

THE TAXONOMY OF *CONCHOECIA*
(OSTRACODA, HALOCYPRIDIDAE) OF THE
GAUSSI AND *EDENTATA* GROUPS FROM THE
NORTHEAST ATLANTIC WITH A NOTE ON
THEIR ECOLOGY

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By A. J. GOODAY

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SYNOPSIS

Conchoecia subedentata sp. n. and *C.* aff. *edentata* are described from the Northeast Atlantic and placed in a new *edentata* species group based on *C. edentata*, an Antarctic species. *C. edentata* was previously assigned to the *gaussi* group which is here restricted to *C. gaussi* and *C. incisa*, both of which are redescribed.

C. subedentata sp. n. and *C.* aff. *edentata* are commonest at 60°N and decrease in abundance southwards. *C. subedentata* sp. n. occurs mainly between 300 m and 900 m depth, *C.* aff. *edentata* is most frequent below 800 m. *C. gaussi* is most abundant at 53°N and *C. incisa* at 30°N. *C. incisa* males are rare and restricted to below 1250 m, while females and juveniles have two peaks of abundance, below 800 m and between 600 m and the surface. *C. gaussi* occurs mainly below 1000 m. None of the species appears to undergo diurnal vertical migration except for females and juveniles of *C. incisa* where all specimens in the top 200 m were taken at night.

Taken together adults and juveniles of *C. gaussi* and *C. incisa* fall into three or four size classes which may have some trophic significance.

INTRODUCTION

SKOGSBERG (1920 : 676) proposed the *gaussi* group of species to include *Conchoecia incisa* Müller, 1906 and *Conchoecia gaussi* Müller, 1908. Later Rudyakov (1962) placed *C. edentata* Müller, 1906 close to *C. gaussi* and Deevey (1974 : 368) included it

TABLE I

Station details and gear used

STATION	LOCATION IN NORTHEAST ATLANTIC	DATE	Discovery CRUISE No.	GEAR
5814 5816 5818 5819 5823 5825	28°N, 14°W	Sept. to Dec. 1965	8	N113
6155 6156 6164 6176 6183 6193	28°N, 14°W 34°N, 80°W	Oct. to Nov. 1966	15	N113
6674	11°35'N, 21°26'W	Jan. to April 1968	21	N113 B
7089	18°N, 25°W	Oct. to Dec. 1969	30	RMT 1 + 8 and N113
7406 7478 7480	48°N, 20°W	Sept. to Nov. 1970	36	RMT 1 + 8
7709 7711	60°N, 20°W 53°N, 20°W	April to June 1971	39	RMT 1 + 8
7803 7856	18°N, 25°W	Feb. to April 1972	45	RMT 1 + 8
8262 8264 8265 8270 8271 8272	32°N, 16°W 32°N, 24°W 32°N, 27°W 34°N, 34°W 34°N, 39°W 34°N, 43°W	Feb. to March 1973	52	RMT 1 + 8

in the *gaussi* group, while in a revision of *Conchoecia* Poulsen (1973 : 103) established the genus *Gaussicia* for these three species. Unfortunately some of the genera into which Poulsen subdivided *Conchoecia* are questionable. In this paper I therefore disregard *Gaussicia* until Poulsen's taxonomy can be thoroughly assessed. I also believe it is wrong to combine *C. edentata* with *C. gaussi* and *C. incisa*. In my view *C. edentata* and its allies described in this paper differ sufficiently from *C. gaussi* and *C. incisa* to warrant their placement in a new *edentata* group.

Plankton samples collected during recent years in the Northeast Atlantic by the RRS *Discovery* have yielded abundant material of the *gaussi* and *edentata* groups. Specimens resembling *C. edentata* predominate and fall into two size classes. The larger form is closer to Müller's (1906) original description of *C. edentata* and is assigned here to *C. aff. edentata* while the smaller form is described as *C. subedentata* sp. n. In addition, the two poorly known species of the *gaussi* group, *C. gaussi* and *C. incisa*, are redescribed, and the ecology of members of the *gaussi* and *edentata* groups is discussed.

Material and methods

The material was obtained from 27 stations in the Northeast Atlantic during seven cruises by RRS *Discovery* between 1965 and 1973. Details of the stations are summarized in Table 1. On earlier cruises, a 1 m² net (N113) fitted with a catch dividing bucket was employed (Foxton, 1969). This was superseded in 1969 by the combination net (RMT 1+8) described by Baker, Clarke & Harris (1973). Most of the ostracods were caught in the RMT 1 part of the combination net although a few adult specimens of *C. incisa* and *C. gaussi* were picked out from the RMT 8 samples.

A few characters measured must be briefly defined here. Carapace length includes the rostrum; carapace height and breadth are maximum values. Segments 1 and 2 of the first antenna are measured along their dorsal margins and the first segment is taken to begin at the base of the frontal organ. Protopodite length includes the anterior hook and segments 2–8 of the second antenna exopodite are measured from the distal end of segment 1 and not from the proximal end of segment 2.

TAXONOMIC SECTION

edentata group

DIAGNOSIS. Both valves bear median ventral glands; asymmetric glands are in usual positions. Male first antenna with long *a* and *c* setae and pad on *b* seta; *e* seta has proximally pointing spines which are difficult to distinguish. Female first antenna has very short dorsal seta, *a*–*d* setae are slightly longer or just shorter than *e* seta which bears group of proximally pointing spines on distal flattened and widened part. Male second antenna with *g* seta slightly widened and flattened distally; in female, *g* seta is rather wider and sword-shaped. Serrated teeth of mandibular basale low with weak primary cusps. Maxilla with only four posterior setae. Labrum has weak hyaline plate and small weak teeth. Female sixth limb with characteristically long and flexible ventral seta and very short dorsal seta on final segment.

REMARKS. *Conchoecia edentata* of Müller (1906) was included with *C. gaussi* and *C. incisa* in the new genus *Gaussicia* (= *gaussi* group) by Poulsen (1973). However this species, together with *C. aff. edentata* and *C. subedentata* sp. n. described here, differs from *C. gaussi* and *C. incisa* in numerous characters which are summarized in Table 5. In contrast the points of similarity are rather few: the presence of the ventral gland, the general character of the *b*, *d* and *e* seta armature on the male first antenna, the shape of the female *g* seta (second antenna) and *e* seta (first antenna), the development of minute spines on various segments of the female first antenna and the male and female second antenna and perhaps the same general structure of the cutting edge and tooth lists of the mandibular coxale.

Because of the large number of differences (Table 5) it seems sensible to remove *C. edentata*, *C. aff. edentata* and *C. subedentata* sp. n. from the *gaussi* group and place them in a new *edentata* group. The arrangement is supported by the fact that many

differences between the two groups are concerned with characters of the mandible, maxilla, fifth and sixth limbs and labrum. These limbs are more conservative in their structure than the first and second antennae and so their characteristics must carry more taxonomic weight.

The *edentata* group is characterized by several features. (i) The development of a median ventral gland; this is also present in *C. gaussi* and in *C. prosadena* the right asymmetric gland (not homologous with the ventral gland in the *edentata* and *gaussi* groups) is situated at the posterior end of the ventral margin. (ii) The *a-d* setae of the female first antenna are slightly shorter or slightly longer than the *e* seta. In no other species of *Conchoecia* do these setae approach the length of the *e* seta. The group of proximally pointing spines with expanded bases on the distal part of the *e* seta are probably also peculiar to this group. (iii) On the terminal segment of the female sixth limb the ventral *a* seta is very long, thin and flexible, the claw-like median *b* seta rather longer or shorter and the dorsal *c* seta is very short. These setae are probably diagnostic for the *edentata* group although characters of the sixth limb have generally been ignored in species descriptions. However, in all species of *Conchoecia* for which information is available the terminal setae of this limb are claw-like and shorter than the two ventral setae of the *edentata* group.

The *edentata* group is probably closely related to the *gaussi* group. It also shares a number of characters with the *mollis* group: distally widened *g* setae on the male and female second antennae and a distally widened *e* seta on the female first antenna, long *a* and *c* setae of the male first antenna and a pad on the *b* seta of this limb. *C. congolensis* Poulsen, 1969, which Poulsen (1969a: 116) felt was related to the *bispinosa* and *gaussi* groups, may be closer to the *edentata* group. In the only known specimen, a female, the dorsal seta is short and the *a-d* setae are long, although not as long as in the *edentata* species group. However the long, rod-shaped capitulum and the absence of a ventral gland distinguish *C. congolensis* from species of both the *edentata* and *gaussi* groups.

Conchoecia subedentata sp. n.

(Figs 2-5)

DIAGNOSIS. Species of *edentata* group characterized by small size (male carapace length 1.123-1.280 mm, mean 1.212 ± 0.030 mm) and setation of final segment of female limb where ventral *a* seta is longer than middle claw *b* seta.

MATERIAL. 1447 specimens comprising 388 females, 392 males and 667 juveniles.

HOLOTYPE AND PARATYPE. The holotype, a male stained with lignin pink and mounted on slides in Euparal, is deposited in the British Museum (Natural History), reg. no. 1974.736. The type locality is *Discovery* station 7711, haul 23; $52^{\circ}57.1'-52^{\circ}53.1'N$, $20^{\circ}0.0'-20^{\circ}3.4'W$. Depth 200-300 m. Time 2342-0142 hr. Date 19-20 May 1971. Gear RMT 1+8. The paratype material comprises a dissected female reg. no. 1974.737 and some undissected male and female specimens in 70% alcohol, reg. nos 1974.738-748.

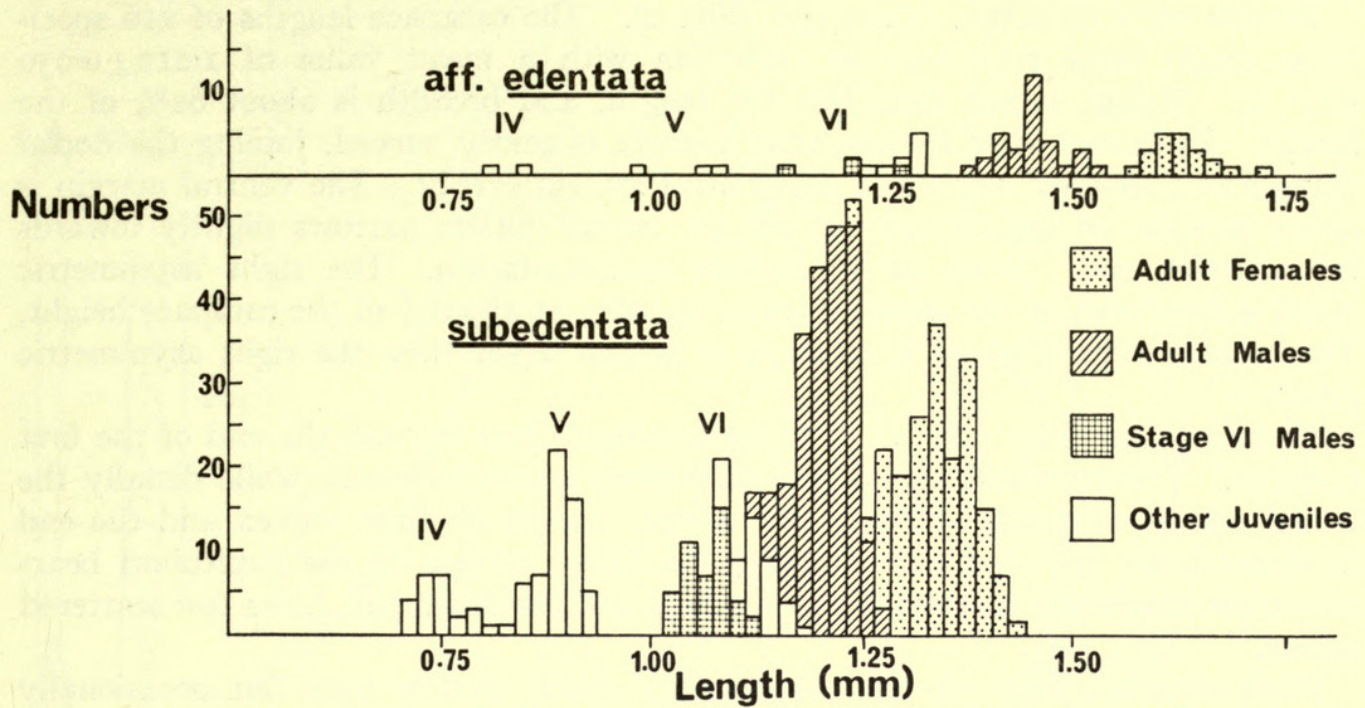


FIG. 1. Histograms showing adult and juvenile carapace lengths of *Conchoecia* aff. *edentata* and *Conchoecia* subedentata sp. n.

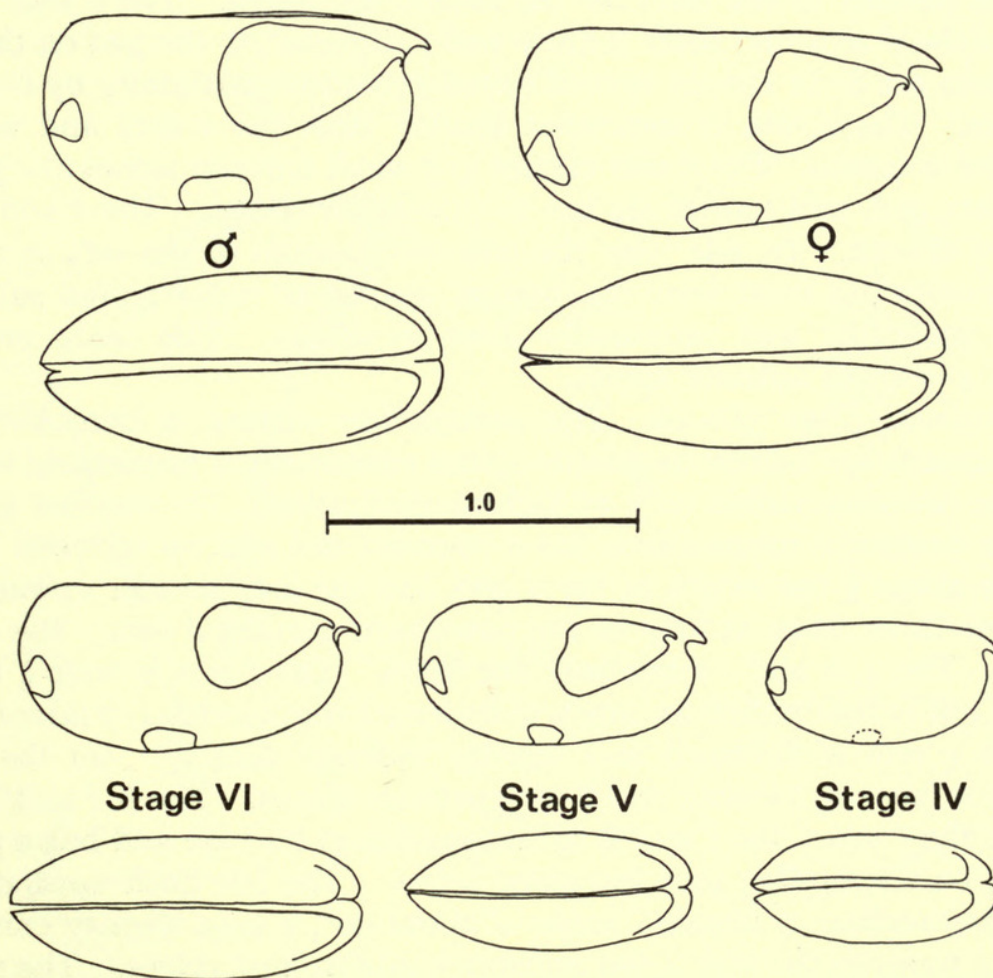


FIG. 2. *Conchoecia* subedentata sp. n. Lateral and ventral carapace outlines of adults and final three juvenile instars.

DESCRIPTION OF MALE. Carapace (Fig. 2). The carapace lengths of 216 specimens range from 1.123 mm to 1.280 mm with a mean value of 1.212 ± 0.030 (Fig. 1). Height is less than half the length, and breadth is about 80% of the height. In lateral view the posterior margin is gently curved, joining the dorsal margin at a rounded angle and the ventral margin evenly. The ventral margin is either straight or slightly curved and the lateral outline narrows slightly towards the anterior end. There is no surface ornamentation. The right asymmetric gland is displaced up the dorsal margin, opening at about $\frac{2}{3}$ of the carapace height. The median ventral gland is as large or rather larger than the right asymmetric gland.

Frontal organ (Figs 3A, C). The stalk extends just beyond the end of the first antenna. The proximal half of the capitulum tapers forwards, while distally the dorsal margin is nearly straight, the ventral margin slightly convex and the end asymmetrically rounded. Proximally, the lower surface of the capitulum bears numerous prominent forward directed spines and the distal part has a few scattered spines.

First antenna (Figs 3A, B). Segments 1-4 are usually bare but occasionally have a few scattered spines. The first segment is shorter than the second. The *a* seta is longer than the limb and swollen near the base; it loops down proximally and then lies parallel to the limb for the rest of its length. The *b* seta is slightly shorter than the *d* seta and bears a distal pad; adjacent to the pad on the anterior side of the seta are 8-11 closely spaced spines preceded proximally by 6-10 widely spaced spines. The *c* seta is somewhat shorter than the *a* seta and usually lies parallel to the antenna. The *d* seta carries 3-5 small anterior spines at a point level with the *b* seta pad, and sometimes has 2-3 posterior spines. The *e* seta armature is difficult to discern. In side view the posterior margin of the seta is raised into 17-22 low 'bumps', in front view the 'bumps' appear as vague paired patches from which arise indistinct and proximally directed spines. This main armature is preceded by 4-7 small anterior spines.

Second antenna (Figs 3D-G). The protopodite surface is bare but the first exopodite segment has numerous minute spines concentrated proximally where they form a dense covering visible only at high magnification. On the first endopodite segment, the processus mammillaris has a rounded end and no terminal tubercle. The *b* seta is about $\frac{3}{4}$ the length of the *a* seta and the long slender upward curving *c* seta is some three times as long as the downward curving *d* seta; the *e* seta is a small spine. The *a*, *b* and *c* setae bear fine hairs. The *f* seta is over $\frac{1}{2}$ the length of the *g* seta; it is thin walled for much of its length and carries 4-7 minute anterior spines. The *g* seta is flattened and slightly widened distally. On the proximal tubular part it has 7-9 anterior and 8-10 posterior spines. The *h*, *i* and *j* setae are shorter than the *f* seta; the *j* seta is rather swollen at its base and bears prominent spines, most on the swollen part but some below. The left hook appendage has a short proximal section, a rounded angle of about 90° , a long slightly curved distal section and a rounded tip with a few indistinct subterminal ridges. The right hook appendage is larger with an angle of about 135° between the proximal and distal sections and about 8 prominent subterminal ridges.

