

TAXONOMIC DIVERSITY AND BIOGEOGRAPHY OF THE SNAKES IN THE ARALO-CASPIAN BASIN

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Zoological Institute, Russian Academy of Sciences, Universitetskaya emb., 1, St. Petersburg, 199034 Russia

**e-mail: coluber@zin.ru*

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Snake diversity of the Aralo-Caspian basin includes 61 species in 8 families, being composed of local faunas of the Northern Caspian Depression, the Greater Caucasus and Ciscaucasia, the Lesser Caucasus and Transcaucasia, the Alborz and Turkmeno-Khorasan mountains, the Aralo-Caspian Isthmus, the deserts and mountains of Middle Asia and the plains of the Aral Sea region. Regions with the richest snake diversity are Alborz, Turkmeno-Khorasanian Mountains and Transcaucasia. The snake fauna is composed of 25 biogeographic groups; all diversity of the distribution patterns is described by 10 main chorotype groups and 36 basic chorotypes. The most common element is Mediterranean (12 species), as well as Armeno-Iranian (7 species). Delta-diversity grows in the latitudinal direction, from the plains of the Aral Sea region and the North Caspian Lowland to the mountain systems of the Iranian Plateau. The level of species endemism is 25%. Six of the fourteen endemics live in the Alborz Mountains.

Keywords: Serpentes, biodiversity, zoogeography, chorotypes, faunistic element, Middle Asia, Western Asia

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The Aralo-Caspian region is a lowland depression in the Middle and partly Western Asia and surrounded by mountain ridges of the Great and Lesser Caucasus, Alborz, Turkmeno-Khorasan, Paropamisus, northern Hindu Kush, Tien-Shan and Pamiro-Alay. The Aralo-Caspian Depression is around of Aral and Caspian Sea and includes two unequal in size, Caspian and Turan depressions. The Caspian Depression encompassing the northern part of the Caspian Sea and bordered by the Caucasus in the west and Ustyurt Plateau in the east. The Turan Depression bordered in the north by Turgay Plateau and Mugodzhar Hills, by Kopet Dag and Paropamisus in the south, by Tien Shan and Pamiro-Alay in the south-east, and by Chu-Ily Mountains and Betpak-Dala in the east. In general, the snake fauna is composed by species of northern deserts and mountains of the Central Asia and the Eastern Mediterranean. The herpetofauna of these vast territory is relatively well studied, with the exception of its southernmost part. Further study of the biodiversity of mountain systems of the Paropamisus and Hindu Kush is required, which still remain underexplored and the species list is incomplete. The species diversity and biogeographic relations of ophidiofauna of the Aralo-Caspian basin within the Caspian and Turanian lowlands and adjacent mountainous regions will be considered here.

MATERIAL AND METHODS

The species diversity on of the snake fauna and their distribution have been described in numerous monographs on the herpetofauna of the USSR, Caucasus, Iran, Middle East and Western Palaearctic (Terenyev, Chernov, 1949; Chernov, 1959; Bannikov et al., 1977; Latifi, 1991; Tuniev et al., 2009, 2019; Sindaco et al., 2013; Rajabizadeh, 2018; Egan, 2022). Physiogeographic maps of the Caucasus, northern Iran, and Middle Asia were used to clarify the distribution and species list of each region. The previously proposed schemes of zoogeographic and herpetofaunistic zoning of the Northern Eurasia, territory of the USSR, Middle Asia with adjacent territories were also used to describe the ophidiofaunas of different zoogeographic provinces (Kryzhanovsky, 1965; Szczerbak, 1981, 1982, 2003; Bobrov, Aleshchenko, 2001, 2001a; Ravkin et al., 2010; Sindaco et al., 2013). Arealography was based on the analysis of the current distribution of each species, analyzing its entire range and presence/absence in certain regions of the Aralo-Caspian basin. Chorotypes were classified according to previously proposed (Gorodkov, 1984; Sindaco et al., 2000, 2013; Taglianti et al., 1999), or new combinations were used. The classification of biogeographic groups for this region was created based on those previously proposed for various groups of animals

with modifications (Darevsky, 1957, 1959, 1981; Anderson, 1968; Spitzenberger, Bauer, 1979; Tchernov, 1992; Ataev et al., 1994; Fet, 1994; Mikhailov, Fet, 1994; Tuniyev, 1995; Disi, Boehme, 1996; Borisov, 2009; Mazanayeva, Tuniyev, 2011). Comparison of species diversity from different units is estimated using a standard similarity index. Sørensen’s Quotient of Similarity: $2 \times \text{number of taxa common to both areas} / \text{sum of totals of taxa from both areas}$, expressed as a percentage (Sørensen, 1948).

RESULTS AND DISSCUSSION

Taxonomic diversity. Species diversity of snakes (Serpentes) of Aralo-Caspian basin are composed by 61 species from 8 families. Two species from two families of blind snakes (Scolophoridae): Leptotyphlopidae и Typhlopidae opposite to all others snakes (Alethinophidia) and number 59 species. Primitive recent snakes (Henophidia) represented only by 5 species from one family (Boidae), while the vast majority belong to advanced snakes (Caenophidia) who are 54 species from 5 families. The true colubrids (Colubridae) and vipers (Viperidae) are most diverse groups and represented by 31 and 16 species respectively. Three species of the sand snakes (Psammophiidae), two species of water snakes (Natricidae) and two species of elapids (Elapidae) rounding out the list.

