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Soil and saproxylic species (*Coleoptera, Collembola, Araneae*) in primeval forests from the northern part of South-Easthern Carpathians

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Abstract. In 2006-2007 we carried out faunal investigations in the vernal, estival and autumnal seasons in the scientific reserve "Codrul Secular Giumalău" using quantitative sampling methods. We identified 189 species of *Coleoptera,* 70 of *Collembola* and 20 of *Araneae*. Of these, 11 phytophagous, 18 myceto/xylo-mycetophagous, 9 mixophagous, 18 xylo- and cambio-xylemophagous, 38 saproxylophagous, 125 (55 *Coleoptera*, 70 *Collembola*) detritivorous (sapro-, copro- and necrophagous), 60 (40 *Coleoptera*, 20 *Aranea*) predators/parasitoids. *Hymenaphorura polonica* Pomorski, 1990 (*Collembola*), and *Leiodes rhaeticus* Erichson, 1845 (*Coleoptera, Leiodidae*), are recorded for the first time in the Romanian fauna. The rare species and characteristic species for the old primeval spruce forests are analysed for each studied taxonomic group. The species richness and faunal diversity from the Giumalău primeval spruce forest are compared with those of other very well preserved forests from the Carpathians scientific reserves (Codrul Secular Slătioara, Pietrosul Rodnei). The species abundances were used to compute the similarity indexes between the sampled sectors of forest and to perform Cluster Analysis. We observed that the dead wood in the 2nd-6th phases of decomposition has a great influence not only on the saproxylic species but also on the soil fauna like ground beetles (*Carabidae*) that use the logs as ecologic microrefuges (winter refugees or diurnal refugees). The structure of the soil fauna is influenced by wood extraction from the forest ecosystem or by natural perturbations, this consisting in the appearance of opportunistic species as *Orchesella pontica* (*Collembola*) and in decreasing of species richness of Carabidae (*Coleoptera*).
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Keywords: Araneae, Collembola, Coleoptera, saproxylic, soil species, primeval forest, new records, Romanian Fauna.

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Introduction

Although some of the largest and well preserved virgin forests in Central and Eastern Europe are to be found in Romania, prior to the present study no quantitative and seasonal studies have been carried out on the coleopteran fauna in these forests.

The knowledge of the species diversity and species richness of such well preserved natural ecosystems is very important in grounding a standard of biodiversity useful in comparative studies and in estimating the depreciation degree of similar ecosystems but more or less influenced by the human activity.

The principal purpose was the evaluation of biodiversity of three invertebrate groups with high relevance in ecological studies (*Coleoptera, Collembola, Araneae*) due to their top position among decomposers and predators in all types of terrestrial microhabitats. The species richness and diversity of *Coleoptera, Collembola* and *Araneae* from the virgin forests could be used as a standard in future environmental studies, being a consistent datum point for the future studies of forest ecology. The use of such taxonomic groups as ecological markers in order to evaluate and control the degree of conservation and ecosystems vulnerability is a long practice in Europe. The experiments carried out by Ponge (1980) on *Collembola*, by Dajoz (1980) on *Araneae* and *Coleoptera* show the importance of these groups on soil and litter evolution - as factors of biodegradation, or as natural estimators of the dynamics and stability of ecosystems (Brandmayr et al., 2005). As Cerretti et al. (2003) mentioned "the knowledge of the quantitative composition of the fauna of an area, in an international, national, regional or local level, it is the starting point for the setting up of conservation strategies regarding particularly important natural environments. Therefore, the list of the species present in a certain territory do not only provide basic ecological and faunistic notions, but are also a necessary instrument for correct environmental planning".

Furthermore, using similar target taxonomic groups, analised with similar statistical methods presently used in other European countries (Ponel 1993, Trautner & Müller-Motzfeld 1995, Nardi 2004, Nardi & Vomero 2007), we target to integrate our results in the larger study of the European pattern of diversity of natural environments.

Materials and methods

We sampled fauna in eight sampling areas of 100 m^2 each. The plots were superimposed over the regular inventory network (100 x 100 m) established in the core area of the forest reserve in 2004 and covering 165 ha in total. Four sampling areas (F11, F13, G11, G13) were located at 1240-1295 m altitude and the others (N11, N13, O11, O13) at 1480-1525 m, the horizontal distance between the two groups being of about 800 m (Fig. 1).

We used two trapping methods: pitfalls (Barber traps) of 110 mm diameter and window traps (9 pitfalls at 1 window trap in each area). Where possible the pitfalls were placed near or under fallen stumps. As experimental design for sampling areas we used the "systematic model" of interspersing and the "homogenous experimental units" design for the pitfalls in each 100 m^2 sampling site. These designs achieve maximum interspersion of treatments at the statistical risk of errors arising from a periodic environment, being considered one of the most acceptable sampling models "that increase precision in any statistical comparison" (Krebs 1989, p. 272-275). For the soil`s fauna, the same sampling design for pitfall traps was used in Giumalău (Nitzu & Olenici 2009), Rodna (Nitzu et al. 2008) and Slătioara (Nitzu & Nae 2006).

Window traps were made of polyethylene film caught on a wire frame. The two panels having the dimensions of 400 x 600 mm were willing to cross. Under them a funnel with a diameter of 40 cm and 40 cm height was set, at the bottom with a plastic drum with a capacity of 1L. Above the panels, it was set up a cap with a diameter of 600 mm designed to reduce the volume of rainfall arriving in the trap. To be accessible from every direction, each trap was suspended with plastic string between trees, therefor the nearest tree was at least 1 m distance, and the mouth of the funnel being at

1 m from the ground. For insect conservation in the field, we used a solution of water, salt (NaCl) and detergent.

The samples were verified and emptied weekly (Barber traps) or at a period of two weeks (window traps); the sampling periods were: May 15-30; July 15-30 and September 1-15. For preparation and identification of sampled material we used Olympus SZ60, Stemi SV-11, Stemi-2000 and Discovery V8 stereoscopes, and Olympus CH-2 microscope.

The faunal differences between the investigated areas were analysed using cluster analysis based on species abundance (Bary-Curtis and Euclidean distance methods), followed, to enable better interpretation, by correspondence analysis (according to Ludwig & Reynolds 1988, Krebs 1989). The species richness was estimated using the Jack-knife method. For statistical analysis we used COA.BAS, CLUSTER.BAS (Ludwig & Reynolds 1988) and Biodiversity Professional V.2 (McAleece 1997) programs. Because the two species of collembolans with abundances much larger than general average were occurred, we used the data transformation *Log (1+y)* in base e.

The terms F11-O13 are those from the sampling areas established by ICAS (Fig. 1).

Results

For the Giumalău scientific reserve only, we collected and identified 190 species of *Coleoptera* (33 families), 70 species of *Collembola* (3 Orders, 11 families) and 20 species of *Araneae* (7 families) (Fig. 2 a, b, c and Annex 1).

Reffering to the identified species in Giumalău presented above, these represent 76.23% of the number of species of soil and saproxylic *Coleoptera* (239 estimated species), 87.5% of the number of species of *Collembolans* (80 estimated) and 80% (25 estimated) of those of *Araneae* predicted using the Jack-knife 2 estimator (Fig. 3 a, b, c).

If we compare the estimated richness of *Coleoptera* species in Giumalău forest with that recorded in other Norway spruce forest of Europe (e.g. Martikainen et al. 2000), we should conclude that our scientific reserve has a quite low diversity of beetles. In fact, the

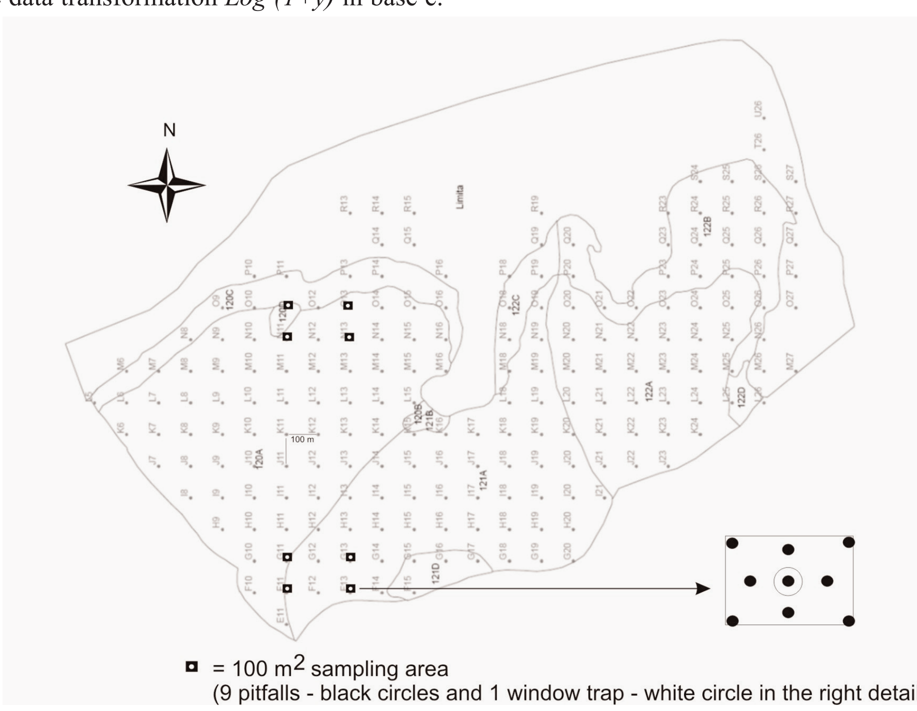


Figure 1 The research area (165 ha) showing the sampling grid and a sketch of the individual sampling areas

