RECENT AND LATE QUATERNARY ECOLOGY, DISTRIBUTION AND PROVINCIALISM OF OSTRACODA IN THE NORTH ATLANTIC AND ARCTIC OCEANS

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VOLUME CONTAINS CLEAR OVERLAYS

OVERLAYS HAVE BEEN SCANNED SEPERATELY AND THEN AGAIN OVER THE RELEVANT PAGE

Family HEMICYTHERIDAE Puri, 1953

Sub Family HEMICYTHERINAE Puri, 1953

Genus *Hemicythere* Sars, 1925

Hemicythere villosa Sars, 1866
pl. 26 figs a-f

1866 *Cythereis villosa* n.sp. Sars: p. 42.

1868 *Cythere villosa* (Sars); Brady: p. 411, pl. XXIX, figs. 28-32.

1874 *Cythere villosa* (Sars); Brady, Crosskey and Robertson: p. 157, pl. III, figs. 7-13.

1889 *Cythere villosa* (Sars); Brady and Norman: p. 146.

1928 *Hemicythere villosa* (Sars); Sars: p. 182, pl. LXXXIV.

1938 *Hemicythere villosa* (Sars); Klie: p. 174, t.figs. 575-579.

1941 *Cythereis* (*Eucythereis*) *villosa* Sars: Elofson: p. 287.

1953a *Hemicythere villosa* (Sars); Puri: p. 174, pl. I, figs. 11-12.

1957 *Hemicythere villosa* (Sars); Wagner: p. 56, pl. XXII.

1957 *Eucythereis villosa* (Sars); de Vos: pl. XIV, figs. 1a-f.

1962 *Hemicythere villosa* (Sars); Woszidlo: p. 82, pl. 4, fig. 13.

1967? *Hemicythere cf. villosa* (Sars); Hazel: p. 14, pl. 2, fig. 4.

1969 *Hemicythere villosa* (Sars); Wall (ms.): p. 175, pl. 10, figs. a-h; pl. 34, fig. K-5.

?1971 *Hemicythere villosa* (Sars); Valentine: pl. 4, figs. 51, 54, 56, 57.

1972 *Hemicythere villosa* (Sars); Whittaker (ms.): p. 125, pl. 16, figs. 1-14.

1976 *Hemicythere villosa* (Sars); Hoskin (ms.): p. 280, pl. 20, figs. 3-4.

1976 *Hemicythere villosa* (Sars); Jasin (ms.): p. 193, pl. 3, figs. 18-19.

1977 *Hemicythere villosa* (Sars); Rosenfeld: p. 27, pl. 6, figs. 72-75.

1981 *Hemicythere villosa* (Sars); Whittaker: 8(5), pls. 27-32.

Material

Total Dead: F. - 20 C. 30 RV. 25 LV.; M - 7 C. 13 RV. 17 LV.
J. - 6 C. 170 RV. 172 LV. = 354 I.

Live: 31 F. 9 M. 15 J.

Southern Irish Sea

Dead				Live	
F. - 01 C.	06 RV.	07 LV.		13	
M. - 02 C.	08 RV.	07 LV.	= 120 I.	08	= 31 I.
J. - 03 C.	58 RV.	59 LV.		10	

Caernarvon Bay

Dead				Live	
F. - 02 C.	03 RV.	04 LV.		18	
M. - 00 C.	01 RV.	01 LV.	= 52 I.	01	= 24 I.
J. - 01 C.	23 RV.	29 LV.		05	

Malin Sea

Dead				Live
F. - 17 C.	21 RV.	13 LV.		00
M. - 05 C.	04 RV.	09 LV.	= 182 I.	
J. - 02 C.	89 RV.	84 LV.		

Sample Distribution (live occurrence is underlined)

Southern Irish Sea

801 803 805 807 810 816 820 822 857 860 868 872 906
910 2354 2360 2361 2365 2366 2367 2369 2370 2372 2375
2378 2381 2765 2779 2783 2788 2789 2791 2810 2812 2813
2822 2854 2903 2904 2905 2906 2915 2916

Caernarvon Bay

2393 2399 2400 2401 2407 2419 2421 2422 2442 2443 2509
2513 2516 2519 2638 2827 2830 2831 2839 2840 2921
HHI HHII

Malin Sea

3010 3012 3090 3092 3099 3101 3103 3145 3154 3161

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	16	. 7A/8	0.644	0.374
	LV. "	16	. 6A/7	0.684	0.410
M.	RV. "	16	. 5A/6	0.687	0.371
	LV. "	16	. 4A/5	0.688	0.386
-I.	RV. "	16	. 9A/10	0.557	0.355
	LV. "	16	. 8A/9	0.563	0.341

The specimens are all from sample 2359 (77 m., fine sand + silt), southern Irish Sea.

Description

See: Wall (ms. 1969, p. 176-183, pl. 10, figs. a-h) for the best description of hard and soft parts and an illustration of the latter. Whittaker (ms. 1972, pl. 16, figs. 1-14; 1981, 8(5): pls. 27-32) provides an illustration of the carapace morphology.

Ontogeny

Instars from the penultimate to -5 growth stage were recognised. Adults and juveniles from a number of samples in the study area were measured and the dimensions given as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.630-0.725	0.385-0.430	40	
	Mean	0.668	0.410		1.63
M.	Range	0.640-0.760	0.360-0.400	28	
	Mean	0.685	0.365		1.88
-1.	Range	0.550-0.585	0.340-0.360	40	
	Mean	0.573	0.354		1.70
-2.	Range	0.480-0.515	0.285-0.305	26	
	Mean	0.503	0.296		1.76
-3.	Range	0.380-0.430	0.205-0.240	21	
	Mean	0.405	0.230		1.77
-4.	Range	0.265-0.345	0.170-0.215	21	
	Mean	0.320	0.190		1.68
-5.	Range	0.230-0.245	0.140-0.165	6	
	Mean	0.241	0.155		1.61

Sexual dimorphism is distinct, males are proportionately longer than females.

There is an irregular increase in the L:H ratio during ontogenetic development.

Remarks

That illustrated by Swain (1963, p. 828) as *H. villosa* is now referred to the species *H. borealis* (Brady).

See: Whittaker (1981, 8(5), 27-32).

Study Area Ecology

Live specimens occurred in many localities along the fishing banks of the southern Irish Sea. Recorded between 9-34 m in coarse sand + gravel, mixed sand and fine sand and silt and mostly from the foremost sediment. In Caernarvon Bay the live material of mostly females was restricted to a few areas, 7-57 m, in coarse sand + gravel and mixed sand. The majority of specimens were found in sample 2399 (7 m, coarse sand + gravel). Live material was not encountered in the Malin Sea.

Otherwise, *H. villosa* occurred in isolated numbers throughout the southern Irish Sea between 2.7-137.5 m, mean 34.8 m in a variety of sediment types from coarse sand and gravel to silt with clay. Specimens were found in many areas of Caernarvon Bay; from the tidemarks of Holyhead Harbour down to 118 m, mean 39 m, in coarse sand + gravel and mixed sand. The species was most abundant within 23.8 m in the mixed sands. In Malin Sea it was found between 45.7-170.1 m, mean 90.6 m, in coarse sand with gravel mixed sand and fine sand with silt, though occurred predominantly within 47.6-91 m in the coarser sediments.

An assemblage of adults was recovered from sample 3012 (47.6 m, coarse sand + gravel) and 3103 (91 m, mixed sand), Malin Sea. However, the greatest number of adults and juveniles occurred S.E. of Islay, sample 3101 (55 m, fine sand + silt).

Palaeoecology and Distribution

Cushman (1906) and Hazel (1967, 1970) indicate that *H. villosa* is a rare shallow water species in the Gulf of Maine and Cape Cod region. Material may also occur in Recent sediments of the St. Lawrence Basin 18-90 m (Brady, 1868; 1870; Elofson, 1941) and Davis St. (Brady, 1868; Brady and Norman, 1889).

Isolated specimens have been found in the sublittoral of Iceland (Brady and Norman, 1889; Stephensen, 1938) and material is reported in Recent sediments of Spitzbergen (Elofson, 1941). The species does not appear to be common anywhere in the Eastern Arctic except in the littoral of Finmark, N. Norway (Brady and Norman, 1895; Norman, 1902).

H. villosa is abundantly alive between the Skagerrak and Lofoten Islands, W. Norway (Norman, 1891; Sars, 1928; Elofson, 1941) and occurs in sediments within 3-180 m off Bergen (Brady and Norman, 1889). Elofson (1941) indicates that within this region it inhabits algae and coarse detritus beneath, 0-30 m in 30‰+ salinity and 0-22^{o}C. The live distribution ranges in the algal zone to Oresund (Hagerman, 1965) and Kiel Bay (Klie, 1938; Elofson, 1941; Hagerman, 1966). It would also seem to penetrate the Ostsee, W. Baltic (Klie, 1929), wherein material occurs between 6-19 m and 14-25‰ salinity (Rosenfeld, 1977).

Recorded in the North Sea from the Shetlands (Brady, 1866), eastern Scotland (Brady, 1868), N.E. England (Brady, 1870, 1903; Brady and Robertson, 1870, 1872, 1874; Norman and Brady, 1909), off Norfolk (Brady, 1868) and within the Thames Estuary (Kilenyi, 1969). It also inhabits the Heligoland

(Klie, 1929; Skaumal, 1977) and Schelde and Maas Estuaries, Netherlands (Brady and Robertson, 1870; Brady and Norman, 1889). These authors record H. villosa alive within intertidal laminarian algae and estuarine muds, and associated with shelly gravel down to 90 m in more open marine conditions.

This species is also well documented and locally abundant off W. Britain. Pearce (ms. 1977) found it commonly alive in the high marsh of N. Uist and H. villosa is ubiquitous in shelly gravels of the Clyde Estuary (Brady, 1868; Brady and Robertson, 1872; Robertson, 1874; Brady and Norman, 1889). The distribution also extends throughout W. Ireland (Brady, 1868; Brady and Robertson, 1872; Norman, 1905), alive within 4-28 on algal debris and coarse sand (Brady and Robertson, 1869; Hoskin ms. 1976). H. villosa is also widely distributed in superficial sediments of the Irish and Celtic Seas (Brady, 1868; Brady and Robertson, 1872; Norman, 1905) though it is not considered to be common below 40 m (Wall ms. 1969; Brassil ms. 1977). In addition, it appears to be a rare inhabitant of bushy and filamentous algae of Caernarvon Bay (Morgan ms. 1977) and it is occasionally alive in Corallina, 18-34 m off the Scillies (Norman and Scott, 1906; Neale, 1970).

H. villosa is primarily associated with shallow water filamentous algae and Zostera in the Fleet, Dorset, wherein Whittaker (ms. 1972) recorded live material in 26-35‰ salinity and 5-19^{o}C. The range extends to the Channel Isles (Brady, 1868; Norman, 1907, 1908) and it is commonly alive in Roscoff Harbour, N. Brittany (de Vos, 1957). There are also reports of isolated specimens in Recent sediments off Cap Breton, S. Biscay (Brady and Folin, 1872; Fischer, 1876) though these records probably refer to reworked material.

This species is a common form in the sub Recent and Holocene of Biscay 100-200 m (Peypouquet, 1971; Moyes and Peypouquet, 1971) and it extends in contemporaneous deposits throughout the Netherlands (Wagner, 1957, 1960) and southern Irish Sea (Wall and Whatley, 1971; Spencer ms. 1976). H. villosa occurs in the Late Devensian of S. Norway (Brady et.al. 1874), Forth Estuary (Henderson, 1870; Bell, 1891) and N.E. Ireland (Brady et.al., 1874). Further, it is most common and widely distributed in raised beach deposits of W. Scotland (Brady et.al., 1874; Robertson, 1874, 1882, 1885, 1887; Anderson, 1948; Peacock et.al., 1978; Graham and Wilkinson, 1978). An abundance of material is recorded by Whatley and Kaye (1971) in the Eemian of S. Sussex and H. villosa is a common form within last interglacial deposits of Somerset (Kidson et.al., 1978) and the southern Irish Sea (Jasin ms. 1976). Woszidlo (1962) records it in the Hoxnian of W. Denmark and material of this age occurs in uplifted sediments of E. Yorkshire (Neale and Howe, 1975).

Summary

The distribution of H. villosa is imperfectly known in the western N. Atlantic, having been reported in superficial deposits of a few areas between Cape Cod and W. Greenland, 41-67^{O}N. Isolated specimens are also reported from Iceland, and Spitzbergen, 79^{O}N. Live material is accurately recorded off Finmark and it occurs in localised abundance throughout W. Scandinavia, British and adjacent waters, 48-72^{O}N. The species may also range in Recent sediments to S. Biscay, 44^{O}N.

However, *H. villosa* is better known in the Holocene of the latter region, Netherlands and Irish Sea, 44-54°N. Its occurrence in the late Glacial extends throughout N. Britain and S. Norway, 56-60°N; with other material found in similar abundance within the Ipswichian of S.W. Britain, 50-54°N and in the Hoxnian interglacial of W. Denmark and E. Yorkshire, 54°N.

H. villosa inhabits sublittoral algae, mostly laminarian types in more northern regions and is commonly alive on algal debris and coarse shelly sand within 4-30 m. Isolated live specimens and most Recent material occurs within 90 m with that found down to 200 m being of Holocene or late Glacial age. It tolerates 10-25‰ salinity in the W. Baltic though outside this region *H. villosa* may be considered a marine species, alive in 26‰+ salinity and 0-22°C.

Genus Aurila Pokorny, 1955

Aurila convexa (Baird) 1850

pl. 26 figs. g-j

1850a Cythere convexa n.sp. Baird: p. 174, pl. XXI, fig. 3.

1865 Cythere arborescens n.sp. Baird; Brady: p. 190, pl. IX, figs. 5-8.

1868 Cythere convexa Baird; Brady: p. 401, pl. XXIX, figs. 19-27.

1874 Cythere convexa Baird; Brady, Crosskey and Robertson: p. 150, pl. III, figs. 14-17.

1889 Cythere convexa Baird; Brady and Norman: p. 140.

1941 Cythere (Eucythereis) convexa (Baird); Elofson: p. 286.

1955 Aurila convexa (Baird); Pokorny: p. 19, t. figs. 8-11.

1957 Eucythereis convexa (Baird); de Vos: p. 30, pl. XII, figs. 3a-b; pl. XIII, figs. 1a-e.

1957 Aurila convexa (Baird); Wagner: p. 59, pl. XXV.

1969 Aurila convexa (Baird); Wall (ms.): p. 203, pl. 11, figs. a-g; pl. 35, figs. a-k.

1969 Aurila convexa (Baird); Yassini: p. 43, pl. XI, XII, XIV, XVI-XIX.

1972 Aurila convexa (Baird); Whittaker (ms.): p. 130, pl. 17, figs. 1-4.

1973 Mutilus convexus (Baird); Doruk: 1(24): pls. 129-136.

1976 Aurila convexa (Baird); Breman: p. 62, pl. 9, fig. 120.

1976 Aurila convexa (Baird); Hoskin (ms.): p. 286, pl. 20, figs. 1-2.

1977 Aurila convexa (Baird); Harrison (ms.) p. 33, pl. 1, figs. 1-4, t. fig. 8a.

1979 Aurila convexa (Baird); Dingwall (ms.): p. 6, figs. 1-7, 9.

Material

Total Dead: F. - 16C. 1 RV. 16 LV.; J. - 4 C 136 RV. 94 LV. = 215 I.

Live: 18 F. 8 J.

Southern Irish Sea

Dead					Live
F. -	02 C.	01 RV.	07 LV.	= 81 I.	06
J. -	01 C.	54 RV.	36 LV.		08

Caernarvon Bay

Dead					Live
F. -	13 C.	05 RV.	07 LV.	= 78 I.	11
J. -	03 C.	39 RV.	32 LV.		00

Malin Sea

Dead					Live
F. -	01 C.	00 RV.	02 LV.	= 56 I.	01
J. -	00 C.	43 RV.	26 LV.		00

<u>Sample Distribution</u> (live occurrence is underlined)

Southern Irish Sea

805 <u>807</u> 820 <u>857</u> 860 868 881 903 906 910 2354 2359
2360 2361 2365 2366 2367 2370 2373 2375 2380 2381
2761 2762 <u>2765</u> 2779 <u>2780</u> 2783 <u>2789</u> <u>2791</u> 2819 2822
2854 2904 2905 2912 2915 2917

Caernarvon Bay

2387 2389 <u>2396</u> 2398 <u>2399</u> <u>2400</u> 2401 2402 2405 2419
2422 2443 2647 2829 2830 2831 2839 2891 HHI HHII

Malin Sea

3012 3099 3101 <u>3103</u> 3154

<u>Figured Specimens</u>

			Film No.	Neg. + Print No.	L. (mm)	H.(mm)
F.	RV.	external	24	. 7/7A	0.749	0.464
	LV.	"	24	. 8/8a	0.772	0.507
-1.	RV.	"	27	. 33a/34	0.612	0.353
	LV.	"	24	. 9/9a	0.616	0.389

The specimens are from sample 2399 (7 m, coarse sand + gravel), Caernarvon Bay.

<u>Description</u>

See: Wall (ms. 1969, p. 205-211, pl. II, figs. a-g) for a description of the hard and soft parts and an illustration of the latter. Whittaker (ms. 1972, pl. 17, figs. 1-4) illustrates the carapace morphology.

Ontogeny

Instars from the penultimate to -4 growth stage were recognised. The dimensions of females and juveniles from samples 2399, Caernarvon Bay and 3101 (55 m, fine sand + silt), Malin Sea, are given as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.670-0.800	0.440-0.510	23	
	Mean	0.751	0.474		1.58
-1.	Range	0.590-0.650	0.340-0.400	18	
	Mean	0.617	0.372		1.66
-2.	Range	0.460-0.510	0.260-0.310	36	
	Mean	0.482	0.286		1.70
-3	Range	0.370-0.390	0.200-0.220	14	
	Mean	0.381	0.214		1.78
-4.	Range	-	-	1	
	Mean	0.320	0.180		1.78

The male of this species is unknown.

Remarks

A. convexa is widely reported as a Tertiary, Pleistocene and Recent species throughout the Mediterranean. However, from the comments of Sissingh (1972, p. 118) it appears that in these waters many authors have found it almost impossible to differentiate between *A. convexa* and several other species of *Aurila*. Therefore, most illustrated references to a Neapolitan distribution are better referred to either *A. punctata* (Münster) or *A. cicatricosa* (Reuss). Lastly, that illustrated as a common occurrence of *A. convexa* in the Upper Pliocene of E. Anglia (Wilkinson ms. 1974) is subsequently considered by the same author (1980) to be a distinct species.

See: Wall (ms. 1969, p. 212); Doruk (1973, 1(24):

pls. 129-136) and Butler (1979, p. 40-41).

Study Area Ecology

Live material occurred in the southern Irish Sea between 9-54.9 m and mostly from 9-37 m in coarse sand + gravel and mixed sand. Otherwise, specimens were found throughout the region within 2.7-137.5 m, mean 31.0 m. Most material occurred between 10-35 m in mixed sand with only isolated specimens found below 40 m or in any other sediment type.

In Caernarvon Bay live females were recovered from 7-29.3 m in coarse sand + gravel and mixed sand. Other material occurred in the intertidal of Holyhead Harbour down to 120.7 m, mean 35.5 m and mostly from 7-23.8 m in coarse sand with gravel and mixed sand. An assemblage of live adults and juveniles was recovered from sample 2399 (7 m, coarse sand + gravel).

A single live female was recovered from sample 3103, Malin Sea, 91 m, mixed sand. The distribution was otherwise restricted to a few samples between 47.6-170.1 m, mean 88.2 m, in the above sediment types. A large juvenile assemblage was found in sample 3101 (55 m, fine sand + silt).

Palaeoecology and Distribution

This is a very rare species in Scandinavian waters. However, Elofson (1941) recorded a few live specimens in sub-littoral bushy and filamentous algae, on algal debris below 5 m and in sands and *Laminaria* roots within 30 m. The last author considered its range to be between Oresund and Trondheim Fiord in waters of 2/3^{o}C-26^{o}C+. Live material is also known in *Zostera* and *Cladophora* of Kiel Bay (Klie, 1929, 1938, 1942).

It seems to be more common in the Outer Hebrides (Brady, 1866; Norman, 1868; Brady and Robertson, 1872, 1874) and is found in localised abundance off N.E. England, Norfolk and S.E. England (Brady and Robertson, 1872, Kilenyi, 1969). A. convexa also occurs in the Schelde Estuary, Netherlands (Brady and Robertson, 1870).

A. convexa is more abundant in western Britain, though it is not especially common off western Scotland or in the Clyde (Brady, 1868; Robertson, 1874; C.S. Harris, ms. 1977; Pearce, ms. 1977). However, this is an abundant species off western Ireland, 6-28 m (Brady 1868; Brady and Robertson, 1869, 1872; Norman, 1905). Hoskin (ms. 1976) indicates that it is plentifully alive in sublittoral algae and on coarse sand and gravel, 2-18 m, in Brandon and Tralee Bays. Further, A. convexa is widely distributed in Recent sediments down to 110 m in the Celtic and Irish Seas, (Brady, 1868; Brady and Robertson, 1869, 1872; Wall ms. 1969; Brassil ms. 1977). Neale (1970) described it as a major live species on sands and gravels, 12-30 m, around the Scilly Isles and it is recorded in shell sands from many localities along the S. Devon (Brady, 1868; Norman and Scott, 1906) and Dorset (Whittaker ms. 1972) coasts.

A. convexa is abundantly alive in Roscoff Harbour, Brittany (de Vos, 1957), a common species around the Channel Isles (Brady, 1868; Brady and Robertson, 1872; Norman, 1907, 1908) and it is very abundant in Fucus and calcareous algae in the Gironde region, 2-26^{o}C, 3-10 m (Moyes and Peypouquet, 1972; Carbonel, 1977). Wherein, Yassini (1969) and Carbonel and Jouanneau (1975) indicate its tolerance of 26-34‰ salinity. In addition, this species occurs in Recent sediments down to

110 m, mostly 20-30 m throughout the Biscay (Brady, 1872, 1911; Brady and Folin, 1872; Fischer, 1876; Brady and Norman, 1889) and extends commonly between 70-110 m in fine sand and silts of Vigo Bay, N.W. Spain (Ralph ms. 1977).

Its distribution in the Mediterranean is unknown. A small variety may range in sands within 150 m, mostly 5-20 m, in the Adriatic (Breman, 1976). However, other records appertaining to this species in the Mediterranean are entirely erroneous.

A. convexa is documented in the Holocene of S. Biscay, 100-200 m (Peypouquet, 1971), Gironde Estuary (Moyes, 1974; Carbonel et. al., 1975), Netherlands (Wagner, 1957, 1960), southern Irish Sea (Wall and Whatley, 1971; Spencer ms. 1976) and W. Turkey (Doruk, 1973). Late Glacial material is known throughout Biscay (Moyes and Peypouquet, 1971) and it is also common in raised beach deposits of E. and W. Scotland and N. Ireland (Brady et. al., 1874; Robertson, 1882, 1887; Bell, 1891; Graham and Wilkinson, 1978; Peacock et. al., 1978). Accurate records extend to the last interglacial of the Seine Estuary (Lautridou and Dupeuble, 1965), Selsey in Sussex (Whatley and Kaye, 1971), Somerset (Kidson et. al., 1978) and southern Irish Sea (Jasin ms. 1976). Other records include the Hoxnian of Nar Valley, Norfolk (Lord and Robinson, 1978) and certain deposits of S.E. Ireland (Whatley in Calhoun and Mitchell, 1971). It may also occur in the Upper Pliocene of E. Anglia (Jones and Sherborn, 1887) and Cornwall (Whatley pers. comm. 1976) and A. convexa is one of the most abundant species in Harrison's (ms. 1977) Brittany material. This species is also reported throughout the Pliocene and Upper Miocene of S.W. France (Moyes, 1965). However, this last record, like so many other accounts of A. convexa in fossil deposits of central or southern Europe, must be considered tentative.

Summary

This species is rarely distributed in S.W. Scandinavia and whilst common in Recent sediments throughout Britain and adjacent waters, 50-64°N, it is not numerously alive in all of this region. However, the live abundance increases dramatically west of Ireland and south of the English Channel and ranges as such to southern Biscay, 44°N. There are also localised and possibly disjunct populations of A. convexa in both the eastern and western Mediterranean, though little is known of its actual distribution there. Holocene material is found in the Biscay, Netherlands and Irish Sea, 44-54°N and with sub Recent material is probably reworked into deep shelf deposits throughout the geographical range. It is also widely distributed in the late Devensian of Britain and Biscay, 44-58°N. Ipswichian, Hoxnian and upper Pliocene specimens are abundant in southern Britain and N.W. France, 48-54°N. Its range in the Pliocene and Upper Miocene may include S.W. France and localised regions of the Mediterranean south to 35°N.

The species inhabits sublittoral Zostera and bushy and filamentous algae, though it is found mostly below 5 m and within 30 m in the Laminarian zone. It also occurs alive on algal debris and coarse shelly sands and otherwise ranges down to 100 m in most types of sediment. A. convexa is usually restricted to marine salinities, though tolerates 26-34‰ in Biscay and has a temperature tolerance of 2/3-26°C.

Genus Baffinicythere Hazel, 1967

Baffinicythere emarginata (Sars), 1866

pl. 26 figs. k-n

1866 Cythereis emarginata n.sp. Sars: p. 38.

1868 Cythere emarginata (Sars); Brady: p. 475.

1874 Cythere emarginata (Sars); Brady, Crosskey and Robertson: p. 166, pl. 5, figs. 1-6.

1889 Cythere emarginata (Sars); Brady and Norman: p. 163, pl. 16, figs. 1-2.

1928 Hemicythere emarginata (Sars); Sars: p. 183, pl. 85, fig. 1.

1941 Cythereis (Eucythereis) emarginata (Sars); Elofson: p. 57, map 22.

1943 Cythereis (Eucythereis) emarginata (Sars); Elofson: p.8.

1967 Baffinicythere emarginata (Sars); Hazel: p. 17, pl. 2, fig. 1, 2, 8, 9; pl. 9, fig. 2.

1969 Baffinicythere emarginata (Sars); Lev: p. 34, pl. 5, fig. 3.

1975 Baffinicythere emarginata (Sars); Neal and Howe: pl. 2, figs. 16, 18-21.

1977 Baffinicythere emarginata (Sars); Cronin: p. 116, pl. III, figs. 9-12.

1980 Baffinicythere emarginata (Sars): Hawley (ms.): p. 33, pl. 3, figs. 1-7; pl. 4, figs. 1-7; t. fig. 1, figs. 6-8, Map 2.

1981 Baffinicythere emarginata (Sars); Masson (ms.): p. 44, pl. 3, figs. 5, 7.

Material

Total: M - 1 LV. J. - 1 LV. = 2 I.

Southern Irish Sea

Dead	Live
J. - 00 C. 00 RV. 01 LV. = 1 I.	00

Malin Sea

Dead	Live
M. - 00 C. 00 RV. 01 LV. = 1 I.	00

Sample Distribution

Southern Irish Sea
2811

Malin Sea
3145

Figured Specimen

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
M.	LV.	external	24 .	5/5A	1.149	0.629
		"	30 .	8/8A		
		"	30 .	9/9A	0.326	0.198
J.	LV.	"	24 .	6/6A	0.326	0.198

Description

See: Hawley (ms. 1980, p. 33-41, pl. 3, 4) and Sars (1928, p. 183-184, pl. 85) for a description and illustration of the hard and soft parts.

Ontogeny

A single juvenile of indeterminate growth stage was recognised.

Remarks

There is no doubt that B. emarginata is alive in the western N. Atlantic. However, that figured by Cushman (1906) is either another species or, more probably, an artistic error as the antennules are drawn bearing 6 podomeres.

See: Hawley ms. 1980, p. 31-32, 42).

Study Area Ecology

Live material was not encountered.

In the southern Irish Sea a juvenile instar was recovered from sample 2811 (59.4 m, silt + clay). Further, a male valve was found in 146.3 m, fine sand and silt from the outer shelf, Malin Sea.

Palaeoecology and Distribution

This species probably inhabits Vineyard Sound, Cape Cod (Cushman, 1906). It occurs alive throughout the Gulf of Maine in sands and silts, 8-50 m, generally within 37 m, in waters of 5°C or less (Williams, 1966; Hazel, 1967, 1970). It also occurs in Recent sediments, 18-90 m, of the St. Lawrence (Brady, 1868, 1870) and is alive in the sublittoral, 29‰+ salinity of Halifax Inlet, Nova Scotia (Siddiqui and Grigg, 1975) and off S.W. Greenland (Hawley ms. 1980), 14-65 m (Norman, 1877; Brady and Norman, 1889; Stephensen, 1913). Further, *B. emarginata* ranges in Recent sediments within Davis St, 55-180 m (Brady, 1868; Brady and Norman, 1889) and occurs throughout Baffin Bay to N.W. Greenland 110-130 m (Sars, 1909).

The species is recorded from Iceland (Brady, 1868; Brady and Norman, 1889), in which region rare live specimens occur on shell sand and stony bottoms, 15-30 m (Stephensen, 1938). An abundance of live material has been found in muddy sands, 4-55 m, off Cape Flora, Franz Joseph Land; off western Novaya Zemlya (Scott, 1899; Neale and Howe, 1975) and off Spitzbergen, Svalbard Isles, 6-75 m (Brady and Robertson, 1872, Brady and Norman 1889; Elofson, 1941; Klie, 1942; Neale and Howe, 1975). It also appears to be distributed throughout the Barents and Norwegian Seas, 6-200 m (Brady and Norman, 1889; Neale and Howe, 1975). In addition, *B. emarginata* occurs alive in the intertidal and within 25 m of E. and W.

Finmark (Brady and Norman, 1889, 1895; Norman, 1891, 1902), Lofoten Isles and in shell sand, 6-50 m, throughout western Norway (Sars, 1866, 1891, 1928; Brady and Norman, 1889).

Specimens have been dredged from 100-200 m in S. Norway (Brady and Norman, 1889) and it is well documented alive in the Skagerrak (Elofson, 1941, 1943). The last author comments that it inhabits silty sand and cobble sand, 7-22 m, occurs often in constant sub $0^{o}C$ conditions and tolerates up to $19^{o}C$ in near normal salinity. Klie (1929) indicates that the species ranges to the Ostsee and its presence in the western Baltic, within 20-30‰ salinity, is confirmed by Elofson (1941).

B. emerginata is also incorporated in Recent sediments off the Shetlands (Norman, 1869; Brady and Robertson, 1872) and specimens are reported from the Clyde Estuary, 55 m (Robertson, 1874).

Holocene and Late Glacial material is well documented in the western N. Atlantic. Recorded from South Virginia, 30-400 m (Valentine, 1971) and northward to Cape Cod (Hazel, 1968), off Maine and in the Champlain Sea extension of the St. Lawrence (Brady and Crosskey, 1871; Brady et. al. 1874; Cronin, 1977). Material of this age is also known from 200 m approx. off N. Labrador, Davis St., in Baffin Bay extending northward off W. Greenland to the Queen Elizabeth Islands (Hazel, 1967, 1970; Neale and Howe, 1975).

In addition, Late Glacial material is known from N.E. Ireland (Brady et. al. 1874); Benderloch, W. Scotland (Morris ms. 1977) and the Clyde Estuary (Brady et. al. 1874; Robertson, 1877). However, B. emarginata seems to be more widely distributed in the Pleistocene eastward of Britain. In which region, this species is moderately abundant in the Late Devensian of S. Norway (Brady et.al. 1874; Lord, 1980), North Sea (Masson ms. 1981) and Forth, E. Scotland (Brady et.al., 1874; Robertson, 1877). It occurs in the Hoxnian interglacial of Dimlington, E. Yorkshire (Neale and Howe, 1975) and material is wide ranging in the late Pleistocene of N. Russia (Lev, 1961).

Summary

This species inhabits the western N. Atlantic between Cape Cod and the northern Davis St, 38-70^{O}N. It also extends in Recent sediments to northern Baffin Bay, 78^{O}N approx. The species is alive in abundance throughout the Barents and Norwegian Seas and extends southward in greatly reduced numbers to Iceland, the Skagerrak and Western Baltic, 56^{O}N-80^{O}N. Isolated material is also known in Recent sediments of northern Britain. Holocene and Late Glacial material is documented in eastern N. America northward of Cape Hatteras to Baffin Bay and N.E. Greenland, 38-75/80^{O}N and occurs most commonly in the Gulf of Maine and St. Lawrence Estuary, 43-50^{O}N. It has also been found in contemporaneous deposits of northern Britain and southern Norway, 55-60^{O}N and northern Russia, 65-70^{O}N. The species is most common in the Pleistocene of E. Britain and material is particularly frequent in the Hoxnian of E. Yorkshire, 54^{O}N.

B. emarginata inhabits the sublittoral and littoral, generally within 50 m approx. It is dredged in Recent sediments down to 200 m, though most of the material from these deeper waters is probably reworked. Several authors indicate that

it lives in the algal zone upon shelly sands, stony bottoms and occasionally on silty sands. Its abundance is recorded in waters of 5°C or less though the species can tolerate summer temperatures of 19-20°C. B. emarginata is a fully marine species, alive in 29% + salinity, with the exception of that found inhabiting the W. Baltic in 20-30% salinity.

Genus Elofsonella Pokorny, 1955

Elofsonella concinna (Jones) 1856
pl. 27 figs. 1-f, t.f. 7i, ii

1856 Cythere concinna n.sp. Jones: p. 29, pl. 4, figs. 7a-f.

1866 Cythereis clavata Sars: p. 39.

1868 Cythere concinna Jones; Brady: p. 408, pl. 26, figs. 28-33; pl. 38, fig. 7.

1874 Cythere concinna Jones; Brady, Crosskey and Robertson: p. 160, pl. 4, fig. 1-16.

1928 Hemicythere concinna (Jones), Sars: p. 189, pl. 87, fig. 1.

1938 Hemicythere concinna (Jones); Klie: p. 175, figs. 580-582.

1941 Cythereis (Paracythereis) concinna (Jones); Elofson: p. 64, maps 25-26.

1955 Elofsonella concinna (Jones); Pokorny: p. 10, t.f. 3-7.

1962 Elofsonella concinna (Jones); Woszidlo: p. 82, pl. 4, fig. 11.

1963 Elofsonella concinna (Jones); Swain: p. 829, pl. 98, fig. 1a, b; pl. 99, figs. 11a-c, t.f. 12c.

1965 Elofsonella concinna concinna (Jones); Bassiouni: p. 511, pl. 2, figs. 1, 2.

1965 Elofsonella concinna neoconcinna Bassiouni: p. 512, pl. 2, figs. 3a-c.

1967 Elofsonella concinna (Jones); Hazel: p. 15, pl. 4, figs. 10, 11, 13.

1969 Elofsonella concinna (Jones); Lev: p. 33, pl. 1, fig. 11, pl. 2, fig. 8.

1976 Elofsonella concinna (Jones); Jasin (ms.): p. 199, pl. 4, figs. 4-8.

1977 Elofsonella concinna (Jones); Rosenfeld: p. 25, pl. 6, figs. 81-83.

1981 Elofsonella concinna (Jones); Masson (ms.): p. 47, pl. 3, figs. 4, 8-10, 13, 15.

Material

Total Dead: F - 3 C, 88 RV. 25 LV.; M - 4 C. 17 RV. 19 LV.; J - 15 C. 1612 RV. 1619 LV. = 2385 I.

Live: 1 F. 1 J.

Southern Irish Sea

Dead					Live
F. -	03 C.	24 RV.	25 LV.		00
M. -	04 C.	17 RV.	18 LV.	= 2,351 I.	00
J. -	14 C.	1,601 RV.	1,609 LV.		02

Caernarvon Bay

Dead					Live
J. -	00 C.	01 RV.	01 LV.	= 2 I	00

Malin Sea

	Dead				Live
F. -	00 C.	04 RV.	00 LV.		00
M. -	00 C.	00 RV.	01 LV.	= 32 I	
J. -	01 C.	10 RV.	09 LV.		

Sample Distribution (live occurrence is underlined)

Southern Irish Sea

2354 2359 2783 2810 2811 2812 2813 2814 2815 2819
2821 2822 2826 2902 2904 2905 2906 <u>2910</u> 2911 <u>2912</u>
2915 2916 2917

Caernarvon Bay

2839 HHII

Malin Sea

3041 3042 3101 3135 3143 3145 3147 3161 3162

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	19 .	38/38A	0.860	0.473
	LV. "	19 .	37/37A	0.873	0.488
M.	RV. "	19 .	35/35A	0.898	0.449
	LV. "	19 .	36/36A	0.907	0.487
-2.	RV. "	19 .	39/39A	0.553	0.344
	LV. "	19 .	40/40A	0.542	0.342

The specimens are from sample 2915 (33 m, silt + clay), southern Irish Sea.

Description

See: Pokorny (1955, p. 12-17) for a description and Masson (ms. 1981, pl. 3) for an illustration of the carapace morphology. The soft parts are dealt with by Sars (1928, pl. 87) and, in part, by Elofson (1941, p. 65, figs. 6, 7).

Ontogeny

Instars from the penultimate to -7 growth stage were recognised. The dimensions of adults and juveniles from samples 2905 (87.8 m, mixed sand + silt) and 2915, southern Irish Sea, are given as follows. (See: Fig. 7i, ii).

Sample 2905

		L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	-	0.480-0.490	3	
	Mean	0.850	0.850		1.76
M.	Range	0.890-0.940	0.460-0.490	8	
	Mean	0.918	0.476		1.93
-1.	Range	0.680-0.780	0.400-0.450	17	
	Mean	0.720	0.424		1.70
-2.	Range	0.510-0.630	0.320-0.380	40	
	Mean	0.566	0.347		1.63
-3.	Range	0.440-0.510	0.280-0.310	55	
	Mean	0.464	0.287		1.62
-4.	Range	0.350-0.390	0.220-0.250	65	
	Mean	0.371	0.236		1.57

Sample 2905 (continued)

		L. (mm)	H. (mm)	Nos.	L.:H. ratio
-5.	Range	0.280-0.310	0.180-0.220	40	
	Mean	0.294	0.196		1.50
-6.	Range	-	-	1	
	Mean	0.230	0.160		1.44

Sample 1915

		L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.800-0.880	0.470-0.490	12	
	Mean	0.853	0.481		1.77
M.	Range	0.880-0.940	0.470-0.520	19	
	Mean	0.910	0.482		1.89
-1.	Range	0.660-0.750	0.390-0.420	37	
	Mean	0.703	0.405		1.74
-2.	Range	0.520-0.600	0.310-0.360	50	
	Mean	0.567	0.344		1.65
-3.	Range	0.430-0.490	0.260-0.310	53	
	Mean	0.458	0.285		1.61
-4.	Range	0.350-0.390	0.210-0.260	62	
	Mean	0.363	0.236		1.54
-5.	Range	0.280-0.310	0.180-0.200	30	
	Mean	0.292	0.194		1.51
-6.	Range	0.220-0.240	0.140-0.150	2	
	Mean	0.230	0.145		1.59
-7.	Range	-	-	1	
	Mean	0.180	0.120		1.50

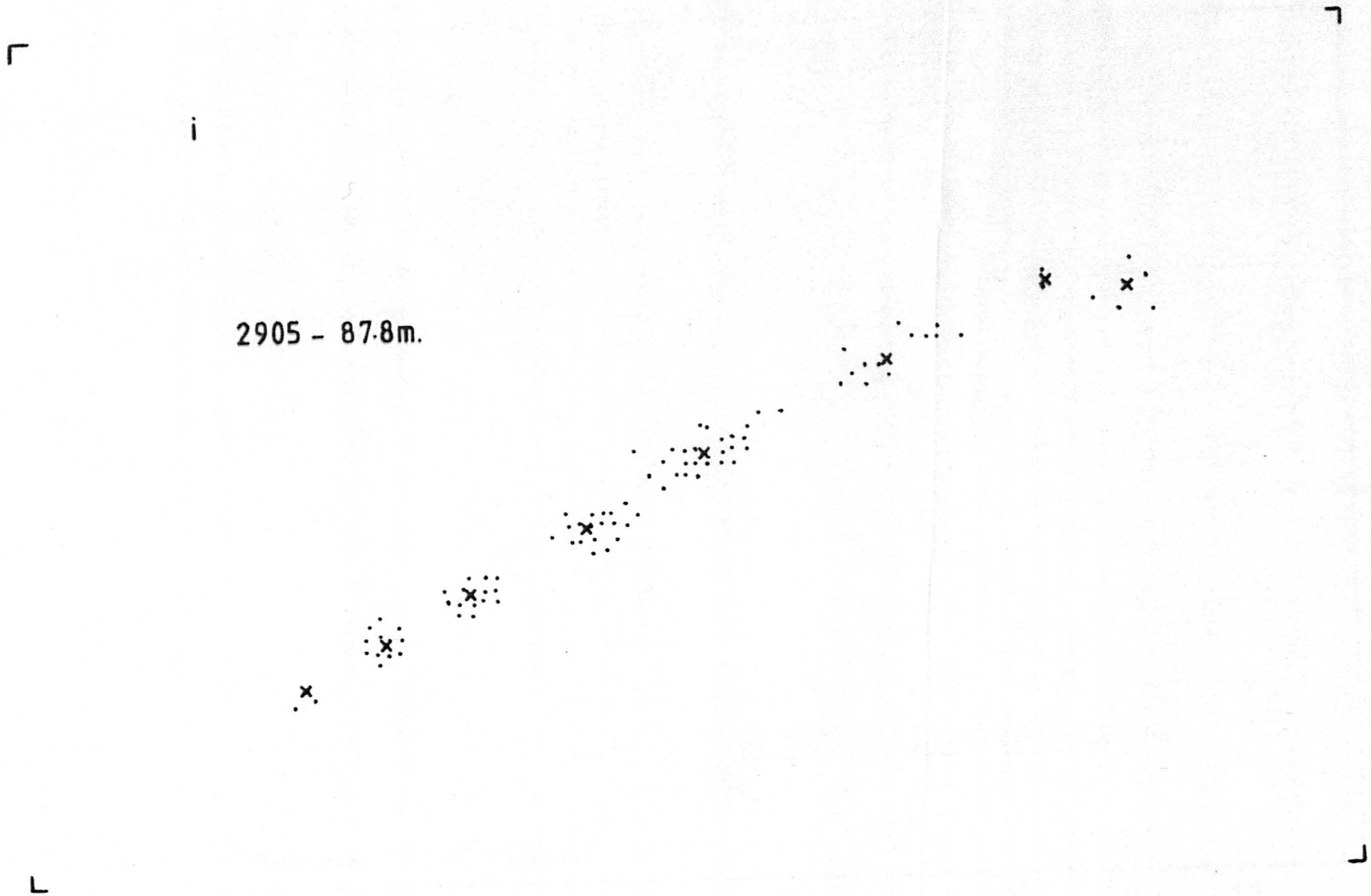
Sexual dimorphism is pronounced. The males are much the larger and proportionately longer than females. The L:H ratios indicate that there is a regular increase in size and streamlining of the shell at each successive growth stage.

Remarks

See: Hazel (1967, p. 16) and Masson (ms. 1981, p. 49-50).

Study Area Ecology

In the southern Irish Sea a live female was recovered from sample 2910, 54.9 m and a live juvenile occurred in sample 2912, 26.5 m, mixed sand.


i
2905 - 87.8m.

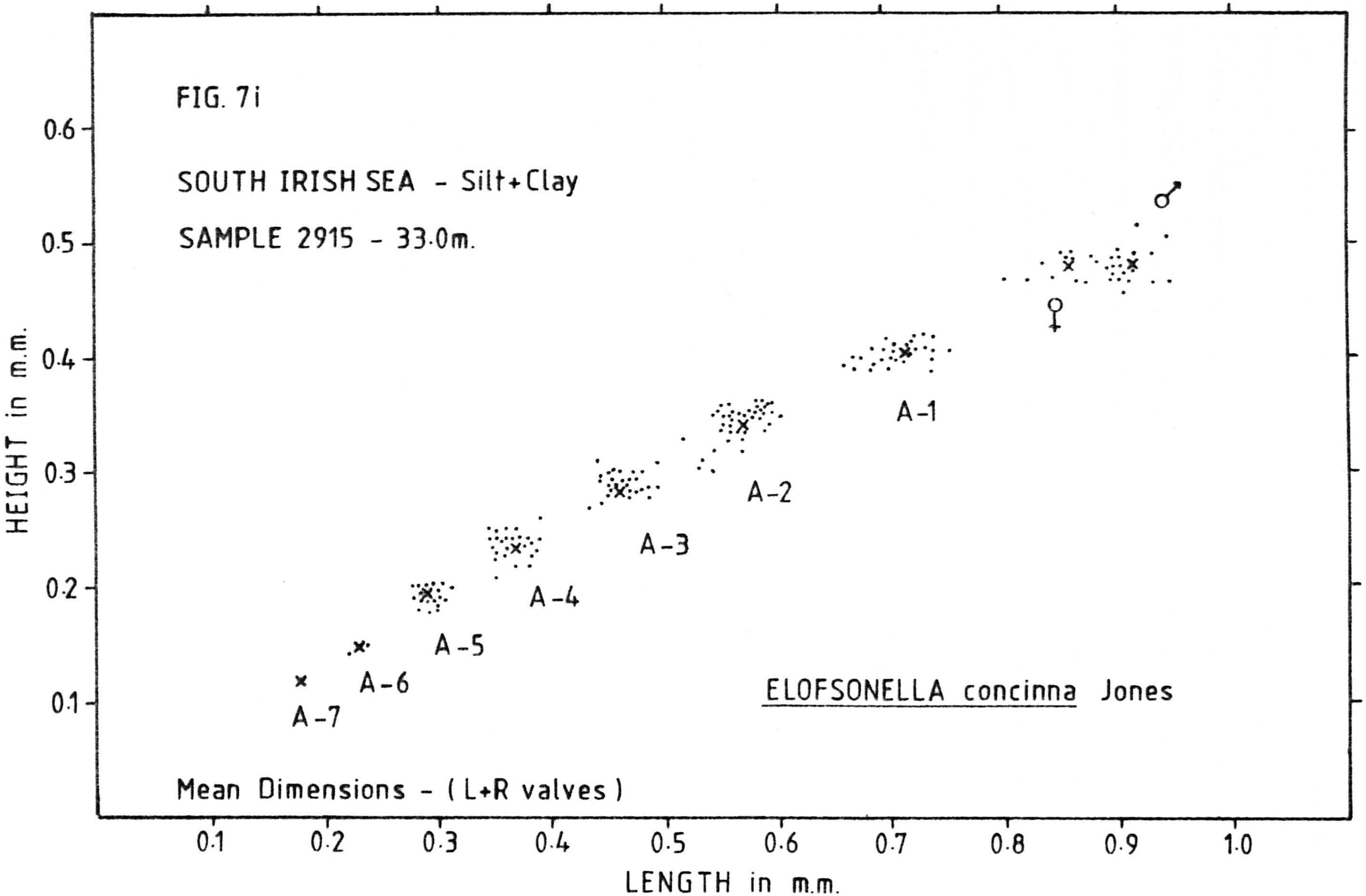


FIG. 7i
SOUTH IRISH SEA - Silt+Clay
SAMPLE 2915 - 33.0m.
HEIGHT in m.m.
0.6
0.5
0.4
0.3
0.2
0.1
A-1
A-2
A-3
A-4
A-5
A-6
A-7
ELOFSONELLA concinna Jones
Mean Dimensions - (L+R valves)
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
LENGTH in m.m.

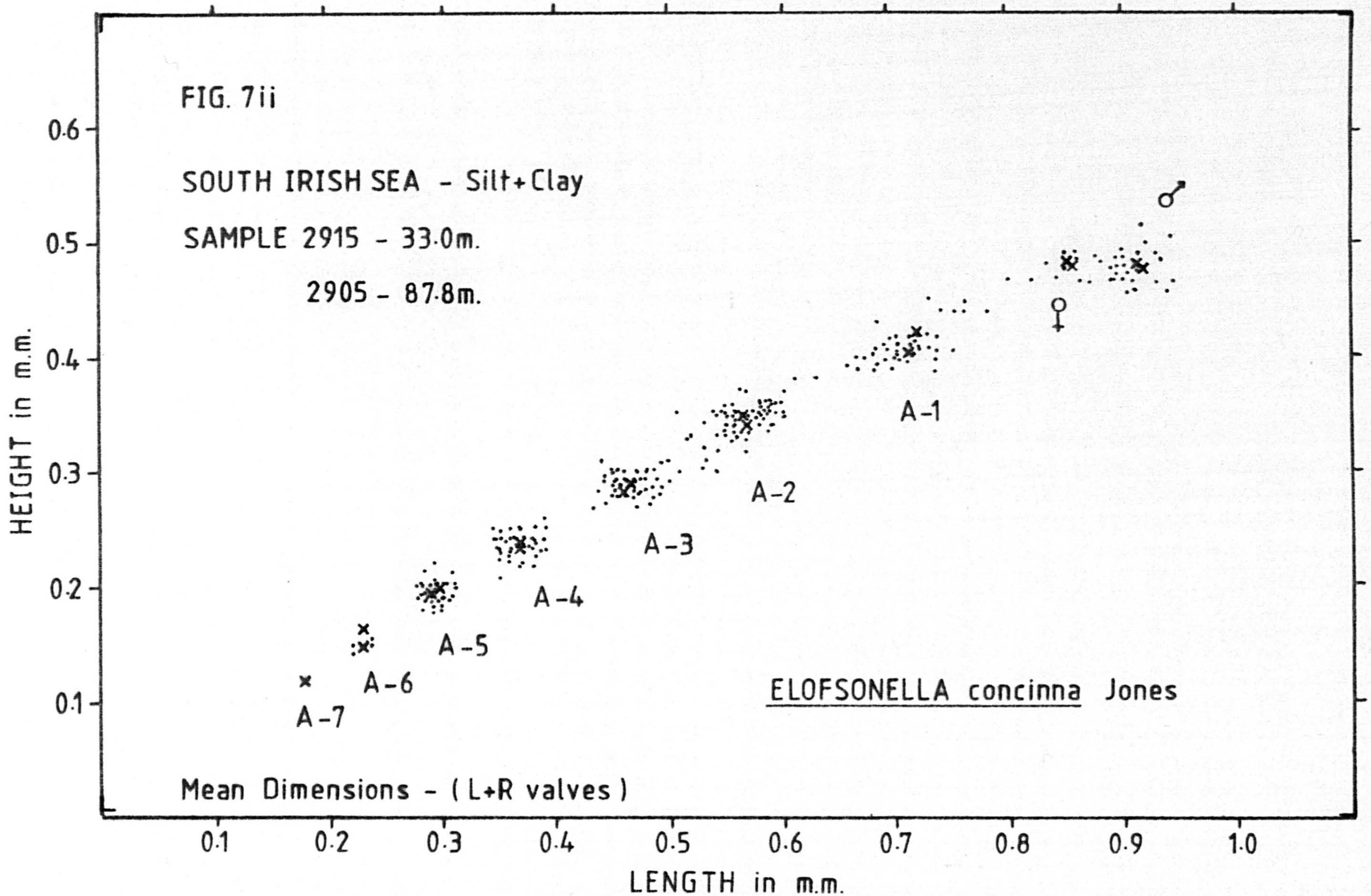


FIG. 7ii
SOUTH IRISH SEA - Silt+Clay
SAMPLE 2915 - 33.0m.
2905 - 87.8m.
HEIGHT in m.m.
0.6
0.5
0.4
0.3
0.2
0.1
A-1
A-2
A-3
A-4
A-5
A-6
A-7
♂
♀
ELOFSONELLA concinna Jones
Mean Dimensions - (L+R valves)
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
LENGTH in m.m.

Otherwise, material was distributed generally northward of Dublin Bay, 6.1-109.7 m, mean 48.6 m in mixed and fine sand with silt and clay. In Caernarvon Bay isolated specimens occurred between the tidemarks of Holyhead Harbour and in sample 2839 (44 m, mixed sand). Material was found in large numbers from the outer shelf of Malin Sea, 55-512.1 m, mean 161.3 m, in all the above sediments.

The overwhelming abundance of this species was recorded in the southern Irish Sea throughout the depth range in sediments composed of sands with a high silt or clay content. Juvenile assemblages occurred in samples 2810, 2902, 2905 and 2906, 60.9-109.7 m. Populations of adults with juveniles were recovered from samples 2811, 2814 and 2904, 36-80.5 m, with more than 50% of the total number found in samples 2813 (33.5 m, fine sand + silt) and 2915 (33 m, silt + clay).

Palaeoecology and Distribution

The species is widely distributed in Recent sediments of the western N. Atlantic (Elofson, 1941) and may range from Vineyard Sound, Cape Cod (Cushman, 1906) throughout Maine, alive within 100 m, 0-15°C (Blake, 1933; Hazel, 1967, 1970). It also occurs in 29‰+ salinity, 7-24 m, of Halifax Inlet, Nova Scotia (Siddiqui and Grigg, 1975). *E. concinna* extends between 18-90 m in the Gulf of St. Lawrence (Brady, 1870) and it is reported in the sublittoral of Hunde Island, W. Greenland (Brady, 1868; Brady and Norman, 1888; Stephensen, 1913), northward to Ellesmere Is., N. Baffin Bay (Brady, 1868; Sars, 1909). In addition, Elofson (1941) indicates that it occurs off Clavering Is., N.E. Greenland, 25-40 m and rare material is reported from 200 m off Iceland (Brady and Norman, 1889; Stephensen, 1938).

In the eastern Arctic Recent material is recorded from Spitzbergen, Svalbard Islands (Brady and Robertson, 1872; Neale and Howe, 1975) in 1-154 m (Elofson, 1941) and it is commonly alive between the tidemarks of Finmark (Brady and Norman, 1895; Norman, 1899, 1902). Live material is also found in many areas of Western Norway, 14-25 m on muddy bottoms (Brady and Norman, 1889; Sars, 1891, 1928). *E. concinna* is abundant off southern Norway, 13-22 m, in Oslo Fiord (Sars, 1866, 1928) and ranges therein on soft sandy silts, 10-150 m (Elofson, 1941). The last author commented that its temperature tolerance was 0-18°C within the Skagerrak. *E. concinna* is also commonly alive in the Oresund, 27-33‰ salinity, 3-16°C, associated with *Corallina officinalis* (Hagerman, 1965, 1968) and ranges to Kiel Bay (Klie, 1929, 1938) and the Ostsee, W. Baltic, 40-50 m, in 16-30‰ salinity (Elofson, 1941; Rosenfeld, 1977).

Stephensen (1929) and Elofson (1941) report it from the Faeroes and it occurs commonly alive in the Shetlands, 90-110 m and off E. Scotland (Brady, 1868; Brady and Norman, 1889). It is also recorded in abundance in muddy sands, 38-70 m, off N.E. England (Brady and Robertson, 1872, 1874; Brady, 1876, 1902, 1903; Norman and Brady, 1909) and from the Heligoland (Skaumal, 1977).

Live specimens are recorded from the Minches, 130 m and otherwise occur in Recent sediments, 10-190 m, throughout W. Scotland (Brady, 1868; Brady and Robertson, 1874; Robertson, 1874; C.S. Harris ms. 1977). Its presence is documented off Antrim, 10-18 m, in Lough Foyle, N. Ireland (Norman, 1905), from many localities west of Ireland (Brady and Robertson, 1869; Norman, 1905) and in the Irish Sea, 6-35 m (Brady and Robertson, 1869; Brady and Norman, 1889).

The fossil distribution extends to both the eastern and western N. Atlantic. Late Glacial and Holocene material is reported between Capes Hatteras and Cod (Hazel, 1968), from Maine and the St. Lawrence Estuary (Brady and Crosskey, 1871). Material of this age has been dredged within 100 m from Ungava Bay, Labrador, Frobisher Bay, Baffin Island, Foxe Basin and northward to the Queen Elizabeth Islands (Hazel, 1967, 1970). Pleistocene material is also known from the Gubik Formation, Point Barrow, N.W. Alaska (Swain, 1963).

Late Devensian and Holocene material is widespread in W. Europe. Recorded from S. Norway (Brady et.al., 1874; Lord, 1980), Dogger (Diebel and Pietrzeniuk, 1971) and North Sea (Masson, ms. 1981). It also occurs throughout the raised beach deposits of W. Scotland (Brady et.al., 1874; Robertson, 1885, 1887; Anderson, 1948; Morris ms. 1977; Peacock et.al., 1978; Graham and Wilkinson, 1978) and N.E. Ireland (Brady, et. al., 1874). Jasin (ms. 1976) found it in the Ipswichian, last interglacial of the Irish Sea. However, *E. concinna* is most abundant in the Hoxnian, ranging from Denmark and N. Germany (Woszidlo, 1962; Bassiouni, 1965) to E. Norfolk (Lord and Robinson, 1978) and E. Yorkshire (Jones, 1856; Brady et.al., 1874; Lamplugh, 1881; Neale and Howe, 1975). Lastly, *E. concimma* is widely distributed in the Late Pleistocene of N. Russia (Lev, 1969).

Summary

This is a rare species in the Recent of the western N. Atlantic, alive between Cape Cod and N.W. Greenland, 43-78^{O}N. There are isolated reports of it from N.E. Greenland, 74^{O}N and off Iceland. *E. concinna* inhabits much of the Eastern Arctic, extends alive in abundance throughout Norway and S. Scandinavia, 60-70^{O}N and ranges to N. Britain in reduced numbers, 52-80^{O}N. Late Glacial and Holocene material is recorded north of Cape Hatteras and extends in superficial sediments to Baffin Bay, 38-78^{O}N. Material of this age is also found in W. Europe, throughout N. Britain, North Sea and S. Norway, 60-56^{O}N. It occurs in the last interglacial of the Irish Sea, 52-54^{O}N and is most abundant in the preceding interglacial. Indeed, *E. concinna* is a dominant species in the Hoxnian of Denmark, N. Germany and E. England, 52-58^{O}N and may range throughout the Late Pleistocene of N. Russia, 60-65^{O}N.

This is a sublittoral and littoral species, mostly alive within 25 m though it inhabits some areas down to 100 m approx. Reworked material is often incorporated in Recent sediments down to 250 m, at which depth the species may occur alive in the Skagerrak. A fully marine species in 29‰+ salinity on mud and fine sand between 0-19^{O}C, though in the W. Baltic it tolerates 16-30‰ salinity in sublittoral algae.

Genus Finmarchinella Swain, 1963

Finmarchinella finmarchica (Sars) 1866

pl. 27 figs. g-h

1866 Cythereis finmarchica n.sp. Sars: p. 41.

1868 Cythere finmarchica (Sars); Brady: p. 410, pl. 31, figs. 9-13.

1874 Cythere finmarchica (Sars); Brady, Crosskey and Robertson: p. 153, pl. 10, figs. 18-21.

1928 Hemicythere finmarchica (Sars); Sars: p. 185, pl. 85, figs. 3.

1963 Finmarchinella finmarchica (Sars); Swain: p. 813.

1967 Nereina finmarchica (Sars); Hazel: p. 18, pl. 1, fig. 1-4, 6; pl. 11, fig. 7.

1969 Finmarchinella finmarchica (Sars); Lev: p. 34, pl. 5, fig. 6.

1971 Finmarchinella finmarchica (Sars); Valentine: pl. 3, figs. 27-28.

1974 Finmarchinella (Finmarchinella) finmarchica (Sars); Neale: p. 84, pl. 1, figs. 6, 7; pl. 2, figs. 1, 5, 11.

1975 Finmarchinella finmarchica (Sars); Neale and Howe: pl. 2, fig. 14, pl. 3, fig. 1; pl. 4, fig. 1.

1977 Finmarchinella finmarchica (Sars); Rosenfeld: p. 26, pl. 6, fig. 80.

1981 Finmarchinella finmarchica (Sars): Masson (ms.): p. 53, pl. 3, fig. 14.

Material

Total: M. - 3 LV.; J. - 3 RV. = 6 I.

Southern Irish Sea

Dead					Live
J. -	00 C.	03 RV.	00 LV.	= 3 I.	00

Caernarvon Bay

Dead					Live
M. -	00 C.	00 RV.	02 LV.	= 1 I.	00

Malin Sea

Dead					Live
M. -	00 C.	00 RV.	01 LV.	= 2 I.	00

Sample Distribution

Southern Irish Sea
2916

Caernarvon Bay
2447 2516

Malin Sea
3143

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
M.	LV. external	16 .	11A/12	0.625	0.289
-1.	LV. "	16 .	12A/13	0.600	0.276

Adult valve - sample 2447 (109.7m), juvenile instar - sample 2516 (49.6 m), mixed sand, Caernarvon Bay.

Description

See: Sars (1928, p. 185-186, pl. 8) for a description and illustration of the hard and soft parts. The carapace morphology is best illustrated by Neale (1974, pl. 1, figs. 6, 7; pl. 2, figs. 1, 5, 11).

Ontogeny

Several juvenile instars were recovered and provisionally assigned as the penultimate growth stage of this species.

Remarks

De Vos (1957) indicates that this species is alive in the Roscoff region, Brittany. However, as this material was only 0.58 mm in length this would, therefore, seem to be a most unlikely record.

See: Hazel (1967, p. 18) and Neale (1974, p. 84).

Study Area Ecology

Live specimens were not found and the material was poorly preserved.

Isolated juveniles occurred in 36.6 m and mixed sands, southern Irish Sea. Adult valves were found in Caernarvon Bay, 49.4 m and 109.7 m, in mixed sand. It occurred on the outer shelf of the Malin Sea, fine sand with silt, 146.3 m.

Palaeoecology and Distribution

The species is rare though widely distributed in the western N. Atlantic. Hazel (1967, 1970) found it distributed between New York Harbour and Ungava Bay, N. Labrador. He found live? material within 122 m, 0-15°C off Maine. Live specimens may also occur in the sublittoral, 29‰+ salinity, of Halifax Inlet, Nova Scotia (Siddiqui and Grigg, 1975); extend to the Davis St. and are found in 0-18 m on sands around Hunde Is., W. Greenland (Norman, 1877; Brady and Norman, 1889; Stephensen, 1913).

In the eastern Arctic Recent material is recorded in 4-28 m from Cape Flora, Franz Joseph Land; off Spitzbergen, Svalbard Islands; Novaya Zemlya, 2-15 m in muddy sands and throughout the Barents and Norwegian Seas (Neale, 1974; Neale and Howe, 1975). In addition, live specimens are well documented in the littoral of N. Norway (Brady and Norman, 1889, 1895; Norman, 1902), in shell sands of S. Norway (Sars, 1928) and material ranges in Recent sediments to the Kattegat and Western Baltic (Klie, 1929; Rosenfeld, 1977).

F. finmarchica also occurs rarely in superficial sediments ranging from the Shetlands to Norfolk (Brady and Norman, 1889); 55 m in the North Sea (Neale, 1974) and occurs in the Schelde and Maas Estuaries, Netherlands (Brady and Robertson, 1870). Most records of this species are from off N.E. England, in gravel sands, 38-55 m (Brady, 1868; Brady and Robertson, 1872, 1876; Norman and Brady, 1909; Bossany, 1967).

Isolated material has been dredged off N.W. Scotland, in the Minches, 28-120 m, fine sand and mud (Brady, 1868; Brady and Norman, 1889; C.S. Harris ms. 1977), with other material found in the Clyde Estuary (Robertson, 1874). Its presence is reported off Western Ireland and in shell sands throughout the Irish and Malin Seas (Brady, 1868; Brady and Norman 1889; Norman, 1905). The range also extends in Recent sediments to the Celtic Sea and off south Devon (Brady, 1868; Norman and Scott, 1906; Harding, 1957; Neale, 1974).

The species is reported alive in the estuary of the R. Morlaix, Brittany (de Vos, 1957), from the Channel Islands (Norman, 1907, 1908) and F. finmarchica is recorded in superficial sediments from Cap Breton, S. Biscay (Fischer, 1876; Brady and Norman, 1889).

In the western N. Atlantic Holocene and Late Glacial material is recorded from S.E. Virginia (Valentine, 1971) and between Capes Hatteras and Cod (Hazel, 1968). The distribution includes Maine, Nova Scotia and Newfoundland (Hazel, 1967, 1970), northern Labrador, Davis St. and western Greenland, north to Disko Island (Hazel, 1867, 1970; Neale, 1974; Neale and Howe, 1975). In the eastern N. Atlantic Holocene material is recorded in the southern Irish Sea (Spencer ms. 1976) and in 100-600 m of S. Biscay (Peypouquet, 1971, 1973; Moyes and Peypouquet, 1971). The Late Glacial record includes S. Norway (Brady et. al., 1874), Forth (Bell, 1891) and the North Sea (Masson, ms. 1981). Material of Late Devensian age also extends to W. Scotland (Brady, et. al., 1874; Morris ms. 1977). Jasin (ms. 1976) found it in the last interglacial of the Irish Sea and F. finmarchinella occurs in the Eemian of S. Sussex (Whatley and Kaye, 1971). The species is further documented in the Hoxnian of E. Yorkshire (Neale and Howe, 1975) and material is reported in the Late Pleistocene of north Russia (Lev, 1969).

Summary

This species is possibly alive from the Gulf of Maine north to Newfoundland and S.W. Greenland, 42-70^{O}N. However, it is likely that material found southward of Cape Cod between 42-35^{O}N relates to reworked Holocene and Late Glacial specimens. Live material is reported throughout the Barents and Norwegian Seas, west of Scandinavia and may extend to north Britain, 55-80^{O}N. It also ranges in Recent sediments to the W. Baltic and there is a dubious report of isolated live individuals off N. Brittany, 49^{O}N. Material occurs in the Holocene of the Irish Sea and Biscay, 54-42^{O}N; with accurate records of F. finmarchica in the Late Glacial of S. Norway and N. Britain, 56-60^{O}N. The species occurs in the Ipswichian of S. and S.W. Britain, 54-50^{O}N; recorded in the Hoxnian of E. Yorkshire, 54^{O}N and it is found in equivalent and other Late Pleistocene deposits of N. Russia, 60-65^{O}N.

F. finmarchica mostly inhabits sublittoral and shallow waters, 4-30 m. It is probable that much of the material recorded below 100 m approx. and down to 500 m is reworked. In open marine conditions the species is mostly associated with shelly gravels and sands. However, in estuarine environments F. finmarchica is recorded from muds and fine sands. The temperature tolerance is between 0-25/27.5°C, though many authors indicate 0-15°C to be more likely in salinities of 25-30‰+.

Finmarchinella angulata (Sars) 1866
pl. 27 figs. i-n

1866 Cythereis angulata n.sp. Sars: p. 40.

1868 Cythere angulata (Sars); Brady: p. 409, pl. 26, figs. 39, 42.

1874 Cythere angulata (Sars); Brady, Crosskey and Robertson: p. 162, pl. 4, figs. 17-24, pl. 10, fig. 22.

1889 Cythere angulata (Sars); Brady and Norman: p. 165.

1928 Hemicythere angulata (Sars); Sars: p. 187, pl. 86, fig. 2.

1941 Cythereis (Eucythereis) angulata (Sars); Elofson: p. 61, map. 23.

1957 'Hemicytherinae' (genus?) angulata (Sars); Wagner: p. 61, pl. 38, figs. 1, 2.

1974 Finmarchinella (Barentsovia) angulata (Sars); Neale: p. 88, pl. 1, fig.8, pl. 2, figs. 2, 4, 6, 10.

1975 Finmarchinella angulata (Sars); Neale and Howe: p. 418, pl. 1, figs. 7, 10, 12; pl. 2, figs. 8, 11.

1979 Finmarchinella angulata (Sars); Rosenfeld: p. 27, pl. 6, figs. 76-79.

1980 Finmarchinella (Barentsovia) angulata (Sars); Hawley (ms.): p. 46, pl. 3, figs. 8-12; t.f. 2, figs. 1, 2; t.f. 3, figs. 1-4.

1980 Finmarchinella (Barentsovia) angulata (Sars); Lord p. 241, pl. 1, figs. 4 (Juv.).

1981 ?Finmarchinella angulata (Sars); Masson (ms.): p. 55, pl. 3, fig. 16.

Material

Total: F. - 1 C. 8 RV. 3 LV.; M. - 2 RV. 5 LV.
J. - 32 RV. 35 LV. = 67 I.

Southern Irish Sea

Dead						Live
F. -	00 C.	02 RV.	01 LV.			00
M. -	00 C.	00 RV.	03 LV.	=	26 I.	
J. -	00 C.	15 RV.	13 LV.			

Caernarvon Bay

Dead						Live
J. -	00 C.	02 RV.	01 LV.	=	3 I.	00

Malin Sea

Dead						Live
F. -	01 C.	06 RV.	02 LV.			00
M. -	00 C.	02 RV.	02 LV.	=	38 I.	
J. -	00 C.	15 RV.	21 LV.			

Sample Distribution

Southern Irish Sea

2359 2361 2370 2380 2810 2811 2812 2904 2905 2915

Caernarvon Bay

2427 2449 2457

Malin Sea

3012 3101 3103 3143 3161 3162

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	16 .	16A/17	0.656	0.323
	LV. "	16 .	15A/16	0.642	0.342
M.	RV. "	16 .	13A/14	0.664	0.340
	LV. "	16 .	14A/15	0.623	0.332
-2.	RV. "	16 .	17A/18	0.457	0.246
	LV. "	16 .	18A/19	0.437	0.258

Female right valve sample 3012 (47.6 m, coarse sand + gravel); female left and juvenile valves - sample 3101 (55 m, fine sand + silt), Malin Sea; male valves - sample 2361 (78.6 m, fine sand + silt), southern Irish Sea.

Description

See: Sars (1928, p. 187-188, pl. 86) and Hawley (ms. 1980, p. 41-54, t.f. 2, figs. 1-2; t.f. 3, figs. 1-4) for a description of the hard and soft parts and illustration of the latter.

The carapace morphology is illustrated by Neale (1974, pl. 2, figs. 2, 4, 6, 10) and Neale and Howe (1975, pl. 1, figs. 7, 10, 12; pl. 2, figs. 8, 11).

Ontogeny

Instars from the penultimate to -4 growth stage were recognised. The dimensions of adults in the study material and the dimensions of juveniles from sample 3101, Malin Sea, are given as follows.

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.620-0.675	0.325-0.365	11	
	Mean	0.650	0.341		1.91
M.	Range	0.610-0.680	0.320-0.350	7	
	Mean	0.654	0.334		1.96
-1.	Range	0.540-0.620	0.280-0.310	10	
	Mean	0.572	0.296		1.93

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
-2.	Range	0.430-0.460	0.210-0.270	20	
	Mean	0.444	0.247		1.80
-3.	Range	0.340-0.360	0.190-0.220	11	
	Mean	0.355	0.206		1.72
-4.	Range	-	-	1	
	Mean	0.300	0.180		1.67

Sexual dimorphism is not distinct. However, the males are proportionately longer than females.

There is a regular increase in size of successive growth stages. The L.:H. ratios also indicate that there is progressive elongation of the shell throughout ontogeny.

Remarks

That illustrated by Masson (ms. 1981, pl. 3, fig. 16) as *F. angulata* is more probably a juvenile of *F. barentzovoensis* (Mandelstam). In addition, Masson gives the size of the adult specimens as 0.76 mm in length which is more in keeping with dimensions of the Mandelstam species than with the rather diminutive *F. angulata* of Sars.

See: Neale (1974, p. 89) and Masson (ms. 1981, p. 56-57).

Study Area Ecology

This species was not recovered live and occurred rarely throughout most of the study area.

In the southern Irish Sea specimens were confined northward of Dublin Bay, 18.3-97 m, mean 56.4 m, in mixed sand, fine sand with silt, and silt and clay. Isolated juveniles were recovered from the deepest parts of Caernarvon Bay, 120.7-150 m, coarse sand with gravel. The species occurred mostly on the outer shelf of Malin Sea between 47.6-146.3 m, mean 101.5 m, in the sediment types given. A small population of adults and juveniles occurred in sample 3101, S.E. of Islay, 55 m, fine sand + silt.

Palaeoecology and Distribution

This species has been confused in the western N. Atlantic with F. barentzovoensis (Mandelstam) and F. curvicostata Neale. Nevertheless, Hazel (1967, 1970) records a moderate abundance of F. angulata in 26-36 m, Gulf of Maine. Material is also reported from 100 m in the Davis St., in Hammerfest Harbour, 2 m (Brady and Norman, 1889), off Holsteinborg, 4-18 m (Brady and Norman, 1889; Stephensen, 1913; Neale, 1974; Neale and Howe, 1975) and from Hunde Island, 2-130 m (Norman, 1877; Brady and Norman, 1889; Neale, 1974; Neale and Howe, 1975). F. angulata also occurs alive in full marine salinity between 0-6°C off S.W. Greenland (Hawley ms. 1980). Reports of this species in Baffin Bay (Müller, 1912) and within the straits between N.W. Greenland and Ellesmere Island (Sars, 1909; Klie, 1929) are probably referable to other species.

Isolated individuals have been dredged within 40 m off W. and N.W. Iceland (Stephensen, 1938). Recorded from Spitzbergen and Danish Island, 45-55 m (Elofson, 1938, 1941); Russian Harbour, Novaya Zemlya and it occurs in many other localities in the Barents and Norwegian Seas (Neale, 1974; Neale and Howe, 1975). There are also reports of F. angulata alive in the intertidal and sublittoral, 6-18 m, of Finmark, N. Norway (Brady and Norman, 1889, 1895; Norman, 1902) and within 45 m off W. Norway (Norman, 1891; Brady and Norman, 1889; Neale, 1974). Sars (1928) comments that this species is alive in the Laminaria zone throughout southern and western

Scandinavia. However, the ecology is best documented in the Skaggerak and Oresund, in which region Elofson (1938, 1941) and Hagerman (1965) found most material associated with Laminaria, 7-10 m and on plant debris beneath in -2-20°C and 18-35‰ salinity. Further, live material extends within 0-28 m and 14-30‰ salinity to Kiel Bay, W. Baltic (Klie, 1929; Rosenfeld, 1977).

Scarce Recent specimens are recorded from deep waters of the North Sea (Norman and Brady, 1909). It also ranges in E. Britain on mud and sand from the Shetlands (Brady, 1966; Norman, 1969), to N.E. England (Brady, 1868; Brady and Robertson, 1870, 1872, 1874; Brady and Norman, 1889; Bossany, 1967).

The distribution is rather better documented off Western Britain though records probably include much reworked material. However, F. angulata is a common find in fine sand and muds, 8-110 m, off N.W. Scotland (Brady, 1968; C.S. Harris ms. 1977) and recorded in numerous localities of the Clyde Estuary (Brady, 1868; Brady and Robertson, 1874; Robertson, 1874; Brady and Norman, 1889). Its distribution also ranges in superficial sediments throughout the Irish Sea though it is mostly confined from the tidemarks to 45 m approx. (Brady, 1868, 1869; Brady and Norman, 1889; Norman, 1905). Isolated specimens are also known from the Celtic Sea, Scilly Isles and westward to the Cockburn Bank, though these records are probably not of Recent age (Neale, 1974).

As a fossil, F. angulata is reported from the Holocene and Late Glacial off Cape Cod (Hazel, 1968) and it may occur in the Holocene, within 150 m, off Maine; Canadian Arctic, Davis St. and in Baffin Bay (Hazel, 1967, 1970; Neale and Howe, 1975). Material of this age is also commonly dredged between 100-200 m in Biscay (Yassini, 1969; Moyes and Peypouquet, 1971) and F. angulata occurs in the Holocene of the Netherlands (Wagner, 1957, 1960). The Late Glacial distribution is well documented from S.W. Scotland (Morris, ms. 1977); N.E. Ireland (Brady et.al. 1874); Clyde Estuary (Brady et.al. 1874; Robertson, 1885, 1887; Anderson, 1948); Forth (Brady et.al. 1874; Bell, 1891), North Sea (Masson ms. 1981) and from S.W. Norway (Brady et.al. 1874; Lord, 1980). Rare material is recorded from the Last interglacial of the Irish Sea (Jasin ms. 1976); Somerset levels (Kidson et.al. 1978) and Selsey, Sussex (Whatley and Kaye, 1971). Lastly, it extends in moderate abundance to the Hoxnian of E. Yorkshire (Brady et.al. 1874; Brady and Norman, 1889; Neale and Howe, 1975).

Summary

In the western N. Atlantic live material is reported from Maine, 42-45^{O}N and is accurately documented off S.W. Greenland, 60-67^{O}N. Alive in abundance off W. Norway between Finmark and Bergen, 60-70^{O}N, with isolated live material extending to the Skagerrak, W. Baltic and N. Britain, 56^{O}N. In the western N. Atlantic Holocene and Late Glacial material occurs off New England and may range throughout the Canadian Arctic and deep waters of N.W. Greenland, 40-76^{O}N. In European waters contemporaneous material is known to extend from S.W. Norway southward into Biscay, 44-60^{O}N, with an abundance of material recorded in the Late Glacial of W. Scotland, 56-58^{O}N. Lastly, F. angulata is recorded in the

Ipswichian of the Irish Sea, Somerset levels and S. Sussex, 50-54°N; with further material in the Hoxnian of E. Yorkshire, 54°N.

This species inhabits the intertidal and sublittoral, 2-18 m and is found commonly within 45 m associated with Laminaria and the plant debris beneath. It is also reworked into Recent sediments down to 200 m+ in the western N. Atlantic and occurs within 8-110 m+ in European waters. The temperature tolerance is given as -2-20°C in 18-35‰ salinity. However, in the western Baltic F. angulata is occasionally found alive in 14-30‰ salinity.

Genus Heterocythereis Elofson, 1941

Heterocythereis albomaculata (Baird), 1838
pl. 27 figs. o-t

1835 Cythere alba n.sp. Baird: p. 98, pl. III, fig. 6 (Juvs.).

1838 Cythere albomaculata n.sp. Baird: p. 142, pl. V, fig. 23 (Adults).

1838 Cythere alba Baird; Baird: p. 143, pl. V, fig. 24 (Juv.).

1850 Cythere albomaculata Baird; Baird: p. 169, pl. XX, fig. 7 (Adults).

1850 Cythere alba Baird; Baird: p. 170, pl. XX, fig. 6 (Juvs.).

1868 Cythere albomaculata Baird; Brady: p. 402, pl. XXVII, figs. 33-39; pl. XXXIX, fig. 3.

1874 Cythere albomaculata Baird; Brady, Crosskey and Robertson: p. 149, pl. IX, figs.1-4.

1889 Cythere albomaculata Baird; Brady and Norman: p. 138.

1928 Cythere albomaculata Baird; Sars: p. 169, pl. LXXVIII, fig. 1.

1938 Cythere albomaculata Baird; Klie: p. 165, t.f. 548-550.

1941	Cythereis (Heterocythereis) albomaculata (Baird); Elofson: p. 292.
1957	Eucythereis albomaculata (Baird); de Vos: p. 28, pl. XI, figs. 3a-e; pl. XII, figs. 2a-g.
1957	Heterocythereis albomaculata (Baird); Wagner: p. 57, pl. XXIV.
1969	Heterocythereis albomaculata (Baird); Wall (ms.): p.185, pl. 12, figs. a-h; pl. 35, figs. a-k.
1969	Heterocythereis albomaculata (Baird); Yassimi: p. 45, pl. X-XII, XV, XVII, XVIII.
1972	Heterocythereis albomaculata (Baird); Whittaker (ms.): p. 134, pl. 17, figs. 5-13.
1976	Heterocythereis albomaculata (Baird); Hoskin (ms.): p. 281, pl. 20, figs. 5-7.

Material

Total Dead: F. - 6 RV.; M. - 1 C. 1 RV. 1 LV.;
J. - 1 C. 87 RV. 71 LV. = 130 I.

Live: 15 F. 9 M, 3 J.

Southern Irish Sea

Dead					Live	
F. -	00 C.	02 RV.	00 LV.		01	
M. -	00 C.	00 RV.	00 LV.	= 54 I.	01	= 4 I.
J. -	00 C.	35 RV.	37 LV.		02	

Caernarvon Bay

Dead					Live	
F. -	00 C.	03 RV.	00 LV.		14	
M. -	00 C.	01 RV.	01 LV.	= 61 I.	08	= 23 I.
J. -	00 C.	46 RV.	28 LV.		01	

Malin Sea

Dead					Live
F. -	00 C.	01 RV.	00 LV.		00
M. -	01 C.	00 RV.	00 LV.	= 15 I.	
J. -	00 C.	06 RV.	07 LV.		

Sample Distribution (live occurence is underlined)

Southern Irish Sea

801 804 860 868 881 2354 2758 2365 2366 2369 2370
2372 2375 2377 2378 2381 <u>2780</u> 2789 2792 2810 2812
2813 2819 <u>2854</u> 2904 2905 <u>2915</u> 2916

Caernarvon Bay

2785 2395 2398 2399 2400 2401 2405 2422 2424 2442
2513 2519 2638 2647 2830 2831 2839 HHII

Malin Sea

3014 3101 3103 3115 3125

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	15 .	21/21A	0.824	0.455
	LV.	"	15 .	20/20A	0.830	0.480
M.	RV.	"	15 .	18/18A	0.937	0.482
	LV.	"	15 .	19/19A	0.949	0.489
-2.	RV.	"	15 .	22/22A	0.566	0.331
	LV.	"	15 .	23/23A	0.563	0.330

Adult specimens - sample 2400 (13 m, mixed sand), Caernarvon Bay; juvenile right valve - sample 881 (33.5 m, coarse sand + gravel), juvenile left valve - sample 2358 (34.8 m, mixed sand), southern Irish Sea.

Description

See: Sars (1928, p. 169-170, pl. 78) and Wall (ms. 1969, p. 187-195, pl. 12) for a description of the hard and soft parts and illustration of the latter. The carapace morphology is illustrated by Whittaker (ms. 1972, pl. 17, figs. 5-13).

Ontogeny

Instars from the penultimate to -4 growth stage were recognised. The dimensions of adults in several samples and the size range of juveniles from sample 2830 (13 m, mixed sand), Caernarvon Bay are given as follows:-

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.790-0.880	0.430-0.490	18	
	Mean	0.852	0.468		1.82
M.	Range	0.925-1.050	0.460-0.505	6	
	Mean	0.949	0.485		1.96
-1.	Range	0.670-0.800	0.390-0.430	12	
	Mean	0.726	0.419		1.73
-2.	Range	0.520-0.580	0.300-0.390	12	
	Mean	0.540	0.317		1.71
-3.	Range	0.380-0.440	0.220-0.270	9	
	Mean	0.424	0.251		1.69
-4.	Range	0.320-0.350	0.200-0.210	7	
	Mean	0.330	0.204		1.62

Sexual dimorphism is pronounced. Males are by far the larger and proportionately longer than females.

