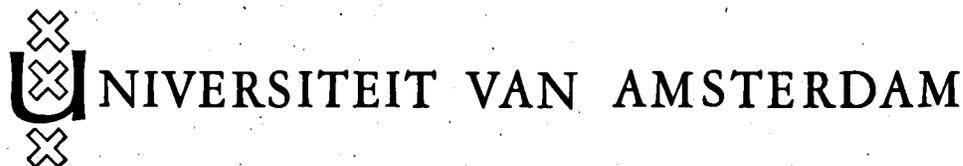


BULLETIN ZOOLOGISCH MUSEUM



Vol. 1 Nr. 6 31 - VII - 1968

HARPACTICOID COPEPODS LIVING IN WOOD INFESTED BY LIMNORIA FROM FRANCE

S. PINKSTER

ABSTRACT

Five species of harpacticoid copepods are recorded as associates of wood-boring gribbles of the genus *Limnoria*, in French coastal waters.

Two of these species, both belonging to the genus *Tisbe*, are new to science. With three of the species rearing experiments have been done in order to determine what kind of relation exists between them and *Limnoria tripunctata* Menzies.

INTRODUCTION

Surveying the copepods associated with species of Gribbles, *Limnoria*, both on the Atlantic and Mediterranean coasts of Europe, five species of harpacticoids were found. The Gribbles examined belong to the species *L. tripunctata* Menzies, 1951 (from Marseille, France), *L. quadripunctata* Holthuis, 1949 (from Brittany, France) and *L. lignorum* Rathke, 1799 (from the Strait of Dover, France and from the coast of Holland).

The greater part of the fieldwork has been carried out at the Station Marine d'Endoume, Marseille, France, and was made possible by a grant of the Royal Netherlands Academy of Sciences, Amsterdam. The fieldwork in Brittany was supported by a small grant of the University of Amsterdam. I am indebted to these sponsoring authorities and to all persons, both in Marseille and Amsterdam who helped me during this study, more in particular to Prof. Dr. A. Bourdillon for his kind assistance and great interest in my work, and to Miss H.M.A. Roelofs who helped me during the fieldwork.

The species of copepods, described below, were collected with a pipette in examining both pieces of wood and *Limnoria*'s found in it, through a dissecting-microscope. The material and types have been deposited in the Zoological Museum of the University of Amsterdam.

The following species were found:

Fam. TISBIDAE

Tisbe eurypleura nov.spec.

MATERIAL AND TYPES. 40 males and females, partly obtained from submerged wrecks of old wooden ships, at Saumaty, in the harbour of Marseille, partly reared in the laboratory, in late May and June 1966. The ♀ holotype, ♂ allotype and 38 paratypes have been deposited in the Zoological Museum of the University of Amsterdam (Cat. nos. Co. 101040 - 101043).

DESCRIPTION

Female: In living specimens the body is nearly colourless; the ovisac is yellowish. The body-shape (fig. 1c) is in so far peculiar that the epimerial areas of the 4th pedigerous segment are extending quite considerably. The total length from the tip of the rostrum to the posterior end of the caudal rami, but without the furcal setae, is 1.03 mm to 0.85 mm (mean 0.95 mm, based on 5 specimens). The 2nd pedigerous segment is the widest.

The ratio of cephalosome plus metasome against urosome plus caudal rami is about 10:6.

The rostrum (fig. 1c) is broadly rounded and bears the 2 minute setae. The ovisac is dorso-ventrally flattened and reaches to the basis of the caudal rami. It contains 9 to 12 eggs, each about 82 μ in diameter. The abdominal segments are dorsally and ventrally armed along their posterior margins with a row of minute spinules. The anal operculum is unadorned. The furcal ramus (fig. 1b) is slightly wider than long. The 2 long terminal setae (numbered 2 and 3 in fig. 1b) show a joint near the base. The 4th terminal seta is much shorter and is implanted on a ventral projection of the ramus. The first 3 terminal setae bear short plumosities as indicated in fig. 1b, the other setae are naked.

The 1st antenna (fig. 1f) has 8 podomeres, whose proportional lengths are as follows:

Segment number	1	2	3	4	5	6	7	8
Relative length	15	23	23	19	3	4	3	10 = 100
Number of elements	1	13	9	5 + 1	1	4	2	8

On the 4th podomere there is an aesthetaske, extending well beyond the tip of the antenna. Every podomere is armed with setae as shown in fig. 1f and as tabulated above.

The 2nd antenna (fig. 1a) is of the usual form in the genus, with the second segment of the endopodite a little longer than the first (8:7). The mouthparts do not show remarkable features; they are as illustrated in figs. 1d, 1e, 2f, 2g.

The 1st leg (fig. 2a) is composed of a 2-segmented protopodite and two rami. The basipodite is bearing a stout spine on the inner and outer corners. The endopodite is much longer than the exopodite.

Endopodite and exopodite each consist of 3 segments with the 2nd and 3rd podomere of the endopodite somewhat indistinctly separated. The 1st podomere of the endopodite is slightly shorter than the entire exopodite.

The 1st exopodal segment is about 0.8 times as long as the 2nd one and bears 1 strong plumose external seta and a longitudinal row of spinules. The 2nd exopodal segment is about 2.5 to 3 times longer than wide and bears 1 seta on the inner side and 1 external seta with a characteristic pectinate brush of hairs; moreover, it is provided with a distal row of spinules. The 3rd exopodal segment is small with 6 elements: 1 plumose seta at the internal margin, 1 long plumose apical seta and 4 latero-terminal setae with a characteristic pectinate brush of hairs.

The 1st segment of the endopodite is about as long as the second, bearing a strong seta at about 2/3 of the internal margin.

The 2nd endopodal segment is about 6 times as long as wide, bearing a strong seta on the internal margin at about 1/3 from the basis.

The 3rd endopodal segment is small, carrying 2 elements; the largest of them with a brush of hairs on the inner side; the shorter, claw-like one, with a brush of hairs on the outer side (figs. 2a, b, c).

The details of legs 2 to 4 can be taken from figs. 2d, 2e and 3a, the chaetotaxis formula, and the following notes.

chaetotaxis formula	leg 2		leg 3		leg 4	
	exp.	end.	exp.	end.	exp.	end.
1st podomere	1 : 1	0 : 1	1 : 1	0 : 1	1 : 1	0 : 1
2nd podomere	1 : 1	0 : 2	1 : 1	0 : 2	1 : 1	0 : 2
3rd podomere	7	5	8	6	8	5

Legs 2 and 4 are similar, except for certain differences in armature (see chaetotaxis formula). The 2nd and 3rd segments of the endopodite and exopodite of P4 are longer and much more slender than those of P2 and P3.

There is no inner basipodite spine, whereas the outer basipodite spine is more slender than in P1. Most long setae have a kind of joint.

Leg 5 (fig. 3e) is fairly large. The basi-endopodite is 2.5 to 3 times as broad as long; it bears 3 setae, on the inner expansion the middle seta is long, the outer one very short. There is a single seta at the outer corner of the basi-endopodite. The exopodite is elongate, 5 times as long as its greatest diameter (113 μ x 23 μ) bearing 5 distal elements: 2 subterminal setae on the external margin, at 1/12 and 1/6, respectively, from the top of the exopodite. The 3 others are terminal setae. The inner 2 much longer than the lateral one. In addition there are irregularly placed spinules on the surface of the exopodite and a row of spinules on the basi-endopodite (see fig. 3e).

Male: Like the female, the male is nearly colourless. The bodyshape is a little more slender than that of the female. The total length is 0.64 to 0.71 mm. The caudal ramus resembles that of the female.

The 1st antenna (fig. 3f) is subprehensile and has 9 podomeres, the 3rd being subdivided into 2, so that the proximal part of the antenna comprises 5 podomeres and the distal part 4. On the 5th podomere an aesthetasc is implanted. The proportional lengths of the 9 podomeres and the setal formula are as follows:

Segment number	1	2	3	4	5	6	7	8	9
Relative length	17	19	13	1	16	3	7	10	14 = 100
Number of elements	1	13	6	3	8 + 1	2	2	4	10

The 2nd antenna and mouth parts are like those in the female. The 1st, 3rd and 4th swimming legs are also like those of the female and have the same chaetotaxis formula.

The 1st podomere of the 2nd leg is different from that in the female, in that the seta at the inner margin is much stronger and has a modified, bifurcated distal part, as shown in fig. 3g.

