ORIBATID MITE (ACARI: ORIBATIDA) SPECIES INVENTORY ON AN ALTITUDINAL GRADIENT IN THE PIATRA CRAIULUI MOUNTAINS (SOUTHERN CARPATHIANS, ROMANIA)

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Abstract. Oribatid mite species from Piatra Craiului Mountains (Southern Carpathians, Romania) were studied according to their altitudinal distribution. The mites were sampled from four sites (beech forest, fir and beech forest, nude scree and subalpine grassland) along an altitudinal gradient, from 1085 m to 1643 m. We identified a total of 60 species, 34 genera and 21 families of oribatid mites, from which four species were found at all altitudes. The species abundances varied with altitude. The faunal differences between the investigated areas were analysed using cluster analysis based on species presence/absence (Jaccard distance coefficient and simple linkage method). The analysis suggests significant differences in species associations between all sampled sites situated at four different altitudes.

Key words: altitudinal gradient, Carpathians, mites, Oribatida, species list.

1. INTRODUCTION

Altitudinal gradient is characterized by steep changes of the physical environment: temperature, atmospheric pressure, moisture, hours of sunshine, ultraviolet (UV) radiation, wind, season length and geology (KÖRNER, 2000). The goals of biodiversity studies using altitudinal gradients are either basic research, such as species diversity and diversity distribution patterns or applied research, such as planning and management and nature conservation (FISCHER *et al*., 2011).

Oribatid mites (Acari: Oribatida) are small arthropods living in soil, tree bark, moss, lichens, decaying wood and other organic substrates (KRANTZ, 1978). Several studies demonstrated that oribatid species composition varies with altitude, but the variation is not always linear (ILLIG *et al.*, 2010; MARAUN *et al*., 2014; LEONOV *et al*., 2015; MUMLADZE *et al*., 2015; MURVANIDZE & ARABULI, 2015).

A recent mite species (mesostigmatid, prostigmatid and oribatid) inventory and their distributions from Piatra Craiului Mountains have been published recently by HONCIUC & STĂNESCU (2003). Although a comparison with older data may offer a better insight on the changes in species distribution (FISCHER & SCHATZ,

2013), unfortunately, in Romania there is a lack of older studies addressing this group of invertebrates. Our study investigates the distribution of oribatid mite species along an altitudinal gradient in the mountain and sub-alpine regions of Piatra Craiului Mountains.

2. MATERIALS AND METHODS

The species were sampled in May 2008 in the Piatra Craiului National Park (Southern Carpathians, Romania). The Piatra Craiului Mountains are a conglomeratic ridge, developed on a NNE – SSW direction, with a length of 20 km and exceeding 2 000 m in height (CONSTANTINESCU & PIȚIGOI, 2003). In the Piatra Craiului Mountains, bellow 1100 m Alt., the dominant habitats are represented by beech forests (*Symphyto cordati-Fagetum*, *Phyllitidi-Fagetum* association) or beech mixed forests, with fir (*Pulmonario rubrae-Fagetum* association) or spruce (*Leucanthemo waldsteinii-Fagetum* association) (MIHĂILESCU, 2011). The subalpine level, above 1500 m, is dominated by pine scrub (*Pinus mugo*) and juniper (*Juniperus communis* ssp. *alpina*). Spread between mountain`s slopes are large accumulations of screes, which, under Nature 2000 classification, are included in R6110 category – S–E Carpathian communities of mobile and semi-mobile limestone screes, with *Acinos alpinus* and *Galium anisophyllon* (DONIȚĂ *et al*., 2015).

All Oribatida material used in this study was collected (Leg. Nae A.) as a part of a broader study concerning the diversity of invertebrates (Araneae, Coleoptera, Collembola, Diplopoda, Isopoda-Oniscidea) from MSS and other scree habitats (NITZU *et al*., 2014; NAE & BĂNCILĂ, 2017), in which pitfall traps were used for monthly sampling. Although the pitfall traps might not be the most effective sampling technique for oribatid mites, they estimate the abundance of each species as a function of its activity during the sampling period and the species occurrence in the habitat (BROWN & MATTHEWS, 2016).

We selected four plots and in each plot five pitfall traps were set at a depth of 9 cm, covering a perimeter of 25 m^2. The traps were installed during May (the only month through the sampling period when oribatid mites were present in all traps), 2008 and emptied at 5-day interval. This made a total of 19 edaphic samples collected from four altitudes (no oribatid species were found in one trap, at 1643 m):

– 1085 m – beech forest – R4109 – S-E Carpathian beech forests (*Fagus sylvatica*) with *Symphytum cordatum*.

– 1343 m – beech and fir forest – R4101 – S–E Carpathian spruce (*Picea abies*), beech (*Fagus sylvatica*) and fir (*Abies alba*) forests with *Pulmonaria rubra.*

– 1526 m – limestone scree – R6110 – S–E Carpathian mobile and semi-mobile scree communities with *Acinos alpinus* and *Galium anisophyllon*.

– 1643 m – subalpine grassland – R3605 –S–E Carpathian *Festuca versicolor* and *Sesleria rigida* ssp. *haynaldiana* grasslands.

The vegetation classification is according to DONIȚĂ *et al*., 2005.

