khamraev (2003). In 2011, Daminova (2011) studied hemipterans in the Nurota Mountain Ranges in the central Samarkand and Navoi Regions and identified 73 species of heteropterans belonging to 15 families. Baltabaev identified 27 species of hemipterans belonging to 17 genera of the Miridae family in the Southern Aral Sea (Baltabaev 1979). Musaev et al. (2023) identified 57 species of blind heteropterans in the southern Uzbekistan and explained their ecological features. In recent times, the species *Halyomorpha halys*, *Creontiades pallidus*, *Zelus renardii*, *Eurystylus bellevoeyi*, *Corythucha ciliata*, *Sarju pavlovskii*, *Xanthochilus*

melanopus, are being studied (Grebennikov and Makhanov 2019; Musaev et al. 2023; Grebennikov et al. 2024).

The nutrition of the true bug species varies. 60% of all heteropterans feed on plants and cause damage to agriculture (Panizzi 2015). A single species of *Lygus hesperus* damages over 300 plant species by feeding on them (Young 1986). There are about 12,000 species of the Miridae family in the world (Schuh et al. 2020). More than 220 species belonging to this family can be found in Uzbekistan (Aukema 2018). Among them, many scientific and research works were conducted on *Adelphacoris lineolatus*, *C. pallidus* and *Lygus pratensis* species, which are of high economic importance in agriculture (Musaev et al. 2023). Musaev et al. (2023) studied the spread of *C. pallidus* species in the cotton agroecosystems of South Uzbekistan and the damage it causes to the crop. In the experiments, it was found that the productivity decreases from 12.5% to 62.9% when 50 and 100 pieces of true bugs correspond to 100 cotton bushes in different periods (Musaev et al. 2020). 3,400 species of useful Mirid true bugs belonging to 561 genera and 7 subfamilies were recorded (Wheeler 2001).

The Nabidae family takes the leading place in Uzbekistan in terms of the variety of species among predatory bugs. Literatures source mention that 49 species of them distributed in different regions of our republic (Kerzhner 1981). These species are mainly active at night and benefit greatly by feeding on various insects, especially the main pests of agricultural crops (Panizzi 2015). It also causes some damage by killing beneficial insects, their

eggs, and larvae. Species such as *Stenolemus bogdanovii* and *Reduvius fedtschenkianus* belonging to the Reduviidae family are included in the Red Book of the Republic of Uzbekistan (2019). They can only be caught with light traps (Kerzhner et al. 2004). Currently, research on the biological diversity of insects is being conducted in Uzbekistan, including studies on Orthoptera alongside true bugs (Nurjanov et al. 2023). The aim of the study is to assess the biodiversity and distribution of species of Heteroptera in the Southern Aral Sea Region, Uzbekistan.

MATERIALS AND METHODS

Study area

The research was conducted in the natural and anthropogenic zones of the Southern Aral Sea of Uzbekistan during 2021-2024 (Figure 1). The Southern Aral Sea Region includes the Khorezm Region of the Republic of Uzbekistan, the Republic of Karakalpakstan, as well as the Tashkhovuz Region of Turkmenistan. This area belongs to the Lower Amudarya agro-climatic district of the Turan agro-climatic province and covers the plain from the Tuyamoin basin to the Aral Sea basin (Medetov et al. 2024a). The Ustyurt plateau and the northern part of the Kyzylkum desert were also studied in the research work. Since it was not possible to collect specimens from the neighboring Tashkhovuz Region, the information provided in scientific sources (Gandzhaeva 2021) was used.

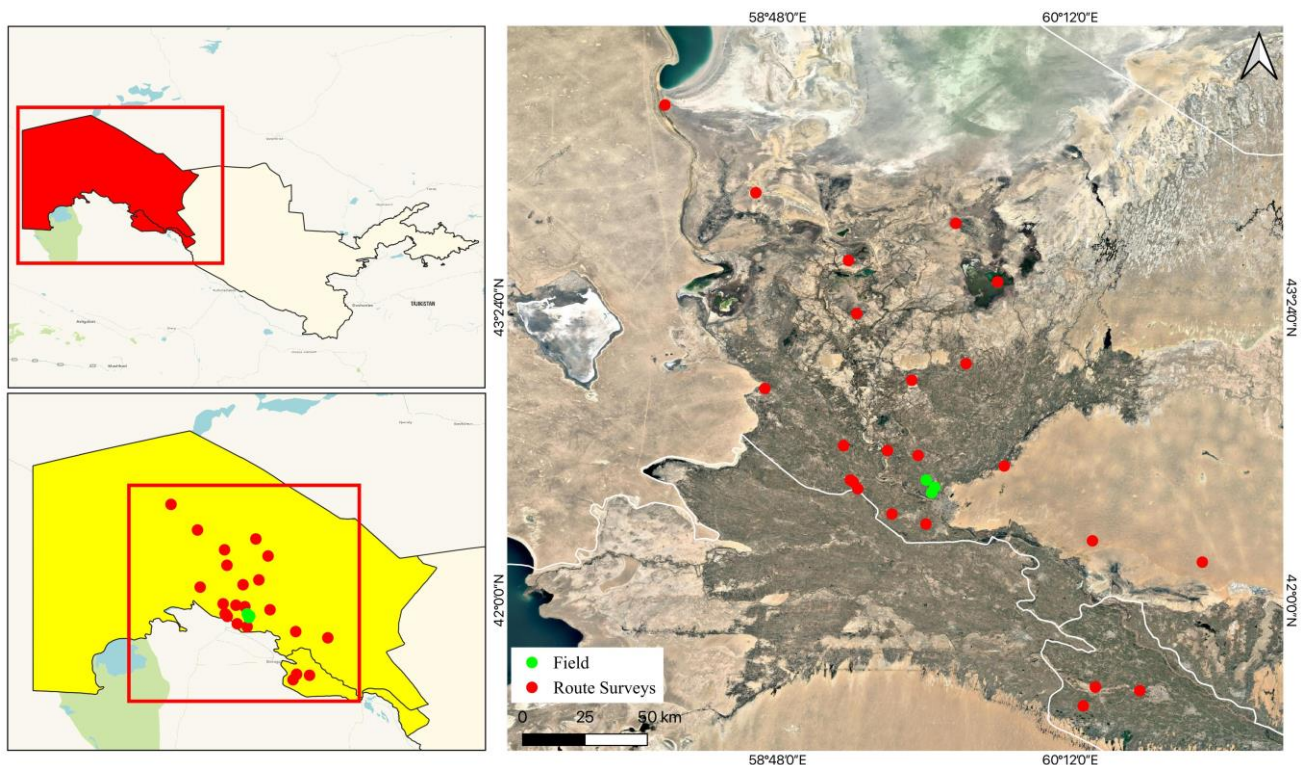


Figure 1. Map of research areas (red-route: surveys, green: field)

