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Morphological analysis of *Provertex kuehnelti* MIHELČIČ, 1959 – an oribatid mite of rocky habitats (Acari: Oribatida: Scutoverticidae)

Günther Krisper & Reinhart Schuster

ABSTRACT

Contrib. Nat. Hist. 12: 795–812.

The redescription of *Provertex kuehnelti* MIHELČIČ, 1959 is based upon two specimens in slides of the collection of Mihelčič and specimens from many localities of Austria and from one locality in Switzerland. An intrageneric comparison shows, that *P. kuehnelti* is very close to *P. delamarei* TRAVÉ, 1962. After an examination of specimens of *P. nepalensis* PIFFL, 1971 (from the collection of Piffel), the latter appears to be a synthetic species, because there is every reason to assume that parts of specimens of two different species of the genera *Scutovertex* and *Hypovertex* have been mixed during the preparation. The taxonomic status of all the species of the genus *Provertex* is critically discussed.

Introduction

In 1959, Mihelčič described *Provertex kuehnelti* as new species and established the genus *Provertex*. His description was based only on one single specimen, and important morphological characters were neglected. Furthermore, the provenience of this material is not described, and he only mentioned in his introduction, that the specimens included in his paper were collected in Southern Carinthia and Eastern Tyrol; therefore it is still not clear where the locus typicus is situated. Some years later, Mihelčič (1963, 1964) published species lists which indicate, that the type might have been collected in Eastern Tyrol. Later, Mihelčič (1966) reports on findings of *P. kuehnelti* in Eastern Tyrol and Carinthia as well as outside of Austria (p. 91): "... auf dem Karst ... an zwei verschiedenen Stellen je zwei Exemplare ... zwischen Görz und Triest ...". Over the intervening years *P. kuehnelti* was collected in different areas of Austria and at one location in Switzerland (Schuster 1961, Schatz 1995, Krisper & Schuster 2001).

On the basis of our intensive sampling activity on saxicolous micro-arthropods we found several populations of *P. kuehnelti* with numerous individuals. Therefore we have enough specimens from different locations to study the intraspecific morphological variation in detail, to redescribe this species, and to compare it with the other members of this genus described by Travé (1962, 1964), Zlotin & Krivoluckij (1969), Piffl (1971), and Shtanchaeva & Netuzhilin (2003).

Material and Methods

Sampling and Material

Collection of animals from broken rock crevices was done with a fine paintbrush; rock pieces densely covered with lichens taken by hammer and chisel and small plugs of mosses were extracted in Berlese-funnels.

For the morphological investigations we used specimens from many different localities of Austria and one from Switzerland (records published in Krisper & Schuster 2001). Samples containing many individuals were used especially for the study of intraspecific variation; most of them collected in Styria (RS-1246 and RS-1314: Koralpe; RS-1519: Mur Valley between Graz and Bruck/Peggauer Wand; KR-242: Seetaler Alpen), and also one in Eastern Tyrol (KR-164: Venedigergruppe).

Additionally, we had at our disposal six samples containing specimens of "*Provertex nepalensis*" for comparison, by courtesy of E. Piffl (Vienna) before he passed away.

Microscopic Investigations

For investigation in transmitted light, the specimens were cleared in concentrated lactic acid in cavity slides. For detailed studies, some specimens were dissected and mounted on permanent slides with Swan-medium.

For SEM-studies specimens preserved in 70% ethanol were dehydrated in ascending ethanol concentrations, dried on air and sputtered with gold. SEM-micrographs were made at the Research Institute for Electron Microscopy, Technical University Graz with a Leitz AMR 1000.

Types and voucher specimens

The investigated and collected material (stored in ethanol or mounted on permanent slides) is deposited in the collection of the authors, and in the Naturhistorisches Museum Bern. We also intend to deposit some specimens stored in ethanol in the Naturhistorisches Museum Wien. Both slides of the collection Mihelčič were in bad condition; therefore the slides were opened and freshly embedded. These two slides will be deposited again in the Tiroler Landesmuseum Ferdinandeum, Innsbruck, where Mihelčič's collection is managed.

Results and Discussion

Redescription of *Provertex kuehnelti* MIHELČIČ, 1959

This redescription is based on the two permanent slides from the collection Mihelčič; these slides contain two specimens. One of them is labelled with "*Provertex kuehnelti* n. sp., *tipicus gen. novi*" (Figs. 1, 2, 3). Additionally, 50 specimens from Austria were studied in detail. Morphological terminology follows Hunt & al. 1998.

Body length: ♂ 423–480 µm, ♀ 451–529 µm. Body width: ♂ 219–270 µm, ♀ 237–292 µm (the differentiation of sexes was made based on the visibility of an ovipositor and/or eggs.)

Colour: In reflected light coffee-brown to grey-brown, yellowish-brown in transmitted light after clearing in lactic acid.

Integument: Body covered by a conspicuous secretion layer, showing a tuberculated structure on prodorsum, notogaster and on the antiaxial side of trochanters and femora. On the rostrum (observation in transmitted light) tubercles fuse to ridges or honey-comb-like structures which are probably caused by small cuticular elevations (Fig. 5a). Fine grained cerotegument covers acetabula and inner part of bothridia as well as all fissures which are caused by cuticular folds (border of genital and anal aperture), leg joints, paraxial side of legs, area of camerostome and subcapitulum, and circumgastric scissure between notogaster and ventral plate (Figs. 5b, c). Regarding some SEM-micrographs it seems as if the fine grained cerotegument extends below the less structured secretion layer (Fig. 5d).

Prodorsum (Figs. 4, 5e, f): Rostral setae robust, pectinate, and bent to median axis. Lamellae and translamella inconspicuous ribs, showing different