The mites from each trap were sorted and identified to species or genus level. We used for identification the keys published by VAN DER HAMMEN (1952), BERNINI (1978), PÉREZ-IÑIGO (1993, 1997) and WEIGMANN (2006).The systematic ranking of the species follows SUBÍAS (2004), updated in 2017. The study included 371 individuals. After identification the material was preserved in 70% ethanol and stored in the collection of "Emil Racoviţă" Institute of Speleology, Bucharest, Romania. The species distribution is according to SUBÍAS (2004), updated in 2017, and the habitat according to WEIGMANN (2006), VASILIU *et al.*, 1993 and IVAN, 2013.

For each altitude we calculated the dominance and constancy of oribatid species. The dominance of an individual species was calculated as DO = Ni / N * 100 (%), where N = the total number of individuals in each habitat, Ni = the total number of individuals of the i^{th} species. The species with DO ≥ 5 were considered dominant and species with DO ≥ 10 – eudominant. Constancy is the percentage of the samples in which the species occurred: C = Ls / L * 100 (%), where L = the total number of samples in each habitat, Ls = the number of samples in which the species was found. Species with C ≥ 50 were considered constant, and species with C > 75 – euconstant.

For cluster analysis we used Jaccard distance coefficient (which is less influenced by rare species than the Euclidian Distance) similarity index, based on species presence/absence for each sampled altitude (calculated with BioDiversity Pro software (MCALEECE *et al.*, 1997).

3. RESULTS AND DISCUSSIONS

We recorded 60 oribatid species, belonging to 21 families and 34 genera from the four sampled areas. Five families had the largest number of species, Compactozetidae, Carabodidae, Phenopelopidae, Oribatellidae and Chamobatidae with four species each, followed by Liacaridae, Achipteriidae, Punctoribatidae and Oribatulidae with three species each. The four sampling sites had in common only three species: *Ceratoppia bipilis* (Hermann, 1804), *Carabodes labyrinthicus* (Michael, 1879) and *Oribatella longispina* Berlese, 1914.

Species richness and abundance show a discontinuous pattern, with a peak at 1526 m, in the limestone scree (Figure 1). The highest number of species (32 spp.) and also the highest abundancy (171 specimens) were recorded at 1526 m altitude. The subalpine grassland, at 1643 m altitude had the lowest number of species (20 spp.), but the lowest abundance was recorded at 1343 m, only 44 specimens. Nineteen species were represented by one specimen.

The majority of species were from Holarctic (24 spp.) and Palaearctic (20 spp.) regions. Four species are European (*Eupelops subuliger* (Berlese, 1916), *Achipteria sellnicki* Hammen, 1952, *Oribatella longispina* Berlese, 1914, and *Oribatula interrupta sitnikovae* Iordansky, 1991) and one species is Cosmopolitan (*Tectocepheus velatus velatus* (Michael, 1880) (Figure 2).

One species was eudominant at three altitudes: *Chamobates cuspidatus* (Michael, 1844) at 1085 m, 1526 m, 1643 m. *Ceratoppia bipilis* was the eudominant species at the lowest altitude (1085 m) and *Minunthozetes pseudofusiger* (Scheweizer, 1922) at the highest (1643 m). Also, the largest number of dominant species were recorded at 1085 m (*Phthiracarus* sp., *Hermannia convexa* (Koch, 1839), *Eupelops acromios* (Hermann, 1804) and *Eupelops plicatus* (Koch, 1835) (Table 1).

As for constancy, six species were constant at 1526 m and three euconstant at the same altitude and the following one, 1643 m (*Phthiracarus* sp., *Liacarus coracinus* (Koch, 1841) and *Chamobates cuspidatus*).

The Jaccard cluster analysis showed less than 50% similarity between oribatid species composition at the four investigated sites indicating that each altitude has its own species composition (Figure 3).

A number of species has occurred only at one particular altitude : six species at 1085 m (*Acrogalumna longipluma* (Berlese, 1904), *Carabodes rugosior* Berlese, 1916, *Chamobates birulai* (Kulczynski, 1902), *Chamobates pusillus* (Berlese, 1895), *E. acromios*, *E. plicatus*); five species at 1343 m (*Mycobates parmeliae* (Michael, 1884), *Ommatocepheus ocellatus* (Michael, 1882**)**, *Pantelozetes paolii* (Oudemans, 1913), *Punctoribates punctum* (Koch, 1839), *Tritegeus bisulcatus* Grandjean, 1953); ten species at 1526 m (*Chamobates voigtsi* (Oudemans, 1902), *Cymbaeremaeus cymba* (Nicolet, 1855), *Eueremaeus oblongus silvestris* (Forsslund, 1956), *Heminothrus peltifer* (Koch, 1839), *Liebstadia humerata* Sellnick, 1928, *O. interrupta sitnikovae*, *Phthiracarus longulus* (Koch, 1841), *Phthiracarus laevigatus* (Koch, 1841), *Hemileius initialis* (Berlese, 1908), *Trichoribates incisellus* (Kramer, 1897)); three species at 1643 m (*Liacarus acutus* Pschorn – Walcher, 1951, *Lepidozetes singularis* Berlese, 1910, *Oribatula interrupta* (Willmann, 1939)) (Table 2). From the sampling sites situated at the four different altitudes, only two have a habitat specific composition: the beech forest from 1085 m, (where all species are usually found in forest soils) and the subalpine grassland from 1643 m (were all three species were found in mountain and alpine habitats).