Picking materials

During the field studies, methods such as entomological traps (Levenhuk LabZZ BT10), Barbara, Melezi methods and light traps (Pelsis) were used to collect real insects. Insects were collected mainly from the upper 15-20 cm of crops (rice, wheat, and vegetables) and grasslands using entomological traps (mattresses) with a diameter of 35-40 cm. To obtain information about seasonal changes in the number of bugs, their distribution and quantity in crops, continuous field and route surveys were conducted every 15 days from April to November of the year.

Also, the true bugs were assembled with the help of light traps. The collected insect specimens were placed on mattresses, and labels were attached to them with the name of the place of work, period, and brief information about the landscape. All collected specimens were processed in laboratory conditions, separated according to their development phases, specimens were subjected to preliminary examination and their taxonomic status was determined (Alimova et al 2024; Medetov et al. 2025).

Species identification

The taxonomic status, morphological and classification features of the true bugs were studied on the basis of a number of identifiers and scientific sources related to the field. In particular, they were analyzed based on the scientific works by Kiritshenko (1951) in Russia, Putshkov (1969) in Ukraine, Asanova (1975), and Esenbekova et al. (2015) in Kazakhstan.

Environmental assessment

In order to compare the species in the fauna, the similarity degree of species in the fauna was determined using the Jaccard similarity coefficient, and cluster analysis was performed (Dick and Laflamme 2022; Khojakulov et al. 2024).

$$K_j = \frac{c}{a + b - c}$$

Where,

Kj : Jaccard's similarity coefficient

c : Number of similar species

a and b : The total number of species in the faunas being compared

Statistical analysis

Statistical processing and drawing of the results were performed using Microsoft Excel 2013 (USA) computer program. In the mathematical-statistical analysis, the mean

values, and deviations of the indicators, as well as the calculation of the probability, were carried out according to the method of Lakin (1990) and Mukhtorova et al. (2024).

RESULTS AND DISCUSSION

Research on the fauna of hemipterans of the Southern Aral Sea Regions of Uzbekistan has been carried out for almost 40 years, and over 7857 specimens were collected and analyzed in terms of five landscapes of this region using various methods during 2021-2024. Of the total 7,857 analyzed specimens, 2,119 were collected in 2021, 1,783 in 2022, 2,392 in 2023, and 1,563 in 2024. A total of 7,857 specimens were collected and analyzed in the cross-section of landscapes: 1,393 specimens (18%) were collected from the Kyzylkum desert, 971 specimens (12%) from the Lower Amudarya biosphere reserve, 1,489 specimens (19%) from the Ustyurt plain, 3,384 specimens (43%) from agrolandscapes, and 620 specimens (8%) from streams and lakes (Table 1).

As a result of scientific research conducted in 2021-2024 in five landscapes of the Southern Aral Regions, 167 species of hemipterans belonging to 4 infraorders, 13 superfamilies, 22 families, 35 subfamilies, 35 tribes, 104 genera, 3 subgenera have been identified. Thus, together with the research results and literature data, the species composition of hemipterans in the north-western regions of Uzbekistan reached to 258 species. Information on the current systematic classification of Hemiptera species, their species composition, global distribution, taxonomy, and global distribution is based on the works of Randall et al. (1995).

Hemipterans in the Southern Aral Sea consisted of 258 species belonging to 4 infraorders, 13 superfamilies, 25 families, 35 subfamilies, 35 tribes, 104 genera and 3 subgenera (Table 2). Pentatomomorpha and Cimicomorpha were the leaders in terms of distribution of heteropterans among the infraorders. The infraorder Pentatomomorpha included 132 species (51.2%), Cimicomorpha-106 species (41.1%), Nepomorpha-13 species (5.03%), Gerromorpha-7 species (2.7%) and the least amount belongs to Gerromorpha with 1 species (0.38%). According to the distribution of hemipterans in the landscapes of northwestern Uzbekistan, 89 species (34.5%) were recorded in agro-biocenoses, 85 species (32.9%) in the Lower Amudarya Biosphere Reserve, 83 species (32.29%) in the Kyzylkum desert, 19 species (7.36%) in water and water banks and 100 species (38.7%) in Ustyurt (Table 3).

Table 1. Information about specimens of hemipterans collected during 2021-2024 in the Southern Aral Sea Region, Uzbekistan

| Research area | Number of coordinates | Repetitions in material collection | Imago | | Lamka | Total |
|----------------------------------|-----------------------|------------------------------------|-------|------|-------|-------|
| | | | ♀ | ♂ | | |
| Agrolandscapes | 45 | 25 | 1304 | 1079 | 1001 | 3384 |
| Lower Amudarya biosphere reserve | 15 | 8 | 480 | 319 | 172 | 971 |
| Kyzylkum desert | 25 | 12 | 550 | 518 | 325 | 1393 |
| Ustyurt plain | 25 | 12 | 511 | 525 | 453 | 1489 |
| Streams and lakes | 15 | 7 | 229 | 269 | 122 | 620 |
| Total | 130 | 64 | 3074 | 2710 | 2073 | 7857 |

