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# *Longipedia corteziensis* sp. nov. (Copepoda, Harpacticoida, Longipediidae) from a coastal lagoon in northwestern Mexico, with the definition of the *helgolandica* species-group of the genus *Longipedia* Claus, 1863

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*Key words:* Copepoda, Harpacticoida, Longipediidae, taxonomy, biogeography, Mexico

**Abstract**

A number of specimens of the genus *Longipedia* Claus, 1863 (Harpacticoida, Longipediidae) were collected during a short-term study of the harpacticoid fauna of Ensenada del Pabellón Lagoon (south-eastern Gulf of California, Mexico). These specimens turned out to belong to a new species closely related to *L. helgolandica santacruzensis* Mielke, 1979, reported from the Galapagos. The latter is raised to the species level. Both species can only be distinguished by the relative size of the inner seta of the coxa of the second swimming leg, and are closely related to *L. americana* Wells, 1980, found along the Atlantic coast of North America and the Caribbean Sea, and as far south as Mar de Dentro (Paranaguá, Brazil). The American species is shown to be related to *L. helgolandica* Klie, 1949, known from the Atlantic coast of northern Europe and south-west Africa. Finally, the *helgolandica* species-group, composed of *L. corteziensis* sp. nov., *L. santacruzensis, L. americana* and *L. helgolandica* is defined.

## Introduction

The taxonomic structure of the genus *Longipedia* Claus, 1863 has undergone drastic changes since its creation to accommodate the type species *L. coronata* Claus, 1863, collected in Germany (Helgoland) and Italy (Naples), and poorly described by Claus in 1863 (for revisions see Lang, 1948: 152–155, and Wells, 1980). In his revision, Wells (1980) recognized 10 valid species within *Longipedia,* four species *incertae sedis,* and one species *nomen dubium.* Since then, two valid species (*Longipedia andamanica nipponica* Itô, 1985, and *Longipedia spinulosa* Itô, 1981), and one species *incertae sedis* (*Longipedia* sp. Fiers, 1984) have been added.

Klie (1949: 97–100) gave a poor description of a new subspecies of *L. minor* T. & A. Scott, 1893, *L. minor helgolandica* Klie, 1949, from Helgoland, making no comment about the lack of the outer spine of the male third endopodal segment of the second swimming leg. Later, González & Bowman (1965), basing themselves on the incomplete original description of the type species by Klie (1949), and probably assuming that Klie's type material had the outer spine of the male third endopodal segment of the second swimming leg (see also Wells, 1980), identified specimens from Puerto Rico and North America with *L. minor helgolandica,* and raised this subspecies to the species level as *L. helgolandica* Klie, 1949. In 1975, Mielke reported *L. helgolandica* from the North Sea island of Sylt, and was able to point out some differences between his material and the description of the North American population provided by González & Bowman (1965), the most striking difference being the lack of the outer spine on the male third endopodal segment of the second swimming leg in his material. In his outstanding revision of the genus, Wells (1980), after analysing Klie's, González & Bowman's and Mielke's

*Table 1.* Armature formula of *Longipedia corteziensis* sp. nov. Exp, exopod; Enp, endopod; spines are denoted by Roman numerals; setae are denoted by Arabic numerals; the element or elements on the outer margin are given first; segments are separated by a hyphen

| | P1 | P2 | P3 | P4 |
|---|---|---|---|---|
| Coxa | 0-1 | 0-1 | 0-I | 0-I |
| Basis | 1.I | 1-0 | 1-0 | 1-0 |
| Exp | I-1; I-1; III-I-2 | I-1; I-1; III-I-2 | I-1; I-1; III-I-2 | I-1; I-I; II-II-1 |
| Enp | 0-1; 0-1; II-I-2 | 0-1; 0-2; II-III-I | 0-1; 0-2; II-I-3 | 0-1; 0-I1; I-II-I |

specimens, showed that the North American population is in fact a new species, *L. americana* Wells, 1980, that can be separated from the European population by several differences (Wells, 1980: 156, Table 1).

Wells (1980: 189) suggested that *L. americana* could be represented also in the Galapagos by a subspecies described by Mielke (1979) as *L. helgolandica santacruzensis,* and suggested that Mielke's subspecies of *L. helgolandica* should be transferred to a new subspecies of *L. americana.* Wells (1980) recognised that his conclusions on the separate species status of *L. helgolandica* and *L. americana* could be proven wrong by Mielke's (1979) material, especially since the male of *L. helgolandica santacruzensis* remained unknown, but stated that "Mielke's specimens cannot represent a distinct species in their own right".

The present contribution deals with the description of a new species of the genus *Longipedia* Claus, *L. corteziensis* sp. nov., from a brackish system (Ensenada del Pabellón Lagoon, northwestern Mexico) collected during a short-term study on the distribution and abundance of meiofauna (Gómez Noguera & Hendrickx, 1997). This new species proved closely related to *L. helgolandica santacruzensis, L. americana* and *L. helgolandica.* In fact, the subtle differences among *L. helgolandica, L. americana, L. helgolandica santacruzensis* and *L. corteziensis* sp. nov. throw some light on the establishment of the *helgolandica* species-group, while justifying raising *L. helgolandica santacruzensis* to the species level as *Longipedia santacruzensis* Mielke, 1979.

## Materials and methods

Triplicate sediment samples were taken in a number of sampling stations throughout Ensenada del Pabellón Lagoon (northwestern Mexico), using a 7 $cm^2$ plastic corer. The sediment samples were sifted using 500 and 63 $\mu$m sieves to separate macrofauna from meiofauna. Harpacticoids were picked out under a dissecting microscope, counted and stored in 70% ethanol. Identification and detailed observation of the specimens were made from whole and dissected material. The dissected parts were mounted separately in glycerin in semipermanent slides sealed with nail polish. Observations were made at 1250× using a Leitz Periplan phase contrast light microscope equipped with a drawing tube. The terminology proposed by Huys & Boxshall (1991) has been adopted.

*Abbreviations:* P1–P6, first to sixth swimming leg; Exp – exopod; Enp – endopod; Benp – baseoendopod.

## Taxonomical account

Order Harpacticoida Sars, 1903
Family Longipediidae Sars, 1903, *sensu* Lang, 1944
Genus *Longipedia* Claus, 1863
*Longipedia corteziensis* sp. nov (Figs 1–9)

*Material:* The following type material has been deposited in the Copepoda collection of the Institute for Marine Sciences and Limnology of the National Autonomous University of Mexico: 1 female holotype (EMUCOP-030192-37) and 1 male allotype (EMUCOP-030192-38) preserved in alcohol; 2 dissected female (EMUCOP-030192-31, EMUCOP-030192-33) and 2 dissected male paratypes (EMUCOP-030192-32, EMUCOP-030192-36) and two females (EMUCOP-240691-12, EMUCOP-030192-41), one CII (EMUCOP-040591-2), and one male paratype (EMUCOP-030192-39) preserved in alcohol. The following material has been deposited in the collection of the United States National Museum: 3 female dissected paratypes (USNM 309766, USNM 309769), and 1 female and 1 male paratypes preserved in alcohol (USNM 309768, USNM 309767).

