Robustunguis gen. nov., a genus of decapod associated Laophontids (Copepoda: Harpacticoida)

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Fiers, F. *Robustunguis* gen. nov., a genus of decapod associated Laophontids (Copepoda: Harpacticoida).

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The genus *Robustunguis* gen. nov. is erected for two species of laophontid harpacticoids: *R. ungulatus* spec. nov. and *R. minor* spec. nov. Both species were recovered from washings of decapod crustaceans collected along the coasts of Florida (U.S.A.) and Shimoni (Kenya). *Robustunguis* gen. nov. is closely related to *Coullia* Hamond, but differs significantly from the latter because of the remarkable prehensile first leg adapted to clench the bristles covering the body and body parts of the hosts.

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Introduction

Whereas several Laophontidae have been found in association with other invertebrates, only a few are considered as real associates. So far, for only thirteen out of roughly 200 known Laophontidae there is sufficient evidence (i.e. abundance, presence of developmental stages, etc.) that they live in close relationship with a specific invertebrate host (see Gotto, 1979; Huys, 1988; also Hicks, 1985: 45).

Apart from *Harrietella simulans* (associated with woodboring isopods), *Laophonte drachi* (associated with bryozoans), *Laophonte adamsiae* (associated with a cnidarian) and *Namakosiramia californiensis* (found on a holothuridian), nine laophontids belonging to at least five different genera are known to live on decapod crustaceans.

Jakubisiak (1932) described the first decapod-associated laophontids found in washings of the majid decapod *Maja squinado* (Herbst). Recently, *Hemilaophonte janinae* was redescribed on the basis of new material obtained from Atlantic common spider crabs and found to be closely related to the genus *Coullia* (Fiers, in press). *Laophonte royi*, the second species that Jakubisiak encountered on spider crabs, has been allocated to the genus *Paralaophonte* in the same contribution.

P. royi included, three species in the genus *Paralaophonte* are known so far to live in the gill chambers of *Maja squinado*. *P. majae* Petkovski was found in spider crabs from the Adriatic Sea, while *P. ormieresi* Raibaut was encountered in the gill chambers of decapods collected along the French Mediterranean coast.

Two species, *M. typica* and *M. proxima* found on the body and mouthparts of beach-dwelling crabs of the genus *Mictyrus*, were described by Nicholls (1957) and placed in the genus *Mictyricola*. This remarkable harpacticoid genus, mainly characterized by the absence of the entire P4, is related most closely to *Heterolaophonte* as evidenced by the reduced exopodite in the antenna and the dimorphic seta of the P2 endopodite in the male. *Mictyricola* has a rather limited distribution along the shores of Tasmania and Queensland (Australia) (Fiers, 1991).

Described by Raibaut (1961), *Laophonte commensalis* was the first laophontid to be known as an associate of xanthid decapods. The species was abundantly present on *Xantho rivulosus* collected along the French Mediterranean coast near Banyuls and Sète, and on two xanthids (*X. pilipes, X. floridus*) from Roscoff, on the French Atlantic coast (names of decapod species after Raibaut, 1961). Besides adults, all developmental copepodid stages were found and subsequently described (Raibaut, 1963). *L. commensalis* has many features in common with the so-called *setosa*-species group of the genus *Laophonte*.

Rather unexpected was the discovery of *Laophonte trispinosa* Sewell as a close associate of xanthid decapods. Together with *X. carcinicola, L. trispinosa* was placed in the genus *Xanthilaophonte* and found to be widely distributed throughout the Indo-west Pacific region. *Xanthilaophonte* is considered to be closely related to the genus *Echinolaophonte* (Fiers, 1991).

From this brief summary it becomes clear that decapod associates originated from at least five different stocks within the family Laophontidae. However, it appears that certain lineages were more succesful in exploring this particular form of cohabitation. Materials recovered from decapods from a widespread range of localities yielded a wealth of unknown laophontids related to only two lineages. Besides representatives of the *setosa*-species group of the genus *Laophonte*, several species were found sharing many characteristics with the genera *Phycolaophonte* Pallares, *Hemilaophonte* Jakubisiak, and *Coullia* Hamond. The present contribution deals with two new species of this second group of xanthid-associated laophontids. Since both species share such specialized features for cohabitation with the host, they are unified in the herein defined genus *Robustunguis* gen. nov.

Material and methods

The animals were collected and treated as described for *Xanthilaophonte* in a previous paper (Fiers, 1991). Abbreviations and terminology used in the present paper are according to Lang (1948, 1965). Specimens deposited in the collections of the Nationaal Natuurhistorisch Museum, Leiden, are labeled RMNH F while those joining the Recent Invertebrates Collections at Brussels are labeled COP.

Systematics

Genus **Robustunguis** gen. nov.

