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Natural Hazards – Hazards for Nature? Avalanches as a promotor of biodiversity.

A case study on the invertebrate fauna in the Gesäuse National Park (Styria, Austria)

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Abstract

Avalanches are feared by humans and considered "catastrophic" due to their unpredictable and destructive force. But this anthropocentric perspective fails to capture the potential ecological value of these natural disturbances. The Gesäuse National Park is a model-region for investigations of such highly dynamic events because of its distinct relief and extreme weather conditions. This project aims to record and analyse the animal assemblages in these highly dynamic habitats as well as document succession and population structure.

1) Dynamic processes lead to one of the very few permanent and natural vegetationless habitat types in Central Europe outside the alpine zone – i. e. screes and other rocky habitats at various successional stages. In addition to the tight mosaic distribution of a variety of habitats over larger areas, avalanche tracks also offer valuable structures like dead wood and rocks. Remarkable is the sympatric occurrence of the three harvestmen species *Trogulus tricarinatus*, *T. nepaeformis* und *T. tingiformis*, a species diversity peak of spiders, true-bugs and ants; and the newly recorded occurrence of *Formica truncorum*.

2) The presence of highly adapted species and coenoses reflect the extreme environmental conditions, specific vegetation cover and microclimate of these habitats. Several of the recorded taxa are rare, endangered and endemic. The very rare dwarf spider *Trichoncus hackmani* is a new record for Styria and the stenotopic and critically endangered wolf-spider *Acantholycosa lignaria* is dependent on lying dead wood. The true bug *Phytocoris intricatus* is a new occurrence record for Austria. The ant species *Myrmica lonae* is an extremely rare recorded ant species in Styria for which avalanche tracks are considered to be its preferred habitat.

3) Avalanche tracks in southern exposition are azonal heat islands providing suitable environmental conditions for thermophilic and heliophilous species as well as those normally considered to have more southern distributions. The surprising inneralpine presence of several southern and submediterranean species reflects these unique microclimatic conditions, e. g. the vulnerable spider species *Atypus piceus* and the grasshopper *Myrmecophila acervorum*. Furthermore, high alpine species disperse via avalanche tracks to lower-altitude sites. Some arachnological examples are the mountain-jumping spider *Sitticus atricapillus*, Austrian subendemic gnaphosid spider *Zelotes zellensis* and the scree inhabiting wolf spider *Pardosa nigra*. Examples among true bugs more typical for subalpine grasslands include *Calocoris alpestris*, *Nithecus jacobaeae*, *Eurydema rotundicollis* and *Carpocoris melanocerus*.

Avalanche tracks play a major role in the survival of rare and endangered arthropod species and coenoses and are important refuges of endemic species. Vascular plant diversity averaged 70 species per 20 m² plot. Such biodiversity hotspots deserve protection. Avalance tracks are additionally considered essential corridors of vertical migration during periods of rapid climate change. While more research is needed to fully understand the ecological importance of these habitats, it is clear that acceptance and protection of these unregulated dynamic processes is required and directly promotes the protection of biodiversity.

Keywords

dynamic, erosion, Northern Alps, endemic, climate change, avalanche tracks, protection, natural processes, spiders (Araneae), harvestmen (Opiliones), true bugs (Heteroptera), plants (Tracheophyta)

Introduction

Avalanches are feared by humans and considered "catastrophic" due to their unpredictable and destructive force. But this anthropocentric perspective fails to capture the potential ecological value of these natural disturbances. Avalanche tracks and other erosion areas are – aside from natural river banks – the most important dynamic biotope types in Central Europe. In general, people have difficulty accepting uncontrolled environmental conditions and thus dynamic landscapes have largely vanished from settled areas.

Erosion areas, especially dynamic and low-altitude carbonatic scree slopes as well as dynamic processes are endangered (IUCN-category EN) in the Northern Alps and in Austria respectively (Essl & Egger 2010). The very last examples of such habitats within the Alps are found especially in alpine zones of National Parks.

