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A key to the mites associated with flying *Ips typographus* in South Germany

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Abstract

A key identifies 32 species of mites associated with flying *Ips typographus* collected from non-destructive pheromone traps in South Germany. Fifteen species were judged phoretic because they were attached to the beetles. The biologies of most of the 32 species are unknown, but three are potential predators.

1 Introduction

In recent years, there has been a concerted effort in Europe to reduce populations of the spruce bark beetle, *Ips typographus* (L. 1758), by means of large numbers of traps baited with synthetic pheromones (Bakke 1981; Vité 1980; Zumr 1982). There has also been a growing interest in developing ways in which the beetle's natural enemies, including its associated mites, can be used for control (Kielczewski et al. 1983; Lieutier 1978). In addition, there

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has been one attempt to use *Pyemotes dryas* (VITZTHUM 1923), a mite predator of European spruce bark beetles, for the biological control of the southern pine beetle, *Dendroctonus frontalis* ZIMMERMANN 1868, in the United States (MOSER et al. 1978).

The number of mite species associated with *I. typographus* is unknown, although KIELCZEWSKI et al. (1983) listed 181 species associated with a large number of bark beetles in Poland. The large-scale *I. typographus* trapping programs now being used in many countries in Europe afford an excellent opportunity to compile a more accurate list of its phoretic mites. The large number of beetles collected permits systematic sampling of the phoretic mites. In addition, it offers an inexpensive and efficient method of collecting live mites for biological studies, including potential candidates for the biological control of exotics, such as the southern pine beetle.

The first step in the search for the mite natural enemies of any bark beetle, including *I. typographus*, is to compile a list of all of the associated mite species with keys to their identification. Until this is done, workers unfamiliar with mite taxonomy find it difficult to identify specimens, and face an almost impossible task of selecting the most appropriate natural enemies on which to concentrate their efforts.

As an aid in solving this problem for *I. typographus*, we constructed a key to its associated mites in South Germany, together with some of the biological characteristics of the mites. This key is limited to those species actually present in our samples, and illustrated here.

2 Methods

Flying *I. typographus* were trapped during May through September in 1980 and 1981. Traps were placed at various localities in the southern part of the State of Baden-Württemberg, Federal Republic of Germany, mostly in the vicinity of the Black Forest.

Traps were of three basic designs (tubes, cones, and window traps), all of which were baited with Pheroprax®[1], a pheromone-impregnated plastic wafer sealed inside a small polyethylene bag. Collected weekly from traps, beetles were placed in alcohol vials and sent to the Forest Insect Project, Southern Forest Experiment Station, Pineville, Louisiana, USA. A total of 8070 beetles were sent in 12 vials of alcohol in 1980, and 4284 were sent in 10 vials in 1981. A sample of 100 beetles was taken from each vial except for the last two vials in 1981, which contained only 37 and 13 beetles, respectively. The species and numbers 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. Although we believe that most of these mites were truly phoretic, a few may have been accidentally stuck to the beetles.

In addition, the sediments at the bottoms of the vials were searched for any mites that may have fallen off the beetles. The phoretic mites and those from the sediments were tallied separately.

3 Results

A total of 2050 adult beetles were examined for phoretic mites. Of the 1200 sampled in 1980, 35.6 % possessed mites; of the 850 in 1981, 30.0 % had mites. The average number of phoretic mites per beetle was 1.10 for all beetles, but 3.30 for those beetles with mites. This is a conservative estimate, since many mites fell off the beetles after they were placed in the alcohol. The percent of

[1] Mention of a company name or a proprietary product in this paper does not constitute a recommendation of this product by the U.S. Department of Agriculture.

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

Species and location on *Ips*	Number of Mites	Percent of total	Adjusted percent[1]
Trichouropoda polytricha		9.1	9.8
Elytral declivity	156		
Ventral abdomen	3		
Ventral thorax	40		
Coxae	4		
Head	2		
Uroobovella vinicolora		0.02	0.3
Under elytra	1		
Elytral declivity	2		
Coxae	1		
Uroobovella ipidis		27.4	21.0
Elytral declivity	76		
Ventral abdomen	1		
Dorsal thorax	2		
Ventral thorax	473		
Coxae	61		
Legs	1		
Head	3		
Proctolaelaps fiseri		0.01	0.5
Under elytra	1		
Elytral declivity	2		
Dendrolaelaps quadrisetus		58.6	32.6
Under elytra	1317		
Ventral thorax	1		
Calvolia sp. no. 33		<0.01	0.1
Ventral abdomen	1		
Histiogaster arborsignis		<0.01	0.1
On elytra	1		
Thyreophagus corticallis		<0.01	0.2
Under elytra	1		
Schwiebea sp. no. 10		<0.01	0.5
Under elytra	1		
Histiostoma piceae		2.9	22.2
Under elytra	56		
On elytra	1		
Elytral declivity	2		
Ventral abdomen	1		
Ventral thorax	3		
Head	1		
Histiostoma serrata		<0.01	0.1
Under elytra	1		
Scutacarus scolyti		0.01	3.0
Ventral thorax	13		
Iponemus gaebleri		0.01	0.2
Under elytra	2		
Elytral declivity	1		
Tarsonemus subcorticalis		0.02	2.6
Under elytra	3		
Dorsal thorax	1		
Paracarophaenax ipidarius		0.6	1.3
Ventral thorax	13		
Total, all above	2249	99.2%	94.0%

[1] Average of percent found attached and percent found in sediments (table 2).

beetles with mites varied from 9 to 60 percent in the 22 samples. In samples with low percentages most beetles were partially deteriorated before being placed in alcohol; presumably this contributed to the loss of phoretic mites.

Fifteen mite species were found on the beetles (and thus judged phoretic) (table 1). The total number of phoretic mites extracted from the 2050 adult beetles was 2249; 61.5 % (mostly *Dendrolaelaps quadrisetus*) were under the elytra; 24.2 %, on the ventral thorax; 10.6 %, on the ventral abdomen; 2.9 %, on the coxae; and less than 1 % on the other body locations.