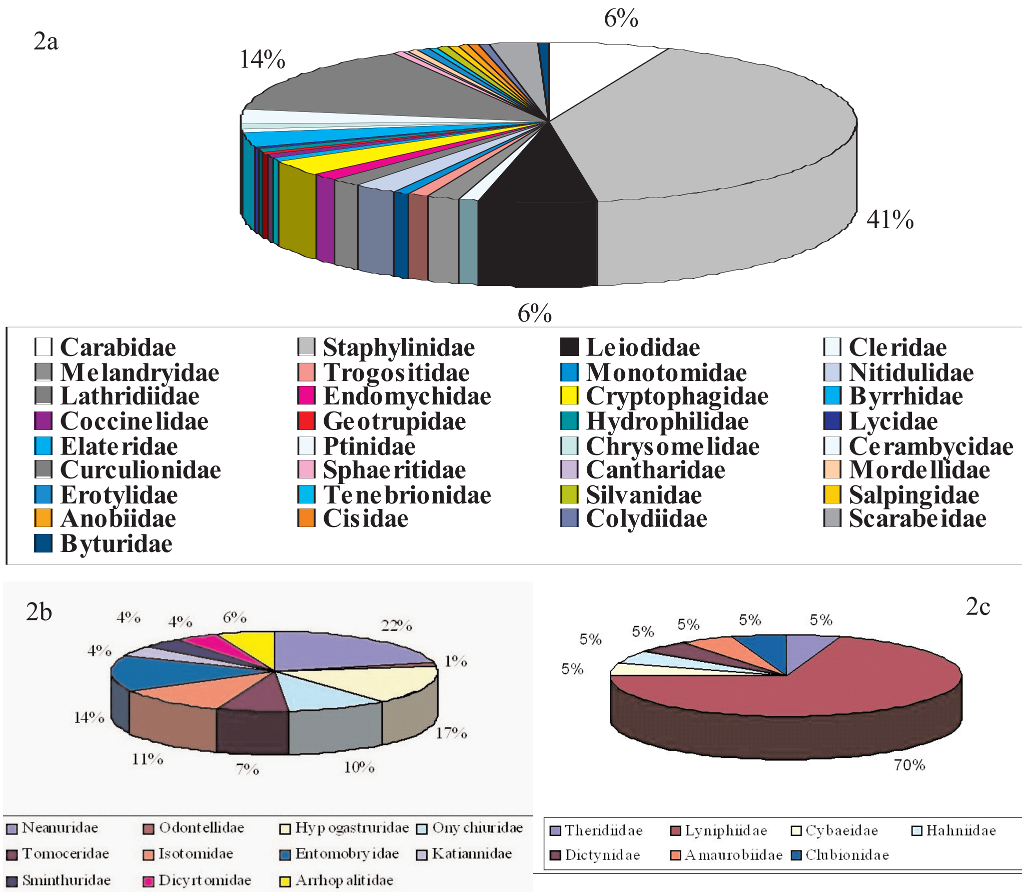


Figure 2 The percentage of species and their distribution per family at Coleoptera (a): 41% Staphylinidae, 14% Curculionidae, 6% (each) Carabidae and Leiodidae, 3% (each) Cerambycidae, Cryptophagi dae, Elateridae, Leiodidae, Scarabaeidae, 2% (each) Melandryidae, Nitidulidae, and 1% Geotrupidae (one of the most frequent in the area but represented by only *Anoplotrupes stercorarius*); Collembola (b): 22% Neanuridae, 17% Hypogasturidae, 14% Entomobryidae, 11% Isotomidae, 10% Onychiuridae, 6% Arrhopalitidae and 4% (each) Katiannidae, Sminthuridae, Dictyomidae, Isodontellidae; Araneae (c): 70% Lyniphiidae and 5% each the other families.

number of species recorded by us reffers mainly to the soil and saproxylic species and it could be also the result of a quite low sampling effort/smaller forest investigated area. It can also be explaiend by the specific microclimatic features that induce low diversity but as it could be observed (Annex 1), a high degree of endemicity.

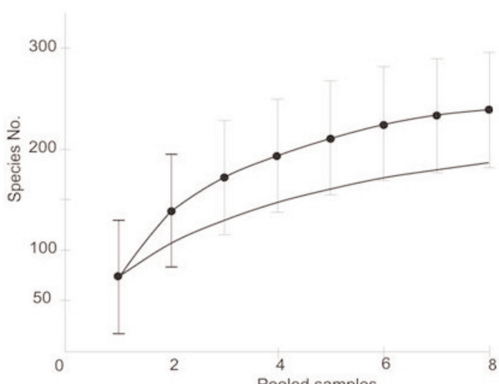
Twelve *Coleoptera* species that could not be captured in our eight sampling areas during the sampling periods, were captured in window traps or by direct sampling in other areas of the reserve or in other time periods. These are: *Cryphalus saltuarius* Weise 1891, *Crypturgus pusillus* (Gyllenhal 1813), *Dendroctonus micans* (Kugelann, 1794), *Ips duplicatus* (Sahlberg, 1836, *Ips amitinus* (Eichhof, 1871), *Phthorophloeus spinulosus* (Rey 1883) and *Xylechinus pilosus* (Ratzeburg 1837) (Scolytidae), *Cornumutila quadrivittata* Gebler 1830, *Judolia sexmaculata* (Linnaeus 1758) (Cerambycidae), *Anthaxia quadripunctata* (Linnaeus, 1758) (Buprestidae), *Calopus serraticornis* (Linnaeus, 1758) (Oedemeridae), *Xestobium rufovillosum* (De Geer 1774) (Anobiidae) and

Ceruchus chrysomelinus (Hochenwarth, 1785) (Lucanidae). Due to the comportamental particularities of the adults, some other species as *Hylastes brunneus* Erichson 1836, *Monochamus sartor* (Fabricius, 1787), *Prionus coriarius* (Linnaeus, 1758) could be captured only using the direct collecting methods. Our methods were selected to be efficient for soil species and for the most of saproxylic species, but they are less efficient for the most of the planticolous species (*Chrysomelidae, Curculionidae, Oedemeridae, Mordellidae* etc.).

Some other species were previously observed or collected by us in the area or the forests surroundinding the investigated area and we expect to be present in the scientific reserve too. Thus, we found *Orthotomicus suturalis* (Gyllenhal 1827), *Otiorhynchus coecus* Germar, 1824 (= Otiorhynchus niger (Fabricius) Auctorum), *Monochamus sutor* (Linnaeus, 1758), *Molorchus minor* (Linnaeus, 1758), *Callidium violaceum* (Linnaeus 1758), C. aeneum (DeGeer 1775), *Arhopalus rusticus* (Linnaeus 1758), *Ernobius mollis* (Linnaeus, 1758) in other spruce forests of Rarău-Giumalău Mountains, and some longhorn beetles living on spruce like *Pidonia lurida* (Fabricius 1792), *Anastragala dubia* (Scopoli 1763), *Pachyta quadrimaculata* (Linnaeus 1758), *Lepturobosca virens* (Linnaeus 1758) are mentioned in the literature (Panin & Săvulescu 1961, Gurău & Ciubotaru 2006) from this region too.

All these aspects indicate the necessity of a higher sampling effort, including simultaneous using of different sampling methods in order to have a good estimation of faunal diversity. This is especially the case in seeking-for rare species (see e.g. Martikainen & Kouki 2003).

We inventoried 280 species from the following trophic categories: 11 phytophagous, 18 myceto/xylo-mycetophagous, 9 mixophagous, 18 xylo- and cambio-xylemophagous, 38 saproxylophagous, 125 (55 *Coleoptera*, 70 *Collembola*) detritivorous (sapro-, copro- and necrophagous), 60 (40 *Coleoptera*, 20 *Aranea*) predators/parasitoids. For the *Coleoptera*, which represents the unique taxonomic group



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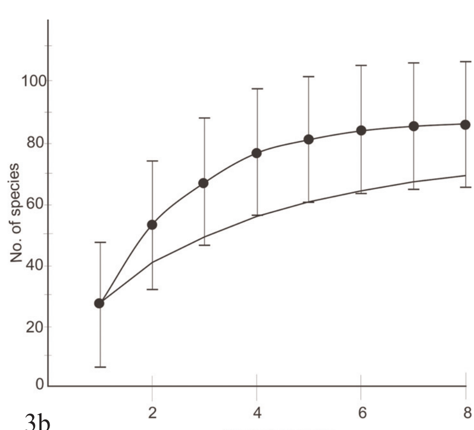

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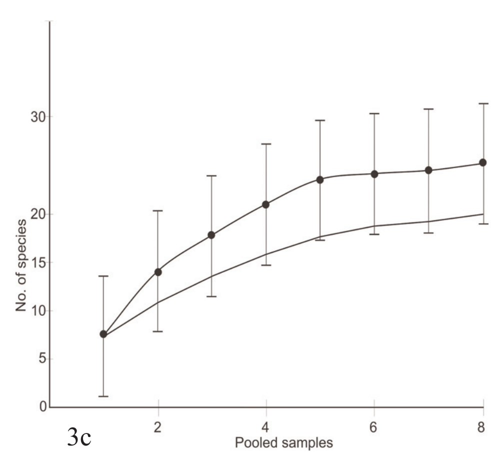

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Figure 3 Accumulation curve (smooth line) and predicted number of soil and saproxylic species (line with filled circles) using the Jack-knife2 estimator (±1) for *Coleoptera* (a), *Collembola* (b) and *Araneae* (c).

with representatives in all trophic categories (all Collembolans are detritivorous and all Araneae are predators), the distribution of trophic categories, each represented by a number of species, among ecological groups (according to the terminology proposed by Bouget et al. 2005) is given in Annex 1.

Taking into consideration the quantitative sampling, the seasonal differences between the studied areas are illustrated by the cumulated abundances of species per sectors (as general representation at "macrotaxonomical" scale) (Fig. 4, 6, 8) and by the species richness (Figs. 5, 7, 9)

A more synthetic analysis, taking into consideration both species richness in each sector

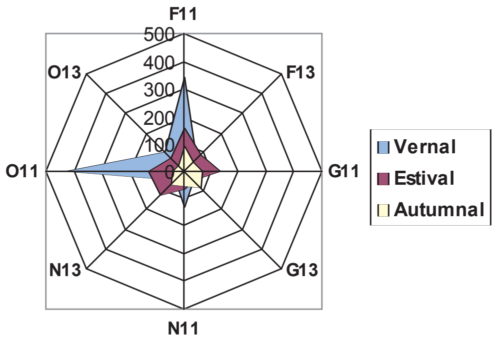

Figure 4 The Radar diagram of the the cumulated abundances of springtails per sectors and seasons in the Giumalău forest

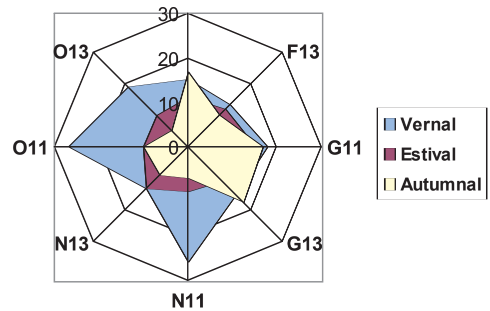

Figure 5 The Radar diagram of the species diversity of springtails per sectors and seasons in the Giumalău forest

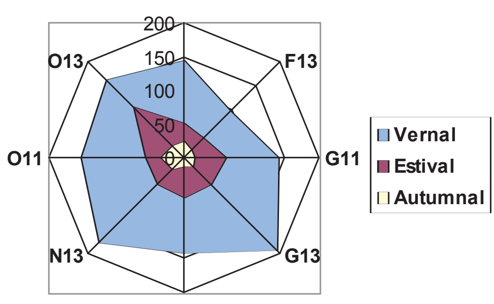

Figure 6 The Radar diagram of the the cumulated abundances of soil and saproxylic beetles per seasons and sectors in the Giumalău forest

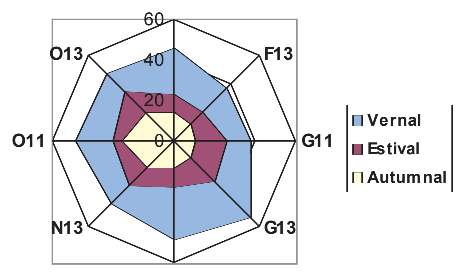

Figure 7 The Radar diagram of the species diversity of soil and saproxylic beetles per sectors and seasons in the Giumalău forest

