Acta Zool. Fennica 190:333–337
Helsinki 21 December 1990

ISBN 951-9481-35-4 ISSN 0001-7299

XI International Congress of Arachnology, Turku, Finland, 7–12 August 1989

The spiders of stony debris

Vlastimil Růžička

Institute of Landscape Ecology, Czechoslovak Academy of Sciences, Na sádkách 7, CS-370 05 České Budějovice, Czechoslovakia

Because of their specific microclimate, stony debris represent a typical island biotope in the central European landscape. The abrupt contrast between the temperature and moisture conditions on the surface and those in the inner zone is typical. Diametrically different communities inhabit the surface and the inner layers of debris. Thermophilous and psychrophilous species occur simultaneously in bare insolated debris. Both the rare, relict species and the common, opportune species live side by side in debris. Amongst the most noteworthy arachnological finds in Czechoslovakia in recent years are the glacial relicts *Bathyphantes eumenis* (L. Koch, 1879) and *Wubanoides longicornis* Eskov, 1986.

1. The specificity of stony debris

The middle-sized and small forms of relief play a very important role in natural ecosystems. As relatively small terrain barriers, they are responsible for minute deviations in microclimatic conditions, which represent a characteristic component of every ecotope. These microclimatic deviations cause the different composition of flora and fauna in the specific site. The specific fauna of caves is generally known, bats live in caves and rock cavities, birds of prey nest below rock shelters, the specific entomofauna in gravel banks is also known. However, what do we know about the fauna of stony debris (Rubín et al. 1986)?

The boulder and stone-gravel accumulations result from the weathering of primarily compact rocks. These accumulations are especially abundant in the subarctic and mountain regions and in the middle latitudes, where in the recent geological past or even more recently, a periglacial climate has prevailed. The size of stones in the accumulation can vary from several centimetres (gravel banks) through tens of centimetres (talus) to several metres (block talus and block fields).

All boulder and stone-gravel accumulations are characterized by definable microclimatic conditions. An abrupt contrast between the temperature and moisture conditions on the surface and those in the inner zone is typical. The surface zone of loose rock debris is overheated and dried by day, and cooled excessively at night. In contrast, the inner zone is characterized by a relatively constant low temperature and high air humidity. The formation of these fundamental conditions depends on exposure and on vegetation cover (if any). The microclimatic conditions in debris may also depend on the kind of rock and on the size, shape and the way the stones have accumulated (Fig. 1).