Remarks

Elofson (1941) indicated that references to this species in the Biscay and Mediterranean regions were not fully reliable. Indeed, many Neapolitan records of _H. albomaculata_, as in Bonaduce et.al. (1975, p. 46, pl. 21, figs. 8-11) are more accurately designated _H. voraginosa_ Athersuch. This latter species differs from the Baird species by its larger sieve pores, fine reticulate ornament and more angular outline. Athersuch (1979) comments that there are also differences in the soft parts between the Mediterranean and N. Atlantic types.

See: Athersuch (1979, 6:23, pls. 125-132).

Study Area Ecology

The live distribution is as follows. Isolated adults occurred in samples 2854 (2.7 m, silt + clay), southern Irish Sea and 2400 (13 m, mixed sand), Caernarvon Bay. Juveniles were found in samples 2780 (14 m, coarse sand + gravel) in the former region and 2442 (46 m, coarse sand + gravel) in the latter area. A small population of adults with juveniles was encountered in sample 2830 (13 m, mixed sand) Caernarvon Bay.

Otherwise, isolated specimens occurred throughout the southern Irish Sea, 2.7-87.8 m, mean 30.9 m, in abundance between 2.7-33 m and in a variety of sediments from coarse sands and gravel to silts with clay. Material in Caernarvon Bay was distributed between the tidemarks of Holyhead Harbour down to 120.7 m, mean 37.7 m, mostly 7-13 m, in coarse sand + gravel and mixed sand. In the Malin Sea a few specimens were recovered from beach sand, Loch Indaal and in isolated samples down to 91 m, coarse sand with gravel and mixed sand.

Palaeoecology and Distribution

This is a little known species in Scandinavian waters (Brady and Norman, 1889). Norman (1891) indicates that it occurs in Hardanger Fiord, W. Norway and a single specimen has been dredged with mud off Iceland (Brady and Norman, 1889; Stephensen, 1938). It is, however, occasionally abundant in the Laminarian zone, 5-15 m, of the Skagerrak (Sars, 1865, 1928; Elofson, 1941) and would seem to extend into Kiel Bay, W. Baltic (Klie, 1929, 1938).

It ranges alive in tidepools, intertidal muds and sub-littoral algae from the Orkneys and E. Scotland in reduced numbers (Baird, 1838, 1850; Brady, 1868) to N.E. England (Brady, 1868, 1869, 1870, 1903). Recorded off Norfolk, Thames Estuary (Brady, 1868; Kilenyi, 1969) and from Heligoland (Klie, 1929, 1938) in ubiquitous abundance. Brady and Robertson (1872) also indicate that live material occurs in the North Sea, 34-55 m on gravels with attached zoophytes.

Brady and Robertson (1870, 1872) and Brady and Norman (1889) comment that although H. albomaculata is distributed throughout western Britain and Ireland it is much less common off W. Scotland. The species is, however, common in the Clyde Estuary (Brady, 1868; Robertson, 1874). Live material is most abundant in tidal rock pools and in shell sands and laminarian algae, 6-28 m, throughout the Irish Seas (Brady, 1868; Brady and Robertson, 1869, Norman, 1905; Hoskin ms. 1976; Morgan ms. 1977). Further, Brassil (ms. 1977) and Lomax (ms. 1978) indicate that H. albomaculata is barely represented below the littoral in Recent sediments of this region. However, the species ranges extensively along the coasts of N. and S. Devon (Brady, 1868; Norman and Scott, 1906; Harding, 1957) and is found alive between 12-50 m on sands in the algal zone of the Scilly Isles (Neale, 1970).

Records of live material extend to the Dorset coast (Whittaker, ms. 1974), N. Brittany (de Vos, 1957) and Channel Isles (Brady, 1868; Norman, 1907, 1908). In addition, it is commonly alive in calcareous algae Cladophora Enteromorpha and Zostera, 3-8 m, of Arcachon Basin Yassini, 1969) and occurs on sands and in algae between 0-28 m throughout the Gironde Estuary (Moyes and Peypouquet, 1972; Carbonel, 1973). Its live distribution seems to extend to S. Biscay (Brady and Folin, 1872; Fischer, 1876; Brady and Norman, 1889). Isolated specimens found in 75 m in Vigo Bay, N.W. Spain (Ralph ms. 1977) are most likely reworked.

Many authors describe H. albomaculata alive and as a fossil from the Mediterranean, though these records are probably referable to other species.

Sub-Recent and Holocene specimens are recorded from the Irish Sea (Wall and Whatley, 1971; Spencer, ms. 1976), Netherlands (Wagner, 1957, 1960), in abundance from the Gironde Estuary (Moyes, 1974; Carbonel et. al. 1975) and in deep waters throughout Biscay (Peypouquet, 1971; Carbonel and Pujos, 1974). It is one of the most common species in Late Glacial deposits of the Forth Estuary (Henderson, 1870; Bell, 1891) and _H. albomaculata_ occurs in nearly all Post Tertiary deposits of Western Scotland and N.E. Ireland (Brady, et. al., 1874; Robertson, 1877; Peacock, et. al., 1978). An abundance of this species occurs in the last interglacial of Somerset (Kidson, et. al., 1978) and Sussex (Bell, 1892; Whatley and Kaye, 1971) and it is recorded in the Upper Pliocene of St. Erth, Cornwall (Nicholson verb. comm., 1976). That described as _H. albomaculata_ by Moyes (1965) in the Upper Miocene and Pliocene of Aquitaine (S.W. France) must be considered as tentative.

Summary

Live specimens may occur in Icelandic waters, 65°N. Rare live material ranges from the W. Baltic and Skagerrak to northern Britain. Its widespread abundance in the Recent is restricted south of 56°N in British and adjacent waters and includes the Bay of Biscay, 44-56°N. The sub-Recent and Holocene distribution incorporates the Irish Sea, Netherlands, Biscay and N.W. Spain, 42-52°N. There is an abundance of this species in the Late Glacial of the Clyde and Forth Estuaries and its presence is recorded in most of the Post Tertiary of Western Scotland and N.E. Ireland, 56-58°N. This is also one of the most common species in the Ipswichian of Somerset and

Sussex, 50-52^{O}N and H. albomaculata is accurately documented in the Upper Pliocene of Cornwall.

This species is restricted to sublittoral Laminaria 5-15 m, in southern Scandinavia. However, in British and other waters it is commonly alive from tidal pools and intertidal muds down to 8 m in a large variety of algae. Localised populations extend in the phytal zone and on shell sand down to 28 m in all regions, though H. albomaculata is also recovered on zoophytes to 55 m in the North Sea. Recent material rarely extends below this last depth in British waters, but fossil material is reworked between 118-300 m^{+} in S. Biscay. The species has a temperature tolerance of 2/3-22^{O}C^{+} with a salinity range of 12-35% (Neale, 1964).

Genus Muellerina Bassiouni, 1965

Muellerina abyssicola (Sars) 1865
pl. 28 figs. a-e

1865 Cythereis abyssicola n.sp. Sars: p. 43.

1874 Cythere latimarginata (Speyer); Brady, Crosskey and Robertson: p. 163, pl. 16, fig. 6.

1889 Cythere latimarginata (Speyer); Brady and Norman: p. 156, pl. XV, figs. 16, 17.

1928 Hemicythere latimarginata (Speyer); Sars: p. 188, pl. 86, fig. 3.

1941 Cythereis (Paracythereis) latimarginata (Speyer); Elofson: p. 291.

1965 Muellerina abyssicola (Sars); Bassionni: pt. 4, p. 510, pl. 1, figs. 3-6.

1967 Muellerina abyssicola (Sars); Hazel: p. 22, pl. 3, figs. 1, 2, 7, 8, 10, 16.

1969 Murrayina latimarginata (Speyer); Yassini: p. 54, pl. XXIV, fig. 5; pl. XXXIX, figs. 15-16.

1979 Muellerina abyssicola (Sars); Wouters: p. 229, pl. 1, figs. 3a-c; pl. II, fig. 3.

1980 Müllerina abyssicola (Sars); Lord: p. 241, pl. 1, fig. 2.

Material

Total: F. - 1 RV.; M. - 1 C. 1 RV. 1 LV.;
J. - 3 RV. 2 LV. = 9 I.

Southern Irish Sea

Dead					Live
M. -	00 C.	01 RV.	00 LV.	= 1 I.	00

Malin Sea

Dead					Live
F. -	00 C.	01 RV.	00 LV.		00
M. -	01 C.	00 RV.	01 LV.	= 8 I.	
J. -	00 C.	03 RV.	02 LV.		

Sample Distribution

Southern Irish Sea

2904

Malin Sea

3147

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	10	21/21A	0.649	0.394
M.	RV.	"	10	20/20A	0.688	0.333
	LV.	"	10	22/22A	0.694	0.385
-1.	RV.	"	10	24/24A	0.593	0.316
	LV.	"	10	23/23A	0.579	0.332

The specimens are from sample 3147, Malin Sea.

Description

See: Brady and Norman (1889, p. 156) and Sars (1928, p. 188-189, pl. 86, fig. 3) for a description of hard and soft parts. The last author also illustrates the carapace morphology and appendages.

Ontogeny

Several instars were provisionally assigned as the penultimate growth stage of this species.

Sexual dimorphism is recognised. Males are somewhat larger and more elongate than the female.

Remarks

Concerning the phyletic development of this species and its association with the Tertiary form C. latimarginata (Speyer). That illustrated by Brady (1878, p. 389, pl. LXIV, fig. 8 a-d) from the Upper Pliocene of the Netherlands and the material figured by Yassini (1969, pl. XXV, fig. 8) from the Pliocene of Aquitaine is best referred to a distinct sp.

See: Hazel (1967, p. 23), Frame (ms. 1977, p. 43) and Wouters (1979, p. 224-228, 230-231).

Study Area Ecology

Live material was not recovered and most specimens were very poorly preserved.

An adult occurred in sample 2904, southern Irish Sea, - mixed sand, 80.5 m. Otherwise, material was recovered in the far west of the Malin Sea, mixed sands in 512.1 m.

Palaeoecology and Distribution

This species occurs in abundance in Recent sediments off Maine, 200 m+ (Hazel, 1967). It also extends at these depths to the St. Lawrence Basin (Brady, 1867; Hazel, 1967, 1970) and Davis St. (Norman, 1877; Brady and Norman, 1889; Stephensen, 1913; Elofson, 1941). That recorded between 10-38 m in Godhavn Harbour and off Disko Island (Norman, 1877; Brady and

Norman, 1889; Stephensen, 1913; Hazel, 1967, 1970) may represent a live occurrence of this species.

The species extends between 75-200 m off Iceland and in many localities eastward to the Barents Sea (Stephensen, 1938; Elofson, 1938, 1941; Hazel, 1967, 1970). In this latter region it has been dredged within 350 m as far north as Spitzbergen, Svalbard Island (Norman, 1877; Brady and Norman, 1889; Elofson, 1941). Live specimens are recorded off the Lofoten Island, N.W. Norway, within 560 m approx. (Sars, 1865, 1890, 1928; Brady and Norman, 1889; Elofson, 1941) and *M. abyssicola* ranges southward to Trondheim, Bergen, 190-380 m and Hardanger Fiords, 220 m approx. (Brady and Norman, 1889; Norman, 1891). Live material has also been found generally throughout southern Norway, 38-220 m (Brady and Norman, 1889). Further, Elofson (1941) indicates that in the Skagerrak this species exclusively inhabits soft silts, deep waters down to 540 m and 0-11^{o}C. Its presence is also reported in the Ostsee, W. Baltic (Klie, 1929).

A few specimens have been dredged from 180-300 m+ in Recent sediments off the Shetlands (Norman, 1869; Brady and Robertson, 1874; Brady and Norman, 1889; Hazel, 1967) though there is no indication whether *M. abyssicola* is alive in British waters. A report of material in the Wash, (Brady and Robertson, 1870) and from 40 m in the Clyde Estuary (Robertson, 1874) most probably indicates reworked individuals.

Hazel (1968) indicates that Late Glacial specimens occur between 40-1,600 m in submarine canyons off Cape Cod and it is probable that the Late Devensian and Holocene range includes much of that recovered in the Gulf of Maine and St. Lawrence (Hazel, 1967, 1970). Contemporaneous material has been recovered from the Rockall Trough (Peypouquet, 1975; Frame ms. 1977) and Skagerrak (Lange, 1956) and probably extends in deep waters throughout high latitudes of the eastern North Atlantic. Late Glacial material is recorded from Sandness, S.W. Norway (Lord, 1980), and *M. abyssicola* is reported from submarine cores and between 190-400 m in southern Biscay (Yassini, 1969; Peypouquet, 1971). Otherwise, the species is only positively recorded from the Hoxnian of Denmark and N. Germany (Bassiouni, 1965).

Summary

The live distribution of this species may extend from the Gulf of Maine as far north as Davis St., 42-67°N. It has also been found off Iceland, 65°N and ranges in Recent sediments throughout much of the Barents Sea, 70-80°N. In European waters live specimens are only known off western Norway and in the Skagerrak, 56-70°N. In the western North Atlantic the sub-Recent and Holocene distribution is reworked into superficial sediments of the St. Lawrence Basin, Gulf of Maine and Davis St., 42-67°N. Otherwise, material of this age occurs in S. Scandinavia, off N. Britain and within the Norwegian Sea, 55-70°N. Late Glacial material may range in deep water south of St. Lawrence to submarine canyons off Cape Cod, 55-40°N. Devensian specimens also occur in S.W. Norway, North Sea and range in isolated numbers to southern Biscay, 44-60°N. Lastly, *M.* abyssicola is recorded from the Hoxnian of N. Germany and E. Denmark, 54°N.

The ecology of this species is difficult to discern as much of the Recent distribution encorporates reworked material. However, it ranges in superficial sediments between 40-1,600 m in the western and eastern N. Atlantic, mostly below 200 m and is recorded alive down to 350 m. M. abyssicola is exclusively associated with soft silts and muds in marine salinities, 33‰+ and appears to have a temperature tolerance of 0-11°C.

Genus Normanicythere Neale, 1959

Normanicythere leioderma (Norman) 1869
pl. 28 figs. f-h

1869 Cythere leioderma Norman: p. 291

1870 Cythere leioderma Norman; Brady: p. 451, pl. 19, figs. 11-13.

1874 Cythere leioderma Norman; Brady, Crosskey and Robertson: p. 149, pl. 9, figs. 5,6.

?1889 Cythere leioderma Norman; Brady and Norman: p. 139, pl. XV, figs. 12, 13.

1933 Cythereis leioderma (Norman); Blake: p. 239.

1941 ?Cythereis leioderma (Norman); Elofson: p. 79.

1959 Normanicythere leioderma (Norman); Neale: p. 78, pl. 13, fig. 1, 2; pl. 14, figs. 1-8, t.f. 1-5.

1967 Normanicythere leioderma (Norman); Neale and Schmidt: p. 345.

1967 Normanicythere leioderma (Norman); Hazel (pars): p. 23, pl. 1, figs. 13-16; fig. 12?

1967 Normanicythere leioderma (Norman); Hulings: p. 322, pl. 4, figs. 18-20; fig. 5, f-h; pl. 6, 8o.

?1969 Normanicythere leioderma (Norman); Lev: p. 33, pl. 1, fig. 13; pl. 2, fig. 12; pl. 5, fig. 2.

1975 Normanicythere leioderma (Norman); Neale and Howe: pl. 3, figs. 9, 10.

1981 Normanicythere leioderma (Norman); Masson (ms.): pl. 3, figs. 6, 17, 18; pl. 4, fig. 1.

Material

Malin Sea + Total

Dead						Live
J. -	00 C.	03 RV.	06 LV.	=	9 I.	00

Sample Distribution

Malin Sea

3143 3144 3152 3162

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
-1.	RV. external	9 .	9/9A	0.922	0.480
-2.	RV. "	9 .	11/11A	0.623	0.366
	LV. "	9.	10/10A	0.600	0.384

Penultimate instar - sample 3143 (146.3 m, fine sand + silt), other juveniles - sample 3144 (127.2 m, mixed sand) Malin Sea.

Description

See: Neale (1959, p. 77-86, pl. 13, 14, t.f. 1-3) for a description and illustration of the hard and soft parts.

Ontogeny

Instars from the penultimate to -4 growth stage were recognised.

Remarks

Neale (1959) indicated that this species does not extend alive or as a fossil to the Mediterranean. In addition, references to N. leioderma in the Pleistocene of N. Alaska and possibly that recorded in N. Russia may be referred to N. conchinella Swain (1963). This last species differs from the type in bearing postero-ventral pitting of the shell.

See: Neale (1959, p. 72-89), Neale and Schmidt (1967, p. 345-349, t.f. 1-4) and Masson (ms. 1981, p. 61).

Study Area Ecology

Live material was not recovered.

A few poorly preserved juveniles occurred in the Malin Sea between 137.2-173.8 m, mean 149.5 m, mixed sand and fine sand with a high content of silt.

Palaeoecology and Distribution

N. leioderma is commonly alive and widely distributed in the western N. Atlantic. Which range includes the Gulf of Maine, alive in 3-140 m and mostly 70 m approx. (Blake, 1952; Neale, 1959, 1960; Hazel, 1967). Live specimens may also occur in Halifax Inlet, Nova Scotia (Siddiqui and Grigg, 1975) and there appears to be an abundance of material in the Gulf of St. Lawrence (Brady, 1870; Neale, 1959; Hulings, 1967). Hazel (1967, 1970) indicates that Recent material extends throughout Labrador, Ungava Bay, Frobisher Bay (S. Baffin Is.) and Hudson St. Its presence is also recorded in numerous localities and often in abundance, 80-150 m approx., off W. Greenland as far north as Cape Frazer (Brady, 1870, 1878; Stephensen, 1913; Neale, 1959) and Ellesmere Island (Brady and Norman, 1889; Neale, 1959; Hazel, 1967, 1970). However, there is no indication whether the species is alive in these most northern latitudes.

The distribution is rather less well known in the eastern Arctic. It has been recorded from Icelandic waters (Brady + Norman, 1889; Stephensen, 1938; Neale, 1959; Hazel,

1967) and ranges in Recent sediments from N.E. Greenland to Spitzbergen and throughout N. Scandinavia (Neale, 1959). However, the ecology of N. leioderma in this region is not recorded except that it occurs commonly in muddy sands within 15 m of Russian Harbour, Novaya Zemlya (Neale and Howe, 1975). The species is also recorded from several localities in western Norway (Norman, 1891) and southern Norway, 90-110 m (Brady and Norman, 1889) with isolated specimens extending to the Ostsee, W. Baltic (Klie, 1929). Neale (1959, 1964) indicates that the southern limit of live material occurs in the Skagerrak and gives the species a temperature tolerance of -2-22°C in 26‰+ salinity. Elofson (1941) comments that N. leioderma is a rare species off S. Norway, wherein it inhabits sand and plant debris within 4-150 m.

Isolated material has been dredged off the Shetlands (Norman, 1869; Brady and Robertson, 1872; Brady and Norman, 1889; Neale, 1959) and in mud and sands, 60-100 m, off N.W. Scotland (Brady and Norman, 1889; Neale, 1959; Hazel, 1967, 1970; C.S. Harris, ms. 1977). The last author suggests that the species may be alive in deep waters of the Minches. Lastly, isolated specimens have been recovered from the Irish Seas (Brady and Norman, 1889; Neale, 1959), though this material is most probably reworked.

N. leioderma is a very common species in the late Quaternary and Holocene. Found off Cape Cod (Hazel, 1968), Maine and in the St. Lawrence Estuary (Brady and Crosskey, 1871; Norman, 1867, 1870; Swain, 1963). It has also been reworked into superficial deposits off N. Labrador, in the Canadian Arctic between 24-146 m, mostly 70 m and extends northwards to

Queen Elizabeth Islands and northern Baffin Bay, 26-34 m (Neale, 1959; Hazel, 1967, 1970; Neale and Howe, 1975). In the eastern N. Atlantic isolated material has been recovered from the Late Glacial of the North Sea (Masson, ms. 1981) and this species is known in marine glauconitic sands in the Hoxnian of E. Yorkshire (Brady et.al., 1874; Neale, 1959, Catt and Penny, 1966). It may also occur in the Pleistocene of N. Russia (Lev, 1969).

Summary

N. leioderma is a common live species in the western N. Atlantic occurring in the Gulf of Maine and throughout the Canadian Arctic, 42-76^{O}N. It is also recorded from Iceland and may range in Recent sediments in more northern latitudes between N.E. Greenland and the Barents Sea, 65-80^{O}N. The species is more rarely alive in the eastern N. Atlantic and has a southern limit in the Skagerrak, 56^{O}N. That found in more southern British latitudes is probably reworked. Sub-Recent and Holocene material is distributed between Maine and Baffin Bay, 42-80^{O}N. Contemporaneous European records include N.W. Britain and the Skagerrak, 55-60^{O}N. Late Devensian specimens have been dredged off Cape Cod and may range to the St. Lawrence Basin and N. Labrador, 41-60^{O}N approx. Late Glacial records include the North Sea, 57^{O}N. *N. leioderma* occurs in the Hoxnian of E. Yorkshire, 54^{O}N and it may extend in the Pleistocene throughout northern Russia, 65-70^{O}N.

Live and reworked material is reported between 3-150 m but it occurs commonly within 70 m approx. This species is primarily associated with plant debris and sands though is often found in fine sand and mud when reworked. Lastly, the temperature tolerance is given as -2-22^{o}C in salinities greater than 26‰.

Sub Family THAEROCYTHEREINAE Hazel, 1967

Genus Thaerocythere Hazel, 1967

Thaerocythere crenulata (Sars) 1865

pl. 28 figs. i-k

1865 Cythereis crenulata Sars: p. 39

1889 ?Cythere crenulata Sars; Brady and Norman: p. 158, pl. XV, figs. 5, 6.

1928 Cythereis crenulata Sars; Sars: p. 184, pl. LXXXV, fig. 2.

1938 Cythereis crenulata Sars; Elofson: p. 1, pl. 1, figs. 1-5.

1941 Cythereis (Eucythereis) crenulata Sars; Elofson: p. 60.

1943 Cytheries (Eucythereis) crenulata Sars; Elofson: p. 9.

1967 Thaerocythere crenulata (Sars); Hazel: p. 25, pl. 4, figs. 2-5, 8; pl. 9, fig. 4.

Material

Malin Sea + Total

Dead					Live
F. -	00 C.	00 RV.	01 LV.		00
M. -	00 C.	01 RV.	01 LV.	= 7 I.	
J. -	00 C.	04 RV.	00 LV.		

Sample Distribution

Malin Sea

3041 3042 3135 3147

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	LV. external	26 .	20/20A	0.755	0.476
M.	LV. "	2 .	30/30A	0.736	0.422
-1.	RV. "	3 .	3/3A	0.570	0.332

Female and juvenile valves - sample 3147 (512.1 m, mixed sand), male valve - sample 3042 (64 m, mixed sand), Malin Sea.

Description

Sars (1928, p. 184-185, pl. 85, fig. 2) and Hazel (1967, p. 25-26, pl. 4, figs. 2-5, 8; pl. 9, fig. 4) describe and illustrate the hard and soft parts.

Ontogeny

Several instars were recovered and tentatively ascribed as the penultimate and antepenultimate growth stage of this species.

Sexual dimorphism is provisionally recognised. The male is smaller and much more elongate than the female.

Remarks

G.W. Müller (1931) may refer to this species as both Cythereis crenulata and Hemicythere crenulata.

See: Hazel (1967, p. 26).

Study Area Ecology

Live specimens were not encountered and the material was very poorly preserved.

Individuals occurred in isolated samples of the Malin Sea between 54.8-512.1 m, mean 203.3 m in mixed sands.

Palaeoecology and Distribution

The distribution of this species is not fully known. There is a dubious report of T. crenulata from S.E. Virginia (Hulings, 1966) though its occurrence is more reliably recorded northward in the Bay of Fundy and Gulf of Maine, 200 m approx. (Hazel, 1967, 1970). Material is also reported from deep waters of the Davis St. (Brady and Norman, 1889; Elofson, 1938;

Hazel, 1967, 1970) and from Godhavn and Disko Is., W. Greenland (Brady and Norman, 1889; Müller, 1912; Stephensen, 1913; Elofson, 1938; Hazel, 1967, 1970).

Live specimens are, however, recorded between 80-250 m, 5.6^{o}C, off Iceland (Stephensen, 1938) and the Faeroes (Stephensen, 1929). In the Eastern Arctic its presence is indicated off Spitzbergen, Svalbard Is., and off N.W. Norway (Klie, 1942; Neale and Howe, 1975). Specimens have been dredged from Kors Fiord, 340 m and Bergen Fiord, 28-75 m and it occurs in 180-360 m generally throughout W. Norway (Brady and Norman, 1889; Norman, 1891). Further, live material has been recorded in many fiords of S. Norway on sponge or gravel sands between 12-360 m (Sars, 1865, 1928; Brady and Norman, 1889; Elofson, 1938, 1941, 1943).

Hagerman (1965) indicates that T. crenulata extends on sand and mud to the Oresund, W. Baltic and North Sea. In the latter region isolated specimens are recorded between 180-250 m+ off Shetland (Norman, 1869; Brady and Robertson, 1872), though no indication is given whether the material was alive in Unst Haaf.

The fossil distribution is almost entirely unknown. Hazel (1968) indicates that rare late Glacial specimens occur within 20-800 m between Capes Hatteras and Cod. Lastly, Holocene or Late Glacial material may be incorporated in deep water superficial sediments within the Gulf of Maine (Hazel, 1967, 1970).

Summary

There is no indication that this speices is alive in the western N. Atlantic, though material has been recovered in the Gulf of Maine and in deeper waters of Davis St., W. Greenland, 42-67°N. However, live material is documented from Iceland and *T. crenulata* may range alive throughout southern Scandinavia and N.E. Britain, 56-62°N. In the eastern N. Atlantic rare specimens have been dredged in Recent sediments as far north as Spitzbergen, 79°N. Late Glacial and Holocene material is recorded between Capes Hatteras and Cod, 35-42°N and it may range in contemporaneous deposits to the Gulf of Maine, 42-45°N. Indeed, material of this age may occur in high latitudes throughout the N. Atlantic Seaboards.

The ecology of *T. crenulata* is little known. Live material is recorded between 80-250 m off Iceland. It may also inhabit sponge and gravel sand and mud, 28-75 m+ off S.W. Norway and is possibly alive below 12 m in the Skagerrak and Oresund. Recent and reworked specimens are found below 200 m throughout the geographical range. Lastly, this is a fully marine species (33‰+ salinity) which inhabits waters of 0-12°C (Neale, 1964).

Sub Family UROCYTHEREIDINAE Hartmann and Puri, 1974

Urocythereis Ruggieri, 1950

Urocythereis britannica Athersuch, 1977

pl. 28 figs. 1-q

1868	Cythere oblonga Brady; Brady: p. 400, pl. XXXI, figs. 14-17.
?1889	Cythere oblonga Brady; Brady and Norman: p. 138.
1957	Paracythereis oblonga (Brady); de Vos: p. 34, pl. XV, figs. la-h.
1957	Urocythereis oblonga (Brady); Wagner: p. 64, pl. XXVI.
1969	Urocythereis sp. Wall (ms.): p. 199, pl. 36, figs. a-i.
1969	Urocythereis oblonga (Brady); Yassini: p. 47, pl. X-XVI.
?1972	Urocythereis margaretifera margaretifera (Müller); Sissingh: p. 128, pl. 10, fig. 8.
?1972	Urocythereis sp. Whittaker: p. 141, pl. 18, figs. 7-11.
1977	Urocythereis britannica n.sp. Athersuch: p. 255, pl. 1, figs. 4-6; pl. 2, figs. 1-6; pl. 3, figs. 1-4, 5-6?; pl. 4, figs. 1-5, t.figs. 3a, b, 4a-c, g.

Material

Total Dead: F. - 2 C. 15 RV. 4 LV.; M. - 2 C. 5 RV. 7 LV.; J. - 5 C. 161 RV. 143 LV. = 234 I.

Live: 1 F.

Southern Irish Sea

Dead					Live	
F. -	00 C.	04 RV.	00 LV.		01	
M. -	02 C.	01 RV.	01 LV.	= 109 I.	00	= 1 I.
J. -	03 C.	84 RV.	80 LV.		00	

Caernarvon Bay

Dead					Live
F. -	02 C.	07 RV.	03 LV.		00
M. -	00 C.	04 RV.	03 LV.	= 57 I.	
J. -	02 C.	32 RV.	19 LV.		

Malin Sea

Dead						Live
F.	-	00 C.	04 RV.	01 LV.		00
M.	-	00 C.	00 RV.	03 LV.	= 68 I.	
J.	-	00 C.	45 RV.	44 LV.		

Sample Distribution (live occurrence is underlined)

Southern Irish Sea

807 815 827 839 875 881 906 910 917 926 2354 2359
2361 2365 2366 2367 2369 2370 2372 2373 2375 2378
2381 2765 2781 2810 2811 2812 2813 2819 2904 2905
2906 2915

Caernarvon Bay

2389 2399 2400 2404 2407 2419 2422 2424 2442 2443
2444 2445 2447 2449 2461 2462 2510 2511 2513 2515
2519 2830 2839 2922 HHII

Malin Sea

3000 3012 3014 3043 3099 3101 3103 3115 3140 3143
3161 3162

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	2	29/29A	0.689	0.358
	LV.	"	2	17/17A	0.687	0.340
M.	RV.	"	2	15/15A	0.614	0.282
	LV.	"	2	16/16A	0.590	0.285
-1.	RV.	"	2	19/19A	0.578	0.297
	LV.	"	2	20/20A	0.582	0.300

Female valves - sample 2510 (62.2 m. coarse sand + gravel), Caernarvon Bay; male valves - sample 2361 (78.6 m. fine sand + silt); juvenile valves - sample 2359 (77 m, fine sand + silt), southern Irish Sea.

Description

See: Wall (ms. 1969, p. 199-201) for a description of the hard parts. The carapace morphology is best illustrated by Athersuch (1977, pls. 1-4).

Ontogeny

Instars from the penultimate to -4 growth stage were recognised, the dimensions of adults and juveniles from a number of samples in the study material are given as follows:

		L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.680-0.710	0.335-0.365	10	
	Mean	0.690	0.348		1.99
M.	Range	0.585-0.625	0.280-0.305	8	
	Mean	0.609	0.293		2.08
-1.	Range	0.580-0.610	0.290-0.310	14	
	Mean	0.598	0.300		1.99
-2.	Range	0.460-0.510	0.250-0.270	17	
	Mean	0.485	0.260		1.87
-3.	Range	0.380-0.410	0.200-0.230	24	
	Mean	0.401	0.216		1.86
-4.	Range	0.320-0.330	0.180-0.200	7	
	Mean	0.327	0.193		1.69

Sexual dimorphism is pronounced, males are much smaller and more elongate than the females. Some penultimate instars are as large as the male of this species, though can be distinguished from the adult by their more inflated nature.

Remarks

Many authors have mistakenly identified U. britannica as U. distinguenda (Neviani). The latter species is now known to be a mostly Mediterranean form that seldom ranges as far as British waters. U. britannica has also been erroneously recorded under the name U. oblonga (Brady) (Juv. objective homonym of C. oblonga McCoy, 1844). Whittaker (ms. 1972, p. 140) indicates this last species should refer only to that found in the Carboniferous Limestone of Ireland.

In addition, Athersuch (1977) indicates that there are several regional varieties or sub-species of U. britannica.

In this respect, the material herein is only directly comparable in size and ornament with that recorded by Wall (ms. 1969) from Cardigan Bay.

See: Athersuch (1977, p. 257).

Study Area Ecology

A single live female was recovered in the southern Irish Sea from sample 917, 35.1 m, coarse sand with gravel.

Otherwise, material was distributed throughout the region between 7-97 m, mean 39.8 m, in a variety of sediments from coarse sand + gravel to silts with clay. Most specimens were recorded between 33-97 m in mixed and fine sand with a high content of silt. A large juvenile assemblage occurred in sample 2905, 87.8 m, mixed sand and silt.

It was present in most samples from Caernarvon Bay, between the tidemarks of Holyhead Harbour, down to 157.3 m, mean 56.3 m, in abundance 7-109.7 m in coarse sand + gravel and mixed sand.

Recorded from only a few localities of the Malin Sea, 22-146.3 m, mean 83.5 m, in coarse sand + gravel and in mixed and fine sand with silt. Most specimens occurred between 140.8-146.3 m, though a large assemblage of juveniles also occurred S.E. of Islay, sample 3101, 55 m, fine sand with silt.

Palaeoecology and Distribution

The geographical distribution and ecology of this species is not fully understood. It barely extends to Scandinavian waters, within which region material has been dredged in muds and shelly sand, 55-220 m, of the Skagerrak (Brady and Norman, 1889; Elofson, 1944) and Oresund (Hagerman, 1965, 1966). Recent material is recorded from off Heligoland (Remane, 1933), alive within 38 m in estuarine muds of the Netherlands (Wagner, 1960, 1964) and it has been found in Recent sediments of the North Sea (Neale, 1970).

U. britannica is best documented from W. Britain. Rare specimens are recorded in mud and sand, 95 m, of the Minches (C.S. Harris, ms. 1977). An isolated instar occurred in sub-littoral Punctaria of Caernarvon Bay (Morgan, ms. 1977) and material has been taken from shell sand off Pembroke (Brady, 1868). A few individuals are reported in mud and sand, 18-28 m, Scillies (Neale, 1970); within 8-30 m off S. Devon (Brady and Robertson, 1872; Brady and Norman, 1889; Norman and Scott, 1906; Neale, 1970) and it occurs as Urocythereis sp. in Poole Harbour, Dorset (Whittaker, ms. 1972; Athersuch, 1977).

The abundance of U. britannica seems to increase southward of the English Channel. Live material is recorded from N. Brittany (de Vos, 1957), it may occur in abundance in the Gironde Estuary (Carbonel, 1973; Carbonel and Jouanneau, 1975) and material is alive, 1-8 m, 27‰+ salinity in Arcachon Basin (Yassini, 1969). The last author indicates this species occurs commonly in Recent sands and mud, 28-78 m, throughout Biscay and Brady and Norman (1889) record its presence within 45-110 m off Cap Breton. The range also extends to Vigo Bay, N.W. Spain (Ralph, ms. 1977).

U. britannica is reported in Recent sediments off S. Italy (Brady and Norman, 1889) and Athersuch (1977) has recorded this species in the sub-Recent of Cyprus. Otherwise, sub-Recent and Holocene material is well documented from Holland (Wagner, 1957, 1960) and it occurs in contemporaneous deposits of Biscay (Caralp et.al., 1970; Peypouquet, 1971; Caralp and

Pujos, 1974) and the Gironde Estuary (Moyes, 1974; Carbonel et.al., 1975). Quaternary specimens have been reported from S. Italy (Ruggieri, 1959) and this species may extend, as U. margaretifera margaretifera (Müller) within the Upper Pliocene of the Aegean Islands (Sissingh, 1972).

Summary

As yet, the live distribution of U. britannica is only known from the southern Irish Sea, Netherlands and throughout Biscay, 44-54°N. Its occurrence in Recent sediments seems restricted to S.W. Scandinavia, British and adjacent waters, south to 44°N. Reworked sub-Recent material extends throughout the given geographical range and is found off N.W. Spain, 42-60°N. Sub-Recent material is also known in the E. Mediterranean. Holocene records include that found in the Netherlands and in many deep water samples off W. France, 54-44°N. U. britannica also occurs in moderate abundance in the Late Glacial of the latter region, 44-48°N. Lastly, Lower Quaternary and Pliocene records may extend the geographical range to the Mediterranean.

Little is known of the ecology. Most reports indicate its association with muds and sand, alive in 8-38 m and in salinities of 27‰+. Recent material is found between 28-90 m though, when reworked, U. britannica is dredged down to 200 m in northern latitudes and ranges down to 700 m in Biscay. This would seem to be a warm temperate species that will tolerate cold temperate and boreal waters.

Family LEPTOCYTHERIDAE Hanai, 1957

Genus Leptocythere Sars, 1957

Leptocythere pellucida (Baird), 1850

pl. 29 figs. a-f

1850 Cythere pellucida n.sp. Baird; (Sars); p. 173, pl. XXI, fig. 7.

1866 Cythere castanea n.sp. Sars: p. 32.

1868 Cythere castanea Sars; Brady: p. 398, pl. XXVIII, fig. 27; pl. XXXVIII, fig. 6.

1869 Cythere castanea Sars; Brady and Robertson: p. 763, pl. XIX, figs. 15-18.

1869 Cythere propinqua n.sp. Sars: p. 361.

1874 Cythere castanea Sars; Brady, Crosskey and Robertson: p. 143, pl. XIII, figs. 8-11, fig. 25.

1889 Cythere pellucida Baird; Brady and Norman: p. 126, pl. XIV, figs. 13-15.

1912 Cythere pellucida Baird; Hirschmann: p. 52, pl. III, figs. 40-42, 47.

1928 Leptocythere castanea (Sars); Sars: p. 174, pl. LXXX, fig. 1.

1938 Leptocythere castanea (Sars); Klie: p. 169, t.figs. 562-564.

1941 Leptocythere castanea (Sars); Elofson: p. 273.

1957 Leptocythere castanea (Sars); de Vos: p. 22.

1957 Leptocythere castanea (Sars); Wagner: p. 53, pl. XXI.

1962 Leptocythere castanea (Sars); Woszidlo: p. 89, pl. 4, fig. 147.

1969 Leptocythere pellucida (Baird); Wall (ms.): p. 215, pl. 15, figs. a-l; pl. 37, figs. a-f.

1969 Leptocythere castanea (Sars) (pars); Yassini: p. 35, pl. IV, V, VIII, XV.

1971 Leptocythere sp.1 Whatley, Whittaker and Wall: p. 407, pl. 1, pl. 2.

1972 Leptocythere pellucida (Baird); Whittaker (ms.): p. 146, pl. 19, figs. 1-12.

1976 Leptocythere castanea (Sars); Guillaume: p. 325, fig. 1f; pl. 4; pl. 6, fig. b.

1977 Leptocythere castanea (Sars); Rosenfeld: p.17, pl. 2, fig. 17, 18.

Material

Total Dead: F. - 2 C. 3 RV. 2 LV.; M. - 2 C. 5 RV. 5 LV.;
J. - 1 C. 5 RV. 8 LV. = 31 I.

Live: 1 M.

Southern Irish Sea

Dead				Live
F. - 02 C.	02 RV.	01 LV.		00
M. - 00 C.	03 RV.	03 LV.	= 21 I.	01
J. - 00 C.	04 RV.	07 LV.		00

Caernarvon Bay

Dead				Live
F. - 00 C.	01 RV.	01 LV.		00
M. - 02 C.	02 RV.	02 LV.	= 10 I.	
J. - 00 C.	01 RV.	01 LV.		

Sample Distribution (live occurrence is underlined)

Southern Irish Sea

803 917 2365 2369 2381 2813 2822 <u>2824</u> 2826 2916

Caernarvon Bay

2398 2830 HHII

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	13	. 8A/9	0.575	0.284
	LV. "	13	. 7A/8	0.582	0.289
M.	RV. "	13	. 6A/7	0.639	0.296
	LV. "	13	. 5A/6	0.598	0.289
-1.	RV. "	13	. 10A/11	0.500	0.266
	LV. "	13	. 9A/10	0.517	0.267

Adult and juvenile left valves - sample 2830 (13 m, mixed sand), Caernarvon Bay, juvenile right valve - sample 2822 (15.2 m, silt + clay), Southern Irish Sea.

Description

See: Wall (ms. p. 216-223, pl. 15, figs. a-i) for a description of the hard and soft parts and an illustration of the latter. The carapace morphology is illustrated by Whatley et.al. (1971, pl. 1, 2) and Whittaker (ms. 1972, pl. 19, figs. 1-12).

Ontogeny

Instars of the penultimate to -3 growth stage were provisionally recognised. The dimensions of adults and juveniles from several samples in the study material are given as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.570-0.625	0.280-0.305	6	
	Mean	0.592	0.291		2.10
M.	Range	0.590-0.640	0.285-0.310	8	
	Mean	0.610	0.290		2.04
-1.	Range	0.465-0.530	0.260-0.285	4	
	Mean	0.516	0.268		1.95
-2?	Range	0.370-0.390	0.220-0.230	4	
	Mean	0.381	0.222		1.72
-3?	Range	0.295-0.320	0.175-0.195	3	
	Mean	0.304	0.188		1.62

Sexual dimorphism is not distinct. The males are, however, the more elongate and somewhat upturned posteriorly. The posterior margin of the female is acutely truncated making almost a right angle with the dorsal and ventral margins.

Remarks

Most records appertaining to L. castanea (Sars) in the eastern N. Atlantic are referrable to L. pellucida. It is also probable that the Baird species does not extend to the western N. Atlantic or Mediterranean. In this respect, material illustrated from the Holocene of the St. Lawrence by Cronin (1976, 1977, p. 118, pl. IV, figs. 5-6) and that in Delaware Bay (Swain and Kraft, 1975, pl. 4, figs. 7a, b; pl. 5, figs. 1a, b) are more probably related to L. nikraveshae Morales.

See: Whatley et.al. (1971, p.399-407, pl. 1, 2) and Whittaker (ms. 1972, p. 148-149).

Study Area Ecology

A single live male specimen was recovered in sample 2824, 24.4 m, coarse sand and gravel, southern Irish Sea.

Within this region isolated material occurred between 6.1 - 40 m, mean 24.4 m, in a variety of sediments from coarse sand with gravel to silts and clay. A few individuals were also found in Caernarvon Bay, in the intertidal of Holyhead Harbour and, otherwise, within 13 m in coarse sand with gravel and mixed sand. Most specimens occurred in sample 2830, 13 m, mixed sand.

Palaeoecology and Distribution

This species is accurately documented in brackish areas of Iceland (Brady and Norman, 1889; Stephensen, 1938) and ranges throughout Scandinavia. Indeed, from Finmark, N. Norway (Brady and Norman, 1895; Norman, 1902) to Bergen, W. Norway (Brady and Norman, 1889; Norman, 1891) and the Skagerrak. In the latter region it is ubiquitously alive in lagoonal and estuarine *Carex* and algae, 0-20 m, 2‰+ salinity and 0-22^{o}C (Sars, 1865, 1928; Anderson, 1901; Elofson, 1941, 1943). The last author indicates that this species extends in these given conditions to Oresund and the W. Baltic. However, in Kiel Bay live material is found in silty muds rich in detritus (Klie, 1929, 1938; Hagerman, 1965; Vesper, 1975), between 15.2-23^{o}C (Vesper, 1975) and in areas of 14-20‰ salinity (Rosenfeld, 1977). Live specimens are mostly recovered within 15 m, W. Baltic and *L. pellucida* has been found in 5‰ salinity from the intertidal of the Gulf of Finland (Hirschmann, 1909, 1912, 1915; Hagerman, 1967).

L. pellucida is widely distributed in British waters as L. castanea Sars. Recorded in the Forth Estuary (Scott, 1906), off E. Scotland (Brady, 1868; Brady and Robertson, 1872) and in abundance in estuarine salt marshes throughout N.E. England (Brady, 1866, 1868, 1869; Norman and Brady, 1909), Norfolk Fens (Brady, 1868; Brady and Robertson, 1872) and the Thames Estuary, 1.8-17‰ salinity (Kilenyi, 1969). In addition, the muds, sands and gravel, 28-55 m, of the North Sea (Brady, 1870; Brady and Robertson, 1870, 1871, 1874) have it commonly incorporated. Abundant live material also ranges from the Heligoland (Klie, 1929) to Zuider Zee (de Leint, 1923; Redeke, 1936; Redeke and Dulk, 1940) and to the Sheldt and Maas Estuaries, Netherlands (Brady, 1869; Brady and Norman, 1889; Redeke and Dulk, 1940; Wagner, 1950).

Pearce (ms. 1977) indicated that the species is a most abundant sediment dweller in the lagoonal and high marsh of N. Uist, western Isles. It is locally common, 2-48 m, in the Clyde Estuary (Brady and Robertson, 1872; Robertson, 1874), Loch Foyle (Norman, 1905) and occurs below the tidemarks, 3-12 m and in 28-75 m throughout western Ireland (Brady and Robertson, 1869, 1872; Norman, 1905; Hoskin, ms. 1976). Live material is recorded in muds of Teifi Estuary, Cardigan Bay, 2-20‰ salinity (Wall, ms. 1969) It ranges between 6-8 m in Dublin Bay (Brady and Robertson, 1869) and is found in sub-littoral Fucus and low marsh areas of S. Ireland (Lomax, ms. 1978). Brady and Robertson (1872) and Norman and Scott (1906) also indicate its presence in N. and S. Devon and off the Scilly Isles.

This is one of the most abundant species in green filamentous algae, Enteromorpha, and Zostera in tidepools of the Fleet. Whittaker (ms. 1972) recovered this live material in clean fine sands in 4-26°C and 14-36‰ salinity. The live distribution also ranges from N. Brittany (de Vos, 1957), and the Channel Isles (Norman, 1907, 1908), in ubiquitous abundance to the Gronde Estuary (Carbonel, 1973) and Arcachon Basin, 0-3 m, 7-33‰ salinity (Yassini, 1969).

It would seem, in the absence of adequate illustrations, that L. pellucida sensu stricto does not extend to the Mediterranean. In addition, that reported by Blake (1933) and Proctor (1933) in sublittoral sands of Mt. Desert, Maine, may also refer to another species.

Moderate numbers of specimens are recorded in the sub-Recent and Holocene of the southern Irish Sea (Wall and Whatley, 1971; Spencer, ms. 1976) and Gironde Estuary (Moyes, 1974). Late Glacial material is generally distributed, but rarely common. Found in W. Scotland (Brady et.al. 1874; Robertson, 1877, 1882, 1885; Peacock et.al. 1978; Graham and Wilkinson, 1978), Dieppe, W. France (Bignot and Dupueble, 1967) and between 350-1,600 m+ in Biscay (Brady and Norman, 1889; Yassini, 1969). Isolated specimens occur in the last interglacial of the Irish Sea (Jasin, ms. 1976); Somerset in abundance (Kidson, et.al. 1978); Sussex, commonly (Whatley and Kaye, 1971). Hoxnian records extend to Nar Valley, Norfolk (Lord and Robinson, 1978) and material of this age may occur in submarine cores of Gascony (Carbonel and Pujos, 1974). Lastly, this species is accurately documented in the Hoxnian of Denmark (Woszidlo, 1962), though a report of it in the Coralline Crag (Upper Pliocene) of E. Anglia (Wilkinson, ms.

1974) must be considered tentative.

Summary

Records of live material extend from Iceland, 65°N and throughout the entire Norwegian coast, 55-72°N, to the Skagerrak and E. and W. Baltic. L. pellucida is also generally distributed in British, adjacent and Biscay waters, 44-60°N. However, reports of it in the western N. Atlantic and Mediterranean probably refer to other species. This is a most abundant species in the sub-Recent and Holocene of the Irish Sea, Netherlands and Gironde estuary, 45-54°N. Late Glacial records of L. pellucida extend to western Scotland, N.W. France and deep waters of Biscay, 44-56°N. Further, it occurs commonly in the Ipswichian of the Irish Sea, Somerset and S. Sussex, 50-54°N approx. Material is also known in the Hoxnian of Norfolk, Denmark and N. Germany, 50-54°N and L. pellucida may occur in the Upper Pliocene of E. Anglia.

It inhabits the intertidal and sublittoral lagoonal areas of estuaries and salt marshes, 0-25 m approx.
This species is rarely recorded in Recent sediments below 35 m. In Scandinavia it primarily inhabits Carex, laminarian algae and the silts and mud beneath. Elsewhere, the species is found in Zostera, filamentous green algae and is most abundant as a sediment dweller in sand and mud. L. pellucida is generally restricted to 2-20‰ salinity and 0-22°C, though certain records indicate an overall tolerance of up to 36‰ salinity and 26°C.

Leptocythere confusa (Brady and Norman) 1889
pl. 29 figs. g-k

1866 Cythere pellucida Baird; Sars: p. 31, (not C. pellucida Baird, 1850).

1868 Cythere pellucida Baird (pars); Brady: p. 397, pl. XXVIII, figs. 22-26, (not fig. 28).

1869 Cythere pellucida Baird; Brady and Robertson: p. 363, pl. XIX, figs. 10-12.

1874 Cythere pellucida Baird; Brady, Crosskey and Robertson: p. 142, pl. III, figs. 20-24.

1889 Cythere confusa nom.nov. Brady and Norman: p. 127, pl. XIV, figs. 16-18.

1941 Leptocythere pellucida (Baird) (pars); Elofson: p. 271.

1957 Leptocythere pellucida (Baird) (pars); Hanai: p. 438.

1957 Leptocythere pellucida? (Baird) (pars); Wagner: p. 51, pl. XX?

1969 Leptocythere confusa (Brady and Norman) (pars); Wall (ms.): p. 224, pl. 14, figs. a-i; pl. 37, figs. g-l (not m-r).

1969 Leptocythere pellucida? (Baird); Yassini: p. 34, pl. IV, VI, VII, XIII, XV.

1971 Leptocythere sp.2. Whatley, Whittaker and Wall: p. 407, pl. 1.

1972 Leptocythere confusa (Brady and Norman) (pars); Whittaker (ms.): p. 151, pl. 20, figs. 1-6; pl. 21, figs. 1-7; pl. 30, fig. 1.

1976 Leptocythere confusa (Brady and Norman); Hoskin (ms.): p. 281, pl. 21, figs. 5-8.

1977 Leptocythere confusa (Brady and Norman); Rosenfeld: p. 17, pl. 2, figs. 19-21.

Material

Total Dead: F. - 4 C. 4 RV. 4 LV.; M. - 3 C. 6 RV. 7 LV.;
J. - 7 C. 40 RV. 34 LV. = 90 I.

Live: 4 J.?

Southern Irish Sea

Dead					Live		
F. -	02 C.	04 RV.	02 LV.		00		
M. -	01 C.	05 RV.	05 LV.	= 43 I.	00	=	1 I.?
J. -	03 C.	14 RV.	14 LV.		01		

Caernarvon Bay

Dead					Live		
F. -	01 C.	00 RV.	01 LV.		00		
M. -	01 C.	01 RV.	00 LV.	= 8 I.	00	=	4 I.?
J. -	04 C.	24 RV.	20 LV.		04		

Malin Sea

Dead					Live
F. -	01 C.	00 RV.	01 LV.		00
M. -	02 C.	00 RV.	02 LV.	= 39 I.	00
J. -	00 C.	02 RV.	00 LV.		00

Sample Distribution (live occurrence is underlined)

Southern Irish Sea

868 906 910 2359 2365 2369 2370 2375 2378 2380 2381
2765 2819 2905

Caernarvon Bay

2399 2406 2424 2442 2443 2445 2447 2509 2513 2829
2830 2831 2839 2926 HHI HHII

Malin Sea

3014 3101 3115

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	14	. 39A/40	0.546	0.262
	LV.	"	14	. 40A/41	0.526	0.259
M.	RV.	"	14	. 38A/39	0.528	0.230
	LV.	"	14	. 37A/38	0.517	0.230
-1.	RV.	"	14	. 21A/22	0.466	0.244

Female valves - sample 3115 (91 m, coarse sand + gravel), Malin Sea; male valves - sample 868 (18.3 m, mixed sand), southern Irish Sea; juvenile valve - sample 2839 (44 m, mixed sand), Caernarvon Bay.

Description

See: Wall (ms. 1969, p. 226-232) for a description of the hard and soft parts. The appendages and carapace morphology are illustrated by Whittaker (ms. 1972, pls. 20, 21, 30, fig. 1).

Ontogeny

Penultimate and antepenultimate instars were recognised. Several instars were tentatively ascribed as the -3 growth stage of this species. The dimensions of adults and juveniles from several samples in the study area are as follows.

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.520-0.555	0.255-0.270	13	
	Mean				2.06
M.	Range	0.515-0.540	0.220-0.245	9	
	Mean	0.528	0.230		2.30
-1.	Range	0.460-0.475	0.225-0.245	5	
	Mean	0.466	0.237		1.97
-2.	Range	0.405-0.420	0.205-0.215	5	
	Mean	0.416	0.208		2.00
-3.	Range	0.325-0.340	0.185-0.195	3	
	Mean	0.333	0.189		1.76

Sexual dimorphism is distinct. Males are proportionately longer and more finely punctate than females. Whittaker (ms. 1972, p. 154) indicates that juveniles of L. confusa are distinguished from those of L. pellucida by their more strongly punctate shells and well defined alar prolongation.

Remarks

See: Whatley et.al. (1971, p. 399-407, pl. 1) and Whittaker (ms. 1972, p. 153-154).

Study Area Ecology

A live juvenile was found in sample 2905, 87.7 m, mixed sand, southern Irish Sea. A number of other live juveniles were recovered from sample 2839, 44 m, in mixed sand of Caernarvon Bay.

In the southern Irish Sea isolated and poorly preserved material was mostly restricted to the area north of Dublin Bay. Found within 11-97 m, mean 35.1 m, in mixed and fine sands with a high content of silt or clay. Most specimens in this region were recovered between 21.9-40 m in the given sediments.

The species was found between the tidemarks of Holyhead Harbour and ranged down to 153.7 m, mean 47.8 m, in coarse sand with gravel and mixed sand, Caernarvon Bay. Much of the material occurred within 13 m.

A number of poorly preserved instars were also encountered in the Malin Sea, between 22-91 m, coarse sand + gravel and fine sand with silt.

Palaeoecology and Distribution

Brady and Norman (1889) and Stephensen (1938) indicate that this species occurs in Icelandic waters. Its distribution may also extend throughout Norway as far north as Finmark (Brady and Norman, 1889, 1895; Norman, 1902; Stephensen, 1938). L. confusa is, however, reliably recorded alive in sands and mud from the Skagerrak and Oresund (Hagerman, 1965), Kiel Bay, 6-21 m in 14-20‰ salinity (Schafer, 1933; Rosenfeld, 1977) and ranges more rarely into the Gulf of Finland (Hagerman, 1967).

L. confusa is also recorded from E. Scotland, occurring in Recent sediments between 45-85 m off N.E. England and ranges southward to the Humber, Wash, and Thames Estuary (Brady 1868; Brady and Norman, 1889). Kilenyi (1969) indicates that it may constitute up to 10% of the ostracod fauna found between

20/25-34‰ salinity of the Thames Estuary. The distribution is known to include the Netherlands estuarine region (Brady, 1869 ; Brady and Norman, 1889; Redeke and Dulk, 1940).

Its presence west of Scotland is recorded from Stornaway (Lewis), Skye and Oban (Brady, 1868) and alive in abundance in brackish lagoons of N. Uist (Pearce, ms. 1977). The records extend to the Clyde Estuary 2-55 m (Brady, 1868; Robertson, 1874) and between 6-28 m west of Ireland (Brady, 1868; Brady and Robertson, 1869). In the latter region it mostly lives in sheltered estuarine Zostera or in intertidal muds, 0-7 m (Hoskin, ms. 1976). L. confusa is also commonly alive on silts within 10 m in the Teifi Estuary, Cardigan Bay (Wall, ms. 1969), inhabits Dublin Bay (Brady and Robertson, 1869) and is alive in intertidal Fucus and Enteromorpha of S. Ireland (Lomax, ms. 1978). The distribution extends to the Scilly Isles, 1-12 m (Neale, 1970) and Plymouth, S. Devon (Brady, 1868). L. confusa is alive in fine sands and filamentous algae of tidepools in the Fleet (Whittaker, ms. 1972). The last author indicates that it was recovered in 9-17^{o}C and 30-35‰ salinity. Lastly, it may occur in the Channel Isles (Brady and Robertson, 1872; Norman, 1907, 1908), but further south its given distribution must be considered tentative.

That illustrated by Yassini (1969) as L. pellucida (Baird), closely approximates L. confusa. The ubiquitous abundance of live material recorded by him occurs in shell sand and Zostera, 0-6 m in 20‰+ salinity, 6-27^{o}C throughout Arcachon Basin.

The fossil distribution of L. confusa is as follows.

Recorded as a common species in the Holocene of the Irish Sea (Spencer, ms. 1976) and Netherlands (Wagner, 1957) and it occurs in many Late Glacial deposits of Western Scotland (Brady et.al. 1874; Robertson, 1877, 1882, 1885), N.E. Ireland and S. Norway (Brady et.al. 1874). Late Pleistocene specimens have been found in Nar Valley, Norfolk (Lord and Robinson, 1978) and L. confusa is found in abundance in the last interglacial (Eemian) of Somerset (Kidson et.al. 1978) and Sussex (Whatley and Kaye, 1971). That recorded in Pleistocene submarine cores of S. Gascony (Moyes and Peypouquet, 1971) and from the Quaternary of S. Italy (Ruggieri, 1953, 1959) may relate to another species.

Summary

This species is recorded alive from Iceland, 65°N and possibly extends throughout the entire Norwegian coast, 55-72°N. It also ranges from the Skagerrak to Kiel Bay and the Gulf of Finland. Live material is best documented in British and adjacent waters from Shetland to the English Channel, 50-60°N. Reports of its ubiquitous abundance in Biscay, 44-48°N may relate to several other species. Sub-Recent and Holocene material is common in the Irish Sea and Netherlands, 52-54°N. Late Glacial records include most estuarine deposits of W. Scotland, N.E. Ireland and S. Norway, 54-60°N and possibly includes contemporaneous sediments of Biscay. There is an abundance of L. confusa in the Ipswichian of Somerset and S. Sussex, 50-52°N and it is a common species in the Hoxnian of Norfolk, 53°N approx.

In the Baltic most live material is found between 6-21 m, though elsewhere it inhabits the estuarine intertidal and sublittoral, 0-10 m. The distribution in Recent marine sediments is widespread down to 85 m, with reworked specimens reported from 1,000 m in Biscay. The species inhabits Zostera tide-pool silts and sands and a variety of algae. It may constitute up to 10% of a localised ostracod fauna in 20-35‰ salinity and is also common in 14-20‰ salinity of the W. Baltic. Neale (1964) indicates a euryhaline tolerance of 3-35‰ overall. The temperature range is probably 0-22°C.

Leptocythere macallana (Brady and Robertson) 1869
pl. 29 figs. 1-n

1869 Cythere macallana n.sp. Brady and Robertson: p. 367, pl. XIX, figs. 5-9.

1874 Cythere macallana Brady and Robertson; Brady, Crosskey and Robertson: p. 144, pl. XIII, figs. 1-2.

1889 Cythere macallana Brady and Robertson; Brady and Norman: p. 128, pl. XIV, figs. 19-21.

1894 ?Cythere levis n.sp. G.W. Müller: p. 357, pl. 27, fig. 31; pl. 28, figs. 11-12.

1950 ?Leptocythere macallana levis (G.V. Müller); Ruggieri: p. 44, pl. 1, figs. 13, 33.

1953 Leptocythere macallana macallana (Brady and Robertson); Ruggieri: p. 125.

1957 ?Leptocythere levis (G.W. Müller); de Vos: p. 26, pl. XI, figs. 2a-c; pl. XII, figs. 1a-c.

1959 ?Leptocythere macallana levis (G.W. Müller); Ruggieri: p. 159.

1959 Leptocythere macallana macallana (G.W. Müller); Ruggieri: p. 196.

1969 ?Leptocythere levis (G.W. Müller); Yassini: p. 38, pl. VI, VII, XV.

1972 Leptocythere macallana (Brady and Robertson); Whittaker (ms.): p. 168, pl. 27, figs. 1-10; pl. 28, figs. 1-6.

1976 Leptocythere macallana (Brady and Norman); Hoskin (ms.): p. 281, pl. 21, figs. 13-14.

Material

Total Dead: F. - 1 C. 1 RV. 3 LV.; M. - 8 C. 2 RV. 3 LV. = 16 I.

Live: 2 F.

Caernarvon Bay

Dead				Live	
F. - 01 C.	00 RV.	03 LV.	= 12 I.	02	= 2 I.
M. - 08 C.	01 RV.	01 LV.		00	

Malin Sea

Dead				Live
F. - 00 C.	01 RV.	00 LV.	= 4 I.	00
M. - 00 C.	01 RV.	02 LV.		

Sample Distribution (live occurrence is underlined)

Caernarvon Bay

2398 2399 2401 2406 2467 2830 HHII

Malin Sea

3101

Figured Specimens

		Film No.	Neg + Print No.	L. (mm)	H. (mm)
F.	RV. external	14	33A/34	0.444	0.221
M.	RV. "	14	35A/36	0.448	0.184
	LV. "	14	36A/37	0.453	0.192

The adult valves are from sample 2830 (13 m, mixed sand), Caernarvon Bay.

Description

The carapace morphology is described by Brady, Crosskey and Robertson (1874, p. 144). The hard and soft parts are illustrated by Whittaker (ms. 1972, pl. 27, figs. 1-10; pl. 28, figs. 1-6).

Ontogeny

Juveniles of this species were not recognised. The dimensions of adult instars from sample 2830, Caernarvon Bay, are as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.430-0.455	0.220-0.230	5	
	Mean	0.445	0.225		1.98
M.	Range	0.445-0.460	0.180-0.205	10	
	Mean	0.452	0.190		2.38

Sexual dimorphism is pronounced. Males are proportionatley longer than females.

Remarks

Whittaker (ms. 1972, p. 169-170) indicates that the Mediterranean varieties L. levis (Müller) or L. macallana levis Ruggieri may be distinct species. These forms are much less punctate and somewhat more elongate than L. macallana sensu stricto. It is also apparent that several other species are misidentified as L. macallana. That illustrated by Schornikov 1966 (L. macallana, p. 44, pl. 8, figs. 1-9 mis-spelling) bears a pronounced longitudinal rib postero-ventrally which feature is absent on the European form. In addition, the Brady and Robertson species may not occur in either Scandinavian (Sars, 1978, p. 173-4, pl. 79, fig. 2) or in N. American (Tressler and Smith, 1948, p. 14, pl. 1, fig. 12) waters. These latter records represent material that is much too quadrate in shape to be L. macallana sensu stricto.

See: Whittaker (ms. 1972, p. 169-170).

Study Area Ecology

Two live females were recovered from sample 2830, 13 m, mixed sand from the near shore of Caernarvon Bay. Indeed, most material occurred in this sample. Otherwise, isolated specimens were found between the tidemarks of Holyhead Harbour, down to 31 m, mean 13.4 m, in coarse sand and gravel and mixed sands.

Several adults were encountered S.E. of Islay, Malin Sea, 55 m, fine sand and silt.

Palaeoecology and Distribution

The species is reported from Montrose, E. Scotland (Fullerton and Scott, 1889), from isolated localities off N.E. England (Brady and Robertson, 1872) and in the R. Ouse, Wash (Brady and Norman, 1889).

L. macallana is mostly recorded to the west of the British Isles, though is never abundant in that region. It ranges from the tidemarks to 15 m in the Clyde Estuary, W. Scotland (Brady and Robertson, 1872; Robertson, 1874; Brady and Norman, 1889); Irish Sea, 6-10 m and occurs mostly within 12 m throughout W. Ireland (Brady and Robertson, 1869, 1872; Brady and Norman, 1889; Norman, 1905). In addition, isolated live individuals have been found in sublittoral Punctaria and Ceramium from Caernarvon Bay (Morgan ms. 1977). The distribution also extends to N. and S. Devon and the Scilly Isles (Brady and Robertson, 1872; Brady and Norman, 1889; Norman and Scott, 1906; Harding, 1957; Neale, 1970). Alive on cobble and fine sands with filamentous green algae, 26-33‰ salinity, along much of the Dorset coast (Whittaker ms. 1972).

The species may extend alive as L. levis (Müller) and

L. macallana levis Ruggieri, from N. Brittany (de Vos, 1957) in abundance, 2-8 m, on Zostera and in 29‰+ salinity to S. Biscay (Yassini, 1969). Isolated specimens are also known in fine sand from 75 m in Vigo Bay, N.W. Spain (Ralph ms. 1977).

Its presence as L. levis (Müller) is recorded from the Ligurian Sea (Boraduce et.al. 1977), in Posidonia off Naples (Müller, 1894; Puri, 1963) and in fine sand and silt, 5-20 m within the Adriatic (Bonaduce et.al. 1975; Breman, 1976). However, the Mediterranean records are considered as tentative.

As a fossil L. macallana is only known with reasonable certainty from the Late Glacial of Clyde, Cumbrae (Brady et.al. 1834) and Ardyne, S.W. Scotland (Peacock et.al. 1978; Graham and Wilkinson, 1978). It is also reported in low numbers from contemporaneous submarine cores of S. Biscay (as L. levis, Caralp et.al. 1970). That reported from the Quaternary of Calabria and the S. Adriatic (Ruggieri, 1953, 1959) and material in the Pliocene of the S. Aegean (Sissingh, 1972) most probably refers to another species.

Summary

Recent material is known from several areas in E. Britain, 53-57°N approx. and is more widely distributed west of Britain, 50-56°N. It may also occur as L. levis (Müller), off N. Brittany and extends in isolated numbers to N.W. Spain, 42°N and southward to the W. Mediterranean and Adriatic, 40-46°N. As yet, only that documented in the Late Glacial of S.W. Scotland, 56°N and material from deep water cores of S. Biscay, 44°N may be considered in the fossil distribution.

Little is known of its ecology. In British waters live material ranges from the tidemarks down to 15 m approx. on Punctaria, filamentous green algae and the cobble sand beneath. That recorded on Zostera, 2-8 m, from Biscay and in Posidonia and fine sands, 5-20 m, from the Mediterranean may relate to another species. Its temperature range is unrecorded, though it would seem to inhabit near or full marine salinity (26-33‰) in cool temperate waters.

Leptocythere sp.cf. L. macella Ruggieri, 1974
pl. 30 figs. a-g

1972 Leptocythere aff. Leptocythere micra (Rome); Uffenorde: p. 63, pl. 2, fig. 2.

1974 ?Leptocythere macella n.sp. Ruggieri: p. 422, 431, fig. 4.

1975 Leptocythere macella Ruggieri; Bonaduce, Ciampo and Masoli: p. 32, pl. 18, figs. 1-5, t.f. 12-15.

1977 Leptocythere macella Ruggieri; Bonaduce, Masoli and Pugliese: pl. 2, figs. 1-2.

1979 ?Leptocythere sp.cf. L. macella Ruggieri; Maybury (ms.): p. 66, pl. 1, figs. 9-12; pl. 7, fig. 7.

1981 ?Leptocythere sp.cf. L. macella Ruggieri; Maybury and Whatley: p. 440, pl. 1, figs. 9-12.

Material

Caernarvon Bay + Total

Dead					Live
F. - 01 C.	00 RV.	01 LV.	=	4 I.	01
M. - 00 C.	01 RV.	01 LV.			00

Sample Distribution (live occurrence is underlined)

Caernarvon Bay

2515 HHII

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	LV.	external	13 .	35A/36	0.371	0.172
M.	RV.	"	13 .	34A/35	0.373	0.160
		internal	29 .	1/1A		
		"	29 .	2/2A		
		"	29 .	3/3A		
		"	29 .	-		
	LV.	external	13 .	33A/34	0.391	0.161

The specimens are all from algae taken between the tide-marks of Holyhead Harbour.

Description

See: Maybury (ms. 1979, p. 66-67, pl. 1, figs. 9-12; pl. 7, fig. 2) for a description and illustration of the carapace morphology. The soft parts are not described in the literature.

Ontogeny

Juvenile instars were not recognised and despite exhaustive search only a few adult specimens were found. Sexual dimorphism is provisionally recognised. Males are less inflated medianly and much more elongate than the females.

Remarks

The carapace morphology of Caernarvon Bay material is somewhat comparable to Leptocythere tenera (Brady), though may be distinguished from the latter species by being smaller, heavily calcified and more elongate. The present author's material bears a very large, almost chordate, frontal scar which feature is well illustrated by Uffenorde (1972) as a distinguishing characteristic of Leptocythere sp.aff.

Leptocythere micra (Rome). The species figured by Maybury (ms. 1979) and Maybury and Whatley (1981) as Leptocythere sp. cf. L. macella Ruggieri is similar in shape and size to the Caernarvon Bay specimens, but these authors make no reference to the enlarged central muscle scar. However, until more material becomes available that, herein, is tentatively designated Leptocythere sp.cf. L. macella Ruggieri.

Study Area Geology

A single live female was recovered in sample 2515, 38.4 m, in mixed sands of Caernarvon Bay.

Otherwise, a few adult instars occurred in intertidal algae of Holyhead Harbour, western Anglesey.

Palaeoecology and Distribution

This is a little known species of Leptocythere and, as yet, there is no published record of its live occurrence. However, Recent material has been found in the Limski Canal, Gulf of Venice (Uffanorde, 1972) in sands and silt within 170 m and mostly from 40 m in the Adriatic (Bonaduce et.al. 1975) and from 28 m in the Ligurian Sea (Bonaduce et.al. 1979).

It may also occur in the Upper Pliocene and Quaternary of Calabria, S. Italy (Ruggieri, 1974) and is present in the Upper Pliocene of Brittany (Maybury ms. 1979; Maybury and Whatley, 1981).

Summary

As yet, records of Recent material are confined to the Adriatic and W. Mediterranean, 40-46°N. It may also occur in the Upper Pliocene and Quaternary of S. Itlay, 38°N and Upper

Pliocene of N. Brittany, 48^{o}N.

Live material is unknown, though it seems primarily associated with silt and sand down to 170 m and is found mostly within 40 m. L. macella appears to be a warm temperate species that may also tolerate cool temperate waters in full marine salinity.

Leptocythere marina Whittaker, 1972
pl. 30 figs. h-m

1866 Cythere pellucida Baird; Sars: p. 31.

1868 Cythere pellucida Baird (pars); Brady: p. 397, pl. XXVIII, fig. 28.

1869 Cythere confusa nom.nov. Brady and Norman (pars): p. 127.

1912 Cythere confusa Brady and Norman; Hirschmann: p. 50, pl. III, figs. 45-46.

1928 Leptocythere pellucida (Baird); Sars: p. 172, pl. LXXIX, fig. 1.

1938 Leptocythere pellucida (Baird); Klie: p. 166, t. figs. 551-553.

1941 Leptocythere pellucida (Baird) (pars); Elofson: p. 271-272.

1957 Leptocythere pellucida (Baird) (pars); Hanai: p. 438.

1957 Leptocythere pellucida (Baird); de Vos: p. 28, pl. X, figs. 2a-d.

1957 Leptocythere pellucida (Baird) (pars); Wagner: p. 51, pl. XX?

1962 Leptocythere pellucida (Baird); Woszidlo: p. 89, pl. 5, fig. 1.

1969 Leptocythere confusa (Brady and Norman) (pars); Wall (ms.): p. 224, pl. 37, figs. m-r.

1969 Leptocythere pellucida (Baird) (pars); Yassini: p. 34, pl. XII?, XIV?, XIX?, XXI?

1971 Leptocythere sp.3 Whatley, Whittaker and Wall: p. 407, pl. I.

1972 *Leptocythere marina* nom.nov. Whittaker (ms.): p.171, pl. 29, figs. 1-9; pl. 30, figs. 2, 3.

1976 *Leptocythere marina* Whittaker (ms.); Hoskin (ms.): p. 281, pl. 21, figs. 1-4.

1976 *Leptocythere pellucida* (Baird); Guillaume: p. 325, pl. 3, figs. 1b, e; pl. 6, fig. a.

1977 *Leptocythere pellucida* (Baird); Rosenfeld: p. 16, pl. 2, figs. 32-36.

1978 *Leptocythere pellucida* (Baird); Yassini: p. 378, pl. 2, figs. 2-4.

Material

Total Dead: F. - 33 C. 26 RV. 22 LV.; M. - 22 C. 12 RV. 12 LV.; J. - 1 C. 5 RV. 5 LV. = 104 I.

Live: 7 F.; 5 M.; 1 J.

Southern Irish Sea

Dead					Live	
F. - 27 C.	23 RV.	18 LV.			06	
M. - 17 C.	11 RV.	09 LV.	=	85 I.	04	= 11 I.
J. - 01 C.	04 RV.	04 LV.			01	

Caernarvon Bay

Dead					Live	
F. - 06 C.	03 RV.	04 LV.			01	
M. - 05 C.	01 RV.	02 LV.	=	18 I.	01	= 2 I.
J. - 00 C.	01 RV.	01 LV.				

Malin Sea

Dead					Live
M. - 00 C.	00 RV.	01 LV.	=	1 I.	00

Sample Distribution (live occurrence is underlined)

Southern Irish Sea

801 803 807 815 816 868 906 910 2354 2359 2360 2361 2365 2369 2370 2372 2373 2375 2377 2378 2380 2381 2762 2764 2765 2783 2789 2812 2813 2819 2822 2826 2903 2904 2912 2915 2916 2917

Caernarvon Bay

2399 2401 2402 2404 2405 2407 2830 2839 HHI

Malin Sea

3115

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	14	. 27A/28	0.635	0.304
	LV. "	14	. 26A/27	0.638	0.298
M.	RV. "	14	. 24A/25	0.647	0.267
	LV. "	14	. 25A/26	0.617	0.263
-1.	RV. "	14	. 28A/29	0.539	0.252
	LV. "	14	. 29A/30	0.555	0.261

Female right valve and male specimens - sample 2830 (13 m, mixed sand), Caernarvon Bay; female left valve - sample 2359 (77 m), juvenile valves - sample 2361 (78.6 m), fine sand with silt, southern Irish Sea.

Description

See: Wall (ms. 1969, p. 227-232) for a description of the soft parts and Whittaker (ms. 1972, p. 173-175, pl. 29, 30) for a description and illustration of the carapace morphology.

Ontogeny

A few instars were recognised as the penultimate growth stage of this species. The dimensions of adults and juveniles from several samples in the study area are given as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.630-0.680	0.290-0.315	40	
	Mean	0.641	0.301		2.13
M.	Range	0.610-0.685	0.260-0.275	40	
	Mean	0.634	0.265		2.39
-1.	Range	0.510-0.550	0.240-0.265	5	
	Mean	0.542	0.255		2.13

Sexual dimorphism is distinct, males are more elongate and much less inflated than the females (see: Whittaker ms. 1972, p. 173-175).

Remarks

See: Whatley et.al. (1971, p. 399-407), Whittaker (ms. 1972, p. 145, 172, 175) and Guillaume (1976, p. 326-329).

Study Area Ecology

Live material was recovered in the southern Irish Sea between 6.1-80.5 m in mixed sand and silts with clay, and occurred in abundance in sample 2826, 6.1 m, silts + clay. A single live male and female were found in 7 m, coarse sand + gravel of sample 2399, Caernarvon Bay.

Most specimens, otherwise, were from the southern Irish Sea, 6.1-127.5 m, 35.6 m, in a variety of sediments from coarse sand with gravel to silts and clay. Most material was found within 97 m in sands with a high constituent of silts and clay. A large population of adults occurred in samples 2359, 77 m and 2370, 18.3 m, fine sand with silt.

The species was rather more restricted in Caernarvon Bay. Ranging from the intertidal of Holyhead Harbour down to 120.7 m, and mostly 10.9-13 m, mean 28.9 m, in coarse sand + gravel and mixed sand. A small adult assemblage occurred in sample 2830, 13 m, mixed sand.

A single adult was found in the Malin Sea, 91 m, coarse sand with gravel.

Palaeoecology and Distribution

The species has been reported from Iceland (Brady and Norman, 1889) and is known to extend below the Laminarian zone from the Skagerrak to Finmark, Norway (Brady and Norman, 1889; Sars, 1865, 1928). Sars (1928) and Elofson (1941) indicate that live material is common on shell sand and silt of southern

Scandinavia. In which region it ranges mostly within 30 m and extends to 100 m in 3-30‰ salinity, 0-22^{o}C. Its live abundance is recorded in the Oresund (Elofson, 1941) and below the algal zone, 6-85 m in 6-30‰ salinity, to Kiel Bay, W. Baltic (Klie, 1929; 1938; Rosenfeld, 1977). Live material also penetrates the Gulf of Finland, in the silts between 5-14 m, wherein Hirschmann (1909, 1912, 1915) indicates the salinity tolerance is 5.6-6.5‰.

It also occurs around the Orkneys and Shetlands (Brady, 1867, 1868), off E. Scotland, in abundance in 48-85 m off N.E. England and ranges in shell sand to Norfolk, Thames Estuary (Brady, 1868; Brady and Norman, 1889) and the Scheldt, Netherlands (Brady, 1869; Brady and Norman, 1889).

The species is recorded throughout the Western Isles (Brady, 1868) and occurs as a rarity in sandy mud, 150 m, in the Minches, N.W. Scotland (C.S. Harris ms. 1977). L. marina inhabits the Clyde Estuary, W. Scotland (Brady, 1868; Robertson, 1875), ranges entirely around the coast of Ireland (Norman, 1905) and is common west of Ireland (Brady, 1868). In particular, Hoskin (ms. 1976) recovered a moderate abundance of live specimens from fine and mixed sands and silts within 12 m of Brandon and Tralee Bays, S.W. Ireland. Brady (1868) recorded material off Preston, Lancashire; Mumbles, Pembroke and Tenby, S. Wales. Two live specimens were found in sub-littoral Laminarian algae of Caernarvon Bay (Morgan ms. 1977) and abundant live material occurs in shallow sands below the algal zone in Teifi Estuary, Cardigan Bay (Wall ms. 1969).

A moderate abundance of the species occurs in Christchurch Harbour, Dorset, in 2-22^{o}C and 30‰ salinity (Whittaker ms. 1972). The distribution extends to the Channel Isles (Brady, 1868), alive in Roscoff Harbour, N. Brittany (de Vos, 1957) and alive on shell sand and Zostera, 0-6 m, 6-27°C and in 20‰+ salinity throughout Arcachon Basin, Biscay (Yassini, 1969).

Brady and Norman (1889) report material in deep water from S. Biscay and in the Gulf of Naples and St. Lawrence Estuary. Unfortunately, these last two records are not in context with the known geographical distribution. However, that illustrated by Yassini (1978) from Bou Ismail, Algeria appears to be a valid record.

Holocene specimens are recorded in the estuarine deposits of the Netherlands (Wagner, 1957), it occurs as a rarity in the last interglacial of Cardigan Bay (Jasin ms. 1976) and has been reported in the Hoxnian of Denmark and N. Germany (Woszidlo, 1962).

Summary

L. marina is reported from Iceland, 65°N and is recorded alive throughout Scandinavia and the W. Baltic, south of 72°N. Its distribution is best known in British and adjacent waters from the Shetlands to the English Channel, 50-60°N. The live distribution may also extend to S. Biscay, 44°N. Sub-Recent and Holocene material is recorded in the Netherlands, 52°N and probably extends in deep water sediments throughout the British Isles. Isolated specimens of Late Glacial age range to 1,000 m+ in Biscay; it occurs in the last interglacial of Cardigan Bay, 52/53°N and ranges within the Hoxnian of E. Denmark and N. Germany, 54-56°N.

In Scandinavia L. marina inhabits the sublittoral and littoral, 0-30 m and is more rarely alive down to 100 m. Elsewhere, the species inhabits inner bay and lower estuarine areas between 0-15 m. Material is locally abundant in Recent sediments, 48-85 m and is sometimes reworked down to 150 m. It is primarily associated with Zostera, Laminaria and shelly sands and estuarine silts below the algal zone. The temperature tolerance is 0-27^{o}C+, though the salinity range is variable. Most records indicate a full or near marine habit, 20-30‰$^{+}$. However, in S. Scandinavia L. marina may also tolerate 3-30‰ salinity.

Leptocythere porcellanea (Brady and Robertson), 1869
pl. 30 figs. n-o

1869 Cythere porcellanea n.sp. Brady: p. 47, pl. VII, figs. 1-4.

1869 Cythere porcellanea Brady and Robertson (re-described): p. 366, pl. XIX, figs. 1-4.

1874 Cythere porcellanea Brady and Robertson; Brady, Crosskey and Robertson: p. 144, pl. XIII, figs. 3-5.

1889 Cythere porcellanea Brady and Robertson; Brady and Norman: p. 127, pl. XIV, figs. 22-24.

?1929 Leptocythere baltica n.sp. Klie: p. 279, figs. 8-11.

1938 ?Leptocythere baltica Klie; Klie: p. 168, t.figs. 556-559.

1941 ?Leptocythere baltica Klie; Elofson: p. 273.

1969 Leptocythere porcellanea (Brady and Robertson); Wall (ms.): p. 246, pl. 36, figs. j-o.

1969 Leptocythere macallana (Brady and Robertson); Yassini: p. 38.

1972 Leptocythere porcellanea (Brady and Robertson); Whittaker (ms.): p. 176, pl. 30, figs. 1-9; pl. 32, figs. 1-9.

1977 Leptocythere baltica Klie; Rosenfeld: p. 18, pl. 2, figs. 22-25, t.figs. 7, 8.

Material

Total: F. - 3 C. 1 LV. = 4 I.

Southern Irish Sea

Dead	Live
F. - 01 C. 00 RV. 00 LV. = 1 I.	00

Caernarvon Bay

Dead	Live
F. - 02 C. 00 RV. 01 LV. = 3 I.	00

Sample Distribution

Southern Irish Sea

906

Caernarvon Bay

HHII

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	13 .	4A/5	0.514	0.223
	LV. "	13 .	3A/4	0.443	0.222

The illustrated adult is from sample 906, southern Irish Sea.

Description

See: Wall (ms. 1969, p. 247-148) for a description of the hard parts. The carapace morphology and soft parts are illustrated by Whittaker (ms. 1972, pl. 31, figs. 1-9; pl. 32).

Ontogeny

Juvenile instars of this species were not recognised.

Remarks

See: Wall (ms. 1969, p. 248-149) and Whittaker (ms. 1972, p. 178-179).

Study Area Ecology

Live specimens were not recovered.

A single female occurred in 27.4 m, mixed sand from the southern Irish Sea. In addition, several adults were found in intertidal algae of Holyhead Harbour, west Anglesey.

