

Gnaphosa badia (Araneae: Gnaphosidae) in the Ukrainian Carpathians with comments on its distribution

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Abstract. An analysis of data on the distribution of the rare spider species *Gnaphosa badia* (L. Koch, 1866) (Araneae: Gnaphosidae) is presented. Until recently, this species had been recorded in the Carpathian Mountains at two localities: Mt. Chorna Hora (Ukraine, Volcanic Ridge) and the Rodna Mountains (Romania). It was subsequently discovered that the species occurs within the subalpine and alpine zones of the Ukrainian (Eastern) Carpathians, in the Chornohora and Rakhiv Mountain massifs. Part of the material was included in a checklist of the spiders of the Chornohora Mountain massif. The species compositions of the alpine and subalpine spider communities, which include *G. badia*, are given. The total distribution of the species is discussed and shown on a map.

Keywords: alpine zone, Chornohora massif, Rakhiv massif, spider, Ukraine

Zusammenfassung. *Gnaphosa badia* (Araneae: Gnaphosidae) in den Ukrainischen Karpaten mit Anmerkungen zu ihrer Verbreitung. Die Verbreitung der seltenen Spinnenart *Gnaphosa badia* (L. Koch, 1866) (Araneae: Gnaphosidae) wird analysiert. Bisher wurde die Art in den Karpaten an zwei Orten erfasst: auf dem Chorna Hora (Ukraine, Vihorlat-Gutin/Volcanic Ridge/Vulkanrücken) und im Rodna-Gebirge (Rumänien). Nun wurde sie auch in der subalpinen und alpinen Zone der ukrainischen Ostkarpaten, im Chornohora Gebirgsmassif und den Rakhiv-Bergen, gefangen. Das Material war zum Teil schon in die Checkliste des Chornohora Gebirgsmassifs enthalten. Die Artenzusammensetzungen der alpinen und subalpinen Spinnengesellschaften, die mit *G. badia* vorkommen, werden gezeigt. Die Gesamtverbreitung der Art wird diskutiert und in einer Karte dargestellt.

Резюме. *Gnaphosa badia* (Araneae: Gnaphosidae) в Українських Карпатах із зауваженнями щодо його поширення. Робота базується на аналізі даних про поширення рідкісного виду павуків – *Gnaphosa badia* (L. Koch, 1866) (Araneae: Gnaphosidae). Донедавна вид був відомий для Карпатської гірської системи лише з двох локалітетів, зокрема одного в Україні: Чорна Гора (дані сумнівні) та одного в Румунії: гори Родна. З'ясовано, що вид трапляється у межах субальпійського та альпійського поясів Українських (Східних) Карпат – Чорногори та Рахівських гір. Частина матеріалів цієї статті увійшла до анотованого списку Чорногори. Наведено різноманіття угруповань павуків альпійського та субальпійського поясів, до складу яких належить *Gnaphosa badia*.

The ground spider *Gnaphosa badia* (L. Koch, 1866) belongs to the *Gnaphosa bicolor*-group (Gnaphosidae), which contains a small number of exclusively Palearctic species (Ovtsharenko et al. 1992). The species has a disjunctive distribution inhabiting some mountainous regions of Eurasia, and has a preference for high altitude ecosystems (1600–2800 m, Grimm 1985). Perhaps because of its chorological peculiarities and ecological preferences, this spider remains poorly investigated. For example, in some regions there are only one or two known localities of *G. badia* in the second half of the 20th century; thus the information is relatively old and was not confirmed by current records, and remains fragmentary regarding certain territories. Some records are doubtful, especially those for lowland areas. From 1971 onwards, the data relating to the occurrence of this species within the Ukrainian Carpathians was repeatedly copied into several publications. Mistakes were neither being detected, nor was it stated precisely where the specimens had been collected. All these factors reveal the need for a generalized approach towards the published data on the distribution of *G. badia*.

Material and methods

Material was collected in the Ukrainian Carpathians on the territory of the Chornohora and the Rakhiv Mountain massifs in the subalpine and alpine zones. The study was conducted based on standard collecting methods, such as pitfall traps and hand collecting. Spiders were identified using the key of Nentwig et al. (2018). Nomenclature follows the World Spi-

der Catalog (WSC 2018). Material of *G. badia* is deposited in the collections of the Institute of Ecology of the Carpathians NAS of Ukraine (Lviv). Photographs were taken using an Olympus DP72 camera connected to an Olympus SZX10 stereoscope (Center for collective use of the scientific equipment, National Museum of Natural History, NAS of Ukraine, Lviv).

