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Gamasid Mites (Parasitiformes, Mesostigmata), Dwellers of Bracket Fungi, from the Pechora-Ilychskii Reserve (Republic of Komi)

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Abstract—Gamasid mites inhabiting seven mass species of bracket fungi were studied. Among 28 species found, 8 species are mycetobionts (Ascidae and Ameroseiidae); 4 species, dendrobionts (Digamasellidae and Phytoseiidae); all other species belong to litter forms. The species diversity in perennial fungi is low (1-6 species); 99-100% of the entire population are specialized mycetobionts *(Hoploseius, Mycolaelaps,* and *Ameroseius)*. In the annual leathery bracket fungi 11-14 species were found. Mycetobionts are represented by unspecialized forms *(Lasioseius, Zerconopsis,* and *Aceosejus)* and the litter forms prevailed.

The fauna and community of gamasid mites dwelling in bracket fungi have never been studied in the territory of Russia. Nearly all the data available in the world literature is limited to listing of habitats of separate species in keys (Opredelitel', 1977; Karg, 1993, etc.) or to description of new species (Berlese, 1910; Chant, 1963; Lindquist, 1963, 1965, 1995; Ishikawa, 1969; Gwiazdowicz, 2002; Masan and Walter, 2004). Only recently a study of gamasid mites from bracket fungi of broad-leaved forests of Poland was published (Gwiazdowicz and Lakomy, 2002). In this work, a long list of mite species was given, their association with separate fungi was traced, species richness and similarity between their communities in different fungi were estimated. Even these publications demonstrate that the complex of gamasid mites dwelling in bracket fungi is formed of different ecological groups and that it differs from that dwelling in litter and on trees themselves; every new collection leads to describing of new species.

The goal of the present study was to reveal the species composition, abundance, and character of distribution of gamasid mites in various bracket fungi in the taiga zone (territory of Pechora-Ilychskii Nature Reserve). At present, data on gamasid mites from this reserve is available only in the publication of Makarova (1988), treated with sphagnum pine forests.

MATERIALS AND METHODS

Pechora-Ilychskii Nature Reserve is situated in the middle taiga subzone of the northern Ural region. The climate is characterized by low average annual (-8°C) and January (-17.9°C) temperatures, relatively high rainfall (620 mm per year), and a short frostless period (75 days) (Bobretsov and Teplova, 2000).

Mites were collected in the dark taiga in the plain area of the reserve (Yakshinsk forestry). Fruit bodies of 7 mass species of bracket fungi were studied. They included both perennial (*Fomes fomentarius, Fomitopsis pinicola,* and *Phellinus igniarius*) and annual species, including the typical mushroom-shaped *Piptoporus betulinus* and coriaceous, flat *Gloeophyllum sepiarium, Lenzites betulina,* and *Coriolus hirsutus*), forming accumulations of fruit bodies. Perennial fungi were collected partly from living trees (*Fomes fomentarius* and *Phellinus igniarius* from birches) and partly from deadwood and stubs of coniferous trees (*Fomitopsis pinicola*). Annual species of fungi were found, as a rule, in dead, usually fallen birches (*Piptoporus betulinus, Lenzites betulina,* and *Coriolus hirsutus*) or coniferous trees (*Gloeophyllum sepiarium*). For the first time, we give the data on the number of mycetobiontic mites per unit of measurement (specimens per dm^2 of the area of the hymenophore), making it possible to compare the abundance of species and their groups in different bracket fungi.

