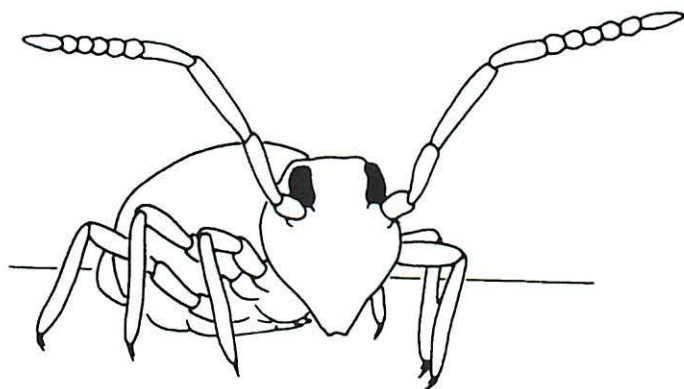


# Synopses on Palaearctic Collembola

Edited by Wolfram Dunger

Volume 2



Gerhard Bretfeld

## SYMPHYPLEONA

Staatliches Museum für Naturkunde Görlitz  
1999

# Synopses on Palaerctic Collembola

## Edited by Wolfram Dunger

Volume 1: Introduction and Tullbergiinae (1994)  
(by Wolfram Dunger and Bettina Zimdars, Görlitz)

Volume 2: Symphypleona (1999)  
(by Gerhard Bretfeld, Kiel)

In preparation:

Volume 3: Isotomidae

Volume 4: Hypogastruridae

Volume 5: Neanuridae and Odontellidae

Volume 6: Onychiuridae (excl. Tullbergiinae)

Volume 7: Entomobryomorpha (excl. Isotomidae)

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The **front cover** shows a male of *Deuterosminthurus sulphureus* (drawing by Mrs. W. RÖHE-HANSEN/Kiel, after a photograph made by G. BRETFFELD).



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## Synopses on Palaearctic Collembola Symphypleona

By GERHARD B R E T F E L D

With 567 figures

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## 1. Introduction

In the first volume of the Synopses, DUNGER (1994) already explained the principles of this series, so I only need to explain certain peculiarities of this part, the Symphypleona.

1. In this volume the whole group Symphypleona Börner is considered, i. e. the Neelida and the Eusymphypleona; whereas the species *Podura aquatica* and *Mackenziella psocoides* are not included (see p. 13).

2. The Palaearctic, as understood here, does not include Nepal. As I am assuming the southern border in East Asia to be the 30th parallel, the Ryukyu Islands are not included, and in E China the border is just south of the Yantze Kiang River. Difficult geographic names are spelled as in the Times Atlas of the World (1993). I was not able to correlate most of the older papers about former Yugoslavia to the present states, so I have used the expression »former Yugoslavia« throughout this work. The Nearctic species have been left out of the keys since there is much new material in the USA with several new descriptions underway (see CHRISTIANSEN & BELLINGER 1981, 2<sup>nd</sup> edit. 1998).

3. New data have been included up to February 1997 and partially up to September 1998.

I would ask all users or readers not to hesitate to point out any gaps or mistakes which they find in this volume, and to send me any new papers concerning Symphypleonan Collembola. I hope that the new data will be published in supplements to this Synopsis.

### Acknowledgements

My sincere thanks go to the colleagues who sent samples or single specimens of the Symphypleona which helped me to identify the species or complete the descriptions or information regarding distribution. All such colleagues are mentioned with the species, but here, because of repeated support, I wish to name: J. I. ARBEA, Pamplona, P. CASSAGNAU, Toulouse, A. FJELLBERG, Tjøme, M. M. da GAMA ASSALINO, Coimbra, J. MERTENS, Gent, and M. v. TSCHIRNHAUS, Bielefeld. I also thank the Museums of Amsterdam and of Geneva for their support.

For advice in special problems I thank P. F. BELLINGER, Northridge, E. CHRISTIAN, Vienna, and W. N. ELLIS, Amsterdam. I thank R. GAEDIKE, Eberswalde, for the personal data about CARL BÖRNER.

I also wish to thank Mrs. W. RÖHE-HANSEN, Kiel, for some new ink drawings of the figures. For correcting my English I wish to thank D. J. RUSSELL, Heidelberg, who did the greater part of the work, and Mrs. P. JOHNSON, Kiel, who checked the Introduction and some additions; any final responsibility for the language, however, remains with the author.

Last but not least, I would like to thank W. DUNGER, Görlitz, for his confidence in my work and his encouragement.

### Abbreviations

Abd I - VI = abdominal segments I - VI  
 Ant I - IV = antennal segments I - IV  
 App. an. = appendices anales  
 Bothr = bothriothrix/trichia  
 Emp = empodium/ia  
 Ret = retinaculum  
 Th I - III = pro-, meso-, and metathorax  
 Tita I - III = tibiotarsi of the pro-, meso-, and metathoracic legs

VT = ventral tube  
 row p:7 or 5:3 = setal row p has 7, row 5 has 3 setae  
 seta p7 or 5/2 = individual setae 7 of row p or 2 of row 5

The compass points are abbreviated as:  
 S XYZ = south part of XYZ  
 S of XYZ = more southern region than XYZ  
 S to XYZ = XYZ is the most southern region

## 2. General description

### **Symphypleona Börner, 1901 sensu Bretfeld, 1986**

Syn.: Sminthuridae Handlirsch, 1929 (615)

#### **Diagnosis**

The taxon *Symphypleona* Börner, 1901 (78) sensu Bretfeld, 1986 (308) is a monophylum of the Collembola with 3 diagnostic apomorphies:

- thorax and first abdominal segments more or less fused to form a globular tagma (plesiomorphy: body segments separated or the last abdominal segments fused without a globular form)
- tendency to form neosminthroid setae at the furca basis (plesiomorphy: normal setae)
- mucro gutterlike (plesiomorphy: mucro hooklike).

Other diagnostic characteristics (plesiomorphies): furca and Ret always present and well developed (apomorphy: both parts more or less reduced).

#### **Morphology**

This section presents a survey of structure. For more detailed studies one should consult the monographs by STACH (1956, 1957), RICHARDS (1968), SCHALLER (1970), BETSCH (1980), and CHRISTIANSEN & BELLINGER (1981). New faunal surveys are found in the studies by NOSEK (1962, 1969), GAMA (1964), SALMON (1964/65), SELGA (1971), UCHIDA (1972), YOSII (1977), CHRISTIAN (1987), STEBAEVA (1988 a, b), JORDANA et al. (1990), and MARI MUTT & BELLINGER (1990, 1996).

The *Symphypleona* are the globular Collembola. The total length of adults ranges from 0.12 mm up to 4 mm. The pigmentation varies from white to black and to various colours, and may be uniform or display a great variety of spots, or longitudinal or cross stripes; the median head region and the intersegmental sutures of the Th I- III and Abd I are often unpigmented. Whether the colour or the chaetotaxy is species specific, must always be carefully considered.

The thoracic and abdominal segments are fused in various manners (BETSCH 1980: 14). In general, the body is divided into 3 tagmata (Fig. 1): the head is well separated (first tagma), Th II and III and Abd I - IV or I - V are fused to the globular large abdomen (second tagma), and Abd V and VI or only VI are separated from the large abdomen as the small abdomen (third tagma). In the large abdomen, the intersegmental sutures of the thorax and Abd I are often observable, the others are usually obscure. Th I is always small and lacks setae. The broadest segments are Th III or Abd IV, or both.

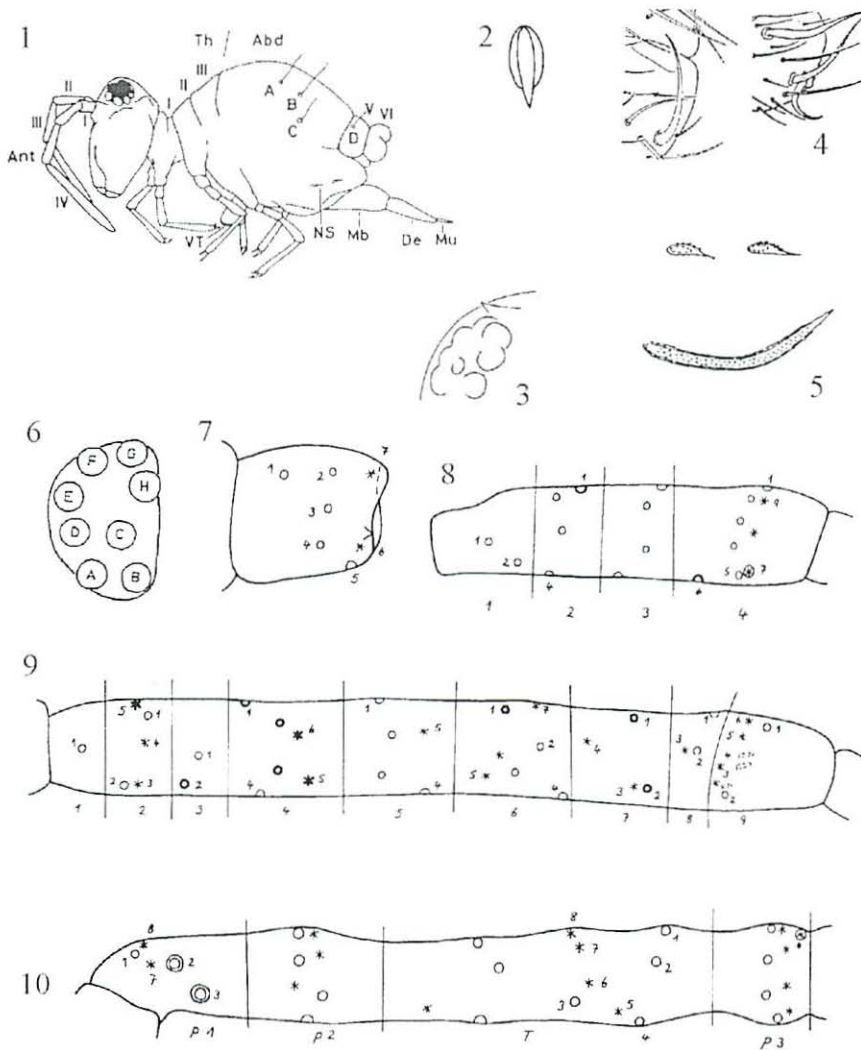
As in all Collembola, the cuticula is hygrophobic. The epicuticula forms primary granules in hexagonal patterns, which may fuse into several forms of secondary granules more or less protruding from the surface, depending on body part and taxon (LAWRENCE & MASSOUD 1973, LAWRENCE 1975). In some taxa, the cuticula forms minute pores on the legs or the large abdomen, and often shows small oval structures, the oval organs (Fig. 2). The latter may be reduced setae, and are supposed to function as proprioceptors (SNIDER & LORING 1984), though their inner structure has not yet been studied. Also the points of muscle attachment to the cuticula are observable as interruptions in the uniform epicuticular patterns.

Special cuticular processes described in some taxa are a pair of small spines on the head apex in the first instar juveniles (Fig. 3); they may be used during hatching from the egg and disappear after the first moult.

The setae vary in length and thickness, thick setae being called spines (for a survey of setal modifications see MASSOUD & ELLIS 1977: 163). The setae may be transformed into special forms, such as the various antennal sensilla, the bothriotrichia, the postantennal setae, the neosminthuroid setae, and the female appendices anales. Scales are absent. Most of these special forms characterize special taxa and are described in detail later. Some generally important setal forms, however, are described here. The bothriothrix is a long and very thin sensillum inserted in large cup-shaped cuticular depression, as it is known from other arthropods. In the Eusymphyleona there are at most 3 pairs of bothriotrichia, ABC, on the large abdomen and 1 or 2 pairs, D or DE, on Abd V (Figs. 1, 18, 31); their number and position is of taxonomic value. The appendices anales are a pair of transformed setae on the ventral anal valves (position av5, Fig. 30) of the adult female in the Appendiciphora. They are directed posteriorly or dorsally, i. e. towards the anus, or ventrally, i. e. towards the genital opening (Fig. 4). The latter position is apomorphic, since the subadult female has the corresponding, not modified setae still directed towards the anus. The special form of the appendices anales is of high taxonomic value. Their function may be to move the egg when it adheres to the anus after having left the genital opening and when it is covered by a mixture extruded from the anus, which protects the egg against desiccation (MASSOUD & PINOT 1973, BRETFELD 1977; also observed in *Sphaeridia pumilis*, in which App. an. are not developed, BLANCQUAERT et al. 1981 a: 118). The neosminthuroid setae lie on the furca basis, i. e. on the ventrolateral part of Abd IV (Fig. 1). They are appressed to the cuticula, covered with small spicules, and usually have only a short free tip directed posteriorly (Fig. 5). The neosminthuroid setae do not occur in all taxa of the Symphyleona, but they never occur in the Arthropleona. Their occurrence can be regarded as convergent, but it is regarded here as an 'underlying synapomorphy' or a 'unique inside-parallelism', comparable to a true synapomorphy (SAETHER 1979, BRETFELD 1994 a: 276; see also the discussion about reactivated, silent genes by STURM 1994).

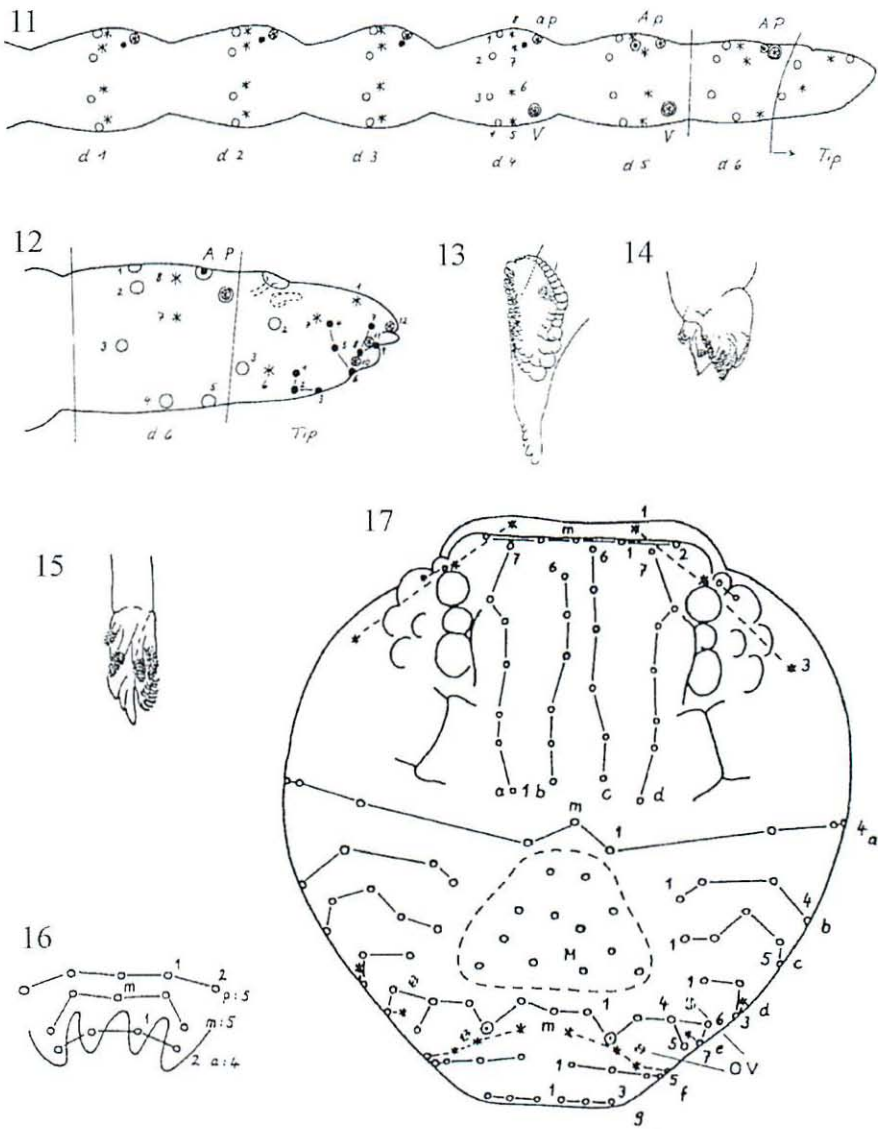
On the always well developed orthognathic head one distinguishes several regions: the dorsal apex between the eyes, the frons between the antennae, the clypeus below the antennae, the lateral parts or genae, and the back dorsal and back ventral sides in relation to the neck (briefly called dorsal or ventral head-back). The chaetotaxy is only well known in a few taxa (BRETFFELD 1990, BETSCH & WALLER 1994). The nomenclature and the main pattern of description - whether cross rows or longitudinal rows - is in dispute; the nomenclature of BRETFELD 1990 is favoured here (Fig. 17). The generally well developed eye-patches mark the anterodorsal corners of the head; they are usually strongly pigmented and have 8+8 ommatidia, which (according to GUTHRIE 1906) are called A - H (Fig. 6). The number is reduced to 1+1 or 0 in special taxa. Between the antennae, the frontal ocellus is sometimes marked by a black spot.

The antennae with their 4 segments are always present. Their sides are named differently depending on whether they are spread laterally or foreward; here the terms anterior and posterior of the lateral position are recommended, besides the non-changing dorsal and ventral sides. The setae are arranged in whorls and in 8 longitudinal rows (BRETFFELD 1990, NAYROLLES 1991 b) with whorl-derived or additional sensilla of different form (Figs. 7 - 12). The sense organ on the distal part of Ant III (called Ant III organ) consists of 3 small sensilla, the dorsal 2 of which are more or less invaginated into the cuticula of the posterior side; the ventral sensillum lies free.



Figs. 1 - 32 Symphyleona general: 1 Habitus and body parts (modified after RICHARDS 1968, NS - neosminthuroid setae) 2 Oval organ (orig.) 3 Left eye-patch and egg-tooth of 1st instar (*Heterosminthurus*, orig.) 4 Main forms of the App. an. (after BETSCH 1980) 5 2 forms of neosminthuroid setae (*Lipothrix* and *Sminthurinus*, after BETSCH 1980) 6 Nomenclature of ommatidia, right eye-patch seen from anterior (after BETSCH 1980).

Figs. 7 - 12 Chaetotaxy of left antenna seen from anterior (*Heterosminthurus*, after BRETZFELD 1990, o = anterior setae, \* = posterior setae, others symbols represent the various sensilla): 7 Ant I 8 Ant II 9 Ant III 10 Ant IV proximal part



11 Ant IV distal part 12 Ant IV tip. Figs. 13 - 15 Tips of mouthparts (after BETSCH 1980):

13 Mandible 14 Normal maxilla 15 Elongate maxilla (Stenognathriopes).

Figs. 16 - 24 Chaetotaxy of head, body, legs (Figs. 16 - 22 *Heterosminthurus*, after BRETFFELD 1990,

Ov = oval organ, other symbols as in previous figures): 16 Labrum 17 Head (M = setae of varying positions)



Ant IV often shows small annuli or subsegments. Numerous modifications of the general form or of the fine structure of the antennae occur. They are dealt with under the special taxa.

The labrum may show sclerotic ridges and has 3 rows of setae (anterior, median, posterior) with mostly a:4, m:5, p:5 setae (Fig. 16) (this nomenclature is the opposite of that of YOSII 1976, see BRETFFELD 1990, BETSCH & WALLER 1994). The mandibles and maxillae are mainly of the chewing type, seldom being elongate for an unknown feeding behaviour (Fig. 13 - 15) (then the clypeus is also longer than normal). The maxillary outer lobe and the labium were studied by FJELLBERG (1984: 87 and in press, respectively).

The main body part is the large abdomen, which is responsible for the main aspect of a Symphypleonan Collembola. The setae are arranged in cross rows on Th II, III, and Abd I, and in cross rows or longitudinal rows or are diffusely distributed on the middle and posterior parts of the large abdomen (Fig. 18); the chaetotaxic analysis of these posterior parts is usually difficult. The basic pattern of row arrangement in the Arthropleona, in a-m-p, i. e. anterior-median-posterior, rows (RUSEK 1986), is also difficult to reconstruct (BETSCH & WALLER 1989, BRETFFELD 1990, BETSCH & WALLER 1994). Well separated symmetrical setal fields are the ventral setae behind the Ret, their number increasing with increasing instar (BETSCH 1980: 36), and the setae of the furca base (Fig. 19), some of which may be transformed to neosminthuroid setae.

The 3 pairs of legs are composed of 7 parts, as in all Collembola (Figs. 20 - 23): subcoxa I and 2, coxa, trochanter, femur, tibiotarsus, and pretarsus with outer claw (or unguis) and inner empodium (or unguiculus). There are only a few setae on the basal parts (BRETFFELD 1990, NAYROLLES 1990 a), and 1 pair or only the anterior seta on the pretarsus. Most of the setae are on the tibiotarsus, where several whorls with 8 longitudinal rows can be distinguished (NAYROLLES 1988, BRETFFELD 1990). On most parts of the legs different numbers of oval organs occur, as well as other special modifications. Subcoxa II and III may have soft inner processes, called subcoxal processes, the occurrence of which is not fully known and the taxonomic value not yet clear. The claw has a triangular cross section with a sharp inner edge, which sometimes bears teeth, and a broad outer side which is smooth or has teeth, a balloonlike duplication (tunica), or lateral, serrate duplications (pseudonychia) (Fig. 24). The empodium consists of a basis which is more or less shortened and pointed, and has 3 edges (outer = directed towards the claw, inner, and anterior), the outer of which can have a tooth and form a filament of different length and shape (NAYROLLES 1996: 526). On the posterior basis of the empodium there is a blunt cuticular tubercule. The homologies of these pretarsal structures with a typical insect claw have not yet been established.

The 3 pairs of abdominal appendages of the Collembola are always well developed in the Symphypleona. The pair of ventral tubes is more or less fused in different taxa. The length of the eversible sacs differ with the taxa, as do their surfaces, which are smooth or have small papillae. The animals can clean the entire large abdomen with the long sacs. The ventral tube has 1 or 2 pairs of setae on the distal valves and sometimes a pair on the corpus. The retinaculum consists of a median corpus, and an anterior and a posterior lobe (Fig. 25). The corpus bears a pair of lateral processes (rami), each of which has a soft basal process and 3 (plesiomorphy) or 2 (apomorphy) sclerotic teeth; thus the retinaculum is described as having a total of 4+4 or 3+3 teeth. The anterior lobe often has a few setae, the posterior lobe may be reduced. The number of teeth and setae correlates with the instars (BETSCH 1980: 60).

The furca has different orientations: held in a resting position under the body, pointed perpendicularly from the body like a leg, or stretched backwards as in many fixed specimens.

The sides of the furca are named differently, relating to the respective orientations. Here the terms anterior and posterior of the perpendicular position are recommended, besides the non-changing internal and external (inner and outer) sides. The manubrium has few posterior setae, seldom also anterior ones (Fig. 26). The dentes are long, leglike, usually undivided but in some taxa a small basal part is separated. The chaetotaxy resembles that of the tibiotarsi (Fig. 27): there are longitudinal rows and indistinct whorls (BRETFFELD 1990, NAYROLLES 1990 b). The setae differ in length and form or are transformed into spines. A few posterior setae are mostly long; they are the sensory setae of the resting furca. The anterior setae are appressed, allowing the furca to be laid more closely against the body. The mucro in general is gutterlike with an anterior, and an inner and an outer posterior edge (Fig. 28). The anterior edge may form a furrow, the posterior edges are often serrate with teeth. There is a special structure, the small, baso-anterior shield (pseudonychium), and sometimes an outer seta.

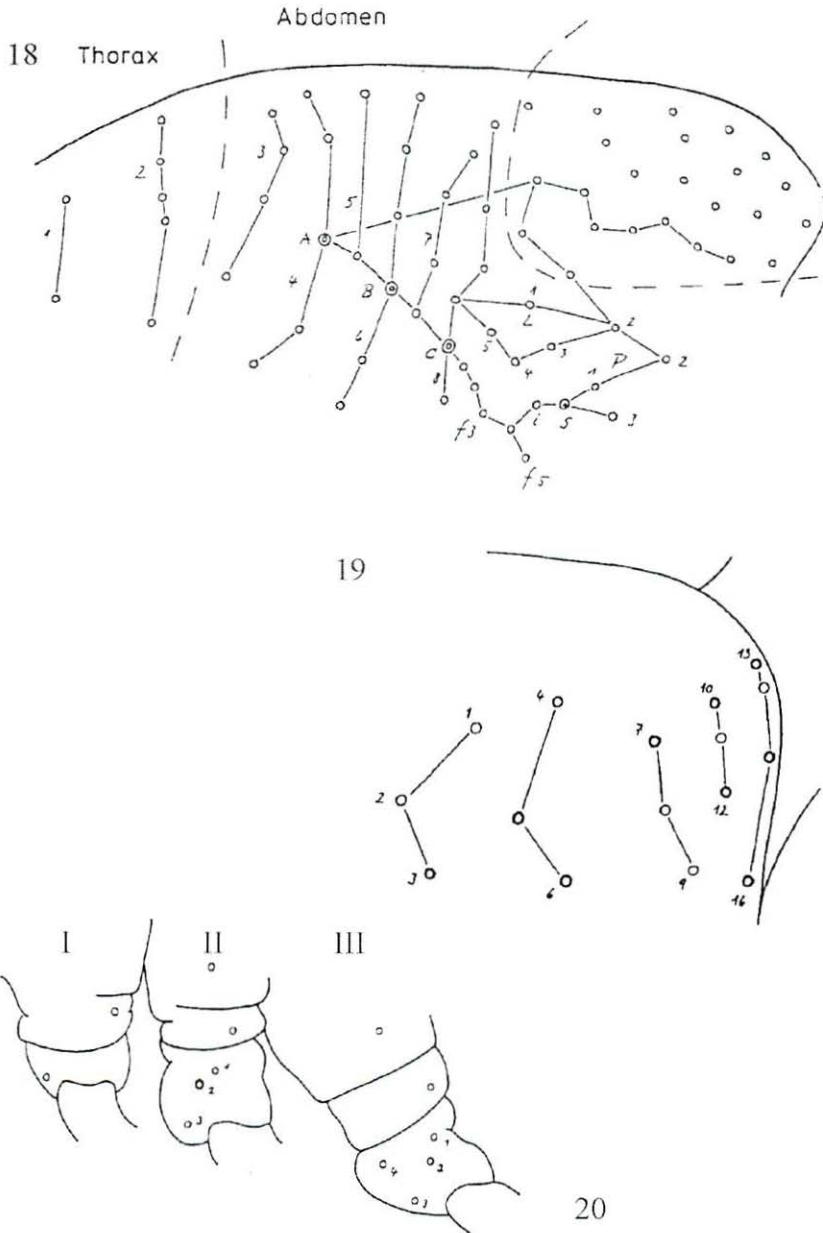
The small abdomen comprises Abd V and VI or only Abd VI. Segment V (Fig. 31) has 2 or 3 cross rows of setae (BRETFFELD 1990, 1994 b, BETSCH & WALLER 1994) and bears the genital opening: in the females a transverse slit with anterior setae, in the males a protruding papilla with a longitudinal slit and symmetrically arranged setae. Females have a pair of thinly sclerotized ducts and sacs near the genital opening, receptacula seminis or accessory reproductive glands, the form of which may be taxonomically important. They are not yet well studied, however, since they are difficult to observe (MURPHY 1966: 69). Segment VI mainly consists of 1 dorsal and 1 pair of ventrolateral anal valves (Figs. 29 - 32). Their setae are arranged in cross rows which may form circles around the anus (BRETFFELD 1990, 1994 b, BETSCH & WALLER 1994). In some genera, the wall of the female rectum has more or less deep invaginations with cuticular teeth; the function is not clear (BETSCH et al. 1995). Since the structures of the small abdomen vary importantly among the taxa, its dissection and careful orientation is necessary for most determinations and for every description.

### Biology

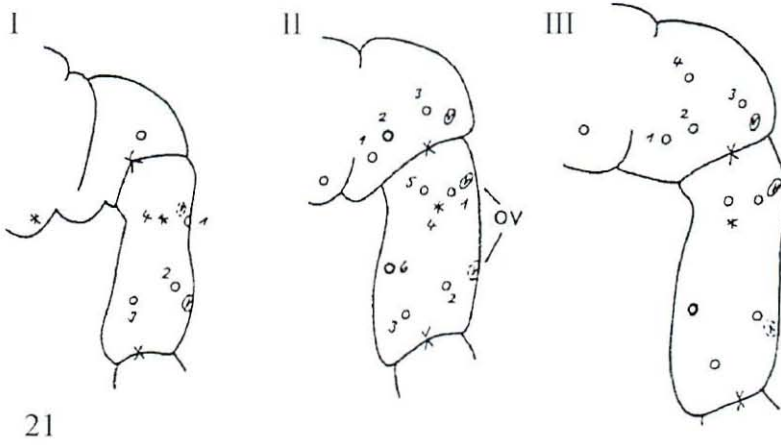
The Symphypleona live in a great variety of habitats, plesiomorphically in moist, apomorphically in dry ones, i. e. in and on the soil and litter, in the low or higher vegetation where they also occur on trees, on the surface of fresh waters, on dry and sunny grounds, in intertidal zones, and in caves. As in the other Collembola, the Symphypleona survive seasons hostile to life in the egg stage. More biological observations are mentioned with the different taxa. For surveys see PACLT 1956, HOPKIN 1997; the cavernicolous species are listed by MASSOUD & THIBAUD 1973: 153.

### Collection and preparation

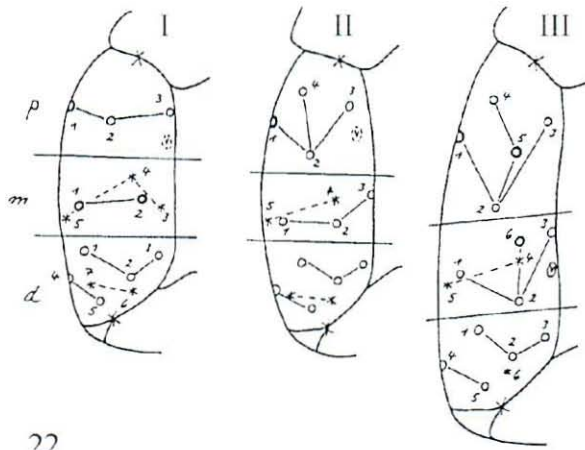
The collection methods are the aspirator, the Berlese-apparatus or its variations, pitfall and colour traps, and the sweeping net. For determination, the specimens are fixed and preserved in 70 % alcohol. They generally must be bleached and dissected (the head, extremities, and small abdomen dissected from the large abdomen), and the body parts mounted on several slides in an aqueous mixture of gum arabic (for details see BRETFFELD 1990, 1991, HÜTHER 1993, DUNGER & FIEDLER 1997). The cover slips should have »feet« to keep the natural shape of the body parts. The mounting medium recommended here is Hoyer's mixture; mounting in resin or synthetic resin mountants seems to be more permanent (UP-TON 1993), but media which do not shrink the Symphypleona must be used.



18 Large abdomen (f, L, P = flank setae, S = sensillum) 19 Left furca base 20 Subcoxae and coxae of left side



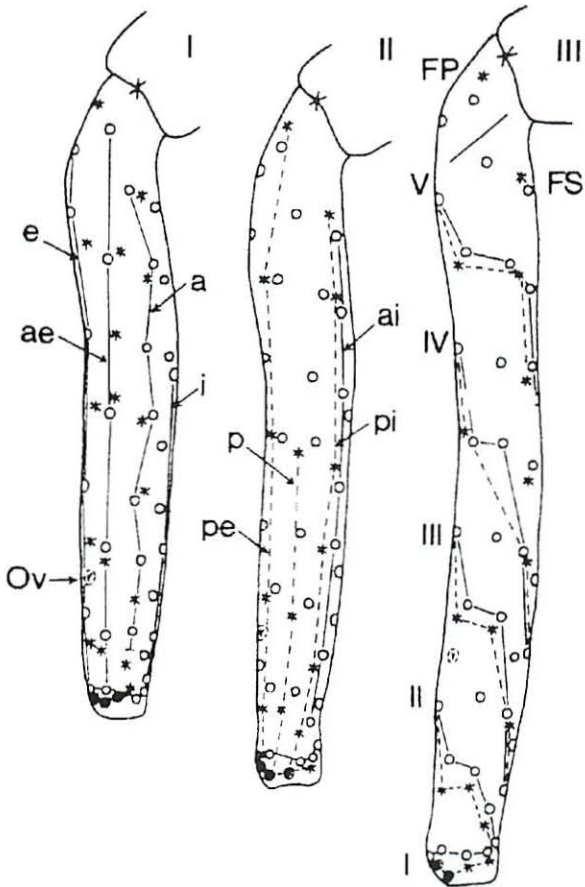
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21 Right coxae and trochanters from anterior 22 Right femora from anterior

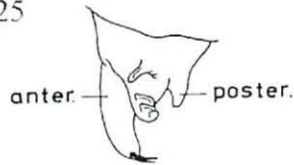
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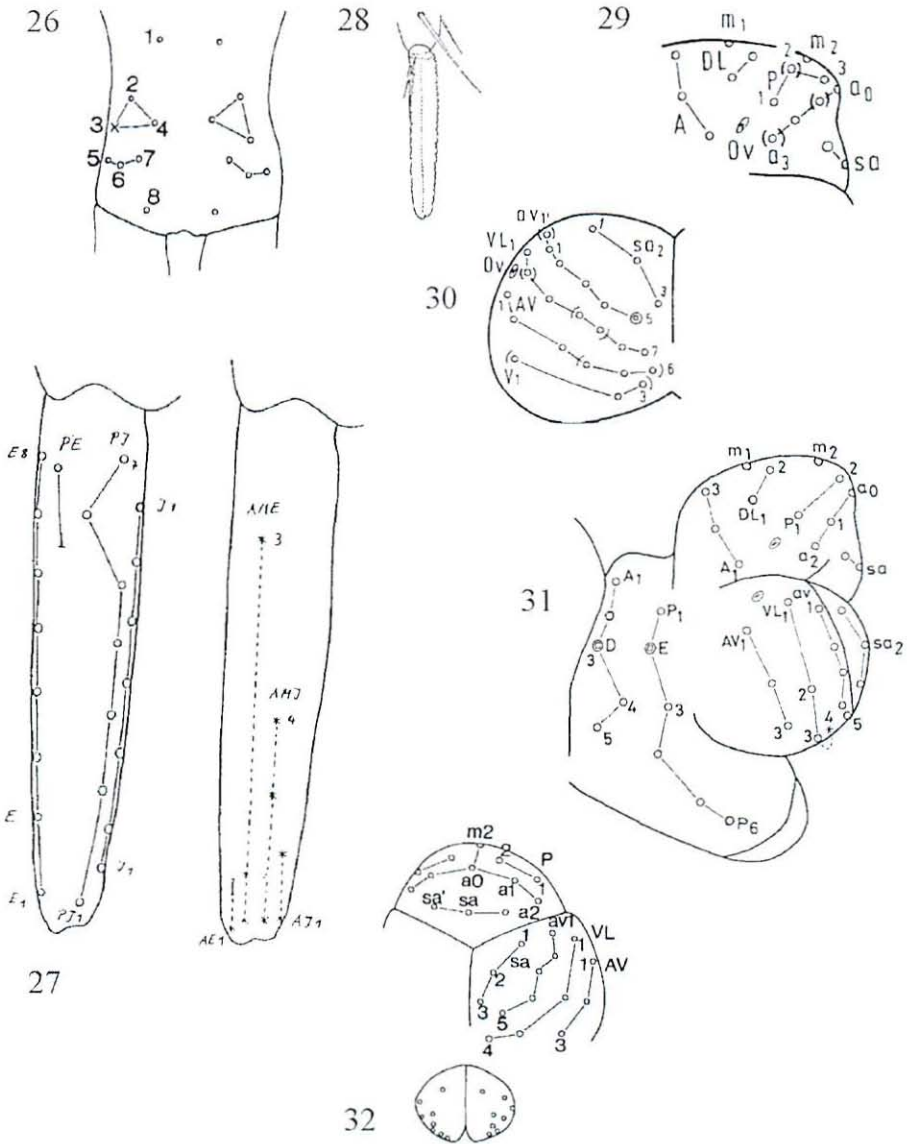
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25



23 Right tibiotarsi from anterior (⊗ = spatulate setae, *Fasciosminthurus*, after BRETFELD 1992)  
 24 Claw and Emp (*Lipothrix*, after BETSCH 1980) 25 Retinaculum (after RICHARDS 1968).



Figs. 26 - 28 Chaetotaxy of furca, and mucro: 26 Manubrium, posterior side (*Fasciosminthurus*, after BRETTFELD 1992) 27 Dens, posterior and anterior sides (*Heterosminthurus*, after BRETTFELD 1990, 1996) 28 Mucro from posterior (*Temeritas*, after BETSCH 1980).

Figs. 29 - 32 Chaetotaxy of small abdomen (symbols as in previous figures, setae in brackets vary between sexes and taxa): 29 Female Abd VI dorsal part, left side (*Heterosminthurus*, after BRETTFELD 1994) 30 Female Abd VI ventral part, left side (*Heterosminthurus*, av5 = App. an., after BRETTFELD 1994) 31 Male left side (*Heterosminthurus*, after BRETTFELD 1990) 32 Male Abd VI, ventral view, and genital papilla (*Fasciosminthurus*, after BRETTFELD 1992).

## History

From the older history, which was reported in detail by LUBBOCK (1873) and BÖRNER (1913), it should be mentioned that the globular springtails known then were at first called the genus *Smynthurus* by LATREILLE (1810), later »Smynthurelles« by NICOLET (1847), and the family Sminthuridae by LUBBOCK (1862). 8 years later, LUBBOCK added the family Papiiriidae and created the order Collembola for all springtails (1870). TULLBERG, at the same time, suggested a different classification, calling all springtails the family Poduridae, and the globular ones the subfamily Sminthurinae (1871). Full circle had come with the Smynthuridae of TÖMÖSVARY (1883), who chose this old name for the 2 families of LUBBOCK 1870. After the creation of the family Neelidae by FOLSOM (1896 a) and the discovery of *Megalothorax minimus*, the 2 families of globular Collembola, the Neelidae and the Sminthuridae, were united in the suborder Symphypleona by BÖRNER (1901). This group has been largely accepted by later authors.

The newer history of the systematic category of the globular springtails and its name is again characterized by changing suggestions. The system of the Collembola was simplified by HANDLIRSCH (1929) who called the suborder Symphypleona Börner the family Sminthuridae, an opinion followed by NOSEK (1962, 1969) and FJELLBERG (1980). The suborder Symphypleona Börner was elevated to an order by CASSAGNAU (1971). In the same year, new characteristics found in the Neelidae caused MASSOUD (1971) to erect 3 suborders within the order Collembola: the Arthropleona Börner, 1901, the Neelipleona Massoud, and the Symphypleona Massoud. This suggestion has been followed by MARI MUTT & BELLINGER (1990) and JORDANA et al. (1990). MASSOUD's suborders Neelipleona and Symphypleona has been elevated to orders by CHRISTIAN (1987). In a last step, the splitting of the larger taxon Symphypleona has been cancelled by BRETTFELD (1986 b, 1994 a), who newly founded the Symphypleona Börner, 1901 on apomorphies and created several monophyla and a phylogenetic system of this group. This system comprises the sister groups: Neelida - Eusymphypleona, Sminthuridida - Appendiciphora, Anteriora (because the angle of the Bothr ABC generally opens anteriorly) - Sminthuriformia, within the Anteriora; Katianniformia - *Sturmius*, within the Sminthuriformia; Dicyrtomida - Tridentata (because the Ret has 3 teeth), and Sminthurida - Bourletiellida. The Katianniformia (with Spinothecida, Collophorida n. nom., Arrhopalitida n. nom., and Katiannida n. comb.) have not yet been analysed enough to clarify the sistergroup relationships of their taxa. For the phylogenetic system of 1986, BRETTFELD (1994 a) also proposed Linnean categories, which comprise within a subclassis Collembola the orders Poduromorpha sensu Cassagnau, 1971, Entomobryomorpha, sensu Cassagnau, 1971, and Symphypleona Börner, 1901, sensu BRETTFELD, 1986 with the suborders Neelida BRETTFELD, 1986 and Eusymphypleona BRETTFELD, 1986.

Remarks: The Linnean categories (BRETTFELD 1994 a: 278) have to be supplemented: the Katiannoidea now comprises the Spinothecidae, Collophoridae n. fam., type genus *Collophora* Richards in Delamare Deboutteville & Massoud, 1964 a (34), Arrhopalitidae Stach, 1956 n. comb., type genus *Arrhopalites* Börner, 1906 (182), and Katiannidae Börner, 1913 n. comb., type genus *Sminthurinus* Börner, 1901 (344).

The species *Podura aquatica* Linnaeus, 1758 and *Mackenziella psocoides* Hammer, 1953, which were placed near the Symphypleona by MOEN & ELLIS (1984) and FJELLBERG (1989) respectively, are here regarded as genera and species incertae sedis and have not been included in this part of the synopsis.

### 3. Key to the main groups of the Symphypleona of the world

- 1 Eyes and bothriotrichia absent; thorax larger than abdomen (Figs. 44, 56)  
Neelida Bretfeld, 1986 (p. 15)
- Eyes and at most 5 pairs of bothriotrichia present; thorax smaller than abdomen  
 (Eusymphyleona Bretfeld, 1986, p. 28) 2
- 2 Females without App. an.; males always with modified Ant II and III  
Sminthuridida Bretfeld, 1986 (p. 29)
- Females with App. an. of various form; males seldom with modified antennae (Appendiciphora Bretfeld, 1986) 3
- 3 App. an. directed posteriorly or towards the anus (Fig. 4) 4
- App. an. directed towards the genital opening (Fig. 4) (Katianniformia Bretfeld, 1986)  
7
- 4 Ant III with papilla; 1+1 neosminthuroid setae; VT bipartite; App. an. resemble thick setae  
Sturmius Bretfeld, 1994
- Without this combination of characteristics (Sminthuriformia Bretfeld, 1986) 5
- 5 Ant IV longer than Ant III; antennae elbowed between segments III and IV  
 (Tridentata Bretfeld, 1986) 6
- Ant IV much shorter than Ant III; antennae elbowed between segments II and III  
Dicyrtomida Bretfeld, 1986 (p. 128)
- 6 Abd V with 1 pair of Bothr D (Fig. 1); pretarsus with 1 pair of setae  
Sminthurida Bretfeld, 1986 (p. 171)
- Abd V with 2 pairs of Bothr DE (Fig. 31); pretarsus with only 1 anterior seta  
Bourletiellida Bretfeld, 1986 (p. 213)
- 7 (3) Neck with 1 pair of large, soft organs Spinothecida Bretfeld, 1986
- Without such organs 8
- 8 Eye-patches with 6+6 to 8+8 ommatidia; Tita with spatulate setae (Figs. 266-268)  
Katiannida Bretfeld, 1986 n. comb. (p. 98)
- At most 4+4 ommatidia; Tita without spatulate setae 9
- 9 Anterior part of Abd V completely included into large abdomen; Bothr D short and capitate  
Collophorida n. nom.
- Abd V only partially included into large abdomen (Fig. 144); Bothr D of normal form  
Arrhopalitida n. nom. (p. 62)

Remarks: This key partly preserves the sister groups within the Symphypleona. Important former keys are found in STACH 1956 and 1957, GISIN 1944, 1960, PALISSA 1964, FJELLBERG 1980, BETSCH 1980, CHRISTIANSEN & BELLINGER 1981, 1998 and STEBAEVA 1988 b.



## 4. Diagnoses of the Palearctic taxa

### Neelida Bretfeld, 1986

- Syn.: Neelidae Folsom, 1896 (391)  
Megalothoracini Börner, 1900 (610)  
Neelinae Handlirsch, 1929 (615)  
*Neelus* Gama, 1961 (34)  
Neelipleona Massoud, 1971 (198)

### Diagnosis

The taxon *Neelida* Bretfeld, 1986 (308) is a monophylum of the Collembola Symphypleona Börner, 1901 sensu Bretfeld, 1986 with 5 diagnostic apomorphies:

- eyes absent (plesiomorphy: present)
- coxae longer than trochanters (plesiomorphy: as long or shorter)
- special sensilla and areas of sensilla on head and body (plesiomorphy: without such areas)
- epicuticula scales off (plesiomorphy: epicuticula stable)
- midgut with 4 pairs of diverticula (plesiomorphy: midgut smooth).

Other diagnostic apomorphies: antennae shorter than head diagonal; thorax larger than abdomen; small abdomen hidden under large abdomen; Ret without setae; dentes bipartite. In relation to the sister group, the Eusymphypleona, these characteristics are considered phylogenetically apomorphic though embryologically primitive, because the *Neelida* are considered to be of neotenic origin (BRETFFELD 1986, see below), which is a derived state of evolution.

### Description

This survey, though considering new findings, is based on the monographs of BONET 1947: 131 and STACH 1957: 3. The *Neelida* are small animals; the total length of adults ranging from 0.3 - 0.7 mm. The background colour is white or yellowish, sometimes with even brown or blue-grey pigment, which may have paler spots; the pigmentation is not species specific. The profile of head and body forms a uniform hemicircle (Figs. 44, 56). The thorax is larger than the abdomen, Th III and Abd IV are the broadest segments. The small abdomen is not protruding. Often the intersegmental sutures are visible in the thorax but not always in the abdomen. There are no tracheae. The midgut has 4 pairs of diverticula.

The epicuticula scales off (MASSOUD 1971). There are no oval organs (SNIDER & LORING 1984). The ventral sides of the head and thorax show narrow cuticular grooves branching from the ventral line; these grooves are supposed to be a water conducting system (DEHARVENG 1978, RUSEK 1987). The few normal setae are short, fine, and stiff. Bothriotrichia are missing. There are, however, sensory fields, short sensilla on the head and the large abdomen, and short, swollen sensilla laterally on the large abdomen (Figs. 44, 56). Within and outside the sensory fields, there are special setae with basal pores (Figs. 45, 46), which secrete thin, waxen rods (VANNIER & MASSOUD 1967). The ventral setae are missing; on the furca base and the manubrium, however, up to 6 pairs of neosminthuroid setae of various form occur (Figs. 42, 56).

Eyes are absent. The antennae are shorter than the head diagonal and insert near the middle of the head. Ant III and IV have sensilla of various form. The ventral sensillum of the Ant III organ is missing. There is no sclerotic ventral margin of the clypeus, and the anterior setal row of the clypeus, the prelabral setae of YOSII 1976, only has 2+2 setae as in the Arthropleona, instead of 3+3 in the Eusymphyleona (Fig. 17, row g). The setal rows of the labrum are called here a, m, p as in the Eusymphyleona (Fig. 16); for reason of general comparison the nomenclature of MASSOUD & VANNIER 1967, anterior = R, posterior = m and r, is not used here. In general the mouthparts are adapted for chewing. The long, curved coxae (Fig. 56) bend the legs below the thorax. Spatulate setae on the tibiotarsus are missing. There is no tunica on the claws, but they have various teeth (Fig. 66): 1 pair of laterobasal teeth are called 'l'; a posterior tooth of various length, which sometimes looks like an inner tooth of the claw, is called 'Bp'; and a similar anterior tooth, observed sometimes, is called 'Ba'. The Emp are shorter than the claws, without a tooth and a filament, but the posterior tubercle may be present (Figs. 49, 55, 59, 66).

The ventral tube is long and cylindrical with 2 pairs of distal setae, and, in 2 genera, a posterior lobe (Fig. 67). The eversible sacs are short. Ret has no setae, the rami have 2+2 or 3+3 teeth each, but no basal papillae. The furca is long and well developed. On the manubrium, there are some posterior setae and a pair of anterior articular processes which meet corresponding processes of the dentes. The slender dentes consist of a small proximal and a longer distal part (Fig. 43) (MASSOUD 1971: 196 considers the manubrium to be bipartite, which seems to be a mistake). The proximal parts have 1 or 2 posterior setae each; the distal parts have a few setae and some small or thick spines. The mucrones are relatively long, the posterior edges of which are smooth or serrate.

The small abdomen only bears few setae as in the juvenile stages of the Eusymphyleona (BRETZFELD 1994 b), and the females lack appendices anales.

Remarks: The minute dimensions of the Neelida and their body parts make their structures difficult to analyse. The findings from a species or genus are also difficult to generalize, since most species are rare. If studied with modern methods, some body parts promise to show new characteristics. There are still few studies on such body parts as the mouth parts, the labrum (MASSOUD & VANNIER 1967), the antennal sensilla (MASSOUD & DELAMARE DEBOUTTEVILLE 1969, DEHARVENG 1978, DEHARVENG & BERUETE 1993), the special body setae and sensilla (BERNARD 1975, DALLAI 1979), and the claws (MASSOUD & VANNIER 1965 b: 235).

### Biology

It is impossible to generalize from the few biological findings on some species (see below under *Megalothorax minimus*). The only general statements possible are that the Neelida are euedaphic (GISIN 1943: 186) and that they are very agile. They may prefer the upper soil layer (BELLINGER 1954: 50), but also occur in deeper layers. By their smallness, their uniform globular body form, and their legs being bent under the thorax, the Neelida are well adapted to the small crevices in the soil and litter. Besides the wormlike euedaphic Arthropleona, which also occur in these crevices, the Neelida represent, together with the larger *Arrhopalites* species, the globular Collembola in these areas. The Neelida also occur in caves. Out of 6 European species compared by MASSOUD & THIBAUD (1973), 3 are troglophile: *Neelus murinus*, *Megalothorax minimus*, and *Megalothorax incertus*. The species *Megalothorax massoudi* and *Megalothorax tuberculatus* are troglobite (DEHARVENG 1978 and DEHARVENG & BERUETE 1993, see below).

## History

In the description of the species *Neelus murinus*, FOLSOM (1896) created the family Neelidae. BÖRNER (1900), not knowing the paper of FOLSOM, proposed the tribe Megalothoracini (he called it a subfamily) for a second species, *Megalothorax minimus* Willem, 1900. But soon BÖRNER (1901 a) became aware of FOLSOM's paper and stated that his family Megalothoracidae (as he now called this taxon) was synonymous with the family Neelidae Folsom (see also BÖRNER 1906 b). Later authors also accepted this family. The exception was HANDLIRSCH (1929), who called this taxon the subfamily Neelinae, an opinion followed by GISIN (1944, 1960), MAYNARD (1951), SCOTT (1964 a), and SCHALLER (1970). A simple nomenclature, the single genus *Neelus* instead of a higher category, has been used by GAMA (1961 a, 1964), NOSEK (1962, 1969), SELGA (1971), and FJELLBERG (1980). New characteristics differing from those of the other Symphypleona caused MASSOUD (1971) to erect a suborder Neelipleona next to the suborders Arthropleona and Symphypleona. MASSOUD's suggestion has been followed by MARI MUTT & BELLINGER (1990) and JORDANA et al. (1990). The suborder Neelipleona was elevated to an order by CHRISTIAN (1987). As an approach to a phylogenetic system based on apomorphies, BRETTFELD (1986) created the monophylum Neelida, which is synonymous with the family Neelidae Folsom. BRETTFELD (1986) considered the Neelida to be of neotenic origin. He referred to DENIS (1933 a: 272), who, under *Sminthurides* (*Sphaeridia*) *pumilio*, described the relatively small abdomen of *Sminthurides* juveniles, and explicitly mentioned the striking similarity with *Megalothorax*, but did not draw the conclusion of neoteny for *Megalothorax* and the other Neelida. For the monophyla and the phylogenetic system of 1986, BRETTFELD (1994 a) recently proposed Linnean categories with the suborder Neelida Bretfeld, 1986, syn. Neelipleona Massoud, 1971, having a single family Neelidae Folsom, 1896.

## Key to the genera of the world

### Neelida Bretfeld, 1986

- 1 Head and body with well developed sensory fields (Figs. 44, 45); Ant IV with 1 thick, short sensillum and several longer sensilla; manubrium with flat or convex articular tips 2
  - Large sensory fields absent; Ant IV with only 4 short sensilla; manubrium with concave articular tips (Figs. 56, 58, 60) 2  
*Neelides* Caroli, 1912 (p. 23)  
 type species: *Neelides folsomi* Caroli, 1912; Italy
- 2 Dens posteriorly with short, conical spines; median labral setae present 3
  - Dens posteriorly with broad triangular spines; median labral setae missing 3  
*Zelandothorax* Delamare Deboutteville & Massoud, 1963  
 type species: *Megalothorax novaezealandiae* Salmon, 1944; New Zealand
- 3 Sensory fields of posterior large abdomen with 5 marginal setae; Ant III and IV fused; articular processes of manubrium long, with flat or slightly convex tips (Figs. 33, 45, 50) 3
  - Megalothorax* Willem, 1900 (p. 18)  
 type species: *Megalothorax minimus* Willem, 1900; Belgium
  - Sensory fields of posterior large abdomen with 2 marginal setae; Ant III and IV separated; articular processes of manubrium short, with hemispherically convex tips (Figs. 35, 63, 68) 3  
*Neelus* Folsom, 1896 (p. 27)  
 type species: *Neelus murinus* Folsom, 1896; USA

### Diagnosis of the Palaearctic genera and species

#### Genus *Megalothorax* Willem, 1900

Syn.: *Neelus* Folsom, 1901 (219) ad partem

*Amerus* Collinge & Shoebbotham, 1909 (47)

*Neelus* Womersley, 1932 a (11) ad partem

*Neelus* (*Megalothorax*) Gisin, 1944 (105)

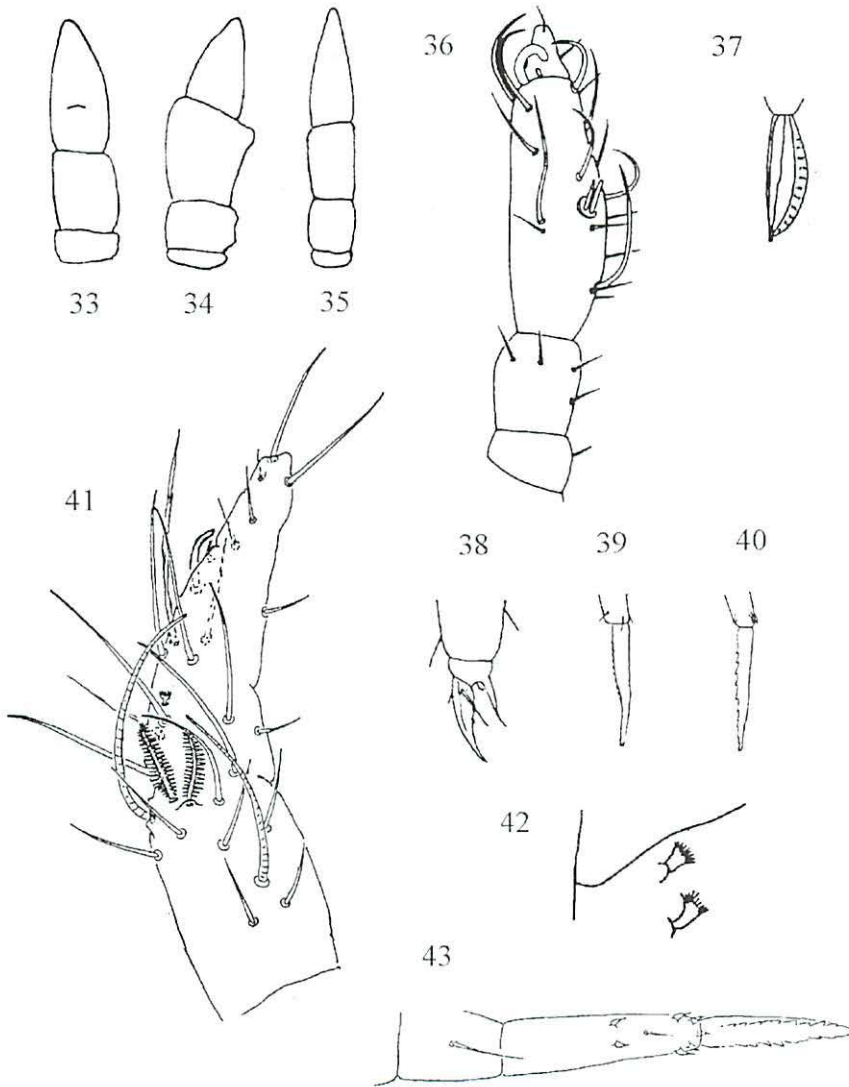
#### Key to the Palaearctic species

- |   |  |   |
|---|--|---|
| 1 | Edges of mucro narrow  | 2   |
| – | Edges of mucro broad, thin, and transversely striate (Fig. 37)   | <i>aquaticus</i> Stach, 1951                  |
| 2 | Edges of mucro smooth  | 3   |
| – | Edges of mucro serrate   | 4   |
| 3 | Ant IV with short, thin subapical seta X (Fig. 48); total length up to 0.4 mm; claws broad (Fig. 49)         | <i>minimus</i> Willem, 1900                   |
| – | Ant IV with cuticular spine instead of seta X (Fig. 54); total length up to 0.55 mm; claws slender (Fig. 55) | <i>tuberculatus</i> Deharveng & Beruete, 1993 |
| 4 | Emp III with protruding basal tubercle   | 5   |
| – | Emp III with basal tubercle not protruding   | <i>incertus</i> Börner, 1903                  |
| 5 | Edges of mucro serrate in basal 2/3 (Fig. 39)  | <i>boneti</i> Stach, 1960                     |
| – | Edges of mucro serrate in full length  | <i>massoudi</i> Deharveng, 1978               |

Remarks: Not all species are well characterized since the teeth of the mucrones vary, and whether the empodial tubercle is protruding or not is difficult to confirm in each special case. Therefore, *M. incertus* may be synonymous to *M. minimus* (see BONET 1947: 174, GAMA 1964: 227; CHRISTIANSEN & BELLINGER 1981: 1049, SNIDER & CALANDRINO 1987: 9). A re-examination of new topotypic material is required.

#### Diagnosis of the genus

Dorsal setae relatively long, about 8 - 10  $\mu\text{m}$ . 6 pairs of well developed sensory fields (Figs. 44, 45, 46): 1 below and 1 above the antennae, 1 laterally on Th II, 1 on subcoxa II, 1 on subcoxa III, and 1 posteriorly on large abdomen (this field with 5 marginal setae). 2+2 neosminthuroid setae with a brushlike tip (Fig. 42). Ant III and IV fused (Fig. 33). Ant III organ with 2 rather large, flat sensilla, and 1 dorsal and 1 ventral long sensillum. Ant IV with 1 very thick, curved sensillum, several long ones which are shorter than those of Ant III organ, and several subapical small setae, sensilla, or spines (Figs. 41, 47, 54). Claws with differing teeth 'l' and 'Bp'; Emp with a large posterior tubercle and 4 lamellae (Figs. 49, 55). VT without posterior lobe. Ret with 3+3 or 4+4 teeth. Manubrium with up to 4+4 setae; manubrial joints in form of relatively long, slender processes with flat or slightly convex tips (Fig. 50). Proximal part of dens with 1 seta; distal part anteriorly with 3 apical setae or spines; distal part posteriorly with 2 outer spines, 1 median seta, and 2 inner spines (Figs. 43, 51). Distal part of mucro may be narrower than proximal part; posterior edges smooth or serrate (Figs. 39, 52).



Figs. 33 - 35 Antennae of Neelida (after CHRISTIANSEN & BELLINGER 1981): 33 *Megalothorax* 34 *Neelides* 35 *Neelus*.

Figs. 36 - 37 *Megalothorax aquaticus*: 36 Antenna (after STACH 1957) 37 Mucro (after GISIN 1960).

Figs. 38 - 39 *Megalothorax boneti* (after STACH 1960): 38 Claw and Emp III 39 Mucro.

Fig. 40 *Megalothorax incertus*, distal dens and mucro (after BONET 1947).

Figs. 41 - 43 *Megalothorax massoudi* (after DEHARVENG 1978): 41 Ant III and IV 42 Neosminthuroid setae 43 Dens and mucro from posterior.

Occurrence: Worldwide.

Descriptions of the genus: WILLEM 1900: 7, BONET 1947: 158, STACH 1957: 12, CHRISTIANSEN & BELLINGER 1981: 1046.

Type species: *Megalothorax minimus* Willem, 1900.

### Diagnosis of the Palearctic species

*Megalothorax aquaticus* Stach, 1951 (102)

Total length up to 0.5 mm. Sensory fields with minute sensilla. Sensilla of antennae more slender than in *M. minimus* (Fig. 36). Ant III organ with slender, rodlike sensilla. Ant IV with about 10 long sensilla; the thick sensillum and 1 small papilla lie at the basis of an apical narrowing. Claws with small but distinct teeth 'l', tooth 'Bp' long; Emp with protruding tubercle. Ret with 3+3 teeth. Manubrium with 1+1 setae. Distal part of dens posteriorly with acuminate spines. Edges of mucro broad, thin, and transversely striate (Fig. 37).

Proportions: Length of antennae about 1/2 of head diagonal. Ant I : II : III+IV = 1 : 2 : 6. Dens : mucro = 1.8.

Type locality: Poland, High Tatra Mts., in moist moss at 1750 m altitude.

Occurrence: Also found in France (Central Pyrenees, Massif du Néouvieille, CASSAGNAU 1961: 210), Portugal (Coimbra, GAMA 1961 a: 35), and N Slovakia (High Tatra Mts., RUSEK 1987: 699 and pers. comm.).

Biology: *M. aquaticus* has been found in moist moss on soil, on a wall (GAMA, see above), and in a bog on limestone (RUSEK, see above), in France, the Pyrenees, at 1850 m altitude (CASSAGNAU, see above).

Species description: STACH 1957: 21.

*Megalothorax boneti* Stach, 1960 (548)

Total length 0.3 mm. Claws with small teeth 'l' and 1 minute inner (?) tooth (= 'Bp', Fig. 38); Emp slender, with tubercle slightly protruding. Mucro in distal 1/3 narrow, basal 2/3 of edges weakly serrate (Fig. 39).

Proportions: Length of antennae about 1/3 of head diagonal.

Type locality: Afghanistan, Tagheh Tschinah cave, on excrements.

Occurrence: Known only from the type locality.

Remarks: The single specimen collected was only briefly described by STACH. The description of the claws does not correspond with the figure, which shows a long anterior tooth 'l' (Fig. 65).

*Megalothorax incertus* Börner, 1903 (160)

Syn.: *Neelus swani* Womersley, 1932 a (12)

*Megalothorax remyi* Denis, 1933 (213)

*Megalothorax incertooides* Mills, 1934 (85)

Total length 0.5 mm. Body setae slightly spinelike, shorter than in *M. minimus* but longer than in *Neelus* and *Neelides*; head setae stronger. Ant IV with 1 thick sensillum and 8 long ones. Labral setae 'a' smooth; Emp with more or less protruding tubercle, difficult to decide.

Ret with 3+3 teeth. Manubrium with 2+2 setae. Mucro narrow, without constriction; edges serrate (Fig. 40).

Type locality: Italy, Palermo, Botanical Garden, under flower pots.

Occurrence: Europe (only southern regions?), Iraq (RUSEK 1981: 80), North America (CHRISTIANSEN & BELLINGER, see below), and Australia (GREENSLADE 1994: 116).

Biology: *M. incertus* lives in upper soil layers of vineyards (HÜTHER 1961: 335) and in deeper layers of good soils (PONGE 1980: 170); it is troglophile (MASSOUD & THIBAUD 1973: 153), perhaps xerophile.

Species descriptions: BONET 1947: 169, CHRISTIANSEN & BELLINGER 1981: 1046.

Remarks: Since the teeth of the dentes and the length of the empodial process vary, BONET (1947: 174) and GAMA (1964: 227) assumed *M. incertus* to be synonymous with *M. minimus*.

#### *Megalothorax massoudi* Deharveng, 1978 (401)

Total length 0.65 - 0.8 mm. Body setae rather thick, 4+4 head setae and those near the legs lanceolate. A few small, special setae (secretion of wax) on Th II and III beside the sensory fields. Ant III organ with 2 featherlike and 2 long sensilla. Ant IV with 9 - 11 long sensilla, 1 thick sensillum, and 1 special seta (Fig. 41). Labral setae 'm' thick and smooth, setae 'a' thick and toothed. Claws with short teeth 'l' and long tooth 'Bp'; Emp with protruding tubercle. Ret with 4+4 teeth. Manubrium with 4+4 setae. Mucro narrow, without constriction; edges with 12 teeth each (Fig. 43).

Type locality: France, Aude, Grottes du l'Aguzou.

Occurrence: Known only from the type locality.

#### *Megalothorax minimus* Willem, 1900 (7)

Syn.: *Neelus minimus* Folsom, 1901 (221)

*Megalothorax maculosus* Maynard, 1951 (202), CHRISTIANSEN & BELLINGER 1981: 1047

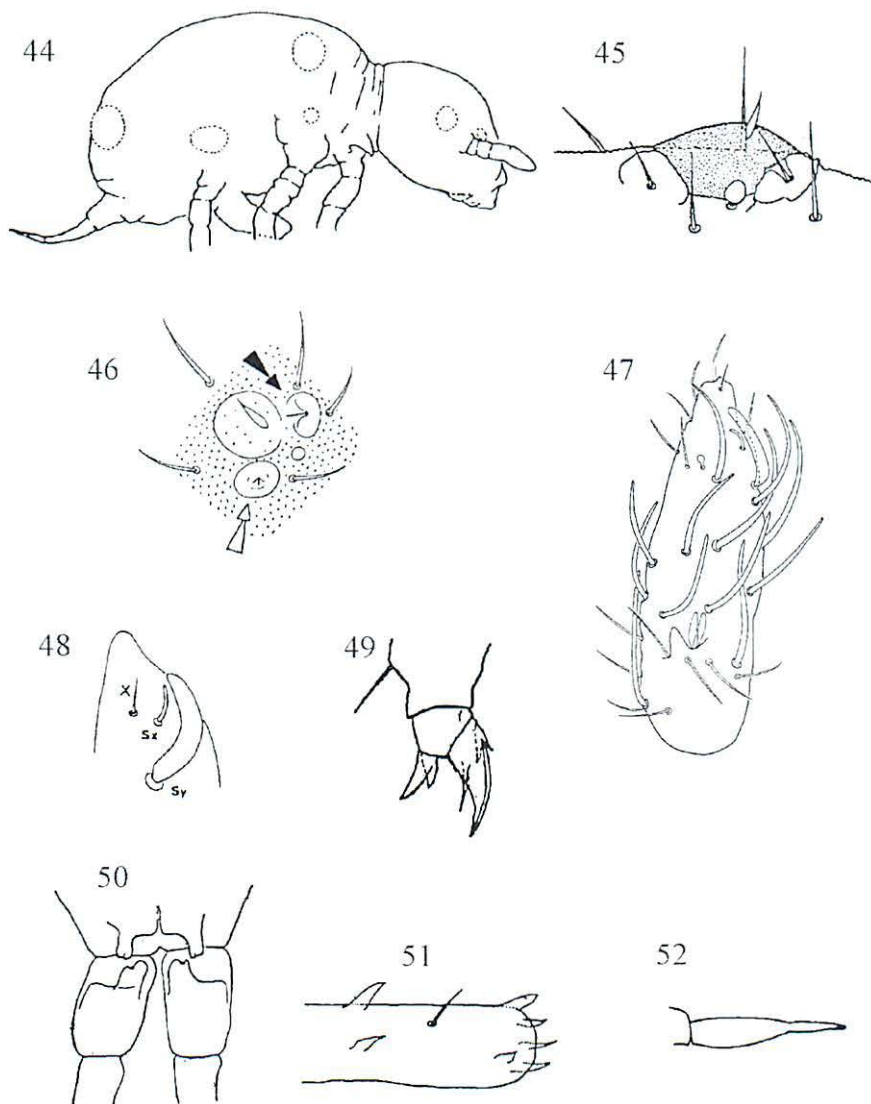
nec *Neelus minimus* Womersley, 1932 a (12) (= *Neelus murinus*, GREENSLADE 1994: 116)

Total length 0.4 mm. Setae of head weakly spinelike, those of trunk short and thin. Ant III organ with 2 relatively large, ovoid, transversely striate and 2 very long sensilla. Ant IV with about 9 long sensilla, 1 thick, and 1 subapical globular sensillum; seta X normal; apical 1/3 of segment narrow (Figs. 47, 48). Labral setae 'm' strong and smooth, setae 'a' varying from smooth to toothed. Claws stout, with short teeth 'l' and long tooth 'Bp'; Emp stout, tubercle protruding (Fig. 49). Ret with 3+3 or 4+4 teeth. Manubrium from 1+1 to 3+3 setae. Distal part of dens posteriorly with 3 spines (Fig. 51). Mucro with distal 2/5 narrow, edges smooth (Fig. 52).

Proportions: Length of antennae about 1/2 of head diagonal. Ant I : II : III+IV = 1 : 2 : 5. Dens : mucro = 1.6.

Type locality: Belgium, Gent, Botanical Garden.

Occurrence: Holarctic and tropics, not confirmed for Australia (GREENSLADE 1994: 116).



Figs. 44 - 52 *Megalothorax minimus*:

44 Habitus and sensory fields (after STEBAEVA 1988) 45 Abdominal sensory field (after BONET 1947) 46 Abdominal sensory field with wax secreting setae (black arrow marks the origin of a thick rod, white arrow of a thin rod) (after VANNIER & MASSOUD 1967) 47 Ant III and IV (after MASSOUD & DELAMARE DEBOUTTEVILLE 1969) 48 Ant IV tip (after DEHARVENG & BERUETE 1993) 49 Claw and Emp III (after BONET 1947) 50 Manubrial joints (after BONET 1947) 51 Dens distal setae (after BONET 1947) 52 Mucro from lateral (after GISIN 1960).



Biology: *M. minimus* lives during the whole year in litter, moss, and upper soil layers, down to 45 cm depth during frost periods (BOCKEMÜHL 1956: 148). It is troglophile (MASSOUD & THIBAUD 1973: 153) and has been found up to 2500 m altitude (France, the Pyrenees, CASSAGNAU 1961: 210). The secretion of waxy rods was described in this species (VANNIER & MASSOUD 1967). Lifespan (200 days), number of instars (25), parthenogenesis (no spermatophores observed), egg laying (in periods lasting several instars), and a spiny egg surface have been observed (BLANCQUAERT & MERTENS 1979, BLANCQUAERT et al. 1981 a, b).

Species descriptions: BONET 1947: 160, STACH 1957: 17, MASSOUD & DELAMARE DEBOUTTEVILLE 1969: 2555, CHRISTIANSEN & BELLINGER 1981: 1047, DEHARVENG & BERUETE 1993: 16.

Remarks: The large area of distribution requires a re-examination of the different populations. The specimens from India (YOSII 1966 b: 390, c. g. PRABHOO 1971: 243) differ from those of Europe in several characteristics.

*Megalothorax tuberculatus* Deharveng & Beruete, 1993 (15)

Total length 0.45 - 0.55 mm. Setae of dorsal head-back slightly thicker than the others. Th II with 1 thick microseta near the leg (Fig. 53). Ant III organ with 2 leaflike and 2 long sensilla. Ant IV with 10 long sensilla, 1 thick sensillum, and subapically with several small phanera; seta X of *M. minimus* as short spine (Fig. 54, simple in French specimens, bilobed in Spanish). Labral setae 'm' smooth, setae 'a' thick with outer teeth. Claws slender with small teeth 'l', long tooth 'Bp', and small tooth 'Ba'; Emp long and slender, tubercle protruding (Fig. 55). Manubrial setae not described. Mucro narrow, without constrictions; edges smooth.

Type locality: France, Pyrénées-Atlantiques, cave of Eaux-Chaudes.

Occurrence: Also found in N Spain (Navarra, Basaburua massif, cave of Arkalde, DEHARVENG & BERUETE, see above).

**Genus *Neelides* Caroli, 1912**

Syn.: *Neelus* Folsom, 1901 (219) ad partem

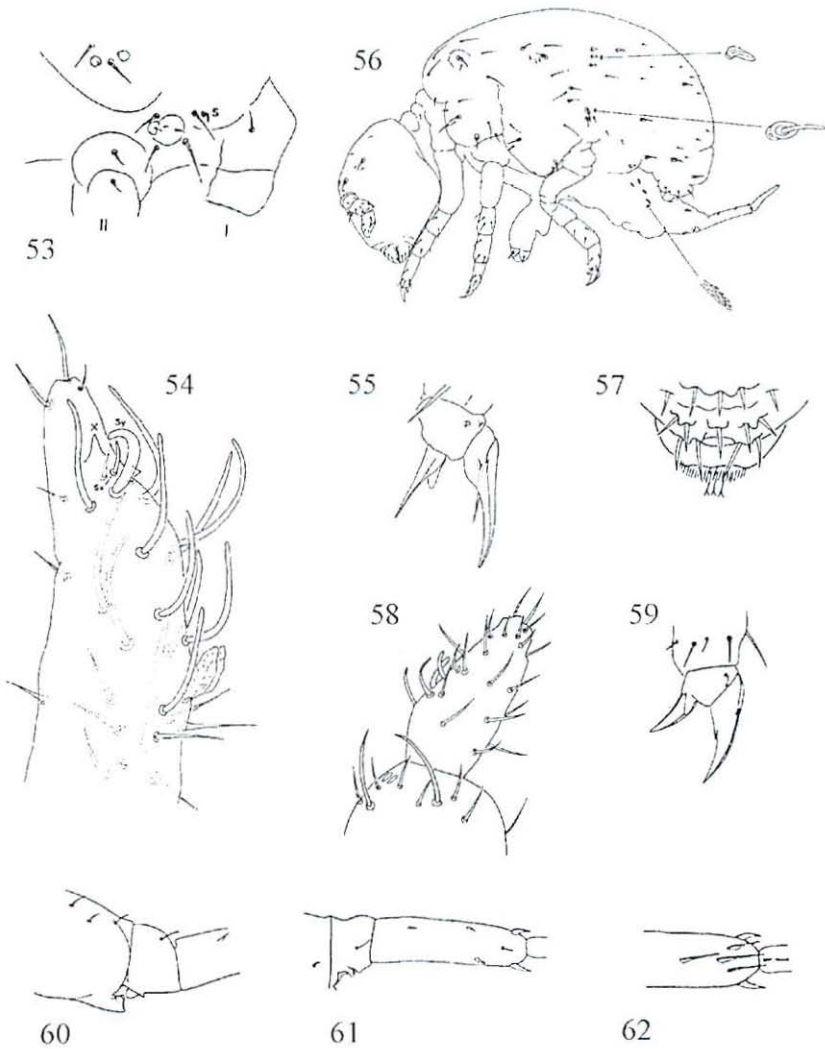
*Neelus* (*Neelides*) Christiansen & Bellinger, 1981 (1050)

**Key to the Palearctic species**

- |   |                                    |                               |
|---|------------------------------------|-------------------------------|
| 1 | Claw III with tooth 'Bp' (Fig. 59) | <i>minutus</i> (Folsom, 1901) |
| – | Claw III without tooth 'Bp'        | <i>folsomi</i> Caroli, 1912   |

**Diagnosis of the genus**

Dorsal setae short, about 2 µm. Sensory fields missing, but several specialized setae present (Fig. 56). Large abdomen laterally with 4 pairs of short, swollen setae. Furca base with 4+4 neosminthuroid setae and 1+1 laterally on manubrium. Labrum with apical fringes and split structures (Fig. 57). Ant IV narrower than Ant III (Fig. 34). Ant III organ with 2 short sensilla and 1 ventral and 1 dorsal long sensillum. Ant IV with only 4 small sensilla (Fig. 58). Claws with teeth 'l' and a varying tooth 'Bp'; Emp with a small posterior tubercle and 3 lamellae (Fig. 59). VT with or without a posterior lobe. Ret with 2+2 teeth. Manubrium with 3+3 setae, manubrial joints with concave tips (Fig. 60).



Figs. 53 - 55 *Megalothorax tuberculatus* (after DEHARVENG & BERUETE 1993):

53 Lateral thorax 54 Ant III and IV 55 Claw and Emp II.

Fig. 56 *Neelides folsomi*, habitus and special setae (after DALLAI 1979).

Figs. 57 - 62 *Neelides minutus*:

57 Labrum (after CHRISTIANSEN & BELLINGER 1981) 58 Ant III and IV (after BONET 1947)

59 Claw and Emp III (after BONET 1947) 60 Manubrial joint (after BONET 1947) 61 Dens

posterior setae (after BONET 1947) 62 Dens anterodistal setae (after BONET 1947).

Proximal part of dens with 1 seta; distal part anteriorly with 1 seta in distal 1/3 and 3 apical setae; distal part posteriorly with 3 outer spines, 1 median seta, and 2 inner spines (Figs. 61, 62). Edges of mucro smooth or serrate.

Occurrence: Holarctic and adjacent subtropics.

Descriptions of the genus: CAROLI 1912: 1, BONET 1947: 145, CHRISTIANSEN & BELLINGER 1981: 1050.

Type species: *Neelides folsomi* Caroli, 1912.

### Diagnosis of the Palearctic species

*Neelides folsomi* Caroli, 1912 (2)

Total length up to 0.4 mm. Claws without tooth 'Bp'. VT with posterior lobe. Edges of mucro with 10 or 11 teeth each (Fig. 56). Other characteristics as described for genus.

Proportions: Ant I : II : III : IV = 1 : 1.5 : 2 : 2.25. Dens : mucro = 1.6.

Type locality: Italy, Naples, Astroni.

Occurrence: Also found in other regions of Italy (Vittorio Veneto and Tuscany, near Siena, DALLAI 1979: 272).

Species descriptions: BONET 1947: 150, DALLAI 1979: 271.

Remarks: After a careful redescription, DALLAI, see above, supposed *N. folsomi* to be a synonym of *N. minutus*. Topotypic specimens of the latter species, however, must still be re-examined. The single specimen from Japan (YOSHII 1965: 45) differed in the ratio of antennal segments (1 : 1.8 : 4 : 4), in the edges of mucro (with 8 - 9 teeth), and in the manubrium (with 4+4 setae).

*Neelides minutus* (Folsom, 1901) (221)

Syn.: *Neelus minutus* Folsom, 1901 (221)

Total length up to 0.64 mm. Claws with tooth 'Bp' (Fig. 59). VT with posterior lobe. Edges of mucro with 10 - 12 teeth each. Other characteristics as described for genus.

Proportions: Dens : mucro = 1.45 - 1.72.

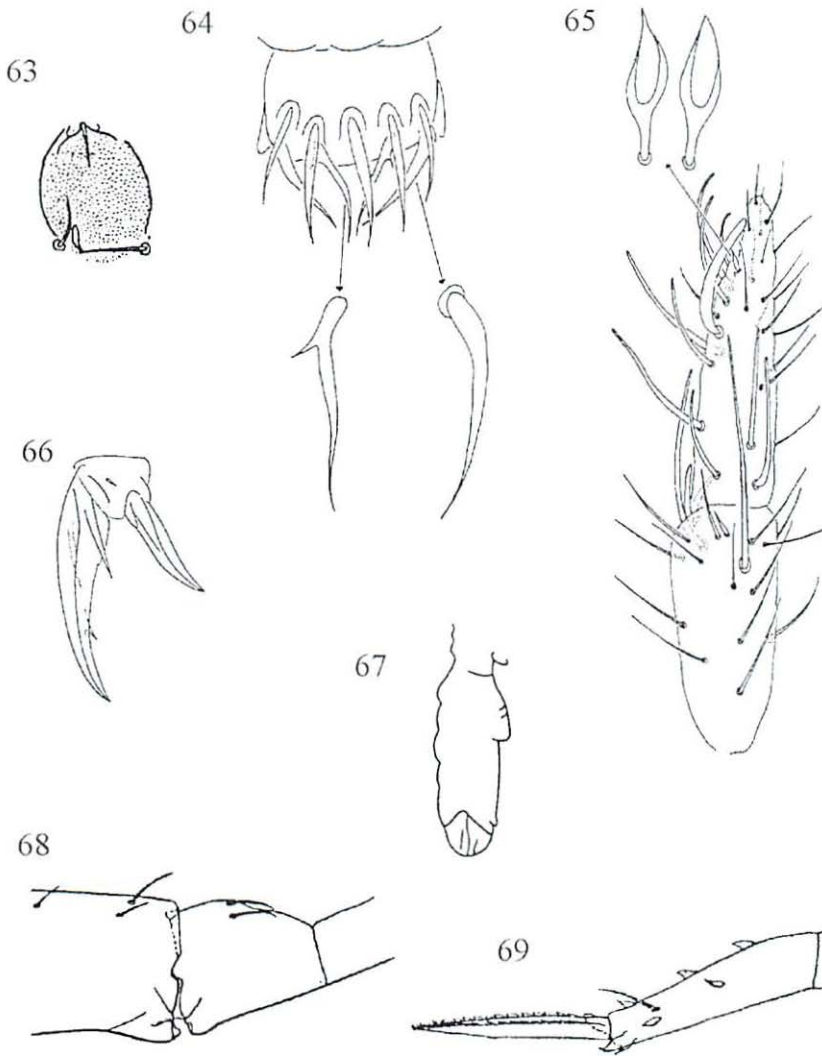
Type locality: USA, Massachusetts, Arlington.

Occurrence: Holarctic, Cape Verde Islands (GAMA 1986: 43), Middle America (BONET, see below), and Hawaii (this or a new species, CHRISTIANSEN & BELLINGER 1992: 328).

Biology: *N. minutus* lives in moist soil, litter, and moss, in Mexico up to 2500 m altitude (BONET 1947: 149), in France, the Pyrenees, up to 1850 m (CASSAGNAU 1961: 210).

Species descriptions: BONET 1947: 146, CHRISTIANSEN & BELLINGER 1981: 1051.

Remarks: Some populations studied by BONET had no tooth 'Bp' on claw III or on all claws. The 5 specimens from Japan (Hokkaido, UCHIDA & TAMURA 1968: 1) differed in length (0.4 mm), VT (without posterior lobe), manubrium (with 1+1 setae), dens (with 2 inner and 4 outer spines), and ratio of dens to mucro (1.3).



Figs. 63 - 69 *Neelus murinus*.

63 Abdominal sensory field (after BONET 1947) 64 Labral setae (after MASSOUD & VANNIER 1967) 65 Ant III and IV (after MASSOUD & VANNIER 1967) 66 Claw and Emp (after MASSOUD & VANNIER 1965) 67 VT with posterior lobe (after GISIN 1960) 68 Manubrial joint and proximal part of dens (after BONET 1947) 69 Distal part of dens and mucro (after BONET 1947).

**Genus *Neelus* Folsom, 1896**

**Key.** Only 1 species: *Neelus murinus* Folsom, 1896 (391)

**Diagnosis of the genus**

Dorsal setae short, about 2  $\mu\text{m}$ . 6 pairs of sensory fields, developed differently (Fig. 44): 1 below and 1 above the antennae, 1 laterally on Th II (being the largest), 1 on subcoxa II, 1 on subcoxa III, and 1 posteriorly on large abdomen (this field with 2 marginal setae, Fig. 63). Neosminthuroid setae not described. Ant III and IV separated, IV longer than III (Fig. 35). Ant III organ with 2 rather long, blunt sensilla, 1 ventral and 1 dorsal long sensillum, and 1 spinelike seta. Ant IV with 1 very thick and 7 to 8 long sensilla, and 1 anterior, flame-shaped seta (Fig. 65). Claws with long, slender teeth 'l', a small tooth 'Bp' in distal 1/3, and a weak incision looking like a second, small inner tooth in basal 1/3; Emp with a small posterior tubercle and 4 lamellae (Fig. 66). VT with posterior lobe (Fig. 67). Ret with 3+3 teeth. Manubrium with 3+3 setae; manubrial joints with convex tips (Fig. 68). Proximal part of dens with 2 setae; distal part anteriorly with 1 medial, subapical seta or small spine and 1+1 strong, apical spines or dental processes; distal part posteriorly with 3 outer spines, 1 median seta, and 2 inner spines (Figs. 68, 69). Edges of mucro serrate.

Occurrence: Holarctic, Asia.

Descriptions of the genus: FOLSOM 1896 a: 391, BONET 1947: 152, STACH 1957: 7, CHRISTIANSEN & BELLINGER 1981: 1054.

Type species: *Neelus murinus* Folsom, 1896.

**Diagnosis of the single species**

*Neelus murinus* Folsom, 1896 (391)

Syn.: *Megalothorax bolivari* Bonet, 1944 (23)

*Neelus minimus* Womersley, 1932 a (12), GREENSLADE 1994: 116

Total length of adults 0.7 mm. Colour yellowish or brownish. Labral setae 'm' strong and smooth, setae 'a' strong and toothed (Fig. 64). Edges of mucro with 15 - 20 teeth each (Fig. 69). Other characteristics as mentioned for genus.

Proportions: Length of antennae : head diagonal = 0.6. Ant I : II : III : IV = 1 : 3.2 : 4.76 : 6.3. Dens : mucro = 1.4 - 1.8.

Type locality: USA, Massachusetts, Cambridge, in a greenhouse among ferns from Jamaica.

Occurrence: Holarctic, Cape Verde Islands (GAMA 1986: 43), Middle America (BONET, see below), India (PRABHOO 1986: 152), Singapore (SALMON 1951: 131), and S Australia (GREENSLADE, see above).

Biology: *N. murinus* lives in moist soil and moss, in Mexico up to 2800 m altitude (BONET 1947: 156), it is troglophile (MASSOUD & THIBAUD 1973: 153).

Species descriptions: BONET 1947: 153, STACH 1957: 8, MASSOUD & VANNIER 1967: 626, CHRISTIANSEN & BELLINGER 1981: 1054.

Remarks: *N. murinus* and its f. *bolivari* Bonet, 1947 (157) differ in the number of manubrial setae: *N. murinus* 4+4, f. *bolivari* 3+3; one cannot decide, however, whether FOLSOM's material really had 4+4 setae because all other specimens studied have 3+3 (MASSOUD & VANNIER 1967: 629). The large area of distribution requires a re-examination of the different populations.

## **Eusymphyleona Bretfeld, 1986**

Syn.: Sminthuridae Lubbock, 1862 (429)

Sminthurinae Handlirsch, 1929 (615)

Symphyleona Massoud, 1971 (198)

### **Diagnosis**

The taxon *Eusymphyleona* Bretfeld, 1986 (309) is a monophylum of the *Symphyleona* Börner, 1901, sensu Bretfeld, 1986 with 1 diagnostic apomorphy:

- abdomen with up to 5 pairs of bothriotrichia (plesiomorphy: without bothriotrichia).

Other diagnostic characteristics: thorax smaller than abdomen; small abdomen separated from large abdomen; epicuticula does not scale off; eyes present; antennae usually longer than head; coxae as long or shorter than trochanters; Ret with setae; dentes of adults not subdivided. These characteristics are plesiomorphic in relation to those of the *Neelida*.

### **Description**

The *Eusymphyleona* contain most species of the *Symphyleona*. Compared with the *Neelida*, the following characteristics must be mentioned.

The head is clearly separated from the large abdomen and always interrupts the body profile. The thorax is smaller than the abdomen, Abd IV being the broadest segment, and the small abdomen protrudes from the large abdomen (Fig. 1). Most taxa have tracheae, which open in a pair of spiracles behind the head (BETSCH 1980: 22). The midgut is smooth. The epicuticula is stable, i. e. it does not scale off. The form of setae varies considerably; bothriotrichia are present, also the ventral setae behind the Ret, and in some taxa there are neosminthuroid setae. Eyes are present, the number of the ommatidia is reduced to 1+1 in some genera. The antennae are usually longer than the head diagonal. The anterior setal row of the clypeus, the prelabral setae of YOSII 1976, has 3+3 setae (Fig. 17, row g). The short coxae bend the legs laterally.

In postembryonic development, 2 to 5 (or more?) juvenile instars precede the adult, males have apparently 1 or 2 juvenile instars less than females. From the few species studied, the characteristics of the different instars can be generalized as follows. 1st instar: without Bothr ABC, Bothr D very long, head apex often with 1 pair of egg-teeth (Fig. 3), Ret with 4+4 teeth but without setae, Tita without secondary setae and oval organs, furca base with few setae, not able to regulate dehydration (BETSCH & VANNIER 1977: 124). 2nd instar: all Bothr present, without egg-teeth, Ret with 3+3 teeth (if the distal teeth are reduced) but without setae, Tita and furca base as in 1st instar. 3rd instar: few Ret setae present, Tita with a first set of secondary setae and oval organs (if at all), furca base as in adults. 4th instar: all Ret setae present, Tita with all secondary setae and oval organs, genital region slightly developed and with fewer setae than in adults. Adults: with genital aperture opened, many genital setae, and secondary sexual characteristics of the taxon, females with App. an. (if at all), males with inner genital ducts. The number of ventral setae increases starting with the 2nd or 3rd instar up to the adult. The adult sets of setae are certainly reached earlier if there are fewer juveniles instars, but secondary setae and those of Ret do not appear in the 1st and 2nd instar. In subadult males, some secondary sexual characteristics may already be weakly differentiated. (Summary by NAYROLLES 1989; some original observations added here.)

### **History**

The complex history of the various taxa is not reported here. Important data of the main subgroups (families) are discussed by BETSCH 1980: 124 ff.

## Sminthuridida Bretfeld, 1986

Syn.: Sminthuridinae Börner, 1906 (163)

Sminthuridini Börner, 1913 (321) sensu Stach, 1956 (8)

Sminthurididae Börner, 1906 sensu Betsch, 1980 (122)

### Diagnosis

The taxon Sminthuridida Bretfeld, 1986 (309) is a monophylum of the Eusymphypleona Bretfeld, 1986 with 3 diagnostic apomorphies:

- Th I included in the large abdomen (plesiomorphy: Th I separated)
- Abd V with 2 pairs of Bothr, DE (plesiomorphy: only pair D)
- Ant II and III sexually dimorphic (plesiomorphy: without dimorphism).

Other diagnostic characteristics (plesiomorphies): female without App. an.; Tita without spatulate setae; VT with short sacs; Ret with 4+4 teeth.

### Description

Most Sminthuridida are small animals; the total length of adults ranging from 0.12 mm up to about 1 mm, the males being smaller than the females. The colour varies from yellowish white to red and dark blue; the dark pigment usually forms longitudinal stripes, but in general the colour is not species specific. Mouth and frontal eye are often dark pigmented.

The large abdomen includes the segments Th I to Abd IV (BETSCH 1980: 14), and generally forms a high arc. Abd V and VI are often fused. A pair of tracheae leads into the head (BETSCH 1980: 22 and orig. observ.). The males, except in *Sphaeridia* and *Yosiides*, have a pair of small vesicles on Th III.

There are 5 pairs of Bothr, ABC on the large abdomen and DE on Abd V (Figs. 139, 140); ABC lie directly behind the thorax and form 4 patterns (BETSCH & WALLER 1989: 18; the pattern of *Sminthuridia* is unknown):

- a rather straight row (*Debouttevillea*)
- an obtuse angle opening anteriorly (genera with a Tita III organ, see below)
- an angle of 90° opening anteriorly (*Denisiella*)
- an obtuse angle opening posteriorly (*Sphaeridia*).

BETSCH & WALLER (1989: 26) also show that Bothr E is here modified from another seta than in the Bourletiellida. There are no App. an. and no neosminthuroid setae. Each eye-patch usually has 6 normal ommatidia and 2 smaller ones (C, D); the latter may be completely reduced. In females, Ant IV is entire, annulate, or subdivided in up to 7 - 8 subsegments. In males, Ant IV is seldom subdivided but Ant II and III are transformed to clasp the antennae of the females in courtship behaviour; the fine structure of these segments is taxonomically important, the nomenclature of the processes and setae follows MASSOUD & BETSCH 1970, 1972, and BETSCH 1980: 91 (Figs. 74, 76; in other figures the nomenclature is consequently changed if necessary, so that b1 is the most proximal process of the b-group and b2 - b6 are named from proximal to distal and from anterior to posterior).

The legs have no spatulate setae. In most genera, the posterior side of Tita III bears a so called tibiotarsal organ consisting of 3 modified setae (Fig. 83). This is an apomorphic organ, the fine structure of which varies, thus generally it is not species specific. The short sacs of the VT are smooth or have differently formed papillae. Ret has 4+4 teeth.

The dentes have only a few or a more or less increased number of setae, in the Palaearctic the genus *Sphaeridia* and the species *Sminthurides aquaticus* - *S. penicillifer* are the respective extremes. The chaetotaxy of the dentes is not sufficiently described in most species, therefore some original observations of setal numbers are added in the species descriptions. Both posterior edges of the mucro are sometimes broad and crenulate, which is regarded as an adaptation to life on water surfaces (as may also be true for the increased number of dental setae); in some species these edges are narrow or do not extend to the tip of mucro. The mucronal seta is usually present.

Near the genital opening of the females lie receptacula seminis or accessory reproductive glands and ducts, which are species specific but difficult to observe (MURPHY 1966: 69).

### Biology

The Sminthuridida live in moist or wet habitats, in and on the soil, on plants near or on the surface of fresh waters, and in intertidal zones of tropical and temperate regions. The courtship behaviour was observed in a few *Sminthurides* species and in *Sphaeridia pumilis* (see below): the male clasps the antennae of a preadult female with his Ant II and III; he is carried by the female for some days, and does not let her go until he deposits the spermatophore. It is unknown whether the other genera behave in the same manner; though, concluding from the morphology of the male antennae, the main procedure may be similar.

### Key to the genera of the world

#### Sminthuridida Bretfeld, 1986

- |   |  |   |
|---|--|---|
| 1 | Tita III organ absent  | 2   |
| – | Tita III organ present   | 4   |
| 2 | Mucro without seta   | <i>Sphaeridia</i> Linnaniemi, 1912 (p. 49)<br>type species: <i>Sminthurus pumilis</i> Krausbauer, 1898; Germany               |
| – | Mucro with seta  | 3   |
| 3 | Mucro narrow   | <i>Denisiella</i> Folsom & Mills, 1938<br>type species: <i>Sminthurides seurati</i> Denis, 1925; Polynesia, Tuamotu Islands   |
| – | Mucro almost as broad as long  | <i>Debouttevillea</i> Murphy, 1965<br>type species: <i>Debouttevillea marina</i> Murphy, 1965; Singapore                      |
| 4 | (1) Head and mouthparts of normal form, ventral head-back with only normal setae | 5   |
| – | Head and mouthparts elongate; ventral head-back with 1 pair of spines            | <i>Sinnamarides</i> Betsch & Waller, 1991<br>type species: <i>Sinnamarides delamarei</i> Betsch & Waller, 1991; French Guiana |
| 5 | Male   | 6   |
| – | Female   | 10  |



- 6 Ant II and III simply modified (1 spine each, Ant II also with 2 minute processes); inner edge of mucro broad and serrate *Sminthuridia* Massoud & Betsch, 1972  
type species: *Sminthurides sphaeridioides* Murphy, 1960; Gambia
- = Ant II and III more complicated (1 spine and several minute processes each); mucro strong, not tapering *Yosiides* Massoud & Betsch, 1972  
type species: *Sminthurides himachal* Yosii, 1966; Nepal
- Ant II and III highly complicated (several large spines and other modified setae each, Figs. 71, 76) 7
- 7 Abd V with 1 pair of large processes *Pygicornides* Betsch, 1969  
type species: *Pygicornides torridus* Betsch, 1969; Australia
- Abd V without large processes 8
- 8 Posterior large abdomen with 6 - 8 pairs of long setae standing close together (Fig. 140) *Stenacidia* Börner, 1906 (p. 59)  
type species: *Sminthurus violaceus* Reuter, 1881; Finland
- Posterior large abdomen without such setae 9
- 9 Mucro narrow, all edges as long as mucro, inner edge serrate (Fig. 72); Ant III with c1 setalike, c2 missing (Fig. 71) *Boernerides* n. gen. (p. 32)  
type species: *Sminthurides hystrix* Börner, 1903; Italy
- Mucro broader, at least 1 edge wavy or serrate, edges sometimes shorter than mucro; Ant III with c1 thick and blunt, c2 present (Figs. 74, 76) *Sminthurides* Börner, 1900 (p. 34)  
type species: *Sminthurus aquaticus* Bourlet, 1842; France
- 10 (5) Ant IV undivided 11
- Ant IV with subsegments 13
- 11 Ant III with 2, Ant IV with 3 long, blunt setae; mucro narrow with small teeth (Figs. 142, 143a) *Stenacidia* Börner, 1906 (p. 59)  
type species: *Sminthurus violaceus* Reuter, 1881; Finland
- Ant III and IV without such setae 12
- 12 Head and large abdomen with only short setae *Sminthurides* Börner, 1900 ad part. (p. 34)  
type species: *Sminthurus aquaticus* Bourlet, 1842; France
- Head and large abdomen with long, rough setae (Fig. 70) *Boernerides* n. gen. (p. 32)  
type species: *Sminthurides hystrix* Börner, 1903; Italy
- 13 (10) Ant IV with 6 subsegments without intermediate annuli 14
- Ant IV with 4 - 7 subsegments, if 6 subsegments, there are intermediate annuli (see Fig. 77) 15

- 14 Abd V laterally with 1 pair of stout spines; mucro basally with 4 edges  
*Pygicornides* Betsch, 1969  
 type species: *Pygicornides torridus* Betsch, 1969; Australia
- Abd V without spines; mucro with 3 edges *Sminthuridia* Massoud & Betsch, 1972  
 type species: *Sminthurides sphaeridioides* Murphy, 1960; Gambia
- 15 Claw III with many large, lateral teeth *Yosiides* Massoud & Betsch, 1972  
 type species: *Sminthurides himachal* Yosii, 1966; Nepal
- Claw III without lateral teeth or with few small ones  
*Sminthurides* Börner, 1900 ad part. (p. 34)  
 type species: *Sminthurus aquaticus* Bourlet, 1842; France

### Diagnosis of the Palaearctic genera and species

#### Genus *Boernerides* n. gen.

Syn.: *Stenacidia* Börner, 1906 (182) ad partem

Key. Only 1 species: *Boernerides hystrix* (Börner, 1903) (161)

#### Diagnosis of the genus

Th III in males with a pair of vesicles. Bothr ABC form an obtuse angle opening anteriorly. Ant II and III in males highly modified: Ant II with 1 Bothr but without seta B1, b1 - b6 present but b2 and b3 as short, stout, pointed spines (orig. observ., leg. BLASCO), b5 as a cuticular process without seta; Ant III with c1 long, thick, setalike, c2 missing (Fig. 71). Ant IV undivided in both sexes. Tita III organ present. Dens with relatively few setae: 3+1 inner (J1 - 3 spinelike), 5+1 outer (E1 - 4 or 5 spinelike), formula of anterior setae 3,2...1,1, and about 15 posterior setae. Mucro in both sexes narrow, inner edge serrate, outer with only 2 teeth; seta missing (Fig. 72).

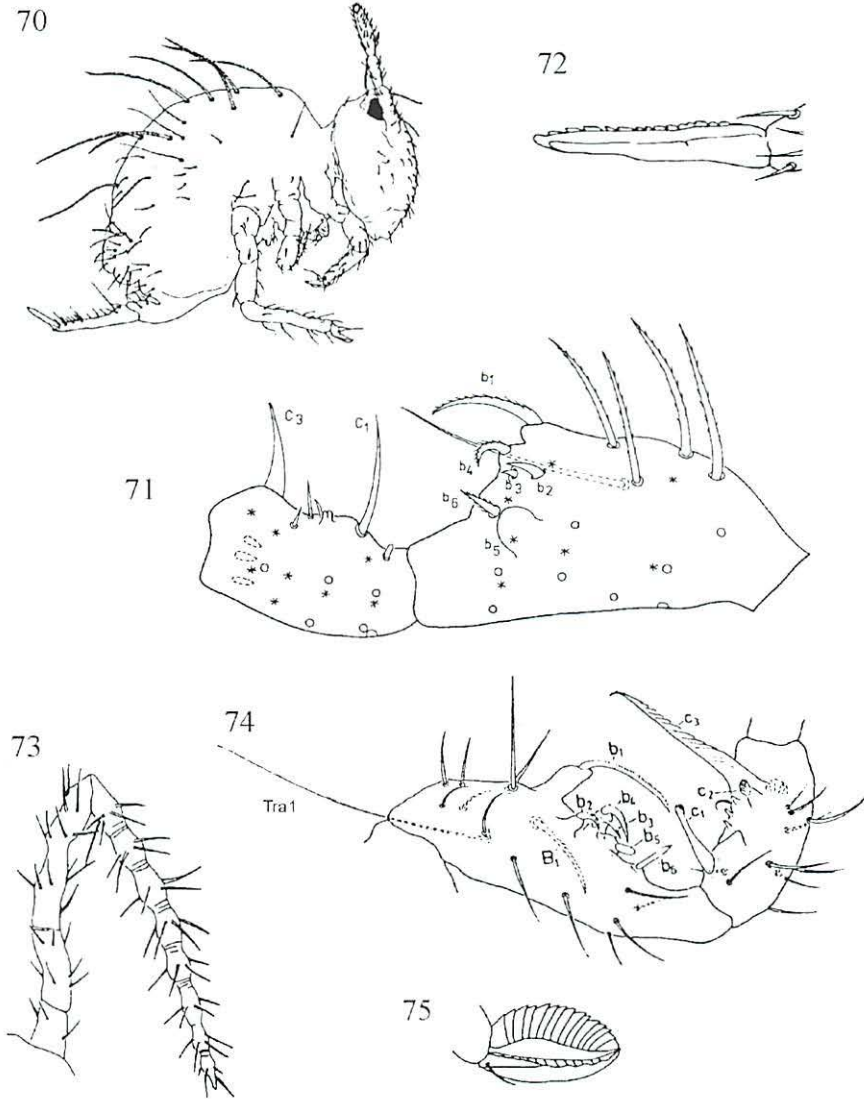
Type species: *Sminthurides hystrix* Börner, 1903.

Derivatio nominis: This new genus is named in honour of CARL J. B. BÖRNER, 28. V. 1880 - 14. VI. 1953, the important German entomologist (see SACHTLEBEN & BÖRNER 1954, SPEYER & BÖRNER 1958).

Occurrence: Mediterranean and the Canary Islands.

Description of the genus: DALLAI 1973: 556 (as *Stenacidia*).

Remarks: *Boernerides* n. gen. must be created since the genus *Stenacidia* has been newly defined in this paper replacing the genus *Jeannenotia* (see below); the main genus specific characteristic, the male antenna, differs considerably between *Boernerides* n. gen. and *Stenacidia* n. comb., thus justifying this separation (Figs. 71, 141).



Figs. 70 - 72 *Boernerides hystrix*:

70 Female habitus (after DALLAI 1973) 71 Male Ant II and III from anterior (orig.) 72 Mucro from outer side (after DALLAI 1973).

Fig. 73 *Sminthurides annulicornis*, female antenna (after LINNANIEMI 1912, CHRISTIANSEN & BELLINGER 1981).

Figs. 74 - 75 *Sminthurides aquaticus*:

74 Male Ant II and III from anterior, Tra1 is a Bothr, B1 and b1-6 are processes and ciliate setae, c1-3 are processes and spinelike setae (after MASSOUD & BETSCH 1972) 75 Mucro (after GISIN 1960).

### Dignosis of the single species

*Boernerides hystrix* (Börner, 1903) (161) sensu Dallai, 1973 (546)

Syn.: *Sminthurides hystrix* Börner, 1903 (161)

*Sminthurides (Stenacidia) hystrix* Folsom & Mills, 1938 (263)

*Stenacidia hystrix* Gama, 1959 b (27); Dallai, 1973 (546)

Total length 0.8 mm in females, 0.6 mm in males. Colour bluish violet to violet with small unpigmented spots. Head and large abdomen dorsally with long, rough setae (Fig. 70). 8+8 ommatidia, C and D small. Male Ant II and III as described for genus (Fig. 71). Claws with tunica, inner tooth, short posterior pseudonychium in males or 2 anterolateral teeth in females, and small basal outer teeth; Emp about 1/2 as long as claws, filaments thick, straight, length > claws. Sacs of VT smooth. Ret with 1 seta. Dens and mucro as described for genus.

Proportions: Length of antennae : head diagonal = 2.3 in females, 2.6 in males. Ant I : II : III : IV = 1 : 1.2 : 1.2 : 2.0 in females, 1.4 : 1.9 : 1 : 2.1 in males. Dens : mucro = 2.1 in both sexes.

Type locality: Italy, Palermo, Botanical Garden, under flower pots.

Occurrence: Mediterranean and Spain, the Canary Islands (Tenerife, orig. observ., leg. FJELLBERG); in the Mediterranean known from Italy (isles of Eoli and Rome, DALLAI, see above), continental Spain (Madrid, SELGA 1971: 248; Zaragoza, Pina de Ebro, orig. observ., leg. BLASCO), Portugal (near Coimbra, GAMA 1959 b: 27, re-exam., and DA GAMA ASSALINO pers. comm.), and Algeria (Bou Malek, orig. observ., leg. MERTENS).

Biology: *B. hystrix* apparently lives on shady soil surfaces and (orig. observ.) in litter and wet moss up to 700 m altitude (Tenerife). The mating behaviour is unknown.

### Genus *Sminthurides* Börner, 1900

Syn.: *Prosmnthurus* Willem, 1900 (55)

*Spinosecellina* Palissa, 1961 (354) ad partem

### Key to the Palaearctic species

1	Female	2
–	Male	16
2	Filament of Emp III split into branches	3
–	All empodial filaments entire	4
3	Filament of Emp III with 2 - 3 (seldom 4) branches (Fig. 78)	<i>bifidus</i> Mills, 1934
–	Filament of Emp III with 4 - 6 branches (Fig. 103)	<i>penicillifer</i> (Schäffer, 1896)
4	Ant IV undivided or with annulations	5
–	Ant IV with 4 or 5 distinct subsegments	9
5	Ant IV thin, with about 7 distinct annulations (Fig. 73); ratio of whole antenna to head diagonal = 1.5	<i>annulicornis</i> Axelson, 1905
–	Ant IV of other form; ratio of whole antenna to head smaller	6

- 6 Whole antenna shorter than head diagonal; large abdomen with dark crosslike pattern (Figs. 86a, b) *cruciatus* Axelson, 1905
- Whole antenna as long as or longer than head diagonal 7
- 7 Mucro at least 1/2 as wide as long *aquaticus* (Bourlet, 1842)
- Mucro only 1/3 as wide as long 8
- 8 VT with smooth, conical sacs; Ret with 2 - 3 setae, corpus entire *malmgreni* (Tullberg, 1876)
- Sacs of VT with short, feathered papillae (Fig. 95); Ret with 2 setae, corpus longitudinally split into 2 parts *monnioti* Massoud & Betsch, 1966
- 9 (4) Ant IV with 4 distinct subsegments (weak supplement annulation may occur) 10
- Ant IV with 5 distinct subsegments 14
- 10 Basal subsegment of Ant IV as long as the distal 11
- Basal subsegment of Ant IV 2 - 3 times longer than the distal 12
- 11 Mucro tapering (seen from lateral) but outer edge distally broadened (Figs. 121, 122) *signatus* (Krausbauer, 1898)
- Mucro gutterlike *shoetti* Axelson, 1903
- 12 Anterior edge of mucro narrow, entire *pseudassimilis* Stach, 1956
- Anterior and posterior edges of mucro broad, crenulate and serrate 13
- 13 Sacs of VT with round tubercles; Tita III organ winged with 1 or 2 teeth *biwae* Yosii, 1970
- Sacs of VT with elongate tubercles; Tita III organ winged without teeth *potamobius* Yosii, 1970
- 14 (9) Mucro pointed, edges not extending to tip of mucro 15
- Outer edge of mucro not tapering, inner edge serrate and pointed, both forming a broad trough, all edges extending to tip of mucro (Figs. 99, 100) *parvulus* (Krausbauer, 1898)
- 15 Ant IV without intermediate annulations (Fig. 89) *inaequalis* Börner, 1903
- Ant IV with intermediate annulations (Fig. 115) *sexoculatus* Betsch & Massoud, 1970
- 16 (1) Ant II with 2 posterior Bothr 17
- Ant II with 1 posterior Bothr and mostly 1 posterior ciliated seta BI 18
- 17 Shaft of mucro of irregular width (Fig. 104); seta of Tita III organ winged and furcate *penicillifer* (Schäffer, 1896)
- Shaft of mucro broad, often with spinelike outer projection (Fig. 79); seta of Tita III organ not winged but thick and furcate *bifidus* Mills, 1934
- 18 Ant IV undivided 19
- Ant IV with constrictions or 4 subsegments *pseudassimilis* Stach, 1956
- 19 Apex of mucro, seen from lateral, broad, not pointed 20
- Apex of mucro, seen from lateral, pointed 21

- 20 Apex of mucro narrow, inner edge serrate except smooth distal 1/4, anterior edge extending to 3/4 of mucro (Fig. 113) *schoetti* Axelson, 1903
- Apex of mucro broad, trough-shaped, all edges extending to tip of mucro (Figs. 99, 100) *parvulus* (Krausbauer, 1898)
- 21 Ant II with long seta b1 and 3 or 4 short setae b 22
- Ant II with long seta b1 and 5 short setae b 28
- 22 Ant III with 2 long processes between c1 and c2 (Fig. 88) *inaequalis* Börner, 1903
- Ant III with only short to minute processes between c1 and c2 23
- 23 Ant II with only 3 short setae b (Fig. 105) *potamobius* Yosii, 1970
- Ant II with 4 short setae b 24
- 24 Ant II seta b2 near b1 and isolated from setae b3 and b4 (Fig. 91) *malmgreni* (Tullberg, 1876)
- Ant II seta b2 near setae b3 and b4 25
- 25 Large abdomen light with dark crosslike pattern (Figs. 86a, b) *cruciatu*s Axelson, 1905
- Large abdomen without such pattern 26
- 26 Mucro narrow, tapering (seen from lateral) or trough-shaped (seen from posterior) (Figs. 121, 122) *signatus* (Krausbauer, 1898)
- Anterior and posterior edges of mucro lamellate and wavy 27
- 27 Mucro broad, seta about 1/2 as long as mucro (Fig. 85) *biwae* Yosii, 1970
- Mucro narrow, seta shorter (Fig. 96) *monnioti* Massoud & Betsch, 1966
- 28 (21) Ant II seta b5 short, straight; Ant III with minute processes near c2 (Fig. 74) *aquaticus* (Bourlet, 1842)
- Ant II seta b2 short, straight; Ant III with 2 long, blunt processes between c1 and c2 (Fig. 114) *sexoculatus* Betsch & Massoud, 1970

Remarks: Not included in this key are:

- *Sminthurides alpinus* Cassagnau, 1960 (= *S. parvulus*)
- *Sminthurides assimilis* (Krausbauer, 1898) (= *S. signatus*)
- *Sminthurides pauliani* Denis, 1936 (= *S. penicillifer*)
- *Sminthurides spinifer* Gama, 1964 (= *Sphaeridia spinifer*).

In the male part, *Sminthurides annulicornis* is not mentioned since the male is unknown.

### Diagnosis of the genus

Total length 0.3 - 1 mm in females, 0.18 - 0.5 mm in males. Background colour white to yellow or grey, often with violet or blue pigment in varying patterns, mostly in a horizontal band on large abdomen. Body setae short, stiff, not spinelike. Th III in males with 1 pair of vesicles. Bothr ABC form an obtuse angle opening anteriorly. Ant II and III in males highly modified and species specific: Ant II with 2 or 1 Bothr and 0 or 1 ciliate seta B1 respectively on posterior side, with thick, smooth or ciliate setae on processes b1 - b6 (of which one or more may be missing); Ant III with several small elements and 3 main spines: c1 long with tip ciliate or broadened; c2 short; c3 long, thick, and acuminate.

Ant IV in females undivided, annulate, or subdivided in up to 7 - 8 subsegments, in males usually undivided. Tita III organ present. Claws I and II longer and more slender than claw III; all may have small inner, outer, and lateral teeth, but seldom a tunica. Emp I and II also more slender than Emp III, length of filaments usually > claws. Dens often with increased setal numbers in additional rows. Mucro narrow or broad, pointed or with a hoodlike tip, at least 1 posterior edge more or less crenulate or serrate; seta present in most species.

Occurrence: Worldwide.

Biology: In all species studied, the maximum lifespan is 30 - 50 days (BLANCQUAERT & MERTENS 1979: 128), and the female can only be fertilized once during her life (BLANCQUAERT et al. 1981 b: 387).

Descriptions of the genus: BÖRNER 1900: 616, STACH 1956: 12, MASSOUD & BETSCH 1972: 72, BETSCH 1980: 128, CHRISTIANSEN & BELLINGER 1981: 1072.

Type species: *Sminthurus aquaticus* Bourlet, 1842.

Remarks: The males are not as well known as the females, perhaps because they are not so abundant, or because they are so small. In most species, therefore, the structure of the male antenna must still be described exactly.

### Diagnosis of the palaeartic species

*Sminthurides annulicornis* Axelson, 1905 (793)

Only 1 female described. Total length 0.6 mm. Colour of body and extremities dark blue, ventral side paler. 8+8 (?) ommatidia. Ant IV thin with 7 subsegments (Fig. 73). Claws with inner tooth and 1 pair of lateral teeth. Sacs of VT smooth. Ret not described. Dens with many setae, but not exactly described. Mucro broad, width 1/2 of length; inner edge crenulate with 12 teeth, outer and anterior edges slightly crenulate; seta probably present.

Proportions: Length of antennae : head diagonal = 1.5, Ant I : II : III : IV = 1 : 1.8 : 4.5 : 7.5. Dens : mucro = 3.

Type locality: Finland, Sortavala, shore of a lake.

Occurrence: Also found in NW Poland (S of Stettin/Szczecin, orig. observ., leg. GRIEGEL).

Biology: *S. annulicornis* has formerly been collected from the water surface of a lake and recently from an inundated meadow.

Species description: LINNANIEMI 1912: 261.

Remarks: The new specimens of *S. annulicornis* (1 female, 3 males, 1 juvenile) will be separately described (BRETFFELD & GRIEGEL, in preparation).

The single female reported from Canada (FOLSOM & MILLS 1938: 258) has a papillate VT and may represent a different species (CHRISTIANSEN & BELLINGER 1981: 1074).

