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FIRST RECORDS OF FUNGI IN THE FAMILIES CALIGONELLIDAE, CRYPTOGNATHIDAE, STIGMAEIDAE AND TECTOCEPHEIDAE MITES (ARACHNIDA: ACARI) FROM TURKEY

BY

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ABSTRACT

First records of fungi in the families Caligonellidae, Cryptognathidae, Stigmaeidae and Tectocepheidae mites (Arachnida: Acari) from Turkey. - Fifteen (15) species of fungi infecting 8 species of acari collected from Erzurum, Turkey have been isolated. The relations between fungi and mites are discussed. Most of fungi isolated from the mites are saprophytic and soilborn, only one fungus species, *Bauveria bassiana*, is entomopathogenic. Fungi of the families Caligonellidae, Cryptognathidae, Stigmaeidae and Tectocepheidae mites are recorded for the first time in Turkey. Most researches on fungi concern infections in the families Tetranychidae and Eriophyidae in the Prostigmata. But, knowledge on fungi of mites of these families is definite and such study on this subject has not been reported before from Turkey.

Key-words: Fungi, mites, new records, entomopathogenic, phytopathogenic, saprophytic, Turkey.

INTRODUCTION

Fungi constitute a very large group of organism found in virtually every ecological niche. HAWKSWORTH (1991) estimated that on a worldwide basis there are about 1.5 million species of fungi (ALEXOPOULOS *et al.*, 1996). Vast numbers of fungi are associated with a variety of mites and other arthropods to form associations of various types. In some cases these associations are obvious; at other times only thorough observations throughout the life cycles of the organisms involved and careful dissection and microscopic examination of insects reveal a fungal presence. The fungi of these associations include necrotrophic (killing and using dead host cells as a nutrient source) and biotrophic (requiring living host cells) parasites, which may be dispersed by their hosts. In other interactions insects use fungi directly as food or as sources of enzymes. Symbioses of this type allow the insects to use refractive nutrient resources. A few fungi of these fungi merely are dispersed by arthropods in their environments (BENJAMIN *et al.*, 2004). Fungi are among the most frequently noticed groups of mite pathogen, mainly

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because the presence of the mycelium and spores can easily be recognized (POINAR & POINAR, 1998).

Mites comprise a large group of Artropoda, belonging to the subclass Acari of the class Arachnida. Mites are the most diverse and abundant of all arachnids, with approximately 50.000 species known, but this is probably only 10% of the world acarine fauna. The former contains the ticks (Metastigmata) and the Mesostigmata. The latter order consists of the Astigmata, Cryptostigmata (also known as Oribatei or Oribatida) and Prostigmata. They are easily distinguished from insects by possession of eight, instead of six legs in the adult stage. Apart from smallness of size (usually less than a millimeter in length), their most conspicuous character is a reduction in the segmentation. The mites are extremely variable in structure, behavior and ecology. The majority are free-living predators, herbivores or detritivores, occupying a wide range of habitats from soil to oceans and from deserts to ice fields. The free-living forms occur in soil, decaying debris, moss and lichens. Many soil mites help break down dead plant material and improve the soil. Only a relatively small number of species are parasites, but some of these are responsible for significant problems in many invertebrates and vertebrates, particularly birds and mammals. The majority of these mite species are ectoparasites, although a small number (about 500 species) are endoparasites, living in the lungs, nasal passages or other tissues (HUGHES, 1959; EVANS *et al.*, 1968; HUGHES, 1976; KRANTZ, 1978; WOOLLEY, 1988; APPLEBAUM & GERSON, electronic publication).

Knowledge on fungi of mites is definite. Herein it has been tried to bring to light the determination of fungi infecting some mites and discussing their relations. This is the first account describing the mycoflora of the mites of the families Caligonellidae, Cryptognathidae, Stigmaeidae and Tectocepheidae.

MATERIALS AND METHODS

Isolation of mites

Soil, litter, grass and moss samples taken from Erzurum province were brought to the laboratory in nylon bags and extracted as live in Berlese funnels. Examined mites were picked from the samples under a stereomicroscope.

Isolation of fungi

Fungi are isolated by placing whole live materials on artificial medium. It was used potato dextrose agar with chloramphenicol (PDA) for fungal isolation. Cultures were held in a dark growth chamber at 25 °C for 1-2 weeks for growth and sporulation. Fungi that sporulated in cultured were transferred to tubes that were stored in a refrigerator at 5°C after which new isolates were prepared.

