

## Fauna and ecology of gnaphosid spiders (Aranei: Gnaphosidae) in clay semidesert of Western Kazakhstan

### Фауна и экология гнафозид (Aranei: Gnaphosidae) глинистой полупустыни Западного Казахстана

T.V. Piterkina<sup>1</sup> & V.I. Ovtcharenko<sup>2</sup>  
Т.В. Питеркина<sup>1</sup>, В.И. Овчаренко<sup>2</sup>

<sup>1</sup> Institute of Ecology and Evolution, Russian Academy of Sciences, Leninsky Prospect 33, Moscow 119071 Russia. E-mail: piterkina@yandex.ru

Институт проблем экологии и эволюции РАН, Ленинский проспект, 33, Москва 119071 Россия.

<sup>2</sup> Hostos Community College of the City University of New York, New York 10451 USA. E-mail: vio@hostos.cuny.edu

Хостос Колледж Городского Университета г. Нью-Йорк, Нью-Йорк 10451 США.

**KEY WORDS:** ground spiders, fauna, structure of population, Caspian Lowland, desert steppe, climate changes.

**КЛЮЧЕВЫЕ СЛОВА:** гнафозиды, фауна, структура населения, Прикаспийская низменность, опустыненные степи, изменения климата.

**ABSTRACT.** Gnaphosids of 41 species of 14 genera were collected in the clay semidesert in the environs of Dzhanlybek Research Station, West Kazakhstan. A zoogeographical analysis of gnaphosid population shows that the main role in the formation of the modern fauna is performed by species that are locally or widely inhabiting the territory of the Ancient Mediterranean. They comprise two-thirds of the entire gnaphosid population of the region. The rest one-third are widespread species. The gnaphosid communities of native biotopes (microelevations and microdepressions) are the most diverse. The population of the artificial associations is much poorer and less equalized. All associations studied have their own complexes of typical species. The comparing of present-day data and materials obtained 20 years ago shows some changes in composition and structure of gnaphosid population of native biotopes. Probably it is connected with a rapid pace of “smoothing” of the climate of the region during recent decades that caused changes in water regime of soils that in its turn influenced the plant and animal communities.

**РЕЗЮМЕ.** В глинистой полупустыне Западного Казахстана (окрестности Джаныбекского стационара) собран 41 вид гнафозид, относящихся к 14 родам. Зоогеографический анализ показал, что ведущую роль в формировании фауны гнафозид региона сыграли виды, широко или локально населяющие территорию Древнего Средиземья. Они составляют две трети фауны. Оставшаяся часть образована широкоареальными видами. Наиболее богато видами население зональных биотопов (микрорельефов и западин), их сообщества полидоминантны и выравнены.

Сообщества гнафозид лесопосадок сильно обеднены, характерно наличие одного-двух высокообильных видов. Также оценена степень биотопической приуроченности видов гнафозид. Сравнение современных данных с материалами 20-летней давности показали изменения в составе и структуре населения гнафозид зональных биотопов. Возможно, это связано с резкими темпами «смягчения» климата в регионе в последние десятилетия, вызвавшими изменения в водном режиме почв, что, в свою очередь, повлияло на растительность и животное население.

### Introduction

Gnaphosidae is a spider family that includes about 1990 species of 114 genera in the world [Platnick, 2007]. With rare exception, they are ground and litter-dwellers, diurnal or nocturnal wandering hunters. As a rule, representatives of the family are thermophilic. On the latitudinal gradient from the arctic tundra to deserts, the gnaphosids show an increase in their abundance and diversity. In the semidesert, where our material was collected, Gnaphosidae is one of the leading families. The Gnaphosidae occupies a special position among semiarid ground-dwellers displaying all features of biological progress: high taxonomical diversity, wide adaptive radiation, high abundance during all vegetative period, and inhabitation of all types of environment. That is why the Gnaphosidae was chosen as a model family for our investigations in clay semidesert of northern Caspian Sea Lowland. The place studied is located at the point of contact of several zoogeographical provinces, so that it was interesting to see what distributional elements took part in the formation of the

modern spider fauna of this territory. In addition, the spatial structure of the gnaphosid communities was studied. As well, having an opportunity to examine the material collected in this place 20 years ago, we were able to observe the changes of gnaphosid population of native biotopes over this period.

### Study area and methods

Spiders were collected in the territory of the Dzhanybek Research Station of the Institute of Forestry, Russian Academy of Sciences (49°23'N, 46°48'E). This station is located in the westernmost point of Kazakhstan, just near the border of Volgograd Area of Russia. The location studied has some interesting features: first, it is situated in the belt of clay semidesert that occupies a narrow strip between the deserts of Central Asia in the south and the Eurasian steppes in the north; second, not so long ago by geological criteria, sea covered this territory. Therefore, the process of formation of fauna is still in progress.

The area studied is a flat plain in the northwest Caspian Lowland. From the Palaeozoic period until the recent past, the Caspian Lowland was repeatedly covered with waters of ancient seas and more recent seas [Dorskatch, 1964]. The last Khvalyn transgression of the Caspian Sea occurred in the Upper Quaternary period. Hence, the sea retreated from the Dzhanybek plain only 37–79 thousand years ago [Varushchenko et al., 1980]. As the sea retreated, the continental climate was set and native semidesert landscapes began forming. Different soil-forming processes in addition to the active burrowing work of the ground squirrel (*Citellus pygmaeus* Pall.) resulted in the mosaic landscape, so typical for clay semidesert [Abaturov, 1985]. It is characterized by a complex pattern of soils and vegetation and is composed of mosaics of desert and steppe plant communities. Microelevations are desert biotopes with *Kochia prostrata* and *Artemisia pauciflora* associations on solonchic soils. Microdepressions are steppe biotopes with forb-grass vegetation (*Stipa* spp., *Festuca valesiaca*, *Agropyron cristatum*, etc.) on dark chestnut and meadow chestnut soils. Besides native associations, there are areas of 50-year-old plantations in the territory of the Station.