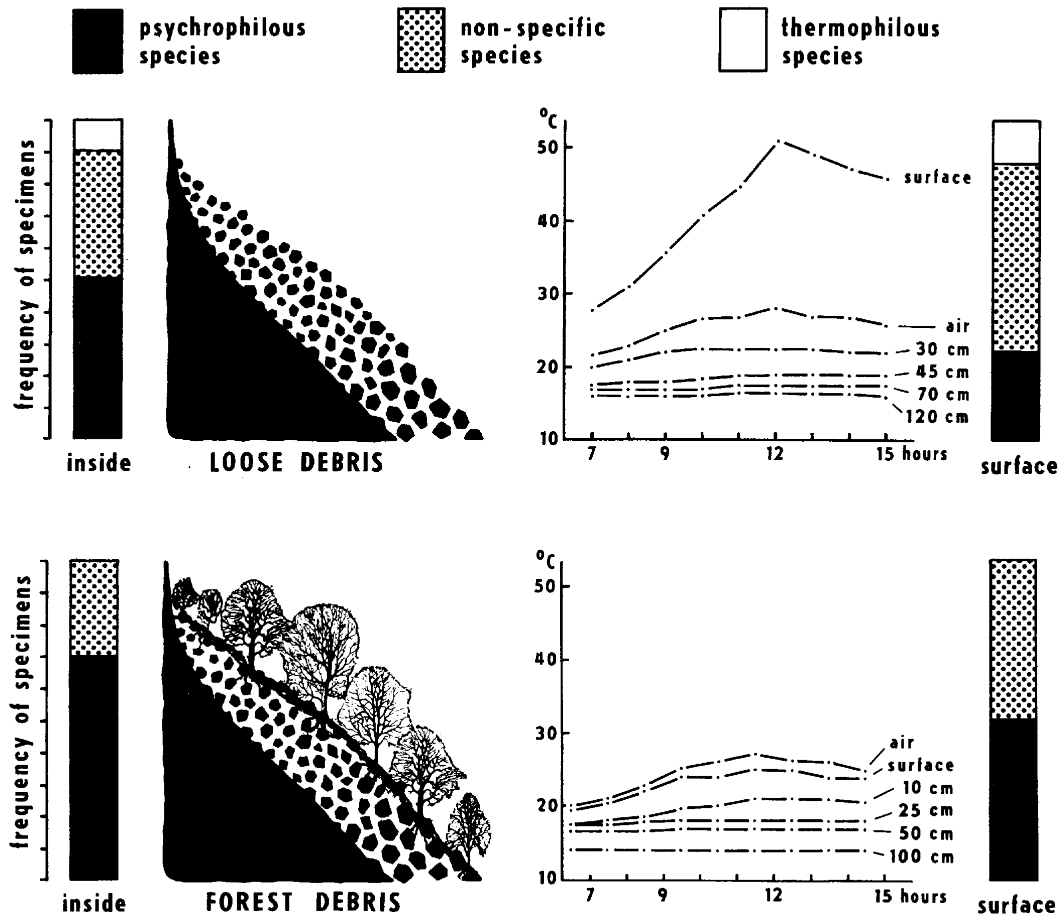

Fig. 1. Schematic cross-section of the loose and forest debris on Lovoš Hill in České Středohoří mountains (Czechoslovakia). Daily course of temperature in various zones of debris (measured by F. Růžička in half clear weather, July, 8, 1989). Composition of spider communities according to species thermopreference (all-year-round sampling with pitfall traps, Růžička 1989c).

In the depths of the stony debris in the Vydra valley (Šumava Mountains or Bohemian Forest, 900 m a. s. l.) in July, at an external temperature of 25°C, a temperature of only 9°C was measured; this is the same temperature which existed in our territory during summer seasons in the Ice Age (Ložek 1972).

Inner zones of stony debris represent a special type of underground environment like a "superficial underground compartment" (Juberthie & Delay 1981).

Penetrating the inside of debris is difficult. Effective collection of invertebrates is made possible by the use of debris pitfalls exposed over long periods (Růžička 1982, 1988c).

2. Spider fauna of stony debris

The fauna of debris is very heterogeneous, corresponding to the heterogeneity of debris. The difference between the fauna of loose and forest debris is evident. Spider communities differ in accordance with the physical differences of microclimatic zones. Approximately half the spider specimens sampled from each zone belongs to species not found in the other zone. A relatively clear-cut boundary between the two zones is documented; e.g. by the almost strict spatial isolation between the families Gnaphosidae in the surface zone and Dysderidae in the inner zone, as found in the loose debris on Lovoš Hill in the České Středohoří Mountains (Růžička 1989c).

A remarkable phenomenon of loose, insolated debris is the occurrence of both thermophilous and psychrophilous species (Fig. 1). Buchar et al. (1979) found the species *Acantholycosa norvegica* and *Pholcus opilionoides* together in loose, south-west-facing basaltic debris in the valley system of the River Labe, at an altitude of 350 metres. The same two species were found by Růžička (1988a) in granite debris in the Šumava Mountains at an altitude of 750 metres together with the species *Echemus angustifrons* and *Bathyphantes eumenis* (L. Koch 1879).

Rare, relict species and common, opportune species live together in debris. For example, Maurer & Thaler (1988) and Thaler & Steinberger (1988) published studies on some endemic species in alpine stony debris. Some of the opportune species are predisposed by their bionomy to colonise human dwellings and other buildings; they are also known as synanthropic species (e.g. *Nesticus cellulanus*, *Meta menardi*).

