

Notable species of invertebrates, amphibians and reptiles at selected sites surrounding Kremnica, Slovakia

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Abstract: This paper provides a review of qualitative and quantitative representation of species of selected taxonomic bio-indicative groups in studied habitats relating to the trophical and topical demands of individual species. The occurrence of 32 species of gastropods and 46 species of spiders, 109 species of heliophilous butterflies, 134 beetle species, 17 species of dragonflies, 6 species of bumblebees and 14 species of bees, 27 species of hoverflies, 32 species of orthopterans and 56 species of bugs have been recorded in the area of interest. We have observed and monitored populations of 6 species of amphibians and of 12 indigenous species of reptiles.

Key words: Kremnica, bioindication, Gastropoda, Araneae, Lepidoptera, Coleoptera, Odonata, Apoidea, Syrphidae, Orthoptera, Heteroptera, Amphibia, Reptilia

Introduction

The Kremnické Mts rank among the volcanic mountains of central Slovakia. They are surrounded by the Velká Fatra Mts and the Turčianska basin in the North, the Žiar Mts, Hornonitrianska basin and Vtáčnik Mts in the west, the Žiarska basin and Štiavnické Mts in the South, partially the Plešovská basin and Javorie Mts in the Southeast and Zvolenská basin and Starohorské Mts in the East. The geomorphological unit of Kremnické Mts is made up of Kunešovská highland in northwest, Jastrabská highland in southwest, Flochovský ridge in central and north part, Turovské foothills in south and Malachovské foothills in east. The highest point is Flochová (1 316.9 m a. s. l.). There are a number of natural monuments and phenomena around Kremnica – Jastrabská skala (Natural Monument, geological feature, remnant of a rhyolite extrusive dome), Kremnický štít, Nature Reserve Kremnický štós, Nature Reserve Bujačia lúka, Ihráčske kamenné more (geological feature, disintegrated andesite lava flow – boulder field), Nature Reserve Mláčik – an area of European importance – with forest swamps and alder growth. The Kremnica Calvary hill is located at the foothill of Šturec, on a slope facing Kremnica town and is together with the town castle one of the landmarks of Kremnica. This architectural-and-landscape complex serves as a recreational area (➔ fig. 1).

The mosaic like nature of the Kremnické Mts ensures high habitat and biological diversity. The area of Kremnica mining license and its surroundings – areas considered for future mining infrastructure, have been the subject of irregular field research since 2005, as part of environmental documentation for the assessment of environmental impact of various mining scenarios. Proposed activity does not interfere with large or small scale protected nature reserves as defined by act 543/2002 Coll., on protection of land and nature, as amended. The closest protected nature reserves are Kremnický štós, a

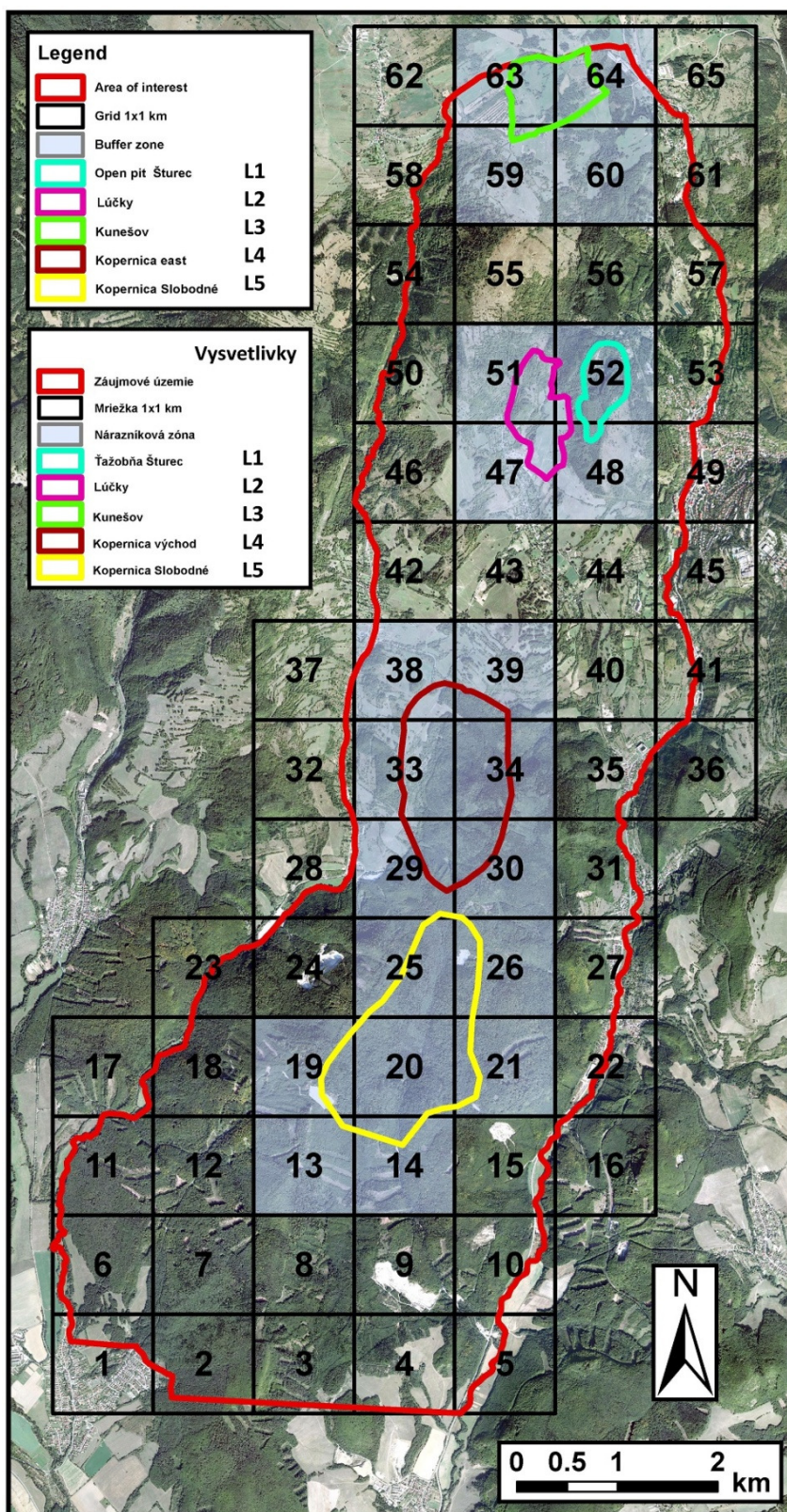


Fig. 1. Air image of the studied territory (adapted by R. Šuvada)

morphologically valuable scenery of rockwalls, towers and scree on the west slope of Kremnický štít) and Bujačia lúka, a meadow with rare and endangered Carpathian crocus (*Crocus heuffelianus*) on the southeastern rim of the Kremnica urban area, on the right side of the road to Skalka.