Diagnosis.— Body prehensile compressed. Length of cephalothorax one third of the entire body. Ventrolateral extensions of the genital and second abdominal segments small, not visible in dorsal view. Furcal rami cylindrical, having an inner blunt expansion near the dorsal seta. Antennule six-segmented, without thorns on the first and second segment. Antenna with a distinct exopodite, bearing four armed, subequal setae. P1 very strong with a two-segmented exopodite. First endopodal segment curved, having a rounded blunt process on the outer proximal margin. Endopodal claw very strong, armed and almost as long as the first endopodal segment.

Exopodites P2-P4 two- or three-segmented. Ultimate exopodal segments with two outer spines, one outer apical spine and a reduced inner apical seta. Endopodites one- or two-segmented. Setal formula in table 1. P5 baseoendopodite small to very small, exopodite ovate and reaching far beyond the apical margin of the baseoendopodite, bearing five or six setae.

Sexual dimorphism: inner edge of the second endopodal segment of the P3 in males, extended into a sharp and curved apophysis. Endopodites of P2 and P4 in males, two-segmented or slightly stronger than in the female. Baseoendopodite of P5 in males fused with the somite and represented as a transversal strip, with two setae at the most. Exopodite of males with five setae or entirely absent.

Juveniles: female juveniles CV and CIV with a strongly modified exopodite P4.

Type-species.— *Robustunguis ungulatus* spec. nov., here designated.

Etymology.— The generic name is a conjunction of *robustus* (Latin: strong) and *unguis* (Latin: claw), referring to the enormous first leg (gender masculine).

Discussion.— Laophontidae living on the surface, between the bristles covering the carapax and appendages of their host, generally display a smooth integument and show a distinct tendency to reduce the lateral extensions of the genital and abdominal somites. Whereas free living sistergroups exhibit conspicuous dorsal integumental processes, the associated congeners lack such ornamentations entirely. The herein described species of the genus *Robustunguis* gen. nov. constitute no exception to this rule, for they have a smooth integument and have lost the ventrolateral extensions of the abdominal somites completely.

Moreover, whereas generally in laophontids the length of the head is about one fourth of the body length, *Robustunguis* species have a rather stout appearance, because of their relatively long cephalothorax which constitutes at least one third of the entire body length.

The outstanding characteristic of *Robustunguis* gen. nov. is obviously the strong and large prehensile first leg. As a matter of fact, no other laophontid yet known has such a large and eye-catching first leg. As illustrated for the male of *R. minor* spec. nov. (fig. 5b), this appendage even reaches up to the distalmost edge of the furcal rami, and as such equals two thirds of the entire body length.

The general appearance of the first leg with its curved and strongly sclerotized integument, proximally having a bold process on the inner margin, and its long arched claw, demonstrate clearly the function as a pincer evolved to clench the bristles of their host. After rinsing the decapods, several specimens of *R. ungulatus* spec. nov. were encountered still clinging by their first leg to a bristle detached from the crabs. It is obvious that such specialized morphology represents a phylogenetic novelty justifying the erection of the genus *Robustunguis* gen. nov. to accomodate the herein described species.

Robustunguis gen. nov. is undoubtedly most closely related to the genera *Coullia* Hamond, 1973, *Phycolaophonte* Pallares, 1975, and *Hemilaophonte* Jakubisiak, 1932. It is mainly the morphology of the sexually dimorphic appendages, the ovate shape of the female fifth legs and the reduced shape of the endopodite of the second leg which is smaller than the P3 endopodite, which demonstrate their close relationship.

As these four genera share many characteristics, they are considered as representatives of a distinct genus group within the Laophontidae.

Robustunguis ungulatus spec. nov.
(figs. 1-4)

Type-material.— Holotype: one female dissected and labeled COP 1062 a, b; allotype dissected and labeled COP 1963 a, b; paratypes (35 females, 12 males) preserved in alcohol, labeled COP 1965), two dissected females (COP 1964, COP 3659 a,b,c), two dissected males (COP 3660, COP 3661 a, b) and 5 females and 5 males, in alcohol, deposited at the Leiden Collection (R.M.N.H. F. 928). Type-locality: United States of America, Florida. Washed from two specimens of *Pilumnus sayi* Rathbun (Decapoda, Xanthidae) dredged at -40 m. Leg. Mercator, 11-th cruise, 24 March 1936, IG. 10911. Figures: holotype: fig. 1a-e; fig. 2a-e; fig. 3a-d; fig. 4a; allotype: fig. 3e-h; fig. 4b-e.
Additional material.— Two females, preserved in alcohol (COP 3662, IG. 27841) from washings of numerous small xanthid decapods found in an algal sample collected on the recif of Majahual, Quintana Roo (Mexico). Leg. D. Torruco, CINVESTAV-IPN, Merida (Yu) Mexico, April 1991.

Etymology.— The specific name *ungulatus* meaning claw (Latin) refers to the enormous first leg which is the most important generic characteristic.