Local faunas and gamma diversity. Eleven geographical units belonging to the Aralo-Caspian region and possessing characteristic ophidiofauna were identified.

The snake fauna of the Aral-Caspian Basin is composed of the faunas of the North Caspian Lowland (11 species), Great Caucasus and Ciscaucasia (23 species), Lesser Caucasus and Transcaucasia (29 species), Alborz (39 species), Turkmeno-Khorasanian Mountains (29 species), Paropamisus and Hindu Kush (23 species), Karakum Desert (19 species), Kyzylkum Desert (16 species), Aralo-Caspian Isthmus (13 species), North-East Aral Lowland (10 species), Tien-Shan and Pamiro-Alay (18 species). The most species-rich regions are the Alborz with piedmont plain, Turkmeno-Khorasanian Mountains and the Transcaucasia (Table 1).

Richness of species and genera. The higher richness of snakes in Aralo-Caspian basin was found primarily at the species level. Generic richness in three regions was identical (14 genera). In North Caspian Lowland and North-East Aral Lowland, there were fewer species. In Kyzylkum Desert were a lower average number of species per genera (1.14 species genus vs. 1.71 in Lesser Caucasus and Transcaucasia). The maximal richness is accounted for by two genera, *Eirenis* and *Vipera*, wich contain 6 of the 8 total species in the Alborz and 5 of the 7 total species in the Lesser Caucasia and Transcaucasia, respectively. 16 genera had single species per genus represented. Colubrids were the most speciose group in all subregions, whereas leptotyphlopids were most rare component in snake fauna. The North Caspian Lowland, Aralo-Caspian Isthmus and North-East Aral Lowland lacked leptotyphlopids, typhlopids and elapids, of which the others sites usually had 1–2 species (Table 2).

Table 1. Number of the snake species in subregions of Aralo-Caspian basin

Subregion	Family								Total
	Leptotyphlopidae	Typhlopidae	Boidae	Colubridae	Natricidae	Psamophiidae	Elapidae	Viperidae	
North Caspian Lowland	—	—	2	3	2	2	—	2	11
Great Caucasus and Ciscaucasia	—	1	2	12	2	1	—	5	23
Lesser Caucasus and Transcaucasia	—	1	1	15	2	2	—	8	29
Alborz	1	1	3	21	2	3	2	6	39
Turkmeno-Khorasanian Mountains	—	1	3	16	1	3	1	3	28
Paropamisus and Hindu Kush	—	1	3	11	1	2	1	4	23
Karakum Desert	—	1	2	10	1	2	1	2	19
Kyzylkum Desert	—	1	2	7	1	1	1	3	16
Aralo-Caspian Isthmus	—	—	2	5	2	1	—	3	13
North-East Aral Lowland	—	—	1	4	2	1	—	2	10
Tien-Shan and Pamiro-Alay	—	1	2	7	1	1	1	5	18

Table 2. Comparison of generis and species richness in the 11 subregions of study area

Subregion	Richness			
	species	genera	species/genera	endemic species
North Caspian Lowland	11	8	1.38	—
Great Caucasus and Ciscaucasia	23	14	1.64	2
Lesser Caucasus and Transcaucasia	29	17	1.71	3
Alborz	39	23	1.70	2
Turkmeno-Khorasanian Mountains	29	20	1.45	2
Paropamisus and Hindu Kush	23	17	1.35	?
Karakum Desert	19	15	1.27	—
Kyzylkum Desert	16	14	1.14	—
Aralo-Caspian Isthmus	13	10	1.30	—
North-East Aral Lowland	10	8	1.25	—
Tien-Shan and Pamiro-Alay	18	14	1.29	2

Zoogeographic zoning. Wide territory of Aralo-Caspian basin traditionally divided into seven zoogeographic provinces (after Kryzhanovsky, 1965): Caspian (20 snake species), Caucasian (24 species), Hyrcanian (20 species), Irano-Azerbaijani mountain (42 species), Turanian desert (19 species), Kazakh (13 species) and Afghano-Turkestanian (28 species). The Irano-Azerbaijani mountain province has the highest number of species in Aralo-Caspian basin. The diversity of the Afghano-Turkestanian province remains underestimated. The whole territory of Aralo-Caspian region, according to herpeto-geographical zoning data, belongs to the Arid Mediterranean-Central Asian subregion (Szczerbak, 1981), or is divided into four sub-regions (Bobrov, Aleshchenko, 2001), with the majority of the territory falling into the Saharo-Gobian subregion (39 species), the significant part — on the Eurasian steppe (13 species), and, to a lesser extent, on the Mediterranean mountain-forest (22 species), Central Asian desert (43 species) and Central Asian mountain (11 species). Nevertheless, the most significant contribution to diversity is made precisely by the West Asian desert subregion.

