

Two co-occurring new *Karllangia* species (Copepoda: Ameiridae) from the Caribbean coast of Costa Rica

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Abstract: Two co-occurring species of the copepod genus *Karllangia* were found in the beach slope of Manzanillo, Caribbean coast of Costa Rica. Until now, the taxon has comprised three species from the Red Sea (*K. arenicola arenicola* Noodt, 1964), North Andaman and Car Nicobar Island (*K. arenicola bengalensis* Wells & Rao, 1987), Inhaca Island of Mozambique (*K. psammophila* Wells, 1967), and South Africa (*K. tertia* Kunz, 1975). The discovery in Costa Rica suggests a circumtropical-subtropical distribution of *Karllangia*. The characteristic sexual dimorphism of the 2nd antennae is interpreted as a significant synapomorphy of both new Costa Rican species (*K. pulchra* and *K. obscura*), which together with *K. psammophila* and *K. a. bengalensis*, probably constitute a monophyletic subgroup.

Key words: *Karllangia*, Copepoda, mesopsammal fauna, Caribbean coast, Costa Rica.

Careful analysis of the mesopsammal species composition of a sandy beach occasionally reveals surprising results. For example, detailed quantitative transects of beach slopes sometimes show a confusing distribution pattern of a "variable species" suggesting that, in reality, it deals with two or even more similar (sibling) species (see Westheide 1972).

Generally, it is difficult to ascertain whether the co-occurrence of a species pair depends on speciation processes within the locality or on a secondary immigration of one (or both) of the species into the habitat (compare Ax 1977).

A considerable number of publications is available treating various aspects of differences between closely related, coexisting harpacticoid copepods (e.g. Bergmans & Janssens 1988, Ivester & Coull 1977, Marcotte 1984). According to the competitive exclusion principle, two species cannot exist within the same habitat if they occupy identical ecological niches (e.g. Hardin 1960). Though field data combined with laboratory experiments are

highly desirable to explain the factors excluding the interspecific competition within such a species pair, the evidence is often restricted to morphological findings. Thus, the realization of the co-occurrence of two *Karllangia* species came only after the dissection of several specimens far from the *locus typicus*: the beach of Manzanillo, on the Caribbean coast of Costa Rica. In any case, the knowledge of the species morphology is the necessary prerequisite for further investigation.

To sum up, since such examples are presumably more frequent than actually documented, the demand of ecologists that systematists offer keys based solely on habitus drawings for ecological statements on genus (extent often arbitrarily changed) or even species level is unrealistic in terms of benthic copepods.

MATERIAL AND METHODS

Several animals of both species were collected in the beach slope of Manzanillo, on

the Caribbean coast of Costa Rica (10° N, 84° W). The specimens were washed out from the sediment, sorted under a dissecting microscope and fixed in 4% formalin seawater solution. Some animals of both species were dissected on slides in W 15 medium (Zeiss); the components were embedded either in W 15 medium or a gum-chloral medium. The covers were then mounted with Eukitt and DePeX. Drawings were made with the aid of a camera lucida (Mielke 1992). The material has been deposited in the collections of the Zoological Museum of the University of Göttingen.

Systematic account

Ameiridae Monard, 1927, emend. Lang, 1936
Karllangia Noodt, 1964

Karllangia pulchra n. sp. (Figs. 1-6)

Locality and material. Playa Manzanillo (Locus typicus; 7 September 1990. Corresponds to locality 3 in Mielke 1992); several adult specimens.

5 ♀♀ and 3 ♂♂ were dissected. Holotype female, reg. no. II CR 5a-j; paratypes the other dissected animals, reg. no. II CR 6 and 7, I CR 84 - 88.

Rostrum, 2. antenna, 2. maxilla and maxilliped are drawn from holotype.

Description

Female: Body length of dissected specimens from tip of rostrum to end of furcal rami 0.33 - 0.38 mm (holotype 0.33 mm). Contour of tongue-shaped rostrum very weak; 2 slender setae laterally (Fig. 2A). Dorsolateral hyaline frill of pereioneres and abdominal somites - with the exception of anal somite - with transparent lobes (cephalothorax indistinct). Ventral distal edge of genital double-somite with spinules on lateral part. Whole distal ventral edge of following somite furnished with spinules. Distal ventral edge of penultimate somite apparently also with transparent lobes (or smooth?). Anal somite with spinules on ventral distal edge. Genital double-somite partly subdivided, dorsal surface stubbly. Genital valves (P.6) of genital area each with 2 setae of different lengths. Anal operculum set with more than 20 slender spinules. Furca slightly broader than long, ventral edge

somewhat protruded and furnished with some spinules; distal outer edge carrying a slender seta. Dorsal seta bipartite at base, standing rather distally. Both terminal main setae spinulose distally, accompanied inside and outside by a slender seta. Inner dorsal surface set with setules (Figs. 1A-C).

1. Antenna (Fig. 2B): 9 segments (last dividing line indistinct). Aesthetascs on 4th and last segment.

2. Antenna (Fig. 2C): Basis with indicated tendency to fuse with endopodite. 1st endopodite-segment carrying 1 seta. 2nd endopodite-segment with 2 spines on anterior edge and 7 appendages apically, 4 of them being geniculate, 1 seta very thin, 2 appendages are fused basally. Exopodite 2-segmented. Proximal segment with 2 setae, distal segment with a hook and 3 setae, basal of which apparently slightly variable in length.

Mandible (Fig. 2D): Chewing edge of precoxa weakly dentate; subapically with a plumose seta. Coxa-basis with 2 hooks laterally and 3 setae apically. On the edge proximal to the exopodite often some hyaline structures are visible; it probably deals with algae (not drawn). Endopodite furnished with 2 setae at inner mid length and 6 setae at distal end. Exopodite short, with 2 setae.

1. Maxilla (Fig. 2E): The presentation of both maxillae is rather difficult because of their weak contours and their clinging setae. Apparently the arthrite of precoxa has 2 stronger and 3 slender appendages apically and 2 setae, each on a socle, on outer surface. Coxa with 4 setae on endite and 1 seta on exite. Basis with at least 5 setae. Endopodite consisting of a slender segment (or only representing the united parts of setae?) having 3 setae. Exopodite represented by a minor socle bearing 1 seta.