The Chornohora Mountain massif is the highest mountain group of the Ukrainian Carpathians. Its main range extends for about 40 km. The western part of the massif contains Mt. Petros (2020 m), from which extends a group of lower mountains. The eastern section is a range with 11 summits over 1800 m (the highest peak is Hoverla with 2061 m), with a minimum elevation of 1750 m above sea level. The subalpine zone (1600–1650 m to 1800–1850 m) is represented by treeline ecotones, green alder and *Pinus mugo* scrubs, secondary *Vaccinium* heaths and *Juniperus* thickets, subalpine tall grass communities and *Nardus stricta* swards. The alpine zone (1800–1850 m to 2061 m) is dominated by alpine heaths, alpine grasslands, and moss and lichen communities. Large areas of the summits of the mountain range are covered with screes, consisting of fragments of rocks that have accumulated on the tops of mountains or on the slopes. The Rakhiv Mountain massif is located in Romania (main part) and Ukraine (northern and north-western parts). The highest peak on the Ukrainian side is Pip Ivan Marmaroshs'kyi (1936 m). The Western ridge of the massif with the mountains Zherban (1793 m), Polonyka (1627 m) and Preluka (1281 m) creates a natural border between the countries. The vegetation of the subalpine zone (up to 1600 m) of this ridge is represented by dense thickets of *Pinus mugo* and *Juniperus sibirica* growing on rocky slopes, and in places by green alder scrub (in treeline ecotones).

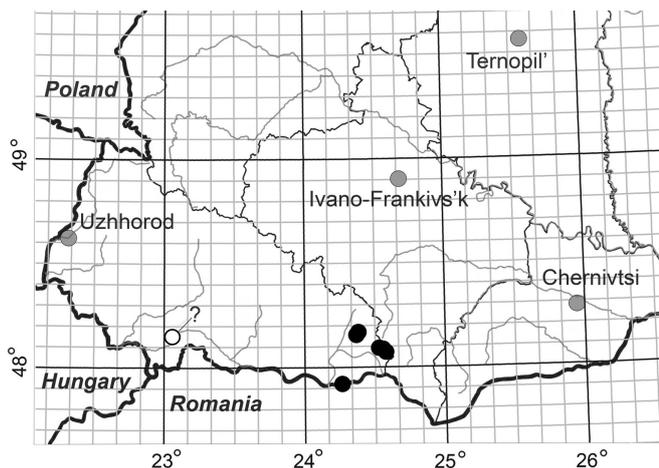


Fig. 1: Localities of *Gnaphosa badia* in the Ukrainian Carpathians (white circle – dubious records from 1970–1971; black circles – valid records from 2012–2016)

Localities of *Gnaphosa badia* in the Ukrainian Carpathians (Fig. 1)

Material not examined (Legotay's material of *Gnaphosa badia* was not preserved.): Inner Eastern Carpathians (The Volcanic Ridge), Vynohradiv's'ke vulkanichne horbohir'ya. Zakarpats'ka oblast', Botanical Reserve "Chorna hora": Mt. Chorna Hora (48.1500°N, 23.0736°E; 503 m a.s.l.), meadows, 10. Apr. 1971: 1 ♂, 1 juv., 1.–30. May 1971: 4 ♂♂, 2 ♀♀, 1.–30. Jun. 1971: 9 ♂♂, 2 ♀♀, 1 juv., 1.–30. Jul. 1971: 1 ♀, 1.–30. Aug. 1971: 2 ♀♀, 9. May 1970: 1 ♂, 6 ♀♀; oak forests, 1.–30. Jun. 1971: 1 ♂, 3 ♀♀, 1.–30. Jul. 1971: 1 juv.; vineyards, 10. Apr. 1971: 1 ♀ (Legotay 1974).