Samples were collected in September 25-28, 2003. The volume of the material collected is given in Table 2. Before collecting of mites from thermoeclectors, samples were stored at a temperature of 0... +8°C in separate polyethylene bags. Mites were

Table 1. Distribution of mesostigmatic miles in abundant species of bracket fungi in a plain area of the Pechora-Ilychskii Reserve (September 2003)

Mite species	*Fomes fomentarius*	*Fomitopsis pinicola*	*Phellinus igniarius*	*Piptoporus betulinus*	*Gloeophyllum sepiarium*	*Lenzites betulina*	*Coriolus hirsutus*
Ameroseius fungicolis Masan, 1904	+	+	+	+	+	+	+
Hoploseius sp. n. aff. *tenuis* Lindquist, 1965		+					
Lasioseius ometes (Oudemans, 1903)					+	+	+
Aceoseius muricatus (C.L. Koch, 1839)						+	+
Dendrolaelaps (Punctodendrolaelaps) trapezoides Hirschmann, I960					+	+	+
Zercon (Isozercon) zelawaiensis aberr. (Sellnick, 1944)		+		+	+	+	+
Zercon (Zercon) forsslundi Sellnick, 1956					+	+	+
Leioseius bicolor (Berlese, 1948)						+	
Dinychus septentrionalis (Tragardh, 1943)		+			+	+	+
Gamasellus silvestris Halaskova, 1958				+	+	+	+
Gamasellus cf. *tundriensis* Davydova, 1982					+	+	+
Trachytes aegrota (C.L. Koch, 1841)					+		+
Dinychys arcuatus (Tragardh, 1943)							+
Uroobovella sp.							+
Parazercon radiatus (Berlese, 1904)		+					
Arctoseius semiscissus (Berlese, 1892)						+	
Iphidozercon cf. *gibbus* Berlese, 1903							+
Zerconopsis (s. str.) *decemremiger* Evans et Hyatt, 1960						+	
Zerconopsis (subgen. n.) sp. n.							+
Mycolaelaps sp. n. aff. *maxinae* Lindquist, 1995		+					
Proctolaelaps pygmaeus (Muller, 1860)	+						
Leioseius naglitschi Karg, 1965					+		
Ameroseius sp. n. aff. *fungicolis* Masan, 1998	+						
Anthoseius verrucosus Wainstein, 1972					+		
Multidendrolaelaps euepistomus (Hirschmann, 1960)						+	
Dendrolaelaps (*Longoseiulus*) cf. *ornatosimilis* Shcherbak, 1980						+	

extracted from bracket fungi in the laboratory in Moscow at a temperature of +24 … +26 °C. Mites were fixed in 85% alcohol. Slides were made with the use of the Four-Berlese fluid. A total of 2480 mesostigmatic mites were obtained from 51 samples.