The spiders were collected in 1984 (June–September) by Kirill G. Mikhailov and in 2004–2005 (April–October) years by Tatyana V. Piterkina in 2 native communities (microelevations and microdepressions) and 3 artificial ones: oak (*Quercus robur*) forest belts, an oak community in local park, and elm (*Ulmus pumila*) forest belts. Both in 1984 and in 2004–2005, the same methods were used: pitfall trapping and manual sorting of serial soil-litter samples (0.25x0.25 m). A 4% formaldehyde solution was applied as fixative to pitfall trapping. The traps were checked every 5–7 days. Soil-litter samples were taken in 10 replications every 10 days.

Over the course of the study total of 15.000 pitfall traps per day were set, 570 soil-litter samples taken.

About 3.000 spider specimens were studied with 1.700 of these spiders being mature.

The biotopical adherence of species was calculated with the help of the Pesenko's coefficient ( $F_{ij}$ ) [Pesenko, 1982] which represents a mathematical transformation of the share of this species in this biotope to its share in all other biotopes:

$$F_{ij} = (n_{ij}/N_j - n_i/N) / (n_{ij}/N_j + n_i/N),$$

where  $n_{ij}$  — number of specimens of  $i$ -species in samples from  $j$ -biotope with total volume  $N_j$ ;  $n_i$  — number of specimens of  $i$ -species in all other biotopes with total volume  $N$ .

The single findings of the species were left out of the account.

The value of the coefficient changes from  $-1$  (absolute avoidance) up to  $+1$  (absolute adherence).

We distinguish the following intervals of the coefficient value:

$0.7 \leq F_{ij} \leq 1.00$  — high level of adherence to the biotope;

$0.3 \leq F_{ij} < 0.7$  — preference of the biotope;

$-0.3 < F_{ij} < 0.3$  — indifference to the biotope;

$F_{ij} \leq -0.3$  — avoidance of the biotope.

For comparing the populations, we used Czekanowski – Sorensen's Index of Similarity of Species Composition [Pesenko, 1982]:

$$I_{CS} = 2a / (a + b) + (a + c),$$

where  $a$  — number of common species for both samples,

$b$  — number of species distinctive for sample 1,

$c$  — number of species distinctive for sample 2;

and Index of Similarity of Structure of Populations:

$$I_{CSb} = \sum \min(p_{ij}, p_{ik}),$$

where  $p_{ij}$  — share of  $i$ -species in  $j$ -sample,

$p_{ik}$  — share of  $i$ -species in  $k$ -sample.

In view of high specificity of spring population and the absence of spring samples in 1984, we used for comparison only summer and autumn collections.

## Results and discussion

### Taxonomical and zoogeographical structure.

Gnaphosids of 41 species of 14 genera (Table 1) were collected in the clay semidesert on the territory of the Dzhanybek Station. The genus *Zelotes* is the richest by its diversity; it is represented by 11 species. The other genera are much poorer. Seven genera are represented by 2–4 species. The remaining six genera are represented by single species.

In the typology of ranges we follow terminology of O.L. Kryzhanovskii [2002] with some modification. We consider the steppe zone of Eurasia to be the subregion of the Ancient Mediterranean region. To generate the distribution patterns of gnaphosid spiders collected at Dzhanybek, we selected 10 types of ranges and united them into 3 groups (Table 2). The 3 groups are:

1. Widespread (includes Circum-Holarctic, Trans-Palaearctic and West-Central-Palaearctic patterns);

Table 1. Checklist of gnaphosids of the clay semidesert of Western Kazakhstan. AM — Ancient Mediterranean, CH — Circum-Holarctic, E — Conventionally endemic, EAM — East Ancient Mediterranean, Eu-AM — Euro-Ancient Mediterranean, S — Scythian, TP — Trans-Palearctic, WAM — West Ancient Mediterranean, WCP — West Central Palearctic, WS — West-Scythian.

Таблица 1. Список видов гнафозид глинистой полупустыни Западного Казахстана. AM — древнесредиземноморский, CH — циркум-голарктический, E — условно-эндемичный, EAM — восточно-древнесредиземноморский, Eu-AM — евро-древнесредиземноморский, S — скифский, TP — транс-палеарктический, WAM — западно-древнесредиземноморский, WCP — западно-центральнопалеарктический, WS — западно-скифский.