2. Maxilla (Fig. 3A): Syncoxa with three endites having 3,2(3?), 2(3?) setae as seen from proximal to distal. Basis with 1 claw and 2 setae. Endopodite with two indicated segments and 4-5 setae altogether.

Maxilliped (Fig. 3B): Basis with a slender seta and some spinules. Endopodite with a claw and an accompanying setule.

P.1 (Fig. 4A): Coxa with some rows of spinules. Basis on distal edge between both rami and on outer edge with spinules; two spine-like appendages on inner part and on outer

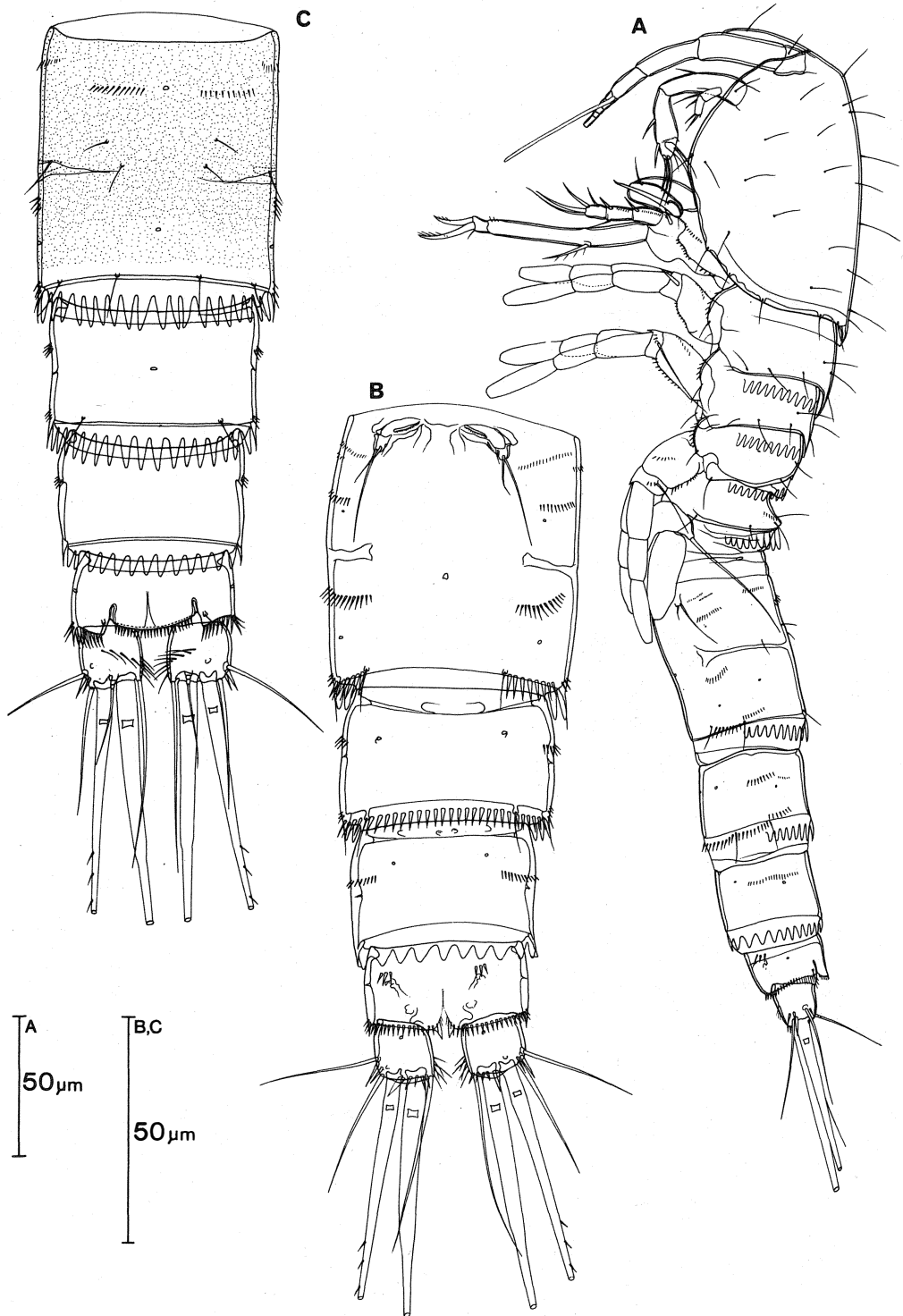


Fig. 1. *Karllangia pulchra* n. sp., ♀- A. Habitus, lateral side; B. Abdomen, ventral side; C. Abdomen, dorsal side.

