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Horrible dynamics in old conservative systems? Undercooled scree slopes in the Austrian Alps – Spider fauna, significance and threat in times of climate change (Arachnida: Araneae)

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Preliminary remark

Here we present an elaborated abstract of our investigations and talk. The long version of this publication will be printed under the same title in the Arachnologische Mitteilungen, volume no 45.

Keywords

Ice cellars, ice holes, ice age, climate warming, endemics, cold-stenothermic species, Styria, Eastern Alps

Introduction

Undercooled scree slopes, also referred to as „ice cellars“ or „cold holes“, are special types of habitats, which have been documented in many places of the Eastern Alps. Due to the formation of basal ice during the winter, the supercooled scree slopes emit cold streams of air during the warm season. Regarding the origin of ice cellars, the most probable explanation holds that they developed as the result of postglacial landslides. From an animal ecological perspective, these habitats house a cold-adapted, stenotopic, arthropod fauna consisting of alpine elements, glacial relicts, endemics and disjunctly-distributed species. However, the specialized micro-fauna of these cold locations is increasingly threatened by global warming, as well as by local factors.

Figure 1: Supercooled scree slopes at the site Untertal near Schladming at the 20th Nov. 2009. Photos: Ch. Komposch/ ÖKOTEAM

Investigation area and methods

The invertebrate fauna, including spiders, of the interstitial was investigated with pitfall traps at 5 selected talus-sites in the Eastern Alps of Styria, Austria: Bräualm, Kreuzsteg near St. Nikolai im Sölktal, Klammhöhe, Pfarrerlacke near Tragöß and the largest study site, the Steilhangmoor Untertal near Schladming, a Natura-2000-site inside the Nature Park Sölktäler.

Results

In all five study sites a total of 116 spider species and 2.515 individuals respectively belonging to 18 spider families was found. First records to Styria are besides others *Robertus lyrifer, Diplocentria bidentata, D. rectangulata, Oreonetides vaginatus, Sisicus apertus, Walckenaeria dysderoides, Pardosa sordidata, Coelotes terrestris, Clubiona kulczynskii* and *Xysticus obscurus;* other remarkable species are *Troglohyphantes novicordis* and *T. tauriscus.*

i) Spiders of boulder fields and rocky screes slopes: Summit-areas in the alpine zone, boulder fields and cave habitats are the only suitable habitats for stenotopic cold-adapted spider communities in Central Europe. ii) Alpine elements, endemics, glacial relicts and cold stenothermic species: Survival in “Massifs de Refuge”, in caves and – in rare cases – on inneralpine nunataks which are peaks not covered with ice or snow within or at the edge of an ice shield or glacier. In the study sites the proportion of specimens of (sub)endemic spiders accounted for

only 4.3 % of the total number of specimens. The most abundant endemic species were the troglophilic linyphiid spider *Troglohyphantes subalpinus* and the epigeic hahniid spider *Cryphoeca lichenum lichenum*. iii) Species diversity: The 116 species of spiders found in the present study represent about 18.4 % of the known spiders from Styria and 11.5 % from Austria. iv) Similarity of coenoses: A hierarchical cluster analysis of spider assemblages however, shows no distinct clusters, e. g. between neighbouring traps, which indicates that at this very small scale, microclimatic parameters might be more relevant for spider site affinities than geographical location criteria. v) Temperature-dependent species: Based on a subset of species in the "Steilhangmoor Untertal" two guilds can be distinguished: "cold air spiders" and "warm air spiders". The first group shows a preference for cold-air exits and includes *Diplocentria rectangulata*, *D. bidentata, Agroeca brunnea, Lepthyphantes antroniensis, Alopecosa taeniata* and *Ozyptila trux* while the second group which prefers warm-air exits consists of *Histopona torpida, Ceratinella brevis* and *Neon reticulatus*. A third group of species such as *Troglohyphantes subalpinus* and *Cybaeus tetricus* seems to prefer intermediate habitat conditions. The dominance of the cold-adapted taxa in the habitats studied is illustrated by the following results: from a total of 39 spider species nearly 50 % of the total inventory can be attributed as cold-stenotherm or at least psychrophilic. One way to represent the two different temperature guilds (thermophilic versus psychrophilic species) is to focus on the occurrence of the boreoalpine and cold stenothermic dwarf spider *Diplocentria rectangulata* and the euryzonal and thermophilic forest spider *Cybaeus tetricus*. *Diplocentria rectangulata* prefers cold-air exits and *Cybaeus tetricus* prefers "normal temperature" reference sites. vi) Proportions of species and specimens of Red-listed spiders: The number as well as the proportion of Red-listed species is higher in cold air sites than in the reference sites. Thus, the spider assemblages of cold air sites should be considered as highly valuable for nature conservation.