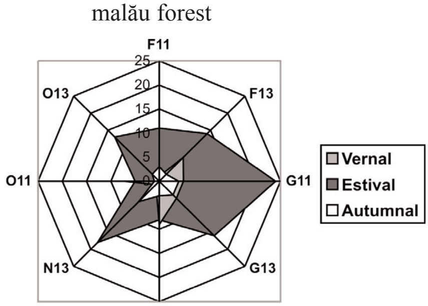

Figure 8 The Radar diagram of the the cumulated abundances of spiders per sectors and seasons in the Giumalău forest

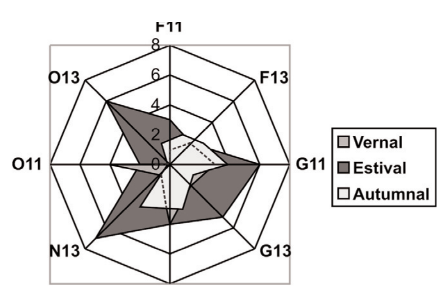

Figure 9 The Radar diagram of the species diversity of Araneae per sectors and seasons in the Giumalău forest

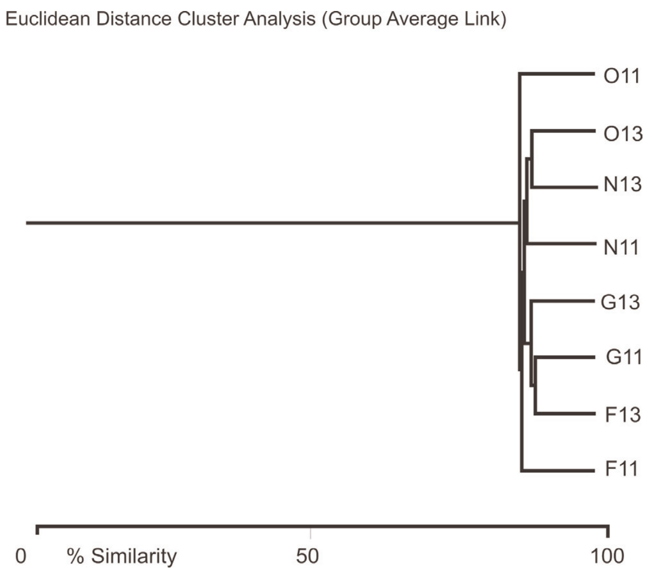

Figure 10 Dendrogram of sampled areas based on the abundances of *Coleoptera, Collembola* and *Araneae* (cumulated data for vernal, aestival and autumnal seasons) (Euclidean distance, Group Average Link).

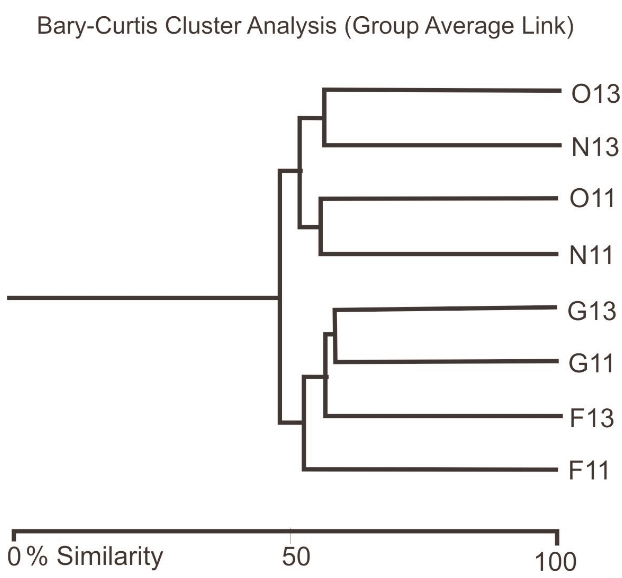

Figure 11 Dendrogram of sampled areas based on the abundances of *Coleoptera, Collembola* and *Araneae* (cumulated data for vernal, aestival and autumnal seasons) (Bary-Curtis Method, Group Average Link)

and their specific abundances is given by the cluster analysis.

The cluster analysis for the sampled areas based on cumulated data for vernal, aestival and autumnal seasons illustrates the general similarity between areas. For a better interpretation of data, we performed cluster analysis using two different methods: Euclidean distance and Gropup Average Link method (Fig. 10) and Bary-Curtis with Group Average Link method (Fig.11).

It could be observed that, putting the accent on the rare species and on the species with low abundances (Euclidean distance and Group Average Link Method), the F11 and O11 areas are the most dissimilar from the faunal point of view (Fig. 10), situation also suggested by Correspondence Analysis (Fig. 12)

Using the Bary-Curtis with Group Average Link method (Fig. 11), that is more influenced by the species with high abundances, but less sensitive at the rare species and species with

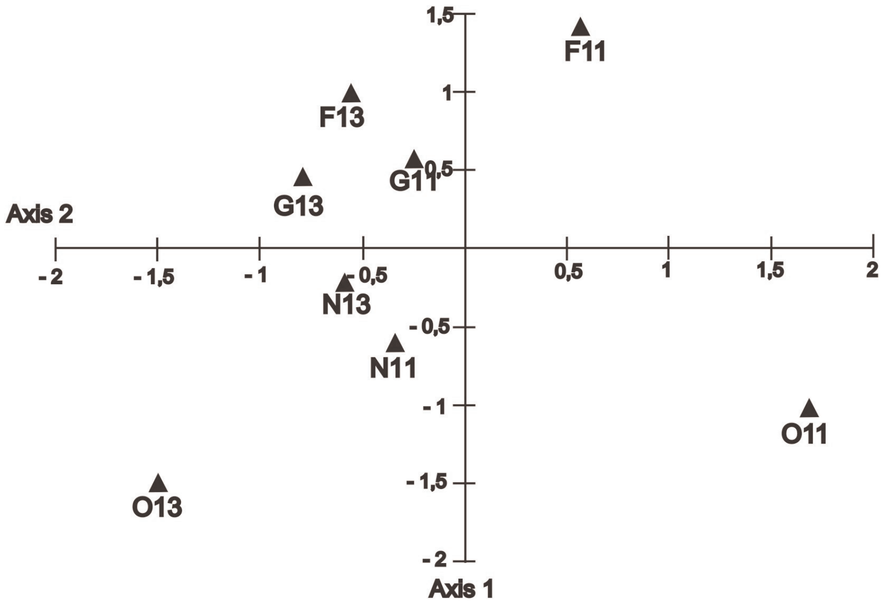

Figure 12 Correspondence analysis for 8 sampling sites in the Giumalău forest based on *Coleoptera*, *Collembola* and *Araneae* abundances

low abunadnces, we observe that the studied areas are clustered concordant to their altitudinal distribution (the areas N11, N13, O11, O13 being situated near to 1500 meters altitude and F11, F13, G11 and G13 situated in areas surround 1200-1300 meters altitude)

The comparative faunal analysis

To appreciate how significant is the faunal structure of this primeval spruce forest for the forest ecosystems from the South-Eastern Carpathians, we turn for comparisons, to our previous studies on fauna of other strictly protected primeval forests from the same geographic area: the primeval mixed forest from the Scientific Reserve "Codrul Secular Slătioara" (Nitzu & Nae 2006) and the primeval spruce forest from the Rodna Mountains Biosphere Reserve (Nitzu et al. 2008). For this comparison we used only the data concerning the edaphic species occurred in the vernal season, the richest in species (referring to the Giumalău only, the species number in the vernal season consists in 126 coleoptera/52 collembola/13 aranea versus 103/30/14 species in the aestival season and 62/31/11 in the autumn). Of the total of 268 soil species inventoried in the Giumalău, Slătioara and Rodna spruce forests, 73 are common for Rodna and Giumalău, 50 for Slătioara and Giumalău and only 37 were observed in all three reserves.

The similarity matrix based on the presence (1) or absence (0) of species in Giumalău, Rodna and Slătioara is presented in Table 1.

The proportion between the soil species of collembolans, coleoptera and spiders are more or less similar in all three forests for the vernal season (Fig. 13), the most rich in species being the order *Coleoptera* (76/56/61), followed by *Collembola* (50/53/30) and *Araneae* (35/14/28).

More information on the coleopteran eco-

Table 1 The similarity matrix for Giumalău, Rodna, Slătioara based on soil species (*Collembola, Coleoptera, Araneae*)

Area	Giumalau	Slatioara	Rodna
Giumalău	*	38,8664	54,3554
Slătioara	*	*	36,6906
Rodna	*	*	*

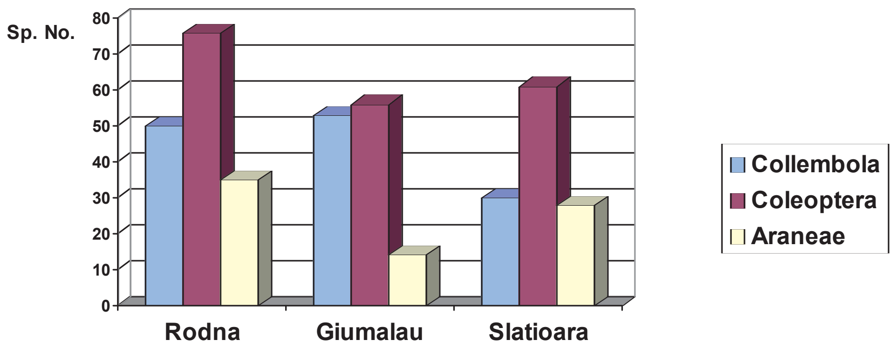

Figure 13 The number of species of *Collembola, Coleoptera* (edaphic species) and *Araneae* for vernal season in three protected primeval forests of South-Eastern Carpathians

faunistic associations in the Giumalău virgin Norway spruce forest was presented by us in a recent paper (Nitzu & Olenici 2009).

Discussion

Several eco-faunistic aspects could be pointed out and discussed for the virgin Norway spruce forest "Codrul Secular Giumalău".

From the faunistic viewpoint, *Hymenaphorura polonica* Pomorski, 1990 (Collembola, Onychiuridae) and *Leiodes rhaeticus* Erichson, 1845 (Coleoptera, Leiodidae) are for the first time recorded in the Romanian fauna.

Hymenaphorura polonica is a saproxylophagous species, specialised on wet and rotten wood (Pomorski 1998), while *Leiodes rhaetica* is a mycetophagous beetle considered as a very rare species in Europe since 1900 (Reitter 1900, Kuhnt 1912) and it is characteristic for old, virgin forests, with a high degree of naturalness.