Based on the data collected at the Kremnica meteorological station between 1987 and 2004, the average annual precipitation is 861 mm and the average annual temperature is 6.4 °C. Within this period, the highest average temperature was above 16 °C and the highest precipitation (above 90 mm) occurring in the middle of July. Ecosystem and species diversity within the concerned is subject to particular research and assessment. Monitoring was carried out in the following sites (➔ tab. 1):

Tab. 1. Preview of monitored sites

L1 (B)	Šturec pit (benches, scree, debris and closed valley) and its wider surroundings
B1	Prevailing grassy habitat partly overgrown with succession woody and bushy plants
B2	Secondary pine forest
B3	Secondary larch-pine-spruce forest
L2 (G)	Lúčky: north-western surroundings of the village (between Kremnica town and Kopernica village) with mosaic of habitats, including meadows, habitats, shrubberies, forest edges, etc.
G1	Grove – bush-tree formation around the water reservoir
G2	Autochthonous hornbeam grove, with thermophilous plants (contains habitat of national importance Ls2.1)
G3	Old quarry with surrounding bushes?
G4	Degraded pasture land
G4a	Preserved pasture land
G5	Degraded pasture land with dominating <i>Festuca pratensis</i> , <i>Dactylis glomerata</i> , <i>Trisetum flavescens</i> , <i>Poa pratensis</i> and <i>Agrostis tenuis</i>
G6	Previous pasture land overgrown by bushes
G7	Stream-side trees and bushes
G7a	Continual tree cover in part of periodically drying up stream
L3	Kremnické Bane – west ('Baronove' meadows and north-eastern valley beside 'Mazuchovej' hill)
1	Mesophilous meadows and forest edges
2	Alder groves and wet meadows
3	Ruderal semi-xerophilous grasslands with pioneering shrubs and trees along the road
L4 (M)	Kopernica – East (Tailings Pond – Alternative Site No. 4)
M1	Degraded pasture land on right side of the valley
M1a	Residual pasture land of more heat-requiring vegetation
M1b	Bushes on right side of the valley
M2	Autochthonous forest on left side of the valley – Carpathian oak-hornbeam forest (habitat of national importance Ls2.1)
M2a	Rest of tenuous oak wood with <i>Quercus petraea</i> on steep slopes
M2b	Spring area on the bottom of the valley belonging to the habitat of national importance Pr1 – soft water springs – bittercress <i>Cardamine hirsuta</i> springs (on non-calcareous rocks)
M2c	Forest road at the bottom of the valley
L5 (N1)	Continuous forest (contains habitats of national importance Ls2.1 and 9130) (forests along the Úkladný creek and close surroundings of the 'Slobodné' lakelet – alder bank groves and head-spring area)
N1a	The lakelet 'Slobodné' and its surroundings
N1b	Anthropogenous alder grove, in upper part with autochthonous features with springs (contains habitats of national importance Pr1)

L1. **Šturec** pit (squares 48, 52) with grassy habitats, partly overgrown with succession woody and bushy plants. Secondary pine forest on the north rim of the pit, with thin soil cover, rocky outcrops and small reefs (originally greenwood with predominant sessile oak/durmast covered the area) and secondary larch-pine-spruce forest around Šturec elevation, with larch mainly on the peak area. In the northern part of the pit, along a path leading towards Lúčky (with proposed waste rock dump), are mainly mesophilous meadows. Due to the advancing succession of denser woody vegetation, these meadows have no significant floristic importance.

L2. **Lúčky** (47, 48, 51, 52) on the northeastern rim (between Kremnica and Kopernica) with a mosaic of habitats. Grove – bushy, woody formation surrounding the water-tank, original hornbeam undergrowth with a presence of thermophilic phytoelements, quarry/pit and surrounding shrubbery, recultivated degraded pasture (G4) with preserved parts, and degraded pasture.

L3. **Kunešov** (59, 60, 23, 64) with valuable wet pastures, alder wetlands associations to the west of Kremnické Bane.

L4. **Kopernica east** (29, 30, 33, 34, 38, 39) Reclaimed pastures on the right side of the valley (M1) with remnants of the original pastures and meadows with a more thermophilic nature of vegetation and shrubs on the north of the right side of the valley. Besides these habitats, the site features original oak-hornbeam forest with remnants of tenous oak wood on steep slopes and springs (Pr1 – springs of lowlands and wolds in non-carbonate rocks).

All alternative sites were designated following the prepared proposal “Mining of precious metal ores in Šturec deposit Kremnica – underground”, which builds on the latest findings on the state of the environment in the assessed area. The document contains detailed characteristics of the Šturec pit. Besides the marked quadrants, the marginal zone is also the subject of research, with the aim of objectively assessing the population of researched species. In the case of project implementation, it would not affect:

- large or small scale protected nature reserves as defined by act 543/2002 Coll., on protection of land and nature, as amended;
- protected bird areas proposed in Slovak government resolution No 636/2003;
- areas of European importance proposed by a decree of the Ministry of environment n. 3/2004-5.1 (Natura 2000).

Material and methods

A. The collection of data in the field – the data collection on selected groups of animals. An evaluation of species was made from the point of importance as unique or vulnerable; or from the point of view of an umbrella effect as universal, respectively. Field surveys were conducted in 2013 on the following dates: March 28, April 18, April 26, May 4 – 5, June 1, June 6 – 9; June 20 – 21, July 10, July 20 – 22, August 2, August 29 – 30, September 30 and October 26. The difference between monitoring and mapping is in regularity and repetition. Monitoring differs from mapping in long term observation of populations, usually joined with abundance determination using standard methods. Results are collected in a long term period in regularly repeated intervals. The method used must be consistent and repeatable. Thus the obtained results give useful information about abundance and population dynamics. Observing a particular species, in the same

spot at regularly repeated intervals, without determining its abundance, can be considered the most simple way of monitoring (Vlašín, Mikátová & Dungel, 2007). Invertebrate research was carried out using qualitative detection methods and for some taxonomic groups using relative quantitative methods. Methods used for detection of molluscs, spiders and insects are set by specimen collection manner. The outstanding diversity of animal species and the variety of their bionomic reflects in numerous methods of their study and scientific assessment. Among the basic and most widely used methods are individual collection and capture, slipping, knocking, sieving and capture in traps. We have used a combination of several collection methods and at the same time, depending on the nature of the habitat and presence of obstacles, an area or spot system of information recording. We either research as extensive area as possible (with the aim of qualitative assessment of species biodiversity), or representative transects to assess the quantitative abundance of some groups and species. Line method works best for us, with transects 100 m long and 50 m wide. When rare species with sporadic occurrence were found, they were assigned to transect and stationary points on the map. When rare species with sporadic occurrence were found, they were assigned to transect and stationary points on the map. Research and monitoring of amphibians and reptiles was carried out using procedures recommended by Maštera (2007), Smolinský, Vongrej & Kautman (2007), Edgar, Foster & Baker (2010) and others. Non destructive research methods, based on specific behavior and characteristics of observed amphibians and reptiles, were applied using rules published by Zwach (2009). Research and monitoring of invertebrates was carried out using a method for molluscs and spiders recommended by Jírovec (1958), Skuhřavý, Škapec & Novák (1989), for insects by Skuhřavý & Novák (1969), Winkler (1974), and Orthoptera by Kočárek et al. (2013) and for dragonflies by Hanel (1995), David & Bitušík (1997). For epigeic Carabinae, we have designed earth traps that ensure that the protected species are not killed and the content of the trap could not be taken out by wild pigs or other mammals (Kizek 2009, Čunderlík & Kizek, 2013). The design of our traps ensures the content is protected during intense rainfall. An inserted smaller container, with smaller holes at the bottom, ensures selection of smaller individuals.