Type locality. Ensenada del Pabellón Lagoon, Sinaloa, Mexico (24° 19′ -24° 35′ N, 107° 28′ -107° 45′ W).

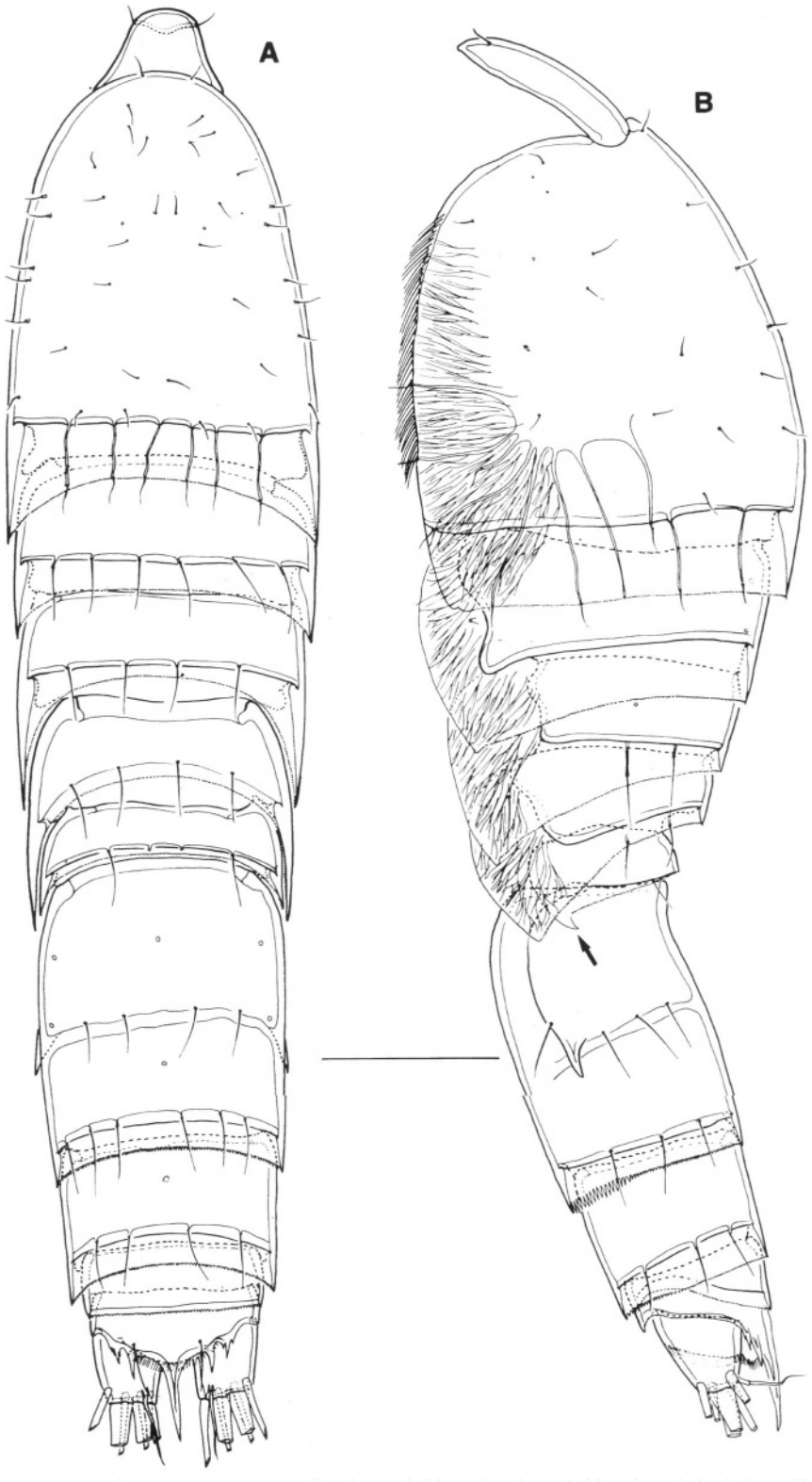


*Figure 1. Longipedia corteziensis* sp. nov., female. (A) habitus, dorsal; (B) habitus, lateral. Scale bar=100 $\mu$m.

