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Utopioniscus kuehni n. gen., n. sp. (Isopoda: Oniscidea: Synocheta) from submarine caves in Sardinia

Helmut Schmalfuss

Abstract

Utopioniscus kuehni, a new genus and species of the taxon Synocheta (Isopoda, Oniscidea) is described from submarine caves of Sardinia. The species is considered to be the most primitive representative of the "Trichoniscidae sensu stricto" and the first member of the Synocheta still living primarily in a marine littoral environment. However, its ancestor must have gone through a phase in which it lived outside the water in the supralittoral.
Keywords: Isopoda, Oniscidea, Synocheta, new genus, new species, submarine caves, Sardinia.

Zusammenfassung

Utopioniscus kuehni, eine neue Gattung und Art des Taxons Synocheta (Isopoda, Oniscidea) wird aus submarinen Höhlen von Sardinien beschrieben. Die Art wird als der primitivste Vertreter der "Trichoniscidae sensu stricto" betrachtet und ist das bisher einzige Mitglied der Synocheta, das primär noch in einem marinen Littoralbiotop lebt. Der Vorfahr muss allerdings außerhalb des Wassers im Supralittoral gelebt haben.

Contents

1 Introduction

In July 2002 a group of German cave divers investigated submarine caves at the east coast of Sardinia. In one of these caves (Grotta della Utopia) an isopod specimen was found 2 km from the entrance and 30 meters below sea level. This female animal proved to be a member of the sub-order Oniscidea ("terrestrial isopods") and a clos-

er investigation revealed it to represent a new genus and species of the Synocheta (Trichoniscidae etc.). In July 2003 the same speleologists continued their investigations of the eastern Sardinian caves and returned with three more specimens from the Grotta della Utopia and a neighbouring cave, and in summer 2004 a further specimen was secured. Two of the new specimens were males, so now it is possible to give a complete diagnose and description of the new genus and species.

Genera and species mentioned in the text are given without author and year, because no misinterpretation of their identity is possible. More details on these taxa can be found in my world catalog of terrestrial isopods (SCHMALFUSS 2003) and in the catalog of terrestrial isopod genera by SCHMIDT & LEISTIKOW (2004).

All material is stored at the Staatliches Museum für Naturkunde Stuttgart/Germany (SMNS, with numbers of isopod-collection).

Acknowledgements

I wish to thank the cave divers Dr. JÜRGEN BOHNERT, HERBERT JANTSCHKE, MICHAEL KÜHN, Mag. ANKE OERTEL and Dr. MARKUS SCHAFHEUTLE for providing the described material, information on the biotope and live photographs of the described species, JOHANNES REIBNITZ for preparing the diagram (Fig. 34) and editing the SEM-photographs and Dr. KARIN WOLF-SCHWENNINGER for operating the SEM.

2 *Utopioniscus* n. gen.

With the diagnostic characters of the taxon Synocheta (key characters: genital papillae fused and genital ducts inside fused papilla united at least in the distal part to a single tube). Eyes lacking. Antennal flagellum in adults with more than 20 segments. Pleopod-exopodites II–V with long terminal seta. Male pleopod-endopodite I elongated, with an individualized strong spiny seta in the apical part. Male pleopod-endopodite II with elongated proximal segment, which is longer than the shortened apical segment. The structure of this appendage resembles very much the situation in the genus *Alpioniscus*, compare figures in BUTUROVIĆ (1958: 15) and ERHARD (1997: 46).

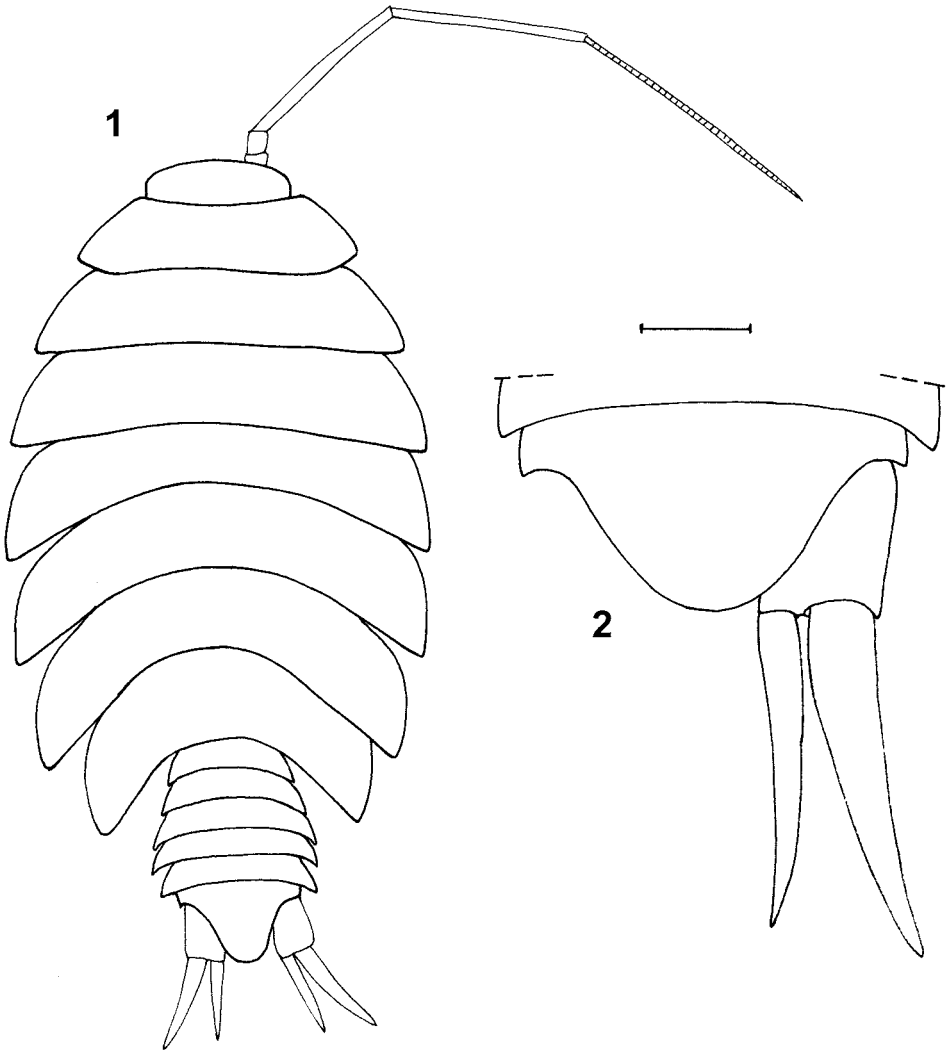
3 *Utopioniscus kuehni* n. sp.

Holotype: ♀ without marsupium, 10.2 × 5.5 mm, Sardinia, east coast, submarine cave Grotta della Utopia, 2000 m from entrance, 30 m below sea level, leg. M. KÜHN, July 2002 (SMNS T566).

Paratypes: ♂, 12.0 × 6.5 mm, same cave as holotype, 1900 m from entrance, 30–40 m below sea level, leg. M. SCHAFHEUTLE, 6 July 2003 (SMNS T567). – ♀ without marsupium, 10.2 × 6.0 mm, same cave as holotype, 1900 m from entrance, 20 m below sea level, leg. M. SCHAFHEUTLE, 6 July 2003 (SMNS T568). – ♂, 10.0 × 5.2 mm, Sardinia, east coast, Golfo di Orosei, near Cala Sisine, Grotta del Bel Torrente, 700 m from entrance, 16 m below sea level, leg. A. OERTEL, 7 July 2003 (SMNS T569). – ♀ without marsupium, 9.3 × 4.8 mm, locality as before, leg. A. OERTEL, 22 July 2004 (SMNS T570).

Description (complete animal see Fig. 1)

The animals are whitish transparent, the cuticle is thin and flexible and seems to be only very weakly calcified. The cuticle of the dorsal parts is equipped with very



Figs. 1–2. *Utopioniscus kuehni* n. sp., paratype ♂, 10 mm long, Grotta del Bel Torrente (SMNS T569). – **1**. Dorsal view of whole animal, drawn after a video film by J. BOHNERT. **2**. Dorsal view of telson and uropods in situ. – Scale: 0.5 mm.

small hair-like setae. No traces of a water-conducting system have been found on the ventral parts and on the hind legs (compare HOESE 1981).

Maximum dimensions: 12.0 × 6.5 mm.

Head (Fig. 3): with moderately developed side-lobes; eyes completely lacking; a frontal ridge which could correspond to the interocular line of other Oniscidea (e. g. *Ligia*, compare SCHMALFUSS 1974: 15, fig. 11) is missing; a supra-antennal line is present and bent downwards between the antennal sockets; the margin of the labrum is laterally and medially equipped with rows of hairy setae.