Among the collembolans, *Deutonura stachi* (Gisin 1952) and *Pseudachorutes corticicolus* (Schaffer 1897) were recently recorded in the Maramureş Mountains (László et al. 2006), our study indicating that this species is spread over larger areas in the South-Eastern Carpathians. Other rare species, recorded here for the first time in the South-Eastern Carpathians are *Arrhopalites principalis* Stach, 1945, known up to now only in caves from Banat (Peştera cu Apă din Cheile Gârliştei and Peştera de după Cârşe) (Gruia 2000) and in Natural Reserve Cheile Vârghişului (Nitzu et al. 2007) and *Xenylla maritima* Tullberg 1869, prior to the present study known only in Dobrogea (Gruia 1965) but recently found by us in the mountain zone in the Biosphere Reserve Pietrosul Rodnei (Nitzu et al. 2008). Other collembolan species like *Neanura parva, Pseudachorutes corticicolus* are characteristic saprophagous for coniferous forests.

Among the Coleoptera`s, *Tachinus marginellus* (Fabricius 1781), *Agaricophagus cephalotes* W. L. E. Schmid, 1841 (Leiodidae), *Xylita livida* Sahlberg, 1834 (Melandryidae), *Salpingus ruficollis* (Linnaeus, 1761) (Salpingidae), *Cornumutila quadrivittata* Gebler 1830 (Cerambycidae) are very rare species, indicators for primeval coniferous forests.

If we consider all 19 bark beetle species caught in Giumalău forest, they represent almost 68 % of the total number of scolitid species which are associated with *Picea abies* in Central Europe according to Pfeffer (1995). This is a very high proportion, because the most insect species mentioned by Pfeffer, and which have not been found so far in Giumalău, are normally associated with tree species from other coniferous genera like *Pinus* and *Larix*, or they are polyphagous, living mainly on broadleave species and only sometimes on conifers. On the other hand, in Europe *Ips duplicatus* usualy occurs at lower altitudes, up to 1000 m (Zúbrik et al. 2006, Holuša & Knížek 2007), and its abundance decreases very much in mountain zone (Holuša 2004), while *Orthotomicus suturalis* (Gyllenhal 1827) prefers the trees which previously have been damaged by fire (Pfeffer 1995), and such trees are not to be found in Giumalău forest.

Longhorn beetles are also quite well represented, although many other species mainly associated with spruce remain to be found. Thus, out of 23 species, whose larvae develop especially on *Picea*, and which were previously mentioned from Romania (Panin & Săvulescu 1961, Bense 1995), we found only eight species. On the other hand, the most abundant longhorn beetle species were *Evodinus clathratus* and *Alosterna tabacicolor*, which develop ususaly on broadleave wood. This it could mean that we should expect to find also other species from this category, altough broadleave tree species seem to lack in the reserve.

The most longhorn beetle species from Giumalău have been repeatedly observed in several other mountain forests of our country (Panin & Săvulescu 1961, Gurău 2005), but *Cornumutila quadrivittata* was aparently found only in Făgăraş Mountains, in 1957 (Panin & Săvulescu 1961). This confirms its rarity in Carpathian Mountains (Witkowski et al. 2003, Hoskovek & Rejzek 1997-2007).

Regarding to the distribution of trophic categories among microhabitat preferences, the greatest number of predator species of *Coleoptera* (preponderantly belonging to *Carabidae* and *Staphylinidae families*) are soil species, but over 70% of these depend on logs as ecological micro-refuge, essential for the species survival during the vernal or hibernal periods of inactivity. The corticolous predators (species which hunt on or under bark) are represented by some species of *Staphylinidae* (Annex 1) and *Cleridae* (*Thanasimus formicarius, Thanasimus femoralis*). These hunt especially cambiophagous species (which feed with cambium) of *Scolytinae*. A rare corticolous species, characteristic for old coniferous forests is *Salpingus ruficollis*, its larvae being parasitoids on *Scolytinae*.

The sapro-lignicolous beetles (which live on dead wood in different stages of decomposition) belong to many families (Annex 1) and are mainly represented by sapro-xylophagous (consumers of decomposed dead wood) or xylo-mycetophagous (consuming rotten wood with mycelium). Of the predators, only *Dictyoptera aurora* was observed in this type of ecological group, but here we should mention the cavicolous predator (which live and hunt in burrows of *Scolytinae*) *Glischrochilus quadripunctatus.*

The Norway spruce dead wood is colonized by saproxylic insects in a certain succession, according to the wood decaying phase, and several stages have been identified. Taking into consideration the above mentioned taxonomical groups (mainly based on coleopterological observations), Ceianu (1978) identifed the folowing "stages": anobioid, scolytoid, limexyloid, early cerambycoid, late cerambycoid, cucujoid, lucanoid, formicoid and lumbricoid. Saproxylic beetle species found in Giumalău forest are associated with all these stages, as follows:

- in the anobioid stage - *Microbregma* (Anobiidae);
- in the scolytoid stage - *Dendroctonus, Ips, Pityogenes, Pityophthorus, Cryphalus, Crypturgus, Polygraphus, Xylechinus, Hylurgops, Hylastes, Dryocoetes* (Scolytinae), *Thanasimus* (Cleridae), *Epuraea* (Nitidulidae), *Rhizophagus* (Monotomidae);
- in the limexyloid stage - *Hylecoetus* (Lymexylidae), *Trypodendron* (Scolytinae); *Epuraea* (Nitidulidae);
- in the early cerambycoid stage - *Tetropium* (Cerambycidae), *Anthaxia* (Buprestidae);
- in the late cerambycoid stage - *Oxymirus, Gaurotes, Evodinus, Alosterna, Cornumutila* (Cerambycidae);
- in the cucujoid stage - *Rhagium* (Cerambycidae), *Glischrochilus* (Nitidulidae);
- in the lucanoid stage - *Ceruchus chrysomelinus* (Lucanidae), *Elateridae*;
- in the formicoid stage - Staphylinidae, Cryptophagidae, Scarabaeidae.

This succesion and the high number of xylophagous, saproxylophagous, xylo-mycophagous and sapro-mycetophagous species reflects the diversity, abundance and the continuity of dead wood in this forest.

Three species of *Coleoptera* found in Giumalău forest are included in the list of "saproxylic insect species useful in identifying forest of international importance to nature conservation" published by Speight (1989). These are:

Carabus auronitens, Cornumutilla quadrivittata and *Ceruchus chrysomelinus*.

As long as *Cornumutilla quadrivittata, Ceruchus chrysomelinus* and *Xylita livida* Sahlberg 1834 are considered "Urwald relict species", associated with continuity of old growth stand features like tree and dead wood maturity and diversity (Müller et al. 2005), their presence in Giumalău forest testifies the conservation of ecosystem naturalness. According to Biström & Väisänen (1988, mentioned by Bakke 1999), *Dendrophagus crenatus* (Paykull 1799) and *Ostoma ferruginea* (Linnaeus 1758) are associated with old-growth spruce forests too.

Other four species observed in Giumalău forest, namely *Calopus serraticornis, Judolia sexmaculata* and *Dictyoptera aurora,* are regarded in France as patrimonial beetles (Dodelin & Lempérier, 2004).

The high number of xylophagous, saproxylophagous, xylo-mycophagous and sapromicetophagous species reflects the diversity and the abundance of dead wood in this forest. Analyzing the cumulated abundances of species per sectors (as general representation at "macrotaxonomical" scale) (Figs. 4, 6, 8.) and the number of species (Figs. 5, 7, 9) it could be observed that for Collembolans (Fig.4), for instance, the cumulated abundances are very high in the sectors O11 and F11 while the species richness is high in sectors O11 and N11 for the spring (vernal) season. This is caused by the presence of two dominant species: *Pogonognathellus flavescens* dominant in F11 (A = 51.54 %), and *Orchesella pontica* in O11 (A = 50.68 %). The area N11 presents a great number of species (26) but without a clear dominant species.

Coleopterans are the most abundant and richest in species. While collembolans appear to have two periods with maximum number of species (one in vernal season for sectors O11 and N11, and one in autumn in sectors G11-G13), the cumulative abundance and number of species of Coleoptera decrease constantly from spring to autumn and the spiders are most abundant and richest in species in summer. This is caused by the habitat preferences. While ground beetles prefer "open" habitats with rare and small soil vegetation, more frequent in the spring period, many species of spiders are planticolous and more frequent in summer when the soil vegetation is developed and more dense. Beside this, many spiders are thermo-xerophylic.

These simple diagrams clearly illustrate that the so called "ecological studies" based on "macrotaxonomy" which took into consideration only the quantitative data referring to "macrotaxa" (classes, orders) and not the quantitative studies carried out at the species level, are superficial and inconclusive for ecological studies. For a suitable ecological study, only the quantitative studies carried out at the specific level are valuable.

The cluster analysis based on species abundances, using Bary-Curtis distance equation, ignores the cases when a species is absent in both samples compared in the moment of clustering and is influenced by the species with high abundances. The similarity index is very little influenced by the rare species (Krebs 1989). On the contrary, the method using Euclidean distance is more sensitive at the presence of rare species and with low abundances. Therefore, if the purpose is to have in view how the dominant species influence the similarity between areas we should see the dendrogram obtained using Bary-Curtis distance equation. If we have in view to observe the similarity between areas weighted by the species with low abundance (rare or not), the dendrogram obtained using Euclidean distance should be analysed. The "Centroid average" clustering method is considered one of the best "space conserving" methods (Ludwig & Reynolds 1988, Pielou 1984)

It could be observed that taking into consideration the rare species and species with low abundances, the areas F11 and O11 are the most dissimilar (fact also suggested by the correspondence analysis - Fig. 12). This is caused by the fact that F11 is an area rich in species with comparable abundances but also containing rare species. Opposite, the area O11 has low species richness but it is populated by the species *Orchesella pontica* (Collembola) eudominant.

Area F13 (near to the road) is characterised by lower number of Carabidae species than other areas, fact induced by the relatively low quantity of logs (in the stages of decomposition 3 to 6) proper for circadian or seasonal micro-refuges.

The presence of eudominant or oportunistic species (like *Orchesella pontica* in the area O11) is characteristic for habitats that recently suffered a sever alteration/modification caused by natural - as wind throw, or anthropic factors. These factors induce a homogeneity in the habitat that causes, in its turn, the dissapearance of the species with low ecological plasticity (specialised species) and the rapid developement of populations of few species with high ecological plasticity. The eco-faunistic associations of terrestrial and saproxylic beetles from Giumalău were presented separately by us in a recent paper (Nitzu & Olenici 2009).

Conclusion

During our researches in the Giumalău Scientific Reserve we collected and identified 189 species of Coleoptera, 20 of Araneae and 70 of Collembolans from the total of 239/25/86 species predicted using the Jack-knife 2 estimator.

Some rare species, indicators for primeval spruce forests (*Rhinosimus ruficollis, Xylita livida, Cornumutila quadrivittata, Ceruchus chrysomelinus* - Coleoptera) were identified.

Deutonura stachi and *Pseudachorutes corticicolus* recently recorded in the Romanian fauna in the Maramures Mountains are cited here for the Giumalău Mountain.

