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Records of aphidophagous Entomophthorales in Slovakia

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Abstract: In Slovakia colonies of various aphid species were investigated in order to determine a spectrum of entomophthoralean fungi parasiting aphids. 70 different localities were visited throughout the country during 1999-2002. The survey was focused on aphid fauna of agricultural crops and non-production sites. Altogether 14 different entomophthoralean species out of three families were identified from aphids; *Erynia neoaphidis, Erynia nouryi, Erynia erinacea, Entomophthora planchoniana, Zoophthora aphidis, Zoophthora radicans, Zoophthora phalloides, Zoophthora occidentalis* (Entomophthoraceae); *Neozygites fresenii, Neozygites microlophii, Neozygites cinarae, Neozygites turbinata* (Neozygitaceae); *Conidiobolus obscurus, Conidiobolus thromboides* (Ancylistaceae). The fungal species were recorded from 69 aphid species belonging to three families (Aphididae, Drepanosiphidae and Anoecidae). Out of the 14 fungal species 10 are the first record from Slovakia. *E. neoaphidis* was a dominant fungal species and caused epizootics in aphid colonies. *E. planchoniana* was the second most frequent pathogen but no epizootics were recorded. Conversely, *N. fresenii* had a strong tendency to establish epizootics in dense aphid colonies, especially in those of *Aphis fabae*. Species *E. nouryi, E. erinacea, Z. phalloides, Z. occidentalis, C. thromboides* were identified from single aphid species despite they are known to have a broader host spectrum. *N. microlophii* and *N. cinarae* are probably monophagous species.

Key words: Aphids, Entomophthorales, Slovakia

Introduction

Entomophthoralean fungi have been found to be important mortality factors for aphids in fields (e.g. Latgé & Papierok, 1988). Three tens of the fungi are known as aphid pathogens at present (Keller, 1987, 1991, 1997; Humber, 1990, Balazy, 1993). Intensive studies have been done to contribute to understanding of the disease distribution, epidemiology, and management in agricultural crops (Pell *et al.*, 2001). The pathogens possess a great potential as biological control agents due to their ability to develop strong epizootics that result in natural regulation of aphid populations (Latgé & Papierok, 1988). Unfortunately, very limited information in respect to the group of fungi is available in Slovakia. Up to know only 4 entomophthoralean fungi have been reported from aphids in fields; *Erynia neoaphidis* Remaudière et Hennebert, *Entomophthora planchoniana* Cornu, *Neozygites fresenii* (Nowakowski) Remaudière et Keller, and *Conidiobolus obscurus* (Hall et Dunn) Remaudière et Keller. They were observed in the pea aphid, the black bean aphid or cereal aphid populations (Weismann, 1961; Stary, 1974; Stalmachová & Cagán, 2000; Cagán & Barta, 2001).

The main goal of the study was to determine the species spectrum of entomophthoralean fungi in aphid populations under conditions of Slovakia.

Material and methods

From 1999 through 2002 numerous localities were visited in Slovakia and colonies of various aphid species were observed in order to determine their entomophthoralean enemies. Each year the observations started at the beginning of March and usually finished at the end of November. 70 different localities were irregularly visited and different types of sites were surveyed. The visited sites varied for sampling occasions and the survey was mainly focused on aphids infesting agricultural and horticulture crops, but observations were extended to include also non-production sites. All cadavers of aphids (fungus-killed aphids) were collected on a random basis. If plants were found infested with aphids, the aphid colonies were simply searched and cadavers were collected. Only cadavers with external symptoms of entomophthoralean disease were collected. The fungus-killed aphids were used for pathogen identification as soon as possible. Some part of the samples were deposited in a herbarium prepared as air-dried cadavers and stored at approximately +4°C in dark conditions. During the survey samples of living aphids were also collected from aphid colonies where a disease was detected. These samples were used for aphid identification.

Results and discussion

69 aphid species were found killed by one or more fungi of the order Entomophthorales in their natural habitats during the survey in Slovakia. Majority of the aphid species belonged to the family Aphididae (59 species) and the remaining ten were from the family Drepanosiphidae (9 species) or the family Anoecidae (one species). Overall, 14 different fungal species out of three families were identified from the aphids in Slovakia; *Erynia neoaphidis*, *Erynia nouryi* Remaudière et Hennebert, *Erynia erinacea* (Ben-Ze'ev & Kenneth) Remaudière et Hennebert, *Entomophthora planchoniana*, *Zoophthora aphidis* (Hoffmann in Fres.) Batko, *Zoophthora radicans* (Brefeld) Batko, *Zoophthora phalloides* Batko, *Zoophthora occidentalis* (Thaxter) Batko (Entomophthoraceae); *Neozygites fresenii*, *Neozygites microlophii* Keller, *Neozygites cinarae* Keller, *Neozygites turbinata* (Kenneth) Remaudière et Keller (Neozygitaceae); *Conidiobolus obscurus*, *Conidiobolus thromboides* Drechsler (Ancylistaceae).