Some species are very closely tied to the stony biotopes. All the year round they move, search for food and reproduce exclusively on bare stones and rocks. Such species can, in accordance with the botanical terminology, be described as lithobious. I consider the following species to be lithobionts: *Pholcus opilionoides*, *Sitticus pubescens*, *Sitticus rupicola*, *Clubiona alpicola*, *Acantholycosa norvegica*, *Theridion betteni*, *Rugathodes bellicosus*, *Nesticus cellulanus*, *Meta menardi*, *Bathyphantes eumenis*, *Lepthyphantes notabilis*, *Wubanoides longicornis* Eskov, 1986. Species which are less restricted to stony biotopes can be described as lithophilous. They occur predominantly in stony biotopes, but not exclusively on bare rocks and stones. Their biotopes are gradually silted (under the influence of overgrowing vegetation) debris, stony forest slopes, rock steppes, as well as the spaces under tree bark, below fallen trees, etc. I consider lithophils the following species: *Harpactes hombergi*, *Segestria senoculata*, *Echemus angustifrons*, *Drassodes lapidosus*, *Meta merianae*, *Lepthyphantes monticola*.

Only those weavers spinning spacious, expanded webs belong to the lithobionts — species of the families Nesticidae, Araneidae, Theridiidae and bigger species of the family Linyphiidae. The tiny species of the subfamily Erigoninae are almost entirely absent from the debris because the spaces on/between the big stones are apparently not suitable for their little webs. The small species *Wideria capito* and *Wubanoides longicornis* seem to live in fine gravel, and at the "bottom" of the debris on the silt surface (Růžička et al. 1989).

The distribution of species living predominantly in the inner environment of debris is at present insufficiently known. For example, until 1982 only two finds of *Lepthyphantes notabilis* in Czechoslovakia were reported (Thaler 1982). Today the occurrence of this species is known in more than 20 localities (Růžička 1989a), and it may be said that it inhabits practically all sun-exposed debris. The discovery of this species is no doubt to be expected in all central European countries in which it has not yet been found, i.e. in the GDR, Poland, Hungary, and the USSR.

The way in which the occurrence of some species was discovered also serves to demonstrate the history of the development of arachnology in European countries. For example, *Trogloneta granulum* was described from France by Simon in 1922. Thaler (1975) ascertained the occurrence of this species in the Alps, as part of his intensive survey of alpine arachnofauna. Finally, Czajka & Pomorski (1987) ascertained its occurrence in Poland, as part of an intensive survey of the Sudeten Mountains (Fig. 3). In a similar way, the known distribution area of *Lepthyphantes improbulus* has been "expanded" (Fig. 2).

The relation of the fauna of debris and caves, of rocks and rock cities is remarkable. *Lepthyphantes notabilis* is a rather widely-distributed species of bare or only partly overgrown debris, *Trogloneta granulum* was found in Austria and Poland in the depths of debris on the slopes of beech forests. The cavicolous occurrence of these two species was ascertained in the southern part of their distribution area (Figs. 3, 4). In contrast, the cavicolous occurrence of *Lepthyphantes improbulus*, which is usually found on rocks and in bare

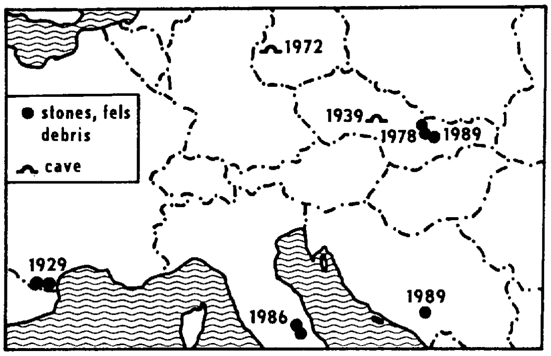

Fig. 2. Distribution of *Lepthyphantes improbulus*, after Thaler (1986) and Růžička (1989b and in press). The year of publication and the type of biotope inhabited are presented.

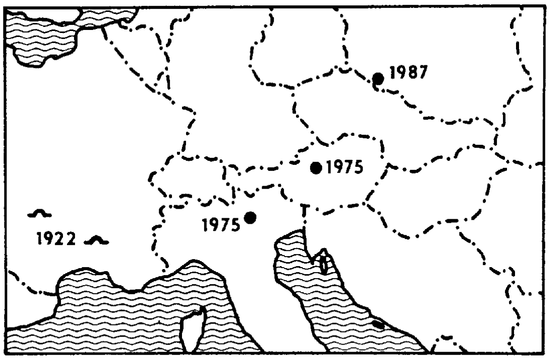

Fig. 3. Distribution of *Trogloneta granulum*, after Thaler (1975) and Czajka & Pomorski (1987). The year of publication is presented. For the type of biotope inhabited, see Fig. 2.