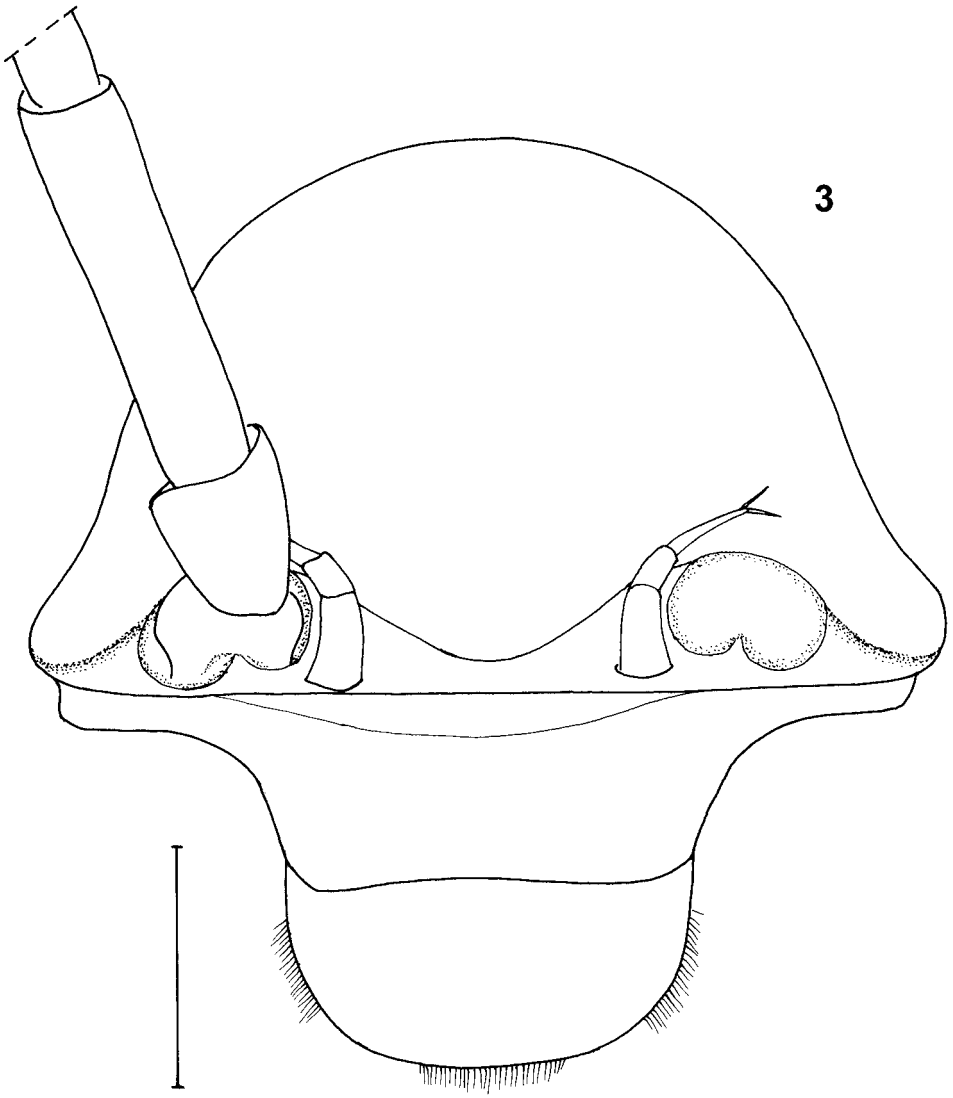


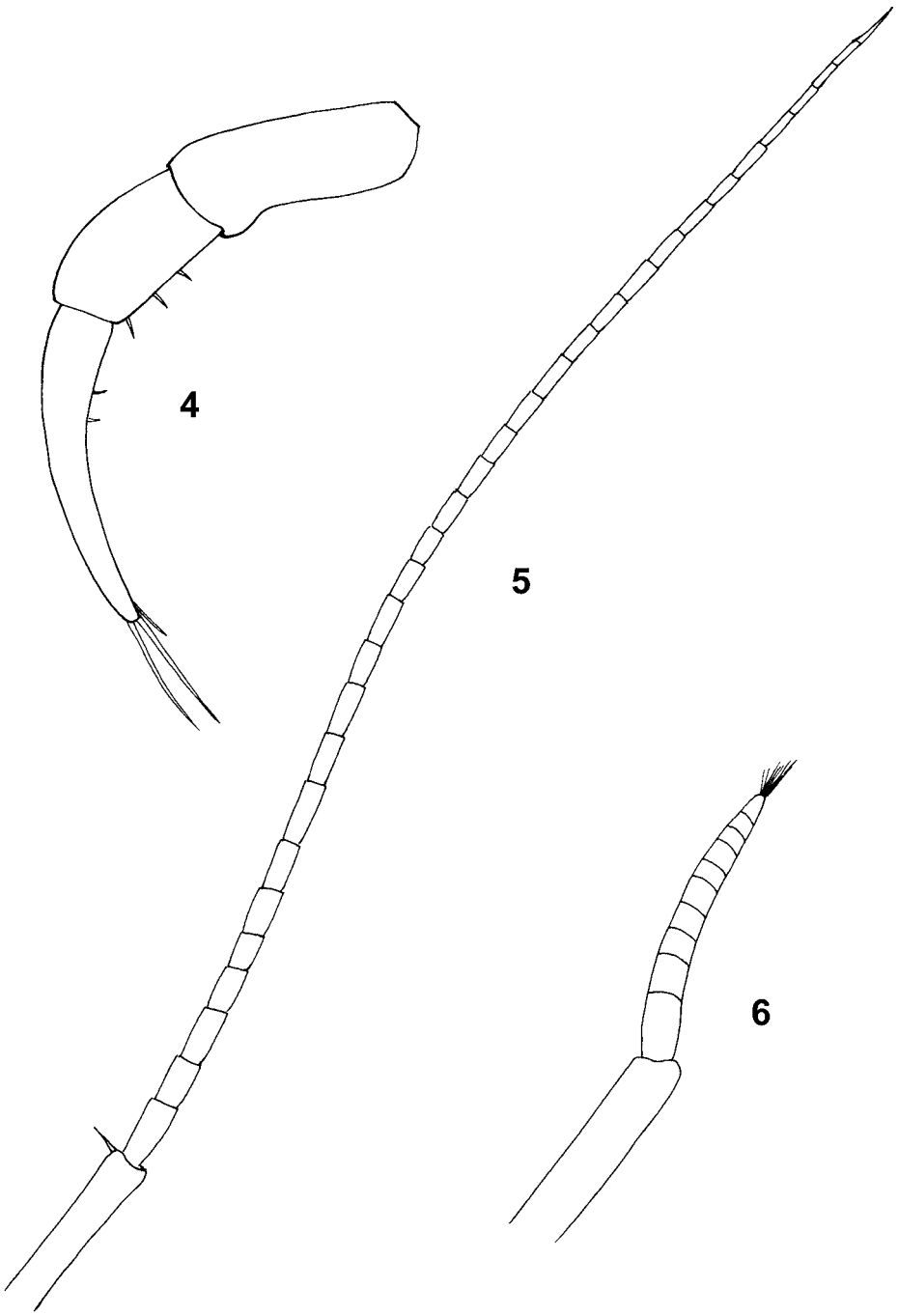
Fig. 3. *Utopioniscus kuehni* n. sp., holotype ♀, 10 mm long, Grotta della Utopia (SMNS T566), head in frontal view. – Scale: 0.5 mm.

Pereion (Fig. 1): epimeron I with slightly convex hind margin and rounded hind corner, epimera II–VII with angled hind corners, posteriorly very pointed.

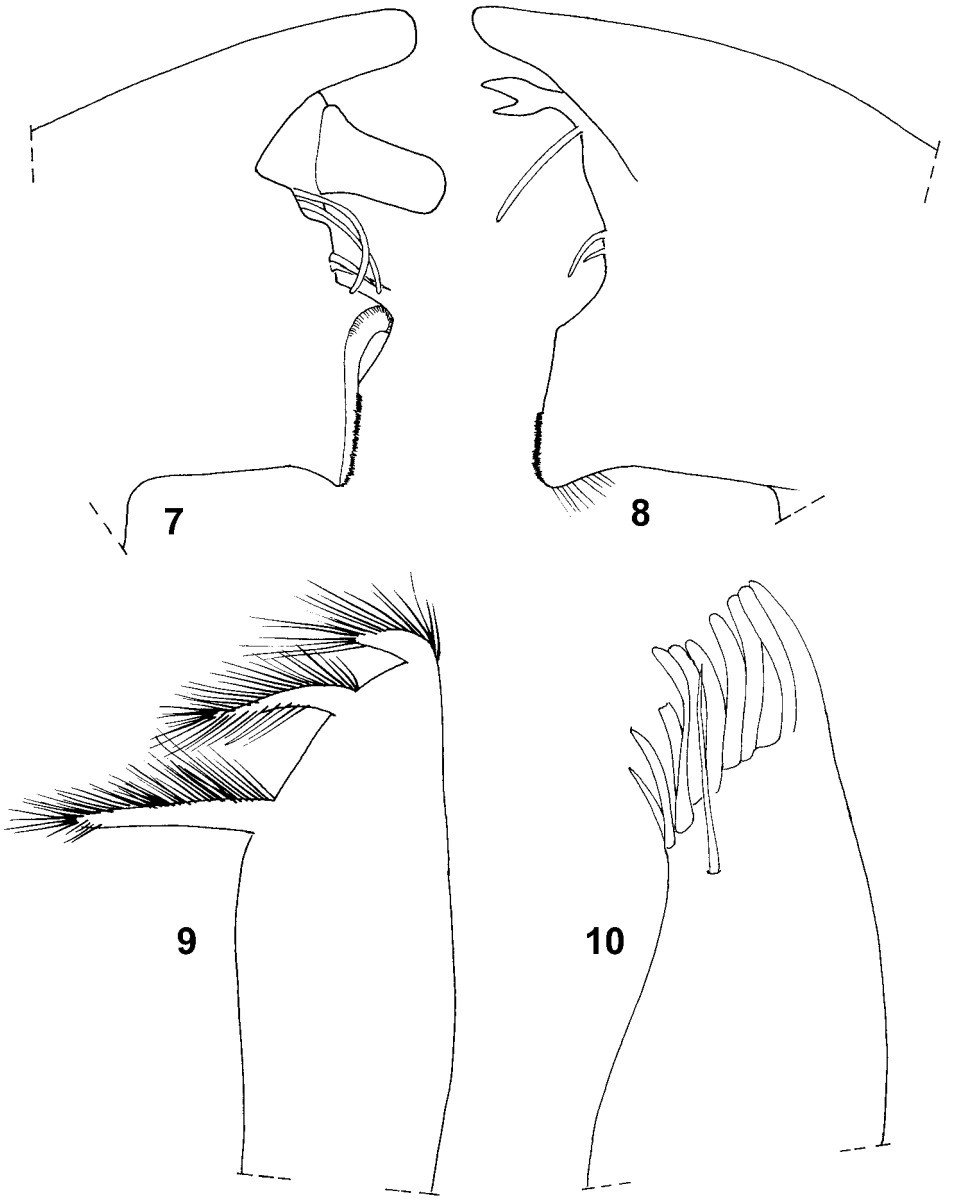
Pleon (Fig. 1): tergites I–II with small pointed epimera, tergites III–V with larger acutely pointed epimera.