Palaeoecology and Distribution

L. porcellanea is reported from Icelandic waters and Bergen, S.W. Norway (Brady and Norman, 1889), but is more accurately recorded as L. baltica Klie, in southern Scandinavia. In which region, localised live populations range in pure sand or silt, 0.5-20 m, throughout the Skagerrak (Brady and Norman, 1889; Elofson, 1941). It occurs on sand, mud or on Fucus serratus within 28 m of the Oresund (Elofson, 1941; Hagerman, 1965, 1966).

It is also quite common and alive on the sands of Kiel Bay (Klie, 1928, 1938), within 6-21 m and 14-20‰ salinity (Rosenfeld, 1977) and penetrates 0.5-20‰ salinity, 3-8 m, throughout the W. Baltic (Remane, 1958; Hagerman, 1967).

In E. Britain L. porcellanea has a northern range in the Shetlands (Brady and Robertson, 1872). It is also described as common in shallow estuarine conditions from north of the Forth Estuary, southward to the Thames and S.E. England (Brady and Robertson, 1869, 1872; Norman and Brady, 1909). This species extends to the North Sea (Brady and Robertson, 1872) and Heligoland (Klie, 1929) and is found in the Sheldt and Maas Estuaries, Netherlands (Brady, 1869; Brady and Robertson, 1870; Brady and Norman, 1889).

Rare specimens have been dredged in Recent sediments, 2-45 m, in the Clyde, though the species is more commonly found in estuarine areas of the Irish Seas (Brady and Robertson, 1874). For instance, live individuals are recorded on muds in 3‰ salinity and 12^{o}C in the Teify Estuary, Cardigan Bay (Wall ms. 1969). It is also locally common within 8 m off Western Ireland (Brady and Robertson, 1869, 1872; Norman, 1905) and occurs in river mouths of S.W. England and the Scilly Isles (Brady and Robertson, 1872; Norman and Scott, 1906; Neale, 1970).

Live material is recorded in 26-35‰ salinity, 2-22^{o}C, in the Fleet and Weymouth Bay. In which region, Whittaker (ms. 1972) recovered most individuals from the sand and filamentous algae of tide pools and in the holdfasts of sub-littoral bushy algae. L. porcellanea is also reported from the Channel Isles (Norman, 1907, 1908) and it is a very rare live species in sands, 2-7 m, and 28‰$^{+}$ salinity of Arcachon Basin, Biscay (Yassini, 1969).

Lastly, scarce Holocene material has been found in Tremadoc Bay, Irish Sea (Spencer ms. 1976) and L. porcellanea is sometimes common in the Late Glacial of Tarbert, Clyde (W. Scotland) and Cardiff, S. Wales (Brady et.al. 1874; Robertson, 1877). In addition, a single specimen is recorded from the last interglacial (Ipswichian) of Cardigan Bay, Irish Sea (Jasin ms. 1976).

Summary

There is a solitary report of this species from Icelandic waters, 65^{O}N. However, its distribution is better documented from S. Scandinavia, to include the Skagerrak, W. Baltic and

Gulf of Finland, south of 60°N. The live range extends throughout Britain and adjacent waters, 50-60°N, with reduced numbers recorded in Biscay, 44°N approx. Holocene material is known from the southern Irish Sea, 53°N and probably occurs in other areas of western Britain. L. porcellanea is quite common in the Late Glacial of W. Scotland, 56-58°N and is recorded in contemporaneous deposits from Cardiff, S. Wales, 51°N. A single specimen is also known in the Ipswichian of Cardigan Bay, 52-53°N.

In Scandinavia live material occurs in tidepools and between 0.5-28 m. However, outside this region the species is mainly restricted to the sublittoral, within 8 m. L. porcellanea is mostly associated with laminarian, bushy and filamentous algae and silts or sand beneath. In the Gulf of Finland it tolerates 0.5-20‰ salinity, though in British waters and elsewhere the species is alive throughout 3-35‰. Further south, in Biscay, isolated individuals have been taken from entirely marine environments. Lastly, its temperature tolerance is greater than 2-22°C.

Leptocythere tenera (Brady), 1868
pl. 30 figs. p-u

1868 Cythere tenera n.sp. Brady: p. 399, pl. XXVIII, figs. 29-32.

1874 Cythere tenera Brady; Brady, Crosskey and Robertson: p. 145, pl. XIII, figs. 6-7.

1880 Cythere tenera Brady; Brady: p. 63, pl. XII, figs. 3a-f.

1889 Cythere tenera Brady; Brady and Norman: p. 129.

1928 Leptocythere tenera (Brady); Sars: p. 175, pl. LXXX, fig. 2.

1953 *Leptocythere tenera* (Brady); Ruggieri: p. 97, pl. 3, figs. 22, 22a.

1962 *Leptocythere tenera* (Brady); Woszidlo: p. 83, pl. 5, fig. 2.

1969 *Leptocythere tenera* (Brady); Yassini: p. 31, pl. XV, XIX.

1969 *Leptocythere tenera* (Brady); Wall (ms.): p. 249, pl. 17, figs. a-g; pl. 36, figs. p-s.

1972 *Leptocythere tenera* (Brady); Whittaker (ms.): p. 180, pl. 31, figs. 10-11.

1976 ?*Leptocythere tenera* (Brady); Breman: p. 50, pl. III, fig. 34; pl. VII, fig. 89.

Material

Total Dead: F. - 51 C. 110 RV. 93 LV.; M. - 61 C. 91 RV. 52 LV.; J. - 11C. 41 RV. 42 LV. = 429 I.

Live: 50 F. 57 M. 25 J.

Southern Irish Sea

Dead					Live		
F. - 22 C.	34 RV.	34 LV.			28		
M. - 34 C.	46 RV.	19 LV.	=	167 I.	28	=	59 I.
J. - 06 C.	07 RV.	10 LV.			03		

Caernarvon Bay

Dead					Live		
F. - 19 C.	14 RV.	11 LV.			18		
M. - 15 C.	10 RV.	04 LV.	=	116 I.	28	=	68 I.
J. - 05 C.	31 RV.	31 LV.			22		

Malin Sea

Dead					Live		
F. - 10C.	62RV.	48LV.			04		
M. - 12C.	35RV.	19LV.	=	146 I.	01	=	5 I.
J. - 00C.	03RV.	01LV.			00		

Sample Distribution (live occurrence is underlined)

Southern Irish Sea

801 868 906 910 917 2354 2359 2365 2366 2370 2373
2375 2380 2381 2780 2810 2811 2812 2813 2815 2819
2821 2822 2824 2902 2904 2905 2906 2911 2915 2916

Caernarvon Bay

2392	2393	2395	2398	2399	2400	2420	2422	2423	2440
2442	2443	2447	2449	2456	2462	2463	2509	2510	2511
2512	2513	2516	2519	2637	2638	2639	2640	2641	2642
2647	2770	2827	2830	2832	2834	2838	2839	2891	2892
2893	2921	2922	2926	HHI	HHII				

Malin Sea

3099	3101	3143	3145	3153	3154	3161	3162

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	13	. 38A/39	0.447	0.200
	LV. "	13	. 39A/40	0.454	0.215
M.	RV. "	13	. 37A/38	0.435	0.183
	LV. "	13	. 36A/37	0.445	0.200
-2.	RV. "	13	. 1	0.300	0.161
	LV. "	13	. 42A	0.312	0.165

Adult valves - intertidal of Holyhead Harbour, Caernarvon Bay; juvenile right valve - sample 3154 (170.1 m, fine sand + silt), Malin Sea; juvenile left valve - sample 2442 (46 m, coarse sand + gravel), Caernarvon Bay.

Description

See: Wall (ms. 1969, p. 250-257, pl. 17) for a description of the hard and soft parts and illustration of the latter. Whittaker (ms. 1972, pl. 31, figs. 10-11) illustrates the carapace morphology.

Ontogeny

Instars of the penultimate growth stage were recognised. A number of other juveline instars were provisionally ascribed as the -2 and -3 stage of this species. The dimensions of adults and juveniles from several samples in the study material are given as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.430-0.520	0.200-0.230	54	
	Mean	0.478	0.215		2.22
M.	Range	0.420-0.465	0.180-0.210	54	
	Mean	0.446	0.187		2.26
-1.	Range	0.360-0.390	0.170-0.190	42	
	Mean	0.371	0.181		2.04
-2?	Range	0.300-0.330	0.155-0.180	14	
	Mean	0.312	0.165		1.89
-3?	Range	0.245-0.285	0.135-0.160	6	
	Mean	0.278	0.150		1.85

Sexual dimorphism is not pronounced. The males tend to be smaller and are more elongate than the females.

The penultimate instars are very similar in shape to the female. Individuals of other growth stages are, in lateral view, much more tapered posteriorly.

The ornament is very subdued. Some adults and juveniles are entirely smooth whereas others are finely punctate and often show traces of polygonal ornamentation.

Remarks

Ruggieri (1953, p. 97) indicates that many fossil and Recent neapolitan records of L. tenera are more probably referable to L. ramosa Rome.

See: Whittaker (ms. 1972, p. 181).

Study Area Ecology

This is one of the most abundant live species in the southern Irish Sea. Within which region it was generally distributed northward of Wicklow, 24.4-109.7 m, in a variety of sediment substrates from coarse sand + gravel to silts with clay. It occurred most commonly within 28.9-87.8 m on sands with a high content of silt. Live specimens were also found in isolated samples of Caernarvon Bay, from the tidemarks of Holyhead Harbour down to 109.7 m, in abundance between 44-51.2 m, coarse sand + gravel and mixed sand. An assemblage of adults with juveniles occurred in sample 2839 (44 m, mixed sand), Caernarvon Bay. A number of live adults were found in samples 3101 (55 m) and 3162 (140.8 m), fine sand + silt, Malin Sea.

Otherwise, the species was distributed throughout the southern Irish Sea, 14-109.7 m, mostly 14-87.8 m, mean 42.2 m, in the given sediments. Further, it occurred in nearly all samples of Caernarvon Bay, in the intertidal of Holyhead Habour down to 131.7 m, mostly 0.5-62.2 m, mean 61.4 m, in coarse sand + gravel and mixed sand. In the Malin Sea material ranged between 55-170.1 m, mean 129.3 m, in mixed and fine sand + silt.

Large adult assemblages were recovered in the central southern Irish Sea from samples 2904 (80.5 m), 2905 (87.8 m), 2906 (87.8 m) and 2915 (33.5 m) in fine sands with a high content of silt. In Caernarvon Bay large assemblages of adults and juveniles were found in sample 2839 (44 m, mixed sand) and occurred in the intertidal of Holyead Harbour. Lastly, adult assemblages were found south of Islay, in sample 3101 (55 m, fine sand + silt) and occurred in fine sand + silt on the outer shelf of Malin Sea in samples 3142 (146.3 m), 3161 (128 m) and 3162 (140.8 m).

Palaeoecology and Distribution

Brady and Norman (1889) and Norman (1890, 1909, 1911) record this species from the tidemarks down to 220 m^{+}, extending south of Hardanger Fiord, W. Norway and mostly throughout the Skagerrak. Sars (1928) indicates that *L. tenera* is found alive at Risor, S. Norway, 2-38 m. Live material also ranges as far east of Kiel Bay, W. Baltic (Klie, 1929).

The species is well documented from the Shetlands (Brady, 1868; Brady and Robertson, 1870, 1872, 1876; Brady and Norman, 1889). It ranges alive in moderate abundance in tidal pools and sublittoral muds and sand and on coarse shelly deposits, 28-80 m, thoughout N.E. England (Brady, 1868, 1870; Brady and Robertson, 1870, 1872; Norman and Brady, 1909). Furthermore, *L. tenera* is recorded off Norfolk, in the Thames Estuary, off S.E. England (Brady and Robertson, 1870, 1872, 1876) and inhabits the estuarine of the Netherlands (Brady, 1869; Brady and Robertson, 1870; Brady and Norman, 1889; Redeke and Dulk, 1940).

L. tenera is also alive on fine sand and muds in 90 m and otherwise, ranges scarcely to 160 m in the Minches, N.W. Scotland (Brady, 1868; Brady and Robertson, 1872; C.S. Harris ms. 1977). Its live abundance is recorded on muddy bottoms, 12-55 m, in the Clyde Estuary (Brady and Robertson, 1872; Robertson, 1874), Lough Foyle, N. Ireland (Norman, 1905) and throughout W. Ireland, 6-28 m (Brady and Robertson, 1872; Norman, 1905). Recent material is commonly distributed from the tidemarks to 140 m in the Irish Seas, associated with cobble bottoms, shelly sands and muds (Norman, 1905; Brassil ms. 1977; Lomax ms. 1978). The last two authors have also recovered isolated live specimens on coarse cobble sands, 55-58 m, in the Celtic Sea. It is possible that such a deep water live occurrence is associated with zoophytes (Wall ms.

1969). The distribution extends to N. Devon (Brady and Robertson, 1878; Norman and Scott, 1906), Western Approaches and Scillies (Neale, 1970) and *L. tenera* is recorded in sparse numbers in the sediments of Dorset (Whittaker ms. 1972).

There are reports of live material in the Channel Isles (Norman, 1907, 1908) and in muds and sand below the littoral, 25-50 m, of the Gironde Estuary (Carbonel, 1973). *L. tenera* also ranges in *Zostera*, 1-10 m and 23-34‰ salinity throughout Arcachon Basin (Yassini, 1969). That dredged in isolated numbers off Cap Breton, 185-400 m (Brady and Norman, 1889; Peypouquet, 1971) and material found in silts and fine sands, 75-150 m, in Vigo Bay, N.W. Spain (Brady and Norman, 1889; Ralph ms. 1977) is most likely reworked.

Breman (1976) indicates that a few specimens have been found in sediments, mostly within 5-40 m, of the Adriatic. However, this record and that of material from W. Turkey in Brady and Norman (1889) is probably referable to another species.

Moderately common sub-Recent and Holocene material occurs in the Irish Sea (Wall and Whatley, 1971; Spencer ms. 1976) and probably ranges in superficial sediments as far south as Biscay. Late Glacial material is recorded from Wick, N. Scotland; Oban, W. Scotland and Cardiff, S. Wales (Brady et.al. 1874). More rarely, this species is found in last interglacial silts and sands of Cardigan Bay, Irish Sea (Jasin ms. 1976), occurs in abundance in the Ipswichian of Somerset (Kidson et.al. 1978) and is found commonly in contemporaneous deposits of S. Sussex (Whatley and Kaye, 1971). Its presence is also indicated in the Hoxnian of E. Denmark and N. Germany (Woszidlo, 1962).

Quaternary material reported from Calabria and Sicily (Seguenza, 1884; Ruggieri, 1953, 1959) and in the Upper Pliocene of the S. Aegean Islands (Sissingh, 1972) is poorly illustrated and may refer to a different species. However, L. tenera is reliably reported in the Upper Pliocene of Cornwall (Whatley, pers. comm., 1975).

Summary

L. tenera ranges alive from S.W. Norway to the Skagerrak and W. Baltic, 55-60°N and localised populations occur throughout British and adjacent waters southward to Biscay, 44°N. Sub-Recent and Holocene material is known from the Irish Sea, deeper parts of the Celtic Sea and is often reworked into superficial sediments of S. Biscay and N.W. Spain, 42-54°N. The species is also common in the last interglacial of the Irish Sea and abundant in contemporaneous deposits of Somerset and Sussex, 50-54°N. Lastly, there is a record of L. tenera in the Hoxnian of Denmark and N. Germany, 54°N, and in the Upper Pliocene of Cornwall, 50°N approx.

Live material is recorded between 2-38 m in the Skagerrak and W. Baltic and occurs abundantly in tidepools and within 1-10 m throughout Britain, Biscay and the Adriatic. Further, it is occasionally found down to 90 m, inhabiting zoophytes and attached cobble or shelly gravel bottoms of the Irish Seas. Reworked specimens are common down to 200 m in S. Scandinavia and within 150 m approx. in other areas. The species is associated with a variety of sediment substrates, mostly found in silty muds and fine sand though often inhabits shelly sands and gravel. Much of the material in Arcachon Basin was recovered from Zostera. Its temperature tolerance is perhaps 7/8°C - 22°C+ in near or full marine salinity, 23-34‰ .

Genus Callistocythere Ruggieri, 1953

Callistocythere littoralis (Müller), 1894

pl. 31 fig. g

1866 Cythere cicatricosa n.sp. Sars: p. 33 (Junior homonym of Cythere cicatricosa - Reuss, 1850).

1868 NON Cythere crispata n.sp. Brady: p. 221, pl. XIV, figs. 14, 15.

1869 Cythere cicatricosa Sars; Brady and Robertson: p. 368, pl. XIX, figs. 13, 14.

1874 Cythere crispata Brady; Brady, Crosskey and Robertson: p. 146, pl. XI, figs. 52, 53; pl. XIII, figs. 12-13.

1889 Cythere crispata Brady; Brady and Norman: p. 131, pl. XV, figs. 1, 2.

1894 Cythere littoralis n.sp. G.W. Müller: p. 353, pl. 28, fig. 18.

1928 Leptocythere crispata (Brady); Sars: p. 176, pl. LXXX, fig. 3.

1941 Leptocythere crispata (Brady); Elofson: p. 275.

1969 Callistocythere crispata (Brady); Wall (ms.): p. 261, pl. 18, figs. a-g; pl. 38, figs. i, j, n, s, t.

1969 Callistocythere pallida (G.W. Müller); Yassini: p. 40, pl. XV, XVII.

1972 Callistocythere crispata (Brady); Whittaker (ms.): p. 185, pl. 33, figs. 1-8.

1972 Callistocythere aff. littoralis (G.W. Müller); Uffenorde: p. 68, pl. 7, fig. 3.

1975 Callistocythere littoralis (G.W. Müller); Bonaduce, Ciampo and Masoli: p. 39, pl. II, figs. 1-7, t. fig. 21.

1976 Callistocythere littoralis (G.W. Müller); Breman: p. 51, pl. VII, fig. 96.

1980 Callistocythere littoralis (G.W. Müller); Athersuch and Whittaker: 7 (11), pl. 61-66.

Material

Southern Irish Sea + Total

Dead					Live
F.? -	00 C.	00 RV.	01 LV.	= 1 I.	00

Sample Distribution

Southern Irish Sea
2378

Figured Specimen

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.?	L.V. external	26 .	6/6A	0.382	0.221

Description

See: Wall (ms. 1969, p. 262-267, pl. 18) for a description of the hard and soft parts and an illustration of the latter. Whittaker (ms. 1972, pl. 33) and Athersuch and Whittaker (1980, 7(11), pls. 61-66) illustrate the carapace morphology.

Ontogeny

Juvenile instars were not recognised.

Remarks

C. littoralis (0.38-0.42 mm) has been frequently misidentified as C. crispata (Brady, 1868 (0.52-0.60 mm) in British and adjacent waters. Indeed, the latter species is mostly recorded from the Mediterranean and may not extend within the North Atlantic to northwest European waters.

See: Wall (ms. 1969, p. 267-268) and Whittaker (ms. 1972, p. 186-187).

Palaeoecology and Distribution

This species ranges alive in sublittoral Laminaria and full marine salinity from the Skagerrak (Sars, 1865, 1928; Brady and Norman, 1881; Elofson, 1941) to Ostsee, W. Baltic (Klie, 1929).

Isolated individuals are recorded below the intertidal in the Outer Hebrides, off Aberdeen (Brady and Robertson, 1872), from Forth (Brady and Robertson, 1872; Scott, 1906) and southward to Dungeness, S.E. England (Brady and Robertson, 1872; Norman and Brady, 1909).

C. littoralis is more widely documented to the west of Britain. Wherein, it is commonly alive in sandy mud, 8-45 m, in the Clyde (Brady and Robertson, 1872; Robertson, 1874), off Antrim (Norman, 1905) and occurs in many areas west of Ireland, 6-28 m (brady and Robertson, 1869, 1872; Brady and Norman, 1889; Norman, 1905; Norman and Scott, 1906; Hoskin ms. 1976). It has been found in Belfast Lough (Norman, 1905), Dublin Bay (Brady and Robertson, 1869) and Cardigan Bay (Wall ms. 1969), Irish Sea. Material is also known from the N. and S. coasts of Devon (Brady and Robertson, 1872; Norman and Scott, 1906) and Scilly Isles (Neales, 1970).

A moderate abundance of live material is recorded by Whittaker (ms. 1972). In Zostera covered tide flats, 2-21°C and 30‰ salinity and in sublittoral Fucus vesiculosus of the Fleet, Dorset. It also extends to the Channel Isles (Norman, 1907, 1908) and ranges as C. pallida (Müller) in Zostera and Fucus within 2-8 m and 29‰+ salinity to Arcachon Basin (Yassini, 1969) and the Gironde Estuary (Carbonel et.al. 1972; Carbonel and Jouanneau, 1975).

The live distribution of *C. littoralis* is well documented in the Mediterranean. Localised live material occurs within 2 m in *Posidonia* and *Zostera* and in many types of bushy algae within the Gulf of Marseilles (Reys, 1964, 1965, 1967). Isolated specimens have also been recovered in 22 m of the Ligurian Sea (Bonaduce et.al., 1977), within 10 m on sands and in *Posidonia*, Bay of Naples (Müller, 1884; Puri, 1963; Puri et.al., 1964) and in *Laminaria* off Messina, S. Italy (Brady and Norman, 1889). The species is widely distributed in Recent sediments, 25-800 m and mostly between 120-150 m in the S. Adriatic (Breman, 1976) and is found between 111-135 m in the N. Adriatic (Bonaduce et.al., 1975). Live specimens are now known from *Enteromorpha intestinalis* in the Limski Canal, N. Adriatic (Uffenorde, 1972) and it is live off Tenedos, E. Aegean (Brady and Norman, 1889; Athersuch and Whittaker, 1980).

It has been found in the Late Glacial of S. Norway, Clyde, W. Scotland and Portrush, N.E. Ireland (Brady et.al., 1874). There is a single occurrence in last interglacial deposits of E. Ireland (Whatley in Calhoun and Mitchell, 1971). That recorded as *C.* cf. *crispata* (Brady) in the Ipswichian of Somerset (Kidson et.al., 1978) and in the Eemian of Selsey, Sussex (Whatley and Kaye, 1971) may also be referable to this species. Lastly, *C. littoralis* is described in the middle Quaternary of Bologna, N. Italy (Ruggieri, 1974) and in the Lower Pleistocene of Calabria, S. Italy (Ruggieri, 1959).

Summary

This species is alive in the Skagerrak and W. Baltic and locally common throughout British waters, 50-60°N. It may also occur, as L. pallida (Müller), in the Gironde Estuary and Arcachon Basin, 44°N. C. littoralis is further documented alive from the W. Mediterranean and N. Adriatic and extends to the eastern Aegean, 36-46°N. However, material is sparingly represented in the Late Glacial of S. Norway, N.W. Britain and E. Ireland, 53-60°N. It may occur in the last interglacial of S.E. Ireland, Somerset and Sussex, 50-52°N and is reported in the Quaternary of N. and S. Italy, 45°N and 38°N respectively.

C. littoralis mostly inhabits the intertidal and 2-10 m throughout the geographical range. It is found in Recent sediments within 8-45 m in N. Britain and W. Ireland, occurs below 25 m in the W. Mediterranean and ranges between 110-150 m in the Adriatic. Reworked material in the Neapolitan region has been dredged down to 800 m. C. littoralis is primarily associated with sandy mud, Laminarian algae and Zostera, though in the W. Mediterranean and Adriatic it also inhabits bushy algae and Posidonia debris. Its temperature tolerance is probably 2-26°C. Although Neale (1964) gave the salinity range as 12-35‰, most other records indicate a fully marine habit, 29‰+.

Callistocythere badia (Norman), 1862

pl. 31 figs. a-f

1862 Cythere badia n.sp. Norman: p. 48, pl. III, figs. 13-15.

1868 Cythere badia Norman; Brady: p. 399, pl. XXIX, figs. 56-59.

1889 Cythere badia Norman; Brady and Norman: p. 130, pl. XV, figs. 3-4.

1969 Callistocythere badia (Norman); Wall (ms.): p. 272, pl. 19, figs. a-g; pl. 38, figs. g-h.

1972 Callistocythere badia (Norman); Whittaker (ms.): p. 194, pl. 33, figs. 9-10.

1977 Callistocythere badia (Norman); Athersuch and Whittaker: 4 (10) pls. 53-58, t.fig. 1.

Material

Caernarvon Bay + Total

Dead					Live
F. - 01 C.	02 RV.	02 LV.			00
M.? - 01 C.	07 RV.	04 LV.	= 17 I.		
J. - 00 C.	02 RV.	02 LV.			

Sample Distribution

Caernarvon Bay

HHII

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	31	. 23/23A	0.485	0.253
	LV.	"	31	. 24/24A	0.496	0.254
M.?	RV.	"	27	. 25A/26	0.495	0.251
	LV.	"	27	. 26A/27	0.496	0.256
-1.	RV.	"	27	. 27A/28	0.415	0.238
	LV.	"	27	. 28A/29	0.418	0.233

Description

See: Wall (ms. 1969, p. 272-278, pl. 19) for a description of the hard and soft parts and an illustration of the latter. The carapace morphology and appendages are illustrated by Athersuch and Whittaker (1977, 4 (10): pls. 53-58).

Ontogeny

Instars of the penultimate growth stage were recognised. The dimensions of adults and juveniles from Holyhead Harbour are given below:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.480-0.530	0.250-0.265	6	
	Mean	0.496	0.258		1.92
M.?	Range	0.485-0.520	0.250-0.265	7	
	Mean	0.489	0.254		1.93
-1.	Range	0.410-0.430	0.230-0.240	4	
	Mean	0.418	0.236		1.77

Sexual dimorphism is indistinct. Some adult instars were rather smaller and less inflated posteriorly than others and are tentatively ascribed as the males.

Study Area Ecology

The species was not recovered alive.

A small population of adults and juveniles was found in intertidal algal debris, Holyhead Harbour, western Anglesey.

Palaeoecology and Distribution

Brady (1868) indicates that this species occurs in Norwegian waters though this record remains unsubstantiated.

Callistocythere badia is, however, recorded by Brady (1866, 1868) from the Orkneys and Shetlands, off Newcastle, N.E. England (Athersuch and Whittaker, 1977) and from Dungeness, S.E. England (Brady and Norman, 1889).

Most of the documented distribution relates to W. Britain. In which region, it is locally common between the low-water line and 38 m in the Clyde Estuary (Brady and Robertson, 1872; Robertson, 1874; Brady and Norman, 1889) and occurs in Recent sediments, 90-110 m, of the Minches, N.W. Scotland (Brady, 1868). The range extends to the Antrim coast, N.E. Ireland (Norman, 1905), includes the oyster ooze off Stranraer, S.W. Scotland (Brady, 1868), Belfast Lough (Norman, 1905) and the Irish Sea (Brady and Robertson, 1872; Brady and Norman, 1889). C. badia is seldom live, 0-18 m, in Cladophora and Corallina in 18^{o}C and 31.5‰ salinity, Cardigan Bay (Wall ms. 1969). In addition, there are many records of this species in shell sand within 30 m West of Ireland (Brady, 1868; Brady and Robertson, 1872; Brady and Norman, 1889; Norman, 1905). Sparse live material also ranges in rock pools and the sub-littoral of N. and S. Devon and Cornwall (Types) (Norman, 1862; Brady, 1868; Brady and Robertson, 1872; Brady and Norman, 1889; Norman and Scott, 1906) and occurs off the Scilly Isles (Norman and Scott, 1906; Neale, 1970).

A few live specimens are recorded in Enteromorpha intestinalis and rock pools, 19-22^{o}C in full marine salinity of the Fleet and Weymouth Bay (Whittaker ms. 1972). C. badia is also reported from Guernsey (Brady, 1868; Norman, 1907, 1908), but there is no record of this species further south than the English Channel.

Live material has recently been recovered from Cyprus, E. Mediterranean. Athersuch and Whittaker (1977) indicate that this material from Dhekelia was taken in filamentous algae, 5 cm, 24°C and in 39‰ salinity. Thus, reports of _C. badia_ off Constantinople, W. Turkey (Brady and Norman, 1889) and in the Quaternary of Calabria, S. Italy (Ruggieri, 1959) may be valid.

Summary

This species is distributed alive and in Recent sediments entirely throughout British and Irish waters, 50-60°N. It has not been positively identified from other N. Atlantic regions. In addition, there is no accurate fossil record of _C. badia_, though it is possible that there are several valid references to this species in the Quaternary of S. Italy.

The ecology of _C. badia_ is poorly known. Live specimens are reported between 0-38 m off West Britain and Ireland and the species inhabits rock pools and the sublittoral of S.W. England and Cyprus. Alive in bushy and filamentous algae and associated with the sands and muds beneath. Recent material is found in British waters down to 110 m. Its temperature tolerance is $<$12-24°C in full marine salinity, 31.5-39‰.

Callistocythere sp.
pl. 31 figs. h-i

1969 Leptocythere macallana (NON Brady and Robertson); Wall (ms.): p. 242, pl. 38, figs. k, l, o, p.

Material

Caernarvon Bay + Total

Dead	Live
F.? - 01 C. 01 RV. 02 LV. = 4 I.	00

Sample Distribution

Caernarvon Bay
2830 HHII

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.?	RV. external	14 .	34A/35	0.451	0.225
	LV. "	14 .	32A/33	0.456	0.234

The specimens are from sample 2830, Caernarvon Bay.

Description

See: Wall (ms. 1969, p. 243-245) for a description of the carapace morphology. The soft parts are undescribed in the literature.

Ontogeny

Juvenile instars were not recognised.

Remarks

This species has been tentatively placed by Wall (ms.) with the genus Leptocythere Sars. He commented (p. 259-260) that while most morphological features were in accord with

Callistocythere Ruggieri, the presence of narrow vestibulae and weakly developed hingement excluded it as member of the latter genus. However, Hanai (1957, p. 442) considered the presence of vestibulae did not necessarily exclude a species as member of Callistocythere. Until more material becomes available the present author tentatively refers the Caernarvon Bay specimens to the genus Callistocythere.

Study Area Ecology

The species was not found alive.

A few poorly preserved specimens occurred in intertidal algal debris of Holyhead Harbour and were found in mixed sand, 13 m, further south in Caernarvon Bay.

Palaeoecology and Distribution

Nothing is known of the ecology of this species. Wall (ms. 1969) indicates that Recent material has been recovered from the Teifi Estuary, Cardigan Bay.

Genus Cluthia Neale, 1973

Cluthia cluthae (Brady, Crosskey and Robertson), 1874

pl. 31 fig. j

1874 Cythere cluthae n.sp. Brady, Crosskey and Robertson: p. 153, pl. 13, figs. 16, 17.

1889 Cythere cluthae Brady, Crosskey and Robertson; Brady and Norman: p. 145, pl. 14, figs. 25-27.

1969 Leptocythere cluthae (Brady, Crosskey and Robertson); Yassini: p. 36.

1969 Leptocythere cluthae (Brady, Crosskey and Robertson); Lev: p. 29, pl. 2, fig. 7.

1970 Callistocythere? cluthae (Brady, Crosskey and Robertson); Hazel: p. E8, E14, pl. 36.

1973 Cluthia cluthae (Brady, Crosskey and Robertson); Neale: p. 684, pl. 1, figs. 1, 6-11.

1980 Cluthia cluthae (Brady, Crosskey and Robertson); Lord: p. 242, pl. 3, figs. 18, 19.

1981 Cluthia cluthae (Brady, Crosskey and Robertson); Masson (ms.): p. 77, pl. 4, figs. 2, 4.

Material

Malin Sea + Total

Dead					Live
F. - 00 C.	00 RV.	01 LV.	= 1 I.		00

Sample Distribution

Malin Sea

3101

Figured Specimen

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	LV. external	6 .	40A/41	0.347	0.216

Description

See: Neale (1973, p. 684, pl. 1, figs. 1, 6-11) for a description and illustration of the carapace morphology. The soft parts are undescribed in the literature.

Ontogeny

Juvenile instars were not recognised.

Remarks

See: Neale (1973, p. 684-686).

Study Area Ecology

A single adult instar was found in fine sand with silt, 55 m, S.E. of Islay, Malin Sea.

Palaeoecology and Distribution

This species is well documented in the western North Atlantic. From which region Recent and possible live material extends between 13-200 m, mostly 90-95 m approx., from the Gulf of Maine to Nova Scotia and the Canadian Arctic (Hazel, 1967, 1970). It is also recorded by Stephensen (1913, 1936) in W. Greenland and from Wolstenholme and Ellesmere Island, N.W. Greenland, 26-48 m (Hazel, 1970). The last author comments that the distribution of this species is controlled by the summer maximum temperature tolerance, 0-7^{o}C+. Neale (1973), however, indicates that live specimens in the Western North Atlantic occur mostly between 2/3^{o}C-15^{o}C. C. cluthae has also been found in 15 m off Cape Stosch and within 95-110 m off Clavering Island, N.E. Greenland (Hazel, 1970).

In addition, material has been dredged in several areas of the Norwegian and Barents Seas. To occur as far north as Spitzbergen, Svalbard Islands, 280 m (Müller, 1912; Neale, 1973 and Howe, 1975), Cape Flora, Frans Joseph Land, 55 m (Scott, 1899) and extends eastward to Russian Harbour, Novaya Zemlya, 15 m, muddy sand (Neale, 1973; Neale and Howe, 1975). Specimens occur in superficial sediments between 240-290 m in the fiords of Finmark, N. Norway (Brady and Norman, 1889, Norman, 1891, 1902) and C. cluthae has also been found alive in this region between 38-55 m approx. (Brady and Norman, 1895).

There is a report of C. cluthae in muds, 6-8 m, off the Orkneys (Scott, 1891, 1899), in fine sand and mud, 220 m+, in the Minches (C.S. Harris, ms. 1977) and in 38 m of Loch Fyne, N.W. Scotland (Scott, 1899). It has also been dredged off Antrim, N.E. Ireland, 110-135 m (Norman, 1905), from comparable depths in the Irish Sea and within 18-35 m in Belfast Lough (Malcomson, 1886). Neale (1973) indicates that live material has never been found south of Belfast Lough, N. Irish Sea and he gives a temperature range for the species of $2/3^{o}$C-$7/8^{o}$C in the eastern North Atlantic. Neale (1973) and Brassil (ms. 1977) indicate that material from Recent shelly sands of the Celtic Sea is most probably reworked.

Late Glacial and Holocene specimens are probably included in the distribution attributed to C. cluthae in the W. North Atlantic. To include, that dredged from 115-150 m and ranging between 100-600 m in S. Biscay (Yassini, 1969; Peypouquet, 1971) and the record from submarine cores off Cap Breton (Caralp et.al., 1968, 1969, 1974). The Late Glacial distribution also extends to Ardyne, S.W. Scotland (Peacock et.al., 1978; Graham and Wilkinson, 1978), Clyde and Oban, W. Scotland (Brady et.al., 1874), North Sea (Masson ms. 1981) and to Sandnes, S.W. Norway (Lord, 1980). C. cluthae is found in the last interglacial, Ipswichian, of S. Biscay (Moyes and Peypouquet, 1971); occurs in the Hoxnian of E. Yorkshire (Neale, 1973; Neale and Howe, 1975) and is found in various Pleistocene deposits of N. Russia (Lev, 1969).

Summary

This is a rare species though it is widely distributed in the N. Atlantic. C. cluthae is probably alive in the Gulf of Maine, Canadian Arctic and west of Greenland northward to the Queen Elizabeth Islands, 42-80^{o}N. It is also recorded

from E. Greenland, 75^{O}N approx., throughout the Barents Sea to Franz Joseph Land, and is alive in Norwegian and northern British waters, 55-80^{O}N. However, most of that found in British waters and all material dredged south of N.E. Ireland is most likely reworked, 44^{O}-55^{O}N. Late Glacial specimens range from S.W. Norway to the North Sea, W. Scotland and Biscay, 60-44^{O}N. Further, material of Ipswichian age is known from Biscay, 42-48^{O}N. C. cluthae also occurs in the Hoxnian of E. Yorkshire, 54^{O}N, and is found in various Pleistocene deposits of N. Russia, 65-70^{O}N.

The ecology is difficult to discern as much of the recorded distribution incorporates reworked material. However, in the western N. Atlantic it is found between 13-200 m, mostly from 90 m approx. in the Gulf of Maine and occurs within 15-48 m off N.E. and N.W. Greenland. In the eastern N. Atlantic it occurs between 240-290 m in the Barents and Norwegian Seas, ranges within 110-150 m+ in British and adjacent waters and is perhaps alive in European waters within 6-55 m approx. Most records indicate an association with fine sands and muds and full marine salinity. Certain authors regard its distribution to be controlled by a summer maximum temperature of 0-8^{O}C. However, if live specimens extend to the Gulf of Maine or to N.E. Ireland this species must also tolerate waters up to 15^{O}C+.

Cluthia keiji Neale, 1975

p. 31 figs. k-n

1973 Cluthia cluthae n.sp. Neale; Neale (pars): p. 684, pl. 1, figs. 2-4 (Juvs.)

1975 Cluthia keiji n.sp. Neale: 2:23: pls. 141-148.

1975 Cluthia keiji Neale; Bonaduce, Ciampo and Masoli: p. 42, pl. 14, figs. 1-8, t. fig. 24.

1976 Cluthia keiji Neale; Breman: p. 48, pl. VII, fig. 101.

1977 Cluthia keiji Neale; Bonaduce, Masoli and Pugliese, pl. 1, fig. 7.

1978 Cluthia keiji Neale; Yassini: p. 378, pl. 12, fig. 6.

Material

Malin Sea + Total

Dead					Live
F. -	03 C.	00 RV.	00 LV.	= 13 I.	00
M. -	07 C.	01 RV.	02 LV.		

Sample Distribution

Malin Sea

3101

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	23	. 28A/29	0.307	0.176
	LV. "	23	. 29A/30	0.300	0.172
M.	RV. "	23	. 27A/28	0.305	0.168
	LV. "	23	. 26A/27	0.305	0.168

Description

See: Neale (1975, pls. 141-148) for a description and illustration of the carapace morphology. The soft parts are undescribed in the literature.

Ontogeny

Juvenile instars were not recognised.

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.295-0.310	0.170-0.180	6	
	Mean	0.304	0.175		1.74
M.	Range	0.295-0.310	0.165-0.170	12	
	Mean	0.302	0.168		1.80

Sexual dimorphism is slight. Males are proportionately larger than the females and, in dorsal view, extremely compressed.

Remarks

See: Neale (1975, 2:3, pls. 141-148).

Study Area Ecology

Live specimens were not recovered.

A small adult assemblage occurred in 55 m, fine sand with silt, Malin Sea.

Palaeoecology and Distribution

This is a rare species throughout its distribution. However, a few individuals have been found in Recent sediments off N.W. Norway and from 140 m approx. in the Celtic Sea, W. Britain (Neale, 1975). It is also known to occur in medium sand taken in Vigo Bay, 24 m, N.W. Spain (as *C. cluthae*, Brady, Crosskey and Robertson; Ralph ms. 1977). However, it is probable that much if not all of the N. Atlantic record is reworked.

C. keiji is mostly documented in the Mediterranean. Recorded from 81 m off E. Spain, within 107 m and common in 22 m in the Ligurian Sea (Bonaduce et.al., 1977) and (as *C. cluthae* in

Puri et.al., 1964) reported by Bonaduce et.al. (1975) to occur off Naples, W. Italy. A moderate abundance of specimens is recorded in sandy silt and medium sand, 71-234 m+, mainly 90-170 m in the Adriatic (Bonaduce et.al., 1975; Breman, 1976). *C. keiji* also occurs in a similar ecology off Bou-Ismail, Algeria (Yassini, 1978).

As yet, fossil material is only accurately known in the Quaternary of Malta (Neale, 1975).

Summary

This is a rare species though ranges in Recent sediments from the W. Mediterranean and Adriatic to N.W. Norway, 37-70°N. Much of the given distribution is based on reworked Devensian or Holocene material.

Live specimens are not recorded in the literature. The species occurs down to 140 m in the N. Atlantic. Found mostly between 90-170 m in the Adriatic, though is known to range within the W. Mediterranean on silts and sand in 22-234 m. *C. keiji* appears to be a fully marine form in cool and warm temperate waters.

Family LOXOCONCHIDAE Sars, 1925

Genus Loxoconcha Sars, 1866

Loxoconcha rhomboidea Fischer, 1855

pl. 31 Figs. m-r; t.f. 8i, ii

1854 Cythere flavida O.F. Müller; Zenker: p. 86, pl. V, figs. B1-4.

1855 Cythere rhomboidea n.sp. Fischer: p. 856.

1865 Cythere (Normania) carinata n.sp. Brady: p. 189-190, pl. IX, figs. 1-4.

1866 Loxoconcha rhomboidea Fischer; Sars: p. 62-63.

1868 Loxoconcha impressa (Baird); Brady: p. 433-434, pl. XXV, figs. 35-40; pl. XL, fig. 4.

1874 Loxoconcha impressa (Baird); Brady, Crosskey and Robertson: p. 185, pl. VIII, figs. 1-4.

1888 Loxoconcha rhomboidea (Fischer); Dahl: p. 621, pl. XVIII, figs. 72-89.

1889 Loxoconcha impressa (Baird); Brady and Norman: p. 183, pl. XXIII, fig. 7.

1894 NON Loxoconcha impressa (Baird); Müller: p. 342, pl. 27, figs. 16, 17, 30; pl. 28, figs. 1, 6.

1912 NON Loxoconcha bairdi A.W. Müller: p. 306.

1928 Loxoconcha impressa (Baird) (pars); Sars: p. 218, pl. 101.

1938 Loxoconcha impressa (Baird) (pars); Klie: p. 201, t. figs. 685-690.

1941 Loxoconcha impressa (Baird); Elofson: p. 322.

1948 NON Loxoconcha impressa (Baird); Tressler and Smith: p. 32, pl. III, fig. 25.

1955 NON Loxoconcha impressa (Baird); Kruit: p. 487, pl. VI, figs. 7a-b.

1957 Loxoconcha impressa (Baird); de Vos: p. 43, pl. XVIII, figs. 1a-g; pl. XIX, figs. 1a-b.

1957 Loxoconcha rhomboidea (Fischer); Wagner: p. 64, pl. XXVII.

1966 NON Loxoconcha rhomboidea (Fischer); Williams: p. 13, t. figs. 8a-c.

1969 *Loxoconcha rhomboidea* (Fischer); Wall (ms.): p. 282, pl. 5, figs. a-i; pl. 39, figs. a-g.

1969 *Loxoconcha rhomboidea* (Fischer); Yassini: p. 108, pl. XI-XV, XIX.

1971 *Loxoconcha aff. rhomboidea* (Fischer); Barbieto-Gonzalez: p. 306, pl. XXXI, figs. 1b, 2b.

1975 *Loxoconcha rhomboidea* (Fischer); Bonaduce, Ciampo and Masoli: p. 109, pl. 59, figs. 8-12, t.fig. 43.

1976 *Loxoconcha rhomboidea* (Fischer); Hoskin (ms.): p. 282, pl. 22, figs. 1-4.

1976 *Loxoconcha rhomboidea* (Fischer); Athersuch and Whittaker: 3 (17): pls. 81-90.

1978 *Loxoconcha rhomboidea* (Fischer); Yassini: p. 387, pl. 6, figs. 3, 4.

Material

Total Dead: F. - 18 C. 104 RV. 92 LV.; M. - 15 C. 65 RV. 45 LV.; J. - 32 C. 1736 RV. 1539 LV. = 2170 I.

Live: 184 F. 129 M. 100 J.

Southern Irish Sea

Dead		Live	
F. - 04 C. 57 RV. 40 LV.		67	
M. - 10 C. 36 RV. 30 LV.	= 750 I.	77	= 242 I.
J. - 15 C. 477 RV. 531 LV.		98	

Caernarvon Bay

Dead		Live	
F. - 13 C. 34 RV. 39 LV.		114	
M. - 04 C. 20 RV. 14 LV.	= 880 I.	051	= 166 I.
J. - 15 C. 481 RV. 615 LV.		001	

Malin Sea

Dead		Live	
F. - 01 C. 13 RV. 13 LV.		03	
M. - 01 C. 09 RV. 01 LV.	= 540 I.	01	= 5 I.
J. - 02 C. 278 RV. 393 LV.		01	

<u>Sample Distribution</u> (live occurrence is underlined)

Southern Irish Sea

<u>801</u> <u>803</u> <u>804</u> <u>805</u> <u>807</u> 815 <u>820</u> <u>822</u> <u>823</u> <u>825</u> 827 829
<u>833</u> <u>843</u> 844 845 <u>850</u> <u>857</u> <u>860</u> 868 <u>872</u> 873 875 880
881 <u>903</u> <u>906</u> 910 914 <u>917</u> 918 923 925 <u>926</u> 2347 2351
2354 2359 2360 2361 2365 <u>2366</u> <u>2367</u> 2369 2370 <u>2372</u>
<u>2373</u> <u>2375</u> 2377 2380 2381 2761 2762 <u>2764</u> <u>2765</u> <u>2779</u>
<u>2780</u> <u>2781</u> <u>2783</u> <u>2788</u> <u>2789</u> <u>2791</u> <u>2792</u> 2810 <u>2812</u> 2819
2822 <u>2854</u> 2903 2904 2905 2906 2915 2916 2917

Caernarvon Bay

2385 2388 2389 2392 2393 2396 <u>2398</u> <u>2399</u> <u>2400</u> 2401
2402 2404 <u>2406</u> 2407 2419 <u>2420</u> <u>2421</u> 2422 2423 2424
2428 <u>2442</u> 2443 2444 2447 2449 2456 2462 2463 2465
2467 2509 2510 2511 2512 2515 2516 2519 <u>2637</u> 2638
2639 2640 2647 <u>2827</u> <u>2829</u> <u>2830</u> 2831 2832 2836 2838
2839 2891 2921 2922 2923 2926 HHI HHII

Malin Sea

3000 <u>3012</u> 3013 3014 3091 3097 3099 <u>3101</u> <u>3103</u> 3115
3125 3136 3140 3152 3154 3162

<u>Figured Specimens</u>

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	12 .	33/32A	0.610	0.416
	LV. "	12 .	34/34A	0.619	0.431
M.	RV. "	12 .	32/32A	0.684	0.437
	LV. "	12 .	31/31A	0.672	0.425
-1.	RV. "	12 .	35/35A	0.495	0.314
	LV. "	12 .	36/36A	0.514	0.343

The specimens are from sample 2399 (7 m, coarse sand + gravel), Caernarvon Bay.

<u>Description</u>

See: Wall (ms. 1969, p. 283-290, pl. 5) for a description of the hard and soft parts and an illustration of the latter. The carapace morphology and appendages are also figured by Athersuch and Whittaker (1976, 3:17: pls. 81-90).

Ontogeny

Instars from the penultimate to -5 growth stage were recognised. The dimensions of adults and juveniles from samples 2375 (23.8 m, fine sand + silt) southern Irish Sea, 2399 (7 m, coarse sand + gravel), Caernarvon Bay and 3101 (55 m, fine sand + silt), Malin Sea are combined into the following (See: figs. 8i, ii).

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.590-0.680	0.380-0.450	40	
	Mean	0.631	0.424		1.49
M.	Range	0.680-0.740	0.400-0.450	46	
	Mean	0.692	0.435		1.59
-1.	Range	0.460-0.560	0.290-0.350	187	
	Mean	0.521	0.338		1.54
-2.	Range	0.370-0.470	0.240-0.290	162	
	Mean	0.405	0.255		1.59
-3.	Range	0.300-0.360	0.180-0.220	157	
	Mean	0.320	0.200		1.60
-4.	Range	0.240-0.290	0.150-0.180	29	
	Mean	0.256	0.163		1.57
-5.	Range	0.180-0.220	0.110-0.140	5	
	Mean	0.196	0.120		1.63

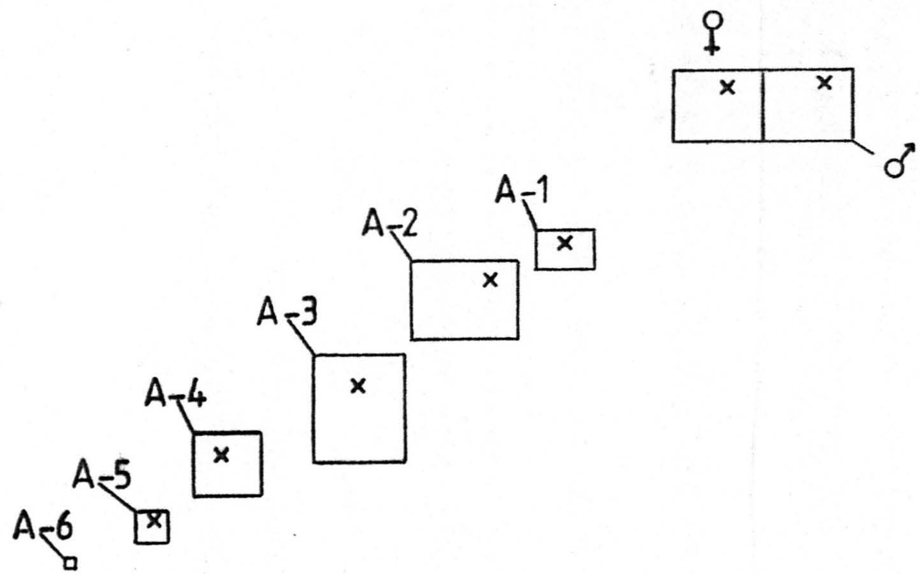
Sexual dimorphism is distinct. Males are much the larger and proportionatley longer than females (See: Wall, p. 290-291).

It is possible that Wall (ms. 1969, p. 290) interpreted precocious sexual dimorphism of the last juvenile growth stage in his Cardigan Bay fauna as both penultimate and ante-penultimate instars (See: Fig. 8ii).

Remarks

Most reports of L. rhomboidea in the Recent and Quaternary of the Mediterranean are referable to other species. Further, L. rhomboidea sensu stricto may not extend to the i

CARDIGAN BAY 0-3 m.



After WALL (M.S.) 1969 p. 290.

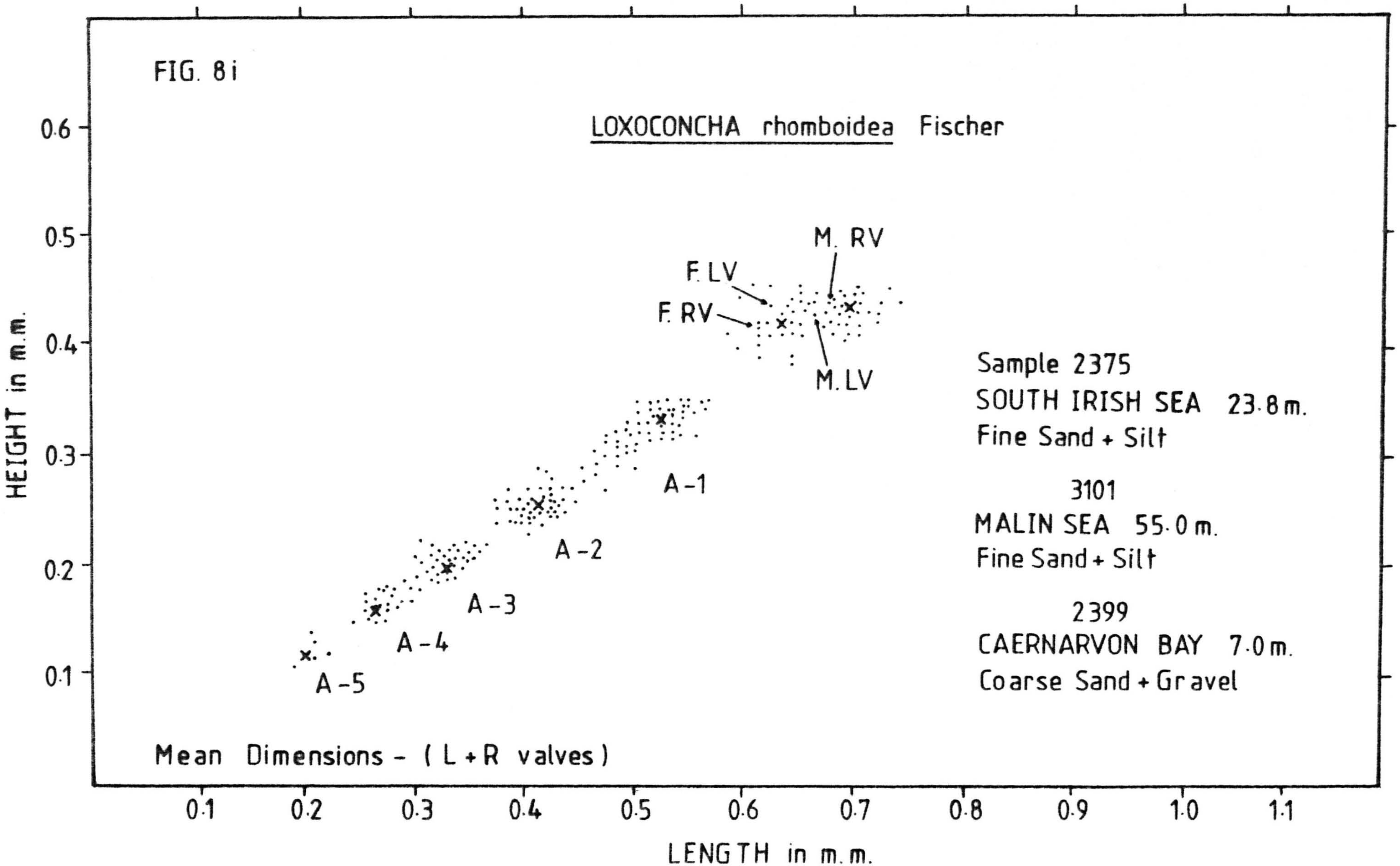


FIG. 8i
LOXOCONCHA rhomboidea Fischer
M. RV
F. LV
F. RV
M. LV
A -1
A -2
A -3
A -4
A -5
Sample 2375
SOUTH IRISH SEA 23.8 m.
Fine Sand + Silt
3101
MALIN SEA 55.0 m.
Fine Sand + Silt
2399
CAERNARVON BAY 7.0 m.
Coarse Sand + Gravel
Mean Dimensions - (L + R valves)
HEIGHT in m.m.
0.6
0.5
0.4
0.3
0.2
0.1
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
LENGTH in m.m.

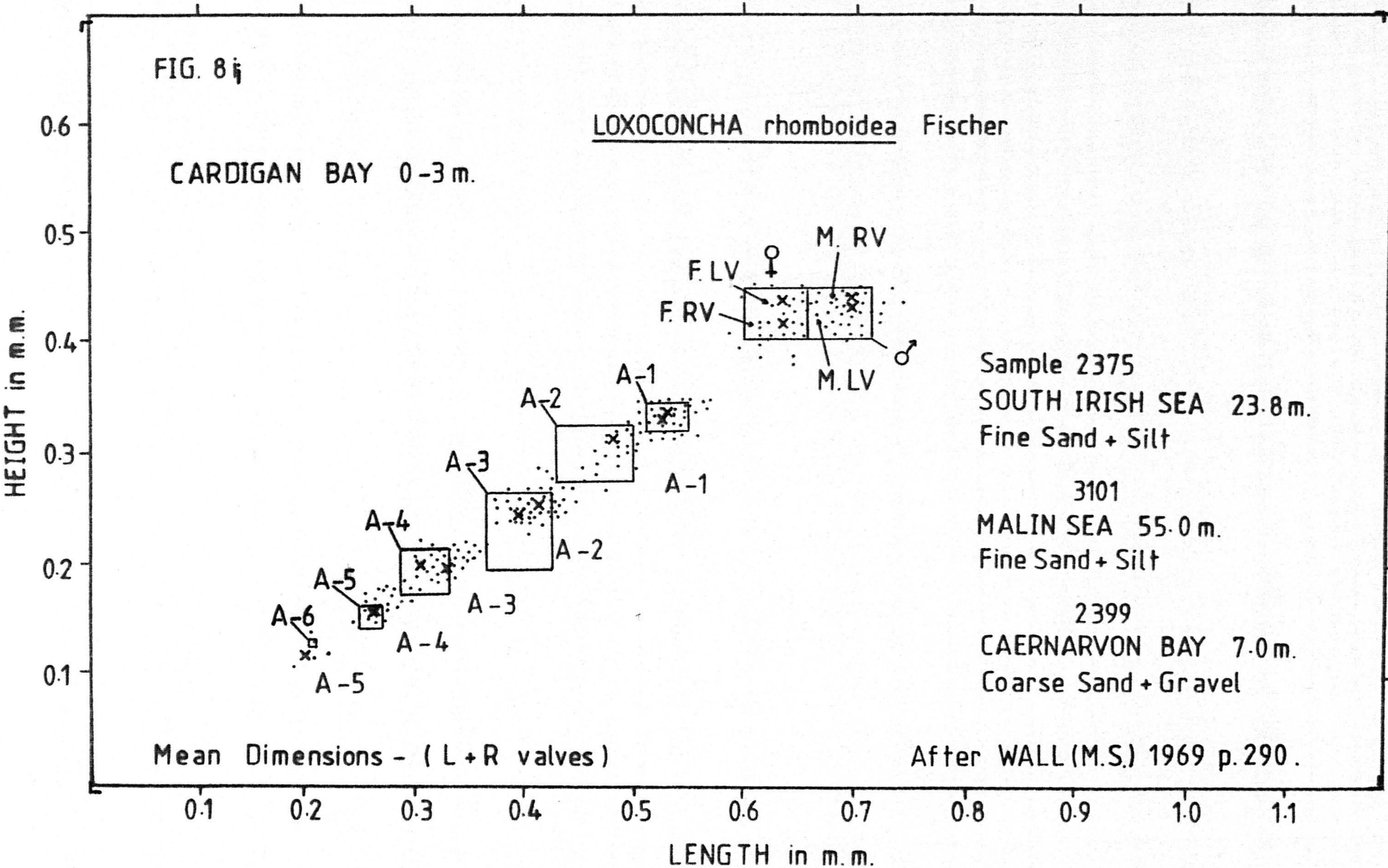


FIG. 8ij
LOXOCONCHA rhomboidea Fischer
CARDIGAN BAY 0-3 m.
HEIGHT in m.m.
0.6
0.5
0.4
0.3
0.2
0.1
F. LV
F. RV
M. RV
M. LV
♀
♂
A-1
A-2
A-3
A-4
A-5
A-6
A-1
A-2
A-3
A-4
A-5
Sample 2375
SOUTH IRISH SEA 23.8 m.
Fine Sand + Silt
3101
MALIN SEA 55.0 m.
Fine Sand + Silt
2399
CAERNARVON BAY 7.0 m.
Coarse Sand + Gravel
Mean Dimensions - (L + R valves)
After WALL (M.S.) 1969 p. 290.
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
LENGTH in m.m.

to the western N. Atlantic. Records of *L. rhomboidea* and *L. impressa* (Baird) from off eastern N. America may be referred to *L. matagordensis* Swain and *L. purisubrhomboidea* (Edwards).

See: Wall (ms. 1969, p. 291) and Whittaker (ms. 1972, p. 200-201).

Study Area Ecology

This was by far the most abundant live ostracod species in the study material.

It was recorded alive in the southern Irish Sea between 7-54.9 m, 8.2-40 m in abundance, on a variety of sediments from coarse sand + gravel to silts with clay. Live material occurred in the intertidal of Holyhead Harbour and within 46 m in coarse sand with gravel and mixed sand of Caernarvon Bay; from 47.6-91 m in the given sediments within Malin Sea.

Otherwise, the species was found in coarse sand + gravel to silts with clay between 1.7-137.5 m, 8.2-97 m in abundance, mean 32.8 m, southern Irish Sea; within 0.5-146.3 m, 0.5-124.4 m in abundance, mean 53.8 m, Caernarvon Bay; and from 22-173.8 m, 47.6-91 m in abundance, mean 80.9 m, Malin Sea.

Large populations of adults and juveniles were recovered in the southern Irish Sea from samples 868 (18.3 m, mixed sand) and 2375 (23.8 m, fine sand with silt). An adult assemblage occurred in sample 2365 (40 m, mixed sand) and a juvenile assemblage occurred in samples 2819 (54.9 m, silt + clay) and 2905 (87.8 m, mixed sand + silt). In Caernarvon Bay a population of adults and juveniles was recorded from samples 2399

(7 m, coarse sand + gravel), 2422 (23.8 m, mixed sand), 2830 (13 m, mixed sand), and HHII (0.5-5 m algae). Large numbers of juveniles occurred in the intertidal of Holyhead Harbour, in sample 2839 (44 m, mixed sand), Caernarvon Bay and in sample 3101 (55 m, fine sand + silt), Malin Sea.

Palaeoecology and Distribution

This species is reliably recorded in littoral algae and on phytal debris throughout Norwegian waters from Finmark to the Skagerrak (Norman, 1891; Sars, 1928). In the latter region abundant live material occurs between 0.3-22 m, mostly 5-10 m, from 0-24°C and in 7‰+ salinity (Elofson, 1941, 1943). It is recorded in the Fucus zone of Oresund (Hagerman, 1965), Kattegat, Ostsee (Zenker, 1854; Dahl, 1888; Klie, 1929, 1938) and the Western Baltic (Hirschmann, 1912, 1915). The live distribution also ranges to the Heligoland, Zuider Zee and estuarine of the Netherlands (Brady and Robertson, 1870; de Lint, 1923; Klie, 1929; Redeke, 1936; Redeke and Dulk, 1940).

L. rhomboidea is also common in the estuarine intertidal and sublittoral of E. Britain including the Shetlands (Brady and Robertson, 1872), Forth (Scott, 1889), N.E. England (Brady, 1868; Brady and Norman, 1889) and Norfolk Fens (Brady, 1868; Brady and Robertson, 1872). Frequently found in the near marine outer estuarine sand and mud flats of the Thames (Brady, 1868; Brady and Robertson, 1872; Kilenyi, 1969) and it is commonly dredged at moderate depth in the North Sea (Norman and Brady, 1909).

The species is most abundant and widespread west of Britain and Ireland (Brady, 1868; Brady and Norman, 1889). Alive in sublittoral algae and tidepools and, otherwise, frequent in fine shelly sand or muds down to 150 m+ off N. Scotland (Brady and Robertson, 1872) and in the Western Isles (Brady, 1868; Robertson, 1874; C.S. Harris ms. 1977; Pearce ms. 1977). It is also abundantly alive from the intertidal down to 28 m, mostly 2-6 m, in Irish and adjacent waters (Brady, 1868; Brady and Robertson, 1869; Norman, 1905). Hoskin (ms. 1976) indicates that most live material in Brandon Bay, S.W. Ireland was found on sand or mud covered rocky reaches, wherever bushy or laminarian algae persist. There are records of it from the Isle of Man, in numerous areas of the Irish Sea (Brady, 1868; Norman, 1905) and it may be one of the commonest live ostracods in Caernarvon and Cardigan Bays (Morgan, ms. 1977; Wall, ms. 1969). Its widespread abundance ranges to the Severn Estuary (Wilson and Harris, 1979), north and south coasts of Devon and Cornwall (Brady, 1868; Norman and Scott, 1906; Harding, 1957) and it occurs in algae and below on gravel sands off the Scillies, 18-30 m (Neale, 1970). However, Brassil (ms. 1977) and Lomax (ms. 1978) indicate that only rare specimens are found when associated with mobile gravel sand and silts, 35-60 m+, of the Celtic Sea.

The species is also ubiquitous in the English Channel (Norman, 1907, 1908), off N. Brittany (de Vos, 1957) and occurs in green filamentous algae, _Zostera_ and epiphyte encrusted _Fucus_, 0.3-16 m, 28-35‰ salinity and 5-24°C, of Dorset (Whittaker, ms. 1972). The range includes the Gironde Estuary (Carbonel et.al., 1972; Carbonel and Jouanneau, 1975) and Arcachon Basin (Oh and Carbonel, 1978). In which region most material is alive on _Zostera_, sands and algal debris in 1-10 m, 26‰+ salinity and 6-27^{o}C (Yassini, 1969). Occasionally, specimens extend to the open shelf of Biscay (Carbonel, 1973) and N.W. Spain (Ralph, ms. 1977).

L. rhomboidea is now known to extend to the W. Mediterranean, though the distribution there is much restricted (Athersuch and Whittaker, 1976). However, live material is abundant along the Algerian coast (Yassini, 1978) and extends in many types of complex algae within 75 m, Gulf of Naples (Brady and Norman, 1889; Puri, 1963; Puri et.al., 1964). It may also range, as L. aff. rhomboidea, to the S. Adriatic (Bonaduce et.al., 1975), Limski Canal (Uffenorde, 1972) and eastern Aegean (Barbieto-Gonzalez, 1971). However, that figured in Bonaduce et.al. (1977) from the Ligurian Sea and in Kruit (1955) from Provence and Gulf of Marseilles are distinct.

Sub-Recent and Holocene material is common in the Netherlands (Wagner, 1957, 1960, 1964), southern Irish Sea (Wall and Whatley, 1971), Gironde (Carbonel et.al., 1975) and Cyprus region (Athersuch and Whittaker, 1976). Its presence in the Late Glacial is widespread though locally rare, ranging from S. Norway (Brady et.al., 1874) to eastern Scotland (Peacock et.al., 1980) and the North Sea (Masson, ms. 1981). The Late Devensian distribution includes Western Scotland (Brady et.al., 1874; Robertson, 1877, 1882; Morris, ms. 1977; Graham and Wilkinson, 1978; Peacock et.al., 1978) and N. Ireland (Brady et.al., 1874). Isolated Devensian material has also been found in E. Ireland (Calhoun and Mitchell, 1971), Seine Estuary (Lautridou and Dupeuble, 1965) and in deep waters, 500 m, of Biscay (Peypouquet, 1971; Moyes and Peypouquet, 1971). The Ipswichian (Last interglacial) occurrence is rare in

Cardigan Bay (Jasin, ms. 1976) and abundant in Somerset (Kidson et.al., 1978) and S. Sussex (Bell, 1892; Whatley and Kaye, 1971). Material of Hoxnian age is reported by Brady, (1865) and Lord and Robinson (1978) from the Nar Valley, E. Anglia.

Summary

The live distribution ranges throughout Scandinavia, Britain and adjacent areas, south to Biscay, 70-44^{O}N and includes, in part, the W. Mediterranean. Most material is found in the Skagerrak, west of Britain and Ireland and Biscay, 44-60^{O}N. Sub-Recent and Holocene material occurs in Cyprus, 36^{O}N and is found in abundance in the Irish Sea, Netherlands, and Gironde Estuary, 44-54^{O}N. The species is never common in the Late Glacial, though material is found in S. Norway, E. and W. of Britain and in deep waters off S.W. France, 44-60^{O}N. Ipswichian material is rare in the Irish Sea and common in estuarine deposits of Somerset and S. England, 50-53^{O}N. Earlier Quaternary and Late Pliocene records from East Anglia and the Mediterranean are considered dubious.

L. rhomboidea is mostly alive in 5-10 m in S. Scandinavia and occurs within 03-10 m in Britain and Biscay. Found primarily in sheltered estuarine mud and sand flats, on algal debris or marine grass and occurs upon rocky reaches and associated algal mats. The species commonly extends in Recent sediments down to 150 m, though material is also rarely re-worked below this depth in the southerly waters. There are records of Scandinavian material in salinities down to 7‰, though in most other areas L. rhomboidea is restricted to near or full marine conditions, 26‰+. A eurythermal species, alive and abundant throughout 0-27°C.

Loxoconcha sp. cf. L. agilis Ruggieri, 1967

pl. 32 figs. a-f

1967 ?Loxoconcha agilis n.sp. Ruggieri: p. 377, pl. 37, fig. 6; t.figs. 42-46.

Material

Malin Sea + Total

Dead					Live
F.? -	00 C.	01 RV.	00 LV.		00
M. -	00 C.	01 RV.	00 LV.	= 3 I.	
J. -	00 C.	00 RV.	01 LV.		

Sample Distribution

Malin Sea

3101

Figured Specimen

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.?	RV.	external	11	36A/37	0.432	0.243
		internal	29	9/9A		
		"	29	8/8A		
		"	29	7/7A		
M.?	RV.	external	11	37A/38	0.447	0.244
-1.	RV.	"	11	38A/39	0.381	0.180

Ontogeny

A single juvenile was recorded and provisionally ascribed as the penultimate growth stage of this species.

Both adult right valves are markedly different in shape and the more elongate of these is proposed as a male instar.

Remarks

These specimens cannot be directly assigned to any particular species of the genus Loxoconcha Sars. They have a shape and ornament somewhat similar to that of L. granulata Sars, but are too small and robust to be the latter species. The Malin Sea specimens also bear a strong likeness to both L. agilis Ruggieri, as illustrated by Bonaduce et.al. (1975, p. 102, pl. 65, figs. 9-14, t.fig. 39) and L. aff. dertobrevis of Uffenorde (1972, p. 82, pl. 3, fig. 4; pl. 7, fig. 2; pl. 12, fig. 12). However, these Adriatic species are much larger and less acutely angled postero-dorsally than the Malin Sea form and may, therefore, be distinct. Until more material becomes available that of this study is tentatively ascribed as Loxoconcha sp.cf. L. agilis Ruggieri.

Study Area Ecology

A few valves were found off S.E. Islay, Malin Sea, in fine sand and silt, 55 m.

Loxoconcha elliptica Brady, 1868

pl. 32 figs. g

1853 Cythere viridis O.F. Müller; Lilljeborg: p. 168, pl. XVIII, figs. 4-6, 8-13; pl. XIX, figs. 3-5.

1868 Loxoconcha elliptica n.sp. Brady: p. 435, pl. XXVII, figs. 38, 39, 45-48; pl. XL, fig. 3.

1874 Loxoconcha elliptica Brady; Brady, Crosskey and Robertson: p. 188, pl. XIV, figs. 23-25.

1888 Loxoconcha elliptica Brady; Dahl: p. 624, pl. XVIII, figs. 90-95, 99-106.

1889 Loxoconcha viridis O.F. Müller (pars); Brady and Norman: p. 185.

1929 Loxoconcha gauthieri n.sp. Klie: p. 292, t.figs. 23-25.

1938 Loxoconcha gauthieri Klie; Klie: p. 203, t.figs. 694-696.

1941 Loxoconcha elliptica Brady; Elofson: p. 324.

1955 Loxoconcha elliptica Brady; Kruit: p. 487, pl. VI, figs. 5a-c.

1957 Loxoconcha elliptica Brady; Wagner: p. 66, pl. XXVIII.

1966 Loxoconcha elliptica Brady; Theisen: p. 234.

1969 Loxoconcha elliptica Brady; Wall (ms.): p. 292, pl. 6, figs. a-g; pl. 39, figs. h-a.

1969 Loxoconcha elliptica Brady; Yassini: p. 105, pl. II, IV, IX.

1972 Loxoconcha elliptica Brady: Whittaker (ms.): p. 204, pl. 37 figs. 1-8.

1975 Loxoconcha elliptica Brady; Bonaduce, Ciampo and Masoli: p. 106, pl. 63, fig. 14; pl. 67, fig. 10.

1976 Loxoconcha elliptica Brady; Hoskin (ms.): p. 282, pl. 22, figs. 9, 10.

1976 Loxoconcha elliptica Brady; Athersuch and Whittaker: 3(19) pls. 99-106.

Material

Caernarvon Bay + Total

Dead	Live
J. - 00 C. 01 RV. 00 LV. = 1 I.	00

Sample Distribution

Caernarvon Bay

2839

Figured Specimen

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
-1.	RV. external	13 .	30A/31	0.442	0.281

Description

See: Wall (ms. 1969, p. 294-300, pl. 6) for a description of the hard and soft parts and an illustration of the latter. The carapace morphology and appendages are best figured by Athersuch and Whittaker (1976, pls. 99-106).

Ontogeny

A single juvenile was recognised and tentatively ascribed as a penultimate instar of the species. The ontogeny of L. elliptica is discussed in detail by Theisen (1966, p. 234-239).

Remarks

See: Wall (ms. 1969, p. 301) and Whittaker (ms. 1972, p. 205-206).

Study Area Ecology

A juvenile instar was recorded in 44 m in mixed sand, Caernarvon Bay.

Palaeoecology and Distribution

There are reports of this species in the phytal zone from Iceland and southern Scandinavia (Brady and Norman, 1889; Stephensen, 1938). Furthermore, a live abundance of material is recorded throughout the phytal, sublittoral and meso-haline (5-18‰) zones of the Kattegat skerries (Elofson, 1941), Oresund and Kiel Bay (Dahl, 1888; Klie, 1929, 1938; Schafer, 1953; Hagerman, 1965; Vesper, 1975). These authors also indicate that it inhabits algal debris and silty muds throughout the western Baltin. Wherein, its range includes Ostsee and the Swedish coast, 0.5-20‰ in 1.5-5 m

(Hirschmann, 1912, 1915; Elofson, 1943) and Gulf of Finland (Brady and Norman, 1889; Remane, 1938; Hagerman, 1967). L. elliptica is also locally common in meso-haline tidal estuaries and reservoirs of Denmark and the Netherlands (Brady, 1868c, 1869; Brady and Robertson, 1870; Brady and Norman, 1889; Redeke and Dulk, 1940).

Brady and Norman (1889) indicate that it is exclusively brackish in British and adjacent waters. However, its distribution in E. Britain is not accurately documented north of Forth (Scott, 1890) and the abundance seems restricted to salt marshes, estuarine sluices and intertidal mud-flats of N.E. England (Brady, 1868, 1869; Brady and Robertson, 1870, 1872; Norman and Brady, 1909). Brady and Norman (1889) also list the R. Humber, East Anglian Fens and Thames estuary in association with L. elliptica. The last of these environments is reviewed by Kilenyi (1969), who found isolated live specimens off Margate in 34‰ salinity and also remarks upon a population inhabiting the upper estuarine region in 2-18‰ salinity. More rarely instars are washed out into the North Sea, 28-55 m, (Brady, 1870).

L. elliptica is not well documented west of Britain. Recorded in several brackish localities west of Ireland (Brady and Norman, 1889; Norman, 1905), found in brackish supra-tidal pools of Dundrum Bay, Irish Sea (Brady, 1909) and occurs in muds and silts, 2-15‰ salinity of the Teify Estuary, Cardigan Bay (Wall ms. 1969). Reports of it extend to Barnstaple, N. Devon; Rivers Plym and Dart, S. Devon (Brady and Norman, 1889; Norman and Scott, 1906) and Channel Islands in abundance (Brady, 1868; Brady and Robertson, 1872; Norman, 1907, 1908). The ecology of L. elliptica is best recorded from the Dorset coast (Whittaker, ms. 1972). This last author found it alive on coarse sand, mud and attached Fucus, mostly in 0-20‰ though rarely in 34‰ salinity, of Christchurch Harbour.

The distribution and abundance is more generalised further south. Recorded in Fucus and on muds, 15-28‰ salinity of the Gironde (Carbonel et.al., 1972; Carbonel, 1973; Carbonel and Pujos, 1973) and occurs in reservoirs and canals, 0-4 m, 6-20‰ salinity of Arcachon Basin (Yassini, 1969; Oh and Carbonel, 1978). Isolated specimens also range in deeper shelf waters to Biscay (Carbonel, 1973) and N.W. Spain (Ralph, ms., 1977).

Hartmann (1952) suggests that L. elliptica is a common species in the Western Mediterranean and Adriatic. It would appear to extend in brackish lagoons and lakes along the coasts of Algeria (Gauthier, 1928; Klie, 1929), Tunisia (Bonaduce and Masoli, 1968) and S. France (Kruit, 1955). The distribution may extend to areas of freshwater discharge in the N. Adriatic, 0-20 m (Stammer, 1932; Bonaduce et.al., 1975), S. Adriatic, 5-7 m mostly (Breman, 1976) and Corfu, W. Greece (Klie, 1938). However, Athersuch and Whittaker (1976) comment that many records in the Mediterranean are incorrect.

Holocene material is mostly sparce, but very widely distributed. Found in Tremadoc Bay (Spencer, ms., 1976), North Sea (Diebel and Pietrzeniuk, 1970), Netherlands (Wagner, 1957, 1960), N.W. France (Bignot and Dupeuble, 1967), Gironde Estuary in abundance (Carbonel et.al., 1975) and occurs in deep waters off Cap Breton (Carbonel et.al., 1977). The Late Pleistocene record includes only Girvan, W. Scotland; Cardiff, S. Wales

(Brady et.al., 1874; Brady and Norman, 1889) and S.E. Ireland (Whatley in Cathoun and Mitchell, 1971). However, there is an abundance of *L. elliptica* in the Ipswichian (last interglacial) of Somerset (Kidson et.al., 1978) and Sussex (Whatley and Kaye, 1971).

Summary

L. elliptica ranges from Iceland, southward of 65°N. However, it is best documented from S. Scandinavia and the Gulf of Finland, 54-60°N and ranges in localised abundance throughout Britain and adjacent waters to S. Biscay, 44-56°N. Material also extends in Recent sediments to N.W. Spain, 42°N and there are a number of live populations in the Mediterranean and Adriatic, south to 36°N. Sub-Recent and Holocene material is common, ranging from the Irish and North Seas to S. Biscay, 44-54°N. Late Devensian specimens are known only from the Irish Sea region, 52-56°N, and *L. elliptica* is a common species in the last interglacial of Somerset and Sussex, 50-52°N.

Found alive mostly on tidal mud and sand flats and in algal debris and *Fucus* of estuarine marshes and lagoons. This species is rarely alive in open marine conditions, though *L. elliptica* is often found reworked between 28-55 m in the North Sea. Records indicate an optimum salinity tolerance of 0.5-17/20‰ with some live able to withstand up to 34‰ salinity. Neale (1944) suggests the temperature tolerance is 0-30°C.

Loxoconcha granulata Sars, 1866

pl. 32 figs. h-j

1865 Loxoconcha granulata n.sp. Sars: p. 64

1868 Loxoconcha granulata Sars; Brady: p. 434, pl. XXV, figs. 51, 52.

1869 Loxoconcha granulata Sars; Brady: p. 368, pl. XIII, figs. 5-7.

1928 Loxoconcha granulata Sars; Sars: p. 219, pl. 102, fig. 1.

1938 Loxoconcha granulata Sars; Klie: p. 205, t.figs. 702-704.

1962 Loxoconcha granulata Sars; Waszidlo: p. 84, pl. 5, fig. 17.

1977 Loxoconcha granulata Sars; Rosenfeld: p. 28, pl. 7, fig. 92.

Material

Caernarvon Bay + Total

Dead				Live
F. - 00 C.	01 RV.	01 LV.	= 4 I.	00
M. - 00 C.	01 RV.	01 LV.		

Sample Distribution

Caernarvon Bay

2516

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	13	. 29A/30	0.594	0.346
M.	RV.	"	13	. 27A/28	0.572	0.337
M.	LV.	"	13	. 28A/29	0.588	0.335

Description

See: Sars (1928, p. 219-220, pl. 102, fig. 1) for a description and illustration of the carapace morphology and soft parts.

Ontogeny

Juvenile instars were not recognised.

Remarks

Most authors agree that the soft parts of both L. granulata and L. guttata (Norman) are very similar, if not identical, though draw a distinction between these species upon the more coarse ornament of Lindisfarnia guttata. Cardigan Bay specimens are more rudely punctate than the 'granular' ornamentation of Sars Scandinavian Types, but do not approach the 'honey-combed' texture of L. guttata sensu stricto. Therefore, until other material becomes available for examination the few specimens, herein, are designated Loxoconcha granulata.

That recorded as L. granulata by Hulings (1966, p. 55, fig. 8e) and Williams (1966, p. 14, fig. 54, 9a-c) from Virginia and Narragansett Bay respectively, is another species. The N. American material is too elongate and more convex postero-dorsally than L. granulata Sars. In addition, Williams (1966) comments upon the concentric nature of pits and delicate ridges both anteriorly and posteriorly on the shell. Which features indicate that the western North Atlantic species may be related to L. matagordensis Swain and L. purisubrhomboidea (Edwards).

See: Whittaker (ms. 1972, p. 209-210), Masson (ms. 1981, p. 68) and Athersuch and Horne (1981, on Lindisfarnia guttata (Norman)).

Study Area Ecology

Several adult instars were recovered from 49.6 m in mixed sand, Caernarvon Bay.

Palaeoecology and Distribution

The distribution of this species is not fully known, it is probably included in the synonymy of many other species.

However, L. granulata is reliably recorded in Scandinavian waters on muddy bottoms from the Skagerrak to Finland (Sars, 1865, 1928). Its ecology is best documented in relation to the Skagerrak (Elofson, 1941). He found live material on hard ground, coarse sand and silts, 8-205 m and mostly between 18-80 m in 10-20‰ salinity and 1-19°C. Live material ranges to the Oresund, 10-18 m (Elofson, 1943; Hagerman, 1965), Kiel Bay, 0-6 m and occurs within the Ostsee, 21-31 m in 20-30‰ salinity (Klie, 1929, 1938; Rosenfeld, 1977).

Records of L. granulata in eastern British waters range from the Hebrides (Brady, 1866) in muddy sand and gravel, 28-65 m, to N.E. England (Brady, 1869, 1870; Brady and Robertson, 1874, 1876; Bossany, 1967).

This species is also reported in the Clyde Estuary (Robertson, 1874), from an oyster ooze off Stranraer (Brady, 1868) and in 0-12 m from Clifden Bay, W. Ireland (Brady and Robertson, 1869).

The distribution in British and Gascoynian waters is least known. Peypouquet (1971) alone remarks upon a few specimens found between 48-480 m off Cap Breton, S. Biscay.

There are records of L. granulata in the Upper Miocene of Romagna, Italy (Ruggieri, 1959) and isolated reports appertain to the Upper Pliocene and Quaternary of Sicily, S. Italy (Neviani, 1906; Ruggieri, 1959; Colalongo, 1965) and Crete (Sissingh, 1972). Unfortunately, there are no adequate illustrations to accompany a possible fossil neapolitan distribution and, therefore, these above records are considered tentative. In addition, that found by Yassini (1978, pl. 12, figs. 11, 12) in Recent sediments off Algeria is most probably another species.

It is, however, recorded from the Holocene of the North Sea (Diebel and Pietrzeniuk, 1970), occurs as a common species in the last interglacial, Ipswichian, of Sussex (Whatley and Kaye, 1971) and is known in the Hoxnian of N. Germany and E. Denmark (Woszidlo, 1962).