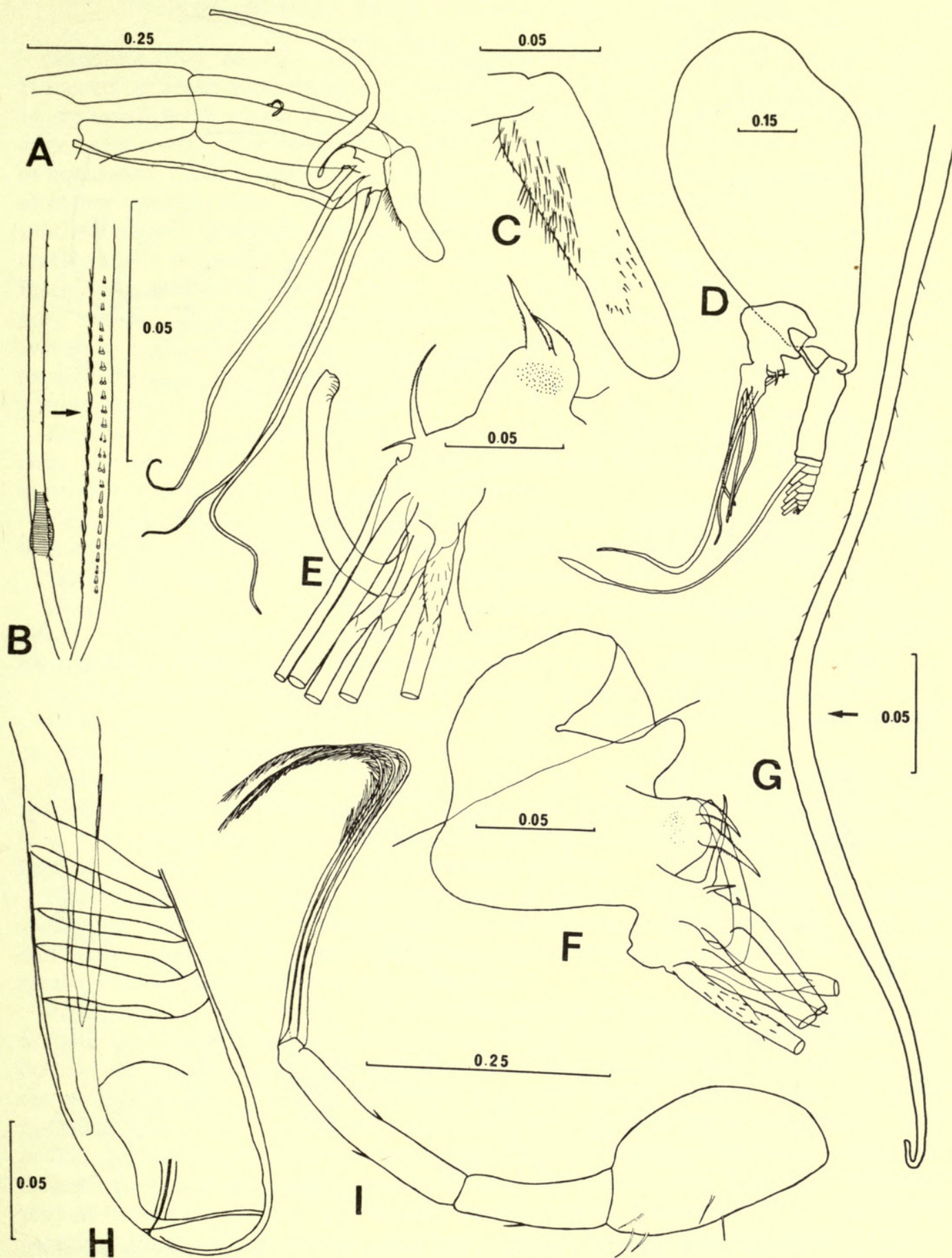


FIG. 3. Male dimorphic parts of *Conchoecia subedentata* sp. n. ; arrow indicates anterior. (A) First antenna and frontal organ. (B) Main armature of *b* and *e* setae of first antenna. (C) Capitulum of frontal organ. (D) Second antenna. (E) Second and third segments of endopodite of right second antenna. (F) Endopodite of left second antenna. (G) *g* seta of second antenna. (H) Penis. (I) Sixth limb.

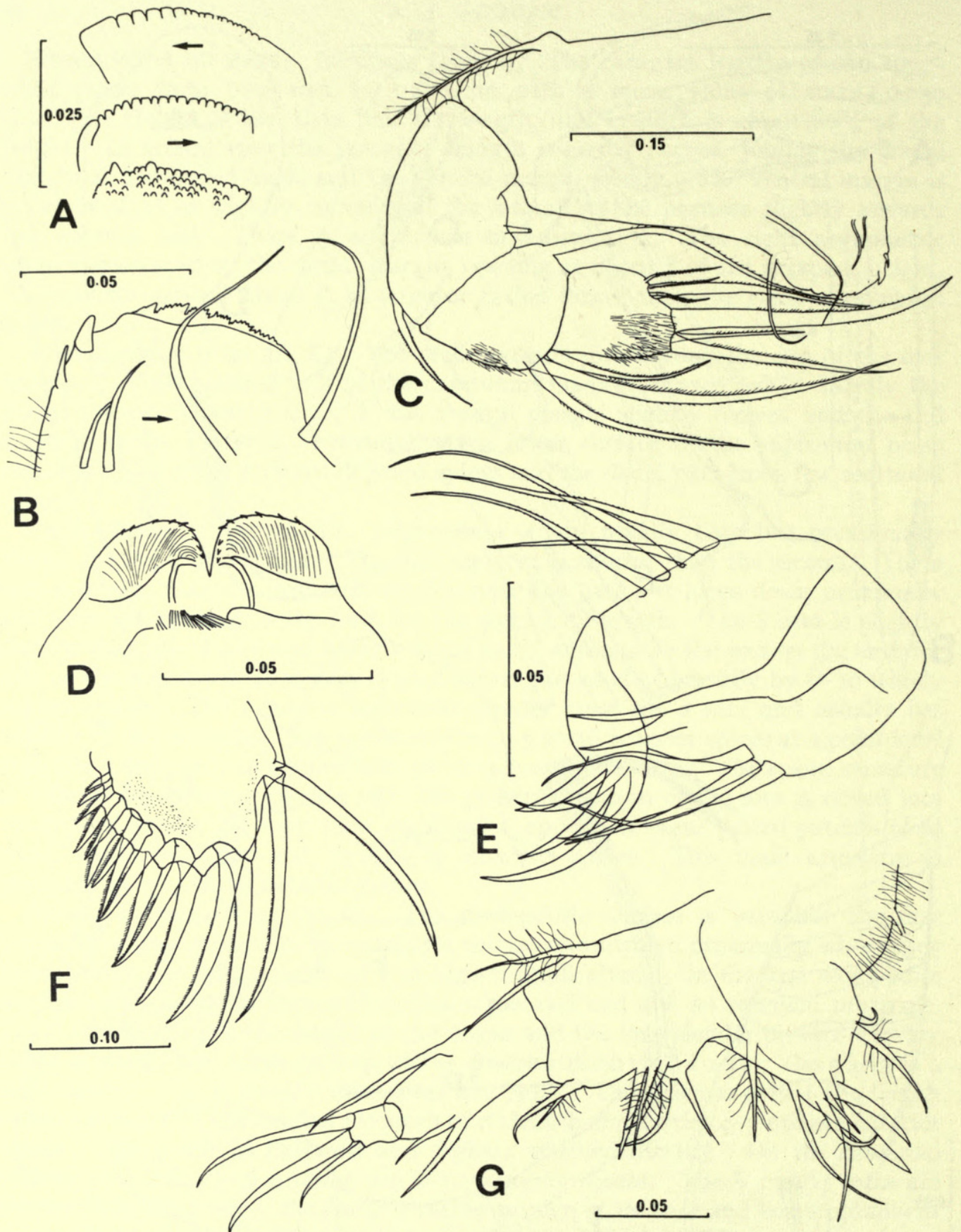


FIG. 4. Non-dimorphic parts of *Conchoecia subedentata* sp. n. ; arrow indicates anterior. (A) From top to bottom, cutting edge, distal and proximal tooth lists of mandibular coxale. (B) Cutting edge and adjacent setae of mandibular basale. (C) Basale, endopodite and exopodite of mandible. (D) Labrum. (E) Maxilla. (F) Caudal furca. (G) Fifth limb.

Mandible (Figs 4A-C). The toothed edge of the coxale slopes down posteriorly. It has 19-23 teeth comprising one elongate anterior tooth, 5-6 fairly large teeth and 13-17 small teeth which decrease in size posteriorly; the posterior $\frac{1}{4}$ of the toothed edge lacks teeth. The distal list has a large posterior tooth and 16-19 regular teeth of equal size. The proximal list has a large posterior tooth and 15-19 smaller teeth of rather variable sizes; the inner surface of this list is covered with papillae. The toothed edge of the basale has the usual arrangement of two spine teeth, six serrate teeth and an unusually long and low outer tooth. Only the posterior two serrate teeth have well-defined main cusps; on the remaining teeth, the main cusps are only slightly larger or are indistinguishable from the secondary cusps. There are two short setae near the spine teeth on the inner surface of the basale. The second exopodite segment has some fine hairs on the outer distal edge, the third segment has a more extensive distal area of hairs.

Maxilla (Fig. 4E). The anterior margin has four long setae, the distal two longer than the proximal two. The posterior margin has three setae. The basal seta extends to the end of the limb.

Fifth limb (Fig. 4G). On the dorsal side of the first exopodite segment, the distal seta extends only as far as the base of the dorsal seta on the next segment.

Sixth limb (Fig. 3I). This is typical for the genus.

Labrum (Fig. 4D). The hyaline membrane is fragile with a deep V-shaped notch. On each side of the notch are about nine small inward facing teeth which become more closely spaced towards the inside.

Caudal furca (Fig. 4F). The caudal lamellae are covered with fine hairs.

Penis (Fig. 3H). The upper margin is almost straight and the lower margin curved. There are five transverse muscle bands.

DESCRIPTION OF FEMALE. Carapace (Fig. 2). The carapace lengths of 190 specimens range from 1.261 mm to 1.438 mm with a mean value of 1.345 ± 0.041 mm (Fig. 1). Apart from being rather more elongate, the lateral outline is identical to that of the male. There is no surface ornamentation.

Frontal organ (Fig. 5C). The capitulum is distinct from the shaft. It tapers slightly anteriorly, with a rounded end and sometimes a slight concavity below the end. The capitulum is armed with long prominent spines on the ventral half and smaller, rather less, extensive spines dorsally.

First antenna (Figs 5A, B). The second segment is longer than the first and one or both may have a few scattered spines, visible only at high magnification. The dorsal seta is very short; the *a-d* setae are longer than the limb and the *a* seta is somewhat expanded proximally. The *e* seta is rather shorter than the more proximal setae. On the posterior side it bears 29-30 spines of varying sizes. The proximal tubular part of the seta has 16-19 spines of which the first 6-8 are small and difficult to distinguish and the remainder long and prominent. The distal flattened part of the seta bears 3-5 long distally pointing spines followed by 8-12 proximally pointing spines with unusually wide bases and 3-4 minute distally directed spines. On the anterior side are 10-13 spines, about $\frac{1}{2}$ on the distal flattened part of the seta.

Second antenna (Figs 5D-F). The armature of the second exopodite segment and the *a* and *b* setae are as for the male limb. The *f* seta is over $\frac{1}{2}$ the length of the

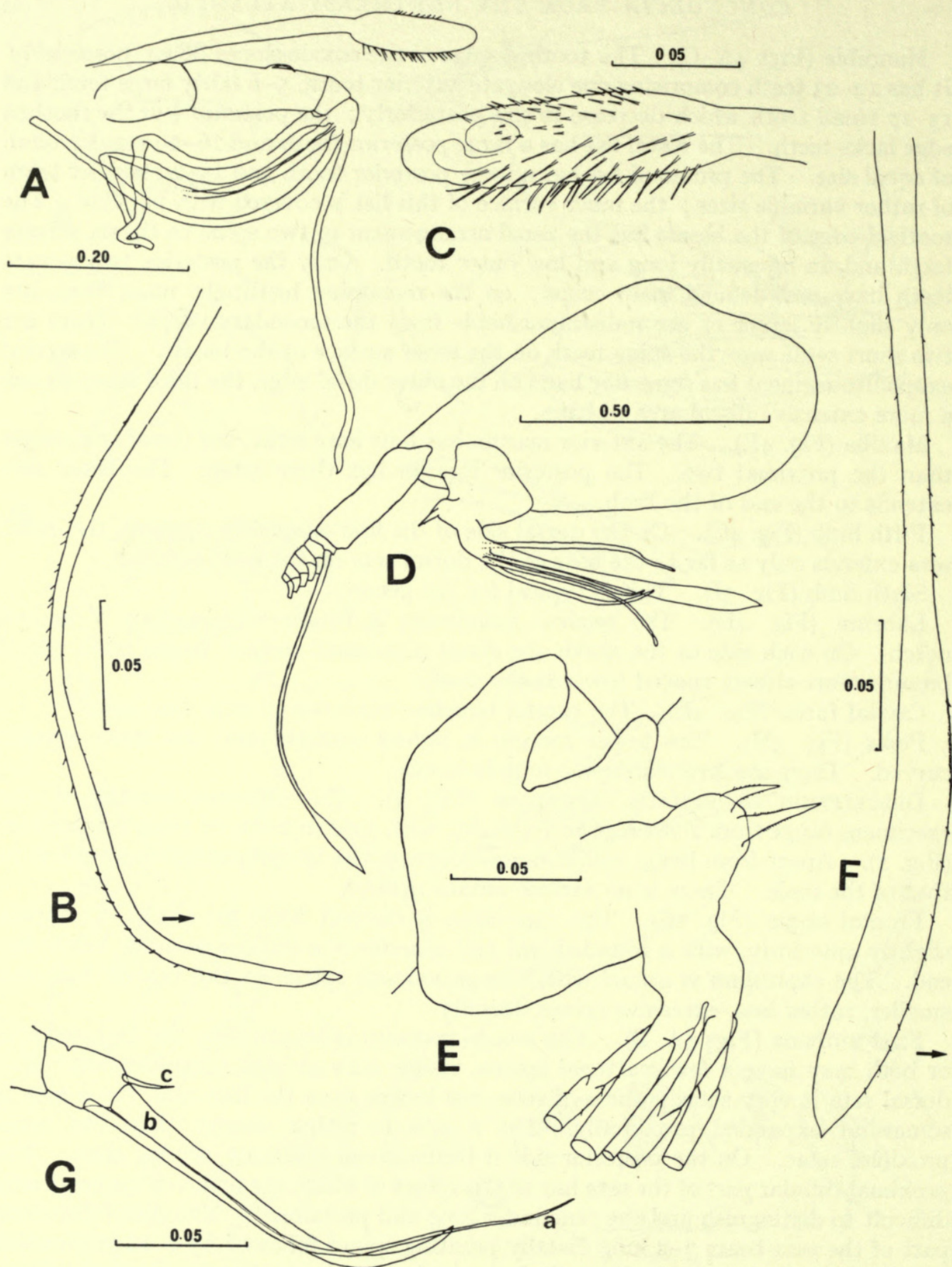


FIG. 5. Female dimorphic parts of *Conchoecia subedentata* sp. n. ; arrow indicates anterior. (A) First antenna and frontal organ. (B) *e* seta of first antenna. (C) Capitulum of frontal organ. (D) Second antenna. (E) Endopodite of left second antenna. (F) *g* seta of second antenna. (G) Terminal segment and setae of sixth limb.

g seta and in some specimens has 1–2 minute anterior spines. The *g* seta is flattened and widened in its distal half. Posteriorly it bears 19–26 spines of which the proximal 5–8 lie on the tubular part of the seta and on the anterior side it carries 6–8 similar spines, all on the tubular section. The *h*, *i* and *j* setae are slightly shorter than the *f* seta and the *j* seta bears a few spines proximally.

Sixth limb (Fig. 5G). On the final segment the three setae are here designated *a*, *b* and *c* from ventral to dorsal (Fig. 5G) and their relative lengths are summarized in Table 4. The *a* seta is thin, long and flexible, the *b* seta is claw-like and shorter than the *a* seta while the *c* seta is a short spine.

JUVENILES (Fig. 2). The range of carapace lengths in 24 Stage IV juveniles is 0.709–0.808 mm (mean 0.745 ± 0.014 mm); 57 Stage V juveniles have a length range of 0.827–0.926 mm (mean 0.888 ± 0.021 mm). Male and female Stage VI instars may be distinguished by the presence of immature eggs in the females and a rudimentary penis and testes in the male. The males are rather smaller (1.024–1.123 mm; mean 1.066 ± 0.013 mm in 44 specimens) than the females (1.084–1.182 mm; mean 1.124 ± 0.019 mm in 37 specimens). Juvenile and adult carapace lengths are summarized in a histogram (Fig. 1).

TABLE 2

Meristic characters of the males of the four described species

	<i>C. subdentata</i> sp. n.		<i>C. aff.</i> <i>edentata</i>		<i>C. incisa</i>		<i>C. gaussi</i>
N	216		40		8		10
Length: range (mm)	1.123–1.280		1.400–1.517		1.822–1.911		2.955–3.330
Length: mean, s.d. (mm)	1.210	0.030	1.460	0.027	1.877	0.030	3.138 0.107
N	20		10		8		6
	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$
Height	46.27	0.90	47.47	1.26	43.66	0.76	44.64
Breadth	40.83	1.24	40.39	1.02	38.49	1.42	40.93
FO shaft	32.30	1.29	31.53	0.69	28.10	0.44	30.33
capitulum	11.51	0.36	11.57	0.69	18.63	1.17	16.52
1st Antenna segment 1	10.07	0.31	11.49	0.70	11.15	0.27	10.99
segment 2	18.09	0.45	16.38	0.43	10.79	0.16	13.93
total	28.84	0.78	27.87	0.62	21.95	0.38	24.92
<i>a</i> seta	36.87	1.49	35.89	1.75	38.44	1.15	22.68
<i>b</i> seta	42.26	0.92	40.40	1.33	46.27	0.84	48.79
<i>c</i> seta	30.63	1.46	30.96	1.92	12.68	0.73	13.21
<i>d</i> seta	42.44	1.03	41.39	1.09	39.86	0.95	49.18
<i>e</i> seta	50.91	1.34	51.81	1.39	51.80	2.25	52.00
2nd Antenna protopodite	53.04	1.32	52.09	0.51	47.72	1.23	46.82
exopodite segment 1	16.80	0.39	17.55	0.27	17.54	0.36	19.26
segments 2–8	8.19	0.31	8.32	0.22	7.95	0.27	7.19
LSS	48.28	1.56	47.70	1.39	48.96	0.28	42.54
<i>g</i> seta	45.96	1.07	48.96	0.48	52.86	1.29	42.77
<i>f</i> seta	24.70	0.94	28.13	1.78	39.46	2.16	39.98
<i>h–j</i> setae	21.44	1.78	22.59	1.29	20.57	1.66	27.31

All measurements, other than the carapace length, are expressed as percentages of the carapace length. The measurements are mean values and are followed by standard deviations. N is the number of specimens measured. LSS is the longest swimming seta. FO is the frontal organ.