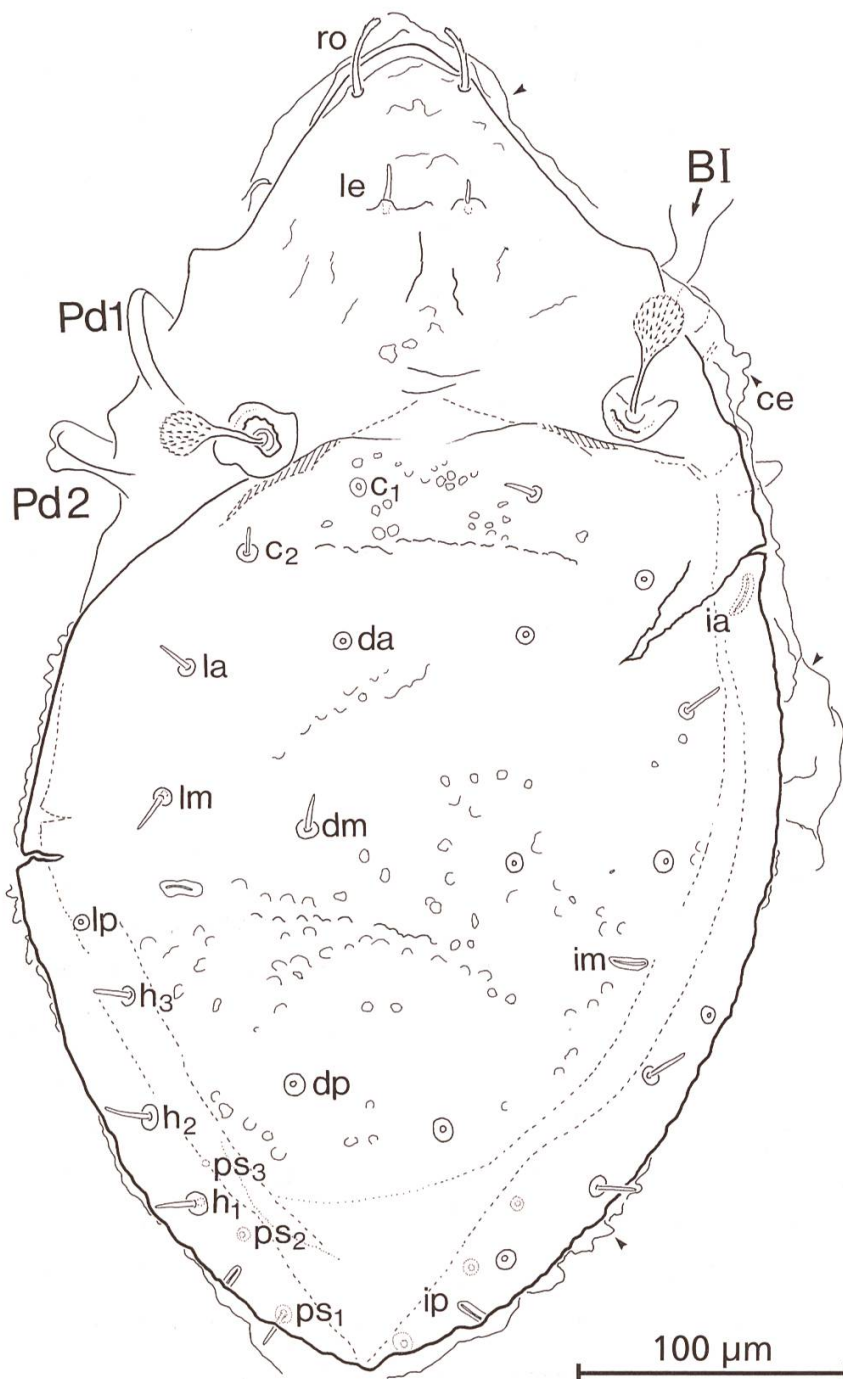
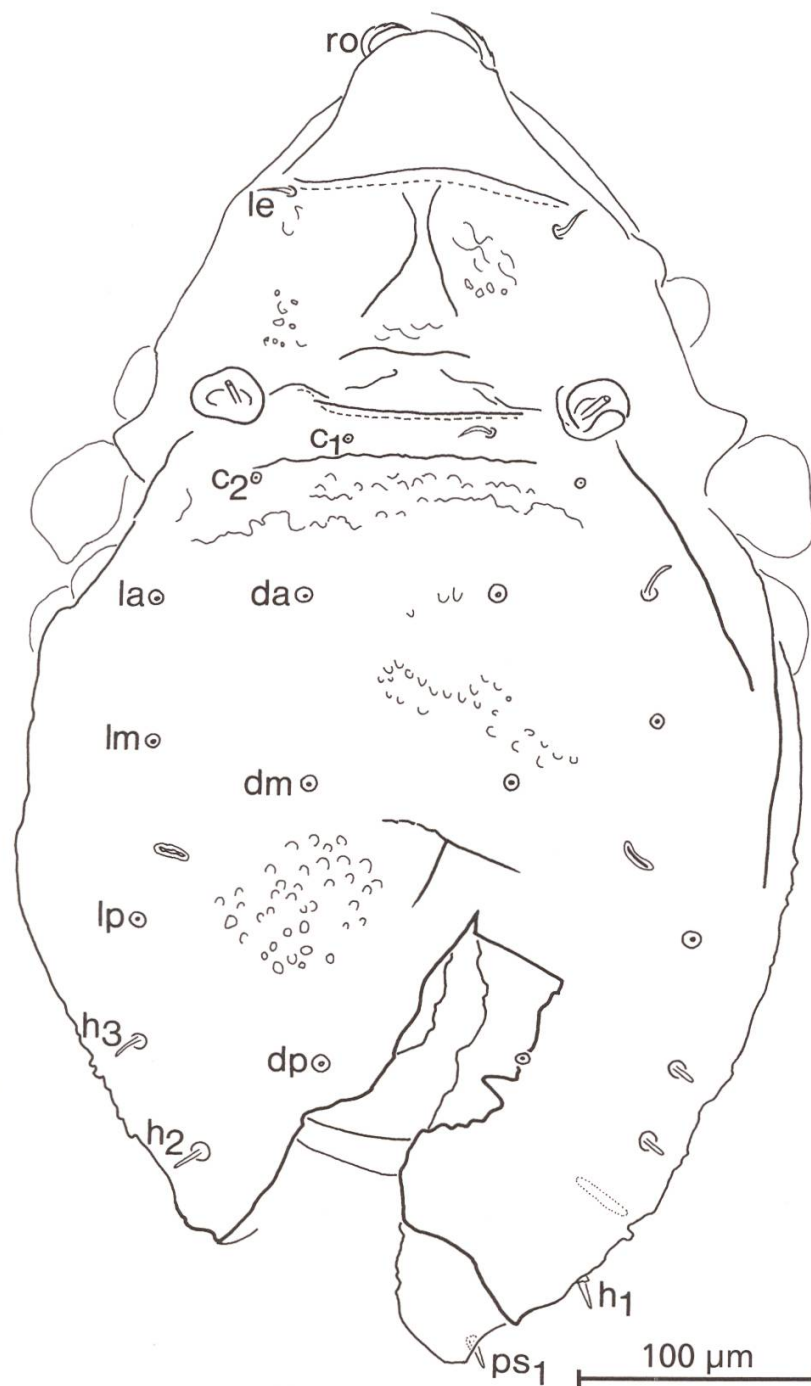


Fig. 1. *Provertex kuehnelti*. Slide of collection Mihelčič, labelled "St. Johann i. Walde"; dorsal aspect, specimen in the slide squashed, legs missing.

variants up to totally disappearing (Fig. 6). Short and slightly pectinate lamellar setae on end of lamellae. No cuspides. Between lamellae two ridges (*ci*) (sometimes not developed) converging to median axis from proximal end of lamellae. No interlamellar setae; only in one specimen (sample RS-1519) vestiges (Fig. 13c). Bothridia cup-like, slightly projecting, antiaxial border with slit (Figs. 5e, f). Sensillus short capitate and spinose (\varnothing 14–17 μ m). On posterior border of prodorsum a transverse ridge, posterior to it prodorsum seems to be close up in the central part, laterally (behind bothridia) clear dorsosejugal suture (Fig. 5e).

Notogaster (Figs. 4, 7): In foremost median part a shallow depression without secretion tubercles. On posterior border, between setae h_1 and ps_1 , dis-

Fig. 2. *Provertex kuehnelti*. Slide of collection Mihelčič, labelled "SJ2; tipicus gen. novi"; dorsal aspect, specimen in the slide squashed, legs missing, posterior area of notogaster cracked (burst).



tinct deepening. 14 pairs of notogastral setae (c_3 missing), short and robust; ps -setae near posterior border of notogaster. Insertions raised, each looks surrounded by a ring in transmitted light. Five pairs of lyrifissures, appearing relatively broad; ia extremely laterally in humeral region of notogaster; im dorsad of line of setae lm and lp ; ip in posterior part of notogaster between setae h_1 and ps_2 ; ips and ih on posterior lateral border of notogaster anterior to seta ps_3 . Orifice of lateral opistosomal gland ventral the line lyrifissure im and seta lp .

