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GAMASID SOIL MITES (ARACHNIDA ACARI) AS INDICATORS OF THE CONSERVATION STATUS OF FORESTS ([1])

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Sabbatini Peverieri G., Romano M., Pennacchio F., Nannelli R., Roversi P.F. – Gamasid soil mites (Arachnida Acari) as indicators of the conservation status of forests.

The Gamasida of 8 study areas in 5 different Sites of Community Interest (SCI of the Nature 2000 network) of Central Italy, characterized by beech forest and by mixed forests, were investigated to collect information for define the conservation status of the investigated sites. Samples were taken in autumn from the forest ground of the study sites (litter and soil till 7 cm in depth) during the three years of the study. Collected adult specimens were identified at species level and data were used to calculate the following indices: Shannon, Simpson, Eveness and Maturity index. On the whole, in the 8 study sites were recorded 63 species of Gamasida, belonging to 17 families, and some species seems to be a rare component of the fauna. Among study sites, diversity indices ranged from 2.20 to 2.57 for the Shannon index and from 0.82 to 0.90 for the Simpson, while the Maturity index ranged from 0.69 to 0.85; no substantial differences were observed among different study areas.

KEY WORDS: site of community interest, mite diversity, acari, Natura 2000

INTRODUCTION

Gamasid mites are mainly predators of arthropods and nematodes in the edaphic environments. These mites are important for the equilibrium of the terricolous fauna and can be used as indicators of soil quality, thus providing useful information to define the conservation status of agricultural and forest environments and to plan environmental conservation strategies (KARG, 1968, 1986; KOEHLER, 1997; WEGENER, 2004; RUF and BECK, 2005; ČOJA and BRUCKNER, 2006). Qualitative (species present) and quantitative (number of individuals) reductions of the Gamasida fauna component are related to different strategies of agricultural production managing and forest vegetation or to the presence of disturbance factors, especially human activities (KARG, 1967; HUTU, 1982; CANCELA DA FONSECA, 1990; RUSEK and MARSHALL, 2000; SCHRADER and BAYER, 2000). HEISLER (1994) showed that human-induced soil compaction was a negative factor for Gamasida diversity, reducing the pore sizes of the soil structure. SALMANE (2003) demonstrated the contrast between natural environments, with a higher number of Gamasida species, and human-affected environments such as cultivated fields, with an abundance of individuals belonging to a small number of species; low species numbers have been recorded in habitats polluted by calciferous dust or in fields subjected to fertilization with pig slurry. Broadleaf forest soils have been found to have a higher faunal diversity and abundance of specimens than soils with conifer-dominated vegetation (SKORUPSKI *et al.*, 2003). In forest habitats, long-turn management strategies have proved to be able to positively affect the mite diversity of the soil (MINOR *et al.*, 2004). However, contrasting results were obtained by MINOR and CIANCIOLO (2007), who did not find significant differences in Gamasida species diversity and abundance among different vegetation management strategies.

The aim of the present study was to analyze the fauna composition of edaphic Gamasida in order to characterize the conservation status of some forest areas of central Italy classified as Sites of Community Importance (SCI), forming part of the NATURE 2000 network according to the EC directive 92/43 of 21/5/92.

MATERIALS AND METHODS

STUDY AREAS

The study was carried out in central Italy (Abruzzo-Molise Apennines) in five Sites of Community Importance (SCI) in the upper Sangro Valley, Sagittario Valley and northern Molise: IT7110100 "M.te Genzana", IT7110054 "Passo Godi", IT7110055 "Intramonti, M.te Godi e Ferroio di Scanno", IT7110053 "Chiarano-Sparvera", IT7212124 "Bosco di M.te di Mezzo, M.te Miglio, M.te Capraro, M.te Cavallerizzo". The overall vegetational aspects of the SCI can be classified as mesophilic beech woods with sub-continental climates at elevations above 1300 m a.s.l., consisting of woods of high forest of beech trees (*Fagus sylvatica* L.), and thermophilic beech woods, consisting of mixed forests at elevations of 1000-1300 m a.s.l., dominated by beech trees with the presence of Italian maple (*Acer obtusatum* Willd.), Wild service tree (*Sorbus torminalis* (L.) Crantz), European hornbeam (*Carpinus betulus* L.), Turkey oak (*Quercus cerris* L.),

