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Oribatid mites (Acari, Oribatida) of open and forested habitats of Korčula Island (Croatia)

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Abstract: Oribatid mites were investigated on Korčula Island (Croatia) in various microhabitats in an open habitat (moss on rock, moss on soil) and in stone pine forest floor (moss, litter, rotting wood) in late August 2004. Special attention was paid to the age structure of species. These mites were rather abundant but their species diversity was low. The highest density was observed in patches of moss in the forest floor, and the lowest density was in rotting wood. Among the oribatid mites, only several species were abundant (*Achipteria nitens*, *Zygoribatula propinqua*, *Pilogalumna crassiclava*, *Scheloribates initialis*, *S. laevigatus*, and *Tectocepheus velatus*). Some species were rich in juveniles, while in others the adults dominated.

Keywords: Korčula Island, habitats, oribatid mites, populations, juveniles

INTRODUCTION

Korčula Island is a mountainous area, with the highest peak Klupca at 569 m above sea level. This island has nearly 280 km^2 (length 47 km, width 5–8 km), and is located almost parallel to the mainland of Croatia. Its climate is Mediterranean, with a warm and dry season in June-September (temperature 22–27°C, mean precipitation 102 mm), and a cool and wet season in October-May (temperature 9–18°C, mean precipitation 986 mm), with about 2700 sunny hours per year on average.

Korčula Island has a rich Mediterranean flora, and forests and shrub vegetation cover 61% of the whole area. In forested areas, stone pine (*Pinus pinea* L.), alpine pine (*P. halepensis* Mill.), black pine (*P. nigra* Arn.) and cypress (*Cupressus* sp.) are frequent, while shrub communities (maquis) are composed mainly of evergreen and drought-resistant plants: dwarf oaks (*Quercus* sp.), juniper (*Juniperus communis* L.), oleander (*Nerium oleander* L.), and olive trees (*Olea europaea* L.). Vegetation is

important for soil animals, including mites, which decompose organic matter and release nutrients for plants (Odum 1971). Oribatid mites of this region were investigated by Balogh (1943) and Tarman (1977, 1983), but mainly in faunistic and zoogeographical aspects.

The aim of this paper is to compare soil oribatid mite communities of selected microhabitats of Korčula Island, like moss on rock and moss on soil in an open habitat, as well as moss, litter, and rotting wood in stone-pine forest floor. We paid special attention to the age structure of abundant species, which is rarely investigated in ecological papers, although juvenile oribatid mites play an important role in decomposition of soil organic matter (Stefaniak & Seniczak 1976).

MATERIAL AND METHODS

Samples of 500 cm^3 each were taken on 28–30 August 2004, in 3 replicates, from 5 types of microhabitats in 2 habitats:

- moss on rock and moss on soil in an open habitat,
- moss, litter, and rotting wood in stone-pine forest floor.

The mites were extracted in Tullgren funnels, preserved, and determined to species or genus level, including the juvenile stages. From the total of 15 samples, 4020 oribatid mites were extracted. For mite populations of each species, abundance (*A*) and dominance (*D*) indices were calculated, while mite communities were compared with respect to total abundance, number of species, and the Shannon index of diversity *H'* (Odum 1971). Names of oribatid species follow Subías (2004) and partly Weigmann (2006).

RESULTS

In the investigated microhabitats of Korčula Island, oribatid mites were rather abundant but poor in species. Their mean density was the highest in patches of moss in stone-pine forest floor, and the lowest in rotting wood (Table 1). However, most species lived in patches of moss on the soil in the open habitat, and consequently the oribatid mite community in these patches achieved the highest Shannon index (*H'*).

Table 1. Characteristics of oribatid mite communities from the studied habitats of Korčula Island: mean abundance (individuals per sample, i.e. 500 cm^3, $n = 3$), number of species, and Shannon index of diversity (*H'*)

Characteristics of Oribatida		Open habitat		Forest floor		
		moss on rock	moss on soil	moss	litter	rotting wood
Abundance, total	*A*	289.0	312.3	470.7	218.7	49.4
Abundance, juveniles	*A*	238.3	141.7	352.0	133.7	24.0
Number of species	*S*	25	31	28	29	22
Shannon index of diversity	*H'*	1.83	3.42	1.86	2.36	3.02

In oribatid mite communities, only several species were abundant (Table 2). The most common and abundant species were *Scheloribates laevigatus* (C. L. Koch, 1835) and *Zygoribatula propinqua* (Oudemans, 1900). Both of them achieved the highest density in patches of moss in the forest floor. In these patches, also *Achipteria nitens* (Nicolet, 1855) was very numerous. *Scheloribates initialis* (Nicolet, 1855) was extremely abundant in patches of moss on rock in the open habitat and in forest litter but was completely absent in forest moss and rotting wood. Patches of moss on