Camerostome and subcapitulum (Fig. 8a): Rostrophragma fused with anterior part of rostrum. Anterior border of mentum folded over therefore with bulging appearance; setae h robust. Genae with robust and pectinate setae

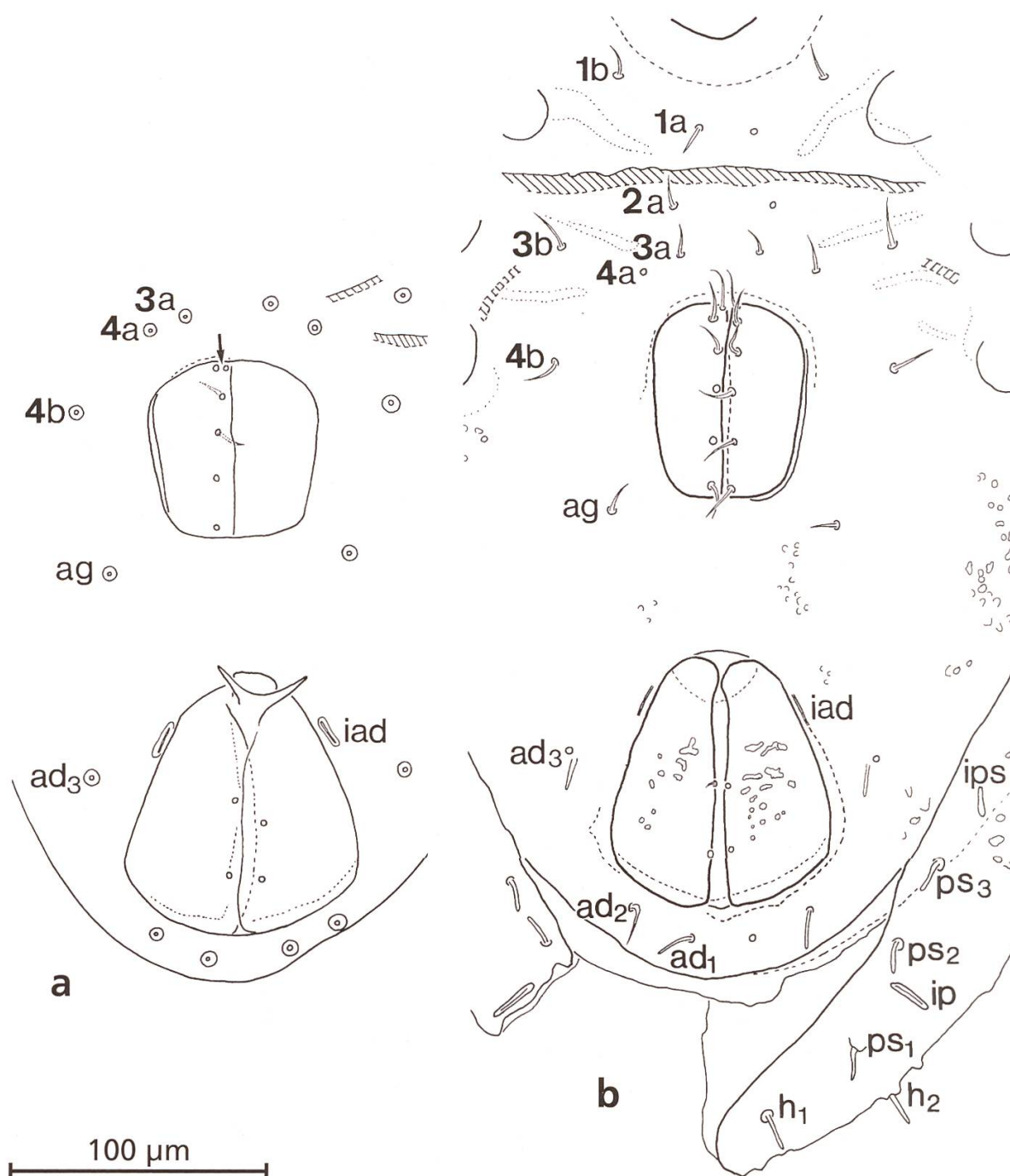
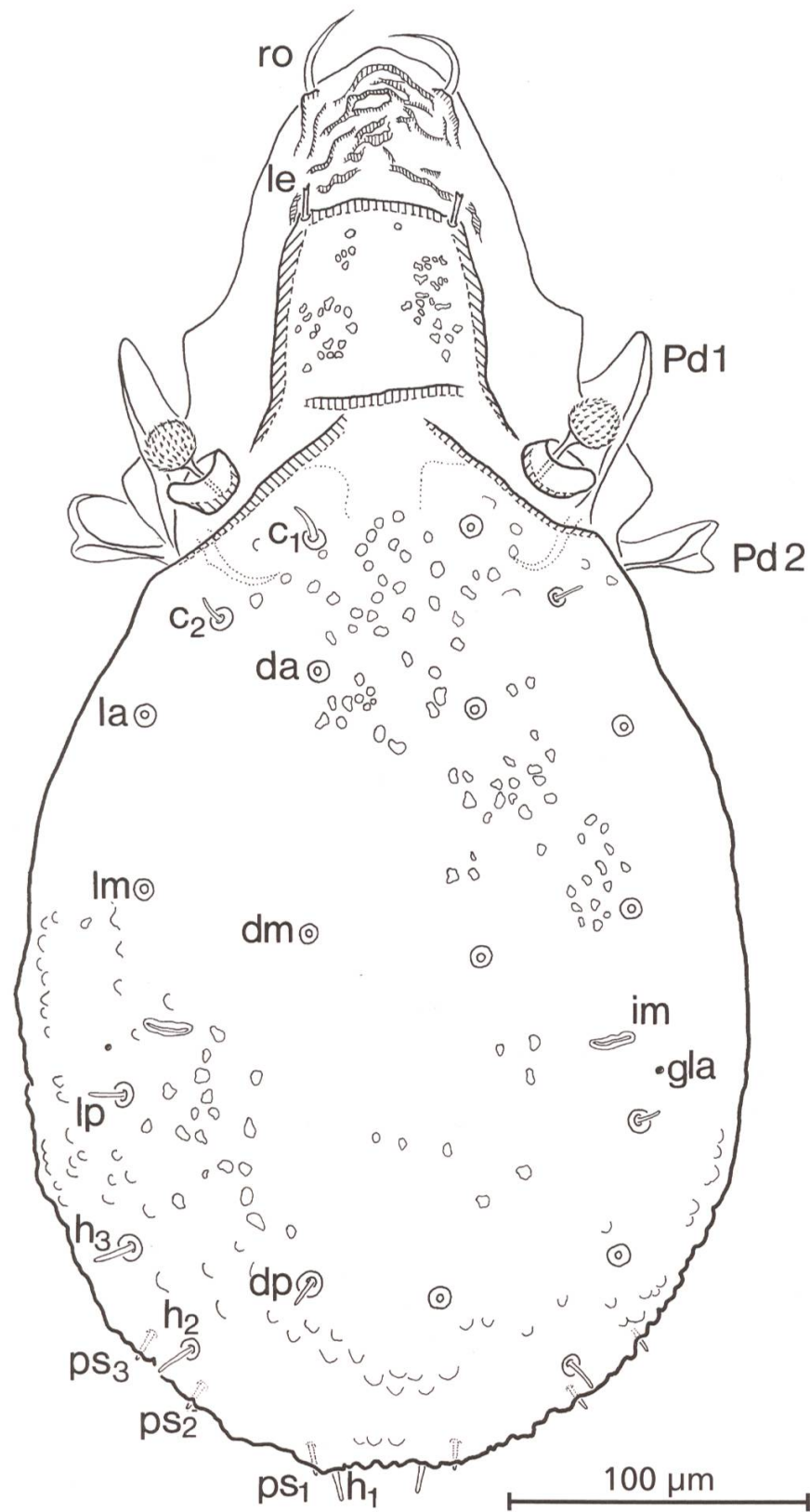


Fig. 3. *Provertex kuehnelti*. Slides of collection Mihelčič. Aspect from dorsal, through the body. – a: Slide labelled "St. Johann i. Walde"; ano-genital region, genital setae 1 and 2 side by side. – b: Slide labelled "SJ2"; genital setae 1 and 2 one behind the other.

a and *m*. Rutellum with two teeth, first tooth separated by a deep notch and therefore projecting like a blade; antiaxial manubrial fissure and manubrial porose area present. On interior side of rutellum broad rutellar brush (*bru*). Adoral setae (or_1 , or_2) long, slightly pectinate, their bases situated side by side. Axillary sacculus and 'epine' present at basis of palp.

Pedipalp (Fig. 9): Five segments, femur longest, tarsus second longest. Chaetome 0-2-1-3-9. Solenidion ω inserts in the proximal part of tarsus, its tip reaches seta *acm*.

Fig. 4. *Provertex kuehnelti*, ex RS-1246. Dorsal aspect, *gla* = orifice of latero-opisthosomal gland, c_1-ps_3 = notogastral setae (some of them broken), lamellar setae in this animal with two tips caused by the weak serration, serration of rostral setae not drawn.



Chelicerae: Setae *cha* and *chb* pectinate; each digit with four strong teeth, whereas the two foremost of each digit interlock. Trägårdh's Organ paraxial.