Fig. 2. Traps for Carabid beetles (photo Tomáš Kizek)

B. The evaluation of data – A preliminary evaluation of the status of populations of endangered species based is on my own experience and on the results of other authors as well. In terms of species survival in affected areas, an assessment of habitats, which are crucial for their existence, was made. Based on two years of research from our own experience and on the results of other authors e. g. Hůrka, Veselý & Farkač (1996), we attempted to preliminary assess the state of populations and to assess the occurrence of protected species, with focus on species of national and European importance. Those are species in the red books and red list (Baruš et al., 1989; Škapec et al., 1992; Vološčuk, 1996; Stloukal et al., 2003; Šeffler et al., 2010; Halčinová et al., 2010). Considering their survival on concerned sites, we also assessed the state of their habitats. The method was designed by Polák & Saxa (eds., 2005) and was elaborated by a collective of authors – specialists in particular taxonomic groups.

Results

Qualitative and quantitative representation of species of selected taxonomic bioindication groups in the studied habitats was related to trophical and topical demands of individual species. Appreciation of natural fauna is one of the important indicators of conservation of biological diversity of ecosystems. In the following part, we attempted a preliminary assessment of the fauna based on a survey of terrestrial gastropods, arachnids, insects and amphibians and reptiles.

Terrestrial gastropods (Mollusca: Gastropoda)

In terms of the environment characteristics indicators in this research, we were first interested in molluscs. Up until now, over 120 000 species have been described, but in Central Europe there are approximately 300 only. We have found the occurrence of 32 species of shellfish in the area of interest. Two of these gastropods are protected species: *Clausilia dubia* (EN) and *Helix pomatia* (NE) (Roman Snail, Burgundy Snail, Edible Snail), but in the case of the garden slug (the Habitats Directive – Annex V and NE category) in Slovakia is considered to be a taxon out of the danger for which only local and seasonal regional restrictions on its collection are in place. Three species belong to the endangered category: *Clausilia dubia carpathica* (EN), *Vitrea subrimata* (NT), *V. transsylvanica* (NT) and *Discus ruderatus* (NT). There is possible occurrence of a relict protected species Desmoulin's whorl snail (*Vertigo moulinsiana*) (Annex II of the Habitats Directive and category EN), which we found in the open alder wetland forest and springs with occurrence of bogbean. Given the great similarity to ten related species and the total lack of data on their distribution, its presence is questionable and subject to verification (based on the expertise of a larger number of subjects revised). The Portuguese slug (*Arion lusitanicus*) ranks among the environmentally problematic, non-native invasive species, like the red slug (*Arion rufus*), that appears in greater numbers in gardens directly in human settlements. This Portuguese slug is extremely abundant. On the contrary, our original Carpathian gastropoda species, the Carpathian blue slug, or simply the blue slug (*Bielzia coerulans*), is an eastern Carpathian endemic. The colouring is typical inky blue, but we observed even darker, violet black individuals. Environmental groups and indicator species therein, the so-called ecoelements, were evaluated on the basis of Lisický (1991). In Slovakia, the silvicolous ecoelement represents 82 species, representing 49.4 % of terrestrial gastropods living in Slovakia. From this number, we distinguish 56 species, which are exclusively bound to forest environments.

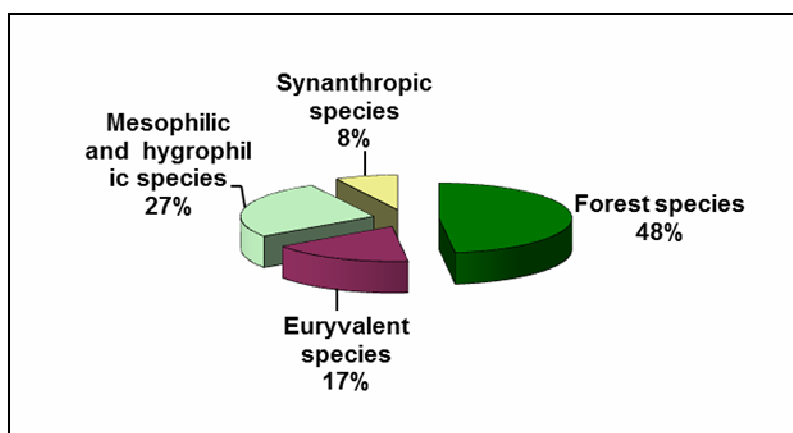


Fig. 3. Relative proportion of ecological groups of gastropods in monitored area – total 31 species (100 %): 21 forest species (SI 67.75 %); 4 hygrophilous species and species of open wetland areas (HG+RI 12.90 %); 4 euryvalent mesophilous species (AG 12.90 %) and 2 steppe species (ST 6.45 %)

Out of 228 species of terrestrial Gastropods, 31 species were found in the Kremnica surroundings. In this area, Lisický (1991) reported 47 species in square DFS: 7279d and 31 species in square 7379b. In our survey, we confirmed the following species (in brackets are the habitat group by according to location): *Ena montana* (B2, B3, G2, M2c, N1b), *Discus ruderratus* (B3, 2, G7a), *Aegopinella pura* (G2, M2), *Macrogastra plicatula* (B3, M2a), *Vitrea diaphana* (M2c), *V. transsylvanica* (N1b), *V. subrimata* (B2, B3, M2c, N1b), *Bielzia coerulans* (2, M2), *Malacolimax tenellus* (B2, B3, G2, G7a), *Faustina faustina* (B2) and *Isognomostoma isognomostomos* (B2, M2a). The next group of forest species consists of those that live predominantly in the woods, but can live in other temporary habitats. This latter group of silvicolous includes 15 species of Slovak malacofauna, we confirmed the presence of 6 agricultural silvicolous that are bound to garden and park habitat types: *Discus rotundatus* (B1, B3, M2a, G7a), *Arion fuscus* (G4a, M1b), *Limax cinereoniger* (2, M2a), *Fruticicola fruticum* (G4a, 1, M2b, M2c, N1b), *Arianta arbustorum* (G1, G3, G6) and *Cepaea hortensis* (G3, G4a, N1a); two additional thamnophilous species, living in shrubbery: *Aegopinella minor* (B3) and *Helix pomatia* (2, G6) and one hygrophilous forest species bound to forest wetlands: *Vitrea crystallina* (B2); and inundatly spreading silvicol – *Arion rufus* (N1a, 2). Ecoelement of stepicolous form xerothermic species living in dry, sunny places, especially on grasslands and with a very small presence of trees. Of the 18 species, we have found only two on the sites of interest, because most species of this group are bound to the limestone areas (steppe zone): *Xerolenta obvia* (M1a) and *Cepaea vindobonensis* (G2, 3, M1a). Of the 27 mainly euryvalent agricols, we only confirmed one species *Cochlicopa lubrica* (B3, G4a), but from this group dwelling on rocks as well as in forest there is *Orcula dolium* (B2, M2a), *Limax maximus* (M2b, G7a) and *Clausilia dubia* (B2). Of the 10 hygrophilous species, that despite their high demands for humidity are not actually directly bound to water environments, only *Succinella oblonga* (N1a) is relatively abundant and of the 12 ripicolous species with higher demand for humidity, one relative species *Succinea putris* (M2b, N1a, N1b), that lives in wetlands and waterway banks. In the ecoelement of 32 patenticolous species, i. e. the silviphibous species group, we have not confirmed any

