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## Some notes on the taxonomy, the distribution and the ecology of four species of the Amphipod genus Corophium (Crustacea, Malacostraca)


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This paper deals with the three species of the genus *Corophium*, described by CRAWFORD, 1937, viz. *C. arenarium*, *C. insidiosum* and *C. sextoni*, and with a new species, belonging to the *volutator* group, which I propose to call *C. multisetosum*.

1. TAXONOMIC NOTES.

a. *Differences between C. arenarium and C. volutator.*

*Corophium arenarium* was first described by CRAWFORD in his excellent review of the entire genus, in 1937. In the description, the author expressed his doubt already whether it might be a distinct species or merely a variety of *C. volutator*. CRAWFORD's observations on the variation of the number of spines on antenna II, segment 4 and 5, suggest that it is only a variety.

CHEVAIS, 1937, does not give a definite opinion, whether he considers the species distinct from each other or not. For biometrical reasons, as well for reasons of variation observed by other authors, he suggests, however, that *C. volutator* and *C. arenarium* are only local races of one species.

CRAWFORD remarks, that male specimens of *C. arenarium* "can scar-

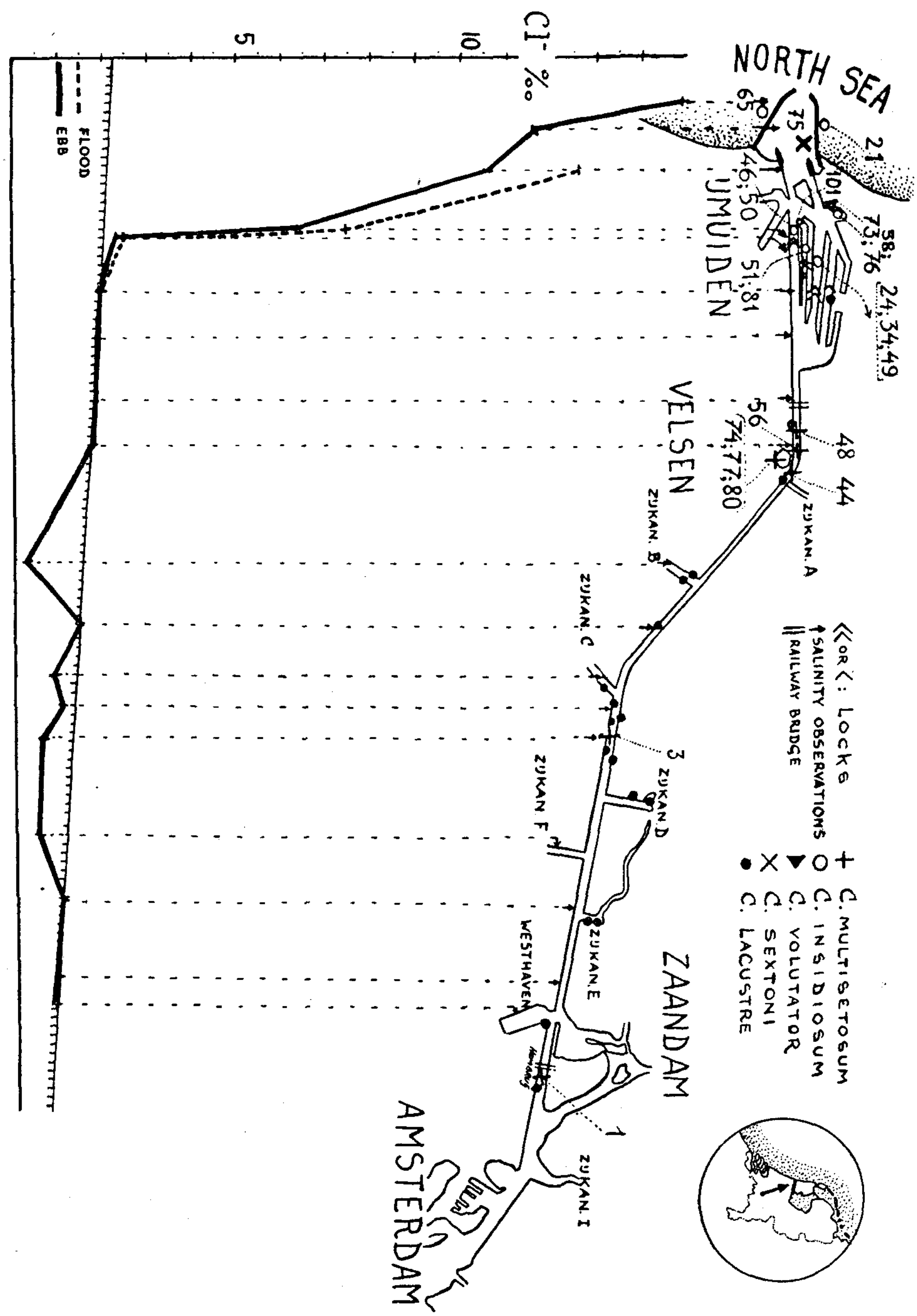


Fig. 1. *Map of the basin of the North Sea Canal, showing the Stations at which Corophium was captured.*

Stations of C. acherusicum Costa have been omitted from the map. The species is usually found together with C. insidiosum Crawf.

Inset right top corner: The Netherlands, showing the geographical position of the North Sea Canal.

The curves below show the salinity (indicated in ⁰/₀₀ Cl. ) in the Canal on October 6, 1952 The continuous line represents the salinity at low tide, the interrupted line that at high tide. The influence of the tides upon the salinity outside the locks is considerable, inside the locks it is negligible.