Species	Zoogeographical group	Native biotopes		Artificial biotopes		
		Microelevations	Microdepressions	Elm forest shelter-belt	Oak forest shelter-belt	Oak community
<i>Berlandina cinerea</i> (Menge, 1872)	Eu-AM	*	*			*
<i>Drassodes rostratus</i> Esyunin et Tuneva, 2002	WS	*	*		*	
<i>Drassodes lapidosus</i> (Walckenaer, 1802)	TP	*	*			
<i>Drassodes lutescens</i> (C.L. Koch, 1839)	AM	*				
<i>Drassodes villosus</i> (Thorell, 1856)	TP	*	*			
<i>Drassyllus pusillus</i> (C.L. Koch, 1833)	TP			*	*	*
<i>Drassyllus</i> sp. aff. <i>pusillus</i> (C.L. Koch, 1833)	TP			*		
<i>Drassyllus sur</i> Tuneva et Esyunin, 2002	WS	*	*			
<i>Gnaphosa steppica</i> Ovtsharenko, Platnick et Song, 1992	AM	*	*		*	*
<i>Gnaphosa taurica</i> Thorell, 1875	EAM	*	*	*	*	*
<i>Gnaphosa lucifuga</i> (Walckenaer, 1802)	Eu-AM	*	*			
<i>Gnaphosa leporina</i> (L. Koch, 1876)	WCP		*			*
<i>Haplodrassus signifier</i> (C.L. Koch, 1839)	CH	*	*			*
<i>Haplodrassus isaevi</i> Ponomarev et Tsvetkov, 2006	WS	*	*			
<i>Haplodrassus kulczynskii</i> Lohmander, 1942	WAM	*	*			
<i>Haplodrassus</i> cf. <i>soerenseni</i> (Strand, 1900)	TP	*	*		*	*
<i>Leptodrassus memorialis</i> Spassky, 1940	S	*		*		
<i>Micaria rossica</i> Thorell, 1875	CH	*	*	*		
<i>Micaria guttulata</i> (C.L. Koch, 1839)	TP	*				
<i>Micaria pallipes</i> (Lucas, 1846)	AM	*	*			
<i>Micaria</i> sp. aff. <i>pulicaria</i> (Sundevall, 1831)	CH			*		
<i>Nomisia aussereri</i> (L. Koch, 1872)	AM	*				
<i>Phaeoedus braccatus</i> (L. Koch, 1866)	TP	*	*			
<i>Talanites strandi</i> Spassky, 1940	WS	*	*			
<i>Talanites mikhailovi</i> Platnick et Ovtsharenko, 1991	E	*	*			
<i>Trachyzelotes adriaticus</i> (Caporiacco, 1951)	AM	*	*			
<i>Trachyzelotes</i> cf. <i>lyonetti</i> (Audouin, 1826)	WAM	*				
<i>Trachyzelotes</i> cf. <i>malkini</i> Platnick et Murphy, 1984	WAM	*				

Table 1 (contituing).  
Таблица 1 (продолжение).

<i>Urozelotes</i> sp.		*				
<i>Zelotes atrocaeruleus</i> (Simon, 1878)	WAM	*	*	*		
<i>Zelotes caucasius</i> (L. Koch, 1866)	AM	*	*	*	*	
<i>Zelotes electus</i> (C.L. Koch, 1839)	Eu-AM	*	*	*	*	*
<i>Zelotes fallax</i> Tuneva et Esyunin, 2003	WS	*				
<i>Zelotes gallicus</i> Simon, 1914	WAM			*	*	*
<i>Zelotes longipes</i> (L. Koch, 1866)	WCP	*	*	*	*	
<i>Zelotes orenburgensis</i> Tuneva et Esyunin, 2002	WS	*	*		*	
<i>Zelotes pygmaeus</i> Miller, 1943	WS		*			
<i>Zelotes rufi</i> Esyunin et Efimik, 1996	WS	*				
<i>Zelotes segrex</i> (Simon, 1878)	AM	*	*			
<i>Zelotes subterraneus</i> (C.L. Koch, 1833)	TP					*
Zelotinae gen. sp.		*				
TOTAL GENERA		13	10	5	5	5
TOTAL SPECIES		34	26	11	10	10

2. Ancient Mediterranean (contains Euro-Ancient Mediterranean, Ancient Mediterranean proper, West-Ancient Mediterranean, East-Ancient Mediterranean, Scythian and West-Scythian patterns);

3. Conventionally endemic for clay semidesert.

As the zoogeographical analysis shows, species living in various parts of the Ancient Mediterranean form the main part of gnaphosid fauna (61%) (Table 2). The Ancient Mediterranean is a vast territory ranging from Macaronesia in the West to Gobi Desert and Tibet in the East. Together with the present-day Mediterranean and Central Asia, much of this area is known to have been covered by the epicontinental Tethys Sea which, until the Miocene, separated the European and North Asian plates from the African and Indian ones [Kryzhanovskii, 2002]. Among the Ancient Mediterranean species, the gnaphosids inhabiting the steppe zone dominate: most of them (19.5%) shows West Scythian distribution pattern (the steppe belt of Eastern Europe and West Siberia), and one species occurs throughout the steppe belt of all Eurasia (Scythian pattern) (Table 2). Ancient Mediterranean proper and West-Ancient Mediterranean distribution patterns are likewise numerous.

One species, *Talanites mikhailovi*, is most likely to be endemic to clay semidesert of Caspian Lowland. It was collected in the environs of the Dzhanybek Research Station in 1982 and described in 1991 [Platnick & Ovtsharenko, 1991] and has not been found since in the adjacent regions, such as the southern Urals, the southeastern Russian Plain or the Crimea, in spite of the rather active recent investigations of these territories [Efimik et al., 1997; Esyunin & Efimik, 1998; Ponomarev & Tsvetkova, 2003; Tuneva & Esyunin,

2003; Ponomarev & Tsvetkov, 2004a, b; Ponomarev, 2005; Kovblyuk, 2006; Esyunin et al., 2007].

About 32% of the gnaphosid fauna are species with a wide distribution (Table 2), with the Trans-Palaearctic pattern predominating.