*Sminthurides aquaticus* (Bourlet, 1842) (XLI)

Syn.: *Smynthurus aquaticus* Bourlet, 1842 (XLI)

*Sminthurus apicalis* Reuter, 1883 (20)

*Sminthurus amicus* Folsom, 1896 (447)

*Sminthurus (Sminthurides) aquaticus* Börner, 1900 (616)

*Prosmynthurus aquaticus* Willem, 1900 (55)

Total length 1 mm in females, 0.5 mm in males. Background colour greenish yellow, grey, or brownish with more or less violet pigment on large abdomen. 8+8 ommatidia, C and D small. In males, Ant II with Bothr and B1, b1 - b6, with b5 small and straight, and with 1 straight spine posterior to b6 (not figured in Fig. 74); Ant III with c2 near c3 and few minute elements near c2 (Fig. 74). Ant IV in females with indistinct annulations (in subadults entire). Claws I and II with inner tooth, lateral teeth vary; claw III with posterior lateral teeth. Sacs of VT smooth. Ret with 3 - 4 setae. Dens with numerous setae: 9 inner (distally in 2 rows), about 20 outer (distally in 2 rows), about 25 anterior, and about 40 posterior setae. Mucro broad, width 0.6 of length; inner and outer edges crenulate, inner with 13 - 15 teeth, outer not extending to tip, anterior edge entire and narrow; seta present (Fig. 75).

Proportions: Length of antennae : head diagonal = 1.25 in females. Ant I : II : III : IV = 1 : 1.1 : 2.3 : 3.4 in females. Dens : mucro = 2.4 (only in females?).

Type locality: France.

Occurrence: Holarctic (and Australia? GREENSLADE 1994: 130).

Biology: *S. aquaticus* is widespread and abundant on and near fresh waters and its plants from North Africa to the High Arctic of Canada (FJELLBERG 1986: 2386). It also occurs in the intertidal zone of marine shores (STRENGKE 1955: 49) and up to 1900 m altitude (Austria, FRANZ & SERTL-BUTSCHEK 1954: 634). Well known are: the general biology (FALKENHAN 1932), the general embryonal and postembryonal developments (BLANCQUAERT et al. 1981 a, b), the monogenie (ANDERS & ANDERS 1959), the courtship behaviour and sperm transfer (MAYER 1957: 512, BLANCQUAERT 1981: 3), and the ultra-microscopic eye structure and binocular vision (PAULUS 1972: 31). EISENBEIS (1989 a, b) reported on the body mass (0.05 - 0.14 mg) and the body surface in relation to climate.

Species descriptions: STACH 1956: 22, CHRISTIANSEN & BELLINGER 1981: 1075, FJELLBERG 1984: 87 (maxillary outer lobe).

Remarks: Colour varieties of this species have been given separate names (SCHÖTT 1893: 37, LINNANIEMI 1912: 259, STACH 1956: 26):

var. *viridula* Reuter, 1892 with dark longitudinal band on dorsal large abdomen.

var. *levanderi* Reuter, 1892 with general light or dark violet pigment.

*Sminthurides bifidus* Mills, 1934 (90)

Syn.: *Sminthurides penicillifer* var. *bifidus* Mills, 1934 (90)

Total length 0.8 mm in females, 0.5 mm in males. Background colour yellow with more or less blue pigment, occasionally in dark longitudinal stripes; ventral side pale. 8+8 ommatidia, C and D small. In males, Ant II with 2 Bothr, b1 - b5, with b2 small, b2 - b4 next to each other; Ant III with tip of c1 broad and flat, c2 near c3 (Fig. 76). Ant IV in females with 7 - 8 subsegments and intermediate annulations (Fig. 77). Seta of Tita III organ thick, bifurcate, not winged (Fig. 78).



Claws I and II with uncertain inner tooth, claw III with outer and lateral teeth and serrate posterior pseudonychium; Emp I and II lanceolate or with basal tooth, Emp III in males pointed, in females split into 2 - 3, seldom 4, branches (Fig. 78). Sacs of VT smooth. Ret with 3 setae. Dens with numerous setae: about 10 inner (the distal 7 long), about 19 outer (distally in 2 rows), 23 anterior, and about 42 posterior setae. Mucro broad, width 1/2 of length; shaft broad, in males of Nearctic populations with outer spinelike projection, inner and outer edges wavy, with 11 - 16 teeth each, anterior edge smooth; seta present (Fig. 79).

Proportions: Length of antennae : head diagonal = 1.3 in females, 1.7 in males. Ant I : II : III : IV = 1 : 1.3 : 2.6 : 4.6 in females, 1.5 : 1.8 : 1 : 2.1 in males. Dens : mucro = 2.5 (in females?).

Type locality: USA, Iowa.

Occurrence: USA and Canada (CHRISTIANSEN & BELLINGER, see below), Korea (YOSII & LEE, 1963: 9), and Germany (Saxony, Görlitz, see below).

Biology: *S. bifidus* occurs on the water surface and in other wet habitats. In Germany it was found on the surface of an aquarium, apparently introduced with plants or fishes (DUNGER & FRITZLAR, see below).

Species descriptions: FOLSOM & MILLS 1938: 250, CHRISTIANSEN & BELLINGER 1981: 1078, DUNGER & FRITZLAR 1986: 47.

Remarks: *S. bifidus* resembles *S. penicillifer* in the structure of female Emp III, in the male antennae (see below), and in the broad shaft of mucro. Since the German population did not show the spinelike projection of the male mucro, and since the Tita III organ generally varies, there is a close similarity to *S. penicillifer*. Therefore, the subspecies status of this taxon seems to be correct.

#### *Sminthurides biwae* Yosii, 1970 (12)

Total length 0.5 mm in females, 0.3 mm in males. Colour pale violet, dorsally darker. Eyes not described. In males, Ant II with Bothr and B1, b1 - b5, with b2 - b4 next to each other; Ant III with 3 small elements near c2 (Figs. 80, 81). Ant IV in females with 4 subsegments, length of basal one = 1/2 Ant IV (Fig. 82). Seta of Tita III organ winged with 1 or 2 teeth (Fig. 83). All claws slender, without inner tooth, claw I with basal lateral teeth. Sacs of VT in females with 4+4 round tubercles (Fig. 84), in males smooth. Ret with 3 setae. Dens with relatively few setae: about 6 inner, 11 outer, formula of anterior setae 2.3.3.2.1.1.1.1, and about 15 posterior setae. Mucro broad, all edges wavy with about 10 teeth each; seta present, long (Fig. 85).

Proportions (measured in females): Length of antennae : head diagonal = 1.4. Ant I : II : III : IV = 1 : 1.3 : 2.6 : 4.3. Subsegments of Ant IV = 3 : 1 : 1 : 1. Dens : mucro = 2.3.

Type locality: Japan, Fujigasaki, shore of Lake Biwa.

Occurrence: Known only from the type locality.

#### *Sminthurides cruciatus* Axelson, 1905 (792) sensu Stach, 1956 (33)

Total length 0.5 mm in females, 0.25 mm in males. Background colour whitish yellow, ventral side dark violet, large abdomen with dark violet crosslike figure (Figs. 86a, b). 8+8 ommatidia, C and D small. In males, Ant II with Bothr and B1, b1 - b5, with b2 - b4 next to each other; Ant III with small element near c2 (Fig. 87). In females, antennae shorter than head diagonal; Ant II as short as Ant I and with 2 long dorsal setae; Ant IV undivided and not annulated. Claws with or without inner tooth and lateral teeth. Sacs of VT with small papillae.

Ret with 2 setae. Dens with many setae, but not exactly described. Mucro moderately broad, width 1/3 of length; inner and outer edges crenulate, inner with 8 - 10 teeth, outer smooth; anterior edge smooth, not extending to tip; seta present.

Proportions: Length of antennae : head diagonal = 0.8 in females. Ant I : II : III : IV = 1 : 1 : 1.5 : 3.2 in females, 1.5 : 1.2 : 1 : 1.6 in males. Dens : mucro = 2.5.

Type locality: Finland, Österbotten and Lagoda-Karelia, the latter now in Russia.

Occurrence: Temperate regions of Europe; known from England (GOTO & LAWRENCE 1964: 10), N Sweden, other sites of Finland and NW Russia (LINNANIEMI, see below), Lithuania (SUKAZKIENJE 1970: 104), Poland and Ukraine (STACH, see below), Slovakia (PACLT 1959: 343), and Austria (CHRISTIAN 1987: 53).

Biology: *S. cruciatus* is rare and lives near open waters up to 1420 m altitude (Austria, FRANZ & SERTL-BUTSCHEK 1954: 634).

Species descriptions: LINNANIEMI 1912: 257, STACH 1956: 33 (male).

Remarks: Some orig. observ. from the types are added. The specimens described by IONESCU (1915: 495) from Romania seem to belong to *Sminthurides malmgreni* as Ant I and II of the female differ in length.

*Sminthurides inaequalis* Börner, 1903 sensu Dallai, 1973 (540)

Total length 0.6 mm in females, 0.4 mm in males. Colour bluish violet, ventral side paler. 6+6 ommatidia, C and D missing. In males, Ant II with Bothr and B1, b1 - b5, with spine-like seta on anterior side (= b2 of *S. sexoculatus*?) and short spine posterior to b5 (orig. observ., not visible in Fig. 88); Ant III with c2 near c3 and 2 long processes between c1 and c2 (Fig. 88). Ant IV in females with 5 subsegments without intermediate annulations, the basal subsegment being the longest (Fig. 89). Claws with inner tooth, several short, basal teeth, and sometimes with tunica. Sacs of VT smooth. Ret with 3 setae. Dens with relatively few setae: about 5 spinelike inner, about 6 outer, formula of anterior setae about 2,3,3,2,1,1,1, about 20 posterior setae. Mucro moderately broad but distally narrow, i. e. all edges shorter than the whole length; inner edge with about 8 rough teeth, outer edge smooth with a middle tooth, anterior edge narrow and smooth; seta present (Fig. 90).

Proportions: Ant I : II : III : IV = 1 : 1.3 : 2 : 4.6 in females, 1 : 2 : 1.2 : 2 in males. Subsegments of Ant IV in females = 3 : 1 : 1 : 1 : 1.4. Dens : mucro = 2.2.

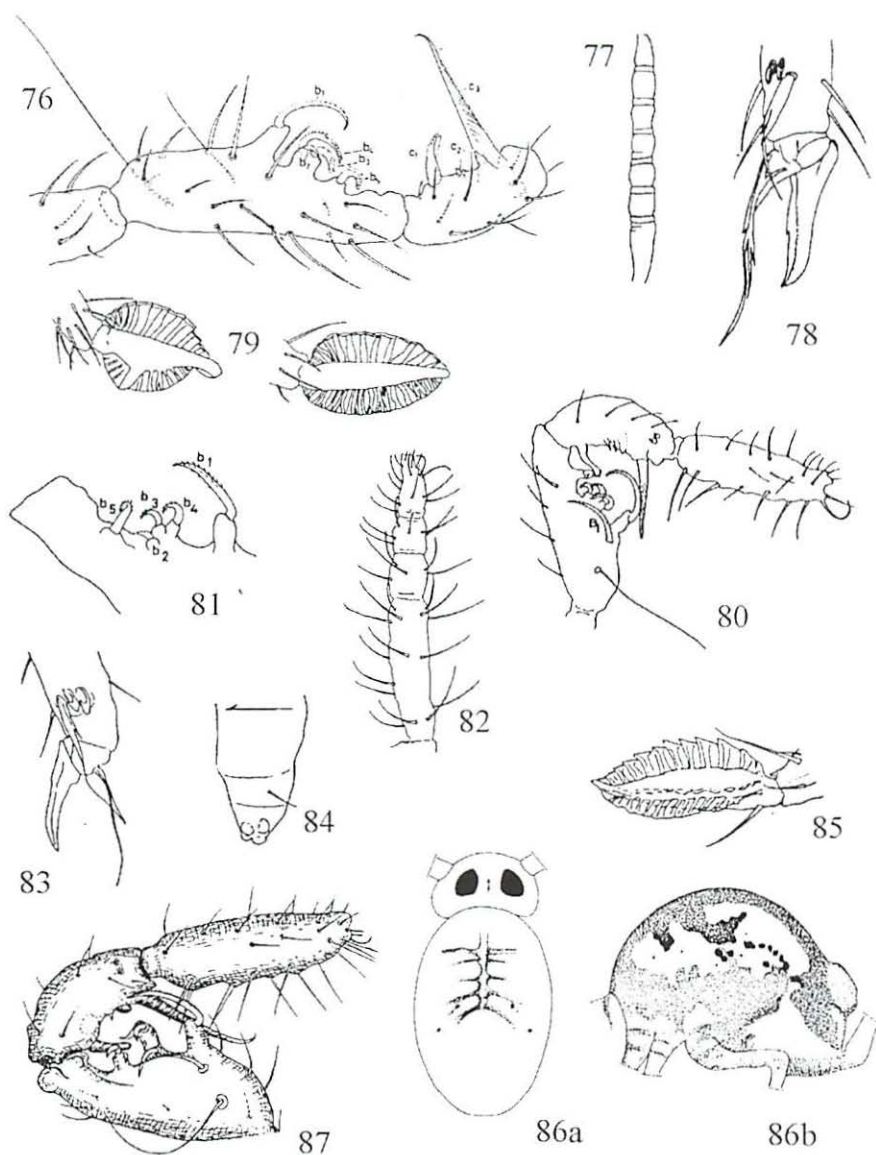
Type locality: S Italy, Sicily, Palermo, Botanical Garden, under a flower pot.

Occurrence: Also found at another site in S Italy (isle of Stromboli, DALLAI, see below) and in Portugal (Coimbra, GAMA 1964: 232).

Biology: *S. inaequalis* lives in moist moss and soil near open waters.

Species description: DALLAI 1973: 540.

Remarks: *S. inaequalis* resembles *S. sexoculatus* except for slight differences in the male Ant II, the female Ant IV, and the mucronal teeth (orig. observ., leg. DALLAI).



Figs. 76 - 79 *Sminthurides bifidus*:

76 Male Ant II and III from anterior (after MASSOUD & BETSCH 1972) 77 Female Ant IV (after CHRISTIANSEN & BELLINGER 1981) 78 Female tip of Tita III (after CHRISTIANSEN & BELLINGER 1981) 79 Different mucrones (after CHRISTIANSEN & BELLINGER 1981).

Figs. 80 - 85 *Sminthurides biwae* (after YOSII 1970):

80 Male Ant II - IV from posterior 81 Male Ant II, detail from anterior 82 Female Ant IV 83 Tip of Tita III 84 VI 85 Mucro.

Figs. 86 - 87 *Sminthurides cruciatus*: 86a, b Pigmentation of pale and dark specimens (after LINNANIEMI 1912), 87 Male Ant II - IV from posterior (after STACH 1956).

*Sminthurides malmgreni* (Tullberg, 1876) (30); Ågren, 1903 (161)

Syn.: *Sminthurus malmgrenii* Tullberg, 1876 (30)

*Sminthurus elegantulus* Reuter, 1881 (204)

*Smynthurus socialis* Folsom, 1896 (446)

*Sminthurides ludovicianus* Folsom & Mills 1938 (244) ad partem, CHRISTIANSEN & BELLINGER 1981: 1066

Total length 0.6 mm in females, 0.3 mm in males. Background colour grey-yellow with violet pigment which varies greatly, dorsal side often violet or with longitudinal violet bands. 8+8 ommatidia, C and D small or difficult to observe. In males, Ant II with Bothr and B1, b1 - b5, with b2 - b4 on separate papillae and b2 near b1; Ant III with c1 apically narrow, c2 rather long and near c3, and 2 short processes near c2 (Fig. 91). Ant IV in females undivided and weakly annulate. All claws with weak inner tooth, claw III with lateral teeth particularly on posterior side. Sacs of VT smooth. Ret with 2 or 3 setae. Dens with slightly increased number of setae (see also NAYROLLES 1990: 41): about 5 inner, about 14 outer (distally in 2 rows), 18 anterior, about 23 posterior setae. Mucro moderately broad, width 1/3 of length; inner and outer edges broad, wavy, inner with rough teeth, outer not extended to tip, anterior edge wavy or smooth; seta present (Fig. 92).

Proportions: Length of antennae : head diagonal = 1.25 in females, 1.5 in males. Ant I : II : III : IV = 1 : 1.4 : 2.7 : 4.8 (also 3 or 4, orig. observ.) in females, 1.3 : 1.9 : 1 : 2.1 in males. Dens : mucro = 2.4.

Type locality: Arctic Islands, i. e. Norway, Spitsbergen, and Russia, Novaya Zemlya (not defined).

Occurrence: Holarctic; in the Palaearctic ranging from North Africa (THIBAUD & MAS-SOUD 1980: 545) to the High Arctic (see below).

Biology: *S. malmgreni* is widespread and common on and near fresh waters and near the seashore (DÜRKOP 1934: 509), also in wet moss and soil up to 2600 m altitude (France, the Pyrenees, CASSAGNAU 1961: 211). Temperature preference is 13.6° in the Arctic (BABENKO 1993: 43), where the animals are active during the day (KRISTENSEN & VESTERGAARD 1975: 21). Chromosome number ( $n = 5$ , BRUMMER-KORVENKONTIO & SAURE 1969: 50), gut content (KRISTENSEN & VESTERGAARD, see above), postembryonal development, courtship, and sperm transfer (BLANCQUAERT 1981: 1, BLANCQUAERT et al. 1981 b: 387) have also been described.

Species descriptions: LINNANIEMI 1912: 254, STACH 1956: 27, PALISSA 1960: 392, CHRISTIANSEN & BELLINGER 1981: 1085, FJELLBERG 1984: 87 (maxillary outer lobe), NAYROLLES 1988: 10, 1990 a: 14, 1990 b: 41, 1991 b: 60 (chaetotaxy of extremities), 1989: 243 (ontogeny of chaetotaxy).

Remarks: It is not certain whether the Palaearctic and Nearctic specimens of *S. malmgreni* are conspecific, since Ant II and III of the males differ in detail (in the Nearctic, Ant II setae b2 - 4 are next to each other, CHRISTIANSEN & BELLINGER, see above). Several colour varieties of this species have been given separate names which are not repeated here (see STACH 1956: 31).

*Sminthurides monnioti* Massoud & Betsch, 1966 (577)

Total length 0.35 mm in females, 0.18 mm in males. Background colour white with pale blue tint. 8+8 ommatidia, diameter of C and D not described. In males, Ant II with Bothr and B1 (?), b1 - b5, with b2 - b4 next to each other; Ant III with minute elements near c2 (Fig. 93). Ant IV in females undivided, slightly annulate. Tita III organ with winged seta (Fig. 94). All claws slender, claws I and II with inner tooth, claw III only with lateral teeth which posteriorly form a serrate pseudonychium. Sacs of VT with feathered papillae (Fig. 95). Ret longitudinally split into 2 lateral parts, with 1 seta each. Dens with slightly increased number of setae: 3 inner, about 9 outer, formula of anterior setae 2.3.2.2.1.1.1.1.1, and about 22 posterior setae. Mucro narrow, all edges wavy and extending to tip, inner edge may have rough teeth; seta present (Fig. 96).

Proportions not described.

Type locality: France, Forêt des Landes, Canal de Sanguinet, in sands below 30 cm of fresh water.

Occurrence: Known only from the type locality.

Biology: The habitat of *S. monnioti* is very strange. The specimens were collected by washing the sand through a plankton net, and thus are believed to live interstitially.

Remarks: The strong setae of male Ant IV, which are directed towards Ant III and were stressed upon in the original description, are also found in other species (e. g. in *S. sexoculatus*).

*Sminthurides parvulus* (Krausbauer, 1898) (497)

Syn.: *Sminthurus parvulus* Krausbauer, 1898 (497)

*Sminthurides quinquelineatus* Gisin, 1943 (179), GISIN 1946: 222

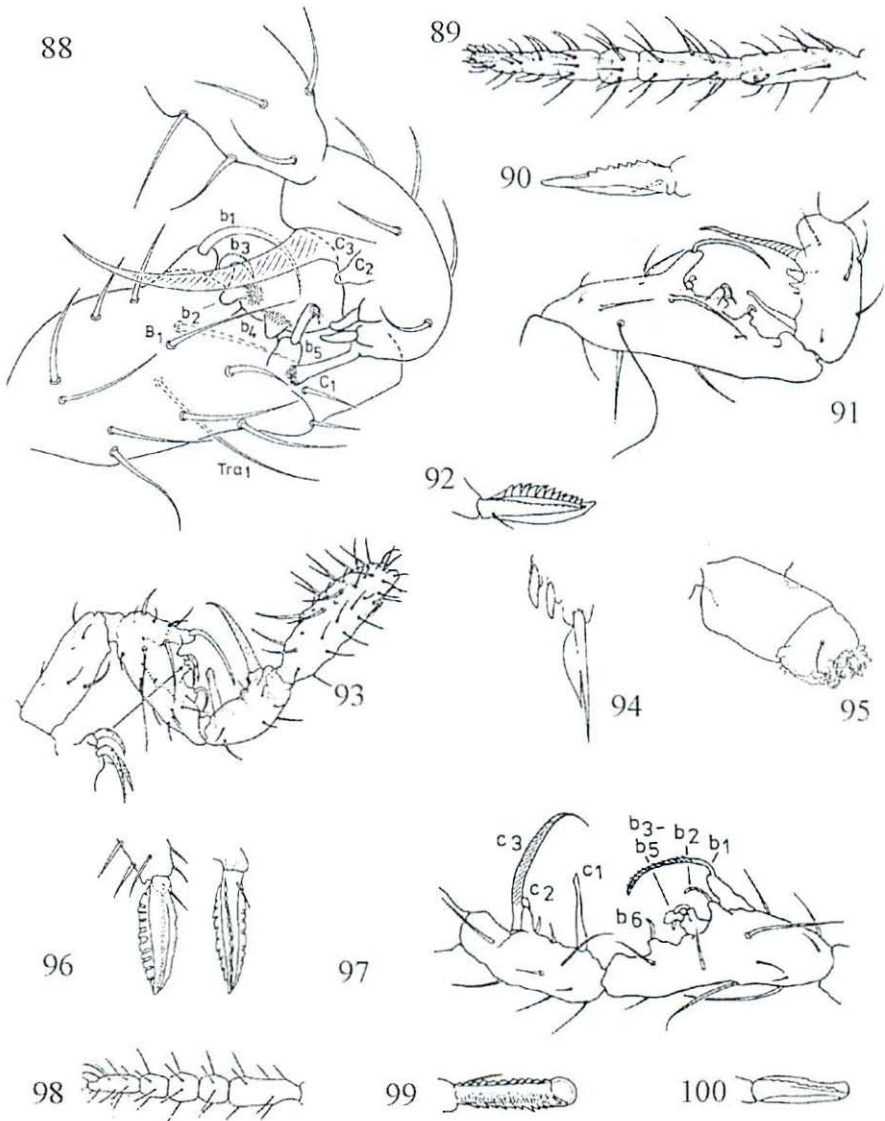
*Sminthurides quinquearticulatus* Gisin, 1944 (30), GISIN 1960: 269

*Sminthurides alpinus* Cassagnau, 1960 (407), CASSAGNAU 1965: 358

Total length 0.55 mm in females, 0.3 mm in males. Colour pale violet. 8+8 ommatidia, C and D small or missing (orig. observ.). In males, Ant II with Bothr and B1, b1 - b6, with b2 setalike, b3 - b5 next to each other, b6 smooth and spinelike, 1 short spine posterior to b6; Ant III with c2 and small elements in middle position (Fig. 97). Ant IV in females with 5 subsegments, the basal one being the longest (Fig. 98). Claws I and II with inner tooth, all claws with 1 pair of lateral teeth, tunica not always observed. Sacs of VT smooth. Ret with 2 - 3 setae. Dens with relatively few setae: 4 inner (with the distal 3 spinelike), about 7 outer, formula of anterior setae 2.3.3.1.1.1.1, and about 17 posterior setae. Mucro broad trough-shaped, width 1/3 of length; inner edge with 8 teeth and apical spine, outer edge with broad apical plate and tooth below the tip, anterior edge narrow and entire extending to tip (Figs. 99, 100); seta generally missing, in large females present (CASSAGNAU 1965: 358).

Proportions: Length of antennae : head diagonal = 1.3 in females. Ant I : II : III : IV = 1 : 1.5 : 2.7 : 5 in females. Subsegments of Ant IV in females = 2 : 1 : 1 : 1 : 1.7. Dens : mucro = 2.5.

Type locality: Germany, Weilburg/Lahn, on puddles in forests.



Figs. 88 - 90 *Sminthurides inaequalis* (after DALLAI 1973): 88 Male Ant II and III from anterior 89 Female Ant III and IV 90 Mucro from inner side.

Figs. 91 - 92 *Sminthurides malmgreni*: 91 Male Ant II and III from posterior (after STACH 1956) 92 Mucro from outer side (after GISIN 1960).

Figs. 93 - 96 *Sminthurides monnioti* (after MASSOUD & BETSCH 1966): 93 Male Ant from posterior 94 Tita III organ, 95 VT, 96 Mucrones.

Figs. 97 - 100 *Sminthurides parvulus*: 97 Male Ant II and III (after MURPHY 1960) 98 Female Ant IV (after NOSEK 1962) 99 Mucro from posterior (after FJELLBERG 1980) 100 Mucro from inner side (after GISIN 1960).

Occurrence: Europe; from Island (BÖDVARSSON 1967: 257) and N Norway (FJELLBERG 1988: 15) S to former Yugoslavia (e. g. CVIJOVIC 1976: 116), and W to Ireland (BOLGER 1986: 209) and Portugal (continental and Madeira, GAMA 1964: 232, 1986: 43 respectively), not reported from Italy. The record from India (YOSII 1966: 391) should be confirmed.

Biology: *S. parvulus* is not frequent, it lives near and on fresh waters, in wet moss and litter up to 2600 m altitude (France, the Pyrenees, CASSAGNAU 1961: 160). Postembryonal development and sperm transfer have been described (BLANCQUAERT 1981: 1, BLANCQUAERT et al. 1981 b: 387).

Species descriptions: KRAUSBAUER, 1905: 53 (redescription), GISIN 1944: 30, MURPHY 1960: 57.

*Sminthurides penicillifer* (Schäffer, 1896) (211)

Syn.: *Sminthurus penicillifer* Schäffer, 1896 (211)

*Sminthurides pauliani* Denis, 1936 (127)

Total length 1 mm in females, 0.3 mm in males. Background colour whitish yellow, large abdomen often with lateral violet band. 8+8 ommatidia, C and D small or missing (orig. observ.). In males, Ant II with 2 Bothr, b1 - b5, with b2 small, b2 - b4 next to each other; Ant III with tip of c1 broad and flat, c2 near c3 (Fig. 101). Ant IV in females with 7 subsegments and intermediate annulations, distinctly subsegmented only in adults (Fig. 102). Seta of Tita III organ strongly winged, bifurcate (Fig. 103). Claws I and II with uncertain inner tooth and lateral teeth, claw III without inner tooth but with 1 pair of distal lateral teeth and serrate posterior pseudonychium; Emp I and II lanceolate, Emp III in males pointed, in females split into 5 - 6, seldom 4, branches (Fig. 103). Sacs of VT smooth. Ret with 3 setae. Dens with numerous setae: about 8 inner (with the distal 7 ones long), about 23 outer (distally in 2 rows), 23 anterior, and about 43 posterior setae. Mucro broad, width 1/2 of length (in males narrower); shaft broad and irregular, all edges crenulate, inner edge with 9 - 10 teeth, outer edge narrower and shorter with apical tooth, anterior edge entire; seta present (Fig. 104).

Proportions: Length of antennae : head diagonal = 1.4 in females. Ant I : II : III : IV = 1 : 1.2 : 3 : 5 in females. Dens : mucro = 2.

Type locality: Germany, Bremen-Vegesack, small pond.

Occurrence: Central Europe; from Finland (LINNANIEMI 1912: 253) and Latvia (GRINBERGS 1974: 47) E to W Russia (Moscow, STACH 1956: 43), S to Romania (GISIN 1960: 266), and W to Austria (CHRISTIAN 1987: 53), Germany (also found in Schleswig-Holstein, orig. observ., leg. BRETZFELD, and Saxony, SCHULZ & DUNGER 1995: 16), and France (GISIN, see above).

Biology: *S. penicillifer* has rarely been found near and on fresh waters.

Species descriptions: BÖRNER 1901: 92, STACH 1956: 38.

Remarks: *S. penicillifer* resembles *S. bifidus*, see above.

*Sminthurides potamobius* Yosii, 1970 (10)

Total length 0.6 mm in females, 0.3 mm in males. Background colour pale violet, large abdomen with darker horizontal band. 8+8 ommatidia, reductions not described. In males, Ant II with Bothr (?) and B1, b1 - b5 but b4 missing (Fig. 105); Ant III with c2 near c3.

Ant IV in females with 4 subsegments, the basal one being the longest (Fig. 106). Claws in males without teeth, claws I and II in females with inner tooth and small lateral teeth, claw III without inner tooth but with serrate pseudonychium (Fig. 107). Sacs of VT with 3 - 5 pairs of slender papillae. Ret with 3 setae. Dens with slightly increased number of setae: 3 - 4 inner (spinelike), about 11 outer, formula of anterior setae 2,3,3,2,1,1,1,1, and about 22 posterior setae. All edges of mucro wavy with about 10 teeth each, inner edge broadest; seta present (Fig. 108).

Proportions: Length of antennae : head diagonal = 1.6 in females. Ant I : II : III : IV = 1 : 1.2 : 2.4 : 4 in females. Subsegments of Ant IV in females = 3 : 1 : 1 : 1. Dens : mucro = 2.5.

Type locality: Japan, Kyoto, water surface with *Sphagnum*.

Occurrence: Also reported from NE China (Changchun, CHEN & SHIN 1990: 221).

*Sminthurides pseudassimilis* Stach, 1956 (43)

Syn.: *Sminthurides assimilis* (Krausbauer, 1898) sensu Linnaniemi, 1912 (265)

*Sminthurides signatus* var. *distincta* Linnaniemi, 1912 (262)? GISIN 1960: 269

Total length 0.55 mm in females, 0.3 mm in males. Colour grey or more or less violet, Ant IV dark violet. 8+8 ommatidia, only D small. In males, Ant II with Bothr and B1, b1 - b5, with b2 - b4 next to each other; Ant III with c2 in middle position (Fig. 109); Ant IV with several constrictions or 4 subsegments. Ant IV in females with 4 subsegments, length of basal > distal (Fig. 110). Claws I and II with inner tooth and 1 pair of lateral teeth, claw III with indistinct teeth. Apex of VT with a ring of 5 conical appendages. Ret with 2 setae. Dens with relatively few setae in 6 longitudinal rows, not exactly described. Mucro trough-shaped, width 0.4 of length; inner and outer edges crenulate, inner edge with 8 rough teeth and apical tooth, anterior edge entire extending to tip; short seta present (Fig. 111).

Proportions: Length of antennae : head diagonal = 1.2 in females. Ant I : II : III : IV = 1 : 1.7 : 3.4 : 6.2 in females. Subsegments of Ant IV in females = 3.7 : 1 : 1 : 1.7 - 2.0. Dens : mucro = 2.1.

Type locality: Poland, Czarny Dunajec, on *Lemna* of a ditch near a peat-moor.

Occurrence: Temperate Europe (and Japan? GOUGH, see below); in Europe from N Norway (FJELLBERG 1988: 15), E to White Russia (STACH 1956: 45), S to former Yugoslavia (e. g. CVIJOVIC 1974: 93), and W to Germany (Saxony, SCHULZ & DUNGER 1995: 16) and Denmark (PETERSEN 1965: 320).

Biology: *S. pseudassimilis* lives near and on fresh waters, also in peat-moor (types), but is not abundant.

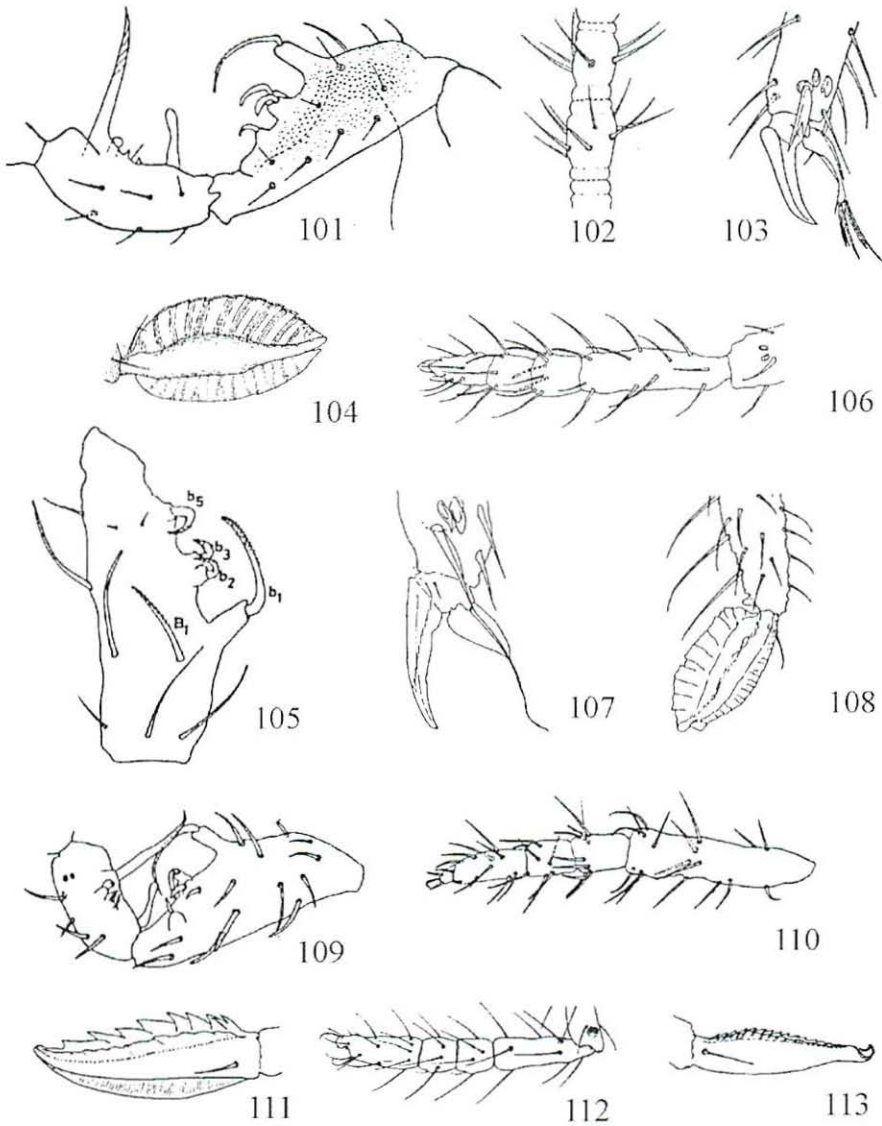
Species description: GOUGH 1975: 650.

Remarks: *S. pseudassimilis* is not sufficiently known. North American records may be *S. macnamai* (CHRISTIANSEN & BELLINGER 1981: 1066).

*Sminthurides schoetti* Axelson, 1903 (12)

Total length 0.5 mm in females, 0.25 mm in males. Background colour pale yellow, large abdomen sometimes with 1 or 2 pairs of longitudinal violet bands. 8+8 ommatidia, C and D small. In males, Ant II with Bothr and B1, b1 - b5, with b2 - b4 next to each other; Ant III with small elements near c2 (as in *S. signatus*, see Fig. 119). Ant IV in females with 4 subsegments, length of basal = distal (Fig. 112).





Figs. 101 - 104 *Sminthurides penicillifer* (after STACH 1956): 101 Male Ant II and III from anterior 102 Female Ant IV, annulations 103 Female tip of Tita III 104 Mucro.  
 Figs. 105 - 108 *Sminthurides potamobius* (after YOSHII 1970): 105 Male Ant II from posterior 106 Female Ant IV 107 Tip of Tita III 108 Mucro.  
 Figs. 109 - 111 *Sminthurides pseudassimilis*: 109 Male Ant II and III (after GOUGH 1975) 110 Female Ant IV (after GOUGH 1975) 111 Mucro from outer side (after FJELLBERG 1980).  
 Figs. 112 - 113 *Sminthurides schoetti*: 112 Female Ant IV (after STACH 1956) 113 Mucro from outer side (after FJELLBERG 1980).

Claws I and II with inner and outer tooth, claw III only with posterior lateral teeth. VT may be smooth. Ret with 2 setae. Dens with relatively few setae: 4 inner (J 1 - 3 spinelike), about 6 outer, formula of anterior setae 2,3,3,2,1,1,1,1, and about 16 posterior setae. Mucro narrow, trough-shaped; inner edge with 10 - 15 teeth but apical 1/4 smooth and narrower, outer and anterior edges smooth, the latter not extending to tip of mucro; seta present (Fig. 113).

Proportions: Length of antennae : head diagonal = 1.25 in females. Ant I : II : III : IV = 1 : 1.5 : 2.6 : 5 in females. Subsegments of Ant IV in females = 2.4 : 1 : 1 : 2.1

Type locality: Finland.

Occurrence: Palaearctic; from the High Arctic (Iceland, BÖDVARSSON 1966: 233; N Russia, BABENKO & BULAVINTSEV 1993: 14) and S Russia (STEBAEVA 1976: 124) S to the Mediterranean (POINSOT 1974: 126) and W to Ireland (BOLGER 1986: 209) and Portugal, the Azores (GAMA 1992: 47).

Biology: *S. schoetti* is abundant not only near fresh waters but also in moss and meadows (GISIN 1943: 179, BÖHLE 1991: 39) and near the sea shore (STRENZKE 1955: 49). It has also been found in winter (DUNGER & SCHULZ 1989: 356) and occurs up to 2260 m altitude (Austria, HAYBACH 1971/72: 17). Postembryonal development, courtship, and sperm transfer have been described (BLANCQUAERT & MERTENS 1979: 128, BLANCQUAERT 1981: 1). Many biological data have been collected by AGRELL (1936, 1941, 1948, 1963).

Species descriptions: LINNANIEMI 1912: 267, STACH 1956: 36, DALLAI 1970: 153 (cuticle).

Remarks: This abundant species has not yet been completely described; some unpublished observations are therefore added in the above description. The colour varieties of *S. schoetti* have been given separate names (LINNANIEMI 1912: 269):

var. *bilineata* Axelson, 1903 with 1 pair of dark stripes posteriorly on large abdomen.

var. *ornata* Axelson, 1903 with almost completely dark dorsal large abdomen.

#### *Sminthurides sexoculatus* Betsch & Massoud, 1970 (213)

Total length 0.75 mm in females, 0.5 mm in males. Colour violet with a few pale spots. 6+6 ommatidia, C and D missing. In males, Ant II with Bothr and B1, b1 - b6, with b2 as short, blunt spine, b2 - b5 next to each other and near b1, and with 1 short, thin seta posterior to b6; Ant III with c2 short, bent, and near c3, and with 2 long processes between c1 and c2 (Fig. 114). Ant IV in females with 5 subsegments and intermediate annulations (Fig. 115). Claws with inner tooth and short, basal teeth, without tunica (Fig. 116). Sacs of VT smooth. Ret with 3 setae. Dens with relatively few setae: 5 spinelike inner, 9 outer, formula of anterior setae 2,3,3,3,2,1,1, and about 20 posterior setae. Mucro narrow, pointed; inner edge serrate except apical 1/4, outer edge smooth with 1 basal and 1 subapical tooth, anterior edge crenulate and only extending to 3/4 of mucro; seta present (Figs. 117, 118).

Proportions (in females): Length of antennae : head diagonal = 1.35. Ant I : II : III : IV = 1 : 1 : 2 : 4. Subsegments of Ant IV = 2 : 1 : 1 : 1 : 1.5.

Type locality: France, Essonne, Brunoy, edges of park lawn.

Biology: *S. sexoculatus* lives on the surface of the lawn and soil together with *Stenacidia violacea*.

Remarks: The species specific characteristic of *S. sexoculatus* is not the reduced number of ommatidia, since other species also have very small or difficultly observable ommatidia C and D, but rather the Ant II and III of the males. *S. sexoculatus* resembles *S. inaequalis* except for slight differences in the male Ant II, the female Ant IV, and the mucronal teeth.

*Sminthurides signatus* (Krausbauer, 1898) (496)

Syn.: *Sminthurus signatus* Krausbauer, 1898 (496)

*Sminthurus assimilis* Krausbauer, 1898 (497) n. syn.

*Sminthurides krausbaueri* Folsom & Mills, 1938 (256)

Total length 0.5 mm in females, 0.35 mm in males. Background colour more or less violet or yellowish brown with 1 pair of longitudinal brown bands dorsally on large abdomen. Only 6+6 distinct ommatidia. In males, Ant II with Bothr and B1, b1 - 5, b2 - 4 next to each other; Ant III with c2 short, tip pointed or ciliate (Fig. 119). Ant IV in females with 4 sub-segments, length of basal = apical (Fig. 120). Claws sometimes with small inner tooth, without tunica but with lateral teeth. Ret with 2 setae. Dens with relatively few setae: 3 - 4 inner (basally thickened), about 9 outer, formula of anterior setae 2,3,3,2,1,1,1,1 with variations, and about 15 - 18 posterior setae. Mucro narrow, width 1/3 of length, tapering (seen from lateral) or trough-shaped (seen from posterior); all edges extending to tip of mucro, inner edge with rough teeth and apical tooth, outer edge smooth or wavy with distal lamella, anterior edge smooth; seta present (Figs. 121, 122).

Proportions (in females): Length of antennae : head diagonal = 1.3. Ant I : II : III : IV = 1 : 1.3 : 1.9 : 4.3. Subsegments of Ant IV = 2.2 : 1 : 1 : 2.4. Dens: mucro = 2.8 (in males 3.0).

Type locality: Germany, Weilburg/Lahn, on puddles in forests.

Occurrence: Palearctic and Australia? (WOMERSLEY 1933: 241); in the Palearctic from Portugal, the Azores (GAMA 1992: 47) to S Russia (STEBAEVA 1976: 124).

Biology: *S. signatus* occurs on small waters and in other wet habitats up to 1210 m altitude (S France, Montagne Noir, CASSAGNAU 1965: 349).

Species descriptions: KRAUSBAUER, 1905: 52, LINNANIEMI 1912: 265, GISIN 1960: 269.

Remarks: The differing aspects of the mucro, whether seen from lateral or posterior, unite the species *S. assimilis* and *S. signatus*, which was described originally one page before the other species, under the latter name. The male Ant II and III are similar in *S. signatus* and *S. schoetti*. The above description is mainly based on original observations from Germany (leg. HÜTHER, RUSSELL) and England (leg. FRAMPTON). *S. signatus* in WOMERSLEY 1939 (222) resembles *S. pseudassimilis* since the basal part of female Ant IV is longer than the distal. Nearctic records may be *S. hyogramme* or *S. macnamarai* (CHRISTIANSEN & BELLINGER 1981: 1066).

### Genus *Sphaeridia* Linnaniemi, 1912

Syn.: *Sminthurides (Sphaeridia)* Linnaniemi, 1912 (248)

*Asphyrotheca* Stach, 1956 (205)

*Indothea* Stach, 1956 (206)

### Key to the Holarctic species

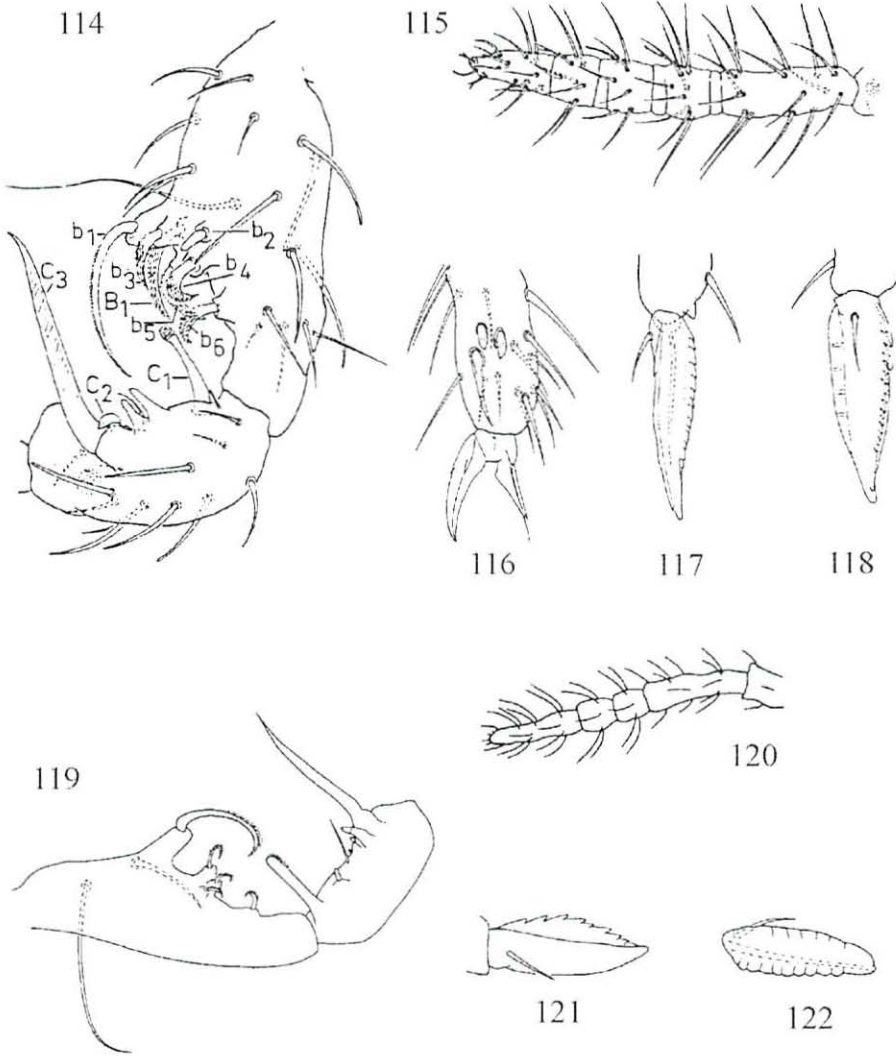
- |   |  |                             |
|---|--|-----------------------------|
| 1 | Male   | 2                           |
| – | Female   | 9                           |
| 2 | Dens row J:2+1 setae, anterior setae as 2,2...1              | <i>asiatica</i> Rusek, 1971 |
| – | Dens row J:3+1 setae, anterior setae as 2,3,2...1 (Fig. 137) | 3                           |

- |    |  |  |    |
|----|--|--|----|
| 3  | Ant II and III with accessory dorsal sensilla and numerous flame-shaped spines   | <i>spinifer</i> (Gama, 1964)   |    |
| –  | Ant II and III without these structures (Fig. 134)   |  | 4  |
| 4  | Posterior side of VT with 1 pair of small vesicles (Fig. 136)  |  | 5  |
| –  | VT with other structures   |  | 6  |
| 5  | Ret with 2 setae   | <i>pumilis</i> (Krausbauer, 1898)  |    |
| –  | Ret with 3 - 4 setae   | <i>tunicata</i> Yosii, 1954  |    |
| 6  | VT with furcate posteromedian process, anterior side with 1 pair of low lobes (Fig. 126)                               | <i>furcata</i> Dunger & Bretfeld, 1989   |    |
| –  | VT with entire posteromedian process, anterior side with other processes   |  | 7  |
| 7  | VT with posteromedian process covered by a median blade (Fig. 124)   | <i>foliata</i> Bretfeld, 1997  |    |
| –  | VT with posteromedian process not covered by a median blade  |  | 8  |
| 8  | VT with posteromedian process tapering, anterior side with 1 pair of long tapering lobes (Fig. 131)                    | <i>leutrensis</i> Dunger & Bretfeld, 1989  |    |
| –  | VT with posteromedian process broadened, anterior side with 1 pair of small lobes with short lateral points (Fig. 130) | <i>inflata</i> Bretfeld, 1997  |    |
| 9  | (1) Ret with 2 setae   |  | 10 |
| –  | Ret with 3 - 4 setae   | <i>tunicata</i> Yosii, 1954  |    |
| 10 | Head and thorax with normal setae  |  | 11 |
| –  | Dorsal setae of head and thorax thickened (Fig. 139)   | <i>spinifer</i> (Gama, 1964)   |    |
| 11 | Dens row J:2+1 setae, anterior setae as 2,2...1  | <i>asiatica</i> Rusek, 1971  |    |
| –  | Dens row J:3+1 setae, anterior setae as 2,3,2...1 (Fig. 137)   |  | 12 |
| 12 | Head frons with all setae (Fig. 133)   | <i>pumilis</i> (Krausbauer, 1898)  |    |
| –  | Head frons without setae b2, c2 (Fig. 125)   | <i>furcata</i> Dunger & Bretfeld, 1989 and <i>leutrensis</i> Dunger & Bretfeld, 1989 |    |

Remarks: The females of *S. foliata* and *S. inflata* are not known. *S. spinifer* and *S. tunicata* have not yet been completely described; some supplementary observations have therefore been extracted from an unpublished key of *Sphaeridia* species elaborated by D. H. MURPHY, Singapore (R. YOSHII, pers. comm.).

### Diagnosis of the genus

Total length up to 0.6 mm in females, 0.12 - 0.35 mm in males (the smallest male, that of *S. pilleata* Bretfeld & Gauer, 1994 from tropical Brazil, may be the smallest adult insect known). Colour more or less bluish grey to reddish with sometimes darker blue dorsally on the large abdomen; colour seldom species specific. Body spherical. Body setae moderately long and stiff, on head and thorax sometimes short and thick (Figs. 125, 128); setae of posterior of large abdomen longer than the others. Th III in males without vesicles. Bothr ABC forming an obtuse angle opening posteriorly. 8+8 ommatidia, C and D small; eye-patches often poorly pigmented and pigment only observable in the 6 large ommatidia.



Figs. 114 - 118 *Sminthurides sexoculatus* (after BETSCH & MASSOUD 1970):

114 Male Ant II and III from anterior 115 Female Ant IV 116 Tip of tita III 117 Mucro from posterior 118 Mucro from outer side.

Figs. 119 - 122 *Sminthurides signatus*:

119 Male Ant II and III (orig.) 120 Female Ant IV (after KRAUSBAUER 1905) 121 Mucro from outer side (orig.) 122 Mucro from posterior (orig.).

Ant II and III in males weakly modified (Fig. 134) with a long spine each (setae b1, c3), a few dorsal small spines or setae, and several long sensilla. Ant IV in both sexes undivided. Tita III (Figs. 132, 135) in females with more or less serrate setae IIIpi, IVpi; in males with normal setae or setae IIpe, IIIpi, IVpi, or also others, modified into thick or serrate setae or bladelike structures (in the tropics of South America), which are all species specific. Tita III organ missing. Claws I and II more slender than claw III, I inner and a few lateral teeth may occur. Emp I and II with lamellae narrow and filaments long, Emp III broader and filament short; filaments sometimes knobbed. VT in males with differently developed, species specific processes; in females with only 1 small pair of posterior vesicles (as in Fig. 136); always with 1+1 setae. Dens with a soft basal inner process, in most species row E:4+1 setae, J:3+1, anterior setae 2,3,2...1; setae E1 and J1-3 thickened, P3 and J4 varying from thin to total loss (Fig. 137), seldom more or fewer setae. Mucro slender, inner posterior edge differently serrate, outer smooth, tip narrow or widened; without a seta (Fig. 138).

Occurrence: Worldwide.

Descriptions of the genus: LINNANIEMI 1912: 248, STACH 1956: 46, MASSOUD & DELAMARE DEBOUTTEVILLE 1964: 85, MURPHY 1966: 69, BETSCH 1980: 137, CHRISTIANSEN & BELLINGER 1981: 1067, DUNGER & BRETFELD 1989: 11, BRETFELD & GAUER 1994: 132, BRETFELD 1995: 15, 1997: 1.

Type species: *Sminthurus pumilis* Krausbauer, 1898.

Remarks: The type species has usually been distinguished worldwide. Following the papers of MASSOUD & DELAMARE DEBOUTTEVILLE 1964 and MURPHY 1966, several new species have been described during the last years concerning in particular the structures of VT and Tita III of the males; the females of many species do not differ. This means that all records of the type species must be confirmed related to males of the definition given below (according to BRETFELD 1995: 18).

### Diagnosis of the Palaearctic species

*Sphaeridia asiatica* Rusek, 1971 (132)

Females: Total length up to 0.4 mm. Setae of head and thorax of normal form. Setae IIIpi and IVpi of Tita III with 1 or 2 small basal spines. Ret and furca as in males.

Males: Total length up to 0.3 mm. Setae of head and thorax of normal form. Tita III seta IIpe furcate with equal branches (Fig. 123), setae IIIpi and IVpi normal. VT without special processes. Ret with 2 setae. Dens with fewer setae than in other species, row J:2+1 setae, anterior setae 2,2...1. Mucro slender, inner edge serrate, outer smooth.

Proportions: Length of antennae : head diagonal = 1.3 in males. Ant I : II : III : IV = 1 : 2.5 : 1.4 : 4.1 in males. Dens : mucro = 1.8.

Type locality: Tropical S China, Canton, Shun-te, in a nest of *Capitermes* sp.

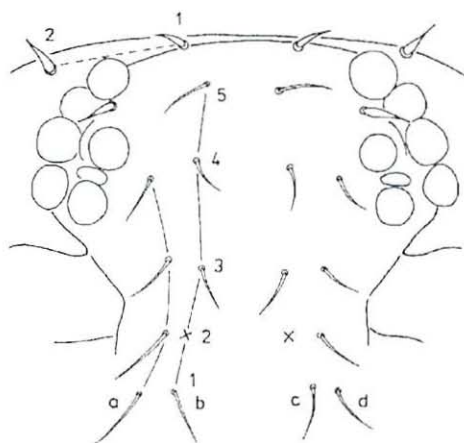
Occurrence: Also found at another site in S China (Canton, Hsin-hui, RUSEK, see above) and in the Palaearctic (NE China, Changchun, CHEN & SHIN 1990: 221).

Biology: *S. asiatica* has been found in S China in termites nests, in NE China in the soil of coniferous forests, of marshland, and farmland.

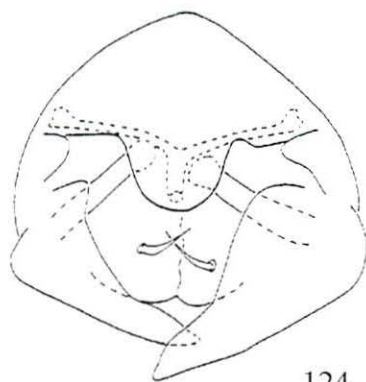
Remarks: The thickened tip of the Bothr of the original description is an artifact (orig. observ. of the type).



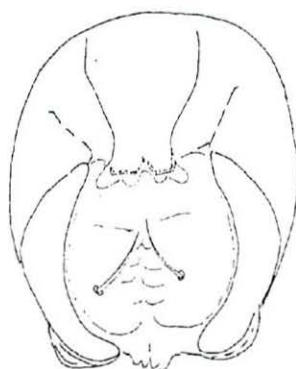
123



125



124



126

Fig. 123 *Sphaeridia asiatica*, Tita III of male (after RUSEK 1971).

Fig. 124 *Sphaeridia foliata*, male VT from posterior (after BRETFELD 1997).

Figs. 125 - 126 *Sphaeridia furcata* (after DUNGER & BRETFELD 1989):

125 Male head, setal rows a, b, c, d of frons, setae of eye-patches, and setal pair 1 and 2 of dorsal head-back 126 Male VT from posterior.

*Sphaeridia foliata* Bretfeld, 1997 (4)

Only 1 male known. Length of head 105  $\mu\text{m}$ . Head, thorax, and Tita III with normal setae. VT posteriorly with broad median shield and strongly rooted, median process, laterally 1 pair of oblique, thick processes, and 1 pair of broad, pointed, leaflike blades (Fig. 124). Furca as in *S. pumilis*.

Proportions: Dens : mucro = 2.

Type locality: Algeria, Chrea, undergrowth of open *Cedrus atlantica* forest at 1500 m altitude.

*Sphaeridia furcata* Dungen & Bretfeld, 1989 (7)

Females: Total length 0.3 mm. Head frons without setae b2, c2 (see Fig. 125), all setae of normal form. Tita III with setae IIIpi and IVpi smooth or serrate. Ret and furca as in males.

Males: Total length up to 0.27 mm. Head frons without setae b2, c2, dorsal head setae thickened (Fig. 125), setae of thorax short and onionlike. Ant II and III as described for genus. Tita III seta IIpe long and knobbed (see Fig. 129), IIIpi and IVpi normal or slightly serrate. VT with 1 forked and papillate posteromedian process, and 1 anterior pair of low processes (Fig. 126). Ret with 2 setae. Dens as described for genus. Mucro slender, inner edge with many teeth, tip as a round cap.

Type locality: Germany, Thuringia, S of Jena, grass slopes and bushes (Onobrychido-Brometum and Viburno-Cornetum) of Leutra valley.

Occurrence: Also found in Germany near Jena in another Onobrychido-Brometum, in E Slovenia (Brezice, meadow near Sava river) (DUNGER & BRETFELD, see above), and in Russia (near Irkutsk, meadow with *Deschampsia caespitosa*, BRETFELD 1996: 209).

Biology: *S. furcata* prefers semi-xerophile habitats. It was collected by pitfall traps.

*Sphaeridia inflata* Bretfeld, 1997 (6)

Only males known: Head frons without setae b2, c2 (as in Fig. 125), setae of dorsal head-back (see Fig. 125 no. 1 and 2) of differing form: outer setae (pair 2) swollen in the middle, inner (pair 1) long and straight (Fig. 127); other setae of normal form. Setae of thorax short and strongly thickened (Fig. 128). Ant II with short setae instead of short, dorsal spines (compare Fig. 134). Tita III seta IIpe long, slender, and knobbed; IIIpi with few small teeth; IVpi with 1 basal tooth (Fig. 129); in 1 male teeth of these last setae hardly observable. VT with 1 thick and apically broadened posteromedian process, and with 1 pair of small and soft anterior processes, each of the latter with lateral blunt point (Fig. 130). Ret with 2 setae. Dens as described for genus. Mucro with very small teeth.

Type locality: Spain, Balearic Islands, Minorca, S of Ciudadela, *Pinus* forest.

Occurrence: Known only from the type locality.

Biology: *S. inflata* was collected by colour traps, i. e. it lives on the soil surface. Whether it also occurs within the soil is unknown.



*Sphaeridia leutrensis* Dunger & Bretfeld, 1989 (3)

Females: Total length up to 0.36 mm. Head frons without setae b2, c2 (as in Fig. 125), all setae of normal form. Tita III with setae IIIpi and IVpi serrate. Ret and furca as in males.

Males: Total length up to 0.28 mm. Head frons without setae b2, c2, (as in Fig. 125), dorsal head setae and those of thorax thickened. Ant II and III as described for genus. Tita III seta Ipe long and knobbed (as in Fig. 129), IIIpi and IVpi normal. VT with 1 conical posteromedian process, 1 lateral pair of low, and 1 anterior pair of long, tapering processes (Fig. 131). Ret with 2 setae. Dens as described for genus. Mucro slender, inner edge with many teeth, tip as a round cap.

Type locality: Germany, Thuringia, S of Jena, xerothermic grass slopes (Epipactis-Seslerietum) of Leutra valley.

Occurrence: Also found in N Russia (arctic tundra of Taimyr Peninsula, FJELLBERG in litt.).

Biology: *S. leutrensis* seems to be xerophile. The types were collected by pitfall traps.

*Sphaeridia pumilis* (Krausbauer, 1898) (495) sensu Bretfeld, 1995 (18)

Syn.: *Sminthurus pumilis* Krausbauer, 1898 (495)

*Sminthurides pumilio* Börner, 1901 (138)

*Sminthurides globosus* Axelson, 1902 (109)

*Sminthurides pumilis* Axelson, 1907 (133)

*Sphaeridia pumilio* Agrell, 1934 (233)

*Sminthurides (Sphaeridia) minimus* (Schött, 1893 a) sensu Paclt, 1959 (63)

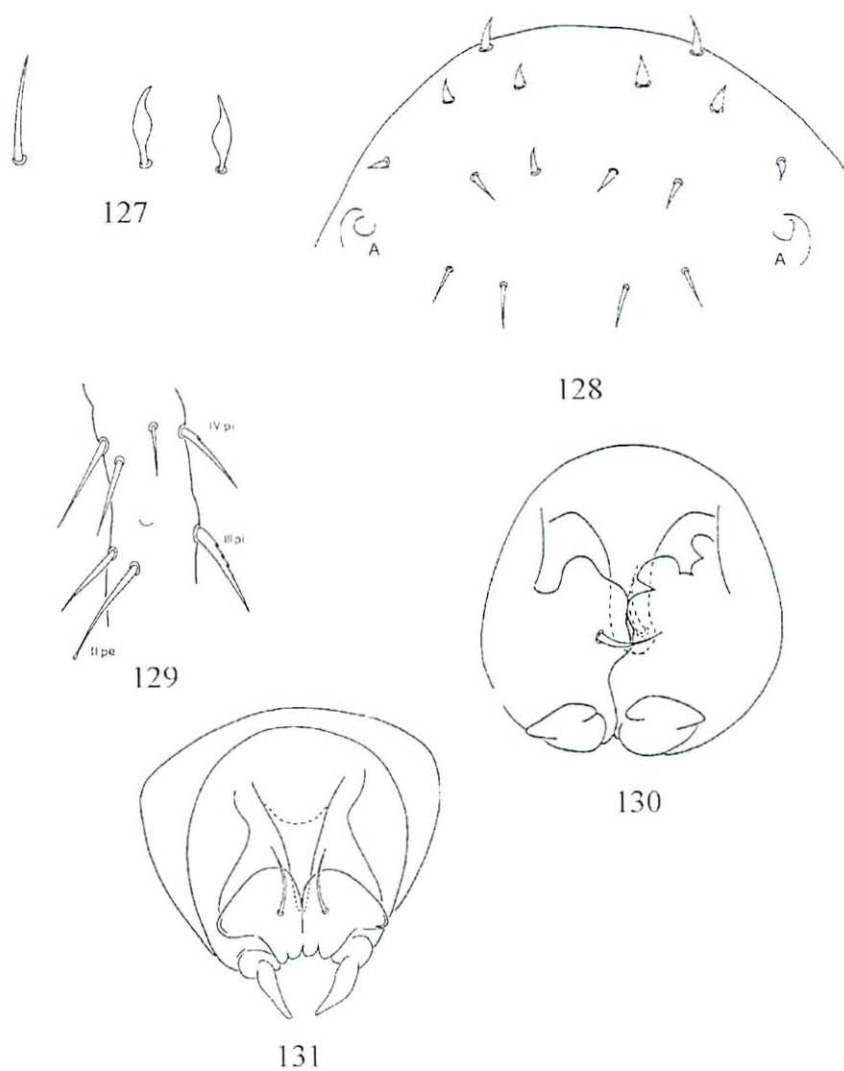
Females: Total length up to 0.5 mm. Setae of head and thorax of normal form, all head setae present. Tita III with setae IIIpi and IVpi serrate (Fig. 132). VT, Ret, and furca as in males.

Males: Total length 0.18 - 0.24 mm, head 100 - 120  $\mu\text{m}$ , dens 60 - 75  $\mu\text{m}$ , mucro 30 - 40  $\mu\text{m}$ . Head frons with all setae and wide distance between lateral rows (Fig. 133). Dorsal head, Ant I and II, and thorax with normal (f. *principalis*) or thickened setae (f. *spinosa*). Ant II and III as described for genus; Ant III with 1 long dorsal seta of antennal organ (Fig. 134). Tita III seta Ipe long and strong (not thin as noted in DUNGER & BRETFFELD, see below), IIIpi and IVpi normal (Fig. 135). VT with 1 pair of small, posterior vesicles (Fig. 136). Ret with 2 setae. Dens as described for genus (Fig. 137). Mucro slender, inner edge with many teeth, tip as a round cap (Fig. 138).

Proportions: Antennae longer than head diagonal. In males dens : mucro = about 2 (1.8 - 2.4).

Type locality: Germany, Hesse, Kissel near Weilburg/Lahn, on *Rumex nemorosus* and *Glyceria* of a forest path.

Occurrence: Holarctic and Australia (GREENSLADE 1994: 134); in the Palearctic certainly recorded from N Sweden to Algeria and from Russia (near Novosibirsk and Irkutsk) (BRETFFELD 1995: 19), recently identified from S Italy (isle of Stromboli, orig. observ., leg. DALLAI).



Figs. 127 - 130. *Sphaeridia inflata* (after BRETFELD 1997):

127 Male head, setae 1 (left) and 2 (right) of dorsal head-back 128 Male large abdomen, anterior part from dorsal 129 Male Tita III modified setae 130 Male VT from posterior.

Fig. 131 *Sphaeridia leutrensis*, male VT from posterior (after DUNGER & BRETFELD 1989).

Biology: *S. pumilis* is widespread in Europe and North America and occurs on the surface and in upper layers of different moist soils and in their low vegetation, but not in winter and in dry summer months. The maximum lifespan is 12 - 37 days (BLANCQUAERT & MERTENS 1979: 128). General embryonal and postembryonal developments, and the occurrence of diapause eggs have been described (BLANCQUAERT et al. 1981 a, b, 1982); the eggs may be laid uncovered, or partly or completely covered as in the Appendiciphora (BLANCQUAERT et al. 1981 a). The sperm transfer is unique among the Symphypleona in that the male directly transports its sperm droplet with its Tita III and its VT to the genital opening of the female (BLANCQUAERT & MERTENS 1977: 343).

Species descriptions: KRAUSBAUER 1905: 47 (redescription), STACH 1956: 49, JEANNENOT 1959: 1, CHRISTIANSEN & BELLINGER 1981: 1067, DUNGER & BRETTFELD 1989: 11, NAYROLLES 1989: 233 and 237 (ontogeny of chaetotaxy), 1990: 43, 1991 b: 58 (chaetotaxy of extremities), BRETTFELD 1995: 18 (new definition of f. *principalis* and f. *spinosa*), BRETTFELD 1996: 209.

Remarks: The identity of *S. pumilis* in older papers and in the mentioned biological observations is not certain. *Sminthurus minimus* Schött, 1893 a (7) (see SCHÖTT 1927: 33) from Africa, former Cameroon, may represent a *Sphaeridia* species of its own. Males with rather large posterior vesicles of VT, recorded from SE Russia and USA (BRETTFELD, see above, Fig. 136c), are not separated taxonomically since no further differences are known. *S. pumilis* f. *spinosa* resembles *S. tunicata* but differs in the number of Ret setae (see below).

*Sphaeridia spinifer* (Gama, 1964) (229)

Syn.: *Sminthurides spinifer* Gama, 1964 (229)

Females: Total length 0.42 mm. Colour more or less blue. Dorsal head setae and those of anterior large abdomen thickened (Fig. 139). Ant I - III with some slightly thickened setae. Claws, Emp, and furca without specific characteristics. Ret with 2 setae.

Males: Total length 0.35 mm. Only setae of dorsal head-back thickened. Ant II and III with accessory dorsal sensilla and numerous flame-shaped spines (according to D. H. MURPHY, see above p. 50). Other characteristics as in females, structure of VT unknown.

Proportions: Antennae longer than head diagonal. Ant I : II : III : IV = 1 : 1.7 : 1.45 : 4 in females.

Type locality: Portugal, Coimbra, Lapa dos Esteios, moss.

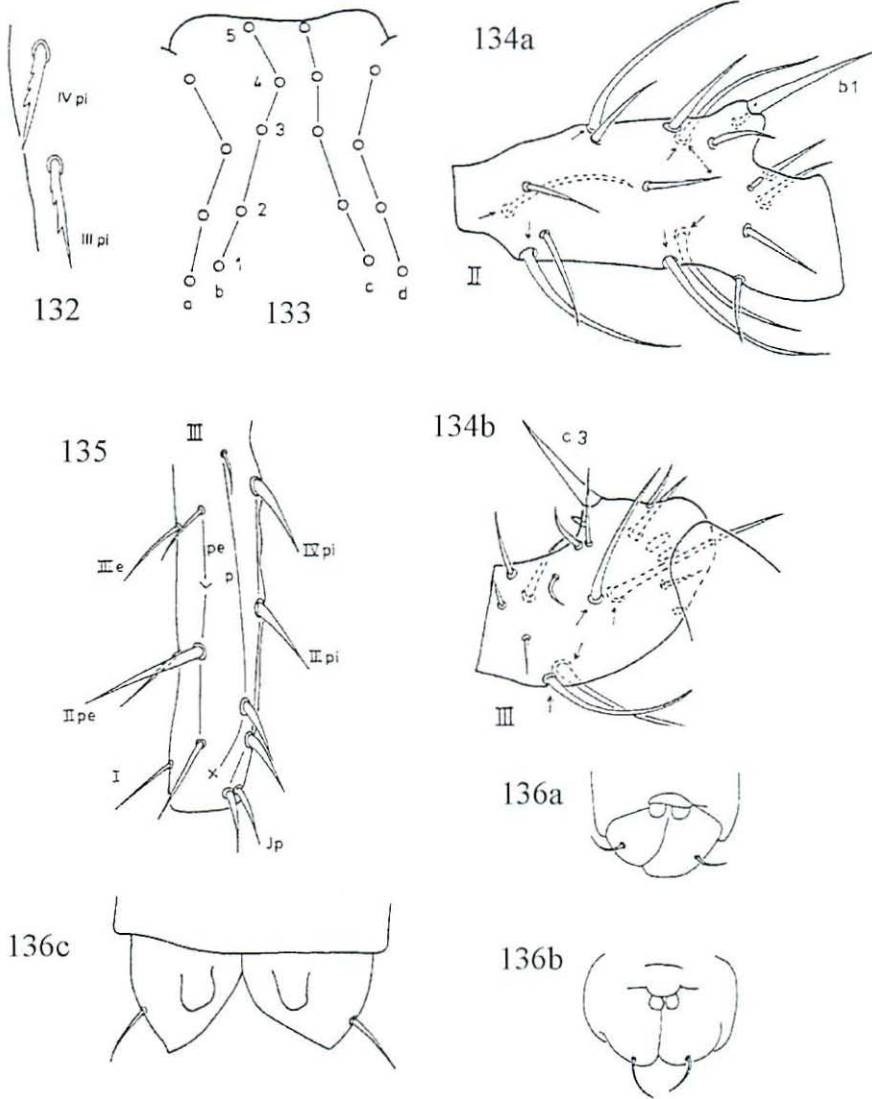
Occurrence: Also found in Spain (SIMÓN et al. 1986: 300, JORDANA et al. 1990: 188).

*Sphaeridia tunicata* Yosii, 1954 (816)

Females: Total length 0.5 - 0.6 mm. Background colour brownish, darker dorsally on large abdomen, antennae reddish blue. Eye-patches black. Claws without inner tooth but with 1 pair of lateral teeth; filaments of Emp I and II thin, not exceeding claws, Emp III broader and without filament. Ret with 3 - 4 setae. Dens without special characteristics. Apex of mucro as a membranous vesicle.

Males: Head dorsally with 6+6 spines. Thorax dorsally and laterally with prominent, conical, dilated spines. Tita III with normal setae, only seta IIpe slightly longer than the others. VT with 1+1 small vesicles.

Proportions: Length of antennae : head diagonal = 1.3. Ant III : IV = 0.4.



Figs. 132 - 136 *Sphaeridia pumilis* (after BRETFFELD 1995):  
 132 Female Tita III serrate setae (after BRETFFELD & GAUER 1994) 133 Head frons  
 134a Male Ant II from anterior, b: Male Ant III from anterior. 135 Male Tita III modified setae  
 136a, b Different male VT from posterior, c: Male VT from S Russia, posterior side.

Type locality: Japan, Isle of Honchu, 150 km N of Tokyo, Ozé Nature Reserve, moor at 2000 m altitude.

Occurrence: Also found in S Japan (Isle of Yakushima, S of the Isle of Kyushu, YOSII, see above).

Remarks: This description differs from the original in the mucro and the males. The mucro was apparently misinterpreted by YOSII (1954), who also did not describe the males. Here corrections are given based on observations by D. H. MURPHY (see above p. 50). *S. tunicata* resembles *S. pumilis* f. *spinosa* and, at the present state of our knowledge, only differs in the 3 - 4 Ret setae instead of 2.

### Genus *Stenacidia* Börner, 1906

Syn.: *Sminthurides* Jeannenot, 1955 (1)

*Jeannenotia* Stach, 1956 (10)

*Spinosecellina* Palissa, 1961 (354) ad partem

**Key.** Only 1 species: *Stenacidia violacea* (Reuter, 1881) (203)

### Diagnosis of the genus

Th III in males with a pair of vesicles and posterior of large abdomen with 2 rows of long setae (Fig. 140). Bothr ABC forming an obtuse angle opening anteriorly. Ant II and III in males highly modified; Ant II with 1 Bothr and 1 ciliate seta B1 on posterior side, processes b1 - b6 of different form; Ant III with c1 short and lamellate (Fig. 141). Ant III and IV in females with 2 and 3 large, blunt setae respectively (Fig. 142). Ant IV in both sexes undivided. Tita III in males with several long, ciliate outer setae (Fig. 140). Tita III organ present. Dens with relatively few setae. Mucro narrow; in females and juveniles inner edge serrate and outer wavy with 2 teeth, in males inner and outer edges serrate; seta present (Fig. 143). Small abdomen in males not protruding.

Occurrence: Holarctic and temperate regions of the Southern Hemisphere.

Descriptions of the genus: BÖRNER 1906: 182; under *Jeannenotia*: BETSCH & MASSOUD 1970: 153, BETSCH 1980: 128.

Type species: *Sminthurus violaceus* Reuter, 1881.

Remarks: *Stenacidia picta* Yosii, 1966 (517) from Nepal is not included here, it seems to belong to the genus *Sminthurides* (BETSCH 1980: 124) or a new genus and is extralimally distributed.

### Diagnosis of the single species

*Stenacidia violacea violacea* (Reuter, 1881) (203) n. comb.

*Stenacidia violacea australiensis* (BETSCH & MASSOUD, 1970) (173)

Syn.: *Sminthurus violaceus* Reuter, 1881 (203)

*Sminthurus (Sminthurides) violaceus* Börner, 1900 (616)

*Sminthurides violaceus* Börner, 1901 (98)

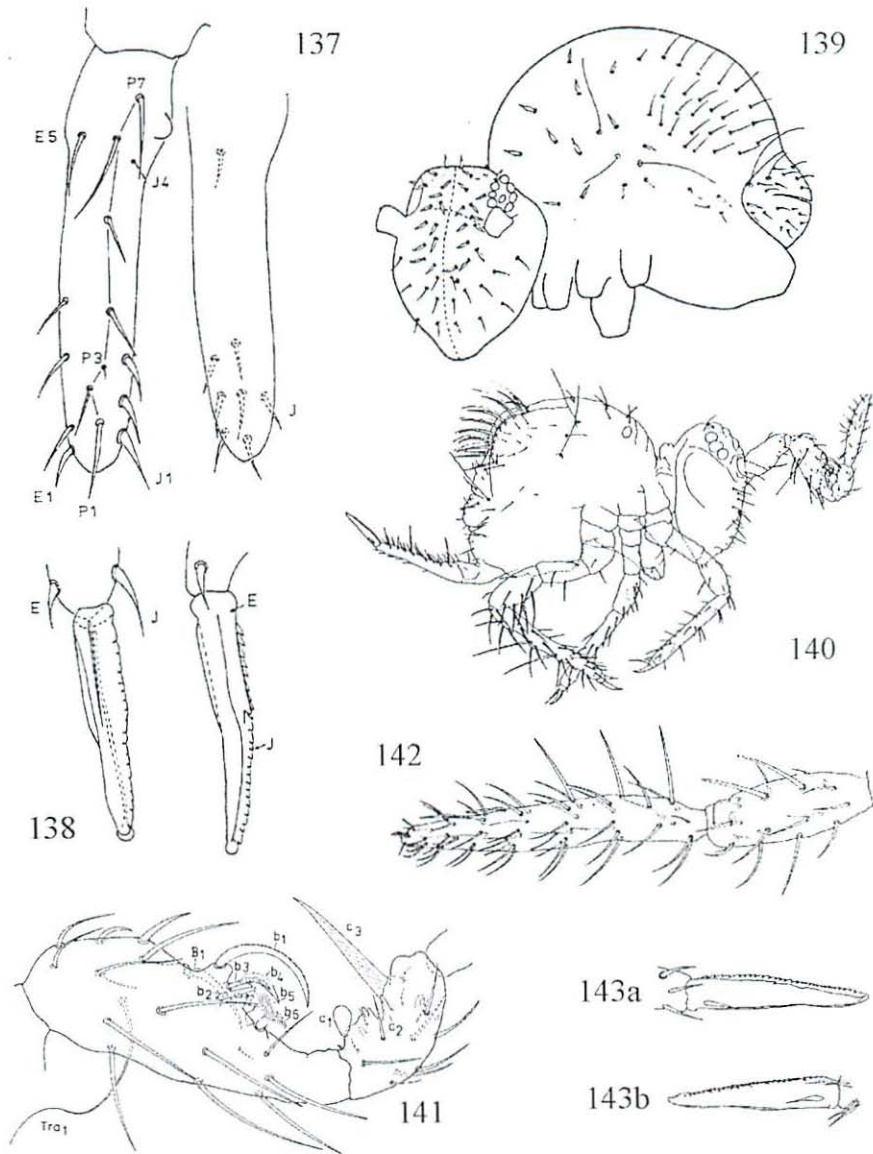
*Sminthurides (Stenacidia) violaceus* Börner, 1906 (182)

*Sminthurides (Stenacidia) stachi* Jeannenot, 1955 (1)

*Jeannenotia stachi* Stach, 1956 (10)

*Jeannenotia stachi australiensis* BETSCH & MASSOUD, 1970 (173)

nec *Stenacidia violacea* Jeannenot, 1959 (14) (= *Sminthurides* spec., BETSCH & MASSOUD 1970: 198)



Figs. 137 - 138 *Sphaeridia pumilis* (after BRETFFELD 1995):

137a, b Dens posterior and anterior setae, E = outer (external), J = inner (internal), P = posterior

138a, b Mucro from posterior and outer sides.

Fig. 139 *Sphaeridia spinifer*, female (after GAMA 1964).

Figs. 140 - 143 *Stenacidia violacea*

140 Male habitus (after BETSCH & MASSOUD 1970) 141 Male Ant II and III from anterior (after

MASSOUD & BETSCH 1972) 142 Female Ant III and IV (after BETSCH & MASSOUD 1970)

143a Mucro of female and juvenile from outer side (after BETSCH & MASSOUD 1970)

143b Male mucro from outer side (after BETSCH & MASSOUD 1970).

Total length 0.7 mm in females, 0.5 mm in males. Background colour yellow with more or less violet pigment. 8+8 ommatidia, C and D small. Claws with inner tooth, 2 pairs of lateral teeth, few outer teeth, and tunica; in males claw III longer than the others. Emp about 1/2 as long as claws; filaments I and II with slightly thickened tips, length > claws, filament III pointed and short. Dens with relatively few setae: 4 inner (spinelike), 8 - 10 outer, formula of anterior setae 3,3,2,2,1...1,1, about 19 posterior setae. Other characteristics as described for genus.

Proportions (according to BETSCH & MASSOUD 1970): Length of antennae : head diagonal = 1.2 in females, 1.8 - 2.1 in males. Ant I : II : III : IV = 1 : 1.5 : 2 : 3.8 in females, 2 : 2.8 : 1 : 2.4 in males. Dens : mucro = 2.6 in both sexes (orig. observ.).

Type locality: Finland, Lofsdal.

Occurrence: Holarctic, Cape Verde Islands, S Australia, Kerguelen Islands (BETSCH 1980: 128, BETSCH & MASSOUD, see below, GAMA 1986: 43, BRETFELD, see below, 1996: 209).

Biology: *S. violacea* lives on the shady soil surface of lawns and parks (BETSCH & MASSOUD, see below), in cornfields and between sugar beets (BEYER & DUNGER 1969: 31), in vineyards (BETSCH & MASSOUD, see below), wet moss (BRETFELD, see below), and salt marshes (GAMA et al. 1989: 366); it has been found in Austria up to 1900 m altitude (Tyrol, Karwendel Mts., BRETFELD, see below). The mating behaviour is unknown.

Species descriptions: BETSCH & MASSOUD 1970: 153 (general), BRETFELD 1989: 295 (distribution).

Remarks: The taxonomic problem of the distinction between *Jeannenotia stachi* and *Stenacidia violacea* (BETSCH & MASSOUD 1970: 195) is here solved in favour of the re-introduction of *Stenacidia violacea* and the reduction of *Jeannenotia stachi* to one of its synonyms. Almost all females and juveniles known (exceptions discussed by BETSCH & MASSOUD 1970: 198) show the mucro of *S. violacea* (only inner edge serrate) and, if developed, the antennae with the large setae of *J. stachi*. All males known show the mucro (both edges serrate) and the antennae of *J. stachi*. This had led to the strange situation that, within the same sample, females were determined as *S. violacea*, males as *J. stachi*. The solution suggested here will settle the conflicts, above all it is expected that new studies will clarify the systematic position of doubtful specimens.

Specimens of *S. violacea* from Southern France and the Isle of Minorca (Spain) were compared with Australian individuals (according to BETSCH & MASSOUD 1970: 173 and new collections lent by P. GREENSLADE). The result (orig. observ.) is that the subspecies *S. violacea australiensis* differs from European populations in the number of the large setae of the male large abdomen (in Australia the  $\alpha$  pair of setae is missing) and in the length of Tita III seta Vi of the females (in Australia it is longer). Some other long setae in males and females from Australia are either longer (with a broad overlap, however) or shorter than those of these Southern European populations.

**Arrhopalitida n. nom.**

Syn.: Arrhopalitidae Stach, 1956 sensu Betsch, 1980 (130) ad partem

Arrhopalitini Stach, 1956 (61) ad partem

**Diagnosis**

The taxon Arrhopalitida is a monophylum of the Katianniformia Bretfeld, 1986 n. comb., with 2 diagnostic apomorphies:

- eyes reduced to maximally 2+2 ommatidia (plesiomorphy: 8+8 ommatidia)
- trochanters II and III with elongate setal socket of trochanteral organ (plesiomorphy: oval/normal socket).

Other diagnostic characteristics: Bothr ABC equidistant, lying behind Abd I and forming an angle opening anteriorly (apomorphy?); Tita without spatulate setae (plesiomorphy); VT with elongate (apomorphy) and smooth (plesiomorphy) sacs; Ret with 4+4 teeth (plesiomorphy); mucro without seta (apomorphy).

Remarks: The elongate setal socket of the trochanteral organ is here regarded as the apomorphic character state, since an oval socket is found in both the Collophorida n. comb. and Katiannida n. comb., which in other characteristics differ considerably.

**Key.** Only 1 genus: *Arrhopalites* Börner, 1906.

**Genus *Arrhopalites* Börner, 1906**

Syn.: *Coecarrhopalites* Yosii, 1967 (66)

**Key to the Palaearctic species**

- |   |  |                                |
|---|--|--------------------------------|
| 1 | Dens with 1 anterodistal median spine or posterior side of Abd VI with small spines or projections in addition to normal setae, also both characteristics present ( <i>caecus</i> -group) (Figs. 153, 156) | 2                              |
| – | Dens without such spine and Abd VI without spines or similar projections   | 8                              |
| 2 | Posterior side of Abd VI with spines or projections  | 3                              |
| – | Abd VI without spines or projections   | <i>ulehlovae</i> Rusek, 1970   |
| 3 | App. an. spatulate, tip cut and with fringes (Fig. 162)  | <i>minutus</i> Yosii, 1970     |
| – | App. an. slender, not spatulate  | 4                              |
| 4 | App. an. thick, tapering but with blunt tip (Fig. 158)   | <i>loczyi</i> Loksa, 1960      |
| – | App. an. thinner, like a blunt seta, or broader, like a cut band   | 5                              |
| 5 | Dens with 1 anterodistal median spine  | 6                              |
| – | Dens without such spine  | 7                              |
| 6 | App. an. bandlike, ratio of its length to width = 10 (Fig. 157)  | <i>caecus</i> (Tullberg, 1871) |
| – | App. an. rodlike, ratio of its length to width = 20 (Fig. 163)   | <i>tenuis</i> Stach, 1945      |
| 7 | Ratio of antennal length to head diagonal = 1.2, Ant IV undivided  | <i>baccetti</i> Dallai, 1969   |
| – | Ratio of antennal length to head diagonal = 2, Ant IV with 5 subsegments   | <i>antrobis</i> Yosii, 1954    |



8	(1) App. an. spoonlike, apical margin almost smooth or finely, densely serrate ( <i>cochlearifer</i> -group)	9
=	App. an. split into 2 main branches ( <i>furcatus</i> -group)	11
-	App. an. not as above	17
9	Dens with 2 outer spines (E1, E3) (see Fig. 227) <i>cochlearifer</i> Gisin, 1947	
-	Dens with 4 - 6 outer spines or only E1 as spine and other outer setae spinelike	10
10	Circumanal setae basally smooth <i>gisini</i> Nosek, 1960	
-	Circumanal setae with basal furcation and teeth (Fig. 170) <i>spinus</i> Rusek, 1967	
11	(8) Ant IV with 5 - 6 subsegments	12
-	Ant IV with 7 - 8 subsegments	16
12	App. an. smooth (Fig. 177)	13
=	App. an. with fine fringes (Fig. 173)	14
-	App. an. with rough fringes or teeth (Fig. 171)	15
13	Claw I with inner tooth, Emp III shorter than claw <i>mauli</i> Delamare Deboutteville & Bassot, 1957	
-	Claw I without inner tooth, Emp III longer than claw <i>furcatus</i> Stach, 1945	
14	Emp III with tooth and shorter than claw <i>chopardi</i> Cassagnau & Delamare Deboutteville, 1955	
-	Emp III without tooth and longer than claw <i>elegans</i> Cassagnau & Delamare Deboutteville, 1953	
15	(12) Emp III longer than claw <i>bifidus</i> Stach, 1945	
-	Emp III shorter than claw <i>subbifidus</i> Travé, Gadea & Delamare Deboutteville, 1954	
16	(11) App. an. smooth (Fig. 179) <i>hungaricus</i> Loksa, 1967	
-	App. an. with fine fringes (Fig. 180) <i>intermedius</i> Loksa, 1969	
17	(8) App. an. racketlike with rough but short teeth in distal 1/2 (Fig. 188) ( <i>postumicus</i> -group)	18
=	App. an. not as above, with teeth, fringes, or several branches longer than shaft diameter (Figs. 196, 203, 206) ( <i>principalis</i> -group)	20
-	App. an. setalike or rodlike, entire, or with teeth or fringes shorter than shaft diameter (Figs. 210 - 215) ( <i>pygmaeus</i> -group s. str.)	29
18	Dens with 2 outer spines (E1, E3) (Fig. 184)	19
-	Dens with 4 - 5 outer spines <i>postumicoides</i> Cassagnau & Delamare Deboutteville, 1953	
19	Ratio of antennal length to head diagonal = 2, Emp III longer than claw <i>postumicus</i> Stach, 1945	
-	Ratio of antennal length to head diagonal about 1.5, Emp III shorter than claw <i>canzianus</i> Stach, 1945	

20	(17) Dens with 1 distinct outer spine (E1), remaining outer setae only basally thicker than normal setae (Fig. 195)	<i>japonicus</i> Yosii, 1956	
=	Dens with 2 outer spines (E1, E3) (Fig. 227)		21
-	Dens with 3 outer spines (E1-3) (Fig. 199)	<i>octacanthus</i> Yosii, 1970	
21	Ant IV with 5 subsegments		22
=	Ant IV with 6 subsegments		28
-	Ant IV with 7 subsegments	<i>habei</i> Yosii, 1956	
22	App. an. setalike, with few long fringes (Figs. 197, 206)		23
-	App. an. not as above		24
23	Circumanal setae of normal form, claw I without inner tooth	<i>jeanneli</i> Cassagnau & Delamare Deboutteville, 1955	
-	Circumanal setae winged, all claws with inner tooth	<i>sericus</i> Gisin, 1947	
24	Dens with stout and oval spine E1 (Figs. 193, 204)		25
-	Dens with slender spine E1		26
25	Head with stout spines	<i>secundarius</i> Gisin, 1958	
-	Head with slender spines	<i>infrasecundarius</i> Loksa & Rubio, 1966	
26	Ant III with distinct distal papilla (Fig. 189)	<i>alticola</i> Yosii, 1970	
-	Distal papilla of Ant III not distinct or missing		27
27	Ant III with prominent basal papilla (see Fig. 174), Emp II and III longer than claws	<i>ornatus</i> Stach, 1945	
-	Ant III simple or with slight basal thickening, Emp II and III shorter than claws	<i>thermophilus</i> Loksa, 1964	
28	(21) All claws with inner, Emp I and II with outer tooth	<i>principalis</i> Stach, 1945	
-	Only claws II and III with inner tooth, claw I and all Emp without tooth	<i>kolymensis</i> Tshelnokov, 1990	
29	(17) Dens without spines	<i>gul</i> Yosii, 1966	
≡	Dens with 1 outer spine (E1)		30
=	Dens with 2 or 3 outer spines (E1, E3 or E1 - E3)		35
-	Dens with 4 outer spines		42
30	Ant IV with 14 subsegments, antennae longer than body	<i>uenoi</i> Yosii, 1956	
-	Ant IV with fewer subsegments		31
31	App. an. setalike, curved, with many small fringes (Figs. 210, 212)		32
-	App. an. rodlike, straight, with few teeth or fringes		33
32	Ant IV with 9 - 10 subsegments, tip of mucro pointed	<i>aggtelekiensis</i> Stach, 1929	
-	Ant IV with 8 subsegments, tip of mucro broad	<i>buekkensis</i> Loksa, 1969	
33	Tip of mucro pointed	<i>giovannensis</i> Cassagnau & Delamare Deboutteville, 1953	
-	Tip of mucro broad (Fig. 231)		34

- 34 Claw I with inner tooth, Emp III without tooth *boneti* Stach, 1945  
 – Claw I without tooth, Emp III with tooth  
*subboneti* Cassagnau & Delamare Deboutteville, 1953
- 35 (29) Ratio of antennal length to head diagonal at most 2 36  
 – Ratio of antennal length to head diagonal about 3 41
- 36 Head with 4+4 stout spines, claws without inner tooth *dudichi* Loksa & Rubio, 1966  
 – Head spines slender, claws with inner tooth 37
- 37 Ret with 1 seta *terricola* Gisin, 1958  
 – Ret with 2 setae 38
- 38 App. an. thin setalike, serrate *slovacicus* Nosek, 1975  
 – App. an. bandlike, tip cut or pointed, distal part with short teeth or fringes 39
- 39 Dens with 2 outer spines (E1, E3; E2 as normal seta or missing) (Fig. 227) 40  
 – Dens with 3 outer spines (E1 - E3; E2 as pointed spine); ratio of Ant IV : Ant I about 9  
*ruseki* Nosek, 1975
- 40 Ratio of Ant IV : Ant I about 7 *pseudoappendices* Rusek, 1967  
 – Ratio of Ant IV : Ant I about 9.5 *pygmaeus* (Wankel, 1860)
- 41 (35) Ratio of basal to distal subsegment of Ant IV at most 3  
*longicornis* Cassagnau & Delamare Deboutteville, 1953  
 – Ratio of basal to distal subsegment of Ant IV about 4  
*delamarei* Nosek & Paoletti, 1984
- 42 (29) Ant IV undivided 43  
 – Ant IV with 5 subsegments 44
- 43 Head with normal setae, App. an. straight (Fig. 224)  
*microphthalmus* Cassagnau & Delamare Deboutteville, 1953  
 – Head with spines, App. an. curved (Fig. 209) *acanthophthalmus* Gisin, 1958
- 44 Head with stout spines *hedrosensis* Selga, 1963  
 – Head with slender spines *slovacicus* Nosek, 1975

Remarks: This key only considers females (males have seldom been described). Some subspecies or forms are regarded as species. Mainly the characteristics mentioned in the original descriptions are referred, since in the secondary descriptions the types have seldom been consulted. Most species have been insufficiently described and isolated populations may vary because of parthenogenesis, thus the entire genus needs a revision.

Not included in this key are:

- *Arrhopalites caecus* var. *attenuatus* (Carpenter & Evans, 1899) (= too briefly described but different from *A. caecus*, orig.),
- *Arrhopalites affinis* (Börner, 1901 c) (= 1st instar juvenile of an unknown species, orig.),
- *Arrhopalites remyi* Denis, 1948 b (= juvenile, STACH 1956: 72),
- *Arrhopalites binoculatus* Yosii, 1954 b (nec Börner, 1903) (= only males, placed by YOSII into 3 different species, 1956: 99 = *japonicus*, 1970: 14 = *octacanthus*, 1977: 164 = *habei*),

- *Arrhopalites nivalis* Yosii, 1966 a (= extralimital, Nepal),
- *Arrhopalites styriacus* Nosek & Neuherz, 1976 (= juvenile without App. an., perhaps near *A. terricola*, orig.),
- *Arrhopalites pukouensis* Wu & Christiansen, 1997 (from China, Jiangsu; belonging to the *pygmaeus*-group s. str. with only E1 spinelike and Ant IV undivided).

For practical purposes, the large number of species is divided into several species groups following STACH (1945: 2), who suggested a *caecus*- and a *pygmaeus*-group. In this paper the former is newly defined and the latter further divided corresponding to the form of App. an. The figures are arranged as the following groups to compare the similar structures better; the species are described alphabetically.

***caecus*-group** (Figs. 148 - 165)

Dens with 1 anterior distal spine or posterior side of Abd VI with small spines or projections in addition to normal setae, also both characteristics present. The species of this group are: *Arrhopalites antrobius*, *baccetti*, *caecus*, *loczyi*, *minutus*, *tenuis*, *ulehlovae*.

***pygmaeus*-group s. lat.**

Dens without anterior distal spine and posterior side of Abd VI without spines or similar projections. This large group is further divided.

***cochlearifer*-group** (Figs. 166 - 170)

App. an. spoonlike, apical margin almost smooth or finely and densely serrate. The species of this group are: *Arrhopalites cochlearifer*, *gisini*, *spinus*.

***furcatus*-group** (Figs. 171 - 183)

App. an. deeply split into 2 main branches. The species of this group are: *Arrhopalites bifidus*, *chopardi*, *elegans*, *furcatus*, *hungaricus*, *intermedius*, *mauli*, *subbifidus*.

***postumicus*-group** (Figs. 184 - 188)

App. an. racketlike with rough teeth in distal 1/2. The species of this group are: *Arrhopalites canzianus*, *postumicoides*, *postumicus*.

***principalis*-group** (Figs. 189 - 207)

App. an. with teeth, fringes, or several branches longer than shaft diameter. The species of this group are: *Arrhopalites alticola*, *habei*, *infrasecondarius*, *japonicus*, *jeanneli*, *kolymensis*, *octacanthus*, *ornatus*, *principalis*, *secundarius*, *sericus*, *thermophilus*.

***pygmaeus*-group s. str.** (Figs. 208 - 236)

App. an. setalike or rodlike, entire or with teeth or fringes shorter than shaft diameter. The species of this group are: *Arrhopalites acanthophthalmus*, *aggtelekiensis*, *boneti*, *buekensis*, *delamarei*, *dudichi*, *giovannensis*, *gul*, *hedrosensis*, *longicornis*, *microphthalmus*, *pseudopendices*, *pygmaeus*, *ruseki*, *slovacicus*, *subboneti*, *terricola*, *uenoi*.

**Diagnosis of the genus**

Total length 0.5 - 1.4 mm in females, males smaller. Colour often white, i. e. specimens completely unpigmented, some species with black or reddish eyes or with grey, brown, violet, yellow, or reddish body pigment. Since the pigments often fade in alcohol, species specificity of the colours is uncertain. Large abdomen including segments I to IV (BETSCH 1980: 15) with Abd V partially included into Abd IV (Fig. 144).

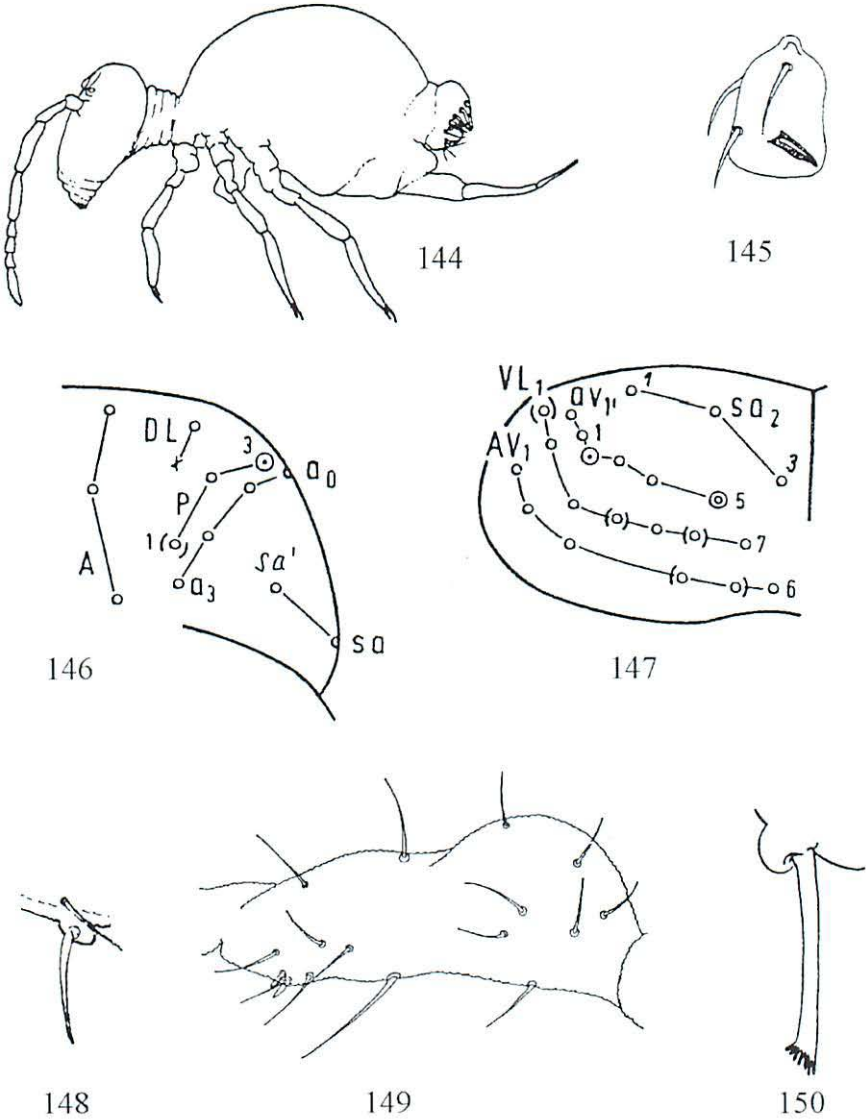
Body setae short, stiff, on large abdomen posteriorly longer than anteriorly; head, thorax, and dens often with spines or stouter setae (chaetotaxy only partially described). Tracheae not observed with certainty (BETSCH 1980: 22). 4 pairs of Bothr; Bothr ABC equidistant, lying behind Abd I (BETSCH & WALLER 1989: 20) and forming an angle opening anteriorly. App. an. directed towards the genital opening, shaped like a seta, rod, feather, or brush, usually with small or long fringes or branches. App. an. often species specific; they must be examined from posterior or dorsal. Seldom with neosminthuroid setae (*A. baccetti*). Head often with stout setae or spines on frons, apex, and dorsal head-back (Figs. 202, 205, nomenclature not uniform, see CHRISTIANSEN & BELLINGER 1981: 1097, BETSCH & WALLER 1994: 8). Eyes with only 1+1 ommatidia, except one species with 2+2 (*A. bellingeri*, USA). Ant III sometimes thickened (Fig. 149), in some species with a cuticular papilla resembling that in *Sminthurinus* (Figs. 174, 189). Ant IV entire or divided into 4 - 12 subsegments, often with distinct sutures, seldom indistinctly annulate. Ratio of length of antennal segments and subsegments often used in species descriptions. Legs mainly known by the trochanteral organ, the claws, and the empodia. Trochanteral organ, on trochanters II and III, with a shortened seta lying in an enlarged socket of elongate, triangular form (Fig. 145). Claw I slender, claw II broader, claw III the broadest, seldom all claws slender; 1 inner tooth, lateral teeth, and a tunica may occur (Figs. 152, 226). Emp I short, Emp II broader and longer, Emp III the broadest and longest; outer tooth and filament often present, the filaments sometimes exceeding the claws, i. e. an entire empodium is described as being shorter or longer than its claw (Figs. 152, 226). VT with 2 - 3 pairs of setae. Ret with 4+4 teeth and usually 2 setae, seldom 1. Manubrium with posterior setae. Dens well known, with different spines: anterodistal, outer, and inner; main chaetotaxic pattern with external, posterior, and internal rows with E:7, P:6, J:3 setae, and E1, E3, J1 - 3 forming spines; formula of anterior setae 3,2,1,(1),1, i. e. with 8 or 7 setae (Fig. 227, compare CHRISTIANSEN & BELLINGER 1981:1097, NAYROLLES 1990: 49). Mucro always slender and relatively long, inner and outer posterior edges usually serrate, anterior edge sometimes indented; tip pointed, broad, or round (Figs. 155, 217, 227); seta missing. Abd VI (chaetotaxy see Figs. 146, 147) with thick and often winged circumanal setae, 1 group (*caecus*-group) with spines or cuticular projections between the setae (Fig. 156); seta a0 and others sometimes furcate; seta P3 inserting between the circumanal setae (Fig. 146); seta sa3 sometimes as large as the App. an. ('pseudoappendices' of RUSEK 1967). *A. pygmaeus* and *A. terricola* with sexual dimorphism of Abd VI (BETSCH & CASSAGNAU 1966).

Occurrence: Worldwide.

Biology: Besides the Neelida, the *Arrhopalites* species are the only unpigmented hemi- and euedaphic Symphypleona in the Palaearctic with a reduced number of ommatidia. They live in damp habitats, in moss, litter, and different soils but also in caves, on surfaces or in substrates, as troglaphiles or troglobites (MASSOUD & THIBAUD 1973: 141). In general they are collected as single specimens or in low numbers, rich populations are rare. Males are seldom found, therefore parthenogenesis was assumed by several authors and has been proven by BLANCQUAERT et al. (1981: 118).

Descriptions of the genus: BÖRNER 1906: 182, STACH 1945: 1, STACH 1956: 63, CHRISTIANSEN 1966: 43, BETSCH 1980: 130, CHRISTIANSEN & BELLINGER 1981: 1095.

Type species: *Sminthurus caecus* Tullberg, 1871.



Figs. 144 - 147 *Arrhopalites* general:

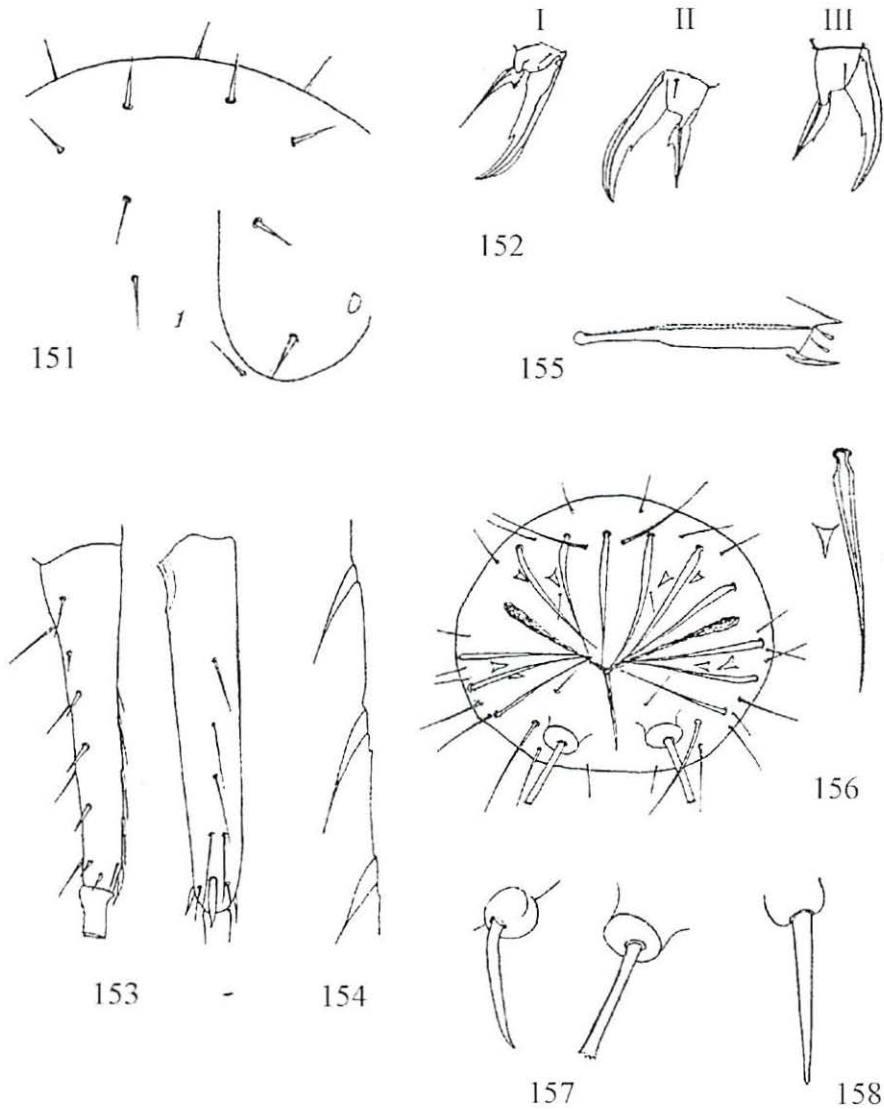
144 Habitus, *Arrhopalites sericus* (after FJELLBERG 1980) 145 Trochanter with trochanteral organ (after RICHARDS 1968) 146 Chaetotaxy of Abd VI dorsal part, left side, (x = missing seta, (o) = varying seta, P3 = sensillum, after BRETFELD 1994) 147 Chaetotaxy of Abd VI ventral part, left side (av5 = App. an., other symbols as in Fig. 146, after BRETFELD 1994).

Figs. 148 - 165 *caecus*-group.

Fig. 148 *Arrhopalites antrobius*, App. an. (after YOSHII 1954).

Figs. 149 - 150 *Arrhopalites baccetti* (after DALLAI 1969):

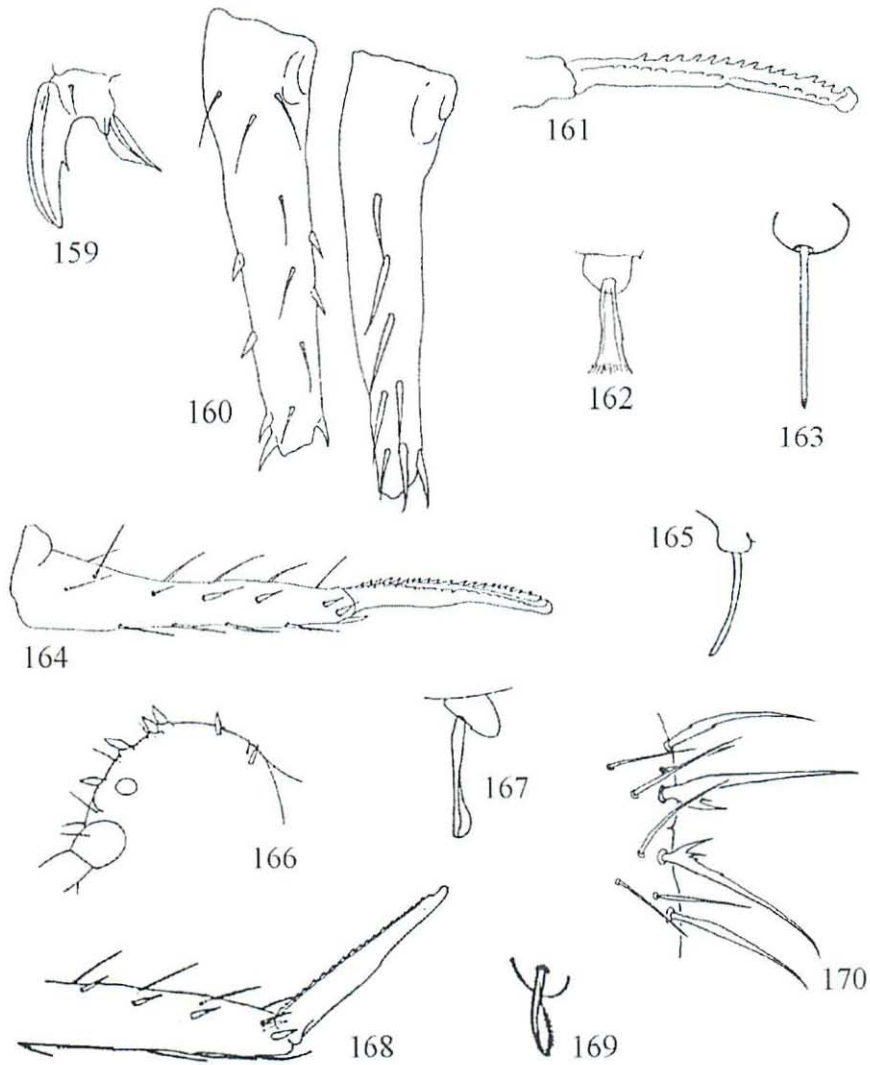
149 Ant III with basal thickening, 150 App. an.



Figs. 151 - 157 *Arrhopalites caecus*.

151 Head setae (after STACH 1956) 152 Claws and empodia (after STACH 1945) 153 Dens, outer and anterior sides (after STACH 1956 and 1945 respectively) 154 Dens setae J1 - 3 (after STACH 1945) 155 Tip of dens and mucro from lateral (after STACH 1956) 156 Abd VI from posterior, small spine and winged seta enlarged (after STACH 1945) 157 App. an. from lateral and posterior (right) (after STACH 1945).

Fig. 158 *Arrhopalites loczyi* App. an. (after LOKSA 1960).



Figs. 159 - 162 *Arrhopalites minutus* (after YOSII 1970):

159 Claw and Emp III 160 Dens, posterior and anterior (right) sides 161 Mucro 162 App. an.

Fig. 163 *Arrhopalites tenuis*, App. an. (after STACH 1945).

Figs. 164 - 165 *Arrhopalites ulehlovae* (after RUSEK 1970):

164 Dens and mucro from outer side 165 App. an.

Figs. 166 - 170 *cochlearifer*-group. Figs. 166 - 167 *Arrhopalites cochlearifer* (after GISIN 1960):

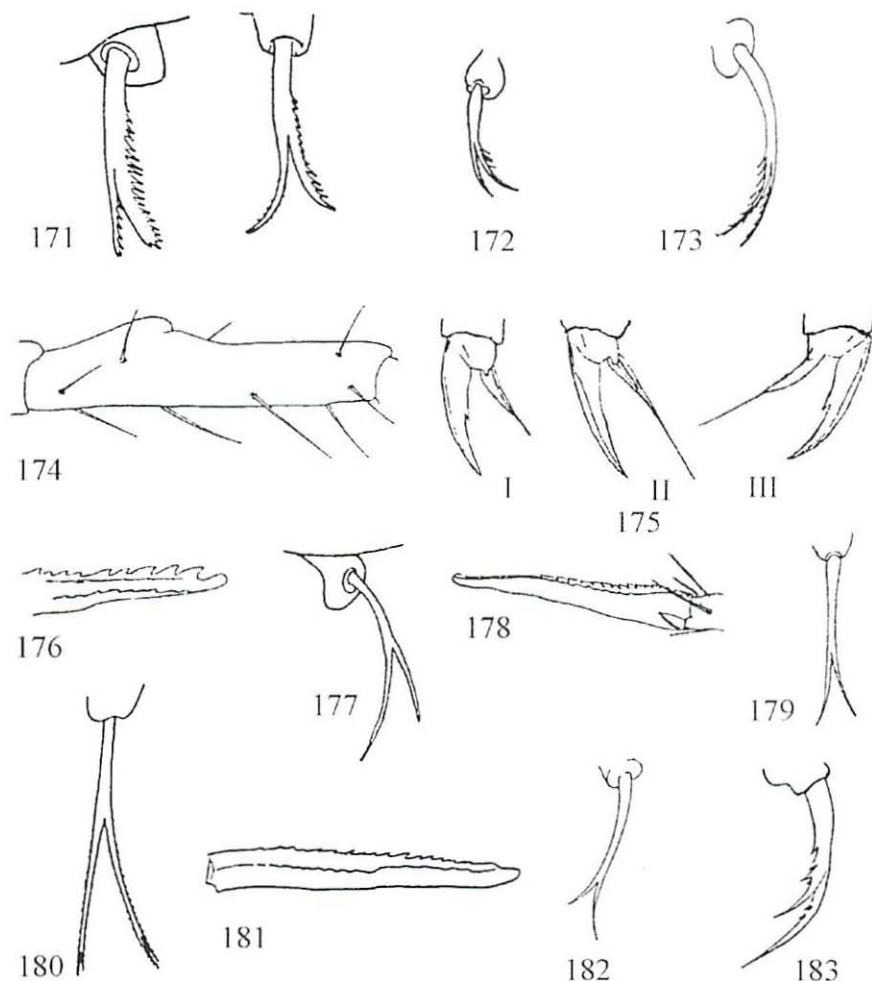
166 Head with spines 167 App. an. from lateral.

Figs. 168 - 169 *Arrhopalites gisini* (after NOSEK 1960):

168 Tip of dens and mucro from outer side, 169 App. an. from lateral.

Fig. 170 *Arrhopalites spinosus*, some circumanal setae (after RUSEK 1967).





Figs. 171 - 183 *furcatus*-group.

