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Advance in the study of biodiversity of Caucasian spiders (Araneae)

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Abstract: The history of investigation of the Caucasian areaneofauna can be divided into four periods: 1866-1938, 1939-1978, 1979-1998 and 1999 to the present. According to published data, over 1000 species belonging to 46 families are known from the Caucasus. The species richest families are as follows: Linyphiidae (~180), Salticidae (122), Gnaphosidae (>100), Lycosidae (>100), Theridiidae (80), Dysderidae (70) and Thomisidae (70). In the different families endemism values vary from 0 to 100%. The average level of endemism in the Caucasus is about 22%, the highest level of endemism among species-rich families was found in the Dysderidae, being around 60%.

Key words: spiders, Caucasus, fauna, zoogeography, endemism

Introduction

The Caucasus is a territory lying between the Black and the Caspian seas. There are no strict geographical borders that separate the mountain from the areas lying to the north and south. Conventionally, the northern border of the Caucasus coincides with the northern foothills of the Caucasus Major, and the southern border is formed by the southern borders of Georgia, Armenia and Azerbaijan (Fig. 1).

The study of Caucasian arachnids was initiated by L. Koch (1866) who described the gnaphosid *Melanophora caucasia* (= *Zelotes c*.) from this region. The history of the study of Caucasian spiders can be conveniently divided into 4 periods: 1) beginning (1866-1938); 2) pre-Dunin (1939-1978); 3) Dunin (1979-1998); and 4) modern (1999 to the present). In the first period the greatest contribution to the knowledge of Caucasian spiders was made by the Russian and foreign authors: A.I. Kroneberg, L. Koch, W. Kulczyński, E. Simon, T. Thorell, E. Werzbitski and A.M. Zavadski (Fig. 2). During this period many new species were described or recorded from the area. According to Charitonov's (1932) catalogue, 178 species of spiders were known from the Caucasus in 1926. A decade later, the number of Caucasian species reached 206 (Charitonov 1936). It is worth mentioning that all these arachnologists lived far from the Caucasus.

We date the beginning of the second period from the series of papers published by Charitonov which dealt with the cave fauna of the region (Charitonov 1939, 1941a, b) (Fig. 3). At the same time, a Georgian arachnologist, Tamara S. Mkheidze began her career. During the second period important contributions to the study of Caucasian arachnids were made by T.S. Mkheidze (Tbilisi), S.A. Spassky (Novocherkassk), D.E. Charitonov, A.S. Utotchkin (Perm), V.E. Pichka (Kiev) and several other authors (Fig. 3). During this period the rise of knowledge of the taxonomy and faunistics of Caucasian spiders was somewhat slow.

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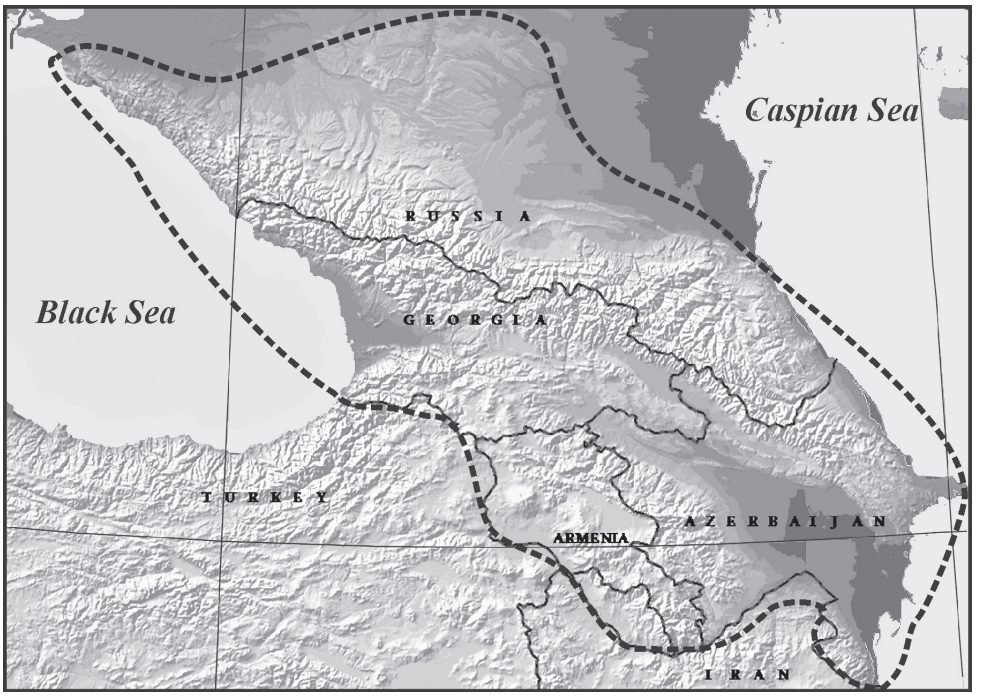

Fig. 1. Conventional borders of Caucasus.

