

NOTES ON THE GENUS *LIEBSTADIA* OUDEMANS, 1906 (ACARINA, ORIBATIDA) IN CENTRAL EUROPE

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Abstract. The genus *Liebstadia* OUDEMANS, 1906 is redefined on the basis of published data and presented descriptions and redescrptions of several Central-European species. *Liebstadia longior* (BERLESE, 1908) and *L. pannonica* (WILLMANN, 1951) are redescrbed using typical/topotypical material. *Protoribates badensis* SELLNICK, 1928 is regarded as new junior synonym of *L. longior*, and *Protoribates variabilis* RAJSKI, 1958 (= *Liebstadia variabilis*) is synonymized with *L. pannonica* (WILLMANN, 1951). *Liebstadia willmanni* sp. nov. from Austria and Slovakia is described.

The position of the genus *Liebstadia* and status of some other species of the genus (*L. nova* comb. nov., *L. austriaca* comb. nov., *L. similis serratomarginata* comb. nov., stat. nov., *L. humerata*, *L. gratiosa* comb. nov.) are discussed. A key of the Central-European species of the genus *Liebstadia* is included along with a table of typical characters.

■ Oribatida, Scheloribatidae, *Liebstadia*, *L. longior*, *L. willmanni*, *L. pannonica*, *L. similis*, taxonomy

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Introduction

European determination keys (e.g. Sellnick 1929, Willmann 1931, Ghilyarov and Krivolutsky 1975) accepted an interpretation of the genus *Liebstadia* with 2 - 3 species present in Europe. After the establishment of the genus *Paraleius* (TRAVÉ, 1960) for *Liebstadia leontorycha* (BERLESE, 1910) sensu Vitzthum, 1926 (see also Sellnick 1929 and Willmann 1931), only 2 species remained: the generic type-species *L. similis* (MICHAEL, 1888) and *L. humerata* SELLNICK, 1928. On the other hand, Kunst (1971) noted that 4 species of the genus *Liebstadia* are living in (former) Czechoslovakia and published a figure with the species *L. longior* (BERLESE, 1908) as another representative of the genus. This interpretation is related to his preceding unpublished work (Kunst 1968), where some species placed in the genus *Protoribates* (*P. badensis*, *P. pannonicus*) are considered as representatives of the genus *Liebstadia*. He specially noted the presence of prolamella and absence of some haplozetid characters, such as the movability of pteromorphs. Weigmann (1969) published a new definition of some scheloribatid genera, including the genus *Liebstadia*. Weigmann's interpretation of this genus agrees principally with Kunst's opinion and was accepted by Wunderle et al. (1990) for the redescription of both classical species of the genus: *L. similis*

and *L. humerata*. This interpretation is also used in the present work, dealing with a redescription of other known *Liebstadia* species in Central Europe. Some different generic interpretations (e.g. Balogh and Balogh 1984, 1992) are also discussed here. An interpretation of the genus quite similar to the one presented here was accepted by Pérez-Iñigo (1993), however, it lacks a fully acceptable definition of the genus. Recently, during the preparation of this paper, the work of Subias and Gil-Martín (1995) appeared, in which some findings similar to the view presented here are published: in particular the synonymization of *Rajskibates* with *Liebstadia*. Even in this work the diagnosis of *Liebstadia* is lacking.

The individuals from collections of Berlese (Firenze), Strenzke (Frankfurt/Main), Rafalski (Poznan) and Willmann (Munich) as well as the topotypical individuals of *Protoribates pannonicus* WILLMANN, 1951 from Austria were used in addition to the rich material from Germany, the Czech Republic and Slovakia for redescriptions and comparisons.

Genus *Liebstadia* OUDEMANS, 1906

syn.:

Rajskibates BALOGH et BALOGH, 1984 (type species: *P. variabilis* RAJSKI, 1958)

Balogh et Balogh (1992) synonymised erroneously *Rajskibates* with *Protoribates*.

Type species: *Liebstadia similis* (MICHAEL, 1888)

Diagnosis: Scheloribatids with a lamella running from lamellar seta to interlamellar seta and backwards as a more or less distinct ridge; pro- and sublamella well developed, prolamella reaching rostral seta. Notogaster with ten pairs of notogastral setae; octotaxic system developed as areae porosae, there is a tendency of reduction of the 4 pairs of notogastral areae to 3 pairs; pteromorphs from very small to large blades, immovable. 4 pairs of genital setae; legs monodactyl.

Liebstadia longior (BERLESE, 1908)

Figs 1-2

syn.:

Protoribates longior BERLESE, 1908

Protoribates badensis SELLNICK, 1928 syn. nov.

non *Liebstadia longior* sensu KUNST (1971: fig. 154)

non *Liebstadia longior* sensu WILLMANN (1930: fig. 12), Ghilyarov et Krivolutsky (1975: fig. 658)

The study of an individual of *Protoribates badensis* SELLNICK, 1928 from the Strenzke Collection, collected near the locus typicus of this species in German Schwarzwald (Black Forest) showed, that this species belongs without any doubts to the same genus as the very similar species *Liebstadia humerata* SELLNICK, 1928, i.e. it must be considered as a member of the genus *Liebstadia*. Other material studied from Poland, the Czech Republic and Bulgaria also confirmed with the original description and the German individual, therefore the identity of the species is definitive.

The comparison of our material of Central European representatives of *Liebstadia* with typical material from the Berlese Collection by one of the authors (G. W.) had an unexpected result: the material of *Protoribates badensis* was found to be conspecific with *Protoribates longior*, a classical Berlese species (Figs 1, 2). Sellnick's species *P. badensis* is therefore considered as a junior synonym of *Protoribates longior*, and the generic status of the species was changed to *Liebstadia*. Because of limited observability of some details of Berlese's material, the following redescription of the species was completed on the basis of the study of the mentioned material from collections of Strenzke, Rafalski and Kunst.

Material studied:

Material from Berlese's collection:

- 1 male in balsam (slide 74/13), in ventral position. Label text: "*Protoribates longior* BERLESE tipico, legno do ordere (=firewood) Firenze".

- 1 female in balsam (slide 74/14), in dorsal position, with 2 eggs inside, labeled: "*Protoribates longior* BERLESE tipico, legno do ordere (=firewood) Firenze".

- 1 female in balsam (slide 74/15), in bad condition. Label text: "*Protoribates longior* BERLESE sphagnum".

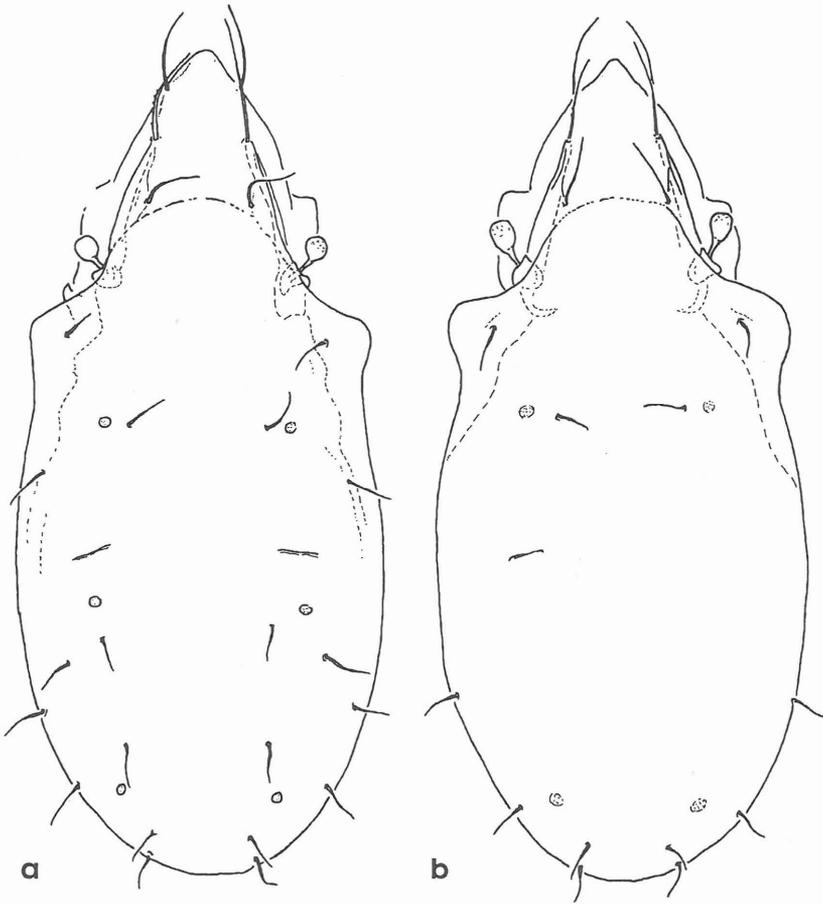


Fig. 1: *Liebstadia longior* (BERLESE, 1908): a - specimen from Berlese Collection, labeled "*Protoribates longior* Berl. - tipico"; b - specimen from Coll. Strenzke, labeled "*Protoribates badensis* SELLN. 1928".

Material from Collection Strenzke:

- 1 mounted female (SMF 16588), Schwarzwald (Black Forest, Germany), in a bog site, 18. 7. 1951, leg. Th. Großpietsch, labeled: "*Protoribates badensis* SELLN. 1928". Seen by "C. Willmann 22. XII.52" (fig. 1).

- (slide SMF 16589, labeled "*Protoribates badensis*" is another species, perhaps a Haplozetidae).

Material from Rafalski's collection:

- 1 female in alcohol, Białowieza Nat. Park (Poland), 5.IX.58 (sample 193a), labeled: "*Protoribates badensis* SELL." (fig. 2).

Material from Willmann's collection (Staatsammlungen Munich):

- slide K671, labeled: "*Protoribates badensis*, Schneeberg 1937 (E28)", with 3 specimens.

- slide K672, labeled: "*P. badensis*, Schneeberg 13, Adelheidsquelle, 14.7.36".

Material from Kunst's collection:

- 2 males and 5 females in alcohol (vial 1757), labeled: "*Liebstadia badensis*, Blatná, 11. 11. 1964", (Czech Republic), leg. M. Kunst.

- 2 males and 2 females in alcohol, labeled: "*Protoribates badensis*, Mas'lenos" (Bulgaria), dry moss growths on the oak bark (*Quercus*), 15. 7. 1958, leg. M. Kunst (the vial contained a lot of individuals, from which four were used for redescription).

Redescription of the adult

Diagnosis:

Small and very flat species of yellow to brown colour; lamellar complex as typical in *Liebstadia* species; sensillus very short, globular or globular-fusiform; 10 notogastral setae; 3 pairs of areae porosae on notogaster; pteromorphs short, subtriangular and distinctly rounded blades, not bent downwards.