Hymenaphorura polonica Pomorski, 1990 (Collembola) and *Leiodes rhaeticus* Erichson, 1845 (Coleoptera, Leiodidae) are for the first time recorded in the Romanian fauna, the last one being considered a very rare species and indicator of primeval forests since the very beginning of XX-th century.

The species richness of the edaphic fauna from the Scientific Reserve "Codrul Secular Giumalău" (analysed for the vernal season) is comparable to other strictly protected forests (Pietrosul Rodnei, Codrul Secular Slătioara).

The cluster analysis performed for 8 sectors (sampling areas), situated at different elevations and in forested areas in different phases of development in the Giumalău Scientific Reserve, shows that the faunal diversity is a valuable indicator for the areas affected by recent environmental disturbance.

The quantity of dead wood in different decomposition phases (mainly from third to sixth phases) shows its huge importance not only for the so called "saproxylic" species but, as microecological refugee, also, for large populations of terrestrial predators (i.e. Carabidae), or terrestrial decomposers which are very sensitive at the quantity and quality of the logs density, or for litter decomposers as *Orchesella pontica*.

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ANNEX 1. The species of Coleoptera collected with pifall and window traps (the species collected with window traps are marcked with "+") (some species collected by both methods) . The indicatives F11-O13 are those from the sampling areas established by ICAS. Abbreviations for microhabitats: (E)-edaphic, (Cr) - corticolous, (Slg) - saprolignicolous, (Lgn) - lignicolous, (Fu) - fungicolous, (Cav) - cavicolous, (Fr) - frondicolous. v/e/a - no. of specimens for vernal/aestival/autumnal seasons

	Species	Trophic cathegories and prefferences for microhabitats	F11 v/e/a	F13 v/e/a	G11 v/e/a	G13 v/e/a	N11 v/e/a	N13 v/e/a	O11 v/e/a	O13 v/e/a
	0	1	2	3	4	5	6	7	8	9
	Fam. Carabidae									
1.	*Calathus metallicus* Dejean, 1828	Predator (E)								2/0/1
2.	*Carabus auronitens escherii* Palliardi, 1825	Predator (E)	1/0/0			2/2/0		1/0/0	1/0/0	
3.	*Carabus linnei* Panzer, 1810	Predator (E)		0/2/0	1/1/0	1/1/0		0/1/1		0/1/0
4.	*Carabus violaceus* Linnaeus, 1758	Predator (E)			1/0/0	0/1/0				
5.	. *Cychrus caraboides* (Linnaeus, 1758)	Predator (E)			2/0/0					
6.	+ *Harpalus atratus* Latreille, 1804	Predator / Mixophagous (E)					1/0/0		2/0/0	
7.	*Pterostichus jurinei* (Linnaeus, 1758)	Predator (E)	17/6/0	1/0/0	10/2/0	12/3/0	9/2/1	31/4/0	9/0/0	16/0/0
8.	*Pterostichus foveolatus* (Duftschmid, 1812)	Predator (E)	8/0/0			6/1/0		1/0/0	3/0/0	1/0/0
9.	*Pterostichus pillosus*	Predator (E)	10/0/0	4/0/0	3/0/0	16/1/0	4/0/0	8/0/0	3/0/0	
10.	*Pterostichus rufitarsis* (Duftschmid, 1812).	Predator (E)	0/2/0	0/0//0	1/0/1	1/1/0	5/1/1	3/0/0	2/0/0	3/0/0
11.	*Pterostichus unctulatus* (Duftschmid, 1812)	Predator(E)	5/8/0	0/1/0	2/3/0	1/9/1	4/6/0	0/4/0	4/3/0	1/2/0
12.	*Trechus striatulus* Putzeys, 1847	Predator (E)	2/0/0	1/0/0	0/1/0	0/1/0		1/0/0	0/0/2	1/2/0
	Fam. Staphylinidae									
13.	+*Acrulia inflata* (Gyllenhal, 1813)	Mycetophagous / Saprophagous (Slg)	0/0/3	3/0/1	1/0/0	5/0/0	1/0/0	2/0/0	2/0/0	1/0/0
14.	*Aleochara diversa*. Sahlberg, 1876	Saprophagous (E)		0/1/0	0/1/0				1/1/0	
	+					2/0/0				1/0/0
15.	*Aleochara laevigata* Gyllenhal, 1810	Saprophagous (E)		0/1/0		0/3/0		0/1/0		0/2/0
	+		0/1/0					0/1/0		
16.	+*Amphichroum canaliculatum* (Erichson, 1840)	Saprophagous (E)	1/0/0					2/0/0	2/0/0	
17.	+*Antophagus (Dimorphoschelus) omalinus arrowi* Koch, 1933	Saprophagous (Slg)						0/1/2	0/1/1	

Annex 1 (follow-up)

18	*Atheta sp.*					0/1/0		1/0/0		
19	*Atheta boletophila* Thomson, 1856	Mycetophagous/Saprophagous (Fu)				7/0/0				
	+		1/1/0						0/0/1	
20	*Atheta contristata* Kraatz, 1856	Saprophagous/Mycetophagous (E)					0/1/0			
21	+*Atheta (Anopleta) corvina* (C.G.Thomson, 1856)	Mixophagous							0/2/1	
22	*Atheta cf. gyllenhalii* Thomson, 1856	Saprophagous/Mycetophagous (E)	0/0/1	2/1/0			0/2/0			0/2/0
23	*Atheta luridipennis*	Saprophagous/Mycetophagous								0/4/0
24	(Mannerheim, 1830)	(E)								
	+								0/0/1	
25	+*Atheta (Besobia) occulta* Erichson, 1837	Saprophagous/Mycetophagous (E)							2/0/0	
	+				1/0/0	2/0/0	1/0/0	3/0/1	2/0/3	0/0/1
26	*Atheta paracrassicornis* Brundin, 1954	Saprophagous/Mycetophagous (E)			0/2/0	0/2/0			0/3/0	
27	+*Atrecus (=Baptolinus) pilicornis* Paykull, 1790	Predator (E)		2/0/0	4/0/0	4/0/0	0/1/0	1/0/0	0/1/0	1/1/0
28	+*Bisnius (=Philonthus) fimetarius* (Gravenhorst, 1802)	Predator (E)							1/0/0	1/0/0
29	*Bolitobius castaneus* Stephens, 1832 =*Bryocharis analis*	Saprophagous (E)		3/0/0						
				2/0/0						
30	*Bryophacis rufus* Erichson, 1839	Saprophagous/Mycetophagous (Slg)	1/0/0							0/2/0
			4/1/0	2/2/0	14/2/0	7/0/0	1/7/0	2/0/0	6/1/1	0/0/1
31	*Parabolitobius inclinans* Gravenhorst, 1806 = *Bryocharis inclinans*	Saprophagous (E)			1/0/0					
32	+*Coprophilus striatulus* Fabricius, 1793	Saprophagous (E)							1/0/0	
33	+*Deliphrosoma prolongatum* Rottenberg, 1873	Saprophagous (E)		1/0/0			2/0/0	1/0/0	1/0/0	4/0/0
	+			1/0/0			2/0/0	1/0/0	1/0/0	4/0/0
34	*Dinaraea linearis* Gravenhorst, 1802	Saprophagous/Mycetophagous (Cr)				0/1/0		0/1/0		0/1/0
35	+*Eusphalerum limbatum* Erichson, 1840	Mixophagous (E)					2/0/0			1/0/0

Annex 1 (follow-up)

36	+*Eusphalerum longipenne* Erichson, 1839	Mixophagous (E)			1/0/0					1/0
37	+*Eusphalerum ophtalmicum* Paykull, 1800	Mixophagous (E)						0/2/0	0/1/0	
38	+*Ischnoglossa prolixa* Gravenhorst, 1802	Mixophagous (E)		0/0/2					0/0/1	
39	+*Leptusa carpathica* Weise, 1877	Saprophagous/Mycetophagous (Slg)		2/0/0		2/0/0	2/0/0			0/1/0
40	*Leptusa eximia* Kraatz, 1856	Mycetophagous (Fu)	1/0/0							
41	+*Leptusa fuliginosa* Aubé, 1850	Mycetophagous/Saprophagous (Slg)	3/0/0	7/0	1/0	7/0	5/0	0/0/2	0/0/1	
42	+*Leptusa pulchella* Mannerheim, 1830	Saprophagous (Slg)	0/0/2	0/0/2		0/0/4	0/0/2	0/0/3	0/0/3	0/0/3
43	*Leptusa (Pachygluta) ruficollis* (Erichson, 1839)	Mycetophagous, (Cr)			0/0/1			0/0/1		
44	+*Lesteva longoelytrata* Goeze, 1777	Saprophagous (E)						11/0/0		4/0/0
45	+*Lordithon (=Bolitobius) lunulatus* Linnaeus, 1760	Mycetophagous, sapro-Xylophylous (Fu)		1/0/0					1/0/0	
46	+*Megarthrus sinuatocollis* (Boisduval et Lacordaire, 1835)	Mycetophagous (probable) (Fu)						1/1/0		
47	+*Mycetoporus lepidus* (Gravenhorst, 1802 (= *brunneus* (Marsh.)	Mycetophagous/sapro-xylophagous (Fu)	0/1/0							
48	*Mycetoporus mulsanti* Ganglbauer, 1895	Mycetophagous (Fu)	0/0/1						0/0/1	
49	+*Mycetoporus splendens* Marsham, 1802	Mycetophagous (Fu)						0/1/0	0/1/0	
50	*Ocypus megalocephalus* Nordmann, 1837	Predator (E)								1/0 /0
51	*Omalium validum* Kraatz, 1857	Saprophagous/Mycetophagous (E)			1/0/0	5/0/0	2/0/0		4/0/0	6/0 /0
	+							1/0/0		2/0/0
52	*Othius crassus* Motschulsky, 1858	Predator (E)	1/0/0			1/0/0	1/0/0			
53	+*Othius lapidicola* Kiesenwetter, 1848	Pradator (E)							0/1/0	
54	*Othius transsilvanicus* Ganglbauer, 1895	Predator (E)	1/0/0			0/1/0				1/0 /0
55	*Oxypoda opaca* Gravenhorst, 1802	Saprophagous/Mixophagous (E)								0/1 /0
56	*Philonthus decorus* Gravenhorst, 1802	Predator (E)				1/0/1				
57	*Philonthus fumarius* Gravenhorst, 1806	Predator/necrophagous (E)	1/0/0							
58	*Philonthus laevicollis* (Boisd. Lacordaire, 1835).	Predator (E)				0/0/1				

Annex 1 (follow-up)