What animal and plant species are settling in these extreme, diverse, rare and endangered biotopes? We hypothesize that these extreme environmental conditions result in habitats that shelter stenotopic, rare and

endangered species. The Gesäuse National Park is a model-region for investigations of highly dynamic events because of its distinct relief and extreme weather conditions. The presented project aims to record and analyse the animal and plant assemblages in these highly dynamic habitats as well as document the zoological and vascular plant diversity and succession.



Figures 1-4: The Gesäuse National Park with its impressive geomorphology and erosion areas: Lugauerplan. Sulzkarhund with the Hochzinödl. Haindlkar with the Hochtor. Kainzenalblschütt with the Großer Ödstein. Photos: Ch. Komposch/ ÖKOTEAM

Investigation area, material and methods

The investigation area is the Gesäuse National Park in the Northern Calcareous Alps, Styria, Austria. The vertical-extension of the National Park and Natura-2000-area reaches from 480 up to 2369 m a. s. l. The area is characterised by the frequent occurrence of dynamic natural processes – on the one hand by the partially unregulated Enns River and its tributaries, especially the Johnsbach, and on the other hand by avalanche tracks and other erosional areas like rock screes and windfalls.



Figures 5-8: Investigated avalanche tracks in the Gesäuse National Park: Tamischbachturm. Kalktal. Lugauerplan. Kalktal. Photos: Ch. Komposch (3x) & K. Geßlbauer/ ÖKOTEAM

Faunistic investigations were carried out using hand collecting, sweep nets, a suction sampler, a soil sifter and pitfall traps on about 40 person-days in the field between the end of June and the beginning of November from 2006 to 2011. Pitfall-traps were only used from July to August 2011. We emphasize that these mappings and analyses are largely qualitative and opportunistic and thus are not necessarily representative nor provide quantitative insights. The data nonetheless provide an initial insight into the diversity and structure of the arthropod coenoses of these erosion tracks.

The herewith presented data are based on the following projects:

- "Lawinenrinnen als bedeutsame Lebensräume im Nationalpark Gesäuse" (ÖKOTEAM 2007): Kalktal: 47°36' N, 14°43' E, 500-740 m, Scheibenbauernkar: 47°36' N, 14°42' E, 760-940 m
- 9. GEO-Tag 2007: "Johnsbachtal" (Langgriesgraben: 47°33' N, 14°34' E, 670-710 m), KOMPOSCH et al. (2008), FRIEß (2008)
- 10. GEO-Tag 2008: "Tamischbachturm" (Kalktal: 47°36' N, 14°43' E, 500-740 m, Scheibenbauernkar: 47°36' N, 14°42' E, 760-940 m), KOMPOSCH (2009a), KOMPOSCH & PLATZ (2009), FRIEß et al. (2009)
- 12. GEO-Tag 2010: "Kalktal, Ennsufer und Hieflau" (Kalktal: 47°36' N, 14°43' E, 505, 560, 690 m (KOMPOSCH 2011, KOMPOSCH & HORAK 2011), FRIEß & BRANDNER (2012)
- "Zoologische Erstuntersuchung in Dauerbeobachtungsflächen im Nationalpark Gesäuse" (ÖKOTEAM 2012): 10 monitoring sites (amongst others avalanche track Hochkarschütt: 47°36' N, 14°42' E, 1070 m, screes Langgriesgraben: 47°33' N, 14°34' E, 750 m, rock- and scree-areas Haindlkar: 47°35' N, 14°36' E, 590 m, rock- and scree-areas Kühgraben: 47°35' N, 14°36' E, 845-860 m).
- 13. GEO-Tag 2011: "Zwischen Bruckstein und Buchstein" (Brucksattelrinne: 47°35' N, 14°35' E, 1.070 m (KOMPOSCH 2012a, b), KORN & FRIEß (2012)

Mapped habitat types are natural avalanche tracks (including debris avalanches) poor in or lacking vegetation in southern or eastern exposures. Some of these avalanche tracks reach from the high alpine zone down to the gravel banks of the Johnsbach (Langgrießgraben, debris avalanche) or Enns (Kalktal) rivers. The plant community mosaic ranges from tall herb vegetation through beech and pioneer pine stands up to open, rock-poor grassland and calcareous screes and rocks free of vegetation.

