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On four new stygobitic cirolanids (Isopoda: Cirolanidae) and several already described species from Mexico and the Bahamas

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Abstract

This is an account of the cirolanid isopods sampled during 1997, 1998 and 1999 expeditions to subterranean habitats in Mexico and the Bahamas. Seven already described species were sampled, mostly in localities new for them. For *Bahalana cardiopus* NOTENBOOM found in a cave on Acklins (Bahamas), the differences separating it from the closely related *B. geracei* CARPENTER are discussed, and the male is for the first time illustrated. The differences between *Speocirolana pelaezi* (BOLIVAR) and *S. bolivari* (RIOJA) are once more discussed. Three new species of *Speocirolana* BOLIVAR, all from Mexico are described: *S. fustiura* n. sp. from a cave in Nuevo León; *S. lapenita* n. sp. and *S. disparicornis* n. sp. from two different karstic springs in Tamaulipas. For a new species from cenotes in Yucatan, a new genus with enigmatic affinities is described: *Yucatalana robustispina* n. g. n. sp. All newly described species show remarkable morphological features in addition to those generally known as characteristic for subterranean animals - a situation raising questions which should be addressed in the frame of the fundamental inquiry concerning adaptation to life in the subterranean realm.

Key Words: Isopoda, stygobitic/troglomorphic fauna, Mexico, Bahamas, taxonomy.

Résumé

Ceci est un compte rendu sur les isopodes cirolanides collectés lors de campagnes en 1997, 1998 et 1999 dans des habitats souterrains du Mexique et des Bahamas. Sept espèces déjà décrites ont été collectées, pour la plupart dans des localités nouvelles pour elles. Pour *Bahalana cardiopus* NOTENBOOM d'une grotte de l'île Acklins (Bahamas) on discute les différences la séparant de l'espèce étroitement apparentée *B. geracei* CARPENTER, et on donne une illustration du mâle auparavant inconnu. Les différences entre *Speocirolana pelaezi* (BOLIVAR) et *S. bolivari* (RIOJA) sont, une fois de plus, discutées. Trois espèces nouvelles de *Speocirolana*, toutes méxicaines, sont décrites: *S. fustiura* n. sp. d'une grotte de Nuevo León; *S. lapenita* n. sp. et *S. disparicornis* n. sp. de deux différentes sources karstiques de Tamaulipas. Pour une espèce nouvelle habitant des cénotes du Yucatan on décrit un genre nouveau aux affinités enigmatiques: *Yucatalana robustispina* n. g. n. sp. Toutes les espèces nouvelles décrites présentent de remarquables particularités morphologiques autres que celles généralement connues comme caractérisant les animaux souterrains - situation qui soulève des questions qui devront être approfondies dans le cadre du problème fondamental de l'adaptation à la vie dans le domaine souterrain.

Mots-clés: Isopoda, faune stygobie/troglomorphe, Mexique, Bahamas, taxonomie.

Introduction

In recent years, many exciting discoveries of stygobitic and troglomorphic animals, especially crustaceans, were made in subterranean aquatic habitats, mainly from tropical or subtropical regions, often difficult or even dangerous to explore. The present paper is an account of the cirolanid isopods sampled mainly by the second author, during 1997, 1998 and 1999 speleological expeditions in Mexico and the Bahamas. Besides several already known species, four new species are described, one of them making necessary the definition of a new genus, the remaining three belonging to a genus surprisingly well diversified in subterranean aquatic habitats of Mexico.

From study of stygobitic Cirolanidae, a conclusion more and more distinctly emerges: that, besides characters generally known - for instance since RACOVITZA's classical memoirs on cave-dwelling Cirolanidae (RACOVITZA, 1905, 1912) - as related to life in the subterranean realm (depigmentation, smooth and thin cuticula, anophtalmy, elongation and delicacy of some appendages), they possess a series of additional interesting and sometimes puzzling morphological features distinguishing them from all marine (epigean) taxa: a situation raising questions which should be addressed in the frame of the fundamental inquiry concerning adaptation to life in the subterranean realm. Several such morphological features are shown by the new species described in the present paper.

All new species here described are depigmented and anophtalmous, with smooth, translucent cuticula: this will not be repeated in the descriptions. From all species in this paper, only *Creaseriella anops* is able to roll into a ball.

For observations and terminology on chaetotaxy, we have generally followed the useful format of BRUSCA, WETZEL & FRANCE (1995). When illustration of chaetotaxic details gives sufficient information, we have refrained from also

describing them in the text. All marginal setae of the pleopods are plumose, but they were not illustrated as such, in order to avoid too much complication of the drawings. Concerning the mandibles: we use "acies" instead of "incisor"; we call "denticles" or "points" the armature of the flat projecting lobe which is the molar process; as for the lobe situated between molar and acies (a lobe whose nature is still unsettled and which has received different names in publications: see, for instance, discussion in BRUSCA, WETZEL & FRANCE, 1995:5) we use "plump spinose lobe" which reflects better the reality than "spine row" (although sometimes no spines but setae are present!). We have made a special effort to correctly illustrate the proximal parts of maxilla I, maxilla II, and maxilliped, which are often damaged during dissection, and seldom completely illustrated in publications. Deserving mention is an observation made on the exopodites of pleopods I and II of all species of *Speocirolana* here described: although they are definitely not bipartite, it is possible to observe in them a vague transverse "border line" marked at its ends by vague notches, and separating two zones of somewhat different consistence (like "predicting" a future bipartition). Finally, we have often observed long spermatophores protruding from the penes (see illustration); and in *Speocirolana fustiura* n. sp., the interesting observation could be made that a long spermatophore was found grasped between propodus and dactylus of two anterior pereiopods, pereiopods I-III being thus probably involved in sperm transfer.

The material is deposited in the Zoological Museum of the University of Amsterdam (Z.M.A.), the Colección Nacional de Crustaceos (C.N.R.C.) in the Universidad Nacional Autónoma de México, or in the Institut Royal des Sciences Naturelles de Belgique (I.R.S.N.B.).

Abbreviations used. AI, AII: antennula, antenna; Mdb: mandibula; Mx I, Mx II: maxillula, maxilla; Mxp: maxilliped; P I-VII: pereiopods; Pl I-V: pleopods.

The sampling localities

(localities for *Bahalana mayana*: under that species).

BAHAMAS

1. Oven Rock Cave, Great Guana Cay, Exumas, Bahamas; station number: 98-015.

The cave entrance is situated in a hillside about 1 km from the southern tip of Great Guana Cay. From the 15 m wide, 2.5 m high entrance, a 40 m long dry chamber descends over breakdown to a tidal anchialine lake. The 1.5 m deep lake extends around the sides and rear of this chamber. Surface salinity in the lake is 35 g/l. An underwater room trending off from the lake is well decorated with large stalagmites at depths to 9 m. A second room, located on the far side of the first, has a small air bell in the ceiling at one end but dips to 17 m depth at the far extreme. From this point, a collapsed-floored passage is followed by a low bedding plane passage reaching depths to 22 m. The length of the cave is more than 300 m (Brian KAKUK, pers. comm., 1995). Isopods were collected with a suction bottle from the water column in 0-22 m depths by Brian KAKUK. Remipedes, amphipods, cyclopoid, harpacticoid and calanoid copepods, ostracods (*Spelaeoecia capax* KORNICKER, 1990, *S. styx* KORNICKER, 1990, *Deeveya exleyi* KORNICKER & ILIFFE, 1998 and *Danielopolina* sp.), hippolytid shrimp (*Barbouria cubensis* (VON MARTENS, 1872) and *Somersiella sterreri* HART & MANNING, 1981) and polynoid and archiannelid polychaetes also were collected from the cave.

2. Duncan Pond Cave, Delectable Bay, Acklins Is., Bahamas; station number: 99-010.

The entrance to this cave is located at the base of a hill near the east coast of the island. Due to past guano mining activities at this site, the cave entrance and passages within it were substantially enlarged and modified. A level roadway was cut to the 3 m wide by 4 m high entrance to allow rail carts access into the cave. Although mining of guano has since long ceased, a large colony of bats still inhabits the interior portions of the cave. Several small, shallow pools are located in dark sections of the cave. Surface salinity was 10 g/l with a temperature of 26°C. Isopods were collected with a dip net from 0-30 cm deep pools by Thomas ILIFFE and Brett DODSON. Copepods and archiannelid polychaetes also were collected from the pools.

YUCATAN

3. Cenote Chac-Dzinic-Chee ("Tree of the Red Ant"), Chunkanan, Yucatan, Mexico; station number: 97-032.

This cenote is located along an old henequen (sisal hemp) rail line, about 5 km west of Chunkanan. The entrance consists of several holes that drop vertically for 8 m into a 20 m diameter lake room. Tree roots hang down to the water and form large clumps of root masses just under the surface. Underwater, a breakdown slope descends to 20 m depth where two passages head off in opposite directions. The north passage contains several large chambers and reaches a depth of 44 m, while the south passage intersects a large east-west trending passage that contains a halocline at 63 m depth. Isopods were collected with individual vials from the water column in 30-45 m depths by Thomas ILIFFE. Also collected from the cave were amphipods, copepods and mysids.

4. Cenote Pabakal ("Mud Stains"), Eknakan, Yucatan, Mexico; station numbers: 98-020, 99-040.

The 30 m wide, cave like entrance to this cenote is located about 3 km south of Eknakan. From the entrance, a breakdown slope descends to a 30 m wide by 20 m long lake containing large, stalagmitic columns. The eastern passage splits and reaches a maximum depth of 23 m at

140 m penetration. The western passage descends to 30 m depth at 190 m penetration. Isopods were collected with a 93 µm mesh plankton net from the water column in 20-33 m depths by Thomas ILIFFE. Also collected from this cave were copepods, amphipods and thermosbaenaceans.

5. Cenote Xlacah, Dzibilchaltun, Yucatan, Mexico; station numbers: 98-022, 99-020.
This cenote occupies a central position in the ruined Mayan city of Dzibilchaltun. The cenote entrance consists of a 25 m long by 15 m wide open pool situated in a shallow depression. The open pool has a maximum depth of 5 m, but a large, breakdown-floored cavern extends away from the pool on the northwest side. This cavern reaches a depth of 40 m where a 30 m wide by 10 m high phreatic tunnel extends for more than 1200 m, reaching depths of 60 m. A halocline at 53 m depth is underlain by anoxic salt water. Isopods were collected with a 93 µm mesh plankton net or with baited traps from the water column in 30-50 m depths by Thomas ILIFFE. Also collected from this cave were copepods, *Typhlatya* shrimp, the mysid *Antromysis cenotensis* CREASER, 1936, and the fish *Ogilbia pearsei* (HUBBS, 1938).

6. Cenote Kankirixche, Mukuyche, Yucatan, Mexico; station numbers: 98-042, 99-021.
The cenote entrance consists of an inclined shaft descending 15 m from the surface to a 15 m wide by 25 m long pool. Underwater, one side of the pool opens onto a large cavern with a cave passage going off under a low archway at 50 m depth. This passage enlarges to form several chambers with depths to 53 m. A slight halocline is evident at 50 m depth. Isopods were collected with individual vials from the water column in 20-50 m depths by Thomas ILIFFE. Also collected from this cave were thermosbaenaceans and *Typhlatya* shrimp.

NORTHERN MEXICO

7. Guayatejo spring, Juamave, Tamaulipas, Mexico; station number: 98-001.
This spring is located on the south bank of the Rio Guayatejo as it passes through a large canyon crossing the Sierra Madre Oriental. The spring pool is located about 50 m inland from the river bank, under a rock ledge; it is shallow and about 5 m in diameter. Underwater, a cave trends away from the river for about 100 m before coming back to the surface in a small air-filled chamber with possible dry cave passages leading off. Maximum depth in the underwater cave was 15 m. Isopods were collected with vials from the rock and sand bottom in 0-13 m depths by Thomas ILIFFE. Amphipods were also collected from the cave.

8. Sima Chupacable, Potreritos, Nuevo León, Mexico.
Sima Chupacable is a 486 m long, 402 m deep cave located 2.2 km south of Potreritos at an elevation of 1513 meters. The entrance, originally just a tiny hole sucking air, is situated in a small sink. The cave consists of a series of nine vertical drops, the largest of which is 141 m. While the upper portion of the cave is developed in a clean, massive reef limestone, the lower portion is a muddy meander that ends in a sump. The most likely resurgence for water from the Tinajas Valley is the Nacimiento de Hervores that flows into the Arroyo Luna about seven kilometers to the north, at an elevation of about 1050 meters. Isopods were collected from small pools at the bottom of the cave by Bev SHADE and Charley SAVVAS. Aquatic fauna also included leaches (Hirudinea undetermined) and branchiobdellid worms (Branchiobdellida undetermined - a symbiote of *Speocirolana*) as compiled by James REDDELL.

9. Cueva de la Espantosa, 11 km SW Rio Cerro Colorado, Lampazos, Nuevo León, Mexico.
This cave is located 4.5 km NW of Minas Viejas, Nuevo León, at the western base of the Sierra Lampazos in the north wall of Canada la Espantosa. It is a seasonal resurgence cave, 108 m long and 24 m deep ending in a terminal sump. Isopods are common in this sump 100 meters inside the cave. The cave is almost certainly a resurgence for caves on top of the sierra, 400 meters above. Isopods were collected by Kevin STAFFORD.

10. Ojo Encantado, Trejo Canyon, Juamave, Tamaulipas, Mexico.
Ojo Encantado is a cave located on the east side of Trejo Canyon. It contains a stream that flows out into the Trejo Canyon during high flow conditions. During low flow conditions, the stream does not come out of the cave, but instead disappears among the boulders and cobbles some meters inside of the cave. The entrance consists of a large funnel shaped depression at the base of a cliff that ends in a pool. This pool fluctuates vertically by several meters or more depending on seasonal rainfall. At times of lower water, as during our visit, the pool can be crossed by swimming to reach an ascending cave passage with a series of pools perched one above the other. The main pool near the entrance is about 3 m deep. Isopods were collected by hand from several pools within the cave by James BROWN, Jean KREJCA, Steve TAYLOR and Dean HENDRICKSON.

11. Manantial La Penita, Ciudad Victoria, Tamaulipas, Mexico; station number: SJT98-16.
This collection site is located 4.5 km southwest of the city of Ciudad Victoria, near the water purification plant. It consists of water flowing underground beneath a dry gravel streambed near Cueva de Manantial La Penita. A cement box with a trap door and metal ladder led down to the flowing water below the dry streambed, which appears to be a kind of hyporheic habitat. Collections were made with a dip net by Jean KREJCA with help from Dean HENDRICKSON and Steve TAYLOR.

12. Sotano de Amezcua, Ciudad Acuña, Coahuila, Mexico. Sotano de Amezcua is located 60 km northwest of Ciudad Acuña. The entrance consists of a 70 m vertical drop from the bottom of a funnel-shaped collapse structure. A small stream at the bottom of this shaft continues for 30 m upstream to a sump, while downstream a crawl over cobbles in a snaking channel ends in another sump. The cave obviously floods dramatically after heavy rains as evidenced by the flood line on the walls. The upstream sump was explored by divers and found to connect to an additional air-filled passage that again sumped. Isopods were collected by Jean KREJCA. Amphipods were also collected from the cave.

The species

Cirolana (C.) troglexuma BOTOSANEANU & ILIFFE, 1997

One female (ca. 10 mm long; without oostegites) was sampled from the type locality: Bahamas, Exumas, Great Guana Cay: Oven Rock Cave, 31 March 1998, Th. M. ILIFFE leg. The male of this species (BOTOSANEANU & ILIFFE, 1997) remains unknown.