occurrence of any species. Occurrence of one of them – field slug *Deroceras agreste* in gardens and fields is more than likely. The possible occurrence is expected for petrophilous species *Faustina cingulella*. And in the environment of sparse canopy trees (orchards, forest debris) also *Vallonia costata*. Furthermore, the silvstepicolous ecoelement, which is represented in Slovakia by *Euomphalia strigella*, which lives in the shrubbery of xerothermic sites and penetrates well into sparse groves, is also a subject of survey. The research shows that in the area of interest, forest species dominate. If we add to this group the drymadiaphorous species (indifferent to forest), which make up 31.3% of our terrestrial mollusc fauna (52 species in Slovakia), then up to 80% of our terrestrial gastropods may occur in the forest. In the prodromal work of Lisický (1991) from the environs of Kremnica, 47 species in square 7279d and 31 species in square 7379b were documented. Summary of the above is that malacofauna of the Kremnické Mts is represented rather poorly particularly due to it being of marginal interest for research and the type of geological substrate. Non confirmed species are subject to verification at all monitoring sites.

Spiders (Araneae) and harvestmen (Opiliones)

More than 900 species of spiders are confirmed in Slovakia, excluding 35 dubious ones, which are reported in older literature and voucher material is inaccessible, or as a species whose status is unknown. Gajdoš, Svatoň & Sloboda (1999) included in the Catalogue of Spiders of Slovakia also unpublished data from many Slovak and Czech arachnologists. More recent work relates to partial results, mainly from the peripheral parts of the territory and surrounding neighboring units, especially from different locations of 'Turiec' and 'Stredohronie' regions.

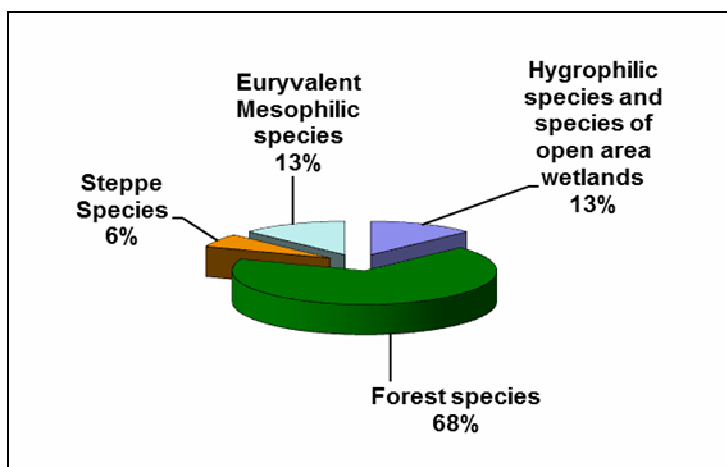


Fig. 4. Relative proportion of ecological groups of spiders in monitored area – total 52 species (100 %): 25 forest species (48.08 %), 9 euryvalent species (17.31 %), 14 meadow species (26.92 %) and 4 synanthropic species (7.69 %)

Spiders found in the territory of the Kremnické Mts are a part of communities, where we distinguish mixed forest communities, communities of grasslands, moorlands, water shores, orchards, rocky habitats and communities of contingent anthropogenic habitats. Based on these communities we derived ecological groups, the so-called ecoelements as in the case of terrestrial gastropods. From the area of the Kremnické Mts 234

species are reported, and in the area of interest we have so far mapped the occurrence of 46 species of spiders. From this number, forest communities of silvicolous ecoelement are represented by 9 forest species. In grass, on herbs and plants up to 2 m high, *Araniella cucurbitina* (B3, G3, 3, M1b, N1a), *Linyphia hortensis* (B1, G1, G3, G5, G7a, 2, M2C, N1a) and *Diaea dorsata* (B1, G3, M2a), in grass, moss and on the leaves *Tenuiphantes menzei* (G3, G7a), under rocks and bark tree *Segestria senoculata* (B3, N1b, G2, M2a, 2) *Tegenaria silvestris* (B2, B3, M2, N1a), *Nerienne montana* (M1b, M2a, M2b, M2C, 2, N1a) and *Amaurobius fenestralis* (B1, 2, M2a, N1a) and under the bark of trees and various crevices of wooden buildings *Nuctenea umbratica* (B2, N1). If we add to this group the species drymadiiformous (indifferent to forest), that live in well-lit forest formations of an ecotone synanthropic nature, but also on various open habitats, then eight species can be attributed to the forest arachnocenose: *Araneus diadematus* (B1, G2, G3, 2, 3, M1a, M2a), *Enoplognatha ovata* (B1, 1, G4), *Phylloneta sisypbia* [= *Theridion sisyphium*] (B1, G3, M1b, M2c), *Linyphia triangularis* (B1, G3, G4, 2, M1a, N1a), *Metellina menzei* (B3, 2, M2a, M2b, N1a), *Metellina segmentata* (M2a, M2b, M2c), *Tetragnatha pinicola* (B2, M2b, N1a), *Heliophanus cupreus* (M1b, G3). This latter group also includes 4 agriculous silvicolous that are bound to abandoned orchards, garden and park habitat types: *Philodromus aureolus* (B1, 3, G1, G7a, M1a, M1b), *Mangora acalypha* (B1, 1, M1b, G1), *Pardosa lugubris* (1, 2, M1a, M2c, G3, G4, G5) and *Evarcha falcata* (B1, G3, G4, M1a). In the apical part of Štuerc in spruce growth, we found the remarkable occurrence of *Parazygiella* [= *Zygiella*] *montana* (B3), which is typical for mountain habitats. So we found a total of 22 species in forest communities. Well lit open forest edges, meadows and shrubs are inhabited by *Aculepeira ceropegia* (1, 2), *Xysticus cristatus* (G1, 1, M2b, N1a), *Trochosa terricola* and *Pisaura mirabilis* (B2, G2, 2, N1a, M1a, M2c). From euryvalent agricols we found *Alopecosa cuneata* (M2b, 1, 2), *Dictyna arundinacea* (B1, G4, G5, 1, 3, M1a) and *Drassodes pubescens* (B1, G4, 1, M1a). Community grassland hosts praticolous types: *Misumena vatia* (B1, G4, 1, 2, 3, M1a), *Pachygnatha degeeri*, on both the humid and drier stations, spider *Clubiona neglecta* (B3, 2, M2a, G2, N1a), *Argiope bruennichi* (G2, M1, 2, 3). Wet meadows, fens and herbaceous vegetation on the banks of watercourses are inhabited by *Araneus marmoreus* (1, 2, M2b), *Araneus quadratus* Cl. (1, 2), *Tetragnatha extensa* (2, 3), *Pardosa amentata* (N1a, 1, 2, M2b) and *Pirata hygrophilus* (N1a, 1). Out of syntropic bound species with wider ecological valence, we confirmed the presence of *Tegenaria domestica* (B2, G3), *Pholcus opilionoides* (B2) and *Meioneta rurestris* (B2, G3).