Chorotype classification. Five major groups of chorotypes emerged from this study: 1. species widely distributed in Palaearctic

2. species from Mediterranean region
3. species widely or strictly distributed in West Asia
4. species distributed or extending Central Asia
5. species distributed in Paleotropics and extending to Palaearctic

Distribution patterns of species with Paleotropic extension and mainly distributed in Paleotropics referred to same major group. Species widely distributed in the West Asia and locally distributed in Armenian Upland and Iranian Plateau merged to one group. Species distributed in countries of Eastern Mediterranean, Caucasus and

Transcaucasia referred to one big Mediterranean group. Small portion of species distributed mainly in regions of Central and Middle Asia provisionally referred to Central Asian group.

Palaearctic chorotypes

1. West Palaearctic. Chorotype of species wide distributed in the Europe, North Africa and South-West Asia.
2. East Palaearctic. Chorotype of species widespread in Middle and Central Asia and Siberia with penetration into Eastern Europe.

Mediterranean chorotypes

1. East Mediterranean. Chorotype of species distributed in the eastern part of Mediterranean including Anatolia, Armenian highland, Levant, Balkans and Caucasus.
2. Caucasian. Chorotype of species with Caucasian and Transcaucasian distribution.

West Asian chorotypes

1. Saharo-Sindian. Chorotype of species widespread from Sahara to the Sind through Arabia.
2. West Asian. Chorotype of species occurring in the Middle East including Levant, Hyrcania, Mesopotamia, Armenian and Iranian highlands with penetration into Turan and Afghanistan.

Central Asian chorotypes

1. Middle Asian. Chorotype of species distributed in the Middle Asia with extension to Iran and Central Asia.
2. Central Asian. Chorotype of species occurring in the Central Asia with extension to the Aralo-Caspian Depression.

Paleotropical chorotypes

1. South Asian. Chorotype of species distributed in the Indian subcontinent, Pakistan, Afghanistan with extension to the Aralo-Caspian Depression.

2. Afroasiatic. Chorotype of species widespread in East and North Africa, Middle East, Turan, Afghanistan and Pakistan.

Chorology and biogeographic groups. Snake diversity is unevenly distributed in the study area. The maximum diversity is recorded for Transcaucasia, Northern Iran and Afghanistan. The largest number of biogeographic groups of species is represented here. All diversity of distributional patterns is described by 10 main chorotype groups and 36 basic chorotypes (Table 3). Which, in turn, are formed into 25 faunistic elements, or biogeographic groups (Western Palaearctic, Eastern Palaearctic, Afro-Sindian, Saharo-Sindian, Irano-Sindian, Turano-Sindian, Mediterranean, Transcaucasian, Caucasian, West Asian, Mesopotamian, Armenian, Armeno-Iranian, Iranian, Hyrcanian, Hyrcano-Khorasanian, Turkmeno-Khorasanian, Irano-Afghanian, Turanian, Turano-Turkestanian, Hissaro-Zeravshanian, Hissaro-Alaian, Indo-Turanian, Indo-Oriental). Of these, 11 are West Asian chorotypes (27 species); 3 East Mediterranean (15 species); 3 South Asian (6 species); 3 Central Asian (3 species); 2 Middle Asian (2 species); 2 Palaearctic (6 species) and 1 Afroasiatic (2 species). The Mediterranean group included species that have a significant part of the range in the Eastern Mediterranean and a probable mediterranean origin. A new Armeno-Iranian group is also proposed for species that have a compact distribution in the Armenian and Iranian Highlands. Species widely distributed in the Middle Asia, Afghanistan and Pakistan are assigned to the West Asian, or South Palaearctic group. Wide distributed species of the deserted areas from Sahara to Southern Pakistan traditionally refer to Saharo-Sindian group. The most common element is Mediterranean (12 species), as well as Armeno-Iranian (7 species). The faunistic core is formed by West Asian and Mediterranean species. Wide distributed Palaearctic species are 6; species with South Asian distributional type are 6; the number of Caucasian (including Transcaucasian) species is 5, while the number of Central Asian species is insignificant.

Delta diversity. The similarity of local faunas is determined by the presence of common species in each unit. Zoogeographical similarity is determined by the presence of common faunal elements. The Caucasus, Transcaucasia and Alborz characterized by predominance of Mediterranean faunal element. Northern regions such as North Caspian Lowland, Aralo-Caspian Isthmus, North-East Aral Lowland and Caucasus have maximal percent of species with palaearctic distribution. Transcaucasia region and Alborz mountain system are characterized by higher number of Armeno-Iranian species. Hyrcano-Khorasanian element presents respectively in Alborz and Turkmeno-Khorasanian mountains. The real diversity of Paropamisus and northern Hindu Kush mountains still unknown, only 23 snake

species currently registered there. Snakes conform to the prediction that latitudinal position and attendant higher mean annual temperature, precipitation and primary productivity correlates with increasing species richness. Δ -diversity grows in the latitudinal direction, from the plains of the Aral Sea region and the North Caspian Lowland to the mountain systems of the Iranian Plateau. The broad latitudinal gradient is however disrupted by high percentage of species restricted to the Alborz and Turkmeno-Khorasanian Mountains. Furthermore, high levels of biodiversity are also recorded in the Eastern Transcaucasia.