The curve shows distinctly that the salinity in the part of the canal landward of the locks, increases regularly seaward; the progress of the increase is shown by the crenulated line. The divergence of the salinity curve from the crenulated line is caused by the inflow of fresh water from the branch canals ("zijkan." in the map) and from the pumping-engines, and by the inflow of salt water near locks at IJmuiden. Outside the locks, the salinity increases rapidly to full North Sea value.

cely be distinguished from *C. volutator*, except by their smaller size and different habitat." The females can only be distinguished by the armature of segment 4 and 5 of antenna II, but this armature appears to be dependent on variation. In the specimens I studied, I never observed a variation similar to that described by CRAWFORD. All my specimens (more than 50 in number) closely resemble typical *arenarium*. There is, however, another, more important reason for considering the species distinguishable. Both males and females are perfectly distinguished from *C. volutator* by the structure of the peduncle of the first uropode. The outer edge of the peduncle is armed distally with paired and unpaired spines. The spines are proximally replaced by a number of setae *). These setae are essential, since they are lacking in *C. volutator*. CRAWFORD does not mention these setae, though he describes the first uropod in great detail. His figure (1 G) indicates, however, a single seta proximally of the spines. He may have overlooked one or more additional setae. The total number of setae varies from 3 to 8. There appears to be a rather regular correlation between the number of setae and the number of distal spines on the peduncle. If there are few setae, there are many spines, and vice versa. The total number of spines and setae together is constant and amounts to 14—16. In very large, quite adult, specimens, this number may be somewhat larger. The number of setae in such specimens is usually considerable (about 8) and the number of paired spines is larger also.

I am of opinion that *C. arenarium* is a distinct species, possessing characters in the armature of the second antennae (female) and the armature of the first uropod (both sexes), which are sufficient to distinguish it from *C. volutator*.