More or less intensively investigated zoological taxa are: harvestmen (Opiliones), spiders (Araneae), true bugs (Heteroptera), leaf- and planthoppers (Auchenorrhyncha), ants (Hymenoptera, Formicidae) and beetles (Coleoptera part.). The material has been collected by Thomas Frieß, Katharina Geßlbauer, Peter Horak, Jördis Kahapka, Brigitte Komposch, Christian Komposch, Gernot Kunz, Franziska Maier, Christian Mairhuber, Laura Pabst, Wolfgang Paill, Alexander Platz, Herbert C. Wagner and Philipp Zimmermann. Biotop mapping was done by Heli Kammerer and Barbara Emmerer (KAMMERER 2006, 2011a, 2011b); permanent plots for vegetation and relevés were done by Andreas Bohner (BOHNER et al. 2009). Some examples were taken from the results of the GEO-Tag 2010 (LAMPRECHT & WERSCHONIG 2011).



Figure 9: Usually the bellflower *Campanula pulla* is found in alpine habitats. Photo: J. Greimler

Results and discussion

Dynamic processes create rich structured habitat mosaics in avalanche tracks and other erosion areas, which again leads to an outstanding high diversity of species. A main reason for this diversity is the occurrence of stenotopic, rare and endangered taxa with both thermophilic and cold-stenothermic ecological demands. Furthermore avalanche tracks are azonal sites exhibiting side-by-side occurrence of alpine and lowland species. These phenomena occur across a variety of taxa as supported by the following examples involving spiders, harvestmen, true bugs and some vascular plants.

1) Biodiversity reaches peak values in avalanche tracks

Dynamic processes lead to one of the very few permanent open habitat types at low altitude areas in Central Europe – screes and other rocky habitats at various successional stages; these include rocky xerotherm grassland, tall herb vegetation, shrub areas and pioneer stands, and primary successional sites free of vegetation each year.

In addition to this tight mosaic of highly variable habitats over large areas, avalanche tracks also offer valuable structures like dead wood and rocks.

- Flora: Biotop mapping of avalanche tracks show a high percentage of threatened biotope types. 40 to 50 % of the investigated area is covered by threatened biotope types like calacareous scree or grassland. The average number of vascular plant species in one plot of 20 m² is 70. This can be considered as very high species richness.
- Opiliones: Remarkable is the sympatric occurrence of three of the four Styrian trogulids, namely *Trogulus tricarinatus*, *T. nepaeformis* und *T. tingiformis* (KOMPOSCH 2011). These species feed on land snails and are therefore dependent on limestone soils.
- Araneae: Epigeal and thermophilic spiders have been recorded in the avalanche tracks with dozens of species by means of hand-collecting, sweeping and a suction sampler, whereas stenotopic hygrophilous and cold-adapted inhabitants of the "underworld" are still missing in our inventories due to the fact that pitfall traps were generally not used.
- Heteroptera: True bug diversity in Central European landscapes reaches maximum values in open and semi-open dry grasslands and fringe habitats; the avalanche track Kalktal has been identified as a hot-spot-of bug-diversity. Furthermore an analysis of the true-bug-fauna shows a variety of different ecological guilds in these unique habitats. The richness in dead wood enables the survival of at least four aradid-species.
- Formicidae: WAGNER (2009, 2011) shows that ant diversity in avalanche tracks and other screes is higher than in neighbouring bush- and forest communities. Worth mentioning is the record of *Formica truncorum* in the Kalktal-track (WAGNER 2011) and Langgriesgraben from a forest-edge community and fine debris and rocky pine and elfin woodland (WAGNER unpubl., ÖKOTEAM 2012).

