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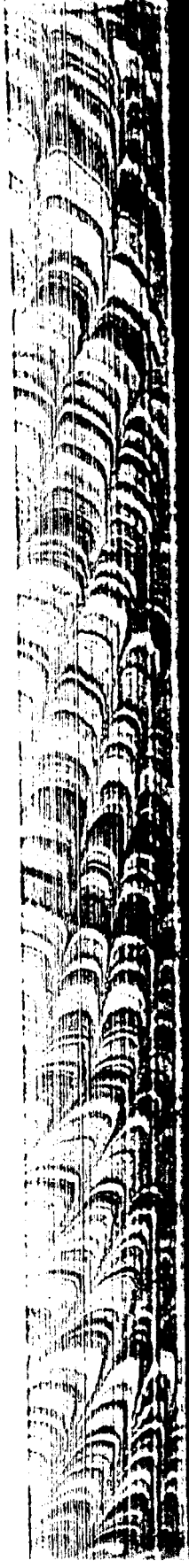
## On the Occurrence of the Thalassinidea in Danish Waters.

By  
Erik M. Poulsen.

The group *Thalassinidea* constitutes according to L. A. Borradaile (1907) and W. T. Calman (1909) a super family or tribe of the *Anomura* (*Crustacea Decapoda*) separated from the 3 other tribes of the *Anomura* (*Galatheidea*, *Paguridea* and *Hippidea*) mainly by their extended, symmetrical abdomen and the existence of a Schizopod-stage in the larval development. Although most authors agree in ranging the *Thalassinidea* among the *Anomura* there is, however, still some doubt as to the systematic position of this group. Thus K. Grobben (1934) regards the *Thalassinidea* as being rather closely allied with the *Nephropsidea* on account of partly the mode of their larval development and partly the form of their spermatzoa.

The *Thalassinidea* are burrowing animals living in a sandy or muddy bottom and with a vertical distribution ranging right from the coast and down to a depth of about 1000 metres. On account of the fossorial habit the *Thalassinidea* are met with only rarely in the gear generally used for scientific research work, and owing to this scarcity of specimens available for research our knowledge of the systematic characters of the various species (and especially their range of variation) within this group is still rather small and therefore also the various statements found in the literature as to the occurrence of species are not always to be relied upon; this especially holds good as to the genera *Upogebia* and *Callianassa*.

From Danish waters the following four species of *Thalassinidea* have been recorded (K. Stephensen, 1910):



*Axius nodulosus* Meinert  
*Calocaris macandreae* Bell  
*Upogebia deltura* Leach  
*Upogebia stellata* (Mont.)

During the research work of the Danish Biological Station and Kommissionen for Danmarks Fiskeri- og Havundersøgelser in Danish waters I have had the opportunity to collect *Thalassinidea* from these parts of the Kattegat, Skagerak and the North Sea which border the Danish coasts. The greater part of this material was gained by the examination of the stomach-contents of fish seeking their food at the bottom (e. g. cod, haddock, plaice); the stomachs of such fishes often contain animals which are found only rarely in the implements generally used for marine research work, and there is no doubt that the knowledge of the bottom fauna of a certain area gained by means of the trawl, the dredge, and the bottom sampler can be usefully supplemented by an investigation of the content of stomachs of fish feeding in the same area. Further K. Stephensen, M. Sc. has been kind enough to place at my disposal for the present investigation a very valuable material of Danish *Thalassinidea* belonging to the Zoological Museum of the University of Copenhagen. This material, for which my best thanks are due, is in the following marked "Z. M."

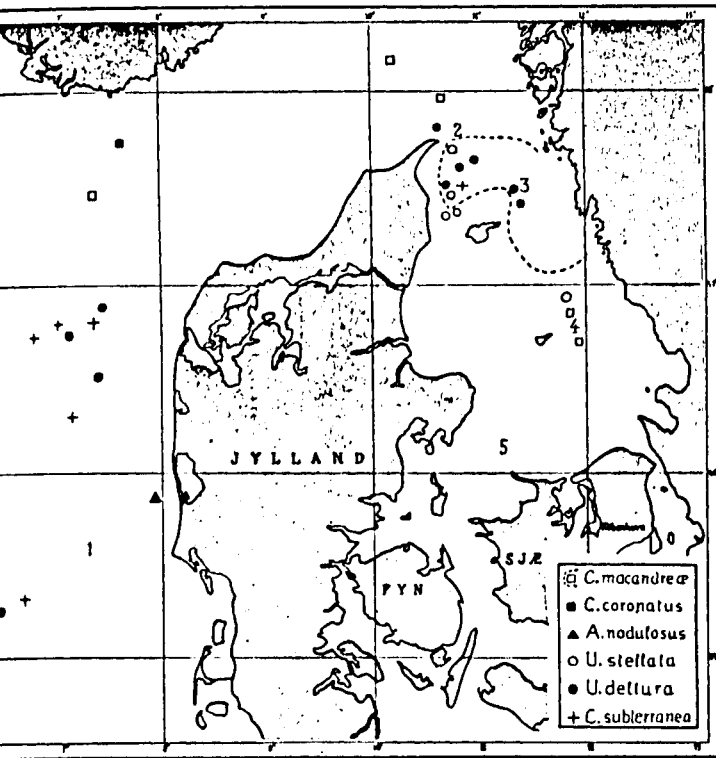
The investigation yields new observations concerning the following 5 species to be dealt with separately on the following pages:

*Calocaris macandreae* Bell  
*Calocarides coronatus* (Trybom)  
*Upogebia deltura* Leach  
*Upogebia stellata* (Mont.)  
*Callianassa subterranea* Mont.

The localities where these species have been found within our waters are marked on the map fig. 1.

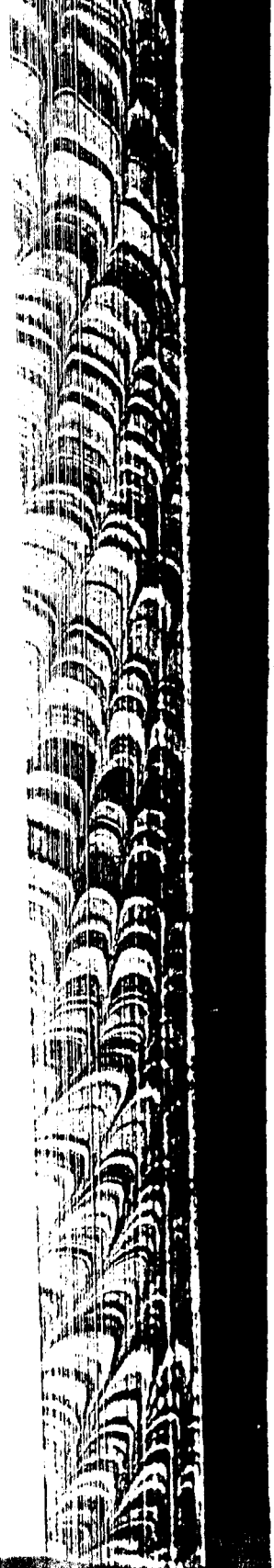
The species *Calocarides coronatus* and *Callianassa subterranea* have not hitherto been recorded from Danish waters. As these two species however have been found in neighbouring waters (*C. coronatus* along the Norwegian coast and the Swedish Skagerak coast in deep waters and *C. subterranea* at medium depths near Helgoland and in the

ds of the Swedish Skagerak coast) it is natural to expect them also  
 the Danish coasts of the same waters.  
 the Thalassinid *Axius nodulosus* Meinert, which was described by  
 Meinert in 1877 on a single specimen, 6.5 mm. long, taken in the



Map showing the localities where *Thalassinidea* have been found in the waters around Denmark. The numbers 1—5 indicate various light-vessels (cfr. p. 237).

North Sea off Nymindegab by H. Krøyer about 1840, has not been discovered during the present investigation, neither has it been recorded by any other investigator in spite of the fact that since 1877 very extensive faunistic investigations have been carried out in the North Sea, but the type specimen is among the material from the Zoological Museum. Meinert's description is in latin, and is not accompanied by any figures. K. Stephensen (l. c. 1910) has in addition to his description given figures of the 1st, 2nd, and 4th pereopods and



of the caudal fan. In view of the possibility that the specimen in question could be a post-larval stage of one of the known species of *Thalassinidea* I have made a new examination (see fig. 2) of the specimen in light of our present knowledge of the Thalassinids of the North Sea region.

The total length of the specimen is 6.5 mm. As the size of grown up Thalassinids on a whole is from about 4 cm. and upwards there is a good reason to suppose that the specimen in question is a rather young one and obviously one of the first post larval stages, (e. g. the 1st post-larval stage of *Callinassa* and *Upogebia* measures 4—5 mm). The following figures give some other measurements in mm.

Length of carapace.....	2,2	Length of abdomen.....	4,3
Length of telson .....	0,78	Breadth of telson .....	0,55
Length of eye-stalks <sup>1)</sup> . . . .	0,48	Length of larger 1st cheliped	4,6

The rostrum is somewhat mutilated; apparently it is short, triangular (?) and covers about  $\frac{1}{3}$  of the eye-stalks only; one or two thorns are present on the carapace near the base of the rostrum. A *linea thalassinica* is not present, at any rate not visible. However as the *linea th.* is not found in the young post-larval stages of e. g. *Callinassa* and *Upogebia* the absence of this line is not a conclusive proof that the specimens in question belong to the family *Axiidae*. The posterior margin of the carapace (see fig. 2 a) is concave in its central part, on either side of the concavity is a prominence provided with a bundle of hairs; the lateral parts of the margin is furnished with minute hairs. The abdomen is about twice as long as the carapace; its segments are furnished with shallow pleura covering the base of the pleopods. The telson (fig. 2 b) is nearly as long as the preceding segment and linguiform, the rounded posterior margin has a median tooth, is fringed with large hairs, and carries along its rounded corners a series of short bristles and two small spines. The eye-stalks are nearly 3 times as long as broad and placed so close together that they touch each other for the proximal third of their length. The eyes cover about  $\frac{1}{3}$  of the length and  $\frac{2}{3}$  of the breadth of the eye-stalks, the pigmented part is placed exclusively on the dorsal part of the eye-stalks; the cornea, however, reaches all round the tip of the eye-stalk. The 1st

<sup>1)</sup> Incl. the cornea.

and 2nd antennae are defective, only the proximal parts of their peduncles being present. Antennal thorns are not found but this may be due to the defective state of the peduncles. As no dissection of the present