Summary

The species is best documented alive in the Skagerrak and W. Baltic, though it may also range in isolated localities throughout Britain, $50-60^{\circ}$N. Disjunct or reworked specimens have been found in S. Biscay, 44°N. It has been reported in the Holocene of the N. Sea, 55°N; *L. granulata* is quite common in the last interglacial of Sussex, 51°N and material is recorded in the Hoxnian of E. Denmark and N. Germany, $54-56^{\circ}$N.

Live material and that recovered in Recent sediments is never abundant, but occurs in 0-200 m+, mostly within 80 m, in Scandinavian waters and the North Sea. It extends rarely down to 480 m in S. Biscay. *L. granulata* is associated with muddy bottoms, coarse sand and areas of hard ground in 20-30‰ salinity, rarely in 10-20‰ salinity and has a temperature tolerance of $1-19^{\circ}$C.

Loxoconcha multifora (Norman), 1865

pl. 33 figs. a-f

1865 Cythere multifora n.sp. Norman: p. 192

1865 Cythere multifora Norman; Norman: p. 18, pl. IV, figs. 13-16.

1868 Cytheropteron multiforum (Norman); Brady: p. 449, pl. 29, figs. 39-42.

1874 Loxoconcha multifora (Norman); Brady, Crosskey and Robertson: p. 187, pl. 14, figs. 11, 12a, b.

1838 Loxoconcha multiflora (mis-spelling) (Norman); Elofson: p. 7, t. figs. 9-13.

1941 Loxoconcha multifora (Norman); Elofson: p. 103.

1969 Loxoconcha multifora (Norman); Wall (ms.): p. 307, pl. 39, fig. p-5 (Juv.?).

1969 Loxoconcha multifora (Norman); Yassini: p. 107, pl. 20, figs. 6, 6a.

1976 Loxoconcha multifora (Norman); Hoskin (ms.): p. 282, pl. 23, figs. 2-3.

1978 Loxoconcha multifora (Norman); Yassini: p. 387, pl. 6, figs. 10-11.

1981 Loxoconcha multifora (Norman); Masson (ms.): p. 70, pl. 4, fig. 18.

Material

Total: F. - 11 C. 71 RV. 73 LV.; M. - 10 C. 41 RV. 28 LV.;
J. - 2 C. 87 RV. 67 LV. = 290 I.

Southern Irish Sea

Dead	Live
F. - 00 C. 05 RV. 01 LV.	00
M. - 00 C. 01 RV. 03 LV. = 16 I.	
J. - 00 C. 02 RV. 04 LV.	

Caernarvon Bay

Dead	Live
J. - 00 C. 02 RV. 02 LV. = 4 I.	00

Malin Sea

Dead				Live
F. - 11 C.	66 RV.	72 LV.		00
M. - 10 C.	40 RV.	25 LV.	= 270 I.	
J. - 02 C.	83 RV.	61 LV.		

Sample Distribution

Southern Irish Sea

2369 2381 2905 2915

Caernarvon Bay

2423 2515 2839 2892

Malin Sea

3012 3042 3101 3103 3115 3140 3143 3145 3147 3150
3152 3153 3154 3161 3162

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	26	. 34/34A	0.397	0.212
	LV.	"	12	. 39/39A	0.359	0.205
M.	RV.	"	12	. 37/37A	0.400	0.208
	LV.	"	12	. 38/38A	0.384	0.214
-1.	RV.	"	12	. 41/41A	0.322	0.185
	LV.	"	12	. 40/40A	0.315	0.176

Adults - sample 3143 (146.3 m, fine sand + silt), juveniles - sample 3101 (55 m, fine sand + silt), Malin Sea.

Description

See: Wall (ms. 1969, p. 308-9, pl. 39, figs. p. 5) for a description and illustration of the carapace morphology. Elofson (1938, p. 7-10) describes and, in part, illustrates the soft parts.

Ontogeny

Instars of the penultimate and antepenultimate growth stage were recognised. The dimensions of adults and juveniles from several Malin Sea samples are given as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.355-0.380	0.205-0.210	18	
	Mean	0.368	0.208		1.77
M.	Range	0.380-0.440	0.205-0.215	28	
	Mean	0.401	0.210		1.91
-1.	Range	0.310-0.325	0.180-0.190	38	
	Mean	0.318	0.183		1.74
-2.	Range	0.260-0.280	0.145-0.170	14	
	Mean	0.270	0.157		1.72

Sexual dimorphism is distinct, males are larger and more elongate than females.

Juveniles are similar in shape to the female and coarsely pitted. They also bear a slight ventral ridge which is developed into an alar prolongation postero-ventrally.

Study Area Ecology

Live specimens were not found.

The species was distributed in isolated samples between 11-87.8 m, mean 32 m, in mixed and fine sand and silt with clay, southern Irish Sea. Most specimens occurred in sample 2905, 87.8 m, mixed sand with silt.

In Caernarvon Bay isolated juvenile instars were recovered between 38.4-82 m in coarse sand + gravel and mixed sands.

It was most abundant in the Outer shelf of Malin Sea, 54.9-512.1 m, mean 140.3 m, in a variety of sediments from coarse sand + gravel to silt with clay. Populations of adults with juveniles were recorded in samples 3101 (55 m) and 3154 (170.1 m), fine sand with silt. Assemblages of adults were found in fine sand with silt of samples 3143 (146.3 m) and 3162 (140.8 m).

Palaeoecology and Distribution

Recent material in Scandinavian waters ranges from the Ostsee (Klie, 1929) and Kiel Bay (Klie, 1938) to the Skagerrak and west coast of Norway (Brady and Norman, 1889; Norman, 1891; Elofson, 1938, 1941). The last author found a single live specimen in 50 m of Koster Fiord and suggested that L. multifora occurs alive from the intertidal down to 360 m in areas of sand or silt and algal debris.

It is recorded as common in the Shetlands (Brady and Robertson, 1872) and Forth Estuary (Scott, 1890). Most reports and the Type specimens are from N.E. England; ranging in this region from the Wash (Brady and Norman, 1889) on shelly gravel within 28-85 m throughout the North Sea (Norman, 1865; Brady, 1868, 1870; Brady and Robertson, 1874, 1876; Norman and Brady, 1909). There is also a record of it in the Scheldt Estuary, Netherlands (Brady and Robertson, 1870; Brady and Norman, 1889).

The distribution is widespread in Recent sediments of western Britain and Ireland, though the species is rarely abundant in dredgings. Moderately common material is known from Stornaway, Skye, Loch Fyne, off Oban, N.W. Scotland and in fine sand or mud, 18-155 m, mostly 80 m+, of the Minches (Brady, 1868; C.S. Harris, ms., 1977). The distribution extends to the Clyde Estuary (Robertson, 1874; Brady and Norman, 1889), Antrim coast, N. Ireland, and to many areas west of Ireland (Brady, 1868; Brady and Norman, 1889; Norman, 1905). It occurs in Belfast Harbour (Brady and Norman, 1889), Cardigan Bay (Wall, ms., 1969) and is recorded in intertidal algae of Caernarvon Bay, W. Wales (Morgan, ms., 1977). Isolated specimens extend in sand and mud to the Irish Channel (Brady and Norman, 1889), Celtic Sea, 70-148 m (Brassil, ms., 1977; Lomax, ms., 1978) and coasts of Devon and Cornwall (Brady, 1868; Brady and Norman, 1889; Norman and Scott, 1906; Harding, 1957). There is also a mention of this species off Lands End (Norman and Scott, 1906; Neale, 1970) and from 150 miles westward in 360 m (Brady and Norman, 1889; Norman and Scott, 1906).

Further south, both Brady (1868) and Norman (1907, 1908) record it from the Channel Isles. It ranges in sparse numbers, 50-200 m, mostly 100 m+, off Gascony (Yassini, 1969) and seems to be moderately common in 120-195 m in S. Biscay (Brady and Norman, 1889; Peypouquet, 1971). Several instars are also known in 75 m from Vigo Bay, N.W. Spain (Ralph, ms. 1977).

L. multifora is found in the sub-Recent of Tremadoc Bay, Irish Sea (Wall and Whatley, 1971) and occurs in the Holocene of the Gironde (Carbonel et.al., 1975). Rare material is known in the Late Glacial of Portrush, N. Ireland (Brady et.al., 1874), North Sea (Masson, ms. 1981) and Biscay (Caralp et.al., 1970; Moyes and Peypouquet, 1971). Lastly, a few specimens are recorded in the Last Interglacial, Ipswichian of Somerset (Kidson et.al., 1978) and have been found in the Upper Pliocene of St. Erth, Cornwall (Whatley, pers. comm., 1975).

Summary

The species is alive in S. Scandinavia, moderately abundant otherwise in this region and the North Sea. It extends alive throughout British and adjacent waters and extends in reduced numbers to the deep waters of Biscay, 42-60°N. Sub-Recent material is known only from the southern Irish Sea, 53°N; it occurs in the Holocene of the Gironde, 45°N and rarely ranges in the Late Glacial between Biscay, North Sea and

N.E. Ireland, 44-56^{O}N. Isolated specimens also extend to the Last Interglacial of Somerset, 51^{O}N and are reported in the Upper Pliocene of Cornwall, 50^{O}N.

Its ecology is little known. Live material occurs in 50 m in S. Scandinavia, though L. multifora may inhabit this region from the sublittoral to 360 m. Most live and Recent individuals are found in 18-80 m in British and adjacent waters and range between 100-200 m in Biscay. The species is primarily associated with sand and silt and is recorded occasionally in sublittoral algae and Zostera debris. The temperature range is unknown but must include near 0^{O}C conditions in the Skagerrak. Neale (1964) indicates the salinity tolerance to be 26/30‰+.

Loxoconcha sp.
pl. 34 figs. a-h

Material

Total: F. - 12 C. 48 RV. 49 LV.; M. - 4 C. 45 RV. 30 LV.;
J. - 1 LV. = 140 I.

Southern Irish Sea

Dead	Live
M. - 00 C. 01 RV. 00 LV. = 1 I.	00

Caernarvon Bay

Dead	Live
M. - 00 C. 00 RV. 01 LV. = 1 I.	00

Malin Sea

Dead	Live
F. - 12 C. 49 RV. 48 LV. M. - 04 C. 44 RV. 29 LV. = 138 I. J.? - 00 C. 00 RV. 01 LV.	00

Sample Distribution

Southern Irish Sea
910

Caernarvon Bay
2389

Malin Sea
3012 3041 3042 3090 3101 3103 3135 3142 3143 3145
3147 3161 3162

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	11 .	41A/42	0.450	0.268
		"	29 .	4/4A		
		"	29 .	6/6A		
		"	29 .	5/5A		
	LV.	"	11 .	42A	0.445	0.265
M.	RV.	"	11 .	40A/41	0.487	0.245
	LV.	"	11 .	39A/40	0.485	0.251
J.?	LV.	"	11 .	1	0.284	0.172

The specimens are from sample 3143 (146.3 m, fine sand + silt), Malin Sea.

Description

Seen laterally, female R.V. oblong, rhomboidal. Height equal to more than half the length. Anterior margin rounded antero-ventrally, antero-dorsally convex; extremity just above mid height. Posterior margin obliquely rounded postero-ventrally, convex postero-dorsally; extremity well above mid height. Dorsal margin straight, cardinal angles distinct. Ventral margin almost straight and embraced by the lateral surface. Greatest height at anterior cardinal angle. Dorsal and ventral margins nearly parallel. From above subhexagonal, greatest width in the postero-median region, equal to more than half the length and tapering to make pointed extremities.

Shell thick opaque and entirely marked by closely set fossae. The majority of which are rounded, more rarely subangular and orientated in lines subparallel to the dorsal margin; longitudinal murae are often developed into ridges that partially close adjoining pits. Ventro-laterally expanded into a subdued ala by the convergence of two longitudinal ridges. A prominent antero-marginal ridge. Eye spots indistinct, small, rounded and situated behind and below the anterior cardinal angle. Normal pores small, round, open, 12-20 in number and situated upon the longitudinal ridges.

Inner lamella moderately wide, widest anteriorly and postero-ventrally and having narrow vestibulae. Radial pore canals simple and straight, 8-10 anteriorly with rather less posteriorly.

Hinge gongylodont. Anterior terminal element an arcuate socket enclosing a small but well developed round tooth. Median element a straight and finely locellate groove. Posterior terminal element is a large crescentic tooth with 5 cusps and enclosing a small socket. Complementary structures in the left valve.

Adductor muscle scars an arcuate line of 4 elongate oval scars. Anterior to which is a 'U' shaped frontal scar that opens antero-dorsally. Antero-ventrally 2 small round mandibular scars.

Ontogeny

A single juvenile instar is provisionally recognised. The dimensions of adults from several samples in the Malin Sea are given as follows.

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.390-0.480	0.250-0.300	38	
	Mean	0.430	0.263		1.63
M.	Range	0.450-0.520	0.240-0.280	38	
	Mean	0.484	0.265		1.83

Sexual dimorphism is marked. The male is larger and proportionately longer than the female. In addition, females tend to be more massively calcified.

The juvenile has a narrow inner lamella, weak gongylodont hinge and a surface ornamentation of coarse pitting.

Remarks

This species is similar in shape to *L. multifora* (Brady) though is much larger than the Brady species. *Loxoconcha* sp., herein, is also somewhat similar in shape to *L. littoralis* G.W. Müller. However, the last species is a well documented Mediterranean form and easily distinguished by its proportionately longer and weakly calcified shell.

Study Area Ecology

Live specimens were not recovered.

Solitary adult instars were recovered from sample 910, 25.6 m, mixed sand, southern Irish Sea and in sample 2389, 20.1 m, mixed sand, Caernarvon Bay.

Most material occurred in the Malin Sea, 47.6-512.1 m, mean 130.5 m, in coarse sand + gravel, mixed sand and fine sand with silt. Its abundance was restricted to the outer shelf, 55-146.3 m, with adult assemblages found in fine sand and silts of samples 3143 (146.3 m), 3161 (128 m) and 3162 (140.8 m).

Genus Bonnyannella Athersuch, 1982

Bonnyannella robertsoni (Brady), 1868

pl. 33 figs. g-l

1868 Cythere robertsoni n.sp. Brady: p. 33, pl. IV, figs. 5, 8-10.

1874 Cythere robertsoni Brady; Brady, Crosskey and Robertson : p. 221.

1889 Cythere robertsoni Brady; Brady and Norman: p. 139, pl. XIV, figs. 32-33.

1969 Loxoconcha? robertsoni (Brady); Wall (ms.): p. 311, pl. 7, figs. a-f; pl. 40, figs. g-l.

1969 Cytheromorpha robertsoni (Brady); Yassini: p. 111, pl. XVIII, XIX.

1972 ?Cytheromorpha robertsoni (Brady); Whittaker (ms.): p. 214, pl. 38, figs. 6-10.

1976 Cytheromorpha robertsoni (Brady); Hoskin (ms.): p. 283, pl. 23, figs. 9-10.

1977 Cytheromorpha robertsoni (Brady); Rosenfeld: p. 14, pl. 1, figs. 9-11.

1982 Bonnyannella robertsoni (Brady); Athersuch: 9 (14): pls. 77-84.

Material

Total Dead: F. - 61 C. 53 RV. 44 LV.; M. - 44 C. 52 RV. 62 LV.; J. - 8 C. 193 RV. 185 LV. = 607 I.

Live: F. - 44, M. - 27.

Southern Irish Sea

Dead					Live	
F. - 29 C.	22 RV.	14 LV.			18	
M. - 28 C.	29 RV.	29 LV.	= 260 I.		15	= 32 I.
J. - 04 C.	90 RV.	81 LV.			00	

Caernarvon Bay

Dead				Live	
F. - 28 C.	20 RV.	16 LV.		26	
M. - 09 C.	17 RV.	17 LV.	= 285 I.	12	= 38 I.
J. - 04 C.	87 RV.	94 LV.		00	

Malin Sea

Dead				Live
F. - 04 C.	9 RV.	14 LV.		00
M. - 07 C.	6 RV.	16 LV.	= 62 I.	
J. - 00 C.	14 RV.	10 RV.		

<u>Sample Distribution</u> (live occurrence is underlined)

Southern Irish Sea

801	803	804	815	827	843	868	910	912	<u>917</u>	925	<u>2347</u>
<u>2354</u>	2359	2360	2361	2365	2369	2370	2372	2375	2378		
2381	<u>2764</u>	<u>2765</u>	<u>2780</u>	2783	<u>2812</u>	2815	2819	2821	2822		
<u>2824</u>	<u>2904</u>	2905	2915	2916	2917						

Caernarvon Bay

2385	2388	2392	2393	2395	2398	<u>2399</u>	2401	2403	2404
<u>2406</u>	2407	<u>2419</u>	2420	<u>2421</u>	2422	2424	2431	2442	2443
2444	2445	2447	2449	2456	2457	2463	<u>2467</u>	2508	2511
2512	2515	2516	2518	2519	2521	2637	<u>2638</u>	2639	2640
2641	2647	2773	2776	<u>2827</u>	<u>2829</u>	2830	2831	<u>2839</u>	2844
2896	<u>2923</u>	<u>2926</u>	HHI	HHII					

Malin Sea

3012 3099 3101 3103

<u>Figured Specimens</u>

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	12 .	27/27A	0.442	0.261
	LV.	"	12 .	28/28A	0.447	0.258
M.	RV.	"	12 .	26/26A	0.441	0.245
	LV.	"	12 .	25/25A	0.410	0.241
-1.	RV.	"	12 .	29/29A	0.382	0.208
	LV.	"	12 .	30/30A	0.398	0.211

The specimens are from sample 2365 (40 m, mixed sand), southern Irish Sea.

<u>Description</u>

See: Wall (ms. 1969, p. 312-318, pl. 7) for a description of the hard and soft parts and an illustration of the latter. Whittaker (ms. 1972, pl. 38, figs. 6-10) and Athersuch (1982, pl. 77-84) illustrate the carapace morphology.

Ontogeny

Juveniles from the -1 to -3 growth stage are recognised. The dimensions of adults and juveniles from several samples in the study material are given below.

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.420-0.470	0.240-0.270	22	
	Mean	0.456	0.258		1.77
M.	Range	0.400-0.455	0.230-0.250	16	
	Mean	0.429	0.240		1.79
-1.	Range	0.370-0.410	0.200-0.230	30	
	Mean	0.389	0.216		1.80
-2.	Range	0.310-0.330	0.180-0.190	18	
	Mean	0.321	0.183		1.75
-3.	Range	0.270-0.300	0.165-0.180	3	
	Mean	0.287	0.170		1.69

Sexual dimorphism is slight, males are mostly smaller and much less inflated posteriorly than females.

Remarks

The taxonomic affinity of this species is uncertain. Several authors include *B. robertsoni* in the genus *Cytheromorpha* Hirschmann. Whittaker (ms. 1972, p. 214) agreed that these affinities are represented in both hard and soft parts. The last author did, however, recognise that the distinct sexual dimorphism exhibited by most species of *Cytheromorpha* was not characteristic of *B. robertsoni*. Further, Wall (ms. 1969) considered from dissection of the animal that there were no discernable differences in the hard or soft parts to exclude this species as member of the genus *Laxoconcha*. However, Athersuch (1982) does distinguish this species by its appendages from others belonging to *Loxoconcha* Sars and *Cytheromorpha*. He places it in the new genus *Bonnyannella*.

Study Area Ecology

Live specimens were distributed northward of Dublin Bay, southern Irish Sea, between 14-80 m, in coarse sand + gravel, mixed sand, and fine sand with silt. It was also found alive in Caernarvon Bay, 7-58 m, in coarse sand with gravel and mixed sand.

Otherwise, material was found generally in the southern Irish Sea, 11-137.5 m, mostly 11-97 m, mean 41.6 m, in coarse sand + gravel to silt with clay; distributed throughout Caernarvon Bay from the intertidal of Holyhead Harbour down to 153.7 m, mostly 7-65.8 m, mean 58.4 m in coarse sand with gravel and mixed sand. A limited number of individuals were found in Malin Sea between 47-91 m, mean 67.7 m, in the above sediments.

Adult assemblages occurred in samples 2359 (77 m, fine sand + silt), 2365 (40 m, mixed sand), 2375 (23.5 m, fine sand + silt) and a juvenile assemblage was found in sample 2905 (87.8 m, mixed sand + silt), southern Irish Sea. A population of adults and juveniles was recovered from the intertidal of Holyhead Harbour and in sample 2839 (44 m, mixed sand). Adult assemblages occurred in samples 2422 (23.8 m) and 2830 (13.0 m) in mixed sand, Caernarvon Bay. Most material in the Malin Sea was recovered in sample 3101 (55 m, fine sand + silt).

Palaeoecology and Distribution

This is a rare species in Scandinavian waters. Live material is recorded in Kiel Bay, W. Baltic, in 20-40 m and 25-30‰ salinity (Rosenfeld, 1977). It extends to the Skagerrak, 55-68 m (Brady, 1868; Brady and Norman, 1889), S.W. Norway, 18-220 m and north to Hardanger Fiord, 230 m (Brady and Norman, 1889; Norman, 1891).

Scott (1891) found specimens in 22 m from the Orkneys. It occurs in the Forth Estuary (Brady and Robertson, 1872), off Montrose (Fullerton and Scott, 1889) and is present in greater numbers on gravel sands from the intertidal to 70 m+ off N.E. England (Brady, 1869, 1870; Brady and Robertson, 1870, 1874; Brady and Norman, 1889; Norman and Brady, 1909). Brady and Robertson (1872) also record B. robertsoni from Dogger, North Sea, Norfolk coast and the Thames Estuary.

Rare specimens have been dredged in sand and mud, 18-150 m in the Minch (Harris, C.S., ms. 1977). It occurs in moderate numbers, 10-40 m from the Clyde (Brady and Robertson, 1872; Robertson, 1874) and off Antrim, N. Ireland (Norman, 1905). The species is also alive and abundant in the sub-littoral of many localities west of Ireland (Brady and Robertson, 1869; Brady and Norman, 1889; Norman, 1905; Hoskin, ms. 1976). These last authors found material in Dublin Bay, Belfast Lough and in many dredgings of the Irish Sea. Wall (ms. 1969) described it as commonly alive on coarse sand, silt and weedy cobbles, 18-25 m in Cardigan Bay, dead in the Teifi Estuary and in accord with Morgan (ms. 1977) he found only isolated individuals in the turbulent algal zone of W. Wales. Material is rarely recovered further south, either in the Celtic Sea, 54-100 m (Brady and Robertson, 1872; Neale, 1974) or from shallow areas of N. and S. Devon, Cornwall and the Scillies (Norman and Scott, 1906; Neale, 1970, 1974).

A solitary live specimen was found in algae from 10 m in Weymouth Bay, Dorset (Whittaker, ms. 1972) and B. robertsoni is perhaps present around the Channel Isles (Norman, 1907, 1908). Yassini (1969) indicates its occurrence in a sample from 30 m in Biscay and the distribution extends to N.W. Spain. Within which region, rare and poorly preserved material has been dredged in fine and shelly sand down to 155 m (Ralph, ms. 1977).

A few specimens occur in the Holocene of Tremadoc Bay (Spencer, ms. 1976); Late Glacial of S.W. Norway (Brady et.al., 1874) and Forth (Brady, 1891); Last interglacial, Ipswichian, of Sussex (Whatley and Kaye, 1971) and Upper Pliocene of Brittany (Harrison, verb. comm. 1975).

Summary

Bonnyannella robertsoni is found alive in small numbers in S.W. Norway, Skagerrak and W. Baltic and occurs throughout British and adjacent waters, 50-60^{O}N. Recent material is most common in N. Britain and W. of Ireland and rare elsewhere. There is a single record of reworked specimens in the Biscay and off N.W. Spain, 42^{O}N. It ranges to the Holocene of the Southern Irish Sea, 53^{O}N, Late Glacial of Norway and Forth, 56-60^{O}N, Ipswichian of Sussex, 50^{O}N and may occur in the Upper Pliocene of Brittany, 48-50^{O}N.

It is alive mostly in 18-40 m and ranges generally between the intertidal and 70 m. Reworked material is found down to 230 m west of Norway and in 150 m+ off western Scotland and Spain. The species is primarily associated with weedy cobble and gravel sand, or silt and mud in deeper waters. The salinity tolerance is 25/30‰+ in 1/2-20^{O}C approx.

Genus *Cytheromorpha* Hirschmann, 1909

?*Cytheromorpha* sp.

pl. 20 figs. a-f

Material

Caernarvon Bay + Total

Dead					Live
Adult	01 C.	00 RV.	00 LV.	= 1 I.	00

Sample Distribution

Caernarvon Bay
2423

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
Adult	RV.	external	6	22A/23	0.220	0.114
		internal	33	9/9A		
		"	31	40/40A		
		"	31	-		
	LV.	external	6	24A/25	0.218	0.111

Remarks

The taxonomic affinity of this specimen is uncertain. Its minute size, coincident line of concrescence and sieve type normal pore canals are features of *Microcytherura*, though it lacks the distinctive polygonal ornamentation of this genus. The carapace shape and modified gongylodont hinge are aspects characteristic of the *Loxoconchidae* Sars, and in particular with the genera *Cytheromorpha* and *Pteroloxa* Swain (1963, p. 820-821). Until more material becomes available it is provisionally referred to the genus *Cytheromorpha*.

Study Area Ecology

Live material was not recovered.

An individual carapace occurred in 64 m, coarse sand + gravel, Caernarvon Bay.

Genus Elofsonia Wagner, 1957

Elofsonia baltica (Hirschmann), 1909

pl. 34 figs. i-j

1869 Cythere gibbosa n.sp. Brady and Robertson: p. 367, pl. XXI, figs. 1-3.

1874 Cythere gibbosa Brady and Robertson; Brady, Crosskey and Robertson: p. 150, pl. XVI, figs. 16-18.

1889 Cythere gibbosa Brady and Robertson; Brady and Norman: p. 136, pl. XIV, figs. 30, 31.

1909 Loxoconcha baltica n.sp. Hirschmann; p. 294, figs. 11, 12.

1941 Loxoconcha baltica Hirschmann; Elofson: p. 330, figs. 20, 21.

1957 Elofsonia baltica (Hirschmann); Wagner: p. 72, pl. XXXI.

1966 Elofsonia baltica (Hirschmann); Theisen: p. 239.

1969 Elofsonia baltica (Hirschmann); Wall (ms.): p. 337, pl. 41, fig. C.

1972 Elofsonia baltica (Hirschmann); Whittaker (ms.): p. 219, pl. 39, figs. 1-12; pl. 40, figs. 1-9.

1973 Elofsonia baltica (Hirschmann); Whittaker: 1:37: pls. 193-200.

1976 Elofsonia baltica (Hirschmann); Hoskin (ms.): p. 283, pl. 23, fig. 11.

1977 Elofsonia baltica (Hirschmann); Rosenfeld: p. 28, pl. 7, figs. 84-85.

Material

Southern Irish Sea + Total

Dead					Live
F. - 00 C.	01 RV.	00 LV.	=	2 I.	00
J. - 00 C.	00 RV.	01 LV.			

Sample Distribution

Southern Irish Sea

2819

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	18	. 25/25A	0.412	0.248
J.	LV. "	18	. 26/26A	0.278	0.159

Description

See: Wall (ms. 1969, p. 337-338) for a description of the carapace morphology. The hard and soft parts are illustrated and diagnosed by Whittaker (ms. 1972, p. 217-219, pls. 39, 40; 1973, pls. 193-200).

Ontogeny

A single juvenile was recognised and is ascribed as an antepenultimate instar of this species. The ecology and ontogeny of E. baltica is described in detail by Theisen (1966, p. 239-245).

Remarks

See: Wall (ms. 1969, p. 335-336) and Whittaker (ms. 1972, p. 217-219, 221-222).

Study Area Ecology

A single adult and juvenile instar were recovered from 54.9 m, silt with clay, southern Irish Sea.

Palaeoecology and Distribution

The species is best documented in S. Scandinavia though ranges perhaps throughout W. Norway to Finmark.
In the Skagerrak it seems primarily associated with Fucus, Potamogeton (planktonic algae) and algal debris covered gravel or silts (Elofson, 1941). The last author found it mostly within 3.5 m in 0.5-18‰ salinity and within these conditions E. baltica extends alive and in abundance to Kattegat and Oresund, 18-24°C (Schafer, 1953; Hagerman, 1965; Theisen, 1966). Theisen (1966) also indicated that the species can tolerate 3-30‰ salinity in 3/5°C+ in the laboratory. It is recorded in brackish areas of S. Sweden (Elofson, 1943); 8-13 m and 12-19°C on silts of Kiel Bay (Klie, 1929; Rosenfeld, 1977) and is alive and widespread in the W. Baltic and Gulf of Finland (Hirschmann, 1909, 1912; Schafer, 1953; Remane, 1958; Hagerman, 1965, 1967). In which region,most material occurs within 8 m on diatom rich sand, algal debris and intertidal algae.

Wagner (1957, 1960) indicates that the species is alive in 1‰+ salinity in the Netherlands, within which area it may also tolerate 31.7‰ salinity (Den Dulk, 1953). Material has been dredged from Dogger, North Sea and is found alive in isolated marsh areas of the Forth, Tweed, Northumberland and Durham and perhaps rarely in the Thames (Brady and Robertson, 1872; Brady and Norman, 1889; Norman and Brady, 1909).

It is moderately common and alive in tufted high-marsh algae of N. Uist, Western Isles (Pearce, ms. 1977) and is found occasionally in areas with a fresh water influence, 16-22 m approx, in the Clyde (Brady and Robertson, 1872; Robertson, 1874; Brady and Norman, 1889). Wall (ms. 1969) found a single live specimen in the Teifi Estuary, Cardigan Bay 15% salinity, and it has been dredged from Belfast Lough and down to 100 m+ from the Celtic Sea (Brady and Robertson, 1872; Brady and Norman, 1889; Lomax, ms. 1978). The species is also found alive in Laminaria and Zostera of tidepools in Mulroy Lough, N. Ireland, and inshore of Roundstone and Westport Bays, W. Ireland (Brady and Robertson, 1872; Brady and Norman, 1889).

Whittaker (ms. 1972) found it to be a common live species on filamentous green algae, Vaucheria and Enteromorpha and fine silty sands, 2-26^{o}C, in 20-40‰ salinity of Christchurch Harbour and Fleet, Dorset. Whittaker (1973) also comments upon live material in Arcachon Basin, Biscay and there is a solitary record of it in Vigo Bay, N.W. Spain (Ralph, ms. 1977).

Reports, as C. gibbosa, from deep water off Cape Frazer, W. Greenland, in Brady (1878) and Brady and Norman (1889) are probably referable to another species.

Lastly, a few specimens occur in the Holocene of Tremadoc Bay, southern Irish Sea (Spencer, ms. 1976) and Netherlands (Wagner, 1957). Material is also recorded in moderate abundance from the Late Glacial of Portrush, N. Ireland (Brady et.al., 1874) and the Clyde, W. Scotland (Robertson, 1877; Anderson, 1948); with an abundance of E. baltica in the last interglacial, Ipswichian, of Sussex (Whatley and Kaye, 1971) and Somerset (Kidson et.al., 1978).

Summary

This is an eastern N. Atlantic Species. Found commonly in Scandinavia, from the Skagerrak to the Gulf of Finland, 54-60°N and ranging therein alive northward to Finmark, 70°N. It is locally common in the estuarine of Britain and adjacent waters though is best documented from Scotland. Rare live material is also known in Biscay, 45°N. It occurs in the Holocene of the Netherlands and southern Irish Sea, 50-54°N and is recorded in moderate numbers in the Late Glacial of N.E. Ireland and W. Scotland, 56-58°N. *E. baltica* is also common in the Last interglacial of Sussex and Somerset, 50-52°N.

This is a brackish and estuarine species, found alive mostly within 3.5 m in the Skagerrak, often down to 13 m in the Baltic and within 22 m throughout N. Britain. *E. baltica* is associated with *Zostera*, tufted and planktonic algae in intertidal marshes and occurs in laminarian algae and on algal debris, fine sand or mud of the sublittoral. Rare reworked material has been found down to 100 m in the southern Irish Sea. It occurs wherever there is a freshwater influence, between 1-40‰, more usually in 3-30‰ salinity and 2-26°C.

Elofsonia pusilla (Brady and Robertson) 1870

pl. 34 fig. k-p

1870 Loxoconcha pusilla n.sp. Brady and Robertson: p. 23, pl. VIII, figs. 1-3.

1889 Loxoconcha pusilla Brady and Robertson; Brady and Norman: p. 186, pl. XVII, figs. 24-25.

1937 Loxoconcha pusilla Brady and Robertson; Klie: p. 47, figs. 5-11.

1938 Loxoconcha pusilla Brady and Robertson; Klie: p. 207, t.figs. 708-713.

1941 Loxoconcha pusilla Brady and Robertson; Elofson: p. 330.

1957 Loxoconcha pusilla Brady and Robertson; de Vos: p. 45, pl. XVIII, fig. 2a; pl. XIX, figs. 2a-d.

1957 Elofsonia pusilla (Brady and Robertson); Wagner: p. 73, pl. XXXII.

1969 Elofsonia pusilla (Brady and Robertson); Wall (ms.): p. 339, pl. 41, figs. a, b, d, e.

1969 Elofsonia pusilla (Brady and Robertson); Yassini: p. 110, pl. VIII, XIII, XV.

1972 Elofsonia pusilla (Brady and Robertson); Whittaker (ms.): p. 224, pl. 41, figs. 1-7.

1973 Elofsonia pusilla (Brady and Robertson); Whittaker: 1:38: pls. 201-204.

1976 Elofsonia pusilla (Brady and Robertson); Hoskin (ms.): p. 283, pl. 23, fig. 12.

Material

Total: F. - 5 RV. 2 LV.; M. - 5 RV. 2 LV.; J. - 4 RV. 2 LV. = 17 I.

Southern Irish Sea

Dead				Live
M. - 00 C.	00 RV.	01 LV.	= 2 I.	00
J. - 00 C.	01 RV.	00 LV.		

Caernarvon Bay

Dead				Live
F. - 00 C.	04 RV.	01 LV.		00
M. - 00 C.	05 RV.	00 LV.	= 11 I.	
J. - 00 C.	02 RV.	02 LV.		

Malin Sea

Dead				Live
F. - 00 C.	01 RV.	01 LV.		00
M. - 00 C.	00 RV.	01 LV.	= 4 I.	
J. - 00 C.	01 RV.	00 LV.		

Sample Distribution

Southern Irish Sea

2915

Caernarvon Bay

2830 2839 HHI HHII

Malin Sea

3101

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	18 .	22/22A	0.432	0.229
	LV.	"	18 .	21/21A	0.424	0.224
M.	RV.	"	18 .	20/20A	0.421	0.213
	LV.	"	18 .	19/19A	0.412	0.205
-1.	RV.	"	18 .	24/24A	0.363	0.200
	LV.	"	18 .	23/23A	0.378	0.195

Female instars and male right valves - sample 2830 (13 m, mixed sand); juvenile left valve - sample HHII (0.5 m, algae), Caernarvon Bay. Male left valve - sample 2915 (33 m, silt + clay), southern Irish Sea.

Description

See: Wall (ms. 1969, p. 339-340) for a description of the carapace morphology. Whittaker (ms. 1972, pl. 41; 1973, pls. 201-204) illustrates the hard parts and de Vos (1957, pl. XVIII, fig. 2a; pl. XIX, fig. 2a-d) figures the soft parts.

Ontogeny

Instars of the penultimate growth stage were recognised. The dimensions of adults and juveniles in the study material are given af follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.420-0.440	0.200-0.240	6	
	Mean	0.432	0.225		1.92
M.	Range	0.410-0.430	0.200-0.225	6	
	Mean	0.425	0.212		2.01
-1.	Range	0.360-0.385	0.190-0.205	6	
	Mean	0.378	0.195		1.94

Sexual dimorphism is slight, males tend to be smaller and are proportionately longer than females.

See: Wall (ms. 1969, p. 340-341)

Remarks

See: Wall (ms. 1969, p. 338).

Study Area Ecology

Live material was not recovered.

In the southern Irish Sea material occurred in 33 m, silt + clay. It ccurred in the intertidal of Holyhead Harbour and in 44 m, mixed sand, Caernarvon Bay. Isolated specimens also occurred in fine sand with silt, 55 m, Malin Sea.

Palaeoecology and Distribution

This is a rare species that is found alive most commonly in S. Scandinavia. Wherein,it inhabits fresh and brackish water sands in the top few centimeters of the Skagerrak intertidal zone (Elofson, 1941). E. pusilla extends in the intertidal to Jutland and Denmark (Whittaker, 1973), Kattegat (Schafer, 1953), Oresund (Hagerman, 1965), Kiel Bay (Klie, 1929, 1938), south

Sweden, 5-7 m (Elofson, 1943) and Gulf of Finland (Hagerman, 1967).

In E. Britain it has been found in moderate numbers near Montrose and in the Forth Estuary, off Northumberland and Durham, Norfolk rarely, and in the Thames Estuary (Brady and Robertson, 1872; Brady and Norman, 1889; Norman and Brady, 1909). Material has been dredged from Dogger, North Sea (Brady and Robertson, 1872) and occurs commonly in estuarine muds and sand within 4 m of the Netherlands (Brady and Robertson, 1870, 1872; Brady and Norman, 1889; Wagner, 1960).

Recent material has been recovered from dense tufted weeds of the high marsh in N. Uist, Western Isles (Pearce, ms. 1977). Alive on intertidal mud flats, 0-6 m, near freshwater streams of the Clyde (Brady and Robertson, 1872; Robertson, 1874; Brady and Norman, 1889) and from similar areas of N.E. Ireland and Westport, W. Ireland (Norman, 1905). This is a dominant live species in Zostera and fine silty sand from the upper estuarine of S.W. Ireland, though E. pusilla is rarely reworked into the marine of Brandon and Tralee Bays (Hoskin, ms. 1976). Brady and Norman (1889) and Norman (1905) indicate that rare material has been dredged down to 90 m in the Irish Sea. It is probably not alive in the latter region and Wall (ms. 1969) comments that the specimens found in Cardigan Bay may be derived from the sub-Recent.

Rare live specimens are associated with fine sands in 5-21°C and 32‰ salinity of the Fleet, Dorset (Whittaker, ms. 1972). It occurs alive in Roscoff Harbour, Brittany (de Vos, 1957) and material is locally abundant, 0-10 m, on sands in 24-32‰ salinity and 6-27°C of Arcachon Basin, Biscay

(Yassini, 1969).

As a fossil it is, as yet, recorded only from the sub-Recent of Tremadoc Bay, Irish Sea (Wall and Whatley, 1971); Holocene of the Netherlands (Wagner, 1957, 1960) and occurs rarely in the Last interglacial, Ipswichian, of Sussex (Whatley and Kaye, 1971).

Summary

This rare species is only reliably recorded in N.W. Europe. It is best documented alive in S. Scandinavia, Skagerrak to the Gulf of Finland, and is common in the estuarine of N. Britain, W. Ireland and the Netherlands. It also ranges alive in reduced numbers to the English Chennel and Biscay, 45-60°N. Recorded in the sub-Recent and Holocene of the Netherlands and is reworked into deep waters of the southern Irish and North Seas, 52-56°N. Lastly, there is a record of it in the Last interglacial of Sussex, 50°N.

The species inhabits intertidal *Zostera*, high marsh algae and estuarine sands and muds, 0-10 m. It is also reworked into the open marine environment, down to 90 m+. The salinity tolerance is 0.5-32‰ in areas with a fluctuating fresh water influence. *E. pusilla* has a temperature range of at least 0-27°C.

Genus *Hirschmannia* Elofsen, 1941

Hirschmannia viridis (O.F. Müller), 1785

pl. 35 figs. a-f

1785 *Cythere viridis* n.sp. O.F. Müller: p. 64, pl. VII, figs. 1-2.

1866 *Cythere viridis* O.F. Müller; Sars: p. 30-31.

1868 *Cythere viridis* O.F. Müller; Brady: p. 397, pl. XXVIII, figs. 40-41, 57-59; pl. XXXVIII, fig. 8.

1874 *Cythere viridis* O.F. Müller; Brady, Crosskey and Robertson: p. 147, pl. III, figs. 26-28.

1889 *Cythere lutea* O.F. Müller (pars); Brady and Norman: p. 125.

1905 *Cythere cyamos* n.sp. Norman: p. 144.

1912 *Loxoconcha sarsi* n.sp. Hirschmann: p. 22, pl. II, figs. 20-25.

1928 *Cythere viridis* O.F. Müller; Sars: p. 170, pl. LXXVIII, fig. 2.

1938 *Cythere viridis* O.F. Müller; Klie: p. 163, t. figs. 540-543.

1941 *Hirschmannia viridis* (O.F. Müller); Elofson: p. 332.

1957 *Hirschmannia viridis* (O.F. Müller); de Vos: p. 46, pl. XVIII, figs. 3a; pl. XIX, figs. 3a-d.

1957 *Hirschmannia viridis* (O.F. Müller); Wagner: p. 68, pl. XXIX.

1969 *Hirschmannia viridis* (O.F. Müller); Wall (ms.): p. 325, pl. 8, figs. a-i; pl. 41, figs. g-m, o-p.

1969 *Hirschmannia viridis* (O.F. Müller); Hagerman: p. 79-98.

1969 *Hirschmannia viridis* (O.F. Müller); Yassini: p. 113, pl. XXI, XXIII.

1972 *Hirschmannia viridis* (O.F. Müller); Whittaker (ms.): p. 229, pl. 42, figs. 1-13.

1975 *Hirschmannia viridis* (O.F. Müller); Whittaker: 2(24) pls. 149-156.

1976 *Hirschmannia viridis* (O.F. Müller); Hoskin (ms.): p.283, pl. 23, figs. 7, 8.

1977 *Hirschmannia viridis* (O.F. Müller); Rosenfeld: p. 29, pl. 7, figs. 90-91, t. fig. 13.

1977 *Hirschmannia viridis* (O.F. Müller); Skaumal: p. 77, pl. 2, figs. 1-3.

Material

Total Dead: F. - 10 RV. 7 LV.; M. - 1 C. 4 RV. 3 LV.; J. - 3 C. 107 RV. 108 LV. = 173 I.

Live: 2 J.

Southern Irish Sea

Dead				Live	
F. - 00 C.	06 RV.	02 LV.		00	
M. - 00 C.	03 RV.	03 LV.	= 96 I.	00	= 1 I.
J. - 03 C.	61 RV.	61 LV.		01	

Caernarvon Bay

Dead				Live
F. - 00 C.	04 RV.	05 LV.		00
M. - 01 C.	01 RV.	00 LV.	= 48 I.	
J. - 02 C.	26 RV.	31 LV.		

Malin Sea

Dead				Live
J. - 00 C.	20 RV.	16 LV.	= 29 I.	01

Sample Distribution (live occurrence is underlined)

Southern Irish Sea

804 873 2354 2359 2361 2365 2369 2370 2375 2378 2381
<u>2765</u> 2780 2810 2812 2813 2819 2854 2904 2905 2915

Caernarvon Bay

2395 2398 2399 2422 2443 2447 <u>2637</u> 2830 2839 HHI HHII

Malin Sea

3101

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	26	. 37/37A	0.460	0.294
	LV. "	14	. 13A/14	0.457	0.289
M.	RV. "	14	. 12A/13	0.452	0.268
	LV. "	26	. 36/36A	0.457	0.271

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
-2.	RV. external	15	. 16/16A	0.309	0.225
-3.	LV. "	15	. 17/17A	0.278	0.194

Female valves - sample 2839 (44 m, mixed sand), juveniles - intertidal of Holyhead Harbour, Caernarvon Bay. Male valves - sample 2904 (80.5 m, mixed sand + silt), southern Irish Sea.

Description

See: Wall (ms. 1969, p. 326-332, pl. 8) for a description of the hard and soft parts and an illustration of the latter. The carapace morphology is well illustrated by Whittaker (ms. 1972, pl. 42; 1975, pls. 149-156).

Ontogeny

Instars of the penultimate to -3 growth stage were recognised. The dimensions of juveniles and adults throughout the study material are given as follows.

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.445-0.480	0.285-0.310	12	
	Mean	0.461	0.300		1.54
M.	Range	0.435-0.470	0.260-0.285	9	
	Mean	0.452	0.272		1.66
-1.	Range	0.370-0.400	0.250-0.260	5	
	Mean	0.388	0.256		1.52
-2.	Range	0.300-0.340	0.210-0.240	18	
	Mean	0.322	0.228		1.41
-3.	Range	0.270-0.280	0.190-0.200	2	
	Mean	0.275	0.195		1.41

Sexual dimorphism was pronounced. Males are proportionately more elongate and less inflated posteriorly than females.

Remarks

See: Wall (ms. 1969, p. 333) and Whittaker (ms. 1972, p. 227-229, 231-232).

Study Area Ecology

Two live individuals were recovered. Recorded from sample 2765, (37 m) mixed sand, southern Irish Sea; sample 2637 (40 m) coarse sand with gravel, Caernarvon Bay.

Otherwise, in the S. Irish Sea material was distributed generally northward of Dublin Bay, 2.7-97 m, mean 37.2 m, in coarse sand + gravel to silt with clay. Most specimens were recovered between 16-87.8 m in mixed sand, fine sand with silt and silt with clay.

It also ranged from the intertidal of Holyhead Harbour down to 109.7 m, mean 33.5 m, in coarse sand with gravel, mixed sand, and algal debris, Caernarvon Bay. Most material occurred within 44 m in mixed sand and algal debris.

Juvenile assemblages were found in sample 2915 (33 m, silt with clay), southern Irish Sea; intertidal of Holyhead Harbour and in sample 3101 (55 m, fine sand with silt), S.E. of Islay, Malin Sea.

Palaeoecology and Distribution

There is an isolated report of this species, as *C. lutea* O.F. Müller, in Brady and Norman (1889) from the St. Lawrence, Davis St. and several localities W. of Greenland.

However, *H. viridis* occurs with greater certainty around Iceland (Brady and Norman, 1889; Stephensen, 1938), E. Finmark (Brady and Norman, 1889; Derjugin, 1916; Elofson, 1941) and in abundance in *Corallina* and beneath on red and brown algae throughout W. Norway (Sars, 1890, 1928; Hagerman, 1968). The species is most abundant in sublittoral algae, 0-22^{o}C and 2/3‰+ salinity of the Skagerrak (Sars, 1928; Elofson, 1941) and Oresund (Hagerman, 1965). Live material is also known in sand, silt and Fucus, 4-20 m, 10-30‰ salinity of Kiel Bay (Klie, 1929, 1938; Rosenfeld, 1977) and Ostsee (Klie, 1929, 1938; Elofson, 1943; Schafer, 1953; Hagerman, 1966). It also ranges in high numbers to E. Sweden and on sand, algae and diatom rich ooze, 6-8 m, within the Gulf of Finland (Hirschmann, 1912, 1915; Klie, 1929, 1938; Schafer, 1953; Hagerman, 1967).

In the North Sea live material is common in bushy and Laminarian algae of the estuarine Heligoland and Netherlands (Brady and Robertson, 1870; Klie, 1929; Redeke and Dulk, 1940; Skaumal, 1977). Brady (1868) indicates that it occurs in the Shetlands and Orkneys and off E. Scotland. H. viridis is common in muddy rock pools and the estuarine intertidal of N.E. England (Brady, 1868, 1870; Brady and Robertson, 1872; Norman and Brady, 1909) and ranges in Recent sediments, 35 m+ offshore (Brady and Robertson, 1876). The species is also fairly common in the R. Humber and R. Ouse (Brady and Robertson, 1870) but is only rarely alive, 20-30‰ salinity, within 2 m on mud flats of the outer Thames Estuary (Brady, 1868; Brady and Robertson, 1870; Kilenyi, 1969).

Pearce (ms. 1977) indicates that it is commonly alive in high marsh algae of N. Uist, Western Isles. Material is also ubiquitous in muds and sand, mostly in 18-90 m of the Minches (Brady, 1868; C.S. Harris, ms. 1977). This is also one of the most abundant brackish ostracod species in the

Clyde Estuary, 0-55 m (Brady, 1868; Brady and Robertson, 1870; Robertson, 1875) and west of Ireland, 6-28 m (Brady, 1868; Brady and Robertson, 1869; Hoskin, ms. 1976). There are reports of it in Dundrum Harbour (Norman, 1905; Brady, 1909), in moderate abundance throughout the Irish Seas and in sub-littoral and tidepool Cladophora and algal holdfasts off W. Wales (Wall, ms. 1969; Morgan, ms. 1977). It is also common in the brackish areas of Barnstaple, N. Devon, the Scillies, Plymstock and Dartmouth, S. Devon (Norman and Scott, 1906; Neale, 1970). The species is rare, however, below the littoral of the Celtic Sea and Western Approaches (Lomax, ms. 1978).

H. viridis is abundantly alive in intertidal Zostera and sublittoral Cladophora and Fucus of Weymouth Bay and the Fleet. From which region, it inhabits 15-35‰ salinity in 2-22°C (Whittaker, ms. 1972). Records range to the Channel Isles (Brady, 1868; Norman, 1907, 1908); Roscoff Harbour, Brittany (de Vos, 1957) and the Gironde Estuary, 28-35‰ salinity (Carbonel, et.al., 1972; Carbonel and Jouanneau, 1975).

Whittaker (1975) indicates that the species does not extend to the Mediterranean.

H. viridis is widely distributed as a fossil. Sub-Recent and Holocene material is known in many areas of the North Sea (Diebel and Pietrzeniuk, 1970), Netherlands (Wagner, 1957, 1960) and upper Thames Estuary (Kilenyi, 1969). Contemporaneous material is rare in the Irish Sea (Wall and Whatley, 1971; Spencer, ms. 1976), Somerset (Haynes and Kidson, 1972) and Gironde Estuary (Carbonel et.al., 1975) and seldom found in 1450-2000 m+ in Biscay (Yassini, 1969). It is moderately common in certain Late Glacial localities of the

Clyde (Brady et.al., 1874; Robertson, 1885, 1887), S.W. Scotland (Anderson, 1948; Graham and Wilkinson, 1978; Peacock et.al., 1978) and N.E. Ireland (Brady et.al., 1874). Isolated specimens have also been recovered in the Late Devensian estuarine of S.W. Norway (Brady et.al., 1874), Cromerty, E. Scotland (Peacock et.al., 1980) and Biscay (Caralp et.al., 1970). Lastly, it occurs occasionally in the last inter-glacial of the southern Irish Sea (Jasin, ms. 1976), Somerset (Kidson et.al., 1978) and Sussex (Whatley and Kaye, 1971) and may range to the Upper Pliocene of Cornwall (Whatley, pers. comm. 1975).

<u>Summary</u>

It occurs in the Recent of the St. Lawrence, Davis St. and W. Greenland, 46-67°N; Iceland, 65°N and is found alive in abundance throughout Scandinavia, south of 70°N. The species is most common in the Skagerrak and Baltic, 54-60°N, and is locally abundant in British and adjacent waters, south to 45°N. Sub Recent and Holocene material is common in the North Sea and rare in the Irish Sea, Severn Estuary and Biscay, 44-54°N. It is common in the Late Glacial of Clyde and N.E. England and rare in more northern raised beaches of Scotland and S.W. Norway, 54-60°N. Lastly, it occurs in the Ipswichian of the southern Irish Sea, Somerset and Sussex, 50-54°N, and is reported in the Upper Pliocene of Cornwall.

This is an intertidal and sublittoral species, alive primarily in 2-20 m though recorded down to 55 m of certain estuaries. Found mostly associated with <u>Zostera</u>, Laminarian and bushy type algae, sands and algal ooze. <u>H. viridis</u> is reworked to 90 m+ in British waters and seldom extends between 1450-2000 m in Biscay. It tolerates a fluctuating salinity, 0.5-30/40% (Hagerman, 1969) and is mostly alive in 10-30‰. Hagerman (1969) indicates the temperature range is -1-32^{o}C, but most records evidence a tolerance within 2/3-22^{o}C.

Genus Lindisfarnia Horne and Kilenyi, 1982

Lindisfarnia laevata (Norman), 1865

pl. 33 figs. m-r; t.fig. 9

1865 Cythere laevata n.sp. Norman: p. 18, pl. 5, figs. 13-16.

1866 Loxoconcha longipes n.sp. Sars: p. 63.

1868 Loxoconcha tamarindus (Jones); Brady: p. 435, pl. XXV, figs. 45-48.

1874 Loxoconcha tamarindus (Jones); Brady, Crosskey and Robertson: p. 188, pl. VIII, figs. 8-11.

1877 Loxoconcha tamarindus (Jones); Fischer: p. 246.

NON 1884 Loxoconcha cuneiformis n.sp. Brady (ms.); Malcomson: p. 261, pl. XXV, figs. 1, 2 (male).

1889 Loxoconcha tamorindus (Jones); Brady and Norman: p. 186.

1928 Loxoconcha tamarindus (Jones; Sars: p. 221, pl. CII, fig. 2.

1938 Loxoconcha tamarindus (Jones); Klie: p. 202, t.figs. 691-693.

1941 Loxoconcha tamarindus (Jones); Elofson: p. 327.

1955? Loxoconcha tamarindus (Jones); Kruit: p. 487, pl. VI, figs. 6a-b.

1957 Hirschmannia tamarindus (Jones); Wagner: p. 69, pl. XXX.

1962 Loxoconcha tamarindus (Jones); Woszidlo: p. 84, pl. 5, fig. 18.

1969 Hirschmannia tamorindus (Jones); Yassini: p. 112, pl. XIII, XV, XVIII, XIX.

1969 Hirschmannia tamaridus (Jones); Wall (ms.): p. 319, pl. 40, figs. a-f.

1972 Loxoconcha tamarindus (Jones); Whittaker (ms.): p. 211, pl. 38, figs. 1-5.

1976 Hirschmannia tamarindus (Jones); Hoskin (ms.): p. 283, pl. 23, figs. 4-6.

1977 Hirschmannia tamarindus (Jones); Rosenfeld: p. 29, pl. 7, figs. 86-89, t.fig. 14.

1981 Lindisfarnia laevata (Norman); Horne and Kilenyi: pl.10 7-116.

Material

Total Dead: F. - 71 C. 129 RV. 97 LV.; M. - 36 C; 55 RV. 67 LV.; J. - 45 C. 276 RV. 333 LV. = 918 I.

Live: 5 F. 2 M. 19 J.

Southern Irish Sea

Dead				Live	
F. - 36 C.	56 RV.	37 LV.		05	
M. - 08 C.	19 RV.	22 LV.	= 380 I.	01	= 8 I.
J. - 21 C.	118 RV.	153 LV			

Caernarvon Bay

Dead				Live	
F. - 30 C.	37 RV.	37 LV.		00	
M. - 23 C.	21 RV.	22 LV.	= 360 I.	01	= 15 I.
J. - 24 C.	100 RV.	113 LV.		14	

Malin Sea

Dead				Live	
F. - 05 C.	76 RV.	23 LV.		00	
M. - 05 C.	15 RV.	23 LV.	= 178 I.	00	= 3 I.
J. - 00 C.	58 RV.	67 LV.		03	

Sample Distribution (live occurrence is underlined)

Southern Irish Sea

801 803 804 815 823 825 827 844 860 868 906 910 917
923 924 925 2354 2359 2360 2361 2365 2369 2370 2375
2381 2761 2764 2765 2780 2810 2819 2821 2822 2824
2825 <u>2904</u> 2905 2906 <u>2915</u> 2916 2918

Caernarvon Bay

2385	2387	2388	2389	2393	2395	2398	2399	2400	2403
2407	2419	2420	2421	2422	2423	2424	2427	2428	2432
2440	2442	2443	2444	2445	2447	2449	2457	2462	2463
2465	2467	2509	2510	2511	2512	2514	2515	2516	2519
2637	2638	2639	2640	2641	2642	2645	2647	2770	2771
2776	2829	2830	2831	2832	2834	2835	2838	2839	2891
2892	2893	2896	2921	2922	2923	2926	HHI	HHII	

Malin Sea

3012	3090	3099	3101	3103	3115	3130	3137	3140	3143
3153	3154	3157	3161	3162					

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	11	. 4A/5	0.532	0.304
	LV.	"	11	. 3A/4	0.529	0.308
M.	RV.	"	11	. 1A/2	0.538	0.285
	LV.	"	11	. 2A/3	0.538	0.282
J.	RV.	"	11	. 5A/6	0.411	0.257
	LV.	"	11	. 6A/7	0.457	0.256

Adults - sample 2375 (23.8 m, fine sand + silt), southern Irish Sea; juveniles - sample 3101 (55 m, fine sand + silt), Malin Sea.

Description

See: Horne and Kilenyi (1982, pl. 107-116) for an illustration of both hard and soft parts. Wall (ms. 1969, p. 321-327) describes the carapace morphology.

Ontogeny

Instars of the penultimate to -5 growth stage were recognised. The adults and juveniles of sample 2905 (87.8 m, mixed sand + silt), southern Irish Sea, were measured and the dimensions given as follows: (See fig. 9.)

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.500-0.570	0.290-0.340	24	
	Mean	0.543	0.308		1.76
M.	Range	0.520-0.550	0.280-0.300	9	
	Mean	0.541	0.289		1.87
-1.	Range	0.400-0.430	0.240-0.260	25	
	Mean	0.416	0.247		1.68
-2.	Range	0.290-0.340	0.180-0.220	36	
	Mean	0.320	0.198		1.61
-3.	Range	0.240-0.280	0.150-0.170	10	
	Mean	0.258	0.159		1.62
-4.	Range	0.190-0.210	0.120-0.130	7	
	Mean	0.194	0.127		1.53
-5.	Range	0.150-0.160	0.100-0.110	3	
	Mean	0.157	0.107		1.47

Sexual dimorphism is pronounced; the male being much more narrow and somewhat smaller than the female.

Remarks

Horne and Kilenyi (1982) distinguish this species upon soft parts from others belonging to the genus *Loxoconcha* Sars. The little known species *Loxoconcha cuneiformis* Malcomson is not synonymous and may be distinguished from *L. laevata* in being more posteriorly tapered, finely pitted and widest in front of mid-length.

Study Area Ecology

Live adults were recovered in sample 2904 (80.5 m, mixed sand + silt) and several live juveniles occurred in sample 2780 (14 m, coarse sand + gravel), southern Irish Sea. In Caernarvon Bay live juveniles ranged between the intertidal of Holyhead Harbour down to 109.7 m, mostly within 7 m in coarse sand with gravel and mixed sand. Live material occurred in samples 3099 (77 m, mixed sand) and 3140 (54.9 m, coarse sand and gravel), Malin Sea.

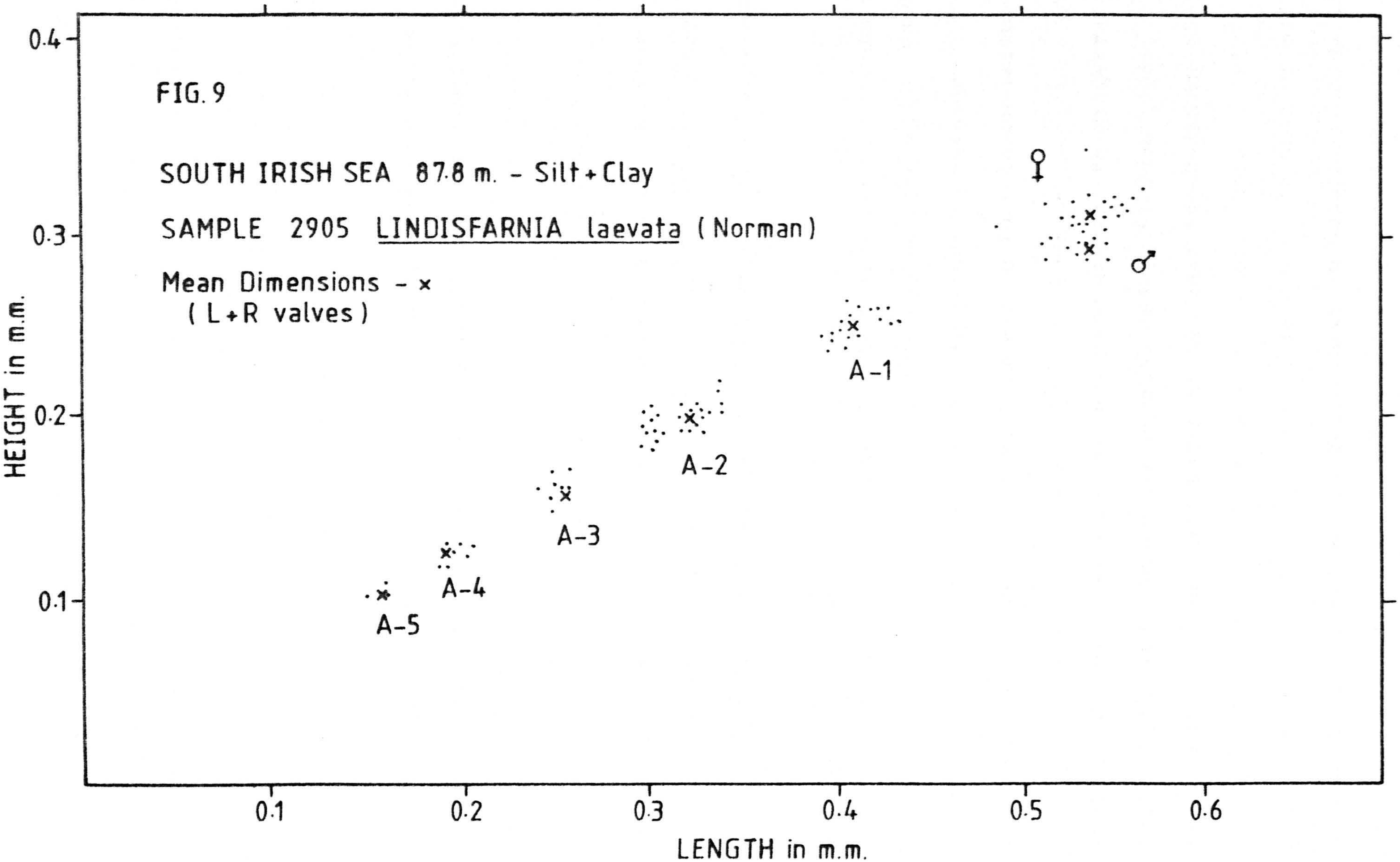


FIG. 9
SOUTH IRISH SEA 87.8 m. - Silt + Clay
SAMPLE 2905 LINDISFARNIA laevata (Norman)
Mean Dimensions - x
(L + R valves)
♀
♂
A-1
A-2
A-3
A-4
A-5
HEIGHT in m.m.
LENGTH in m.m.
0.1
0.2
0.3
0.4
0.5
0.6

Otherwise, in the southern Irish Sea material ranged within 2.7-137.5 m, mostly 15.2-97 m, mean 40.7 m, in coarse sand + gravel to silt with clay. Specimens were distributed throughout Caernarvon Bay from the intertidal to 157.3 m, mean 63.3 m in coarse sand + gravel and mixed sand. It was also found in the Malin Sea between 47.6-170.1 m, mean 92.5 m, in the given sediments.

Populations of adults with juveniles occurred in samples 2780 (14 m, coarse sand + gravel) and 2905 (82.8 m, mixed sand with silt), southern Irish Sea; in samples 2399 (7 m, coarse sand + gravel) and 2839 (44 m, mixed sand), Caernarvon Bay; in sample 3101 (55 m, fine sand + silt), Malin Sea. Assemblages of adults were recorded in samples 2904 (80.5 m, mixed sand), southern Irish Sea; 2422 (23.8 m) and 2447 (109.7 m), mixed sand, Caernarvon Bay.

Palaeoecology and Distribution

Stephensen (1938) indicates that this species occurs around Iceland, in the Faeroes and in accord with Norman (1902) found it alive in N. Norway. The distribution extends throughout W. Norway, 28-75 m, from Bergen to Lofoten Isles and Finmark (Brady and Norman, 1889; Norman, 1889; Sars, 1890, 1928). It would also seem to be widespread in the Skagerrak (Sars, 1866, 1928; Brady and Norman, 1889). Elofson (1941, 1943) indicates that live material is found in 12-250 m, mostly 50-200 m on sandy silt and shell ooze, between 2-19°C and 12-14‰+ salinity. L. laevata is common in sand or mud of the Oresund (Hagerman, 1965), ranges to Ostsee and Kiel Bay, 6-67 m on sands in 14-30‰ salinity (Klie, 1929, 1938; Elofson, 1941; Schafer, 1953; Rosenfeld, 1977).

In the North Sea region it extends throughout the Heligoland (Klie, 1929, 1938) to the estuarine Netherlands (Brady and Robertson, 1872). In addition, the species ranges from the Shetlands to E. Scotland (Brady, 1868) and is moderately common between the tidemarks and on shelly gravel, 28-85 m, mostly in 40 m+ off N.E. England (Norman, 1865; Brady, 1868, 1870; Brady and Robertson, 1872, 1876; Norman and Brady, 1909). Material has also been found alive in estuarine muds of Norfolk (Brady, 1868; Brady and Robertson, 1870) and the Thames (Brady, 1868; Kilenyi, 1969).

Isolated live specimens are known in the high marsh algae of N. Uist (Pearce, ms. 1977) though, otherwise, the live distribution extends in muds and sands throughout N.W. Scotland and Minches, tidemarks to 150 m+ and mostly 80 m+ (Brady, 1868; Harris, C.S., ms. 1977). L. lavata is often abundant in the Clyde, 0-55 m (Brady, 1868; Robertson, 1874), off Antrim and occurs in L. Foyle, N. Ireland (Norman, 1905). Ubiquitous and alive throughout W. Ireland, 2-28 m (Brady, 1868; Brady and Robertson, 1869; Norman, 1905) and in the Irish Sea (Brady, 1868; Brady and Robertson, 1869; Malcomson, 1885; Norman, 1905; Wall, ms. 1969). Only scarce specimens have been dredged from shelly gravel sand and cobbles, 10-110 m, Celtic Sea (Brassil, ms. 1977; Lomax, ms. 1978) and it occurs in the intertidal of N. and S. Devon, Cornwall and the Scilly Isles (Brady, 1868; Norman and Scott, 1906; Harding, 1957; Neale, 1970).

Two live specimens occurred on filamentous algae in a rock pool, Weymouth Bay (Whittaker, ms. 1972) and it may occur alive in the Channel Isles (Brady, 1868; Norman, 1907, 1908).

L. laevata is a phytal marine species of the Gironde Estuary (Carbonel, 1973; Carbonel and Jouanneau, 1975) and is found in abundance in Zostera and on sand, 2-8 m in 26-34‰ salinity of Arcachon Basin (Yassini, 1969). The last author also comments upon rare juvenile material in 28-78 m of the open shelf. The species ranges to S. Biscay (Brady and Folin, 1872; Fischer, 1876; Brady and Norman, 1889) and is a rarity in deep water of N.W. Spain (Ralph, ms. 1977).

Elofson (1941) indicates the Biscay to be the southerly limit of this species. However, it would seem to extend into the Mediterranean. Kruit (1955) reports a ubiquitous and live abundance in the Rhône Delta, 15-50 m. Other records are considered tentative but, in brief, include Messina and Gulf of Athens (Carus, 1885; Brady and Norman, 1889), 72-234 m in the Adriatic (Ascoli, 1955, 1964, as L. tamarinda).

The species is also widely recorded as a fossil. Sub-Recent and Holocene material is rare in the Irish Sea (Wall and Whatley, 1971; Spencer, ms. 1976) though moderately abundant in the Netherlands (Wagner, 1957, 1960, 1964) and Gironde Estuary (Carbonel et.al., 1975). The Late Glacial occurrence includes nearly all localities of W. Scotland and N. Ireland (Brady et.al., 1874; Robertson, 1877, 1885; Anderson, 1948; Graham and Wilkinson, 1978; Peacock et.al., 1978). It is also known from Forth and Cromerty and in contemporaneous deposits of E. Scotland (Brady et.al., 1874; Bell, 1891; Peacock et.al., 1980). Isolated Late Pliocene material occurs in subsurface sediments (Caralp et.al., 1970) and reworked deposits, 100-1,800 m, in Biscay (Yassini, 1969; Peypouquet, 1971). L. laevata is also abundant in the

Ipswichian, last interglacial, of Selsey, Sussex (Whatley and Kaye, 1971) and the Somerset Levels (Kidson et.al., 1978). though has a somewhat restricted distribution in contemporaneous deposits of the Irish Sea region (Jasin, ms. 1976). Woszidlo (1962) recovered it in the Hoxnian of N. Germany and E. Denmark and it ranges throughout the Quaternary Crags of E. Anglia (Jones, 1856; Brady et.al., 1874). There are several uncertain records, which include that from the Upper Pliocene and Quaternary of S. Italy (Brady and Norman, 1889; Neviani, 1928) and material in the Coralline Crag, Upper Pliocene of Suffolk (Wilkinson, ms. 1974).

Summary

The species is alive throughout Scandinavia, in Iceland and the Faeroes and is ubiquitous in the Skagerrak and W. Baltic, 60-70°N. Live material is only locally abundant around Britain, in Biscay, Gulf of Marseilles and N. Adriatic, 42-60°N. It occurs in the sub-Recent and Holocene of the Irish Sea, Netherlands and in moderate abundance in the Gironde, 45-54°N. Found in the Late Glacial of E. and W. Scotland, N.E. Ireland and in Biscay, 44-58°N. It occurs commonly in the last interglacial of Somerset and Sussex and extends more rarely to that in the southern Irish Sea, 50-54°N. *L. laevata* is also recorded in the Quaternary Crags of E. Anglia and ranges to the Hoxnian of N. Germany and E. Denmark, 54-56°N.

In Scandinavia live material ranges between 6-250 m and mostly in 50-200 m, while in British and adjacent waters it extends commonly from the estuarine intertidal downwards and occurs mostly in 28-85 m. Recent and reworked material is often dredged to 150 m off N. Britain and in 100-1,800 m from

Biscay. The species is alive in sublittoral algae and Zostera, silts and sand beneath. L. laevata tolerates 12‰+ and occurs mostly in waters of 26‰+ salinity, 0-19°C.

Lindisfarnia guttata (Norman), 1865

pl. 32 figs. k-p

1865 Cythere guttata n.sp. Norman: (reported by Brady), p. 192.

1865 Cythere guttata n.sp. Norman: p. 19, pl. VI, figs. 9-12.

1868 Loxoconcha guttata (Norman); Brady: p. 436, pl. XXVII, figs. 40-44.

1874 Loxoconcha guttata (Norman); Brady, Crosskey and Robertson: p. 186, pl. VIII, figs. 5-7.

1880 Loxoconcha guttata (Norman); Brady: p. 120, pl. XXIX, figs. 1a-f.

1889 Loxoconcha guttata (Norman); Brady and Norman: p. 184.

1906 NON Loxoconcha guttata (Norman); Cushman: p. 370, pl. 31, figs. 42-48; pl. 32, fig. 56.

1940 Loxoconcha guttata (Norman); Elofson: p. 503, t.figs. 9-11.

1969 Loxoconcha guttata (Norman); Wall (ms.): p. 303, pl. 40, figs. m-r.

1969 Loxoconcha guttata (Norman); Yassini: p. 106, pl. IX, XIII, XV, XVIII-XX.

1972 Loxoconcha guttata (Norman); Whittaker (ms.): p. 208, pl. 37, figs. 9-11.

1976 Loxoconcha guttata (Norman); Hoskin (ms.): p. 282, pl. 22, figs. 5-8.

1981 Loxoconcha guttata (Norman); Masson (ms.): p. 67, pl. 4, figs. 3, 5, 7.

1981 Lindisfarnia guttata (Norman); Athersuch and Horne: pls. 117-124.

<u>Material</u>

Total Dead: F. - 47 C. 166 RV. 171 LV.; M. - 24 C. 25 RV. 17 LV.; J. - 03 C. 85 RV. 64 LV. = 432 I.

Live: 15 F. 4 M.

Southern Irish Sea

Dead				Live	
F. - 41 C.	82 RV.	84 LV.		15	
M. - 09 C.	09 RV.	03 LV.	= 242 I.	04	= 19 I.
J. - 02 C.	63 RV.	42 LV.		00	

Malin Sea

Dead				Live
F. - 06 C.	84 RV.	87 LV.		00
M. - 15 C.	16 RV.	14 LV.	= 190 I.	
J. - 01 C.	21 RV.	22 LV.		

<u>Sample Distribution</u> (live occurrence is underlined)

Southern Irish Sea

868 <u>2359</u> 2360 2361 2365 2372 2375 2377 2378 2380
2381 2761 2783 2810 <u>2811</u> 2812 2813 2814 <u>2819</u> <u>2821</u>
2822 2902 2903 <u>2904</u> 2905 2906 2912 2915 2916 2917

Malin Sea

3101 3142 3143 3144 3145 3152 3153 3154 3157 3161
3162

<u>Figured Specimens</u>

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	13	. 23A/24	0.555	0.342
	LV.	"	13	. 24A/25	0.580	0.333
M.	RV.	"	13	. 21A/22	0.582	0.300
	LV.	"	13	. 22A/23	0.595	0.316
-1.	RV.	"	13	. 26A/27	0.440	0.256
	LV.	"	13	. 25A/26	0.453	0.255

Female valves - sample 3142 (128 m, mixed sand), juvenile valves - sample 3101 (55 m, fine sand + silt), Malin Sea; male valves - sample 2811 (59.4 m, silt + clay) southern Irish Sea.

Description

See: Elofson (1940, p. 500-503, t.figs. 9-13) for a description of the carapace morphology. Athersuch and Horne, (1981, pl. 117-124) illustrate the hard and soft parts .

Ontogeny

Instars of the penultimate and antepenultimate growth stage were recognised. The dimensions of adults and juveniles from several samples are given as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.540-0.600	0.320-0.350	46	
	Mean	0.580	0.334		1.74
M.	Range	0.570-0.620	0.290-0.325	46	
	Mean	0.593	0.309		1.92
-1.	Range	0.430-0.460	0.245-0.260	30	
	Mean	0.448	0.255		1.76
-2.	Range	0.360-0.380	0.195-0.220	8	
	Mean	0.368	0.202		1.82

Sexual dimorphism is distinct. The male is much the larger and more elongate. Several authors consider *L. guttata* and *L. granulata* Sars to be synonymous. However, Sars (1928, p. 219-220) indicates that in *Loxoconcha granulata* the male is somewhat smaller than the female. Therefore, although related these two forms are quite distinct.

Remarks

Certain reports of *L. guttata* in the Quaternary and Pliocene of S. Italy are most probably based on misidentification of *Loxoconcha rubritincta* Ruggieri (1964).

See: Whittaker (ms. p. 209-210) and Athersuch and Horne (1981).

Study Area Ecology

Live adults were found north of Dublin Bay, southern Irish Sea. Wherein, *L. guttata* ranged between 24.4-97 m, commonly within 54.9-97 m, in mixed and fine sand with silts and silt with clay.

Otherwise, material occurred in the southern Irish Sea between 15.2-137.5 m, mean 51.0 m, in the given sediments. In the Malin Sea most specimens occurred in the deeper regions of the Outer Shelf, 54.9-173.8 m, mean 128.9 m, in coarse sand with gravel to fine sand with silt.

Adult assemblages were recovered from sample 2375 (23.8 m), 2904 (80.5 m) and 2916 (36.6 m) in mixed and fine sands with a high silt content, southern Irish Sea. A population of adults with juveniles occurred in sample 2905 (87.8 m) in mixed sand and silt.

Adult assemblages also occurred in samples 3101 (55 m), 3143 (146.3 m), 3161 (128 m) and 3162 (140.8 m), fine sand + silt, Malin Sea.

Palaeoecology and Distribution

Records of this species in Scandinavian waters are few and most uncertain. Stephensen (1938) questioned an occurrence from Iceland and, otherwise, only Brady and Norman (1889) indicate its presence in 18-22 m from Christiania, S. Norway.

The distribution is better known in the North Sea region. From which it is recognised, down to 180 m in the Shetlands (Brady, 1868; Robertson, 1875) off Aberdeen (Brady, 1868), from Forth (Brady and Norman, 1889) and in moderate numbers, 28-130 m off N.E. England (Norman, 1864; Brady, 1865, 1868, 1869, 1903; Brady and Robertson, 1870, 1874, 1876). Brady and Robertson (1874) and Norman and Brady (1909) comment that most material is found in muddy sand, 35-75 m, though there was no indication whether this represents the live distribution. Isolated specimens are also reported in tidal rivers of N.E. England (Brady and Robertson, 1870), Fens (Brady and Robertson, 1872; Brady and Norman, 1889), Thames Estuary (Brady, 1868; Brady and Robertson, 1872) and off Dungeness, S.E. England (Brady and Norman, 1889).

L. guttata is widely distributed west of Britain though mostly reworked, 60-130 m, into fine sands and mud off N.W. Scotland (Brady, 1866, 1868; Brady and Norman, 1889; Harris, C.S. ms. 1977). It occurs generally in the Clyde, 15-55 m (Brady and Robertson, 1872; Robertson, 1875; Brady and Norman, 1889) in shell sand off Stranraer (Brady, 1868) and in Loughs Swilly and Mulroy, N. Ireland (Brady and Norman, 1889; Norman, 1905). Although widespread, much of the material found within 28 m to the west of Ireland is not live (Brady and Robertson, 1869, 1872; Norman, 1905; Hoskin, ms. 1976). The latter would also seem to be true of its occurrence in Belfast and Dublin Bays and the Irish Sea (Brady and Robertson, 1869, 1872; Brady and Norman, 1889; Norman, 1905). Wall (ms. 1969) indicates that a few live specimens occurred in Cardigan Bay in fine sand and silt and on epiphyte encrusted cobbles between 15-28 m. In the Celtic Sea a single live individual was recovered from shell gravel in 54 m (Brassil, ms. 1977) and L. guttata occurred otherwise in moderate abundance within 45 m (Lomax, ms. 1978). It becomes progressively more common in deeper waters, often below 100 m, of the Western Approaches

(Brady, 1868; Brady and Robertson, 1872; Brady and Norman, 1889; Norman and Scott, 1906; Harding, 1957; Neale, 1970, 1974).

The abundance and distribution is much increased further south. With ubiquitous live material found within 25-50 m, otherwise in 75-120 m, in the Gironde Estuary (Carbonel, 1973). Yassini (1969) indicates that only isolated live specimens occur in sand and silt in 3-10 m, 27‰ salinity, of Arcachon Basin. He also recorded L. guttata as a dominant ostracod species on the open shelf, 40-200 m, of Biscay. Its abundance in Recent sediments, 100-150 m, extends at least to Cap Breton, S. Biscay (Fischer, 1876; Brady and Norman, 1889; Peypouquet, 1971, 1973) and N.W. Spain (Ralph, ms. 1977).

Isolated records of L. guttata in Vineyard Sound, Massachusetts (Cushman, 1906), off Mt. Desert Is., Maine (Blake, 1933), western N. Atlantic and from Capri, W. Mediterranean (Brady and Norman, 1889) must be considered as speculative.

Sub-Recent and Holocene material is common in the southern Irish Sea (Wall and Whatley, 1971; Spencer, ms. 1976), Gironde Estuary (Carbonel and Pujos, 1973; Carbonel et.al., 1975) and in 30 m+ off Cap Breton (Carbonel et.al., 1973). The Late Glacial distribution includes rare instars found at Drip Bridge (Brady et.al., 1874), in the Forth Estuary, E. Scotland (Bell, 1891) and North Sea (Masson, ms. 1981). It appears to be more common in the Late Pleistocene of E. Ireland (Calhoun and Mitchell, 2971) and in sub-surface sediments below 100 m of water in Biscay (Caralp et.al., 1970; Moyes and Peypouquet, 1971). Lastly, isolated specimens have been found in the last interglacial, Ipswichian of Cardigan Bay, southern Irish Sea (Jasin, ms. 1976) and Somerset (Kidson et.al., 1978).

Summary

Lindisfarnia guttata is only accurately documented in the eastern N. Atlantic. It may occur in Icelandic waters, 65°N, but is known with greater certainty in moderate numbers around Britain and Ireland, north to 60°N. In which waters, the species is only rarely alive. A moderate abundance of material has been dredged in deep water sediments of the Western Approaches. The species is ubiquitous alive and dead on the open shelf of Biscay and ranges to N.W. Spain, 42-52°N. Sub-Recent and Holocene material is found throughout W. Britain and Biscay, 44-58°N. Late Glacial specimens are rare in the North Sea and E. Scotland, common in E. Ireland and very abundant off Gascony, 44-58°N. Isolated records of *L. guttata* also extend to the Ipswichian of the southern Irish Sea and Somerset, 51-54°N.

Live material extends from the estuarine sublittoral downwards, 3-200 m. *L. guttata* is common only below 40/50 m, mostly 100-150 m, in open marine conditions. It is primarily associated with fine sand and mud and epiphyte encrusted cobbles in 27‰+ salinity and $4/5$-30°C.

Genus *Roundstonia* Neale, 1973

Roundstonia globulifera (Brady), 1868

pl. 35 figs. g-h

1868 *Cythere globulifera* n.sp. Brady: p. 406, pl. 31, fig. 42.

1874 *Cythere globulifera* Brady; Brady, Crosskey and Robertson: p. 155, pl. 9, figs. 18-20; pl. 12, figs. 11, 12; pl. 15, figs. 19-20.

1963 NON *Pseudocythereis simpsonensis* n.sp. (pars) Swain: p. 825, fig. 16.

1969 ?*Cythere globulifera* Brady; Lev: pl. 2, fig. 5.

1973 *Roundstonia globulifera* (Brady); Neale: p. 126, pl. 1, figs. 1-16.

1975 *Roundstonia globulifera* (Brady); Neale: p. 125, pl. 1, fig. 1.

1975 *Roundstonia globulifera* (Brady); Neale and Howe: p. 426, pl. 5, fig. 13.

1977 *Roundstonia globulifera* (Brady); Cronin: p. 117, pl. III, fig. 4.

1979 *Roundstonia globulifera* (Brady); C.R. Harris: p. 297, figs. 2, 4, 5a-f.

1980 *Roundstonia globulifera* (Brady); Lord: p. 242, pl. 3, figs. 15-17.

1981 *Roundstonia globulifera* (Brady); Masson (ms.): p. 73, pl. 4, figs. 6, 8-10.

Material

Total: F. - 2 RV. 2 LV. = 4 I.

