

# Towards a revision of the genus *Halectinosoma* (Copepoda, Harpacticoida, Ectinosomatidae): new species from the North Atlantic and Arctic regions

MICHEL CLÉMENT and COLIN G. MOORE\*

School of Life Sciences, Heriot-Watt University, Riccarton, Edinburgh EH14 4AS, UK

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This paper contributes to a revision of the genus *Halectinosoma*. Four new species are described, based on examination of ectinosomatid material from localities in western Europe, eastern Canada and the Arctic. *Halectinosoma mandibularis* sp. nov. is distinguishable from other species by the reduced setation of the mouthparts and enlarged mandibular gnathobase. *Halectinosoma latisetifera* sp. nov. bears an affinity with *H. cooperatum* but is easily distinguished by the shape of the setae on the female fifth leg. A species previously erroneously ascribed to *H. finmarchicum* (Scott) by several authors is described here as *Halectinosoma kliei* sp. nov. *Halectinosoma gothiceps* (Giesbrecht) is redescribed and the closely related *Halectinosoma paragothiceps* sp. nov. is described and distinguished from *H. gothiceps*. It is considered likely that some previous records of *H. gothiceps* are in error. © 2007 The Linnean Society of London, *Zoological Journal of the Linnean Society*, 2007, 149, 453–475.

ADDITIONAL KEYWORDS: copepod – meiobenthos – taxonomy.

## INTRODUCTION

Species of *Halectinosoma* are often dominant members of the harpacticoid copepod assemblage of marine sediments and yet their identification is notoriously difficult. Differences between species within this large genus of around 63 species are often subtle and a lack of appreciation of this subtlety has caused much taxonomic confusion. This has led to the production of descriptions that, in many cases, do not permit the accurate identification of species.

Clément & Moore (1995) commenced a revision of *Halectinosoma* with a reappraisal of *H. sarsi* and descriptions of 11 related species. This was followed by redescriptions of *H. elongatum* (Sars, 1904) and *H. herdmani* (Scott & Scott, 1894), together with descriptions of related species (Clément & Moore, 2000). In this third paper in the series we complete our description of new species by consideration of four new species from the North Atlantic and Arctic regions. A final paper, yet to be published, will consider the

remaining known species and provide a generic diagnosis and key to the species.

## MATERIAL AND METHODS

Copepod material was examined from sediment samples collected by the authors from around the British Isles, western Mediterranean and eastern Canada (Table 1). In the descriptions of species that follow, the provenance of this material is given by citing the sample code from Table 1. Arctic and western European material was also examined from museum and personal collections.

Specimens were dissected in lactic acid and mounted on slides in polyvinyl lactophenol. All figures were prepared with the aid of a drawing tube. Habitus length measurements are from the base of the rostrum to the posterior edge of the anal somite. Because this measure varies significantly due to the telescoping action of the body somites, an additional and more reliable method for measuring the length of the animal was used. The specimen was placed on its side and the length of each individual somite measured along the dorsal margin (Clément & Moore, 1995: Fig. 1A).

\*Corresponding author. E-mail: c.g.moore@hw.ac.uk

**Table 1.** Details of the sediment samples collected by the authors containing *Halectinosoma* material described in this study. The locations are in British waters unless stated otherwise

Sample code	Location	Sediment type	Depth (m)	Date
S17	Forth Estuary, 55°59.73'N, 3°23.70'W	muddy sand	5	26.x.1983
S18	Firth of Forth, 56°00.14'N, 3°16.93'W	mud and gravel	13	7.xi.1983
S21	Firth of Forth, 55°57.85'N, 3°02.70'W	mud	10	10.xi.1983
S58	North Sea, 55°00.0'N, 0°20.0'E	muddy sand	82	19.iv.1984
S65	Banyuls, France, 42°30.1'N, 3°12.6'E	mud	90	1976
S68	Anchorage Bay, Summer Isles	mud	17	5.vii.1988
S70	Loch Creran, 56°31.27'N, 5°20.63'W	mud	11	1986
S71	Forth Estuary, 56°01.71'N, 3°36.30'W	coarse silt	2	17.ii.1981
S73	Forth Estuary, 56°02.28'N, 3°33.57'W	muddy sand	subtidal	1983
S85	Celtic Sea, 50°30'N, 7°00'W	muddy sand	subtidal	1985
S91	Glenuig, 56°49.77'N, 5°49.00'W	sand	lower shore	iv.1988
S95	Kinlochmoidart	mud	lower shore	iv.1988
S96	Loch Creran, 56°31.35'N, 5°19.93'W	muddy sand	5	1997
S97	Les Escoumins, Québec, St. Lawrence, Canada	sandy mud	13	ix.1997
S98	Les Escoumins, Québec, St. Lawrence, Canada	sandy mud	20	ix.1997
S99	Le Bic, Québec, St. Lawrence, Canada	muddy sand	intertidal	vi.1996

The length of the somite was taken from its anterior margin, defined by a thickened cuticular ring, often embedded in the preceding somite, to the posterior edge, which includes the hyaline frill when present and the pseudoperculum of the penultimate urosomite. This measure is referred to in the text as the sum of all somites, and excludes the rostrum and caudal rami.

As a means of facilitating the description of the location of the surface seta on the exopod of the fifth leg, we have introduced the term surface-seta insertion line. This is a hypothetical straight line passing from the posterior margin of the exopod at the junction of the middle and outer exopod lobes, through the base of the surface seta (not including its small basal lobe) and terminating at the suture of the exopod with the baseendopod (Clément & Moore, 2000: Fig. 1J).

The length/width ratio of the caudal ramus is calculated from the length of the inner margin, including the part embedded in the anal somite, and the greatest width. Nomenclature follows that of Huys *et al.* (1996). The only abbreviations used in the text are P1 to P6 for legs 1–6. The setal formulae of the legs follows Lang (1948). For practical considerations we have retained the terms *lacinia* and *pars incisiva* for the coxal gnathobase of the mandible. Scale bars in all illustrations are in mm.

Much of the British and French material examined in this study has been deposited at the Natural History Museum, London. Natural History Museum registration numbers are given the prefix NHM. The material was fixed using a 4% formaldehyde solution but transferred to alcohol following examination.

## SYSTEMATICS

### *HALECTINOSOMA MANDIBULARIS* SP. NOV.

*Type material:* 1♀ holotype dissected on three slides (NHM1990.425), 1♀ paratype dissected on slide (NHM1990.426), collected by grab from the North Sea (site S58). 1♂ paratype dissected on two slides (NHM1990.427), 1♂ paratype in tube (NHM1990.1219), collected by C. G. Moore by grab from off Banyuls, France (site S65).

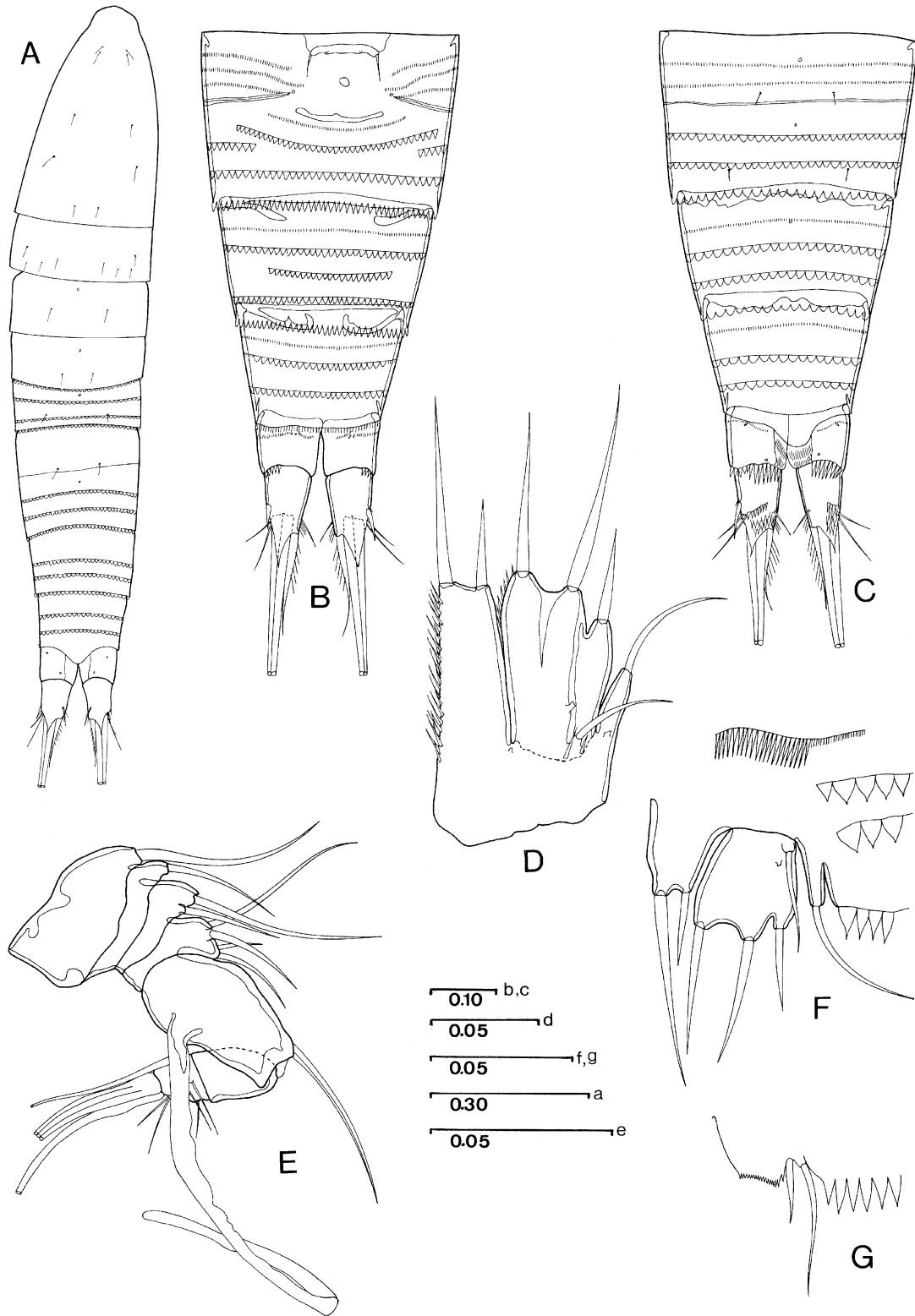
*Other material examined:* England: S85 (1♀ in tube NHM1990.1218). France: S65 (1♂ in tube NHM1990.1220).

#### *Description of female holotype*

*Length:* Habitus 1195 µm; sum of all somites 1380 µm; cephalothorax 400 µm; genital double-somite 185 µm. Habitus fusiform (Fig. 1A). Colour of preserved specimen dark brown. Surface of cuticle densely covered with small pores. Cephalothorax gradually attenuating anteriorly. Rostrum broadly rounded and partially fused at base with cephalothorax and furnished with two small sensilla subapically. Genital double-somite with a short, transverse chitinous stripe ventrally and divided dorsally by a suture reaching ventro-laterally. Penultimate somite with rounded pseudoperculum.

*Caudal ramus* (Fig. 1B, C). Nearly 1.5 times as long as broadest width. Principal setation and general form as in *H. pseudosarsi* Clément & Moore, 1995.

*Somitic ornamentation* (Fig. 1A–C). Body somites, except penultimate, sparsely furnished with sensilla



**Figure 1.** *Halectinosoma mandibularis* sp. nov. Female holotype: A, habitus, dorsal; B, urosomites 2–6, ventral; C, urosomites 2–6, dorsal; D, P5. Male paratype (NHM1990.427): E, antennule; F, P5; G, P6.

and pores. Posterior margin of cephalothorax, first and second free thoracic somites unadorned. Surface of first and second free thoracic somites with one and two rows of fine spinules, respectively. Posterior margin of third free thoracic somite and first urosomite finely crenulated. The surface of third free thoracic somite with two rows of fine spinules, first urosomite with two rows of lappet-like spinules and one row of fine spinules anteriorly. Genital double-somite with a complex arrangement of rows of fine spinules and posteriorly with two rows of lappet-like spinules and a semi-incised subulate hyaline frill. Fourth urosomite with a similar hyaline frill to preceding somite and furnished with one row of fine spinules and three rows of lappet-like spinules, one of which is only present mid-ventrally. Penultimate somite with one row of fine spinules and two rows of lappet-like spinules; very fine fully incised subulate hyaline frill interrupted dorsally by unadorned pseudoperculum.