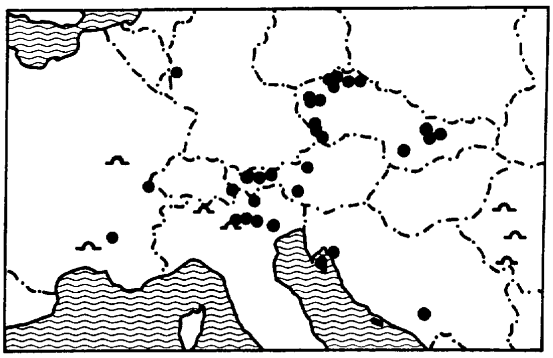

Fig. 4. Distribution of *Lepthyphantes notabilis*, after Thaler (1982) and Růžička (1989a). For the type of biotope inhabited, see. Fig. 2.

debris, was recorded in the GDR, i.e. on the northern border of its distribution area (Fig. 2). Of course, the occurrence of a species in a certain biotope is also dependent on the altitude and on other important microclimatic factors. The occurrence of *Bathyphantes eumenis* in Czechoslovakia was ascertained at altitudes of 1400–1750 metres, at shallow depths in the talus fields, at an altitude of 1100 metres in a block field (the flank moraine of a lake), at altitudes between 750 and 900 metres (exceptionally 450 metres) in the depths of forest stony debris in cold inversion valleys, and at altitudes of about 600 metres in cold sites of the sandstone rock cities, in pseudo-karstic caves and in the subterranean spaces of Cyclopean debris of these rock cities.

Various morphological changes, troglomorphisms, may be connected with the transition from life among surface stones to life in the depth of debris or in caves. Their significance should not be overestimated from the standpoint of taxonomy (cf. Moritz 1972, and Thaler 1986). Moritz (1972) describes the lengthening of extremities and the diminishing and depigmentation of eyes in *Lepthyphantes improbulus*. Růžička (1988b) describes the lengthening of extremities and spines on extremities and depigmentation in *Bathyphantes eumenis*, and also (Růžička 1989a) body diminution and depigmentation in *Rugathodes bellicosus*.

The discovery of *Bathyphantes eumenis*, along with *Wubanoides longicornis*, is one of the most remarkable arachnological finds in Czechoslovakia in recent years. The proper distribution area of *B. eumenis* in Europe extends into the northern region of Finland and the Soviet Union, *W. longicornis* occurs in the region of the middle and lower Yenisei River, in the northern and polar Ural Mountains and in polar Cisuralia as far as the Cheshskaya Guba on the Barents Sea (Eskov 1986). Both of these glacial relicts live in the centre of their recent distribution area, among the stones of gravel banks, along brooks and rivers and on the sea coast. From the species dwelling in these gravel banks, there may emerge further isolated populations which live in the depth of debris in central Europe.

3. Conclusion

In the central European landscape, stony debris represent a typical island biotope. They are isolated from the surrounding biotopes to the same degree as, e.g. peatbogs, whose isolation is commonly acknowledged. The occurrence of isolated populations of some invertebrate animals results from this isolation.

Isolated populations of invertebrates in the depth of debris can live everywhere on the Earth, just as they do in caves. This is especially true in the case of spiders, whose whole development cycle can occur on bare stones. The relations of these isolated populations to the surrounding fauna will result from the historical development of the particular region.

Acknowledgements. I am obliged much to my brother Mr. Fr. Růžička for his help with collecting of materials and in measurement of temperature in stony debris. I wish to thank Ing. M. Bartoš, CSc. for his helpful comments on my manuscript.

References

Buchar, J., Antuš, M., Hajer, J., Potužáková, H. & Šteigerová, A. 1979: Arachnofauna aus dem Tale Brná nad Labem. [in Czech] — Fauna Bohemiae Septentrionalis, Ústí nad Labem 1979:77–92.