REMARKS. *C. subedentata* sp. n. is identical in many respects to *C. aff. edentata*. It is compared and contrasted with this form in detail below but the main points may be summarized here. (i) The mean carapace length in *C. subedentata* sp. n. is 81% (♀) to 83% (♂) that of *C. aff. edentata*; (ii) the *f* and *g* setae of the male and female second antennae are proportionally shorter in *C. subedentata* sp. n. (Tables 2

TABLE 3

Meristic characters of the females of the four described species

	<i>C. subedentata</i> sp. n.		<i>C. aff.</i> <i>edentata</i>		<i>C. incisa</i>		<i>C. gaussi</i>
N	190		31		39		4
Length: range (mm)	1.261-1.438		1.576-1.734		2.462-2.837		3.369-3.546
Length: mean, s.d. (mm)	1.345	0.041	1.651	0.067	2.624	0.062	3.462
N	20		10		8		4
	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$
Height	46.08	0.99	47.20	1.29	49.54	1.23	46.94
Breadth	38.37	0.85	38.77	1.12	41.65	1.49	41.08
FO total length	29.83	0.69	28.77	0.74	28.92	0.91	35.58
1st Antenna segment 1	6.75	0.36	6.89	0.52	4.88	0.18	5.73
segment 2	10.33	0.69	9.54	0.70	6.71	0.14	8.25
total	16.98	0.58	16.66	0.65	11.58	0.26	13.13
<i>a-d</i> setae	29.51	1.57	29.15	1.78	11.78	0.84	14.77
<i>e</i> seta	28.77	0.77	33.87	0.02	32.22	0.64	37.02
2nd Antenna protopodite	47.32	0.80	44.96	0.70	38.83	0.83	42.21
exopodite segment 1	15.04	0.72	15.67	0.34	14.23	0.24	17.47
segments 2-8	7.23	0.29	7.25	0.19	6.46	0.17	6.98
LSS	41.42	1.28	42.18	0.84	34.58	1.50	36.47
<i>g</i> seta	32.24	0.34	34.79	0.66	28.14	0.49	33.98
<i>f</i> seta	18.18	0.81	20.27	0.67	19.64	0.91	26.34
<i>h-j</i> setae	22.36	1.05	24.52	1.40	18.49	0.66	28.01

All measurements, other than the carapace length, are expressed as percentages of the carapace length. The measurements are mean values and are followed by standard deviations. N is the number of specimens measured. LSS is the longest swimming seta. FO is the frontal organ.

TABLE 4

Meristic characters of the sixth limb in males and females of *C. subedentata* sp. n. and *C. aff. edentata*

	<i>C. subedentata</i> sp. n.		<i>C. aff. edentata</i>	
	♀	♂	♀	♂
N	9	6	6	6
Segment 1	14.32	12.58	14.02	11.97
Segment 2	19.09	17.96	18.71	18.01
Total	33.48	30.55	32.73	29.98
<i>a</i> seta	11.09	37.69	12.59	40.50
<i>b</i> seta	16.51		12.56	
<i>c</i> seta	1.55		3.06	

All measurements are mean values and are expressed as percentages of the carapace length. N is the number of specimens measured.

and 3) and the female *g* seta is relatively wider distally ; (iii) the right hook appendage extends to just above the base of the *c* seta in *C. subedentata* sp. n. but well above this point in *C. aff. edentata* ; (iv) on the inner side of the mandibular basale there are two setae near the spine teeth but only one in *C. aff. edentata* ; (v) the thin ventral *a* seta of the female sixth limb extends well beyond the end of the middle claw *b* seta in *C. subedentata* but not to the end of the *b* seta in *C. aff. edentata* and the short dorsal *c* seta in *C. subedentata* sp. n. is about twice the proportional length of this seta in *C. aff. edentata* (Table 4).

The characters which separate *C. subedentata* sp. n. and *C. aff. edentata* also distinguish *C. subedentata* sp. n. from previously described and figured specimens of *C. edentata*. Thus *C. subedentata* sp. n. is much smaller than *C. edentata* and differs from the figured male of Müller (1906: pl. XV, fig. 2a) and Rudyakov (1962: fig. 12), in having a shorter right hook appendage and from the females of Barney (1921: fig. 5F) and Rudyakov (1962: fig. 11E) in the relative lengths of the terminal setae on the sixth limb and from Rudyakov's (1962: fig. 13B) figured specimens in the presence of two setae rather than one next to the spine teeth on the mandibular basale.

GEOGRAPHICAL DISTRIBUTION. In the Northeast Atlantic this previously unrecorded species was found at the following stations ; the number of specimens caught at each station is given in parentheses : Station 7709, 60°N, 20°W (708) ; Station 7711, 53°N, 20°W (408) ; Stations 7406 (245), 7478 (14) and 7480 (1) all 40°N, 20°W ; Stations 8262 (1), 8264 (2), 8265 (1), 8270 (4), 8271 (4), 8272 (3), all along 32°N, ; Station 7856, 30°N, 23°W (63), Station 7089, 18°N, 25°W (3). The depth distribution at different latitudes is summarized in Fig. 19.

Conchoecia aff. *edentata* Müller 1906

(Figs 6–9)

MATERIAL. Ninety-nine specimens comprising 26 females, 43 males and 30 juveniles. Dissected male and female specimens, stained with lignin pink and mounted in Euparal, are deposited in the British Museum (Natural History), reg. nos 1974.749 and 750.

DESCRIPTION OF MALE. Carapace (Fig. 6). The carapace lengths of 40 specimens range from 1.399 mm to 1.517 mm with a mean value of 1.459 ± 0.027 mm (Fig. 1). The lateral outline and gland positions are as for *C. subedentata* sp. n. There is no surface ornamentation.

Frontal organ (Fig. 7D). As for *C. subedentata* sp. n.

First antenna (Figs 7A, C). Segments 1 and 2 are together proportionally rather longer than in *C. subedentata* sp. n., are usually bare but may have a few scattered spines. The *a–e* setae have about the same proportional lengths as in *C. subedentata* sp. n. and similar armature. The *b* seta bears 9–12 widely spaced spines and 8–10 more closely spaced and rather weaker spines level with the pad. The *d* seta carries 6–12 weaker anterior spines and sometimes a few similar posterior spines while the *e* seta has 19–25 paired 'bumps' from which arise indistinct spines.

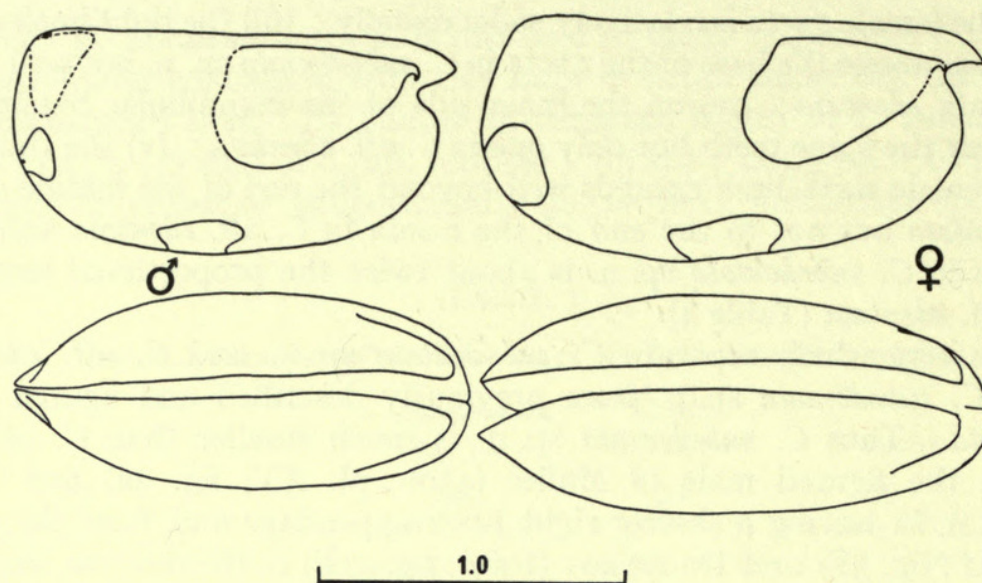


FIG. 6. *Conchoecia* aff. *edentata*. Lateral and ventral carapace outlines of adults.

Second antenna (Figs 7B, E-G). The proportional lengths and armature of the limb segments are as for *C. subedentata* sp. n. but the *f* and *g* setae are proportionally longer (Table 2). The *f* seta bears 5-7 minute anterior spines. The *g* seta has 6-11 small proximal and median posterior spines and 6-9 similar, mainly median spines on the anterior surface; the distal flattened part of this seta is bare. The remaining setae are as described for *C. subedentata* sp. n. Also the right hook appendage is markedly longer in *C. aff. edentata*, extending well above the bases of the *c* and *d* setae, but only just above this point in *C. subedentata* sp. n.

Mandible (Figs 8A-C). The toothed edge, the proximal and distal lists of the coxale and the basale toothed edge have the same structure as in *C. subedentata* sp. n. The toothed edge of the coxale bears 15-19 teeth comprising a broad posterior tooth, five large teeth and 10-13 small teeth. The distal list has a large curved posterior tooth and 18-21 smaller teeth of equal size, while the proximal list has a large posterior tooth and 15-22 smaller teeth of rather variable size. As in *C. subedentata* sp. n. the second and third exopodite segments carry fine hairs. There is only a single short seta near the spine teeth on the inner surface of the basale compared with two setae here in *C. subedentata* sp. n. Also the three small setae at the base of the dorsal claw seta of the third exopodite segment are appreciably shorter than in *C. subedentata* sp. n.

Maxilla (Fig. 8F) and furca (Fig. 8D). As for *C. subedentata* sp. n.

Labrum (Fig. 8E). This differs from the labrum of *C. subedentata* in having only very faint lines on the hyaline plate.

Penis (Fig. 7H). There are usually six, but occasionally only five, transverse muscle bands.

Sixth limb (Fig. 7I). As in *C. subedentata* sp. n. except for the proportionally rather longer setae on the final segment (Table 4).

DESCRIPTION OF FEMALE. Carapace (Fig. 6). The carapace lengths of 31 specimens range from 1.576 mm to 1.734 mm with a mean value of 1.651 ± 0.067 mm

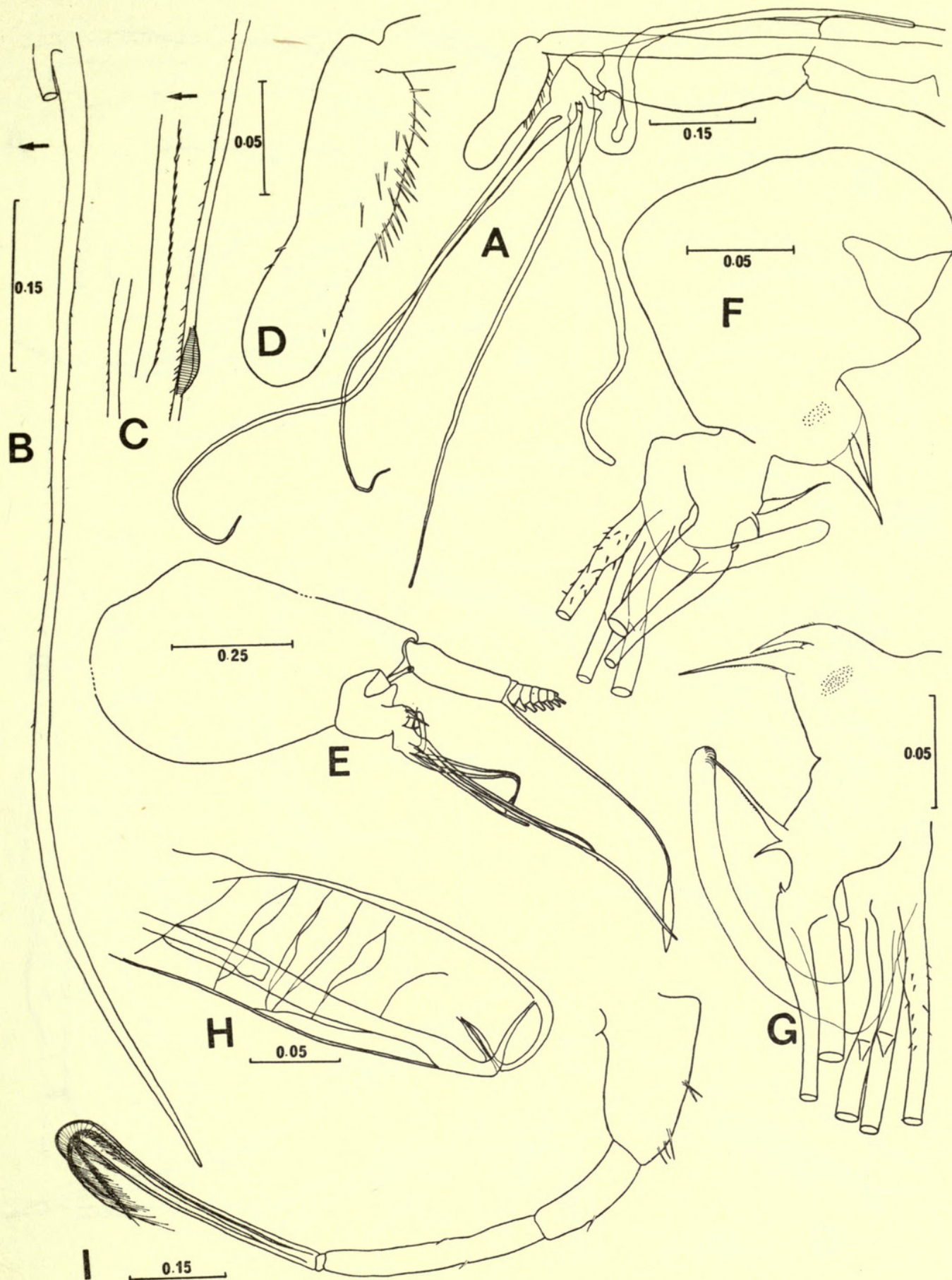


FIG. 7. Male dimorphic parts of *Conchoecia* aff. *edentata*; arrows indicate anterior. (A) First antenna and frontal organ. (B) *g* seta of second antenna. (C) Main armature of (from left to right) *d*, *e* and *b* setae of first antenna. (D) Capitulum of frontal organ. (E) Second antenna. (F) Endopodite of left second antenna. (G) Second and third segments of endopodite of right second antenna. (H) Penis. (I) Sixth limb.

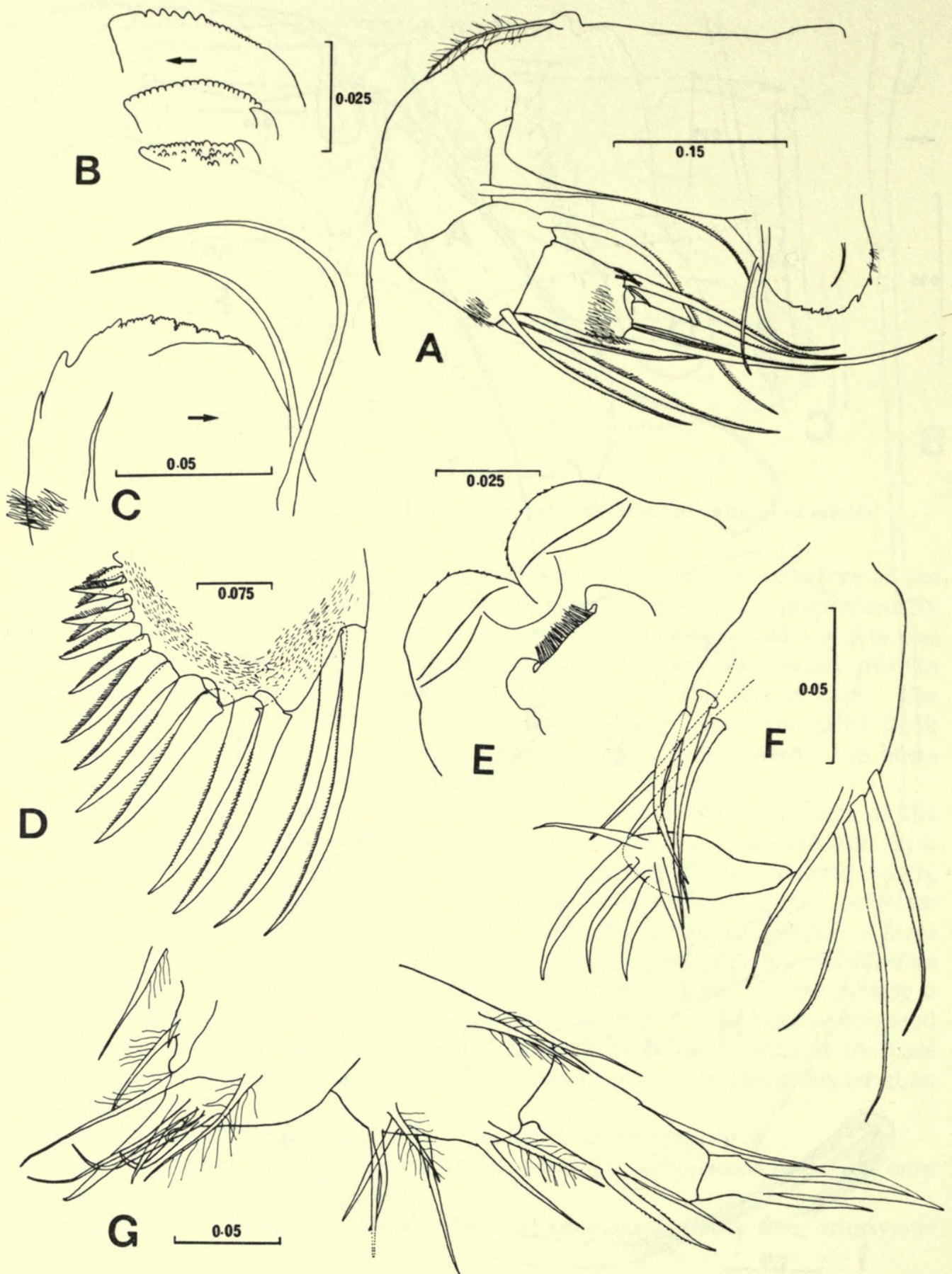


FIG. 8. Non-dimorphic parts of *Conchoecia* aff. *edentata*; arrows indicate anterior. (A) Basale, endopodite and exopodite of mandible. (B) From top to bottom, cutting edge, distal and proximal tooth lists of mandibular coxale. (C) Cutting edge and adjacent setae of mandibular basale. (D) Caudal furca. (E) Labrum. (F) Maxilla. (G) Fifth limb.

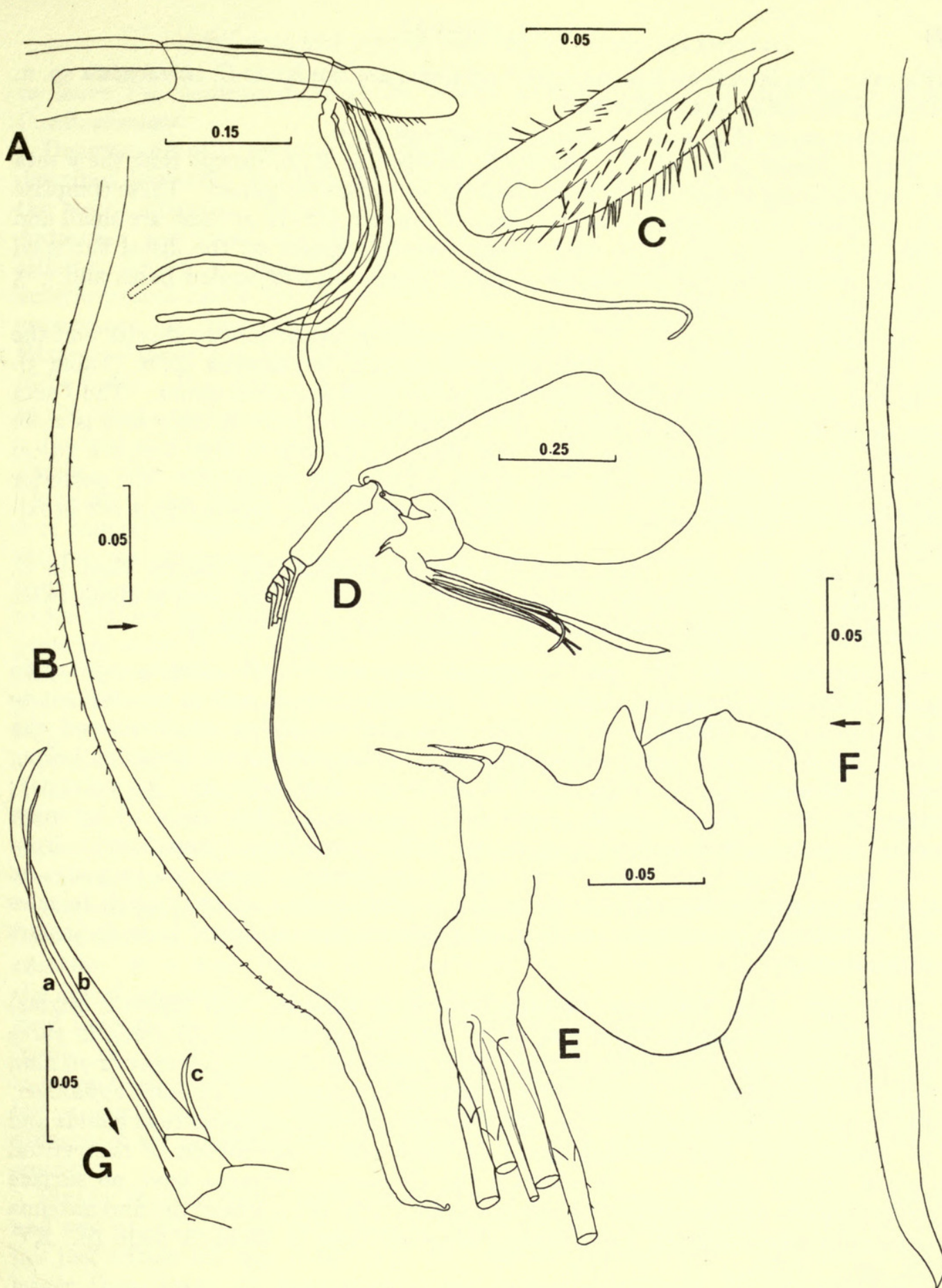


FIG. 9. Female dimorphic parts of *Conchoecia* aff. *edentata*; arrows indicate anterior. (A) First antenna and frontal organ. (B) *e* seta of first antenna. (C) Capitulum of frontal organ. (D) Second antenna. (E) Endopodite of right second antenna. (F) *g* seta of second antenna. (G) Final segment and setae of sixth limb.