The immatures are unknown.

General characters:

Total length of males 325-336 μm (average 330 μm , $n=4$), width on notogaster behind the pteromorphs 133-139 μm (average 137 μm). Measures of females: length 336-395 μm , width 139-162 μm (average 356 \times 151 μm , $n=9$). Dorsoventral thickness in postgenital area about 70-80 μm ; length:width ratio ranking from 2.25:1 to 2.45:1 (usually about 2.3:1), length:dorsoventral thickness ratio over 4.5:1. Colour of body bright yellowish brown or yellow.

Prodorsum:

Rostrum rounded; with long setae *in*, *le* and *ro*. Lamellar ridge from *le* to *in* ("*Liebstadia*-type"); sublamella well developed, ending basal of bothridium; prolamella is a well developed ridge (fig. 2c). Sensillus 20-24 μm long, with short stalk and globular or globular-fusiform head (fig. 1c). Exobothridial seta short; area porosa sublamellaris small but well developed. Tutorial ridge absent, pedotecta I and II small.

Notogaster:

Anterior border curved, expanding to the prodorsum, hardly visible. The pteromorphs well developed, rounded horizontal blades, short, not reaching posteriorly to the 1/3 of the notogaster length. 10 notogastral setae of 10-20 μm length; normal number and position of lyrifissures, lyrifissure *iam* comparatively very long; 3 pairs of areae porosae (Aa, A1, A2+3), mostly with about ten pores each. Seta *lp* not positioned closely to area A1 (ratio of distances *lp*-A1 : *h3*-A1 about 1:3).

Gnathosoma:

With typical characters of the family; pedipalp setation normal: 0-2-1-3-9(+1).

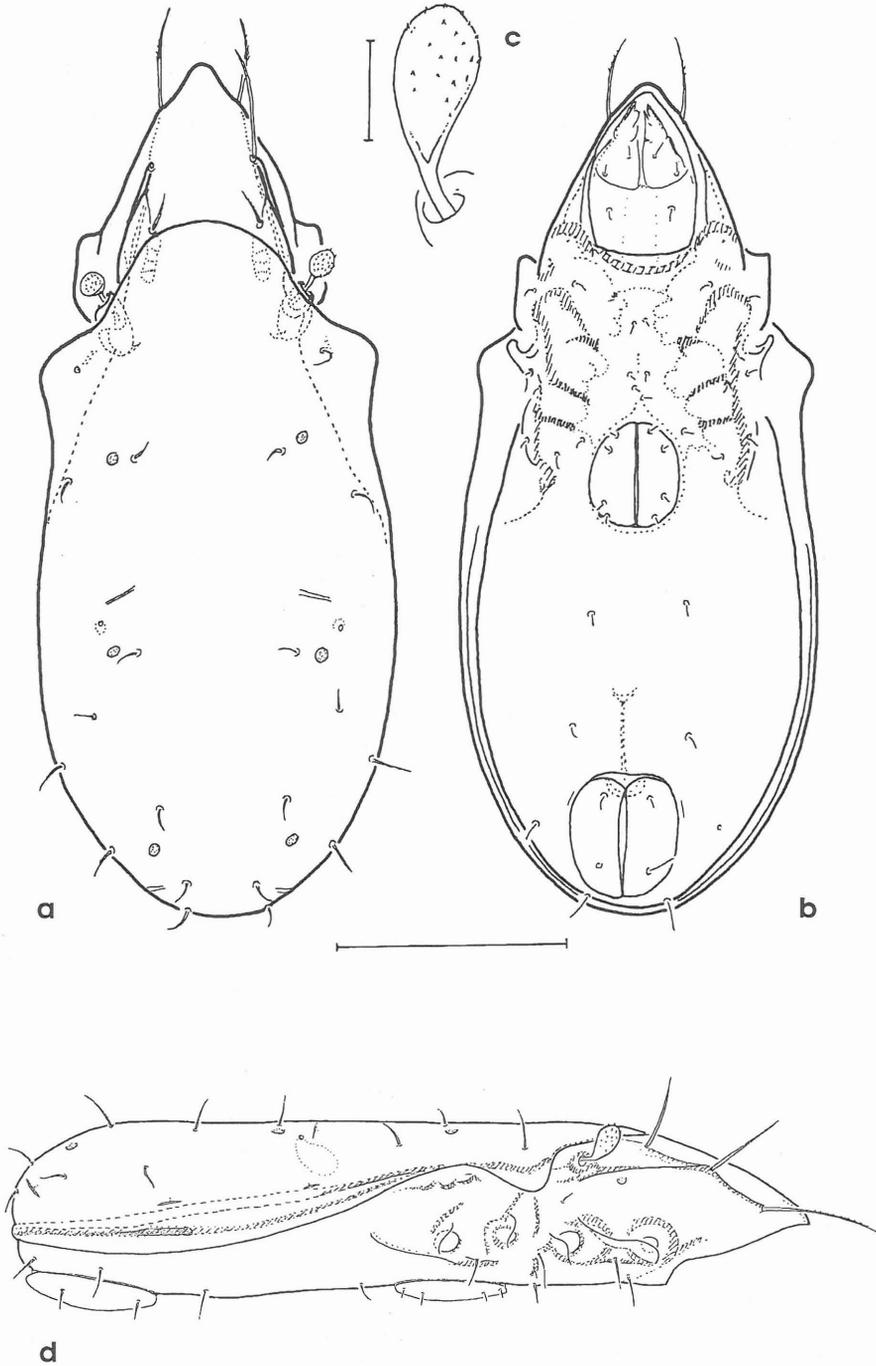


Fig.2: *Liebstadia longior* (BERLESE, 1908), specimen from Poland (Białowieża): a - dorsal, b-ventral view without legs; c - sensillus; d - lateral view. Bars: a,b: 100 μm , c: 10 μm .

Ventral region:

Epimeral setae short, epimeral setal formula normal (3133); no specific characters in apodemes. Genital plates of about 40 - 45 µm in length. 4 genital, 1 aggenital, 3 adanal and 2 anal setae present. Length of anal plates about 45 - 54 µm. At the lateral and posterior border of the ventral plate a long, area-porosa-like ribbon present (typical of all *Liebstadia* species and present also in other Scheloribatidae).

Legs:

Normal shape and setation is present. All legs are monodactyl. Seta *l'* in tarsus I absent. The setal formulae of femora to tarsi including famulus, without solenidia (number of solenidia in parenthesis) as follows:

leg I : 5 - 3(1) - 4(2) - 18 (2)

leg II : 5 - 2(1) - 4(1) - 15(2)

leg III: 3 - 1(1) - 3(1) - 15

leg IV : 2 - 2 - 3(1) - 12.

Distribution:

Europe, Northern Asia, Japan.

Ecology:

Living on the bark of trees (Willmann 1933, 1956), which might be the favoured habitat (see also the high number of individuals from mosses on tree bark from Bulgaria in the Kunst Collection and locus typicus of Berlese's material); occasionally occurring in alder wood and in different forests; in bog (Strenzke Coll. specimen).

Liebstadia willmanni sp. nov.

Figs 3-9; Pl. 1, figs 1-6

The individuals of this species were collected together with another species of *Liebstadia* in the locus typicus of *Protoribates pannonicus* WILLMANN, 1951. It was not clear which, of the two species found is Willmann's *P. pannonicus*. The material of Willmann likely contained both species, but for the description of *Protoribates pannonicus* a more robust one was chosen, with seta *lp* removed from area A1 and with 4 pairs of areae porosae (as can be seen on the figure in the original description). The other, flat species with 3 pairs of area porosae differs from the similar *L. humerata* SELLNICK, 1928 and *L. longior* (BERLESE, 1908) by several characters (development of pteromorphs and shape of sensillus). Therefore this species is considered a new, undescribed species of *Liebstadia*.

A similar species with identical main characters was also found in our material from Slovakia. The slight differences observed are not regarded to be of specific character. The new species is also described on the basis of material from Austria and Slovakia.

Liebstadia longior sensu KUNST (1971, fig. 154) differs from *Liebstadia longior*, as redescribed above, by the shapes of the pteromorphs and of the sensillus, and most probably it is conspecific with this new species.

Material studied:

- 5 females and 4 males from Austria, Brunnlust Natural Reserve (near the Moosmühle), wet meadow, in bulks of *Juncus* and *Phragmites* (locus typicus of *Liebstadia pannonica*, see below). 15. 6. 1992, leg. L. Miko and A. Bruckner - locus typicus. Holotype and 3 paratypes in the collections of the authors (L. M. holotype and 1 paratype, G. W. 2 paratypes), 1 paratype in the collection of Staatssammlungen Munich.

- 2 females and 1 male from Slovakia, Dreveník natural reserve (near the Spišské Podhradie, East Slovakia), sample Nr. LM-332-90, soil and litter under *Corylus* in rocky clough. 4. 10. 1990, leg. L. Miko.