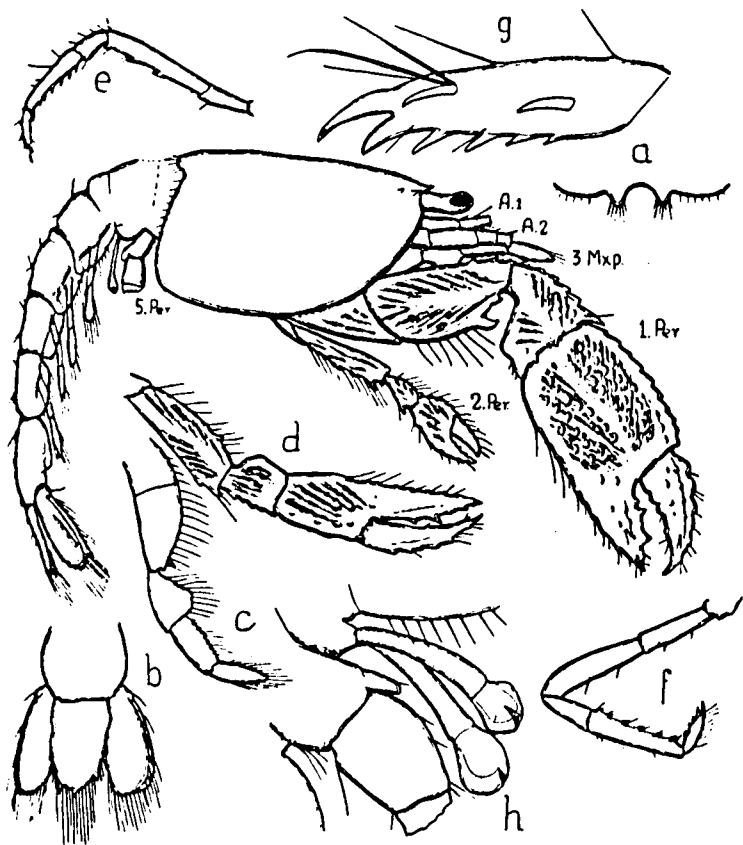


Fig. 2. *Axis nodulosus* Meinert. A. 1. 1st antenna, A. 2. 2nd antenna, 3. Mxp. 3rd maxilliped, 1. Per. 1st pereopod, 2. Per. 2nd pereopod, 5. Per. 5th pereopod; a hind margin of carapace seen from above, b caudal fan, c endopodite of 3rd maxilliped, d 1st left pereopod, e 3rd pereopod, f 4th pereopod, g last joint of 4th pereopod, h proximal part of 5th pereopod and 1st pair of pleopods (g and h are drawn to a larger scale).

type-specimen was undertaken the oral limbs as well as the branchiae could not be investigated. The 3rd maxillipeds (fig. 2 c) are slender and pediform; the lower margin of the propodus is finely serrated and the lower margin of the 4 last joints are furnished with fringes of long hairs, near the distal, lower corner of the merus is a strong spine; the

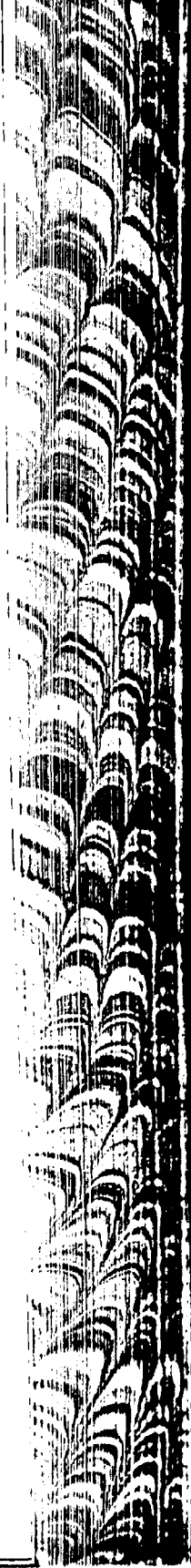
ischium and merus are slightly broader than the carpus and about twice as broad as the two distal joints; the juncture of the merus and the ischium seems not to be flexible. The 1st pereopods (chelipeds) are both of nearly the same length but of quite different sizes, the right one being much stouter than the left one (cf. fig. 2 and 2*d*). The right cheliped, and especially its propodus and carpus, is somewhat flattened, the longest transverse diameter of the propodus being about twice as long as the shortest one. The measurements (in mm.) of the length (= l) and breadth (= b) of the separate joints are as follows: Dactylus l. 0.98; fixed finger l. 0.75; propodus incl. fixed finger l. 2.05, excl. fixed finger l. 1.34, b. 1.06; carpus l. 0.72, b. 0.75, merus l. 1.27, b. 0.58. The dactylus is about  $\frac{1}{4}$  longer than the fixed finger. The left pereopod is only a little shorter but much narrower than the right one. The total length of the 4 last joints is of the right 1st pereopod 4.11 mm. and of the left 3.25 mm. The stoutness of the right 1st per. compared with the left one appears from the following figures giving the breadth in mm. of certain of the joints:

	Right	Left
Propodus .....	1.06	0.51
Carpus .....	0.75	0.41
Merus .....	0.58	0.38

The cutting edges of the right chelipeds are armed with crushing tubercles or teeth; the dorsal margins of the dactylus, propodus, and carpus and the ventral margin of the propodus are roughly serrated. The dactylus has a well marked ridge and some few tubercles on its outer side. The outer side of the propodus carries numerous small tubercles and a few tubercles are found on the carpus too. The distal upper edge of the merus has 2—3 teeth, its lower margin carries 2 strong teeth of which the proximal one is curved. On the whole lines oblique strings of muscles are seen through the integument. The armature of marginal teeth and of tubercles is much weaker on the left than on the right cheliped; both limbs are rather sparsely hairy. The 2nd pereopod is considerably smaller and weaker than the 1st; its chela is oval and with serrated edges, it is rather flat, the lower edge of the merus carries 3 teeth. The 3rd and 4th pereopods are slender legs and resemble one another very closely (see fig. 2*e* and *f*). The dactylus is blade-shaped and carries on the inner (lower) margin a

comb (see fig. 2 g) of about 4—5 pointed teeth and a couple of hairs; the end of the joint is formed like a pointed tooth, on the side of the joint are found 2 strong thorns and a couple of long hairs; the upper margin of the joint is sparsely hairy. The propodus has a similar but more open comb of about 6 teeth; the merus of the 3rd pereopod has 2 low teeth on its lower margin. The 5th per. has been broken off on both sides only the two proximal joints being left; a small knob (a rudimentary epipodite?) springs from the 1st joint. All 5 pairs of pleopods are present; the 1st pair of pleopods are set closely together (fig. 2 h) and attached near the median line; they have a slender basal part and a distal, almost circular, flat lamella; the shape of the 1st pair of pleopods shows that the specimen in question is a male. The 2nd—5th pleopod are built as small biramous swimming legs. The lamellae of the uropods are oval, of nearly the same size and fringed with long plumose setae; there is no suture on the exopodite.

The fact that no specimen of *A. nodulosus* has been recorded since the type-specimen was found nearly a century ago is astonishing; especially as very intensive research work has been carried out in the North Sea since then. Therefore, it is only natural that some doubt has arisen as to the validity of this species, especially as the type-specimen is not only small (young) but rather mutilated too; the nearest possibility should then be that *A. nod.* is a post-larval stage of one of the other Thalassinids. From the post-larvae of *Upogebia (stellata and deltura)* as described by G. E. Webb (1919—22) it differs decidedly. Larval and post-larval stages of *Calocarides coronatus* have not hitherto been described; from the grown-up *C. cor.* it differs especially as to the shape of the 2nd pereopod and regarding the armature of the dactylus of the 3rd and 4th pereopod, a fossorial comb being present in *A. nod.* but absent in *C. cor.* However, as it is hardly possible that a burrowing animal should lose a fossorial comb during the development from the post-larval to the grown-up stage, it may scarcely be regarded as probable that *A. nod.* should be a post-larval stage of *C. cor.* *A. nod.* has a number of characters in common with the genus *Callianassa*: The unequal sizes of the 1st pereopod, the shape of the big 1st pereopod and of the 3rd maxilliped; however it differs from *Callianassa* by the shape of the penultimate joint of the 3rd pereopod. From all the above mentioned genera: *Calocarides*, *Upogebia*, *Callianassa* as well as the genus *Jaxea*, *A. nod.* differs decidedly by having a male



1st pleopod, whereas the 1st pleopod is lacking in the male of these genera. Within the *Thalassinidea* of our region a male 1st pleopod is only present in *Calocaris macandreae* and in the *Axiidae*. The post larva of *Cal. macandreae* is however well known through the description given by W. Bjørck (1913) and it differs in many respects from *A. nod.* e. g. in the shape of the 1st pereopods. Thus there can hardly be any doubt that *A. nod.* belongs to the genus *Axius*. In some respects it resembles the post-larval stage of *Axius stirhynchus* as it is described by G. E. Webb (l. c. p. 408, no figure), however, in other respects it differs from it, e. g. regarding the dactylus of the 3rd and 4th pereopod which are formed as a fossorial comb in *A. nod.*, whereas G. E. Webb writes that these pereopods in the post larva of *A. stirh.* terminate in slender joints; the same is the case in grown-up specimens of *A. stirh.* Thus with the present knowledge of the *Thalassinidea* and their post-larval stages there seems to be little reason to assume that *A. nod.* is a developmental stage of one or other of the already known *Thalassinids*. In order to decide whether *A. nod.* is a true species or not a closer comparison of the type-specimen with other *Thalassinids* or with their post-larval stages than that possible by means of the existing literature is necessary; it is hoped that the present description will facilitate such a comparison.

*Calocaris macandreae* Bell.

*Calocaris macandreae* Runnström, 1925, pl. I. figs. 1 and 2.

Danish Records: Various localities in the Kattegat N. and E. of Læsø depth 50—90 m. (Fr. Meinert, 1893), 29 naut. M. N.  $\frac{1}{2}$  W. of the Skaw L. V. (Skagerak) 310 m. (K. Stephensen, 1910). W. of Vigø (Kattegat) 58 m. and 3 naut. M. E. b. S. of Læsø 60—75 m. (C. G. Joh. Petersen, 1913). 7—8 naut. M. NE. b. N. of Anholt Light 50—51 m. (H. Blegvad, 1914). E. of Læsø 60—75 m. (C. G. Joh. Petersen, 1918). 25 naut. M. SE. of Læsø 40 m. and 10 naut. M. E. of Anholt 50 m. (H. Blegvad, 1930).