(Fig. 1). The lateral outline and gland positions are similar to *C. subedentata* sp. n. There is no surface ornamentation.

Frontal organ (Fig. 9C). As for *C. subedentata* sp. n.

First antenna (Figs 9A, B). As for *C. subedentata* sp. n. except that the *e* seta is proportionally longer (Table 2) and bears 36–46 posterior spines. These comprise 18–24 spines on the proximal tubular part of the seta (11–12 of these are small and difficult to distinguish), 7–10 long distally pointing spines on the distal flattened section followed by 7–9 proximally pointing spines with expanded bases and 3–5 weaker distally pointing spines.

Second antenna (Figs 9D–F). The protopodite is proportionally shorter and the *f*–*j* setae are proportionally rather longer than in *C. subedentata* sp. n. (Table 3). The first exopodite segment usually bears a few small scattered spines. The *f* seta has up to six small anterior spines. The distal flattened part of the *g* seta is more slender than in *C. subedentata* sp. n. On the anterior side of this seta are 19–26 spines of which the proximal 5–8 lie on the tubular part of the seta; the posterior side bears 6–8 similar spines, all on the tubular part. The *j* seta carries a few proximal spines.

Sixth limb (Fig. 9G). The ventral *a* seta is considerably shorter than in *C. subedentata* sp. n. and does not extend beyond the *b* seta. The *c* seta is about twice the proportional length of this seta in *C. subedentata* sp. n. (Table 4).

JUVENILES. Earlier (IV and V) juvenile stages of *C. aff. edentata* overlap in length with the corresponding stages of *C. subedentata* sp. n. and so are difficult to distinguish. The following lengths are of a few specimens which exceed the maximum size for the corresponding instar of *C. subedentata* and so probably belong to *C. aff. edentata* (Fig. 1): Stage IV, 0.808–0.847 mm, mean 0.827 mm (3 specimens); Stage V, 0.985–1.083 mm, mean 1.047 mm (6 specimens). Male Stage VI juveniles range from 1.162 mm to 1.300 mm, mean 1.281 (5 specimens) and females from 1.281 mm to 1.320 mm, mean 1.311 mm (7 specimens). Stage VI juveniles of *C. aff. edentata* are thus comparable in size to adult males and small adult females of *C. subedentata* sp. n. and so easily distinguishable from the final juvenile instars of this species.

REMARKS. This Northeast Atlantic form is at variance with Müller's original description of *C. edentata* (1906: 76, pl. 15, figs 24–29) from the Antarctic in three important respects. (i) Müller's single adult specimen, a male, is longer (1.70 mm) than Atlantic males. (ii) The carapace of Müller's specimens has 'ziemlich auffälliger' dorsal and anterior striations, 'ungewöhnlich umfangreich' asymmetrical glands and an 'umfangreiche sehr auffällige' group of gland cells in the middle of the ventral margin (Müller 1906: 77). In contrast the *Discovery* specimens have no surface ornamentation and the glands are much smaller. (iii) The *c* seta of the first antenna is considerably longer in the *Discovery* material than in Müller's male (pl. XV, fig. 27).

There is insufficient evidence to decide whether these differences warrant separating the North Atlantic and Antarctic forms as distinct species or whether they are only intraspecific variations. Until Antarctic specimens are redescribed, it seems best

to leave the nomenclature of the North Atlantic form open and assign it to *C. aff. edentata*.

Descriptions of *C. edentata* by later workers also differ more or less from the form described here and, like Müller's, the material of these authors was caught outside the North Atlantic. Barney (1921: 183, 184) first described the female (from the Antarctic) and found the ventral gland to be 'less noticeable than in the male' although his fig. 5a shows it to be larger than in the *Discovery* material. Also 'the anterioventral curve [of the outline] viewed from the inside has an imbricate appearance' in Barney's specimen. Although there are no other differences, Barney's figures and descriptions are too inadequate for a meaningful comparison to be made. However, it is significant that his specimen (1.62 mm) is comparable to the mean carapace length of North Atlantic females (1.651 ± 0.067 mm).

Rudyakov (1962) records three adults and two juveniles from the Northwest Pacific. His description and figures agree well with the form described here. There are a few minor differences: Rudyakov's male has no small spines on the first exopodite segment of the male second antenna, and the *d* seta of this limb is shorter (see Rudyakov, figs 12B, G), the proximal mandibular tooth list has more teeth, there are no hairs above the spine teeth of the mandibular basale (according to Rudyakov, fig. 13B), in fig. 11G of Rudyakov the basal seta, the lateral and three posterior setae of the maxilla are shorter than in my specimens and the hyaline plate of the labrum has fewer teeth (Rudyakov, fig. 12). These differences are probably only of intraspecific significance. Of more importance are the carapace lengths of Rudyakov's adult female (1.83 mm) and two Stage VI females (1.43 and 1.45 mm) which are much greater than the corresponding lengths for the North Atlantic form, although his two adult males (lengths also 1.43 and 1.45 mm) measure close to the mean carapace length of North Atlantic males. This size difference between the females but not the males is puzzling and makes it difficult to assess the conspecificity or otherwise of the two forms.

Poulsen (1973: 107, 108) attributes a juvenile female from the Pacific off New Caledonia to *C. edentata*. This individual differs in several respects from *C. aff. edentata*. It is much longer (1.50 mm) than *Discovery* Stage VI juvenile females, the dorsal seta of the first antenna is longer (Poulsen, fig. 53g); there are 'medium-long' hairs on the lunular bulge of the second antenna (fig. 53c); on the mandibular basale, the spine teeth are longer and the primary cusps of the serrated teeth are more pronounced (fig. 53d); the edge of the mandibular coxale lacks teeth (fig. 53d), the proximal and distal tooth lists have two large posterior teeth (fig. 53d). These differences are considerable and Poulsen's specimen probably belongs to a distinct species.

Finally Deevey (1974: 368) records three females (1.65, 1.73 and 1.73 mm long) and two juveniles (1.40 and 1.45 mm long) from the South Atlantic. The females fall just within the size range of *C. aff. edentata* although the juveniles are rather larger than Stage VI specimens in the *Discovery* material. In the absence of additional details the comparison can be taken no farther. Other authors (Müller, 1908, 1912; Iles, 1953; Hillman, 1967, 1969) give no descriptions, figures or lengths.

GEOGRAPHICAL DISTRIBUTION. Müller (1906 : 76), 1♂, 1 juvenile ? ♀, Indian Ocean sector of Antarctic, 55°S ; Müller (1908 : 65), Antarctic, 61°S and Indian Ocean, 0° ; Barney (1921 : 163), 2♀ (1 juvenile), 2♂ (1 juvenile), Antarctic, 72°S, 0–1000 m ; Iles (1953 : 263), 1♀, Atlantic 23°S, 500–250 m ; Rudyakov (1962), 2♂, 3♀ (2 juvenile), Northwest Pacific, 44°N (1568–1900 m), 46°N (1190–2500 m), 49°N (580–1300 m) ; Hillman (1967, 1969), Antarctic, numerous stations between 50°S and 70°S ; Deevey (1974 : 368) 3♀, 2 juveniles, South Atlantic between 23°S and 55°S. As discussed above, most of these specimens are regarded as only questionable synonyms of *C. aff. edentata*.

In the Northeast Atlantic, this form was found at the following stations ; the number of specimens caught at each station is given in parentheses : Station 7709, 60°N, 20°W (37) ; Station 7711, 53°N, 20°W (21) ; Stations 7406 (18), 7478 (3), both 40°N, 20°W ; Station 7856, 30°N, 23°W (1) ; Station 7089, 18°N, 25°W (23) ; Station 6665, 11°N, 20°W (2). The depth distribution at different stations is summarized in Fig. 20.

TABLE 5

Summary of the main differences between the *edentata* and *gaussi* species groups of *Conchoecia*

<i>edentata</i> group	<i>gaussi</i> group
1. Capitulum of ♂ and ♀ frontal organ shorter (Tables 2 and 3)	—
2. ♂ and ♀ first antenna longer (Tables 2 and 3)	—
3. Pad on <i>b</i> seta of ♂ first antenna relatively short	Pad elongate
4. <i>c</i> seta of ♂ first antenna longer than limb (Table 2)	Short and wide
5. <i>a-d</i> setae of ♀ first antenna longer or slightly shorter than <i>e</i> seta (Table 3)	These setae much shorter than <i>e</i> seta
6. <i>e</i> seta of ♀ first antenna with distal, proximally directed spines	All spines point distally
7. Dorsal seta of ♀ first antenna very short	Long and extends well beyond limb
8. Protopodite of second antenna longer, particularly in ♂ (Tables 2 and 3)	—
9. No hairs on protopodite	Hairs present behind endopodite
10. <i>h</i> and <i>i</i> seta of ♀ and ♂ second antenna spineless	Spines near base
11. <i>f</i> seta of ♂ second antenna slightly longer than <i>h-j</i> setae (Table 2)	Much longer than <i>h-j</i> setae
12. Ventral surface of mandibular basale lacks hairs	Carries fine hairs
13. Only one marginal seta on inside of first mandibular exopodite segment	3 additional smaller setae inside margin
14. 4 posterior setae on maxilla endopodite	6 setae
15. Labrum with small weak teeth	Teeth larger and stronger
16. Short distal seta on dorsal surface of first exopodite segment of fifth limb	This seta long, extending to final segment
17. ♀ sixth limb with long flexible <i>a</i> seta, claw-like <i>b</i> seta and very short <i>c</i> seta	All 3 setae are claw-like and <i>a</i> seta is shortest

gaussi group

gaussi group Skogsberg, 1920 : 676, 677.

Gaussicia Poulsen, 1973 : 103, 104 (in part).

DIAGNOSIS. Both valves with median glands ; asymmetric glands are in usual place. Male first antenna with *a* seta reaching to base of limb (*C. incisa*) or to end of first segment (*C. gaussi*) ; *c* seta is short, flat and widened with short continuation above horizontal basal stalk ; armature of *b*, *d* and *e* setae is as in *edentata* group. Dorsal seta of female first antenna is long, *a*–*d* setae are short. Male second antenna has blunt ended (*C. incisa*) or narrow and tapering (*C. gaussi*) *f* seta, and *g* seta is blunt ended (*C. incisa*) or slightly widened and then tapered distally (*C. gaussi*). Maxilla bears six anterior setae. Labrum with numerous large teeth. Female sixth limb carries three terminal claw setae.

REMARKS. The *gaussi* group is restricted in this paper to *C. gaussi* and *C. incisa*, the two species originally included by Skogsberg (1920). This group is probably related to the *bispinosa* group to which Müller (1906, 1908) assigned *C. incisa* and *C. gaussi*. These species, particularly *C. gaussi*, resemble typical members of the *bispinosa* group (i.e. *C. bispinosa* Claus, 1890, *C. secernenda* Vávra, 1906, *C. haddoni* Brady & Norman, 1896 and *C. striola* Müller, 1906 as redescribed by Angel, 1970 and Poulsen, 1973) in a number of the characters which were used in Table 5 to distinguish them from the *edentata* group. The main points of similarity are the short *a*–*d* setae and long dorsal seta of the female first antenna, the short hairs behind the endopodite on the female second antenna, the development of spines in both sexes near the bases of the *h* and *i* setae of the second antennae, the four setae on the inside of the first mandibular exopodite segment and the ventral hairs on the basale of this limb, the six anterior setae of the first endopodite segment of the maxilla, the rounded notch and well-developed teeth of the labrum, the long distal dorsal seta on the first exopodite segment of the fifth limb and the three stiff claw setae on the final segment of the female sixth limb. In addition, *C. gaussi* was described by Müller (1908) as having several enlarged gland cells near the middle of the posterior margin resembling the gland cells which he regarded as typifying the *bispinosa* group. These cells were also observed by Skogsberg (1920) in *C. gaussi* but were not visible in any *Discovery* specimens. Angel (1968b) reported that glands in this region release a bioluminescent secretion in *C. secernenda* and *C. bispinosa*.

The *gaussi* group is distinguished from the *bispinosa* group by the presence of the ventral gland, the absence of the *c* seta and the distally widened *g* seta (thin and tapered in *bispinosa* group) on the female second antenna, the shorter *c* seta of the male second antenna and the *g* seta of this limb which is tapered in the *bispinosa* group but square ended in *C. incisa* and in *C. gaussi* is widened distally before tapering and finally the absence of a terminal spine on the hook appendages (see Skogsberg, 1920 and Granata & di Caporiacco, 1949 : 12, 13). Also the *c* seta of the male first antenna is flattened and widened and extends dorsally above the basal stalk in the *gaussi* group ; this seems to be a unique feature.

Conchoecia incisa Müller, 1906

(Figs 10-14)

Conchoecia incisa Müller, 1906: 94, pl. 19, figs 1-11; Müller, 1912: 80; Angel, 1969: 541; Poulsen, 1969: 163, 164; Deevey, 1974: 368, 369.
Conchoecia gaussi? (Müller) Angel, 1968a: 308 (*non* Müller, 1908).

DIAGNOSIS. Species of *gaussi* group characterized by carapace length (σ 1.822-1.911 mm, mean 1.877 ± 0.030 mm; ϕ 2.462-2.837 mm, mean 2.644 ± 0.024 mm) and tapering lateral outline of female; male frontal organ long and slender with long hairs, *a* seta of σ first antenna has lateral lobes near base and *e* seta bears 25-33 pairs of spines; *f* and *g* setae of σ second antennae are square ended; cutting edge of mandibular coxale lacks teeth.

MATERIAL. One hundred and twenty-four specimens comprising 31 females, 8 males and 85 juveniles. Dissected male and female specimens, stained with lignin pink and mounted on slides in Euparal, are deposited in the British Museum (Natural History) reg. nos 1974.751 and 752.

DESCRIPTION OF MALE. Carapace (Fig. 11). The carapace lengths of eight specimens range from 1.822 mm to 1.911 mm with a mean value of 1.877 ± 0.030 mm (Fig. 10). In lateral view the posterior margin is gently curved and joins the ventral margin at a slightly truncated posteroventral corner. The ventral margin is almost straight and converges only slightly with the dorsal margin anteriorly. In ventral view, the carapace outline does not curve evenly towards the posterior end but is chisel shaped, the sides of the carapace in the posterior $\frac{1}{3}$ or so being straight or even slightly concave. There is no surface ornamentation. The right asymmetric gland opens above $\frac{1}{3}$ of the maximum carapace height. The median ventral gland is fairly well developed.

Frontal organ (Fig. 12D). The shaft extends beyond the first antenna, and the capitulum is about $\frac{2}{3}$ the length of the shaft. The capitulum is narrow, elongate and often curves slightly forwards; the distal $\frac{1}{4}$ is rather expanded and the end is asymmetrically rounded. The proximal $\frac{2}{3}$ of the capitulum bears long, fine hairs mainly ventrally.

First antenna (Figs 12A-C). The first segment is slightly longer than the second and the limb lacks armature. The *a* seta is rather less than twice the length of the

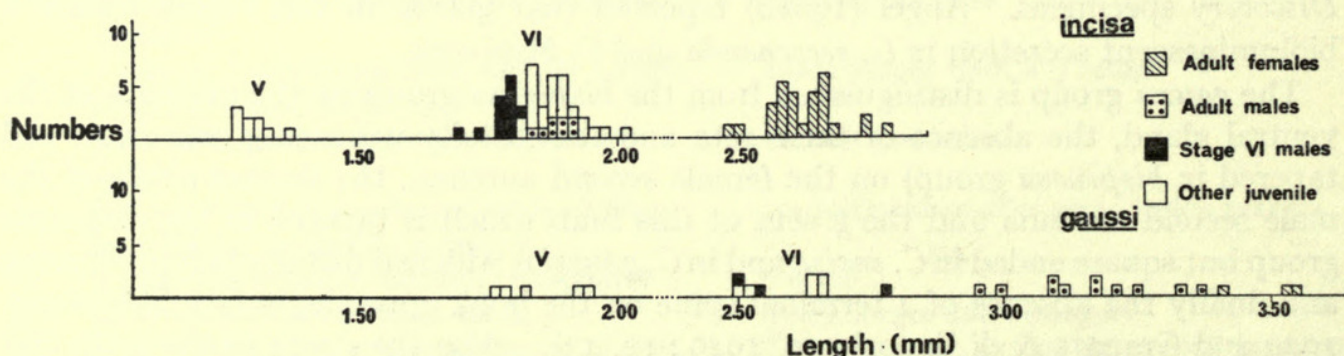


FIG. 10. Histograms showing carapace lengths of the adults and last two juvenile instars of *Conchoecia incisa* and *Conchoecia gaussi*.