*Antennule* (Fig. 2A). Short, robust and six-segmented. Principal setation and form as in *H. pseudosarsi* except for small differences in relative length and spinulation of some setae.

*Antenna* (Fig. 2B). Coxa short. Basis with a short row of spinules along outer margin and a set of setules at inner distal corner. Endopodite two-segmented; segment 1 unadorned, segment two furnished with two adjacent setae mid-way along inner margin and seven terminal setae (three spinulose geniculate and one dwarfed plumose). Exopodite three-segmented; basal segment well developed and armed with one short seta, segment 2 short, with a strong, spinulose seta, distal segment slightly longer than basal one and armed with two apical setae, which are spinulose and subequal in length.

*Mandible* (Fig. 2C). Coxal gnathobase extremely well developed and furnished with a short, spiniform seta at ventral base of bidentate *pars incisiva* and tridentate *lacinia*. Basis with a row of fine spinules on surface and one spinulose seta issuing from distal inner corner. Endopodite one-segmented and furnished with two juxtaposed setae mid-way along inner margin and five terminal setae. Exopodite one-segmented and armed with three setae.

*Maxillula* (Fig. 2D). Praecoaxal arthrite broad and armed along distal edge with three unguiform spines and three small setae. Coxa absent. Basis small and armed with two strongly spinulose setae and a few spinules along inner margin. Exopodite consisting of a small lobe fused with basis and fringed with few spinules along inner margin, and furnished with two slender setae, the outer seta being spinulose. Endopodite one-segmented and consisting of two lobes each furnished with a pair of setae; the inner lobe with a short, thick spinulose seta adjacent to a much more slender seta, the outer lobe with two slen-

der setae, the innermost seta being more coarsely spinulose.

*Maxilla* (Fig. 2E). Syncoxa short, broad, with spinule rows on anterior surface and at outer distal corner, and with one short spinulose seta and one endite armed with three setae along its inner margin (two short and spinulose, one bare and slender). Basis approximately twice as long as syncoxa, with short, spinulose seta approximately midway along inner margin. Endopodite three-segmented, segments 1 and 2 armed with one thick, long geniculate seta, distal segment represented by a broad base from which one lateral and three distal confluent setae arise.

*Maxilliped* (Fig. 2F). Syncoxa short, with a row of fine spinules. Basis segment long, slightly tapering distally and with strong spinules along inner and outer margin. Endopodite segment short, armed with two spinulose setae and two closely set bare apical setae.

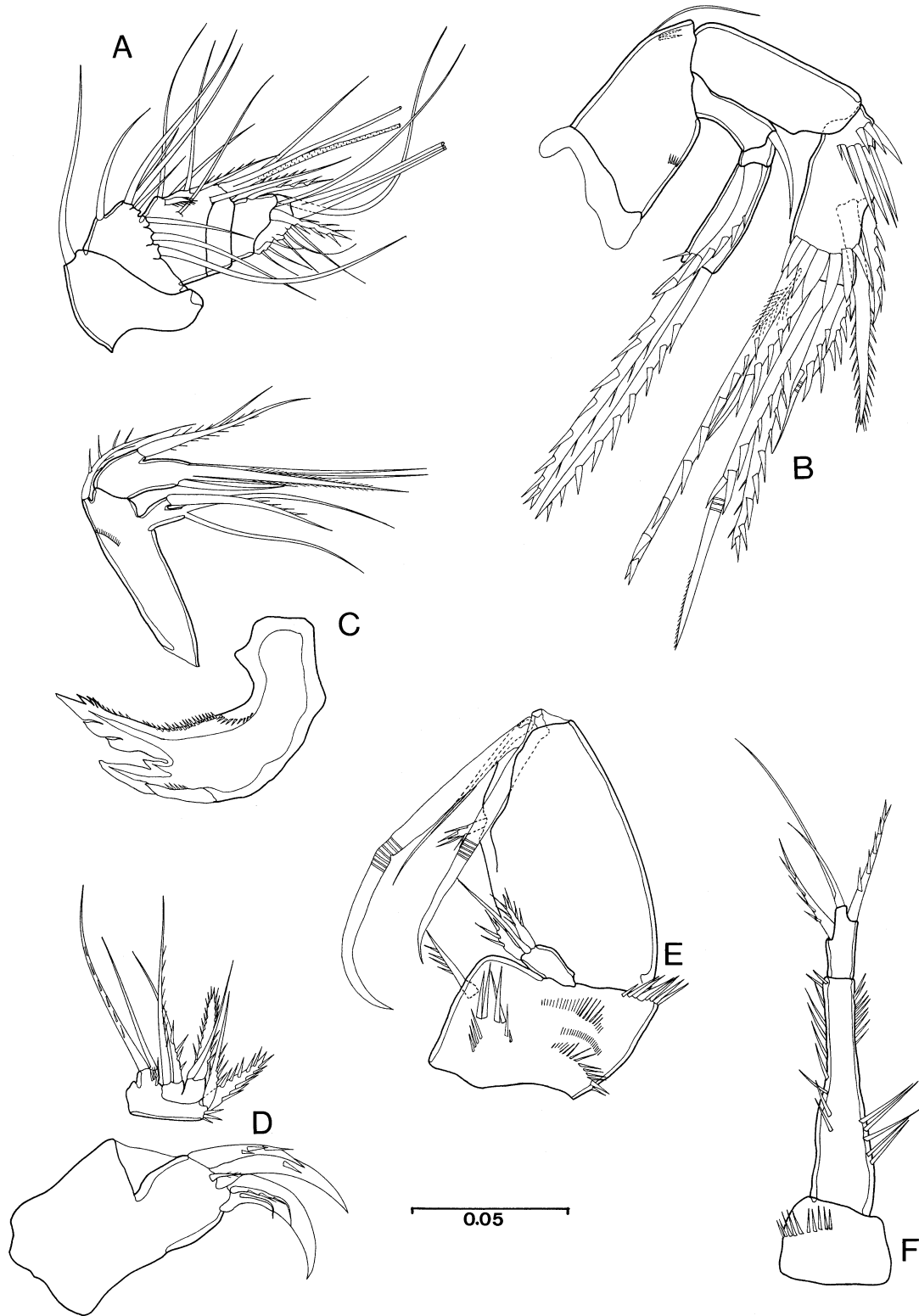
*P1–P4* (Fig. 3A–D). Coxa with transverse row of spinules on anterior surface and two rows along distal edge (but only one on P1). Exopod and endopod three-segmented with setal formula as follows:

	Exopod	Endopod
P1	0 : 1 : 123	1 : 1 : 221
P2	1 : 1 : 223	1 : 1 : 221
P3	1 : 1 : 323	1 : 1 : 221
P4	1 : 1 : 323	1 : 1 : 221

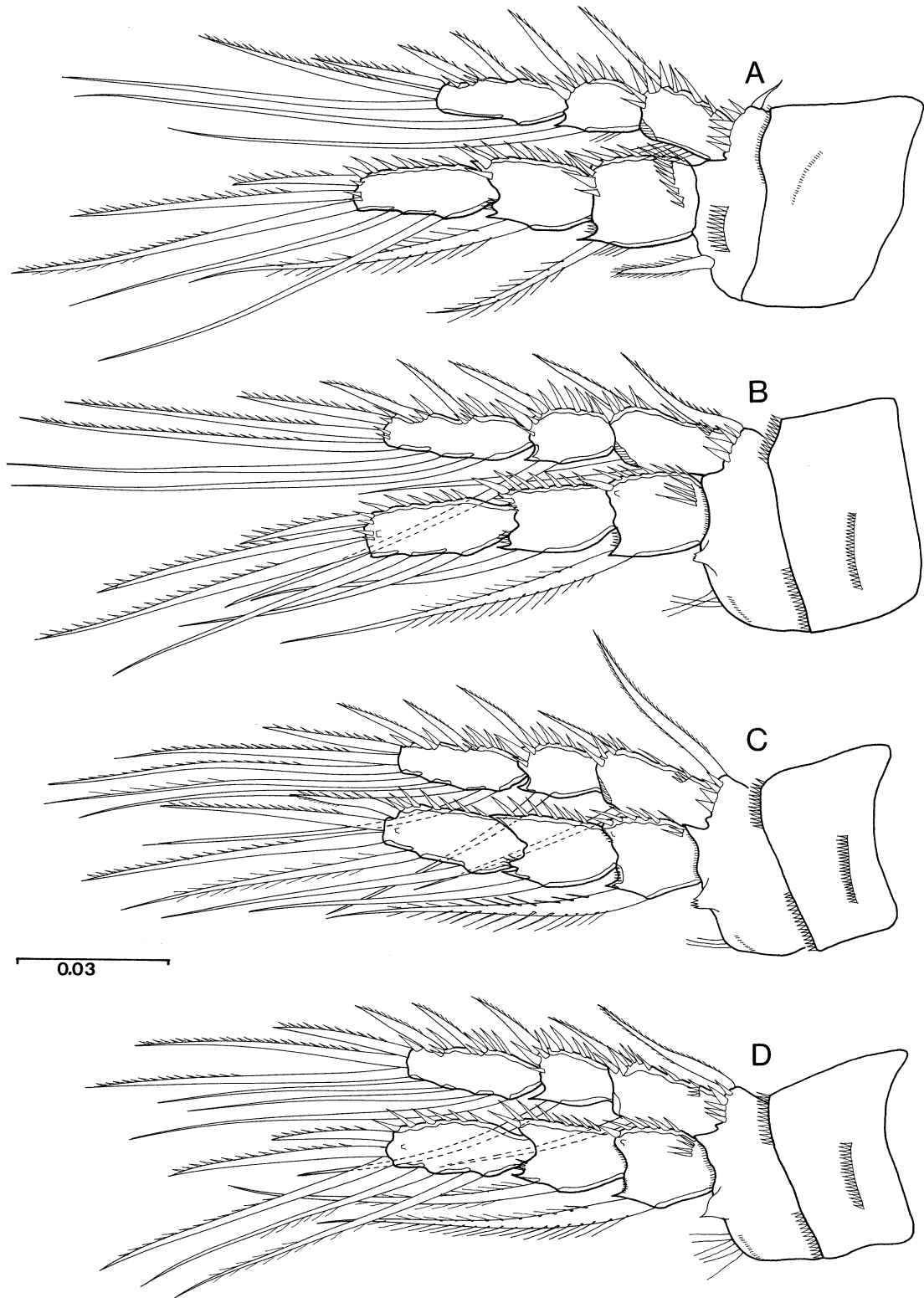
*P5* (Fig. 1D). Exopod almost twice as long as broad, separated from baseoendopod by suture on posterior surface only. Inner expansion of baseoendopod reaching almost to inner distal lobe of exopod, with spinules along inner margin and with two setae distally, the inner seta twice as long as outer seta. Outer expansion of baseoendopod with one long slender seta and a small pore on anterior surface. Inconspicuous pore present on anterior surface of baseoendopod at base of outer margin of inner expansion. Exopod with spinules along inner distal margin, one small pore on anterior surface, and three bare lobes at distal edge, each armed with a seta: innermost seta twice as long as outer seta of baseoendopod; middle seta slightly longer than innermost seta; outer seta short and about half as long as inner seta. Surface-seta not reaching beyond exopod, articulating on a small lobe accompanied by two spinules and issuing from a point distal to the exopod–baseoendopod suture (representing a distance of about one-eighth of exopod length).