Endemism. The study area has a moderate level of species endemism, which is 25%. Fifteen species from three families are endemic (*Eryx elegans*, *Eryx vittatus*, *Eirenis medus*, *Eirenis walteri*, *Oligodon transcaspicus*, *Platycephalus atayevi*, *Zamenis persicus*, *Montivipera latiffi*, *Montivipera wagneri*, *Vipera darevskii*, *Vipera dinniki*, *Vipera kaznakovi*, *Vipera pontica*, *Gloydius caucasicus*, *Gloydius rickmersi*). Eight groups of endemics identified from this study (Transcaucasian, Caucasian, Armenian, Hyrcanian, Hyrcano-Khorasanian, Turkmeno-Khorasanian, Hissaro-Zeravshanian and Hissaro-Alaian). The Alborz Mountains had substantially more endemic species than others sites. The Alborz Mountains, distinguished by the highest γ -diversity, are at the same time the center of endemism. Six of the fourteen endemics occur here, with two (*Zamenis persicus*, *Montivipera latiffi*) being strictly distributed in Alborz. In general, the endemism rate is not high, with only the southernmost regions having significant species diversity and endemics. The endemic species are mainly distributed along side three main mountain ranges. The Lesser Caucasus with Armenian Upland, Alborz and Turkmeno-Khorasanian Mountains located almost in the subtropical zone and climatically different from the cold deserts and mountains of the Middle and Central Asia. The importance of the mountain systems of Paropamisus and northern Hindu Kush cannot be assessed due to the poor knowledge. It is very likely, these two mountain ridges are also centers of species richness and endemism. At present their biodiversity is composed of widespread species of West and Middle Asia. In contrast, vast areas of the subboreal zone are characterized by noticeably less diversity and their importance is secondary. The proportion of narrow-ranged species is small (11 species), most of them relate to vipers (6 species) and colubrids (4 species). The previously proposed schemes of more fractional division into provinces are not always ensured by the originality of ophidiofauna and the presence of endemism.

Gamma diversity. The faunas are most similar: Karakum Desert and Kyzylkum Desert (86%); Paropamisus + Hindu Kush and Karakum Desert (82%); Tien Shan + Pamiro-Alay and Kyzylkum Desert (82%); Kyzylkum Desert and Paropamisus + Hindu Kush (82%);

Table 3. Chorotypes and biogeographic affinities of snake species in Aralo-Caspian basin

Species	Basic chorotype	Chorotype group	Biogeographic group
<i>Myriopholis macrorhyncha</i> (Jan 1860)	Afrotropical, Saharo-Sindian	Afroasiatic	Afro-Sindian
<i>Xerotyphlops vermicularis</i> (Merrem 1820)	East Mediterranean, Turano-Turkestanian, Armeno-Iranian	Mediterranean	Mediterranean
<i>Eryx elegans</i> (Gray 1849)	Turkmeno-Khorasanian, Afghanian	West Asian	Turkmeno-Khorasanian endemic
<i>Eryx jaculus</i> (Linnaeus 1758)	Mediterranean, Levantine-Mesopotamian, Caucasian, Transcaucasian, Armeno-Iranian	Mediterranean	Mediterranean
<i>Eryx miliaris</i> (Pallas 1773)	Irano-Turanian	Middle Asian	Turanian
<i>Eryx tataricus</i> (Lichtenstein 1823)	Turano-Turkestanian	Central Asian	Turkestanian
<i>Eryx vittatus</i> Chernov 1959	Pamiro-Alaian	Central Asian	Hissaro-Zeravshanian endemic
<i>Boiga trigonata</i> (Schneider 1802)	Turano-Sindian, Irano-Afghanian, Indo-Turanian	South Asian	Indo-Turanian
<i>Coronella austriaca</i> Laurenti 1768	Euro-Caucasian, Euro-Siberian	Palearctic	Western Palearctic
<i>Dolichophis caspius</i> (Gmelin 1789)	East Mediterranean, European, Balkano-Caucasian	Mediterranean	Mediterranean
<i>Dolichophis schmidtii</i> (Nikolsky 1909)	Anatolian, Transcaucasian, Armeno-Iranian	West Asian	Armeno-Iranian
<i>Eirenis collaris</i> (Ménétries 1832)	Caucasian, Transcaucasian, Armeno-Iranian	West Asian	Armeno-Iranian
<i>Eirenis coronella</i> (Schlegel 1837)	Levantine-Mesopotamian, Irano-Arabian	West Asian	Mesopotamian
<i>Eirenis medus</i> Chernov 1949	Hyrcanian, Turkmeno-Khorasanian	West Asian	Hyrcano-Khorasanian endemic
<i>Eirenis modestus</i> (Martin 1838)	East Mediterranean, Anatolian, Caucasian, Transcaucasian, Armenian	Mediterranean	Mediterranean
<i>Eirenis persicus</i> (Anderson 1872)	Levantine-Mesopotamian, Armeno-Iranian, Irano-Sindian	West Asian	Irano-Sindian
<i>Eirenis punctatolineatus</i> (Boettger 1892)	Armeno-Iranian, Transcaucasian	West Asian	Armeno-Iranian
<i>Eirenis walteri</i> Boettger 1888	Turkmeno-Khorasanian	West Asian	Turkmeno-Khorasanian endemic
<i>Elaphe dione</i> (Pallas 1773)	Euro-Siberian, Turano-Turkestanian	Palearctic	Eastern Palearctic
<i>Elaphe sauromates</i> (Pallas 1811)	East Mediterranean, Anatolian, Balkano-Caucasian, Armenian, Turanian	Mediterranean	Mediterranean
<i>Hemorrhois nummifer</i> (Reuss 1834)	East Mediterranean, Armeno-Iranian, Turanian	West Asian	West Asian
<i>Hemorrhois ravergieri</i> (Ménétries 1832)	Levantine, Armeno-Iranian, Irano-Afghanian, Turano-Turkestanian	West Asian	West Asian
<i>Lycodon bicolor</i> (Nikolsky 1903)	Turano-Sindian	South Asian	Turano-Sindian
<i>Lytorhynchus ridgewayi</i> Boulenger 1887	Irano-Afghanian, Turano-Sindian	South Asian	Turano-Sindian
<i>Oligodon transcaspicus</i> (Nikolsky 1903)	Turkmeno-Khorasanian	West Asian	Turkmeno-Khorasanian endemic