E. neoaphidis was the predominant species. The fungus was identified from 47 aphid species. It could be encountered from the beginning of April to the half of November and in some sites an epizootic level of disease was observed resulting in a collapse of host population. The fungus seasonal distribution fully corresponds with observations of other authors made in central Europe (e.g. Keller, 1991; Balazy, 1993). There is no doubt that *E. neoaphidis* is truly the most important and most frequent pathogen observed in aphid populations in Slovakia. It has a worldwide distribution and has being recorded from nearly all continents (Keller, 1991; Balazy, 1993). The fungus is characterized by a potential for epizootic development and a great effectiveness to control of various aphid populations (e.g. Dean & Wilding, 1971).

E. planchoniana was the second most frequent pathogen. It was identified from 27 aphid species. The pathogen attacked several pest aphids but it was a typical pathogen of *Aphis sambuci* L. The seasonal dynamics of the disease was the same as that of *E. neoaphidis* but no epizootics were recorded. *E. planchoniana* is known worldwide (Keller, 1987; Balazy, 1993) and is frequently reported as a causal agent for epizootics (e.g. Milner *et al.*, 1980; Feng & Nowierski, 1991). It is of interest that despite its rather great prevalence, no epizootics were recorded in host populations in Slovakia. The majority of aphids were infected at dryer sites. Keller (1987) also noticed that the fungus preferred relatively dry habitats and did not occur in dense humid crops.

N. fresenii was identified from 24 aphid species in 21 localities. A seasonal dynamics of the disease was similar to those of *E. neoaphidis* and *E. planchoniana*, but the infection usually appeared one month later. *N. fresenii* had a strong tendency to establish epizootics in dense aphid colonies, especially in those of *Aphis fabae* Scop., *Aphis nasturtii* Kaltenbach and *Microlophium carnosum* (Buckton). The species is known from nearly all continents including the South Pacific region (Keller, 1997). It is considered to be better adapted to tropical conditions (Steinkraus *et al.*, 1991; Keller, 1997) although it is effective in the subpolar region as well (Nielsen *et al.*, 2001). If a coexistence of *N. fresenii* with more fungi was present in the colonies, *N. fresenii* usually gained dominance over the other fungus species in a short time. A great effectiveness of the species was presented by many authors (e.g. Steinkraus *et al.*, 1991; Nielsen *et al.*, 2001). The species was identified from less number of host species when compared with *E. planchoniana*, although it was recorded in more localities. This may imply a narrower host spectrum of *N. fresenii*, however, this may probably relate with different types of niches occupied by both species. While *N. fresenii* was frequent in humid habitats at ground dense vegetation, *E. planchoniana* infected aphids living in relatively dryer microclimates at upper levels of vegetation. Resting spores were generally observed during dry and hot periods in the summer.

C. obscurus is next important aphid pathogenic fungus. In Slovakia it infected 17 aphid species and the infection was normally recorded during June and October. The fungus was present within aphid colonies at low levels as an occasional species alongside other fungi and the disease development never reached epizootic character. This is in agreement with observations of Keller & Suter (1980). At the end of vegetation period resting spores were usually produced. From a viewpoint of natural aphid control in Slovakia *C. obscurus* is considered not as important control agent as the previous ones.

C. obscurus closes the foursome of the most important aphid pathogenic Entomophthorales characterised by a worldwide distribution, an obligate specificity to aphids, a pathogenity to rather great variety of aphid species, a high prevalence in aphid colonies, and finally by the ability to cause epizootics in host populations.

Remaining species are usually considered as minor pathogen of aphids for various reasons, e.g. for a broader host spectrum (*Z. radicans, C. thromboides*) or, on the other hand, an obligate specificity to simple aphid species (*N. microlophii, N. cinarae*), an absence of epizootics or for a rare presence in aphid populations (*E. nouryi, E. erinacea, Z. aphidis, Z. phalloides, Z. occidentalis, N. turbinata*). All these species represent the first records from Slovakia. They were mostly identified from one aphid species with a very low prevalence, however two *Neozygites* species, *N. microlophii* and *N. turbinata* caused severe epizootics in populations of *Microlophium carnosum* and *Tuberolachnus salignus* (Gmelin), respectively. *Z. radicans* was observed on three aphid species but epizootic was recorded only in the cabbage aphid population. Epizootics of *C. thromboides* were not observed in Slovakia, but experimental applications of resting spores usually resulted with high infections in tested aphid populations (Cudare, 1990).

We found a great species diversity of entomophthoralean fungi attacking aphids in Slovakia. Out of the 30 species known from aphids, 23 have been recorded from Europe (Keller, 1987, 1991; Balazy 1993). The 14 species observed during the survey in Slovakia surpass the number of pathogens reported from the aphid fauna by other authors in different countries or regions all over the world. Regional list of aphid pathogenic fungi were published for instance in France (Thoizon, 1970), Australia (Milner *et al.*, 1980), Finland (Papierok, 1989), Poland (Balazy et al., 1990), or Iceland (Nielsen *et al.*, 2001). We found a set of four fungus species to be the most important pathogens in the country. They were *E. neoaphidis, E. planchoniana, N. fresenii,* and *C. obscurus*. These species were the most frequent in aphid colonies and they were identified

from many aphid species. Plenty of findings were from agricultural crops including important pestiferous aphids. This was because fields were specifically targeted in our survey.

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