RESULTS

We examined 8 mite species belonging to the families Caligonellidae, Cryptognathidae, Stigmaeidae and Tectocepheidae from a total of 14 locations in 2003. It has been isolated 15 species of fungi in the mites. *Absidia cylindrospora*, *Altenaria alternata*, *Aspergillus flavus*, *Bauveria bassiana*, *Mortierella alpina*, *Mortierella* sp., *Penicillium*

jensenii, *P. simplicissimum* and *P. waksmanii*, were isolated from *Eustigmaeus*. *Absidia cylindrospora* and *Absidia cylindrospora* var. *rhizomorpha* were determined on *Stigmaeus*. *Absidia cylindrospora* and *Cladosporium* sp. were found on cryptognathid mites. *Cladosporium herbarum*, *Mortierella alpina*, *Mucor hiemalis*, *Mucor hiemalis* f. *corticola* and *Penicillium waksmanii* were isolated from *Tectocepheus velatus*. *Penicillum atro-venatum* was found on *Neognathus spectabilis* (Table 1).

DISCUSSION

The presence of fungi on mites is expected. Because fungi have various relationships with mites. Although mites examined in this study have very wide distribution, feeding habits of most of these and other mites groups are still unknown. Examined mites that are associated with fungi occur naturally in soil, litter or moss.

Beauveria bassiana is fungal pathogen of mites. But non-entomopathogenic fungi, *Mortierella alpina Mortierella* sp., *Absidia cylindrospora*, *Absidia cylindrospora* var. *rhizomorpha*, *Altenaria alternata*, *Aspergillus flavus*, *Penicillium atro-venetum*, *P. jensenii*, *P. simplicissimum*, *P. waksmanii*, *Cladosporium herbarum*, *Cladosporium* sp., *Mucor hiemalis*, *Mucor hiemalis* f. *corticola* were assessed as food for the mites or carried their spores. The vast majority of fungi isolated from the mites are saprophytic and soilborn. Only one species of entomopathogenic fungi, *Bauveria bassiana*, were found in the mites.

Modes feeding differ among prostigmatid, oribatid and acarid mites. Oribatid mites have mouthparts to engulf particles of hyphae and spores, whereas some prostigmatid and acarid mites have piercing mouthparts to suck out protoplasm (McGonigle & Hyakumachi, 2001). Grazing on fungi by mites is a significant relationship on fungivory. Because, mites feed on saprophytic, phytopathogenic or mycorrhizal fungi (McGonigle & Hyakumachi, 2001). It has been suggested that mites of the family Cryptognathidae are predatory animals (Meyer & Ryke, 1960). But their mouthparts are so delicate, and their size so small, that is difficult to imagine the type of prey with which they might be associated. Their mouthparts are often highly extrudable, with delicate, elongate, edentate chelicerae, so that they may be selective feeders on, say, fungal spores (Luxton, 1973). The needle-like chelicerae may also be adapted to select algal cell or else, and this seems the best of several alternatives, to pierce plant cell and drain the contents (Luxton, 1973, 1993). Oribatid mites feed principally on fungi and algae. *Tectocepheus velatus* is thinking of intermediate feeders (Woolley, 1988).

Mites may feed the agents of the plant disease. *Altenaria alternata* and *Cladosporium herbarum* commonly occur on plant surfaces or in decaying or dead tissues of plants. Furthermore, these phytopathogenes cause various diseases on plant (Ellis & Ellis, 1985). For example, *Alternaria alternata* found on *Eustigmaeus segnis* causes "Alternaria rot disease" of grape (*Vitis* spp.) and "Alternaria alternata black spot disease" of pear (*Pyrus communis*) (Common Names of Plant Diseases, electronic publication), *Cladosporium herbarum* determined on *Tectocepheus velatus* causes "Cladosporium fruit rot disease" of grape (*Vitis* spp.) and pear (*Pyrus communis*) (Common Names of Plant Diseases, electronic publication). Another species, *Mucor hiemalis*, isolated from

TABLE 1. Fungi of mites.

