Echinoderms of the Rockall Trough and adjacent areas 3. Additional records

R. Harvey & J. D. Gage
Dunstaffnage Marine Research Laboratory, Scottish Marine Biological Association, P.O. Box 3, Oban, Argyll PA34 4AD

D. S. M. Billett
Institute of Oceanographic Sciences, Brook Road, Wormley, Godalming, Surrey GU8 5UB

Ailsa M. Clark & G. L. J. Paterson
Department of Zoology, British Museum (Natural History), Cromwell Road, London SW7 5BD

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Introduction

This paper is the third part of a study primarily on the distribution of the echinoderm fauna of the Rockall Trough. Part 1 dealt with the crinoids, asteroids and ophiuroids, while Part 2 covered the echinoids and holothurians (Gage *et al.* 1983, 1985*a*). Taxonomic descriptions and discussion of new or problematic species in these collections are given separately in papers cited in the text.

The present paper results from sampling undertaken from RRS *Challenger* by the Scottish Marine Biological Association (SMBA) since the publication of Parts 1 and 2. This has resulted in the recovery of four additional species of crinoids, ten asteroids, seven ophiuroids, one echinoid and eight holothurians. Of these, one asteroid, the goniasterid *Mediaster bairdi*, is a new record for the NE. Atlantic while another, a pterasterid, appears to be undescribed. Seven of the species mentioned in Parts 1 and 2 (one crinoid, one ophiuroid, one asteroid, one echinoid and three holothurians) are identified or re-identified as a result of further research. Additional records of species included in Parts 1 and 2 are given, together with a summary of the zoogeographic and bathymetric distribution with details of any range extension within the Trough provided by the new records. These data have mainly resulted from a greater intensity of sampling effort in the depth range 500–2000 m than in the period 1973 to 1982 covered by the previous papers. The majority of new records are from the Feni Ridge and Hebridean Slope, the latter having been obtained largely from fishing cruises by Dr J. D. M. Gordon of SMBA using a semi-balloon otter trawl (Gordon, 1986).

In addition to records from new stations, an updated total is given for the number of specimens recovered from old stations where sorting of additional subsamples have provided more material. The depth range at the end of the list of stations for each species is the new range within the Rockall Trough area as indicated by our samples.

The format of Part 3 broadly follows that of the two previous papers. Details of the gears employed in the sampling programme may be found in Part 1, while lists of sampling stations worked are distributed among all three parts.

List of Species

Only species additional to those included in Parts 1 and 2 are listed below. An asterisk denotes species included in Parts 1 and 2 under another name.

Class Crinoidea
  Order Millericrinida
    Family Bathycrinidae
      Bathycrinus gracilis Wyville Thomson
      **Democrinus parfaiti* Perrier

Order Comatulida
Family Antedonidae
Trichometra cubensis (Pourtales)
Poliometra prolixa (Sladen)
Family Atelecrinidae
Atelecrinus balanoides (P. H. Carpenter)

Class Asteroidea
Order Paxillosida
Family Astropectinidae
**Persephonaster patagiatus* (Sladen)
Order Notomyotida
Family Benthopectinidae
Cheiraster sepitus (Verrill)
Order Valvatida
Family Asterinidae
Anseropoda placenta (Pennant)
Family Goniasteridae
Ceramaster granularis (Retzius)
Mediaster bairdi (Verrill)
Family Poraniidae
Chondraster grandis (Verrill)
Poraniomorpha hispida rosea Danielssen & Koren
Order Spinulosida
Family Pterasteridae
Pteraster (Apterodon) sp.
Diplopteraster multipes (M. Sars)
Hymenaster regalis Verrill
Order Brisingida
Family Brisingidae
Novodinia pandina Sladen
Order Forcipulatida
Family Asteriidae
Neomorphaster talismani E. Perrier

Class Ophiuroidea
Order Phrynophiurida
Family Ophiomyxidae
Ophiomyxa serpentaria Lyman
Ophioscolex glacialis Müller & Troschel
Ophiophrixus spinosus (Storm)
Order Myophiurida
Family Ophiacanthidae
Subfamily Ophiacanthinae
Ophiolebes bacata Koehler
Subfamily Ophiotominae
Ophiotoma coriacea Lyman
Subfamily Ophioplinthacinae
Ophiomitrella clavigera (Ljungman)
Family Amphiuridae
Amphiura tritonis Hoyle
Family Ophiuridae
Subfamily Ophiurinae
**Ophiura scomba* Paterson

Class Echinoidea
Order Spatangoida
Family Spatangidae
**Brissopsis ?lyrifera* (Forbes)
Brisaster fragilis (Düben & Koren)

Class Holothurioidea
Order Dendrochirotida
Family Paracucumidae
Paracucumaria hyndmani (Thompson)
Family Sclerodactylidae
Pseudothyone raphanus (Düben & Koren)
Family Cucumariidae
Thyone fusus (O. F. Müller)
Order Aspidochirotida
Family Synallactidae
Mesothuria intestinalis (Ascanius & Rathke)
Mesothuria verrilli (Théel)
Order Elasipodida
Family Elpidiidae
Ellipinion delagei (Hérouard)
Order Apodida
Family Synaptidae
Leptosynapta decaria (Östergren)
Family Myriotrochidae
**Myriotrochus clarki* Gage & Billett
**Prototrochus zenkevitchi rockallensis* Gage & Billett
**Parvotrochus belyaevi* Gage & Billett
Order Molpadiida
Family Caudinidae
Hedingia albicans (Théel)

Systematic Account

A chart showing the localities of all records covered by the three papers is given in Fig. 1. Classification of the Ophiuroidea follows Fell (1982). Treatment of the other four classes follows Parts 1 & 2 with the following exceptions: Asteriidae Blake (1987), Brisingidae Downey (1986), and Dendrochirotida Panning (1949) as amended by Pawson & Fell (1965). References to works describing species have only been given for those species which are listed here for the first time or where a new work has appeared since the publication of Parts 1 & 2, as in the case of the monograph of the deep North Atlantic Ophiuroidea (Paterson, 1985).

Taxonomic responsibility is shared as follows: Crinoids, A.M.C.; Asteroids, A.M.C. & R.H.; Ophiuroids, G.L.J.P.; Echinoids, J.D.G.; Holothurians, D.S.M.B. & J.D.G.

Class **CRINOIDEA**
Order **MILLERICRINIDA**
Family **BATHYCRINIDAE**

Bathycrinus gracilis Wyville Thomson, 1872

See: A. M. Clark, 1977: 164–167, fig. 1; A. M. Clark, 1980: 206–207, fig. 5.

Sample. ES 27 (1). [*c*. 2900 m]

Distribution. Previously known from the West European and Iberian Basins in 4430–5275 m; the northernmost and also the least deep record was from the Porcupine Abyssal Plain, *c*. 50°N, 15°55′W (A. M. Clark, 1977). There is also an unpublished intermediate record in the collections of the Institute of Oceanographic Sciences (IOS), Wormley, from the Porcupine Seabight (Sta. 51109 #2) in *c*. 3985 m depth. The new record, from the southern Rockall Trough, is somewhat shallower and farther north.

Remarks. The specimen consists of a crown including proximal parts of some arms to the sixth brachial. The total height is *c*. 6 mm. The appearance is similar to that of the specimen shown in Fig. 5 in A. M. Clark (1980), except that the knob-like fused basals and short uppermost columnals

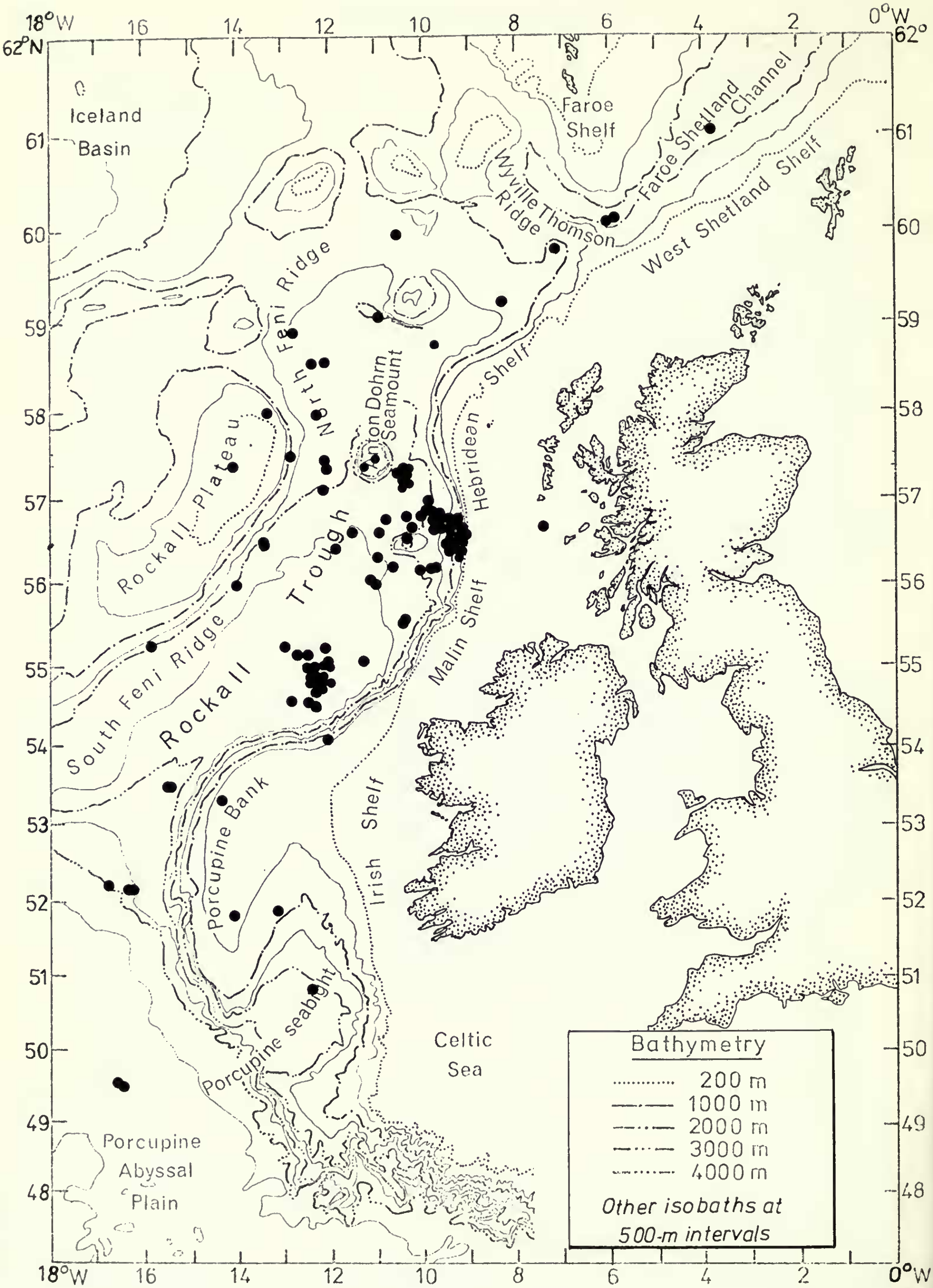

Fig. 1 Bathymetric chart of the area sampled showing location of all stations yielding echinoderms.

are missing. The division series have sharp lateral flanges and a median keel, unlike the medially rounded ossicles of *B. carpenteri* (Danielssen & Koren), known from the deep basin of the Norwegian Sea in 1360–2815 m.

In addition the collections include a very young specimen of *Bathycrinus* from SBC 211 on the Hebridean Slope in the anomalous depth of 402 m. This is at the same stage of development as the small *B. gracilis* figured by A. M. Clark (1977, fig. 1e) from the Porcupine Abyssal Plain, with rudimentary arms and an inverted conical calyx with all the sutures distinct and the basal ring 'integrated' with the radial ring, so that the suture between the two rings forms a zigzag. In larger specimens of *Bathycrinus* the articulation becomes almost a straight line. Only two division series remain attached to the calyx and these are too poorly developed to exhibit the specific characters. It is just possible that the specimen may be a juvenile *Bathycrinus carpenteri* that has been carried over the Wyville Thomson Ridge.

Democrinus parfaiti Perrier, 1883

See: Roux, 1977: 39–40, figs 4, 9, 10, 11, 16, pl. 2, figs 6–8, pl. 5, figs 1–6; A. M. Clark, 1977: 172–177, fig. 3a. Also Gage *et al.*, 1983: 270 (as *Rhizocrinus lofotensis*).

SAMPLES. SBC 66 (? frag.), SBC 67(2), SBC 216(1), AT 230(15), SBC 280 (1) [also ES 18(3), ES 20(8) in Part 1 as *Rhizocrinus lofotensis*]. [*c*. 1000–2200 m]

DISTRIBUTION. The most northerly record hitherto is from SW. Ireland at *c*. 50°N. The discovery of these specimens since the completion of Part 1 suggests that the species represented in the Rockall Trough is not *Rhizocrinus lofotensis*, as thought by A.M.C. in 1983, but *Democrinus parfaiti*. The depths of more than 1000 m are also indicative of this species which ranges from 870–2500 m (and possibly 2959 m) off Western Europe and NW. Africa to the Azores. The specimen from Sta. 10 of the *Ingolf*, off SW. Iceland, that was figured by A.M.C. (1970, fig. 4e) as *Rhizocrinus lofotensis*, is likely to be referable to *Democrinus parfaiti* on the basis of the Rockall Trough records, thus extending the range even further. Records from *Knight Errant, Lightning* and *Porcupine* are also likely to be *D. parfaiti*. However the fragment described by Doderlein (1912) from the Wyville Thomson Ridge in 547 m under the name of *R. rawsoni* may well have been *R. lofotensis*, the latter species occupying relatively shallow depths of 140–700 m in the southern part of the Norwegian Basin. It has however been recorded from down to 3475 m off Greenland. An unpublished recent IOS record of *D. parfaiti* in the Porcupine Seabight (Sta. 10111 ♯8) in *c*. 1630 m helps to confirm the *Helga* record of A. H. Clark (1913), that specimen now being in a badly decalcified condition. The distinction between *D. parfaiti* and *Rhinzocrinus lofotensis* is discussed in Clark (1970: 21).

REMARKS.The calyx of the largest of the present specimens, from SBC 67, is only 2.5 mm high, the same size as the smallest one given in the table of measurements of *D. parfaiti* in A. M. Clark (1977). Study of the material indicates that the supposition made in 1977 that the calyx is consistently narrow, even in young specimens of this species, was incorrect. Judging from the smaller specimens from the Rockall Trough, the initial shape is inverted conical as in the other species of the genus for which ontogenic series have been observed.

Order **COMATULIDA**
Family **ANTEDONIDAE**

Trichometra cubensis (Pourtales, 1869)

See: A.M. Clark, 1970: 46–48; 1980: 195–197.