The distribution of the different range patterns between the habitats is summarized in Table 2. Native associations (microdepressions and microelevations) show that species from the Ancient Mediterranean group sufficiently prevail (65–68%), with an especially high share of West Scythian (20–23%) and Ancient Mediterranean proper (about 20%) elements. Species with a Trans-Palaearctic pattern are numerous as well (about 15%). *Talanites mikhailovi*, the conventional endemic of the clayey semidesert, occurs only in microelevations and microdepressions. In forest plantations, the diversity of gnaphosids is very low (10–11 species) so it is rather difficult to discuss the dominance of zoogeographical groups in these associations.

Therefore, the territory of the recessing Khvalyn Sea, which occurred in the Upper Pleistocene, was the arena for colonization and mixing of fauna of different origins. The key roles in the formation of spider communities are performed by thermophilic species that are locally or widely inhabiting the territories of the Ancient Mediterranean; in a lesser extent, are performed by widespread species.

**Structure of population.** The microelevation-associated population is the most diverse: 34 species of 13 genera were collected (Table 1). The diversity of microdepression-associated populations is slightly lower: 26 species of 10 genera. Artificial biotopes are much poorer: they contain 10–11 species of 5 genera.

Table 2. Zoogeographical structure of gnaphosid population in different biotopes of clay semidesert.  
Табл. 2. Зоогеографическая структура населения гнафозид в различных биотопах глинистой полупустыни.

Groups and ranges of distribution	Total		Biotopes											
	Number of species	%	Microelevations		Microdepressions		Elm forest shelter-belt		Oak forest shelter-belt		Oak community			
			Number of species	%	Number of species	%	Number of species	%	Number of species	%	Number of species	%		
<b>Widespread</b>	<b>13</b>	<b>31.7</b>	<b>8</b>	<b>23.5</b>	<b>8</b>	<b>30.8</b>	<b>5</b>	<b>45.5</b>	<b>3</b>	<b>30</b>	<b>5</b>	<b>50</b>		
Circum-Holarctic	3	7.3	2	5.9	2	7.7	2	18.2	–	–	1	10		
Trans-Palaearctic	8	19.5	5	14.7	4	15.4	2	18.2	2	20	3	30		
West-Central-Palaearctic	2	4.9	1	2.9	2	7.7	1	9.1	1	10	1	10		
<b>Ancient Mediterranean</b>	<b>25</b>	<b>61.0</b>	<b>23</b>	<b>67.6</b>	<b>17</b>	<b>65.4</b>	<b>6</b>	<b>54.5</b>	<b>7</b>	<b>70</b>	<b>5</b>	<b>50</b>		
Euro-Ancient Mediterranean	3	7.3	3	8.8	3	11.5	1	9.1	1	10	2	20		
Ancient Mediterranean	7	17.1	7	20.6	5	19.2	1	9.1	2	20	1	10		
West-Ancient Mediterranean	5	12.2	4	11.8	2	7.7	2	18.2	1	10	1	10		
East-Ancient Mediterranean	1	2.4	1	2.9	1	3.8	1	9.1	1	10	1	10		
Scythian	1	2.4	1	2.9	–	–	1	9.1	–	–	–	–		
West-Scythian	8	19.5	7	20.6	6	23.1	–	–	2	20	–	–		
<b>Conventionally endemic</b>	<b>1</b>	<b>2.4</b>	<b>1</b>	<b>2.9</b>	<b>1</b>	<b>3.8</b>	<b>–</b>	<b>–</b>	<b>–</b>	<b>–</b>	<b>–</b>	<b>–</b>		
Gnaphosidae undet.*	2	4.9	2	5.9	–	–	–	–	–	–	–	–		
<b>TOTAL</b>	<b>41</b>	<b>100</b>	<b>34</b>	<b>100</b>	<b>26</b>	<b>100</b>	<b>11</b>	<b>100</b>	<b>10</b>	<b>100</b>	<b>10</b>	<b>100</b>		

\*Gnaphosidae undetermined to species.

Table 3. Pesenko's coefficient [Pesenko, 1982] of a biotopical adherence ( $F_{ij}$ ) of gnaphosid spiders. Grey accentuation — preference of the biotope ( $0.3 \leq F_{ij} \leq 0.7$ ), bold — high level of adherence to the biotope ( $0.7 \leq F_{ij} \leq 1.00$ ).

Табл. 3. Коэффициент относительной биотопической приуроченности Песенко ( $F_{ij}$ ) [Песенко, 1982] гнафозид. Выделение серым — предпочтение биотопа ( $0,3 \leq F_{ij} \leq 0,7$ ), жирным шрифтом — высокая степень биотопической приуроченности ( $0,7 \leq F_{ij} \leq 1,00$ ).