Valid records: Polonyna Carpathians, Chornohora mountain massif. Ivano-Frankivsk's'ka oblast' Carpathian National Nature Park: Mt. Brebeneskul (48.0992°N, 24.5800°E; 1982 m a.s.l.), siliceous screes of the alpine level, in Barber pitfall traps, Jun.–Jul. 2016: 1 ♀ (unpubl. data, leg. A. Hirna). Mt. Dzembronia (field name Pohane Misce) (48.0689°N, 24.6142°E; 1841 m a.s.l.), alpenrose (*Rhododendron myrtifolium*) heath, in Icelandic moss, 7. Sep. 2014: 1 ♀ (Hirna et al. 2016). Zakarpats'ka oblast', Carpathian Biosphere Reserve: Mt. Hutyn Tomnatyk (48.1000°N, 24.5583°E; 1925 m a.s.l.), alpine wet rock grooves with tall grass (*Festuca*) communities, in pitfall traps, Jun.–Jul. 2012: 3 ♂♂, 1 ♀. Mt. Petros (48.1714°N, 24.4206°E; 1996 m a.s.l.), siliceous screes of the alpine level, under stones, 20. Jun. 2013: 1 ♀, 20. Aug. 2014: 1 ♂; between dead grass remains, 2. Jul. 2015: 1 ♂ (Hirna et al. 2016); siliceous screes of the alpine level, in pitfall traps, Jun.–Jul. 2012: 1 ♀, Jun.–Jul. 2015: 5 ♂♂, 4 ♀♀ (unpubl. data, leg. A. Hirna). Mt. Rogneska (48.1575°N, 24.3742°E; 1640 m a.s.l.), subalpine thickets (*Juniperus sibirica*), in Icelandic moss, 20. Jun. 2013: 3 ♀♀ (Hirna et al. 2016).

Maramureş Mountains, Rakhiv mountain massif. Zakarpats'ka oblast', Carpathian Biosphere Reserve: Mt. Zherban (47.9119°N, 24.2981°E; 1761 m a.s.l.), subalpine (*Pinus mugo*) scrub with thickets (*Juniperus sibirica*), in Icelandic moss under *Juniperus*, 10. Aug. 2015: 1 ♂, 1 ♀ (unpubl. data, leg. A. Hirna).

Results

Gnaphosa badia occurs sporadically in the highlands of the Ukrainian (Eastern) Carpathians. Adult individuals were

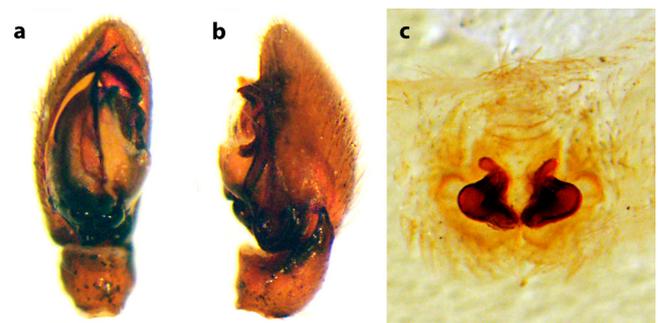


Fig. 2: *Gnaphosa badia* from Ukraine (the mountain massif Chornohora, Mt. Petros), male palp: **a.** ventral view; **b.** retrolateral view; **c.** vulva

caught in the period June to September. Photos of the male palp and vulva are shown in Fig. 2. Specimens were collected at an altitude over 1600 m a.s.l., which corresponds to records of specimens in the territory of the Eastern Carpathians within northern Romania. At lower altitudes, in the spruce forest zone of the investigated mountain massifs, *G. badia* was not found.

Tab. 1: Spider communities of the alpine zone of the Chornohora Mt. massif (period from June to July). In bold: relative abundance >3.2 %; according to Engelmann (1978): eudominant – 32–100 %, dominant – 10–31.9 %, subdominant – 3.2–9.9 %. A – Mt. Hutyn Tomnatyk, B – Mt. Petros, C – Mt. Petros, D – Mt. Brebeneskul