Epimeral region (Fig. 10): Epimeral setae 3-1-2-2. Apodeme I continuous; apodeme II, sejugal apodeme, and apodeme III short; no apodeme IV.

Anogenital region (Fig. 3, 8c, 10): Genital valves anteriorly broadened. Genital aperture of ♀: length 59–81 μm, width 54–69 μm; of ♂: length 57–71 μm,

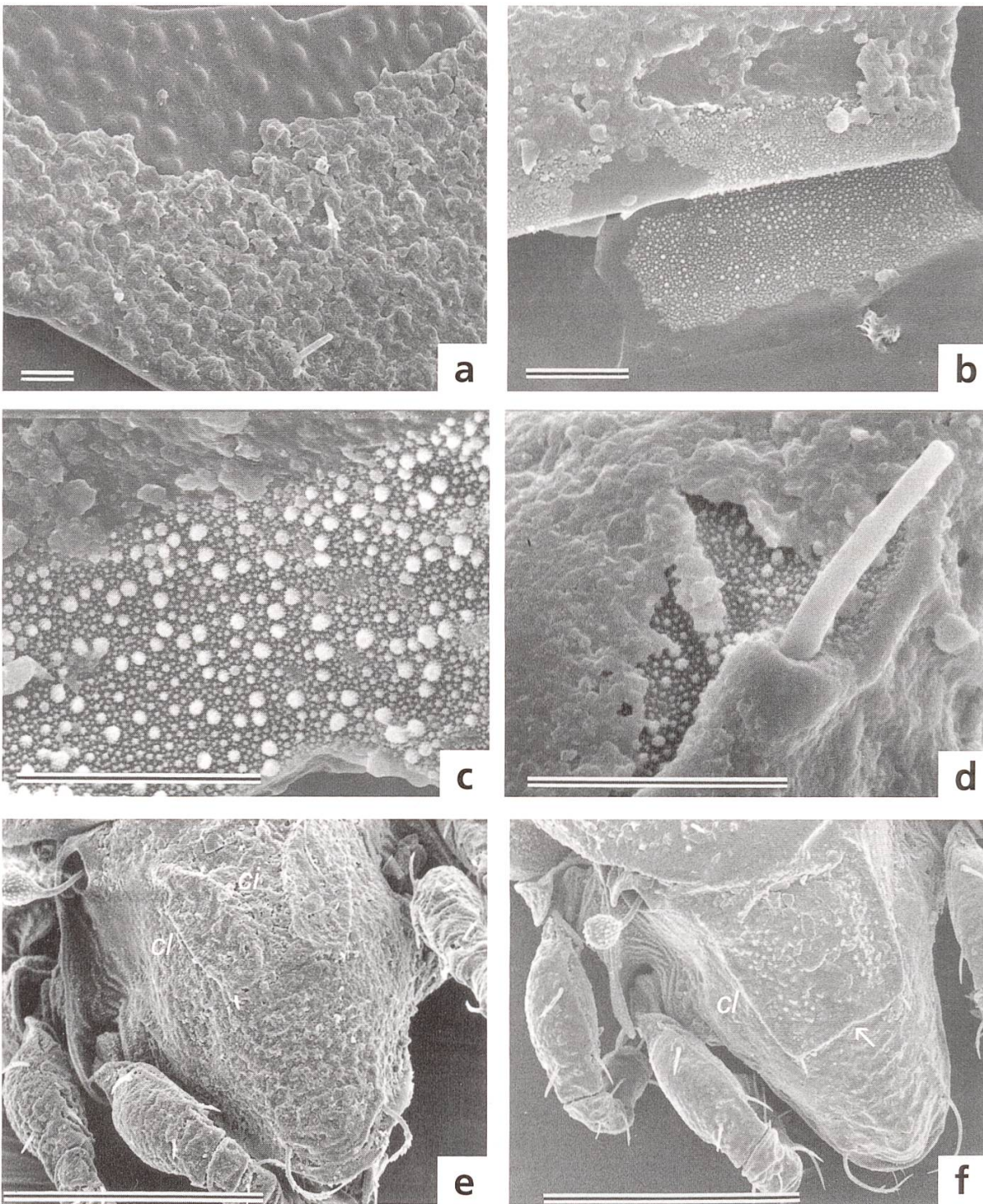
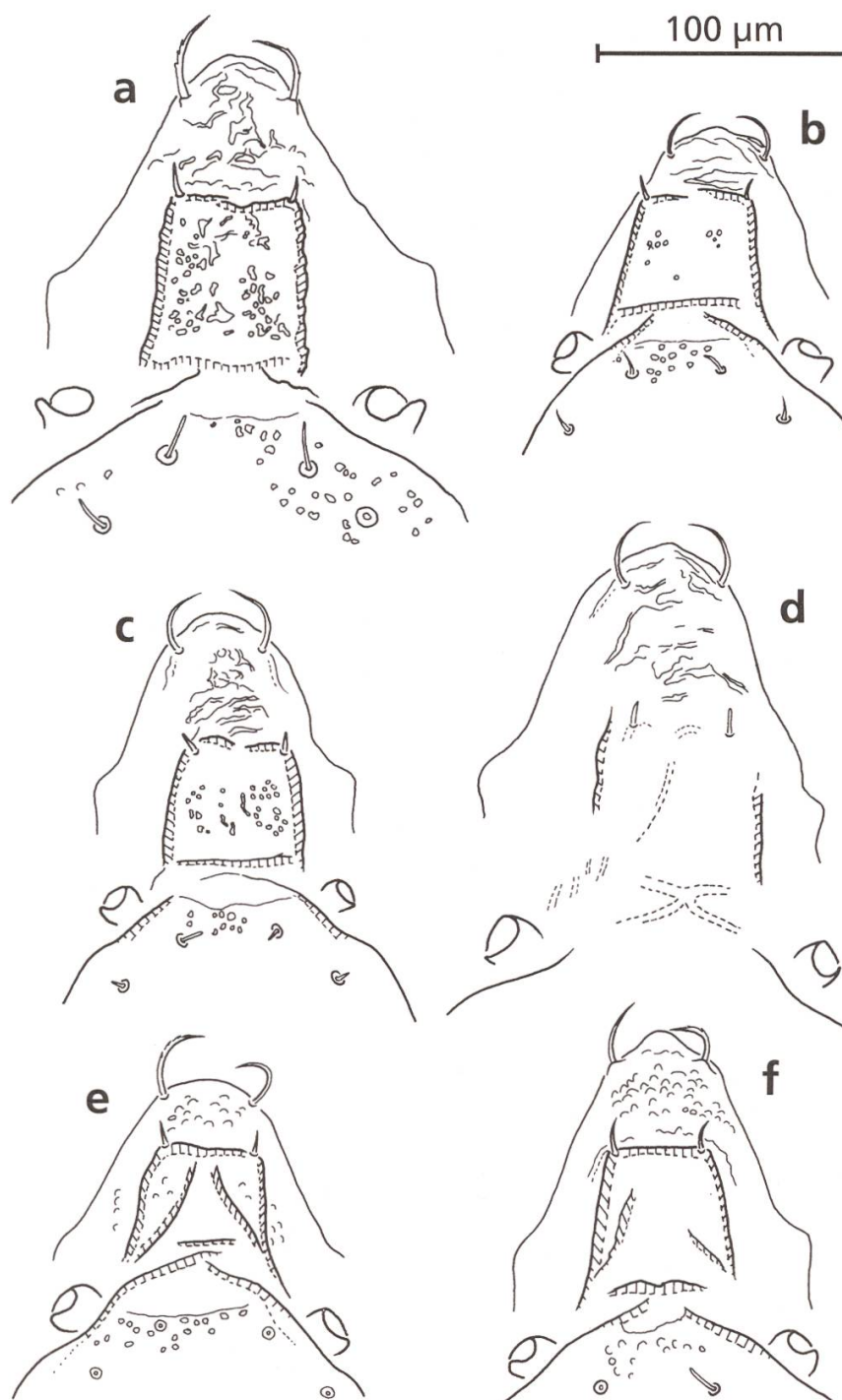


Fig. 5. *Provertex kuehneli*. – a: ex RS-1519; piece of notogaster covered in part by outer (amorphous) secretion layer (cerotegument?), part of cuticle free of cerotegument shows low tubercles; scale bar = 10 μ m. – b: ex RS-1314; posterior border of notogaster with secretion layer and circumgastric membrane covered by fine granulated cerotegument; scale bar = 10 μ m. – c: Border of notogaster, transition cerotegument – secretion layer; scale bar = 10 μ m. – d: ex RS-1314; right leg I, femur paraxial; distal end of the fissure like opening of platytrachea (on the bottom of the basis of the dorsal seta); cerotegument covered by outer secretion layer; scale bar = 10 μ m. – e: ex RS-1519; prodorsum in frontal aspect; *cl* = lamella, *ci* = median ridges; secretion layer forms on rostrum a polygonal pattern; scale bar = 100 μ m. – f: ex RS-1314; prodorsum in frontal aspect; *cl* and translamella (arrow) distinct; secretion layer less structured than in Plt. 1e; scale bar = 100 μ m.