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European silver fir (*Abies alba* L.) and European ash (*Fraxinus excelsior* L.). The study areas are in a territory of marked faunistic importance, especially in regard to the presence of a Southern subspecies of the Brown bear (*Ursus arctos marsicanus* Altobello)*,* Gray wolf (*Canis lupus* L.), Golden eagle (*Aquila chrysaetos* L.), Peregrine falcon (*Falco peregrinus* Tunstall.), Northern goshawk (*Accipiter gentilis* L.), Eagle Owl (*Bubo bubo* L.) and the longhorned beetle *Rosalia alpina* L., plus many other species of animals and plants listed in Appendices II, IV and V of the EEC directive "Habitat" 92/43 and in Appendices I and II of the directive "Birds" 2009/147/EC. Human activities in the study areas are mainly related to temporary sheep breeding (pasturing), which although not intensive is widespread. Eight study stations within the five SCI were chosen on the basis of uniform characteristics and territorial representativeness (Tab. 1).

SAMPLING AND STUDY OF THE MATERIAL

The study was conducted in the three-year period 2006-2008. Samplings were done in rectangular areas (10 x 10 m) at each of the 8 study sites once in autumn of each year (ČOJA and BRUCKNER, 2006). Samples, consisting in soil and litter, were taken with a 5x7 cm stainless steel core samplers to a depth of 7 cm. In each sampling, five samples were taken at each station: at the vertices of the rectangular area plus one at the centre. Berlese funnels were used to extract the mites and the collected material was preserved in 75% alcohol. The Gamasida were separated from the rest of the collected soil fauna under a stereomicroscope and the specimens were mounted on slides in Hoyer's medium for species identification. All the gamasid mites were identified at least to the family level, while adults were identified to the species level using the systematic keys of SELLNICK (1958a, 1958b), HIRSCHMANN and KRAUSS (1965), HIRSCHMANN and ZIRNGIEBL-NICOL (1965), KARG (1989, 1993), BREGETOVA (1977), WIŚNIEWSKI and HIRSCHMANN (1993), MAŠÁN (2001, 2003, 2007), MAŠÁN and FENĎA (2004). In addition, we consulted the original material conserved in the A. Berlese Mite Collection of the Agrobiology and Pedology Research Centre of the Agricultural Research Council in Florence (Italy), as well as the descriptions and drawings in the original works by Berlese (BERLESE 1903, 1904, 1916, 1920).

DATA ANALYSIS

The recorded data obtained from the taxonomic investigations at species level were used to estimate the soil Gamasida diversity of the eight study sites; the following diversity indices were calculated: Shannon (H'), Simpson (1-D), Eveness ($E_{(H')}$) (KREBS, 1989); the Maturity Index (MI), based on the number of species with type "r" and type "K" reproductive strategies, were calculated for assess perturbation level of the sites (RUF, 1997, 1998, ČOJA and BRUCKNER, 2006). The Sørensen coefficient (degree of similarity between study areas) was calculated with EstimateS 8.0 Win using cumulative data for each study site (KREBS, 1989; COLLWELL, 2006).

RESULTS

In the three-year study period, on the whole were recorded 1,782 gamasid mites, of which 62.51% were adults. The highest number of specimens were recorded in the study site MEZ1 (548 specimens), while the lowest number were recorded in the site PGO (59 specimens) (Tab. 2).

Totally, the collected gamasid mites (considering both adults and juvenile specimens) were distributed among 17 families. The Zerconidae had the highest number of individuals, followed by the Veigaiidae, the Parasitidae and the Laelapidae. The families Parasitidae, Zerconidae, Laelapidae and Veigaiidae were represented by a higher number of species than the other families.