New Danish Records: W. of Groves Flak (Kattegat) 80 m.  $\frac{11}{7}$  1923. 2 naut. M. SE. b. S. of Læsø Trindel 65 m.  $\frac{17}{6}$ -1923. 14 naut. M. N. b. E. of the Skaw 190 m. (a female with eggs)  $\frac{2}{4}$ -1927. Between Læsø and Lille Middelfgrund 13 m.  $\frac{2}{6}$ -1930, 47 m.  $\frac{20}{6}$ -1932. 57°31' N. Lat. 7°18' E. Long. (North Sea) 200 m.  $\frac{27}{6}$ -1930. E. of Læsø 66 m.  $\frac{16}{7}$ -1934.



Distribution: From the Mediterranean Sea along the west coast of Europe to Norway. Along the Norwegian coast it was found as far North as at the Trondhjems fjord (Runnström, 1925). It is further recorded by H. I. Hansen (1908) from the Atlantic south of Iceland at 62° N. Lat. In the Kattegat it is found as far south as E. of Anholt. In the Western Atlantic it has been found along the coasts of U. S. A. and of southern Canada.

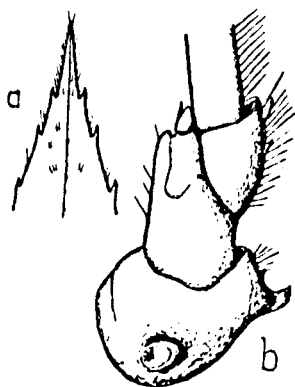


Fig. 3.

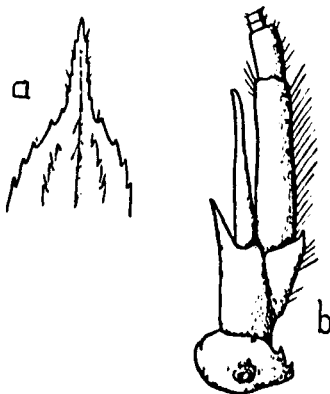


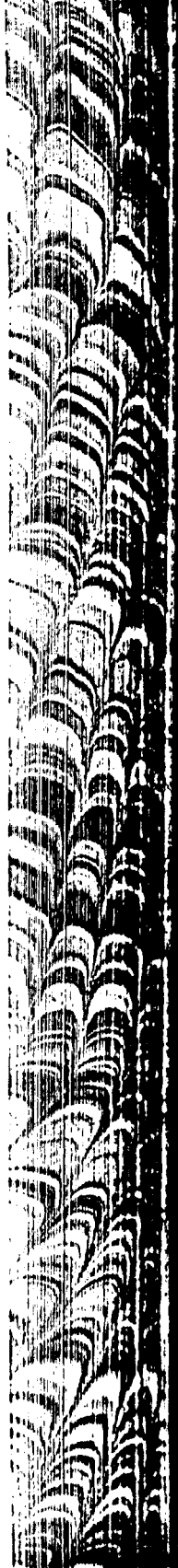
Fig. 4.

Fig. 3. *Calocaris macandreae* Bell, SE. b. S. of Læsø Trindel L. V. May 17th, 1923; a rostrum with adjacent part of carapace, b proximal part of the right 2nd antenna, seen from below.

Fig. 4. *Calocarides coronatus* (Trybom), 52 naut. M. NNW. 1/4 W. of Hanstholm June 21st 1911; a rostrum with adjacent part of carapace, b proximal part of the right 2nd antenna, seen from below.

Remarks: *C. macandreae* is rather common on the soft bottom in the eastern and northern Kattegat between depths from 13—88 m., in the Skagerak it is recorded from depths down to 310 m. In the Kattegat it penetrates as far south as E. of Anholt where the salinity of the bottom water varies between 29 and 34 ‰, the temperature of the bottom water not even in the coldest months falling below 4° C.

*C. mac.* is distinguished from the allied species *Calocarides coronatus* by its slender first pereopod and especially by the long narrow fingers of the chelae of this appendage; further the 2nd antenna has no scaphocerite as is the case with *C. coronatus* (cf. figs. 3 and 4). Also the rostrum and the anterior part of the carapace vary in some respects in the two species. The rostrum of *C. mac.* is triangular (see fig. 3)



its margins are continued as keels on the gastric area of the carapace; these keels, but not the rostrum itself, are furnished with 3—6 teeth, a smooth keel (without teeth) runs from the rostrum along the median line to the hind margin of the carapace. The rostrum of *C. cor.* (see fig. 4), however, is narrower than that of *C. mac.* and furnished along its margins right to its tip with about 4 teeth; it is continued as keels on the gastric area of the carapace, these marginal keels have each 5—6 teeth; the median keel carries 2 teeth and reaches backwards to the cervical groove only, on either side of the median keel is a ridge bearing 3—4 teeth. The rostrum of *C. mac.* is more densely hairy than that of *C. cor.* In both species the proximal part of the rostrum is bent downwards.

#### *Calocarides coronatus* (Trybom).

*Euconaxius coronatus* + *E. crassipes* Trybom 1904 pl. 20 and 21.

*Calocarides crassipes* Wollebæk 1908 pl. I—VII.

Danish Records: 52 naut. Miles NNW.  $\frac{1}{4}$  W. of Hænstheden (the Skagerak) 440—460 m.  $\frac{21}{8}$ -1911 S/S "Thor" (Z. M.). Not hitherto recorded from Denmark.

Distribution: Swedish Skagerak-Fjords, the deep parts of the Skagerak, the Fjords of the Norwegian West-coast as far North as 62°30' N. Lat.

Remarks: Of this species only a few specimens have been recorded, all of them from deep water off the southern part of the Scandinavian peninsula. Fig. 4 shows the anterior part of the carapace with the rostrum and the proximal part of the 2nd antenna of the Danish specimen; the specimen has lost all its pereopods.

#### *Upogebia*.

Like G. E. Webb (1919—22) I refer the two species generally (especially in the older literature) recorded under the names *Cebu stellata* and *Upogebia (Gebiopsis) deltura* to one and the same genus *Upogebia*. The morphological characters by which the two species can be separated from one another are small, confined to minor variations in the form of some of the joints of the appendages and in the armature of spines and hairs. A subdivision in two subgenera (*Upogebia* and *Calliadne*) as made by J. G. de Man (1927) I find hardly advisable.

truly since by an examination of the antennae, the oral limbs, and the maxillipeds I have found only very small differences and such merely refer to the shape of some of the joints and to the density of hairs, and secondly as the two separating characters used by de Man (1928, 2) do not always exist together. The characters of the two subgenera are as follows:

*Upogebia*

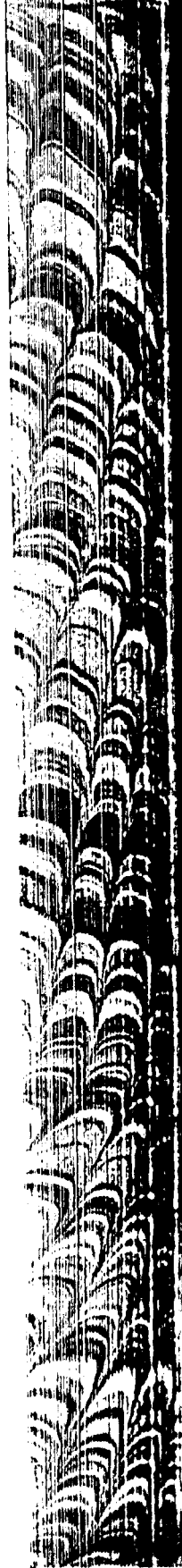
1. Fixed finger of 1st pereiopod much shorter than dactylus.
2. A small spine on antero-lateral corner of the carapace between the eyes and the 2nd antenna.

*Calliadne*

1. Dactylus as long as fixed finger, rarely a little longer.
2. No small spine on antero-lateral corner of the carapace.

Since there are, as stated already by de Man himself, two species of *Upogebia* with the fixed finger considerably shorter than the dactylus but without the antero-lateral spine and one species of *Upogebia* (*U. longipollex*) with a fixed finger almost as long as the dactylus, but with an antero-lateral spine, there are species in which the "separating" characters of the two subgenera are united. Therefore, it is hardly serviceable to divide the genus into two subgenera which, in any case, cannot be based on the combination of the two above mentioned characters, the more so because the first of these characters (the finger-length) is very difficult to handle.

In part of the existing literature seems to be some doubt as to the proper means of separating the two species *U. stellata* and *U. deltura* I therefore give a comparative description of the two species based on the material from Danish waters. The best distinguishing character has no doubt been recorded by W. de Morgan (1910) who has shown that *U. stellata* has a small spine on the antero-lateral corner of the carapace behind and below the eye-stalks, whereas such a spine is absent in *U. delt.* This character I have found to be precise and also easily visible and it is therefore preferable to such not always distinct characters as the proportionate length of the chelipeds and the degree of hairiness of the rostrum and the chelipeds. Morgan states that this carapace-spine is also present in small specimens of *U. stellata* but he does not mention the smallest specimens in which he has observed the spine. G. E. Webb does not mention the spine in the de-



scription of the 1st and 2nd post-larval stages (4—4½ mm l). However as I have found the spine in an individual with a length of 12 mm, the character is serviceable at any rate down to that size. The length of the fixed finger of the chela on the 1st pereiopod in proportion to that of the dactylus varies in both species considerably during growth from the post-larval stages and onwards, and in such a way that the difference regarding this character between the two species is reduced gradually during growth. This fact will appear from the following figures of the length of the fixed finger in per cent. of that of the dactylus in specimens of various lengths (the measurements are taken along a straight line from a point of the distal margin of the palm between the base of the two fingers up to their tips)<sup>1)</sup>:

<i>U. stellata</i>		<i>U. deltura</i>	
Tot. length of spec. mm.	%	Tot. length of spec. mm.	%
4.5	15 G. E. W. <sup>2)</sup>	3.5 G. E. W.	13
4.5	16 G. E. W.	3.9 G. E. W.	16
12	23	4.0 G. E. W.	16
32	34	4.5	18
45	36	19	25
47 Pl. <sup>3)</sup>	37	28	31
		40	43
		48	56
		50	54
		67 Pl.	54

As it will appear from these percentages this character is of small value for the separation of the two species only when big growing specimens are concerned. For the post-larval stages and for those a little older the character is however quite serviceable and useful, as far as the carapace-spine of *U. stel.* is not developed in such small individuals. Figs. 5 and 6 show the 1st pereiopod of *U. stel.* and *U. del.* by various individual sizes.