The basi-endopodite and the exopodite of the 5th pair of legs are much smaller than in the female; the armature is shown in fig. 3d. The exopodite is more than 3 times as long as the greatest diameter, 40 μ x 13 μ , bearing as in the female 5 setae, whose mutual lengths are shown in fig. 3d. The 6th leg consists of a broad lobe, bearing a long, stout, plumose, distally attenuated spine, and 2 outer setae, the latter being much shorter and naked (see fig. 2h).

DEVELOPMENT AND RELATION TO THE HOST

It is very easy to rear this species in the laboratory. In seawater of 15°C., with a few pieces of wood in it, the eggs of ovigerous females hatched in a few days. From this moment the development from nauplius to adult took 20 days.

In order to determine the relation existing between *Tisbe eurypleura* nov.spec. and *Limnoria tripunctata* Menzies, the following experiment was carried out:

In each of 3 finger-bowls with seawater, called A, B and C, 10 specimens of *Tisbe eurypleura* nov.spec. were put. In finger-bowl A we also put 10 specimens of *Limnoria tripunctata* and a piece of cleaned wood (free of crustaceans). In finger-bowl B we put 10 specimens of *Limnoria tripunctata* and no wood. In finger-bowl C we put a piece of cleaned wood, without *L. tripunctata* but with *T. eurypleura*, without further sources of food. The temperature of the water was constantly kept at 15°C. The bowls were checked after one hour, one day, two days and three days, respectively. The results are shown in the following table:

Experiment	Situation after			
	1 hour	1 day	2 days	3 days
A. 10 <i>L. tripunctata</i> 10 <i>T. eurypleura</i> pieces of wood	10 T.W. 10 L.W.	10 T.W. 10 L.W.	10 T.W. 9 L.W. 1 L.D.	9 T.W. 8 L.W. 1 T.D. 2 L.D.
B. 10 <i>L. tripunctata</i> 10 <i>T. eurypleura</i> no wood	10 T.S. 10 L.S.	7 T.S. 3 T.D. 10 L.S.	1 T.S. 9 T.D. 6 L.S. 4 L.D.	10 T.D. 10 L.D.
C. 10 <i>T. eurypleura</i> pieces of wood	10 T.W.	9 T.W. 1 T.D.	9 T.W. 1 T.D.	7 T.W. 3 T.D.

Explanation:

L.D. *Limnoria tripunctata* dead
 L.W. *Limnoria* alive clinging to the wood
 L.S. *Limnoria* swimming around or clinging together
 T.D. *Tisbe* dead
 T.W. *Tisbe* alive, clinging to the wood
 T.L. *Tisbe* fixed on *Limnoria*
 T.S. *Tisbe* swimming around

This experiment shows that, although *T. eurypleura* shows a marked tendency towards a close association with *L. tripunctata*, this association is not strictly necessary for the copepod to stay alive. *T. eurypleura* can very well live on wood without *L. tripunctata*. Probably it only uses the holes made by *Limnoria* as a hiding-place.

DISCUSSION

Comparative study of the species in the genus *Tisbe* is very difficult, because of the often incomplete original descriptions, and since the males of many species are not yet known.

Tisbe eurypleura nov.spec. belongs to those species, which show a secondary sexual dimorphism in the seta of the first endopodal podomere of the second leg.

As far as we know this feature is present in *Tisbe gracilis* (T. Scott, 1895), *T. wilsoni* (Seiwell, 1928), *T. holothuriae* Humes, 1954, *T. cucumariae* Humes, 1957, and *T. helgolandica* Uhlig & Noodt, 1966. Of these species, *T. gracilis*, *T. wilsoni* and *T. cucumariae* are very different from the new species in the lengthwidth ratio of the furcal rami, the proportional length of the podomeres of P1, the fifth leg or in a combination of these characters. Moreover, the transformed seta of the second endopodal segment of P2 has a different shape.

T. holothuriae and *T. helgolandica*, however, seem to be closely related to the new species. We nevertheless believe the newly found *Tisbe* is not identical with these species. Besides certain smaller details, *T. holothuriae* differs from the new species in:

1. The exopodite of the fifth leg of the female, which is only four times as long as wide, instead of five times.
2. The basi-endopodite of the fifth leg, which is about as long as wide, whereas in the new species it is 2 1/2 to 3 times as wide as long.

3. The fifth leg of the male, which bears only two setae on the inner expansion of the basi-endopodite, instead of three. This basi-endopodite is both in its absolute size and in its relative size longer than in the new species.
4. The body shape, which is more slender than that of *T. eurypleura*.
5. The two long terminal setae of the caudal rami, which do not show a joint near the base in *T. holothuriae*.
6. The short element of the third endopodal segment of P1, which is spine-like against claw-like in *T. eurypleura*.

Tisbe helgolandica differs from the new species in:

1. The furcal ramus, which is a little longer than wide instead of a little wider than long.
2. The body shape, which is much less slender in *T. eurypleura*.
3. The first leg, whose second podomere of the exopodite is only two times longer than wide instead of 2 1/2 to 3 times.
4. The second podomere of the endopodite of P1, which is only four times longer than wide instead of six times.
5. The short element on the third endopodal segment of P1, which is not claw-like as in the newly found species.
6. The absence of a distal row of spinules on the second exopodal segment of P1.

The new species differs also from *T. furcata* (Baird, 1837), *T. elongata* (A. Scott, 1896), *T. inflata* (Sars, 1909), *T. graciloides* (Sars, 1920), *T. longisetosa* Gurney, 1927, *T. wilsoni* (Seiwell, 1928), *T. gurneyi* (Lang, 1934), *T. tenella* (Sars, 1910), *T. celata* Humes, 1954, *T. dilatata* Klie 1949 and *T. robusta* Monk, 1941. All these species do not show marked sexual dimorphism of the endopodal elements of the second leg.

The other species, of which the males are not known, all show great differences in P5, furca, P1, body shape or a combination of these characters. Uhlig & Noodt, 1966, supposed that *T. helgolandica* might be a geographical form of *T. holothuriae*. Although the differences between the new species at the one hand, and *T. helgolandica* and *T. holothuriae* at the other hand, are of about the same order as the differences - supposed to be of subspecific value - between *T. helgolandica* and *T. holothuriae*, there seems little evidence for a subspecific rank of *T. eurypleura*, since it has been found in the same geographical area (coastal waters of the French Mediterranean) as *T. holothuriae*.

Tisbe parviseta nov.spec.

MATERIAL: 6 females and 1 male from *Limnoria lignorum*, in wooden poles used for demarcating mussel-beds. Wimereux (France, Pas-de-Calais). April, 22, 1965. The ♀ holotype, ♂ allotype and 5 paratypes have been deposited in the Zoological Museum of the University of Amsterdam (cat. no. Co. 101.050).

DESCRIPTION

Female: the colour of live specimens is not known. The body shape resembles that of other species in the genus. The cephalosome is about as wide as long. The total length from the tip of the rostrum to the posterior end of the caudal rami is 0.85 mm to 0.61 mm (mean 0.72 mm, based on 5 specimens). The greatest body-width at the level of the 2nd pedigerous segment is 0.29 mm. The ratio of cephalosome plus metasome against urosome plus caudal rami is about 9:5. The rostrum is broadly rounded and bears 2 setae. The abdominal segments are dorsally and ventrally armed along their posterior margins. The anal operculum is unadorned.

The furcal ramus (fig. 4f) is slightly wider than long. The 1st internal terminal seta shows a

slight knee-like bent. The 2nd and 3rd terminal setae are very strong and barbelate. The 4th and external terminal seta is implanted on a ventral projection of the ramus and is naked. Near its base a setiform element is implanted.

The 1st antenna (fig. 4c) has 8 podomeres with proportional lengths as follows:

Segment number	1	2	3	4	5	6	7	8
Relative length	13	23	25	20	3	3	3	10 = 100
Number of elements	1	13	9	5 + 1	2	4	2	8

The 4th segment is bearing an aesthetasck, extending far beyond the tip of the antenna. The armature is shown in fig. 4c and in the table above.

The 2nd antenna, mouth parts and the 2nd to 4th leg do not show any differences from those in *Tisbe eurypleura* (see figs. 1d, e; 2d, e, f, g). The exopodite of the 1st leg (fig. 4d) is slightly longer than the 1st endopodal segment and is composed of 3 podomeres. The 1st one is about 0.9 times as long as the 2nd, bearing 1 strong plumose external seta and a longitudinal row of spinules. The 2nd exopodal segment is about 2.5 times longer than wide and bears 1 seta on the inner side and another on the outer side. The last one is provided with a brush of hairs. There is no distal row of spinules. The 3rd exopodal segment bears 6 elements as in *T. eurypleura*. The endopodite is likewise composed of 3 podomeres; the 1st segment being a little longer than the 2nd and bearing a strong plumose seta at about 7/10 of the internal margin. The 2nd endopodal segment is about 4.5 to 5 times as long as wide and has a short internal seta at about 4/10 from the proximal articulation line. The 3rd endopodal segment bears 2 elements as in *Tisbe eurypleura*.

