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ECOLOGICAL GROUPINGS OF MITES OF THE COHORT TARSONEMINA AND THE GROUP OF FAMILIES ACARIDIAE

ЭКОЛОГИЧЕСКИЕ ГРУППИРОВКИ КЛЕЩЕЙ КОГОРТЫ TARSONEMINA И ГРУППЫ СЕМЕЙСТВ ACARIDIAE

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ABSTRACT

This review summarizes data on the habitat diversity, species richness and the present state of knowledge of two large taxonomic groups of acariform mites: Tarsonemina and Acaridiae.

Four ecological groupings of these mites were under consideration:

1. Entomophilous mites, associated with the Orthoptera, Dermaptera, Coleoptera, Diptera, solitary and social Hymenoptera, and those, parasitic on insects. 2. Inhabitants of ephemeral substrates such as dung, plant exudates, treeholes, insect burrows in living and dead wood, nests of mammals and birds. 3. Inhabitants of soil and litter, including agricultural systems. 4. Plant-inhabiting phytophagous, saprophagous, mycophagous, and predatory mites.

The analysis of our knowledge of these ecological groupings of mites makes it possible for the author to suggest that less than 3% of the real diversity of Tarsonemina and Acaridiae is known to date.

РЕЗЮМЕ

Обобщаются данные о местах обитания, видовом разнообразии и степениизученности двух групп семейств акариформных клещей: Tarsonemina и Acaridiae.

Рассмотрены следующие группировки: 1) энтомофильные клещи: мирмекофилы, карабидофилы, диптерофилы, клещи, специфичные для одиночных и общественных перепончатокрылых, уховерток, прямокрылых, а также паразиты насекомых; 2) обитатели эфемерных субстратов: навоза, эксудатов растений, дупел деревьев, ходов насекомых в живой и мертвой древесине, гнезд млекопитающих и птиц; 3) обитатели различных типов почв и почвенных биоценозов; 4) растение-обитающие клещи: фитофаги, сапрофаги, мицетофаги, хищники; обитатели отдельных видов или групп видов растений.

Анализ изученности этих группировок, по мнению автора, свидетельствуето том, что науке известно не более 3% Tarsonemina и Acaridiae, существующих вприроде.

INTRODUCTION

At present several acarologists [Sevastianov, 1985; Behan-Pelletier et al., 1988] consider mites as the second in species richness, after insects,group of terrestrial arthropods.

The aim of this communication is the evaluation of the present state of knowledge of the biodiversity of mites of the cohort Tarsonemina (Trombidiformes) and the group of families Acaridiae (Sarcoptiformes), which include various ecological groupings of mites, as well as the approximate estimation of possible real diversity of these mites in the nature. The joint consideration of two highly remote taxa is explained by the demonstrated biological progress of these groups that is expressed in the great species richness, high abundance and worldwide distribution of these mites.

RESULTS AND DISCUSSION

Entomophilous mites

Myrmecophilous mites

28 species of Pygmephoridae, 16 species of Scutacaridae, 5 species of Tarsonemidae, 15 species of Anoetidae, and 15 species of Acaridae can be found inside the anthills or being attached to ants of 16 species in Europe and Asia. Among them, 32 species of mites are specific to the particular species of ants. For example, 7 species of miteswere described only from the nests of *Lasius fuliginosus* [Sevastianov, 1965], 5 species were found in the

anthills of each *Formica* and *Myrmica*. Mahunka [1979] described about 40 new species of mites, representing 6 new genera, from 19 species of ants of the subfamilty Dorilinae, collected in Costa Rica, Ecuador, Brazil and Panama.

These examples, which show the great species richness of myrmecophilous mites, make it possible to suggest that thorough study of a single ant species may yield at least one species of mites. It can be expected that perhaps several thousand species of myrmecophilous mites currently exist.

Mites associated with solitary and social Hymenoptera

The high level of specificity of mites to some families, genera and species of wasps is evident from having a look at generic and specific names of mites. *Sphegopus elseni* was reported from *Sphex umbratus* in Zair. The species of *Archidispus* inhabit the nests of *Sphex* sp. and *Larga* sp. in Viet Nam. 9 species of mites of the genus *Zethus* are endemic to South America and the Caribbean region. Hypopi of *Crabrovidia estemnii* are common on 14 species of wasps of the genus *Crabro* (subgenus *Estemnius*) in a wide geographical region from Belgium to Okinawa, North and South America.