As a part of the material at hand for the present investigation consists of remains (especially the chelipeds) of specimens only it has

<sup>1)</sup> See fig. 5

<sup>2)</sup> The figures marked G. E. W. are calculated on the basis of measurements taken from the drawings by G. E. Webb (1919—22). The specimens marked Pl. were kindly forwarded to me from the Marine Laboratory of Plymouth.

been necessary to look for additional characters for the separation of the two species. Regarding the 1st pereiopod there is within one and the same species a considerable variation as to the armature of spines and density of hairs; therefore, when single individuals of the two species are compared, differences between the two species are found

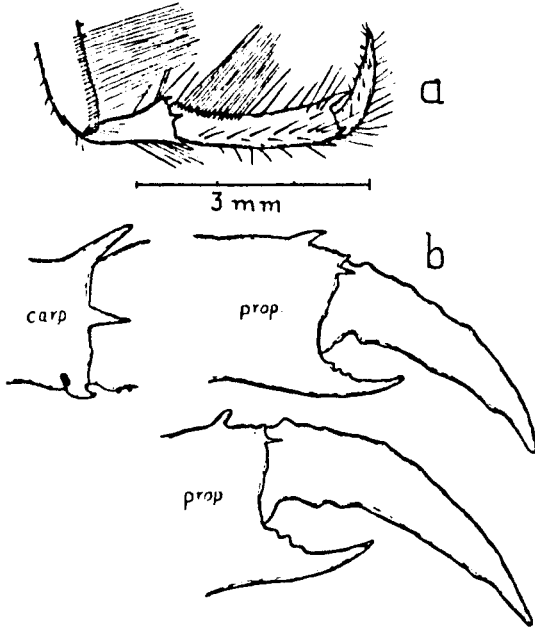
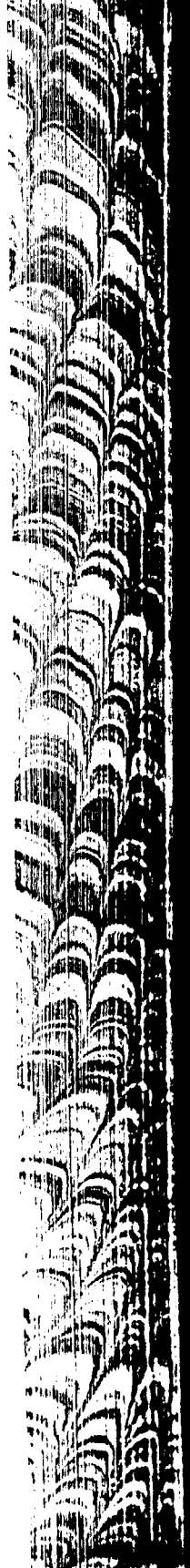


Fig. 5. *Upogebia stellata* (Mont.); distal part of 1st pereiopod, seen from the inside, *a* from a specimen of 12 mm. length. *b* from a specimen of 32 mm. length (the median part of propodus omitted), *c* from an egg-carrying female of 45 mm. length, all from the northern Kattegat, and drawn to the same scale (in *b* and *c* the hairs are omitted).

easily enough, when, however, more specimens are considered the number of differences becomes much reduced. J. G. de Man (1928, 1) has given a thorough description of the 1st pereiopod based on one (or two) specimens of each species; among the characters numerated by de Man I have found one only to be serviceable for the separation of the two species, i. e. the median spine on the inner distal margin of the carpus; this spine is always present in *U. stel.*, at any rate down to a size of 12 mm. (cfr. fig. 5 *a* and *b*), whereas it is lacking or, in a few cases, represented by a small tubercle in *U. delt.* (fig. 6). The small acute tooth on the distal margin of the outer surface of the palm which,



according to de Man (1928, 1, p. 39) is present in *U. delt.* but wanting in *U. stel.*, I have found to be wanting in some specimens of *U. del.* too. Concerning the 1st antennae (figs. 7 and 8) a notable difference is present only in the length of the 3rd joint of the peduncle, the

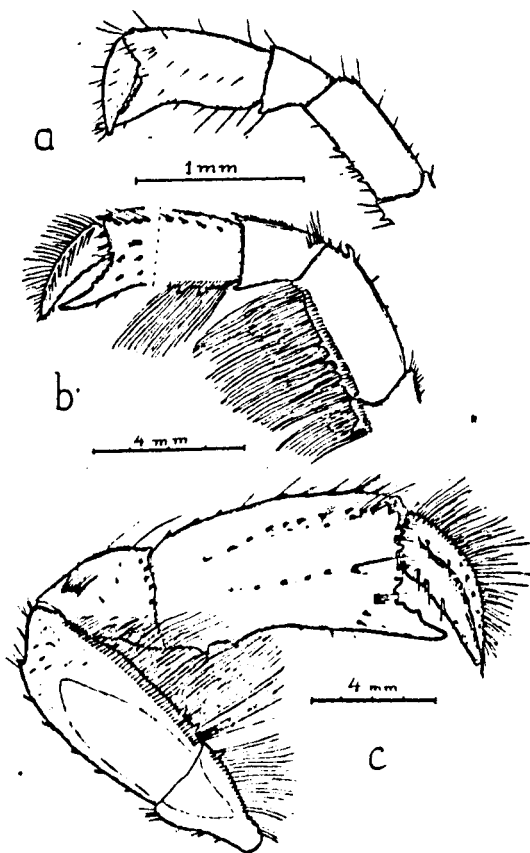


Fig. 6. *Upogebia deltura* Leach; distal part of 1st pereopod, seen from the inside, *a* from a specimen of 4.5 mm. length, *b* from a specimen of 28 mm. length, *c* from a specimen of 48 mm. length (*a* and *b* caught in the northern Kattegat, *c* at the Jutland Bank).

being, as already stated by de Man more slender in *U. delt.* than in *U. stel.*; the difference is however not quite as large in the present collection as that found by de Man. As to the flagelli there is hardly any difference between de Man's description and my observations. In the thinner flagellum the number of joints are 20—23 (de Man 24

in *U. stel.* against 13—14 (de Man 13) in *U. delt.* In the thicker flagellum the number of joints are 22—28 (de Man 31—32) in *U. stel.* against 15—17 (de Man 17) in *U. delt.* In both flagelli the number of joints thus are fewer in *U. delt.* than in *U. stel.* The two flagelli (the thicker and the thinner) are of nearly the same length. In accordance

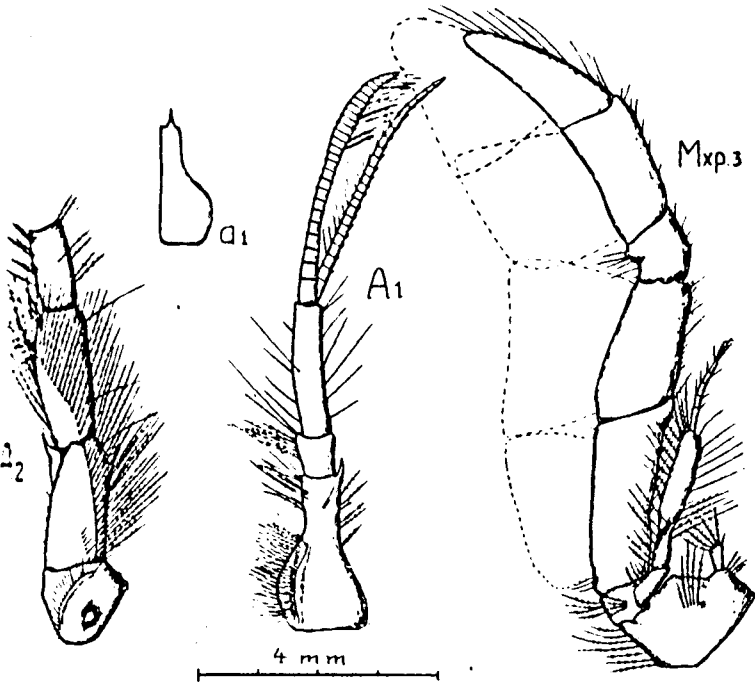
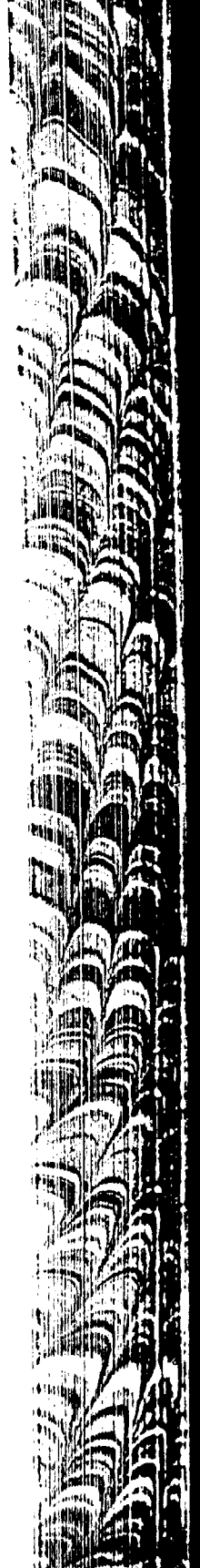


Fig. 7. *Upogebia stellata* (Mont.), ca. 40 mm. long, caught 2 naut. M. SE. b. S. of the Skaw L.V. A1. 1st left antenna seen from the side (a 1. 1st joint of peduncle seen from below), A2. 2nd antenna seen from below, Mxp. 3. 3rd maxilliped (the stippled lines indicate the contours of the hair combs on the ventral margins of the endopodite).

with the lower number of joints, the flagelli of *U. delt.* are shorter than those of *U. stel.*, the length being in the former 50% and in the latter 80% of the peduncle. The 2nd antennae (figs. 7 and 8) are — as far as the investigation goes — identical in the two species. This appendage has not been described nor figured by de Man who, regarding *U. stel.* only mentions that "the squamiform scaphocerite on the 2nd segment ends distally into two spinules", in my specimens, however, the point of the scaphocerite is simple. The 3rd maxillipeds are likewise identical



in the two species; in fig. 7 *c* is shown the 3rd maxilliped of *U. del.* From the 1st joint of the peduncle arises a minute club shaped epipodite furnished with long plumose setae; from the 2nd joint comes a well-developed exopodite consisting of a two-jointed shaft and a slender flagellum with about 5 joints. In the Thalassinidea the shaft is generally stated to be one-jointed, however, although the 1st joint in this species

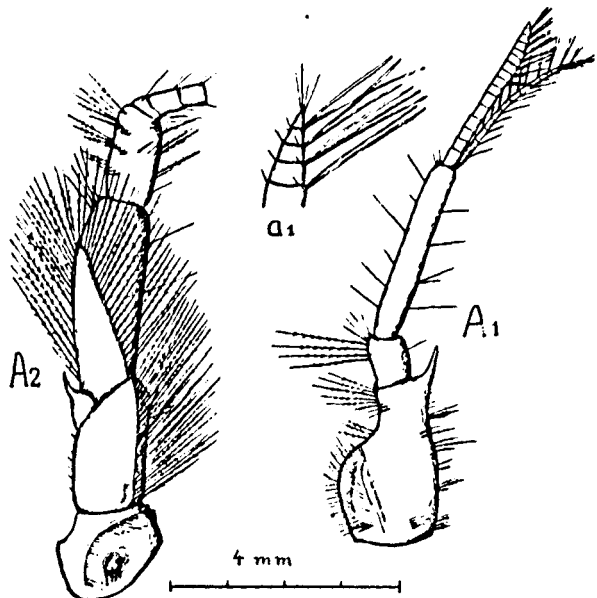


Fig. 8. *Upogebia deltura* Leach, 48 mm. long, the Jutland Bank. A 1. 1st antenna (distal end of the thicker flagellum), A 2. 2nd antenna, seen from below.

