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The mites associated with *Ips typographus* in Sweden

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Twenty-four species of mites were found associated with *Ips typographus* (Linnaeus) collected from pheromone traps in Sweden, bringing to 38 the total recorded for this scolytid. Because three of the species are parasites, it may be possible to use them in biological control of *I. typographus*. Couplets from an earlier key to these mites in south Germany have been modified to include three of the newly found Swedish genera and species not presented in the old key.

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During the period 1971 to 1982, a widespread outbreak of *Ips typographus* (L. 1758), the spruce bark beetle (SBB), devastated large areas of Norway spruce (*Picea abies*) forest in Scandinavia (Eidmann 1983). In Sweden SBB outbreaks have been a recurrent phenomenon. For this reason, interest runs high for control procedures that are effective and environmentally safe. Biological control with mites is one possibility, but before this is tried, a data base is needed that would address the following: species and abundance of mites associated with SBB, if these associated mites have an impact on the beetle, and how populations in Sweden differ from those in other areas where SBB is found. Mite studies may also reveal much about the transmission of bluestain (Ophiostomataceae) diseases in trees (Bridges and Moser 1986). A number of bluestain species have been isolated from spruce infested by SBB; some or all of these may be tree pathogens (Solheim 1986).

Here we present a list of mites from Sweden, most of which appear to be phoretic on *Ips typographus*. We compare results with an earlier collection of mites from South Germany by Moser and Bogenschutz (1984) in which 33 mite species were listed.

Materials and methods

First generation of *Ips typographus* in first and second flights were caught in drainpipe traps, Swedish model 1979 (with funnel) (Regnander and Solbreck 1981). There were six collection dates during the period May 19 to June 20, 1983. The traps had been placed on a clearcut in a coniferous forest area 18 km east of Uppsala and baited with commercial pheromone dispensers (Borregaard Ipslure plastic strips containing 1500 mg methylbutenol, 70 mg *cis*-verbenol, and 15 mg ipsdienol).

Collected beetles were placed in vials containing 70% ethanol, labeled as to place of collection and date, and sent to the USDA Forest Service, Southern Forest Experiment Station, Pineville, Louisiana, USA. A total of 2523 beetles were contained in 6 vials. A 100-beetle sample was taken from each vial for identification of mites that remained on the adult SBB. The species and number of mites found on each beetle were tallied and their location noted: under elytra, on elytra, elytral declivity, ventral abdomen, dorsal thorax, ventral thorax, coxae, legs, and head. In addition, the sediment at the bottom of the vials was searched for any mites that may have fallen off the beetles. The phoretic mites (defined here as those mites attached to the beetles) and those from the sediments were tallied separately. Mite species represented by only one specimen in the sediments were omitted from the list unless they belonged to species or genera previously known to be associated with scolytids. It was felt that these mites may have accidentally fallen or crawled into the traps.

Table 1. Mite species phoretic on adult *Ips typographus*.

Species and location on Ips	Number of mites	% of total	Adj. %[1]
Trichouropoda polytricha (Vitzthum 1923)		5.8	9.6
Elytral declivity	31		
Ventral abdomen	1		
Ventral thorax	3		
Uroobovella ipidis (Vitzthum 1923)		8.2	8.7
Elytral declivity	7		
Ventral thorax	39		
Coxa	2		
Leg	1		
Dendrolaelaps quadrisetus (Berlese 1921)		78.2	51.2
Under elytra	470		
Thyreophagus corticalis (Michael 1885)		0.2	0.7
Under elytra	1		
Schwiebea sp. no. 10		0.2	1.4
Under elytra	1		
Histiostoma piceae (Scheucher 1967)		2.7	6.7
Under elytra	16		
Scutacarus scolyti Mahunka & Moser 1980		0.2	0.9
Under elytra	1		
Iponemus gaebleri (Schaarschmidt 1959)		1.0	9.4
Under elytra	5		
Elytral declivity	1		
Tarsonemus subcorticalis Lindquist 1969		0.2	2.9
Under elytra	1		
Heterotarsonemus lindquisti (Smiley 1969)[2][3]		0.2	0.2
Under elytra	1		
Paracarophaenax ipidarius (Redikortsev 1947)		2.7	3.2
Ventral thorax	16		
Elattoma n. sp. no. 10[2]		0.3	1.0
Ventral thorax	2		
Pyemotes dryas (Vitzthum 1923)		0.3	0.2
Ventral thorax	2		
Total, all 13 species	601	100.2	96.1

[1] Average of percent found attached and percent in sediments (Table 2).
[2] Species not recorded from South Germany.
[3] Mite species not found in alcohol sediments (see Table 2).