Fig. 171 *Arrhopalites bifidus*, 2 different App. an. (after STACH 1945)

Fig. 172 *Arrhopalites chopardi*, App. an. (after CASSAGNAU & DELAMARE DEBOUTTEVILLE 1955)

Fig. 173 *Arrhopalites elegans*, App. an. (after CASSAGNAU & DELAMARE DEBOUTTEVILLE 1953)

Figs. 174 - 177 *Arrhopalites furcatus* (after STACH 1945):

174 Ant III with basal papilla 175 Claws and empodia 176 Tip of mucro 177 App. an.

Figs. 178 - 179 *Arrhopalites hungaricus* (after LOKSA 1967):

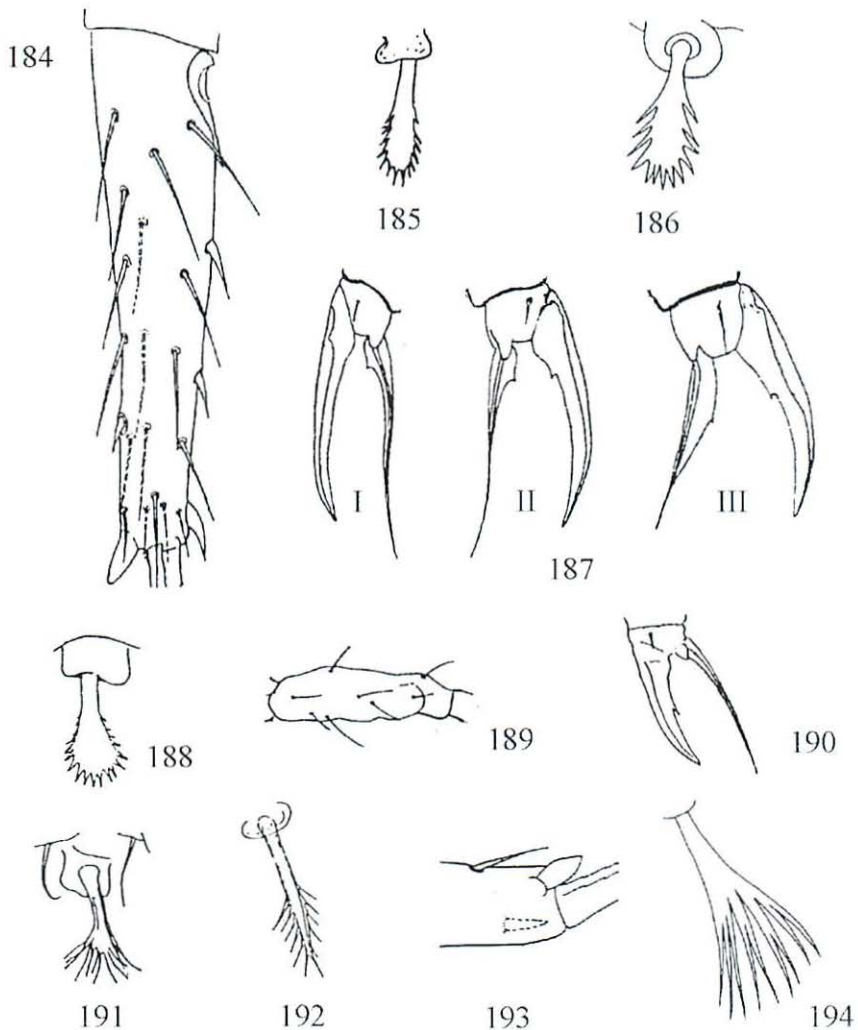
178 Mucro from outer side 179 App. an.

Fig. 180 *Arrhopalites intermedius*, App. an. (after LOKSA 1969).

Figs. 181 - 182 *Arrhopalites mauli* (after DELAMARE DEBOUTTEVILLE & BASSOT 1957):

181 Mucro from outer side 182 App. an.

Fig. 183 *Arrhopalites subbifidus*, App. an. (after TRAVÉ et al. 1954).



Figs. 184 - 188 *postumicus*-group.

Figs. 184 - 185 *Arrhopalites canzianus* (after STACH 1945): 184 Dens from posterior 185 App. an.

Fig. 186 *Arrhopalites postumicoides*, App. an. (after CASSAGNAU & DELAMARE DEBOUTTEVILLE 1953).

Figs. 187 - 188 *Arrhopalites postumicus* (after STACH 1945): 187 Claws and empodia 188 App. an.

Figs. 189 - 207 *principalis*-group.

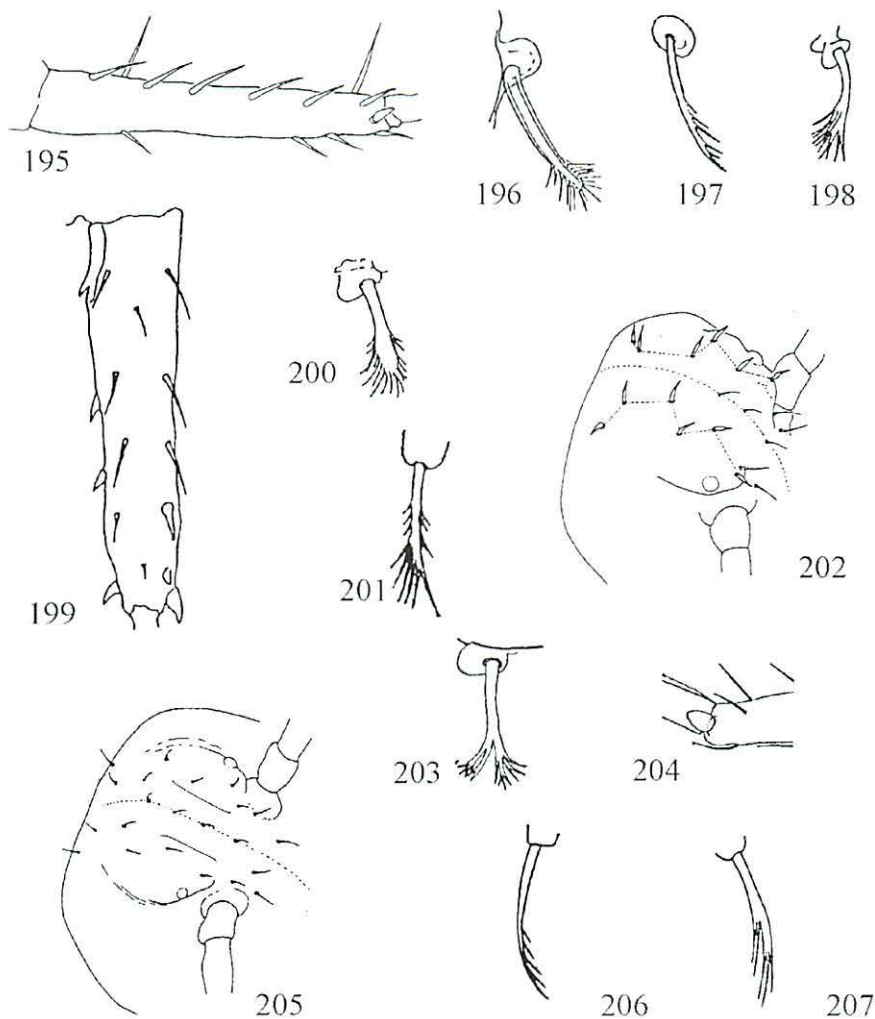
Figs. 189 - 191 *Arrhopalites alticola* (after YOSII 1970): 189 Ant III with distal papilla

190 Claw and Emp I 191 App. an.

Fig. 192 *Arrhopalites habeii*, App. an. (after YOSII 1956).

Figs. 193 - 194 *Arrhopalites infrasecundarius* (after LOKSA & RUBIO 1966)

193 Tip of dens with stout spine E1 194 App. an.



Figs. 195 - 196 *Arrhopalites japonicus* (after YOSHII 1956): 195 Dens, outer side 196 App. an.  
 Fig. 197 *Arrhopalites jeanneli*, App. an. (after CASSAGNAU & DELAMARE DEBOUTTEVILLE 1955).

Fig. 198 *Arrhopalites kolymensis*, App. an. (after TSHELNOKOV 1990).

Figs. 199 - 200 *Arrhopalites octacanthus* (after YOSHII 1970): 199 Dens, posterior side 200 App. an.

Fig. 201 *Arrhopalites ornatus*, App. an. (after STACH 1945).

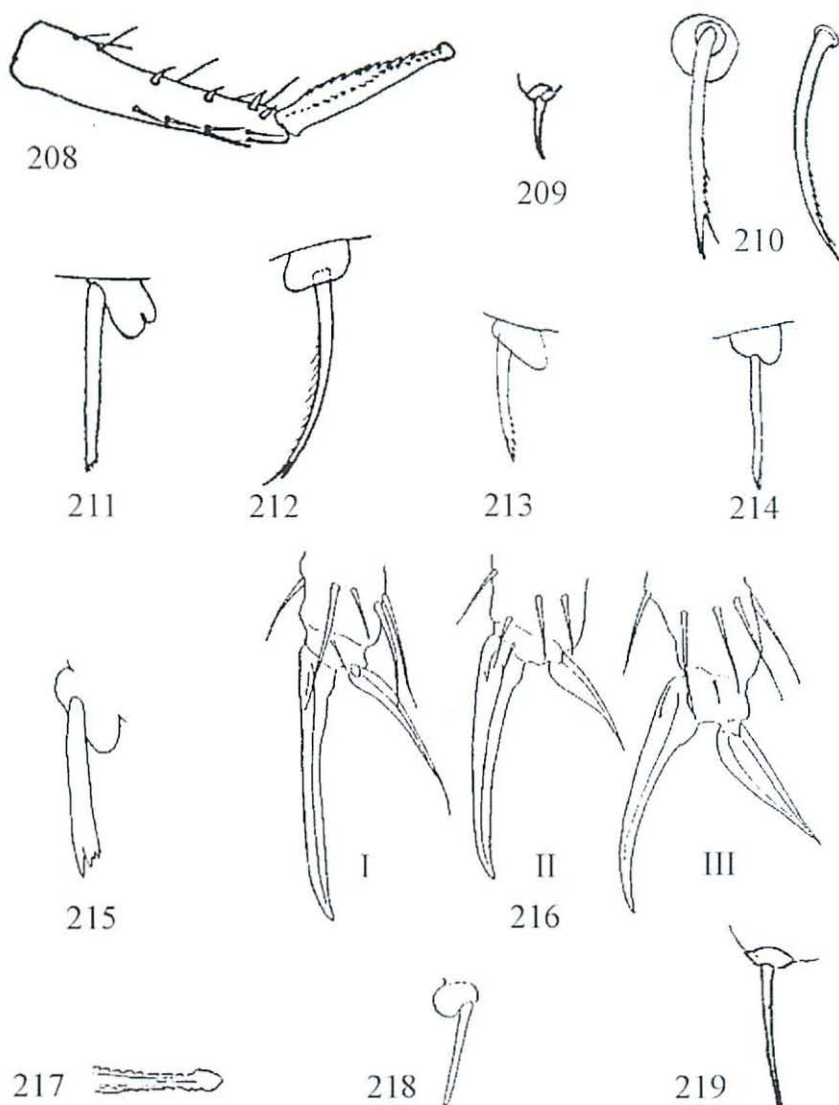
Figs. 202 - 203 *Arrhopalites principalis*:

202 Stout head setae (after FJELLBERG 1980) 203 App. an. (after STACH 1945).

Fig. 204 *Arrhopalites secundarius*, tip of dens with stout spine E1 (after GISIN 1958).

Figs. 205 - 206 *Arrhopalites sericus*: 205 Normal head setae (after FJELLBERG 1980) 206 App. an. (after GISIN 1960).

Fig. 207 *Arrhopalites thermophilus*, App. an. (after LOKSA 1964).



Figs. 208 - 236 *pygmaeus*-group.

Figs. 208 - 209 *Arrhopalites acanthophthalmus* (after GISIN 1958):

208 Dens and mucro from outer side 209 App. an.

Fig. 210 *Arrhopalites aggtelekiensis*, 2 different App. an. (after STACH 1945).

Fig. 211 *Arrhopalites boneti*, App. an. (after STACH 1945).

Fig. 212 *Arrhopalites buekkensis*, App. an. (after LOKSA 1969).

Fig. 213 *Arrhopalites delamarei*, App. an. (after NOSEK & PAOLETTI 1984).

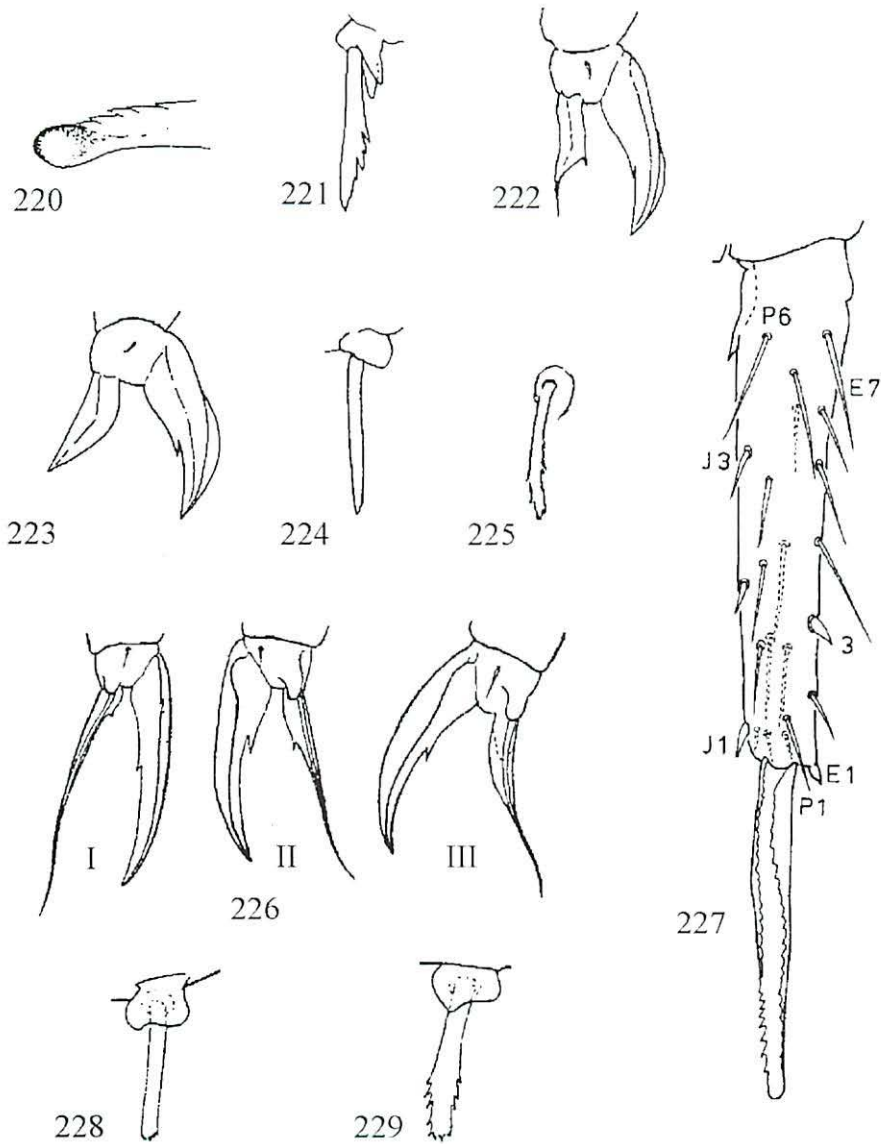
Fig. 214 *Arrhopalites dudichi*, App. an. (after LOKSA & RUBIO 1966).

Fig. 215 *Arrhopalites giovannensis*, App. an. (after CASSAGNAU & DELAMARE DEBOUTTEVILLE 1953).

Figs. 216 - 218 *Arrhopalites gul* (after YOSII 1966):

216 Claws and empodia 217 Tip of mucro 218 App. an.

Fig. 219 *Arrhopalites hedrosensis*, App. an. (after SELGA 1963).



Figs. 220 - 221 *Arrhopalites longicornis* (after CASSAGNAU & DELAMARE DEBOUTTEVILLE 1953): 220 Tip of mucro 221 App. an.

Figs. 222 - 224 *Arrhopalites microphthalmus* (after CASSAGNAU & DELAMARE DEBOUTTEVILLE 1953): 222 Claw and Emp II 223 Claw and Emp III 224 App. an.

Fig. 225 *Arrhopalites pseudoappendices*, App. an. (after RUSEK 1967).

Figs. 226 - 229 *Arrhopalites pygmaeus* (after STACH 1945): 226 Claws and empodia 227 Dens and mucro from posterior (nomenclature orig., figure after STACH 1945) 228 App. an. 229 App. an. of another specimen.

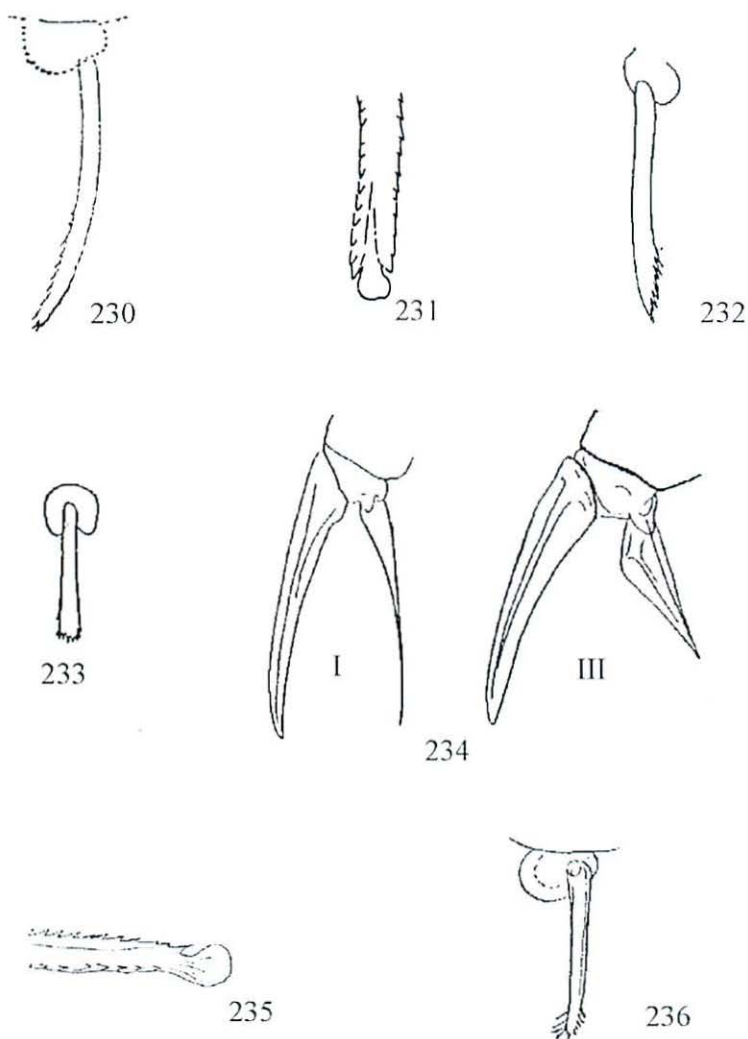


Fig. 230 *Arrhopalites ruseki*, App. an. (after NOSEK 1975).

Figs. 231 - 232 *Arrhopalites subboneti* (after CASSAGNAU & DELAMARE DEBOUTTEVILLE 1953):  
231 Tip of mucro 232 App. an.

Fig. 233 *Arrhopalites terricola*, App. an. (after GISIN 1958).

Figs. 234 - 236 *Arrhopalites uenoi* (after YOSHII 1956):

234 Claws and Emp I and III 235 Tip of mucro 236 App. an.

### Diagnosis of the Palaearctic species

*Arrhopalites acanthophthalmus* Gisin, 1958 (773)

Only females known. Total length 0.55 mm. Colour white. Head with 13 spines. 1+1 unpigmented ommatidia. Ant III basally thickened. Ant IV undivided. Claws with uncertain inner tooth. Ret with 1 seta. Dens with setae E1 - 4 and J1, J3 (?) as spines (Fig. 208). Edges of mucro serrate; tip spherical (Fig. 208). Circumanal setae stout but not winged. App. an. rodlike, smooth, slightly curved with pointed (?) tip (Fig. 209).

Proportions: Ant I : II : III : IV = 1 : 2.5 : 3.5 : 5.5.

Type locality: N Spain, Santander, near Espinama, N slope of Salvaron valley, in a *Fagus* forest at 1400 m altitude.

Occurrence: Also reported from S France (POINSOT 1974: 126, STOMP et al. 1982: 21), former Yugoslavia (e. g. CVIJOVIC 1974: 111), E and W Austria (LOUB & HAYBACH 1983: 116, KOPESZKI & MEYER 1994: 157 respectively), and SW Germany (upper Rhine valley, RUSSELL, pers. comm.).

*Arrhopalites aggtelekiensis* Stach, 1929 (308) sensu Stach, 1945 (19)

Syn.: *Arrhopalites pygmaeus aggtelekiensis* Stach, 1929 (308)

Only females known. Total length 1.4 mm. Colour white to rusty red. Setae posteriorly on large abdomen 1.3 times longer than claw III. 1+1 unpigmented ommatidia. Ant III with basal papilla. Ant IV with 9 - 10 subsegments, the second sometimes indistinctly separated from the first. Claws slender with weak inner tooth; Emp I and II (rarely also Emp III) with tooth, length of all Emp < claws. Ret with 2 setae. Dens with E:7, P:2 (?), J:?, anteriorly 7 setae; only E1 as a slender spine. Inner edge of mucro serrate, outer with few indistinct teeth; tip pointed. Circumanal setae not winged. App. an. setalike, slightly curved, distal 1/2 with small teeth or fringes; tip pointed and usually a little split (Fig. 210).

Proportions: Length of antennae : head diagonal = 2.5. Ant I : II : III : IV = 1 : 2 : 3 : 10. Ant IV subsegments from basal to distal = 5 (or 4) : 1 : ... : 1 : 2.5. Dens : mucro = 1.55.

Type locality: Hungary, Aggtélek cave, on wet stalagmites.

Occurrence: Known only from the type cave but collected from different sites.

*Arrhopalites alticola* Yosii, 1970 (15)

Only 1 female known. Total length 0.7 mm. Colour pale grey, large abdomen posteriorly darker. Head setae short, normal. 1+1 black ommatidia. Ant III with distinct distal papilla (Fig. 189). Ant IV with 5 subsegments. Claws with inner tooth, claws II and III with tunica; Emp without tooth, Emp I setaceous (Fig. 190), length of Emp I and II > claws, Emp III < claw. VT with 1+1 setae. Ret with 2 setae. Manubrium with 6+6 setae. Dens with E:7, P:5 (P1 is missing), J:3, anteriorly 7 setae; setae E1, E3 and J1 - 3 as spines. Edges of mucro irregularly serrate; tip blunt. Circumanal setae not or only slightly winged. App. an. stout, straight; tip broadened with long fringes (Fig. 191).

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 2 : 3 : 6.5. Ant IV subsegments from basal to distal = 3 : 1 : 1 : 1 : 2.6. Dens : mucro = 1.5.

Type locality: Japan, Nagano, Shigakogen.

Occurrence: Known only from the type locality.

Remarks: One special characteristic of *A. alticola* is the missing dens seta P1.

*Arrhopalites antrobius* Yosii, 1954 (68) sensu Yosii, 1967 (64)

Only females known. Total length 1.3 mm. Colour white. Head frons with 3 - 4 lateral pairs of spinelike setae. 1+1 unpigmented ommatidia. Ant IV with 5 subsegments. Claws with inner tooth and tunica, in claw I both elements weakly developed; Emp with tooth, however sometimes missing in Emp I, length of Emp I > claw, Emp II and III < claws. Ret with 1 seta. Manubrium with 4+4 posterior setae. Dens with E:7, P:5, J:4, anteriorly 8 setae; setae E1 - 6 and J1 - 4 stout, spinelike, without anterodistal median spine. Edges of mucro serrate; tip pointed. Circumanal setae winged, 3+3 spines on dorsal anal valves and 2+2 on ventral. App. an. slender, slightly curved; tip blunt (Fig. 148).

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 2.3 : 4 : 8.8. Ant III : Ant IV basal subsegment = 1. Ant IV subsegments from basal to distal = 4.7 : 1.3 : 1.3 : 1 : 2.6. Dens : mucro = 1.7. Mucro : claw III = 2.4. App. an. : claw III = 0.7.

Type locality: Japan, Akiyoshi, in cave »Tonogochi no Ko-Ana«.

Occurrence: Also known from another cave in Japan ("Yakujin Do« in the type district, YOSII 1967: 64).

*Arrhopalites baccetti* Dallai, 1969 a (235)

Only females described. Total length 0.6 mm. Colour white. Head setae slightly stouter than normal. 1+1 ommatidia. Ant III proximally thickened (Fig. 149). Ant IV undivided. Claws with inner tooth and tunica; only Emp II with tooth, length of all empodia < claws. 1 pair of short neosminthuroid setae. Ret with 1 seta. Dens E:5, P:4, J:3, anteriorly 7 setae; setae E1 - 4 and J1 - 3 spinelike, without anterodistal median spine. Distal 2/5 of mucro narrowed, edges serrate; tip spherical. Circumanal setae stout but not winged, short spines or cuticular projections on dorsal and ventral anal valves. App. an. bandlike, straight or slightly curved, ratio of length to width = 15; tip cut with about 7 small teeth (Fig. 150).

Proportions: Length of antennae : head diagonal = 1.24. Ant I : II : III : IV = 1 : 2.4 : 4.1 : 5.5. Dens : mucro = 1.45. App. an. : claw III outer side = 1. App. an. : Mucro = 0.4.

Type locality: Italy, S Sicily, Casteluccio near Ragusa, in humus under *Pinus halepensis* and *Ceratonia siliqua*.

Occurrence: Also known from S Italy, the Liparic Islands (DALLAI, see below), Israel (orig. observ., leg. BROZA & POLIAKOV), and Germany (Baden-Württemberg, Stuttgart, orig. observ., leg. STIERHOF).

Species description: DALLAI 1973: 560.

*Arrhopalites bifidus* Stach, 1945 (34) sensu Stach, 1956 (83)

Only females known. Total length 1.3 mm. Colour white to reddish or brown-violet. Setae posteriorly on large abdomen 2 times longer than claw III. Head with normal setae. 1+1 more or less pigmented ommatidia. Basal 1/2 of Ant III thickened and with cuticular papilla. Ant IV with 5 - 6 subsegments. Claws with inner tooth and lateral teeth; Emp I and II with tooth, length of all empodia > claws. Ret with 2 setae. Dens with E:6, P:6, J:3, anteriorly 7 setae; setae E1, E3 and J1 - 3 as spines. Distal 1/2 of mucro slightly narrowed, edges irregularly serrate; tip spoonlike. Circumanal setae winged, seta a0 and sometimes also setae al furcate. App. an. thick, slightly curved, furcate, with rough teeth (Fig. 171).

Proportions: Length of antennae : head diagonal = 1.8. Ant I : II : III : IV = 1 : 2 : 4 : 10. Ant IV subsegments from basal to distal = 4.5 : 1 : 1 : 1 : 2.5 (or 1 : 1.5). Dens : mucro = 1.5.



Type locality: Not defined. Originally described from Ukraine, Bilcze cave; Poland, Reyersdorfer cave in the E Sudeten; Germany, several caves in North Rhine-Westphalia and Bavaria, Franconia.

Occurrence: Also found in caves in the Czech Rep. (DUNGER 1970:506) and Slovakia (RUSEK 1966: 62).

Biology: *A. bifidus* is troglobite (MASSOUD & THIBAUD 1973: 154).

Remarks: *A. bifidus* was also reported from Great Britain, (Scotland, Ulva, extracted from beech humus, GOUGH 1978:63), and from caves in Belgium (ex coll. BONET, SELGA 1963: 474). These specimens are not completely identical with the original description, since the Scottish have Emp III with an outer tooth and length < claw, the Belgish also have Emp III < claw.

*Arrhopalites boneti* Stach, 1945 (16)

Syn.: *Arrhopalites pygmaea* Bonet, 1931 (368)

Only females known. Total length 1 mm. Colour white. Setae posteriorly on large abdomen 2 times longer than claw III. 1+1 unpigmented ommatidia. Ant III not modified. Ant IV with 6 subsegments. Claws slender with inner tooth; Emp I and II with tooth, length of only Emp I > claw. Dens with E:6 - 7, P:6, J:5 (?), anteriorly 7 setae; only spine E1. Distal 1/3 of mucro narrowed, edges serrate; tip spoonlike and somewhat broadened. Circumanal setae not winged. App. an. bandlike, straight; tip cut with 4 - 5 small teeth (Fig. 211).

Proportions: Length of antennae : head diagonal = 2.3. Ant I : II : III : IV = 1 : 2 : 3.4 : 9.5. Ant IV subsegments from basal to distal = 2.5 : 1.2 : 1.1 : 1.1 : 1 : 2.5. Dens : mucro = 1.3.

Type locality: Not defined. Originally described from Spain, Guipúzcoa, 3 caves (Aitzquirri, Hernialde, and San Adrián caves), on water surface.

Occurrence: Also found in other Spanish caves (JORDANA et al. 1990: 28) and in N Germany (caves of the Harz Mts., SCHULZ 1994).

Biology: *A. boneti* is troglobite (MASSOUD & THIBAUD 1973: 154).

Species description: SELGA 1963: 459 and 458 (length of antennae : head diagonal = 2 - 2.4, length of App. an.  $\geq$  claw III inner edge, dens : mucro = 1.5 - 1.7).

*Arrhopalites buekkensis* Loksa, 1969 (359) n. comb.

Syn.: *Arrhopalites aggtelekensis* [sic] *buekkensis* Loksa, 1969 (359)

Only females known. Total length 1.3 mm. Colour yellowish white. 1+1 unpigmented ommatidia. Ant IV with 8 subsegments. Claws slender, with weak inner tooth and 1 pair of distal lateral teeth; Emp I and II with tooth, length  $\leq$  claws; Emp III without tooth, length  $\leq$  claw. Dens with E:8 (?), P:6, J:3, anteriorly 8 setae; only E1 as a slender spine, J1 - 3 short and spinelike. Inner edges of mucro serrate, outer with weak teeth or only wavy; tip broadened, spoonlike. Circumanal setae not winged but setae a0 and a1 forked, seta sa3 shorter than App. an.. App. an. setalike, slightly curved, distal 2/3 with small teeth or fringes; tip pointed and usually slightly split (Fig. 212).

Proportions: Length of antennae : head diagonal = 2.25. Ant I : II : III : IV = 1 : 2 : 3.7 : 10. Ant IV subsegments from basal to distal = 5.2 : 1 : ... : 1 : 1.65.

Type locality: Hungary, Bükk Mts., Szamentu cave.

Occurrence: Known only from the type locality.

Remarks: *A. buekkensis* differs from *A. aggtelekiensis* mainly in colour (yellowish white instead of white or rusty), the number of Ant IV subsegments (8 instead of 9 - 10), the broadened tip of mucro, and the slightly different proportions of the antennae. The setae a0 and a1 of Abd VI are forked in *buekkensis*, a characteristic not mentioned by STACH for *aggtelekiensis*. This taxon is regarded as a separate species here, since it is partially better described than *aggtelekiensis* and since the specimens of coll. STACH had not been consulted.

*Arrhopalites caecus* (Tullberg, 1871) (146) sensu Stach, 1956 (73)

Syn.: *Sminthurus caecus* Tullberg, 1871 (146)

*Sminthurinus coecus* Börner, 1901 (344)

*Arrhopalites coecus* Börner, 1906 (182)

Only females known. Total length < 1 mm. Colour white, sometimes with reddish spots. Setae posteriorly on large abdomen as long as claw III. Head setae slightly stouter than normal (Fig. 151). 1+1 unpigmented ommatidia. Ant III not modified. Ant IV undivided or with 5 weak subsegments. Claws with inner tooth and tunica; Emp with tooth, length of all empodia < claws (Fig. 152). Ret with 2 setae. Dens with E:6 - 7, P:6?, J:3, anteriorly 8 setae; setae E1 - 5 and J1 - 3 spinelike, anterodistal median seta as a stout spine (Figs. 153, 154). Distal 2/5 of mucro narrowed, edges serrate; tip spherical (Fig. 155). Circumanal setae winged, 2+2 short spines on dorsal and also ventral anal valves (Fig. 156). App. an. band-like, straight or slightly curved, ratio of length to width = 10; tip cut with 3 - 4 small teeth (Fig. 157).

Proportions: Length of antennae : head diagonal = 1.4. Ant I : II : III : IV = 1 : 2.3 : 3.6 : 7. Dens : mucro = 1.4 - 1.6.

Type locality: Sweden, Uppland.

Occurrence: Palaearctic; from Island (BÖDVARSSON 1957: 38) E to Russia (S Ural Mts. and S Siberia, STEBAEVA 1976: 124, 1989: 303 respectively) and W to the Mediterranean including Italy (POINSOT 1974: 124, FRATELLO et al. 1995: 140) and Morocco (THIBAUD & MASSOUD 1980: 543), and in Portugal, Madeira and the Azores (GAMA 1986: 43, 1992: 47). Whether this species occurs in the Nearctic, Hawaii, and Australia remains to be confirmed (see below).

Biology: *A. caecus* lives in damp litter and soil, under moist decaying bark, in vineyards down to a depth of 30 cm (HÜTHER 1961: 336), and in decaying seaweed (STRENZKE 1955: 49). It was found under flower pots in dwellings (TULLBERG 1871: 146, STACH 1956: 76) and is also a troglophile species (MASSOUD & THIBAUD 1973: 155).

Species descriptions: TULLBERG 1872: 33, SELGA 1963: 467, CHRISTIANSEN 1966: 56, CHRISTIANSEN & BELLINGER 1981: 1104, CHRISTIANSEN & BELLINGER 1992: 344.

Remarks: The wide distribution of *A. caecus* may cause morphological (and taxonomical?) differences, e. g. GISIN (1960: 270) figured a dens with several anterior spines in a specimen from a Burgundy cave, and DALLAI (1973: 559) reported stout head and dens spines from Italy. In the Nearctic, this species also has several anterior dens spines (CHRISTIANSEN, see above, CHRISTIANSEN & BELLINGER 1981: 1104), there and in Hawaii (CHRISTIANSEN & BELLINGER 1992: 344) the circumanal setae have basal teeth, and in Australia Ant IV has 6 subsegments (WOMERSLEY 1932: 17). *Sminthurus caecus* Guthrie, 1903 (49) from USA, Minnesota, has a stout dental spine E1 and thus does not belong to this species.

*Arrhopalites canzianus* Stach, 1945 (28)

Only females known. Total length 1 mm. Colour white. Setae posteriorly on large abdomen 1.5 - 2 times longer than claw III. 1+1 unpigmented ommatidia. Ant III not modified. Ant IV with 5 subsegments. Claws with inner tooth, but in claw I weakly developed; Emp with tooth, length of Emp I and II > claws, Emp III < claw. Dens with E:7, P:6, J:3, anteriorly 7 setae; setae E1, E3 and J1 - 3 as spines, E1 very stout (Fig. 184). Edges of mucro serrate; tip as a round tooth. Circumanal setae not winged. App. an. stout and straight, distal 1/2 racketlike with rough teeth (Fig. 185).

Proportions: Length of antennae : head diagonal = 1.5. Ant I : II : III : IV = 1 : 2.3 : 3.1 : 7.7. Ant IV subsegments from basal to distal = 4 : 1.2 : 1 : 1 : 3. Dens : mucro = 1.3.

Type locality: Former Yugoslavia, Rudolf cave of the S. Canziano caves, in a water-hole.

Occurrence: Also found in Germany (Hesse, Vogelsberg, humus between rocks, BÖHLE 1991: 39).

Remarks: This species may be a modification of *A. postumicus* (STACH 1945: 30).

*Arrhopalites chopardi* Cassagnau & Delamare Deboutteville, 1955 (388)

Only females known. Colour white. Head with normal setae. 1+1 unpigmented ommatidia. Ant III not modified, with several long setae. Ant IV with 5 subsegments. Claws with inner tooth and lateral teeth; Emp I and III with tooth, length of Emp I >> claw, Emp III < claw, Emp II not described. Dens with E:7, P:6, J:3, anteriorly 7 setae; setae E1, E3 as spines and J1 - 3 spinelike. Distal 1/3 of mucro narrowed, edges serrate; tip spoonlike. App. an. slightly curved, deeply furcate, with few fine fringes (Fig. 172).

Type locality: Lebanon, Ghita cave.

Occurrence: Known only from the type locality.

*Arrhopalites cochlearifer* Gisin, 1947 (89) sensu Gough, 1978 (64)

Only females known. Total length 0.5 - 0.7 mm. Colour pale grey. Head apex with 4+4 stout anterior and 2+2 smaller posterior spines (Fig. 166). Ant III not modified. Ant IV with 6 subsegments. Dens with E:6, P:6, J:3, anteriorly 7 setae; setae E1, E3 and J1 - 3 as spines. App. an. straight; tip spoonlike with very fine serrations (Fig. 167).

Type locality: Switzerland, environs of Basel, Reinacherheide, young *Fagus silvatica* forest.

Occurrence: Also found in other W European countries from England (GOUGH, see above) and Norway (FJELLBERG 1980: 131) S to N Italy (DALLAI & MARTINOZZI 1980: 46).

Biology: *A. cochlearifer* lives in damp litter and bogs from the plains up to 2000 m (Switzerland, GISIN 1947: 80).

Species description: FJELLBERG 1984: 87 (maxillary outer lobe).

Remarks: GOUGH (see above) consulted the types.

*Arrhopalites delamarei* Nosek & Paoletti, 1984 (211)

Also males known. Total length 0.9 - 1 mm. Colour white. Setae posteriorly on large abdomen shorter than claw III. Head with very fine spiniform setae. 1+1 unpigmented ommatidia. Ant III with basal papilla. Ant IV with 9 subsegments. Claws slender, claws II and III with inner tooth; Emp I and II with tooth, length of Emp I > claw, Emp II and III < claws. VT with 3+3 setae. Dens with E6 - 7, P:7 (?), J:3, anteriorly 7 setae; E1, E3 as spines, J1 - 3 spinelike. Edges of mucro serrate; tip spherical. Circumanal setae slightly winged. App. an. rather short, stout, slightly curved, tapering, distal 1/3 with small teeth (Fig. 213).

Proportions: Length of antennae : head diagonal = 3. Ant I : II : III : IV = 1 : 2.1 : 4.2 : 12.2. Ant IV subsegments from basal to distal = 7.2 : 1.4 : 1.4 : 1.2 : 1.2 : 1.2 : 1.1 : 1 : 1.8. Dens : mucro = 1.5.

Type locality: NE Italy, Friuli-Venciúlia, Prealpi Venete, Grotta (cave) della Fous.

Occurrence: Known only from the type locality.

Remarks: The original description and the figure of dental outer setae are not identical. Whereas the text reads: »spine-like setae stand in a long row", the corresponding figure only shows E1 and E3 as spines. *A. delamarei* was found together with *A. pygmaeus*; all specimens of the former species were white, of the latter red.

*A. delamarei* resembles *A. longicornis* and *aggtelekiensis*. It differs from *A. longicornis* mainly in the number of the Ant IV subsegments (9 instead of 6), from *A. aggtelekiensis* in the number of dens spines (several instead of only 1) and the tip of the mucro (spherical instead of pointed).

*Arrhopalites dudichi* Loksa & Rubio, 1966 (154) n. comb.

Syn.: *Arrhopalites cochlearifer dudichi* Loksa & Rubio, 1966 (154)

Only 1 female known. Total length about 0.55 mm. Colour rusty red. Head with 4+4 stout spines. 1+1 unpigmented ommatidia. Ant IV with 6 subsegments. Claws without tooth; Emp with tooth, length of Emp I and II > claws, Emp III = claw. Dens with E7 (?), anteriorly 7 setae; E1 as a stout spine, E3 spinelike. Edges of mucro irregularly serrate; tip as a round tooth. App. an. thin, straight, smooth; tip weakly spoonlike, not broadened (Fig. 214).

Proportions: Ant IV subsegments from basal to distal = 2.6 : 1 : 1 : 1 : 1 : 2.4.

Type locality: Hungary, Pálháza, litter of a Fagetum silvaticae caricetosum pilosae association.

Occurrence: Known only from the type locality.

Remarks: *A. dudichi* is regarded here as a separate species because the original description of *A. cochlearifer* is very short, e. g. claws, empodia, and proportions not being described. The main difference from *cochlearifer* is the form of App. an., which in *dudichi* are not spoonlike.

*Arrhopalites elegans* Cassagnau & Delamare Deboutteville, 1953 (138)

Only females known. Basal 1/2 of Ant III with cuticular papilla. Ant IV with 5 subsegments. Claws with inner tooth; only Emp I with tooth, length of all Emp > claws. App. an. slender, slightly curved, deeply furcate, with small fringes (Fig. 173).

Type locality: Spain, Málaga, Sierra Bermeja, La Hanadilla, at 1020 m altitude.

Occurrence: Also found at several other sites in Spain and in continental Portugal (JORDANA et al. 1990: 29), Portugal, Madeira (GAMA 1961 b: 17), S France (IZARRA 1969: 459), and former Yugoslavia (PAGLIARINI 1971: 79).

Biology: *A. elegans* has been found in caves and in open habitats in moss, it is troglophile (MASSOUD & THIBAUD 1973: 154).

Species description: SELGA 1963: 469.

Remarks: The specimens from Portugal have App. an. with unequal branches and very fine fringes (GAMA 1962: 108).

*Arrhopalites furcatus* Stach, 1945 (22)

Only females known. Total length 1 mm. Colour white. Setae posteriorly on large abdomen 2.5 times longer than claw III. 1+1 unpigmented ommatidia. Ant III basal 1/2 with prominent cuticular papilla (Fig. 174). Ant IV with 5 subsegments. Claws slender, claws II and III with inner tooth; Emp without tooth, length > claws (Fig. 175). Ret with 2 setae. Dens with E:7, P:6, J:3, anteriorly 7 setae; setae E1, E3 and J1 - 3 as spines. Distal 1/2 of mucro slightly narrowed, edges serrate; tip spatulate (Fig. 176). Circumanal setae not winged. App. an. thin, slightly curved, smooth, deeply furcate, inner branch shorter than outer (Fig. 177).

Proportions: Length of antennae : head diagonal = 1.8. Ant I : II : III : IV = 1 : 1.8 : 3.2 : 8.3. Ant IV subsegments from basal to distal = 3.4 : 1 : 1 : 1 : 2.5. Dens : mucro = 1.5.

Type locality: Spain, Guipúzcoa, S. Sebastian, Landarbaso cave.

Occurrence: Also found in S Portugal (Algarve, GAMA et al. 1989: 366). France (S France and Corsica, POINSOT 1974: 126, POINSOT-BALAGUER 1978: 186 respectively), and Italy (Tuscany and Liparic Islands, DALLAI 1970: 465, 1973: 561 respectively).

Biology: *A. furcatus* is troglophile since it has been collected from open sites, damp moss, and litter, besides the type locality.

Remarks: The specimen from the Liparic Islands has head spines (DALLAI, see above).

*Arrhopalites giovannensis* Cassagnau & Delamare Deboutteville, 1953 (136)

Only females known. Claws slender, with inner tooth; Emp I and II with tooth, length > claws; Emp III without tooth, length < claw. Dens with E:7, P:6, J:3; E1 as a stout spine, J1 - 3 slightly thickened. Edges of mucro weakly serrate; tip pointed. App. an. thick, straight, distally slightly broadened; tip with rough teeth (Fig. 215).

Type locality: Italy, Sardinia, San Giovanni cave.

Occurrence: Known only from the type locality.

Remarks: This species resembles *A. boneti* and *pygmaeus*, however the mucro and App. an. respectively differ from those species.

*Arrhopalites gisini* Nosek, 1960 (167)

Also males known. Total length 0.5 - 0.6 mm. Colour white. Head with 4+4 stout spines. 1+1 black ommatidia. Ant IV with 6 - 7 subsegments. Claws with small inner tooth; Emp I with toothlike outer corner, length of all Emp > claws. Ret with 2 setae. Dens chaetotaxy uncertain, anteriorly 7 setae; setae E1 - 5 and J1 as spines, E2 only slightly thickened (Fig. 168). Distal 1/2 of mucro narrowed, edges serrate; tip as a round tooth (Fig. 168). Circumanal setae winged, basally smooth. App. an. straight; tip spoonlike with very fine serration (Fig. 169).

Proportions: Length of antennae : head diagonal = 1.5. Ant III : IV = 1.9. Ant IV subsegments from basal to distal = 2.5 : 1 : 1 : 1 : 1 : 3.5 (or 1 : 2.5). Dens : mucro = 1.85.

Type locality: Czech Rep., primeval forest of Boubín, humus and moss under *Picea* and *Fagus*.

Occurrence: Also found in other mountains in the Czech Rep. and Slovakia (NOSEK 1969: 402, DUNGER 1970: 503, RUSEK 1977: 16), S Poland (SZEPTYCKI, see below), Ukraine (NOSEK & VYSOTSKAYA 1973: 35), and former Yugoslavia (e. g. CVIJOVIC 1976: 105).

Biology: *A. gisini* lives in damp litter, moss, and humus; it was also found in nests of small mammals (NOSEK & VYSOTSKAYA, see above).

Species description: SZEPTYCKI 1967: 240 (head spines, dens, App. an.).

Remarks: The only difference to *A. cochlearifer* seems to be the chaetotaxy of dens.

*Arrhopalites gul* Yosii, 1966 c (559)

Also males known. Total length 1.2 mm. Colour white or brownish. Setae posteriorly on large abdomen 3 times longer than those on anterior part. Head dorsal setae stout. 1+1 unpigmented ommatidia. Ant III not thickened. Ant IV with 7 subsegments. Claws very slender, with 1 pair of basal lateral teeth and weak inner tooth; Emp sometimes with tooth, length always < claws (Fig. 216). VT with 1+1 setae. Ret with 1 seta. Manubrium with 4+4 posterior setae. Dens with E:7, P:6, J:3, anteriorly 8 setae; without spines. Distal 1/3 of mucro narrowed, edges serrate; tip as a round lobe (Fig. 217). Circumanal setae winged and with basal teeth, seta a0 not forked. App. an. rodlike, straight, smooth; tip blunt (Fig. 218).

Proportions: Length of antennae : head diagonal = 3. Ant I : II : III : IV = 1 : 3 : 5.5 : 13.5. Ant IV subsegments from basal to distal = 3.5 : 1 : 1 : 1 : 1 : 1.8. Dens : mucro = 2.2.

Type locality: South Korea, Kangwon-do, Hwaam-gul cave.

Occurrence: Also found in other South Korean caves (YOSII, see above).

Remarks: *A. gul* resembles *A. uenoi* but differs in its antennae, claws, and App. an.

*Arrhopalites habei* Yosii, 1956 (98)

Also males known. Total length about 1 mm. Colour white and weakly brown-reddish. Anterior of large abdomen with only few setae, posterior part with more but smaller setae. Head with 1 pair of spinelike setae near eyes. 1+1 brown ommatidia. Ant III not modified. Ant IV with 7 subsegments. Claws II and III with inner tooth; Emp with tooth, length  $\geq$  claws. Ret with 1 seta. Manubrium with 6+6 posterior setae. Dens with E:7, P:6, J:3, anteriorly 7 setae; setae E1, E3 and J1 - 3 as spines. Edges of mucro serrate; tip pointed. Circumanal setae not winged, seta a0 forked. App. an. stout and tapering, slightly curved, distal 1/2 with long fringes (Fig. 192).

Proportions: Length of antennae : head diagonal = 1.75. Ant I : II : III : IV = 1 : 2.3 : 3.5 : 8. Ant III : Ant IV basal subsegment = 1.5. Ant IV subsegments from basal to distal = 2.8 : 1 : 1 : 1 : 1 : 1.8. Dens : mucro = 1.8.

Type locality: Japan, Aichi, Toyohashi, Susé no Dja Ana cave.

Occurrence: Also found in other Japanese caves and in open habitats (YOSII, see above). Specimens from Nepal differ slightly (YOSII 1966: 521). Uncertainly recorded from South Korea (YOSII 1966: 559).

Remarks: *A. habei* is said to resemble *A. spadica* Salmon, 1963 from Sikkim (YOSII 1966: 521).

*Arrhopalites hedrosensis* Selga, 1963 (465)

Only 1 female known. Total length 0.8 mm. Colour white. Setae posteriorly on large abdomen about 1.5 times longer than claw (III?) inner edge. Head with 4+4 stout spines. Ant III basally thickened. Ant IV with 5 subsegments. Claws with small inner tooth; Emp I and II with tooth, length > claws; Emp III without tooth, length = claw. Ret with 1 seta. Dens with E:7, P:6, J:3, anteriorly 7 (?) setae; setae E1 - 4 and J1 - 3 as spines, E1 strongest. Edges of mucro serrate; tip more or less rounded. Circumanal setae winged. App. an. rodlike, slightly curved, tapering, with fine fringes (Fig. 219).

Proportions: Length of antennae : head diagonal = 1.6. Ant I : II : III : IV = 1 : 3 : 4.5 : 10. Ant IV subsegments from basal to distal = 3.3 : 1 : 1 : 1 : 2.5. App. an. : claw III inner edge = 1.7. Dens : mucro = 1.4.

Type locality: Spain, Zamora, Hedroso, between *Sphagnum*.

Occurrence: Known only from the type locality.

Remarks: *A. hedrosensis* resembles *A. acanthophthalmus* and *A. microphthalmus*. It differs from the former in its fewer head spines and its subdivided Ant IV, from the latter in the presence of head spines and the Ret seta.

*Arrhopalites hungaricus* Loksa, 1967 (294)

Also males known. Total length 1.2 - 1.4 mm. Colour white to pale yellow. Head with normal setae. 1+1 unpigmented ommatidia. Ant III basal 1/2 thickened. Ant IV with 8 subsegments. Claws slender, with inner tooth and lateral teeth; Emp with tooth, length > claws. Dens with E:7, P:6, J:3, anteriorly 7 setae; seta E1 as a spine, and J1 - 3 spinelike. Edges of mucro serrate only in proximal 2/3, but inner edge densely, outer irregularly serrate; tip spoonlike (Fig. 178). Circumanal setae not winged. App. an. slender, curved, distal 1/3 furcate, smooth (Fig. 179).

Proportions: Length of antennae : head diagonal = 2.2. Ant I : II : III : IV = 1 : 2.7 : 4.4 : 10.3. Ant IV subsegments from basal to distal = 10 : 1.4 : 1.5 : 1.4 : 1.4 : 1.4 : 1 : 3.6. Dens : mucro = 1.6 - 1.8.

Type locality: Hungary, Oz cave.

Occurrence: Also found in other caves of Hungary (Kifli and Hideglik caves, LOKSA, see above).

*Arrhopalites infrasecondarius* Loksa & Rubio, 1966 (154)

Only 1 female known. Colour pale violet. Head with 4+4 slender spines. 1+1 black ommatidia. Ant III not modified. Ant IV with 5 subsegments. Claws with inner tooth; Emp setaceous, without tooth, length  $\geq$  claws. Chaetotaxy of dens uncertain, seta E1, E3 and J1 - 3 as spines, E1 stout, rather oval (Fig. 193). Edges of mucro finely serrate; tip spherical. App. an. like a broad brush with 7 - 9 long branches (Fig. 194).

Proportions: Length of antennae : head diagonal = 1.4. Ant III : Ant IV basal subsegment = 1.1. Ant IV subsegments from basal to distal = 4.2 : 1 : 1.2 : 1.2 : 3.3.

Type locality: Hungary, Odvaskö, litter of a Ceraso-Quercetum plant association.

Occurrence: Known only from the type locality.

Remarks: This species resembles *A. secundarius* and *thermophilus*, but differs in colour and in head and dens spines.

*Arrhopalites intermedius* Loksa, 1969 (357) n. comb.

Syn.: *Arrhopalites hungaricus intermedius* Loksa, 1969 (357)

Also males known. Total length 1.2 mm. Colour pale yellow or reddish. 1+1 unpigmented ommatidia. Basal 1/2 of Ant III thickened. Ant IV with 7 - 8 subsegments. Claws slender, with inner tooth and lateral teeth; Emp with tooth, length > claws. Dens with E:7, P:6, J:3, anteriorly 7 setae; setae E1, E3, and J1 - 3 as spines or spinelike. Inner edge of mucro densely serrate, outer only wavy; tip spoonlike. Circumanal setae not winged, setae a0 and a1 furcate, sa3 long. App. an. slender, curved, distal 1/2 furcate, with small fringes, length sometimes asymmetrical and tips split again (Fig. 180). Other characteristics as in *A. hungaricus*.

Proportions: Length of antennae : head diagonal = 1.9. Ant I : II : III : IV = 1 : 1.4 : 4 : 10.2. Ant IV subsegments from basal to distal = 7.2 : 1.2 : 1 : 1 : 1 : 1 : 2.2.

Type locality: Hungary, Tornaer karstland, Meteor cave.

Occurrence: Known only from the type locality.

Remarks: More than 4000 specimens have been collected. 2 characteristics varied independently: in 32 % Ant IV had 8 subsegments and in 30 % dens seta E3 was elongate or had the normal setal form and setae J1 - 3 were elongate.

*Arrhopalites japonicus* Yosii, 1956 (99)

Only females known. Total length 1.4 mm. Colour white and reddish brown, posterior of large abdomen darkest. Anterior of large abdomen with only few setae, posterior with more. Head with few pairs of spinelike setae. 1+1 brown ommatidia. Ant III medially thickened. Ant IV with 5 - 8 subsegments. Claws with inner tooth and tunica; Emp without tooth, length > claws. Ret with 1 seta. Manubrium with 6+6 posterior setae. Dens with E:7, P:6, J:3, anteriorly 7 setae; setae E1 and J1 - 3 as spines, the other outer setae only basally thickened (Fig. 195). Edges of mucro serrate; tip pointed. Circumanal setae thick but not winged, setae a3 with basal tooth. App. an. thick, slightly curved, distal 1/3 with long fringes (Fig. 196).

Type locality: Japan, Tokyo, Nippara cave.

Occurrence: Also found in other Japanese caves (YOSII, see above).

*Arrhopalites jeanneli* Cassagnau & Delamare Deboutteville, 1955 (390)

Only 1 female known. Colour white. 1+1 unpigmented ommatidia. Ant III thickened, without papilla. Ant IV with 5 subsegments. Claws II and III with inner tooth; Emp without tooth, length of Emp I and II > claws, Emp III = claw. Dens with E:7, P:6, J:3, anteriorly 7 setae; setae E1, E3 and J1 - 3 as spines. Edges of mucro serrate; tip as a round tooth. Circumanal setae not winged. App. an. setalike with few long fringes on one side in distal 1/2 (Fig. 197).

Type locality: Libanon, Jabal Aanjar cave.

Occurrence: Known only from the type locality.

*Arrhopalites kolymensis* Tshelnokov, 1990 (351)

Only females known. Total length 0.7 mm. Colour light rose-ochre, head darkest. Head with 4+4 spines. 1+1 dark brown ommatidia. Ant III not modified. Ant IV with 6 subsegments, however the fifth only weakly separated from the distal. Claws II and III with inner tooth and tunica; Emp without tooth, length > claws. Manubrium with 4+4 setae. Dens with E:7, J:3 setae; setae E1, E3 and J1 - 3 as spines.



Edges of mucro serrate but outer edge with round teeth; tip pointed. Circumanal setae winged. App. an. thick, slightly curved, distal 1/3 with long branches (Fig. 198).

Proportions: Length of antennae : head diagonal = 1.6. Ant I : II : III : IV = 1 : 1.5 : 2.3 : 5.5. Ant IV subsegments from basal to distal = 3.3 : 1 : 1 : 1 : 1 : 2. Dens : mucro = 1.5.

Type locality: E Russia, tundra near Kolym River at 1200 m altitude, litter of *Betula exilis* bushes.

Occurrence: Known only from the type locality.

Remarks: *A. kolymensis* differs from *A. octacanthus* by the chaetotaxy of dens and the fewer teeth of mucro, and from *A. principalis* by the different form of the App. an.

*Arrhopalites loczyi* Loksa, 1960 (264) n. com.

Syn.: *Arrhopalites coecus* f. *loczyi* Loksa, 1960 (264)

Only females described. Colour white. Eyes absent (?). Claws with inner and often with outer tooth. Circumanal setae not winged, 1+1 short spines on dorsal and ventral anal valves. App. an. thick, tapering but with blunt tip (Fig. 158). Other characteristics as in *A. caecus*.

Type locality: Hungary, NE of Lake Balaton, Lóczi cave.

Occurrence: Known only from the type locality.

Remarks: The differences from *A. caecus* (number of small spines of Abd. VI and form of App. an.) justify the new species level of *A. loczyi*.

*Arrhopalites longicornis* Cassagnau & Delamare Deboutteville, 1953 (141)

Only females known. Colour white. Ant IV with 6 subsegments, the second not always observable. Claws with inner tooth, in claw I not always observable; Emp with tooth but sometimes missing in Emp III, length always > claw. Dens with E:7, P:6, J:3, anteriorly 7 setae; setae E1, E3 and J1 - 3 as spines or spinelike. Edges of mucro serrate; tip spherical (Fig. 220). App. an. thick, straight, tapering, distal 1/2 with rough teeth (Fig. 221).

Proportions: Length of antennae : head diagonal = 3. Ant I : II : III : IV = 1 : 2.4 : 4 : 11. Ant IV subsegments from basal to distal = 5 : 1 : 1 : 1 : 1 : 1.8.

Type locality: Not defined; collected in France, Alpes-Maritimes, Tende, Vieura cave, and France, Isère, Balme cave.

Occurrence: Also known from Austria (Styria, Lurgrotte cave, NEUHERZ 1975: 159).

Remarks: This species resembles *A. pygmaeus* and was synonymized with that species (PACLT 1957: 269), but the mucro and App. an. differ.

*Arrhopalites mauli* Delamare Deboutteville & Bassot, 1957 (78)

Only females known. Colour white. 1+1 unpigmented ommatidia. Basal 1/2 of Ant III thickened. Ant IV with 5 - 6 subsegments. Claws with inner tooth; Emp without tooth, length of Emp I and II > claws, Emp III < claw. Ret with 2 setae. Dens with E:6, P:7, J:3, anteriorly 7 setae; setae E1, E3 and J1 - 3 as spines. Distal 1/2 of mucro slightly narrowed, inner edge serrate, outer wavy; tip as blunt tooth (Fig. 181). App. an. thin, slightly curved, distal 1/4 furcate, smooth, length of one branch generally only 1/2 of the other (Fig. 182).

Proportions: Ant IV subsegments from basal to distal = 2.9 : 1 : 1 : 1 : 2.6 (or 1 : 1.6).

Type locality: Portugal, Madeira, Caldeirão Verde near Quiemadas, in dry Marchantiales.

Occurrence: Also found in continental Portugal (GAMA et al. 1994: 45) and Bulgaria (CONEV & KAZANDZIEVA 1991: 80).

*Arrhopalites microphthalmus* Cassagnau & Delamare Deboutteville, 1953 (133)

Only females known. Colour white. Head without spines. 1+1 small, unpigmented ommatidia. Ant IV undivided, form as in *Sminthurinus*. Claws broad, with inner tooth and tunica; Emp I not described, Emp II with tooth, length of Emp II and III < claws (Figs. 222, 223). Ret without seta. Dens with E:5, P:6, J:2 (?), anteriorly 7 setae; setae E1 - 4 and J1, J2 as spines or spinelike. Edges of mucro serrate; tip spatulate. App. an. rodlike, straight; tip pointed, distal 1/3 sometimes with small fringes as in *A. pygmaeus* (Fig. 224).

Proportions: Ant I : II : III : IV = 1 : 1.7 : 3.1 : 4.6.

Type locality: France, Haute-Garonne, environs of Toulouse, forest of Laramette, humus under oak trees.

Occurrence: Also known from Spain (JORDANA et al. 1990: 30).

*Arrhopalites minutus* Yosii, 1970 (17)

Only 1 female known. Total length 0.5 mm. Colour white. Head with 13 spinelike setae. 1+1 unpigmented ommatidia. Ant III not modified. Ant IV undivided. Claws with inner tooth and 1 pair of basal lateral teeth, claw III also with tunica (Fig. 159); only Emp I with tooth, length of Emp I = claw, Emp II and III < claws. Manubrium with 4+4 posterior setae. Dens with E:5, P:6, J:3, anteriorly 8 setae; setae E1 - 4 and J1 - 3 as short spines, anterior setae thicker than normal but without stout distal spine (Fig. 160). Anterior edge of mucro indented (or distal 2/5 narrowed), edges roughly serrate; tip spoonlike (Fig. 161). Circumanal setae strongly winged, 2+2 short spines on dorsal and also ventral anal valves. App. an. bandlike but spatulate, ratio of length to width about 5; tip cut with many small fringes (Fig. 162).

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 2.7 : 3.7 : 8. Dens : mucro = 1.5.

Type locality: Japan, Nagano, Shigakogen.

Occurrence: Also known from NE China (Changchun, CHEN & SHIN 1990: 221).

*Arrhopalites octacanthus* Yosii, 1970 (14)

Only females known. Total length 0.8 mm. Colour brownish, strongly mottled. Anterior of large abdomen with 3+3 stout setae. Head with 4+4 spines. 1+1 pale reddish-brown ommatidia. Ant III not modified. Ant IV with 7 subsegments. Claw I with 1 pair of small lateral teeth, claws II and III with inner tooth and tunica; Emp without tooth, length of Emp I > claw, Emp II and III ≤ claws. Manubrium with 4+4 posterior setae. Dens with E:6, P:6, J:3, anteriorly 7 setae; setae E1 - E3 and J1 - 3 as spines, P1 small (Fig. 199). Edges of mucro irregularly serrate with about 20 teeth each; tip as a round tooth. Circumanal setae not winged. App. an. relatively short, flattened, distal 1/2 with long fringes (Fig. 200).

Proportions: Length of antennae : head diagonal = 1.7. Ant I : II : III : IV = 1 : 2 : 3 : 6.5. Ant III : Ant IV basal subsegment = 1.8. Ant IV subsegments from basal to distal = 2.6 : 1 : 1 : 1 : 1 : 3.2. Dens : mucro = 2.7 [sic].

Type locality: Japan, Nara, Yoshino.

Occurrence: Also found at other sites in Japan (in other open habitats and in Tokushima, Zenyokutsu cave, YOSII, see above).

Remarks: *A. octacanthus* resembles *A. principalis* and *habei* but differs from these species by its 3 outer dental spines.

*Arrhopalites ornatus* Stach, 1945 (24)

Only females known. Total length 0.8 mm. Colour white. Setae posteriorly on large abdomen 2 times longer than claw III. 1+1 unpigmented ommatidia. Ant III with prominent basal papilla. Ant IV with 5 subsegments. Claws slender, almost of equal form, with small inner tooth; Emp without tooth, length > claws. Ret with 2 setae. Dens with E:7, P:6, J:3, anteriorly 7 setae; setae E1, E3 and J1 - 3 spinelike. Distal 1/2 of mucro narrowed, edges serrate. Circumanal setae not winged. App. an. bandlike, slightly curved, distal 1/2 with small teeth and apical long branches like a brush (Fig. 201).

Proportions: Length of antennae : head diagonal = 1.7. Ant I : II : III : IV = 1 : 1.7 : 3.1 : 7.7. Ant IV subsegments from basal to distal = 3.2 : 1 : 1 : 1 : 2.4. Dens : mucro = 1.4.

Type locality: Spain, Santander, near Puente Viesgo, Del Castillo cave, on water.

Occurrence: S Europe; from Spain (JORDANA et al. 1990: 30), S France (IZARRA 1969: 459), and Italy (DALLAI, see below) to Hungary (DUNGER 1975: 25) and former Yugoslavia (e. g. CVIJOVIC 1974: 93); also reported from Germany (Hesse, Vogelsberg, BÖHLE 1991: 39).

Biology: *A. ornatus* is troglophile (MASSOUD & THIBAUD 1973: 155); it also lives in open habitats in damp soil, humus, and moss.

Species descriptions: CASSAGNAU & DELAMARE DEBOUTTEVILLE 1953: 138 (App. an.), DALLAI 1973: 563 (Ant, female Abd VI, App. an.). The types have never been consulted.

Remarks: The specimens of the secondary descriptions differ in some characteristics from the original.

*Arrhopalites postumicoides* Cassagnau & Delamare Deboutteville, 1953 (137)

Only females known. 1+1 (unpigmented?) ommatidia. Ant IV undivided but with 8 annulations. Claws with inner tooth and lateral teeth, claws II and III with tunica; Emp broad, Emp I and II with tooth, length of all empodia > claws. Ret with 2 setae. Dens with E:7, P:6, J:3 setae; setae E1 - 5 and J1 - 3 spinelike. Edges of mucro serrate; tip slightly broadened. App. an. stout and straight, distal 2/3 racketlike with rough teeth (Fig. 186).

Type locality: S France, Tarn, forest of Gresigne, soil.

Occurrence: Also found in central Spain (SELGA 1971: 252).

Remarks: *A. postumicoides* resembles *A. canzianus* and *postumicus*. It differs mainly in the subsegmentation of Ant IV and the dens spines.

*Arrhopalites postumicus* Stach, 1945 (25)

Only females known. Total length 1.3 mm. Colour white or reddish. Setae posteriorly on large abdomen 2 times longer than claw III. 1+1 unpigmented or pigmented ommatidia. Ant III not modified. Ant IV with 6 - 7 subsegments. Claws II and III with inner tooth; Emp with tooth, length > claws (Fig. 187). Ret with 2 setae.

Dens with E:7, P:6, J:3, anteriorly 7 setae; setae E1, E3, and J1 - 3 as spines, E1 stout. Distal 2/5 of mucro narrowed, edges serrate; tip as a round tooth. Circumanal setae not winged. App. an. thick and straight, distal 1/2 racketlike with rough teeth (Fig. 188).

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 2 : 3 : 9. Ant IV subsegments from basal to distal = 5.5 (or 4.2 : 1.3) : 1.3 : 1.3 : 1 : 1 : 2. Dens : mucro = 1.2.

Type locality: Former Yugoslavia, Postumica cave, on water and stalactites.

Occurrence: Also reported from France (S France and Corsica, POINSOT 1974: 126) and Germany (Hesse, Vogelsberg, BÖHLE 1991: 39).

Biology: *A. postumicus* is troglobite (MASSOUD & THIBAUD 1973: 154), but also occurs in open habitats (in Germany it has been found in humus between rocks, see above).

Remarks: This species resembles *A. canzianus*, it mainly differs in its broader App. an. and longer antennae.

*Arrhopalites principalis* Stach, 1945 (37) sensu Stach, 1956 (87)

Syn.: *Sminthurinus binocolatus* Börner, 1903 (163)

*Arrhopalites binocolatus* Linnaniemi, 1912 (273)

Originally, only females described. Total length up to 1 mm. Colour brownish or bluish-grey. Setae posteriorly on large abdomen 2 times longer than claw III. Head with 4 - 6 pairs of spines (Fig. 202). 1+1 dark ommatidia. Ant III not modified. Ant IV generally with 6 subsegments, the 2 distal may be indistinctly separated or fused. Claws slender, with inner tooth; Emp I and II with tooth, length of all empodia > claws. Ret with 2 setae. Dens with E:7, P:6, J:3, anteriorly 7 setae; setae E1, E3, and J1 - 3 as spines, E1 stoutest. Distal 1/2 of mucro narrowed, edges serrate; tip spoonlike. Circumanal setae not winged. App. an. with bandlike shaft, distally curved, distal 1/3 split into branches and long fringes (Fig. 203).

Proportions: Length of antennae : head diagonal = 1.3 - 1.6. Ant I : II : III : IV = 1 : 1.8 : 3 : 7. Ant IV subsegments from basal to distal = 4.5 : 1.3 : 1.3 : 1.2 : 1 : 2.3. Dens : mucro = 1.3 - 1.7.

Type locality: Not defined; the oldest samples mentioned by STACH (1945: 40) from S Poland, Tatra Mts., in moss and damp litter up to 2300 m altitude.

Occurrence: Holarctic; ranging from North America and Greenland to S Russia, in Europe S to the Pyrenees, the Alps, and former Yugoslavia. *A. principalis* is usually regarded as a boreo-alpine species (KOPESZKI & MEYER 1994: 157), but it also occurs in the Russian steppe (STEBAEVA 1966: 1144) and the German lowlands (VOGEL 1988: 53) and highlands (BOCKEMÜHL 1956: 148, BÖHLE 1991 a: 50, 1991 b: 79, SCHULZ 1994: 127).

Biology: *A. principalis* lives in damp moss, litter, and soil down to 15 cm, and is troglophile (MASSOUD & THIBAUD 1973: 155). It was found throughout the entire year in the highlands of Germany (near Tübingen, BOCKEMÜHL, see above) and occurs up to 2100 m altitude in Europe (Switzerland and France, the Pyrennes, GISIN 1947: 80, CASSAGNAU 1961: 210 respectively) and 3900 m in the USA (Colorado, FJELLBERG 1984: 206).

Species descriptions: GISIN 1947: 88 (head spines, dens, winged circumanal setae, App. an.), NOSEK 1962: 337 (Ant IV, claw, mucro, App. an.), FJELLBERG 1984: 206 (head spines, Ant. IV, dens, App. an.), FJELLBERG 1984: 87 (maxillary outer lobe). The types have never been consulted.

Remarks: GISIN (1947: 88) described males, and winged circumanal setae and a furcate seta a0 in females, FJELLBERG (1984: 206) observed additional 2+2 spinelike setae on dorsal head-back (Fig. 202). *A. principalis* from Rumania (GRUIA 1966: 251) had 9 head spines and asymmetrically furcate and fringed App. an., thus not belonging to this species. It may be that *A. principalis* is identical with *A. benitus* (Folsom, 1896 c), though in that species the length of Emp III < claw and Ant IV only has 5 subsegments (CHRISTIANSEN & BELLINGER 1981: 1103, FJELLBERG 1984: 206).

*Arrhopalites pseudoappendices* Rusek, 1967 (23)

Only females known. Total length 0.8 mm. Colour white to pale rusty red. Dorsal thorax with 4+4 thickened setae. Head with 5 - 6 pairs of weak spines. 1+1 unpigmented ommatidia. Ant IV with 5 subsegments. Claws with inner tooth, basal lateral teeth, and tunica; Emp with tooth, length of Emp I > claw, Emp II and III = claws. Ret with 2 setae. Dens with E:7, P:5, J:4, anteriorly 7 setae; setae E1, E3, and J1 - 4 as spines or spinelike. Edges of mucro serrate. Circumanal setae winged, setae sa3 long ('pseudoappendices'). App. an. slender, slightly curved; tip pointed, distal 1/2 with small teeth (Fig. 225).

Proportions: Length of antennae : head diagonal = 1.5. Ant I : II : III : IV = 1 : 1.8 : 2.6 : 6.8. Ant III about as long as Ant IV basal subsegment. Ant IV subsegments from basal to distal = 3.2 : 1 : 1 : 1 : 2.5. Dens : mucro = 1.3.

Type locality: Slovakia, Low Tatra Mts., near a creek at the foot of Mount Siná, wet moss on limestone.

Occurrence: Also found in mountains of the Czech Rep. (DUNGER 1970: 503, 1976: 41), in the Austrian Alps (BRETZFELD 1975: 301), in Finland (VILKAMAA 1989: 64), Italian caves (DALLAI & MALATESTA 1982: 190), and Germany (Hesse, Vogelsberg, BÖHLE 1991: 39).

Biology: *A. pseudoappendices* often lives in damp moss and soil; it is troglophile. In the Czech Rep., it was found up to 1450 m altitude in soil and damp moss under *Pinus mugo* (DUNGER 1976: 10, 11), in Germany in dry forests (see above).

Species description: DUNGER 1970: 42 (with critical comments on the characteristics).

Remarks: *A. pseudoappendices* resembles *A. pygmaeus* and *terricola*, and may be synonymous with the former. The 'pseudoappendices' (i. e. the large setae sa3 of Abd VI) also occur in other species, e. g. in *A. sericus* (DUNGER 1970: 42). *A. pseudoappendices* is retained here as a separate species because antennal ratios and Ret setae differ from *A. pygmaeus* and *terricola* respectively.

*Arrhopalites pygmaeus* (Wankel, 1860) (203) sensu Stach, 1945 (30) and Stach, 1956 (78)

Syn.: *Dicyrtoma pygmaea* Wankel, 1860 (203)

*Sminthurinus binoculatus* Börner, 1901 (343)

Also males known. Total length 1.2 mm. Colour white or more or less rusty red. Setae posteriorly on large abdomen about 2 times longer than claw III. Head setae slightly stouter than normal. 1+1 more or less pigmented ommatidia. Ant III basally thickened. Ant IV with 5 subsegments. Claws with inner tooth; Emp with tooth, in Emp III sometimes missing, length always > claws (Fig. 226). Ret with 2 setae. Dens with E:7 (but E2 sometimes missing), P:6, J:3, anteriorly 7 setae; setae E1, E3, and J1 - 3 as spines or spinelike (Fig. 227). Edges of mucro serrate (but outer sometimes smooth); tip spoonlike (Fig. 227). Circumanal setae not winged. App. an. rodlike, straight; tip cut, tip and distal 1/3 with small teeth (Figs. 228, 229).

Proportions: Length of antennae : head diagonal = 1.7 - 1.8. Ant I : II : III : IV = 1 : 2 : 3.5 : 9.5. Ant IV subsegments from basal to distal = 5 : 1.3 : 1.3 : 1 : 3. Dens : mucro = 1.3 - 1.6.

Type locality: Slovakia, Slouper and Katharina cave, in excrements of bats.

Occurrence: Holarctic.

Biology: *A. pygmaeus* usually lives in caves, in cooler and moister climates of Europe (Sweden, Ireland, Germany, France) also in damp moss, litter, and soil of open habitats, thus it is troglophile (MASSOUD & THIBAUD 1973: 155). It was found up to 2400 m altitude (Switzerland, GISIN 1947: 80).

Species descriptions: GISIN 1947: 90, 1958: 774 (antennae longer than in *A. terricola*, length of Ant III << basal subsegment of Ant IV), GISIN 1960: 96, SELGA 1963: 458 (female circumanal setae winged, length of antennae : head diagonal = 1.5 - 2, length of App. an.  $\leq$  claw III inner edge), BETSCH & CASSAGNAU 1966: 128 (a secondary sexual characteristic of male Abd VI in the same manner as in *A. terricola*), CHRISTIANSEN 1966: 64, CHRISTIANSEN & BELLINGER 1981: 1109. The specimens of coll. STACH have never been consulted.

Remarks: The specimens of Australia (GREENSLADE 1994: 119) should be re-examined. Those of North America vary considerably (CHRISTIANSEN & BELLINGER, see above).

*Arrhopalites ruseki* Nosek, 1975 (45)

Also males known. Total length 0.7 mm. Colour white. Head with 7 spines. 1+1 black ommatidia. Ant III distally thickened. Ant IV with 5 subsegments. Claws with inner tooth; Emp I and II with tooth, length of all empodia > claws. VT with 2+2 setae. Ret with 2 setae. Dens with E:7, P:6, J:3, anteriorly 7 setae; setae E1 - E3 (also other outer setae?) and J1 - 3 as spines, E1 as a stout spine. Distal 2/5 of mucro narrowed, edges serrate. Circumanal setae winged. App. an. rather long, slightly curved; tip pointed, distal 1/2 with small fringes (Fig. 230).

Proportions: Length of antennae : head diagonal = 1.7. Ant I : II : III : IV = 1 : 2.5 : 3.2 : 8.7. Ant III about as long as Ant IV basal subsegment. Ant IV subsegments from basal to distal = 4 : 1.2 : 1 : 1 : 3. Dens : mucro = 1.5. Length of App. an. > claw III inner edge.

Type locality: Slovakia, Moravian Karst cave.

Occurrence: Known only from the type locality.

*Arrhopalites secundarius* Gisin, 1958 (776)

Only females known. Total length 0.5 - 0.6 mm. Head with 6+6 stout spines, the 2+2 anterior smaller than the others. 1+1 ommatidia. Ant III basally thickened. Ant IV with 5 subsegments. Claws with inner tooth; Emp I and II with tooth, length of all empodia > claws. Ret with 2 setae. Dens with E:7, P:6, J:3, anteriorly 7 setae; setae E1, E3, and J1 - 3 as spines, E1 as a stout, oval spine (Fig. 204). Distal 1/2 of mucro narrowed, edges serrate; tip spoonlike. Circumanal setae winged. App. an. featherlike with about 6 long, distal branches (but said to be similar to *A. principalis*).

Proportions: Length of antennae : head diagonal = 1.5. Ant I : II : III : IV = 1 : 1.8 : 2.7 : 6.5. Ant IV subsegments from basal to distal = 3.5 : 1 : 1 : 1 : 2.6.

Type locality: France, Ain, St-Genis-Pouilly, forest of Querceto-Carpinetum aegopodietosum association, soil near Allondon River.

Occurrence: Palearctic; from N Norway (FJELLBERG 1988: 15) S to the Mediterranean (DALLAI 1971: 367, POINSOT 1972: 293) and S Russia (STEBAEVA 1976: 124).

Biology: *A. secundarius* lives in small numbers in litter and soil.

Species descriptions: RUSEK 1965: 160 (head spines, antenna, female Abd. VI), WEINER 1981: 466 (head spines, dens, mucro). The types have not been consulted.

Remarks: *A. secundarius* resembles *A. principalis* but differs in its smaller anterior head spines, its Ant IV with 5 subsegments, and its oval dental spine E1.

*Arrhopalites sericus* Gisin, 1947 (89) sensu Gisin, 1960 (275)

Also males known. Total length 0.6 - 0.75 mm in females (Fig. 144), 0.4 - 0.6 mm in males. Colour grey from sparse pigment laterally on large abdomen. Head with normal setae (Fig. 205). 1+1 grey ommatidia. Basal part of Ant III weakly thickened. Ant IV with 5 subsegments. Claws with inner tooth. Dens with E:7, P:6, J:3, anteriorly 7 setae; setae E1, E3, and J1 - 3 as spines, E1 as a normal, conical spine. Edges of mucro serrate. Circumanal setae winged. App. an. setalike with few long fringes on one side (Fig. 206).

Proportions: Ant IV subsegments from basal to distal = 2.8 : 1 : 1 : 1 : 2.5.

Type locality: Switzerland, Basel, Allschwil, forest of Querceto-Carpinetum association, in moss on the soil.

Occurrence: Europe and Morocco (THIBAUD & MASSOUD 1980: 543).

Biology: *A. sericus* lives in damp moss, litter, and soil (also in deeper layers, PONGE 1980: 160), and in the Mediterranean also in caves (troglophile, MASSOUD & THIBAUD 1973: 155). In Germany, near Tübingen, it was more abundant than *A. principalis* but was only collected in March and October - December (BOCKEMÜHL 1956: 149). Egg deposition and parthenogenetic development have been described (MASSOUD & PINOT 1973: 197, BETSCH-PINOT 1980: 15, BLANCQUAERT et al. 1981: 118).

Species descriptions: CASSAGNAU & DELAMARE DEBOUTTEVILLE 1953: 139 (App. an.), SZEPTYCKI 1967: 240 (Ant IV, dens, App. an.), LAWRENCE & MASSOUD 1973: 77 (cuticula structure), MASSOUD & PINOT 1973: 199 (female Abd VI), WEINER 1981: 466 (head setae, dens, and mucro), FJELLBERG 1984: 87 (maxillary outer lobe). The types have never been consulted.

Remarks: *A. sericus* resembles *A. principalis* but differs in its normal head setae and 5 Ant IV subsegments.

*Arrhopalites slovacicus* Nosek, 1975 (599)

Also males known. Total length 0.9 - 1 mm. Colour white with reddish pigment on abdomen. Setae posteriorly on large abdomen shorter than claw III. Head apex with 8+8 spinelike setae. 1+1 reddish ommatidia. Ant III weakly thickened. Ant IV with 5 subsegments. Claws with inner tooth; Emp I and II with tooth, length > claws; Emp III without tooth, length < claw. VT with 3+3 setae. Ret with 2 setae. Manubrium with 5+5 (?) setae. Dens with E:6 (?), P:6, J:3, anteriorly 8 setae; setae E1 - 4 (or only E1, E3?) and J1 - 3 as spines or spine-like, E1 as a stout spine, other outer setae basally toothed. Mucro anteriorly indented, edges serrate; tip as a round tooth (?). Circumanal setae only slightly longer than those of abdomen, not winged. App. an. setalike, rather short, both lateral sides with small teeth.

Proportions: Length of antennae : head diagonal = 1.8. Ant I : II : III : IV = 1 : 2.4 : 3.8 : 9.6. Ant III : Ant IV basal subsegment = 1.1. Ant IV subsegments from basal to distal = 3.3 : 1 : 1 : 1 : 2.8. Dens : mucro = 1.3.

Type locality: Slovakia, Domicia cave, in guano mixed with limestone detritus.

Occurrence: Known only from the type locality.

Species description: Nosek 1975: 223 (App. an.).

Remarks: The described females seem to be subadult since the circumanal setae are rather short and the App. an. short and setalike. In the key, this species is listed twice because the original figure of the dental outer setae differs from the original description.

*Arrhopalites spinosus* Rusek, 1967 (25)

Only females known. Total length 0.7 mm. Colour white. Thorax dorsally with 5+5 spine-like setae. Head apex with 4+4 stout anterior and 2+2 smaller posterior spines. 1+1 unpigmented ommatidia. Ant IV with 6 subsegments. Claws with inner tooth, lateral teeth, and tunica; Emp with tooth, length  $\geq$  claws. Ret with 2 setae. Dens with E:7, P:6, J:3, anteriorly 7 setae; setae E1 - 6 and J1 - 3 as spines or spinelike. Edges of mucro roughly serrate; tip a round tooth. Circumanal setae winged, the lateral basally furcate and toothed (Fig. 170). App. an. straight; tip spoonlike, margin with small fringes.

Proportions: Length of antennae : head diagonal = 1.7. Ant I : II : III : IV = 1 : 1.7 : 2.7 : 6. Ant IV subsegments from basal to distal = 3.6 : 1 : 1 : 1 : 1 : 1.75. Dens : mucro = 1.9.

Type locality: Slovakia, Low Tatra Mts., S slope of Mount Siná, wet litter of a Acereto-Carpinetum forest.

Occurrence: Also found in S Poland (Pieniny Mts., WEINER, see below), W Austria (KOPESZKI & MEYER 1994: 157), Central Germany (Hesse, Vogelsberg, BÖHLE 1991: 39), and S Finland (VILKAMAA 1989: 64).

Biology: *A. spinosus* lives in damp or dry litter and in moss of forests.

Species description: WEINER 1981: 465 (head spines, dens with only E1 and E2 as spines).

Remarks: *A. spinosus* differs from other *Arrhopalites* species by the thickened setae of its thorax and the toothed circumanal setae. The form of the head spines and App. an. resemble that of *A. cochlearifer* and *gisini*. Perhaps, there is only 1 species, *A. cochlearifer*, with local variations.

*Arrhopalites subbifidus* Travé, Gadea & Delamare Deboutteville, 1954 (213)

Only 1 female known. Colour white. 1+1 unpigmented ommatidia. Ant III slightly thickened. Ant IV with 5 subsegments. Claws long with inner tooth; Emp slender without tooth, length  $\leq$  claws. Dens with E:6, P:6, J:3, anteriorly 7 setae; setae E1, E3 and J1 - 3 as spines. Edges of mucro serrate [?]; tip not enlarged. App. an. stout, curved, distal 1/2 asymmetrically furcate with rough teeth (Fig. 183).

Proportions: Ant I : II : III : IV = 1 : 3 : 4 : 10. Ant IV subsegments from basal to distal = 3 : 1 : 1 : 1 : 2.3.

Type locality: S France, Pyrénées-Oriental, near Banyuls, forest of Massane, litter under *Fagus silvatica* at about 600 m altitude.

Occurrence: Known only from the type locality.

Remarks: The short original description is supplemented here with some characteristics of the original figures. This species was said to resemble *A. bifidus* except the missing empodial tooth. Another topotypic female has been described by SELGA (1963: 469) but without re-examination of the type. This second female is only 0.67 mm long, has winged circumanal setae, and mainly differs from the type by having claws with lateral teeth, Emp I and II with tooth or sharp outer corner, and the ratio of antennal segments = 1 : 4 : 5 : 12.5.



*Arrhopalites subboneti* Cassagnau & Delamare Deboutteville, 1953 (135)

Syn.: *Arrhopalites pygmaeus* var. *subboneti* Selga, 1963 (460)

Only females known. Claws II and III with inner tooth; Emp with tooth, length > claws. Dens with E:7, P:6, J:3; seta E1 as a stout spine, inner setae spinelike. Edges of mucro serrate; tip spoonlike and broadened (Fig. 231). App. an. straight, thick, rodlike, distal 1/4 with small teeth (Fig. 232).

Type locality: France, Jura, Saint-Claude, Foules cave.

Occurrence: Also known from Spanish caves (SELGA, see below) and from Romania (GRUIA, see below).

Biology: *A. subboneti* is troglobite (MASSOUD & THIBAUD 1973: 154).

Species descriptions: SELGA 1963: 460 (Ant IV with 6 subsegments, also claw I with inner tooth, only length of Emp I and II > claws), GRUIA 1966: 251 (total length 1.1 mm, Ret with 2 setae, only tip of App. an. with small fringes). The types have not been consulted.

Remarks: In the original description, *A. subboneti* is said to resemble *A. boneti* except the tooth of Emp III.

*Arrhopalites tenuis* Stach, 1945 (14)

Only females known. Total length 1 mm. Colour white. Setae posteriorly on large abdomen shorter than claw III. 1+1 unpigmented ommatidia. Ant III not modified. Ant IV with 5 weak subsegments. Claws with indistinct inner tooth; Emp I and II with tooth, Emp I with filament, length of all Emp < claws. Ret with 2 setae. Dens with E:7, P:6?, J:3?, anteriorly 8 setae; seta E1 spinelike, anterodistal median seta as a stout spine. Distal 1/2 of mucro narrowed, edges serrate; tip spoonlike. Circumanal setae winged, 2+2 short spines on dorsal, 1+1 on ventral anal valves. App. an. thin, rodlike, slightly curved, ratio of length to width = 20; tip with indistinct teeth (Fig. 163).

Proportions: Length of antennae : head diagonal = 1.4. Ant I : II : III : IV = 1 : 3 : 5 : 10. Dens : mucro = 1.5 - 1.6.

Type locality: Germany, North Rhine-Westphalia, Hülloch cave near 'Krispe' (instead of Kierspe?), distr. Altena (not 'Altona').

Occurrence: Known only from the type locality.

Remarks: STACH (see above) held *A. tenuis* to be a local form of *A. caecus*.

*Arrhopalites terricola* Gisin, 1958 (774)

Also males known. Total length 0.7 - 0.8 mm. Colour white. Head setae slightly stouter than normal, the most dorsal thickest. 1+1 unpigmented ommatidia. Ant III with weak basal thickening. Ant IV with 5 subsegments. Claws with inner tooth; Emp with tooth but in Emp III sometimes missing. length of all Emp > claws. Ret with 1 seta. Dens with E:7 (but E2 sometimes missing), P:6, J:3, anteriorly 7 setae; setae E1, E3, and J1 - 3 as spines or spine-like. Edges of mucro serrate; tip spoonlike. Circumanal setae winged. App. an. rodlike, straight; tip cut, distal 1/4 with small teeth (Fig. 233).

Proportions: Length of antennae : head diagonal = 1.4 - 1.5. Ant I : II : III : IV = 1 : 3 : 4.5 : 10.5. Length of Ant III  $\geq$  Ant IV basal subsegment. Ant IV subsegments from basal to distal = 3.5 : 1 : 1 : 1 : 2.8.

Type locality: Switzerland, Vaud, Epesses, soil of a vineyard near Lake Geneva.

Occurrence: Europe, except the northern parts.

Biology: *A. terricola* usually lives in open habitats, in soil of forests and meadows, seldom in caves (it is troglodene, SCHULZ 1994: 128). It was found up to 2400 m altitude (Switzerland, GISIN, see above).

Species descriptions: NOSEK 1962: 337, SELGA 1963: 464, BETSCH & CASSAGNAU 1966: 123 (colour rusty red; head without spinelike setae; male Abd VI with a secondary sexual characteristic; development of chaetotaxy of Abd VI in female and male; length of antennae : head diagonal = 1.5 in females, 1.75 in males), DALLAI 1970: 152 (cuticula structure), NAYROLLES 1988: 11, 1990 a: 14, 1990 b: 39, 1991 b: 55 (chaetotaxy of extremities), 1989: 243 (ontogeny of chaetotaxy). The types have never been consulted.

Remarks: *A. terricola* resembles *A. pygmaeus* in most characteristics except the antennae, which are shorter with other proportions.

*Arrhopalites thermophilus* Loksa, 1964 (96)

Only females known. Total length 0.6 mm. Colour pale violet. Head apex with 6 spines or short setae. 1+1 black ommatidia. Ant III basally thickened. Ant IV with 5 subsegments. Only claw III with inner tooth; Emp without tooth, length of Emp I = claw, Emp II and III about 1/2 of claws. Dens with E:7, P:6; anteriorly with 2 [sic] setae; setae E1, E3 (and J1 - 3?) as spines. Edges of mucro serrate; tip as a round tooth. Circumanal setae not winged. App. an. slightly curved, distal 1/2 asymmetrically branched, with long fringes (Fig. 207).

Proportions: Ant III : Ant IV basal subsegment = 0.9. Ant IV subsegments from basal to distal = 3.4 : 1 : 1 : 1 : 2.5.

Type locality: Hungary, Pilis and Börzsöny Mts., in Ceraso-Quercetum association.

Occurrence: Also found in Germany (Saxony, Neiße valley in Upper Lusatia, DUNGER 1972: 24).

Biology: *A. thermophilus* lives in damp litter of forests.

Remarks: The specimens from Germany (see above) have all claws with inner tooth, length of Emp I and II > claws, ventral anal valves with winged setae. App. an. thick and feathered with about 6 fringes.

*Arrhopalites uenoi* Yosii, 1956 (100)

Only females known. Total length 1 mm. Colour white. Setae on large abdomen longer and more curved than in other species. Head with normal but long setae. 1+1 unpigmented ommatidia. Ant III not modified. Ant IV with 14 subsegments. Claws and Emp without tooth, claw I very slender, length of Emp I ≤ claw, Emp II and III < claws (Fig. 234). Manubrium with 5+5 setae. Dens with E:7, P:6, J:3; anteriorly 7 setae; seta E1 as a spine, J1 - 3 almost of normal form. Mucro indented anteriorly below tip, edges serrate; tip broadened and spoonlike (Fig. 235). Circumanal setae not winged. App. an. rodlike; tip with short fringes (Fig. 236).

Proportions: Length of antennae : head diagonal = 4 (i. e. longer than total length). Ant I : II : III : IV = 1 : 3 : 5.3 : 16.7. Ant III : Ant IV basal subsegment = 1.5. Ant IV subsegments from basal to distal = 3 : 1 : ... : 1 : 1.7. Dens : mucro = 1.8.

Type locality: Japan, Iwaté, Iwaizawa no Ana cave.

Occurrence: Known only from the type locality.

*Arrhopalites ulehlovae* Rusek, 1970 (312)

Only females known. Total length 0.9 - 1 mm. Colour white to yellowish. Head with 13 spines. 1+1 unpigmented ommatidia. Ant IV with 3 - 4 subsegments, only the basal distinct. Claws with inner tooth and lateral teeth, claw III with tunica; Emp with tooth, length of Emp I > claw, Emp II = claw, Emp III < claw. Ret with 1 seta. Manubrium with 5+5 setae. Dens with E:6, P:6, J:3, anteriorly 8 setae; setae E1 - 4 (5) and J1 - 3 as spines, anterodistal median seta as a stout spine (Fig. 164). Distal 1/2 of mucro narrowed, edges serrate; tip round (Fig. 164). Circumanal setae winged, without spines. App. an. like slender rods, slightly curved; tip pointed (Fig. 165).

Proportions: Length of antennae : head diagonal = 1.3. Ant I : II : III : IV = 1 : 2.2 : 2 : 6. Ant III : Ant IV basal subsegment = 1.3. Dens : mucro = 1.6.

Type locality: S Slovakia, near Lanzhot, in a soil sample from *Gratiola officinalis*-*Carex praecox-suzae* subassociation.

Occurrence: Also found in SW Germany (floodplain forest of Upper Rhine valley, orig. observ., leg. RUSSELL).

## Katiannida Bretfeld, 1986 n. comb.

Syn.: Katiannidae Börner, 1913 n. comb.

### Diagnosis

The taxon Katiannida Bretfeld, 1986 (309) n. comb. is a monophylum of the Eusymphyleona-Katianniformia Bretfeld, 1986 with 2 diagnostic apomorphies:

- distal Tita with 2 additional outer setae Ka and Kp (plesiomorphy: without these setae)
- distal Tita with 3 - 11 spatulate setae (plesiomorphy: setae pointed).

Other diagnostic characteristics: angle of Bothr ABC opening anteriorly (apomorphy?); trochanter III generally with an oval trochanteral organ (plesiomorphy/apomorphy); sacs of VT long (apomorphy) and smooth (plesiomorphy) or warty (apomorphy); Ret generally with 4+4 teeth (plesiomorphy).

Remarks: This new monophylum contains the Katiannidae Börner, 1913 sensu Betsch, 1980 and the genera incertae sedis sensu Betsch, 1980, Bretfeld, 1986: *Betschurinus* Dallai & Martinuzzi, 1980, *Katiannina* Maynard & Downs in Maynard, 1951, *Millsurus* Betsch, 1977, *Papirinus* Yosii, 1954, *Rusekianna* Betsch, 1977, *Vesicephalus* Richards in Delamare Deboutteville & Massoud, 1964. All these taxa are strongly united by the first apomorphy noted above (presence of the setae Ka and Kp, Fig. 242, according to NAYROLLES 1988: 4), a character not found in any other taxon of the Eusymphyleona. The second apomorphy (spatulate setae) does not occur in the other taxa of the Katianniformia, rather only as special apomorphy in the Tridentata (in *Spatulosminthurus* and in the Bourletielida). The other characteristics mentioned above show that the evolutionary level of the genera differs within this new taxon: most genera incertae sedis have the sacs of VT not smooth but warty and in 2 genera incertae sedis the trochanteral organ is missing. Thus, the phylogenetic systematics within the Katiannida n. comb. is not yet fully understood and even a precise definition of some genera (e. g. *Polykatianna*) is missing.

### Description

The Katiannida are small to medium-sized animals; the total length of adults ranging from 0.5 mm up to about 2 mm, the males being smaller than the females. The pigmentation varies from pale yellow to dark black; it may be uniform or contain several additional colours or various patterns. The large abdomen includes the segments Th II to Abd IV (plesiomorphy) or Abd V (apomorphy) (BETSCH 1980: 14) (Fig. 237). There are no tracheae (BETSCH 1980: 22). The setae are usually short and of normal form; on the head and abdomen of some genera, spines or long, rough macrochaetae occur. There are 4 pairs of Bothr. ABCD, except in *Papirinus* which, in adults, only has the pair C. The Bothr ABC lie behind Abd I (BETSCH & WALLER 1989) and form an obtuse angle opening anteriorly; Bothr A and B lie close to one another (Fig. 238) except in *Vesicephalus* where they are almost equidistant. The App. an. are directed towards the genital opening, mostly curved towards the posterior, and split into several branches (Fig. 239). In some genera neosminthuroid setae are present (Fig. 238). Each eye-patch has 8+8 or 6+6 ommatidia. C and D are often small or completely reduced. In *Stenognathellus*, the mandibulae and maxillae are elongate in favour of an unknown feeding behaviour (Fig. 296). Ant III often has a cuticular papilla of unknown ultrastructure and function (Fig. 240). Ant IV is sometimes subsegmented.

The legs II and III usually have a trochanteral organ with a short seta lying in an enlarged, oval socket (Fig. 241). On the distal Tita, the additional outer setae Ka and Kp occur (Fig. 242); these and a various number of other distal setae are spatulate. The claws and Emp are mostly uniform (Figs. 266 - 268).

The VT has long sacs, which are smooth in most genera and warty in a few others. The latter state is an adaptation to dryer habitats because the larger surface allows a better re-sorption of water by the sacs (EISENBEIS 1982). The Ret, with few exceptions, has 4+4 teeth. The dentes have a differing number of setae, the arrangement of which is often species specific: according to the description introduced by GISIN (e. g. 1963) in *Sminthurinus*, the single anteroproximal seta and the constant set of (generally 7) apical setae remain disregarded, the other setae are subdivided in anterior subapical and posterior setae (proximal, outer subapical, and median subapical setae) (Fig. 251, compare the alternative nomenclature by NAYROLLES 1990: 40). The posterior edges of mucro are differently serrate, a seta being missing.

### Key to the genera of the world

#### Katiannida Bretfeld, 1986 n. comb.

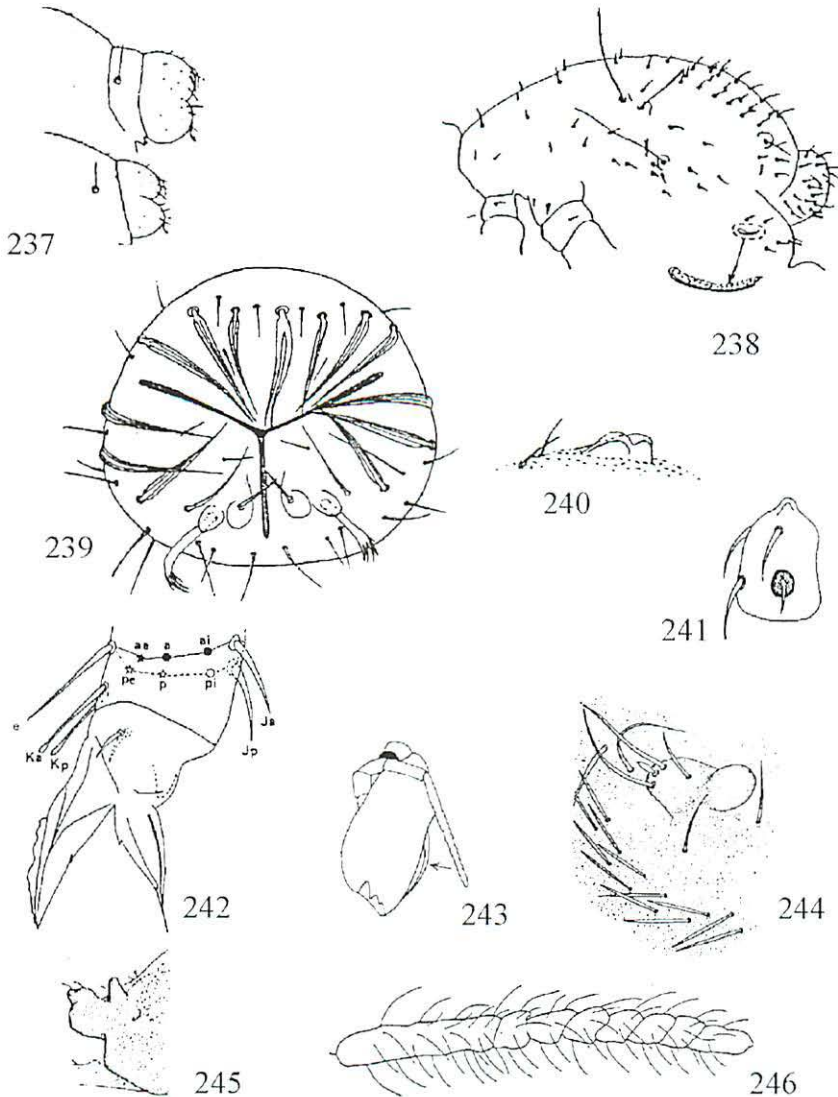
- |   |  |   |
|---|--|---|
| 1 | Head with thickened or long setae, neosminthuroid setae always missing   | 2 |
| – | Head with thin, normal setae, neosminthuroid setae sometimes present   | 4 |
| 2 | Ant IV undivided, Ant III without papilla (Fig. 300), Ret with 3+3 teeth<br><i>Vesicephalus</i> Richards in Delamare Deboutteville & Massoud, 1964 (p. 126)<br>type species: <i>Sminthurus longisetis</i> Guthrie, 1903; USA         |   |
| – | Ant IV subdivided or annulate, Ant III with papilla, Ret with 4+4 teeth  | 3 |
| 3 | Abd VI in females with normal seta a0, ventral head-back without spur<br><i>Katianna</i> Börner, 1907<br>type species: <i>Katianna mnemosyne</i> Börner, 1907; Argentina   |   |
| – | Abd VI in females with furcate seta a0, ventral head-back with spur (Fig. 243)<br><i>Neokatianna</i> Snider, 1989<br>type species: <i>Neokatianna acantholaema</i> Snider, 1989; USA   |   |
| 4 | (1) Ant IV as long as Ant III or shorter, setae of large abdomen in doublets (Fig. 256),<br>only Bothr C present in adults<br><i>Papirinus</i> Yosii, 1954 (p. 105)<br>type species: <i>Papirinus prodigiosus</i> Yosii, 1954; Japan |   |
| – | Ant IV longer than Ant III, setae of large abdomen single, full set of Bothr present   | 5 |
| 5 | Head and mouthparts elongate (Fig. 296)<br><i>Stenognathellus</i> Stach, 1956 (p. 124)<br>type species: <i>Stenognathellus denisi</i> Cassagnau, 1953; France  |   |
| – | Head and mouthparts normal   | 6 |
| 6 | Male with hump on Th II - III, claws in both sexes with large, serrate pseudonychium,<br>known only from Madagascar<br><i>Zebulonia</i> Betsch, 1970<br>type species: <i>Zebulonia massoudi</i> Betsch, 1970; Madagascar             |   |
| – | Male with simple thorax, not restricted to Madagascar  | 7 |
| 7 | Abd VI in females with furcate seta a0, Ant IV undivided, neosminthuroid setae present or missing  | 8 |
| – | Abd VI in females with normal seta a0, Ant IV undivided or subsegmented, neosminthuroid setae missing  | 9 |

- 8 Neosminthuroid setae present, Ant III with papilla, sacs of VT smooth  
*Sminthurinus* Börner, 1901 (p. 107)  
type species: *Sminthurus niger* Lubbock, 1868; Great Britain
- Neosminthuroid setae missing, Ant III without papilla, sacs of VT warty  
*Betschurinus* Dallai & Martinuzzi, 1980 (p. 102)  
type species: *Betschurinus farmae* Dallai & Martinuzzi, 1980; Italy
- 9 Small spines anteriorly on large abdomen, cuticular protuberances laterally on large abdomen (Fig. 244), Ant IV clearly subsegmented *Parakatianna* Womersley, 1932  
type species: *Parakatianna spinata* Womersley, 1932; Australia
- Abd only with normal setae, without such cuticular protuberances 10
- 10 Tita I - III basally with distinct pores (Fig. 260), Ant IV weakly subsegmented  
*Rusekianna* Betsch, 1977 (p. 106)  
type species: *Rusekianna mongolica* Betsch, 1977; Mongolia
- Tita without such pores 11
- 11 Bothr D short, on large papilla (Fig. 245) 12
- Bothr D not on large papilla 13
- 12 Ant IV obliquely subsegmented (Fig. 246), sacs of VT warty  
*Katiannina* Maynard & Downs in Maynard, 1951  
type species: *Sminthurus macgillivrayi* Banks, 1897; USA
- Ant IV transversely subsegmented, sacs of VT smooth *Pseudokatianna* Salmon, 1944  
type species: *Pseudokatianna nigretalba* Salmon, 1944; New Zealand
- 13 Ant IV obliquely subsegmented (Fig. 250), both edges of mucro clearly serrate  
*Dalianus* Cassagnau, 1969 (p. 102)  
type species: *Dalianus galae* Cassagnau, 1969; Greece
- Ant IV undivided or transversely subsegmented 14
- 14 Sacs of VT warty, each Tita with 10 - 11 spatulate setae, known only from USA  
*Millsurus* Betsch, 1977  
type species: *Neosminthurus sminthurinus* Mills, 1934; USA
- Sacs of VT smooth, Tita also with fewer spatulate setae, not restricted to USA 15
- 15 Ant III with papilla, Tita with few or many spatulate setae, known from New Zealand, Australia (and USA?)  
*Polykatianna* Salmon, 1946  
type species: *Polykatianna flammea* Salmon, 1946; New Zealand
- Ant III without papilla, each Tita with 3 spatulate setae, known only from Europe  
*Gisinianus* Betsch, 1977 (p. 103)  
type species: *Sminthurinus flammeolus* Gisin, 1957; Great Britain

Remarks: Not included in this key is:

- *Katiannelina* Delamare Deboutteville & Massoud, 1963 (= juvenile, 1 pair of neosminthuroid setae present, BETSCH 1980: 134).

A new definition of some genera is to be expected (GREENSLADE, pers. comm.).



Figs. 237 - 246 Katiannida general and non-Palaeartic genera:

237 Position of Abd V (after STACH 1956) 238 Position of Bothr ABCD and neosminthuroid seta (after STEBAEVA 1988) 239 Circumanal setae of female Abd VI and App. an. (*Sminthurinus niger*, after STACH 1956) 240 Ant III papilla (*Sminthurinus niger*, after STACH 1956) 241 Trochanter with trochanteral organ (after RICHARDS 1968) 242 Tip of Tita with setal whorl I and setae Ka and Kp (after NAYROLLES 1988) 243 *Neokatianna acantholaema*, head with spur lateral view (after SNIDER 1989) 244 *Parakatianna prospina*, large abdomen with lateral protuberance (after SALMON 1946).

Fig. 245 - 246 *Katiannina macgillivrayi* (after MAYNARD 1951):

245 Papilla of Abd V 246 Subsegmentation of Ant IV.

## Diagnosis of the Palearctic genera and species

### Genus *Betschurinus* Dallai & Martinozzi, 1980

**Key.** Only 1 species: *Betschurinus farmae* Dallai & Martinozzi, 1980

#### Diagnosis of the genus

Abd V included in the small abdomen. Head and Abd with normal setae. Bothr ABCD present. Neosminthuroid setae missing. Mouthparts normal. Ant III without a papilla. Ant IV undivided. Trochanteral organ present. Sacs of VT warty. Ret with 4+4 teeth. Abd VI in females with furcate seta a0, other circumanal setae slightly winged.

Occurrence: Italy, Tuscany, Val di Farma.

Description of the genus: DALLAI & MARTINOZZI 1980: 31.

Type species: *Betschurinus farmae* Dallai & Martinozzi, 1980.

#### Diagnosis of the single species

*Betschurinus farmae* Dallai & Martinozzi, 1980 (33)

Total length 0.9 mm in females, 0.6 mm in males. Colour dark violet or black, head and Abd dorsally with pale spots. 8+8 ommatidia, corneae yellow. Trochanter III with 4 anterior setae, seta of trochanteral organ thick and serrate (Fig. 247). Each Tita with 3 spatulate setae. Claws with inner tooth, 1 pair of lateral teeth, and tunica; Emp with outer tooth and filament, length  $\geq$  claws. Ret with 2 setae. Manubrium with 6+6 posterior setae. Dens with 2 anterior subapical setae, posterior setae: 4 proximal (2 outer, 1 long median, 1 inner), and 3 outer and 4 median subapical setae (Fig. 248). Only inner edge of mucro serrate, but distal 1/3 smooth (Fig. 248). App. an. broad with many branches.

Proportions: Length of antennae : head diagonal = 1. Ant I : II : III : IV = 1 : 2 : 2.7 (2.3) : 4 (4.2) in females (and males). Dens : mucro = 2.4.

Type locality: Italy, Tuscany, Val di Farma, in litter and humus under *Quercus ilex* and *Castanea sativa*.

Occurrence: Known only from the type locality.

### Genus *Dalianus* Cassagnau, 1969

**Key.** Only 1 species: *Dalianus galae* Cassagnau, 1969

#### Diagnosis of the genus

Abd V included in the small abdomen. Head and Abd with normal setae. Bothr ABCD present. Neosminthuroid setae missing. Mouthparts normal. Ant III without a papilla. Ant IV with alternate subsegmentation (Fig. 250). Trochanteral organ present. Sacs of VT **smooth**. Ret with 4+4 teeth. Abd VI in females with normal seta a0, other circumanal setae not described.

Occurrence: Greece, Evritania, N of Karpension (or Karpenission), Timfristos Mt.

Descriptions of the genus: CASSAGNAU 1969: 124, BETSCH 1980: 138.

Type species: *Dalianus galae* Cassagnau, 1969.



**Diagnosis of the single species**

*Dalianus galae* Cassagnau, 1969 (126)

Total length 1 - 1.5 mm. Background colour yellow-orange with broad, irregular marbled patterns of red-violet to black-violet pigment (Fig. 249). 8+8 ommatidia. Trochanter III with 4 anterior setae and normal trochanteral organ. Each Tita with 9 spatulate setae. Claws with inner tooth, several small lateral teeth, without tunica; Emp I narrow without outer tooth but with short, thick filament, Emp II and III broad with serrate outer edges and without filament, length of all Emp < claws. Ret with 2 setae. Manubrium with 8+8 posterior setae. Dens with 3 (arranged as 2,1) anterior subapical setae, posterior setae: 5 proximal, and 4 outer and 4 median subapical setae (Fig. 251). Both edges of mucro serrate, tip with posterior tooth. App. an. broad with broad branches, tips toothed (Fig. 252).

Proportions: Ant I : II : III : IV = 1 : 2.2 : 3.2 : 7.5. Dens : mucro = 3.4.

Type locality: Greece, Evritania, N of Karpension (or Karpenission), Timfristos Mt., at 1300 m altitude on soil surface below *Abies cephalonica*, short time after snow thawing.

Occurrence: Known only from the type locality.

Species description: NAYROLLES 1991 b: 57 (chaetotaxy of antenna).

**Genus *Gisinianus* Betsch, 1977**

**Key.** Only 1 species: *Gisinianus flammeolus* (Gisin, 1957)

**Diagnosis of the genus**

1/2 of Abd V included in the small abdomen (Fig. 253). Head and Abd with normal setae. Bothr ABCD present. Neosminthuroid setae missing. Mouthparts normal. Ant III without a papilla. Ant IV undivided. Trochanteral organ present. Sacs of VT smooth. Ret with 4+4 teeth. Abd VI in females with normal seta a0, other circumanal setae not winged (Fig. 253).

Occurrence: Central Europe.

Descriptions of the genus: BETSCH 1977: 212, 1980: 137.

Type species: *Sminthurinus flammeolus* Gisin, 1957.

**Diagnosis of the single species**

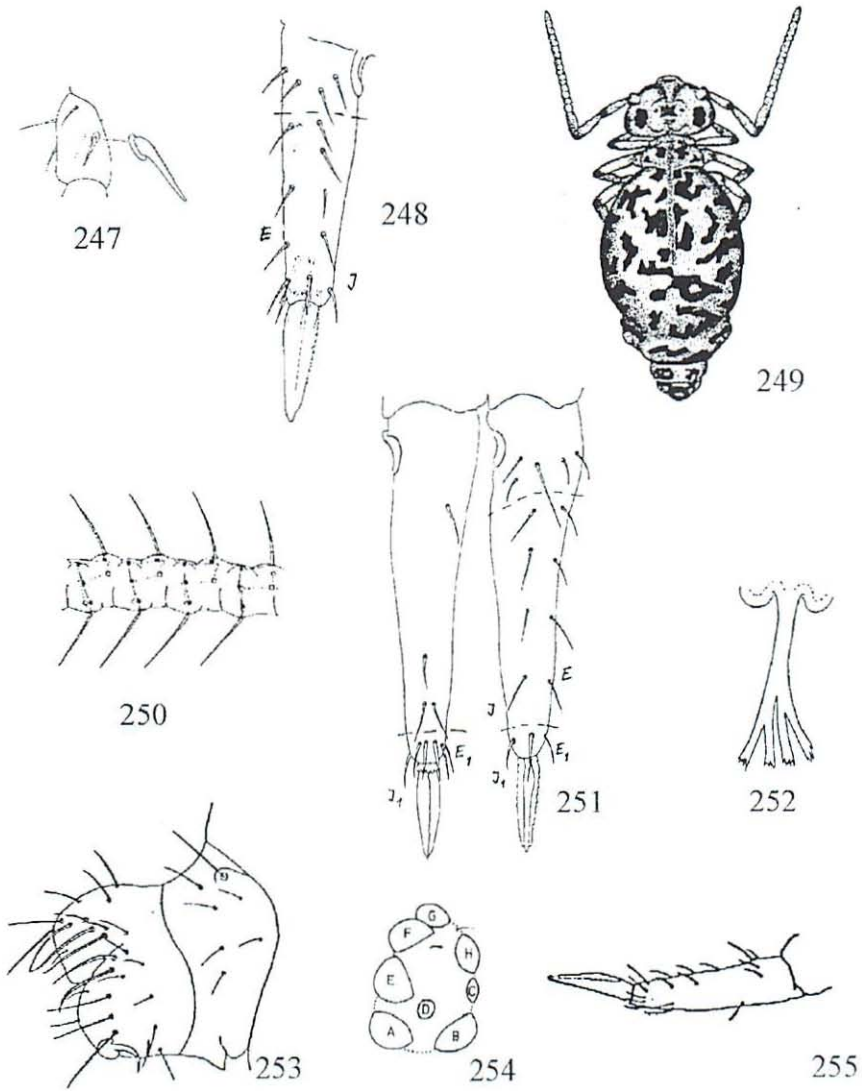
*Gisinianus flammeolus* (Gisin, 1957) (488)

Syn.: *Sminthurinus flammeolus* Gisin, 1957 (488)

Total length 0.75 mm. Colour yellow-brown to grey. 8+8 ommatidia, C and D small or completely reduced, each eye-patch with 2 setae (Fig. 254). Trochanter III with 4 anterior setae and normal trochanteral organ. Each Tita with 3 spatulate setae. Claws with small inner tooth, lateral teeth, and tunica; Emp with outer tooth and filament, length of Emp I and II > claws, Emp III = claw. Ret with 1 seta. Manubrium with 6+6 posterior setae. Dens with 2 anterior subapical setae, posterior setae: 4 proximal (2 outer, 1 long median, 1 inner), and 2 outer and 3 median subapical setae (Fig. 255). Only inner edge of mucro serrate. App. an. as curved rod with tip split into 4 - 6 branches.