Creaseriella anops (CREASER, 1936)

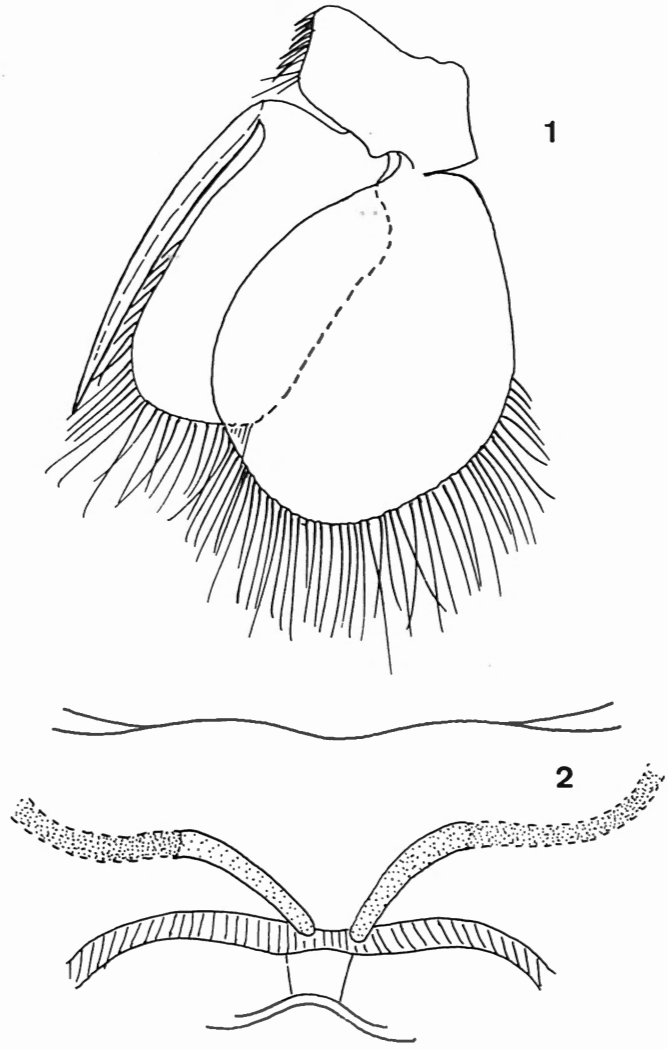
One male from Mexico, Yucatan: Cenote Xlacah, Dzibilchaltun, 27 June 1998; and 43 specimens from the same cenote, 14 March 1999; one female from Mexico, Yucatan: Cenote Chac-Dzinic-Chee, Chunkanan, 14 December 1997. Th. M. ILIFFE leg.

Bahalana cardiopus NOTENBOOM, 1981

25 females and 3 males were sampled from the Bahamas, Acklins Island: Duncan Pond Cave, 13 January 1999, Th. M. ILIFFE leg. This is the second locality for this species that was described (NOTENBOOM, 1981) from a cave on Mayaguana Island in the southern Bahamas.

Males 6 mm, 9 mm, and 10 mm long. Females (all with 7 pereiopods; none with oostegites): length varying between 4.5 mm and 10.5 mm (!). Because the male was not previously found, we illustrate here (figs. 1-2) the penes and pleopod II, which are exactly as illustrated in CARPENTER (1981) for *B. geracei*. The cuticula of this species is very transparent, allowing good observation of many details of internal anatomy.

The differences separating *B. cardiopus* from *B. geracei* CARPENTER, 1981 (described from a cave on San Salvador Island) are slight (see also BOWMAN, 1987: Table I, and CARPENTER, 1994). As a matter of fact, the only reliable character distinguishing *B. cardiopus* from *B. geracei* is: endopodites of pleopods III- V devoid of marginal setae. The maxilliped endite is armed only with 3 setae (illustrated - but not described! - with several setae for *geracei*) and with a single coupling hook (in *geracei*: mostly 2-3, but also a single coupling hook may be present). Examination of the numerous specimens from the Duncan Pond Cave population, does not validate other differences mentioned in the original description of *B. cardiopus*: we could not find any difference in the shape and structure of the "lacinia mobilis" (*recte*: the molar process); in no specimen were exopodites of Pl V found with deep distal sinus - certainly an anomaly; in all specimens the exopodites of Pl III-V are clearly completely bipartite - in the original description of *B. cardiopus* all three are illustrated bipartite, whereas in the text we find that those of Pl III and IV are "with partial transverse suture" and that of pl V "with transverse suture" (for *B. geracei* the bipartition is described as incomplete for the exopodites of Pl III and Pl IV and as complete for Pl V). The variability of *Bahalana* from caves on the various islands of the Bahamas is an interesting problem.



Figs. 1-2.
Bahalana cardiopus, male. 1. Left Pl II. 2. Penes, with ridge separating ventrally pereionite VII from pleon.

Bahalana mayana BOWMAN, 1987

One female and one juvenile specimen from Mexico, Cozumel, Quintana Roo: cenote Aerolito, 27-28 June 1993; one female from Mexico, Quintana Roo: Cenote Temple of Doom, Tulum, 1 July 1993. See discussion on this species in BOTOSANEANU & ILIFFE, 1997.

Cirolanides texensis BENEDICT, 1896

One male was caught from Mexico, Coahuila: Sotano de Amezcua, 15-17 June 1998, J. KREJCA leg. - this having been the first known Mexican locality for this species (BOTOSANEANU, ILIFFE & HENDRICKSON, 1998). But not less than 16 females were caught from a new Mexican locality (Nuevo León: Cueva de la Espantosa, Lampazos, 23 January 1998, K. STAFFORD leg.) - still not far from the Texas border. It should be added that incomplete examination of the Mexican specimens shows that there are differences from the published descriptions of *C. texensis*; this problem will be tackled in a separate publication.

Speocirolana pelaezi (BOLIVAR y PIELTAIN, 1950) and ***S. bolivari*** (RIOJA, 1953)

9 males and 9 females indubitably of *S. pelaezi* were caught from Mexico, Tamaulipas: Ojo Encantado, Cañon, Trejo, Juamave, 18 March 1998, J. BROWN, J. KREJCA, S. TAYLOR & D. HENDRICKSON leg. 4 females of *S. bolivari* were sampled from the same locality, and 1 female from Mexico, Nuevo León: Sima Chupacable, Potreritos, 30 December 1997, B. SHADE & C. SAVVAS leg.

Moreover, 2 males and 4 females from Ojo Encantado (one of the males in bad condition, the other one without appendix masculina - although the penes are present; one of the females exceedingly small) have confronted us with a special problem, forcing us to examine once more the characters distinguishing these two rather widely distributed species, often coexisting, and certainly closely related. The results are as follows (compare with the original descriptions). The only reliable distinguishing characters are, according to our observations: in *S. pelaezi* uropod exopodite without spines on its internal margin, endopodite with 3 or 4 (in *S. bolivari* exopodite with one small subapical spine on its internal margin, endopodite with 4 or 5); in *S. pelaezi* pleotelson rounded (in *S. bolivari*: subtrapezoidal). Only two additional characters may be useful, but not in all cases: lamina frontalis with truncate apex in *S. pelaezi*, more triangular in *S. bolivari*; and antennae shorter in *S. pelaezi* where they generally reach - or almost reach - the Vth pereionite, and longer in *S. bolivari*, where they generally reach the VIIth pereionite (but the length of AII varies with the body size, and they are often broken, malformed, or regenerated). The 2 males and 4 females mentioned above seem to be intermediate between the two species; they may be hybrids (introgression in such a mixed population would be no wonder); but, because the two distinguishing characters described above as "reliable" are those of *S. bolivari*, this could simply be evidence for the non-reliability of the two additional characters.

Other observations include: in the population from Ojo Encantado, *S. pelaezi* seems to be more abundant than *S. bolivari*; in this same population, the body size variability is conspicuous (mature females measuring between 8.5 and 31 mm); no females with oostegites were found.

Speocirolana fustiura n. sp.
Figs. 3-25

MATERIAL EXAMINED

1 male (holotype) from Mexico, Nuevo León: Sima Chupacable, Potreritos; 30 December 1997, B. SHADE & C. SAVVAS leg. In the Z.M.A.

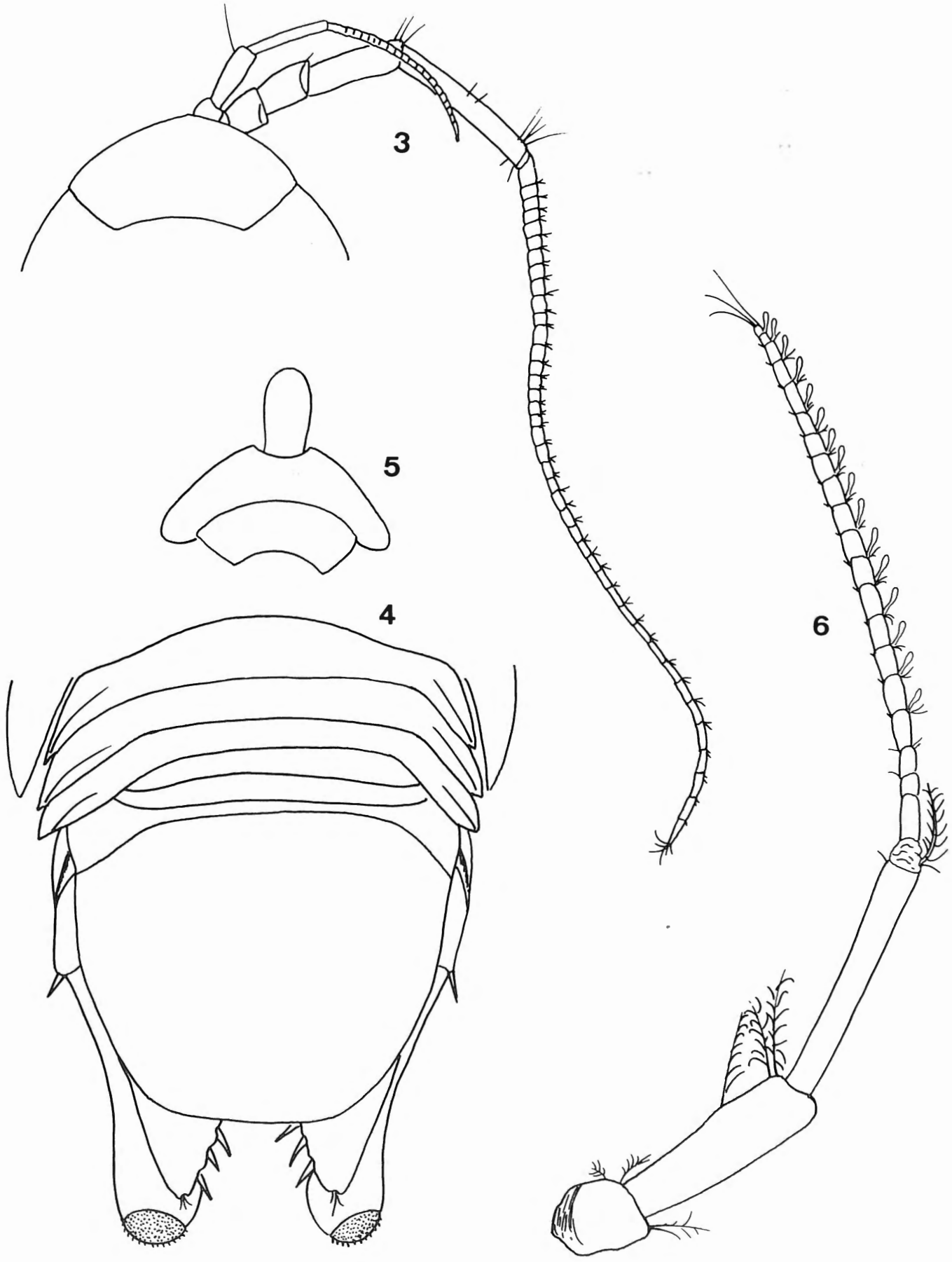
DESCRIPTION

Body length (male): 28 mm. Body width increasing from anterior end to VIIth pereionite. Cephalon of moderate length, anteriorly regularly rounded, posteriorly concave; no rostrum. Structure of pereion and pleon like generally found in *Speocirolana*. Pleotelson roughly trapezoidal, maximal width exceeding maximal length, lateral margins gently rounded, posterior margin straight, devoid of setae or spines. Antennula and antenna of dissimilar length, AI reaching only to end of AII peduncle (and to end of pereionite I), whereas AII reaches to end of pereion. Peduncle of AI almost as long as its flagellum, 3rd article slender and as long as the much stronger articles 1 and 2 together; flagellum with 20 generally short articles, bearing - with the exception of the first three and of the last one - one short aesthetasc. AII peduncle with two short basal articles, articles 3-5 gradually longer and more slender, length of article 5 equaling that of 3 and 4 together; flagellum with 40 articles, those in proximal half shorter than those in distal half.

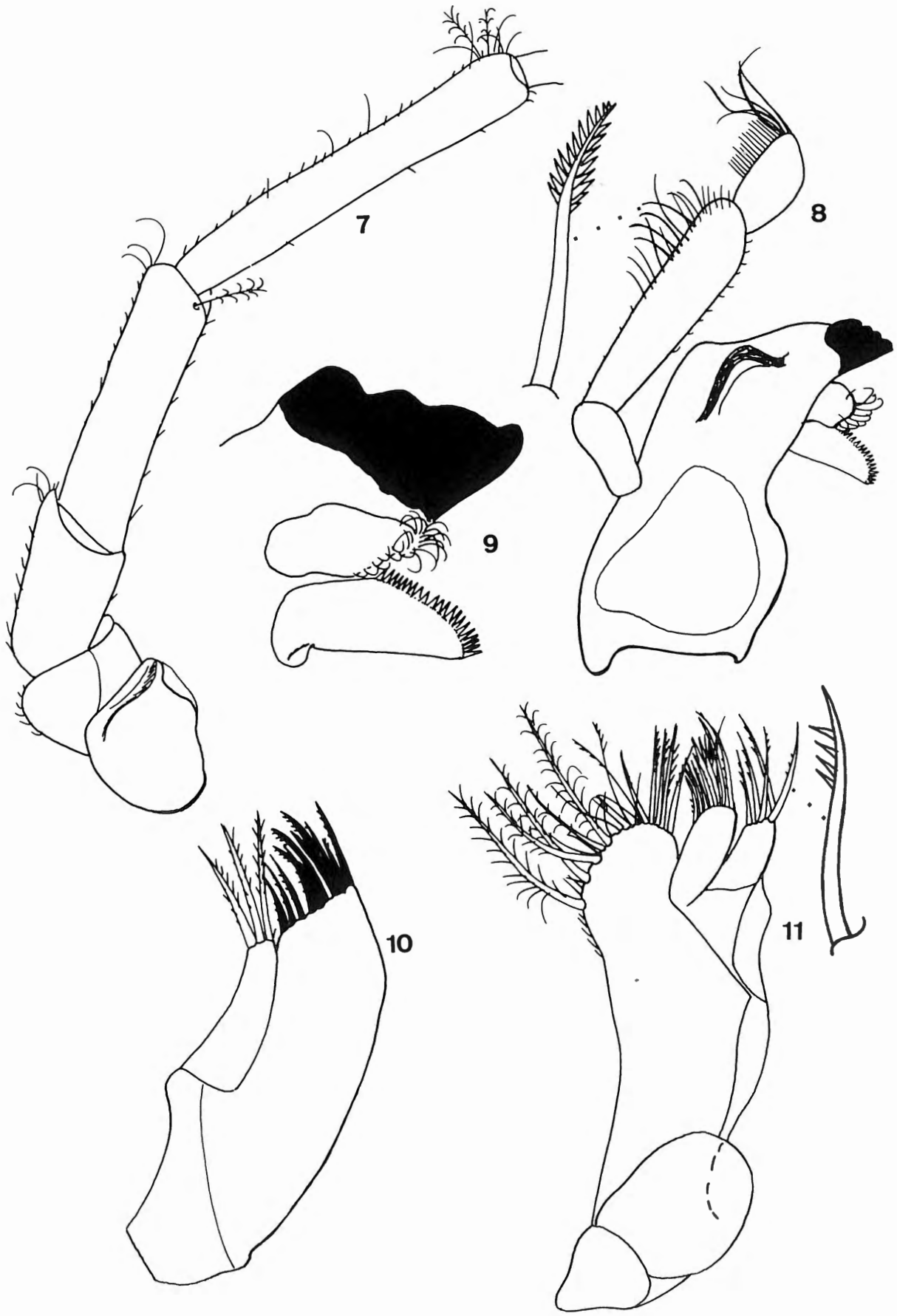
Lamina frontalis very slightly widening towards the rounded apex. Clypeus stronger developed than labrum, anteriorly with small but rather deep median sinus, lateral angles blunt. Labrum with large posterior sinus. Mandibular acies: shape correctly illustrated in fig. 9; molar process with marginal row of ca.20 sharp denticles (no setulae proximal and distal from them); "plump lobe" apically with numerous rather long setae (not spines!) with curled end.

Maxilla I: lateral lobe armed with ca. 10 black, shortly plumose (ciliate) spines; endite very elongate, gradually narrowing towards the tip, armed with 3 similar shortly plumose spines.