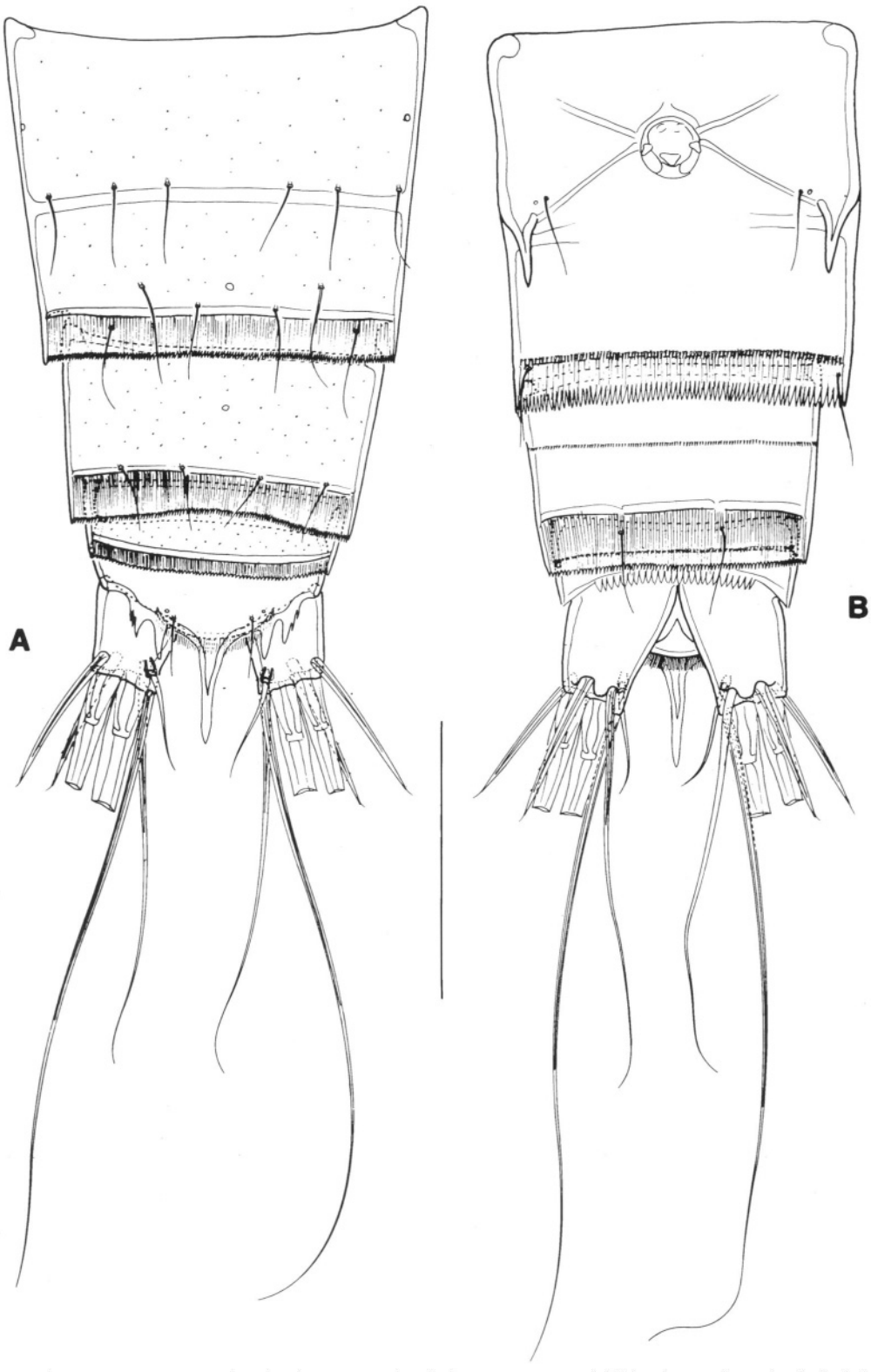


*Figure 2.* *Longipedia corteziensis* sp. nov., female. (A) urosome, dorsal; (B) urosome, ventral (P5 bearing-somite omitted). Scale bar=100 $\mu$m.

*Figure 3. Longipedia corteziensis* sp. nov., female. Antennule, showing opposite armature of proximal and distal segments. Scale bar=100 $\mu$m.

*Etymology:* The specific name refers to the Sea of Cortez.

## Description

*Female:* Habitus (Fig. 1A,B): body length ranging from 595 to 764 $\mu$m including tip of rostrum and caudal rami, tapering from posterior edge of head shield. Rostrum (Fig. 4F) articulated with cephalosome, with broad base and rounded apex, with 2 small subdistal sensilla. Cephalic shield furnished with setules along ventrolateral margin; with lateral tubular internal structures; posterior edge with finely serrated hyaline frill. Surface of prosomites smooth; lateral tubular structures and frill as in cephalosome. Major body articulation between third prosomite and first urosomite, the latter with acute posterolateral

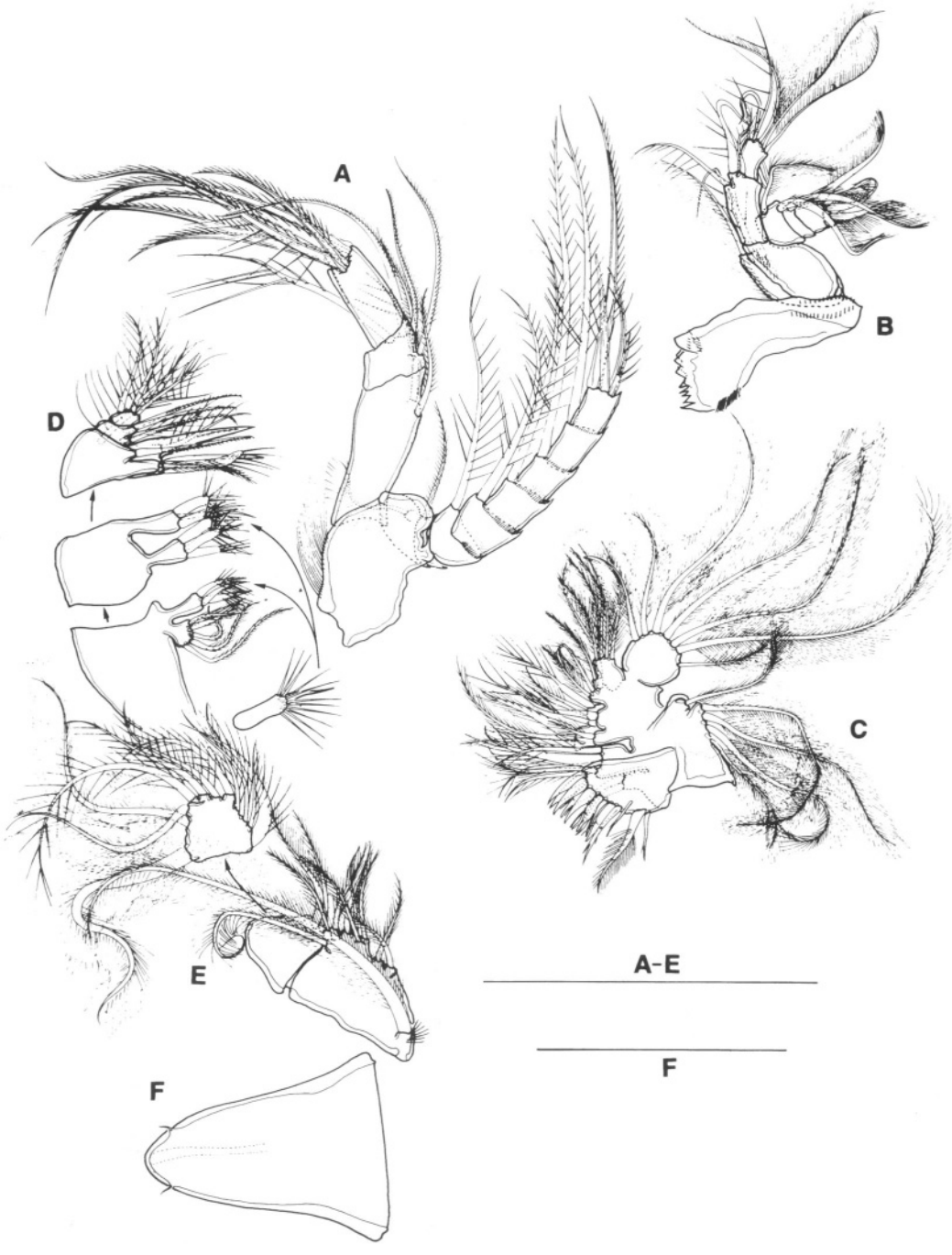


*Figure 4. Longipedia corteziensis* sp. nov., female. (A) antenna; (B) mandible; (C) maxillule; (D) maxilla; (E) maxilliped; (F) rostrum. Scale bar=100 $\mu$m.