Figure 2: The "Steilhangmoor Untertal" near Schladming: warm-air site with an accelerated thaw of snow at the 27th Oct. 2010 (above left) and at the 20th Nov. 2009 (above right), cold-air site with a delayed thaw of snow at the 20th Nov. 2009 (below left) and the reference site at the same date. Photos: Th. Frieß, G. Kunz & Ch. Komposch/ ÖKOTEAM

Conclusion

i) Singularity and nature conservation value of the coenoses: Based on literature data at least 13 spider species seem to be restricted to supercooled boulder sites and scree slopes. The record of *Troglohyphantes novicordis*, an endemic species which was previously known only from one cave habitat in Austria, the "Raudnerhöhle" near Stiwoll is absolutely remarkable. Of the 116 species found in this study a proportion of 36 % must be considered as endangered. The occurrence of the two boreoalpine dwarf spider species of the genus *Diplocentria* in comparatively very low altitudes (*Diplocentria rectangulata*: 1000-1020 m, *D. bidentata*: 1000-1160 m) demonstrate the importance of supercooled block and scree slopes as special habitats for the survival of cold stenotopic glacial relicts at lower altitudes. In sum, the nature conservation value of the spider assemblages of the supercooled boulder sites and scree slopes goes beyond the national to the international dimension due the presence of several endemic and subendemic species, the occurrence of zoogeographically remarkable species and the presence of a high proportion of Red-listed species. ii) Dynamic processes meet conservative systems – endangering and protection measures: During the last Ice Age few spider species managed to adapt to low temperatures. These acquisition of these adaptations required a relatively long period of evolution. The current climate warming, however, is characterised by a relatively rapid increase in global warming. Evidently,

psychrophilic species will not be able to develop physiological adaptations in such a short time. The stenoecious arachnid fauna of the supercooled boulder sites and scree slopes is literally entrapped in these isolated locations without the alternative of other suitable habitats. The effects of climate change on these habitats which are characterised by a stable microclimate regimes over thousands of years are, thus, well predictable: The loss of the ice nucleus of the undercooled scree slopes due to climate warming will lead probably to a warming of the micro-climate, the termination of undercooled scree slopes, habitat loss of the cold-adapted invertebrates and a partial or total loss of the local populations.

Therefore, the need for action and management is necessary and urgent at two different levels: At the international level, it is urgent to stop climate warming by reducing Co_2-emissions significantly. The second plan of action to save these precious treasures of biodiversity is the strict avoidance of local endangerments. Potential threats at the investigated sites are timber harvest, construction of farming and forestry roads, other mechanical impacts on the moss cover and anthropogenic effects on hydrology.

Figure 3: Recorded spider species: Harpactea lepida. Troglohyphantes subalpinus. *T. tauriscus. T. noricus. Meta menardi. Alopecosa pinetorum*. A. *taeniata. Pardosa palustris. Xerlycosa nemoralis. Drassodes sp. Zora spinimana. Ozyptila atomaria* (from above left to blow right). Photos: Ch. Komposch/ ÖKOTEAM

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