The basi-endopodite of the 5th pair of legs is 2.5 to 3 times as broad as long (fig. 4h). On the inner expansion it is bearing some fine hairs and 3 setae, the one in the middle being the longest. A strong seta is implanted on the outer corner of the basi-endopodite. The exopodite is 3 to 3.5 times longer than wide. There are 4 terminal setae, the 2 inner ones very long and the 4th one, the outermost, much shorter. A 5th seta is located on the outer edge of the podomere at about 1/6 to 2/13 from the top of the exopodite. Small spinules occur along both edges of the podomere.

Male: The body-shape (fig. 4b) is a little more slender than that of the female. The total length is 0.66 mm. The caudal ramus resembles that of the female.

As in *T. eurypleura* the 1st antenna (fig. 4e) is subprehensile and has 9 podomeres.

The 2nd antenna, mouth parts and the 1st, 3rd and 4th swimming legs are like those of the female.

As in *T. eurypleura*, this species shows a secondary sexual dimorphism in the seta of the 2nd endopod, in that this seta is much stronger and has a modified bifurcated distal part (see fig. 3c).

The basi-endopodite of the 5th leg has been lost during the preparation. The exopodite (fig. 3c) is more than 3 times as long as the greatest diameter. It is provided with 5 setae, the inner distal one being very short.

The 6th leg, consists of a broad lobe, bearing a large distal spine and 2 outer slender and naked setae, the outermost on a low projection (see fig. 4i).

DISCUSSION

Tisbe holothuriae differs from this new species in:

1. The exopodite of the legs of the female, which is 4 times as long as wide instead of 3 - 3.5 times.
2. The basi-endopodite of the fifth leg of the female which is as long as wide.

3. The inner terminal seta of the caudal rami which are not bent in a knee-like way.
4. The internal seta of the second endopodal segment of P1, which is very long.
5. The body-shape which is more slender.

Tisbe helgolandica differs from *T. parviseta* in:

1. The furcal ramus, which is a little longer than wide instead of a little wider than long.
2. The exopodite of the fifth leg of the female, which is 5 times as long as wide instead of 3 to 3.5 times.
3. The internal seta of the second endopodal segment of P5, which is very long in *T. helgolandica* and very short in this new species.

T. eurypleura differs from *T. parviseta* in:

1. The exopodite of the fifth leg of the female, which is 5 times as long as wide instead of 3 to 3.5 times.
2. The internal seta of the second endopodal segment of P1, which is very long (versus very short in *T. parviseta*).
3. There is no distal row of spinules on the second exopodal segment in the new species.
4. The body-shape which is wider in *T. eurypleura*.

T. parviseta differs from the other species in the genus in the same way as discussed for *T. eurypleura*.

Fam. DIOSACCIDAE

Amonardia normani (Brady, 1872)

Syn.: *Dactylopus(ia) similis* Bray, 1872: 441, pl. XX figs. 13-17; Brady, 1880: 110, pl. 55 figs. 14-16; Norman & T. Scott, 1906: 169; T. Scott, 1896: 152; T. Scott, 1905: 801, pl. 2; Thompson, 1889: 79, 82;

Dactylopus Strömii Claus, 1863: 126, pl. 16 fig. 9; Timm, 1896: 158;

Amphiascus similis Farran, 1913: 12; Gurney, 1927: 516; Monard, 1928: 370, 386; Pesta, 1920: fig. M48; Pesta, 1927: 40; Sars, 1906: 151, pl. 94; T. Scott, 1906: 321; Stephensen, 1929: 6; *Microthalestris forficula* Stephensen, 1929: 5;

Amonardia normani Lang, 1948: 677, fig. 273.

MATERIAL EXAMINED - 9 females and 1 male collected from submerged wood, attacked by *Limnoria tripunctata*, at Saumaty, Marseille, at a depth of 1.5 to 4 meters, in late May and June 1966 (Cat. no. Z.M.A. Co. 101045).

DESCRIPTION

Female: the body (fig. 5a, d) is very slender, almost cylindrical, the anterior segments slightly wider than the posterior segments. The total length from the top of the rostrum to the end of the caudal rami is 0.95 - 1.63 mm (mean 1.2 mm based on 9 specimens).

The rostrum is very long and curved downwards, with a sensory seta on each side. The cephalic segment is of about the same length as the three following segments together. The urosome is nearly as long as cephalosome + metasome, tapering only very slightly in caudal direction. The ovisacs are paired, elongately elliptical in outline, containing numerous eggs. The anal operculum is finely spinulose.

The caudal rami (fig. 5b) are about as long as wide, with a kind of lateral protuberance, bearing 4 spinules and a long thin plumose seta. The inner terminal seta is short, naked, and has some spinules at its base. The 2nd inner terminal seta is also naked and has an articulation near the base. The 2 outer terminal setae are very strong, barbelate, and have likewise an articulation near the base. The dorsal seta is naked and has 2 little spines near its implantation.

The 1st antenna (fig. 5e) is comparatively short and has 8 podomeres, the 1st being far the largest. An aesthetasc is implanted on the 4th podomere. The relative lengths and the arrangement

of the elements are shown in the figure.

The 2nd antenna (fig. 6b) consists of an allobasis with a 3-segmented exopodite and a 1-segmented endopodite. The 1st segment of the exopodite has 1 plumose seta near its tip; the small 2nd segment bears no setae, whereas the 3rd segment has a plumose, internal, subbasal seta, 2 naked apical spine-like setae and rows of hairs around the top. The internal margin of the endopodite is armed with minute spinules and 2 setiform spines, the distal one being implanted on a level with some minute spines at the base. On the apex we find 1 seta on the inner, and 1 on the outer edge, and moreover, 4 geniculate setae in between them. The internal margin is provided only with a few spinules.

Mouthparts and maxillipeds are as illustrated in figs. 6a, d, e, f.

The basipodite of the 1st leg is bearing a strong plumose spine on the outer side and one on the inner side, the last one implanted on a kind of projection. The exopodite is much shorter than the 1st endopodal segment. The 1st podomere is armed with an outer plumose distal spine. The 2nd segment, which is about 1.5 times as long as the first, bears a distal spine on the outer side and a distal plumose seta on the inner margin. The 3rd segment is provided with 4 elements, the inner one being geniculate, the outer 3 being spinelike. The 1st podomere of the endopodite is about 8 times as long as the two succeeding segments together and is furnished with 1 plumose seta near the end of the inner margin. The 2nd and 3rd segments are each provided with a fine seta at the inner distal corner. The 3rd one also has 2 claw-like spines, the inner one being twice as long as the outer one. Besides, there are rows of minute spinules on basi-, endo-, and exopodite as shown in fig. 7b.

Legs 2 to 4 each consist of two 3-segmented rami. The differences between the individual legs can be seen in figs. 6c, 7a, c.

Apart from the ornamentation of the lateral margins, the first 2 segments of the exopodites are furnished with an additional row of spinules at the base of a dentiform process of the distal outer corners.

The basi-endopodite of the 5th leg (fig. 7e) is slightly wider than long, bearing some spinules and 5 spine-like elements, 4 of them being rather long and barbelate, the 5th and outer one being very short and naked. The exopodite is ovate 1.5 times longer than wide, with 6 spine-like elements, the 3rd one from the inner side very short and naked, the others longer and barbelate. Near the base of the internal seta some spinules are implanted.

Male: the body (fig. 8a) is smaller than the female (1.07 mm). The 1st antenna is geniculate and consists of 10 podomeres, the first one very long, the 4th swollen. On the 3rd, 4th, and last segments an aesthetascer is implanted. On the 5th and 6th podomeres we find some strange, plumose, spiniform projections. The arrangement of the other elements is shown in fig. 8c.

The inner spine on the basipodite of the 1st leg has been transformed into a strong falciform element. The endopodite and exopodite show no differences from those of the female (see fig. 8d).