is only small, it is well defined and in articulation as well with the peduncle as with the 2nd joint. On the inner surface of the proximal part of the ischium 2 conspicuous spines are present both in *U. del.* and *U. del.* Concerning the oral limbs an investigation does not disclose any difference serviceable for the separation of the two species. The oral limbs have been investigated by I. E. V. Boas (1880) for the species *Gebia littoralis*. The description and figures given by Boas differ on minor points only from the present investigations of *U. del.* and *U. stel.*: In the 1st maxilliped the lacinia interna is better developed and more lobe-shaped than in Boas' figure, and the flagellum of the exopodite is two-jointed (the 1st joint being obviously fused



with the shaft. The 2nd maxilla of *U. stel.* (not figured by Boas) is shown in fig. 9 *b*; it resembles that of *Axius* (as described by Boas) rather strongly, except that the proximal lobe of lac. externa is much more strongly developed and the distal lobe has a constriction of its median part. The distal part of some of the hairs on lac. interna is swollen and of a brownish colour. The 1st maxilla has an exognathus slightly developed. A mandible (not figured by Boas) of a speci-

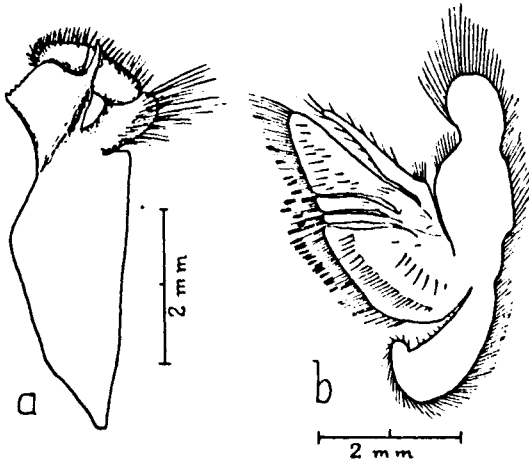


Fig. 9. *Upogebia stellata* (Mont.). Northern Kattegat. *a* the mandible, *b* the 2nd maxilla.

men of *U. stel.* is shown in fig. 9 *a*. The palp is 3-jointed, its 1st joint is furnished with long hairs along its outer margin, the two last joints carry along their outside a thick cushion of short, strong, plumose setae. The molar and incisor processes are united and the molar part is bent in a right angle to the incisor part. From the distal part of the mandible opposite to the angle between the molar and the incisor part a strong, pointed and slightly curved process arises. The shaft of the mandible is rather long, triangular and backwardly pointed. I have not found any differences between the mandible of the two species of *Upogebia*.

It is clear from the above that the two species of *Upogebia* are very much alike as to their appendages, and no conspicuous difference can be found in the oral limbs. However, it is still possible to separate the two species from one another by means of (1) the antero-lateral



thorn of the carapace, (2) the thorn on the inner anterior margin of the carpus of the 1st pereopod, and (3) the proportionate length of the fingers of the chelipeds.

*Upogebia stellata* (Mont.).

*Upogebia stellata* W. de Morgan 1910 fig. 1.

*Upogebia stellata* G. E. Webb 1919—22 pl. X fig. 1 and pl. XII figs. 7 and 8

Danish Records: Fr. Meinert (1893 p. 221) records two quite young specimens (total length 4 mm. and 12 mm.) taken by the Danish research vessel "Hauch" in the Northern Kattegat between the Skan and Læsø; K. Stephensen (1910) refers however the largest of these two specimens to the species *Upogebia deltura*. An examination of these two specimens shows that the smaller must be referred to *U. deltura* also, as the cheliped of the 1st pereopod has the two fingers of very nearly the same length, just as it is the case with the post-larval stages of *U. delt.* whereas the post-larva of *U. stel.* has the fixed finger much shorter than the movable one (cf. G. E. Webb, 1919—22, pl. XII, figs. 5—6). H. Blegvad (1930 p. 41) records *U. stellata* from the Lille Middelgrund in the Kattegat between Læsø and Anholt, 33 m.; this specimen, present in the Z. M. collection, has a total length of 12 mm., the antero-lateral thorn of the carapace is present and shown together with the short fixed finger that the specimen in question belongs to *U. stel.*

New Danish Records: Remains of two specimens were found in the stomach of a plaice caught by the S/S "Biologen" on July 12th, 1934, 2 naut. M. SE. by S. of Skagen (Northern Kattegat) at a depth of 26 m.; the antero-lateral spine is clearly visible in both specimens. In the collection from the Zoological Museum the following specimens are present, all caught in the Northern Kattegat: One spec. 35 mm. l., Læsø Rende (57°24' N. Lat. 10°46' E. Long.), 36 m., Aug. 8th, 1925 (P. L. Kramp leg.); one spec. 45 mm. l., berried ♀, ESE. of Frederikshavn, July 14th, 1938 (P. L. Kramp leg.); one spec. 32 mm. l., E. of Frederikshavn 25 m., July 1st, 1939 (P. L. Kramp leg.).

Distribution: Swedish coast of the northernmost Kattegat (W. Björck, 1916) and of Skagerak (T. Lagerberg, 1908, G. Gustafson, 1935). West coast of Norway (J. A. Grieg 1926). Southern North Sea (J. J. Tesch 1908 and A. Blohm 1915). It is also found

other commonly in the Channel, more rarely along the east coast of Great Britain; the species is also recorded from the Atlantic coast of W.-Europe and from the Mediterranean Sea. However, the possibility remains that part of these records refer to the species *U. dell.* Thus the figure given by J. A. Grieg (1926 p. 36) as that of *U. stel.* strongly resembles *U. dell.* as it shows a very densely haired rostrum and broad propodites on the uropods; also the large size, 65 and 66 mm. of two of the recorded specimens bears evidence to the effect that at any late part of the collection belong not to *U. stel.* but to *U. dell.* Further there is some reason to assume that the statement by J. J. Tesch refers to both species as he records *Gebia stellata* (Mont.) with the synonym *Gebia dellura* Leach.

Remarks: The morphological characters of this species are treated on p. 217-24 Webb (l. c.) writes that in grown up specimens (and probably in the post-larval stages too) a difference exists as to the shape of the chelipeds of the two sexes: "the limb in the male is stout and broad, the fixed finger which bears a denticle on the inside is more than half as long as the movable one, and is evidently capable of acting as an efficient grasping organ. The movable finger or dactylus is strongly curved, broad at the base and tapering towards the point. In the female, on the other hand, the limb is altogether of a more slender character; the fixed finger is much shorter and does not bend inwards towards the dactylus, which itself is much weaker in appearance and not nearly as broad at the base as that of the male". In the scanty material from Danish waters I have not been able to find such a marked sexual dimorphism. The cheliped of a berried female with a large genital aperture in the coxa of the 3rd pereopod (figured fig. 5) is of the same shape as in the other Danish specimens and shows hardly any of the features characteristic of the female according to G. E. Webb, the fixed finger is of normal length and bend inward towards the dactylus, the movable finger is curved, though not quite as much as in the male figured by G. E. Webb.

All the specimens of *U. stel.* recorded from Danish waters were found in the northern Kattegat between Skagen and Lille Middelfund and at depths between 25 and 36 m. It is rather astonishing that it has not been found in the stomachs of haddock from the Jutland Reef in the eastern North Sea where *U. dell.* and *Callinassa subterranea* were fairly common.



*Upogebia deltura* Leach.*Gebia deltura* W. de Morgan 1910 fig. 2.*Upogebia deltura* G. E. Webb 1919—22.

Danish Records: *Gebia stellata* Fr. Meinert 1893 p. 221 (cf. this paper p. 224), *Gebiopsis deltura* K. Stephensen 1910 p. 277.

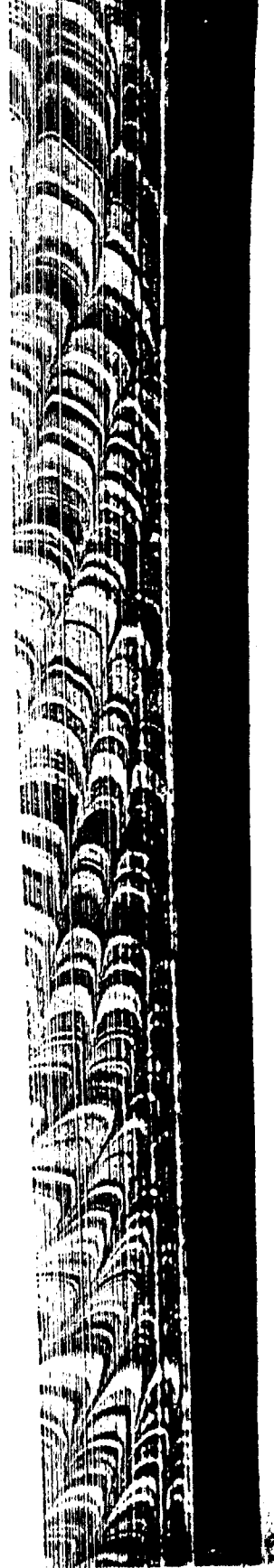
New Danish Records: Northern Kattegat, 57°27' N. Lat. 11°20' E. Long. 35 m., July 16th, 1934, one cheliped taken in the dredge; northern Kattegat, 57°40' N. Lat. 10°58'30" E. Long. 34 m., July 21st, 1935, one specimen, 28 mm. long, taken in the Petersen bottom sampler. Remains of specimens have further been observed in the stomachs of haddock caught in the following localities in the eastern part of the North Sea. 55°15' N. Lat. 6°20' E. Long. 40 m., Oct. 22nd 1927 (hindmost part of abdomen with caudal fan). The Jutland Reef, ca. 30 m., Oct. 1927 (two chelipeds). 55°48' N. Lat. 5°10' E. Long. 50 m., Nov. 11th, 1927 (two chelipeds and some other remains). 31 naut. M. WSW. of Thyborøn 33 m., Oct. 19th, 1929 (two chelipeds and part of the uropods). 40 naut. M. W. 1/2 N. of Thyborøn 30 m., Dec. 18th, 1929 (one specimen, 48 mm. long, only little damaged). In the material from the Zoological Museum the following specimens (besides the two specimens from the "Hauch" recorded formerly) were present: One specimen, 19 mm. long, caught by the research steamer of the Danish Biological Station at Herthas Flak (the northern Kattegat) 22 m., Sept. 3rd, 1912 and a post-larval stage, 5 mm. long caught off Frederikshavn (northern Kattegat) at night on the surface, Aug. 13th, 1934 (I. Lieberkild leg.).