The list of identified species is presented below. The distribution and preference for habitat of each species are given according to SUBÍAS (2004), updated in 2017, WEIGMANN (2006) and IVAN (2013). The species marked with * were found by us, the other ones were already recorded by HONCIUC & STĂNESCU (2003).

3.1. IDENTIFIED SPECIES

Phthiracaridae Perty, 1841

***Phthiracarus (P.) laevigatus* (Koch, 1841)**

Distribution: Palaearctic (less frequent in the North), Neotropical (Peru), Afrotropical (St. Helen Island, Reunión Island) Regions.

Habitat: forest litter, moss, on wood.

Piatra Craiului Mountains: limestone scree at 1526 m (2008).

***Phthiracarus (P.) longulus* (Koch, 1841)**

Distribution: Holarctic and Neotropical Regions.

Habitat: forest litter.

Piatra Craiului Mountains: limestone scree at 1526 m (2008).

Crotoniidae Oudemans, 1900

***Heminothrus (Platynothrus) peltifer* (Koch, 1839)**

Distribution: Semi-cosmopolitan in Holarctic, Australian (Australia, New Zeeland), Neotropical and Afrotropical (St. Helen Island) Regions.

Habitat: euryoecious, different types of grasslands and forests; salt tolerant; preferably in humid and cold forests.

Piatra Craiului Mountains: limestone scree at 1526 m (2008).

Hermanniidae Sellnick, 1928

***Hermannia (H.) convexa* (Koch, 1839)**

Distribution: Holarctic, Oriental (India, Sikkim) and Afrotropical (Seychelles Islands) Regions.

Habitat: forest soils and moss.

Piatra Craiului Mountains: beech forest at 1085 m; limestone scree at 1526 m (2008).

***Hermannia (H.) gibba* (C.L. Koch, 1839)**

Distribution: Holarctic and Afrotropical (Seychelles Islands) Regions.

Habitat: forest soils and moss.

Piatra Craiului Mountains: beech forest at 1085 m; limestone scree at 1526 m; subalpine grassland at 1643 m (2008).

Compactozetidae Luxton, 1988

***Cepheus dentatus* (Michael, 1888)**

Distribution: Palaearctic (frequent) Region.

Habitat: forest soil, especially in acidic litter.

Piatra Craiului Mountains: beech forest at 1085 m; beech and fir forest at 1343 m; limestone scree at 1526 m (2008).

***Conoppia palmicincta* (Michael, 1880)**

Distribution: Holarctic, Nearctic, Indomalayan and Neotropical (Bolivia) Regions.

Habitat: forest soil, forest litter and moss.

Piatra Craiului Mountains: beech and fir forest at 1343 m; limestone scree at 1526 m (2008).

***Ommatocepheus ocellatus* (Michael, 1882)**

Distribution: Palaearctic Occidental (except North) and Indomalayan (India – Hymalaia) Regions.

Habitat: lichen and trees.

Piatra Craiului Mountains: beech and fir forest at 1343 m (2008).

***Tritegeus bisulcatus* Grandjean, 1953**

Distribution: Palaearctic Region.

Habitat: forest soil.

Piatra Craiului Mountains: beech and fir forest at 1343 m (2008).

Ceratoppiidae Kunst, 1971

***Certoppia bipilis* (Hermann, 1804)**

Distribution: Holarctic (frequent) and Neotropical (Central America) Regions.

Habitat: frequent in forest soil.

Piatra Craiului Mountains: beech forest at 1085 m; beech and fir forest at 1343 m; limestone scree at 1526 m; subalpine grassland at 1643 m (2008).

***Ceratoppia quadridentata* (Haller, 1882)**

Distribution: Palearctic Regions.

Habitat: forest soil, marsh areas and acidic forests.

Piatra Craiului Mountains: beech forest at 1085 m; beech and fir forest at 1343 m; limestone scree at 1526 m (2008).

Liacaridae Sellnick, 1928

***Adoristes (A.) ovatus* (Koch, 1839)**

Distribution: Palaearctic and Nearctic (U.S.A.: Minnesota) Regions.

Habitat: frequent in forest litter; they mine conifer needles.

Piatra Craiului Mountains: limestone scree at 1526 m; subalpine grassland at 1643 m (2008).

***Liacarus (L.) coracinus* (Koch, 1841)**

Distribution: Palaearctic and Afrotropical (St. Helen Island) Regions.

Habitat: in forest soil and grasslands.

Piatra Craiului Mountains: beech and fir forest at 1343 m; limestone scree at 1526 m; subalpine grassland at 1643 m (2008).

***Liacarus (Dorycranosus) acutus* Pschorn – Walcher, 1951**

Distribution: Palaearctic Region.

Habitat: forest soil.

Piatra Craiului Mountains: subalpine grassland at 1643 m (2008).

Eremaeoidea Oudemans, 1900
***Eremaeus hepaticus* Koch, 1825**
Distribution: Holarctic, Oriental and Neotropical Regions.
Habitat: forest soil.
Piatra Craiului Mountains: limestone scree at 1526 m (2008).