The 2nd endopodal segment of the 2nd leg (figs. 8b, 7d) is very characteristic for this species; it is elongated, bearing at the inner margin 2 short plumose spines and 1 long plumose terminal seta. Moreover, it is provided with a broad, pointed spiniform projection on the outer edge and a strong terminal lobe, ending into three curved hooks. The presumed 3rd segment is very small, bearing a plumose seta.

The basi-endopodite of the 5th pair of legs (fig. 8e) are fused and carry each 2 plumose setae on the inner expansions, the inner one being about 4 times as long as the outer one, and one naked seta on the outer expansions. The exopodite is constricted near the base, a little longer than wide, bearing 3 long and 1 short setae, the inner one plumose.

Remarks - Up to now, *Amonardia normani* has been recorded from the Faroes, the British isles, the south and west coasts of Norway; Bohuslän (S.W. Sweden) and from the Mediterranean at Nice (Stephensen, 1929). It is a species living at moderate depths among algae. As far as I know this is the first time it was found hiding in the holes made by a species of *Limnoria*.

Fam. LAOPHONTIDAE

Harrietella simulans (T. Scott, 1894)

Laophonte simulans T. Scott, 1894: 248, pl. 7 figs. 24-32, pl. 8 fig. 1.

Harrietella simulans T. Scott, 1906: 464, pl. II figs. 9-10; Sars, 1920: 73, pl. 49; Pesta, 1927: 44; Vervoort, 1950: 279-305.

MATERIAL EXAMINED - 8 females and 1 male collected from submerged wood attacked by *Limnoria tripunctata* at Saumaty in the harbour of Marseille, in late May and June 1966 (Z.M.A. Co.101.046).

10 adult females and 1 immature female from *Limnoria lignorum* (Rathke) in logs of wood washed ashore at Katwijk, the Netherlands, February 20, 1949. Leg. J.A.W. Lucas (Z.M.A. Co. 101.047).

1 adult female from *L. lignorum* in logs of wood washed ashore at Noordwijkerhout, the Netherlands, March 2, 1949. Leg. J.A.W. Lucas (Collection Rijksmuseum Natuurlijke Historie, Leyden).

18 females and males from *L. lignorum*, in wooden poles, used for demarcating mussel-beds. Wimereux (France, Pas-de-Calais), April 22, 1965 (Cat. no. 101.048).

DESCRIPTION

Female: in live specimens the body is nearly colourless. The total length of the adult is 0.50 to 0.68 mm (mean 0.59 mm, based on 10 specimens). The body is dorso-ventrally flattened. The cephalosome is the widest, and is composed of the cephalic segment and the 1st pedigerous segment; it bears a broad, square, recurved rostrum with 2 minute setae and a fringe of hairs. An eye-spot has not been observed (see fig. 9a). All segments are dorsally armed along their posterior margins with a row of minute spinules. The ratio cephalosome plus metasome to urosome is about 2:1. The anal operculum is finely adorned.

The furcal rami (fig. 9e) are nearly twice as long as wide and bear a remarkable pointed latero-terminal projection. The external margin is straight, the internal one is slightly convex, bearing 2 small spines and some fine hairs. The internal terminal seta is small and naked; the 2nd internal terminal seta is strong and elongate, finely plumose. The 3rd terminal seta is also strong but more slender and shorter than the second. The 4th terminal seta has moved to the outer margin, to the base of the projection, and is short and naked. The lateral seta is short and very thin; the dorsal seta is attached in about the middle, at the base of the two strong terminal setae.

The 1st antenna (fig. 9b) is composed of 6 podomeres with proportional lengths as shown below:

Segment no.	1	2	3	4	5	6
Relative length	17	27	25	9	5	17 = 100

At the top of the 4th podomere there is an aesthetask, extending far beyond the top of the antenna. The various segments are bearing a large number of setae, mostly on the inner side. In addition there are numerous strong, almost setiform cuticular hairs on the internal and external margins of the 1st and 2nd podomeres and some fine hairs on the 3rd and 4th segment.

The 2nd antenna (fig. 9d) has a basal segment, nearly twice as long as wide, with on the inner side some fine teeth and a seta at about 1/4 from the top of the segment. The exopodite which is implanted on the basal segment has only 1 short podomere, bearing 4 plumose setae.

On the internal margin of the 1-segmented endopodite we find a strong spine near the base and 2 spines at about 1/3 from the apex. Between these 2 spines a thin flagelliform seta is found. The top of the endopodite is bearing 5 strong, hook-shaped elements. Two rows of hairs are implanted near the apex, one of them on a spiniform projection of the external margin.

The mouth-parts are not studied in detail.

The maxilliped (fig. 9c) is very well developed and is composed of 3 podomeres; the last of them being a strong claw, forming a powerful clasping organ in opposition with the 2nd segment.

The 1st leg (fig. 10e) is also strongly built and composed of a 2-segmented protopod and 2 rami. A stout spine is implanted on the external margin of the basipod, with a small spine-like hair near its base. Another spine is implanted at about 1/3 from the top of the basipod, while the inner margin of it is furnished with some spine-like hairs. The endopod has 3 podomeres, the 3rd of them being transformed into a hook. On the internal margin of the 1st podomere we find a row of spine-like hairs, decreasing in length from the base to the top. The 2nd podomere bears 3 lateral hairs and 1 near the articulation with the 3rd segment. The 3-segmented exopod, whose total length is about 3/4 of the 1st endopodal segment, bears 1, 1 and 4 elements on each of the respective segments. The two inner of the terminal elements of the 3rd exopodal segment are very long and hooked.

The basipod of the 2nd leg (fig. 10d) is provided with an external prolongation, bearing a strong plumose seta. The exopod has 3 podomeres, the 1st and 2nd each with a strong spine on the outer edge and rows of spiniform hairs on the external margins. The 3rd segment bears 2 external spines and 2 terminal ones. The endopod is 2-segmented, the 1st segment with 2 internal spiniform hairs, the 2nd with 2 plumose apical setae and some hairs, both on inner and outer margins.

The basipod of the 3rd leg is also bearing a strong plumose external seta. The exopod has 1, 1 and 4 spines respectively; the one on the 1st segment being barbelate. Rows of spine-like hairs are implanted on all three segments (fig. 10b).

The 1st podomere of the endopod is only bearing some spine-like hairs, while the second one is provided with 4 long and 1 short seta and some spiniform hairs on the inner and outer margins.

The 4th leg (fig. 10e) is characteristic of the genus *Harrietella*, because of the reduction of the number of segments in both exo- and endopod. The basipod bears a strong external projection with a long plumose seta. The exopodite has only 2 podomeres, the first of them bearing a strong spiniform external seta. The 2nd one carries a spiniform seta on a projection of the external margin, 4 more or less spine-like setae around the apex and 1 seta on the inner side. All setae of the exopodite are plumose. A row of strong spiniform hairs is implanted on the external margins of segment 2. The single endopodal segment is slightly hairy and bears 2 apical spiniform setae.

The 5th leg has a very short basi-endopodite. The outer part is provided with a slender projection, a seta implanted on its top; the inner part with 3 marginal plumose setae of about equal length. The hairy exopod is constricted near the base, widening to the top, bearing 5 plumose elements, implanted as shown in fig. 10c.

Male: The body shape differs slightly from that in the female, in that the body is a little narrower in the region between the 4th pedigerous segment and the anal segment (fig. 9f).

The 1st antenna is modified into a powerful subchelate grasping organ. It consists of 8 podomeres, the 6th one being apparently subdivided into three, forming a kind of prehensile structure. On the inner margins of the last 4 segments, many chitinous thickenings are found. Besides some setae, the 5th podomere is bearing an aestetask near its top and a pectinate spine near the joint with the 4th segment. The arrangement of the setae is shown in fig. 11b.

The maxilliped resembles that of the female, and so are the legs.

The basi-endopodite of the 5th leg is small, with a setiferous projection on its outer side;

the exopodite is also very small, bearing 4 plumose setae on the apex (fig. 11a).

Remarks - In comparing the material described above with descriptions of T. Scott (1894, 1896, 1906), Stephensen (1936), Sars (1920) and Vervoort (1950) several aberrant points came to notice. Especially the description of Vervoort (1950) showed remarkable differences, such as:

- A. The smaller number of elements on the 1st antenna.
- B. The absence of the pointed latero-terminal projection on the furcal rami.
- C. No inner spine on the endopodite of the 2nd antenna.
- D. No outer spine on the basipodite of the 1st leg.
- E. The lack of a large setiferous projection on the basipodite of the 3rd leg.
- F. The difference in shape and number of the elements of the female.