SAMPLES. AT 219(1), AT248(41), AT249(1), ES 250(3). [1150–1991 m]

DISTRIBUTION. North Atlantic from the Gulf of Mexico to the Davis Strait and from Morocco to Portugal and NW. Spain; 210–2380 m (?2432 m). Also recorded from SW. of Iceland in 311 m. The present records from W. of the Anton Dohrn Seamount and from the North Feni Ridge represent an extension of range in the deeper NE. Atlantic. It is possible that the smaller specimens recorded from *Helga* stations in the Bay of Biscay and W. of Ireland under the name *T. delicata* A. H. Clark, 1911, will also prove to be conspecific with *T. cubensis*.

REMARKS. The colour in life (AT 248) was brownish except for the very flared arm joints which were white.

Poliometra prolixa (Sladen, 1881)

See: A. M. Clark, 1970: 42–45, figs 15, 16.

SAMPLES. ES 87(1), AT 226(11). [*c.* 1050–1118 m]

DISTRIBUTION. Known only from the Arctic and Norwegian Sea, from Greenland to the seas off western Siberia. The present records from the Faeroe Bank Channel and Faeroe-Shetland Channel represent the southernmost limit of the range. The bathymetric range is 20–1960 m, but all of the more southern records exceed 500 m.

Family **ATELECRINIDAE**

Atelecrinus balanoides P. H. Carpenter, 1881

See: A. H. Clark, 1913: 45 (as *A. helgae*; A. M. Clark, 1970: 49–51, fig. 19 (as *A. balanoides*).

SAMPLES. AT 223(1), AT 230(2), AT 248(3), AT 249(1), ES 250(1). 13/83/6 OTSB(1), 3/85/20 OTSB(2). [980–1005 m to 1270 m]

DISTRIBUTION. Known in the western tropical Atlantic from Florida to NW. Brazil, and in the NE. Atlantic from the southern Rockall Trough (*Helga*) *c.* 54°N, 12°30′W and south west of the Faeroes (*Thor*). The present records are intermediate in position between these last two. The recorded bathymetric range is 532–1256 m.

REMARKS. The very long straight delicate and easily lost cirri of this species contrast with the relatively short, curly ones of *Trichometra cubensis* which was often collected in the same haul, both in the Rockall Trough and in the western tropical Atlantic where both species extend. They are also distinguished by their habitats, *T. cubensis* being epizoic on other organisms such as the gorgonian *Acanella,* while *A. balanoides* is self-supporting on muddy substrates with its widely spread cirri. The colour in life (AT 249) was a yellowish-buff.

Class **ASTEROIDEA**
Order **PAXILLOSIDA**
Family **LUIDIIDAE**

Luidia ciliaris (Philippi, 1837)

SAMPLES. AT 291(2), AT 292(4). 13/83/3 GT(11), 13/83/4 GT(7), 13/83/7 OTSB(6), 13/83/8 OTSB(23), 3/85/14 OTSB(10), 3/85/38 OTSB(1), 3/85/43 OTSB(9), 3/85/44 OTSB(1). [220–270 m to 650–805 m]

DISTRIBUTION. The new shallower records from the Hebridean Slope are more typical of the distribution of this common bathyal species than the single record from 650–805 m given in Part 1.

Family **ASTROPECTINIDAE**

Astropecten irregularis (Pennant, 1777)

SAMPLES. RD 258(1), 13/83/7 OTSB(5). [135 m to 650–805 m]

DISTRIBUTION. The new shallow records from Rockall Bank and the Hebridean Slope are not unexpected given the sublittoral and bathyal distribution of this species.

Bathybiaster vexillifer (Thomson, 1873)

SAMPLES. ES 34(?[juveniles] 4), ES 197(2), ES 200(3,?[juvenile] 1, AT 201(17), AT 218(1), AT 219(15), AT 228(1), ES 232(2), AT 233(14), ES 244(1), AT 245(8), AT 247(juveniles 2), AT 248(1), AT 267(juveniles 2), AT 271(10), AT 273(2), AT 288(22), 13/83/5 OTSB(1), 3/85/7 OTSB(3), 3/85/17 OTSB(16). [992–2600 m]

DISTRIBUTION. The record from AT 267 provides a slight increase in the lower bathymetric range within the Rockall Trough.

Plutonaster bifrons (Thomson, 1873)

SAMPLES. ES 184(2, ?[juvenile] 1), ES 190(?[juveniles] 2), AT 201(11), ES 202(5), ES 218(1;?[juvenile] 1), AT 219(18), AT 221(1), AT 223(15), AT 228 (?[juveniles] 3), AT 229(1, juvenile 1), AT 230(103, ?[juvenile] 1), ES 232(2), AT 233(1), AT 239(5), ES 244(2), AT 245(4), AT 247(5), AT 249(4), ES 250(6), AT 251(7), ES 252(juvenile 1), AT 254(2), ES 255(juvenile 1), AT 256(23), ES 264(juveniles 6), AT 267(7), AT 271(3), AT 273(1), ES 285(?[juvenile] 1), AT 286(juvenile 1), AT 287(?[juvenile] 1), AT 288(8), ES 289(1), 13/83/1 OTSB(?[juvenile] 1), 13/83/2 OTSB(38), 13/83/5 OTSB(71), 13/83/6 OTSB(13), 13/83/7 OTSB(1), 9/84/9 OTSB(22), 9/84/10 OTSB(1), 9/84/13 OTSB(12), 3/85/9 OTSB(1), 3/85/17 OTSB(77), 3/85/18 MBA(11), 3/85/19 MBA(1), 3/85/20 OTSB(10), 3/85/25 OTSB(2), 3/85/29 OTSB(10), 3/85/30 OTSB(55). [580–630 m to 2965 m]

DISTRIBUTION. The new records from the Hebridean Slope give an upward extension of bathymetric range by *c.* 400 m.

Psilaster andromeda (Müller & Troschel, 1842)

SAMPLES. ES 23(3), AT 223(12), AT 230(juvenile 1), AT 239(8), AT 291(20), GT 2(1), GT 7(1), GT 11(5), GT 14(2), GT 15(1), GT 16(4), AT 1(3), 13/83/6 OTSB(15), 13/83/7 OTSB(16), 9/84/1 OTSB(2), 9/84/13 OTSB(4), 3/85/9 OTSB(8), 3/85/10 OTSB(2), 3/85/13 OTSB(111), 3/85/14 OTSB(5), 3/85/18 MBA(27), 3/85/19 MBA(2), 3/85/25 OTSB(2), 3/85/28 OTSB(1). [640–780 m to 990–1075 m]

DISTRIBUTION. Further studies on this and the related *Persephonaster patagiatus* (formerly *Psilaster*) (see remarks below and under that species) have shown that in the Rockall Trough on the Hebridean Slope *Psilaster andromeda* has a more restricted distribution than hitherto recorded, being common in the 700–1000 m zone.

REMARKS. Following additional studies of the Astropectinidae by A.M.C., the distinction of *Psilaster andromeda* and *Persephonaster patagiatus* by the relative breadth of the superomarginal plates in dorsal view as shown by Mortensen (1927) was found to be fallacious. This character is variable in both species. A better distinction is the more convex contours of individual marginals in dorsal view in *Persephonaster patagiatus* compared with the flat surface but sharply-cut intermarginal fascioles visible in *Psilaster andromeda*, when specimens are denuded with bleach. In section, the marginals of *Psilaster andromeda* tend to form continuously rounded arcs. In *Persephonaster patagiatus* however, the superomarginals in particular are more abruptly bent, making the sides of the arms flatter. Other differences are the more attenuated arms of *P. patagiatus* with somewhat longer and fewer marginal plates, usually 25–30 at R 60–90 mm as opposed to 35+ in *P. andromeda* at this size. The armament of the marginals is also different, the inferomarginal spines being more needle-like in *P. patagiatus*, and the armament at the apex of the jaw projecting horizontally below the mouth is very different. In *Persephonaster patagiatus* there is a pair of inset fascicles of blunt spines partly concealed above the apical spines, which are rounded in section, whereas in *P. andromeda* there is only a line of 3 or 4, very flat spade-like apical spines. Indeed this last character coupled with the absence of well-defined intermarginal fascioles in *P. patagiatus* justifies generic isolation of the species in the genus *Persephonaster*, which has previously been confused to some extent with *Psilaster* but can now be distinguished by these characters. The nomenclature is therefore restored to the combinations used by Mortensen (1927).

Use of the above characters has resulted in the re-identification of some of the samples recorded in Part 1.

Persephonaster patagiatus (Sladen, 1889)

SAMPLES. ES 15(2), ES 18(3), AT 68A(1), AT 107A(5), AT 186(3), AT 192(30,?[juveniles] 5), AT 221(4,?[juvenile] 1), AT 229(63), AT 254(1), AT 256(37), AT 287(27,?[juvenile] 1), SWT 18(8), SWT 27(4?), 13/83/1 OTSB(274), 13/83/2 OTSB(10), 13/83/5 OTSB(15), 9/84/9 OTSB(3), 3/85/20 OTSB(?[juvenile] 1), 3/85/29 OTSB(13), 3/85/30 OTSB(66). [1265–1130 m to 1809 m (?2965 m)]

DISTRIBUTION. This species is widely distributed in the N. Atlantic (but see notes in Part 1. for possible complications). On the Hebridean Slope it occurs slightly deeper than *Psilaster andromeda*.

Curiously there are no samples in which both species occurred. Following the reassignment of this species to the genus *Persephonaster*, as explained above, further clarification of the depth limits of the two species was sought by recourse to the collections from the Porcupine Seabight held at IOS, Wormley. These were found to include 21 samples of *Psilaster andromeda* identified by D.S.M.B. with positive depths ranging from 700 to 1490 m, compared with 11 samples of *Persephonaster patagiatus* from 1360–2000 m. The deepest sample of *P. andromeda* also included seven specimens of *P. patagiatus*. The SMBA record from SWT 27 (a fishing station) in 2965 m therefore seems doubtful, and may be a contaminant from an earlier haul.

Family **PORCELLANASTERIDAE**

Porcellanaster ceruleus Wyville Thomson, 1877

Samples. ES 4(5, juveniles 2), ES 10(101, juveniles 7), ES 27(99), ES 57(1, juveniles 7), ES 111(75), ES 118(43), ES 129(75), ES 152(61 juvenile 1), SBC 174(juveniles 2), ES 184(5), ES 185(330), ES 190(165), ES 197(2, juveniles 3), ES 204(90), ES 207(344), ES 218(3), ES 231(201), ES 266(7), AT 267(37), AT 282(4), ES 283(317), AT 284(6), ES 285(21), AT 286(3). [1993 m to 3425–3500 m]

Distribution. No change.

Order **NOTOMYOTIDA**
Family **BENTHOPECTINIDAE**

Benthopecten simplex Perrier, 1881

Samples. ES 105(?[juvenile] 1), ES 184(17, ?[juvenile] 1), ES 197(37), ES 200(11, ?[juveniles] 8), AT 201(61), ES 202(3,?[juveniles] 8), AT 218(44), AT 219(103), AT 228(132), ES 232(12), AT 233(95), ES 244(12), AT 245(70), AT 247(4), ES 255(juvenile 1), AT 256(41), ES 257(1), ES 264(9), AT 271(82), AT 273(60), AT 288(102), ES 289(32), 13/83/5 OTSB(75), 13/83/6 OTSB(4), 9/84/9 OTSB(3), 3/85/7 OTSB(2), 3/85/17 OTSB(239), 3/85/29 OTSB(13). [1595 m to 3425–3500 m]

Distribution. The new records raise the upper bathymetric limit in the Rockall Trough from 1785–1845 m to 1595 m.

Pectinaster filholi Perrier, 1885

Samples. ES 34(8), ES 197(juveniles 20), AT 201(1), AT 219(4), AT 233(3), AT 267(3), AT 288(4), 3/85/7 OTSB(34). [1752–2909 m]

Distribution. No change.

Cheiraster sepitus (Verrill, 1885)

See: Sladen, 1889: 52–55, pl. 8, figs 5 & 6, pl. 12, figs 5 & 6 (as *Pontaster venustus*); A. M. Clark, 1981: 117–118, figs 4i–r & 5c.

Samples. AT 229(7), AT287(9), 13/83/1 OTSB(45), 3/85/29 OTSB(4), 3/85/30 OTSB(23), 3/85/45 OTSB(2). [1383 m to 1690–1740 m]

Distribution. Nova Scotia south to the Caribbean, Azores and Bay of Biscay south to Cape Verde; 485–3703 m, but mainly 1000–2000 m. The present records from the Hebridean Slope extend the known distribution in the NE. Atlantic to *c.* 56° 30′N. confirming the prediction of Mortensen (1927) that *Pontaster venustus* Sladen, a synonym of *Cheiraster sepitus* according to A. M. Clark (1981), would probably be found in British waters.

Remarks. The 45 specimens measured from Sta. 13/83/1 OTSB range from R 45 mm to R 22 mm, R/r 4.8/1 to 3.0/1 (mean 3.7/1). Arm length varied within individuals and several specimens had regenerating arm tips. There was little tendency for the arm tips to curl dorsally in preserved specimens unlike those of *Pontaster tenuispinus*. The specimens are of a robust appearance due to the encroachment of the superomarginal plates on to the abactinal surface of the arms, and the tumidity of the inferomarginals. Sladen (1889) states that no pedicellariae of any kind are to be found in *Cheiraster*, whereas A. M. Clark (1981) found some to be present but only rarely. At least 8 of the Rockall specimens have small pectinate pedicellariae on the actinal interradii formed by the opposition of short spines on the plates. Their occurrence varies between interradii but where present they are distinctive.

Pontaster tenuispinus (Düben & Koren, 1846)

SAMPLES. AT 226(1), AT 239(2), AT 271(2), AT 273(2), AT 291(22), 13/83/2 OTSB(1), 13/83/7 OTSB(159), 13/83/8 OTSB(6), 9/84/1 OTSB(9), 9/84/2 OTSB(1), 9/84/10 OTSB(1), 3/85/10 OTSB(174), 3/85/11 OTSB(2), 3/85/14 OTSB(1), 3/85/43 OTSB(1), 3/85/44 OTSB(2). [500–560 m to 2255 m]

DISTRIBUTION. The record from AT 271 extends the lower bathymetric limit to 2255 m.

Order **VALVATIDA**
Family **ODONTASTERIDAE**

Hoplaster spinosus Perrier, 1882

SAMPLES. ES 266(1), AT 267(1). [2300–2910 m]

DISTRIBUTION. The new records from the Feni Ridge are intermediate in depth between those of the two specimens recorded in Part 1. R was 12 mm in the specimen from ES 266.

Family **RADIASTERIDAE**

Radiaster tizardi (Sladen, 1882)

SAMPLES. AT 223(22), 13/83/2 OTSB(2), 3/85/20 OTSB(1). [1075 m to 1130–1265 m]

DISTRIBUTION. The new records confirm the occurrence of this species in the Rockall Trough, the record in Part 1 being from a single juvenile. They are all within the previously known bathymetric range.