Description.— Female (holotype, fig. 1a, b) cephalothorax bell-shaped, about one third of the whole body-length. Largest width in the posterior half of cephalothorax. Body length: 650 μm. Thoracic and abdominal segments strongly sclerotized. Genital segments much wider than long, ratio (L/W) about $^1/_2$, without extended posteroventral edges.

Rostrum (fig.1d) broad at base, having curved lateral margins. Rostral tip rounded, not prominent.

Furcal rami (fig. 1b) cylindrical, having a small inner expansion near the implantation of the dorsal seta. Four times as long as wide. Lateral setae implanted in the distal fourth. Principal apical setae not fused. Inner apical one rather small.

Integument of all somites smooth. Posterior margins of thoracic and abdominal segments set with minute spinules. Margin of anal operculum spinulose (fig. 1b). Furcal rami with spinules near the implantation of the setae.

Antennule (fig. 2a) six-segmented, with a row of slender teeth along the distal anterior edge and along posterior margin of the first segment. Second, third and fourth segments with minute spinules along their posteriorly directed margin. Setal number: 1-8-6-2+Aest-1-12.

Allobasis and endopodal segment of antennule with spinules and hairs along their margins (fig. 2e). Exopodite slightly longer than wide, bearing four sub-equal spinulose setae.

Mandibular palp slightly curved with obsolete rami (fig. 2d). Apicalmost seta rather thick and finely feathered. Endopodite represented as three setae, exopodite represented as a single one.

Arthrite of maxillule bearing five strongly armed spines and two setae (fig. 2b). Inner expansion of coxa with two spinulose setae, and of the basis with three feathered ones. Rami represented as two setae each.

Maxilla (fig. 2c) with three endites. Proximal one minute, bearing a single seta. Median and distal endites with three setae each. Extended basis armed with two lat-

eral and three apical setae.

Maxilliped (fig. 1c) with a short basis, bearing two setae and some rows of slender spinules. Endopodal segment with a few spinules along the inner distal margin and in the middle of the outer margin. Claw long, armed in distal half and bearing a single seta near the articulation with the segment.

P1 (fig. 3a) coxa cylindrical with a tuft of hairs on the inner apical edge. Basis spinulose along outer and inner margins. Exopodite two-segmented: first segment with one outer spine, second with two outer and two apical setae. Endopodite robust and strongly sclerotized showing a distinct inner expansion in the proximal third and the typical process of the outer margin. Claw strongly curved, densely teethed along the entire inner margin. General appearance of P1 twice as large as the following legs.

P2-P4 (fig. 3b-d) with three-segmented exopodites and one-segmented endopodites. Protopodites furnished with spinules along their outer and inner margins. Inner apical seta of the third exopodal segments short, smooth in P2 and P4, feathered in P3. Endopodites minute, only slightly longer than wide. Setal formula in table 1.

P5 (fig. 4a) with distinct baseoendopodite. Endopodal process rather small. Surface smooth, margins spinulose. Sub-apical seta and apical setae smooth. Proximal seta armed with small spinules. Exopodite ovate, reaching far beyond the apical edge of the baseoendopodite and bearing six setae. Surface smooth, margins set with long spinules.

Male (allotype); habitus as in the female. Length 565 μm. Ventral surface of the abdominal segments smooth except for some small spinules on the lateral sides of the anal segment and along the posterior margins of the abdominal segments (fig. 4e).

Antennule (fig. 4d) six-segmented and sub-chirocer. Proportional lengths of the first and second segment smaller than in the female. Penultimate segment long and curved. Integumental structures present only on first segment. Aesthetasc arising from the fourth segment.

P2 (fig. 3e) with smooth outer spines on the third exopodal segment. Endopodite two-segmented having a single apical seta on the second segment.

P3 (fig. 3f) exhibiting smooth outer spines on exopodal segment two and three. Endopodite two-segmented. Second segment forming a long curved apophysis, reaching the apical edge of the third exopodal segment.

P4 (fig. 3h) with armed spines on each exopodal segment. Endopodite two-segmented, bearing three strong setae.

P5 (fig. 4c) baseoendopodite with two feathered setae. Exopodite slightly longer than wide, having five setae, the innermost distinctly barbed along one side.

Variability.— Whereas females show less variability, males exhibit a highly variable P2 setal formula. In the majority of the males, only the second exopodal segment bears an inner seta. Male specimens without inner setae are rare, but specimens with an additional seta on the third segment are frequently encountered.

One male specimen (allotype) has three outer exopodal spines on the ultimate segment of the right leg. The opposite leg has a normal formula with two outer spines.

The allotype, as well as several other males, has two-segmented exopodites in their P3 and/or P4 with a reduced chaetotaxy. Two-segmented legs may occur on either side.