I am indebted to Dr. W. Vervoort for entrusting me the material on which he based his paper, thus enabling me to compare it with my own specimens. Notwithstanding the considerable divergences with Vervoort's description and illustrations, the actual material proved to be completely identical with *Harrietella simulans* as described in the preceding pages.

Likewise, I believe that the small divergences observed between the descriptions of Scott, Sars and Stephensen, are also due to inaccurate observations and not to morphological differentiations within the genus *Harrietella*.

Donsiella limnoriae Stephensen, 1936

Stephensen, 1936: 6, figs. 2-4.

MATERIAL EXAMINED - 11 females and males from *Limnoria tripunctata* in submerged wood (depth 1.5-4 m), at Saumaty in the harbour of Marseille, in late May and June 1966 (Z.M.A. Co. 101.044).

23 females and males from *Limnoria lignorum*, in wooden poles, used for demarcating mussel-beds. Wimereux (France, Pas-de-Calais), April 22, 1965 (Z.M.A. Co. 101.049).

Remarks - The adults were only found clinging to the body of *Limnoria*, while the larval stages were found both on wood, clinging to *Limnoria*, and swimming freely in the water. It proved to be very difficult to rear this species in the laboratory. About a twenty times ovigerous females were placed in fingerbowls with seawater, constantly kept at 15°C, together with a piece of wood and one specimen of *Limnoria*. In only three cases the eggs hatched after a few days. The free-swimming larvae, however, all died after a lapse of 4 to 6 days, when they had reached the metanauplius-stage.

In order to determine the relation existing between *D. limnoriae*, and *Limnoria tripunctata* Menzies, the same experiment was carried out as described before for *Tisbe eurypleura*. The results were completely different from those with *Tisbe eurypleura*, as the table on the next page shows.

This experiment, and the experiment to rear *Donsiella limnoriae*, make it probable that there is a very close association with *Limnoria*, in that the gribble is a necessary factor to stay alive for the adult copepod, while the larval stages are free-living. This is not surprising, when we regard the somewhat reduced second to fourth pereopods of the adults, which are not at all fit to swim.

	Situation after			
	1 hour	1 day	2 days	3 days
A. 10 <i>L. tripunctata</i>	10 D.L.	10 D.L.	10 D.L.	9 D.L. 1 D.D.
10 <i>D. limnoriae</i>	10 L.W.	2 L.S. 8 L.W.	3 L.S. 7 L.W.	3 L.D. 1 L.S. 6 L.W.
pieces of wood				
B. 10 <i>L. tripunctata</i>	10 D.L.	9 D.L.	9 D.L.	8 D.L.
10 <i>D. limnoriae</i>	10 L.S.	1 D.D. 6 L.S. 4 L.D.	1 D.D. 5 L.S. 5 L.D.	2 D.D. 5 L.S. 5 L.D.
no wood				
C. 10 <i>D. limnoriae</i>	10 D.S.	6 D.S. 4 D.D.	3 D.S. 7 D.D.	10 D.D.
pieces of wood				
Explanation:	L.D. <i>Limnoria tripunctata</i> dead L.W. <i>Limnoria</i> alive clinging to the wood L.S. <i>Limnoria</i> swimming around or clinging together D.D. <i>Donsiella</i> dead D.W. <i>Donsiella</i> alive, clinging to the wood D.L. <i>Donsiella</i> fixed on <i>Limnoria</i> D.S. <i>Donsiella</i> swimming around			

REFERENCES

- BARNARD, J.L. & D.J. REISH, 1958. First discovery of marine wood-boring copepods. *Science*, 125 (3241): 236.
- , 1958. Woodbrowsing habits of the copepod *Tisbe gracilis*. *Pacific Natural.*, 1 (22): 9-12.
- BOCQUET, C., 1951. Recherches sur *Tisbe* (= *Idyaea*) *reticulata* n.sp. Essai d'analyse génétique du polychromatisme d'un Copépode harpacticofde. *Arch. Zool. exp. gen.*, 87: 335-416.
- BOWMAN, T.E., 1962. *Tisbe monozota*, a new harpacticoid copepod from Florida. *Proc. biol. Soc. Washington*, 75: 125-132.
- BRADY, G.S., 1872. A list of the non-parasitic copepods of the northeast coast of England. *Trans. nat. Hist. Soc. Northumberland Durham*, 4: 441.
- CLAUS, C., 1866. Die Copepoden-fauna von Nizza. *Schr. Gesellsch. Naturw. Marburg, Suppl.*, 9: 25.
- GURNEY, R., 1927. Zoological results of the Cambridge expedition to the Suez-canal 1924, free-living Copepoda. *Trans. zool. Soc. London*, 22: 516-517.
- HUMES, A.G., 1954. *Tisbe celata* n.sp. from mantle-cavity of edible mussel in New Brunswick. *J. Fish. Res. Bd. Canada*, 11 (6): 816-826.
- , 1957. Deux Copépodes harpacticoides nouveaux du genre *Tisbe*, parasite de Holothuries de la Méditerranée. *Vie et Milieu*, 8 (1): 9-22.
- KLIE, W., 1949. Harpacticoida (Cop.) aus dem Bereich von Helgoland und der Kieler Bucht. *Kieler Meeresforsch.*, 6: 90-128.
- KRISHNASWAMY, S. & C.T. JONES, 1958. Occurrence of *Donsiella limnoriae* Stephensen (Copepoda, Harpacticoida) in the Southampton Area. *Nature*, 181: 1016-1017.
- LANG, K., 1948. Monografie der Harpacticiden, 2 Vols. (Haken Ohlssons boktryckeri Lund).
- , 1965. Copepoda harpacticoida from the California Pacific coast. *Kungl. Svenska Vet. Akad. Handl.*, 10 (2): 279.
- MENZIES, R.J., 1957. The marine borer-family Limnoridae (Crustacea - Isopoda). *Bull. mar. Sci. Gulf Caribbean*, 7 (2): 101-200.
- MONK, C.R., 1941. Marine harpacticoid copepods from California. *Trans. Amer. micr. Sci., Menasha*, 60: 75-103.
- NICHOLS, A.G., 1941. A revision of the families Diosaccidae Sars, 1906 and Laophontidae T. Scott, 1905. *Res. S. Austr. Mus.*, 7 (1): 65-110.
- NOODT, W., 1954. Copepoda Harpacticoida von den chilenischen Meereskisten. *Kieler Meeresforsch.*, 10: 247-252.
- , 1955. Copepoda Harpacticoida von Teneriffa (Kanarische Inseln). *Zool Anz.* 154: 200-222.
- PETKOVSKI, T., 1964. Zur Kenntnis der Harpacticiden Portugals (Crust. Cop.). *Lunds Univ. Arsskr.* (2) 59 (14): 3-22.

- POR, F.D., 1964. A study of the Levantine and Pontic Harpacticoidea (Crustacea, Copepoda). Zool. Verh. Rijksmus. nat. Hist. Leiden, 64: 1-128.
- POR, F.D. & A. MARCUS, 1961. Die Copepoden der polyhalinen Lagunen Sinve (Schwarzen Meer - Rumänische Küsten). Acta Mus. Mac. Sci. nat., 7 (6): 105-126.
- SARS, G.O., 1906. An account of the Crustacea of Norway, 5. Copepoda harpacticoidea. (Bergen Museum, Bergen).
- , 1921. An account of the Crustacea of Norway, 7. Copepoda (Suppl.). (Bergen Museum, Bergen).
- SCOTT, T., 1894. Additions to the fauna of the Firth of Clyde. Ann. Rep. Fish. Bd. Scotland, 12 (3): 231-270.
- , 1906. Some notes on Copepoda from the Scottish seas. Ann. Rep. Fish. Bd. Scotland, 24 (3): 336.
- , 1906. Notes on British Copepoda. Change of names. Ann. Mag. nat. Hist., 17 (7): 458-468.
- , 1907. Some additional notes on Copepoda from the Scottish seas. Ann. Rep. Fish. Bd. Scotland, 25 (3): 209.
- SEIWELL, H.R., 1928. Two new species of commensal copepods from the Woods- Hole region. Proc. U.S. Nat. Mus., 73 (2739): 1-5.
- SEWELL, R.B.S., 1940. Copepoda harpacticoidea. Sci. John Murray Exp. 1933-1934, 8 (2): 117-351.
- STEPHENSEN, K., 1929. Marine parasitic and non pelagic Crustacea Copepoda. Zool. Faoes, 30: 5.
- , 1936. Copepoda found on *Limnoria lignorum*. Kgl. Norske vidensk. Selsk. Skr., 39: 1-10.
- TANAKA, O., 1960. Pelagic Copepoda. Biol. Rés. Jap. Antarct. Exp., 10: 1-95.
- UHLIG, G. & W. NOODT, 1966. *Tisbe helgolandica* n.sp. aus dem Seewasser-Freibad Helgoland (Crustacea, Copepoda). Kieler Meeresforsch., 22 (1): 133-137.
- VERVOORT, W., 1950. *Harrietella simulans* (T. Scott), a commensal copepod on *Limnoria lignorum* Rathke. Zool. Mededel. Leiden, 30 (20): 297-305.
- , 1962. Report on some Copepoda collected during the Melanesia Expedition of the Osaka Museum of Natural History. Publ. Seto mar. biol. Lab., 10: 393-470.