Distribution: Swedish coast of the Skagerak (T. Lagerberg 1908, recorded as the female of *U. stellata*). Fjords of the Swedish coast of Skagerak (G. Gustafsson 1934). The southern North Sea (J. J. Tesch 1908). The English Channel (W. de Morgan 1910 and G. E. Webb 1919—22). The Irish coast (C. M. Selbie 1914). North east coast of Scotland (?) (Sim, 1879, fide C. M. Selbie, 1914). The species is further recorded from the Mediterranean (O. Pesta, 1914).

Remarks: The morphology of this species is treated on p. 217 together with that of *U. stellata*. In Danish waters the species is rarely met with in the northern part of the Kattegat; in the North Sea off the coast of Jylland it seems to be more common, as it is found fairly often in haddock stomachs. It is of interest to note that a post-larva

stage of 4.5 mm. was taken at night on the surface on Aug. 13th; another post larva of 4 mm. was taken on Aug. 21st in the dredge (i. e. on the bottom) whereas the 12 mm. long spec. of "Hauch" was taken on Sept. 12th, these dates indicate that the larval development takes place during the summer (i. e. when the water is warmest). At Plymouth G. E. Webb has found the larval stages during the summer months; thus also in the Channel the larvae develop during the summer. The two larvae of 4.5 mm. total length has a rostrum which reaches just beyond the end of the eyes; there are no dense fringes of hairs on the 1st pereopod. The numbers of denticles on the fixed finger of the chela of the 1st pereopod are 2 and 3 in one spec. and 4 and 5 in the other one; the fixed and the movable fingers are of the same length. The outer margin of the endopodites of the uropod is weakly concave and bare of setae; there can be no doubt that these two post-larvae belong to *U. deltura*. As I have not, owing to the scarcity of material, made any dissection of the limbs, it cannot with certainty be stated if they belong to the 1st or 2nd post-larval stage; the fact that the rostrum reaches beyond the end of the eye should, according to Webb's description, show them to belong to the 2nd stage and not to the 1st stage.

In 1884 G. O. Sars described some larval and post-larval stages of a species of *Upogebia* which he calls *Gebia littoralis* Risso. Both Meinert (1893) and K. Stephensen (1910) give *Gebia littoralis* of Sars as a synonym of *U. stellata*. G. E. Webb (1919—21) has shown, however, that Sars' *G. littoralis* is not identical with *U. stellata* and writes further, "neither does Sars' account agree with the description here given of the development of *U. deltura* Leach — the greater number of plumose setae on the exognath of the 2nd maxilla, and of denticles on the fixed finger of the chela in the 1st post-larval stage of Sars' species being two points of difference. These facts seem to denote that Sars' description refers to neither of the British species [*U. stellata* (Mont.) and *U. deltura* Leach], but to a different and possibly purely Norwegian form". However the fact that the fixed and the movable finger in Sars' specimen are of the same length denotes that this post-larva belongs to *U. deltura*. The two above mentioned points by which this post-larva should differ from the post-larva of *U. deltura* are of little importance only as far as they separate it from the 1st post-larval stage of *U. deltura* only and not from the 2nd or 3rd stage as



they are described by G. E. Webb; but the stage described by Sars as the 1st young stage (første Ungdomsstadium) can hardly be the 1st post-larval stage but rather the 2nd or the 3rd. Sars' 1st young stage measures 5 mm. and its rostrum reaches decidedly beyond the end of the eyes, whereas G. E. Webb's 1st post-larval stage measures 3.5—3.9 mm. only and its rostrum terminates behind the level of the eyes. Now, according to Webb the 2nd post-larval stage measures "about 4" or "over 4" mm. and its rostrum reaches to the level of the eyes or slightly beyond the eyes, and the 3rd post-larval stage measures nearly  $4\frac{1}{2}$  mm., its rostrum projects slightly beyond the eyes<sup>1</sup>). Thus Sars' "1st young stage" corresponds as to individual size and as to length of rostrum far better with the 2nd than with the 1st post-larval stage. But between Sars' stage and the 2nd (or 3rd) post-larval stage there are hardly any differences and especially not as to the two main points mentioned by Webb: The number of denticles of the first finger are in Sars' stage 5, in the 2nd post-larval stage 5 (G. E. Webb, in the 1st post-larval stage (G. E. Webb), however, 3; the number of plumose setae on the exognath of the 2nd maxilla are in Sars' stage 35, in the 1st and the 2nd post-larval stage 37 and 29. I therefore hold that we are justified in regarding the young *G. littoralis* of Sars as identical with the 2nd or 3rd post-larval stage of *Upogebia deltura*. On p. 108—109 Webb has tabled a thorough and valuable comparison of the various developmental stages of *G. littoralis* of Sars, *U. deltura* and *U. stellata*; the table shows that *G. littoralis* of Sars differs in only a few points from *U. deltura* (in more points, however, from *U. stellata*). The features set down in the table as characteristic of *G. littoralis* of Sars are nearly all re-found in the 2nd (or 3rd) post-larval stage of *U. deltura* as described by Webb p. 97—102; the points, where differences are found, are two or three only (out of 8) viz. the arrangement of setae on the exognath of the 2nd maxilla and the form of the margin (slightly concave or straight) and its furnishing with setae. Such minute differences can of course be of value when they are

<sup>1</sup>) The moulting from the 2nd to the 3rd stage was not observed by Webb who writes, "it is extremely probable that the more advanced stage found among preserved specimens is the 3rd post-larval stage". I am not quite convinced that Webb is right in this supposition because, firstly the morphological differences between the two stages are very small and, secondly the growth between the two stages then is very small, the 2nd post-larval stage measuring "just over 4 mm." and the 3rd "nearly  $4\frac{1}{2}$  mm." only.

and by a comparative investigation of one and the same investigator; when they, however, appear from the researches of two quite independent investigators each working his own material their value is much enhanced.

*Callianassa subterranea* Mont.

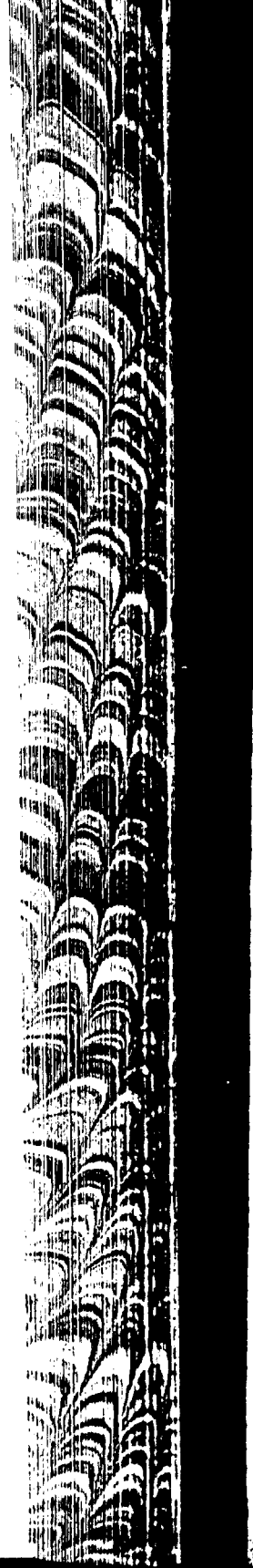
*Callianassa subterranea* de Man 1928, pl. I figs. 1—1 g.

*Callianassa subterranea* J. Lutze 1938 figs. 28—51.

Danish Records: This species which is not hitherto recorded in Denmark was found in the stomachs of haddock from the following localities in the eastern North Sea off the coast of Jutland: The Herring Reef ca. 30 m. Oct. 1927; 41 naut. M. W. of Thyborøn, in Nov. 1925; 35 naut. M. NW. of Lyngvig L. 38 m., Dec. 1st, 1925, and 46 naut. M. W. of Thyborøn 46 m. Nov. 3rd, 1925. It has further been caught in the Knudsen bottom sampler from the S/S "Dana" on 55°06' N. Lat. 6°05' E. Long. 40 m. (10 spec. on 0.1 m.<sup>2</sup>) and 55°18' N. Lat. 4°40' E. Long. 38 m. (4 spec. on 0.1 m.<sup>2</sup>) June 17th, 1934 (Aage J. C. Knudsen leg.), and off Frederikshavn (the Kattegat) 1938 (H. Nielsen leg. Z. M.).

Distribution: The Swedish coasts of Skagerak and the northern Kattegat (G. Gustafsson, 1935), the southern part of the North Sea (J. Lutze 1938), the Channel, the Atlantic coast of W.-Europe and the Mediterranean Sea, in the Mediterranean Sea it is however very rare (de Man 1938, 2).

Remarks: This species is generally found in depths between 10—60 meters, where the species of *Upogebia* are found also; *Upogebia* is however found in lower water also which is not the case with *Callianassa*. In the Swedish Fjords Gustafsson (1935) found the same difference regarding the distribution of these species as *U. deltura* where occurs in depths between 10 and 14 meters, *U. stellata* between 15 and 30 m. and *Callianassa* between 30 and 60 m. In suitable localities in the eastern North Sea *C. subterranea* is obviously very common as appears from the large catches made by the Knudsen bottom sampler. From the North Sea and adjacent waters 3 species of the genus *Callianassa* have been recorded, viz. *C. stebbingi* Borradaile (= *C. laticaudata* Otto according to de Man 1928, 2), *C. subterranea* Mont., and *C. helgolandica* Lutze; the last mentioned species was established by J. Lutze in 1938. The two first mentioned species may according to M. Selbie (1914) be separated as follows:



Third maxillipeds pediform, slender; telson as long as the inner branch of the uropods ..... *C. subterranea*  
 Third maxillipeds operculiform, third and fourth joint very broad, last three joints slender; telson distinctly shorter than the inner branch of the uropods ..... *C. stebbingi*

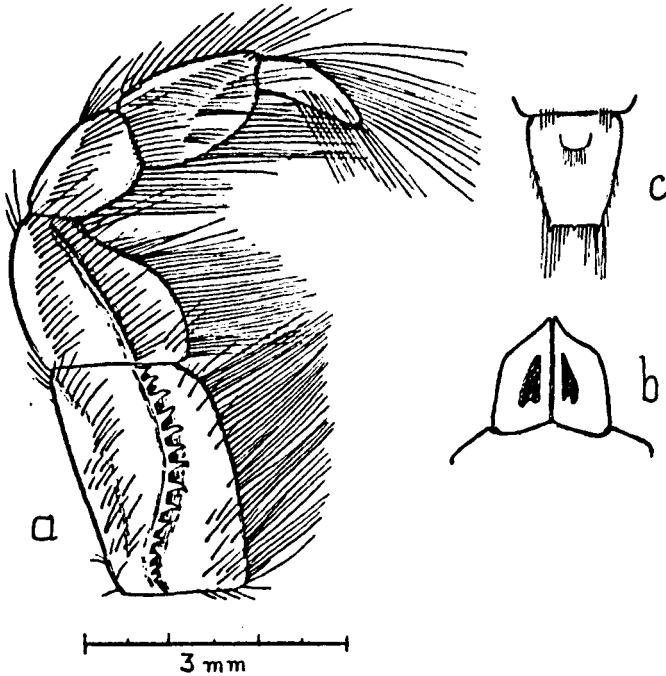


Fig. 10. *Callianassa subterranea* Mont., length ca. 7 cm., the Jutland Bank; a endopod of 3rd maxilliped, seen from the inside, b the eye-stalks, c the telson seen from above, the size-scale refers to a only.