The third period began when Peter M. Dunin started working at the Institute of Zoology of Azerbaijan, Baku (Fig. 3). The time of Dunin's employment coincides with the activation of arachnological studies in the entire Soviet Union. During this period many young arachnologists such as A.A. Zyuzin, V.I. Ovtsharenko, A.V. Ponomarev, K.Yu. Eskov, A.V. Tanasevitch, K.G. Mikhailov, Yu.M. Marusik and D.V. Logunov started to study spiders, including those from the Caucasian region. This period was characterized by a great growth in the number of described and reported species. We name this period after Dunin because he made the most important contribution, publishing over 30 papers on Caucasian spiders and describing over 60 species from the area.

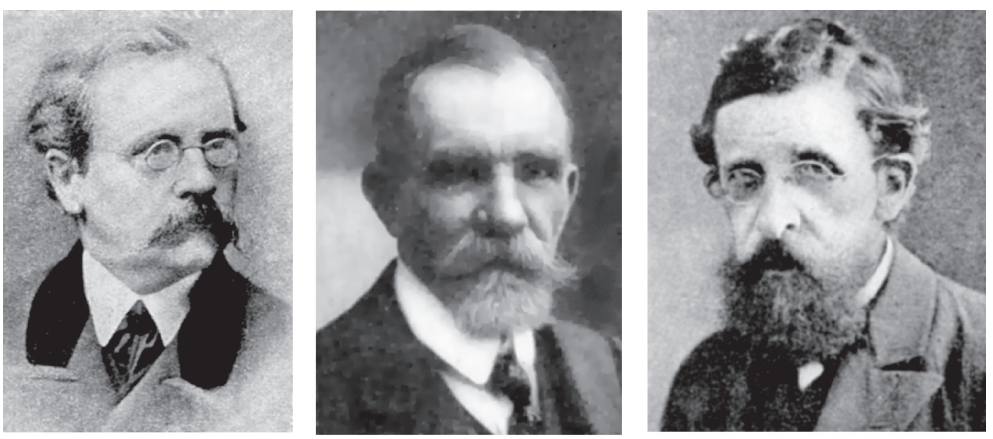

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Fig. 2. Portraits of the first generation of arachnologists, who had taken part in the study of the Caucasian fauna.

Fig. 3. Portraits of the second and third generations of arachnologists, who had taken part in the study of the Caucasian fauna.

Besides Dunin, an important contribution was made by A.V. Tanasevitch in his revisional studies of Caucasian linyphiids (Tanasevitch 1987, 1990). He described about 40 species and reported over 100 species from the Caucasus. Besides this, Tanasevitch revised the Central Asian fauna, and many species from Central Asia were later found in the Caucasus. After the collapse of the Soviet Union, the study of Caucasian arachnids nearly ceased because of military conflicts, lack of financing and other reasons. During this period most studies were based on museum materials collected earlier. Most of the works from this period were published by Ovtsharenko and co-authors (Ovtsharenko *et al*. 1992, 1994, 1995).

In the fourth, or modern period, arachnological studies intensified in Azerbaijan. During this period papers were published by E.F. Guseinov (=Huseynov), D.V. Logunov, Yu.M. Marusik, K.G. Mikhailov, S. Koponen, P.T. Lehtinen, G.N. Azarkina, M.M. Kovblyuk and several other authors. Although the number of species described was not high, this period was marked by the large number of new supraspecific taxa (4 families, about 25 genera) reported from the Caucasus for the first time (Marusik, Guseinov 2003, Marusik *et al*. 2005). During all periods of investigation of Caucasian spiders there were taxonomical, faunistic and mixed papers. Faunistic papers published during the 2nd and 3rd periods have many deficiencies: 1) many species, genera and even families were incorrectly identified; 2) many descriptions and redescriptions were inadequate, and it is impossible to identify spiders based on these papers. Inaccuracy of identifications during this period was related to the lack of appropriate literature in Azerbaijanian and Georgian libraries, the lack of revisional studies and the lack of access to comparative material stored in Moscow, St. Petersburg and abroad.