Drs. S. PINKSTER
Zoological Museum of the University of Amsterdam
Plantage Middenlaan 53
Amsterdam - The Netherlands

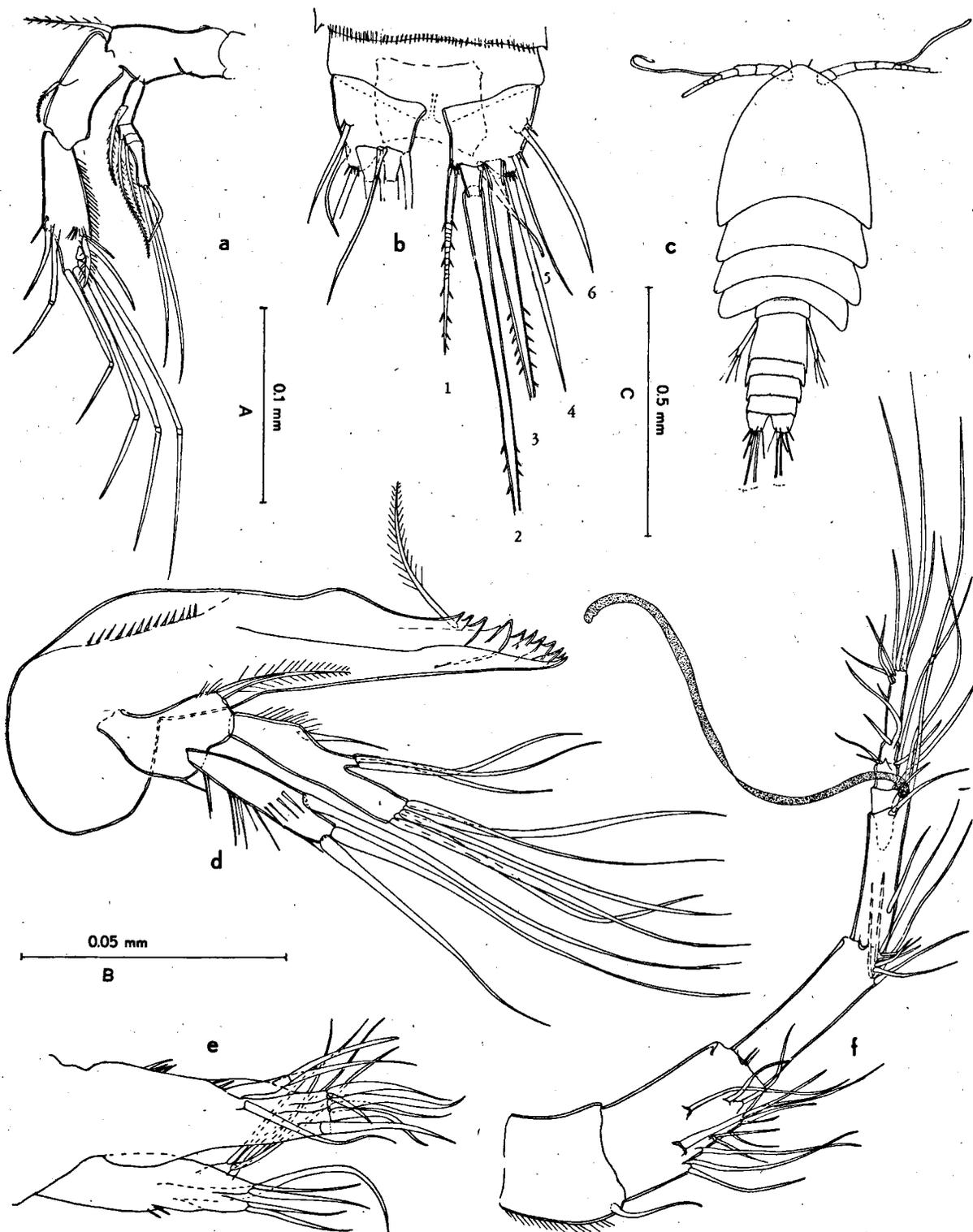


Fig. 1. *Tisbe eurypleura* nov. spec., female. a, second antenna (scale A); b, furcal rami, ventral view (scale A); c, habitus, dorsal view (scale C); d, mandible (scale B); e, first maxilla (scale B); f, first antenna (scale A).



Fig. 2. *Tisbe eurypleura* nov. spec., (a-g, female; h, male). a, first leg (scale A); b and c, details of the endopodite of first leg (scale B); d, fourth leg (scale A); e, third leg (scale A); f, first maxilliped (scale A); g, second maxilliped (scale A); h, sixth leg (scale B).

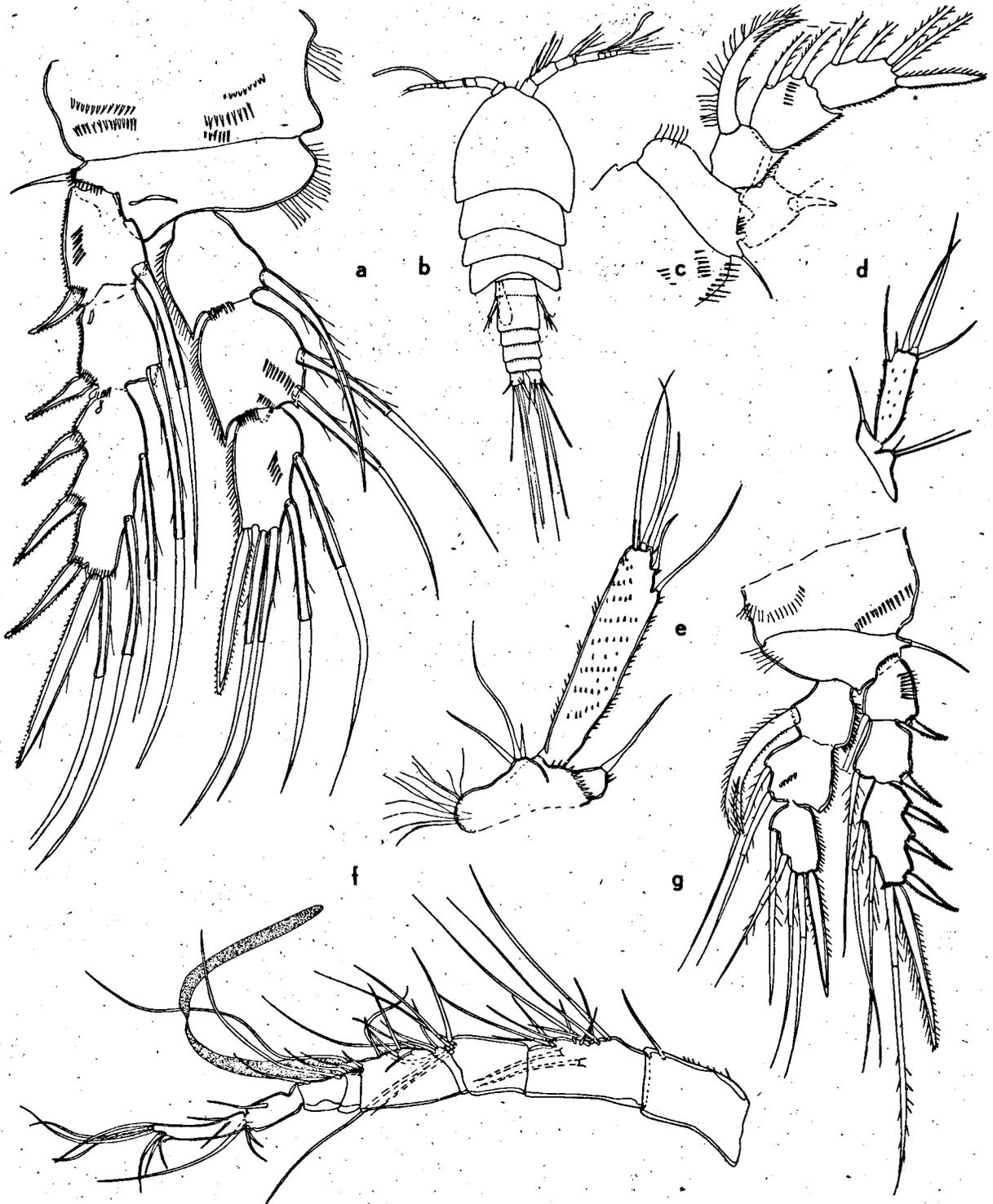


Fig. 3. *Tisbe euryleura* nov. spec., a, second leg of female (scale A); b, habitus of male, dorsal view (scale C); d, fifth leg of male (scale A); f, first antenna of male (scale A); g, second leg of male (scale A).

