

**The Fauna of Certain Estuaries in West England and
South Wales, with Special Reference to the
*Tanaidacea, Isopoda and Amphipoda.***

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With 2 Figures in the Text.

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INTRODUCTION.

DURING the summer of 1935 Captain Nicholson of Saltash kindly put his motor-boat at my disposal and took me for seven full-day collecting trips on the estuaries of the Tamar and its confluent, the Tavy and Lynher. I also made some collections from land in the estuaries of the Plym and Exe (S. Devon), Taw (N. Devon), Camel (N. Cornwall), and Towy (S. Wales).

All collecting was done intertidally or in shallow water and was practically confined to the brackish-water reaches. No gear was used except a hand-net of stramin, and a zinc sieve of 1-mm. mesh. More attention was paid to the Crustacean orders Tanaidacea, Isopoda, and Amphipoda than to the rest of the fauna, observations on which were only occasionally made.

No salinity measurements were taken, since Percival (1929) had already recorded enough to give a general impression of salinity-range at various parts of the Tamar estuary, and I had not time for the periodic measurements necessary for a real understanding of the effect of salinity on the distribution of species.

FAUNA OF THE ESTUARIES.

Rivers Tamar, Tavy, and Lynher.

An account of the Tamar and Lynher and their fauna has already been given by Percival (1929). Some of his identifications, as I show on page 656, are probably incorrect.

In the following summary of my collecting the species are arranged in the order adopted in the Plymouth Marine Fauna (1931). The localities are considered in order from the most to the least saline, and the rivers in the order Tamar, Tavy, Lynher. Their position is shown in Fig. 1. For most of the identifications I am entirely responsible. Some specimens of the following species have, however, been examined, and their identification confirmed, by experts to whom I wish here to express my deep gratitude. *Heterotanais ørstedii*† was referred to Dr. J. H. Schuurmans Stekhoven of Utrecht; *Cyathura carinata*, *Idotea viridis*, and *Paragnathia formica* to Professor W. M. Tattersall; *Gammarus duebeni*, *G. zaddachi*, and *G. chevreuxi* to Mrs. Sexton; and *Melita pellucida* and *Leptocheirus pilosus* to Dr. K. Stephensen of Copenhagen.

ISOPODA.

- **Cyathura carinata* (Krøyer). Tavy, Mt. Jessop, in mud-flat on river bank : Lynher, Sconner Creek, in mud.
- **Paragnathia formica* (Hesse). Tavy, Mt. Jessop, under stone : Lynher, Wivelscombe Lake, Sconner Creek, in "salting cliff."
- **Sphaeroma rugicauda* Leach. Tamar, Kingsmill Lake, salting pools ; Clifton Marsh, salting pools ; Whitsam, open creek ; Haye, creek above sluice : Tavy, Mt. Jessop, under stones : Lynher, Sconner Creek, salting pools and cliff ; Wivelscombe Lake, salting pools.
- **S. hookeri* Leach. Tamar, Crosspark Wood, creek above sluice : Tavy, Lopwell Ford, main channel and creek above sluice.
- **Idotea viridis* (Slabber). Tamar, Neille Point, in weed on buoys : Lynher, Wivelscombe Lake, salting pools.

AMPHIPODA.

- Melita palmata* (Montagu). Tamar, Weston Mill Lake, near H.W.M. among weed ; Neille Pt., mussel bed and buoy ; Crosspark Wood, among *Obelaria gelatinosa* : Lynher, Rat I., pools and under stones ; Wivelscombe Lake, in ditch.
- **M. pellucida* G. O. Sars. Tamar, Haye, creek above sluice : Tavy, Blaxton (open) creek, among oak-leaves, etc. ; Lopwell Ford, creek above sluice ; Lopwell Ferry, main channel under stones.

† Krøyer's original spelling of this name was *Ørstedii* : any change beyond altering the capital to a small letter seems to me a breach of Article 19 of the Int. Rules of Zool. Nomenclature.