Telson (Fig. 2): with concave sides and broadly rounded apex.

Antennula (antenna I, Fig. 4): with three articles, the second one being the shortest, the first (basal) one slightly longer and the third (apical) one about twice as long as the second and much narrower; the third article bears apically two long aes-



Figs. 4–6. Antennal flagellum and antennula. – **4–5**. *Utopioniscus kuehni* n. sp., holotype ♀. **4**. Antennula. **5**. Flagellum of antenna. – **6**. *Cantabroniscus primitivus*, flagellum of antenna, after VANDEL (1965b: 492).



Figs. 7–10. *Utopioniscus kuehni* n. sp., paratype ♀, 10 mm long, Grotta della Utopia (SMNS T568). – **7.** Apical part of left mandible. **8.** Apical part of right mandible. **9.** Endite of maxilla I. **10.** Exite of maxilla I.

thetascs and subapically a shorter seta which could be an aesthetasc or "only" a tactile seta.

Antenna (antenna II, Figs. 1, 3, 5): extremely long, in situ reaching the telson; the peduncle consists of two basal quadrangular articles and three long apical articles, the second of these being more than twice as long, and the third one more than three

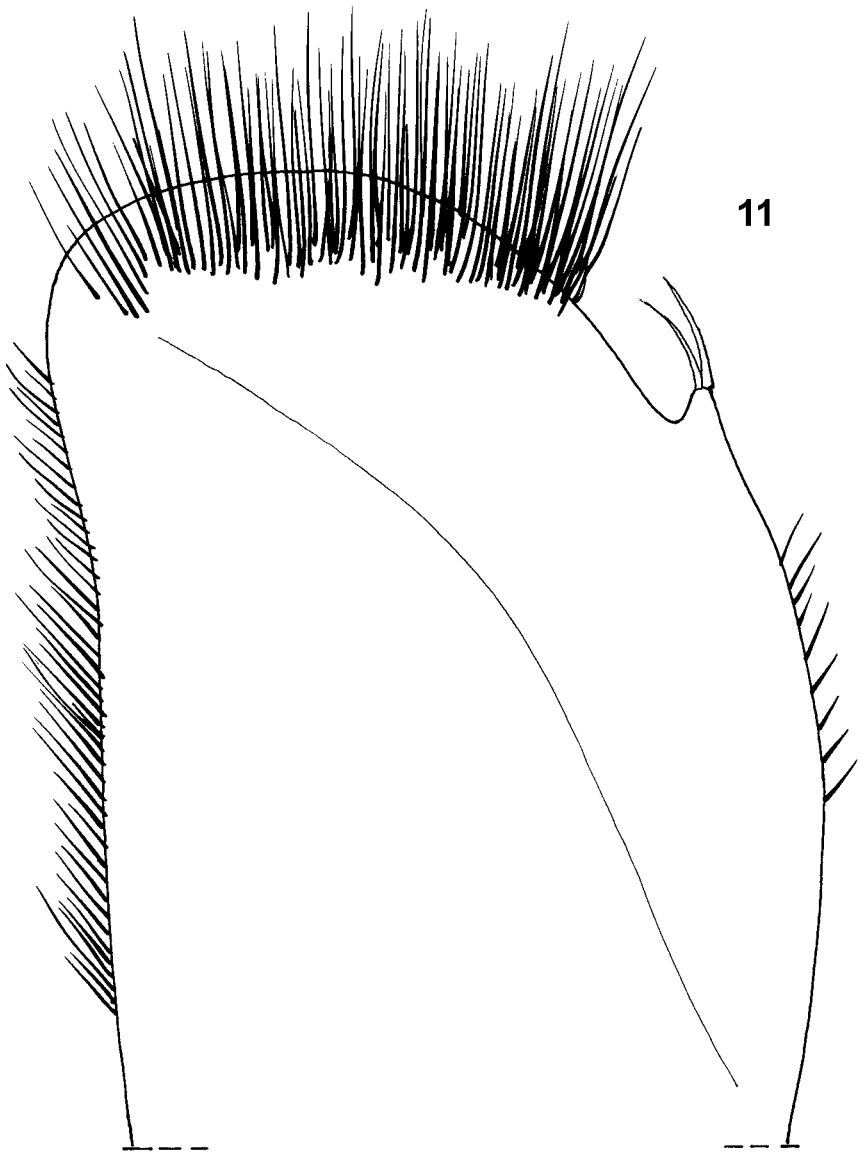


Fig. 11. *Utopioniscus kuehni* n. sp., paratype ♀, 10 mm long, Grotta della Utopia (SMNS T568), maxilla II.

times as long as the first one; the flagellum has around 30 articles. For comparison, the antennal flagellum of *Cantabroniscus primitivus* is shown in Fig. 6.

Mandible (Figs. 7, 8): left mandible with one blunt big exterior tooth, a big blunt lacinia mobilis of the same size accompanied by two long setae; before well developed pars molaris two shorter pointed setae, pars molaris surrounded by a row of small tooth-like structures and without ventral "beard" of setae; right mandible with one blunt exterior tooth as in left mandible, lacinia mobilis a fork-like structure with

