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Stony debris ecosystems and their spider and mite inhabitants

from

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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, and which cause the different composition of flora and fauna in the specific site.

The stony accumulations result from the weathering (prevailingly frost 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 periglacial climate has prevailed. The size of stones in the accumulation can vary from several centimetres (gravel taluses) through tens of centimetres (stony taluses) to several metres (block fields).

In the Central European landscape the stony debris represent typical natural island ecosystems. Although situated within the region of climax forests, mostly they have not yet been colonized by trees.

Each stony accumulation has a specific microclimate. Two microclimatic gradients play an ecological role in bare stony debris encompassing internal spaces with air-flow: (A) The gradient between the debris surface exposed to direct contact with weather fluctuations and the sheltered internal space of the debris, approximately at depth below one metre, where daily and annual temperature oscillations are absent or small. (B) The gradient between the upper debris field margin and the lower margin. At the upper field margin the surface layer warms strongly in summer sunny days and cools down at nights, whilst in the inner compartments the temperature is steady and rather high in summer and drops below zero only slightly, or not at all, in winter. At the lower margin cold air accumulates in the depth, ice can form in spring and temperature does not exceed 7 °C in summer. This phenomenon occurs in so called freezing taluses (Růžička et al. 1995; Molenda 1996).

The climatic system of the freezing talus with ice forming on lower margin in spring and wapor exhalations on upper margin in witner can develope when (1) the cold air flow through the stony accumulation in its lower part and (2) the cold air affect the lower part for a longer time. This long-term action of the cold air is possible in four model situations: (A) the debris field is sufficietly high and deep, (B) the debris field is situated in a narrow valley, (C) the debris field is situated in a concave depression, (D) the debris surface is covered with vegetation layer preserving a mass of cold air within stony accumulation. All these aspects can combine, and contribute significantly to forming an extraordinary cool microclimate on the lower margin of a debris slope. There psychrophilous plants and animals can occur. The latter type (D) of freezing talus can be expected on gravel slopes orientated north.

The temperature of the cold, internal space on the lower margin of the debris field never exceeds 7 °C, similarly like in karst caves. However, in contrast to the majority of caves, temperature usually drops below zero there in winter and early spring (Růžička & Kopecký 1994).

Various invertebrates can be effectively collected in depth of stony debris using pitfall traps. They consist of a cylinder and a desk fitting to the upper opening of the cylinder. The traps contain a mixture of 7% formaldehyde and 10% glycerol with a few drops of detergent. These traps can be left in place for one year, after which they are removed and the catch processed in the laboratory (Růžička 1982, 1988b). In the stony debris consisting of boulders about 20 cm and more in size, the traps are positoned in excavated pits. In gravel accumulations, it is necessary to use metal rings to prevent the gravel from falling-down into the pit.

Arthropods collected in the pitfall traps are mostly representatives of Araneae (spiders), Opiliones (harvestmen), Acari (mites), Collembola (springtails), Coleoptera (beetles) and Diptera (flies). Some of them are exclusive inhabitants of stony biotopes. The fauna of debris is very heterogeneous. Some spiders (*Trogloneta granulum* Simon) are adapted to stable microclimate in forest debris. Both thermophilous and psychrophilous species occur in bare, insolated debris. Rare, relict and common, opportune species frequently share the same stony debris (Růžička 1990b).

Appreciable differences in the occurrence of various representatives of spiders and predatory rhagidiid mites are correlated with the microclimatic conditions in the different parts of the bare debris fields. Thermophilous species occur on the surface of the upper margin and middle part. Smaller spiders, e.g., Linyphiidae, do not inhabit upper margins of the stony accumulations where they are endangered by dessication. Rhagidiid mites from the genus *Evadorhagidia* Zacharda that usually occur in various types of rocky steppes are adapted to this environment by a monovoltine life cycle. They successively develop from autumn to spring when adults can be encountered and later, in hot summer, they disappear (Zacharda 1980). Psychrophilous species occur in the lower part of the debris fields where they can live in the whole profil, bare stones included (spiders *Bathyphantes simillimus buchari* Růžička, *Micrargus apertus* (O. P.-Cambridge), rhagidiid mites *Rhagidia gigas* (Canestrini), *Rhagidia gelida* Thorell), or esxclusively in the rich layers of moss and lichens (spider *Diplocentria bidentata* (Emerton)). The spider *Lepthyphantes tripartitus* Miller & Svatoň occurs exclusively on the lower margin of freezing taluses (Růžička et al. 1995).

Some spiders inhabiting the stony debris are adapted to extreme moisture and temperature conditions and also can colonize man-made habitats. For example, the spider *Salticus scenicus* (Clerck) is adapted to extreme fluctuations of temperature near the surface of bare debris and lives also on walls of buildings. In contrast, spiders *Meta menardi* (Latreille), *Metellina merianae* (Scopoli) and *Nesticus cellulanus* (Clerck) are adapted to stable low temperature and high humidity occurring in the deeper debris zone and colonize the cellars, wells, or drains (Růžička 1990a).

Discoveries of spiders and rhagidiid mites with the disjunctive arcto-alpine type of geographic distribution, e.g., *Bathyphantes simillimus buchari*, *Diplocentria bidentata* and *Rhagidia gelida*, *Poecilophysis recussa* (Thor), respectively, in taluses are of biogeographic importance. The spider *Wubanoides uralensis* (Pakhorukov) has only been found at the northernmost sites in the Czech Republic, i.e. near the southern border of the pleistocene glaciation (Růžička & Zacharda 1994).

In Giant Mountains in North-East Bohemia, psychrophilous spiders with an arcto-alpine type of distribution (*Bathyphantes simillimus*) occur in stony debris exposed to wind, while the spiders with the center of their distribution in the Alp region (*Lepthyphantes notabilis* Kulczynski) prefere leeward sites (Růžička & Zacharda 1994).

Inner spaces of stony debris represent a well-defined underground biotop and are always inhabited by many invertebrates. The biomass and species diversity of spiders decreases with increasing depth of underground spaces. Some spiders and rhagidiid mites (e.g., *Lepthyphantes improbulus* Simon, *Bathyphantes simillimus buchari*, *Porrhomma egeria* Simon and *Poecilophysis spelaea* (Wankel), respectively) exhibit morphological adaptations to subterranean life. They are depigmented, have elongated and attenuated leggs, reduced eyes. Their occurrence in the basalt, gneiss or granite boulder debris gives evidence that underground cavities play an important role in the underground evolution of troglophilous or troglobitic invertebrates also in non-karst areas (Růžička 1988a; Růžička 1996; Růžička et al. 1995).

Stony debris ecosystems contribute significantly to the spatial, site and biological diversity of landscape. Stony debris are among the few ecosystems that have only minimally been affected by man, and which often constitute expressive aesthetic elements in the landscape. Ecosystems of bare stony debris can be endangered by extraction of the stones and afforestation. In contrast, different ecosystems of afforested taluses can be endangered by deforestation (Růžička 1993).

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