Taxon	A	B	C	D
	2012	2012	2015	2016
	% of the total number of specimens			
<i>Coelotes pickardi carpathensis</i> Ovtchinnikov, 1999	3.2	8.4	9.2	7.0
<i>Clubiona alpicola</i> Kulczyński, 1882	1.3	0.5	2.1	4.1
<i>Cryphoea silvicola</i> (C. L. Koch, 1834)	0.6	1.0	0.8	1.8
<i>Cybaeus angustiarum</i> L. Koch, 1868	4.7	3.1	2.1	.
<i>Drassodes cupreus</i> (Blackwall, 1834)	0.3	.	.	.
<i>Gnaphosa badia</i> (L. Koch, 1866)	1.6	0.5	3.8	0.6
<i>Haplodrassus signifer</i> (C. L. Koch, 1839)	12.0	13.1	12.6	9.9
<i>Macrargus rufus</i> (Wider, 1834)	.	.	.	0.6
<i>Taranucnus carpaticus</i> Gnelitsa, 2016	.	.	0.4	.
<i>Tenuiphantes alacris</i> (Blackwall, 1853)	.	.	0.4	.
<i>Tiso vagans</i> (Blackwall, 1834)	.	0.5	.	.
<i>Walckenaeria cuspidata</i> Blackwall, 1833	.	0.5	1.7	3.5
<i>Alopecosa pulverulenta</i> (Clerck, 1757)	2.8	.	.	.
<i>Pardosa nigra</i> (C.L. Koch, 1834)	1.9	.	0.4	0.6
<i>Pardosa palustris</i> (Linnaeus, 1758)	0.6	0.5	0.4	.
<i>Pardosa saltuaria</i> (L. Koch, 1870)	69.4	70.7	65.3	69.6
<i>Xerolycosa nemoralis</i> (Westring, 1861)	.	0.5	.	.
<i>Ozyptila trux</i> (Blackwall, 1846)	0.6	0.5	0.4	0.6
<i>Xysticus obscurus</i> Collett, 1877	0.9	.	0.4	1.8
Total number of species	13	12	14	11

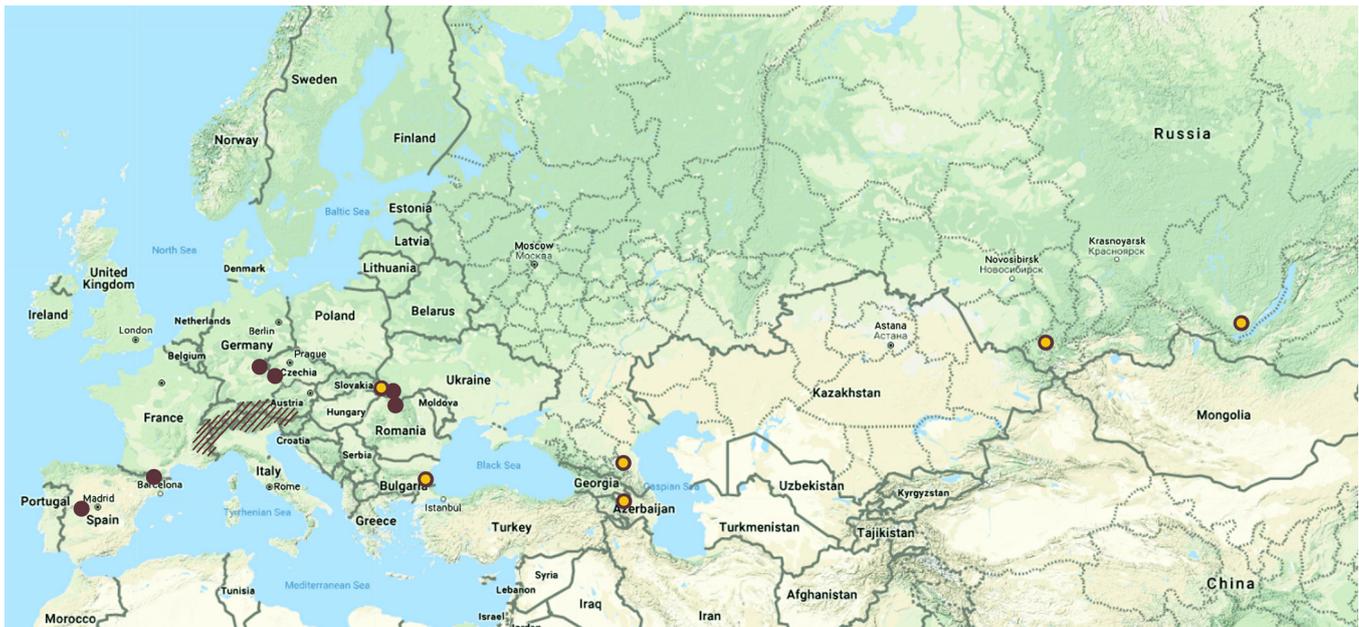


Fig. 3: Distribution of *Gnaphosa badia* in Eurasia (see text for references; black circles – valid records; yellow circles – data need confirmation; the circle corresponds to the region; does not indicate the number of localities). In the shaded area (the Alps), the species is widely distributed and found at many localities