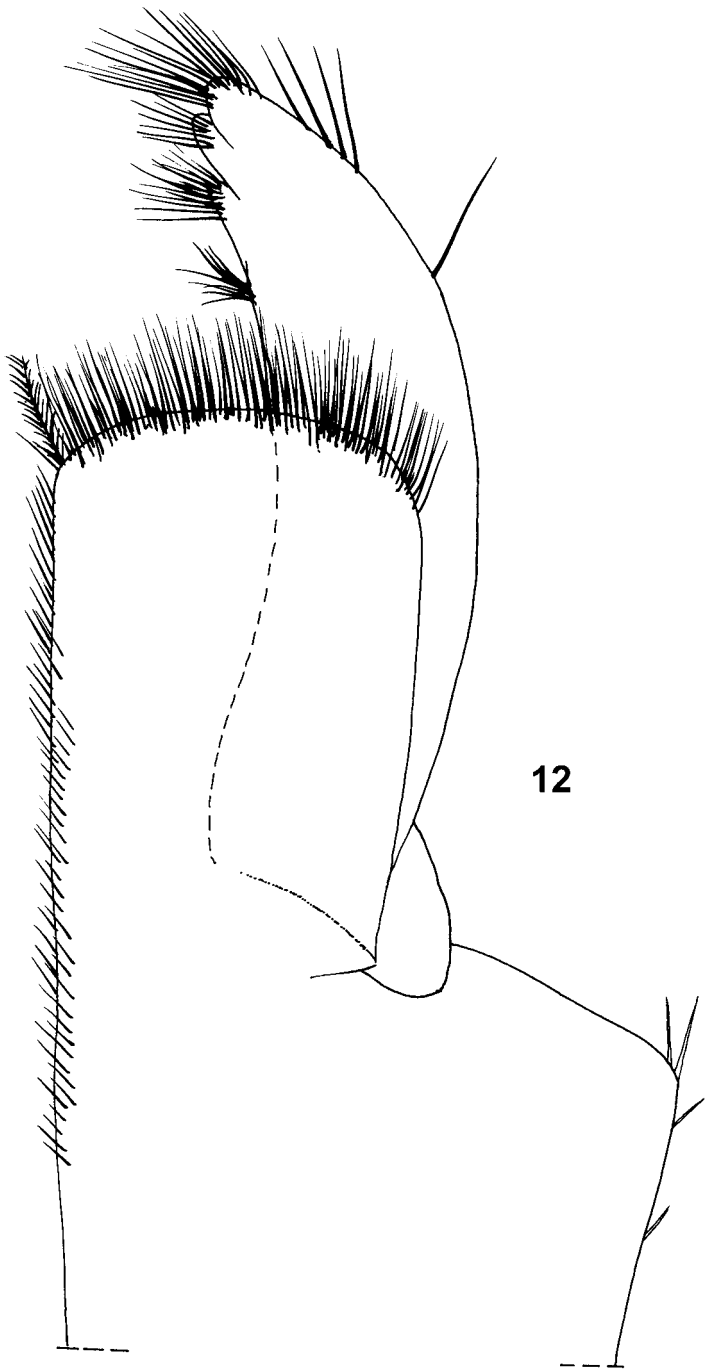
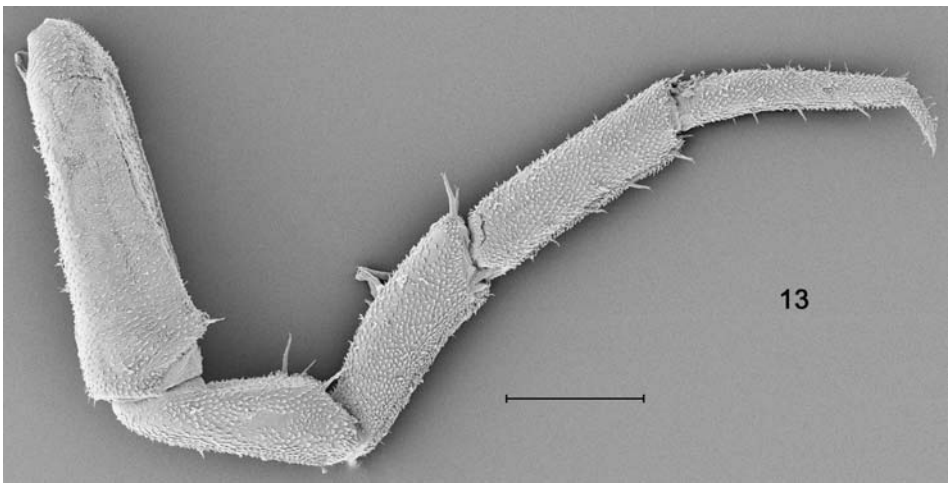
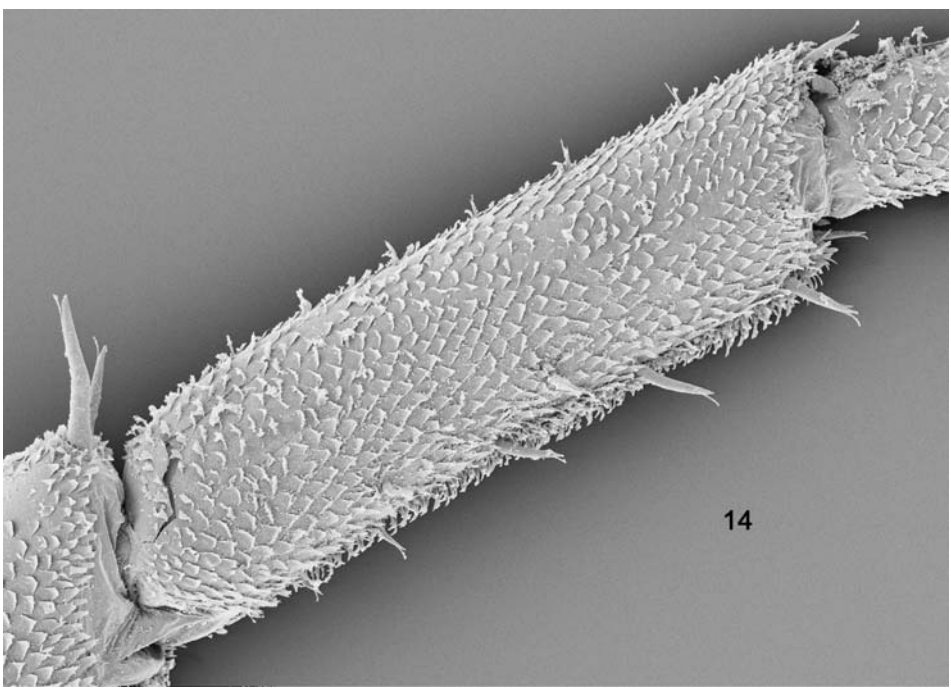


Fig. 12. *Utopioniscus kuehni* n. sp., paratype ♀, 10 mm long, Grotta della Utopia (SMNS T568), maxilliped.

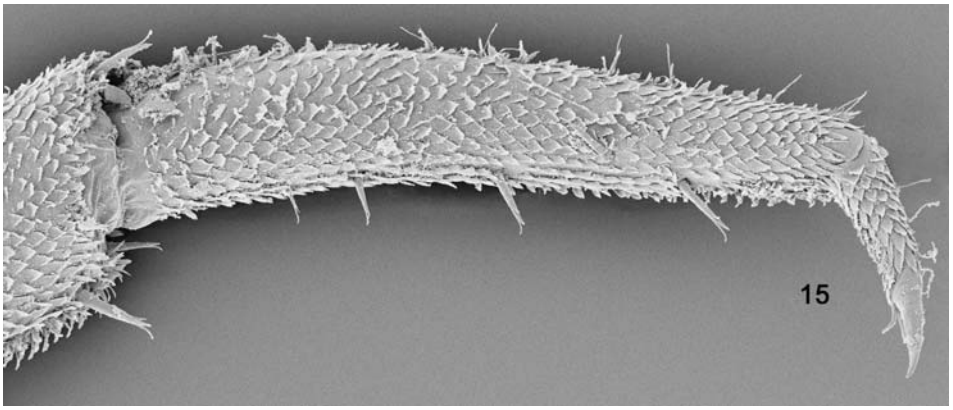


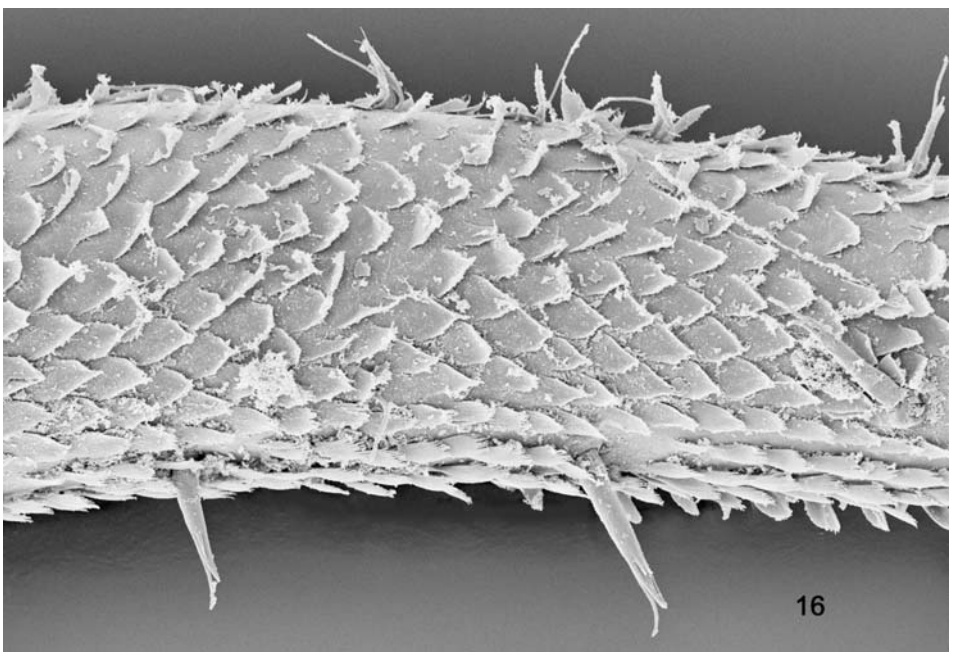


Figs. 13–14. *Utopioniscus kuehni* n. sp., paratype ♂, 12 mm long, Grotta della Utopia (SMNS T567), SEM-photographs after critical point treatment. – **13**. Pereiopod I. **14**. Carpus of pereiopod I. – Scale: 0.5 mm.

two pointed apices, accompanied by one long seta; next to pars molaris two shorter pointed setae of different length; pars molaris surrounded by tooth-like structures and with ventral "beard" of setae.

Maxilla I (Figs. 9, 10): exite with 11 simple teeth and one subapical seta which is longer than the teeth, endite with the usual three plumose penicils.