Those mites found in the alcohol sediments were mostly the same species as those found attached to the beetles. Species that we think may have accidentally fallen or crawled into the traps were omitted from the species list. In all, the sediment samples included 15 phoretic species (table 1) that comprised 92 % of the total 1667 mites tallied (table 2).

Those phoretic species totaling less than 3 percent (table 1) were without exception much more common as percentages of the alcohol sediments (table 2), indicating that these species were easily dislodged. The adjusted

Table 2. Numbers of mites found in the alcohol sediments

Species[1]	Number of mites	Percent of total
**Trichouropoda polytricha* (Vitzthum, 1923)	173	*10.4
**Uroobovella vinicolora* (Vitzthum, 1926)	8	* 0.5
**Uroobovella ipidis* (Vitzthum, 1923)	241	*14.5
**Proctolaelaps fiseri* (Vitzthum, 1926)	16	* 1.0
Vulgarogamasus n. sp. no. 3	25	1.5
Dendrolaelaps disetus Hirschmann, 1960	5	0.3
**Dendrolaelaps quadrisetus* (Berlese, 1921)	109	* 6.5
Paraleius leontonychus (Berlese, 1910)	14	0.8
Carabodes labyrinthicus (Michael, 1879)	7	0.4
Cymbaeremaeus cymba (Nicolet, 1855)	4	0.2
Eporibatula gessneri Willmann, 1932	7	0.4
Adoristes ovatus (Koch, 1839)	8	0.5
Nanacarus n. sp. no. 13	5	0.3
**Calvolia* n. sp. no. 33	4	* 0.2
**Histiogaster arborsignis* Woodring, 1963	5	* 0.3
**Thyreophagus corticalis* (Michael, 1885)	6	0.4
New genus (near *Histiogaster*) n. sp. no. 27	5	0.2
**Schwiebea* n. sp. no. 10	16	* 1.0
Schwiebea n. sp. no. 31	12	0.7
**Histiostoma piceae* Scheucher, 1967	686	*41.2
**Histiostoma serrata* (Mahunka, 1962)	2	* 0.1
Histiostoma dryocoeti Scheucher, 1957	4	0.2
Histiostoma n. sp. no. 23	12	0.7
**Scutacarus scolyti* Mahunka and Moser, 1980	97	* 5.8
**Iponemus gaebleri* (Schaarschmidt, 1959)	50	* 3.0
**Tarsonemus subcorticalis* Lindquist, 1969	84	* 5.0
Tarsonemus ips Lindquist, 1969	6	0.4
Pyemotes dryas (Vitzthum, 1923)	1	< 0.1
**Paracarophaenax ipidarius* (Redikortsev, 1947)	33	* 2.0
Pygmephorellus sp(p).	4	0.2
Pseudopygmephorus bogenschutzi Mahunka and Moser, 1982	12	0.7
Bakerdania hylophila (Cooreman, 1963)	6	0.4
All species	1667	99.8
All nonphoretic species		7.9

[1] * = Mite species also found attached to adult *Ips typographus* (see table 1).

percentage given in table 1 is the average of the percentages for attached and detached specimens. We think that this average is a more realistic estimate of the actual percentages of phoretic mite species present on the beetles when trapped.

The 17 species found in the alcohol sediments but not attached to the beetles were all uncommon or rare, representing only 7.9 % of the total specimens in the sediments. They are included in our key because they are species that could have occurred phoretically in low numbers and might have been easily dislodged from *I. typographus*. They could also have been transported by other Coleoptera such as *Geotrupes stercorosus* Scriba 1891, a scarabaeid not associated with the habitat of *I. typographus*, or *Thanasimus formicarius* L. 1758, a clerid predator of *I. typographus* found in low numbers in window traps.

Many of the 7.9 % may eventually be documented as phoretic on *I. typographus*, and at least one species already has been. GAEBLER (1947) recorded *Iponemus gaebleri* as phoretic on *I. typographus*. Another, the oribatid *Paraleius leontonychus*, is apparently nonselective in its phoretic bark beetle host, having been found elsewhere on bark beetles of three different genera (NORTON 1980). KIELCZEWSKI et al. (1983) and LIEUTIER (1978) also record this species from galleries of *I. typographus*. *Pyemotes dryas*, though represented by only one specimen in the sediments, appears to be commonly phoretic on other spruce bark beetles such as *Polygraphus poligraphus* (L. 1758), although its exact relation to *I. typographus* is uncertain. But phoretic abundance sometimes bears little relation to the abundance of a mite species in the galleries of a bark beetle. *Histiogaster arborsignis*, for example, may be common in galleries of *Dendroctonus frontalis* (MOSER and ROTON 1971), although it is rare-infrequent on bodies of flying adults.

The biologies of most of the 32 species are unknown, but three are undoubtedly predators on various stages of beetle brood. *Iponemus gaebleri* preys on eggs of *Ips* spp. including *I. typographus* (GAEBLER 1947); *Pyemotes dryas* preys on brood of spruce bark beetles (MOSER et al. 1978). Although the biology of *Paracarophaenax ipidarius* is unknown, related species feed on beetle eggs (RACK 1959); it was not only the most common of the three species, but definitely phoretic on *I. typographus*. Of the three, it may account for the most brood mortality.

The 32 mite species listed in table 2 are all included in a key to mite species that are possibly phoretic on flying *I. typographus*. The total number of species associated with the subcortical habitat may be much higher. MOSER and ROTON (1971) listed 96 species of mites within the subcortical habitat of *Dendroctonus frontalis*, but only 15 species were included by KINN (1976) in a key to the phoretic species.

It is important to note that the figures accompanying the key emphasize morphological characters to separate the various species in the key. They are not intended for discriminating between closely related species.

Although the key is artificial, references to the higher categories (those hierarchal levels above species) are given in brackets so that the key may relate, in part, to a standard phylogenetic key (KRANTZ 1978). The starred (*) species are those actually found on beetle adults.