Table 3. Continuation

Species	Basic chorotype	Chorotype group	Biogeographic group
<i>Platycephalus karelini</i> (Brandt 1838)	Levantine-Mesopotamian, Irano-Turanian, Irano-Afghanian, Turano-Sindian	West Asian	West Asian
<i>Platycephalus najadum</i> (Eichwald 1831)	East Mediterranean, Caucasian, Transcaucasian, Armeno-Iranian	Mediterranean	Mediterranean
<i>Platycephalus atayevi</i> (Tuniyev et Shammakov 1993)	Turkmeno-Khorasanian	West Asian	Turkmeno-Khorasanian endemic
<i>Platycephalus rhodorachis</i> (Jan 1863)	Afrotropical, Arabian, Irano-Afghanian, Turano-Sindian	Afroasiatic	Afro-Sindian
<i>Ptyas mucosa</i> (Linnaeus 1758)	Turano-Sindian, Indo-Oriental	South Asian	Indo-Oriental
<i>Rhynchocalamus satunini</i> (Nikolsky 1899)	Levantine, Armeno-Iranian	West Asian	Armeno-Iranian
<i>Spalerosophis diadema</i> (Schlegel 1837)	Saharo-Arabian, Turano-Sindian, Saharo-Sindian	West Asia	Saharo-Sindian
<i>Telescopus fallax</i> Fleischmann 1831	East Mediterranean, Levantine, Caucasian, Transcaucasian, Armeno-Iranian	Mediterranean	Mediterranean
<i>Telescopus rhinopoma</i> (Blanford 1874)	Irano-Afghanian	West Asian	Irano-Afghanian
<i>Telescopus tessellatus</i> (Wall 1908)	Iranian	West Asian	Iranian
<i>Zamenis hohenackeri</i> (Strauch 1873)	East Mediterranean, Caucasian, Armenian, Transcaucasian	Mediterranean	Mediterranean
<i>Zamenis longissimus</i> (Laurenti 1768)	European, Mediterranean, Caucasian	Mediterranean	Mediterranean
<i>Zamenis persicus</i> (Werner 1913)	Hyrceanian	West Asian	Hyrceanian endemic
<i>Natrix natrix</i> (Linnaeus 1758)	Euro-Siberian, Mediterranean	Palearctic	Western Palearctic
<i>Natrix tessellata</i> (Laurenti 1768)	European, Mediterranean-Turkestanian, Irano-Turanian	Palearctic	Western Palearctic
<i>Malpolon insignitus</i> (Geoffroy 1827)	East Mediterranean, Caucasian, Transcaucasian, Armeno-Iranian	Mediterranean	Mediterranean
<i>Psammophis lineolatus</i> (Brandt 1838)	Irano-Turanian, Turkestanian	Middle Asian	Turano-Turkestanian
<i>Psammophis schokari</i> (Forskål 1775)	Saharo-Arabian, Irano-Afghanian, Saharo-Sindian	West Asian	Saharo-Sindian
<i>Naja oxiana</i> (Eichwald 1831)	Irano-Turanian, Turano-Sindian	South Asian	Turano-Sindian
<i>Walterinnesia morgani</i> (Mocquard 1905)	Levantine-Mesopotamian, Irano-Arabian	West Asian	Mesopotamian
<i>Echis carinatus</i> (Schneider 1801)	Irano-Arabian, Turano-Sindian, Indian	South Asian	Indo-Turanian
<i>Macrovipera lebetina</i> (Linnaeus 1758)	East Mediterranean, Caucasian, Levantine-Mesopotamian, Transcaucasian, Armeno-Iranian, Turano-Sindian	West Asian	West Asian
<i>Montivipera latifii</i> (Mertens, Darevsky et Klemmer 1967)	Hyrceanian	West Asian	Hyrceanian endemic
<i>Montivipera raddei</i> (Boettger 1890)	Armeno-Iranian	West Asian	Armeno-Iranian
<i>Montivipera wagneri</i> (Nilson et Andrén 1984)	Armenian	West Asian	Armenian endemic
<i>Vipera ammodytes</i> (Linnaeus 1758)	East Mediterranean, Balkano-Caucasian, Transcaucasian	Mediterranean	Mediterranean
<i>Vipera darevskii</i> Vedmederjia, Orlov et Tuniyev 1986	Armenian, Transcaucasian	Mediterranean	Transcaucasian endemic