corner. Genital double-somite (Fig. 2A,B) with complete dorsal suture; first somite with pair of lateral sharp epimeral lappets ventrally, second somite with serrated hyaline frill, the latter more accentuated in ventral view, and with ventral row of small spinules close to caudal margin. Fourth urosomite with serrated frill, the latter somewhat more accentuated ventrally. Fifth urosomite relatively small; apparently longer

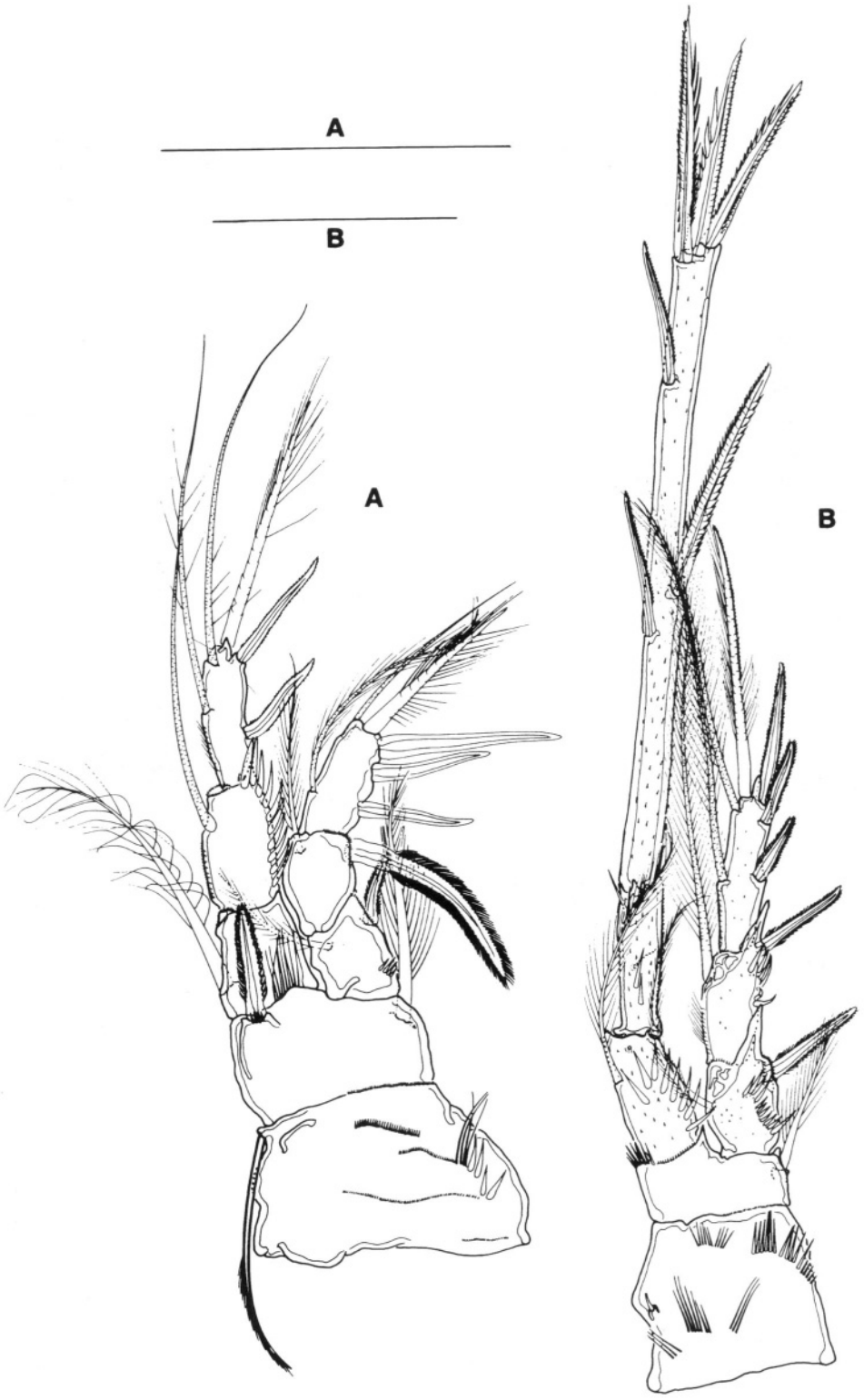


*Figure 5.* *Longipedia corteziensis* sp. nov., female. (A) P1; (B) P2. Scale bar=100 $\mu$m.