#### *Description of male paratypes*

*Length*: Habitus 900–1080 µm; sum of all somites 1170–1185 µm; cephalothorax 310–330 µm. Urosomites two and three distinct. Otherwise as in female, except the following features.



**Figure 2.** *Halectinosoma mandibularis* sp. nov. Female holotype: A, antennule; B, antenna; C, mandible; D, maxillula; E, maxilla; F, maxilliped.



**Figure 3.** *Halectinosoma mandibularis* sp. nov. Female holotype: A, P1; B, P2; C, P3; D, P4.

*Antennule* (Fig. 1E). Seven-segmented. Principal segmentation and setation (setae on anterior side not illustrated) as in male of *H. neglectum* (see Clément & Moore, 1995) except posterior margin of fifth segment with a broader and longer aesthetasc and without grasping processes.

*P5* (Fig. 1F). Baseoendopod confluent with first urosomite: inner expansion armed with two setae, innermost almost three times as long as outermost seta. Exopod clearly demarcated from baseoendopod and armed with three setae: the innermost seta subequal in length to middle seta and longer than outermost seta. Surface of exopod with a small pore located near the insertion point of the surface seta.

*P6* (Fig. 1G). Plate-like with two setae at outer distal corner, the outer seta twice as long as inner one. Distal edge of plate finely denticulate.

*Variability*: The following length variations were observed in female specimens from the Celtic Sea and Banyuls: habitus 990–1170 µm; sum of all somites 1325–1405 µm; cephalothorax 420–450 µm; genital double-somite 160 µm.

*Etymology*: The species name, *mandibularis*, alludes to the well-developed nature of the mandibular coxal gnathobase.

#### Remarks

*Halectinosoma mandibularis* has some distinctive features in the form of reduction in the mouthparts, which place it apart from all other species in the genus. The basis of the mandible has only one seta at the distal inner corner, whereas other *Halectinosoma* species typically have three, but sometimes two. The endopodite has only seven setae, a reduction from the typical ten setae. The coxal gnathobase is also extremely well developed, being larger than the basis, exo- and endopodite combined. The syncoxa of the maxilla also possesses only one of the three endites, although one of the missing two endites is represented by a seta. The maxillula also shows reduction in the number of setae, with the coxa wanting and the absence of a suture between the exopod and the basis. The syncoxa of the maxilliped also has no seta, which is unique within the genus *Halectinosoma*. The size and shape of the habitus, as well as the P5 of the female, resemble those of *H. pseudosarsi* but the two species can be easily distinguished by the characters mentioned above and the rows of lappet-like spinules on the urosome of *H. mandibularis*.

#### *HALECTINOSOMA LATISETIFERA* SP. NOV.

*Type material*: 1♀ holotype dissected on five slides (NHM1990.421), 2♀ paratypes on four slides

(NHM1990.422–423), 2♀ paratypes in tubes (NHM1990.1213–1214), collected by grab from the North Sea (site S58).

*Other material examined*: France: 3♀ in tubes (NHM1990.1215–1217), 1♀ on two slides (NHM1990.424), collected by grab from the subtidal, off Banyuls.

#### *Description of female holotype*

*Length*: Habitus 375 µm; sum of all somites 455 µm; cephalothorax 55 µm; genital double-somite 130 µm. Habitus fusiform (Fig. 4A). Cephalothorax gradually attenuating anteriorly. Rostrum broadly rounded and partially fused at base with cephalothorax and furnished with two small sensilla subapically. Labrum terminating in two spinous projections (Fig. 4B). Genital double-somite subdivided ventrally by a short transverse chitinous stripe and laterally by a suture. Penultimate somite with broadly rounded pseudoperculum.

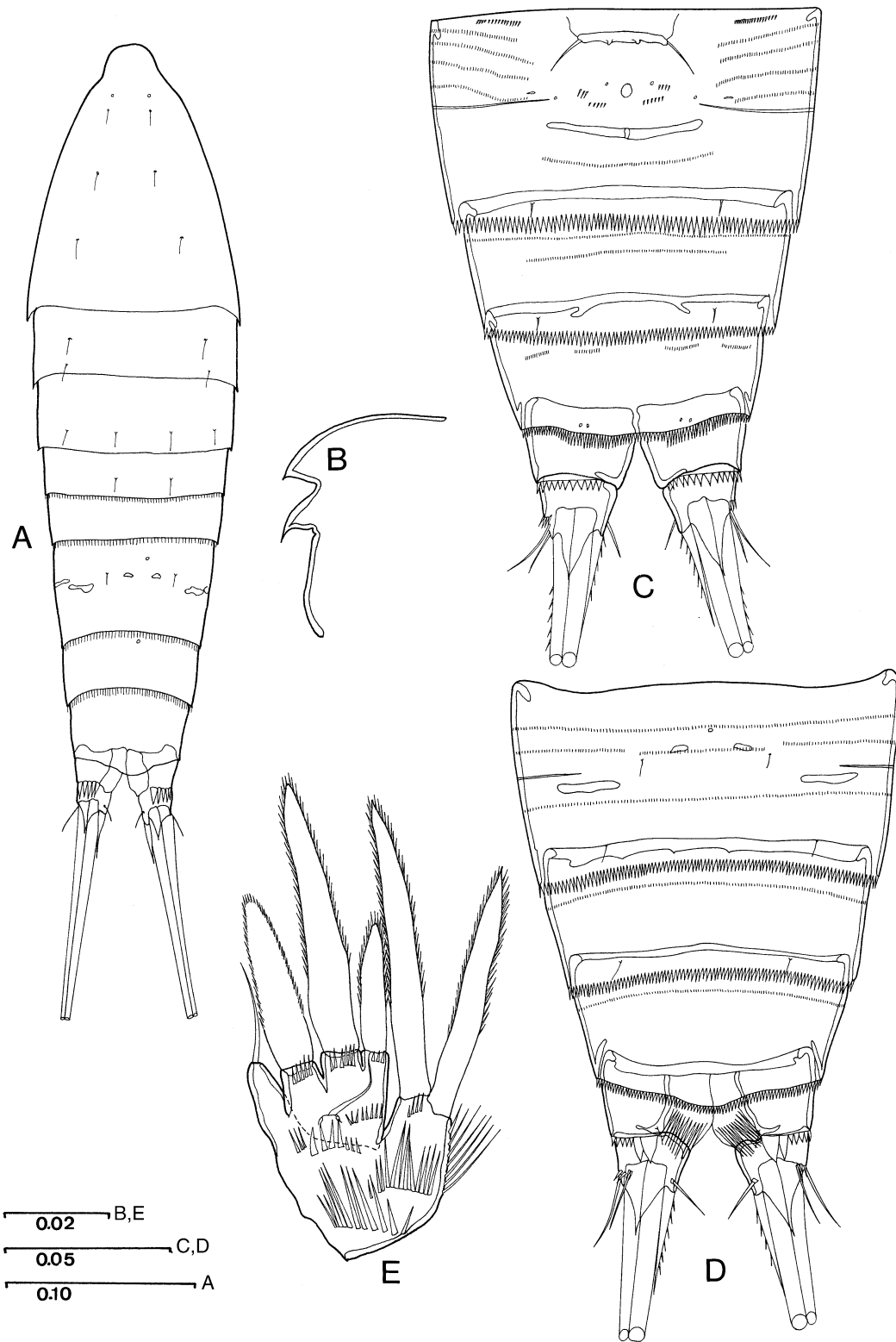
*Caudal ramus* (Fig. 4C, D). Much shorter than broad. Principal setation and general form as in *H. pseudosarsi* Clément and Moore.

*Somitic ornamentation* (Fig. 4A, C, D). Body somites, apart from penultimate, sparsely furnished with sensilla and pores. Posterior margin of cephalothorax, first and second free thoracic somites unadorned. Posterior margin of third free thoracic somite and first urosomite finely spinulose. Genital double-somite with complex arrangement of rows of fine spinules and semi-incised subulate hyaline frill. Urosomite 4 with hyaline frill similar to preceding somite and furnished with one row of fine spinules dorsally and two rows ventrally. Penultimate somite with one spinular row and a fully incised subulate hyaline frill, which extends dorsally to pseudoperculum. Anal segment with posterior row of spinules, which become lappet-like dorsally.

*Antennule* (Fig. 5A). Short and six-segmented. Principal setation and form as in *H. pseudosarsi*.

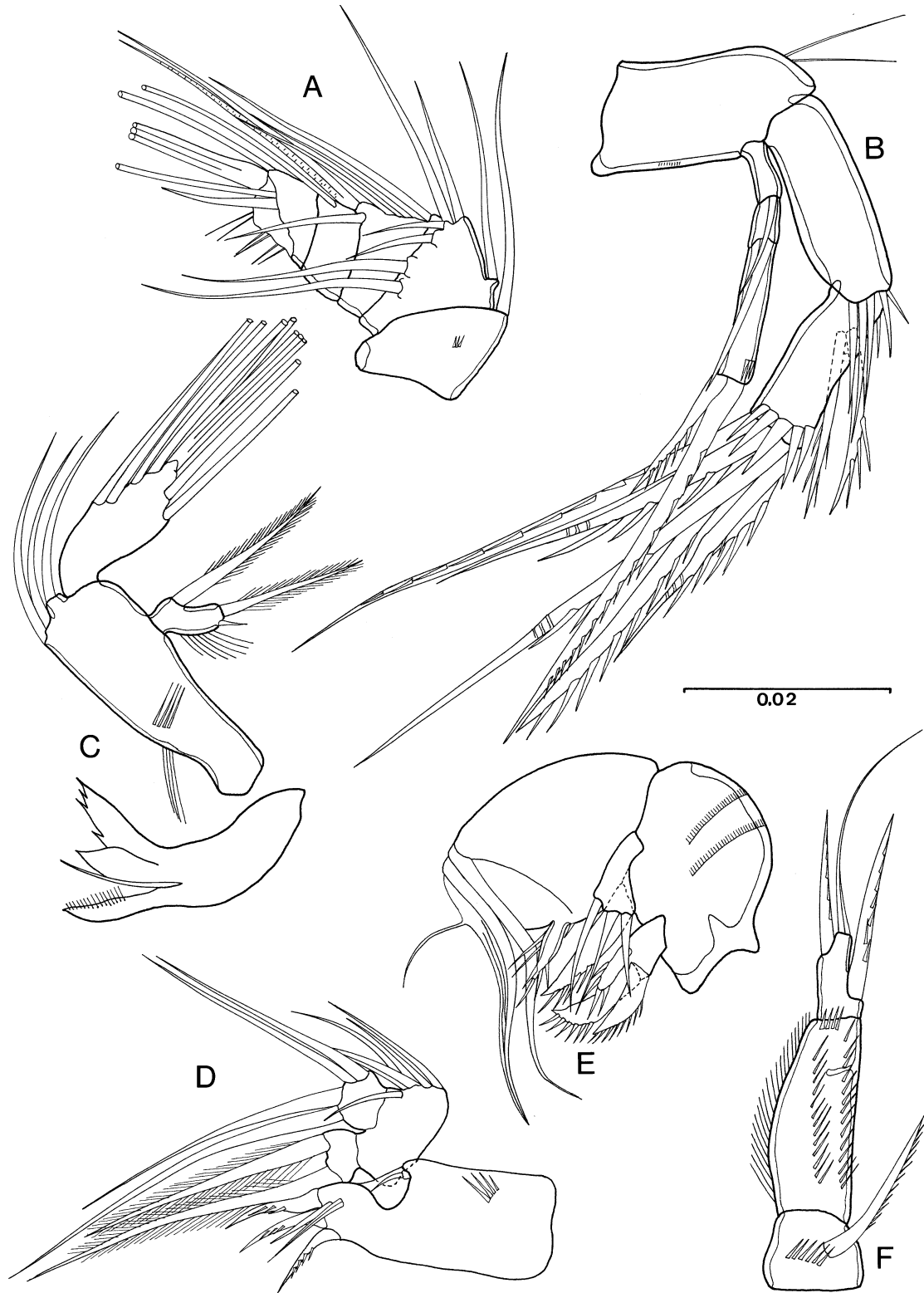
*Antenna* (Fig. 5B). Coxa short. Basis with a short row of fine spinules along outer margin and a set of long setules at inner distal corner. Endopodite two-segmented; segment 1 unadorned, segment 2 furnished with two adjacent setae mid-way along inner margin and seven terminal setae (three spinulose geniculate, one dwarfed plumose). Exopodite three-segmented; basal segment well developed and armed with a short seta, second segment short and furnished with a seta, distal segment over twice as long as basal one and armed with two apical spinulose setae.