Proportions: Length of antennae : head diagonal > 1.5. Ant I : II : III : IV = 1 : 2 : 2.5 : 5. Dens : mucro = 2.2.

Type locality: Great Britain, Scotland, Milngavie near Glasgow, litter under *Pteridium aquilinum*.



Figs. 247 - 248 *Betschurinus farmae* (after DALLAI & MARTINOZZI 1980):

247 Trochanter and trochanteral organ 248 Dens, posterior view (nomenclature orig.).

Figs. 249 -252 *Dalianus galae* (after CASSAGNAU 1969):

249 Habitus 250 Subsegmentation of Ant IV 251 Dens, anterior (left) and posterior (right) side (nomenclature orig.) 252 App. an.

Figs. 253 - 255 *Gisinianus flammeolus* (after GISIN 1957):

253 Small abdomen 254 Right eye-patch 255 Dens, lateral view.

Occurrence: Europe, except the most northern and most southern regions; from Great Britain (Scotland, GISIN, see above) and S Finland (BRUMMER-KORVENKONTIO 1979) S to S France (Montagne Noir, CASSAGNAU 1965: 356), S Austria (BRETTFELD 1975: 301), and former Yugoslavia (e. g. CVIJOVIC 1974: 93).

Biology: *G. flammeolus* lives on the soil in wet and dry litter, moss, rotten wood, and in flower pots in dwellings (SCHULZ & DUNGER 1995: 16). It is not abundant, but sometimes occurs in great numbers, and has also been found in winter. Number of chromosomes ( $n = 6$ , BRUMMER-KORVENKONTIO & SAURE 1969: 51), growth (PETERSEN 1975: 222), and respiration (PETERSEN 1981: 273) have been studied.

Species descriptions: RUSEK 1966: 63, HÜTHER 1969: 146.

Remarks: Some original observations have been added in this description.

### Genus *Papirinus* Yosii, 1954

**Key.** Only 1 Palearctic species: *Papirinus prodigiosus* Yosii, 1954

#### Diagnosis of the genus

Th II - Abd I not completely included in the large abdomen, Abd V often weakly separated from the large abdomen. Head with normal setae but with interocular tubercles. Abd with doublets of 1 normal with 1 thickened seta (Fig. 256). Adults with only Bothr C. Neosminthuroid setae missing. Mouthparts normal. Ant III without a papilla. Ant IV undivided or irregularly subsegmented. Trochanteral organ missing. VT incompletely fused, sacs warty. Ret with 3+3 teeth. Abd VI in females with furcate seta a0, other circumanal setae sometimes also furcate or with various specialisations.

Occurrence: Japan (at 2000 m and in lower altitudes, YOSII 1954: 828), South Africa (at 2000 m, PACLT 1959: 69), and intertropical mountains of Nepal, Zaïre, and Madagascar up to more than 2800 m altitude (DELAMARE DEBOUTTEVILLE & MASSOUD 1963: 227, BETSCH 1980: 142).

Descriptions of the genus: YOSII 1954: 828, DELAMARE DEBOUTTEVILLE & MASSOUD 1963: 225, LAWRENCE & MASSOUD 1973: 85 (cuticula), DELAMARE DEBOUTTEVILLE & MASSOUD 1964 c: 80, BETSCH 1974: 539, BETSCH 1980: 141, CASSAGNAU 1981: 47.

Type species: *Papirinus prodigiosus* Yosii, 1954.

#### Diagnosis of the single Palearctic species

*Papirinus prodigiosus* Yosii, 1954 (828) sensu Yosii, 1970 (25)

Syn.: *Papirinus prodigiosum* Yosii, 1954 (828)

Total length 1.5 mm. Colour yellowish brown. Ant distally black. 7+7 (?) ommatidia, not exactly described. Inner setae of Tita thick, long, and some apically hooked (Fig. 257). Tita I - III with 4, 3, 2 spatulate setae respectively. Claws broad, without inner tooth, with broad smooth lateral edges, and large tunica; Emp broad, without tooth, with thick filament split brushlike into many branches, length > claws (Fig. 257). Ret with 2 setae. Manubrium with 5+5 posterior setae. Dens without anterior setae (?), posterior setae: 4 proximal (1? outer, 1 long median, 2? inner), and 4 outer and 3 median subapical setae. Inner edge of mucro with few round teeth, outer smooth and distally with a round tooth.

Abd VI in females with furcate setae a0 and a1, a2 unbranched, a3 short, sa2 thick and blunt, sa3 thick and ciliate; App. an. broad with 6 - 7 ciliate branches.

Proportions: Length of antennae : head diagonal = 1. Ant I : II : III : IV = 1 : 2.7 : 2.3 : 2.3. Dens : mucro = 2.8.

Type locality: Japan, N of Tokyo, Ozé Nature Reserve.

Occurrence: Also known from other sites in Japan (YOSII, see above).

Biologie: *P. prodigiosus* lives in Japan up to 2000 m altitude. Head, body, antennae, and legs, except the claws, are covered with detritus from the humus habitat (YOSII, see above).

### Genus *Rusekianna* Betsch, 1977

**Key.** Only 1 species: *Rusekianna mongolica* Betsch, 1977

#### Diagnosis of the genus

Abd V included in the small abdomen. Head and Abd with normal setae. Bothr ABCD present. Neosminthuroid setae missing. Mouthparts normal. Ant III with a papilla. Ant IV obliquely or incompletely subdivided (Fig. 259). Trochanteral organ present. Tita basally with distinct pores (Fig. 260). Sacs of VT warty. Ret with 4+4 teeth. Abd VI in females with normal seta a0, other circumanal setae not winged.

Occurrence: Mongolia.

Descriptions of the genus: BETSCH 1977: 61, 62, BETSCH 1980: 141.

Type species: *Rusekianna mongolica* Betsch, 1977.

#### Diagnosis of the single species

*Rusekianna mongolica* Betsch, 1977 (62)

Total length 0.9 mm. Background colour yellow, head and Abd dorsally with violet longitudinal and cross stripes (Fig. 258). 8+8 ommatidia. Trochanter III with 4 anterior setae. Each Tita with 6 - 7 basoexternal pores (Fig. 260) and 6 - 7 spatulate setae. Claws small, with 2 - 3 small inner and 2 outer teeth, without tunica; Emp I and II without tooth but with short filament, Emp III with outer tooth but without filament, length of all Emp < claws. Ret with 2 setae. Manubrium with 6+6 posterior setae. Dens with 1 anterior subapical seta, posterior setae: 4 proximal (2 outer, 1 long median, 1 inner), and 3 outer and 4 median subapical setae. Inner edge of mucro serrate, outer smooth with apical tooth, tip with posterior tooth. App. an. broad, distal 1/3 irregularly branched.

Proportions: Length of antennae : head diagonal = 1.9. Ant I : II : III : IV = 1 : 2.2 : 3.2 : 8. Dens : mucro = 2.5.

Type locality: Mongolia, Central district, litter of birch forest at 1100 m altitude.

Occurrence: Known only from the type locality.

**Genus *Sminthurinus* Börner, 1901**Syn.: *Smynthurella* Houlbert, 1924 (157)**Key to the Palearctic species**

- |    |   |                                    |    |
|----|---|------------------------------------|----|
| 1  | Outer length of claw III about 1/3 of mucro; Abd and head black with large white spot between eye-patches           | <i>albifrons</i> (Tullberg, 1871)  |    |
| –  | Outer length of claw III = 1/2 of mucro or larger; pigmentation with other colours or patterns than above           |                                    | 2  |
| 2  | Dens anteriorly without subapical setae (Fig. 261)  |                                    | 3  |
| –  | Dens anteriorly with at least 1 subapical seta (Fig. 274)   |                                    | 8  |
| 3  | Dens posteriorly with 1 outer subapical and 3 proximal setae (Fig. 262), <i>aureus</i> -group s. str.               |                                    | 4  |
| –  | Dens posteriorly with 2 outer subapical and 4 proximal setae (Figs. 261, 277)                                       |                                    | 6  |
| 4  | Large abdomen without or with only diffuse dark pigment   | <i>aureus</i> (Lubbock, 1862)      |    |
| =  | Large abdomen with black sides and 1 posterolateral pair of large white spots (Fig. 263); claws without inner tooth | <i>bimaculatus</i> Axelson, 1902   |    |
| –  | Large abdomen with clear cut dark, longitudinal stripes   |                                    | 5  |
| 5  | Large abdomen with only longitudinal stripes (Fig. 264)   | <i>elegans</i> (Fitch, 1863)       |    |
| –  | Large abdomen with longitudinal and irregular cross stripes (Fig. 265)  | <i>reticulatus</i> Cassagnau, 1964 |    |
| 6  | (3) Dens posteriorly with 2 outer, 1 long median, 1 inner proximal seta (Fig. 277)                                  | <i>lawrencei</i> Gisin, 1963       |    |
| –  | Dens posteriorly with 1 outer, 1 long median, 2 inner proximal setae (Figs. 261, 294)                               |                                    | 7  |
| 7  | App. an. curved, tip with branches; body black  | <i>alpinus</i> Gisin, 1953         |    |
| –  | App. an. rodlike with blunt tip (Fig. 295); body reddish brown mottled with black                                   | <i>wakhanicus</i> Yosii, 1966      |    |
| 8  | (2) Dens anteriorly with 1 subapical seta (Fig. 274)  |                                    | 9  |
| =  | Dens anteriorly with 2 subapical setae (Fig. 272)   |                                    | 10 |
| –  | Dens anteriorly with 4 subapical setae (Fig. 279), posteriorly with 5 proximal setae (Fig. 280)                     | <i>modestus</i> Yosii, 1970        |    |
| 9  | Dens posteriorly with 3 proximal and 2 outer subapical setae (Fig. 274)   | <i>gamae</i> Gisin, 1963           |    |
| –  | Dens posteriorly with 4 proximal and 3 outer subapical setae (Fig. 283)   | <i>niger</i> (Lubbock, 1868)       |    |
| 10 | (8) Dens posteriorly with 2 outer subapical setae (Fig. 275)  |                                    | 11 |
| –  | Dens posteriorly with 3 outer subapical setae (Fig. 272)  |                                    | 17 |
| 11 | Dens posteriorly with 3 proximal setae (Fig. 288)   | <i>planasiensis</i> Dallai, 1969   |    |
| =  | Dens posteriorly with 4 proximal setae (1 outer, 1 long median, 2 inner) (Fig. 275)                                 |                                    | 12 |
| –  | Dens posteriorly with 5 proximal setae (Fig. 286)   |                                    | 14 |

- 12 Inner and outer edges of mucro serrate *gisini* Gama, 1965  
 – Inner edge of mucro serrate, outer smooth 13
- 13 Body with broad dark lateral band, head frons with black patch (Fig. 284)  
*orientalis* Stach, 1964  
 – Head and body black-violet with large white areas on head and ventral Abd IV - VI  
 (Fig. 287) *pekinensis* Stach, 1964
- 14 (11) Inner edge of mucro serrate, outer almost smooth; head and body brownish yellow,  
 Abd dorsally sometimes paler *pallescens* Yosii, 1970  
 – Inner and outer edges of mucro serrate; body black 15
- 15 Ret with 1 seta; large abdomen with 1 posterolateral pair of large white spots (Fig. 292)  
*trinotatus* Axelson, 1905  
 – Ret with 2 setae; large abdomen without large white spots 16
- 16 Head and body bluish black without distinct paler patterns *concolor* (Meinert, 1896)  
 – Body and head-back bluish black, other parts of head white (Fig. 276)  
*igniceps* (Reuter, 1881)
- 17 (10) Dens posteriorly with 2 outer, 1 long median, 1 inner proximal seta (Fig. 291)  
*speciosus* Yosii, 1970  
 – Dens posteriorly with 1 outer, 1 long median, 2 inner proximal setae (Fig. 272)  
*domesticus* Gisin, 1963

Remarks: Not included in this key is:

- *Sminthurinus krausbaueri* Börner, 1901 c (= *Sminthurus* sp., 1st instar, BETSCH 1977: 211).

Two species groups have been distinguished (BETSCH 1980: 135): the *niger*-group with Abd V included in the small abdomen (plesiomorphy) and the *aureus*-group (s. lat.) with Abd V included in the large abdomen (apomorphy) (Fig. 237). These two groups have also been characterized by the serration of the mucro: the *niger*-group with both posterior edges serrate, the *aureus*-group with only the inner posterior edge serrate (see GISIN 1960: 277, 278). In the present key, the position of Abd V and the mucronal serrations are not used to distinguish these groups because it is sometimes difficult to decide whether Abd V belongs to the small or large abdomen (or whether there is a clear suture between Abd IV and V or not) and often, in the *aureus*-group, not only the inner mucronal edge but also the outer is weakly or basally serrate. An *aureus*-group s. str. is here defined by: claw III large (outer length = 1/2 of mucro or longer); dens anteriorly without subapical setae, posteriorly with 3 proximal, 1 outer sub-apical, and 3 median subapical setae (Fig. 262).

In the Palaearctic, the *aureus*-group s. str. comprises the species: *Sminthurinus aureus*, *bimaculatus*, *elegans*, and *reticulatus*. It is not known whether the species of the *aureus*-group and their main colour varieties are biologically separated taxa or only varieties of *Sminthurinus aureus*. The *aureus*-group sensu Betsch also comprises the species *Sminthurinus planasiensis*. All other species belong to the *niger*-group with the chaetotaxy of the dentes being their main discriminating character.

### Diagnosis of the genus

Abd V included in the small or the large abdomen. Head and Abd with normal setae. Bothr ABCD present. Neosminthuroid setae present. Mouthparts normal. Ant III mostly with a papilla. Ant IV undivided. Trochanteral organ present. Sacs of VT smooth. Ret with 4+4 teeth. Abd VI in females with furcate seta a0, other circumanal setae usually winged (Fig. 239).

Occurrence: Worldwide.

Descriptions of the genus: BÖRNER 1901: 344, STACH 1956: 96, BETSCH 1980: 135, CHRISTIANSEN & BELLINGER 1981: 1112.

Type species: *Sminthurus niger* Lubbock, 1868, Börner, 1906.

### Diagnosis of the Palaearctic species

*Sminthurinus albifrons* (Tullberg, 1871) (145) Linnaniemi, 1912 (277)

Syn.: *Sminthurus albifrons* Tullberg, 1871 (145)

Total length up to 1 mm. Abd V included in small abdomen. Colour black with large whitish yellow spot between eye-patches. 8+8 ommatidia. Ant III with undivided papilla. Each Tita with 5 - 7 spatulate setae. Claws remarkably short (outer length of claw III about 1/3 mucro) with 2 inner teeth; Emp broad with small outer tooth, without filament, length 1/2 of claws. Ret with 1 seta. Chaetotaxy of dens not known. Both posterior edges of mucro serrate. App. an. stout with tip broadened and split into branches.

Proportions: Length of antennae : head diagonal = 1.5. Ant I : II : III : IV = 1 : 2.3 : 3.5 : 8.3. Dens : mucro = 2.

Type locality: Sweden, environs of Uppsala, in moss of forests.

Occurrence: NW Palaearctic; from Great Britain (GOTO & LAWRENCE 1964: 11) and Norway (LINNANIEMI 1911: 26, FJELLBERG 1980: 133, 1988: 15) to the S Urals (GRINBERGS 1960: 58, STEBAEVA 1976: 124); doubtfully recorded from Germany (North Rhine-Westphalia, near Bonn, FRÜND 1989: 92).

Biology: *S. albifrons* has been collected in summer from moss, litter, and under pieces of wood, but also swept from the low vegetation (LINNANIEMI, FJELLBERG, see above).

*Sminthurinus alpinus alpinus* Gisin, 1953 (234)

*Sminthurinus alpinus bisetosus* Ellis, 1976 (318)

Syn.: *Sminthurinus concolor alpinus* Gisin, 1953 (234)

Total length 0.9 mm in females, 0.6 mm in males. Abd V included in small abdomen. Colour bluish black. 8+8 ommatidia, only D small, each eye-patch with 1 seta. Papilla of Ant III small, undivided, or indistinctly divided. Each Tita with 5 spatulate setae. Claws and Emp as in *S. niger*. Ret with 1 seta (or 2 setae in ssp. *bisetosus*). Dens without anterior subapical setae, posterior setae: 4 proximal (1 outer, 1 long median, 2 inner), and 2 outer and 3 median subapical setae (Fig. 261). Both edges of mucro serrate. App. an. deeply split into about 10 apical branches.

Proportions: Not described.

Type locality: Switzerland, Upper Valais, Reckingen, sunny slope with fibrous soil under *Rhododendron* and *Larix* at 1400 m altitude.

Occurrence: Also found in other regions of Switzerland and in S Austria (GISIN 1963: 86), Czech Rep., Slovakia, S Poland, Bulgaria (WEINER 1981: 465), and S Norway (FJELLBERG 1980: 134). Doubtfully recorded from Spain (the Balearic Islands, Minorca, ARBEA & JORDANA 1990: 199) and N Russia (Novaya Zemlya Islands and Taimyr Peninsula, BABENKO & BULAVINTSEV 1993: 14). The subspecies *bisetosus* has been recorded from Greece (Rhodes and Crete, ELLIS 1974 c: 134, 1976: 318). A record from India needs confirmation (CHOUDHURI & ROY 1972 in ELLIS 1976: 318).

Biology: *S. alpinus* occurs in mountain forests in damp moss, litter, and under dead wood. In the Mediterranean, it seems to tolerate dryer conditions.

*Sminthurinus aureus* (Lubbock, 1862) (589)

Syn.: *Smynthurus aureus* Lubbock, 1862 (589)

*Metakatianna anglicana* Salmon, 1955 (242), GISIN 1960: 279

Total length up to 1 mm. In adults, Abd V fused with large abdomen. Colour white, more or less deep yellow, brown, or black, without distinct pattern. 8+8 ommatidia, C and D often reduced, each eye-patch with 2 setae. Papilla of Ant III missing or small and often divided into 3 - 4 parts. Tita I - III with 5, 5, 6 spatulate setae respectively. Claws with 0 - 3 inner teeth, small lateral teeth, sometimes with tunica; Emp broad, sometimes with small outer tooth, Emp I with long filament and length > claw, Emp II and III with short filament and length < claws. Ret with 1 seta. Dens without anterior subapical setae, posterior setae: 3 proximal, and 1 outer and 3 median subapical setae (Fig. 262). Inner edge of mucro serrate, outer smooth or only basally or weakly serrate, sometimes both edges smooth. App. an. with 3 - 5 branches.

Proportions: Length of antennae : head diagonal = 1.3. Ant I : II : III : IV = 1 : 1.1 : 2 : 5.1. Dens : mucro = 2.4.

Type locality: Great Britain, England, Kent, under damp pieces of wood and among decaying leaves.

Occurrence: Palaearctic: from Morocco (GERS & DEHARVENG 1985: 60), Portugal, Madeira and the Azores (GAMA 1986: 43, 1992: 47), and the W Mediterranean (POINSOT 1974: 124) N to Island (BÖDVARSSON 1967: 257), and E to Japan (YOSII 1977: 164). Not confirmed for Australia (GREENSLADE 1994: 131).

Biology: *S. aureus* is abundant and lives hemiedaphic or epigeic (CASSAGNAU 1964 a: 465) in the upper layers of moist soil and in the low vegetation, also in decaying sea-weed (STRENZKE 1955: 49). It occurs throughout the year, also in winter (WINK 1969: 124). In Europe, it has been found up to 2300 m altitude (Austria, HAYBACH 1992: 183), in Morocco up to 2650 m (High Atlas, see above). Reproduction and behaviour have been observed by MAYER (1957: 503); females lay non-diapause and diapause eggs (BLANCQUAERT et al. 1981: 122); there were 30 % males in a population studied by PETERSEN (1980: 25).

Species descriptions: GISIN 1944: 31, STACH 1956: 118, PALISSA 1960: 395, LAWRENCE & MASSOUD 1973: 83 and 98 (structure of eyes and cuticula respectively), NAYROLLES 1988: 9, 1990 a: 13, 1990 b: 41, 1991 b: 56 (chaetotaxy of extremities), 1989: 243 (ontogeny of chaetotaxy).

Remarks: The colour varieties of *S. aureus* have been given separate names, some are (STACH 1956: 122):

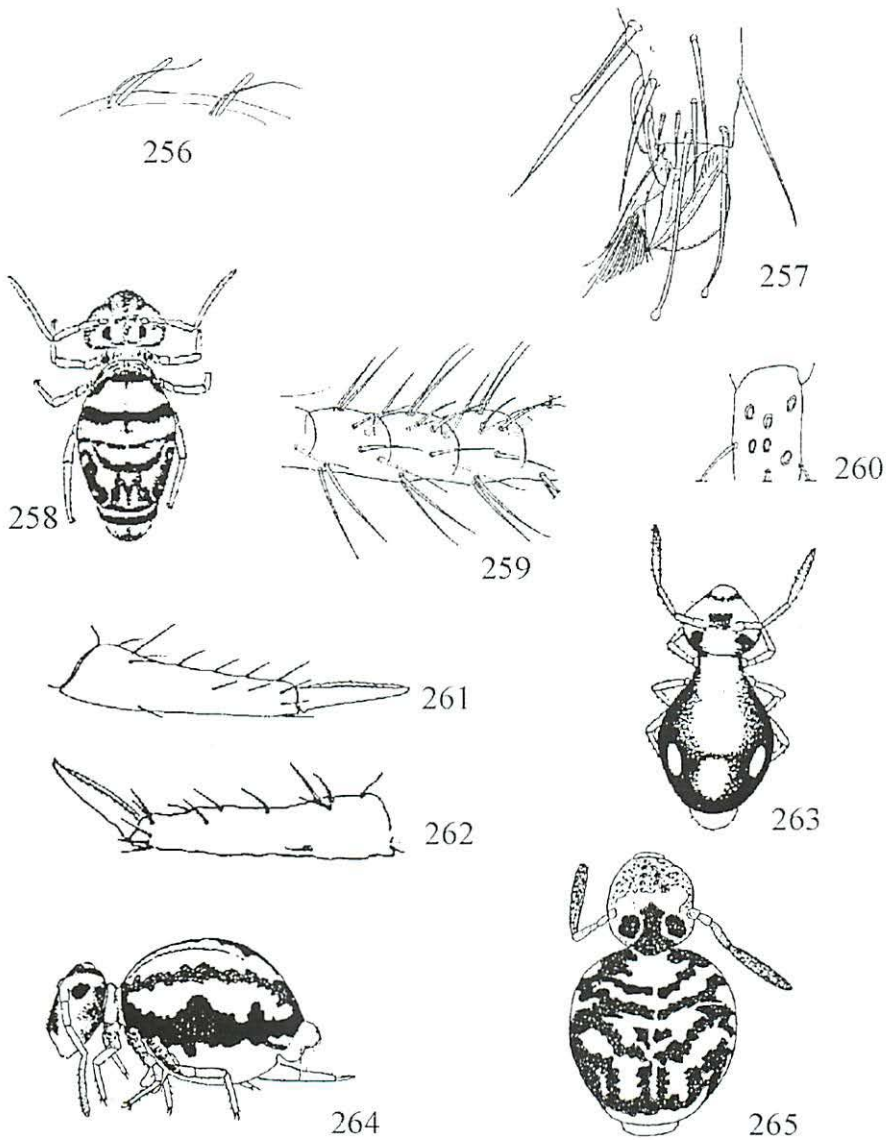
var. *alba* Krausbauer, 1902 with white colour,

var. *ochropus* Reuter, 1892 Börner, 1901 with dark brownish pigment,

var. *atrata* Börner, 1901 with bluish-black pigment.

According to STACH (1956: 122), PALISSA (1964: 254), and HÜTHER (1982: 97) the colour varieties with distinct stripes are regarded to belong to *Sminthurinus elegans* and *reticulatus*.





Figs. 256 - 257 *Papirinus prodigiosus* (after YOSHII 1954):  
 256 Setal doublets on large abdomen 257 Tip of Tita III, claw, and Emp.  
 Figs. 258 - 260 *Rusekianna mongolica* (after BETSCH 1977):  
 258 Habitus 259 Subsegmentation of Ant IV. 260 Pores of basal Tita.  
 Fig. 261 *Sminthurinus alpinus*, dens, lateral view (after GISIN 1963).  
 Figs. 262 - 265 *Sminthurinus aureus*-group s. str.:  
 Fig. 262 *Sminthurinus aureus*, dens, lateral view (after FJELLBERG 1980).  
 Fig. 263 *Sminthurinus bimaculatus*, habitus (after STACH 1956).  
 Fig. 264 *Sminthurinus elegans*, habitus (after STACH 1956).  
 Fig. 265 *Sminthurinus reticulatus*, habitus (after CASSAGNAU 1964).

*Sminthurinus bimaculatus* Axelson, 1902 (110) sensu Stach, 1956 (127) and Gisin, 1960 (278)

Syn.: *Sminthurinus igniceps* (?) var. *bimaculata* Axelson, 1902 (110)

*Sminthurinus aureus* var. *bimaculata* Linnaniemi, 1912 (286)

*Sminthurinus aureus* var. *circumfasciata* Stach, 1922 (58)

nec *Sminthurus bimaculatus* Tullberg, 1871 (145) (= *Sminthurinus niger* var.? STACH 1956: 238)

Total length up to 0.7 mm. In adults, Abd V fused with large abdomen. Background colour white to yellow, large abdomen with black pigment, sometimes more or less faded dorsally, always with 1+1 large oval white spots posterolaterally, small abdomen without dark pigment, head with dark patches and bands (Fig. 263). 8+8 ommatidia, C and D small, each eye-patch with 2 setae. Papilla of Ant III rather broad, divided into 4 parts (see Fig. 240). Each Tita with 4 - 5 spatulate setae. Claws without or with small inner tooth, small lateral teeth, and tunica; Emp I longish with filament, length > claw, Emp II and III broader with small outer tooth and short filament, length < claws. Ret with 1 seta. Dens without anterior subapical setae, posterior setae: 3 proximal, and 1 outer and 3 median subapical setae (see Fig. 262). Inner edge of mucro serrate. outer smooth or weakly serrate. App. an. with 2 - 3 short branches.

Proportions: Length of antennae : head diagonal = 1.5. Ant I : II : III : IV = 1 : 1.5 : 2.8 : 6.1. Dens : mucro = 2.3.

Type locality: N Finland, Lapland, wet moss.

Occurrence: Palearctic, but not in Japan (YOSII 1977: 164).

Biology: *S. bimaculatus* lives in Finland in wet moss, but in southern regions it has been mainly reported from dryer soils and their low vegetation. In Portugal, it lives under *Pinus* but not under *Eucalyptus* (e. g. GAMA et al. 1995: 83). It generally occurs in small numbers (STACH 1956: 130) but has also been collected in larger numbers with a sweeping net (BRETFFELD 1972: 120). It has been found up to 1650 m altitude (S Poland, High Tatra Mts., STACH 1956: 129).

Species description: NOSEK 1962: 338.

Remarks: Some original observations have been added above to the published descriptions. The var. *circumfasciatus* Stach, 1922 (58) mainly shows a broad lateral dark band and thus the white patches are incompletely delimited from the light background colour. The discrepancy of wet habitat in the North and dry in the South (BRETFFELD 1972: 120) has not yet been solved.

*Sminthurinus concolor* (Meinert, 1896) (167) sensu Stach, 1962 (16) and Gisin, 1963 (80)

Syn.: *Sminthurus concolor* Meinert, 1896 (167)

Total length up to 1.5 mm. Abd V included in small abdomen. Colour black violet. 8+8 ommatidia, D small, each eye-patch with 2 setae. Papilla of Ant III sometimes weakly divided. Each Tita with 5 spatulate setae. Claws with 1 - 3 small inner and weak lateral teeth; Emp with small outer tooth, Emp I narrow with long filament and length > claw, Emp II and III broad with short filament and length ≤ claws (Figs. 266 - 268). Ret with 2 setae. Dens with 2 anterior subapical setae, posterior setae: 5 proximal, and 2 outer and 3 median subapical setae (Fig. 269). Both edges of mucro serrate. App. an. stout with about 7 branches (Fig. 270).

Proportions: Length of antennae : head diagonal = 1.3 in females, 1.5 in males. Ant I : II : III : IV = 1 : 2 : 3 : 6 in females. Dens : mucro = 1.8.

Type locality: Nearctic, Greenland, Frederikshaab in the West and Kap Stewart in the East (according to TUXEN, see below).

Occurrence: In the Palaearctic from N Norway (Jan Mayen and Spitsbergen, FJELLBERG 1984: 69) S to S Norway (FJELLBERG 1987: 73) and England (GOTO & LAWRENCE 1964: 11); isolated records from Luxembourg (STOMP, see below), Central Germany (Hesse, Vogelsberg, BÖHLE 1991: 39), N Austria (BAUER 1993: 240), S Italy (isle of Lipari, DALLAI, see below), and Spain (the Balearic Islands, Minorca, orig. observ., leg. SICK). North American records are probably *S. quadrimaculatus* (CHRISTIANSEN & BELLINGER 1981: 1117).

Biology: *S. concolor* lives in humid habitats near or on the soil and in moss. In Luxembourg, Austria, and Italy it has been collected in humid habitats sheltered from the warmer environment, in Spain under *Phragmites* near the sea shore (authors see above).

Species descriptions: TUXEN 1934: 4, STOMP 1969: 175, DALLAI 1973: 566, FJELLBERG 1984: 87 (maxillary outer lobe).

*Sminthurinus domesticus* Gisin, 1963 (84)

Syn.: *Sminthurinus niger* Gama, 1959 b (27) ad partem, Gama, 1961 (37) ad partem, GISIN 1963: 80

Total length 1 mm in females, 0.5 mm in males. Abd V included in small abdomen. Colour blackish blue, sometimes large abdomen with yellow median band, seldom entire body pale, head-back darkest. 8+8 ommatidia, D small, each eye-patch with 1 seta (Fig. 271). Papilla of Ant III sometimes weakly divided. Claws, Emp, and spatulate setae of Tita as in other species of *niger*-group. Ret with 2 setae. Dens with 2 anterior subapical setae, posterior setae: 4 proximal (1 outer, 1 long median, 2 inner), and 3 outer and 3 median subapical setae (Fig. 272). Both edges of mucro serrate. App. an. with about 10 short branches.

Proportions: Dens : mucro = 2.

Type locality: Portugal, Coimbra, Penedo da Saudade, in flowerpots in a dwelling.

Occurrence: Also found in other sites from Portugal (GISIN, see above, GAMA et al. 1991: 13), in N Spain (Navarra, JORDANA et al. 1990: 183), Great Britain (GISIN, see above), and Austria (CHRISTIAN 1987: 55). Nearctic records are *S. quadrimaculatus* (CHRISTIANSEN & BELLINGER 1981: 1117).

Biology: *S. domesticus* lives in flower pots in dwellings, in greenhouses, and in wet litter and moss of open habitats.

Species descriptions: LAWRENCE & MASSOUD 1973: 82 and 92 (structure of eyes and cuticula respectively), CHRISTIAN & SCHALLER 1982: 54 (eye structure).

*Sminthurinus elegans* (Fitch, 1863) (657)

Syn.: *Smynthurus elegans* Fitch, 1863 (657)

*Sminthurus quadrilineatus* Tullberg, 1871 (146)

*Sminthurinus aureus elegans* Ponge, 1980 (168) n. syn.

*Sminthurinus aureus signatus* Ponge, 1980 (168) n. syn.

Total length up to 0.7 mm. In adults, Abd V fused with large abdomen. Background colour white to yellow, large abdomen with 2 - 5 bluish black longitudinal stripes, head with a dark band between eye-patches (Fig. 264). 8+8 ommatidia, C and D often reduced, each eye-patch with 2 setae. Papilla of Ant III missing or small and divided into 4 parts. Each Tita with 3 - 5 spatulate setae. Claws without or with small inner teeth, small lateral teeth, sometimes with tunica; Emp broad, sometimes with small outer tooth, Emp I with long filament and length = claw, Emp II with short filament, Emp III without filament, length of Emp II and III < claws. Ret with 1 seta. Dens without anterior subapical setae, posterior setae: 3 proximal, and 1 outer and 3 median subapical setae (see Fig. 262). Inner edge of mucro serrate, outer smooth or only basally or weakly serrate, sometimes both edges smooth. App. an. with 3 - 5 branches.

Proportions: Length of antennae : head diagonal = 1.4. Ant I : II : III : IV = 1 : 1.9 : 2.6 : 5.9. Dens : mucro = 2.4.

Type locality: USA, bred in a jar with New York earth and Virginia wheat straw.

Occurrence: Holarctic and Hawaii (see below); in the Palaearctic only in western parts including Portugal, Madeira and the Azores (GAMA 1986: 43, 1992: 47), not reported from E Russia (STEBAEVA 1976: 124).

Biology: *S. elegans* lives hemiedaphic or epigeic (CASSAGNAU 1964 a: 466) in more open and dryer habitats than *S. aureus* (GISIN 1960: 278, CASSAGNAU 1965: 365, PONGE 1980: 168). In vineyards it was more abundant than *S. aureus* and has been found down to 50 cm depth (HÜTHER 1961: 337). In the Pyrenees it occurs in wet meadows up to 1200 m altitude (CASSAGNAU 1964 a: 466).

Remarks: The colour varieties of *S. elegans* have been given separate names, some are (STACH 1956: 127):

var. *signatus* Krausbauer, 1902 with only 1 lateral band on large abdomen,

var. *transversalis* Axelson, 1905 with 1 lateral and a median band on large abdomen with some transvers connections (see below),

var. *dorsalis* Axelson, 1905 with 1 lateral band and posteriorly two black patches on large abdomen.

The var. *signatus* has been regarded as a subspecies of *S. aureus* (mainly for ecological reasons, for it has been found in dry and acid soils, PONGE 1980: 168), the var. *transversalis* as *S. reticulatus* (HÜTHER 1982: 97, see below). The specimens from the Nearctic and Hawaii also have 3 proximal posterior setae as in the Palaearctic, not 4 as reported by MILLS 1934: Fig. 167 and cited by CHRISTANSEN & BELLINGER 1981: 1129 (BELLINGER pers. comm.). *S. elegans* is the only *Sminthurinus* species occurring in both the Palaearctic and the Nearctic.

*Sminthurinus gamae* Gisin, 1963 (88)

Syn.: *Sminthurinus* cf. *igniceps* Gama, 1959 (37), GISIN 1963: 88

Total length 0.75 mm in females. Abd V included in small abdomen. Background colour light, large abdomen with blue violet median and lateral bands, lateral bands connected posteriorly; head with a dark clypeal patch (Fig. 273). Papilla of Ant III sometimes weakly divided. Claws, Emp, and spatulate setae of Tita as in *S. niger*.

Ret with 2 setae. Dens with 1 anterior subapical seta, posterior setae: 3 proximal, and 2 outer and 3 median subapical setae (Fig. 274). Both edges of mucro serrate. App. an. with about 10 unequal branches.

Proportions: Not described.

Type locality: Portugal, Madeira, Caldeirao Verde, wet soil with fern and *Marchantia* near a waterfall in the mountains.

Occurrence: Known only from the type locality.

*Sminthurinus gisini* Gama, 1965 (277)

Syn.: *Sminthurinus niger* Szeptycki, 1967 (240) ad partem, WEINER 1981: 467

*Sminthurinus carpathicus* Rusek, 1966 (25), DUNGER 1970: 42

Total length up to 1 mm in females, 0.7 mm in males. Abd V included in small abdomen. Colour more or less dark blue with small pale spots, head with 1+1 white spots behind the eye-patches. 8+8 ommatidia, D small, each eye-patch with 2 setae. Papilla of Ant III sometimes weakly divided. Each Tita with 5 spatulate setae. Claws with 3 small inner teeth, 1 pair of lateral teeth, and outer tooth; Emp with outer tooth, Emp I narrow with long filament and length > claw, Emp II and III broad with short filament and length < claws. Ret with 2 setae. Dens with 2 anterior subapical setae, posterior setae: 4 proximal (1 outer, 1 long median, 2 inner), and 2 outer and 3 median subapical setae (Fig. 275). Both edges of mucro serrate. App. an. with about 10 long branches.

Proportions: Ant I : II : III : IV = 1 : 2.4 : 2.6 : 5 (RUSEK, see above).

Type locality: Portugal, Castelo Branco, bark of *Pinus pinaster*.

Occurrence: Also found at another site in Portugal (Evora, Arraiolos, GAMA, see above), in the mountains of Czech Rep., Slovakia, and S Poland (DUNGER, RUSEK, WEINER respectively, see above), and in N Austria (BAUER 1993: 240).

Biology: *S. gisini* lives near the soil and under damp bark. It has been collected up to 1400 m altitude (Slovakia, Low Tatra Mts., RUSEK, see above). In Austria it was found on overgrown rocks in forests and in clearings, but not on soil or under bark (BAUER, see above).

*Sminthurinus igniceps* (Reuter, 1881) (203) sensu Reuter, 1892 (22) and Gisin, 1963 (83)

Syn.: *Sminthurus igniceps* Reuter, 1881 (203)

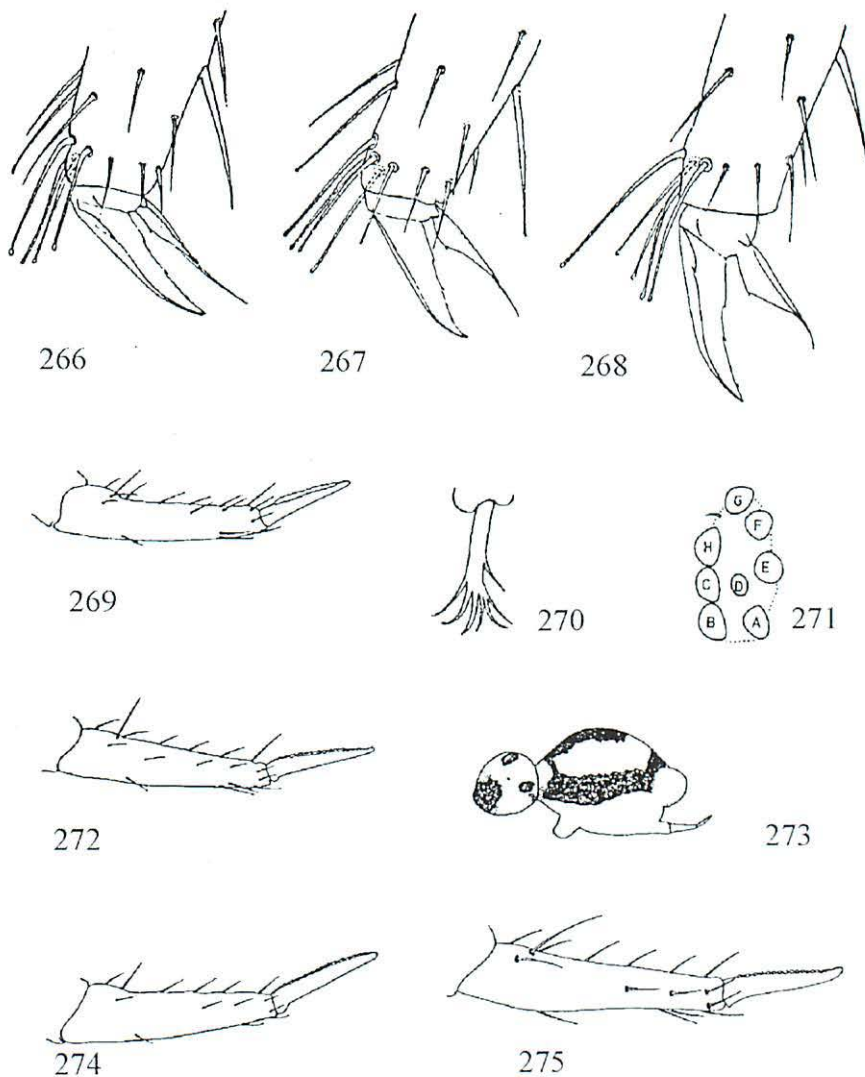
*Sminthurus rex* Uzel, 1891 (37) n. syn.(?)

nec *Sminthurinus igniceps* Stach, 1956 (112) (= *Sminthurinus niger*?)

*Sminthurinus* cf. *igniceps* Gama, 1959 (37) (= *Sminthurinus gamae*, GISIN 1963: 88)

*Sminthurinus igniceps* Gisin, 1961 (350) (= *Sminthurinus niger*, GISIN 1963: 80)

Total length about 0.7 mm. Abd V partially included in small abdomen. Colour of large abdomen blackish blue, small abdomen only dorsally dark, ventral side white, head whitish or yellow with dark head-back, extremities without dark pigment (Fig. 276). Ant yellow, but Ant IV apically blue. Papilla of Ant III sometimes weakly divided. Each Tita with 3 - 4 (5?) spatulate setae. Claws and Emp probably as in other species of *niger*-group. Dens with 2 anterior subapical setae, posterior setae: 5 proximal, and 2 outer and 3 median subapical setae (see Fig. 269). Both edges of mucro weakly serrate. App. an. with few branches.



Figs. 266 - 270 *Sminthurinus concolor*:

266 - 268: Tips of Tita I - III (after STACH 1962) 269 Dens, lateral view (after GISIN 1963)

270 App. an. (after STACH 1962).

Figs. 271 - 272 *Sminthurinus domesticus* (after GISIN 1963):

271 Left eye-patch 272 Dens, lateral view.

Figs. 273 - 274 *Sminthurinus gamae* (after GISIN 1963): 273 Habitus 274 Dens, lateral view.

Fig. 275 *Sminthurinus gisini*, dens, lateral view (after GAMA 1965).

Proportions: Dens : mucro = 2 - 2.5 (i. e. relatively shorter than in *S. niger*).

Type locality: Finland, Helsinki, orangery of Botanical Garden.

Occurrence: Known from Finland (REUTER, see above, LINNANIEMI 1912: 289), Sweden (SCHÖTT 1893: 33), Norway (LIE-PETTERSEN 1897: 10), England (CARPENTER & EVANS, see below, BAGNALL 1910: 507), Ireland (BOLGER 1986: 210 according to WOMERSLEY 1930), Germany (KRAUSBAUER 1905: 47), Switzerland (CARL 1899: 353), S Austria (LATZEL 1922: 74), and Japan (YOSII 1970: 19).

Biology: *S. igniceps* lives mostly in greenhouses (5 - 15°, LINNANIEMI, see above) or other sheltered places in dwellings (in Ireland, Dublin, in snail breeding boxes, see above). It has been found in open habitats with certainty only in Japan (see above).

Species description: CARPENTER & EVANS 1899: 231.

Remarks: Other reports of an occurrence of *S. igniceps* in open habitats except those from Japan (CARL, see above, PAGEL 1953, GRINBERGS 1960: 58, STEBAEVA 1976: 124, 1966: 1144, WINK 1969: 126, 1971: 46) do not mention the chaetotaxy of dentes, they probably deal with varieties of *S. niger* or undescribed species. There are no recent records of *S. igniceps* from greenhouses; it may be that it has been exterminated by insecticides.

#### *Sminthurinus lawrencei* Gisin, 1963 (87)

Total length 1 mm in females, 0.6 mm in males. Abd V included in small abdomen. Colour completely black violet. 8+8 ommatidia, D small, each eye-patch with 2 setae. Ant III with undivided papilla. Claws, Emp, and spatulate setae of Tita as in *S. niger*. Ret with 1 seta. Dens without anterior subapical setae, posterior setae: 4 proximal (2 outer, 1 long median, 1 inner), and 2 outer and 3 median subapical setae (Fig. 277). Both edges of mucro serrate. App. an. with about 6 short branches.

Proportions: Dens : mucro = 1.7.

Type locality: Great Britain, England, Kent, Keston, on a piece of wood in a *Sphagnum* bog.

Occurrence: Also found in humus of Keston bogs (GISIN, see above).

#### *Sminthurinus modestus* Yosii, 1970 (20)

Total length 0.8 mm. Abd V included in small abdomen. Background colour brownish yellow, black spots forming 1+1 longitudinal bands behind eye-patches and laterally and posteriorly on large abdomen, with brown pigment between eye-patches and dorsally on large abdomen, small abdomen without dark pigment (Fig. 278), Ant basally brown, distally violet. Papilla of Ant III almost completely reduced. Each Tita with 4 - 5 spatulate setae. Claws with small teeth of pseudonychium, only claw I with inner tooth; Emp broad without tooth, Emp I with long filament and length > claw, Emp II and III with short filament and length = claws. Ret with 2 setae. Dens with 4 (arranged as 2,2) anterior subapical setae (Fig. 279), posterior setae: 5 proximal, and 3 outer and 4 median subapical setae; with rough cuticular tubercles basally on outer side (Fig. 280). Both edges of mucro smooth, tip blunt. Circumanal setae in females not winged; App. an. short and thick with about 5 thick branches fringed distally (Fig. 281).

Proportions: Length of antennae : head diagonal = 1.5. Ant I : II : III : IV = 1 : 2 : 2.5 : 7. Dens : mucro about 2.5.

Type locality: Japan, Kyoto, Tambacho.

Occurrence: Also found at other sites in Japan (Kyoto, Daimonji, and Kanagawa, Manazuru, YOSII, see above).

*Sminthurinus niger* (Lubbock, 1868) (297) sensu Stach, 1956 (108) and Gisin, 1963 (78)

Syn.: *Smynthurus niger* Lubbock, 1868 (297)

*Sminthurinus igniceps* Gisin, 1961 (350), GISIN 1963: 80

nec *Sminthurinus niger* Gama, 1959 b (27), 1961 (37) ad partem (= *S. domesticus*, GISIN 1963: 80)

*Sminthurinus niger* Szeptycki, 1967 (240) ad partem (= *Sminthurinus gisini*, WEINER 1981:467)

Total length up to 1 mm. Abd V included in small abdomen. Colour black or blackish blue, often with 1+1 white spots on inner side of eye-patches, large abdomen sometimes with a narrow pale median line, legs and furca paler than other body parts. 8+8 ommatidia, only D small, each eye-patch with 2 setae (Fig. 282). Papilla of Ant III divided into 4 parts (Fig. 240). Each Tita with 5 spatulate setae. Claws with 1 - 3 small inner teeth, small lateral and outer teeth, without tunica; Emp mostly broad (only Emp I sometimes narrow) and mostly with outer tooth, Emp I with long filament and length  $\geq$  claw, Emp II and III with short filament and length  $\leq$  claws (see Figs. 266 - 268). Ret with 2 setae. Dens with 1 anterior subapical seta, posterior setae: 4 proximal (1 outer, 1 long median, 2 inner), and 3 outer and 3 median subapical setae (Fig. 283). Both edges of mucro serrate. Abd VI in females with furcate seta a0, other circumanal setae winged; App. an. thick with short branches in distal half and on tip (Fig. 239).

Proportions: Length of antennae : head diagonal = 1.3. Ant I : II : III : IV = 1 : 2 : 2.8 : 5.6. Dens : mucro = 1.5.

Type locality: Great Britain, England, Kent, Down, under boards in the kitchen-garden.

Occurrence: Palaearctic (?), often not distinguished from similar species, even in papers according to GISIN 1963. Certain determinations are or seem to be from Germany (Mecklenburg-Western Pomerania, SCHULZ 1991: 8; Lower Saxony, caves of Harz Mts., SCHULZ 1994: 128; Saxony, SCHULZ & DUNGER 1995: 16), Poland (STERZYNSKA 1987: 3, Table 1, 1989: 66, KACZMAREK 1995: 347), Czech Rep. and Slovakia (RUSEK 1977: 16), Norway (FJELLBERG 1980: 134), S Italy (Liparic Islands, DALLAI 1973: 565), Spain (continental, ARDANAZ & JORDANA e. g. 1986: 255; the Canary Islands, GAMA 1988: 84), Portugal (Madeira and the Azores, GAMA 1986: 43, 1992: 47), and W Russia (Moscow, KUZNETSOVA 1995: 152). Nearctic records are *S. quadrimaculatus* (CHRISTIANSEN & BELLINGER 1981: 1117).

Biology: *S. niger* lives in humid habitats on the soil, in litter, and moss. It has been found up to 2500 m altitude (France, the Pyrenees, CASSAGNAU 1961: 211; this species ?).

Species descriptions: GISIN 1963: 80 (spatulate setae of Tita, with the description of *S. concolor*), FJELLBERG 1984: 87 (maxillary outer lobe).



*Sminthurinus orientalis* Stach, 1964 (21)

Total length 0.8 mm in females, 0.5 mm in males. Abd V included in small abdomen. Background colour dirty yellow, broad dark-brown band laterally from head to Abd V; Abd VI without dark pigment; head with a black frontal patch; Ant dark brownish violet; ventral side of abdomen, legs, and furca uncoloured (Fig. 284). 8+8 ommatidia, only D small. Papilla of Ant III divided into 4 parts (see Fig. 240). Each Tita with 3 spatulate setae. Claws relatively small (outer length of claw III about 1/2 of mucro) with small inner tooth, without tunica; Emp broad, Emp I without tooth but long filament, length > claw, Emp II and III with outer tooth and short filament, length < claws. Ret setae unknown. Dens with 2 anterior subapical setae, posterior setae: 4 proximal (1 outer, 1 long median, 2 inner), and 2 outer and 3 median subapical setae (Fig. 285). Only inner edge of mucro serrate. Circumanal setae in females not winged, seta a0 not described; App. an. with rough and fine branches.

Proportions: Length of antennae : head diagonal = 1.4. Ant I : II : III : IV = 1 : 2 : 3 : 6.7. Dens : mucro = 2.

Type locality: China, Hangchow, in forest litter.

Occurrence: Known only from the type locality.

Remarks: STACH (see above) described 2 pairs of anterior subapical setae of dens, but his Plate XI, Fig. 5 only shows 1 pair (Fig. 285).

*Sminthurinus pallescens* Yosii, 1970 (22)

Total length 0.8 mm. Abd V with intermediate position between large and small abdomen. Colour uniformly brownish yellow, large abdomen dorsally sometimes pale, Ant bluish. Papilla of Ant III large, not or only weakly divided. Each Tita with up to 5 spatulate setae. Claws with tooth, without lateral teeth or tunica; Emp broad with tooth, Emp I with long filament and length > claw, Emp II and III with short filament and length  $\leq$  claws. Ret with 1 seta. Dens with 2 anterior subapical setae, posterior setae: 5 proximal, and 2 outer and 3 median subapical setae (Fig. 286). Inner edge of mucro serrate, outer almost smooth, tip blunt. Circumanal setae in females not winged, seta a0 furcate; App. an. broad with fine branches.

Proportions: Not described.

Type locality: Japan, Kyoto, Shimogamo.

Occurrence: Also found at another site in Japan (Kyoto, Yoshidayama, YOSII, see above).

*Sminthurinus pekinensis* Stach, 1964 (22)

Only 1 female known. Total length 1.2 mm. Abd V included in small abdomen. Colour blackish violet, white areas between eye-patches, laterally on head, and ventrolaterally on Abd IV - VI; legs and furca white; 1 pair of white and black eyelike spots on Abd VI (Fig. 287). 8+8 ommatidia, only D small. Papilla of Ant III divided into 4 parts (see Fig. 240). Each Tita with 3 spatulate setae. Claws relatively small (outer length of claw III about 1/2 of mucro) with small inner tooth, weak lateral teeth, without tunica; Emp I narrow, with small tooth and long filament, length < (?) claw, Emp II broad with outer tooth and short filament, Emp III broad without tooth and filament, length of Emp II and III < claws. Ret setae unknown. Dens with 2 anterior subapical setae, posterior setae: 4 proximal (1 outer, 1 long median, 2 inner), and 2 outer and 3 median subapical setae (see Fig. 285). Only inner edge of mucro serrate. Circumanal setae in females winged, seta a0 furcate; App. an. with short branches.

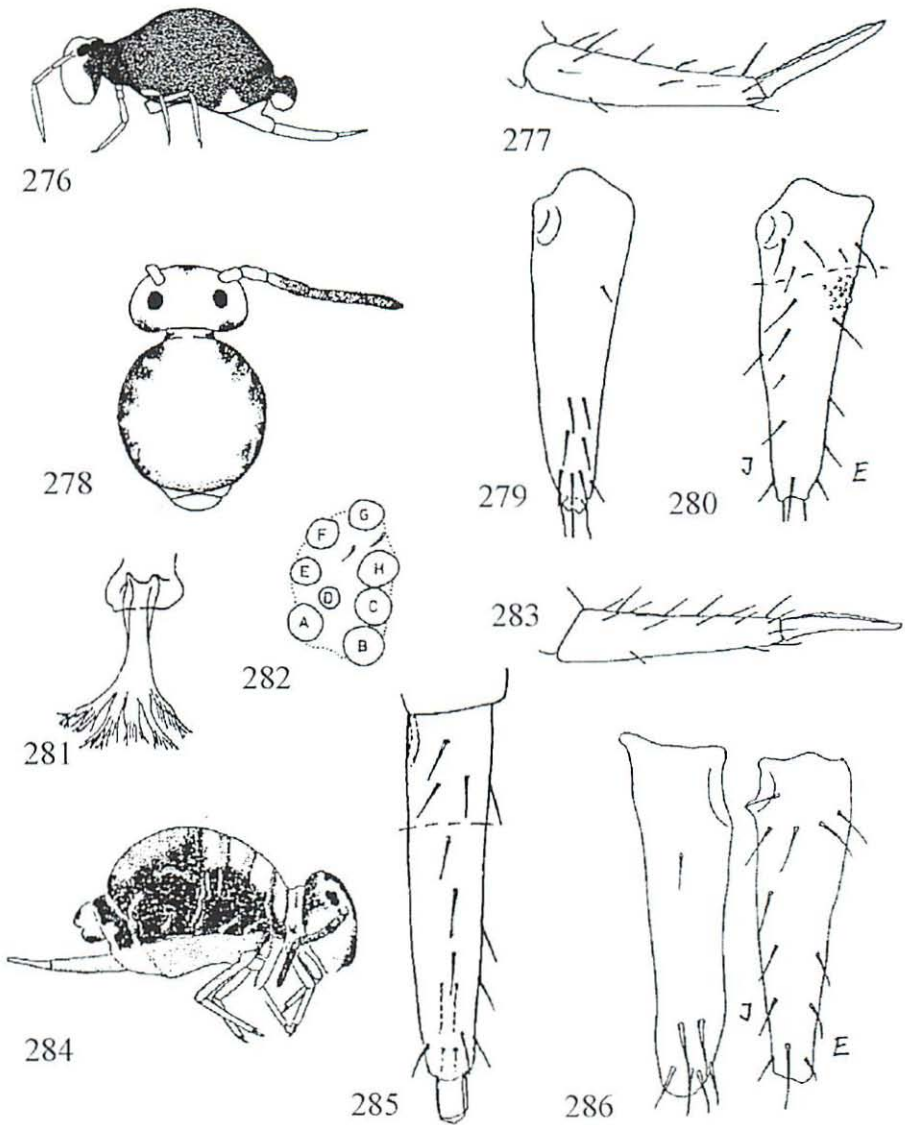


Fig. 276 *Sminthurinus igniceps*, habitus (after REUTER 1890).

Fig. 277 *Sminthurinus lawrencei*, dens, lateral view (after GISIN 1963).

Figs. 278 - 281 *Sminthurinus modestus* (after YOSII 1970):

278 Habitus 279 Dens, anterior side 280 Dens, posterior side 281 App. an.

Figs. 282 - 283 *Sminthurinus niger* (after GISIN 1963): 282 Right eye-patch 283 Dens, lateral view.

Figs. 284 - 285 *Sminthurinus orientalis* (after STACH 1964): 284 Habitus 285 Dens, posterior view.

Fig. 286 *Sminthurinus pallescens*, dens, anterior (left) and posterior (right) side (nomenclature orig.) (after YOSII 1970).

Proportions: Length of antennae : head diagonal = 1.4. Ant I : II : III : IV = 1 : 2 : 3 : 6.7.  
Dens : mucro = 2.

Type locality: China, Hangchow, in forest litter.

Occurrence: Known only from the type locality.

Remarks. This single female of *S. pekinensis* is apparently a full grown specimen of *S. orientalis* because it belongs to the same sample and has the same chaetotaxy of dens, same small claws, same mucro, same proportions. Therefore, *S. pekinensis* seems to be synonymous with *S. orientalis*.

*Sminthurinus planasiensis* Dallai, 1969 (299)

Only 1 female known. Total length 1 mm. Position of Abd V not described. Background colour deep yellow, dark red pigment in bases of Bothr and on Ant IV. Papilla of Ant III small and undivided. Each Tita with 5 spatulate setae. Ret with 2 setae. Dens with 2 anterior subapical setae, posterior setae: 3 proximal, and 2 outer and 2 (rather 3?) median subapical setae (Fig. 288). Only inner edge of mucro serrate. App. an. racketlike with many irregular fringes (Fig. 289).

Proportions: Length of antennae : head diagonal = 1.4.

Type locality: Italy, isle of Pianosa, Punta del Marchese.

Occurrence: Known only from the type locality.

Remarks: The original figure of the dens of *S. planasiensis* shows 3 proximal posterior setae and thus does not correspond to *Gisinianus flammeolus* as DALLAI (see above) supposed, because that species has 4 such setae.

*Sminthurinus reticulatus* Cassagnau, 1964 a (481)

Syn.: *Sminthurinus aureus* var. *transversalis* Axelson, 1905 (794), HÜTHER 1982: 97

*Sminthurinus aureus* Ellis, 1976 (318) (orig.)

Total length 0.7 mm. In adults, Abd V fused with large abdomen. Background colour yellow, bluish green lateral and cross stripes on large abdomen, head with a dark band between eye-patches (Fig. 265). Other characteristics as in *S. aureus*.

Type locality: France, Aude, S slopes of Montagne Noir.

Occurrence: Also reported from Spain (MATEOS 1988: 99, 101, MATEOS & SELGA 1991: 23), Greece (Crete, ELLIS 1976: 318), Germany (HÜTHER, see above, BÖHLE 1991: 39), and Finland (AXELSON 1905, 794).

Biology: *S. reticulatus* usually lives in soil and moss, but also on fields and dry meadows (BÖHLE, see above).

Species description: HÜTHER 1982: 97 (critical discussion).

*Sminthurinus speciosus* Yosii, 1970 (19)

Total length 0.6 mm. Abd V included in small abdomen. Background colour light brown, black longitudinal lateral band from head to posterior of large abdomen; with 3 white patches: 1 between eyes and 1 pair laterally on large abdomen, large and small abdomen dorsally darker brown (Fig. 290); Ant dark blue, legs and furca pale. Ant III with large, undivided papilla. Tita without (?) spatulate setae.

Claws elongate with weak pseudonychium but large tunica, only claw I with inner tooth; Emp broad without tooth, Emp I and II with long filament and length > claws, Emp III with short filament and length = claw. Ret with 2 setae. Dens with 2 anterior subapical setae, posterior setae: 4 proximal (2 outer, 1 long median, 1 inner), and 3 outer and 3 median subapical setae (Fig. 291). Inner edge of mucro weakly serrate, outer smooth, tip blunt. Circumanal setae in females not winged, seta a0 furcate; App. an. with fine branches.

Proportions: Length of antennae : head diagonal = 1.4. Ant I : II : III : IV = 1 : 2 : 3.3 : 5.5. Dens : mucro = 2.

Type locality: Japan, Kyoto, Tambacho.

Occurrence: Also found at another site in Japan (Kyoto, Daimonji, YOSII, see above).

Remarks: The small abdomen has been figured without pigment. The absence of the spatulate setae of the Tita must still be confirmed.

*Sminthurinus trinotatus* Axelson, 1905 (794) sensu Gisin, 1963 (84) and Hüther, 1969 (146)

Syn.: *Sminthurinus igniceps* var. *trinotatus* Axelson, 1905 (794)

*Sminthurinus fenestratus* Börner, 1909 (124), STACH 1956: 115

*Sminthurus biflavopunctatus* Collinge & Shoebottom, 1909 (9), STACH 1956: 115  
nec *Sminthurinus trinotatus* Prabhoo, 1971 (251) (= other species)

Total length up to 0.75 mm in females, 0.45 mm in males. Abd V included in small abdomen. Background colour white to brownish yellow, more or less black pigment on thorax, laterally on large abdomen, and dorsally on small abdomen, 1 pair of bright white spots laterally on large abdomen; head with 1 pair of white spots between eye-patches; Ant IV with weak dark pigment (Fig. 292). 8+8 ommatidia, D small, each eye-patch with 2 setae. Papilla of Ant III small, divided into four parts. Each Tita with 5 spatulate setae. Claws rather narrow with 1 - 3 small inner teeth and weak lateral teeth; Emp broad with small outer tooth, Emp I with long filament and length = claw. Emp II with short filament, Emp III without filament, length of Emp II and III < claws. Ret with 1 seta. Dens with 2 anterior subapical setae, posterior setae: 5 proximal, and 2 outer and 3 median subapical setae (see Fig. 269). Both edges of mucro serrate. App. an. distally broadened with several branches (Fig. 293).

Proportions: Length of antennae : head diagonal = 1.3. Ant I : II : III : IV = 1 : 1.6 : 2.1 : 4.3. Dens : mucro = 2.

Type locality: Middle Finland, Oulu, in greenhouses (see LINNANIEMI 1912: 290).

Occurrence: Europe, Japan (YOSII 1970: 19), and NE China, (Changchun, CHEN & SHIN 1990: 221). In Europe from Scandinavia (Finland, see above; Norway, FJELLBERG 1980: 134) S to S France (CASSAGNAU 1962: 229), and N Italy (Prealpe Venete, RUSEK 1973: 87).

Biology: In northern regions of Europe, but also in S France (see above) and SE Germany (Saxony, SCHULZ & DUNGER 1995: 16), *S. trinotatus* has only been found in greenhouses and on flowerpots in dwellings. In Japan and NE China (see above), and in more southern regions of Europe it also occurs in open habitats, e. g. in Central and SE Germany (Saxony-Anhalt, in *Medicago*, NAGLITSCH 1962: 626; Saxony, in moss, DUNGER 1973: 27), S Austria (Carinthia, in wet hay, LATZEL 1922: 75), and N Italy (in moss, see above).

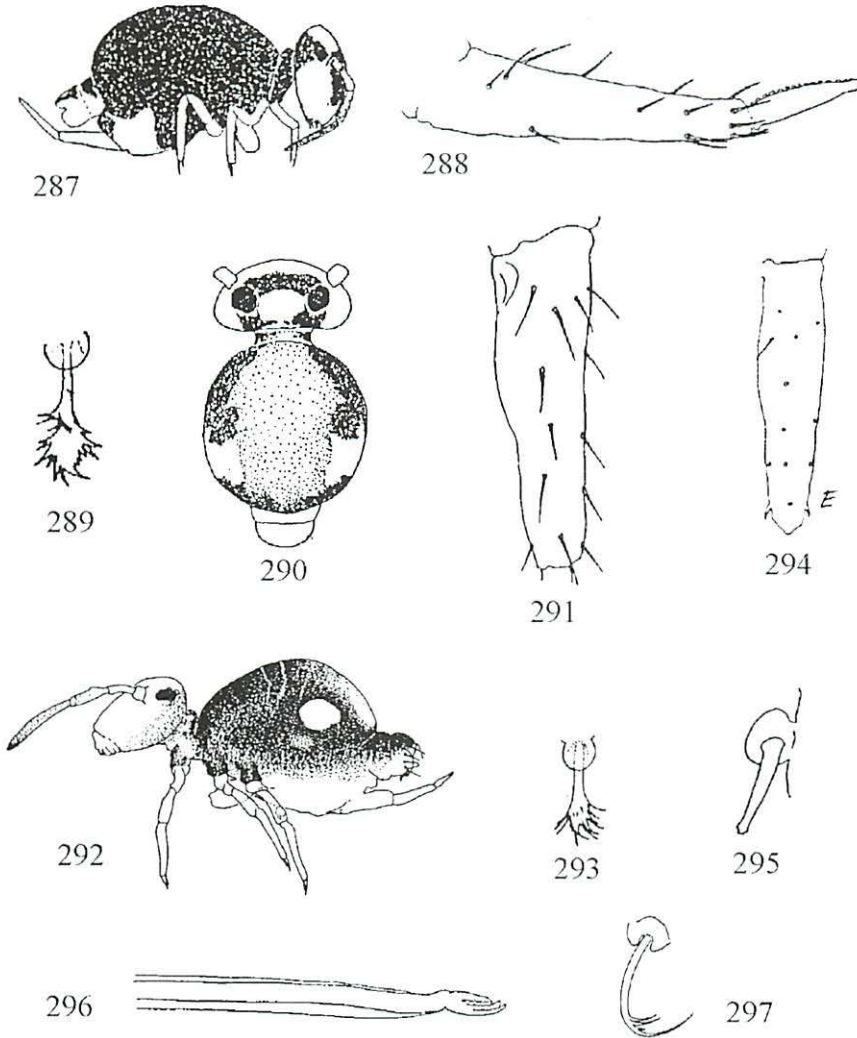


Fig. 287 *Sminthurinus pekinensis*, habitus (after STACH 1964).

Figs. 288 - 289 *Sminthurinus planasiensis* (after DALLAI 1969): 288 Dens, lateral view 289 App. an.

Figs. 290 - 291 *Sminthurinus speciosus* (after YOSII 1970): 290 Habitus 291 Dens, posterior side.

Figs. 292 - 293 *Sminthurinus trinotatus*:

292 Habitus (after FJELLBERG 1980) 293 App. an. (after HÜTHER 1969).

Figs. 294 - 295 *Sminthurinus wakhanicus* (after YOSII 1966): 294 Dens, posterior side 295 App. an.

Fig. 296 *Stenognathellus cassagnai*, elongate maxilla (after YOSII 1966).

Fig. 297 *Stenognathellus denisi*, App. an. (after BETSCH 1980).

Species descriptions: STACH 1956: 115, DUIVEN 1972: 134 (life in a flowerpot), FJELLBERG 1984: 87 (maxillary outer lobe).

Remarks: In open habitats, *S. trinotatus* may be confused with *S. bimaculatus* if the position of Abd V is unclear and the chaetotaxy of dens is not checked; such older records are, therefore, not certain. In the above description some original observations are included.

*Sminthurinus wakhanicus* Yosii, 1966 (348)

Total length 0.8 mm. Abd V with intermediate position between large and small abdomen. Colour uniformly chestnut brown with fine black spots; Ant dark, legs and furca paler. 8+8 ommatidia. Papilla of Ant III distinct and undivided. Tita with spatulate setae, number not described. Claws with 2 small inner teeth, without pseudonychium or tunica; Emp broad with small outer tooth, without filament. Ret with 1 seta. Dens without anterior subapical setae, posterior setae: 4 proximal (1 outer, 1 long median, 2 inner), and 2 outer and 3 median subapical setae (Fig. 294). Inner edge of mucro serrate, outer wavy. App. an. short rodlike with blunt tip (Fig. 295).

Proportions: Length of antennae : head diagonal = 1.3. Ant I : II : III : IV = 1 : 2 : 2.5 : 5.5. Dens : mucro = 2.

Type locality: Afghanistan, Wakhan, Ishikashim.

Occurrence: Also found at another site in Afghanistan (Badakhshan, Borak, YOSII, see above) and N of Afghanistan between Uzbekistan and Tadzhikistan (Babatag Mountain Ridge, VTOROV & MARTYNOVA 1977: 502).

**Genus *Stenognathellus* Stach, 1956**

**Key to the Palaearctic species**

- 1 Abd VI in females with furcate seta a0, dens posteriorly with 2 outer subapical setae, Abd V often included in small abdomen (*denisi*-group) *denisi* Cassagnau, 1953
- Abd VI in females with normal seta a0, dens posteriorly with 1 outer subapical seta, Abd V included in large abdomen (*polygonalis*-group) *cassagnai* Yosii, 1966

**Diagnosis of the genus**

Abd V often included in the small abdomen (*denisi*-group) or large abdomen (*polygonalis*-group). Head and Abd with normal setae. Bothr ABCD present. Neosminthuroid setae present. Mouthparts elongate (Fig. 296). Ant III with a protuberance or a papilla. Ant IV undivided. Trochanteral organ present. Sacs of VT smooth. Ret with 4+4 teeth. Abd VI in females with seta a0 furcate (*denisi*-group) or normal (*polygonalis*-group), other circumanal setae not winged.

Occurrence: Worldwide.

Descriptions of the genus: STACH 1956: 95, BETSCH 1980: 135.

Type species: *Stenognathellus denisi* Cassagnau, 1953.

### Diagnosis of the Palaearctic species

#### *Stenognathellus cassagnai* Yosii, 1966 (525)

Total length 0.6 mm. Colour dark grey, setal bases and thoracic sutures pale. 8+8 ommatidia, C and D small. Ant III with large protuberance. Setae of trochanter III and spatulate setae of Tita not described. Claws with inner tooth and weak tunica, without lateral teeth; Emp triangular, sometimes with outer tooth, only Emp I and II with filament, length of Emp I, II > claws, Emp III = claw. Ret with 1 seta. Manubrium with 4+4 posterior setae. Dens without anterior subapical setae, posterior setae: 3 proximal, and 1 outer and 3 median subapical setae (see Fig. 261). Both edges of mucro serrate, tip with posterior tooth. Abd V included in large abdomen. Abd VI in females with normal seta a<sub>0</sub>; App. an. smooth, asymmetrically furcate.

Proportions: Length of antennae : head diagonal = 1.8. Ant I : II : III : IV = 1 : 1.3 : 2.3 : 5. Dens : mucro = 2.2.

Type locality: Nepal, Chagma.

Occurrence: In the Palaearctic found in Greece (Rhodes and Crete, ELLIS 1974 c: 134, 1976: 318 respectively).

Species description: ELLIS 1976: 318.

Remarks: The identification of the Mediterranean specimens should be confirmed (BETSCH 1980: 137).

#### *Stenognathellus denisi* Cassagnau, 1953 (227)

Total length 0.7 mm. Colour grey with small pale spots. 8+8 ommatidia, C and D small or completely reduced, each eye-patch with 2 setae. Ant III with papilla. Trochanter III with 3 anterior setae. Each Tita with 3 spatulate setae. Claws with inner tooth, 1 pair of lateral teeth, and tunica; Emp with outer tooth and filament, length > claws. Ret with 1 seta. Manubrium with 6+6 posterior setae. Dens without anterior subapical setae, posterior setae: 3 proximal, and 2 outer and 3 median subapical setae. Inner edge of mucro serrate, outer smooth, weakly serrate or only distal 1/3 smooth, tip pointed or with posterior round tooth. Abd V often included in small abdomen but also in large abdomen. Abd VI in females with furcate seta a<sub>0</sub>; App. an. smooth with few subapical branches (Fig. 297).

Proportions: Length of antennae : head diagonal = 1.6. Ant I : II : III : IV = 1 : 2.2 : 3 : 7. Dens : mucro = 1.8.

Type locality: France. Haute-Garonne, Saint-Jean-de-L'Union, moss on the foot of *Quercus* trees.

Occurrence: Central and S Europe; S to N Spain (JORDANA et al. 1990: 189), S France and Corsica (POINSOT 1974: 126, 1978: 186), and Italy (e. g. DALLAI 1971: 368). Recorded uncertainly from Australia (GREENSLADE, pers. comm.).

Biology: *S. denisi* has been found in litter and moss of mountain forests up to 1400 m altitude (Italy, DALLAI, see above). In S France, Montagne Noir, it was typically found in litter of the part with a mediterranean climate (CASSAGNAU 1965: 356). It is thermophile (KOPESZKI & MEYER 1994: 157).

Remarks: Some original observations are added in the above description. Whether Abd V is included in the large or small abdomen is sometimes difficult to decide, i. e. there are populations which have Abd V obviously included in the large abdomen. The mucronal serration also varies.

### Genus *Vesicephalus* Richards in Delamare Deboutteville & Massoud, 1964

**Key.** Only 1 Palearctic species: *Vesicephalus europaeus* Ardanaz & Pozo, 1986

#### Diagnosis of the genus

Abd V (always?) included in the small abdomen. Head and Abd with long and rough setae (Figs. 298, 299). Head with 1 pair of interocular vesicles (Fig. 298). Bothr ABCD present, ABC mostly equidistant. Neosminthuroid setae missing. Mouthparts normal. Ant III without papilla; Ant IV undivided (Fig. 300). Trochanteral organ missing. Sacs of VT smooth. Ret with 4+4 or 3+3 teeth. Abd VI in females with normal seta a0, other circumanal setae winged, rough, or thickened.

Occurrence: USA and N Spain.

Biology: The species of *Vesicephalus* live in litter and moss on moist soil.

Descriptions of the genus: DELAMARE DEBOUTTEVILLE & MASSOUD 1964: 81, BETSCH 1980: 139, CHRISTIANSEN & BELLINGER 1981: 1136.

Type species: *Sminthurus longisetis* Guthrie, 1903.

#### Diagnosis of the single Palearctic species

*Vesicephalus europaeus* Ardanaz & Pozo, 1986 (271)

Total length about 0.6 mm in male. Colour blue to brownish arranged in round and helioid spots. Head frons, Ant II and III, and large abdomen with several long and rough setae (Figs. 298 - 300). Bothr AB next to one another. 8+8 ommatidia, C and D small, each eye-patch with 2 short setae. Trochanter III with 3 anterior setae, without trochanteral organ (see below). Tita with thick outer and inner setae. Tita I - III with 9, 9, 8 spatulate setae respectively. Claws with inner tooth, lateral teeth, and tunica; Emp short, pointed, without tooth, filaments more or less ribbonlike, length > claws (Figs. 301, 302). Ret with 2 setae, 4+4 teeth. Manubrium with at least 11+11 posterior setae. Dens without anterior subapical setae, posterior setae: 5 proximal, and 5 outer and 3 median subapical setae. Mucro rather short, inner edge with few round teeth, outer wavy (Fig. 303), shaft and each edge with apical tooth. Abd VI in females with 2+2 ciliate circumanal setae, setae sa and sa2 thick and blunt; App. an. split into branches.

Proportions (from 1 male): Length of antennae : head diagonal = 1.9. Ant I : II : III : IV = 1 : 3.2 : 3.6 : 5.8. Dens : mucro = 3.2.

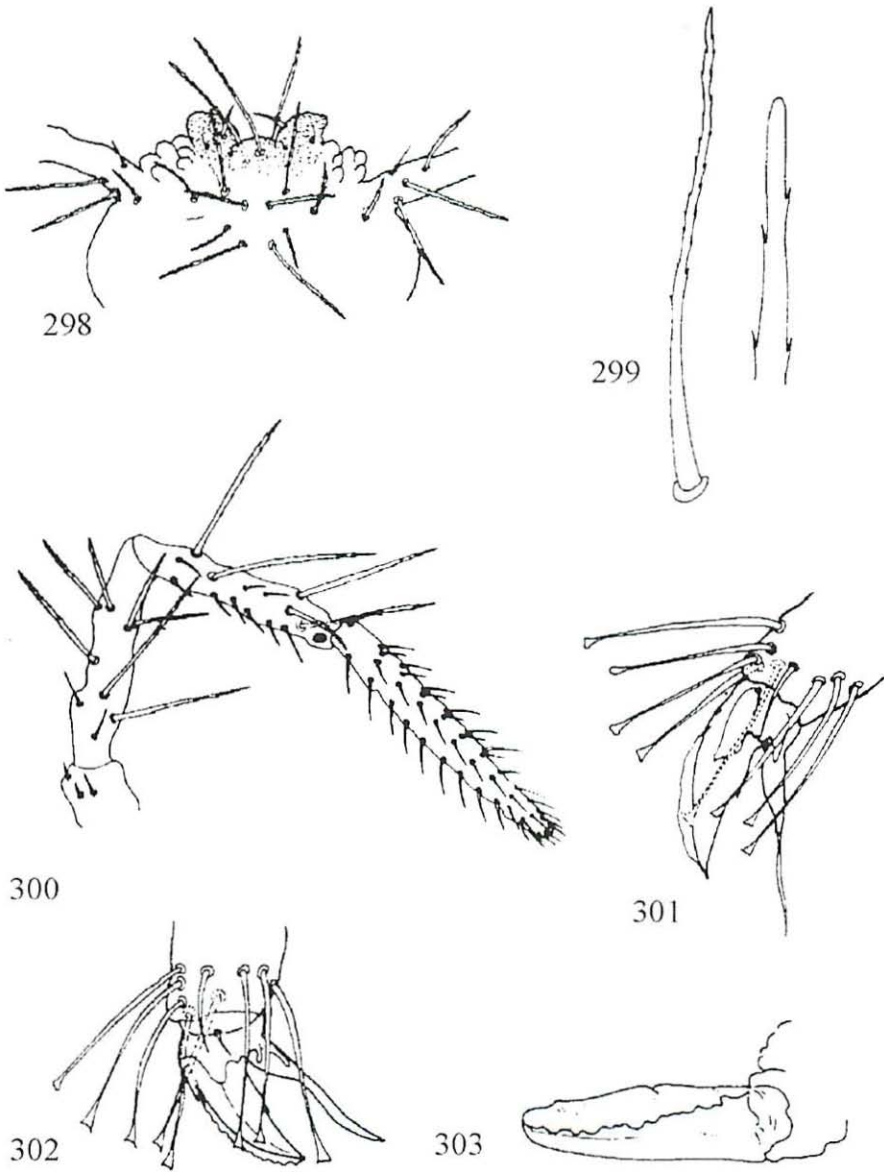
Type locality: Spain, Navarra, Echauri, litter and moss of a *Quercus* forest.

Occurrence: Also found at other sites in Spain (Navarra, other *Quercus* forests, and Vizcaya, *Fagus* forest, ARDANAZ & POZO, see above).

Biology: *V. europaeus* lives on the soil in litter and moss; it was only found in autumn and winter.

Remarks: In the description above, some original observations are added based on 1 male (NA-001, 17/01/84), which has been kindly given to this author's collection by J. I. ARBEA, Corella, Spain. The structure in the original Pl. II, Fig. 5, which resembles a trochanteral organ, belongs to the trochanteral joint to femur (orig. observ.).





Figs. 298 - 303 *Vesicephalus europaeus* (after ARDANAZ & POZO 1986):

298 Head upper part, interocular vesicles and long setae 299 Long seta and its tip 300 Antenna

301 Tip of Tita I 302 Tip of Tita III 303 Mucro

## Dicyrtomida Bretfeld, 1986

Syn.: Dicyrtomidae Börner, 1906 sensu Betsch, 1980 (142)

Dicyrtomoidea Bretfeld, 1994 (279)

### Diagnosis

The taxon Dicyrtomida Bretfeld, 1986 (310) is a monophylum of the Eusymphyleona-Sminthuriformia Bretfeld, 1986 with 3 diagnostic apomorphies:

- Ant IV shorter than 1/2 Ant III (plesiomorphy: Ant IV longer than Ant III)
- antennae elbowed between Ant II and III (plesiomorphy: antennae elbowed between Ant III and IV)
- several setae transformed to cup sensilla (plesiomorphy: these setae of normal form).

Other diagnostic characteristics: Abd V generally included in large abdomen (apomorphy); Bothr A on large papilla (apomorphy); Bothr BC insert close to one another (apomorphy); Tita generally without spatulate setae (plesiomorphy); Tita III usually with 2 or 3 smooth, rough, or serrate spinelike posterior setae (apomorphy); sacs of VT long and warty (apomorphy); Ret generally with 4 teeth (plesiomorphy); mucro without seta (apomorphy).

There are 2 subgroups of the Dicyrtomida (= subfamilies, NAYROLLES & BETSCH 1996: 281) which differ in Bothr D (see BETSCH 1980: 143) and in the dorsal setae of Abd VI in females (BRETZFELD 1994: 14):

- Ptenothricinae Richards, 1968: Bothr D always present, sensillum P3 (S) of Abd VI not directly anterior to circumanal setae (Fig. 320),
- Dicyrtominae Richards, 1968: Bothr D missing from the 2nd instar to adult, sensillum P3 (S) of Abd VI directly anterior to circumanal setae (Fig. 321).

### Description

The Dicyrtomida are medium-sized to large animals, the total length of adults ranging from 1 - 3 mm. The pigmentation varies from pale yellow to dark brown-violet; it may be uniform or show various patterns. The large abdomen generally stretches from 1/2 segment Th II to Abd V (BETSCH 1980: 14). It is ovoid and, in some genera, protrudes dorsoposteriorly as a more or less long club (Figs. 304, 305). There are only short tracheae in the head (BETSCH 1980: 22). The setae are often modified to spines and macrochaetae of various form; the longest occurring on the head apex (Fig. 346), the anterior of large abdomen (Fig. 326), and Abd VI (Fig. 351); smaller spines on the head clypeus; the smallest posteriorly on the large abdomen (Fig. 308). The apex of the abdominal humps or clubs always bears short and stout spines (Figs. 359, 363). On the large abdomen, in most genera, the posterior spinelike setae are centres of long and thin waxen rods secreted by their tormogene cells (MASSOUD & VANNIER 1965: 4819, JUBERTHIE & MASSOUD 1977: 125); only in *Bothriovulsus* are these posterior abdominal setae of normal setal form (BETSCH & WEINER 1987: 626). In all genera, some setae form special cup sensilla (Fig. 309). There are, on principal, 4 pairs of Bothr, ABCD; A inserts on a large papilla, B and C insert close to one another and in front of A (Fig. 308). Exceptions occur in *Bothriovulsus*, which lack the A pair, and in the adults of Dicyrtominae, which lack the D pair (in *Gibberathrix* Bothr A is present, see below). The segmental position of the Bothr is discussed by BETSCH & WALLER 1989: 23.

The App. an. are directed posteriorly or towards the anus; they are setalike and slightly curved dorsally, or short and thick (Figs. 341, 367). In some genera neosminthuroid setae are present.

The eye-patches have 8+8 ommatidia, C and D often being smaller than the others. The clypeus has a medial row of setae or spines, the arrangement of which is often species specific and has been described from the upper to the lower setae as, e. g., 1,1,2,1,1,1 (Figs. 310, 311). The mandibulae and maxillae are always of the normal chewing type. Ant IV is shorter than III and the whole antenna is elbowed between Ant II and III (Figs. 304, 305). Ant IV and the distal part of Ant III may be subsegmented, but this characteristic is of low taxonomic value since it is at least age dependent. The tibiotarsi have spatulate distal setae only in one species (*Ptenothrix beta* of USA). On the posterior side of Tita III, 1 - 3 thick spinelike setae occur, which are smooth, rough, or serrate like a slender oak leaf (Figs. 312 - 314). The claws and Emp are usually uniform; the claws having sometimes a tunica, 1 - 2 inner teeth, few outer teeth, 2 or more pairs of lateral teeth, and smooth or serrate lateral duplications (pseudonychium); the Emp are usually slender with 1 outer tooth and a subapical filament, which is pointed or clavate apically and generally exceeds the claws (Figs. 315, 316).

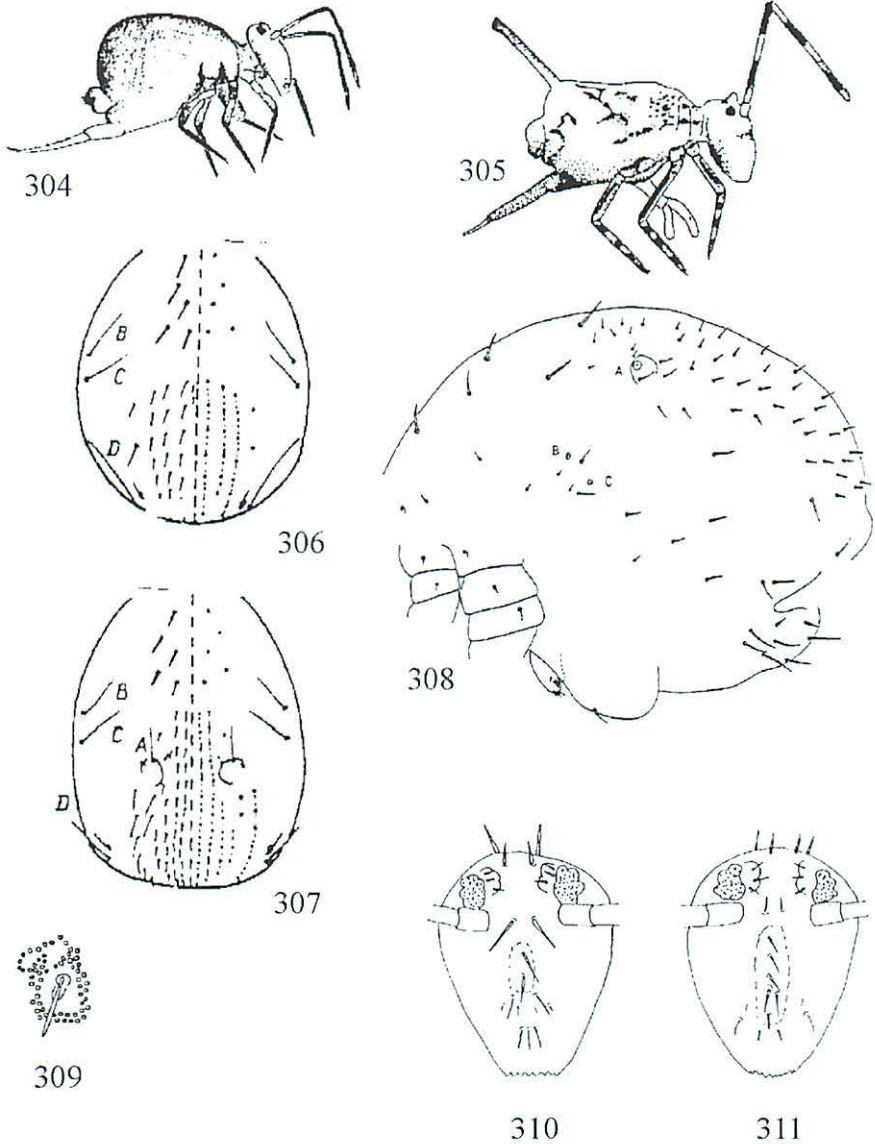
The sacs of VT are long and warty. The Ret has 4+4 teeth, except 3+3 in *Gibberathrix*. The setae of the dentes are often rough, the outer (E) and inner (J) often strongly serrate basally; the seta E1 incerts laterally, its form differs distinctly from the appressed anterior setae (Figs. 317 - 319, 330, 354). Both posterior edges of the straight and slender mucro are toothed, a seta being missing.

The important species specific chaetotaxy of Abd VI is most completely developed and described only in females, there are thin, thick, or cylindrical spinelike setae, and 1 pair of additional sensilla on each of the anal valves. The general nomenclature of BRETZFELD (1994: 13) is used here with the special nomenclature of YOSII (1969: 221, 225) added in brackets: m1 (M), A1 (cup sensillum), A2 (cup sensillum), A3 (M'), AL1 (E2), AL2 (E1), DL1 (N'), DL2 (N), P0 (G'), P1' (T or a4), P1 (H), P2 (G), P3 (S = sensillum). Chaetotaxy and nomenclature are explained in Figs. 320 - 324 and with the genera.

### Biology

The species of the Dicyrtomida belong to the atmobios. They need a moist habitat, however, and usually live in shady woods on or near the soil, under stones or dead wood, but also higher up on tree trunks. Adults can also be found in winter in sheltered places. The secretion of waxen rods is already mentioned above. Of the 6 cavernicolous species of the Dicyrtomida, 2 are troglobite (*Ptenothrix cavicola* and *P. kuraschvilii*, MASSOUD & THIBAUD 1973: 154).

Remarks: The original and secondary descriptions mainly consider females because of the more complete and differentiated chaetotaxy of Abd VI; males are often not even mentioned. The following keys, therefore, also consider mainly females. Most males cannot be identified except, for instance, in species showing a clear colour pattern.



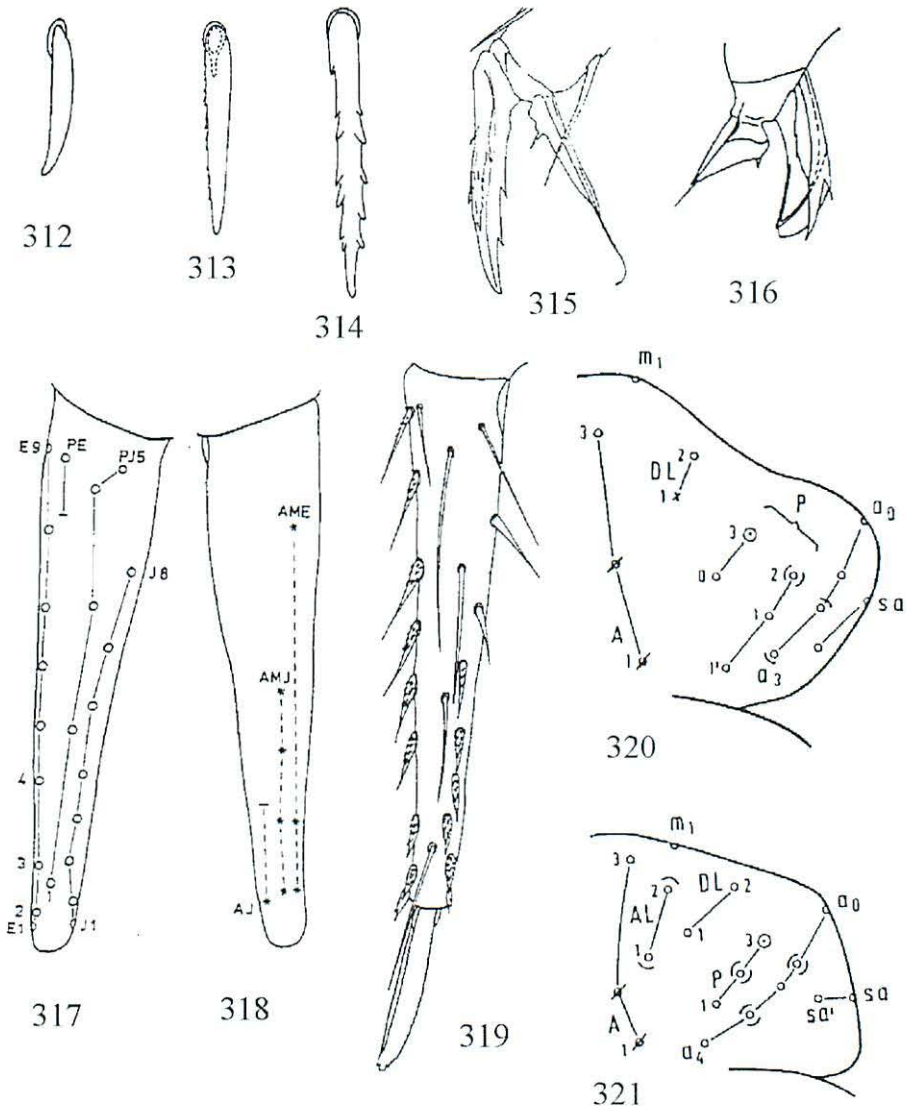
Figs. 304 - 324 Dicyrtomida general:

304 Egglike habitus of most genera (*Dicyrtoma christinae*, after SZEPTYCKI 1981) 305 Habitus of genus with protuberance (*Papirioides jacobsoni*, after YOSII & LEE 1963) 306 Dorsal chaetotaxy of large abdomen of *Bothriovulsus* (after BETSCH & WEINER 1987) 307 Dorsal chaetotaxy of large abdomen of *Ptenothrix* (after BETSCH & WEINER 1987) 308 Large abdomen and Bothr ABC (*Dicyrtoma ghilarovi*, after BRETFFELD 1996) 309 Cup sensillum (after BETSCH 1980) 310 Head clypeus with 2 unpaired upper setae (Ptenotricinae, after CHRISTIANSEN & BELLINGER 1981) 311 Head clypeus with 4 - 6 unpaired setae (Dicyrtominae, after CHRISTIANSEN & BELLINGER 1981)

## Key to the genera of the world

## Dicyrtomida Bretfeld, 1986

- 1 Bothr D always present, sensillum P3 (S) of Abd VI not directly anterior to circumanal setae (Fig. 320) (Ptenothricinae Richards, 1968) 2
- Bothr D missing from 2nd instar to adult, sensillum P3 (S) of Abd VI directly anterior to circumanal setae (Fig. 321) (Dicyrtominae Richards, 1968) 4
- 2 Bothr A present, large abdomen posteriorly with short spines 3
- Bothr A missing, large abdomen posteriorly with only normal setae  
*Bothriovulsus* Richards, 1968 (p. 133)  
type species: *Ptenothrix pineolae* Wray, 1946; USA
- 3 Large abdomen of normal globular form (Fig. 304), posteriorly with many short spines  
*Ptenothrix* Börner, 1906 (p. 154)  
type species: *Podura atra* Linnaeus, 1758; Europe
- Large abdomen posteriorly with prominent short or long protuberance with few pairs of short spines (Figs. 305, 363)  
*Papirioides* Folsom, 1924 (p. 151)  
type species: *Papirioides jacobsoni* Folsom, 1924; Sumatra
- 4 (1) Head and anterior of large abdomen with setae or spines of normal setal length or longer 5
- Head and anterior of large abdomen with only minute setae 8
- 5 Ret with 4+4 teeth, setae of dens smooth, rough, or serrate 6
- Ret with 3+3 teeth, most setae of dens clearly ciliate  
*Gibberathrix* Uchida, 1952 (p. 147)  
type species: *Gibberathrix tsugarensis* Uchida, 1952; Japan
- 6 Dorsal head-back with setal pairs 1 + 2 (or 1 - 3) (Fig. 17) modified to long spines; claws with tunica (Fig. 316)  
*Dicyrtomina* Börner, 1903 (p. 141)  
type species: *Podura minuta* O. Fabricius, 1783; Europe
- Dorsal head-back with only setal pair 1 (Fig. 17) modified to slender spines, pairs 2 + 3 to short or minute spines; claws with or without tunica (Fig. 315) 7
- 7 Claws without tunica, neosminthuroid setae missing, Abd VI dorsally often with thick spines  
*Dicyrtoma* Bourlet, 1842 (p. 137)  
type species: *Papirius fuscus* Lubbock, 1873; Europe
- Claws with tunica, neosminthuroid setae (always?) present, Abd VI dorsally with only normal setae  
*Jordanathrix* Bretfeld & Arbea n. gen. (p. 148)  
type species: *Dicyrtomina articulata* Ellis, 1974; Greece
- 8 (4) Large abdomen of normal globular form, neosminthuroid setae present  
*Calvatomina* Yosii, 1966 (p. 135)  
type species: *Dicyrtomina (Calvatomina) cruciata* Yosii, 1966; India
- Large abdomen posteriorly with prominent protuberance with few pairs of short spines, neosminthuroid setae missing  
*Pseudodicyrtomina* Stach, 1957  
type species: *Dicyrtomina trukana* Uchida, 1944; Caroline Islands



312 Smooth posterior spine of Tita III (*Jordanathrix articulata*, orig.) 313 Rough posterior spine of Tita III (*Dicyrtoma fusca*, after BETSCH 1980) 314 Serrate posterior spine of Tita III (*Dicyrtoma ghilarovi*, after BRETFFELD 1996) 315 Claw III without tunica, Emp slender (*Ptenothrix monochroma*, after YOSHII & LEE 1963) 316 Claw III with tunica, Emp broad (*Dicyrtomina minuta*, after GISIN 1960).

317 - 318 Chaetotaxy of dens, posterior and anterior sides (*Dicyrtoma ghilarovi*, after BRETFFELD 1996) 319 Dens with rough inner and outer setae (*Dicyrtoma ghilarovi*, after BRETFFELD 1996)

320 Chaetotaxy of Abd VI of Ptenothricinae, dorsal part, left side (complete pattern only in females,  $\emptyset$  = cup sensillum, P3 = sensillum, x = missing seta, (O) = varying setae, after BRETFFELD 1994)

321 Chaetotaxy of dorsal side of Abd VI of Dicyrtominae (complete pattern only in females, symbols as in Fig. 320, after BRETFFELD 1994)

## Diagnosis of the Palaearctic genera and species

### Genus *Bothriovulsus* Richards, 1968

#### Key to the Palaearctic species

- 1 Large abdomen anterolaterally with 3 blunt microspines (Fig. 326), circumanal setae a1 - a3 in females long and of normal form *sohungensis* Weiner & Betsch, 1992
- Large abdomen anterolaterally with 3 pointed microchaetae, circumanal setae a1 - a3 in females rough and winged *kymgangensis* Weiner & Betsch, 1992

#### Diagnosis of the genus

A genus of the Ptenothricinae. Large abdomen without a protuberance. Head, anterior of large abdomen, and Abd VI with spines. Large abdomen posteriorly with 3+3 longitudinal rows of normal setae (Figs. 306, 326). Bothr A missing, D present. Neosminthuroid setae missing. Tita III posteriorly with 2 modified, serrate setae. Claws without a tunica. Ret with 4+4 teeth. Outer and inner setae of dens serrate.

Occurrence: USA, North Korea.

Descriptions of the genus: RICHARDS 1968: 26, BETSCH 1980: 145, CHRISTIANSEN & BELLINGER 1981: 1218, BETSCH & WEINER 1987: 622, WEINER & BETSCH 1992: 81.

Type species: *Ptenothrix pineolae* Wray, 1946.

#### Diagnosis of the Palaearctic species

*Bothriovulsus kymgangensis* Weiner & Betsch, 1992 (87)

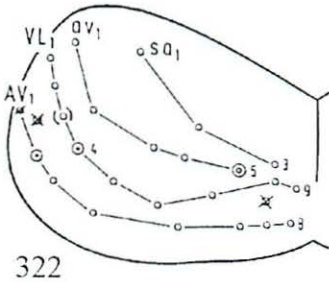
Males unknown. Total length 1.2 mm. Background colour light, head and large abdomen with brown-violet cross bands, antennae dark (see Fig. 325). Head apex with spines, setal pair 1 of dorsal head-back as slender spines, pairs 2 + 3 as microspines, clypeus with (1),1,1,2,2,1,1 medial setae. Large abdomen anteriorly with 6 pairs of long spines and laterally 3 pairs of pointed microchaetae. Tita III posteriorly with 2 serrate spines. Claws with 2 inner teeth and lateral teeth: 2 large and several small basal pairs; Emp I with 1, others with 2 teeth, all filaments pointed, length > claws. Ret with 4 setae. Most outer and inner setae of dens broadened basally and with basal teeth, formula of anterior setae 3,2,1,1...1. Both edges of mucro with about 20 teeth each. Dorsal setae of Abd VI rough and acuminate, circumanal setae a0, a1 - a3 thick, rough, acuminate, and winged except a0; App. an. thick, blunt, and serrate.

Proportions: Length of antennae : head diagonal = 3.3. Ant I : II : III : IV = 1 : 4.6 : 5.75 : 1.75. App. an. : mucro = 0.55.

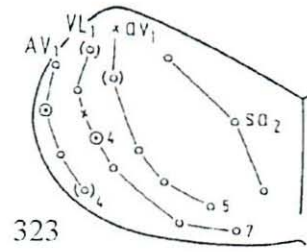
Type locality: North Korea, Kangvon-do Prov., Kymgang-san Mts., litter near Kurjong waterfall at about 400 m altitude.

Occurrence: Known only from the type locality.

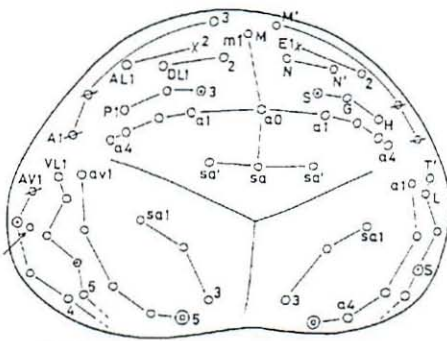
Remarks: The chaetotaxy, except those of the antennae, has been described in detail.



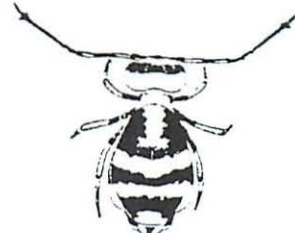
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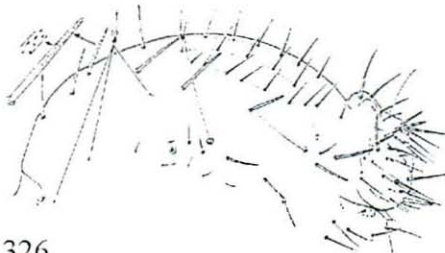
324



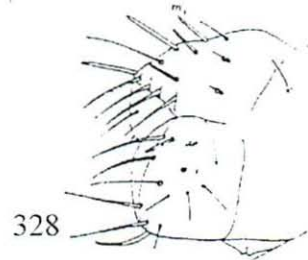
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326



328

322 Chaetotaxy of female Abd VI, ventral part, left side, (⊗ = cuticular cone, AV2 and VL4 = sensilla, av5 = App. an., other symbols as in previous figures, after BRETFELD 1994) 323

Chaetotaxy of male Abd VI, ventral part, left side (symbols as in previous figures, after BRETFELD 1994) 324 Setal nomenclature of female Abd VI, left after BRETFELD 1994, right after YOSII 1969 (symbols as in previous figures, after BRETFELD 1996).

Figs. 325 - 326 *Bothriovulsus sohungensis* (after WEINER & BETSCH 1992):

325 Habitus 326 Female body.

Figs. 327 - 328 *Calvatomina rufescens* (after HÜTHER 1965):

327 Claw and Emp I 328 Female Abd VI.



*Bothriovulsus sohungensis* Weiner & Betsch, 1992 (83)

Total length up to 1.1 mm in females, 0.75 mm in males. Background colour light, head and large abdomen with brown-violet cross bands, antennae dark (Fig. 325). Head apex with spines, setal pair 1 of dorsal head-back as slender spines, pairs 2 + 3 as microspines, clypeus with 1,1,2,2,1,1 medial spines and setae (2 ventral as setae). Large abdomen anteriorly with 6 pairs of long spines and laterally 3 pairs of blunt microspines (Fig. 326). Tita III posteriorly with 2 serrate spines. Claws with 2 inner teeth, 1 outer tooth, and lateral teeth: 2 large and several small basal pairs; Emp with 1 tooth, filaments pointed, length > claws. Ret with 4 setae. Most outer and inner setae of dens broadened basally and with basal teeth, formula of anterior setae 3,2,1,1...1. Both edges of mucro with about 20 teeth each. Dorsal setae of Abd VI long and acuminate, circumanal setae a0, a1 - a3 of normal setal form; App. an. slender, smooth, and blunt.

Proportions: Length of antennae : head diagonal = 2 in females, 2.2 in males. Ant I : II : III : IV = 1 : 4.25 : 5.6 : 1.6 in females, 1 : 4.65 : 5.35 : 1.85 in males. App. an. : mucro = 0.7.

Type locality: North Korea, Hvanghe-pukto Prov., small woody valley near Lake Sohung-ho at about 150 m altitude.

Occurrence: Also collected at others sites in North Korea (Phjongan-namdo and Janggang-do Provinces, WEINER & BETSCH, see above).

Biology: *B. sohungensis* lives in the low vegetation and in litter of shady forests and on basalt rocks up to 1000 m altitude.

Remarks: The chaetotaxy, except those of the antennae, has been described in detail.

**Genus *Calvatomina* Yosii, 1966****Key to the World species groups and Palearctic species**

- |   |  |                                 |
|---|--|---------------------------------|
| 1 | Formula of anterior setae of dens 4,2,1,1,1...1; Tropics   | <i>bougainvillea</i> -group     |
| – | Formula of these setae 4,2,1,1...1   | 2                               |
| 2 | Seta a0 of Abd VI of normal form; Tropics  | <i>formosana</i> -group         |
| – | Seta a0 thick and blunt; Tropics and Holarctic; <i>rufescens</i> -group with 1 Holarctic species | <i>rufescens</i> (Reuter, 1892) |

**Diagnosis of the genus**

A genus of the Dicyrtominae. Large abdomen without a protuberance. Head and anterior of large abdomen with only minute setae. Setal pair 1 of dorsal head-back as short normal setae, pairs 2 + 3 as microspines. Large abdomen posteriorly with short spines. Abd VI with longer spines. Bothr A present, D missing. Neosminthuroid setae present. Tita III posteriorly with 2 or 3 modified, smooth setae. Claws with a tunica. Ret with 4+4 teeth. Outer and inner setae of dens smooth or slightly serrate.

Occurrence: Worldwide, mainly Tropics.

Descriptions of the genus: YOSII 1966: 400, YOSII 1969: 226, BETSCH 1980: 147, NAYROLLES & BETSCH 1996: 281.

Type species: *Dicyrtomina (Calvatomina) cruciata* Yosii, 1966.

### Diagnosis of the single Palaearctic species

*Calvatomina rufescens* (Reuter, 1892) (22) sensu HÜTHER, 1965 (47)

Syn.: *Papirius rufescens* Reuter, 1892 (22)

*Dicyrtomina opalina* Folsom, 1896 (120) sensu CHRISTIANSEN & BELLINGER 1981 (1228) n. syn.

*Dicyrtomina rufescens* Axelson, 1907 (134)

nec *Dicyrtomina rufescens* Schött, 1927 (36) (= other species)

*Dicyrtomina rufescens* f. *nivalis* Uchida, 1953 (3) (= *Dicyrtomina leptothrix*, YO-SII 1977: 166 = *Jordanathrix leptothrix*, see below)

*Dicyrtomina rufescens* Uchida & Fujita, 1968 (36) (= *Jordanathrix leptothrix*, see below)

*Calvatomina rufescens* Mari Mutt, 1987 (378) (= other species)

*Calvatomina rufescens* Soto-Adames, 1988 (65) (= other species)

Total length about 1.5 mm. Colour reddish or light with various dark patterns. Abd V separated from large abdomen. Head and large abdomen with microchaetae, clypeus with 4 - 6 unpaired setae. Tita III posteriorly with 3 weakly modified, pointed spines. Claws with tunica, 2 inner, 2 outer teeth, and 2 pairs of basally serrate lateral teeth; Emp I narrower than others, all with tooth, filament of Emp I longer than claw, others very short, all pointed (Fig. 327). Furca base with 5+5 neosminthuroid setae. Ret with 2, 3, or 4 setae. All setae of dens smooth, formula of anterior setae 3,2,1,1...1. Both edges of mucro with about 35 - 40 teeth each. Setae m1 (M), DL2 (N), and P1 (H) of Abd VI thick and spinelike, setae AL (E) and P2 (G) absent, circumanal seta a0 thick and spinelike, setae a1 - a4 thick, smooth, and setalike; App. an. setalike, smooth, curved dorsally (Fig. 328).

Proportions: Length of antennae : head diagonal = 1.75. Ant I : II : III : IV = 1 : 4.5 : 5.75 : 1.25. Ratio of dens setae E1 - E4 = 1 : 1.1 : 1.1 : 1.9. Dens : mucro = 2.8.

Type locality: Finland, Helsinki, on flowerpots in warmhouses of Botanical Garden.

Occurrence: Holarctic; known only from S Finland and USA (Massachusetts, FOLSOM, see above).

Biology: *C. rufescens* was only found on flowerpots in greenhouses.

Species descriptions: LINNANIEMI 1912: 323, STACH 1957: 41.

Remarks: The records from Africa (SCHÖTT, see above), Colombia (MARI MUTT, see above), and Puerto Rico (SOTO-ADAMES, see above) apparently belong to other species; these American specimens have a thin (instead of thick) seta m1 (M) on Abd VI in females (HÜTHER, see above).

There are no recent records of this species from greenhouses; it may be that it has been exterminated by insecticides.

### Genus *Dicyrtoma* Bourlet, 1842 sensu Börner, 1906

Syn.: *Papirius* Lubbock, 1862 (431) ad partem

#### Key to the Palaearctic species

- |   |   |                                   |   |
|---|---|-----------------------------------|---|
| 1 | Dens with smooth setae, head with 1 pair of small cuticular cones between antennae (Fig. 335) | <i>grinbergi</i> Stebaeva, 1966   |   |
| – | Dens with rough or serrate setae, head without such cones                                     |                                   | 2 |
| 2 | Most outer and inner setae of dens thickened basally and coarsely serrate                     |                                   | 3 |
| – | These setae slender and of normal form but with rough surface                                 | <i>christinae</i> Szeptycki, 1981 |   |
| 3 | Ratio of setae E4 : E3 of dens about 1  |                                   | 4 |
| – | This ratio = 2 - 3  | <i>melitensis</i> Stach, 1957     |   |
| 4 | Ratio of setae E3 : E2 of dens about 1  | <i>ghilarovi</i> Bretfeld, 1996   |   |
| – | This ratio $\geq 3$ (Fig. 330)  | <i>fusca</i> (Lubbock, 1873)      |   |

#### Diagnosis of the genus

A genus of the Dicyrtominae. Large abdomen without a protuberance. Head, anterior of large abdomen, and Abd VI with spines. Setal pair 1 of dorsal head-back as slender spines, pairs 2 + 3 as microspines. Large abdomen posteriorly with small spines. Bothr A present, D missing. Neosminthuroid setae missing. Tita III posteriorly with 2 (Nearctic) or 3 (Palaearctic) modified, rough setae. Claws without a tunica. Ret with 4+4 teeth. Outer and inner setae of dens serrate.

Occurrence: Holarctic.

Descriptions of the genus: BOURLET 1842: XL, BÖRNER 1906: 184, STACH 1957: 60, BETSCH 1980: 145, CHRISTIANSEN & BELLINGER 1981: 1220.

Type species: *Papirius fuscus* Lubbock, 1873.

#### Diagnosis of the Palaearctic species

*Dicyrtoma christinae* Szeptycki, 1981 (173)

Colour orange or pale brown, antennae and legs darker, furca lighter (Fig. 304). Head apex with spines, clypeus with 5 unpaired, slightly thickened setae. Large abdomen anteriorly with fine and short setae. Tita III posteriorly with 3 rather short, finely ciliate spines. Claws with weak teeth, 2 inner and 2 pairs of lateral teeth; Emp with large tooth, filaments clavate, length > claws. Ret with 5 setae. Manubrium with 9+9 smooth setae. Most outer and inner setae of dens slender and rough. Outer edge of mucro with 31 - 42, inner 27 - 36 teeth. Dorsal setae of Abd VI thin and blunt, AL (E) setae missing, circumanal setae a1 - a3 thick, smooth, and setalike, seta P1/a4 (T) thinner than a3; App. an. setalike, smooth, curved dorsally.

Proportions: Length of antennae : head diagonal = 1.7 in females, 2 in males. Ant I : II : III : IV = 1 : 3.7 - 4.5 : 4.7 - 5.5 : 1.3 - 1.8. Ratio of dens setae E1 - E4 = 1 : 0.7 - 1.1 : 2.5 - 3.3 : 3.3 - 4, seta J5 = J4. Dens : mucro = 2.7 - 3.4.

Type locality: Poland, Gdansk, Ostrowo, on decaying plants on very wet soil.

Occurrence: Known only from the type locality.

*Dicyrtoma fusca* (Lubbock, 1873) (120) sensu Stach, 1957 (67)

Syn.: *Papirius cursor* Lubbock, 1862 (436)

*Papirius silvaticus* Tullberg, 1871 (146), LINNANIEMI 1912: 324

*Papirius fuscus* Lubbock, 1873 (120)

*Dicyrtoma albella* Wahlgren, 1906 (265), SALMON 1964: 636

nec *Dicyrtoma fusca* Yosii, 1940 (189) (= *Ptenothrix* spec., YOSII 1977: 166)

Total length up to 2 mm. Colour completely yellowish grey or dark violet with pale or white head apex, large abdomen posteriorly sometimes also pale or spotted. Head apex with spines, setal pair 1 of dorsal head-back as slender spines, pairs 2 + 3 as microspines (orig. observ.), clypeus with about 5 unpaired, slightly thickened setae. Large abdomen anteriorly with fine and short setae. Tita III posteriorly with 3 rather long, rough or finely ciliate spines (Fig. 313). Claws with 2 inner, 1 or 2 indistinct outer, and 2 or more pairs of lateral teeth; Emp with large tooth, filaments clavate, length > claws (Fig. 329). Ret with 4 setae. Most outer and inner setae of dens broadened basally and with large basal teeth (Fig. 330), formula of anterior setae 3,2,1,1...1. Both edges of mucro with about 35 - 40 teeth each. Setae m1 (M), A3 (M'), and DL2 (N) of Abd VI thick and spinelike, AL1 (E2) always present, AL2 (E1) varies, circumanal setae a1 - a3 thick, smooth, and setalike, seta P1<sup>1/4</sup> (T) smaller than a3; App. an. setalike, smooth, straight, or curved dorsally (Fig. 331).

Proportions: Length of antennae : head diagonal = 1.7 - 2.5. Ant I : II : III : IV = 1 : 4.9 : 5.8 : 1.3. Ratio of dens setae E1 - E4 = 1.2 : 1 : 3.6 - 4.5 : 5 (Fig. 329), setae E4 : E3 = 1.1 - 1.4, seta J5 >> J4. Dens : mucro = 2.3 - 2.8.

Type locality: Not specified, France, England.

Occurrence: Holarctic; in the Palaearctic from Island (BÖDVARSSON 1957: 79) E to SE Russia (STEBAEVA 1976: 126) and S to Italy (DALLAI & MARTINOZZI 1980: 42), Algeria (CASSAGNAU 1963: 199), and Portugal, the Azores (GAMA 1992 :47). Not confirmed for Japan (YOSII 1977: 166).

Biology: *D. fusca* has been mostly collected near the soil, in litter, on dead wood, mushrooms, or under stones, in moist or wet habitats of meadows and forests from the lowlands to subalpine regions, and in moors (HALE 1966: 107). It occurs up to 1500 m (Slovakia, STACH 1957: 70). In Switzerland it has been found in xerothermic forests (GISIN 1948: 515). Several data concerning the general biology have been reported (AGRELL 1941: 20), also of the breeding biology (HALE 1965: 146), of the structure and transfer of spermatophores (MAYER 1957: 501), and the body weight (500 - 620 µg, ZINKLER 1966: 104). Adults have been collected mainly in summer and autumn (BOCKEMÜHL 1956: 150, HALE 1965: 168). This species is troglophile (MASSOUD & THIBAUD 1973: 155) or troglaxene (SCHULZ 1994: 128).