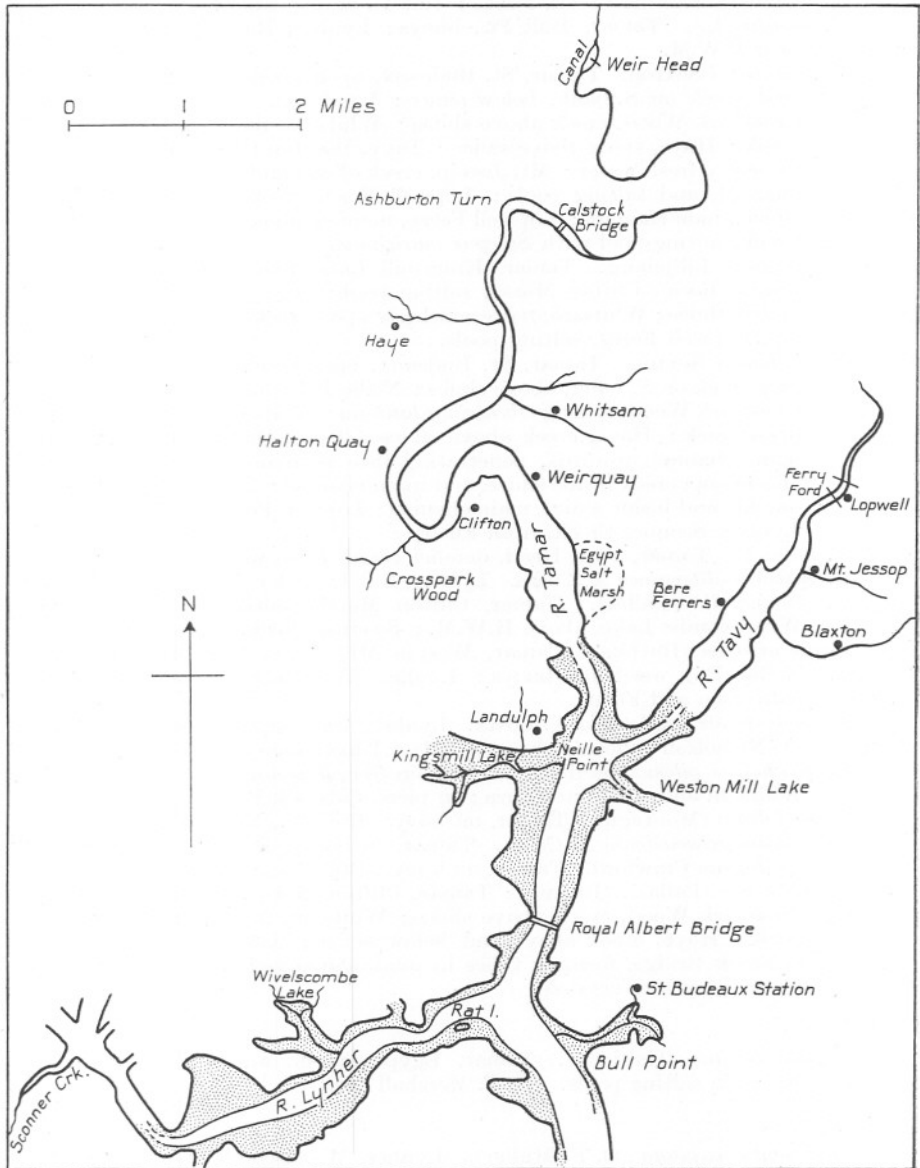


FIG. 1.—Map of Estuaries of Tamar, Tavy and Lynher.