59	*Philonthus (Onychophilonthus) marginatus* Fabricius, 1775	Predator (E)					0/1/0			
60	+*Phloenomus (Xylostiba) monilicornis* Gyllenhal, 1810	In borrows of Scolitinae (Cav)						1/0/0		
61	+*Phyllodrepa floralis* Paykull, 1789	Saprophagous/Mixophagous/ pholeuophyl (E/Cor)								4/0/0
62	+*Phyllodrepa (Dropephylla) linearis* Zetterstedt, 1828	Mixophagous (Cr)		0/2/2	0/3/2	0/0/1		0/0/1	0/0/3	0/0/1
63	+*Phyllodrepa melanocephala* (Fabricius, 1787)	Saprophagous/Mixophagous (Cr)	0/0/1							
64	*Proteinus brachypterus* Fabricius, 1792	Saprophagous/Mycetophagous (E)	0/0/3	0/0/2	0/0/1	0/0/1	0/0/1			
65	+*Proteinus brachypterus* Fabricius, 1792	Saprophagous (E)								0/0/1
66	+*Quedius alpestris* Heer, 1839	Predator (Cr)							1/0/0	
67	*Quedius cincticollis* Kraatz, 1857	Predator (E)						0/1/0		0/4/0
68	+*Quedius collaris* Erichson, 1840	Predator		1/0/0						
69	*Quedius fumatus* Stephens, 1833	Predator (E)			1/0/0	1/0/0		1/0/0		2/0/0
70	*Quedius mesomelinus* Marsham, 1802	Predator/necrophagous (E)		0/1/0	0/1/0	3/0/0			1/0/0	
	+				1/0/0	1/0/0	1/0/0		4/0/0	1/0/0
71	*Quedius ochropterus* Erichson, 1840	Predator (E)	0/1/0				0/1/0			
72	+*Quedius paradisianus* Heer, 1839	Predator (Cr)			1/0/0	5/0/0	1/0/0	2/0/0		1/0/0
73	+*Quedius (Quedionuchus) plagiatus* Hochhuth, 1849	Predator (Cr)	5/0/0	1/0/1	3/0/2	1/0/1	3/0	7/1/1		1/0/2
74	+*Quedius (Quedionuchus) punctatellus* Heer, 1839	Predator (Cr)					1/0/0		3/0/0	2/0/0
75	*Quedius transsilvanicus* Weise, 1875	Predator (E)	4/0/0	1/0/0	3/0/0	3/0/0		0/3/0	0/0/1	0/1/0
76	+*Quedius xanthopus* Erichson, 1839	Predator (Cr)	1/0/0	1/0/0	1/0/3			0/0/1		
77	+*Scopaeus cognatus* Mulsant & Rey, 1855	Mixophagous (E)						0/0/1		
78	*Silusa rubra* Erichson, 1839	Mycetophagous (Fu)	1/0/0							
79	+*Stichoglosa gobanzi* Reitter, 1891	(E)					0/1/0			
80	+*Tachinus marginellus* (Fabricius, 1781)	Saprophagous/Coprophagous (E)						0/1/0		
81	*Tachinus pallipes* Gravenhorst, 1806	Saprophagous/copro/necrophagous (E)	8/10/5	14/2/0	5/6/0	24/5/2	18/16/0	20/7/1	1/9/0	13/38/0
	+		0/0/1	1/0/0	1/0/0	3/0/0	1/0/0		4/0/0	3/0/0

Annex 1 (follow-up)

82	*Tachinus proximus* Kraatz, 1855	Saprophagous/ Necrophagous (E)					0/3/0			
83	*Tachinus rufipennis* Gyllenhal, 1810	Saprophagous/Necrophagous (E)							1/0/0	0/0/3
84	*Tachinus subterraneus* Linnaeus, 1758	Saprophagous/ Necrophagous (E)			1/0/0					
	+							2/0/0		
	Subfam Pselaphinae									
85	+*Bryaxis ruthenus* (Saulcy, 1877)	Saprophagous (Slg)						0/1/0		
86	+*Euplectus kirbyi revelierei* Reitter, 1884	Saprophagous (Slg)			0/3/2	0/3/0	0/2/1	0/3/0	0/5/0	0/2/1
87	+*Bibloporus bicolor* Denny, 1825	Saprophagous (Slg)				1/0/0	4/1/0	0/1/0	0/4/0	1/0/1
	Fam. Leiodidae									
88	*Agaricophagus cephalotes* W. L. E. Schmidt, 1841	Mycetophagous (Fu)							0/0/1	
89	*Agathidium convexum* Sharp, 1866	Sapro-xylophagous/ Mycetophagous (Slg)								0/1/0
90	+*Agathidium nigrinum* Sturm, 1807	Sapro-xylophagous/ mycetophagous (Slg)	2/1/2	5/0/2	22/2/2	3/1/3	12/1/1	24/0/2	23/2/1	16/1/2
91	+*Agathidium nigripenne* Fabricius, 1792	Saprophagous/Mycetophagous (Slg)	4/0/0	3/0/0	1/0/0	1/0/0	3/0/0	5/2/2	5/0/0	8/0/1
92	+*Anisotoma castanea* Herbst, 1792	Saprophagous/Mycetophagous (Slg)			1/0/0			0/0/1		
93	+*Anisotoma glabra* Fabricius, 1787	Saprophagous/myccrophagous (Slg)	2/0/0							
94	+*Anisotoma humeralis* Fabricius, 1792	Saprophagous/Mycetophagous (Slg)			1/0/0		1/0/0			1/0/0
95	*Apocatops nigrita* Erichson, 1837	Saprophagous/necrophagous (E)				2/0/0	1/0/0			
96	*Catops subfuscus* Kellner, 1846	Saprophagous/necrophagous (E)			1/0/0					
97	*Catops tristis* Panzer, 1794	Saprophagous/necrophagous (E)	0/0/1		1/0/0	1/0/0				
	+		2/0/0						2/0/0	0/0/1
98	*Fissocatops westi* Krogerus, 1931	Saprophagous/necrophagous (E)		1/0/0	1/0/0			1/0/0		
99	+*Leiodes rhaeticus* Erichson, 1845	Mycetophagous (Fu)		0/0/1						0/0/1

Annex 1 (follow-up)

	Fam. Spaheritidae									
100	+*Sphaerites glabratus* Fabricius, 1792	Sapro-xylophagous (Slg)				2/0/0		1/0/0		
	Fam. Hydrophilidae									
101	*Megasternum concinuum (Marsham, 1802)*	Mycetophagous/Saprophagous (Slg)			0/0/1				0/0/1	
	+					5/1/0	0/0/1	0/4/0	4/3/1	
	Fam. Geotrupidae									
102	*Anoplotrupes stercorosus* (Hartmann in L.G.Scriba, 1791)	Coprophagous (E)	5/2/0	1/0/0	3/0/0	12/10/0	1/4/0	2/5/1	2/5/0	7/12/2
	Fam. Scarabaeidae (*Aphodiinae*)									
103	+*Agrilinus ater* (De Geer, 1774)	Coprophagous (E)					1/0/0	1/0/0	1/1/0	7/0/0
104	+*Acrossus depressus* (Kugelann, 1792)	Coprophagous (E)					1/0/0			1/0/0
105	+*Agolius abdominalis* (Bonelli, 1812) *(=Aphodius mixtus)*	Coprophagous (E)		1/0/0						
106	+*Planolinus uliginosus* (Hardy, 1847) *(=Aphodius) putridus* Herbst.	Coprophagous (E)								0/0/1
107	+*Acrossus rufipes* (Linnaeus, 1758)	Coprophagous (E)				0/1/0		0/1/0	0/0/1	
	Fam. Byrrhidae									
108	*Byrrhus pilula* (Linnaeus, 1758)	Saprophagous (E)			1/0/0					
	Fam. Elateridae									
109	*Athous bicolor* (Goeze, 1777) *(longicollis)*	Xylophagous/sapro-xylo. (larva) (Lgn)	3/0/0							
	+		9/0/0	3/0/0	5/0/0	3/0/0	2/0/0	1/0/0	1/1/0	
110	+*Athous niger* (Linnaeus, 1758)	Larva sapro-xylophagous		1/0/0	1/0/0		3/0/0	2/0/0	6/0/0	5/0/0
111	+*Athous zebei* Bach, 1854	Larva sapro-xylo/xylophagous (Lgn)	1/1/0							
112	+*Melanotus villosus (= rufipes)* (Fourcroy, 1785)	Larva sapro-xylophagous (Slg)	1/0/0		1/0/0					
113	+*Eanus (=Paranomus) guttatus* (Germar, 1817)	Larva sapro-xylophagous (Slg)								1/0/0
114	+*Procraerus tibialis* (Lacordaire, 1835)	Larva xylopahous in stubs of old coniferals (Lgn)	2/1/0		1/2/0	0/1/0	2/0/0	2/0/0	2/0/0	
	Fam. Lycidae									
115	*Dictyoptera aurora* (Herbst, 1784)	Predator. Larva sapro-xylobiontic (Lgn)		3/0/0						
	+		4/1/0		4/0/0			3/0/0	1/0/0	3/0/0

Annex 1 (follow-up)

	Fam. Cantharidae									
116	+*Rhagonycha nigripes* W.Redtenbacher, 1842.	Mixophagous (Slg –Larva)						0/1/0		
	Fam. Anobiidae									
117	+*Microbregma emarginatum* (Duftschmid, 1825)	Xylophagous (in coniferal woods) (Lgn)	1/0/0	0/0/1		2/0/0				
	Fam. Ptinidae									
118	*Ptinus dubius* Sturm, 1795	Sapro-xylophagous (Cr)	0/1/0							
	+						6/0/0		3/0/0	3/0/0
	Fam. Trogositidae									
119	+*Nemosoma elongatum* (Linnaeus, 1761)	Predator Corticolous – hunt the larvae of Scolitinae	1/0/0					0/1/0		
120	+*Ostoma ferruginea* (Linnaeus, 1758)	Sapro-xylophagous (Cr)					1/0/0			
	+		3/0/0		1/0/0	2/0/0		1/0/0		1/0/0
	Fam. Cleridae									
121	+*Thanasimus formicarius* (Linnaeus, 1758)	Predator xylobiont (hunt Scolytidae, larvae) (Cr)				1/0/0	1/0/0			
122	*Thanasimus Thanasimus femoralis* (Zetterstedt, 1828)	Predator xylobiont (Cr)	0/1/0							
	+		0/1/0	0/1/0	0/2/0	0/1/0	0/1/0	0/1/0		0/1/0
	Fam. Momotomidae (Rhizophaginae)									
123	*Rhizophagus dispar* (Paykull, 1800)	Sapro-xylophagous (Cr)					0/0/1		0/0/1	
	+			0/6/0	0/3/0			0/4/0	0/4/0	0/5/0
124	+*Rhizophagus paralleocollis* Gyllenhal, 1827	Sapro-xylophagous (Cr)		3/0/0		1/0/0	1/0/0		1/0/0	2/0/0
	+				1/0/0					
	Fam. Nitidulidae									
125	+*Epuraea boreela* (Zetterstedt, 1828)	Sapro-xylophagous (Cav)						1/0/0	2/0/0	1/0/0
126	+*Epuraea marseuli* Reitter, 1872	Sapro-xylophagous (in rooted woods in burrows of Scolitinae) (Cav)				1/0/0				
	+									1/0/0
127	*Epuraea pygmaea* (Gyllenhal, 1808)	Sapro-xylophagous xylophagous (in rooted woods in burrows of Scolitinae (Cav)	1/1/0	2/0/0	0/1/0	0/1/0				1/1/0
	+		2/0/0	2/0/0	2/0/0	3/0/0	3/0/0		4/0/0	