Considering cumulative data of all three years of study, the 1114 collected adult specimens belonged to 63 species of Gamasida (Tab. 2). On the whole, a high number of species were recorded at stations GEN1, MEZ1 and MEZ2 (40, 35 and 37 species, respectively), while station PGO yielded a lower number (23 species) (Tab. 2). The numbers of species at the other study sites ranged from 28 to 31. Some species of the families Uropodidae, Zerconidae and Veigaiidae were frequently eudominant or dominant, in particular the species *Uropoda minima* Kramer, *Zercon zangheri* Sellnick, *Veigaia nemorensis* (Koch) and *V. planicola* (Berlese). Moreover, *Geolaelaps aculeifer* (G. Canestrini), *U. minima*, *V. nemorensis* and *V. planicola* were found at all the study sites. In overall, 41.9% of the recorded species were accessory or accidental ones and 79% were recedent or subrecedent species.

The Shannon index (H') ranged between 2.20 at station PGO and 2.57 at station MEZ2; values close to those recorded at station MEZ2 were 2.55 at station GEN1 and 2.54 at station MEZ1 (Tab. 3). The Simpson index (1-D) was highest at station MEZ2, while the lowest values were

Table 1 – Main characteristics of the study sites.

SCI	Code	Altitude m a.s.l.	Forest typology	Forest managing	Soil type
Chiarano-Sparvera	CHI1-CHI2	1600	Beech	High forest	Dysmull/Hemimoder
Monte Genzana	GEN1– GEN2	1300	Beech	High forest	Olygomull/Dysmull
Passo Godi	PGO	1500	Beech	High forest	Olygomull
Feudo Intramonti, M.te Godi, Ferroio di Scanno	FER	1300	Beech	Coppice	Eumoder
Bosco di M.te di Mezzo, M.te Miglio, M.te Capraro, M.te Cavallerizzo	MEZ1-MEZ2	1000	Turkey oak, European beech European ash, Silver fir	High forest	Eumoder/Dysmoder/ Dysmull

Table 2 – Total number of soil Gamasida recorded at the eight stations during the three-year study.