REMARKS. The specimens from AT 223 and 3/85/20 OTSB have R 60–110 mm.

Family **ASTERINIDAE**

Anseropoda placenta (Pennant, 1777)

See: Mortensen, 1927: 99–101, fig. 57.

SAMPLES. 13/83/3 GT(14), 13/83/4 GT(4), 13/83/8 OTSB(4). [220–270 m to 500–560 m]

DISTRIBUTION. Known from the Shetlands to the Mediterranean around both the west and east coasts of Britain in 10–200 m, but previously down to 600 m only in the eastern Mediterranean. The present records from the Hebridean Shelf and Slope provide an extension of bathymetric range in northern waters.

REMARKS. This species is thought to prefer sandy ground, which may explain its failure to penetrate far beyond the shelf edge.

Family **GONIASTERIDAE**

Ceramaster granularis (Retzius, 1783)

See: Mortensen, 1927: 81–82, fig. 44.

SAMPLES. AT 229(1), AT 248(1), AT 259(1), AT 273(1), AT 287(1). [1150–2185 m]

DISTRIBUTION. Widely distributed on both sides of the North Atlantic. Previously recorded from British waters from the Faeroe Channel, Lousy Bank, and on the Irish slope; 20–1400 m. The present records from the Feni Ridge and Hebridean Slope extend the lower bathymetric limit by nearly 800 m. Some of the specimens appear to intergrade morphologically with the more southern species *C. grenadensis* (recorded as *C. balteatus* by Mortensen, 1927).

Pseudarchaster parelii (Düben & Koren, 1846)

SAMPLES. AT 201(1), ES 202(juvenile 1), AT 223(1), AT 229(1), AT 230(2), AT 248(3), AT 251(juvenile 1;?3), AT 259(1), AT 267(?4), AT 287(?4), AT 288(4), AT 291(1), 13/83/8 OTSB(3), 3/85/10 OTSB(?1), 3/85/14 OTSB(7), 3/85/20 OTSB(2), 3/85/29 OTSB(1), 3/85/30 OTSB(4), 3/85/43 OTSB(2), 3/85/44 OTSB(2). [225–2965 m]

DISTRIBUTION. No change.

REMARKS. The distinction between *P. parelii* and *P. gracilis* is not clear in the Rockall samples. Halpern (1972) has separated the species on the basis of the armament of the actinal and inferomarginal plates, those of *P. gracilis* bearing cylindrical spines 3 to 5 times longer than wide, while in *P. parelii* the spines, if any, are short and flattened. Some of the specimens identified as *P. parelii* from the Rockall area have a few longer cylindrical spines. Mortensen (1927) states that *P. parelii* grows to nearly 200 mm R, and Farran (1913) recovered specimens from the west of Ireland reaching R 192 mm, the majority of the Irish specimens measured being >80 mm R. None of the Rockall specimens with R > 60 mm appear to be *P. parelii*, having very thorny actinal plates and a conspicuous pectinate pedicellaria-like arrangement of subambulacral spines said to be characteristic of *P. gracilis* (Halpern, 1972). It is possible therefore that the '*P. parelii*' specimens from the Rockall area are merely the young of '*P. gracilis*'. Until more work can be done on the distinction of these two nominal species, the Rockall records of *P. parelii* refer to the small specimens with few spines on the actinal plates and less obvious 'pectinate pedicellariae'.

Pseudarchaster gracilis (Sladen, 1889)

SAMPLES. AT 219(1), AT 223(3), AT 229(2), AT 233(1,?[juvenile] 1), AT 254(?1), AT 287(1, ?1), AT 288(2), ES 289(1), 13/83/1 OTSB(6), 13/83/2 OTSB(1), 13/83/5 OTSB(21), 13/83/6 OTSB(5), 13/83/7 OTSB(7), 13/83/8 OTSB(1), 9/84/9 OTSB(1), 9/84/13 OTSB(1), 3/85/7 OTSB(5), 3/85/8 OTSB(1), 3/85/17 OTSB(14), 3/85/29 OTSB(1), 3/85/30 OTSB(2), 3/85/36 OTSB(1). [?500–560 m to 2190 m]

DISTRIBUTION. The new records extend the known distribution northwards to just south of the Wyville Thomson Ridge and the North Feni Ridge *c.* 59° 40′N (but see remarks under *P. parelii* and below).

REMARKS. The above records relate to the larger specimens of *Pseudarchaster* with more thorny actinal plates and prominent 'pectinate pedicellariae' along the subambulacrals. The colour in life was a bright brick red. The largest specimen measured R 165 mm.

Paragonaster subtilis (Perrier, 1881)

SAMPLES. ES 204(2), AT 267(18), AT 282(1), ES 283(1), AT 284(3), ES 285(juvenile 1), AT 286(18), 51301 OTSB(6), 3/85/5 OTSB(4), 3/85/7 OTSB(2). [1785–1845 m to 2970–2980 m]

DISTRIBUTION. The new records slightly extend the maximum recorded depth for this species in the Rockall Trough.

Plinthaster dentatus (Perrier, 1884)

SAMPLES. ES 129(?[juvenile] 1), AT 223(1), AT 287(17), 13/83/1 OTSB(37), 13/83/5 OTSB(1), 3/85/17 OTSB(8), 3/85/29 OTSB(1), 3/85/30 OTSB(30), 3/85/37 OTSB(1), 3/85/45 OTSB(4). [945–985 m to 2910 m]

DISTRIBUTION. The new records raised the upper bathymetric limit on the Hebridean Slope by almost 400 m.

Mediaster bairdi (Verrill, 1882)

See: Gray, Downey & Cerame-Vivas, 1968: 150–151, fig. 24.

SAMPLES. AT 229(14), ES 252(5), AT 287(49), 13/83/1 OTSB(22), 3/85/30 OTSB(72), 3/85/45 OTSB(2). [1383–1587 m]

DISTRIBUTION. Previously known only in the W. Atlantic from Newfoundland to New Jersey, in the lesser Antilles and off Guyana; 642–1446 m. The Rockall records from the Hebridean Slope and North Feni Ridge are the first from the NE. Atlantic. Downey (pers. comm.) has found very little difference between N. American *M. bairdi* and *M. capensis* from S. Africa, and believes that any taxonomic distinction between them is infraspecific.

REMARKS. The specimens from AT 287 ranged from R 53 mm to R 21 mm, R/r = 2.4–3.1/1. Gray *et al.* (1968) state that the specimen in their figure 24 has R/r 3.3/1, but measurements from this figure suggest a ratio nearer 2.5/1. The specimens from AT 287 were a pale orange-ochre when collected fading to off-white in spirit.

Family **PORANIIDAE**

Porania pulvillus (O. F. Müller, 1766)

SAMPLES. ES 113(1, juveniles 2), AT 292(8), 13/83/3 GT(69), 13/83/4 GT(43), 13/83/8 OTSB(52), 3/85/38 OTSB(4), 3/85/43 OTSB(3). [148 m to 565–700 m]

DISTRIBUTION. The new records are all from the Hebridean Slope and suggest that this species is more common below 300 m than was thought previously, four of the above samples having come from >400 m.

Poraniomorpha hispida rosea Danielssen & Koren, 1881

See: Mortensen, 1927: 92–93, fig. 53; A. M. Clark, 1984: 34, fig. 11 B, C.

SAMPLES. ES 112(?[juvenile] 1), AT 230(1), AT 287(1). [1210–1383(?1900)m]

DISTRIBUTION. This subspecies was previously recorded from just south of the Wyville Thomson Ridge under the name *Lasiaster villosus* Sladen, 1889 (*Porcupine* Sta. 47A, 990 m). The synonymy of *Poraniomorpha hispida* and *P. rosea* is complicated but *rosea* has usually been treated as a stellate variety of the more nearly pentagonal *P. hispida*. However, in 1984 A.M.C. distinguished it subspecifically on account of the isolation of *rosea* for much of its range, both geographically and bathymetrically. Whereas *P. hispida hispida* is found all round the coast of Norway extending north to the southern Barents Sea, with positive depths of 100–350 m, *P. hispida rosea* seems to be essentially an upper bathyal taxon extending south from the Norwegian Basin along the Norwegian Trench to the Skaggerak in the east and down the Rockall Trough to the Bay of Biscay further west in 290 m to *c.* 1400 m. If the small specimen (R only 3·2 mm) from ES 112 is a young *P. hispida rosea*, as its already stellate form suggests, than the depth range extends further to 1900 m.

Chondraster grandis (Verrill, 1878)

See: A. M. Clark, 1984: 27, figs 4A, B, 5A, 6, 7d.

SAMPLES. AT 229 (1), AT 247(2), 3/85/9 OTSB(1). [945–1010 m to 2084 m]

DISTRIBUTION. This species was recorded from the NE. Atlantic for the first time by A. M. Clark (1984) on the basis not only of the two deeper SMBA samples but also of six others ranging from the Lousy Bank south to the southern Bay of Biscay (BIOGAS), including *Helga* and more recent IOS material from the Porcupine Seabight. The small holotype of *Marginaster fimbriatus* Sladen, 1889 from *Porcupine* Sta. 31 (*c.* 56°N 11′W) in 2487 m is almost certainly conspecific with *C. grandis*, though this depth exceeds by *c.* 300 m the positive maximum from AT 247. The type locality of *C. grandis* is in the vicinity of Cape Cod in *c.* 400 m but other records from N. America extend down to 1640 m, while E. Atlantic records range from 840 to 2070 (?2487)m.

REMARKS. The colour in life of the specimens from AT 247 was light red midradially on the dorsal surface paling laterally to cream below. The specimen collected from 3/85/9 OTSB retained vermilion red colour in formalin on the upper side and around the ventral margin, the rest of the lower side being off-white. Distinct areas of white papulae were present along each arm of the latter specimen, with a central narrow naked zone and naked interradii. The madreporite was off-white in colour.

Order **SPINULOSIDA**

Family **PTERASTERIDAE**

Pteraster militaris (O. F. Müller, 1776)

SAMPLES. 13/83/6 OTSB(1), 3/85/13 OTSB(1), 3/85/28 OTSB(1). [934–1054 m to 990–1075 m]

DISTRIBUTION. The new records bring the total number of specimens recorded from the Rockall Trough to only 6, all from the Hebridean Slope at around 1000 m.

Pteraster pulvillus M. Sars, 1861

SAMPLES. AT 230(1), 13/83/3 GT(1), 3/85/14 OTSB(1). [168–1210 m]

DISTRIBUTION. The new records, all from the Hebridean Slope, supplement the two previous records to provide a more continuous bathymetric distribution.

Pteraster reductus Koehler, 1907

SAMPLE. AT 251(1). [1530–1900 m]

DISTRIBUTION. Only two other specimens of this species have been recorded from the NE. Atlantic, both from the Feni Ridge. The new record is almost 400 m shallower than the record in Part 1.

Pteraster (Apterodon) sp. aff. ***P. acicula*** (Downey, 1970)

See: Downey, 1973: 79, pl. 34 C, D (for *P. acicula*). Also Gage *et al.*, 1983: 282 (For *P.* sp. aff. *P. acicula*).

SAMPLE. 3/85/13 OTSB(2). [958–995 m]

DISTRIBUTION. The new specimens were recovered from almost the identical position and depth on the Hebridean Slope from which a specimen subsequently confirmed as *P. acicula* (M. Downey, pers. comm.) was recorded (see Part 1). These are the only records for the NE Atlantic, the type locality being in the Gulf of Mexico.

REMARKS. The specimens are plump and pentagonal, both with R 16 mm, r10 mm and in good condition with blunt arms curling dorsally at the tips. There is no webbing at all between the oral spines, an absence characteristic of the subgenus *Apterodon*. There are six spines on each oral plate, the apical spine being the largest and at least twice as long and thick as the distalmost spine. The single stout suboral spine is longer and slightly broader than the apical oral spine, glassy throughout its length and distincitively tricarinate, ending in an acute point. The grooves on the sides of these spines which give rise to their tricarinate form commence at about one third of the length from the spine base. The paxillae of the dorsal surface consist of a peripheral ring of *c.* 10 spinelets each around 0·06 mm thick with an imperforate portion immediately above the base which becomes regularly trabeculate distally without becoming broader, as in many echinoid spines. This structure continues to the spine tip. Within this ring are > 15 spinelets with more slender rod-like bases only 0·02 mm thick which become spatulate and trabeculate in their distal half and 0·14 mm in width. The tips of both types of spinelet protrude through the dorsal membrane, those of the spatulate type having trifid tips. This feature, combined with the large number of spinelets, gives the dorsal surface a dense prickly appearance with only small inter-paxillar spaces. As this description is slightly at variance with that for *P. acicula* (Downey, 1973), some doubt remains as to the specific identity of these new specimens.

Pteraster (Apterodon) sp.

See: Downey, 1973: 77, pl. 33, figs A, B (for *P. caribbaeus*).

SAMPLES. AT 247(2), ES 264(10). [2084–2144 m]

DISTRIBUTION. North Feni Ridge at the foot of Rosemary Bank and at the foot of Rockall Bank.

REMARKS. This species is distinguished from *P. acicula* by having more attenuated arms and a distinctly hispid appearance as collected due to the protrusion through the dorsal membrane of the paxillar spinelets which end in a single point. There are *c.* 18–24 spinelets on each paxilla, all of uniform thickness for most of their length. The interpaxillar spaces are relatively large and the membrane is almost transparent. The unwebbed oral spines decrease evenly in size from the apical to the most distal sixth or occasionally seventh spine. Each oral plate bears one or sometimes two suboral spines which are larger than the apical oral spine and have a hyaline tip where the outer opaque sheath has worn away. They are trabeculate for most of their length with the exception of the slightly tricarinate distal portion. This species is superficially similar to *P. caribbaeus* Perrier, 1881, but the paxillae have almost twice as many spinelets and there are other small differences between the spines on the jaw plates and the musculature of the dorsal membrane. Seven of the specimens are in good condition.

The records of this species and *P.* sp. aff. *P. acicula* suggest that there may be some separation on the basis of habitat, given the differences in depth and geographic distribution within the Trough.

Diplopteraster multipes (M. Sars, 1865)

See: Fisher, 1911: 371, pl. 107, figs 1, 2.

SAMPLES. 3/85/20 OTSB(1), 3/85/34 OTSB(1), 3/85/36 OTSB(1). [980–990 m to 1225–1245 m]

DISTRIBUTION. This species is circumarctic extending south in the NE. Atlantic along the Norwegian coast to the Skagerrak, in the NW. Atlantic to the latitude of Chesapeake Bay, and in the Pacific to California in the east and Japan in the west. These are the first records from the Rockall Trough and they also provide an extension of the previous known bathymetric range of 91–1170 m. A further sample has been taken by IOS in the Porcupine Seabight (Sta. 50602 #4) in 1080–1120 m. The specimen from 3/85/34 OTSB has six arms.

