The diversity of phoretic Mesostigmata on *Ips typographus* (Coleoptera: Scolytinae) caught in the Karkonosze forest

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**Abstract.** This study determined the scale of the phoresy of mesostigmatid mite by *Ips typographus*. Thirty pheromone traps in the Karkonosze National Park (Poland) caught 10,575 bark beetles on which there were 2,388 mesostigmatid mites belonging to eight species. The most numerous mites were *Dendrolaelaps quadrisetus* (1076 ind.) and *Trichouropoda polytricha* (1067 ind.).

**INTRODUCTION**

Phoresy is defined as the passive transport of certain organisms on the body of others of different species for purposes other than direct parasitization (Rocha et al., 2009). It is also seen as the process by which an animal actively seeks out and attaches to another animal, for a period of time, in order to disperse to other areas (Holte et al., 2001). Phoresy, as a form of dispersal, is particularly frequent in wingless organisms including mites living in patches of ephemeral resources (Binns, 1982). An ecological and evolutionary advantage of this type of migration, especially for entomophagous phoretic species, is the possibility of colonizing a new food source/host (Clausen, 1976).

Phoresy is recorded for many Gamasida Actinedida and Acaridida mites (Binns 1973, 1982; Athias-Binche, 1993). It is well documented for the mite *Uropoda orbicularis* on beetles (Coleoptera) associated with cattle dung (Bajerlein & Błoszyk, 2004) but the information about the phoresy of mesostigmatid mites by bark beetles, in particular forest pests is scarce. Phoresy of mesostigmatid mites on bark beetle bodies is not well investigated and there are only a few records (described as single cases of phoresy) in the faunistic and taxonomic studies of Kiełczewski & Michalski (1962), Westerboer (1963), Kinn (1971), Bregetova (1977), Eickword (1983), Michalski et al. (1985) and Haitlinger (1991, 2004). However, mites caught in pheromone traps have only been recorded previously by Gwiazdowicz (2007), who records *Proctolaelaps fisheri* Samukhàk on *I. typographus* body, and there are no reports in which mesostigmatid mite species colonize new habitats by having a phoretic relationship with beetles. This research also has a practical aspect as these beetles are pests of spruce stands in Central Europe and mesostigmatid mites may feed on their eggs and larvae (Kiełczewski & Michalski, 1962). The spruce bark beetle, *Ips typographus* (L.) (Coleoptera: Scolytinae), is one of the most important pests of mature Norway spruce trees in Eurasia (Schroeder, 2001). The beetle normally exists at a low level of abundance in all spruce forests but population outbreaks can result in significant economic loss (Feicht, 2004), for example the dead standing trees in Central Europe, Scandinavia and Russia (Faccoli & Buffo, 2004). In addition, the outbreaks of this pest during 1981 and 1987 in Western Sudeten in Poland resulted in damage to nearly 15,000 ha of spruce forest (Grodzki, 2004).

The main aims of this study were to:

1. confirm that phoresy is the primary method of transport used by mesostigmatid mites to move between the galleries of the bark beetle *I. typographus*;
2. determine the species diversity of the phoretic mites collected;
3. determine the scale of the death of mites associated with the death *I. typographus* caught in pheromone traps.

Using pheromone traps to reduce populations of *I. typographus* can result in the reduction in the abundance of their natural enemies, including mites. Due to the lack of knowledge about the phoresy of mites by bark beetles between galleries and the extensive use of pheromone traps in forestry, there is need to determine the extent of the phoretic relationship between mites and bark beetles.

**MATERIAL AND METHODS**

The study area is located in the Karkonosze National Park (SW Poland – 50°44’N, 15°44’E) at an altitude of between 700–800 m a. s. l. Research areas were located close to spruce stands (c.a. 80 years old). Thirty Boregard traps, 6 in each of the 5 study areas, were emptied between 15 and 31 of August 2008. Traps were located 2 m from each other 25 m from the forest boundary. The traps were located in the forest close to the border zone and exposed to direct sunshine (therefore the sunshine was not an experimental factor). A Boregard trap consists of a pipe (length = 135 cm, \(\varnothing = 15\) cm), which contains the commercial attractant Ipsodor W (Chemipan, Poland) (Michalski & Mazur, 1999). The construction of this trap prevents mites from entering or escaping and so all the mites that were in the traps must have been carried on the bodies of the bark beetles. This study focused mainly on mites and the abundance and sex of the bark beetles were not investigated. A sample consisted of all the bark beetles collected in one Boregard trap and gave a measure of the number of mites killed in one trap. All the bark beetles collected from each trap were placed in 70% ethanol. Then the mites were collected and placed in 70% ethanol and later permanent (using Hoyer’s medium) or semi-permanent (using lactic acid) slide prepara-
The zoocenological analysis of mesostigmatid mite communities was based on indices of dominance (D) and frequency (F) (Błoszyk, 1999). Dominance classes were as follows: eudominants (>30%); dominants (15.01 – 30%); sub-dominants (7.01 – 15.0%); residents (3.01 – 7%) and subresidents (<3%).