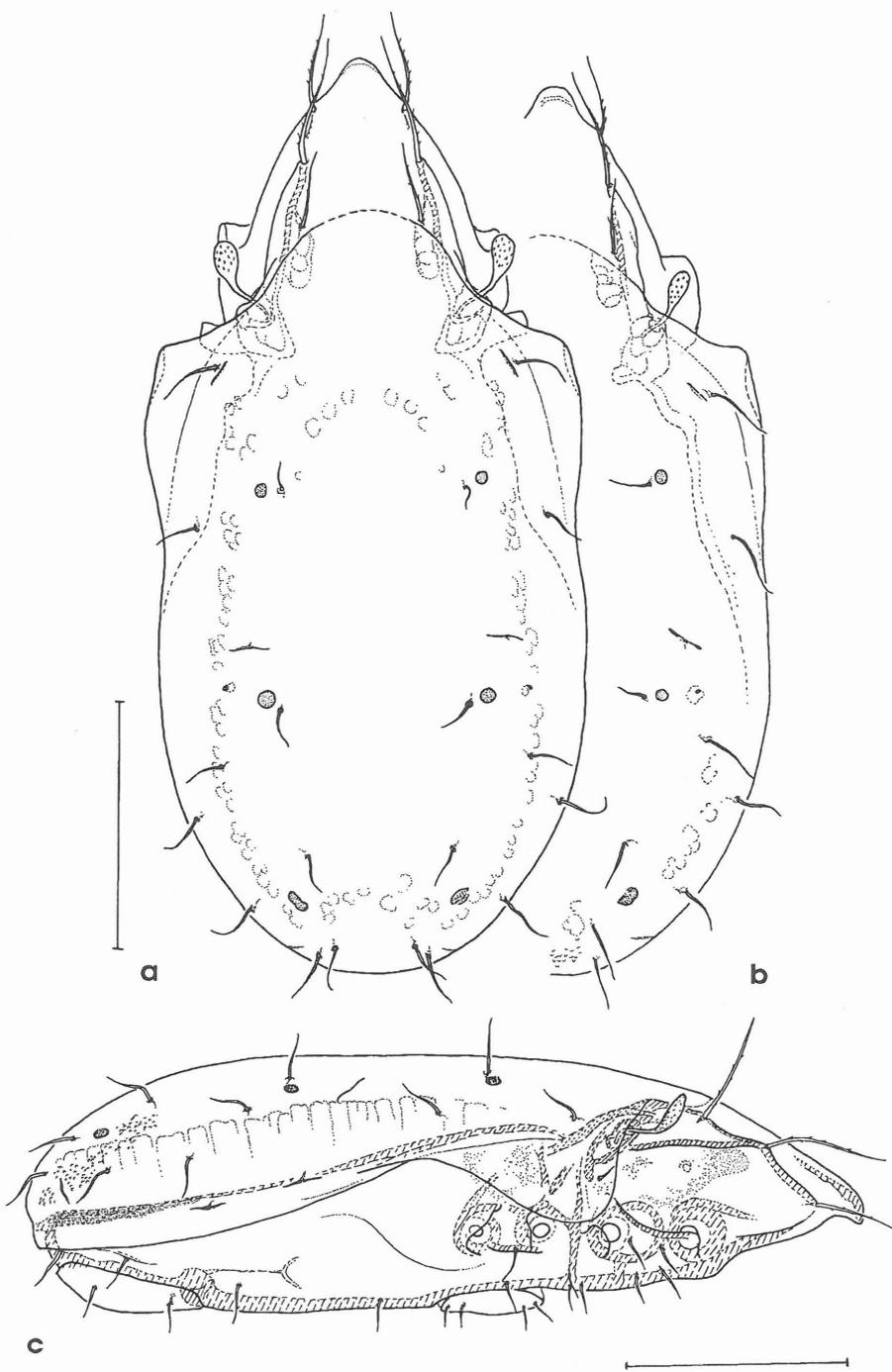


Fig. 3: *Liebstadia willmanni* sp. nov.: a - specimen from Austria, Brunnlust Nat. Reserve, dorsal view; b - "form A" from Slovakia, dorsal view; c - lateral view. All without legs. Bars = 100 μ m.

Description of the adult

Diagnosis:

Small to medium large, flat species with typical characters of *Liebstadia* (lamellar complex, monodactyl, areae porosae). Sensillus with short stalk and fusiform or globular-fusiform head. 3 pairs of areae porosae present on notogaster: A2 and A3 fused (rarely fusion incomplete, or A2-A3 not fused, in this case areae situated very near to each other). Seta *lp* much nearer to area A1 than seta *h3*, ratio *lp*-A1 to *h3*-A1 over 3. Pteromorphs well developed, clearly bent downwards and reaching or nearly reaching the upper level of acetabula in lateral view. Ventral side with microstriate sculpture, adanal shield with more or less visible sclerotized band laterally of anal plates.

The immatures are unknown.

General characters:

Length of females 355-439 μm (average 387 μm , n=5), width 159-214 μm (average 179 μm). Measures of males: 352-384 \times 160-189 μm (average 365 \times 171 μm , n=4). Length:width ratio 2-2.3:1. Dorsoventral thickness in postgenital transect 95-125 μm . Length:dorsoventral thickness ratio 3.3-4:1 (usually about 3.8:1). Colour light yellowish brown to dark yellow. Cuticle smooth, ventrally with microstriate sculpture. Sublamellar, subbothridial and acetabular region with fine granular cerotegument.

Prodorsum:

General view typical of *Liebstadia*. Rostrum rounded, distinctly protruding. Lamellar complex typically developed; lamella (lamellar ridge) joins the insertions of setae *in* and *le*, ventrad curved. Sublamella long, narrow, joined to ventral part of bothridial complex. Prolamella present, reaching the *ro* insertions. Tutorium absent, or present as an indistinct line. Bothridium comparatively small, only slightly overlooking the anterior border of notogaster or fully covered (form "A", see figs 3b, c). Posterolateral scale of bothridium absent. Bothridial lamellae between lamella and sublamella (*bl*, *bl'*) short and weakly developed or indistinct. Sensillus comparatively short (about 35-40 μm), with very short stalk (10-12 μm). Head of sensillus subglobular or fusiform-globular in dorsal view, but clearly fusiform in lateral view, about 25-28 μm long. All prodorsal setae except exobothridial seta long, with bristles (*in* 30-50 μm , *le* 40-60 μm , *ro* 30-40 μm), lamellar setae reaching the rostrum. Sublamellar area porosa present, sometimes indistinct.

Notogaster:

Elongated, anteriorly with subparallel lateral sides. Anterior border strongly curved, protruding to the prodorsum, indistinct. Pteromorphs immovable, well developed, posteriorly reaching to 1/3-1/2 of notogaster length, distinctly bent downwards and rounded. 10 pairs of medium long notogastral setae present (21-28 μm). 3 pairs of areae porosae present; Aa subequal or slightly smaller than A1. A2 and A3 fused, forming a single, slightly elongated and sometimes comparatively large area porosa. Rarely the fusion of A2 and A3 is incomplete or interrupted (1 case unilaterally in our material). In this case areae A2 and A3 are near each other. Area A1 very close to seta *lp*; ratio of distances *lp*-A1:*h3*-A1 ranking from 1:2.5 to 1:7.5 (usually about 1:5). All lyrifissures present in usual place, notogastral gland pore visible. Posterior border of notogaster slightly angulated and narrowed in posterodorsal view (fig. 4c).

Gnathosoma:

With usual characters of superfamily. Rutellum (fig. 6c) large, robust, with 2 medium long setae. Adoral setae long, distinctly barbed. Spine *e* baculiform. Chelicera (fig. 6a) robust, distally well sclerotized, with long and barbed setae, especially *cha*. Palp setation 0-2-1-3-9(+1). Corne double short, not inserted on apophyse (fig. 6b). Three eupathids present on palp tarsus distally except come double.

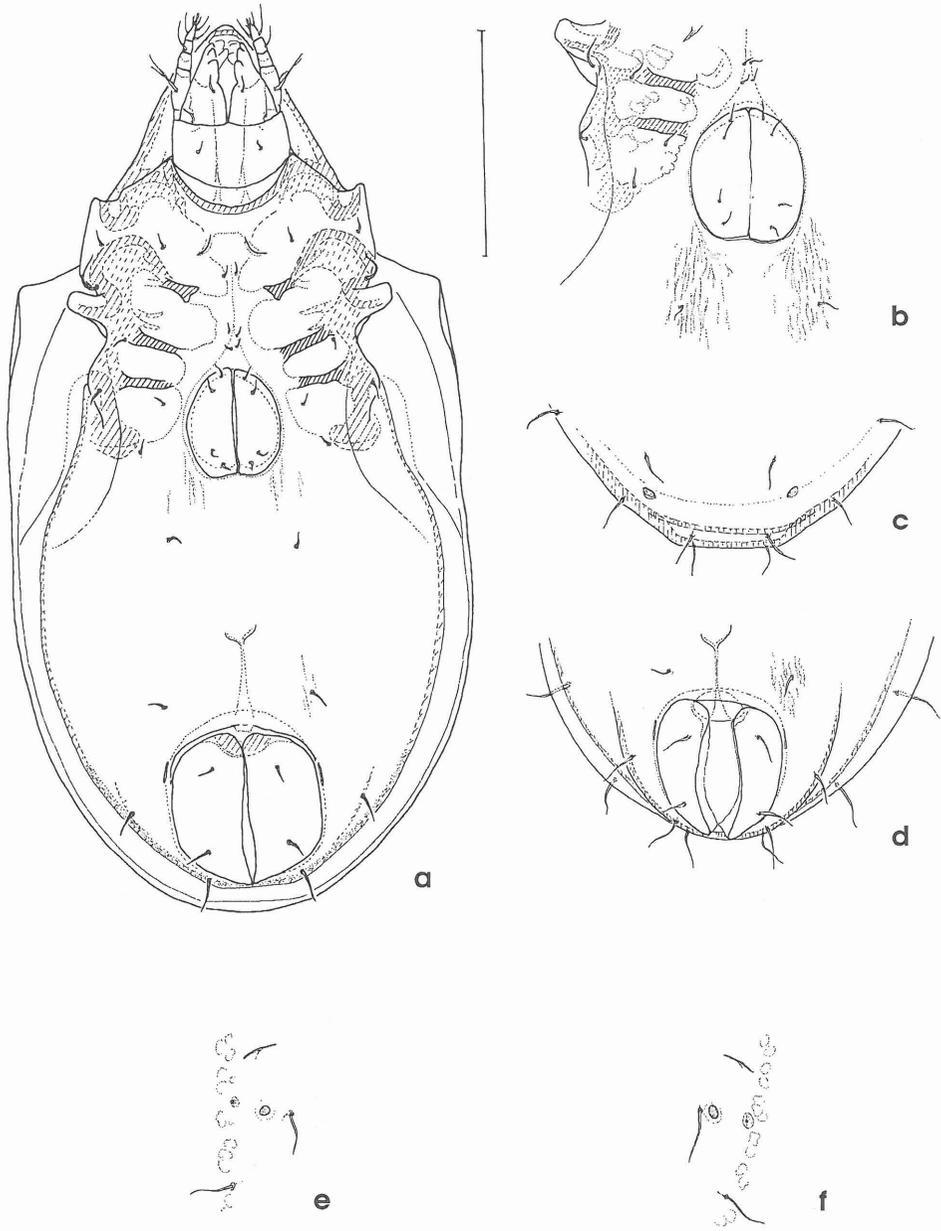


Fig. 4: *Liebstadia willmanni* sp. nov.: a - ventral view on "form A"; b - ventral view on genital area; c - posterior part of notogaster in anterodorsal view; d - anal and adanal area; e, f - position of lyrifissure *im*, area A1 and setae *h3* and *lp*. Bar indicates 100 μ m (a).



Fig. 5: *Liebstadia willmanni* sp. nov.: a - rostrum; b - sensillus; c-f - variability of the sensillus and the position of the bothridium; g - lamellar complex and bothridium in dorsolateral view. Bar (b) = 20 μ m

Ventral region:

Epimeral setal formula as usual (3133), epimeral setae short, *Ic* somewhat longer. Apodemes not reaching to the genital aperture. A furrow between the genital plates and gnathosoma present, in light microscope indistinct. Pedotectum I small, pedotectum II distinct in ventral view. Discidium developed as a rounded blade, bearing the seta *4c*. Circumpedial line long, reaching the pedotectum II. Custodial tip absent.