Southern Irish Sea

Dead	Live
F. - 00 C. 01 RV. 01 LV. = 2 I.	00

Malin Sea

Dead	Live
F. - 00 C. 01 RV. 01 LV. = 2 I.	00

Sample Distribution

Southern Irish Sea
2810 2905

Malin Sea
3161 3162

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	6 .	39A/40	0.443	0.278
	LV. "	6 .	38A/39	0.449	0.245

Female right valve - sample 2810 (60.9 m, silt + clay), southern Irish Sea. Female left valve - sample 3162 (140.8 m, fine sand + silt), Malin Sea.

Description

See: Wall (ms. 1969, p. 421-422) and Neale (1973, p. 126-127, pl. 1) for a description and illustration of the carapace morphology. The soft parts are not described in the literature.

Ontogeny

Juveniles were not recognised. However, the entire ontogenetic development of the species is well illustrated and described by C.R. Harris (1979, figs. 2, 4).

Remarks

Some authors consider P. simpsonensis Swain (1963, p. 825, pl. 97, fig. 16) to be conspecific. From its large size (1.3 mm length) and general ornament there is a greater affinity of the Swain material to C. septentrionalis Brady.

See: Neale (1973, p. 129).

Study Area Ecology

Individual adult instars were recovered from 60.9 m and 87.8 m, respectively mixed sand and silt with clay, southern Irish Sea. Isolated material also occurred in 128 m and 140.8 m, fine sand with silt, outer shelf, Malin Sea.

Palaeoecology and Distribution

There are few records of this species in Recent sediments. Indeed,Neale (1973) suggests that it may be extinct. Nevertheless, in the western N. Atlantic R. globulifera has been dredged in muds from 90-150 m off Capes Ravine and Frazer, N.W. Greenland (Brady, 1878; Brady and Norman, 1889; Stephensen, 1913).

Isolated material has been found off Spitzbergen, Svalbard Islands (Brady and Norman, 1889; Müller, 1931) and a single specimen was recovered in mud and sand from 15 m in Russian Harbour, Novaya Zemlya (Neale and Howe, 1975). It also occurs in 230 m of Hardanger Fiord, W. Norway (Brady and Norman, 1889).

That reported from the Norfolk Fens (Brady and Robertson, 1870, 1872), in 135 m off the Antrim coast (Norman, 1905), Irish Channel (Brady and Norman, 1889) and in deep water shell sand off Roundstone and Valentia, W. Ireland (Brady, 1868; Brady and Robertson, 1872; Norman, 1905) is probably reworked.

Sub-Recent and Holocene material occurs in moderate abundance in certain areas of Lake Champlain, St. Lawrence (Cronin, 1977); in estuarine muds of Dublin Bay (C.R. Harris, 1978) and from Tremadoc Bay (Wall and Whatley, 1971), southern Irish Sea. Rare Late Glacial specimens are known in the

Ottowa, Montreal and Quebec regions of the St. Lawrence (Brady and Crosskey, 1871; Wagner, 1968), in silts of Sandnes, S.W. Norway (Lord, 1980) and in muds and sand of the North Sea (Masson, ms. 1981). It is also locally common in raised beach deposits of the Clyde (Brady et.al., 1874; Robertson, 1885; Anderson, 1948) and S.W. Scotland (Morris, ms. 1978; Peacock et.al., 1978; Graham and Wilkinson, 1978). Lastly, R. globulifera is recorded in the Last interglacial, Ipswichian, of the Irish Sea (Jasin, ms. 1976); Hoxnian of N.E. England and possibly N. and S. Alaska (Brady et.al., 1874; Brady and Robertson, 1874; Saar, 1973). The species is also reported from numerous Quaternary deposits of N. Russia (Lev., 1969).

Summary

This species is possibly extinct. It has, however, been found rarely in Recent deep water sediments of N.W. Greenland 82°N and in several areas south of 79°N in the Barents Sea. R. globulifera also occurs in deep water west of Norway, Britain and Ireland, though these last records are probably of reworked material. Sub-Recent and Holocene material occurs in moderate abundance from Lake Champlain, eastern N. America, 44-45°N and in the southern Irish Sea, 52-54°N. The Late Glacial distribution includes the St. Lawrence Estuary, 45-47°N; S.W. Norway, North Sea and W. Scotland, 54-59°N. It also occurs in the Ipswichian of the southern Irish Sea, 52-54°N; Hoxnian of N.E. England, 54-56°N and N. and S. Alaska, 60-70°N and ranges in the Quaternary throughout N. Russia, 65-70°N.

The ecology of this species is unknown. It is mostly reworked into Recent sediments in 100 m+. However, R. globulifera seems associated with shallow, 15 m approx., estuarine muds and silty sands in waters of near $0^{o}C$ and perhaps 15‰+ salinity (C.R. Harris, 1978).

Family PARADOXOSTOMATIDAE Brady and Norman, 1889

Sub Family PARADOXOSTOMATINAE Brady and Norman, 1889

Genus *Paradoxostoma* Fischer, 1855

Paradoxostoma variabile (Baird), 1835

pl. 35 figs. i-n

1835 *Cythere variabilis* n.sp. Baird: p. 98, pl. III, figs. 7a-b.

1838 *Cythere variabilis* Baird: p. 143, pl. V, figs. 25a-b.

1850 *Cythere variabilis* Baird; Baird: p. 170, pl. XXI, figs. 10-11.

1866 *Paradoxostoma variabilis* (Baird); Sars: p. 93.

1868 *Paradoxostoma variabile* (Baird); Brady: p. 457, pl. XXXV, figs. 1-7.

1874 *Paradoxostoma variabile* (Baird); Brady, Crosskey and Robertson: p. 213, pl. X, figs. 29-32.

1888 *Paradoxostoma variabile* (Baird); Dahl: p. 632, pl. XIX, figs. 127-136.

1889 *Paradoxostoma variabile* (Baird); Brady and Norman: p. 229, pl. XXIII, fig. 10.

1928 *Paradoxostoma variabile* (Baird); Sars: p. 256-257, pl. CXVI.

1938 *Paradoxostoma variabile* (Baird); Klie: p. 224, t.figs. 775-782.

1941 *Paradoxostoma variabile* (Baird); Elofson: p. 349, fig.27.

1957 *Paradoxostoma variabile* (Baird); de Vos: p. 64, 66, pl. XXV, figs. 2a-h.

1957 *Paradoxostoma variabile* (Baird); Wagner: p. 97, pl. XLVII.

1969 *Paradoxostoma variabile* (Baird); Wall (ms.): p. 343, pl. 20, figs. a-l; pl. 42, figs. a, b, d, e, f.

1969 ?*Paradoxostoma variabile* (Baird); Tomakh: pl. 41, fig. 4.

1969 ?*Paradoxostoma variabile* (Baird); Yassini: p. 119, pl. V-VII, IX, XV.

1972 *Paradoxostoma variabile* (Baird): Whittaker (ms.): p. 237, pl. 43, figs. 1-3.

1976 *Paradoxostoma variabile* (Baird); Hoskin (ms.): p. 284, pl. 24, figs. 8-9.

1977 *Paradoxostoma variabile* (Baird); Rosenfeld: p. 38, pl. 10, fig. 119.

Material

Total Dead: F. - 6 RV. 6 LV.; M. - 4 C. 2 RV. 3 LV.; J. - 8 C. 45 RV. 46 LV. = 95 I.

Live: 14 J.

Southern Irish Sea

Dead					Live	
F. - 00 C.	02 RV.	01 LV.			00	
M. - 04 C.	00 RV.	02 LV.	= 52 I.		00	= 11 I.
J. - 02 C.	25 RV.	30 LV.			11	

Caernarvon Bay

Dead					Live	
F. - 00 C.	02 RV.	02 LV.			00	
M. - 00 C.	00 RV.	00 LV.	= 21 I.		00	= 2 I.
J. - 02 C.	10 RV.	07 LV.			02	

Malin Sea

Dead					Live	
F. - 00 C.	02 RV.	03 LV.			00	
M. - 00 C.	02 RV.	01 LV.	= 22 I.		00	= 1 I.
J. - 04 C.	10 RV.	09 LV.			01	

Sample Distribution (live occurrence is underlined)

Southern Irish Sea

807 <u>843</u> <u>850</u> <u>857</u> <u>872</u> 880 <u>906</u> <u>917</u> <u>923</u> 925 <u>926</u> 2359
2365 2780 2789 2854 2904

Caernarvon Bay

2393 2400 2422 2443 2463 2509 2513 <u>2637</u> 2638 2645
2891 2896 2923 HHI

Malin Sea

3090 <u>3092</u> <u>3097</u> 3099 3101 3115 3147 <u>3162</u>

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	7 .	20A/21	0.660	0.344
	LV. "	7 .	19A/20	0.641	0.328
M.	RV. "	7 .	16A/17	0.706	0.387
	LV. "	7 .	17A/18	0.701	0.378
-1.	RV. "	7 .	24A/25	0.573	0.278
	LV. "	7 .	23A/24	0.575	0.278

The specimens are from sample 2854 (2.7 m, coarse sand + gravel), S. Irish Sea.

Description

See: Wall (ms. 1969, p. 344-350, pl. 20) for a description of the hard and soft parts and an illustration of the latter. The carapace morphology is figured by Whittaker (ms. 1972, pl. 47, figs. 1-3).

Ontogeny

Instars from the penultimate to -4, including -6?, growth stage were recognised. The dimensions of adults and juveniles from sample 2854, southern Irish Sea are given as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.630-0.710	0.325-0.360	8	
	Mean	0.678	0.346		1.96
M.	Range	0.700-0.760	0.365-0.390	4	
	Mean	0.742	0.374		1.98
-1.	Range	0.550-0.590	0.275-0.290	3	
	Mean	0.567	0.283		2.00
-2.	Range	0.500-0.530	0.240-0.270	9	
	Mean	0.510	0.253		2.02
-3.	Range	0.450-0.470	-	2	
	Mean	0.460	0.220		2.09
-4.	Range	-	-	1	
	Mean	0.410	0.190		2.16
-6?	Range	-	-	1	
	Mean	0.270	0.140		1.93

Wall (ms. p. 350) commented that the L.:H. ratio was remarkably consistent throughout ontogeny. However, in this study P. variabile proved one of the most difficult species to identify. The shape and size of adults and the penultimate juvenile varied considerably, e.g. in populations from sample 2854 and Rathlin Island. The dimensions of specimens in algal debris from S. Rathlin Is., Malin Sea, are as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.680-0.735	0.330-0.370	15	
	Mean	0.698	0.390		1.79
M.	Range	0.740-0.820	0.390-0.420	18	
	Mean	0.795	0.405		1.96
-1.	Range	0.610-0.665	0.310-0.345	32	
	Mean	0.644	0.321		2.01

Remarks

Elofson (1944) and Whittaker (ms. 1972) indicate several species are included in the given distribution of P. variabile. One of which is P. arctica Elofson, perhaps best described and illustrated by Hawley (ms. 1981, p. 68-74, pl. 7, 8). This latter species may represent most of the Recent and fossil western N. Atlantic and Arctic distribution attributed to P. variabile. In addition, Yassini (1969) illustrates material that is too compressed laterally and more sinuous ventrally than P. variabile sensu stricto. He also records the male of the Baird species to be somewhat smaller than the female. It is, therefore, probable that the Biscay distribution is of a distinct species. A disjunct Black Sea fauna (Tomakh, 1969) may also be distinct.

See: Wall (ms. 1969, p. 351) and Whittaker (ms. 1972, p. 238-240).

Study Area Ecology

Live specimens occurred in coarse sand with gravel, 8.2-67.1 m, south of Dublin Bay; in 40 m, Caernarvon Bay; between 37-140.8 m, Malin Sea.

Otherwise, in the southern Irish Sea material was found between 2.7-97 m, mean 36 m, in coarse sand with gravel, to fine sand with silt. A population of adults and juveniles was recovered in sample 2854 (2.7 m, coarse sand + gravel).

Specimens occurred in the intertidal of Holyhead Harbour and extended down to 146.3 m, mean 55.5 m, on algal debris, coarse sand with gravel and mixed sands, Caernarvon Bay.

Isolated specimens were recorded in the Malin Sea, 37-140.8 m and 512.1 m, mean 85.5 m, in coarse sand with gravel and mixed sands. Much of the entire Malin Sea material occurred in sample 3101 (55 m, fine sand with silt).

Palaeoecology and Distribution

There are numerous reports of this species alive in the *Laminaria* zone and down to 140 m west of Greenland and in the N. Arctic (Brady, 1868; Brady and Norman, 1889; Stephensen, 1913). These records are now considered to be inaccurate.

However, records of abundant live material from Iceland, 25-75 m (Stephensen, 1938) and Finmark (Brady and Norman, 1895; Norman, 1891, 1902) are probably correct. The species is best documented in tidepools and littoral Laminarian algae of S. and W. Norway (Sars, 1866, 1928; Elofson, 1941, 1943). The last author reports it alive and abundant in 0-22^{o}C, 0.1-18 m in salinity 3‰+ throughout the Skagerrak. The range extends exclusively in the phytal zone to Oresund (Hagerman, 1966, 1967), Kiel and Wismar Bays and to Ostsee, W. Baltic, 0-200 m, 10-25‰ salinity (Dahl, 1888; Klie, 1929, 1938; Hagerman, 1965, 1966; Rosenfeld, 1977).

E. of Britain the live distribution extends in reduced numbers to the Shetlands (Norman, 1869) and Forth Estuary (Scott, 1893). Its occurrence is more frequent in the intertidal and sublittoral of the Tweed Estuary (Baird, 1835, 1838, 1845; Brady, 1868) and most common off N.E. England (Brady, 1868, 1902, 1903; Brady and Robertson, 1870, 1872; Norman and Brady, 1909). Localised populations are also recorded in many parts of N.W. Europe, from Heligoland (Klie, 1929, 1938; Skaumal, 1977) southward throughout the Netherlands estuarine (Brady, 1869; Brady and Robertson, 1870; Brady and Norman, 1889; Redeke and Dulk, 1940). P. variabile is also found in sediments of the North Sea, between 28-55 m (Brady, 1870; Brady and Robertson, 1876) and occurs alive on zoophytes and encrusted shell gravel down to 85 m (Brady and Robertson, 1874).

Rare live specimens have been found off St. Kilda and N. Uist, western Isles (Pearce, ms. 1977). It forms localised populations in the Clyde Estuary, 12-55 m (Brady, 1868; Robertson, 1874) and around the Irish coast, 6-28 m (Brady and Robertson, 1869; Norman, 1905; Farran, 1913; Brassil, ms. 1977). It is also alive and abundant in tidepool and sublittoral bushy and Laminarian algae of Caernarvon Bay (Morgan, ms. 1977), Cardigan Bay (Wall, ms. 1969), Irish Sea and the coasts of Devon, Cornwall (Brady, 1868; Norman and Scott, 1906; Harding, 1957) and the Scillies (Neale, 1970).

The distribution extends to the English Channel, and includes the Channel Isles (Norman, 1907, 1908) and N. Brittany

(Brady, 1868; de Vos, 1957). A few live specimens are also known down to 8.5 m in 28‰+ salinity and Fucus of the Dorset coast (Whittaker, ms. 1972). Otherwise, reports of this species in Biscay and within the Black Sea probably refer to distinct species.

As a fossil, P. variabile occurs rarely in the sub-Recent and Holocene of the southern Irish Sea (Wall and Whatley, 1971; Spencer, ms. 1976; Haynes et.al., 1977) and Netherlands (Wagner, 1957, 1960, 1964). Widespread and moderately common material is reported in the Late Glacial of S. Norway, N.E. Ireland (Brady et.al., 1874) and, in particular, the Clyde Estuary (Brady et.al. 1874; Robertson, 1877, 1885; Anderson, 1948). Devensian specimens may also range to S. Gascony, 100-400 m (Peypouquet, 1971; Moyes and Peypouquet, 1971) and N.W. Spain, 75 m (Ralph, ms. 1977). However, that reported in the Late Glacial of New England and the St. Lawrence, N. America (Brady and Crosskey, 1871; Brady et.al., 1874) most probably refers to other species.

Summary

P. variabile is live and extends south from Finmark throughout Scandinavia, Iceland and the W. Baltic. The species also occurs alive in reduced numbers throughout British and adjacent waters, though is noticeably less common in the English Channel, 70-49^{o}N. Scarce sub-Recent and Holocene material is recorded from the southern Irish Sea and Netherlands and is reworked with fossil material into deep waters of S. Biscay and N.W. Spain, 54-43^{o}N. Late Glacial material is locally common and widespread in S. Norway, W. Scotland and N.E. Ireland,

$54-60^{o}N$ and may possibly occur in S. Biscay, $44^{o}N$.

P. variabile is alive in sheltered estuarine intertidal and sublittoral waters, 0.1-20/30 m, associated with Laminarian and bushy algae. It is often alive on encrusted shelly gravels and sands in 25-85 m+ and is reworked with fossil specimens down to 100-400 m. The salinity tolerance is 3‰+ , commonly 10-25‰ in the W. Baltic and Skagerrak, though P. variabile occurs mostly in near and full marine conditions and $0-22^{o}C$.

Paradoxostoma abbreviatum Sars, 1866
pl. 35 figs. o-t

1866 Paradoxostoma abbreviatum n.sp. Sars: p. 94.

1868 Paradoxostoma abbreviatum Sars; Brady: p. 458, pl. XXV, figs. 22-25.

1880 ? Paradoxostoma abbreviatum Sars; Brady: p. 150, pl. XXV, figs. 1a-d.

1928 Paradoxostoma abbreviatum Sars; Sars: p. 263, pl. CXIX, fig. 1.

1938 Paradoxostoma abbreviatum Sars; Klie: p. 226, figs. 783-786.

1969 Paradoxostoma abbreviatum Sars; Wall (ms.): p. 353, pl. 21, figs. a-i; pl. 42, figs. i-l, q.

1976 Paradoxostoma abbreviatum Sars; Hoskin (ms.): p. 284, pl. 24, fig. 1.

1977 Paradoxostoma abbreviatum Sars; Rosenfeld: p. 39, pl. 10, fig. 121.

Material

Total Dead: F. - 4 C. 8 RV. 6 LV.; M. - 4 C. 4 RV. 5 LV.; J. - 4 RV. 4 LV. = 39 I.

Live: 4 F.

Southern Irish Sea

Dead					Live	
F. - 03 C.	03 RV.	03 LV.			04	
M. - 04 C.	03 RV.	02 LV.	=	23 I.	00	= 4 I.
J. - 00 C.	01 RV.	04 LV.			00	

Caernarvon Bay

Dead					Live
F. - 01 C.	02 RV.	02 LV.	=	6 I.	00
J. - 00 C.	01 RV.	00 LV.			

Malin Sea

Dead					Live
F. - 00 C.	03 RV.	01 LV.			00
M. - 00 C.	01 RV.	03 LV.	=	10 I.	
J. - 00 C.	02 RV.	00 LV.			

<u>Sample Distribution</u> (live occurrence is underlined)

Southern Irish Sea

825 <u>903</u> 917 926 2365 <u>2366</u> 2375 2764 2780 2854

Caernarvon Bay

2399 2442 2830 HHI HHII

Malin Sea

3099 3101

<u>Figured Specimens</u>

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	9	31/31A	0.500	0.300
	LV. "	9	29/29A	0.508	0.288
M.	RV. "	9	28/28A	0.516	0.280
	LV. "	9	30/30A	0.515	0.285
-1.	RV. "	9	32/32A	0.456	0.253
	LV. "	9	33/33A	0.478	0.279

Females, male right valve, and juvenile instars - sample 2365 (40 m, mixed sand), male left valve - sample 825 (14.6 m, fine sand + silt), southern Irish Sea.

Description

See: Wall (ms. 1969, p. 354-359, pl. 21, pl. 42, figs. i-l, q) for a description and illustration of both hard and soft parts.

Ontogeny

A small number of penultimate and ante-penultimate juveniles were recognised. The ontogeny is adequately discussed by Wall (ms. 1969, p. 360).

Remarks

See: Wall (ms. 1969, p. 360-361).

Study Area Ecology

Live females occurred in samples 903 (15.2 m) and 2366 (26 m), mixed sand, southern Irish Sea.

It occurred dead in isolated areas throughout the above region, 2.7-54.9 m, mostly 23.8-40 m, mean 32.2 m, in a variety of sediments from coarse sand + gravel to fine sand with silt. It also occurred in the intertidal of Holyhead Harbour and within 46 m, mean 15.2 m, coarse sand + gravel and mixed sand of Caernarvon Bay. Poorly preserved specimens were recovered from sample 3099 (77 m, mixed sand) and from sample 3101 (55 m, fine sand + silt), S.E. of Islay, Malin Sea.

Palaeoecology and Distribution

Records of this species extend south from Flöro, 380 m, to Hardanger Fiord, 150-340 m, S.W. Norway (Brady and Norman, 1889; Norman, 1891). A number of live specimens were also found exclusively associated with Laminarian algae, 6-48 m, in

Oslo Fiord (Sars, 1866, 1928; Brady and Norman, 1889). Otherwise, in the Skagerrak, P. abbreviatum is recorded by Elofson (1941, 1943) to occur alive within 0-2-20 m, 0-22^{o}C wherever salinity is greater than 10/12% + . The live distribution extends to the Oresund and commonly within the Fucus zone of the Western Baltic (Hagerman, 1965, 1966). In which region, it is tolerant of 14-25% salinity in 8-16 m (Klie, 1929, 1928; Schafer, 1953; Rosenfeld, 1977).

In the North Sea there are records of it from Heligoland and the Scheldt Estuary (Brady and Robertson, 1870; Brady and Norman, 1889; Klie, 1929, 1938). The species also ranges in isolated numbers throughout E. Britain, from the Orkneys and Shetlands to the Thames Estuary (Brady, 1868; Brady and Robertson, 1872). P. abbreviatum is best documented from the Northumberland and Durham coast, being commonly alive between the tidemarks and often occurs reworked into muds and gravels down to 55 m (Brady, 1870; Brady and Robertson, 1870, 1872, 1874; Norman and Brady, 1909).

P. abbreviatum was most abundant in sublittoral Laminarian holdfasts of St. Kilda (Pearce, ms. 1977), though the species is rarely common in other parts of W Scotland or the Western Isles (Brady, 1868; Brady and Robertson, 1872; Robertson, 1874). Brady and Robertson (1869, 1872) and Norman (1905) record it in tidepools and within 6-28 m in many localities around the Irish Coast, though these authors fail to comment upon its abundance. Wall (ms. 1969) and Morgan (ms. 1977) indicate that the live abundance along the W. Wales coast is mostly concentrated in bushy and filamentous algae and their roots rather than within Laminarian type algae.

The association with bushy type algae is maintained on the rocky shore line of Devon and Cornwall (Brady, 1868; Norman and Scott, 1906) and the Scilly Isles (Neale, 1970).

Specimens are also recorded from the Channel Isles and rarely in the Roscoff region of N. Brittany (de Vos, 1957). However, the isolated reports of it in 350-380 m from Cap Breton, S. Biscay and in silts, 75-100 m+, off N.W. Spain (Ralph, ms. 1977) more likely refer to reworked material.

Rare sub-Recent and Holocene material is known in the southern Irish Sea (Wall and Whatley, 1971; Spencer, ms. 1976); it ranges to the Late Glacial of Cardiff, S. Wales (Brady et.al., 1984) and occurs in isolated numbers within the last interglacial of Sussex (Whatley and Kaye, 1971).

<u>Summary</u>

The live and Recent distribution extends from the Skagerrak in great abundance, to the western Baltic. It also ranges throughout British and adjacent waters with moderate numbers recovered from western coasts, 49-60^{o}N. Sub-Recent and Holocene material is very rare and may range from deep waters off S.W. Scandinavia to S. Biscay and N.W. Spain, 62-43^{o}N. Isolated Late Glacial specimens are only known from S. Wales, 51^{o}N, approx. Lastly, there is a record of material from the last interglacial, Eemian, of Sussex, 50^{o}N.

This is an intertidal and sublittoral species, found alive in 0.2-20 m, off Scandinavia and recorded down to 30 m around Ireland. Isolated fossil material occurs in 75-380 m off S.W. Norway and in S. Biscay. <u>P. abbreviatum</u> is primarily associated with Laminarian type algae and holdfasts in northern waters and occurs often in bushy and filamentous algae off S. Britain. The salinity tolerance is 10/12‰+, mostly 14-25‰ in the W. Baltic, in 0-22°C.

Paradoxostoma bradyi Sars, 1928
pl. 36 figs. a-d

1868 Paradoxostoma obliquum Sars; Brady: p. 459, pl. XXXV, figs. 18-21.

1889 Paradoxostoma obliquum Sars; Brady and Norman: p. 230.

1928 Paradoxostoma bradyi n.sp. Sars: p. 260, pl. CXVIII, fig. 1.

1941 Paradoxostoma bradyi Sars; Elofson: p. 353.

1957 Paradoxostoma bradyi Sars; de Vos: p. 56, pl. XXIII, figs. 1a-k.

1969 Paradoxostoma bradyi Sars; Wall (ms.): p. 364, pl. 22, figs. a-j; pl. 43, figs. a-d.

1969 ? Paradoxostoma subelliptica Sars; Wall (ms.): p. 381 (Juvs.)

1972 Paradoxostoma bradyi Sars; Whittaker (ms.): p. 241, pl. 43, figs. 4-7.

1976 Paradoxostoma bradyi Sars; Hoskin (ms.): p. 284, pl. 24, figs. 2-3.

Material

Total Dead: F. - 1 RV.; M. - 1 RV.; J. - 2 C, 34 RV. 48 LV. = 67 I.

Live: 17 J.

Southern Irish Sea

Dead				Live	
F. - 00 C.	01 RV.	00 LV.		00	
M. - 00 C.	01 RV.	00 LV.	= 8 I.	00	= 7 I.
J. - 01 C.	01 RV.	04 LV.		07	

Caernarvon Bay

Dead				Live	
J. - 01 C.	28 RV.	35 LV.	= 45 I.	06	= 6 I.

Malin Sea

Dead	Live
J. - 00 C. 05 RV. 09 LV. = 14 I.	04 = 4 I.

<u>Sample Distribution</u> (live occurrence is underlined)

Southern Irish Sea

<u>917</u> 923 2375 2788

Caernarvon Bay

2393 2422 <u>2423</u> 2443 2509 2513 <u>2637</u> 2644 2647 <u>2770</u>
2891 2892 <u>2926</u> HHI HHII

Malin Sea

<u>3097</u> 3101

<u>Figured Specimens</u>

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	9 .	25/25A	0.624	0.371
	LV.	"	9 .	23/23A	0.678	0.380
M.	RV.	"	9 .	26/26A	0.542	0.304
	LV.	"	9 .	27/27A	0.590	0.321

The specimens are all from sample 923 (67.1 m, coarse sand + gravel, Southern Irish Sea.

<u>Description</u>

See: Wall (ms. 1969, p. 364-369, pl. 22; pl. 43, figs. a-d) for a description and illustration of the hard and soft parts.

<u>Ontogeny</u>

The penultimate to -4 growth stage is provisionally recognised. The dimensions of Juveniles from samples in Caernarvon Bay are given as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
-1.	Range	0.540-0.610	0.300-0.325	18	
	Mean	0.580	0.315		1.84
-2.	Range	0.470-0.500	0.255-0.275	10	
	Mean	0.491	0.263		1.87
-3.	Range	0.370-0.410	0.210-0.220	10	
	Mean	0.392	0.214		1.83
-4.	Range	0.310-0.325	0.170-0.190	8	
	Mean	0.318	0.185		1.72

The juveniles of P. bradyi and P. subelliptica Sars are not adequately figured in the literature and, therefore, there is some confusion concerning the identification of respective instars. Whilst Wall (ms. 1969) described the adults of both these species it seems probable that the juvenile of P. bradyi are included by him in his Ontogeny (p. 387) of P. subelliptica.

See: Wall (ms. 1969, p. 370).

Study Area Ecology

Live juveniles are identified in 35.1 m of the southern Irish Sea; between 36.6-82.3 m in Caernarvon Bay and in 37 m from Malin Sea, coarse sand with gravel and mixed sand.

Other material was found within 23.8-67.1 m in the south Irish Sea in the intertidal of Holyhead Harbour and extending down to 82.3 m, mean 55.5 m, Caernarvon Bay; between 37-55 m in the Malin Sea. Several adult instars occurred in coarse sand with gravel of the southern Irish Sea. Juveniles were recovered from sublittoral algal debris of Caernarvon Bay or occurred in fine sand with silts throughout the depth range.

Palaeoecology and Distribution

This is a very rare species in Scandinavian waters. Brady and Norman (1889) record material from Oxfiord, Finmark and Sars (1928) found it in several places on the Norwegian coast. Elofson (1941) recovered a few live specimens from W. Sweden in algae, 4-25 m, and as such its range may extend to the W. Baltic (Klie, 1929).

In addition, P. bradyi is seldom common in the North Sea. With its range including that attributed to P. obliquum Sars, the species extends from Shetland (Brady, 1868) to Forth (Brady and Robertson, 1872; Scott, 1906) and the intertidal of N.E. England (Brady and Robertson, 1872; Brady and Norman, 1889; Norman and Brady, 1909; Bossany, 1967).

Pearce (ms. 1977) found it abundantly alive in sub-littoral Laminaria and holdfasts of St. Kilda, Western Isles. However, in deep water sands and mud of the Minches (C.S. Harris, ms. 1977), off S.W. Scotland and in the Clyde, 12-38 m (Brady, 1868; Brady and Robertson, 1872; Robertson, 1874) this is a rare species and there is no suggestion by these authors that the material is not reworked. There are numerous reports of P. bradyi all around the Irish coast (Brady, 1868; Brady and Robertson, 1869, 1872; Brady and Norman, 1889; Farran, 1913). However, only Hoskin (ms. 1976) actually comments upon the ecology, alive in Polysiphonia of Brandon and Tralee Bays, Co. Kerry. Morgan (ms. 1977) recorded abundant live material in bushy and laminarian type algae and holdfasts in Caernarvon Bay. In addition, Wall (ms. 1969) indicates that the species is mostly alive, in 19°C, within 6 m in the Laminaria beds of Cardigan Bay. It would also seem to be moderately common in the inner bay areas of N. and S. Devon, Cornwall and the Scillies (Brady and Robertson, 1872; Brady and Norman, 1889; Norman and Scott, 1906; Harding, 1957). However, Neale (1970) and Lomax (ms. 1978) indicate that it is only rarely found below the littoral in the more open marine areas of the Celtic Sea and Western Approaches.

Whittaker (ms. 1972) found a few live individuals in Enteromorpha and full marine salinity of Christchurch Harbour, Dorset; live material is known from Roscoff, N. Brittany (de Vos, 1957) and both Brady and Robertson (1872) and Norma- (1907) report it around the Channel Isles. However, isolated records of P. bradyi in the Fucus zone, 15-28‰ salinity, of the Gironde Estuary (Carbonel et.al., 1972) and Black Sea (Dubowsky, 1939; Marinov, 1964) must remain tentative.

As a fossil, this species is recorded as a rarity from the Holocene of Tremadoc Bay, W. Wales (Spencer, ms. 1976; Haynes et.al., 1977) and occurs in the Ipswichian of Somerset (Kidson et.al., 1978).

Summary

P. bradyi may range alive throughout Norway, south of 70°N; though live material is known only within the Skagerrak, British and adjacent waters, 50-60°N. It appears to be most common west of Britain and Ireland. There is a dubious report of this species alive in the Gironde Estuary, 46°N. Further, isolated specimens are recorded in the Holocene of the southern Irish Sea, 52-54°N and P. bradyi has been found in the Ipswichian of Somerset, 51°N.

It has a sublittoral ecology, 4-25 m approx., though is found in Recent sediments of sheltered estuaries down to 40 m+. P. bradyi is a phytal species, associated primarily with laminarian type algae and holdfasts and may also be found in

Polysiphonia and bushy type algae in more southern regions. Most records indicate a full or near marine habit in 0-19°C+.

Paradoxostoma ensiforme Brady, 1868

pl. 36 figs. e-i

1868 *Paradoxostoma ensiforme* n.sp. Brady: p. 460, pl. XXXV, figs. 8-11.

1874 *Paradoxostoma ensiforme* Brady; Brady, Crosskey and Robertson: p. 215, pl. 10, figs. 27-28.

1880 *Paradoxostoma ensiforme* Brady; Brady: p. 150, pl. XXV, figs. 3a-d.

1889 *Paradoxostoma ensiforme* Brady; Brady and Norman: p. 229,

1894 *Paradoxostoma angustum* n.sp. G.W. Müller: p. 314, pl. 23, figs. 18, 41, 42.

1928 *Paradoxostoma ensiforme* Brady; Sars: p. 258, pl. CXVII, fig. 1.

1941 *Paradoxostoma ensiforme* Brady; Elofson: p. 352.

?1961 *Paradoxostoma ensiforme* Brady; Kurc: p. 194, pl. V, fig. 87.

1969 *Paradoxostoma ensiforme* Brady; Wall (ms.): p. 371, pl. 43, figs. e, f, h, i, k, l, q, r.

1969 *Paradoxostoma ensiforme* Brady; Yassini: p. 117, pl. XV, XVIII.

1972 *Paradoxostoma ensiforme* Brady; Whittaker (ms.): p. 243, pl. 44, figs. 1-3.

1976 *Paradoxostoma ensiforme* Brady; Hoskin (ms.): p. 284, pl. 24, fig. 11.

Material

Total Dead: F. - 6 C. 25 RV. 20 LV.; M. - 9 C. 17 RV. 40 LV.; J. - 3 C. 27 RV. 33 LV. = 142 I.

Live: 6 F. 4 M. 1 J.

Southern Irish Sea

Dead					Live	
F. -	03 C.	07 RV.	10 LV.		04	
M. -	06 C.	03 RV.	12 LV.	= 43 I.	10	= 5 I.
J. -	00 C.	05 RV.	02 LV.		00	

Caernarvon Bay

Dead					Live	
F. -	01 C.	04 RV.	03 LV.		02	
M. -	01 C.	03 RV.	08 LV.	= 41 I.	01	= 4 I.
J. -	03 C.	10 RV.	18 LV.		01	

Malin Sea

Dead					Live	
F. -	02 C.	14 RV.	07 LV.		00	
M. -	02 C.	11 RV.	20 LV.	= 58 I.	02	= 2 I.
J. -	00 C.	12 RV.	13 LV.		00	

Sample Distribution (live occurrence is underlined)

Southern Irish Sea

801 803 827 868 881 906 2359 2365 2369 2370 2372
2375 2764 2780 2789 2791 2822 2904 2906

Caernarvon Bay

2385 2393 2399 2400 2406 2424 2443 2456 2467 2637
2638 2642 2771 2827 2339 2840 2844 2896 2921 2923
HHII

Malin Sea

3004 3014 3090 3099 3101 3103 3112 3115 3130 3140
3150 3157 3162

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	8	. 11A/12	0.772	0.333
	LV.	"	8	. 10A/11	0.749	0.328
M.	RV.	"	8	. 8A/9	0.744	0.306
	LV.	"	8	. 9A/10	0.737	0.321
-1.	LV.	"	8	. 12A/13	0.657	0.266

Female valves - sample 868 (18.3 m, mixed sand), male valves - sample 2365 (40 m, mixed sand) and juvenile left valve - sample 2375 (23.8 m, fine sand + silt) southern Irish Sea.

Description

The carapace morphology is described and illustrated by Wall (ms. 1969, p. 372, pl. 43). The soft parts are figured in part by Sars (1928, pl. 117, fig. 1).

Ontogeny

A large number of penultimate instars were recognised. The dimensions of adults and juveniles from a number of samples in the southern Irish Sea and Caernarvon Bay are given as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.730-0.810	0.310-0.345	44	
	Mean	0.770	0.332		2.31
M.	Range	0.720-0.775	0.290-0.325	34	
	Mean	0.745	0.312		2.40
-1.	Range	0.610-0.660	0.245-0.275	12	
	Mean	0.638	0.260		2.45

Sars (1928, p. 258-259) indicates that sexual dimorphism is slight. Male instars are proportionately longer and tend to be smaller than the females.

See: Wall (ms. 1969, p. 373).

Remarks

That illustrated by de Vos (1957, p. 58, pl. 23, fig. 2 a i), as P. ensiforme is too produced posteriorly to be the Brady species sensu stricto. The Roscoff Bay material compares more favourably in shape and size to P. angustatum Müller. In addition, material figured from the Antwerp Crag in Brady (1878, p. 406, pl. LXIV, figs. 2) is also distinct.

See: Wall (ms. 1969, p. 373-374) and Whittaker (ms. 1972, p. 244).

Study Area Ecology

Isolated live adults in the southern Irish Sea occurred between 9-33.5 m on coarse sand with gravel and mixed sands. Other live material was found in 13-73 m of Caernarvon Bay, with two further adults recorded in the given sediments from 77 m and 82 m, Malin Sea.

Otherwise, in the southern Irish Sea specimens ranged between 9-97 m, mean 35.3 m in a variety of sediments from coarse sand and gravel to silts with clay. Most material occurred within 18.3-80.5 m in mixed sand and fine sand with silt. Isolated individuals were recovered from the intertidal of Holyhead Harbour and within 146.3 m, mean 59.9 m, in coarse sand with gravel and mixed sand of Caernarvon Bay. In the Malin Sea specimens occurred between 22-140.8 m, mean 71.8 m, in the given sediments and were most common within 54.9-77 m. An assemblage of adults was recovered in sampe 3101, south of Islay, 55 m, fine sand and silt.

Palaeoecology and Distribution

A single specimen was recovered in mud and sand, 15 m, from Russian Harbour, Novaya Zemlya (Neale and Howe, 1975) and live specimens have been found in several places, 6-48 m, of S.W. and S. Norway (Sars, 1890, 1891, 1928). P. ensiforme is more common in algae on the Swedish west coast, mostly between 5-18 m, and is often alive on sand or coarse cobble detritus in 50 m+ (Elofson, 1941). The last author comments that it may tolerate 0-22°C in salinities of 27‰+.

Material is frequently encountered in open marine estuaries of the Netherlands (Brady and Robertson, 1870; Brady and Norman, 1889; Redeke and Dulk, 1940), though occurs to a lesser extent in the Shetlands and off E. Scotland (Brady, 1868; Brady and Robertson, 1872). Most records in the North Sea region are from Northumberland, Durham and E. Yorkshire. From which region, it is generally common in intertidal algae and is often dredged in algae encrusted shelly gravel, 28-55 m, (Brady, 1870; Brady and Robertson, 1872, 1874, 1876). The range also extends to the Fens and Thames estuary, but Brady (1868) and Brady and Robertson (1872) mention nothing of its abundance there.

Rare live material has been found on sands, 80-140 m, off N.W. Scotland and, otherwise, occurs commonly in the muds and sands below 60 m in the Minch (C.S. Harris, ms. 1977). It ranges commonly on hard and soft ground, 8-55 m, of the Clyde (Robertson, 1874) and in numerous inner Bay localities, 6-28 m, around Ireland (Brady and Robertson, 1869; Norman, 1905; Hoskin, ms. 1976). Wall (ms. 1969) indicated that whilst _P. ensiforme_ was moderately common in sediments all over Cardigan Bay, W. Wales, rare live material occurred mostly within 10 m associated with encrusted cobbles in temperatures down to 7°C. There are numerous reports of it from river mouths and the near shore of N. and S. Devon and Cornwall and Scilly Isles (Brady, 1868; Brady and Robertson, 1872; Norman and Scott, 1906; Harding, 1957). Indeed, Neale (1970, 1974) described it as the most common _Paradoxostoma_ species, 11-52 m, of the latter region. However, the last author in conjunction with the findings of Brassil (ms. 1977) and Lomax (ms. 1978) recorded only isolated material in offshore areas of the Celtic Sea and Western Approaches.

Whittaker (ms. 1972) recovered dead material in sublittoral algae and organic rich muds of Dorset and there are reports of it from the Channel Isles (Brady and Robertson, 1872; Norman, 1907, 1908). Isolated live material is also reported in Fucus, 15-18‰, of the Gironde Estuary and in intertidal Zostera of Arcachon Basin, 27‰+ salinity (Yassini, 1969). In accordance with both Brady and Norman (1889) and Peypouquet (1971), the last author found isolated specimens reworked between 28-120 m, mostly 100 m+, on the open shelf of S. Biscay. Which occurrence with that in carbonate sands, 12-75 m, in Vigo Bay, N.W. Spain (Brady and Norman, 1880, 1889; Ralph, ms. 1977) is probably representative of fossil material.

There is no accurate record of this species in the Mediterranean. However, the reports of Kruit (1955) and Kurc (1961) suggest that a very similar species is alive in the Rhône Delta and in other parts of the Marseilles coast.

The fossil distribution of P. ensiforme is widespread. Material occurs rarely in the sub-Recent and Holocene of the southern Irish Sea (Wall and Whatley, 1971; Spencer, ms. 1976; Haynes et.al., 1977) and Gironde Estuary, Gascony (Moyes, 1974). However, it appears to be locally common in the Late Glacial of Clyde (Robertson, 1877), S.W. Scotland and N.E. Ireland (Brady et.al., 1874; Graham and Wilkinson, 1978), S. Wales (Brady et.al., 1874). It occurs rather rarely in comparable marine deposits of Biscay (Caralp et.al., 1970; Moyes and Peypouquet, 1971). Moderate numbers have been recovered from the last interglacial (Ipswichian) of the southern Irish Sea (Jasin, ms. 1976), Somerset (Kidson et.al., 1978) and Sussex (Whatley and Kaye, 1971). Lastly, Brady et.al. (1874) and Neale and Howe (1975) record it from the Hoxnian interglacial of E. Yorkshire.

Summary

There is an isolated report of it from Novaya Zemlya, 75°N, 55°E, though *P. ensiforme* is more generally distributed alive in S.W. Norway, the Skagerrak and E. Britain, 60-54°N. Live material ranges in moderate numbers throughout Britain, adjacent waters and south to central Biscay, 45°N. Sub-Recent and Holocene specimens are rare, found in deep water off N.W. Scotland, in the Irish Sea, Biscay and off N.W. Spain, 58-43°N. Recorded commonly in the Late Glacial of Clyde, S.W. Scotland, N.E. Ireland and the outer shelf of Biscay, 56-44°N. *P. ensiforme* is also reliably recorded in the last interglacial of the Irish Sea, Somerset and Sussex, 54-50°N and occurs in the Hoxnian of E. Yorkshire, 54°N.

This is a mostly phytal species, recorded alive in the intertidal and sublittoral, 5-18 m of estuarine bays. Live material is also distributed locally down to 50 m+, associated with encrusted shelly gravel or cobbles and with organic rich muds and sands. Recent material is widespread in the littoral and is sometimes reworked with fossil individuals down to 100-150 m approx. Lastly, this is a fully marine species, alive in 27‰+ salinity and 0-22°C+.

Paradoxostoma *sp*. *cf*. *P*. *hibernicum* Brady, 1868
pl. 36 figs. j-m

1868 *Paradoxostoma hibernicum* n.sp. Brady: p. 460, pl. XXXV, figs. 35, 36; pl. XL, fig. 7.

1870 *Paradoxostoma hibernicum* Brady; Brady: p. 362, pl. XII, figs. 10, 11.

Material

Southern Irish Sea + Total

Dead					Live
F.	- 01 C.	00 RV.	00 LV.	= 2 I.	00
Adult	- 01 C.	00 RV.	00 LV.		

Sample Distribution

Southern Irish Sea
2375

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.?	RV. external	1	. 22/22A	0.650	0.316
	LV. "	1	. 19/19A	0.633	0.304
Adult	RV. "	1	. 20/20A	0.600	0.300
	LV. "	1	. 21/21A	0.624	0.300

Description

See: Brady (1868, p. 460, pl. XXXV, figs. 35, 36; pl. XL, fig. 7) for a description and illustration of the hard and soft parts of P. hibernicum Brady.

Ontogeny

Juveniles were not recognised.

Remarks

The few specimens,herein,are in many respects comparable to that described and illustrated by Whittaker (ms. 1972, p. 256-257, pl. 46, figs. 1-5) as P. sarsiense Brady. Indeed, Whittaker (ms. 1972, p. 254) indicates that most records of P. hibernicum should more properly refer to P. sarsiense. However, this last species differs from the southern Irish Sea material in possessing a straight dorsal margin and a prominent keel. Therefore, until more material becomes available the present author designates both carapaces as Paradoxostoma sp. cf. P. hibernicum.

Study Area Ecology

Two adults were recovered from 23.8 m, fine sand with silt, southern Irish Sea.

Palaeoecology and Distribution

The species is only accurately recorded from a few localities. Found in moderate numbers in intertidal rockpools near Boulmer and to a lesser extent off Durham (Brady, 1870). Brady (1868, 1870) recorded it in Loch Carron and around Arran, S.W. Scotland and recovered material associated with intertidal algae of several localities west of Ireland. Lastly, isolated specimens are reported reworked into deeper waters of the Celtic Sea (Brassil, ms. 1977).

Frame (ms. 1977) indicates that comparable material occurs in the Holocene of Rockall Trough, 200 miles west of Scotland.

Summary

The geographical distribution is not known. Moderate numbers are recorded alive from E. Britain, S.W. Scotland and W. Ireland, 52-56^{O}N approx. Isolated sub-Recent or Holocene material may also range to Rockall Trough and the Celtic Sea, south to 50^{O}N.

It appears to be a marine intertidal and sublittoral species which is associated with algae in the cool temperate of N.W. Europe.

Paradoxostoma normani Brady, 1868

pl. 37 figs. a-f

1868 _Paradoxostoma normani_ n.sp. Brady: p. 458-459, pl. XXXV, figs. 39-40.

1869 ? _Sclerochilus contortus_ (Norman); _var abbreviatus_ Brady and Robertson: p. 372, pl. XX, figs. 15-16 (Juvs.).

1889 _Paradoxostoma normani_ Brady; Brady and Norman: p. 231.

1928 _Paradoxostoma normani_ Brady; Sars: p. 264, pl. CXIX, fig. 2.

1941 _Paradoxostoma normani_ Brady; Elofson: p. 355.

1957 _Paradoxostoma normani_ Brady; Wagner: p. 98, pl. XLVIII.

1969 _Paradoxostoma normani_ Brady; Wall (ms.): p. 378, pl. 42, figs. c, g, h, m-p.

1969 _Paradoxostoma normani_ Brady; Yassini: p. 118, pls. XIV, XIX.

1972 _Paradoxostoma normani_ Brady; Whittaker (ms.): p. 249, pl. 44, figs. 8-10.

1976 _Paradoxostoma normani_ Brady; Hoskin (ms.): p. 284, pl. 24, fig. 10.

1977 _Paradoxostoma normani_ Brady; Rosenfeld: p. 39, pl. 10, fig. 120.

Material

Total Dead: F. - 2 RV. 2 LV.; M. - 2 C. 7 RV. 8 LV.; J. - 2 C. 9 RV. 9 LV. = 36 I.

Live: 2 F. 5 M. 14 J.

Southern Irish Sea

Dead					Live	
F. - 00 C.	00 RV.	01 LV.			02	
M. - 02 C.	02 RV.	05 LV.	= 17 I.		05	= 19 I.
J. - 00 C.	06 RV.	06 LV.			12	

Caernarvon Bay

Dead					Live	
F. - 00 C.	02 RV.	01 LV.			00	
M. - 00 C.	03 RV.	02 LV.	= 4 I.		00	= 2 I.
J. - 01 C.	03 RV.	03 LV.			02	

Malin Sea

Dead				Live
M. - 00 C.	02 RV.	01 LV.	= 15 I.	00
J. - 01 C.	00 RV.	00 LV.		

Sample Distribution (live occurrence is underlined)

Southern Irish Sea

801 803 825 903 906 917 925 926 2359 2365 2367 2369
2375 2381 2822 2904 2905

Caernarvon Bay

2399 2424 2447 2457 2513 2516 2519 2637 2639 2770
2839 2892 2926 HHI

Malin Sea

3099 3101

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	8	. 33A/34	0.598	0.328
	LV. "	8	. 32A/33	0.595	0.336
M.	RV. "	8	. 31A/32	0.540	0.300
	LV. "	8	. 30A/31	0.521	0.300
-1.	RV. "	8	. 35A/36	0.475	0.275
	LV. "	8	. 34A/35	0.470	0.256

Female and juvenile valves - sample 825 (14.6 m, fine sand + silt), male valves - sample 903 (15.2 m, mixed sand), southern Irish Sea.

Description

The carapace morphology is described and illustrated by Wall (ms. 1969, p. 379, pl. 42). The soft parts are figured and described in part by Sars (1928, p. 264-265, pl. CXIX, fig. 2).

Ontogeny

Instars of the penultimate and antepenultimate growth stage were recognised. The dimensions of juvenile and adult material within the study are given below.

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.580-0.620	0.325-0.345	5	
	Mean	0.598	0.333		1.80
M.	Range	0.515-0.550	0.285-0.310	12	
	Mean	0.534	0.298		1.79
-1.	Range	0.455-0.480	0.240-0.280	12	
	Mean	0.468	0.264		1.77
-2.	Range	0.395-0.420	0.195-0.225	8	
	Mean	0.408	0.211		1.93

Sexual dimorphism is not pronounced. Males are smaller and less inflated posteriorly than females.

Remarks

See: Whittaker (ms. 1972, p. 250).

Study Area Ecology

Most live adults and juveniles were recovered in the southern Irish Sea from 14.6-35.1 m, on coarse sand with gravel and fine sand with silt. Two juveniles occurred in coarse sand with gravel from 40 m and 91 m in Caernarvon Bay.

Otherwise, in the S. Irish Sea specimens were dredged between 11-97 m, mean 40-2 m, in a range of sediments from coarse sand + gravel to silt with clay. Isolated material occurred in the intertidal of Holyhead Harbour and ranged in coarse sand with gravel and mixed sand down to 120.7 m, mean 58 m, Caernarvon Bay. Its presence in the Malin Sea was noted in only two samples, 55 m, mixed and fine sand with silt.

Palaeoecology and Distribution

The species is reported from the Faeroe Islands (Stephensen, 1929) and S.W. Norway (Elofson, 1941), though is best documented in Scandinavia from the Skagerrak. In which region, Sars (1928) and Elofson (1941) found live material mostly in the littoral, 0-5-20 m and commonly within 10 m, associated with algae. The last author remarks that *P. normani* has a salinity tolerance of 10/12‰+ , a temperature range of 0-22°C along the W. coast of Sweden and is often dredged in the Skagerrak between 100-380 m. The live distribution extends in the *Fucus* zone to Oresund (Hagerman, 1965, 1966) and as a rarity to Kiel Bay, 17-25‰ salinity (Klie, 1929; Rosenfeld, 1977).

Brady and Robertson (1874) and Brady and Norman (1889) indicate that material is found in *Laminaria*, 10-90 m, off Shetland and Orkneys. However, it appears to be a rarity off E. Scotland, in the Forth and from the littoral of N.E. England (Brady, 1868; Brady and Robertson, 1870, 1874). *P. normani* is commonly recorded in 20-55 m associated with zoophytes and attached gravels of the North Sea (Brady and Robertson, 1874, 1876; Brady and Norman, 1889; Norman and Brady, 1909). Klie (1929) indicates that live material occurs off the Heligoland and it is recorded as *P. normani* and *Sclerochilus contortus* (Norman) var. *abbreviatus* Brady and Robertson, in the Scheldt Estuary (Brady and Robertson, 1870; Redeke and Dulk, 1940). Live material is also common in 0.3-4 m and extends down to 16 m in the Thames Estuary (Kilenyi, 1969) and ranges to Dungeness (Brady and Norman, 1889).

Brady and Robertson (1872) indicate it is a rare species off N.W. Scotland. This has been confirmed by reports of scarce live material found in sublittoral Laminaria of St. Kilda (Pearce, ms. 1977) and from that in a single littoral sample of sand dredged in the Minches by Harris, C.S. (ms. 1977). However, P. normani is commonly recorded from the Antrim coast, in the Laminaria of most Loughs, N. Ireland (Brady and Norman, 1889; Norman, 1905) and is listed from the intertidal and below from many localities east and west of Ireland (Brady and Robertson, 1869; Norman, 1905). It is alive but not common in sublittoral algae, 7-15^{o}C of Caernarvon Bay (Morgan, ms. 1977) and in Corallina and Chondrus, 5-8 m in 10-18.8^{o}C from Cardigan Bay (Wall, ms. 1969), W. Wales. Brady and Robertson (1872) also indicate that this is an uncommon species in S.W. Britain, though it occurs in many localities of N. and S. Devon and Cornwall (Norman and Scott, 1906). Although almost entirely lacking in deeper water dredgings of the Celtic Sea (Brassil, ms. 1977), P. normani is most common in samples of rock scraping, 11-30 m, from the Scillies (Neale, 1970).

Limited numbers range to the Channel Isles (Brady and Robertson, 1872; Norman, 1907) and are recorded in green filamentous and red algae of the Dorset coast (Whittaker, ms. 1972). It occurs in moderate numbers southward to the Gironde Estuary, within which region Carbonel et.al. (1972) record it in Fucus, 15-28‰ salinity. Yassini (1969) found material in Arcachon Basin associated with Zostera in 2-7 m and 27‰+ salinity and recorded reworked specimens on the open shelf of Gascony down to 78 m. Lastly, the few individuals recovered from 78 m in Vigo Bay, N.W. Spain (Ralph, ms. 1977) may represent the southern limit of this species.

There is an isolated record of material in the Holocene of the Barents Sea (Neale and Howe, 1975). However, sub-Recent and Holocene records are more accurately documented from the southern Irish Sea (Wall and Whatley, 1971; Spencer, ms. 1976; Haynes et.al., 1977), Netherlands (Wagner, 1957, 1960, 1964) and in deep water cores of the Gironde Estuary (Moyes, 1974; Carbonel et.al., 1975). Scarce specimens have also been found in the Late Glacial of S.W. Scotland (Peacock et.al., 1978) in marine deposits of central and southern Biscay (Caralp et.al., 1970; Moyes and Peypouquet, 1971) and perhaps in 340-380 m off Cap Breton (Brady and Norman, 1889). Lastly, a few specimens range to the Ipswichian, Last Interglacial of Cardigan Bay (Jasin, ms. 1976) and Somerset (Kidson et.al., 1978).

Summary

P. normani may range west of Norway north to 62°N, though it is most commonly alive in the Skagerrak and deep waters of Shetland and North Sea, 52-60°N. It is locally numerous in shallow, sheltered estuaries and bays throughout Britain, adjacent waters, southwards to 45°N in Biscay. Sub-Recent and Holocene material is reported from Barents Sea, 75°N, 22°E and in deeper waters of S. Scandinavia, Netherlands commonly, Irish Sea, Biscay and off N.W. Spain, 60-43°N. Late Glacial specimens are rare in Scandinavian fiords, raised deposits of S.W. Scotland and from the open shelf of S. Biscay, 60-44°N. It also occurs in the Last interglacial of W. Britain, 51-54°N.

Live material is generally common in the intertidal and sublittoral, 0.5-20 m. It is alive mostly within 10 m of S. Scandinavia, in 10-90 m off Shetland and from 20-55 m of the North Sea, with reworked material found down to 100-380 m in some regions. The species is alive in Laminarian algae, zoophytes and associated coarse shelly gravel beneath in northern waters. However, it occurs more often in bushy and filamentous algae in S. British latitudes and is associated with Zostera in Biscay. The temperature range is 0-22°C in 10/12‰+ salinity, though most records are from near or full marine conditions, 26-28‰+.

Paradoxostoma sp. cf. P. normani Brady, 1868

p. 37 figs. g-m

Material

Total Dead: F. - 2 C. 20 RV. 10 LV.; M. - 2 C. 3 RV. 7 LV.; J. - 3 C. 10 RV. 24 LV. = I.

Live: 3 F. 8 M. 18 J.

Southern Irish Sea

Dead					Live	
F.? -	01 C.	08 RV.	02 LV.		01	
M.? -	02 C.	00 RV.	01 LV.	= 22 I.	02	= 18 I.
J. -	02 C.	06 RV.	06 LV.		15	

Caernarvon Bay

Dead					Live	
F.? -	01 C.	11 RV.	08 LV.		02	
M.? -	00 C.	01 RV.	04 LV.	= 26 I.	06	= 11 I.
J. -	01 C.	02 RV.	12 LV.		03	

Malin Sea

Dead					Live
F.? -	00 C.	01 RV.	00 LV.		00
M.? -	00 C.	02 RV.	02 LV.	= 11 I.	
J. -	00 C.	02 RV.	06 LV.		

Sample Distribution (live occurrence is underlined)

Southern Irish Sea

801 *804* *815* *843* *872* 903 917 923 *2354* 2369 2375 *2780*
2783 2824 *2904*

Caernarvon Bay

2385 *2388* 2392 *2393* 2399 2419 2423 *2442* 2447 *2456*
2467 2516 2642 *2831* 2770 2834 2839 2844 *2893* HHI

Malin Sea

3097 3101 3130 3154 3162

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
Adult	RV.	external	8 .	5A/6	0.548	0.281
		internal	33 .	1/1A		
		"	32 .	7A/8		
		"	32 .	6A/7		
	LV.	external	8 .	3A/4	0.561	0.292
-1?	RV.	"	8 .	38A/39	0.458	0.231
	LV.	"	8 .	39A/40	0.442	0.232

Adult right valve - sample 923 (67.1 m, coarse sand + gravel), adult left valve - sample 2904 (87.8 m, mixed sand + silt), juvenile valves - sample 815 (40.3 m, coarse sand + gravel), southern Irish Sea.

Description

Seen laterally, female R.V. oviform. Anterior margin rounded antero-ventrally, slightly oblique antero-dorsally; extremity just below mid-height. Posterior margin broadly rounded postero-ventrally, postero-dorsally convex; extremity slightly produced and above mid-height. Dorsal margin shallowly and evenly arched, cardinal angles indistinct though vaguely represented antero-dorsally. Ventral margin sinuous, broadly convex posteriorly, antero-medianly a shallow concavity with a slight convexity anteriorly. Greatest height postero-medianly dorsal and ventral margins converge anteriorly. From above, laterally compressed, lenticular, greatest width just behind the middle, margins gradually convergent, extremities acutely pointed, more so anteriorly.

Left valve the larger. Valves thin translucent, smooth. Eyes spots not observed. Normal pores, few, scattered, small, rounded, open.

Inner lamella moderately wide. Inner margin and line of concrescence divergent throughout, subparallel to the outer margin; line of concrescence sub-peripheral. Radial pore canals simple, straight, mostly false, approximately 12-15 in number

Hinge lophodont, the terminal elements comprise a single well defined tooth with a long, narrow, arched, smooth groove between. Corresponding structures are located in the left valve.

Adductor muscle scars a slightly oblique row of 4 scars, elongate longitudinally, especially the middle two. Antero-dorsally two further scars, one of which is much lengthened, the other, behind, small and round.

Ontogeny

Juvenile instars of the penultimate to -3 growth stage are provisionally recognised. The dimensions of these from several samples in the southern Irish Sea and Caernarvon Bay are given as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
-1?	Range	0.440-0.470	0.225-0.245	9	
	Mean	0.458	0.234		1.96
-2?	Range	0.380-0.410	0.180-0.195	9	
	Mean	0.398	0.188		2.12
-3?	Mean	0.315-0.355	0.165-0.170	5	
	Mean	0.331	0.168		1.97

Sexual dimorphism is tentatively proposed. Males are represented by certain of the proportionately longer instars. There is no discernable difference in size between the sexes.

Remarks

The hingement and muscle scar pattern is somewhat similar to that of P. normani Brady. However, Paradoxostoma sp. cf. P. normani may be distinguished by its smaller size, less sinuous ventral margin and by the rather more compressed posterior when seen from above.

Study Area Ecology

Live material was recovered in many areas of the southern Irish Sea and mostly from samples to the south of Howth, in coarse sand + gravel and mixed sand within 27.4-41 m. A number of live individuals were associated with similar sediments, mostly coarse sand with gravel, 12-110 m, Caernarvon Bay.

Otherwise, isolated specimens were found in a variety of deposits from coarse sand + gravel to silts with clay, 11-80.5 m, mean 36.5 m, southern Irish Sea. In Caernarvon Bay it occurs between the tidemarks of Holyhead Harbour and within 124.4 m, mean 49.2 m, in coarse sand with gravel and mixed sand. Scarce material also ranged in the given sediment between 37.170 m, mean 78.3 m, in Malin Sea.

A small assemblage of instars was recorded in mixed sand, 27.4 m, southern Irish Sea and from 46 m in coarse sand with gravel of Caernarvon Bay.

Paradoxostoma sp. cf. *P. obliquum* Sars, 1865

pl. 36 figs. n-v

1866 *Paradoxostoma obliquum* n.sp. Sars: p. 97.

1928 *Paradoxostoma obliquum* Sars; Sars: p. 259, pl. CXVII, fig. 2.

Material

Total Dead: F. - 2 RV. 2 LV.; M. - 3 C. 12 RV. 15 LV.; J. - 2 RV. 1 LV. = 37 I.

Live: 5 M.

Southern Irish Sea

Dead					Live	
F. -	00 C.	01 RV.	02 LV.		00	
M. -	00 C.	05 RV.	09 LV.	= 19 I.	05	= 5 I.
J. -	00 C.	01 RV.	01 LV.		00	

Caernarvon Bay

Dead					Live
F. -	00 C.	01 RV.	00 LV.		00
M. -	02 C.	07 RV.	02 LV.	= 13 I.	
J. -	00 C.	01 RV.	00 LV.		

Malin Sea

Dead					Live
M. -	01 C.	00 RV.	04 LV.	= 5 I.	00

Sample Distribution (live occurrence is underlined)

Southern Irish Sea

<u>815</u> <u>844</u> 914 <u>923</u> <u>925</u> 2359 2361 2366 2369 2370 2375 2765 2780 <u>2902</u> 2904

Caernarvon Bay

2388 2447 2456 2463 2513 2516 2891

Malin Sea
3092 3099 3101 3103

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	8	25A/26	0.624	0.337
		internal	33	3/3A		
		"	33	4/4A		
		"	33	5/5A		
	LV.	external	8	27A/28	0.642	0.342
M.	RV.	"	8	28A/29	0.643	0.319
	LV.	"	8	23A/24	0.646	0.330
-1.	RV.	"	8	2A/3	0.559	0.281
	LV.	"	8	4A/5	0.533	0.283

Female right valve - sample 914 (57.9 m, mixed sand); female left valve - sample 2366 (26 m, mixed sand); male valves - sample 815 (40.3 m, coarse sand + gravel); juvenile valves - sample 2369 (11 m, fine sand + silt), southern Irish Sea.

Description

See: Sars (1928, p. 254-260, pl. CXVII, fig. 2) for a description and illustration of the hard and soft parts.

Ontogeny

Instars of the penultimate growth stage were recognised.

Sexual dimorphism is apparent in that the males are the larger and more elongate of the sexes.

Remarks

The form, herein, is comparable in size and by its up-turned posterior extremity to *P. bradyi* Sars. However, *Paradoxostoma* sp. cf. *P. obliquum* may be distinguished from this latter species by being more produced anteriorly, less inflated in dorsal view and weakly calcified. Records are few, the entire geographical range of *P. obliquum* is probably included in the distribution attributed to *P. bradyi* and other large species of *Paradoxostoma* Fischer.

Study Area Ecology

Live adults were recovered between 36.6-109.7 m on coarse sands with gravel and mixed sand of the southern Irish Sea.

Otherwise, in this above region isolated specimens occurred between 11-109.7 m, mean 49.7 m, in a variety of sediments from coarse sands and gravel to fine sand with silt. Caernarvon Bay material was found in gravel sands and mixed sands within 38.4-109.7 m, mean 65.6 m. A few adults were recovered in the given sediments, 55-91 m, mean 78.5 m, Malin Sea.

Small juvenile assemblages occurred in mixed sand, 80.5 m, southern Irish Sea and in 69.5 m, coarse sand and gravel, Caernarvon Bay.

Palaeoecology and Distribution

The only comparable records are known from shell sand of Oxfiord, Finmark and in the littoral algae of the Lof ten Isles, N. Norway (Sars, 1866, 1928).

Summary

This species is known only from N. Norway, 68-70°N, though without doubt *P. obliquum* extends much further south in European waters.

Its ecology is almost unknown. _P_. _obliquum_ appears to be a sublittoral and littoral phytal species in fully marine arctic waters.

Genus _Cytherois_ G.W. Müller, 1894

Cytherois _fischeri_ Sars, 1866

pl. 37 figs. n-o

1866 _Paradoxostoma_ _fischeri_ n.sp. Sars: p. 96.

1870a _Paradoxostoma_ _fischeri_ Sars; Brady: p. 363, pl. XII, figs. 1-3.

1874 _Paradoxostoma_ _fischeri_ Sars; Brady, Crosskey and Robertson: p. 215, pl. XVI, figs. 23-24.

?1884 _Cytherois_ _virens_ n.sp. Müller: p. 16, pl. 2, figs. 10-13.

1889 _Cytherois_ _fischeri_ (Sars); Brady and Norman: p. 228, pl. XXI, figs. 20-22.

1928 _Cytherois_ _fischeri_ (Sars); Sars: p. 253, pl. CXIV.

1938 _Cytherois_ _fischeri_ (Sars); Klie: p. 221, t.figs. 759-760.

1941 _Cytherois_ _fischeri_ (Sars); Elofson: p. 347.

1957 _Cytherois_ _fischeri_ (Sars); Wagner: p. 99, pl. XLIX.

1966 _Cytherois_ _fischeri_ (Sars); Theisen: p. 248.

1969 _Cytherois_ _fischeri_ (Sars); Yassini: p. 122, pl. V-IX, XIII, XV.

1972 _Cytherois_ _fischeri_ (Sars); Whittaker (ms.): p. 261, pl. 49, figs. 1-3; pl. 50, figs. 1-10.

1976 _Cytherois_ _fischeri_ (Sars); Hoskin (ms.): p. 285, pl. 26, figs. 4-5.

1977 _Cytherois_ _fischeri_ (Sars); Rosenfeld: p. 40, pl. 10, fig. 122.

Material

Total Dead: J. - 4 C. 2 RV. 2 LV. = 8 I.
Live: 2 J.

Southern Irish Sea

Dead	Live
J. - 03 C. 01 RV. 01 LV. = 5 I.	02

Caernarvon Bay

Dead	Live
J. - 01 C. 01 RV. 01 LV. = 3 I.	00

Sample Distribution (live occurrence is underlined)

Southern Irish Sea
815 <u>872</u> 2915

Caernarvon Bay
2395 2828 HHII

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
-3?	RV. external	22	. 37A/38	0.370	0.161
-1.	LV. "	22	. 34A/35	0.440	0.192

Juvenile right valve - sample 815 (40.3 m, coarse sand + gravel), juvenile left valve - sample 2915 (33 m, silt + clay), southern Irish Sea.

Description

See: Whittaker (ms. 1972, p. 263-264, pl. 49, 50) for a description of the hard parts and an illustration of both carapace morphology and soft parts.

Ontogeny

Juveniles only were recognised and tentatively ascribed as the penultimate to -3 growth stage of this species. The ontogeny is discussed by Theisen (1966, p. 248-250).

Remarks

An isolated report of C. fischeri illustrated in Hulings (1967, p. 650, fig. 6j) from the western N. Atlantic is an entirely distinct species.

Unfortunately, the present author has not had the opportunity to study illustrations of the neopolitan species C. virens Müller which some authors consider conspecific.

See: Whittaker (ms. p. 264-265).

Study Area Ecology

Live specimens occurred on mixed sand in 27.4 m of sample 872, southern Irish Sea.

Otherwise, the south Irish Sea instars were recorded between 27.4-40.3 m in a variety of sediments including coarse sand + gravel and silt with clay. A few individuals were also found in the intertidal of Holyhead Harbour and in coarse sand + gravel within 55 m of Caernarvon Bay.

Palaeoecology and Distribution

Brady and Norman (1889) and Sars (1866, 1928) found it alive associated with intertidal and tidepool algae of Oslo Fiord and other areas of S. Norway. In addition, Elofson (1941) recovered live material in algae and on sand and coarse detritus from 0.5-14 m, 0-22°C and in 3‰+ salinity of Gullmar and Koster Fiords, W. Sweden. The species extends in these ecological conditions to Oresund (Hagerman, 1965), Kiel Bay and Ostsee, 6-17 m (Klie, 1929, 1938; Rosenfeld, 1977) and coast of Pommerania, W. Baltic (Müller, 1884; Brady and Norman, 1889;

Schafer, 1953). Further, C. fischeri ranges throughout the Baltic, 0-10 m, mostly in 3-5 m (Hirschmann, 1912, 1915) to the Gulf of Finland, in which region the last author and Hagerman (1967) found it abundantly alive within 5-6‰ salinity.

Otherwise, it ranges alive in abundance from the Danish coast (Theisen, 1966) to the Heligoland and Netherlands estuarine (Brady and Robertson, 1872; Redeke and Dulk, 1940). It is also common in brackish pools of the Forth Estuary (Brady and Robertson, 1872; Scott, 1890) and moderately common in intertidal and shallow estuarine muds of N.E. England and the Fens (Brady, 1870; Brady and Robertson, 1872; Brady and Norman, 1889). Moderate numbers have been dredged in muds and sand of several areas, 60-70 m off N.E. England (Brady and Robertson, 1874, 1876; Norman and Brady, 1909) and extends to the Thames Estuary (Brady and Robertson, 1872).

A solitary live specimen occurred in the high marsh of N. Uist, Western Isles (Pearce, ms. 1977). Otherwise, C. fischeri is locally common in 12-38 m on muds of the Clyde (Brady and Robertson, 1872; Robertson, 1874). It ranges in N. Ireland from the Antrim coast to Lough Foyle (Norman, 1905) and occurs, often in super abundance, in upper estuarine areas of W. Ireland (Brady and Robertson, 1872; Norman, 1905; Farran, 1913; Hoskin ms. 1976). Norman (1905) records the species in Dublin Bay and Belfast Lough and reports material with Brady (1903) in brackish pools above high water of Dundrum Bay, E. Ireland. Isolated reworked material has been found offshore in carbonate sands of the southern Irish Sea (Brady and Robertson, 1872), Celtic Sea (Lomax, ms. 1978) and in several river mouths of N. and S. Devon, Cornwall and the Scillies

(Brady and Robertson, 1872; Norman and Scott, 1906; Harding, 1957; Neale, 1970).

Its ecology is best documented by Whittaker (ms. 1972), who found C. fischeri to be one of the dominant species in the Fleet and Christchurch Harbour, Dorset. The last author found most material in tidepools, associated with filamentous green algae and Zostera and in sublittoral sheltered areas on muds and fine sand, 4-36‰ salinity and 1-26^{o}C. Rare live specimens are recorded in intertidal and shallow algae, 15-28‰ salinity, of the Gironde Estuary (Carbonel et.al., 1972; Carbonel, 1973; Boellmann et.al., 1977). However, in the sheltered Arcachon Basin and adjoining waterways it is recovered in abundance, alive in Zostera and on sands within 10 m and in 7-35‰ salinity (Yassini, 1969).

There is an isolated report, as C. virens Müller, from the W. Mediterranean though this remains unconfirmed.

As a fossil, C. fischeri occurs in the Holocene of the Netherlands (Wagner, 957, 1960, 1964); Gironde Estuary (Moyes, 1974; Carbonel et.al., 1975) and is dubiously reported in the Holocene of the N. Adriatic (Ascoli, 1967). The Late Glacial record extends from the Clyde, in moderate numbers (Brady et.al., 1874; Robertson, 1877; Anderson, 1948), to Belfast and Cardiff (Brady et.al., 1874) and in abundance to the outer Biscay shelf (Carbonel and Pujos, 1973). It also occurs in great numbers in the Ipswichian from Somerset (Kidson et.al., 1978) and is common in the Eemian, Last interglacial of Sussex (Bell , 1891; Whatley and Kaye, 1971). Reports of C. fischeri in the Quaternary of S. Italy and Sicily (Segguenza, 1883; Ruggieri, 1953; Ascoli, 1967) are not illustrated and are so geographically isolated from the general distribution as to be considered entirely speculative.

Summary

This species is abundantly alive in the Skagerrak and throughout the Baltic and Gulf of Finland. It also extends in localised abundance to British and adjacent latitudes, southward to Central Biscay, 60-45°N. There is a solitary report of live specimens in the Gulf of Naples, 41°N, which may refer to a distinct species. Material occurs in the Holocene of the Netherlands and Gironde, 52-46°N and is dubiously reported in that of the N. Adriatic, 46°N. A moderate abundance of *C. fischeri* is recorded from the Late Glacial of S.W. Scotland, N.E. Ireland, S. Wales and the outer shelf of Biscay, 56-44°N. Large numbers of specimens also range to the Ipswichian of Somerset and Sussex, 50-51°N.

C. fischeri is recorded as a dominant species in sheltered upper estuarine or lagoonal areas in W. European waters. It is found mainly in intertidal pools and the sublittoral, 0.5-14 m, and occurs mostly within 3-5 m. Localised populations range alive down to 38 m in extensive open estuaries and may be seldom reworked down to 60-70 m. The species is primarily associated with *Zostera*, *Laminaria* and filamentous algae and occurs in the organic rich sands, muds and algal debris below. The salinity tolerance is 3-35‰, mostly 5-6‰, in 0-26°C.

Cytherois vitrea (Sars), 1866

pl. 37 figs. p-q

1866 *Paradoxostoma vitreum* n.sp. Sars: p. 95

1889 *Paradoxostoma vitreum* Sars; Brady and Norman: p. 272, pl. XXI, figs. 27, 28.

1928 *Cytherois vitrea* (Sars); Sars: p. 253, pl. CXV, fig. 1.

1936 *Cytherois vitrea* (Sars); Klie: p. 71, figs. 49-50.

1938 *Cytherois vitrea* (Sars); Klie: p. 223, figs. 770-774.

1941 *Cytherois vitrea* (Sars); Elofson: p. 122.

Material

Caernarvon Bay + Total

Dead	Live
F. - 00 C. 00 RV. 01 LV. = 1 I.	00

Sample Distribution

Caernarvon Bay
2642

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	LV. external	21 .	23/23A	0.462	0.208
	internal	32 .	23A/24		

Description

The hard and soft parts are best described and illustrated by Sars (1928, p. 253-254, pl. CXV).

Remarks

This is a very distinctive species, differing from *C. fischeri* Sars by its more compressed form in dorsal view and in possessing an almost straight ventral margin.

Study Area Ecology

A single adult instar was recovered from 82.3 m in coarse sand with gravel, Caernarvon Bay.

Palaeoecology and Distribution

A single specimen recorded as Paracytherois cf. vitrea may extend the range north to Russian Harbour, Novaya Zemlya (Neale and Howe, 1975). Otherwise, there is a report of this species from the Faeroes (Brady and Norman, 1889; Stephensen, 1929) and it occurs alive in Scandinavia ranging throughout W. Norway to the Lofoten Isles, 35-90 m (Sars, 1866, 1891, 1928). Most records of this species are from S. Norway, 6-48 m (Brady and Norman, 1889), though Elofson (1941) comments that it is not abundant in the Skagerrak. The last author found live material associated with Zostera, mostly in the lower algal zone or below, on coarse detritus in 2-19°C and 17‰+ salinity. C. vitrea also extends alive in the phytal zone and beneath on algal debris to the Oresund (Hagerman, 1965) and to Kiel Bay and the West Baltic (Klie, 1929, 1938). In the last region it occurs on Amphioxus debris and within 8 m on Laminaria (Schafer, 1953).

Live material is known in the Laminaria of Balta, Shetlands (Brady and Norman, 1889), off the Heligoland (Klie, 1929, 1936, 1938) and has been found in the south eastern North Sea.

Isolated live material also occurs off the Scillies, associated with intertidal stones and boulders (Neale, 1970).

Summary

This species may extend to the E. Barents Sea, 75°N, though is recorded alive only south of 68°N, west of Norway. Live material may range from the Faeroes and Shetlands in greater numbers to the Skagerrak and W. Baltic and is found in reduced numbers throughout the North Sea. It has also been recorded from the Scillies, 50°N.

Found alive in 38-90 m off N.W. Norway, but occurs more commonly in 6-48 m and between the tidemarks of the Skagerrak and British waters. *C. vitrea* is primarily associated with intertidal *Zostera*, *Laminaria*, algal debris and coarse shelly gravel beneath. Neale (1964) gives it a salinity tolerance of 12-35‰, in waters of 2-19°C.

Cytherois sp.

pl. 38 figs. a-d

Material

Total Adults: 2 C. = 2 I.

Southern Irish Sea

Dead	Live
Adult - 01 C. 00 RV. 00 LV. = 1 I.	00

Caernarvon Bay

Dead	Live
Adult - 00 C. 01 RV. 00 LV. = 1 I.	00

Sample Distribution

Southern Irish Sea
2375

Caernarvon Bay
2424

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
Adult	RV. external	21	. 21/21A	0.610	0.257
	internal	27	. 35/35A		
	"	32	. 25A/26		
	"	32	. 24A/25		

The adult specimen is from sample 2424 (80.5 m, coarse sand + gravel), Caernarvon Bay.

Remarks

Cytherois sp., herein, accords in most respects with the description of hard parts given for *C. fischeri* Sars in Whittaker (ms. 1972, p. 263-264). Its shape in lateral view and size also closely approximate the male of the Sars species. However, the two Irish Sea specimens may be distinguished by their more inflated form, seen dorsally, being widest behind the middle and in bearing a heavily calcified shell.

Study Area Ecology

Live material was not found.

A single adult carapace occurred in fine sand with silt, 22.8 m, in the southern Irish Sea. One other adult instar was recognised in coarse sand with gravel, 80.5 m, off Lleyn Peninsula, Caernarvon Bay.

Genus *Paracytherois* G.W. Müller, 1894

Paracytherois flexuosum (Brady), 1866

pl. 38 figs. e-g

1866 *Bythocythere? flexuosa* n.sp. Brady: p. 211.

1868 *Paradoxostoma flexuosum* Brady; Brady: p. 461, pl. XXVI, figs. 30-34.

1872 Paradoxostoma flexuosum Brady; Brady and Robertson: p. 55, pl. 1, figs. 8-9.

1874 Paradoxostoma flexuosum Brady; Brady, Crosskey and Robertson: p. 216, pl. XVI, figs. 19-20.

1874 Paradoxostoma tenerum n.sp. Brady, Crosskey and Robertson: p. 217, pl. XVI, figs. 21-22.

1889 Paradoxostoma flexuosum Brady; Brady and Norman: p. 236, pl. XXI, figs. 11-12.

1928 Paracytherois flexuosa (Brady); Sars: p. 250, pl. CXIII, fig. 2.

1941 Paracytherois flexuosa (Brady); Elofson: p. 347.

1969 Paracytherois flexuosum (Brady); Wall (ms.): p. 375, pl. 41, figs. g-m, o-p.

1969 Paracytherois flexuosa (Brady); Yassini: p. 124, pl. XIV.

1972 Paracytherois flexuosa (Brady); Whittaker: p. 276, pl. 53, figs. 4, 5.

1975 Paracytherois flexuosa (Brady); Bonaduce, Ciampo and Masoli: p. 121, pl. 71, figs. 6-8.

1976 Paracytherois flexuosa (Brady); Hoskin (ms.): p. 285, pl. 24, figs. 4-5.

Material

Total: F. - 1 C. 2 RV. 2 LV.; M. - 4 RV.; J. - 1 RV. = 10 I.

Southern Irish Sea

Dead	Live
M. - 00 C. 03 RV. 00 LV. = 3 I.	00

Caernarvon Bay

Dead	Live
F. - 01 C. 02 RV. 02 LV. = 5 I.	00

Malin Sea

Dead	Live
M. - 00 C. 01 RV. 00 LV. J. - 00 C. 01 RV. 00 LV. = 2 I.	00

Sample Distribution

Southern Irish Sea
2904

Caernarvon Bay
2385 2395 2456

Malin Sea
3101 3140

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	9 .	34/34A	0.551	0.190
	"	9 .	36/36A		
	LV. "	9 .	35/35A	0.575	0.182

Female right valve - sample 2456 (50 m approx.), female left valve - sample 2385 (54.9 m), coarse sand + gravel, Caernarvon Bay.

Description

See: Wall (ms. 1969, p. 375-376, pl. 41) for a description and illustration of the carapace morphology. The soft parts are not described in the literature.

Ontogeny

A single penultimate juvenile is provisionally recognised.

Sexual dimorphism is moderate, males are smaller and proportionately more elongate than the females.

Remarks

Several authors consider P. flexuosum and P. striata Müller synonymous. However, the neapolitan species is distinct and the distribution of P. flexuosum is now recognised by

Bonaduce et.al. (1975, 1977) to be much more restricted in the Mediterranean than previously thought.

See: Wall (ms. p. 376, 377).

Study Area Ecology

Live material was not recovered.

In the southern Irish Sea several instars were recovered from 80.5 m. Isolated individuals occurred in 54.9-100 m from Caernarvon Bay, and ranged between 32.9-54.9 m, associated with coarse sand + gravel and mixed sand, Malin Sea.

Palaeoecology and Distribution

There are isolated reports of material in 180 m off Disko Island, W. Greenland (Stephensen, 1913) and in the Davis St. (Brady and NOrman, 1889), though these occurrences have not yet been substantiated by other authors.

Material, as P. cf. flexuosa, may occur in limited numbers in the Barents Sea and around Frans Joseph Land (Scott, 1889; Neale and Howe, 1975). However, the species is better documented in S.W. Norway and the Skagerrak. Within which region, live material has been recovered from Hardanger Fiord, 6-75 m, Drobak and Christiania, Oslo Fiord, 55-180 m (Brady and Norman, 1889; Sars, 1928). Isolated live material is known in Gullmar Fiord, W. Sweden, 1.5-10 m, associated with holdfasts of Fucus and algal debris. There is also a report of it by Klie (1929) in the Ostsee, W. Baltic, though the author does not confirm this record in his 1938 Monograph.

P. flexuosum is moderately common in the Shetlands (Brady and Robertson, 1872; Brady and Norman, 1889), but is found more rarely further south (Brady and Robertson, 1872).