Tab. 2: Spiders of subalpine (*Juniperus*) thickets of the Chornohora Mt. massif and the Rakhiv Mt. massif (three samples of Icelandic moos 40 cm × 40 cm, under *Juniperus sibirica*). A – Chornohora Mt. massif: Mt. Rogneska, B – Rakhiv Mt. massif Mt. Zherban

Taxon	A	B
	20. Jun. 2013	10. Aug. 2015
<i>Coelotes terrestris</i> (Wider, 1834)	1 ♀	.
<i>Callobius claustrarius</i> (Hahn, 1833)	.	1 ♂
<i>Cybaeus angustiarum</i> L. Koch, 1868	.	1 ♂
<i>Gnaphosa badia</i> (L. Koch, 1866)	3 ♀♀	1 ♂, 1 ♀
<i>Agyneta rurestris</i> (C.L. Koch, 1836)	5 ♀♀	.
<i>Bolyphantes alticeps</i> (Sundevall, 1833)	1 ♂	.
<i>Centromerus arcanus</i> (O. P.-Cambridge, 1873)	.	1 ♂, 6 ♀♀
<i>Centromerus pabulator</i> (O. P.-Cambridge, 1875)	.	2 ♂♂, 1 ♀
<i>Centromerus sylvaticus</i> (Blackwall, 1841)	4 ♀♀	.
<i>Diplocephalus latifrons</i> (O. P.-Cambridge, 1863)	4 ♀♀	1 ♀
<i>Mansuphantes arciger</i> (Kulczyński, 1882)	1 ♀	1 ♂
<i>Mansuphantes mansuetus</i> (Thorell, 1875)	.	1 ♀
<i>Minyriolus pusillus</i> (Wider, 1834)	2 ♂♂	1 ♂, 7 ♀♀
<i>Mughiphantes mughii</i> (Fickert, 1875)	1 ♂	1 ♂, 4 ♀♀
<i>Walckenaeria cuspidata</i> Blackwall, 1833	2 ♀♀	.
<i>Pardosa amentata</i> (Clerck, 1757)	3 ♀♀	1 ♀
<i>Pardosa pullata</i> (Clerck, 1757)	.	1 ♀
<i>Pardosa saltuaria</i> (L. Koch, 1870)	3 ♀♀	1 ♀
<i>Robertus lividus</i> (Blackwall, 1836)	3 ♀♀	.
<i>Robertus scoticus</i> Jackson, 1914	.	2 ♀♀
<i>Robertus truncorum</i> (L. Koch, 1872)	.	1 ♂

In addition, the species was not confirmed at other localities known from the literature (Legotay 1974), therefore, the data from the Mt. Chorna Hora are doubtful.

In general, a limited number of species were caught in the alpine zone of the mountain massif Chornohora using pitfall traps: from 11 to 14 (Tab. 1). Three of them, *Pardosa saltuaria*, *Haplodrassus signifer* and *Coelotes pickardi carpathensis* have a high relative abundance in all spider communities (84.6–92.2 % of the total number captured). Species richness and composition do not differ very much between different mountain tops. The relative abundance of *G. badia* ranges from 0.5 to 3.8 %. Most specimens were caught in the alpine zone of Mt. Petros, in 2015 (3.8 %).

In the subalpine zone only several specimens of *G. badia* were observed under *Juniperus sibirica* thickets at two localities: Mt. Rogneska and Mt. Zherban (Tab. 2; in pitfall traps that had been placed for a duration similar to the exposition in the alpine zone, no specimens were captured). These two localities differ in their levels of human activity. A known tourist route passes through the Mt. Rogneska area, as well as sheep movement to the pastures. On the contrary, Mt. Zherban is located on the border between Ukraine and Romania, but is hard-to-reach for tourists because of the steep slopes and dense thickets of subalpine shrubs.

In the Ukrainian Carpathians *G. badia* has a preference for the alpine zone (over 1800 m a.s.l.) and occasionally occurs in the subalpine zone. The species is localized mainly in the gaps between stones and in clumps of Icelandic moss, actively hunting on the surface of the soil and stones.