species of fungus	mite host			sampling place
	order	family	species	
Mortierella alpina	Prostigmata	Stigmaeidae	*Eustigmaeus anauniensis*	soil and litter under *Pinus* sp.
Mortierella sp.	Prostigmata	Stigmaeidae	*Eustigmaeus anauniensis*	soil and litter under *Pinus* sp.
Penicillium waksmanii	Prostigmata	Stigmaeidae	*Eustigmaeus anauniensis*	soil and litter under *Syringa vulgaris*
Absidia cylindrospora	Prostigmata	Stigmaeidae	*Eustigmaeus anauniensis*	soil and litter under *Syringa vulgaris*
Beauveria bassiana	Prostigmata	Stigmaeidae	*Eustigmaeus segnis*	soil and litter under *Pinus* sp.
Alternaria alternata	Prostigmata	Stigmaeidae	*Eustigmaeus segnis*	moss on soil
Aspergillus flavus	Prostigmata	Stigmaeidae	*Eustigmaeus vacuus*	moss on soil
Penicillium simplicissimum	Prostigmata	Stigmaeidae	*Eustigmaeus vacuus*	moss on soil
Penicillium jensenii	Prostigmata	Stigmaeidae	*Eustigmaeus vacuus*	moss on soil
Absidia cylindrospora var. *rhizomorpha*	Prostigmata	Stigmaeidae	*Stigmaeus* sp.	soil and litter under *Pinus* sp.
Penicillium atro-venatum	Prostigmata	Caligonellidae	*Neognathus spectabilis*	soil from the nest of a wild animal
Cladosporium sp.	Prostigmata	Cryptognathidae	*Favognathus orbiculatus*	soil from the nest of a wild animal
Absidia cylindrospora	Prostigmata	Cryptognathidae	*Cryptognathus ozkani*	soil and litter under *Astragalus* sp.
Mucor hiemalis	Cryptostigmata	Tectocepheidae	*Tectocepheus velatus*	soil and litter under *Syringa vulgaris*
Mortierella alpina	Cryptostigmata	Tectocepheidae	*Tectocepheus velatus*	grassy soil under *Betula pendula*
Mortierella alpina	Cryptostigmata	Tectocepheidae	*Tectocepheus velatus*	soil and litter under *Syringa vulgaris*
Mucor hiemalis	Cryptostigmata	Tectocepheidae	*Tectocepheus velatus*	grassy soil under *Salix* sp.
Mucor hiemalis f. *corticola*	Cryptostigmata	Tectocepheidae	*Tectocepheus velatus*	soil from the nest of a wild animal
Cladosporium herbarum	Cryptostigmata	Tectocepheidae	*Tectocepheus velatus*	grassy soil under *Salix* sp.
Penicillium waksmanii	Cryptostigmata	Tectocepheidae	*Tectocepheus velatus*	soil and litter under *Pinus* sp.

Tectocepheus velatus causes "Mucor rot disease" of the guava (*Psidium guajava* L.) (MORTON, 1987). Furthermore, *Mortierella alpina* isolated from *Tectocepheus velatus*, *Penicillium waksmanii* isolated from *Tectocepheus velatus*, *Penicillium simplicissimum*, *P. jensenii* and *Aspergillus flavus* found on *Eustigmaeus vacuus*, *Penicillium atrovenetum* found on *Neognathus spectabilis*, *Absidia cylindrosposra* found on *Cryptognathus ozkani*, *Mucor hiemalis* f. *corticola* found on *Tectocepheus velatus* are saprophytic species.

This leads to the other relationship that several fungi are attractive to fungivorous mites, including some mites are potentially important vectors of fungi (OKABE, 1999). Mites and other arhropods are agents of vector-dispersal in fungi, and vector dispersal by arthropods is dissemination of fungal spores (ABBOTT, 2002). Their vectorial capacity seems to be low due to their small size (HUBERT *et al.*, 2003). Mites may transport of fungi directly effects us when the fungi are the agents of the plant disease. Some mites are known to have specialized structures such mouthpatch, leg setae and body setae for carrying fungus spores. Fungal spores occur in the soil and on decaying plant material and mites carry the spores in and on these structures (MILLS, 1996). They may change fungal communities (FRANZOLIN *et al.*, 1999).

Some fungi are fungal parasites of mites. Fungal pathogens have been stated to attacked and kill species of Astigmata, Oribatida, Prostigmata, Mesostigmata and Metastigmata. Most research on entomopathogenic fungi concern infections in the families Tetranychidae and Eriophyidae especially in the Prostigmata (CHANDLER *et al.*, 2000; GEEST *et al.*, 2000). *Beauveria bassiana* found on *Eustigmaeus segnis*, is mite pathogen which is used as potential for biological control of some parasitic mite (KAAYA & HASSAN, 2000; SHAW *et al.*, 2002). *Beauveria bassiana* is a fungus which causes a disease known as the white muscadine disease in insects. When spores of this fungus come in contact with the cuticle (skin) of susceptible insects, they germinate and grow directly through the cuticle to the inner body of their host. The fungus proliferates throughout the insect's body, producing toxins and draining the insect of nutrients, eventually killing it. Therefore, unlike bacterial and viral pathogens of insects, *Beauveria* and other fungal pathogens infect the insect with contact and do not need to be consumed by their host to cause infection. Once the fungus has killed it's host, it grows back out through the softer portions of the cuticle, covering the insect with a layer of white mold (hence the name white muscadine disease). This downy mold produces millions of new infective spores that are released to the environment.

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