Table 2. Taxonomic structure of hemipterans in the Southern Aral Sea Region, Uzbekistan

| Infraorder | Superfamily | Family | Subfamily | Tribe | Genera | Subgenera | Species |
|-----------------|-------------|--------|-----------|-------|--------|-----------|---------|
| Cimicomorpha | 3 | 6 | 14 | 14 | 42 | - | 106 |
| Gerromorpha | 1 | 2 | 4 | 1 | 3 | 1 | 7 |
| Nepomorpha | 6 | 6 | 5 | 3 | 6 | - | 13 |
| Pentatomomorpha | 3 | 8 | 12 | 17 | 53 | 2 | 132 |
| Total | 13 | 25 | 35 | 35 | 104 | 3 | 258 |

Table 3. The species composition of true bugs of the Southern Aral Sea Region, Uzbekistan

| Names of the species | Our research | Khamraev | Gandzhaeva | Agrocenosis | Lower Amudarya biosphere reserve | Kyzylkum desert | Streams and lakes | Ustyurt plain |
|---|--------------|----------|------------|-------------|----------------------------------|-----------------|-------------------|---------------|
| Anthocoridae (Fieber, 1837) | | | | | | | | |
| * <i>Anthocoris angularis</i> (Reuter, 1884) | + | - | - | + | - | - | - | + |
| <i>A. pilosus</i> (Jakovlev, 1877) | + | + | + | + | - | - | - | + |
| <i>Orius niger</i> (Wolff, 1811) | + | + | + | - | - | - | - | + |
| <i>O. albidipennis</i> (Reuter, 1884) | - | - | + | + | - | - | - | - |
| * <i>O. horvathi</i> (Reuter, 1884) | + | - | - | + | - | - | - | - |
| <i>O. ribauti</i> (Wagner, 1952) | - | + | + | - | - | - | - | + |
| Cimicidae (Latreille, 1802) | | | | | | | | |
| * <i>Cimex lectularius</i> (Linnaeus, 1758) | + | - | - | + | - | - | - | - |
| Nabidae (Costa, 1852) | | | | | | | | |
| * <i>Nabis viridulus</i> (Spinola, 1837) | + | - | - | - | + | - | - | - |
| <i>N. viridis</i> (Brullé, 1839) | - | + | + | - | - | - | - | + |
| <i>N. sareptanus</i> (Dohrn, 1862) | - | + | + | - | - | + | - | - |
| <i>N. palifer</i> (Seidenstücker, 1954) | + | + | + | + | - | + | - | + |
| <i>N. remanei</i> (Kerzhner, 1962) | - | - | + | - | + | - | - | - |
| <i>N. ferus</i> (Linnaeus, 1758) | + | + | + | - | + | + | - | + |
| * <i>N. punctatus</i> (Costa, 1847) | + | - | - | + | - | - | - | + |
| <i>N. rugosus</i> (Linnaeus, 1758) | + | + | + | - | + | + | - | + |
| Miridae (Hahn, 1833) | | | | | | | | |
| * <i>Dicyphus orientalis orientalis</i> (Reuter, 1879) | + | - | - | + | + | - | - | - |
| * <i>Nesidiocoris tenuis</i> (Reuter, 1895) | + | - | - | + | + | - | - | - |
| <i>Macrolophus pygmaeus</i> (Rambur, 1839) | + | - | - | + | + | - | - | - |
| <i>Deraeocoris punctulatus</i> (Fallen, 1807) | + | + | + | + | - | + | - | + |
| <i>D. serenus</i> (Douglas and Scott, 1868) | + | - | + | - | - | + | - | + |
| <i>Adelphocoris lineolatus</i> (Goeze, 1778) | + | + | + | + | - | - | - | + |
| <i>A. seticornis</i> (Fabricius, 1775) | - | - | + | + | - | - | - | + |
| <i>Agnocoris rubicundus</i> (Fallén, 1807) | + | + | + | - | - | - | - | + |
| <i>Lygus pratensis</i> (Linnaeus, 1758) | + | - | + | + | - | - | - | - |
| <i>L. gemellatus gemellatus</i> (Herrich-Schaeffer, 1835) | + | + | + | + | + | + | - | + |
| <i>L. punctatus</i> (Zetterstedt, 1838) | + | - | + | + | + | + | - | + |
| <i>L. rugulipennis</i> (Poppius, 1911) | - | + | + | + | - | - | - | - |
| <i>L. pachynemis</i> (Reuter, 1879) | - | + | + | + | - | - | - | - |
| <i>Orthops basalis</i> (Costa, 1853) | + | + | + | + | + | + | - | + |
| <i>O. kalmi</i> (Linnaeus, 1758) | + | + | + | + | - | - | - | + |
| <i>Polymerus cognatus</i> (Fieber, 1858) | + | + | + | + | - | + | - | + |
| * <i>P. brevicornis</i> (Reuter, 1879) | + | - | - | + | - | - | - | + |
| <i>P. vulneratus</i> (Panzer, 1806) | + | + | + | - | - | - | - | + |
| * <i>Phytocoris kyzylkumi</i> (Muminov, 1989) | + | - | - | - | - | - | - | + |
| * <i>P. kirilschenkoi</i> (Poppius, 1912) | + | - | - | - | - | + | - | - |
| * <i>P. turkestanicus</i> (Poppius, 1912) | + | - | - | - | - | + | - | - |
| * <i>P. undulates</i> (Reuter, 1877) | + | - | - | - | - | - | - | + |
| <i>Notostira elongata</i> (Geoffroy, 1785) | + | + | + | - | + | - | - | + |
| <i>Megaloceroea recticornis</i> (Geoffroy, 1785) | - | - | + | + | - | - | - | - |
| <i>Stenodema calcarata</i> (Fallen, 1807) | + | + | + | + | + | + | - | + |
| <i>Stenodema tripsinosa</i> (Reuter, 1904) | - | + | + | + | - | - | - | - |
| <i>S. turanica</i> (Reuter, 1904) | - | + | + | - | - | - | - | + |
| <i>S. laevigata</i> (Linnaeus, 1758) | + | + | + | + | - | - | - | + |