Table 3. End

Species	Basic chorotype	Chorotype group	Biogeographic group
<i>Vipera dinnikii</i> Nikolsky 1913	Caucasian	Mediterranean	Caucasian endemic
<i>Vipera eriwanensis</i> (Reuss 1933)	Transcaucasian, Armenian, Hyrcanian	West Asian	Armeno-Iranian
<i>Vipera kaznakovi</i> Nikolsky 1909	Caucasian, Transcaucasian	Mediterranean	Caucasian
<i>Vipera pontica</i> Billing, Nilson et Sattler 1990	Transcaucasian	Mediterranean	Transcaucasian endemic
<i>Vipera renardi</i> (Christoph 1861)	European, Caucasian, Turkestanian	Palaeartic	Western Palaeartic
<i>Pseudocerastes persicus</i> (Duméril, Bibron et Duméril 1854)	Armeno-Iranian, Iranian	West Asian	Armeno-Iranian
<i>Gloydius caucasicus</i> (Nikolsky 1916)	Hyrcanian, Turkmeno-Khorasanian	West Asian	Hyrcano- Khorasanian endemic
<i>Gloydius halys</i> (Pallas 1776)	Turano-Turkestanian, Siberian	Palaeartic	Eastern Palaeartic
<i>Gloydius rickmersi</i> Wagner, Tiutenko, Borkin et Simonov 2015	Pamiro-Alaian	Central Asian	Hissaro-Alaian endemic

Table 4. Quotients (%) of similarity obtained from comparing total Aralo-Caspian subregion assemblages between eleven units, gamma diversity in each case

Natural region	North Caspian Lowland	Great Caucasus and Ciscaucasia	Lesser Caucasus and Transcaucasia	Alborz	Turkmeno-Khorasanian Mountains	Paropamisus and Hindu Kush	Karakum Desert	Kyzylkum Desert	Aralo-Caspian Isthmus	North-East Aral Lowland	Tien-Shan and Pamiro-Alay
North Caspian Lowland		53	35	32	25	29	27	37	67	67	28
Great Caucasus and Ciscaucasia	53		73	48	27	26	29	31	33	36	24
Lesser Caucasus and Transcaucasia	35	73		65	38	31	29	27	24	31	26
Alborz	32	48	65		65	45	41	36	27	29	32
Turkmeno-Khorasanian Mountains	25	27	38	65		69	63	58	33	21	55
Paropamisus and Hindu Kush	29	26	31	45	69		90	82	56	42	73
Karakum Desert	27	29	29	41	63	90		86	56	41	76
Kyzylkum Desert	37	31	27	36	58	82	86		62	54	82
Aralo-Caspian Isthmus	67	33	24	27	33	56	56	62		78	45
North-East Aral Lowland	67	36	31	29	21	42	41	54	78		50
Tien-Shan and Pamiro-Alay	28	24	26	32	55	73	76	82	45	50	

The highest values are in bold.

Aralo-Caspian Isthmus and North-East Aral Lowland (78%); Tien Shan + Pamiro-Alay and Karakum Desert (76%); Tien Shan + Pamiro-Alay and Paropamisus + Hindu Kush (73%); Great Caucasus + Ciscaucasia and Lesser Caucasus + Transcaucasia (73%); Turkmeno-Khorasan Mountains and Paropamisus and Hindu

Kush (69%); North-East Aral Lowland and North Caspian Lowland (67%); Lesser Caucasus + Transcaucasia and Alborz (65%); Turkmeno-Khorasan Mountains and Alborz (65%). Neighboring regions usually have the greatest similarity, while at the same time there is a low percentage of similarity between Lesser Caucasus

+ Transcaucasia and Alborz and Turkmeno-Khorasan Mountains and Alborz. The lowest similarity indices are characterized by remote regions, such as Great Caucasus and Tien Shan or Aralo-Caspian Isthmus and Lesser Caucasus (Table 4). The similarity of faunas in such cases is formed by wide-distributed and palaearctic species.