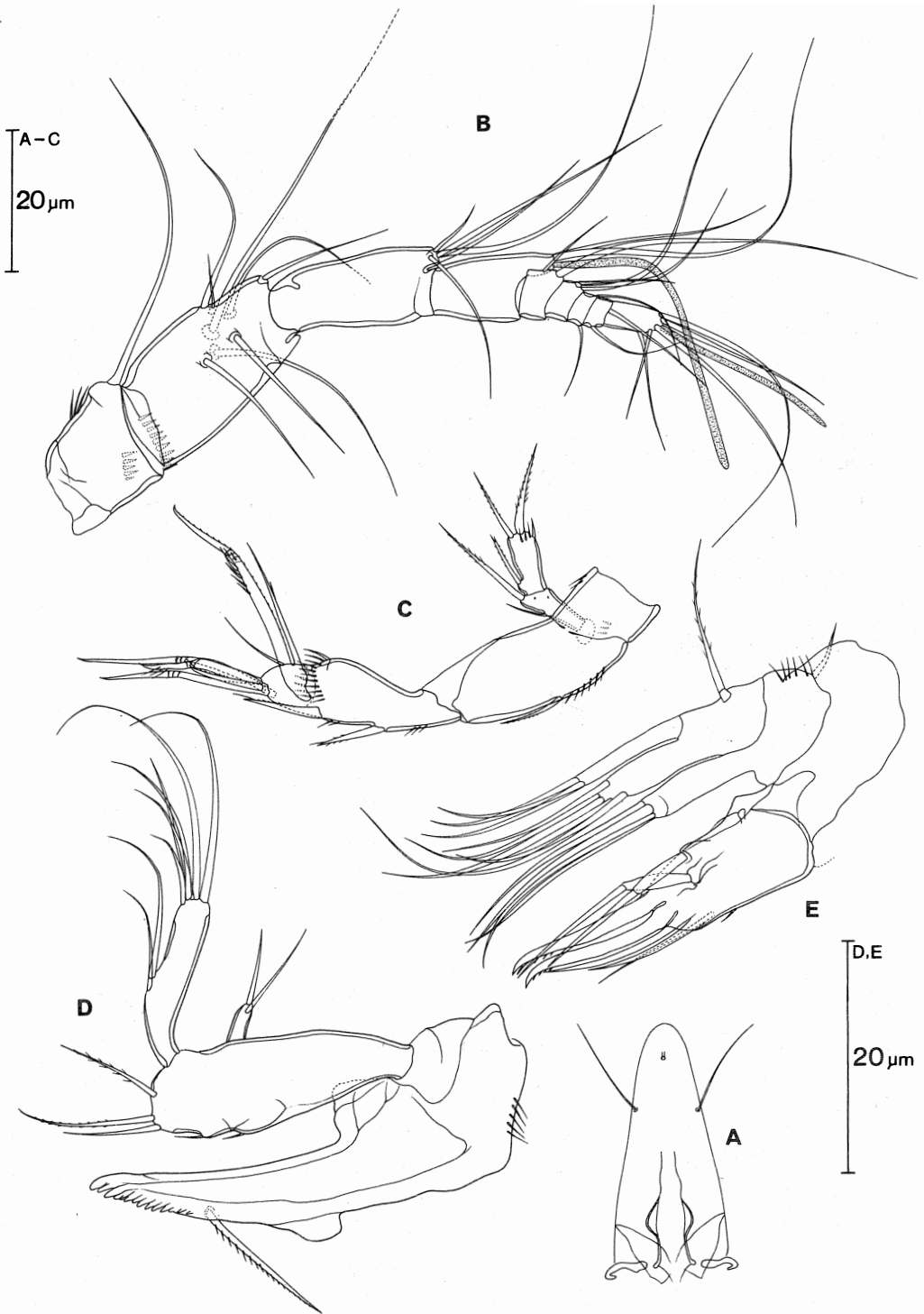


Fig. 2. *Karllangia pulchra* n. sp., ♀ - A. Rostrum; B. 1. Antenna; C. 2. Antenna; D. Mandible; E. 1. Maxilla.

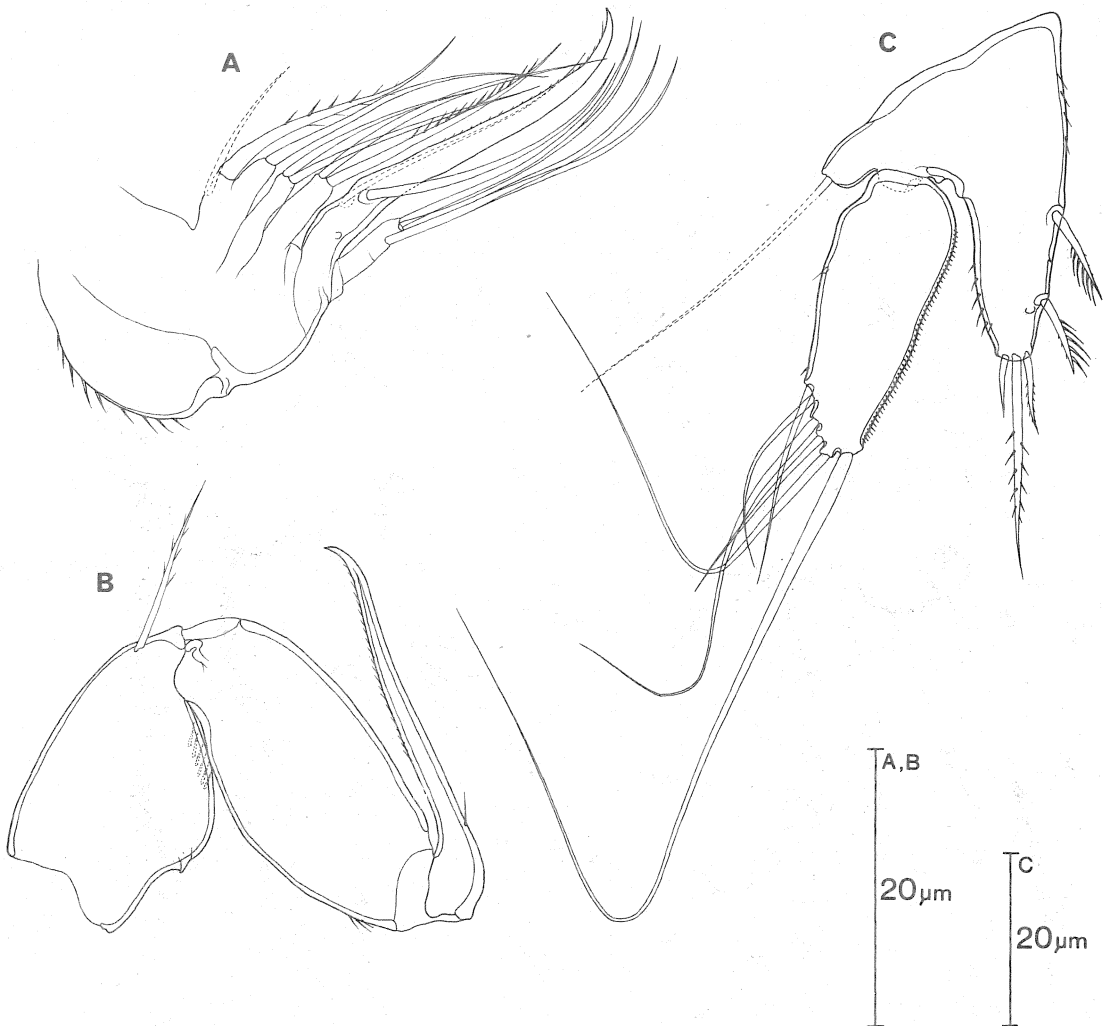


Fig. 3. *Karllangia pulchra* n. sp., ♀ - A. 2. Maxilla; B. Maxilliped; C. P.5.