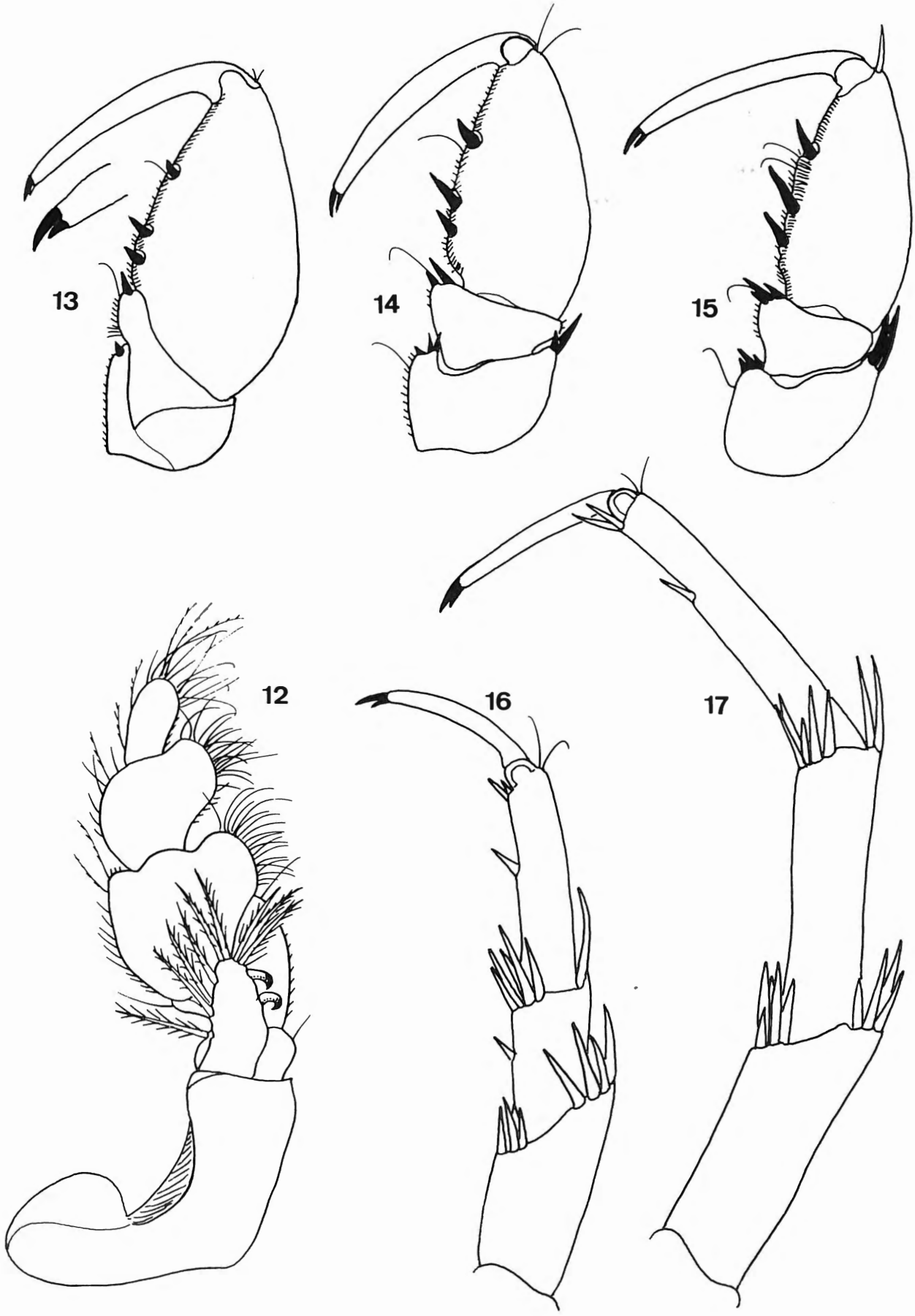
Maxilla II: internal lobe very obtuse and rather curiously twisted, armed with some 20 very dissimilar setae (largest



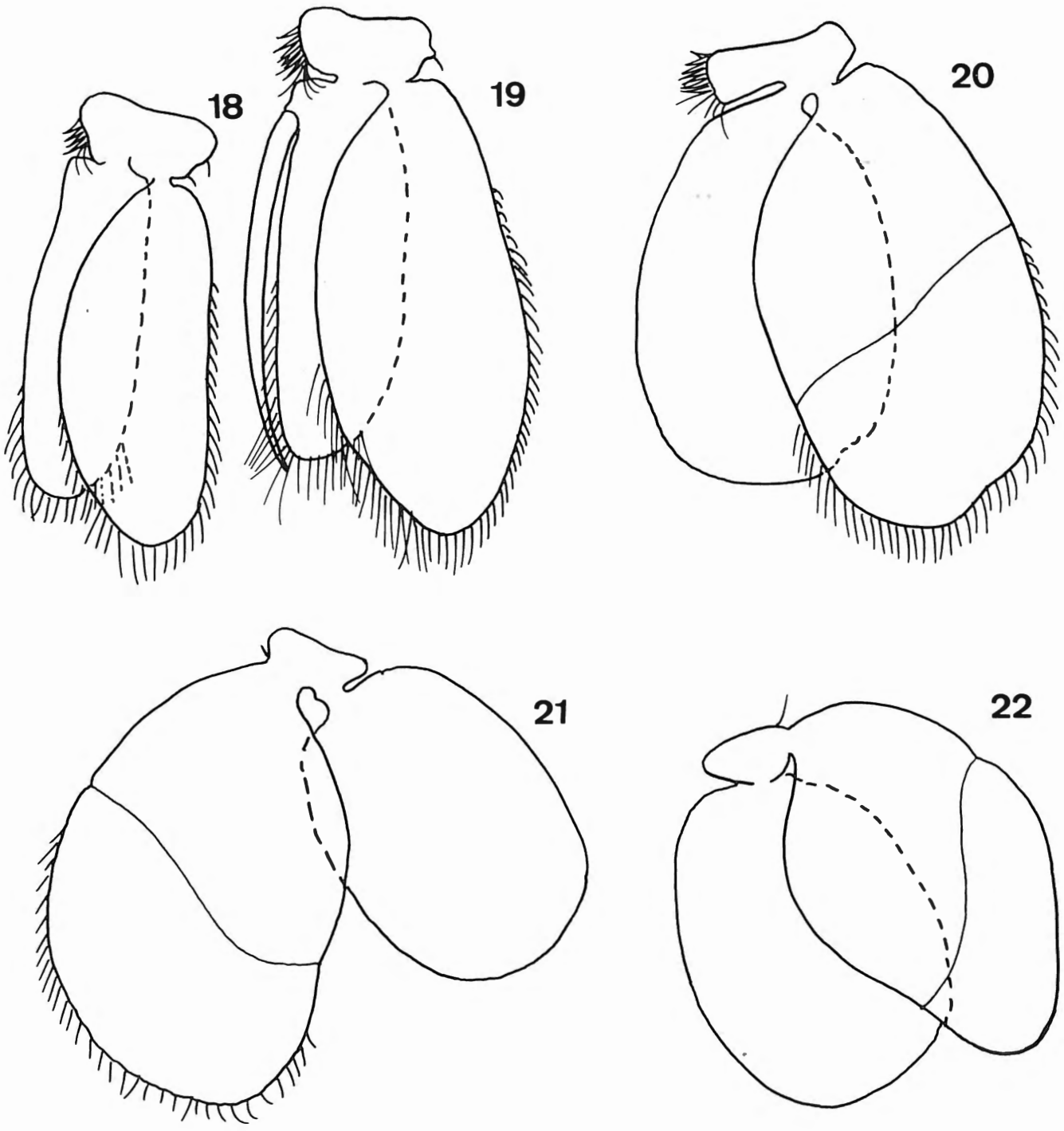
Figs. 3-6. – *Speocirolana fustiura* n. sp., male holotype. 3. cephalon with antennae. 4. Pleon, pleotelson, and uropods (3 and 4: same scale). 5. Lamina frontalis, clypeus, and labrum. 6. Left AI.



Figs. 7-11. – *Speocirolana fustiura* n. sp., male holotype. 7. Left AII peduncle. 8. Left Mdb with strongly magnified seta of palp. 9. Acies, "plump lobe", and molar of left Mdb. 10. Left Mx I. 11. Left Mx II with strongly magnified seta of middle and external lobes.

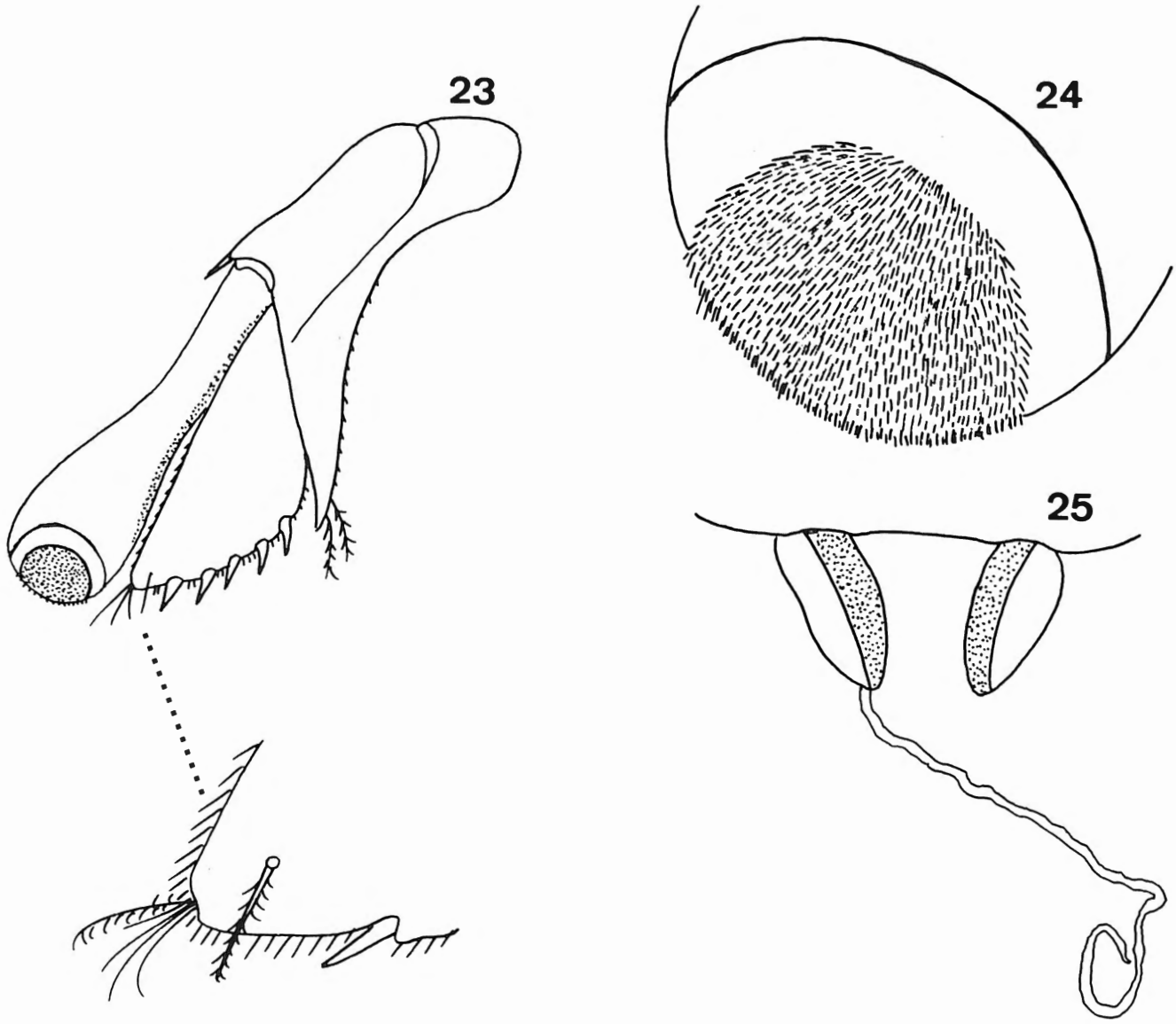


Figs. 12-17. – *Speocirolana fustiura* n. sp., male holotype. 12. Left Mxp. 13-17. Left P I-III, IV and VII, merus and beyond it; all same scale.



Figs. 18-22. – *Speocirolana fustiura* n. sp., male holotype. Left Pl I-V, all same scale.

ones plumose, medium-sized ones shortly ciliate); middle lobe with ca.12 setae, external one with 5 setae (setae of median and external lobes are "comb-setae").
Maxillipedal palp from 5 articles; masticatory lobe (endite) with 4 setae along its margin opposite to the coupling hooks, and 5 apical setae, all setae plumose; two coupling hooks.
The pereiopods show - typically for all *Speocirolana* - a contrast between the first three, strongly prehensile (raptorial) and the remaining four, ambulatory and spinose. Only the terminal articles (merus and beyond it) are illustrated for P I-III, IV, and VII, the basal articles not offering significant details (the same is done for the other new species of *Speocirolana* described in this paper). For P I-III note: the gradually less strong propodus (there is, nevertheless, no impressive contrast between them); the propodial palm armed in all three with 3 short dark spines; the long swinging dactylus; the black unguis with well developed "additional spine". For P IV-VII note, besides



Figs. 23-25. – *Speocirolana fustiura* n. sp., male holotype. 23. Left uropod, with strongly magnified apex of endopodite. 24. Strongly magnified apex of exopodite. 25. Penes.

the conspicuous gradual elongation of various articles, the bundles of stout spines in the distal internal and external angles of merus and carpus, the fact that dactylus is here, too, long, slender (and possibly swinging), and that unguis and "additional spine" are like in P I-III.

Pleopods all with small coxopodites, those of Pl IV-V practically unarmed. Pl I-II with elongate, relatively narrow exo- and endopodites, both with short marginal setae, exopodites undivided; appendix masculina with subbasal insertion, sharp tip reaching slightly beyond end of endopodite II. Pl III-V with exo- and endopodites wider, exopodites bipartite, only those of Pl III-IV with short marginal setae, endopodites without setae.

Uropods completely (or almost completely) ankylosed, exo- and endopodite amply reaching beyond the pleotelson. The strong internal projection of the protopodite ends in a sharp point armed with one pair of short plumose setae. Endopodite rather broad, shorter than exopodite, dorsally concave, ventrally with a well defined longitudinal carina, with row of 5 regularly inserted spines along its internal margin, and a small apical tuft of short setae (one of them plumose), and with one plumose seta subapically on its dorsal face. The exopodite is modified in an extraordinary manner, being a hard, strong, club-shaped appendage completely devoid of setae or spines, but apically with a rather large round zone entirely covered by extremely dense setulae (easily retaining fine mud or detritus particles, this zone is brownish, in contrast with the color of most of the exopodite). Dense setulae are, too, developed along the median face of the exopodite.

The penes are ogival, posterior face concave, medially more opaque than laterally.

DISCUSSION

The specific name was coined from (Lat.) *fustis* = club, and (Greek) *oura* = tail, alluding to the extraordinary

shape of the uropod exopodite. It would be untimely to speculate about the affinities of this new species. This will be distinguished from all other species of *Speocirolana* BOLIVAR Y PIELTAIN, 1950 described to this day by numerous morphological details, but especially by the uropods with exopodites transformed from natatory appendages to strange organs of unknown function: one more morphological structure particular to stygobitic Cirolanidae and absent from the epigean (marine) ones.