Mites associated with bees (Halictidae, Megachilidae, Anthophoridae, and Apidae) are also diverse. Magowski [1986] described the species *Tarsonemus xypocopae* and *T.platynopodae* from the nests of *X.latipes* and *X.frontalis* as insect commensals.

Hence, approximately 100 species of Acaridiae and 50 species of Tarsonemina are presently known as associates of wasps and bees. The real number of these mites in the world fauna is expected to be 15–20 times of the known number.

Mites associated with the Coleoptera

Up to 15 species of Anoetidae and several species of Acaridae and Saproglyphidae are known as associates of beetles of the families Staphilinidae, Silphidae, Hysteridae, Lucanidae, Elateridae, Tenebrionidae, Cerambycidae, Curculionidae, Chrysomelidae.

A complex of mites associated with the Carabidae is one of the most diverse and specific. The author [Sevastianov, 1966] has recorded 10 species of Tarsonemina, 8 species of Anoetidae, 15 species of acarid and saproglyphid mites from more than 2000 individuals of 48 species of Carabidae, by most part being the representatives of the genera *Amara, Bembidion, Calosoma, Carabus, Pterostichus,* inhabiting different biocenoses of Ukraine, 1000 specimens of Carabidae collected in the fields of Tselinograd region in Kazakhstan, and 200 specimens of beetles collected in other regions of Russia. This list was extended after the description of *Bakerdania loricophila* ex *Carabus coriaceus*, *Imparipes carabidophilus* ex *Ophonus pubescens, Pygmephorus harpali* ex *Harpalus* sp. More than 30 species of mites belonging to the genus *Archidispus* were found in Japan on the Carabidae by Kurosa [1989].

Thus, 20 species of Acaridiae and no less than 50 species of Tarsonemina associated with carabid beetles are presently known. No doubt, this is a slight portion of the world carabidophilous acarofauna diversity.

Several species of mites associated with beetles will also be reviewed when discussing the ephemeral substrates.

Mites associated with the Diptera

The species approximate estimate of these mites is basedmainly on the information provided by specimens of mites, attached to insects kept in the entomological collections. Only the locality is usually shown on the specimen labels. More rarely, labels contain the information on the habitats, for example "dung", "carrion", etc. The mites were found on flies of the following families: Ceratophagidae, Limoniidae, Chloropidae, Anthomiidae, Platypezidae, Glossinidae, and others. The mites associated with the Schaeroceridae and Muscidae are most diverse. Samsinak [1984, 1989] found 27 species of mites associated with 35 species of spherocids, collected in different regions of the world. At least 5 species of *Myianoetus* are hosted by flies of the genera *Morellia* and *Hydrotaea* in different parts of their natural areas.

We will also discuss the beetle and fly mite associates while reviewing the fauna of mites of the ephemeral substrates.

Parasites of insects

The mites parasitic on insects are found in the following families:

1. Tarsonomidae. Larvae and adult mites *Amcortarsonemus brasiliensis, Asiotarsonemus malayi,* and 21 species and subspecies of mites of the genus *Coreitarsonemus* parasitize the frightening glands of Coreidae bugs in Africa, South America, Java and the Philippines.

2. Pyemotidae. Species of the genus *Pyemotes* are known as parasites of the larvae of Lepidoptera, Hymenoptera, Diptera, and various Coleoptera, most often the bark beetles (Ipidae).

3. Podapolipidae. All instars are the parasites of Orthoptera, Blattoptera and different families of Coleoptera, most often carabid beetles. More than 60 species of these mites were recorded from 500 species of carabid beetles from all over the world. Many of podapolipids are known only by their neotenic larvae, which are considered as the "larviform-female" or the "larval female" [Husband, 1978, 1980]. *Podapolipis* is parasitic on many insects in Ukraine [Sevastianov, 1988].

These mites often attack ladybugs (Coccinelidae), and also can be found on hymenopterans. For example, the abdominal aerial bags of 13 species of bumblebees of the genus *Bombus* and 4 species of bumblebees of the genus *Psithyrus* in their natural habitats are parasitized by *Lacustacarus buchneri* [Husband, Sinha, 1970].