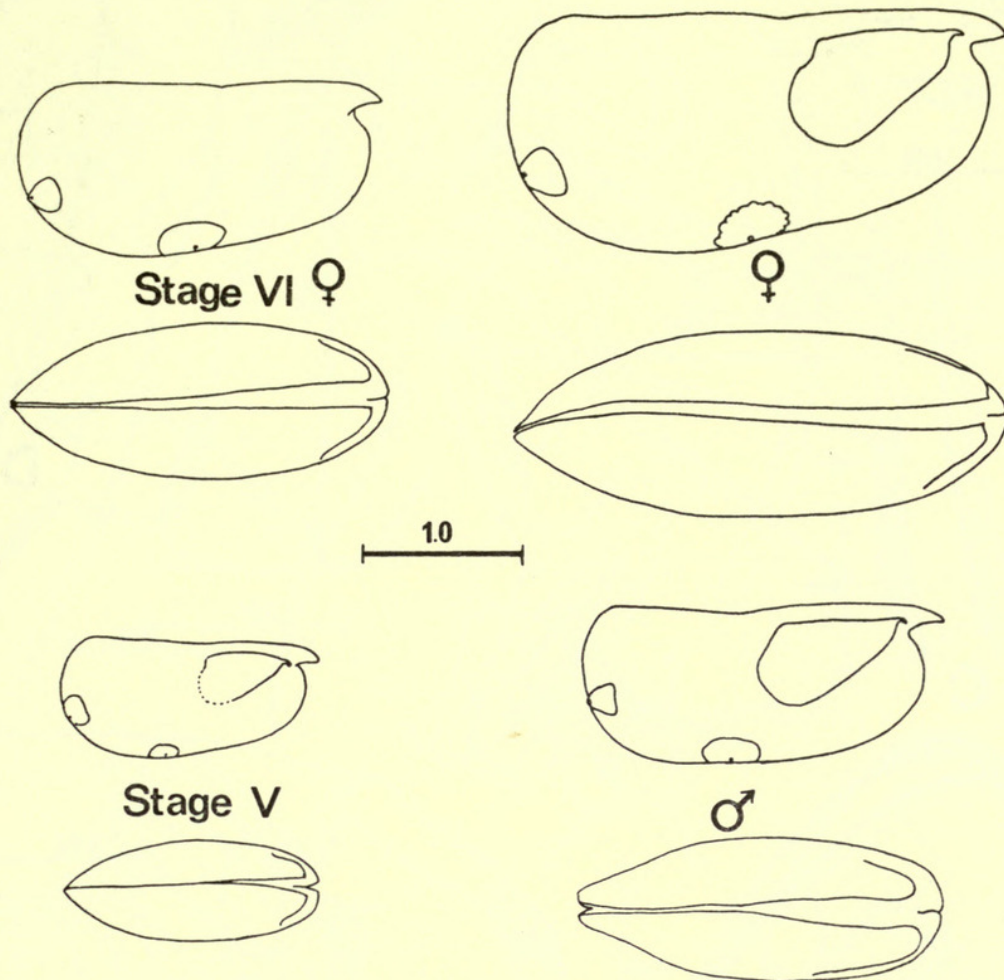


FIG. 11. *Conchoecia incisa*. Lateral and ventral carapace outlines of adults and last two juvenile instars.

limb ; proximally it loops down and up and then lies parallel to the antenna. Near its base, the *a* seta is expanded and bears side lobes, usually three dorsal and one lateral. The *b*, *d* and *e* setae are thin walled distal of their main armature. The *b* seta is rather longer than the *d* seta and carries a number of anterior spines, 4-6 are widely spaced and 7-13 closely spaced and adjacent to an elongate narrow pad ; on the thin-walled part of the seta below the pad are 8-10 smaller, closely spaced pairs of spines followed by up to 36 minute spines, usually on the anterior side. The *c* seta is short and wide with a basal horizontal stalk above which is a short dorsal continuation. The *d* seta carries 4-18 small spines usually on each side. The main *e* seta armature comprises 25-33 paired posterior spines and there may also be a few small anterior spines above the main armature.

Second antenna (Figs 12E-H). The limb has no additional armature. The processus mammillaris is conical with a terminal tubercle. The swimming setae are distally thin walled and flaccid. The *b* seta is rather more than $\frac{1}{2}$ the length of the *a* seta, the *c* seta is the same length or rather shorter than the *b* seta and the *d* seta is just under $\frac{1}{2}$ the length of the *c* seta. There are a few short hairs on the *a* and *b* setae. The *f* and *g* setae are thin walled for approximately their distal $\frac{1}{3}$ and have blunt ends, often with a filament. Both setae are bare or have 1-2 small median

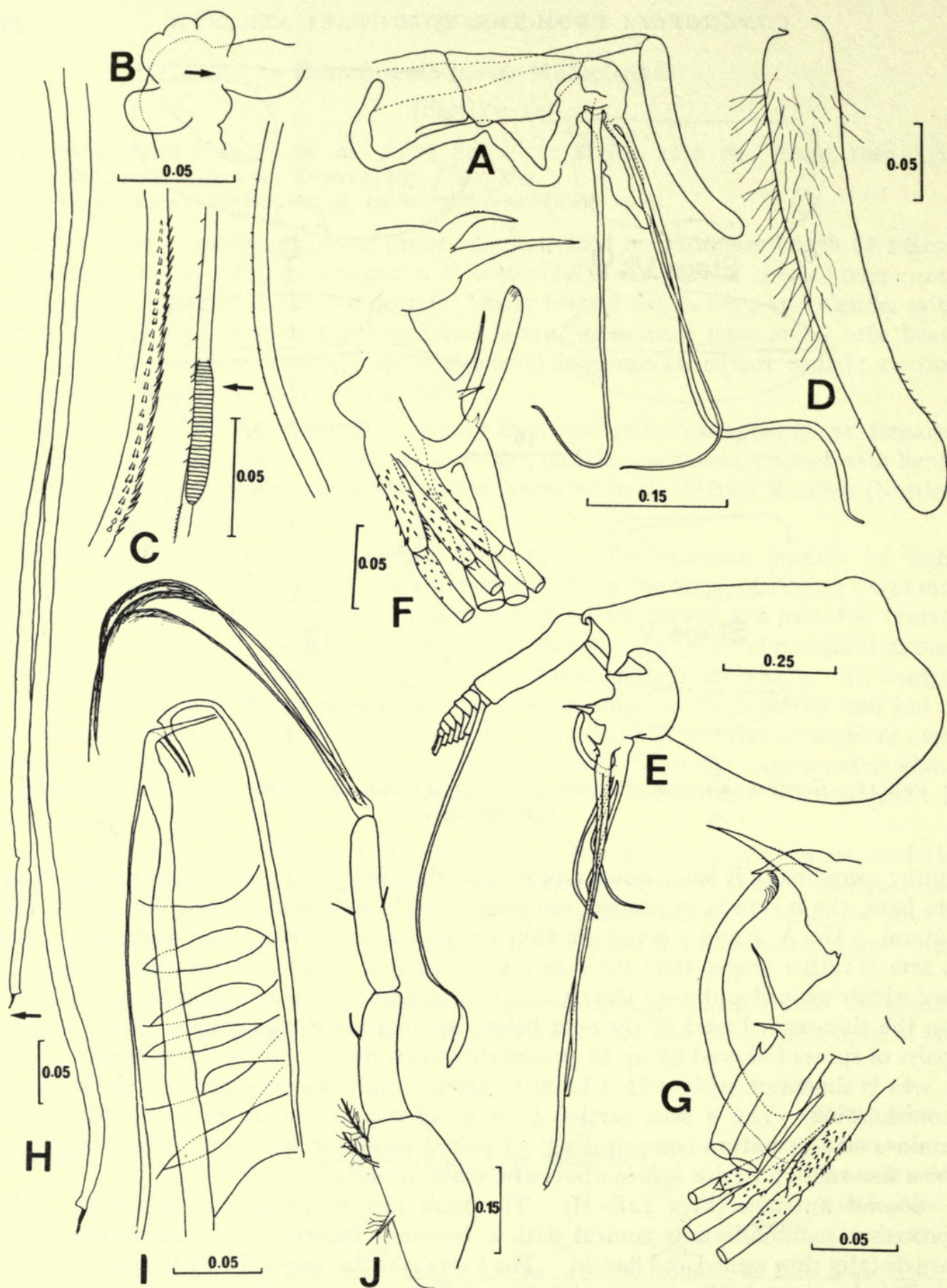


FIG. 12. Male dimorphic parts of *Conchoecia incisa*; arrows indicate anterior. (A) First antenna and frontal organ. (B) Proximal part of *a* seta of first antenna showing lateral lobes. (C) Main armature of (from left to right) *e*, *b* and *d* setae of first antenna. (D) Capitulum of frontal organ. (E) Second antenna. (F) Second and third segments of endopodite of left second antenna. (G) Second and third segments of endopodite of right second antenna. (H) *f* and *g* setae of second antenna. (I) Penis. (J) Sixth limb.

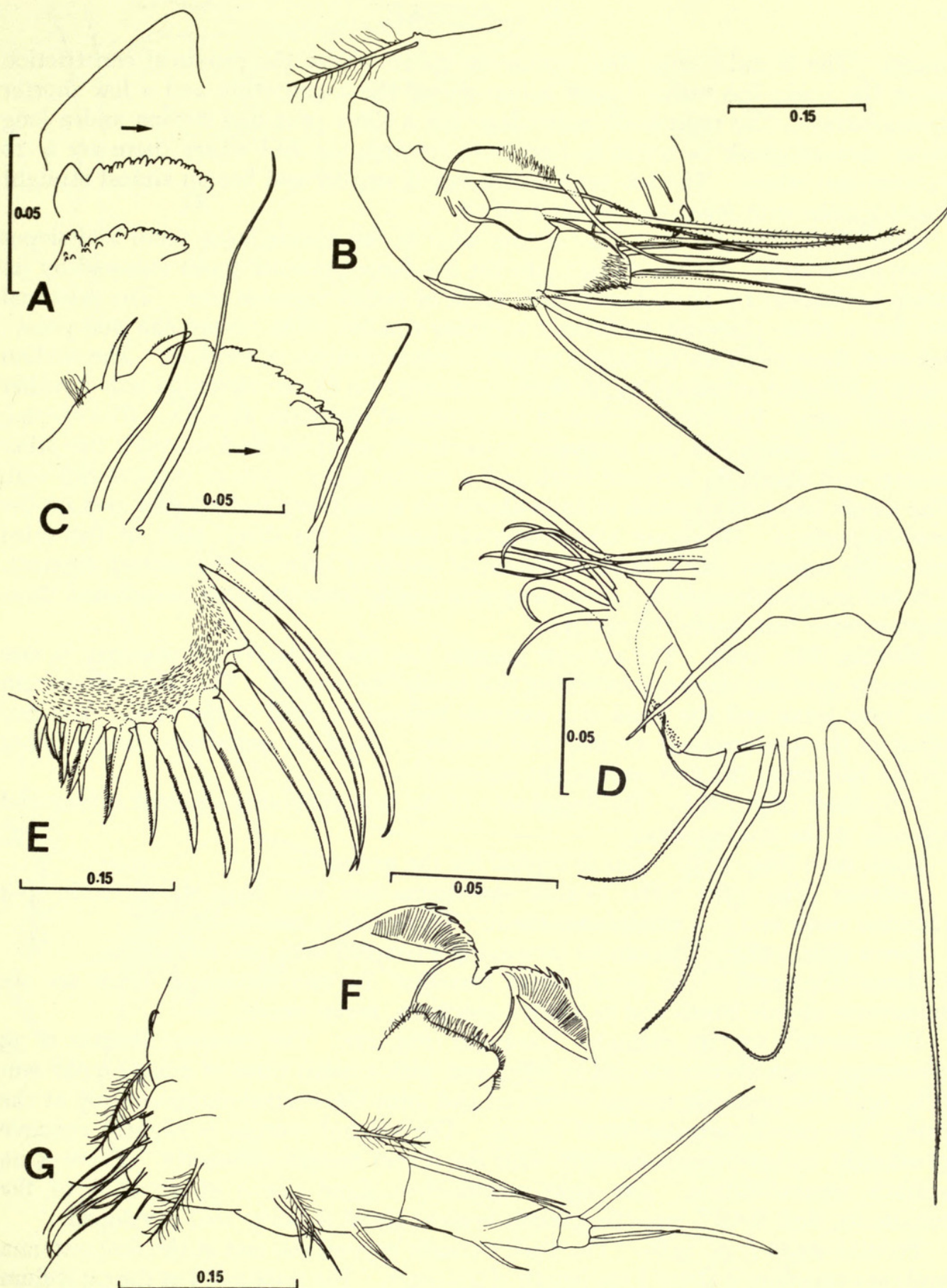


FIG. 13. Non-dimorphic parts of *Conchoecia incisa*; arrows indicate anterior. (A) From top to bottom, cutting edge, distal and proximal tooth lists of mandibular coxale. (B) Basale, endopodite and exopodite of mandible. (C) Cutting edge and adjacent setae of mandibular basale. (D) Maxilla. (E) Caudal furca. (F) Labrum. (G) Fifth limb.

spines. The *h* and *i* setae bear numerous spines above the proximal constriction while the *j* seta has rather longer spines above the constriction and a few shorter spines below. The right hook appendage has a short proximal section and a long distal section which increases in curvature towards the end where there are 9–10 subterminal ridges. The left hook appendage is smaller and has an almost straight distal section with fewer subterminal ridges.

Mandible (Figs 13A–C). The cutting edge of the coxale lacks teeth and slopes down posteriorly. On the distal tooth list is a large posterior tooth followed by (in three specimens) 17, 19 and 22 smaller teeth of rather variable size. The proximal list has a large posterior tooth and a rather smaller tooth before the mid-point; between these teeth the list slopes up and is either straight or toothed. The median tooth is followed anteriorly by (in three specimens) 12, 15 and 18 small teeth of rather variable sizes. The inner surface of the proximal list bears papillae. The cutting edge of the basale has two posterior spine teeth, one long and pointed, the other shorter and blunt, six serrated teeth and a conical inner tooth at the anterior end. The basale has a small patch of hairs above the spine teeth and a larger area on the ventral surface. There are also numerous hairs on the distal part of the third exopodite segment and a small distoventral patch of hairs on the second segment. The first exopodite segment has one long seta arising from the inner margin and three shorter setae just inside the margin.

Maxilla (Fig. 13D). The anterior margin has five setae, which decrease in size ventrally, and one shorter seta arising just inside the margin. The posterior margin has three setae and the basal seta extends beyond the end of the limb. The five setae on the final segment are long and slender. There are numerous minute spines on the bottom of the first endopodite segment.

Fifth limb (Fig. 13G). The dorsal seta of the first exopodite segment is long and extends to the final segment.

Sixth limb (Fig. 12J). This is typical for the genus.

Labrum (Fig. 13F). The hyaline membrane has four large outer teeth, 3–4 rounded teeth and 3–4 small inner teeth. The notch is rounded.

Furca (Fig. 13E). The caudal lamellae are covered with fine hairs.

Penis (Fig. 12I). The penis tapers distally. In two specimens there are six transverse muscle bands and in a third specimen, seven bands.

DESCRIPTION OF THE FEMALE. Carapace (Fig. 11). The carapace lengths of 39 specimens range from 2.462 mm to 2.837 mm with a mean value of 2.624 ± 0.062 mm (Fig. 9). The posterior margin is curved and joins the ventral margin evenly at the rather truncated posteroventral corner. The ventral margin is slightly concave or straight and converges strongly with the dorsal margin anteriorly. There is no surface ornamentation. The right asymmetric gland opens at about $\frac{1}{3}$ of the maximum shell height and the median ventral gland is fairly well developed.

Frontal organ (Fig. 14B). The shaft extends beyond the end of the first antenna and the capitulum is about $\frac{3}{4}$ the length of the shaft. The proximal $\frac{3}{4}$ of the capitulum is parallel-sided or very slightly tapered, the distal part is slightly expanded and the end is asymmetrically rounded. There are prominent ventral spines on the proximal $\frac{3}{4}$ of the capitulum and a few similar proximal spines dorsally.

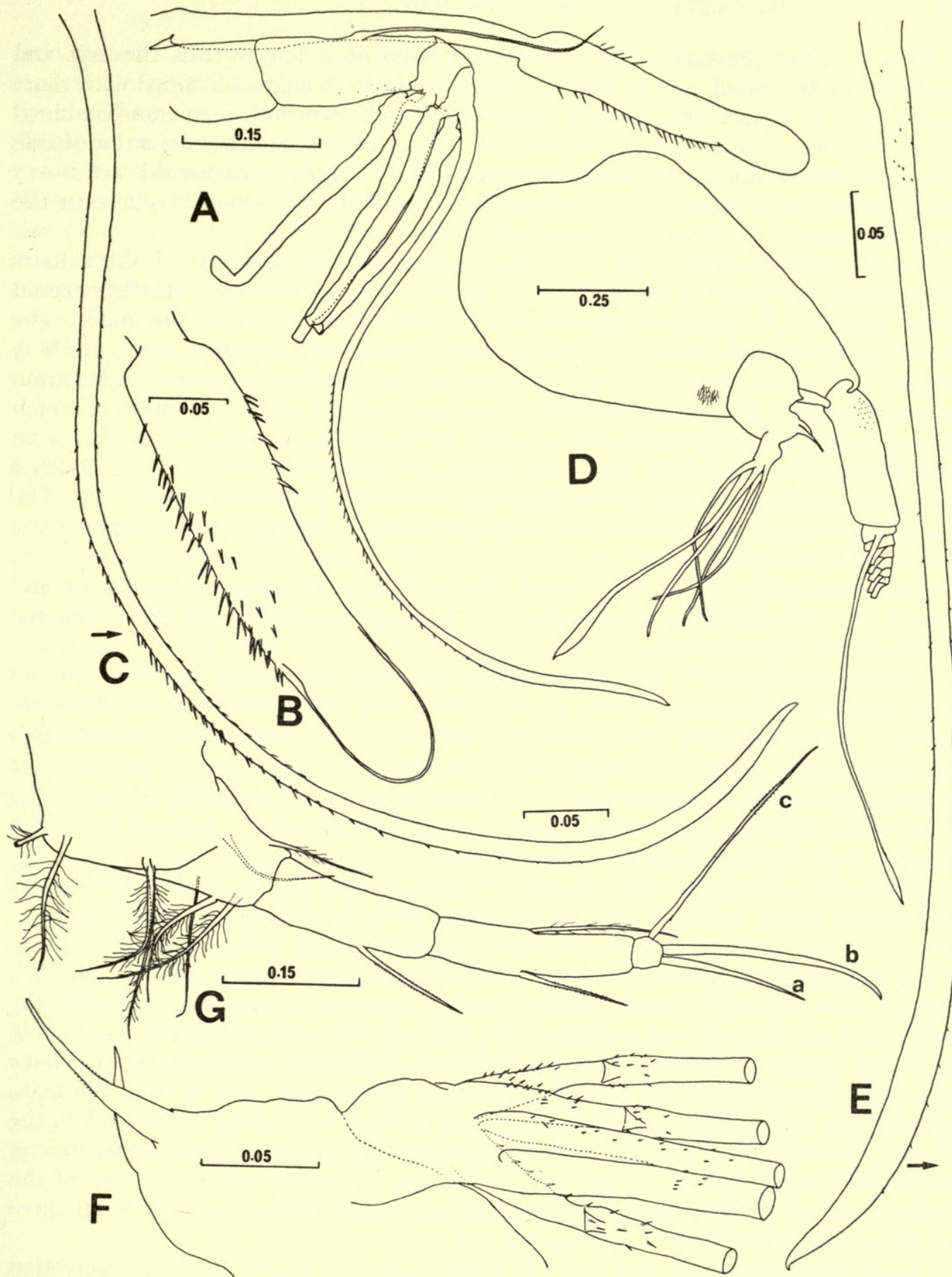


FIG. 14. Female dimorphic parts of *Conchoecia incisa*; arrows indicate anterior. (A) First antenna and frontal organ. (B) Capitulum of frontal organ. (C) *e* seta of first antenna. (D) Second antenna. (E) *g* seta of second antenna. (F) Second and third segments of endopodite of left second antenna. (G) Sixth limb.

First antenna (Figs 14A, C). The second segment is longer than the first and both have a few small ventral spines. The dorsal seta is long and armed with short hairs. The *a-d* setae are about as long as the first two limb segments combined while the *e* seta is just under three times the length of *a-d* setae and its anterior side bears 20-39 (usually 24-30) small, flat-lying hairs. On the posterior side are 16-17 small hairs, 30-35 stout spines, mostly in pairs, and 7-11 smaller spines on the distal flattened and slightly widened part of the *e* seta.