- Gammarus marinus* Leach. Tamar, Clifton Marsh, and Crosspark Wood, in Fucus intertidally: Tavy, Blaxton Creek, Fucus at outflow: Lynher, Sconner Creek, Fucus; Rat I., under stones.
- G. locusta* (L.). Tamar, Bull Pt., buoys; Lynher, Rat I., under stones near L.W.M.
- **G. chevreuxi* Sexton. Tamar, St. Budeaux, open creek; Kingsmill Lake, first creek on S. bank, below sluice; Landulph, creek above sluice; Crosspark Wood, creek above sluice; Whitsam, more southerly open creek; Haye, creek above sluice: Tavy, Blaxton Creek, from outflow to nearly fresh water; Mt. Jessop, creek above and below sluice, main channel, and salting pools; Lopwell Ford, creek above and below sluice, main channel; Lopwell Ferry, main channel: Lynher, Sconner Creek, salting pool with *Scirpus maritimus*.
- **G. duebeni* Lilljeborg. Tamar, Kingsmill Lake, first creek on S. bank, inside sluice; Clifton Marsh, salting pools; Crosspark Wood, creek above sluice; Whitsam, more southerly open creek: Tavy, Mt. Jessop, and Lopwell Ferry, salting pools.
- **G. zaddachi* Sexton. Tamar, St. Budeaux, open creek; Kingsmill Lake, first creek on S. bank, above sluice; Neille Pt., mussel-bed and buoy; Crosspark Wood, among *Obelaria gelatinosa*; Whitsam, more southerly open creek; Haye, creek above sluice: Tavy, Blaxton Creek, from main channel upwards, penetrating into permanently fresh water; Mt. Jessop, creek inside sluice, and main channel; Lopwell Ford, creek outside and inside sluice, main channel; Lopwell Ferry, main channel: Lynher, Sconner Creek, from Fucus.
- G. pulex* L. Tamar, Weir Head, derelict canal (fresh water).
- Orchestia mediterranea* A. Costa. Lynher, Rat I., under stones, H.W.M.
- O. gammarella* (Pallas). Tamar, Clifton Marsh, salting cliff: Lynher, Wivelscombe Lake, above H.W.M.; Sconner Creek, salting cliff.
- Hyale nilssonii* (Rathke). Tamar, Weston Mill Lake, H.W.M. in weed; Neille Pt., weed on buoys: Lynher, Wivelscombe Lake, among *Salicornia* and Fucus.
- Microdeutopus gryllotalpa* A. Costa. Lynher, Wivelscombe Lake, in ditch (J. Nicholson collected these in 1934: I have seen his specimens).
- **Leptocheirus pilosus* Zaddach. Tamar, in *Cordylophora lacustris* on rocks, Whitsam and Ashburton turn; on piers, Calstock Bridge.
- Jassa falcata* (Montagu). Tamar, on buoys, Bull Pt., Neille Pt.
- Corophium acherusicum* A. Costa. Tamar, on buoys, Bull Pt., Neille Pt.
- **C. insidiosum* Crawford. Tamar, on buoys, Bull Pt., Neille Pt.
- **C. volutator* (Pallas). In mud: Tamar, Clifton Marsh, in salting pools; Crosspark Wood, creek above sluice; Whitsam, more southerly open creek; Haye, creek above and below sluice; Ashburton Turn and Calstock Bridge, forming tubes in mud aggregated about the stolons of *Cordylophora lacustris*.

INSECTA.

- **Aedes detritus* (Halliday). Tamar, Egypt marsh, and Clifton marsh, larvae in salting pools. (J. F. Marshall det.)

MOLLUSCA.

- Limapontia capitata* (O. F. Müller). Lynher, Wivelscombe Lake, salting pools. (Miss M. V. Lebour det.)

Of these species those marked with an asterisk may be considered the truly brackish-water species, which do not occur normally in fully marine or freshwater conditions. Of the remainder *G. pulex* is a freshwater

species (whose presence in Tamar fresh water deserves notice since it is not found in all rivers), and the rest are marine.

From a study of the habitats chosen by the species of *Gammarus*, it appears to me (as has been remarked by previous workers) that *G. marinus* inhabits a higher tidal level than *G. locusta*, and penetrates farther up the estuary. I can, however, make no general statement about the ecological relationships of the three brackish-water species which would accord with all the facts observed while collecting in this and other estuaries.

The drainage creeks running into these estuaries are usually fitted with a sluice, which is closed by the pressure of the rising tide. Above the sluice the creek is not subject to any considerable influx of salt-water, although the soil may be impregnated with salt, but the level of water rises forming a "freshwater tide." Conditions below these sluices or in "open creeks" are subject to the same fluctuations as those in the main channel.

Two special habitats should be mentioned. (i) The buoys, the weed on which contains a characteristic fauna of which the most noteworthy species are *Corophium acherusicum* and *Jassa falcata*, both marine species. In 267 specimens counted at random from Neille Point buoys there were found:—

<i>Corophium acherusicum</i>	259	<i>Gammarus zaddachi</i>	2
<i>C. insidiosum</i>	3	<i>Melita palmata</i>	1
<i>Jassa falcata</i>	2		

Idotea viridis and *Hyale nilssoni* were also present.

(ii) The "Salting Cliff," or vertical face where the salt-marsh gives on to the mud-flats. *Paragnathia formica* is found practically nowhere else: *Orchestia gammarella*, *Sphaeroma rugicauda*, and *Carcinus maenas* are present in this and several other habitats.

River Plym.