Species	$F_{ij}$				
	Micro-elevations	Micro-depressions	Elm forest shelter-belt	Oak forest shelter-belt	Oak community
<i>Drassodes lutescens</i>	<b>1.00</b>	-1.00	-1.00	-1.00	-1.00
<i>Micaria guttulata</i>	<b>1.00</b>	-1.00	-1.00	-1.00	-1.00
<i>Nomisia aussereri</i>	<b>1.00</b>	-1.00	-1.00	-1.00	-1.00
<i>Urozelotes</i> sp.	<b>1.00</b>	-1.00	-1.00	-1.00	-1.00
<i>Zelotes orenburgensis</i>	<b>0.90</b>	-0.84	-1.00	-0.86	-1.00
<i>Phaeoedus braccatus</i>	<b>0.88</b>	-0.79	-1.00	-1.00	-1.00
<i>Drassodes rostratus</i>	<b>0.88</b>	-0.80	-1.00	-0.82	-1.00
<i>Micaria pallipes</i>	<b>0.85</b>	-0.74	-1.00	-1.00	-1.00
<i>Talanites mikhailovi</i>	<b>0.63</b>	-0.40	-1.00	-1.00	-1.00
<i>Talanites strandi</i>	<b>0.60</b>	-0.36	-1.00	-1.00	-1.00
<i>Trachyzelotes adriaticus</i>	<b>0.63</b>	-0.40	-1.00	-1.00	-1.00
<i>Gnaphosa lucifuga</i>	<b>0.54</b>	-0.29	-1.00	-1.00	-1.00
<i>Drassyllus sur</i>	<b>0.49</b>	-0.22	-1.00	-1.00	-1.00
<i>Gnaphosa steppica</i>	<b>0.37</b>	-0.14	-1.00	-0.66	-0.63
<i>Zelotes pygmaeus</i>	-1.00	<b>1.00</b>	-1.00	-1.00	-1.00
<i>Haplodrassus kulczynskii</i>	-0.95	<b>0.98</b>	-1.00	-1.00	-1.00
<i>Berlandina cinerea</i>	-0.88	<b>0.91</b>	-1.00	-1.00	-0.62
<i>Zelotes electus</i>	-0.97	<b>0.88</b>	0.27	-0.66	-0.63
<i>Haplodrassus isaevi</i>	-0.77	<b>0.87</b>	-1.00	-1.00	-1.00
<i>Gnaphosa leporina</i>	-1.00	<b>0.79</b>	-1.00	-1.00	<b>0.53</b>
<i>Zelotes longipes</i>	-0.71	<b>0.77</b>	-0.32	-0.33	-1.00
<i>Drassodes villosus</i>	-0.39	<b>0.62</b>	-1.00	-1.00	-1.00
<i>Drassodes lapidosus</i>	-0.47	<b>0.67</b>	-1.00	-1.00	-1.00
<i>Haplodrassus signifer</i>	-0.11	<b>0.36</b>	-1.00	-1.00	-0.46
<i>Gnaphosa taurica</i>	-0.45	<b>0.32</b>	<b>0.31</b>	0.03	0.18
<i>Haplodrassus</i> cf. <i>soerenseni</i>	0.28	-0.01	-1.00	-0.75	-0.72
<i>Zelotes segrex</i>	0.11	0.20	-1.00	-1.00	-1.00
<i>Zelotes caucasius</i>	0.17	0.03	-0.11	-0.44	-1.00
<i>Drassyllus</i> sp. aff. <i>pusillus</i>	-1.00	0.26	<b>0.94</b>	-1.00	-1.00
<i>Micaria rossica</i>	-0.39	-0.19	<b>0.92</b>	-1.00	-1.00
<i>Zelotes atrocaeruleus</i>	-0.29	-0.08	<b>0.88</b>	-1.00	-1.00
<i>Zelotes gallicus</i>	-1.00	-1.00	<b>0.82</b>	<b>0.88</b>	<b>0.66</b>
<i>Drassyllus pusillus</i>	-1.00	-1.00	<b>0.37</b>	<b>0.82</b>	<b>0.90</b>
<i>Zelotes subterraneus</i>	-1.00	-1.00	-1.00	-1.00	<b>1.00</b>



The populations of native biotopes are polydominant (Fig. 1). The dominant complex consists of 8 species with an abundance of more than 5% from a total number of the gnaphosid spiders. Among these 8 species, there are 3–4 species with an abundance of 10–20%. They are: *Zelotes orenburgensis*, *Drassodes rostratus*, *Gnaphosa lucifuga* in microelevations and *Berlandina cinerea*, *Zelotes electus*, *Haplodrassus isaevi* and *Gnaphosa taurica* in microdepressions.

The structure of artificial communities is less equalized (Fig. 1). All the biotopes have two super-dominant species with an abundance of 20–50% (*Zelotes gallicus* and *Drassyllus pusillus* in the oak plantations and *Zelotes gallicus* and *Gnaphosa taurica* in the elm forest shelter-belts). In addition, there are 1–3 species with an abundance of 5–15%. The remaining species are represented by single specimens.

The biotopical adherence of species was estimated using the Pesenko's coefficient ( $F_{ij}$ ) [Pesenko, 1982]. All associations studied have their own complexes of typical species (Table 3). Native biotopes contain the highest number of them. Eight species in microelevations and seven species in microdepressions display a high level of biotopical adherence ( $0.7 \leq F_{ij} \leq 1.00$ ) and several species show a preference ( $0.3 \leq F_{ij} < 0.7$ ) for the biotopes (Table 3). The complexes of the typical species of the plantations are much poorer; they contain 2–5 species. *Zelotes gallicus* and *Drassyllus pusillus* show a high level of biotopical adherence to all types of artificial biotopes.

**Comparison of the present-day data with the materials obtained 20 years ago.** We compared the populations of native communities in 2 different time periods separated by 20 years. The material obtained in 1984 and 2004–2005 differ to some extent. To make the comparison correct and appropriate, we used the material collected in the same seasons, namely summer and autumn periods.

Generally, 16 species were found both 20 years ago and recently; 8 species — only in 1984, 6 — only in 2004–2005 (Table 4). The gnaphosid diversity of desert biotopes has not changed sufficiently; 21 species were collected in 1984 and 18 were collected in 2004–2005. However the gnaphosid diversity of steppe biotopes has noticeably risen: from 9 to 20 species accordingly.

For the comparison, we used Czekanowski – Sorensen's Index of Similarity of Species Composition and Index of Similarity of Structure of Populations.