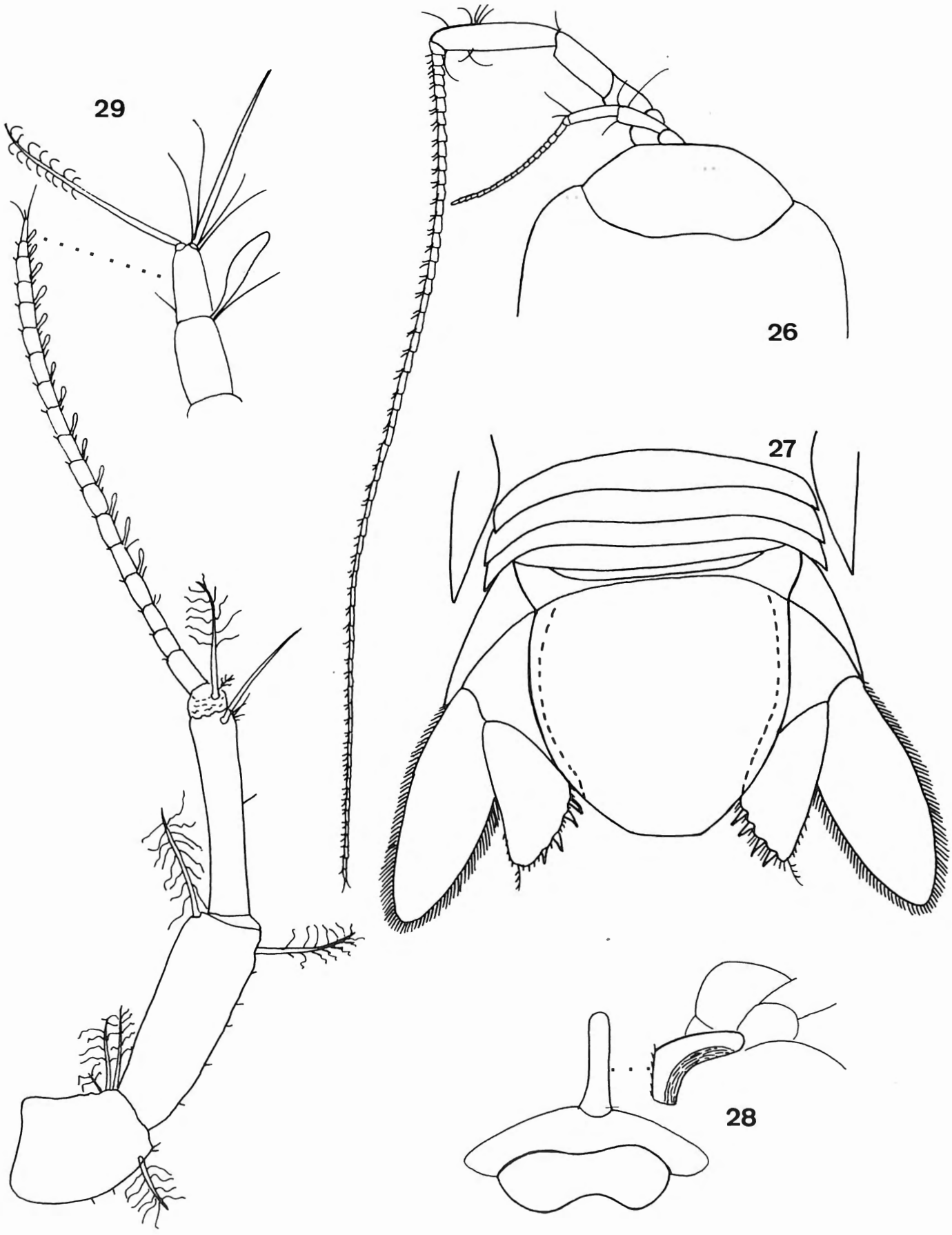
Speocirolana lapenita n. sp.
Figs. 26-47

MATERIAL EXAMINED

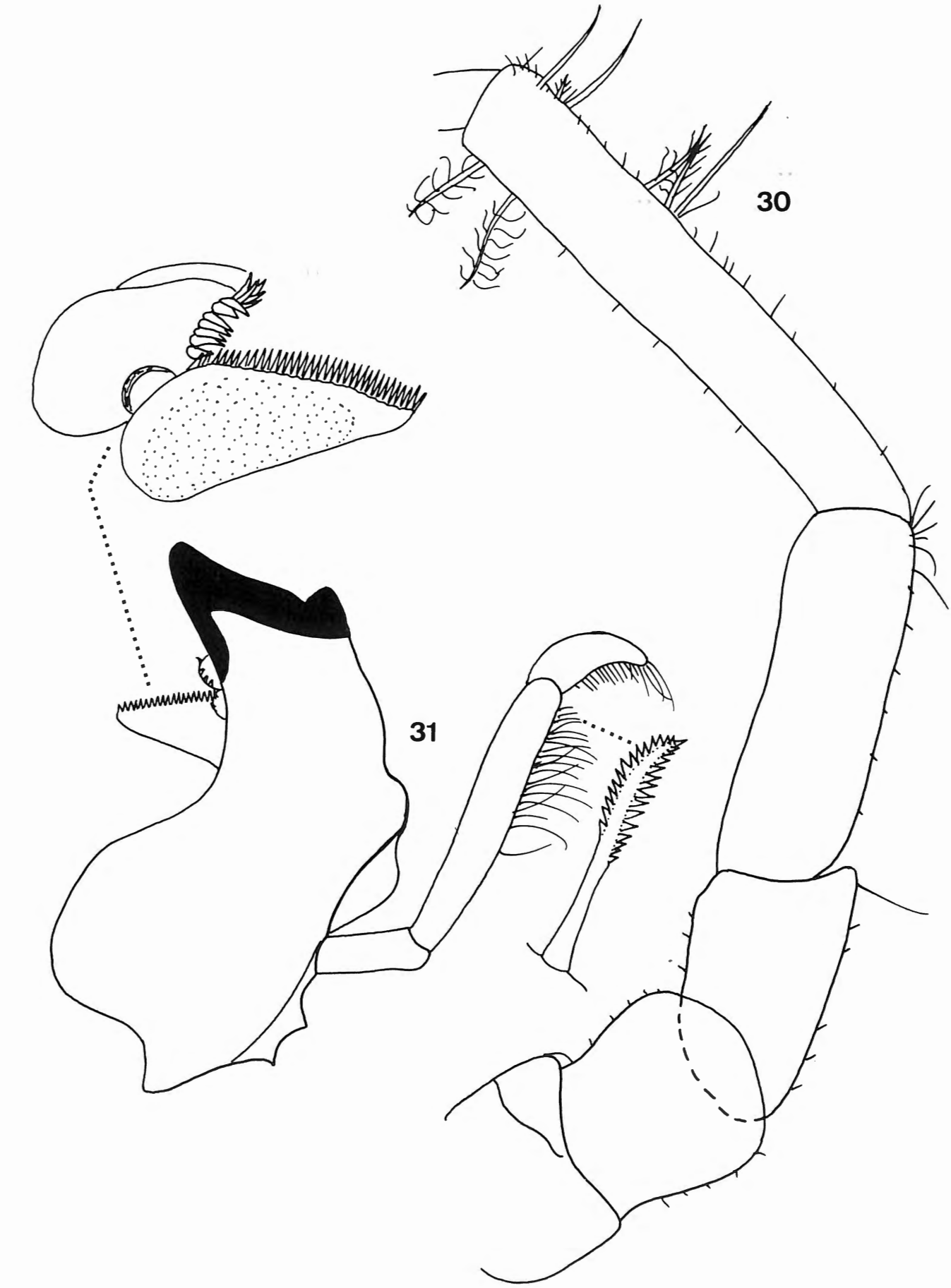
1 male (holotype) and 1 female (allotype) from Mexico, Tamaulipas: Manantial La Penita, Ciudad Victoria; 19 March 1998, J. KREJCA, S. TAYLOR, & D.A. HENDRICKSON leg. In the Z.M.A.

DESCRIPTION

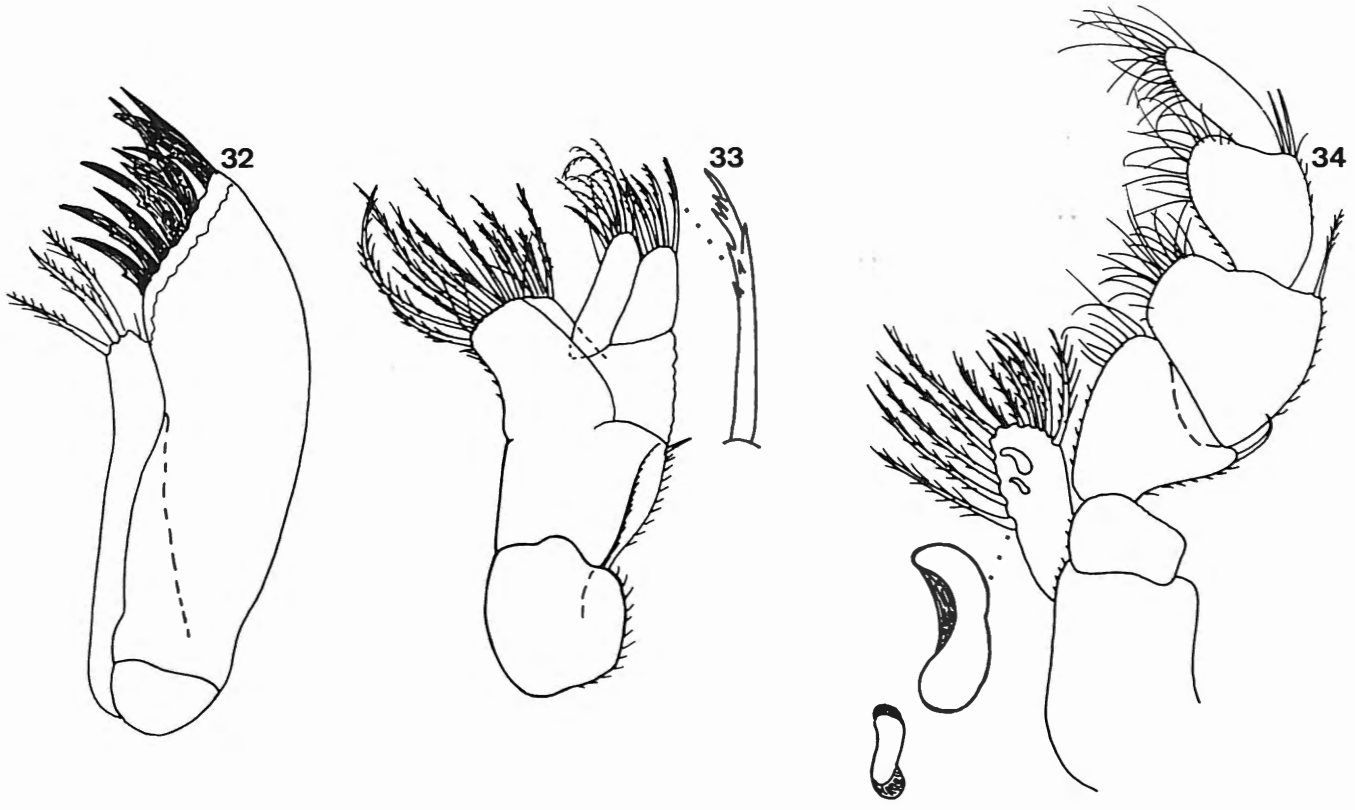
Based mainly on study of the male (female not in good condition, especially pleon and pleotelson damaged, several pereiopods detached; nevertheless, the uropod could be well observed).
Body length male 22 mm; female maybe slightly smaller; width not increasing from the anterior end to end of pereion, thus with remarkably straight margins. Cephalon more than two times wider than long, anterior and posterior margins almost straight, lateral margins oblique, no rostrum. Structure of pereion and pleon as generally found in *Speocirolana*. Pleotelson: a shield with regularly rounded lateral margins, apically truncate only for a very short portion; devoid of any setae or spines.
Antennula and antenna of very dissimilar length. AI extremely short, reaching only to anterior 1/3 of pereionite I and only to middle of last peduncular article of AII, whereas AII is considerably longer, reaching to the anterior end of pleotelson - and even slightly beyond it. AI peduncle with stout basal article, strong 2nd article and slender 3rd article (articles 2 and 3 of similar length); flagellum (male, female) with 18 elongate articles, with the exception of the first three and the last one each bearing a short aesthetasc. AII peduncle with two short, stout basal articles, following articles gradually longer and more slender, last article almost equaling in length articles 3 and 4 together; flagellum with 55 articles (male holotype; 53 in the female allotype).
Lamina frontalis remarkably narrow and elongate, bent almost at right angle at ca. 1/3 of its length, its blunt tip reaching between the basal articles of the antennulae. Clypeus more slender than labrum, anteriorly with very small median sinus from which lamina frontalis projects, lateral margins obliquely truncate. Labrum with sinuous anterior and posterior margins.
Mandibulae: molar process with row of ca. 35 marginal points, without setae at both ends of this row; "plump lobe" apparently bilobed, with row of rather numerous short and strong spines; setae of the mandibular palp beautifully "serrate".
Maxilla I: basal parts correctly illustrated in fig. 32; lateral lobe with ca. 10 stronger or less strong black spines, practically all armed with a single denticle; endite long and slender, almost not capitate, with 3 shortly plumose apical spines.
Maxilla II: basal parts correctly illustrated in fig. 33; internal lobe squarish, offering insertion to some 17 very dissimilar setae, most of them shortly plumose; middle lobe with 10 setae, external lobe with 6.
Maxillipedal palp with 5 articles; masticatory lobe (endite) with a total of 11 shortly plumose setae along its margins; the two coupling hooks are interesting: in both maxillipeds of the two available specimens, the more basally placed is much smaller than the other one, appearing "stunted".
The striking contrast between the raptorial pereiopods I-III and the ambulatory pereiopods IV-VII, typical for all *Speocirolana*, can be observed also in *S. lapenita* n. sp. Characteristic for this species is the excessive development of the propodus of P I - the propodus of P II and III being much smaller (P I propodus more than two times wider than that of P III). Spine armature of P IV-VII roughly similar to that seen in *S. fustiura* n. sp. Note also the fact that the dactyli of P IV-VII are relatively short - that of P VII attaining only 1/3 of the length of the respective propodus.
Pleopods I and II with elongate, ovoid exo- and endopodites; exopodites with numerous short marginal setae, whereas endopodite I has only quite a few apical setae, and endopodite II only a vestigial one; appendix masculina with subbasal insertion, distinctly shorter than endopodite II, and with blunt apex. Pleopods III-V with small protopodites (those of IV and V devoid of coupling spines and setae), large bipartite exopodites all with row of short distal setae, and shorter fleshy endopodites devoid of setation.
The uropods - amply reaching beyond the pleotelson - are apparently normally developed as natatory appendages. They are characterized by a strong sexual dimorphism: in the male exopodite perfectly ovoid, much larger than endopodite, with a continuous "hem" of long and dense setulae along its margins, but no other armature; whereas in the female the somewhat narrower exopodite is slightly shorter than the endopodite, with only shortly ciliate margins, and on its internal margin with one spine similar to the four ones of the foliaceous endopodite in the two sexes (details of chaetotaxy: figs. 45-46).
The penes have broad bases and slightly sinuous upper margins - but otherwise they are like in other *Speocirolana*.
One pair of large oostegites was seen on the IInd pleonal segment of the allotype.
The male holotype is parasitized by entocytherid ostracods, many of which were found attached for instance to the maxillary palps.



Figs. 26-29. – *Speocirolana lapenita* n. sp., male holotype. 26. Cephalon with antennae. 27. Pleon, pleotelson, and uropods (26 and 27: same scale). 28. Lamina frontalis, clypeus, and labrum - with a ½ lateral and ½ ventral view of lamina frontalis. 29. Left AI, with strongly magnified apex of flagellum.



Figs. 30-31. – *Speocirolana lapenita* n. sp., male holotype. 30. Left AII peduncle. 31. Left Mdb, with strongly magnified seta of palp, and another view of molar and "plump lobe".



Figs. 32-34. – *Speocirolana lapenita* n. sp., male holotype. 32. Left Mx I. 33. Left Mx II, with strongly magnified seta of middle and external lobes. 34. Left Mxp, with strongly magnified coupling hooks.

DISCUSSION

The specific name was coined from La Penita, the type locality.

S. lapenita n. sp. is mainly distinguished by the combination of several characters like: lamina frontalis long, slender, and bent almost at right angle; two dissimilar coupling hooks on maxillipedal endite; endopodites of pleopods I and II only with very scarce setation; and finally, markedly sexually dimorphic uropods.

To the best of our knowledge such a sexual dimorphism is presently known only in 3 stygobitic species, all belonging to genus *Speocirolana* BOLIVAR Y PIELTAIN, 1950: *S. guerrai* CONTRERAS-BALDERAS & PURATA-VELARDE, 1981; *S. pubens* BOWMAN, 1981; and *S. lapenita* n. sp. BOWMAN (1981) considers *S. guerrai* and *S. pubens* as being related species, and it is possible that the new species belongs to the same group, although its uropods (male, female) are clearly distinct from those of *S. guerrai* (imperfectly illustrated in the original description) and of *S. pubens* (good drawings in the original description). In BOWMAN (1981), a comparison in tabular form is attempted between *S. guerrai* and *S. pubens*, and it may be useful to see what place the new species could occupy in such a comparative table: telson shape like in *guerrai*; relative length of distomedial projection of uropodal protopodite like in *pubens*; shape of uropod endopodite like in *guerrai*; number of spines on internal margin of uropod endopodite differing from both; number and length of spines on propodial palm of P I-III differing from both; bipartition of pleopod III exopodite like in *guerrai*; setation of pleopod V exopodite differing from both.