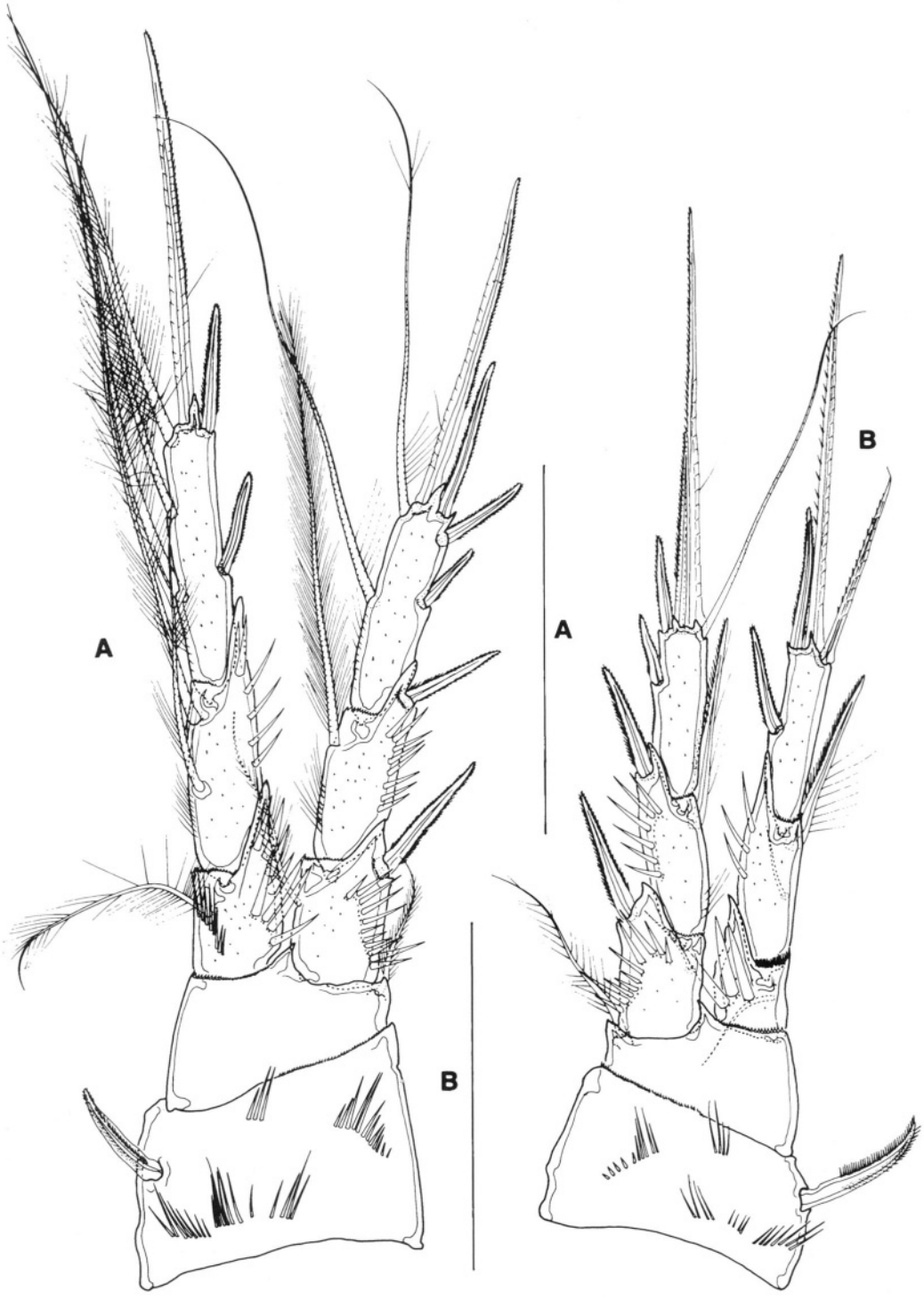


*Figure 6.* *Longipedia corteziensis* sp. nov., female. (A) P3; (B) P4. Scale bar=100 $\mu$m.

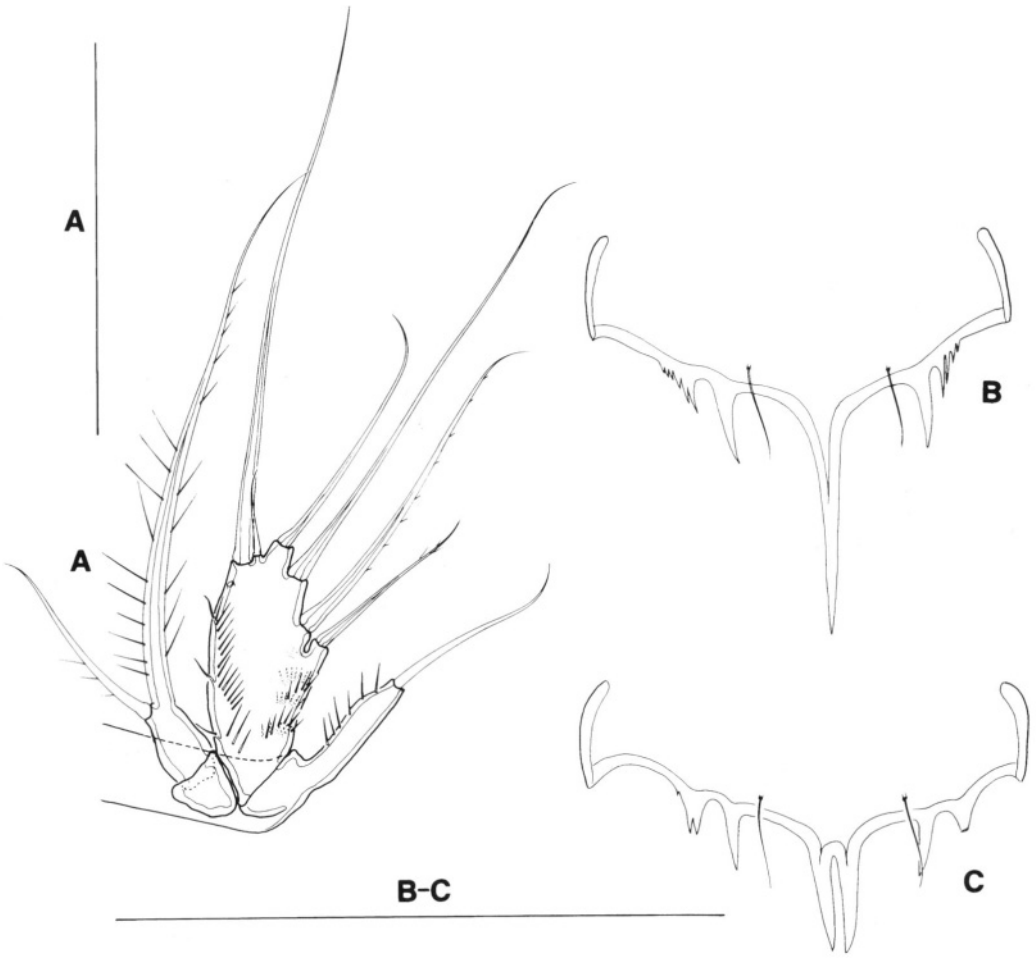


*Figure 7. Longipedia corteziensis* sp. nov., female. (A) P5; (B–C) variability of shape of anal somite, dorsal. Scale bar=100 $\mu$m.

dorsally than ventrally, with finely serrated hyaline frill. Anal somite with long median acute projection flanked on either side by pair of smaller acute projections (outermost serrated), and 1 sensillum. Anal operculum rounded, set with fringing setules. Caudal rami about twice as long as broad; with 7 elements.

*Antennule* (Fig. 3), with 6 indistinctly separated segments; integument of segments smooth except for 2 rows of long spinules and 1 row of small spinules on first segment. Third and fourth segment with 1 aesthetasc, last segment with 2 aesthetascs.

*Antenna* (Fig. 4A): basis ornamented with fragile setules close to joint with endopod, the latter three-segmented. First endopodal segment with 2, second one with 4, third one with 6 setae. Exopod eight-segmented; first to seventh segments each with 1 element, last segment with 4 setae.

*Mandible* (Fig. 4B): with multi-dentate coxal gnathobase. Basis with 2 setae, and furnished with delicate setules. Endopod two-segmented; first segment with 3, second segment with 6 setae. Exopod four-segmented; first segment with 2 elements, second and third segments with 1 seta, last segment with 2 setae.