*Mandible* (Fig. 5C). Coxal gnathobase furnished with a spiniform seta and a slender seta at ventral base of unidentate *pars incisiva* and quadridentate



**Figure 4.** *Halectinosoma latisetifera* sp. nov. Female holotype: A, habitus, dorsal; B, labrum; C, urosomites 2–6, ventral; D, urosomites 2–6, dorsal; E, P5.





**Figure 5.** *Halectinosoma latisetifera* sp. nov. Female: A, antennule (holotype); B, antenna (holotype); C, mandible (paratype NHM1990.422); D, maxillula (paratype NHM1990.423); E, maxilla (holotype); F, maxilliped (paratype NHM1990.423).

*lacinia*. Basis with a row of fine spinules on surface, a set of setules on inner margin and three slender setae issuing from distal inner corner. Endopodite one-segmented and furnished with ten setae. Exopodite one-segmented with slender hairs along outer margin and armed with three setae, one of which is dwarfed.

*Maxillula* (Fig. 5D). Praecoxal arthrite broad and armed along distal edge with three unguiform spines and on surface with three small setae. Coxa very short and armed with a bare seta. Basis with six slender setae along inner margin. Exopodite small, one-segmented and furnished with two plumose setae. Endopodite one-segmented and carrying four setae.

*Maxilla* (Fig. 5E). Syncoxa broad, with two transverse rows of spinules around outer margin and furnished along its inner margin with two endites and a broad spiniform seta. Proximal endite armed with three broad, spiniform setae. Distal endite with three slender setae. Basis as broad as syncoxa, with a broad, spinulose seta with no base, accompanied by a diminutive seta, along its inner margin. Endopodite three-segmented, segments 1 and 2 armed with a thick and very long geniculate seta and the distal segment represented by a broad base from which one lateral and three distal confluent setae arise.

*Maxilliped* (Fig. 5F). Syncoxa short, armed with one seta and with a row of fine spinules on posterior face. Basis segment long, slightly tapering anteriorly and with strong spinules on posterior face and slender hairs along outer margin. Endopodite segment short, armed with two spinulose setae and two closely set bare apical setae.

*P1–P4* (Fig. 6A–D). Coxa with two rows of spinules along distal edge in P2–P4, one row in P1. Exopod and endopod three-segmented, with setal formula as in *H. mandibularis* sp. nov.

*P5* (Fig. 4E). Exopod slightly broader than long and separated from baseoendopod by a suture on posterior surface only. Anterior surface of baseoendopod with three rows of spinules. Inner expansion of baseoendopod reaching halfway along inner margin of exopod, with slender spinules along inner margin and with two broad spinulose setae distally, the inner seta shorter than outer seta. Outer expansion of baseoendopod with one slender seta. Exopod with several proximal spinule rows and with three spinulose lobes at distal edge, each armed with a thick seta: innermost seta short and much shorter than outer seta of inner expansion of baseoendopod; middle seta twice as long as innermost seta; outer seta thicker and longer than innermost seta. Surface-seta reaching beyond exopod and inserted just within proximal half of surface seta insertion line.

*Variability*: The following variation in length was observed among paratypes: habitus 375–390 µm; sum

of all somites 435–450 µm; cephalothorax 135–145 µm; genital double-somite 50 µm. Two specimens from Banyuls were slightly smaller with the following length: habitus 325–360 µm; sum of all somites 400–405 µm; cephalothorax 125 µm; genital double-somite 45 µm.

*Male*. Unknown.

*Etymology*: The species name, *latisetifera*, alludes to the unusually broad nature of the marginal setae of the female P5.

#### Remarks

This species can be differentiated from other *Halectinosoma* species by the following characters: the female P5 is armed with characteristic broad spiniform setae; the inner expansion of the baseoendopod with an outer seta issuing from a lobe, which extends beyond the insertion point of the inner seta (the latter being also slightly shorter and not reaching beyond the outer seta); the proximal endite of the syncoxa of the maxilla with only three thick setae and the middle endite is represented by a large, broad seta between the proximal and distal endites; the syncoxa of the maxilliped is furnished with only one seta.

This species is most closely related to *H. cooperatum* Bodin, Bodiou & Soyer, 1970, as it shares some distinctive features such as the presence of a broad seta with no defined base along the inner margin of the basis of the maxilla, the characteristic setation of the mandibular exopod, the number of setae on the endopodite of the maxillula and an ornamented pseudoperculum. *Halectinosoma latisetifera* can be easily distinguished from *H. cooperatum* by the shape of the setae on the female P5.

#### *HALECTINOSOMA GOTHICEPS* (GIESBRECHT, 1881)

*Ectinosoma gothiceps* Giesbrecht, 1881: 255

*Ektinosoma gothiceps* Giesbrecht, 1882: 106, pl. I figs 3, 12, pl. IV fig. 17, 35, pl. V fig. 3, pl. VII fig. 8, pl. VIII figs 10–11, pl. IX fig. 17, pl. X figs 10, 21, pl. XI fig. 13, pl. XII fig. 6, 10

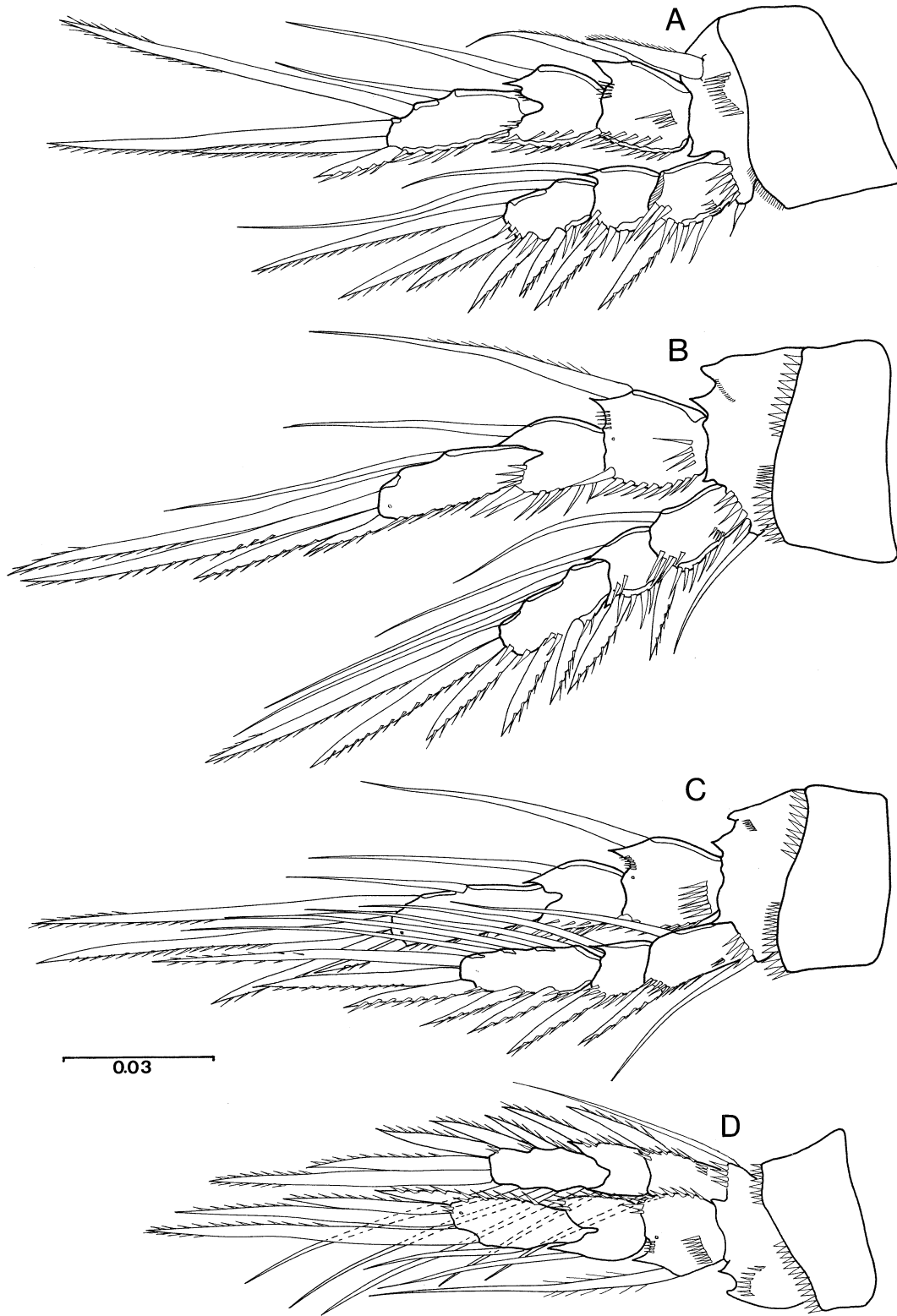
*Halectinosoma gothiceps* Mielke, 1975: 23, fig. 9

?*Ectinosoma* (*Halectinosoma*) *gothiceps* Lang, 1948: 216–217, figs 112.10, 117.2

?*Halectinosoma gothiceps* Lang, 1965: 38

Not *Ectinosoma gothiceps* Sars, 1904: 37, pl. XX fig. 2

*Material examined*: Alaska: 2♀ from Island Flats, Port Valdez, collected by H. M. Feder, 6.ii.1973 (in R. Hamond's personal collection). Scotland: S17 (4♀ dissected on six slides NHM1990.378–381, 1♂ dissected on two slides NHM1990.383, 9♀ in tubes NHM1990.1169–1177); S18 (20♀, 2♂ in tubes NHM1990.1180–1189 and NHM1990.1190–1191);



**Figure 6.** *Halectinosoma latisetifera* sp. nov. Female holotype: A, P1; B, P2; C, P3; D, P4.

S21 (1♂); S70 (29♀, 4♂ in authors' personal collection); S71 (2♀, NHM1990.1178–1179); S91 (2♀ NHM1990.1192–1193); S95 (28♀, 3♂ NHM1990.1194–1203 and NHM1990.1204–1206); 10♀ from Limekilns, Forth Estuary, muddy sand, lower shore (in authors' personal collection); 24♀, 6♂ from South Queensferry, Forth Estuary, soft mud, lower shore (in authors' personal collection). England: 1♀ from Blakeney Harbour, Norfolk and 1♀ from Wells Rocks, among *Bowerbankia imbricata*, collected by R. Hamond (in R. Hamond's personal collection). Ireland: the following material from the National Museum of Ireland: 1♀ from Dunlaoghaine, Dublin Bay, collected by C. E. O'Riordan, 31.viii.1966 (NMI17.1975); 1♀ from Dalkey I., Co. Dublin, collected by K. M. Roe netsweeping in flat pool, 3.xi.1952 (NMI66.1982); 1♀ from Loch Hyne, Co. Cork, collected by J. M. C. Holmes from gravel under stones, 8.vii.1982. Germany: 1♀ from List, Island of Sylt, collected by W. Mielke (in W. Mielke's personal collection).

*Description of female*

*Length* (n = 10): Habitus 460–550 µm; sum of all somites 530–575 µm; cephalothorax 165–180 µm; genital double-somite 60–70 µm. Cephalothorax with light brown pigment spot near base of antennule and with spinules at anterior distal edge (Fig. 7E). Rostrum broadly rounded and partially fused at base with cephalothorax, with two small sensilla subapically (not visible at magnifications < 1250×). Labrum terminating in a spinous projection. Genital double-somite subdivided ventrally by a short transverse chitinous stripe (Fig. 9C). Penultimate somite with rounded pseudoperculum (Fig. 9D).