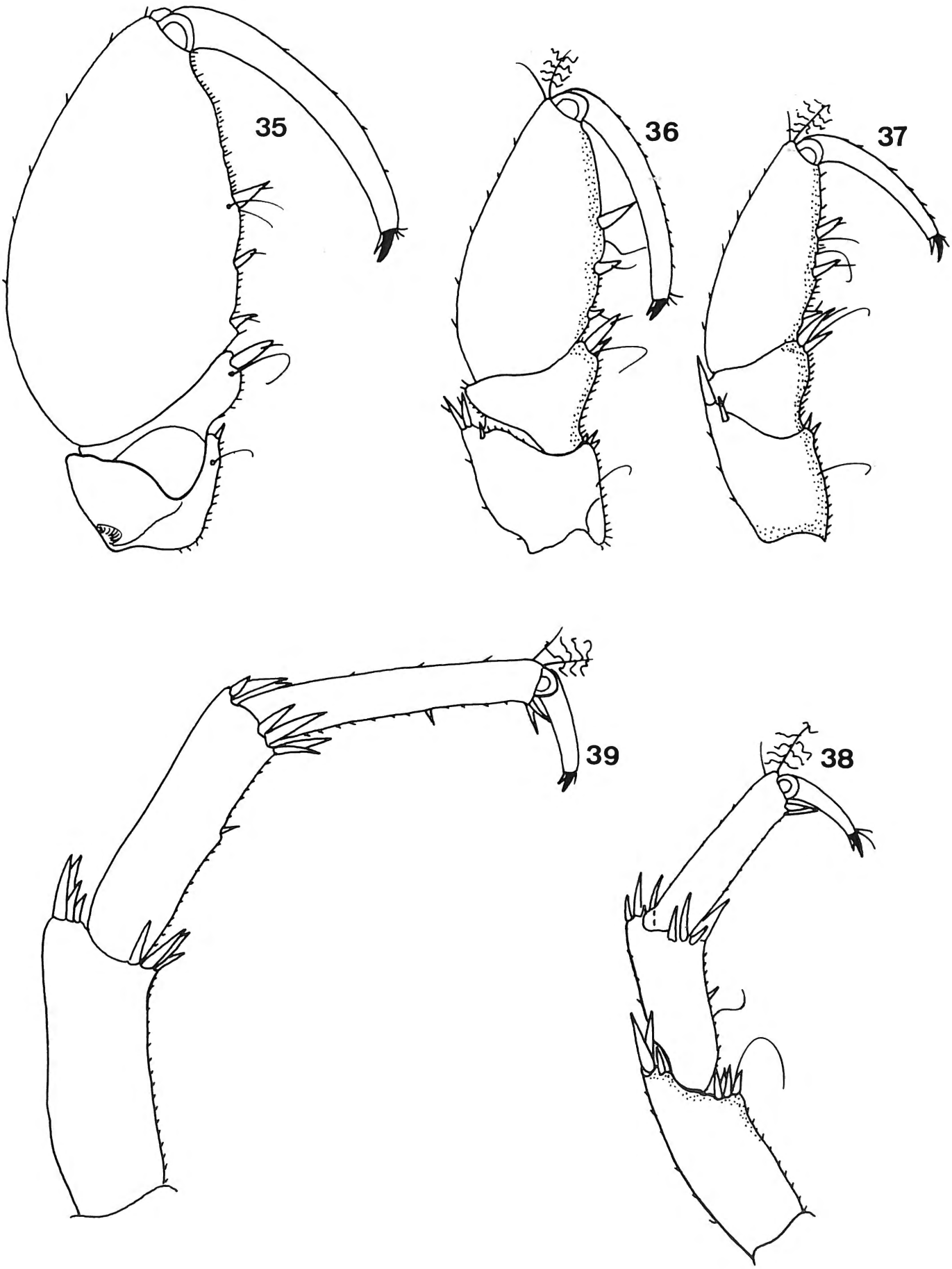
Speocirolana disparicornis n. sp.
Figs. 48-68

MATERIAL EXAMINED

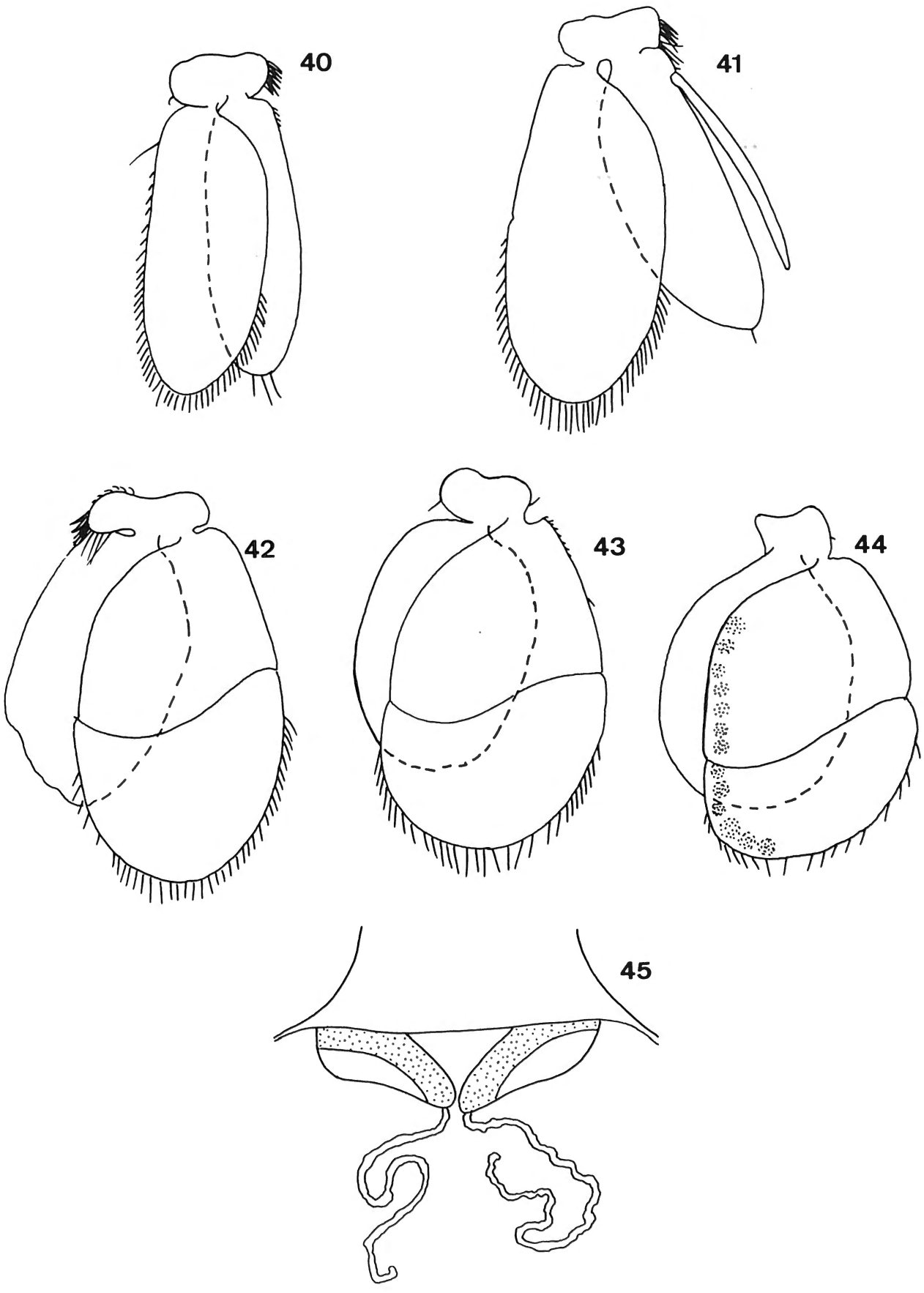
Male holotype, 2 male paratypes, female allotype, 5 female paratypes from Mexico, Tamaulipas: Guayatejo Spring, Juamave; 15 March 1998, TH. M. ILIFFE leg. Holotype and allotype in the Z.M.A.; male and female paratypes in the C.N.R.C. or in the I.R.S.N.B.

DESCRIPTION

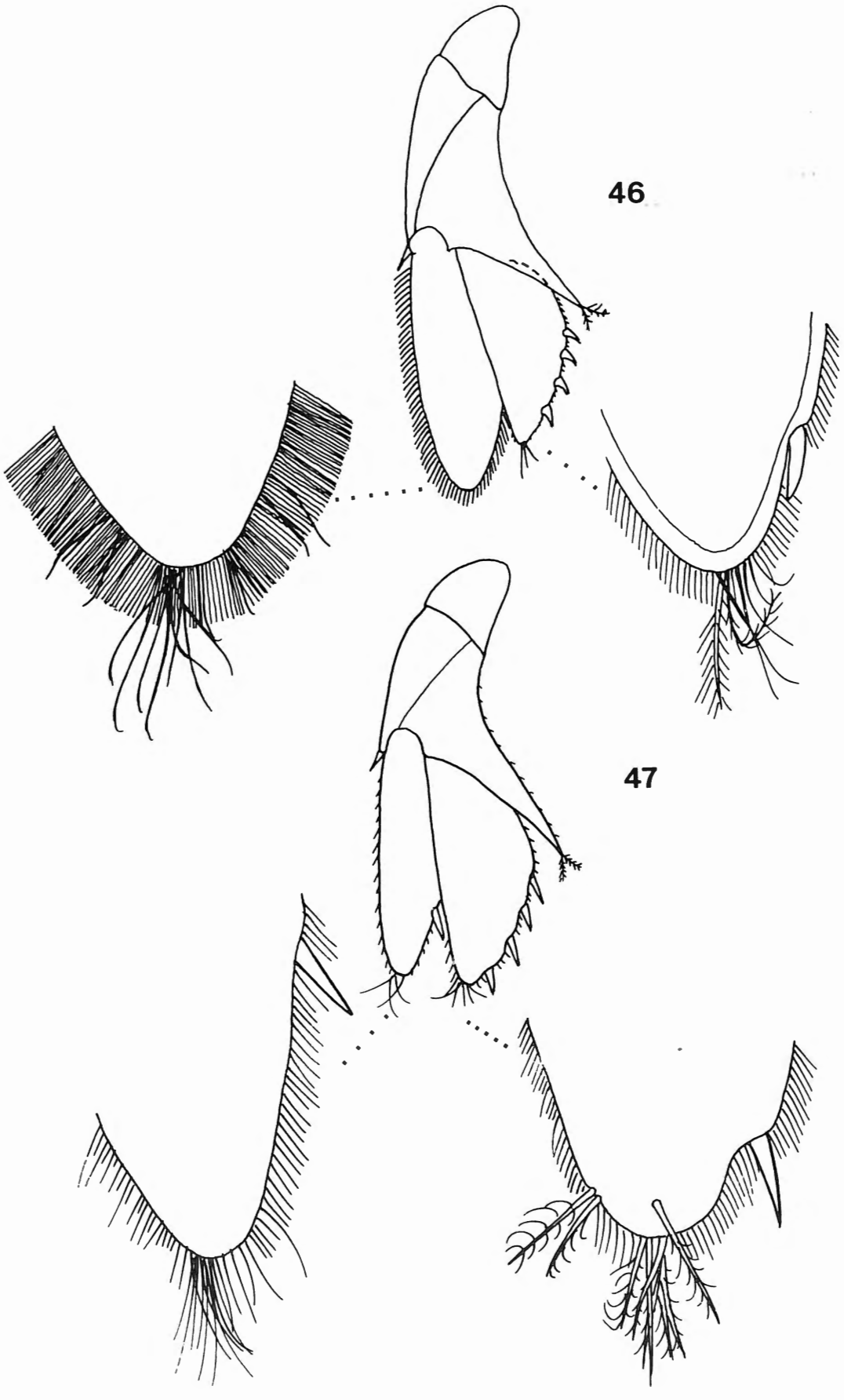
Body length: males 11-16 mm (holotype: 15 mm), females 11.5- 21 mm (allotype: 21 mm). The maximum width is



Figs. 35-39. – *Speocirolana lapenita* n. sp., male holotype. Right P I-III, IV, and VII, merus and beyond it; all same scale.



Figs. 40-45. – *Speocirolana lapenita* n. sp., male holotype. 40-41. Right Pl I-II. 42-44. Left Pl III-V (40-44: same scale). 45. Penes.



Figs. 46-47. – *Speocirolana lapenita* n. sp. 46. Left uropod of male holotype, with strongly magnified apex of exo- and endopodite. 47. Left uropod of female allotype, with strongly magnified apex of exo- and endopodite (46 and 47: same scale).

attained by the VIth pereionite - body outline thus fusiform. Cephalon anteriorly rounded, but antero-laterally with small "shoulders"; posteriorly strongly convex; a well developed rostral point. Structure of pereion and pleon as is generally found in *Speocirolana*. Pleotelson strongly vaulted, very slightly trapezoidal (almost square), lateral margins proximally with small sinuosity, entire distal margin shallowly emarginate; no armature of setae or spines.

Antennula and antenna of extremely dissimilar length: AI reaching at most to end of AII peduncle (or to mid-length of pereionite II), AII reaching almost to the end of pleotelson. Both AI and AII are very fragile, often found broken. AI: article 3 of peduncle subequal with article 2 but much more slender; on the three peduncular articles a number of long "palmate" setae loosely attached to their alveolae and making up a powerful sensorial system; flagellum with a number of articles varying with the size of the animal (10 in the male holotype, but with a minute, incompletely developed, eleventh one at the flagellum tip - fig. 51, detail; 11 and respectively 13 in the male paratypes; 14 in the female allotype); 1st article of flagellum longest, 2nd one shorter than those following; number of aesthetascs apparently very variable, and, unfortunately, they are often broken. AII peduncle with articles 1-5 gradually longer, articles 4 and 5 with one and respectively 3 long, palmate setae similar with those on the AI peduncle; flagellum with some 39 articles (smallest specimen) to at least 45 (largest specimen); 1st flagellar article long and apparently formed by fusion of two articles.

Lamina frontalis ogival, strongly bent dorsad and reaching with its tip the rostral point (fig.48). Clypeus strong, with medio-distal sinus, lateral angles broadly rounded. Labrum with proximal rather shallow emargination, distally not emarginate.

Mandibulae: molar lobe with only 15-16 small or very small marginal denticles and devoid of setulae at both ends of this row. Plump lobe armed with 10 rather short spines, some of them curved. On 2nd article of the palp, the setae (serrate, like those on the 3rd article) are restricted to the distal half of the article.

Maxilla I: external lobe with 10 dissimilar dark spines, almost all with one denticle (some with 2-3), internal lobe not capitate, with 3 spines shortly plumose only in their distal half, and with a pair of small setae in the apico- external angle; from the internal margin of the internal lobe, a small, shortly pedunculate lobe was seen protruding: this is probably an epipodite (never observed by us earlier in the Mx I of a cirolanid).

Maxilla II: internal lobe squarish, armed with 15 setae, the four largest ones plumose (two strongest inserted in the disto-internal angle), remaining ones only sparsely ciliate, or glabrous. The two small lobes have an identical armature of 5 setae, serrate in their distal half.

Maxilliped endite armed with 6 plumose setae and with 2 coupling hooks.

Pereiopods showing not only the dissimilarity between P I-III and P IV-VII characterizing all *Speocirolana*, but also an excessive dissimilarity between the development of the propodus of the first three: propodus of P I more than two times wider than that of P II and more than three times than that of P III. The three spines on the propodial palm of P I- III are relatively long and somehow flexible. Dactylus of all pereiopods long and swinging. Additional spine of unguis very small in all pereiopods. P IV-VII are paucispinose.

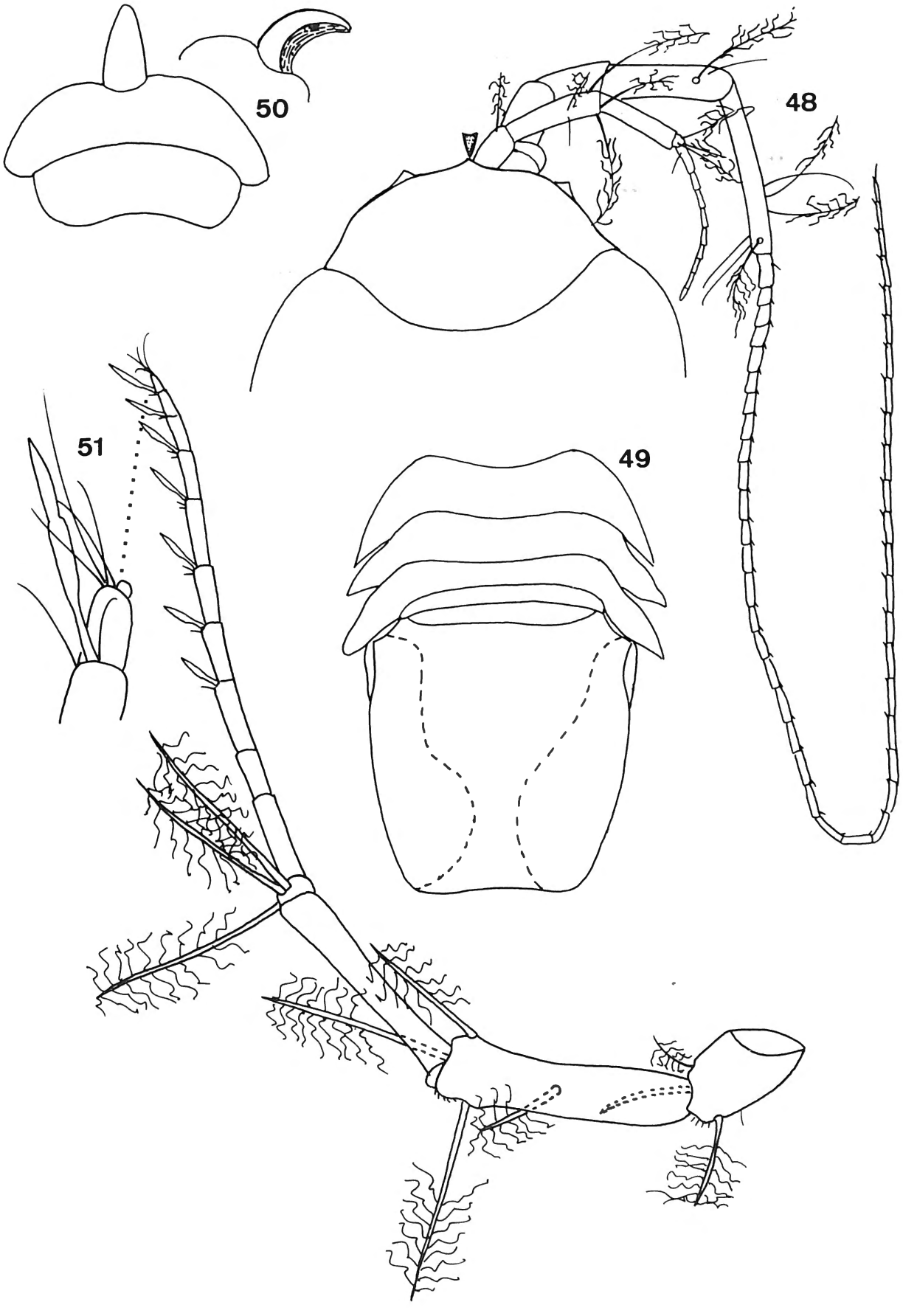
Pleopods with relatively small protopodites (that of Pl V unarmed); Pl I and II with elongate exo- and endopodites, those of Pl III-IV wider, exopodites entirely bipartite, endopodites large; all exopodites with short marginal setae; endopodites Pl I-II with relatively sparse distal setation, endopodites Pl III-V glabrous. Appendix masculina with subbasal insertion, shorter than the respective endopodite, slightly curved, bluntly ending.