All collecting from the Plym Estuary was done in the brackish-water ditches of Chelson Meadow on August 9, 1935. These drain by means of a sluice into the estuary of the Plym, at a point where it is practically an arm of the sea. Near the sluice the ditches contain a dense growth of *Ruppia marina*, from which the following species were washed:—

<i>Sphaeroma hookeri</i> , abundant.	<i>Leptocheirus pilosus</i> , common.
<i>Melita palmata</i> , a few.	<i>Corophium insidiosum</i> , abundant.

This fauna persisted in the larger ditches for some distance from the sluice. It was replaced in fresher water by the following:—

<i>Sphaeroma hookeri</i> , abundant.
<i>Gammarus chevreuxi</i> , abundant.
<i>Corophium insidiosum</i> , a few.

These three species penetrated, but not commonly, into water which contained a freshwater flora and insect larvæ.

Gammarus zaddachi was not seen, and only one specimen of *G. duebeni* (in nearly fresh water). On occasions the latter species has been recorded as common, and *Corophium volutator* is known to be present.

River Exe.

Five collections were made in brackish water on July 21, 1935.

1. Countess Wear, bed of main stream under bridge, tidal. *Phragmites communis* on bank, *Enteromorpha* sp. and *Potamogeton pectinatus* in stream.

Gammarus zaddachi abundant, together with several *Limnæa pereger* and a few *Asellus* sp.

2. Countess Wear, in a tidal ditch to W. of R. Exe.

G. zaddachi, a few.

G. pulex, common.

Succinea putris (Gastropod) and *Haemopsis sanguisuga* (Leech) also present.

3. A pond formed behind a sluice on the upper of two streams running through the Powderham Estate. *Scirpus maritimus* and *Fucus* sp.

Sphaeroma hookeri, 20-30.

Gammarus zaddachi, abundant.

Jaera marina, 2.

Leptocheirus pilosus, 2.

Hydrobia ulvae was also present.

4. Dawlish Warren, stream with freshwater tide, drying out at low water, exposing mud flats. These species, except for *Corophium volutator*, were washed from *Fucus* and *Enteromorpha*.

Heterotanais ørstedii form *ørstedii*, 15 ♂♂, ♀♀ abundant.

Cyathura carinata, 1 (presumably from mud around *Fucus* roots).

Leptocheirus pilosus, common. *Gammarus duebeni*, common.

Melita pellucida, several.

Corophium volutator, common in the mud.

5. The same stream below the sluice.

Leptocheirus pilosus, 1.

Gammarus sp., 2.

Melita palmata, 6.

River Taw (Caen River).

On August 4, 1935, several collections were made on the estuary of the Caen River, a confluent of the Taw on its right bank. The results are enumerated below from the mouth upstream, that is in order of descending salinity, with the exception of a few isolated waters which are placed at the end of the section. Their position is shown in Figure 2.

1. Sand at L.W.M., at confluence with R. Taw.

Eurydice pulchra, a few.

Haustorius arenarius, a few.

Bathyporeia sp. indet., estimated at 4,000 per sq. m.

It seems that conditions at this point are nearly marine.

2. Outside sluice of small stream.

Gammarus chevreuxi, 1.

Orchestia ?gammarellus, 3 juv.

3. Salting cliff.

Paragnathia formica, 13.

Sphaeroma ?hookeri, 1.