Where indicated in the key or in figure captions, the form (deutonymph, hypopus, female, or adult) of each species indicates the phoretic stage for that species. Normally only one stage of the mite's life cycle exhibits phoresy.

Where the form appears in the key couplet, all of the species to which that couplet leads are of that stage. For example, "deutonymphs" in couplet 6 means that all three species in couplets 7 and 8 are phoretic as deutonymphs. It should be noted that the hypopus is just a deutonymphal stage specialized for phoresy. The most obvious difference between the two forms is that the hypopus lacks functional mouthparts.

New species (n. sp.) are followed by a reference number, which refers to the order in which the species (named or unnamed) was found in the study. Until the species is named, this number should be used in all future correspondence or literature references. All of the specimens that were classified as *Pygmephorellus* may represent one or more species; hence the species is designated as sp(p).

An artificial key to mites associated with flying *Ips typographus*

1 Chelicerae large and easy to see; chelae toothed for grasping or grinding (fig. 6) 2
1′ Chelicerae absent or small and difficult to see; when present chelae usually stylet-like modified for piercing (fig. 14, 29) 13
2 More or less flattened with peritremes located on lateral region of the body; pseudostigmatic organs absent (fig. 5) [Supercohort Monogynaspides] 3
2′ Beetle-like, usually heavily sclerotized; most cannot be mounted on slides without crushing; peritremes absent; pair of pseudostigmatic organs present (fig. 12) [Suborder Oribatida] (adults) 9
3 Turtle shaped; legs can be withdrawn into grooves; attached to beetle by anal pedicle (fig. 1) [Family Uropodidae] (deutonymphs) 4
3′ Not turtle shaped; leg grooves absent; attached to beetle by the mouthparts and/or leg claws (fig. 5) [Cohort Gamasina] 6
4 Setae on dorsal shield thick and long; more than half as long as distance between setal bases (fig. 1) . . . . . *Trichouropoda polytricha**
4′ Setae on dorsal shield thin and short, less than half as long as distance between setal bases (fig. 2) 5
5 Numerous light refractant spots on sternal shield (fig. 2) . . . . . *Uroobovella vinicolora**
5′ Without numerous light refractant spots on sternal shield (fig. 3) . . . *Uroobovella ipidis**
6 Distinct line above legs III and IV dividing the dorsal shield into two plates (fig. 5, deutonymph) 7
6′ Dorsal shield not divided (fig. 4) [Family Ascidae] (females) . . . . . *Proctolaelaps fiseri**
7 One or two pairs of setae at posterior end of dorsal shield at least five times longer than adjacent setae, and at least one-third as long as leg IV (fig. 5) [Family Digamasellidae]. 8
7′ None of the posterior setae of the dorsal shield more than twice as long as smallest adjacent setae, and none more than one-fifth as long as leg IV (fig. 5) [Family Parasitidae] . . . . . *Vulgarogamasus* n. sp. no. 3
8 One pair of long posterior dorsal setae (fig. 6) *Dendrolaelaps disetus*
8′ Two pairs of long posterior setae (fig. 7) *Dendrolaelaps quadrisetus**
9 Single large claw on legs (fig. 8) 10
9′ Three claws on legs (fig. 10) 11

10 Claw strongly curved backward (fig. 8) [Family Oribatulidae] . . . . . *Paraleius leontonychus*

10′ Claw evenly curved (fig. 9) [Family Carabodidae] . . . . . *Carabodes labyrinthicus*

11 Genital and anal plates almost adjacent to each other (fig. 10) [Family Cymbaeremaeidae] . . . . . *Cymbaeremaeus cymba*

11′ Genital and anal plates separated by at least the length of the genital plate (fig. 11) 12

12 Small, weakly sclerotized, and more or less flattened mite, capable of being mounted on a slide; setae on dorsal shield long, setal tips capable of touching if pointed toward each other (fig. 11) [Family Oribatulidae] . . . . . *Eporibatula gessneri*

12′ Large, strongly sclerotized, rounded mite; setae on dorsal shield short, setal tips not capable of touching (fig. 12) [Family Liacaridae] . . . . . *Adoristes ovatus*

13 Mouthparts greatly reduced and nonfunctional; opisthosomal sucker plate present (fig. 13) [Superfamily Acaroidea] (hypopae) . . . 14

13′ Mouthparts present, opisthosomal sucker plate absent (fig. 24) [Subcohort Heterostigmae] (females) 24

14 All legs stout, although in some families leg IV may appear slender because of two thick tarsal setae which are longer than the leg; legs III and IV often directed backward (fig. 13) 15

14′ Legs I and II stouter than legs III and IV; legs III and IV often directed forward, with long, slender distal segments (fig. 20) [Family Histiostomatidae (= Anoetidae)] 21

15 Leg IV without claws, terminating in two thick setae which are longer than the leg (fig. 13) [Superfamily Hemisarcoptoidea] 16

15′ Leg IV terminating in a claw (fig. 14): [Superfamily Acaroidea] 17

16 Solenidia on "head" short and poorly developed; tarsus III very short, bearing only 3 setae (fig. 13) [Family Hemisarcoptidae] . . . . . *Nanacarus* n. sp. no. 13

16′ Solenidia on "head" long and well developed; tarsus III longer, with more than 3 setae (fig. 14) [Family Winterschmidtiidae (= Saproglyphidae)] . . . . . *Calvolia* n. sp. no. 33*

17 Median epimere absent, and epimere III open at apical end (fig. 15) . . 18

17′ Median epimere present and epimere III closed at apical end (fig. 17) . 19

18 Eyes closely spaced at anterior edge of dorsum (fig. 15) . . . . . *Histiogaster arborsignis**

18′ Eyes widely separated, some distance posterior to edge of dorsum (fig. 16) . . . . . *Thyreophagous corticalis**

19 Leg IV terminal setae stout, at least twice as long as leg IV (fig. 17) . . New genus (near *Histiogaster*) n. sp. no. 27