Tisbe parviseta nov. spec., c, second leg of male (scale A).



Fig. 4. *Tisbe parviseta* nov. spec., (a, c, d, f, h, female; b, e, g, i, male). a, habitus of female, dorsal view (scale A); b, habitus of male, dorsal view (scale A); c, first antenna of female (scale A); d, first leg of female (scale A); e, first antenna of male (scale A); f, furcal rami in ventral view, ♀ (scale A); g, fifth leg of male (scale B); h, fifth leg of female (scale B); i, sixth leg of male (scale B).

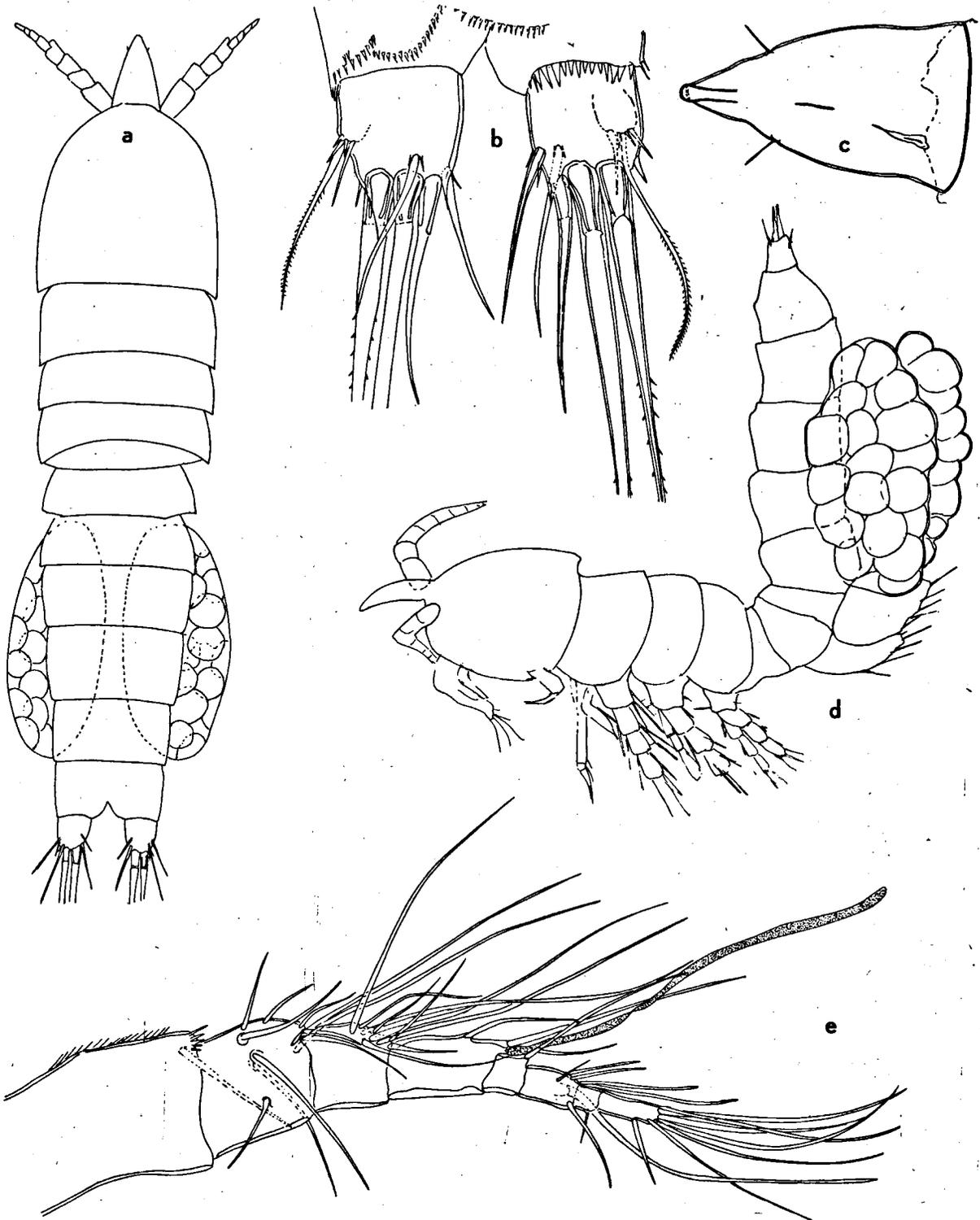


Fig. 5. *Amonardia normani* (Brady, 1872), female. a, habitus, dorsal view (scale C); b, furcal rami, ventral view (scale A); c, rostrum (scale A); d, habitus, lateral view (scale C); e, first antenna (scale A).

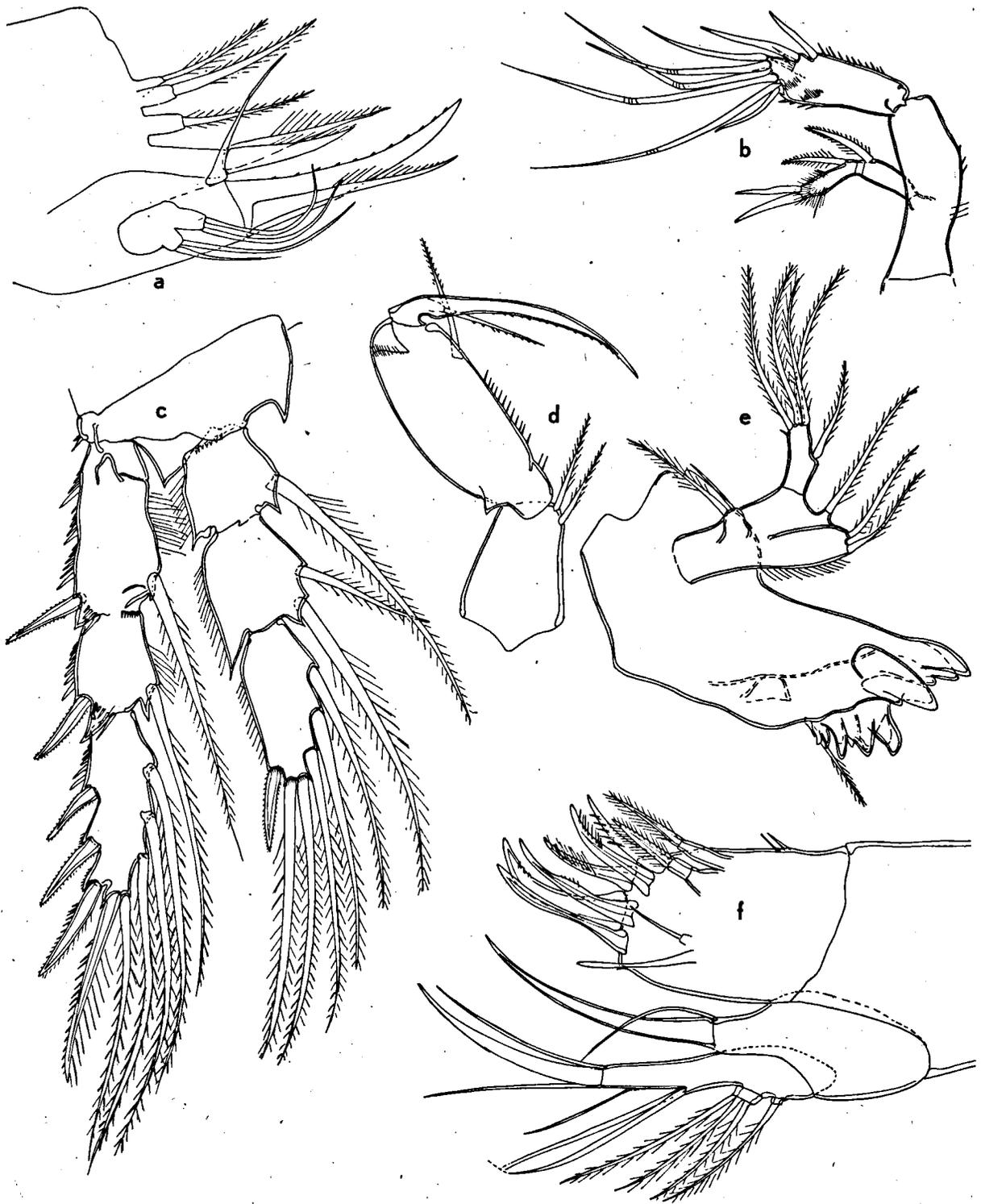


Fig. 6. *Amonardia normani* (Brady, 1872), female. a, first maxilla (scale B); b, second antenna (scale A); c, third leg (scale A); d, second maxilliped (scale D); e, mandible (scale D); f, second maxilla (scale D).