Species descriptions: LINNANIEMI 1912: 324, GISIN 1960: 297 (Abd VI in females), CHRISTIANSEN & BELLINGER 1981: 1222.

Remarks: The discussion of *D. fusca* as type species of *Dicyrtoma* is given by ELLIS & BELLINGER 1973: 17, 1984: 5.

The Nearctic specimens (from Canada) differ from those of the Palaearctic in having claws with 5 - 8 pairs of lateral teeth and normal dorsal setae of Abd VI.

The colour varieties of this species have been given separate names (STACH 1957: 69):

var. *silvatica* Tullberg, 1871 (146) with a greyish-red colour,

f. *principalis* Lubbock, 1873 (120) with completely dark pigment,

var. *flavescens* Axelson, 1902 (111) with yellowish-grey colour,

var. *medialis* Stach, 1930 (82) with dark pigment only laterally on large abdomen,

var. *maculifera* Stach, 1957 (70) with a light dorsal pattern.

*Dicyrtoma g hilarovi* Bretfeld, 1996 (221)

Total length 1.6 mm in females, 1 mm in males. Colour of head and body deep black with some varying white to yellow spots. Head apex with slender spines, setal pair 1 of dorsal head-back as slender spines, pairs 2 + 3 as microspines, clypeus with 6 unpaired slender spines (Fig. 332). Large abdomen anteriorly with 5 pairs of slender spines (Fig. 308). Tita III posteriorly with 3 serrate spines (Fig. 314). Claws with 2 inner teeth, 1 small outer tooth, and several lateral teeth; Emp with tooth, filaments thick and blunt, about as long as claws (Fig. 333). Ret with 3 setae. Manubrium with 8+8 setae, 1 outer pair thick, rough. All outer and most inner setae of dens broadened basally and with large basal teeth, formula of anterior setae 3,2,1,1...1 (Figs. 317 - 319). Both edges of mucro with about 40 small teeth each. All dorsal setae of Abd VI slender and blunt, AL1 (E2) always present, AL2 (E1) missing, circumanal setae a1 - a4 thick, smooth, and setalike, seta a4 slightly thinner than a3; App. an. short, thick, and blunt.

Proportions: Length of antennae : head diagonal = 1.7 in females, 2.1 in males. Ant I : II : III : IV = 1 : 4.2 : 4.8 : 1.4. Ratio of dens setae E1 - E4 = 1 : 1 : 1.1 : 1.3 in both sexes, seta E4 : E3 = 1.1 - 1.5. Dens : mucro = 3 in females, 3.5 in males.

Type locality: Russia, Irkutsk Reg., valley of Goloustnaya River near Lake Baykal, slate slopes of a small lake with moss and lichens at 800 m altitude.

Occurrence: Also found in a birch-pine wood of the type locality.

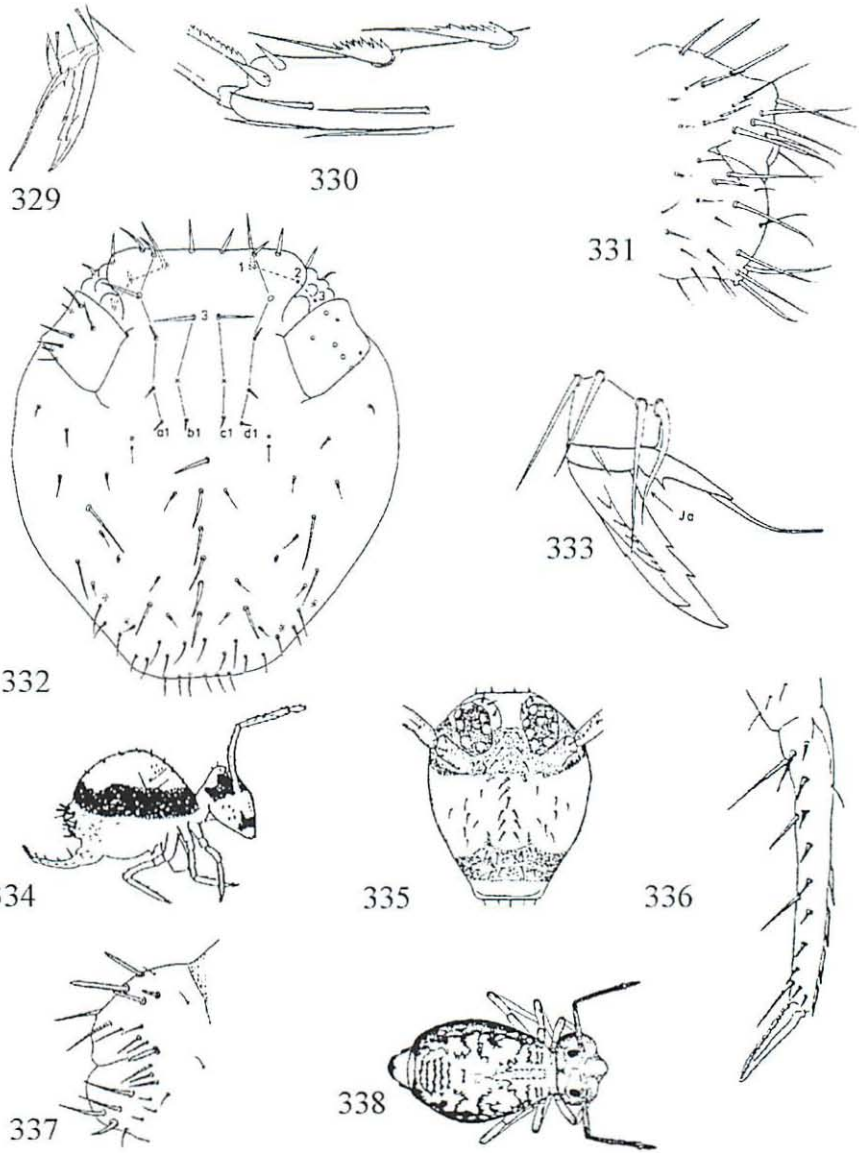
*Dicyrtoma grinbergi* Stebaeva, 1966 (10)

Only 1 female known. Total length 1.26 mm. Background colour pale rose, lateral violet band around large abdomen, head with 2 broad violet cross bands (Fig. 334). Head apex with short spines, 1 pair of short cuticular cones between antennae, clypeus with 3 unpaired and 3 pairs of slightly thickened medial setae (Fig. 335). Large abdomen without spines. Posterior spines of Tita III not described. Claws with 2 inner and 2 pairs of lateral teeth; Emp I narrower than III, all with tooth, filament of Emp I longer than claw and clavate, of Emp III short and pointed. Ret with 3 teeth (?) and 3 setae. All setae of dens smooth, outer setae short and spinelike (Fig. 336). Both edges of mucro serrate. Abd VI dorsally with probably 3 long and 2 short spines; App. an. short, thick, and pointed (Fig. 337).

Proportions: Length of antennae : head diagonal = 2.4. Ant I : II : III : IV = 1 : 4 : 5 : 2. Dens : mucro = 2.8. App. an. : mucro = 0.3.

Type locality: Russia, West Sayan Mts., Polu-Buyba, floodland of river Buyba, in litter of fir taiga.

Occurrence: Also found at another site in SE Russia (Tuva Reg., S slope of Tannu-Ola Ridge, STEBAEVA 1976: 126).



Figs. 329 - 331 *Dicyrtoma fusca*:

329 Claw and Emp II (after STACH 1957) 330 Apex of dens, anterior setae and outer setae E1 - E4 (after STACH 1957) 331 Female Abd VI (after GISIN 1960).

Figs. 332 - 333 *Dicyrtoma ghilarovi* (after BRETTFELD 1996):

332 Chaetotaxy of head, micropores marked by arrows, x = missing setae, 0 = oval organs 333 Claw and Emp I.

Figs. 334 - 337 *Dicyrtoma grinbergi* (after STEBAEVA 1966):

334 Habitus 335 Head 336 Dens and mucro seen from lateral 337 Female Abd VI.

Fig. 338 *Dicyrtoma meltensis*, habitus (after STACH 1967).

*Dicyrtoma melitensis* Stach, 1957 (73) sensu Stach, 1967 (415)

Syn.: *Dicyrtoma fusca* Stach, 1924 (123) ad partem

Background colour pale yellowish, head and large abdomen with varying irregular dark brown spots and bands, large abdomen posteriorly with 5 cross stripes or 5 pairs of dark spots (Fig. 338). Head apex with spines, clypeus with 7 or 8 unpaired setae. Large abdomen anteriorly with 3 pairs of spines. Tita III posteriorly with 3 rather long, rough or finely ciliate spines. Claws with 2 inner teeth, 1 small outer tooth, and 2 pairs of lateral teeth; Emp with large tooth, filaments pointed, length > claws. Chaetotaxy of dens and Abd VI, also App. an. as in *Dicyrtoma fusca* (see Figs. 330, 331). Both edges of mucro densely serrate.

Proportions: Length of antennae : head diagonal = 1.4. Ratio of dens seta E4 : E3 = 2.1 - 3.

Type locality: Malta, Valetta, Porto Reale, under stones in grass.

Occurrence: Also found at others sites in Malta (STACH, see above), in Italy (in the islands e. g. Stromboli and Sardinia, and continental Italy, ALTNER 1961: 270, DALLAI 1973: 570), Greece (Crete, ELLIS 1976: 321), Spain (JORDANA et al. 1990: 47), Bulgaria (CONEV & KAZANDZIEVA 1991: 82), and former Palestine (Dagania in Jordan Valley, HANDSCHIN 1942: 443).

Biology: The spermiogenesis of *D. melitensis* has been described by DALLAI (1970: 275).

Species descriptions: ALTNER 1961: 270, DALLAI 1969: 301.

Remarks: The colour varieties of *D. melitensis* have been given separate names (STACH 1957: 73):  
var. *dorsosignata* STACH 1924 (125) with much dark pigment but always with posterior cross stripes,

var. *pallida* STACH 1924 (125) with few dark spots, posteriorly with faded cross stripes or only 5 pairs of dark spots.

### Genus *Dicyrtomina* Börner, 1903

Syn.: *Dicyrtoma* Bourlet, 1842 (XLI) ad partem

*Papirius* Lubbock, 1862 (431) ad partem

*Dicyrtoma* Stach, 1929 (312)

#### Key to the Palaearctic species

- |   |   |                                  |
|---|---|----------------------------------|
| 1 | Posterior edges of mucro smooth or with few incisions   | 2                                |
| – | Both posterior edges of mucro serrate   | 3                                |
| 2 | Large abdomen with 2 pairs of dark brown longitudinal bands, outer pair joined posteriorly          | <i>dorsolineata</i> Latzel, 1918 |
| – | Abdomen dorsally blackish brown, large abdomen posteriorly with several small or 1 large light spot | <i>venusta</i> Latzel, 1918      |
| 3 | Large abdomen posteriorly with dark pigment   | 4                                |
| – | Large abdomen posteriorly light or large abdomen completely light                                   | 7                                |
| 4 | Large abdomen posteriorly with rectangular black spot or completely black                           | 5                                |
| – | Large abdomen posteriorly with dark, multi-armed crosslike figure (Fig. 343)                        | <i>saundersi</i> (Lubbock, 1862) |

- 5 Large abdomen laterally without or with light violet pigmentation (Fig. 340) 6  
*minuta* (O. Fabricius, 1783)
- Large abdomen laterally with dark violet pigmentation
- 6 Large abdomen dark violet with light median band and laterally small light spots 6  
*violacea* (Krausbauer, 1898)
- Large abdomen with irregular, bluish black longitudinal and cross stripes (Fig. 342)  
*ornata* (Nicolet, 1842)
- 7 (3) Large abdomen laterally with dark pigment (Fig. 344) 8  
*signata* Stach, 1957
- Large abdomen light or weakly pigmented
- 8 Large abdomen without dark pigment  
*minuta* (O. Fabricius, 1783) var. *pallida* Ågren, 1903
- Large abdomen with 1 pair of weakly pigmented dorsolateral spots with irregular light ornaments (Fig. 339)  
*flavosignata* (Tullberg, 1871)

Remarks: Nowbody certainly knows whether these *Dicyrtomina* species are only colour varieties or real biological species. The chaetotaxy is only partially known and mainly from *D. ornata*, a comparison with the other species is still missing. Allozyme analysis may be a method to confirm the colour distinctions (FANCIULLI et al. 1995: 21).

### Diagnosis of the genus

A genus of the Dicyrtominae. Large abdomen without a protuberance. Head, anterior of large abdomen, and Abd VI with spines. Setal pairs 1 - 3 of dorsal head-back as slender spines. Large abdomen posteriorly with short spines. Bothr A present, D missing. Neosminthroid setae missing. Tita III posteriorly with 2 or 3 modified, smooth and blunt setae. Claws with a tunica. Ret with 4+4 teeth. Outer and inner setae of dens serrate.

Occurrence: Holarctic.

Descriptions of the genus: BÖRNER 1903: 167, STACH 1957: 34, BETSCH 1980: 145, CHRISTIANSEN & BELLINGER 1981: 1226.

Type species: *Podura minuta* O. Fabricius, 1783.

### Diagnosis of the Palearctic species

*Dicyrtomina dorsolineata* Latzel, 1918 (252)

Total length up to 1.4 mm. Background colour pale yellow, large abdomen with 2+2 dark brown longitudinal bands, outer pair joined posteriorly. Claws with tunica. Both edges of mucro smooth. Other characteristics not described.

Type locality: Austria, Carinthia, meadows near the E shore of Lake Wörthersee, below wet hay.

Occurrence: Known only from the type locality.

Remarks: *D. dorsolineata* has been only briefly described. It is mentioned here since the colour pattern is so distinct.



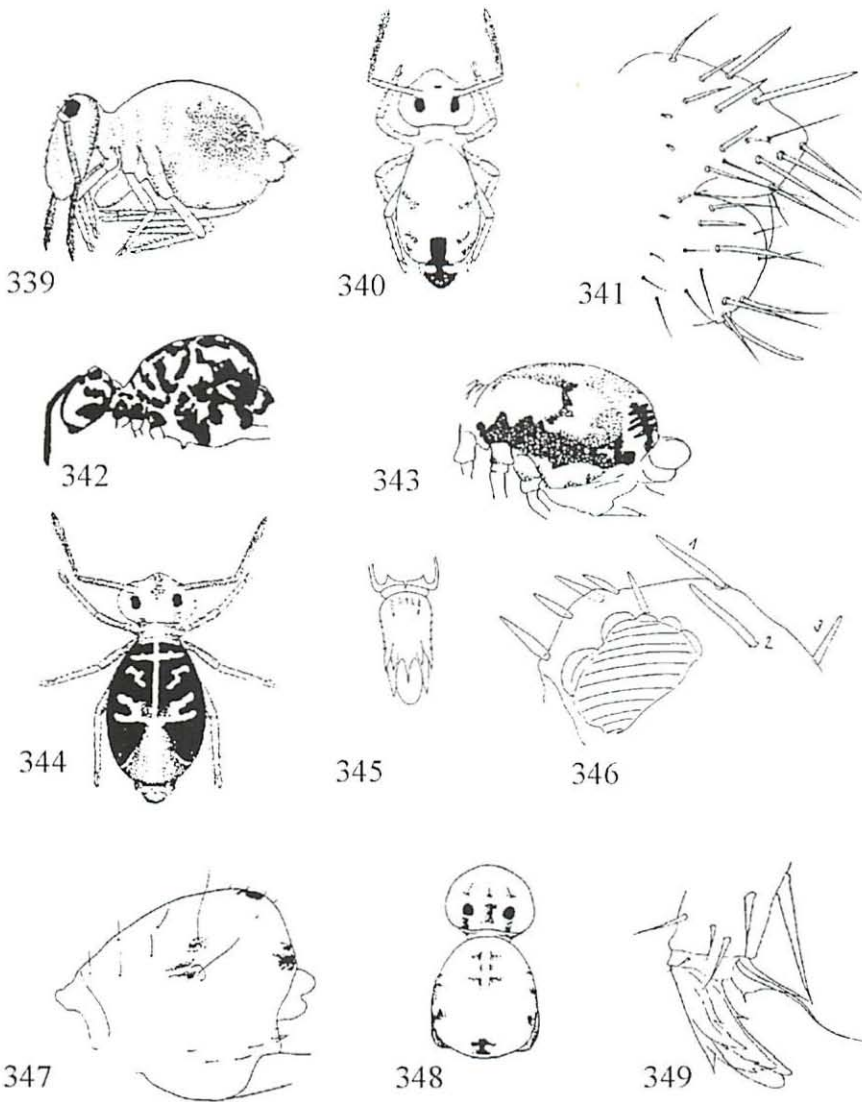


Fig. 339 *Dicyrtomina flavosignata*, habitus (after STACH 1957).

Figs. 340 - 341 *Dicyrtomina minuta*:

340 Habitus (after STACH 1957) 341 Female Abd VI (after GISIN 1960).

Fig. 342 *Dicyrtomina ornata*, habitus (after GISIN 1960).

Fig. 343 *Dicyrtomina saundersi*, colour pattern (after FJELLBERG 1980).

Fig. 344 *Dicyrtomina signata*, habitus (after STACH 1957).

Fig. 345 *Dicyrtomina violacea*, claw III outer side (after IONESCO 1916).

Figs. 346 - 349 *Gibberathrix tsugarensis* (after YOSII 1970):

346 Setae of head apex, 1, 2, 3 = setae of dorsal head-back 347 Left and right Bothr A 348 Colour pattern, 349 Claw and Emp I.

*Dicyrtomina flavosignata* (Tullberg, 1871) (146)

Syn.: *Papirius flavosignatus* Tullberg, 1871 (146)

*Dicyrtomina minuta* var. *flavosignata* Stach, 1957 (47)

Background colour whitish yellow, large abdomen laterally with grey-violet pigment and irregular light ornaments within these pigmented areas (Fig. 339). Outer and inner setae of dens finely serrate basally. Other characteristics as in *D. minuta*.

Type locality: SE Sweden, Uppland and Södermanland, near gardens.

Occurrence: W Palaearctic (SALMON 1964: 632, BRETTFELD 1996: 221).

Biology: *D. flavosignata* is not as abundant as *D. minuta* but also occurs in forests and adjacent meadows in the lower vegetation, in litter, and on dead wood; it is more frequent in lowlands than in mountains (NOSEK 1969: 405).

*Dicyrtomina minuta* (O. Fabricius, 1783) (307) sensu Stach, 1957 (43)

Syn.: *Podura minuta* O. Fabricius, 1783 (307)

nec *Dicyrtomina minuta* Handschin, 1942 (443) (= *D. ornata*)

*Dicyrtomina minuta* Ponge, 1980 (174) ad partem (= *D. ornata* and *D. saundersi*, Ponge 1980: 174)

Total length up to 2.8 mm. Background colour yellowish white, large abdomen laterally with about 3 pairs of light violet spots and posteriorly with unpaired black rectangular patch, apex of Abd VI often black, Ant III and IV dark blue (Fig. 340); sometimes whole body without black pigment (var. *pallida*, see below). Head apex with spines, clypeus with 6 unpaired spines. Large abdomen anteriorly with 5 spines of different lengths. Tita III posteriorly with 3 smooth and blunt spines. Claws rather short with tunica, 1 or 2 inner teeth, 1 outer tooth, and lateral teeth: 1 or 2 large and several small basal pairs (pseudonychium); Emp I narrower than others, all with tooth, filament of Emp I longer, of Emp III shorter than claw, all filaments pointed (Fig. 316). Ret with 4 setae. Outer and inner setae of dens smooth or weakly serrate, formula of anterior setae 3,2,1,1...1. Both edges of mucro with about 35 - 40 teeth each. Setae m1 (M), DL1 (N'), DL2 (N), and P1 (H) of Abd VI thick and spinelike, AL1 and AL2 (E2 and E1) present but not always spinelike, circumanal setae a1 - a4 smooth and setalike, seta a3 slightly smaller than others; App. an. setalike, smooth, weakly curved dorsally (Fig. 341).

Proportions: Length of antennae : head diagonal = 1.5 - 1.8. Ant I : II : III : IV = 1 : 5.4 : 5.8 : 1.8. Ratio of dens setae E1 - E4 = 3 : 1 : 5 : 5. Dens : mucro = 2.5 - 2.8. App. an. : mucro > 0.5.

Type locality: Not specified, Europe.

Occurrence: Holarctic; in the Palaearctic in the western regions, from Island (BÖDVARSSON 1957: 79) E to W Russia (GRINBERGS 1960: 62) and S to the W Mediterranean from former Yugoslavia (e. g. CVIJOVIC & ZIVADINOVIC 1973: 74) W to N Africa (POINSOT 1974: 124) and Portugal, Madeira and the Azores (GAMA 1959: 34, 1992: 47). The records from Iran (COX 1982: 39), South Africa (PACLT 1959: 69), Argentina (DELAMARE DEBOUTTEVILLE & MASSOUD 1963: 281), and New Zealand (SALMON 1941: 419) should be confirmed. Not confirmed for Australia (GREENSLADE 1994: 138). It is almost sure that former records also contain colour varieties which are treated here separately.

Biology: *D. minuta* is sometimes abundant in moist forests and the adjacent shady meadows where it occurs near the soil, in litter, in the low vegetation, or on dead wood. It has been collected from the seashore (STRENZKE 1955: 49, WEIGMANN 1973: 309) to subalpine regions of 1900 m altitude (Austria, TÖRNE 1958: 674; S France, the Pyrenees, CAS-SAGNAU 1961: 160). Biological observations comprise: growing relations (PETERSEN 1975: 222), mating behaviour, sperm transfer, occurrence on tree trunks, and others (MAYER 1957: 503), breeding biology (HALE 1965: 146), O<sub>2</sub>-consumption (ZINKLER 1966: 114, PETERSEN 1981: 273), and the use of VT (SEDLAG 1952: 110). The gut content, mainly fungi, has been studied by POOLE (1959: 71) and DUNGER (1963: 92), gut enzymes by URBASEK & RUSEK (1994: 400); parasitic fungi were observed by PURRINI (1983: 366). *D. minuta* is troglophile (MASSOUD & THIBAUD 1973: 155) or troglaxene (SCHULZ 1994: 128).

Species descriptions: GISIN 1960: 296 (claw and Emp III, chaetotaxy of Abd VI), YOSII 1965: 58 (chaetotaxy of Abd VI), LAWRENCE & MASSOUD 1973: 85 (cuticula), KRZYSZTOFOWICZ 1977: 81 (ovary), CHRISTIANSEN & BELLINGER 1981: 1227 (specimens from the Eastern Coast of N America).

Remarks: *D. minuta* as type species of *Dicyrtomina* is discussed by ELLIS & BELLINGER 1973: 18, 1984: 5. Of the many colour varieties summarized by STACH (1957: 43), only var. *pallida* Ågren, 1903 (169) is mentioned here since its colour differs distinctly from the typical pattern, both, however, can be collected from the same habitat.

*Dicyrtomina ornata* (Nicolet, 1842) (83), sensu Stach, 1957 (51)

Syn.: *Smynthurus ornatus* Nicolet, 1842 (83)

*Smynthurus coulonii* Nicolet, 1842 (84)

*Dicyrtomina minuta* Ponge, 1980 (174)

Total length 2 mm. Background colour white or yellowish, head and large abdomen with bluish-black irregular ornaments; black posterior patch and colour of Abd VI as in *D. minuta* (Fig. 342). Most outer and inner setae of dens finely serrate. Other characteristics as in *D. minuta*.

Proportions: Length of antennae : head diagonal = 1.5 - 1.8 in females, 2.1 in males. Ant I : II : III : IV = 1 : 4.8 : 5 : 1.6. Ratio of E1 - E4 = 2.5 : 1.2 : 4.2 - 4.5 : 5 in females, 2.2 : 1 : 4 : 4 in males. Dens : mucro = 2.4 - 2.8. App. an. : mucro = 0.5 - 0.6.

Type locality: Switzerland, Neuchâtel, under moss and stones.

Occurrence: W and SW Palaearctic; from S Scandinavia (LINNANIEMI 1912: 323, FJELLBERG 1980: 143) and Ireland (BOLGER 1986: 211) E to Azerbaijan (RASULOVA 1980: 1462) and S to the W Mediterranean from former Yugoslavia (e. g. CVIJOVIC & ZIVADINOVIC 1973: 74) W to Algeria and Morocco (THIBAUD & MASSOUD 1980: 544), and Portugal, the Azores (GAMA 1992: 47). The record from former Palestine (Dagania in Jordan Valley, HANDSCHIN 1942: 443) should be confirmed.

Biology: *D. ornata* lives in the same habitats as *D. minuta*, but prefers more temperate climates. Adults can be found in winter (CASSAGNAU 1965: 356, USHER 1970: 224) until May (VOLZ 1989: 93); no juveniles were found from June to August or September in Germany (Rhineland-Palatinate, Rhine Valley, VOLZ, see above). In this species, the occurrence of waxen rods posteriorly on large abdomen has been described (MASSOUD & VANNIER 1965: 4819). It has not been found in a cave (THIBAUD & MASSOUD 1977: 6).

Species descriptions: GISIN 1960: 296 (colour pattern), PAULUS 1974 a : 126, 1974 b: 245 (ultrastructure of ommatidia and of antennal scolopar-organs respectively), MASSOUD & ELLIS 1977: 175 (forms of setae), DALLAI 1975: 355 (structure of spermatophore), DALLAI & CALLAINI 1979: 45 (pylorus), DALLAI et al. 1989: 207 (mid-gut), NAYROLLES 1990 a: 13, 1990 b: 36, 1991 b: 62 (chaetotaxy of extremities), 1989: 237 (ontogeny of chaetotaxy).

*Dicyrtomina saundersi* (Lubbock, 1862) (438) sensu Stach, 1957 (50)

Syn.: *Papirius saundersi* Lubbock, 1862 (438)

*Dicyrtomina minuta meridionalis* Stach, 1930 (76)

*Dicyrtomina minuta* Ponge, 1980 (174)

Background colour light yellow, large abdomen laterally with greenish or darker patches, posteriorly with dark multi-armed crosslike figure (Fig. 343). Other characteristics as in *D. minuta*.

Type locality: Great Britain, Kent, among leaves and under logs of wood.

Occurrence: W Europe; from N Norway (FJELLBERG 1980: 142) to Ireland (BOLGER 1986: 211), the W Mediterranean (from Albania, POINSOT 1974: 126, W to Algeria, orig. observ., leg. MERTENS), and Portugal, the Azores (GAMA 1992: 47).

Biology: *D. saundersi* lives in a wide variety of habitats, from moist forests in Norway (FJELLBERG, see above) to dunes in Portugal (GAMA et al. 1989: 342).

Species descriptions: FJELLBERG 1980: 142, 1984: 87 (colour pattern and maxillary outer lobe respectively).

Remarks: In older publications, *D. saundersi* had apparently not been separated from *D. minuta*.

*Dicyrtomina signata* Stach, 1920 (221) sensu Stach, 1957 (57)

Syn.: *Dicyrtomina minuta* var. *signata* Stach, 1920 (221)

Total length 2 - 3 mm. Background colour light yellowish, large abdomen with broad areas of black violet pigment (Fig. 344). Tita III posteriorly with shorter spines as in *D. ornata*. Both edges of mucro with about 20 teeth each. Other characteristics as in *D. minuta*.

Proportions: Ratio of dens setae E1 - E4 = 2.8 : 1 : 4.3 : 4.3. Dens : mucro = 2.8 - 3.

Type locality: S Poland, Pieniny Mts., under dead bark on the soil of spruce forests.

Occurrence: Also found at another site in S Poland (High Tatra Mts.), in the adjacent regions of Slovakia, in Ukraine (the E Carpathians) (STACH 1957: 58), and Austria (the Alps, CHRISTIAN 1985: 144).

Biology: *D. signata* lives in moist habitats near the soil, in forests under pieces of dead wood and bark, and in the low vegetation, more abundant in the mountains than in lowlands; in mountains it was found higher up than *D. minuta* (up to 2000 m altitude, STACH 1957: 59). In the Alps it has been found in a permafrost soil at 1300 m altitude (CHRISTIAN, see above).

Remarks: In older publications, *D. signata* has apparently not been separated from *D. minuta*.

*Dicyrtomina venusta* Latzel, 1918 (251)

Total length up to 1.3 mm. Background colour whitish yellow, head sides and large abdomen dorsally blackish brown. large abdomen posteriorly with 2 pairs of small light spots or 1 large, lobed light patch. Claws with tunica. Outer edge of mucro smooth, inner minutely serrate. Other characteristics not described.

Type locality: Austria, Carinthia, in the low vegetation of forests and meadows, on dead wood, or below wet hay.

Occurrence: Known only from the type locality.

Remarks: *D. venusta* has only been briefly described. It is mentioned here since the colour pattern is so distinct.

*Dicyrtomina violacea* (Krausbauer, 1898) (499) sensu Ionesco, 1916 (510)

Syn.: *Papirius violaceus* Krausbauer, 1898 (499)

Total length 2 or 3 mm. Background colour of head, body, and extremities dark violet, large abdomen dorsally with irregular light violet band and laterally with several light spots, 1+1 light spots on inner sides of eye-patches. Claws rather short with tunica, 2 inner teeth, 1 outer tooth, and lateral teeth: 3 large pairs and several small basal pairs (pseudonychium) (Fig. 345). Setae of dens smooth or ciliate. Both edges of mucro serrate. Other characteristics as in *D. minuta*.

Proportions: Dens : mucro = 2.6.

Type locality: Germany, Hesse, environs of Weilburg/Lahn, Steinbühl, in rock debris.

Occurrence: Also found in S Poland (Rytro, SCHILLE 1912: 18), Romania (Olténie, IONESCO, see above), France (Haute-Saône, near the saline of Gouhenans, DENIS, see below), and Germany (North Rhine-Westphalia, forest near Wuppertal, KAMPMANN 1977: 95).

Species descriptions: KRAUSBAUER 1905: 61 (redescription), DENIS 1924: 583.

**Genus *Gibberathrix* Uchida, 1952**

**Key.** Only 1 species: *Gibberathrix tsugarensis* Uchida, 1952

**Diagnosis of the genus**

A genus of the Dicyrtominae. Large abdomen without a clearly differentiated protuberance. Head, anterior and posterior of large abdomen, and Abd VI with spines. Setal pairs 1 - 3 of dorsal head-back as thick and blunt spines (Fig. 346). Bothr A present (Fig. 347), D missing. Neosminthuroid setae missing. Tita III posteriorly with 3 modified, smooth setae. Claws with a tunica. Ret with 3+3 teeth. Outer and some posterior setae of dens ciliate, inner as short spines.

Occurrence: Japan.

Descriptions of the genus: UCHIDA 1952: 1, BETSCH 1980: 145.

Type species: *Gibberathrix tsugarensis* Uchida, 1952.

### Diagnosis of the single species

*Gibberathrix tsugarensis* Uchida, 1952 (1) sensu Yosii, 1970 (28)

Syn.: *Dicyrtomina tsugarensis* Yosii, 1970 (28)

Total length about 1.8 mm. Background colour dirty white, head and large abdomen with light violet spots, large abdomen posteriorly with 2 unpaired black spots (Fig. 348). Head clypeus with 6 unpaired blunt spines. Tita III posteriorly with 3 smooth and blunt spines. Claws rather short with tunica, 1 or 2 inner teeth, 1 outer tooth, and lateral teeth: 2 large and several small basal pairs (pseudonychium); Emp broad with 1 or 2 teeth, filament of Emp III shorter than others, all filaments pointed (Fig. 349). Ret with 4 setae and 1 pair of posterior swellings. Outer and some posterior setae of dens ciliate, inner as smooth, short spines (Fig. 350), formula of anterior setae 3,2,1,1...1. Both edges of mucro with about 34 - 38 small teeth each. Setae m1 (M), AL1 and AL2 (E2 and E1), DL1 and DL2 (N' and N), and P1 (H) of Abd VI thick and spinelike; circumanal setae a0, a1 - a4 smooth and setalike, seta a3 smaller than others; App. an. setalike, straight, blunt, and shorter than long setae sa3 (Fig. 351).

Proportions: Length of antennae : head diagonal = 1.4. Ant I : II : III : IV = 1 : 4.5 : 4.5 : 1.5. Dens : mucro = 2.75.

Type locality: Japan, N Honshu, Aomori.

Occurrence: Known only from the type locality.

Remarks: *G. tsugarensis* here remains in a separate genus because of its 3+3 Ret teeth, the ciliate setae of dens, and the spinelike setae AL1 and 2 (E2, E1) of Abd VI. UCHIDA 1952 argues mainly with the humplike posterior of the large abdomen, but such an egglike form also occurs in other genera. The pair of Bothr A is present, Fig. 18 A of YOSII 1970 (see here Fig. 347) only shows these Bothr, the left papilla in full line, the right in broken line (BETSCH 1980: 143 supposed Bothr A to be missing).

### Genus *Jordanathrix* Bretfeld & Arbea n. gen.

#### Key to the Palaearctic species

- |   |  |                                  |
|---|--|----------------------------------|
| 1 | Setae E1 - E4 of dens almost of equal length | <i>leptothrix</i> (Börner, 1909) |
| – | Seta E2 of dens as a short spine (Fig. 354)  | <i>articulata</i> (Ellis, 1974)  |

### Diagnosis of the genus

A genus of the Dicyrtominae. Large abdomen without a protuberance. Head and anterior of large abdomen with normal or spinelike setae. Setal pair 1 of dorsal head-back as slender spines, pairs 2 + 3 as microspines. Abd VI with normal setae. Large abdomen posteriorly with small spines. Bothr A present, D missing. Neosminthuroid setae (always?) present. Tita III posteriorly with 2 modified, blunt setae. Claws with a tunica. Ret with 4+4 teeth. Most outer and inner setae of dens setalike.

Occurrence: Palaearctic.

Type species: *Dicyrtomina articulata* Ellis, 1974.

Derivatio nominis: This new genus is named in honour of Prof. Dr. Rafael JORDANA, Head of the Department of Zoology, University of Navarra, Pamplona, Spain, who collected the first specimens of the Navarran subspecies of this new genus. The gender of this genus is feminine.

Remarks: The new genus *Jordanathrix* differs from others mainly by the rather normal setae of the head apex and of the anterior of large abdomen and the normal, undifferentiated dorsal setae of Abd VI. The neosminthuroid setae have only been described in *J. articulata*.

### Diagnosis of the Palaearctic species

*Jordanathrix articulata articulata* (Ellis, 1974) (148)

*Jordanathrix articulata navarrae* Bretfeld & Arbea n. ssp., see below

Syn.: *Dicyrtomina (Calvatomina) articulata* Ellis, 1974 (148)

Total length 1 mm in females, 0.8 mm in males. Background colour whitish yellow, large abdomen laterally with irregular brown-blue spots and tints, posteriorly and Abd V with dark median patch, Abd VI in ssp. *articulata* without dark pigment (Fig. 352) (in ssp. *navarrae* with dark pigment, see below), antennae blue, legs and furca white. Head clypeus with 7 unpaired, slightly thickened setae. Large abdomen posteriorly with 3+3 longitudinal rows of stout spines. 2 pairs of neosminthuroid setae in ssp. *articulata* (only 1 pair in ssp. *navarrae*, see below). Tita III posteriorly with 2 smooth or slightly rough and blunt spines (Fig. 312). Claws with tunica, perhaps without inner tooth, but with several pairs of lateral teeth (pseudonychium); Emp with tooth, filament of Emp I longer than claw, others shorter, all tips pointed (Fig. 353). Ret with 3 - 4 setae. Manubrium with 8+8 setae. Most outer setae of dens of normal form and rough, only seta E2 as short spine (Fig. 354), inner setae of normal form and smooth, formula of anterior setae 3.2.1...1. Both edges of mucro with small teeth. Setae AL1 and AL2 (E2 and E1) of Abd VI missing, circumanal setae a1 - a3 slightly thicker than others, seta P1' (T) clearly separated from setae a1 - a3; App. an. setalike, smooth, curved dorsally (Fig. 355).

Proportions: Length of antennae : head diagonal = 1.6. Ant I : II : III : IV = 1 : 4.2 : 5.5 : 0.9. Dens : mucro = 3.

Type locality: Greece, Rhodes, Lindos, swept from low vegetation.

Occurrence: In the Mediterranean widespread: also found at another site in Greece, Rhodes (Laerma, ELLIS, see above), and (orig. observs., leg. SICK, WERNER) in Spain (the Balearic Islands, Ibiza and Menorca) and former Yugoslavia (Split).

Remarks: Some original observations have been added above to the published description.

In N Spain, Navarra and Zaragoza, a subspecies occurs which is called here *Jordanathrix articulata navarrae* Bretfeld & Arbea n. ssp. The differences from the nominate subspecies are:

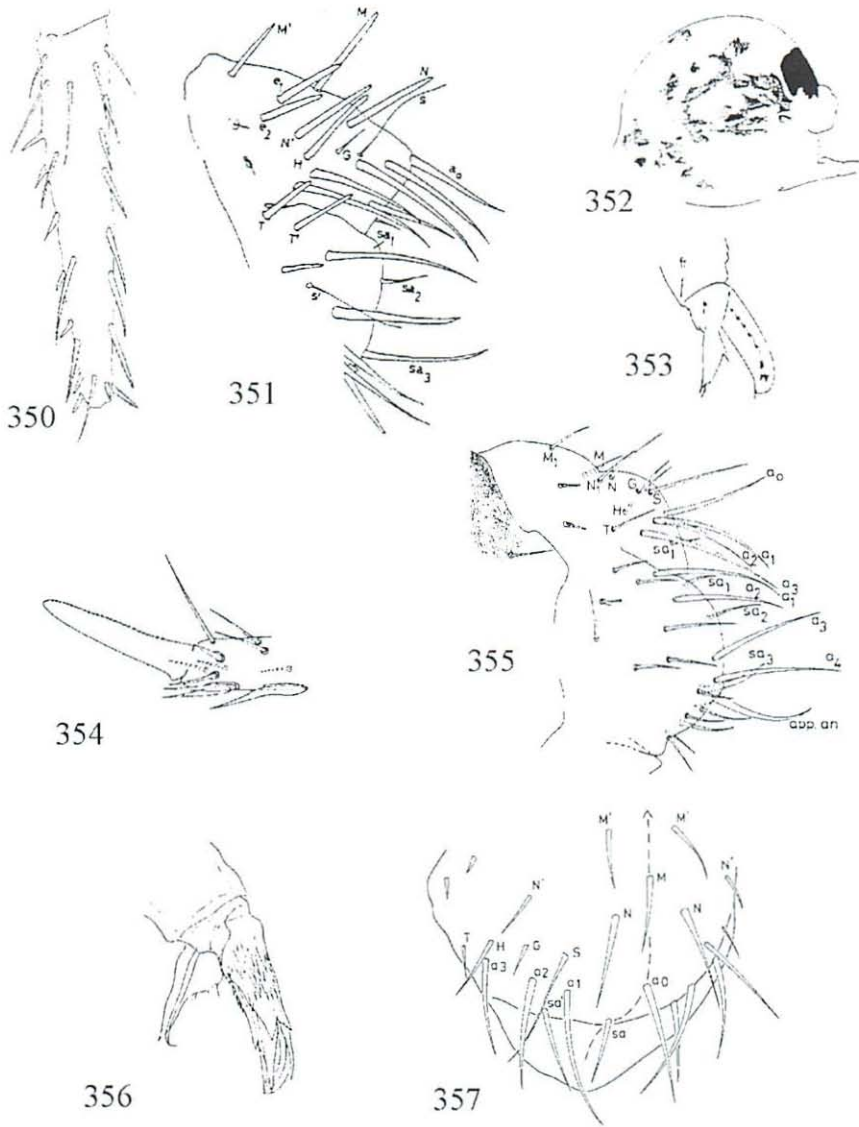
- black spot of large abdomen and Abd V extended to Abd VI

- furca base with only 1 pair of neosminthuroid setae.

Holotype: Female, slide (in Museum of Zoology, University of Navarra, Pamplona, Spain); Spain, Navarra, Olaberri, litter in *Pinus nigra nigra* grove at 610 m altitude, sample II BPT, 21. V. 1986 leg. ARBEA & MORENA.

Paratypes: Numerous specimens (in Museum of Zoology, University of Navarra, Pamplona, Spain; Muséum Nat. d' Hist. Natur., Paris/Brunoy, France; and coll. BRETfeld, Kiel, Germany); same locality as the Holotype and from other sites with *Pinus nigra* and *Quercus coccifera* in Navarra, Spain.

Further occurrence: Also found at others sites in Spain (Navarra, in fields; Zaragoza, in litter of *Quercus pyrenaica* at 1085 m altitude, ARBEA, pers. comm.).



Figs. 350 - 351 *Gibberathrix tsugarensis* (after YOSII 1970):

350 Dens, posterior side 351 Female Abd VI.

Figs. 352 - 355 *Jordanathrix articulata* (after ELLIS 1974):

352 Colour pattern of ssp. *articulata* 353 Claw and Emp III 354 Apex of dens, seen from lateral, anterior setae and outer setae E1 - E3 355 Female Abd VI.

Figs. 356 - 357 *Jordanathrix leptothrix*:

356 Claw and Emp III (after YOSII 1954) 357 Female Abd VI (after YOSII 1965).



*Jordanathrix leptothrix* (Börner, 1909) (128) sensu Yosii, 1954 (820), 1965 (56) n. comb.

Syn.: *Dicyrtomina leptothrix* Börner, 1909 (128)

*Dicyrtomina rufescens* f. *nivalis* Uchida, 1953 (3), YOSII 1977: 166

*Dicyrtomina rufescens* Uchida & Fujita, 1968 (36)

Total length 1.5 mm. Colour variable, uniformly red violet to black or dark with paler stripes and spots on large abdomen, extremities always dark. Head clypeus with 5 - 6 unpaired, slightly thickened setae. Neosminthuroid setae not described. Tita III posteriorly with 2 blunt spines. Claws broad with tunica, without inner and outer tooth, but with 2 large and several small lateral and basal teeth (pseudonychium); Emp I narrower than others, Emp III with 2 teeth, others with 1; filaments of Emp I and II longer than claws, of Emp III shorter, all tips pointed (Fig. 356). Ret with 4 setae. Manubrium with 8+8 smooth setae. Most outer setae of dens of normal form, smooth or rough, inner setae of normal form and rough, formula of anterior setae 3,2,1,1(?)...1. Both edges of mucro with about 25 teeth each. Setae AL1 and AL2 (E2 and E1) of Abd VI missing, circumanal setae a1 - a3 slightly thicker than others, seta P1' (T) clearly separated from setae a1 - a3 (Fig. 357); App. an. setalike, smooth, curved dorsally.

Proportions: Length of antennae : head diagonal = 1.3. Ant I : II : III : IV = 1 : 3.5 : 3.7 : 1.8. Ratio of dens setae E1 - E4 = 1.1 : 1 : 1 : 1.1. Dens : mucro = 2.0.

Type locality: Japan, Bukenji, on the soil of a wet *Chamaecyparis* forest.

Occurrence: Known from several localities in Japan (UCHIDA, YOSII, see above).

Biology: *J. leptothrix* lives near the soil in wet localities on dead leaves or wood, and has also been collected on snow (authors see above).

Species description: UCHIDA 1953: 3.

### Genus *Papirioides* Folsom, 1924

#### Key to the Palearctic species

- 1 Large abdomen with short, round protuberance (Fig. 358)
    - Large abdomen with elongate protuberance 2
  - 2 Protuberance long and straight, slightly thickened apically (Figs. 305, 363); most setae of dens serrate
    - Protuberance clavate, gradually thickened apically; setae of dens smooth or weakly serrate 2
- caishijiensis* Wu & Chen, 1996  
*jacobsoni* Folsom, 1924  
*uenoi* Uchida, 1957

#### Diagnosis of the genus

A genus of the Ptenothricinae. Large abdomen with a posterior protuberance. Head, anterior of large abdomen, and Abd VI with spinelike setae or spines. Protuberance of large abdomen with few short, stout spines (Figs. 359, 363). Bothr A and D present. Neosminthuroid setae missing. Tita III posteriorly with 2 modified, serrate setae. Claws without a tunica. Ret with 4+4 teeth. Outer and inner setae of dens serrate.

Occurrence: S and SE Asia and Hawaii.

Descriptions of the genus: FOLSOM 1924: 515, BETSCH 1980: 144.

Type species: *Papirioides jacobsoni* Folsom, 1924.

Remarks: In this genus, the setae P2 (G) of Abd VI in females are generally missing (YOSII & LEE 1963: 30).

### Diagnosis of the Palaearctic species

*Papirioides caishijiensis* Wu & Chen, 1996 (138)

Syn: *Ptenothrix (Papirioides) caishijiensis* WU & CHEN, 1996 (138)

Total length up to 1.9 mm. Background colour white to pale yellow, head dark purple, large and small abdomen with pale and dark purple patterns, extremities with bands of dark purple (Fig. 358). Head apex with small spines, clypeus with 1,1,1,(1),2,1,1,(1,1) medial setae. Large abdomen anteriorly with 1+1 normal and 4+4 spinelike setae, posteriorly with many short spinelike setae, protuberance short and round with short, stout spines (Fig. 359). Tita III posteriorly with 2 serrate spines. Claws slender with 2 inner and 1 or 2 pairs of lateral teeth, claws I and III with 1 outer tooth; Emp with tooth, filaments acuminate, length > claws (Figs. 360 - 362). Distal outer and inner setae of dens rough or broadened basally and with basal teeth, (except smooth E<sub>1</sub> and J<sub>1</sub>, CHEN, pers. comm.) formula of anterior setae 3,2,1,1...1. Both edges of mucro with teeth (inner edge 24 - 29, outer 27 - 34). Most dorsal setae of Abd VI as thick and blunt spines, circumanal seta a0 as thick spine, setae a1 - a3 long setalike, a1 ciliate, seta P2 (G) present; App. an. smooth, curved and pointed.

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 5.4 : 5 : 1.1. Ratio of dens setae E1 - E4 = 2 : 1 : 3 : 4 (CHEN, pers. comm.).

Type locality: China, Anhui, Ma'anshan City, Caishiji Garden, Guangji Temple, under a heap of brick.

Occurrence: Known only from the type locality.

Remarks: *P. caishijiensis* differs from the 2 other Palaearctic species in that its setae P2 (G) are present. It resembles *P. aequituberculatus* (Stach, 1965) from North Vietnam but differs in the medial setae of clypeus (3 unpaired upper setae instead of 2 in *P. a.*) and the anterior spines of large abdomen (4 pairs instead of 3 in *P. a.*).

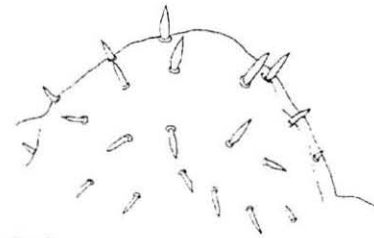
*Papirioides jacobsoni* Folsom, 1924 (515) sensu Yosii & Lee, 1963 (34)

Total length 2.3 mm. Background colour yellowish white, head and body ventrally dark blue to black, large abdomen with dark spots and stripes; antennae and legs with dark bands (Fig. 305). Eye-patches small. Head apex with small spines, clypeus with 1,1,2,1,1,3 medial setae. Large abdomen anteriorly with 5+5 setae, posteriorly with many short spinelike setae, protuberance long and straight, apex slightly thickened with short, stout, and blunt spines (Fig. 363). Tita III posteriorly with 2 serrate spines. Claws slender with 2 small inner teeth, 1 small outer tooth, and 2 or more pairs of small lateral teeth (pseusonychium); Emp with tooth, filaments pointed, length > claws. Most outer and inner setae of dens broadened basally and with basal teeth. Both edges of mucro with about 32 - 35 teeth each. Most dorsal setae of Abd VI as thick and blunt spines, circumanal seta a0 as blunt spine, setae a1 - a3 long, ciliate, and setalike; App. an. thick, smooth, and blunt (Fig. 364).

Proportions: Length of antennae : head diagonal = 3.3. Ant I : II : III : IV = 1 : 8 : 8 : 1.5. Ratio of dens setae E1 - E4 = 2 : 1 : 4.4 : 6.4. Dens : mucro = 3.3.



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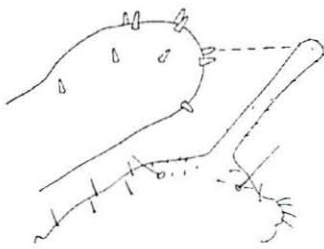
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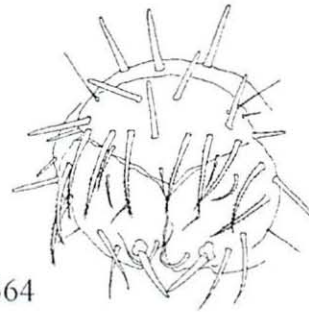
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Figs. 358 - 362 *Papirioides caishijiensis* (after WU & CHEN 1996):  
 358 Habitus 359 Posterior protuberance of large abdomen 360 - 362 Claw and Emp I - III.  
 Figs. 363 - 364 *Papirioides jacobsoni* (after YOSII & LEE 1963):  
 363 Protruberance of large abdomen and its spines 364 Female Abd VI.

Type locality: Sumatra, Fort de Kock, on fungi at 920 m altitude.

Occurrence: Also found in Formosa and S Japan (Yakushima island) (YOSHII & LEE, see above).

*Papirioides uenoi* Uchida, 1957 (459)

Total length 1.4 mm. Background colour yellowish brown, head and lateral of large abdomen reddish-brown, large abdomen dorsally with 2 brown stripes, antennae with violet bands. Eye-patches with 8+8 individually pigmented ommatidia. Head apex with large spines. Large abdomen with small setae or spines, protuberance clavate and gradually thickened apically, apex with short spines; Abd VI with large spines. Claws slender with 2 or more pairs of small lateral teeth (pseudonychium); Emp with tooth, filaments moderately long. Most outer and inner setae of dens weakly serrate. Both edges of mucro with about 30 teeth each.

Proportions: Ant I : II : III : IV = 1 : 6.8 : 7.4 : 1.5. Dens : mucro = 3.25.

Type locality: Japan, Nagano, Hinagura pass, on dead wood laying on the ground at 1000 m altitude.

Occurrence: Known only from the type locality.

Remarks: *P. uenoi* has been incompletely described.

### Genus *Ptenothrix* Börner, 1906

Syn.: *Papirius* Lubbock, 1862 (431) ad partem

#### Key to the Palaearctic species

- |   |   |                                       |
|---|---|---------------------------------------|
| 1 | Western Palaearctic species   | 2                                     |
| – | Eastern Palaearctic species   | 9                                     |
| 2 | Large abdomen usually dark without distinct lighter pattern   | 3                                     |
| – | Large abdomen with distinct dark and light pattern  | 5                                     |
| 3 | Tita III posteriorly with 2 modified serrate setae  | 4                                     |
| – | Tita III posteriorly with 3 modified serrate setae  | <i>kuraschvili</i> Djanaschvili, 1970 |
| 4 | Ratio of setae E1 - E4 of dens = 1 : 1 : 3 : 4.5, seta sa of Abd VI thick and longer than a0 (Fig. 365)           | <i>atra</i> (Linnaeus, 1758)          |
| – | Ratio of setae E1 - E4 of dens = 1 : 1 : 1.5 : 4, seta sa of Abd VI of normal form and shorter than a0 (Fig. 393) | <i>setosa</i> (Krausbauer, 1898)      |
| 5 | (2) Ant II with 3 - 7 setae much longer than diameter of segment, App. an. long and setalike                      | 6                                     |
| – | Ant II with only short setae, App. an. short and stout  | 7                                     |
| 6 | Abd VI with thick and spinelike dorsal setae, seta sa short with normal socket (Fig. 389)                         | <i>reticulata</i> Stach, 1957         |
| – | Abd VI with slender dorsal setae, seta sa long with papillate socket (Fig. 383)                                   | <i>leucostrigata</i> Stach, 1957      |
| 7 | Large abdomen brown violet with lighter dorsal pattern (Fig. 366)   | <i>ciliata</i> Stach, 1957            |
| – | Large abdomen marbled with blue or violet   | 8                                     |

- 8 Basal part of Ant III dark, claws with 2 pairs of lateral and 3 outer teeth  
*cavicola* Cassagnau & Delamare Deboutteville, 1955
- Ant II and III with dark parts, claws with 2 pairs of lateral teeth and only 1 outer tooth  
*italica* Dallai, 1973
- 9 (1) All claws with 1 inner tooth *ryoheii* Uchida, 1953
- At least 1 pair of claws with 2 inner teeth 10
- 10 Body with only light pigment, whitish or brownish, without dark pigment or contrasting pattern 11
- Body dark or with contrasting pattern 12
- 11 Dens with only smooth outer and inner setae *lactea* Uchida, 1953
- Most of these setae serrate *monochroma* Yosii & Lee, 1963
- 12 Body with dark, contrasting longitudinal or cross bands 13
- Body light or dark, sometimes with various lighter or darker patches or bands, but always without clear dark bands 16
- 13 Large abdomen with only dark and light cross bands (Fig. 387) *narumii* Uchida, 1940
- Large abdomen additionally with longitudinal bands 14
- 14 Three dark bands run around large and small abdomen (Fig. 394)  
*tricycla* Uchida, 1953
- Bands not closed posteriorly or fewer bands present 15
- 15 Large abdomen with 1 pair of dark, broad, longitudinal bands (Fig. 391), circumanal setae in females ciliate *saxatilis* Yosii & Lee, 1963
- Large abdomen with dark, anterior longitudinal and posterior cross bands (Fig. 373), circumanal setae in females smooth *denticulata* (Folsom, 1899)
- 16 (12) Head with dark, contrasting longitudinal or cross bands 17
- Head light, dark, or with dark patches, but without bands 19
- 17 Head with 1 dark, longitudinal band, large abdomen with symmetrical light patches (Fig. 395) *vinnula* Uchida, 1957
- Head with dark cross bands 18
- 18 Large abdomen completely black, sometimes with light, irregular pattern (Fig. 370), all circumanal setae in females smooth and of normal setal form  
*corynophora* Börner, 1909
- Large abdomen with dark, irregular patches, dorsally with light and dark longitudinal bands (Fig. 396), circumanal setae in females ciliate except thick seta a0  
*vittata* Folsom, 1896
- 19 (16) Outer and inner setae of dens only ciliate, not distinctly serrate  
*tateyamana* Uchida, 1958
- These setae distinctly serrate 20
- 20 Circumanal setae in females smooth or rough, not ciliate 21
- These setae ciliate 22

- 21 Anterior spinelike setae of large abdomen as long as mucro, App. an. setalike and shorter than seta sa3 *higumai* Yosii, 1965
- Anterior spinelike setae of large abdomen 1.5 times longer than mucro, App. an. setalike and as long as seta sa3 *janthina* Yosii, 1963
- 22 Abd VI in females with blunt seta P2 (G), App. an. straight and longer than seta sa3 *ciliophora* Yosii & Lee, 1963
- Seta P2 (G) in females missing, App. an. thick and shorter than seta sa3 *mongolica* Yosii, 1954

Remarks: Several original or secondary descriptions are very incomplete, which is demonstrated by the fact that not one characteristic, besides the pigmentation which may vary, has been described in all species. This key, therefore, had to be divided into geographical species groups. A further consequence of this incomplete knowledge is that it is not certain whether all the species described in this genus really belong to it. A revision is needed.

Not included in this key are:

- *Papirius dorsalis* Reuter, 1876 (= *Ptenothrix atra*? STACH 1957: 90),
- *Ptenothrix palmata* (Folsom, 1902) (reported from N Russia, GRINBERGS 1960: 64, see *P. setosa*).
- *Ptenothrix huangshanensis* Chen & Christiansen, 1996 (from China, Anhui, with dark and light purple spots, setae of dens distinctly serrate).

### Diagnosis of the genus

A genus of the Ptenothricinae. Large abdomen without a protuberance. Head, large abdomen anteriorly, and Abd VI with spines. Large abdomen posteriorly with duplicate longitudinal rows of short spines (Fig. 307). Bothr A and D present. Neosminthuroid setae missing. Tita III posteriorly with 2 (seldom 3) modified, serrate setae. Claws mostly without a tunica. Ret with 4+4 teeth. Outer and inner setae of dens often serrate.

Occurrence: Holarctic and Tropics.

Descriptions of the genus: BÖRNER 1906: 184, STACH 1957: 74, BETSCH 1980: 144, CHRISTIANSEN & BELLINGER 1981: 1230.

Type species: *Podura atra* Linnaeus, 1758.

### Diagnosis of the Palearctic species

*Ptenothrix atra* (Linnaeus, 1758) (608) sensu Stach, 1957 (86)

Syn.: *Podura atra* Linnaeus, 1758 (608)

*Papirius ater* Tullberg, 1871 (146)

*Papirius annulatus* var. *ocellata* Bekker, 1902 (23)?

*Dicyrtoma atra* Ågren, 1903 (169)

nec *Ptenothrix atra* Yosii, 1949 (34) (= *P. mongolica*)

Total length up to 2.7 mm. Head and body completely blackish or reddish-violet or with irregular light spots without constant pattern. Head apex with long spines, clypeus dorsally with 1,1 unpaired, slightly thickened upper setae (see Fig. 310). Ant II with 4 or 7 long spines.

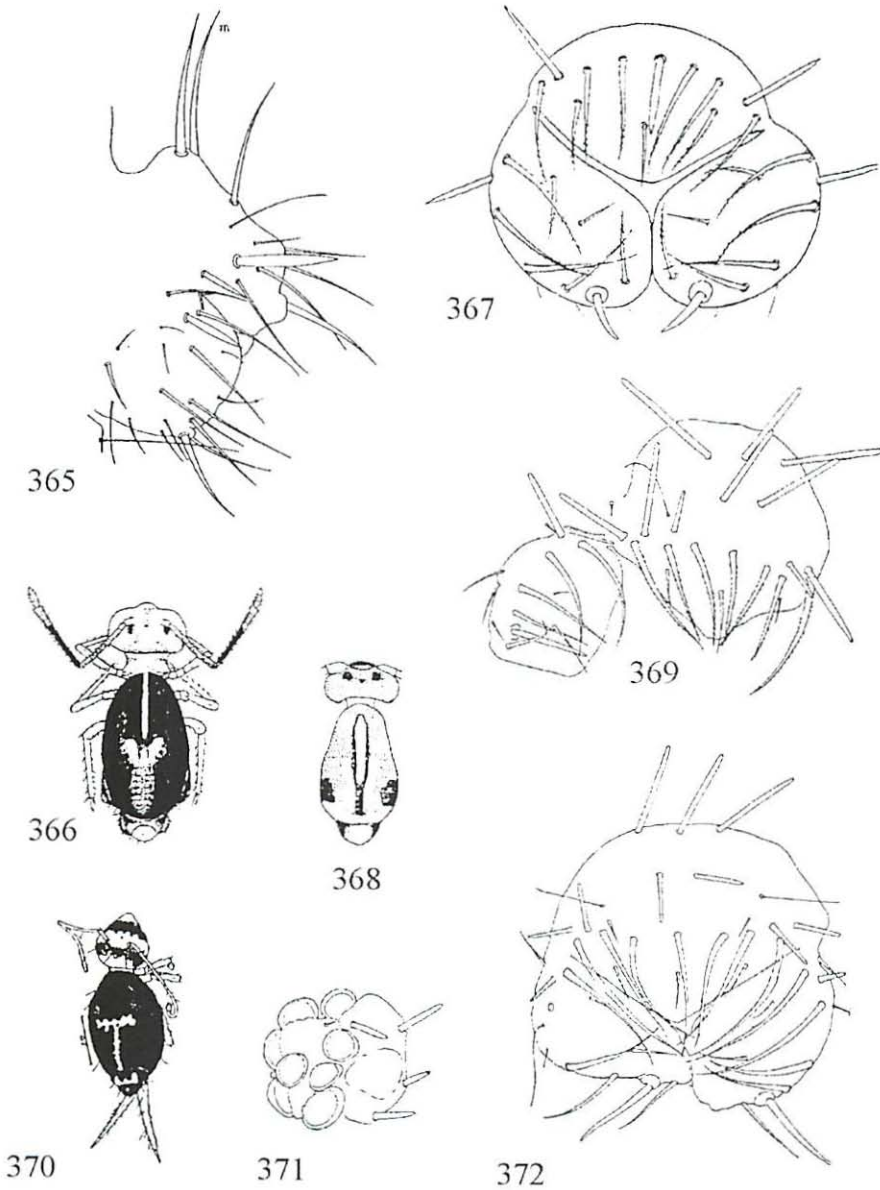


Fig. 365 *Ptenothrix atra*, female Abd VI (after GISIN 1961).

Figs. 366 - 367 *Ptenothrix ciliata* (after STACH 1957): 366 Habitus 367 Female Abd VI.

Figs. 368 - 369 *Ptenothrix ciliophora* (after YOSHII & LEE 1963):

368 Colour pattern 369 Female Abd VI.

Figs. 370 - 372 *Ptenothrix corynophora*:

370 Habitus (after UCHIDA 1957) 371 Eye-patch and adjacent spines (after YOSHII & LEE 1963)

372 Female Abd VI (after YOSHII & LEE 1963).

Large abdomen anteriorly with 4+4 or 5+5 long spines. Tita III posteriorly with 2 serrate spines. Claws with 2 inner, 1 or 2 small outer, and lateral teeth: 2 large and few small basal pairs; Emp with tooth, filaments pointed, length > claws. Ret with 3 - 4 setae. Most outer and inner setae of dens broadened basally and with large basal teeth, formula of anterior setae 3,2,1,1...1. Outer edge of mucro with 26, inner with 33 teeth. Setae m1 (M), A3 (M'), and DL2 (N) of Abd VI thick and blunt or (?) acuminate, seta P0 (G') small and sometimes missing, P1 (H) as thick spine, P1'(T) small and spinelike, circumanal setae a0, a1 - a3 thin, seta sa thick and blunt or (?) acuminate; App. an. setalike, smooth, curved dorsally (Fig. 365).

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 5.2 : 6.2 : 1.4. Ratio of dens setae E1 - E4 = 1 : 1 : 3 : 4.5. Dens : mucro = 2.8. App. an. : mucro = 0.65.

Type locality: Not specified, Europe.

Occurrence: Holarctic?, see Remarks; in the Palaearctic in the western regions, from W Russia (GRINBERGS 1960: 63, MARTYNOVA 1964: 100) and Scandinavia W to England (GOTO & LAWRENCE 1964: 11) and S to Italy (DALLAI & MARTINOZZI 1980: 43) and S France (Corsica, POINSOT 1972: 293; Var, cave, GAMA 1991: 176). Not found in the Iberian Peninsula (JORDANA et al. 1990: 177).

Biology: *P. atra* is rare, it lives in moist forests in litter, on mushrooms, under stones, or on dead wood up to 1250 m altitude (Poland and Slovakia, High Tatra Mts., HRIVNAK, see below). In Slovakia it was also collected in nests of small mammals (HRIVNAK 1981: 363). Temperature tolerance (STEBAEVA et al. 1977: 1021) and secretion of waxen rods (MASSOUD & VANNIER 1965: 4819) have been described. Ants have been seen feeding on *P. atra* (VANNIER 1971: 119). This species is troglophile (MASSOUD & THIBAUD 1973: 155).

Species descriptions: LINNANIEMI 1912: 327, GISIN 1961: 353 (Abd VI in females), LAWRENCE & MASSOUD 1973: 85 (cuticula pattern), PAULUS 1974: 126 (ultrastructure of ommatidia), JUBERTHIE & MASSOUD 1977: 125 (wax secretion by tormogence cells).

Remarks: The North American specimens may represent a separate species (*P. unicolor* Harvey, 1893, see CHRISTIANSEN & BELLINGER 1981: 1231), since Ant II has 7 long spines in the Palaearctic species but only 4 in the Nearctic (STACH 1966: 217 with the description of the Nearctic *P. atra apigmentata*); more differences may be discovered in a re-examination.

The colour varieties (STACH 1957: 90) albosignata Parona, 1888, dorsalis Reuter, 1876, flavescens Axelson, 1905, and nigricornis Ionesco, 1916 are incompletely known and may represent separate species.

#### *Ptenothrix cavicola* Cassagnau & Delamare Deboutteville, 1955 (392)

Total length 3 mm. Background colour reddish violet, abdomen and legs marbled with blue, basal part of Ant III blackish blue. Head apex with short, thick, not spinelike setae. Ant II without long setae. Large abdomen anteriorly with slightly elongate setae, Abd VI not described. Tita III posteriorly with 2 weakly serrate spines. Claws long and narrow with 2 inner, 3 outer, and 2 pairs of lateral teeth; Emp with tooth, filaments pointed, length > claws. Ret with 4 setae. Most outer and inner setae of dens broadened basally, distal setae with large basal teeth. Both edges of mucro with about 50 small teeth each; App. an. short and thick.

Proportions: Dens : mucro = 2.8; App. an. : claw inner edge = 0.6.

Type locality: Lebanon, Embarcadere, Ghita cave.

Occurrence: Known only from the type locality.



*Ptenothrix ciliata* Stach, 1957 (102)

Total length 2.2 mm. Background colour white or dirty yellow, large abdomen mostly dark brown, posteriorly with paler median region (Fig. 366), Ant III basally dark. Head apex with short spines. Ant II without long spines. Large abdomen anteriorly with short spines. Tita III posteriorly with 2 serrate spines. Claws narrow with 2 inner teeth, without or with 1 outer tooth, and 2 pairs of lateral teeth; Emp with tooth, filaments pointed, length > claws. Ret with 3 setae. Most outer and inner setae of dens broadened basally and with large basal teeth, formula of anterior setae 3,2,1,1...1. Both edges of mucro serrate. Dorsal setae of Abd VI not entirely described but seta P2 (G) absent, setae P1 (H) ? and a0 as thick spines, other circumanal setae ciliate and of normal setal form; App. an. short and stout (Fig. 367).

Proportions: Length of antennae : head diagonal = 2.3. Ant I : II : III : IV = 1 : 6.6 : 6.8 : 1.4. Ratio of dens setae E1 - E4 = 1 : 1 : 2.7 : 4. Dens : mucro = 3. App. an. : mucro = 0.33.

Type locality: S Poland, Pieniny Mts., under stones near river Dunajec.

Occurrence: Also found in Ukraina (Nizniów and environs of Kiev, STACH, see above), in Czech Rep. and Slovakia (Sudetes Mts., DUNGER 1970: 40, WEINER 1981: 471), and Germany (Thuringia, valley of river Saale, 12 km N of Jena, FRITZLAR et al. 1986: 419).

Biology: *P. ciliata* is rare, it was found in forests, in litter and on dead wood (WEINER, see above), and in grassy vegetation on limestone (FRITZLAR et al., see above). It occurs in the Czech Rep. and Slovakia between 700 and 1000 m (DUNGER, see above).

Species descriptions: YOSII & LEE 1963: 30 (seta P2 = G of Abd VI missing), SZEPTYCKI 1967: 244 (distal part of dens, some dorsal setae of male Abd VI).

*Ptenothrix ciliophora* Yosii & Lee, 1963 (17)

Total length 2.5 mm. Colour brown with darker ornaments; large abdomen with median stripes, anteriorly pale with dark margins, posteriorly dark with pale margins (Fig. 368), extremities pale. Head apex with spines, clypeus with 1,1,2,2,1,1 medial spines. Ant II with some thick spines. Large abdomen anteriorly with 5+5 long spines. Tita III posteriorly with 2 sparsely serrate spines (only 6 pairs of teeth). Claws with 2 pairs of lateral teeth; Emp with tooth, filaments I and II knobbed, III pointed or blunt. Ret with 4 setae. Manubrium with 9+9 setae. Most outer and inner setae of dens broadened basally and with large basal teeth. Outer edge of mucro with 33, inner with 48 teeth. Nearly all dorsal setae of Abd VI, also P2 (G), thick, long, and blunt, dorsal circumanal setae acuminate and ciliate, ventral ones smooth; App. an. straight, slender, and blunt (Fig. 369).

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 8 : 10 : 2. Ratio of dens setae E1 - E4 = 1 : 1 : 2.8 : 3.3. Ratio of anterior setae of large abdomen : mucro = 2.5.

Type locality: Korea, He-In Temple.

Occurrence: Known only from the type locality.

*Ptenothrix corynophora* Börner, 1909 (130) sensu Yosii & Lee, 1963 (26)

Total length 2 mm. Background colour white to yellow, head with 1 or 2 purple cross bands, large abdomen blackish blue sometimes with light, irregular pattern (Fig. 370), extremities blue or light. Head apex with rather short and slender spines, seta of each eye-patch as a microspine (Fig. 371). Large abdomen anteriorly with 5+5 long and blunt spines. Tita III posteriorly with 2 serrate spines.

Claws with 2 inner and lateral teeth: 2 large and several small pairs; Emp with tooth, tips of filaments I and II pointed, III knobbed, length of all > claws. Manubrium with more than 7+7 setae. Most outer and inner setae of dens broadened basally and with large basal teeth. Outer edge of mucro with 26, inner with 42 teeth. Nearly all dorsal setae of Abd VI rather short, thick, and blunt, seta DL2 (N) shorter than a0, seta P2 (G) pointed, all circumanal setae smooth and acuminate; App. an. slender, smooth, tip almost pointed (Fig. 372).

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 5 - 6 : 6 - 7 : 1.5. Ratio of dens setae E1 - E4 = 1 : 1 : 3 : 4. Dens : mucro = 3.

Type locality: Japan, Kanagawa, from oak trees, and Oyama, from planks ("Bretterwand").

Occurrence: Also known from other sites in Japan (from Honshu and Hokkaido, authors see below).

Biology: *P. corynophora* lives in moist litter, on dead wood, and on bushes up to 1100 m altitude (UCHIDA, see below).

Species descriptions: YOSII 1954: 822, UCHIDA 1957: 28.

*Ptenothrix denticulata* (Folsom, 1899) (268) sensu Yosii & Lee, 1963 (24)

Syn.: *Papirius denticulatus* Folsom, 1899 (268)

nec *Ptenothrix denticulata* Yosii, 1954 (824) (= other species, YOSII & LEE 1963: 24)

Total length 2 mm. Background colour white to yellow, head and body with purple longitudinal and cross stripes (Fig. 373). Head apex with short and blunt spines, seta of each eyepatch small and blunt (Fig. 374). Large abdomen anteriorly with 5+5 long and blunt spines. Tita III posteriorly with 2 weakly serrate spines. Claws slender with 2 inner teeth, 1 small outer tooth, and several pairs of lateral teeth (pseudonychium); Emp with tooth, filaments clavate, length > claws. Most outer and inner setae of dens broadened basally and with basal teeth. Outer edge of mucro with 31, inner with 38 teeth. Nearly all dorsal setae of Abd VI long, thick, and blunt, setae P0 (G') and P2 (G) small, all circumanal setae of normal setal form; App. an. thick, smooth, and pointed (Fig. 375).

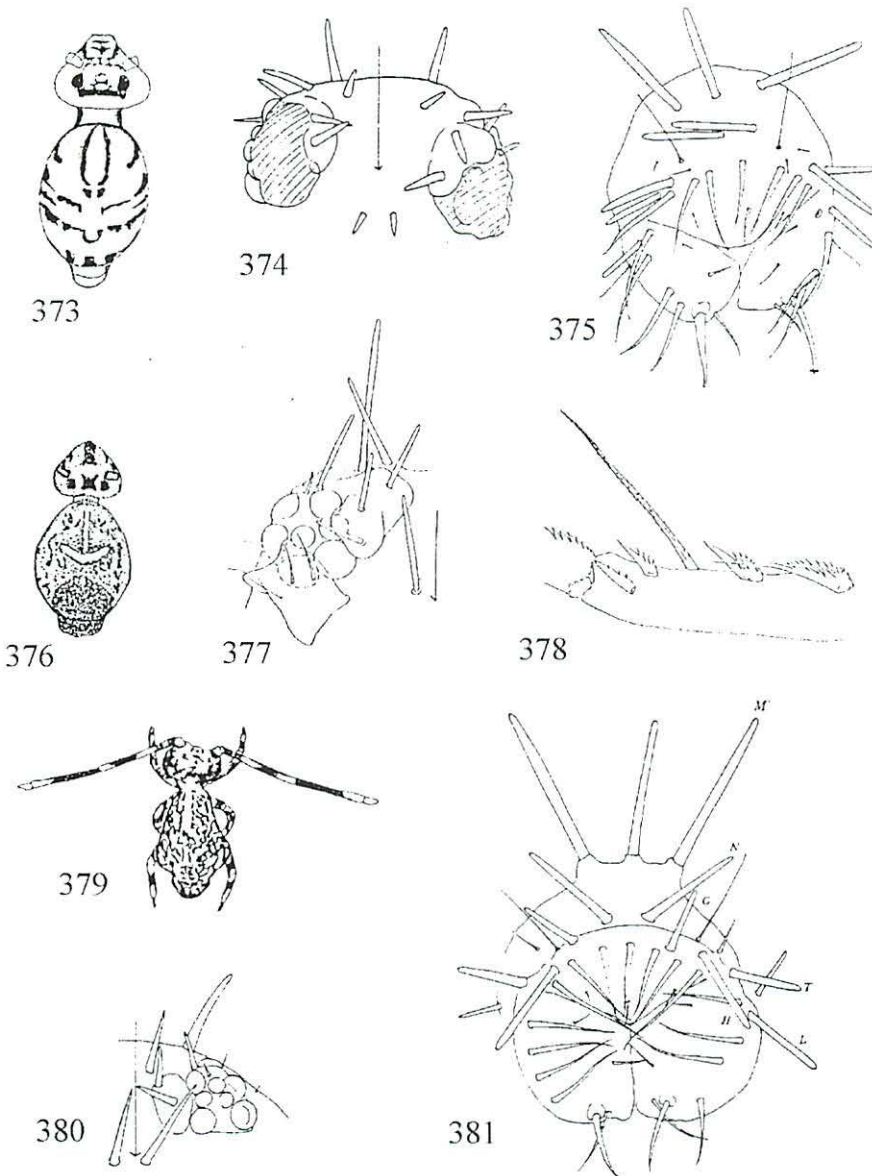
Proportions: Ant I : II : III : IV = 1 : 4.8 : 6.4 : 2. Ratio of anterior spines of large abdomen : mucro = 0.66. Ratio of dens setae E1 - E4 = 1 : 1.3 : 2.2 : 2.8. Dens : mucro = 4.

Type locality: Japan, Tokyo, Komaba.

Occurrence: Also known from other sites in Japan (campus of Kyoto University, YOSII & LEE, see above; from Yamanaka and Oyama up to about 1000 m altitude, var. *catenata* Börner, 1909: 131).

*Ptenothrix higumai* Yosii, 1965 (68)

Total length 2.2 mm. Background colour light brown, head and body with dark brown and few pale spots (Fig. 376). Head apex with long and rough spines (Fig. 377), clypeus with 1,1,2,1,1,3 spinelike medial setae. Large abdomen anteriorly with 5+5 long and blunt spines. Tita III posteriorly with 2 weakly serrate spines. Claws with 2 inner and several small pairs of lateral teeth (pseudonychium); Emp with tooth, filaments pointed, length > claws. Manubrium with 9+9 setae. Outer and distal inner setae of dens broadened basally and with large basal teeth (Fig. 378). Outer edge of mucro with 34, inner with 22 teeth. Nearly all dorsal setae of Abd VI long, thick, and blunt, all circumanal setae smooth and acuminate; App. an. setalike, shorter than seta sa3.



Figs. 373 - 375 *Ptenothrix denticulata* (after YOSHII & LEE 1963):

373 Colour pattern 374 Head apex 375 Female Abd VI.

Figs. 376 - 378 *Ptenothrix higumai* (after YOSHII 1965):

376 Colour pattern 377 Head apex 378 Dens setae E1 - E4 and 1 posterior seta.

Fig. 379 *Ptenothrix italica*, habitus (after DALLAI 1973).

Figs. 380 - 381 *Ptenothrix janthina* (after YOSHII & LEE 1963):

380 Head apex 381 Female Abd VI.

Proportions: Length of antennae : head diagonal = 1.8. Ant I : II : III : IV = 1 : 5 : 5.4 : 1.4. Setae of anterior of large abdomen as long as mucro. Ratio of dens setae E1 - E4 = 1 : 1.1 : 1.4 : 2.9. Dens : mucro = 3.5.

Type locality: Japan, Niigata, Awashima.

Occurrence: Known only from the type locality.

*Ptenothrix italica* Dallai, 1973 (570) sensu Dallai, 1976 (514)

Total length 2.2 mm in females, 1.75 mm in males. Head and body marbled with violet, antennae with 3 white and 3 violet rings (Fig. 379). Head apex with short spines, clypeus with 1,1,3,1,1,1 thick medial setae. Ant II in males without long spines. Large abdomen anteriorly with long spines. Tita III posteriorly with 2 serrate spines. Claws with 2 inner teeth, 1 outer tooth, and 2 pairs of lateral teeth; Emp with tooth, filaments blunt but not clavate, length > claws. Ret with 4 setae. Most outer and inner setae of dens broadened basally and with large basal teeth. Both edges of mucro serrate. Dorsal setae of Abd VI and circumanal seta a0 long, rough, and blunt, other circumanal setae rough and acuminate; App. an. short, stout, and blunt.

Proportions: Length of antennae : head diagonal = 2.4 in males. Ant I : II : III : IV = 1 : 6 : 7 : 6 : 1.5 in males.

Type locality: S Italy, isle of Lipari.

Occurrence: Also known from other sites in S Italy (Calabria, Sicily, and isle of Montecristo, DALLAI, see above), and from Greece (Crete, Knossos, ELLIS, see below).

Biology: *P. italica* lives near the soil, in Crete it has been collected from under stones and dead wood.

Species descriptions: DALLAI 1976: 514 (cuticula and some chaetotaxy in females), ELLIS 1976: 322 (Abd VI in one female).

*Ptenothrix janthina* Börner, 1909 (131) sensu Yosii & Lee, 1963 (28)

Syn.: *Ptenothrix setosa* var. *janthina* Börner, 1909 (131)

*Ptenothrix setosa* var. *picta* Börner, 1909 (131), YOSII 1977: 166

*Ptenothrix setosa* Yosii, 1954 (826)

Total length 1.8 mm. Colour uniformly light brown with dark spots dorsally on abdomen. Head apex with long spines (Fig. 380), clypeus with 1,1,2,2,1,1 spinelike medial setae. Large abdomen anteriorly with 5+5 long spines. Tita III posteriorly with 2 serrate spines. Claws with 2 inner, 1 or 2 distal outer, and lateral teeth: 2 - 3 large and few small basal pairs (pseudonychium); Emp with tooth, filaments pointed, length > claws. Manubrium with 10+10 setae. Most outer and inner setae of dens broadened basally and with large basal teeth. Both edges of mucro serrate. All dorsal setae of Abd VI long, thick, and rough, setae m1 (M) and A3 (M') longer than others, only seta P0 (G') small and thin, circumanal setae a0, a1 - a3 of normal setal form, seta sa much shorter than a0; App. an. setalike, smooth, curved dorsally (Fig. 381).

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 2.3 : 3.5 : 1. Ratio of anterior setae of large abdomen : mucro = 1.5. Ratio of dens setae E1 - E4 = 1 : 1.3 : 1.7 : 2.7. Dens : mucro = 3.

Type locality: Japan, Bukenji, on soil of a wet *Chamaecyparis* forest.

Occurrence: Also found at others sites in Japan (YOSII, YOSII & LEE, see above).

*Ptenothrix kuraschvili* Djanaschvili, 1970 (209)

Total length 1.3 mm. Colour uniformly brown, antennae and legs violet. Head apex with long spines. Tita III posteriorly with 3 serrate spines. Claws rather broad with 2 inner teeth, 1 outer tooth, and 2 large pairs of lateral teeth; Emp I and III with 1, Emp II with 2 teeth, filaments blunt, length > claws. Most outer and inner setae of dens broadened basally and with large basal teeth, formula of anterior setae 3,2,1,1...1. Outer edge of mucro with 35, inner with 29 teeth. Setae of Abd VI not described; App. an. straight and pointed.

Proportions: Length of antennae : head diagonal = 1.9. Ant I : II : III : IV = 1 : 4 : 4 : 1.3. Ratio of dens setae E1 - E4 = 1 : 1 : 1 : 1.25. Dens : mucro = 3.6.

Type locality: Georgia, Sataplia cave IV.

Occurrence: Known only from the type locality.

Remarks: This species should be re-examined.

*Ptenothrix lactea* Uchida, 1953 (5)

Total length up to 1.7 mm. Background colour milky white, large abdomen and Ant IV with faint wash of grey and violet. Head apex with spines. Large abdomen anteriorly with long spines. Modified setae of Tita III not described. Claws slender with 2 inner and 2 pairs of lateral teeth; Emp with small tooth, filaments clavate, length > claws. All setae of dens smooth. Outer edge of mucro with 32, inner with 26 teeth. Abd VI with thick spines, not described in detail; App. an. setalike, smooth, curved dorsally.

Proportions: Length of antennae : head diagonal = 2.2. Ant I : II : III : IV = 1 : 4.5 : 5 : 1.1. Dens : mucro = 3.

Type locality: Japan. Odake, Mt. Hakkoda at 1550 m altitude.

Occurrence: Known only from the type locality.

*Ptenothrix leucostrigata* Stach, 1957 (98)

Total length up to 2.7 mm. Background colour white with brownish violet pigment, large abdomen with more or less broad, light pattern (Fig. 382). Head apex with long spines. Ant II with 7 long spines. Large abdomen anteriorly with 3+3 or 4+4 long spines. Tita III posteriorly with 2 serrate spines. Claws with 2 inner teeth, 1 outer tooth, and 2 pairs of lateral teeth; Emp with large tooth, filaments pointed, length > claws. Ret with 4 setae. Most outer and inner setae of dens broadened basally and with large basal teeth, formula of anterior setae 3,2,1,1...1. Outer edge of mucro with 20 - 23, inner with 25 - 30 teeth. Most dorsal setae of Abd VI thick but acuminate, circumanal setae a0, a1 - a3 thin, seta sa long, thick, acuminate with papillate socket; App. an. setalike, smooth, curved dorsally (Fig. 383).

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 5.4 : 5.7 : 1.7. Ratio of dens setae E1 - E4 = 1 : 1 : 2 : 3. Dens : mucro = 3. App. an. : mucro = 0.6.

Type locality: Not defined, Poland, High Tatra Mts. and several other localities.

Occurrence: Also known from other sites in Poland (WEINER 1981: 471, KACZMAREK 1995: 348), from White Russia (Antonowka near river Horyn on dead moss, var. simplifcata, see below), and uncertainly from N Hungary (Börzsöny Mts., DUNGER 1975: 26).

Biology: *P. leucostrigata* lives near the soil in litter, on dead wood, and under stones up to the montan region of mountains.

Remarks: *P. leucostrigata* var. *simplificata* Stach, 1957 (101) differs from the main form in having a shorter and thinner seta sa of Abd VI.

*Ptenothrix mongolica* Yosii, 1954 (827) sensu Yosii & Lee, 1963 (32)

Syn.: *Ptenothrix atra* Yosii, 1949 (34)

Only 1 female known. Total length 1.2 mm. Background colour brownish yellow, large abdomen dorsally red-brown, Abd VI and legs with blackish blue spots, antennae distally blackish blue, Ant III proximally reddish purple. Eye-patches poorly pigmented, each ommatidium isolated from the other. Head apex with short, conical spines (Fig. 384), clypeus with 1,1,2,1,1,3 thick medial setae. Tita III posteriorly with 2 serrate spines. Claws with only 2 inner teeth; Emp with tooth, filaments pointed, length < claws. Most outer and inner setae of dens broadened basally and with large basal teeth. Outer edge of mucro with 24, inner with 39 teeth. Most dorsal setae of Abd VI and seta a0 rather short, thick, and blunt, seta P0 (G') small, P2 (G) missing, circumanal setae of normal setal form and ciliate, only setae sa and sa2 smooth; App. an. short, thick, blunt, and slightly curved, shorter than seta sa3 (Fig. 385).

Proportions: Length of antennae : head diagonal = 1.7. Ant I : II : III : IV = 1 : 2.8 : 3.3 : 0.8. Ratio of dens setae E1 - E4 = 1.4 : 1 : 2.3 : 2.6. Dens : mucro = 4. App. an. : mucro = 0.5.

Type locality: Mongolia, Urannol.

Occurrence: Known only from the type locality.

Species description: STACH 1957: 84 (difference to *P. ciliata*).

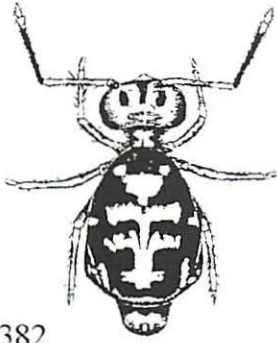
*Ptenothrix monochroma* Yosii & Lee, 1963 (20)

Total length 2 mm. Colour of head, body, and Ant I and II light brown, other antennal segments and other extremities white. Head apex with rough spines, clypeus with 1,1,2,2,1,1 medial spines. Large abdomen anteriorly with 5+5 large spines. Tita III posteriorly with 2 serrate spines. Claws with 2 inner and few pairs of small lateral teeth (pseudonychium); Emp with tooth, filaments I and II clavate, III pointed, length of all > claws (Fig. 315). Ret with 4 setae. Manubrium with 9+9 setae. Most outer and inner setae of dens broadened basally and with large basal teeth. Outer edge of mucro with 47, inner with 36 teeth. Most dorsal setae of Abd VI short, thick, and blunt, seta P0 (G') missing, P2 (G) small and thin, all circumanal setae smooth and of normal setal form; App. an. straight, thick, and slightly curved dorsally (Fig. 386).

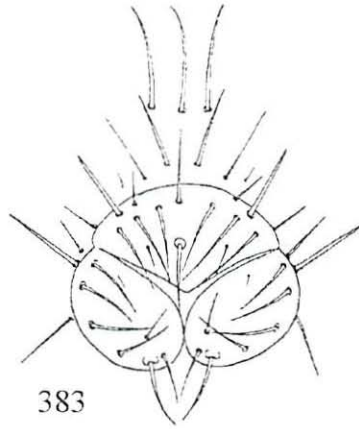
Proportions: Length of antennae : head diagonal = 3. Ant I : II : III : IV = 1 : 5.6 : 6.9 : 1.25. Ratio of anterior spines of large abdomen : mucro = 0.6. Ratio of dens setae E1 - E4 = 1 : 1 : 2.5 : 3. Dens : mucro = 3.

Type locality: Not defined, Korea, Mt. Phal-Gong and Mt. Un-Mun, He-In Temple.

Occurrence: Also known from Japan (Niigata, Awashima, YOSII & LEE 1963: 37).



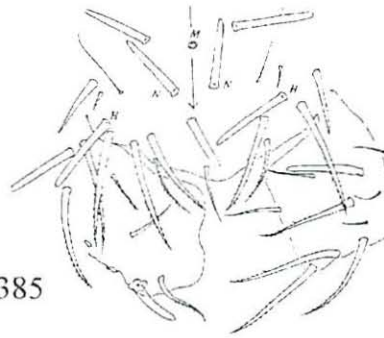
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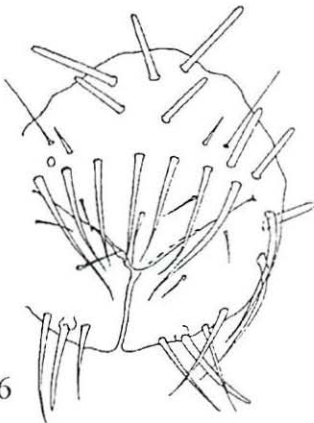
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Figs. 382 - 383 *Ptenothrix leucostrigata* (after STACH 1957): 382 Habitus 383 Female Abd VI.  
 Figs. 384 - 385 *Ptenothrix mongolica* (after YOSII & LEE 1963):  
 384 Setae of head apex 385 Female Abd VI.  
 Fig. 386 *Ptenothrix monochroma*, female Abd VI (after YOSII & LEE 1963).  
 Fig. 387 *Ptenothrix narumii*, colour pattern (after UCHIDA 1940).

*Ptenothrix narumii* Uchida, 1940 (7 and 9)

Total length 1.5 mm. Background colour pale purple, large abdomen with 3 blackish purple cross bands (Fig. 387). Claws with 2 inner teeth; Emp with tooth, filaments pointed, length > claws. Most outer and inner setae of dens broadened basally and with large basal teeth. Both edges of mucro with 15 - 20 teeth each. Setae of Abd VI not described; App. an. thick, blunt, curved dorsally.

Proportions: Ant I : II : III : IV = 1 : 3.5 : 3.8 : 1. Ratio of dens setae E1 - E3 = 1 : 1 : 1. Dens : mucro = 3. App. an. : mucro = 0.8.

Type locality: NE China, Manchuria, Suiyang.

Occurrence: Known only from the type locality.

Remarks: *P. narumii* has been incompletely described, but its colour pattern is apparently characteristic.

*Ptenothrix reticulata* Stach, 1957 (105)

Total length 1.8 mm. Background colour white, large abdomen dark brown, dorsally with white spots, posteriorly with a net of minute spots (Fig. 388), antennae and legs dark. Head apex with long spines. Ant II with 3 - 4 long spines. Large abdomen anteriorly with 3+3 or 4+4 long spines. Tita III posteriorly with 2 serrate spines. Claws with 2 inner and lateral teeth: 2 large and few small basal pairs (pseudonychium); Emp with tooth, filaments pointed, length > claws. Ret with 4 setae. Most outer and inner setae of dens broadened basally and with large basal teeth, formula of anterior setae 3,2,1,1...1. Outer edge of mucro with 20, inner with 23 teeth. Setae m1 (M), A3 (M'), DL2 (N), and P1 (H) of Abd VI long, thick, and blunt, seta P0 (G') small, P2 (G) as short spine, P1 (T) as moderately long spine, all circumanal setae of normal form; App. an. setalike, smooth, curved dorsally (Fig. 389).

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 3.8 : 5.8 : 1.4. Ratio of dens setae E1 - E4 = 1.2 : 1 : 1.5 : 3.2. Dens : mucro = 3.2. App. an. : mucro = 0.75.

Type locality: Not defined, Ukrainia, Janowa Dolina near Berestowiec under stones and Germakowka near Borszewow in beech forest.

Occurrence: Known only from the type locality.

*Ptenothrix ryoheii* Uchida, 1953 (8)

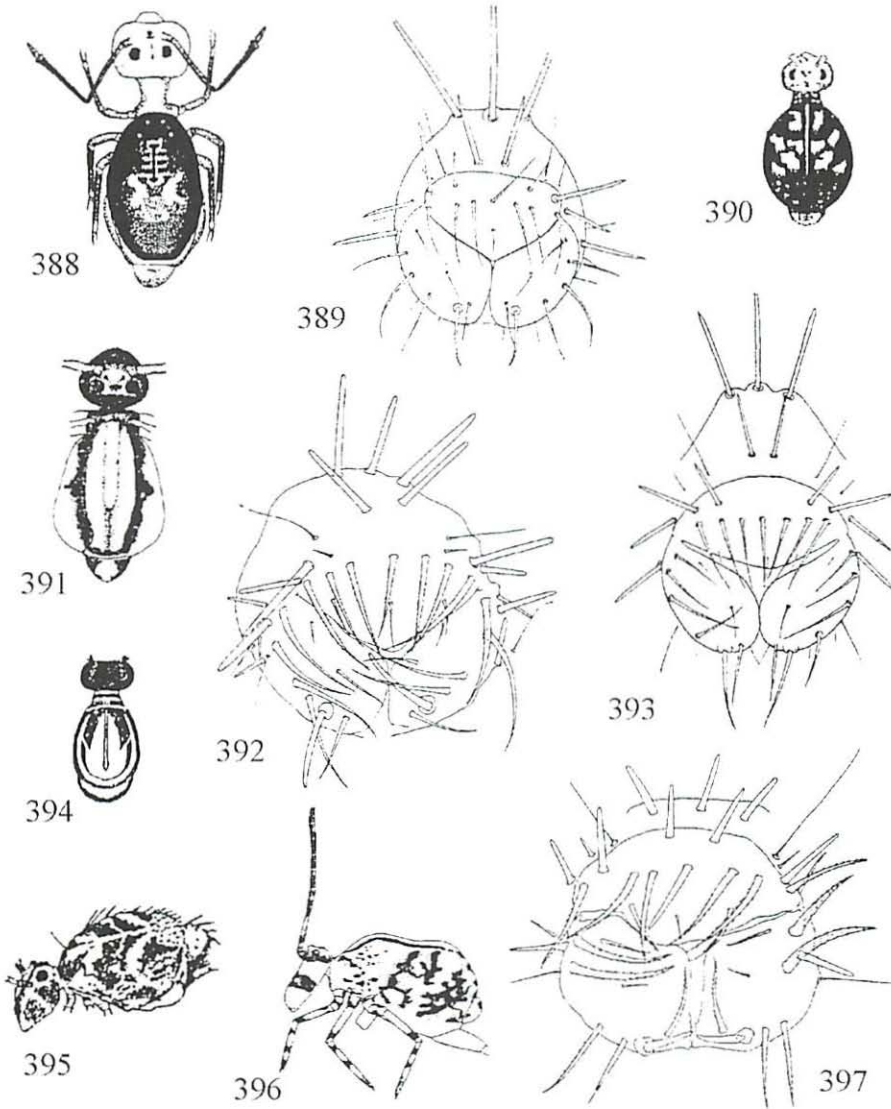
Total length up to 1.7 mm. Background colour yellow to pink, large abdomen dark reddish purple with light patches (Fig. 390). Head apex with spines. Anterior of large abdomen and Abd VI with long spines. Claws with tunica and only 1 inner tooth; Emp without tooth, filaments pointed, length < claws. Most outer and inner setae of dens broadened basally and with large basal teeth. Both edges of mucro serrate. Chaetotaxy of Abd VI and App. an. not described.

Proportions: Length of antennae : head diagonal = 1.5. Ant I : II : III : IV = 1 : 3.5 : 3.6 : 1.1. Ratio of dens setae E1 - E4 = 1 : 1.8 : 1.8 : 2.5 ?. Dens : mucro = 2.5.

Type locality: Japan, Aomori, Takedate-mura, Minamitsugaru-gun.

Occurrence: Known only from the type locality.





Figs. 388 - 389 *Ptenothrix reticulata* (after STACH 1957): 388 Habitus 389 Female Abd VI.  
 Fig. 390 *Ptenothrix ryohiei*, colour pattern (after UCHIDA 1953).  
 Figs. 391 - 392 *Ptenothrix saxatilis* (after YOSHII & LEE 1963):  
 391 Colour pattern 392 Female Abd VI.  
 Fig. 393 *Ptenothrix setosa*, female Abd VI (after STACH 1957).  
 Fig. 394 *Ptenothrix tricycla*, colour pattern (after UCHIDA 1953).  
 Fig. 395 *Ptenothrix vinnula*, colour pattern (after UCHIDA 1957).  
 Fig. 396 - 397 *Ptenothrix vittata* (after YOSHII & LEE 1963): 396 Habitus 397 Female Abd VI.

*Ptenothrix saxatilis* Yosii & Lee, 1963 (19)

Total length 2 mm. Background colour brownish white, head black, body with 1+1 black longitudinal bands (Fig. 391). Head clypeus with 1,1,2,2,1,1 medial spines. Ant II with some spiny setae. Large abdomen anteriorly with 5+5 long spines. Tita III posteriorly with 2 serrate spines. Claws with 2 small inner teeth, 1 outer tooth, and 2 pairs of lateral teeth; Emp with tooth, filaments clavate, length > claws. Ret with 4 setae. Manubrium with 9+9 setae. Most outer and inner setae of dens broadened basally and with large basal teeth. Outer edge of mucro with 39, inner with 45 teeth. Most dorsal setae of Abd VI long, thick, and blunt, seta P0 (G') apparently missing, P2 (G) short and setalike, dorsal circumanal setae ciliate and acuminate, ventral almost smooth; App. an. long, thick, blunt, and slightly curved (Fig. 392).

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 5.4 : 5.7 : 1.7. Ratio of anterior spines of large abdomen : mucro = 0.6. Ratio of dens setae E1 - E4 = 1 : 0.8 : 2.4 : 3. Dens : mucro = 3.2.

Type locality: Korea, He-In Temple.

Occurrence: Known only from the type locality.

*Ptenothrix setosa* (Krausbauer, 1898) (501) sensu Stach, 1957 (92)

Syn.: *Papirius setosus* Krausbauer, 1898 (501)

*Dicyrtoma setosa* Börner, 1903 (167)

nec *Ptenothrix setosa* Denis, 1931 (159) (= other species)

Total length up to 2.5 mm. Background colour dark brown, head paler or white, Abd VI with 1+1 round, white spots, extremities brown. Head apex with long spines. Ant II with 7 long spines. Large abdomen anteriorly with 5+5 long spines. Tita III posteriorly with 2 sparsely serrate spines. Claws with 2 inner, 2 small outer, and 2 pairs of large lateral teeth; Emp with tooth, filaments pointed, length > claws. Ret with 4 setae. Most outer and inner setae of dens broadened basally and with large basal teeth, formula of anterior setae 3,2,1,1...1. Both edges of mucro serrate. Most dorsal setae of Abd VI long, thick, and blunt, seta P0 (G') small, all circumanal setae of normal setal form; App. an. setalike, smooth, curved dorsally (Fig. 393).

Proportions: Length of antennae : head diagonal = 1.75 - 1.9. Ant I : II : III : IV = 1 : 5 : 5.5 : 1.5. Ratio of anterior spines of large abdomen : mucro = 1. Ratio of dens setae E1 - E4 = 1 : 1 : 1.5 : 4. Dens : mucro = 2.7. App. an. : mucro = 0.6.

Type locality: Germany, Hesse, Weilburg/Lahn, Odersbacher Heide on *Calluna*.

Occurrence: Central Europe; only recently reported from Germany again (Hesse, Vogelsberg, BÖHLE 1991: 39), mainly collected in the Carpathian and Sudetes Mts. (STACH, see above, NOSEK & VYSOTSKAYA 1973: 37, DUNGER 1976: 15, WEINER 1981: 471). Also found in Ukraine (near Kiev, STACH, see above), N Austria (CHRISTIAN 1987: 56), N Hungary (LOKSA 1978: 63), and former Yugoslavia (e. g. CVIJOVIC 1976: 105). Uncertainly recorded from S France (Banyuls, DENIS 1932: 380), Belgium (MARLIER 1942: 11), Spain (only 1 cave record, JORDANA et al.: 1990: 177), and Russia (near Lake Baykal, BRETZFELD 1996: 224).

Biology: *P. setosa* lives in moist forests near the soil, in moors (DUNGER, see above), or on carcass (Ukraine, the E Carpathians, at 1500 m altitude, NOSEK & VYSOTSKAYA, see above). It seems to be hygrophile (CHRISTIAN, see above) and troglophile (MASSOUD & THIBAUD 1973: 155).

Species descriptions: KRAUSBAUER 1905: 63 (redescription), SZEPTYCKI 1967: 242 (distal setae of dens).

Remarks: The specimens of *P. palmata* (Folsom, 1902) reported from N Russia (AXELSON 1903: 12, see also GRINBERGS 1960: 64) seem to belong to *P. setosa*.

*Ptenothrix tateyamana* Uchida, 1958 (76)

Total length up to 2.9 mm. Background colour blackish purple, ventral side and furca white, antennae and legs white with dark bands or spots. Head apex and anterior of large abdomen with long spines. Claws with 2 inner and 1 pair of lateral teeth; Emp with tooth, filaments clavate, length > claws. Most outer setae of dens broadened basally and with only fine basal teeth, inner setae absent (?). Outer edge of mucro with 35, inner with 39 teeth. Abd VI with long spines, not described in detail; App. an. slender, smooth, and pointed.

Proportions: Ant I : II : III : IV = 1 : 4.8 : 6.4 : 1. Ratio of dens setae E1 - E4 = 1 : 1 : 3 : 4. Dens : mucro = 3.

Type locality: Japan, Toyama, Tateyama Mts., Babatani, on rods lying on the ground at 1500 m altitude.

Occurrence: Known only from the type locality.

*Ptenothrix tricycla* Uchida, 1953 (7)

Total length 2 mm. Background colour light yellow, head blackish purple, body rounded by 3 brown or violet bands (Fig. 394). Head and body with only normal setae (?). Posterior spines of Tita III not described. Claws with 1 or 2 inner teeth, 1 outer tooth, and 1 pair of lateral teeth; Emp with tooth, filaments pointed, length > claws. Most outer and inner setae of dens weakly serrate. Both edges of mucro serrate. Setae of Abd VI and App. an. not described in detail.

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 7 : 7 : 2. Dens : mucro = 4.2.

Type locality: Japan, Aomori, Aoni, under moist leaves, on decaying logs, and on mushroom.

Occurrence: Also known from another site in Japan (Aomori, Yamagata-mura, UCHIDA, see above).

*Ptenothrix vinnula* Uchida, 1957 (26)

Total length up to 2.7 mm. Background colour reddish brown, head paler with dark brown median band, large abdomen with symmetrical, light spots (Fig. 395). Ant II with few long spines. Large abdomen anteriorly with long spines. Posterior spines of Tita III not described. Claws with 2 inner teeth, 1 outer tooth, and 1 basal pair of lateral teeth; Emp with tooth, filaments clavate, length > claws. Outer and inner setae of dens weakly serrate. Both edge of mucro serrate. Setae of Abd VI not described; App. an. long, thick, and slightly curved.

Proportions: Length of antennae : head diagonal = 2.6. Ant I : II : III : IV = 1 : 5.5 : 5.5 : 1.2. Dens : mucro = 2.8.

Type locality: Japan, Hokkaido, Jonzakei, pond side.

Occurrence: Known only from the type locality.

*Ptenothrix vittata* Folsom, 1896 (119) sensu Yosii & Lee, 1963 (30) and Christiansen & Bellinger, 1981 (1244)

Syn.: *Ptenothrix fasciata* Womersley, 1932 (40)

Total length up to 3.3 mm. Background colour white to yellow, various patterns of brown to purple pigment, often head with 2 dark cross bands, large abdomen more or less marbled, with dark and light longitudinal stripes, each Tita with 3 - 4 purple rings (Fig. 396). Head apex with short spines, clypeus with 1,1,1,2,1,1,1,3 slightly thickened medial setae. Large abdomen anteriorly with 5+5 short, slender setae. Tita III posteriorly with 2 serrate spines. Claws with 2 inner and lateral teeth: 2 large and few small pairs (pseudonychium); Emp with tooth, filament I longer than claw, II and III as long as claws, all tips pointed. Ret with 4 setae. Most outer and inner setae of dens broadened basally and with weak basal teeth. Outer edge of mucro with 27, inner with 42 teeth. Most dorsal setae of Abd VI short, thick, and blunt, seta P2 (G) missing, circumanal seta a0 long, thick, and blunt, other circumanal setae ciliate; App. an. short, thick, and blunt (Fig. 397).

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 5.3 : 5.6 : 1.2. Ratio of dens setae E1 - E4 = 1.5 : 1 : 2.3 : 3.8 (after YOSII & LEE, see above), setae E1 - E3 = 1 : 1 : 2.3 (after CHRISTIANSEN & BELLINGER, see above). Dens : mucro = 3.7.

Type locality: USA, Massachusetts, Middlesex Co., in a greenhouse.

Occurrence: Holarctic and Australia (GREENSLADE 1994: 138); in the Palaearctic known from Japan (Osaka, YOSII & LEE, see above) and Vietnam (Cha-Pa, STACH, see below).

Biology: *P. vittata* occurs generally in greenhouses. One specimen has been found in Vietnam under a piece of wood lying on the ground (STACH, see below).

Species descriptions: FOLSOM 1934: 475, STACH 1965: 368, SNIDER 1985 a: 565, 1985 b: 586 (comparison with other species).

## Sminthurida Bretfeld, 1986

Syn.: Sminthuridae Börner, 1913 sensu Betsch, 1980 (147)

### Diagnosis

The taxon Sminthurida Bretfeld, 1986 (310) belongs to the Eusymphyleona-Sminthuri-formia-Tridentata Bretfeld, 1986; it has not yet been defined as a monophylum based on apomorphies.

Diagnostic characteristics: Ret with 3 teeth (apomorphy); Bothr ABC often forming an obtuse angle opening posteriorly (apomorphy?), Bothr B sometimes missing apomorphically in adults; Abd V with 1 pair of Bothr D (plesiomorphy), sometimes present only in 1st instar (apomorphy); Abd V included in small abdomen (plesiomorphy); Ant IV longer than III (plesiomorphy); antennae elbowed between Ant III and IV (plesiomorphy); pretarsus with 1 pair of setae (plesiomorphy); sacs of VT long and warty (apomorphy).

There are 2 subgroups of the Sminthurida (= subfamilies) which differ in several characteristics (BETSCH 1980: 148):

- Sphyrothecinae Betsch, 1980: 1 pair of neosminthuroid setae, antennae rather short, dens without or with only few (at most 6) anterior setae, apex of mucro asymmetrical, Abd VI in males with 1 pair of short spines resembling App. an.,
- Sminthurinae sensu Betsch, 1980: neosminthuroid setae missing, antennae long, dens with many (9 - 15) anterior setae, apex of mucro symmetrical, males without spines resembling App. an.

The genus *Songhaica* Lasebikan, Betsch & Dallai, 1980 takes an intermediate position between these subgroups; it combines 3 pairs of neosminthuroid setae and only few anterior dens setae with the remaining characteristics of the Sminthurinae.

### Description

The Sminthurida are small to large animals; the total length of adults ranging from 0.7 to nearly 4 mm. The pigmentation varies from white to dark brown or black; spots of different colours are often mixed together. The large abdomen generally stretches from Th II to Abd IV (BETSCH 1980: 14) and is usually globular. There are short or branched tracheae in the head and in higher evolved genera branched tracheae are also present in the large abdomen (BETSCH 1980: 22). Most genera of the Sphyrothecinae show a specific number of vesicles on the thorax (Fig. 417). The setae are generally long and sometimes modified into thick spines and macrochaetae on the head apex and large abdomen, or are short, stout spines (some Sphyrothecinae, Figs. 417, 418). Most genera have 4 pairs of Bothr: ABCD; B and D may be missing in adults and ABC often form an obtuse angle opening posteriorly. The segmental position of the Bothr is discussed by BETSCH & WALLER 1989: 26. The App. an. are directed towards the anus; they are usually long and simple, but may also be broad and thin (*Spatulosminthurus*, Figs. 444, 452). 1 pair of neosminthuroid setae is present in the Sphyrothecinae and 3 pairs in *Songhaica*.

The eye-patches usually have 8+8 ommatidia, C and D of which often being smaller than the others; they may be reduced to 5+5 or 0+0 in *Disparrhopalites* and *Pararrhopalites* respectively. On the head apex, 1 or more pairs of cuticular vesicles may be present. In a few genera, there is 1 pair of short, ciliated postantennal setae (Fig. 434). The mandibulae and maxillae are always of the normal chewing type. Ant IV is longer than III and the whole antenna is elbowed between Ant III and IV.

Ant II and III may show macrochaetae (Figs. 399, 400). Ant IV is clearly subsegmented in the Sminthurinae and often undivided or weakly subsegmented in the Sphyrothecinae.

The subcoxa III generally has 1 short distal seta, sometimes 2, short and long, in the subadult and adult (Fig. 426a). Trochanter III, except in *Sminthurus* and *Spatulosminthurus*, has 1 posterior spine (Fig. 413). Femur I has 1 or 2 posteriorly curved anterior setae, and in the Sphyrothecinae femur III may have 1 posterior blunt or soft spine (Fig. 413). The tibiotarsi have spatulate distal setae in *Richardsitas*, *Spatulosminthurus* (Fig. 447), and *Sminthurus sylvestris* (USA), and always have 1 pair of pretarsal setae. The claws often have a tunica and 1 pair of basal and lateral duplications with teeth or fringes (pseudonychium, Figs. 401, 447). The empodial filaments may be fine, thick, or missing.

The VT has long and warty sacs; the apical flaps generally bear 1 pair, the corpus sometimes another pair of setae in subadults and adults (Fig. 423a). The Ret has 3+3 teeth. The setae of dentes are usually normally shaped, some may be spinelike, the anterior setae occur in either low (at most 6: Sphyrothecinae) or high numbers (9 - 15: Sminthurinae). The apex of mucro is asymmetrical (Sphyrothecinae, Fig. 421) or symmetrical (Sminthurinae, Fig. 424); the posterior edges are smooth or variously toothed; a seta is present or absent.

The circumanal setae in females are modified only in *Spatulosminthurus*. Secondary sexual differences have been observed in *Richardsitas* (males with small dorsal setae) and *Sminthurus* (papillate cuticula of male genital area); in the Sphyrothecinae the males possess 1 pair of small spines resembling App. an.

Most species are incompletely known and, as in other groups, only the abundant species have been studied under different aspects.

### Biology

The species of the Sminthurida are rare to abundant. They live on the soil or in litter (Sphyrothecinae) or belong to the atmobios and live in all strata from the surface of litter to the trees (Sminthurinae). The Sphyrothecinae usually need a moist habitat, the Sminthurinae live in all habitats from humid woods to dune vegetation though not in truly wet localities. In some genera of the Sphyrothecinae, small particles of detritus from the soil stick to the cuticula. There are 3 caverniculous species (*Disparrhopalites patrizii*, *Caprainea marginata*, *Lipothrix lubbocki*, MASSOUD & THIBAUD 1973: 154). The sperm is transferred by spermatophores without a complicated courtship behaviour, but it is unknown in most genera. The species feed on fungi, algae, pollen grains, plant debris, and seldom on living plant tissue. The latter are damaged by the large species *Sminthurus viridis* when introduced overseas. The most biological data of a Symphypleonan Collembola, therefore, are present from this species.

### Key to the genera of the world

#### Sminthurida Bretfeld, 1986

- |   |  |   |
|---|--|---|
| 1 | Neosminthuroid setae present, dens with 0 - 6 anterior setae   | 2 |
| - | Neosminthuroid setae missing, dens with 9 - 15 anterior setae (Sminthurinae Betsch, 1980)  | 8 |
| 2 | 1 pair of neosminthuroid setae; apex of mucro asymmetrical, inner or both posterior edges often coarsely serrate (Fig. 421, Sphyrothecinae Betsch, 1980) | 3 |
| - | 3 pairs of neosminthuroid setae; apex of mucro symmetrical, posterior edges smooth   |   |
|   | <i>Songhaica</i> Lasebikan, Betsch & Dallai, 1980  |   |
|   | type species: <i>Songhaica nigeriana</i> Lasebikan, Betsch & Dallai, 1980; Nigeria   |   |

- 3 Bothr D present, Ant IV always subsegmented, Th II with or without vesicles (see Fig. 417) 4
- Bothr D missing (except in 1st instar), Ant IV with or without subsegments, Th II always with vesicles (Fig. 417) 6
- 4 Th II without vesicles *Sphyrotheca* Börner, 1906 (p. 211)  
type species: *Sminthurus multifasciatus* Reuter, 1881; Finland
- Th II with vesicles 5
- 5 Th II with 1 pair of vesicles, anterior of large abdomen with several spines  
*Parasphyrotheca* Salmon, 1951  
type species: *Parasphyrotheca magnificata* Salmon, 1951; SE Asia
- Head laterally and Th II with rows of small vesicles, anterior of large abdomen with 1 pair of long spines *Afrosmminthurus* Delamare Deboutteville & Massoud, 1964  
type species: *Afrosmminthurus gladiator* Delamare Deboutteville & Massoud, 1964; Angola
- 6 (3) Bothr B present in adults, Ant IV subsegmented, Tita with only straight apical setae, femur I with 1 curved anterior seta *Lipothrix* Börner, 1906 (p. 184)  
type species: *Sminthurus lubbocki* Tullberg, 1872; Sweden
- Bothr B missing in adults 7
- 7 Ant IV subsegmented, Tita with only straight apical setae, femur I with 1 curved anterior seta *Paralipothrix* n. gen. (p. 187)  
type species: *Neosminthurus natalicius* Ellis, 1974; Spain
- Ant IV undivided or weakly subsegmented, Tita with 1 curved apical seta (Fig. 419), femur I with 2 curved anterior setae *Neosminthurus* Mills, 1934 (p. 187)  
type species: *Sminthurus curvisetis* Guthrie, 1903; USA
- 8 (1) Trochanter III with normal posterior seta 9
- Trochanter III with posterior spine (Fig. 413) 10
- 9 Tita with only pointed distal setae *Sminthurus* Latreille, 1802 (p. 188)  
type species: *Podura viridis* Linnaeus, 1758; Europe
- Tita with also spatulate distal setae (Fig. 447)  
*Spatulosminthurus* Betsch & Betsch-Pinot, 1984 (p. 204)  
type species: *Sminthurus lesnei* Carl, in Denis, 1925; France
- 10 Head frons without postantennal setae 11
- Postantennal setae present (Figs. 398, 404) *Allacma* Börner, 1906 (p. 174)  
type species: *Podura fusca* Linnaeus, 1758; Europe
- 11 Ant III without very long and thick setae 12
- Ant III with 3 - 5 long, thick setae (see Fig. 400) 15
- 12 Tita II and III with only pointed distal setae 13
- Tita II and III each with 1 spatulate distal seta *Richardsitas* Betsch, 1975  
type species: *Richardsitas najtae* Betsch, 1975; Madagascar

- 13** Head and large abdomen with only normal setae **14**  
 – Head and large abdomen with spines *Pararrhopalites* Bonet & Tellez, 1948  
     type species: *Pararrhopalites anops* Bonet & Tellez, 1948; Mexico
- 14** Claws of normal form, dens with 9 anterior setae, posterior edges of mucro with small teeth *Disparrhopalites* Stach, 1956 (p. 182)  
 type species: *Parrhopalites patrizii* Cassagnau & Delamare Deboutteville, 1953; Europe  
 – All claws with cavity (Fig. 412), dens with 13 anterior setae, posterior edges of mucro with coarse teeth *Gisinurus* Dallai, 1970 (p. 183)  
     type species: *Gisinurus malatestai* Dallai, 1970; Italy
- 15** (11) Antennae shorter than body, Ant IV with at most 18 subsegments, claws with or without tunica **16**  
 – Antennae as long as or longer than body, Ant IV with 20 - 40 subsegments, claws always without tunica *Temeritas* Delamare Deboutteville & Massoud, 1963 (p. 212)  
     type species: *Sminthurus macroceros* Denis, 1933; Costa Rica
- 16** Ant III with long, thick setae only in basal 1/2, large abdomen anteriorly without very long setae, claws always with tunica *Caprainea* Dallai, 1970 (p. 178)  
     type species: *Sminthurus echinatus* Stach, 1930; Spain  
 – Ant III with long, thick setae in basal (4) and distal 1/2 (1), large abdomen anteriorly with very long setae, claws sometimes with tunica *Novokatianna* Salmon, 1944  
     type species: *Novokatianna cummyxa* Salmon, 1944; New Zealand

Remarks: The above definition of the genus *Pararrhopalites* mainly follows BETSCH (1980: 148); a revision, however, is needed.