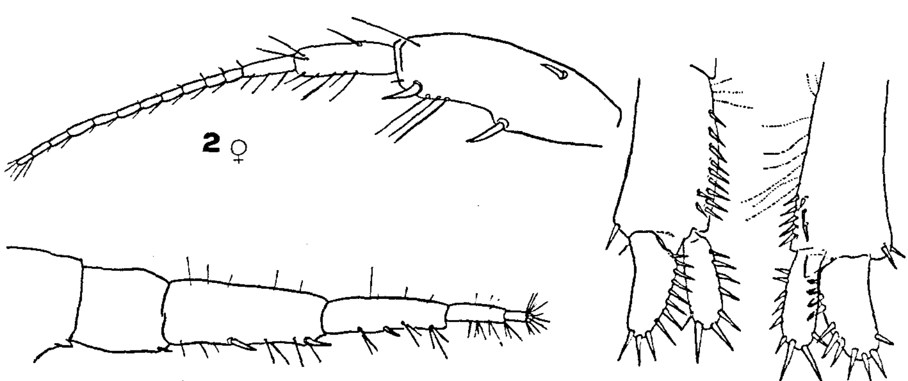


Fig. 2—5. *Corophium arenarium Crawford*. 2, Antenna I, female. 3, Antenna II, female. 4, Uropod I. 5, Uropod I of another specimen.

b. *Description of C. multisetosum n.sp.*

To our surprise the Dutch brackish waters, thoroughly investigated though they are, yielded an as yet undescribed species of *Corophium*. It may be assumed that the species hitherto has been confused with the closely related *C. volutator*, which has been reported frequently from brackish or nearly fresh waters.

*) For studying the number of spines and setae it is best to isolate the first uropod, for some setae borne on the urosome may easily be mistaken for pedunculous setae.

*Localities*: Up to now the species has been found only in Dutch waters, during the investigations in the basin of the North Sea Canal (Noordzeekanaalonderzoek) and during the investigations of the research vessel „Meerval", 1918—1932. I am much indebted to Miss A. P. C. DE VOS, of the Zoological Museum Amsterdam, who kindly put the entire *Corophium* collection of the „Meerval" at my disposal.

The species was captured by the „Meerval" in the following stations:

1921. Sta. 7. Ditch along Twijverweg, near Pancras. Depth 1.40 m. Mar. 18. Cl.$^-$ 1.05$^0/_{00}$. 1 male (juv.), Z.M.A. coll. no. Amph. 100,331.

1922. Sta. 47. Vaart near Grote Del, Geestmerambacht polder. Depth 1.40 m. May 5. Cl.$^-$ 2.02$^0/_{00}$. 1 female, Z.M.A. coll. no. Amph. 100,373.

1922. Sta. 112. Mouth, of the Eem. Depth 1.50 m. Aug. 3. Cl.$^-$ less than 1$^0/_{00}$. 1 female, Z.M.A. coll. no. Amph. 100,374.

1922. Sta. 133. Eem near Baarn. Depth 2.80 m. Aug. 15. 2 females, 1 male, 1 juvenile, Z.M.A. coll. no. Amph. 100,375.

1922. Sta. 141. Eem South of Springstok. Depth 2.90 m. Aug. 16. Cl.$^-$ less than 1$^0/_{00}$. Many specimens, Z.M.A. coll. no. Amph. 100,376.

1922. Sta. 143. Eem South of Kleine Gat. Depth 2.90 m. Aug. 16. About 85 specimens, Z.M.A. coll. no. Amph. 100,342, and 100,377.

1926. Sta. 75. Spui near pedestrian ferry. Depth 2.70 m. Dredge. 18 females, 2 males, 11 juveniles, Z.M.A. coll. no. Amph. 100,403.

The species was captured in the following stations in the basin of North Sea Canal:

Sta. 1. Southern bank of the Canal, near the Hembrug. Apr. 22, 1950. Depth 2 m. 1 female (Z.M.A. coll. no. Amph. 100,320), building free tube on a cable. Salinity 1.82$^0/_{00}$ Cl.$^-$ The salinity in this locality fluctuates between Cl.$^-$ 0.8$^0/_{00}$ and Cl.$^-$ 3.3$^0/_{00}$. Annual average in 1950 Cl.$^-$ 1.9$^0/_{00}$. Annual average in 1951 Cl.$^-$ 1.6$^0/_{00}$.

Sta. 3. Southern bank of the Canal, near Pumping-station Houtrakpolder. April 29, 1950. Depth 1 m. 1 female (Z.M.A. coll no. Amph. 100.330). Building free tube on stone. Salinity 1.95$^0/_{00}$.