| | | | | | | | | |
|--|---|---|---|---|---|---|---|---|
| <i>Brachycoleus decolor</i> (Reuter, 1887) | - | - | + | | + | - | - | - |
| <i>Poeciloscytus vulneratus</i> (Panzer, 1806) | - | + | - | | + | - | - | - |
| <i>Trigonotylus ruficornis</i> (Geoffroy, 1785) | + | + | + | + | + | + | - | + |
| <i>T. pulchellus</i> (Hahn, 1834) | - | - | + | - | - | - | - | + |
| <i>Megacoelum brevistre</i> (Reuter, 1879) | - | + | + | - | + | - | - | - |
| * <i>Myrmecophyes alboornatus</i> (Stal, 1858) | + | - | - | - | - | + | - | - |
| * <i>Malacocoris chlorizans</i> (Panzer, 1794) | + | - | - | + | - | + | - | - |
| <i>Orthotylus flavosparsus</i> (Sahlberg, 1841) | + | + | + | + | + | + | - | + |
| <i>O. eleagni</i> (Jakovlev, 1881) | - | + | + | - | - | - | - | + |
| <i>Atomoscelis onusta</i> (Fieber, 1861) | + | + | - | + | - | - | - | + |
| * <i>Auchenocrepis reuteri</i> (Jakovlev, 1876) | + | - | - | - | - | + | - | - |
| * <i>Plagiognathus chrysantemi</i> (Wolff, 1804) | + | - | - | + | - | - | - | - |
| <i>P. alpinus</i> (Van Duzee, 1916) | + | + | - | - | - | + | - | - |
| * <i>Camptotylus bipunctatus</i> (Reuter, 1879) | + | - | - | - | + | + | - | - |
| <i>C. meyeri</i> (Frey-Gessner, 1863) | - | - | + | - | - | + | - | + |
| <i>C. verbasci</i> (Meyer-Dur, 1843) | + | - | + | + | + | + | - | + |
| <i>C. diversicorne</i> (Reuter, 1878) | + | + | + | + | + | + | - | + |
| <i>C. annulicorne</i> (Signoret, 1865) | - | - | + | | - | + | - | - |
| <i>C. alba</i> (Reuter, 1879) | - | - | + | - | - | + | - | - |
| <i>Europiella alpine</i> (Reuter, 1875) | - | - | + | + | - | - | - | - |
| <i>Heterocapillus tigris</i> (Meyer and Dur, 1852) | - | - | + | + | - | - | - | - |
| <i>Macrotylus herrichi</i> (Reuter, 1873) | - | - | + | + | - | - | - | - |
| * <i>Psallopsis haloxylis</i> (Putshkov, 1976) | + | - | - | - | - | + | - | - |
| <i>Atomophora alba</i> (Reuter, 1879) | - | + | - | - | - | - | - | - |
| <i>Tuponia elegans</i> (Jakovlev, 1867) | + | + | + | + | + | + | - | + |
| * <i>T. turanica</i> (Drapolyuk, 1980) | + | - | - | + | + | + | - | + |
| <i>T. pallida</i> (Jakovlev, 1867) | - | + | + | + | - | - | - | - |
| <i>T. roseipennis</i> (Reuter, 1889) | - | + | + | + | - | - | - | - |
| <i>T. brevicornis</i> (Reuter, 1979) | - | + | - | - | - | - | + | - |
| Tingidae (Laporte, 1832) | | | | | | | | |
| * <i>Agramma atricapillum</i> (Spinola, 1837) | + | - | - | - | + | - | - | - |
| <i>Monosteira discoidalis</i> (Jakovlev, 1883) | + | + | + | + | - | - | - | + |
| <i>Stephanitis pyri</i> (Fabricius, 1775) | - | - | + | + | - | - | - | - |
| <i>Tingis (Tingis) leptochila</i> (Horváth, 1906) | + | + | + | + | - | - | - | + |
| Reduviidae (Latreille, 1807) | | | | | | | | |
| * <i>Empicoris culiciformis</i> (De Geer, 1773) | + | - | - | - | + | - | - | - |
| <i>Prostemma sanguineum</i> (Rossi, 1790) | - | - | + | - | - | - | - | + |
| <i>Ectomocoris ululans</i> (Rossi, 1790) | + | + | + | - | - | - | - | + |
| * <i>Peirates hybridus</i> (Scopoli, 1763) | + | - | - | - | + | - | - | - |
| * <i>Holotrichius moestus</i> (Reuter, 1891) | + | - | - | - | - | + | - | - |
| * <i>H. mesoleucus</i> (Kiritshenko, 1914) | + | - | - | - | - | + | - | + |
| <i>Stenolemus bogdanovi</i> (Oshanin, 1896) | - | + | + | + | - | - | - | - |
| * <i>Pasira basiptera</i> (Shil, 1859) | + | - | - | - | + | - | - | - |
| * <i>Coranus griseus</i> (Rossi, 1790) | + | - | - | - | - | + | - | - |
| <i>C. aegyptius</i> (Fabricius, 1775) | + | + | + | + | - | - | - | + |
| <i>C. subapterus</i> (De Geer, 1773) | + | - | + | - | - | - | - | + |
| * <i>Mecistocoris lineatus</i> (Reuter, 1877) | + | - | - | + | - | - | - | - |
| * <i>Rhynocoris iracundus</i> (Poda, 1761) | + | - | - | + | - | + | - | - |
| * <i>R. abramovii</i> (Oshanin, 1871) | + | - | - | + | - | - | - | + |
| <i>R. monticola monticola</i> (Oshanin, 1890) | + | + | + | + | - | - | - | + |
| <i>R. niger</i> (Herrich-Schäffer, 1842) | - | + | - | - | + | - | - | - |
| <i>Rhinocoris nigronitens</i> (Reuter, 1881) | - | + | + | | + | - | - | - |
| <i>Vachiria deserta</i> (Becker, 1867) | + | + | + | | - | - | - | + |
| * <i>V. semerwvi</i> (Jakovlev, 1903) | + | - | - | - | - | + | - | - |
| * <i>Reduvius ciliatus</i> (Jakovlev, 1879) | + | - | - | - | - | + | - | + |
| <i>R. christophi</i> (Jakovlev, 1874) | - | + | + | - | - | + | - | - |
| <i>R. semenovi</i> (Jakovlev, 1885) | - | + | + | - | + | - | - | - |
| <i>R. elegans</i> (Jakovlev, 1885) | - | + | + | - | + | - | - | - |
| <i>R. disciger</i> (Horváth, 1896) | + | + | + | - | - | - | - | + |
| <i>R. fedtschenkianus</i> (Oshanin, 1871) | + | + | + | - | + | - | - | - |
| ** <i>R. carinatus</i> (Fabricius, 1798) | + | - | - | - | - | + | - | - |
| <i>R. testaceus</i> (Herrich-Schaeffer, 1845) | + | + | + | - | + | - | - | + |
| * <i>Oncocephalus plumicornis</i> (Germar, 1822) | + | - | - | - | - | + | - | - |
| <i>O. brachymerus</i> (Reuter, 1882) | + | + | + | - | - | - | - | + |
| <i>O. termezanus</i> (Kiritshenko, 1914) | + | - | + | - | - | - | - | + |
| Mesoveliidae (Douglas and Scott, 1867) | | | | | | | | |
| * <i>Mesovelia furcata</i> (Mulsant and Rey, 1852) | + | - | - | - | - | - | + | - |