*Caudal ramus* (Fig. 9C, D). Slightly longer than broad. Principal setation and general form as in *H. pseudosarsi*.

*Somatic ornamentation* (Fig. 9C, D). Genital double-somite with six rows of fine spinules dorsally and a row of hair-like spinules near posterior margin. Urosomite 4 with three rows of fine spinules dorsally and a row of hair-like spinules near distal margin. Penultimate somite with two spinular rows and a dorsal row of hair-like spinules near distal edge.

*Antennule* (Fig. 7E). Six-segmented. Setation as in *H. pseudosarsi*. Other cephalosomic appendages are as in *H. paragothiceps* sp. nov.

*P1–P4*. Exopod and endopod three-segmented with setal formula as follows:

	Exopod	Endopod
P1	0 : 1 : 123	1 : 1 : 221
P2	1 : 1 : 223	1 : 1 : 221
P3	1 : 1 : 222	1 : 1 : 221
P4	1 : 1 : 322	1 : 1 : 221

*P5* (Fig. 7D). Exopod about as long as broad and separated from baseopod by a suture on posterior surface only. Anterior surface of baseopod with one row of strong spinules near base and on inner expansion and three rows of fine spinules. Inner expansion of baseopod reaching almost halfway along inner margin of exopod, with spinules along inner margin (not illustrated) and furnished distally with two spinulose setae, the inner seta longer than outer seta. Outer expansion of baseopod furnished with a slender seta. Exopod with three spinulose lobes at distal edge, each armed with a spinulose seta: innermost seta short, shorter than outer seta of inner expansion of baseopod; middle seta more than twice as long as innermost seta; outer seta twice as long as innermost seta. Surface-seta reaching beyond exopod, articulating on a small lobe accompanied by a row of spinules and issuing from within the proximal half of the surface-seta insertion line.

*Description of male*

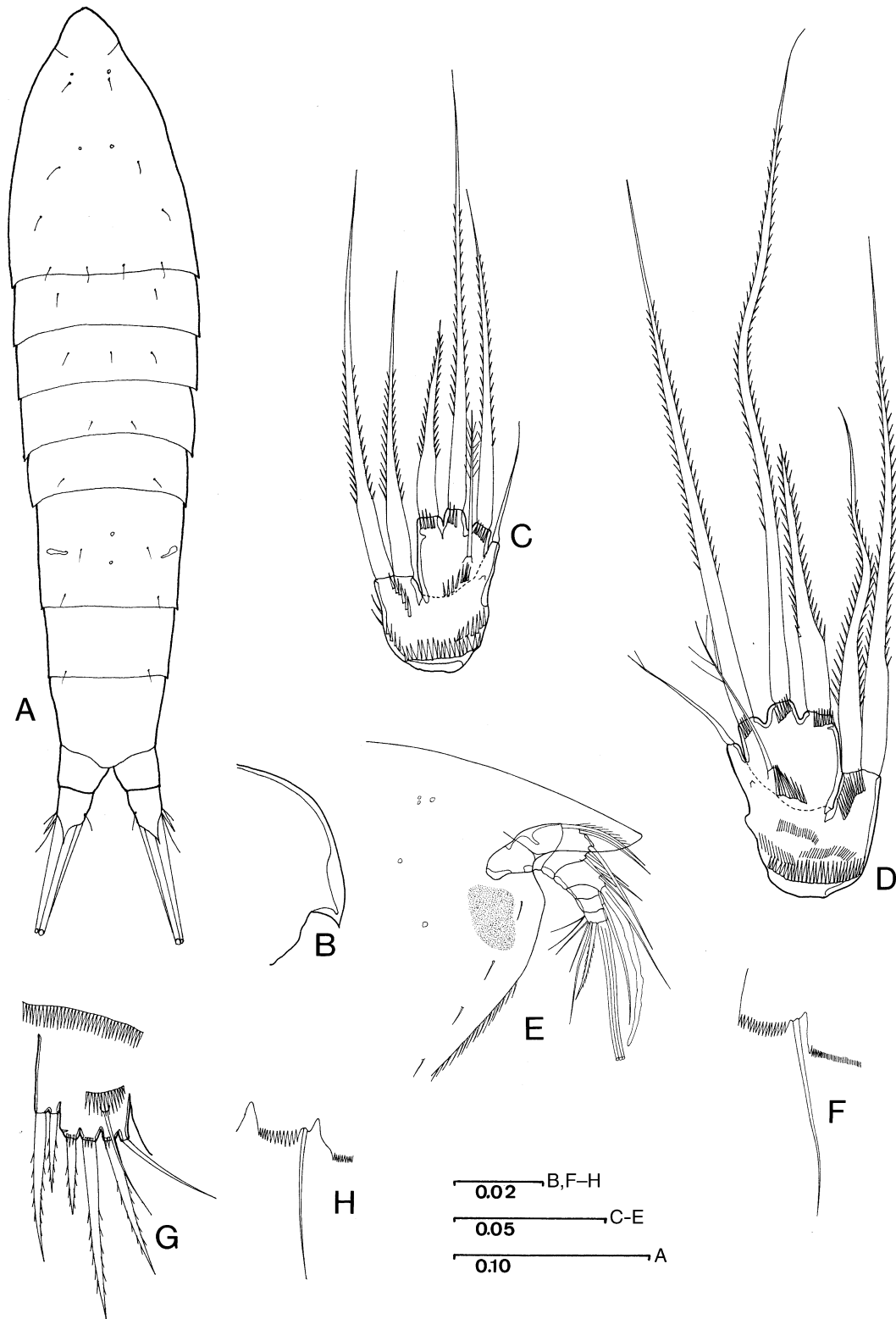
*Length* (n = 11): Habitus 340–400 µm; sum of all somites 385–430 µm; cephalothorax 125–145 µm. Urosomites 2 and 3 distinct. Otherwise as in female apart from the following features.

*Antennule* (not illustrated). Seven-segmented with fifth segment enlarged and furnished with an aesthetasc.

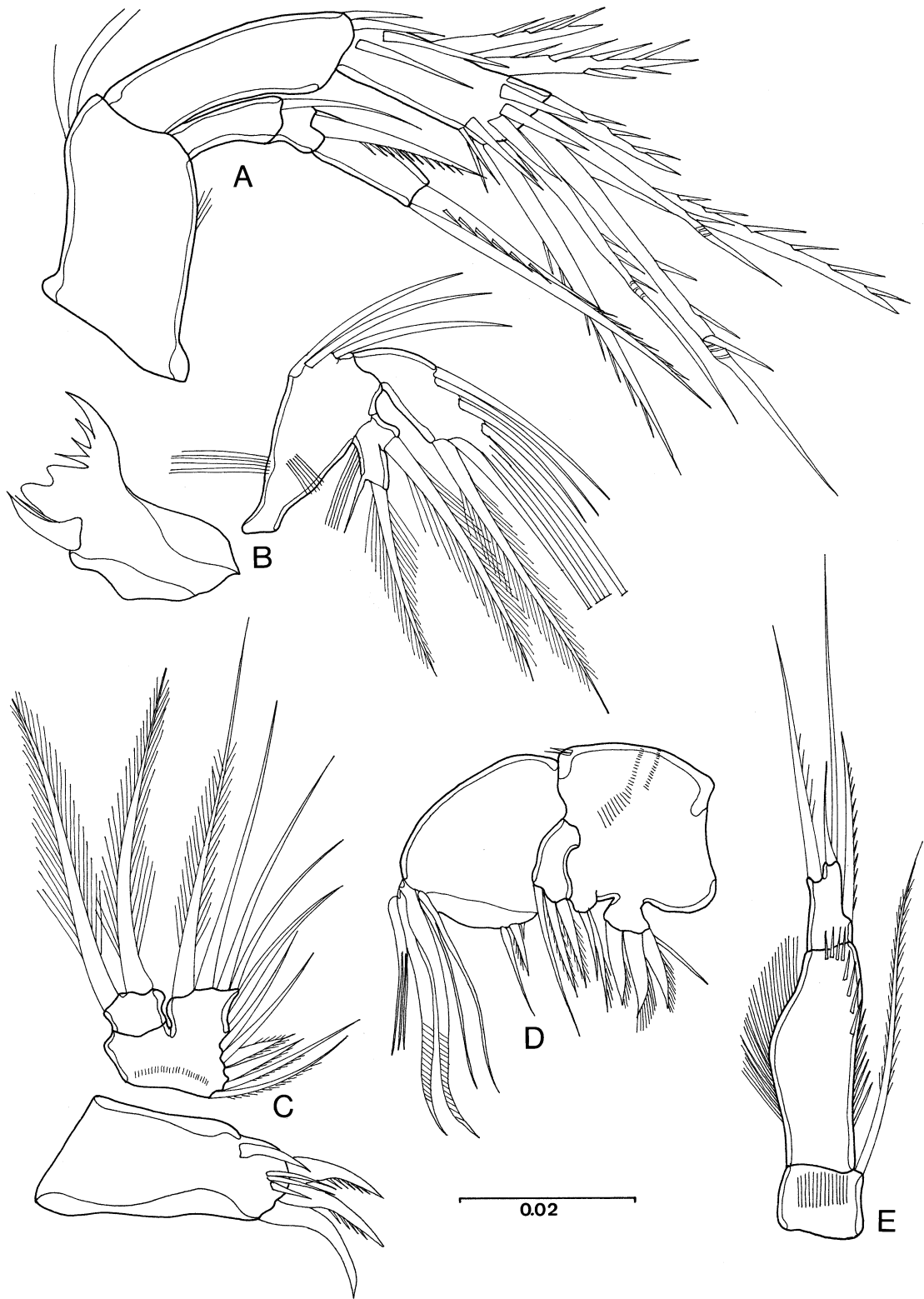
Previous description of the male P5 has been given by Mielke (1975). The male P6 (Fig. 7F) consists of a plate with a denticulate posterior edge and one seta at outer distal corner.