In fig. 10 is shown the third maxilliped, the eye-stalks, and the telson of a specimen caught 41 naut. Miles W. of Thyborøn; the 3rd mxp. is slender, not operculiform, as in *C. stebbingi* (cf. C. M. Selbie's figs. 8 and 9 pl. XIV) and the telson is very nearly as long as the inner branch of the uropods. Also the fact that the eye-stalks are distinctly longer (20 units of scale) than broad (15 units of scale) (a character given by de Man (1928) and J. Lutze (1938)) shows that the individuals from the eastern North Sea belong to the species *C. subterranea*.

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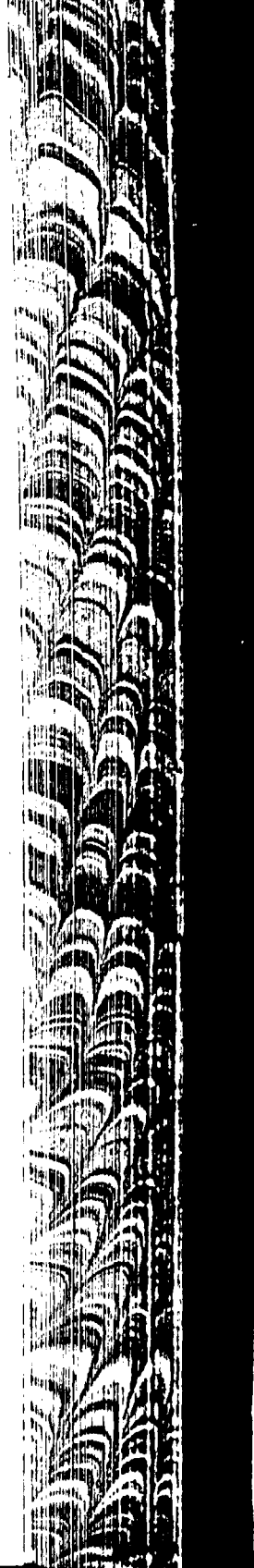
defined by the above mentioned three authors. The shape of the 3rd mxp. is elucidated by the following measurements (in units of micrometer scale) from 3 spec. caught in the eastern North Sea:

	Length			Breadth		
Carapace	19	15	20	6	5	7
Propodus	25	19	25	16	11	17
Carpus	24	15	24	15	11	15
Merus	28	18	28	26	17	28
Ischium	47	42	52	27	21	31

The comparatively slender form of the 3rd mxp. in these specimens is seen from the fact that merus + ischium is here 3 times as long as broad against in *C. stebbingi*, according to Selbie's and Lutze's measurements only 1.4 times as long as broad. The merus and ischium are in the Danish specimens nearly twice as broad only as the carpus and propodus against in *C. stebbingi* according to Selbie 4 times and to Lutze 3 times as broad as the carpus and propodus. The shape of the various parts of the caudal fan appears from the following measurements given in units of micrometer scale from 4 specimens of the Danish material (eastern North Sea):

Telson		Endopodite		L. of telson in % of length of endopodite	L. of telson in % of width of telson	L. of endop. in % of width of endopodite
length	width	length	width			
95	84	92	80	103	113	115
93	76	88	70	106	122	126
80	66	85	70	94	121	121
84	65	87	68	96	129	124

Telson is thus of about the same length as the endopodite at any rate "not distinctly shorter" (Selbie's and Borradaile's character for *C. stebbingi*); further the telson is nearly  $\frac{1}{6}$  longer than broad; according to Borradaile it is in *C. subt.* "long" and in *C. steb.* "as broad as or broader than long". Concerning the form of the endopodites Borradaile writes "Endopodite of medium width or broad" in *C. subt.* against "narrow" in *C. steb.*; in the Danish specimens the length of the endopodite is about 120% of the width, a joint of this shape may rather be said to be "of medium width or broad" than to be narrow. Thus there is hardly any doubt that the species of *Callinectes* found along the Danish North Sea coast (and probably elsewhere



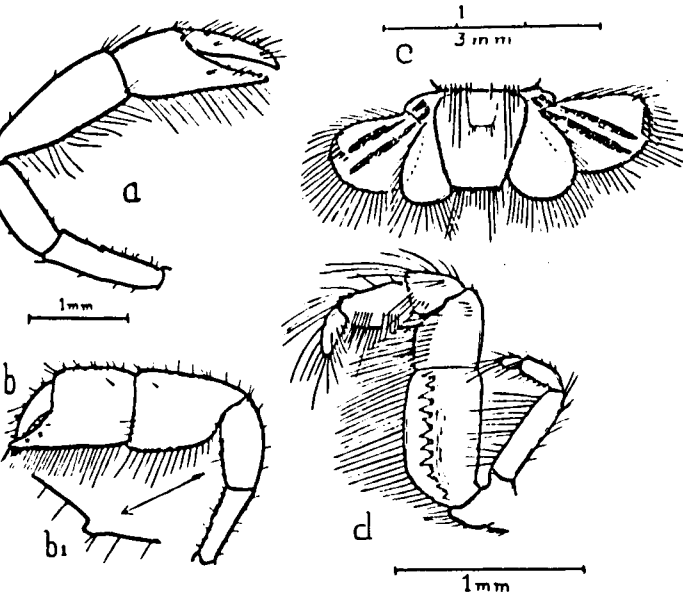
in the South Scandinavian waters (cf. Gustafsson, 1935) is *C. subterranea* or the same species as is found in the German Bay.

From the German Bay J. Lutze (1938) has described a new species: *Callianassa helgolandica* based on two specimens, one with a length of 10 mm., the other still smaller; a third specimen which Lutze found later is mentioned in a foot-note, as the size of this specimen is not stated, it must be assumed to be of the same small size as the two others of which that with a length of 10 mm. is described and figured by Lutze (l. c. p. 174—175 figs. 52—61). However, it is hardly advisable to establish new species on young specimens, especially within the Decapoda where so many "new species" have been reduced to developmental stages of other species. Apart from the small size the shape of the limbs of *C. helg.* indicates that the specimens in question are quite young ones and yet not fully developed. Further many of the morphological features mentioned by Lutze as characteristic of *C. helg.* are found in the post-larval stages of *C. subt.* as well, as it will appear from the following survey of *C. subt.*, *C. helg.*, and *C. subt.* post-larva based on the descriptions and figures published by Lutze.

	<i>C. helg.</i>	<i>C. subt.</i> adult	<i>C. subt.</i> post-larva
1. Eye-stalks	broader than long	longer than broad	?
2. Flagellum of 1st antenna	shorter than peduncle	longer than peduncle	shorter than peduncle
3. 3rd maxilliped	subpediform	pediform	pediform
4. Process on merus of 1st large pereiopod	only a tooth	large sharp curved hook	absent
5. 1st small pereiopod, carpus	not as broad as propodus	as broad as propodus.	not as broad as propodus <sup>1)</sup>
6. 2nd pereiopod, movable finger	a little longer than fixed finger	a little shorter than fixed finger	a little longer than fixed finger <sup>2)</sup>
7. 3rd pereiopod, inner margin of propodus	with small prominences only	7 rounded prominences	no prominences <sup>3)</sup>
8. Pleopods	endopodite $\frac{1}{2}$ shorter than exopodite	end. as long as exopodite	end. $\frac{1}{2}$ shorter than exopodite <sup>4)</sup>
9. Telson	as long as broad <sup>5)</sup>	longer than broad	longer than broad
10. Exopodite of uropods	no projecting part	with projecting part	no projecting part <sup>6)</sup>

<sup>1)</sup> According to fig. 98. <sup>2)</sup> acc. to fig. 99. <sup>3)</sup> acc. to fig. 100. <sup>4)</sup> acc. to fig. 102. <sup>5)</sup> acc. to Lutze's fig. 59 however distinctly longer than broad. <sup>6)</sup> acc. to fig. 102.