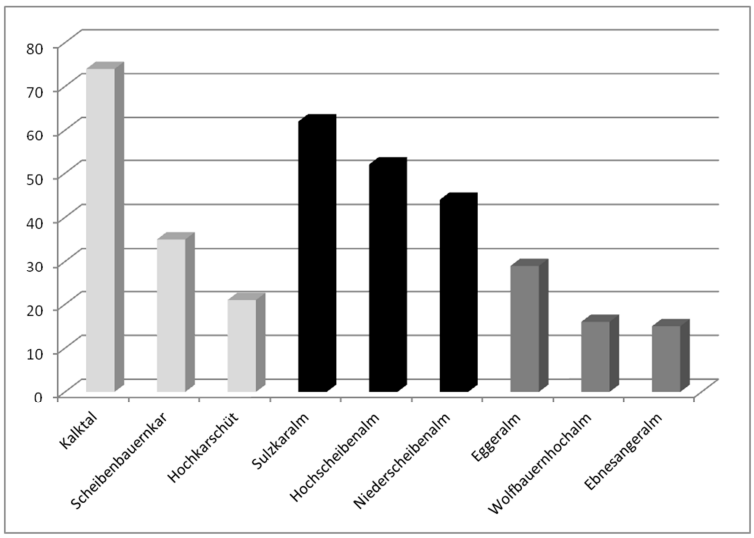


Figure 10: True bug species numbers in avalanche tracks (light grey), pastures (black) and abandoned pastures (dark grey) in the Gesäuse National Park. The graph shows a comparison between the avalanche track Kalktal as an azonal habitat-complex and the grasslands of alpine pastures. Highest diversity in a grassland is found in the Sulzkaralm (62 spp.), followed by the Hochscheibenalm (52 spp.) and the Niederscheibenalm (44 spp.). These species numbers will not be reached by the investigated abandoned pastures like the Eggeralm (29 spp.), Wolfbauernhochalm (16 spp.) and Ebersangeralm (15 spp.) (FRIEß 2006, unpubl.). Despite the cursory sampling, the avalanche track Kalktal takes first rank with 74 species of Heteroptera; it is expected to shelter about 100 true bug species.

2) Presence of faunistic and floristic peculiarities

The extreme environmental conditions, vegetation cover and microclimate result in the presence of highly adapted species and coenoses. Several of these stenotopic taxa are rare endangered and endemic. Moreover, some of these species have not been recorded for Styria before.

- Flora: In the avalanche tracks we find some endemics that are also found in more alpine habitats like *Campanula pulla*, but there are no highly specialized ones.
- Opiliones: *Lacinius dentiger*, a south-eastern-European-mediterranean species (MARTENS 1978), shows a wider distribution in southern Carinthia, southern Styria and the Pannonian parts of Eastern Austria. However, in the inner part of the Alps it is only found occasionally along the bigger valleys (KOMPOSCH & GRUBER 2004). An example is the Gesäuse National Park, where this phalangiid can be found in avalanche tracks e. g. on the southern slope of the Tamischbachturm (KOMPOSCH 2011).
- Araneae: The dwarf spider *Trichoncus hackmani*, classified by WIEHLE (1960) as heliophilous-xerobiotic, has been known from Austria exclusively from the Apetlon´s common pastures (MALICKY 1972). In the Gesäuse National Park this very rare species was found in fine scree areas of the Langgriesgraben (KOMPOSCH et al. 2008) and in the avalanche track Brucksattelrinne of the Buchstein mountain (KOMPOSCH 2012a). One of the rarest wolf spiders of Austria, previously known only from an uncertain record in Styria, is *Acantholycosa lignaria*. Classified as Critically Endangered for Austria this stenotopic spider species is dependent on the presence of lying dead trunks. The blocky and dynamic parts of the avalanche track Kalktal have to be considered a refugium of deadwood-inhabiting species (KOMPOSCH & HORAK 2011) – comparable to the occurrence of the cerambycid beetle *Rosalia alpina*.