Genital plates comparatively small, about 47-56 μm long. 4 pairs of short genital setae present (2+2). One pair of aggenital setae present. Distance of genital-anal aperture at least 2 times longer than genital plates. Striate longitudinal microsculpture of ventral plate is best visible in aggenital and adanal area (fig. 4b, Pl. 1, fig. 3).

Anal plates larger than genital ones, 65-68 μm long. Normal numbers of setae present in anoadanal area (*2an*, *3ad*). Anal and adanal setae longer than other ventral setae. Posterior part of ventral plate, laterally to anal plates with more or less distinct adanal ridge, ending usually before the insertions of *ad2*. This ridge is in fact a thickening of cuticle, sometimes well visible in lateroventral view only. Posterior and posterolateral border of ventral plate with distinct, area-porosa-like punctulation.

Legs:

Legs monodactyl, robust, with rugose surface. Ventral lamellar carinae on trochanter III and all femora present. Ventral carina of femur I and II rounded, on femur III proximally angled and on femur IV proximally with a blunt tip (figs 7-9). Leg setation of trochanter to tarsus as follows (famulus included, solenidions in parenthesis):

leg I: 1 - 5 - 3(1) - 4(2) - 18(2) (fig. 7)

leg II: 1 - 5 - 2(1) - 4(1) - 15(2) (fig. 8)

leg III: 2 - 3 - 1(1) - 3(1) - 15 (fig. 9a)

leg IV: 1 - 2 - 2 - 3(1) - 12 (fig. 9b)

Solenidions ϕ 1(I) and ϕ (II) very long, setiform and tactile. Solenidion ϕ 2(I) on a distinct apophysis. Solenidions ω 1(I), ω 1(II), ω 2(II) and σ (III) ceratiform, blunt. All other solenidions setiform.

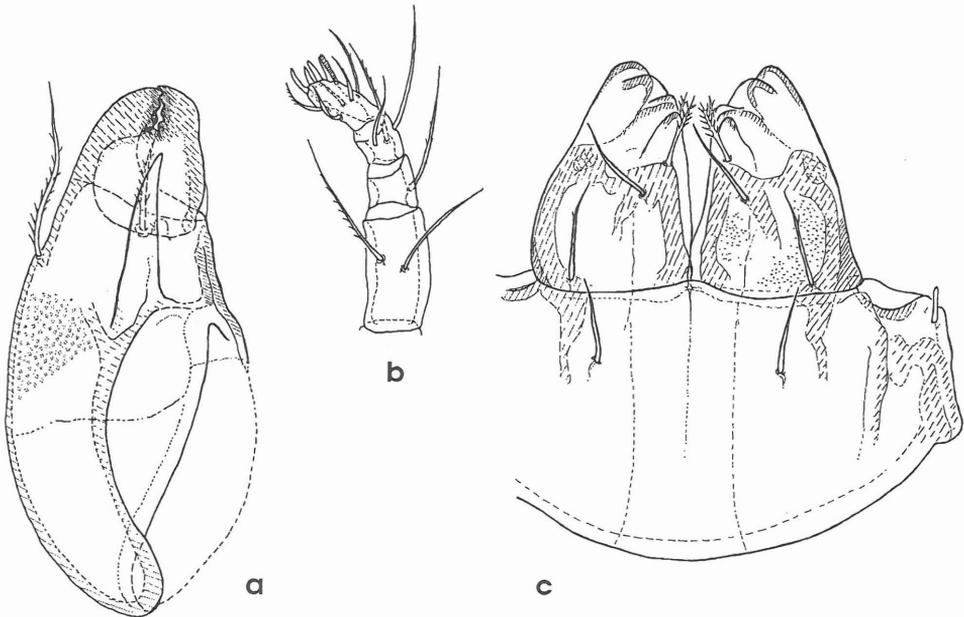


Fig. 6: *Liebstadia willmanni* sp. nov.: a - chelicere; b - palp; c - infracapitulum.

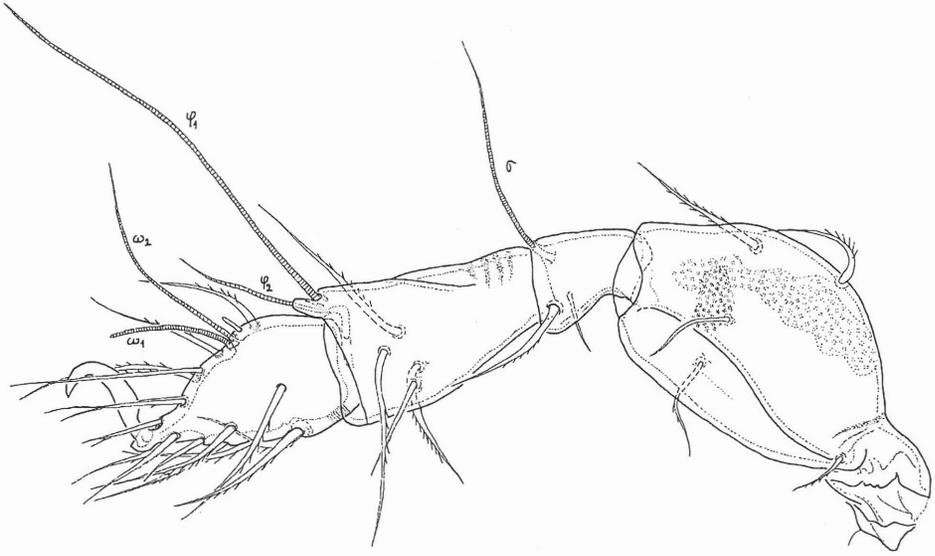


Fig. 7: *Liebstadia willmanni* sp. nov.: leg I, antiaxial view.

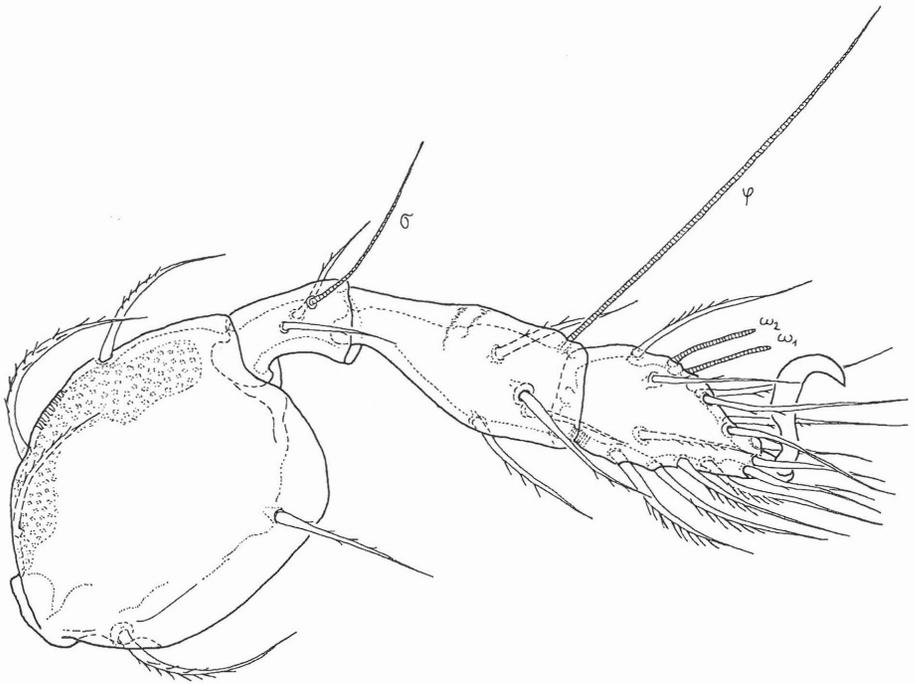


Fig. 8: *Liebstadia willmanni* sp. nov.: leg II, antiaxial view.

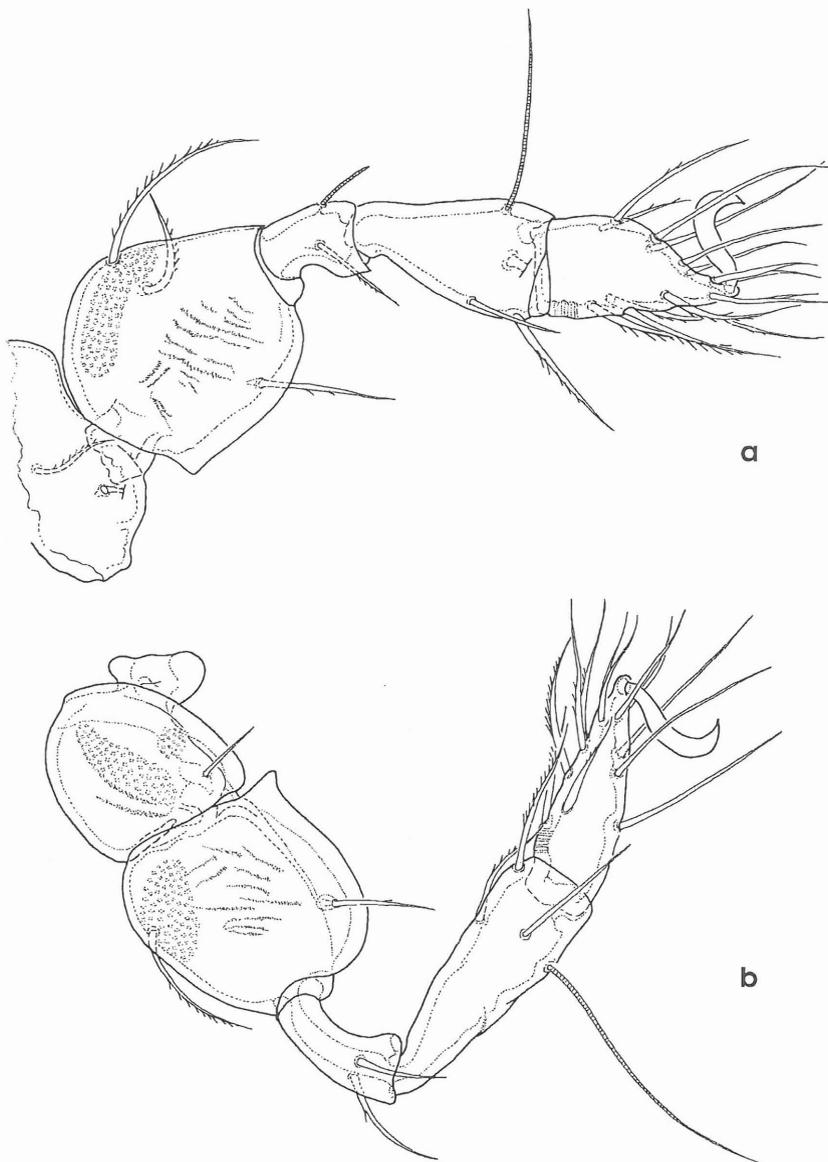


Fig. 9: *Liebstadia willmanni* sp. nov.: a - leg III, paraxial view; b - leg IV, antiaxial view.