REMARKS. This is the largest pterasterid occurring in British waters, R max can reach *c.* 110 mm. In life the colour is pale mauve dotted with white dorsally continuing to the ventral interradii. The wide ambulacra are emphasised by red colouration along the subambulacral plates.

Hymenaster membranaceus Wyville Thomson, 1887

SAMPLES. ES 184(82), ES 185(?[juveniles] 5), ES 197(37, ?[juveniles] 4), AT 201(324), ES 202(12), ES 218(9), AT 219(277), ES 232(15), AT 233(324), ES 244(15), AT 245(421), AT 271(104), AT 273(? 1), AT 287(1), AT 288(367), ES 289(25), 3/85/5 OTSB(juvenile 1). [1383–2909 m]

DISTRIBUTION. The record from AT 287 on the Hebridean Slope raises the upper bathymetric limit within the Trough by some 600 m, although this is still within the known distribution of this species (1000–3000 m).

Hymenaster regalis Verrill, 1895

See: Verrill, 1895: 203–204; H. L. Clark, 1941: 64.

SAMPLE. AT 195(1) [in Part 1 as *H. ?gennaeus*], AT 288(1). [2190 m]

DISTRIBUTION. *Hymenaster regalis* is a rare species known only from the holotype taken in the NW. Atlantic off N. Carolina at 36°34′N, 73°48′W; 2521 m, and from another single specimen taken off Cuba in 1847 m.

REMARKS. The specimen from AT 195 measures 75 mm R, 40 mm r, while that from AT 288 measures *c.* 75 mm R, *c.* 55 mm r, the measurements being approximate due to the arched dorsal surface and recurved arm tips. Both of the previously known specimens were of a similar size. The dorsal surface is firm and opaque with distinct muscle fibres between the paxillae which consist of only a single stout spine raising the dorsal membrane into firm peaks. The membrane is perforated by small spiraculae numbering > 50 in the space within a ring of paxillae. In the life the specimen from AT 288 was a pale red dorsally.

These are the first records of this species from the eastern Atlantic, and also represent a considerable extension of range northwards.

Hymenaster gennaeus H. L. Clark, 1923

SAMPLE. AT 233(1). [2180–2910 m]

Family SOLASTERIDAE

Crossaster squamatus (Döderlein, 1900)

SAMPLE. AT 287(3). [1050–1383 m)

DISTRIBUTION. Previously unknown south of the Faeroe Channel, this new record extends the range south to the Hebridean Slope at *c*. 56°N.

Family ECHINASTERIDAE

Henricia Gray

Madsen is currently revising this genus (pers. comm.). The synonymy is complex and rather than confuse the literature further by publishing new records at this stage, it is felt that this should await the revision. Two species with slightly different depth distributions appear to be represented (see Gage *et al.*, 1983: 284), that from the deeper stations being conspecific with *Henricia abyssicola* sensu Mortensen, 1927 (non *Cribrella sanguinolenta* var. *abyssicola* Norman, 1869) and distinguished by more attenuated arms and abactinal spinelets with a prolonged glassy point. The shallower species has less attenuated arms and abactinal spinelets ending in three points all at the same level. This taxon is conspecific with Norman's variety *abyssicola*.

Order BRISINGIDA

Family BRISINGIDAE

Brisinga endecacnemos Asbjornsen, 1856

SAMPLES. AT 201(5), AT 219(2), AT 233(1), AT 245(1), AT 254(1), ES 264(?[juvenile] 1), 13/83/5 OTSB(24), 9/84/9 OTSB(19), 3/85/17 OTSB(43), 3/85/29 OTSB(10). [1690–1740 m to 2220 m]

DISTRIBUTION. The new records raise the upper bathymetric limit on the Hebridean Slope although this is still much deeper than the shallowest known record of 286 m from Trondheim Fjord.

REPRODUCTION. Tyler *et al.* (1984) have described the reproductive biology of this species. Up to 60 000 eggs may be produced by each individual and there was no clear evidence of any seasonality in breeding in the limited number of samples available. The oocytes reach a maximum diameter of *c*. 1250 μm suggesting a direct form of demersal development.

Brisingella coronata (G. O. Sars, 1871)

SAMPLE. ES 289(1). [992–2450 m]

REMARKS. This specimen is unusual in having only eight arms instead of the usual 9–13.

DISTRIBUTION. No change.

REPRODUCTION. This appears to follow a similar pattern to that in *Brisinga endecacnemos* (Tyler *et al.*, 1984).

Novodinia pandina (Sladen, 1889)

See: Sladen, 1889: 597–601, pl. 109, figs 1–5; Mortensen, 1927: 123–125, fig. 72 (as *Odinia pandina*); Downey, 1986: 27–29, fig. 13.

SAMPLE. 3/85/28 OTSB(1). [990–1075 m]

DISTRIBUTION. Known from the 'cold' area of the NE. Atlantic from the Faeroe Channel *c.* 790–900 m (*Lightning* and *Porcupine*), to Iceland in 225 m (Einarsson, 1948). A single specimen was recently recovered from the western Atlantic off N. Carolina (Downey, 1986). The occurrence of this rarely found species at *c.* 56°N on the Hebridean Slope represents a southerly extension of range in the eastern Atlantic into the 'warm' area. Mortensen (1927) speculated however that *O. pandina* may be synonymous with *O. semicoronata* E. Perrier, 1885 recorded from the Denmark Strait and south of the Canaries in 1000–1435 m, and also *O. robusta* E. Perrier, 1885 known from the Bay of Biscay and south of the Canaries *c.* 880–1445 m. Following the discovery that the name *Odinia* is preoccupied, all these nominal species were referred to *Novodinia* by Dartnall *et al.*, (1969). In her revision of the Atlantic brisingids, Downey (1986) synonymises *N. semicoronata* with *N. robusta*, while retaining *N. pandina* as a separate entity. She suggests that *Novodinia* is a genus of only moderately deep water *c.* 250–1500 m.

REMARKS. The specimen, in common with most brisingids recovered, is incomplete, consisting of a disc of radius 18 mm with one partly detached arm and an arm fragment. There are sixteen ambulacral furrows. The attached arm measures 60 mm from the disc edge and 23 mm in height at the point of maximum gonadal swelling. The specific characters agree with Sladen's precise description and the presence of papulae on the disc and arms in particular distinguishes this specimen from all brisingids hitherto recorded from the Rockall Trough. This specimen is a male so no information can be given on the possible mode of development.

Order **FORCIPULATIDA**

Family **ASTERIIDAE**

Stichastrella rosea (O. F. Müller, 1776)

SAMPLES. RD 258(1). [135 m]

DISTRIBUTION. Further study of the bathymetric limits of *Stichastrella* suggests that in the Rockall Trough area, *S. rosea* is confined to the shelf in depths of less than 200 m. The record from GT 14 in 713–788 m listed in Part 1 is therefore reassigned to the variety *ambigua*.

Stichastrella rosea var. ***ambigua*** (Farran, 1913)

SAMPLES. AT 259(2), AT 291(7), AT 292(21), GT 14(3) [listed as *S. rosea* in Part 1], 13/83/3 GT(44), 13/83/4 GT(45), 13/83/7 OTSB(10), 13/83/8 OTSB(165), 3/85/38 OTSB(15), 3/85/43 OTSB(21), 3/85/44 OTSB(5). [220–270 m to 1632 m]

DISTRIBUTION. No change.

Neomorphaster talismani Perrier, 1894

See: Mortensen, 1927: 134–135, fig. 76.

SAMPLES. AT 259(1), 3/85/30 OTSB(1). [1041 m to 1420–1480 m]

DISTRIBUTION. Known from SW. Ireland in 1350 m and south to Morocco mainly *c.* 400–2000 m but exceptionally found at 5413 m. The above records from the Rockall Bank and Hebridean Slope extend the known geographic range of this species to the Rockall Trough.

Family **ZOROASTERIDAE**

Zoroaster fulgens Wyville Thomson, 1873

SAMPLES. AT 198(3), AT 201(1), AT 219(1), AT 223(8), AT 229(5), AT 230(2), ES 232(3), AT 233(3), AT 239(6; ?[juvenile] 1), AT 245(1), AT 256(13), AT 257(1), AT 259(14), ES 261(1), ES 264(juvenile, 1), AT 267(3), AT 273(3), AT 287(190), AT 288(4), 13/83/1 OTSB(4), 13/83/2 OTSB(1), 13/83/5 OTSB(33), 13/83/6 OTSB(21), 9/84/9 OTSB(14), 9/84/10 OTSB(3), 9/84/13 OTSB(30), 3/85/7 OTSB(182), 3/85/8 OTSB(3), 3/85/9 OTSB(1), 3/85/17 OTSB(4), 3/85/18 MBA(10), 3/85/20 OTSB(11), 3/85/25 OTSB(43), 3/85/29 OTSB(49), 3/85/30 OTSB(101). [940–975(?580–630) m to 4810 m]

DISTRIBUTION. The records from 9/84/10 OTSB approach the minimum depth known for this species, but it is possible that these specimens were contaminants from the previous samples in 1750–1770 m. This is supported by their small size, similar to the specimen figured as *Z. fulgens* var. *ackleyi* by Farran (1913 pl. 1, fig. 3). On the Hebridean Slope it is noticeable that individuals of *Z. fulgens* from depths greater than *c.* 1500 m are nearly always of this smaller slender-armed form, whereas those from around 1000 m are larger and more robust.

Class **OPHIUROIDEA**
Order **PHRYNOPHIURIDA**
Family **ASTERONYCHIDAE**

Asteronyx loveni Müller & Troschel, 1842

See: Paterson, 1985: 13–15, fig. 9.

SAMPLE. 3/85/32 OTSB(1). [1055 m to 1995–2020 m]

DISTRIBUTION. All three specimens recovered in our samples have been from the Hebridean Slope.

Family **ASTEROSCHEMATIDAE**

Asteroschema inornatum Koehler, 1906

See: Paterson, 1985: 16, fig. 10.

SAMPLE. ES 264(1). [1900–2144 m]

DISTRIBUTION. This and the previous specimen are from the west side of the Trough and both were entwined in the branches of gorgonians.

Family **GORGONOCEPHALIDAE**

Gorgonocephalus caputmedusae (Linnaeus, 1758)

See: Paterson, 1985: 11–13, fig. 8.

SAMPLES. AT 239(1), ES 250(?[juvenile] 1), GT 2(1), 13/83/2 OTSB(1), 13/83/6 OTSB(1), 9/84/13 OTSB(1), 3/85/13 OTSB(1), 3/85/19 MBA(4), 3/85/23 OTSB(1), 3/85/24 OTSB(2), 3/85/25 OTSB(4), 3/85/26 OTSB(6), 3/85/27 OTSB(4), 3/85/28 OTSB(2), 3/85/31 OTSB(3), 3/85/33 OTSB(1), 3/85/34 OTSB(2), 3/85/36 OTSB(6), 3/85/46 OTSB(1). [940–985 m to 1130–1265(?1270)]

DISTRIBUTION. All specimens, with the exception of the queried one from the Feni Ridge are from the Hebridean Slope where this species is apparently common. The new records extend the bathymetric range in this area.

Family **OPHIOMYXIDAE**

Ophiomyxa serpentaria Lyman, 1883

See: Paterson, 1985: 18–20, fig. 11.

SAMPLE. AT 259(15). [1041 m]

DISTRIBUTION. Previously recorded in the eastern Atlantic from the Faeroe Channel and SW. Ireland to the Azores; 450–2440 m. Its occurrence on the Feni Ridge is therefore not unexpected.

Ophioscolex glacialis Müller & Troschel, 1842

See: Paterson, 1985: 20–21, fig. 11.

SAMPLES. AT 248(1), AT 249(1), AT 251(1), AT 259(2), 9/84/2 OTSB(1), 3/85/28 OTSB(1). [910–960 m to 1530 m]

DISTRIBUTION. Previously recorded from both sides of the N. Atlantic and from Arctic seas; 50–2727 m. These specimens, mainly from the N. Feni Ridge but also from the Hebridean Slope, provide a link between a specimen recovered by IOS at the extreme SW. end of the Trough and the Arctic populations.

Ophiophrixus spinosus (Storm, 1881)

See: Paterson, 1985: 21–22, fig. 12.

SAMPLES. AT 287(1), 3/85/9 OTSB(1), 3/85/10 OTSB(1), 3/85/14 OTSB(1), 3/85/28 OTSB(1), 3/85/46 OTSB(1). [720–775 m to 1383 m]

DISTRIBUTION. Known from the Denmark Strait and SE. Iceland to the Azores; 40–1310 m. These specimens are all from the Hebridean Slope and provide a slight increase in bathymetric range.

Order **MYOPHIURIDA**
Family **OPHIACANTHIDAE**
Subfamily **OPHIACANTHINAE**

Ophiacantha abyssicola G. O. Sars, 1871

See: Paterson, 1985: 47–48, fig. 20.

SAMPLES. AT 239(? 1), AT 259(2), AT 290(1), GT 1(?1), 13/83/5 OTSB(2), 13/83/13 OTSB(1), 3/85/17 OTSB(9), 3/85/28 OTSB(5). [?650–805 m to 1955–1995 m]

DISTRIBUTION. The new records from the Rockall Bank and Hebridean Slope provide a considerable extension of bathymetric range in the Trough from the maximum of *c.* 1000 m given in Part 1, although still well within the range known for this species.

Ophiacantha bidentata (Retzius, 1805)

See: Paterson, 1985: 34–36, fig. 15.

SAMPLES. ES 129(2, ?[juvenile] 1), ES 184(61), ES 185(?[juvenile] 1), ES 197(160), ES 200(56), AT 201(265), ES 202(11), ES 207(?[juvenile] 1), AT 218(20), AT 219(308), AT 221(17), SBC 222(?[juvenile] 1), AT 228(6), AT 229(1), ES 232(23; ?[juvenile] 1), AT 233(95), ES 244(1, ?[juveniles] 3), AT 245(110), AT 247(32), AT 248(1), AT 251(4), ES 252(1), ES 255(3), AT 256(8), ES 257(1), ES 264(27), ES 266(2), AT 267(6), AT 271(93), AT 273(144), ES 283(juvenile 1), AT 288(1), ES 289(7), 13/83/6 OTSB(1), 3/85/7 OTSB(1), 3/85/17 OTSB(8). [980–1005 m to 2946 m]

DISTRIBUTION. The new records extend the upper bathymetric limit in the Trough from 1330 m to *c.* 1000 m.

Ophiacantha crassidens Verrill, 1885

See: Paterson, 1985: 40–41, fig. 17.

SAMPLES. AT 223(4), AT 230(1). [1075–1862 m]

DISTRIBUTION. The new records are from just south of the Wyville Thomson Ridge and Hebridean Slope and indicate a wider distribution within the Trough than the few previous samples suggested.

Ophiolebes bacata Koehler, 1921

See: Paterson, 1985: 51, fig. 22.