Sta. 44. Southern bank, near shed of "Ballast Mij.", Velsen. Apr. 21, 1951. Depth 1 m. 2 females (Z.M.A. coll. no. Amph. 100,322), building free tube on pole. Salinity 1.30$^0/_{00}$. The salinity in this locality changes from 0.97$^0/_{00}$ Cl.$^-$ to 3.13$^0/_{00}$ Cl.$^-$ Annual average in 1950 2.1$^0/_{00}$ Cl.$^-$ Annual average in 1951 1.8$^0/_{00}$ Cl.$^-$

Sta. 48. Southern bank, western landing stage of ferry-boat, Velsen. May 13, 1951. Depth 1 m. 8 specimens, females and juveniles (Z.M.A. coll. no. Amph. 100,323), building free tubes upon Cordylophora caspia. Salinity 1.25$^0/_{00}$ Cl.$^-$ Fluctuation and average: similar to Sta. 44.

Sta. 56. A few hundred meter W. of the locality of Sta. 44. June 6, 1951. Small trawl, depth about 5 m. 1 ovigerous female (Z.M.A. coll. no. Amph. 100,324), burrowing in clayish black mud. Salinity 1.72$^0/_{00}$ Cl.$^-$ Fluctuation and average: similar to Sta. 44.

Sta. 74. Building pit of lay-out of the tunnel, Velsen. May 10, 1952. Depth 4 m. 1 male, burrowing in muddy sand (Z.M.A. coll. no. Amph. 100,325). Salinity 1.50$^0/_{00}$ Cl.$^-$ Fluctuation of salinity from 1.00 to 1.60$^0/_{00}$ Cl.$^-$

Sta. 77. As Sta. 74. Juni 16, 1952. Depth 6.5 m. 4 males and 2 females (Z.M.A. coll. no. Amph. 100,326), burrowing in clayish sand. Salinity 1.43$^0/_{00}$ Cl.$^-$ Fluctuation compare Sta. 74.

Sta. 80. As Sta. 74. July 5, 1952. Depth 8 m. Salinity 1.08$^0/_{00}$. Fluctuation compare Sta. 74. Many specimens of both sexes, among which overigerous females (Z.M.A. coll. no. Amph. 100,327'), burrowing in reduced sand.

*Types*: The types are selected from specimens captured in Sta. 80. 1 male (Z.M.A. coll. no. Amph. 100,328) is made the species holotype; 1 female is allotype (Z.M.A. coll. no. Amph. 100,329).

*Description*: Female (ovigerous).

Length about 8 mm. Rostrum short, triangular (fig. 11). Eyelobes rounded, not reaching to tip of rostrum. Eyes well-pigmented.

Antenna I: slightly longer than ¼ of the total length of the body. Segment 1, lower edge armed with 2 proximal and 1 distal spine (fig. 6). Proximally of the first spine 2—5 long setae. The concave edge between the 2nd and 3rd spine bears a great many (about 14) of long setae. On this character the proposed trivial name is based. Inner edge of segment 1 with 1 (left) or 2 (right) spines, near te base. Segment 2 and 3 with several long setae. The relative proportions of segments 1, 2 and 3 amount to: 40-19-12. Flagellum 13- or 14-segmented.

Antenna II: somewhat longer than $^1/_3$ of the total length of the body. Penultimate joint of peduncle produced at the lower distal end in a long toothlike projection, which is $^1/_3$ as long as the last peduncular joint. The sinus at the base of the terminal projection is much less defined