Difficulties in the study of Caucasian spiders

There are several difficulties in the study of Caucasian spiders. They are related to the following factors: 1) lack of access to the types described by Mkheidze in 1940-1990 (more than 30 species); 2) lack of the types of species described by L. Koch (9 species) and V. Kulczyński; 3) the materials on which faunistic papers by Mkheidze, Kulczyński, Werzbitski were based are not accessible or were lost during World War II. Some materials collected by Guseinov were also lost. Until recently, the study of Caucasian spiders was hampered by the lack of revisions and redescriptions of old materials from adjacent areas like Turkey, Asia Minor and Near East, Bulgaria, Greece and the Crimea. Many new species were described from these areas at the end of 19th century and the

beginning of 20th. Most of these species had long been known only from the original publications. Significant progress in the study of Caucasian spiders was achieved because of revisions of various families from Israel made by G. Levy (1985, 1986, 1987, 1991, 1992, 1995, 1996, etc.). Levy revised and redescribed many spider species previously described from the eastern Mediterranean and northern Africa. Besides Levy, large contributions were made by K. Thaler and B. Knoflach (Knoflach 1996, 1999, Knoflach, Thaler 2000, Thaler, Knoflach 1998, Thaler *et al*. 2000, etc.) on the Theridiidae and several other groups from southern Europe. Near the end of 20th century, the spiders of the family Salticidae were almost completely revised in Central Asia and partially in the Caucasus by Logunov and his co-authors (Logunov 1996, 1999 a, b, Logunov, Marusik 1999, 2003, Logunov *et al*. 1999, Rakov, Logunov 1996, etc.)

Recent state of knowledge

According to Mikhailov's (1997) catalogue, 886 species of spiders were known from the Caucasus in 1997. In the following years over 100 additional species were reported from Georgia (Mkheidze 1997) and Azerbaijan. Of the Transcaucasian regions, the most thoroughly studied country is Azerbaijan with over 600 species (Marusik, Guseinov 2003). In Georgia, 456 species of spiders are known to date, and only 127 species from Armenia (Mikhailov 2002). We do not have exact data about the number of species from the Russian Caucasus.

Studies conducted by us in Azerbaijan after 2001 revealed that the fauna of the Caucasus was inadequately known. During a short-term expedition to the Absheron Peninsula and Lenkoran we found 16 genera and 4 families (Desidae, Mysmenidae, Palpimanidae and Prodidomidae) new to the Caucasus as a whole, including 5 genera new to the fauna of the former Soviet Union (Marusik, Guseinov 2003). Subsequent expeditions to Nakhchivan and other parts of Azerbaijan revealed several additional genera new to Azerbaijan, the whole of the Caucasus and even the former USSR, e.g. *Siwa* Grasshoff, 1970 (Marusik *et al*. 2004). The number of new species reported for Azerbaijan, the Caucasus, and all of the former Soviet Union is several dozen. It is worth mentioning that the species new to the Caucasus were found not only among poorly studied families such as the Lycosidae and Gnaphosidae, but also in the well studied Araneidae. For example, *Cyclosa sierrae* Simon, 1870, *Singa neta* (O. P.-Cambridge, 1872) and *Siwa atomaria* (O. P.-Cambridge, 1876) found in Nakhchivan (Marusik *et al*. 2005b) were new to the former Soviet Union. Two days of collecting in Sukhum, Abkhazia, and several hours of collecting in Adler (near Sochi) revealed a family new to the Caucasus (Zoropsidae) (Marusik, Kovblyuk 2004), and two families new to the European part of Russia (Mysmenidae, Oonopidae) (Marusik 2005).

Because of collecting efforts during the last 5 years, the spider fauna of Azerbaijan, with 44 families, became the most family-rich of all the regions of the former Soviet Union. The total number of families known from the Caucasus is now 46. Two of them, Cybaeidae and Zoropsidae, have not yet been found in Azerbaijan. There is no doubt that the diversity of families in the Caucasus, and particularly in Azerbaijan, will be increased. The presence of representatives of the Anapidae, Cithaeronidae, Hersiliidae, Phyxelididae, Sicariidae and Synaphridae is likely. *Comaroma simony* Bertkau, 1889, belonging to the first mentioned family, is common in Europe in thick leaf litter. Cithaeronids, hersiliids and sicariids are known from adjacent Turkmenistan and Iran. Phyxelidids are known from Turkey and synaphrids have been reported from Turkmenistan, the Crimea and several Mediterranean countries (Marusik *et al*. 2005b). It is worth mentioning that most of the undescribed and newly reported taxa were found not in mountains, or other poorly accessible areas, but in coastal lowlands: the Absheron Peninsula, Lenkoran and Sukhum. These areas have a semi-arid or subtropical climate.