RESULTS AND DISCUSSION

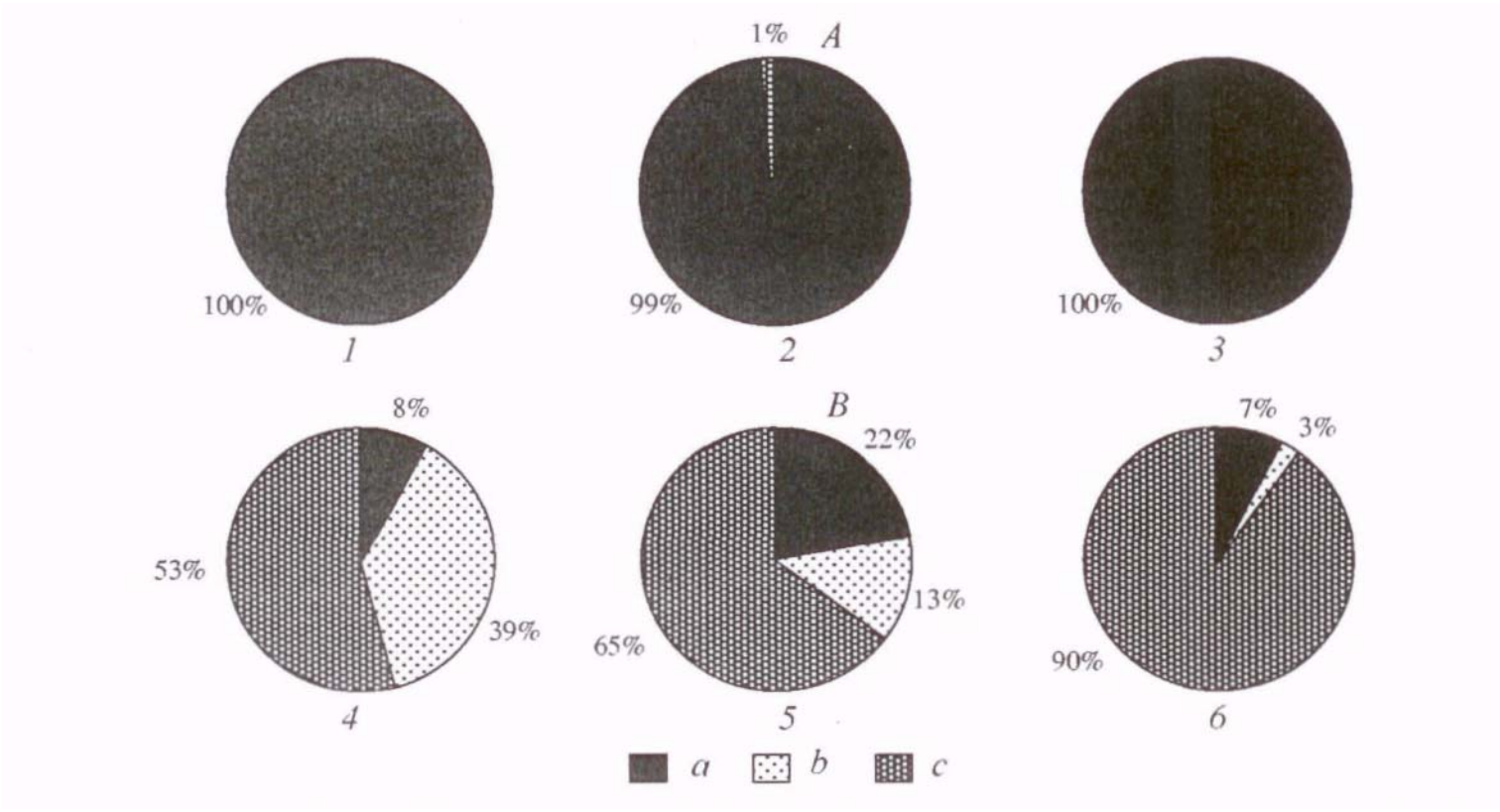
Taxonomic Composition

On the whole, 26 species of gamasid mites were found in bracket fungi examined; 11 of these species belong to the family Ascidae (Table 1). Previously, species of this family were found in bracket fungi more frequently. The family Digamasellidae is also rather well represented, mainly owing to dendrobiontic species. By contrast, a total absence of such large families as Pergamasidae and Macrochelidae in bracket fungi attracts attention. In the litter of spruce forests examined, the latter are also absent, which is also characteristic of the northern Siberian taiga (Mordkovich *et al.,* 2003; my unpublished data of Evenkia and Yakutia).

Against the background of this faunal poverty, the presence of some species of the genera *Dinychus* (Uropodidae) and *Gamasellus* (Rhodacaridae) and of

Table 2. Community structure of mesostigmatic mites in different bracket fungi (Pechora-Ilychskii Reserve, September 2003)