- Heteroptera: The true bug fauna of the Styrian Enns valley is well known based on intensive investigations of the last century. Nonetheless, species records of faunistic interest occur regularly. In the site Langgriesgraben *Phytocoris intricatus* could be documented for the first time for Austria; in the avalanche track Kalktal we were successful with the two new species for Styria, *Phytocoris austriacus* and *Stygnocoris cimbricus* (FRIEß & BRANDNER 2013). Examples for red-data-list species (after FRIEß & RABITSCH 2009) are the endangered tingid *Oncochila simplex* and the vulnerable taxa *Megalonotus hirsutus* and *Dicranocephalus medius*.
- Formicidae: *Myrmica lonae* is an extreme rare recorded ant species in Styria; avalanche tracks are considered to be preferred habitat types (WAGNER 2011).

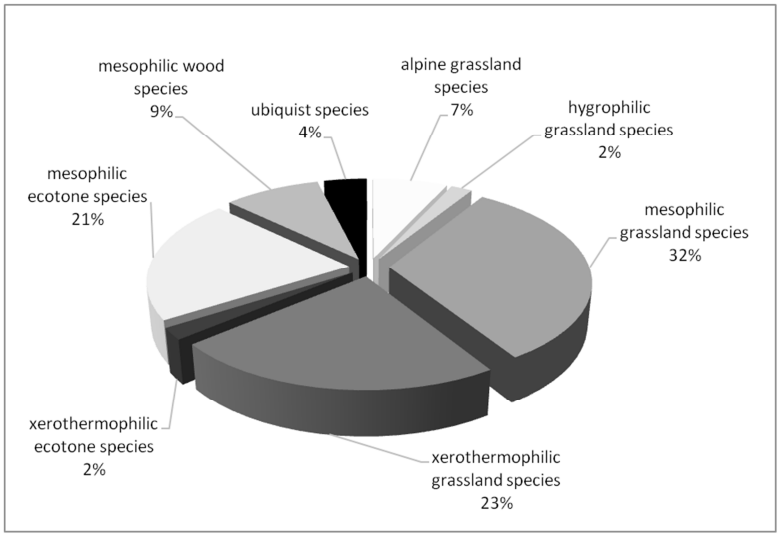


Figure 11: Classification of Heteroptera to different ecological types within the avalanche track Kalktal.
In total the species of mesophilic open grassland are dominant (32 %); they are concentrated in the ruderal vegetation and the shrubby slope extensions with mainly eurytopic species. Further 30 % of the species belong to the mesophilic edge- and forest species – witnesses of the diversity in structures and the tendency of forest-growth on the brim of the erosion tracks. One fourth of the species is xerothermophilic – a quite high value for an inneralpine montane locality. Remarkable is the well represented guild of xerophilic, epigeal bug species. Four (7 %) montane-alpine species of open land complete this rich bug coenosis.



Figures 12-15: Harvestmen (Opiliones) of avalanche tracks in the Gesäuse: *Trogulus tricarinatus*. *Trogulus nepaeformis*. *Trogulus tingiformis*. *Lacinius dentiger*. Photos: Ch. Komposch/ ÖKOTEAM

3) Avalanche tracks as azonal sites

a) Avalanche tracks and other erosion areas offer suitable environmental conditions for thermophilic, heliophilous and southern species

Avalanche tracks in south-exposition are due to the dynamic and consequently consistent lack of trees as well as the dominance of rocks and scree slopes, which lead to the occurrence of thermophilic and heliophilous species. Rocky habitats have a higher heat capacity than the soil and therefore, early on, were known to lead to higher

temperature sums and provide suitable conditions for arthropods (FOREL 1892). The surprising inneralpine presence of several southern and submediterranean species reflects these special microclimatic conditions.