Discussion

The species was described by Ludwig Koch as *Pythonissa badia* from the Alps (historical region – Tyrols and the Bavarian Alps, Koch 1866). Today, besides the Alps (Austria, Italy, France, Germany, Liechtenstein, Slovenia and Switzerland), the species is found in other mountain systems of Europe: the Pyrenees (Andorra), the Central System (Spain), the Bohemian Forest (Czech Republic: Šumava, Germany: Bava-

rian Forest) and in the Fichtel Mountains (Germany) (Fig. 3; Buchar 1962, Kúrka 1995, Růžička 1997, Buchar & Růžička 2002, Blick et al. 2004, Thaler & Knoflach 2003, Cardoso & Morano 2010, Kostanjšek & Kuntner 2015, Arachnologische Gesellschaft 2018, Czech Arachnological Society 2018, WSC 2018). Part of these data was summarized by Grimm (1985).

The possible occurrence of *G. badia* in the Carpathian Mountains was proposed by Kolosváry (1939). In his work, Kolosváry used known publications relating to the altitudinal distribution of spider species in the European mountains. Based on the faunal list of Lessert (1909) it was indicated that *G. badia* should occur in the alpine zone of the Carpathians at altitudes of 2300–2700 m a.s.l.

Information on records of *G. badia* from the Ukrainian (Eastern) Carpathians (the Chorna Hora Mt., Vynohradiv rayon, Zakarpats'ka Oblast') was presented in a PhD work by Legotay (1974; the data are given above in 'Material and methods'; Figs 1, 3). In a later paper based on the material of this PhD thesis it was not specified where the specimens had been collected (Legotay 1989). Since 1971, the species has also been known to occur in the Ukrainian Carpathians (without localities being specified) from another published work (Tyschchenko 1971), and later from the catalogues by Mikhailov (1997, 1998, 2013) as well as from other papers (Ovtsharenko 1982, Ovtsharenko et al. 1992).

In 2005–2006, the species was recorded within the Eastern Carpathians in northern Romania: the Pietrosul Mare Scientific Reserve (subalpine zone: 1650–1800 m; the Rodna Mountains; Nitzu et al. 2008; Fig. 3). Recently, it was found in the Chornohora (Ukraine) and added to the checklist of the spiders of this massif (Hirna et al. 2016).

According to the literature, *G. badia* occurs also in Europe within the East European Plain (Mikhailov 1997, 1998, 2013), in particular in the Caspian Depression (Minoransky 1988: the Chechen Republic, Russia, Budary Lake region, and Terek-Kuma Lowland of Ciscaucasia; Fig. 3). In several places the Caspian Depression is below sea level (0 to -28 m), and in the Budary Lake region between 4 and 15 m. The lake region, located in the steppe zone, includes agricultural land, vineyards and floodplain forests of the Terek River. Therefore, it is most likely the specimens from this locality were misidentified. *Gnaphosa badia* has also been recorded within the Burgas Plain territory of Bulgaria (Burgas (Deltshev 1976: "1 ♀ /15. Jun. 1948"), Deltshev et al. 1998, Fig. 3), and included in the checklist of spiders of this country (Blagoev et al. 2018). The data from these lowland areas are also doubtful and in need of confirmation.

The notifications attributed to *G. badia* within the East European Plain from the forest-steppe zone of Ukraine (Kharkiv oblast'; Kirilenko & Legotay 1981), the Volga Upland (Ehorov 2012: cit. by Sidorenko & Dunin, 1997, Sidorenko 1998: the Chuvash Republic, Russia, NNP "Chavash Varmane"), and also from Fenno-Scandinavia (Mikhailov 1998, 2013, Oligier 2003: Russia, Ladoga Lake region, on the verge of Leningrad Oblast' and Karelian) were all based on erroneous identifications (Tsvietkov 2007, Polchaninova & Prokopenko 2013, M. V. Sidorenko and T. I. Oligier pers. comm.: based on the revision of collected material).