SAMPLE. AT 259(4). [1041 m]

DISTRIBUTION. Eastern Atlantic from the Bay of Biscay and off Madeira; 1300–2034 m. This record from the North Feni Ridge is a considerable extension of range north to *c.* 57°N and to slightly shallower depths.

Subfamily **OPHIOTOMINAE**

Ophiotoma coriacea Lyman, 1883

See: Paterson, 1985: 57, fig. 23.

SAMPLES. AT 221(1), AT 256(1). [1605–1705 m]

Distribution. Recorded from both the western and eastern Atlantic; Cape Cod 1242 m and the Azores to Iceland 1765–4106 m including a *Helga* record from SW. of Ireland. The present specimens from east of Rosemary Bank and the North Feni Ridge provide a small upward extension of bathymetric range in the eastern Atlantic and the first records from the Rockall Trough.

Ophiolimna bairdi (Lyman, 1883)

See: Paterson, 1985: 60, fig. 24.

Sample. ES 264(3). [2144–2910 m]

Distribution. This second record from the the foot of the Rockall Bank is shallower than the previous record by 750 m. The flow of cold water along the Feni Ridge and east side of the Rockall Bank may allow this circumpolar arctic species to extend into shallower depths on this side of the Trough.

Subfamily OPHIOPLINTHACINAE

Ophiomitrella clavigera (Ljungman, 1864)

See: Paterson, 1985: 71, fig. 28.

Sample. AT 259(1). [1041 m]

Distribution. Known from both sides of the N. Atlantic: Davis Strait and W. Greenland; the Azores to the Faeroes; 166–1348 m. The single specimen was taken from the east side of Rockall Bank.

Family OPHIACTIDAE

Ophiactis abyssicola (M. Sars, 1861)

See: Paterson, 1985: 76–78, fig. 32.

Samples. ES 99(juvenile 1), ES 112(783; ?[juveniles 22), AT 153(2), ES 197(22), AT 201(2), ES 202(5), ES 218(1), AT 219(2), AT 223(18), AT 226(juvenile 1), AT 228(9), AT 229(33), AT 230(39), AT 233(1), AT 239(3), AT 247(19), AT 248(47), AT 249(1), ES 250(16), AT 251(6), ES 255(6), AT 256(2), AT 259(62), ES 261(1), ES 264(237), AT 271(32), AT 273(10), AT 287(21), AT 290(1), 13/83/1 OTSB(54), 3/85/28 OTSB(32), 3/85/29 OTSB(1), 3/85/30 OTSB(59). [168–3000 m]

Distribution. No change.

Family AMPHIURIDAE

Amphiura tritonis Hoyle, 1884

See: Mortensen, 1927: 213; Paterson, 1985: 85–86, fig. 33.

Sample. SBC 222(juvenile 1). [1101 m]

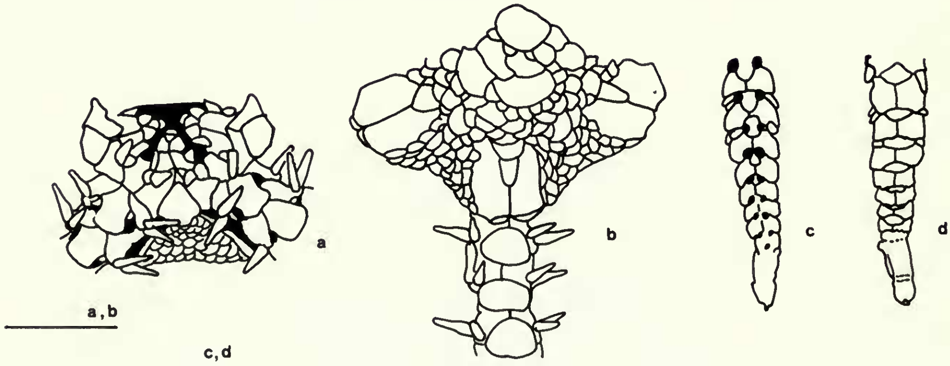

Fig. 2 *Amphiura tritonis* (a) ventral (b) dorsal view of disk; (c) ventral (d) dorsal view of the ends of the arms. Scale bars = 1 mm.

DISTRIBUTION. A rare species having been recorded once from a position very near the current record just south of the Wyville Thomson Ridge and twice from the Bay of Biscay; 627–1290 m

REMARKS. The undamaged specimen, which was recovered from a 0·25 m^2 box core, is considerably smaller than the holotype from the same locality (disc diameters 2·5 and 12 mm respectively). The arm tips bear numerous newly added arm segments (Fig. 2c, d) which lack spines. This small specimen is characterised by the ventral interradial area being scaled; by large, broadly triangular oral papillae and by three arm spines, of which the middle one tends to be the largest (Fig. 2a). Of the three N. Atlantic species with similar characteristics, *A. tritonis, A. richardi* Koehler and *A. abyssorum* Norman, it appears to be closest to *A. tritonis*. The oral shield lacks the pronounced distal lobe seen in *A. tritonis*, but this might be due to the small size of the specimen. Both *A. richardi* and *A. abyssorum* lack scaling on the ventral interradial area and the oral papillae of *A. abyssorum* are spine-like. These features readily distinguish them from the Rockall specimens.

Amphiura otteri Ljungman, 1871

See: Paterson, 1985: 86–87, fig. 33.

SAMPLES. ES 112(1), SBC 205(1), ES 207(1), ES 231(3), ES 285(1). [1000–2906 m)

DISTRIBUTION. The new records, while mainly from the SMBA Permanent Station in *c.* 2900 m, include a record from 1900 m on the South Feni Ridge. This, together with a 1000 m record listed in Part 1 from the Hebridean Slope and its wide distribution in the N. Atlantic suggests that this species is tolerant of a variety of bottom conditions. The bathymetric range is 198–3200 m.

Amphipholis squamata (Delle Chiaje, 1829)

See: Paterson, 1985: 91, fig. 36.

SAMPLES. ES 112(17), SBC 211(juvenile 1), ES 250(1). [402–1900 m]

DISTRIBUTION. The record from ES 112 gives a further surprising extension of nearly 600 m to the known bathymetric range of this species; 0–1900 m.

Amphilepis ingolfiana (Mortensen, 1933)

See: Paterson, 1985: 93–94, fig. 37.

SAMPLES. ES 27(2, ?[juveniles] 2), ES 118(2, juveniles 2), ES 129(1), ES 135(1, ?1), SBC 160(juvenile 1), ES 184(15, ?[juvenile] 1), ES 185(21), ES 197(76), ES 200(16), AT 201(1), ES 202(3), ES 204(5), ES 207(9), ES 218(juveniles 5), AT 219(5), SBC 220(juveniles 2), AT 221(1), ES 231(7), ES 232(6), AT 239(1), ES 244(juveniles 17), ES 255(1), AT 267(7), AT 271(1), SBC 272(3), AT 273(1), SBC 275(?[juvenile] 1), SBC 276(juvenile 1), AT 282(20), ES 283(9), ES 285(1), AT 286(4), ES 289(juveniles 31). [1047–2946 m]

DISTRIBUTION. The record from AT 239 raises the upper limit of this species in the Rockall Trough to near the minimum of 957 m quoted by Mortensen (1933).

Family **OPHIOCHITONIDAE**

Ophiochiton ternispinus Lyman, 1883

See: Paterson, 1985: 96–97, fig. 39.

SAMPLES. AT 221(5), AT 223(3), AT 228(4), AT 229(1), AT 230(1), AT 239(1), AT 251(1), ES 255(1), AT 256(2), AT 287(1), 13/83/1 OTSB(2), 13/83/2 OTSB(2), 13/83/5 OTSB(1), 9/84/9 OTSB(1), 3/85/17 OTSB(1), 3/85/29 OTSB(7), 3/85/30 OTSB(6). [1047–2200 m]

DISTRIBUTION. The new records from the Hebridean Slope raise the known upper bathymetric limit within the Trough by 700 m.

Family **OPHIURIDAE**
Subfamily **OPHIURINAE**

Ophiopleura inermis (Lyman, 1878)

See: Paterson, 1985: 128, fig. 48.

Samples. AT 223(6), AT 230(5), AT 239(3), AT 248(4), AT 249(1), ES 250(4), AT 259(6), AT 290(10), 13/83/2 OTSB(3), 13/83/6 OTSB(182), 9/84/13 OTSB(3), 3/85/8 OTSB(3), 3/85/9 OTSB(28), 3/85/13 OTSB(35), 3/85/20 OTSB(18), 3/85/23 OTSB(2), 3/85/24 OTSB(52), 3/85/25 OTSB(8), 3/85/26 OTSB(11), 3/85/27 OTSB(3), 3/85/28 OTSB(119), 3/85/31 OTSB(1), 3/85/32 OTSB(2), 3/85/33 OTSB(21), 3/85/36 OTSB(6), 3/85/46 OTSB(3). [650–805 m to 1271 m]

Distribution. No change.

Homophiura tesselata (Verrill, 1894)

See: Paterson, 1985: 135–138.

Samples. AT 181(4), AT 228(1). [1785–1845 m to 2264 m]

Distribution. No change.

Amphiophiura saurura (Verrill, 1894)

See: Paterson, 1985: 134, fig. 50.

Sample. 3/85/20 OTSB(4). [1225–1245 m to 1900 m]

Distribution. This record extends the known distribution within the Trough to the Hebridean Slope and into shallower water.

Ophiocten gracilis (G. O. Sars, 1871)

See: Paterson, 1985: 130, fig. 50.

Samples. ES 6(juveniles 1583), ES 14(juveniles 88), ES 15(juveniles 2908), ES 27(juveniles 5), ES 57(juveniles 76), ES 105(juveniles 3362), ES 129(juveniles 5, ?[juvenile] 1), SBC 150(juveniles 39), SBC 160(juveniles 3), SBC 163(juveniles 5), SBC 174(juvenile 1), ES 178(juveniles 789), ES 184(juveniles 654), SBC 188(juvenile 1), ES 197(juveniles 2700), ES 200(juveniles 9), ES 202(juvenile 1), ES 204(juvenile 1), ES 207(juveniles 38), SBC 215(juveniles 2), SBC 216(?[juvenile] 1), ES 218(juveniles 1768), SBC 220(juvenile 1), AT 226(3), AT 239(162), ES 244(juveniles 285), ES 264(9), SBC 276(juveniles 4), SBC 278(juveniles 3), ES 283(juveniles 10), AT 290(11), 13/83/6 OTSB(118), 13/83/7 OTSB(95), 9/84/2 OTSB(27), 9/84/13 OTSB(54), 3/85/10 OTSB(68), 3/85/24 OTSB(10), 3/85/26 OTSB(3), 3/85/28 OTSB(25), 3/85/36 OTSB(1). [704–2946 m]

Distribution. No change.

Ophiocten hastatum Lyman, 1878

See: Paterson, 1985: 129, fig. 49.

Samples. SBC 64(1), ES 111(2), ES 129(2), ES 185(8), ES 204(1), ES 207(1, ?1), ES 266(1), AT 267(1), ES 283(2), 3/85/5 OTSB(9). [2000 m to 2970–2980 m]

Distribution. The new records slightly extend the bathymetric range within the Trough of this esentially abyssal species.

Ophiura carnea Lütken, 1858

See: Paterson, 1985: 117, fig. 42.

Sample. 3/85/9 OTSB(1). [630–2857 m]

Distribution. The new record extends the known distribution within the Trough to the Hebridean Slope.

Ophiura scomba Paterson, 1985

See: Paterson, 1985: 125–127, figs 46 & 56; Gage *et al.*, 1983: 297–298 (as *O. irrorata*).

SAMPLES. AT 201(1), ES 218(1), AT 219(1), AT 245(1), AT 247(28), ES 252(5), AT 254(3), ES 255(11), AT 256(24), ES 257(7; ?[juvenile] 1), ES 261(17), ES 264(13), 3/85/17 OTSB(1). [1510–2220 m]

DISTRIBUTION. *O. scomba* is known from Rockall south to Morocco; 1595–4406 m. The new records are from the North Feni Ridge and also in the vicinity of a 2200 m repeat station (Sta. 'M') in the northern Rockall Trough and provide a new slightly shallower upper bathymetric limit.

REMARKS. This species was recorded as *O. irrorata* in Part 1. Subsequent studies have shown that the Rockall specimens should be referred to *O. scomba*. The swollen oral shields, rounded ventral arm plates and pointed oral papillae distinguish this species from its congener *O. ljungmani*, which has an overlapping bathymetric distribution in the Trough.

Ophiura ljungmani (Lyman, 1878)

See: Paterson, 1985: 118–120, fig. 44.

SAMPLES. ES 27(172), ES 57(927), SBC 58(2), ES 105(juveniles 13), ES 111(623), ES 118(401), ES 129(951), SBC 159(juveniles 3), SBC 160(juvenile 1), SBC 163(juveniles 2), ES 180(305), ES 184(359), ES 185(634), ES 197(807), ES 200(juveniles 70), AT 201(8), ES 202(69), ES 204(106), SBC 205(juvenile 1), ES 207(232), ES 218(194), AT 219(8), SBC 220(2), AT 228(41), ES 231(286), ES 232(26), AT 233(16), ES 244(170), AT 245(17), AT 247(3), ES 264(67), ES 266(21), AT 267(22), AT 271(6), AT 273(14), SBC 278(juvenile 1), ES 283(414), ES 285(39), AT 288(4), ES 289(juveniles 111), 13/83/5 OTSB(2). [1050 m to 3425–3500 m]

DISTRIBUTION. No change.

Ophiura ophiura (Linnaeus, 1758)

See: Süssbach & Breckner, 1911: 234–241 (as *O. ciliaris*); Mortensen, 1927: 236–238, fig. 128 (as *O. texturata*).

SAMPLES. SBC 210(?1), AT 292(2), 13/83/3 GT(8), 3/85/43 OTSB(2). [220–270 m to 704 m]

DISTRIBUTION. These new records confirm the presence of this sublittoral to bathyal species at depths >500 m on the Hebridean Slope as reported from a single record in Part 1.

Subfamily **OPHIOLEPIDINAE**

Ophiomusium lymani Wyville Thomson, 1873

See: Paterson, 1985: 147–148, fig. 58.

SAMPLES. ES 105(juveniles 2), ES 184(1196), ES 185(juvenile 1), AT 186(1015), ES 197(451), ES 200(240), AT 201(948), ES 202(31), ES 218(juveniles 12), AT 219(1458), SBC 220(juvenile 1), AT 221(44), AT 228(1224), ES 232(121), AT 233(1039), AT 239(3), ES 244(48), AT 245(392), AT 247(391), ES 250(2), AT 251(17), ES 252(6), AT 254(12), AT 256(86), ES 257(12), ES 261(3), ES 264(10), AT 271(860), AT 273(572), ES 285(20), AT 287(3), AT 288(1787), ES 289(171), 13/83/5 OTSB(417), 3/85/7 OTSB(44), 3/85/17 OTSB(1800), 3/85/29 OTSB(1614), 3/85/30 OTSB(29). [810–2921 m]

DISTRIBUTION. No change.