edge, outer one having long hairs. Endopodite 2-segmented. First segment elongated, inner seta inserting at the proximal third of the length; outer edge with some hairs proximally and some spinules subdistally. Second segment short, carrying 2 claw-like appendages, 1 setule and 2 spinules. Exopodite 3-segmented. Proximal and middle segment with spinules and a spine on outer edge; inner edge of middle segment with some spinules and a weakly contoured inner seta. Distal segment shortest with 1 slender inner seta and 3 stronger, comb-like appendages.

P.2 - P.4 (Figs. 4B; 5A,B): Coxa with some rows of spinules. One row - not drawn - inserts proximally but apparently not on coxa (on

precoxa?). Distal edge of basis prolonged lobe-like in the middle and furnished with spinules, inner edge with a tooth-like projection. Outer appendage stout in P.2 and slender in P.3 and P.4. All segments of exp. and enp. with spinules on outer edge. Exopodite 3-segmented. Middle segment with an inner seta. Distal segment with 2 inner setae in P.2 and 3 inner setae in P.3 and P.4; middle inner seta in P.4 comb-like distally. Furthermore 2 apical and 3 outer appendages insert on distal segment. Endopodite 3-segmented. Proximal and middle segment with a plumose inner seta. Distal segment with 4 setae in P.2 and 5 setae in P.3 and P.4, outermost seta short.

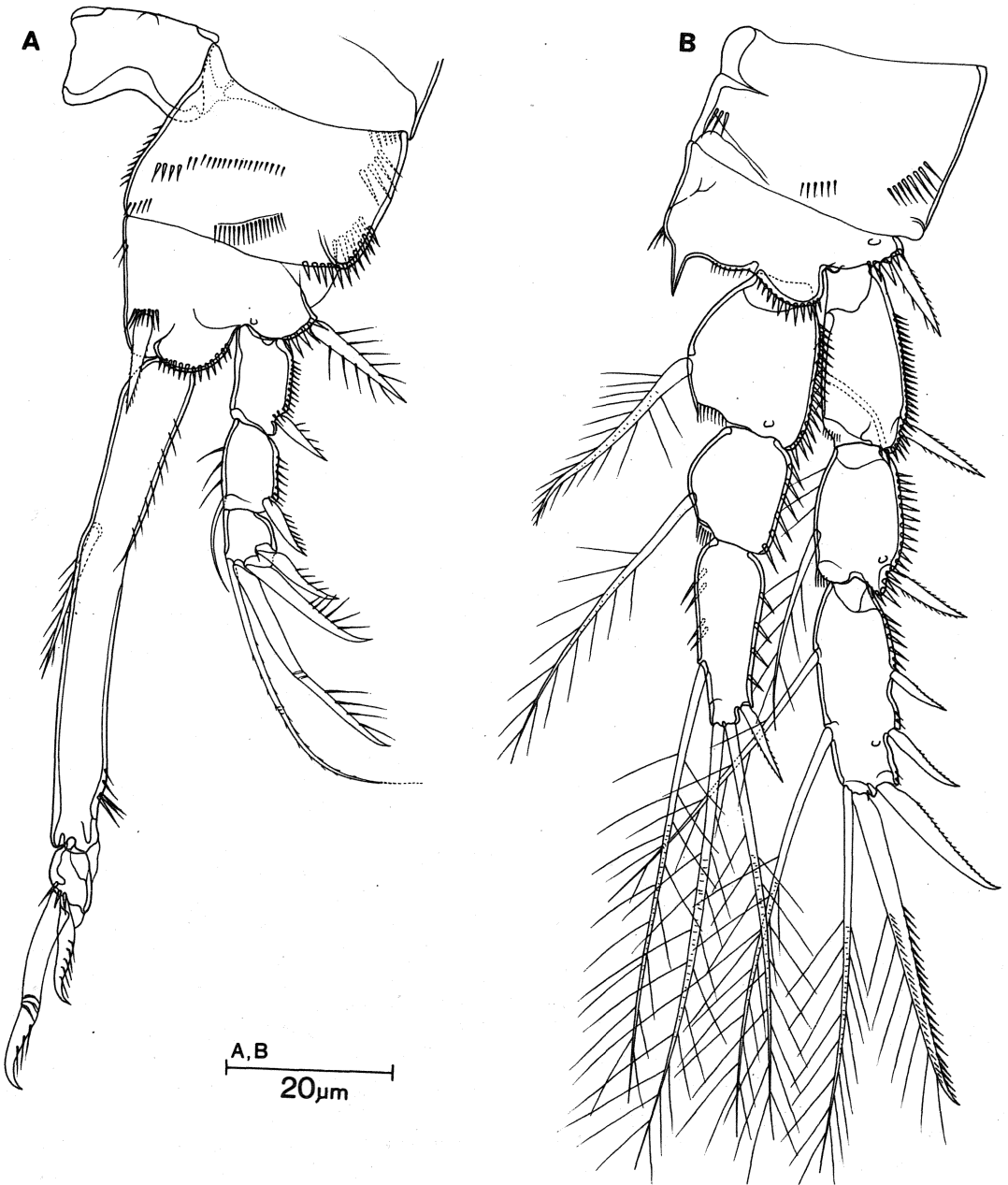


Fig. 4. *Karllangia pulchra* n. sp., ♀ - A. P1; B. P2.