The thoroughness with which the various Caucasian spider families have been studied differs greatly. Among species-rich families the best studied ones are the Clubionidae, Dysderidae, Linyphiidae and Salticidae. Several special publications are devoted to these families. The least

studied families are the Agelenidae, Dictynidae, Gnaphosidae, Lycosidae, Philodromidae, Theridiidae and Thomisidae. The study of the Azerbaijanian Agelenidae reveals that, among 19 species found in the republic, 14 are new to the science and one is new to the Caucasus (Guseinov *et al*. 2005). A very high number of new taxa were found in the Gnaphosidae. Many species found in Azerbaijan belong to genera unknown to us. Among other families from Azerbaijan, such as the Lycosidae, Dictynidae, Thomisidae and Theridiidae, the proportion of new taxa is lower than in the Agelenidae. For instance, the percentage of new species among the theridiids is about 20%. Although the Linyphiidae is the most species-rich family and one of the best studied in the region, we recognized, among new material from Azerbaijan, several species new to the science or to Azerbaijan. New species were found also among other well studied families such as the Dysderidae.

The species diversity of all families represented in the Caucasus is summarized in Table 1. According to the literature and unpublished personal data the fauna of the region includes at least 970 species. For some of the families we provide estimated data, which is slightly higher than the number of reported species.

Table 1. Number of species in each family found in the Caucasus, number and percentage of endemic species. * evaluation data; ** % from reported/ known species.

	Family	**Number of species**	**Number of endemics**	**%****
1.	Agelenidae	35	18	51
2.	Amaurobiidae	5	1	20
3.	Anyphaenidae	2	0	0
4.	Araneidae	48	0	0
5.	Argyronetidae	1	0	0
6.	Atypidae	1	0	0
7.	Clubionidae	29	4	14
8.	Cheiracanthidae	8	0	0
9.	Cybaeidae	2	1	50
10.	Desidae	1	1	100
11.	Dictynidae	18	1	6
12.	Dysderidae*	70	>59	91
13.	Eresidae	3	1	33
14.	Filistatidae	3	1	33
15.	Gnaphosidae*	100	>10	>12
16.	Hahniidae	6	1	17
17.	Heteropodidae	2	0	0
18.	Leptonetidae	2	2	100
19.	Linyphiidae*	180	>45	>27
20.	Liocranidae	6	3	75
21.	Corinnidae	6	3	50
22.	Lycosidae*	100	16	>20
23.	Mimetidae	3	1	50
24.	Mysmenidae	2	0	0
25.	Nemesiidae	4	4	100
26.	Nesticidae	9	7	78
27.	Oecobiidae	6	0	0

Table 1. Continued.

	Family	Number of species	Number of endemics	%**
28.	Oonopidae	5	3	60
29.	Oxyopidae	4	0	0
30.	Palpimanidae	1	1	100
31.	Philodromidae*	30	1	>4
32.	Pholcidae	6	2	33
33.	Pisauridae	3	0	0
34.	Prodidomidae	2	1	50
35.	Salticidae	122	17	14
36.	Scytodidae	1	0	0
37.	Segestriidae	3	0	0
38.	Tetragnathidae	18	0	0
39.	Theridiidae	80	6	8
40.	Theridiosomatidae	1	0	0
41.	Thomisidae*	70	>10	>15
42.	Titanoecidae	7	1	14
43.	Uloboridae	6	0	0
44.	Zodariidae	7	5	71
45.	Zoridae	4	0	0
46.	Zoropsidae	1	0	0
		1022	>226	>22

The most diverse spider families in Caucasus are as follows: Linyphiidae (~180), Salticidae (122), Gnaphosidae (>100), Lycosidae (>100), Theridiidae (80), Dysderidae (70) and Thomisidae (70). The spider fauna of the Caucasus comprises about 1/3 of the species diversity of the former Soviet Union and about 2.5% of the world species diversity. In terms of family diversity, the fauna of Caucasus encompasses 42% of the families of the world. The value of endemism in different families ranges from 0 to 100%. The highest level of endemism was found not only in the families with few species like the Nemesiidae, Leptonetidae or Desidae, but also in the species-rich families like the Dysderidae. In total, the level of endemism in the Caucasian fauna is not less than 22%, and probably this value will increase when several families like the Gnaphosidae, Philodromidae and Linyphiidae are properly revised. We think that the largest growth in species, new to the science and new to the region, will be in such families as the Gnaphosidae, Lycosidae, and Linyphiidae. There is no doubt that in Armenia and Georgia numerous new species of Agelenidae and Dysderidae will be found as well.