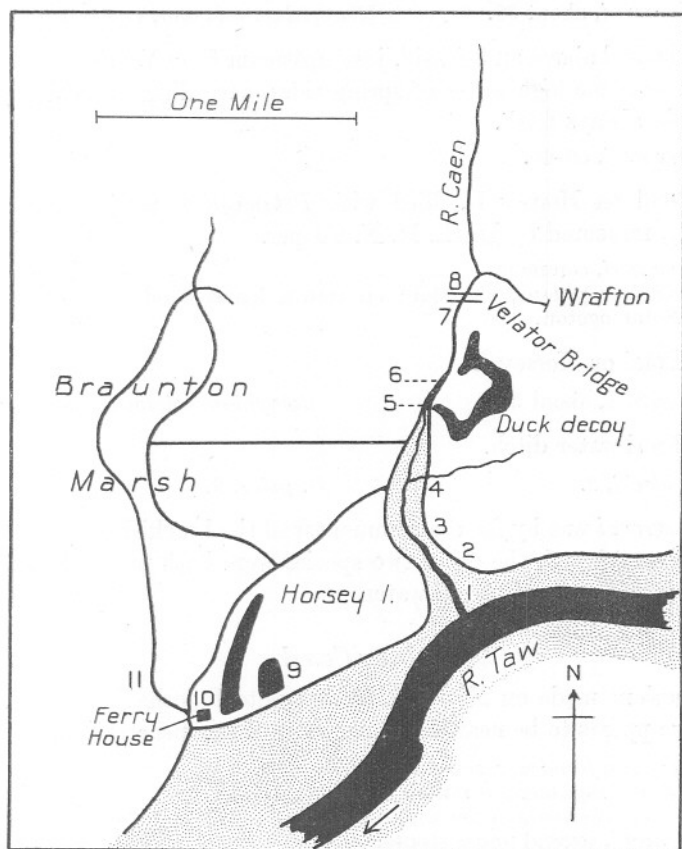


FIG. 2.

4. Open stream, above sea-wall.

Cyathura carinata, 1.

Gammarus chevreuxi, several hundred.

Sphaeroma hookeri, 1.

G. duebeni, a few.

Melita pellucida, a few.

4a. The same, below sea-wall.

G. marinus, 9.

G. chevreuxi, 1.

5. S.W. end of Duck Decoy Pond.

G. chevreuxi, 30.

Anopheles maculipennis (mosquito), 3 larvæ.

Palaemonetes varians, 3.

Corixa sp., sticklebacks, water-mites.

This water is presumably nearly fresh.

6. From *Fucus* at half tide.*Sphaeroma hookeri*, 1.*G. chevreuxi*, 3.*G. marinus*, 5.*G. zaddachi*, 2.7. Channel below Velator Bridge (*Enteromorpha* and sewage).*G. chevreuxi*, about 30.[*Corophium volutator*, common in mud.]

8. Channel above an 8-ft. sill, just upstream from Velator—entered by tide at extreme high water of spring tides, according to local boys, but probably always fresh.

G. chevreuxi, 50–60.

9. Pond on Horsey I., filled with *Potamogeton pectinatus*. Salinity 10.7‰, measured by Dr. L. H. N. Cooper.

G. chevreuxi, common.*Leptocheirus pilosus*, abundant on stems, leaves, and especially roots of *Potamogeton*.

10. Pond on Horsey I.

G. chevreuxi, about 30.*Corophium volutator*, about 20.

11. Freshwater ditch.

G. zaddachi, 2.*G. pulex*, 9.

G. chevreuxi was by far the commonest of the brackish-water species of *Gammarus* (though the other two species were both present), and penetrated into completely fresh water.

River Camel.

Collections made on May 5, 1935, opposite Egloshayle Church. This locality appears to be near the upper limit of salt penetration.

Paragnathia formica, common in salting cliff.*Sphaeroma rugicauda*, common in salting pools.*Gammarus chevreuxi*, a few under stones.*G. zaddachi*, several under stones.*River Towy.*

Ferryside and Carmarthen are about 7 miles apart: my collecting was done on August 25, 1935, half-way between them, on an extensive salting, intersected by streams coming from high ground to the East. A short distance upstream from this salting, rocky shores came down to L.W.M., near which *Cordylophora lacustris* grew on the rocks. The locality resembled the Tamar between Clifton and Whitsam.

Heterotanais ørstedii f. *ørstedii*, 1♂, about 20♀♀ in *Cordylophora lacustris*.*Paragnathia formica*, 4 in salting cliff.*Sphaeroma hookeri*, 2 in salting cliff.*Melita pellucida*, 2 among *Enteromorpha* in open stream.

Gammarus zaddachi, about 30 among grasses, etc., above a sluice; about 20 among Enteromorpha in open stream.

G. duebeni, 15 in hanging grass in open stream.

Orchestia gammarella, 3 in salting cliff.

Leptocheirus pilosus, about 12 in *Cordylophora lacustris*.

Corophium volutator, 5 in salting cliff.

It is surprising that *Heterotanais ørstedii*, whose connexion with *Cordylophora lacustris* has been previously noted by Gurney (1907), was not found in the far greater quantities of this hydroid collected from the Tamar. *Gammarus chevreuxi* was specially looked for in the Tavy, and therefore may be presumed to be absent.

BRACKISH-WATER CRUSTACEA IN ENGLAND.

Definition.