The Similarity of Species Composition amounted to:

$$I_{CS} \text{ (microelevations: 1984 and 2004)} = 0.65$$

$$I_{CS} \text{ (microdepressions: 1984 and 2004)} = 0.55$$

We should note that 20 years ago, there were much more species restricted to one or another native biotope. Thus there were less species common for both biotopes: 6 in 1984 and 16 in 2004–2005 (Table 4). The Index of Similarity of Species Composition between microelevations and microdepressions has almost doubled from 1984 to 2004:

Table 4. Comparing of gnaphosid populations of native associations of clay semidesert in 1984 and 2004–2005 (summer–autumn).

Табл. 4. Сравнение населения гнафозид зональных биотопов глинистой полупустыни в 1984 и 2004–2005 гг. (лето–осень).

Species	Micro-elevations		Micro-depressions	
	1984	2004–2005	1984	2004–2005
<i>Gnaphosa lucifuga</i>	*	*	*	*
<i>Gnaphosa steppica</i>	*	*	*	*
<i>Gnaphosa taurica</i>	*	*	*	*
<i>Zelotes caucasius</i>	*	*	*	*
<i>Zelotes segrex</i>	*	*	*	*
<i>Drassodes rostratus</i>	*	*		*
<i>Phaeoecedes braccatus</i>	*	*		*
<i>Talanites strandi</i>	*	*		*
<i>Zelotes atrocaeruleus</i>	*	*		*
<i>Zelotes orenburgensis</i>	*	*		*
<i>Micaria rossica</i>	*	*	*	
<i>Berlandina cinerea</i>		*	*	*
<i>Zelotes longipes</i>		*	*	*
<i>Zelotes electus</i>			*	*
<i>Micaria pallipes</i>	*	*		
<i>Drassyllus sur</i>	*			*
<i>Leptodrassus memorialis</i>	*			
<i>Nomisia aussereri</i>	*			
<i>Trachyzelotes cf. lyonetti</i>	*			
<i>Trachyzelotes cf. malkini</i>	*			
<i>Urozelotes sp.</i>	*			
<i>Zelotes fallax</i>	*			
<i>Genus sp.</i>	*			
<i>Zelotes rufti</i>	*			
<i>Drassodes villosus</i>		*		*
<i>Haplodrassus isaevi</i>		*		*
<i>Talanites mikhailovi</i>		*		*
<i>Trachyzelotes adriaticus</i>		*		*
<i>Drassodes lapidosus</i>				*
<i>Gnaphosa leporina</i>				*
TOTAL	21	18	9	20

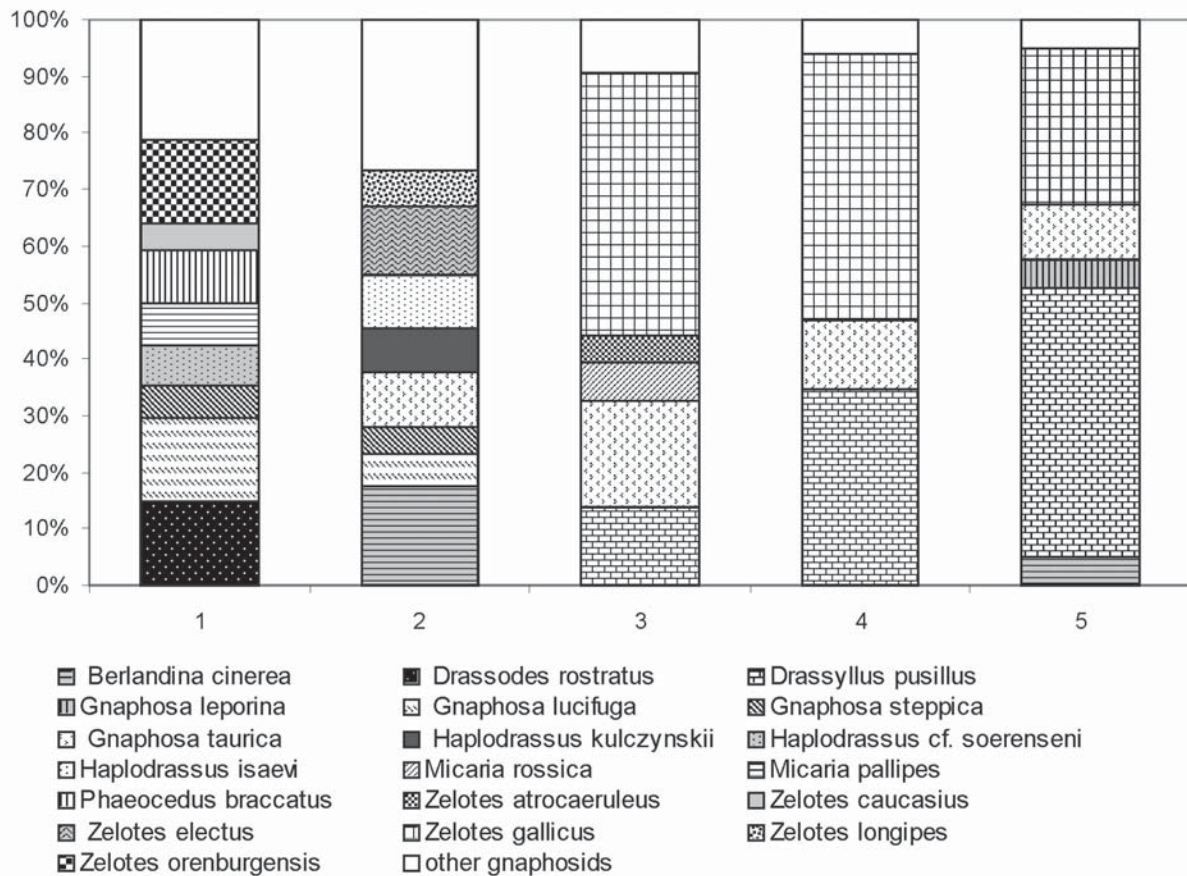


Fig. 1. Dominant complex of gnaphosid population of different associations found in clay semidesert (pitfall traps; 1, 2, 4, 5 — 2004, 3 — 1984): 1 — microelevations, 2 — microdepressions, 3 — elm forest shelter-belt, 4 — oak forest shelter belt, 5 — oak community in a local park.