The most promising areas for finding species new to the fauna of the Caucasus are the arid regions of Azerbaijan, Georgia and Armenia, the subtropical coasts of the south-east, the whole western Caucasus and the high mountains. High altitudes are promising only in terms of new species with limited ranges, but subtropical and arid territories should produce many new or newly reported supraspecific taxa. At present we are working in collaboration with colleagues from different countries on revisions of the Corinnidae, Liocranidae, Lycosidae, Oonopidae, Philodromidae and Theridiidae. In their general species diversity, spiders of the Caucasus are similar to those of oribatid mites. According to Tarba (2002) the number of oribatids in the Caucasus reaches 770 species. This number comprises 10% of the world species diversity (2.5% in spiders). Possibly, the high value of species diversity of mites in the Caucasus reflects a poor level of study of Oribatida in the rest of the world. The value of endemics among spiders (22%) and oribatids (17%) is very similar.

Caucasus – Far East disjunctions

One of the most interesting and unique characteristics of the Caucasian spider fauna is the presence of about a dozen species with Caucasus-Far East disjunctions. When we began to study spiders of this area in 1980 we were faced with five species (*Octonoba yesoensis*, *Phintella castriesiana*, *Myrmarachne formicaria*, *Rhomphea sagana* and *Tmarus horvathi*) that were known in Azerbaijan and/or Georgia and in the Far East (Marusik 1987, Logunov, Marusik 1991). Now, the number of such species has increased to 9 (Marusik *et al*. 2004) due to the recent discovery of Caucasian species in the Far East (*Rhomphea hyrcana, Larinia bonneti*) and of Far Eastern species in Caucasus (*Yaginumena maculosa, Howaia mogera*).

Why do we call this situation unique? It is because such long disjunctions are unknown in other groups of animals. We were able to find one species of feather beetle, one species of saw-fly and one terrestrial mollusc with the same disjunction pattern. All these groups are taxonomically difficult in comparison to those of the spider species with disjunctions. We asked several experts in species-diverse groups such as Curculiniodae, Carabidae, Rhopalocera, Arctiidae, Noctuidae, Heteroptera, but none of them knew of disjunctive ranges at the species level. Although they are more common in spiders, supraspecific disjunctions are also known in insects. The high percentage of spider species with disjunctive ranges indicates that evolution, or at least morphological evolution, occurs more slowly in them than in other arthropods.

Ethological studies

Despite the almost 140 years of faunistic and taxonomic studies of the Caucasian araneofauna, investigation of the biology of spiders in this region began only recently. It started with a paper by Guseinov (1997), who gave preliminary information on the natural prey of some species of wandering spiders occurring in the Absheron Peninsula, Azerbaijan. Later, the diets of 20 species from six families (Salticidae, Thomisidae, Philodromidae, Oxyopidae, Gnaphosidae, Filistatidae) were studied in detail, and this formed an important part of the Ph.D. thesis of the third author (Guseinov 1999). Some of these results are already published in a series of separate papers (Guseinov 2004a, b, 2005), and some are in press. Moreover, in cooperation with Robert Jackson (Canterbury, New Zealand) and his students, some ethological aspects, such as predatory behaviour and prey preference, of a few Azerbaijanian jumping spiders have been investigated (Cerveira *et al*. 2003, Guseinov *et al*. 2004). In addition to these studies on the natural prey and predatory behaviour of spiders in Azerbaijan, investigation of their microhabitat preferences is also in progress.

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Възход в изследванията на паяците на Кавказ (Araneae)

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(Резюме)

Направен е преглед на проучванията на кавказката аранеофауна, които според авторите могат да бъдат разделени на четири периода: Начален – от 1866 до 1938 г., преди Дунин – от 1939 до 1978 г., по времето на Дунин – от 1979 до 1998 г., и Съвременен – от 1999 г. досега. Понастоящем от територията на Кавказ са известни над 1000 вида паяци, принадлежащи към 46 семейства. Най-богати на видове са: Linyphiidae (около 180), Salticidae (122), Gnaphosidae (над 100), Lycosidae (над 100), Theridiidae (80), Dysderidae (70) и Thomisidae (70). Ендемизмът сред семействата варира в широки граници – от 0% до 100%, като средно е около 22%. Сред семействата с по-голям брой видове най-висок ендемизъм се наблюдава при Dysderidae – около 60%.