Robustunguis minor spec. nov.
(figs. 5-6)

Type-material.— Holotype: one female dissected and labeled COP 1966 a, b. Allotype dissected and labeled COP 1967. One paratype juvenile male CV preserved in alcohol, labeled COP 1968. Type-locality: Kenya, Shimoni, washed off a single damaged xanthid crab collected on *Pocillopora* (Scleratina). Leg. K.B.I.N., August 1972, IG: 24409. Figures: holotype: fig. 5a; 6a, b, d, e, f, g; allotype: fig. 5b; fig. 6c, h.

Etymology.— The specific name, *minor*, Latin for small, refers to the small size of the animals.

Description.— Female (holotype: habitus (fig. 5a and fig. 6g) fusiform compressed. Body length 320 μm. Cephalothorax slightly shorter than half the body-length. Thoracic and abdominal somites tapering slowly towards the anal segment in dorsal view. Cephalothorax parallel-sided in the posterior two thirds but tapering gently towards the rostrum in the anterior third. Genital double segment twice as wide as long. Anal segment with a convex anal operculum.

Rostrum as in the preceding species but more downwards directed. Furcal rami cylindrical with straight margins and about 2.5 times as long as wide. Inner margin with a small process, near the implantation of the dorsal seta. Outer apical principal seta very slender, only twice as long as the inner apical one. Lateral setae sub-apically implanted.

Integument of cephalothorax, thoracic and abdominal somites smooth. Posterior margin of the cephalothorax smooth. Thoracic somites with spinulose posterior margins except for a naked median part. Posterior margins of the abdominal segments spinulose. Anal operculum with long hairs on the margin. Furcal rami with a smooth dorsal and ventral surfaces and only set with spinules on the inner margin, near the implantation of the dorsal seta.

Antennule, antenna and mouthparts as in *R. ungulatus* spec. nov

P1 (fig. 5a) with typical appearance. Total length about half the whole body-length. Exopodite reaching halfway the first endopodal segment. Endopodal claw armed over half the length of the outer margin. Outer margin of the first endopodal segment furnished with minute spinules near the middle.

P2-P4 (fig. 6b, d, e) with two-segmented exopodites. Protopodites and exopodal segments with strong outwards-directed spinules. Endopodite P2 one-segmented, of P3 two-segmented and of P4 vestigial. The latter represented as a slender naked seta. Chaetotaxy in table I.

Baseoendopodite P5 (fig. 6f) oblong, inner expansion not protruded and bearing one small seta on the inner edge. Exopodite oblong, bearing five setae. Surface and margins of baseoendopodite and exopodite naked.

Male (allotype); habitus (fig. 5b) as in the female but with a shorter abdomen. Length 210 μm. Integumental structures, antennule mouthparts and P1 as in the female.

Exopodites P2-P4 not transformed. Endopodites of the P2 and P4 slightly stronger but with the same chaetotaxy as in the female. Endopodite P3 (fig. 6c) two-segmented, showing a curved apophysis arising from the inner edge and reaching just beyond the articulation between the exopodal segments.

P5 (fig. 6g) represented as a transversal chitinous strip with two setae. General appearance as the P6 known for other Laophontidae.

P6 very indistinct, without setae, but with a small plate on the right ventral side of the first genital segment.

Variability.— The female specimen lacks the dorsal seta and one of the laterale seta on her left furcal ramus (fig. 5a).

Discussion.— *Robustunguis minor* spec. nov. differs in many aspects from *R. ungulatus* spec. nov. The former is easily distinguishable from its congener by the two-segmented exopodites, the reduced endopodites, and the strongly reduced fifth legs in both sexes. These highly advanced characteristics would perhaps justify erecting a separate genus for *R. minor* spec. nov. As, however, the species of the closely related genus *Coullia* display a comparable diversity of leg segmentation within the genus, the marked regression of the appendages in *R. minor* spec. nov. are considered as specific adaptations to its way of life on the bristles of xanthid crabs.

Table 1. Chaetotaxy of *Robustunguis* gen. nov.

		P2		P3		P4	
R. ungulatus	♀	0-0-022	010	0-0-022	020	0-0-022	020
	♂*	0-1-022	0-010	0-0-022	0-020	0-0-022	0-021
R. minor	♀	0-022	010	0-022	0-020	0-022	1
	♂	0-022	010	0-022	0-020	0-022	1

*: P2 chaetotaxy highly variable.