*Sminthurus sylvestris* from N America has Tita with especially spatulate setae and may belong to a separate genus different from *Spatulosminthurus* (BETSCH & BETSCH-PINOT 1984: 79).

Not included in this key are:

- *Austrosminthurus* Delamare Deboutteville & Massoud, 1963 (= juvenile, Bothr D strangely stout and ciliate; it may belong to the Sminthurinae, BETSCH 1980: 150),
- *Cordobaia* Simón, Bach & Gaju, 1986 (= *Caprainea*, see below).

### Diagnosis of the Palaearctic genera and species

#### Genus *Allacma* Börner, 1906

##### Key to the Palaearctic species

- 1** All outer setae of dens long and of normal form **2**  
 – 2 - 3 proximal of these setae very short *koreana* Yosii & Lee, 1963
- 2** All long posterior setae of dens pointed, dens with 15 anterior setae *gallica* (Carl, 1899)  
 – 2 - 3 of these posterior setae knobbed, dens with 13 anterior setae *fusca* (Linnaeus, 1758)



### Diagnosis of the genus

A genus of the Sminthurinae. Head apex and large abdomen with long, rough, and often blunt setae. Large abdomen posteriorly with 1 pair of large cuticular glands except in 1st instar. Eye-patches with 8+8 ommatidia. Postantennal setae present. Antennae shorter than body. Basal 1/2 of Ant III with about 5 long, thick setae. Ant IV with 12 - 15 subsegments. Trochanter III posteriorly with 1 spine. Tita distally with only pointed setae. Claws without cavity. Dens anteriorly with 11 - 15 setae, inner setae of normal form. Outer edge of mucro smooth, inner serrate; seta present.

Occurrence: Holarctic.

Descriptions of the genus: BÖRNER 1906: 183, STACH 1956: 216, BETSCH 1980: 167, NAYROLLES 1994: 151.

Type species: *Podura fusca* Linnaeus, 1758.

### Diagnosis of the Palearctic species

*Allacma fusca* (Linnaeus, 1758) (608)

Syn.: *Podura fusca* Linnaeus, 1758 (608)

*Smynthurus buskii* Lubbock, 1862 (431)

*Sminthurus fuscus* Tullberg, 1871 (144)

*Sphyrotheca stachi* Jeannenot, 1957 (405), GISIN 1960: 294

nec *Sminthurus fuscus* Schött, 1893 a (6) (= *Allacma dubia*, GREENSLADE 1977: 250, Central Africa)

*Sminthurus fuscus* Guthrie, 1903 (53) (= *Allacma purpurescens*, CHRISTIANSEN & BELLINGER 1981: 1195)

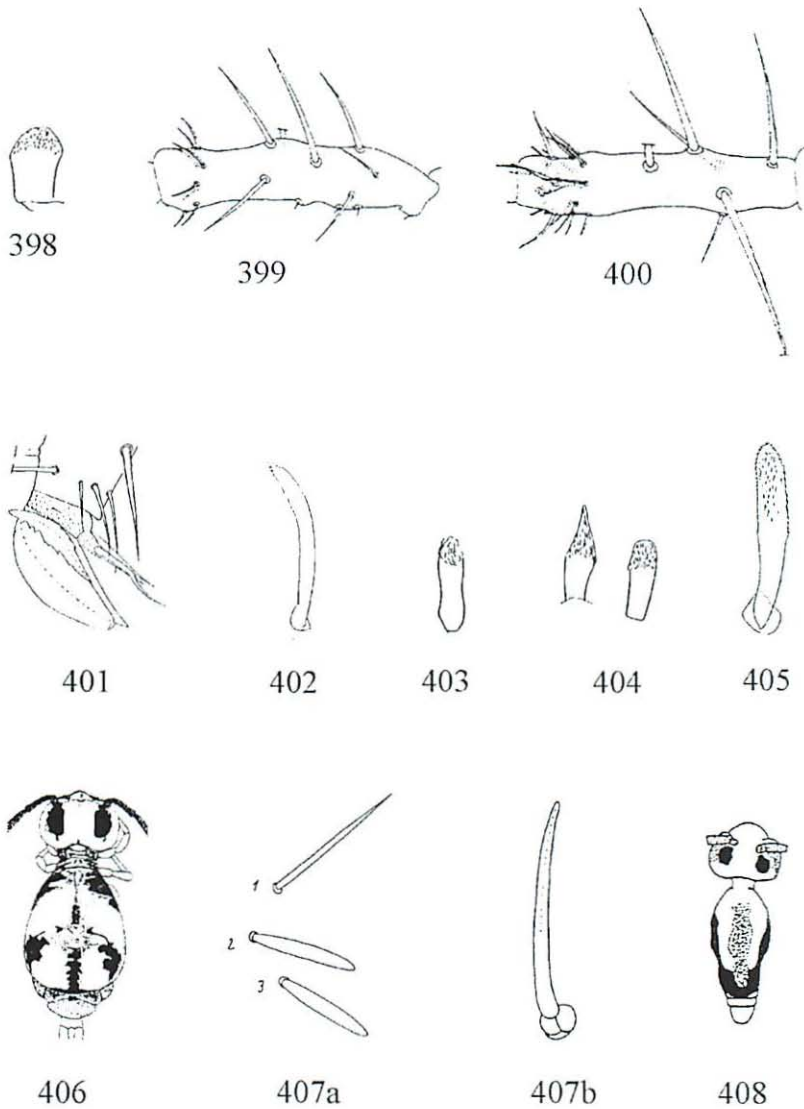
*Allacma fusca* Stach, 1966 (216) (= *Allacma purpurescens*, CHRISTIANSEN & BELLINGER 1981: 1195)

*Allacma fusca* Dallai, 1970 (475) (= *Allacma gallica*, DALLAI 1973: 568)

Total length up to 4 mm, males smaller. Colour more or less dark brown, head often paler; head and body seldom completely white. Head apex and large abdomen with long, rough setae. Posterodorsal glands of large abdomen with flat cuticular orifices. Eye-patches with 8+8 ommatidia, D smaller than the others. Postantennal setae short and thick with fine apical serrations (Fig. 398). Ant II with 3 short ventral setae; Ant II and III each with 5 long, thick setae (Figs. 399, 400). Ant IV with about 15 subsegments. Claws broad, with large tunica and long, serrate pseudonychia, inner tooth missing; only Emp III with tooth, all Emp with 1 pair of apical points, filaments acuminate, length = claws (Fig. 401). VT with 2+2, Ret with 4 setae. All outer setae of dens of normal length, 2 - 3 long posterior setae knobbed, formula of anterior setae 3,3,3,2,1...1, proximal anterior seta very short. Inner edge of mucro coarsely serrate, outer smooth with 1 basal and 1 apical round tooth; seta present. App. an. long, flattened, tip pointed and with coarse teeth (Fig. 402).

Proportions: Length of antennae : head diagonal = 1.2. Ant I : II : III : IV = 1 : 2.7 : 2.5 : 4.2. Dens : mucro = 2.6. App. an. : mucro = 0.6 - 0.9.

Type locality: Not defined, Europe.



Figs. 398 - 402 *Allacma fusca*:

398 Postantennal seta (after ELLIS 1973) 399 Ant II (after NAYROLLES 1994) 400 Ant III (after NAYROLLES 1994) 401 Claw and Emp I (after STACH 1956) 402 App. an. (after ELLIS 1973).

Figs. 403 - 405 *Allacma gallica* (after ELLIS 1973):

403 Protruding orifice of abdominal gland 404 Different shapes of postantennal setae 405 App. an.

Figs. 406 - 408 *Capraínea bremondi*:

406 Colour pattern (after NAYROLLES 1993) 407a Setae 1 - 3 of furca base (orig.), 407b App. an. (after SIMÓN, BACH & GAJU 1986) 408 Other colour pattern (after GISIN 1960).

Occurrence: Holarctic; in the Palaearctic only in Europe, NW Africa (THIBAUD & MASSOUD 1980: 543), and Portugal, the Azores (GAMA 1986: 44), in the Nearctic in Canada (Quebec, Parc de Gaspésie, SNIDER, pers. comm.). The record from E Russia (STEBAEVA 1976: 126) concerns *Sminthurus variegatus* Tullberg, 1876 (29), the identity of which is uncertain (discussion by LAWRENCE 1966: 518).

Biology: *A. fusca* is a common species which lives in moist forests and bushes near the soil in litter, on dead wood, and in the low vegetation from the lowlands up to the timber line (FRANZ 1945: 126, NOSEK & VYSOTSKAYA 1973: 51). It also climbs on tree trunks (while feeding on algae during moist weather, BAUER 1979: 165) and occurs in nests of small mammals (NOSEK & VYSOTSKAYA 1973: 36) and in caves (troglone, RUSEK 1972: 63). Winter is passed in the egg stage (VOLZ 1989: 95). Sperm transfer, reproduction (LEMOINE 1883: 483, MAYER 1957: 503), and its phoretic Acari were described (WALDORF 1974: 363), and several analyses of ecophysiology have been published (summary by BETSCH et al. 1980: 77; ZINKLER & RÜSSBECK 1986: 123, EISENBEIS 1989: 376, 390, ZINKLER & PLATTHAUS 1996: 443).

Species descriptions: General: STACH 1956: 217, JEANNENOT 1957: 405 (only males), ELLIS 1973: 170 (compared with *A. gallica*), NAYROLLES 1994: 154 (mainly chaetotaxy). General anatomy: WILLEM 1900: 56, 1901: 653. Morphology and ecophysiology of juveniles: BETSCH & VANNIER 1977: 124. Central nervous system: BRAUNER 1981: 259. Ovary: KRZYSZTOFOWICZ 1967: 298, 1977: 81. Structure and development of spermatophores: SCHLIWA 1965: 445. Ultrastructure of: cuticula, DALLAI 1974: 313; ommatidia, PAULUS 1974: 126; postantennal seta, ALTNER et al. 1970: 263; antennal sensilla, several papers by ALTNER et al., the latest 1988: 173, 1989: 199. Genetic differences to *A. gallica*: FANCIULLI et al. 1994: 73.

Remarks: Since this species is rather common and large, it has been so often studied that only a few papers could be noted above.

The colour varieties were given separate names, which are not repeated here (see STACH 1956: 222).

*Allacma gallica* (Carl, 1899) (7)

Syn.: *Sminthurus gallicus* Carl, 1899 (7)

*Sminthurus punctatus* Lucas, 1846 (255) sensu Denis, 1933 (306) n. syn.

*Allacma fusca* Dallai, 1970 (475), DALLAI 1973: 568

Total length up to 2.7 mm. Background colour yellowish white with more or less black pigment; head often, body sometimes pale. Posterodorsal glands of large abdomen with prominent orifices (Fig. 403). Postantennal setae short but slender and pointed with fine apical serrations (Fig. 404). Ant II with 3 short ventral setae (see Fig. 399); Ant II with 3, Ant III with 5 long, thick setae. Ant IV with about 13 subsegments. All Emp or only Emp III with tooth. All posterior setae of dens pointed, formula of anterior setae 3,3,3,2,2,1,1, proximal anterior seta of normal length. Inner edge of mucro coarsely serrate, outer edge smooth or distally wavy; seta present. App. an. long, flattened, apically rounded, and distal 1/2 finely serrate (Fig. 405). All other characteristics as in *A. fusca*.

Proportions: Length of antennae : head diagonal = 1.6 in females, 1.7 in males. Ant I : II : III : IV = 1 : 2.2 : 2.6 : 5.6 (6.3) in females (and males). App. an. : mucro = 0.7.

Type locality: NW France, Eure, Lyons-la-Forêt.

Occurrence: W and S Europe and N Africa (POINSOT 1974: 124); in Europe from the Netherlands (ELLIS, see below) and Switzerland (CARL 1901: 274, GISIN 1948: 511) to the W Mediterranean (from Greece and Albania westwards, POINSOT, see above, PEJA 1981: 75); not reported from Spain (JORDANA et al. 1990: 23), not confirmed for Portugal, the Azores (GAMA 1992: 45).

Biology: *A. gallica* prefers warm climates where it occurs near the soil in litter, on dead wood, and in the low vegetation. It has been collected together with *A. fusca* in dune valleys (the Netherlands, ELLIS, see below) and occurs up to 1400 m altitude (Italy, Apuane Alps, DALLAI 1970: 475). *A. gallica* has a larger range of habitat preferences than *A. fusca* (FANCIULLI et al. 1995: 25). Reproduction was also described (BETSCH-PINOT 1977: 15, 1980: 13).

Species descriptions: GISIN 1948: 510 (abdominal glands), ELLIS 1973: 170 (general, compared with *A. fusca*), DALLAI 1974: 313 (cuticula), DALLAI & CALLAINI 1979: 45 (anatomy of pylorus), NAYROLLES 1994: 154 (general, mainly chaetotaxy). XUE et al. 1994: 144 (ultrastructure of tracheae). FANCIULLI et al. 1994: 73 (genetic differences to *A. fusca*).

Remarks: *Sminthurus punctatus* from N Africa (see above) may be a juvenile of *A. gallica*.

#### *Allacma koreana* Yosii & Lee, 1963 (14)

Total length up to 2 mm in females, 1.5 mm in males. Colour more or less brown or purplish blue, head sometimes white (f. *leucocephala* Yosii & Lee, 1963 (15)). Head apex and body with long, rough, and slightly blunt setae. Posterodorsal glands of large abdomen with circular, flat orifices. Eye-patches with 8+8 ommatidia. Postantennal setae slender with rounded apex, distal 1/2 finely ciliate. Ant II and III each with 4 long, thick setae. Ant IV with 12 subsegments. Claws broad, with large tunica and long, serrate pseudonychia, inner tooth sometimes present; Emp broad with tooth, filaments acuminate, length > claws. Proximal 2 - 3 outer setae of dens very short, all posterior setae pointed, formula of anterior setae 3,2,2,2,1...1, proximal anterior seta very short. Inner edge of mucro with 12 round teeth, outer smooth; seta present. In females, circumanal setae sa', sa1, and sa3 (see Figs. 29, 30) very short. App. an. long, distally broadened and ciliate.

Proportions: Length of antennae : head diagonal = 1.5. Ant I : II : III : IV = 1 : 2.6 : 2.6 : 5. Dens : mucro = 2.2.

Type locality: Korea, He-In Temple.

Occurrence: Known only from the type locality.

#### Genus *Caprainea* Dallai, 1970

Syn.: *Cordobaia* Simón, Bach & Gaju, 1986 (303) n. syn.

#### Key to the Palaearctic species

- 1 Furca base with only acuminate setae; App. an. branched (Fig. 410)  
*marginata* (Schött, 1893)
- Furca base with 2 pairs of thick, blunt spines (Fig. 407a); App. an. thick, setalike (Fig. 407b) *bremondi* (Delamare Deboutteville & Bassot, 1957)

### Diagnosis of the genus

A genus of the Sminthurinae. Head apex and large abdomen with short and long spines respectively. Large abdomen posteriorly without large cuticular glands. Eye-patches with 8+8 ommatidia. Postantennal setae missing. Antennae shorter than body. Basal 1/2 of Ant III with about 4 or 5 long, thick setae. Ant IV with 15 - 18 subsegments. Trochanter III posteriorly with 1 spine. Tita distally with only pointed setae. Claws without cavity. Dens anteriorly with about 13 setae. Posterior edges of mucro serrate; seta present or missing.

Occurrence: W Palaearctic.

Descriptions of the genus: DALLAI 1970: 52, 1972: 220, BETSCH 1980: 168, NAYROLLES 1993: 51.

Type species: *Sminthurus echinatus* Stach, 1930.

Remarks: This genus has been separated from *Sminthurus* mainly by reason of the cuticular structure. The genus *Cordobaia* is synonymous with *Caprainea* since its type species, *Cordobaia bembzarensis*, shows the same chaetotaxic characteristics as *Caprainea bremondi*.

### Diagnosis of the Palaearctic species

*Caprainea bremondi* (Delamare Deboutteville & Bassot, 1957) (80) sensu Nayrolles, 1993 (53)

Syn.: *Sminthurus bremondi* Delamare Deboutteville & Bassot, 1957 (80)

*Sminthurus* sp. Gama, 1959 (28), GAMA 1961: 38

*Cordobaia bembzarensis* Simón, Bach & Gaju, 1986 (305) n. syn.

Total length up to 1.2 mm in females, 0.75 mm in males. Background colour white or yellow, large abdomen with dark purple pigment in varying patches and stripes, or completely dark; head with purple frons and antennae, small abdomen pale (Figs. 406, 408) or pigmented. Head apex with 3 or 4 pairs of spines. Large abdomen with long, straight, rough, and abruptly pointed spines and with normal setae. Distal part of Ant II with 4 short, dorsal setae; Ant III proximally with 4 long, thick setae. Ant IV with 15 - 17 subsegments. Tita I - III without seta Ia (see Figs. 23, 242). Claws with tunica, inner and basal outer tooth, and short, serrate pseudonychia; Emp with tooth, filaments thin and acuminate, length of Emp I and II > claw, III < claw. VT with 2+2, Ret with 2 setae. Setae 2 and 3 of furca base as thick, blunt spines (Fig. 407a, see Fig. 19). Inner setae of dens spinelike, formula of anterior setae 3,3,2,2,2,1,1. Both edges of mucro densely serrate; seta missing. App. an. long, thick, setalike, and smooth or rough (Fig. 407b).

Proportions: Length of antennae : head diagonal = 1.8. Ant I : II : III : IV = 1 : 2.1 : 3.3 : 8.3 in both sexes. Dens : mucro = 2.8. App. an. : mucro = 0.9.

Type locality: Portugal, Madeira, Quiemadas, Caldeirão Verde, litter of *Laurus*.

Occurrence: Also collected from continental Portugal and Spain (SIMÓN et al., see above; JORDANA et al. 1990: 37; NAYROLLES, see above), former Yugoslavia (e. g. CVIJOVIC 1973: 53), and Albania (PEJA 1981: 67).

Biology: *C. bremondi* lives in warm, humid habitats near the soil in litter and moss.

Species descriptions: GAMA 1961: 38 (Emp, App. an.), DALLAI 1972: 217 (cuticula).

Remarks: *C. bremondi* (from Portugal, Madeira and continental, ex coll. DA GAMA ASSALINO and from Spain, ex coll. NAYROLLES) and *C. bembezarensis* (bleached female type, ex coll. SIMÓN) show the same chaetotaxic characteristics (orig. observ.), the colour pattern differs between populations (see Figs. 406, 408).

*Capraïnea marginata* (Schött, 1893 b) (25) sensu Nayrolles, 1993 (57)

Syn.: *Sminthurus marginatus* Schött, 1893 b (25)

*Sminthurus erinaceus* Börner, 1903 (165) n. syn.

*Sminthurus echinatus* Stach, 1930 (72) n. syn.

*Capraïnea echinata* Dallai, 1970 (52)

Total length up to 1.4 mm in females, 0.7 mm in males. Background colour dirty white to pale blue, large abdomen pink to rusty without distinct pattern (*C. marginata*) or with black violet irregular longitudinal and cross stripes (*C. echinata*, Fig. 409). Head apex with stout setae and 2+2 spines. Large abdomen with long, straight, rough, and abruptly pointed spines and with normal setae. Distal part of Ant II with only setae of normal length; Ant III with 5 long, thick setae. Ant IV with 15 subsegments. Tita I - III with seta Ia (see Figs. 23, 242). Claws with tunica, inner tooth, and clearly serrate pseudonychia; Emp with tooth, filaments acuminate, length  $\geq$  claws. VT with 2+2, Ret with 2 setae. Setae 2 and 3 of furca base setalike (orig. observ., see Figs. 19, 407a). Inner setae of dens spinelike, formula of anterior setae 3.3,2,2,2,1,1. Both edges of mucro densely serrate; seta present or missing. App. an. long, slender, distal 1/3 branched (Fig. 410).

Proportions: Length of antennae : head diagonal = 1.9 in females, 2.1 in males. Ant I : II : III : IV = 1 : 2 : 3.3 : 8.6 - 9.3. Dens : mucro = 2.4 - 2.8. App. an. : mucro = 0.8.

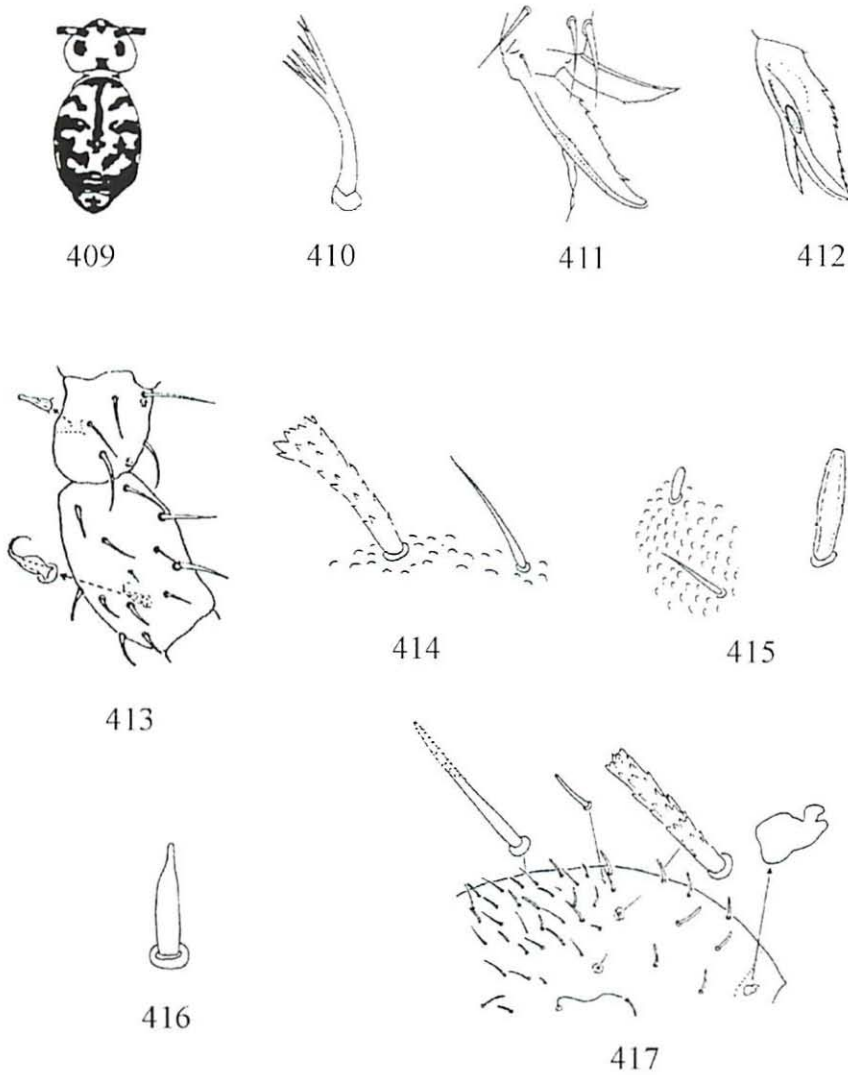
Type locality: Sweden, Upland, Skokloster, bushes, in moss and on dead branches.

Occurrence: Europe, except the most northern regions, and Algeria (CASSAGNAU 1963: 199).

Biology: *C. marginata* is widespread, but usually rare, and lives in warm, humid, or wet forests and meadows where it occurs in the soil, litter, and moss. It was found up to 1700 m (Ukraine, the E Carpathians, in nests of small mammals, NOSEK & VYSOTSKAYA 1973: 51). It is troglophile (MASSOUD & THIBAUD 1973: 155, DALLAI & MALATESTA 1982: 190, GAMA 1991: 177).

Species descriptions: ÅGREN 1903: 167 (App. an.), STACH 1920: 210, 1956: 235, 252 and Table XXXI (colour pattern), LAWRENCE 1961: 157, NOSEK 1962: 341, DALLAI 1969: 248, 1970: 50 and 1972: 217 (cuticula), POINSOT-BALAGUER 1976: 1239 (spermatophore).

Remarks: *C. echinata* is synonymous with *C. marginata* since the chaetotaxy is identical, only the colour pattern is different (see DUNGER 1977: 179). *Sminthurus erinaceus* from Italy, Sicily, is synonymous with *C. marginata* since the dorsal setae are identical and the pigmentation resembles *C. echinata* (see DENIS 1925: 209).



Figs. 409 - 410 *Caprainea marginata*: 409 Colour pattern (after GISIN 1960) 410 App. an. (after NAYROLLES 1993).

Fig. 411 *Disparrhopalites patrizii*, claw and Emp III (after DALLAI 1970).

Fig. 412 *Gisinurus malatestai*, claw with cavity, seen from anterior (after NAYROLLES 1993).

Fig. 413 *Lipothrix* general, trochanter and femur III with modified posterior setae (after BETSCH 1980).

Fig. 414 *Lipothrix bernardi*, spine and normal seta of large abdomen (after CASSAGNAU 1968).

Figs. 415 - 416 *Lipothrix italica*.

415 Spine and normal seta of large abdomen; spine enlarged (after CASSAGNAU 1968) 416 Spine with compressed tip, lateral view (orig. from types).

Fig. 417 *Lipothrix lubbocki*, vesicles and dorsal setae of large abdomen (after BETSCH 1980).

### Genus *Disparrhopalites* Stach, 1956

**Key.** Only 1 species: *Disparrhopalites patrizii* (Cassagnau & Delamare Deboutteville, 1953)

#### Diagnosis of the genus

A genus of the Sminthurinae. Head and abdomen with only normal setae. Large abdomen posteriorly without large cuticular glands. Eye-patches each with 5 - 8 ommatidia. Postantennal setae missing. Antennae shorter than body. Ant III with only normal setae. Ant IV with 12 subsegments. Trochanter III posteriorly with 1 spine. Tita distally with only pointed setae. Claws without cavity. Dens anteriorly with 9 setae, inner setae of normal form. Posterior edges of mucro finely serrate; seta missing.

Occurrence: SW Europe.

Descriptions of the genus: STACH 1956: 63, BETSCH 1980: 168.

Type species: *Pararrhopalites patrizii* Cassagnau & Delamare Deboutteville, 1953.

#### Diagnosis of the single species

*Disparrhopalites patrizii* (Cassagnau & Delamare Deboutteville, 1953) (144)

Syn.: *Pararrhopalites patrizii* Cassagnau & Delamare Deboutteville, 1953 (144)

Total length up to 1 mm. Colour almost completely white, eye-patches dark blue, large abdomen sometimes with faint dorsal pigment. Tita long, slender. Claws with 6 - 7 inner teeth, tunica, or weakly serrate pseudonychia; Emp broad with several teeth, filaments missing, length < claws (Fig. 411). Ret with 2 setae. Formula of anterior setae of dens 3,2,2,1...1. App. an. long, thick, setalike. Other characteristics as mentioned for genus.

Proportions: Length of antennae : head diagonal = 2.4. Ant I : II : III : IV = 1 : 1.1 : 2.2 : 7.5. Dens : mucro = 2.5. App. an. : mucro = 0.75.

Type locality: Not defined; collected from caves in S France, Italy, and Greece (Crete).

Occurrence: Also known from other caves in France and Italy (DELAMARE DEBOUTTEVILLE & BASSOT 1957: 82, DALLAI 1970: 150) and from caves in continental Greece (DELAMARE DEBOUTTEVILLE & BASSOT, see above). Great Britain (S England, GOUGH 1972), Spain (the Canary Islands, Tenerife, GAMA 1988: 85), and Portugal (Madeira and the Azores, DELAMARE DEBOUTTEVILLE & BASSOT, see above, GAMA 1992: 45). It has been collected in the catacombs of St. Stephan's Cathedral, Vienna, Austria (CHRISTIAN 1999), and from open air habitats in S Italy (isle of Salina, DALLAI 1973: 567) and Germany (North Rhine-Westphalia, near Cologne, SCHLEUTER 1985: 154, and E of Bonn, AHRENS 1989: 60, 61).

Biology: *D. patrizii* is troglophile (CHRISTIAN, see above) and hygrophile (DALLAI & MALATESTA 1982: 190). In Germany it has been collected in a forest and from grassland and fields (see above).

Species descriptions: DALLAI 1970 b: 149 (cuticula, history of distribution), 1970 c: 472 (cuticula, claw).

Remarks: The specimens from Vienna and near Cologne have been re-examined (orig. observ.).



**Genus *Gisinurus* Dallai, 1970**

**Key.** Only 1 species: *Gisinurus malatestai* Dallai, 1970

**Diagnosis of the genus**

A genus of the Sminthurinae. Head and abdomen with normal setae. Large abdomen posteriorly without large cuticular glands. Eye-patches with 8+8 ommatidia. Postantennal setae missing. Antennae as long as body (?). Ant III with only normal setae. Ant IV with 15 subsegments. Trochanter III posteriorly with 1 spine. Tita distally with only pointed setae. Claws with cavity (Fig. 412). Dens anteriorly with 13 setae, inner setae of normal form. Posterior edges of mucro coarsely serrate; seta missing.

Occurrence: W Mediterranean.

Descriptions of the genus: DALLAI 1970: 467, BETSCH 1980: 170, NAYROLLES 1993: 51 (general, mainly chaetotaxy).

Type species: *Gisinurus malatestai* Dallai, 1970.

**Diagnosis of the single species**

*Gisinurus malatestai* Dallai, 1970 (469)

Total length up to 0.85 mm in females, 0.75 mm in males. Colour almost completely violet with few pale areas. Eye-patches rather small. Subsegments of Ant IV elongate. Tita long, slender. Claws broad with cavity opening anteriorly, several inner teeth, tunica, large outer tooth, and only posteriorly with long, serrate pseudonychia (Fig. 412); Emp broad with 2 weak teeth, filaments short or missing, length < claws. VT with 2+2, Ret with 2 setae. Formula of anterior setae of dens 3,2,2,2,2,1,1. App. an. long, setalike. Other characteristics as mentioned for genus.

Proportions: Length of antennae : head diagonal = 2.3 in females, 2.4 in males. Ant I : II : III : IV = 1 : 1.7 : 3.1 (4) : 8.5 (11.3) in females (and males). Dens : mucro = 3.

Type locality: Italy, Tuscany, Apuane Alps, Mt. Forato, soil.

Occurrence: Also found in Italy at other sites in the Apuane Alps (DALLAI 1970: 469) and in the isle of Montecristo (DALLAI 1976: 512), in France (Corsica and caves in S France, POINSOT-BALAGUER 1978: 186, BETSCH 1980: 170 respectively), Spain (Catalonia, NAYROLLES, see below; the Canary Islands, GAMA 1988: 85), and Greece (cave in Crete, BETSCH 1980: 170).

Biology: *G. malatestai* lives in forests in the soil, litter, moss, and in other low vegetation.

Species descriptions: DALLAI 1970: 474 (cuticula), NAYROLLES 1993: 51 (general, mainly chaetotaxy of males).

Remarks: Some specimens have been collected which have still longer antennae and slightly thickened setae of head apex; they may belong to another, new species (France, Pyrénées-Orientales, Mt. Canigou at 800 m altitude, orig. observ., leg. MERTENS).

**Genus *Lipothrix* Börner, 1906**Syn.: *Sphyrotheca* Stach, 1956 ad partem*Delatheca* Salmon, 1964 ad partem**Key to the Palaearctic species**

- 1 Large abdomen with slender, rough spines (length  $\geq$  mucro) (Figs. 414, 417) 2  
 – Large abdomen with short, stout spines, length < claws (Fig. 415)  
*italica* (Cassagnau, 1968)
- 2 Head apex with anteriorly protruding vesicles; large abdomen anteriorly with long median and short lateral spines, spines of 3rd row also often shorter than those of 1st and 2nd row *bernardi* (DELAMARE DEBOUTTEVILLE, 1954)  
 – Vesicles of head apex not protruding anteriorly; large abdomen anteriorly with spines of rather uniform length (Fig. 417) *lubbocki* (Tullberg, 1872)

**Diagnosis of the genus**

A genus of the Sphyrothecinae. Head apex with vesicles. Head apex and large abdomen with short, stout spines. Th II with 1 pair of vesicles (Fig. 417). In adults, Bothr A and B short, C long, D missing. Ant IV with 5 - 7 subsegments. Trochanter III posteriorly with 1 spine. Femur I anteriorly with 1 curved seta; femur III posteriorly with 1 soft, apically curved spine (Fig. 413). Tita distally with only straight setae. Dens anteriorly with 3...1 setae.

Occurrence: W and SW Palaearctic, not confirmed for the Nearctic (CHRISTIANSEN & BELLINGER 1981: 1178 and pers. comm.).

Descriptions of the genus: BÖRNER 1906: 183, BETSCH 1980: 152.

Type species: *Sminthurus lubbocki* Tullberg, 1872.

**Diagnosis of the Palaearctic species**

*Lipothrix bernardi* (Delamare Deboutteville, 1954) (315)

Syn.: *Sphyrotheca bernardi* Delamare Deboutteville, 1954 (315)

*Delatheca bernardi* Salmon, 1964 (609)

*Lipothrix lubbocki* Cassagnau, 1968 (250) ad partem, n. syn.

*Lipothrix lubbocki* Bretfeld, 1975 (302) ad partem, n. syn.

*Lipothrix lubbocki* Dallai & Martinuzzi, 1980 (41) n. syn.

Total length up to 1 mm in females, 0.7 mm in males. Background colour of head and body yellow to pale brown; dark brown to violet pigment only laterally on large abdomen, in males darker than in females. Head apex with 1 pair of large, anteriorly protruding vesicles and with short, stout, rather smooth, and blunt spines of different length, pair 3 of dorsal head-back longer than pairs 1 + 2 (see Fig. 17). Large abdomen with stout, cylindrical, rough spines, apically cut and broadened (Fig. 414), and shorter, blunt, spinelike and few very short, blunt setae (see Fig. 417); anterior spines of row 1 - 3 of different length: median setae of row 1 and 2 about as long as mucro, longer than lateral spines and longer than the single pair of row 3, ratio of spines of 2nd : 3rd row up to 2 in females, up to 4 in males. Eye-patches with 8+8 ommatidia, C and D smaller than the others. Claws with weak pseudonychia. Other characteristics as in *L. lubbocki*.

Proportions: Length of antennae : head diagonal = 1.4 in females, 1.5 in males. Ant I : II : III : IV = 1 : 1.5 : 2 : 2.8 (3.2) in females (and males). Dens : mucro = 2.3 in females, 2.5 in males. App. an. : mucro = 0.9.

Type locality: Algeria, sandy beach of Miramar near Stora.

Occurrence: Also collected in Spain (Sierra Bermeja), Italy (Tuscany), and S Austria (S Styria) (CASSAGNAU, DALLAI & MARTINOZZI, BRETTFELD respectively, see above).

Biology: Except in the type locality, *L. bernardi* has been found in moss and litter under various trees. It is thermophile.

Species descriptions: BETSCH 1980: 152 (eye-patches each with 4 or 5 ommatidia, the originally described ciliate setae of the head are artifacts), DALLAI & MARTINOZZI 1980: 40 (setae and spines of large abdomen).

Remarks: The description above is based on original observations of the specimens from Italy and Austria. The specimens from Italy have already been recognized as *L. bernardi* by the pale colour and the anteriorly protruding vesicles of the head apex; the latter character was well figured in the original description. The head vesicles and the short spines of the 3rd row of the large abdomen are already observable with low magnification. A reduction of the number of ommatidia (original description and BETSCH, see above) has not been confirmed. The type was not available.

*Lipothrix italica* (Cassagnau, 1968) (249)

Syn: *Sphyrotheca italica* Cassagnau, 1968 (249)

nec *Lipothrix italica* Dallai & Martinozzi, 1980 (40) (= *Lipothrix lubbocki*)

Total length up to 0.8 mm. Colour more or less marbled dark blue. Dorsal spines of head and spines and setae of large abdomen very short, other setae of normal length. Head apex with short, stout, smooth spines. Large abdomen with short, stout, blunt, and apically compressed spines (length < claws), with longer, spinelike setae (length about 2x stout spines), and few small, blunt setae (length < stout spines) (Figs. 415, 416, see 417). Other characteristics as in *L. lubbocki*.

Proportions: Ant I : II : III : IV = 1 : 1.5 : 1.8 : 2.5. Dens : mucro = 2.8. App. an. : mucro = 1.1.

Type locality: Italy, Prealpe Veneti, Racoaro, Mt. Spitz, up to 930 m on limestone.

Occurrence: Also found in Hungary (Börzsöny Mts., at 200 and 350 m altitude, DUNGER 1975: 26, re-exam.).

Biology: *L. italica* is thermophile (CASSAGNAU, see above).

Remarks: Most of the above description and Fig. 416 are original observations from 2 types.

*Lipothrix lubbocki* (Tullberg, 1872) (33) sensu Stach, 1956 (210) and Nayrolles, 1993 (48)

Syn.: *Sminthurus lubbockii* Tullberg, 1872 (33)

*Sminthurus poppei* Reuter, 1885 (214)

*Sminthurus tuberculatus* Lie-Petersen, 1898 (5)

*Sphyrotheca (Lipothrix) lubbocki* Börner, 1906 (183)

*Sphyrotheca lubbocki* Linnaniemi, 1912 (310)

*Lipothrix italica* Dallai & Martinuzzi, 1980 (40) n. syn.

nec *Lipothrix lubbocki* Cassagnau, 1968 (250) ad partem (= *Lipothrix bernardi*)

*Lipothrix lubbocki* Bretfeld, 1975 (302) ad partem (= *Lipothrix bernardi*)

*Lipothrix lubbocki* Dallai & Martinuzzi, 1980 (41) (= *Lipothrix bernardi*)

Total length up to 2 mm. Background colour whitish with more or less blue or black violet pigment; head apex often with dark median stripe. Head apex with short, stout, and rough spines, pair 3 of dorsal head-back shorter than pairs 1 + 2 (see Fig. 17). Large abdomen with stout, cylindrical, rough spines, apically cut and sometimes slightly broadened (length  $\geq$  mucro), also with blunt, spinelike setae, as well as few very short, blunt setae; anterior spines of rows 1 - 3 of rather uniform length (Fig. 417). Small abdomen with normal setae. Eye-patches with 8+8 ommatidia, D smaller than the others. Claws broad with inner tooth, large tunica, and ciliate pseudonychia; Emp short and smooth, filaments thick, length  $>$  claws. VT with 1+1, Ret with 4 setae. Dens with few setae, formula of anterior setae 3...1, proximal anterior seta very short. Inner edge of mucro coarsely serrate, outer smooth; seta missing. App. an. long, setalike, curved, and finely ciliate.

Proportions: Length of antennae : head diagonal = 1.2. Ant I : II : III : IV = 1 : 1.7 : 2.3 : 3. Dens : mucro = 2.7. App. an. : mucro = 1.1.

Type locality: Sweden, coniferous forest near Uppsala.

Occurrence: Europe; also known from Portugal, Madeira and the Azores (GAMA 1959: 38, 1992: 47 respectively), and N Africa (Algeria and Morocco, HANDSCHIN 1925: 172, THIBAUD & MASSOUD 1980: 544 respectively).

Biology: *L. lubbocki* is common but usually occurs in low numbers. It lives in forests from lowlands to subalpine habitats near the soil in moist litter, moss, or on dead wood, in the Mediterranean also in dryer habitats together with *L. bernardi*, and in nests of small mammals (NOSEK & VYSOTSKAYA 1973: 36, HRIVNAK 1981: 363). It was found up to 1850 m altitude (France, the Pyrenees, CASSAGNAU 1961: 211). Adults have only been collected in summer (BOCKEMÜHL 1956: 150), though some specimens were extracted from frozen moss and humus in S France (juveniles? Mt. Noire, CASSAGNAU 1965: 356). It moves slowly like a mite, springs seldom (LINNANIEMI 1912: 311), and is troglophile (MASSOUD & THIBAUD 1973: 155) or troglonexene (SCHULZ 1994: 128).

Species descriptions: DALLAI 1970: 42, 1974: 313 (cuticula), DALLAI & MARTINOZZI 1980: 40 (setae and spines of large abdomen), BETSCH 1980: 152.

**Genus *Neosminthurus* Mills, 1934**

**Key.** Only 1 Palearctic species: *Neosminthurus mirabilis* (Yosii, 1965)

Not mentioned here : *Neosminthurus natalicius* Ellis, 1974 b (131) (= *Paralipothrix natalicia* n. gen., see below).

**Diagnosis of the genus**

A genus of the Sphyrothecinae. Head apex and large abdomen with short, stout spines. Th II with 1 pair of vesicles. In adults Bothr A short, B missing, C long, D missing. Ant IV undivided or with traces of sutures. Trochanter III posteriorly with 1 spine. Femur I anteriorly with 2 curved setae, femur III posteriorly with 1 soft spine. Tita distally with 1 horizontally curved seta (Fig. 419). Dens anteriorly without or with 1...1 setae.

Occurrence: E Palearctic, Nearctic, and Tropics.

Descriptions of the genus: MILLS 1934: 98, BETSCH 1980: 150, CHRISTIANSEN & BELLINGER 1981: 1183.

Type species: *Sminthurus curvisetis* Guthrie, 1903.

**Diagnosis of the single Palearctic species**

*Neosminthurus mirabilis* (Yosii, 1965) (52)

Syn.: *Lipothrix mirabilis* Yosii, 1965 (52)

Only females known. Total length up to 1 mm. Colour completely mottled bluish black, small abdomen pale, extremities dark blue. Head apex with short, spatulate or cylindrical, irregularly serrate spines. Large abdomen with short, fanlike spines (Fig. 418), and normal setae. Small abdomen with normal setae. Eye-patches with 8+8 ommatidia. Claws broad with large tunica and ciliate pseudonychia; claws I and II with inner tooth, III often without; Emp short and smooth, filaments I and II lanceolate, III thin, length > claws (Fig. 419). Ret with 4 setae. Dens with few setae, anterior setae missing. Inner edge of mucro coarsely serrate, outer smooth with indentation; seta missing (see Fig. 421). App. an. long, smooth, tip truncate and minutely ciliate (Fig. 420).

Proportions: Length of antennae : head diagonal = 1.1. Ant I : II : III : IV = 1 : 1.7 : 2.5 : 3. Dens : mucro = 2.7.

Type locality: Not defined, Japan, Kyoto, Daimonji, and Ehime, Ohnogahara.

Occurrence: Known only from Japan.

Species descriptions: YOSII 1976: 238 (labrum), GREENSLADE & GREENSLADE 1983: 650 (sticky cuticula; but this species was not confirmed for Australia, GREENSLADE, pers. comm.).

**Genus *Paralipothrix* n. gen.**

**Key.** Only 1 Palearctic species: *Paralipothrix natalicia* (Ellis, 1974 b)

**Diagnosis of the genus**

A genus of the Sphyrothecinae. Head apex and large abdomen with short, stout spines. Th II with 1 pair of vesicles. In adults Bothr A and C present, B and D missing. Ant IV with 4 - 6 subsegments. Trochanter III posteriorly with 1 spine. Femur I anteriorly with 1 curved seta, femur III posteriorly with 1 apically curved spine. Tita distally with only straight setae. Dens anteriorly with 3...1 setae.

Occurrence: Mediterranean.

Type species: *Neosminthurus natalicius* Ellis, 1974 b.

Derivatio nominis: This new genus is named after its resemblance to *Lipothrix*; the gender is feminine.

Remarks: *Paralipothrix* differs from *Lipothrix* by the missing Bothr B. It differs from *Neosminthurus*, as already stated by ELLIS (see above), in that femur I has only 1 curved anterior seta and the Tita have straight distal setae instead of 1 curved seta each.

### Diagnosis of the single Palaearctic species

*Paralipothrix natalicia* (Ellis, 1974 b) (131)

Syn.: *Neosminthurus natalicius* Ellis, 1974 b (131)

Total length up to 1.2 mm in females, 0.7 mm in males. Main colour blackish blue, body dorsally with more or less paler spots, ventrally dark or pale; head apex pale with dark median stripe, extremities completely blue or with pale spots. Head apex with short, truncate, almost smooth spines. Large abdomen with short, truncate, rough spines, often apically broadened, also with shorter, slender, blunt spinelike setae, as well as few very small, blunt setae. Small abdomen with normal setae. Eye-patches with 8+8 ommatidia, D smaller than the others. Claws broad with inner tooth, large tunica, and serrate pseudonychia; Emp short and smooth, filaments thick, length > claws. VT with 1+1, Ret with 4 setae. Dens with few setae, formula of anterior setae 3...1. Inner edge of mucro coarsely serrate, outer smooth; seta missing. App. an. long, curved like a thick seta, and apically ciliate.

Proportions: Length of antennae : head diagonal = 1.4 in both sexes. Ant I : II : III : IV = 1 : 1.5 : 2.1 : 2.6 (2.9) in females (and males). Dens : mucro = 2.4. App. an. : mucro = 1.1.

Type locality: Spain, Balearic Islands, Ibiza, near Santa Eulalia under *Pinus halepensis* on *Erica* and *Rosmarinus*.

Occurrence: Also collected in S France (Var), N Spain (Navarra), and NW Africa (Algeria, Wilaya Blida; Morocco, between Bab Azhar and Bab Boudir) (orig. observ., leg. v. TSCHIRNHAUS, ARBEA, and MERTENS respectively), and in Greece (Rhodes and Crete, ELLIS 1974 c: 138, 1976: 321 respectively).

Biology: *P. natalicia* lives in the low vegetation and on the soil, it occurs in Morocco (see above) up to 1500 m altitude.

### Genus *Sminthurus* Latreille, 1802 sensu Betsch & Betsch-Pinot, 1984

Syn.: *Rhopalothrix* Schött, 1927 (34)

#### Key to the Palaearctic species

1	Posterior edges of mucro smooth or wavy	2
–	One or both posterior edges of mucro serrate	16
2	Mucronal seta present	3
–	Mucronal seta missing	11

- 3 Dorsal side of head and abdomen with dark band (Fig. 427) *maculatus* Tömösvary, 1883  
 = Only Abd VI with 3 dark spots *bozoulensis* Nayrolles, 1995  
 – Colour with other or without dark pattern 4
- 4 Body with blue or violet spots *coeruleus* Strebelt, 1938  
 – Body with other colours 5
- 5 Abd V with 1+1 setae above Bothr D (see Fig. 426b) 6  
 – Abd V with 2+2 setae above Bothr D (Fig. 426b) 9
- 6 Subcoxa III with 1 short, distal seta (see Fig. 426a) 7  
 – Subcoxa III with 2 (short and long) distal setae (Fig. 426a) 8
- 7 Femora II and III with proximal seta (p4 in Fig. 22), Tita III row p:7 setae, VT with 1+1 setae *viridis* Linnaeus, 1758  
 – Femora II and III without proximal seta (p4 in Fig. 22), Tita III row p:8 setae, VT with 2+2 setae *bourgeoisii* Nayrolles, 1995
- 8 VT with 1+1 setae, App. an. short ( $\leq 1/2$  mucro), claws without or with small tunica *multipunctatus* Schäffer, 1896  
 – VT with 2+2 setae, App. an. long ( $> 1/2$  mucro), claws with large tunica *nigromaculatus* Tullberg, 1871
- 9 (5) Inner setae of Tita III long, thick, and acuminate 10  
 – Inner setae of Tita III long, thick, but abruptly pointed *pardalinus* Betsch, 1977
- 10 VT with 1+1 setae, Abd V with 2+2 long setae above Bothr D ( $A1 \geq A2$ , see Fig. 31) *hispanicus* Nayrolles, 1995  
 – VT with 2+2 setae, Abd V with 1+1 short, 1+1 long setae above Bothr D ( $A1 < A2$ , see Fig. 31) *leucomelanus* Nayrolles, 1995
- 11 (2) Pseudonychia of claws shorter than  $1/2$  claw 12  
 – Pseudonychia of claws longer than  $1/2$  claw 15
- 12 Both posterior edges of mucro smooth 13  
 – Both posterior edges of mucro wavy (Fig. 433), App. an. apically ciliate *musciolus* Betsch, 1977
- 13 App. an. setalike, Ant IV with about 21 subsegments *wahlgreni* Stach, 1920  
 – App. an. rather short and smooth, Ant IV with about 17 subsegments 14
- 14 Claws slender, claw III with weak inner tooth *stachi* Betsch, 1977  
 – Claws broad, claw III with distinct inner tooth *wutaii* Uchida, 1948
- 15 (11) Claws with tunica, App. an. long ( $> 1/2$  mucro) *bourgeoisii* Nayrolles, 1995  
 – Claws without tunica, App. an. short ( $\leq 1/2$  mucro) *multipunctatus* Schäffer, 1896
- 16 (1) Both posterior edges of mucro serrate, all posterior setae of dens pointed 17  
 – Inner edge of mucro serrate, outer smooth; dens with 2 knobbed posterior setae *melanonotus* Uchida, 1938

- |    |   |  |
|----|---|--|
| 17 | Mucronal seta as long as mucro                          | 18                                       |
| -  | Mucronal seta distinctly shorter than mucro             | 19                                       |
| 18 | App. an. setalike, long, and smooth                     | <i>abei</i> Yoshii, 1992                 |
| -  | App. an. short, stout, and smooth                       | <i>serrulatus</i> Börner, 1909           |
| 19 | Claws with tunica                                       | <i>ghilarovi</i> Stebaeva, 1966          |
| -  | Claws without tunica                                    | 20                                       |
| 20 | App. an. smooth, mucro with many small teeth            | <i>serratomucronatus</i> Grinbergs, 1962 |
| -  | App. an. distally serrate, mucro with few, coarse teeth | <i>cogsonzavi</i> Betsch, 1977           |

Remarks: The two species sometimes lacking the mucronal seta, *S. bourgeoisi* and *S. multipunctatus*, appear in the key twice. The variability of the chaetotaxic characteristics and of the tunica may not allow the identification of single specimens with certainty. Geographical differences within the species are unknown except for an observation of the App. an. in *S. viridis*, see below.

Not included in this key are:

- *Sminthurus collensis* Selga, 1966 (nom. nud.)
- *Sminthurus erinaceus* Börner, 1903 (= *Caprainea marginata*, see above)
- *Sminthurus maglicianus* Cvijovic, 1985 (incompletely described)
- *Sminthurus marmorellus* Latzel, 1918 (incompletely described)
- *Sminthurus punctatus* Lucas, 1846 in Denis, 1933 (= *Allacma gallica*, see above)
- *Sminthurus sexpunctatus* Bekker, 1905 (may belong to *Heterosminthurus*)
- *Sminthurus variegatus* Tullberg, 1876 (Ant II almost as long as Ant III, Ant IV with about 30 subsegments, see LAWRENCE 1966: 518)
- *Sminthurus variegatus* Axelson, 1903 (Tita with 3 spatulate setae, see BETSCH & BETSCH-PINOT 1984: 79).

### Diagnosis of the genus

A genus of the Sminthurinae. Head apex and large abdomen generally with long and rough setae. Large abdomen posteriorly without large cuticular glands. Eye-patches with 8+8 ommatidia, D smallest. Postantennal setae generally present, short, pointed, and ciliate (Fig. 434). Antennae shorter than body. Basal 1/2 of Ant III with 3 - 5 long, thick setae (see Fig. 400). Ant IV with 14 to about 20 subsegments. Trochanter III posteriorly with 1 normal seta. Tita distally with only pointed setae. Claws without cavity. Dens anteriorly usually with 15 setae, inner setae of normal form. Posterior edges of mucro smooth, wavy, or serrate; seta present or missing. Circumanal setae in females of normal setal form; App. an. generally long, setalike. Males with cuticular papillae around genital opening.

Occurrence: Holarctic; in the Southern Hemisphere introduced in regions with temperate climates.

Descriptions of the genus: LATREILLE 1802: 72, STACH 1956: 224, BETSCH 1980: 167, CHRISTIANSEN & BELLINGER 1981: 1189 (inclusive *Allacma*), BETSCH & BETSCH-PINOT 1984: 71, NAYROLLES 1995: 215.

Type species: *Podura viridis* Linnaeus, 1758, Börner, 1906.



Remarks: Many of the species formerly placed into the genus *Sminthurus* have been placed within other genera or were incompletely described, the names of these are not repeated here (see STACH 1956: 237, SALMON 1964: 590). As partially shown by NAYROLLES (1995: 215), a re-examination of the chaetotaxy is needed.

### Diagnosis of the Palaearctic species

*Sminthurus abei* Yoshii, 1992 (107)

Total length up to 1.5 mm. Background colour brownish mottled with black pigment, large abdomen only brown, Abd V with 1 pair of pale spots. Head apex with 2 pairs of slightly thicker setae. Large abdomen with long, smooth setae. Postantennal seta short. Ant IV with 18 subsegments. Claws with tunica, weak inner tooth, and medium long, serrate pseudonychia; Emp with small tooth, all filaments short, length < claws. VT with 2+2. Ret with 4 setae. Formula of anterior setae of dens 3,2,2,2,2,1,1. Both edges of mucro serrate; seta present (length = mucro). App. an. long, thick, curved, acuminate, and smooth.

Proportions: Length of antennae : head diagonal = 1.8. Ant I : II : III : IV = 1 : 2.5 : 5 : 12.5. Dens : mucro = 5.

Type locality: Japan, Wakayama, Kushimoto, Ohshima.

Occurrence: Known only from the type locality.

Biology: Juveniles were abundant in winter.

*Sminthurus bourgeoisi* Nayrolles, 1995 (221)

Total length up to 2.5 mm in females, 1.4 mm in males. Colour pale to dark brown without purple tints, pigment forming spots or larger patches up to complete darkness, dark specimens with 2 median black spots on Abd VI. Head apex and large abdomen with long setae. Postantennal seta rather long. Ant II with 4 short ventral setae. Ant III proximally with 5 long, rough setae. Ant IV with 15 - 17 subsegments, basal whorl with 3 setae (Fig. 422). Anterior side of femora II and III without proximal seta (p4 in Fig. 22). Subcoxa III with 1 distal seta (see Fig. 426a). Tita III with row p:8 setae. Claws with tunica, inner tooth, and long, serrate pseudonychia; Emp I without, Emp II and III with tooth, all filaments long. VT with 2+2, Ret with 4 setae. Formula of anterior setae of dens 3,3,3,2,2,1,1. Both edges of mucro smooth; seta present or missing. Abd V with 1+1 setae above Bothr D (see Fig. 426b). App. an. long, curved, pointed, and smooth.

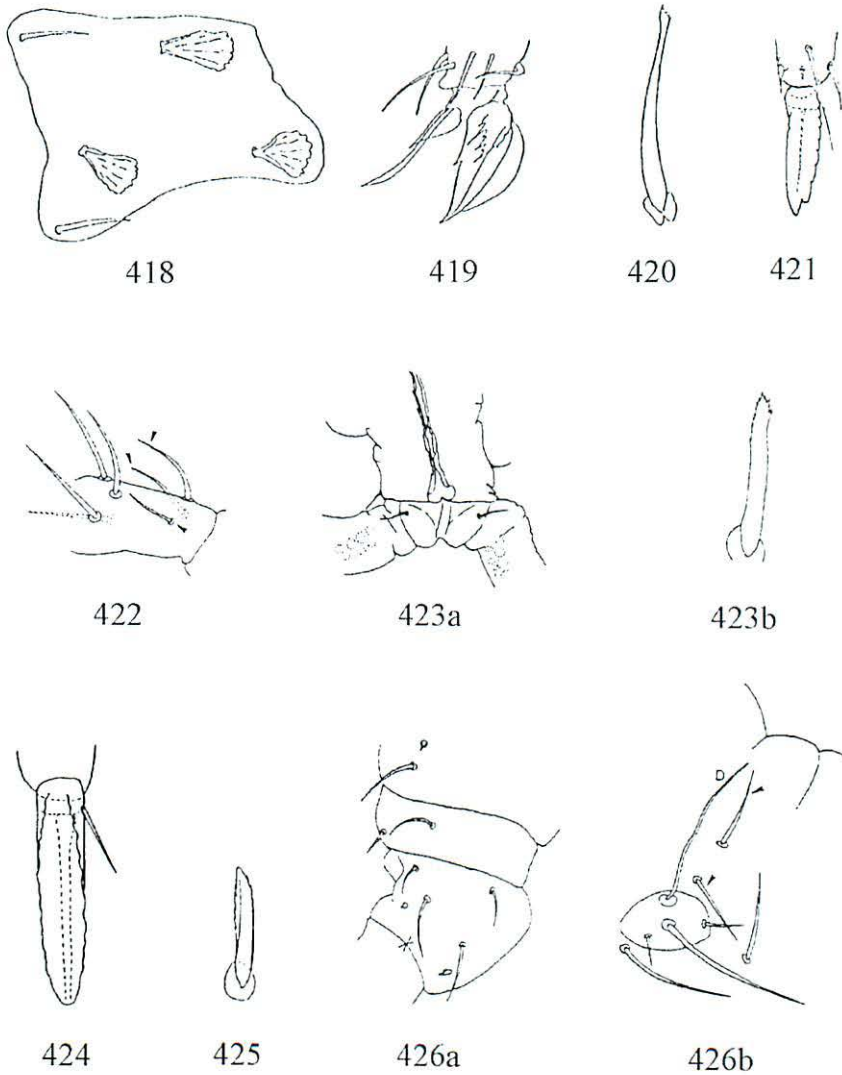
Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 2 : 3.5 : 8. App. an. : mucro = 0.6.

Type locality: France, Hérault, Olargues, in the vegetation of a garrigue at 220 m altitude.

Occurrence: Known only from the type locality.

*Sminthurus bozoulensis* Nayrolles, 1995 (222)

Total length up to 1.9 mm in females, 1.3 mm in males. Background colour uniformly greenish yellow, only Abd VI dorsally with 3 black spots. Eye-patches small. Head apex and large abdomen with long setae. Postantennal seta of medium length. Ant II with 4 short ventral setae. Ant III proximally with 5 long, rough setae. Ant IV with 15 - 16 subsegments, basal whorl with 4 setae. Anterior side of femora II and III with proximal seta (p4 in Fig. 22). Subcoxa III with 2 distal setae (Fig. 426a).



Figs. 418 - 420 *Neosminthurus mirabilis* (after YOSII 1965):

418 Dorsal spines and normal setae of large abdomen 419 Curved distal seta of Tita, claw, and Emp I  
420 App. an. (after YOSII 1965).

Fig. 421 *Neosminthurus clavatus*, mucro (after BETSCH 1980).

Fig. 422 *Sminthurus bourgeoisi*, three basal setae of Ant IV, marked by arrowheads (after NAYROLLES 1995).

Fig. 423 *Sminthurus bozoulensis* (after NAYROLLES 1995): 423a VT with 2+2 setae 423b App. an.

Figs. 424 - 425 *Sminthurus cogsonzavi* (after BETSCH 1977): 424 Mucro 425 App. an.

Fig. 426 *Sminthurus hispanicus* (after NAYROLLES 1995):

426a Leg III, subcoxa with 2 distal setae and coxa 426b 2 setae above Bothr D, marked by arrowheads.

Tita III with row p:7 or 8 setae. Claws with tunica, inner tooth, and serrate pseudonychia; Emp I without, Emp II and III with tooth, all filaments long. VT with 2+2 (Fig. 423a), Ret with 4 setae. Formula of anterior setae of dens 3,3,3,2,2,1,1. Both edges of mucro smooth; seta present. Abd V with 1+1 setae above Bothr D (see Fig. 426b). App. an. of medium length, stout, obliquely cut, and distally serrate (Fig. 423b).

Proportions: Length of antennae : head diagonal = 1.9. Ant I : II : III : IV = 1 : 2 : 3 : 7.7. App. an. : mucro = 0.5.

Type locality: France, Aveyron, Montrozier, Causse Comtal, in the vegetation on limestone at 620 m altitude.

Occurrence: Also collected at a site near the type locality (NAYROLLES, see above).

*Sminthurus coeruleus* Strebel, 1938 (260)

Only 1 female known. Total length 1.5 mm. Background colour yellowish brown with blue or violet spots. Ant III proximally with long setae. Ant IV with about 21 subsegments. Claws without tunica, with inner tooth and few lateral teeth; Emp I without tooth, Emp II and III with tooth, all filaments long and spatulate, length > claws. Both edges of mucro wavy; seta present (length = 1/3 mucro). App. an. short, stout, and pointed.

Proportions: Length of antennae : head diagonal about 1.5. Ant I : II : III : IV = 1 : 1.7 : 2.7 : 6.7. Dens : mucro : 3.

Type locality: Greece, the S Peloponnes, environs of Leonidion, site with *Thymus vulgaris* and *Pistacia lentiscus*.

Occurrence: Known only from the type locality.

*Sminthurus cogsonzavi* Betsch, 1977 (72)

Total length up to 2.6 mm in females, 1.7 mm in males. Background colour yellow with violet pigment in 1 pair of large spots laterally on large abdomen and in few small spots on head and thorax. Head apex with blunt, large abdomen with long and finely serrate setae (length on abdomen = mucro). Postantennal seta slender. Ant II with 4 short ventral setae. Ant III proximally with 4 long setae. Ant IV with 19 subsegments. Claws without tunica, with inner and weak, basal outer tooth, and short, smooth pseudonychia; Emp with small or weak tooth, all filaments short, length < claws. Formula of anterior setae of dens 3,3,3,2,2,1,1. Both edges of mucro roughly serrate; seta present (length = 2/5 mucro) (Fig. 424). App. an. short, stout, pointed, and distally serrate (Fig. 425).

Proportions: Length of antennae : head diagonal = 1.8 in females, 2.2 in males. Ant I : II : III : IV = 1 : 2 : 3 (3.3) : 6.5 (8) in females (and males). Dens : mucro : 2.7. App. an. : mucro = 0.4.

Type locality: Mongolia, Central Distr., steep and stony river bank at 1340 m altitude.

Occurrence: Also known from other localities in Mongolia (Central and Chentej Distrs., BETSCH, see above).

Biology: *S. cogsonzavi* lives on the soil of steppe and forests up to 1650 m altitude, and has also been collected from a nest of *Microtus brandti* (BETSCH, see above).

*Sminthurus ghilarovi* Stebaeva, 1966 (9)

Total length up to 1.4 mm. Background colour pink, violet pigment in 1+1 longitudinal bands on large abdomen and a median band on small abdomen. Head apex and large abdomen with long and rough setae (length on abdomen = mucro). Postantennal seta short. Ant III proximally with 5 long setae. Ant IV with 17 subsegments. Claws with tunica and inner tooth; Emp with tooth and filaments, length of Emp III < claws. Ret with 2 setae. Formula of anterior setae of dens 3,2,2,2,2,1,1. Both edges of mucro serrate; seta present. App. an. short, stout, curved, and smooth.

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 2.4 : 3.4 : 7.6. Dens : mucro = 3.6. App. an. : mucro = 0.5.

Type locality: S Russia, Kemerovsky Reg., West Sayan Mts. near Prokopyevsk, in taiga with *Abies* and *Populus*.

Occurrence: Also found in S Russia, Tuva Reg. (S slope of Tannu-Ola Mts., STEBAEVA 1976: 126).

Biology: *S. ghilarovi* was always collected in mixed forests of *Abies*, *Larix*, and *Populus* (STEBAEVA, see above).

*Sminthurus hispanicus* Nayrolles, 1995 (231)

Total length up to 2.3 mm in females, 1.6 mm in males. Background colour rusty ochre, large abdomen ventrally dark green or black, dorsally with dark or black spots forming mainly 1+1 irregular, longitudinal, dorsolateral bands. Head apex and large abdomen with long setae. Postantennal seta short. Ant II with 4 short ventral setae. Ant III proximally with 5 long, rough setae. Ant IV with 17 - 20 subsegments, basal whorl with 4 setae. Anterior side of femora II and III with proximal seta (p4 in Fig. 22). Subcoxa III with 1 or 2 distal setae (Fig. 426a). Tita III with row p:7 or fewer setae. Claws with tunica varying, with inner tooth and serrate pseudonychia; Emp I without, Emp II and III with tooth, all filaments long. VT with 1+1, Ret with 4 setae. Formula of anterior setae of dens 3,3,3,2,2,1,1. Both edges of mucro smooth; seta present. Abd V with 2+2 long setae above Bothr D (orig. observ.; Fig. 426b; A1 ≥ A2, see Fig. 31). App. an. short, stout, obliquely cut, and distally serrate.

Proportions: Length of antennae : head diagonal = 1.9. Ant I : II : III : IV = 1 : 2 : 3 : 7.7. App. an. : mucro = 0.4.

Type locality: Spain, Huesca, Puerto de Monrepós, short grassy meadow at 1260 m altitude.

Occurrence: Also collected at other sites in Spain (Lérida, Barcelona, Navarra, and Zaragoza, NAYROLLES, see above).

Biology: *S. hispanicus* lives in the vegetation of dry habitats, also on limestone, up to 1450 m altitude (NAYROLLES, see above).

*Sminthurus leucomelanus* Nayrolles, 1995 (226)

Total length up to 2.3 mm in females, 1.8 mm in males. Background colour almost white, dark brown spots mainly forming irregular, oblique bands on posterior of large abdomen; Abd VI with 2 median, black spots; ventrolateral sides of large abdomen also black. Head apex and large abdomen with long setae. Postantennal seta rather long. Ant II with 4 short ventral setae. Ant III proximally with 5 long, rough setae.

Ant IV with 16 - 19 subsegments, basal whorl with 4 setae. Anterior side of femora II and III with proximal seta (p4 in Fig. 22). Subcoxa III with 1 distal seta (see Fig. 426a). Tita III with row p:7 setae. Claws with tunica, inner tooth, and long, serrate pseudonychia; Emp I without, Emp II and III with tooth, all filaments long, length = claws. VT with 2+2, Ret with 4 setae. Formula of anterior setae of dens 3,3,3,2,2,1,1. Both edges of mucro smooth; seta present. Abd V with 1+1 short, 1+1 long setae above Bothr D (orig. observ.; see Fig. 426b; A1 < A2, see Fig. 31). App. an. of medium length and curved.

Proportions: Length of antennae : head diagonal = 1.9. Ant I : II : III : IV = 1 : 2 : 3.3 : 7.4 (8) in females (and males). App. an. : mucro = 0.5.

Type locality: S France, Pyrénées-Orientales, Laroque-des-Albères, Pic de Neulos, moor with *Calluna* at 1250 m altitude.

Occurrence: Also collected at another site in S France (Pyrénées-Orientales, Sorède), and in Spain (Gerona) (NAYROLLES, see above).

Biology: *S. leucomelanus* lives in the low vegetation of moors, under trees, and in the garigue (NAYROLLES, see above).

*Sminthurus maculatus* Tömösvary, 1883 (36) sensu Stach, 1956 (273)

Total length up to 2.8 mm. Background colour light yellow, head and body dorsally with dark brown band, broad on head and narrowing posteriorly, large abdomen laterally orange yellow (Fig. 427) or more or less marbled violet (orig. observ.). Head apex and large abdomen with long, rough setae (length on abdomen = 2x mucro). Postantennal seta rather long. Ant II with 4 short ventral setae. Ant III proximally with 5 long, rough setae. Ant IV with 15 subsegments, basal whorl with 4 setae. Anterior side of femora II and III with proximal seta (p4 in Fig. 22). Subcoxa III with 2 distal setae (Fig. 426a). Tita III with row p:8 setae. Claws narrow with tunica, inner and basal outer tooth, and long, serrate pseudonychia; Emp I without, Emp II and III with tooth, all filaments long, length > claws. VT with 1+1 or 2+2, Ret with 4 setae. Formula of anterior setae of dens 3,3,3,2,2,1,1. Both edges of mucro smooth; seta present (length = 2/5 of mucro). Abd V with 1+1 setae above Bothr D (orig. observ., see Fig. 426b). App. an. rather long, weakly curved, tapering, smooth, or apically ciliate (Fig. 428).

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 2.4 : 3.5 : 8. Dens : mucro = 2.3 - 3. App. an. : mucro = 0.6.

Type locality: Central Hungary, collected from a marshy meadow.

Occurrence: Central and S Europe; from central Germany (GISIN 1961: 352, HÜTHER 1964: 297), S Poland (WEINER 1981: 469), and Ukrainia (STACH, see above) S to former Yugoslavia (e. g. CVIJOVIC & ZIVADINOVIC 1973: 72) and the Iberian Peninsula and Morocco (WALLACE 1973: 219).

Biology: *S. maculatus* lives, except in the type locality, in the low vegetation of sandy, xerothermic habitats (SCHALLER 1951: 463, HORNUNG 1986: 137, and other authors, see above).

Species descriptions: PISTOR 1955: 513 (abdominal musculature), SZEPTYCKI 1967: 242 (colour shifting of several specimens to that of *S. viridis* and *S. nigromaculatus*), DAL-LAI 1972: 219 (structure of cuticula as in *S. viridis*), NAYROLLES 1995: 235 (key based on colour).

Remarks: The main chaetotaxy of this species is identical with that of *S. nigromaculatus* (orig. observ.), thus only the colour seems to differ.

*Sminthurus melanonotus* Uchida, 1938 (133) sensu Yosii, 1956 (96)

Total length up to 2 mm in females, 1.3 mm in males. Colour deep black, mouth and ventral side pale brown. Setae of head apex and large abdomen long, straight, tip cut with 3 - 6 teeth (Fig. 429). Postantennal seta missing. Ant III proximally with 4 long setae. Ant IV with 14 - 17 subsegments. Claws broad without tunica, with inner tooth and long pseudonychia; Emp narrow, without tooth, all filaments long, length > claws. Ret with 3 setae. Dens with 2 long, knobbed posterior setae, formula of anterior setae 3,2,2,2,2,1,1. Inner edge of mucro irregularly serrate, outer smooth; seta missing. Circumanal setae a0 and a1 - 4 in females ciliate; App. an. short, stout, and abruptly curved (Fig. 430).

Proportions: Length of antennae : head diagonal = 1.6 - 2. Ant I : II : III : IV = 1 : 2 : 2 : 4. Dens : mucro = 2.7.

Type locality: Japan, Fukuoka, Hikosan, in decaying stems.

Occurrence: Also found at other sites in Japan (Kumamoto and Nara, YOSII, see above).

Biology: *S. melanonotus* is troglone (YOSII, see above).

Remarks: This species may not be correctly placed within the genus *Sminthurus*.

*Sminthurus multipunctatus* Schäffer, 1896 (210) sensu Stach, 1956 (262) and Nayrolles, 1995 (229)

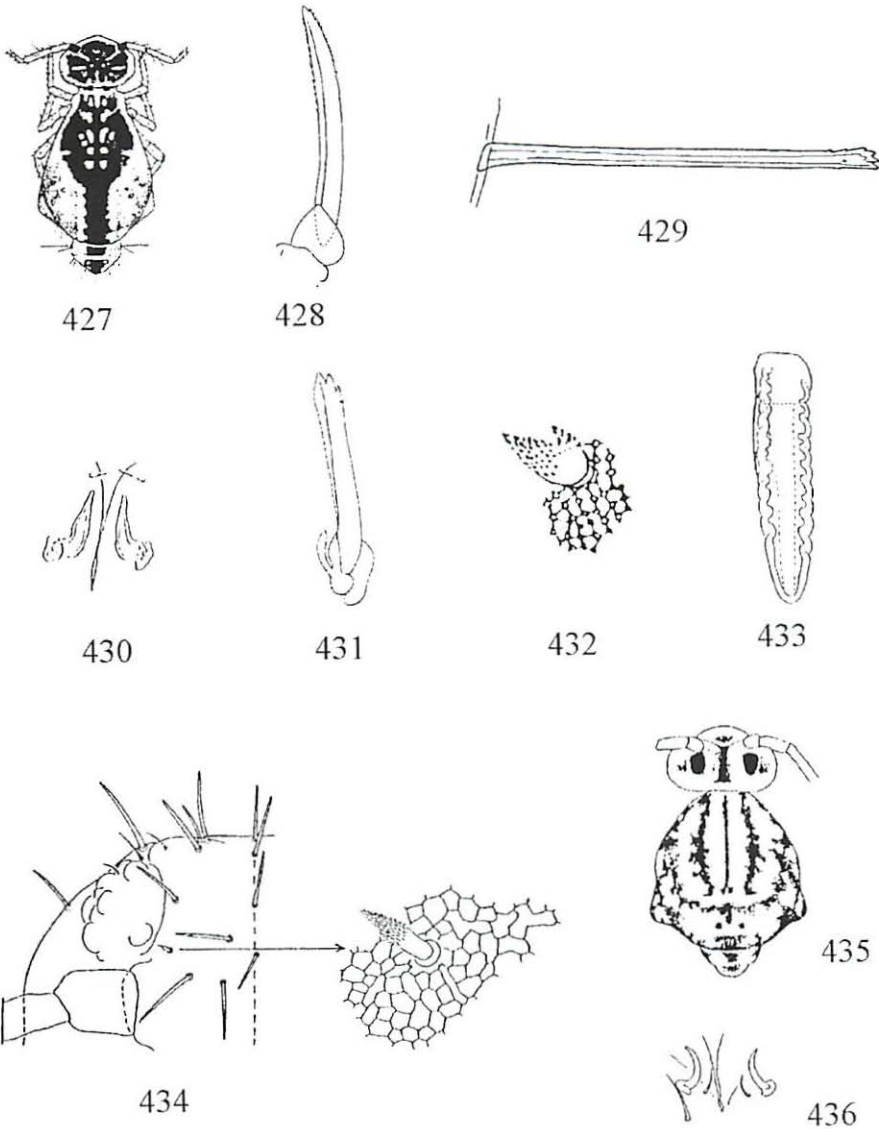
Syn.: *Sminthurus viridis* var. *multipunctata* Schäffer, 1896 (210)

Total length up to 2.5 mm in females, 1.5 mm in males. Background colour rusty, black pigment mainly in 1+1 patches behind eyes, irregular cross stripes anteriorly on large abdomen, 2 or 3 longitudinal stripes posteriorly, and 2 median spots on Abd VI. Head apex and large abdomen with long, rough setae (length on abdomen  $\geq$  mucro). Postantennal seta of medium length. Ant II with 4 short ventral setae. Ant III proximally with 5 long, rough setae. Ant IV with 16 - 18 subsegments, basal whorl with 4 setae. Anterior side of femora II and III with proximal seta (p4 in Fig. 22). Subcoxa III with 2 distal setae (Fig. 426a). Tita III with row p:8 setae. Claws without or with small tunica, with inner and outer tooth, and long, weakly serrate pseudonychia; Emp I without, Emp II and III with tooth, all filaments long, length = claws. VT with 1+1, Ret with 4 setae. Formula of anterior setae of dens 3,3,3,2,2,1,1. Both edges of mucro smooth; seta present or missing. Abd V with 1+1 setae above Bothr D (see Fig. 426b). App. an. short, curved, bandlike, and apically serrate (Fig. 431).

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 2.1 : 3.1 : 7.4 (8) in females (and males). Dens : mucro = 2.1 - 2.7. App. an. : mucro = 0.4.

Type locality: Germany, Berlin, Charlottenburg.

Occurrence: Palaearctic; from Belgium (MARLIER 1942: 11), central Germany (SCHÄFFER, see above, DALLAI 1972: 218, SCHULZ & DUNGER 1995: 48), S Poland (STACH 1956: 264), S Russia (Siberia, STEBAEVA 1976: 126), and the Caucasus (STACH 1956: 265) S to the Iberian Peninsula (JORDANA et al. 1990: 185, NAYROLLES, see above), Morocco (THIBAUD & MASSOUD 1980: 543), and Greece (Rhodes, orig. observ., leg. v. TSCHIRNHAUS); not yet reported from Italy.



Figs. 427 - 428 *Sminthurus maculatus* (after STACH 1956): 427 Colour pattern, 428 App. an.  
 Figs. 429 - 430 *Sminthurus melanonotus* (after YOSII 1956):  
 429 Long dorsal seta of large abdomen 430 App. an.  
 Fig. 431 *Sminthurus multipunctatus*, App. an. (after STACH 1956).  
 Figs. 432 - 433 *Sminthurus muscicolus* (after BETSCH 1977): 432 Postantennal seta 433 Mucro.  
 Fig. 434 *Sminthurus pardalinus*, head apex with postantennal seta; seta enlarged (after BETSCH 1977).  
 Figs. 435 - 436 *Sminthurus serrulatus* (after YOSII 1970): 435: Colour pattern 436: App. an.

Biology: *S. multipunctatus* is xerothermophile (SCHULZ, see above, KAMPICHLER 1992: 371). It lives in the low vegetation of dry habitats and has been collected in the Caucasus at 2800 m (STACH, see above) and in Morocco at 2100 m altitude (THIBAUD & MASSOUD, see above). It was also found in a nest of *Microtus arvalis* (NOSEK & VYSOTSKAYA 1973: 36).

Remarks: Some colour varieties have been given separate names:

var. *albopunctata* Stach, 1922 (68) with many white dorsal spots,

var. *viridipunctata* Stach, 1922 (68) with much green pigment,

var. *tristrigata* Stach, 1956 (265) with 3 dark longitudinal bands posteriorly on large abdomen.

All specimens should be redetermined. From Greece (Crete) a subadult female has been collected (ELLIS 1976: 320), the cuticula of which shows large, irregular meshes on posterior of large abdomen and Ant IV has about 25 setal whorls, the basal whorl with 3 setae, thus apparently belonging to another species (orig. observ.).

#### *Sminthurus muscicolus* Betsch, 1977 (66)

Total length up to 2.5 mm in females, 1.5 mm in males. Background colour yellowish with some violet marblings. Head apex and large abdomen with long setae, those on head smooth and on abdomen rough. Postantennal seta broad, sometimes forked (Fig. 432). Ant II with 4 short ventral setae. Ant III proximally with 4 long setae. Ant IV with 16 subsegments. Claws without tunica, with inner and weak, basal outer tooth, and short, serrate pseudonychia; Emp with tooth, all filaments very short and thin, length < claws. Ret with 4 setae. Formula of anterior setae of dens 3,3,2,2,1,1. Both edges of mucro wavy; seta missing (Fig. 433). App. an. long, straight, obliquely cut, and apically ciliate.

Proportions: Length of antennae : head diagonal = 2.2 in both sexes. Ant I : II : III : IV = 1 : 2 : 2.5 (2.8) : 6.3 (8.4) in females (and males). Dens : mucro : 2.8.

Type locality: Mongolia, Central Distr., humid valley at 1600 m altitude, in moss near tree bases.

Occurrence: Known only from the type locality.

Remarks: The cuticula of the head and the anterior of large abdomen is patterned with primary granules.

#### *Sminthurus nigromaculatus* Tullberg, 1871 (145) sensu Nayrolles, 1995 (219)

Syn.: *Sminthurus viridis* var. *nigro-maculata* Tullberg, 1871 (145)

*Sminthurus viridis* Stach, 1956 (266) ad partem

Total length up to 2 mm in females, 1.5 mm in males. Colour greenish to dark purple, pigment forming spots or larger patches up to completely dark purple, Abd VI with 2 median black spots. Head apex and large abdomen with long, rough setae. Postantennal seta rather long. Ant II with 4 short ventral setae. Ant III proximally with 5 long, rough setae. Ant IV with 15 - 17 subsegments, basal whorl with 4 setae. Anterior side of femora II and III with proximal seta (p4 in Fig. 22). Subcoxa III with 2 distal setae (Fig. 426a). Tita III with row p:8 setae. Claws with tunica, inner and weak basal outer tooth, and long, weakly serrate pseudonychia; Emp I without, Emp II and III with tooth, all filaments long, length = claws (see Fig. 438). VT with 2+2, Ret with 4 setae. Formula of anterior setae of dens 3,3,3,2,2,1,1. Both edges of mucro smooth; seta present (length = 2/5 mucro). Abd V with 1+1 setae above Bothr D (see Fig. 426b). App. an. long, curved, pointed, smooth, or apically ciliate.



Proportions: Length of antennae : head diagonal = 1.9 in females, 2.2 in males. Ant I : II : III : IV = 1 : 2.1 : 3.4 : 8 in females, 1 : 2.3 : 3.6 : 8.5 in males. Dens : mucro = 2.5 - 3.3 (STACH 1956: 268). App. an. : mucro = 0.5 - 0.7.

Type locality: Sweden, Gotland.

Occurrence: Holarctic; in the Palaearctic from the Arctic to N Africa; in the Nearctic in USA (Michigan, LORING 1983: 101, SNIDER & CALANDRINO 1987: 12, SNIDER, pers. comm.); also in South Africa (PACLT 1959: 68, WALTERS 1967/68: 18). Not certainly recorded in Australia and New Zealand.

Biology: *S. nigromaculatus* is abundant in the low vegetation of dry grasslands and has been distributed, like *S. viridis* apparently in the egg stage with seeds, from Europe overseas. In habitats with extreme climatic conditions, it has been collected in Switzerland at 2540 m altitude (Caricetum firmae plant association of National Park, LIENHARD et al. 1981: 585), in France in subalpine habitats (the Pyrenees, CASSAGNAU 1964: 453), and in Ukraina up to 1600 m altitude (the E Carpathians, NOSEK & VYSOTSKAYA 1973: 51). On shore of a reservoir, this species survived inundation periods in the egg stage (TAMM 1984: 417).

Species descriptions: GISIN 1957: 494 (gut contains pollen grains instead of leaf tissue in *S. viridis*), LAWRENCE 1966: 516 (total length smaller than in *S. viridis*), ELLIS 1976: 320 (setal differences from *S. viridis* in subcoxa III and VT), FJELLBERG 1984: 87 (maxillary outer lobe).

Remarks: *S. nigromaculatus* was not separated from *S. viridis* or other similar species in many former papers. New and old collections, therefore, must be re-examined by means of chaetotaxy; several observations concerning *S. viridis* may actually be about *S. nigromaculatus*, some observations of *S. nigromaculatus* about other species.

#### *Sminthurus pardalinus* Betsch, 1977 (69)

Total length up to 3 mm in females, 1.7 mm in males. Background colour yellow with many brown spots. Head apex and large abdomen with long, blunt, and rough setae. Postantennal seta elongate (Fig. 434). Ant II with 4 short ventral setae. Ant III proximally with 4 long, thick setae. Ant IV with 16 subsegments. Inner setae of Tita III stout, rough, and abruptly pointed. Claws without tunica, with inner and basal outer tooth, and short pseudonychia with few serrations; Emp with tooth, all filaments short, length < claws. Formula of anterior setae of dens 3,3,3,2,2,1,1. Both edges of mucro smooth; seta present. Abd V with 2+2 setae above Bothr D (A1 short, A2 long, see Fig. 31). App. an. long, straight, obliquely cut, and apical 1/4 serrate.

Proportions: Length of antennae : head diagonal = 1.8 in both sexes. Ant I : II : III : IV = 1 : 2 : 2.6 : 5.5 (6.2) in females (and males). Dens : mucro : 2.7.

Type locality: Mongolia, Central Distr., on soil of a mountain steppe at 1650 m altitude.

Occurrence: Also known from other sites in Mongolia (Central and Archangaj Distrs., BETSCH, see above).

Biology: *S. pardalinus* has been collected in large numbers on the soil and the low vegetation of the mountain steppe and on decaying vegetation on the edge of a clearing (BETSCH, see above).

*Sminthurus serratomucronatus* Grinbergs, 1962 (65)

Only 2 females known. Total length 2 mm. Background colour yellow, head and dorsal of large abdomen with violet tints. Large abdomen with long, rough setae (length = 2x mucro). Postantennal seta short. Ant III proximally with 3 (?) long, rough setae. Ant IV with 21 subsegments. Claws without tunica, with inner tooth, and medium long, serrate pseudonychia; Emp without tooth, filaments short, length < claws. Ret with 4 setae. Both edges of mucro with many small teeth; seta present (length = 1/3 mucro). App. an. short, stout, and smooth.

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 2 : 2.8 : 7.6. Dens : mucro = 2.8. App. an. : mucro = 0.3.

Type locality: S Russia, S Tuva Reg., near Hol-Jezu, on the soil of a deciduous forest.

Occurrence: Known only from the type locality.

*Sminthurus serrulatus* Börner, 1909 (127) sensu Yosii, 1970 (28)

Syn.: *Sminthurus serrulatus* var. *trimaculata* Börner, 1909 (128)

Total length up to 2 mm. Background colour yellowish white, with light and dark brown pigment on head apex and on large abdomen in longitudinal and cross stripes, and in irregular lateral mottlings (Fig. 435). Head apex with normal setae. Large abdomen with long, rough setae. Postantennal seta short. Ant IV with 15 subsegments. Claws with tunica, inner tooth, and long, finely serrate pseudonychia; Emp I without tooth but long (knobbed?) filament, Emp II and III with tooth and short filaments, length ≤ claws. Ret with 4 setae. Formula of anterior setae of dens 3,3,3,2,2,1,1. Both edges of mucro coarsely serrate; seta present (length = mucro). App. an. short and hornlike (Fig. 436).

Proportions: Length of antennae : head diagonal = 1.9. Ant I : II : III : IV = 1 : 2 : 3 : 7.5. Dens : mucro = 3.5.

Type locality: Japan, not defined: Kanagawa, Bukenji, Hiranuma, and Rokkakubashi, in the vegetation and in litter.

Occurrence: Also known from another site in Japan (Kyoto, Hieizan, YOSII, see above).

*Sminthurus stachi* Betsch, 1977 (75)

Total length up to 2.6 mm in females, 1.75 mm in males. Background colour pale, dorsal sides with few violet spots (Fig. 437), ventral sides dark violet. Head apex with blunt setae. Large abdomen with rather short, thin, acuminate, and weakly rough setae. Postantennal seta short. Ant II with 4 short ventral setae. Ant III proximally with 4 rather short, thick setae, only 2 of which blunt. Ant IV with 17 subsegments. Claws slender without tunica, with small inner and basal outer tooth, and short, serrate pseudonychia; Emp with tooth, all filaments short, length < claws. Formula of anterior setae of dens 3,3,3,2,2,1,1. Both edges of mucro smooth, apex truncate; seta missing. App. an. short, stout, abruptly pointed, and smooth.

Proportions: Length of antennae : head diagonal = 2.15 in females, 2.35 in males. Ant I : II : III : IV = 1 : 2 : 3 : 7.2 (8.3) in females (and males).

Type locality: Mongolia, Suchebaator Distr., steppe vegetation at 950 m altitude.

Occurrence: Known only from the type locality.

Remarks: Except for the colour pattern, *S. stachi* resembles *S. wutaii* (see below).

*Sminthurus viridis* Linnaeus, 1758 (608) sensu Nayrolles, 1995 (217)

Syn.: *Podura viridis* Linnaeus, 1758 (608)

Total length up to 3 mm in females, males smaller. Background colour light green to yellow; some populations with dark pigment laterally on large abdomen, 1 pair of dark dorso-lateral stripes, and 2 black spots medianly on Abd VI. Head apex and large abdomen with long, rough, normal setae. Postantennal seta rather long. Ant II with 4 short ventral setae. Ant III proximally with 5 long, rough setae. Ant IV with 16 - 17 subsegments, basal whorl with 3 or 4 setae. Anterior side of femora II and III with proximal seta (p4 in Fig. 22). Subcoxa III with 1 distal seta (see Fig. 426a). Tita III with row p:7 setae. Claws slender with tunica, inner and weak basal outer tooth, and long, weakly serrate pseudonychia; Emp I without, Emp II and III with tooth, all filaments long, length  $\geq$  claws (Fig. 438). VT with 1+1, Ret with 4 setae. Formula of anterior setae of dens 3,3,3,2,2,(1),1. Both edges of mucro smooth; seta present (length = 2/5 of mucro). Abd V with 1+1 setae above Bothr D (see Fig. 426b). App. an. long or of medium length (shorter in specimens from Spain), curved, pointed, smooth, or apically ciliate.

Proportions: Length of antennae : head diagonal = 1.7 in females, 2 in males. Ant I : II : III : IV = 1 : 2 : 3.2 : 7 (8) in females (and males). Dens : mucro = 2.5 - 3.3 (STACH 1956: 268). App. an. : mucro = 0.4 - 0.6.

Type locality: Europe, not specified.

Occurrence: Palaearctic, from the Arctic to N Africa (THIBAUD & MASSOUD 1980: 544) and Manchuria (UCHIDA 1940: 8); also found in South Africa (PACLT 1959: 68), S America (NAJT 1969: 183), S Australia (GREENSLADE 1994: 133), New Zealand (SALMON 1941: 418), and India (BAIJAL & KOHLI 1972: 407).

Biology: *S. viridis* is one of the most abundant Symphypleonan. It lives in the vegetation of moister grasslands and in herbaceous fields (*Trifolium*, *Medicago*), and has been distributed, apparently in the egg stage with seeds, from Europe overseas.

Only some of the biological observations published can be mentioned: General biology and ecology (DAVIES 1927/28: 291, DAVIDSON 1934: 1, WALTERS 1967/68: 1); biology and biological control in Australia (GREENSLADE 1994: 134, IRESOON & WEBB 1995: 237, BISHOP et al. 1998); fungal pathogen (STEENBERG et al. 1996: 97); structure of spermatophore, primitive courtship behaviour, and egg laying (MAYER 1957: 503, BETSCH-PINOT 1976: 427, 1977: 17); jumping (CHRISTIAN 1979: 457) and flight behaviour (HINTZPETER & BAUER 1986: 615); respiration and body weight (ZINKLER 1966: 99); positive phototaxis (SCHALLER 1972: 249). It occurs up to more than 2000 m altitude (Ukraine, the East Carpathians, NOSEK & VYSOTSKAYA 1973: 51) and seldom in caves (trogloxen, DALLAI & MALATESTA 1982: 190).

Species descriptions: STACH 1956: 266 (included *S. nigromaculatus*), PALISSA 1960: 397, and LAWRENCE 1966: 511 (general), DAVIES 1927: 15 (tracheae), CASSAGNAU et al. 1968: 65 (neuroendocrine system), DALLAI 1970: 42, 1977: 117 (cuticula), SEMENOVA 1973: 379 (midgut epithelium), DALLAI & CALLAINI 1979: 45 (ultrastructure of pylorus), NAYROLLES 1989: 236 (ontogeny of chaetotaxy), ZINKLER & WILKING 1989: 467 (colour corresponding with feed).

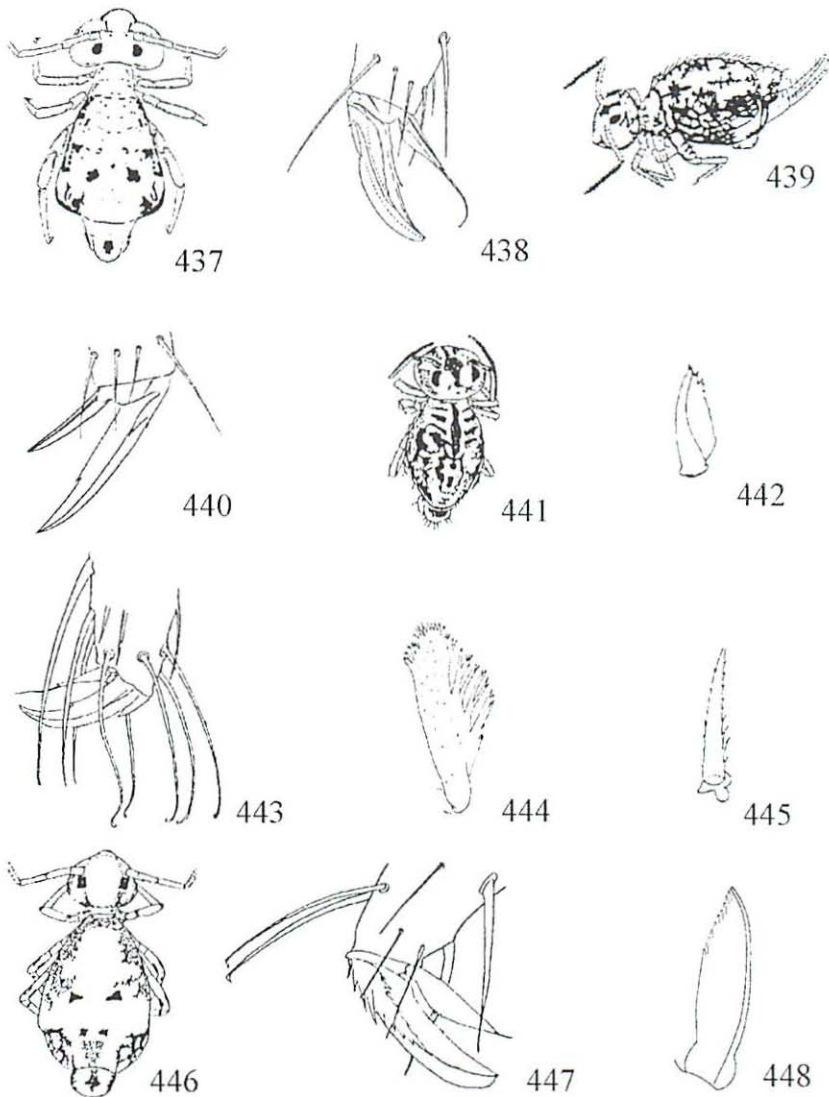


Fig. 437 *Sminthurus stachi*, colour pattern (after BETSCH 1977).

Fig. 438 *Sminthurus viridis*, claw and Emp I (after STACH 1956).

Figs. 439 - 440 *Sminthurus wahlgreni* (after STACH 1956): 439 Habitus 440 Claw and Emp III.

Fig. 441 *Sminthurus wutaii*, habitus (after UCHIDA 1948).

Fig. 442 *Spatulosminthurus betschi*, App. an. (after NAYROLLES 1990).

Fig. 443 *Spatulosminthurus daisetsuzanus*, knobbed setae of Tita (after UCHIDA 1957).

Figs. 444 - 445 *Spatulosminthurus flaviceps*: 444 App. an. of northern populations (after BETSCH & BETSCH-PINOT 1984) 445 App. an. of southern populations (after STACH 1956).

Figs. 446 - 448 *Spatulosminthurus gattoi*: 446 Habitus (after STACH 1967) 447 Clavate setae of Tita (after STACH 1967) 448 App. an. (orig.).

Remarks: Since the colour varies and the specimens from New Zealand and India (see above) have claws with 2 inner teeth, a redetermination of new and old collections of *S. viridis* and related species is necessary. The colour varieties have been given different names, which are not repeated here (see LINNANIEMI 1912: 313, STACH 1956: 268). *S. nigromaculatus* (see above) was also formerly regarded as a variety of *S. viridis*, thus the older papers may concern both or other species. Specimens reported from N America are a separate species, *S. incisus* Snider (CHRISTIANSEN & BELLINGER 1981: 1205) or *S. nigromaculatus* (SNIDER & CALANDRINO 1987: 12). More species may be hidden under the former *S. viridis* s. lat.

*Sminthurus wahlgreni* Stach, 1920 (207) sensu Stach, 1956 (246)

Total length up to 1.5 mm. Background colour pale brown with many irregular black spots (Fig. 439), body ventrally white or blue. Head apex and large abdomen with long, rough, normal setae (length on head < mucro, on abdomen = mucro). Postantennal seta short. Ant III proximally with 5 long, rough setae. Ant IV with 21 subsegments. Claws slender without tunica and pseudonychia, with inner, outer, and short lateral teeth; Emp without tooth and filament, length < claws (Fig. 440). Ret with 2 setae. Formula of anterior setae of dens 3,2,2,2,2,1,1. Both edges of mucro smooth; seta missing. Abd V with 1+1 setae above Bothr D (see Fig. 426b). App. an. setalike and curved.

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 2.2 : 3.2 : 8. Dens : mucro = 3. App. an. : mucro < 0.5.

Type locality: S Poland, Kroszowice near Pieniny Mts., under loose bark of an old apple tree in a garden.

Occurrence: Also known from Poland at other sites in the Pieniny Mts., and from mountains in Slovakia, Hungary, former Yugoslavia, Romania, and S France (DALLAI 1972: 218, WEINER 1981: 470). Uncertainly recorded from Russia (S Urals) and Austria (Vienna Forest) (WEINER, see above).

Biology: *S. wahlgreni* lives in litter and moss, on bushes and trees, in meadows and rocky habitats, even on snow, and, in the Pieniny Mts., it has been mainly collected from autumn to spring (NOSEK 1962: 341, 1963: 112, GRUIA 1970: 195, WEINER, see above).

Species description: NOSEK 1962: 341 (setae of Abd V).

*Sminthurus wutaii* Uchida, 1948 (4)

Total length up to 0.9 mm. Background colour yellow to orange, large abdomen with many grey mottlings forming 4 or 5 pairs of cross bands, 1 median stripe, and irregular posterior patches (Fig. 441). Ant III proximally with 3 (?) long setae. Ant IV with about 17 subsegments. Claws broad with distinct inner tooth and basal pair of weak lateral teeth, tunica uncertain; Emp I and II with weak tooth, filaments missing, length < claws. Ret with 4 (?) setae. Both edges of mucro smooth, apex pointed; seta missing. App. an. short, curved, tapering, and smooth.

Proportions: Dens : mucro = 3.

Type locality: China, Shansi, Tungtai, Wutaishan, at 3200 m altitude.

Occurrence: Known only from the type locality.

Remarks: Except for the colour pattern, *S. wutaii* resembles *S. stachi* (see above).

**Genus *Spatulosminthurus* Betsch & Betsch-Pinot, 1984****Key to the Palearctic species**

- |   |   |                                      |
|---|---|--------------------------------------|
| 1 | Tita I - III each with 1 or 2 spatulate setae                                 | 2                                    |
| – | Tita I - III each with more spatulate setae                                   | 6                                    |
| 2 | Tita II and III each with 1 spatulate seta                                    | <i>flaviceps</i> (Tullberg, 1871)    |
| – | Tita II and III each with 2 spatulate setae                                   | 3                                    |
| 3 | Tita I with 1 spatulate seta, postantennal seta missing                       | <i>gattoi</i> (Stach, 1967)          |
| – | Tita I with 2 spatulate setae, postantennal seta present                      | 4                                    |
| 4 | Claws without tunica  | <i>guthriei</i> (Stach, 1920)        |
| – | Claws with tunica   | 5                                    |
| 5 | Ant IV with at least 22 subsegments, claws II and III with minute inner tooth | <i>lesnei</i> (Carl, in Denis, 1925) |
| – | Ant IV with at most 21 subsegments, all claws with distinct inner tooth       | <i>betschi</i> Nayrolles, 1990       |
| 6 | (1) Tita I - III each with 3 spatulate setae, mucro without seta              | <i>sensibilis</i> (Börner, 1909)     |
| – | Tita I - III each with 5 - 6 spatulate setae, mucro with seta                 | <i>daisetsuzanus</i> (Uchida, 1957)  |

Remarks: The dark colour pattern of some species (*S. flaviceps*, *guthriei*, *lesnei*) is very characteristic but there are always populations without it or with the dark pigment dispersed in many spots. The status of these varieties should be clarified (as in *S. guthriei*, see below).

Not included in this key are:

- *Sminthurus arborealis* Itoh, 1985 (= *Spatulosminthurus sensibilis* n. syn.),
- *Sminthurus bulgaricus* Rusek, 1965 (= *Spatulosminthurus flaviceps* n. syn.),
- *Sminthurus variegatus* Axelson, 1903 (Tita each with 3 spatulate setae, see BETSCH & BETSCH-PINOT 1984: 79).

**Diagnosis of the genus**

A genus of the Sminthurinae. Head apex and large abdomen with normal or long, rough setae. Large abdomen posteriorly without large cuticular glands. Eye-patches with 8+8 ommatidia. Postantennal setae in most species present. Antennae generally shorter, sometimes longer than body. Basal 1/2 of Ant III with 3 - 5 long, thick setae (see Fig. 400). Ant IV with about 14 - 25 subsegments. Trochanter III posteriorly with 1 normal seta. Tita distally with 1 - 6 spatulate setae (Figs. 443, 447). Claws without cavity. Dens anteriorly with about 13 - 15 setae, inner setae of normal form. Posterior edges of mucro smooth or coarsely serrate; seta present or absent. Circumanal setae in females of normal form or more or less winged; App. an. short setalike, oval or leaflike (Figs. 442, 452).

Occurrence: Palearctic.

Descriptions of the genus: BETSCH & BETSCH-PINOT 1984: 77, NAYROLLES 1990: 69, 1994: 157.

Type species: *Sminthurus lesnei* Carl, in Denis, 1925.

### Diagnosis of the Palaearctic species

*Spatulosminthurus betschi* Nayrolles, 1990 (65)

Total length up to 2.3 mm in females, 1.8 mm in males. Background colour white to orange, brown pigment mostly laterally on large abdomen, small abdomen with a median row of dark spots. Head apex and large abdomen with long, rough setae. Postantennal seta short. Ant II with 3 short ventral setae. Ant III proximally with 5 long, thick setae. Ant IV with 19 - 21 subsegments. Tita I - III each with 2 spatulate setae. Claws with inner and basal outer tooth, tunica, and long, serrate pseudonychia; Emp narrow, Emp I without tooth, II and III with finely serrate outer edges, filaments acuminate, length = claws. Ret with 4 setae. Formula of anterior setae of dens 3,3,3,2,2,1,1. Both edges of mucro serrate; seta present. In females, circumanal setae a1 - a3 winged; App. an. elongate, inner edge stout and pointed, outer as roughly serrate lamella (Fig. 442).

Proportions: Length of antennae : head diagonal = 2 in females, 2.4 in males. Ant I : II : III : IV = 1 : 2.1 : 3 : 7.8 (8.4) in females (and males). App. an. : mucro = 0.3 (orig. observ.).

Type locality: Spain, Huesca, Lac de Sotenera, meadow at 450 m altitude.

Occurrence: Also known from other sites in Spain (Saragossa and Tarragona, NAYROLLES, see above; Navarra, orig. observ., leg. ARBEA).

Biology: *S. betschi* lives in the vegetation of maquis, garrigue, and meadows up to 650 m altitude (NAYROLLES, see above).

Species description: NAYROLLES 1994: 162 (chaetotaxy of extremities).

Remarks: The mottled specimens of *S. lesnei* may belong to *S. betschi*.

*Spatulosminthurus daisetsuzanus* (Uchida, 1957) (25)

Syn.: *Sminthurus daisetsuzanus* Uchida, 1957 (25)

Total length up to 2.4 mm. Background colour greenish brown, head and abdomen with many black and bright white spots, dark pigment on large abdomen forming 5 dorsal, medially interrupted cross stripes; eye-patches light green with isolated, black ommatidia. Setae of head apex and postantennal seta not described. Large abdomen with long, normal setae. Ant III proximally with 3 long, thick setae. Ant IV with 25 subsegments. Tita I - III each with 5 or 6 knobbed setae (Fig. 443). Claws broad with inner and basal outer tooth, tunica and lateral teeth missing; Emp I broad, III narrow, all with tooth, filaments short and thin, length > claws (Fig. 443). Both edges of mucro smooth; seta present. Circumanal setae in females not described; App. an. short, stout, setalike.

Proportions: Ant I : II : III : IV = 1 : 2.2 : 2.5 : 6.5. Dens : Mucro = 2.5.

Type locality: Japan, Hokkaido, Daisetsu Mts., Yukomanbetsu, on living coniferous branches at 1100 m altitude.

Occurrence: Known only from the type locality.

Species description: BETSCH & BETSCH-PINOT 1984: 79.

Remarks: *S. daisetsuzanus* and *S. sensibilis* (see below) differ from the other species of the genus *Spatulosminthurus* in having setalike instead of broad App. an.

*Spatulosminthurus flaviceps* (Tullberg, 1871) (145) sensu Ågren, 1903 (168)

Syn.: *Sminthurus flaviceps* Tullberg, 1871 (145)

*Sminthurus bulgaricus* Rusek, 1965 (189) n. syn.

nec *Sminthurus flaviceps* Buitendijk, 1941 (91) (= other species, ELLIS 1976: 320)

Total length up to 1.6 mm. Background colour yellowish white, black pigment on posterior side of head and dorsally and laterally on abdomen; segments IV - VI ventrally unpigmented; body dorsally also with more black pigment or more or less faded (see Remarks). Head apex and large abdomen with long, thick, and rough setae (length on large abdomen > mucro), large abdomen also with normal setae. Postantennal seta short, ciliate, and pointed. Ant III proximally with 5 long, thick setae. Ant IV with 14-16 subsegments. Tita I - III each with 1 spatulate seta. Claws broad with or without small inner tooth, with basal outer tooth, tunica, and long serrate pseudonychia; Emp I without tooth, with filament, length > claw, Emp II and III with tooth, distally with short tooth and short filament, length = claws. Ret with 3 setae. Formula of anterior setae of dens 3,3,3,2,2,1,1. Only inner edge of mucro or both edges serrate (inner edge with more teeth than outer); seta present. In females, circumanal setae a1 - a3 slightly winged; App. an. elongate, outer edge with long branches, tip broad and serrate (Fig. 444, see Remarks).

Proportions: Length of antennae : head diagonal = 1.9. Ant I : II : III : IV = 1 : 2.7 : 4.8 : 10.2. Dens : mucro = 2.5 - 3. App. an. : mucro = 0.35.

Type locality: Sweden, Skåne, in grass.

Occurrence: Central and SE Europe; from S Scandinavia (LINNANIEMI 1912: 317), Germany (several records), and W Russia (MARTYNOVA 1964: 98) S to former Yugoslavia (e. g. CVIJOVIC 1979: 33), Bulgaria (RUSEK 1965: 189, CONEV & KAZANDZIEVA 1991: 82), Greece (Crete, ELLIS 1976: 320), and Spain (Ciudad Real, DENIS 1930); not recorded from Italy and W Europe. In the Alps known only from Austria (Lower Austria, Marchfeld, FRANZ & SERTL-BUTSCHEK 1954: 636; Tyrol, Oetzal near Umhausen, orig. observ., leg. BRETFELD).

Biology: *S. flaviceps* is rather rare and usually occurs in small numbers, only occasionally in richer populations (DUNGER 1975: 26). It lives in lowlands and highlands in litter and moss of humid forests and in the low vegetation of wet meadows (LINNANIEMI, see above), but in the south also in dry forests (FRANZ & SERTL-BUTSCHEK, DUNGER, see above).

Species descriptions: IONESCO 1916: 504, STACH 1956: 256, NOSEK 1962: 341, BETSCH & BETSCH-PINOT 1984: 75.

Remarks: The specimens described as *S. flaviceps* are not homogeneous:

1. The App. an. differ between those from northern regions (Fig. 444, sensu ÅGREN, also BETSCH & BETSCH-PINOT, see above) and southeastern regions (Fig. 445, as in IONESCO, STACH, NOSEK, see above).
2. The pigmentation varies from black to pale and to 1 pair of dark lateral bands, thus several colour varieties have been distinguished (STACH, see above):
  - f. *principalis* = var. *fennica* Reuter, 1876 (79) with dark dorsal side,
  - var. *ornatus* Uzel, 1891 (34), Ionesco, 1916 (504) = var. *medius* STACH, 1922 (69) with large, pale dorsal patch,
  - var. *bifasciatus* Stach, 1956 (260) with 1 pair of dark lateral bands on large abdomen,
  - var. *discolor* Stach, 1956 (260) with few dark shades and spots on pale body.



3. The slight differences of *S. bulgaricus* (claws without inner tooth, mucro inner edge smooth) are neglected here in favour of the other identical characteristics (App. an. were not described) and the typical colour pattern.

The specimens from different regions and of different colour patterns should be re-examined.

*Spatulosminthurus gattoi* (Stach, 1967) (413)

Syn.: *Sminthurus gattoi* Stach, 1967 (413)

Total length up to 2 mm. Background colour yellowish white, head and lateral of large abdomen more or less completely brown to black, large abdomen posteriorly with 2 pairs of black spots (Fig. 446) (the smaller posterior ones can fuse to one), small abdomen dorsally with dark median spots, extremities with few dark spots. Head apex with long, rough setae. Large abdomen with long, normal setae. Postantennal seta missing. Ant II with 3 short ventral setae. Ant III proximally with 5 long, thick setae. Ant IV with about 20 subsegments. Tita I with 1, Tita II and III each with 2 spatulate setae. Claws broad, with inner tooth (claws II and III sometimes with weak inner tooth), basal outer tooth, tunica, and long, serrate pseudonychia; Emp I narrow without tooth, with filament, length > claw. Emp II and III broad with several teeth on outer edges, filaments short, length = claws (Fig. 447). Ret with 4 setae. Formula of anterior setae of dens 3,3,3,2,2,1,1. Inner edge of mucro with few irregular, outer with several blunt teeth; seta present. In females, circumanal setae a1 - a3 with large wings; App. an. elongate, outer lamella thin, serrate, and obliquely truncate (Fig. 448).

Proportions: Length of antennae : head diagonal = 2. Ant I : II : III : IV = 1 : 2 : 2.7 : 7. Dens : mucro = 3. App. an. : mucro = 0.35.

Type locality: Malta, isles of Ghirgenti, under decayed bundles of *Arundo*.

Occurrence: Also found in Italy (Tuscany, near Siena, DALLAI 1970: 41 and orig. observ., leg. BRETFELD).

Biology: *S. gattoi* has been collected near Siena (orig. observ.) in dry habitats by sweeping *Calluna* and grass under *Pinus* trees.

Species descriptions: DALLAI 1970: 42 (cuticula), BETSCH & BETSCH-PINOT 1984: 77.

Remarks: Some original observations have been added in the above description.

*Spatulosminthurus guthriei guthriei* (Stach, 1920) (211) sensu Bretfeld, 1996 (218)

*Spatulosminthurus guthriei dimorphus* Bretfeld, 1996 (220)

*Spatulosminthurus guthriei sibiricus* Bretfeld, 1996 (220)

Syn.: *Sminthurus guthriei* Stach, 1920 (211)

Total length up to 1.3 mm in females, 1 mm in males. Background colour dirty white; females pale or with few dark spots (ssp. *sibiricus*); males pale (ssp. *guthriei*), sometimes with dark blue head and large abdomen with 1 pair of dark blue longitudinal bands (ssp. *dimorphus*, Fig. 449), or always with these patterns and with dark blue small abdomen (ssp. *sibiricus*). Head apex with long, rough setae. Large abdomen anteriorly with long, rough, and blunt, posteriorly with normal setae. Postantennal seta broad (ssp. *guthriei*), or slender and pointed (ssp. *dimorphus* and *sibiricus*), always ciliate (Figs. 450, 451). Ant II with 3 short ventral setae. Ant III proximally with 4 or 5 long, rough setae. Ant IV with 15 - 19 subsegments in females, 17 - 22 in males (larger numbers in ssp. *dimorphus*). Tita I - III each with 2 spatulate setae.

Claws slender without tunica, with 2 small inner teeth, basal outer tooth, and long, serrate pseudonychia; Emp broad, Emp I without tooth, filament long, length > claw, Emp II and III with 1 - 3 teeth, filaments short, length < claws. Ret with 2 setae. Formula of anterior setae of dens 3,3,3,2,2,1,1. Both edges of mucro with irregular, blunt teeth; seta present. In females, circumanal setae a1 - a3 slightly winged; App. an. short, thin, broader than long (Fig. 452).

Proportions: Length of antennae : head diagonal = 2, 2.2, 2.3 in females, 2.5, 3, 3.6 in males (ssp. *guthriei*, *sibiricus*, *dimorphus* respectively). Ant I : II : III : IV = 1 : 2 : 3 - 4 : 7 - 8 in females (larger values in ssp. *dimorphus*), 1 : 2 : 4 : 9, 10, 12 in males (ssp. *guthriei*, *sibiricus*, *dimorphus* respectively).

Type locality: S Poland, Pieniny Mts., Króścienko, swept from meadows with exuberant vegetation (ssp. *guthriei*).

Occurrence: Also known from Ukraine (the E Carpathians, ssp. *guthriei*), Azerbaijan (Caucasus, ssp. *dimorphus*), and Russia (from Omsk to Amur Regs. and in the Sayan Mts., ssp. *sibiricus*) (BRETZFELD, see above). Formerly recorded also from S Slovakia (NOSEK 1962: 341), former Yugoslavia (e. g. CVIJOVIC 1979: 33), Romania (GRUIA 1966: 252), and Russia, S Tuva Reg. (STEBAEVA 1963: 75).

Biology: *S. guthriei* lives in the vegetation of meadows in low lands and mountains (ssp. *dimorphus* up to 1700 m), in forest steppe (NOSEK, see above), and in rocky habitats (GRUIA, see above).

Species descriptions: STACH 1956: 248, BETSCH & BETSCH-PINOT 1984: 77.

Remarks: Some original observations have been added in the above description.