To occur in the Forth Estuary (Brady and Norman, 1889; Scott, 1890), estuarine muds of N.E. England (Brady and Robertson, 1870, 1872) and alive in zoophytes and associated gravel, 38-55 m and perhaps down to 90 m, in the North Sea (Brady and Robertson, 1870, 1874, 1876; Brady and Norman, 1889). Brady (1868) and Brady and Robertson (1872) found it ranging to the Thames Estuary and off Dungeness, Kent and record it alive in the estuarine Netherlands. This is confirmed by Redeke and Dulk (1940).

Material has been found off N.W. Scotland (Brady and Robertson, 1872), 90 m+ and in mixed sand with mud of the Minches (Brady, 1866, 1868; Harris, C.S., ms. 1977). It occurs commonly on various bottoms, 6-55 m of the Clyde Estuary (Brady and Robertson, 1972; Robertson, 1874; Brady and Norman, 1889). Further, it occurs in most sea loughs and sheltered estuarine areas around Ireland and particularly off the west coast (Brady and Robertson, 1869, 1872; Brady and Norman, 1889; Norman, 1905; Farran, 1913), within 4-28 m (Brady, 1868). A single live individual and dead material occurs in 20 m on hydroid encrusted boulders and bivalve shells of Cardigan Bay (Wall, ms. 1969) and isolated dead material has been dredged from the deeper waters of the Irish Sea (Brady and Robertson, 1872; Brady and Norman, 1889). A solitary instar was also recovered in coarse sand and gravel in the Celtic Sea (Brassil, ms. 1977).

Although a rarity in S.W. Britain (Brady and Robertson, 1872) it has been recovered from several river mouths of N. and S. Devon, Cornwall and Scillies (Brady, 1868; Norman and Scott, 1906; Harding, 1957; Neale, 1970).

In the English Channel rare dead material is recorded in the sublittoral of Weymouth Bay and Christchurch Harbour, Dorset (Whittaker, ms. 1972) and there is a record of it from the Channel Isles (Norman, 1907, 1908). Several live specimens were also found in Zostera, 2-8 m and in 27‰+ salinity of Arcachon Basin (Yassini, 1969). In addition, reworked material has been found by Brady and Norman (1889) and Peypouquet (1971) in 104-140 m+, mostly 118 m+ in S. Biscay.

The distribution of P. flexuosum is not fully understood in the Mediterranean. It is, however, found as a rarity in 69-89 m of the Ligurian Sea, W. Mediterranean (Bonaduce et.al., 1977) and in 106 m+, mostly 170 m, in sand and silts of the S. Adriatic (Bonaduce et.al., 1975). It may also occur in moderate abundance, as P. striata, in Posidonia and calcareous algae from the Gulfs of Marseilles (Reys, 1963, 1965) and Naples (Puri, 1963; Puri et.al., 1964).

Late Glacial and Holocene material is reported from the Upper Clyde region (Anderson, 1948) and, as P. tenerum n.sp. (Brady et.al., 1874), from several other localities of S.W. Scotland and Cardiff. Contemporaneous records also extend to the Gironde Estuary (Carbonel et.al., 1975) and deep waters, 360-1800 m of S. Biscay (Brady and Norman, 1889; Yassini, 1969; Moyes and Peypouquet, 1971). Finally, a dubious reworked record, as P. striata, may extend down to 150-1226 m in certain parts of the Mediterranean (Puri et.al., 1969).

Summary

Live material occurs mostly off S.W. Norway, Shetlands and N. Britain, 60-54°N. It also ranges more rarely to the

Skagerrak and W. Baltic, throughout British and adjacent waters, Biscay and the W. Mediterranean, south to 36°N. That recovered in deep water of the Barents Sea, south of 79°N and off Greenland, 60-70°N may refer to another species. Rare Holocene material may be found in deep waters throughout the geographical range, 36-60°N. Scarce Late Glacial specimens have been recovered from raised beach deposits of W. Scotland, S. Wales and deep waters of S. Biscay and the W. Mediterranean, 36-56°N.

P. flexuosa is found alive in the sheltered estuarine intertidal and sublittoral, 1.5-10 m, in Zostera, various algae and beneath down to 30 m on algal debris, organic rich mud and encrusted cobble sands. Isolated live specimens and fossil material may occur down to 180 m approx. Holocene material is found in moderate numbers below 118 m in S. Biscay and in 170 m of the S. Adriatic. It is also possible that material of Late Glacial age has been dredged in 360-1800 m from the Gulf of Gascony and down to 1,200 m+ in the W. Mediterranean. Most reports indicate a full or near marine habit, 27‰+ salinity, in cool and warm temperate waters.

Paracytherois sp. cf. P. arcuata (Brady), 1868
pl. 38 figs. h-l

1868a Paradoxostoma? arcuatum n.sp. Brady: p. 461, pl. XXXV, figs. 37-38.

1874 ?Paradoxostoma arcuatum Brady; Brady, Crosskey and Robertson: p. 217, pl. XVI, fig. 25.

1889 ?Paradoxostoma arcuatum Brady; Brady and Norman: p. 234, pl. XXI, figs. 5, 6.

1928 Paracytherois arcuata (Brady); Sars: p. 249, pl. CXIII, fig. 1.

1938 Paracytherois arcuata (Brady); Klie: p. 220, t.figs. 755-758.

1941 Paracytherois arcuata (Brady); Elofson: p. 346.

1969 ?Paradoxostoma cf. arcuatum Brady; Wall (ms.): p. 361, pl. 41, figs. n, q - t.

1969 ?Paracytherois arcuata (Brady); Yassini: p. 123, pl. XV.

1972 Paracytherois cf. arcuata (Brady); Whittaker (ms.): p. 278, pl. 53, figs. 1-3.

Material

Total Dead: F. - 4 C. 7 RV. 6 LV.; M. - 22 C. 6 RV. 16 LV.; J. - 4 C. 12 RV. 11 LV. = 72 I.

Live: 1 F. 3 M. 3 J.

Southern Irish Sea

Dead				Live
F. - 01 C.	02 RV.	02 LV.		00
M. - 03 C.	00 RV.	02 LV.	= 13 I.	
J. - 01 C.	01 RV.	04 LV.		

Caernarvon Bay

Dead				Live	
F. - 02 C.	02 RV.	02 LV.		01	
M. - 18 C.	02 RV.	05 LV.	= 38 I.	03	= 7 I.
J. - 02 C.	08 RV.	05 LV.		03	

Malin Sea

Dead				Live
F. - 01 C.	03 RV.	02 LV.		00
M. - 01 C.	04 RV.	09 LV.	= 21 I.	
J. - 01 C.	03 RV.	02 LV.		

Sample Distribution (live occurrence is underlined)

Southern Irish Sea

910 917 923 2375 2381 2904 2915

Caernarvon Bay

2392 2395 <u>2424</u> 2443 2447 2449 2463 2513 2515 2519
2637 2638 <u>2640</u> <u>2770</u> <u>2828</u> 2830 <u>2839</u> <u>2840</u> 2892 2922

Malin Sea

3092 3097 3099 3101 3107 3115 3130 3140 3143 3151
3154 3161 3162

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	9	38/38A	0.556	0.203
	LV. "	9	39/39A	0.500	0.185
M.	LV. "	9	37/37A	0.538	0.195
-1.	RV. "	9	40/40A	0.448	0.181
	LV. "	9	41/41A	0.439	0.181

Female valves - sample 923 (67.1 m, coarse sand + gravel), male left valve - sample 910 (25.6 m, mixed sand), southern Irish Sea. Juvenile valves - sample 3097 (37 m, coarse sand + gravel), Malin Sea.

Description

The hard and soft parts are described and illustrated in Sars (1928, p. 249-250, pl. CXIII, fig. 1).

Ontogeny

Instars of the penultimate and antepenultimate growth stage were recognised. The dimensions of these from several samples in the study area are given as follows.

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
-1.	Range	0.430-0.465	0.170-0.185	8	
	Mean	0.450	0.180		2.50
-2.	Range	0.360-0.385	0.145-0.165	6	
	Mean	0.370	0.148		2.50

The size range of adults is pronounced. Sexual dimorphism is slight and expressed by the more elongate and less dorsally arched nature of the male shell.

Remarks

Sars (1928) considered P. rara Müller from the Gulf of Naples to be synonymous. However, Elofson (1941) subsequently refuted this Mediterranean record. In addition, Whittaker (ms. 1972) doubts the affinity of that recorded in the Biscay to P. arcuata sensu stricto.

See: Whittaker (ms. 1972, p. 279).

Study Area Ecology

Live material occurred in Caernarvon Bay between 44-82.3 m and was associated with coarse sand + gravel and mixed sands.

Otherwise, isolated specimens were recovered in many areas of the southern Irish Sea, 21.9-80.5 m, mean 41 m; within 13-131.7 m, mean 70.5 m, of Caernarvon Bay and from 37-170.1 m, mean 90.5 m, in Malin Sea. The species occurred in a variety of sediments from coarse sand and gravel, to fine sand with silt.

Palaeoecology and Distribution

Several species are likely included in the given geographical distribution.

Nevertheless, it would seem to extend in isolated numbers, as P. cf. arcuata to Russian Harbour, Novaya Zemlya (Neale and Howe, 1975) and to Iceland (Brady, 1868). It is rarely alive in deep water hydroids west of Norway (Sars, 1928) and in algae, 1.5-22 m, of the Skagerrak (Elofson, 1941). Live material has also been found in the intertidal and sub-littoral plants of Kiel Bay (Klie, 1929, 1938) and in similar areas, 14-20‰ salinity, of the Oresund (Hagerman, 1965).

A few specimens are reported from St. Magnas Bay, Shetland (Brady, 1868; Norman, 1869; Brady and Robertson, 1872; Brady and Norman, 1889), Orkneys (Scott, 1891), E. Scotland (Brady and Robertson, 1872) and in gravel, 28-55 m, off Durham, N.E. England (Brady and Robertson, 1874, 1876). In addition, there is a single record of material from the Maas Estuary, Netherlands (Brady and Robertson, 1870).

Pearce (ms. 1977) found a moderate abundance of live specimens in the Laminaria of St. Kilda and a number of specimens have been recovered in mixed and fine sand with mud, 68 m, of the Minches (C.S. Harris, ms. 1977). It is also moderately common in certain muddy localities, 38-48 m, in the Clyde (Robertson, 1874). Brady and Robertson (1872) report it as a rare species west of Ireland. Though, it is widely distributed between Roundstone, Clifden and Birterbuy Bays, 8-28 m (Brady, 1868; Brady and Robertson, 1869; Brady and Norman, 1889; Norman, 1905) and occurs off Clare Island (Farran, 1913). Live material is reported in algae, 3-10 m, of Cardigan Bay (Wall, ms. 1969) and a single live individual was found in holdfasts of sublittoral algae from Caernarvon Bay (Morgan, ms. 1977), southern Irish Sea. There is a report of it from Ilfracombe, N. Devon (Norman and Scott, 1906) and Dartmouth, S. Devon (Brady and Norman, 1889), with live specimens taken from a few metres in Corallina of the Scilly Isles (Norman and Scott, 1906; Neale, 1970).

The ecology is best discussed by Whittaker (ms. 1972), who found live specimens in several areas of the Dorset coast. This material occurred in the Fleet and Weymouth Bay, within 14 m in exposed Laminaria, Fucus and Enteromorpha. Whittaker indicated that the salinity tolerance was 26-35‰ in 5-22^{o}C. There are also isolated reports of it in Zostera, 2-8 m and 27‰+ salinity from Arcachon Basin (Yassini, 1969), from Cap Breton in S. Biscay (Fischer, 1876) and in calcareous algae from the Gulf of Naples (Puri et.al., 1964). However, these latter records probably refer to distinct species.

A sub-Recent and Holocene occurrence is documented from Tremadoc Bay, southern Irish Sea (Wall and Whatley, 1971; Spencer, ms. 1976) and from the Gironde Estuary (Carbonel et.al., 1975). Robertson (1885) reports it in moderate numbers in the Late Glacial of Clyde and it may also occur in contemporaneous deposits of Oban, N.W. Scotland (Brady et.al., 1874) and S. Biscay (Moyes and Peypouquet, 1971). Lastly, a few specimens are recorded in the last interglacial, Ipswichian, of Selsey, Sussex (Whatley and Kaye, 1971).

Summary

It may range in the Recent north to Novaya Zemlya, Barents Sea, 75^{O}N, and is possibly alive in deep waters off Iceland and S.W. Norway, south of 65^{O}N. Otherwise, rare live material extends throughout the Skagerrak, W. Baltic and British waters, 50-60^{O}N. Reports of this species inhabiting areas further south are probably erroneous. It is recorded as a rarity in the sub-Recent and Holocene of the southern Irish Sea, 52-54^{O}N and the Gironde, 46^{O}N. Moderate numbers are reported in the Late Glacial of W. Scotland, though it may range in similar deposits to S. Biscay, 58-44^{O}N. Lastly, scarce specimens occur in the Ipswichian of Sussex, 50^{O}N.

It is found alive in deep water hydroids of W. Norway, though occurs elsewhere in the intertidal and below. To occur, 1.5-22 m, mostly within 10 m on Laminarian and bushy algae and in their roots. Live and Recent material is also associated with organic rich muds and encrusted gravel sands down to 55 m approx. This is a full and near marine species, 26-35‰ salinity, within 2/3-22°C. It is also able to tolerate 14-20‰ salinity in the W. Baltic.

Genus Sclerochilus Sars, 1866

Sclerochilus contortus (Norman), 1862
pl. 38 figs. m-r, t.fig. 10

1862 Cythere contortum n.sp. Norman: p. 48, pl. II, fig. 15.

1866 Sclerochilus contortus (Norman); Sars: p. 90.

1868 Sclerochilus contortus (Norman); Brady: p. 455, pl. XXXIV, figs. 5-10; pl. XLV, fig. 7.

1874 Sclerochilus contortus (Norman); Brady, Crosskey and Robertson: p. 212, pl. X, figs. 33-35.

1880 Sclerochilus contortus (Norman); Brady: p. 147, pl. XXV, figs. 8a-b.

1928 Sclerochilus contortus (Norman); Sars: p. 247, pl. CXIII.

1938 Sclerochilus contortus (Norman); Klie: p. 218, figs. 751-754.

1941 Sclerochilus contortus (Norman); Elofson: p. 118, map 41.

1957 Sclerochilus contortus (Norman); Wagner: p. 101, pl. L, figs. 1-5.

1962 Sclerochilus contortus (Norman); Woszidlo: pl. 5, fig. 19.

1969 Sclerochilus contortus (Norman); Wall (ms.): p. 389, pl. 43, figs. n-p.

?1974 Sclerochilus contortus (Norman); Wilkinson (ms.): p. 90, pl. 8, figs. 11-12.

1975 Sclerochilus contortus (Norman); Neale and Howe: p. 13, figs. 7, 8.

1976 *Sclerochilus contortus* (Norman); Hoskin (ms.): p. 285, pl. 24, fig. 12.

1977 *Sclerochilus contortus* (Norman); Rosenfeld: p. 78, pl. 10, fig. 124.

1980 *Sclerochilus contortus* (Norman); Hawley (ms.): p. 77, pl. 8, figs. 4-12, t.fig. 6, figs. 4-6, map. 6.

Material

Total Dead: F. - 9 C. 52 RV. 51 LV.; M. - 7 C. 44 RV. 7 LV.; J. - 27 C. 316 RV. 299 LV. = 620 I.

Live: 14 F. 1 M. 55 J.

Southern Irish Sea

Dead		Live	
F. - 00 C. 04 RV. 09 LV.		00	
M. - 02 C. 01 RV. 01 LV.	= 126 I.	00	= 42 I.
J. - 10 C. 86 RV. 64 LV.		42	

Caernarvon Bay

Dead		Live	
F. - 06 C. 17 RV. 18 LV.		14	
M. - 05 C. 34 RV. 06 LV.	= 290 I.	01	= 27 I.
J. - 12 C. 125 RV. 130 LV.		12	

Malin Sea

Dead		Live	
F. - 03 C. 31 RV. 24 LV.		00	
M. - 00 C. 09 RV. 00 LV.	= 204 I.	00	= 1 I.
J. - 05 C. 105 RV. 105 LV.		01	

Sample Distribution (live occurrence is underlined)

Southern Irish Sea

803 <u>804</u> <u>805</u> <u>807</u> <u>825</u> 827 <u>829</u> <u>833</u> <u>844</u> 857 868 <u>873</u>
881 903 906 <u>914</u> <u>916</u> 917 <u>923</u> <u>925</u> <u>926</u> 2359 2361
2365 2366 2367 2369 2375 2378 2381 2762 2765 2779
2780 2783 2788 <u>2791</u> 2819 2904 2905 2906 2917

Caernarvon Bay

2385 2387 2389 2392 2393 2395 2396 2399 2420 2422
2424 2428 2440 2442 2443 2444 2445 2447 2449 2456
2457 2462 2463 2467 2509 2510 <u>2511</u> 2513 <u>2514</u> 2515
2516 2518 2519 2521 2637 2638 2639 2640 2642 2645
<u>2770</u> 2773 2776 2827 2829 2830 2834 <u>2839</u> <u>2840</u> <u>2843</u>
2891 2892 2894 2896 2921 2922 2923 2926 HHI HHII

Malin Sea

3012	3013	3043	3090	3091	3092	3099	3101	3103	3115
3130	3140	3142	3143	3145	3147	3152	3157	3161	3162

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	5	. 23/23A	0.722	0.336
	LV. "	5	. 22/22A	0.698	0.334
M.	RV. "	5	. 21/21A	0.785	0.328
	LV. "	5	. 20/20A	0.773	0.337
-1.	RV. "	5	. 25/25A	0.581	0.257
	LV. "	5	. 24/24A	0.581	0.267

Female and male left valves - sample 3162 (140.8 m, fine sand + silt); male right valve - sample 3142 (128 m, mixed sand), Malin Sea. Juvenile valves - sample 2904 (80.5 m, mixed sand + silt), southern Irish Sea.

Description

Sars (1928, p. 247-248, pl. CXIII) and Hawley (ms. 1980, p. 77-83, pl. 8, figs. 4-12) describe and illustrate the hard and soft parts.

Ontogeny

Instars of the penultimate to -5 growth stage are provisionally recognised. Adults and juveniles of sample 3162 (140.8 m fine sand + silt), Malin Sea, were measured and the dimensions given as follows (See: Fig. 10):

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.680-0.710	0.270-0.300	7	
	Mean	0.693	0.291		2.38
M.	Range	0.730-0.860	0.290-0.350	19	
	Mean	0.767	0.319		2.40
-1.	Range	0.580-0.670	0.230-0.320	45	
	Mean	0.633	0.280		2.26

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
-2.	Range	0.520-0.550	0.230-0.260	30	
	Mean	0.543	0.245		2.21
-3.	Range	0.450-0.520	0.180-0.250	27	
	Mean	0.484	0.223		2.17
-4.	Range	0.390-0.440	0.180-0.210	6	
	Mean	0.418	0.192		2.18
-5.	Range	0.350-0.380	0.150-0.200	2	
	Mean	0.365	0.155		2.35

S. contortus expresses considerable variation in shape throughout ontogeny. Which feature may be related to precocious sexual dimorphism of the penultimate and antepenultimate? growth stage.

Sexual dimorphism of adults in pronounced. Males are much the larger and proportionately longer than females.

Remarks

Several species are now known to be included in the given geographical distribution of *Sclerochilus contortus* (Norman).

Live material in the Gulf of Maine (Blake, 1933) and most certainly that from Narragansett Bay, S. of Cape Cod (Williams, 1966) are too small (0.63-0.71 mm length) to be *S. contortus sensu stricto*. In addition, Elofson (1941) comments that material found in northern Arctic waters may be distinct. He also considered records southward of the English Channel to be dubious. Indeed, several authors consider that most records attributed to the (Norman) species in the Biscay and Mediterranean should be referred to *S. gewimülleri* Dubowsky.

See: Whittaker (ms. 1972, p. 284-285, on *S. gewimulleri* Dubowsky) and Masson (ms. 1981, p. 80-82).

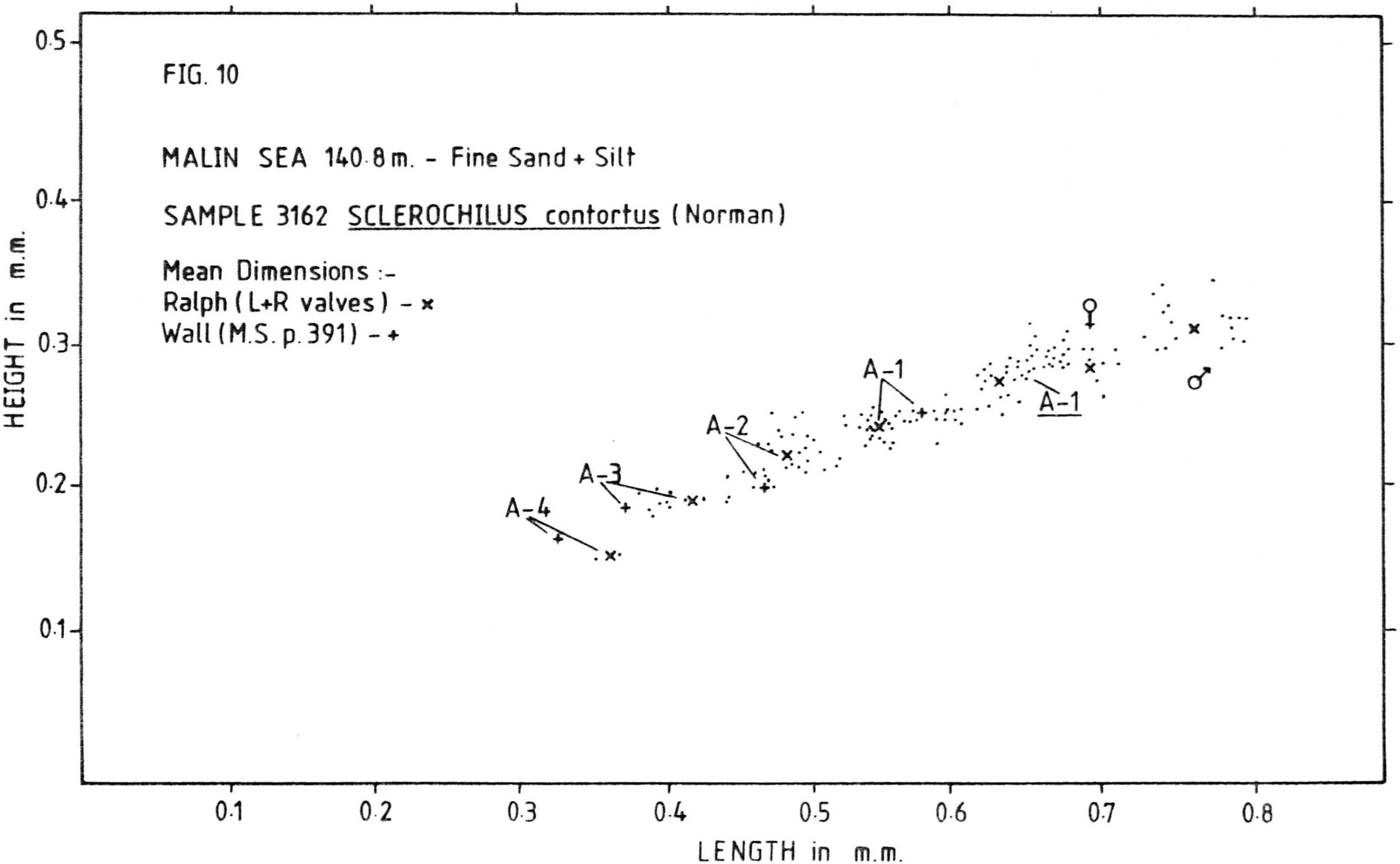


FIG. 10
MALIN SEA 140·8 m. - Fine Sand + Silt
SAMPLE 3162 SCLEROCHILUS contortus (Norman)
Mean Dimensions :-
Ralph (L+R valves) - ×
Wall (M.S. p. 391) - +
A-1
A-1
A-2
A-3
A-4
♀
♂
HEIGHT in m.m.
LENGTH in m.m.
0.1
0.2
0.3
0.4
0.5
0·1
0·2
0·3
0·4
0·5
0·6
0·7
0·8

Study Area Ecology

Live juvenile material was generally distributed southward of Wicklow, southern Irish Sea. It occurred in this region between 14.6-67 m on a variety of sediments from coarse sand and gravel to fine sand with silt, associated mostly with the coarsest deposits. A few live specimens in Caernarvon Bay were found in 44-82.3 m on coarse sand with gravel and mixed sand. A solitary individual occurred in 51.2 m, mixed sand with silt, Malin Sea.

Otherwise, the species was generally distributed in the southern Irish Sea, 8.2-97 m, mean 36.2 m, in coarse sand with gravel to silt and clay. Most specimens were found within 14-87.8 m in the more coarse sediments. Material occurs in the intertidal of Holyhead Habour and within 146.3 m, mean 68.4 m, throughout Caernarvon Bay. From which region it was mostly dredged within 36.6-124.4 m in coarse sand with gravel. The species also occurred in many areas of the Malin Sea, 42.1-512.1 m, mean 113.4 m, and mostly between 54.9-146.3 m in coarse sand with gravel to fine sand with silt.

Large, poorly preserved, populations of adults and juveniles were recovered from sample 2904 (80.5 m, mixed sand + silt), southern Irish Sea; sample 2839 (44 m, mixed sand), Caernarvon Bay, and in sample 3162 (140.8 m, fine sand + silt), Malin Sea. An assemblage of juveniles occurred in sample 2905 (87.8 mixed sand + silt), southern Irish Sea.

Palaeoecology and Distribution

The species is widely distributed in the western North Atlantic. Recorded live from Halifax Inlet, Nova Scotia

(Siddiqui and Grigg, 1975) along the Labrador coast, 25-40 m (Elofson, 1941), down to 180 m in the Davis St. (Brady and Norman, 1889) and from Holsteinborg and S.W. Greenland, 14-68 m (Norman, 1877; Brady and Norman, 1889; Stephensen, 1913; Hawley, ms. 1980). Reports of S. contortus in Ellesmere Land, N.W. Greenland, within 28 m (Brady, 1878; Sars, 1909) and from Clavering Island, N.E. Greenland (Elofson, 1941) are possibly of a distinct variety.

Rare live material is recorded from Spitzbergen (Brady and Robertson, 1872; Scott, 1899; Klie, 1942); Frans Joseph Land, N. Barents Sea, in moderate numbers from 4-28 m and in muds, 15 m, of Russian Habour, Novaya Zemlya (Neale and Howe, 1975). Elofson (1941) commented that the species is usually found in 10-80 m in the Barents Sea. The range extends throughout Scandinavia from Finmark southward (Brady and Norman, 1889; Norman, 1891, 1902; Sars, 1928), occurring commonly, 18-55 m, in most localities (Sars, 1890, 1928) and often dredged down to 400 m+ in the fiords of W. Norway (Brady and Norman, 1889; Elofson, 1941). It also ranges to the Skagerrak (Norman, 1865; Sars, 1866, 1928) and western Sweden (Elofson, 1941, 1943). The last author found live material in the lower algal zone and beneath, 5-30 m, on coarse detritus within 0-22^{o}C. The distribution extends in these ecological conditions to the Oresund and Kiel Bay, W. Baltic in 14-20‰ salinity (Klie, 1929, 1938; Hagerman, 1965; Rosenfeld, 1977) and from the Skagerrak southward to Denmark and the Netherlands (Brady and Robertson, 1870; Brady and Norman, 1889; Redeke and Dulk, 1940).

Brady and Robertson (1872) record it in abundance from the Shetlands and, with Norman (1861, 1862), found it off E. Scotland. S. contortus is also commonly alive throughout N.E. England in shallow estuarine muds (Brady, 1870; Brady and Robertson, 1870; Norman and Brady, 1909) and occurs in moderate abundance on shell sand, 28-85 m (Brady, 1868, 1870, 1902, 1903; Brady and Robertson, 1874, 1876; Norman and Brady, 1909). The range extends to the Fens (Brady, 1868) and intertidal sands of the Thames Estuary, 20-30‰ salinity (Brady, 1868; Kilenyi, 1969).

Rare live specimens occur on sand and mud, 70 m, and generally otherwise between 18-180 m in the Minches (C.S. Harris, ms. 1977). Brady (1868), Brady and Robertson (1872) and Robertson (1874) found it abundantly alive in the Clyde Estuary, 12-55 m on hard and soft ground though prevailing on the former substrate. There are also numerous reports of it around Ireland, 6-28 m (Brady, 1868; Brady and Robertson, 1869; Norman, 1905; Farran, 1913; Hoskin, ms. 1976), though only the last author actually indicates that the material was non living. Solitary live specimens are recorded on sublittoral algae and zoophytes off the West Wales coast (Wall, ms. 1969; Morgan, ms. 1977). However, Wall indicated that dead material was widely distributed in Cardigan Bay. S. contortus is recorded from several localities of N. and S. Devon and Cornwall and Scillies (Brady, 1868; Norman and Scott, 1906; Harding, 1957; Neale, 1970), though no indication is given whether the material was alive. In addition, isolated reworked specimens have been dredged in 35-98 m from the shelly cobble bottom of the Celtic Sea (Brassil, ms. 1977; Lomax, ms. 1978).

Reports of it from the English Channel (Norman, 1907, 1908; de Vos, 1957) and alive in Fucus of the Gironde Estuary (Carbonel et.al., 1972; Carbonel, 1973; Carbonel and Jouanneau, 1975) are not illustrated and probably refer to, or at least include, the distribution of other species. That reported in Vigo Bay, N.W. Spain (Ralph, ms. 1977) is most certainly distinct.

In addition, there are numerous reports of S. contortus in the Mediterranean, from calcareous algae in the Gulf of Naples (Puri, 1963; Puri et.al., 1964, 1969) and in deep water sands and silts of the S. Adriatic (Ascoli, 1964; Bonaduce et.al., 1975; Breman, 1976). These neapolitan records are also considered dubious.

As a fossil,it is recorded as a rarity in the sub-Recent and Holocene of the Barents Sea (Neale and Howe, 1975), southern Irish Sea (Wall and Whatley, 1971; Spencer, ms. 1976; Haynes et.al., 1977), Netherlands (Wagner, 1957, 1960, 1964) and is reported in that of the Gironde (Moyes, 1974; Carbonel et.al., 1975). There is also a record of it in the Holocene off Holsteinborg, W. Greenland (Neale and Howe, 1975) and in the Late Glacial, south of Cape Cod (Hazel, 1968), off Portland, New England (Brady and Crosskey, 1871) and from Canada (Brady et.al., 1874). Late Glacial material extends in isolated numbers from S. Norway (Brady et.al., 1874) and the North Sea (Masson, ms. 1981), commonly throughout the Forth and Clyde Estuaries (Brady et.al., 1874; Robertson, 1877, 1885; Anderson, 1948) to S.W. Scotland (Morris, ms. 1978; Peacock et.al., 1978; Graham and Wilkinson, 1978). Contemporaneous material is recorded from N.E. and E. Ireland (Brady et.al., 1874), Cardiff (Brady et.al., 1874) and possibly S. Biscay (Caralp et.al., 1970; Moyes and Peypouquet, 1971). Rare material is also known in the Ipswichian of the southern Irish Sea (Jasin, ms. 1976), Somerset (Kidson et.al., 1978) and Sussex in moderate numbers (Whatley and Kaye, 1971). The range extends to the Hoxnian interlgacial of N. Germany and E. Denmark (Woszidlo, 1962) and E. Yorkshire (Neale and Howe, 1975). However, that reported in the Upper Pliocene (Coralline Crag) of E. Anglia (Wilkinson, ms. 1974) is probably another species.

Summary

Live material ranges in the western N. Atlantic from Nova Scotia to S.W. Greenland, 45-69°N; possibly south to Maine, 44°N and north of Baffin Bay, 71°N. There is a report of it alive from E. Greenland, 74°N and in moderate numbers south of 80°N in the Barents Sea. Its abundance increases throughout Scandinavia, W. Baltic, British and adjacent waters. Reports of it further south than 49°N in the Recent are probably erroneous. Rare sub-Recent and Holocene specimens occur in S.W. Greenland and perhaps in deep waters throughout the Davis St., 60-70°N. Material of this age is moderately common from 75°N 22°E in the Barents Sea, extends to deep waters of Norwegian fiords, and possibly ranges to central Biscay, 46°N. Isolated Late Glacial material may range north of Cape Hatteras to New England and St. Lawrence, 38-50°N and extends from S. Norway and west of Britain in abundance to S. Biscay, 60-44°N. Finally, material is recorded from the Ipswichian, of the Irish Sea, Somerset, and Sussex, in moderate numbers, 54-50°N; with the certain stratigraphical range extending to the Hoxnian of S.W. Baltic and E. Yorkshire, 53-55°N.

This species inhabits the sublittoral and below between 5-80 m approx, but occurs mostly within 28 m depth. However, it is also found alive occasionally with reworked material down to 180 m+. It is primarily associated with algae, encrusted coarse shelly sands and estuarine muds. S. contortus is abundant within 14-20‰ salinity in the W. Baltic and in 20-30‰+ elsewhere, 0-22°C.

Sclerochilus truncatus (Malcomson), 1886
pl. 38 figs. s-x

1886 Paradoxostoma truncatum n.sp. Malcomson: p. 262, pl. XXV, figs. 3-4.

1969 Sclerochilus truncatus (Malcomson); Wall (ms.): p. 392, pl. 43, figs. g, j, m.

Material

Total Dead: F. - 6 RV. 2 LV.; M. - 4 RV. 5 LV.;
J. - 20 RV. 15 LV. = 41 I.

Live: 1 F. 1 M. 2 J.

Southern Irish Sea

Dead				Live
F. - 00 C.	02 RV.	01 LV.		00
M. - 00 C.	02 RV.	02 LV.	= 11 I.	00
J. - 00 C.	03 RV.	03 LV.		02

Caernarvon Bay

Dead				Live
F. - 00 C.	04 RV.	00 LV.		00
M. - 00 C.	01 RV.	03 LV.	= 24 I.	01
J. - 00 C.	14 RV.	11 LV.		00

Malin Sea

Dead				Live
F. - 00 C.	00 RV.	01 LV.		01
M. - 00 C.	01 RV.	00 LV.	= 6 I.	00
J. - 00 C.	03 RV.	01 LV.		00

Sample Distribution

Southern Irish Sea

805 2375 2764 2821 2824 2904 2905

Caernarvon Bay

2393 2422 2443 2447 2449 2514 2519 2637 2647 2834
2839 2892 2922 HHII

Malin Sea

3043 3101 3112 3130

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	5	. 17/17A	0.517	0.288
	LV. "	5	. 16/16A	0.494	0.286
M.	RV. "	5	. 15/15A	0.500	0.256
	LV. "	26	. 27/27A	0.469	0.244
-1.	RV. "	5	. 19/19A	0.408	0.207
	LV. "	5	. 18/18A	0.403	0.219

Female valves - sample 2824 (24.4 m, coarse sand + gravel), male right valve - sample 805 (22.9 m), male left valve - sample 2905 (87.8 m, mixed sand with silt), southern Irish Sea. Juvenile valves - sample 2393 (65.8 m, coarse sand + gravel), Caernarvon Bay.

Description

See: Wall (ms. 1969, p. 292-293, pl. 43) for a description and illustration of the carapace morphology. The soft parts are undescribed in the literature.

Ontogeny

A few juvenile instars were recovered and tentatively ascribed as the penultimate growth stage of this species. The dimensions of adults and juveniles from several samples in the study are given as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.480-0.530	0.270-0.300	10	
	Mean	0.508	0.288		1.76
M.	Range	0.460-0.510	0.237-0.270	9	
	Mean	0.493	0.252		1.96
-1.	Range	0.390-0.420	0.210-0.225	10	
	Mean	0.405	0.218		1.86

The species is sexually dimorphic. Males are smaller, proportionately longer and are much less dorsally arched than females.

Remarks

See: Wall (ms. 1969, p. 393).

Study Area Ecology

Two live juveniles occurred in 22.9 m and mixed sand, southern Irish Sea. A live adult was found in coarse sand and gravel, 44 m in Caernarvon Bay and in 82 m of the Malin Sea.

Material occurs mainly in the northern region of the southern Irish Sea, 22.9-87.8 m, mean 43.3 m in coarse sand and gravel to silt with clay. It is also distributed from the intertidal of Holyhead Habour down to 131.7 m, mean 65.9 m, in Caernarvon Bay. A few individuals were found between 51.2-82 m, mean 62.5 m, in coarse sand with gravel, mixed sand and fine sand with silt of the Malin Sea.

Palaeoecology and Distribution

This is a little known species. Malcomson (1886) first described it from Recent sediments of Belfast Lough, N.E. Ireland.

In addition, Wall (ms. 1969) found a few specimens in the sub-Recent of Tremadoc Bay, W. Wales. Jasin (ms. 1976) recovered a single individual from the Ipswichian, Last interglacial of Cardigan Bay, southern Irish Sea and Whatley and Kaye (1971) list it from the Last interglacial of Selsey, Sussex.

Summary

It occurs in the Recent, sub-Recent and Ipswichian of the Irish Sea, 55-52^{O}N, with certain isolated specimens found in the Last interglacial of Sussex, 50^{O}N approx.

Its ecology is not precisely known.

Genus Machaerina (Brady and Norman), 1889

Machaerina tenuissima (Norman), 1869

pl. 39 figs. a-b

1869 Bythocythere tenuissima n.sp. Norman: p. 294.

1870 Xiphicilus tenuissima (Norman); Brady: p. 369, pl. XII, figs. 6-9; pl. XIV, figs. 5-10.

1874 Xiphicilus tenuissima (Norman); Brady, Crosskey and Robertson: p. 122, pl. 71, fig. 9.

1889 Machaerina tenuissima (Norman); Brady and Norman: p. 237, pl. XXI, figs. 13, 14.

?1967 Xiphicilus sp. cf. flexuosa (Brady); Hulings: p. 651, fig. 4f, 61.

1975 Machaerina tenuissima (Norman); McKenzie and Kaesler: p. 623, pl. 32-34, figs. 3-16.

1976 Machaerina tenuissima (Norman); Breman: p. 80, pl. 4, fig. 50.

Material

Total Dead: F. - 2 C.

Live: 2 F.

Southern Irish Sea

Dead	Live
F. - 01 C. 00 RV. 00 LV. = 01 I.	02

Malin Sea

Dead	Live
F. - 01 C. 00 RV. 00 LV. = 01 I.	00

Sample Distribution (live occurrence is underlined)

Southern Irish Sea

2915 2916

Malin Sea

3140

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	11	. 34A/35	1.145	0.378
	LV. "	11	. 33A/34	1.161	0.371

This specimen is from sample 2915 (33 m, silt + clay), southern Irish Sea.

Description

See: Brady (1870, p. 369-370, pl. XII, XIV) or McKenzie and Kaesler (1975, p. 623, pl. 32-34) for a description and illustration of hard and soft parts.

Remarks

See: McKenzie and Kaesler (1975, p. 634).

Study Area Ecology

Two live females and a single empty carapace were recovered from mixed sand and silt with clay, 33-36.6 m, northward of Dublin Bay, southern Irish Sea.

One other individual occurred in coarse sand with gravel, 54.9 m, Malin Sea.

Palaeoecology and Distribution

McKenzie and Kaesler (1975) indicate that this species has a possible world wide distribution. It is most certainly wide ranging in the N. Atlantic and Mediterranean.

The rare species Xiphicilus sp. cf. flexuosa (Brady) found in 49 m and 137 m off Cape Hatteras, North Carolina, may refer to this species.

An isolated report of material from the Ostsee, W. Baltic, (Klie, 1929) has not been confirmed in subsequent literature.

M. tenuissima is widespread in British and adjacent waters, extending live in isolated numbers from the Shetlands in 55-110 m to Forth, E. Scotland (Brady and Robertson, 1872; Brady and Norman, 1889). It also occurs south of Dogger and off the N.E. coast of England in 28-110 m, mostly 28-75 m, on muds and sand (Brady, 1870, 1902, 1903; Brady and Robertson, 1872, 1874, 1876; Brady and Norman, 1889; Norman and Brady, 1909).

McKenzie and Kaesler (1975) found live material in 10 m of the Clyde Estuary and it seems to be moderately common in this region, 18-55 m, on muds and sand and hardground areas (Robertson, 1874). Brady and Robertson (1872, 1874) also record the species from S.W. Scotland and include the Irish Seas in the distribution. Brady and Norman (1889) and Norman (1905) list the species from Roundstone and Valentia, in addition to Farran's (1913) account of it from Clare Island,

W. Ireland. Malcomson (1885) reports it in Belfast Lough and Neale (1974) has indicated its occurrence in the Celtic Sea.

This species is reported as Xiphicilus sp. in the Fucus zone, 15-28‰ salinity, of the Gironde Estuary (Carbonel et.al., 1972; Carbonel and Jouanneau, 1975). It also occurred in isolated numbers on fine sand in 75 m and 160 m off the coast of N.W. Spain (Ralph, ms. 1975).

Furthermore, a single specimen was recorded in 86 m from the Ligurian Sea, W. Mediterranean (Bonaduce et.al., 1977). It may also occur in the Gulf of Naples and is reported in limited numbers on sand and especially silty sediments, 75-210 m, of the N. and S. Adriatic (Bonaduce et.al., 1975; Breman, 1976).

Summary

This is a very rare species, though may have a cosmopolitan distribution in the Recent. M. tenuissina is known to range alive throughout British and adjacent waters and is reported in the W. Baltic, 50-60°N. Recent and reworked material is recorded off N.W. Spain and from the W. Mediterranean and Adriatic, 46-36°N. Lastly, it may occur in the Holocene or sub-Recent off Cape Hatteras, North Carolina, 35°N.

Live and Recent material has been found in 10-110 m and mostly between 18-75 m in British waters, occurs with reworked material within 75-160 m off N.W. Spain and from 75-210 m of the Mediterranean and Adriatic. M. tenuissima is associated with sand, hard grounds and perhaps Laminarian algae in the littoral of the N. Atlantic. However, it is primarily recovered from silty sediments in the Adriatic. This is a fully marine species of cool and warm temperate waters.

Machaerina sp. cf. *M. amygdaloides* (Brady), 1870

pl. 39 figs. c-d

1870 *Xiphicilus amygdaloides* n.sp. Brady: p. 370, pl. XIII, figs. 8-10.

1889 *Machaerina amygdaloides* (Brady); Brady and Norman: p. 238, pl. XVII, figs. 20, 21.

Material

Caernarvon Bay

Dead					Live
Adult	00 C.	00 RV.	01 LV.	= 1 I.	00

Sample Distribution

Caernarvon Bay

2828

Figured Specimen

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
Adult	LV.	external	11 .	35A/36	0.698	0.302
		internal	32 .	1A/2		

Description

The carapace morphology is illustrated and described by Brady and Norman (1889, p. 238-239, pl. XVII). The soft parts are not described in the literature.

Remarks

Until other material becomes available this specimen is best referred to as *Machaerina* sp. cf. *M. amygdaloides* (Brady).

Study Area Ecology

Live material was not found.

A single specimen occurred in 47 m, coarse sand with gravel, Caernarvon Bay.

Palaeoecology and Distribution

There is a report of *M. amygdaloides* from Ostsee, W. Baltic (Klie, 1929) and the Type material was dredged from St. Magnus Bay, Shetland (Brady, 1870; Brady and Robertson, 1872; Brady and Norman, 1889).

Lomax (ms. 1978) indicates that a live specimen, *M.* cf. *amygdaloides* was found off Cork, S. Ireland, though gives no further information.

This species is also reported from the Channel Isles (Norman, 1907, 1908) and Brady and Norman (1889) record material in 350-380 m off Cap Breton, S. Biscay.

Brady and Norman (1889) further comment that 3 specimens have been taken from shallow water in the Gulf of Naples.

Summary

There is a dubious report of a live specimen in the Celtic Sea, 51^{O}N. Recent material is reported from the W. Baltic, Shetlands, 60^{O}N, and from several other localities south to the English Channel, 50^{O}N. *M. amygdaloides* is also reported from the W. Mediterranean, 44^{O}N. That dredged from deep waters of Biscay, 44^{O}N, may represent a Late Glacial or Holocene occurrence.

The ecology of this species is unknown, though it appears to be a littoral and marine form tolerant of both cool and warm temperate waters.

Sub Family MICROCYTHERINAE Klie, 1978

Genus Microcythere Müller, 1894

Microcythere inflexa Müller, 1894

pl. 39 figs. e-k

1894 Microcythere inflexa n.sp. G.W. Müller: p. 328, pl. 24, figs. 30-32, 40-42, 48, 50.

1963 Microcythere inflexa G.W. Müller; Van Morkhoven: vol.2, p. 272, figs. 419-421.

1972 Microcythere inflexa G.W. Müller; Uffenorde: p. 97, pl. 3, fig. 11, (Male).

Material

Total Dead: F. - 2 C, 1 FR.; M. - 5 C. 4 LV. = 12 I.

Live: 1 M. 2 J.

Southern Irish Sea

Dead	Live
M. - 00 C. 00 RV. 00 LV. = 00 I.	01

Caernarvon Bay

Dead	Live
F. - 02 C. 01 RV. 00 LV.	00
M. - 04 C. 00 RV. 03 LV. = 10 I.	00
J. - 00 C. 00 RV. 00 LV.	02

Malin Sea

Dead	Live
M. - 01 C. 00 RV. 01 LV. = 02 I.	00

Sample Distribution (live occurrence is underlined)

Southern Irish Sea

926

Caernarvon Bay

2385 2399 2424 2449 2457 2638 2647 2834

Malin Sea

3097 3154

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	11 .	20A/21	0.322	0.148
		internal	30 .	2/2A		
		"	30 .	4/4A		
		"	30 .	3/3A		
	LV.	external	11 .	19A/20	0.330	0.148
M.	RV.	"	11 .	18A/19	0.345	0.145
	LV.	"	11 .	17A/18	0.351	0.150

Female carapace - sample 2834 (57 m, coarse sand + gravel), Caernarvon Bay; male carapace - sample 926 (54.9 m, mixed sand), southern Irish Sea.

Description

A description and illustration of hard parts is given in Van Morkhoven (1963, vol. 11, p. 272-274). The appendages are discussed and figured by Müller (1894, p. 328, pl. 24).

Ontogeny

Two penultimate juveniles are provisionally recognised. The dimensions of adults in the study material are given as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.310-0.340	0.140-0.160	4	
	Mean	0.330	0.147		2.24
M.	Range	0.340-0.355	0.140-0.160	9	
	Mean	0.348	0.150		2.32

Remarks

See: Van Morkhoven (1963, vol. 2, p. 273).

Study Area Ecology

A single live male occurred in mixed sand, 54.9 m, southern Irish Sea and two live juveniles were dredged in coarse sand with gravel, 120.7 m, Caernarvon Bay.

Otherwise, isolated specimens ranged between 7-124.4 m, mean 72.9 m, within Caernarvon Bay and were found in 37 m and 170.1 m in Malin Sea. Material was exclusively associated with coarse sand and shelly gravel.

Palaeoecology and Distribution

Elofson (1944) indicates that it inhabits shelly sand banks and attached algae, 5-20 m, along the coast of W. Sweden.

Otherwise, *M. inflexa* is reported wholly from the W. Mediterranean and Adriatic. In which region, rare live material has been recovered in calcareous algae from the sublittoral off Naples (Müller, 1894; Puri, 1963), with a solitary instar found in the Limski Canal, Gulf of Venice (Uffenorde, 1972).

Isolated specimens have been dredged in a variety of sediments from 165-764 m in the W. Mediterranean (Puri et.al., 1969), though these may not represent a Recent occurrence.

Summary

The geographical range of this species is imperfectly known. Rare live material occurs off W. Sweden, 56-60^{o}N, W. Italy and perhaps in the N. Adriatic. A Holocene or Late Glacial record occurs in the W. Mediterranean, 41-45^{o}N.

This is a sublittoral species, 5-20 m approx., found in various algae and beneath on coarse shelly detritus. Isolated reworked material is also known in deep water, 265-764 m, of the W. Mediterranean. *M. inflexa* appears to be extremely eurythermal in marine and near marine salinities.

Microcythere sp. cf. M. bahusiensis Elofson, 1944
pl. 39 figs. 1-q

1944 Microcythere bahusiensis n.sp. Elofson: p. 11, figs. 6-11.

Material

Total: ?F. - 1 C. ?M. - 2 LV. = 3 I.

Caernarvon Bay

Dead	Live
?M. - 00 C. 00 RV. 02 LV. = 2 I.	00

Malin Sea

Dead	Live
?F. - 01 C. 00 RV. 00 LV. = 1 I.	00

Sample Distribution

Caernarvon Bay
2433

Malin Sea
3153

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	10 .	39/39A	0.297	0.120
		internal	30 .	21/21A		
		"	30 .	20/20A		
	LV.	external	10 .	40/40A	0.300	0.125
M.	LV.	"	10 .	41/41A	0.287	0.122

Description

A description and illustration of hard and soft parts is given by Elofson (1944, p. 11-13, figs. 6-11).

Remarks

This species is somewhat similar in shape to both M. inflexa Müller and M. obliqua Müller. However, M. bahusiensis and that of this study may be distinguished from these others in possessing a straight ventral margin. Further, the N. Atlantic material bears a much less sinuous inner lamella than that exhibited by the Mediterranean species, M. obliqua.

Study Area Ecology

The species was not found alive.

Isolated specimens occurred in only one locality off Lleyn Peninsula, Caernarvon Bay, in coarse sand with gravel, 70 m. One other individual was taken from 170.1 m in fine sand with silt, northern Malin Sea.

Palaeoecology and Distribution

Comparable material, in the form of M. bahusiensis, is recorded by Elofson (1944). Alive in 5-20 m on algae and shell sand from the west coast of Sweden, 56-60^{o}N.

Microcythere sp. cf. M. depressa G.W. Müller, 1894
pl. 4a figs. a-e

1894 Microcythere depressa n.sp. G.W. Müller: p. 332, pl. 24, figs. 38, 39, 57, 60.

Material

Total: F. - 4 C. 2 RV.; M. - 1 LV.; ?Adult - 1 C. = 8 I.

Caernarvon Bay

Dead					Live
F. -	03 C.	02 RV.	00 LV.	= 6 I	00
M. -	00 C.	00 RV.	01 LV.		

Malin Sea

Dead					Live
Adult? -	01 C.	00 RV.	00 LV.	= 2 I.	00
F. -	01 C.	00 RV.	00 LV.		

Sample Distribution

Caernarvon Bay

2424 2639

Malin Sea

3098 3162

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	11 .	25A/26	0.260	0.107
		29 .	10/10A		
	LV. "	11 .	26A/27	0.268	0.106
M.?	LV.	11 .	28A/29	0.250	0.093
		32 .	4A/5		

Female valves - sample 2424 (80.5 m), male? valve - sample 2639 (91 m), coarse sand + gravel, Caernarvon Bay.

Description

The carapace morphology and soft parts are described and illustrated by G.W. Müller (1894, p. 332, pl. 24).

Remarks

Microcythere sp. cf. M. depressa has an acutely pointed postero-ventral extremity from which a vague striation extends subventrally to about mid-length. Otherwise, the shape and internal hard part features are very comparable with those of M. depressa G.W. Müller.

Study Area Ecology

Live material was not found.

Isolated individuals occurred in 80.5 and 91 m, coarse sand with gravel, Caernarvon Bay. It was also encountered in coarse sand and fine sand with silt from 100 m and 140.8 m, Malin Sea.

Palaeoecology and Distribution

Comparable material is described only from the Bay of Naples, W. Mediterranean, 41°N. In which region, *M. depressa* is recorded in isolated numbers associated with calcareous algae (Müller, 1894; Puri, 1963; Puri et.al., 1964).

Microcythere helgolandica Klie, 1936

pl. 40 figs. f-m

1936 *Microcythere helgolandica* n.sp. Klie: p. 63, figs. 30-33.

1938 *Microcythere helgolandica* Klie; Klie: p. 215, figs.739-742.

Material

Caernarvon Bay + Total

Dead					Live
F.	- 01 C.	01 RV.	01 LV.	= 5 I.	01
M.?	- 02 C.	00 RV.	00 LV.		00

Sample Distribution (live occurrence is underlined)

Caernarvon Bay

2393 2395 2447 2513 2830

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	11	14A/15	0.362	0.138
		internal	30	15/15A		
		"	30	13/13A		
		"	30	14/14A		
	LV.	external	11	13A/14	0.376	0.136
M.?	RV.	"	11	16A/17	0.300	0.109
	LV.	"	11	15A/16	0.294	0.096

Female valves - sample 2513 (60.4 m, coarse sand + gravel), male? carapace - sample 2395 (55 m, mixed sand).

Description

Klie (1936, p. 63-64, figs. 30-33) gives a full description of the hard parts and an illustration of the appendages.

Study Area Ecology

A single live female was taken from 13 m in a sample of coarse sand with gravel.

Isolated adult material occurred in Caernarvon Bay between 55-109.7 m, mean 60.8 m, in coarse sand with gravel and mixed sand.

Palaeoecology and Distribution

The species was first described from the Heligoland, North Sea and within Kiel Bay, W. Baltic (Klie, 1936, 1938). Isolated specimens have subsequently been found in 40 m in the Minches, N.W. Scotland (Harris, C.S., ms. 1977).

M. helgolandica is also known to extend to the last interglacial, Ipswichian, of Somerset (Kidson et.al., 1978).

Summary

Live material may range from S. Scandinavia to N. Britain, 54-58°N, with a solitary record from the Ipswichian of Somerset, 51°N approx.

The ecology is little known. However, *M. helgolandica* appears to be a shallow marine form in boreal and cool temperate waters.

Microcythere sp. cf. M. monstruosa Elofson, 1944

pl. 40 figs. n-v

1944 Microcythere montruosa n.sp. Elofson: p. 13, figs. 12-17.

Material

Caernarvon Bay + Total

Dead					Live
F.? -	01 C.	00 RV.	00 LV.		00
M.? -	00 C.	00 RV.	01 LV.	= 5 I.	00
J.? -	02 C.	01 RV.	00 LV.		01

Sample Distribution (Live occurrence is underlined)

Caernarvon Bay

2424 2510 <u>2834</u>

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.?	RV.	external	10	. 34/34A	0.293	0.118
		internal	30	. 24/24A		
		"	30	. 23/23A		
		"	30	. 22/22A		
	LV.	external	10	. 36/36A	0.298	0.124
M.?	LV.	"	10	. 35/35A	0.302	0.116
-1.?	RV.	"	10	. 37/37A	0.250	0.098
	LV.	"	10	. 38/38A	0.250	0.105

Adult specimens - sample 2834 (57 m, coarse sand + gravel), the juvenile is from sample 2424 (80.5 m, coarse sand + gravel).

Description

Elofson (1944, p. 13-17, figs. 12-17) describes and illustrates the carapace morphology and appendages.

Ontogeny

Several juveniles were recognised and provionally assigned as the penultimate growth stage of this species.

Remarks

The female has a wide opening in the postero-ventral region of the carapace, which feature van Morkhoven (1963) considers to be distinctive of M. monstruosa Elofson.

Study Area Ecology

A single live juvenile occurred in 57 m on coarse sand + gravel.

Otherwise, in Caernarvon Bay, it was found in coarse sand within 57-80.5 m, mean 66.6 m.

Palaeoecology and Distribution

M. monstruosa is, as yet, known only from S. Sweden, 56-60^{o}N.

Alive in 5-20 m, associated with shell debris, sand banks and attached algae. It appears to be a near or fully marine form in boreal or cool temperate waters.

Microcythere sp. cf. M. nana Müller, 1894
pl. 41 figs. a-g

1894 Microcythere nana n.sp. Müller: p. 329, pl. 24, figs. 16-19, 46, 62.

Material

Caernarvon Bay + Total

Dead					Live
F.? -	01 C.	00 RV.	00 LV.	= 5 I.	00
M.? -	01 C.	03 RV.	00 LV.		00

Sample Distribution

Caernarvon Bay

2395 2447 2642 2892

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.?	RV.	external	11 .	23A/24	0.337	0.139
		internal	30 .	-		
		"	30 .	1/1A		
		"	30 .	0/0A		
	LV.	external	11 .	24A/25	0.343	0.147
M.?	RV.	"	11 .	22A/23	0.293	0.100
	LV.	"	11 .	21A/22	0.295	0.110

Female? specimens - sample 2892 (82 m, coarse sand + gravel), male? specimens - sample 2447 (109.7 m, mixed sand).

Description

The hard and soft parts are described and illustrated by Müller (1894, p. 329-330, pl. 24, figs. 16-19, 46, 62).

Remarks

Despite a vague similarity of shape to the male of both M. bahusiensis Elofson and M. parva Klie, this species can be distinguished by certain features. It has pronounced dorsal overlap of the RV. upon the LV., and a longitudinal division of the 3 topmost adductor muscle scars.

Microcythere sp.cf. M. nana can be primarily distinguished by its well developed crenulate terminal dentition. Although this feature is characteristic of M. dentata Müller the latter species also bears a dentate median hinge element that is absent in both M. nana and the Caernarvon Bay material.

Study Area Ecology

Live material was not recovered.

Isolated specimens occurred between 55-109.7 m, mean 82.8 m, mixed sand and coarse sand with gravel, Caernarvon Bay.

Palaeoecology and Distribution

M. nana has only been recorded by Müller (1894), alive in calcareous algae from the Gulf of Naples. Material is also recorded in the same region and in a similar ecology by Puri et.al. (1964). In addition, Puri et.al. (1969) record a few individuals, as *M.* cf. *nana*, reworked in sediments from 265 m of the W. Mediterranean, which latter may represent a Late Glacial or Holocene occurrence.

Summary

This species is only known alive from the Gulf of Naples and may occur, otherwise, in superficial sediments off W. Italy, 41^{O}N approx.

Live material is found in sublittoral calcareous algae and from its distribution this would seem to be a fully marine and warm temperate species.

Microcythere sp. cf. *M. producta* Elofson, 1944
pl. 41 figs. h-o

1944 *Microcytherura producta* n.sp. Elofson: p. 8, figs. 1-5.

?1969 *Microcythere minuta* Klie; Yassini: p. 60, pl. XVIII, fig. 14.

Material

Caernarvon Bay + Total

Dead					Live
F.? -	01 C.	00 RV.	00 LV.	= 4 I.	00
M.? -	01 C.	01 RV.	01 LV.		

Sample Distribution

Caernarvon Bay

2457 2513 2892 2893

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.?	RV.	external	10 .	42/42A	0.322	0.121
		internal	32 .	5A/6		
		"	30 .	18/18A		
		"	30 .	17/17A		
	LV.	external	10 .	-	0.334	0.134
		"	30 .	16/16A		
M.?	RV.	"	10 .	1/1A	0.248	0.089
	LV.	"	10 .	2/2A	0.252	0.100

Female? carapace - sample 2893 (110 m), male? right valve - sample 2457 (120.7 m) and the male? left valve - sample 2892 (82 m, coarse sand + gravel), Caernarvon Bay.

Description

Elofson (1944, p. 8-11, figs. 1-5) describes and illustrates the soft parts and carapace morphology.

Remarks

Specimens of *Microcythere* sp. cf. *M. producta* have a similar shape in lateral aspect to the male of *M. monstruosa* Elofson. However, the Caernarvon Bay material and *M. producta sensu stricto* may be distinguished from *M. monstruosa* by the shallow antero-dorsal concavity of the shell and by the pronounced antero-ventral 'beak-like' extension of the right valve.

Study Area Ecology

Live material was not recovered.

Otherwise, specimens occurred in isolated localities of coarse sand with gravel between 60.4-120.7 m, mean 93.3 m, Caernarvon Bay.

Palaeoecology and Distribution

Microcythere producta is, as yet, only recorded from the west coast of Sweden, in 5-20 m, associated with bivalve shells and sand banks and attached algae (Elofson, 1944).

Comparable material, as *M. minuta* Klie, has been found in 78 m on the open shelf of central Biscay (Yassini, 1969). The last author suggested this might be a reworked Glacial occurrence.

Summary

Isolated live material is known in the Skagerrak, W. Sweden, 56-60°N, with a possible record from the Late Glacial of Biscay, 45°N.

This is a species of the lower sublittoral, 5-20 m, alive amongst weeds and on coarse shelly detritus beneath in near or full marine salinity. It is a boreal or cool temperate form.

<u>Microcythere</u> sp.
pl. 41 fig. p

<u>Material</u>

Caernarvon Bay

Dead					Live
Adult -	00 C.	01 RV.	00 LV.	= 1 I.	00

<u>Sample Distribution</u>

Caernarvon Bay
2770

<u>Figured Specimens</u>

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
Adult	RV. external	10	. 33/33A	0.237	0.094

<u>Study Area Ecology</u>

A single specimen was found in mixed sand, 82.3 m from the western reaches of Caernarvon Bay.

<u>Microcythere</u> sp. A
pl. 41 fig. q

<u>Material</u>

Malin Sea + Total

Dead					Live
Adult -	00 C.	00 RV.	01 LV.	= 1 I.	00

<u>Sample Distribution</u>

Malin Sea
3090

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
Adult	LV. external	11 .	27A/28	0.337	0.122

Study Area Ecology

A single specimen was dredged in coarse sand and gravel from 100 m,southward of Islay, eastern Malin Sea.

Sub Family CYTHEROMATINAE Elofson, 1938

Genus Cytheroma Müller, 1894

Cytheroma variabilis Müller, 1894

pl. 42 figs. f-m

1894 Cytheroma variabilis n.sp. Müller: p. 350, pl. 26, figs. 5, 9-15.

1969 Cytheroma variabilis Müller; Tomakh: p. 196, pl. XXII, fig. 2.

1971 Cytheroma variabilis Müller; Barbieto-Gonzalez: p. 287, pl. 19, figs. 1b, 2b, 3b.

1972 Cytheroma variabilis Müller; Uffenorde: p. 79, pl. 3, fig. 1, t.figs. 30-31.

1975 Cytheroma variabilis Müller; Uffenorde: p. 160, t.fig. 11.

1975 Cytheroma variabilis Müller; Bonaduce, Ciampo and Masoli: p. 123, pl. 9, figs. 9-13.

Material

Total: F. - 4 C. 6 RV. 6 LV.; M. - 2 C. 4 RV. 3 LV.; J. - 1 RV. = 22 I.

Southern Irish Sea

Dead				Live
F. - 02 C.	01 RV.	03 LV.	= 7 I.	00
J. - 00 C.	01 RV.	00 LV.		

Caernarvon Bay

Dead				Live
F. - 02 C.	05 RV.	03 LV.	= 15 I.	00
M. - 02 C.	04 RV.	03 LV.		

Sample Distribution

Southern Irish Sea

803 804 825 880 2381 2822

Caernarvon Bay

2393 2400 2443 2463 2828 2834 2892 HHII

Figured Specimens

			Film No.		Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	21	.	15/15A	0.441	0.180
		internal	27	.	36/36A		
		"	32	.	30A/31		
		"	32	.	29A/30		
	LV.	external	21	.	14/14A	0.445	0.179
M.	RV.	"	21	.	12/12A	0.450	0.163
	LV.	"	21	.	13/13A	0.436	0.167
-1.?	RV.	"	21	.	16/16A	0.341	0.141

Female right valve and male valves - sample 2834 (57 m), female left valve - sample 2393 (65.8 m, coarse sand + gravel), Caernarvon Bay. Juvenile valve - sample 2431 (75 m, mixed sand), Caernarvon Bay.

Description

In lateral aspect, female RV. elongate oval. Anterior margin acutely rounded antero-ventrally and produced below, gently convex antero-dorsally; extremity well below mid-height. Posterior margin more or less pointed, postero-dorsal slope convex extending gradually to meet ventral margin at the extremity. Dorsal margin boldly arched, less so in male. Cardinal angles indistinct. Ventral margin almost straight, a slight concavity in the oral region. Greatest height at mid-length. Seen from above, saggitate, extremities pointed especially anteriorly. Greatest width in the posterior third. RV. smaller than LV., though overlaps the latter along the dorsal margin.

Valves thin, smooth, translucent or dull milk-white. Eye spots not observed. Normal pores few in number, widely spaced, small, simple, open.

Inner lamella wide anteriorly and posteriorly, narrow ventrally (oral region), line of concrescence and inner margin divergent throughout,the latter being very narrow. Marginal pores numerous, 15-20 anteriorly and ventrally, short simple and mostly true.

Hinge, weak lophodont. In RV. posterior and anterior terminal elements a single long smooth tooth. Median element a shallow accommodation groove overhung by the dorsal margin. The LV. bears complementary structures.

Adductor muscle scars an anteriorly oblique line of 4 oval scars. The dorsal most scar is triangular, the two intermediate scars are greatly elongated and the ventral scar is a compressed oval. Anterior to which is situated a large club-shaped frontal scar with two small rounded mandibular scars vertically below and two smaller scars above.

Ontogeny

A single juvenile was found and tentatively assigned as a penultimate instar of this species. The dimensions of adults from several samples are given as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.435-0.450	0.175-0.185	11	
	Mean	0.443	0.180		2.46
M.	Range	0.430-0.460	0.160-0.170	9	
	Mean	0.443	0.166		2.66

Sexual dimorphism is provisionally recognised. The males are proportionately longer and more evenly arched dorsally than females.

Remarks

This species is somewhat similar in shape to the next in this study though males and females of C. variabilis are readily identified by their larger size and more acuminate posterior.

The shape of C. variabilis is also comparable to C. karadagiensis Dubowsky, though this latter species may be distinguished by its divided mid-dorsal adductor scar.

Study Area Ecology

It was not found alive.

In the southern Irish Sea isolated valves occurred between 14.6-33.5 m, mean 21.2 m, in a variety of sediments from coarse sand with gravel to silt with clay. Material was also dredged in sands and gravel from the intertidal of Holyhead Harbour down to 131.7 m, mean 57.4, Caernarvon Bay.

Palaeoecology and Distribution

C. variabilis is documented entirely in the Mediterranean. Its nearest relative is an isolated occurrence of C. latientennata Elofson which lives on littoral silt, sand and coarse detritus in the Kattegat.

Müller (1894) described the Type species alive and a common occurrence in sublittoral Posidonia from the Gulf of Naples. It has also been found alive in calcareous algae of this region (Puri, 1963; Puri et.al., 1964) and ranges in Recent sediments throughout the Ligurian Sea and rarely 22-102 m (Bonaduce et.al., 1977) to Malta (Bonaduce and Massoli, 1964). Bonaduce et.al. (1975) indicate that C. variabilis is widely distributed in the Adriatic, 15/24?-172 m and found mostly in sandy sediments. Uffenorde (1970, 1972, 1975) remarked upon its live abundance in the Limski Canal, N.

Adriatic, primarily associated with carbonate sand, 6-37 m, in 9-24°C and 26-38.7‰ salinity. The species also ranges to the E. Aegean (Barbieto-Gonzalez, 1971) and is recorded alive from both the Black Sea (Marinov, 1964; Tomakh, 1969) and Sea of Azov (Shornikov, 1971, 1972).

Summary

Abundant live material is recorded from Western Italy, N. Adriatic and the Black Sea, 40-46°N approx., with a range in Recent sediments southward to Malta and the E. Aegean, 36°N.

This is a lower sublittoral species, alive in 6-37 m. Found in Posidonia and calcareous algae and on sandy sediments beneath. Other material is dredged from sands within 20-170 m. Its temperature range is given as 9-24°C in near or full marine salinity, 26-38‰.

Cytheroma sp. cf. C. variabilis Müller, 1894

pl. 42 figs. a-e

1971 Cytheroma sp. cf. C. karadagiensis Dubowsky; Barbieto-Gonzalez: p. 287, pl. XIX, fig. 1c, 2c.

1972 Cytheroma sp. Uffenorde: p. 80, pl. 3, fig. 2.

Material

Total: F. - 1 C. 3 RV. 2 LV.; M. - 3 C. 11 RV. 10 LV.; J. - 2 RV. = 32 I.

Southern Irish Sea

Dead				Live
F. - 00 C.	01 RV.	01 LV.	= 11 I.	00
M. - 01 C.	06 RV.	02 LV.		

Caernarvon Bay

Dead				Live
F. - 00 C.	01 RV.	00 LV.		00
M. - 00 C.	03 RV.	02 LV.	= 8 I.	
J. - 00 C.	02 RV.	00 LV.		

Malin Sea

Dead				Live
F. - 01 C.	01 RV.	01 LV.	= 13 I.	00
M. - 02 C.	02 RV.	06 LV.		

Sample Distribution

Southern Irish Sea

2375 2381 2824 2915

Caernarvon Bay

2431 2447 2639 2647 HHI

Malin Sea

3145 3154

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	21 .	20/20A	0.395	0.183
		internal	32 .	28A/29		
	LV.	external	21 .	19/19A	0.431	0.177
M.	RV.	"	21 .	17/17A	0.400	0.149
	LV.	"	21 .	18/18A	0.391	0.145

Female right valve - sample 2431 (75 m, mixed sand), Caernarvon Bay; female left valve and male valves - sample 3145 (146.3 m, fine sand + silt), Malin Sea.

Description

Seen laterally, female RV. oval. Anterior margin acutely rounded antero-ventrally and slightly produced below, gently convex antero-dorsally; extremity well below mid-height. Posterior margin acutely rounded postero-ventrally more gently convex postero-dorsally; extremity well below mid-height. Dorsal margin gently arched, though a more symmetrical convexity in male. Cardinal angles indistinct. Ventral margin slightly sinuous with a shallow concavity in the oral region. Greatest height one-third the length from the posterior extremity. Seen from above, extremities acutely pointed, less so posteriorly with greatest width in the posterior third. Right valve and left valve are of equal size, the former overlaps the other dorsally.

Valves thin, smooth, translucent or dull white and opaque. Eye spots not observed. Normal pores few in number, widely distributed, minute and open.

Inner lamella very wide anteriorly and posteriorly, narrow ventrally (oral region). Line of concrescence and inner margin divergent throughout. Inner margin very narrow. Radial pores numerous, 15 - 20 anteriorly and postero-ventrally, short, simple and mostly true.

Hingement weak lophodont. In right valve posterior and anterior terminal elements comprise a single bar-like smooth tooth between which is situated a shallow, smooth, groove overhung by the dorsal margin. The left valve bears complementary structures.

Adductor muscle scars form a vertical row of 4 embracing elongate oval scars, the two intermediate scars being the longest and anterior to which is an 'L' shaped frontal scar with two small round scars vertically below this. Several other laterally aligned elongate scars above the central muscle scars.

Ontogeny

Two juvenile specimens were recovered and are designated penultimate instars of this species. The dimensions of adults from a number of samples is given as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.405-0.440	0.160-0.185	5	
	Mean	0.428	0.178		2.40
M.	Range	0.385-0.420	0.140-0.155	14	
	Mean	0.402	0.147		2.73

Sexual dimorphism is distinct. Males are proportionately more elongate, less arched dorsally and more inflated in lateral view than the female.

Remarks

This species is characterised by its 'L' shaped frontal muscle scar in conjunction with very rounded extremities and a maximum height in the posterior third of the shell.

Study Area Ecology

The species was not found alive.

In the southern Irish Sea it was dredged in coarse sand and gravel, fine sand with silt and mostly in silt with clay between 21.9-33 m, mean 25.8 m. Material also ranged in coarse sand with gravel and mixed sand from the intertidal of Holyhead Harbour down to 109.7 m in Caernarvon Bay. Most specimens were found in fine sand with silt in 146.3 m and 170.1 m in northern Malin Sea.

Palaeoecology and Distribution

Comparable material is only recorded from the Mediterranean region. Uffenorde (1972) found isolated specimens in 18 m and sands of Limski Canal, N. Adriatic. Barbieto-Gonzalez (1971) recovered similar material from the shallow waters of Naxos, E. Aegean.

Genus Pellucistoma Coryell and Fields, 1937

Pellucistoma sp.

pl. 42 figs. n-u

Material

Malin Sea + Total

Dead					Live
Adult -	01 C.	04 RV.	03 LV.	= 13 I.	00
J. -	00 C.	03 RV.	04 LV.		

Sample Distribution

Malin Sea

3147 3152 3153 3154

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.?	RV.	external	7	7A/8	0.489	0.286
		internal	31	39/39A		
		"	31	38/28A		
		"	31	37/37A		
	LV.	external	7	6A/7	0.496	0.300
Adult	RV.	"	7	4A/5	0.534	0.336
	LV.	"	7	5A/6	0.549	0.349
-1.?	LV.	"	26	31/31A	0.400	0.257

These specimens are from sample 3154 (170.1, fine sand + silt), Malin Sea.

Description

In lateral view, female right valve rhomboidal. Anterior margin broadly rounded antero-ventrally, convex antero-dorsally and obliquely so in the left valve; extremity at mid-height. Posterior margin with short pointed sub-dorsal caudal process, obtusely rounded postero-ventrally with a wide, sinuous flange somewhat produced beneath, postero-dorsally a shallow concavity;

extremity well above mid-height. Dorsal margin broadly and shallowly convex. Ventral margin straight or with a shallow concavity in the anterior third (oral region) and having the postero-ventral flange tapering out anteriorly at mid-length. Greatest height just behind mid-length. From above, greatest width medianly, sides evenly convex, bluntly pointed anteriorly and posteriorly. Both valves of a carapace are of equal size.

Valves are thin, translucent or hyaline, finely perforate with a figure of 8 lucid spot situated below the dorsal margin at about mid length. The lucid spot is coarsely pitted in the ventral portion and divided by a 'Y' shaped structure in the dorsal portion. Eye spots not observed. Normal pores small, round, simple and widely distributed.

Inner lamella wide, mostly developed anteriorly and posteriorly, narrow antero-ventrally. Inner margin and line of concrescence divergent throughout, the latter being sub-parallel to and almost embracing the outer margin. Radial pores few, mostly simple, straight and true, occasionally branched antero-dorsally.

Hingement weakly merodont. Anterior terminal element a shallow blade-like or triangular socket with anti-slip bar beneath. A long locellate accommodation groove extends backward to terminate near the posterior cardinal angle. Posterior hinge element almost entirely lacking, a short slightly raised angular bar terminating the median groove. Complementary structures occur in the left valve.

Muscle scars consist of a vertical line of 4 indistinct, widely separated and elongate adductor scars in front of which at mid-height is a 'V' shaped frontal scar. Numerous other small scars surround the central muscle scar pattern.

Ontogeny

Juveniles of the penultimate and antepenultimate growth stage were recognised. The dimensions of adults and juveniles in the Malin Sea is as follows.

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.?	Range	0.485-0.515	0.285-0.515	6	
	Mean	0.504	0.296		1.70
Adult	Range	0.530-0.560	0.330-0.350	3	
	Mean	0.540	0.338		1.60
-1.?	Range	0.400-0.405	0.250-0.260	5	
	Mean	0.402	0.255		1.58
-2?	Range	-	-	1	
	Mean	0.315	0.190		1.66

Sexual dimorphism is undistinct.

Adults differ markedly in size and shape. The smaller variety, of possible females, are highly domed while other, larger and less inflated specimens may represent the male of this species.

Remarks

This is a very distinctive species of Pellucistoma. Its rhomboidal shape is quite unlike most other species of this genus which tend towards an elongate oval form.

The size and shape of Pellucistoma sp, herein, is also comparable with that of the Mediterranean species Loxoconcha (Phlyctocythere, Keij) pellucida Müller 1894. However, the last species is easily distinguished from any belonging to Pellucistoma. Members of the genus Pellucistoma are all characterised by a sub-dorsal lucid spot.

Study Area Ecology

The species was not found alive.

A few specimens were recovered from the outer shelf, Malin Sea, in mixed sand and fine sand with silt, 170.1-512.1 m, mean 256.5 m. Most material occurred in fine sand and silt, 170.1 m.

Family PROGONOCYTHERIDAE Sylvester-Bradley, 1948

Sub Family PROGONOCYTHERINAE Sylvester-Bradley, 1948

Genus Xenocythere Sars, 1925

Xenocythere cuneiformis (Brady), 1868

pl. 43 figs. a-f

1866 Cythere ventricosa n.sp. Sars: p. 34 (name prev. occupied)

1868 Cythere cuneiformis n.sp. Brady: p. 404, pl. XXXI, figs. 47-54.

1874 Cythere cuneiformis Brady; Brady, Crosskey and Robertson: p. 154, pl. X, figs. 23-26.

1889 Cythere cuneiformis Brady; Brady and Norman: p. 143.

1928 Xenocythere cuneiformis (Brady); Sars: p. 179, pl. LXXXII.

1941 Xenocythere cuneiformis (Brady); Elofson: p. 276.

1969 Xenocythere cuneiformis (Brady); Wall (ms.): p. 169, pl. 34, figs. a-j.

1972 Xenocythere cuneiformis (Brady); Whittaker (ms.): p. 290, pl. 56, figs. 1-9.

1977 Xenocythere cuneiformis (Brady); Rosenfeld: p. 15, pl. 1, fig. 12.

Material

Total: F. - 6 RV. 2 LV.; M. - 7 RV. 7 LV.; J. - 16 RV. 17 LV. = 47 I.

Southern Irish Sea

Dead				Live
F. - 00 C.	02 RV.	00 LV.		00
M. - 00 C.	01 RV.	01 LV.	= 9 I.	
J. - 00 C.	02 RV.	03 LV.		

Caernarvon Bay

Dead				Live
F. - 00 C.	02 RV.	01 LV.		00
M. - 00 C.	01 RV.	02 LV.	= 17 I.	
J. - 00 C.	07 RV.	06 LV.		

Malin Sea

Dead				Live
F. - 00 C.	02 RV.	01 LV.		00
M. - 00 C.	05 RV.	05 LV.	= 21 I.	
J. - 00 C.	07 RV.	08 LV.		

Sample Distribution

Southern Irish Sea

910 2359 2365 2367 2375 2819 2904 2916

Caernarvon Bay

2385 2398 2399 2401 2406 2420 2422 2424 2830 2831
2839

Malin Sea

3012 3101 3103

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	2	. 11/11A	0.625	0.315
	LV. "	2	. 10/10A	0.635	0.313
M.	RV. "	2	. 9/9A	0.575	0.255
	LV. "	2	. 8/8A	0.605	0.263
-2.	RV. "	2	. 14/14A	0.398	0.198
	LV. "	2	. 12/12A	0.398	0.194

Female right and juvenile valve - sample 3101 (55 m, fine sand + silt), Malin Sea. Female left valve - sample 2422 (23.8 m, mixed sand), male valves - sample 2399 (7 m, coarse sand + gravel), Caernarvon Bay.

Description

See: Wall (ms. 1969, p. 170-171) for a description and Whittaker (ms. 1972, pl. 56) for an illustration of the hard parts. Sars (1928, p. 179-181, pl. 82) describes and figures the appendages.

Ontogeny

Juveniles of the penultimate to -3 growth stage were recognised. The dimensions of these and adults from the study material are given below.

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.620-0.660	0.315-0.330	7	
	Mean	0.643	0.333		2.00
M.	Range	0.575-0.630	0.255-0.290	14	
	Mean	0.614	0.279		2.20
-1.	Range	0.480-0.550	0.240-0.270	15	
	Mean	0.522	0.257		2.03
-2.	Range	0.390-0.430	0.190-0.210	11	
	Mean	0.423	0.207		2.04
-3.	Range	0.325-0.330	0.170-0.185	4	
	Mean	0.328	0.180		1.83

Sexual dimorphism is pronounced. Males are smaller and proportionately longer (being almost emaciated posteriorly) than females.

See: Wall (ms. 1969, p. 172).

Remarks

See: Whittaker (ms. 1972, p. 291).

Study Area Ecology

It was not recovered alive.

In the southern Irish Sea most specimens occurred to the north of Dublin Bay, 23.8-97 m, mean 47.9 m, in mixed and fine sands with silt or clay. Caernarvon Bay material was also widespread, 7-80.5 m, mean 27.9 m, in coarse sand with gravel and mixed sands. The distribution was very localised in Malin Sea, 47.9-91 m, mean 64.3 m, and was found mostly in sample 3101 (55 m, fine sand + silt), S.E. of Islay.

Palaeoecology and Distribution

This is a rare live species in Scandinavia. Recorded in Hardanger Fiord, S.W. Norway (Norman, 1891) from several localities, 18-55 m, of S. Norway (Brady, 1868; Sars, 1866, 1890, 1928; Brady and Norman, 1889) and in Gullmar and Koster Fiords, W. Sweden (Elofson, 1941). The last author comments that in the Skagerrak it tolerates 2-19°C and 18-35‰ salinity in 7-30 m, though found mostly within 15 m on coarse sands and shelly silts. There is a record of live material on sand and mud, 18 m, in the Oresund (Hagerman, 1965), possibly in the Ostsee, W. Baltic (Klie, 1929) and within Kiel Bay between 6-22 m and 17-25‰ salinity (Rosenfeld, 1977).

Live specimens have been recorded from intertidal muds of the Forth Estuary (Wall, ms. 1969) and from a tidepool environment and in 28-80 m off N.E. England (Brady, 1868; Brady and Robertson, 1870, 1872; Brady and Norman, 1889; Norman and Brady, 1909). In addition, Brady and Robertson (1870, 1872) indicate that isolated specimens have been found in river mouths and estuaries as far south as the R. Thames.

Isolated material occurs in sand and mud in 80 m+ of the Minch, N.W. Scotland (Brady, 1868; C.S. Harris, ms. 1977) and it occurs alive in moderate numbers 0-55 m, in the Clyde Estuary (Brady, 1868; Robertson, 1874). Rare dead specimens are known in sublittoral algae of Caernarvon Bay (Morgan, ms. 1977), from shallow muds and sands of Cardigan Bay (Wall, ms. 1969) and in 6-28 m of Dublin Bay. The range also extends in Recent sediments throughout inner bay areas off W. Ireland (Brady, 1868; Brady and Robertson, 1869, 1872; Norman, 1905; Farran, 1913) and in cobble sands to many parts of the Celtic

Sea (Lomax, ms. 1978). The species is more scarce further south. Found almost entirely in muds of river mouths and harbours of N. and S. Devon and Cornwall (Brady, 1868; Brady and Robertson, 1870; Norman and Scott, 1906; Harding, 1957), Scilly Isles (Norman and Scott, 1906; Neale, 1970), Dorset coast (Whittaker, ms. 1972) and the Channel Isles (Brady, 1868; Brady and Robertson, 1872; Norman, 1907, 1908).