***Eueremaeus oblongus silvestris* (Forsslund, 1956)**
Distribution: Palaearctic Region.
Habitat: forest soil.
Piatra Craiului Mountains: subalpine grassland at 1643 m (2008).

Oribellidae Kunst, 1971
****Pantelozetes (P.) paolii* (Oudemans, 1913)**
Distribution: Holarctic and Indomalayan (Java) Regions.
Habitat: fresh forest soil, grasslands.
Piatra Craiului Mountains: beech and fir forest at 1343 m (2008).

Carabodidae Koch, 1837
***Carabodes (C.) femoralis* (Nicolet, 1855)**
Distribution: Palaearctic Region.
Habitat: fresh and humid forest soil, peat.
Piatra Craiului Mountains: beech forest at 1085 m; beech and fir forest at 1343 m (2008).

****Carabodes (C.) labyrinthicus* (Michael, 1879)**
Distribution: Holarctic and Neotropical (Mexico) Regions.
Habitat: humid and acidic forest soils; moss covered areas and tree bark.
Piatra Craiului Mountains: beech forest at 1085 m; beech and fir forest at 1343 m; limestone scree at 1526 m; subalpine grassland at 1643 m (2008).

****Carabodes (C.) reticulatus* Berlese, 1913**
Distribution: Palaearctic Region.
Habitat: forest soil; moss covered areas and tree stumps.
Piatra Craiului Mountains: beech forest at 1085 m; subalpine grassland at 1643 m (2008).

****Carabodes (C.) rugosior* Berlese, 1916**
Distribution: Holarctic Region.
Habitat: forest litter and tree stumps.
Piatra Craiului Mountains: beech forest at 1085 m (2008).

Tectocepheidae Grandjean, 1954

***Tectocepheus velatus velatus* (Michael, 1880)**

Distribution: Cosmopolitan.

Habitat: relative eurytopic in marshes, humid grasslands and forests, avoids ruderal soils.

Piatra Craiului Mountains: limestone scree at 1526 m; subalpine grassland at 1643 m (2008).

Cymbaeremaeidae Sellnick, 1928

****Cymbaeremaeus cymba* (Nicolet, 1855)**

Distribution: Palaearctic and Indomalayan (India) Regions.

Habitat: lichens, moss and tree bark.

Piatra Craiului Mountains: limestone scree at 1526 m (2008).

Phenopelopidae Petrunkevitch, 1955

***Eupelops acromios* (Hermann, 1804)**

Distribution: Semi cosmopolitan in Palaearctic, Afrotropical (Ethiopia, South Africa), Neotropical (Argentina) Regions.

Habitat: frequent on trees, also in different types of soil, rather xerophilic.

Piatra Craiului Mountains: beech forest at 1085 m (2008).

****Eupelops plicatus* (Koch, 1835)**

Distribution: Holarctic Region.

Habitat: forest soils, on trees.

Piatra Craiului Mountains: beech forest at 1085 m (2008).

****Eupelops subuliger* (Berlese, 1916)**

Distribution: Southern Europe.

Habitat: mountain and alpine forest soils.

Piatra Craiului Mountains: limestone scree at 1526 m; subalpine grassland at 1643 m (2008).

****Eupelops torulosus* (Koch, 1839)**

Distribution: Palaearctic (except East, frequent), Afrotropical (Ethiopia) Regions.

Habitat: forest soil, humid and peaty substratum.

Piatra Craiului Mountains: beech forest at 1085 m, subalpine grassland at 1643 m (2008).

Achipteriidae Thor, 1929

***Achipteria (A.) coleoptrata* (Linnaeus, 1758)**

Distribution: Holarctic, Indomalayan (India) and Afrotropical (St. Helens Island) Regions.

Habitat: fresh, humid grasslands and forests.

Piatra Craiului Mountains: beech and fir forest at 1343 m; limestone scree at 1526 m; subalpine grassland at 1643 m (2008).

***Achipteria (A.) nitens* (Nicolet, 1855)**

Distribution: Holarctic Region.

Habitat: predominant in litter, mesophilic forests.

Piatra Craiului Mountains: beech forest at 1085 m; beech and fir forest at 1343 m; limestone scree at 1526 m (2008).

****Achipteria (A.) sellnicki* Hammen, 1952**

Distribution: Europe and Mongolia.

Habitat: unclear.

Piatra Craiului Mountains: beech and fir forest at 1343 m; limestone scree at 1526 m (2008).

Oribatellidae Jacot, 1925

***Oribatella (O.) calcarata* (Koch, 1835)**

Distribution: Holarctic Region.

Habitat: fresh litter, humid forests, moss and lichen covered areas.

Piatra Craiului Mountains: beech forest at 1085 m; limestone scree at 1526 m (2008).

***Oribatella (O.) foliata* Krivolutsky, 1974**

Distribution: Palaearctic Region.

Habitat: unclear.

Piatra Craiului Mountains: beech and fir forest at 1343 m; subalpine grassland at 1643 m (2008).

****Oribatella (O.) longispina* Berlese, 1914**

Distribution: East Europe.

Habitat: alpine grass, moss, litter.

Piatra Craiului Mountains: beech forest at 1085 m; beech and fir forest at 1343 m; limestone scree at 1526 m; subalpine grassland at 1643 m (2008).