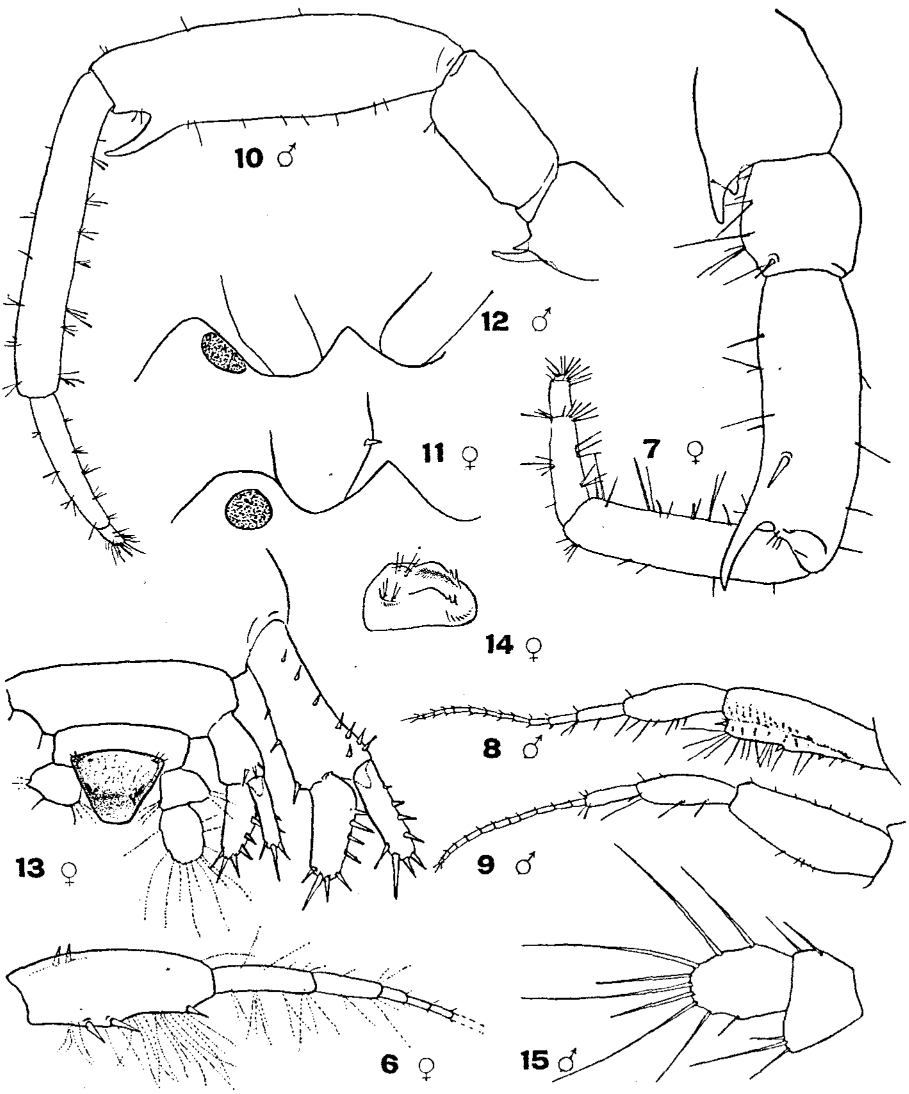


Fig. 6—15. *Corophium multisetosum* n.sp. 6, Antenna I, female, in lateral view. 7, Antenna II, female. 8, Antenna I, male, in lateral view. 9, Antenna I, male, in dorsal view. 10, Antenna II, male. 11, Rostrum and eye-lobe, female. 12, Rostrum and eye-lobe, male. 13, Urosome, female. 14, Telson, female, in lateral view. 15, Uropod III, male.

than that occurring in C. volutator. But for the terminal projection, the penultimate joint bears a spine at about 3/5 of the way to the distal end. Last peduncular joint slightly shorter than the preceeding, and provided with some setae, but without any spines. Flagellum much shorter than that joint, 3-segmented.

Mouth-parts, legs 1—7 and pleopods are very similar to those parts of C. volutator.

Urosome distinctly segmented. Uropod I : outer edge of peduncle with about 7 spines in a row and 1 outside the row. The inner edge with 2—3 spinules. Distal end of peduncle with triangular projection. Rami each with about 8 spines. Uropod II : peduncle with 3 spines ; ending distally in a triangular projection. Rami with 5 or 6 spines. Uropod III : pedunculus roughly trapezium-shaped, inner and outer edge with 2—3 setae. Ramus elongate-ovate, inserted excentrically. The peduncle therefore gives an impression to be projected laterally. Telson is a tri-dimensional body, of a somewhat rounded triangular shape. Each proximal corner is slightly raised and provided with 4 small setae. Parallel to the margins of the telson runs on each side a projecting crest, which terminates distally in 2 recurved denticulations. These details are best seen in lateral view (cf. fig. 14).