Annex 1 (follow-up)

128	*Epuraea terminalis* Mannerheim, 1843	Sapro-xylophagous (Cav)		0/3/0						
	+		0/0/1					0/1/0		
129	+*Glischrochilus quadripunctatus* (L.) [quadripusulatus (L.) (Linnaeus, 1758)	Predator in burrows of Ipidae (Cav)								1/0/0
	Fam. Silvanidae									
130	+*Dendrophagus crenatus* (Paykull, 1799)	Corticolous, sapro-xylophagus in coniferous wood (Cr)	2/1/0		0/1/0		2/0/0		1/0/0	0/1/0
	Fam. Cryptophagidae									
131	+*Antherophagus nigricornis* (Fabricius, 1787)	Saprophagous – in burrows of Bombus (E)							0/1/0	
132	+*Atomaria carpathica* Reitter, 1875	Saprophagous/ saproxylophagous(Cr)		1/0/0	1/1/0	1/0/0	7/1/0	1/1/0		0/2/0
133	+*Cryptophagus cylindus* Kiesenwetter, 1858	Saproxylophagous (Slg)						0/0/1		0/0/1
134	+*Cryptophagus dentatus* (Herbst, 1793)	Saprophagous/sapro-xylophagous (Slg)		1/0/0		1/1/0		0/0/1		
135	*Cryptophagus deubeli* Ganglbauer, 1897	Saprophagous (E)					1/0/0		0/0/2	
136	*Cryptophagus pseudodentatus* Bruce 1936	Saprophagous (Slg)	0/1/0							
137	*Cryptophagus transsilvanicus*	Saprophagous (E)							1/0/1	
138	+*Micrambe abietis* (Paykull, 1798)	Saproxylophagous (Slg)		0/1/0	0/1/0	0/0/1	0/1/1		0/1/0	0/1/0
	Fam. Erotylidae									
139	+*Triplax aenea* (Schaller, 1783)	Sapro-xylophagous (Cr-Slg)	0/0/1			1/0/0	0/0/1			
	Fam. Byturidae									
140	+*Byturus ochraceus* (L.G.Scriba, 1790) (*= fumatus)*	Larva xylophagous on *Rubus* (Lgn)				1/0/0			1/0/0	
	Fam. Coccinelidae									
141	*Rhizobius chrysomeloides* (Herbst, 1792)	Predator/Mixophagous (E- Cr)							0/0/1	
142	*Scymnus (Pullus) suturalis* Thunberg, 1795	Predator (E)					1/0/0			
	Fam. Endomychidae									
143	+*Mycetina cruciata* (Schaller, 1783)	Mycetophagous (Fu)		0/1/1	1/0/0					
	Fam Alexiidae									
144	*Sphaerosoma punctatum* Reitter 1897	Mycetophagous/Saprophagous (Fu)				0/1/0				
145	*Sphaerosoma pilosum* (Panzer, 1793)	Mycetophagous/Saprophagous (Slg)			0/1/0					

Annex 1 (follow-up)

	Fam. Lathridiidae									
146	+*Corticarina fuscula* (Gyllenhal, 1827)	Saprophagous (Cr)		1/1/0					1/0/0	
147	*Corticaria longicollis* (Zetterstedt, 1838)	Saprophagous, myrmecophilous (E)							0/1/1	
	+				0/0/1		0/0/1			
148	+*Latridius (=Enicmus) minutus* (Linnaeus, 1767)	Sapro-xylophagous (Cr)	0/1/0			0/1/0	0/0/1	0/0/1	1/1/0	0/2/1
	Fam. Ciidae (=Cisidae)									
149	+*Cis punctulatus* Gyllenhal, 1827	Xylophagous (Lgn)		0/1/0						0/1/0
	Fam. Melandryidae									
150	+*Abdera flexuosa* (Paykull, 1799)	Mycetophagous/Saprophagous (in tinder) (Fu)							0/1/0	
151	*Hylecoetus dermestoides* (Linnaeus, 1761)	Sapro-xylophagous (Lgn)		1/0/0	1/0/0					
	+		2/0/0	5/0/0	2/0/0	1/0/0	1/0/0	2/0/0	2/0/0	2/0/0
152	+*Xylita buprestoides* (Fabricius, 1792)	Sapro-xylophagous on coniferous (Lgn)	2/0/0	1/0/0			2/0/0		0/1/0	0/3/0
153	+*Xylita livida* Sahlberg, 1834	Sapro-xylophagous (Lgn)				1/0/0				0/1/0
	Fam. Mordellidae									
154	+*Anaspis pulicaria* Costa, 1854	Sapro-xylophagous (Cr)	0/0/1				0/1/0		0/0/1	
	Fam. Colydiidae									
155	+*Cerylon deplanatum* Gyllenhal, 1827	Sapro-xylophagous corticicolous and in burrows of Scolytidae (Cr)		0/1/0				0/1/0		
	Fam. Tenebrionidae (Alleculini)									
156	+*Hymenalia rufipes* (Fabricius, 1792)	(Lgn)						0/1/0		
	Fam. Salpingidae									
157	+*Salpingus (=Rhinosimus) ruficollis* (Linnaeus, 1761)	Larvae parasitoids on Scolitinae (Cr)		2/0/0		0/0/1				
	Fam. Cerambycidae									
158	+*Alosterna tabacicolor* Degeer, 1775	Xylophagous (Lgn)			0/1/0				0/1/0	
159	+ *Cornumutilla quadrigutatta* Gebler 1830	Xylophagous (Lgn)								0/2/0
160	+*Evodinus clatrathus* Fabricius,1792	Xylophagous (Lgn)	3/0/0		1/0/0	2/0/0	3/0/0	4/0/0	8/0/0	1/0/0
161	+*Oxymirus cursor* (Linneaus, 1758)	Xylophagous (Lgn)			1/0/0					
162	+*Rhagium mordax* Degeer, 1775	Xylophagous (Lgn)			1/0/0					
163	+ *Tetropium castaneum* (Linnaeus, 1758)	Xylophagous (Lgn)	0/0/1						0/1/0	

Annex 1 (follow-up)

	Fam. Chrysomelidae									
164	*Mniophyla muscorum*	Phytophagous/muscicolous		0/1/0			1/0/0			
165	*Sclerophaedon carinolicus* (Germ.)	Phytophagous/ saproxylophagous(Fr)								0/0/1
	Fam. Curculionidae									
166	+*Anthonomus phyllocola* (Herbst, 1795)	Phytophagous (Fr)	1/1/0	2/0/1	3/0/0	3/0/0	1/0/0		0/0/1	
167	*Hylobius abietis* (Linnaeus, 1758)	Xylophagous (Lgn)	1/0/0							
168	*Hylobius excavatus* (Laicharting, 1781) = *H. piceus* Deg.	Xylophagous (Lgn)							0/1/0	
169	*Notaris aterrima* (Hampe, 1850) (Fam Erirhinidae ?)	Phytophagous/Saprophagous (Fr)							1/0/0	
170	*Bryodaemon (=Omiamima) hanakii* (Frivaldszkyi, 1865)	Phytophagous/Saprophagous (E)	0/5/0	0/11/0	0/17/0	0/1/0	0/2/0		0/1/0	0/5/0
171	*Otiorhynchus desertus* Rosenhauer, 1847	Phytophagous (Fr)					0/2/0			
172	*Dodecastichus (=Otiorhynchus) geniculatus* (Germar, 1817)	Phytophagous (Fr)	1/0/0							
173	*Otiorhynchus proximus* Stierlin, 1861	Phytophagous (Fr)			1/3/0					
174	*Otiorhynchus scaber* (Linnaeus, 1758)	Phytophagous (Fr)		0/1/0	0/1/0					
175	*Phyllobius transsylvanicus* Stierlin, 1894	Phytophagous (Fr)	0/1/0							
176	*Plinthus tischeri* Germar, 1824	Phytophagous (pe *Rumex*) (Fr)		1/0/0						
	Fam. Curculionidae (Scolytinae)									
177	+*Cryphalus abietis* (Ratzeburg, 1837)	Cambiophagous/sapro-xylophagous (Cr)								0/1/0
178	+*Crypturgus cinereus* (Herbst, 1793)	Cambiophagous/sapro-xylophagous (Cr)	1/0/0			1/0/0				0/1/0
179	*Dryocoetes autographus* (Ratzeburg, 1837)	Sapro-xylophagous/ xylophagous (Cr)		1/0/0	1/0/0	1/0/0				
	+		4/0/0		5/0/0	1/0/0	2/0/0	6/0/0	4/0/0	3/1/0
180	+*Dryocoetes hectographus* Reitter, 1913	Sapro-xylpophagous/ cambiophagous (Cr)	2/0/0			2/0/0	2/0/0	1/0/0	2/0/0	
181	*Hylastes cunicularius*Erichson 1836	Sapro-xylophagous/ xylophagous (Cr)	0/1/1	2/0/0		2/0/0	1/2/0		0/0/1	
	+		4/0/0		3/0/0	8/0/0	5/0/0	6/0/0	6/0/0	10/0/0
182	+*Hylurgops glabratus* (Zetterstedt, 1828)	Sapro-xylophagous/ cambiophagous (Cr)		1/0/0	3/0/0	1/0/0	2/0/0	6/0/0	4/0/0	5/0/0

Annex 1 (follow-up)

183	+*Hylurgops palliatus* (Gyllenhal, 1813)	Sapro-xylo/cambiophagous (Cr)	1/0/0		1/0/0			2/0/0	0/00	1/0/0
184	+*Ips typographus* (Linnaeus, 1758)	Idem. Cr-Xy						1/0/1	0/0/1	
185	+*Pityophthorus micrographus* (Linnaeus, 1758)	Idem (Cr)			0/1/0			0/1/0		0/1/0
186	+*Pityophthorus pityographus* (Ratzeburg, 1837)	Idem (Cr)				0/1/0				
187	+*Pityogenes chalcographus* (Linnaeus, 1761)	Idem (Cr)								1/1/0
188	+*Polygraphus poligraphus* (Linnaeus, 1758)	Idem (Cr)	1/0/0	0/1/0			0/0/1	0/1/0	0/1/0	0/0/1
189	+*Trypodendron lineatum* (Olivier, 1795)	Idem (Cr)		3/0/0	7/1/0	3/0/0	1/0/0	2/0/0	2/0/0	1/0/0

The species of Collembola collected with pifall traps. The indicatives F11-O13 are those from the sampling areas established by ICAS) V/E/A = vernal/estival/autumnal