Parameter of mite community (Mesostigmata)	*Fomes fomentarius*	*Fomitopsis pinicola*	*Phellinus igniarius*	*Piptoporus betulinus*	*Gloeophyllum sepiarium*	*Lenzites betulina*	*Coriolus hirsutus*
Number of species	3	6	1	5	11	14	14
Average abundance (number of specimens per dm^2 of the surface of the hymenophore)	247.9	260.6	2.7	6.8	28.9	31.4	31.6
Most frequent species (% of samples)	*A. fungicolis* (100.0)	*Hoploseius* sp. (100.0) *Mycolaelaps* sp. (15.4) *A. fungicolis* (30.8)	*A. fungicolis* (40.0)	*A. fungicolis* (28.6)	*G. silvestris* (100.0) *Z. zelawaiensis* (60.0) *D. trapezoides* (60.0)	*Z. zelawaiensis* (100.0) *G. silvestris* (75.0) *L. ometes* (75.0) *Z. forslundi* (75.0) *D. trapezoides* (50.0)	*Z. zelawaiensis* (100.0) *G. silvestris* (100.0) *Z. forslundi* (100.0) *L. ometes* (80.0) *D. trapezoides* (60.0)
Dominant species and their fraction (% of total abundance)	*A. fungicolis* (99.8)	*Hoploseius* sp. (95.4) *Mycolaelaps* sp. (2.4)	*A. fungicolis* (100.0)	*A. fungicolis* (67.9) *G. silvestris* (17.8) *Z. zelawaiensis* (10.1)	*Z. zelawaiensis* (38.5) *D. trapezoides* (36.5)	*Z. zelawaiensis* (42.7) *Z. forslundi* (27.3) *L. bicolor* (9.1) G. *silvestris* (8.2)	*Z. forslundi* (33.3) *Z. zelawaiensis* (19.8) *D. trapezoides* (12.5) *G. silvestris* (10.6)
Fraction (% of total number)							
mycetobionts	100.0	99.4	100.0	67.9	7.7	7.1	21.9
dendrobionts	0	0	0	0	38.5	2.7	13.4
Litter species	0	0.6	0	32.1	53.8	90.2	64.7
Material							
number of fruit bodies or their groups*	12	13	5	7	5*	4*	5*
number of mite specimens	1115	938	7	28	72	112	208



Percentage of ecological groups of gamasid mites in perennial hard *(A)* and annual skinny *(B)* bracket fungi (Pechora-Ilychskii Reserve, plain area, September 2003): (*1*) *Fomes fomentarius;* (*2*) *Fomitopsis pinicola*; (*3*) *Phellinus igniarius*; (*4*) *Gloeophyllum sepiarium*; (*5*) *Coriolus hirsutus:* (*6*) *Lenzites betulina*; (*a*) mycetobionts; (*b*) dendrobionts; (*c*) litter dwellers.

the family Zerconidae point to its boreal character; all the above taxa are very usual taxa of Mesostigmata at the northernmost limit of the forest and in the tundra zone. No mites of the genus *Veigaia* were found in bracket fungi. In the same areas of the forest, 3-4 representatives of this genus were found in litter, testifying to their strict station association. The absence in our samples of fungi representatives of the genera *Uropoda, Trichouropoda,* and also rare findings of mites of the genus *Uroobovella* (Uropodidae) strongly distinguish the fauna revealed from that examined in Poland (Gwiazdowicz and Lakomy, 2002) and Moscow Province (my unpublished data), demonstrating the severe climatic conditions of the region examined. Mites of this large family are most diverse in the tropics, and in the tundra zone they are represented only by a single genus (*Dinychus*) with few species.

Among the species found, there are 4 species new to science.[1] All of them belong to genera *(Hoploseius, Mycolaelaps,* and *Zerconopsis)* or a group of species (the *Ameroseius fungicolis* group), associated with fungal substrates. Until recently, the genus *Mycolaelaps* Lindquist was a monotypic one; it is reported from the Palaearctic Region for the first time. The genus *Hoploseius* and *Ameroseius fungicolis* are for the first time recorded from the territory of Russia.