Further studies should consider conducting follow-up surveys to inspect the SBB galleries, because other insect associates usually share the galleries. Some, such as clerids and cerambycids, may transport many species of phoretic mites to the beetle galleries, only a portion of which may also be phoretic on SBB. Some of these mites may prey upon or have some other impact on the scolytid.

Results and discussion

Mites found on adult Ips typographus.

A total of 600 adult beetles were examined for phoretic mites. Of these, 136 carried mites. The percentage of beetles with mites varied from 7 to 45 percent in the six samples, and the mean was 23%. The average number of phoretic mites per beetle was 1.0 for all beetles, but 4.4 for those beetles with mites. This is a conservative estimate, since many mites fell off the beetles after they were placed in the alcohol.

Thirteen mite species were judged phoretic (Table 1). The total number of phoretic mites extracted from the 600 adult beetles was 601: 82.5% (mostly *Dendrolaelaps quadrisetus*) under the elytra, 10.3% on the ventral thorax, 6.5% on the elytral declivity, and less than 1% on the other body locations. Of the 732 mites found in the alcohol sediments, 92% were from 12 of the same species as those attached to the beetles (Table 2). Hence, of those mites deemed phoretic, it is believed that 53% fell off the beetles when they were

Table 2. Number of mites found in the alcohol sediments.

Species	Number of mites	Percent of total
Trichouropoda polytricha (Vitzthum 1923)	97	13.3
Uroobovella vinicolora (Vitzthum 1923)	4	0.5
Uroobovella ipidis (Vitzthum 1923)	67	9.2
Proctolaelaps fiseri (Vitzthum 1926)	11	1.5
Vulgarogamasas n. sp. no. 3	17	2.3
Dendrolaelaps quadrisetus (Berlese 1921)	177	24.2
Paraleius leontonychus (Berlese 1910)	19	2.6
Carabodes labyrinthicus (Michael 1879)	1	0.1
Eporibatula gessneri Willmann 1932	3	0.4
Thyreophagus corticalis (Michael 1885)[1]	8	1.1
Schwiebea sp. no. 10[1]	19	2.6
Schwiebea sp. no. 31	1	0.1
Histiostoma piceae (Scheucher 1967)[1]	78	10.7
Scutacarus scolyti Mahunka & Moser 1980[1]	11	1.5
Iponemus gaebleri (Schaarschmidt 1959)[1]	131	17.9
Tarsonemus subcorticalis Lindquist 1969[1]	40	5.5
Pyemotes dryas (Vitzthum 1923)[1]	1	0.1
Paracarophaenax ipidarius (Redikortsev 1947)[1]	28	3.8
Elattoma n. sp. no. 10[1][2]	12	1.6
Pseudopygmephorus bogenschutzi Mahunka & Moser 1982	1	0.1
Bakerdania n. sp. (not *hylophila* (Cooreman 1963))[2]	1	0.1
Pleuronectocelaeno barbara Athias-Henriot 1959	2	0.3
Ereynetes nr. *scutulis* Hunter 1964[2]	3	0.4
All 23 species	732	99.9
All 11 nonattached species	63	8.6

[1] Mite species also found attached to adult *Ips typographus* (see Table 1).
[2] Species not recorded from south Germany.

placed in the alcohol. The adjusted percentage given in Table 1 is the average of the percentages for attached and detached specimens. This average may be a more realistic estimate of the actual percentages of phoretic mite species present on the beetles when trapped. Only *Dendrolaelaps quadrisetus, Heterotarsonemus lindquisti*, and *Pyemotes dryas* were more common as percentages on the adult beetles than in the alcohol sediments (Table 2), indicating that these species were less easily dislodged. In the case of *D. quadrisetus*, this is probably because the mite rides under the elytra where it would be less easily dislodged.

Mites found in the sediments.

It is felt that all of the 11 species listed in Table 2 as found only in the alcohol sediments are phoretic on SBB. *Uroobovella vinicolora* and *Proctolaelaps fiseri* were documented as being phoretic by Moser and Bogenschutz (1984). *Vulgarogamasus* n. sp. no. 3, *Paraleius leontonychus, Carabodes labyrinthicus, Eporibatula gessneri, Schwiebea* n. sp. no. 31, and *Pseudopygmephorus bogenschutzi* were found in the alcohol sediments of that study, strongly suggesting phoretic relationships.

The largest mite, *Pleuronectocelaeno barbara*, has been found in galleries of at least two other species of bark beetles attacking pine and spruce in Sweden (Kinn 1968) and may be phoretic on a number of the larger bark beetles in those subcortical habitats. Although the species is not very common, it is quite obvious when present due to its large size. Because of its size, the mite may have difficulty remaining attached to the adult beetles; this may be the reason why it is almost always found in the sediments and only rarely seen attached to beetles.