****Oribatella (O.) quadricornuta* Michael, 1880**

Distribution: Holarctic (frequent) Region.

Habitat: forest and grassland soils with variable humidity, occasional on trees.

Piatra Craiului Mountains: beech and fir forest at 1343 m; limestone scree at 1526 m (2008).

Ceratozetidae Jacot, 1925

***Lepidozetes singularis* Berlese, 1910**

Distribution: Holarctic (frequent) Region.

Habitat: montane and alpine species; moss and dried lichens and humid habitats, also on trees.

Piatra Craiului Mountains: subalpine grassland at 1643 m (2008).

***Trichoribates (Latilamellobates) incisellus* (Kramer, 1897)**

Distribution: Holarctic Region.

Habitat: humid and fresh grasslands and reeds, salt tolerant.

Piatra Craiului Mountains: limestone scree at 1526 m (2008).

Chamobatidae Thor, 1937

***Chamobates (C.) birulai* (Kulczynski, 1902)**

Distribution: Holarctic Region.

Habitat: forest soils.

Piatra Craiului Mountains: beech forest at 1085 m; beech and fir forest at 1343 m (2008).

***Chamobates (C.) cuspidatus* (Michael, 1844)**

Distribution: Holarctic (frequent in Palaearctic) and Afrotropical (Seychelles Islands) Regions.

Habitat: forest soils rich in humus with variable humidity.

Piatra Craiului Mountains: beech forest at 1085 m; limestone scree at 1526 m; subalpine grassland at 1643 m (2008).

****Chamobates (C.) pusillus* (Berlese, 1895)**

Distribution: Palaearctic (frequent) Region.

Habitat: forest soils and moors.

Piatra Craiului Mountains: beech forest at 1085 m (2008).

****Chamobates (Xiphobates) voigtsi* (Oudemans, 1902)**

Distribution: Palaearctic Region.

Habitat: acidic forest soil.

Piatra Craiului Mountains: limestone scree at 1526 m (2008).

Punctoribatidae Thor, 1937

***Minunthozetes (M.) pseudofusiger* (Scheweizer, 1922)**

Distribution: Palaearctic (frequent) Region.

Habitat: moss and lichen turf, on trees and rocks, wet and acid habitats.

Piatra Craiului Mountains: beech forest at 1085 m; subalpine grassland at 1643 m (2008).

***Mycobates (M.) parmeliae* (Michael, 1884)**
Distribution: Holarctic Region.
Habitat: mountain and alpine moss covered humid areas, on trees.
Piatra Craiului Mountains: beech and fir forest at 1343 m (2008).

***Punctoribates (P.) punctum* (Koch, 1839)**
Distribution: Semi-Cosmopolitan in Palaearctic, Nearctic (East of U.S.A.), Oriental and Australian (New Zeeland) Regions.
Habitat: different types of grasslands and forest soils with medium humidity.
Piatra Craiului Mountains: beech and fir forest at 1343 m (2008).

Oribatulidae Thor, 1929
****Oribatula (O.) interrupta* (Willmann, 1939)**
Distribution: Holarctic Region.
Habitat: mountain and alpine species; moss and lichen turf.
Piatra Craiului Mountains: subalpine grassland at 1643 m (2008).

****Oribatula (O.) interrupta sitnikovae* Iordansky, 1991**
Distribution: East Europe.
Habitat: mountain habitats, mountain and subalpine shrubs (Ivan 2013).
Piatra Craiului Mountains: limestone scree at 1526 m (2008).

***Oribatula (O.) tibialis* (Nicolet, 1855)**
Distribution: Holarctic and Indomalayan (India) Regions.
Habitat: relative euryoecious; grassland and forest soils, moss and lichen turf; salt tolerant.
Piatra Craiului Mountains: beech and fir forest at 1343 m; limestone scree at 1526 m.

Hemileiidae J. & P. Balogh, 1984
****Hemileius (H.) initialis* (Berlese, 1908)**
Distribution: Semi-cosmopolitan in Palaearctic, Oriental (Bali), Neotropical Regions.
Habitat: forest soils.
Piatra Craiului Mountains: limestone scree at 1526 m (2008).

Liebstadiidae J. & P. Balogh, 1984
****Liebstadia (L.) humerata* Sellnick, 1928**
Distribution: Holarctic and Oriental (Vietnam and Nepal) Regions.
Habitat: tree bark, lichens.
Piatra Craiului Mountains: limestone scree at 1526 m (2008).

Galumnidae Jacot, 1925

***Acrogalumna longipluma* (Berlese, 1904)**

Distribution: Semi-cosmopolitan in Holarctic, Afrotropical (Ethiopia), Oriental (India: Kerala and South-East China), and Australian (New Zeeland) Regions.

Habitat: forest soil.

Piatra Craiului Mountains: beech forest at 1085 m (2008).

4. CONCLUSIONS

Twenty-five species of Oribatid mites were for the first time recorded in the Piatra Craiului Mountains.