Рис. 1. Доминантный комплекс населения гнафозид различных ассоциаций глинистой полупустыни (почвенные ловушки, 1, 2, 4, 5 — 2004, 3 — 1984): 1 — микроповышения, 2 — западины, 3 — лесополоса с вязом мелколистным, 4 — лесополоса с дубом черешчатым, 5 — дубрава (дендропарк).

$I_{CS}$  (1984: microelevations and microdepressions) = 0.43;

$I_{CS}$  (2004: microelevations and microdepressions) = 0.84.

The structure of the populations has changed as well. In 1984, the spider population was more typical of arid habitats and more extreme: 1–3 species were superdominant, other species were rather rare (Fig. 2). Currently, the communities are polydominant and much more equalized. The similarity of the structure of populations of native biotopes between 1984 and 2004 amounted to:

$I_{CS}$  (microelevations: 1984 and 2004) = 0.49;

$I_{CS}$  (microdepressions: 1984 and 2004) = 0.53.

What are the possible reasons for such changes? The analyses of the main climatic characteristics on the territory of the northern Caspian Lowland [Lindeman et al., 2005; Sapanov, 2006] showed significant changes during the past 50 years, especially during the last two decades. Specifically, annual rainfall has increased by more than 50 mm, due to higher precipi-

tation during warm half-years (April – September). Also, the average annual temperature has increased almost by 1.5°C, mainly owing to the higher temperature of the winter period (the average winter temperature has increased by 2.5°C). This has resulted in frequent thaws, snow melting and the absence of spring drainage of thaw waters. This has radically changed the character of the redistribution of thaw waters and soil water retention. Due to these changes, ice water did not accumulate in microdepressions as it had been before. Instead, the ice water thoroughly saturated the solonchic soils of microelevations, leaching the salts. All of these changes decreased the differences in the salinity and water saturation of soils belonging to the two types of native communities. It is reflected in the vegetation cover (steppe herbs began growing on microelevations) and in the animal communities as well. Spiders, being a group strongly dependent on hydrothermal conditions, should distinctly react to those changes. Probably, we are observing just those reactions.



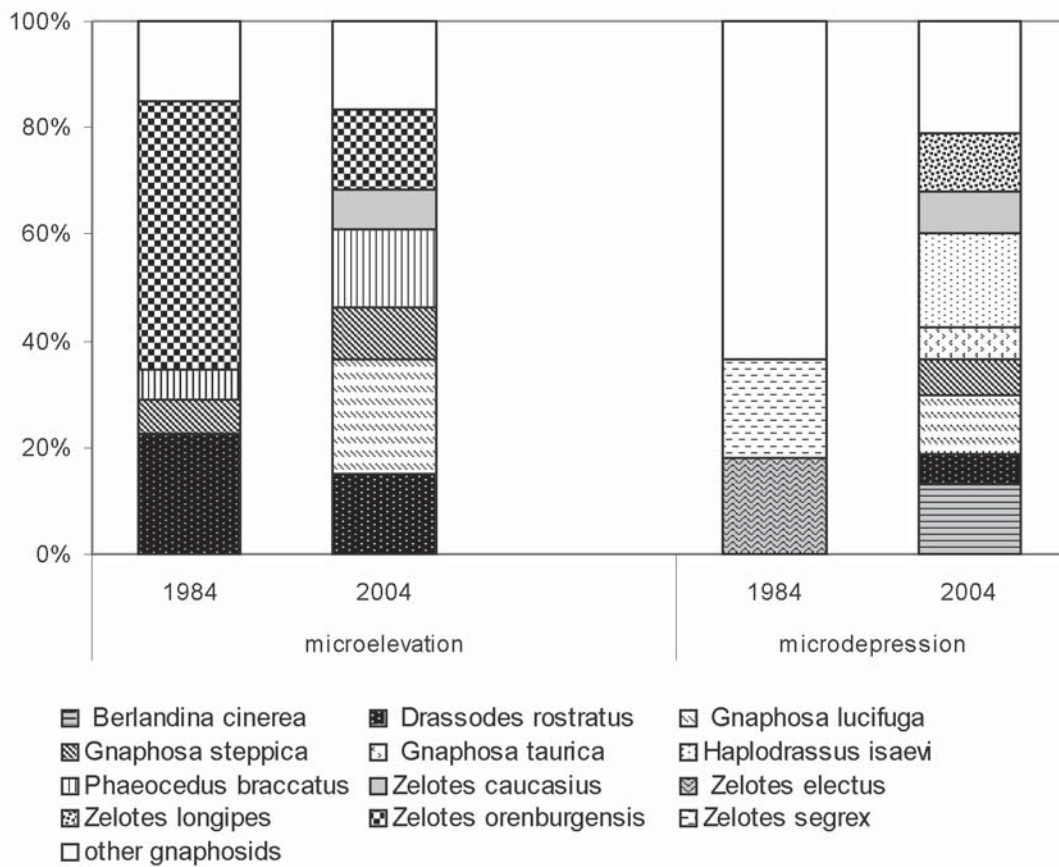


Fig. 2. Comparison of structure of gnaphosid population of native associations found in clay semidesert in 1984 and 2004 (pitfall traps; summer–autumn).