Family/Species	CHI1	CHI2	GEN1	GEN2	PGO	FER	MEZ1	MEZ2	Total
Ascidae									
Arctoseius eremita (Berlese)	–	–	3	–	–	–	–	–	3
Arctoseius semiscissus (Berlese)	1	–	1	–	–	–	–	–	2
Arctoseius venustulus (Berlese)	3	1	1	5	–	1	1	1	13
Asca bicornis (G. Canestrini & Fanzago)	–	1	2	–	–	–	1	1	5
Leioseius bicolor (Berlese)	–	1	2	–	–	2	–	11	16
Cillibidae									
Cilliba cassidea (Hermann)	–	–	–	1	–	–	5	1	7
Discourellidae									
Discourella modesta (Leonardi)	–	–	–	1	–	6	3	–	10
Epicriidae									
Epicrius mollis (Kramer)	–	–	–	–	–	–	–	1	1
Halolaelapidae									
Leitneria granulata (Halbert)	1	–	1	–	1	–	–	–	3
Laelapidae									
Geolaelaps aculeifer (G. Canestrini)	5	9	5	9	1	14	6	3	52
Hypoaspis praesternalis Willmann	–	–	–	1	–	–	–	–	1
Pneumolaelaps asperatus (Berlese)	–	–	–	–	3	1	–	–	4
Pseudolaelaps gamaselloides Berlese	–	–	–	1	–	4	–	–	5
Pseudolaelaps paulseni (Berlese)	–	1	1	3	–	1	9	8	23
Pseudoparasitus meridionalis (G. & R. Canestrini)	–	–	–	–	–	5	–	–	5
Pseudoparasitus sp.	–	2	4	6	2	–	1	2	17
Macrochelidae									
Geholaspis longula (Berlese)	1	1	–	–	–	–	2	2	6
Geholaspis pauperior (Berlese)	–	–	–	–	1	–	–	–	1
Macrocheles terreus (G. Canestrini & Fanzago)	1	–	1	–	–	–	–	–	2
Pachylaelapidae									
Olopachys scutatus Berlese	–	–	–	–	–	–	–	1	1
Pachylaelaps karawaiewi Berlese	1	–	–	–	–	–	–	–	1
Pachylaelaps magnus Halbert	6	2	3	–	2	–	–	4	17
Pachylaelaps regularis Berlese	1	–	–	–	–	–	–	–	1
Pachylaelaps sculptus Berlese	1	1	2	2	–	–	–	–	6
Pachylaelaps siculus Berlese	–	–	1	1	–	–	–	–	2
Pachylaelaps sp.	1	1	–	–	–	–	1	–	3
Pachyseius humeralis Berlese	2	2	2	–	1	1	1	6	15
Parasitidae									
Amblygamasus hamatus Koch	1	2	1	1	–	2	–	–	7
Cornigamasus lunaris (Berlese)	–	–	1	–	–	–	–	–	1
Holoparasitus calcaratus (Koch)	1	–	1	1	–	–	1	2	6
Leptogamasus parvulus var. *dilatatellus* (Berlese)	–	–	–	–	–	1	–	–	1
Leptogamasus sp.1	1	–	1	4	1	–	6	5	18
Leptogamasus sp.2	–	1	1	–	–	–	2	3	7
Paracarpais lunulata (Müller)	–	–	1	–	–	2	1	–	4
Paragamasus judeortus Athias-Henriot	1	1	1	–	–	3	4	5	15
Pergamasus quisquiliarum (G. & R. Canestrini)	2	–	2	2	2	4	6	1	19
Pergamasus sp.	1	–	–	3	1	–	–	3	8
Phorytocarpais fimetorum (Berlese)	1	–	1	1	–	–	–	–	3
Vulgarogamasus sp.	2	3	–	–	1	–	–	1	7
Phaulodinychidae	–	–	–	–	–	–	–	–	–
Phaulodinychus porticensis (Berlese)	–	–	–	4	4	6	35	8	57
Phaulodinychus pulcherrimus (Berlese)	–	–	–	–	–	–	–	1	1
Phaulodinychus splendidus Kramer	–	–	–	1	–	–	1	1	3
Phytoseiidae	–	–	–	–	–	–	–	–	–
Amblyseius sp.	–	–	1	1	1	–	1	1	5
Rhodacaridae									
Dendroseius reticulatus (Sheals)	–	–	–	–	–	–	1	–	1
Rhodacarellus silesiacus Willmann	–	2	11	1	3	2	4	7	30
Rhodacarus reconditus Athias-Henriot	1	1	3	2	–	4	4	11	26

(continued)

Continued Table 2

Family/Species	CHI1	CHI2	GEN1	GEN2	PGO	FER	MEZ1	MEZ2	Total
Trachytidae									
Trachytes aegrota (Koch)	2	1	1	–	1	1	–	–	6
Trachytes lambda Berlese	–	2	3	14	2	1	9	7	38
Urodiaspididae									
Urodiaspis rectangulovata Berlese	1	9	4	–	1	1	–	–	16
Urodiaspis tecta (Kramer)	1	1	1	2	–	1	1	3	10
Uropodidae									
Uropoda minima Kramer	9	2	4	12	4	22	4	12	69
Uropoda minor (Berlese)	–	–	–	–	–	1	1	2	4
Veigaiidae									
Veigaia cerva (Kramer)	–	–	–	–	–	–	1	–	1
Veigaia exigua (Berlese)	–	1	–	3	2	2	8	1	17
Veigaia nemorensis (Koch)	1	3	10	14	3	4	20	8	63
Veigaia planicola (Berlese)	7	5	12	16	4	8	11	6	69
Zerconidae									
Prozercon fimbriatus (Koch)	–	–	4	–	–	1	51	13	69
Prozercon sp.	–	–	1	5	–	13	40	–	59
Prozercon traeghardhi (Halbert)	5	2	4	57	–	26	1	2	97
Zercon romagniolus Sellnick	–	–	4	–	–	–	–	1	5
Zercon similis Sellnick	1	–	2	1	–	8	10	10	32
Zercon sp.	1	1	3	–	1	–	–	–	6
Zercon zangherii Sellnick	14	5	33	20	9	–	27	4	112
Total number of species (adult specimens)	31	28	40	31	23	30	35	37	63
Total number of adult specimens	77	64	140	195	51	148	280	159	1114
Total number of specimens (adults + juveniles)	118	95	203	292	59	215	548	252	1782

Table 3 – Values of different diversity indices for the soil Gamasida at the eight study sites.