There are no older species inventories of oribatid mite species made (older than 2000) in Piatra Craiului Mountains, thus a comparison between species composition and their plasticity could not be made. The inventory made using altitudinal gradient for sampling sites was, although, useful and we could see how abundance and species richness varied with altitude. The large majority of species are specific to forest soils, followed by moss, lichens and grasslands. Two habitats showed a distinct species composition (the beech forest from 1085 m and the subalpine grassland from 1643 m). The other two habitats have characteristic species that came from different types of habitats (forest soil, lichens, moss, tree bark, grassland, mountain and subalpine shrubs, wood).

The majority of species are found in Holarctic biogeographic region (24 species), followed by Palaearctic (20 species). Four species are European.

The similarity index of the sampling areas (situated at different altitudes), was less than 50%, showing their oribatid faunal dissimilarities for the sampled period. We showed that mountain and sub-alpine habitats from Piatra Craiului Mountains are inhabited by numerous oribatid taxa. Further work in the Carpathians carried on altitudinal gradient and its influence on oribatid species communities will provide new insights in species – environment interactions.

Table 1

Name, abundance (N), dominances (DO) and constancies (C) of the oribatid mite species from the Piatra Craiului Mountains.

	1085 m			1343 m			1526 m			1643 m		
	N	DO	C	N	DO	C	N	DO	C	N	DO	C
Phthiracarus sp.	6	7.89	40	5	11.36	60	46	26.9	100	12	15.18	100
Phthiracarus (P.) laevigatus	0	0	0	0	0	0	3	1.75	40	0	0	0
Phthiracarus (P.) longulus	0	0	0	0	0	0	2	1,16	20	0	0	0
Phthiracarus (Archiphthiracarus) sp.	1	1.31	20	0	0	0	0	0	0	0	0	0
Steganacarus sp.	0	0	0	1	2.27	20	3	1.75	40	1	1.26	25

Table 1 (continued)

Heminothrus (Platynothrus) peltifer	0	0	0	0	0	0	1	0.58	20	0	0	0
Hermannia (H.) convexa	5	6.57	20	0	0	0	1	0.58	20	0	0	0
Hermannia (H.) gibba	5	6.57	40	0	0	0	3	1.75	60	2	2.53	50
Cephaeus dentatus	1	1.31	20	1	2.27	20	1	0.58	20	0	0	0
Conoppia palmicincta	0	0	0	2	4.54	40	1	0.58	20	0	0	0
Ommatocepheus ocellatus	0	0	0	1	2.27	20	0	0	0	0	0	0
Tritegeus bisulcatus	0	0	0	1	2.27	20	0	0	0	0	0	0
Ceratoppia sp.	0	0	0	1	2.27	20	0	0	0	0	0	0
Ceratoppia bipilis	15	19.73	80	3	6.81	60	4	2.33	40	3	3.79	25
Ceratoppia quadridentata	1	1.31	20	1	2.27	20	1	0.58	20	0	0	0
Adoristes ovatus	0	0	0	0	0	0	6	3.5	60	1	1.26	25
Liacarus (L.) coracinus	0	0	0	1	2.27	20	7	4.09	80	2	2.53	25
Liacarus (Dorycranosus) acutus	0	0	0	0	0	0	0	0	0	3	3.79	25
Eremaeus hepaticus	0	0	0	0	0	0	2	1.16	20	0	0	0
Eueremaeus oblongus silvestirs	0	0	0	0	0	0	0	0	0	1	1.26	25
Pantelozetes sp.	0	0	0	3	6.81	20	0	0	0	0	0	0
Pantelozetes (P.) paolii	0	0	0	1	2.27	20	0	0	0	0	0	0
Rhinoppia sp.	0	0	0	0	0	0	1	0.58	20	0	0	0
Carabodes sp.	0	0	0	2	4.54	20	0	0	0	0	0	0
Carabodes (C.) femoralis	2	2.63	40	1	2.27	20	0	0	0	0	0	0
Carabodes (C.) labyrinthicus	2	2.63	20	2	4.54	20	5	2.92	60	6	7.59	50
Carabodes (C.) reticulatus	1	1.31	20	0	0	0	2	1.16	40	0	0	0
Carabodes (C.) rugosior	3	3.94	20	0	0	0	0	0	0	0	0	0
Tectocepheus velatus velatus	0	0	0	0	0	0	1	0.58	20	5	6.32	50
Cymbaeremaeus cymba	0	0	0	0	0	0	1	0.58	20	0	0	0
Eupelops acromios	5	6.57	40	0	0	0	0	0	0	0	0	0
Eupelops plicatus	6	7.89	40	0	0	0	0	0	0	0	0	0
Eupelops subuliger	0	0	0	0	0	0	3	1.75	40	1	1.26	25
Eupelops torulosus	1	1.31	20	0	0	0	0	0	0	1	1.26	25
Achipteria (A.) coleoptrata	0	0	0	4	9.09	40	5	2.92	60	1	1.26	25
Achipteria (A.) nitens	1	1.31	20	2	4.54	20	1	0.58	20	0	0	0
Achipteria (A.) sellnicki	0	0	0	2	4.54	20	1	0.58	60	0	0	0
Oribatella sp.	0	0	0	2	4.54	40	0	0	0	0	0	0
Oribatella (O.) calcarata	3	3.94	20	0	0	0	7	4.09	80	0	0	0
Oribatella (O.) foliata	0	0	0	1	2.27	20	0	0	0	1	1.26	25
Oribatella (O.) longispina	4	5.26	20	1	2.27	20	15	8.77	40	6	7.59	50