Second antenna (Figs 14D-F). The protopodite has a patch of short hairs behind the endopodite and the first exopodite segment has some small proximal outer spines. The processus mammillaris, *a* and *b* setae are as for the male. The *f* seta is rather longer than the *h-j* setae, with a number of proximal spines and 1-5 median and distal anterior spines. Proximally, the *g* seta also has a concentration of small spines. On the anterior side, these are followed by 15-19 spines of which 5-9 are on the distal flattened and widened part of the seta; the posterior side bears 7-9 similar spines of which only 1-2, if any, are on the flattened section. Both *h* and *i* setae have numerous spines above and below the proximal constriction. The *j* seta has rather longer spines, 7-8 arising from slight 'bumps' on the inside of the seta, above the constriction.

Sixth limb (Fig. 14G). The three setae on the final segment are slender and claw-like. The dorsal *c* seta is longer than the *b* seta and rather less than twice the length of the ventral *a* seta.

JUVENILES (Fig. 11). Nine Stage V juveniles range from 1.280 mm to 1.379 mm with a mean length of 1.308 ± 0.031 mm. Male and female Stage VI juveniles are readily distinguishable; the males are shorter (1.694-1.812 mm, mean length 1.773 ± 0.03 mm in 13 specimens) than the females (1.793-2.009 mm, mean of 1.878 ± 0.05 mm in 25 specimens). The males only increase slightly in size at the final moult while the size increase is much greater for females. Juvenile and adult lengths of *C. incisa* are summarized in Fig. 10.

REMARKS. This form differs somewhat from Müller's (1906) original description of *C. incisa* which was based on two specimens from the Indian Ocean. (i) Müller's male is larger (2.15 mm) than the North Atlantic males (1.822-1.911 mm, mean 1.877 mm) and the carapace has a much more tapered lateral outline (Müller: pl. XIV, fig. 1). On the other hand, Müller's female specimen compares well with the Atlantic form in size and outline. (ii) The original male specimen has 'wenig auffallige' surface striations although the female shell lacks ornamentation (Müller: 94). (iii) The *a* seta of the male first antenna extends only just beyond the main joint of the limb (Müller: pl. XIX, fig. 4) but at least to the base of the limb in the North Atlantic form. (iv) The *e* seta of the female first antenna seems rather shorter in Müller's female (pl. XIX, fig. 3). (v) On the second antenna, only two of the 'tube setae' (*h-j*) have basal spines in Müller's female (Müller: 94) while all three of these setae are spinose in *Discovery* females.

Apart from points (iv) and (v), which are relatively minor, Müller's description and figures of his female specimen agree well with the *Discovery* females particularly in carapace length, outline and lack of surface ornamentation. The differences between Müller's male from the Indian Ocean and the North Atlantic males are more

pronounced. The degree to which the two forms differ in carapace length and outline is particularly significant and this possibly warrants a taxonomic distinction between them. They are not separated here because females from the North Atlantic closely resemble Müller's female.

Another possibility is that while the females in the *Discovery* material belong to *C. incisa*, the males are of a distinct species. This would explain the considerable size difference between the two sexes. However, it is unlikely because (i) the non-dimorphic characters of males and females are closely similar and (ii) in such a comprehensive series of samples, it is improbable that of two sympatric species, one would be represented by males alone and the other by females. The conspecificity of Müller's male with his female and with the *Discovery* material should however be regarded as somewhat questionable.

Poulsen's (1969a : 163, 164) brief description of three females of *C. incisa* from the Atlantic near the equator agrees well with *Discovery* females although his later (1973) account of this species from the Pacific, Indian and Atlantic Oceans differs in a few respects. The proximal and distal tooth lists of the mandibular coxale both have a large anterior tooth which is absent from *Discovery* specimens and the structure of the labrum is rather different. These are probably only intraspecific variations. Deevey (1974 : 368) records a single female from just south of the equator in the Atlantic ; this specimen is only just shorter than the *Discovery* females.

The juveniles and females of *C. incisa* reported by Angel (1969 : 541) are included in my material. Angel (1968a : 308) earlier tentatively identified two juveniles caught above and within the thermocline at 34°N off Morocco as *C. gaussi*. On re-examination, these proved to be Stage V juveniles of *C. incisa*.

GEOGRAPHICAL DISTRIBUTION. Müller (1906, 1912), 1♀, 1♂, Indian Ocean, 0° and 26°S ; Angel (1968a : 308), North Atlantic, 34°N, 2 juveniles ; Angel (1969 : 541), 23♀ and juveniles, North Atlantic off Canaries, 28°N ; Poulsen (1969 : 163, 164), 3♀, Atlantic, just south of equator, about 2500 m ; Poulsen (1973), 103♀, Pacific, about 32° to 9°S, Indonesian Seas, about 4° to about 23°N, Indian Ocean, about 24° to about 3°N, Atlantic, about 4° to about 38°N, most common at 1000–2500 m ; Deevey (1974 : 368), 1♀, Atlantic Ocean, 3°40'S, 30°W, 200–0 m.

In the Northeast Atlantic this species was found at the following stations ; the number of specimens at each station is given in parentheses : Station 7709, 60°N, 20°W (2) ; Station 7406, 40°N, 20°W (3) ; Stations 8263 (2) and 8270 (1), both 32°N, 27°W ; Stations 7803 (1), 7856 (37), both 30°N, 23°W ; Stations 5814 (7), 5816 (1), 5818 (9), 5819 (2), 5825 (5), 6155 (12), 6156 (10), 6164 (14), 6176 (8), 6183 (1), 6193 (1) all 28°N, 14°W ; Station 7089, 18°N, 25½°W (10). The depth distribution at different latitudes is summarized in Fig. 21.

Conchoecia gaussi Müller 1908

(Figs 10, 15–18)

Conchoecia gaussi Müller, 1908 : 71, 72, pl. IX, figs 14–16, pl. X, figs 9–12 ; Müller, 1912 : 80 ; Skogsberg, 1920 : 677–681, figs CXXIX 1–11 ; Poulsen, 1969 : 164 ; Poulsen, 1973 : 106, 107, fig. 52 ; Deevey, 1974 : 369.

Non Conchoecia gaussi ? (Müller) Angel, 1968a : 308 (= *C. incisa*).

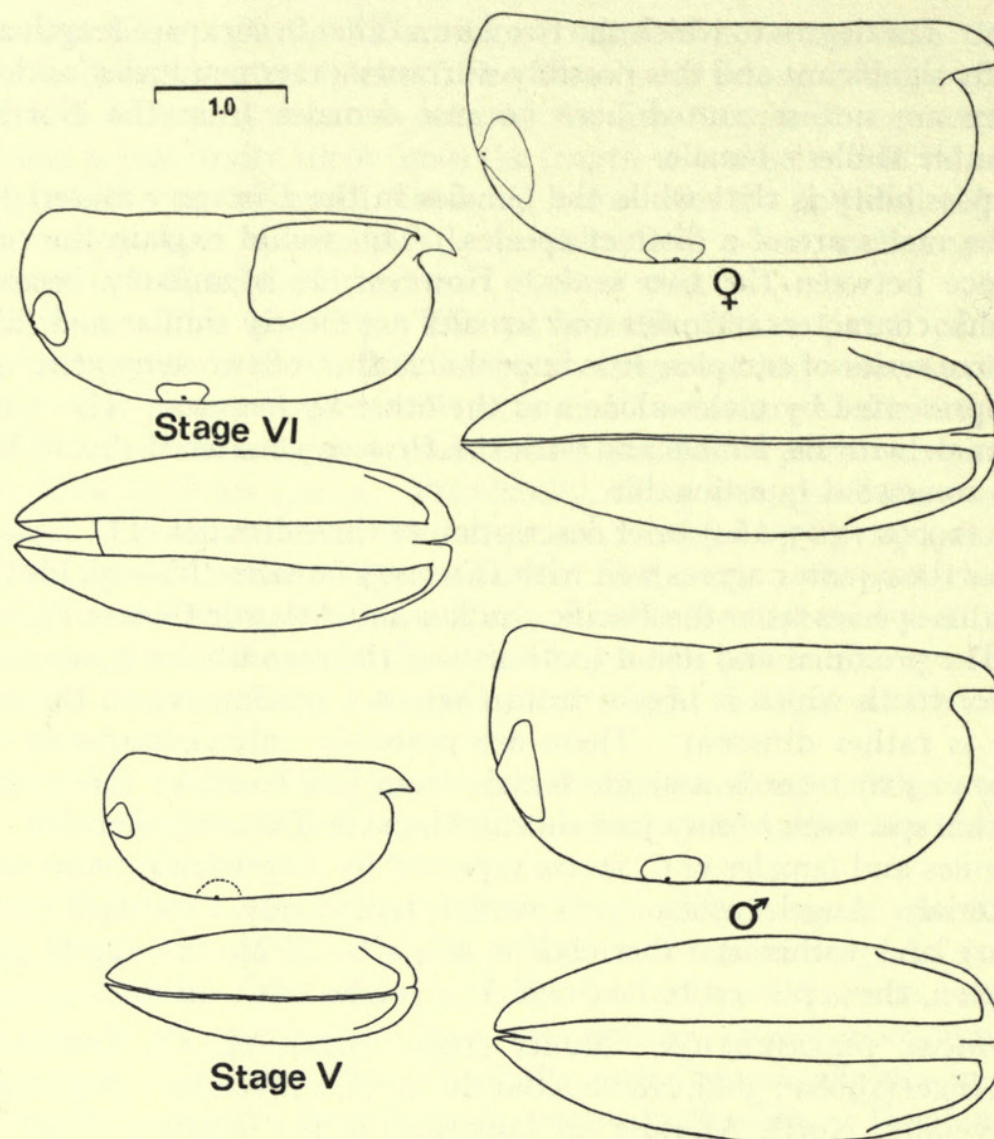


FIG. 15. *Conchoecia gaussi*. Lateral and ventral carapace outlines of adults and final two juvenile instars.

DIAGNOSIS. Species of *gaussi* group characterized by large size (δ 2.955–3.329 mm, mean 3.138 ± 0.101 mm; η 3.369–3.546 mm, mean 3.462 mm) and subrectangular lateral outline with truncated posteroventral corner; *a* seta of δ first antenna is shorter than limb, *b* and *d* setae are only slighter shorter than *e* seta which bears 44–49 paired spines; on δ second antenna, *f* and *g* setae both taper to whip-like extremities and *f* seta is only slightly shorter than *g* seta.

MATERIAL. Forty-one specimens, comprising 5 females, 12 males and 24 juveniles. Dissected male and female specimens, stained with lignin pink and mounted on slides in Euparal, are deposited in the British Museum (Natural History) reg. nos 1974.753 and 754.

DESCRIPTION OF MALE. Carapace (Fig. 15). The carapace lengths of 10 specimens range from 2.955 to 3.329 mm with a mean value of 3.138 ± 0.107 mm (Fig. 10). In lateral view the carapace is subrectangular and the dorsal margin usually curves

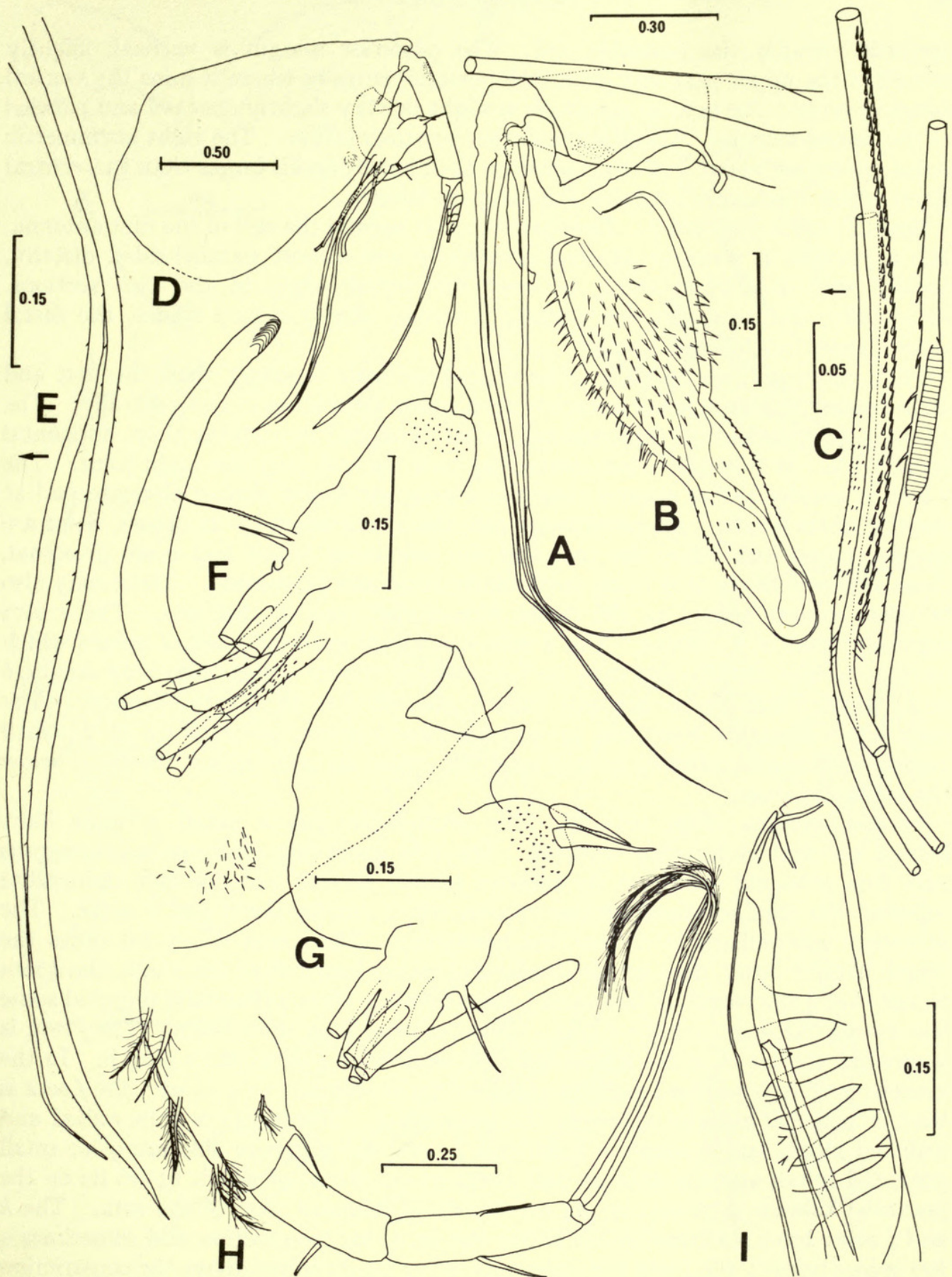


FIG. 16. Male dimorphic parts of *Conchoecia gaussi*; arrows indicate anterior. (A) First antenna. (B) Capitulum of frontal organ. (C) Main armature of (from left to right) *d*, *e* and *b* setae of first antenna. (D) Second antenna. (E) *f* and *g* setae of second antenna. (F) Second and third segments of endopodite of right second antenna. (G) Endopodite of left second antenna. (H) Sixth limb. (I) Penis.

upwards towards the posterior end. The posterior margin is vertical, slightly curved in the upper part and truncated posteroventrally where it joins the ventral margin evenly; the ventral margin is straight or very slightly concave and parallel to the dorsal margin. There is no surface ornamentation. The right asymmetric gland opens just about $\frac{1}{3}$ of the maximum shell height and is larger than the ventral gland which discharges behind $\frac{1}{2}$ the carapace length.

Frontal organ (Fig. 16B). The shaft extends beyond the end of the first antenna. The capitulum is strongly tapered proximally and almost parallel-sided distally, usually with a distinct angle between the dorsal edges of the two sections. Proximally, the capitulum has numerous strong closely spaced spines, the distal section bears much smaller spines.

First antenna (Figs 16A, C). The second segment is longer than the first and often carries numerous small anteroventral spines decreasing in size ventrally. The *a* seta is shorter than the limb and somewhat expanded beyond the short horizontal basal stalk. It S-bends before extending back to just past the main joint. The *b* seta is usually rather shorter than the *d* seta and has a narrow elongate pad at about $\frac{2}{3}$ of its length. On its anterior side the *b* seta bears 17–22 spines, 8–12 are closely spaced and below the pad and the remainder larger and more proximal, those adjacent to the pad being particularly large and prominent. There may also be some minute spines on the distal, thin-walled part of this seta. The *c* seta resembles that of *C. incisa*. The *d* seta has 15–20 anterior pairs of spines which increase in size distally and may be followed by minute spines like those on the *b* seta. Both *b* and *c* setae are only slightly shorter than the *e* seta (Table 2). The main *e* seta armature comprises 44–49 large paired spines, preceded by 14–23 small anterior spines and followed by 4–5 long stiff spines on both sides of the bend below the main armature.

Second antenna (Figs 16D–G). The protopodite has a patch of large hairs behind the first endopodite segment. The first exopodite segment has numerous very fine proximal spines on its anterior (outer) surface and the first endopodite segment has similar spines on the process which carries the *a* and *b* setae. The processus mammillaris is narrow and triangular. The *a* seta is 1.5–1.6 times the length of the *b* seta; the *c* seta is slender and rather longer than the *a* seta, the *d* seta is just over $\frac{1}{3}$ the length of the *c* seta; the *e* seta is a short proximally directed spine less than $\frac{1}{2}$ the length of the *d* seta. The *a*–*c* setae bear short hairs. The *f* seta is somewhat shorter than the *g* seta and thin walled for $\frac{2}{3}$ or so of its length. In the median part it is widened slightly and then tapers distally to a point; the *f* seta is bare or has 1–2 anterior spines in the proximal $\frac{1}{3}$. The *g* seta is thin walled and widened into a lancet shape in the distal $\frac{1}{3}$. On the posterior side are 9–10 small proximal spines and the anterior side bears 33–38 spines of which 13–16 lie on the proximal tubular part and 20–24 on the distal widened part of the seta. The *h* and *i* setae have scattered spines above the proximal constriction and sometimes a few spines below; the *f* seta has numerous rather larger spines above the constriction and scattered spines beyond this point. The proximal section of the right hook appendage is more than $\frac{1}{2}$ the length of the gently curved distal section; the angle between the two sections is less than 90° and there are 8–9 subterminal ridges. The

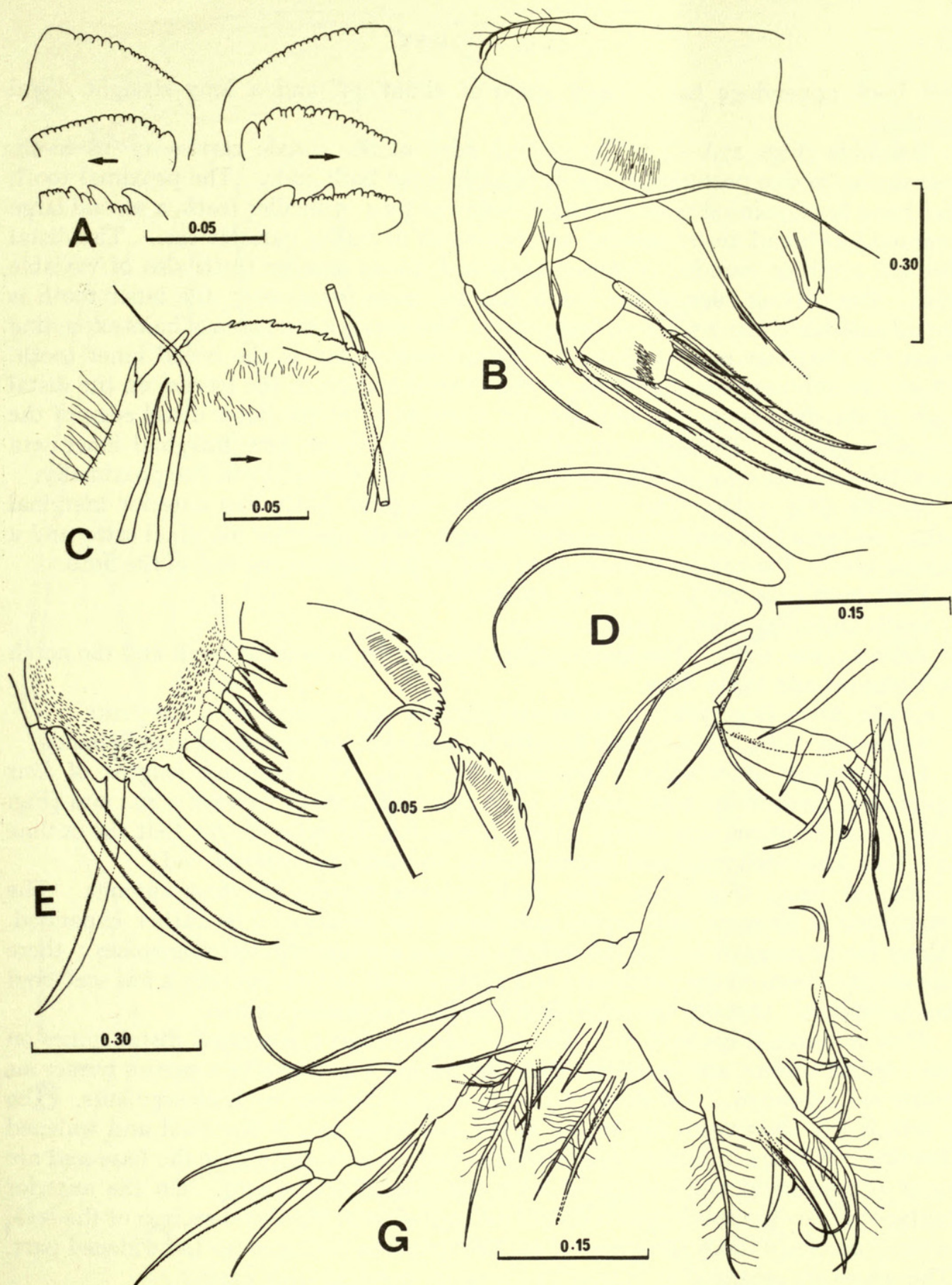


FIG. 17. Non-dimorphic parts of *Conchoecia gaussi*; arrows indicate anterior. (A) From top to bottom, cutting edges, distal and proximal tooth lists of two specimens. (B) Basale, endopodite and exopodite of mandible. (C) Cutting edge and adjacent setae of mandibular basale. (D) Maxilla. (E) Caudal furca. (F) Labrum. (G) Fifth limb.

left hook appendage has a basal angle of about 45° and a long straight distal section.