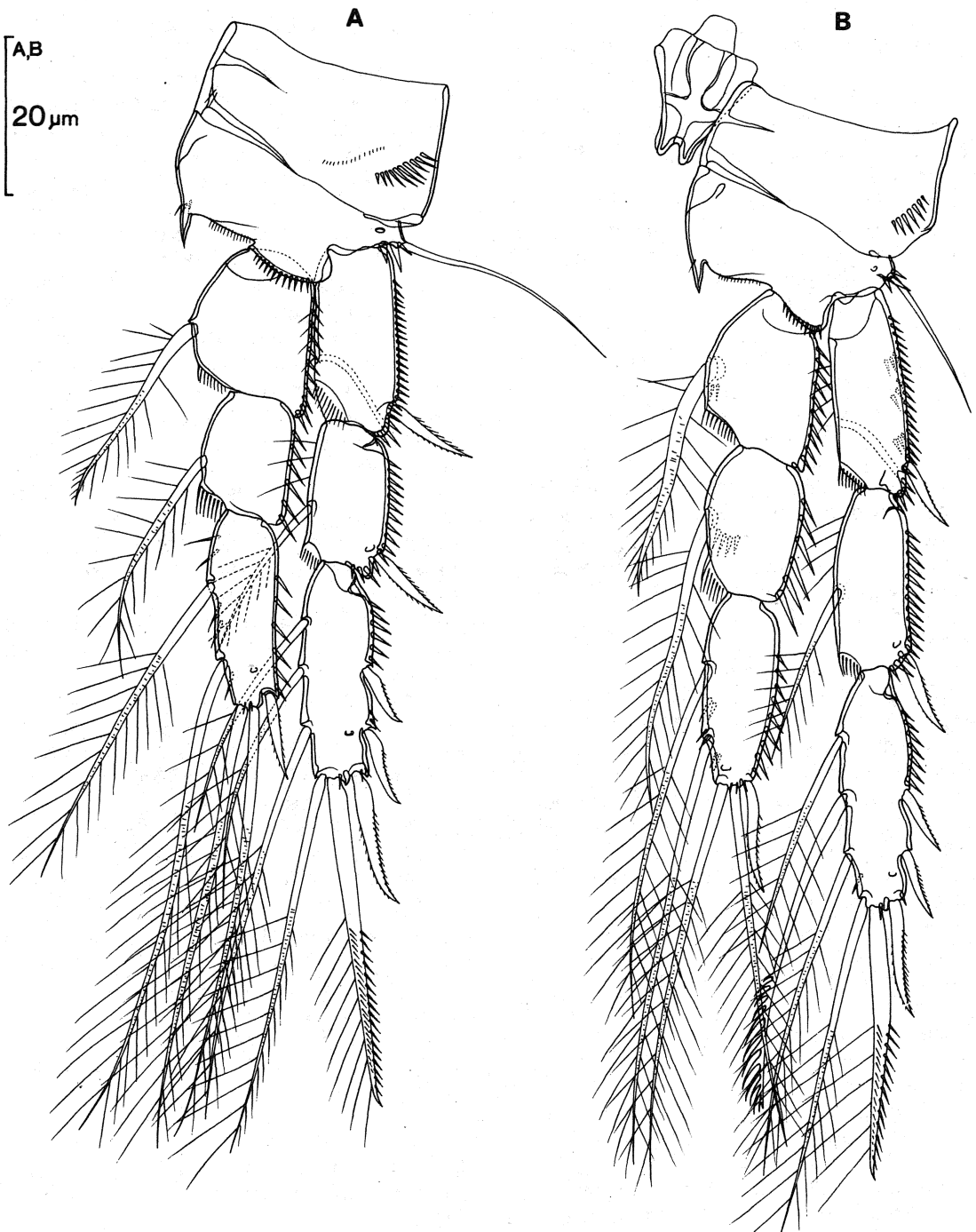


Fig. 5. *Karllangia pulchra* n. sp., ♀ - A. P3; B. P4.

Seta and spine formula:

	Exopodite	Endopodite
P.2	(0.1.223)	(1.1.121)
P.3	(0.1.323)	(1.1.221)
P.4	(0.1.323)	(1.1.221)

P.5 (Fig. 3C): Baseoendopodite with 2 plumose setae on inner edge and 3 setae apically, inner and outer of which are rather short. Exopodite narrow, furnished with 6 slender setae concentrated distally. Inner margin set with small spinules. In the middle of outer edge a break is to be seen, probably set with a minute setule.

Male: Differs from the female in the following respects:

Body length of three dissected animals 0,28 - 0,32 mm. Second abdominal somite proximally with two slightly bent chitinous stripes on ventral side. Distal ventral edge with a continuous row of spinules just as in following somite. Distal ventral edge of penultimate somite smooth (or with transparent lobes?, Fig. 6F; compare with female, Fig. 1B).

1. Antenna (Fig. 6A): Subchirocer. 7 segments. A few appendages on both proximal segments stand on socles. One appendage - probably brush-like distally - on second segment is directed caudally. 4th segment strongest, a dividing line is to be seen on frontal surface; furthermore an aesthetasc arises from middle part. 5th segment with projections. Distal segment also with an aesthetasc and a terminal seta bent inwardly.

2. Antenna (Fig. 6B): Seta on anterior edge of 1st endopodite segment strongly developed, plumose. 2nd endopodite segment apparently with a transparent structure inserting near both setae which are fused basally. Exopodite irregularly shaped, 2-segmented. Proximal segment with 1 plumose appendage, distal segment furnished with 2 plumose appendages and 1 slender seta.

P.3 (Fig. 6C): Outer seta of distal segment of endopodite only present in a rather reduced state.

P.5 (Fig. 6D): Both baseoendopodites confluent, each one with 1 strong appendage and 1 small seta. Exopodite bearing 4 setae, outer one longest.

P.6 (Fig. 6E): Small plate with 3 setae.

Etymology. The species name means "nice, pretty", as is the appearance of the animals.

Discussion. See following species.