It is not possible to define the term "Brackish-Water Species" in terms of salinity, since the changes of salinity to which an animal is subject depend as much on its habits as on the position of its habitat along the estuary. It is possible, however, in the fauna of an estuary to distinguish certain species which belong more properly to fresh water (e.g. *Gammarus pulex*), or to the sea (e.g. *G. locusta*, *G. marinus*, *Melita palmata*, etc.), than to brackish water, although such distinctions are not always clearly marked, and may have only local significance.

If such as these are omitted, there remain 14 brackish-water species of Tanaidacea, Isopoda, and Amphipoda in England, of which I have collected all, except *Corophium lacustre*, from the south-western estuaries.

Literature.

The most important lists of brackish-water Crustacea in Britain are included in the following papers:—

Gurney (1907); Rivers Bure, Yare and Waveney, Norfolk.

Serventy (1935); River Deben, Suffolk.

Omer-Cooper (1916); Christchurch Harbour, Hants (Tanaidacea and Isopoda only).

Percival (1929); Rivers Tamar and Lynher, Devon and Cornwall.

A great number of comparable lists have been compiled for brackish water on the coasts of the Baltic and North Sea. A bibliography of these and a summary of their contents are given by Sick (1933).

Some of these lists contain errors for which I here suggest corrections, either after examining specimens myself, or on the authority of other writers, or (with less assurance) on circumstantial evidence contained in the original paper.

GURNEY (1907). *Gammarus duebeni* refers in part to *G. zaddachi*,

Serventy (1935, p. 292). *Microdeutopus* (= *Coremapus*) *versiculatus* on p. 427 and Table II refers to *Leptocheirus pilosus*: I have examined specimens in the British Museum. *Leptocheirus* sp. also refers to *L. pilosus*, Norman (1908). *Corophium grossipes* refers in part to *C. volutator* (pp. 417, 421, 427 part, 435 part, Table II part) and in part to *C. lacustre* (pp. 423, 427 part, 435 part, Table II part). I base this conclusion on circumstantial evidence. *C. volutator* burrows in the mud of estuaries, and *C. lacustre* builds tubes, usually among *Cordylophora lacustris*, in regions of low salinity, and was abundant in collections of this hydroid made for me in Heigham Sound in 1935. *Gnathia maxillaris* refers to *Paragnathia formica*, Monod (1926), and *Heterotanais gurneyi* to *H. ørstedii* f. *gurneyi*, Monod (1924).

SERVENTY (1935). *Heterotanais gurneyi* refers to *H. ørstedii* f. *gurneyi*.

OMER-COOPER (1916). *Paragnathia halidaii* refers to *P. formica*, Monod (1926).

PERCIVAL (1929). Percival's specimens are not available, and the following corrections are based on what seems to me satisfactory circumstantial evidence. All the species to which I suggest his names apply have been collected by me in the Tamar estuary in localities similar to those which he records. For *Anthura gracilis*, a marine species, read *Cyathura carinata*, a burrower in estuarine mud: for *Sphaeroma serratum* possibly read *S. rugicauda*: for *Idotea baltica* read *I. viridis*, which was common in the *Zostera* of St. John's Lake: for *Gammarus locusta* read *G. zaddachi*, at least in the less saline parts of its range: for *Corophium crassicornae* read *C. acherusicum*, which was present in the mussel-bed and abundant on the buoys at Neille Point.

POISSON AND REMY (1926). Canal de Caen, France. For *Corophium acutum* var. *chevreuxi* read *C. lacustre*. I have examined specimens sent me by Mme Leroux.

TESCH (1922). Zuider Zee, Holland. For *Corophium grossipes* read *C. volutator* (a synonym), and for *C. crassicornae* read *C. lacustre*. Tesch's figures, though crude, seem to refer to *C. lacustre*, and Redeke (1922 and 1932) records *C. lacustre* from the Zuider Zee.

SCHLIENZ (1923). Elbe, Germany. For *Leptocheirus hirsutimanus* read *L. pilosus*. He found his *Leptocheirus* in *Cordylophora lacustris*, which is the favourite habitat of *L. pilosus*: at Plymouth *L. hirsutimanus* is a marine species.

Table I has been compiled from the papers of Gurney (1907), Serventy (1935), and Omer-Cooper (1916), with such alterations in identification of species as I have suggested. The presence of species in the Tamar is based entirely on my own collecting: the presence of *Corophium volutator* in Chelson Meadow (Plym) is based on the Plymouth Marine Fauna (1931).

TABLE I.