Fig. 6. *Provertex kuehnelti*. Prodorsa of various specimens of different provenance showing differently formed lamellae, translamellae and prodorsal ridge ci as well as different transition between prodorsum and notogaster.

- a, b, c: ex RS-1246;
- d: ex KR-242;
- e: ex RS-1519;
- f: ex KR-164.



width 50–67 μm. Genital setae 6+6 (in one specimen of sample KR-255 5+5); first seta longer, often about twice as long as others, its position variable, either in line with others or displaced to a more medial position (differences on right and left valves of the same individual observed). Aggenital setae 1+1, lateral to genital aperture. Distance between genital- and anal aperture in ♀ 52–64 μm, in ♂ 38–57 μm. Anal valves broadened posteriorly; anal setae 2+2, located on paraxial border of valves. Lyrifissure *iad* lateral to anterior border of anal aperture. Adanal setae 3+3; *ad*₁ and *ad*₂ posterior, *ad*₃ lateral to anal aperture. In the area of setae *ad*₁ ventral plate forming a weak ventral projection. Preanal organ cup-like (Fig. 8d).

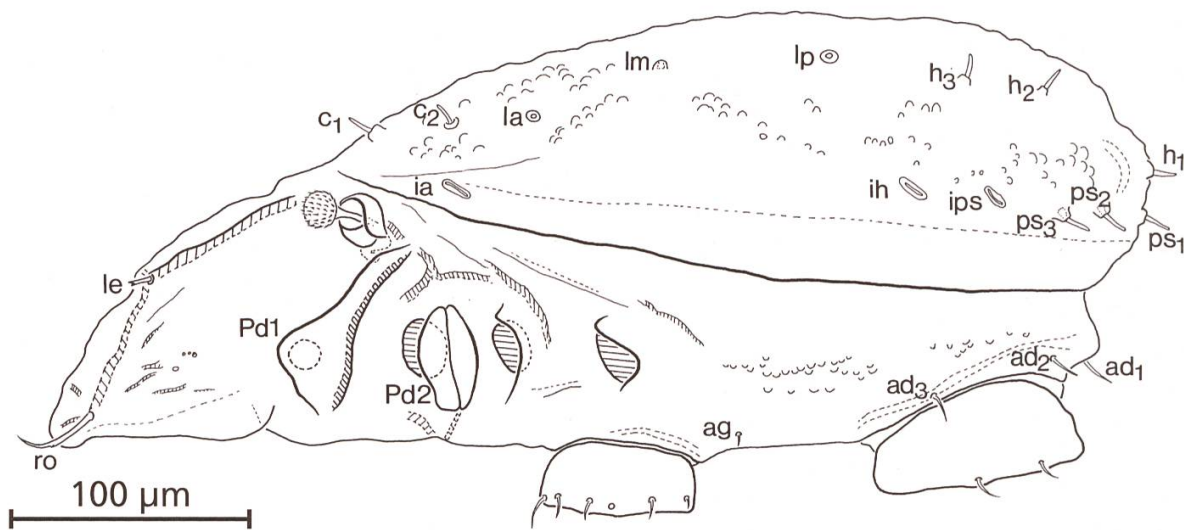


Fig. 7. *Provertex kuehnelti*, ex RS-1246. Lateral aspect; genital- and anal valves open, legs omitted, some setae broken.

Lateral region (Fig. 7): No exobothridial seta (in one individual of sample RS-1519 a vestigial seta; Fig. 13c). No tutorium. Pedotectum I, originating near bothridium broadening ventrally to a strong lamella. Pedotectum II projecting laterally, protecting the articulation between leg II and III and the body (see Fig. 8e). Posterior borders of acetabula III and IV projecting and protecting articulation between legs III and IV. Dorsal to acetabula II–IV, some irregular ribs and ridges; one ridge runs from bothridium to acetabulum II and splits into two branches dorsal to acetabulum II; a second ridge between acetabulum III and IV, a third one runs dorsal to acetabulum IV.

Legs: tridactyl; lateral claws thinner; all claws dorsally slightly dentate. All tarsi proximally with lyrifissure. Sacculi on ventral side of all tibiae, platytrocheae on dorsal-paraxial side of femora I and II (Fig. 8f) and sacculi on femora III and IV as well as on trochanters III and IV.

Leg I (Fig. 11a): Chaetome 1-4-3-4-18, spiniform setae: two on tarsus, one per tibia and genu. Solenidia 1-2-2; solenidium ϕ_1 of tibia inserting on distal process.

Leg II (Fig. 11b): Chaetome 1-4-3-4-15; spiniform setae: three on tarsus, one per tibia and genu inserting on bumps. Solenidia 1-1-2.

Leg III (Fig. 12a, 13b): Chaetome 2-2-1-3-15; spiniform setae: three on tarsus, one on tibia. Solenidia 1-1-0.

Leg IV (Fig. 12b, 13a): Chaetome 1-2-2-3-12; three spiniform setae on tarsus (in some individuals only two, because of variable size of seta *ft''*), two on tibia, sometimes all three setae very robust. Solenidia 0-1-0.