Distribution:

Slovakia and Austria, probably also in the Czech Republic (see Kunst, 1971, as “*Liebstadia longior*”). Very likely, it has often been misidentified and should have a broader distribution.

Ecology:

Living in litter and organic horizon of soil in open habitats (grasslands, shrub formations etc.).

Note:

The "form A" differs generally by its slightly longer body, bothridia fully covered by anterior border of notogaster and tendency to have areae A2 - A3 not fully fused. The form is in some characters similar to *L. pannonica*. The body form, form of sensillus and bothridium, microstriation of ventral side (even if less distinct) and development of lamellar area are the main reasons for placing this form into the new species described here (see also the discussion).

For affinities to *Liebstadia humerata* (Poland) sensu Seniczak (1990), *L. humerata* (Spain) sensu Perez-Iñigo (1993) and *L. gratiosa* VASILIU et CALUGAR, 1973 (Romania) see the discussion.

Liebstadia pannonica (WILLMANN, 1951)

Figs 11-13; Pl. 2, figs 1-7

syn.:

Protoribates pannonicus WILLMANN, 1951

Protoribates variabilis RAJSKI, 1958 syn. nov.

Rajskibates variabilis; Balogh et Balogh, 1984

Liebstadia variabilis; Subias et Gil-Martin, 1995

Comparison of topotypical specimens of *Protoribates pannonicus* WILLMANN, 1951 with the specimen of *Protoribates variabilis* RAJSKI, 1958 from the Poznan environs, and also with rich material (designated mostly as *P. variabilis*) from Germany, the Czech Republic and Slovakia showed undoubtedly, that all specimens belong to the genus *Liebstadia* and there is no specific difference between Austrian, Polish and other material. All specimens principally confirm with both original descriptions. The main differing character of Rajski is the greater number of notogastral setae due to a misidentification of Willmann's figure, where the lyrifissure *im* is drawn like a seta. With the exclusion of a second similar species from Willmann's locus typicus (see description of *L. willmanni* sp. nov. above) we consider *Protoribates variabilis* RAJSKI, 1951 to be a junior synonym of Willmann's species. The other possible synonymies are discussed in the discussion.

Material studied:

- 4 females and 4 males from Austria, Brunnlust Natural Reserve (near the Moosmühle), wet meadow, in bults of *Juncus* and *Phragmites* and in moss (locus typicus). 15. 6. 1992, leg. L. Miko and A. Bruckner.

- 1 female from Rafalski Collection, Poznan environs, (sample 71a), labeled: "*Protoribates variabilis*, Raj. leg., det."

- 3 females and 2 males from a total of 16 specimens from Germany, Frankfurt/Main, meadow at Batelle-Institute (samples D-Fr-1 to D-Fr-10), leg. 1986, Coll. Weigmann.

- 2 females and 2 males from Germany, Erlangen-Bruch, meadow near Regnitz river, leg. J. Ohm 22.11.68 (sample 502), Coll. Weigmann, 1 slide in bad condition.

- 3 females and 9 males from the Czech Republic, České Středohoří (Czech Midlands Mountains), Hrušovka, dry grassland, in grass litter and organic horizon of the soil. 25. 2. 1989 leg. L. Miko (sample LM-31-89).

- 2 females from Slovakia, Pieniny National Park (Northeast Slovakia), Huta in Dunajec river valley, in moss growths and primary soil on the rocks. 18. 4. 1987 leg. L. Miko (sample LM-178-87).

- 2 females and 1 male from Slovakia, Pieniny National Park, Lesnica, mesophile meadow on southern slope, upper soil layer with grass rhizosphere. 8. 6. 1990 leg. L. Miko.

Redescription of the adult

Diagnosis:

Small to medium large, comparatively robust species with typical characters of *Liebstadia*. Sensillus with fusiform head and comparatively long stalk. Bothridium with distinct small posterolateral scale. 4 pairs of areae porosae present on notogaster. Area A1 situated approximately in the middle between setae *lp* and *h3*, ratio *lp*-A1 to *h3*-A1 less than 2.5. Pteromorphs well developed, bent downwards.

The immatures are unknown.

General characters:

Length of females 350-430 μm (average 389 μm , n=11), width 190-250 μm (average 206 μm), males 360-410 \times 185-215 μm (average 377 \times 197 μm , n=12). Length:width ratio 1.72:1. Dorsoventral thickness in postgenital transect 125-160 μm . Length:dorsoventral thickness ratio 2.3-3.1:1. Colour yellowish brown to reddish brown. Cuticle smooth, sublamellar, subbothridial and acetabular region with fine granular cerotegument.

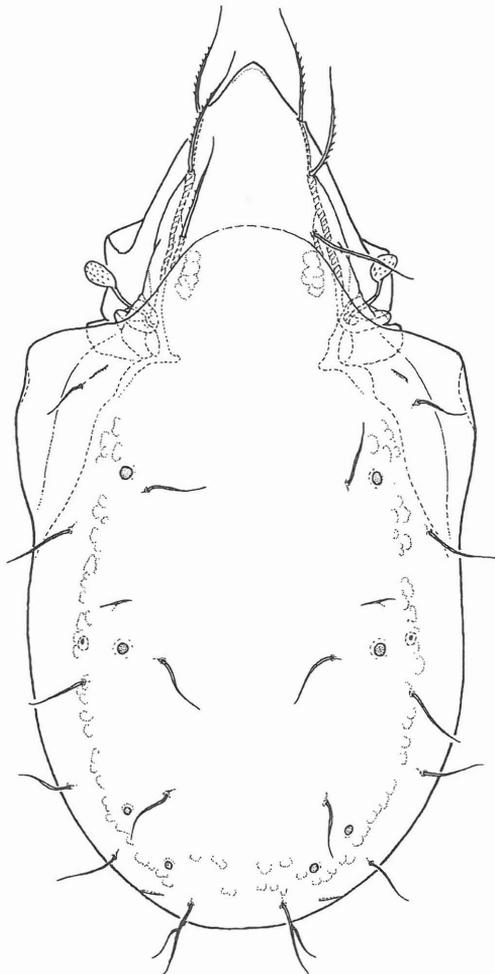


Fig. 10: *Liebstadia pannonica* (WILLMANN, 1951): toptotypical specimen, dorsal view without legs. Bar = 100 μm .

Prodorsum:

Rostrum protruding, lamellar complex typical of *Liebstadia*. Tutorium present as a distinct line, sometimes with small blade. Bothridium usually not fully covered by anterior border of notogaster, posterolaterally with a small, but distinct scale (figs 12b-d, Pl. 2, figs 5,6). Bothridial lamellae (*bl*, *bl'*) distinct. Sensillus with comparatively long stalk and fusiform, sometimes slightly distally pointed head, with total length about 43-50 μm (stalk 20-25 μm , head 20-29 μm , see figs 12a-d). Exobothridial seta short, other prodorsal setae long (*in* 45-56 μm , *le* 56-66 μm , *ro* 45-50 μm), finely, but distinctly bristled. Sublamellar area porosa present, comparatively large.

Notogaster:

Comparatively broad and arched, with anterior border indistinct, protruding to the prodorsum. Pteromorphs well developed, immovable, rounded and bent downwards. 10 pairs of medium long notogastral setae (about 18-32 μm) and 4 pairs of area porosae present. Areae A2 and A3 often near to each other, but only very exceptionally unilaterally fused (fig. 13). In one case a divided area A1 was found. Area A1 not close to seta *lp*, ratio *lp*-A1:*h3*-A1 ranking from 1:0.75 to 1:2.6, usually about 1:1.6. All lyrifissures present in usual place, notogastral gland pore visible. Posterior border of notogaster broadly rounded.

Gnathosoma:

Without notable differences from those of *L. willmanni* (see above).

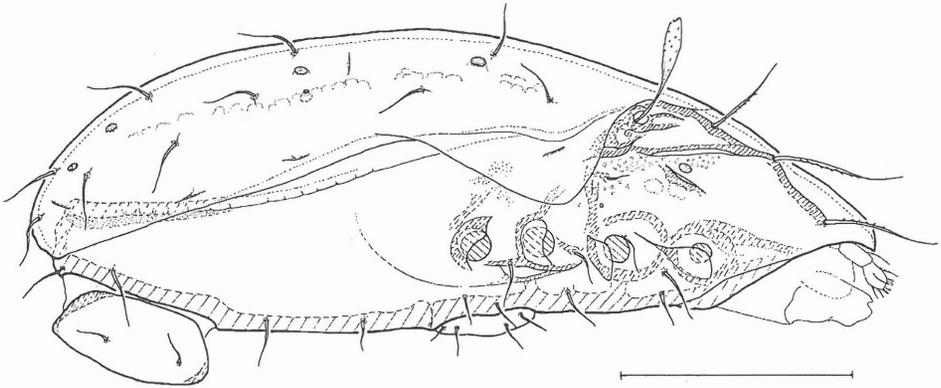


Fig. 11: *Liebstadia pannonica* (WILLMANN, 1951): topotypical specimen, lateral view without legs. Bar indicates 100 μm .

Ventral region:

Epimeral area, genital and anal shields similar to *L. willmanni*. Distance of genital to anal aperture about 2 times longer than genital plates (these about 45 μm long), or somewhat shorter. Longitudinal microstriation of ventral plate absent or indistinct. Adanal ridge laterally to anal plates absent, or reaching maximally the second adanal seta, indistinct. Border of ventral plate along the notogaster in posterior part with area-porosa-like fine punctulation.

Legs:

Legs monodactyl, with characters typical of *Liebstadia*.

Distribution:

The species is known from Poland, Slovakia, the Czech Republic, Austria and Germany. Recently reported from Spain (Subias and Gil-Martin 1995).

Ecology:

In wet to dry meadows, grasslands and in moss on rocks.