19′ Leg IV terminal setae thin, not more than twice as long as leg IV (fig. 18) 20

20 Posterior epimeres II joined at base by a *very* thin sclerite; median apodeme connecting apimeres III and IV undivided; gnathosomal remnant always undivided (fig. 18) . . . . . *Schwiebea* n. sp. no. 10*

20′ Posterior epimeres II never joined at base; median apodeme connecting epimeres III and IV partially divided; gnathosomal remnant usually divided (fig. 19) . . . . . *Schwiebea* n. sp. no. 31

21 Anterior opisthosomal setae elongate, overlapping bases of adjacent setae (fig. 21) 22
21′ Anterior opisthosomal setae shorter, not overlapping bases of adjacent setae (fig. 23) 23
22 Anterior opisthosomal setae long, thick (fig. 20) *Histiostoma piceae**
22′ Anterior opisthosomal setae shorter, thin (fig. 21) . . . . . *Histiostoma serrata**
23 Seta dp4 more than half as long as distance to base of dp3 (fig. 22) . . . *Histiostoma dryocoeti*
23′ Seta dp4 not more than a quarter as long as distance to base of dp3 (fig. 23) . . . . . *Histiostoma* n. sp. no. 23
24 Leg IV without claws and terminating in two whiplike hairs (fig. 24) . 25
24′ Leg IV terminating in two claws (fig. 28) [Family Pyemotidae] 28
25 Leg I terminating in single large claw specialized for grasping beetle setae (fig. 24) [Family Scutacaridae] . . . . . *.Scutacarus scolyti**
25′ Leg I terminating in small claws (fig. 25) [Family Tarsonemidae] . . . 26
26 Dorsal setae conspicuously stout; dorsal surface conspicuously punctate or striate (fig. 25) . . . . . *Iponemus gaebleri**
26′ Dorsal setae thin; dorsal surface smooth (fig. 26) 27
27 Apodemes III extending laterally beyond bases of legs III (fig. 26) . . . *Tarsonemus subcorticalis**
27′ Apodemes III not extending laterally beyond bases of legs III (fig. 27) . . . . . *Tarsonemus ips*
28 Mouthparts adapted for piercing-sucking; pharyngeal pump and/or stylets enlarged (fig. 28) 29
28′ Pharyngeal pump and stylets small, difficult to see (fig. 30) 30
29 Body slender, dorsum ridged (fig. 28) . . . . . *Pyemotes dryas*
29′ Body stocky, dorsum smooth (fig. 29) . *Paracarophaenax ipidarius**
30 Median apodeme and apodemes III and IV well developed, easy to see (fig. 32) 31
30′ Median apodeme poorly developed and apodemes III and IV very poorly developed or absent (fig. 30) . . . . . *Pygmephorellus* sp(p)
31 Dorsal setae thick; body heavily sclerotized (fig. 31) . . . . . *Pseudopygmephorus bogenschutzi*
31′ Dorsel setae of normal thickness; body normally sclerotized (fig. 32) . . . . . *Bakerdania hylophila*

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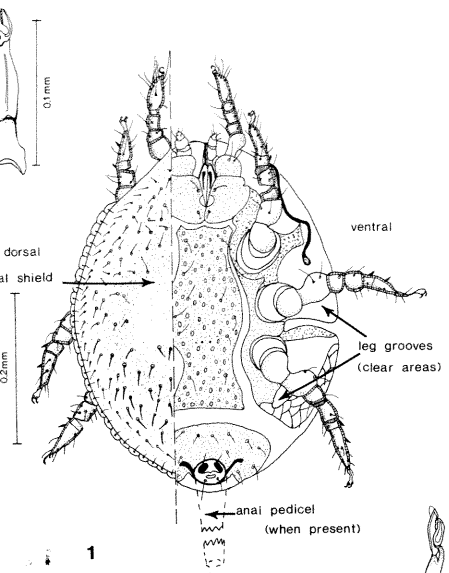
Fig. 1. Trichouropoda polytricha, deutonymph. – *Fig. 2. Uroobovella vinicolora*, deutonymph. – *Fig. 3. Uroobovella ipidis*, deutonymph. – *Fig. 4. Proctolaelaps fiseri*, female. – *Fig. 5. Vulgarogamasus* n. sp. no. 3, deutonymph. – *Fig. 6. Dendrolaelaps disetus*, deutonymph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dorsal
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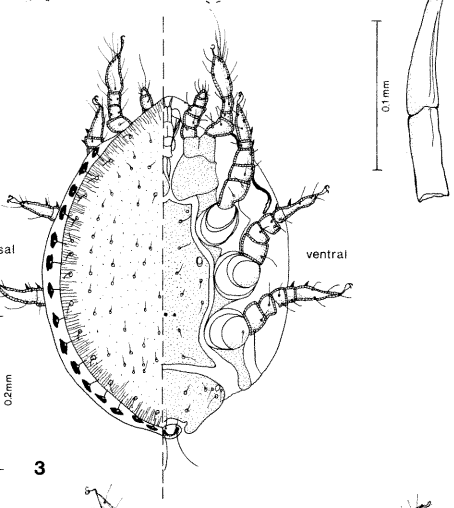
0.2mm
ventral
leg grooves
(clear areas)
anal pedicel
(when present)