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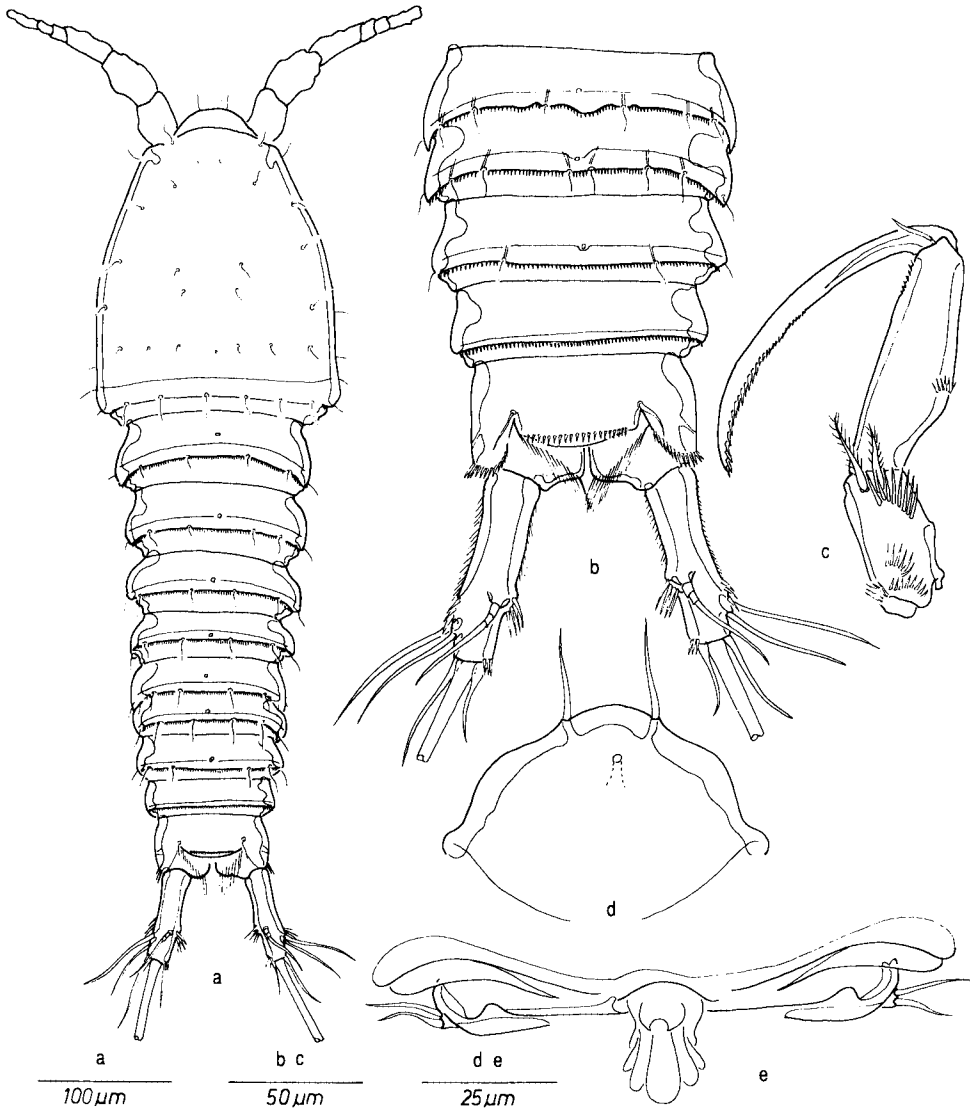

Fig. 1. *Robustunguis ungulatus* spec. nov.; a, female habitus, dorsal view; b, female abdomen, dorsal view; c, maxilliped; d, rostrum, ventral view; e, female genital field.

Fig. 2. *Robustunguis ungulatus* spec. nov.; a, female antennule; b, maxillule; c, maxille; d, mandible; e, antenna.