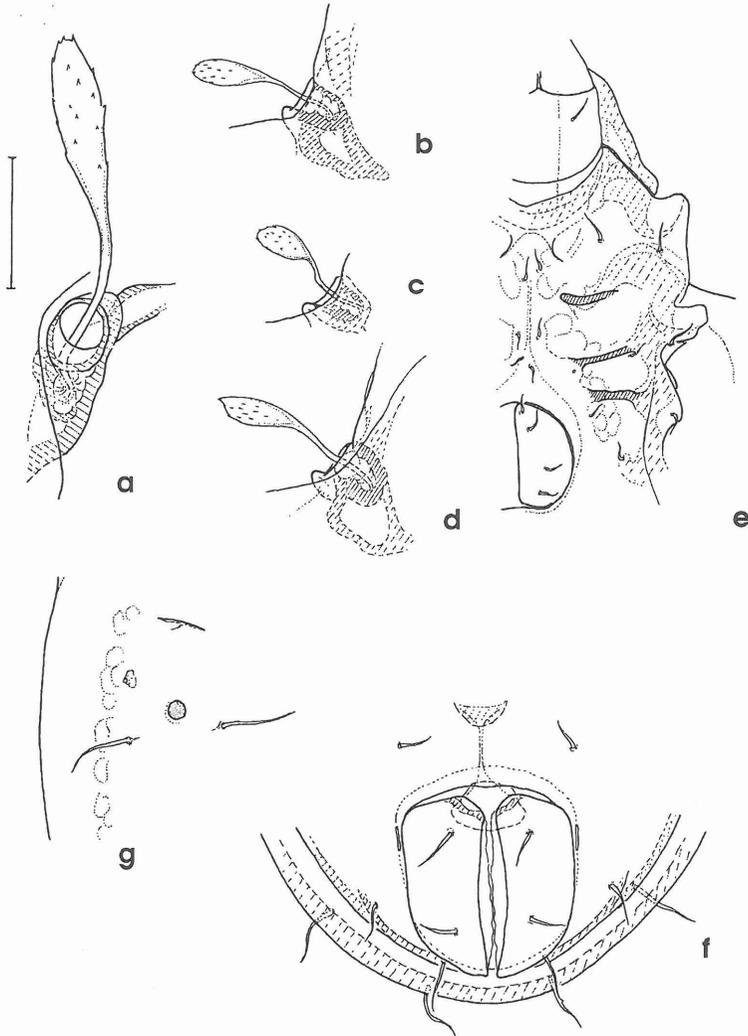


Fig. 12: *Liebstadia pannonica* (WILLMANN, 1951): a - sensillus; b-d - variability of the sensillus; e - epimeral area; f - anoadanal area; g - position of lyrifissure *im*, area A1 and setae *h3* and *lp*. Bar indicates 20 μ m (a).

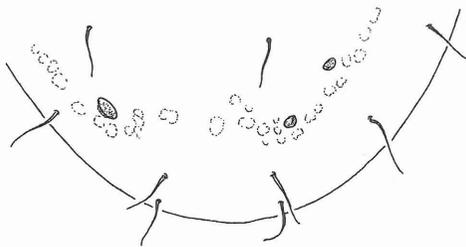


Fig. 13: *Liebstadia pannonica* (WILLMANN, 1951): posterior part of notogaster in dorsal view, case with arecae A2-A3 fused unilaterally.

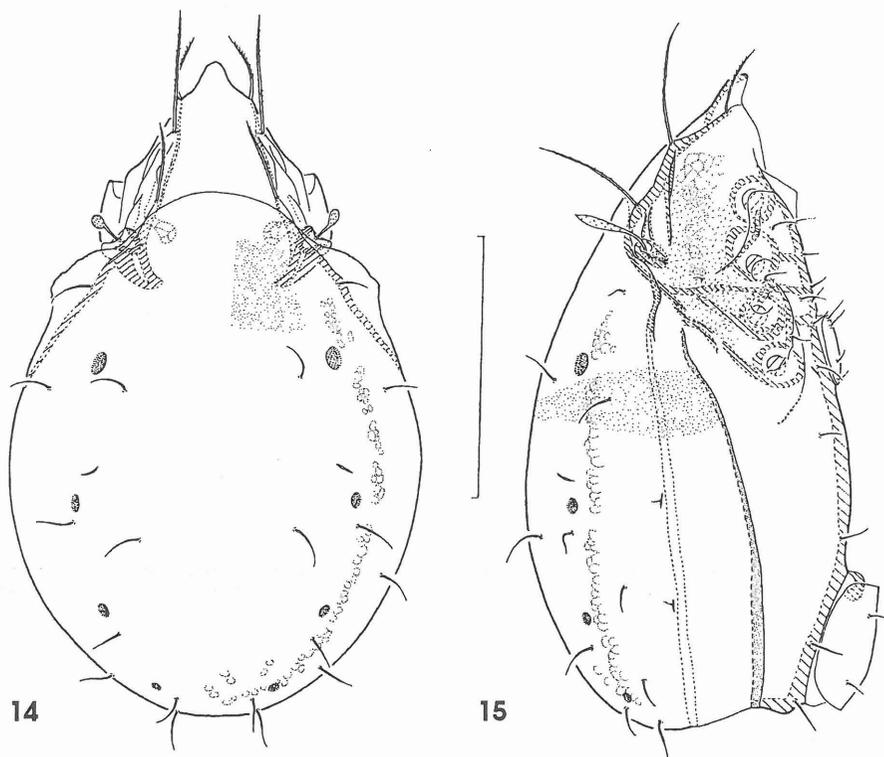
Liebstadia similis (MICHAEL, 1888)

Figs 14-15

The typical form of the species was recently redescribed by Wunderle et al. (1990). It is the largest and most well-known species of the genus, being rather variable in some features, but easily distinguishable from the other species by the following combination of characters (figs 14-15, after Wunderle et al., 1990): body robust and arched; body length 500-565 μm , width 330-360 μm , length:width ratio 1.45-1.60; sensillus (in lateral view) lanceolate; 4 pairs of areae porosae developed; pteromorphs developed as horizontal humeral blades, not bent downwards; length of notogastral setae 30-35 μm ; tarsus of leg I with 21 setae (including solenidions and famulus).

One slightly different form was present in our study material, possessing all the most important characters of the nominate form. The differences found are not considered to be at the species level. Because of the variability of the nominate species and an insufficient number of different specimens, we prefer to describe this form without fixing the taxonomical status. Further study may show, whether the different form is of subspecific character.

The main characters of the form (denotated as "*longisetosa*") are as follows (figs 16, 17):



Figs 14-15: *Liebstadia similis* (MICHAEL, 1888): dorsal (fig. 14) and lateral (fig. 15) view (after Wunderle et al. 1990). Bar indicates 200 μm .

Generally with characters of *L. similis* s. str. Dimensions $493 \times 254 \mu\text{m}$. Body slender, arched dorsoventrally, with indistinct anterior border. Prodorsum very short in dorsal view. Lamellar and interlamellar setae over $100 \mu\text{m}$, rostral setae $63 \mu\text{m}$, exobothridial seta $28 \mu\text{m}$ long. Sensillus lanceolate, $65 \mu\text{m}$ long, with head length $34 \mu\text{m}$ and width about $6 \mu\text{m}$. Lateral sides of notogaster bent down. Notogastral setae long, mostly between $55\text{-}60 \mu\text{m}$, seta *h2* posteriorly reaching area A3. The female studied was a light coloured, perhaps freshly moulted adult, without eggs. It is possible, that the slender body form may only be a time-limited character occurring during the development of eggs. Also, the most important differential character of the form is the length of the notogastral and other setae. For the similarities with *Protoribates serratomarginatus* MAHUNKA, 1983 see the discussion.

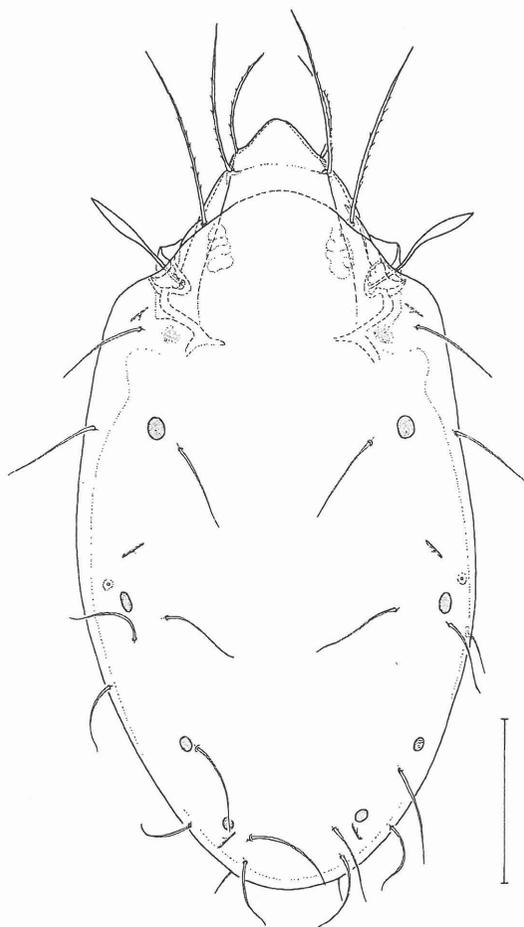


Fig. 16: *Liebstadia similis*, form with long prodorsal and notogastral setae (“*longisetosa*”) from East Slovakia: dorsal view without legs. Bar = $100 \mu\text{m}$.

Material studied:

- 1 female from East Slovak Lowlands (Slovakia), Svätá Mária, corn field on fluvisol, lower soil layer (5-10 cm, sample LM-250-91), 21. 3. 1991 leg. L. Miko, in one of the author's (L. M.) collection.
- 1 female from East Slovak Lowlands (Slovakia), Egreš, corn field on albic luvisol, upper soil layer (0-5 cm, sample LM-541-92), 19. 5. 1992 leg. L. Kováč (the specimen was lost).



Fig. 17: *Liebstadia similis*, form with long prodorsal and notogastral setae ("*longisetosa*") from East Slovakia: a - prodorsum in lateral view, b - sensillus, c - epimeral and genital area. Bar indicates 20 μm (b).