As it appears from the survey there is no difference between *C. helg.* and *C. subt.* post larva as to the points 2, 5, 6 and 10, the same holds as to point 9 when the figure and not the description is considered. Regarding points 4 and 7 *C. helg.* holds a position intermediate between *C. subt.* post larva and *C. subt.* adult, and concerning point 8 the difference is smaller between *C. helg.* and *C. subt.* post larva than



1. *Callianassa subterranea* Mont., length 12 mm., the Horns Reef Area; a small 1st cheliped, b large 1st cheliped (with the hook on the merus drawn to a larger scale), c ventral view of the gill fan seen from above, d 3rd maxilliped seen from the inside (b and c are drawn to the same scale).

between *C. helg.* and *C. subt.* adult. There is thus left point 1 (the antennal stalks) and point 3 (the 3rd maxillipeds). As to the 3rd maxilliped it is hardly possible to see why it is termed subpediform in *C. helg.* and pediform in *C. subt.* According to Lutze the 3rd maxilliped of *C. helg.* "zeigt keine Verschmelzung von Merus und Ischium. Auch kann keine Fortsetzung der Leiste auf den Merus, nicht einmal durch den Gelenkansatz, erkennen". In *C. subt.*, however, the ischium and merus are united, but according to Lutze this limb must be termed pediform because the spinous ridge of the ischium is not continued on to the merus. The main difference between the two species regarding the 3rd maxil-



liped is thus that ischium and merus are "united" in *C. subt.* but not united in *C. helg.* As, however, the coalescence of these two joints is a character acquired during the individual development there is in this case too no difference between *C. helg.* and *C. subt.* post larva. Among the Danish specimens from the Horns Reef Area were 2 small individuals of 12 and 17 mm. total length. I have examined these individuals and found (see figs. 11 and 12) that they in certain respects

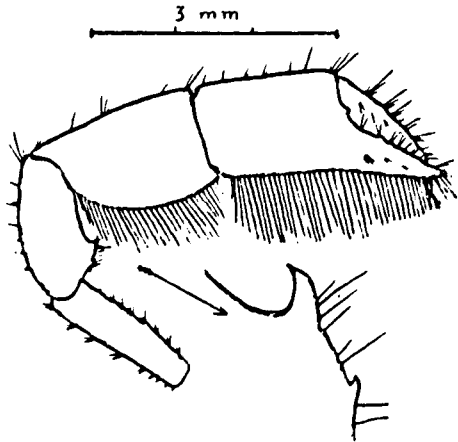


Fig. 12. *Callianassa subterranea* Mont., length 17 mm., the Horns Reef Area; large as cheliped (with the hook on the merus drawn to a larger scale).

resemble *C. helg.* whereas they in other respects hold an intermediate position between *C. helg.* and *C. subt.* This especially holds good as to the hook on the merus of the 3rd maxilliped, the point which Lutze lays most stress on. In *C. helg.* the hook is a small blunt tooth, in the Horns Reef specimen of 12 mm. length the hook is a small tooth, just as in *C. helg.*; in the specimen of 17 mm. (fig. 12) the hook is sharp and curved but not nearly as big as in the grown up *C. subt.* Also the position of the hook on the joint varies with the individual size: in *C. helg.* and in the 12 mm. long specimen the tooth is situated at the middle of the margin, in the 17 mm. long spec. it is placed on the proximal third of the joint, and finally in the grown up specimens the hook arises almost from the base of the joint. The oblique striation on the surface of the chelipeds (cf. Lutze figs. 54 and 56) is present also in the two small specimens from the Horns Reef Area, obviously as a

... a figuration on the surface but caused by the oblique muscles  
 ... through the thin integument of these young individuals.  
 As it will no doubt appear from the above, the morphological  
 ... characteristic of *C. helg.* are either found in the post-larval  
 ... of *C. subt.* or they are intermediate between the corresponding  
 ... of *C. subt.* post-larva and *C. subt.* adult, therefore, there is  
 ... every reason to doubt the validity of the species *C. helgolandica* which  
 ... previously have been established on quite young bottom stages of  
*subterranea*.

### Concluding Remarks.

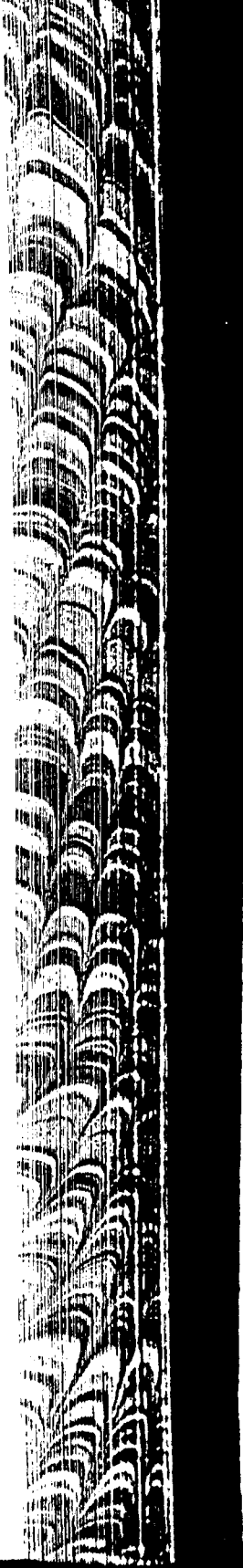
The fauna of Thalassinidea in the waters round Denmark com-  
 ... the following 6 species:

*Axius nodulosus*  
*Calocaris macandreae*  
*Calocarides coronatus*  
*Upogebia stellata*  
*Upogebia deltura*  
*Callianassa subterranea*.

The validity of the species *A. nodulosus* is discussed on p. 210.  
*Callianassa helgolandica* Lutze is not included in the survey as there  
 ... strong reasons to suppose that it is identical with young specimens  
 of *C. subterranea* (see p. 235).

The following 3 species, *Axius stirhynchus*, *Jaxea nocturna* and  
*Callianassa stebbingi* which have been found along the coasts of Great  
 Britain may possibly be found in our waters too, therefore, they are  
 included in the following key to the Danish species of Thalassinidea:

- L. 2nd pereopod simple (without chela).
  - A. Both exopodite and endopodite of the uropods with suture. . .  
*Jaxea nocturna*
  - B. Exopodite and endopodite of the uropods without suture. . .  
 Genus *Upogebia*
    - a. Antero-lateral thorn on carapace present. . . . . *U. stellata*
    - b. Antero-lateral thorn on carapace absent . . . . . *U. deltura*



11. 2nd pereopod with chela.
- A. A suture near the distal margin of the exopodite of the uropods.
    - a. The median carapace keel reaches to the hind margin of the carapace, no scaphocerite on the peduncle of the 2nd antenna (fig. 3) ..... *Calocaris macandreae*
    - b. The median carapace keel does not reach behind the cervical groove, long scaphocerite on the peduncle of the 2nd antenna (fig. 4) ..... *Calocarides coronatus*
  - B. No suture on the exopodite of the uropods.
    - a. Rostrum of median size, triangular with teeth .... *Azia*
      - 1. Last joint of the 3rd and 4th pereopod with fossorial comb (fig. 2 g)..... *A. nodulosus*
      - 2. Last joint of the 3rd and 4th pereopod simple..... *A. stirhynchus*
    - b. Rostrum very small, without teeth (distal part of large cheliped broad and flattened) ..... *Callianassa*
      - 1. Merus of 3rd maxilliped not broader than long (fig. 1b), telson longer than broad ..... *C. subterranea*
      - 2. Merus twice as broad as long, telson as broad as or broader than long ..... *C. stellata*

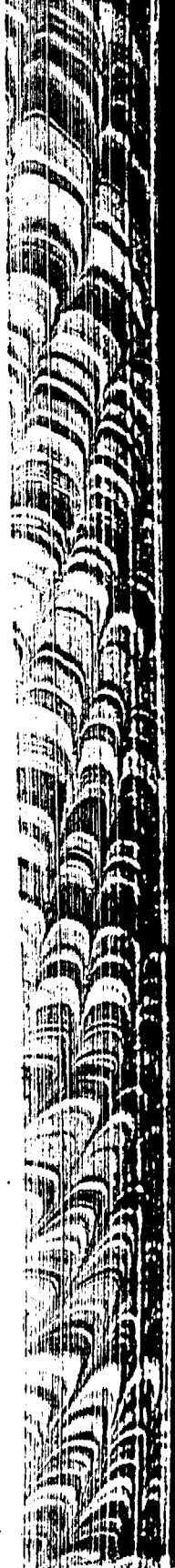
None of the species of the *Thalassinidea* penetrate into the inner, more or less brackish, Danish waters (see the map, fig. 1). *C. macandreae* is the species which penetrates farthest south within our waters, occurring as far south as east of Anholt, (the central Kattegat) where it has been found at a depth of 50 m., at a salinity of ca. 33 ‰; at the Lille Middelgrund it has been found at a depth of only 13 m. i. e. in a salinity of about 28 ‰. *U. stellata* is found nearly as far south as *C. macandreae*, viz. at the Lille Middelgrund northeast of Anholt at a depth of 33 m., at about 32—33 ‰ salinity. Thus these two species are found in the central Kattegat. The northern Kattegat is the inner limit of *Upogebia deltura* and *Callianassa subterranea*, both being found east of Frederikshavn, *U. deltura* at a depth up to 22 m. or at ca. 32 ‰ sal.; for the locality of *C. subterranea* no depth is stated. *Calocarides coronatus* has been found only in the deep northwestern Skagerrak (ca. 450 m.). The lowest temperature (in the winter) of the bottom water in the localities are as follows: East of Anholt, 30 m., 4.3° C. N. of Læsø, 20 m. 3.3°. The mean temperatures (C°) during the summer

months i. e. when the larval development takes place are for the surface- and bottom water as follows (after "Mean Values of Observations from Danish Light-Vessels", Publ. fra det danske Meteorologiske Institut, 1933):

	Depth to bottom	July		August	
		0 m.	bottom	0 m.	bottom
1 Horns Reef <sup>1)</sup> .....	30 m.	14.9	12.4	15.7	14.6
2 The Skaw Reef .....	30 m.	15.8	12.7	16.0	14.4
3 Læsø Trindel .....	30 m.	16.5	11.7	16.3	13.9
4 Anholt Knob .....	28 m.	16.8	9.7	16.7	12.7
5 Schultz' Grund .....	26 m.	16.5	7.5	16.6	10.3

The reason why the *Thalassinidea* are not found further towards the Baltic in our waters can hardly be the decreasing salinity, as this even in parts of the Belt Sea at the bottom is as high as on the more shallow localities where Thalassinids were found in the northern Kattegat. The limiting factor may rather be found in the temperature at the summer when the larvae are developing. The temperature of the surface water is nearly the same as well in the northern Kattegat where larvae of *Upogebia* have been found, as in the southern Kattegat where neither larvae nor adult specimens have been found. As to the temperature of the bottom water, however, there is a marked difference, the bottom water in the southern Kattegat being considerably colder than in the northern Kattegat, therefore, there is reason to suppose that the comparatively low bottom temperature is not suitable to the young bottom stages of the *Thalassinidea*, whose main area of distribution is to the south of our waters. In this connection it is of interest to note that the *Thalassinidea* do not occur in arctic or subarctic waters. Along the Norwegian coast no *Thalassinidea* has been found further north than ca. 63°30' N. Lat. (Runnstrøm, 1925). From the coasts of the Faroes, Iceland and Greenland Thalassinids have not been recorded (K. Stephensen, 1939). The northernmost locality in the Atlantic Ocean (apart from the Norwegian coast, where species of this group have been observed) is south of Iceland on 62° N. Lat. where *Cal. macandreae* were found at a depth of ca. a thousand metres (H. I. Hansen, 1908). Apart from *Calocarides coronatus*, which is endemic for the South-Scandinavian waters—at any rate not yet found

<sup>1)</sup> The positions of the light-vessels are shown by their numbers on the map fig. 1.



elsewhere—all the species of *Thalassinidea* recorded from our waters are found further to the south too, and they have within the waters between Scandinavia and Great Britain the northern borders of their area of distribution.

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