Karllangia obscura n. sp. (Figs. 7-8)

Locality and material. As in the preceding species. 3 ♀♀ and 4 ♂♂ were dissected. Holotype female, reg. no. II CR 8a-i; paratypes the other dissected animals, reg. no. II CR 9a-i, I CR 89 - 93.

Main differences to the preceding species:

Female: Body length of dissected specimens from tip of rostrum to end of furcal rami 0.32 - 0.35 mm (holotype 0.35 mm). Dividing line of genital double-somite better developed than in *K. pulchra* n. sp., furnished with spinules; dorsal surface not stubby. Dorsolateral edge of abdominal somites seemingly without transparent lobes. Distal dorsal edge of genital double-somite with spinules on outer part. Whole distal dorsal edge of following somite with spinules. Distal dorsal edge of penultimate somite smooth (?), that of anal somite spinulose. Anal operculum bearing about 12 - 14 coarse spinules. Ventral edge of furca more distinct. On distal outer edge a "spine" is to be seen; it apparently represents the basal part of the apical outer seta (Figs. 7A,B).

2. Antenna: Length of basal seta of distal segment exp. apparently also slightly variable but in general shorter than in *K. pulchra* n. sp.

Mandible (Fig. 8A): Exopodite better developed, set with 3 slender setae.

P.1 (Fig. 8B): Compared to the leg of *K. pulchra* n. sp. the outer spine of basis is not as plumose. The inner seta of the proximal endopodite-segment is longer, the row of spinules on distal outer edge is more extended. The middle segment of exopodite is longer; it lacks an inner seta but has more slender spinules on inner edge.

P.5 (Fig. 8C): Length-breadth ratio of exopodite reduced; exp. furnished only with 5 setae.

Male: Body length of four dissected animals 0.30 - 0.35 mm. Second abdominal somite with a continuous, irregularly semicircular chitinous stripe (Fig. 7C).

2. Antenna (Fig. 8D): Seta on anterior edge of 1st endopodite-segment and setae on

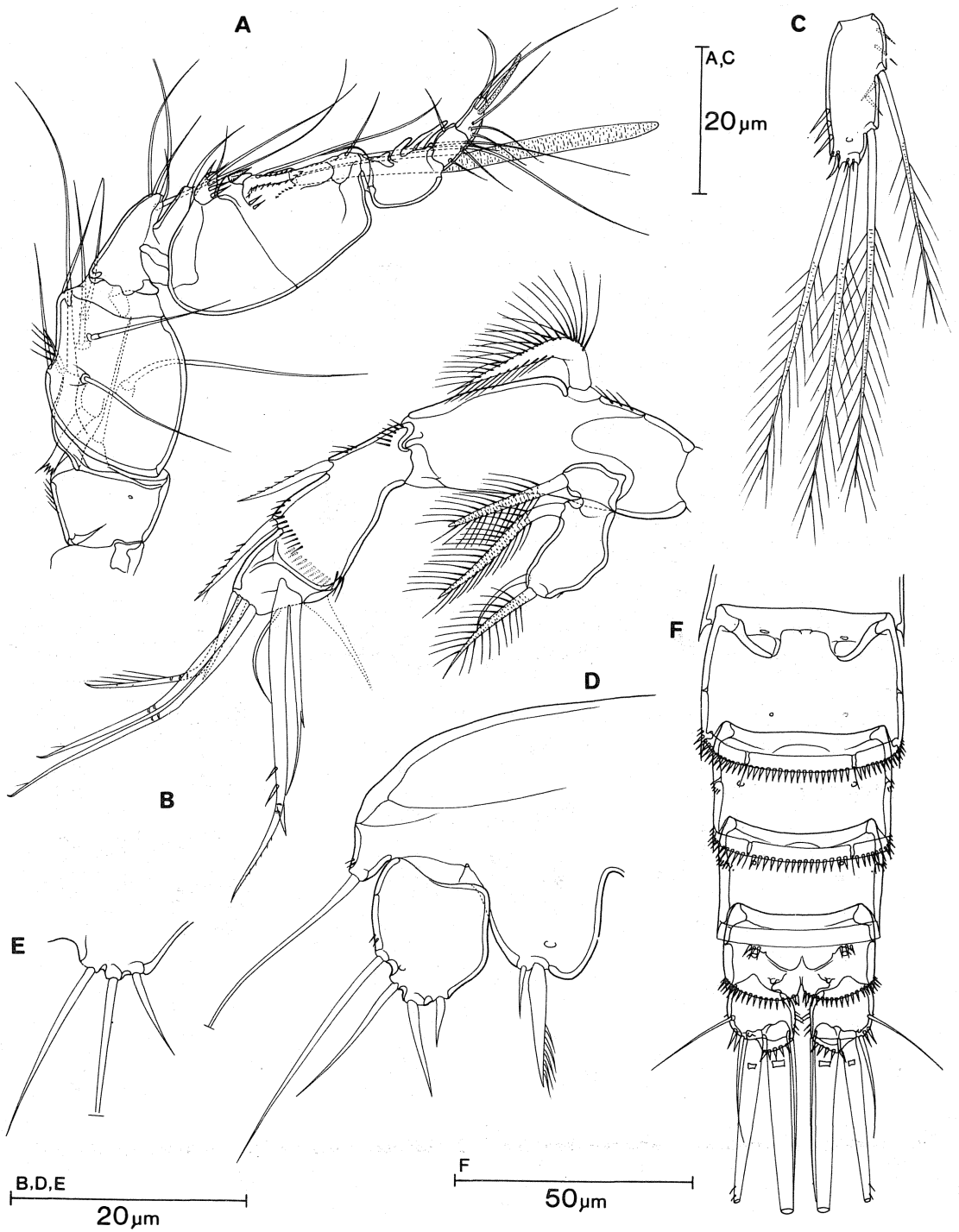


Fig. 6. *Karllangia pulchra* n. sp., ♂ - A. 1. Antenna; B. 2. Antenna; C. Last segment of endopodite P3; D. P5; E. P6; F. Abdomen, ventral side.