Until now, 33 species of harvestmen (Opiliones) have been identified in Slovakia. Most abundant on researched sites was the European species *Nemastoma lugubre* (2 G7a, M2b, N1a, N1b), a hygrophilous forest species. In forests, there was a higher incidence of *Trogulus napaiformis* (B3, G2, N1a) and *Lacinius ephippiatus* (M2a, N1b), that were found under lying timber. Several species prove eurytopic character, including *Mitopus morio* (1, M1a, M2b) and *Oligolophus tridens* (B1, G4, M1a), often swept from the vegetation; in grassland and ruderal habitats *Phalangium opilio* (G1, G3, M1,2) and on the walls of buildings and quarries synanthropic *Opilio parietinus* (B2, G3, N1a). From the zoogeographical point of view, most species of harvestmen found, belong to European or Central European species, i. e. species with range, not exceeding the European or central European territory. Of these, euryvalent and eurytopic harvestman species are extended almost continuously throughout Slovakia. Coherent occurrence in our area is by the holarctic species *Mitopus morio*, *Opilio parietinus*, *Phalangium opilio* and *Oligo-*

lophus tridens as well, which is of Siberian origin.

Insects (Insecta)

The third indication group consists of selected orders from the insect class. Because the class of insects is among the most species abundant of arthropods (Arthropoda), in this part of the report, we have focused only indicatively on the total amount of species detected in the monitored orders of insects. Besides quantifying the faunistic data, we mention only the most significant for indication. Protected species are specifically introduced in the next section of the report. Diversity and dispersity of other species is being updated, with view of the ongoing determination and is included in Annexes of the electronic version of the final report. In «Prodromus Lepidopter Slovenska», Hrubý (1964) summarized all previously published data on the occurrence of butterflies, and in the vicinity of Kremnica data from 1787 (by E. C. J. Esper) are included. In Slovakia more than 3,500 species of butterflies are known. We pay particular attention to the occurrence of heliophilous butterflies (Lepidoptera). Overall, we found 109 species, among which, the Clouded Apollo (*Parnassius mnemosyne*) and its large population around Lúčky deserve special attention, the Large Copper (*Lycaena dispar*) (1) and other wet meadows species of the Geranium Argus (*Aricia eumedon*) (1 M2b), the Lesser Marbled Fritillary (*Brenthis ino*), False Heath Fritillary (*Mellicta diamina*) in Kunešov. The Eastern Eggar, or Orange Eggar (*Eriogaster catax*) was recorded only at one site in Kopernica – east (M1a), where we found several nests with caterpillars on blackthorn. During sunny days the caterpillars were individually spread all over blackthorn side branches. Out of more than 80 species of planipennis living in our area there is the remarkable adult osmylid – *Osmylus fulvicephalus* (N1a) at the spring near Slobodné pond, which indicates a clean, preserved forest environment around aquatic habitats, as does the occurrence of the ground beetle *Carabus variolosus*. From more than 6,500 beetle species (Coleoptera) of Slovakia, an incidence of 134 species was recorded, among which the stag beetle (*Lucanus cervus*), the rosalia longicorn (*Rosalia alpina*), the cliff tiger beetle (*Cicindela germanica*) and the violet oil beetle (*Meloe violaceus*) deserve special mention. Unfortunately, the incidence of the aforementioned was sporadic. Particularly favorable and suitable habitats for the stag beetle, are located around Ihráč and Jastrabská skala. It is also reported from Nevoľnícka basin with the European rhinoceros beetle (*Oryctes nasicornis*) and the rosalia longicorn. Our observations suggest that the occurrence of the cliff tiger beetle is concentrated mainly in karst areas. The list of dragonflies of Slovakia includes 75 taxa (David 1996, 2001). We confirmed the incidence of 17 species of dragonflies. Among the most notable are the brilliant emerald (*Somatochlora metallica*) and the four-spotted chaser (*Libellula quadrimaculata*) that we observed at the Slobodné pond (only one imago). The sombre goldenring (*Cordulegaster bidentata*) can be found regularly in Kopernica. From more than 5 800 other kinds of insects, we focused only on the solitary bee and bumblebee. Overall, we recorded six species of bumblebee and 14 species of bees. In Slovakia, more than 6,000 species of Diptera are known and the number is increasing. Results from the fauna survey throughout Slovakia were compiled in three volumes of Diptera Slovakia by Čepelák (1984, 1986). On flowers, we recorded the plant pollinators hoverflies (Syrphidae), horseflies (Tabanidae), and others. Hoverflies were abundant at all sites, the greatest diversity – 27 species were observed on wet meadows at Kunešov. Of 118 species of orthopterans (Orthoptera) known in Slovakia, we recorded the incidence of 32 species in mapped locations. Numerous populations of the European bushcricket (*Ephippiger*

ephippiger) were observed near a quarry in Lucky and the surrounding area, as well as in Kopernica and on Calvary hill. Out of more than 800 species of Heteroptera in Slovakia, 56 species were recorded but many more remain undetermined.

Amphibians (Amphibia) and reptiles (Reptilia)

Of the 18 indigenous species of amphibians, this research focused on the occurrence of *Triturus cristatus*, *Triturus* (= *Lissotriton*) *vulgaris*, *Triturus* (= *Lissotriton*) *montandoni*, *Rana viridis* and *Rana dalmatina*. We record and monitor populations of 6 species which are *Salamandra salamandra*, *Triturus* (= *Mesotriton*) *alpestris*, *Bombina variegata*, *Bufo bufo*, *Hyla arborea* and *Rana temporaria*. Particular attention is paid to their breeding sites and migration routes. Of the 12 indigenous species of reptiles in the concerned area, we register the occurrence of eight species. They are *Anguis colchicus*, *Lacerta agilis*, *Lacerta vivipara*. In the quarry near Lucky and nearby we checked for *Podarcis muralis*, which is found quite rarely in Šturec, but it is numerous in the Kremnické Mts, in some suitable locations, e. g. Jastrabská skla. *Vipera berus* was observed in Lúčky and Kunešov, *Natrix natrix* was observed particularly in Kunešov and Calvary hill, grass snake *Natrix natrix*, in a quarry near Lúčky and in Šturec *Coronella austriaca*, and around Kopernica and Lúčky *Elaphe* (= *Zamenis*) *longissima*. It is quite prevalent throughout the area, and often falls victim to road traffic (e. g. in 2013 Kopernica, Ihráč). Its occurrence is well known in Nevolnícka basin where the viper also occurs (Filanda & Kovár, 2015; http://www.filhistory.wbl.sk/Fauna_flora.html). In Slovakia, the increasing incidence of introduced species (*Trachemis scripta*) was not confirmed in the area of interest.