About one hundred species of Tarsonemina parasitic on insects have been described to date that is probably less than one tenth of their real world fauna. It is worthy to note that the white-ant hills still remain poorly studies. The mites associated with Dermaptera are also almost unknown. The presence of the close associations of mites with Dermaptera is supported by the fact of finding 4 new species of mites on several specimens of the earwig *Labidura riparia* in Egypt [Sevastianov, Gad Hamada Hassan, 1991]. Collaborative efforts of acarologists and entomologists are necessary for the better understanding of existing associations of insects and mites [Sevastianov, 1990].

Inhabitants of ephemeral substrates

Mites associated with the dung of ungulate mammals

The succession of the mite complex in the cow dung was studied in Ukraine, Middle Volga region, Tatarstan, Kalmykiya by Sevastianov et al. [1969]. Different stages of the dung decomposition are characterized by the presence of flies of the families Muscidae, Sepsidae, Spheroceridae, Borboridae, and, more rarely, others. As the succession goes on the dung-beetles of the genera *Aphodius, Geotrupes, Oniticellus* appear.

According to our guesstimate the list of mites being permanent inhabitants of the cow dung includes 15 species of Anoetidae, up to 10 species of Acaridae and more than 20 species of Tarsonemina. This list can be enlarged more than two times if one adds mites inhabiting the dung of goats, pigs, horses, donkey (*Equus asinus*), red deer (*Cervus elaphus*), African buffalo (*Syncerus cafer*), and African elephant (*Loxodonta africana*). The numbers cited do not reflect the real species richness of mites associated with the dung because they are based exclusively on the analysis of dung of only several species of ungulates. The species, which have been found on the dung beetles outof the mammal dung, were also included in the group of coprobiontic mites. There is a high probability that those mites will later be proven as the specific inhabitants of dung. However, it is also possible that these mites are necrophagous or commensalsof insects. For example, the author [Sevastianov, Tamam Nasem Marroch, 1993] has found hypopi of the new species of mites *Rodinovia helenae, Rhysoglyphus ocidentalis, Caloglyphus kendae, C.argillaceous,* and *C.fimetarius* on the beetles *Geotrupes silvaticus* and *G. stercorosus,* which were collected in the forest litter in Belarus and Lithuania. As the necrophagy of mites belonging to the genus *Caloglyphus* was demonstrated by Chmilewski and Lipa [1967], it is possible that the numerous caloglyphids are necrophagous.

9 species of mites of the genus *Athyreacarus* belonging to the new family Athyreacaridae were found in burrows or attached to *Neathyreus* beetles themselves in Mexico, Central and South America. A new family was established for these mites by assume they have symbiotic relationships with insects [Lindquist et al., 1990].

Associates of the nests of mammals and birds

Only the fragmentary data on the species diversity of the Acaridiae and Tarsonemina in the nests of mammals and birds are available for 22 species and subspecies of rodents, 21 species of insectivorous mammals and such predators as the weasel (*Mustela nivalis*) and American pole cat (*Mustela nigripes*). No less than three hundred species of mites were found in the nests of these mammals. Sklyar and Sevastianov [1997] reported about 20 thousand individuals, belonging to 67 species of Tarsonemina, in the nests of 7 species of rodents in Donetsk region near the Sea of Azov. The species of the genus *Pygmephorus* are characteristic associates of the vertebrate hosts of the nests. More than 60 species of them are known in the world fauna [Smiley, Whitaker, 1984; Dastych et al., 1991].

The mites of the genus *Acarus* use predominantly nest fleas for their dispersal. In France the hypopi of *Acarus nidicolus* were found on 20 species and subspecies of fleas associated with 9 species of mammals. In Great Britain the mites of this genus were recorded from fleas of the squirrel, hedgehog, and forest mouse. In Poland they were reported from 5 species of fleas. The mites of the genus *Psylloglyphus* use fleas parasitic on mammals and birds, particularly the stormy petrel *Procellaria cinerea,* for their dispersal.