The uropods are freely movable, but probably not efficient natatory appendages; they are placed - somehow like in *Skotobaena* FERRARA & MONOD, 1972, or in *Faucheria* DOLLFUS & VIRÉ, 1905 - in such a manner as to form with the pleotelson a deep ventral cavity for the pleopods (in dorsal view, observation of the uropods is not possible, they are entirely concealed under the pleotelson). Internal projection of the protopodite much shorter than the endopodite which is excessively developed, more than two times wider than the distinctly shorter ovoid exopodite; the endopodite is dorsally concave, its 3 or 4 marginal spines are rather long, along its ventral face there is a longitudinal "keel" almost reaching its distal end, and four large plumose setae from large alveolae (again a powerful sensorial system) are inserted on its dorsal face near the distal margin.

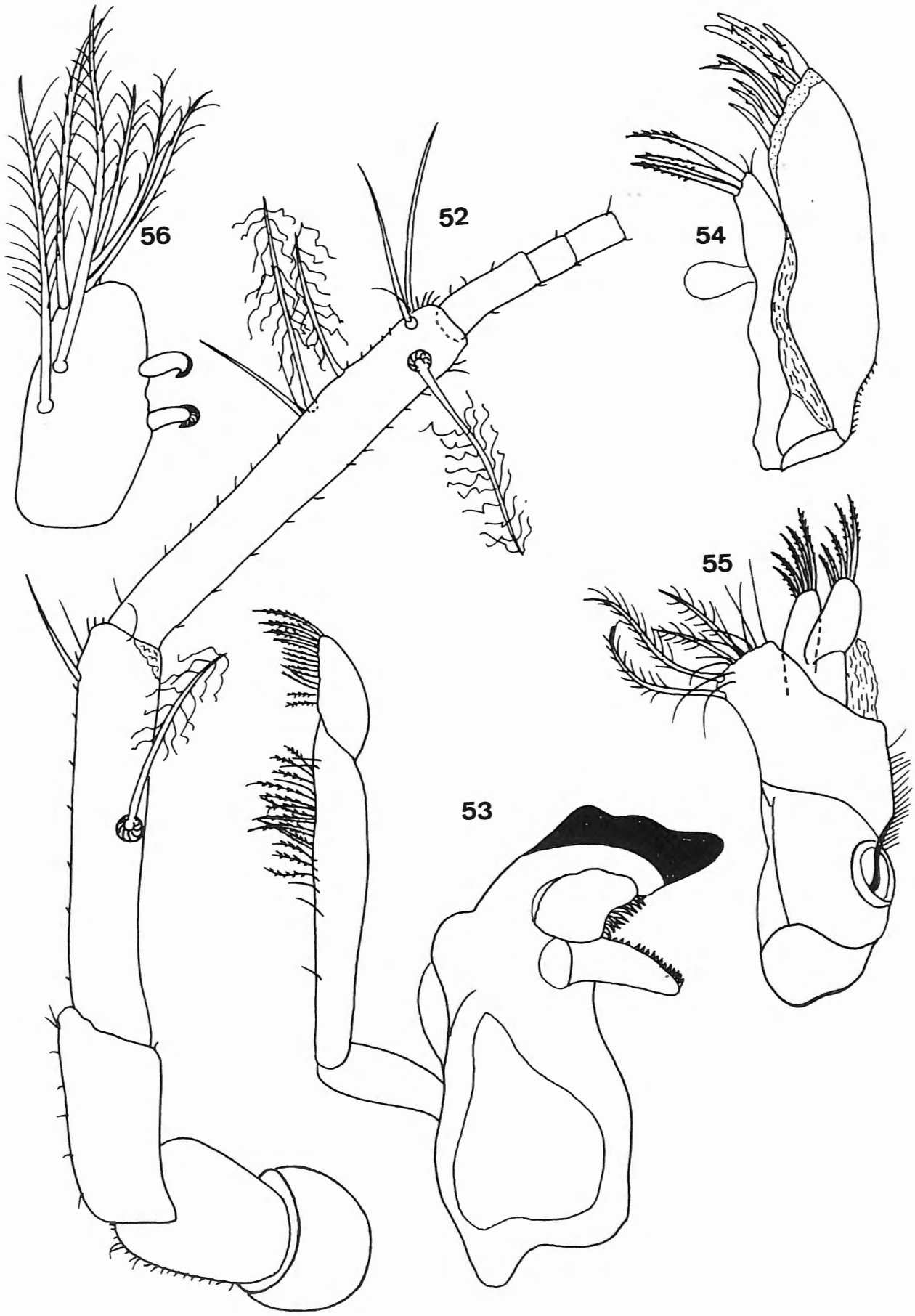
The two penes have pointed tips.

DISCUSSION

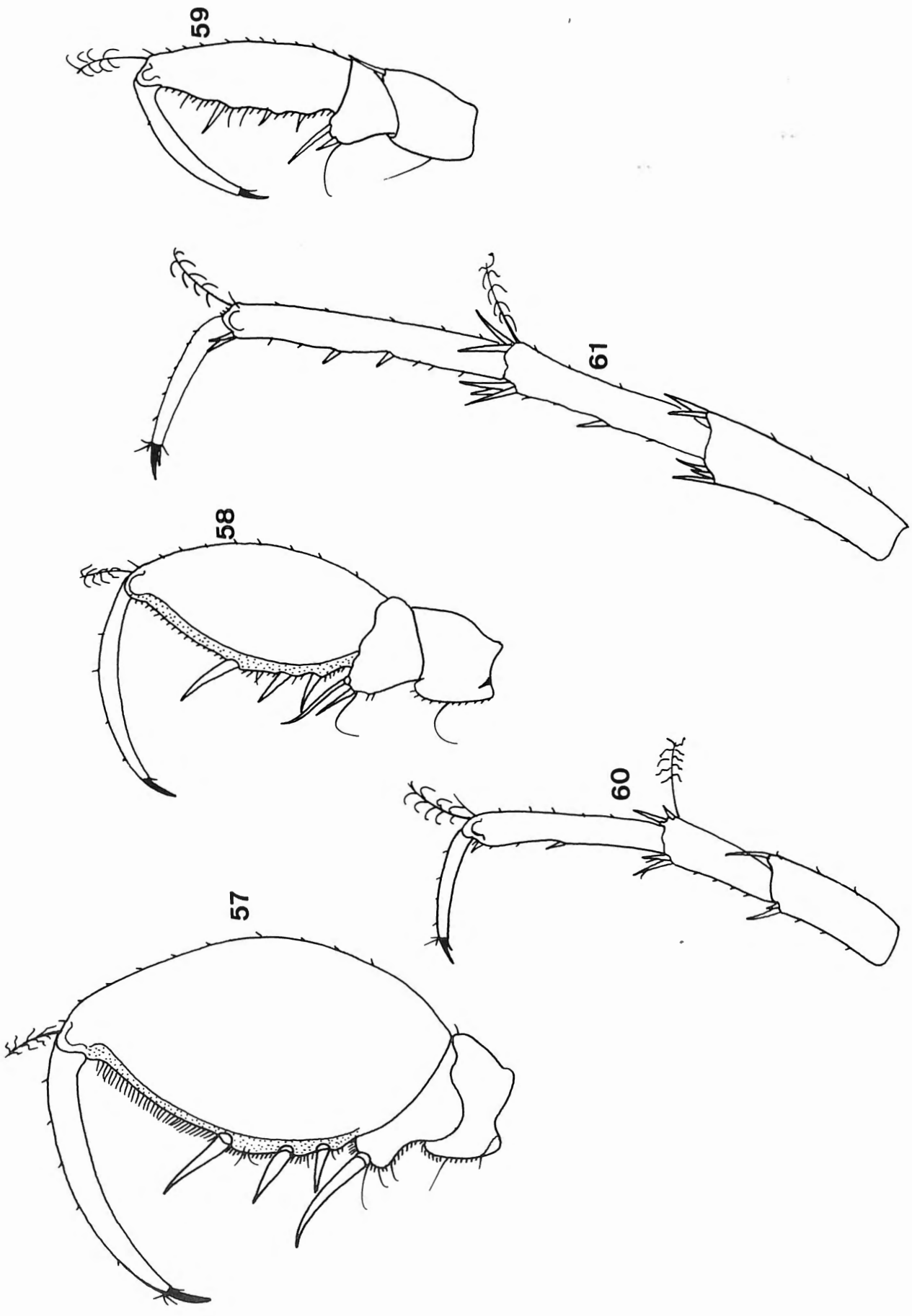
The specific name was coined from (Lat.) *dispar* = dissimilar, and *corniculum* = antenna (Plinius!), alluding to one of the remarkable distinctive characters of the new species: AI and A II of very dissimilar length. *S. dispari-cornis* n. sp. is amply distinct from all species of *Speocirolana* described to this day its most distinctive characters being: AI and A II of excessively dissimilar length, their peduncles armed with several long palmate setae; the identical armature of the two small lobes of Mx II; propodus of the raptorial P I-III of very dissimilar development; uropods entirely concealed under the pleotelson (although normally developed) and with strongly developed endopodites with peculiar architecture and setation. Of course, the new species shares some characters with already described species (one example: the cephalon outline resembles that of *S. bolivari* or *S. zumbadora* BOTOSANEANU, ILIFFE & HENDRICKSON, 1998). Nevertheless, we do not see anything representing serious evidence for close affinity with some other species.



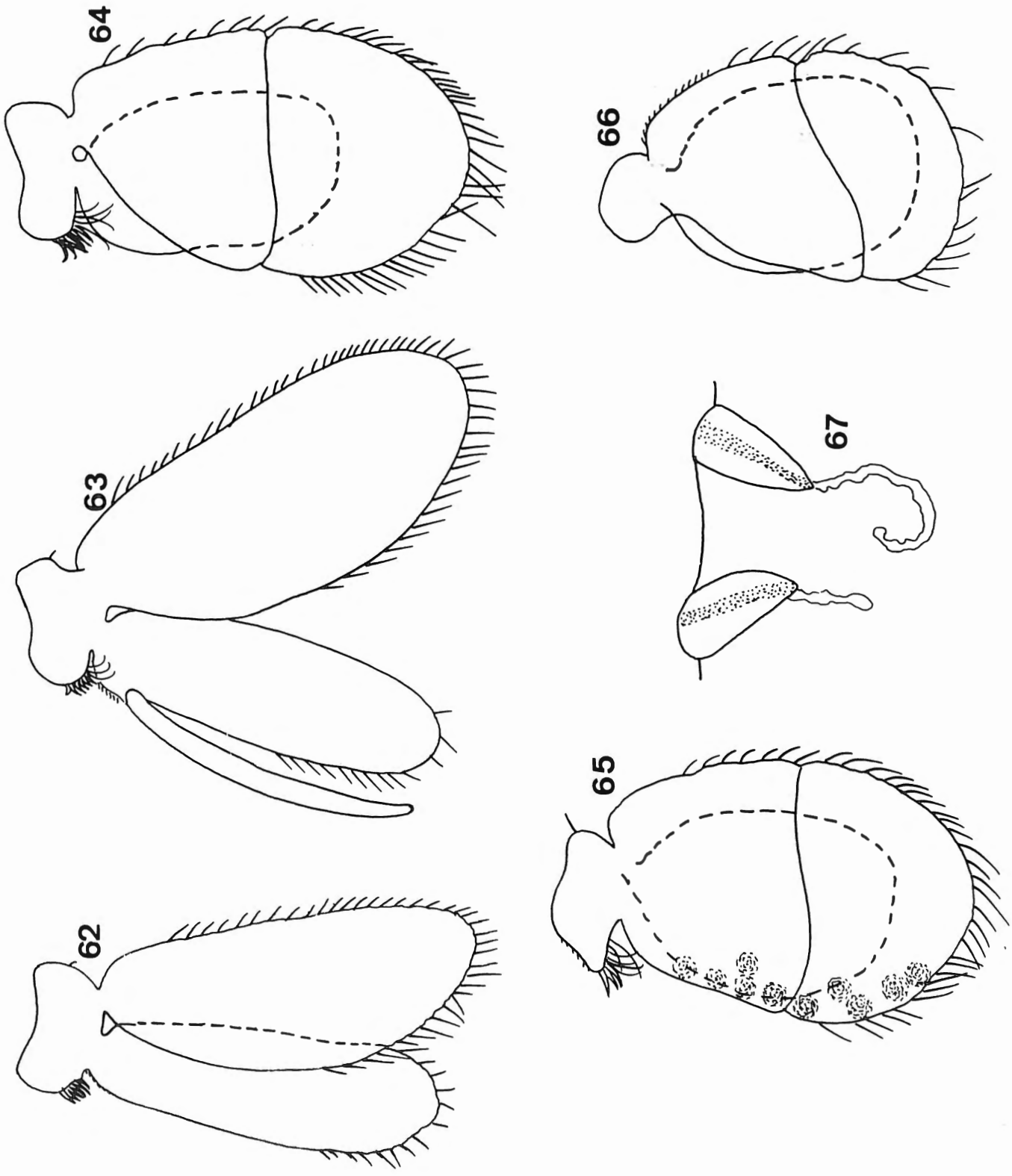
Figs. 48-51. – *Speocirolana disparicornis* n. sp., male holotype. 48. Cephalon with antennae (tip of lamina frontalis also represented). 49. Pleon and pleotelson (49 less magnified then 48). 50. Lamina frontalis, clypeus, and labrum, with 1/2 lateral and 1/2 ventral view of lamina frontalis. 51. Left AI, with strongly magnified tip of flagellum.