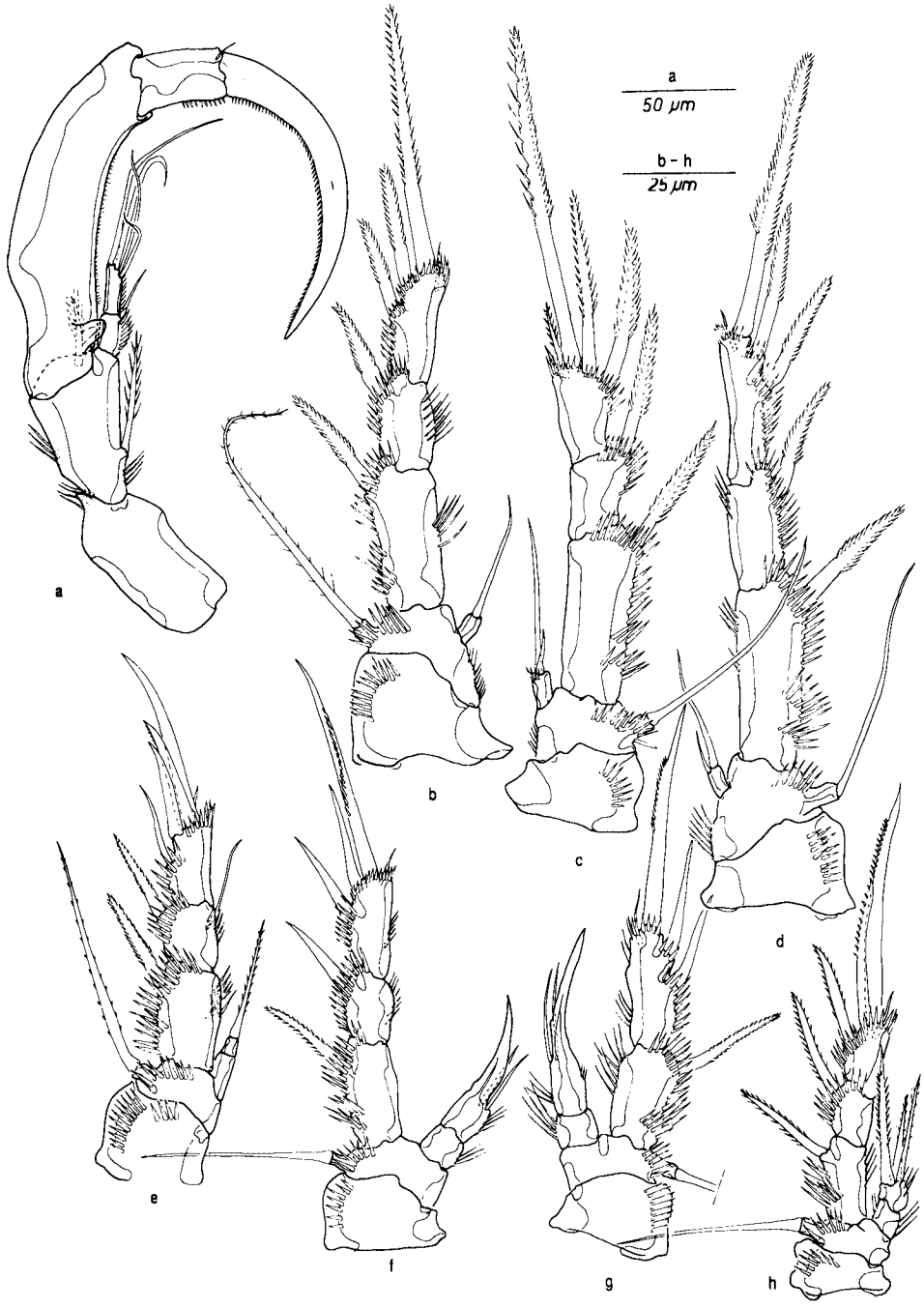

Fig. 3. *Robustunguis ungulatus* spec. nov.; a, P1; b, P2, female; c, P3, female; d, P4, female; e, P2, male; f, P3, male (normal); g, P3, male (abberant); h, P4, male.