| | | | | | | | | |
|--|---|---|---|---|---|---|---|---|
| <i>*Microvelia reticulata</i> (Burmeister, 1835) | + | - | - | - | - | - | + | - |
| <i>*Velia affinis affinis</i> (Kolenati, 1857) | + | - | - | - | - | - | + | - |
| Gerridae (Leach, 1815) | | | | | | | | |
| <i>Gerris (Gerris) costae fieberi</i> (Stichel, 1938) | + | + | - | - | - | - | + | - |
| <i>*G. lacustris</i> (Linnaeus, 1758) | + | - | - | - | - | - | + | - |
| <i>*G. lateralis</i> (Schummel, 1832) | + | - | - | - | - | - | + | - |
| <i>G. argentatus</i> (Schummel, 1832) | - | + | - | - | - | - | - | - |
| Nepidae (Latreille, 1802) | | | | | | | | |
| <i>Nepa cinerea</i> (Linnaeus, 1758) | + | - | + | - | - | - | + | - |
| Micronectidae (Leach, 1815) | | | | | | | | |
| <i>*Micronecta mesmini</i> (Poisson, 1939) | + | - | - | - | - | - | + | - |
| <i>*M. anatolica anatolica</i> (Lindberg, 1922) | + | - | - | - | - | - | + | - |
| <i>*M. pusilla</i> (Horvath, 1895) | + | - | - | - | - | - | + | - |
| Corixidae (Leach, 1815) | | | | | | | | |
| <i>*Sigara lateralis</i> (Leach, 1817) | + | - | - | - | - | - | + | - |
| <i>*S. striata</i> (Linnaeus, 1758) | + | - | - | - | - | - | + | - |
| <i>*S. assimilis</i> (Fieber, 1848) | + | - | - | - | - | - | + | - |
| <i>S. concinna</i> (Fieber, 1848) | - | + | - | - | - | - | + | - |
| <i>S. limitata</i> (Fieber, 1848) | - | + | - | - | - | - | + | - |
| Naucoridae (Leach, 1815) | | | | | | | | |
| <i>*Ilyocoris cimicoides cimicoides</i> (Linnaeus, 1758) | + | - | - | - | - | - | + | - |
| Notonectidae (Latreille, 1802) | | | | | | | | |
| <i>*Notonecta glauca</i> (Linnaeus, 1758) | + | - | - | - | - | - | + | - |
| Pleidae (Fieber, 1851) | | | | | | | | |
| <i>*Plea minutissima minutissima</i> (Leach, 1817) | + | - | - | - | - | - | + | - |
| Alydidae (Amyot and Serville, 1843) | | | | | | | | |
| <i>Camptopus lateralis</i> (Germar, 1817) | + | + | + | + | - | - | - | + |
| <i>Megalotomus ornaticeps</i> (Stal, 1858) | - | + | + | - | - | - | - | + |
| <i>M. zaitzevi</i> (Kerzhner, 1972) | + | - | - | - | + | - | - | - |
| Coreidae (Leach, 1815) | | | | | | | | |
| <i>Centrocoris volxemi</i> (Puton, 1878) | + | + | + | + | - | - | - | + |
| <i>Coreus marginatus marginatus</i> (Linnaeus, 1758) | + | + | + | + | - | - | - | + |
| <i>Enoplops evermanni</i> (Jakovlev, 1881) | - | + | + | - | - | - | - | - |
| <i>Bathysolen nubilus</i> (Fallen, 1807) | - | - | + | + | - | - | - | - |
| <i>Bothrostethus annulipes</i> (Herrich-Schaeffer, 1835) | + | - | + | - | - | - | - | + |
| <i>*Cercinthus lehmanni</i> (Kolenati, 1891) | + | - | - | - | - | + | - | - |
| <i>Coriomeris vitticollis</i> (Reuter, 1900) | + | + | + | + | - | - | - | + |
| Rophalidae (Amyot and Serville, 1843) | | | | | | | | |
| <i>*Chorosoma gracile</i> (Josifov, 1968) | + | - | - | - | - | - | - | - |
| <i>C. schillingi</i> (Schilling, 1829) | - | + | + | - | + | - | - | + |
| <i>Corizus hyoscyamihyoscyami</i> (Linnaeus, 1758) | + | + | + | + | - | - | - | + |
| <i>C. tetraspilus</i> (Horvath, 1917) | - | - | + | + | - | - | - | - |
| <i>C. limbatus</i> (Rey, 1887) | - | + | + | - | + | - | - | - |
| <i>Liorhyssus hyalinus</i> (Fabricius, 1794) | + | + | + | - | - | - | - | + |
| <i>Maccevethus corsicus persicus</i> (Jakovlev, 1882) | + | + | + | - | + | - | - | + |
| <i>Rhopalus distinctus</i> (Signoret, 1853) | + | + | + | - | + | - | - | + |
| <i>R. parumpunctatus</i> (Schilling, 1829) | + | + | + | + | - | - | - | + |
| <i>*Stictopleurus angustus</i> (Reuter, 1900) | + | - | - | - | + | - | - | + |
| <i>S. unicolor</i> (Jakovlev, 1873) | - | + | + | - | + | - | - | - |
| <i>Brachycarenum tigrinus</i> (Schilling, 1829) | - | + | + | - | + | - | - | - |
| Stenocephalidae (Dallas, 1852) | | | | | | | | |
| <i>Dicranocephalus marginatus</i> (Ferrari, 1874) | + | + | - | - | + | - | - | + |
| <i>D. ferghanensis</i> (Horvath, 1887) | - | + | - | - | + | - | - | - |
| <i>Bleteogonus beckeri</i> (Frey-Gessner, 1863) | - | - | + | - | + | + | - | - |
| Geocoridae (Baerensprung, 1860) | | | | | | | | |
| <i>Geocoris ater</i> (Fabricius, 1787) | + | - | + | + | - | - | - | + |
| <i>G. arenarius</i> (Jakovlev, 1867) | + | - | + | + | - | - | - | + |
| <i>G. dispar</i> (Waga, 1839) | + | - | + | - | + | - | - | + |
| <i>G. lapponicus</i> (Zetterstedt, 1838) | - | - | + | - | + | - | - | - |
| <i>G. scutellatus</i> (Montandon, 1907) | - | - | + | - | + | - | - | - |
| <i>G. fedtschenkoi</i> (Reuter, 1885) | - | + | + | - | + | - | - | + |
| <i>Engistus salinus</i> (Jakovlev, 1874) | - | + | + | - | + | - | - | - |
| <i>E. exsanguis</i> (Stål, 1872) | - | - | + | - | + | - | - | - |
| Lygaeidae (Schilling, 1829) | | | | | | | | |
| <i>Lygaeus equestris</i> (Linnaeus, 1758) | + | + | + | + | + | - | - | + |
| <i>Henestaris halophilus</i> (Burmeister, 1835) | - | + | + | - | + | - | - | - |
| <i>Oxycarenum pallens</i> (Herrich-Schäffer, 1850) | - | + | + | - | + | - | - | - |