Czajka, M. & Pomorski, R. J. 1987: Trogloneta granulum Simon (Symphytognathidae) — the new spider species in Poland. [in Polish] — XIV Zjazd Polsk. Towarzystwa Zool., Szczecin 1987:42–43.

Eskov, K. Yu. 1986: On Veles Pakhorukov, 1981 and Wubanoides n. gen., two Siberian linyphiid genera (Arachnida: Araneae: Linyphiidae). — Senckenbergiana Biol. 67:173–182.

Juberthie, C. & Delay, B. 1981: Ecological and biological implications of the existence of a "Superficial Underground Compartment". — Proc. 8th Int. Congr. Speleology: 203–206. Bowling Green, USA.

Ložek, V. 1973: Nature in the Quaternary. [in Czech] — Academia, Praha. 372 pp.

Maurer, R. & Thaler, K. 1988: Über bemerkenswerte Spinnen des Parc National du Mercantour (F) und seiner Umgebung (Arachnida: Araneae). — Rev. Suisse Zool. 95:329–352.

Moritz, M. 1972: Lepthyphantes improbulus Simon, 1929, eine troglobionte Spinne des Kyffhäusergebirges (Araneae, Linyphiidae). — Deutsche Entomol. Zeitschr., N.F. 19:307–314.

Rubín, J., Balatka, B., Ložek, V., Malkovský, M., Pilous, V. & Vítek, J. 1988: Atlas of fels, earth and soil forms. [in Czech] — Academia, Praha. 385 pp.

Růžička, V. 1982: Modification to improve the efficiency of pitfall traps. — Newsl. Brit. Arachnol. Soc. 34:2–4.

— 1988a: Spinnen (Araneae) aus Blockfeldern in Šumava (Böhmerwald, Südböhmen). [in Czech] — Sbor. Jihočes. Muz. v Čes. Budějovicích, Přír. Vědy 28:73–82.

— 1988b: Problems of Bathyphantes eumenis and its occurrence in Czechoslovakia (Araneae, Linyphiidae). — Věst. Čs. Společ. Zool. 52:149–155.

— 1988c: The longtimely exposed rock debris pitfalls. — Věst. Čs. Společ. Zool. 52:238–240.

— 1989a: On the lithobionts Lepthyphantes notabilis, Rugathodes bellicosus and on Rugathodes instabilis (Araneae: Linyphiidae, Theridiidae). — Acta Entomol. Bohemoslov. 96:432–441.

— 1989b: Spinnen (Araneae) aus Schutthalden in Nízké Tatry (Niedere Tatra, Slowakei). [in Czech] — Střední Slovensko 8:115–121.

— 1989c: Spider (Araneae) communities of rock debris on a typical hillside in the České Středohoří Mts. (North Bohemia). — Acta Entomol. Bohemoslov. 86:419–431.

— in press: Some spider species from the rock debris of the Rumanian and Yugoslavian mountain ranges. — Fragmenta Balcanica.

Růžička, V., Boháč, J., Syrovátka, O. & Klimeš, L. 1989: Invertebrates from rock debris in north Bohemia (Araneae, Opiliones, Coleoptera, Diptera). [in Czech] — Sborn. Severočes. Mus. — Přír. Vědy, Liberec 17: 25–36.

Thaler, K. 1975: Trogloneta granulum Simon, eine weitere Reliktart der Nordostalpen (Arachnida, Aranei, Symphytognathidae). — Rev. Suisse Zool. 82:283–291.

— 1982: Weitere wenig bekannte Lepthyphantes-Arten der Alpen (Arachnida: Aranei, Linyphiidae). — Rev. Suisse Zool. 89:395–417.

— 1986: Vier bemerkenswerte Lepthyphantes-Arten aus dem Mittelmeergebiet und aus Vorderasien (Arachnida: Aranei, Linyphiidae). — Sitzungsber. Österr. Akad. Wiss., Mathem.-naturw. Kl., Abt. I, 194(6–10):311–325.

Thaler, K. & Steinberger, K.-H. 1988: Zwei neue Zwerg-Kugelspinnen aus Österreich (Arachnida: Aranei, Theridiidae). — Rev. Suisse Zool. 95:997–1004.