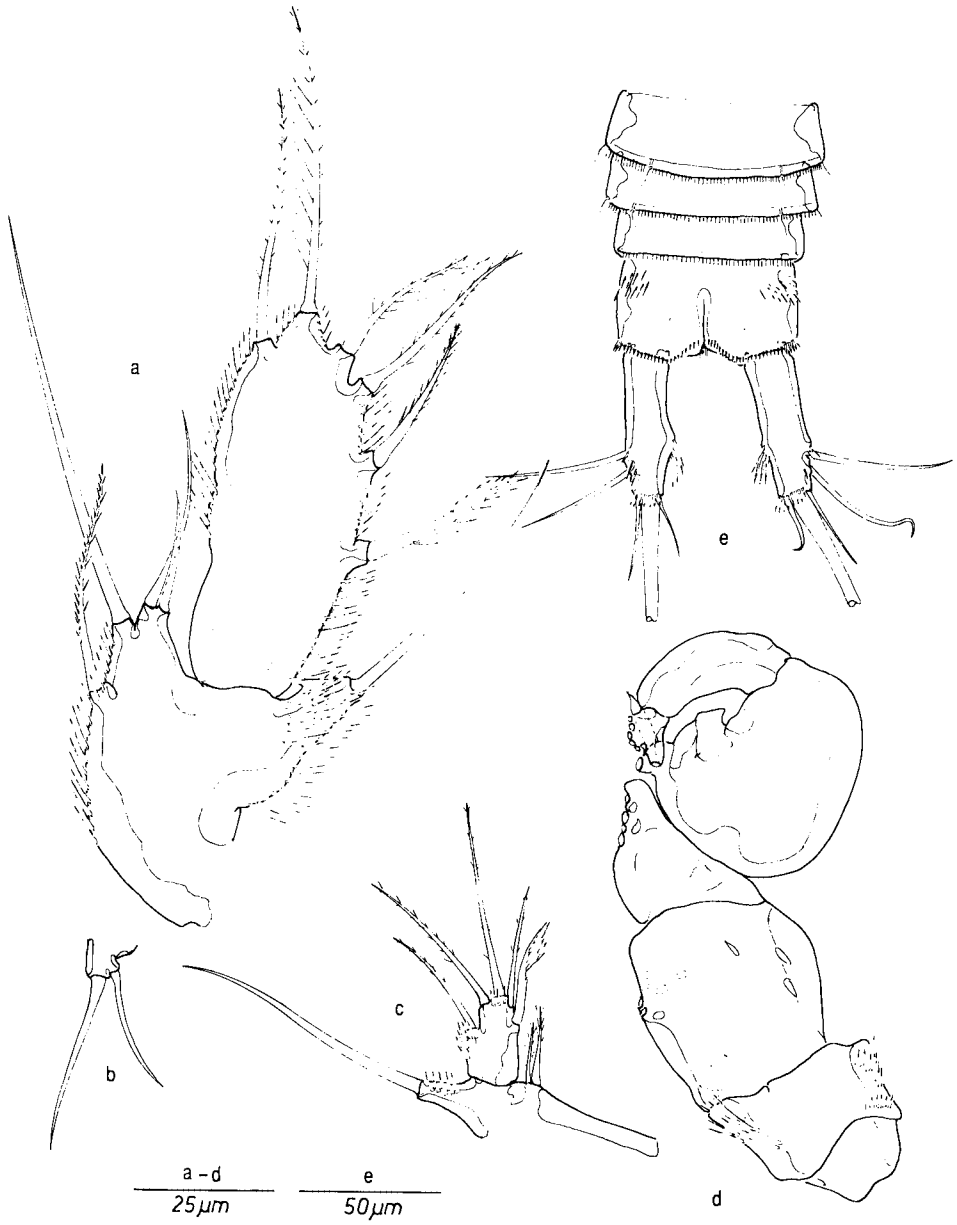

Fig. 4. *Robustunguis ungulatus* spec. nov.; a, P5, female; b, P6, male; c, P5, male; d, antennule, male; e, male abdomen, ventral view.