1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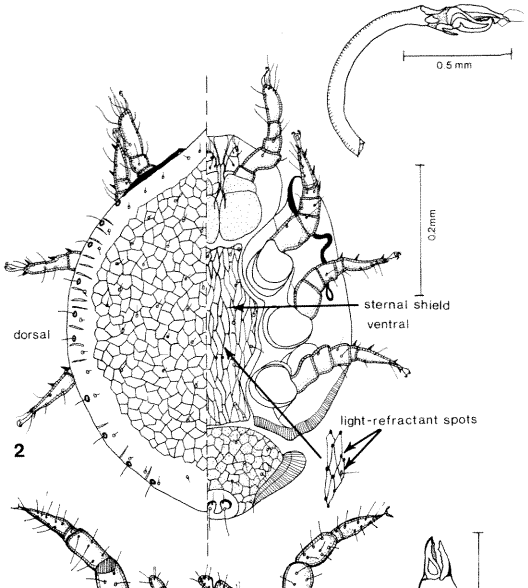
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dorsal
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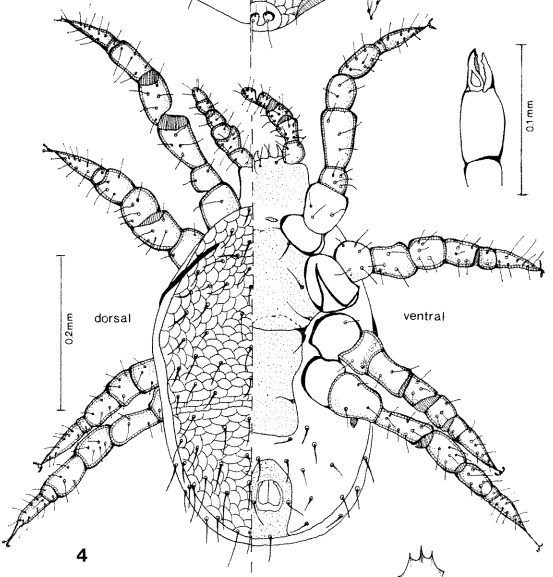
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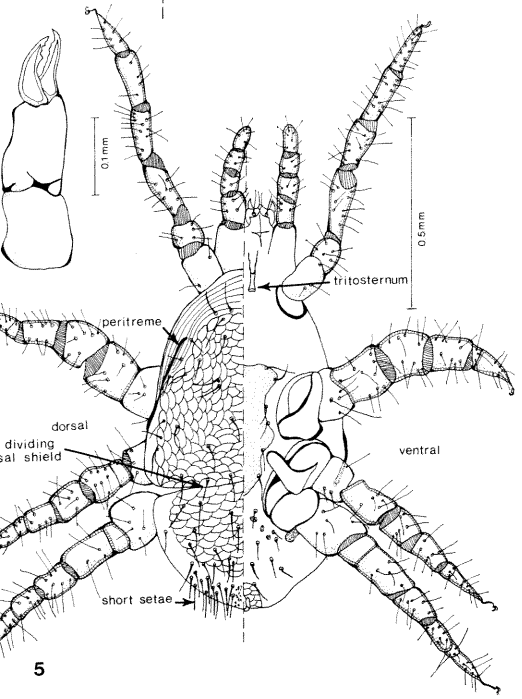
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dividing
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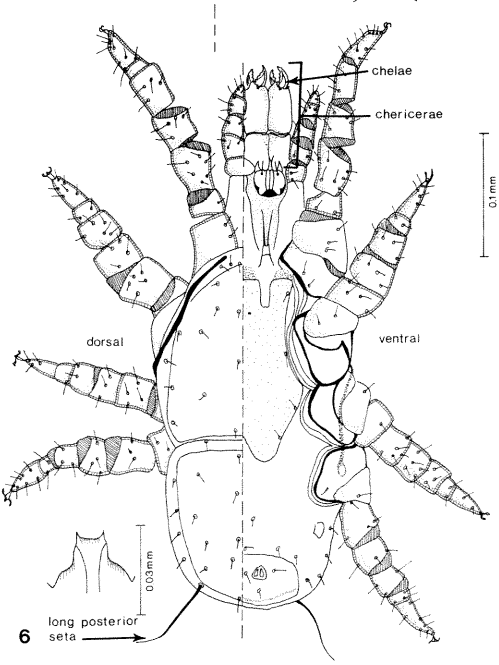
ventral
short setae

5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ventral
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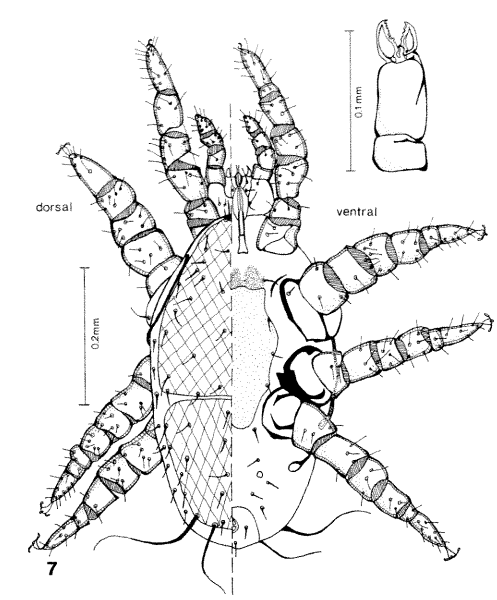
long posterior
seta

6



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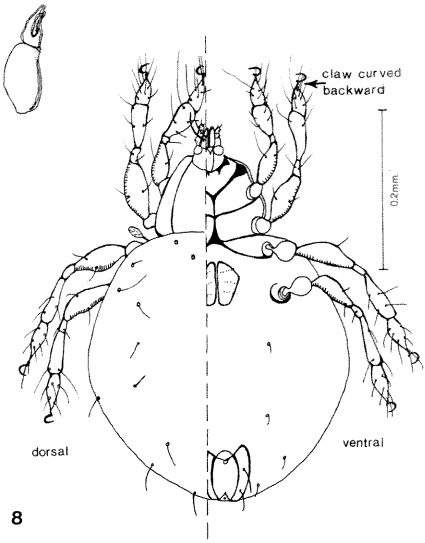

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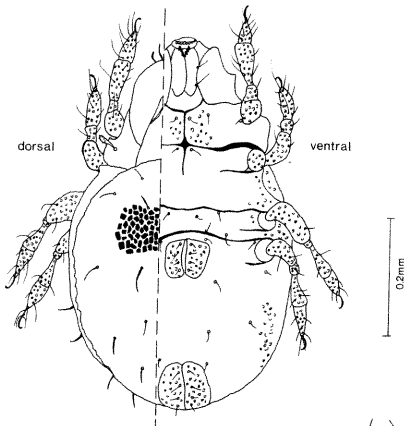