Fig. 7. *Amonardia normani* (Brady, 1872), (a, b, c, female; d, e, male). a, fourth leg (scale A); b, first leg (scale A); c, second leg (scale A); d, endopodite of second leg, detail (scale B); e, fifth leg (scale A).

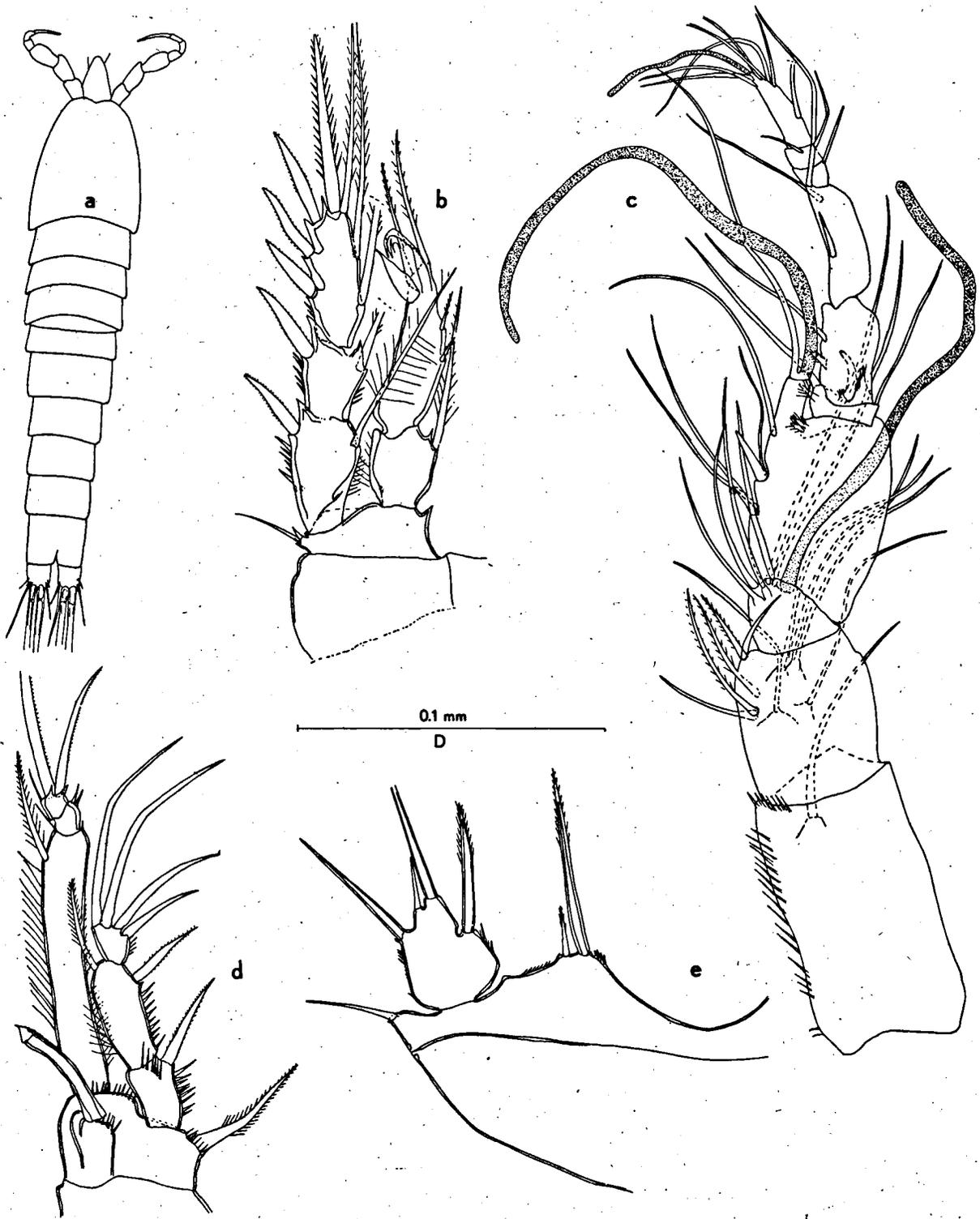


Fig. 8. *Amonardia normani* (Brady, 1872), male. a, habitus (scale C); b, second leg (scale A); c, first antenna (scale D); d, first leg (scale A); e, fifth leg (scale D).



Fig. 9. *Harrietella simulans* (T. Scott, 1894), (a, b, c, d, e, female; f, male). a, habitus, dorsal view (scale C); b, first antenna (scale B); c, maxilliped (scale B); d, second antenna (scale B); e, furcal rami, dorsal view (scale B); f, habitus (scale C).



Fig. 10. *Harrietella simulans* (T. Scott, 1894), female. a, first leg (scale B); b, third leg (scale B); c, fifth leg (scale B); d, second leg (scale B); e, fourth leg (scale B).

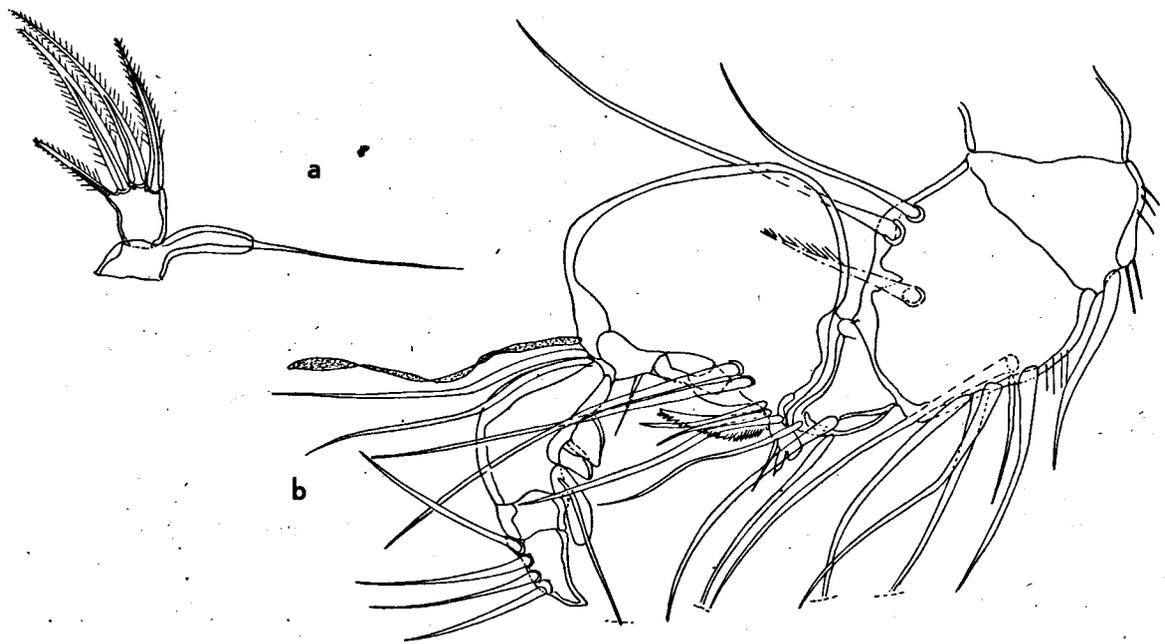


Fig. 11. *Harrietella simulans* (T. Scott, 1894), male. a, fifth leg (scale B); b, first antenna (scale B).