[1] They will be described in the *Zoologicheskii Zhurnal.*

It should be noted that new species of the genera *Hoploseius* and *Mycolaelaps* possess a significant similarity in the appearance. This similarity appeared in these representatives of different tribes of the subfamily Ascinae of the family Ascidae (Blattisociini and Melicharini, respectively) in parallel, owing to the similar way of life in tubules of the hymenophore of poliporous fungi. This pair of new species is analogous to the pair of species *(Hoploseius tenuis - Mycolaelaps maxinae)* described from coniferous forests of North America (Lindquist, 1965, 1995). The presence of such pairs of morphologically similar species from different tribes on different continents testifies to the existence of a distinct life form of gamasid mites: "the dweller of tubular fungi". It is characterized by a small size, very narrow body, weak cheliceral claws with pointed similar denticles, and a reduced chaetom of the dorsal shield and legs.

A new species of the genus *Zerconopsis* belong to the new subgenus, which differs from the nominotypical subgenus in the following set of characters: female with a large anal shield bearing only anal setae; male with a long bent spermatodactyle (nearly twice as long as cheliceral claw); specialized oar-shaped setae on dorsal shield of both sexes absent.

Groups of Mites in Different Fungi

Species composition of gamasid mites strongly differs in different fungi (Table 1). Species richness is

poorly manifested in perennial fruit bodies with rigid "woodened" mycelium (1-6 species in different fungi, 8 species on the whole). Five of these species are specialized mycetobionts, and two species, *Hoploseius* sp. n. and *Mycolaelaps* sp. n., dwell only in the hymenophore of *Fomitopsis pinicola.* The mite *Ameroseius fungicolis,* recently described from Slovakia from the fungi *Fomes fomentarius* and *Phellinus igniarius* (Masan, 1998), in my material is also associated mainly with these species, although it was occasionally found in other bracket fungi. The species composition of mites in annual fungi with skinny fruit bodies is more diverse (11-14 mite species in different bracket fungi and 21 species on the whole) and less specific. About half the species are common to two or all three species of fungi, and only 6 species are mainly unspecialized mycetobionts *(Lasioseius ometes, Aceoseius muricatus, Iphidozercon* cf. *gibbus,* and *Zerconopsis dezemremiger),* according to some publications (Gwiazdowicz and Lakomy, 2002; Masan and Walter, 2004) and my unpublished data.

The first attempt to estimate the abundance of mites in bracket fungi (detailed measurements of the hymenophore area in samples) demonstrated strong differences among species of bracket fungi (Table 2). High abundance of mites in *Fomitopsis pinicola* and *Fomes fomentarius* were similar, in spite of the different character of the use of the environment by these mites abundant in bracket fungi *(Hoploseius* sp. n. stays mainly in tubules, whereas *Ameroseius fungicolis,* on the surface of the hymenophore). Solitary gamasid mites were found in *Phellinus igniarius.* In groups of gamasid mites from perennial bracket fungi, specialized mycetobionts comprise 99-100% of the total abundance (figure). Density of mites in annual fungi is characterized by mean values (Table 2); usual litter species, for which environmental conditions in these fungi are similar to those in litter, prevailed.[2]

Biological Characteristics of Species

A small amount of the material together with observations of the living mites allowed noticing of some very characteristic peculiarities in the biology of mycetobiontic species. In the period of investigation (late autumn, regular night frosts, daily temperature +2 ... + 8°C), many specialized species (myceto- and dendrobionts) contained a large volume of fat; it was characteristic only of the survival phases (females of *Ameroseius fungicolis, Hoploseius* sp. n., *Mycolaelaps* sp. n., *Aceosejus muricatus, Lasioseius ometes,* and *Arctosius semiscissus* and deutonymphs of *Dendrolaelaps trapezoides).*