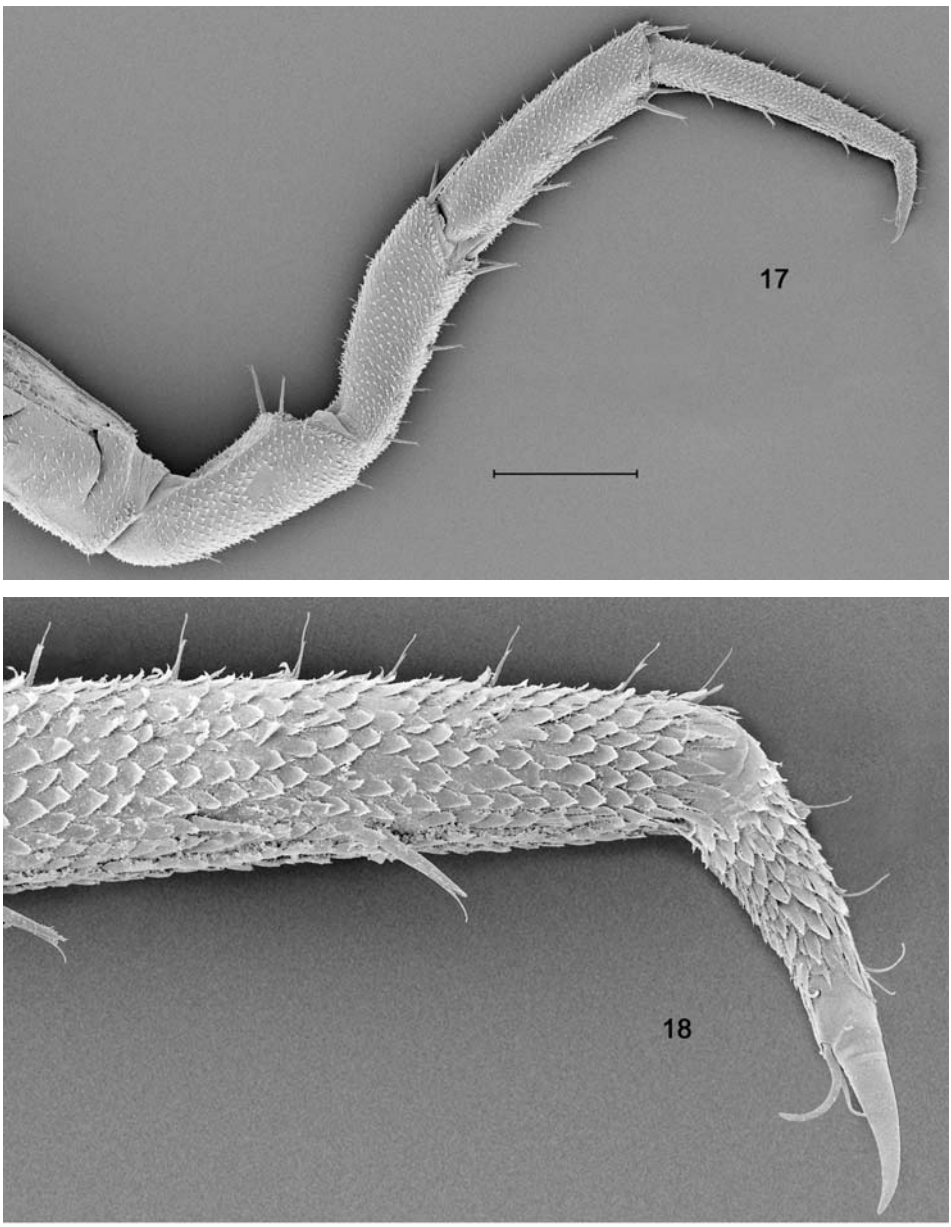




Figs. 15–16. *Utopioniscus kuehni* n. sp., paratype ♂, 12 mm long, Grotta della Utopia (SMNS T567), SEM-photographs after critical point treatment. – **15**. Propodus and dactylus of pereiopod I. **16**. Detail of propodus I.

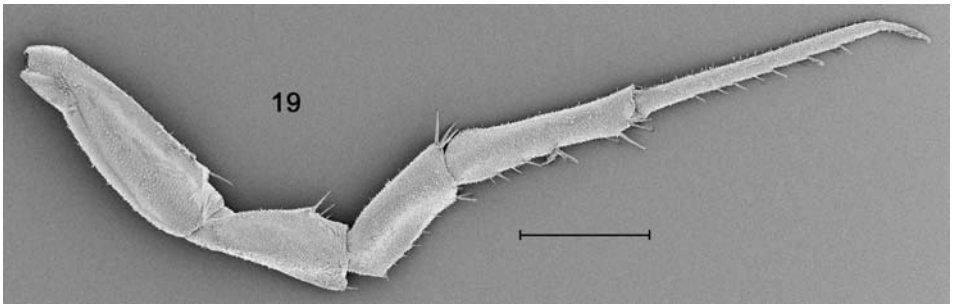
Maxilla II (Fig. 11): distally uniformly rounded, apically with brush of long hairs, medially with a row of setae, laterally with a small process (remnant of an exite) equipped with two spiny setae.

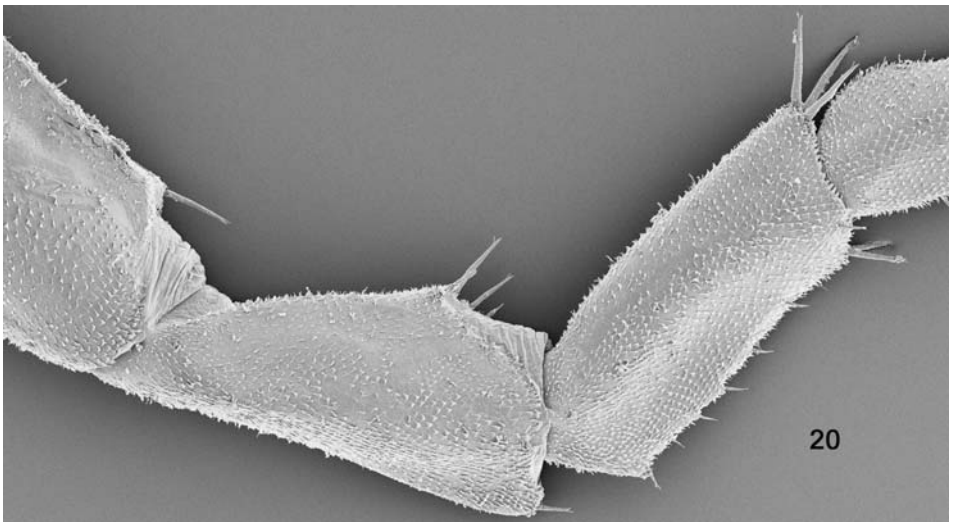
Maxilliped (Fig. 12): endopodite narrow and bent in medial direction, apically with setae and the rudimentary tips of three segments which are otherwise completely fused; endite quadrangular with apical setal brush and a plumose penicil in the medial corner.

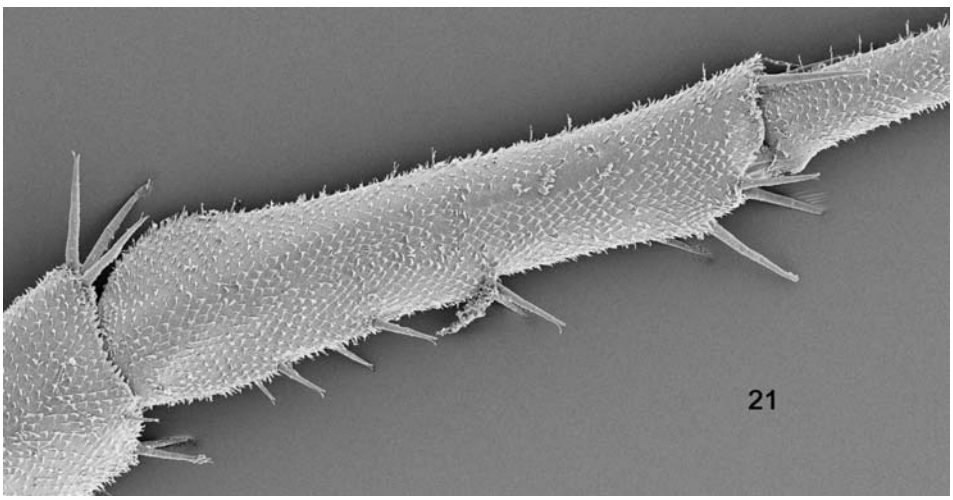


Figs. 17–18. *Utopioniscus kuehni* n. sp., holotype ♀, SEM-photographs after critical point treatment. – **17**. Pereiopod I. **18**. Apical part of pereiopod I. – Scale: 0.5 mm.

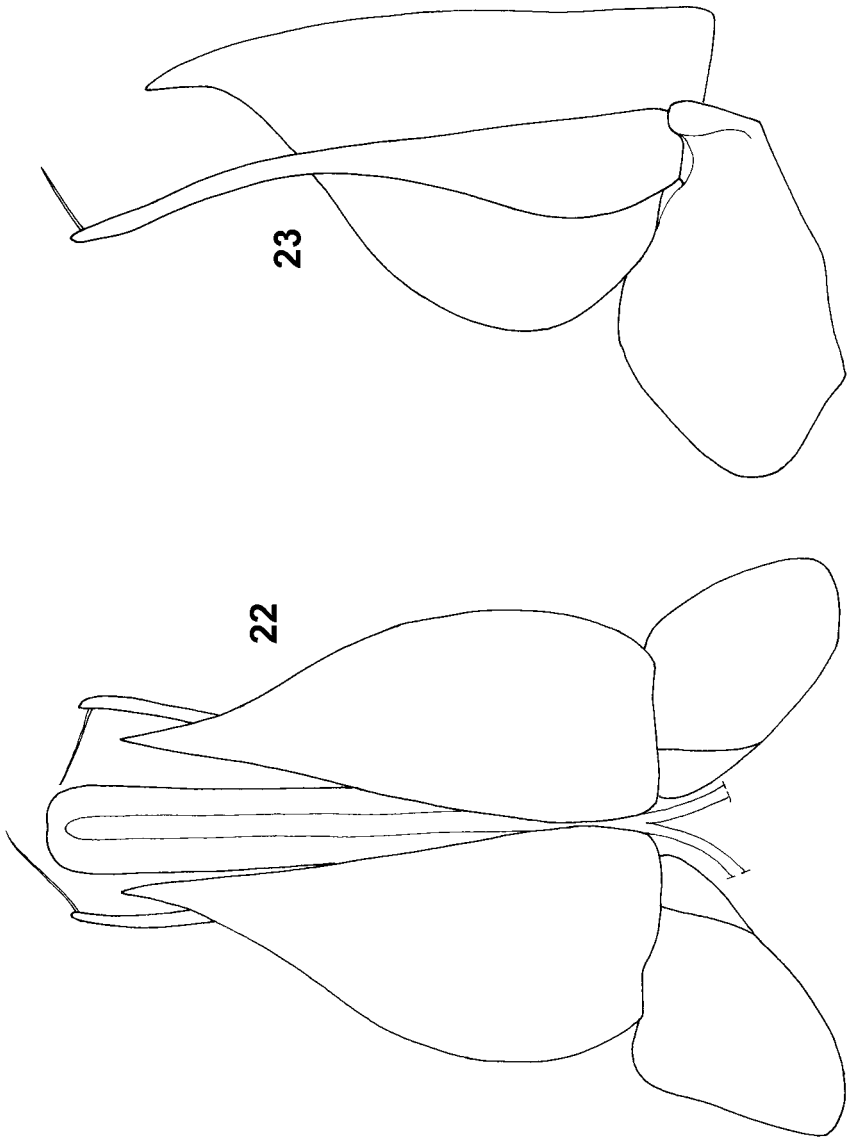
Pereiopods: male pereiopod I (Figs. 13–16) ventrally with hook-like scaly setae bent backwards on merus, carpus and propodus; female pereiopod I (Figs. 17, 18) very similar, but the rows of hook-like scales missing. Male pereiopod VII (Figs. 19–21) with ischium ventrally nearly straight and with carpus basally enlarged.