Diversity indices	CHI1	CHI2	GEN1	GEN2	PGO	FER	MEZ1	MEZ2
Shannon (H')	2.34	2.44	2.55	2.24	2.20	2.42	2.54	2.57
Simpson (1-D)	0.87	0.89	0.88	0.82	0.86	0.87	0.89	0.90
Eveness ($E_{(H')}$)	0.56	0.59	0.61	0.54	0.53	0.58	0.61	0.62
Maturity index (MI)	0.80	0.69	0.79	0.76	0.77	0.79	0.85	0.82

recorded at stations GEN2 and PGO. The Eveness index (E) was between 0.53 and 0.62 (respectively at PGO and MEZ2). The "Maturity Index" (MI) ranged between 0.69 and 0.85, with the lowest value at station CHI2 and the highest at station MEZ1.

The Sørensen coefficient showed a high similarity between stations MEZ1 and MEZ2 and, secondarily, between MEZ1 and GEN2, and among GEN1, CHI2 and CHI1. The study site PGO had the lowest similarity with all other sites (Tab. 4).

DISCUSSION

The data collected in the present study shows that there is relative high diversity level of the edaphic Gamasida at the eight stations inside the five Sites of Community Interest, with no substantial differences among the different areas. We recorded a total of 63 species, with a minimum of 23 species at the station in the Passo Godi site (PGO) and a maximum of 40 in one of the two study sites of the Monte Genzana SCI (GEN1). The site MEZ2 has the highest diversity indices, while the site PGO the lowest. On the whole, the various parameters describing the diversity levels of gamasid mites in the study areas gave a largely comparable results, as found in similar investigations in central European forest areas with a prevalence of beech trees and used for timber production or with a naturalistic management (LUXTON, 1982; RUF, 2000; WEGENER, 2004). The Maturity index values show that the soils in the eight study areas have good stability and the habitats have been relatively unaffected by disturbance events; these values are similar to those in studies conducted in central European beech woods managed with naturalistic criteria (RUF, 1997; ČOJA and BRUCKNER, 2006).

Many of the recorded Gamasida species are common to different agricultural and forest environments of the

Table 4 – Sørensen coefficients of the eight study sites based on the soil Gamasida diversity.

	CHI1	CHI2	GEN1	GEN2	PGO	FER	MEZ1
CHI2	0.67						
GEN1	0.70	0.70					
GEN2	0.54	0.56	0.64				
PGO	0.44	0.50	0.51	0.51			
FER	0.49	0.61	0.63	0.61	0.45		
MEZ1	0.52	0.63	0.67	0.72	0.48	0.68	
MEZ2	0.56	0.67	0.68	0.67	0.50	0.60	0.81

Palaearctic and Nearctic Regions, while others seems to be more rare species: *Pseudolaelaps gamaselloides* Berlese, *Pseudolaelaps paulseni* (Berlese), *Pseudoparasitus meridionalis* (G. & R. Canestrini), *Phaulodinychus porticensis* (Berlese) and *Zercon zangherii* Sellnick. Special mention must be given to *Leitneria granulata* (Halbert) since our specimens are the first Italian records of a species known for other European countries. We also confirmed the presence of *Pachylaelaps magnus* Halbert, *Paragamasus judeortus* Athias-Henriot, *Dendroseius reticulatus* Sheals, *Rhodacarellus silesiacus* Willmann and *Rhodacarus reconditus* Athias-Henriot, recently reported as new species for the Italian fauna (SABBATINI PEVERIERI *et al.*, 2008).

The results of our study provide important information about the faunal composition of the five Sites of Community Importance. They could also be the starting point for the creation of a wider monitoring network to supplement the existing faunal and floral monitoring systems and to help with the analysis of the conservation status and evolution of these natural habitats aimed to best practices in environment and forest management.

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