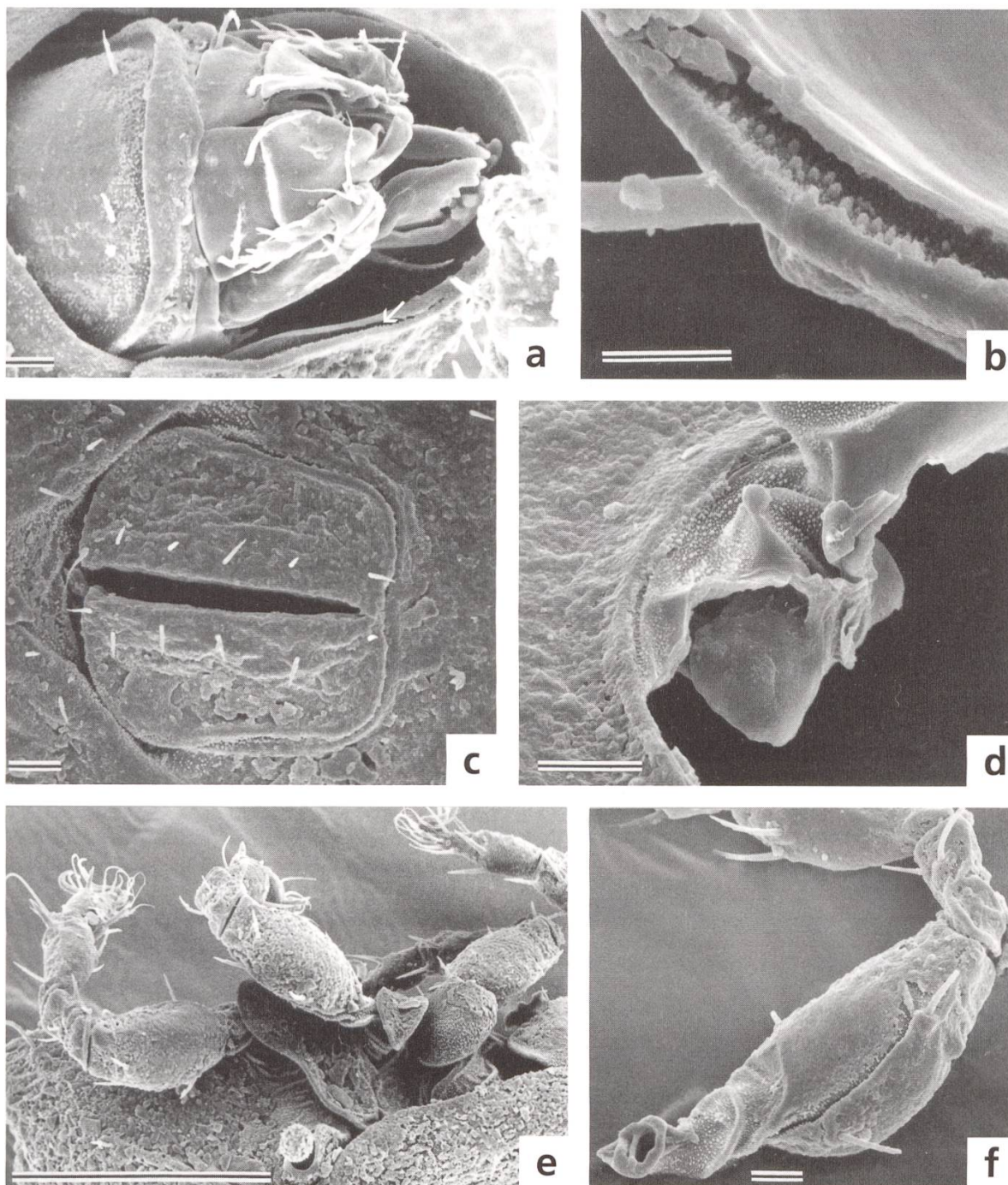


Fig. 8. *Provertex kuehneli*. – a: ex RS-1519; arrow points to cleft between rostrophragma and lateral border of rostrum. On subcapitulum anterior border of mentum folded over roll-like; scale bar = 10 μ m; – b: ex RS-1314; cleft between rostrophragma and border of rostrum coated with fine cerotegument; scale bar = 5 μ m; – c: ex RS-1314; anterior border of genital valves with fine granulated cerotegument; setae arranged one after the other (g_1 perspective shortened); Scale bar = 10 μ m; – d: ex RS-1314; anterior area of anal opening with preanal sclerite and anterior part of left anal valve; both of them covered by cerotegument; Scale bar = 10 μ m; – e: ex RS-1314; dorsolateral aspect of the right side of body with legs I-III and pedotectum I and II; scale bar = 100 μ m; – f: ex RS-1314; genu and femur of right leg I, paraxial; femur with slit like orifice of platytrachea; scale bar = 10 μ m.

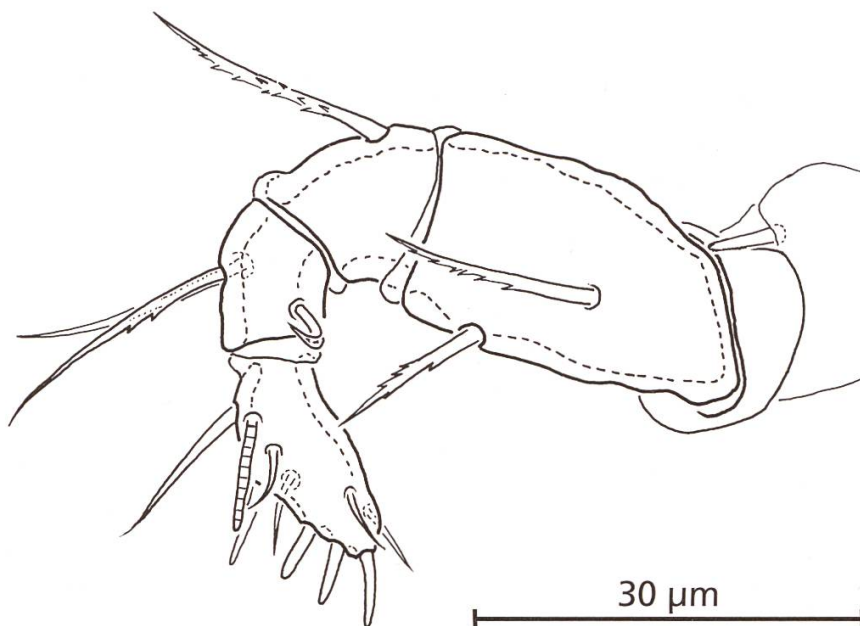


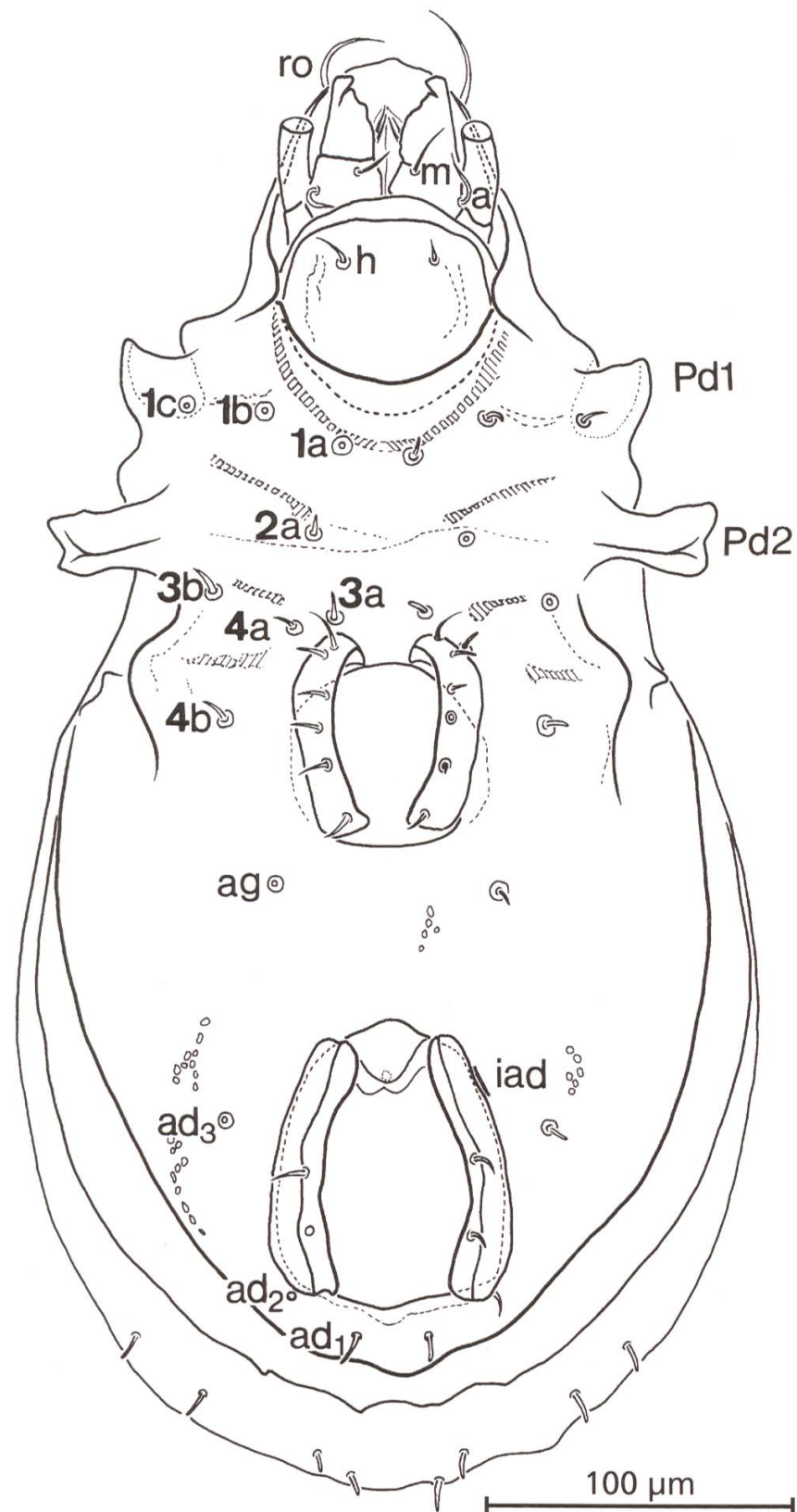
Fig. 9. *Provertex kuehnelti*, ex RS-1314. Left pedipalp, antiaxial; solenidium hatched. At the basis of palp 'epine' visible.