It should be also noted that in this pre-winter period, 99-100% of *Hoploseius* sp. n. and *Mycolaelaps* sp. n. populations were represented by adult mites, whereas juvenile phases comprised only 12% of *Ameroseius fungicolis* (including 5% of larvae). Moreover, copulation was observed in this species at such low day temperatures (although no developed eggs were found in females). Such differences between mite species may be associated with the phenology of spore formation in fungi *(Fomitopsis pinicola* produces spores in May and *Fomes fomentarius,* in September, see Bondartsev, 1953).[3] In my material, the overwhelming majority of females of *Hoploseius* sp. n. were also fertilized (some of them contained spermatophores in both spermathecae), guaranteeing the rapid spring development of a population containing mites of both sexes.[4] The dendrobiontic *Dendrolaelaps trapezoides* was represented mainly by deutonymphs (80%). Populations of mass species of the litter complex (*Zercon* spp., and *Gamasellus* spp.) contained mites of different life phases, and juvenile individuals comprised 75-80% of each sample.

In specialized mycetobiontic species, the sex ratio was strongly shifted to females. Males constituted only 4, 12, and 10% in *Ameroseius fungicolis, Hoploseius* sp. n., and *Mycolaelaps* sp. n., respectively. Male and female fractions were nearly similar in litter species *(Zercon* spp., *Gamasellus* spp., and *Leioseius bicolor*). Only ready for wintering females containing

[2] The annual species of bracket fungi examined were usually found in fallen trees covered with moss, with their fruit bodies forming dense groups.

[3] No direct data on feeding of *Hoploseius, Mycolaelaps,* and *Ameroseius* are available; however, consuming of hyphae and sporophores was assumed (Lindquist, 1963, 1995; Krantz and Lindquist, 1979; O'Connor. 1984; Walter, 1998). Examining of the gut content in many specimens of these species, including specimens from other regions, we did not find any structured particles. This fact points to the existence of the extra-intestinal digestion, whereas some litter species of the genus *Ameroseius gulp* down the mycelium and conidia of micromycets (Evans, 1992; my observations).

[4] The reproduction of this species is unknown, but diplo-diploidy is characteristic of most of species of the tribe Blattisociini (Walter and Lindquist, 1995).

a large volume of fat in the body cavity were noted in *Lasioseius ometes* and *Arctoseius semiscissus.*

The study revealed a significant taxonomic diversity of gamasid mites in fruit bodies of bracket fungi and also a high specificity of the community as a whole and of complexes developing in separate species. Subsequent investigations of gamasid mites, populating these temporary biotopes, must include the revealing of phoretic associations of mycetobiontic mite species with flying mycetophagous insects. Only such associations provide populating of new bracket fungi by mite species.