CONCLUSION

The Aralo-Caspian snake fauna is more likely to be West Asian-Mediterranean than Middle Asian. The contribution of Central Asian and South Asian biogeographic elements is insignificant. The proportion of Palaearctic species is also low, and the proportion of Turanian species is minimal. Endemism of the species level is associated exclusively with the mountainous regions bordering the Aralo-Caspian Depression to the south. There are no endemic or even sub-endemic species of the vast plains of the Ciscaucasia, North Caspian and Aral Sea depressions, Ustyurt Plateau, Karakum and Kyzylkum deserts. The lack of endemics and the high level of similarity between the faunas of the northern deserts suggest that the above characteristics reflect the fauna's youthfulness, which would limit the amount of time available for adaptive diversification. Considering the high level of biodiversity and a significant percentage of endemic species in the Alborz-Turkmeno-Khorasanian Mountains, it is possible to assume a West Asian origin of the Turanian ophidiofauna. The contribution and importance of the fauna of the vast mountain systems of Paropamisus and northern Hindu Kush are still unclear, further faunistic study of these regions will lead to the discovery of new biodiversity hotspots.

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CONFLICT OF INTEREST

The author declares that he has no conflict of interest.

REFERENCES

- Anderson S.C., 1968. Zoogeographic analysis of the lizard fauna of Iran // The Cambridge History of Iran 1. Fisher W.B. (Ed.). Cambridge: Cambridge University Press. P. 305–371.
- Ataev Ch., Rustamov A.K., Shammakov S., 1994. Reptiles of Kopetdag // Biogeography and Ecology of Turkmenistan. Fet V., Atamuradov K.I. (Eds.). Dordrecht–Boston–London: Kluwer Academic Publishers. P. 329–350.
- Bannikov A.G., Darevsky I.S., Ishchenko V.G., Rustamov E.A., Szczerbak N.N., 1977. A guide to amphibians and reptiles of the fauna of USSR. Moscow: Prosveshchenie. 414 p. [in Russian]
- Bobrov V.V., Aleshchenko G.M., 2001. Scheme of herpetogeographic zoning of Russia and neighboring countries // The Problems of Herpetology. Proceedings of the 1th Meeting of the Nikolsky Herpetological Society 4–7 December 2000. Pushchino–Moscow: MSU. P. 31–34 [in Russian]
- Bobrov V.V., Aleshchenko G.M., 2001a. Herpetogeographical regionalization of the Russia and adjacent countries // Russian Journal of Herpetology. V. 8. № 3. P. 223–238.
- Borisov S.N., 2009. Pattern of dragonfly (Odonata) distribution in Central Asia // Zoologicheskii Zhurnal. V. 88. № 1. P. 11–17. [In Russian].
- Chernov S.A., 1959. Reptiles. Fauna of Tajik SSR. V. 18. Stalinabad: Publishing House of the Academy of Sciences of the Tajik SSR. 202 p. [In Russian].
- Darevsky I.S., 1957. Turanian elements in the herpetofauna of Transcaucasia and probable ways of their migration from Middle Asia // Bulletin of the Academy of Sciences of the Armenian SSR. Biological and Agricultural Sciences. V. 10. № 12. P. 69–77. [In Russian].
- Darevsky I.S., 1959. Zoogeographical peculiarities of the herpetofauna of Lake Sevan basin and probable reasons for their occurrence // Bulletin of the Academy of Sciences of the Armenian SSR. Biological and Agricultural Sciences. V. 12. № 10. P. 15–22. [In Russian].
- Darevsky I.S., 1981. Kopet-Dagh hotspot of endemic herpetofauna and probable reasons for its formation // The Problems of Herpetology. Proceedings of the 5th Herpetological Conference of the USSR, Ashkhabad. 22–24 September 1981. Leningrad: Nauka. P. 47–48. [In Russian].
- Disi A.M., Boehme W., 1996. Zoogeography of the amphibians and reptiles of Syria, with additional new records // Herpetozoa. V. 9. № 1/2. P. 63–70.
- Egan D., 2022. Snakes of the Middle East. London: Bloomsbury Publishing. 240 p.
- Fet V., 1994. Biogeographic position of the Khorassan-Kopetdag // Biogeography and Ecology of Turkmenistan. Fet V., Atamuradov K.I. (Eds.). Dordrecht–Boston–London: Kluwer Academic Publishers. P. 197–204.
- Gorodkov K.B., 1984. Ranges types of insects of tundra and forests zones of European part of U.S.S.R. // Provisional atlas of the insects of the European part of U.S.S.R. Gorodkov K.B. (Ed.) Leningrad: Nauka. P. 3–20. [in Russian].
- Kryzhanovskiy O.L., 1965. Composition and origin of the terrestrial fauna of Middle Asia. Leningrad: Nauka. 420 p. [in Russian].
- Latifi M., 1991. The snakes of Iran. Contributions to Herpetology. № 7. Oxford: Soc. Stud. Amph. Rept. 160 p.
- Mazanayeva L.F., Tuniyev B.S., 2011. Zoogeographical analysis of the Daghestan herpetofauna // Current Studies in Herpetology. V. 11. № 1/2. P. 55–76. [in Russian].
- Mikhailov K.G., Fet V., 1994. Zoogeography of spiders (Aranei) of Turkmenistan // Biogeography and Ecology of Turkmenistan. Fet V., Atamuradov K.I. (Eds.). Dordrecht–Boston–London: Kluwer Academic Publishers. P. 499–524.