Protected, rare and endangered species

This section provides brief characteristics of the identified, probable or referred to protected species that were not confirmed in this survey though. Particular attention is paid to the species of particular groups (invertebrates, amphibians and reptiles), which are of European priority (European protected areas declared due to the presence of these species). In the following review, maps of occurrence in Slovakia were used, compiled based on data as of December 31, 2006, based on documents reporting to the European Commission under Article 17 of the Habitats Directive (SNC, 2007). Species protection on the basis of rarity and threat to species at a national and international level, according to Law no. 543/2002 Coll. on nature and landscape protection, as amended, Slovak Red List, IUCN Red List and other conventions. Species of national importance and species of European interest as defined under act and decree no. 579/2008 Coll., are declared as protected. All species of wild birds naturally occurring in the European territory of the Member States of the European Community are considered as protected animals under this law.

Roman snail, or edible snail (*Helix pomatia*). This species is often found in bushland in hills, on the river / stream banks near water and roads, in gardens and on warm, south-exposed slopes of the edges of mountains etc. In the examined area it is found in many places, but due to substratum, it is not as common as is in areas of carbonate rocks (e. g. Lúčky, Kunešov, Šturec pit). Due to the continuous occurrence of the population in the Kremnické mountains, especially in the area of human settlements, it is not threatened by the project outline (Habitat Directive V a category NE).

Carpathian blue slug or simply the blue slug (*Bielzia coerulans*). This is an Eastern Carpathian endemic. It prefers humid and semi-humid places under bark and old tree

trunks. We located it in deciduous and mixed forests (e. g. Kopernica). We recorded it quite often in coniferous sites, but mostly just individually (e. g. Slobodné). Like other species, we found it most often during humid and rainy weather. The colouring is highly variable, typical is blue, but we observed dark blue to violet black individuals. The population in the Kremnické Mts forest area is not threatened and it seems to be stable.

Noble crayfish (*Astacus astacus*). Currently it is protected under the law of nature and landscape, as well as under fishing regulations and it is also included in Annex V (animal and plant species important for the community. Its occurrence was unexpectedly confirmed in the right tributary creek of Slobodné pond. A young individual was found repeatedly over two years, suggesting its local reproduction and a larger number of individuals. The size of the total population is unknown, but it is quite remarkable given the position.

Eastern eggjar, or orange eggjar (*Eriogaster catax*). The only site with confirmed occurrence of this species (Kopernica) would be destroyed in the case of a tailings dam construction, but based on observation of only 4 nests of caterpillars, it is difficult to say whether it is a permanent population or only the off spring of one female. No special management is required, just to keep unconnected rugged forests, forests with lots of meadows, clearings, ecotones, scrubby and forest steppe habitats. Protected: 4b, 6a (24/2003 Coll.), HD2, HD4, Be2, E. Status of species endangerment: LR: nt.

Jersey tiger (*Euplagia quadripunctaria*). Although this is a significant European species, it is a fairly widespread species in Slovakia, with the exception of locations above the tree line. It inhabits sparse forests, forest ecotones, scrubland habitats and similar. It was recorded in several places around Kremnica, but only individually, for example, in Lúčky. Protected: 4b (24/2003 Coll.), HD2, but it does not have endangered species status in Slovakia. The vulnerability of populations around Kremnica is low, considering that it is fairly widespread in suitable habitats.

Clouded apollo (*Parnassius mnemosyne*). Protected: 4b, 6a (24/2003 Coll.), HD4, Be2, W2. Status of species endangerment: VU. On the Lúčky site the project would have partial impact, as host plants were also recorded at the top of the gully and pasture, but the population biocentre is located in an undulation above the village. The recorded relative abundance of butterflies, calculated on an area of 1 ha site, from May to June was around 150 individuals. This number was obtained by a transect count method with a recommended transect width of 5 m. Its status is considered to be very favourable (subcategory A)!

Large copper (*Lycaena dispar*). Status of species endangerment (VU); protected 4b, 6a, (24/2003 Coll.), HD2, HD4, Be2, E. It is widespread in the valleys of lower and middle altitudes, especially along waterways. In dry and often ruderal places, sporadically, usually in the vicinity of wet and waterlogged meadows. Only two individuals found on the site Kunešov – east. The population size is unknown, but individuals seemingly occur throughout the area, in the Turiec and Hron river basins.

Large blue butterfly (*Maculinea arion*). Inclusion in national and international legislation: 4b, 6a (24/2003 Coll.), HD4, Be2. Status of species endangerment: VU. Individual butterflies fly in June and July within 300 meters. Metapopulations in isolated locations with abundance below 400 individuals per hectare are dying out. So far this species has been found only very sporadically in Lúčky in Kopernica. In the surveyed areas, sporadic occurrence is reported without permanent populations (Kremnická viewing tower near Šturec pit and Kopernica).

Sombre goldenring (*Cordulegaster bidentata*). A protected species of national importance (Annex 6B). Vulnerable (VU). It was more abundant outside the area of interest, in Kunešov, where it occurs along creek and forest edges. The adults hunt flying insects of the forest paths glare along shores and water level to be. The remaining adults rest and seek sunlit vegetation above the water. Direct observation of adult and exuvia search on transects along shores of 100 m length. If the project on the Kopernica site is implemented, then the bog and its population would vanish. Annually 2 – 5 flying imagos were observed. Also one female was observed laying eggs in alder vegetation in the centre of the bog.

Fossulated ground beetle (*Carabus variolosus*). It inhabits deciduous forests (oak-hornbeam and beech), mixed forests, but also mountain coniferous forests, and may be found also in secondary, young spruce forests. This year it was confirmed in the area of interest by Michal Wiezik (in verb.). It requires forest wetlands and clean streams. Extensive deforestation or melioration could lead to the extinction of its population.

Rosalia longicorn (*Rosalia alpina*). It is obvious that the optimum habitat is independent of altitude, but in a climatically suitable and phytosociological natural environment. The most numerous populations are linked to the original plantations of beech with fallen or dying individual trees. Only one living specimen was found in the research study area. There is no stable population living in the surveyed area, and incidence is only sporadic. The same applies to the stag beetle (*Lucanus cervus*) – one dead female was found on the road in Lúčky village. The stag beetle and the European rhinoceros beetle (*Oryctes nasicornis*) have been documented from Žiar nad Hronom by Vítek (June 1975, June 5 and 7, 1977).