Class **ECHINOIDEA**
Order **CIDAROIDA**
Family **CIDARIDAE**

Cidaris cidaris (Linnaeus, 1758)

SAMPLES. AT 223(1), AT 292(3), 13/83/8 OTSB(1), 9/84/10 OTSB(1), 3/85/28 OTSB(4), 3/85/31 OTSB(1), 3/85/43 OTSB(155), 3/85/44 OTSB(52). [500–560 m to 1075 m]

DISTRIBUTION. No change.

Poriocidaris purpurata (Wyville Thomson, 1872)

SAMPLES. AT 223(31), AT 230(4), AT 239(1), AT 248(3), AT 259(1), 13/83/2 OTSB(3). [1041–1296 m]

DISTRIBUTION. The record from AT 223 is near the type locality of this species. The new records raise the known upper bathymetric limit for the Rockall Trough by *c*. 150 m.

Order **ECHINOTHURIOIDA**
Family **ECHINOTHURIIDAE**

Araeosoma fenestratum (Wyville Thomson, 1869)

SAMPLES. 13/83/2 OTSB(1), 13/83/7 OTSB(1). [631 m to 1265–1130 m]

DISTRIBUTION. These new records from the Hebridean Slope provide an extension of the lower bathymetric range of this species in the NE. Atlantic.

Calveriosoma hystrix (Wyville Thomson, 1869)

SAMPLES. AT 223(19), AT 239(1), AT 248(2), AT 259(2), AT 291(11), AT 3(1), 13/83/2 OTSB(6), 13/83/6 OTSB(180), 13/83/7 OTSB(5), 9/84/1 OTSB(2), 9/84/2 OTSB(3), 9/84/10 OTSB(1), 9/84/13 OTSB(45), 3/85/8 OTSB(1), 3/85/9 OTSB(3), 3/85/10 OTSB(8), 3/85/13 OTSB(183), 3/85/14 OTSB(126), 3/85/18 MBA(109), 3/85/19 MBA(16), 3/85/25 OTSB(103), 3/85/28 OTSB(1). [580–630 m to 1265–1130 m]

DISTRIBUTION. The new records extend both the upper and lower bathymetric limits of this species within the Trough. The numbers taken in fish trawls suggest that it is abundant on the Hebridean Slope at around 1000 m.

REMARKS. The specimen from AT 239 was in excellent condition when recovered, with most of its long red spines intact and the body wall still supported by coelomic fluid. Trawled specimens are generally almost completely devoid of spines and give little impression of the magnificence of this species in life.

The size-frequencies (Table 1) from semi-balloon trawls (OTSB) suggest that the largest individuals occur at the upper end of the depth range on the Hebridean Slope, whereas recruitment occurs towards the lower end of the depth range. The occurrence of juveniles at a greater depth than adults has been noted in a number of echinoderm taxa in the Rockall Trough (Gage *et al*., 1983, 1985*a*). The smallest individual recovered measured 55 mm, considerably larger than the smallest echinoids taken with this trawl, suggesting that recruitment may be sporadic in this non-seasonally reproducing species (Tyler & Gage, 1984*a*).

Hygrosoma petersii (A. Agassiz, 1880)

SAMPLES. AT 230(2), AT 233(2), AT 239(1), AT 282(1), ES 283(2), AT 286(3), AT 287(2), SWT 27(2), 13/83/1 OTSB(1), 13/83/5 OTSB(1), 3/85/5 OTSB(10), 3/85/21 OTSB(1), 3/85/30 OTSB(9), 3/85/45 OTSB(3). [1160 m to 2970–2980 m]

DISTRIBUTION. The new records provide a small extension of the known lower bathymetric limit, the total range now being 730–2980 m.

Sperosoma grimaldii Koehler, 1897

SAMPLES. AT 239(9), AT 248(2), AT 249(?2), 13/83/2 OTSB(167), 13/83/5 OTSB(1), 13/83/6 OTSB(40), 9/84/13 OTSB(6), 3/85/8 OTSB(2), 3/85/9 OTSB(1), 3/85/11 OTSB(4), 3/85/13 OTSB(3), 3/85/18 MBA(88), 3/85/19 MBA(37), 3/85/20 OTSB(62), 3/85/23 OTSB(1), 3/85/24 OTSB(19), 3/85/25 OTSB(58), 3/85/28 OTSB(7), 3/85/33 OTSB(17), 3/85/43 OTSB(2). [565–700 m to 2910 m]

DISTRIBUTION. Intensive trawlings on the Hebridean Slope suggest that this species is common at around 1000 m where it is frequently recovered with *Calveriosoma hystrix*. The upper bathymetric limit within the Trough is raised by around 500 m.

REMARKS. Size-frequency data (Table 1) suggest that this species attains a smaller size on the Hebridean Slope than *Calveriosoma hystrix*. It appears also that as in *C. hystrix* the smallest

Table 1 Size-frequencies of echinothuriid urchins from the Hebridean Slope

Date	Station	Depth	Lower bound of size class of flattened test diameter (mm)														
Calveriosoma hystrix			50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
22.9.83	13/83/6 OTSB	980–1005	1	2	4	35	66	33	6	2	0	0	0	0	0	0	
5.11.84	9/84/13 OTSB	940–975	0	0	0	0	8	11	15	6	3	0	0	0	0	0	
18.4.85	3/85/13 OTSB	960–995	0	0	0	3	48	67	56	8	2	0	1	0	0	0	
18.4.86	3/85/14 OTSB	720–775	0	0	0	0	0	3	10	16	23	23	18	12	2	1	
23.4.85	3/85/25 OTSB	1000–1005	0	0	3	4	23	41	15	5	1	0	0	0	0	0	
Sperosoma grimaldi			20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
21.9.83	13/83/2 OTSB	1130–1265	1	1	2	3	1	23	54	59	15	2	2	2	0	0	
22.9.83	13/83/6 OTSB	980–1005	0	0	0	0	0	1	1	14	16	6	2	0	0	0	
22.4.85	3/85/20 OTSB	1225–1245	2	10	7	4	0	1	6	15	10	1	1	1	0	1	
23.4.85	3/85/25 OTSB	1000–1005	0	0	0	0	0	1	2	11	22	16	3	2	0	0	
Phormosoma placenta			10	20	30	40	50	60	70	80	90	100					
21.9.83	13/83/2 OTSB	1130–1265	1	0	1	5	56	122	40	5	1						
21.9.83	13/83/5 OTSB	1775–1835	0	0	0	0	14	39	13	0	0						
22.9.83	13/83/6 OTSB	980–1005	0	0	1	3	47	21	3	0	0						
22.9.83	13/83/7 OTSB	750–800	0	0	0	0	0	23	45	7	0						
4.11.84	9/84/9 OTSB	1750–1770	0	0	0	0	1	39	30	0	0						
5.11.84	9/84/13 OTSB	940–975	0	0	0	0	2	44	46	11	0						
18.4.85	3/85/13 OTSB	960–995	0	0	0	0	4	20	17	4	0						
21.4.85	3/85/17 OTSB	1955–1995	1	1	10	31	90	103	24	1	0						
22.4.85	3/85/20 OTSB	1225–1245	0	4	18	20	23	2	0	0	0						
23.4.85	3/85/25 OTSB	1000–1005	0	0	0	6	57	138	109	41	1						

individuals are found in depths greater than 1000 m, with no juveniles recovered from the shallower stations sampled at or about the same time. *Sperosoma grimaldii* appears to have a non-seasonal reproductive cycle (Tyler & Gage, 1984*a*).

Family **PHORMOSOMATIDAE**

Phormosoma placenta Wyville Thomson, 1872

SAMPLES. AT 223(88), AT 228(55), AT 230(4), ES 231(1), AT 239(34), AT 248(47), AT 249(8), ES 250(3), AT 251(2), AT 254(40), ES 255(64), AT 256(7), AT 257(1), AT 259(1), ES 261(1), AT 287(1), AT 288(2), AT 291(2), AT 292(1), GT 7(2), GT 8(1), 13/83/2 OTSB(232), 13/83/5 OTSB(753), 13/83/6 OTSB(76), 13/83/7 OTSB(91), 9/84/9 OTSB(71), 9/84/13 OTSB(104), 3/85/9 OTSB(11), 3/85/10 OTSB(2), 3/85/13 OTSB(46), 3/85/14 OTSB(3), 3/85/17 OTSB(262), 3/85/18 MBA(17), 3/85/19 MBA(8), 3/85/20 OTSB(69), 3/85/25 OTSB(353), 3/85/29 OTSB(14), 3/85/34 OTSB(1), 3/85/46 OTSB(1). [525–2898 m]

DISTRIBUTION. The new records extend both the upper bathymetric limit within the Trough, and the known lower bathymetric limit of this species. The total range is now 260–2898 m.

REMARKS. The size-frequency data (Table 1) indicate that as in *Calveriosoma hystrix* and *Sperosoma grimaldi* juveniles tend to occur at a greater depth than adults.

Order **ECHINOIDA**
Family **ECHINIDAE**

Echinus acutus var. *norvegicus* Düben & Koren, 1844

SAMPLES. ES 115(?[juveniles] 4), ES 178(?2), SBC 210(juveniles 2), AT 223(65), AT 230(juveniles 7), AT 239(48, ?[juveniles] 3), AT 248(?[juveniles] 2), AT 291(214), 13/83/2 OTSB(juveniles 16), 13/83/4 GT(?1), 13/83/7 OTSB(6), 13/83/8 OTSB(134), 9/84/1 OTSB(49), 3/85/10 OTSB(26), 3/85/13 OTSB(1), 3/85/14 OTSB(1000), 3/85/18 MBA(1), 3/85/20 OTSB(4, ?1), 3/85/24 OTSB(2), 3/85/36 OTSB(2). [401 m to 1225–1245 m]

DISTRIBUTION. The new records raise the upper bathymetric limit by over 300 m in the Trough and provide a small extension of the lower bathymetric limit. Intensive trawlings on the Hebridean Slope suggest that this species is most common in the 500–800 m depth interval.

REMARKS. The maximum size in these samples was found to be 77 mm test diameter, which is in approximate agreement with Mortensen (1943) who thought that it does not reach a size larger than *c*. 70 mm. Morphometric data from these large samples is given by Gage *et al*., (1986), these data showing good agreement with measurements given by Mortensen (1943) from material collected from various locations. These authors found size frequency distributions for this sea urchin to be quite variable in the hauls from the Hebridean Slope, this variability apparently being unrelated to bathymetry or time of year. This species occurs at depths similar to those yielding large numbers of its congener *E. elegans* yet analysis of these records shows that in most trawlings either one or the other species is overwhelmingly dominant, and in many only one of the two species occurs (see under Remarks for *E. elegans*).

LIFE HISTORY. Gage *et al*. (1986) describe the seasonal cycle in oogenesis in this species on the Hebridean Slope; spawning occurring in about March. These authors, in interpreting growth banding in the plates of the test as reflecting a seasonal pattern of growth, infer that specimens > 50 mm in test diameter are 6–11 yr old. The estimated age of specimens of around 30 mm is 6 yr and agrees fairly well with results of Sime & Cranmer (1985) from a study of populations at depths of 108–149 m in the northern North Sea.

Echinus affinis Mortensen, 1903

SAMPLES. ES 112(juveniles 94 [not 1073 as stated in Part 2]), AT 154(116), ES 176(7, ?[juveniles] 73), AT 177(548), ES 184(58), AT 192(?17), ES 197(110, ?[juveniles] 8), ES 200(62, ?[juvenile] 1), ES 218(6, juveniles 2), ES 232(11), ES 244(10, ?[juveniles] 5), AT 245(92), AT 247(291), ES 264(130, ?[juveniles] 4), AT 267(7), AT 271(154), AT 273(708), AT 288(122), ES 289(14), 13/83/5 OTSB(191), 9/84/9 OTSB(78), 3/85/7 OTSB(juvenile 1), 3/85/17 OTSB(204), 3/85/29 OTSB(22), SWT 13(none [listed as 3 in Part 2]). [1605–2605 m]

DISTRIBUTION. The new records extend the known lower bathymetric limit of this species slightly.

LIFE HISTORY. In the northern Rockall Trough at Sta 'M' in 2200 m where this species is abundant, *E. affinis* has a seasonal reproductive cycle and probably produces a planktotrophic larva. This seasonal reproduction is thought by Tyler & Gage (1984*b*) possibly to be tuned to a pulsed annual fallout of phyto-detrital food to the sea floor in this area. Additional studies at this station have revealed skeletal banding which is thought to result from a seasonal growth pattern controlled by the same factor (Gage & Tyler, 1985). Adults were inferred to be up to *c*. 28 years old. These latter authors also indicate that postlarval survivorship is probably very low; a markedly uneven representation of ages in a large sample aged by means of growth rings was interpreted by them as probably reflecting multi-year cycles in recruitment success.

Echinus alexandri Danielssen & Koren, 1883

SAMPLES. ES 112(12, ?[juveniles] 108), AT 248(7), AT 251(juvenile 1), AT 256(3), AT 259(4), AT 288(1), 13/83/1 OTSB(3), 3/85/30 OTSB(?[juvenile] 1). [1041–2300 m]

DISTRIBUTION. The new records raise the upper bathymetric limit in the Trough by *c*. 230 m.

Echinus elegans Düben & Koren, 1844

SAMPLES. AT 287(?18), AT 291(63), 13/83/3 GT(3), 13/83/6 OTSB(7), 13/83/7 OTSB(1), 13/83/8 OTSB(1), 9/84/2 OTSB(15), 9/84/13 OTSB(3), 3/85/9 OTSB(241), 3/85/13 OTSB(77), 3/85/14 OTSB(5), 3/85/18 MBA(9), 3/85/20 OTSB(?10), 3/85/23 OTSB(1), 3/85/24 OTSB(21), 3/85/25 OTSB(1), 3/85/28 OTSB(205), 3/85/31 OTSB(2), 3/85/36 OTSB(1). [220–270 m to 1210(?1383) m]

DISTRIBUTION. The new records extend the known distribution within the Trough onto the shelf to considerably shallower depths than reported in Part 2, although still within the overall recorded range for this species.

REMARKS. The maximum size of the specimens was 93 mm in test diameter, which is close to the maximum of 80 mm given by Mortensen (1927). Morphometric data from these large samples is given by Gage *et al.* (1986), these measurements showing good agreement with more limited data given by Mortensen (1943) from material collected from various other locations. The size frequencies of the Rockall samples are variable from haul to haul, with from one to three modes present; these appeared to show no relationship to either time of year or bathymetry. This species occurs at depths similar to those of trawlings yielding large numbers of its congener *E. acutus* var. *norvegicus*; yet, as pointed out above for the latter species, analysis of these hauls shows that in all of them either one or the other species is overwhelmingly dominant, while in many only one species occurs. Gage *et al.* (1986) suggest that this may result from differing habitat requirements. The muddy gut contents of *E. acutus* var. *norvegicus* indicate deposit feeding, while the varied particulate remains found in *E. elegans*, that include both sediment and small prey, suggest a more omnivorous diet (Mortensen, 1943; Gage *et al.*, 1986).