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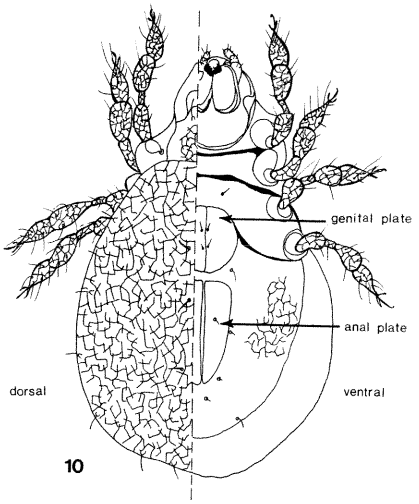

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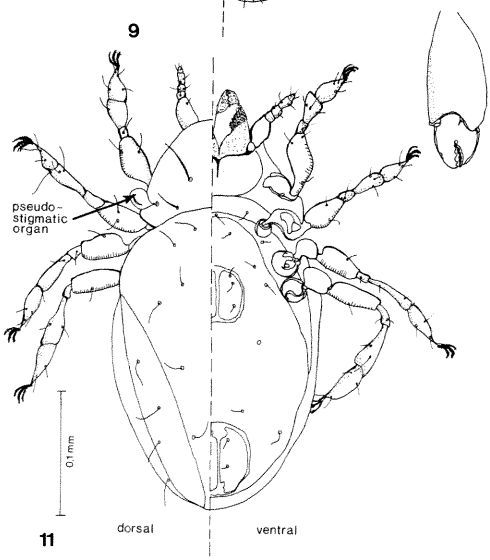

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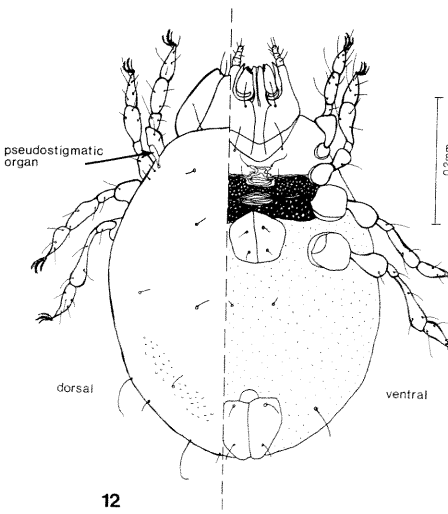

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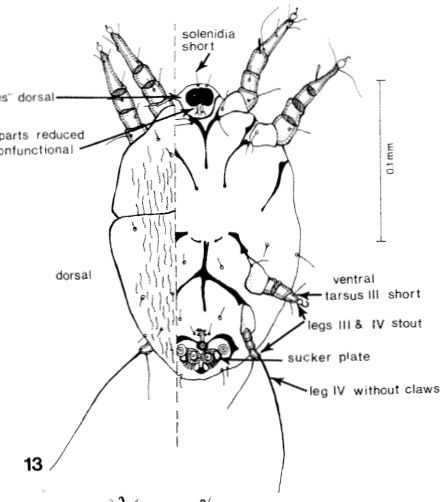
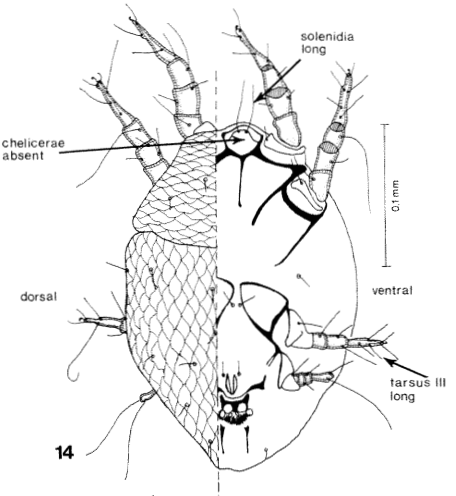
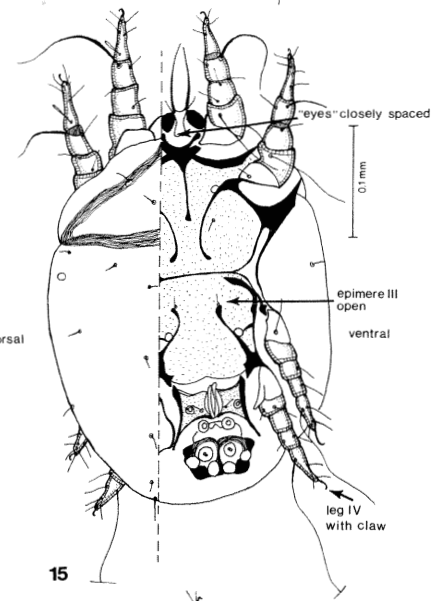
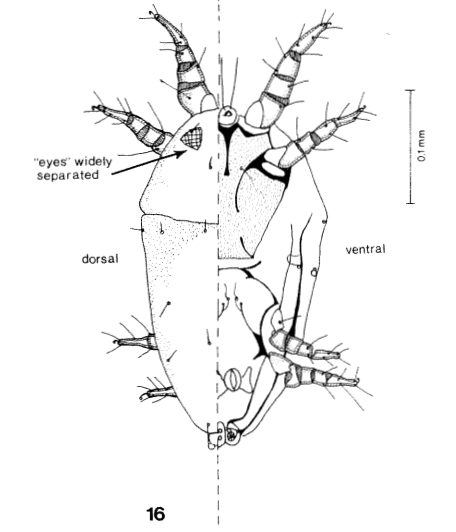
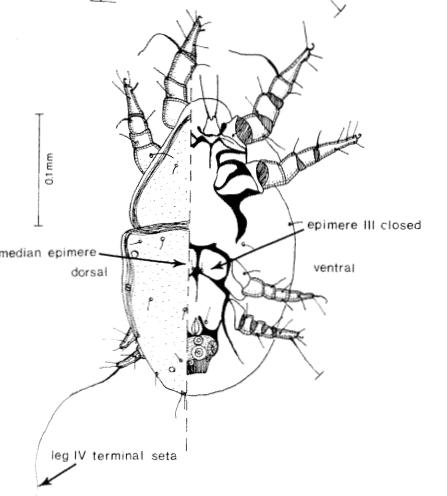
Fig. 7. Dendrolaelaps quadrisetus, deutonymph. – *Fig. 8. Paraleius leontonychus*, adult. – *Fig. 9. Carabodes labyrinthicus*, adult. – *Fig. 10. Cymbaeremaeus cymba*, adult. – *Fig. 11. Eporibatula gessneri*, adult. – *Fig. 12. Adoristes ovatus*, adult