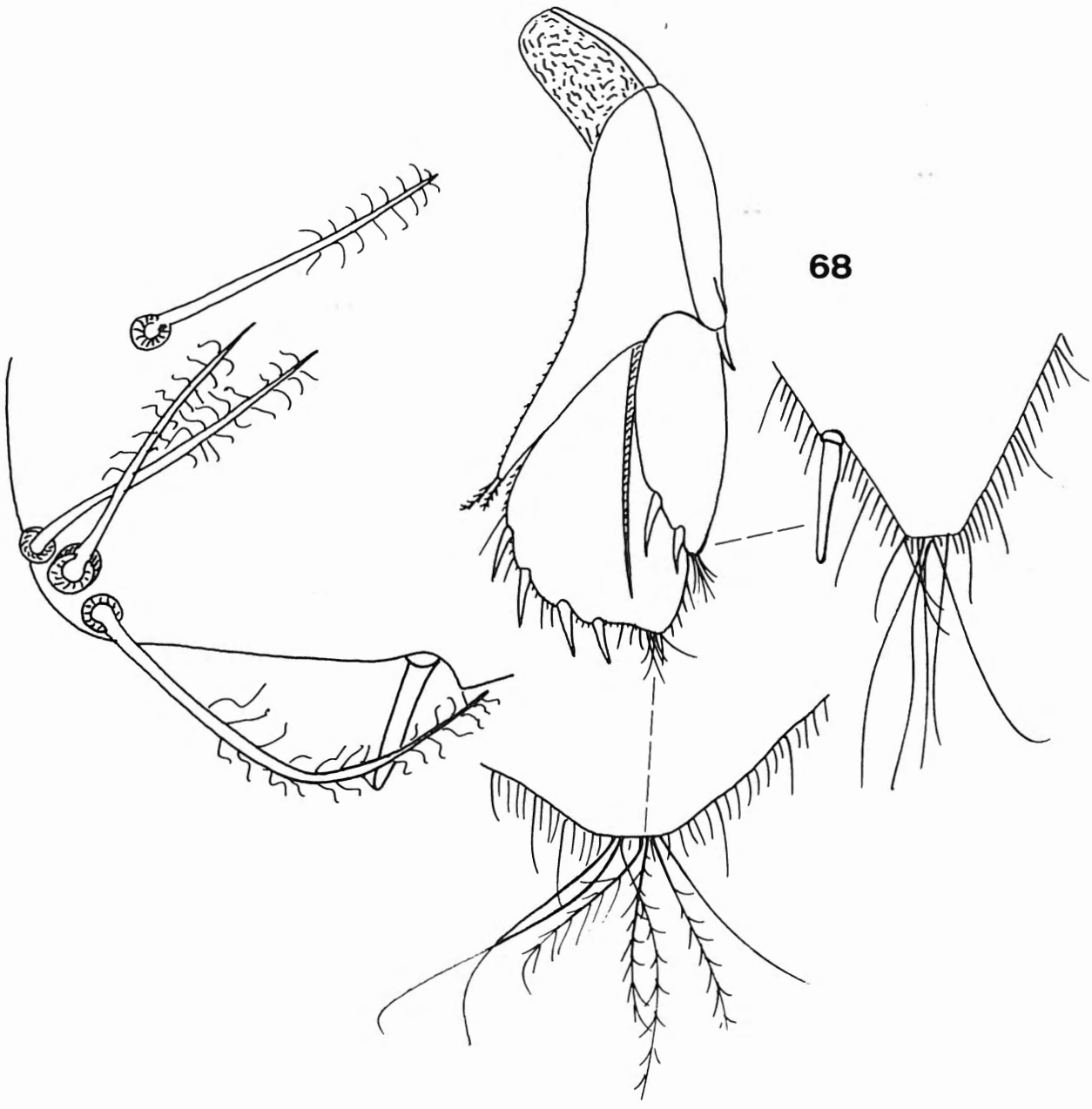
Figs. 52-56. – *Speocirolana disparicornis* n. sp., male holotype. 52. Left AII peduncle (with three flagellar articles). 53. Left Mdb. 54. Left Mx I. 55. Left Mx II (53-55: same scale). 56. Endite of left Mxp, more magnified than 53-55.



Figs. 57-61. – *Speocirolana disparicornis* n. sp., male holotype. P I-III, IV, and VII, merus and beyond it (all same scale).



Figs. 62-67. – *Speocirolana disparicornis* n. sp., male holotype. 62-66. Left Pl I-V (same scale). 67. penes.



Figs. 68. – *Speocirolana disparicornis* n. sp., male holotype. Ventral view of left uropod, with strongly magnified apices of exo- and endopodite (left side detail: apex of endopodite in dorsal view).

Yucatalana robustispina n. g. n. sp.
Figs. 69-90

MATERIAL EXAMINED

5 males (holotype and paratypes) and 4 females (allotype and paratypes) from Mexico, Yucatan: Cenote Pabakal, Eknakan; 25 July 1998 and 26 June 1999, TH. M. ILIFFE leg. 4 females (paratypes) as well as one manca and 1 exuvium, from Mexico, Yucatan: Cenote Kankirixche, Mukuyche; 21 November 1998 and 15 March 1999, TH. M. ILIFFE leg. Holotype, allotype, and several paratypes in the Z.M.A.; other specimens in the C.N.R.C. or in the I.R.S.N.B.

DIAGNOSIS OF YUCATALANA N. G.

A very small (3-4 mm) stygobitic cirolanid, not able to roll into a ball. Cephalon with round lateral bulges and rather well developed rostrum. Five well developed pleonites. Telson subtrapezoidal, with sinuous lateral margins and distal margin only with few very short setae. Short and subequal antennulae and antennae with pauci-articulate flagelli. Mandibles: acies with strong "teeth" "plump lobe" armed only with quite a few short spines, molar only with quite a few short points distant from the margin. Only pereiopod I raptorial, with very large spines with particular structure on propodus (2), carpus (1) and merus (1), and with long unguis finishing in a hook; pereiopods II- VII ambulatory, all similar (very slender),

although progressively longer. Appendix masculina subbasally inserted, with capitate apex preceded by short row of minute "teeth". A single hemispherical penis.

TYPE SPECIES

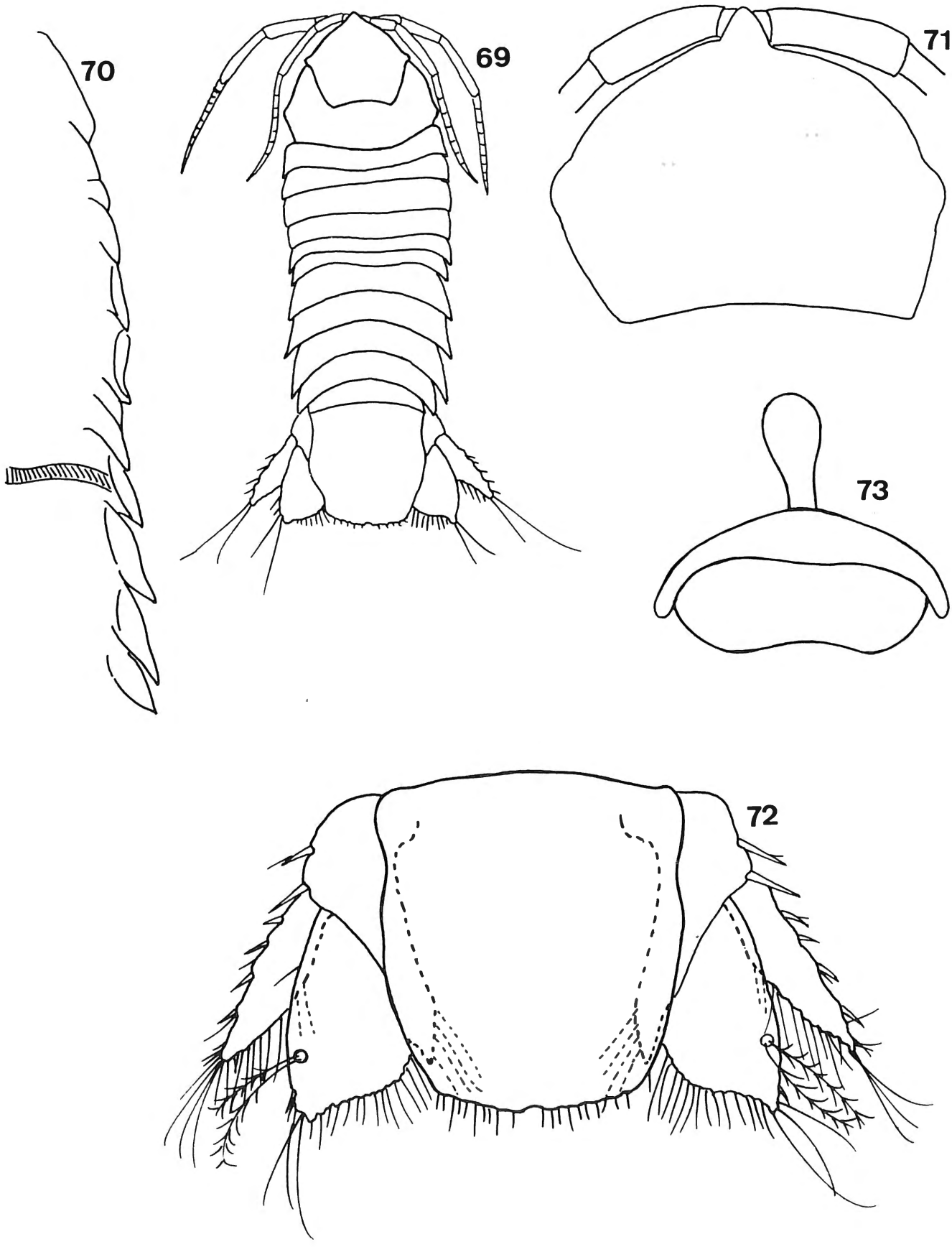
Yucatalana robustispina n. sp., here designated.

DESCRIPTION OF YUCATALANA ROBUSTISPINA N. SP.

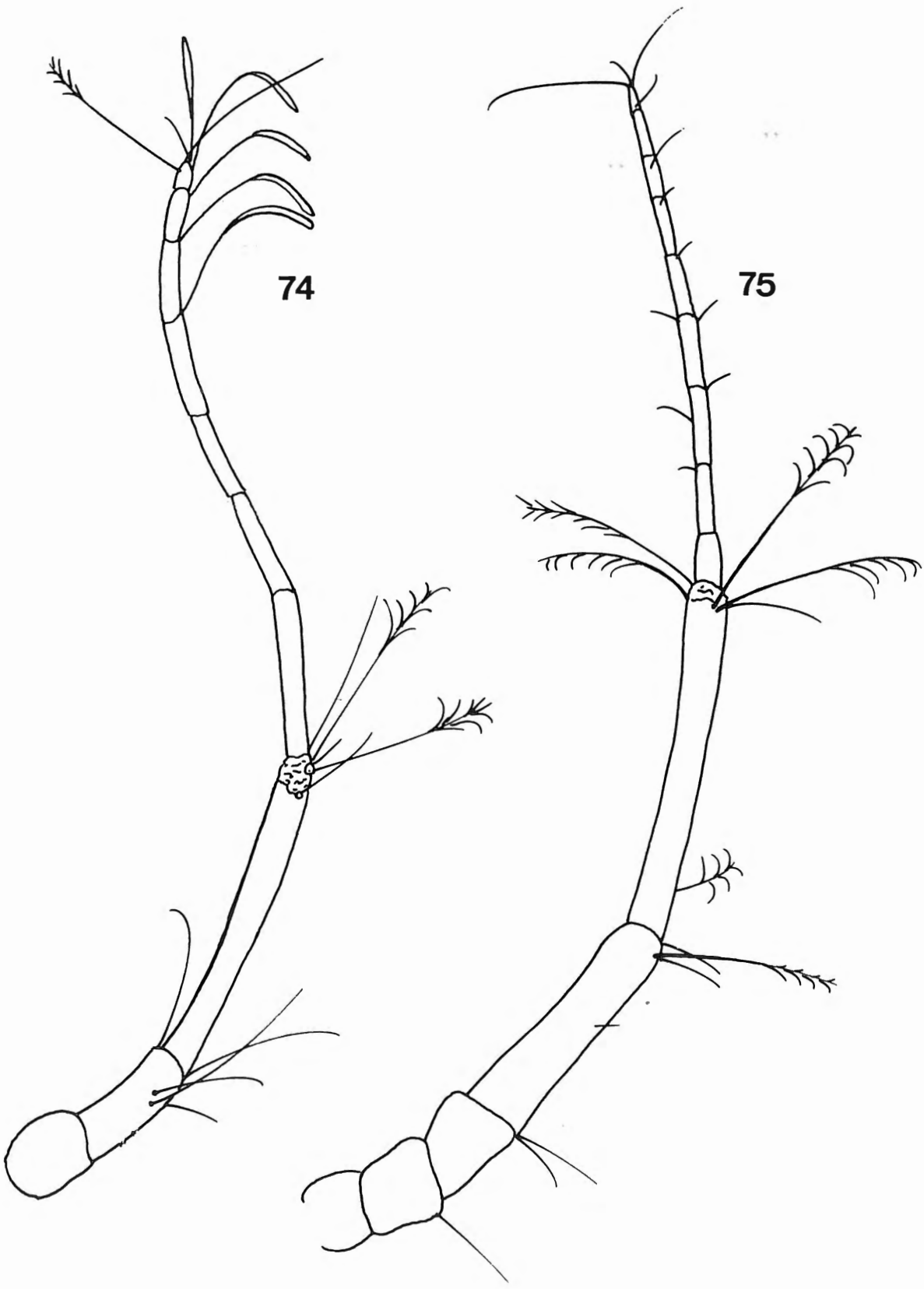
Body length: male 3 mm, female 3.5-4 mm. Cephalon on each side, almost in the middle, with distinct bulge - possibly indicating the place where the lost eyes were located, and with rather large triangular rostrum. Pereional segment I particularly well developed; pereional epimera much less developed than those of the pleonites I-IV; all 5 pleonites distinct, the inconspicuous epimera of the narrowest Vth one either free or slightly concealed under pleonite IV. Pleotelson of rather characteristic shape, subtrapezoidal but with the unarmed lateral margins sinuous near base, distal margin armed only with some very short setae, and maybe with minute median sinus.
Antennula and antenna short, subequal, not reaching beyond pereionite IV. AI peduncle with 2nd article almost two times as long as 1st, 3rd one almost two times as long as 1st and 2nd together; flagellum with only 7 elongate articles (male, female), 1st one longest, last two shortest, articles 4-6 each with one very long aesthetasc, last article with two. AII peduncle with 3 short subequal basal articles, 4th one as long as first three together, 5th article almost as long as 2-4 together; flagellum much shorter than that of AI, with only 8-9 articles (8 seen in a male paratype, 9 in a female paratype), articles elongate, 1st one shorter than the following.
Lamina frontalis club-shaped, flat, almost reaching the rostrum. Clypeus with lateral angles freely hanging. Labrum much stronger developed than clypeus, proximally emarginate.
Mandibulae: acies dissimilar in left and right mandibula, but in both with long, sharp median tooth, and well developed, round lateral tooth. Molar process large, with row of few (ca. 7) acute points on its surface (not marginal), and rows of setulae proximal and distal from them. "Plump lobe" strong, characteristically armed only with very few (2-3) minute sharp spines. Setae of 2nd article of palp all subapical.
Maxilla I: lateral lobe armed with ca. 10 longer or shorter spines, only a few of them shortly ciliate; endite shortly pedunculate, squarish, with 3 similar plumose spines.
Maxilla II: normally developed; large squarish internal lobe with 5 very dissimilar setae: the most external three small and glabrous, the following one longer and shortly plumose, internalmost one very long and strong, and equally shortly plumose; middle and external lobe slender, with 4 and respectively 2 setae.
Maxillipedal palp with 5 articles; masticatory lobe (endite) armed apically with 4 plumose setae and having one or two strong, somewhat spoon-like coupling hooks.
The pereiopods are characterized by a conspicuous dissimilarity between the gnathopod and the remaining ones. Gnathopod typically raptorial: on internal margin of merus one enormous spine, on that of the much smaller carpus, one shorter but still very strong; on the basal half of that of the strongly developed (although not very dilated) propodus, two enormous ones; all these 4 "daggers" have a characteristic structure, being like articulate in their distal half (this makes them, possibly, even more efficient weapons than normal "daggers" of the same size); the very elongate dactylus is followed by a long unguis finishing in a small, sharp hook, and devoid of additional spine; besides the 4 "daggers", the armature of the gnathopod is reduced to almost nothing. In strong contrast with the gnathopod, pereiopods II-VII are all typically ambulatory, all very slender but increasing in length from II-III to IV-VII (especially due to the outstretching of ischium and carpus).
Pleopods I and II with massive coxopodites, undivided exopodites, and large endopodites; exo- and endopodites with setose distal margins. Pleopods III-V with smaller (not very small either) coxopodites, completely bipartite exopodites with rather long marginal setae, and much smaller, glabrous endopodites. Male pleopod II with robust appendix masculina with subbasal insertion, slightly curved, basal part finely ciliate externally, with slightly capitate apex preceded by a row of 3 minute denticles.
In the male holotype, a single hemispherical penis with median position was found.
The female allotype has a well-developed marsupium in which 3 very large eggs were found.