For frequency the following criteria were used: euconstants (> 50%); constants (30.01 – 50%); subconstants (15.01 – 30%); accessory species (5.01 – 15%) and accidental occurrences (< 5%). Numbers of bark beetles collected per sample and of mites collected from a trap are given as means with standard deviation.

RESULTS

10575 bark beetles were examined for phoretic mesostigmatid mites and eight mite species were identified. The number of bark beetles collected per sample ranged from 76 to 861 and the average number was 352.5 ± 207. In total 2,388 mites were caught (Table 1). The number of mites collected from a trap were given as means with standard deviation.

DISCUSSION AND CONCLUSIONS

Under the bark, I. typographus is accompanied by a species-rich arthropod community. In Europe, about 140 species of Coleoptera, Diptera, Hymenoptera and other orders have been recorded in trees attacked by I. typographus (Hedgen & Schroeader, 2004). Thus far, almost 60 species of mesostigmatid mites have also been found in the galleries of I. typographus (Gwiazdowicz, 2008). The most numerous and most frequently represented families are the Aecidae, Digaenidae and Trematidae. It may be hypothesized that they reach the galleries by means of phoresy on bark beetles. However, there is little information concerning the phoretic relationships between I. typographus and mesostigmatid mites. It is noteworthy that Gwiazdowicz (2007) found Proctolaelaps fisheri Samsišták on this species of bark beetle. Research on other bark beetle species, however, indicates the existence of phoretic relationships with mites. Kieleczewski & Michalski (1962) found Lasioseius onomatus (Oudemans) on the body of Scolytus multivorus (Bechstein), Westerboer (1963) Proctolaelaps eccoptogasteris (Vitzthum) on the body of Scolytus laevis Chapsiu, Kinn (1971) Lasioseius on the body of Ips mexicanus (Hopskis), Bregetova (1977) records phoretic Pleuronecotocelaeno austriaca Vitzthum on Scolytus laevis and Michalski et al. (1985) found this species on the elytra of Pityokeites curvidens (Germar) and Ips acuminatus (Gyllenhal). Mites of the genera Lasioseius and Proctolaelaps were found by Eckword (1983) on bodies of many bark beetle species. Haitlinger (1991, 2004) observed Proctolaelaps fisheri on bodies of Pityokeites curvidens, Dryocetes autographus (Ratzeburg), Rosalia alpina (L.) and Spondylis buprestoides (L.).

Almost all these mites are recorded exclusively from bark beetle galleries. D. quadrisetus, for instance, is recorded in galleries of many Scolytinae species in Europe, North America (Canada, Guatemala, USA) and North Africa. T. polytricha is recorded in Europe and Central Asia (Hirschmann & Würnberg, 1982; Wiśniwski & Hirschmann, 1993). Other species are reported from Europe, North Africa and USA (Wiśniwski & Hirschmann, 1993; Gwiazdowicz, 2007, 2010). U. obovata is an exception as it is more frequently found in ants than in bark beetle galleries (Wiśniwski & Hirschmann, 1993). So far, this species has been recorded only in Europe.

Different developmental stages of the mites are phoretic. For instance in D. quadrisetus and mites of the suborder Uropodina (T. polytricha, T. polytricha, U. obovata, U. sp.), only deutonymphs, while in other species only adults, both females and males, were found in the traps. That phoresy is the primary method of dispersal used by mesostigmatid mites is indicated by the large number of phoretic mites found on bark beetles. However, the small number of species of mite recorded in this study, which is probably related to the specificity of local populations, is surprising. It is likely that the communities of phoretic mites are different in other regions of Europe.

In conclusions, the use by forest managers of Boregard traps to catch Ips typographus might result in the extermination of mesostigmatid mites, which are considered to be important natural enemies of this forest pest.

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