Male.

Length about 6 mm. Rostrum as in female. Eye-lobes triangular, rounded at tip, longer than the rostrum.

Antenna I slightly shorter than half the length of the body. First segment with a lamellar basal expansion, which bears 10 or more setae and 3—4 small basal and 1 small terminal spine. Inner edge of first joint without spines, with a few short setae only. The relative length of the peduncular joints amounts to : 38—27—15. Flagellum with 13 or 14 joints.

Antenna II as long as the total length of the body. Penultimate joint of peduncle terminating in a tooth-like projection, defined above by a deep sinus. This joint, and the following one, without spines.

First uropod : rami with about 10 spines.

Other features as in female.

*Remarks* : The proposed new species evidently is restriced to less saline waters. In the greater part of the known localities it occurs together with C. *lacustre*. In one place only (Meerval Sta. 1922/112) it has been found together with *C. volutator*.

*Affinities* : The species is closely related to the widely distributed *C. volutator* (PALL.) and to the Caspian *C. monodon* G. O. SARS, but both male and female of *C. multisetosum* are quite distinctive from these species, as the following table shows :

FEMALE

| *multisetosum* | *volutator* | *monodon* |
|---|---|---|
| **Antenna I, lower edge of segment 1:** | | |
| with 3 spines and about 14 setae between 2nd and 3rd spine | with 2 (rarely 3) spines and only 3 (rarely 4) setae between them | only 1 terminal spine and sparingly setous |

| | *multisetosum* | *volutator* | *monodon* |
|---|---|---|---|
| **Antenna II, penultimate joint of peduncle:** | with 1 spine and a terminal tooth, which is $^{1}/_{3}$ as long as the following joint | without spines; terminal tooth hardly overreaching the tip of its own joint | without spines; tooth $^{1}/_{3}$ as long as last peduncular joint |
| **Uropod I, outer edge of peduncle:** | with 8 spines, 6 of which are unpaired, the remaining two forming a pair | with 10 or more unpaired spines | with 10 or more unpaired spines |
| **Uropod II, peduncle:** | with 3—4 spines and a prominent triangular projection | with much more spines and with the triangular projection scarcely visible | with 3—4 spines |
| **Uropod III, ramus:** | set off excentrically. Lateral projection of peduncle as wide as the basal diameter of the ramus. Ramus ovate, armed with setae only. | hardly set off excentrically. Lateral projection of peduncle insignificant. Ramus ovate, armed with setae only. | set off excentrically. Lateral projection of peduncle as wide as the basal diameter of the ramus. Ramus elongate, with parallel margins, with 1 spine and some setae. |
| MALE | | | |
| **Antenna I, lower edge of segment 1:** | with lamellar expansion, which bears 4—5 small spines and numerous setae | without expansion, with 2 small spines and few setae | without expansion, with 1 terminal spine and very numerous setae |
| **Antenna II, last peduncular joint:** | without dentiform process | without dentiform process | with small dentiform process |
| **Uropod I, II and III:** | as in female | as in female | as in female. |

MERCIER, 1920, and HART, 1930, described the variation in *C. volutator*. MERCIER found males and females, which showed an aberrant armature of the first antenna. He considered these aberrations "variations de place" and he remarked, that they occur more frequently in specimens from water with comperatively low salinity than in marine specimens. HART, 1930, did not find any variation in the males; in females he observed similar aberrations as described by MERCIER, but he explained them in quite a different way. According to him, the salinity has no influence on the spination. Aberrant specimens are found especially in summer, variation being due to enlarged metabolism during that time.