*Remarks*

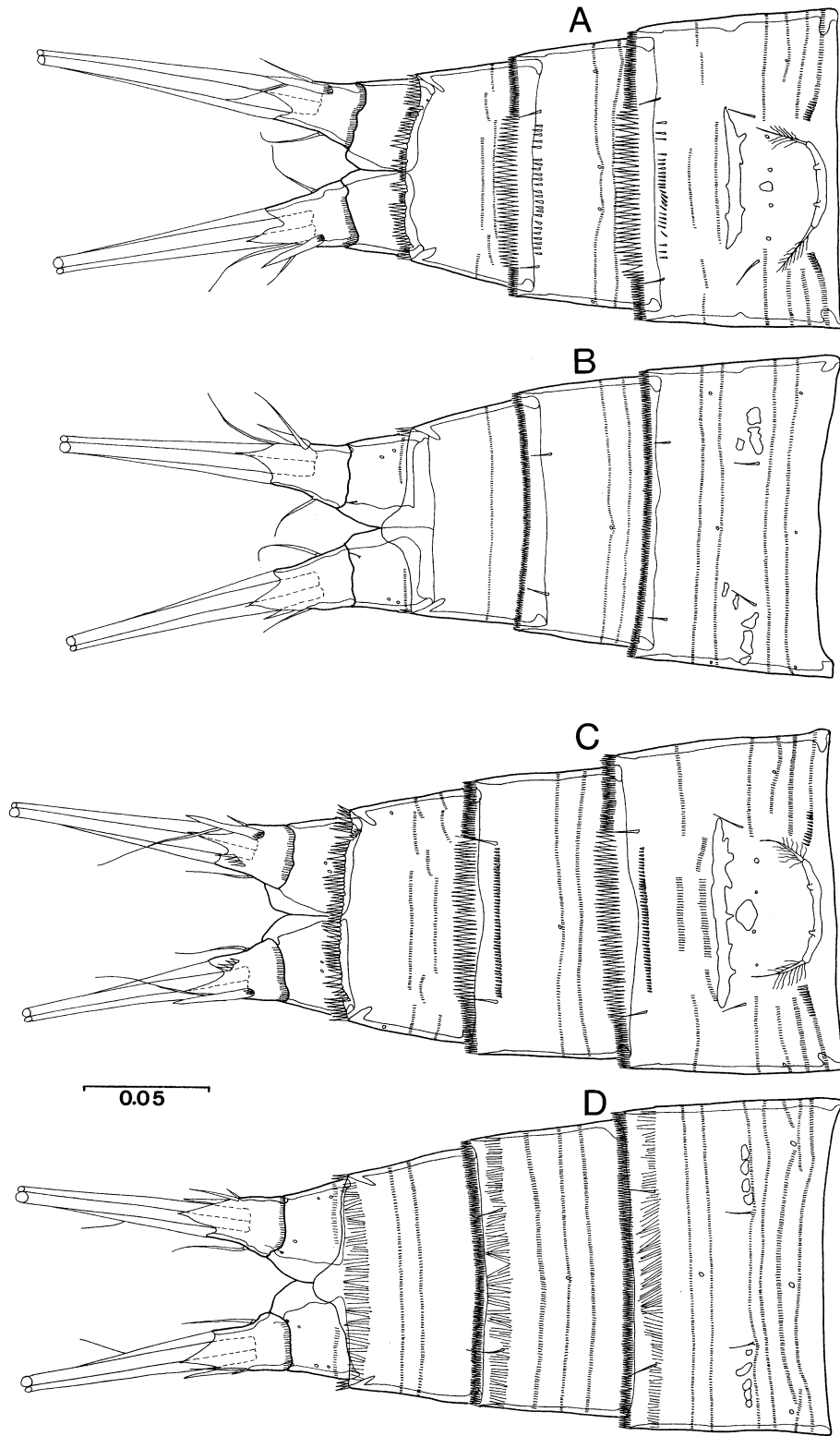
Of the previously recognized species of the genus, *H. gothiceps* has a unique setation formula for the pereopods P1–P4. Also, the male P5 is unusual in having the exopod confluent with the baseopod and the male P6 is unusual in possessing only a single seta. We have, however, discovered during our study that a closely related species which shares these features, which we have named *H. paragothiceps* sp. nov., has been mistakenly assigned to *H. gothiceps* by some workers. A full description of *H. paragothiceps* sp. nov. and a further discussion on the morphological differences between these two species are given below. We are, however, certain that the material examined corresponds to the original description given by Giesbrecht (1881). Giesbrecht omitted to mention the pigmented patch on the cephalothorax, but this feature can be easily missed and has not been reported before. We were able to examine a specimen collected by Mielke (1975) and confirm it as *H. gothiceps*.



**Figure 7.** *Halectinosoma paragothiceps* sp. nov. Female holotype: A, habitus, dorsal; B, labrum; C, P5. *H. gothiceps* (Giesbrecht, 1881). Female (South Queensferry): D, P5; E, anterior cephalothorax, lateral. *H. gothiceps* (Giesbrecht, 1881). Male (S21): F, P6. *H. paragothiceps* sp. nov. Male paratype NHM2005.2639 (S96): G, P5; H, P6.



**Figure 8.** *Haectinosoma paragothiceps* sp. nov. Female holotype: A, antenna; B, mandible; C, maxillula; D, maxilla; E, maxilliped.



**Figure 9.** *Halectinosoma paragothiceps* sp. nov. Female (South Queensferry): A, urosomites 2–6, ventral; B, urosomites 2–6, dorsal. *H. gothiceps* (Giesbrecht, 1881). Female (South Queensferry): C, urosomites 2–6, ventral; D, urosomites 2–6, dorsal.

Following examination of material from Sars' collection we can confirm that his description of *H. gothiceps* (Sars, 1904) is based on *H. paragothiceps* sp. nov. Other records, such as those of Lang (1948) and Chislenko (1967), lack too many important details and must be taken with great caution. *Halectinosoma gothiceps* is often found intertidally in muddy sediments but can also be found occasionally in coarser sediments.

#### **HALECTINOSOMA PARAGOTHIPEPS SP. NOV.**

*Ectinosoma gothiceps* Sars, 1904: 37, pl. XX fig. 2

*Type material*: 1♀ holotype dissected on two slides (NHM1990.385), 4♀ paratypes dissected on eight slides (NHM1990.386–389), 14♀ paratypes in tube (NHM1990.1142–1148) from the Forth Estuary (site S17); 2♂ paratypes dissected on two slides (NHM2005.2639–2640) from Loch Creran (site S96).

*Other material examined*: Canada: 1♀ (S97); 2♀ (S98), 1♀ (S99) (in authors' personal collection). Norway: 8♀ and 1♂ (labelled *E. gothiceps*) from G. O. Sars collection, tube F20027, Zoology Museum, Oslo. Scotland: S18 (1♀ in authors' personal collection, 1♀ in tube NHM1990.1149); S21 (61♀ in tube NHM1990.1150–1159); S68 (1♀); S70 (9♀ in tube NHM1990.1160–1168); S73 (1♀); S95 (3♀ in tube in authors' collection, 1♀ dissected on two slides NHM1990.389); 2♀ from shallow muddy sand, Forth Estuary (in authors' personal collection).

#### *Description of female holotype*

*Length*: Habitus 430 µm; sum of all somites 490 µm; cephalothorax 145 µm; genital double-somite 60 µm. Habitus fusiform (Fig. 7A). Cephalothorax gradually attenuating anteriorly and without a light brown pigment spot near base of antennule but furnished with spinules on anterior distal edge. Rostrum broadly rounded, partially fused at base with cephalothorax and furnished with two small sensilla subapically. Labrum terminating in a spinous projection (Fig. 7B). Genital double-somite subdivided ventrally by a short transverse chitinous stripe (Fig. 9A). Penultimate somite with rounded pseudopericulum (Fig. 9B).

*Caudal ramus* (Fig. 9A, B). Slightly longer than broad. Principal setation and general form as in *H. gothiceps*.

*Somitic ornamentation* (Fig. 9A, B). Body somites, apart from penultimate, sparsely furnished with sensilla and pores. Posterior margin of cephalothorax, first and second free thoracic somites unadorned. Posterior margin of third free thoracic somite and first urosomite finely spinulose. Genital double-somite with semi-incised subulate hyaline frill and with four

rows of fine spinules dorsally, ventrally with a complex arrangement of spinule rows. Urosomite 4 with a similar hyaline frill to preceding somite and with two rows of fine spinules in anterior half and a ventral row of spinules near distal margin. Penultimate somite dorsally with one fine spinule row in anterior half and ventrally with two fine rows in anterior half and a row of stronger spinules along distal margin.

*Antennule* (not illustrated). Short and six-segmented. Principal setation and form as in *H. gothiceps*.

*Antenna* (Fig. 8A). Coxa short. Basis with a short row of fine spinules along outer margin and a set of long setules near inner distal corner. Endopodite two-segmented; segment 1 unadorned, segment 2 with two adjacent setae mid-way along inner margin and seven terminal setae (three spinulose geniculate and one dwarfed plumose). Exopodite three-segmented; basal segment well developed and armed with a short seta, segment 2 short with a strong, spinulose seta, distal segment slightly longer than basal one and armed with two spinulose apical setae.

*Mandible* (Fig. 8B). Coxal gnathobase furnished with two setae, a spiniform seta and a slender seta, at ventral base of bidentate *pars incisiva* and quadridentate *lacinia*. Basis with two rows of fine spinules on surface and three slender setae issuing from distal inner corner. Endopodite one-segmented with ten setae. Exopodite one-segmented with slender hairs along outer margin and armed with three setae (1 dwarfed).

*Maxillula* (Fig. 8C). Praecoxal arthrite broad and armed along distal edge with three unguiform spines and subdistally with three small setae. Coxa represented by bare seta. Basis with six setae along inner margin. Exopodite small, one-segmented, with two plumose setae. Endopodite one-segmented, with no apparent suture with basis, and furnished with six setae.

*Maxilla* (Fig. 8D). Syncoxa broad, with two transverse spinule rows around outer margin, a small group of spinules near outer distal corner, with three endites along its inner margin. Proximal endite armed with three spiniform setae and a slender seta. Middle endite with two slender setae. Distal endite with three slender setae. Basis as broad as syncoxa, with three small setae along inner margin and two long and slender setae at distal inner margin. Endopodite three-segmented, segments 1 and 2 each armed with a thick, long, geniculate seta, distal segment represented by a broad base from which one lateral and three distal confluent setae arise.

*Maxilliped* (Fig. 8E). Syncoxa short, armed with one seta and with a row of fine hairs on posterior face. Basis segment long, with slender hairs along outer margin and strong transverse spinule row around



inner margin. Endopodite segment short, armed with two spinulose setae and two closely set, bare, apical setae.

*P1–P4* (Fig. 10A–D). Coxa with one row of spinules along distal edge. Exopod and endopod three-segmented with setal formula as in *H. gothiceps*.

*P5* (Fig. 7C). Exopod as long as broad and separated from baseoendopod by a suture on posterior surface only. Anterior surface of baseoendopod with two rows of strong spinules near base and one row on inner expansion. Inner expansion of baseoendopod reaching less than halfway along inner margin of exopod, with spinules along inner margin and two spinulose setae distally, the inner seta longer than outer seta. Outer expansion of baseoendopod furnished with a slender seta. Exopod with three spinulose lobes at distal edge, each armed with a spinulose seta: innermost seta short and shorter than outer seta of inner expansion of baseoendopod; middle seta twice as long as innermost seta; outer seta longer than innermost seta. Surface-seta reaching beyond exopod, inserted on a small lobe just within the proximal half of surface-seta insertion line and accompanied by a row of fine spinules.

*Variability*: The following variation in length was observed among paratypes: habitus 405–460  $\mu\text{m}$ ; sum of all somites 485–530  $\mu\text{m}$ ; cephalothorax 145–160  $\mu\text{m}$ ; genital double-somite 60–70  $\mu\text{m}$ .

#### *Description of male paratype*

*Length*: Sum of all somites 406  $\mu\text{m}$ ; cephalothorax 142  $\mu\text{m}$ . Urosomites 2 and 3 distinct. Otherwise as in female apart from the following features.

*Antennule* (not illustrated). Seven-segmented, segment 5 enlarged and with an aesthetasc.

*P5* (Fig. 7G). As in *H. gothiceps* except terminal setae slightly broader towards the distal end.

*P6* (Fig. 7H). As in *H. gothiceps*.

*Etymology*: The species name, *paragothiceps*, reflects the similarity of this species with *H. gothiceps*.

#### *Remarks*

This species can be distinguished from its close relative *H. gothiceps* by the following characteristics. The pigmented patch on the cephalothorax is absent in *H. paragothiceps*. The setae of the female *P5* exopod are distinctly shorter relative to the length of the exopod in *H. paragothiceps*. There are also differences in the ornamentation of the female *P5* baseoendopod and also in the spinulation of the urosomites in both female and male. *H. paragothiceps* is also smaller in size than *H. gothiceps* when the sum of all somites is taken into consideration. Examination of material

from Sars' collection has confirmed that his description of *H. gothiceps* (Sars, 1904) is in fact based on material of *H. paragothiceps* sp. nov. It is likely that some other records of *H. gothiceps* are also erroneous. Both species have been found to coexist at three sites around Britain.

#### *HALECTINOSOMA KLIEI* SP. NOV.

*Ectinosoma finmarchicum* Willey, 1920: 26, fig. 33

*Ectinosoma finmarchicum* Smirnov, 1932: 200, fig. 2

*Ectinosoma finmarchicum* Chislenko, 1977: 238–239, pl. 1 figs 3–5

*Type material*: 1 ♀ holotype from the Klie collection, Zoology Museum, Kiel, dissected on two slides (COP1841) from Denmark Sarafse, collected by Jespersen on 13.viii.1932; 1 ♀ paratype from the Klie collection, Zoology Museum, Kiel, dissected on two slides (COP269) (labelled *Ectinosoma finmarchicum*), from the Dana Expedition, station 4677, 60°47'N, 42°34'W on 13.viii.1933; 1 ♂ paratype from the Canadian Museum of Nature, Ottawa, dissected on two slides (NMCC1990-0356), collected by E. H. Grainger from station 75-566 in the Beaufort Sea, 78°06'N, 138°56'W, using a plankton net from 0 to 220 m, 18.vii.1975.