Table 1 (continued)

Oribatella (O.) quadricornuta	0	0	0	1	2.27	20	1	0.58	20	0	0	0
Lepidozetes singularis	0	0	0	0	0	0	0	0	0	1	1.26	25
Trichoribates (Latilamellobates) incisellus	0	0	0	0	0	0	1	0.58	20	0	0	0
Chamobates sp.	0	0	0	1	2.27	20	0	0	0	0	0	0
Chamobates (C.) birulai	1	1.31	20	0	0	0	0	0	0	0	0	0
Chamobates (C.) cuspidatus	10	13.15	60	0	0	0	34	19.88	80	17	21.51	75
Chamobates (C.) pusillus	2	2.63	20	0	0	0	0	0	0	0	0	0
Chamobates (Xiphobates) voigtsi	0	0	0	0	0	0	3	1.75	20	0	0	0
Minunthozetes pseudofusiger	1	1.31	40	0	0	0	0	0	0	10	12.65	25
Mycobates sp.	0	0	0	0	0	0	2	1.16	40	3	3.79	50
Mycobates (M.) parmeliae	0	0	0	1	2.27	20	0	0	0	0	0	0
Punctoribates (P.) punctum	0	0	0	1	2.27	20	0	0	0	0	0	0
Oribatula sp.	0	0	0	1	2.27	20	0	0	0	0	0	0
Oribatula (O.) interrupta	0	0	0	0	0	0	0	0	0	2	2.53	25
Oribatula (O.) interrupta sitnikovae	0	0	0	0	0	0	1	0.58	20	0	0	0
Oribatula (O.) tibialis	0	0	0	1	2.27	20	4	2.33	40	0	0	0
Hemileius (Hemileius) initialis	0	0	0	0	0	0	1	0.58	20	0	0	0
Liebstadia (L.) humerata	0	0	0	0	0	0	1	0.58	20	0	0	0
Acrogalumna longipluma	1	1.31	20	0	0	0	0	0	0	0	0	0

Table 2

Oribatid species presence/absence at the four altitudes from the Piatra Craiului Mountains (Data from 2008).

Species	Altitudes			
	1085 m	1343 m	1526 m	1643 m
Phthiracarus sp.	X	X	X	X
Phthiracarus (P.) laevigatus			X	
Phthiracarus (P.) longulus			X	
Phthiracarus (Archiphthiracarus) sp.	X			
Steganacarus sp.		X	X	X
Heminothrus (Platynothrus) peltifer			X	
Hermannia (H.) convexa	X		X	
Hermannia (H.) gibba	X		X	X
Cephaeus dentatus	X	X	X	
Conoppia palmicincta		X	X	
Ommatocepheus ocellatus		X		

Table 1 (continued)

Tritegeus bisulcatus		X		
Ceratoppia sp.		X		
Ceratoppia bipilis	X	X	X	X
Ceratoppia quadridentata	X	X	X	
Adoristes ovatus			X	X
Liacarus (L.) coracinus		X	X	X
Liacarus (Dorycranosus) acutus				X
Eremaeus hepaticus			X	
Eueremaeus oblongus silvestirs				X
Pantelozetes sp.		X		
Pantelozetes (P.) paolii		X		
Rhinoppia sp.			X	
Carabodes sp.		X		
Carabodes (C.) femoralis	X	X		
Carabodes (C.) labyrinthicus	X	X	X	X
Carabodes (C.) reticulatus	X		X	
Carabodes (C.) rugosior	X			
Tectocepheus velatus velatus			X	X
Cymbaeremaeus cymba			X	
Eupelops acromios	X			
Eupelops plicatus	X			
Eupelops subuliger			X	X
Eupelops torulosus	X			X
Achipteria (A.) coleoptrata		X	X	X
Achipteria (A.) nitens	X	X	X	
Achipteria (A.) sellnicki		X	X	
Oribatella sp.		X		
Oribatella (O.) calcarata	X		X	
Oribatella (O.) foliata		X		X
Oribatella (O.) longispina	X	X	X	X
Oribatella (O.) quadricornuta		X	X	
Lepidozetes singularis				X
Trichoribates (Latilamellobates) incisellus			X	
Chamobates sp.		X		
Chamobates (C.) birulai	X	X		
Chamobates (C.) cuspidatus	X		X	X
Chamobates (C.) pusillus	X			
Chamobates (Xiphobates) voigtsi			X	
Minunthozetes pseudofusiger	X			X
Mycobates sp.			X	X
Mycobates (M.) parmeliae		X		
Punctoribates (P.) punctum		X		
Oribatula sp.		X		
Oribatula (O.) interrupta				X
Oribatula (O.) interrupta sitnikovae			X	
Oribatula (O.) tibialis		X	X	
Hemileius (Hemileius) initialis			X	
Liebstadia (L.) humerata			X	
Acrogalumna longipluma	X			
Total number of species	22	28	34	20