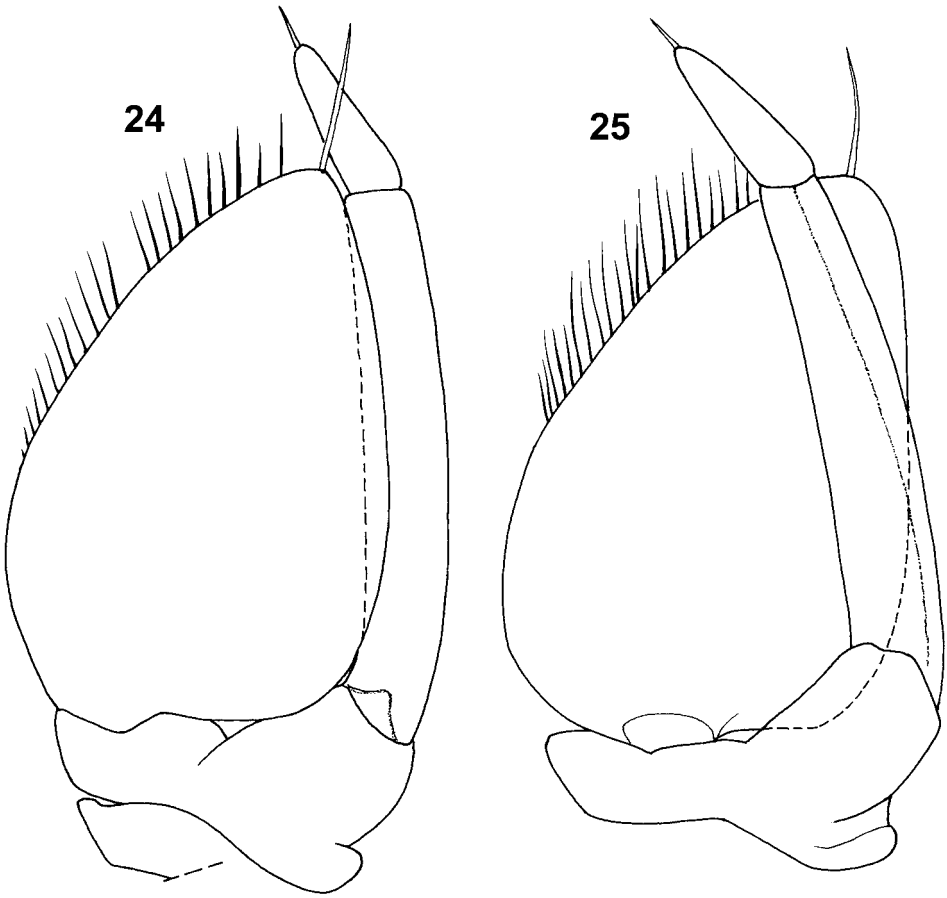
Figs. 19–21. *Utopioniscus kuehni* n. sp., paratype ♂, 12 mm long, Grotta della Utopia (SMNS T567), SEM-photographs after critical point treatment. – **19**. Pereiopod VII. **20**. Ischium and merus of pereiopod VII. **21**. Carpus of pereiopod VII. – Scale: 1 mm.



Figs. 22–23. *Utopioniscus kuehni* n. sp., paratype ♂, 12 mm long, Grotta della Utopia (SMNS T567). – **22**. Pleopods I and genital papilla, frontal view. **23**. Pleopod I, caudal view.

Genital papilla (Fig. 22) with parallel sides, apex broadly rounded.

Pleopods: male pleopod-exopodite I with acutely pointed apex, endopodite I elongated, in situ slightly surpassing the exopodite, subterminally with a long seta directed medially (Figs. 22, 23). Male pleopod-exopodite II with rounded apex and with a setal fringe at the exterior margin, endopodite II with a long basal segment, about three times as long as apical segment, the latter with an apical spine (Figs. 24, 25). Male exopodites III–V ovoid (Figs. 26–28); male exopodites II–V apically with a long terminal spine and a row of lateral spiny setae. Female pleopod-exopodites I–V



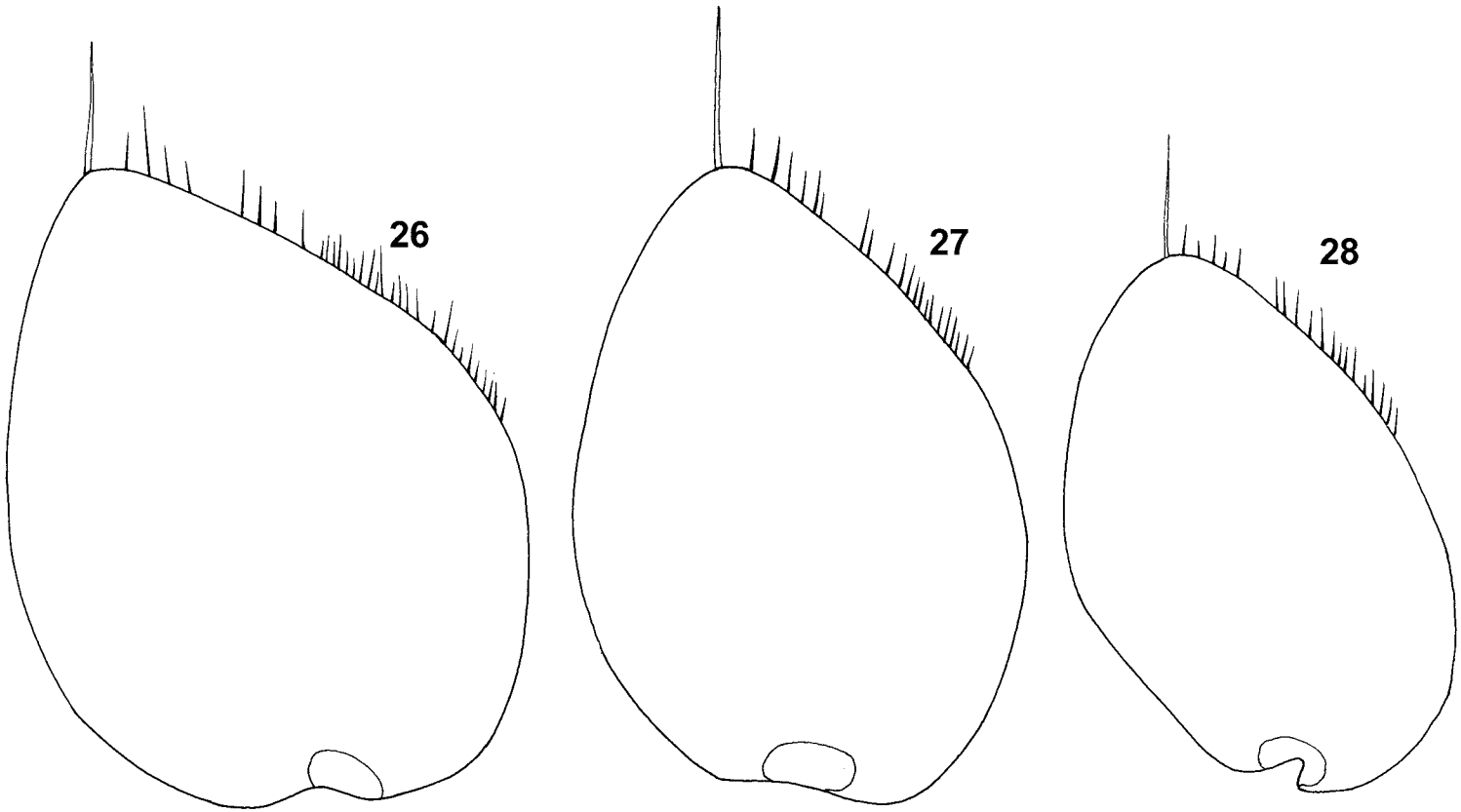
Figs. 24–25. *Utopioniscus kuehni* n. sp., paratype ♂, 12 mm long, Grotta della Utopia (SMNS T567). – **24**. Left pleopod II, frontal view. **25**. Right pleopod II, caudal view.

see Figs. 29–33; in conspicuous contrast to male the exopodites II–V are equipped only with a long terminal spine, but not with a row of lateral spiny setae.