*Maxillule* (Fig. 4C): praecoxal arthrite with 7 distal spines, 2 subdistal elements, 1 lateral bipinnate strong spine and 1 lateral spine, and 2 surface setae; coxa with 5 inner and 5 outer setae; inner edge of basis with 8 setae; endopod with 4 setae on the base and 5 on the distal portion; exopod rounded, with 7 setae.

*Maxilla* (Fig. 4D): praecoxa with 2 endites, proximal endite with 6 plumose setae, distal endite with 3 spinulose elements; coxa with 2 endites, each with 3 elements ornamented as in distal praecoxal endite; basis with claw and 6 setae. Endopod three-

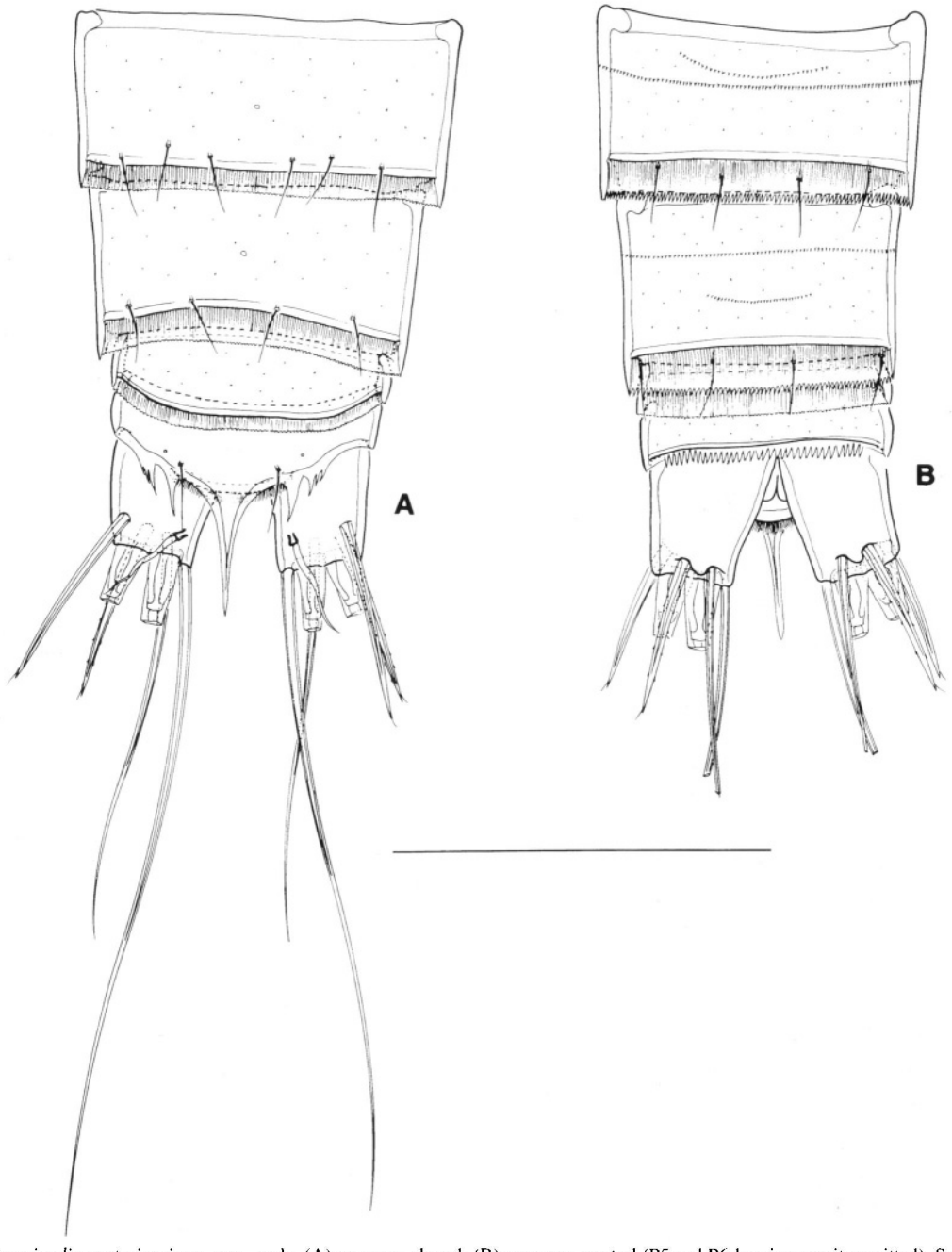


*Figure 8. Longipedia corteziensis* sp. nov., male. (A) urosome, dorsal; (B) urosome, ventral (P5 and P6-bearing somite omitted). Scale bar=100 $\mu$m.

segmented; first and second segments apparently fused, with 2 setae each; last segment with 4 elements.

*Maxilliped* (Fig. 4E): not prehensile. Praecoxa and coxa fused, with 1 long proximal seta, 2 median elements, 5 subdistal and 2 distal setae; basis with 2 setae, endopod with 11 setae.

*P1* (Fig. 5A): coxa ornamented with several rows of small spinules and 1 group of strong spinules and fragile setules near outer edge, and armed with 1 long pinnate seta directed downwards (upwards if seen from the animal in its normal position); basis smooth except for few spinules between rami and small spin-