Gnaphosa badia is mentioned as part of the spider fauna of the mountain systems of Asia by Mikhailov (1997, 1998,

2013) and Otto (2017). In particular, the species is known from the Caucasus Mountains (Dunin 1989: Azerbaijan, Transcaucasia, Greater Caucasus; Fig. 3) and the mountain systems of the Cis-Baikal (Izmailova 1977, 1989: Russia; Irkutsk Oblast', Primors'k mountain range, on the outskirts of vil. Nizhnii Kocherhat; Fig. 3). However, the data by M. Izmailova are based on the identification of adult females; the published figure of a vulva (Izmailova 1977, 1989) does not give an unambiguous answer about the correctness of the identification. Records of several specimens (up to three) at an altitude up to 1200 m on both the Caucasus and the Cis-Baikal are quite old: there have been no confirmations for more than 30–40 years. Ovtsharenko et al. (1992) omitted them in the summarizing work about North Asian ground spiders of the genus *Gnaphosa*, where the authors pointed out: "We have seen no material of this species from the USSR, but the species has been recorded from the Carpathian Mountains (Tyschchenko, 1971, Kirilenko & Legotay, 1981)".

In 2010, the discovery of *G. badia* was reported from the Altai Mountains (Volkovskij & Romanenko 2010: on the outskirts of vil. Chermal; Fig. 3). However, in 2013, these data were not included the list of spiders of the Russian Altai (Azarkina & Trilikauskas 2013) due to their doubtful nature (G. Azarkina pers. comm.).

The specimens from the Sikhote-Alin mountain range in the reserve "Lazovsky" (2004, Russia, Primorsky Krai, Sundukov & Shokhrin 2004, leg. and det. T. I. Oligier) were misidentified (Oligier pers. comm.).

Apparently, not only data from lowland areas of Europe, but also from mountain systems of Asia appear questionable. Until there are verified records of specimens from these territories, the range of *G. badia* should be delimited to the mountain systems of Europe: in the south-west in the Central System of the Iberian Peninsula, the Pyrenees, the Alps, the Bohemian Forest, the Fichtel Mountains and the most easternmost ones in Carpathians.

Comparison of the chorological and ecological peculiarities of *G. badia* within different mountain systems is difficult due to the differences of altitudinal zones. The habitats of this species in the Carpathians are similar to those described in the researches for the Alps, in particular subalpine-alpine grasslands, heaths and scrubs, and scree; but in the Carpathians the species does not occur in coniferous forests (Grimm 1985, Kropf & Horak 1996, Zingerle 2000, Steinberger 2013). The spider fauna of the two mountain systems is different, however in both of them *G. badia* have a high relative abundance in some epigeic spider communities, for example a sub-dominant position in a high altitude (2100 m) in the Zillertal Alps (Paulus & Paulus 1997). It should be noted that in the Bohemian Forest (Šumava: Czech Republic and Bavarian Forest: Germany) and in the Fichtel Mountains (Germany), the species occurs at the lower hypsometric levels. Nevertheless, most of the records are at an altitude more than 1000 m (from 830 to 1350 m in the Bavarian Forest (unpublished data of T. Blick), Buchar 1962, Kúrka 1995, Růžička 1997, Buchar & Růžička 2002).

In the Ukrainian Carpathians *G. badia* only occasionally occurs in the subalpine zone and mainly belongs to the spider communities of the alpine zone, which are relatively species-poor, have a specific composition and are adapted to a number

of climatic factors. These factors are, in particular, the low average annual temperatures (the average temperature is between -6 and -12 °C in January, and between +8 and +12 °C in July), with long-term freezing of the soil, strong gusty winds (up to 40 meters per second), high air humidity and significant annual precipitation (more than 1500 mm per year, Holubets et al. 1988).

The alpine zone occupies only 0.1 % of the Ukrainian Carpathians (14.2 km²). Despite the fact that the territory is protected, the main habitats of *G. badia* within the Chornohora Massif are suffering from an annual uncontrolled increase in the number of tourists. The consequences of this are heavily trampled areas on the summits of mountains and on their slopes adjacent to the many paths as well as an accumulation of plastic litter under stones. Besides this, in the last decade an increase in annual average temperatures and a longer period of vegetative growth has caused an upward movement of the tree line and overgrowing of the alpine zone by subalpine scrubs. Ecological and chorological peculiarities of *G. badia*, as well as human impact on its habitats and uncertainty about the impact of climate change on the native fauna of the highlands determine a need to include this species in the list of threatened species of the Carpathians mountain system.

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