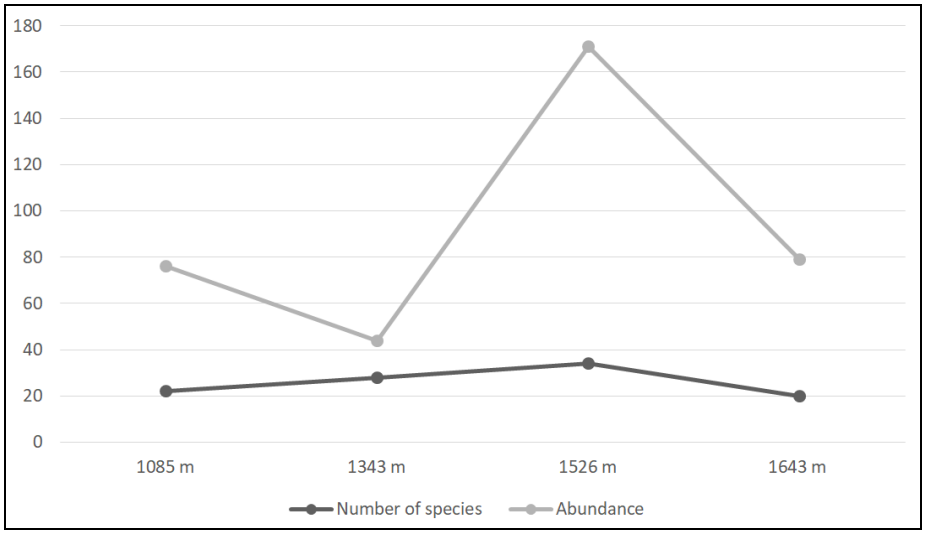

Fig. 1. Number of oribatid species and their abundance
at four altitudes from the Piatra Craiului Mountains.

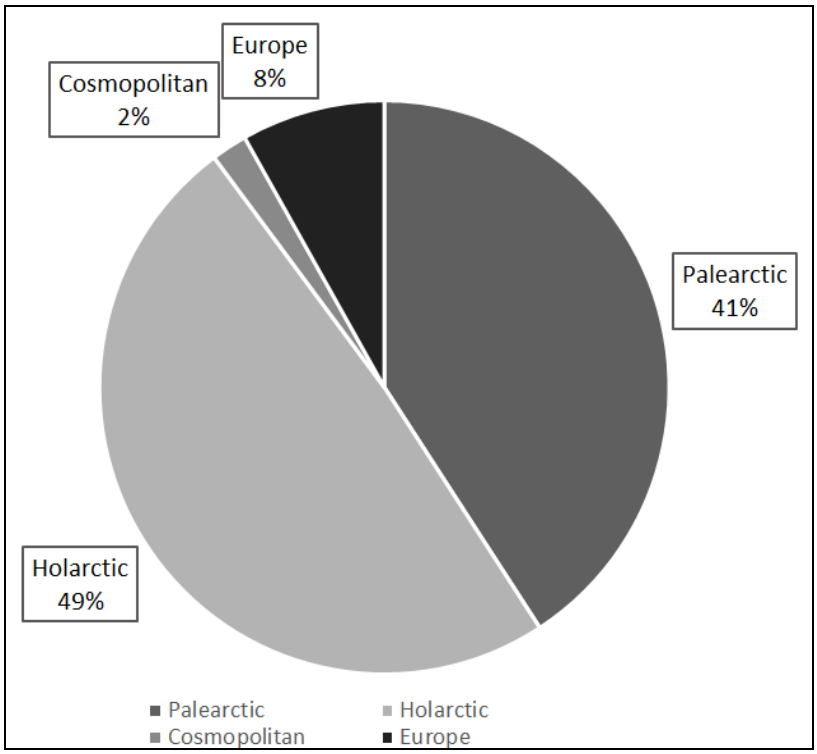

Fig. 2. Representation of biogeographical distribution of oribatid species identified
at four altitudes from the Piatra Craiului Mountains.

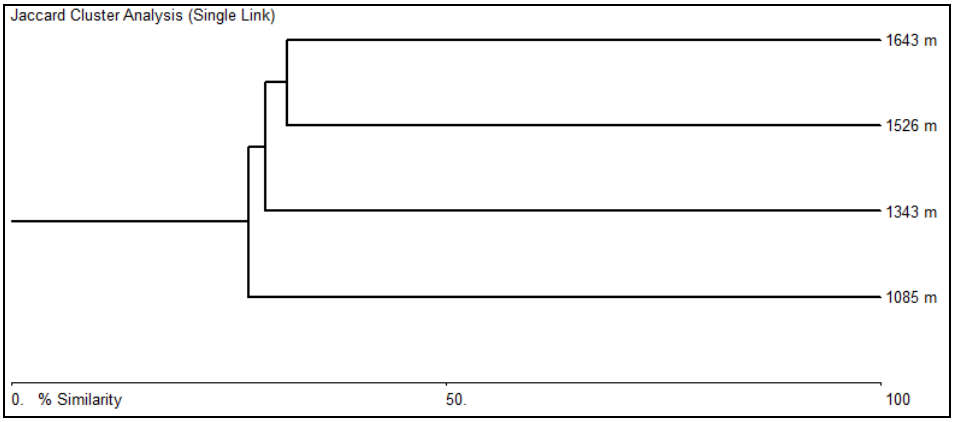

Fig. 3. Dendrogram of cluster analysis. Jaccard similarity index of oribatid species at the four altitudes from the Piatra Craiului Mountains.

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