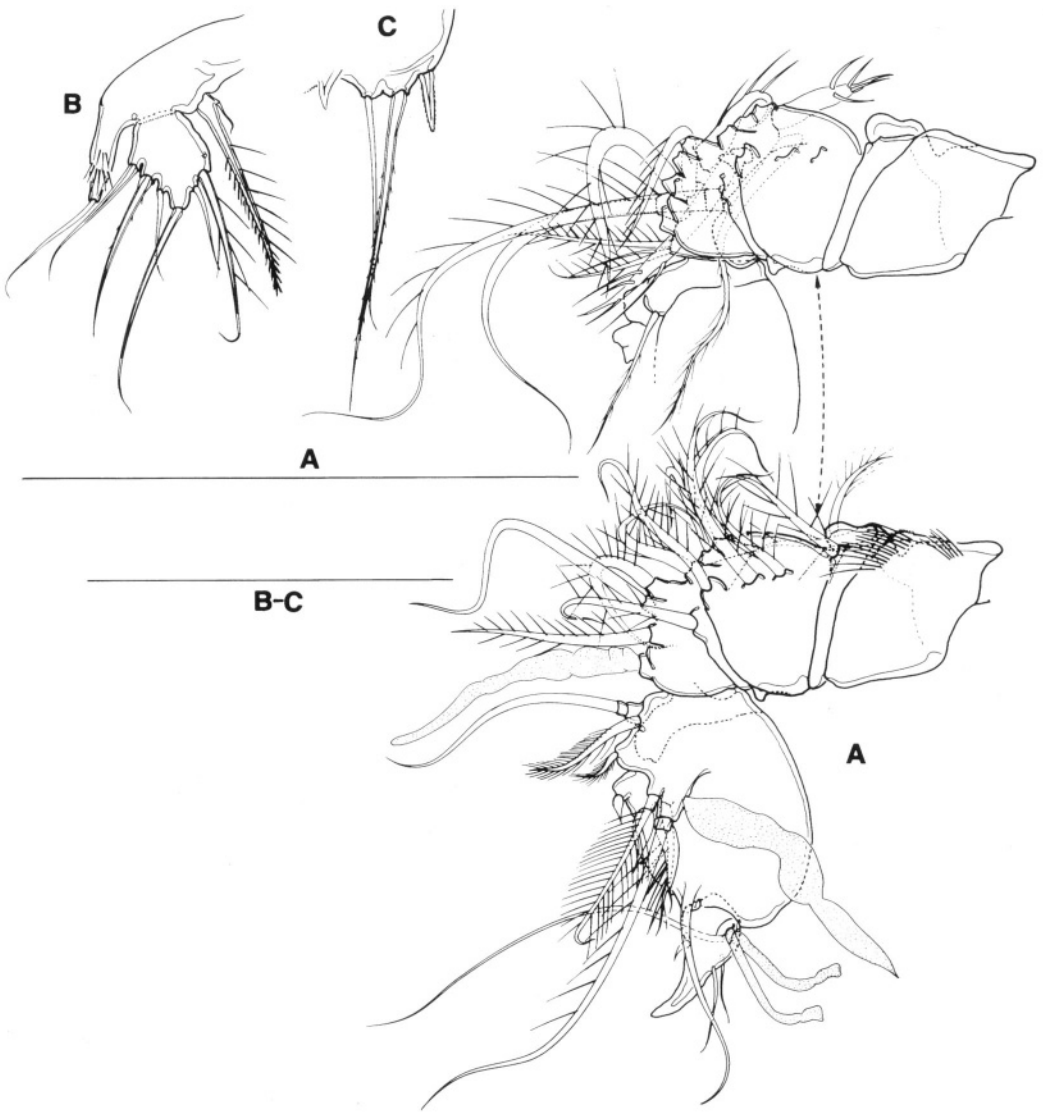


*Figure 9. Longipedia corteziensis* sp. nov., male. (A) antennule, showing opposite armature of proximal segments; (B) P5; (C) P6. Scale bar=100 $\mu$m.

ules at base of inner spine, armed with 1 long outer plumose seta. Rami three-segmented; exopod reaching proximal third of last endopodal segment. Armature formula as in Table 1.

*P2* (Fig. 5B): coxa ornamented with several groups of spinules and fragile setules, and armed with 1 tiny seta near inner edge; basis with spinules near joint with endopod, with 1 outer plumose seta. Rami three-segmented; third endopodal segment about 2.3 times longer than preceding segments combined, and about 18 times longer than broad. Armature formula as in Table 1.

*P3–P4* (Fig. 6A,B): coxa furnished with several transverse rows of spinules and with 1 additional row of minute spinules near joint with basis, the latter smooth, with inner and median acute projections, and with 1 outer plumose seta. Rami three-segmented; exopod of P3 reaching about 2/3 of third endopodal segment, of P4 as long as entire endopod. Armature formula as in Table 1.

*P5* (Fig. 7A): both distinct. Baseoendopod apparently articulated; outer seta arising from long cylindrical projection furnished with spinules. If articulated, endopod two-segmented; first segment without

armature; second segment with 1 long whip-lash shaped element and 1 inner seta at its base. Exopod with 6 setae.

*Male:* Habitus (not illustrated), as in female, except for genital double-somite (Fig. 8A,B). Length 527–550 $\mu$m including rostrum and caudal rami. Third and fourth urosomite with continuous ventral row of spinules. Fifth urosomite, anal somite and caudal rami as in female.

*Antennule* (Fig. 9A): five-segmented, chirocer; third and fourth segment with 1 aesthetasc, last segment with 2 aesthetascs.

Mouthparts and P1–P4 (not illustrated) as in female.

*P5* (Fig. 9B): both confluent. Baseoendopod clearly not articulated; baseoendopodal lobe as in female, though relatively smaller and with reduced accessory seta. Exopod with 6 setae.

*P6* (Fig. 9C): represented by a lappet with 1 inner spine and 2 outer setae.

*Variability:* The only variability observed consists of the structure of the anal somite (Fig. 7B,C).

## Discussion

The new Mexican species herein described proved more closely related to *L. helgolandica santacruzensis,* than to *L. helgolandica* or *L. americana,* especially with regard to the state of the female P5 baseoendopod (Table 2). Besides the differences listed in Table 2, other minor differences between *L. helgolandica santacruzensis* and *L. corteziensis* sp. nov, and *L. helgolandica* and *L. americana* can be found when comparing the relative length of the distal element of P4 Enp 2 and of the inner spine of P4 Exp 2. These are comparatively longer in *L. helgolandica santacruzensis* and *L. corteziensis* sp. nov. than in *L. helgolandica* and *L. americana.*

*Longipedia helgolandica santacruzensis* and *L. corteziensis* sp. nov. share some features with *L. americana* that are not present in *L. helgolandica* (see Table 2), i.e. *L. helgolandica santacruzensis* and *L. corteziensis* sp. nov. are more closely related to *L. americana.*

*Longipedia helgolandica santacruzensis* and *L. corteziensis* sp. nov. can be easily mistaken for each other. However, both species can be distinguished by the inner element of coxa of P2, which appears as a slender and relatively longer seta in *L. helgolandica santacruzensis,* and is very reduced in *L. corteziensis* sp. nov. (compare Fig. 5B in this study with Mielke, 1979: 15, Fig. 4B). In my opinion, *L. helgolandica santacruzensis* Mielke, 1979, can be considered as a distinct species from those mentioned above, i.e. Wells' (1980) suggestion considering this taxon as a new subspecies of *L. americana* lacks sufficient grounds. Therefore, *L. helgolandica santacruzensis* warrants raising to species level.