| | | | | | | | | |
|--|-----|-----|-----|----|----|----|----|-----|
| * <i>Acrosternum breviceps</i> (Jakovlev, 1889) | + | - | - | - | - | + | - | - |
| * <i>Piezodorus lituratus</i> (Fabricius, 1794) | + | - | - | - | + | - | - | - |
| <i>Menaccarus deserticola</i> (Jakovlev, 1900) | + | - | + | + | - | - | - | + |
| <i>M. transparentis</i> (Jakovlev, 1900) | - | + | - | + | - | - | - | - |
| <i>Sciocoris deltocephalus</i> (Fieber, 1861) | + | - | - | - | - | + | - | - |
| * <i>S. distinctus</i> (Fieber, 1851) | + | - | - | - | - | + | - | - |
| * <i>S. kiritshenkoi</i> (Wagner, 1965) | + | - | - | - | - | + | - | - |
| * <i>Bagrada kaufmanni</i> (Oshanin, 1870) | + | - | - | - | - | + | - | - |
| <i>Eurydema ornata</i> (Linnaeus, 1758) | + | + | + | - | - | - | - | + |
| * <i>E. fieberi</i> (Fieber, 1837) | + | - | - | - | - | + | - | - |
| <i>E. maracandica</i> (Oshanin, 1871) | - | - | + | - | - | - | - | + |
| <i>E. oleracea</i> (Linnaeus, 1758) | - | - | + | - | - | - | - | + |
| <i>E. wilkinsi</i> (Distant, 1879) | - | - | + | + | - | - | - | - |
| * <i>E. pulchrigena</i> (Kiritshenko, 1925) | + | - | - | - | - | + | - | - |
| <i>E. ventralis</i> (Kolenati, 1846) | + | - | + | + | - | - | - | + |
| * <i>Ancyrosoma leucogrammes</i> (Gmelin, 1790) | + | - | - | - | - | + | - | - |
| * <i>Derula longipennis</i> (Oshanin, 1871) | + | - | - | - | - | + | - | - |
| <i>Graphosoma consimile</i> (Horváth, 1903) | + | + | + | + | - | - | - | + |
| <i>G. lineatum</i> (Linnaeus, 1758) | + | + | + | + | + | + | - | + |
| <i>G. italicum</i> (Myuller, 1766) | - | + | - | + | + | + | - | - |
| <i>Holcostethus nitidus</i> (Kiritshenko, 1914) | - | + | + | + | + | - | - | - |
| <i>H. strictus vernalis</i> (Wolff, 1804) | - | - | + | + | + | - | - | - |
| * <i>Tholagmus flavolineatus</i> (Fabricius, 1798) | + | - | - | - | - | + | - | - |
| * <i>Ventocoris oschanini</i> (Horváth, 1889) | + | - | - | - | - | + | - | - |
| * <i>V. trigonus</i> (Krynicky, 1871) | + | - | - | - | - | + | - | - |
| * <i>Tarisa subspinoso subspinoso</i> (Germar, 1839) | + | - | - | - | - | + | - | - |
| <i>T. elevata</i> (Reuter, 1901) | + | + | + | - | - | - | - | + |
| <i>T. fraudatrix</i> (Horváth, 1889) | - | + | - | - | - | - | - | - |
| <i>T. virescens</i> (Herrich-Schäffer, 1851) | - | + | + | - | - | - | - | + |
| <i>T. pallescens</i> (Jakovlev, 1871) | - | + | + | - | + | + | - | - |
| Scutelleridae (Leach, 1815) | | | | | | | | |
| * <i>Odontotarsus purpureolineatus</i> (Rossi, 1790) | + | - | - | - | - | + | - | - |
| <i>O. impictus</i> (Jakovlev, 1886) | - | + | + | - | - | - | - | + |
| <i>O. angustatus</i> (Jakovlev, 1883) | - | + | + | - | - | - | - | + |
| * <i>O. fuliginosa</i> (Linnaeus, 1761) | + | - | - | - | - | + | - | - |
| <i>Eurygaster integriceps</i> (Puton, 1881) | + | + | + | + | + | + | - | + |
| Total | 167 | 124 | 146 | 89 | 85 | 83 | 19 | 100 |

Note: *: Recorded for the first time in this region, **: Recorded for the first time in Uzbekistan

In order to make a similarity cluster of 258 hemipterans belonging to the fauna of the Southern Aral Sea Region of Uzbekistan, a comparative analysis was conducted on 166 previously known species and 167 newly identified species in our research, using the similarity coefficient of Jaccard: 167 newly identified species in our research materials were found to be close to the 124 species in Khamraev (2003) (KJ: 0.25), and to 146 species in Gandzhaeva (2021) (KJ: 0.30) (Table 4).