Рис. 2. Сравнение структур населения гнафозид зональных местообитаний глинистой полупустыни 1984 и 2004 гг. (почвенные ловушки, лето–осень).

**ACKNOWLEDGMENTS.** The authors would like to thank Drs. Mamai Sapanov and Marina Sizemskaya, the managers of the Dzhanybek Research Station, for the opportunity to work at its territory. Also, we are thankful to Dr. Kirill Mikhailov for collecting the material in 1984 and for consultation. We appreciate the continual help and support of the Laboratory of Synecology (Institute of Ecology and Evolution, RAS) at all the stages of the work. The study was partly supported by the Russian Foundation for Basic Research, the Program “Biosphere Origin and Evolution” of Russian Academy of Sciences and the Program for the Support of Leading Academic Schools. We thank Dr. Julie Trachman of Hostos Community College for her editing of the manuscript.

## References

- Abaturov B.D. 1985. [Formation of microrelief and complex soil cover in semidesert of the Northern Caspian Region] // *Mleko-pitayushchiye v nazemnykh ekosistemakh*. Moscow: Nauka. P.225–249 [in Russian].
- Doskatch A.G. 1964. [Nature of the northern Volga-Ural inter-fluve] // *Pochvy kompleksnoi ravniny Severnogo Prikaspiya i ikh meliorativnaya kharakteristika*. Moscow: Nauka. P.7–21 [in Russian].
- Efimik V.E., Esyunin S.L., Kuznetsov S.F. 1997. Remarks on the Urals spider fauna, 7. New data on the fauna of the Orenburg Region (Arachnida Aranei) // *Arthropoda Selecta*. Vol.6. No.1/2. P.85–90.
- Esyunin S.L., Tuneva T.K., Farzalieva G.Sh. 2007. The remarks on the Ural spider fauna (Arachnida, Aranei), 12. Spiders of the steppe zone of Orenburg Region // *Arthropoda Selecta*. Vol.16. No.1. P.43–63.
- Esyunin S.L., Efimik V.E. 1998. Remarks on the Urals spider fauna, 8. New and unidentified species from steppe landscapes of the South Urals // *Arthropoda Selecta*. Vol.7. No.2. P.145–152.
- Kovblyuk M.M. 2006. [Spiders of the family Gnaphosidae (Arachnida, Aranei) in the Crimea fauna]. PhD Thesis. Kiev. 20 p. [in Ukrainian].
- Kryzhanovskii O.L. 2002. [Composition and distribution of entomofaunas of the Globe]. Moscow: KMK Scientific Press Ltd. 237 p. [in Russian].
- Lindeman G.V., Abaturov B.D., Bykov A.V., Lopushkov V.A. 2005. [Dynamics of the vertebrate animal population in semidesert of the area east of the Volga River]. Moscow: Nauka. 252 p. [in Russian].
- Pesenko Yu.A. 1982. [Principles and methods of quantitative analysis in faunistical researches]. Moscow: Nauka. 288 p. [in Russian].
- Platnick N.I. 2007. The World Spider Catalogue, Version 8.0. American Museum of Natural History, New York. Online at <http://research.amnh.org/entomology/spiders/catalog/INTRO1.html>

- Platnick N. I., Ovtsharenko V. I. 1991. On Eurasian and American *Talanites* (Araneae, Gnaphosidae) // J. Arachnol. Vol.19. P.115–121.
- Ponomarev A.V. 2005. [Spiders (Aranei) of the Rostov-on-Don Region: fauna, landscape-zonal distribution]. PhD Thesis. Stavropol'. 22 p. [in Russian].
- Ponomarev A.V., Tsvetkov A.S. 2004a. [Generalized data on spiders (Aranei) of the "Rostovskii" Nature Reserve] // Trudy Gosudarstvennogo prirodnogo zapovednika "Rostovskii". Rostov-on-Don: Donskoi izdatel'skii dom 4. P.84–104 [in Russian].
- Ponomarev A.V., Tsvetkov A.S. 2004b. [Spiders] // Flora, fauna i mikrobiota gosudarstvennogo muzeya-zapovednika M.A. Sholokhova. Rostov-on-Don: Gosudarstvennyi muzei-zapovednik M.A. Sholokhova. P.81–87 [in Russian].
- Ponomarev A.V., Tsvetkova Yu.A. 2003. [Spiders (Aranei) of the territory of the Razdorskii Museum and Nature Reserve] // Istoriko-kul'turnye issledovaniya na territorii Razdorskogo etnographicheskogo muzeya-zapovednika. Rostov-on-Don: Izdatel'stvo Rostovskogo universiteta 1. P.167–208 [in Russian].
- Sapanov M.K. 2006. [Conditions for protective afforestation growing in semidesert of Northern Caspian Region in view of climate changes in the second half of the XX century] // Lesovedenie. Vol. 6. P.45–51 [in Russian].
- Tuneva T.K., Eyunin S.L. 2003. A review of the family Gnaphosidae in the fauna of the Urals (Aranei), 3. New species and new records, chiefly from the South Urals // Arthropoda Selecta (2002). Vol.11. No.3. P.223–234.
- Varushchenko A.N., Varushchenko S.I., Klige R.K. 1980. [Changes of the Caspian Sea level in the late Pleistocene – Holocene] // Kolebaniya uvlazhnennosti Aralo-Kaspiiskogo regiona v goltsene. Moscow: Nauka. P. 79–90 [in Russian].