Alpine newt [*Triturus* (= *Mesotriton*) *alpestris*]. It was identified in only one location in the area of interest – a forest road near Slobodné pond. The breeding habitat consisted of several large puddles. An overall maximum incidence of 6 males and 4 females was recorded in one day, which were found buried in mud in the morning. One of the males was observed dancing before noon and documented, impressing the female with its kinked tail. All puddles (5) were without tadpoles, which confirms the fact that besided larvae of mosquito and other insects, it feeds on the eggs and tadpoles of the Yellow-bellied

Tab. 2. Assessment of abundance and habitat state of the Alpine newt

Criterium		State*	Coefficient (0 – 3)	Value (State x coefficient)
Population characteristics	Size, density, dynamics	3	3	9
	Size, trend and continuity of area	2	3	6
	Interconnection/isolation	1	3	3
Habitat state	Habitat of adults and subadults	2	2	4
	Breeding habitats	2	3	6
Habitat and population threats	Adults threatened	1	2	2
	Breeding threatened	1	3	3
	Other threats	2	1	2
VALUE TOTAL:				35
Highest possible value:				60

* A – favourable, B – average, C – unfavourable

Toad (*Bombina variegata*) and common frog (*Rana temporaria*). Those were found a few meters away at an intersection of forest roads. The puddles did not contain individuals, but rather serve as an important breeding habitat. The alpine newt has been found here, in trackage and periodic puddles being supplied influent suitable breeding habitat and at that time larvae were present here. Mortality, given the small populations has not been established. Migration barriers have been identified. If we had provisionally assessed its reproduction sites according to criteria relating to the alpine newt (*Triturus alpestris*), the results would be displayed in table 2 (↑).

The above table shows that with an overall assessment of 58.33 %, on the monitored site in 2013, the Alpine newt showed an average favourable condition (B), which only slightly exceeds the limit of adverse state, in terms of population survival!

European tree frog (*Hyla arborea*). In the studied area, we observed the incidence at the pond at Calvary below Šturec and in wetlands at Kunešov, where several males were heard. Individuals occasionally occur around Kremnica. The main measure for maintaining the status quo is to stop the drainage of sites, saving the smaller water bodies from drying out, eutrophication and anthropogenic negative impacts, intensive fish farming and in particular chemical pollution resulting from agricultural activities. Only *Salamandra salamandra* and *Rana temporaria* have favourable conditions for reproduction at selected locations in the examined region. We frequently found salamander larvae in larger puddles and the same is true for eggs and tadpoles of *Rana temporaria*. However, those small water bodies that are in sunny places, dry out quickly which causes high mortality of offspring. We have transferred the eggs of *Rana temporaria*, whenever possible.

Reptiles (Reptilia). The survey of reptiles in the field was based on a visual search of individuals and hides, which is most effective when used in combination (also referred to as a "visual encounter survey"). Checks under suitable weather conditions are required. Warming up of air to temperatures of about 10 – 20 °C is necessary, but there are differences due to the type, period, age and habitat. For example, viviparous lizards are commonly observed at lower temperatures than *Natrix* spp., sometimes less than 10 °C in spring. A visual search is most effective in the spring, shortly after awakening from hibernation, when reptiles spend a lot of time warming and searching for mates. Among the vulnerable (VU) – *Coronella austriaca* and *Vipera berus*. Another 6 species: *Anguis colchica*, *Elaphe longissima*, *Natrix natrix*, *Podarcis muralis* and *Zootoca* (= *Lacerta*) *vivipara* are in the category of less endangered taxa (NT).

Conclusion

From the faunistic point of view the Kremnické Mts territory is not well researched, because not enough attention is being paid to it. One reason could be that it doesn't feature as a large scale protected area. There are older works, mostly from occasional inventory surveys or spatially broader prodromal works. The range of taxonomic groups, although most comprehensive, are only due to the results of the several day survey brought by XXVIII. "Camp of nature conservationists" in 1992 from the projected area of the water reservoir Turček and its vicinity (Kadlečík et al., 1994). Therefore, we considered that it was necessary to examine the area longer to obtain relevant and coherent knowledge of the state of individual populations, the impact of the environment on them with the emphasis on European importance, protected and endangered species. Our research will undoubtedly enrich the overall view of the state of biodiversity. Since the

area has a wide range of different communities that are bound to different habitats, for protection of fauna it is very important to ensure the preservation of this spectrum of habitats through long-term management of the area. Management should aim at preserving the remainder of the original and small undisturbed forests, an active approach in the preparation of forest management plans, preservation of the dry parts of the territory by cutting down unwanted shrubs and trees, mowing, grazing, or small-scale (supervised) burning in winter and also the conservation of residue wetland habitats, and the reduction of the negative impact of human activities, resulting from commercial and recreational activities. Impoverishment of species richness of fauna and flora in the wider context, invariably causes the destruction of the fine links between the different components of living nature, on which the ecological stability of the landscape depends.

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Tab. 3 (suppl.): GPS coordinates of notable species

Species (subspecies)	Latitude	Longitude	Syst. category
<i>Helix pomatia</i>	48°69'976"	18°88'195"	Gastropoda
<i>Helix pomatia</i>	48°73'584"	18°89'586"	Gastropoda
<i>Helix pomatia</i>	48°73'389"	18°89'296"	Gastropoda
<i>Helix pomatia</i>	48°71'028"	18°90'328"	Gastropoda
<i>Helix pomatia</i>	48°71'028'	18°90'328"	Gastropoda
<i>Bielzia caerulea</i>	48°67'154"	18°88'740"	Gastropoda
<i>Bielzia caerulea</i>	48°66'253"	18°89'092"	Gastropoda
<i>Vertigo antivertigo</i>	48°70'510"	18°90'749"	Gastropoda
<i>Vertigo antivertigo</i>	48°44'164"	18°53'658"	Gastropoda
<i>Vitrea subrimata</i>	48°64'752"	18°88'497"	Gastropoda
<i>Vitrea subrimata</i>	48°42'868"	18°54'149"	Gastropoda
<i>Discus rudersat rudersat</i>	48°70'998"	18°90'146"	Gastropoda
<i>Discus rudersat rudersat</i>	48°71'380"	18°90'144"	Gastropoda
<i>Arion lusitanicus</i>	48°71'353"	18°90'296"	Gastropoda
<i>Clausilia dubia carpatica</i>	48°71'097"	18°90'023"	Gastropoda
<i>Astacus astacus</i>	48°64'752"	18°88'497"	Decapoda
<i>Eriogaster catax</i>	48°66'726"	18°88'070"	Lepidoptera
<i>Maculinea arion</i>	48°70'591"	18°90'650"	Lepidoptera
<i>Maculinea arion</i>	48°70'521"	18°90'528"	Lepidoptera
<i>Maculinea arion</i>	48°66'485"	18°88'462"	Lepidoptera
<i>Euplagia quadripunctaria</i>	48°73'537"	18°89'440"	Lepidoptera
<i>Euplagia quadripunctaria</i>	48°70'721"	18°89'412"	Lepidoptera
<i>Aricia eumedon</i>	48°66'762"	18°88'175"	Lepidoptera
<i>Aricia eumedon</i>	48°73'562"	18°89'455"	Lepidoptera
<i>Lycaena dispar</i>	48°73'582"	18°89'472"	Lepidoptera
<i>Limenitis populi</i>	48°40'104"	18°52'974"	Lepidoptera