*Other material examined*: Arctic: 1 ♀ on slide NMC1990-0358 (Canadian Museum of Nature, Ottawa), identified as *E. finmarchicum* by Willey, from the Canadian Arctic Expedition, 1913–18, Collinson Point, Beaufort Sea, station 27, 69°59'N, 144°50'W, collected from 2 m depth with plankton net by F. Johansen, 4.x.1913; 1 ♀ copepodite V on slide NMC1990-0357 (Canadian Museum of Nature, Ottawa), Beaufort Sea, 78°06'N, 138°56'W, collected with plankton net from 0 to 220 m by E. H. Grainger, station 75-566, 18.vii.1975; 1 ♀ dissected on slide NMC1990-0359 (Canadian Museum of Nature, Ottawa), from Frobisher Bay, Baffin Island, 63°25'N, 68°10'W, collected from seabed by E. H. Grainger, 50 m, 7.vii.1975.

#### *Description of female holotype*

*Length*: Habitus 800  $\mu\text{m}$ ; sum of all somites 935  $\mu\text{m}$ ; cephalothorax 255  $\mu\text{m}$ ; genital double-somite 130  $\mu\text{m}$ . Habitus fusiform (Fig. 11A). Colour of preserved specimen yellowish brown. Surface of cuticle densely covered with small pores. Cephalothorax gradually attenuating anteriorly. Rostrum broadly rounded and partially fused at base with cephalothorax, with two small sensilla subapically. Genital double-somite with short transverse chitinous stripe ventrally (Fig. 11B). Penultimate somite with rounded pseudopericulum (Fig. 11C).

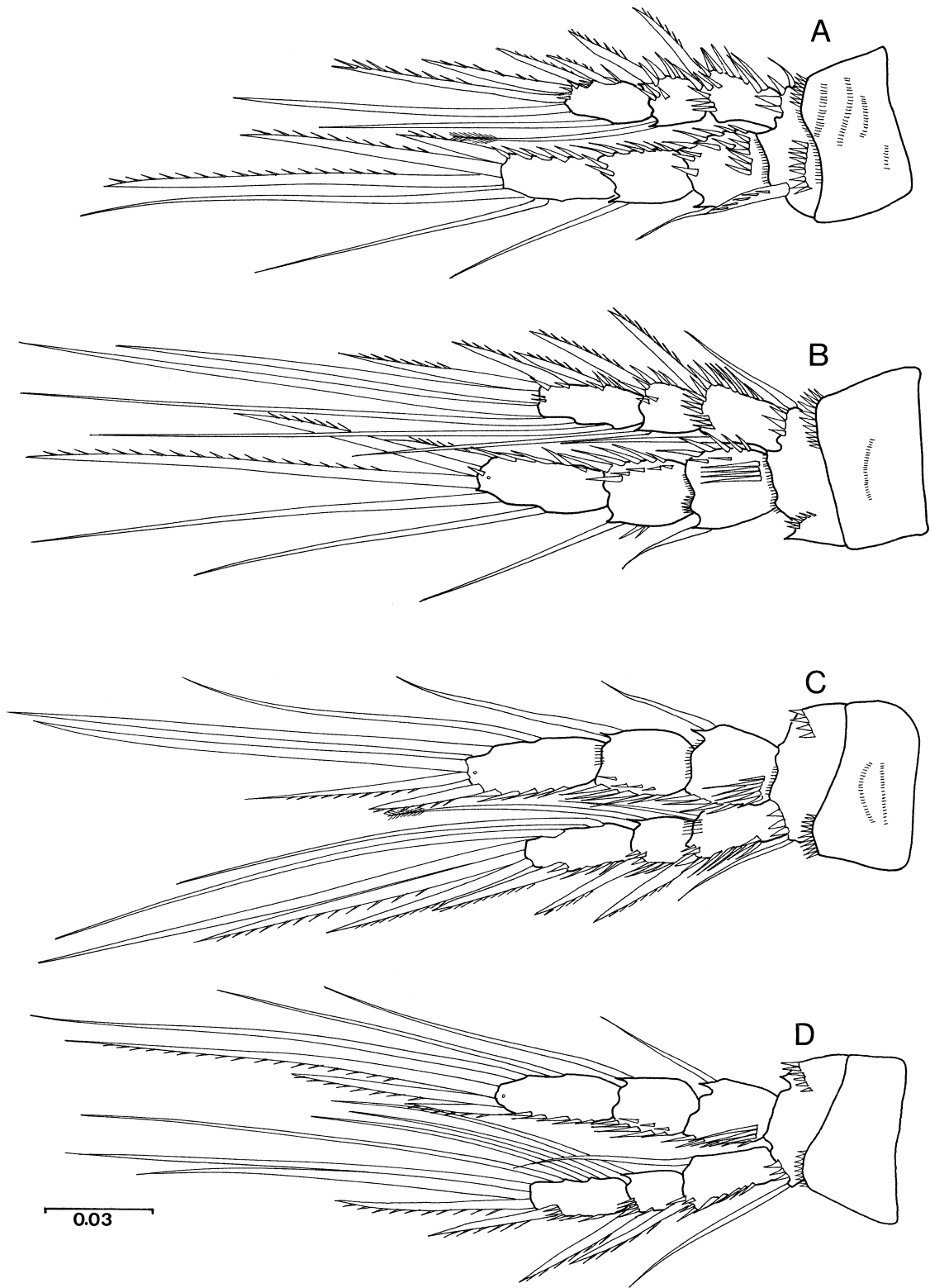
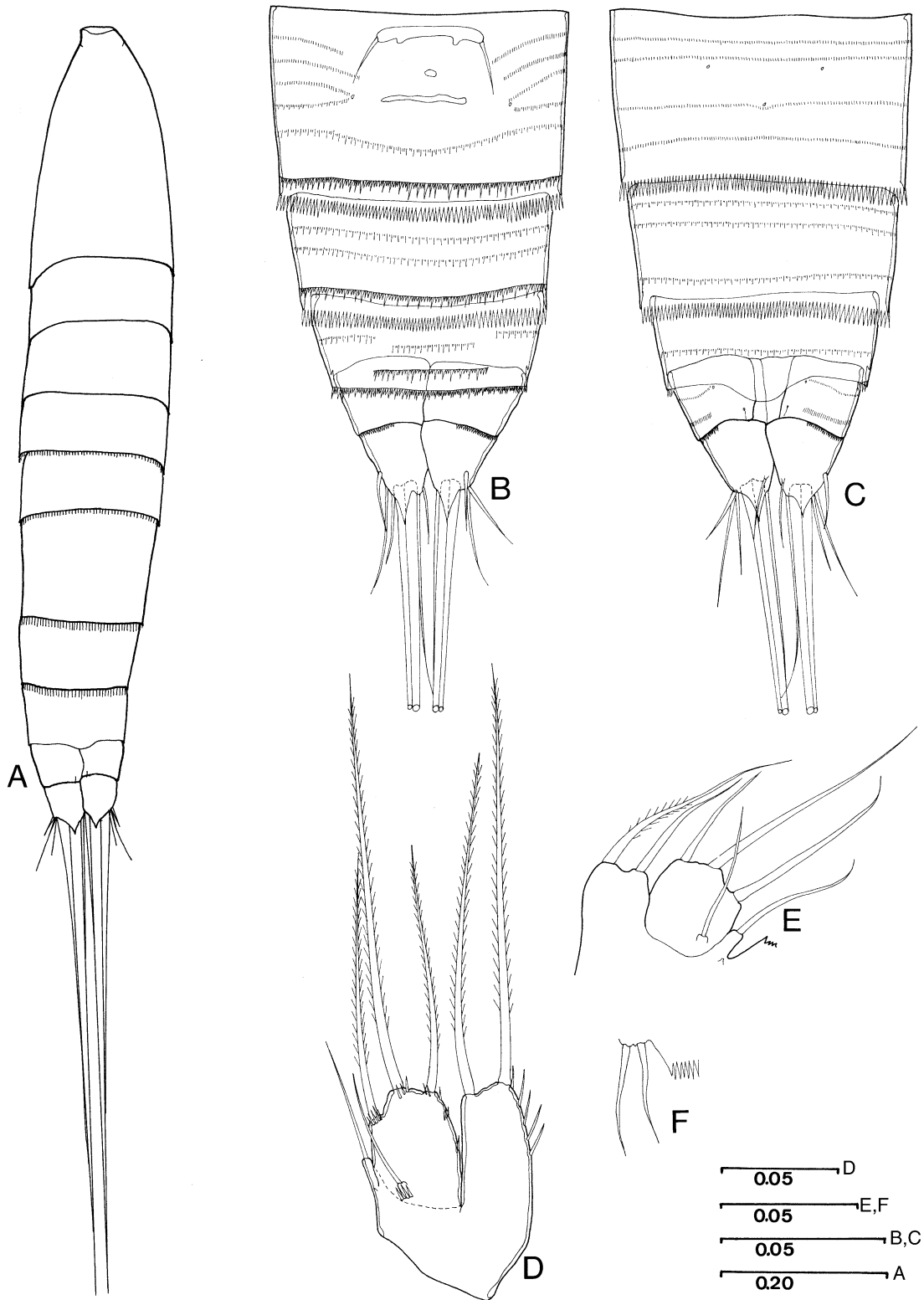


Figure 10. *Halectinosoma paragothiceps* sp. nov. Female (South Queensferry): A, P1; B, P2; C, P3; D, P4.



**Figure 11.** *Halectinosoma kliei* sp. nov. Female holotype: A, habitus, dorsal; B, urosomites 2–6, ventral; C, urosomites 2–6, dorsal; D, P5. Male paratype: E, P5; F, P6.

*Caudal ramus* (Fig. 11B, C). About as long as broadest width. Principal setation and general form as in *H. pseudosarsi* Clément and Moore.

*Somatic ornamentation* (Fig. 11A–C). Body somites, excluding penultimate, sparsely furnished with sensilla and pores. Posterior margin of cephalothorax, first and second free thoracic somites unadorned. Posterior margin of third thoracic somite and first urosomite finely crenulated. Genital double-somite with a complex arrangement of rows of fine spinules and a semi-incised subulate hyaline frill. Urosomite 4 with hyaline frill similar to preceding somite and with three rows of fine spinules. Penultimate somite with one dorsal and two ventral spinular rows and a very fine, fully incised, subulate hyaline frill which is interrupted dorsally by the unadorned pseudopericulum.

*Antennule* (Fig. 12A). Elongate and six-segmented. Principal setation (not illustrated) and form as in *H. pseudosarsi* except for small differences in the relative length and spinulation of some setae.

*Antenna* (Fig. 12B). Coxa short. Basis with a set of long setules at inner distal corner. Endopodite two-segmented; segment 1 unadorned, segment 2 with two adjacent setae mid-way along inner margin and seven terminal setae (including three spinulose, geniculate and one dwarfed, plumose). Exopodite three-segmented; basal segment well developed and armed with a slender seta, segment 2 short, with a spinulose seta, distal segment twice as long as basal one and armed with two apical setae which are spinulose and subequal in length.

*Mandible* (Fig. 12C). Only the coxal gnathobase, furnished with a short spiniform seta at ventral base of bidentate *pars incisiva* and tridentate *lacinia*, could be observed.

*Maxillula* (Fig. 12D). Only the praecoxal arthrite, armed along distal edge with three unguiform spines, could be observed.