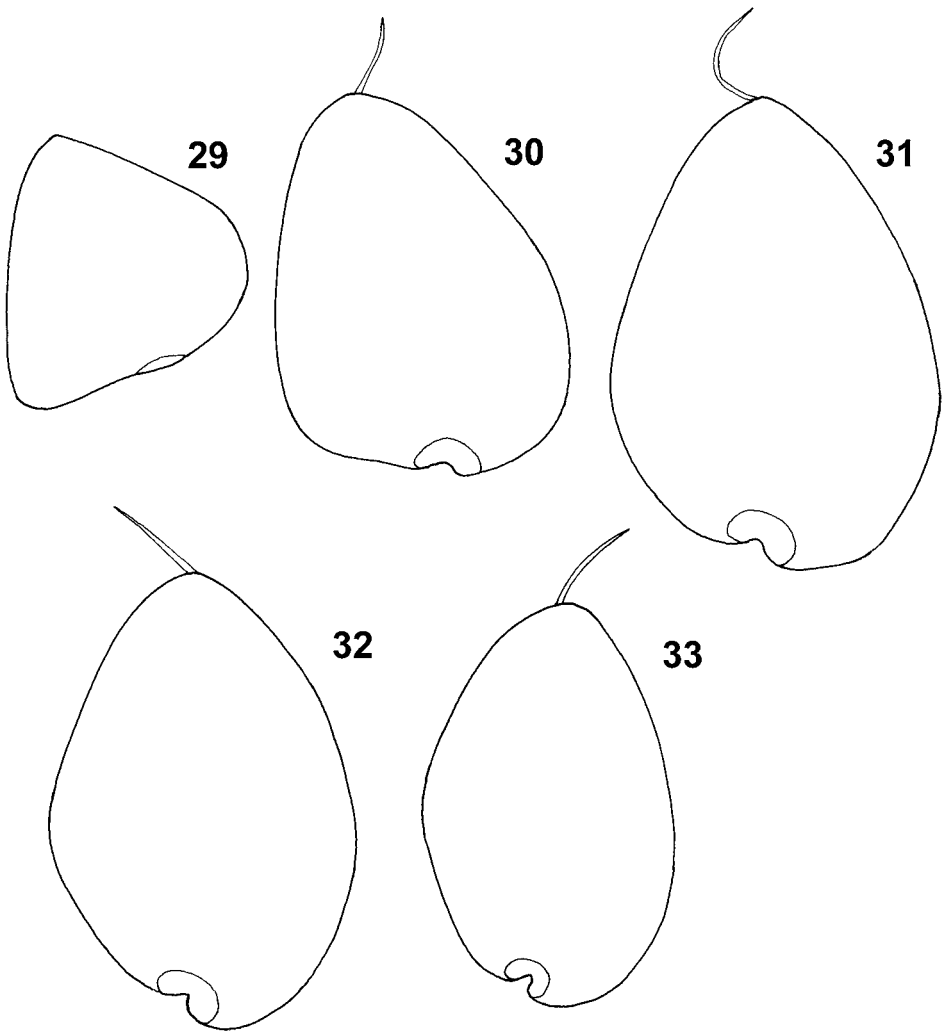
Uropods: exopodite and endopodite inserting at the same level (Fig. 2).

4 Ecological observations

In the Grotta del Bel Torrente, 700 m from the entrance and 16 m below sea level a temperature of 15 °C and a salinity of 1 % was measured by A. OERTEL in July 2003. In the Grotta della Utopia, about 2000 m from the entrance and 30 m below sea level some specimens of *Stenasellus* sp. (Isopoda, Asellota, Stenasellidae) were collected together with the *Utopioniscus* specimens.



Figs. 26–28. *Utopioniscus kuehni* n. sp., paratype ♂, 12 mm long, Grotta della Utopia (SMNS T567). – **26**. Pleopod-exopodite III. **27**. Pleopod-exopodite IV. **28**. Pleopod-exopodite V.



Figs. 29–33. *Utopioniscus kuehni* n. sp., holotype ♀. – **29**. Pleopod-exopodite I. **30**. Pleopod-exopodite II. **31**. Pleopod-exopodite III. **32**. Pleopod-exopodite IV. **33**. Pleopod-exopodite V.

5 Systematics

The Oniscidea (terrestrial isopods) are considered a suborder of the Isopoda. Overwhelming morphological evidence proves the group to be monophyletic. Contrary statements from molecular studies up to now seem rather to reflect methodological deficiencies than convincing arguments. Inside the Oniscidea five branches have been distinguished: Ligiidae, Tylidae, Mesoniscidae, Synocheta and Crinocheta (ERHARD 1998). While the sequence of the basic branching events is still debated (TABACARU & DANIELOPOL 1996) there is a general agreement on the sister-group relationship of the Synocheta and the Crinocheta, which has been convincingly worked out already 60 years ago (LEGRAND 1946).

The new genus described in the present paper is with certainty a member of the Synocheta. The main common derived characters of the Synocheta are a fused male genital duct and the reduction of the eyes to three or less ommatidia. These characters are present in all genera ascribed to this group except the genus *Buchnerillo*, which in my view is a member of the Crinocheta closely related to the genus *Armadilloniscus*.

The Synocheta are commonly divided into the families Trichoniscidae, Styloniscidae and the highly specialized Titanidae and Schoebliidae. The Trichoniscidae, populating the Holarctic region, are certainly paraphyletic, they do not possess any common derived characters that are not present in the remaining families. Inside these traditional "Trichoniscidae" the genus *Cantabroniscus* is considered by VANDEL (1965b, 1966) as the most primitive member of the group. This monotypic genus lives in freshwater of caves in northern Spain. VANDEL sees a close relationship of *Cantabroniscus* to another aquatic cave species described from Mexico as *Typhlotricholigioides aquaticus*.

At this point the question arises, whether the aquatic mode of life of *Cantabroniscus*, *Typhlotricholigioides*, *Utopioniscus* and a number of other species of the Synocheta has to be considered a primitive trait, or have these species secondarily returned to a life under water. This question can be definitely answered: The taxa under consideration must have secondarily returned to a completely aquatic life and the common ancestor of all Synocheta must have led at least an amphibious life. This can be deduced from the presence of a water-conducting system in all major branches of the Oniscidea (see HOESE 1981, 1982). The water-conducting system consists of belts of scale-rows along the bases of the legs, the antennae and partly the sixth and seventh walking leg. These structures are to be considered as homologous and must have been achieved by the common ancestor of all Oniscidea. The functions are excretion and possibly respiration and temperature regulation. In any case the water-conducting system proves that the animals must have lived at least temporarily outside the water, and this means that the aquatic species of the Oniscidea have secondarily returned to a life under water. This conclusion has also been reached by TABACARU (1999).

For an analysis of the phylogenetic relations inside the Synocheta the characters of the male pleopods reflecting the copulation strategies seem to play a key role. These copulation strategies are rather independent from the specific ecological situations and requirements as are e. g. the characters connected with nutrition (mouth parts etc.) which means a greater consistency and a reduced "danger" of convergent evolution. Especially the morphology of the male first pleopods pleads for two different phyletic lines (Fig. 34):

1. The first male endopodite is elongated, compared with the female, but consists of one solid segment without any individualized setae or other appendages. Instead, the apex of the first male exopodite shows specializations certainly connected with the copulation behaviour. This group contains the North American genera *Amerigoniscus*, *Brackenridgia* and *Typhlotricholigioides* (compare VANDEL 1950, 1965a) and the Eurasian genera *Finaloniscus*, *Escualdoniscus*, *Trichonethes*, *Caucasonethes* and *Psachonethes*.

2. The first male endopodite is elongated and bears an individualized long seta which in the more advanced groups has developed into a second segment of this appendage ("Trichoniscidae sensu stricto"). The first exopodite has a simple apex or is