In the comparative analyze, 99 species were found to be the closest similar to species identified by Khamraev (2003) and Gandzhaeva (2021) (KJ: 0.57). This indicates that during the next 30 years, the number of mesophilic species decreased in the north-western region of Uzbekistan, while the number of xerophilic species increased.

In order to evaluate the influence of the temperature of the area on the number and density of heteropterans in the Southern Aral Sea Region under the conditions of global climate change today, the average temperature and precipitation of each ten years from 1990 to 2023 were chosen. According to it, it was determined that the average winter season of 2022 and 2023 was the coldest season

with 40 degrees. We can see that in 2023, the density and number of heteropterans species, which winter in imago or larval stage, had decreased by up to three times compared to 2020. This rate decreases to 3/1 percent in wintering species in the egg stage. As it can be seen from this, a sharp drop in temperature during the winter season has a negative effect on heteropterans in the imago and larval stages, significantly reducing their number. Some species, such as *R. fedtschenkianus*, whose population is limited and whose area is shrinking, need protection, may even lead to extinction. Also, in order to assess the influence of abiotic factors on the seasonal dynamics of the biodiversity of the heteropterans, the active periods of 162 species distributed in the Southern Aral Sea Region were determined by months (Figure 2).

Nine species became active in the second decade of March, and 139 species became active in the second decade of May. By the beginning of July, the number of species can be explained by the fact that summer species take the place of wintering species in the imago stage. By November, despite the fact that 140 wintering species were born in the winter season, only three species were found to be in the active state due to the temperature drop.

In 2023, we can see that the period of activity will be delayed by up to 15 days, as well as the decrease in their numbers. When we compare and analyze the density and number of heteropterans in 2020 and 2023, if at the beginning of May 2020 there were 140 species, in October this indicator decreased to 25 species (Figure 3).

In 2023, with a decrease in temperature, their number decreased three times compared to 2020. In 2022, when we studied active species such as *R. fedtschenkianus* by attracting light, one species is detected every three hours in 2023, since this species was not detected at all during the research, it may even lead to the level of extermination of this species in the winter season (Figure 4).

Thus, the active state of insects is limited by certain temperature limits. This is what determines productivity, the duration of the development stage, nutrition, mobility, the decrease or increase in mortality, so each species requires a certain amount of heat energy and moisture for its development.

Based on the number and density of the biological diversity of hemipterans in the Southern Aral Sea Region, we carried out the evaluation of their frequency levels, using partial changes to the methods developed for this

class of insects, only on 167 species identified in the research. It is mainly carried out by entomological trap in this way: if up to 100 species were collected in one hour, or 50 species, when using the trap 5 times, they were recorded as very common species; if up to 11-20 species were collected in 1 hour, they were recorded as common species, up to 4-10 species in 1 hour-rare species, and 1-3 species as very rare species. Based on the density and number of 167 species of hemipterans distributed in the natural and anthropogenic regions of the Southern Aral Sea, 13 species were recorded as very rare (7.8%), 25 species-rare (15%), 63 species-permanent (38%), 27 species-common (16.1%), and 39 species-very common (23.3%).

Table 4. Similarity coefficient of hemipterans in the compared regions

| Regions | Research results | Khamraev (2003) | Gandzhaeva (2021) |
|-------------------|------------------|-----------------|-------------------|
| Research results | 1 | - | - |
| Khamraev (2003) | 0.25 | 1 | - |
| Gandzhaeva (2021) | 0.30 | 0.57 | 1 |

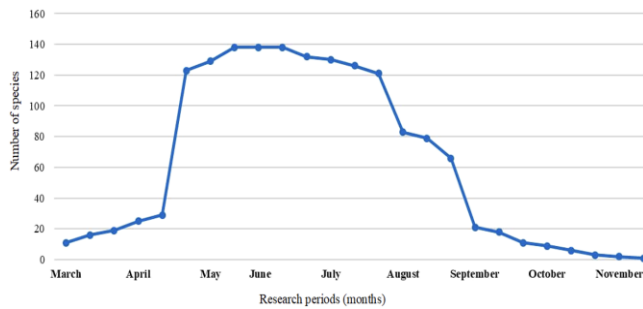


Figure 2. Active periods of heteropterans in terms of months (in terms of species)