REFERENCES

1. Berlese, A., Brevi diagnosi di generi e specie nuovi di Acari, *Redia.* 1910, vol. 6, pp. 346-388.
2. Bhattacharrya. S.K., New Species of *Hoploseius* and *Pseudoparasitus* (Acarina: Mesostigmata) from India, *Ind. J. Acarol.* 1977. vol. 1, pp. 1-5.
3. Bobretsov, A.V. and Teplova, V.P., Natural Conditions of the Pechora-Ilychskii Reserve, *Zakonomernosti poluvekovoi dinamiki bioty devstvennoi taigi Severnogo Preduralya* (Regularities in the Half-Century Dynamics of the Biota of the Virgin Taiga in Northern Ural Re gion), Syktyvkar, 2000.
4. Bondatsev, A.S.. *Trutovye griby Evropeiskoi chasti SSSR i Kavkaza* (Bracket Fungi of the European USSR and the Caucasus), Moscow: Nauka, 1953, 725 pp.
5. Chant. D.A., The Subfamily Blattisocinae Garman (= Aceosejinae Evans) (Acarina: Blattisocinae Garman) (= Aceosejidae Baker et Wharton) in North America, with Description of New Species, *Can. J. Zool.,* 1963, vol. 41. pp. 243-305.
6. Evans, G.O., *Principles of Acarology,* Wallingford: CAB International. 1992, 563pp.
7. Gwiazdowicz, D.J., New Species of *Hoploseius* Berlese, 1914 (Acari: Gamasida, Ascidae) from Poland, *Acta Zool. Acad. Sci. Hung.,* 2002, vol. 48. no. 3, pp. 219-224.
8. Gwiazdowicz, D.J. and Lakomy, P., Mites (Acari: Ga masida) Occurring in Fruiting Bodies of Aphyllophorales. *Fragm. Faun.,* 2002. vol. 45. pp. 81-89.
9. Ishikawa, K.. Studies on the Mesostigmatic Mites in Japan: IV. Family Blattisocidae Garman. *Rep. Res. Matsuyama Shinonome Jun. College,* 1969, vol. 4. no. 1, pp. 111-139.
10. Karg, W., Acari (Acarina) Milben. Parasitiformes (Anactinochaeta). Cohors Gamasina Leach. Raubmilben (2., Auff.), *Die Tierwelt Deutschlands,* 1993, vol. 59, 523 S.
11. Krantz. G.W. and Lindquist, E.E., Evolution of Phytophagous Mites (Acari). *Ann. Rev. Entomol.,* 1979, vol. 24, pp. 121-158.
12. Lindquist, E.E., A Taxonomic Review of the Genus *Hoploseius* Berlese (Acarina: Blattisocidae). *Can. Entomol.,* 1963. vol. 95. no. 11, pp. 1175-1185.
13. Lindquist, E.E., An Unusual New Species of *Hoploseius* Berlese (Acarina: Blattisocidae) from Mexico, *Can. Entomol.,* 1965, vol. 97, no. 11, pp. 1121-113 1.
14. Lindquist, E.E., Remarkable Convergence between Two Taxa of Ascid Mites (Acari: Mesostigmata) Adapted to Living in Pore Tubes of Bracket Fungi in North America, with Description of *Mycolaelaps* New Genus, *Can. J. Zool.,* 1995. vol. 73, pp. 104-128.
15. Makarova, O.L.. Community of Gamasid Mites (Parasitiformes: Mesostigmata) in Sphagnum Pine Forests, *Ekologiya mikroartropod lexnykh pochv* (Ecology of Microarthropods of Forest Soils), Moscow: Nauka, 1988, pp. 69-81.
16. Masan, P., *Ameroseius fungicolis* sp. n. and *A. callosus* sp. n.. Two New Ameroseiid Species (Acarina: Mesostigmata) Associated with Wood-Destroying Fungi. *Biologia,* Bratislava, 1998. vol. 53. pp. 645-649.
17. Masan. P. and Waller, D., Description of the Male of *Hoploseius mariae* (Acari: Mesostigmata), an European Ascid Mite Associated With Wood-Destroying Fungi, *Biologia,* Bratislava, 2004, vol. 59, pp. 135-149.
18. Mordkovich, V.G., Andrievskii, V.S., Berezina, O.G., and Marchenko, I.I., The Zoological Method of Soil Diagnostics in the Northern Taiga of Western Siberia, *Zool. Zh*., 2003, vol. 82, no. 2, pp. 188-196.
19. O'Connor, B.M., Acarine-Fungal Relationships: the Evolution of Symbiotic Associations, *Fungus-Insect Relationship,* New York: Columbia Univ. Press, 1984, pp. 354-381.
20. *Opredelitel' obitayushchikh v pochve kleshchei (Mesostignidta)* [A Key to Soil-Dwelling Mites (Mesostigmata)]. Gilyarov, M.S., Ed., Leningrad: Nauka, 1978.
21. Walter, D.E., *Hoploseius australianus* sp. n. (Acari: Mesostigmala: Ascidae), a Unique Element in the Australian Acarofauna, *Austral. Entomol.,* 1998, vol. 25, no. 3. pp. 69-74.
22. Walter. D.E. and Lindquist, E.E., The Distribution of Parthenogenetic Ascid Mites (Acari: Parasitiformes) Do Not Support the Biotic Uncertainty Hypothesis. *Exp. Appl. Acarol.,* 1995, vol. 19, pp. 423-442.