Critical Analysis of the First Description

Due to the incomplete description of *Provertex kuehnelti* by Mihelčič (1959) it was not possible for us to determine unequivocally those specimens of the genus *Provertex* collected. The examination of the two permanent slides from the collection of Mihelčič did not eliminate the doubts on the species determination. The two specimens in Mihelčič's permanent slides do not have any legs. Furthermore, some morphological details of the animals mounted on the slides were different from the description of Mihelčič! These concern the body length (too long), the number of notogastral setae (11), epimeral setae (2-1-2-2), genital setae (5+5) and the position of their first two pairs.

Schuster (1961) already refers to the existing epimeral seta 1c and to the six pairs of genital setae amongst other characters. Moreover, Mihelčič (1959: 367) reported on very short interlamellar setae in his annotation to the diagnosis of the genus *Provertex*. But such setae are not figured in his description and they are also not observable in his slides! Interestingly, we found one specimen in the sample RS-1519 which still shows vestiges of interlamellar and exobothridial setae. Possibly Mihelčič used more slides for his description and amongst those, there could have been one specimen with short interlamellar setae. Such highly variable characters are not reliable for the diagnosis of a genus!

Fig. 10. *Provertex kuehnelti*, ex RS-1246. Ventral aspect; genital- and anal valves open, legs omitted, some setae broken.

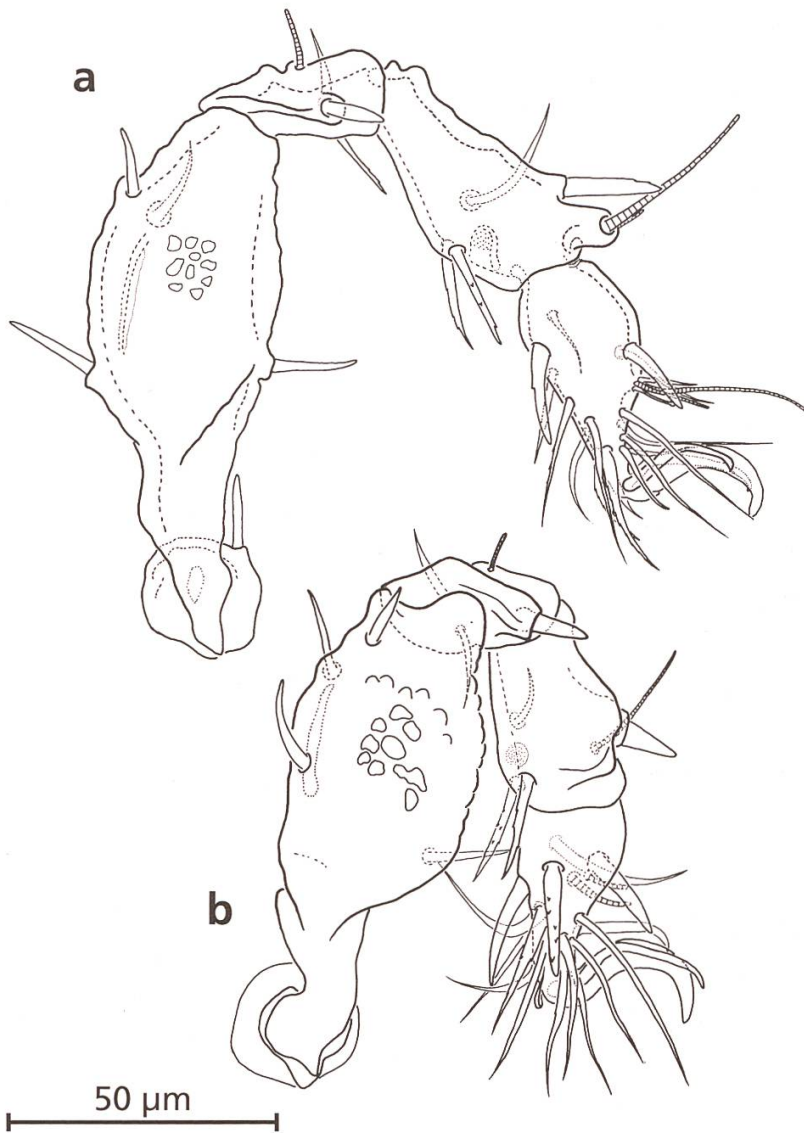


Species of the genus *Provertex* and evaluation of diagnostic characters

The intraspecific morphological variation seems to be higher in *Provertex kuehnelti* than in other species of the genus. Travé (1964) reports on different shapes of the translamella, different numbers of genital setae and the variable length of notogastral setae. Prodorsal characters as lamellae and median

Fig. 11. *Provertex kuehnelti*, ex RS-1314.

– a: right leg I, antiaxial;
– b: right leg II, antiaxial;
trochanteral seta
and tibial saccule
not drawn; solenidia
hatched.



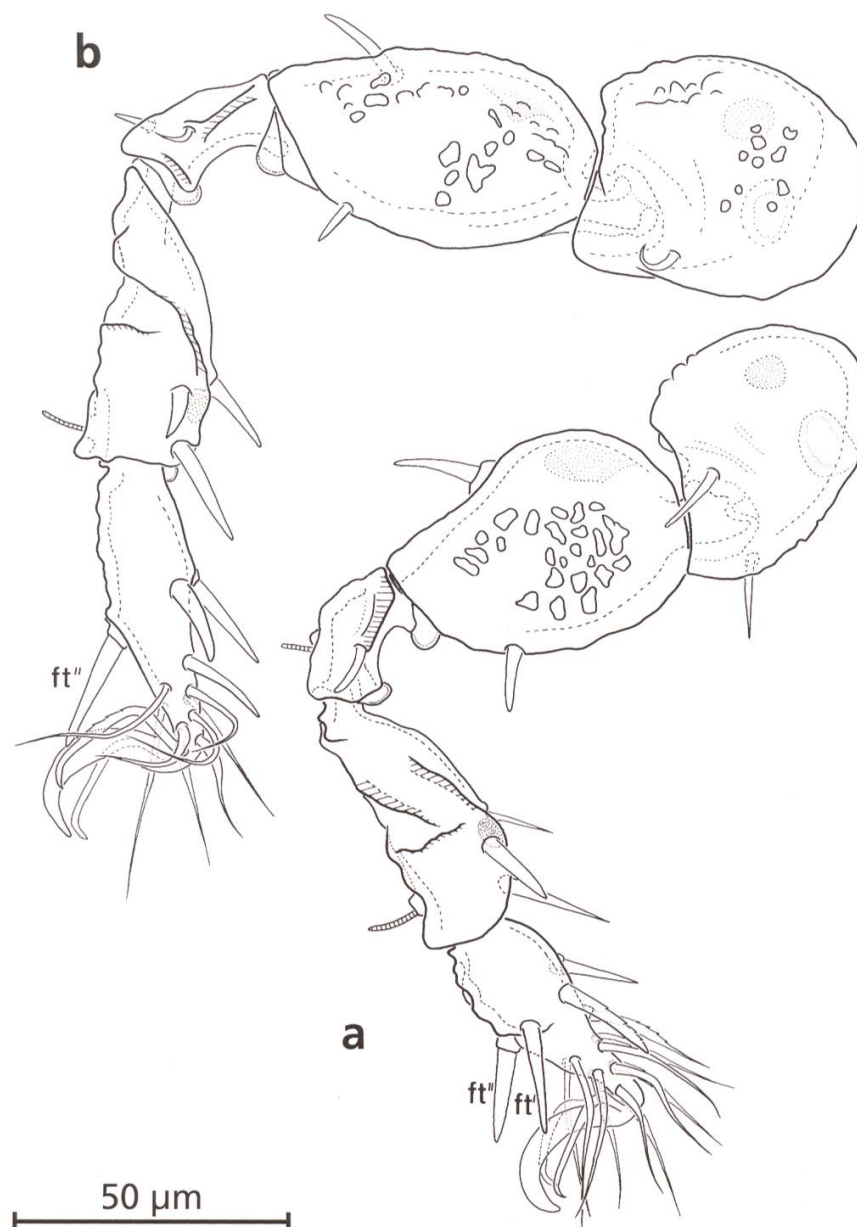
ridges which are always clearly developed in *P. delamarei* (Travé 1962, 1964) should serve to distinguish between *P. kuehnelti* and *P. delamarei*. These structures are highly variable in *P. kuehnelti*; therefore, the application of these morphological features for differentiation might be difficult. Nevertheless, the combination of more weakly developed prodorsal structures with a first genital seta clearly longer than the others in *P. kuehnelti* allows separating this species from *P. delamarei*.