- Flora: At the species level, occurrences that are rare or even missing in other areas of the National Park because they require the thermal conditions found on the lower parts of the avalanche tracks with south-eastern exposition. Examples include *Primula veris veris, Seseli libanoti*, *Agrimonia eupatoria*, *Geranium pyrenaicum* and *Echium vulgare*.
- Opiliones: The phalangiid *Phalangium opilio* is one of the few European harvestmen that prefers open and light exposed habitats (MARTENS 1978). Avalanche and other erosion tracks like the Kalktal tracks or on southern slopes of the Buchstein consistently offer these conditions (KOMPOSCH 2011, 2012b).
- Araneae: Both thermophilic araneid spiders *Mangora acalypha* and *Hypsosinga sanguinea* find suitable conditions in the avalanche track Kalktal. *Philaeus chrysops* is thermophilic, heliophilous and bound to rocky habitats with a just disjunctive occurrence in Central Europe; this striking salticid finds suitable conditions in some avalanche tracks of the Gesäuse National Park, e. g. in the Kalktal site (KOMPOSCH & HORAK 2011). Most surprising is the current record of *Atypus piceus* in a small meadow quite close to the avalanche track Kalktal (KOMPOSCH & HORAK 2011). With one single exception from the Haller Mauern, all previous records of this nationwide vulnerable species are situated in the South-Eastern Alpine foothills. In addition to this sun-adapted coenoses, contrasting environmental conditions are found just under the surface of avalanche tracks – but they are still quite unexplored in the Gesäuse National Park – the chasmocolous linyphiid *Porrhomma convexum* for example has been recorded from the Kalktal (KOMPOSCH & HORAK 2011) –, as well as in all the other National Parks.
- Heteroptera: Several thermophilic bug species have been collected in the avalanche track Kalktal, which occur in these inneralpine areas exclusively on isolated xerothermic sites. They are character species of calcareous dry and rocky grasslands with a narrow trophic relationship to plant species of xerothermic habitats. Selected examples are (feeding plant in brackets): *Copium clavicorne* (*Teucrium chamaedrys*), *Oncochila simplex* (*Euphorbia cyparissias*), *Megalonotus hirsutus* (*Teucrium*, *Thymus*), *Dicranocephalus medius* (*Euphorbia* spp.) and *Thyreocoris scarabaeoides* (*Viola* spp.).
- Saltatoria: The thermophilic species *Myrmecophila acervorum* was found in a nest of *Tetramorium impurum* in the Kalktal site at an altitude between 520 and 620 m a. s. l. (WAGNER et al. 2012); this is the countrywide most inneralpine record of the smallest grasshopper of Austria.



Figures 16-19: Spiders (Araneae) of avalanche tracks in the Gesäuse: *Philaeus chrysops*. *Harpactea lepida*. *Acantholycosa lignaria* (2x). Photos: Ch. Komposch/ ÖKOTEAM

b) Species of the (high) alpine altitudinal zone go downhill via avalanche tracks to lower-altitude localities

Both plants and animals are known for using avalanche tracks as sliding transport corridors. Rockfalls seems to be a quite common, quick and frequent way of downhill transport for nests of eggs, juvenils and adults. This dangerous dispersal mechanism inside avalanche tracks offers the advantage that the arrival area contains a wide spectrum of different habitat types and microclimatic niches. Therefore the chance of finding suitable conditions is quite good to establish long-lasting populations. Furthermore, the valley-populations of these alpine species can count on a regular supply of new colonists from higher elevation habitats.



Figures 20-23: True bugs (Heteroptera): *Aradus versicolor* is fungicolous on beech-deadwood. *Copium clavicorne* is xerothermophilic and lives on *Teucrium chamaedrys*. *Dicranocephalus medius* ist xerothermophilic and lives on *Euphorbia*. *Oncochila simplex* can be found on *Euphorbia cyparissias* in warm and dry habitats. Photos: Ch. Komposch/ ÖKOTEAM, G. Kunz (2x), E. Wachmann