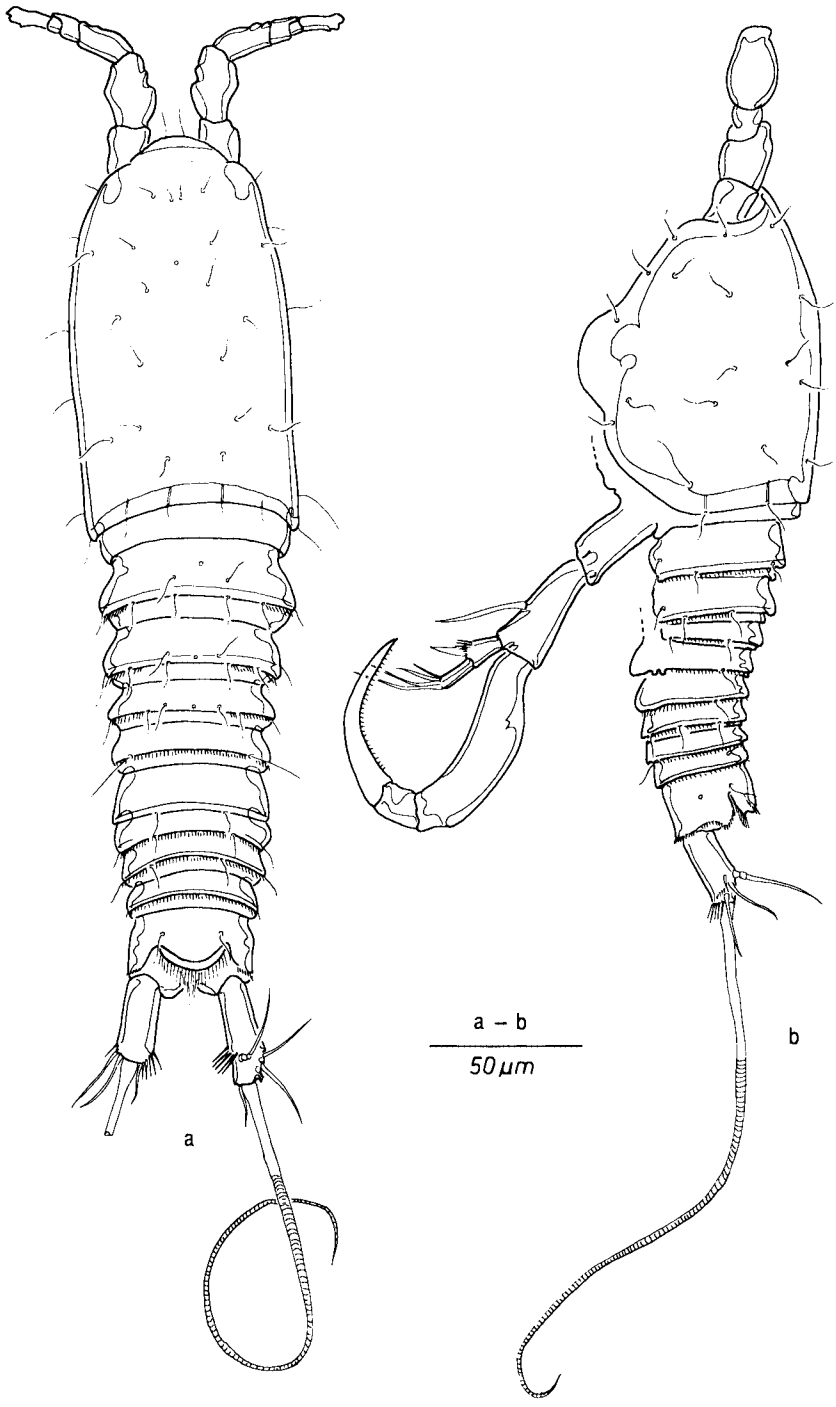

Fig. 5. *Robustunguis minor* spec. nov.; a, female habitus, dorsal view; b, male habitus, lateral view.

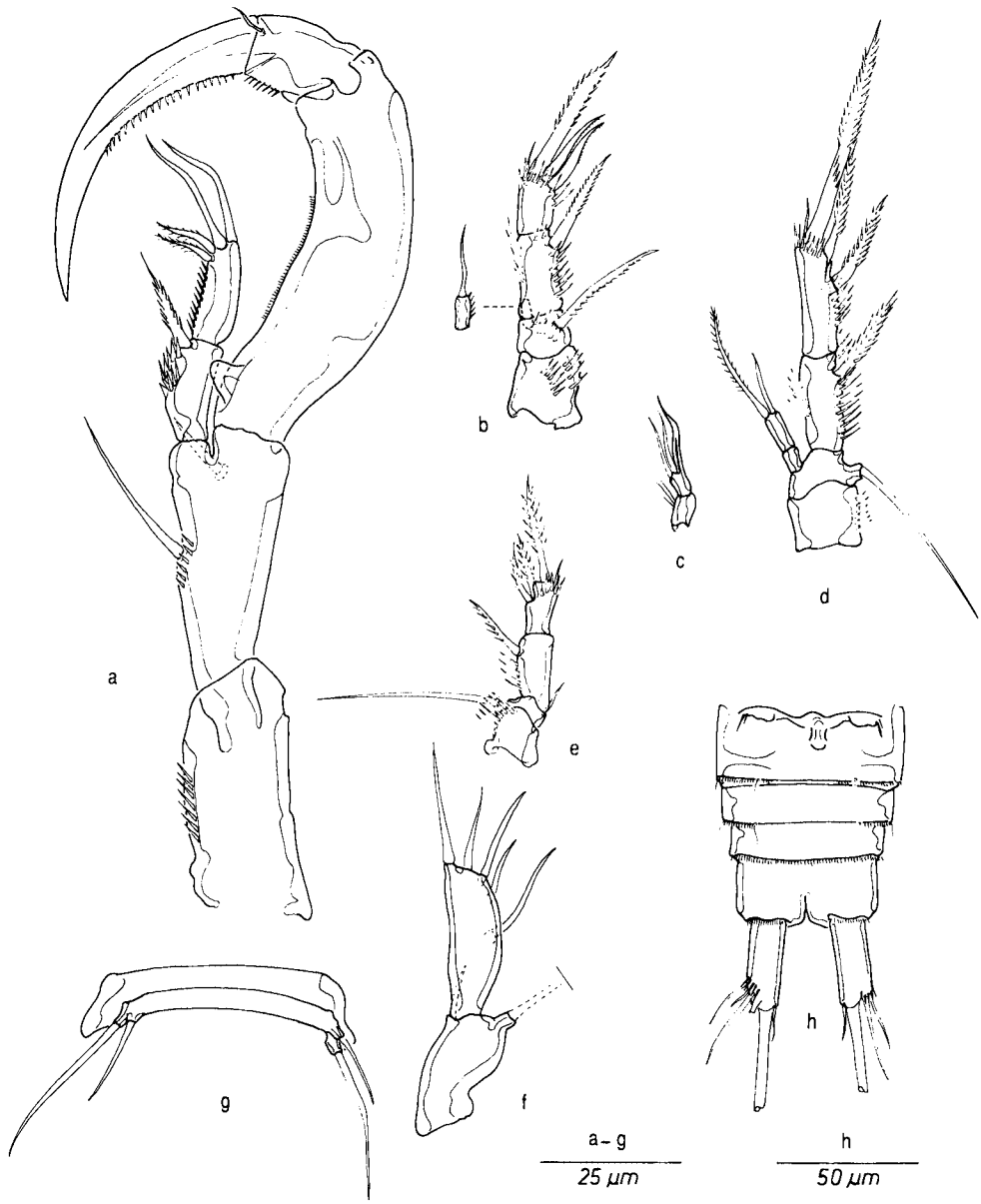

Fig. 6. *Robustunguis minor* spec. nov.; a, P1, female; b, P2, female; c, endopodite P3, male; d, P3, female; e, P4, female; f, P5, female; g, P5, male; h, abdomen of the female in ventral view.