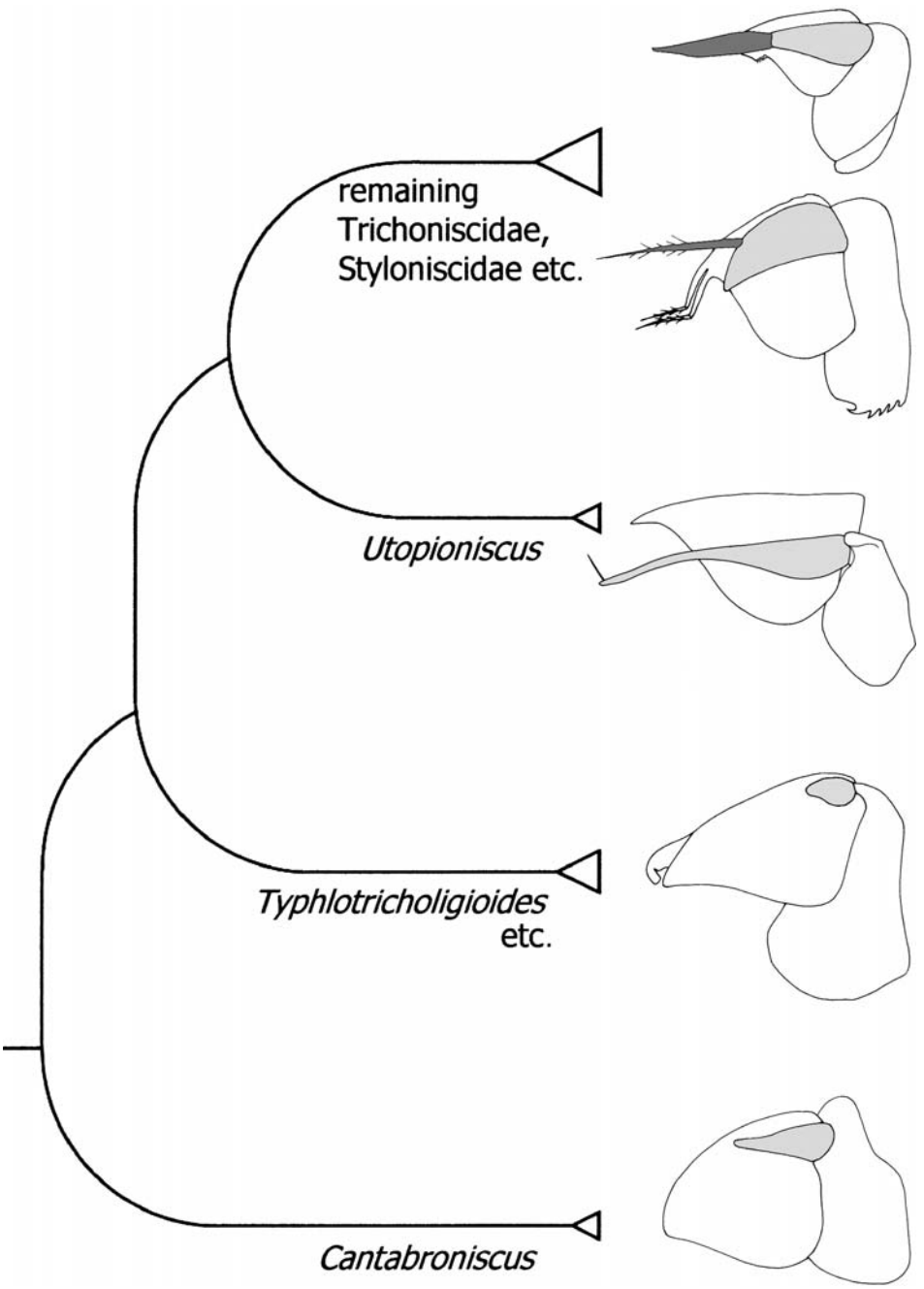


Fig. 34. Possible phylogenetic relations inside the Synocheta, based on the structure of the male first pleopods.

slightly modified as in e. g. *Hyloniscus*. This group contains the remaining holarctic genera of the "Trichoniscidae" (with the exception of *Cantabroniscus*, but including the Haplophthalminae, the genus *Buddelundiella* and the "Turanoniscidae") and the Gondwanian Styloniscidae, Titanidae and Schoebliidae.

Cantabroniscus does not belong to one of these two groups, so it can be either the sister-group of all other Synocheta (thus being "the most primitive" member of all Synocheta, compare VANDEL 1965b), or it can be a member of the stem-group of one of these two lines.

The two above-mentioned groups have already been recognized by VANDEL (1953). This author did, however, not include the Haplophthalminae and the Styloniscidae plus related "families" in the first group, and he did not exclude *Cantabroniscus* from the second group. The reason for these differences is the indifferent use of common primitive characters (symplesiomorphies) and common derived characters (synapomorphies) in VANDEL's argumentation.

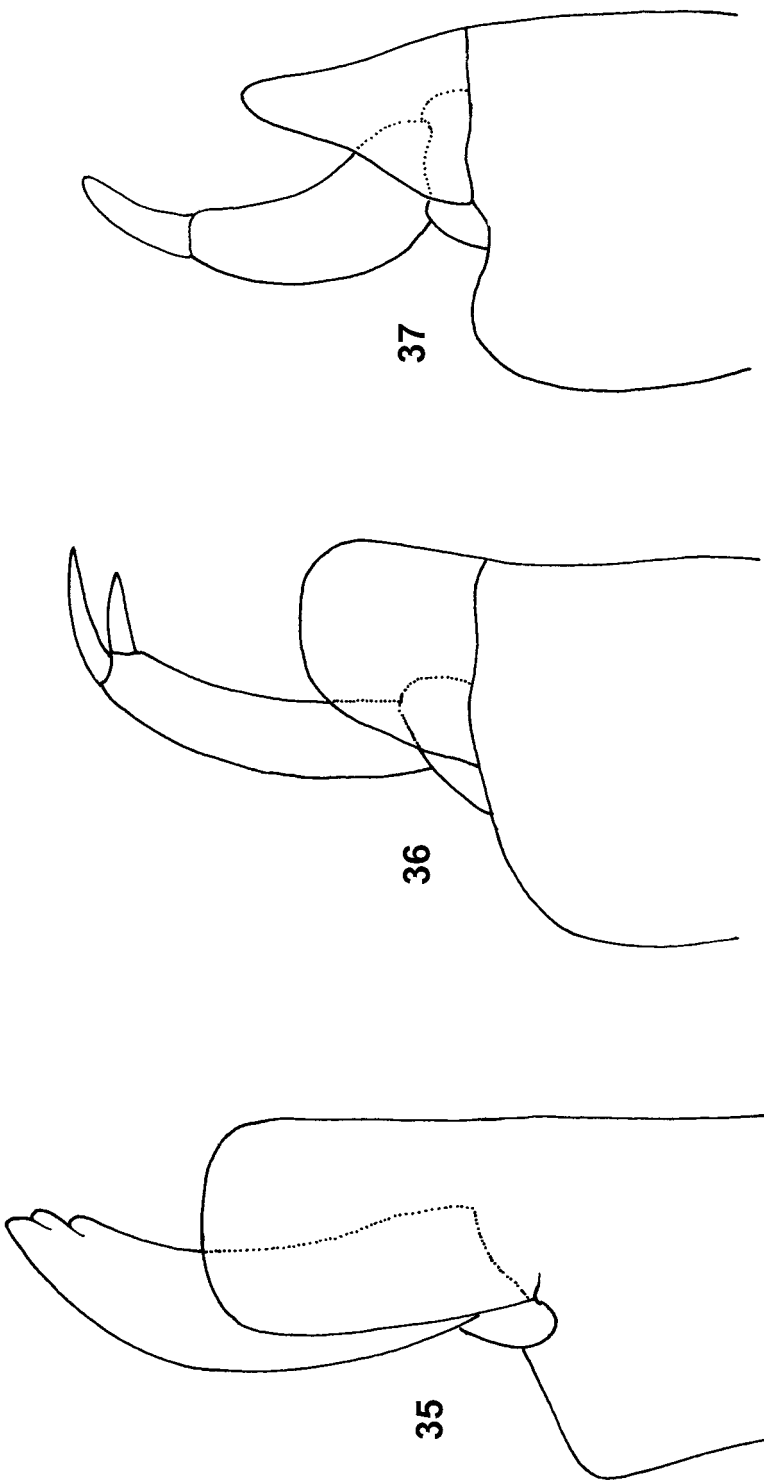
Utopioniscus is clearly a member of the "Trichoniscidae sensu stricto"-branch, the first male pleopod-endopodite is prolonged and bears a long subterminal seta. It forms the most basic branch of this group. Concerning the structure of the antennal flagellum it reflects the situation in the common ancestor of the Synocheta. The antennal flagellum has by far the highest number of segments (around 30) of all Synocheta and it is equalled inside the Oniscidea only by some species of *Ligia*. In all the remaining Synocheta the number of segments in the antennal flagellum is reduced to less than 15 (compare *Cantabroniscus primitivus*, Fig. 6).

The reduction of the eyes and of the water-conducting system are derived characters of *Utopioniscus* due to a life in underground waters. In the groundplan of the Synocheta eyes with three ommatidia and an open water-conducting system are present.

A number of characters which *Utopioniscus* shares with *Cantabroniscus* are to be seen as symplesiomorphies (specific structure of the mandible and of the maxilliped-endopodite, see Figs. 35–37). Also the similarities of *Utopioniscus* with *Typhlotricholigioides*, living in freshwater in a cave in Mexico, must be considered as synplesiomorphies (e. g. the specific structure of the maxilliped) or as convergencies probably due to the aquatic environment (e. g. the very similar structure of the antennula, compare RIOJA 1952, fig. 4).

According to this interpretation *Utopioniscus* is a true living fossil which is underlined by the fact that it is the only representative of the Synocheta which still lives primarily in a marine littoral environment (but secondarily inside the water!). If we except the enigmatic Mesoniscidae (two alpine species) we find in all other main groups of the terrestrial isopods (Ligiidae, Tylidae, Crinocheta) one guild still living in the marine supra-littoral zone.

Further detailed morphological studies and critical molecular investigations should help to ascertain or to contradict the phylogenetic interpretation given above. With one of the possible alternatives confirmed, the basal branches of the Synocheta should be considered as separate families. At the moment *Utopioniscus* is ascribed to the family Trichoniscidae, which, however, will certainly turn out to be paraphyletic and therefore will have to be split up in a number of separate families.



Figs. 35–37. Apical parts of maxillipedes (setal armature not depicted). – **35**. *Utopioniscus kuehni* n. sp. **36**. *Typhlotricholigioides aquaticus* after VANDEL (1965b: 500). **37**. *Cantabroniscus primitivus* after VANDEL (1965b: 495).

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