Table 2. Characteristics of oribatid species of the studied habitats of Korčula Island: mean abundance (A = individuals per sample, i.e. 500 cm^3, n = 3) and dominance (D = % of the total number of oribatid mites in the mean sample). Species with maximum $A \leq 10$ are listed below the table; [1] – mean D has no sense

Species		Open habitat		Forest floor			Mean
		moss on rock	moss on soil	moss	litter	rotting wood	
Achipteria nitens	*A*	0	20.0	142.7	7.7	0.7	34.2
(Nicolet, 1855)	*D*	0	6.4	30.3	3.5	1. 1	-[1]
Carabodes quadrangulus	*A*	0	0	0	0	10.7	2.1
Bernini, 1979	*D*	0	0	0	0	17.3	-
Chamobates sp. 1	*A*	6.0	3.7	0	0.3	3.3	2.7
	D	2.1	1.2	0	0.2	5.4	-
Eueremaeus oblongus	*A*	1.0	0	0.3	0.7	15.7	3.5
(C. L. Koch, 1835)	*D*	0.4	0	0.1	0.3	25.4	-
Licnobelba latiflabellata	*A*	0.3	2.3	0	1.7	9.3	2.7
(Paoli, 1908)	*D*	0.1	0.8	0	0.8	15.1	-
Metabelba pulverulenta	*A*	0.7	6.7	5.0	3.0	0.7	3.0
(C. L. Koch, 1839)	*D*	0.2	2.1	1.1	1.4	1.1	-
Oppia denticulata (G. Canestrini	*A*	11.7	32.7	0	19.7	1.0	13.0
and R. Canestrini, 1882)	*D*	4.0	10.5	0	9.0	1.6	-
O. unicarinata	*A*	0	36.0	4.3	0	0	8.1
(Paoli, 1908)	*D*	0	11.5	0.9	0	0	-
Oppiella sp. 1	*A*	0	33.7	0	11.7	0	9.1
	D	0	10.8	0	5.3	0	-
Oribatula tibialis	*A*	18.0	1.3	0	0	0	3.9
(Nicolet, 1855)	*D*	6.2	0.4	0	0	0	-
Pilogalumna crassiclava	*A*	0.3	52.3	18.7	32.0	0	20.7
(Berlese, 1914)	*D*	0.1	16.8	4.0	14.6	0	-

Ramusella insculpta	*A*	0	0	0	0	16.0	3.2
(Paoli, 1908)	*D*	0	0	0	0	25.9	-
Rhysotritia duplicata	*A*	0	1.0	0.3	1.0	3.3	1.1
(Grandjean, 1953)	*D*	0	0.3	0.1	0.5	5.4	-
Scheloribates initialis	*A*	180.7	63.0	0	143.7	0	77.5
(Nicolet, 1855)	*D*	62.5	20.2	0	65.7	0	-
S. laevigatus	*A*	53.7	102.7	120.3	8.7	3.3	57.7
(C. L. Koch, 1835)	*D*	18.6	32.9	25.6	4.0	6.7	-
S. pallidulus	*A*	10.3	5.7	0	0	3.0	3.8
(C. L. Koch, 1840)	*D*	3.6	1.8	0	0	6.1	-
Sphaerochthonius	*A*	0.7	14.7	7.3	9.0	9.0	8.1
splendidus (Berlese, 1904)	*D*	0.2	4.7	1. 6	4.1	14.6	-
Suctobelba altvateri	*A*	0	34.3	13.3	0.7	0	9.7
Moritz, 1970	*D*	0	11.0	2.8	0.3	0	-
Tectocepheus velatus	*A*	7. 7	54.3	12. 7	0.3	2.3	15.5
(Michael, 1880)	*D*	2.7	17.4	2.7	0.2	3.8	-
Trhypochthonius tectorum	*A*	0.7	0.7	2.3	19.0	0	4.5
(Berlese, 1896)	*D*	0.2	0.2	0.5	8.7	0	-
Zygoribatula propinqua	*A*	42.0	23.0	154.7	46.0	2.7	53.7
(Oudemans, 1900)	*D*	14.5	7.4	32.9	21.0	4.3	-