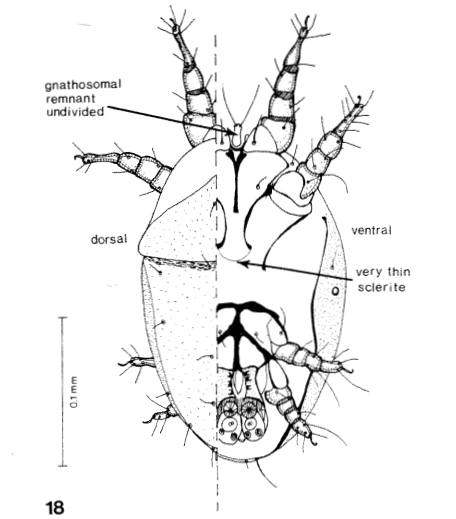
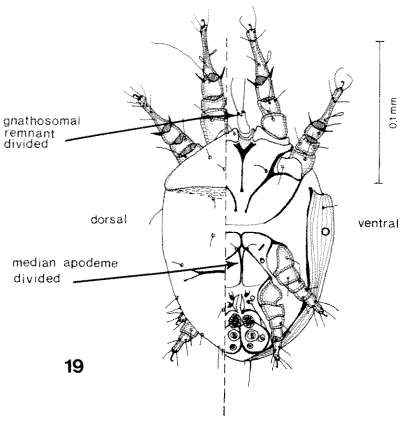
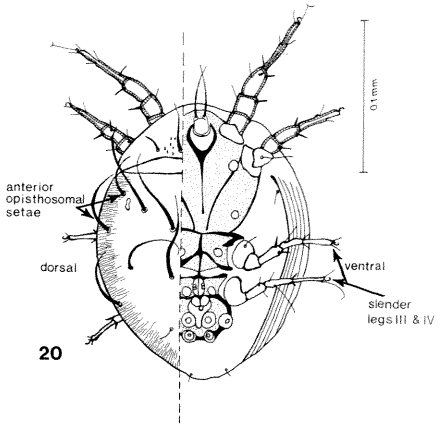
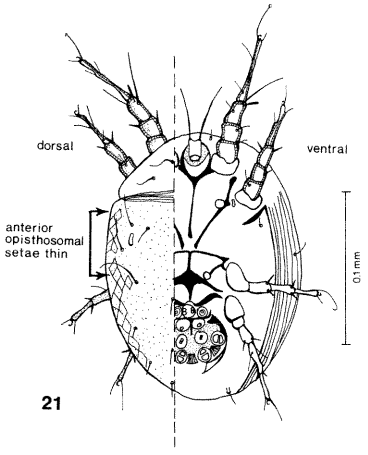
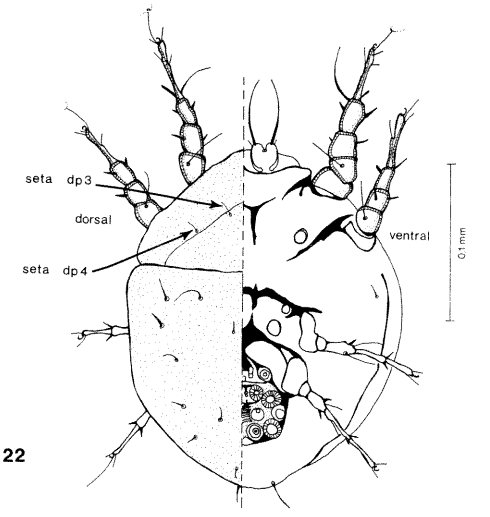


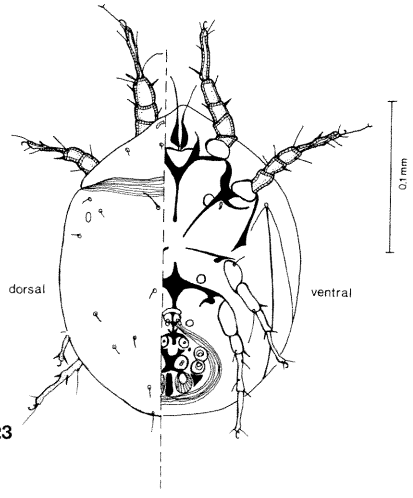
Fig. 13. Nanacarus n. sp. no. 13, hypopus. – *Fig. 14. Calvolia* n. sp. no. 33, hypopus. – *Fig. 15. Histiogaster arborsignis*, hypopus. – *Fig. 16. Thyreophagus corticalis*, hypopus. – *Fig. 17.* New genus (near *Histiogaster*) n. sp. no. 27, hypopus. – *Fig. 18. Schwiebea* n. sp. no. 10, hypopus