LIFE HISTORY. The sexes are separate and equal in number. Females show a seasonal cycle in oogenesis, spawnout probably occurring in March. An egg size up to 60 μm diameter is indicative of planktotrophic development as in other species of this genus (Gage *et al.*, 1986). These authors interpret growth banding visible in the skeletal plates as reflecting a seasonal growth pattern. Counts of these growth zones and a fitted growth curve indicate that a size of 70 mm test diameter is reached at an age of 12–20 yr.

Order **SPATANGOIDA**
Family **HEMIASTERIDAE**

Hemiaster expergitus Loven, 1874

SAMPLES. ES 15(juveniles 2), ES 18(juveniles 3), SBC 61(juveniles 3), SBC 156(juveniles 3), SBC 160(juveniles 2), SBC 168(1), ES 172(juveniles 2), ES 176(juveniles 3), AT 177(?[juvenile] 1), ES 197(5), ES 204(juvenile 1), ES 207(1, juvenile 1), ES 218(juveniles 52), SBC 220(juveniles 2), SBC 222(juvenile 1), ES 232(2, juveniles 3), AT 239(juveniles 15), ES 244(juveniles 19), AT 245(9), ES 250(juvenile 1), AT 251(2), ES 252(40), ES 255(juveniles 4), ES 261(1), AT 271(1), AT 282(1), ES 289(juvenile 1). [1047–2910 m]

DISTRIBUTION. These records raise the upper bathymetric limit slightly within the Trough.

LIFE HISTORY. Counts of growth bands present in the test plates indicate a test length of 30 mm might be reached by *c.* 16 yr (Gage, 1987).

Family SPATANGIDAE

Spatangus raschi Loven, 1869

SAMPLES. SBC 210(?[juveniles] 4), AT 239(juvenile 1), AT 291(36), 13/83/7 OTSB(54), 13/83/8 OTSB(2), 9/84/1 OTSB(1), 3/85/10 OTSB(13), 3/85/13 OTSB(1), 3/85/14 OTSB(40), 3/85/18 OTSB(3), 3/85/26 OTSB(1), 3/85/43 OTSB(37). [225 m to 990–1020 m]

DISTRIBUTION. The new records are all from the Hebridean Slope and extend the lower bathymetric limit within the Trough by some 200 m. This species appears to be most common in the 500–800 m depth zone in this area.

Brissopsis ?lyrifera (Forbes, 1841)

See: Mortensen, 1907: 152–160, pl. 3, figs 2, 3, 7, 11, 12, 18, 20–23, pl. 4, figs 2, 3, 9, 14–17, pl. 18, figs 1, 6, 12, 18, 25–26, pl. 19, figs 3, 6, 10, 15, 18–21, 29, 34; 1927: 338–340, figs 200, 201; 1951: 380–390, pl. 30, figs 1–4, 7–13, pl. 32, figs 15, 20, 22, pl. 57, fig. 15; Gage *et al.*, 1985*a*: 187, fig. 3 (as *Brissopsis* sp.).

SAMPLES. ES 99(1), AT 239(31 + fragments). [1047–1160 m]

DISTRIBUTION. NE. Atlantic from Lofoten, S. and W. Iceland along the European coasts and the Mediterranean to S. of the Canaries; *c.* 5–1400 m; in soft mud.

REMARKS. Except for the specimen from ES 99, the present material is all from a large haul (AT 239) of small, very fragile specimens, most of which were broken when examined. In this haul the cod-end of the trawl was full of a muddy deposit containing *Brissopsis*, specimens of *Hemiaster expergitus* (see above), and a single specimen of *Brisaster fragilis* (see below). The largest intact specimen measures 22·9 mm and the smallest 9 mm in test length. It is likely that smaller specimens had been lost through the 10 mm-wide meshes of the trawl.

B. lyrifera is typically an inshore species, with only a few, somewhat doubtful records from deep water (Mortensen, 1927). For example, it seems very unlikely that it is this species that Thomson (1874) records from depths to 2090 fathoms (3873 m) from the *Porcupine* in 1869. However, the absence of any confluence in the posterior petals of the present material from deep water immediately distinguishes it from the species *Brissopsis atlantica* and *B. mediterranea* which are known to occur to bathyal depths in the western Atlantic (Chesher, 1968). Furthermore, *B. mediterranea*, although known from the eastern Atlantic and Mediterranean, is thought there to be restricted to relatively shallow water.

The present specimens are similar in size and appearance to two lots, each consisting of two partly broken specimens about 15 mm in length, labelled as *Brissopsis lyrifera*, in the collections of the British Museum (Natural History) (BMNH). These were dredged by the *Triton* (presumably on her voyage in 1882, see Deacon, 1977) from 942 m and 1170 m depth, respectively, from the Wyville Thomson Ridge and Faroe Bank Channel. A larger specimen at BMNH measuring 27·5 mm length was collected by the *Helga* in 1909 from the Porcupine Seabight at 956–1088 m depth (see Farran, 1913). The fragmented specimen recorded under '*Brissopsis* sp.' in Part 2 that was taken from the same area and depth on the upper Hebridean Slope as the specimens from AT 239 is now identified as *Brissopsis ?lyrifera*. On the basis of the lengths and widths of the anterior and posterior petals it is estimated that this specimen was about 30 mm in test length. The pedicellaria in Fig. 3a, b of Part 2 from this specimen is a rostrate pedicellaria and not globiferous as labelled. Similar rostrate pedicellariae were found on inshore *B. lyrifera*. Examples of the double-pronged globiferous pedicellariae typical of *B. lyrifera* were not found on any of the deep-water specimens from BMNH. The tridentate pedicellaria in figure 3c of Part 2 that was also obtained from the large fragmented specimen from ES 99 agrees somewhat with Mortensen's

Table 2 Critical morphometric characters of deep-water *Brissopsis ? lyrifera* compared to inshore specimens of *B. lyrifera* from the W. of Scotland. Measurements standardised as percentages of test length

	LOCALITY							
	Arran Deep 40·9–70 mm length, n = 23		The Minch 32·0–53 mm length, n = 5		Hebridean Slope 14·4–22·9 mm length, n = 4		Faroe Bank Channel, *Triton* 15·3 mm length, n = 1	Porcupine Seabight, *Helga* 27·5 mm length, n = 1
Character (see Chesher, 1968)	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Test height	51·43	6·41	60·5	3·9	*66·63	1·43	*73·2	*65·5
Length anterior petal	29·02	3·51	26·4	2·3	23·40	2·30	*20·9	*22·2
Length posterior petal	23·49	3·15	22·0	1·2	*15·86	1·22	*16·3	*14·5
Length from apical system to peripetalous fasciole:								
at interambulacrum 5	18·10	2·37	14·9	1·0	*12·95	0·63	*12·2	14·5
at interambulacrum 4	21·55	2·31	20·9	1·2	18·09	0·95	20·3	*16·4
Span of distal ends of anterior petals	49·63	4·68	43·6	3·0	*37·56	0·39	*33·3	*36·5
Span of distal ends of posterior petals	31·80	3·65	24·8	1·9	*19·65	1·35	*17·0	*18·2
Width of subanal fasciole	43·76	4·04	39·3	2·6	*30·81	4·85	*33·3	*31·3
Height of subanal fasciole	19·32	1·73	21·3	1·6	20·58	2·04	*25·5	15·5

*Outside ±2 S.D. of mean of urchins from Arran Deep

(1907) third form of tridentate of *B. lyrifera*, examples of the other two kinds, although described by Mortensen as richly developed, not being found on the present specimens. However, a typical form of the largest, narrow-bladed variety of tridentate pedicellaria, with the valves rather widely separated along their lower length, was found on one of the *B. lyrifera* from the *Triton*. Not surprisingly, no pedicellariae were found on the somewhat denuded specimens from AT 239.

Measurements of 21 of the morphometric characters of the test, established by Chesher (1968), were made on the *Triton* and *Helga* specimens (although the accuracy of many of these is reduced as a result of not removing their spines) and on the present material from AT 239. In Table 2 these data are compared to similar measurements on inshore specimens dredged in 1968 from *c.* 165 m depth in the Arran Deep, Firth of Clyde, in the possession of J. D. G. The relatively small number and limited size range of the sample of inshore specimens is insufficient to adequately define the natural variation in this species, in which monstrosities in test form are known to occur (Brattstrom, 1946, Mortensen, 1951). However, measurements on specimens in BMNH trawled from stations in the Minch (*c.* 58°N, 06′W) by the Scottish Fisheries Board in 1927, nearly all lie within 2 S.D. of the mean of the measurements on those from the Arran Deep, only measurements of the span of the posterior petals on two specimens in one of the hauls falling slightly below this range. In contrast, values of 9 out of 21 characters measured on the small deep-water urchins fall outside 2 S.D. of the mean for the Arran Deep sample for some specimens while for 5 of these characters measurements on all specimens fall outside this range (Table 2).

The present, and our previous, finds of this urchin in the SMBA samples concur with Thomson (1874) who noted that at great depths specimens of *B. lyrifera* decrease in size, having '. . . all the appearance of being very young . . .'. However, on the present material genital pores were present on specimens as small as 15 mm test length, which also possessed small gonads, indicating that sexual maturity is reached at a small size.

Such differences might suggest that the deep water urchins constitute a distinct taxonomic entity. However, *Brissopsis lyrifera* is known to have a planktotrophic echinopluteus that may be dispersed over wide areas. Since such larvae are likely to stay in the plankton for some time, it seems likely that the deep-water populations off the W. of Scotland are in genetic continuity with inshore stocks. The small size of the deep-water individuals possibly then results from dwarfing as a result of resource limitation in the deep sea. The differences in test characters may possibly reflect other differences in bottom conditions as well as their smaller size. Until the range of variation amongst larger inshore samples, covering both a wider range in size and bottom environment, becomes better understood the possible separate identity of the deep-water urchins must remain uncertain.

Brisaster fragilis (Düben & Koren, 1844)

See: Mortensen, 1907: 108–123, pl. 1, figs 6–7, pl. 13, pl. 14, fig. 3, 7, 11, 13, 16, 18, 20, 24–25, 31, 37, 39, 43, 46, 50–51; 1927: 325–326, figs 187, 2–3, fig. 188, 2, fig. 189, 1–2.

SAMPLES. SBC 224(1), AT 239(juvenile 1). [903–1047 m]

DISTRIBUTION. NE. Atlantic from Finmark to Bergen, to north and west of the Shetlands, the Faroe–Shetland Channel, and from south and west of Iceland. In the western Atlantic from the Davis Strait to Florida; *c.* 65–1300 m on soft mud.

REMARKS. The single specimen recovered in perfect condition from a box-core sample (SBC 224) measures 38 mm in overall test length. It was collected from 903 m depth in the Faroe Shetland Channel, where this species was previously taken by the *Porcupine* at about the same depth. The juvenile specimen from AT 239 measures 10·5 mm test length and was recovered from 1047 m on the upper continental slope west of Barra in a haul containing a mixed sample of small *Brissopsis ?lyrifera* and juvenile *Hemiaster expergitus*. As shown in the growth series figured and described by Mortensen (1907, pl. 13) the posterior petals at this size are relatively undeveloped. Genital pores, indicating sexual maturity, were not found, although Mortensen (1907) remarks that they appear at a size of 9–11 mm.

The present records extend the recorded range of this species in the NE. Atlantic from the Faroe Shetland Channel to a latitude of 57°N in the Rockall Trough.

REPRODUCTION. The large yolky eggs of *Brisaster fragilis* are thought to indicate direct development (Mortensen, 1907, 1927).

Order **POURTALESIOIDA**
Family **POURTALESIIDAE**

Pourtalesia miranda A. Agassiz, 1869

SAMPLES. ES 59(8), ES 118(2), ES 120(2), ES 122(4), ES 143(3), ES 147(2), ES 152(3), ES 164(3), ES 204(9 [not 54 as stated in Part 2], ?[juvenile] 1), ES 207(6), ES 266(2), AT 282(1), ES 283(1). [2245–2946 m]

DISTRIBUTION. The additional records extend the lower bathymetric limit slightly within the Trough.

Echinosigra phiale (Wyville Thomson, 1874)

SAMPLES. ES 27(24), ES 59(2), ES 111(2), ES 118(7), AT 121(14), ES 122(10), ES 129(9), AT 153(2), ES 172(23), ES 180(3), ES 184(1), ES 185(37), ES 197(5), ES 204(19), ES 207(15), ES 218(4), ES 231(6), AT 245(2), ES 257(1), AT 267(5), AT 282(6), ES 283(14), ES 285(3), AT 286(2), ES 289(2). [1993–2946 m]

DISTRIBUTION. The lower bathymetric limit within the Trough is extended slightly and predictably, given the abyssal distribution of this species.

LIFE HISTORY. Counts of growth zones present in the plates of the test indicate a size of 50 mm length may be reached by an age of 5–8 yr (Gage, 1987).

Class **HOLOTHURIOIDEA**
Order **DENDROCHIROTIDA**
Family **PSOLIDAE**

Psolus pourtalesi Théel, 1886

SAMPLE. AT 247(233). [2084–2190 m]

DISTRIBUTION. This sample, like the first described in Part 2 (Gage *et al.*, 1985*a*) was taken from the west side of the Trough. The specimens were recovered from the base of Rosemary Bank close to areas where this species was found during the *Ingolf* Expedition (Heding, 1942). Gage *et al.* (1985*a*) followed Mortensen (1927) in reporting *P. pourtalesi* from the West Indies. Mortensen (1927) cited specimens from the *Blake* Expedition (Theel, 1886*b*), but these came from the eastern seaboard of North America, not the West Indies. *P. pourtalesi* has not been recorded south of 39°N in the western Atlantic. The lower bathymetric limit reported in Part 2 as 2271 m should be increased slightly to 2341 m to include the records of Deichmann (1940). The total range is therefore 1096–2341 m.

REMARKS. Heding (1942) and Gage *et al.* (1985*a*) refer to this species as *P. pourtalesii* but it should be referred to as *P. pourtalesi* as in the original description (Théel, 1886*b*).

The present specimens were found attached to a collection of small, probably ice-rafted, cobbles. The specimens range from 12–33 mm in length. There is some suggestion of bimodality in the size distribution, with a small mode around 16 mm and a much larger mode around 25 mm (Table 3).

Table 3 *Psolus pourtalesi* length frequencies from station AT 247

	Lower bound of size class (mm)																						
	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	
Frequency	1	3	2	2	5	4	3	8	13	12	13	32	28	33	24	16	13	5	7	3	2	1	(n = 230)

Family **PARACUCUMIDAE**

Paracucumaria hyndmani (Thompson, 1840)

See: Mortensen, 1927: 400-401, figs 237, 3; 239, 1 (as *Cucumaria hyndmani*); Madsen, 1942: 395–406, figs 1–6 (as *Cucumaria hyndmani*).