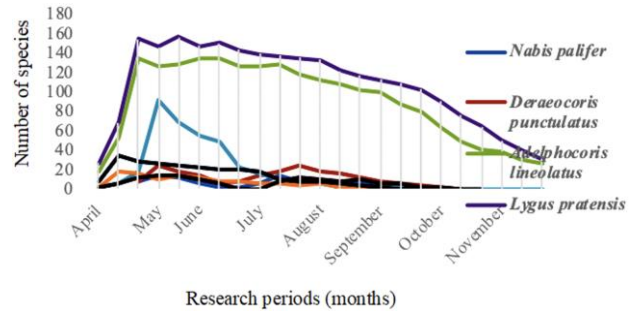


Figure 3. Density of heteropterans in month 2020

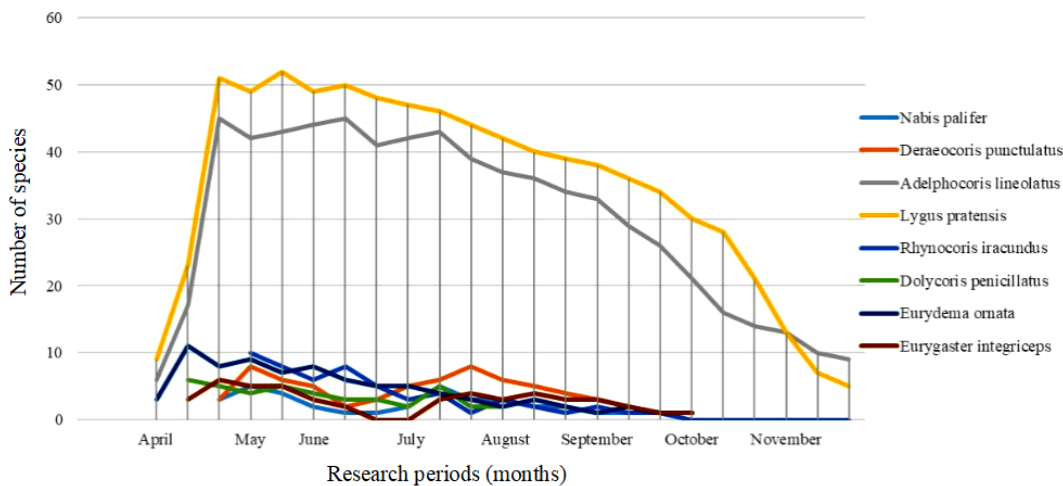


Figure 4. Density of heteropterans in month 2023

Discussion

We can see that in the natural geographical and climatic conditions of the Southern Aral Sea Region from the 1990s to the present day, 18 of the total 258 species belonging to the fauna of hemipterans were recorded in the work of Khamraev (2003), in particular: *Poeciloscytus vulneratus*, *Exaeretus meyeri*, *Atomophora alba*, *Rhynocoris niger*, *Sigara concina*, *Sigara limitata*, *Tarajala brevicornis*, *Dicranocephalus ferghanensis*, *Lygaeus rubriceps*, *Scantius struarium*, *Emblethis exanguis*, *Aethus nigronevrosus*, *Neaethus nigronevrosus*, *Microporus virgate*, *Menaccarus transparentis*, *Graphosoma italicum*, *Tarisa fraudatrix* and *Piocoris scutellatus*. Further 17 species, in particular, *Nabis remanei*, *Gerris argentatus*, *Corizus tetraspilus*, *Bleteogonus beckeri*, *Geocoris lapponicus*, *G. scutellatus*, *Engistus exanguis*, *Stibaropus hohlbecki*, *Adelphocoris seticornis*, *Microporus nigrita*, *H. halys*, *Brachycarenum tigrinus*, *Palomena prasina*, *Eurydema maracandica*, *E. oleracea*, *E. wilkinsi*, *Holcostethus strictus vernalis* were recorded in the works of Gandzhaeva (2021).

35 species listed by these authors were found to be mesophilic species. Today, these species are considered to be sufficiently distributed in the mountainous regions of Uzbekistan. Of the 124 species identified by Khamraev (2003), 20 species were not recorded in Gandzhaeva (2021). 47 species, which were not determined by Khamraev (2003), were recorded by Gandzhaeva (2021). Even so, the number of similar species in the results of the research conducted by both authors is 99, which is 57%. Although 166 hemipterans were recorded by these two authors, it was found out from the research results that the fauna of Southern Aral Sea Region was enriched with 92 more species, and the total number of species was 258.

Furthermore, of the 167 Hemiptera species in this region, additional 92 species were recorded for the first time. These species are adapted to xerophilic conditions, or some of them have a range from high mountains to marshes. In the study of these species, *Reduvius carinatus* was recorded as a new species for Uzbekistan (Table 3).

Also, *Auchenocrepis reuteri* species was found in 4 pieces in 1 hour from the common lichen plant in Kyzylkum deserts. This species was identified by the great entomologist of the world (Kerzhner 1981) from the Gazli deserts of Bukhara in 1953, and today it is not available in the collection of Uzbekistan, which is kept in the German Museum of Nature. *Cercinthus lehmannii*, belonging to the Coreidae family, included in the Red Book of the Republic of Uzbekistan (2019), was found in the Kyzylkum desert of the Republic of Karakalpakstan, expanding the habitat of the Heteroptera species. The current population status of *R. fedtschenkianus* is very low.

In conclusion, in the natural and anthropogenic regions of the Southern Aral Sea, of the total 7,857 analyzed specimens, 2,119 were collected in 2021, 1,783 in 2022, 2,392 in 2023, and 1,563 in 2024. A total of 7,857 specimens were collected and analyzed in the cross-section of landscapes: 1,393 specimens (18%) were collected from the Kyzylkum desert, 971 specimens (12%) from the Lower Amudarya biosphere reserve, 1,489 specimens

(19%) from the Ustyurt plain, 3,384 specimens (43%) from agrolandscapes, and 620 specimens (8%) from streams and lakes. 167 species of hemipterans belonging to 4 infraorders, 13 superfamilies, 22 families, 35 subfamilies, 35 tribes, 104 genera, 3 subgenera have been identified in the Southern Aral Sea. In terms of distribution of hemipterans among the infraorders, the infraorder Pentatomomorpha included 132 species (51.2%), Cimicomorpha-106 species (41.1%), Nepomorpha-13 species (5.03%), Gerromorpha-7 species (2.7%) and the least amount belongs to Gerromorpha with 1 species (0.38%). 167 newly identified species in our research materials were found to be close to the 124 species in Khamraev (2003) (KJ: 0.25), and to 146 species in Gandzhaeva (2021) (KJ: 0.30). According to the distribution of heteroptera in the Southern Aral Sea Region in landscapes, 89 species (34.5%) were identified in agrobiocenoses, 85 species (32.9%) in the Lower Amudarya Biosphere Reserve, 83 species (32.29%) in Kyzylkum desert areas, 19 species (7.36%) on water and water banks, as well, 100 species (38.7%) in Ustyurt. Based on the density and number of 167 species of hemipterans distributed in the natural and anthropogenic regions of the Southern Aral Sea, 13 species were recorded as very rare (7.8%), 25 species-rare (15%), 63 species-permanent (38%), 27 species-common (16.1%), and 39 species-very common (23.3%).

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