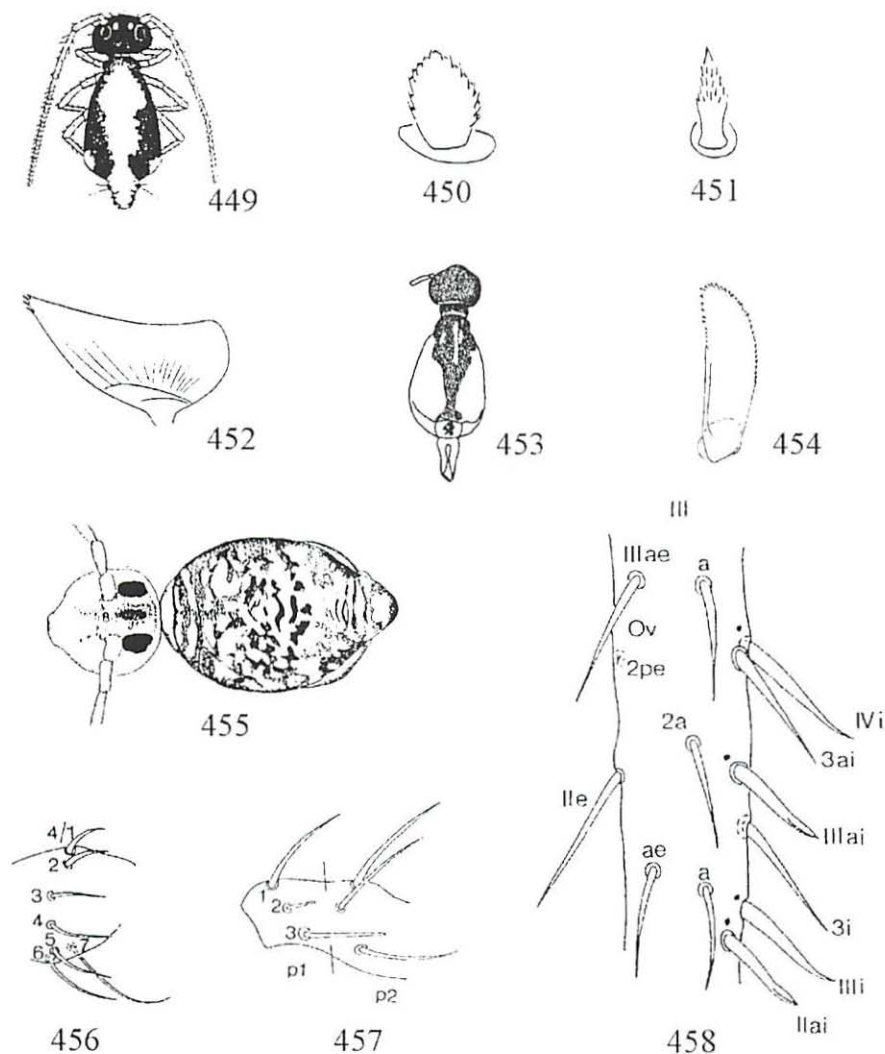
*Spatulosminthurus lesnei* (Carl, in Denis, 1925) (279) sensu Nayrolles, 1994 (159)

Syn.: *Sminthurus lesnei* Carl, in Denis, 1925 (279)

Total length up to 2.1 mm in females, 1.8 mm in males. Background colour yellowish white, black pigment on head and in a band dorsally on large and small abdomen, anteriorly broad, posteriorly narrowing (Fig. 453); large abdomen laterally also more or less dark, or head and body dark mottled. Head apex and large abdomen with long, rough setae. Postantennal seta short, pointed, and ciliate. Ant II with 3 short ventral setae. Ant III proximally with 5 long, thick setae. Ant IV with 22 - 24 subsegments. Tita I - III each with 2 spatulate setae. Claws with tunica, inner tooth (in claw III weak), 2 - 3 basal outer teeth, and long serrate pseudonychia; all Emp with double outer edge, Emp I without tooth, II and III with several teeth, filament of Emp I long, length > claw, filaments of Emp II and III short, length ≤ claws. Ret with 4 setae. Formula of anterior setae of dens 3,3,3,2,2,1,1. Both edges of mucro with irregular, blunt teeth; seta present. In females, circumanal setae a1 - a3 winged; App. an. elongate, inner edge thick, apically lamellate or sometimes pointed, outer edge thinly lamellate, tip and lamellate edges finely serrate (Fig. 454).

Proportions: Length of antennae : head diagonal = 2.3 in females, 2.6 in males. Ant I : II : III : IV = 1 : 2.3 : 3.2 : 9 in females, 1 : 2.4 : 3.4 : 9.7 in males. Dens : mucro = 3. App. an. : mucro = 0.3.

Type locality: S France, Banyuls-sur-Mer (?).



Figs. 449 - 452 *Spatulosminthurus guthriei*:

449 Habitus of male of ssp. *dimorphus* (after STACH 1956) 450 Postantennal seta of ssp. *guthriei*

(after BRETFELD 1996) 451 Postantennal seta of ssp. *sibiricus* (after BRETFELD 1996)

452 App. an. (after BRETFELD 1996).

Figs. 453 - 454 *Spatulosminthurus lesnei*:

453 Colour pattern (after DENIS 1925) 454 App. an. (after BETSCH & BETSCH-PINOT 1984).

Fig. 455 *Spatulosminthurus sensibilis*, colour pattern (after ITOH 1985).

Figs. 456 - 469 Bourletiellida general and non-Palaeartic genera:

456 Ant II, distal whorl with sensillum 4/7 (after BRETFELD 1992) 457 Ant IV, basal whorls with

sensilla p1/2 and 3 (after BRETFELD 1992) 458 Tita with obliquely truncate setae marked by points

(after BRETFELD 1992).

Occurrence: Also known from Spain (N and NE provinces, JORDANA et al. 1990: 186, NAYROLLES, see above, and orig. observ., leg. SICK, SUTTROP; near Marbella, WALLACE 1973: 219; in the isle of Menorca, orig. observ., leg. SICK), Italy (Livorno, DALLAI, see below), Algeria (DENIS 1925: 282, 283), and Morocco (THIBAUD & MASSOUD 1980: 543).

Biology: *S. lesnei* is rather rare, it lives in the vegetation and in litter of warm mediterranean habitats.

Species descriptions: DALLAI 1967: 445 (female, f. maculata), BETSCH & BETSCH-PINOT 1984: 77.

Remarks: The following colour varieties have been described:

f. *principalis* (DENIS 1925: 279) with black head and dorsal black band,

f. *obscura* (Algeria, DENIS 1925: 282) with head and body almost completely black, small abdomen ventrally pale,

var. *remaudierei* (S France, DELAMARE DEBOUTTEVILLE 1945: 72) resembling f. *principalis* and f. *obscura* (?),

f. *maculata* (Algeria, DENIS 1925: 283, Italy, DALLAI, see above) dark mottled.

The identity of the dark and mottled specimens should be confirmed, the latter may belong to *S. betschi*.

*Spatulosminthurus sensibilis* (Börner, 1909) (126) sensu Itoh, 1985 (83) and Yoshii, 1992 (108)

Syn.: *Sminthurus sensibilis* Börner, 1909 (126)

*Sminthurus arborealis* Itoh, 1985 (83) n. syn.

Total length up to 2.3 mm in females, 2 mm in males. Background colour dirty white or light brown, abdomen with dark pigment in irregular patches, on large abdomen anteriorly in more or less symmetrical cross stripes, posteriorly in irregular wavy cross stripes (Fig. 455). Head and abdomen with long normal setae. Postantennal seta short, pointed, and ciliate. Ant II with 3 or 4 small ventral setae. Ant III proximally with about 5 long, thick setae. Ant IV with 17 - 20 subsegments. Tita I - III each with 3 spatulate setae. Claws broad without tunica and inner tooth, with middle outer tooth and short, roughly serrate pseudonychia; Emp narrow without tooth, Emp I with short filament, Emp II and III often without filament, length always < claws. Ret with 4 setae. Formula of anterior setae of dens 3,3,3,2,2,1,1. Outer edge of mucro smooth, inner with irregular blunt teeth; seta missing. In females, all circumanal setae of normal form; App. an. short, stout, and setalike.

Proportions: Length of antennae : head diagonal = 1.7 - 2. Ant I : II : III : IV = 1 : 2 : 3 - 5 : 7 - 12(?). Dens : mucro = 3 - 4.

Type locality: Japan, Kanagawa, near a pond.

Occurrence: Also known from other sites in Japan (Yamanashi, ITOH, see above; Wakayama, YOSHII, see above).

Biology: *S. sensibilis* lives in the low vegetation and in litter (BÖRNER, see above), but was also collected from branches of red pine trees (*Pinus densiflora*) (ITOH, see above). It is active in Central Japan, at the foot of Mt. Fuji at 950 m altitude, only in winter from November - May, adults appear from March - May and lay their eggs in the soil (ITOH 1994: 87).

Remarks: *S. sensibilis* and *S. daisetsuzanus* (see above) do not completely correspond with the other species of *Spatulosminthurus*, since the App. an. resemble stout setae, whereas those of the other species are more or less broad and leaflike. These 2 species should be re-examined (see also BETSCH & BETSCH-PINOT 1984: 79).

**Genus *Sphyrotheca* Börner, 1906**

Syn.: *Sminthurotheca* Delamare Deboutteville & Massoud, 1964 b

**Key.** Only 1 Palearctic species: *Sphyrotheca multifasciata* (Reuter, 1881)

**Diagnosis of the genus**

A genus of the Sphyrothecinae. Head apex and large abdomen with short or long spines. Th II without vesicles. In adults Bothr ABCD present, B short. Ant IV with about 12 sub-segments. Trochanter III posteriorly with 1 spine. Femur I anteriorly with 1 curved seta, femur III posteriorly with 1 normal seta. Tita distally with only straight setae. Dens anteriorly with few, at most 2,2,1...1 setae.

Occurrence: Holarctic and Tropics.

Descriptions of the genus: BÖRNER 1906: 183, BETSCH 1980: 154, CHRISTIANSEN & BELLINGER 1981: 1178.

Type species: *Sminthurus multifasciatus* Reuter, 1881 (203) Börner, 1906.

**Diagnosis of the single Palearctic species**

*Sphyrotheca multifasciata* (Reuter, 1881) (203)

Syn.: *Sminthurus multifasciatus* Reuter, 1881 (203)

*Sminthurus minnesotensis* Guthrie, 1903 (52), BÖRNER 1909: 125, STACH 1964: 23

*Sphyrotheca multifasciata* var. *ornata* Börner, 1909 (126)

*Sphyrotheca multifasciata* var. *pallidinota* Börner, 1909 (126)

nec *Sphyrotheca multifasciata* Ionesco, 1916 (499) (= other, unknown genus, STACH 1956: 206)

Total length up to 1.6 mm. Background colour yellow, large abdomen with several more or less dark blue cross stripes. Head apex with stout, rough, and blunt spines of varying length. Large abdomen with similar spines as head, anteriorly few, posteriorly many, also with normal setae. Small abdomen with short, normal setae. Eye-patches with 8+8 ommatidia. Claws slender with small inner tooth, weak tunica, and 1 basal pair of ciliate or smooth pseudonychia; Emp short and smooth, filaments thin, length variable. Ret with 4 setae. Dens with few setae, formula of anterior setae about 3...1 (?). Inner edge of mucro with few teeth, outer smooth; seta missing. App. an. long, acuminate, and ciliate.

Proportions: Length of antennae : head diagonal = 1.25 - 1.5. Ant I : II : III : IV = 1 : 2.4 : 3.5 : 5.7. Dens : mucro = 3.3. App. an. : mucro = 0.75.

Type locality: Finland, Helsinki, Botanical Garden, on flowerpots in a warmhouse of 30°C.

Occurrence: Holarctic; in Europe also reported from Great Britain (GOTO & LAWRENCE 1964: 11), Spain (3 records, JORDANA et al. 1990: 188), former Yugoslavia (e. g. CVIJOVIC & ZIVADINOVIC 1973: 72), and Bulgaria (CONEV & KAZANDZIEVA 1991: 82); further records in the Palaearctic from China (Nanking, STACH, see below) and Japan (BÖRNER, YOSII, UCHIDA, see below); in the Nearctic known from USA and Canada (CHRISTIANSEN & BELLINGER, see below). Also reported from India (PRABHOO & SESHAN, see below) and Australia (GREENSLADE 1994: 135).

Biology: Except in the type locality, *S. multifasciata* was found in forest soils (CVIJOVIC & ZIVADINOVIC, see above).

Species descriptions: BÖRNER 1909: 125, LINNANIEMI 1912: 309, YOSII 1954: 819, UCHIDA 1957: 22, STACH 1964: 23, PRABHOO & SESHAN 1967: 155 (neuroendocrine system), CHRISTIANSEN & BELLINGER 1981: 1180 (as *S. minnesotensis*).

Remarks: Since *S. multifasciata* was originally collected from a warmhouse, the records from outdoor habitats in the Holarctic, but also those of India and Australia, should be re-examined. Structural differences, which could have been overlooked because of the striking pigmentation, may still be undetected.

Similar to *S. multifasciata*, as described by YOSII and STACH (see above), is *Sphyrotheca nanjingensis* Chen & Wu n. nom. (syn.: *Sphyrotheca stachi* Chen & Wu, 1996, type locality: China, Jiangsu Prov., Nanjing). This species mainly differs from *S. multifasciata* in number and form of the spines of the head apex and in the claws which lack basal teeth (pseudonychia). The number of head spines, however, seems to vary and the slightly swollen spines of the head apex are also figured by UCHIDA (see above) in specimens from Japan. So further studies are needed to clarify the position of this new species.

### **Genus *Temeritas* Delamare Deboutteville & Massoud, 1963**

**Key.** Only 1 Palaearctic species: *Temeritas sinensis* Dallai & Fanciulli, 1985

Not included here is *Sminthurus variegatus* Tullberg, 1976, which is only incompletely known (Ant IV with about 30 subsegments, see LAWRENCE 1966: 518).

### **Diagnosis of the genus**

A genus of the Sminthurinae. Head apex with few spines. Large abdomen with long, thick setae; posteriorly without large cuticular glands. Eye-patches with 8+8 ommatidia. Postantennal setae missing. Antennae generally longer than body. Ant III sometimes with several long, thick setae. Ant IV with 20 - 40 subsegments. Trochanter III posteriorly with 1 spine. Tita distally with only pointed setae. Claws without cavity. Dens anteriorly usually with 13 setae, inner setae sometimes spinelike. Posterior edges of mucro serrate; seta present or missing.

Occurrence: Tropics, S Australia, and China.

Descriptions of the genus: DELAMARE DEBOUTTEVILLE & MASSOUD, 1963: 276, NAJT 1968: 631, ARLÉ & OLIVEIRA 1977: 1, BETSCH 1971: 167, 1980: 155.

Type species: *Sminthurus macroceros* Denis, 1933.

### **Diagnosis of the single Palaearctic species**

*Temeritas sinensis* Dallai & Fanciulli, 1985 (157)

Total length up to 1.9 mm. Background colour of body reddish brown, darker spots on large abdomen, head paler. Head apex with 3 pairs of spines. Large abdomen with straight, pointed spines and also small normal setae, Abd V with few spines, other setae of small abdomen normal. Antennae as long as body. Ant IV with 26 subsegments. Claws without tunica, with inner tooth, and narrow, serrate pseudonychia; Emp narrow with tooth, filaments acuminate, length > claws. Ret with 3 setae. Dens with normal setae, formula of anterior setae 3,2,2,2,1,1. Both edges of mucro serrate; seta present. App. an. stout, pointed, curved.

Proportions: Length of antennae : head diagonal = 2.3. Ant I : II : III : IV = 1 : 2.5 - 3 : 3.8 - 4.7 : 9.7 - 10.

Type locality: China, Hopei.

Occurrence: Also found at another site in China (Shaanxi, DALLAI & FANCIULLI, see above).

## Bourletiellida Bretfeld, 1986

Syn.: Bourletiellidae Börner, 1913 sensu Betsch, 1980 (170)

### Diagnosis

The taxon Bourletiellida Bretfeld, 1986 (310) is a monophylum of the Eusymphyleona-Sminthuriformia-Tridentata Bretfeld, 1986 with 4 diagnostic apomorphies:

- pretarsus with 1 anterior seta (plesiomorphy: 1 pair of setae)
- Ant II with 1 ventrodistal sensillum similar to a bothriothrix (plesiomorphy: normal seta)
- Ant IV basally with 2 thick anterior sensilla (plesiomorphy: normal setae)
- Abd V with 2 pairs of Bothr, DE (plesiomorphy: only pair D).

Other diagnostic characteristics: Ret usually with 3 teeth (apomorphy); Bothr ABC in a straight line (apomorphy?); Abd V included in small abdomen (plesiomorphy); Ant IV longer than III (plesiomorphy); antennae elbowed between Ant III and IV (plesiomorphy); tibiotarsi with up to 4 distal, spatulate setae each (apomorphy); sacs of VT long and warty (apomorphy); mucro without seta (apomorphy).

The Bourletiellida have been divided into 2 subgroups (= subfamilies), the Bourletiellinae and Parabourletiellinae Betsch, 1974 (181); the latter, endemic to Madagascar, was originally characterized by mating without pair formation or, later, by the winged seta Ja of Tita I (Fig. 459, BETSCH 1980: 181). Both characteristics, however, are not restricted to the genera of Madagascar: the pair formation is also apparently missing in other genera lacking secondary sexual characteristics in males and the seta Ja of Tita I is also winged in Palaearctic genera. This separation can therefore not be maintained.

### Description

The Bourletiellida are small to large animals; the total length of adults ranging from 0.5 (males) to 3.5 (females) mm, females always being larger than males. The pigmentation varies from pale yellow to dark black or violet; it may be uniform or show various patterns. The large abdomen includes the segments Th II to Abd IV (BETSCH 1980: 14), it is globular or elongate with a dorsal depression, possessing in a few genera a posterior club. On the head apex or on the anterior of large abdomen, a protuberance may occur as a secondary sexual characteristic. There are branched tracheae in the head and large abdomen (BETSCH 1980: 22). The setae are generally of medium length and thin, seldom long and thick, in several genera some are modified as secondary sexual characteristics (see BETSCH 1980: 96 for a survey). Except the genus *Aneuempodialis* with only Bothr BDE (GREENSLADE 1982: 269), all genera have 5 pairs of Bothr: ABC on the large abdomen, DE on Abd V; ABC lie in a straight line, the segmental position of which is discussed by BETSCH & WALLER (1989: 26), where it is also shown that Bothr E is modified in the Bourletiellida from a different seta than in the Sminthuridida. The App. an. are directed towards the anus, are usually long, often bandlike with a toothed tip but may also be thin and fanlike. Neosminthuroid setae are missing.

The eye-patches have 8+8 ommatidia, of which C and D are often smaller than the others. The mandibulae and maxillae are generally of the normal chewing type, only in *Stenognathriopes* they are elongate in favour of an unknown feeding behaviour (Fig. 15). Ant IV is longer than III and the entire antenna is elbowed between Ant III and IV; Ant IV is clearly subsegmented.

A long sensillum similar to a bothriothrix is developed ventrodistally on Ant II (seta 4/7, see Figs. 8, 456), and on Ant IV there are 2 thick basal sensilla (setae p1/2, 3, see Figs. 10, 457) and several dorsal and ventral distal sensilla (Figs. 11, 12).

Each Tita may have normal, thick, or spinelike setae, in some genera also obliquely truncate or distally flattened posterior setae (Fig. 458), and 1 or more oval organs. Seta Ja of Tita I is often winged (see Figs. 242, 459). Tita I - III each have up to 4 spatulate distal setae and always only 1 anterior pretarsal seta. The claws usually have no important modifications except some teeth, but the empodia show a large variety of forms, which are often genus specific: a broad lamella or reduced to strong or fine needles with or without a filament, or completely reduced (Figs. 459 - 467).

The VT has long and warty sacs; the Ret 3+3, in a few genera 4+4, teeth. The setae of the dentes are of normal form, they may be long and thick in species living near or on the water surface. The mucro has smooth edges, a seta is missing.

### Biology

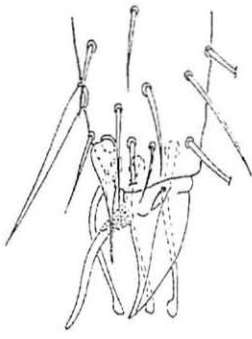
The species of the Bourletiellida are rare to abundant. They belong mostly to the atmobios and live in all strata from wet to dry habitats: on the soil surface, on or under stones, in the low vegetation, and on bushes. Some tolerate hot sunshine, some are found near or on waters, few in litter and on dead wood, none in caves. They occur from the seashore up to the high alpine regions near the glaciers and can be collected by pitfall traps or a sweeping net, soil samples are generally not an adequate method to collect Bourletiellida. The species feed on fungi, algae, pollen grains, plant debris, and dead insects but only occasionally on living plants; they drink with the mouth or absorb water with the long sacs of VT. The secondary sexual characteristics of the males are used in a mating behaviour with pair formation, which is known in some species of the genera *Bourletiella*, *Deuterosminthurus*, *Heterosminthurus*, and *Bovicornia* (BRETZFELD 1970: 259, 1971: 145, BETSCH 1974: 179, 1980: 113). The mating behaviour is unknown in a further 7 genera with modified setae in males and in the genera without secondary sexual characteristics in males. Seasons hostile to life are passed as eggs laid on the soil.

### Key to the genera of the world

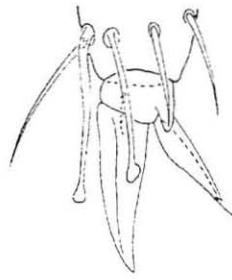
#### Bourletiellida Bretfeld, 1986

- |   |  |    |
|---|--|----|
| 1 | Head roundish, mouth and mouthparts normal                                       | 2  |
| - | Head triangular, mouth and mouthparts elongate (Fig. 15)                         |    |
|   | <i>Stenognathriopes</i> Betsch & Lasebikan, 1979                                 |    |
|   | type species: <i>Stenognathriopes huetheri</i> Betsch & Lasebikan, 1979; Nigeria |    |
| 2 | All posterior setae of Tita III smooth, acuminate                                | 3  |
| - | 5 or 6 posterior setae of Tita III especially thick, rough or toothed (Fig. 468) |    |
|   | <i>Rastriopes</i> Börner, 1906   |    |
|   | type species: <i>Sminthurus aculeatus</i> Schött, 1901; New Guinea               |    |
| 3 | All legs with distinct Emp   | 4  |
| - | Some or all legs without or with only minute Emp                                 | 22 |

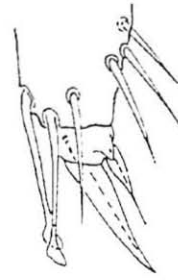




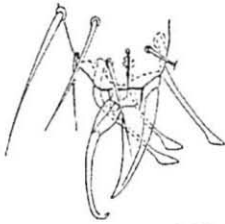
459



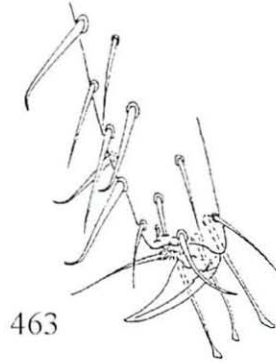
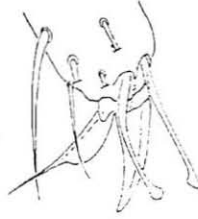
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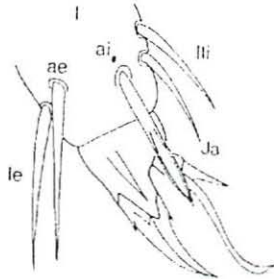
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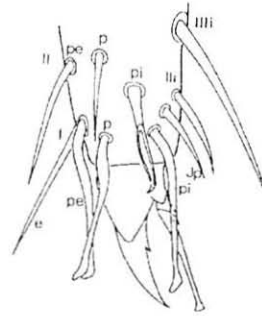
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459 - 467 Claw and Emp.: 459 *Parabourletiella*, Tita I with winged seta Ia (after BETSCH 1980)

460 *Bourletiella* (after BETSCH 1980) 461 *Deuterosminthurus* (after BETSCH 1980)

462 *Heterosminthurus*, left leg I, right leg III (after BETSCH 1980) 463 *Bovicornia* (after BETSCH 1980)

464 *Nasosminthurus* (after BETSCH 1980) 465 *Fasciosminthurus* (after BRETTFELD 1992)

466 *Cyprania* (after BRETTFELD 1992).

- 4 Some or all Emp without lamellae, tapering directly into fine or thick filaments, or with only a minute basal point 5
- All Emp distinctly pointed, either with or without lamellae, with or without subapical filaments 14
- 5 Only Emp I as a thick filament (Fig. 462) *Heterosminthurus* Stach, 1955 (p. 258)  
type species: *Sminthurus insignis* Reuter, 1876; Finland
- All Emp as filaments 6
- 6 Ant shorter than body; if in males longer, then head with secondary sexual characteristics 7
- Ant longer than body, head in males without secondary sexual characteristics 12
- 7 Emp shorter than claws 8
- Emp longer than claws 10
- 8 All inner setae of Tita normal, acuminate *Vatomadiella* Betsch, 1974  
type species: *Vatomadiella pauliani* Betsch, 1974; Madagascar
- Some inner setae of Tita obliquely truncate 9
- 9 Dens anteriorly with 3 setae thicker than others (Fig. 507); females with only normal circumanal setae *Ellisiella* n. gen. (p. 242)  
type species: *Deuterosminthurus pandayi* Ellis, 1974; Greece
- All anterior setae of dens thin; females with 1 or more furcate circumanal setae *Kaszabellina* Betsch, 1977 (p. 275)  
type species: *Kaszabellina variabilis* Betsch, 1977; Mongolia
- 10 (7) All inner setae of Tita normal, acuminate *Anjavidiella* Betsch, 1974  
type species: *Anjavidiella ankaratrensis* Betsch, 1974; Madagascar
- Some inner setae of Tita obliquely truncate 11
- 11 Head in males with apical protuberance, in females with 1 (?), 3, or 5 furcate circumanal setae *Bovicornia* Delamare Deboutteville, 1947  
type species: *Bovicornia coronata* Delamare Deboutteville, 1947; Senegal
- Large abdomen in males with small spines, in females with only 1 furcate circumanal seta, a0 *Massoudia* Betsch, 1975  
type species: *Massoudia griveaudi* Betsch, 1975; Madagascar
- 12 (6) Dens with only normal outer setae 13
- Dens also with 3 small outer spines appearing like oval organs *Bourletiellitas* Betsch, 1974  
type species: *Bourletiellitas imerinensis* Betsch, 1974; Madagascar
- 13 Tita I - III with 2, 2, 1 spatulate setae respectively *Parabourletiella* Betsch, 1975  
type species: *Parabourletiella mahafalensis* Betsch, 1975; Madagascar
- Tita with 3 spatulate setae each *Paulianitas* Betsch, 1978  
type species: *Paulianitas viettei* Betsch, 1978; Madagascar

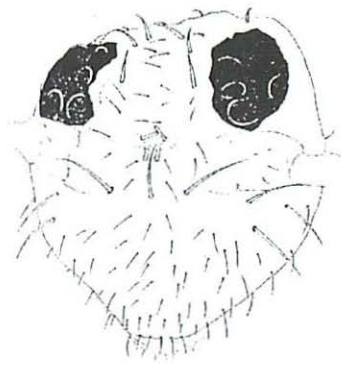
- 14 (4) All inner setae of Tita normal, acuminate 15  
 – Some inner setae of Tita obliquely truncate 18
- 15 Emp without subapical filaments (at least Emp II, III) (Fig. 461) 16  
 – Emp with subapical filaments (Fig. 460), anterior setae of dens longer than spaces between rows 17
- 16 Dens with at most 7 anterior setae (setae shorter than spaces between rows), head frons in males with only normal setae *Deuterosminthurus* Börner, 1901 (p. 234)  
 type species: *Smynthurus bicinctus* Koch, 1840; Germany  
 – Dens with 9 or 10 anterior setae, head frons in males with 2 pairs of spinelike setae between antennae (Fig. 469) *Arlesminthurus* n. gen.  
 type species: *Deuterosminthurus richardsi* Arlé, 1971; Brazil
- 17 Emp with thin filaments, length < claws; Abd VI in males with (Fig. 470) (subgenus *Bourletiella*) or without (subgenus *Cassagnaudiella*) secondary sexual characteristics *Bourletiella* Banks, 1899 (p. 219)  
 type species: *Smynthurus hortensis* Fitch, 1863; USA  
 – Emp with thick filaments, length > claws *Tritosminthurus* Snider, 1988  
 type species: *Tritosminthurus schuhi* Snider, 1988; South Africa
- 18 (14) Emp without subapical filaments (Fig. 464) *Nasosminthurus* Stach, 1955  
 type species: *Deuterosminthurus dimorphus* Womersley, 1932 a; Australia  
 – Emp with short or long subapical filaments 19
- 19 Emp with short filaments, length < claws *Bourletides* Betsch & Massoud, 1972  
 type species: *Bourletides wallacei* Betsch & Massoud, 1972; Australia  
 – Emp with long filaments, length  $\geq$  claws 20
- 20 Genital papilla in males  $\geq$  1 ventral anal valve, females with 5 dorsal circumanal setae 21  
 – Genital papilla in males  $\cdot$  1 ventral anal valve, females with 7 dorsal circumanal setae *Prorastriopes* Delamare Deboutteville, 1947  
 type species: *Prorastriopes pulcher* Delamare Deboutteville, 1947; Senegal
- 21 Emp S-shaped, tip curved internally (Fig. 465), Ant IV with large sensillum P on 1st whorl behind the tip (as in Fig. 11) *Fasciosminthurus* Gisin, 1960 (p. 243)  
 type species: *Sminthurus quinquefasciatus* Krausbauer, 1898; Germany  
 – Emp straight or slightly curved externally (Fig. 466), Ant IV with large sensillum P on 3rd whorl behind the tip (see Fig. 11) *Cyprania* Bretfeld, 1992 (p. 232)  
 type species: *Cyprania gisae* Bretfeld, 1992; Cyprus
- 22 (3) Emp I and II minute, Emp III short, pointed; dens with many very long setae (Figs. 565, 566) *Pseudobourletiella* Stach, 1956 (p. 276)  
 type species: *Smynthurus spinatus* MacGillivray, 1893; USA  
 – Emp I - III missing 23



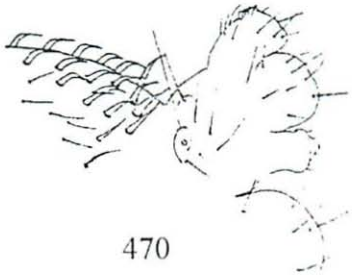
467



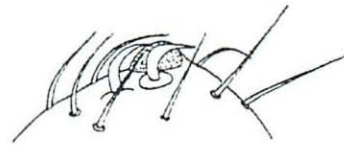
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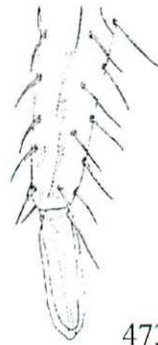
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467 *Aneuempodialis* (after BEISCH 1980).

468 468 Tita III of *Rastriopes* (after HÜTHER 1969).

469 Head of *Arlesminthurus aucti*, male (after ARLÉ 1971).

Figs. 470 - 472 *Bourletiella arvalis* (after STACH 1956):

470 Male Abd IV - VI, 471 Male Abd VI, tip 472 App. an.

Figs. 473 - 474 *Bourletiella canigouensis* (after NAYROLLES 1995):

473 Dens, apical part with 2 anterodistal setae 474 App. an.

- 23 Large abdomen with Bothr ABC *Corynephorina* Absolon, 1907  
 type species: *Corynephorina jacobsoni* Absolon, 1907; Indonesia
- Large abdomen with only Bothr B *Aneuempodialis* Stach, 1955  
 type species: *Deuterosminthurus cinereus* Womersley, 1932 a; Australia

Remarks: The genus *Arlesminthurus* n. gen., type species *Deuterosminthurus richardsi* Arlé, 1971 (1), also includes the species *Deuterosminthurus aueti* Arlé, 1961 (37) and *Deuterosminthurus salinensis* Arlé, 1971 (4). The empodia of these species are like those of the genus *Deuterosminthurus* but the males possess 2 pairs of spinelike instead of normal setae on head frons between the antennae (Fig. 469). The new genus is named in honour of the author of these species, Prof. Dr. ROGER ARLÉ, the eminent Brazilian soil zoologist. The 3 species described only occur in Brazil. The gender of this genus is masculine.

*Cassagnaudiella* is maintained here as a subgenus of *Bourletiella*, not as a separate genus, since the only difference to the nominate subgenus is the absence of the sexually modified setae on Abd VI in males (Fig. 470, see below).

In N America, the genus *Deuterosminthurus* seems to contain also species of other, new genera (see CHRISTIANSEN & BELLINGER 1981: 1159).

Not included in this key are:

- *Deuterosminthurus kaplini* Martynova in Martynova, Tshelnokov & Kaplin, 1979 (41), the Tita of which have 3 spatulate setae and lanceolate Emp each; it may belong to a new genus.
- *Madecassiella* Betsch & Waller, 1996, type species: *Madecassiella ibityensis* Betsch & Waller, 1996 from Madagascar, which is near *Anjavidiella* in the above key and differs from that genus by a reduced number of the anterior setae of large abdomen and by Ret 4+4 teeth, instead of 3+3.
- *Tenentiella* Palacios-Vargas & Vázquez, 1997, type species: *Tenentiella siankaana* Palacios-Vargas & Vázquez, 1997 from Mexico, the Tita of which have thick spatulate setae and the App. an. are finely palmate. This genus has originally been considered to be a subgenus of *Stenognathriopes* but its head and mouthparts are not lengthened.

## Diagnosis of the Palaearctic genera and species

### Genus *Bourletiella* Banks, 1899 sensu Linnaniemi, 1912

#### Key to the Palaearctic species

- |   |   |                               |
|---|---|-------------------------------|
| 1 | Ant IV with about 7 subsegments   | 2                             |
| – | Ant IV with about 10 subsegments  | <i>gamae</i> Bretfeld, 1994   |
| 2 | Dens distally with 2+1 anterior setae (Fig. 479)  | 3                             |
| – | Dens distally with 2 anterior setae (Fig. 473)  | 7                             |
| 3 | Tita II row p:3 setae (see Fig. 23); Abd VI in males with sexually modified setae; App. an. broad or narrow | 4                             |
| – | Tita II row p:4 setae (see Fig. 23); Abd VI in males with only normal setae; App. an. broad                 | <i>cruciata</i> Haybach, 1972 |
| 4 | Body colour mainly yellow; App. an. broad or narrow   | 5                             |
| – | Body colour mainly dark blue; App. an. broad  | 6                             |

- 5 Abd VI in males with seta m1 short and acuminate, spine DL1 as broad as DL2 (Fig. 471); App. an. broad fanlike *arvalis* (Fitch, 1863)
- Abd VI in males with seta m1 long and coiled, spine DL1 broader than DL2 (Fig. 493); App. an. narrow, spatulate *viridescens* Stach, 1920
- 6 Abd VI in males with seta m1 long and coiled, spines DL1+2 of equal form but curved oppositely (Fig. 480); App. an. apically smooth or with fine fringes (Fig. 481) *hortensis* (Fitch, 1863)
- Abd VI in males with seta m1 as a stout spine, spine DL1 broader than DL2, both curved posteriorly (Fig. 491); App. an. apically with rough teeth (Fig. 492) *sicki* Bretfeld, 1994
- 7 (2) Tita II row p:3 setae (see Fig. 23); Abd VI in males with sexually modified setae 8
- = Tita II row p:4 setae (see Fig. 23); Abd VI in males with only normal setae *canigouensis* (Nayrolles, 1995)
- Tita II row p:5 setae (see Fig. 23); Abd VI in males with only normal setae 9
- 8 Body colour mainly yellow; Ant III in males dorsobasally with 1 thick spine (Fig. 487); App. an. bandlike, distal 3/4 fringed, not broadened or furcate (Fig. 489) *radula* Gisin, 1946
- Body colour mainly blue; Ant III in males with only normal setae; App. an. bandlike, distal 1/3 fringed, sometimes broadened or furcate (Figs. 474, 483) *pistillum* Gisin, 1946
- 9 Cuticle of head frons and clypeus with small granules, always smaller than the basal diameter of setae; circumanal setae in females only finely serrate 10
- Cuticle of head frons and clypeus with large granules, some as large as or larger than the basal diameter of setae; ventral circumanal setae av1' and av1 in females generally branched basally (Fig. 485) *pruinosa* (Tullberg, 1871)
- 10 Body colour mainly yellow *luteoernalis* (Nayrolles, 1995)
- = Body colour mainly blue *coeruleoernalis* (Nayrolles, 1995)
- Body colour a mixture of dark purple and orange-ochre *cadiensis* (Nayrolles, 1995)

Remarks: Not included in this key are:

- *Bourletiella agreni* Stach, 1956 (= *B. pistillum*),
- *Bourletiella mongolica* Betsch, 1977 (= *B. pistillum*),
- *Bourletiella trichroma* Nayrolles, 1995 (= *B. cruciata*).

### Diagnosis of the genus

Large abdomen globular, row 5:1 seta. Ant IV with large sensillum P on 1st whorl behind the tip, with 2 ventral and 12 tip sensilla (see Figs. 11, 12). Inner setae of Tita not obliquely truncate, seta Ia missing, Iii present (Fig. 23). Tita I - III with 3, 3, 2 spatulate setae respectively. All Emp pointed, with lamellae, with short and pointed subapical filaments, length < claws (Fig. 460).

Most anterior setae of dens longer than the spaces between rows; formula of anterior setae 2 or 3 (= 2+1), 2, 1, 1...1 (Figs. 473, 479). Secondary sexual characteristics: in males: Abd VI dorsally with median crest and modified setae (Figs. 470, 480, subgenus *Bourletiella*) or without secondary sexual characteristics (subgenus *Cassagnaudiella* Ellis, 1975), large abdomen sometimes dorsally with swollen setae (Fig. 470); in females: circumanal setae often fringed or toothed, setae av1', av1, and av3 sometimes bandlike (Figs. 485, 488).

Occurrence: Holarctic and some regions of the Southern Hemisphere.

Descriptions of the genus: BANKS 1899: 194, LINNANIEMI 1912: 292, STACH 1956: 137, BETSCH 1980: 176, CHRISTIANSEN & BELLINGER 1981: 1148, NAYROLLES 1995: 43.

Type species: *Smynthurus hortensis* Fitch, 1863.

Remarks: The subgenus *Bourletiella* comprises the species *Bourletiella arvalis*, *gamae*, *hortensis*, *pastillum*, *radula*, *sicki*, and *viridescens*.

The subgenus *Cassagnaudiella* comprises the species *Bourletiella cadicensis*, *canigouensis*, *coeruleovernalis*, *cruciata*, *luteovernalis*, and *pruinosa*.

#### Diagnosis of the Palearctic species

*Bourletiella* (*Bourletiella*) *arvalis* (Fitch, 1863) (673) sensu Stach, 1956 (143)

Syn.: *Smynthurus arvalis* Fitch, 1863 (673)

*Smynthurus luteus* Schött, 1891 (11)

*Bourletiella lutea* Jeannenot, 1954 (1)

nec *Smynthurus luteus* Lubbock, 1868 (296) (= *Deuterostmynthurus sulphureus*)

Total length up to 1.6 mm in females, 1 mm in males. Main colour yellow, sometimes washed with blue; frontal eye dark. Ventral head-back with 2+2 oval organs. Ant IV with about 7 subsegments. Tita II row p:3 setae, length of longest setae of Tita III > diameter of Tita. Formula of anterior setae of dens 2+1, 2, 1, 1...1; mucro without anterior furrow. Secondary sexual characteristics: in males: Abd VI mostly with median crest, seta m1 long acuminate, DL1+2 as slender spines of equal form, and curved posteriorly, large abdomen posterodorsally with swollen, hooklike setae (Figs. 470, 471); in females: dorsal circumanal setae slightly ciliate, setae a0 and a2 - av1 stronger than the others. App. an. thin, broad fanlike, apically finely fringed (Fig. 472).

Proportions: Length of antennae : head diagonal = 1.5 in females, 2 in males. Ant I : II : III : IV = 1 : 1.7 : 2.7 : 5.3. Dens : mucro = 3. App. an. : mucro = 0.3 - 0.4.

Type locality: USA, New York, in the low vegetation of a garden, on fruit trees, and in fields of clover.

Occurrence: Holarctic; in the Palearctic reported from N Russia (N Siberia ?, STE-BAEVA 1976: 124 according to SCHÖTT), W to the Netherlands (ELLIS 1974: 235), and S to France (Corsica), former Yugoslavia, N Greece (Sithonia) (orig. observ., leg. BRET-FELD), and Algeria (orig. observ., leg. MERTENS). The records from New Zealand (SALMON 1941: 415) and India (DENIS 1936: 278) should be confirmed; not confirmed for Australia (GREENSLADE 1994: 120). The exact distribution remains to be shown since this species has often been confused with others (GISIN 1960: 287).

Biology: *B. arvalis* lives in the vegetation of open habitats; in the USA, Michigan, also in litter, on *Sphagnum*, under loose bark, and in flood plains (SNIDER 1967: 227); in the Palearctic it seems to prefer low, sparse grass vegetation (ELLIS 1974: 235 and orig. observ.).

It has been recorded from salt meadows (WEIGMANN 1973: 309) and has been found feeding on pollen (KEVAN & KEVAN 1970: 311).

Species descriptions: GISIN 1960: 287, SCOTT & YOSHII 1972: 109, GOUGH 1974: 445 (small abdomen in males), CHRISTIANSEN & BELLINGER 1981: 1148.

Remarks: *B. arvalis* is well characterized by the yellow colour, the sexually modified setae in males, and the broad App. an. in females (this latter character is similar to the generally darker coloured *B. hortensis*, CHRISTIANSEN & BELLINGER, see above). GISIN (1960: 287) confused the App. an. with those of *B. viridescens*. FITCH, together with the original description (see above), noted a courtship behaviour, which in reality is that of a yellow *Deuterostminthurus* species of the New York area.

*Bourletiella (Cassagnaudiella) cadiensis* (Nayrolles, 1995) (51)

Syn.: *Cassagnaudiella cadiensis* Nayrolles, 1995 (51)

Total length up to 1.2 mm in females, 0.7 mm in males. Main colour dark blue-purple, orange pigment dorsally on head and in irregular cross stripes on large abdomen, Abd V and VI each with 1 pair of light spots; antennae brown purple. Other characteristics as in *B. coeruleovernalis* (see below).

Proportions: Length of antennae : head diagonal = 1.5 in females, 1.8 in males. Ant I : II : III : IV = 1 : 2.2 : 3 : 6.7 (7.4) in females (and males). App. an. : mucro = 0.45.

Type locality: Spain, Lérida, Sierra del Cadí, near the Perbes pass, mountain garrigue at 1280 m altitude.

Occurrence: Also found at another site in Spain, Lérida (Collado de Jou at 1480 m altitude, NAYROLLES, see above).

Remarks: The colour distinctly distinguishes *B. cadiensis* from *B. coeruleovernalis* and *B. luteovernalis*; there are no intermediate colour forms (NAYROLLES 1995: 59).

*Bourletiella (Cassagnaudiella) canigouensis* (Nayrolles, 1995) (56)

Syn.: *Cassagnaudiella canigouensis* Nayrolles, 1995 (56)

Total length up to 1 mm in females, 0.85 mm in males. Main colour light blue, head and large abdomen dorsally also with yellow pigment; antennae brown. Ventral head-back with 2+2 oval organs. Ant IV with about 7 subsegments. Tita II row p:4 setae. Formula of anterior setae of dens 2,2,1,1...1 (Fig. 473); mucro with anterior furrow. Secondary sexual characteristics: in males missing; in females: circumanal setae av1', av1, and av3 broad and slightly serrate. App. an. broad ribbonlike, distally broadened, serrate, and slightly furcate (Fig. 474).

Proportions: Length of antennae : head diagonal = 1.5 in females, 1.6 in males. Ant I : II : III : IV = 1 : 2 : 2.7 : 5.5 (6) in females (and males). App. an. : mucro = 0.55.

Type locality: France, Pyrénées-Orientales, Massif de Canigou, alpine meadow near Puig Roja at 2700 m altitude.

Occurrence: Also found at another site in the Massif de Canigou (NAYROLLES, see above).

Remarks: The App. an. of *B. canigouensis* resemble those of *B. pistillum*, only the setae of Tita II and the males differ.



*Bourletiella (Cassagnaudiella) coeruleovernalis* (Nayrolles, 1995) (48)

Syn.: *Cassagnaudiella coeruleovernalis* Nayrolles, 1995 (48)

Total length up to 1 mm in females, 0.75 mm in males. Main colour blue, head dorsally orange, Abd V sometimes with 1 pair of pale spots; antennae brown. Ventral head-back with 2+2 oval organs. Ant IV with about 7 subsegments. Tita II row p:5 setae. Formula of anterior setae of dens 2,2,1,1...1; mucro with anterior furrow. Secondary sexual characteristics: in males missing; in females: circumanal setae av1', av1, and av3 broader than others. App. an. broad ribbonlike, apically serrate.

Proportions: Length of antennae : head diagonal = 1.5 in females, 1.6 in males. Ant I : II : III : IV = 1 : 2 : 2.8 : 6.2 in females, 1 : 2.3 : 3.1 : 6.9 in males. App. an. : mucro = 0.53.

Type locality: France, Ariège, between Suc and La Prade, in the low vegetation of a meadow with beeches at 960 m altitude.

Occurrence: Known only from the type locality.

Remarks: *B. coeruleovernalis* occurs together with *B. luteovernalis* without intermediate coloured specimens. There are also no intermediate colour forms between this species and *B. cadiensis* (NAYROLLES 1995: 59).

*Bourletiella (Cassagnaudiella) cruciata* Haybach, 1971/72 (31)

Syn.: *Cassagnaudiella trichroma* Nayrolles, 1995 (56) n. syn.

Total length up to 1.2 mm in females, 1 mm in males. Main colour blackish blue with whitish parts; head dorsally pale, large abdomen anteriorly with 2 or 3 pairs of pale cross stripes, posteriorly with irregular pale net, the large dorsal pair of pale patches with blue tints (coloured orange in *B. trichroma*), antennae dark. Abd V with pale cross stripe. Abd VI with 1 pair of pale spots (Fig. 475). Ventral head-back with 2+2 oval organs. Ant IV with about 7 subsegments. Tita II row p:4 setae, length of longest setae of Tita III > 3x diameter of Tita. Formula of anterior setae of dens 2+1,2,1,1...1; mucro with narrow anterior furrow. Secondary sexual characteristics: in males missing; in females: circumanal setae a0 and a1 ciliate, a2, a3, av1', and av1 with distal fringes, all mentioned setae thicker and longer than others. App. an. thin, broad fanlike, apically toothed (Fig. 476).

Proportions: Length of antennae : head diagonal = 1.4 in females, 1.7 in males. Ant I : II : III : IV (in *B. trichroma*) = 1 : 2.1 : 3.2 : 7 in females, 1 : 2.3 : 3.3 : 7.2 in males. Dens : mucro = 3. App. an. : mucro = 0.3.

Type locality: Austria, Carinthia, Großglockner Mt., on *Saxifraga rudolphiana* on a moraine at 2340 m altitude.

Occurrence: Also found at several sites in S France and N Spain (NAYROLLES, see above), and in Germany (Thuringia, Leutra valley near Jena, orig. observ., leg. DUNGER).

Biology: *B. cruciata* lives in xerothermic grasslands from the highlands up to the alpine regions and in mediterranean vegetation.

Remarks: This new description of *B. cruciata* is based on a re-examination of the types.

*Bourletiella (Bourletiella) gamae* Bretfeld, 1994 (147)

Only 1 male (and juveniles) known. Total length 1 mm. Main colour blackish blue with pale parts; head dorsally with small pale region, large abdomen with irregular, pale cross stripes, laterally with pale spots (Fig. 477). Ventral head-back with 2+2 oval organs. Ant IV with about 10 subsegments. Tita II row p:5 setae, length of longest setae of Tita III > 3x diameter of Tita. Formula of anterior setae of dens 2+1,2,1,1...1; mucro with narrow anterior furrow.

Secondary sexual characteristics of male: Abd VI dorsally with median crest, setae m1+2 as long, abruptly curved spines, DL1+2 as slender spines of equal form, other neighbouring setae forming a basket around tip, all setae curved posteriorly (Fig. 478), large abdomen posterodorsally with slightly swollen setae.

Proportions: Length of antennae : head diagonal = 2.1. Ant I : II : III : IV = 1 : 2.4 : 2.9 : 7.1. Dens : mucro = 2.7.

Type locality: Portugal, Beira Baixa, Idanha-a-Nova, in plantations of *Eucalyptus globulus*.

Occurrence: Also found at other sites in Portugal (e. g. SOUSA et al. 1997).

Remarks: In the 1st instar juveniles, the long setae of Tita III and the colour pattern are already developed.

*Bourletiella (Bourletiella) hortensis* (Fitch, 1863) (186)

Syn.: *Smynthurus hortensis* Fitch, 1863 (186)

*Smynthurus pruinus* Guthrie, 1903 (48), CHRISTIANSEN & BELLINGER 1981: 1151

*Bourletiella signata* Linnaniemi, 1912 (293)

*Bourletiella pruinosa* Kinoshita & Uchida, 1950 (21), YOSII 1977: 164

nec *Bourletiella hortensis* Stach, 1956 (149) ad partem (= *Bourletiella viridescens*)

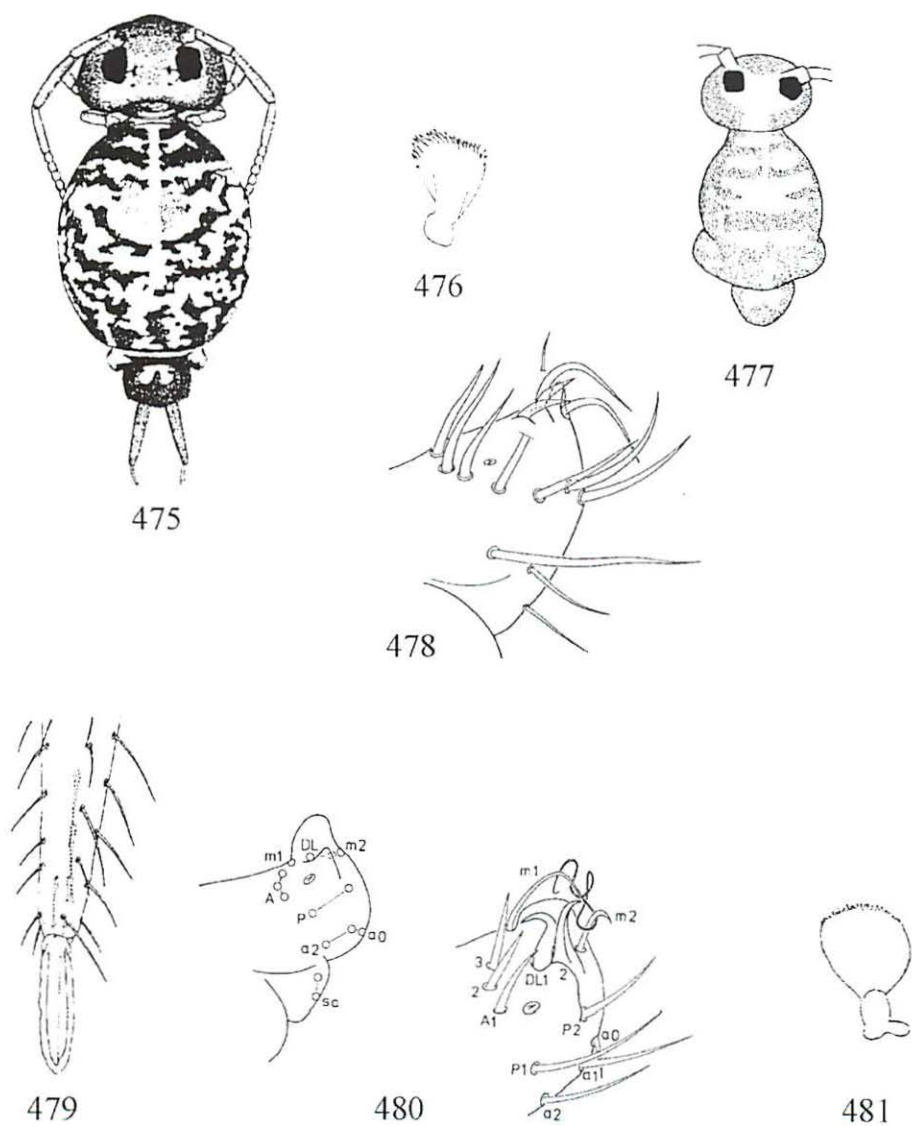
*Bourletiella hortensis* Hopkin, 1997 (41, 139) (= *Deuterostmynthurus sulphureus*)

Total length up to 1.8 mm in females, 0.9 mm in males. Main colour blackish blue; head and large abdomen dorsally more or less pale, males paler than females. Ventral head-back with 2+2 oval organs. Ant IV with about 7 subsegments. Tita II row p:3 setae, length of longest setae of Tita III  $\geq$  diameter of Tita. Formula of anterior setae of dens 2+1,2,1,1...1 (Fig. 479); mucro with very narrow anterior furrow or furrow only in basal 1/3. Secondary sexual characteristics: in males: Abd VI dorsally with median crest, seta m1 long and coiled, m2 short and curved posteriorly, DL1+2 as slender spines of equal form but curved oppositely (Fig. 480), large abdomen posterodorsally with slightly thickened setae; in females: circumanal setae a0 - av1 longer than others, ciliate, or slightly serrate, some setae sometimes with basal teeth. App. an. thin, broad fanlike, apically almost smooth (Fig. 481).

Proportions: Length of antennae : head diagonal = 1.5 in females, 1.6 in males. Ant I : II : III : IV = 1 : 2 : 3 (3.3) : 6 (6.3) in females (and males). Dens : mucro = 3. App. an. : mucro = 0.27.

Type locality: USA, New York, in gardens on leaves and soil.

Occurrence: Holarctic; in the Palaearctic from Japan (YOSII 1977: 164) and Russia (Siberia, STEBAEVA 1976: 124) W to Island (BÖDVARSSON 1967: 257) and S to Portugal, the Azores (GAMA 1992: 47), Spain (JORDANA et al. 1990: 34), and the Alps (Switzerland and Austria, GISIN 1946: 260, CHRISTIAN 1987: 58 respectively). Also found in N Vietnam (STACH 1965: 368), S Australia (GREENSLADE 1994: 120), New Zealand (SALMON 1941: 415), Hawaii (CHRISTIANSEN & BELLINGER 1992: 357), and S Africa (1 female, orig. observ., leg. SICK). The records from India (BAIJAL & MATHUR 1969: 257) and Korea (LEE 1973: 435) should be confirmed. Observed in a house in the Antarctic, Campbell Island, in thawed, imported soil (WISE 1967: 123).



Figs. 475 - 476 *Bourletiella cruciata* (after NAYROLLES 1995): 475 Habitus 476 App. an.

Figs. 477 - 478 *Bourletiella gamae* (after BRETFELD 1994): 477 Colour pattern 478 Male Abd VI.

Figs. 479 - 481 *Bourletiella hortensis*:

479 Dens, apical part with 2+1 anterodistal setae (after NAYROLLES 1995) 480 Male Abd VI, schematic and natural (after BRETFELD 1990), 481 App. an. (after STACH 1956).

Biology: *B. hortensis* is common and one of the most draught resistant and sun-loving Symphypleonan species: it can be found on hot, sunny garden slabs (orig. observ.) and concrete walls (SNIDER 1967: 227), post-fire sites (TAMM 1986: 113), raw man-made tip soils (DUNGER 1979: 13), small urban greens (STERZYNSKA 1987: 3), and flat roofs (orig. observ.). But it also lives in low, grassy or herbaceous vegetation or on agricultural soils, where it may occasionally damage plants (GREENSLADE & IRESOON 1986: 279). Mass occurrence has been observed several times on and in houses in Germany (orig. observ.). The large draught tolerance is also demonstrated by reports that eggs were laid with developed eye-patches (DELAMARE DEBOUTTEVILLE 1945: 80) and that juveniles occurred down to 0.5 m depth in vineyard soils (HÜTHER 1961: 337). *B. hortensis* has been collected up to the alpine regions at 2800 m altitude (Switzerland, CARL 1901: 277).

Species descriptions: GISIN 1946: 259, 1960: 286, CHRISTIANSEN & BELLINGER 1981: 1151, FJELLBERG 1984: 87 (maxillary outer lobe), BRETFELD 1990: 441 (chaetotaxy), NAYROLLES 1995: 45 (general, mainly chaetotaxy of the extremities).

Remarks: Females of *B. hortensis* differ from *B. arvalis* only in the colour, which also varies (CHRISTIANSEN & BELLINGER, see above).

*Bourletiella (Cassagnaudiella) luteovernalis* (Nayrolles, 1995) (51)

Syn.: *Cassagnaudiella luteovernalis* Nayrolles, 1995 (51)

Total length up to 1 mm in females, 0.75 mm in males. Background colour golden yellow, large abdomen posteriorly with more or less brownish pigment. Other characteristics as in *B. coeruleovernalis* (see above).

Proportions: Length of antennae : head diagonal = 1.6 in females, 1.7 in males. Ant I : II : III : IV = 1 : 2 : 3 : 6.4 (7) in females (and males). App. an. : mucro = 0.5.

Type locality: France, Ariège, between Suc and La Prade, in the low vegetation of a meadow with beeches at 960 m altitude.

Occurrence: Also found at another site in S France (Pyrénées-Orientales, Massif de Canigou) and in N Spain (Lérida, Sierra del Cadí) (NAYROLLES, see above).

Biology: *B. luteovernalis* lives in the vegetation of grasslands up to 1760 m altitude (France, the Pyrenees, NAYROLLES, see above).

Remarks: At the type locality, *B. luteovernalis* occurs together with *B. coeruleovernalis* without intermediate coloured specimens. There are also no intermediate colour forms between this species and *B. cadicensis* (NAYROLLES 1995: 59).

*Bourletiella (Bourletiella) pistillum pistillum* Gisin, 1946 (261)

*Bourletiella pistillum incisa* Ellis, 1975 (77)

Syn.: *Bourletiella pruinosa* Ågren, 1903 (164)

*Bourletiella agreni* Stach, 1956 (140), ELLIS 1975: 77

*Bourletiella mongolica* Betsch, 1977 (77) n. syn.

Total length up to 0.8 mm in females, 0.7 mm in males. Main colour blue with irregular, small, white points. Ventral head-back with 2+2 oval organs. Ant IV with about 7 subsegments. Tita II row p:3 setae, length of longest setae of Tita III 3 - 4x diameter of Tita. Formula of anterior setae of dens 2,2,1,1...1; mucro without anterior furrow or furrow only in basal 1/3.

Secondary sexual characteristics: in males: Abd VI dorsally with median crest, seta m1 of medium length and curved posteriorly, m2 short and curved anteriorly, DL1+2 as stout spines, DL1 about 2x broader than DL2 (Fig. 482), large abdomen posterodorsally with swollen, hooklike setae; in females: circumanal setae av1', av1, and av3 broad bandlike, sometimes with basal teeth. App. an. bandlike, distal 1/3 fringed, sometimes broadened or furcate (Figs. 474, 483).

Proportions: Length of antennae : head diagonal = 1.6 in females, 1.8 in males. Ant I : II : III : IV = 1 : 2 : 3 (3.2) : 7 (7.5) in females (and males). Dens : mucro = 3. App. an. : mucro = 0.6.

Type locality: Switzerland, the Grisons, in the low vegetation of a pasture at 2400 m altitude.

Occurrence: Palaearctic; found in Scandinavia (Finland, LINNANIEMI, ELLIS, see below; S Sweden, ÅGREN, see above; N Sweden, orig. observ., leg. v. TSCHIRNHAUS; Norway, FJELLBERG 1980: 135), Germany (North Rhine-Westphalia near Wuppertal, KAMPMANN 1977: 95; Rhineland-Palatinate, Eifel Mts., HÜTHER 1982: 98; Saxony, Oberlausitz, SCHULZ & DUNGER 1995: 16), Luxembourg (ELLIS, see below), Czech Rep. and Slovakia (NOSEK 1969: 404, DUNGER 1970: 503), Austria (Lower Austria, BAUER 1993: 240; Tyrol, CHRISTIAN 1987: 58 and orig. observ., leg. BRETTFELD, leg. MERTENS), Switzerland (see type locality and LIENHARD 1980: 369, LIENHARD et al. 1981: 585), former Yugoslavia (e. g. CVIJOVIC 1974: 112), Italy (N Italy, the Dolomites, orig. observ., leg. BRETTFELD; Tuscany, Apuane Alps, DALLAI 1970: 467), France (Ain, Jura Mts., GISIN 1948: 494; the Central Pyrenees, CASSAGNAU 1964: 463; S France and Corsica, IZARRA 1969: 459, POINSOT 1974: 126), and N Spain (JORDANA et al. 1990: 34). Doubtfully recorded from S Russia (SE Altay Mts., STEBAEVA 1976: 124). *B. mongolica* has been described originally from Mongolia (Central district).

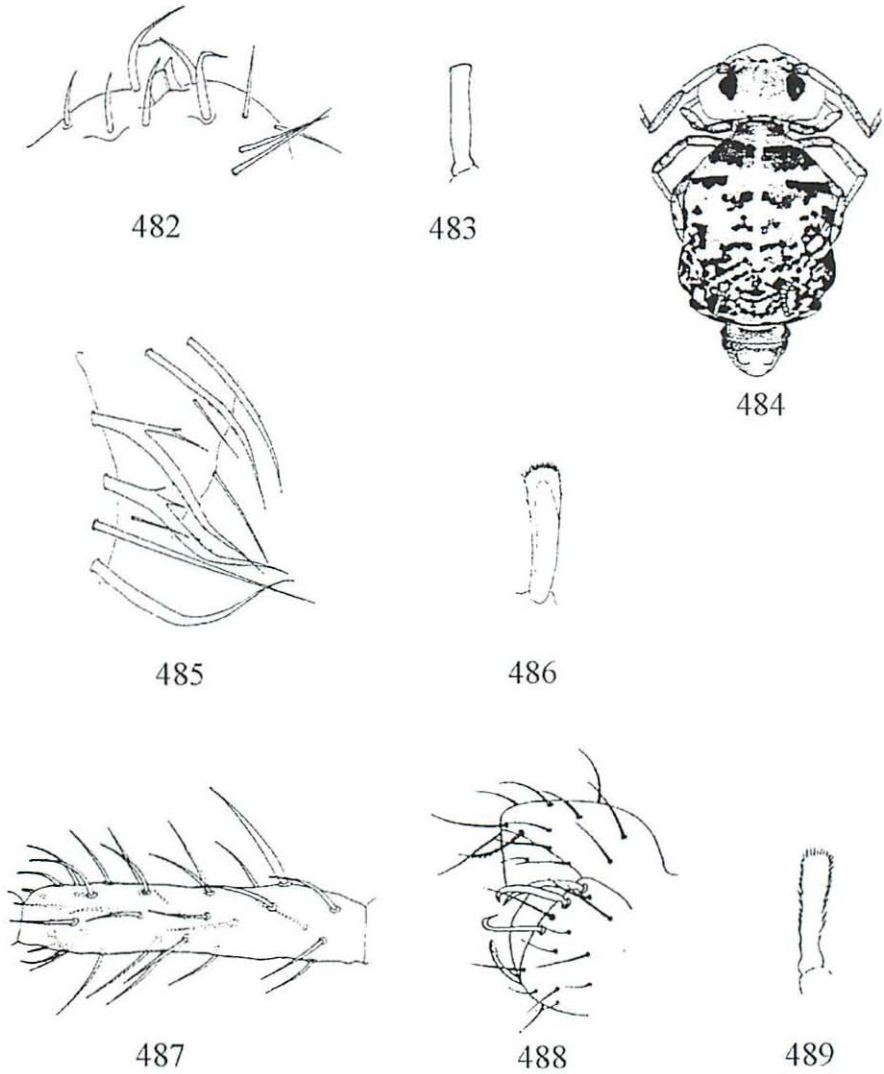
Biology: *B. pistillum* usually lives in open, dry, and low vegetation in the mountain and alpine regions, seldom in moister habitats, in forests, and in moss. It occurs in the Alps of Switzerland between about 1400 - 2500 m altitude (GISIN 1948: 505, LIENHARD et al. 1981: 585) and in France, the Pyrenees, between 1800 - 2400 m (CASSAGNAU, see above).

Species descriptions: LINNANIEMI 1912: 296, ELLIS 1975: 76, FJELLBERG 1984: 87 (maxillary outer lobe), NAYROLLES 1995: 47 (general, mainly chaetotaxy of the extremities).

Remarks: The males of *B. pistillum incisa*, occurring in Luxembourg and the Pyrenees, have a low, notched median crest on Abd VI and much stronger dorsal setae on the large abdomen than the type and those from Scandinavia (ELLIS, see above).

The secondary sexual characteristics of *B. mongolica* are like those of *B. pistillum*; this synonymy thus seems correct, although the females are larger in *B. mongolica* and the chaetotaxic characteristics have not been described.

The App. an. of *B. pistillum* resemble those of *B. canigouensis* (see above).



Figs. 482 - 483 *Bourletiella pistillum*:

482 Male Abd VI, tip (after ELLIS 1975) 483 App. an. (after GISIN 1946).

Figs. 484 - 486 *Bourletiella pruinosa*:

484 Colour pattern (after NAYROLLES 1995) 485 Female circumanal setae (after ELLIS 1975)  
486 App. an. (after ELLIS 1975).

Figs. 487 - 489 *Bourletiella radula*:

487 Male Ant III (after NAYROLLES 1995) 488 Female circumanal setae (after GISIN 1960)  
489 App. an. (after GISIN 1946).

*Bourletiella* (*Cassagnaudiella*) *pruinosa* (Tullberg, 1871) (145) sensu Ellis, 1975 (74) and Nayrolles, 1995 (54)

Syn.: *Sminthurus pruinus* Tullberg, 1871 (145)

*Bourletiella radula* Cassagnau 1964 b (467) ad partem, NAYROLLES 1995: 44

*Bourletiella radula* Raynal, 1974 (182) ad partem, NAYROLLES 1995: 44

Total length up to 1.5 mm in females, 0.9 mm in males. Background colour yellow, without other pigment or with orange or dirty blue spots and stripes (Fig. 484). Cuticle of head frons and clypeus with large granules, some as large as or larger than the basal diameter of setae. Ventral head-back with 2+2 oval organs. Ant IV with about 7 subsegments. Tita II row p:5 setae, length of longest setae of Tita III nearly 3x diameter of Tita. Formula of anterior setae of dens 2,2,1,1...1; mucro with narrow anterior furrow. Secondary sexual characteristics: in males missing; in females: circumanal setae av1', av1, and av3 broad bandlike, fringed, with basal teeth or pointed branches (Fig. 485). App. an. bandlike, apically broadened, and distal 1/3 ciliate. (Fig. 486).

Proportions: Length of antennae : head diagonal = 1.5 in females, 1.7 in males. Ant I : II : III : IV = 1 : 2.3 : 2.9 (3.1) : 6 (6.4) in females (and males). Dens : mucro = 2.5. App. an. : mucro = 0.5.

Type locality: Sweden, isle of Gotland, in short grass of a dry meadow.

Occurrence: Found throughout Scandinavia (S Sweden, ÅGREN 1903: 164; the whole of Finland, LINNANIEMI 1912: 296; S Norway, FJELLBERG 1980: 135, 1987: 73), the Netherlands (ELLIS, see above), S France (NAYROLLES, see above), S Portugal (GAMA et al. 1989: 366), N Spain (NAYROLLES, see above, and orig. observ. ex coll. ARBEA), and Austria (Carinthia, Kreuzeck Mts., near Sattlegger House, orig. observ., leg. BRETFELD).

Biology: *B. pruinosa* generally lives on low grass or *Calluna* of open habitats up to 2200 m altitude (France, the Pyrenees, NAYROLLES, see above). In the Netherlands (ELLIS, see above), SW France (NAYROLLES, see above), and Portugal (GAMA et al., see above), it lives in the low, dry vegetation of coastal dunes or of dune valleys. In all populations studied by NAYROLLES (see above), the adult females have an additional instar without secondary sexual characteristics. The colour varies from darker low land to complete yellow subalpine populations (NAYROLLES, see above); the latter have apparently been assumed to be sexually neutralized specimens of *Bourletiella radula*, i. e. to lack secondary sexual characteristics (CASSAGNAU, RAYNAL, NAYROLLES, see above).

Species descriptions: FJELLBERG 1984: 87 (maxillary outer lobe), NAYROLLES 1995: 54 (colour varieties, chaetotaxy mainly of extremities).

Remarks: Old records need to be confirmed since *B. pruinosa* has been confused with *B. hortensis*, e. g. the records of *B. pruinosa* from Japan and N America belong to *B. hortensis* (YOSII 1977: 164, CHRISTIANSEN & BELLINGER 1981: 1151 respectively).

*Bourletiella (Bourletiella) radula* Gisin, 1946 (260) sensu Nayrolles, 1995 (47)

nec *Bourletiella radula* Cassagnau 1964 b (467) ad partem, (= *Bourletiella pruinosa*, NAYROLLES 1995: 44)

*Bourletiella radula* Raynal, 1974 (182) ad partem, (= *Bourletiella pruinosa*, NAYROLLES 1995: 44)

Total length up to 1 mm in females, 0.7 mm in males. Main colour yellow; sometimes, mainly in males, posterior of large abdomen washed with ochre; antennae brown; frontal eye dark. Ventral head-back with 1+1 ventral oval organs. Ant IV with about 7 subsegments. Tita II row p:3 setae, length of longest setae of Tita III 2 - 3x diameter of Tita. Formula of anterior setae of dens 2,2,1,1...1; mucro without anterior furrow. Secondary sexual characteristics: in males: Ant III dorsobasally with 1 thick spine (Fig. 487), Abd VI dorsally with median crest, setae m1+2 of medium length, m1 spinelike and curved posteriorly, m2 curved anteriorly, DL1+2 as stout spines and DL1 about 1.5x thicker than DL2 (see Fig. 482), large abdomen posterodorsally with swollen, hooklike setae; in females: circumanal setae av1', av1, and av3 broad bandlike, sometimes with basal teeth (Fig. 488). App. an. bandlike, distal 3/4 fringed, not broadened or furcate (Fig. 489).

Proportions: Length of antennae : head diagonal = 1.6 in females, 2 in males. Ant I : II : III : IV = 1 : 2.2 : 3.3 : 7.2 (7.5) in females (and males). Dens : mucro = 3. App. an. : mucro = 0.6.

Type locality: Switzerland, the Grisons, in a rich meadow near Scarl.

Occurrence: Also found at other sites in Switzerland (the Alps and low lands, GISIN 1948: 505), in S France (CASSAGNAU 1961: 34, THIBAUD & STOMP 1978: 13, STOMP et al. 1982: 22, NAYROLLES, see above), N Spain (JORDANA et al. 1990: 34, MATEOS & SELGA 1991: 27), and former Yugoslavia (e. g. CVIJOVIC 1974: 93).

Biology: *B. radula* lives in meadows up to subalpine and alpine regions of 2100 m altitude in the Alps of Switzerland (GISIN 1948: 494, 505), and 2200 m or perhaps 2600 m altitude in France, the Pyrenees (NAYROLLES, see above, CASSAGNAU 1964 b: 463 respectively).

Species descriptions: JUBERTHIE & CASSAGNAU 1971: 62 (neuroendocrine system), ELLIS 1975: 77.

Remarks: Specimens of *B. radula* have apparently been confused with completely yellow *B. pruinosa* and thus supposed to be sexually neutralized, i. e. to lack secondary sexual characteristics (CASSAGNAU, RAYNAL, NAYROLLES, see above).

*Bourletiella (Bourletiella) sicki* Bretfeld, 1994 (149)

Total length up to 0.9 mm in females, 0.7 mm in males. Main colour blackish blue with pale parts; head dorsally with large pale region, large abdomen with irregular, pale cross stripes or patches (Fig. 490). Ventral head-back with 2+2 oval organs. Ant IV with about 7 subsegments. Tita II row p:3 setae, length of longest setae of Tita III > 2x diameter of Tita. Formula of anterior setae of dens 2+1,2,1,1...1; mucro with narrow anterior furrow. Secondary sexual characteristics: in males: Abd VI dorsally with median crest, setae A1-3, m1, and DL1 as stout spines, A3 with lateral tooth, m1 longer than m2, DL1 broader than DL2, all curved posteriorly (Fig. 491), large abdomen dorsally with rather normal setae; in females: circumanal setae a0 - av1 stronger than others and with long fringes, a1 sometimes with basal teeth. App. an. broad fanlike, apically with rough teeth (Fig. 492).



Proportions: Length of antennae : head diagonal = 1.5 in females, 1.9 in males. Ant I : II : III : IV = 1 : 1.8 : 2.9 : 6.2 in females, 1 : 2.1 : 3.2 : 7.1 in males. Dens : mucro = 2.8. App. an. : mucro = 0.25.

Type locality: Spain, Balearic Islands, Minorca, Cala'n Bosch, collected by colour traps in a *Pinus* forest with low vegetation.

Occurrence: Also known from Spain, Balearic Islands, Ibiza (BRETTFELD, see above).

Biology: In Minorca, *B. sicki* also occurs in the low vegetation of sand and dunes with *Phragmites* near the shore and in the maquis; in Ibiza, it has been collected from fallow land and in a *Pinus* forest.

*Bourletiella (Bourletiella) viridescens* Stach, 1920 (199) sensu Gisin, 1948 (501)

Syn.: *Bourletiella signata* var. *viridescens* Stach, 1920 (199)

*Bourletiella arvalis* var. *fusca* Womersley, 1932 a (27), GREENSLADE 1994: 120

*Bourletiella arvalis* var. *dorsobscura* Salmon, 1941 (415) (?)

*Bourletiella lutea* Gisin, 1946 (258)

*Bourletiella hortensis* Stach, 1956 (149) ad partem

Total length up to 1.5 mm in females, 0.9 mm in males. Main colour yellow, large abdomen sometimes washed with blue or green; antennae brown; frontal eye dark. Ventral head-back with 2+2 oval organs. Ant IV with about 7 subsegments. Tita II row p:3 setae, length of longest setae of Tita III > 2x diameter of Tita. Formula of anterior setae of dens 2+1,2,1,1...1; mucro without or with very narrow anterior furrow. Secondary sexual characteristics: in males: Abd VI dorsally with median crest, seta m1 long and coiled, m2 as a hooklike spine, DL1 as a stout spine, broader than DL2, all curved posteriorly (Fig. 493), large abdomen posterodorsally sometimes with swollen, hooklike setae; in females: dorsal circumanal setae slightly ciliate, setae av1' and av1 sometimes stronger than others. App. an. narrow, spatulate or blunt, outer edge often thick, other edges thin and finely serrate (Figs. 494).

Proportions: Length of antennae : head diagonal = 1.7 in females, 1.9 in males. Ant I : II : III : IV = 1 : 2 : 3 : 6 (6.4) in females (and males). Dens : mucro = 2.7. App. an. : mucro = 0.3.

Type locality: S Poland, Pieniny Mts., in the low vegetation of meadows and on clover.

Occurrence: Europe, introduced to S Australia (GREENSLADE 1994: 120) and perhaps to New Zealand (SALMON, see above); in Europe known from many countries, even from Portugal, the Azores (GAMA 1992: 47), but not e. g. from N Scandinavia and Italy. Some further, original observations are from Finland (Bergö, leg. AXELSON), S Sweden (near Kristineberg Biol. Stat., leg. PRINZING), S Spain (isle of river Guadalquivir, leg. SCHULTE), and (leg. BRETTFELD) Austria (Burgenland, near Apetlon; Upper Austria, Mühlviertel), France (Essonne, near Brunoy), former N Yugoslavia (near Zagreb), and Germany (several localities in Schleswig-Holstein, Lower Saxony, and Hesse).

Biology: *B. viridescens* often occurs in large numbers, it lives in dry and wet grassland vegetation from the sea-shore (ALTNER 1963: 37, 53, PALISSA 1969: 51) and dunes (ELLIS 1973: 197, GAMA et al. 1989: 366) up to subalpine regions at 1700 m altitude (CASSAGNAU 1964 b: 463). It also occurs in lawns (orig. observ. and GREENSLADE & IRESO 1986: 279), post-fire sites (TAMM 1986: 113), and field crops (Australia, damage not confirmed, GREENSLADE & IRESO, see above).

In the populations studied by NAYROLLES (see below), the adult females have a facultative, additional instar without secondary sexual characteristics.

Species descriptions: GISIN 1955: 147, 1957: 490, 1960: 287, MURPHY 1960: 61, NAYROLLES 1995: 45.

Remarks: The population of *B. viridescens* from Portugal (Algarve, Vila Real de Santo Antonio, orig. observ., leg. SERRANO, see GAMA et al. 1989: 366) has more pointed App. an. Some other original observations are added above. GISIN (see above) and PALISSA (1964: 260) confused the App. an. with those of *B. arvalis*. *Sminthurus luteus* Lubbock is commented on under *Deuterostminthurus sulphureus*.

### Genus *Cyprania* Bretfeld, 1992

#### Key to the Palaearctic species

- 1 Large abdomen with diffuse grey to brown pigment; dorsal circumanal setae in females obliquely cut and partially ciliate (Fig. 496) *gisae* Bretfeld, 1992
- Large abdomen with blue spots at the bases of all Bothr; dorsal circumanal setae in females acuminate with small fringes *inopinata* Bretfeld, 1996

Remarks: This key does not contain the species *Fasciosminthurus coronatus* and *lacazei* (see below under *Fasciosminthurus*), the empodia of which resemble those of *Cyprania* and not of *Fasciosminthurus*.

#### Diagnosis of the genus

Large abdomen elongate, row 5:1 seta. Ant IV with large sensillum P on 3rd whorl behind the tip, with 2 ventral and 12 tip sensilla (see Figs. 11, 12). Some inner setae of Tita obliquely truncate, seta Ia missing, II present (Fig. 23). Tita I - III with 3, 3, 2 spatulate setae respectively. All Emp without lamellae, pointed, with long, slightly externally curved, spatulate subapical filaments, length > claws (Fig. 466). Most anterior setae of dens longer than the spaces between rows; formula of anterior setae 3+1,2,1,1...1. Secondary sexual characteristics: in males missing; in females: some circumanal setae fringed or obliquely cut.

Occurrence: SE Palaearctic (Cyprus, S Russia, Kazakhstan).

Descriptions of the genus: BRETFELD 1992: 45, 1996: 218.

Type species: *Cyprania gisae* Bretfeld, 1992.

#### Diagnosis of the Palaearctic species

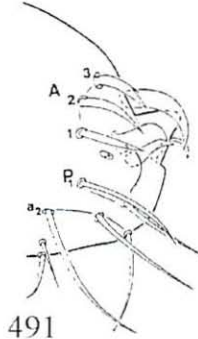
*Cyprania gisae* Bretfeld, 1992 (46)

Total length up to 0.9 mm in females, 0.6 mm in males. Background colour yellow to orange, with grey to brown pigment mainly in a bow posteriorly and laterally on large abdomen; head, legs, and furca without grey pigment, antennae brown, head of briefly fixed specimens with additional white spots. Ant III whorls 3, 6, 7 with 2, 5, 3 setae respectively (Fig. 495). Dens row J:4 (seldom 3 or 5) distal and 0 - 1 (seldom 2) proximal setae. Abd VI dorsally without oval organs; in females dorsal circumanal setae a1 and a2 stout, basal part broad, obliquely cut, and roughly ciliate, distal part acuminate (Fig. 496); ventral setae av1 and av3 thick, av1 fringed, av3 smooth. App. an. short bandlike with several round teeth (Fig. 497).

Proportions: Length of antennae : head diagonal = 1.65 in females, 1.75 in males. Ant I : II : III : IV = 1 : 1.9 : 2.6 : 5.6. Dens : mucro = 3. App. an. : mucro = 0.3.



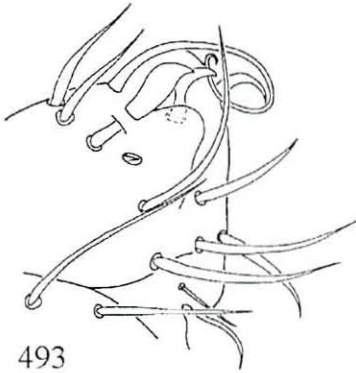
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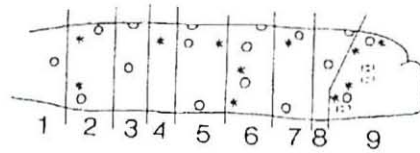
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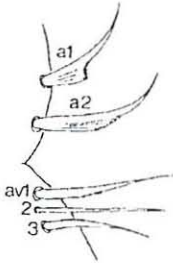
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Figs. 490 - 492 *Bourletiella sicki* (after BRETFELD 1994):

490 Colour pattern 491 Male Abd VI, tip. 492 App. an.

Figs. 493 - 494 *Bourletiella viridescens* (orig.): 493 Male Abd VI, dorsal part 494 App. an.

Figs. 495 - 497 *Cyprania gisae* (after BRETFELD 1992):

495 Ant III schematic 496 Female circumanal setae 497 App. an.

Fig. 498 *Cyprania inopinata*, 2 different App. an. (after BRETFELD 1996).

Type locality: Cyprus, SW coast, valley of the Diarizos River, herbaceous meadow of valley slope at 200 m altitude.

Occurrence: Also found in Kazakhstan (S Turgay Reg., BRETFFELD 1996: 216).

Biology: *C. gisae* lives in the herbaceous vegetation of valley slopes and flood plains.

Species description: BRETFFELD 1996: 216.

*Cyprania inopinata* Bretfeld, 1996 (216)

Total length up to 1 mm in females, 0.6 mm in males. Background colour yellow to whitish with blue spots at the bases of Bothr ABCDE, large abdomen seldom with blue shadow or 1+1 pale blue horizontal bands posteriorly; Abd IV with 1+1 short blue stripes, Abd V with blue cross stripe; antennae brown, legs and furca unpigmented. Ant III whorls 3, 6, 7 with 1, 4, 2 setae respectively (see Fig. 495). Dens row J:4 (seldom 3) distal and 2 proximal setae. Abd VI dorsally with 1+1 oval organs; in females dorsal circumanal setae a0, a1, a2 thick, a1 and a2 fringed, ventral setae av1 and av3 slightly thicker than others and smooth. App. an. long, broad, apically narrowed, with small or rough teeth (Fig. 498).

Proportions: Length of antennae : head diagonal = 1.6. Ant I : II : III : IV = 1 : 2 : 2.5 : 5.5. Dens : mucro = 3. App. an. : mucro = 0.6.

Type locality: Kazakhstan, Pavlodar Reg., Osmeryzsk, meadow with *Agrostis* in the floodplain of the Irtish River.

Occurrence: Also found at other sites in Kazakhstan (Pavlodar and Turgay Regs.) and in Russia (Semipalatinsk, Khakasia, and Irkutsk Regs., BRETFFELD, see above).

Biology: *C. inopinata* lives mostly in wet grassland vegetation but also in dry ones and in steppe vegetation.

**Genus *Deuterosminthurus* Börner, 1901 sensu Stach, 1955**

**Key to the Palaearctic species**

- |   |  |  |   |
|---|--|--|---|
| 1 | Abdomen with 2 dark cross bands (Figs. 499) or many dark points          | <i>bicinctus</i> (Koch, 1840)  |   |
| – | Abdomen only yellow or with other pigmentation                           |  | 2 |
| 2 | Abdomen with large violet patches or more or less completely dark violet | <i>pallipes</i> (Bourlet, 1843), f. <i>fenyesi</i> (Stach, 1926) and f. <i>principalis</i> |   |
| – | Abdomen with other pigmentation  |  | 3 |
| 3 | Abdomen with only 7 violet lateral patches (Fig. 504)                    | <i>quadrangulatus</i> (Loksa & Bogojevic, 1970)  |   |
| – | Abdomen without such violet patches                                      |  | 4 |
| 4 | Large abdomen yellow or with diffuse darker pigment                      |  | 5 |
| – | Large abdomen with brown spots (Fig. 502)                                | <i>maculatus</i> Nayrolles, 1996   |   |
| 5 | Dens with 2 anterodistal setae (as in Fig. 473)                          | <i>ezoensis</i> Yosii, 1972  |   |
| – | Dens with 3+1 anterodistal setae (as in Fig. 27)                         |  | 6 |
| 6 | Female   |  | 7 |
| – | Male   |  | 9 |

- 7 Length of circumanal setae av1' and av1 almost = av2 (see Fig. 30) **8**  
 – Length of circumanal setae av1' and av1 << av2 (Figs. 30, 505)  
*sulphureus* (Koch, 1840) and *pleuracanthus* Nayrolles, 1996
- 8 Femur III with, rarely without, seta d7 (as in femur II, see Fig. 22); Tita I - III rows p:7 (or 6), 3 - 5, 2 setae respectively *pallipes* f. *repanda* (Ågren, 1903)  
 – Femur III without seta d7 (Fig. 22); Tita I - III rows p:5 (or 6), 3, 2 setae respectively  
*bicinctus* f. *flava* (Gisin, 1946)
- 9 (6) Large abdomen posteriorly with only normal setae **10**  
 – Large abdomen posteriorly also with swollen, spinelike setae  
*pleuracanthus* Nayrolles, 1996
- 10 Ant I and II dorsally with only normal setae, head clypeus laterally with long, thin setae **11**  
 – Ant I and II dorsally with spinelike setae, head clypeus laterally with thick setae  
*pallipes* f. *repanda* (Ågren, 1903)
- 11 Length of longest outer setae of Tita III  $\geq$  diameter of Tita; Abd VI dorsally with only long setae *bicinctus* f. *flava* (Gisin, 1946)  
 – Length of outer setae of Tita III > 2x diameter of Tita; Abd VI dorsally with long and short setae **12**
- 12 Abd VI dorsally with 1+1 long, thick sabrelike setae (Fig. 506)  
*sulphureus sulphureus* (Koch, 1840)  
 – These setae long, but not thick sabrelike *sulphureus mediterraneus* Ellis, 1974

Remarks: This key follows BRETFFELD (1996: 210) concerning *D. bicinctus* and its f. *flava* (see below) and NAYROLLES (1996: 536) who united the species, subspecies, or forms described as *D. pallipes*, *repandus*, *mixtus*, *fenyesi*, and *beckeri* under one species, *D. pallipes*.

The characteristics of the males are the best to identify the species.

### Diagnosis of the genus

Large abdomen elongate, row 5:1 seta. Ant IV with large sensillum P on 1st whorl behind the tip, with 3 ventral and 12 tip sensilla (see Figs. 11, 12). Inner setae of Tita not obliquely truncate, setae Ia and Ii present (see Fig. 23). Tita I - III with 3, 3, 2 spatulate setae respectively. All Emp with narrow lamellae, pointed, without filaments, length < claws (Fig. 461). Anterior setae of dens shorter than the spaces between rows; formula of anterior setae mostly 3+1,1,1...1, seldom 2,2..1. Secondary sexual characteristics: in males: some setae of head, Ant I and II, large abdomen, and Abd VI modified in a few species; in females: 2 species with some circumanal setae smaller than others (Fig. 505).

Occurrence: Holarctic and S Australia.

Descriptions of the genus: BÖRNER 1901: 104, STACH 1955: 53, 1956: 156, BETSCH 1980: 176, CHRISTIANSEN & BELLINGER 1981: 1159, NAYROLLES 1996: 535.

Type species: *Smynthurus bicinctus* Koch, 1840.

### Diagnosis of the Palaearctic species

*Deuterominthurus bicinctus* (Koch, 1840) (353) sensu Stach, 1956 (171)

Syn.: *Smynthurus bicinctus* Koch, 1840 (353)

*Sminthurus cinctus* Tullberg, 1871 (145)

*Bourletiella (Deuterominthurus) flava* Gisin, 1946 (254)

*Bourletiella (Deuterominthurus) bicincta* Gisin, 1946 (255)

*Deuterominthurus flavus* Nayrolles, 1996 (541)

Total length 0.8 mm in females, 0.6 mm in males. Background colour white to yellowish, dark black pigment in 2 broad patches mainly dorsally on large abdomen (Fig. 499) or in small points (var. *puncteola* Börner, 1901: 112), or uniformly yellow (f. *flava* Bretfeld, 1996: 210); extremities unpigmented. Ventral head-back without oval organs. Ant IV with 7 subsegments. Femur III without seta d7 (Fig. 22). Tita I - III rows p:5 (or 6), 3, 2 setae respectively; length of longest setae of Tita III  $\geq$  diameter of Tita. Claws with or without small basal and distal inner teeth. Abd VI dorsally with 2 median setae. App. an. bandlike, tip cut or pointed, tip or distal 1/3 with rough teeth (Fig. 500). Formula of anterior setae of dens 3+1,1,1...1. Secondary sexual characteristics in males: most setae of dorsal parts of head short and thicker than others, those near the antennae long and thick, clypeus with short median setae, laterally with long, thin setae; Ant I and II with only normal setae; Abd VI dorsally with only long setae.

Proportions: Length of antennae : head diagonal = 1.7 in females, 2.3 in males. Ant I : II : III : IV = 1 : 2 : 3 (3.2) : 5.5 (6.5) in females (and males). Dens : mucro = 3. App. an. : mucro = 0.55.

Type locality: Germany, Regensburg, on gardens plants.

Occurrence: Palaearctic, introduced to S Australia (f. *flava*, GREENSLADE 1994: 122); in the Palaearctic from Japan (YOSHII 1977: 165) to N Scandinavia (orig. observ., leg. v. TSCHIRNHAUS) and the Faroe Islands (BÖDVARSSON 1960: 174), S to S Russia (STEBAEVA 1976: 126), former Yugoslavia (e. g. CVIJOVIC 1976: 105), Austria (CHRISTIAN 1987: 58, KOPEŠKI & MEYER 1994: 158), and Spain (JORDANA et al. 1990: 42, 43; MATEOS & SELGA 1991: 27; NAYROLLES 1996: 540, 541). Not recorded from Ireland (BOLGER 1986: 210) and Italy.

Biology: *D. bicinctus* usually lives in the low vegetation of deciduous forests and on bushes (GISIN 1960: 289), has also been recorded from sunny meadows (STACH, see above) but does not occur in subalpine habitats of the Austrian Alps (BRETFFELD 1972: 122); in France, the Pyrenees, it has been collected up to 1800 m altitude (CASSAGNAU 1964 b: 463). It has been rarely found in sand from groundwater samples (PICARD 1962: 471, BRETSCHKO & CHRISTIAN 1989: 494) and occasionally occurs in large numbers (in a house, ROSSEM 1954: 246).

In courtship behaviour, the male steps back from the female to a large distance, spreads its antennae laterally, and imitates the deposition of a spermatophore in front of the female (BRETFFELD 1970: 262).

Species descriptions: BRETFFELD 1990: 441 (chaetotaxy), NAYROLLES 1996: 536, 540, 541 (general, status of *f. flava*, mainly chaetotaxy of the extremities).

Remarks: The problem with *D. bicinctus* and its *f. flava* is whether the yellow specimens are a separate species (NAYROLLES, see above) or only a colour form (BRETFFELD 1996: 210). The latter was concluded since the chaetotaxy is identical and mixed couples were observed in mating behaviour (BRETFFELD 1970: 264, 271). The *f. flava* seems to tolerate dryer habitats (GISIN 1948: 512).

*Deuterostminthurus ezoensis* Yosii, 1972 (95)

Total length 0.75 mm in females, 0.6 mm in males. Colour pale brownish. Ant IV with 8 subsegments. Claws with small basal inner tooth. App. an. bandlike, distal 1/2 with long fringes (Fig. 501). Formula of anterior setae of dens 2,1...1. Secondary sexual characteristics not described.

Proportions: Length of antennae : head diagonal = 1.6. Ant I : II : III : IV = 1 : 1.8 : 2.8 : 5. Dens : mucro = 3.

Type locality: Japan, Hokkaido, Mt. Poroshiri.

Occurrence: Known only from the type locality.

Remarks: The reduced anterior setae of dens are unique in *Deuterostminthurus*; if these findings are correct, *D. ezoensis* should be placed in another, new genus.

*Deuterostminthurus maculatus* Nayrolles, 1996 (543)

Total length 0.9 mm in females, 0.6 mm in males. Background colour yellow, brown pigment on large abdomen in several patches in a constant pattern (Fig. 502), males anteriorly paler; antennae light brown. Ventral head-back with 1+1 oval organs. Ant IV with 8 subsegments. Femur III with seta d7 (see Fig. 22). Tita I - III rows p:7, 5, 2 setae respectively; length of longest setae of Tita III  $\geq$  diameter of Tita. Claws with or without small basal and distal inner teeth. Abd VI dorsally with 2 median setae. App. an. bandlike, distal 1/4 pointed and with rough teeth (Fig. 503). Formula of anterior setae of dens 3+1,1,1...1. Secondary sexual characteristics in males: head clypeus laterally with some long and thick setae, Ant I and II with several spinelike setae.

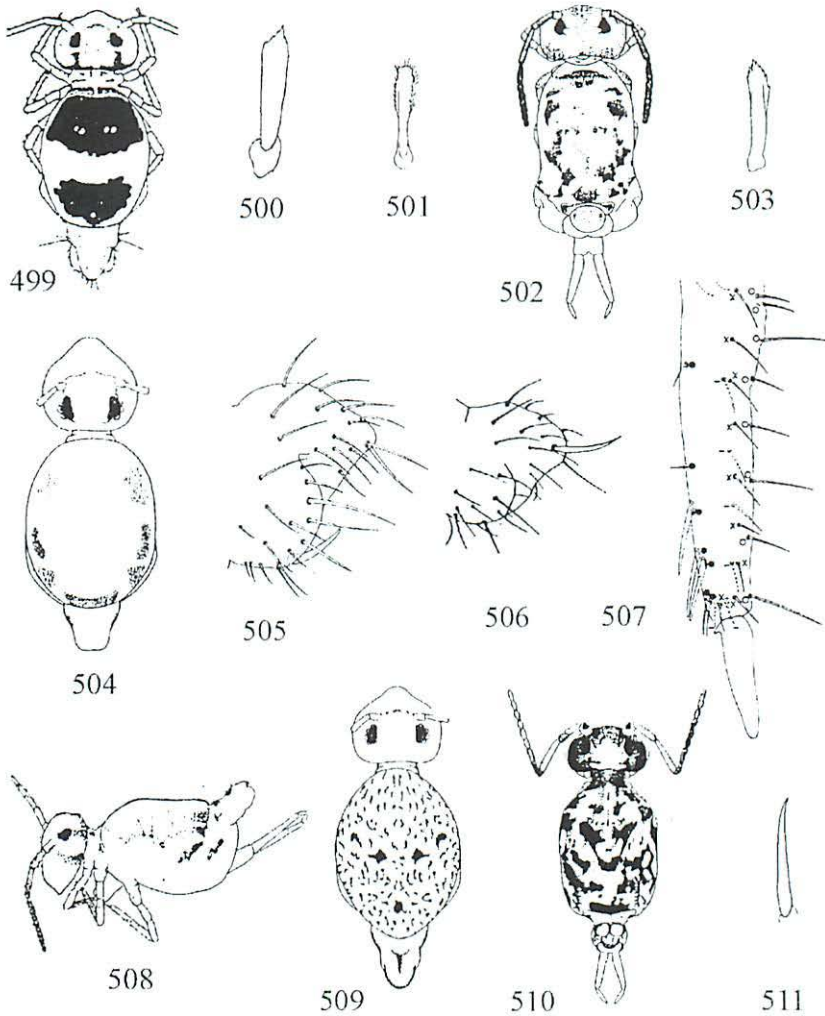
Proportions: Length of antennae : head diagonal = 1.6 in females, 2 in males. Ant I : II : III : IV = 1 : 1.8 : 2.6 (2.8) : 5.1 (5.5) in females (and males). App. an. : mucro = 0.5.

Type locality: S France, Aveyron, Causse Comtal, on *Juniperus communis* at 620 m altitude.

Occurrence: Also found at other sites in S France (Aveyron, Aude, Haute-Garonne).

Biology: *D. maculatus* lives on grass, herbs, and shrubs of the Mediterranean but has also been collected in a moor on *Pteridium* at 680 m altitude.

Remarks: *D. maculatus* differs from *D. pallipes* only by its constant colour pattern; it may also be a colour variety of the latter.



Figs. 499 - 500 *Deuterosminthurus bicinctus* (after STACH 1956): 499 Habitus 500 App. an.  
 Fig. 501 *Deuterosminthurus ezoensis*, App. an. (after YOSHII 1972).  
 Figs. 502 - 503 *Deuterosminthurus maculatus* (after NAYROLLES 1996): 502 Colour pattern  
 503 App. an.  
 Fig. 504 *Deuterosminthurus quadrangulatus*, colour pattern (after LOKSA & BOGOJEVIC 1970).  
 Figs. 505 - 506 *Deuterosminthurus sulphureus*: 505 Female Abd VI (after ELLIS 1974) 506 Male  
 Abd VI (after GISIN 1960).  
 Fig. 507 *Ellisiella pandayi*, dens (after ELLIS 1974). Fig. 508 *Fasciosminthurus albanicus*, colour  
 pattern (after STACH 1956).  
 Fig. 509 *Fasciosminthurus angulipunctatus*, colour pattern (after LOKSA & BOGOJEVIC 1970).  
 Figs. 510 - 511 *Fasciosminthurus bedosae* (after NAYROLLES 1994): 510 Habitus 511 App. an.



*Deuterominthurus pallipes* (Bourlet, 1842) (XLI) sensu Nayrolles, 1996 (536, 546)

Syn.: *Sminthurus pallipes* Bourlet, 1842 (XLI)

*Sminthurus speciosus* Krausbauer, 1898 (498), KRAUSBAUER 1905: 41

*Sminthurus repandus* Ågren, 1903 (163)

*Deuterominthurus repandus* Stach, 1920 (201)

*Deuterominthurus fenyesi* Stach, 1926 (82)

*Bourletiella (Deuterominthurus) mixta* Gisin, 1946 (254), GISIN 1957: 492

*Deuterominthurus beckeri* Coineau & Delamare Deboutteville, 1961 (161), CAS-SAGNAU 1964: 452

Total length up to 1 mm in females, 0.6 mm in males. Background colour yellow, often without other pigment or posteriorly orange (f. *repanda* n. comb.), with red violet spots (f. *fenyesi* n. comb.), or more or less dark violet (f. *principalis*), males generally more intensely coloured than females; antennae yellow to brown. Ventral head-back with 1+1 oval organs. Ant IV with 6 - 8 subsegments. Femur III with, rarely without, seta d7 (as in femur II, see Fig. 22). Tita I - III rows p:7 (or 6), 3 - 5, 2 setae respectively; length of longest setae of Tita III  $\geq$  diameter of Tita. Claws with small or large (f. *fenyesi*) distal inner tooth, sometimes also with small basal inner tooth. Abd VI dorsally with 0 - 2 median setae. App. an. varying: bandlike, often distally broadened, pointed or tip round with few or rough teeth, sometimes split and distal 1/2 with rough teeth. Formula of anterior setae of dens 3+1,1,1...1. Secondary sexual characteristics in males: lateral setae of head frons short and thicker than others, those near the antennae long and thick, clypeus with short median setae, laterally with long, thick setae; Ant I and II dorsally with blunt, spinelike setae; some setae of Abd VI longer than others, setae P2 (see Fig. 31) long and rather thick but not sabrelike.

Proportions: Length of antennae : head diagonal = 1.6 in females, 2 in males. Ant I : II : III : IV = 1 : 2 : 3.3 : 6 (6.6) (or 1 : 1.8 : 2.7 : 5.2 (5.4), NAYROLLES 1996: 548) in females (and males). Dens : mucro = 3. App. an. : mucro = 0.5.

Type locality: Not defined, France.

Occurrence (several original observations are marked by the collector's name): Holarctic; in the Nearctic found in Canada, Quebec (leg. v. TSCHIRNHAUS); in the Palearctic known from S Russia (the Altay Mts., STEBAEVA 1976: 126) and Kazakhstan (BRET-FELD 1996: 210) N to Iceland (leg. GRAEBER), W to Ireland (BOLGER 1986: 210), and S to former Yugoslavia (e. g. CVIJOVIC 1974: 93), S Italy (Isles of Eolie, DALLAI 1973: 567), Malta (STACH 1967: 413), N Spain (the Pyrenees, JORDANA et al. 1990: 43; Navarra, leg. ARBEA; Barcelona, leg. v. TSCHIRNHAUS; Zaragoza, leg. BLASCO), continental Portugal (ex coll. DA GAMA ASSALINO), and Algeria (leg. MERTENS). Not known from Japan (YOSII 1977: 165) and S Australia (GREENSLADE 1994: 122); doubtfully recorded from New Zealand (WOMERSLEY 1942: 30).

Biology: *D. pallipes* in its violet f. *principalis* has been collected from low and high mountains, its f. *repanda* is common mainly in lowlands in all kinds of low, open vegetation and on sunny bushes (often together with *D. sulphureus*) but avoids woodlands and moors (orig. observ.). It occurs up to 2500 m altitude (Switzerland, LIENHARD 1980: 369). *D. pallipes* f. *repanda* was rarely found in sands of groundwater samples (France, PICARD 1962: 471) and of glacial dunes (Austria, THIBAUD & CHRISTIAN 1986: 405). Biological and ecological observations of the f. *repanda* have been collected by AGRELL (1934, 1936, 1941, 1948).

*D. pallipes* f. *fenyesi* was found in dryer habitats: In Hungary (STACH, see above), former Yugoslavia (e. g. CVIJOVIĆ 1974: 131), Greece (Rhodes, ELLIS 1974c: 138), and Spain (JORDANA et al. 1990: 42).

In courtship behaviour, the male steps back from the female to a short distance, the antennae being elbowed, and does not imitate the deposition of a spermatophore in front of the female (BRETFFELD 1970: 262).

Species descriptions: STACH 1956: 166, FJELLBERG 1984: 87 (maxillary outer lobe).

Remarks: For other opinions about the taxonomy of this species and its colour varieties, see ELLIS (1974 c: 138, 1978: 62).

In populations from Central Portugal, the seta d7 of femur III was missing, the other characteristics of males and females, however, were identical (orig. observ., ex coll. DA GAMA ASSALINO).

*Deuterostminthurus pleuracanthus* Nayrolles, 1996 (537)

Syn.: *Deuterostminthurus sulphureus* Greenslade, 1977 (248)

*Deuterostminthurus sulphureus mediterraneus* Greenslade, 1994 (123)

Total length up to 0.9 mm in females, 0.6 mm in males. Background colour light yellow, frontal eye and posterior of large abdomen orange; antennae light brown. Ventral head-back without oval organs. Ant IV with 8 subsegments. Femur III without seta d7 (Fig. 22). Tita I - III rows p:5, 3, 2 setae respectively; length of longest setae of Tita III  $\geq$  diameter of Tita. Claws with or without small inner tooth. Abd VI dorsally with 2 median setae. App. an. bandlike, distal 1/3 pointed and with few teeth. Formula of anterior setae of dens 3+1,1,1...1. Secondary sexual characteristics: in males: several setae swollen, curved, and spinelike: lateral setae of head frons, those of head apex and dorsal head-back (orig. observ.), some setae of posterior of large abdomen, and Abd V setae A1 (orig. observ., see Fig. 31); in females: length of circumanal setae av1' and av1  $\ll$  av2 (see Figs. 30, 505).

Proportions: Length of antennae : head diagonal = 1.7 in females, 2 in males. Ant I : II : III : IV = 1 : 2 : 3.1 (3.3) : 5.5 (6.3) in females (and males). App. an. : mucro = 0.65.

Type locality: Spain, Huesca, Puerto de Monrepós, in the low vegetation of a pasture at 1260 m altitude.

Occurrence: Also found in Portugal, the Azores, São Miguel and in Spain, the Balearic Islands, Majorca (both orig. observ., leg. v. TSCHIRNHAUS), and in S Australia and New Zealand (confirmed by NAYROLLES; GREENSLADE, pers. comm.).

Remarks: The females do not surely differ from those of *D. sulphureus* (orig. observ.).

*Deuterostminthurus quadrangulatus* (Loksa & Bogojevic, 1970) (140)

Syn.: *Bourletiella* (*Deuterostminthurus*) *quadrangulata* Loksa & Bogojevic, 1970 (140)

Only 1 female known. Total length 0.55 mm. Background colour yellow, large abdomen laterally and posteriorly with large violet patches, Abd V with 1+1 lateral spots (Fig. 504). Ant IV with 6 subsegments. Claws without inner tooth. App. an. long, narrow, thick, and blunt. Formula of anterior setae of dens 3+1,1,1...1. Secondary sexual characteristics not described.

Proportions: Length of antennae : head diagonal about 1.7. Ant I : II : III : IV = 1 : 1.8 : 2.8 : 4.7. Dens : mucro = 4.

Type locality: Former Yugoslavia, NE of Belgrade, sand plain of Deliblat, in a *Chrysopogonetum pannonicum* typical plant association.

Occurrence: Known only from the type locality.

Species description: NAYROLLES 1996: 549 (discussion of status).

*Deuterostminthurus sulphureus sulphureus* (Koch, 1840) (353)

*Deuterostminthurus sulphureus mediterraneus* Ellis, 1974 (144)

Syn.: *Smynthurus sulphureus* Koch, 1840 (353)

*Smynthurus luteus* Lubbock, 1868 (296) n. syn.

*Corynephorina gibbera* Salmon, 1941 (416), GREENSLADE 1977: 248

*Bourletiella (Deuterostminthurus) sulphurea* Gisin, 1946 (253)

*Deuterostminthurus gisini* Stach, 1956 (159, 164), GISIN 1957: 491

*Deuterostminthurus mediterraneus* Nayrolles, 1996 (537)

*Bourletiella hortensis* Hopkin, 1997 (41, 139)

nec *Deuterostminthurus sulphureus* Greenslade, 1977 (248) (= *Deuterostminthurus pleuracanthus*)

*Deuterostminthurus sulphureus mediterraneus* Greenslade, 1994 (123) (= *Deuterostminthurus pleuracanthus*)

Total length up to 1 mm in females, 0.8 mm in males. Colour yellow without further pigmentation. Ventral head-back without oval organs. Ant IV with 6 - 8 subsegments. Femur III without seta d7 (Fig. 22). Tita I - III rows p:7 (also 5 or 6), 3 - 5, 2 setae respectively; length of longest setae of Tita I - III > 2x diameter of Tita. Claws with or without small basal and distal inner teeth. Abd VI dorsally with 2 median setae. App. an. bandlike, pointed, distal 1/2 with rough teeth on both edges or only inner edge. Formula of anterior setae of dens 3+1,1,1...1. Secondary sexual characteristics: in males: lateral setae of head frons and those between the antennae longer and slightly thicker than others; clypeus medially with short or normal setae, laterally with longer thin setae; Ant I and II with only normal setae; in ssp. *sulphureus* some setae of Abd VI thicker than others, setae p2 as long, blunt, and thick sabrelike spines (Figs. 31, 506), in ssp. *mediterraneus* these setae of Abd VI longer than others, but not thick sabrelike; in females of both ssp.: circumanal setae a1-3 (= dorsal) and av1', av1 (= ventral) thinner and shorter than other circumanal setae (Figs. 30, 505).

Proportions: Length of antennae : head diagonal = 1.3 - 1.6 in females, 2 in males. Ant I : II : III : IV = 1 : 1.9 : 3.1 (3.3) : 5.5 (6.5) in females (and males). Dens : mucro = 3. App. an. : mucro = 0.66.

Type locality: Germany, Bavaria, Regensburg, on low garden plants.

Occurrence (several original observations are marked by the collector's name):

- ssp. *sulphureus*: Europe, from S Sweden (leg. PRINZING) to Ireland (BOLGER 1986: 210) and S to former S Yugoslavia (leg. BRETFFELD), Italy (Tuscany, leg. VERWIEBE), France (Corsica, leg. BRETFFELD), and N Spain (Barcelona and Gerona, leg. v. TSCHIRNHAUS), the occurrence in E Europe is not known;
- ssp. *mediterraneus*: in the Mediterranean from Cyprus (leg. BRETFFELD) to N Africa (Algeria and Morocco, leg. MERTENS), Greece (Rhodes, ELLIS, see above), N Spain (Navarra, JORDANA et al. 1990: 43), and in Spain, the Canary Islands (leg. v. TSCHIRNHAUS).

**Biology:** *D. sulphureus* often occurs in large numbers, it lives in all kinds of low, open vegetation (often together with *D. pallipes* f. *repanda*) from the seashore and dune vegetation up to subalpine regions but rarely in deciduous woods. It has been collected up to 2500 m altitude (France, the Pyrenees, CASSAGNAU 1964 b: 463). In Switzerland, *D. sulphureus* seems to be replaced by *D. pallipes* f. *repanda* in summer and autumn (GISIN 1948: 514); in the Netherlands (ELLIS 1974: 236) and in N Germany, *D. sulphureus* has been found until August and October respectively. The ssp. *sulphureus* seems to prefer more humid habitats, the ssp. *mediterraneus* the drier habitats of the Mediterranean (NAYROLLES 1996: 537).

The courtship behaviour resembles that of *D. pallipes* f. *repanda* (orig. observ.).

**Species descriptions:** GISIN 1946: 253, 1960: 287, NAYROLLES 1996: 542 (general, mainly chaetotaxy of the extremities).

**Remarks:** There are only a few records in the literature since *D. sulphureus* has apparently been confused with *D. pallipes* f. *repanda*.

The females of *D. sulphureus* do not surely differ from those of *D. pleuracanthus* (orig. observ.).

*Smynthurus luteus* Lubbock has already been identified as a yellow species of *Deuterosminthurus* by BRETFFELD (1970: 270); the new synonymy with *D. sulphureus* is based on the description by LUBBOCK (1868: 296): »At the end of the abdomen are two setae much stronger than the rest.«

### **Genus *Ellisiella* n. gen.**

**Key.** Only 1 species: *Ellisiella pandayi* (Ellis, 1974) (143)

#### **Diagnosis of the genus**

Large abdomen elongate. Ant IV with large sensillum P on 1st whorl behind the tip and with 2 ventral sensilla (see Figs. 11, 12). Some inner setae of Tita obliquely truncate (see Fig. 458). Tita I - III with 3, 3, 3 spatulate setae respectively. All Emp without lamellae, directly forming thin filaments, length < claws. Most anterior setae of dens longer than the spaces between rows; formula of anterior setae 3+1,2,1,(1)...1, middle setae thicker than others (Fig. 507). Secondary sexual characteristics of chaetotaxy missing.

Occurrence: Greece, Rhodes.

Type species: *Deuterosminthurus pandayi* Ellis, 1974 (143).

**Derivatio nominis:** This new genus is named after Dr. WILLEM N. ELLIS, Amsterdam, the last professional Collembola taxonomist of the Netherlands, who collected and described this and several other remarkable species. The gender of this genus is feminine.

**Remarks:** ELLIS himself (see above) noted that these specimens stand »isolated in the genus *Deuterosminthurus*«. The re-examination of 2 paratypes (1 female, 1 male) showed the distinct differences from all other genera of the Bourletiellida.

#### **Diagnosis of the single Palaearctic species**

*Ellisiella pandayi* (Ellis, 1974) (143)

Syn.: *Deuterosminthurus pandayi* Ellis, 1974 (143)

Total length 1 mm in females, 0.7 mm in males. Background colour yellow, body with traces of pigment, especially on head-back, antennae, and ventrally on thorax; frontal eye dark. Ant IV with 6 subsegments. Femur III without seta d7 (Fig. 22). Length of longest setae of Tita I - III 2x diameter of Tita. Claws with small distal inner tooth. Abd VI dorsally with 2 median setae, dorsal setae rather short in both sexes. App. an. daggershaped, slightly curved. Other characteristics as described for genus.

Proportions: Length of antennae : head diagonal = 1.4 in female, 1.5 in male. Ant I : II : III : IV = 1 : 1.9 : 2 : 4.8 (5) in female (and male). Dens : mucro = 3.3. App. an. : mucro = 0.5.

Type locality: Greece, Rhodes, Lindos, near Lemn Apostolou Pavlou swept from the vegetation.

Occurrence: Known only from the type locality.