Seeking the phylogenetic relationships among the species of a given genus according to the reduction in segmentation and armature of the mouthparts, legs and somitic ornamentation among other characters, is a generally accepted procedure. As in many taxa, the reduction in number of setae/spines in *Longipedia* seems to occur at random, leading to a weird assemblage of apomorphic and plesiomorphic character states that makes their phylogenetic analysis difficult. After detailed analysis of the state of a number of characters that I considered potentially useful to analyse the phylogenetic relationships among the species of *Longipedia,* only one synapomorphy could be found to define the *helgolandica* species-group (*L helgolandica, L. americana, L. santacruzensis* and *L. corteziensis* sp. nov.). This is the reduction of the inner spine of P4 Enp 1 to a setiform element (the remaining species exhibit a spiniform element). Following the analysis, the American taxa are eventually united by three synapomorphies, namely the lack of sexual dimorphism regarding the chaetotaxy of P2 Enp 3, reduction of the inner element of the coxa of P2 to a slender seta, and the pore pattern in male and female P5 Exp (the male of *L. santacruzensis* remains unknown). *Longipedia helgolandica* and the remaining species do exhibit sexual dimorphism in the chaetotaxy of the male P2 Enp (the male of *L. weberi* A. Scott remains unknown), a spiniform inner element of the P2 coxa, and the lack of pores in the male and female P5 Exp. The Pacific taxa, *L. santacruzensis* and *L. corteziensis* sp. nov. can be defined by one more synapomorphy, namely the presence of an apparently articulated female P5 and, as stated above, can be distinguished by the relative size of the inner element of the P2 coxa, being markedly smaller in the latter.

The lack of sexual dimorphism in P2 Enp 3, inner element of coxa of P2 being setiform and progressively reduced through *L. helgolandica, L. americana, L. santacruzensis* and *L. corteziensis* sp. nov., presence of an articulated female P5 Benp and pores in the male and female P5 Exp, are considered here as the most apomorphic state of these characters. Therefore, it is perfectly logical to envisage a scen-

*Table 2.* Differences between *L. helgolandica* Klie, *L. americana* Wells, *L. santacruzensis* Mielke and *L. corteziensis* sp. nov. (modified after Wells, 1980: 156, Table 1). P2 Exp 1, first exopodal segment of the first swimming leg; Enp 3, third endopodal segment; P2 Enp 3, third endopodal segment of the second swimming leg; P4 Enp 2, second endopodal segment of the fourth swimming leg; P5 Benp, baseoendopod of the fifth swimming leg; P5 Exp, exopod of the fifth swimming leg

| | *L. helgolandica* Klie | *L. americana* Wells | *L. santacruzensis* Mielke | *L. corteziensis* sp. nov. |
|---|---|---|---|---|
| Abdominal ornamentation | Sparse but with some well developed rows of spinules | Extremely sparse; spinulation very restricted | Extremely sparse; spinulation very restricted | Extremely sparse spinulation very restricted |
| P2 Coxa | Well-developed, spiniform inner element. Long proximal spinule row, with short spinules | Reduced, setiform inner element. Short proximal long spinules | Reduced, setiform inner element. Short proximal spinule row, with spinule row, with long spinules | Very reduced, setiform inner element. Short proximal spinule row, with long spinules |
| P2 Exp 1 | Normally developed unguiform projection | Massive unguiform projection | Massive unguiform projection | Massive unguiform projection |
| P2 Enp 3 | Outer spine absent in male, i.e. chaetotaxy of male Enp 3 different from female Enp 3 | Outer spine present in male, i.e. chaetotaxy of male Enp 3 the same as female Enp 3 | Male unknown | Outer spine present in male, i.e. chaetotaxy of male Enp 3 the same as female Enp 3 |
| P4 Enp 2 | Moderately well developed proximal inner seta | Small and weak proximal inner seta | Small and weak proximal inner seta | Small and weak proximal inner seta |
| Female P5 Benp | Not articulated | Not articulated | Articulated; with two-segmented endopodal lobe | Articulated; with two-segmented endopodal lobe |
| Female P5 Exp | No ornamentation on posterior face. No tubercle | Minute spinules on posterior face. Tubercle present | Omitted | Minute spinules on posterior face. Tubercle present |
| Male P5 Exp | No tubercle | Tubercle present | Male unknown | Tubercle present |

ario where the state of a number of characters (see Table 2) observed in *L. helgolandica* are the most plesiomorphic ones, followed by those of *L. americana. Longipedia santacruzensis* and *L. corteziensis* sp. nov. prove to exhibit the most apomorphic states of these characters. Bearing this in mind, a similar biogeographical history to that of *Darcythompsonia fairliensis* T. Scott, 1899 (Gómez, 2000), and certain species of *Leptastacus* T. Scott, 1906 (Huys, 1992) can be envisaged, i.e. they follow a track, to some extent similar to Rosen's (1975) Eastern Atlantic (West African)-Caribbean track and Stock's (1993: 808, Fig. 4) Amphi-Atlantic/eastern Pacific track.

The ancestral *L. helgolandica* was probably distributed along only a part of the Tethys shores (those corresponding to northern Europe and the west coast of Africa) during the Early or Late Jurassic–Early Cretaceous period (about 135–152 Myr BP), well before the opening of the Atlantic Ocean. The opening of the Atlantic Ocean eventually led the ancestral population to split into two subpopulations that started speciating at their own rates, the present day *L. americana* in the northwestern Atlantic and *L. helgolandica* in the northeastern Atlantic. Jakobi (1954: 210–211, Fig. 1) described *L. mourei* Jakobi, 1954, from Brazil. This species has been considered as *incertae sedis* by Wells (1980: 180) on the basis of Jakobi's poor description. Bearing in mind that *L. helgolandica* has been reported from southwest Africa and that *L. mourei* somewhat resembles *L. americana* (after Wells, 1980),

*L. mourei* could well represent another component of the *helgolandica* species-group. However, this requires a detailed redescription of Jakobi's material, which is apparently unavailable (Wells, 1980).

Despite *L. minor* T. & A. Scott, 1893, haying been reported from the northeastern Atlantic coast of Europe (as well as sites in the Mediterranean), and from Angola (Scott, 1894) and Guinea-Bissau (Marques, 1947; but see also Wells, 1980), it has not been reported from American localities, and so it remains unexplained why this species is not represented along western Atlantic coasts.

*Longipedia americana* reached the northwestern coast of South America (along-shore dispersal is presumed) probably during the Early Tertiary period (about 65 Myr BP), before the consolidation of the Central American isthmus (see Malfait & Dinkelman, 1972; Rosen, 1975), whose consolidation led to *L. santacruzensis* about 40 Myr BP (Early Oligocene), when the ancestral Galapagos originated as a series of islands (see Holden & Dietz, 1972). Along-shore dispersal and further speciation would explain the presence of a closely related taxon, *L. corteziensis* sp. nov. in the mouth of the Gulf of California.

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