In any case, MERCIER's and HART's observations show that among normal specimens of *C. volutator* (with 2 spines on the lower edge of antenna I) aberrant specimens may be found, having 3 or 4 spines on that place. In *C. multisetosum* 3 spines are present. This, as well as the fact that the species was found in nearly fresh water (just as MERCIER's aberrant material) might suggest that it is only a variety of *C. volutator*. The remaining characters, however, point clearly to its being a distinct species.

## 2. NOTES ON THE DISTRIBUTION.

A number of new localities may be recorded for *C. insidiosum*, *C. sextoni* and *C. arenarium*. All records are based on material collected by myself during the last few years. All specimens are preserved in the Zoological Museum, Amsterdam.

### a) *C. arenarium* CRAWFORD.

I collected the species in four localities, which extend its range from the southern part of Jutland to Bretagne.

— Intertidal flat of slightly muddy sand near Mont St. Michel (France). Aug. 23, 1951. Very common. Zoological Museum Amsterdam, collection no. Amph. 100,175.

— Zuidwal, intertidal flat of slightly muddy sand near Den Helder (Netherlands), together with *Bathyporeia sarsi* WATKIN and *Haustorius arenarius* (SLABBER). Juni 27, 1949. Z.M.A. coll. no. Amph. 100,037. The Zuidwal does not exist any longer; it disappeared at the time of the extension of the navel port. In 1949 the species was quite common in this locality; it is not present, however, in earlier collections from the same place.

— Eastern part of the Bosplaat (Island of Terschelling, Netherlands), in pure sand at the extreme high water mark, together with *Bathyporeia* spec. Apr. 30, 1950. Very common. Z. M.A. coll. no. Amph. 100,038. Several females bear eggs.

— Ho Bugt (S.W. Jutland). Between the tide marks on sandy beach. July 30, 1952. 1 specimen. Z.M.A. coll. no. Amph. 100,378.

### b) *C. sextoni* CRAWFORD.

This species has been collected in two localities, extending the range from the mouth of the Tagus (Portugal) to the Netherlands.

— Rocky coast near Douarnenez (Bretagne), low tide, very abundant on weeds, sponges, ascidians, etc. Full Atlantic salinity. Aug. 19, 1951. Z.M.A. coll. no. Amph. 100,191.

— IJmuiden (Netherlands), inside the Northern pier, small trawl. May 11, 1952. A single specimen on *Clava multicornis*. (Noordzeekanaalonderzoek Sta. 75). Z.M.A. coll. no. Amph. 100,319.

### c) *C. insidiosum* CRAWFORD.

This species was collected in numerous localities in the Netherlands. It has not been recorded before as belonging to the Dutch autochtonous fauna.

— Common in the entire part of the basin of the North Sea Canal, outside the locks at IJmuiden. Captured in Noordzeekanaalonderzoek Sta. 21, 24, 34, 46, 49, 50, 51, 65, 73, 76, 81, 97, 101. It is noteworthy that two of these stations are situated outside the piers of IJmuiden, consequently in contact with North Sea water of full salinity. For the situation of the stations, see map.

— Abundant in the Canal through the Isle of Beveland, Netherlands. Several localities, situated along the Canal, have been investigated during 1950 and 1951.

— Canal through the Isle of Walcheren, Netherlands. A few specimens. Dec. 28, 1951. Collected by Mr. H. de Vuijst. Z.M.A. coll. no. Amph. 100,252.

— Ambleteuse, Pas de Calais (France). July 6, 1951. Two females (Z.M.A. coll. no. Amph. 100,255) were collected from littoral weeds. Water of full Atlantic salinity.

3. Ecological notes.

a) *Substratum.* As far as we know, all species of the genus build tubes of mud. There are two different kinds of tubes: (1) the tube has been burrowed in the bottom, which may vary from firm sand to soft mud and (2) the tube has been build upon a sessile substratum: camp sheddings, jetties, cables, buoys, weeds, sponges, etc. It was assumed till now that each species was able to build tubes of one type only, either in the bottom, or upon the substratum. A burrowing species would never build a free tube upon some substratum, and the free tube builders would never burrow. I have found two curious exceptions to this rule. Two species, *C. insidiosum* and *C. multisetosum*, are able to construct tubes of both types, depending on the nature of the bottom. Research may reveal more species of the genus *Corophium*, which are able to do so.