### Genus *Fasciosminthurus* Gisin, 1960 sensu Bretfeld, 1992

Syn.: *Prorastriones* sensu Betsch, 1977 (214) ad partem, BRETFELD 1992: 8

#### Key to the Palaearctic species

- |    |   |  |
|----|---|--|
| 1  | Length of outer setae of Tita II and III up to 2x diameter of Tita                        | 2  |
| –  | Length of these setae > 3x diameter of Tita   | <i>longisetus</i> Nayrolles, 1994                |
| 2  | Dark pigment mainly on head, thorax, and ventrally on large abdomen (Fig. 523)            | 3  |
| –  | Other colour pattern  | 4  |
| 3  | Described from the Canary Islands   | <i>canariensis</i> (Paclt, 1964)                 |
| –  | Described from N Italy  | <i>melanocephalus</i> (Dallai, 1966)             |
| 4  | Body almost completely dark with black, brown, blue, or red pigment                       | 5  |
| –  | Body not completely dark, with spots, stripes, or pale                                    | 7  |
| 5  | Body with blue pigment  | <i>strasseni</i> (Paclt, 1964)                   |
| –  | Body with black, brown, or red pigment  | 6  |
| 6  | Small abdomen without pale spots (Fig. 518)   | <i>cugnyi</i> (Nayrolles, 1987)                  |
| –  | Small abdomen with 2+2 pale spots (Fig. 524)  | <i>obtectus</i> Bretfeld, 1992                   |
| 7  | (4) Body with many large or small dark irregular spots                                    | 8  |
| –  | Body with spots forming dark or light regular stripes, with other colour pattern, or pale | 10   |
| 8  | Body with many small spots, dens row J:4 distal and 2 proximal setae                      | 9  |
| –  | Body with many large spots (Fig. 510), dens row J:2 distal and 2 proximal setae           | <i>bedosae</i> Nayrolles, 1994                   |
| 9  | Head mainly light (Fig. 509)  | <i>angulipunctatus</i> (Loksa & Bogojevic, 1970) |
| –  | Head with many spots (Fig. 520)   | <i>lacazei</i> (Denis, 1925)                     |
| 10 | (7) Body with dark or light stripes   | 11   |
| –  | Body without clear stripes, with diffuse pigment, or pale                                 | 20   |
| 11 | Body with dark stripes on light background  | 12   |
| –  | Body with light stripes on dark background  | 19   |
| 12 | Body and head with 1 broad, surrounding band (Fig. 529)                                   | 13   |
| –  | Large abdomen with other colour pattern   | 14   |
| 13 | Emp with S-shaped filaments, described from Switzerland                                   | <i>sauteri</i> (Nayrolles & Lienhard, 1990)      |
| –  | Emp with thin, almost straight filaments; described from Mongolia                         | <i>coronatus</i> (Betsch, 1977)                  |

- 14 Large abdomen anteriorly with rather diffuse pigment, posterolaterally with longitudinal stripes **15**  
 – Large abdomen without diffuse pigment but with several stripes **16**
- 15 Large abdomen posteriorly with 1 pair of longitudinal stripes (Fig. 512) **15**  
*cassagnai* Nayrolles, 1994  
 – Large abdomen posteriorly with 2 - 3 pairs of longitudinal stripes (Fig. 508) **15**  
*albanicus* (Stach, 1956)
- 16 Some stripes of large abdomen continue on head **17**  
 – Stripes of large abdomen do not continue on head (Fig. 514) **17**  
*circumfasciatus* (Stach, 1956)
- 17 Large abdomen with only longitudinal stripes **18**  
 = Large abdomen anteriorly with cross stripes, posteriorly with longitudinal stripes (Fig. 519) **18**  
*dictyostigmatus* Nayrolles, 1993  
 – Large abdomen mainly with cross stripes or posteriorly with irregular spots (Fig. 520) **18**  
*lacazei* (Denis, 1925)
- 18 Abd VI with dark U-shaped margin (Fig. 530) **18**  
*strigatus* (Stach, 1922)  
 – Abd VI with other colour pattern (Fig. 532) **18**  
*virgulatus* (Skorikow, 1899)
- 19 (11) Body with light wreath around large abdomen (Fig. 524) **19**  
*obtectus* Bretfeld, 1992  
 = Large abdomen with 5 or more light cross stripes (Fig. 526) **19**  
*quinquefasciatus* (Krausbauer, 1898)  
 – Large abdomen with 3 long and 1+1 short, white longitudinal stripes (Fig. 528) **19**  
*raynalae* (Nayrolles, 1987)
- 20 (10) Dens row J:3 distal and 2 proximal setae, or 3 - 5 setae irregularly arranged **21**  
 – Dens row J:2 distal and 2 proximal setae **22**
- 21 Ventral head-back without oval organs **21**  
*strigatus* (Stach, 1922)  
 – Ventral head-back with 2+2 oval organs (see Fig. 17) **21**  
*obtectus* Bretfeld, 1992
- 22 Ventral head-back without oval organs **23**  
 – Ventral head-back with 1+1 oval organs, Tita II and III rows p:4 and 3 setae respectively **23**  
*virgulatus* (Skorikow, 1899)
- 23 Tita II and III rows p:6 and 4 - 5 setae respectively **23**  
*cassagnai* Nayrolles, 1994  
 = Tita II and III rows p:4 and 3 setae respectively **23**  
*albanicus albanicus* (Stach, 1956)  
 – Tita II and III rows p:3 and 2 setae respectively **23**  
*albanicus pontignanoi* Bretfeld, 1992

Remarks. This key is mainly based on the colour pattern, which is often constant and species specific; species with varying patterns or with naturally pale specimens appear several times. *F. coronatus* and *lacazei* differ from the other species of *Fasciosminthurus* in their empodial filaments, which are rather straight and even slightly curved externally (instead of S-shaped filaments with tip curved internally, Figs. 465, 521), which look more like those of *Cyprania* than of *Fasciosminthurus*. *F. lacazei* has been redescribed by NAYROLLES 1993: 665; *F. coronatus* should be re-examined.

Not included in this key are:

- *Prorastriones maculatus* Betsch, 1977 (85) (= *Fasciosminthurus circumfasciatus maculatus* n. comb.);

- *Fasciosminthurus saportae* Nayrolles, 1997 (366) (from S France and NE Spain, the pigmentation and the Emp are similar to those of *F. coronatus* but *F. saportae* has the ventral sides of head and large abdomen also black);
- *Fasciosminthurus pseudovirgulatus* Nayrolles, 1997 (368) (from S France and NE Spain, the pigmentation is very similar to that of *F. virgulatus* but the chaetotaxy of Ant III differs and the antennae are shorter).

### Diagnosis of the genus

Large abdomen usually elongate or sometimes globular, row 5:2 setae. Ant IV with large sensillum P on 1st whorl behind the tip, with 2 ventral and 11 tip sensilla (see Figs. 11, 12). Some inner setae of Tita obliquely truncate (Fig. 458), seta Ia missing, Iii present (Fig. 23). Tita I - III with 3, 3, 2 spatulate setae respectively. All Emp without lamellae, pointed; filaments long, S-shaped, curved internally, and spatulate (sometimes unusually straight, even curved externally), length always > claws (Figs. 465, 521). Most anterior setae of dens longer than the spaces between rows; formula of anterior setae usually 3+1,2,1,1...1. Secondary sexual characteristics of chaetotaxy missing.

Occurrence: S Palaearctic; apparently not in the Nearctic.

Descriptions of the genus: GISIN 1960: 281, BRETTFELD 1992 a: 8, 1992 b: 37, NAYROLLES 1993: 655, 1997: 365.

Type species: *Sminthurus quinquefasciatus* Krausbauer, 1898.

Remarks: For the chaetotaxy of Ant IV (region T and dorsal sensilla) mentioned in the species descriptions, see Figs. 10 and 11 respectively.

### Diagnosis of the Palaearctic species

*Fasciosminthurus albanicus albanicus* (Stach, 1956) (164) sensu Bretfeld, 1992 (11)

*Fasciosminthurus albanicus pontignanoi* Bretfeld, 1992 (12)

Syn.: *Deuterostminthurus albanicus* Stach, 1956 (164)

*Bourletiella (Fasciosminthurus) albanica* Gisin, 1960 (284)

*Fasciosminthurus pontignanoi* Nayrolles, 1993 (662)

Total length 0.9 mm in females, 0.6 mm in males. Background colour white to yellow with diffuse, greyish blue pigment and sometimes dark stripes on head and 2 - 3 pairs on posterior of large abdomen (Fig. 508). Ventral head-back without oval organs. Ant III whorls 4, 5, 6 with 1 - 2 setae irregularly missing or with 4, 4, 5 setae respectively (ssp. *pontignanoi*) (see Fig. 515). Ant IV region T sometimes without setae; distal part with 5 anterior and 3 posterior dorsal sensilla. Tita I - III with 7, 8 - 9, 9 - 10 obliquely truncate setae and 1, 1, 1 oval organs respectively; Tita II and III rows p:4 and 3 setae respectively (3 and 2 in ssp. *pontignanoi*). Claws with small inner tooth and seldom also outer tooth. Dens row J:2 distal and 2 proximal setae, formula of anterior setae 3+1,2,1,1...1. App. an. narrow spinelike, blunt or tip with small teeth.

Proportions: Length of antennae : head diagonal = 1.7 in females, 1.9 in males. Ant I : II : III : IV = 1 : 2 : 3 : 6.2 (6.7) in females (and males). Dens : mucro = 3. App. an. : mucro = 0.6.

Type locality: Albania.

Occurrence: Also known from N Greece (Macedonia), former Yugoslavia (near Miravci), and Italy (Tuscany, ssp. *pontignanoi*) (BRETFFELD, see above).

Biology: *F. albanicus* lives in dry or humid grasslands and in *Medicago* fields (BRETFFELD, see above).

Remarks: Type locality of ssp. *pontignanoi*: Italy, Tuscany, E of Siena, Certosa di Pontignano, grassy way, meadow with grass and *Medicago*. These specimens had the same colour pattern as the types of the nominate ssp., those from Greece and former Yugoslavia were paler with more homogeneous pigmentation.

*Fasciosminthurus angulipunctatus* (Loksa & Bogojevic, 1970) (138), BRETFFELD 1992: 13

Syn.: *Bourletiella (Fasciosminthurus) albanica angulipunctata* Loksa & Bogojevic, 1970 (138)

Apparently only females known. Total length about 0.9 mm. Background colour yellow, head almost pale, large abdomen with uniformly distributed, irregular small spots and 5 larger spots of violet black pigment (Fig. 509). Claws without teeth. Dens row J:4 distal and 2 proximal setae, formula of anterior setae 3+1,2,1...1. App. an. narrow bandlike, blunt or tip cut with some teeth.

Proportions: Length of antennae : head diagonal = 1.5. Ant I : II : III : IV = 1 : 2.4 : 3.7 : 7. Dens : mucro = 2.6.

Type locality: Former Yugoslavia, NE of Belgrade, sand plain of Deliblat, in a *Chrysopogonetum pannonicum typicum* plant association.

Occurrence: Known only from the type locality.

*Fasciosminthurus bedosae* Nayrolles, 1994 (326)

Total length up to 0.8 mm in females, 0.55 mm in males. Background colour white, large abdomen with large irregular, dark and grey patches, head dorsally white, other parts dark (Fig. 510). Ventral head-back with 2+2 oval organs. Distal part of Ant IV with 5 anterior and 4 - 5 posterior dorsal sensilla. Tita I - III with 7, 8, 9 obliquely truncate setae and 1, 1, 1 oval organs respectively; Tita II and III rows p:5 and 3 - 5 setae respectively. Claws broad with inner tooth. Dens row J:2 distal and 2 proximal setae, formula of anterior setae 3+1,2,1,1...1. App. an. thick, setalike (Fig. 511).

Proportions: Length of antennae : head diagonal = 1.6 in both sexes. Ant I : II : III : IV = 1 : 1.9 : 2.9 : 6 (6.4) in females (and males). Dens : mucro = 2.8. App. an. : mucro = 0.54.

Type locality: Spain, Huesca, between Ontiñena and Candasnos, salty soil with *Thymus vulgaris* at 300 m altitude.

Occurrence: Also found at other sites in Spain (Huesca, Barcelona, Zaragoza), and in S France (Pyrénées-Orientales) (NAYROLLES, see above).

Biology: *F. bedosae* lives in the low vegetation of salty and calcareous soils, of garrigues, and of open pinewoods in the low mountain region up to 450 m altitude (NAYROLLES, see above).



*Fasciosminthurus canariensis* (Paclt, 1964) (53)

Syn.: *Prorastriones canariensis* Paclt, 1964 (53)

nec *Prorastriones canariensis strasseni* Paclt, 1964 (54) (= *Fasciosminthurus strasseni* n. comb.)

Only females (and juveniles) known. Total length 1 mm. Background colour white, bluish black pigment mainly on head and thorax, large abdomen ventrolaterally with few dark spots (see Fig. 523). Claws without teeth. Length of circumanal setae in females up to 40  $\mu$ m. App. an. setalike.

Proportions: Ant I : II : III : IV = 1 : 2 : 2.7 : 6. App. an. : mucro = 0.6.

Type locality: Spain, the Canary Islands, Fuerteventura, Istmo de la Pared, on flowers of *Pulicaria burchardii*.

Occurrence: Also found in the Canary Islands, Lanzarote (GAMA 1988: 84).

Remarks: *F. canariensis* has the same colour pattern as *F. melanocephalus*, which is here regarded as a separate species since it is only known from N Italy and *F. canariensis* has not been completely described (BRETFFELD 1992: 21).

*Fasciosminthurus cassagnau* Nayrolles, 1994 (330)

Total length up to 0.6 mm in females, 0.5 mm in males. Background colour white to yellow, grey pigment in 2+2 stripes on head and laterally on large abdomen, anterior large abdomen with rather diffuse pigment (Fig. 512). Ventral head-back without oval organs. Distal part of Ant IV with 5 anterior and 3 - 4 posterior dorsal sensilla. Tita I - III with 7, 8, 9 obliquely truncate setae and 1, 1, 1 oval organs respectively; Tita II and III rows p:6 and 4 - 5 setae respectively. Claws with inner tooth. Dens row J:2 distal and 2 proximal setae, formula of anterior setae 3+1,2,1,1...1. App. an. straight, acuminate, basally thick (Fig. 513).

Proportions: Length of antennae : head diagonal = 1.6 in both sexes. Ant I : II : III : IV = 1 : 2 : 2.9 : 6.5 in both sexes. App. an. : mucro = 0.6.

Type locality: Spain, L rida, between Coll de Narg  and Collado de B ixols, calcareous garrigue at 900 m altitude.

Occurrence: Also found at other sites in Spain (Barcelona, Tarragona), and in S France (Var) (NAYROLLES, see above).

Biology: *F. cassagnau* lives in the low vegetation of garrigues and other dry, calcareous habitats of the Mediterranean (NAYROLLES, see above).

*Fasciosminthurus circumfasciatus circumfasciatus* (Stach, 1956) (176) sensu Bretfeld, 1992 (13)

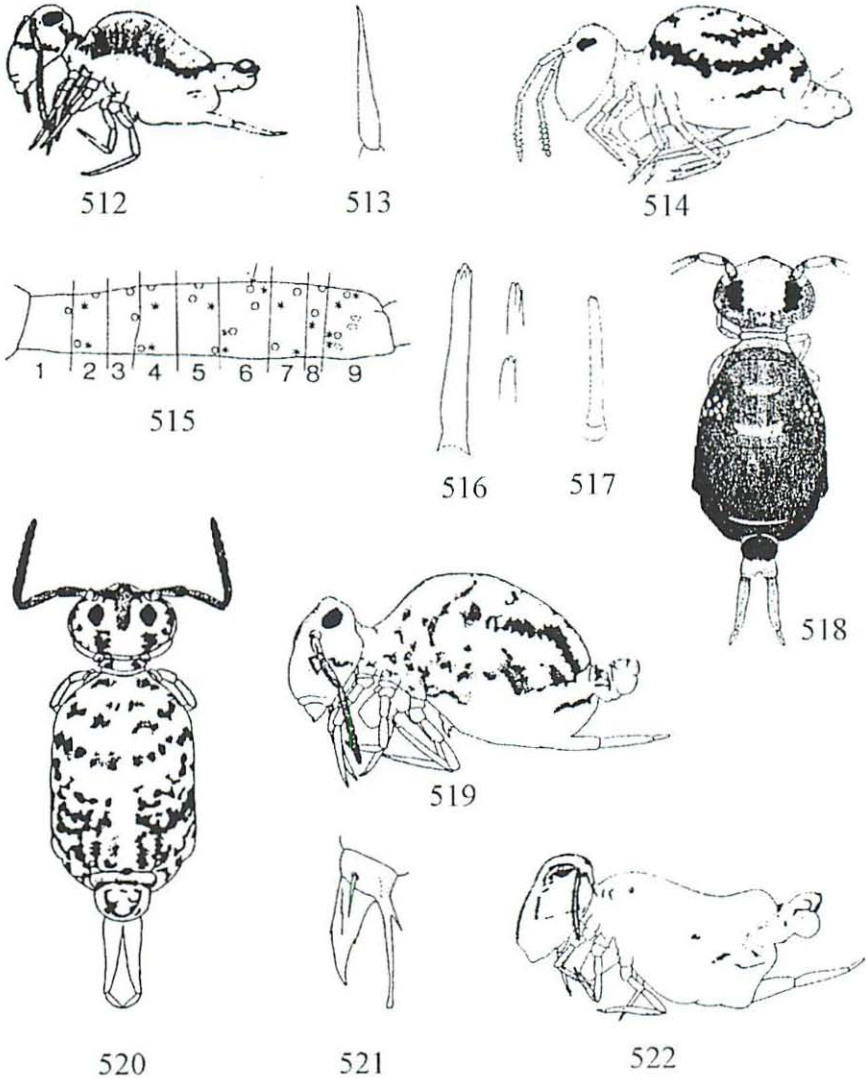
*Fasciosminthurus circumfasciatus maculatus* (Betsch, 1977) (85) n. comb.

Syn.: *Deuterosminthurus circumfasciatus* Stach, 1956 (176)

*Prorastriones maculatus* Betsch, 1977 (85) n. syn.

*Prorastriones circumfasciatus* Betsch, 1980 (178)

nec *Fasciosminthurus* cf. *circumfasciatus* Dunger, 1975 (26) (= *Fasciosminthurus strigatus*, BRETFFELD 1992: 18)



Figs. 512 - 513 *Fasciosminthurus cassagnai* (after NAYROLLES 1994):

512 Habitus 513 App. an.

Figs. 514 - 517 *Fasciosminthurus circumfasciatus*:

514 Habitus (after STACH 1956) 515 Ant III schematic (after BRETTFELD 1992) 516 App. an. of

ssp. *circumfasciatus* (after BRETTFELD 1992) 517 App. an. of ssp. *maculatus* (after BETSCH 1977).

Fig. 518 *Fasciosminthurus eugnyi*, colour pattern (after NAYROLLES 1987).

Fig. 519 *Fasciosminthurus dictyostigmatus*, habitus (after NAYROLLES 1993).

Figs. 520 - 521 *Fasciosminthurus lacazei* (after NAYROLLES 1993):

520 Colour pattern 521 Claw and Emp.

Fig. 522 *Fasciosminthurus longisetus*, colour pattern (after NAYROLLES 1994).

*Prorastriopes circumfasciatus* Christian & Kampichler, 1984 (136) (= *Fasciosminthurus strigatus*, BRETFFELD 1992: 18)

*Prorastriopes* cf. *circumfasciatus/strigatus* Thibaud & Christian, 1986 (405) (= *Fasciosminthurus strigatus*, BRETFFELD 1992: 18)

Body globular (in most other *Fasciosminthurus* species elongate). Total length up to 0.9 mm in females, 0.6 mm in males (1.1 and 0.75 mm respectively in ssp. *maculatus*). Background colour white to yellow, dark blackish blue pigment mainly in longitudinal stripes around the large abdomen, not on head (Fig. 514), ssp. *maculatus* more intensely pigmented and sometimes even darkened. Ventral head-back with 2+2 oval organs. Ant III whorls 4, 5, 6 with 4, 4, 6 setae respectively (Fig. 515). Ant IV region T sometimes with only 1 seta; distal part with 5 anterior and 3 - 4 posterior dorsal sensilla. Tita I - III with 7, 8, 9 obliquely truncate setae and 1, 1, 1 oval organs respectively; Tita II and III rows p:4 - 5 and 3 setae respectively. Claws broad with small inner tooth and sometimes small outer tooth. Dens row J:3 distal and 2 proximal setae (3 and 3 in ssp. *maculatus*), formula of anterior setae 3+1,2,1,1...1. App. an. long and broad, blunt or pointed, sometimes with large teeth (Fig. 516) (bandlike, cut, with small teeth in ssp. *maculatus*, Fig. 517).

Proportions: Length of antennae : head diagonal = 1.7 in females, 1.9 in males. Ant I : II : III : IV = 1 : 2 : 3 : 6.2 (6.7) (6.3 in ssp. *maculatus*) in females (and males). Dens : mucro = 2.6. App. an. : mucro = 0.6.

Type locality: White Russia, Biala on Horyn River, in a sandy pasture.

Occurrence: Europe and Central Asia; in Europe also found in NE Poland (Lomza, STACH 1956: 178), S Slovakia (NOSEK 1962: 339), Hungary (LOKSA 1978: 62), former Yugoslavia (e. g. CVIJOVIC 1974: 93, ZIVADINOVIC & CVIJOVIC 1974: 309), and S France (Camargue, POINSOT-BALAGUER 1979: 138); in Central Asia recorded from S Russia (Khakasia, Altay, and S Tuva Regs., STEBAEVA 1976: 126) and Mongolia (ssp. *maculatus*).

Biology: *F. circumfasciatus* lives in the low vegetation of dry, sunny habitats, in former Yugoslavia up to 1200 m altitude (ZIVADINOVIC & CVIJOVIC, see above).

Remarks: Type locality of ssp. *maculatus*: Mongolia, Bulgan Distr., sandy steppe with *Caragana* at 1000 m altitude. The specimens from S Russia (see above) may belong to this ssp. since they occur in the same larger geographical region.

*Fasciosminthurus coronatus* (Betsch, 1977) (85)

Syn.: *Prorastriopes coronatus* Betsch, 1977 (85)

Total length 1 mm in females, 0.75 mm in males. Background colour yellowish, blue pigment mainly in a broad lateral band on large abdomen and head (see Fig. 529). Claws with inner tooth. Formula of anterior setae of dens 3+1,2,1,1...1. App. an. thick setalike, blunt.

Proportions: Length of antennae : head diagonal = 1.6 in females, 1.75 in males. Ant I : II : III : IV = 1 : 2 : 2.5 : 5.5 in both sexes. Dens : mucro = 2.7. App. an. : mucro = 0.55.

Type locality: Mongolia, South Gobi Distr., rocky desertlike steppe at 1550 m altitude.

Occurrence: Known only from the type locality.

Remarks: The colour pattern resembles *F. sauteri* but other characteristics differ: empodial filaments thin, straight, and even curved externally (instead of S-shaped), Ant IV and App. an. shorter. The empodial filaments are like those of *Cyprania*; a re-examination is needed.

*Fasciosminthurus cugnyi* (Nayrolles, 1987) (126) sensu Nayrolles, 1994 (319)

Syn.: *Prorastriopes cugnyi* Nayrolles, 1987 (126)

Total length up to 1.1 mm in females, 0.7 mm in males. Background colour dark brown, head dorsally and large abdomen anteriorly paler, large abdomen often posteriorly with 2+2 light spots, small abdomen without light patches (Fig. 518). Ventral head-back with 2+2 oval organs. Distal part of Ant IV with 5 - 6 anterior and 5 - 7 posterior dorsal sensilla. Tita I - III with 8, 8, 9 obliquely truncate setae and 1, 1, 1 oval organs respectively; Tita II and III rows p:4 - 6 and 3 setae respectively. Claws with inner tooth. Dens row J:3 distal and 2 proximal setae, formula of anterior setae 3+1,2,1,1...1. App. an. long, thick, acuminate.

Proportions: Length of antennae : head diagonal = 1.5 in both sexes. Ant I : II : III : IV = 1 : 2 : 2.7 (2.9) : 5.5 (6) in females (and males). Dens : mucro = 2.9. App. an. : mucro = 0.6.

Type locality: Spain, Lérida, Collado de Perves, short meadow at 1500 m altitude.

Occurrence: Also found at other sites in Spain (Lérida, Tarragona, Huesca) (NAYROLLES 1994: 319).

Biology: *F. cugnyi* lives in the low vegetation of meadows, garrigues, and even a salty soil of the Mediterranean (NAYROLLES, see above).

*Fasciosminthurus dictyostigmatus* Nayrolles, 1993 (669)

Total length up to 0.9 mm in females, 0.65 mm in males. Background colour yellow, dark grey-blue pigment mainly in irregular stripes on large abdomen, anteriorly in cross stripes, posteriorly in longitudinal stripes (Fig. 519). Ventral head-back without oval organs. Distal part of Ant IV with 4 anterior and 4 (seldom 5) posterior dorsal sensilla. Tita I - III with 7, 9, 11 obliquely truncate setae and 1, 1, 1 oval organs respectively; Tita II and III rows p:5 - 6 and 4 setae respectively. Claws sometimes with inner tooth. Dens row J:4 distal and 2 proximal setae, formula of anterior setae 3+1,2,1,1...1. App. an. straight spinelike.

Proportions: Length of antennae : head diagonal = 1.5 in females, 1.7 in males. Ant I : II : III : IV = 1 : 2 : 2.5 : 5 (5.4) in females (and males). Dens : mucro = 2.8. App. an. : mucro = 0.5.

Type locality: France, Aveyron, Causse Comtal, calcareous meadow at 620 m altitude.

Occurrence: Known only from the type locality.

*Fasciosminthurus lacazei* (Denis, 1925) (199) sensu Nayrolles, 1993 (665)

Syn.: *Deuterosminthurus lacazei* Denis, 1925 (199)

*Prorastriopes lacazei* Betsch, 1980 (178)

Total length up to 0.8 mm in females, 0.7 mm in males. Background colour white to yellow, dark grey or brown pigment in many small spots, large abdomen often anteriorly with irregular cross stripes (Fig. 520). Ventral head-back with 1+1 (seldom 2+2) oval organs. Distal part of Ant IV with 5 anterior and 4 posterior dorsal sensilla. Tita I - III with 7, 8, 9 obliquely truncate setae and 2, 2, 2 oval organs respectively; Tita II and III rows p:6 - 7 and 3 - 4 setae respectively. Claws with inner tooth; filaments of Emp straight and even externally curved (Fig. 521). Dens row J:4 distal and 2 proximal setae, formula of anterior setae 3+1,2,1,1...1. App. an. straight spinelike, tip with or without small teeth.

Proportions: Length of antennae : head diagonal = 1.6 in both sexes. Ant I : II : III : IV = 1 : 2 : 2.4 : 6 in both sexes. Dens : mucro = 2.6. App. an. : mucro = 0.55.

Type locality: France, Pyrénées-Orientales, Banyuls-sur-Mer, jardin du Laboratoire Arago.

Occurrence: Also found in Spain (Lérida and Huesca, NAYROLLES, see above).

Biology: *F. lacazei* lives in low numbers in the sunny vegetation of gardens and garrigues of the Mediterranean (DELAMARE DEBOUTTEVILLE 1951: 135, NAYROLLES, see above).

Species descriptions: DENIS 1925: 581, BRETTFELD 1992: 14.

Remarks: The straight and even externally curved empodial filaments of *F. lacazei* resemble those of *Cyprania*; the 2 oval organs of each tibiotarsus (instead of 1 each) also show that this species seems not to be definitely placed in the genus *Fasciosminthurus*.

*Fasciosminthurus longisetus* Nayrolles, 1994 (322)

Total length up to 0.85 mm in females, 0.65 mm in males. Background colour white to yellow, black pigment in 3 longitudinal stripes on the head and in a few spots laterally on large and small abdomen (Fig. 522). Ventral head-back without oval organs. Distal part of Ant IV with 4 anterior and 2 posterior dorsal sensilla. Tita I - III with 7, 8, 9 obliquely truncate setae and 1, 1, 1 oval organs respectively; Tita II and III rows p:5 and 2 setae respectively, length of longest setae > 3x diameter of Tita. Claws with inner tooth. Dens with reduced number of setae, row J:2 distal and 2 proximal setae, formula of anterior setae 3+1,1...1. App. an. straight spinelike, pointed or blunt.

Proportions: Length of antennae : head diagonal = 1.7 in females, 1.8 in males. Ant I : II : III : IV = 1 : 2 : 2.7 : 5.5 (5.9) in females (and males). Dens : mucro = 3. App. an. : mucro = 0.5.

Type locality: Spain, Zaragoza, Refugio Cruz de San Vincente, dry calcareous plateau with some *Pinus halepensis* at 400 m altitude.

Occurrence: Known only from the type locality.

*Fasciosminthurus melanocephalus* (Dallai, 1966) (491)

Syn.: *Bourletiella* (*Fasciosminthurus*) *melanocephala* Dallai, 1966 (491)

*Prorastriopes melanocephalus* Betsch, 1980 (178)

Total length up to 1.2 mm in females, 0.75 mm in males. Background colour yellow, dark blue pigment mainly on head, thorax, and ventrally on large abdomen, large abdomen laterally with some dark spots (Fig. 523). Claws without inner tooth, but 1+1 lateral teeth. Dens row J:3 distal and 2 proximal setae, formula of anterior setae 3+1,2,1,1...1. App. an. straight spinelike, without teeth.

Proportions: Length of antennae : head diagonal = 1.4 in females, 1.7 in males. Ant I : II : III : IV = 1 : 2 : 3 : 6 in both sexes. Dens : mucro = 2.8. App. an. : mucro = 0.5.

Type locality: Italy, Tuscany, W of Pisa, sandy beach of S. Rossore.

Occurrence: Known only from the type locality.

Species description: DALLAI 1970: 153 (cuticula structure).

Remarks: *F. melanocephalus* resembles *F. canariensis* with only slight differences in the colour pattern (see above).

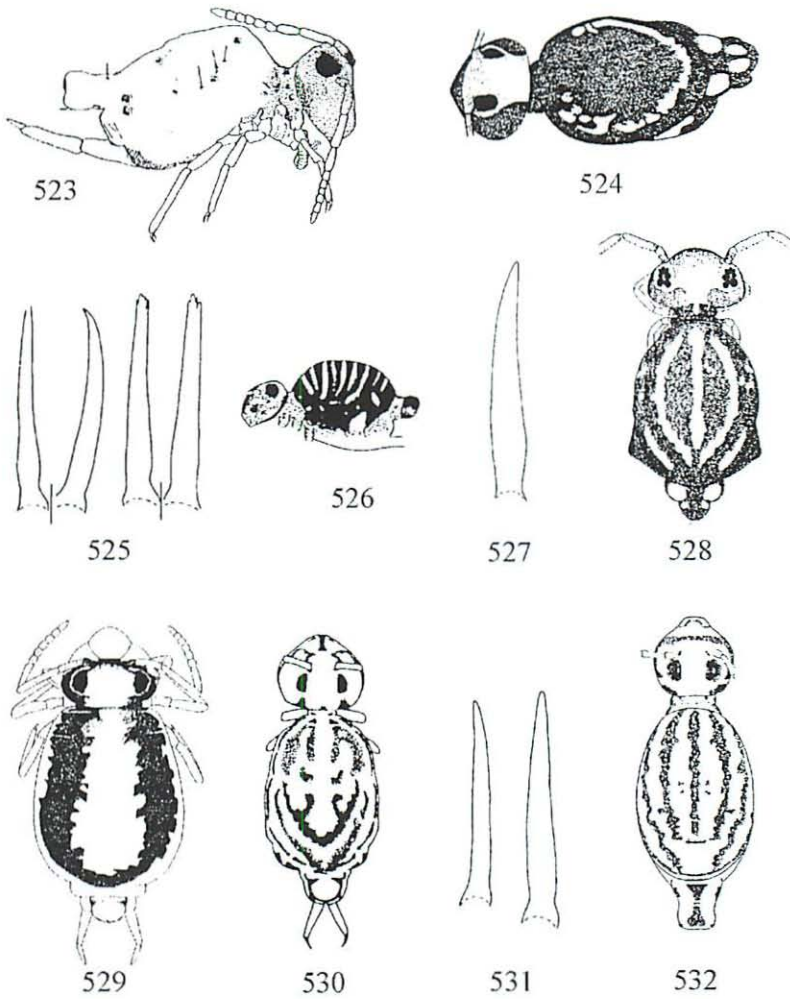


Fig. 523 *Fasciosminthurus melanocephalus*, habitus (after DALLAI 1966).

Figs. 524 - 525 *Fasciosminthurus obtectus*:

524 Colour pattern (after BRETFELD 1996) 525 2 pairs of App. an. (after BRETFELD 1992).

Figs. 526 - 527 *Fasciosminthurus quinquefasciatus*:

526 Colour pattern (after GISIN 1960) 527 App. an. (after BRETFELD 1992).

Fig. 528 *Fasciosminthurus raynalae*, colour pattern (after NAYROLLES 1987).

Fig. 529 *Fasciosminthurus sauteri*, habitus (after NAYROLLES & LIENHARD 1990).

Figs. 530 - 531 *Fasciosminthurus strigatus* (after BRETFELD 1992):

530 Colour pattern 531 2 different App. an.

Fig. 532 *Fasciosminthurus virgulatus*, colour pattern (after LOKSA & BOGOJEVIC 1970).

*Fasciosminthurus obtectus* Bretfeld, 1992 (15)

Body globular (in most other species of *Fasciosminthurus* elongate). Total length up to 0.7 mm in females, 0.6 mm in males. Background colour dirty white with varying, black pigment from almost completely dark with few pale spots (especially 2+2 on small abdomen), with pale dorsal head or large abdomen with silver-wreath (Fig. 524) to mostly pale with few dark spots, also blue-red specimens. Ventral head-back with 2+2 oval organs. Ant III whorls 4, 5, 6 with 4, 4, 6 setae respectively (see Fig. 515). Ant IV region T sometimes with only 1 seta; distal part with 4 anterior and 3 posterior dorsal sensilla. Tita I - III with 7 - 8, 8 - 9, 9 - 10 obliquely truncate setae and 1, 1, 1 oval organs respectively; Tita II and III rows p:4 - 5 and 3 setae respectively. Claws often with small inner tooth; outer tooth and strong lateral teeth more often in females than in males. Dens row J in females with 3 distal and 2 proximal setae, in males 4 - 6 setae arranged irregularly; formula of anterior setae 3+1,2,1,1...1. App. an. long and slender, tip often roughly toothed, seldom blunt (Fig. 525).

Proportions: Length of antennae : head diagonal = 1.7 in females, 1.9 in males. Ant I : II : III : IV = 1 : 2 : 3 : 6.2 (6.7) in females (and males). Dens : mucro = 3. App. an. : mucro = 0.6.

Type locality: Austria, Lower Austria, Hainburg Mts., xerothermic grassland of Hundsheimer Berg at 380 m altitude.

Occurrence: Also found in S Russia (Novosibirsk, Khakasia, and Krasnoyarsk Regs.) and Kazakhstan (Semipalatinsk and Kokchetav Regs.) (BRETFFELD, see below).

Biology: *F. obtectus* lives in eastern steppe vegetation and its western remnants, sometimes also on arable land (BRETFFELD, see below).

Species description: BRETFFELD 1996: 215.

Remarks: *F. obtectus* seems to vary greatly in the pale spots of its general dark colour. At the type locality, it had been collected together with many specimens of *F. strigatus*.

*Fasciosminthurus quinquefasciatus* (Krausbauer, 1898) (498)

Syn.: *Sminthurus quinquefasciatus* Krausbauer, 1898 (498)

*Sminthurus zebrinus* Börner, 1900 (614)

*Bourletiella zebrina* Denis, 1922 (112)

*Deuterosminthurus cinquefasciatus* Womersley, 1932 a (7)

*Bourletiella* (*Deuterosminthurus*) *quinquefasciatus* Gisin, 1946 (255)

*Deuterosminthurus quinquefasciatus* Stach, 1956 (164)

*Bourletiella* (*Fasciosminthurus*) *quinquefasciatus* Gisin, 1960 (284)

*Andiella quinquefasciata* Delamare Deboutteville & Massoud, 1963 (255)

*Prorastriones quinquefasciatus* Betsch, 1980 (177)

Total length up to 0.9 mm in females, 0.5 mm in males. Background colour dark black to violet or greenish, large abdomen with 5 or more white cross stripes (Fig. 526). Ventral head-back with 2+2 oval organs. Ant III whorls 4, 5, 6 with 4, 4, 6 setae respectively (see Fig. 515). Ant IV region T with at least 6 setae; distal part with 6 anterior and 6 - 7 posterior dorsal sensilla. Tita I - III in females with 11, 12, 9, in males 8, 9 - 10, 9 obliquely truncate setae and 1, 1, 1 oval organs respectively; Tita II and III rows p:4 - 6 and 3 setae respectively.

Claws with small inner tooth and lateral teeth. Dens row J:3 distal and 2 proximal setae, formula of anterior setae 3+1,2,1,1...1. App. an. long, broad, tapering, and blunt, or tip seldom with small teeth (Fig. 527).

Proportions: Length of antennae : head diagonal = 1.4 - 1.8 in females, 1.6 in males. Ant I : II : III : IV = 1 : 2 : 3 : 6. Dens : mucro = 2.8. App. an. : mucro = 0.5.

Type locality: Germany, Hesse, near Weilburg/Lahn, in rocky habitats.

Occurrence: Europe and Australia; mainly in Central Europe, seldom in W and SW France, W Spain, former S Yugoslavia, and Lithuania (BRETfeld 1989: 316), only 3 new records from adjacent regions: Central Portugal (Santarém, SOUSA et al. 1997: 150, and Castelo Branco, orig. observ., ex coll. da GAMA ASSALINO) and Portugal, the Azores (Faial, GAMA 1992: 47); in Australia it has been introduced from Europe and is known only from Tasmania (GREENSLADE 1994: 123). Further new records not mentioned in BRETfeld 1989: 316 are: Germany (Thuringia, Poxdorfer Hang near Jena, orig. observ., leg. SANDER; Saxony-Anhalt, Bennstedt, orig. observ., leg. SCHNITTER; Hesse, Vogelsberg, BÖHLE 1991: 39) and Czech Rep. (Central Bohemia, RUSEK 1990: 55).

Biology: *F. quinquefasciatus* lives on the soil surface and in the low vegetation of xerothermic habitats, in sunny grasslands, gardens, and field crops, even on hot sunny gravel or rails (BRETfeld 1989: 317). In the Azores, it has been found on old lava with sparse grass (GAMA, see above). There is no primary damage to pastures in Australia (GREENSLADE & IRESON 1986: 275, 279). In Switzerland, *F. quinquefasciatus* disappeared in the middle of the summer (GISIN 1948: 500), a phenomenon not observed in other regions. It has been collected up to 1370 m altitude in Switzerland.

Species descriptions: KRAUSBAUER 1905: 42 (redescription), GISIN 1948: 498 (male), JEANNENOT 1956: 1 (general, colour pattern), RUSEK 1965: 162 (colour pattern), BRETfeld 1989: 316 (distribution), 1992: 17 (chaetotaxy), NAYROLLES 1994: 316 (general, mainly chaetotaxy of the extremities).

Remarks: *F. quinquefasciatus* is a European species and had not been imported from S America (as believed by DELAMARE DEBOUDEVILLE & MASSOUD, see above) since this species does not belong to *Andiella* (= *Prorastriones*), but rather to *Fasciosminthurus*, a genus not occurring in S America.

*Fasciosminthurus raynaliae* (Nayrolles, 1987) (123) sensu Nayrolles, 1994 (320)

Syn.: *Prorastriones raynaliae* Nayrolles, 1987 (123)

Total length up to 0.7 mm in females, 0.55 mm in males. Background colour light red, large abdomen with 3 long and 1+1 short, white longitudinal bands, small abdomen with 2+2 white spots; eye-patches orange, only ommatidia black (Fig. 528, see Remarks). Ventral head-back without oval organs. Distal part of Ant IV with 5 anterior and 4 posterior dorsal sensilla. Tita I - III with 7, 8, 9 obliquely truncate setae and 1, 1, 1 oval organs respectively; Tita II and III rows p:4 and 3 setae respectively. Claws with inner tooth. Dens row J:2 distal and 2 proximal setae, formula of anterior setae 3+1,2,1,1...1. App. an. long setalike.

Proportions: Length of antennae : head diagonal = 1.5 in females, 1.6 in males. Ant I : II : III : IV = 1 : 2 : 2.7 : 5 in both sexes. Dens : mucro = 2.7. App. an. : mucro = 0.8.

Type locality: France, Hautes-Pyrénées, Plateau of Aumar in the Massif du Néouvielle, short meadow at 2200 m altitude.



Occurrence: Also found in Central Portugal (Beira Beixa, Idanha-a-Nova, orig. observ., ex coll. da GAMA ASSALINO).

Remarks: The specimens from Portugal differed from the original description only by their black eye-patches and darker body pigment.

*Fasciosminthurus sauteri* (Nayrolles & Lienhard, 1990) (623)

Syn.: *Prorastriopes sauteri* Nayrolles & Lienhard, 1990 (623)

Total length up to 0.65 mm in females, 0.5 mm in males. Background colour yellow to rose, dark violet pigment mainly in a broad longitudinal band around the head and large abdomen (Fig. 529). Ventral head-back without oval organs. Tita I - III with 7, 8, 9 obliquely truncate setae and 1, 1, 1 oval organs respectively; Tita II and III rows p:4 - 5 and 3 setae respectively. Claws with minute inner tooth and lateral teeth. Dens row J:2 distal and 2 proximal setae, formula of anterior setae 3+1.2.1.1...1. App. an. straight and smooth.

Proportions: Length of antennae : head diagonal = 1.7 in both sexes. Ant I : II : III : IV = 1 : 2 : 3 : 6.3 in both sexes. Dens : mucro = 3. App. an. : mucro = 0.7.

Type locality: Switzerland, Grisons, Samedan, vegetation on gravel at about 1800 m altitude.

Occurrence: Known also from another site in Switzerland (Ticino, near Piora, NAYROLLES & LIENHARD, see above).

Biology: *F. sauteri* has only been found on the soil of subalpine habitats with sparse vegetation (on gravel and in a Seslerio-Caricetum plant association) at 1800 m and 2000 m altitude (NAYROLLES & LIENHARD, see above).

Species description: NAYROLLES 1994: 330 (oval organs of head), 1997: 368 (mainly chaetotaxy of extremities).

Remarks: The colour pattern resembles *F. coronatus*, see above.

*Fasciosminthurus strasseni* (Paclt, 1964) (54) n. comb.

Syn.: *Prorastriopes canariensis strasseni* Paclt, 1964 (54)

Only 2 females known. Total length 1 mm. Background colour pale with many blue patches, ventrally paler. Length of circumanal setae in females up to 60  $\mu$ m. Other characteristics as in *F. canariensis* (see above).

Proportions: Ant I : II : III : IV = 1 : 2.7 : 4 : 7 - 8.

Type locality: Spain, the Canary Islands, Fuerteventura, Valle de la Mosquitos, Jandia, on *Gymnocarpus decandrus*.

Occurrence: Known only from the type locality.

Remarks: *F. strasseni* is here regarded as a separate species and not as a ssp. of *F. canariensis*, although both have been collected from Fuerteventura, since the colour pattern differs distinctly.

*Fasciosminthurus strigatus strigatus* (Stach, 1922) (61) sensu Bretfeld, 1992 (18), 1996 (216)

*Fasciosminthurus strigatus sajanensis* Bretfeld, 1996 (216)

Syn.: *Deuterostminthurus strigatus* Stach, 1922 (61)

*Bourletiella (Fasciosminthurus) strigata* Gisin, 1960 (284)

*Fasciosminthurus* cf. *circumfasciatus* Dunger, 1975 (26), BRETFELD 1992: 18

*Bourletiella carpatica* Nosek, 1978 (387), BRETFELD 1992: 18

*Prorastriones strigatus* Betsch, 1980 (178)

*Prorastriones circumfasciatus* Christian & Kampichler, 1984 (136), BRETFELD 1992: 18

*Prorastriones* cf. *circumfasciatus/strigatus* Thibaud & Christian, 1986 (405), BRETFELD 1992: 18

Total length up to 0.8 mm in females, 0.5 mm in males. Background colour white to yellow, blackish blue pigment mainly in several longitudinal stripes on large abdomen, small abdomen with dark U-shaped margin (more intense pigmentation in ssp. *sajanensis*) (Fig. 530); also less pigmented or pale specimens, males palest (only Ant IV pigmented). Ventral head-back without oval organs. Ant III whorls 4, 5, 6 with 3, 3, 5 (4, 3, 5 in ssp. *sajanensis*) setae respectively (see Fig. 515). Ant IV region T sometimes without seta; distal part with 5 anterior and 4 posterior (4 and 4 in ssp. *sajanensis*) dorsal sensilla. Tita I - III with 7, 8, 9 obliquely truncate setae and 1, 1, 1 oval organs respectively; Tita II and III rows p:4 and 3 (3 and 2 in ssp. *sajanensis*) setae respectively. Claws with inner, sometimes also outer tooth, and doubtful lateral teeth. Dens row J:3 distal and 2 proximal setae (seldom 4 - 6 irregularly arranged), formula of anterior setae 3+1,2,1,1...1. App. an. long, slender, tapering, and blunt without teeth (Fig. 531).

Proportions: Length of antennae : head diagonal = 1.7 in females, 1.9 in males. Ant I : II : III : IV = 1 : 2 : 2.7 : 5.8 in both sexes. Dens : mucro = 3. App. an. : mucro = 0.7.

Type locality: SE Slovakia, near Levice, on grass on sunny rocks.

Occurrence: Also found in SW Slovakia (the Little Carpathians), NW Hungary (Börzsöny Mts.), E Austria (Lower Austria, Hainburg Mts.) (BRETFELD 1992: 19), and S Russia (Krasnoyarsk Reg., West Sayan Mts., BRETFELD 1996: 216). The western collection sites lie within a distance of only maximally 150 km.

Biology: In Europe, *F. strigatus* lives in xerothermic grasslands, i. e. in the vegetation of humid but warm mountain meadows and small western steppe remainders up to 700 m altitude; in Central Asia in grassland and steppe vegetation up to 1100 m altitude (ssp. *sajanensi*, BRETFELD, see above).

Remarks: Type locality of ssp. *sajanensis*: S Russia, S Krasnoyarsk Reg., West Sayan Mts., rocky steppe at 1100 m altitude.

The few type specimens of *F. obtectus* have been collected in Austria together with many *F. strigatus* (BRETFELD 1992: 16).

*Fasciosminthurus virgulatus* (Skorikow, 1899) (390) sensu Bretfeld, 1992 (8)

Syn.: *Sminthurus virgulatus* Skorikow, 1899 (390)

*Deuterosminthurus bilineatus* var. *pluslineata* Stach, 1922 (63), BRETfeld 1989: 319

*Deuterosminthurus bilineatus* ab. *prodromata* Stach, 1922 (64), BRETfeld 1989: 319

*Deuterosminthurus virgulatus* Denis, 1932 (380)

*Bourletiella* (*Fasciosminthurus*) *virgulata* Gisin, 1960 (285)

*Bourletiella* (*Deuterosminthurus*) *virgulata* Altner, 1961 (269)

*Prorastriopes virgulatus* Betsch, 1980 (177)

Total length up to 0.9 mm in females, 0.6 mm in males. Background colour white to yellow, dark black, brown, or blue pigment mainly in 2 - 3 horizontal stripes on head, and 5 long and 1+1 short longitudinal stripes on large abdomen (Fig. 532) (more intense pigmentation in specimens from Kazakhstan); also less pigmented or pale specimens, males palest. Ventral head-back with 1+1 oval organs. Ant III whorls 4, 5, 6 with 4, 4, 5 setae respectively (see Fig. 515). Ant IV region T sometimes without a seta; distal part with 4 - 5 anterior and 4 posterior dorsal sensilla. Tita I - III with 7, 8, 9 obliquely truncate setae and 1, 1, 1 oval organs respectively; Tita II and III rows p:4 and 3 setae respectively. Claws often with inner tooth and small lateral teeth, seldom with outer tooth. Dens row J:2 distal and 2 proximal setae, formula of anterior setae 3+1,2,1,1...1. App. an. slender, blunt, tip seldom with small teeth.

Proportions: Length of antennae : head diagonal = 1.7 in females, 1.9 in males. Ant I : II : III : IV = 1 : 2 : 3 : 6.2 (6.7) in females (and males). Dens : mucro = 3. App. an. : mucro = 0.6.

Type locality: Ukrainia, in gardens near Charkov.

Occurrence: S Palearctic, known from S Europe, NW Africa (BRETfeld 1989: 319), and Central Asia (Kazakhstan, BRETfeld 1996: 216); in Europe mainly in the Mediterranean region, only single records from NW France, S Slovakia, E Austria, and former NE Yugoslavia; in NW Africa known from Morocco, Algeria, and Tunisia, from near the sea S to the Ahaggar Mts.; not known from central Spain and central Italy (BRETfeld 1989: 319, 1990: 442). Also found in S Australia (GREENSLADE, pers. comm.).

Biology: *F. virgulatus* lives in the low vegetation of very warm and rather humid habitats, in Africa often on *Medicago* and other field crops of the oases where they may be introduced as eggs with seeds (like *Sminthurus viridis* overseas, see above); it has been collected up to more than 1000 m altitude in France (Corse) and Morocco (High Atlas) (BRETfeld 1989: 320).

Species description: ALTNER 1961: 269 (dens, colour pattern), DALLAI 1969: 244 (male, pigmentation of head), LOKSA & BOGOJEVIC 1970: 135 (colour pattern), BRETfeld 1989: 319 (distribution), 1990: 441 (chaetotaxy), 1996: 216 (2 females from Kazakhstan), NAYROLLES 1997: 372 (mainly chaetotaxy of extremities).

Remarks: The females from Kazakhstan, besides the more intense pigmentation, have thicker circumanal setae and App. an. than the western specimens; they may represent a subspecies but more material is needed to create it (BRETfeld 1996: 216).

**Genus *Heterosminthurus* Stach, 1955**

**Key to the Palaearctic species**

- |    |   |                                       |
|----|---|---------------------------------------|
| 1  | Large abdomen with 9 dark blue or brown longitudinal stripes (Fig. 547)   |                                       |
|    |   | <i>novemlineatus</i> (Tullberg, 1871) |
| –  | With other pattern  | 2                                     |
| 2  | Large abdomen with 1+1 long and 1+1 short brown longitudinal stripes (Fig. 533)   | 3                                     |
| –  | With other pattern  | 4                                     |
| 3  | Head frons in males with 2+2 thick, acuminate setae (Fig. 535); flank setae as 4/-  |                                       |
|    |   | <i>bilineatus</i> (Bourlet, 1842)     |
| –  | Head frons in males with 1+1 acuminate and 1+1 compressed setae (Fig. 538); flank setae as 5/+  | <i>claviger</i> (Gisin, 1958)         |
| 4  | Head dark, abdomen with dark dorsal band narrowing posteriorly, or at least head frons with broad dark patch (Figs. 542 - 544)  | <i>linnaniemii</i> (Stach, 1920)      |
| –  | With other pattern  | 5                                     |
| 5  | Head with 3 brown longitudinal stripes, large abdomen with brown sides (Fig. 550)   |                                       |
|    |   | <i>pirika</i> Yosii, 1972             |
| –  | With other pattern  | 6                                     |
| 6  | Abdomen yellow with 6+6 dark blue spots and few pale blue patches (Fig. 552)  |                                       |
|    |   | <i>punctatus</i> Bretfeld, 1996       |
| –  | With other pattern  | 7                                     |
| 7  | Male  | 8                                     |
| –  | Female  | 21                                    |
| 8  | All anterior setae of large abdomen of normal form  | 9                                     |
| –  | Many anterior setae of large abdomen short onionlike (Fig. 546)   | 20                                    |
| 9  | Head frons and clypeus with short or normal setae, without especially long or modified setae  | 10                                    |
| –  | Head with especially long or modified setae   | 11                                    |
| 10 | Head and abdomen with several dark, longitudinal stripes, these stripes sometimes disappearing under dark blue pigment, or stripes faded to traces of blue pigment (Fig. 547); most body setae rather thick; flank setae as 5/+ |                                       |
|    |   | <i>novemlineatus</i> (Tullberg, 1871) |
| –  | Head and abdomen mainly yellow, sometimes with small blue spots or blue tints; all body setae thin; flank setae as 4/+  | <i>stebaevae</i> Bretfeld, 1996       |
| 11 | Frons only with normal setae (short or long)  | 12                                    |
| –  | Frons also with short onionlike setae (Fig. 535)  | 18                                    |
| 12 | Clypeus with short or long normal setae but without special, modified setae   | 13                                    |
| –  | Clypeus with special, modified setae  | 14                                    |

- 13 Frons medially with short setae, laterally with 2 or 3 pairs of long setae (Fig. 541); Ant II with only normal setae *insignis* (Reuter, 1876)
- Frons medially and laterally with 1 pair of long setae each; Ant II with 2 distal spines (Figs. 553, 554) *punctatus* Bretfeld, 1996
- 14 Clypeus medially with normal setae, laterally with 6+6 short spinelike setae (Fig. 551) *pirika* Yosii, 1972
- Clypeus medially with modified setae 15
- 15 Frons with only normal or long setae 16
- Frons medially with 2+2 thick, blunt spines; clypeus with several short spines (Fig. 556) *setiger* (Gisin, 1961)
- 16 Clypeus with several spinelike setae, 6 of which forming 3 arches; Tita I curved (Figs. 536, 537) *chaetocephalus* Hüther, 1971
- Clypeus with straight spines; Tita I straight 17
- 17 Clypeus with 5 long spines (Fig. 549) *nymphes* Yosii, 1970
- Clypeus with 3 - 5 lancetlike spines (Fig. 560) *undulans* Yosii & Lee, 1963
- 18 (11) Frons dorsally only with acuminate setae 19
- Frons dorsally with 1 pair of compressed setae (Fig. 538) *claviger* (Gisin, 1958)
- 19 Frons with lower medial pair of dorsal setae shorter than upper pair (Fig. 535); Ant II with several dorsal spines, Ant III with 1 basal spine *bilineatus* (Bourlet, 1842)
- Frons with lower medial pair of dorsal setae as long as or longer than upper pair (Fig. 545); only Ant III with 1 basal spine *linnaniemii* (Stach, 1920)
- 20 (8) Frons dorsally with 1+1 thick setae (Fig. 546), clypeus with 2 long, median spines *nonlineatus* (Gisin, 1946)
- Frons dorsally with 2+2 thick setae (Fig. 539), clypeus with 4 - 6 spinelike setae *diffusus* (Gisin, 1962)
- 21 (7) Ant IV with 7 - 8 subsegments and ventral sensilla V on 2nd and 3rd whorl behind the tip 22
- Ant IV with 10 - 11 subsegments and ventral sensilla V on 2nd to 5th whorl behind the tip *diffusus* (Gisin, 1962)
- 22 Tita I row p:7 setae 23
- = Tita I row p:6 setae; abdomen with 6+6 dark blue spots and few pale blue patches (Fig. 552) *punctatus* Bretfeld, 1996
- Tita I row p:5 setae; abdomen only yellow *chaetocephalus* Hüther, 1971
- 23 Flank setae as 4/- (if traces of pigment, see entry 2) *bilineatus* (Bourlet, 1842), *linnaniemii* (Stach, 1920)
- = Flank setae as 4/+ 24
- Flank setae as 5/+ 25
- 24 Circumanal setae av1' almost as long and thick as av2; ventral head-back with 2+2 oval organs *stebaevae* Bretfeld, 1996
- Circumanal setae av1' distinctly shorter and thinner than av2; ventral head-back with 1+1 oval organs *undulans* Yosii & Lee, 1963

- |    |   |                                       |
|----|---|---------------------------------------|
| 25 | Inner setae of dentes short, length $\leq$ diameter of dentes   | 26                                    |
| –  | Inner setae of dentes long, length about 2x diameter of dentes  | 27                                    |
| 26 | Circumanal setae av1' almost as long and thick as av2; abdomen yellow or with traces of blue pigment                                | <i>nonlineatus</i> (Gisin, 1946)      |
| –  | Circumanal setae av1' distinctly shorter and thinner than av2; abdomen yellow or with brown spots, without blue tints               | <i>claviger</i> (Gisin, 1958)         |
| 27 | All distal setae of femora of same thickness; App. an. acuminate, sharply curved in basal 1/3 (Fig. 548)                            | <i>novemlineatus</i> (Tullberg, 1871) |
| –  | Some distal setae of femora thicker than others; App. an. rather broad, distal 1/2 narrower, straight or steadily curved (Fig. 540) | <i>insignis</i> (Reuter, 1876)        |

Remarks: Within most species, the pigmentation varies considerably from yellow or striped to light or blackish blue or brown and from striped to completely pale (except the eye-patches). This key, therefore, starts with a few species showing a characteristic colour pattern; the modifications of these patterns are not mentioned but the males and females of all species are dealt with on other morphological characteristics in the later entries. The females of the following species are not considered: *H. nymphes*, *H. setiger* (in both species females not completely known), and *H. pirika* (females unknown). Except in these 3 species, the key and the species descriptions contain several original observations.

#### Diagnosis of the genus

Large abdomen elongate, row 5:1 seta. Ant IV with large sensillum P on 1st whorl behind the tip, with 2 ventral and 12 tip sensilla (see Figs. 11, 12). Inner setae of Tita not obliquely truncate, seta Ia present, Iii missing (see Fig. 23). Tita I - III with 3, 3, 2 spatulate setae respectively. Emp I without lamella and directly forming a thick filament, Emp II and III with lamellae abruptly narrowed to long and pointed filaments, length of all Emp > claws (Fig. 462). Distal anterior setae of dens as long as or longer than the spaces between rows; formula of anterior setae 3+1,3,1,1...1 (Fig. 27). Secondary sexual characteristics: in males: in most species some setae of head, and sometimes of Ant II and III, leg I, and anterior of large abdomen modified; in females: circumanal setae av1' as long as av2 or shorter (see Fig. 555).

Occurrence: Holarctic.

Descriptions of the genus: STACH 1955: 53, 1956: 178, BETSCH 1980: 177, CHRISTIANSEN & BELLINGER 1981: 1170, NAYROLLES 1996: 527.

Type species: *Sminthurus insignis* Reuter, 1876.

Remarks: The large abdomen shows a special pattern of flank setae posterolaterally below Bothr C and in front of an additional sensillum S (Fig. 18): the formula 5/+ means 5 setae f1 - f5 plus intermediate seta i, 4/- means 4 setae f1 - f4 without seta i (BRETZFELD 1986: 19).

**Diagnosis of the Palaearctic species**

*Heterosminthurus bilineatus bilineatus* (Bourlet, 1842) (XLI) sensu Gisin, 1957 (493)

*Heterosminthurus bilineatus caucasicus* (Stach, 1956) (192)

Syn.: *Sminthurus bilineatus* Bourlet, 1842 (XLI)

*Deuterosminthurus coronatus* Bagnall, 1921 (16), GOTO & LAWRENCE 1964: 89

*Heterosminthurus cornutus* Stach, 1956 (190), GISIN 1957: 493

*Heterosminthurus cornutus caucasicus* Stach, 1956 (192)

nec *Bourletiella bilineata* Linnaniemi, 1911 (27) (= *H. claviger*, BRETZFELD 1989: 307)

*Deuterosminthurus bilineatus* Tuxen, 1944 (143, 181) (= *H. claviger*, BRETZFELD 1989: 307)

*Deuterosminthurus bilineatus* Bödvarsson, 1957 (40) (= *H. claviger*, BRETZFELD 1989: 307)

*Bourletiella bilineata* Haybach, 1971/72 (17, 18) (= *H. claviger*, BRETZFELD 1989: 307)

Total length up to 1 mm in females, 0.7 mm in males. Background colour white to yellow, orange to dark brown pigment in 1+1 longitudinal stripes on the head and large abdomen and 1+1 shorter stripes posterolaterally (Fig. 533), often with only bases of Bothr brown, seldom dark brown stripes; ssp. *caucasicus* only yellow; antennae always brown. Ventral head-back with 1+1 oval organs. Ant IV with 7 - 8 subsegments; ventral sensilla V on 2nd and 3rd whorl behind the tip. Flank setae as 4/-. Tita I - III rows p:7, 4 - 5, 2 setae respectively. Claws with small lateral teeth. Inner setae of dentes short, length  $\leq$  diameter of dens. App. an. long, lancetlike, pointed or blunt, straight or slightly curved (Fig. 534). Secondary sexual characteristics: in males: head frons dorsally with 2+2 thick, acuminate setae, upper pair longer and thicker than lower, laterally with 1+1 long setae, ventral part with several short onionlike setae (Fig. 535); Ant II with 4 - 7 dorsal spines, Ant III with 1 basal spine; in females: length of circumanal setae  $av1' < av2$ .

Proportions: Length of antennae : head diagonal = 2 in females, 2.5 in males. Ant I : II : III : IV = 1 : 2.3 : 4 : 7.2 in females, 1 : 2.6 : 4.5 : 7.5 in males. Dens : mucro = 3. App. an. : mucro = 0.7.

Type locality: Not defined, France.

Occurrence: Europe and S Russia; in Europe certainly known from SW Finland, N Denmark, and Great Britain (England) S to former N and W Yugoslavia, Italy (Tuscany), and N Spain (Navarra); in S Russia known from Tuva Reg. (BRETZFELD 1989: 299). Not confirmed for the Nearctic (see below). The records from S Russia and from Central Spain (DENIS 1930: 82) should be confirmed.

Biology: *H. bilineatus* lives in the low vegetation of dry or humid, open localities: in Central Europe in dry or humid meadows, degenerated moors, and dry *Calluna* sites; in northern regions, in the Alps, and the Pyrenees only in humid meadows; in the warm south (Italy, Tuscany) only in dry *Calluna* sites. In Central Europe, pale populations are more abundant than brown striped; dark brown striped specimens have only been found in the Tuscany. Alcohol does not fade the pigmentation.

*H. bilineatus* has been collected up to 2100 m altitude in N Italy (the Dolomites), the main habitats in the high mountain regions, however, are the valley meadows where it has been found up to 1850 m altitude in the Pyrenees (France, Valée d'Aure) and 1750 m in the Alps (Austria, Stubai Valley). (All data according to BRETFFELD 1989: 298, 299.)

In mating behaviour, the male contacts the genital region of the female with the large setae of its head frons and rubs there with these setae and twitches with its antennae. Immediately before depositing a spermatophore in front of the female, the male vigorously rubs its frons setae on the genital region. The male touches its spermatophore with one antenna. Both male and female can defend themselves against an unwelcome comrade by leaving the abdomen and suddenly dealing a blow with the furca that catapults the annoyer away. (See BRETFFELD 1970: 267, 1971: 153, 1973).

Species descriptions: GISIN 1960: 283, BRETFFELD 1989: 298 (distribution, colour differences to *H. claviger*), SCHALLER 1974: 414, 415 (colour prints of mating behaviour), NAYROLLES 1996: 529 (general, mainly chaetotaxy of the extremities).

Remarks: For a discussion of the older literature and more synonyms and exclusions, see BRETFFELD 1989: 298, 307. *H. bilinetus caucasicus* is here also regarded as a subspecies since the males resemble those of the nominate subspecies; the differences are slight or uncertain (orig. observ. with the types), more material is needed. Nearctic records apparently belong to *H. dreisbachi* (Snider, 1969) (CHRISTIANSEN & BELLINGER 1981: 1147).

*Heterosminthurus chaetocephalus* Hüther, 1971 (257)

Syn.: *Heterosminthurus* spec. Traser, 1995 (47)

Total length up to 1 mm in females, 0.7 mm in males. Colour pale yellow; antennae light violet. Ventral head-back with 1+1 or 2+2 oval organs. Ant IV with 7 - 8 subsegments; ventral sensilla V on 2nd and 3rd whorl behind the tip. Flank setae as 4/+. Tita I - III rows p:5, 3, 2 setae respectively. Claws with minute lateral teeth. Inner setae of dentes long, length  $\geq$  diameter of dens. App. an. long, spinelike, pointed, slightly curved, tip or distal 1/2 sometimes with small teeth. Secondary sexual characteristics: in males: head clypeus with several thick setae, 6 forming 3 arches; femur I anteriorly with thick spine, Tita I curved and anteriorly with 3 spines (Figs. 536, 537); in females: length of circumanal setae av1'  $\ll$  av2.

Proportions: Length of antennae : head diagonal = 1.8 in females, 2.7 - 3.2 in males. Ant I : II : III : IV = 1 : 1.9 : 3 : 6.1 in females, 1 : 2.2 : 4.6 : 7.8 in males. Dens : mucro = 3.3. App. an. : mucro = 0.65 - 0.7.

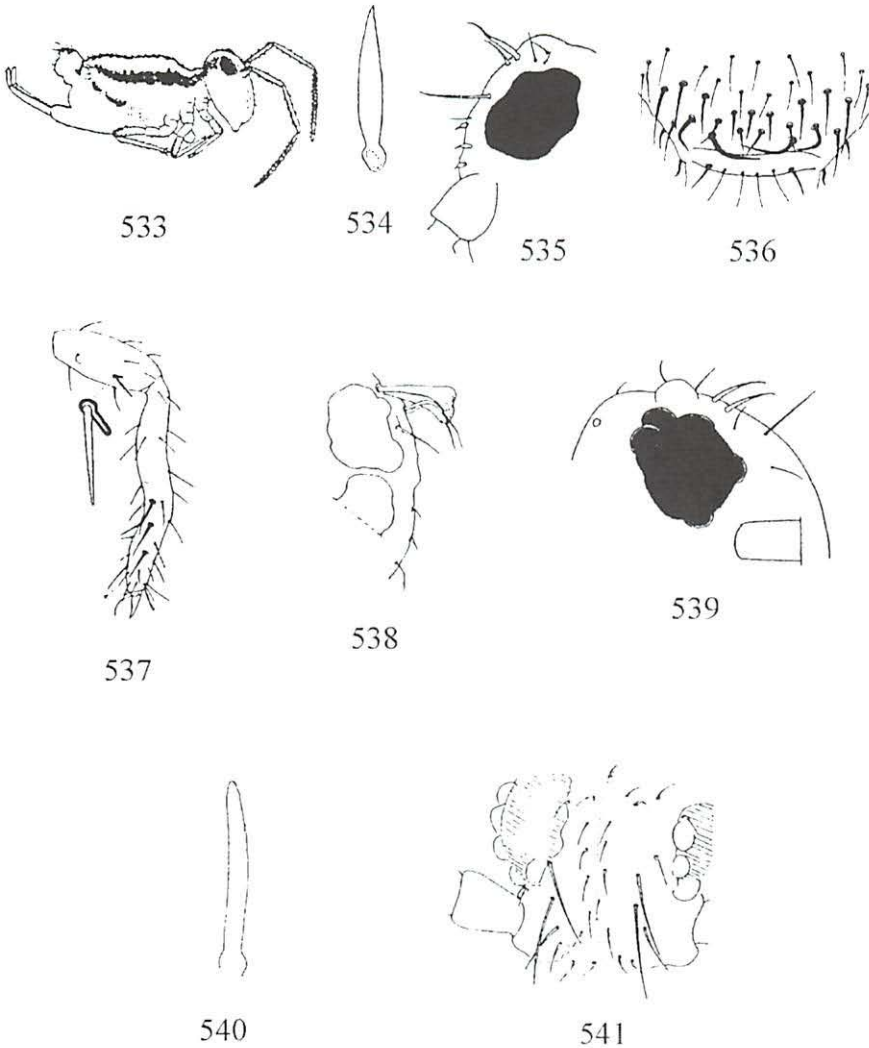
Type locality: Germany, Schleswig-Holstein, W Kiel, in the low vegetation of a humid meadow near Lake Russee.

Occurrence: Palaearctic; also known from Germany at another site in Schleswig-Holstein, in Lower Saxony and Brandenburg, from E Poland (BRETFFELD 1989: 312), W Hungary (TRASER, see above, orig. observ.), and from Russia (SE of Moscow and near Lake Baykal, BRETFFELD 1996: 210).

Biology: *H. chaetocephalus* lives in the low vegetation of humid meadows and adjacent sites and in active or degenerated moors. In Europe it has only been found north of the highlands, in Siberia up to 600 m altitude.

In mating behaviour, the male contacts the head of the female with its thick clypeal setae and moves its antennae slowly up and down. Finally the male deposits a spermatophore in front of the female, presses the droplet with one leg I on his head and contacts the stalk with the other Tita I. Both male and female can defend themselves against an unwelcome comrade by leaving the abdomen and suddenly dealing a blow with the furca that catapults the annoyer away. (See BRETFFELD 1976 b). In the laboratory, several males have been observed gathering in front of a mating couple waiting to court with the female and to deposit a spermatophore one after the other (orig. observ.).





Figs. 533 - 535 *Heterosminthurus bilineatus*: 533 Habitus (after STACH 1956) 534 App. an. (after STACH 1956) 535 Male frons of head (after GISIN 1960).

Figs. 536 - 537 *Heterosminthurus chaetocephalus* (after HÜTHER 1971): 536 Male clypeus of head 537 Male leg I.

Fig. 538 *Heterosminthurus claviger*, male frons of head (after MURPHY 1960).

Fig. 539 *Heterosminthurus diffusus*, male frons of head (after GISIN 1962).

Figs. 540 - 541 *Heterosminthurus insignis*: 540 App. an. (after BRETFELD 1988) 541 Male frons of head (after FJELLBERG 1980).

*Heterosminthurus claviger* (Gisin, 1958) (777)

Syn.: *Bourletiella bilineata* Linnaniemi, 1911 (27), BRETTFELD 1989: 307

*Deuterosminthurus bilineatus* Tuxen, 1944 (143, 181), BRETTFELD 1989: 307

*Deuterosminthurus bilineatus* Bödvarsson, 1957 (40), BRETTFELD 1989: 307

*Bourletiella (Heterosminthurus) clavigera* Gisin, 1958 (777)

*Bourletiella (Heterosminthurus) craggi* Murphy, 1960 (62), HALE 1966: 106

*Bourletiella (Heterosminthurus) linnaniemii* Petersen, 1965 (383), BRETTFELD 1989: 313

*Bourletiella bilineata* Haybach, 1971/72 (17, 18), BRETTFELD 1989: 307

Total length up to 0.9 mm in females, 0.6 mm in males. Background colour white to yellow, usually blackish brown pigment in 1+1 longitudinal stripes on the head and large abdomen and 1+1 shorter stripes posterolaterally (see Fig. 533), stripes sometimes paler or only Bothr with brown bases, seldom only yellow; antennae always brown. Ventral head-back with 1+1 oval organs. Ant IV with 7 - 8 subsegments; ventral sensilla V on 2nd and 3rd whorl behind the tip. Flank setae as 5/+. Tita I - III rows p:7, 4 - 5, 2 setae respectively. Claws sometimes with small inner tooth. Inner setae of dentes short, length  $\leq$  diameter of dens. App. an. long, lancetlike, pointed or blunt, straight or slightly curved. Secondary sexual characteristics: in males: head frons dorsally with 2+2 thick setae, upper pair compressed, lower pair long, curved, and acuminate, laterally with 1+1 long setae. ventral part with several short onionlike setae (Fig. 538); Ant II with 5 (seldom 6 or 7) dorsal spines, Ant III with 1 basal spine; in females: length of circumanal setae  $av1' < av2$ .

Proportions: Length of antennae : head diagonal = 2 in females, 2.7 in males. Ant I : II : III : IV = 1 : 2.2 : 3.7 (4.2) : 6.6 (6.7) in females (and males). Dens : mucro = 3. App. an. : mucro = 0.7.

Type locality: Germany, Bavaria, Bernrieder Filz, on *Betula nana* and *Calluna*.

Occurrence: Europe and S Russia; in Europe from Island and N Norway W to Ireland, E to E Finland and W Russia (St. Petersburg), and S to SW France, N Italy (the Dolomites), and central former Yugoslavia; in S Russia in Altai Reg. (BRETTFELD 1989: 305).

Biology: *H. claviger* lives in the low vegetation of dry or humid, usually open localities: in N Europe in various vegetation from wet to dry habitats, in Central Europe mainly in moors or dry localities with *Calluna*, and in the Alps again in various vegetation from wet moors to dry heaths with lichens and on the sparse vegetation near glaciers. The main colour form is the dark brown striped one, mixed sometimes with paler specimens, only the bases of the Bothr were dark in specimens from Norway (Hardangervidda) and Austria (Carinthia, SE Styria), these spots were also missing in specimens from near a glacier in Austria (Tyrol, Obergurgl). Alcohol does not fade the pigmentation.

*H. claviger* has been collected up to 2500 m altitude (Switzerland). On the valley meadows of the Alps it is replaced by *H. bilineatus*: in Switzerland (Nidwalden, Oberrickenbach) *H. claviger* only occurs above 800 m, in Austria (Tyrol, Ötz Valley) above 1500 m altitude. (All data according to BRETTFELD 1989: 298, 305.)

The mating behaviour resembles that of *H. bilineatus*, the differences being: when contacting the genital region of the female, the male quickly trembles with its antennae, this being interrupted by short rests: before the deposition of a spermatophore, the male trembles with its antennae for several minutes. The male can defend itself against an unwelcome comrade by leaving the abdomen and suddenly dealing a blow with the furca that catapults the annoyner away. (See BRETTFELD 1970: 266, 1971: 153).

Species descriptions: BRETFFELD 1989: 298, 305 (distribution, colour differences to *H. bilineatus*), NAYROLLES 1996: 533 (general, mainly chaetotaxy of the extremities).

Remarks: For a discussion of the older literature and more synonyms see BRETFFELD 1989: 298, 307.

*Heterosminthurus diffusus* (Gisin, 1962) (23)

Syn.: *Bourletiella (Heterosminthurus) diffusa* Gisin, 1962 (23)

*Bourletiella nonlineata* Haybach, 1971/72 (15, 16), Christian, 1985 (88), 1987 (60)  
n. syn.

nec *Heterosminthurus* cf. *diffusus* Topp, 1975 (278), Christian, 1987 (59) (= *H. nonlineatus*)

Total length up to 1.2 mm in females, 1 mm in males. Background colour white or yellow without darker pigment or with more or less blue to blackish violet-brown pigment up to completely dark (except head apex and frons, tips of Tita, and dentes); antennae always violet. Ventral head-back without oval organs. Ant IV with 10 - 11 subsegments; ventral sensilla V on 2nd to 5th whorl behind the tip. Flank setae as 5/+. Tita I - III rows p:7, 4 - 6, 2 setae respectively. Claws with small inner tooth and lateral teeth. Inner setae of dentes short, length  $\leq$  diameter of dens. App. an. long, lancet- or bandlike, pointed, tip or distal 1/2 with small teeth or fringes. Secondary sexual characteristics: in males: head frons dorsally with 2+2 thick, blunt spines, upper pair slightly longer than lower (Fig. 539), laterally with 2+2 or 3+3 long setae, ventral part with several short, normal, swollen, or onionlike setae; clypeus medially with 4 - 6 spinelike, laterally with several long setae, large abdomen anteriorly with many short onionlike setae (see Fig. 546); in females: length of circumanal setae  $av_1' = av_2$ .

Proportions: Length of antennae : head diagonal = 1.7 - 2 in females, 2.2 - 2.6 in males (higher values in yellow specimens). Ant I : II : III : IV = 1 : 2 : 3.5 : 7 in both sexes. Dens : mucro = 3.3. App. an. : mucro = 0.45 - 0.65 (higher values in blue specimens).

Type locality: Austria, Tyrol, Rossrücken Mt. in the Zillertal Alps, Curvuletum at 2800 m altitude.

Occurrence: Austrian Alps; known from Tyrol (Ötztal, Stubai, and Zillertal Alps, JANETSCHKE 1958: 210, GISIN 1962: 23, and orig. observ., leg. BRETFFELD, v. TSCHIRNHAUS), Styria (Tauplitzalm near Bad Mitterndorf, CHRISTIAN 1987: 59 and pers. comm.), and Carinthia (Großglockner Mt., HAYBACH, see above).

Biology: *H. diffusus* lives on the sparse vegetation near glaciers, under stones (orig. observ., leg. BRETFFELD), on karst fields (CHRISTIAN, see above), and in other stony habitats from subalpine to high-alpine regions from 1700 m (CHRISTIAN, see above) up to 2900 m altitude (orig. observ., leg. BRETFFELD) (other authers, see above).

Remarks: The yellow and the blue specimens occur together in the same sample and the males have the same modified head setae, the blue specimens are larger; the differing proportions mentioned above may be due to the different populations studied: the blue from Stubai Alps, the yellow from Ötztal Alps (orig. observ., leg. v. TSCHIRNHAUS).

*Heterosminthurus insignis* (Reuter, 1876) (79, 83)

Syn.: *Sminthurus insignis* Reuter, 1876 (79, 83)

*Sminthurus novemlineatus* var. *insignis* Schött, 1893 b (26)

*Sminthurus oblongus major* var. *insignis* Börner, 1901 (113)

*Sminthurus novemlineatus* var. *palustris* Bekker, 1902 (21)

*Bourletiella insignis* Linnaniemi, 1907 (51)

*Deuterosminthurus insignis* Linnaniemi, 1912 (305)

*Deuterosminthurus novemlineatus* var. *pilosicauda* Linnaniemi, 1912 (307) ad partem (= *H. insignis* f. *cyanea*, BRETfeld 1988: 3)

*Heterosminthurus novemlineatus* Cassagnau, 1961 (211), CASSAGNAU 1964: 453 (= *H. insignis* f. *cyanea*, BRETfeld 1988: 3)

nec *Deuterosminthurus insignis* Yosii, 1954 (819) (= probably *H. undulans*, YOSII 1977: 164)

Total length up to 1.8 mm in females, 1 mm in males. Background colour yellow without other pigment (f. *principalis* Bretfeld, 1988: 1), with light to blackish blue pigment on dorsal and ventral sides (f. *cyanea* Bretfeld, 1988: 2), or with ochre and brown spots (f. *maculata* Bretfeld, 1988: 2); antennae always brown or dark. Ventral head-back with 2+2 oval organs. Ant IV with 7 - 8 subsegments; ventral sensilla V on 2nd and 3rd whorl behind the tip. Large abdomen posterodorsally with only thin setae; flank setae as 5/+. Femur I - III with some distal setae thicker than others. Tita I - III rows p:7, 5, 2 setae respectively. Claws sometimes with small inner tooth. Inner setae of dentes long, length > 2x diameter of dens. App. an. long, broad, distal 1/2 narrower, straight or slightly curved (Fig. 540). Secondary sexual characteristics: in males: head frons medially with short, laterally with 2+2 or 3+3 long setae (Fig. 541); clypeus laterally with several long setae; in females: length of circumanal setae  $av1' < av2$ .

Proportions: Length of antennae : head diagonal = 1.8 in females, 2.5 in males. Ant I : II : III : IV = 1 : 2.7 : 3.8 : 6.7 (7.5) in females (and males). Dens : mucro = 3.2. App. an. : mucro = 0.4 - 0.6.

Type locality: E Finland.

Occurrence: Europe and E Palearctic; in whole N, W, and Central Europe (but not recorded from Ireland, BOLGER 1986: 210), E to Lithuania, White Russia (STACH, see below), and Hungary (DUNGER 1975: 25, LOKSA 1978: 62), S to former Yugoslavia (STACH, see below), Austria (CHRISTIAN 1987: 60), Switzerland (GISIN 1948: 508), S France (the Pyrenees, CASSAGNAU 1964: 462), and N Spain (Santander, SELGA 1971: 259); in the E Palearctic, in NE Russia (Chukchi Peninsula and near Anadyr River) and S Russia (near Novosibirsk and in Tuva Reg.) (STEBAEVA 1976: 126), NE China (Manchuria, KINOSHITA 1941), and Mongolia (YOSII 1949: 33). The records in the Nearctic may belong to *H. aquaticus* Maynard, 1951 (CHRISTIANSEN & BELLINGER 1981: 1170).

The f. *maculata* has only been found in France (Essonne) and S Poland (the Pieniny Mts.); the f. *cyanea* may occur in all regions together with yellow specimens or in separate populations (BRETfeld 1988: 1).

Biology: *H. insignis* is abundant in the low, usually open vegetation of wet meadows, moors, lake shores, and on floating plants (LINNANIEMI 1912: 306, STACH, see below, DUNGER 1976: 12, 25, FJELLBERG 1980: 139, NAYROLLES 1996: 527).

It has been collected from the lowlands to the mountains up to 2200 m altitude (France, the Pyrenees, CASSAGNAU, see above). The chromosome number ( $n = 5$ , BRUMMER-KORVENKONTIO & SAURE 1969: 50) and the cycle of moulting, mating, and oviposition (BRETTFELD 1977: 1) have been described.

In mating behaviour, the male contacts the anal and genital regions of the female with its head and rubs it on the genital opening; the antennae of the male are sharply elbowed below the female. After depositing a spermatophore in front of the female, the male presses the droplet with one leg I on his head (BRETTFELD 1970: 264, 1971: 150, 1976 a).

Species descriptions: STACH 1956: 198 (further synonyms), BRETTFELD 1988: 1 (colour forms, differences to *H. novemlineatus*), 1990: 441 (chaetotaxy), FJELLBERG 1984: 87 (maxillary outer lobe), NAYROLLES 1996: 527 (general, mainly chaetotaxy of the extremities).

Remarks: The specimens from high-alpine habitats of Switzerland and Austria (HANDSCHIN 1924: 151, JANETSCHKE 1949: 139, FRANZ & SERTL-BUTSCHEK 1954: 636) may belong to other yellow species. The specimens of *H. insignis* from NE China and Mongolia should be re-examined (YOSII 1970: 25), those from NE and S Russia may partially belong to *H. stebaevae*.

*Heterosminthurus linnaniemii* (Stach, 1920) (202)

Syn.: *Sminthurus bilineatus bilineatus* var. *nigriceps* Schille, 1908 (15), 1912 (15), BRETTFELD 1972: 122

*Bourletiella nigriceps* Latzel, 1918 (250), 1922 (75), BRETTFELD 1972: 122

*Deuterosminthurus linnaniemii* Stach, 1920 (202)

nec *Bourletiella (Heterosminthurus) linnaniemii* Petersen, 1965 (383) (= *H. claviger*, BRETTFELD 1989: 313)

Total length up to 1 mm in females, 0.6 mm in males. Background colour yellowish, black violet pigment on head and in a broad, posteriorly narrowing band on abdomen (f. principalis), males posteriorly paler; often with only a dark patch on head frons and rarely completely pale (var. *decolorata* Stach, 1920: 205) (Figs. 542 - 544); Ant IV always brown. Ventral head-back with 1+1 oval organs. Ant IV with 7 - 8 subsegments; ventral sensilla V on 2nd and 3rd whorl behind the tip. Flank setae as 4/-. Tita I - III rows p:7, 5, 2 setae respectively. Claws without teeth. Inner setae of dentes short, length  $\leq$  diameter of dens. App. an. long, broad lancetlike, pointed. Secondary sexual characteristics: in males: head frons dorsally with several long, medially with 2+2 long, thick setae, upper pair usually shorter than lower (Fig. 545), ventral part with several short onionlike setae; Ant III with 1 basal spine; in females: length of circumanal setae  $av1' < av2$ .

Proportions: Length of antennae : head diagonal = 1.9 in females, 2.6 in males. Ant I : II : III : IV = 1 : 2.4 : 4 : 7.5 in both sexes. Dens : mucro = 3.5. App. an. : mucro = 0.72.

Type locality: S Poland, Pieniny Mts., in the low vegetation of sunny meadows.

Occurrence: E Central Europe and S Russia; in Europe in Austria (Eastern Alps), Czech Rep., Slovakia, and Poland (Sudetes and Carpathian Mts. and lowlands of Poland), Ukrainia (NE Carpathian Mts.), and White Russia (near Goryn River); in S Russia in Altay and Tuva Regs. The most western records are in Austria from W Styria (Ennstal, Pürgg) and W Carinthia (Kreuzeck Mts.), and in N Czech Rep. (Riesengebirge = Krkonose). Records connecting the populations of the Alps, of E Central Europe, and S Russia are not known. (All data according to BRETTFELD 1989: 313.)

Biology: *H. linnaniemi* lives in the low vegetation of dry to swampy habitats, in the valleys of the Alps and in E Central Europe preferentially in wet habitats; it has been collected up to 1800 m altitude (Kreuzeck Mts., see above). The mating behaviour is unknown.

*Heterosminthurus nonlineatus* (Gisin, 1946) (257)

Syn.: *Bourletiella* (*Deuterostminthurus*) *nonlineata* Gisin, 1946 (257)

*Heterosminthurus* cf. *diffusus* Topp, 1975 (278), Christian, 1987 (59) n. syn.

nec *Bourletiella nonlineata* Haybach, 1971/72 (15, 16), Christian, 1985 (88), 1987 (60) (= *H. diffusus*)

Total length up to 1.2 mm in females, 0.7 mm in males. Background colour yellow, blue pigment in the frontal eye and antennae, seldom in traces on the abdomen. Ventral head-back with 1+1 oval organs. Ant IV with 7 - 8 subsegments; ventral sensilla V on 2nd and 3rd whorl behind the tip. Flank setae as 5/+. Tita I - III rows p:7, 3 - 5, 2 setae respectively. Claws with small inner tooth and lateral teeth. Inner setae of dentes short, length  $\mu$  diameter of dens. App. an. long, lancetlike, pointed, slightly curved. Secondary sexual characteristics: in males: head frons dorsally with 1+1 thick, acuminate and laterally with 1+1 long setae; clypeus with 2 median long spines, large abdomen anteriorly with many onionlike setae (Fig. 546); in females: length of circumanal setae  $av1' = av2$ .

Proportions: Length of antennae : head diagonal = 1.6 in females, 2.3 in males. Ant I : II : III : IV = 1 : 2.2 : 3.4 : 6 in both sexes. Dens : mucro = 3. App. an. : mucro = 0.6.

Type locality: Switzerland, Grisons, National Parc, alpine meadow of Mt. Munt la Schera.

Occurrence: Also known from Austria (Vorarlberg, Silvretta Mts., Wiesbadener Hütte, CHRISTIAN 1985: 88; Tyrol, Ötztal Alps, Obergurgl, orig. observ., leg. BRETFFELD; Carinthia, High Tauern Mts., TOPP 1975: 278, re-exam.), Central Spain (Madrid, Sierra de Guadarrama, SELGA 1971: 259), and S Russia (Altay Reg., Kuraiskii Mts., STEBAEVA 1976: 126).

Biology: *H. nonlineatus* lives in the European Alps in the low vegetation of meadows (GISIN 1948: 505 and orig. observ., leg. BRETFFELD) and the sparse vegetation on gravel and near glaciers, and in the Altay Mts. on moss and lichens. It has been found in subalpine and alpine regions from 1700 m (GISIN, see above) up to 2650 m altitude (orig. observ., leg. BRETFFELD) (other authors, see above).

Species descriptions: GISIN 1957: 494 (male), 1960: 282, LIENHARD 1980: 375 (ecology near type locality).

*Heterosminthurus novemlineatus* (Tullberg, 1871) (145)

Syn.: *Sminthurus novem-lineatus* Tullberg, 1871 (145)

*Sminthurus pilosicauda* Reuter, 1876 (84)

*Sminthurus oblongus major* var. *novemlineata* Börner, 1901 (113)

*Bourletiella novemlineata* Linnaniemi, 1907 (134)

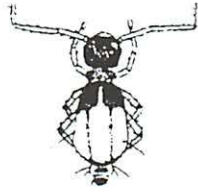
*Deuterostminthurus novemlineatus* Linnaniemi, 1912 (306)

nec *Deuterostminthurus novemlineatus* var. *pilosicauda* Linnaniemi, 1912 (307) ad partem (= *H. insignis* f. *cyanena*)

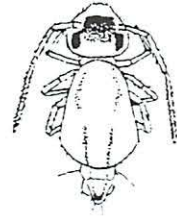
*Heterosminthurus novemlineatus* Cassagnau, 1961 (211) (= *H. insignis* f. *cyanena*)



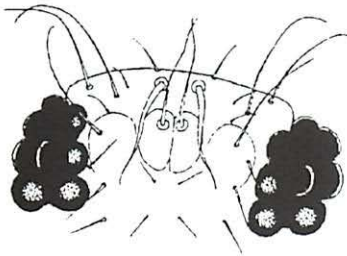
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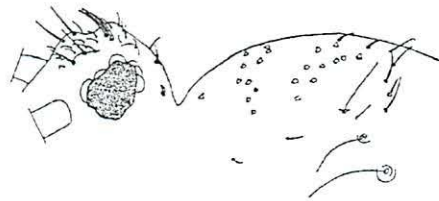
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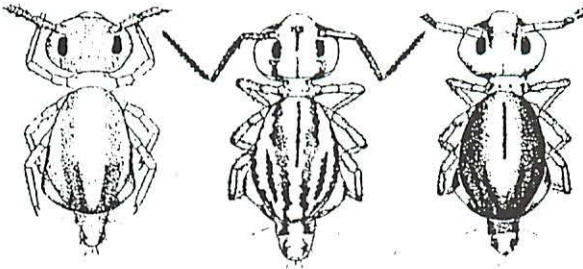
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Figs. 542 - 545 *Heterosminthurus limnaniemii* (after STACH 1956): 542 Colour pattern of female, f. principalis

543 Colour pattern of male, f. principalis 544 Colour pattern of female, var. decolorata

545 Male frons of head.

Fig. 546 *Heterosminthurus nonlineatus*, male, head apex and anterior of large abdomen (after GISIN 1960).

Figs. 547 - 548 *Heterosminthurus novemlineatus*:

547 Pale, normal, and darker colour pattern (after STACH 1956) 548 App. an. (after BRETFFELD 1988).

Total length up to 1.7 mm in females, 1 mm in males. Background colour yellowish white, black or brown pigment in several stripes on the head and 9 longitudinal stripes on the large abdomen (f. *principalis*), also with more or less blackish blue pigment on dorsal side, ventral side always paler (the darkest = var. *pilosicauda* Reuter, 1876: 84, var. *cyanofusca* Bekker, 1902: 21), or more or less faded with few dark stripes (the palest = f. *malopigmentata* Stach, 1956: 196) (Fig. 547); antennae always brown or dark. Ventral head-back with 2+2 oval organs. Ant IV with 7 - 8 subsegments; ventral sensilla V on 2nd and 3rd whorl behind the tip. Large abdomen posterodorsally with 2+2 small areas of thin setae between the generally thick ones; flank setae as 5/+. Femur I - III with all distal setae of the same form. Tita I - III rows p:7, 3 - 5, 2 setae respectively. Claws with small lateral teeth. Inner setae of dentes long, length > 2x diameter of dens. App. an. long, acuminate, sharply curved in basal 1/3 (Fig. 548). Secondary sexual characteristics: in males: head frons medially with short and normal but without modified setae; clypeus laterally with a few long setae; in females: length of circumanal setae  $av1' < av2$ .

Proportions: Length of antennae : head diagonal = 2 in females, 3 in males. Ant I : II : III : IV = 1 : 2.5 : 4 : 5.8 - 7.2 (6.4 - 9.4) in females (and males). Dens : mucro = 3. App. an. : mucro = 0.4 - 0.6.

Type locality: Sweden, isle of Gotland, on *Carex*.

Occurrence: NW Europe and S Russia; in Europe from Scandinavia, except the most northern parts and alpine regions (LINNANIEMI 1912: 307, FJELLBERG 1980: 139, 1988: 15), E to W Russia (Volga landscapes E of Moscow, ALEJNIKOVA & MARTYNOVA 1966: 35), S to Hungary (STACH 1956: 197, LOKSA 1978: 62), former Yugoslavia (e. g. CVIJOVIC 1974: 93), S Austria (Carinthia, CHRISTIAN 1987: 60), and Central Germany (Hesse, KRAUSBAUER 1905: 41), and W to the Netherlands (ELLIS 1974: 235) and Ireland (LAWRENCE 1961: 156); in S Russia only near Novosibirsk (Baraba steppe, STEBAEVA 1976: 126; shore of lake Krotovaya Lyaga, BRETFFELD 1996: 211).

Biology: *H. novemlineatus* lives in the low vegetation of wet, usually open habitats, on the banks of rivers, lakes, and small waters, at the seashore (LINNANIEMI 1912: 307, STRENZKE 1955: 49), and in moors, rarely in drier meadows, often nearer to the water than *H. insignis*. It is widespread in Scandinavia but only found occasionally in the adjacent regions where it seems to be restricted to lowlands or valleys (authors, see above).

The mating behaviour resembles that of *H. insignis*, the differences being: the male stretches its antennae laterally when contacting the small abdomen of the female and does not rub with its head; before depositing a spermatophore, the male interrupts the courtship several times to immitate the deposition in front of the female (BRETFFELD 1970: 265 with a discussion of the observations by LIEPETERSEN 1900: 3, BRETFFELD 1971: 150).

Species descriptions: STACH 1956: 197, BRETFFELD 1988: 1 (colour forms, differences to *H. insignis*).

#### *Heterosminthurus nymphes* Yosii, 1970 (23)

Total length up to 1 mm in females, 0.7 mm in males. Colour pale, only distal 1/2 of antennae violet. Ant IV with 9 subsegments. Claws without teeth. Inner setae of dentes long, length 2x diameter of dens. App. an. long, narrow, blunt, slightly curved. Secondary sexual characteristics: in males: head frons laterally with 2+2 long setae, clypeus below antennae with 3 upper and 2 lower long spines (Fig. 549); in females: length of circumanal setae  $av1' < av2$ .



Proportions: Length of antennae : head diagonal = 2 in females, 3 in males. Ant I : II : III : IV = 1 : 1.8 : 3.5 : 5.8 in females (in males unknown). Dens : mucro = 2.5.

Type locality: Japan, Aomori, Suren-numa, Mt. Hakkoda, on grass.

Occurrence: Known only from the type locality.

*Heterosminthurus pirika* Yosii, 1972 (96)

Only 1 male known. Total length 0.8 mm. Background colour pale, chestnut brown pigment in 3 longitudinal stripes on the head and brown sides on large abdomen (Fig. 550). Ant IV with 8 subsegments. Claws without teeth. Inner setae of dentes short, length < diameter of dens. Secondary sexual characteristic: head clypeus laterally with 6+6 short, spinelike setae (Fig. 551).

Proportions: Length of antennae : head diagonal about 1 [sic]. Ant I : II : III : IV = 1 : 1.7 : 3.7 : 6. Dens : mucro = 3.3.

Type locality: Japan, Hokkaido, Hidaka Mts., north cirque of Mt. Poroshiri.

Occurrence: Known only from the type locality.

*Heterosminthurus punctatus* Bretfeld, 1996 (211)

Total length up to 0.8 mm in females, 0.5 mm in males. Background colour whitish yellow, blue pigment in 4+4 dark spots at the bases of Bothr and 2+2 on the furca base, and 3+3 pale patches laterally on abdomen (Fig. 552); pigmentation of Abd VI varies; antennae brown. Ventral head-back with 1+1 oval organs. Ant IV with 7 - 8 subsegments; ventral sensilla V on 2nd and 3rd whorl behind the tip. Flank setae as 4/+. Tita I - III rows p:6, 3, 2 setae respectively. Claws sometimes with small inner tooth. Inner setae of dentes long, length > diameter of dens. App. an. long, acuminate, slightly curved, blunt or tip with small teeth. Secondary sexual characteristics: in males: head frons dorsally and laterally with 1+1 long setae each; Ant II distally with 2 blunt spines (Figs. 553, 554); in females: length of circumanal setae  $av1' < av2$  (Fig. 555).

Proportions (only 1 male considered): Length of antennae : head diagonal = 2 in females, 2.6 in male. Ant I : II : III : IV = 1 : 2.3 : 3.7 : 6.2 in females, 1 : 2.6 : 4 : 6.5 in male. Dens : mucro = 3.6 in females, 3.3 in male. App. an. : mucro = 0.6.

Type locality: Kazakhstan, Semipalatinsk Reg., S slope of Tarbagatay Range, low floodplain of the river near Blagodarnoye.

Occurrence: Known only from the type locality.

Remarks: *H. punctatus* may be synonymous with *Sminthurus sexpunctatus* Bekker, 1905 (93) but this cannot be decided without the types.

*Heterosminthurus setiger* (Gisin, 1961) (351)

Syn.: *Bourletiella (Heterosminthurus) setigera* Gisin, 1961 (351)

*Heterosminthurus setigerus* Christian, 1987 (60)

Total length up to 0.9 mm in females, 0.8 mm in males. Colour yellow. Ant IV with about 7 subsegments. App. an. as in *H. bilineatus*. Secondary sexual characteristics in males: head frons apically with 2+2 thick, blunt spines of same thickness, upper pair longer than the lower; clypeus with several short, spinelike setae (Fig. 556).

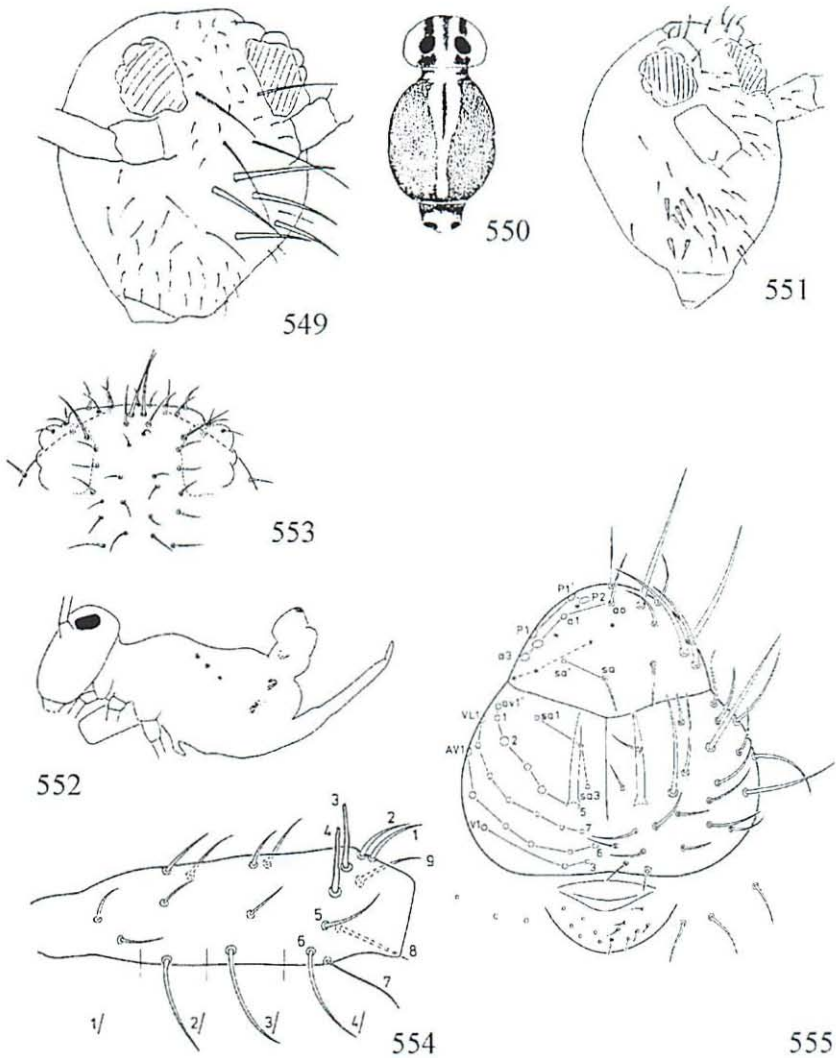


Fig. 549 *Heterosminthurus nymphes*, male head (after YOSII 1970).

Figs. 550 - 551 *Heterosminthurus pirika* (after YOSII 1972): 550 Colour pattern 551 Male head.

Figs. 552 - 555 *Heterosminthurus punctatus* (after BRETFELD 1996):

552 Colour pattern 553 Male frons of head 554 Male Ant II 555 Female Abd V and VI from posterior.

Proportions: Length of antennae : head diagonal = 2 in females, 2.5 in males.

Type locality: Austria, Lower Austria, Mt. Schneeberg, under *Pinus montana*.

Occurrence: Known only from the type locality.

*Heterosminthurus stebaevae* Bretfeld, 1996 (211)

Total length up to 1.2 mm in females, 0.7 mm in males. Background colour white or yellow, sometimes with blue pigment in 1+1 stripes on the head and varying patterns on abdomen, irregular longitudinal stripes or posteriorly darkened; antennae always brown. Ventral head-back with 2+2 oval organs. Ant IV with 7 - 8 subsegments; ventral sensilla V on 2nd and 3rd whorl behind the tip. Flank setae as 4/+. Tita I - III rows p:7, 5, 2 setae respectively. Claws sometimes with small inner tooth. Inner setae of dentes vary, often length < 2x diameter of dens. App. an. long, broad, apically narrowed, tip with rough teeth (Fig. 557). Secondary sexual characteristics: in males: without special, modified setae, only head frons dorsally with few short setae, clypeus laterally with slightly longer setae than others; in females: length of circumanal setae  $av1' = av2$ .

Proportions: Length of antennae : head diagonal = 2.2 in females, 3 in males. Ant I : II : III : IV = 1 : 2.7 : 4 : 7 in females, 1 : 3 : 4.5 : 8 in males. Dens : mucro = 3. App. an. : mucro = 0.55.

Type locality: S Russia, Gorno-Altay Reg., NW shore of Lake Teletskoye near Artybash, bog with *Carex*.

Occurrence: Also found at other sites in S Russia (Krasnoyarsk Reg., West Sayan Mts. and near Nazarovo) and in Kazakhstan (Semipalatinsk Reg., S of Tarbagatay Range, and Pavlodar Reg., Osmerysk near Irtysh River) (BRETfeld, see above).

Biology: *H. stebaevae* lives in the low vegetation of wet habitats (bog, flood-plains) but in lower numbers also in drier meadows; it has been collected up to 1100 m altitude (BRETfeld, see above).

Remarks: *H. stebaevae* resembles *H. insignis* and *H. novemlineatus* but has a character combination of its own (discussion by BRETfeld, see above). The records of *H. insignis* and *H. novemlineatus* from the E Palaearctic may partially belong to this species.

*Heterosminthurus undulans* Yosii & Lee, 1963 (11)

Syn: *Deuterosminthurus insignis* Yosii, 1954 (819) (?), YOSII 1977: 164

Total length up to 1.5 mm in females, 0.8 mm in males. Background colour brownish white, dark brown pigment in 1+1 longitudinal stripes on head and large abdomen and 4+4 dark patches posteriorly on the large and small abdomen (Fig. 558); also with blue pigment or with 2+2 stripes. Ventral head-back with 1+1 oval organs. Ant IV with 7 - 8 subsegments; ventral sensilla V on 2nd and 3rd whorl behind the tip. Flank setae as 4/+. Tita I - III rows p:7, 5, 2 setae respectively. Claws without teeth. Inner setae of dentes long, length < 2x diameter of dens. App. an. long, almost blunt or tip with rough teeth, outer 1/3 obliquely cut and faintly serrate (Fig. 559). Secondary sexual characteristics: in males: head clypeus with 2 thin upper and 3 broad lower, lancetlike, long acuminate setae, surrounded by several long setae (Fig. 560); femur I medially thickened and with long setae; in females: length of circumanal setae  $av1' < av2$ .

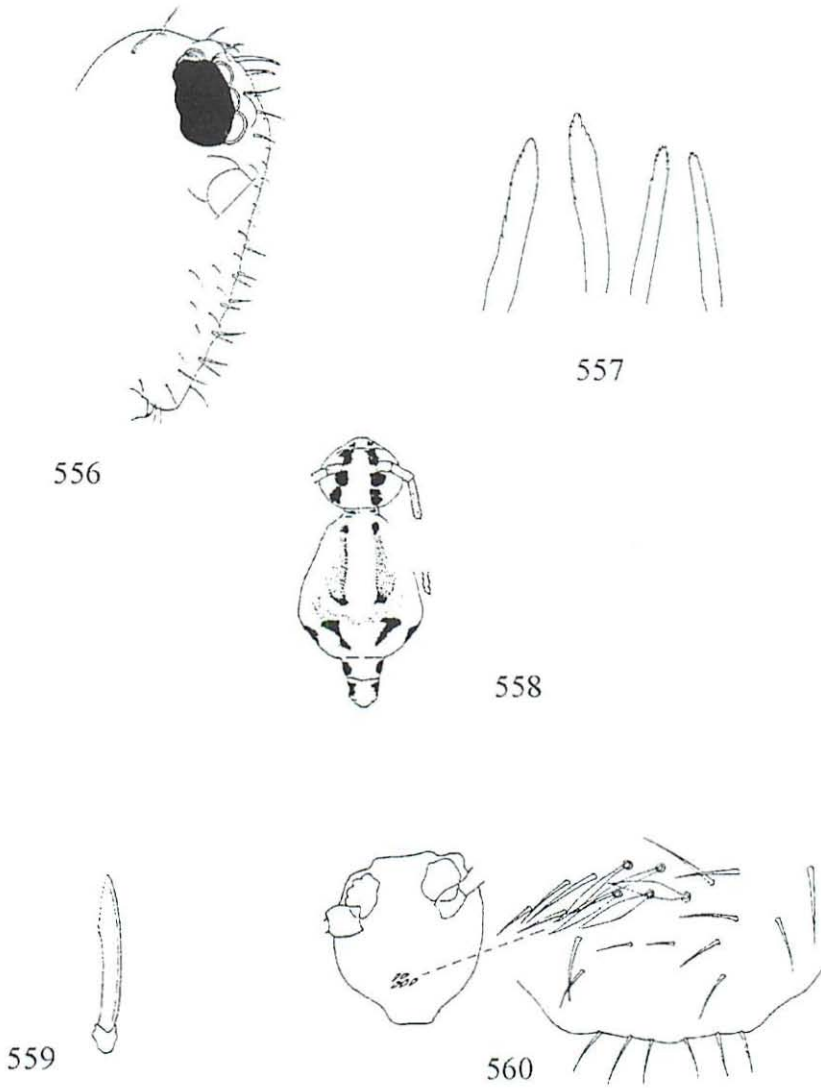


Fig. 556 *Heterosminthurus setiger*, male head (after GISIN 1961).

Fig. 557 *Heterosminthurus stebaevae*, 2 pairs of App. an. (after BRETFELD 1996).

Figs. 558 - 560 *Heterosminthurus undulans* (after YOSII & LEE 1963):

558 Colour pattern 559 App. an. 560 Male head.

Proportions: Length of antennae : head diagonal = 2 in females, 2.7 in males. Ant I : II : III : IV = 1 : 2 : 3.2 (3.7) : 5.5 (6.3) in females (and males). Dens : mucro = 3. App. an. : mucro = 0.6.

Type locality: Korea, Nack-Dong River near Taegu.

Occurrence: Also found in Japan, Atsugi near Yokohama, herbaceous meadow at about 100 m altitude (orig. observ., leg. PRINZING).

Remarks: The name-giving undulations of the mucrones are artifacts (orig. observ.).

### Genus *Kaszabellina* Betsch, 1977

#### Key to the Palearctic species

- |   |   |                                |
|---|---|--------------------------------|
| 1 | Claws with small inner tooth; females with only circumanal seta a0 furcate constantly; App. an. lancetlike, distally toothed (Fig. 562) | <i>minima</i> Betsch, 1977     |
| – | Claws with large inner tooth (Fig. 563); females with 7 or more furcate circumanal setae  | 2                              |
| 2 | App. an. straight, smooth, blunt (Fig. 561)   | <i>major</i> Betsch, 1977      |
| – | App. an. lancetlike, pointed, smooth (Fig. 564)   | <i>variabilis</i> Betsch, 1977 |

Remarks: The males are not yet completely known.

#### Diagnosis of the genus

Some inner setae of Tita obliquely truncate. Tita with 3 spatulate setae each. Emp without lamellae, directly forming thick, pointed filaments, length < claws (Fig. 563). Distal anterior setae of dens as long as the spaces between rows; formula of anterior setae 2,2...1 or 3,2,1...1. Secondary sexual characteristics: in males missing; in females: 1 - 13 furcate circumanal setae.

Occurrence: Mongolia.

Description of the genus: BETSCH 1977: 79.

Type species: *Kaszabellina variabilis* Betsch, 1977.

#### Diagnosis of the Palearctic species

*Kaszabellina major* Betsch, 1977 (83)

Total length up to 1.4 mm in females, 1 mm in males. Background colour yellowish, with weak violet marblings. Claws with large inner tooth (see Fig. 563). App. an. long, narrow, straight, and blunt (Fig. 561). Secondary sexual characteristics in females: 7 or more furcate circumanal setae.

Proportions: Length of antennae : head diagonal = 1.85 in females, 1.8 in males. Ant I : II : III : IV = 1 : 1.85 : 2.45 : 5.4 in females, 1 : 1.8 : 2.4 : 5.2 in males.

Type locality: Mongolia, Uburchangaj Distr., desert steppe at 1760 m altitude, in dry plant debris.

Occurrence: Also found at other sites in Mongolia (Central Gobi and South Gobi Distrs.) (BETSCH, see above).

Biology: *K. major* lives on the soil or in dry plant debris of the desert steppe in 1500 - 1760 m altitude.

*Kaszabellina minima* Betsch, 1977 (84)

Total length up to 1 mm in females, 0.8 mm in males. Colour yellow without other pigment (except in the eye-patches). Ant IV with 8 subsegments. Claws with small inner tooth. Inner setae of dentes short, length < diameter of dens, formula of anterior setae 3,2,1...1. App. an. long, lancetlike, pointed, distal edges with small teeth (Fig. 562). Secondary sexual characteristics in females: only circumanal seta a0 furcate constantly.

Proportions: Length of antennae : head diagonal = 1.6 in females, 1.85 in males. Ant I : II : III : IV = 1 : 2.2 : 2.8 : 5.8 in females, 1 : 2.1 : 2.5 : 7.1 in males.

Type locality: Mongolia, Central Gobi Distr., desert steppe at 1480 m altitude, on the soil.

Occurrence: Known only from the type locality.

*Kaszabellina variabilis* Betsch, 1977 (79)

Total length up to 1.2 mm in females, 1 mm in males. Background colour yellowish, head and large abdomen with more or less violet pigment in 1 posterior patch or spread in symmetrical marblings. Ant IV with 8 subsegments. Claws with large inner tooth (Fig. 563). Inner setae of dentes short, length < diameter of dens, formula of anterior setae 2,2...1. App. an. long, lancetlike, pointed, smooth (Fig. 564). Secondary sexual characteristics in females: more than 7 furcate circumanal setae.

Proportions: Length of antennae : head diagonal = 1.7 in females, 1.75 in males. Ant I : II : III : IV = 1 : 1.9 : 2.5 : 5.2 in females, 1 : 1.8 : 2.6 : 5.4 in males. Dens : mucro = 2.8.

Type locality: Mongolia, South Gobi Distr., rocky desert steppe at 1550 m altitude, on the soil.

Occurrence: Also found at another site in Mongolia (Central Distr., sandy steppe at 1380 m altitude, on the soil) (BETSCH, see above).

**Genus *Pseudobourletiella* Stach, 1956**

**Key.** Only 1 species: *Pseudobourletiella spinata* (MacGillivray, 1893) (127)

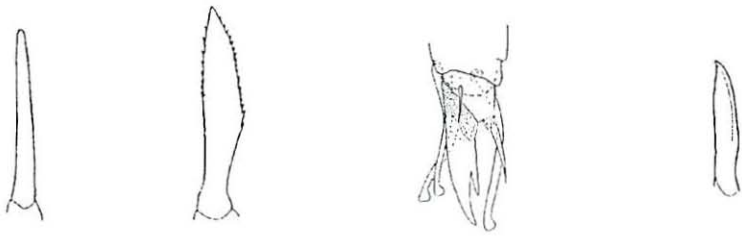
**Diagnosis of the genus**

Large abdomen elongate. Inner setae of Tita not obliquely truncate. Tita with 3 spatulate setae each. Emp I and II minute; Emp III with lamellae, filament short, pointed, length < claws (Fig. 565). Number of inner and outer setae of dentes increased, these setae very long (Fig. 566). Secondary sexual characteristics: in males: head frons with protruding medial group of setae; Abd VI and posterior side of Abd IV each with a medial group of spines (Fig. 567); in females: missing.

Occurrence: USA, Canada, Korea.

Descriptions of the genus: STACH 1956: 134, CHRISTIANSEN & BELLINGER 1981: 1175.

Type species: *Smynthurus spinatus* MacGillivray, 1893.

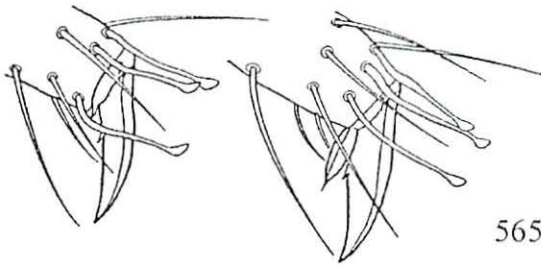


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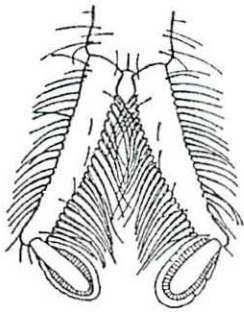
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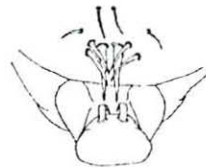
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Figs. 561 - 564 *Kaszabellina* (after BETSCH 1977):

561 *Kaszabellina major*, App. an. 562 *Kaszabellina minima*, App. an.

563 *Kaszabellina variabilis*, claw and Emp 564 *Kaszabellina variabilis*, App. an.

Figs. 565 - 567 *Pseudobourletiella spinata*:

565 Claw and Emp I and III (after FOLSOM 1934) 566 Furca (after FOLSOM 1934)

567 Male Abd IV - VI (after PEDIGO 1968).

**Diagnosis of the single Palearctic species**

*Pseudobourletiella spinata* (MacGillivray, 1893) (127)

Syn.: *Smynthurus spinatus* MacGillivray, 1893 (127)

*Pseudobourletiella chandleri* Pedigo, 1968 (550), CHRISTIANSEN & BELLINGER 1981: 1175

Total length up to 2.3 mm in females, 1.6 mm in males. Background colour yellowish white, brown to purple pigment on the antennae or more or less on head and abdomen. Ant IV with more than 15 indistinct subsegments. Claws with inner tooth and 1 pair of lateral teeth (Fig. 565). App. an. long, truncate, apically flattened, tip with small teeth. Other characteristics as described for genus.

Proportions: Length of antennae : head diagonal = 2 in females, > 2 in males. Ant I : II : III : IV = 1 : 2.6 : 2.8 : 6.4 in females (YOSII & LEE, see below), 1 : 3 : 4.5 : 9 in both sexes (FOLSOM, see below). Dens : mucro about 2.5.

Type locality: USA, New York, Ithaca, on the surface of standing water.

Occurrence: Nearctic (USA and Canada, CHRISTIANSEN & BELLINGER, see below; not in Alaska, SKIDMORE 1995: 62) and E Asia (Korea, 2 females from Nack-Dong River, YOSII & LEE, see below). Few specimens recorded from Brazil (ARLÉ 1971: 9).

Biology: In the Nearctic, *P. spinata* is common on standing water and in wet vegetation and plant debris on the shores of ponds and streams; it is able to leap on the surface of water (FOLSOM, SNIDER, see below) and feeds on pollen grains (KEVAN & KEVAN 1970: 311).

Species descriptions: FOLSOM 1934: 467, MAYNARD 1951: 250, YOSII & LEE 1963: 12, SNIDER 1967: 226, CHRISTIANSEN & BELLINGER 1981: 1175, SNIDER & LORING 1984: 35 (oval organ).



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Author's address:

Dr. Gerhard Bretfeld, Zoologisches Institut der Universität, Olshausenstr. 40,  
D-24098 Kiel, Germany

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