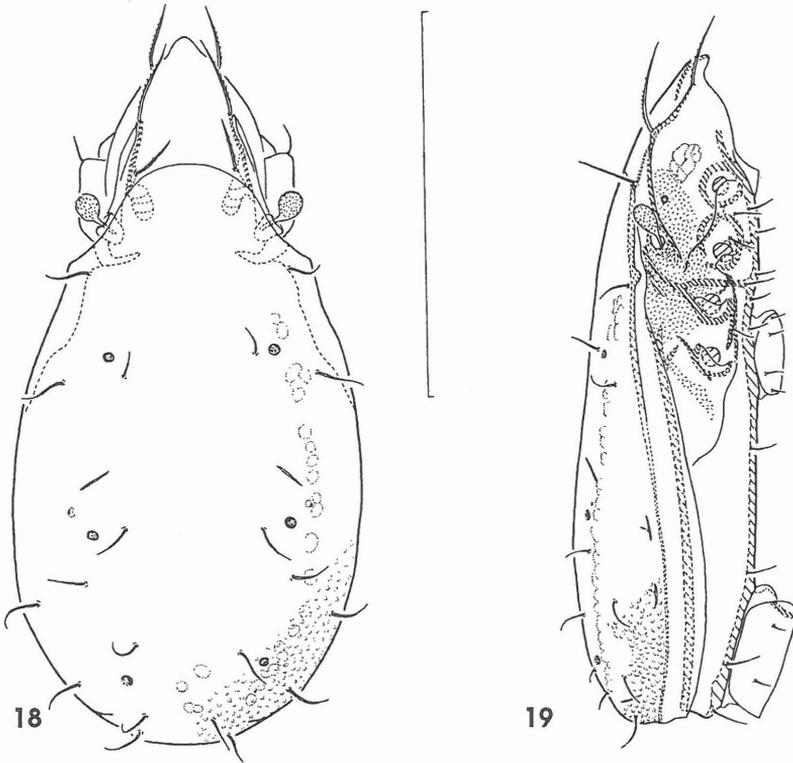
Remarks:

We are not able to decide whether "*Protoribates longior*" sensu Willmann, 1930: fig. 12, redrawn by Ghilyarov and Krivolutsky 1975: fig. 658, belongs to *L. similis* sensu lato, but the size of 525 μm suggests this. Some other forms, similar to the nominate form, are included in the discussion (see below).

Liebstadia humerata SELLNICK, 1928

Figs 18-19

The species (figs 18-19) was recently redescribed by Wunderle et al. (1990), and is easily distinguishable by the following combination of characters: body slender, flat; dimensions: length/width 330-380 μm /145-200 μm (females), 310-360 μm /140-180 μm (males); length:width ratio 1.85-2.40; sensillus short and globular; 3 pairs of areae porosae developed; pteromorphs very small, but usually with distinct horizontal humeral blades of triangular form; length of notogastral setae 20-25 μm ; tarsus of leg I with 20 setae (including solenidions and famulus) and tarsus of leg III with 12 setae.



Figs 18-19: *Liebstadia humerata* SELLNICK, 1928: dorsal (fig. 18) and lateral (fig. 19) view (after Wunderle et al. 1990). Bar indicates 100 μm .

Discussion

The special lamellar-sublamellar complex with the lamella touching the insertion point of interlamellar seta is regarded as a specific and apomorphic character of the genus *Liebstadia*. Other characters with diagnostic value are less specific and obviously often developed convergently in different genera within the Oripodoidea: i.e. having prolamella and sublamella, 10 notogastral setae, 3-4 areae porosae, 4 genital setae, legs monodactyl - some of which are considered typical for scheloribatid mites.

The monodactyly of the *Liebstadia* species is (along with the habitual similarity in dorsal view) the reason that some of them have been placed within the genus *Protoribates* BERLESE, 1908. This is the only generic character given by Berlese (1908) to separate *Protoribates* from *Scheloribates*. Recent research has shown that some *Protoribates* auct. species in the literature belong to the revised genus *Protoribates* (Weigmann et al. 1993), and some other species with the specific lamellar complex ("*Liebstadia* type") belong to *Liebstadia* as defined in this paper, in accordance with Weigmann (1969) and Wunderle et al. (1990). Additional species of "*Protoribates*", *Liebstadia* and other related genera, described worldwide, will likely belong to the genus *Liebstadia* as described here. However, usually no lateral drawings present in the literature, and for this reason it is very difficult to determinate the generic status. Further more, at least in some recently described species of the genus *Liebstadia* the position in the genus cannot be proven from the original description (see discussion of the species *L. ahumerata* below).

As we do not intend to produce a worldwide revision of the *Liebstadia* species we have focused only on the Central European species on which we have enough information. Some other species are discussed, using the original descriptions and redescrptions from the literature, or (as in the case of Willmann's species *Protoribates novus* and *P. austriacus*) on the basis of the original material, which is unfortunately not sufficient for redescription. Generally, the most important fact is that the always immovable pteromorphs of *Liebstadia* species show a high diversity in shape, forming a continuous row from small toothlike blades (*L. humerata*, *L. similis*), over small rounded blades, not bent downwards (*L. longior*) to large pteromorphs bent downwards (*L. pannonica*, *L. willmanni* sp. nov.), without recognizable gaps (see also Pérez-Iñigo 1993). Therefore, the shape of pteromorphs cannot be used as a generic character. This result raises the immediate question of which diagnostic character of the pteromorph development should be used in the other scheloribatid genera, e.g. *Scheloribates* vs. *Hemileius*, as the use of this character for family separation seems to be unacceptable (e.g. Pérez-Iñigo 1993). This question needs further detailed investigation and will be discussed in a later paper.

Liebstadia belongs to the family Scheloribatidae GRANDJEAN, 1933 in the conservative view of Grandjean (1958). Balogh and Balogh (1992) put *Liebstadia* into the family Protoribatidae BALOGH and BALOGH, 1984, which we believe to be a mixed composition of members from different families. The nominal genus *Protoribates* belongs to *Haplozetidae*, while *Liebstadia* definitely does not (see Weigmann et al. 1993 for further discussion).

Except for the continual change of pteromorph shapes, two trends are easily recognizable: the changes in dorsoventral thickness and the form and shape of the sensillus (see figs 1c, 5b, 12a, 17b). Considering the known facts on the ecology of the different species, we recognized two typical "life forms" of *Liebstadia*:

(a) the species with large body size, dorsoventrally thick, with a longer sensillus stalk and more-less lanceolate sensillus head (e.g. *L. similis*),

(b) the species with very flat, oblonged body of medium size, with the sensillus stalk short and spherical or sub-spherical sensillus head (*L. humerata*, *L. longior*).

In addition to the two mentioned forms, intermediates could also be found (e.g. *L. pannonica*). Probably, the life-form (a) belongs to the species living in the litter, soil surface or surface layer of the soil, and the life-form (b) seems to be an adaption for life in flat moss/lichen growths or the crevices and slots of tree bark. The intermediate forms were found mostly in grasslands or in shrub formations.

Some other "*Protoribates*" auct. species, known from central Europe, are considered to be in fact *Liebstadia*. Both individuals of *Liebstadia nova* (WILMANN 1953) comb. nov. (= *Protoribates novus* WILLMANN, 1953) studied from Willmann's original slide (Staatssammlungen Munich, labeled: "K6-91, *Protoribates novus* sp. nov., det. C. Willmann, G 294") are strongly damaged, and no longer usable for redescription. Nevertheless, from the slide it is clear that the species has no 11

notogastral setae. The eleventh seta in Willmann's description is most probably the lyrifissure, which is also visible on the damaged specimens in the slide. From the characters visible, the species belongs to *Liebstadia* as defined here, and probably is a synonym of *L. pannonica*. A definitive classification requires the study of topotypical material. Mahunka (1987) reported on the species from Kiskunság National Park in Hungary, but without notes on specific characters. The species was reported as being sylvan (found in plant association *Junipero-Populetum albae*).

The classification of *Liebstadia austriaca* (WILLMANN, 1953) comb. n. (= *Protoribates novus* WILLMANN, 1953) is very similar. The original material of Willmann (3 slides from Staatssammlungen Munich labeled: "K6-68 (E4/0-3) *Protoribates austriacus* sp. nov.", "K6-69 *Liebstadia*, A 77/0-3, Admont, det. E. Leitner" with "*Protoribates austriacus*" added by pencil, and "K6-70 *Protoribates austriacus* sp. nov.") cannot be used for redescription, but from the crushed individuals in the slides it is clear, that it is a species of *Liebstadia*, according to the present description. Moreover, considering the body shape and form of the sensillus, the species is probably also a synonym of the presently redescribed *L. pannonica*. As in previous species, definitive classification is possible only after the study of topotypical material.

The species *Protoribates serratomarginatus*, described by Mahunka (1983) from the Hortobágy National Park in Hungary is definitely *Liebstadia* (see figs 30 and 32 of original description). The species is nearly identical (from comparison of available description and drawings) with the nominal species *Liebstadia similis*. Typical characters of the species, as given by author, are: serrated to denticulated edge of pteromorphs, comparatively long notogastral and prodorsal setae and body size. We did not study the Hungarian material, but the description and pictures closely resemble our material from Germany (2 specimens - 1 female and 1 male from Leipzig, 14. 7. 1991, leg. W. Dunger), which belongs to *Liebstadia similis* sensu lato. We also note the remark of Wunderle et al. (1990), that the border of the pteromorphs of *L. similis* is slightly undulated or denticulated. The only other notable difference is in body size: Mahunka gives a length of 431 - 498 μm and a width of 245-302 μm for *Protoribates serratomarginatus*, while the measurements for *L. similis* are 500-565 \times 330-360 μm (Wunderle et al., 1990). Measurements of specimens studied from Leipzig were more or less intermediate: length 500 μm (male) and 525 μm (female), and width 320 μm , so the body size is not usable as a differential character. Remaining characters, i.e. slender body and comparatively longer notogastral and prodorsal setae, are insufficient to establish a species. Differences between this form and *L. similis* are in the same range as differences between the nominate form and form with long notogastral and prodorsal setae, described here ("*longisetosa*"). Also, the identity of a Hungarian form and "*longisetosa*" is not fully excluded. All the questions mentioned could be solved by the further study of the Hungarian material. At present stage of our knowledge, the name *Liebstadia similis serratomarginata* comb. nov., stat. nov. is proposed for the Hungarian form.

Mahunka (1987) described the species *Liebstadia ahumerata* from the juniper litter from Kiskunság Nat. Park, Hungary. The differential diagnosis in the description is lacking. The placement of the species in *Liebstadia* is probable, but in the original drawing of the lateral prodorsum (fig. 53) the interlamellar seta does not touch the lamella. As seen from the dorsal view (fig. 51), the setae *in* cannot be placed in so large distance from the lamella, as shown in the fig. 53, so very probably the proximal (right) seta *in* is omitted and instead the distal (left) seta is depicted. If the position of seta *in* is on the lamella, the species could be placed in *Liebstadia*. In this case the difference from other similar *Liebstadia* species must be defined. The author states in the description that the species has only three pairs of small areae porosae (similarly as *L. longior*, *L. humerata* or *L. willmanni* sp. nov.), on the other hand, the depicted specimen (fig. 51) has four pairs of areae (along with the small size, and somewhat different shape of the sensillus head it could be a specific character). To determine, if the species is or is not a synonym of some of the known species, further evaluation must be done.