*C. insidiosum*, described and usually found as building tubes upon fixed objects, has been found in tubes of the other type. During an investigation on the fauna of the brackish waters of the basin of the North Sea Canal (a canal connecting Amsterdam with the North Sea), I found *C. insidiosum* in plenty together with *C. volutator*, burrowing in a mud flat. The mud flat is situated outside the locks of IJmuiden, hence subject to tide waters. I frequently visited the locality (Noordzeekanaal-onderzoek Station 58, 73 and 76, cf. map), which is used as a salving harbour, and always I was able to collect *C. insidiosum* in a sieve. The species was building U-shaped tubes, like *C. volutator*. Said locality is the only one in which *C. insidiosum* had been found in the burrowing stage. It was by no means rare in that place: it is even 2 or 3 times as common as *C. volutator*. In favourable places I sieved about 10 specimens from 1 dm$^2$. The salinity during the observations changed from Cl.$^-$ 5.1 $^0/_{00}$ to Cl.$^-$ 12.2 $^0/_{00}$. This curious habitat of *C. insidiosum* may be due to circumstance, that no sesile objects are in the neighbourhood, whereas the remaining conditions, such as food, salinity, enemies, competition, are optimal for the species. The kind of tube evidently is not of primary importance, and the type of tube may change if no fixed objects are available.

In the remaining part of the harbour of IJmuiden, the conditions of salinity and food are similar to that found in the salving harbour. Moreover there are, however, plenty of fixed objects. As was to be expected, *C. insidiosum* is common here too, but now quite normally, building tubes upon the substratum.

The very same case, the different kind of tube according to the nature of the substratum, other conditions being optimal, has been found in *C. multisetosum*. The normal habitat of the species is in burrows in clay or sand, in almost fresh water. In other localities, food and physical conditions being nearly the same, *C. multisetosum* has been found in tubes of mud upon fixed substratum. In these cases, there was no muddy bottom available to burrow in. Under these conditions, the species is always accompanied by *C. lacustre* VANHÖFFEN, another non-burrowing species. The tubes of *C. multisetosum* and those of *C. lacustre* proved to be of just the same construction.

In the normal, burrowing, stage, *C. multisetosum* is common in its type locality (Noordzeekanaalonderzoek Sta.80, cf. map): about 20 specimens on 1 dm$^2$. The other kind of tube, on the contrary, is very rare. Sometimes I was able to collect 1 single specimen of *C. multisetosum* only among several thousands of *C. lacustre*. *)

b) *Salinity*. It is known since long that several species of *Corophium* are able to resist considerable fluctuations of salinity. Several species are described from estuarine waters, the salinity of which changes at each tide. *C. volutator* (PALLAS), for instance, is known from intertidal mud flats in contact with water of full salinity, as well as from inshore waters, with low salt content.

I was not surprised to meet with two species of Corophium in the open sea, although these species had been regarded heretofore as inhabitants of estuarine waters only. *C. insidiosum*, common in less saline waters, has been recorded in a previous paper (STOCK & BLOKLANDER, 1952) from a beam drifted ashore North of Bloemendaal. The species is very numerous, moreover, in the Canal through the Isle of Beveland (Netherlands), which contains water of full salinity. A few specimens were collected on the Atlantic coast near Ambleteuse (France). *C. sextoni*, known from Plymouth waters only, and from a single female captured off the mouth of the Tagus (Portugal) has been collected in great abundance at low tide on the Atlantic coast of Douarnenez (Bretagne). It is one of the most common amphipods in that locality, which is surrounded by water of full salinity.

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*) Quite recently I received ENEQUIST's paper (1949, Zool. Bidr. Uppsala, 28) who also found a species of *Corophium* which constructed tubes of both types. He observed specimens of *C. bonelli*, normally building tubes upon the substratum, burrowing in the bottom (p. 377).