	Norfolk, Gurney (1907).	R. Deben, Serventy (1935).	Christ Church Omer- Cooper (1916).	R. Tamar, etc.	R. Plym.	R. Exe.	R. Tav.	R. Camel.	R. Towy.	Other British Records (list incomplete).
TANAIDACEA.										
<i>Heterotanais ørstedii</i>										
f. <i>ørstedii</i> Krøyer.	—	—	×	—	—	×	—	—	×	
f. <i>gurneyi</i> Norman.	×	×	—	—	—	—	—	—	—	
ISOPODA.										
<i>Cyathura carinata</i> (Krøyer).	×	×	×	×	—	×	×	—	—	
<i>Paragnathia formica</i> (Hesse).	×	×	×	×	—	—	×	×	×	R. Welland (G.I.C.).
<i>Sphaeroma rugicauda</i> Leach.	×	×	—	×	—	—	—	×	—	See Omer-Cooper and Rawson (1934), pp. 34-36.
<i>S. hookeri</i> Leach.	—	—	—	×	×	×	×	—	×	See Omer-Cooper and Rawson (1934), pp. 36-38.
<i>Idotea viridis</i> (Slabber).	×	—	×	×	—	—	—	—	—	
AMPHIPODA.										
<i>Melita pellucida</i> G. O. Sars.	×	—	—	×	—	×	×	—	×	Benfleet, Essex (G.I.C.).
<i>Gammarus chevreuxi</i> , Sexton.	—	—	—	×	×	—	×	×	—	Warwickshire, Pen- telow (1931).
<i>G. duebeni</i> , Lilljeborg.	?×	×	—	×	×	×	×	—	×	Essex (G.I.C.). R. Tees, Alexander, etc. (1935)
<i>G. zaddachi</i> , Sexton.	×	×	—	×	—	×	×	×	×	Towkesbury, Glos ; R. Test, Hants ; R. Frome, Dorset ; Benfleet, Essex (G.I.C.). R. Tay, Bassindale (1933). Essex, Palmer (1933). R. Tees, Alexander, etc. (1935).
<i>Leptocheirus pilosus</i> Zaddach.	×	×	—	×	×	×	×	—	×	
<i>Corophium volutator</i> (Pallas).	×	×	—	×	×	×	×	—	×	Numerous.
<i>C. insidiosum</i> Crawford.	—	—	—	×	×	—	—	—	—	
<i>C. lacustre</i> Vanhöffen.	×	—	—	—	—	—	—	—	—	

Distribution in England.

For all these species, except *Gammarus chevreuxi*, records have been published of occurrences abroad. In Southern England most of them seem to be present in every sizeable estuary. A few do not range over the whole of S. England.

Heterotanais ørstedii was not found in England west of the Exe, though in the Tamar and Taw suitable habitats were carefully searched. According to Monod (1924) the two forms *ørstedii* and *gurneyi* may live together.

Gammarus chevreuxi was present in the Tamar, Plym, Camel, and Taw, but not in the Towy, Exe, Frome (Dorset), Test (Hants), New England Creek (Essex), or at Benfleet (Essex). Collecting, except in the Frome and Test, was calculated to find this species if present. It is almost certainly absent from the Norfolk rivers and the Deben investigated by Gurney and Serventy. Its presence in inland brackish water near Coventry is well authenticated, Pentelow (1931).

Corophium insidiosum is so far known in England only from the Tamar, Chelson Meadow, and Plymouth Sound. Abroad it has been collected from Denmark, Germany (Kiel Canal), and Italy (Lake of Venice).

C. lacustre is so far known in England only from the Norfolk Broads. It is found abroad in France, Holland, Germany, and North America.

Habitats of Certain Estuarine Species.

Heterotanais ørstedii builds tubes on hydroids and weed.

Cyathura carinata burrows in mud. *Paragnathia formica* makes burrows in salting cliffs, but I have found it under stones, cf. Monod (1926). The two species of *Sphaeroma* are not rigidly attached to one habitat, but live among weed, under stones or in holes in salting cliffs. *S. rugicauda* is especially common in salting pools, and *S. hookeri* in large brackish-water ditches as at Chelson Meadow (Plym). *Idotea viridis* lives on weed, especially on *Zostera* spp. and *Ulva* sp.