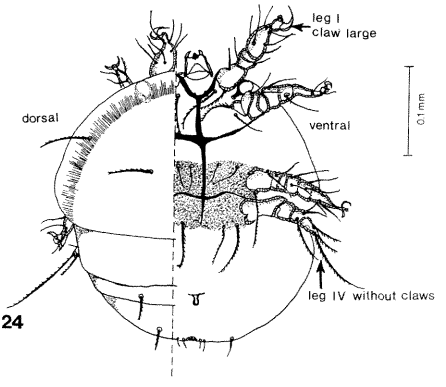
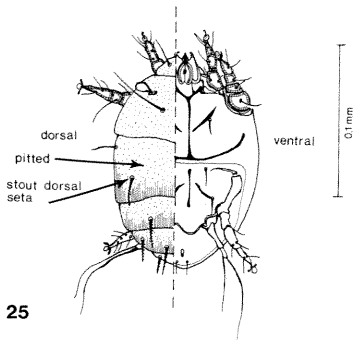


Fig. 19. Schwiebea n sp. no. 31, hypopus. – *Fig. 20. Histiostoma piceae*, hypopus. – *Fig. 21. Histiostoma serrata*, hypopus. – *Fig. 22. Histiostoma dryocoeti*, hypopus. – *Fig. 23. Histiostoma* n. sp. no. 23, hypopus. – *Fig. 24. Scutacarus scolyti*, female



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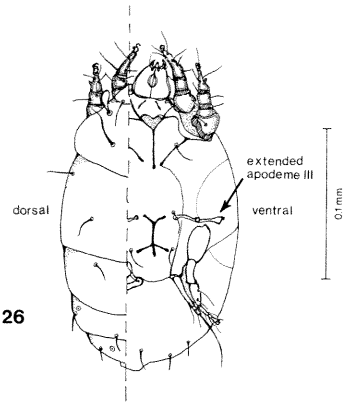

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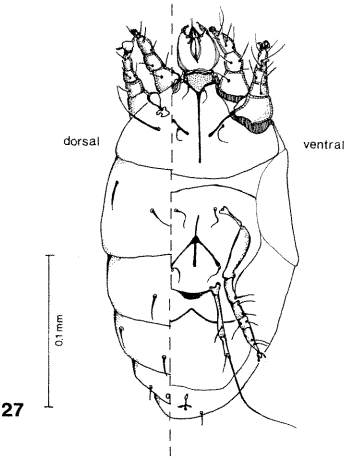

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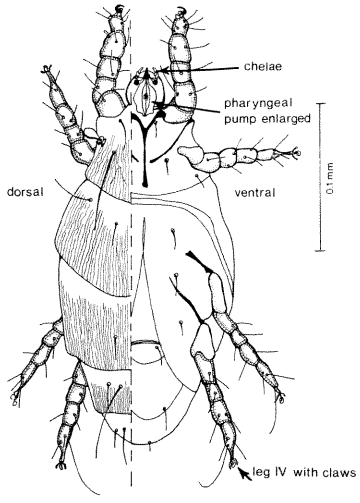

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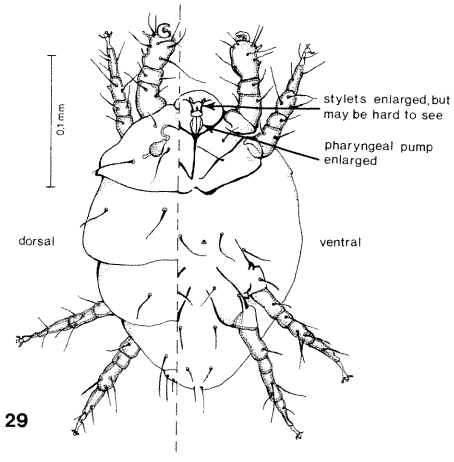

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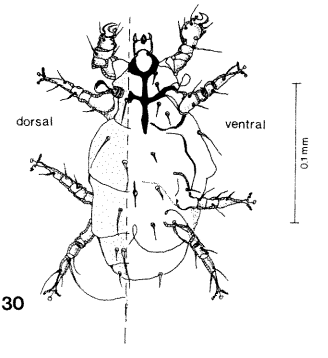

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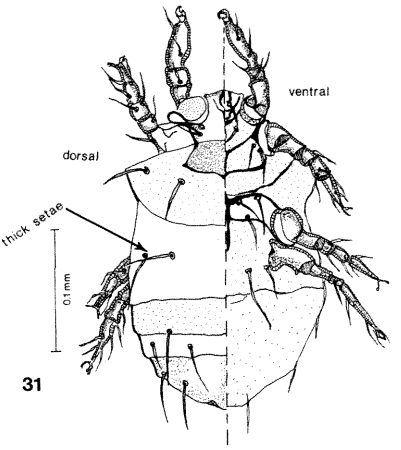
Fig. 25. Iponemus gaebleri, female. – *Fig. 26. Tarsonemus subcorticalis*, female. – *Fig. 27. Tarsonemus ips*, female. – *Fig. 28. Pyemotes dryas*, female. – *Fig. 29. Paracarophaenax ipidarius*, female. – *Fig. 30. Pygmephorellus* sp(p)., female



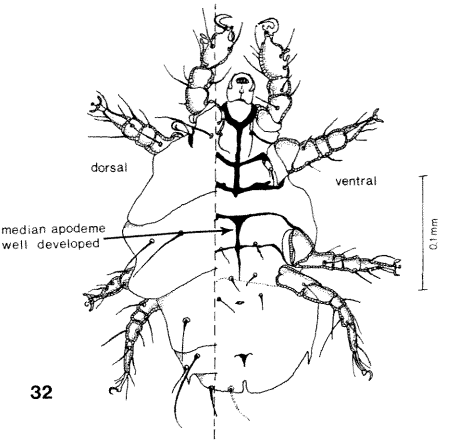


Fig. 31. Pseudopygmephorus bogenschutzi, female. – *Fig. 32. Bakerdania hylophila,* female

Zusammenfassung

Ein Schlüssel zur Bestimmung der mit fliegenden Ips typographus in Süddeutschland assoziierten Milbenarten

Es wird ein Bestimmungsschlüssel mit 32 Arten Milben aufgestellt, die in Süddeutschland an *Ips typographus* aus Pheromonfallen gefunden wurden. Alle Arten werden abgebildet. 15 Arten sind als phoretisch zu betrachten, 3 bilden potentielle Prädatoren.

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