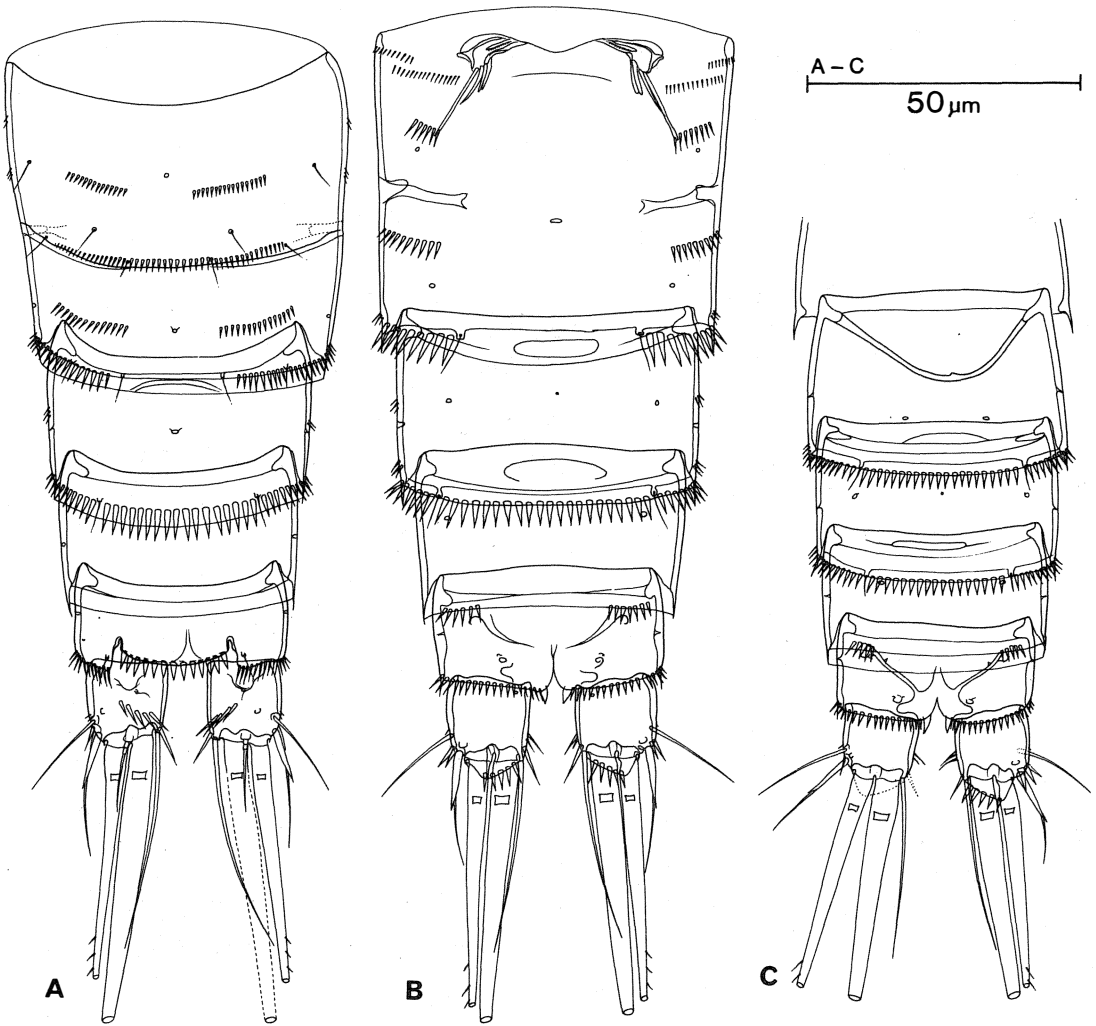


Fig. 7. *Karllangia obscura* n. sp.- A. Abdomen, dorsal side ♀; B. Abdomen, ventral side ♀; C. Abdomen, ventral side ♂.