P. E. Hunter (personal communication) regards the three specimens of *Ereynetes* (=*Ereynetoides*) listed in Table 2 as a probable new species closely related to *Ereynetes scutulis*, a species common in the southern pine bark beetle habitat and phoretic on at least three species of southern pine bark beetles as well as at least one histerid associate in North America (Moser and Roton 1971). Precise determination of this species must await a larger series of specimens. The three

specimens document the first time this genus is associated with bark beetles in Europe. Since the mite was collected in Sweden on two separate dates (June 8 and 10), there is little likelihood that catches were accidental.

M. Kaliszewski (personal communication) is revising the systematics of the genus *Elattoma*, a name replacing *Pygmephorellus* used by Moser and Bogenschutz (1984). *Elattoma* n. sp. no. 10 (Tables 1 and 2), the only species collected from this genus in the present study, had been collected from the ventral thorax of adult *Ips typographus* during a recent survey of bark beetles in Poland (Kielczewski et al. 1983). Curiously, *E.* n. sp. no. 10 was not one of the species listed by Moser and Bogenschutz (1984). Kaliszewski (personal communication) has confirmed that the four specimens of "*Pygmephorellus* sp(p)" listed by Moser and Bogenschutz (1984) were a mixture of two species; one was *E. bennetti* and the other three were *E.* n. sp. no. 9. Both of these species are so far known only from southern pine bark beetles in North America. This finding increases the total number of species recorded by Moser and Bogenschutz (1984) from 32 to 33.

Moser and Bogenschutz (1984) identified three parasites of SBB: *Iponemus gaebleri, Pyemotes dryas,* and *Paracarophaenax ipidarius*. All three species were identified as contributors to brood mortality and were more common in Sweden than in south Germany. Here we confirm *Pyemotes dryas* as phoretic on *Ips typographus* for the first time. Of the three parasites, *P. dryas* may have the best potential for reducing populations. Its normal phoretic hosts are probably *Polygraphus poligraphus* (L. 1758) and *Pityophthorus pityographus* (Ratzeburg 1836) (Moser et al. 1978). Both species commonly attack spruce in Europe, but only *Polygraphus poligraphus* occurs in Sweden. Moser et al. (1978) documents a spruce bolt infested with *P. poligraphus* in which a population explosion of *Pyemotes dryas* was taking place. Not one beetle brood survived. The conditions under which this takes place are not understood, but when galleries of *Polygraphus poligraphus* and *Pityophthorus pityographus* intersect those of *I. typographus*, the possibility for total control by this native natural enemy exists for selected trees.

It should be noted here that the male of *Paracarophaenax ipidarius* is unknown and very few males exist for *I. gaebleri*. Because only females of both species are known to be phoretic, the other stages must be collected in galleries. It is suggested that a detailed study of the biology of *P. ipidarius,* at least, would contribute materially to an understanding of the natural control dynamics of SBB.

In summary, 19 species of mites were common to both Sweden and south Germany. Five were recorded from Sweden only, and 14 were listed only from South Germany; this totals 38 SBB-associated mite species. Of the five from Sweden, only *Elattoma* n. sp. was not "rare" (it exceeded 1% of the total). Conversely, all 14 species found only in Germany were rare.

Moser and Bogenschutz (1984) provided a key to 32 of the species they listed for South Germany. Couplets from that key can be modified as follows to accommodate the newly found genera and species from Sweden, except for those in the genera *Bakerdania* and *Elattoma* (=*Pygmephorellus*), which are presently under revision.

6' Dorsal shield not divided (Fig. 4) (females).
Leg one terminating with two claws [Family Ascidae] ..... *Proctolaelaps fiseri*
Leg one without claws [Supercohort Trigynaspides, Family Celaenopsidae] ..... *Pleuronectocelaeno barbara*

24' Leg IV terminating in two claws (Fig. 28); pseudostigmatic organ club-shaped (as in Fig. 11); setae naked [Family Pyemotidae] 28

24" Leg IV terminating in two claws; pseudostigmatic organ (=prodorsal sensilla) long, seta like; setae barbed [Family Ereynetidae] .... *Ereynetes* (=*Ereynetoides*) nr. *scutulis*

27 Apodemes III extending laterally beyond bases of legs III (Fig. 26)
Leg 2 with two claws ..... *Tarsonemus subcorticalis*
Leg 2 with single claw ..... *Heterotarsonemus lindquisti*

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