Species	F 11 V/E/A	F 13 V/E/A	G 11 V/E/A	G 13 V/E/A	N 11 V/E/A	N 13 V/E/A	O 11 V/E/A	O 13 V/E/A
Ord. Poduromorpha								
Fam. Neanuridae								
1. *Deutonura plena* (Stach, 1951)	0/0/1		1/0/1	2/0/1		0/1/0		
2. *Deutonura stachi* (Gisin, 1952)	0/0/1							
3. *Endonura tatricola* (Stach, 1929)				1/0/0				
4. *Friesea claviseta* Axelson, 1900					2/0/0			
5. *Friesea mirabilis* (Tullb., 1871)		1/0/0						
6. *Morulina verrucosa* *(Borner, 1903)	1/1/2		1/7/1	1/2/7				0/1/2
7. *Neanura muscorum** (Templeton, 1835)					2/0/0			2/0/0
8. *Neanura parva* (Stach, 1951)				0/1/0	2/0/0			
9. *Pseudachorutella asigillata* (Borner, 1901)				1/0/0			1/0/0	
10. *Pseudachorutes corticicolus* (Schaffer, 1897)							5/0/0	
11. *Pseudachorutes dubius* (Krausbaueri, 1838)	7/0/0	0/1/0	4/1/1		2/0/0	2/0/0	6/0/0	1/0/0
12. *Pseudachorutes palmiensis* (Borner, 1903)			0/1/0	1/0/0				5/0/0
13. *Pseudachorutes parvulus* (Borner, 1901)						1/0/0	5/0/0	4/0/0
14. *Pseudachorutes subcrassus* Tullb., 1871			0/0/1	0/0/1	4/0/0		2/0/0	
15. *Thaumanura carolii* (Stach, 1920)	1/0/1		1/0/1			0/0/1	2/0/0	

Annex 1 (follow-up)

Fam. Odontellidae								
16. *Superodontella lamellifera* (Axelson, 1903)	2/0/0		8/0/0			0/0/1	2/0/0	
Fam. Hypogastruridae								
17. *Ceratophysella armata* (Nicolet, 1841)	0/0/15	0/0/3	0/0/8	0/0/1				
18. *Ceratophysella denticulata* (Bagnall, 1941)				0/0/1				
19. *Ceratophysella engadinensis* (Gisin, 1949)					4/0/0	0/0/1		
20. *Ceratophysella sigillata* (Uzel, 1891)					1/0/0			2/0/0
21. *Ceratophysella silvatica** Rusek, 1964	1/0/0				10/0/0	7/0/0	12/0/0	
22. *Hypogastrura sahlbergi** (Reuter, 1895)		1/0/0	1/0/0			2/0/0		14/0/0
23. *Hypogastrura socialis* (Uzel, 1891)					15/0/0		26/0/0	
24. *Hypogastrura tullbergi** (Schaffer, 1900)						0/1/0		
25. *Schoettella ununguiculata** (Tullb., 1869)					9/0/0		0/1/0	
26. *Xenylla humicola* (Fabricius, 1780)		1/0/0					3/0/0	
27. *Xenylla maritima* Tullb., 1869	0/0/2			0/0/2				
Fam. Onychiuridae								
28. *Hymenaphorura polonica* Pomorski, 1990			0/2/0					
29. *Kalaphorura paradoxa* (Schaffer, 1900)	0/0/5	0/0/2						
30. *Kalaphorura tuberculata* (Moniez, 1890)	0/0/3	0/0/7	0/0/4	0/0/2	0/0/1			
31. *Protaphorura armata* (Tullb., 1869)			0/0/1					
32. *Protaphorura cancellata* (Gisin, 1956)							1/0/0	
33. *Protaphorura fimata* (Gisin, 1952)		1/1/1	1/2/0	0/2/1	1/0/0			
34. *Tetrodontophora bielanensis* (Waga, 1842)	8/6/12	16/16/7	13/13/9	1/1/13	1/2/5	2/20/31	7/4/4	3/5/5
Ord. Entomobryomorpha								
Fam. Tomoceridae								
35. *Plutomurus carpaticus* Rusek & Weiner, 1978	0/2/0	0/0/1	0/0/1					
36. *Pogonognathellus flavescens* (Tullb., 1871)	100/18/17	26/7/10	13/26/15	15/11/2	27/3/33	7/45/18	27/21/6	9/25/14
37. *Tomocerus baudoti* Denis, 1932					2/0/0			
38. *Tomocerus minor* (Lubbock, 1862)	31/17/3	6/20/7	22/16/3	15/10/15	13/15/1	3/5/1	3/2/2	3/5/0
39. *Tomocerus vulgaris** (Tullb., 1871)	1/0/0	2/0/0		0/0/4		0/0/2		1/0/5
Fam. Isotomidae								
40. *Desoria fennica* (Reuter, 1895)			1/0/0					
41. *Desoria olivacea* (Tullb., 1871)					1/0/0		1/0/0	
42. *Desoria violacea** (Tullb., 1876)	0/0/2		0/1/0	1/0/0		0/2/0	3/2/0	2/0/0
43. *Folsomia alpina* (Kseneman, 1936)			1/1/0	1/0/0	1/1/0			
44. *Folsomia inoculata* (Stach, 1947)			0/1/0					
45. *Folsomia quadrioculata* (Tullb., 1871)			2/0/2		1/0/0		9/0/0	
46. *Pseudisotoma sensibilis** (Tullb., 1876)	0/1/0		1/0/0		2/0/0	3/0/0	9/0/0	4/0/0
47. *Vertagopus cinereus* (Nicolet, 1842)						0/1/0	2/0/0	

Annex 1 (follow-up)

Fam. Entomobryidae								
48. *Entomobrya multifasciata* (Tullb., 1871)				0/2/0				
49.*Entomobrya nivalis** (Linne, 1756)	1/4/0		0/1/0		0/2/0	0/2/0		1/1/0
50.*Lepidocyrtus cyaneus* (Tullb., 1871)	1/0/0	0/1/0	1/0/0	0/0/1	1/0/0	0/1/0	6/0/2	
51. *Lepidocyrtus lignorum** Fabricius, 1781	3/6/2	0/3/7	21/7/5	5/7/7	16/19/1	10/16/4	19/16/2	29/22/9
52.*Lepidocyrtus paradoxus* Uzel, 1891					2/0/0		2/0/0	
53.*Orchesella alticola* (Uzel, 1891)		0/3/0						
54.*Orchesella angustistrigata* Stach, 1960		0/1/0						
55. *Orchesella bifasciata** Nicolet, 1842	2/6/5	0/1/0	0/0/1	0/2/3	1/7/0	0/4/0	54/14/3	0/3/0
56. *Orchesella multifasciata* (Stscherbakov, 1898)		0/1/0		2/0/0		1/0/0		
57. *Orchesella pontica** Ionesco, 1915	34/94/14	1/27/4	0/49/10	0/3/10	6/13/5	2/18/10	221/83/20	0/5/0
Ord. Symphypleona								
Fam. Katiannidae								
58. *Sminthurinus aureus* (Lubbock, 1862)		2/0/0		0/0/2				
59. *Sminthurinus elegans* (Fitch, 1836)	1/0/0	1/0/0	4/0/0	1/0/0				7/0/0
60. *Sminthurinus niger* (Lubbock, 1867)							1/0/0	13/0/0
Fam. Sminthuridae								
61. *Allacma fusca* (Linne, 1758)				2/0/0			5/4/2	1/0/0
62. *Caprainea marginata** (Schott, 1893)	0/3/5		0/1/2	0/1/7	0/1/9	0/2/0	0/1/3	0/2/0
63. *Sminthurus viridis* (Linne, 1758)						1/0/0	1/0/0	1/0/0
Fam Dicyrtomidae								
64. *Dicyrtoma fusca* (Lubbock, 1873)		1/0/0				1/0/0		
65. *Dicyrtomina ornata* (Nicolet, 1841)					1/0/0			3/0/0
66. *Ptenothrix atra** (Linne, 1758)			1/0/0		3/0/0		1/0/0	
Fam. Arrhopalitidae								
67. *Arrhopalites principalis* Stach, 1945							0/0/1	
68. *Arrhopalites pygmaeus* (Wankel, 1860)	0/0/1							
69. *Arrhopalites sericus* Gisin, 1947					0/2/0			0/1/0
70. *Arrhopalites terricola* Gisin, 1958		1/0/0		1/0/0				

Annex 1 (follow-up)

The species of Araneae collected with pifall traps. The indicatives F11-O13 are those from the sampling areas established by ICAS)
V/E/A = vernal/estival/autumnal

Specie	F11 v/e/a	F13 v/e/a	G11 v/e/a	G13 v/e/a	N11 v/e/a	N13 v/e/a	O11 v/e/a	O13 v/e/a
Fam. Theridiidae								
1. *Robertus truncorum* (L. Koch, 1872)				0/1/0		0/2/0	-	0/6/0
Fam. Lyniphiidae								
2. *Anguliphantes monticola* (Kulczynski, 1882)			2/1/0		1/0/0			
3. *Centromerus pabulator* (O.P.- Cambridge, 1875)	0/12/0		0/0/1					0/1/0
4. *Centromerus sellarius*	0/3/0							
5. *Centromerus sylvaticus*	1/0/0							
6. *Diplocephalus latifrons* (O.P.- Cambridge, 1875)	6/8/0		0/1/0					
7. *Gonatium paradoxum* (l. Koch, 1869)	0/0/1							
8. *Gonatium rubellum* (Blackwall, 1841)	0/1/0		0/1/0			0/1/0		
9. *Micrargus herbigradus* (Blackwall, 1841)		5/0/0	1/1/0		3/3/1			
10. *Mughiphantes mughi* (Fickert, 1875)	7/0/0					0/0/2	1/0/0	
11. *Poeciloneta variegata*	1/0/0							
12. *Saloca kulczynskii* Miller& Kratochvil, 1939	1/0/0	0/0/1						
13. *Taranucnus bihari* Fage, 1931						0/1/0		
14. *Tenuiphantes alacris* (Blackwall, 1853)	45/10/2	0/4/0	0/2/1	3/4/0	2/2/0	1/4/0	2/0/0	0/0/1
15. *Tenuiphantes tenebricola* (Wider, 1834)	23/15/0							0/1/1
Fam. Cybaeidae								
16. *Cybaeus angustiarum* L. Koch, 1868	0/9/0	0/10/0	0/18/2	0/8/4	0/2/0	0/7/1	1/2/0	0/3/0
Fam. Hahniidae								
17. *Cryphoeca silvicola* (C.L. Koch, 1834)	3/6/0						3/3/1	
Fam. Dictynidae								
18. *Cicurina cicur* (Fabricius, 1775)		0/0/1		0/1/0	0/1/1	0/1/2		0/1/0
Fam. Amaurobiidae								
19. *Coelotes atropos* (Walckenaer, 1830)	1/4/0	2/0/0	1/0/0	2/2/0	3/0/1	0/2/1		0/1/0
Fam. Clubionidae								
20. *Clubiona alpicola*	1/0/0							