- Flora: There are several species in the avalanche tracks with their source populations at higher altitudes, like the previously mentioned endemic species *Campanula pulla*, but also *Arabis alpina* and *Linaria alpina*. They appear together with species from lower and thermophilic stands like *Teucrium chamaedrys* or *Allium lusitanicum*.
- Opiliones: From the Southern Alps the above described phenomenon is documented for *Mitostoma alpinum* on the northern slopes of the Koschuta, Karawanken (MARTENS 1978) and the nature reserve and Natura-2000-site Vellacher Kotschna in the Steiner Alps (KOMPOSCH unpubl.). It can be expected that this rare nemastomatid species in the steep northern avalanche tracks in the Gesäuse mountains shows similar patterns of distribution at a small scale. Specific research is required!
- Araneae: We know several examples for low altitude populations of high alpine spider species; some prominent ones are listed below. The mountain-jumping spider *Sitticus atricapillus* is known from 1600 m a. s. l. and is considered to be a high alpine species (KRONESTEDT & LOGUNOV 2003). The current finding, together with the Austrian subendemic *Zelotes zellensis* (KOMPOSCH 2009b), in the lowest section of the Langgriesgraben at not more than 700 m a. s. l., are textbook examples of this phenomenon (KOMPOSCH et al. 2008). The detection of several individuals of each is good evidence for the presence of established populations. The same with *Pardosa nigra*, normally occurring in the alpine and nival zone up to 3500 m (Austria), has been collected in the avalanche and erosion tracks Brucksattelrinne and Kühgraben on the Buchstein-slopes at 1070 and 1000 m a. s. l. (KOMPOSCH 2012a). The subalpine and alpine scree-theridiid *Rugathodes bellicosus* is currently documented from just 520 m a. s. l. in the Kalktal (KOMPOSCH & HORAK 2011).
- Heteroptera: Some typical species of open grasslands of the subalpine altitudinal zone could be found in submontane sites, e. g. *Calocoris alpestris*, *Nithecus jacobaeae*, *Eurydema rotundicollis* and *Carpocoris melanocerus*.



Figure 24: The thermophilic true bug *Phytocoris austriacus*, living on *Melampyrum pratense*, has been recorded in the Kalktal; it is new to Styria. Photo: E. Wachmann

Conclusions

Due to their consistent dynamic nature, avalanche tracks and similar erosion areas are among the very few sites in Central European landscapes that offer permanent treeless or even vegetationless habitats. These important extreme environments offer a wide spectrum of mosaic-like habitat-structures and microclimatic conditions, especially rocky areas and deadwood. They are considered to be primary refuges for several thermophilic and heliophilous species, from which they can disperse into the surrounding cultural landscape. Therefore they play a major role in the survival of rare and endangered arthropod species and coenoses and are important refuges of endemic species. As a hot-spot of biodiversity they are deserving of protection.



Figure 25: A surprising inneralpine presence of *Atypus piceus* in the Gesäuse National Park. Photo: Ch. Komposch/ ÖKOTEAM

In times of climate change they are considered to be essential paths for vertical migration, due to their extension through several altitudinal zones with similar habitat types and environmental conditions.

Continuing scientific investigations are necessary. Representative and semi-quantitative data are urgently required to gain an overview of the whole species spectrum, coenoses and guilds. The application of pitfall-traps is essential to record the ombrophilous, hygrophilous, cold-adapted and crevice- and cave-species (KOMPOSCH 2010).



Figures 26-27: Side-by-side occurrence of the heliophilic harvestman (Opiliones) *Phalangium opilio* and the hygrophilous *Gyas titanus* – avalanche tracks offer suitable conditions for both. Photos: Ch. Komposch/ ÖKOTEAM

Nature reserves and national parks are among the very few areas where even the possibility exists for such unhindered dynamic processes. But even in these so called “strongly” protected natural landscapes, general acceptance of natural dynamic processes resulting from variable river flows, wind or avalanches is not to be taken for granted. In fact, due to security issues concerning hydroelectric and wind power production facilities, forest resources and potential bark beetle “damages”, such habitats raise consistent and controversial discussion. A clear commitment to the acceptance of unregulated dynamic processes in these rare protected areas, amidst our otherwise highly restricted cultural landscape is required! Finally the long-term protection of biodiversity can be reached through a deeper understanding and protection of dynamic processes.



Figures 28-29: The impact of dynamic processes: an avalanche track and a forest on the southern slopes of the Tamischbachturm. Photos: B. & Ch. Komposch/ ÖKOTEAM

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