Mandible (Figs 17A-C). The cutting edge of the coxale carries 17-18 teeth, decreasing in size posteriorly, and is straight near both ends. The proximal tooth list has a large pointed posterior tooth, followed by 4-5 smaller teeth, a second large pointed tooth and 10-12 smaller anterior teeth of rather variable size. The distal list has a rather rounded posterior tooth and 19-21 smaller teeth also of variable size. The cutting edge of the basale has the usual structure; the inner tooth is broad and raised into a small central point. The basale has an area of hairs extending from the posterior margin above the spine teeth as far as the broad inner tooth. There are also numerous hairs above the ventral margin of the basale, on the distal part of the third exopodite segment and a few hairs on the outer distal edge of the second segment. The first exopodite segment bears one long marginal inner seta and three smaller setae arising inside the margin and decreasing in size proximally.

Maxilla (Fig. 17D). The first endopodite segment bears five anterior marginal setae, one seta just inside the anterior margin, three posterior marginal setae and a lateral seta. The basal seta extends to near or just beyond the end of the limb.

Fifth limb (Fig. 17G). As for *C. incisa*.

Sixth limb (Fig. 16H). As for genus.

Labrum (Fig. 17F). The hyaline plate bears 9-10 prominent teeth and the notch is V-shaped and fairly deep.

Caudal furca (Fig. 17E). The caudal lamellae are covered with fine hairs.

Penis (Fig. 16I). Slender and distally tapered with six transverse muscle bands.

DESCRIPTION OF FEMALE. Carapace (Fig. 15). The carapace lengths of four specimens range from 3.369 mm to 3.546 mm with a mean value of 3.462 mm (Fig. 10). Gland positions and lateral outline are as for the male except that the outline is rather more elongated and tapers slightly towards the anterior end.

Frontal organ (Fig. 18C). The shaft extends beyond the first antenna. The capitulum is elongate and tapers anteriorly, the proximal $\frac{1}{3}$ is rather expanded. Along the proximal $\frac{2}{3}$ to $\frac{3}{4}$ of the ventral surface are numerous strong spines; there are similar spines on the proximal $\frac{1}{4}$ to $\frac{1}{3}$ of the dorsal surface but only a few scattered lateral spines. Distally the capitulum bears much smaller spines.

First antenna (Figs 18A, B). The first segment has a few small distal spines on the ventral surface and is shorter than the second segment which carries numerous small ventral spines. The dorsal seta is as long as the first two limb segments. The *e* seta is less than twice the length of the *a-d* setae and is flattened and widened distally. It bears numerous spines which start on both sides near the base and are most concentrated and prominent near the middle of the seta. On the anterior surface are 80-100 spines which do not extend far onto the distal section of the seta, while posteriorly there are at least 130-140 spines extending onto the widened part. The spines are arranged in at least two rows for much of their extent.

Second antenna (Figs 18D-G). The *a* and *b* setae and the armature of the protopodite, the first exopodite and endopodite segments are as for the male. The *f* seta is rather more than $\frac{3}{4}$ the length of the *g* seta and bears fairly numerous basal anterior spines. The *g* seta has 7-10 rather larger basal, anterior spines followed by 28-40

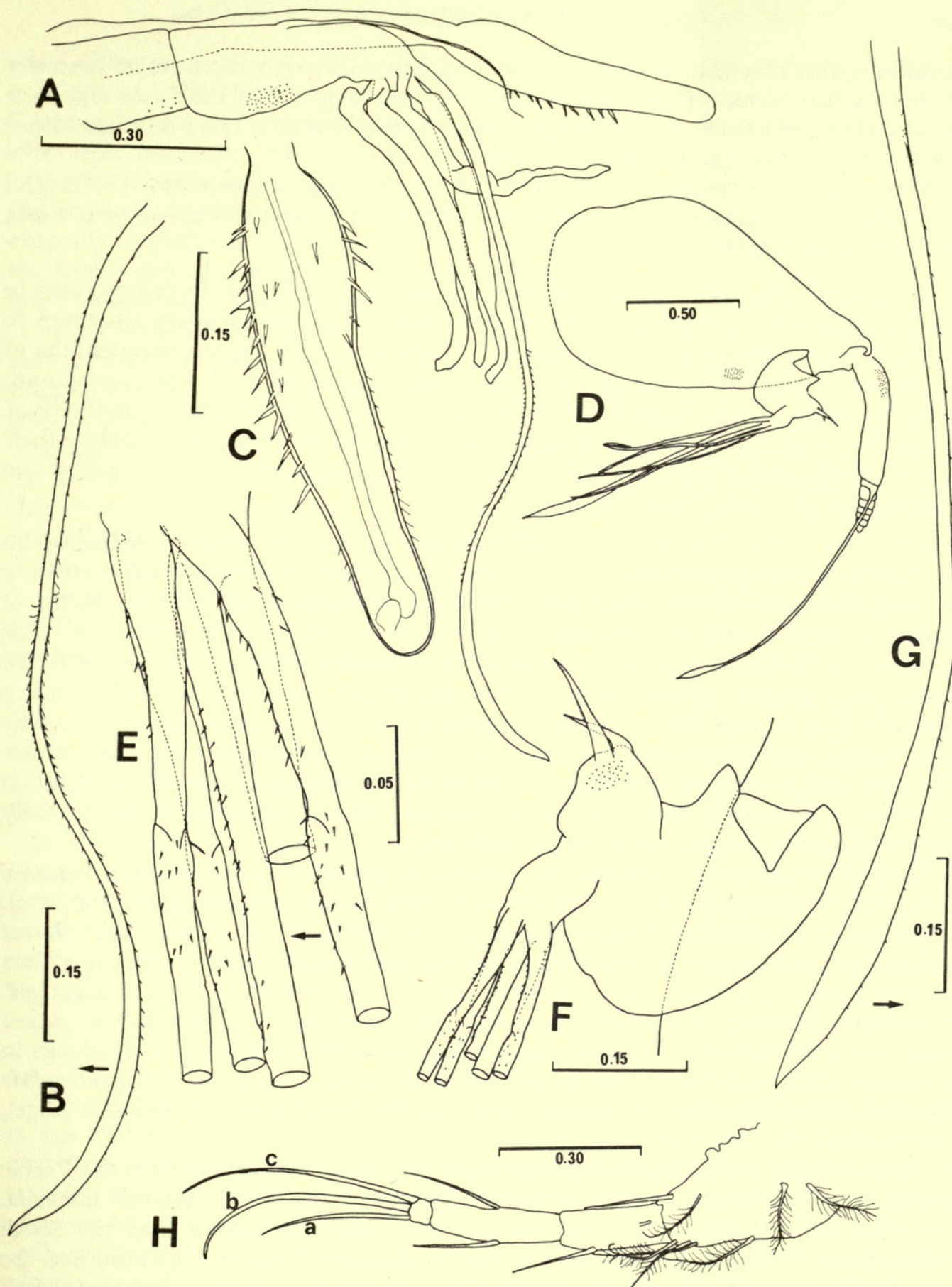


FIG. 18. Female dimorphic parts of *Conchoecia gaussi*; arrows indicate anterior. (A) First antenna and frontal organ. (B) *e* seta of first antenna. (C) Capitulum of frontal organ. (D) Second antenna. (E) Armature on proximal parts of *f-j* setae of second antenna. (F) Endopodite of right second antenna. (G) *g* seta of second antennae. (H) Sixth limb.

anterior spines of which 12–18 lie on the distal flattened part ; there are no posterior spines on the *g* seta. The *h* and *i* setae are rather longer than the *f* seta and have scattered spines above and below the proximal constriction. The *j* seta has rather more spines above and below the constriction.

Sixth limb (Fig. 18H). The three setae on the final segment are slender and claw-like. The dorsal *c* seta is slightly longer than the *b* seta and the ventral *a* seta is about $\frac{2}{3}$ the length of the *b* seta.

JUVENILES (Fig. 15). Five Stage V juveniles range in length from 1.753 mm to 1.931 mm (mean 1.836 mm). Seven female Stage VI instars measure 2.502 mm to 2.719 mm long (mean 2.620 mm) and three male Stage VI instars have lengths of 2.778 mm, 2.541 mm and 2.502 mm. The Stage V and VI instars of *C. gaussi* are thus the same size as Stage VI juvenile females and adult females respectively of *C. incisa*. However, juvenile instars of the two species can be distinguished by their characteristic and differing outlines. Adult and juvenile lengths for *C. gaussi* are summarized in a histogram (Fig. 10).

REMARKS. The *Discovery* material is closely similar to the male described by Müller (1908 : 71–72) and the female of Skogsberg (1920 : 677–681). There are only a few differences. (i) The posteroventral corner of Müller's specimen (pl. X, fig. 9) is less truncated and more rightangular than in North Atlantic males. (ii) The carapace of Müller's specimen bears dorsal and anterior striations. (iii) There are more teeth on the cutting edge of the mandibular coxa figured by Skogsberg (fig. CXXIX 6) and the teeth have a greater size range than in the *Discovery* specimens. (iv) Skogsberg noted that the joints of the female first antenna are 'smooth' and so presumably lack the small spines present in the North Atlantic material. These differences are minor and the *Discovery* material is undoubtedly conspecific with that of Müller and Skogsberg.

Rudiyakov (1962) has described the female of *C. gaussi curilensis*, a new subspecies from the Northwest Pacific, characterized mainly by its large size (4.08–4.18 mm). Two females reported by Poulsen (1969a : 164) from the South Atlantic are almost comparable in size (4.0 mm) to Rudiyakov's subspecies and Poulsen's male specimen is also larger (3.30 mm) than *Discovery* males. Size seems to be an important taxonomic character in halocyprids, so this large form may be a new species rather than just a subspecies. It is also conceivable (although unlikely) that it belongs to a second adult instar of *C. gaussi* similar to the large specimens of *Gigantocypris agassizi* Müller reported by Poulsen (1962 : 34 and Table 4, p. 54 ; see also Angel, 1970 : 164).

Poulsen (1973 : 106) described a male and two females of *C. gaussi* from the Pacific which agree well in size and other characteristics with the North Atlantic material. Recently Deevey (1974 : 369) has reported two female specimens from the South Atlantic one of which is comparable in size to *Discovery* females (3.45 mm) and the other rather larger (3.85 mm). As noted above the two juveniles of *C. gaussi* ? reported by Angel (1968a : 308) are juveniles of *C. incisa*.

Apart from its larger size and dissimilar carapace outline, *C. gaussi* differs from *C. incisa* as follows. (i) The capitulum of the male frontal organ is shorter, broader

and a different shape in *C. gaussi* and is armed with spines rather than long hairs as in *C. incisa*. (ii) The *a* seta of the male first antenna is shorter than the limb in *C. gaussi* but longer than the limb in *C. incisa* (Table 2), where it also bears lateral lobes near the base. (iii) The *b* and *d* setae of this limb are proportionally much longer in *C. gaussi* and are almost as long as the *e* seta (Table 2). (iv) The *e* seta of the female first antenna is proportionally longer in *C. gaussi* (Table 3). (v) The first exopodite segment of the male and female second antennae and the protopodite of the female second antenna are proportionally longer in *C. gaussi* (Tables 2 and 3). (vi) The swimming setae of the male second antenna are proportionally longer in *C. incisa* (Table 2) and the distal flattened part is thinner walled and more flaccid than that of *C. incisa*. (vii) In *C. gaussi* the *f* and *g* setae of this limb both taper to whip-like extremities while those of *C. incisa* are square-ended. Also the *g* seta is proportionally much shorter in *C. gaussi* and only slightly longer than the *f* seta. (viii) The *c* seta of this limb is more slender and proportionally longer in *C. gaussi*. (ix) The *h-j* setae of the male and female second antennae are proportionally much shorter in *C. incisa* (Table 2). (x) In *C. gaussi*, the cutting edge of the mandibular coxale is toothed, but in *C. incisa* it lacks teeth.

The Antarctic species *C. hettacra* Müller, 1906 is remarkably similar in outline to *C. gaussi*, particularly in the male. However, this species is smaller, the female has a rather more tapered outline and the prominent right asymmetric gland opens much further down, on the posteroventral corner.

GEOGRAPHICAL DISTRIBUTION. Müller (1908 : 72), 1♂, South Atlantic, 35°S, 2°E ; Skogsberg (1920 : 681), 1♀, South Atlantic 50°S, 50°W, 2700–0 m ; Poulsen (1969 : 164), 2♀, 1♂, Atlantic, 6°35'S (725 m) and 2°S (2500 m) ; Poulsen (1973 : 106), 1♂, 2♀, near New Guinea, about 9°S, off New Zealand, about 35°S ; Deevey (1974 : 369), 2♀, South Atlantic, 32°30'S, 750 m wire, 51°30'S, 3000 m wire.

In the Northeast Atlantic *C. gaussi* was found at the following stations ; the number of specimens at each station is given in parentheses : Station 7709, 60°N, 20°W (8) ; Station 7711, 53°N, 20°W (24) ; Stations 7482 (1), 7406 (4), both 40°N, 20°W ; Station 7856, 30°N, 23°W (2) ; Stations 7089, 18°N, 25°W (3) ; Station 6674, 11°N, 21½°W (1). The depth distribution at different latitudes is summarized in Fig. 22.

ECOLOGY

The vertical distributions of the four species described here at different latitudes in the Northeast Atlantic are shown in Figs 19–22. These sections include only data from stations where the top 2000 m of the water column was comprehensively sampled with the RMT 1+8. Angel & Fasham (1975) have analysed associations of ostracod species in this region.

Conchoecia subedentata sp. n. (Fig. 19) is a high-latitude species which is more abundant at the most northerly station sampled (60°N). It becomes steadily less common southwards and is very rare at 18°N and absent at 11°N. This species was caught mainly between 300 m and 900 m but was never present in the top 200 m and only occasionally taken below 100 m. There is a slight tendency for *C.*

subedentata sp. n. to live deeper further south. *C. aff. edentata* has a similar geographic distribution and is also commonest at 60°N, although there is a secondary peak of abundance at 18°N (Fig. 20). This species was usually caught at greater depths than *C. subedentata* sp. n. It was never present above 400 m and occurred most frequently below 800 m. In neither species of the *edentata* group is there any evidence for diurnal vertical migrations.

The two species of the *gaussi* group tend to occur further south; *C. gaussi* is most abundant at 53°N, and *C. incisa* at 30°N (Figs 21, 22). The vertical distribution of *C. incisa* is rather anomalous. Males are rare and none was caught above 1250 m. The females and juveniles tend to be rather shallower (below 800 m) but may sometimes be taken quite near the surface. This was particularly true at 28°N where

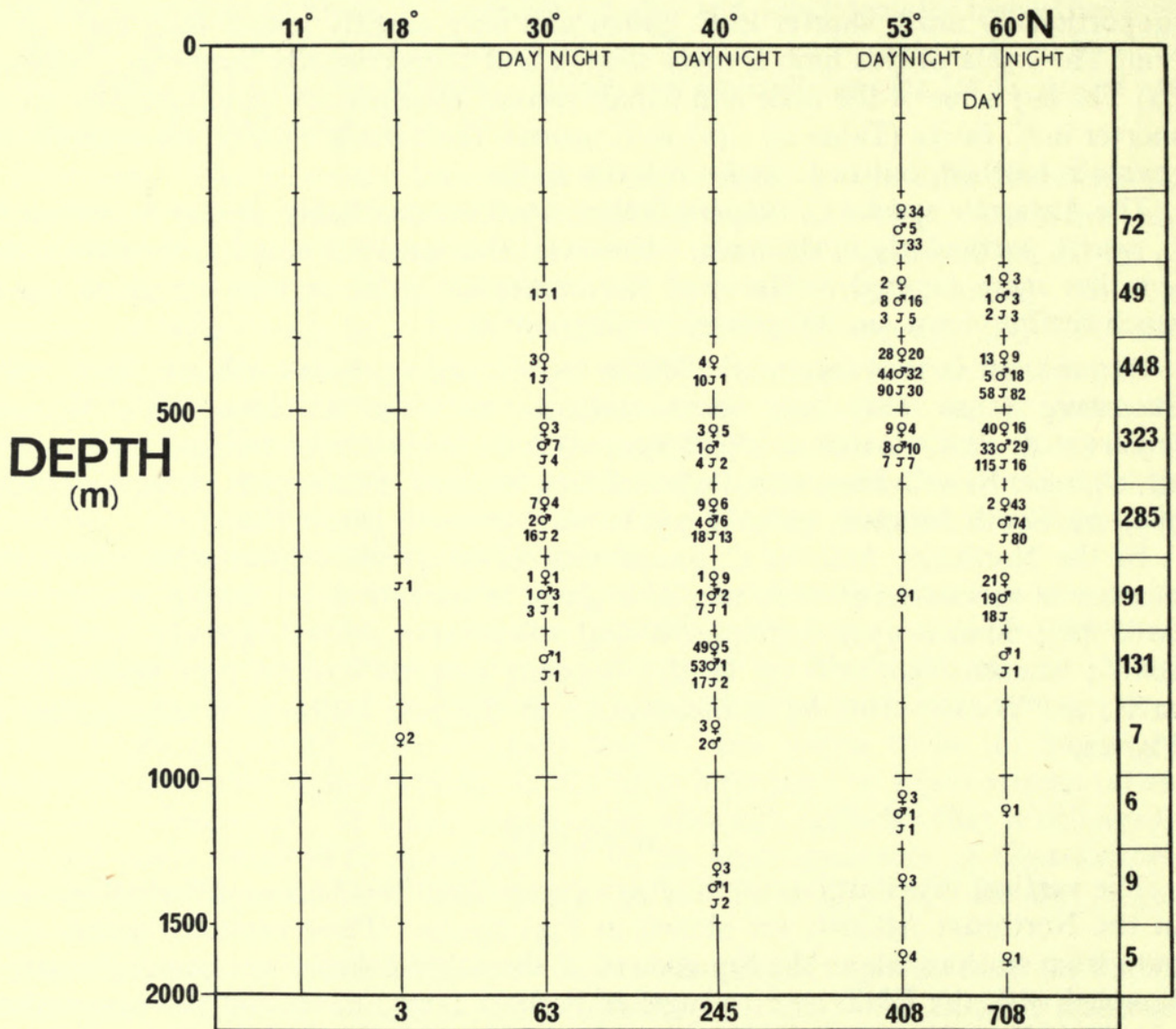


FIG. 19. *Conchoecia subedentata* sp. n. Depth distribution at various latitudes in the Northeast Atlantic Ocean. The number of males, females and juveniles caught with the RMT 1 + 8 during day and night in 100 m horizons down to 1000 m and wider horizons between 1000 m and 2000 m are shown. The figures along the bottom of the diagram are the total numbers of specimens occurring at each latitude and the figures in the right-hand column give the total numbers of specimens caught in each depth horizon.