AFFINITIES

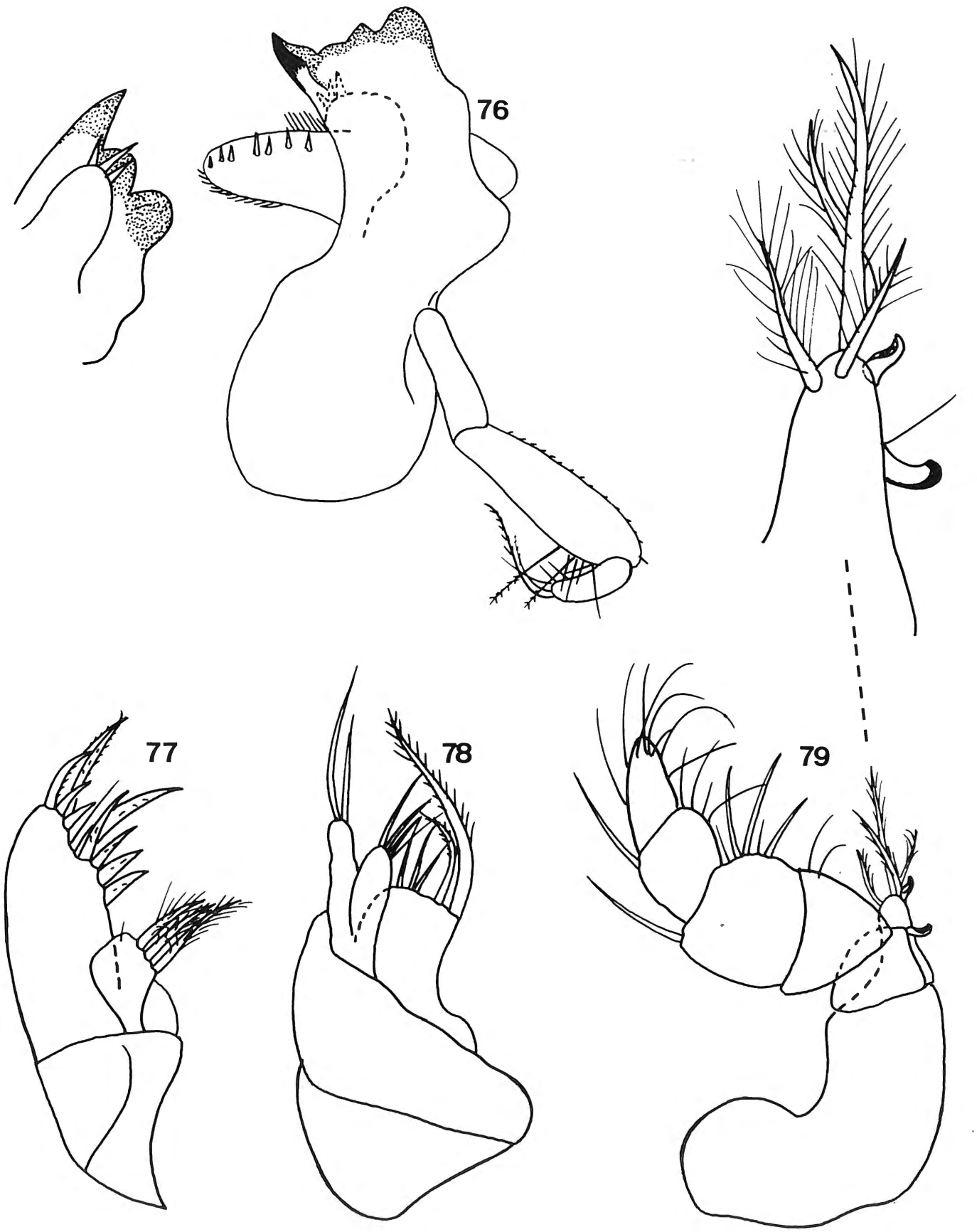
Our first idea - possibly not completely wrong - was that there may be some remote affinity with *Aruboļana* BOTOSANEANU &. STOCK, 1979 (a genus comprising 3 described species from Aruba, Jamaica, and Bermuda). Some (admittedly, vague) evidence in this direction could be the small size, the short AI and AII with pauciarticulate flagelli, the appendix masculina with relatively complex apex (something seldom seen in stygobitic Cirolanidae); and the general structure of the pleon and the armature (not the shape) of the pleotelson are not contradicting this evidence. But there are numerous, and sometimes really major differences from *Arubolana*: AI and AII subequal; lamina frontalis club-shaped, without a ventral carina; mandibular "plump lobe" with only very few spines; Mx II normally developed; Mxp. palp from five articles, masticatory lobe with normally developed retinacula; the highly characteristic set of pereiopods; appendix masculina with subbasal insertion; and the single penis. The real affinities of *Yucatalana robustispina* are enigmatic for the time being.



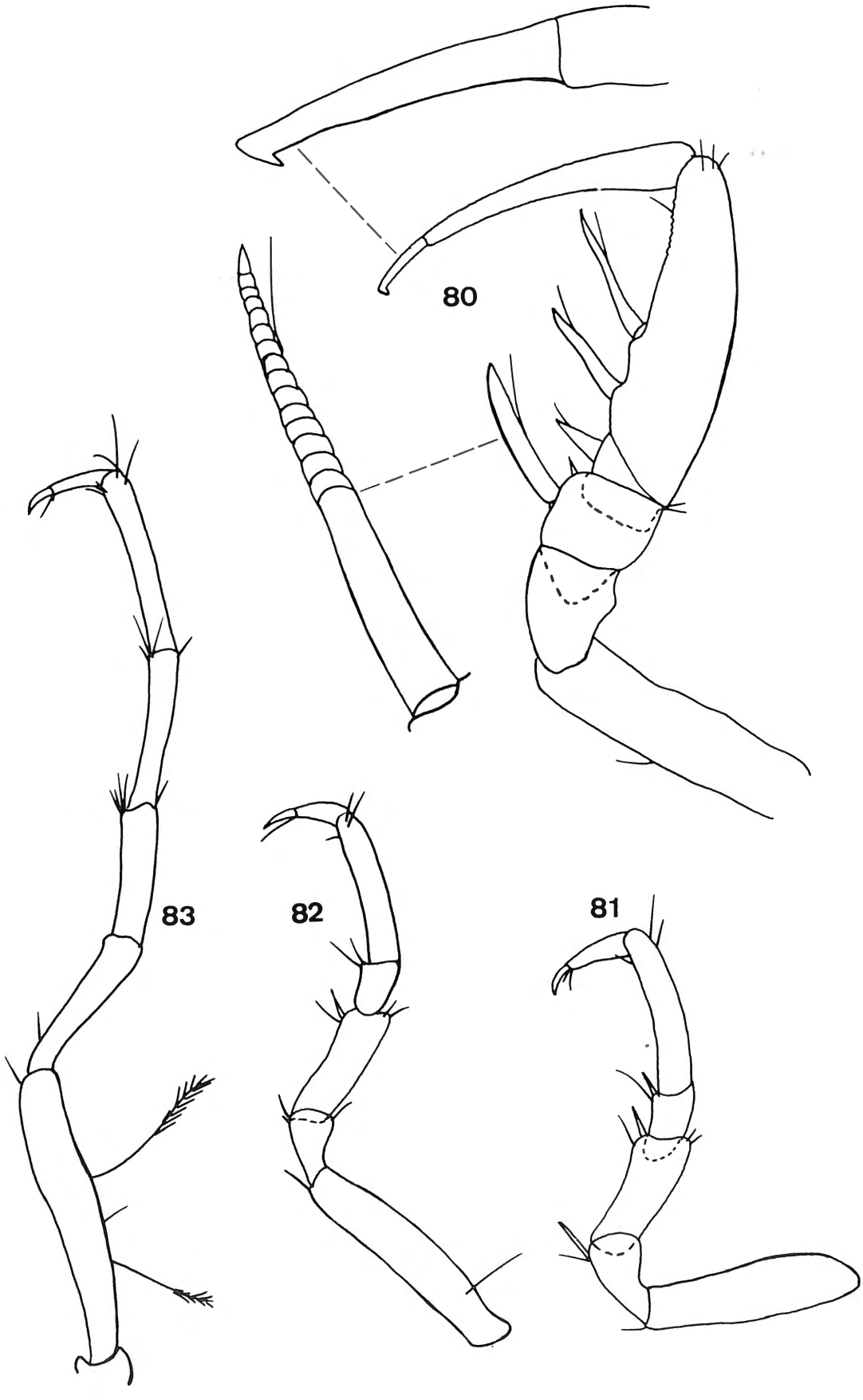
Figs. 69-73. – *Yucatalana robustispina* n. g. n. sp., female. 69. Habitus. 70. Left epimera, ventral (that - very small - of pleonite V not represented). 71. Cephalon. 72. Pleotelson and uropods. 73. Lamina frontalis, clypeus, and labrum.



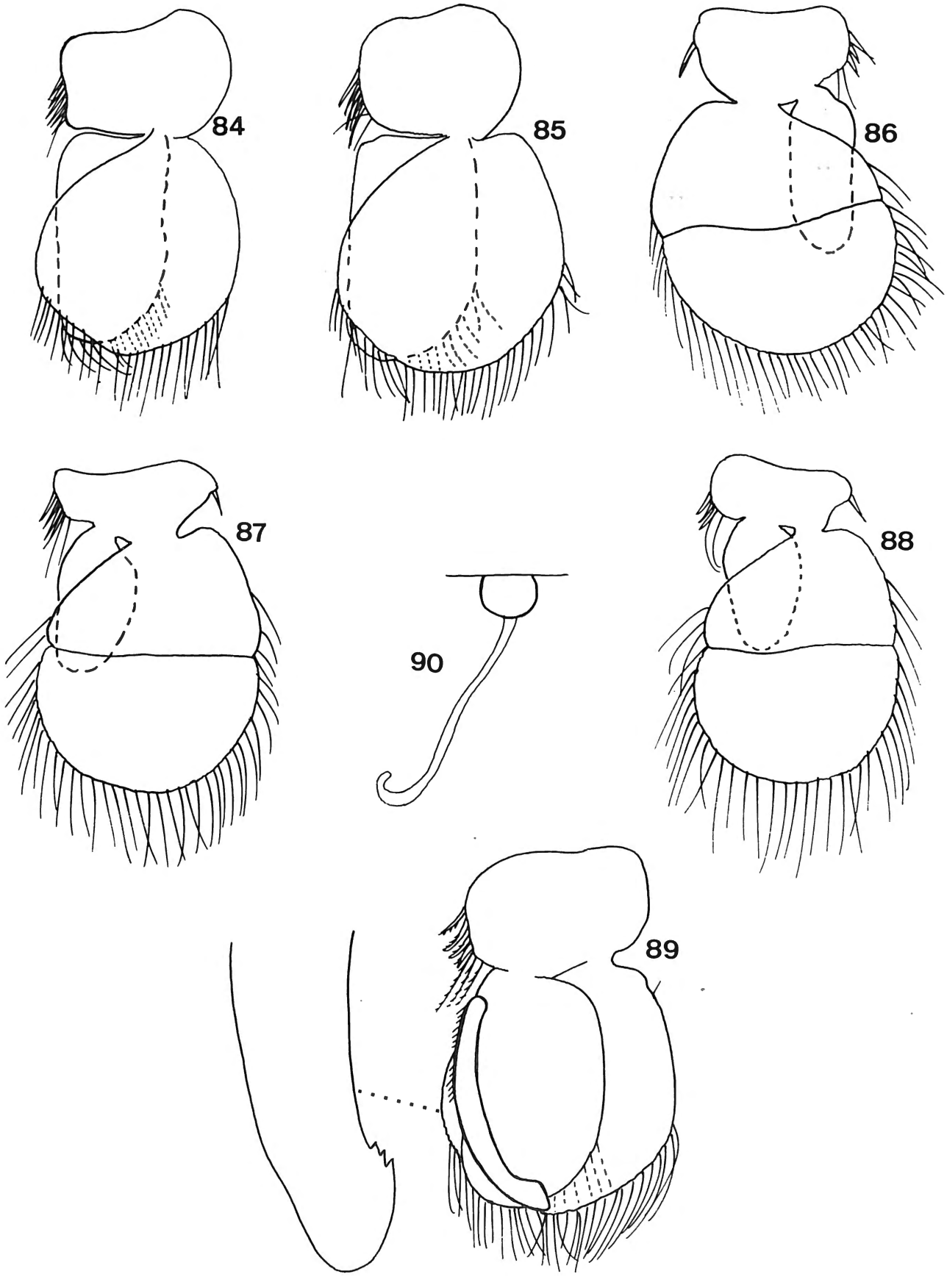
Figs. 74-75. – *Yucatalana robustispina* n. g. n. sp., female. Left AI and AII (same scale).



Figs. 76-79. – *Yucatalana robustispina* n. g. n. sp., female. 76. Left Mdb, with (left side) acies + "plump lobe" of right Mdb. 77. Right Mx I. 78. Right Mx II. 79. Right Mxp, with more strongly magnified endite (76,77,79:same scale; 78: slightly more magnified).



Figs. 80-83. – *Yucatalana robustispina* n. g. n. sp., female. Left P I-III, and VII, all same scale (P I with strongly magnified spine and unguis).



Figs. 84-90. – *Yucatalana robustispina* n. g. n. sp. 84-88. Pl I-V of female (I-II and IV-V: left; III: right; all same scale). 89. Right Pl II of male, with strongly magnified apex of appendix masculina. 90. The single median penis of the holotype (the long filament is a spermatophore).

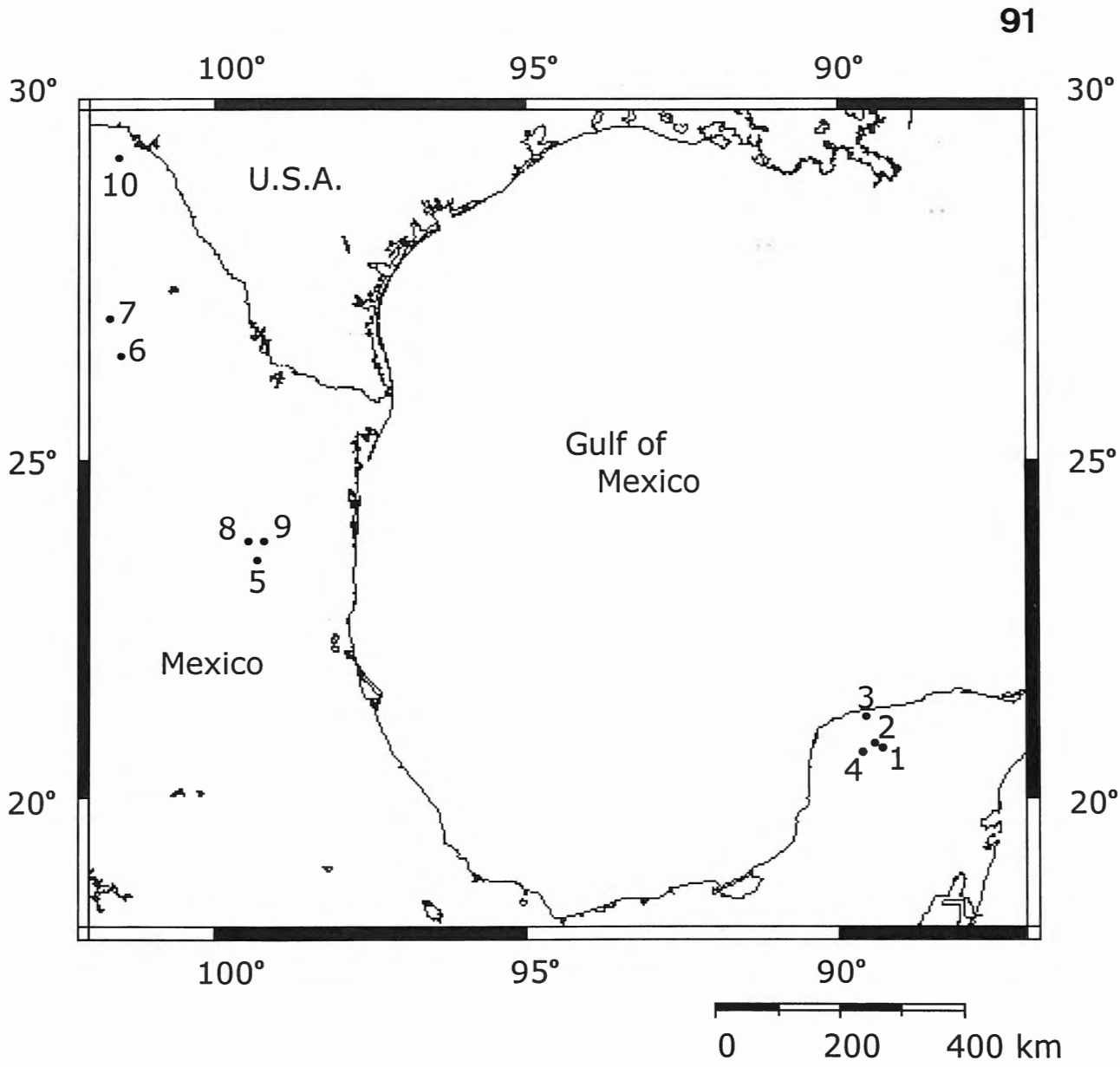


Fig. 91. – Map of Mexico showing the location of isopod collection sites: 1: Cenote Chac-Dzinic-Chee, 2: Cenote Pabakal, 3: Cenote Xlacah, 4: Cenote Kankirixche, 5: Guayatejo spring, 6: Sima Chupacable, 7: Cueva de la Espantosa, 8: Ojo Encantado, 9: Manantial La Penita, 10: Sotano de Amezcua

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