*Maxilla* (Fig. 12E). Syncoxa short and broad, with three rows of fine spinules and furnished with three endites along distal half of inner margin; proximal endite armed with four setae, middle and distal endites with two and three setae, respectively. Basis narrower than syncoxa and nearly twice as long as broad and furnished with three setae midway along inner margin, and two slender setae near apex. Endopodite three-segmented, the first two segments each armed with a thick and very long geniculate seta and the distal segment represented by a broad base from which one lateral and three distal confluent setae arise.

*Maxilliped* (Fig. 12F). Syncoxa short with two setae. Basis segment long and with short spinules along inner and slender hairs along outer margin. Endopodite segment short, armed with two lateral and two closely set apical setae.

*P1–P4* (Fig. 13A–D). Principal setation and form of P1–P4 as in *H. mandibularis* sp. nov., except setae slender and also much longer relative to the length of each leg. Coxa of P2–P4 with a row of spinules along outer distal edge and a row of very fine spinules near inner distal corner.

*P5* (Fig. 11D). Exopod longer than broad and separated from baseopod by a suture on posterior surface only. Inner expansion of baseopod reaching to distal edge of exopod, with spinules along inner margin and furnished distally with two setae, the outer seta reaching beyond innermost seta of exopod. Outer expansion of baseopod furnished with a long slender seta. Exopod with a few spinules along inner margin, and with three somewhat sinuous lobes at distal edge, each accompanied by a row of spinules and armed with a slender spinulose seta: innermost seta about as long as outer seta; middle seta about as long as inner seta of baseopod. Surface-seta reaching beyond exopod, articulating on a small lobe accompanied by a few spinules and issuing from a point just distal to the exopod–baseopod suture.

#### *Description of male paratype*

*Length*: Habitus 770 µm; sum of all somites 750 µm; cephalothorax 220 µm. Urosomites 2 and 3 distinct. Otherwise as in female apart from the following features.

*Antennule* (Fig. 12G). Seven-segmented. Principal segmentation and setation (setae not illustrated) as in male of *H. neglectum* (Sars, 1904) except posterior margin of segment 5 with a broader and longer aesthetasc and with only one grasping process which is accompanied by a short spinulose seta.

*P5* (Fig. 11E). Baseopod confluent with first urosomite: inner expansion armed with two distal setae; outer expansion armed with a slender seta. Exopod clearly demarcated from baseopod and armed with three distal setae. Surface-seta issuing from a small lobe on exopod.

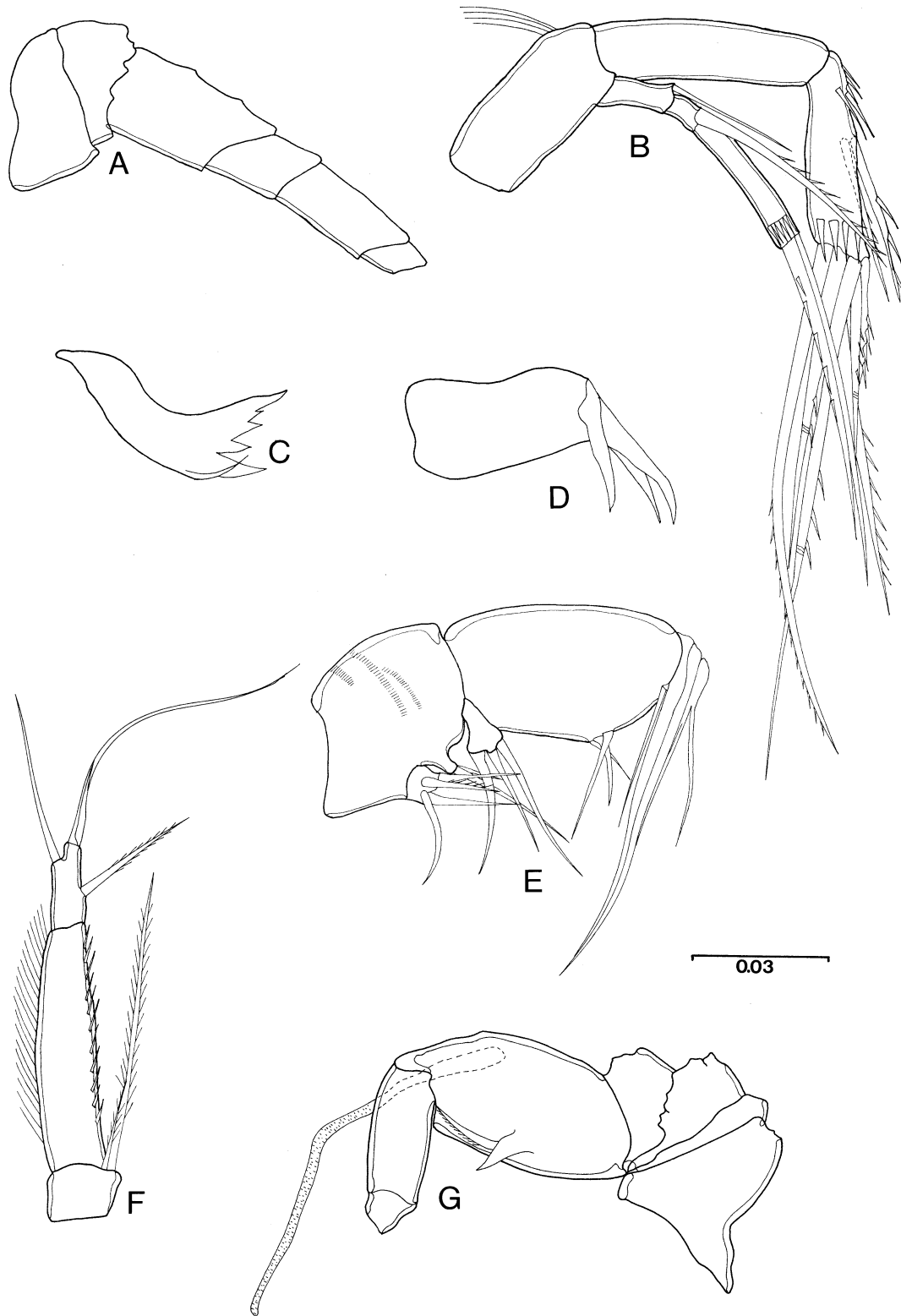
*P6* (Fig. 11F). A plate with two subequal setae at outer distal corner. Distal edge of plate denticulate.

*Variability*: No differences were found among specimens examined.

*Etymology*: *Halectinosoma kliei* is named in honour of Dr Walter Klie, whose collection provided some of the type material.

#### *Remarks*

*H. kliei* shares many taxonomic affinities with the *H. pseudosarsi* group of species. It is differentiated from all the other species of this group by having a more elongated habitus and correspondingly more



**Figure 12.** *Halectinosoma kliei* sp. nov. Female holotype: A, antennule (setae omitted); B, antenna; C, coxal gnathobase of mandible; D, praecoxal arthrite of maxillula; E, maxilla; F, maxilliped. Male paratype: G, antennule (setae omitted).

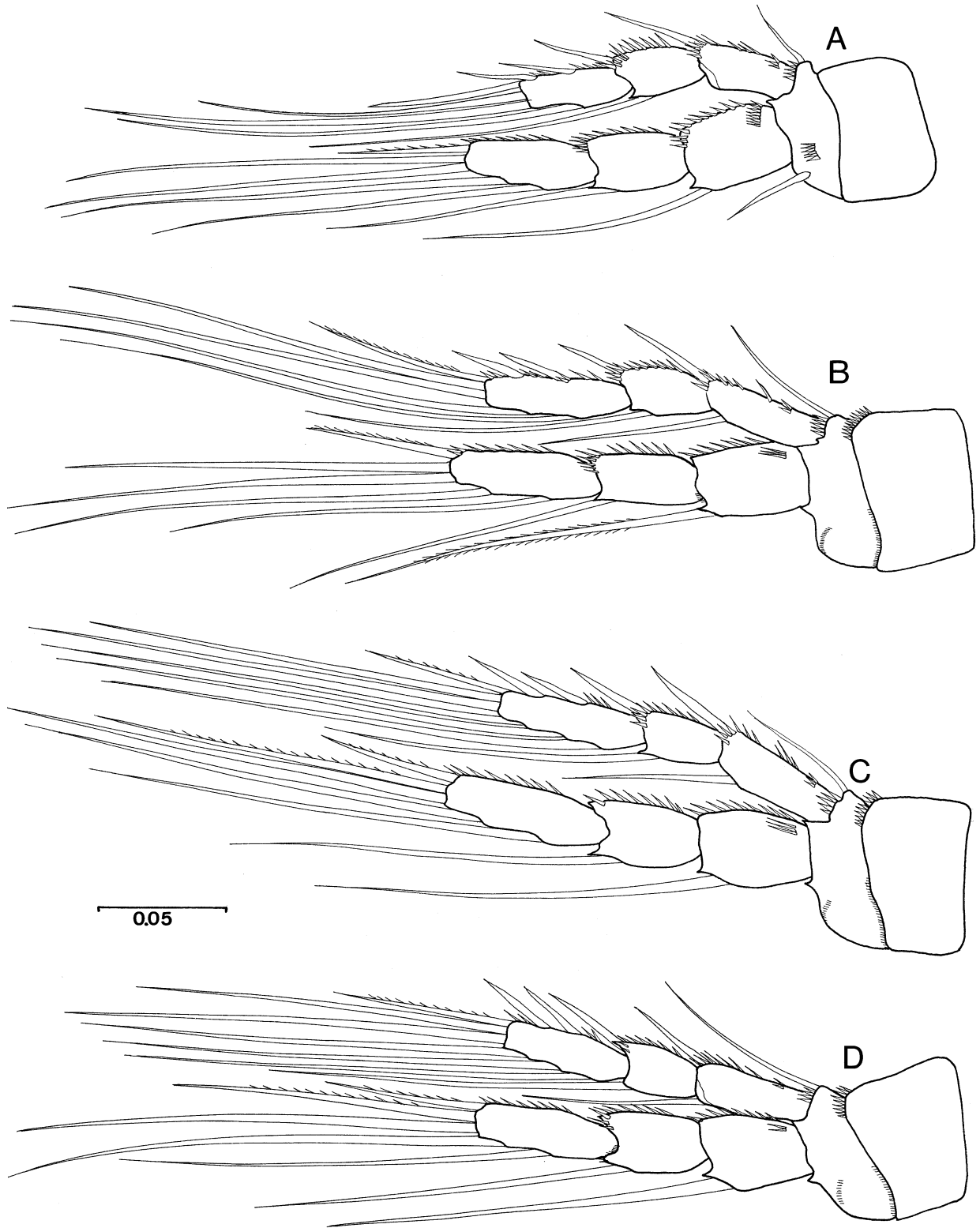


Figure 13. *Halectinosoma kliei* sp. nov. Female holotype: A, P1; B, P2; C, P3; D, P4.

distinctly elongated cephalosomic appendages and pereopods. The marginal lobes of the female P5 exopod are undeveloped and are armed with thin elongated setae. These latter features are very distinctive and this provides good evidence that *H. kliei* is the same species Smirnov (1932) and Chislenko (1977) described as *H. finmarchicum* (Scott, 1903). In an earlier paper (Clément & Moore, 2000) we have shown that the original description of *H. finmarchicum* by Scott (1903) has caused much confusion as it was based on material of two different species and so *H. finmarchicum* must be dropped from classification. We have also examined the material from which Willey (1920) described the female P5 of *H. finmarchicum* and we found that this too is ascribable to *H. kliei*.

The species described by Becker (1970) as *H. finmarchicum* and recorded from Germany is very distinct from *H. kliei*: the distal lobes of the P5 are well defined and the surface-seta does not extend beyond the exopod. Becker (1970) also noticed that in some specimens the distal lobes of the P5 exopod were devoid of spinules. Because of the complexities surrounding this group of species and the brief description given by Becker (1970), we cannot be certain of the identity of the species he recorded.

The distribution of *H. kliei* appears to be restricted to the Arctic seas. Smirnov (1932) and Chislenko (1977) recorded this species from Franz-Joseph Land.

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