The fossil record is poorly represented. Wall (ms. 1969) indicates that sub-Recent material may be reworked down to 100 m in the southern Irish Sea. However, isolated Holocene specimens are well documented in this region by Spencer (ms. 1976) and Haynes et.al. (1977). Lastly, Brady et.al. (1874) report *X. cuneiformis* in the Late Glacial of S. Norway and N.W. Scotland with, perhaps, the earliest record as a rarity in the last interglacial of Selsey, Sussex (Whatley and Kaye, 1971).

Summary

X. cuneiformis is alive but never more than locally common in S. Scandinavia. Isolated live material is also known off N.E. England and may range off W. Britain to the northern Irish Sea, 54-60°N. Recent and Holocene specimens are generally reworked into deeper parts of the southern Irish Sea, though probably occur throughout the geographical range, 50-60°N. Finally, the species is sparsely distributed in the Late Glacial of S. Norway and N.W. Scotland, 58-60°N and has been found in the last interglacial of S. Sussex, 50°N.

Live material occurs in 18-55 m of S.W. Norway and is found mostly between 7-15 m in the Skagerrak and W. Baltic.

In British waters *X. cuneiformis* inhabits the intertidal of estuaries and sheltered inner bays. The species is more usually found in superficial sediments between 28-80 m and may be reworked down to 100 m+. *X. cuneiformis* is primarily associated with silts and coarse shell sand in full marine salinity, though will tolerate 18-35‰ salinity and 2-19^{o}C.

Family SCHIZOCYTHERIDAE Howe, 1963

Genus Palmenella Hirschmann, 1915

Palmenella limicola (Norman), 1864
pl. 43 figs. g-j

1864 Cythereis limicola n.sp. Norman: p. 193.

1865 Cythere areolata Brady: p. 381, pl. 62, figs. 2a-d.

1865 Cythereis limicola n.sp. Norman: p. 20, pl. VI, figs. 1-4.

1866 Cythere nodosa Sars: p. 34.

1868 Cythere limicola (Norman); Brady: p. 405, pl. 31, figs. 38-41.

1874 Cythere limicola (Norman); Brady, Crosskey and Robertson: p. 154, pl. 10, figs. 1-4.

1878 Cythere limicola (Norman); Brady: p. 389, pl. LXIV, figs. 9a-b.

1915 Palmenella limicola (Norman); Hirschmann: p. 582, t.figs. 8-27.

1928 Kyphocythere limicola (Norman); Sars: p. 181, pl. 82.

1938 Kyphocythere limicola (Norman); Klie: p. 172, t.figs. 571-574

1941 Palmenella limicola (Norman); Elofson: p. 54, map 21.

?1963 Palmenella limicola (Norman); Swain: p. 830, pl. 99, fig. 3a-d, t.fig. 9d.

1969 Palmenella limicola (Norman); Lev: pl. 1, fig. 10; pl. V, fig. 4.

1975 Palmenella limicola (Norman); Neale and Howe: pl. 5, figs. 7, 8.

1977 Palmenella limicola (Norman); Rosenfeld: p. 15, pl. 1, figs. 3-6.

1977 Palmenella limicola (Norman); Cronin: p. 116, pl. III, fig. 7.

1980 Palmenella limicola (Norman); Lord: p. 234, pl. 3, fig. 6.

1981 Palmenella limicola (Norman); Masson (ms.): p. 83, pl. 4, figs. 14, 15, 17, 20.

Material

Total: F. - 2 RV.; M. - 1 LV.; J. - 3 C. 7 RV. 22 LV.
= 29 I.

Southern Irish Sea

Dead	Live
J. - 00 C. 02 RV. 02 LV. = 5 I.	00

Caernarvon Bay

Dead	Live
J. - 01 C. 00 RV. 00 LV. = 1 I.	00

Malin Sea

Dead	Live
F. - 00 C. 02 RV. 00 LV. M. - 00 C. 00 RV. 01 LV. = 23 I. J. - 02 C. 05 RV. 20 LV.	00

Sample Distribution

Southern Irish Sea

2812 2915

Caernarvon Bay

2406

Malin Sea

3101 3143 3153 3161 3162

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	9	. 4/4A	0.646	0.383
M.	LV. "	9	. 3/3A	0.600	0.366
-1.	RV. "	9	. 5/5A	0.547	0.308
	LV. "	9	. 6/6A	0.540	0.305

Adult specimens - sample 3161 (128 m, medium sand), juveniles - sample 3101 (55 m, fine sand + silt), Malin Sea.

Description

The hard and soft parts are described and illustrated by Hirschmann (1915, p. 582-94, t.figs. 8-27) and Sars (1928, p. 181-182, pl. 82).

Ontogeny

The penultimate to -4? growth stage was recognised. The dimensions of juveniles within the Malin Sea is as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
-1.	Range	0.510-0.560	0.280-0.325	7	1.74
	Mean	0.542	0.310		1.74
-2.	Range	0.440-0.510	0.260-0.290	11	
	Mean	0.485	0.278		1.74
-3.?	Range	0.370-0.430	0.240-0.260	6	
	Mean	0.413	0.251		1.65
-4.?	Range	0.300-0.340	0.195-0.220	6	
	Mean	0.318	0.206		1.54

Remarks

In the literature, P. limcola is incorporated in the distribution of several other species.

Blake (1929, p. 12, fig. 5) comments that his discovery of P. americana in the sublittoral off Maine may account for many erroneous records of P. limicola off the east coast of N. America. These two species have almost identical hard part features. However, P. americana is slightly the longer form (0.69 mm - L.), bears eye tubercles, 2 postero-dorsal nodes (P. limicola has 3 nodes) and possesses acutely pointed ventro-lateral wings. There is a closely related but distinct form on the Novo-Siberian Shelf which Akatova (1946, p.226, fig. 4) termed P. limicola (Norman) var. dentato marginata. Akatova distinguished the Russian material by its antero-marginal dentation and acute postero-dorsal noding. That recorded as P. limicola by Swain (1963) in the Pleistocene of N. Alaska may also be distinct. The Gubik Formation material bears an inverted horse-shoe shaped depression around the median tubercle and has rudely reticulate ornament over most of the shell surface.

Study Area Ecology

Live material was not found.

This is a rare species in the study material. Juveniles occurred in 28.9 m and 33 m, fine sand silt and clay, southern Irish Sea; in 18 m, mixed sand, Caernarvon Bay. Most individuals were recovered between 55-170.1 m, mean 128 m, in fine sand with silt, Malin Sea.

Palaeoecology and Distribution

Hazel (1967, 1970) indicates that P. limicola occurs within 24-64 m in a few isolated localities from Maine to the northern Davis St. Norman (1865), Brady (1868) and Stephensen (1913) report it in 48-130 m off Hunde Island, W. Greenland, though there is little indication that the material is live. A few live specimens are recorded from the sublittoral of Halifax Inlet, Nova Scotia (Siddiqui and Grigg, 1975).

The species is, however, distributed in Recent sediments throughout Scandinavia, in 20 m from King Karl Land (Elofson, 1941), 55 m off Frans Joseph Land (Scott, 1899) and generally within 13-130 m of the N. Arctic (Elofson, 1941). Live material is recorded between 5-30 m from Finmark, N. Norway (Norman, 1891, 1902; Brady and Norman, 1895; Elofson, 1941) and ranges in reduced numbers on muds from Lofoten, 12-18 m, southward to Trondheim Fiord (Sars, 1866, 1928; Brady and Norman, 1889; Norman, 1891). Isolated live specimens also range on dark silts and sometimes on shelly sands down to 150 m in the E. Skagerrak (Elofson, 1941) and the Oresund (Hagerman, 1965). However, in Ostsee and Kiel Bay it only inhabits 21-67 m, in 14-30‰ salinity (Hirschmann, 1915; Klie, 1929, 1938; Rosenfeld, 1977). Lastly, Elofson (1941) reports on overall depth range down to 92 m in the W. Baltic, in which region _P. limicola_ is tolerant of 0-12°C in 10‰+ salinity.

Unfortunately, no indication is given whether the generally rare material recovered from the North Sea and off N.E. Britain, in Norman (1865), Brady (1868), Brady and Robertson (1872) and Norman and Brady (1909), represents a live or dead distribution. However, Norman (1862), Brady (1870) and Brady and Robertson (1876) have found it to be moderately common, 28-55 m in isolated localities off Northumberland and Durham.

This is a rare species west of Britain, found in muds and sands, 48-90 m, in the Minch (Brady, 1866; Brady and Norman, 1889; C.S. Harris ms. 1977). Live specimens are recorded in this region off Skye (Brady, 1868). Isolated Recent material ranges to the Clyde Estuary, 18-28 m (Brady and Robertson, 1872; Robertson, 1874; Brady and Norman, 1889); Antrim coast (Norman, 1905) and Irish Sea, down to 35 m (Brady and Robertson, 1872; Brady and Norman, 1889; Norman, 1905). Lastly, reworked specimens have been dredged from 200 m approx. off S.W. Ireland (Norman, 1905).

Isolated Holocene specimens are known from the Champlain

Sea area of the St. Lawrence Estuary (Cronin, 1976, 1977) and are reworked into 48-140 m off Hinde Island and in 25 m off Baffin Island, Davis St. (Neale and Howe, 1975). Late Glacial material is widespread. Reported from Portland, Maine (Brady and Crosskey, 1871), St. Lawrence Estuary (Brady et.al., 1874) and in submarine canyons off eastern N. America (Hazel, 1968). It also occurs rarely in contemporaneous silts and clays of S.W. Norway (Lord, 1980) and S.W. Scotland (Morris, ms. 1978; Graham and Wilkinson, 1978; Peacock et.al., 1978). However, P. limicola is common in the Late Devensian of the North Sea (Masson, ms. 1981) and it is ubiquitous in raised beach deposits of the Clyde Estuary, W. Scotland (Brady et.al., 1874; Brady, 1877, 1885). Isolated material is recorded from the last interglacial, Ipswichian, of Cardigan Bay (Jasin, ms. 1976); Hoxnian interglacial of E. Yorkshire (Neale and Howe, 1975) and from various Pleistocene deposits of N. Russia (Lev, 1969) and N. Alaska (Swain, 1963). It is, however, probable that the Gubik Formation specimens are distinct. Lastly, an isolated record of P. limicola in the Upper Pliocene of Belgium may represent the earliest stratigraphical occurrence of this species.

Summary

Isolated material ranges in the western N. Atlantic from Maine to the northern Davis St., 44-69^{O}N, though it is not known whether other species are included in the given range. Rare live specimens do, however, extend from Finmark, N. Norway to the N. Barents Sea, 80^{O}N and W. Norway. P.

limicola is best documented from the Skagerrak and W. Baltic and ranges alive to northern Britain, 54-60°N. Sub-Recent and Holocene material occurs in the Lake Champlain region, St. Lawrence Estuary and in several areas of Davis St., W. Greenland, 43-70°N. Rare Late Glacial specimens are recorded from Portland, Maine, St. Lawrence Estuary and submarine canyons off New England, 38-50°N. This species is also known in contemporaneous deposits of S.W. Norway and it is common in the Late Devensian of the North Sea and W. Scotland, 55-60°N. Isolated individuals are recorded from the last interglacial, Ipswichian, of the southern Irish Sea, 52-54°N and occur in the Hoxnian interglacial of E. Yorkshire, 54°N. Lastly, *P. limicola* may occur in several Pleistocene deposits of N. Russia, 65-70°N and possibly extends to the Upper Pliocene Crag of N. Belgium, 51°N approx.

Its ecology is very variable. Isolated live specimens are reported between 24-64 m off Maine and in British waters and perhaps occur with reworked material in 48-140 m. *P. limicola* is rarely alive in 5-30 m off N. Norway and ranges down to 180 m in S.W. Norway and the Skagerrak. Records indicate a mud or silt habitat in full marine salinity. However, live material is also dredged from shell sands of the Oresund and W. Baltic in 10/14-30‰ salinity. The temperature tolerance is -2-12°C.

Family TRACHYLEBERIDIDAE Sylvester-Bradley, 1948

Sub Family TRACHYLEBERIDINAE Sylvester-Bradley, 1948

Genus *Trachyleberis* Brady, 1898

Trachyleberis dunelmensis (Norman), 1864

pl. 43 figs. k-q; t.fig. 11

1864 *Cythereis dunelmensis* n.sp. Norman: p. 193.

1865 *Cythereis dunelmensis* n.sp. Norman: p. 22, pl. VII, figs. 1-4.

1866 *Cythereis horrida* Sars: p. 45.

1868 *Cythere dunelmensis* (Norman); Brady: p. 416, pl. 30, fig. 1-12.

1874 *Cythere dunelmensis* (Norman); Brady, Crosskey and Robertson: p. 168, pl. 5, figs. 13-20; pl. 11, figs. 36, 37.

1928 *Cythereis dunelmensis* Norman; Sars: p. 195, pl. XC.

1938 *Cythereis dunelmensis* Norman; Klie: p. 181, figs. 606-608.

1941 *Cythereis dunelmensis* Norman; Elofson: p. 72, maps 29, 30.

1962 *Trachyleberis* cf. *dunelmensis* (Norman); Woszidlo: p. 81, pl. 4, figs. 8, 9.

1963 *Cletocythereis noblissimus* Swain: p. 824, pl. 98, fig. 5; pl. 99, figs. 15a, b, t.fig. 10a.

1965 *Cletocythereis dunelmensis dunelmensis* (Norman); Bassiouni: p. 513, pl. 2, fig. 8.

1965 *Cletocythereis dunelmensis minor* n.sp. Bassiouni: p. 513, pl. 2, fig. 9.

1965 *Cletocythereis elofsoni elofsoni* Bassiouni: p. 514, pl. 2, figs. 4, 5.

1965 *Cletocythereis elofsoni abbreviata* Bassiouni: p. 516, pl. 2, figs. 6, 7.

1967 *Acanthocythereis*? *dunelmensis* (Norman); Hazel: p. 34.

1969 *Trachyleberis dunelmensis* (Norman); Yassini: p. 49, pl. 24, figs. 6, 6a.

1969 *Trachyleberis dunelmensis* (Norman); Lev: pl. I, fig. 2; pl. II, fig. 13; pl. III, fig. 9; pl. IV, fig. 5.

1975 <u>Acanthocythereis</u> <u>dunelmensis</u> (Norman); Neale and Howe: p. 418, pl. I, figs. 3, 11, 13-16.

1977 <u>Acanthocythereis</u> <u>dunelmensis</u> (Norman); Cronin: p. 116, pl. III, fig. 8.

1977 <u>Acanthocythereis</u> <u>dunelmensis</u> (Norman); Rosenfeld: p. 23, pl. 5, figs. 65-68.

1980 <u>Acanthocythereis</u> <u>dunelmensis</u> (Norman); Lord: p. 234, pl. I, figs. 8-13.

1981 <u>Trachyleberis</u> <u>dunelmensis</u> (Norman); Masson (ms.): p. 87, pl. 5, figs. 2, 5-8, 12.

<u>Material</u>

Total Dead: F. - 1 C. 19 RV. 21 LV.; M. - 2 C. 24 RV. 12 LV.; J. - 2 C. 720 RV. 576 LV. = 986 I.

Live: 1 F.

Southern Irish Sea

Dead					Live
F. -	01 C.	16 RV.	17 LV.		01
M. -	02 C.	22 RV.	10 LV.	= 950 I.	00
J. -	02 C.	698 RV.	568 LV.		00

Malin Sea

Dead					Live
F. -	00 C.	03 RV.	04 LV.		00
M. -	00 C.	02 RV.	02 LV.	= 36 I.	
J. -	00 C.	08 RV.	22 LV.		

<u>Sample Distribution</u> (Live occurrence is underlined)

Southern Irish Sea

2360 2810 2811 2812 2813 2814 2819 2821 2904 2905
2906 <u>2910</u> 2911 2915 2916 2917

Malin Sea

3041 3042 3101 3135 3143 3152 3161 3162

<u>Figured Specimens</u>

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	31 .	20/20A	0.781	0.466
	LV. "	2 .	23/23A	0.782	0.491

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
M.	RV. external	2	. 22/22A	0.810	0.435
	LV. "	2	. 21/21A	0.790	0.437
-1.	RV. "	2	. 25/25A	0.636	0.382
	LV. "	2	. 26/26A	0.634	0.392
-4.	RV. "	2	. 27/27A	0.362	0.226

Adults - sample 2915 (33 m, silt +clay), juveniles - sample 2905 (87.8 m, mixed sand + silt), southern Irish Sea.

Description

See: Sars (1928, p. 195-196, pl. 90) and Elofson (1941, p. 72-76) for a description of the hard and soft parts. The former author illustrates the appendages and carapace morphology.

Ontogeny

Juveniles of the penultimate to -6 growth stage were recognised. The dimensions of two large instar populations from samples 2905 and 2915, southern Irish Sea, are given as follows (See: Fig. 11).

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.770-0.840	0.450-0.480	12	
	Mean	0.835	0.470		1.78
M.	Range	0.780-0.880	0.420-0.460	13	
	Mean	0.861	0.434		1.98
-1.	Range	0.620-0.720	0.360-0.430	88	
	Mean	0.690	0.404		1.71
-2.	Range	0.510-0.580	0.300-0.350	95	
	Mean	0.549	0.333		1.65
-3.	Range	0.430-0.480	0.260-0.310	105	
	Mean	0.458	0.286		1.60
-4.	Range	0.350-0.400	0.210-0.250	80	
	Mean	0.376	0.333		1.61
-5.	Range	0.290-0.330	0.190-0.210	45	
	Mean	0.307	0.197		1.56
-6.	Range	0.220-0.280	0.170-0.180	3	
	Mean	0.277	0.167		1.42

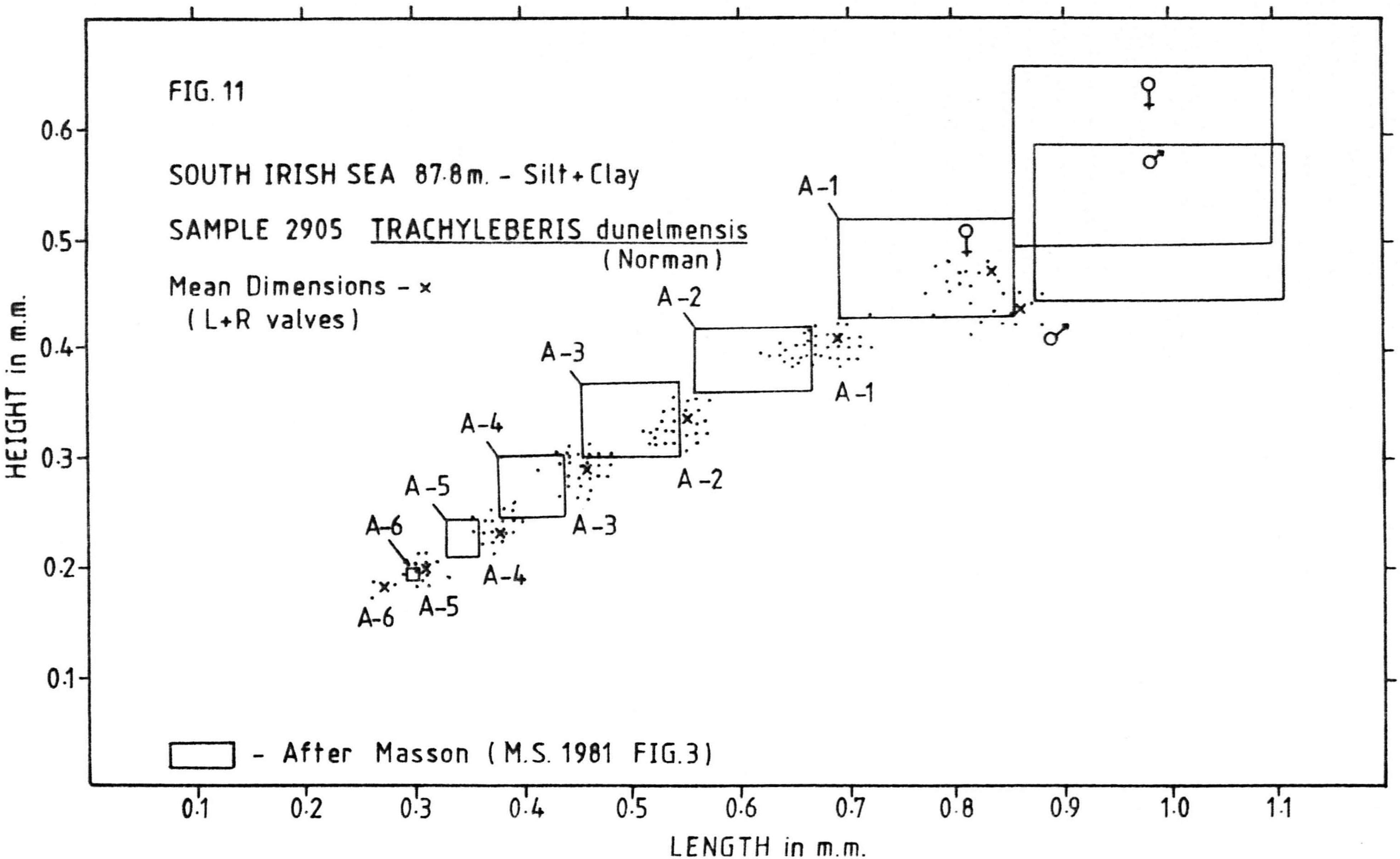


FIG. 11
SOUTH IRISH SEA 87·8m. - Silt+Clay
SAMPLE 2905 TRACHYLEBERIS dunelmensis (Norman)
Mean Dimensions - ×
(L+R valves)
A-1
A-2
A-3
A-4
A-5
A-6
♀
♂
- After Masson (M.S. 1981 FIG.3)
HEIGHT in m.m.
0·1
0·2
0·3
0·4
0·5
0·6
LENGTH in m.m.
0·1
0·2
0·3
0·4
0·5
0·6
0·7
0·8
0·9
1·0
1·1

Sex dimorphism is most marked, which feature has caused some authors to consider both sexes as distinct species. Males are very much larger and more elongate than females.

By comparison with Masson's ms. 1981 North Sea material there would seem to have been a 15.20% size reduction of T. dunelmensis since the Late Glacial.

Remarks

It is possible that at least some of the western North Atlantic records of T. dunelmensis refer to a distinct species. In this respect, Hulings (1967, p. 324, pl. IV) illustrates specimens with fewer spines and tubercles and comments that the compulatory appendage of his own material is structurally different from that of the Scandinavian Types.

See: Masson (ms. 1981, p. 88-90).

Study Area Ecology

A single live female was found in 54.9 m, mixed sand, southern Irish Sea.

Otherwise, this is one of the most abundant species in northern parts of the S. Irish Sea. Wherein, it occurred between 24.4-137.5 m, mean 56.4 m, and mostly in 24.4-87.8 m, mixed sand, fine sand with silt and silt with clay. Isolated individuals were found in scattered areas of the Malin Sea, 54.9-182 m, mean 118.1 m, mixed sand and fine sand with silt.

A large population of adults and juveniles occurred in samples 2813, 2905 and 2915, 33.5-87.8 m with assemblages of juveniles encountered in samples 2810, 2811 and 2906, 59.4-87.8 m, sands with a high content of silt + clay, southern Irish Sea.

Palaeoecology and Distribution

T. dunelmensis is widely distributed in the western N. Atlantic and Arctic. Brady and Norman (1889) and Stephensen (1913) dredged it from northern Davis St. and it occurs off Hunde Is., W. Greenland, in 110-140 m (Brady, 1868). The species may also be present off the coast of Labrador and Nova Scotia, 0-100 m (Hulings, 1967), occurs in the St. Lawrence Estuary, 20-100 m (Brady, 1870; Hazel, 1967), rarely in 10 m off Mount Desert, Maine (Blake, 1933) and is reported in Vineyard Sound, Massachusetts (Cushman, 1906). Hazel (1967) also records isolated material in 200 m off Shannon Is., N.E. Greenland.

Elofson (1941) indicates that it is common in the Barents Sea, alive in 15-90 m and otherwise found down to 430 m. The last author, in accord with Brady and Norman (1889), found it in 150 m off Spitzbergen and with Scott (1899) recorded isolated material in 28 m off Frans Joseph Land. Elofson (1941) also considers the range to extend to King Karl Land and the Kara Sea. In addition, Brady and Norman (1895), Norman (1902) and Elofson (1941) record it alive from the tide-marks and down to 180 m+ off Finmark, N. Norway. T. dunelmensis is also alive and moderately common throughout W. and S. Norway, from Oslo Fiord to the Lofoten Isles, 18-100 m (Sars, 1866, 1890, 1928; Brady, 1868). The species is best documented in the Skagerrak. Wherein, Elofson (1941, 1943) found two morphological variants of T. dunelmensis that share the same ecology on sandy silts between 50-70 m approx. He also indicates that the larger form was alive throughout W. Scandinavia and adjacent waters in 13-400 m, mostly 50-225 m approx., on loose silts and in full marine salinity. Elofson (1941) found the smaller variety was restricted to S. Scandinavia and the W. Baltic, alive in 14-150/200 m approx., and mostly within 50 m on shelly sands, 26‰+ salinity. Both Elofson (1941) and Hagerman (1965) found the small variety abundantly alive in the Kattegat and Oresund, whilst Klie (1929, 1938) and Rosenfeld (1977) found this form alive on silts in 21-32 m and 25-30‰ salinity of Keele Bay and Ostsee. Elofson (1941) considered the small form to have a tolerance of 2-18/19^{o}C and the large form to inhabit waters of -1.7-11^{o}C, mostly 4^{o}C+. Lastly, Stephensen (1929, 1938) records the latter variety in reduced numbers on muds, 40-365 m, off Iceland and the Faeroe Isles.

Brady and Robertson (1872) and Norman and Brady (1909) record it generally common in deeper parts of the North Sea, from N. and E. Scotland southward to Northumberland and Durham. Indeed, in this region, Norman (1865), Brady (1868, 1903) and Brady and Robertson (1874, 1876) found material in sand and mud, 38-110 m and mostly from 70 m approx. However, there is no indication that live material is represented in this distribution.

T. dunelmensis is also found in muds and sand, 80-160 m, of the Minch, N.W. Scotland (Brady, 1868; Brady and Norman, 1889; C.S. Harris, ms. 1977) and it occurs in moderate abundance in muds, 16-55 m, of the Clyde Estuary (Brady, 1868; Brady and Robertson, 1872; Robertson, 1874). Brady and Robertson (1872) indicate that this species is common in the Irish Sea and with Norman (1905) remark upon the scarcity of material westward of Ireland. Isolated specimens have also been dredged further south in the Celtic Sea and Western Approaches (Neale, 1974; Brassil, ms. 1977) though there is little evidence to suggest that live material is incorporated in its distribution.

This species is widely distributed as a fossil. Cronin (1976, 1977) indicates that it occurs commonly in the Holocene Champlain Sea, St. Lawrence and Peypouquet (1971, 1973) and Moyes and Peypouquet (1971) indicate that isolated material of this age is reworked down to 400 m in S. Biscay. Late Glacial specimens may range to Portland, New England (Brady and Crosskey, 1871) and occur rarely in submarine canyons down to 435 m off E. America (Hazel, 1968). It is locally abundant in raised beach clays and sand of S.W. Norway (Lord, 1980) and occurs in similar deposits throughout W. Scotland (Brady et.al., 1874; Robertson, 1885, 1887; Morris, ms. 1978; Graham and Wilkinson, 1978; Peacock et.al., 1978). Cromerty and Forth, E. Scotland (Peacock et.al., 1980) and the North Sea (Masson, ms. 1981) are also included in its widespread abundance during the Late Glacial. In addition, Caralp et.al. (1967, 1968, 1970) records it as a rarity in Glacial submarine cores of Biscay and isolated reworked juveniles have been recovered in 500 m and 1,800 m of this region (Yassini, 1969). T. dunelmensis is also abundant in the Hoxnian interglacial of E. Ireland (Haynes and Whatley, 1970; Calhoun and MacCabe, 1973) and E. Yorkshire (Brady et.al., 1874; Neale and Howe, 1975) though is only moderately common in that of Esjberg, W. Denmark (Bassiouni, 1965), N. Germany and E. Denmark (Woszidlo, 1962). Finally, Lev (1969) found it widely distributed in the Pleistocene of N. Russia and it appears to be a common species in Gubik Formation, N. Alaska (Swain, 1963).

Summary

The species is rarely distributed in the eastern N. Atlantic, from Davis St. to the St. Lawrence Estuary, 67-46^{O}N and perhaps ranges to Cape Cod, 42^{O}N, and deep waters of E. Greenland, 75^{O}N. It also ranges in live abundance from N. Norway to the Kara Sea and extends in increasing numbers southwards throughout W. Norway to the Skagerrak and W. Baltic, 80-56^{O}N. Although very common in Recent sediments only isolated live individuals are recorded from Iceland and southward to 52^{O}N west of Britain. Sub-Recent and Holocene material is common in the Lake Champlain area, eastern N. America and may be distributed in deep waters northward to the Davis St., 44-67^{O}N. Contemporaneous material is abundant throughout Britain and adjacent waters, 50-60^{O}N and occurs very rarely in S. Biscay, 44-46^{O}N. Isolated Late Glacial specimens are reported from Portland, Maine and submarine canyons in the western N. Atlantic, 44-38^{O}N. Material of this age is locally abundant and widespread in S. Norway and northern Britain, 55-60^{O}N approx. and occurs rarely in Biscay, 44-48^{O}N. The species is also common in the Hoxnian, interglacial of E. Ireland and W. Yorkshire, though is only moderately common in that of N. Germany and Denmark, 56^{O}N. Lastly, there are reports of _T. dunelmensis_ in Pleistocene deposits of N. Alaska and N. Russia, 65-70^{O}N.

Its ecology in the western N. Atlantic is not fully known. However, live material is found in 15-90 m of the N. Barents Sea, occurs commonly from the tidemarks down to 180 m off N. Norway and is found between 18-100 m west of Norway. Two different morphological forms cohabit sandy silts, 50-70 m

of the Skagerrak and Kattegat. The large form ranges outside S. Scandinavia on silty sediments mostly within 50-225 m, whilst the smaller form extends mostly within 50 m into the W. Baltic on coarse shell sand and silts. Much of that in 35-160 m+ muds and fine sands; from the western N. Atlantic, Britain and adjacent waters is of sub-Recent and Holocene age. Finally, the large form of T. dunelmensis is fully marine, found alive in -1.7-11°C and mostly in 4°C+, whereas the other form is common in 25‰+ salinity between 2-19°C.

Genus Buntonia Howe, 1937

Buntonia corpulenta (Brady and Norman), 1889
pl. 44 figs. a-i

1889 Cythere corpulenta n.sp. Brady and Norman: p. 134, pl. XVI, figs. 11, 12.

1943 Semicythereis corpulenta (Brady and Norman): Elofson: p. 18, t.figs. 9-16.

1959 Buntonia (Buntonia) corpulenta (Brady and Norman); Reyment and Elofson: p. 157, t.figs. 3-7; pl. 2, figs. 1, 4, 5.

?1969 Buntonia corpulenta (Brady and Norman); Yassini: p. 59.

Material

Malin Sea + Total

Dead					Live
F. - 02 C.	02 RV.	03 LV.			00
M. - 00 C.	03 RV.	01 LV.	= 13 I.		
J. - 00 C.	00 RV.	02 LV.			

Sample Distribution

3152 3153 3154

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	24 .	2/2A	0.469	0.300
		internal	30 .	11/11A		
		"	27 .	3A/4		
		"	27 .	2A/3		
	LV.	external	24 .	3/3A	0.486	0.304
M.	RV.	"	24 .	1/1A	0.497	0.302
	LV.	"	24 .	-	0.488	0.316
		"	30 .	10A/11		
-1.	LV.	"	24 .	4/4A	0.420	0.276

Female right and male left valves - sample 3153, male right and juvenile left valves - sample 3154, 170.1 m, fine sand and silt, Malin Sea.

Description

Brady and Norman (1889, p. 134) describe the hard parts. A more complete description and illustration of the carapace and appendages is given in Elofson (1943, p. 18-22).

Ontogeny

Two penultimate instars were recognised. The dimensions of adults in the study material are given as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.455-0.490	0.285-0.305	9	
	Mean	0.481	0.295		1.63
M.	Range	0.480-0.505	0.290-0.320	3	
	Mean	0.498	0.302		1.65

Sexual dimorphism is expressed by males being larger and more elongate than females.

Study Area Ecology

The species was not found alive, most individuals were poorly preserved.

Material occurred in only one region of the northern

Malin Sea, fine sand with silt between 170.1-173.8 m.

Palaeoecology and Distribution

This is a very rare N.W. European species. Isolated live material has been recovered from 150-350 m in fine and shell sands of Trondheim Fiord, S.W. Norway (Elofson, 1943). It has also been dredged in Recent sediments from 180 m+ in Oster Fiord, north of Bergen (Brady and Norman, 1889; Norman, 1891).

Peypouquet (1971) indicates that this species forms part of the biocoenosis between 113-500 m, mostly within 160 m of S. Biscay. Yassini (1969), however, regards _B. corpulenta_ as a rare Late Glacial relict of this region having dredged a solitary individual in sands from 1,500 m.

Summary

Live material occurs off S.W. Norway, 60°N and may range to S. Biscay, though that from the latter region, 44-46°N, is more likely to be a Late Glacial or Holocene relict.

B. corpulenta is alive in 150-350 m on fine and shelly sands of cold boreal waters. It appears to be a fully marine form.

Genus Carinocythereis Ruggieri, 1956

Carinocythereis carinata (Roemer), 1838
pl. 44 fig. j-o; t.fig. 12

1838 Cytherina carinata n.sp. Roemer: p. 518, pl. 6, fig. 28.

1856 Cythere senilis n.sp. Jones: p. 37, pl. 3, figs. 8a-b.

1874 Cythere antiquata Baird; Brady, Crosskey and Robertson: p. 170, pl. XII, figs. 8-10.

1878 Cythere senilis Jones; Terquem: p. 115, pl. 13, fig. 14.

?1939 Cythereis antiquata (Baird): Dubowsky: p. 55, t.figs. 55, 56.

1953 Cythereis carinata (Roemer); Ruggieri: p. 72.

1956 Carinocythereis carinata (Roemer); Ruggieri: p. 165, t.fig. 1.

1957 Carinocythereis carinata (Roemer); Keij: p. 101, pl. XIII, fig. 10; pl. XX, fig. 12.

1961 Carinocythereis carinata (Roemer); Kurc: p. 193, pl. V, fig. 83.

1962 Carinocythereis carinata (Roemer); Ruggieri: p. 32, pl. III, figs. 8-9.

1965 Carinocythereis carinata (Roemer); Moyes: p. 79, pl. IX, fig. 10.

1969 Carinocythereis carinata (Roermer); Uliczny: p. 76, pl. 16, fig. 6; pl. 18; fig. 6.

1969 Carinocythereis antiquata (Baird); Wall (ms.): p. 396, pl. 9, figs. a-f; pl. 45, figs. a-j.

1969 Carinocythereis carinata (Roemer); Yassini: p. 51, pl. XV, XVI, XIX.

1970 Carinocythereis form A. Carbonel and Moyes: pl. 1, figs. 1, 4; pl. 2, figs. 1-8.

1971 Carinocythereis carinata (Roemer); Barbieto-Gonzalez: p. 282, pl. XV, figs. 1b, 2b; pl. XLVII, fig. 7.

1971 Carinocythereis carinata (Roemer); Uffenorde: p. 72, pl. 7, fig. 9.

1972 Carinocythereis carinata (Roemer); Sissingh: p. 98, pl. 6, fig. 12.

1972 Carinocythereis antiquata (Baird); Whittaker (ms.): p. 300, pl. 57, figs. 6-10.

1974 Carinocythereis carinata (Roemer); Wilkinson (ms.): p. 49, pl. 7, figs. 5, 6.

1975 Carinocythereis antiquata (Baird); Bonaduce, Ciampo and Masoli: p. 49, pl. 25, figs. 8-10.

1975 Carinocythereis sp. Bonaduce, Ciampo and Masoli: p.49, pl. 54, fig. 11.

1976 Carniocythereis bairdi (Uliczny); Pugliese et.al.: p. 486, pl. 1, figs. 1, 2.

1976 Carniocythereis carinata (Roemer); Breman: p. 57, pl. VII, fig. 105.

1978 Carinocythereis carinata (Roemer); Yassini: p. 380, pl. 4, fig. 12.

Material

Total: F. - 17 C. 12 RV. 15 LV.; M. - 6 C. 9 RV. 8 LV.;
J. - 9 C. 219 RV. 132 LV. = 346 I.

Southern Irish Sea

Dead		Live
F. - 14 C. 09 RV. 10 LV.		00
M. - 06 C. 09 RV. 08 LV.	= 318 I.	
J. - 08 C. 205 RV. 124 LV.		

Caernarvon Bay

Dead		Live
F. - 02 C. 01 RV. 04 LV.	= 10 I.	00
J. - 01 C. 04 RV. 00 LV.		

Malin Sea

Dead		Live
F. - 01 C. 02 RV. 01 LV.	= 18 I.	00
J. - 00 C. 10 RV. 08 LV.		

Sample Distribution

Southern Irish Sea

868 2359 2360 2361 2369 2370 2377 2378 2380 2381 2381
2765 2810 2811 2812 2813 2814 2815 2819 2821 3822
2823 2824 2904 2905 2910 2912 2915 2916 2917

Caernarvon Bay

2404 2405 2407 2839

Malin Sea

3037 3101

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	23 .	38A/39	0.838	0.425
	LV. "	23 .	39A/40	0.844	0.451
M.	RV. "	23 .	36A/37	0.858	0.400
	LV. "	23 .	37A/38	0.830	0.394
-1.	RV. "	23 .	40A/41	0.682	0.351
	LV. "	23 .	41A/42	0.701	0.360

Female valves - sample 2378 (16 m, fine sand + silt), male valves - sample 2916 (36.6 m, mixed sand + silt), juveniles - sample 2819 (54.9 m, silt + clay), southern Irish Sea.

Description

A full description and illustration of carapace morphology and the appendages is given by Wall (ms. 1969, as *C. antiquata* (Baird), p. 397-404, pls. 9; 45, figs. a-j).

Ontogeny

Instars from the penultimate to -5 growth stage were recognised. The dimensions of adults and juveniles from several samples are given as follows. (See: Fig. 12).

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.820-0.890	0.420-0.460	10	
	Mean	0.832	0.426		1.91
M.	Range	0.830-0.880	0.370-0.430	11	
	Mean	0.840	0.399		2.16
-1.	Range	0.650-0.720	0.330-0.380	53	
	Mean	0.680	0.351		1.90
-2.	Range	0.520-0.590	0.270-0.310	55	
	Mean	0.539	0.288		1.92
-3.	Range	0.410-0.450	0.220-0.250	40	
	Mean	0.432	0.237		1.80

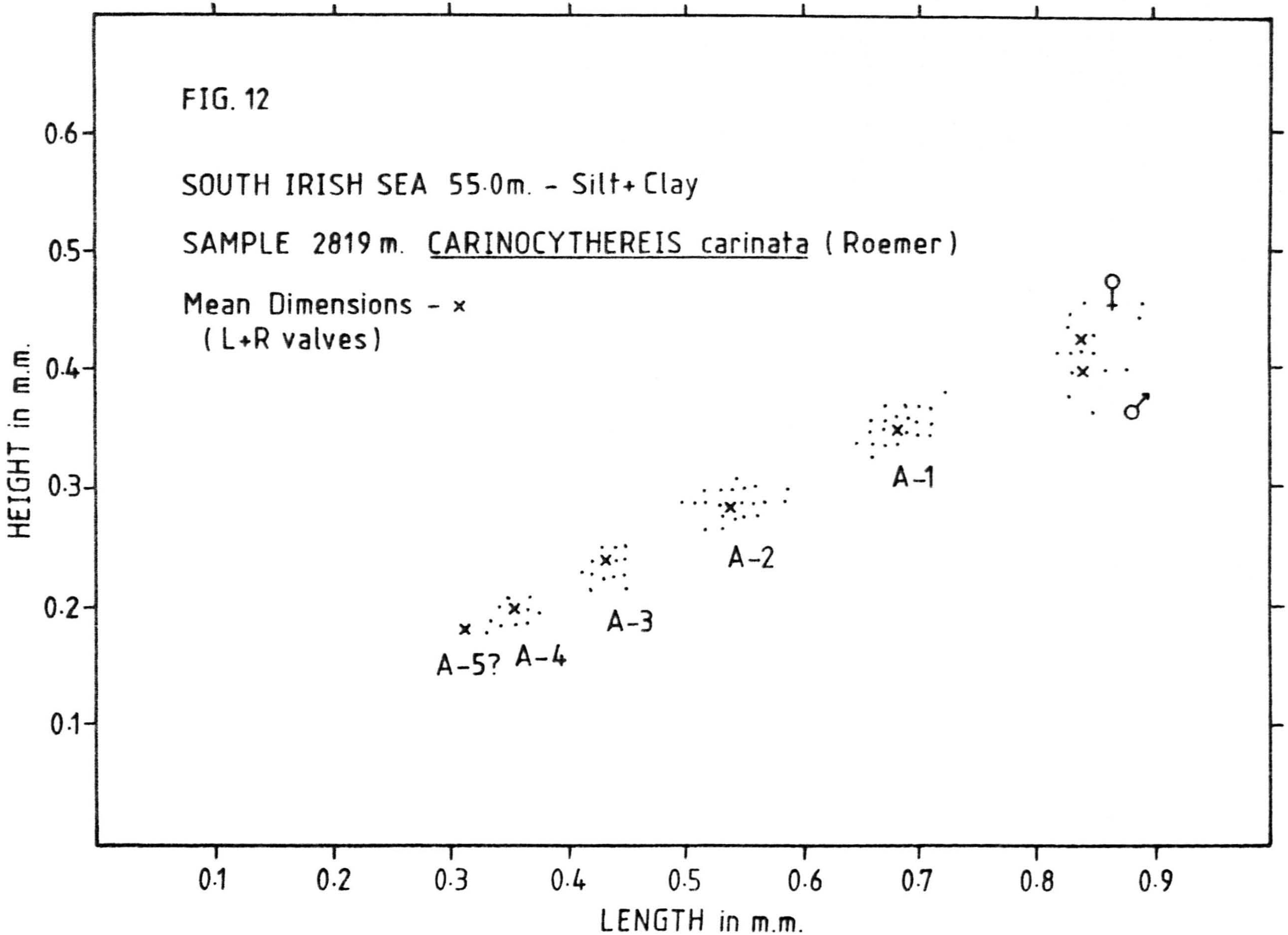


FIG. 12
SOUTH IRISH SEA 55.0m. - Silt+Clay
SAMPLE 2819 m. CARINOCYTHEREIS carinata (Roemer)
Mean Dimensions - ×
(L+R valves)
HEIGHT in m.m.
LENGTH in m.m.
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
A-5?
A-4
A-3
A-2
A-1
♀
♂

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
-4.	Range	0.340-0.370	0.190-0.210	22	
	Mean	0.355	0.196		1.81
-5?	Range	-	-	1	
	Mean	0.310	0.180		1.72

Sexual dimorphism is marked. Males are proportionately longer than females and bear a median concavity of the dorsal and ventral margins.

Remarks

Many previous authors have mistakenly regarded C. carinata as an ecological or geographical variant of C. antiquata (Baird). The Roemer species, C. carinata, is the smaller form and is distinguished by a continuous subventral carina which extends almost entirely around the anterior margin. It is nearly always the Baird species that, in dorsal aspect, exhibits the massive alae form ridges.

These above species have been further misidentified in British and Biscay waters as C. whiteii (Baird). This latter form exhibits the replacement of lateral ridges with 3 or 4 longitudinal rows of rounded tubercles and spines. C. carinata is also erroneously incorporated in the Recent and fossil Mediterranean distribution attributed by Ruggieri (1974) and Pugliese et.al. (1976) to C. bairdi (Uliczny).

See: Wall (ms. 1969, p. 405) and Carbonel and Moyes (1970, as Carinocythereis form A, p. 147-154).

Study Area Ecology

Live specimens were not recovered.

Most material was found in the southern Irish Sea and predominantly in the region north of Dublin Bay, 11-137.5 m, mean 41.9 m, in a variety of sediments from coarse sand and gravel to silts with clay. It occurred in abundance within 15.2-54.9 m in fine sand and silts with clay.

Isolated specimens were found in 22-120.7 m of Caernarvon Bay and from 55 m and 91.5 m in mixed sand and fine sand with silt, Malin Sea.

Populations of adults and juveniles occurred in sample 2381 (21.9 m), 2819 (54.9 m), 2822 (15.2 m), and 2915 (33.5 m), silts with clay, southern Irish Sea.

Palaeoecology and Distribution

The accurate distribution in British and adjacent waters is not known as this species is incorporated by most authors in the distribution attributed to *C. antiquata* (Baird). However, a solitary specimen is recorded in fine sand, 90 m, of the Minch (C.S. Harris, ms. 1977). In addition, Wall (ms. 1969) found a live individual, as *C. antiquata*, in sublittoral weed of Cardigan Bay and with Whatley (verb. comm. 1977) comments that it is distributed in moderate numbers on fine sands and silt in many areas of the Irish Sea. Rare dead material, as *C. antiquata*, has also been found in the sublittoral of the Dorset coast (Whittaker, ms. 1972).

Its abundance is greatly increased further south in the Biscay. In which region,Yassini (1969) found this species constituting up to 25% of the open shelf fauna, 40-200 m. He also found it in great abundance in sublittoral *Zostera* of Arcachon Basin. Most material in central Biscay is found alive in 15-75 m and appears to co-exist with *C. antiquata* down to 90 m (Carbonel and Moyes, 1970; Carbonel, 1973; Carbonel and Jouanneau, 1975). However, in southern Biscay it is primarily recovered from 100-200 m and occurs commonly in Recent sediments within 48-500 m (Peypouquet, 1971, 1973).

Isolated specimens have been recovered within 6 m in the lagoonal of the Rhône Estuary (Kurc, 1961) and C. carinata occurs in moderate numbers, 20-70 m, off the Algerian coast (Yassini, 1978). It is more commonly alive in 11-78 m, and otherwise abundant , 20-87 m in algae and on algal debris and silts off W. Italy. Further, this species appears to cohabit the Gulf of Naples, 39-87 m, with several other species of the genus Carinocythereis Ruggieri (Müller, 1894 ; Ruggieri, 1953, 1959; Pugliese et.al., 1976). It is also probable that C. carinata ranges with C. antiquata in Posidonia, calcareous algae and in other sea weeds down to 140 m in neapolitan areas (Puri, 1963; Puri et.al., 1964). In addition, C. carinata is abundantly alive from 31-206 m in full marine salinity and 12.5-16.7°C in the Adriatic (Ascoli, 1964, 1965; Bonaduce et.al., 1975; Breman, 1976, as C. antiquata). Isolated dead material is recorded in 4-34 m in the Limski Canal, N. Adriatic (Uffenorde, 1970) and it may also extend as C. antiquata to the Black Sea region, 18-33 m (Dubowsky, 1939; Shornikov, 1971, 1972) and E. Aegean (Barbieto-Gonzalez, 1971).

C. carinata occurs in limited numbers in the sub-Recent and Holocene of the southern Irish Sea (Wall, ms. 1969), Biscay below 90 m (Carbonel and Moyes, 1970; Peypouquet, 1971, 1973; Carbonel, 1973; Carbonel and Pujos, 1974; Carbonel et.al., 1977) and material is reworked into Recent sediments, 16-166 m+, off N.W. Spain (Ralph, ms. 1977). Isolated reworked specimens also occur in 121 m of the S. Adriatic (Bonaduce et.al., 1975) and in 18 m of the Limski Canal, N. Adriatic (Uffenorde, 1971).

The Late Glacial record may range, as *C. antiquata*, from N.W. Scotland and N.E. Ireland (Brady et.al., 1874) in reduced numbers to Biscay (Caralp and Moyes, 1970; Peypouquet, 1971). There is also a rare record of this species in the Lower Pleistocene of N. and S. Italy (Ruggieri, 1953, 1956, 1959, 1962).

The stratigraphical range extends to the Upper Pliocene of E. Anglia (Jones, 1856; Wilkinson, ms. 1974), N. France (Keij, 1957), Italy (Roemer, 1838; Capeder, 1900; Ruggieri, 1962), W. Greece (Uliczny, 1969) and the E. Aegean (Terquem, 1878; Sissingh, 1972). Finally, *C. carinata* would seem to extend into the Tortonian (Upper Miocene) of Aquitaine, S.W. France (Moyes, 1965), S. Italy (Ruggieri, 1962) and the S. Aegean (Sissingh, 1972).

Summary

This species may be distributed alive in deep water throughout the British Isles, 50-58^{O}N. *C. carinata* is, however, abundantly alive on the open shelf of Biscay and in the sub-littoral of Arcachon Basin, 50-44^{O}N. It also extends throughout much of the E. and W. Mediterranean. Sub-Recent and Holocene material is rare in the southern Irish Sea, Biscay and off N.W. Spain, 52-42^{O}N and probably ranges southward and into the W. Mediterranean and S. Adriatic, 35-44^{O}N. Late Glacial material is moderately common in N.W. Scotland and N.E. Ireland, 55-58^{O}N approx. and rare in Biscay, 44-48^{O}N. This species is also known in the Lower Pleistocene of N. and S. Italy. The range includes the Upper Pliocene of E. Anglia and N. France, 48-53^{O}N; Pliocene of W. Greece, Italy and E. Aegean, 40-36^{O}N and the Upper Miocene of S.W. France, 44°N and the S. Aegean, 40-36°N.

This species is rarely alive in the sublittoral within 10 m, occurs commonly down to 75 m+ and is most abundant within 100-200 m. It is also commonly distributed in Recent sediments between 48-500 m and may be seldom reworked in deeper waters, 1000 m+ in the Mediterranean. In the littoral _C. carinata_ is associated with algae and _Zostera_, though below this depth it is recovered primarily on fine sand and mud. Finally, this is a fully marine species typical of warm temperate waters.

Carinocythereis antiquata (Baird), 1850
pl. 44 figs. p-v, t.fig. 13

1850 _Cythereis antiquata_ n.sp. Baird: p. 176, pl. XX, fig. 2.

?1865 _Cythere aspera_ n.sp. Brady: p. 190, pl. IX, figs. 12-19.

1868 _Cythere antiquata_ (Baird); Brady: p. 417, pl. XXX, figs. 17-20.

1886 _Cythereis antiquata_ (Baird); Kaufmann: p. 191, pl. 6, figs. 5-7; pl. 8, figs. 1-5; pl. 10, figs. 1-3.

1889 _Cythere antiquata_ (Baird); Brady and Norman: p. 168.

?1894 _Cythereis antiquata_ (Baird); Müller: p. 374, pl. 29, figs. 18-24; pl. 31, figs. 1, 5, 6.

1969 _Carinocythereis carinata_ (Roemer); Yassini: p. 50, pls. XVII, XIX, XX, XXIII.

1969 _Carinocythereis antiquata_ (Baird); Uliczny: p. 73, pl. 4, figs. 9, 10; pl. 16, fig. 5.

1970 _Carinocythereis_ form B. Carbonel and Moyes: p. 148, pl. 1, figs. 2, 3; pl. 2, fig. 10.

1971 _Carinocythereis antiquata antiquata_ (Baird); Uffenorde: p. 70, pl. 7, fig. 7.

1972 _Carinocythereis antiquata_ (Baird); Sissingh: p. 97, pl. 6, fig. 10.

1976 *Carinocythereis antiquata antiquata* (Baird); Breman: p. 57, pl. VII, fig. 103.

1976 *Carinocythereis antiquata* (Baird); Pugliese et.al.: p. 486, pl. I, figs. 5-8.

1978 *Carinocythereis antiquata* (Baird); Rosenfeld and Bein: p. 17, pl. I, fig. 6.

1978 *Carinocythereis antiquata* (Baird); Yassini: p. 380, pl. 5, figs. 12, 13.

1981 *Carinocythereis antiquata* (Baird); Doruk: 8:12: pls. 63-70.

Material

Total: F. - 21 RV. 9 LV.; M. - 10 RV. 12 LV.; J. - 1 C. 184 RV. 176 LV. = 305 I.

Southern Irish Sea

Dead					Live
F. - 00 C.	01 RV.	00 LV.			00
M. - 00 C.	00 RV.	02 LV.	=	15 I.	
J. - 00 C.	12 RV.	04 LV.			

Malin Sea

Dead					Live
F. - 00 C.	20 RV.	09 LV.			00
M. - 00 C.	10 RV.	10 LV.	=	290 I.	
J. - 01 C.	172 RV.	157 LV.			

Sample Distribution

Southern Irish Sea

868 2375 2822

Malin Sea

3041 3042 3043 3101 3135 3142 3143 3144 3145 3146
3152 3153 3154 3161 3162

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	26	. 4A/5	0.937	0.536
	LV. "	26	. 5A/6	0.962	0.504
M.	RV. "	23	. 42A	0.943	0.467
	LV. "	23	. 1	0.966	0.467

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
-2.	RV. external	26	. 3A/4	0.587	0.330
	LV. "	31	. 22/22A	0.578	0.324
-5?	LV. "	26	. 2A/3	0.347	0.196

These specimens are from sample 3143 (146.3 m, fine sand + silt), Malin Sea.

Description

See: Brady (1868, p. 417, pl. XXX, figs. 17-20) and Doruk (1981, pl. 63-70) for a description of the hard and soft parts and an illustration of the former.

Ontogeny

Instars from the penultimate to -5 growth stage were recognised. The dimensions of adults and juveniles from samples 3143 and 3161 (128 m, fine sand), Malin Sea, are given as follows (See: Fig. 13).

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.880-0.970	0.470-0.510	13	
	Mean	0.917	0.494		1.86
M.	Range	0.900-0.990	0.450-0.490	6	
	Mean	0.930	0.467		1.99
-1.	Range	0.690-0.790	0.380-0.420	38	
	Mean	0.740	0.402		1.84
-2.	Range	0.560-0.610	0.320-0.340	40	
	Mean	0.587	0.329		1.78
-3.	Range	0.460-0.500	0.260-0.280	35	
	Mean	0.480	0.272		1.76
-4.	Range	0.395-0.410	0.230-0.235	5	
	Mean	0.400	0.232		1.73
-5.?	Range	-	-	1	
	Mean	0.347	0.196		1.75

Sexual dimorphism is distinct. Males are proportionately longer than females and tend to possess a slight median concavity of the dorsal and ventral margins.

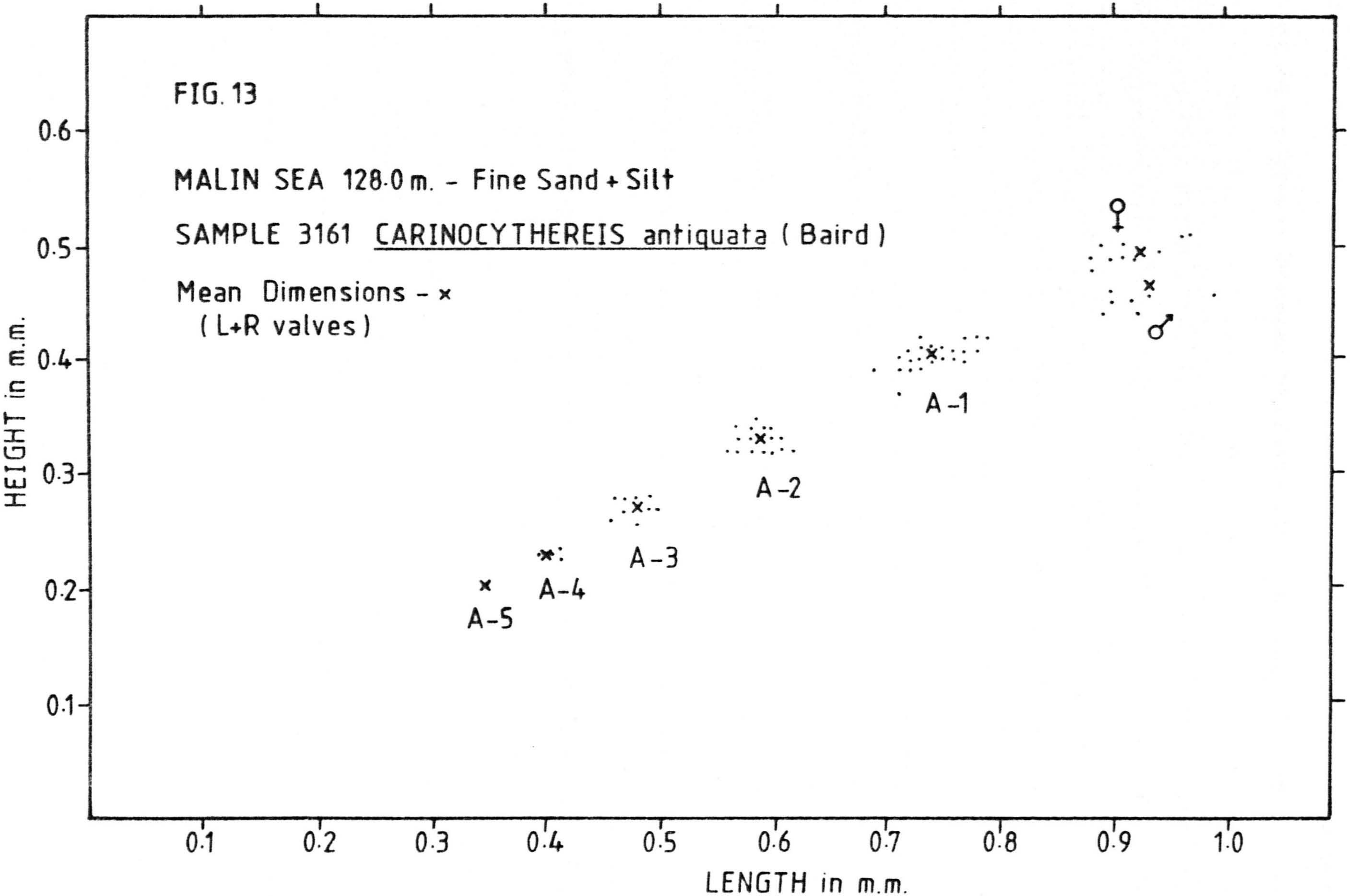


FIG. 13
MALIN SEA 128·0 m. - Fine Sand + Silt
SAMPLE 3161 CARINOCYTHEREIS antiquata (Baird)
Mean Dimensions - ×
(L+R valves)
HEIGHT in m.m.
0·6
0·5
0·4
0·3
0·2
0·1
A-5
A-4
A-3
A-2
A-1
♀
♂
0·1
0·2
0·3
0·4
0·5
0·6
0·7
0·8
0·9
1·0
LENGTH in m.m.

The ornament remains remarkably consistent throughout ontogeny for both C. carinata (Roemer) and C. antiquata. Of these two species C. antiquata is much the larger and more heavily calcified.

Remarks

Lord and Robinson (1978) consider C. aspera Brady to be conspecific. The nodular anterior margin of C. aspera in the Brady (1865) Monograph indicates that this species may be distinct.

Certain Mediterranean records are better ascribed to C. antiquata var. bairdi Uliczny. This form is distinguished by its well rounded 'beak-like' ventral margin and rather weak surface ornament. The synonymy of the last species should include Cythereis antiquata of Kruit (1955), C. aff. antiquata (1 + 2) of Barbieto-Gonzalez (1971) and Favella? antiquata of Ruggieri.

See: Carbonel and Moyes (1970, as Carinocythereis form B, p. 147-154) and Doruk (1981).

Study Area Ecology

The species was not found alive.

Isolated specimens occurred in mixed sand to silt with clay, 15.2-23.8 m in the southern Irish Sea. Its distribution was widespread on the mid and outer shelf of Malin Sea, 54.9-182 m, mean 125.6 m, coarse sand with gravel to fine sand with silt. Much of the material occurred between 128-146.3 m, in fine sand with silt.

Populations of adults and juveniles were recovered in samples 3143, 3161 and 3162, 128-146.3 m, in fine sand with silt. An adult assemblage occurred in sample 3145 (146.3 m) and a juvenile assemblage occurred in sample 3101 (55 m), fine sand with a high silt content, Malin Sea.

Palaeoecology and Distribution

Brady (1868) comments that *C. antiquata* occurs in roots of *Laminaria* off Aberdeen, E. Scotland and in accord with Brady and Robertson (1870, 1872) and Brady and Norman (1889), he considers that it extends in low numbers to the Forth Éstuary, Fens and Thames Estuary. There is no mention of live material in this region.

A live specimen is, however, recorded in 130 m on fine sand and mud of the Minch, N.W. Scotland (C.S. Harris, ms. 1977). Indeed, Baird (1850) first described *C. antiquata* in this locality. In accordance with Brady (1866, 1868), C.S. Harris (ms. 1977) reported moderate numbers of dead individuals in the given sediments between 80-120 m of N.W. Scotland. The distribution includes the Clyde Estuary (Robertson, 1874; Brady and Norman, 1889), coast of Antrim, N. Ireland, Irish Sea and the entire west coast of Ireland, 8-110 m (Brady, 1868; Brady and Robertson, 1869, 1872; Brady and Norman, 1889; Norman, 1905). Unfortunately, there is no indication whether the Irish material includes live specimens or whether *C. carinata* (Roemer) is mistakenly included in the distribution. The Baird species is, however, accurately documented and much more common down to 150 m in the sands and silts of the Celtic Sea (Brassil, ms. 1977; Lomax, ms. 1978) and Western Approaches (Neale, 1974).

It is also moderately common within the English Channel, from the Scillies and south coast of Devon and Cornwall to the Isle of Wight (Brady, 1868; Brady and Robertson, 1872; Brady and Norman, 1889; Norman and Scott, 1906; Neale, 1970) and Channel Isles (Norman, 1907, 1908). Further south Carbonel and Moyes (1970), Carbonel (1973) and Carbonel and Jouanneau (1975) found it abundantly alive in 70-200 m and co-existing in the Biscay between 75-90 m with C. carinata (Roemer). In addition, Yassini (1969) commented that its live dominance of the open shelf ranged down to 250 m and that with C. carinata it consituted up to 25% of the deeper littoral ostracod fauna. C. antiquata was also generally distributed in sands, 12-160 m+, off N.W. Spain, though no live material was found (Ralph, ms. 1977).

An isolated record of it from Maderia, N.W. Africa, in 55-130 m (Brady, 1911) and off Cape Blanc, W. Africa (Rosenfeld and Bein, 1978) may not represent part of the Recent distribution.

Material may occur alive in low numbers off E. Spain (Hartmann, 1952), within 90-160 m off Provence (Rome, 1942; Reys, 1964, 1965) and possibly in the Ligurian Sea, 35-107 m (Bonaduce et.al., 1977). The species is alive in algae and on algal detritus and silts between 12-104 m in the Gulf of Naples and is otherwise found in this region within 39-130 m (Brady and Norman, 1889; Müller, 1894; Pugliese et.al., 1976). There is a report of it in the St. of Messina (Brady and Norman, 1889) and in moderate abundance in mud and sand down to 180 m along the Algerian coast (Yassini, 1978). The last author adds that live material occurs mostly in 55 m, 36.5-38‰ salinity, 13-23°C and is almost entirely lacking in more shallow waters. Bonaduce et.al. (1975) and Breman (1976) found it very abundant, 5-100 m, in muds and fine sands and often incorporated in sediments between 150-900 m of the S. Adriatic. However, much of this latter distribution likely includes the ecology of both C. antiquata and C. carinata (Roemer). C. antiquata is certainly rare in the shallow N. Adriatic, 0-95 m and was found to be non living in the Limski Canal (Uffenorde, 1971). Lastly, there are isolated reports of it from Bisika Bay and Athens, Greece (Brady, 1869; Brady and Norman, 1889) and from the E. Aegean (Brady and Norman, 1889), though these E. Mediterranean records are not yet substantiated.

Sub-Recent and Holocene material is mostly rare, ranging from the southern Irish Sea (Wall and Whatley, 1971; Spencer, ms. 1976; Haynes et.al., 1977) to S. Biscay (Yassini, 1969; Carbonel, 1973; Carbonel et.al. 1977). The Late Glacial distribution is also sparse and known only from Cyprus (Doruk, 1981). A single specimen has been found in the last interglacial, Ipswichian, of Cardigan Bay, Irish Sea (Jasin, ms. 1976), though a moderate abundance occurs in the Eemain of Selsey, Sussex (Wall and Whatley, 1971). Moderate numbers of this species may also occur, recorded both as C. aspera Brady and C. antiquata, in the Hoxnian interglacial of E. Anglia Brady, 1865; Lord and Robinson, 1978). Otherwise, this species is recorded in abundance from the Lower Pleistocene and Upper Pliocene of S. Italy (Neviani, 1928) and in the Pliocene of W. Greece (Uliczny, 1969) and the S.W. Aegean (Sissingh, 1972).

Summary

Rare Live material occurs in the estuarine sublittoral from N.E. Scotland to the R. Thames, 57-51^{O}N. It also ranges in deep water sediments from N.W. Scotland in moderate numbers throughout the Irish Seas southward to the English Channel, 58-50^{O}N. C. antiquata is abundantly alive on the open shelf of Biscay and common in Recent sediments off N.W. Spain, 42^{O}N. Although incorporated in the distribution attributed to C. carinata (Roemer), this species is widespread and alive in deep coastal waters of the W. Mediterranean, N. and S. Adriatic and may extend to the eastern Aegean, 36-44^{O}N. Sub-Recent and Holocene material is rare, found in Biscay and the southern Irish Sea and may range in deep water sediments to N.W. Scotland, 58-44^{O}N. Isolated Late Glacial specimens are known from Cyprus, 35^{O}N.33^{O}E approx. It occurs in the last interglacial of the southern Irish Sea and is common in the Eemain of S. Sussex, 50-54^{O}N; and Hoxnian of E. Anglia, 52-53^{O}N. Lastly, C. antiquata is recorded widely in the Lower Pleistocene and Upper Pliocene of S. Italy and may range to the Pliocene of W. Greece and the S.W. Aegean, 40-36^{O}N.

Isolated live specimens may occur in the sublittoral of E. Britain and W. Ireland. Otherwise, abundant live and dead material is recorded throughout Biscay and the W. Mediterranean, 70-250 m, and mostly in 100 m+. In which regions, C. antiquata and C. carinata (Roemer) share the same ecology between 75-90 m. Material is primarily associated with Laminarian and bushy algae and algal debris in the littoral and is found in muds and fine sands within deeper waters of the open shelf. Finally, C. antiquata is a fully marine and warm temperate species, 9-23^{O}C

approx., which will also tolerate cool temperate waters.

Genus Celtia Neale, 1973

Celtia quadridentata (Baird), 1850

pl. 45 figs. a-f

1850 Cythere quadridentata n.sp. Baird: p. 173, pl. 21, fig. 2.

1868 Cythere quadridentata Baird; Brady: p. 413, pl. 31, figs. 19-20.

1874 Cythere quadridentata Baird; Brady, Crosskey and Robertson: p. 161, pl. 13, fig. 22.

1928 Hemicythere quadridentata (Baird); Sars: p. 186, pl. 86, fig. 1.

1956 Carinocythereis quadridentata (Baird); Ruggieri: p. 165.

1969 Carinocythereis quadridentata (Baird); Yassini: p. 53, pl. 19, fig. 2, 2a; pl. 20, figs. 4, 4a.

1973 Celtia quadridentata (Baird); Neale: p. 436, pl. I, figs. 1-8; t.figs. 1, 2.

?1974 Celtia sp.A Wilkinson (ms.): p. 56, figs. 9, 10.

1975 Celtia quadridentata (Baird); Neale: p. 287, pl. 1-4, 2 t.fig.

1977 Celtia quadridentata (Baird); Ralph (ms.): p. 209, pl. III, fig. 5.

1978 Falunia quadridentata (Baird); Yassini: p. 380, pl. 7, figs. 7-8.

1978 Celtia quadridentata (Baird); Rosenfeld and Bein: p. 17, pl. I, fig. 8.

Material

Total Dead: F. - 5 C. 18 RV. 14 LV.; M. - 4 C. 13 RV. 5 LV.; J. - 4 C. 97 RV. 76 LV. = 173 I.

Live: 5 F. 3 M. 2 J.

Southern Irish Sea

Dead				Live	
F. - 03 C.	02 RV.	03 LV.		02	
M. - 02 C.	02 RV.	02 LV.	= 48 I.	02	= 5 I.
J. - 02 C.	26 RV.	22 LV.		01	

Malin Sea

Dead				Live	
F. - 02 C.	16 RV.	11 LV.		03	
M. - 02 C.	11 RV.	03 LV.	= 125 I.	01	= 5 I.
J. - 02 C.	71 RV.	54 LV.		01	

<u>Sample Distribution</u> (Live occurrence is underlined)

Southern Irish Sea

2360 2375 2380 2381 2812 <u>2815</u> 2821 <u>2822</u> <u>2904</u> 2915
2916 2917

Malin Sea

3041 3042 3043 3101 3135 <u>3142</u> <u>3143</u> 3144 3145 3152
3154 <u>3161</u> 3162

<u>Figured Specimens</u>

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	23 .	32A/33	0.783	0.438
	LV. "	23 .	33A/34	0.786	0.421
M.	RV. "	23 .	30A/31	0.750	0.365
	LV. "	23 .	31A/32	0.747	0.373
-1.	RV. "	23 .	35A/36	0.657	0.329
	LV. "	23 .	34A/35	0.634	0.349

Adult valves - sample 2815 (30.5 m, mixed sand), juvenile valves - sample 2380 (20.1 m, silt + clay), southern Irish Sea.

<u>Description</u>

See: Neale for a description (1973, p. 437-438) and illustration (1975, pl. 287-294) of the hard and soft parts.

Ontogeny

Instars of the penultimate to -4 growth stage were recognised. The dimensions of adults and juveniles from several Malin Sea samples are given as follows.

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.750-0.810	0.410-0.440	6	
	Mean	0.797	0.420		1.90
M.	Range	0.740-0.780	0.360-0.400	12	
	Mean	0.762	0.374		2.04
-1.	Range	0.580-0.660	0.310-0.360	28	
	Mean	0.632	0.330		1.92
-2.	Range	0.480-0.540	0.260-0.290	35	
	Mean	0.511	0.281		1.82
-3.	Range	0.400-0.410	0.220-0.230	3	
	Mean	0.405	0.228		1.78
-4.	Range	-	-	1	
	Mean	0.330	0.200		1.65

The species exhibits a regular incremental increase in size throughout ontogeny. Sexual dimorphism is distinct. Males are slightly smaller and rather more pointed posteriorly than the females.

Remarks

Neale (1973) considered that records of *C. quadridentata* in the Recent of the Mediterranean probably refer to other species. However, Yassini (1978) has recently illustrated that moderate numbers of *C. quadridentata* are present in superficial sediments along the Algerian coast. Most Tertiary records from West and Central Europe exhibit considerable ornamental variation. Which may indicate that several species, closely approximating *Cythereis turbida* Müller, have been mistakenly incorporated in the distribution. In this respect, *Falunia quadridentata sensu* Uliczny (1969, p. 97, pl. 8, fig. 5) and *F.* (*Hiltermannicythere*) *quadridentata sensu* Sissingh (1972,

p. 106, pl. 7, fig. 16) should now be considered distinct.

See: Neale (1973, p. 437-442) and Masson (ms. 1981, p. 94-95).

Study Area Ecology

Isolated live material was found in 15.2-30.5 m, silt + clay to the north of Dublin Bay, southern Irish Sea and in 128-146.3 m, fine sand with silt from the outer shelf of Malin Sea.

Otherwise, in the S. Irish Sea its distribution is widespread, 15.2-137.5 m, mostly 15.2-33 m, mean 31.8 m in sands with a high content of silt. Most material was found on the mid and outer shelf of the Malin Sea, 54.9-182 m, mostly 128-173.8 m, mean 144.1 m in a variety of sediments from coarse sand + gravel to fine sand with silt.

Small populations of adults and juveniles were found in Malin Sea samples 3143 and 3162, 140.8-146.3 m; with a juvenile assemblage occurring in sample 3101 (55 m), fine sand and silt.

Palaeoecology and Distribution

Sars (1866, 1928) indicates that this species occurs alive near Risor, and with Brady and Norman (1889) found it rare in Recent sediments, 18-48 m, from several localities of S. and S.W. Norway. Klie (1929) reports *C. quadridentata* in the W. Baltic though this record and that found in 70 m off Iceland (Stephensen, 1938) is probably in error.

C. quadridentata is a rarity, though perhaps alive off N. Scotland and the Shetlands (Brady, 1868; Brady and Norman, 1889). It does, however, occur alive on a variety of sediments, 28-90 m approx., off N.E. England (Norman, 1862; Brady, 1868, 1903; Brady and Robertson, 1872, 1876; Norman and Brady, 1909). Brady (1870) and Brady and Robertson (1876) indicate that most material is found in 28-68 m of this region.

A single live specimen occurred in 40 m on sand and, otherwise, ranges in moderate numbers, 18-80 m, off N.W. Scotland (Brady, 1866, 1968; C.S. Harris, ms. 1977). The species is probably alive between 12-55 m in the Clyde Estuary (Brady and Robertson, 1869; Robertson, 1874). In addition, rare material is known off the Antrim coast, 28-35 m and from Mulroy Lough, N. Ireland (Brady and Norman, 1889; Norman, 1905). Isolated live specimens are widely distributed in inner bay areas, 8-35 m, between Aran Is. and Valentia, W. Ireland (Brady and Robertson, 1869; Brady and Norman, 1889; Norman, 1905; Farran, 1913) and Lomax (ms. 1978) records the species as most common in areas further southward. However, this latter report is not certain as Neale (1974) and Brassil (ms. 1977) specify the rarity of even dead material in 35-160 m from both the Celtic Sea and Western Approaches. It would also seem to be sparsely distributed in the littoral off Plymouth, S. Devon (Brady and Norman, 1889; Norman and Scott, 1906; Harding, 1957).

In Central Biscay a live abundance occurs in 35-90 m (Carbonel, 1973) with Recent material distributed commonly in sands and sandy silts between 50-250 m (Yassini, 1969). The range extends to Cap Breton (Fischer, 1876; Brady and Norman, 1889). In which region, Peypouquet (1971, 1973) found the live abundance in 100-150 m, with the species commonly incorporated in Recent sediments down to 480 m. C. quadridentata is also very common in sands, 16-100 m+ off N.W. Spain, though the preservation of this material indicates that it may be reworked (Ralph, ms. 1977).

Until recently, records of live material in the Mediterranean have been considered entirely erroneous. Yassini (1978) now illustrates that Recent material occurs commonly on muds and shell sands in 2-75 m along the coast of Algeria. The last author comments that the salinity tolerance was 36-39‰ in a water temperature of 13-23^{o}C. Therefore, reports of it in Posidonia and other algae, 20-100 m, off the French Riviera (Rome, 1942) and Gulf of Naples (Puri et.al., 1964) indicate that this species may, indeed, be locally abundant in the W. Mediterranean.

Peypouquet (1971, 1973) indicates that it occurs rarely in sub-Recent and Holocene deposits of S. Biscay. A solitary specimen is recorded from the Late Glacial of the North Sea (Masson, ms. 1981) and a few individuals are known in contemporaneous sediments from E. Scotland (Brady et.al., 1874) and Central Biscay (Caralp et.al., 1970). It is also found in the Hoxnian interglacial of E. Yorkshire (Neale and Howe, 1975; mid-Pleistocene, Sicilian, of W. Italy (Ruggieri, 1971, 1973) and is reported in the Lower Pleistocene, Calabrian, of S. Italy and Sicily (Neviani, 1906; Ruggieri, 1953, 1959; Benson and Sylvester-Bradley, 1971). In addition, C. quadridentata may occur in the Upper Pliocene of E. Anglia (Wilkinson, ms. 1974) and Brittany (Whatley, verb. comm., 1978). Material is reported in low numbers from the Pliocene of N. and S. Italy and it may occur in Upper Miocene deposits of S. Germany (Benson and Sylvester-Bradley, 1971). In accordance with Neale (1973) the present author regards the numerous Mediterranean Tertiary records as dubious. However, the species is accurately documented in the Pliocene and Upper Miocene of Aquitaine, S.W. France (Moyes, 1965; Moyes and Ducasse, 1971).

Summary

Live material is known from Risor, 59°N and may occur in several other areas of S. Norway and northern Scotland. Isolated live specimens and Recent material ranges throughout British and adjacent waters, south to 50°N. However, the species is alive in abundance in Biscay, 48-44°N. In addition, C. quadridentata is common in Recent sediments off N.W. Spain, 42/43°N and occurs in certain areas of the W. Mediterranean, 36-44°N, though, as yet, has not been found alive in lower latitudes than S. Biscay. Sub-Recent and Holocene material is rare in the Biscay region and probably ranges to S.W. Britain and Ireland, 52-44°N. Isolated Late Glacial specimens occur in E. Scotland, North Sea and Biscay, 57-44°N approx., whilst the Hoxnian interglacial record is known only from E. Yorkshire, 54°N. There are also reports of scarce material in the Middle Pleistocene of W. Italy and Lower Pleistocene of S. Italy and Sicily, 37-44°N. Further, some records include the Upper Pliocene of E. Anglia and Brittany, 48-53°N, entire Pliocene of N. and S. Italy and S.W. France, 46-38°N and Upper Miocene of Aquitaine and S. Germany, 44-48°N.

Isolated live material may occur in 18-48 m off S. Norway and ranges with rare Recent material between 18-80 m+ in British and adjacent waters. The species is abundantly alive in Central Biscay, 35-90 m, but inhabits southern Biscay from 100-150 m and occurs commonly in sediments throughout 50-250 m+.

C. quadridentata is also common within 2-75 m+ in the W. Mediterranean, though at least some of this material is of sub-Recent or Holocene age. Material is mostly recorded from shelly sands or silts below the phytal zone, in full marine salinity and warm temperate waters -13-23°C.

Genus Falunia Grekoff and Moyes, 1955

Falunia emaciata Brady, 1868
pl. 45 figs. g-l

1866 Cythere emaciata n.sp. Brady: p. 210.

1868 Cythere emaciata Brady; Brady: p. 414, pl. XXXI, figs. 31-37.

1874 Cythere emaciata Brady; Brady, Crosskey and Robertson: p. 161, pl. IX, figs. 14-17.

1969 Costa emaciata (Brady); Wall (ms.): p. 409, pl. 45, figs. k-s.

1969 Carinocythereis emaciata (Brady); Yassini: p. 52, pl. XV, XVI, XIX, XX.

1976 Falunia emaciata (Brady); Hoskin (ms.): p. 286, pl. 25, figs. 8-9.

1977 Falunia emaciata (Brady); Ralph (ms.): p. 213, pl. III, fig. 5.

?1978 Falunia emaciata (Brady); Yassini: p. 380, pl. 7, figs. 5-6.

Material

Total Dead: F. - 4 C. 10 RV. 5 LV.; M. - 5 C. 5 RV. 4 LV.; J. - 3 C. 92 RV. 86 LV. = 145 I.

Live: 1 F. 2 M.

Southern Irish Sea

Dead					Live	
F. - 02 C.	03 RV.	02 LV.			01	
M. - 03 C.	00 RV.	01 LV.	= 30 I.		02	= 3 I.
J. - 00 C.	16 RV.	10 LV.			00	

Caernarvon Bay

Dead					Live
F. - 00 C.	01 RV.	00 LV.	= 13 I.		00
J. - 00 C.	03 RV.	09 LV.			

Malin Sea

Dead					Live
F. - 02 C.	03 RV.	06 LV.			00
F. - 02 C.	05 RV.	03 LV.	= 102 I.		
J. - 03 C.	73 RV.	67 LV.			

Sample Distribution (Live occurrence is underlined)

Southern Irish Sea

843 2361 2377 2381 2812 <u>2819</u> 2823 2824 <u>2904</u> 2905 2912 2915 2916

Caernarvon Bay

2393 2401 2406 2830 2839 HHII

Malin Sea

3003 3041 3101 3103 3140 3142 3143 3144 3145 3146 3154 3161 3162

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	16	. 21A/22	0.853	0.400
	LV.	"	16	. 22A/23	0.859	0.435
M.	RV.	"	16	. 20A/21	0.848	0.352
	LV.	"	16	. 19A/20	0.831	0.371
-1.	RV.	"	16	. 23A/24	0.650	0.315
	LV.	"	16	. 24A/25	0.680	0.324

Female valves - sample 3161 (128 m, medium sand), juvenile valves - sample 3145 (146.3 m, fine sand + silt), Malin Sea. Male valves - sample 2912 (26.5 m, mixed sand), southern Irish Sea.

Description

See: Neale (ms. 1969, p. 410-411, pl. 45, figs. k-s) for a description and illustration of the hard parts. The animal is not accurately known.

Ontogeny

Penultimate and antepenultimate juveniles were recognised. The dimensions of these and adults from several samples in the study material are given as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.840-0.870	0.390-0.455	12	
	Mean	0.858	0.428		2.00
M.	Range	0.830-0.860	0.340-0.380	10	
	Mean	0.842	0.370		2.28
-1.	Range	0.640-0.700	0.290-0.340	47	
	Mean	0.672	0.316		2.13
-2.	Range	0.510-0.560	0.250-0.290	19	
	Mean	0.534	0.272		1.96

This is a distinctive species with a prominent longitudinal rib running between the antero-ventral margin and the postero-dorsal cardinal angle. Which feature is consistent throughout the last few growth stages.

Sexual dimorphism is marked. Males are proportionately more elongate than females.

Remarks

Several species have been misidentified as *F. emaciata* in the Quaternary and Recent of the neapolitan region. Indeed, there are no accurate figured references of this species from the Mediterranean.

That illustrated in Yassini (1978, p. 380, pl. 7, figs. 5, 6) is more quadrate than *F. emaciata sensu stricto*. It may refer, like many other reports, to varieties of *Cythereis rubra* Müller and *Cythereis turbida* Müller.

Study Area Ecology

Isolated live specimens ranged within 54.9-80.5 m, silt + clay and mixed sand, southern Irish Sea. Otherwise, material was found only in the region northward of Dublin Bay, 13-87.8 m, mostly 36.6-54.9 m, mean 40.8 m, in a variety of sediments from coarse sand and gravel to silt with clay.

In Caernarvon Bay the species was recovered from the tide-marks of Holyhead Habour, down to 65.8 m, mean 26.2 m, in coarse sand with gravel, mixed sand and algal debris.