Melita palmata lives among weed, and is often abundant under stones: *M. pellucida* was chiefly found where there was much decayed land or freshwater vegetation among which it sheltered. The various species of *Gammarus* shelter among weed, dead leaves or twigs, or under stones.

Orchestia gammarella is found near high-tide mark along sea coasts and estuaries, sheltering under decaying vegetation or stones: it is also found on salt marshes and in holes in the salting cliff. I have found it in fresh water on the cliff near Kynance Cove, 200 ft. above sea-level.

Leptocheirus pilosus builds tubes, especially on *Cordylophora lacustris*, but also on any weed growing in suitable water. *Jassa falcata* builds tubes, especially on buoys.

The species of *Corophium* build tubes. *C. acherusicum* lives most often on buoys: *C. insidiosum* among weeds in water of rather high salinity (ca. 20‰). *C. volutator* builds its tubes in mud, usually on the intertidal mud-flats, or the floor of salting pools or creeks. At Ashburton Turn and Calstock its burrows are made in mud aggregated round the base of *Cordylophora lacustris*. It is frequently found in mud which has settled on horizontal piles. On the Towy I found it in holes in the salting cliff. *C. lacustre* builds tubes on weeds in water of low salinity, especially among *Cordylophora lacustris*.

NOTES ON THE IDENTIFICATION OF GAMMARUS SPECIES.

Seven species of *Gammarus* are known from England.

- G. marinus* Leach, marine.
- G. locusta* (L.), marine.
- G. campylops* Leach, marine.
- G. chevreuxi* Sexton, brackish-water.
- G. duebeni* Lilljeborg, brackish-water.
- G. zaddachi* Sexton, brackish-water.
- G. pulex* (L.), freshwater.

I have collected all of these except *G. campylops*. It is probable that there are other species, both marine and estuarine, in Great Britain which are as yet unnamed. Since also the known species are often confused with one another, records should always be critically examined by later workers, if possible with the help of specimens deposited in some trustworthy and accessible institution.

The species about which most confusion has arisen is *G. zaddachi*, which has been frequently recorded as *G. locusta* or *G. duebeni*.

Usually I found *G. zaddachi* easy to distinguish by the criteria listed by Sexton (1912), especially when there were numerous adult specimens available for examination. Younger specimens were not always identifiable unless accompanied by adults. Of these distinctions the most useful is the arrangement of hairs in graduated clusters on the first antenna, and especially on the basal joint; these vary greatly in length from one locality to another, but the general arrangement is characteristic. Other important characters are: (i) hand larger in the second gnathopod than in the first gnathopod, especially in ♂ (in *G. duebeni* the difference in size is slight): (ii) in adult ♂♂ the basal joints of the fifth and sixth pereopods are only slightly expanded, and the hind corner is free only in the fifth pereopod. Sexton based her statements on specimens from Bremerhaven, Hamburg, and Ireland. I have found them to be true also for specimens from Devon and Cornwall.

Poulsen (1932) gives a list of features which he states are characteristic of *G. zaddachi*. A number of these were not found in the type material which Mrs. Sexton kindly allowed me to examine, and were not in agreement with statements made in her original description. In particular, Poulsen states that the hind corner of the basal joint of the fifth pereopod is pointed: I have always found it rounded. Further that the urosome of *G. zaddachi* is not hairy. I have found it always hairy and sometimes, as in the type German material, very hairy. Possibly Poulsen was examining some other species.

Gammarus duebeni is a very stout species, and usually of a muddy greenish- or reddish-brown colour. *G. zaddachi* is more slender, and its colours are more clear. The length and density of the setae on the antennae, limbs, and urosome of *G. duebeni* are very variable, as in *G. zaddachi*, but there are never more than a few small tufts of hairs (not graduated) on the basal joint of the first antenna.

I am not able to distinguish between the habitats of the three brackish-water species, *G. chevreuxi*, *G. duebeni*, and *G. zaddachi*. I found all three in every sort of brackish water in the rivers investigated, and sometimes one and sometimes another penetrated farthest upstream. I found all in fresh water—*G. chevreuxi* in the Taw; *G. zaddachi* in the Taw (Braunton Marsh), the Tavy (Blaxton Creek), and the Avon at Tewkesbury; *G. duebeni* up to 200 ft. above sea-level in streams running into the English Channel at Kynance, Cornwall, and nearby, and in similar situations in Anglesey.

There is a great deal of investigation still needed into the systematics, ecology, and physiology of *Gammarus*, even of the British species.

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