Several additional species of *Liebstadia* were reported from the Mediterranean area and the Balkan Peninsula. According to Pérez-Iñigo (1993), 5 species of *Liebstadia* are present in the Spanish fauna. The species *L. humerata*, sensu the mentioned papers differs from the species, as redescribed by Wunderle et al. (1990) by its 4 pairs of areae porosae and possibly (according to fig. 77B) by longer interamellar and lamellar setae. On the other hand, it is nearly identical with *Liebstadia humerata* sensu Seniczak (1990, fig. 9). Because no more details of adult morphology are given in both papers (especially the lateral view: bothridial area and pteromorphs, ventral side,

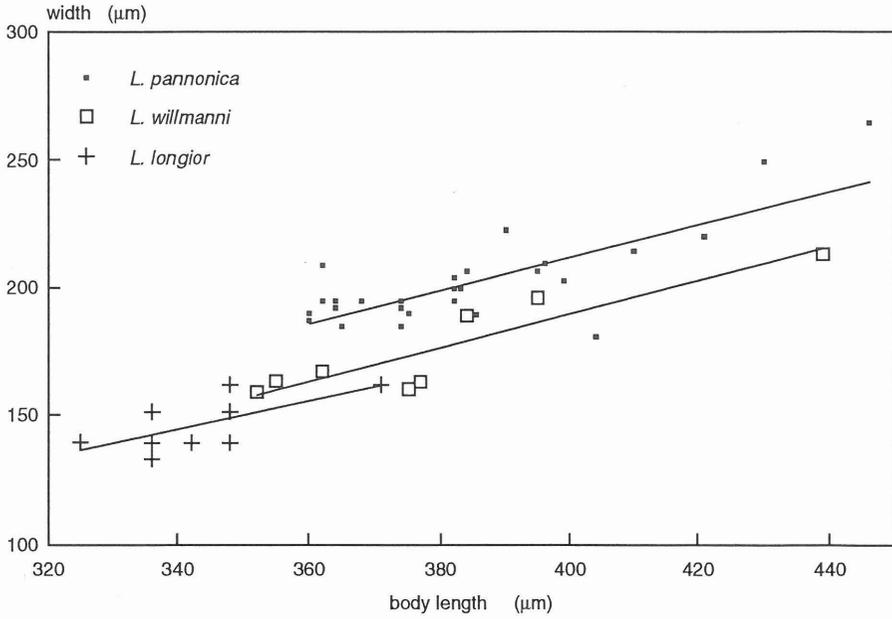


Fig. 20: Differences of length/width ratios in studied specimens of *L. pannonica*, *L. willmanni* and *L. longior* (linear regression).

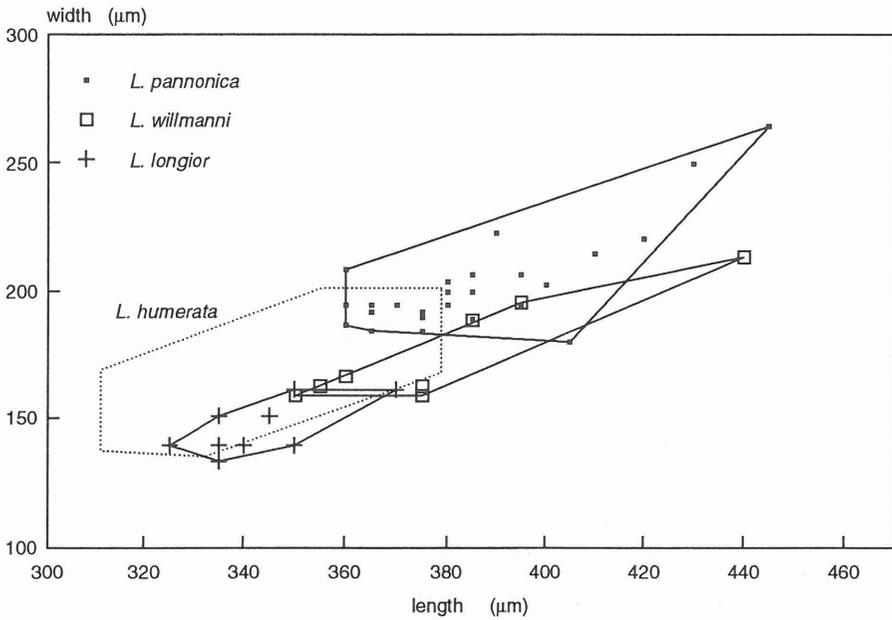


Fig. 21: Comparison of length/width ratios of 3 studied species and *L. humerata* (data after Wunderle et al. 1990).

leg chaetotaxy etc.), the real position of these species is uncertain. The body shape, position of seta *lp*, sensillus shape and the classification of bothridia is very similar to the new species *L. willmanni* (especially the form "A" from Slovakia), described here. On the other hand, the presence of 4 pairs of areae porosae resembles that of the species *L. pannonica*. It is not excluded, that presence of 3 pairs of areae in *L. humerata* or *L. willmanni* could be variable, and that populations with 4 pairs could exist (see also the opinion of Wunderle et al. 1990). More detailed study may also show, that *L. humerata* sensu Seniczak and *L. humerata* sensu Perez-Iñigo represent a new, undescribed species of *Liebstadia*. The next two species from Spain (*L. gallardoi* and *L. microptera*) are most probably Mediterranean forms, not present in Central Europe. The pteromorphs of last two species are developed similarly to *L. longior*, however, the differences in number of areae porosae, shape of sensillus and prodorsal setae are present.

The species *Protoribates gratosus* VASILIU et CALUGAR (1973) is most likely also a species of the genus *Liebstadia* (but the lateral view is absent in the description, only the formulation "... et les poils interlamellaires fixés au milieu de la lamelle ..." is present in the description). If the species is in fact *Liebstadia*, the correct name should be *Liebstadia gratosia* (VASILIU et CALUGAR 1973) comb. nov. In this case the species stands near the new species *L. willmanni*. The differences are in the length of prodorsal setae, the shape of bothridium, the shape of sensillus, and general body length and form: the presence of only 9 notogastral setae (seta *lp* missing) seems to be improbable.

In conclusion, the following key could be used for the determination of Central-European species of *Liebstadia* (see also the table 1 with characters of studied species):

- 1 Body more or less elongated and flat, ratio length:dorsoventral thickness over 3.3:1. Three pairs of areae porosae developed usually, sensillus with short stalk and globular, globular-fusiform or fusiform head. Bothridial lamellae (*bl*, *bl'*) missing or indistinct in lateral view. Length 310 - 440 μm 3
- Body more robust, not flat, ratio length:dorsoventral thickness under 3.1:1. Four pairs of areae porosae present, sensillus with longer stalk and fusiform or lanceolate head. Two bothridial lamellae (*bl*, *bl'*) well developed, bothridium usually with posterolateral lobe or scale. Length 350 - 600 μm 2
- 2 (1) Pteromorphs well developed, bent downwards, in lateral view reaching the acetabular area. Body size 350 - 430 μm , sensillus usually fusiform, rarely lanceolate *Liebstadia pannonica* (WILLMANN, 1951)
- Pteromorphs developed as horizontal humeral blades, not bent downwards. Body size over 430 μm , sensillus lanceolate *Liebstadia similis* (MICHAEL, 1888)
- 3 (1) Pteromorphs well developed, bent downwards, in lateral view reaching or almost reaching the acetabular region. Sensillus fusiform or globular-fusiform in lateral view. Ventral surface microstriated, adanal area with distinct adanal ridge. Body size 352 - 439 μm *Liebstadia willmanni* sp. nov.
- Pteromorphs not bent downwards, slightly developed or absent. Sensillus with more-less globular head. Ventral surface without a clear microstriation. Body size 310 - 395 μm 4
- 4 (3) Pteromorphs developed as a small triangular tubercle in humeral area or nearly absent. Tarsus III with 12 setae, genu I with 2+1 setae. Length-width ratio 1.85 - 2.40 *Liebstadia humerata* SELLNICK, 1928
- Pteromorphs developed as distinct, rounded horizontal blades. Tarsus III with 15 setae, genu I with 3+1 setae. Length-width ratio 2.25 - 2.45, body extremely flat (length:dorsoventral thickness ratio over 4.5) *Liebstadia longior* (BERLESE, 1908)

	<i>similis</i>	<i>pannonica</i>	<i>willmanii</i>	<i>longior</i>	<i>humerata</i>
body form	robust, wide, arched	robust, moderately, arched	slender, flat	elongated, very flat	slender, flat
length (L)	500-600	350-430	352-439	325-395	310-380
width (W)	330-360	185-250	159-214	133-162	140-200
thickness (T)	ca 240	125-160	95-105	75-85	ca 90
L/W ratio	1,45-1,60	1,7-1,9	2,0-2,3	2,25-2,45	1,85-2,40
L/T ratio	about 2,2	about 2,7	about 3,6	about 4,9	about 4,0
length of <i>in</i>	80-90	45-56	30-50	30-40	ca40-50
length of <i>ng</i> setae	30-35	18-32	21-28	10-20	20-25
$h_3 - A_1/l_p - A_1$ ratio	0,2-0,3	1,1-2,6	2,5-7,5	about 3	about 2
pairs of areae porosae	4	4	3 (rarery 4)	3	3
pteromorphs	small, horizontal	well developed, bent downwards	well developed, bent downwards	horizontal blades	very small to absent
length of sensilus, form of sens. head	long, lanceolate	medium to long, clavate	medium, fusiform to subglobular	short, subglobular to globular	short, subglobular to globular
setae on targus I	19+2	18+2	18+2	18+2	18+2
setae on targus II	15	15	15	15	12
special characters		posterolateral scale on bothridium	microstriated ventrally		genu I with 2+1 setae only

Table 1: Characters of Central-European species of the genus *Liebstadia*.

Acknowledgements

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EXPLANATION OF THE PLATES

PLATE 1

Liebstadia willmanni sp. nov.

1. general, dorsal view.
2. sensillus and bothridial region, lateral view.
3. microstriation in the postgenital area.
4. notogaster in dorsolateral view (3 pairs of areae porosae).
5. sensillus.
6. prodorsum in lateral view.

Bars indicating 100 μm (1), 50 μm (4,6) and 10 μm (2,3,5).

PLATE 2

Liebstadia pannonica (WILLMANN, 1951)

1. prodorsum dorsolateral.
2. posterior part of notogaster with areae A2 and A3 (white arrows).
3. genital plates and postgenital area.
4. anal plates and adanal area.
5. sensillus and bothridium in lateral view.
6. sensillus and bothridium in dorsal view.
7. lamellar komplex in dorsolateral view.

Bars: 20 μm (1-4,6,7) and 10 μm (5).