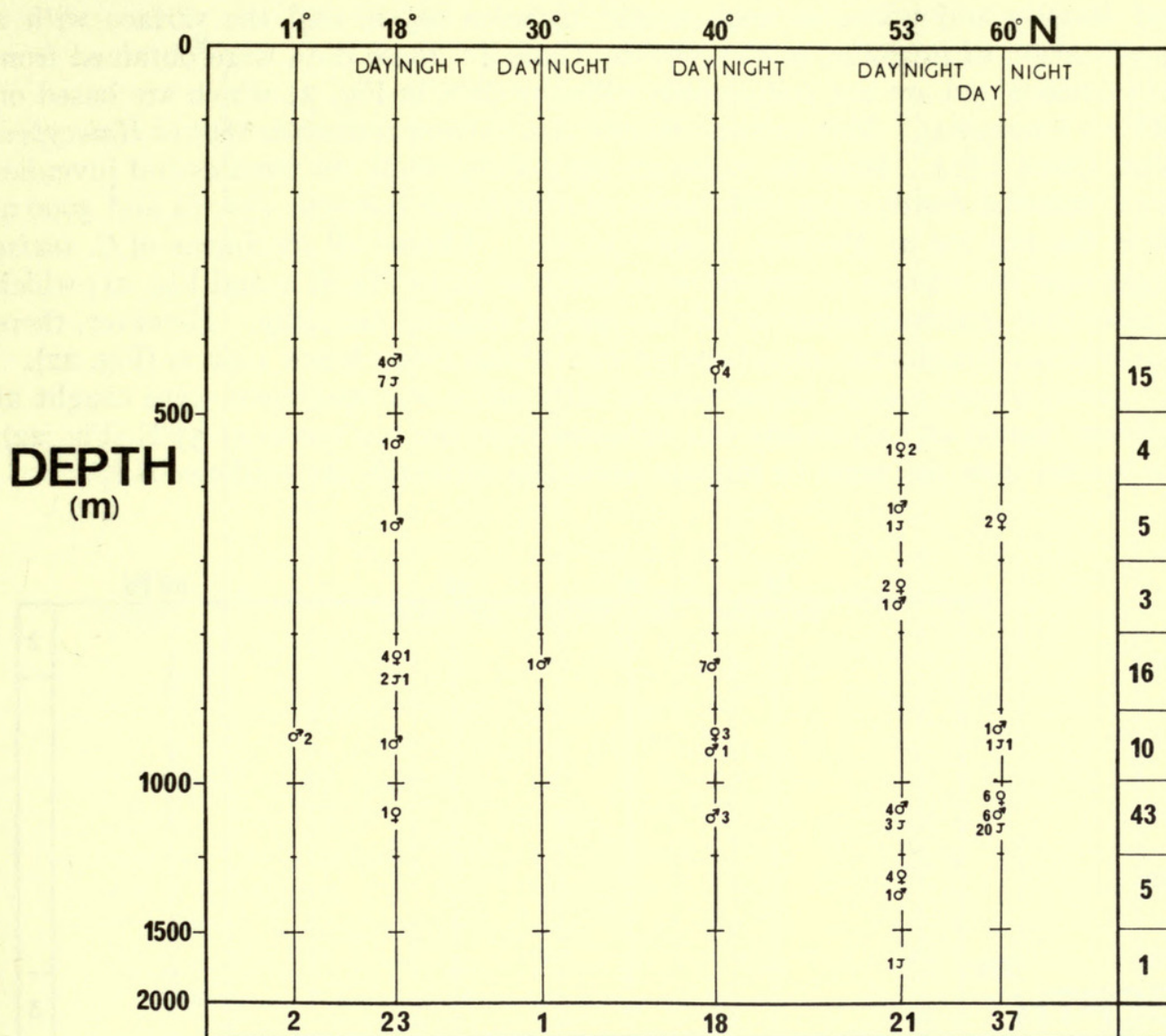


FIG. 20. *Conchoecia aff. edentata*. Depth distribution at various latitudes in the Northeast Atlantic Ocean. For explanation see Fig. 19.

TABLE 6

Vertical distribution during the day and night of females and juveniles of *Conchoecia incisa* at 28°N

DEPTH (m)	DAY		NIGHT	
	FEMALES	JUVENILES	FEMALES	JUVENILES
0-100			1	3
100-200		1	1	7
200-300				
300-400				1
400-500		7		
500-600	3	4 ¹		
600-700				
700-800	1	1		
800-900				2

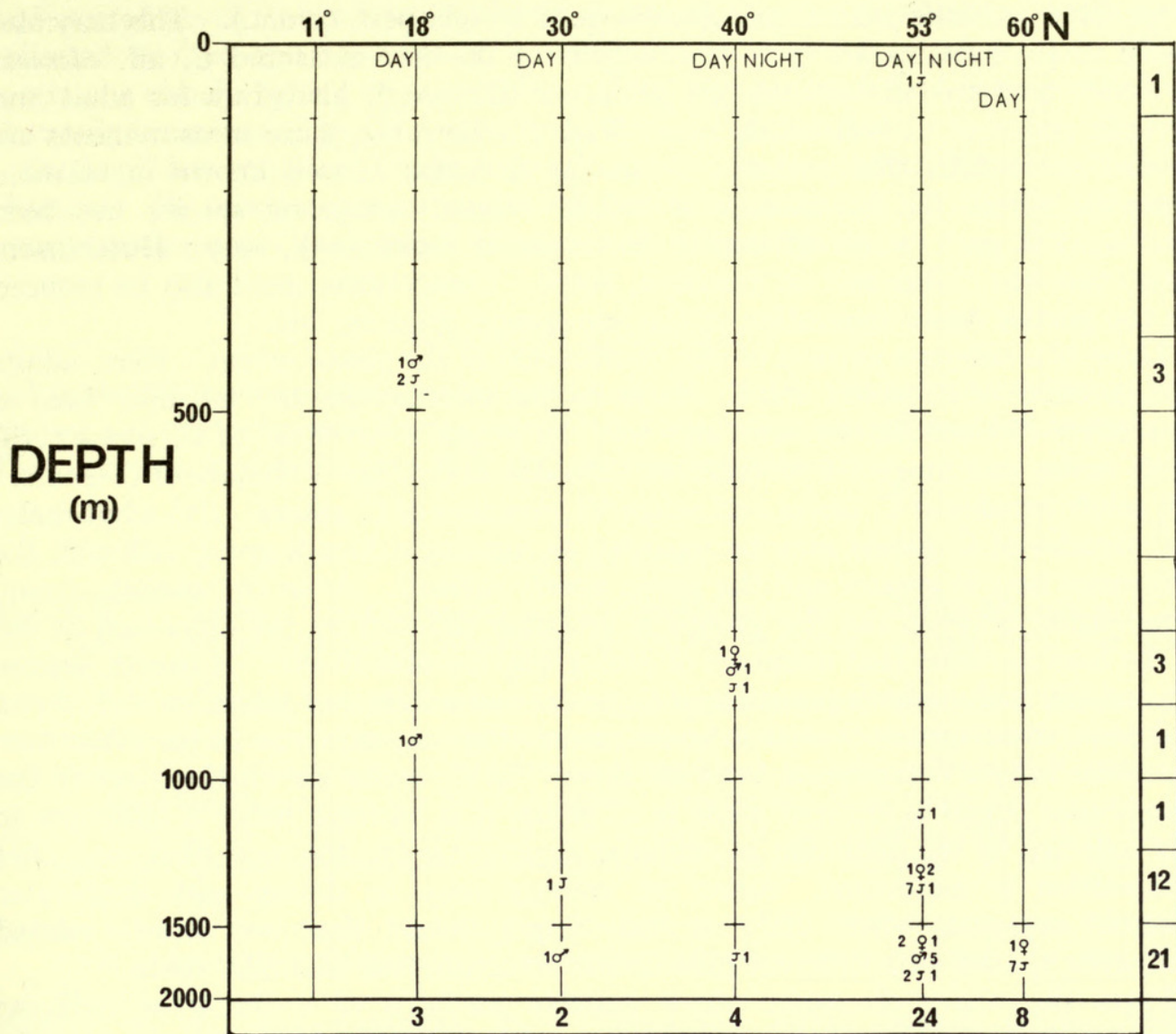


FIG. 22. *Conchoecia gaussi*. Depth distribution of various latitudes in the Northeast Atlantic Ocean. For explanation see Fig. 19.

It is notable that most species of *Conchoecia* occurring in the Arctic have Antarctic counterparts (*C. borealis* Sars, 1866, *C. antipoda* Müller, 1906, *C. obtusata* Sars, 1866, *C. elegans* Sars, 1866). Only *C. maxima* Brady & Norman, 1896 is endemic to the Arctic region although this species is closely related to *C. borealis*/*C. antipoda*. On the other hand, several species appear to be endemic to the Antarctic area (*C. belgica* Müller, 1906, *C. chuni* Müller, 1906, *C. hettacra* Müller, 1906, *C. isocheira* Müller, 1906, *C. schwabenlandica* Hartmann, 1962, *C. serrulata* Claus, 1874). Should *C. aff. edentata* prove to be conspecific with Müller's *C. edentata*, then this will be another species having a bipolar distribution.

C. subedentata sp. n. and *C. aff. edentata* are to some extent sympatric and this raises the question of how competition between these two closely related species is reduced far enough to allow their coexistence. The mandibular structure is virtually identical in both species and so they presumably eat the same sort of food. The main factor may thus be the larger body size of *C. aff. edentata* allowing it to eat

larger food particles than *C. subedentata* sp. n. (Angel pers. comm.). This may also apply to juvenile instars since the lengths of the few measured *C. aff. edentata* juveniles tend to fall between the peaks on the length histogram for adult and juvenile stages of *C. subedentata* sp. n. (Fig. 1); however, more measurements are needed to confirm this pattern. A similar situation is well known in calanoid copepods where the coexistence of closely related sympatric species has been attributed in part to size differences (for example, Sandercock, 1967; Hutchinson, 1967: 680-684; Hammer & Sawchyn, 1968). Competition must also be reduced by the partial depth separation of the two species (Figs 19, 20).

There is a different pattern of size distribution in the *gaussi* group. Here, adults and juveniles of *C. gaussi* and *C. incisa* do not interdigitate but fall into three or four fairly distinct size classes (Fig. 10); (i) Stage V juveniles of *C. incisa*; (ii) adult males and Stage VI juveniles of *C. incisa* and Stage V instars of *C. gaussi*; (iii) adult females of *C. incisa* and Stage VI juveniles of *C. gaussi*; (iv) adult males and females of *C. gaussi* may be regarded as forming a fourth group although the size range here is greater and the group poorly defined. As in the *edentata* group, competition between the size groups is probably reduced by the difference in size of the food particles that members of each group are able to eat. However, groups (ii) and (iii) include both juveniles of *C. gaussi* and adults and juveniles of *C. incisa* and since these species coexist to some extent (Figs 21, 22) some factor other than size must reduce competition between them. In *C. incisa* the cutting edge of the mandibular coxale is straight while in *C. gaussi* it is toothed, hence a difference in diet reflected by the dissimilar mandibular structure seems the most likely way that competition is minimized. Again an analogy may be drawn with freshwater calanoid copepods where Maly & Maly (1974) found that two closely related sympatric species with different mandibular structure had dissimilar diets.

From the above discussion three possible methods of avoiding or reducing competition between closely related sympatric species of *Conchoecia* may be suggested. (i) Depth separation, as is partially the case with *C. subedentata* sp. n. and *C. aff. edentata*. (ii) Differences in the size of food particle eaten as reflected by differences in body size; here one would expect the adult and juvenile size ranges of closely related species to interdigitate as apparently happens in the *edentata* group. (iii) Differences in diet reflected by dissimilar mandibular structure; this would allow closely related species of similar size to coexist as with adults and juveniles of *C. incisa* and juveniles of *C. gaussi*.

ADDENDUM

After this paper was submitted, Dr G. B. Deevey kindly sent me two females of *C. edentata* from Stations 18 and 25 of the Hudson 70 Expedition (Deevey 1974). The specimens are mounted on slides and before dissection measured 1.70 mm and 1.77 mm long. The relative lengths of the setae on the final segment of the sixth limb and the single seta near the spine teeth on the mandibular basale suggest that Deevey's specimens are probably my *C. aff. edentata*. Dr Deevey also sent me some material identified as *C. edentata* from Station S off Bermuda. It comprises some

undissected specimens in formalin and four mounted males and females which were collected in 1969 and 1970 and so not included in Deevey's (1968) paper. These specimens clearly belong to *C. subedentata* and the occurrence of this species near Bermuda is confirmed by its presence at *Discovery* station 8281.

Dr Angel has restudied Fowler's (1909) material in the British Museum (Natural History). He reports (pers. comm.) that Fowler's (1909 : 255, pl. 25, figs 258-262) female specimen of *Conchoecia* C belongs in *C. subedentata* sp. n.

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REFERENCES

- ANGEL, M. V. 1968a. The thermocline as an ecological boundary. *Sarsia* **34** : 299-312.
- 1968b. Bioluminescence in planktonic halocyprid ostracods. *J. mar. biol. Ass. U.K.* **48** : 255-257.
- 1969. Planktonic ostracods from the Canary Island region; their depth distribution, diurnal migrations and community organisation. *J. mar. biol. Ass. U.K.* **49** : 515-553.
- 1970. The redescription of *Conchoecia bispinosa* Claus, *C. haddoni* Brady & Norman and *C. secernenda* Vavra from the North Atlantic. *Crustaceana* **18** (2) : 147-166.
- & FASHAM, M. 1975. Analysis of the vertical and geographical distribution of the abundant species of planktonic ostracods in the north-east Atlantic. *J. mar. biol. Ass. U.K.* **55** : 739-757.
- BAKER, A. DE C., CLARKE, M. R. & HARRIS, M. J. 1973. The N.I.O. combination net (RMT 1+8) and further developments of rectangular midwater trawls. *J. mar. biol. Ass. U.K.* **53** : 167-184.
- BARNEY, R. W. 1921. Crustacea, Pt. V—Ostracoda. *British Antarctic ("Terra Nova") Expedition, 1910, Zoology* **3** (7) : 175-190.
- DEEVEY, G. B. 1974. Planktonic ostracods collected on the Hudson 70 between the Equator and 55°S in the Atlantic. *Proc. biol. Soc. Wash.* **87** (2) : 351-380.
- FOWLER, G. H. 1909. Biscayan plankton Pt. XII. The Ostracoda. *Trans. Linn. Soc. Lond. Zool. ser. 2*, **10** : 219-358.
- FOXTON, P. 1969. SONDA Cruise 1965 : biological sampling methods and procedures. *J. mar. biol. Ass. U.K.* **49** : 603-620.
- GRANATA, L. & CAPORIACCO, L. DI 1949. Ostracodes marins recueillis pendant les croisières du Prince Albert 1er de Monaco. *Rés. Camp. sci. Monaco* **109** : 1-51.
- HAMMER, U. T. & SAWCHYN, W. W. 1968. Seasonal succession and congeneric associations of *Diaptomus* spp. in Saskatchewan ponds. *Limnol. Oceanogr.* **13** : 476-484.
- HILLMAN, N. S. 1967. Ecology of Antarctic pelagic Ostracoda. *Ant. Journ. U.S.* **2** (5) : 199-200.
- 1969. Halocypridae. In: Hedgpeth, J. W. (ed.). Distribution of selected groups of marine invertebrates in waters south of 35°S latitude. *Antarctic Map Folio Ser.* **11** : 29-30, pls 15-16.
- HUTCHINSON, G. E. 1967. *A Treatise on Limnology*, vol. 2, New York.
- ILES, E. J. 1953. A preliminary report on the Ostracoda of the Benguela Current. '*Discovery*' *Rep.* **57** : 259-280.
- MALY, E. J. & MALY, M. P. 1974. Dietary differences between two co-occurring calanoid copepod species. *Oecologia* **17** : 325-333.

- MÜLLER, G. W. 1906. Ostracoda. *Wiss. Ergebn. Deutsch. Tiefsee-Exped.* **8**: 29-154.
- 1908. Die Ostracoden der Deutschen Südpolar Expedition 1901-1903. *Südpolar Exped.* **10**: 51-182.
- 1912. Ostracoden. *Das Tierreich* **31**: 1-434.
- POULSEN, E. M. 1962. Ostracoda-Myodocopa, 1. Cypridiniformes - Cypridinidae. *Dana Rep.* **57**: 1-414.
- 1969a. Ostracoda-Myodocopa from the eastern tropical Atlantic. *Viddensk. Meddr. dansk naturh. Foren.* **132**: 129-197.
- 1969b. Ostracoda-Myodocopa, 3a. Halocypriformes - Thaumatoocypridae and Halocypridae. *Dana Rep.* **75**: 1-100.
- 1973. Ostracoda-Myodocopa, 3b. Halocypriformes - Halocypridae, Conchoecinae. *Dana Rep.* **84**: 1-223.
- RUDYAKOV, YU. A. 1962. Ostracoda Myodocopida (family Halocypridae) from the N.W. Pacific Ocean. *Trudy Inst. Okeanol.* **58**: 172-201.
- SANDERCOCK, G. A. 1967. A study of selected mechanisms for coexistence of *Diaptomus* species in Clarke Lake, Ontario. *Limnol. Oceanol.* **12**: 97-112.
- SKOGSBERG, T. 1920. Studies on marine ostracodes, 1. Cypridinids, halocyprids and polycopids. *Uppsala Univ. Zool. Bidrag Suppl.-Bd* **1**: 1-784.

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Gooday, Andrew J. 1976. "The taxonomy of Conchoecia (Ostracoda, Halocyprididae) of the gaussi and edentata groups from the northeast Atlantic with a note on their ecology." *Bulletin of the British Museum (Natural History) Zoology* 30, 57–100. <https://doi.org/10.5962/bhl.part.2375>.

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