Distinct differences between the two species mentioned above and *P. mailloli* TRAVÉ, 1964 exist in the smaller body size of *P. kuehnelti* and *P. delamarei*, and the presence of cuspides in *P. mailloli*. The diagnostic value of the number of spiniform setae on the tarsi for the discrimination of *P. delamarei* and *P. mailloli* is highly limited by the variation of these characters in *P. kuehnelti*.

The fourth known species – *P. forsslundi* KRIVOLUCKIJ, 1969 – is well characterized by its clavate sensillus, by the long lamellar setae and by the slender anterior part of the notogaster (Krivoluckij himself is responsible for the

Fig. 12. *Provertex kuehnelti*, ex RS-1314.

– a: right leg III, antiaxial;
– b: right leg IV, antiaxial.



description of species in the paper of Zlotin & Krivoluckij (1969), therefore only his name is mentioned in the species name!).

Provertex nepalensis PIFFL, 1971 is very different. The author himself characterised this species (1971, p. 36) as: "Mittelgrosse Oribatide vom Aussehen eines *Scutovertex* mit ...". The comparison of specimens of the collection Piffel to his description on the one hand and to the descriptions of species of the genus *Scutovertex* and *Hypovertex* on the other hand leads to the conclusion that *P. nepalensis* represents a synthetic taxon, erroneously generated by the description of a mixture of dissected parts of two different species! The following details support this conclusion:

1) The number of notogastral setae reaches from 10, 11 (*Scutovertex*) up to 13, 14 pairs (*Hypovertex*, *Provertex*). The examined individuals with 10 pairs of notogastral setae show tracheae in their legs and belong therefore to *Scutovertex*!

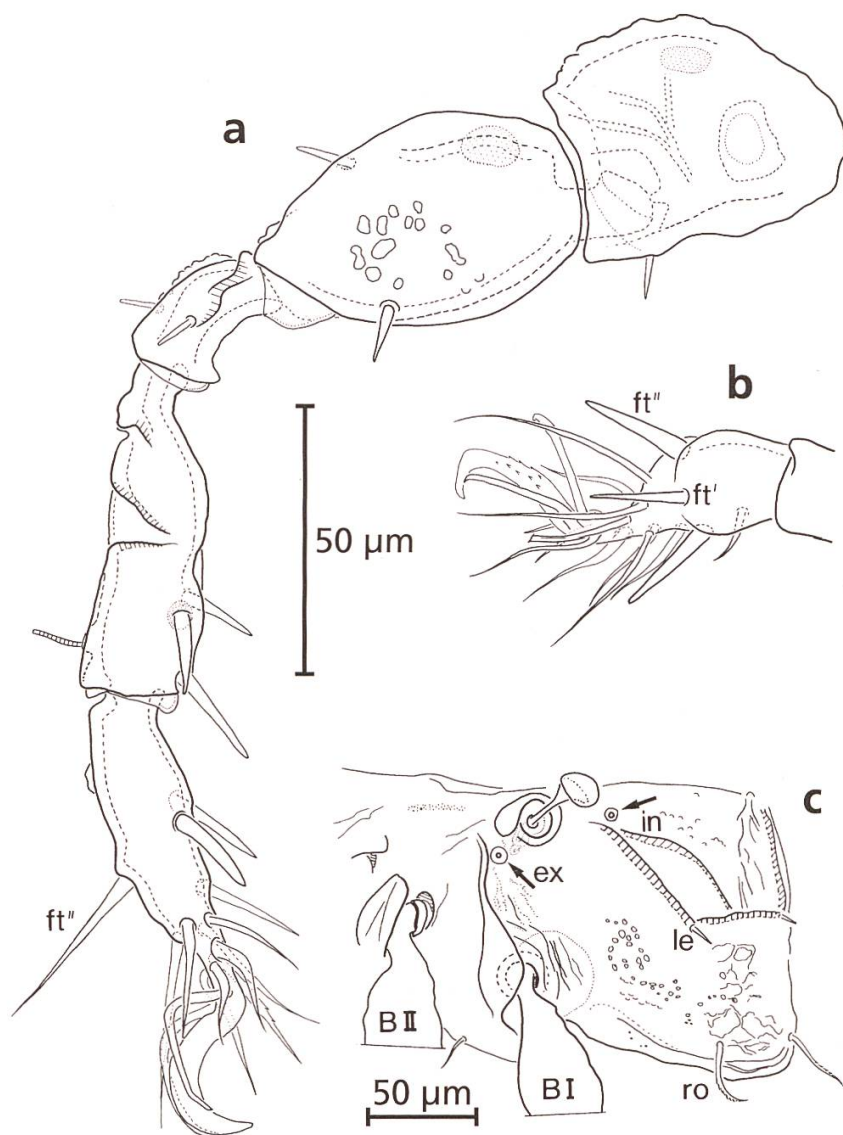


Fig. 13. *Provertex kuehnelti*, ex RS-1519.

– a: right leg IV, anti-axial; seta *ft''* of tarsus thick but not spiniform;
 – b: right leg III, dorso-lateral aspect of tarsus; seta *ft'* thinner as in RS-1314 (Fig. 12a);
 – c: laterofrontal aspect of proterosoma with vestigial interlamellar- and exobothridial setae.

2) Specimens with 13 or 14 pairs of notogastral setae are characterised by a rostrum with two lobe-like projections, a mentum with a transverse ridge, and 12 setae on tarsus III (*Hypoververtex*?).

3) Piffel's description is probably based only on slides which contained dissected animals. Therefore, he published no figure of a whole specimen of *P. nepalensis*, and there is no information on body size or other measurements in his paper!

Drawings of the habitus of specimens with 10 and 14 pairs of notogastral setae during the preparation of his paper would have prevented his error.

Additionally, his discussion is based on incorrect data, e.g. 11 pairs of notogastral setae in *P. kuehnelti* – at this time already clarified (14) by Travé (1962). Due to this fact Piffel's conclusions are invalid concerning the classification of *Scutovertex contiguus* and *S. africanus* within the genus *Provertex* (*S. africanus* was classified as *Hypoververtex* by Sitnikova in 1980). Consequently the membership of the newly described species *P. travei* and *P. cendsureni* by Shtanchaeva & Netuzhilin (2003) in the genus *Provertex* is more than

questionable because the classification of their species refers to the diagnosis of Piffel.

Once more it became clear in the course of this investigation that the classification of genera and species of Scutoverticidae suffers from fragmentary datasets. For most species no information exists about characters of appendages, intraspecific variation, etc. We agree with Bernini (1976) who suggests that only a detailed revision of the family Scutoverticidae will solve the systematic problems in a satisfactory manner. Therefore, the present redescription should be seen in this context and it forms a part of a current investigation on the systematics and evolutionary history of European Scutoverticidae.

Acknowledgements

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