Malin Sea material was widespread though never locally common, 54.9-182 m, mean 121.1 m, mostly in 128-182 m on the outer shelf. Found in sands and gravel and especially fine sand with silt.

Palaeoecology and Distribution

This is a very distinct species in British waters. In the North Sea it occurs rarely in deep waters off the Shetlands and Orkneys (Brady, 1868; Brady and Robertson, 1872; Brady and Norman, 1889) and ranges along the Aberdeen coast (Brady, 1868). It is possibly alive on shelly gravel and hydroids (Brady and Robertson, 1874) in 28-55 m off N.E. England (Brady, 1868, 1870, 1903; Brady and Robertson, 1872; Norman and Brady, 1909). Specimens have been found in the R. Ouse (Brady and Robertson, 1870; Brady and Norman, 1889) and there is also a report of isolated material in the Thames Estuary (Brady and Robertson, 1872).

Rare dead material is recorded, 80-130 m, in the Minch (Brady, 1866; C.S. Harris, ms. 1977) and _F. emaciata_ has been found in sublittoral _Laminaria_ of St. Kilda (Pearce, ms. 1977).

The species is more locally abundant in 14-55 m of the outer Clyde Estuary (Robertson, 1874), occurs in Mulroy Lough, N. Ireland (Brady and Norman, 1889) and is found in 8-28 m, throughout W. Ireland (Brady, 1868; Brady and Robertson, 1869, 1872; Brady and Norman, 1889; Norman, 1905; Farran, 1913). Unfortunately, only Hoskin (ms. 1976) records the live distribution, on sands, 1.5-10 m and found it otherwise between 0.8-24 m in Brandon and Tralee Bays, S.W. Ireland. Norman (1905) records it from the east Irish coast and Brady (1868) found F. emaciata north of Liverpool Bay. Brady and Robertson (1872) and Wall (ms. 1969) indicate this is a very rare live and Recent species in the Irish Sea. In addition, isolated instars occur in the sands and muds, 54-109 m, of the Celtic Sea (Brassil, ms. 1977; Lomax, ms. 1978), Western Approaches and English Channel (Brady, 1868; Brady and Norman, 1889; Norman and Scott, 1906; Neale, 1970, 1974).

Live material is recorded from the marine of the Gironde Estuary, within 50 m (Carbonel, 1973; Moyes, 1974; Carbonel and Jouanneau, 1975) and is widespread on sands of Arcachon Basin (Yassini, 1969). The last author also found it in 55-600 m on the open shelf of Biscay, abundantly alive in 100-150 m and commonly inhabiting 250 m. Peypouquet (1971) found live material common in 60-150 m off Cap Breton and in accord with Brady (1868), Fischer (1876) and Brady and Norman (1889) recovered dead specimens in nearly all samples of S. Biscay, 48-360 m. Lastly, rare and poorly preserved material occurs down to 160 m off N.W. Spain (Ralph, ms. 1977).

Reports of *F. emaciata* from the Fulf of Naples, W. Mediterranean (Carus, 1885; Brady and Norman, 1889) are probably distinct.

Sub Recent and Holocene specimens in the southern Irish Sea are most rare (Wall and Whatley, 1971; Haynes et.al., 1977), but material is fairly common in contemporaneous deposits of outer Gironde Estuary, Biscay (Carbonel et.al., 1975). *F. emaciata* is rare and stunted in the Late Glacial of Oban, W. Scotland and Portrush, N.E. Ireland (Brady et.al., 1874) and barely present in Late Pleistocene cores of Biscay (Caralp et. al., 1970).

Finally, reports of *F. emaciata* in Segguenza (1883-1886), Capeder (1902, p. 7, fig. 5) and Capelli (1905, p. 316, pl. 9, fig. 24) probably refer to distinct though closely related species.

Summary

F. emaciata ranges as a rarity in Recent sediments throughout Britain and adjacent waters from the Shetlands to the English Channel, 50-60°N. It is occasionally alive in these waters northward to 56/58°N. The species is abundantly alive in central and southern Biscay, 44-46°N. Sub-Recent and Holocene material is found in the southern Irish Sea, reworked into Recent sediments throughout W. Britain and is fairly common in superficial deposits of Biscay and N.W. Spain, 43-60°N. Late Glacial material occurs in moderate numbers in Biscay, 44-46°N and ranges in isolated numbers within raised beach deposits of N.W. Scotland and N.E. Ireland, 55-57°N. Finally, there are several dubious reports of *F. emaciata* in the Lower Pleistocene of Italy, 38-45°N.

In northern latitudes isolated live material occurs in sublittoral Laminarian holdfasts and below between 14-55 m on shelly gravel and hydroids. However, F. emaciata is commonly alive from the littoral down and live mostly between 100-500 m on sands of Biscay. Reworked sub-Recent and Holocene specimens occur rarely in 80-130 m west of Britain. They often extend down to 600 m off Gascony in fine sands and mud. This is a fully marine warm temperate species which can tolerate shallow cool temperate waters.

Genus Robertsonites Swain, 1963

Robertsonites tuberculata (Sars), 1866

pl. 45 fig. m-t; t.fig. 14i,ii

1866 Cythereis tuberculata n.sp. Sars: p. 37.

1866 Cythere mutabilis n.sp. Brady: p. 337, pl. LIX, figs. 14a-g.

1866 Cythere clathrata Reuss var. lyrata and var. latimarginata Brady: p. 376, figs. 12a-c, 13a-c.

1868 Cythere tuberculata (Sars); Brady: p. 406, pl. XXX, figs. 25-41.

1871 Cythere logani n.sp. Brady and Crosskey: p. 63, pl. 2, figs. 8, 9.

1874 Cythere tuberculata (Sars); Brady, Crosskey and Robertson: p. 164, pl. V, figs. 7-12.

1874 Cythere logani Brady and Crosskey; Brady, Crosskey and Robertson: p. 165, pls. XX, figs. 17, 18.

1906? Cythereis tuberculata Sars; Cushman: p. 376, pl. 36, figs. 108-109.

1915 Cythereis tuberculata Sars; Hirschmann: p. 580, figs. 5-7.

1928 Cythereis tuberculata Sars; Sars: p. 192, pl. LXXXVIII.

1938 Cythereis tuberculata Sars; Klie: p. 180, t.figs. 603-605.

1941 Cythereis tuberculata Sars; Tressler: p. 100, pl. 19, fig. 20.

1941 Cythereis tuberculata Sars; Elofson: p. 69, map. 27.

1962 Cythereis? tuberculata Sars; Woszidlo: p. 81, pl. 4, fig. 10.

1963 Robertsonites gubikensis n.sp. Swain: p. 821, pl. 98, figs. 8a, b; pl. 99, fig. 12, t.fig. 9b.

1963 Robertsonites tuberculatina n.sp. Swain: p. 822, pl. 98, fig. 10; pl. 99, fig. 1, t.fig. 9c.

1963? Robertsonites logani (Brady and Crosskey); Swain: p. 823, pl. 97, fig. 13.

1967 Robertsonites tuberculata (Sars); Hazel: p. 34, pl. 6, figs. 1-3.

1967 Robertsonites tuberculata (Sars); Hulings: p. 324, pl. IV, figs. 21-23, t.figs. 4E, 8P-S.

1969 Robertsonites tuberculata (Sars); Wall (ms.): p. 416, pl. 44, figs. j-r.

1970 Robertsonites tuberculata (Sars); Hazel: pl. 37.

1975 Robertsonites tuberculata (Sars); Neale and Howe: pl. 1, fig. 1; pl. 2, figs. 1-3.

1977 Robertsonites tuberculata (Sars); p. 24, pl. 5, figs. 61-64.

1981 Robertsonites tuberculata (Sars); Masson (ms.): p. 102, pl. 5, figs. 9-11, 15.

Material

Total Dead: F. - 7 RV. 5 LV.; M. - 1 C. 10 RV. 3 LV.; J. - 12 C. 296 RV 324 LV. = 490 I.

Southern Irish Sea

Dead		Live	
F. - 00 C. 04 RV. 04 LV.		04	
M. - 01 C. 07 RV. 02 LV.	= 360 I.	00	= 9 I.
J. - 11 C. 210 RV. 233 LV.		05	

Caernarvon Bay

Dead		Live
J. - 01 C. 00 RV. 01 LV.	= 2 I.	00

Malin Sea

Dead				Live
F. - 00 C.	03 RV.	01 LV.		00
M. - 00 C.	03 RV.	01 LV.	= 128 I.	
J. - 00 C.	86 RV.	90 LV.		

Sample Distribution (Live occurrence is underlined)

Southern Irish Sea

868 2359 2360 2361 2370 2373 2375 2377 2380 2381 2765
2810 2811 <u>2812</u> 2813 2814 <u>2815</u> 2816 2819 2821 2822
<u>2904</u> 2905 <u>2910</u> 2912 2915 <u>2916</u> 2917

Caernarvon Bay

2407 2515

Malin Sea

3090 3099 3101 3143 3148 3152 3153 3154 3162

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	6	. 32A/33	0.928	0.494
	LV. "	6	. 33A/34	0.965	0.523
M.	RV. "	6	. 31A/32	0.987	0.485
	LV. "	6	. 30A/31	1.000	0.502
-1.	RV. "	6	. 34A/35	0.742	0.430
	LV. "	6	. 35A/36	0.753	0.440
-2.	RV. "	6	. 37A/38	0.324	0.217
	LV. "	6	. 36A/37	0.339	0.230

Female valves - sample 2904 (80.5 m mixed sand + silt), male valves - sample 2816 (36.6 m, mixed sand), juvenile valves - sample 2915 (33 m, silt + clay), southern Irish Sea.

Description

See: Sars (1928: p. 192-193, pl. 88) and Wall (ms. 1969, p. 417-418, pl. 44, figs. j-r) for a description and illustration of the hard parts. The former author also figures the appendages.

Ontogeny

Instars from the penultimate to -6 growth stage were recognised. The adults and juveniles from samples 2819 (54.9 m silt + clay), southern Irish Sea and 3101 (55 m, fine sand + silt), Malin Sea are given as follows:(See: Figs. 14i, ii)

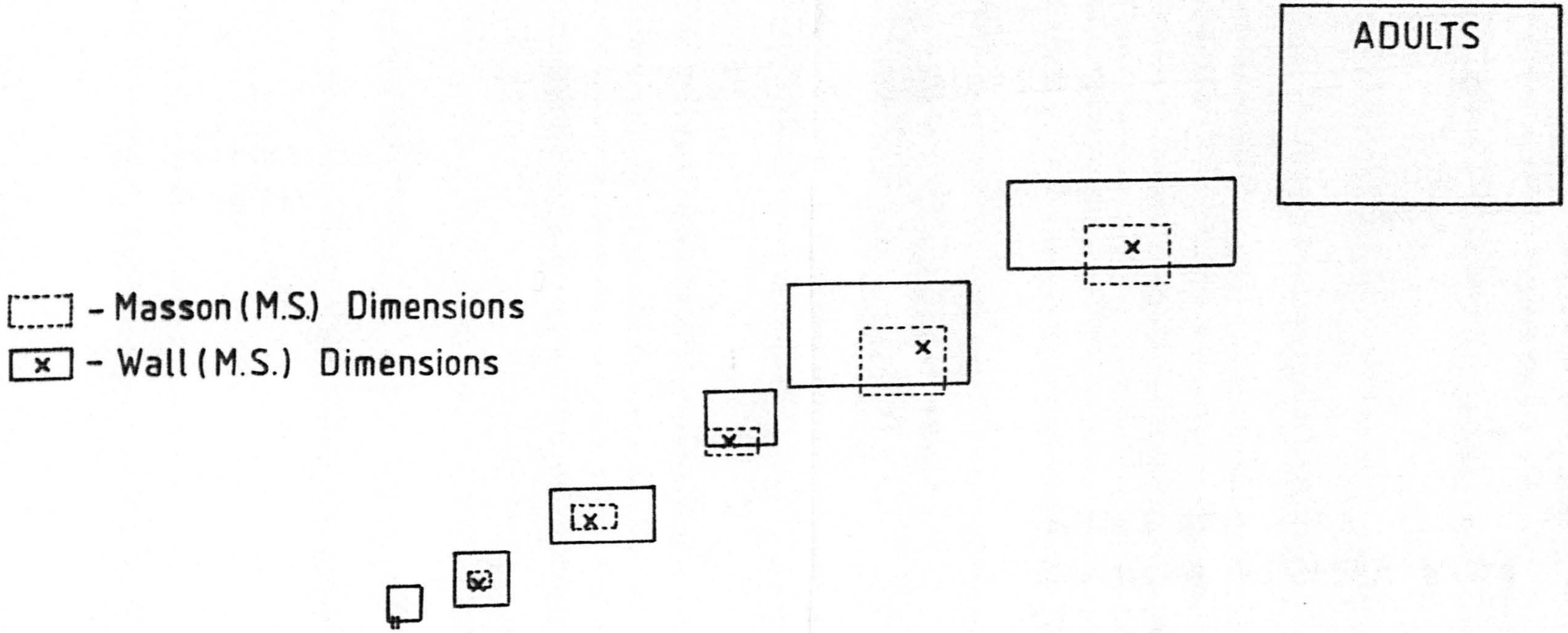
	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	1.000-1.030	0.510-0.530	3	
	Mean	1.015	0.520		1.95
M.	Range	0.960-0.990	-	2	
	Mean	0.975	0.460		2.12
-1.	Range	0.740-0.840	0.410-0.470	24	
	Mean	0.813	0.442		1.84
-2.	Range	0.590-0.680	0.340-0.400	40	
	Mean	0.666	0.382		1.74
-3.	Range	0.490-0.560	0.290-0.340	54	
	Mean	0.531	0.323		1.64
-4.	Range	0.390-0.440	0.240-0.280	34	
	Mean	0.427	0.266		1.61
-5.	Range	0.320-0.370	0.200-0.240	19	
	Mean	0.356	0.224		1.59
-6.	Range	0.280-0.300	0.180-0.200	14	
	Mean	0.286	0.190		1.51

The species exhibits an irregular increase in the L.:H. ratio throughout ontogeny. The distinct sub-central tuberculation of the shell is maintained in all juvenile growth stages.

Sexual dimorphism is distinct. Males are proportionately longer than females. The L.:H. ratios of both sexes is considerably greater than that of the juveniles.

Masson's (ms. 1981, fig. 4) Late Glacial material is only marginally larger, 5% or less at each growth stage, than that measured by Wall (ms. 1969) from the sub-Recent of Tremadoc Bay, southern Irish Sea. The dimensions of these two populations correspond closely to the instar plot of _R. tuberculata_ in this study.

i



After WALL (M.S.) 1969 p. 416.
MASSON (M.S.) 1981 p.102, FIG. 4.

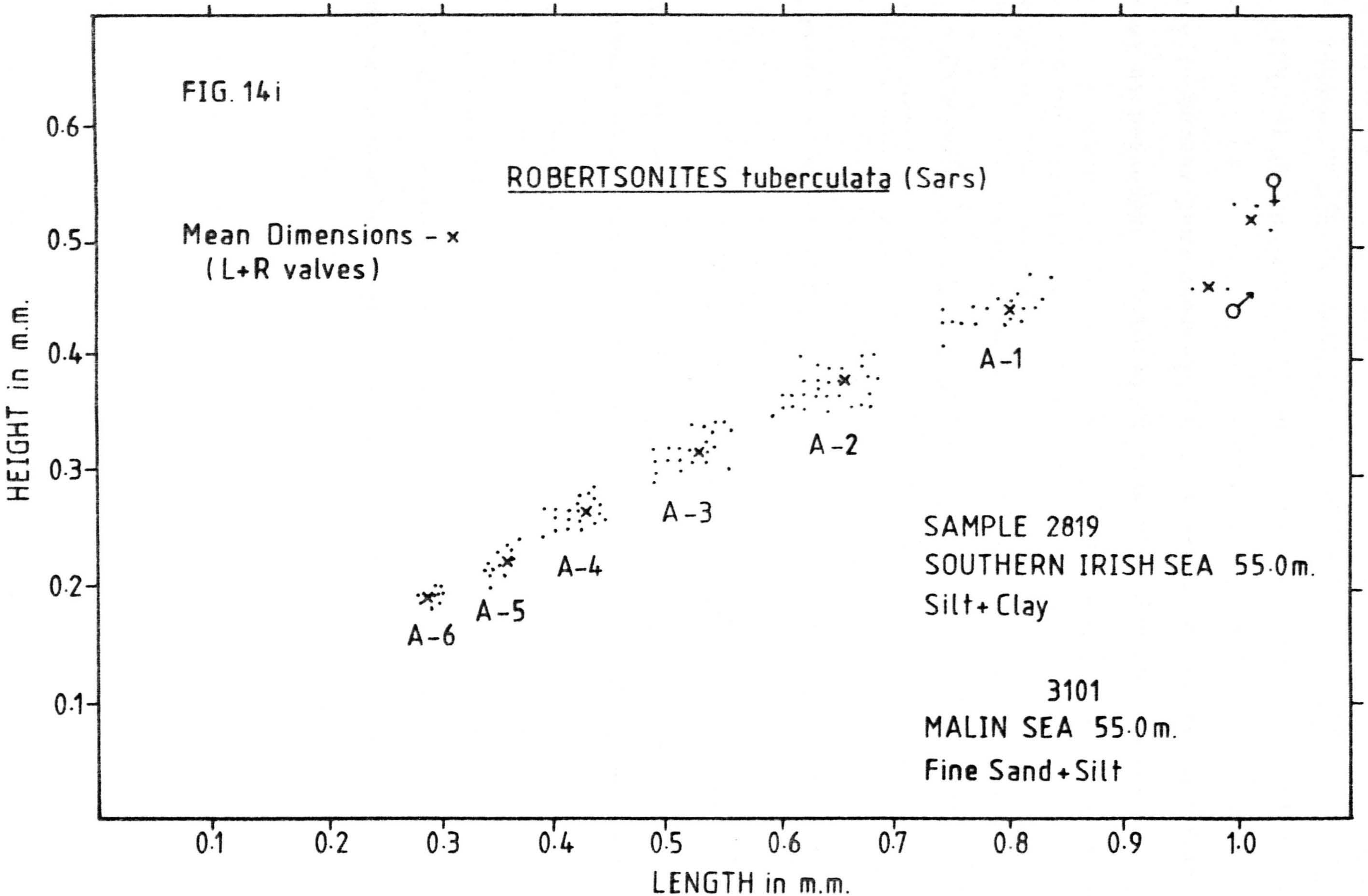


FIG. 14i
ROBERTSONITES tuberculata (Sars)
Mean Dimensions - ×
(L+R valves)
A-1
A-2
A-3
A-4
A-5
A-6
SAMPLE 2819
SOUTHERN IRISH SEA 55.0m.
Silt+Clay
3101
MALIN SEA 55.0m.
Fine Sand+Silt
HEIGHT in m.m.
LENGTH in m.m.
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

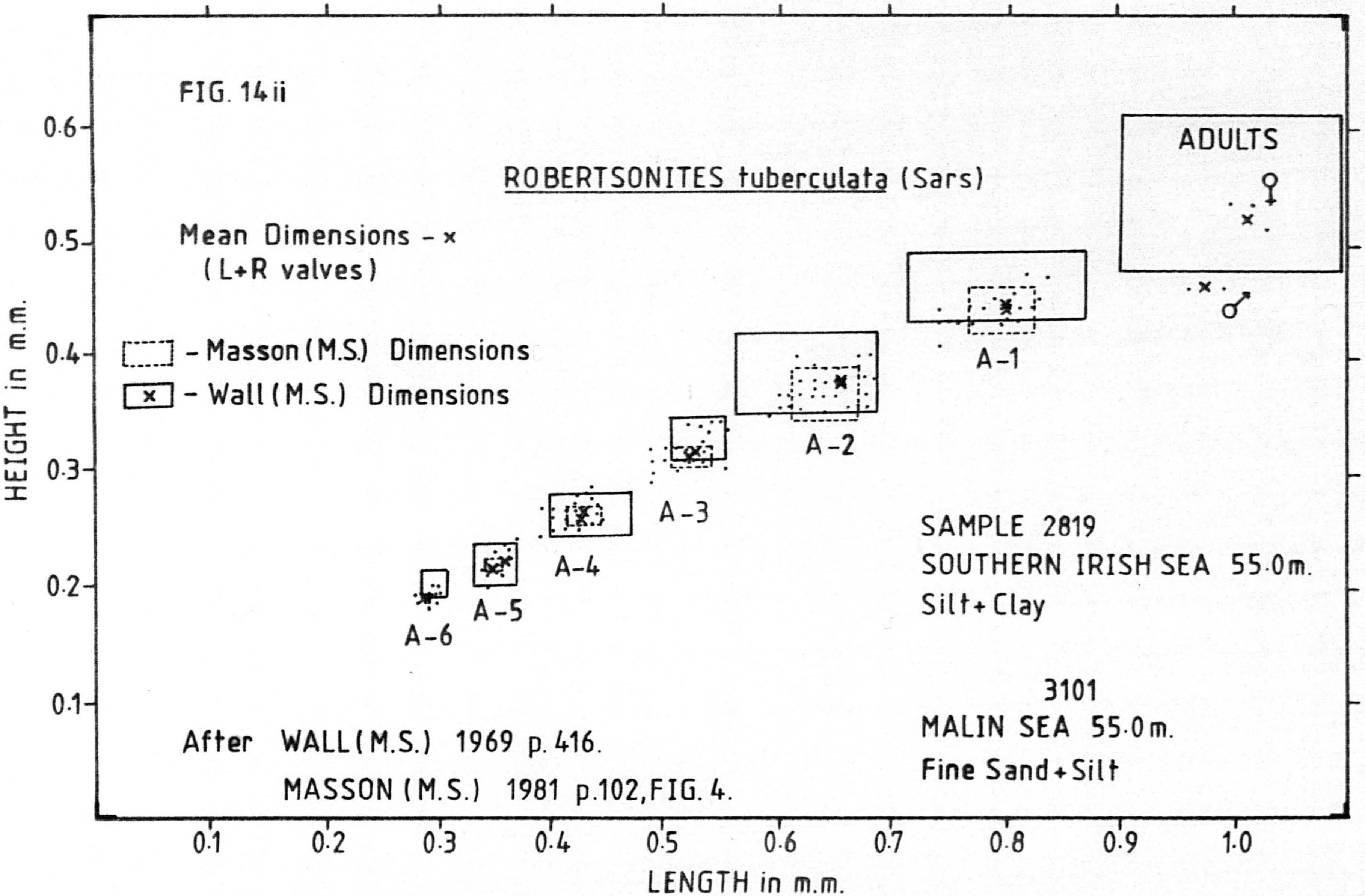


FIG. 14ii
ROBERTSONITES tuberculata (Sars)
Mean Dimensions - x
(L+R valves)
- Masson (M.S.) Dimensions
x - Wall (M.S.) Dimensions
ADULTS
A-1
A-2
A-3
A-4
A-5
A-6
SAMPLE 2819
SOUTHERN IRISH SEA 55.0m.
Silt + Clay
3101
MALIN SEA 55.0m.
Fine Sand + Silt
After WALL (M.S.) 1969 p. 416.
MASSON (M.S.) 1981 p.102, FIG. 4.
HEIGHT in m.m.
LENGTH in m.m.
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

Remarks

See: Wall (ms. 1969, p. 419) and Masson (ms. 1981, p. 103-104).

Study Area Ecology

A few live specimens occurred in mixed sand and fine sand with silt, 28.9-80.5 m, northward of Dublin Bay.

Otherwise, this species was most abundant and widespread in the southern Irish Sea, occurring in silty sands and silts with clay between 13-137.5 m. Much of the abundance was concentrated to the north of Dublin Bay within 15.2-87.8 m, mean 44.4 m, in the given sediments. Two juveniles occurred in mixed sand in 22 m and 38.4 m of Caernarvon Bay. It was much more common on the mid and outer shelf of Malin Sea, mixed sand and fine sand with silt, 55-512.1 m, mean 169.3 m.

A population of adults with juveniles was recovered from sample 2812 (28.9 m, fine sand + silt); large juvenile assemblages were taken from samples 2819, 2822 and 2915, 15.2-54.9 m, exclusively silt and clay, southern Irish Sea. A large number of juveniles also occurred in sample 3101 (55 m, fine sand + silt), S.E. of Islay, Malin Sea.

Palaeoecology and Distribution

This is a very wide ranging species. Reported in the western N. Atlantic, alive in the Ellesmere Land region of N.W. Greenland (Brady, 1878; Stephensen, 1913). It is more accurately documented further south in the Davis St., off Hunde Is. and Holsteinborg, 10-140 m (Brady, 1868, 1877; Brady and Robertson, 1869; Stephensen, 1913). It also occurs in the sublittoral of Halifax Inlet, Nova Scotia (Siddiqui and Grigg, 1975) and may range as a rarity to the St. Lawrence Estuary, 20-95 m (Brady, 1877; Hulings, 1967). In addition, R. tuberculata is reported from Mt. Desert, Maine in 13-25 m (Blake, 1933). However, Cushman (1906) found variations in the soft parts between that from Vineyard Sound, Massachusetts and material illustrated by Sars (1928). Nevertheless, there is an accurate record of material from 25-40 m off Clavering Is., N.E. Greenland (Elofson, 1941).

R. tuberculata is best documented in Scandinavian waters. Alive in the N. Arctic, commonly between 25-30 m though ranging on muds within 9-63 m (Elofson, 1941), off Spitzbergen (Svalbard Isles), Frans Joseph Land, King Karl Lands (Brady and Robertson, 1872; Scott, 1899; Elofson, 1941) and Novaya Zemlya (Neale and Howe, 1975). It is widely distributed and often abundantly alive between the tidemarks and within 28-55 m of E. and W. Finmark (Brady and Norman, 1895; Scott, 1899; Norman, 1902) and ranges alive on muddy ground, 18-55 m, throughout W. Norway (Sars, 1866, 1928; Norman, 1891; Elofson, 1941). There is an isolated report of specimens in 40 m off Iceland (Stephensen, 1938) and from the Faeroes (Stephensen, 1929). The species is commonly alive on silts and sand in 36-100 m of the W. Skagerrak and between 128-170 m off W. Sweden. In which region, Elofson (1941) found live material in -2-18°C, mostly within -2-8°C in 10-35‰ salinity. R. tuberculata is also frequently alive on muds of the Oresund (Elofson, 1941; Hagerman, 1965) and W. Baltic (Anderson, 1901; Hirschmann, 1915; Klie, 1929, 1938; Schafer, 1953; Rosenfeld, 1977), in 3-105 m and primarily between 10-30 m (Elofson, 1941; Rosenfeld, 1977).

The distribution ranges to the North Sea. Wherein, this species is commonly dredged in muds and sands, 38-70 m, from the Shetlands (Norman, 1869) to the Outer Thames Estuary (Brady, 1868; Brady and Robertson, 1870) and mostly off N.E. England (Brady, 1868, 1870, 1902; Brady and Robertson, 1874; Norman and Brady, 1909).

R. tuberculata is also common in sands and muds, 60-130 m, off N.W. Scotland (Brady, 1866, 1868; C.S. Harris, ms. 1977) and in 8-55 m of the Clyde Estuary (Brady, 1868; Robertson, 1874). Norman (1905) records it from the intertidal down to 110 m off the Antrim coast, N. Ireland and it is widely reported from inner bay areas off W. Ireland (Brady, 1868; Brady and Robertson, 1869; Norman, 1905; Farran, 1913). Further, Wall (ms. 1969) found it in abundance in muds and sands of Cardigan Bay, south Irish Sea. Rare dead material also occurs in the Celtic Sea, Western Approaches (Norman and Scott, 1906; Neale, 1974) and English Channel (Brady, 1868; Norman, 1907, 1908). There is little evidence that this species is more than rarely alive in British or adjacent waters.

To the south, its distribution is entirely represented by reworked material. Rare specimens are recorded from 50-500 m and mostly in 100-200 m off Cap Breton, S. Biscay (Brady and Folin, 1872; Fischer, 1876; Elofson, 1941; Peypouquet, 1971, 1973).

It occurs in moderate numbers in the Holocene throughout much of the Canadian arctic and W. Greenland, ranges to the Labrador coast, 31-55 m and occurs in 24-46 m+ off Shannon Island, E. Greenland (Hazel, 1967, 1970; Neale and Howe, 1975). This species is very common in contemporaneous deposits of the North Sea (Diebel and Pietrzeniuk, 1970) and southern Irish Sea

(Wall and Whatley, 1971). R. tuberculata also forms a major part of the palaeothenatocoenosis in S. Biscay, 100-200 m (Peypouquet, 1971; Carbonel, 1973; Moyes, 1974). Brady and Crosskey (1871) and Brady et.al., (1874) report it as C. logani n.sp., from the Late Glacial of Montreal and Tressler (1941) remarks upon material from submarine Glacial cores taken between Newfoundland and W. Ireland. Material is only locally common though widespread in raised beach deposits of S. Norway, Scottish Western Isles and Clyde Estuary (Brady et.al., 1874; Robertson, 1877, 1882; Anderson, 1948; Graham and Wilkinson, 1978; Peacock et.al., 1978; Morris, ms. 1978). R. tuberculata occurs as a rarity in similar deposits of Forth and Cromerty, E. Scotland (Henderson, 1870; Peacock et.al., 1980) and is found in moderate abundance in the Late Glacial of the North Sea (Masson, ms. 1981). Ipswichian, last interglacial, material is widespread in the southern Irish Sea (Jasin, ms. 1976) although R. tuberculata is a rarity in the Ipswichian of Somerset (Kidson et.al., 1978). The species is abundant in the Hoxnian interglacial of N. Germany and E. Denmark (Woszidlo, 1962) and in the Hoxnian of E. Yorkshire (Brady et.al., 1874; Neale and Howe, 1975), Nar Valley, Wash (Lord and Robinson, 1978) and Droghedo, E. Ireland (Colhoun and McCabe, 1973). Finally, several varieties of this species are recorded in the Pleistocene of N. Alaska (Swain, 1963).

Summary

Live material is reported from N.W. Greeland, 80^{O}N and off Clavering Island, 74^{O}N, N.E. Greenland. However, R. tuberculata is more probably found alive off S.W. Greenland and southward to Nova Scotia, 67-45°N. Live material is also reported to the south of Cape Cod, 42°N, though this may refer to a distinct species. R. tuberculata commonly inhabits the northern Barents Sea, 80°N, eastward to Novaya Zemlya and is abundant throughout Finmark, W. Norway, Skagerrak and the W. Baltic, 70-56°N approx. Material is most frequent in Recent deep water sediments southward to 52°N though records of live material are scarce in British and adjacent waters. Moderate numbers of sub-Recent and Holocene specimens are documented in the Canadian Arctic, from Davis St., Newfoundland, 76-45°N and off N.E. Greenland, 75°N. There is an abundance of contemporaneous material from the North Sea, Biscay and the Irish Sea, 60-44°N. Late Glacial specimens are reported from Montreal, Canada and in submarine cores across the N. Atlantic, 45°N approx. The species is, however, locally common in raised beach deposits of S. Norway and W. Scotland and most abundant in the North Sea Late Glacial, 55-60°N. R. tuberculata is also very common in the Ipswichian of the southern Irish Sea, though rare in that of Somerset, 51-54°N. This species is most abundant in the Hoxnian of E. Denmark, N. Germany and E. Yorkshire and frequent in the Hoxnian of East Anglia and E. Ireland, 52-56°N. Finally, it is known in Pleistocene deposits of Point Barrow, N. Alaska, 71°N.

R. tuberculata inhabits muddy sands or silts between 10-30 m in the western N. Atlantic and northern Arctic. It is abundantly alive in the intertidal and within 18-55 m off Finmark, N. Norway. It is also commonly alive in the Skagerrak, 36-100 m; Kattegat, 128-170 m and occurs mostly within 10-30 m of the Oresund. Material also ranges frequently in muds and sand, 8-70 m approx. in British and adjacent waters. However, its abundance in deeper waters, 60-200 m is probably of sub-Recent or Holocene age. This is a marine species, alive commonly in -2-8^{o}C though it will tolerate waters up to 18^{o}C and salinity down to 10‰.

Sub Family ECHINOCYTHEREIDINAE Hazel, 1967

Genus *Rabilimis* Hazel, 1967

Rabilimis mirabilis (Brady), 1868

pl. 46 figs. a-d

1868 *Cythere mirabilis* n.sp. Brady: p. 415, pl. 27, figs. 7-8.

1874 *Cythere mirabilis* Brady; Brady, Crosskey and Robertson: p. 147, pl. 7, figs. 22-26; pl. 15, figs. 13-16.

1943 *Cythereis mirabilis* (Brady); Elofson: pl. 10, figs. 2-8.

1946 *Cythereis mirabilis* (Brady); Akatova: p. 227, t.figs. 6a-d, 7.

1967 *Rabilimis mirabilis* (Brady); Hazel: p. 38.

1969 *Rabilimis mirabilis* (Brady); Lev: pl. 2, fig. 14.

1970 *Rabilimis mirabilis* (Brady); Hazel: pl. 47.

1980 *Rabilimis mirabilis* (Brady); Lord: p. 234, pl. 3, figs. 1-5.

1981 *Rabilimis mirabilis* (Brady); Masson (ms.): p. 99, pl. 5, figs. 14, 16-19.

Material

Total: F. - 2 RV. 1 LV.; J. - 7 RV. 10 LV. = 20 I.

Caernarvon Bay

Dead	Live
J. - 00 C. 01 RV. 01 LV. = 2 I.	00

Malin Sea

Dead	Live
F. - 00 C. 02 RV. 01 LV. J. - 00 C. 06 RV. 09 LV. = 18 I.	00

Sample Distribution

Caernarvon Bay

2447

Malin Sea

3041 3042 3092 3135 3142 3154

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	6 .	42A	1.155	0.800
	LV. "	6 .	41A/42	1.198	0.806
-2.?	RV. "	6 .	1	0.764	0.567
-3.?	LV. "	6 .	1A/2	0.578	0.439

These specimens are from sample 3042 (182 m, mixed sand) in the Malin Sea.

Description

See: Brady (1868, p. 415, pl. 27, figs. 7, 8) and Elofson (1943, p. 10-14, figs. 2-8) for a description and illustration of the carapace morphology and appendages.

Ontogeny

Instars of the penultimate to -6? growth stage are provisionally recognised. The dimensions of these from available study material are as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
-1.	Range	0.950-0.980	0.650-0.675	5	
	Mean	0.957	0.665		1.44
-2.?	Range	0.720-0.795	0.510-0.580	5	
	Mean	0.764	0.552		1.38
-3.?	Range	-	-	1	
	Mean	0.578	0.439		1.32
-4.?	Range	0.445-0.470	0.345-0.360	3	
	Mean	0.454	0.351		1.29
-5.?	Range	-	-	1	
	Mean	0.360	0.245		1.47
-6.?	Range	-	-	1	
	Mean	0.270	0.185		1.46

The 'net-like' ornament and rhomboidal shape of this species is maintained throughout ontogeny.

Remarks

The juvenile specimen figured as Trachyleberis (genre?) mirabilis (Brady) by Yassini (1969, p. 58, pl. 39, fig. 18) from the Quaternary of Gascony should be referred to another species. In addition, R. mirabilis is very similar to P. paramirabilis Swain from the Pleistocene of N. Alaska. However, the latter species may be distinguished by its strongly reticulate nature and by its concentric sub-marginal ornament.

Study Area Ecology

The species was not found alive and material was poorly preserved.

Two juvenile instars were recovered from 109.7 m in mixed sand of Caernarvon Bay. The species was otherwise rare, occurring in isolated deep water samples of Malin Sea, 54.9-182 m, mean 119.4 m, in coarse sand + gravel and mixed and fine sands with a high silt content.

Palaeoecology and Distribution

R. mirabilis has been found in moderate numbers associated with glacio-marine sediments, 30-200 m+ approx., off Shannon Is. (Neale and Howe, 1975) and Cape Parry, E. Greenland (Elofson, 1943). The last author considers most material in this region to be dredged between 30-60 m, which occurrence may also represent the live distribution.

Most records and the live distribution occurs in the Finmark province, N. Norway (Brady and Norman, 1895; Norman, 1891, 1902) on muds, sand and gravel between 20-250 m in $-2^{o}C+$ (Elofson). In accordance with the last author Neale and Howe (1975) consider R. mirabilis to be generally distributed in the

Barents Sea, possibly alive down to 430 m and to occur in abundance within 150 m (Elofson, 1943). The range also extends eastward to the Kara Sea (Elofson, 1943) and Novo Siberian Shelf (Akatova, 1946). Lastly, it extends alive to the permanent sub-zero conditions around Spitsbergen, Svalbard Islands (Brady and Norman) in 350 m (Elofson, 1943); Franz Joseph Land (Scott, 1899) and King Karl Land, 20 m (Elofson, 1943). Haynes and Whatley (1970) indicate that the species is not alive south of the Arctic Circle. Indeed, there seems to be only one other report of it further south in the Ostsee, W. Baltic (Klie, 1929).

Isolated specimens have been recovered in sands below 60 m in the Minches, N.W. Scotland (Brady, 1868; Brady and Robertson, 1872; C.S. Harris, ms. 1977). This last record with that from 200 m off N.E. Greenland (Hazel, 1970; Neale and Howe, 1975) is probably entirely reworked Holocene material. However, R. mirabilis is most abundant in raised beach silts of Sandnes, S.W. Norway (Lord, 1980) and Perth, E. Scotland (Davidson, 1932). It is also common in Late Glacial deposits of the North Sea (Masson, ms. 1981) and N.W. Scotland (Brady et.al., 1874). Material is abundant in the Hoxnian of E. Ireland (Colhoun and McCabe, 1973) and Dimlington (Neale and Howe, 1975) and Bridlington (Brady et.al., 1874), E. Yorkshire. Finally, there is a record of this species in the Pliestocene of N. Russia (Lev, 1969).

Summary

Moderate numbers of R. mirabilis have been dredged off N.E. Greenland, 70-75^{O}N and throughout the Barents Sea, Kara Sea and Novo Siberian shelf, 70-80^{O}N. Rare live material is

reported from many parts of these Arctic waters and occurs in moderate abundance off N. Norway, 68-70^{O}N. *R. mirabilis* is not recorded alive below the Arctic Circle. Records of isolated material in deep water off N.E. Greenland, 75^{O}N, from the Baltic and in the Minch, N.W. Scotland, 54-58^{O}N, are probably of Holocene or Late Glacial age. There is an abundance of material in the Late Glacial of W. Scotland and especially E. Scotland, North Sea and S.W. Norway, 56-60^{O}N. It is also common in the Hoxnian interglacial of E. Ireland and E. Yorkshire, 52-54^{O}N and throughout Pleistocene deposits of N. Russia, 65-70^{O}N.

Live material is probably restricted between 30-60 m off N.E. Greenland in 20-250 m of the Barents Sea and mostly within 150 m off N. Norway. Much of that found below these depths and all material in British and adjacent waters is reworked. The species is mostly associated with mud and sand with gravel, will tolerate waters of permanent sub-zero temperature, -2^{O}C+ and lives in full marine salinity.

Family XESTOLEBERIDIDAE Sars, 1928

Genus *Xestoleberis* Sars, 1866

Xestoleberis aurantia (Baird), 1838

pl. 46 figs. e-k

1838 *Cythere aurantia* n.sp. Baird: p. 143, pl. 5, fig. 26.

1850 *Cythere aurantia* Baird; Baird: p. 171, pl. XXI, fig. 8.

1868 *Xestoleberis aurantia* (Baird); Brady: p. 437, pl. XXVII, figs. 34-37; pl. XXXIX, fig. 6.

1874 *Xestoleberis aurantia* (Baird); (Pars) Brady, Crosskey and Robertson: p. 191, pl. XVI, figs. 32-33.

1941 *Xestoleberis pusilla* n.sp. Elofson: p. 341, t.figs. 22-25.

1957 *Xestoleberis pusilla* Elofson; de Vos: p. 51, pl. XXI, figs. 1a-f.

1972 *Xestoleberis aurantia* (Baird); Whittaker (ms.): p. 316, pl. 62, figs. 1-2; pl. 63, figs. 1-9.

1978 *Xestoleberis aurantia* (Baird); Whittaker: 5:4: pls. 27-34.

Material

Total: F. - 2 RV. 4 LV.; M. - 1 RV. 2 LV.; J. - 4 RV. 8 LV. = 21 I.

Caernarvon Bay

Dead				Live
F. - 00 C.	02 RV.	04 LV.		00
M. - 00 C.	01 RV.	02 LV.	= 16 I.	
J. - 00 C.	03 RV.	04 LV.		

Malin Sea

Dead				Live
J. - 00 C.	01 RV.	04 LV.	= 5 I.	00

Sample Distribution

Caernarvon Bay

2388 2392 2398 2516 2839 HHII

Malin Sea

3101

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	1 .	-	0.489	0.322
	"	1 .	3/3A		
	LV. "	1 .	42/42A	0.488	0.326
M.	RV. "	1 .	41/41A	0.381	0.231
	LV. "	1 .	1/1A	0.375	0.225
-1.	RV. "	1 .	2/2A	0.374	0.346
	LV. "	1 .	4/4A	0.378	0.251

Adult valves - sample HHII (0.5-5 m, algae), juvenile right valve - sample 2516 (49.6 m), juvenile left valve - sample 2839 (44 m, mixed sand), Caernarvon Bay.

Description

See: Brady (1868, p. 437-438, pl. XXVII, figs. 34-37) and Whittaker (ms. 1972, p. 317-318, pls. 62, 63) for a description and illustration of hard and soft parts.

Ontogeny

Juvenile instars of the penultimate to -3 growth stage were recognised. The dimensions of which, from Caernarvon Bay material, are given as follows:

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
-1.	Range	0.350-0.380	0.220-0.265	6	
	Mean	0.372	0.257		1.45
-2.	Range	0.310-0.325	0.205-0.215	2	
	Mean	0.318	0.210		1.51
-3.	Range	0.245-0.270	0.160-0.175	4	
	Mean	0.258	0.165		1.56

Sexual dimorphism is distinct. Males are much the smaller and more elongate than females.

Juveniles are extremely inflated and highly arched dorsally.

Remarks

In accordance with Brady (1868, p. 438) and Whittaker (ms. 1972), the present author considers *X. aurantia* to be a strictly littoral and entirely marine species. Therefore, those records appertaining to brackish waters are not included herein.

Most references to *X. aurantia* (Baird) in British and Scandinavian waters and perhaps all reports of it from the W. Baltic are probably referable to *X. nitida* (Lilljeborg). This species may be distinguished from *X. aurantia* by its triangular shape and flattened venter. In addition, certain other erroneous reports of *X. aurantia* may be referred to *X. rubrens* Whittaker (ms. 1972). Which latter species is recognised by its gross size (Length: F. - 0.595-0.680 mm) and distinctive radial pore canals.

See: Whittaker (ms. 1972, p. 307-309, 312-313, 324-325).

Study Area Ecology

Live specimens were not recovered.

A few instars were found between the tidemarks in algal debris of Holyhead Harbour and, otherwise, ranged down to 82.3 m, mean 37.8 m, in coarse sand with gravels and mixed sands of Caernarvon Bay. A number of juveniles were also found in fine sand with silt, 55 m, south of Islay, Malin Sea.

Palaeoecology and Distribution

Brady and Norman (1889) and Hagerman (1968) comment that *X. aurantia* ranges in the intertidal and sublittoral along the west coast of Norway, from Hardanger Fiord to Lofoten.

However, this distribution may include several other species of the genus Xestoleberis Sars. X. aurantia is, however, very common in the E. Skagerrak, as X. pusilla Elofson, alive on algae, 0-20 m, in 0-22^{o}C and 35-38‰ salinity (Elofson, 1971). It may also range in Corallina to areas of near marine salinity in the Oresund (Hagerman, 1968).

There are numerous reports of X. aurantia along the coast of N.E. Britain though most of these records are now placed with other species. However, this species does occur off the Shetlands and Orkneys (Brady and Norman, 1889; Scott, 1891), frequently alive in the intertidal and littoral and found otherwise down to 100 m, off N.E. England (Baird, 1838, 1845; Brady, 1870, 1903; Brady and Robertson, 1872; Norman and Brady, 1909). Brady (1868) and Brady and Norman (1889) also report material much further south on Girdler Sands, Thames Estuary and from Dungeness, S.E. England.

X. aurantia is more thoroughly documented to the west of Britain. A single live specimen was recorded from sublittoral Laminaria of St. Kilda (Pearce, ms. 1977) and Harris (ms. 1977) found rare dead material in fine sand and mud of the Minches, 80-155 m, N.W. Scotland. Robertson (1874) and Brady and Norman (1889) record it in abundance from the sublittoral of Cumbrae, Outer Clyde Estuary and it is a common occurrence in the pools and between 2-28 m throughout western Ireland (Brady, 1868; Brady and Robertson, 1869, 1872; Norman, 1905). These last authors also note X. aurantia as a rarity in Belfast Lough and Dublin Bay. Otherwise, there is little evidence of it in the Irish Sea with the exception of moderate numbers of live material in sublittoral bushy algae of Caernarvon Bay (Morgan, ms. 1977). Isolated dead specimens occur in shelly sands and muds, 54-100 m approx., in the Celtic Sea (Brassil, ms. 1977; Lomax, ms. 1978; Neale, 1974), off the Scillies and from Eddystone, Plymouth (Brady and Norman, 1889; Norman and Scott, 1906; Harding, 1957). There are also numerous records of X. aurantia in river mouths and harbours of N. and S. Devon and Cornwall (Norman and Scott, 1906). However, this S.W. England distribution is considered by the present author as tentative.

A number of reports of this species in Poole Harbour (Brady, 1868) and from the Channel Isles (Brady, 1868; Brady and Robertson, 1872; Norman, 1907, 1908) and N. Brittany (de Vos, 1957) are certainly accurate. In addition, Whittaker (ms. 1972) found it commonly alive in rock pools, bushy algae and on littoral Fucus of Weymouth Bay, Dorset. The last author found it alive in areas only of 33-35‰ salinity and in $19^{\circ}C$ or less. It would also seem from Whittaker's (ms.) comprehensive comments that this species does not range alive further south than the English Channel.

A few specimens have been found in the Holocene of Cardigan Bay (Haynes et.al., 1977) and are reworked into Recent sediments, 75 m, of Vigo Bay, N.W. Spain (Ralph, ms. 1977). Otherwise, it is a rarity in the Late Glacial of S. Wales, Belfast (Brady et.al., 1874) and S.W. Scotland (Peacock et.al., 1978), though moderately abundant in raised beach deposits of the outer Clyde Estuary (Brady et.al., 1874). The last authors also remark that this species occurs in the Late Devensian of S. Norway. Lastly, there is a report of rare material in the Ipswichian of the Somerset Levels (Kidson et.al., 1978) and an abundant occurrence of X. aurantia in the last interglacial of Selsey, Sussex (Whatley and Kaye, 1971).

Summary

X. aurantia may range alive throughout W. Norway northward to 68°N. However, it is more probably restricted in Scandinavia to the Skagerrak, in moderate abundance, and to the Oresund, 56-60°N. Reports range throughout British and adjacent waters, though this species has a very patchy distribution in this region and may be completely absent in some areas, 50-60°N. Holocene specimens are known from Cardigan Bay, southern Irish Sea, 52-54°N and material of this age is probably reworked into deep water sediments of N.W. Scotland, 58°N and N.W. Spain, 43°N. Late Glacial material occurs in S. Wales, N.E. Ireland and is found in moderate numbers within raised beach material of W. Scotland and S. Norway, 51-60°N. Rare individuals occur in the Ipswichian, last interglacial, of Somerset, 51°N and *X. aurantia* is reported in abundance in the Eemain of Selsey, Sussex, 50°N.

This is an intertidal and sublittoral species, found in 0-20 m of the Skagerrak and between 0.5/2-28 m in British and adjacent waters. It is also reworked down to 100 m in Recent sediments, though much of that in 80-155 m off N.W. Scotland is probably of sub-Recent or Holocene age. *X. aurantia* is primarily associated with Laminarian and bushy algae in full marine salinity, 30‰+ and waters of 0-22°C.

<u>Xestoleberis</u> <u>depressa</u> Sars, 1865

pl. 46 figs. l-q; t.fig. 15

1865 <u>Xestoleberis</u> <u>depressa</u> n.sp. Sars: p. 68.

1868 <u>Xestoleberis</u> <u>depressa</u> Sars; Brady: p. 438, pl. XXVII, figs. 27-33.

1874 <u>Xestoleberis</u> <u>depressa</u> Sars; Brady, Crosskey and Robertson: p. 190, pl. VII, figs. 13-19.

1878 <u>Xestoleberis</u> <u>depressa</u> Sars; Brady: p. 401, pl. LXVI, figs. 8a-d.

1928 <u>Xestoleberis</u> <u>depressa</u> Sars; Sars: p. 245, pl. CXI, fig. 2.

1938 <u>Xestoleberis</u> <u>depressa</u> Sars; Klie: p. 211, t.figs. 722-724.

1941 <u>Xestoleberis</u> <u>depressa</u> Sars; Elofson: p. 116.

1957 <u>Xestoleberis</u> <u>depressa</u> Sars; Wagner: p. 95, pl. 46.

1974 <u>Xestoleberis</u> <u>depressa</u> Sars; Wilkinson (ms.): p. 89, pl. II, figs. 11, 12.

1976 <u>Xestoleberis</u> <u>depressa</u> Sars; Hoskin (ms.): p. 286, pl. 26, figs. 6, 7.

1977 <u>Xestoleberis</u> <u>depressa</u> Sars; Rosenfeld: p. 37, pl. 10, figs. 127-129, tabs. 27-29.

1978 <u>Xestoleberis</u> <u>depressa</u> Sars; Ralph (ms.): p. 218, pl. IV, fig. 25, t.figs. 11, 12.

1980 <u>Xestoleberis</u> <u>depressa</u> Sars: Hawley (ms.): p. 108, pl. II, figs. 1-17, t.fig. 7; figs. 1-3, map 9.

<u>Material</u>

Total Dead: F. - 2 C. 12 RV. 6 LV.; M. - 5 C. 16 RV. 9 LV.; J. - 13 C. 977 RV. 638 LV. = 1212 I.

Live: 4 J

Southern Irish Sea

Dead	Live
F. - 00 C. 00 RV. 01 LV.	00
M. - 00 C. 01 RV. 01 LV. = 26 I.	
J. - 00 C. 21 RV. 08 LV.	

Caernarvon Bay

Dead					Live	
F. -	00 C.	01 RV.	01 LV.		00	
M. -	00 C.	00 RV.	00 LV.	= 6 I.	00	= 4 I.
J. -	01 C.	01 RV.	02 LV.		04	

Malin Sea

Dead					Live
F. -	02 C.	11 RV.	04 LV.		00
M. -	05 C.	15 RV.	08 LV.	= 1180 I.	
J. -	12 C.	955 RV.	628 LV.		

Sample Distribution (Live occurrence is underlined)

Southern Irish Sea

910 2365 2366 2367 2369 2375 2381 2783 2819 2822
2824 2854 2905 2915 2918

Caernarvon Bay

2389 <u>2431</u> <u>2447</u> 2515 HHI

Malin Sea

3000 3001 3004 3011 3012 3014 3090 3092 3098 3099
3101 3103 3107 3115 3140 3142 3143 3145 3146 3147
3150 3151 3152 3153 3154 3161 3162

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV. external	1 .	7/7A	0.642	0.324
	LV. "	1 .	9/9A	0.620	0.338
M.	RV. "	1 .	6/6A	0.533	0.298
	LV. "	1 .	5/5A	0.544	0.300
-1.	RV. "	1 .	10/10A	0.435	0.236
	LV. "	1 .	11/11A	0.453	0.255

Female right valve - sample 3004 (45 m, coarse sand + gravel); male left valve - sample 3099 (77 m, mixed sand); juveniles - sample 3101 (55 m, fine sand + silt), Malin Sea. Female left valve - sample 2839 (20.1 m, mixed sand), Caernarvon Bay and male right valve - sample 3000 (86 m, mixed sand), southern Irish Sea.

Description

See: Sars (1928, p. 245, pl. CXI, fig. 2) and Hawley (ms. 1980, p. 108-114, pl. II, t.fig. 7) for a description and illustration of hard and soft parts.

Ontogeny

Instars of the penultimate to -5 or -6 growth stage were recognised. The dimensions of adults and juveniles from sample 3101 (55 m, fine sand + silt), Malin Sea are given as follows: (See: Fig. 15)

				Nos.	L.:H. ratio
F.	Range	0.580-0.650	0.300-0.340	10	
	Mean	0.601	0.325		1.85
M.	Range	0.500-0.570	0.260-0.300	28	
	Mean	0.534	0.281		1.90
-1.	Range	0.430-0.500	0.210-0.270	67	
	Mean	0.453	0.245		1.85
-2	Range	0.320-0.370	0.170-0.210	42	
	Mean	0.349	0.191		1.83
-3	Range	0.270-0.320	0.150-0.200	95	
	Mean	0.295	0.169		1.75
-4	Range	0.240-0.270	0.150-0.160	12	
	Mean	0.255	0.152		1.68
-5	Range	-	-	1	
	Mean	0.190	0.120		1.58

Juveniles exhibit a most irregular increase in the L.:H. ratio throughout ontogeny.

Sexual dimorphism is distinct. Males are proportionately more elongate, smaller and less inflated posteriorly than females.

Study Area Ecology

A number of live juveniles occurred in 75 m and 109.7 m in mixed sand of Caernarvon Bay.

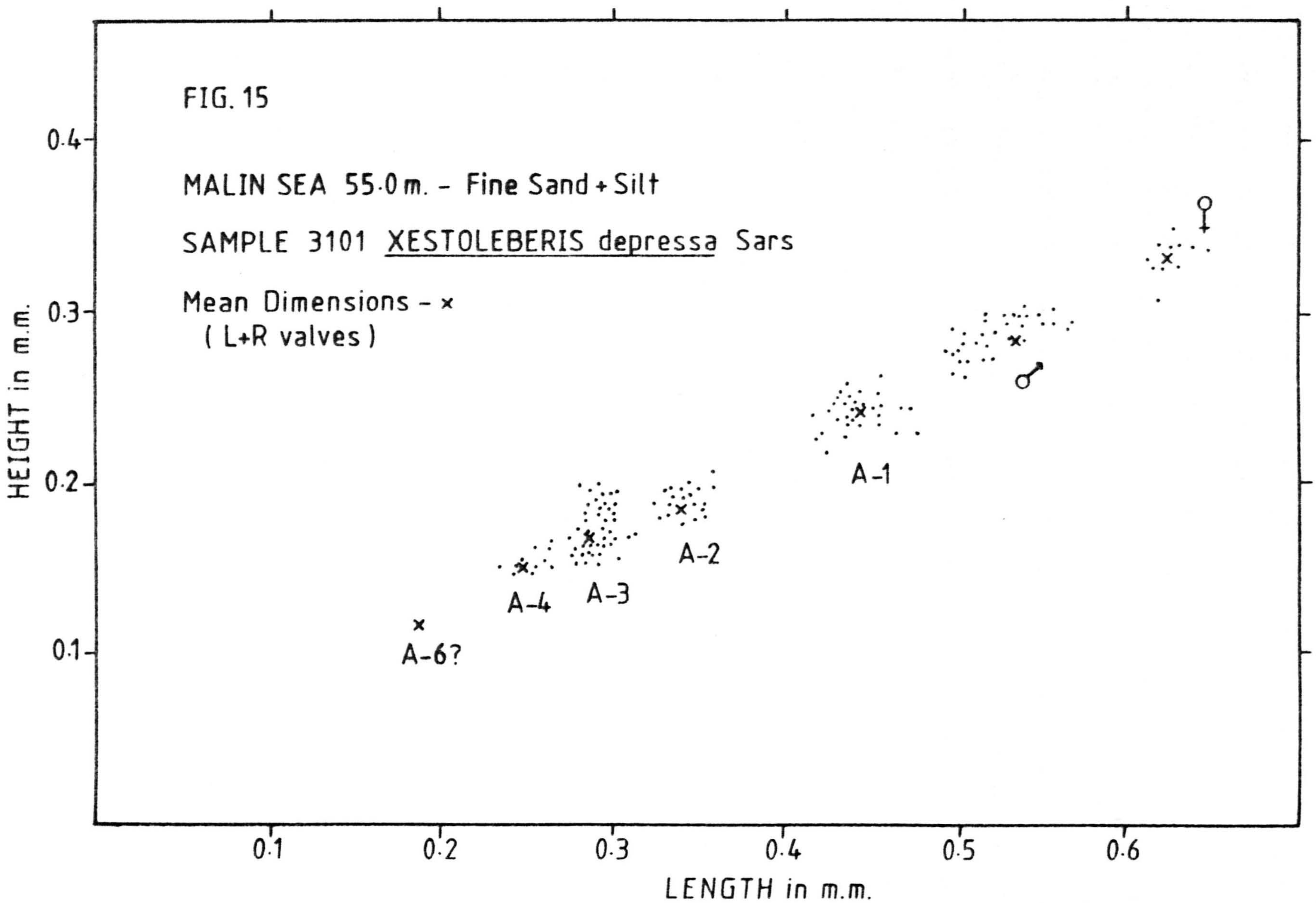


FIG. 15
MALIN SEA 55·0 m. - Fine Sand + Silt
SAMPLE 3101 XESTOLEBERIS depressa Sars
Mean Dimensions - ×
(L+R valves)
HEIGHT in m.m.
0·4
0·3
0·2
0·1
A-6?
A-4
A-3
A-2
A-1
♂
♀
0·1
0·2
0·3
0·4
0·5
0·6
LENGTH in m.m.

In the southern Irish Sea isolated dead material ranged from 2.7-87.8 m, mean 30.7 m, in a variety of sediments from coarse sand and gravel to silts with clay. A small number of specimens were found in the intertidal of Holyhead Harbour and down to 109.7 m, mean 46.6 m in mixed sand of Caernarvon Bay.

This is one of the most abundant species in the Malin Sea, ranging between 22-512.1 m, mean 111.8 m, in coarse sand with gravel to fine sand with silt. Most specimens occurred in 47.6-170.1 m in fine sand with silt.

Large populations of adults with juveniles were recovered in samples 3101 (55 m) and 3143 (146.3 m); large juvenile assemblages occurred in samples 3162 (140.8 m) and 3154 (170.1 m), fine sand with silt, Malin Sea.

Palaeoecology and Distribution

X. depressa is widely documented off W. Greenland from Godhavn, 180 m (Stephensen, 1913), Holsteinborg, 14-70 m (Brady, 1877; Stephensen, 1913) and from S.W. Greenland, alive in the sublittoral (Hawley, ms. 1980). In addition, Brady and Norman (1889), Klie (1938), and Elofson (1941) comment upon its distribution in Davis St., off the Labrador coast and with Brady (1870) report it in muds of the St. Lawrence Estuary. The range may extend throughout to the Gulf of Maine, associated with mud and algae from the tidemarks down to 28 m (Blake, 1933), further south to Vineyard Sound, Massachusetts (Cushman, 1906).

Rare material occurs off Spitzbergen (Brady and Robertson, 1872; Brady and Norman, 1889) and near Cape Flora, Frans Joseph Land, 4-28 m (Scott, 1899). The species is more common and alive in the sublittoral of Finmark, N. Norway (Brady and Norman, 1889, 1895; Norman, 1902) and off the Kola Peninsula (Derjugin, 1916). An abundance of live material is recorded in littoral Laminaria and in marine intertidal Corallina between Oslo Fiord and the Lofoten Isles, S. and W. Norway (Sars, 1866, 1890, 1928; Hagerman, 1968). Elofson (1941, 1943) also found it commonly alive in 3-25 m, mostly below 10 m, in the Skagerrak and considered the overall tolerance to be -2-22^{o}C in 10‰+ salinity. Hagerman (1965), in accord with the last author, found X. depressa frequent and ubiquitous in the Kattegat and Oresund. Live material also ranges to the W. Baltic and especially Keele Bay (Klie, 1929, 1938). Within which region, the species tolerates 14-30% salinity in the phytal zone and occurs beneath on silts, 6-40 m (Rosenfeld, 1977). Lastly, isolated specimens occur in 6-8 m off Iceland (Stephensen, 1938).

X. depressa is commonly dredged off the Shetlands, Orkneys and east coast of Scotland (Brady, 1868; Brady and Robertson, 1872). Rare live specimens and locally abundant dead material occur in areas of mud and gravel sands with zoophytes, 28-90 m, in the North Sea (Brady, 1868, 1870, 1902; Brady and Robertson, 1874, 1876; Norman and Brady, 1909). The species is further recorded by Brady and Robertson (1872) in the sublittoral off Northumberland and Durham.

A solitary live specimen and, otherwise, an abundance of material was recorded in the lagoonal of N. Uist, Western Isles (Pearce, ms. 1977). Isolated live individuals are also recorded in shell sand, 18 m, of the Minch. Within this region, X. depressa occurs dead in ubiquitous abundance, 80-190 m (C.S. Harris, ms. 1977). It is also frequent on hard and soft ground of the Clyde Estuary, 8-55 m (Brady, 1868; Robertson, 1874) and distributed dead in inner bay sediments, 8-28 m throughout W. Ireland (Brady, 1868; Brady and Robertson, 1869; Norman, 1905; Hoskin, ms. 1976). Isolated instars occur in the Lomax (ms. 1978) Celtic Sea samples and off N. and S. Devon and Cornwall (Brady, 1868; Norman and Scott, 1906; Harding, 1957). In addition, a few live specimens occur in intertidal weeds of the Scilly Isles (Norman and Scott, 1906; Neale, 1970) and Channel Isles (Brady, 1868; Norman, 1907, 1908). Little is known of its distribution elsewhere in the English Channel or further south.

Brady and Norman (1889) record it from S. Biscay and isolated material does occur in sands, 24-100 m, off N.W. Spain (Ralph, ms. 1977). However, in accordance with Elofson (1941) the present author doubts the validity of records from Madeira, N.W. Africa (Brady, 1911) and especially those records appertaining to the Recent and Quaternary of the Mediterranean.

Neale and Howe (1975) indicate that much of the material dredged in the N. Barents Sea, from King Karl Land and Danish Is., 16-70 m, is of Holocene age. In addition, Wagner (1957) found it in moderate numbers in the Netherlands Holocene and sub Recent and it is probable that much of the deep water material off N.W. Scotland (Harris, ms. 1977), S.W. France (Brady and Norman, 1889) and N.W. Spain (Ralph, ms. 1978) is also of this age. X. depressa is reported in the Late Glacial of Portland, Maine and Canada (Brady and Crosskey, 1871). It is also one of the most abundant and widely distributed ostracod species in the Late Glacial of N.E. Ireland; Clyde Estuary, W. Scotland and S. Norway (Brady et.al., 1874). However, this species appears to be rare in raised beach deposits of Forth, E. Scotland (Bell, 1891). Isolated specimens are recorded in the last interglacial, Eemian, of Selsey in Sussex (Whatley and Kaye, 1971). Finally, there are records of X. depressa in the Upper Pliocene Coralline Crag of E. Anglia (Wilkinson, ms. 1974) and from bryozoan sands of the Antwerp Crag, Belgium (Brady, 1878; Brady and Norman, 1889).

Summary

This species is alive in reduced numbers in the Davis St., off Labrador and southward to Cape Cod, 70-42^{O}N. Rare live material is also known from the northern Barents Sea, 80^{O}N. However, X. depressa occurs more commonly around Finmark and is abundantly alive off W. Norway, in the Skagerrak and W. Baltic, 56-70^{O}N. Isolated specimens have been dredged in Icelandic waters, 65^{O}N, though material is very common in Recent sediments off N. Britain, southward to 54^{O}N. It is probable that much of that recorded from the N. British Seas and adjacent waters is referable to the sub-Recent and Holocene distribution. Holocene records extend from the Netherlands in reduced numbers to S. Biscay and N.W. Spain, 42-60^{O}N. Late Glacial material is reported from Portland, Maine and the St. Lawrence region, 43-45^{O}N though is best documented from E. and W. Scotland and S. Norway, 55-60^{O}N. Finally, X. depressa is recorded in low numbers in the last interglacial, Eemian, of S. Sussex, 50^{O}N and is reported in the Upper Pliocene Crags of E. Anglia and N. Belgium, 51-53^{O}N.

This is a sublittoral and littoral species, 3-28 m approx. It occurs mostly within 10-40 m in S. Scandinavia

on laminarian algae, Corallina and the muds beneath. However, in northern British waters rare live material is mostly associated with zoophytes gravel sands and muds, 28-90 m. Material recorded down to 180 m+ in Davis St., in abundance between 80-130 m off W. Scotland and in deep waters of Biscay and N.W. Spain is probably sub Recent or Holocene. X. depressa appears to be a fully marine species able to tolerate permanently reduced salinity, 14-30‰, in the W. Baltic. Lastly, its temperature tolerance is given as -2-22^{o}C.

Sub Order PLATYCOPINA Sars, 1866

Family CYTHERELLIDAE Sars, 1866

Genus *Cytherella* Jones, 1849

Cytherella sp.cf. *C. scotica* Brady, 1866

pl. 47 figs. a-h; t.fig. 16

1866 *Cytherella scotica* n.sp. Brady: p. 211.

1868 *Cytherella scotica* Brady; Brady: p. 473, pl. XXXIV, figs. 18-21.

Material

Malin Sea + Total

Dead					Live	
F. -	00 C.	04 RV.	01 LV.		00	
M. -	00 C.	02 RV.	03 LV.	= 58 I.	01	= 2 I.
J. -	04 C.	29 RV.	41 LV.		01	

Sample Distribution (Live occurrence is underlined)

Malin Sea

3041 3042 3153 3143 3152 3153 <u>3154</u> 3161

Figured Specimens

			Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	RV.	external	22	. 39A/40	0.800	0.439
	LV.	"	22	. 40A/41	0.840	0.488
M.	RV.	"	22	. 41A/42	0.800	0.474
	LV.	"	22	. 42A	0.812	0.447
		"	22	. 33A/34		
-2.	RV.	"	22	. 1A/2	0.582	0.400
	LV.	"	22	. 1	0.589	0.388

Female and male valves - sample 3152 (173.8 m, fine sand + silt), Malin Sea.

Description

See: Brady (1868, p. 473, pl. 34) for a description and illustration of the carapace morphology. The soft parts are not described in the literature.

Ontogeny

Juvenile instars of the penultimate to -4 growth stage were recovered. The dimensions of specimens from sample 3152 and measurements of other adults in the study material are given as follows:(See: Fig. 16).

	Size	L. (mm)	H. (mm)	Nos.	L.:H. ratio
F.	Range	0.840-0.880	0.480-0.500	4	
	Mean	0.860	0.490		1.76
M.	Range	0.800-0.830	0.430-0.480	5	
	Mean	0.818	0.450		1.78
-1.	Range	0.690-0.750	0.420-0.480	11	
	Mean	0.718	0.455		1.58
-2.	Range	0.580-0.620	0.360-0.390	5	
	Mean	0.596	0.376		1.59
-3.	Range	0.450-0.510	0.300-0.320	5	
	Mean	0.474	0.310		1.53
-4.	Range	0.370-0.380	-	2	
	Mean	0.375	0.240		1.56

Left and right valves of a carapace are markedly dissimilar in shape with the right valve being the more rectangular.

Sexual dimorphism is slight. Males are proportionately longer than females and much more compressed in dorsal aspect.

Remarks

This species is considered by many authors to be synonymous with C. abyssorum Sars. Indeed, the limited amount of published information on C. scotica is likely due to its inclusion within the geographical and ecological range attributed to

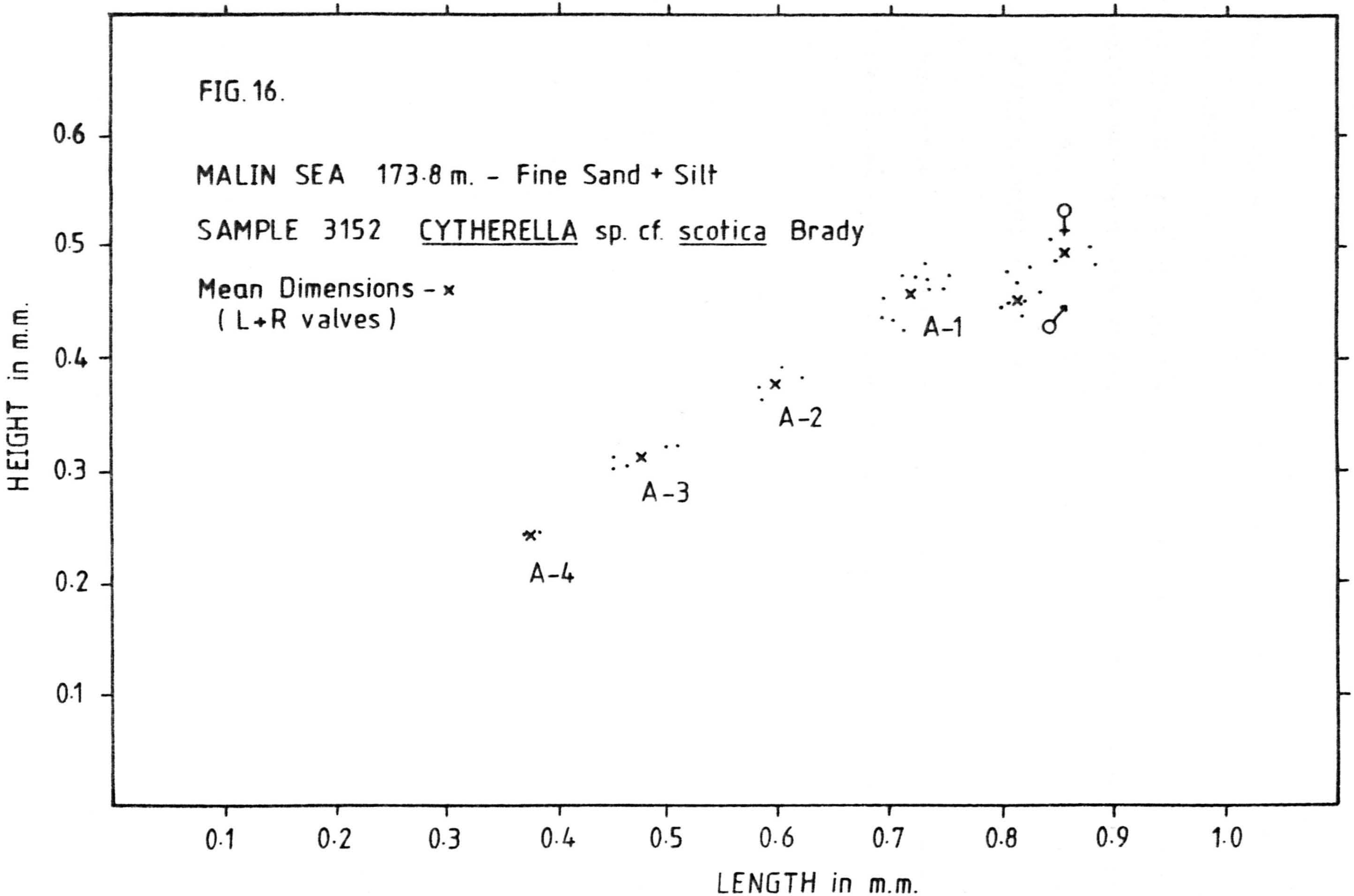


FIG. 16.
MALIN SEA 173·8 m. - Fine Sand + Silt
SAMPLE 3152 CYTHERELLA sp. cf. scotica Brady
Mean Dimensions - x
(L+R valves)
A-1
A-2
A-3
A-4
♀
♂
0.1
0.2
0.3
0.4
0.5
0.6
HEIGHT in m.m.
0·1
0·2
0·3
0·4
0·5
0·6
0·7
0·8
0·9
1·0
LENGTH in m.m.

C. abyssorum. These two species are most certainly distinct and distinguished in a number of ways. In dorsal view, C. abyssorum has the more truncate extremities. In lateral aspect, C. scotica and Cytherella sp. cf. C. scotica, herein, are regularly elliptical and unlike C. abyssorum are profusely punctate.

Study Area Ecology

A live male and juvenile were recovered in fine sand with silt, 170.1 m, from the northern Malin Sea.

Otherwise, isolated specimens were found between 54.9-182 m, mean 136.1 m, in mixed sand and fine sand with silt. Most material occurred in one region of the Outer shelf, 170.1-173.8 m. A population of adults and juveniles occurred in sample 3152 (170.1 m, fine sand + silt).

Palaeoecology and Distribution

This species is only accurately documented in the North Sea, off the Shetlands (Brady and Robertson, 1876) and in mud and sand, 68 m, off Northumberland and Durham (Brady and Robertson, 1874; Norman and Brady, 1909).

Isolated reports of C. scotica extend within 90-120 m of the Minches, N.W. Scotland (Brady, 1866, 1867, 1868; Brady and Robertson, 1876). Brady (1867) indicates that the shells are so durable that some dredgings probably include Late Glacial or Holocene specimens. This last observation may account for a solitary individual found by Malcomson (1885) in shallow muds of Belfast Lough.

Summary

Recent and Late Glacial material is ncorporated in the known distribution from Shetland, off N.E. and N.W. Britain, 54-60^{O}N. The species probably ranges to W. Norway and the Skagerrak, recorded as C. abyssorum Sars.

Its ecology is unknown. However, most material has been dredged in muds and fine sand between 68-120 m. It would seem to be a cool temperate and boreal marine form.

Order MYODOCOPIDA Sars, 1866

Sub Order MYODOCOPINA Sars, 1866

Super Family CYPRIDINACEA Baird, 1850

Family CYPRIDINIDAE Baird, 1850

Sub Family PHILOMEDINAE Müller, 1912

Genus *Philomedes* Lilljeborg, 1853

Philomedes brenda (Baird), 1850
pl. 47 figs. i-j

1850 *Cypridina brenda* n.sp. Baird: p. 181, pl. XXIII, figs. 1a-g (female).

1853 *Cypridina globosa* Lilljeborg; Lilljeborg: p. 171, pl. XVII, figs. 2-10; pl. XVIII, figs. 1-3, 7 (female).

1853 *Philomedes longicornis* Lilljeborg; Lilljeborg: p. 176, pl. XXVI, figs. 4-6, 14-16 (male).

1855 *Asterope groenlandica* Fischer; Fischer: p. 26, pl. II, figs. 26-34 (female).

1866 *Bradycinetus globosus* Sars; Sars: p. 110 (female).

1866 *Philomedes longicornis* Lilljeborg; Sars: p. 107 (male).

1868 *Bradycinetus brenda* (Baird); Brady: p. 466, pl. XXXIII, figs. 1-5; pl. XLI, fig. 5 (female).

1869 *Philomedes globosus* (Lilljeborg); Sars: p. 51 (female + male).

1871 *Bradycinetus brenda* Baird; Brady: p. 292, pl. XXVI, fig. 6.

1891 *Philomedes brenda* (Baird); Norman: p. 119.

1895 *Philomedes brenda* (Baird); Brady and Norman: p. 654, pl. L, figs. 1-3; Pl. LVI, figs. 1-3 (female + male).

1909 *Halocypris globosa* n.sp. Paulsen: p. 35.

1920 *Philomedes (Philomedes) globosa* (Lilljeborg); Skogsberg: p. 381, pls. LXVI-LXIX.

1928 *Philomedes globosus* (Lilljeborg); Sars: p. 12, pl. V-VII.

1937 *Cypridina norvegica* Baird; Spärck: p. 26.

1941 Philomedes (Philomedes) globosus (Lilljeborg); Elofson: p. 12.

1950 Philomedes brenda (Baird); Sylvester-Bradley: p. 777.

A more complete synonymy is given in Skogsberg (1920).

Material

Caernarvon Bay + Total

Dead					Live	
F. -	00 C.	00 RV.	00 LV.	= 00 I.	01	= 2 I.
J. -	00 C.	00 RV.	00 LV.		01	

Sample Distribution (Live occurrence is underlined)

Caernarvon Bay

HHI HHII

Figured Specimens

		Film No.	Neg. + Print No.	L. (mm)	H. (mm)
F.	LV. external	7 .	2A/3	1.005	0.670
	"	7 .	3A/4		

Description

See: Skogsberg (1920, p. 382-396, pls. LXVI-LXIX) and Sars (1928, p. 12-14, pls. V-VII) for a full description and illustration of the hard and soft parts.

Ontogeny

A single penultimate juvenile was recovered. It was very weakly calcified, transparent in parts and entirely smooth.

Remarks

The female specimen exhibited discoidal plating of the shell and was, otherwise, poorly preserved and weakly calcified.

Sohn and Kornicker (1969, p. 99-109, pl. 1-3) consider these amorphous calcitic plates to be formed by post-mortem re-crystallization of the carapace. However, Müller (1894, p. 93-95) proposed that this feature was the response of certain live Myodocopid ostracods to disease or nutrition deficiency

See: Elofson (1941, p. 13), Sylvester-Bradley (p. 777) and especially Skogsberg (1920, p. 396-399).

Study Area Ecology

Two live individuals were recovered from algal debris taken below the intertidal in Holyhead Harbour, Caernarvon Bay.

Palaeoecology and Distribution

This species ranges alive in the western Arctic, eastward into the Beaufort Sea from Point Barrow, N. Alaska (MacGinitie, 1955) and is found in abundance in the western N. Altantic from northern Baffin Bay, 40-240 m (Baird, 1850, 1860; Sars, 1901; Skogsberg, 1920; Klie, 1929) southward. Indeed, Skogsberg (1920) in accordance with Brady (1877), Norman (1877), Sars (1890) and Stephensen (1913, 1936) found that it primarily inhabits 1-40 m, occurs commonly down to 70 m and is seldom in 500 m throughout much of the Davis St. (W. Greenland) and Danish St. (E. Greenland). Stephensen (1913) suggested that P. brenda is, in the main, associated with Laminarian type algae and the sands and muds beneath. The range includes Newfoundland, it extends in moderate numbers, within 35 m, southward of Nova Scotia (Skogsberg, 1920; Klie, 1929) and ranges on hard ground areas, 6-20 m, to the Gulf of Maine (Blake, 1933).

Live material is recorded from Jan Mayen (Sars, 1886;

Klie, 1929), occurs in moderate numbers, 40-80 m, off Spitzbergen (Lilljeborg, 1876; Sars, 1886; Klie, 1929, 1942) and is common in 3-18 m (Skogsberg, 1920) off Frans Joseph Land (Scott, 1899, 1905; Klie, 1929). P. brenda ranges more rarely, 18-27 m, around Novaya Zemlya (Skogsberg, 1920) and may extend eastward into the Kara Sea (Hansen, 1887; Klie, 1929). Both Skogsberg (1920) and Elofson (1941) consider this species to be best accustomed to the permanent sub-zero and near freezing conditions, -2-8°C of the eastern Arctic. Within which region, it is widely distributed in the Barents Sea and is especially abundant along the coasts of Finmark (Brady and Norman, 1895) and the Kola Peninsula (Derjugin, 1916).

Derjugin (1916), in accordance with Sars (1890, 1928), Norman (1891, 1902) and Brady and Norman (1895) recorded material commonly from many localities west of Norway, associated with mud between 28-180 m. Live material is recorded throughout Iceland, in abundance from 10-80 m, mostly in 40 m and dredged down to 200 m (Stephensen, 1938). The previous author also records it from the Faeroes (1929) and, with Ostenfeld (1906), from the northern North Sea.

Sars (1866 , 1928) and Brady and Norman (1889) record P. brenda in 38-180 m of Oslo Fiord, S. Norway, but this species is best documented from open waters of the E. Skagerrak and Kattegat and fiords of W. Sweden. Wherein Lilljeborg (1853), Skogsberg (1920) and Elofson (1941, 1943) found it ubiquitous on muds, silts and primarily sand and gravel between 10-100 m. Elofson (1941, 1943) also found live specimens down to 420 m in the central Skagerrak. He indicated that P. brenda is a fully marine species that will tolerate 20-35‰ salinity and

4-18°C in summer months. Live material also ranges commonly on muds to the Oresund (Elofson, 1941; Hagerman, 1965), though records of it in the W. Baltic refer to other closely related species.

The range extends in reduced numbers to Britain and adjacent waters, from the Shetlands, 180 m (Brady, 1868, 1902; Brady and Robertson, 1872, 1876) to Dogger, North Sea (Brady and Robertson, 1872; Brady and Norman, 1889; Norman and Brady, 1909). In addition, moderate numbers of *P. brenda* have been recovered in isolated areas, 28-95 m, off N.E. England (Norman, 1862, 1865; Brady and Robertson, 1872, 1874, 1876; Brady, 1903; Norman and Brady, 1909), though there is no indication given whether the material was found alive.

Otherwise, this species is reported in the Hebrides, W. Scotland (Brady, 1866), off S. Devon (Brady, 1868) and probably in error from 90 m in S. Biscay (Fischer, 1855, 1876).

Summary

Live material has been found in the Beaufort Sea, N. Alaska and in the Queen Elizabeth Islands, N.W. Greenland, eastward of 160°W. *P. brenda* occurs in live abundance throughout E. and W. Greenland and inhabits coastal waters of Newfoundland, Nova Scotia and certain areas off Maine, 78-44°N.

Abundant live specimens have also been found off Jan Mayen Island, 71°N, throughout the N. Barents Sea, northward to 80°N and perhaps range to 70/80°E in the Kara Sea. This species is most abundant and alive off N. Finmark and Kola Peninsula, 68-70°N and very common off W. Norway, Iceland and Faeroes, southward to 60°N. The live distribution extends throughout the Skagerrak and to parts of the Oresund, N.E. Britain and Dogger, 54°N. Lastly, there are isolated reports of _P. brenda_ alive off N.W. Scotland and from S. Devon, 50°N, though that in S. Biscay, 44°N is most probably distinct.

In the N.W. Arctic and western N. Atlantic the abundance of live material is found in 1-40 m, commonly ranges down to 200 m approx. and is seldom recovered from 500 m. Although commonly alive within 200 m, _P. brenda_ occurs mostly between 10-80 m in the N.E. Arctic, Barents Sea and west of Norway. In addition, _P. brenda_ is associated with _Laminaria_ in the littoral, muds beneath and ranges mostly on the hard ground sands with gravel. Finally, live material ranges within -2-18°C, rarely above 8°C in full marine salinity. It will also tolerate 20-35‰ salinity in the Kattegat and Oresund.