<i>Limenitis populi</i>	48°42'868"	18°54'149"	Lepidoptera
<i>Melitaea diamina</i>	48°73'562"	18°89'472"	Lepidoptera
<i>Brenthis ino</i>	48°73'562"	18°89'472"	Lepidoptera
<i>Brenthis daphne</i>	48°71'323"	18°90'150"	Lepidoptera
<i>Brenthis daphne</i>	48°70'532"	18°89'779"	Lepidoptera
<i>Brenthis daphne</i>	48°42'357"	18°53'887"	Lepidoptera
<i>Brenthis daphne</i>	48°67'632"	18°88'041"	Lepidoptera
<i>Iphiclides podalirius</i>	48°42'470"	18°53'612"	Lepidoptera
<i>Iphiclides podalirius</i>	48°67'023"	18°88'127"	Lepidoptera
<i>Parnassius mnemosyne</i>	48°42'601"	18°53.350"	Lepidoptera
<i>Parnassius mnemosyne</i>	48°70'548"	18°89'075"	Lepidoptera
<i>Melitaea aurelia</i>	48°67'296"	18°87'979"	Lepidoptera
<i>Melitaea aurelia</i>	48°42'647"	18°53'386"	Lepidoptera
<i>Satyrium w-album</i>	48°73'769"	18°88'715"	Lepidoptera
<i>Satyrium w-album</i>	48°73'575"	18°89'498"	Lepidoptera
<i>Arcyptera fusca</i>	48°66'934"	18°88'011"	Orthoptera
<i>Rosalia alpina</i>	48°66'163"	18°88'886"	Coleoptera
<i>Ephippiger ephippiger</i>	48°66'976"	18°88'127"	Orthoptera
<i>Ephippiger ephippiger</i>	48°42'379"	18°53'518"	Orthoptera
<i>Ephippiger ephippiger</i>	48°69'976"	18°88'195"	Orthoptera
<i>Mantis religiosa</i>	48°70'723"	18°90'508"	Mantodea
<i>Bombus hortorum</i>	48°67'064"	18°88'088"	Hymenoptera
<i>Bombus (Pyrobombus) lapidarius</i>	48°73'839"	18°88'880"	Hymenoptera
<i>Bombus lucorum</i>	48°70'915"	18°89'390"	Hymenoptera
<i>Bombus pascuorum</i>	48°70'913"	18°89'268"	Hymenoptera
<i>Bombus rupestris</i>	48°70'510"	18°90'749"	Hymenoptera
<i>Bombus sylvarum</i>	48°70'532"	18°89'779"	Hymenoptera
<i>Bombus terrestris</i>	48°73'586"	18°89'248"	Hymenoptera
<i>Bombus pratorum</i>	48°70'874"	18°90'577"	Hymenoptera
<i>? Carabus menetriesi pseudogranulatus</i>	48°66'729"	18°88'304"	Coleoptera
<i>Donacia semicuprea</i>	48°38'851"	18°53'098"	Coleoptera
<i>Lamia textor</i>	48°44'164"	18°53'658"	Coleoptera
<i>Harmonia axyridis</i>	48°73'647"	18°89'670"	Coleoptera
<i>Meloe violaceus</i>	48°70'591"	18°90'650"	Coleoptera
<i>Cordulegaster bidentatus</i>	48°66'728"	18°88'295"	Odonata
<i>Somatochlora metallica</i>	48°64'752"	18°88'497"	Odonata
<i>Hyla arborea</i>	48°73'805"	18°89'303"	Amphibia
<i>Hyla arborea</i>	48°70'513"	18°90'756"	Amphibia
<i>Bufo bufo</i>	48°66'744"	18°88'264"	Amphibia
<i>Bufo bufo</i>	48°70'512"	18°90'749"	Amphibia

<i>Bufo bufo</i>	48°70'594"	18°89'009"	Amphibia
<i>Bufo bufo</i>	48°44'164"	18°53'658"	Amphibia
<i>Rana temporaria</i>	48°73'635"	18°89'324"	Amphibia
<i>Rana temporaria</i>	48°66'786"	18°88'292"	Amphibia
<i>Rana temporaria</i>	48°66'503"	18°87'944"	Amphibia
<i>Rana temporaria</i>	48°70'512"	18°90'749"	Amphibia
<i>Rana temporaria</i>	48°70'947"	18°88'865"	Amphibia
<i>Bombina variegata</i>	48°70'573"	18°89'086"	Amphibia
<i>Bombina variegata</i>	48°66'140"	18°88'904"	Amphibia
<i>Bombina variegata</i>	48°67'723"	18°88'416"	Amphibia
<i>Bombina variegata</i>	48°70'591"	18°90'650"	Amphibia
<i>Bombina variegata</i>	48°73'472"	18°89'303"	Amphibia
<i>Salamandra salamandra</i>	48°66'800"	18°88'258"	Amphibia
<i>Salamandra salamandra</i>	48°65'947"	18°88'792"	Amphibia
<i>Salamandra salamandra</i>	48°70'860"	18°88'886"	Amphibia
<i>Salamandra salamandra</i>	48°71'478"	18°90'187"	Amphibia
<i>Triturus (= Mesotriton) alpestris</i>	48°66'140"	18°88'904"	Amphibia
<i>Zamenis longissimus</i>	48°69'976"	18°88'195"	Reptilia
<i>Zamenis longissimus</i>	48°67'006"	18°88'052"	Reptilia
<i>Anguis colchicus</i>	48°67'736"	18°88'384"	Reptilia
<i>Anguis colchicus</i>	48°70'867"	18°89'451"	Reptilia
<i>Anguis colchicus</i>	48°71'462"	18°90'611"	Reptilia
<i>Vipera berus</i>	48°73'630"	18°89'590"	Reptilia
<i>Zootoca (= Lacerta) vivipara (pannonica)</i>	48°70'915"	18°89'472"	Reptilia
<i>Zootoca (= Lacerta) vivipara (pannonica)</i>	48°73'321"	18°88'708"	Reptilia
<i>Zootoca (= Lacerta) vivipara (pannonica)</i>	48°73'401"	18°89'172"	Reptilia
<i>Lacerta agilis</i>	48°73'696"	18°89'560"	Reptilia
<i>Lacerta agilis</i>	48°66'759"	18°88'084"	Reptilia
<i>Natrix natrix</i>	48°73'405"	18°89'144"	Reptilia
<i>Coronella austriaca</i>	48°42'364"	18°53'473"	Reptilia

* Baláz, Marhold & Urban (2001)