In nidicolous glycerophagids the transition from entomochorous to therochorous dispersal is observed. More often these mites are quite selective to a particular species of mammals. For example, *Dermacarus liomis* is known only from the nests of *Liomus irroratua* in the USA, and *Dermacarus ondatrae* is found only on muskrat. The species of the new subgenus *Glycyphagus (Zapodacarus)* are described from *Zapus hudsonicus* in the USA.

The mites of the Chiroptera

The Tarsonemina very rarely occur in the roosts and guano of Chiroptera. Only *Imparipes cavernophilus* was found in the guano of bats in the

cave "Azoch" in Azerbaijan [Sevastianov, 1974] . The species of the Acaridiae, which are common in the nests of mammals and birds, can also be found in the roosts. The species of mites belonging to the genera *Nycteriglyphus* and *Chiroptoglyphus*, which are placed by some acarologists in the family Rosensteiniidae, are quite specific to habitats where bats dwell. The mites, which inhabit the bat roosts, are considered to be not only the consumers of the fresh animal droppings, but also of the bat food remnants. O'Connor and Reisen [1978] observed the developmental cycle of *Chiroptoglyphus americanus*, that is found exclusively on the body of *Myotis velifer*, *M.lucifugus*, and *Plecotus rufinesqui*, which hibernate in the cave. Despite the absence of the guano in the studied cave the mites were found on 89.9% of the examined animals.

Mites associated with the bird nests

The mite communities of the bird nests were studied for only 15 species of birds of the world fauna. The diversity of mites appeared to be closely connected with the type of the bird feeding and the duration of the bird nesting period. Several species of mites were found in the nests of such an apparently well-studied bird as the domestic hen [Sevastianov, Gad Hamada Hassan, 1991].

Mites inhabiting living and dead wood

More than one hundred species of mites belonging to the discussed taxa were discovered in the exudates of trees, under the tree bark, in hollows and insect passages. The species of the genera *Anoetus* and *Hericia* are common in the wound outflows of the poplar, elm, oak and other trees in Western Europe, Eastern Africa, India and other regions of the world. The hypopi of these mites are dispersed by the xylobiontic coleopterans and more rarely by ants. The complexes of mites found in the passages of bark beetles of the families Scolitidae and Ipidae are the most diverse. They appeared to be insect and tree-specific.

The rotten wood is inhabited by eurybiontic species, which use various insects for their dispersal.

Plant-inhabiting mites

The phytophagous Tarsonemina are represented by at least 10 species of mites of the genus *Siteroptes* [Nikolenko et al., 1986]. The Acaridae, Scutacaridae, and predominantly Tarsonemidae are saprobiontic, mycetophagous, or predatory mites. We did not find the comprehensive list of these mites associated with different species of plants or even groups of species of plants in the literature. Uzhevskaya [1991] has found 17,000 individuals of 57 species of the family Tarsonemidae on only 76 species of cereals.

If we assume, based on the data presented, that at least one unknown species of a mite inhabits, for example, ten species of cereals, then the total number of mites known to be associated with plants of the world flora will reach 1,000 species. If this relationship will be spread out on fungi and dicotyledon plants, the species diversity of Tarsonemina and Acaridiae would be estimated as 10,000 species.

Soil mites

The analysis of the soil mite complexes in the Middle Volga region [Aleynikova, Sevastianov, 1967], Lithuania [Lasauskene, Sevastianov, 1972], Northern Kazakhstan [Sevastianov, Grichina, 1987], Ukraine [Sevastianov, 1986; Nikolenko, Omeltchenko, Sevastianov et al., 1988] has revealed almost 200 species of Tarsonemina, mainlyfrom the agricultural soils. Among them only the agrocenoses of wheat appeared to contain 13 new species of mites. 12 new species of mites were found in soils under the cotton-plant in Turkmenia [Sevastianov, Chidirov, 1992]. The fauna of these mites is rich in the soils of Egypt where new Tarsonemina and Acaridiae species were found in soils under the cotton-plant, millet, potatoes, cabbage, beans and other agricultural crops. Thus, it is possible to expect that at least 1,000 species of these mites can be found in the agricultural soils only.

Summarizing all the calculations we can conclude that at present more than 1,500 species of Tarsonemina and about 1,000 species of Acaridiae are known. The world fauna of mites from these taxonomic groups can be estimated to have not less than 100,000 species.

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