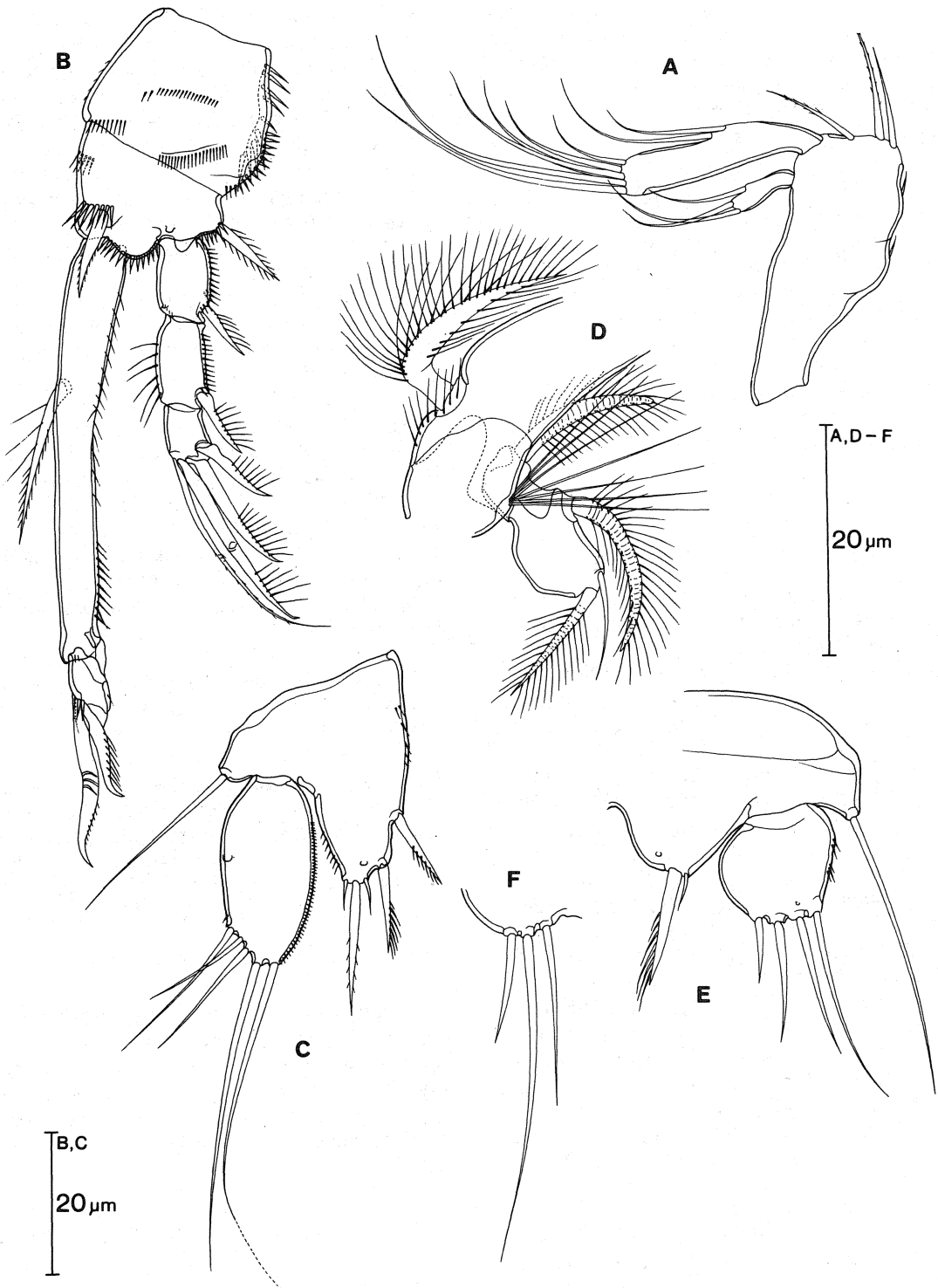


Fig. 8. *Karllangia obscure* n. sp.- A. Mandible palp ♀; B. P.1 ♀; C. P.5 ♀; D. 2. Antenna ♂ (part.); E. P.5 ♂; F. P.6 ♂.

exopodite better developed. Furthermore a fan of long slender setules is to be seen near the insertion plane of exopodite (lacking or most rudimentary in *K. pulchra* n. sp.). On the other hand the transparent structure on 2nd endopodite-segment could not be detected.

Distal segment of endopodite P.3 also with a rudimentary outer appendage; outer edge furnished with more spinules.

P.5 and P.6 (Figs. 8E, F): Corresponding \pm to the ones of *K. pulchra* n. sp. Setae of exopodite P.5 a little shorter (in Fig. 8E the leg is somewhat tilted).

Etymology. The species name means "hidden, dark" and refers to the "concealment" of the species, whose identity was apparent only after the dissection of some animals.

DISCUSSION

At present the genus *Karllangia* shows a scattered distribution: Noodt (1964) reported *K. arenicola* from the Egyptian coast near Ghardaqa of the Red Sea; Wells (1967) found *K. psammophila* at Inhaca Island (Mozambique); Kunz (1975) collected *K. tertia* from the reef of Gonubie near East London (South Africa). Furthermore, Wells & Rao (1987) added a new subspecies of *K. arenicola* from North Andaman and Car Nicobar Island: *K. a. bengalensis*. The new record from Costa Rica suggests a circumtropical/-subtropical distribution of *Karllangia*, though any statement on its biogeography is surely premature.

Wells & Rao (1987) assigned *K. psammophila* merely the status of a subspecies of *K. arenicola*. Likewise, both Costa Rican forms could conceivably be attributed to *K. arenicola*. However, since two subspecies cannot coexist within the same living space, both must be good species.

There are several differences between both Costa Rican and the other species as to segment number of the 1st antenna, structure of the 2nd antenna and the mandibular exopodite, armature of the pereopods, structure of enp. P.3 σ justifying the establishment of the new species. Within *Karllangia*, two evolutionary lines obviously exist. The more primitive branch is represented by *K. arenicola*

and *K. tertia*, the more advanced one by *K. psammophila*, *K. arenicola bengalensis* and both Costa Rican species. The most decisive autapomorphy of the latter group concerns the modified exopodite of the 2nd antenna σ . Sexually dimorphic 2nd antennae are not numerous in harpacticoid copepods (compare Huys 1988) but have evolved independently and in different modes within several taxa. As to *K. psammophila*, *K. a. bengalensis*, *K. pulchra* n. sp. and *K. obscura* n. sp. this specific character is postulated to have evolved only once in the stem species, thus the four (sub-)species constitute a monophyletic section. In contrast to *K. psammophila* and *K. a. bengalensis* (which should be regarded as a subspecies of *K. psammophila* or should be given species rank), in both Costa Rican species the seta on 1st endopodite-segment is also modified in the male. Compared with the dimorphic structure of the 2nd antenna, other features like middle segment of exopodite P.1 or basal segment of exopodite P.2 - P.4 with or without seta are of lesser significance.

Remark. Using the keys of Lang (1948) and Wells (1976) I was first led to the Parastenheliidae. If one compares the *Karllangia* species (Ameiridae) and *Parastenhelia megarostrum*, which was found in New Zealand by Wells *et al.* (1982) and assigned to the Parastenheliidae, one can question the systematic gap expressed by placing these species into two different families.

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RESUMEN

Se halló dos especies nuevas de copépodos del género *Karllangia* coexistiendo en playa Manzanillo, costa caribefia de Costa Rica. Hasta

ahora este género solo tenía tres especies, *K. arenicola* Noodt, 1964 (Mar Rojo) con su subespecie *K. arenicola bengalensis* Wells & Rao, 1987 (Andaman norte e Isla Car Nicobar), *K. psammophila* Wells, 1967 (Isla Inhaca en Mozambique) y *K. tertia* Kunz, 1975 (Suráfrica). Este descubrimiento en Costa Rica es de particular importancia pues sugiere que el género tiene distribución circumtropical-subtropical. Se interpreta el dimorfismo sexual característico en la segunda antena como una sinapomorfía significativa de ambas especies costarricenses, *K. pulchra* y *K. obscura*, las cuales, junto con *K. psammophila* y *K.a. bengalensis*, constituyen probablemente un subgrupo monofilético.

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