Open habitat, moss on rock: *Arthrodamaeus reticulatus* (Berlese, 1910); *Camisia segnis* (Hermann, 1804); *Chamobates* sp. 1; *Eupelops acromios* (Hermann, 1804); *Galumna* sp. 1; *Galumna* sp. 2; *Hermanniella septentrionalis* Berlese, 1910; *Microtritia minima* (Berlese, 1904); *Phthiracarus* sp. 1; *Trichoribates incisellus* (Kramer, 1897); *Zetorchestes falzonii* Coggi, 1898.
Open habitat, moss on soil: *Arthrodamaeus reticulatus*, *Galumna* sp. 1; *Hermaniella septentrionalis*; *Liebstadia similis* (Michael, 1888); *Microtritia minima*; *Nothrus silvestris* Nicolet, 1855; *Phthiracarus* sp. 1; *Phthiracarus* sp. 2; *Quadroppia quadricarinata* (Michael, 1885); *Suctobelbella subcornigera* (Forsslund, 1941); *Trichoribates trimaculatus* (C. L. Koch, 1835).
Forest floor, moss: *Arthrodamaeus reticulatus*; *Brachychthonius* sp.; *Camisia segnis*; *Carabodes* sp. 1; *Cosmochthonius foliatus* Subías, 1982; *Dissorhina ornata* (Oudemans, 1900); *Hermaniella septentrionalis*; *Liacarus coracinus* (C. L. Koch, 1841); *Neoliodes theleproctus* (Hermann, 1804); *Peloptulus phaenotus* (C. L. Koch, 1844); *Phthiracarus* sp. 1; *Phthiracarus* sp. 2; *Quadroppia quadricarinata*; *Suctobelba* sp. 1; *Trichoribates incisellus*; *T. trimaculatus*.
Forest floor, litter: *Anachipteria* sp. 1; *Arthrodamaeus reticulatus*; *Beckiella africana* (Balogh, 1958); *Camisia spinifer*; *Ceratozetes* sp. 1; *Dissorhina ornata*; *Eupelops* sp. 1; *Galumna* sp. 1; *Gustavia fusifer* (C. L. Koch, 1841); *Hafenrefferia gilvipes* (C. L. Koch, 1839); *Micreremus brevipes* (Michael, 1888); *Neoliodes theleproctus*; *Phthiracarus* sp. 1.
Forest floor, rotting wood: *Cepheus latus* C. L. Koch, 1835; *Galumna* sp. 1; *Liacarus coracinus*; *Malaconothrus* sp. 1; *Odontocepheus espatulatus* Saloña and Iturrondobeitia, 1989; *Trichoribates trimaculatus*; *Zetorchestes falzonii*.

soil in the open habitat were dominated by *S. laevigatus* and *S. initialis*, while *Tectocepheus velatus* (Michael, 1880) and *Pilogalumna crassiclava* (Berlese, 1914) were relatively abundant there. In rotting wood, *Eueremaeus oblongus* (C. L. Koch, 1835), *Ramusella insculpta* (Paoli, 1908), and *Carabodes quadrangulus* Bernini, 1979, were relatively abundant.

In summer populations of oribatid species, usually juveniles dominated, except for patches of moss on soil (open habitat), where adults were more abundant, and rotting wood, where juveniles were as abundant as adults (Table 1). Several species, like *Scheloribates initialis*, *S. laevigatus*, *Zygoribatula propinqua*, *Achipteria nitens*, *Tectocepheus velatus* and *Trhypochthonius tectorum* (Berlese, 1896), were rich in juveniles (Table 3). For example, in the population of *Scheloribates initialis* in moss on rock (open habitat), juveniles were over 10 times more abundant than adults, and in the nearby moss on soil, juveniles of this species were over 3-fold more abundant than adults. In the population of *Zygoribatula propinqua* in moss (forest floor), juveniles were more than 7-fold more abundant than adults, while in litter and moss on rock (open habitat), adults dominated. In populations of *Pilogalumna crassiclava*,

Table 3. Age structure of selected oribatid species in the studied habitats of Korčula Island: mean abundance (individuals per 500 cm^3, $n = 3$) of juvenile stages (Juv) and adults (Ad).

Species	Habitat	Juv	Ad	Total
Achipteria nitens	Forest floor, moss	107.0	35.7	142.7
	Open habitat, moss on soil	11.0	9.0	20.0
	Forest floor, litter	6.0	1.7	7.7
Eueremaeus oblongus	Forest floor, rotting wood	14.7	1.0	15.7
Metabelba pulverulenta	Open habitat, moss on soil	4.4	2.7	6.7
	Forest floor, litter	0.3	2.7	3.0
Oppia denticulata	Open habitat, moss on soil	16.4	16.3	32.7
	Forest floor, moss on rock	4.3	7.4	11.7
Oribatula tibialis	Open habitat, moss on rock	9.7	8.3	18.0
Pilogalumna crassiclava	Forest floor, litter	22.0	10.0	32.0
	Forest floor, moss	13.3	5.4	18.7
	Open habitat, moss on soil	24.7	27.6	52.3
Scheloribates initialis	Open habitat, moss on rock	164.4	16.3	180.7
	Forest floor, litter	106.3	37.4	143.7
	Open habitat, moss on soil	47.7	15.3	63.0
S. laevigatus	Open habitat, moss on soil	83.0	19.7	102.7
	Open habitat, moss on rock	41.7	12.0	53.7
	Forest floor, moss	94.7	25.6	120.3
Tectocepheus velatus	Open habitat, moss on soil	35.7	18.6	54.3
Trhypochthonius tectorum	Forest floor, litter	12.7	6.3	19.0
Zygoribatula propinqua	Forest floor, moss	136.4	18.3	154.7
	Open habitat, moss on rock	16.3	25.7	42.0
	Forest floor, litter	10.3	35.7	46.0