- Rajabizadeh M.*, 2018. Snakes of Iran. Tehran: Iranshensai Publishing. 496 p. [in Farsi]
- Ravkin Yu.S., Bogomolova I.N., Yudkin V.A.*, 2010. Herpetofaunistic zonation of Northern Eurasia // Contemporary Problems of Ecology. V. 3. № 1. P. 63–75.
- Sindaco R., Venchi A., Carpaneto G.M., Bologna M.A.*, 2000. The reptiles of Anatolia: a checklist and zoogeographical analysis // Biogeographia. V. 21. P. 441–554.
- Sindaco R., Venchi A., Grieco C.*, 2013. The Reptiles of the Western Palearctic. V. 2. Annotated checklist and distributional atlas of the snakes of Europe, North Africa, Middle East and Central Asia, with an update to Vol. 1. Latina: Edizioni Belvedere. 543 p.
- Sorensen T.*, 1948. A method of establishing groups of equal amplitude in plant sociology based on similarity of species and its application to analyses of the vegetation on Danish commons // Biologiske Skrifter. № 5. P. 1–34.
- Spitzenberger V.F., Bauer K.*, 1979. Die Säugetierfauna Zyperns Teil II: Chiroptera, Lagomorpha, Carnivora und Artiodactyla // Annalen des Naturhistorischen Museums in Wien. Bd. 82. S. 439–465.
- Szczerbak N.N.*, 1981. Base of herpetogeographic zoning of the USSR // The Problems of Herpetology. Abstracts. Fifth herpetological Conference. Ashkhabad, 22–24 September 1981. P. 157–158. [In Russian].
- Szczerbak N.N.*, 1982. Grundzüge einer herpetogeographischen Gliederung der Paläarktis // Vertebrata Hungarica. T. 23. S. 227–239.
- Szczerbak N.N.*, 2003. Guide to the reptiles of the Eastern Palearctic. Malabar: Krieger Publishing Company. 260 p.
- Taglianti A.N., Audisio P.A., Biondi M., Bologna M.A., Carpaneto G.M., De Biase A., Fattorini S., Piattella E., Sindaco R., Venchi A., Zapparoli M.*, 1999. A proposal for a chorotype classification of the Near East fauna, in the framework of the Western Palearctic region // Biogeographia. V. 20. P. 31–59.
- Terentyev P.V., Chernov A.S.*, 1949. A guide to reptiles and amphibians. Moscow: Sovetskaya Nauka. 340 p. [in Russian].
- Tchernov E.*, 1992. The Afro-Arabian component in the Levantine mammalian fauna — a short biogeographical review // Israel Journal of Zoology. V. 38. P. 155–192.
- Tuniyev B.S.*, 1995. On the Mediterranean influence on the formation of herpetofauna of the Caucasian Isthmus and its main xerophylous refugia // Russian Journal of Herpetology. V. 2. № 2. P. 95–119.
- Tuniyev B.S., Orlov N.L., Ananjeva N.B., Aghasyan A.L.*, 2009. Snakes of the Caucasus: taxonomic diversity, distribution, conservation. St. Petersburg–Moscow: KMK Scientific Press. 223 p. [in Russian].
- Tuniyev B.S., Orlov N.L., Ananjeva N.B., Aghasyan A.L.*, 2019. Snakes of the Caucasus: taxonomic diversity, distribution, conservation. St. Petersburg–Moscow: KMK Scientific Press. 276 p.

ТАКСОНОМИЧЕСКОЕ РАЗНООБРАЗИЕ И БИОГЕОГРАФИЯ ЗМЕЙ АРАЛО-КАСПИЙСКОГО БАССЕЙНА

К. Д. Мильто*

Зоологический институт РАН, Университетская наб. 1, Санкт-Петербург, 199034 Россия

*e-mail: coluber@zin.ru

Фауна змей Арало-Каспийского бассейна включает 61 вид, относящийся к восьми семействам, и складывается из локальных фаун Северного Прикаспия, Большого Кавказа и Предкавказья, Малого Кавказа и Закавказья, Эльбурса, Туркмено-Хорасанских гор, Арало-Каспийского перешейка, пустынь и гор Средней Азии и равнин Приаралья. Наибольшим разнообразием обладают регионы Эльбурса и Приэльбурсы, Туркмено-Хорасанских гор и Закавказья. Описано 10 основных типов ареалов и выделено 25 биогеографических групп. Самые распространённые фаунистические элементы — Средиземноморский (12 видов) и Армяно-Иранский (7 видов). Δ-разнообразие растёт в широтном направлении, от равнин Приаралья и Северо-Каспийской низменности — к горным системам Иранского плато. Уровень видового эндемизма составляет 25%. Шесть из пятнадцати эндемиков обитают в Эльбурских горах.

Ключевые слова: serpentes, биоразнообразие, зоогеография, ареалы, фаунистические элементы, Средняя Азия, Ближний Восток