either juveniles (litter and moss, forest floor) or adults (moss on soil, open habitat) dominated. Also the population of *Oppia denticulata* (G. Canestrini and R. Canestrini, 1882) in moss on soil (open habitat) was richer in juveniles than that in forest litter. Generally, the age structure of species greatly depended on the type of vegetation.

DISCUSSION

Summer populations of oribatid mites in the investigated habitats of Korčula Island were generally more abundant and richer in species than those on Rhodes Island (Greece) and Andalusia (Spain) (Seniczak & Seniczak 2006, 2010, respectively). This was probably due to a better water regime of soils on Korčula Island. It is covered mainly by forests and shrub vegetation, which accumulate more water than arable fields and grasslands. The high summer temperatures and low precipitation on Rhodes Island and in Andalusia limit the abundance of soil animals (Attenborough et al. 1989; Stamou & Sgardelis 1989; Seniczak & Seniczak 2006, 2010). The trees and shrubs protect the soil from intensive solar radiation and reduce the speed of wind, which is favourable for soil mites. In steppe vegetation on Crimean Cape Tarkhankut (Ukraine), the soil oribatid mites are also relatively abundant and rich in species (Seniczak et al. 2009), mainly due to the fresh sea breeze. The presence of bushy patches in this steppe highly increases the density of oribatid mites (Seniczak et al. 2011).

In the investigated microhabitats of Korčula Island, *Scheloribates* Berlese, 1908, was relatively abundant and common. This genus was present in all microhabitats, but achieved higher values of dominance index in the open habitat than in the forest floor (54.9–84.7%, and 10.3–69.7% of total oribatid mites, respectively). The percentage contribution of this genus to soil oribatid mite communities in the investigated habitats of southern Rhodes, Andalusia, Italy, and Crimea was distinctly lower – at most 6–40% of total oribatid mites (Seniczak & Seniczak 2006, 2010, 2012; Seniczak et al. 2009, 2011).

The most abundant oribatid species on Korčula Island were *Scheloribates initialis, S. laevigatus*, and *Zygoribatula propinqua*. *Scheloribates initialis* was also the most abundant on La Gomera Island (Canary Islands, Spain) (Moraza & Peña 2005a), while *Zygoribatula propinqua* was abundant in pine and cypress litter in southern Italy (Seniczak & Seniczak 2012). Mites of the family Oribatulidae were numerous and most diverse in habitats of Canary Islands (Spain) (Moraza & Peña (2005a, b). On Korčula Island a large oppioid species *Oppia denticulata* was also relatively abundant. It is rather frequent in the southern region and classified as thermophilous and xerophilous (Migliorini 2009; Ivan & Vasiliu 2010). Probably that is why this species was more abundant in moss in the open habitat than in moss in the forest floor. A high participation of few species in the studied microhabitats of Korčula Island indicates, in the light of Thienemann's (1939) principles, a rather low soil fertility.

Populations of *Scheloribates* on Korčula Island were rich in juveniles, which indicates good living conditions for this genus. Juveniles of *S. initialis* were 3–10-fold more abundant, while juveniles of *S. laevigatus* were 3.5–4.2-fold more abundant

than adults. Also populations of *Zygoribatula propinqua*, *Achipteria nitens*, *Pilogalumna crassiclava*, *Tectocepheus velatus*, and *Trhypochthonius tectorum* were rich in juveniles, while in populations of *Oppia denticulata* and *Oribatula tibialis*, adults usually dominated. However, *Oppia denticulata* has delicate juveniles, which are usually insufficiently extracted from soil samples (Seniczak 1979).

CONCLUSIONS

1. In the investigated microhabitats of Korčula Island, summer populations of oribatid mites were rather abundant but poor in species, which is typical of the Mediterranean climate.
2. Among oribatid mites in the study area, only several species were abundant (*Achipteria nitens*, *Zygoribatula propinqua*, *Pilogalumna crassiclava*, *Scheloribates initialis*, *S. laevigatus*, and *Tectocepheus velatus*).
3. In some species (*Achipteria nitens*, *Pilogalumna crassiclava*, *Scheloribates initialis*, *S. laevigatus*, *Tectocepheus velatus* and *Trhypochthonius tectorum*), juveniles clearly dominated, while in *Oppia denticulata* and *Oribatula tibialis* the adults were usually more abundant than the juveniles among the extracted mites.

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