SAMPLE. 13/83/8 OTSB(1). [500–560 m]

DISTRIBUTION. The coasts of Europe from the Mediterranean north to the Shetland Isles and the coast of Norway including Rockall Bank. Mortensen (1927) notes that it is usually found in deep water, *c*. 20–1150 m. The present specimen was taken at the top of the Hebridean Slope.

REMARKS. Madsen (1942) recognised two forms of the species which he considered 'would prove to be of two geographical races of the same species': a more northern *P. (Cucumaria) hyndmani* f. *typica* and a more southern *P. (Cucumaria) hyndmani* f. *robusta*. Our single specimen agrees with the northern form and is close to the locality of a deep-water specimen examined by Madsen (1942, p. 405).

Family **SCLERODACTYLIDAE**

Pseudothyone raphanus (Düben & Koren, 1844)

See: Mortensen, 1927: 407–408, fig. 242: 2, 245: 1 (as *Thyone raphanus*); Panning, 1949: 456–457, fig. 52.

SAMPLE. SBC 222(4, ?[juveniles] 2), AT 248(11). [1101–1150 m]

DISTRIBUTION. *P. raphanus* occurs around the coasts of the British Isles and Norway as far north as *c*. 65°N. It is also known to occur in the Mediterranean. Bathymetric range *c*. 10–1050 m, the present records extending this slightly to 1150 m.

REMARKS. The two juvenile specimens from SBC 222, both 1 mm long, have only primary cross deposits which differ from the plate deposits normally found in adult *P. raphanus*. However, primary cross deposits are the precursors to plates, and in specimens intermediate in size, 3 to 4 mm long, both types of deposits occur.

Family **CUCUMARIIDAE**

Thyone fusus (O. F. Müller, 1776)

See: Madsen, 1941: 17–26, Figs 3b, 4g–h, 7b, 12–16.

SAMPLES. SBC 211(juvenile, 1). [402 m]

DISTRIBUTION. Northeast Atlantic from Trondheim Fjord to the Mediterranean, including the North Sea and adjacent Scandinavian Seas. There is some uncertainty in the bathymetric range of this species since *T. fusus* has been confused in the past with other species, such as *T. gadeana* Perrier and *T. wahrbergi* Madsen. From his analysis of Scandinavian holothurians, Hansen considers that *T. fusus* generally occurs between 10 and 200 m (Hansen, pers. comm.). The present specimen from 402 m increases the lower bathymetric limit. However, since the specimen is a juvenile it is possible that as with several asteroids, ophiuroids and echinoids (Gage *et al.* 1983, 1985*a*) the lower bathymetric limit is greater for juveniles than for adults.

REMARKS. The specimen is only 2·5 mm long. The deposits of the body wall are irregular polyporous plates similar to those described for *T. fusus* f. *subvillosa* (Hérouard, 1890; Madsen, 1941) with a spire made of two slender columns as in *T. fusus* and unlike those of *T. wahrbergi* and *T. gadeana*. The tubefeet are large in comparison to the size of the body and have terminal plates 100 to 125 µm in diameter. These are smaller than the plates found in adult specimens but possess the concentric circles of large holes typical of *T. fusus*. The size of the specimen precluded an examination of the tentacle deposits.

Order **DACTYLOCHIROTIDA**
Family **YPSILOTHURIIDAE**

Ypsilothuria talismani talismani E. Perrier, 1886

Samples. SBC 168(3), SBC 222(10, juvenile 1), AT 226(1), AT 230(2), AT 239(37), AT 248(8), ES 250(38). [*c*. 1000–1271 m]

Distribution. These additional records extend the distribution of this species to the North Feni Ridge and provide a geographical link between our previous records from the Rockall Trough and those of the *Ingolf* from Iceland. Furthermore they confirm the essentially bathyal distribution of this species.

Ypsilothuria bitentaculata attenuata R. Perrier, 1902

Samples. ES 27(79, juvenile 1), ES 56(15), ES 111(23), ES 118(37), ES 129(30), ES 184(31, juvenile 15), ES 185(221), ES 190(48), ES 200(113), ES 204(33 [not 78 as stated in Part 2]), ES 218(92), ES 231(97), ES 232(18), AT 233(2), ES 244(20), AT 245(268), ES 261(1), ES 266(4), AT 267(80), AT 271(4), AT 273(10), AT 282(5), ES 283(67), ES 285(5), AT 286(7), AT 288(6), ES 289(41). [1862–2951 m]

Distribution. No change.

Echinocucumis hispida (Barrett, 1857)

Samples. SBC 222(juveniles, 3), AT 248(8), ES 250(13), 3/85/9 OTSB(1). [945–1270 m]

Distribution. These records from the Feni Ridge and Hebridean Slope broaden the known geographic and bathymetric range of this species within the Trough.

Order **ASPIDOCHIROTIDA**
Family **SYNALLACTIDAE**

Bathyplotes natans (M. Sars, 1868)

Samples. AT 239(37), AT 248(3), AT 249(1), AT 259(1), 13/83/2 OTSB(25), 3/85/36 OTSB(2). [1000–1025 m to 1130–1265 m]

Distribution. No change.

Remarks. These specimens were in better condition than those described in Part 2, and had spicules present in both the skin and papillae. A mid ventral groove was a distinctive feature of the better preserved specimens. The colour in spirit was off-white with the orange body organs showing faintly through the skin.

Benthothuria funebris R. Perrier, 1902

Samples. ES 204(2), AT 284(1), ES 285(1), AT 286(9), 3/85/5 OTSB(9). [2890–2996 m]

Distribution. No change.

Paelopatides grisea R. Perrier, 1902

Samples. AT 219(1), AT 273(7), AT 288(1), 13/83/5 OTSB(35), 9/84/9 OTSB(18), 3/85/29 OTSB(3). [1690–1740 m to 2190 m]

Distribution. These are the first records from the Rockall Trough, the single sample recorded in Part 2 having been taken in the Porcupine Seabight. They are all from the area between the lower Hebridean Slope and the Anton Dohrn Seamount and fall within the known bathymetric range.

Mesothuria lactea (Théel, 1886)

Samples. AT 254(2), ES 255(7), 13/83/5 OTSB(1), 9/84/9 OTSB(13), 3/85/29 OTSB(86). [1595 m to 1775–1835 m]

DISTRIBUTION. These records from the North Feni Ridge and Hebridean Slope confirm the bathymetric distribution reported by Hérouard (1923) for the NE. Atlantic. The Rockall records suggest a ribbon-like distribution along the margins of the Trough.

Mesothuria intestinalis (Ascanius & Rathke, 1767)

See: Mortensen, 1927: 381, figs 225, 228: 3; Heding, 1942: 7, text-fig. 6.

SAMPLES. AT 292(1), 3/85/38 OTSB(1). [410–490 m to 525 m]

DISTRIBUTION. Widely distributed in the NE. Atlantic from off NW. Africa (Hérouard, 1923) to the coasts of Norway, although nowhere in the deep sea does it appear to be particularly common. A few specimens are known from the Mediterranean (see Perrier, 1902; Koehler, 1927; Sibuet, 1974) and the western Atlantic (Deichmann, 1930). The species has a wide bathymetric range *c.* 18–1445 m, but reports of this species occurring as deep as 2000 m , appear to be the result of confusion with *Mesothuria verrilli.* The shallowest records come only from cold waters off Norway. The present records are from the upper Hebridean Slope.

Mesothuria verrilli (Théel, 1886)

See: Mortensen, 1927: 381, 382, fig. 224: 4–5; Deichmann, 1930: 93–94, pl. 6, figs 1–8.

SAMPLES. AT 287(2), 3/85/30 OTSB(1). [1383 m to 1420–1480 m]

DISTRIBUTION. Widely distributed in the north Atlantic with some records from the Mediterranean. In the western Atlantic it is known from the Caribbean Sea, eastern Gulf of Mexico (Deichmann, 1954; Miller & Pawson, 1984) and off the Bahamas (Pawson, 1982). In the eastern Atlantic it is previously known from NW. Africa, the Canary Islands (Perrier, 1902), the Azores (Hérouard, 1902, 1923; Perrier, 1902), the Bay of Biscay (Sibuet, 1977) and as far north as the Porcupine Seabight, southwest of Ireland (Mortensen, 1927). The present records extend the distribution northwards into the Rockall Trough on the Hebridean Slope.

The bathymetric range is not known with certainty partly as a result of confusion with *M. intestinalis.* Hansen (1975) gives a wide bathymetric range of 618–4165 m for *M. verrilli* in the Atlantic and 280 to 1103 m in the Mediterranean. With the aid of detailed bathymetric charts available today it is possible to see that all reliable records of this species deeper than 2000 m come from areas where the seabed is particularly steep e.g. on the continental slope off NW. Africa or in the area of the King's Trough (see Perrier (1902) for details of some stations). The accuracy of the depths from which some samples were taken must therefore be called into question. This also applies to a shallow sample of *M. verrilli* on the Magazan escarpment in 550 m (Perrier, 1902). Mortensen (1927) gives a reduced range of *c.* 990–1765 m for *M. verrilli* sampled to the southwest of Ireland. Recent intensive sampling in the same area, the Porcupine Seabight, confirms this total range but indicates that *M. verrilli* is only common in a reduced range between 1250 and 1500 m (Billett, in preparation). The present samples from the Hebridean Slope fall within this narrower range, as do most of those taken off the Azores (Marenzeller, 1893; Hérouard, 1902, 1923; Perrier, 1902).

The samples from the eastern Atlantic fall within the total range proposed for *M. verrilli* in the western Atlantic of 699–3720 m (Deichmann, 1954; Miller & Pawson, 1984; Pawson, 1982; Suchanek *et al.*, 1985). The study of Suchanek *et al.* (1985) increased the lower bathymetric limit from 2141 to 3720 m. The shallowest record, from 618 m, quoted by Hansen (1975) for material from the Atlantic should be referred to specimens collected within the Mediterranean.

REMARKS. In the western Atlantic *M. verrilli* is known to cover itself with detrital seagrass and shell material such as the seagrass *Thalassia* and brachiopod shells (Suchanek *et at.*, 1985).

Family **STICHOPODIDAE**

Stichopus tremulus (Gunnerus, 1767)

SAMPLES. AT 292(4), 13/83/3 GT(14), 13/83/4 GT(29), 13/83/7 OTSB(1), 13/83/8 OTSB(91), 3/85/9 OTSB (juvenile 1), 3/85/14 OTSB(6), 3/85/18 OTSB(1), 3/85/38 OTSB(2), 3/85/43 OTSB(18), 3/85/44 OTSB(4). [168 m to 990–1020 m]

DISTRIBUTION. The new records from the Hebridean Slope extend the lower bathymetric limit within the Trough by some 300 m.

Order **ELASIPODIDA**

Family **LAETMOGONIDAE**

Laetmogone violacea Théel, 1879

SAMPLES. AT 239(11), AT 248(9), AT 249(5), ES 250(1), AT 259(37), GT 8(6), 13/83/2 OTSB(5), 13/83/6 OTSB(157), 13/83/7 OTSB(9), 9/84/13 OTSB(54), 3/85/18 MBA(4), 3/85/19 MBA(7), 3/85/20 OTSB(112), 3/85/22 MBA(7), 3/85/23 OTSB(18), 3/85/24 OTSB(35), 3/85/25 OTSB(99), 3/85/28 OTSB(3), 3/85/33 OTSB(126). [940–975 m to 1400(3000) m]

DISTRIBUTION. The new records from the North Feni Ridge and Hebridean Slope indicate the presence of large populations of this species in suitable localities.

REPRODUCTION. A non-seasonal cycle with abbreviated development is indicated (Tyler *et al.*, 1985*b*).

Benthogone rosea Koehler, 1896

SAMPLES. AT 271(10), 13/83/5 OTSB(3). [1745–2255 m]

DISTRIBUTION. No change.

REPRODUCTION. Direct development is indicated by the large oocyte size and there is no evidence of seasonality in oogenesis (Tyler *et al.*, 1985*b*).

Family **PSYCHROPOTIDAE**

Psychropotes longicauda Théel, 1882

SAMPLE. SWT 15(3) (incorrectly listed in Part 2 as SWT 5(3)). [2910–4810 m]

REMARKS. *P. longicauda* has the largest known egg size for a holothurian at 4·4 mm diameter (Hansen, 1975). This size of egg probably leads to a prolonged form of early development within the deep-sea plankton, and juveniles of this species 13–23 mm in length have been recovered in pelagic nets fished at between 17 and 1500 m above the seabed at abyssal depths (Billett *et al.*, 1985).

Family **ELPIDIIDAE**

Peniagone azorica von Marenzeller, 1893

SAMPLES. AT 121(79), AT 271(23). [1991–3463 m]

DISTRIBUTION. No change.

REPRODUCTION. Additional information to that given for this species in Part 2 is provided by Tyler *et al.* (1985*a*).

Kolga hyalina Danielssen & Koren, 1879

SAMPLES. ES 266(61). [2591–2910 m]

DISTRIBUTION. These records extend the geographic range within the Rockall Trough of this patchily distributed species to the north central part of the Trough and Feni Ridge.

Ellipinion delagei (Hérouard, 1896)

See: Hérouard, 1902: 39–40, pl. 6 figs 1–3, pl. 8 figs 8–9; Hansen, 1975: 163, fig. 122.

SAMPLE. AT 247(18). [2084 m]

DISTRIBUTION. An extremely rare species found previously only around the Azores and Cape Verde Islands close to steep slopes (Hérouard, 1902, 1923). The presence of specimens on the Rosemary Bank indicates a preference for steep topography by this species, particularly around seamounts and oceanic islands in the N. Atlantic. The total bathymetric range is 1165–2478 m.

REMARKS. Only one specimen is in good condition. It widens towards the posterior end and has 12 pairs of tubefeet bordering the entire ventral surface. Those tubefeet at the anterior end are spaced more widely than those at the posterior end. The posterior few pairs of tubefeet are slightly smaller than the rest. The deposits include large rods (up to 550 μm long), regular c-shaped deposits (about 130 μm long) and small irregularly curved rods (40–50 μm in size) which are usually c-shaped and are often developed into tripartite deposits (Hérouard, 1902).

Order **APODIDA**

Family **SYNAPTIDAE**

Labidoplax southwardorum Gage, 1985

SAMPLES. ES 10(1), ES 34(?2), ES 53(1), SBC 66(?3), ES 129(8, ?3), ES 137(3), ES 172(6), ES 176(10 [not 22 as stated in Part 2]), ES 185(21), ES 190(7), ES 197(?20), ES 200(1), ES 204(1), ES 218(16), SBC 220(2), ES 244(10), ES 283(37), ES 285(1), ES 289(6). [1000–2946 m]

DISTRIBUTION. The new records provide a slight extension of the lower bathymetric limit.

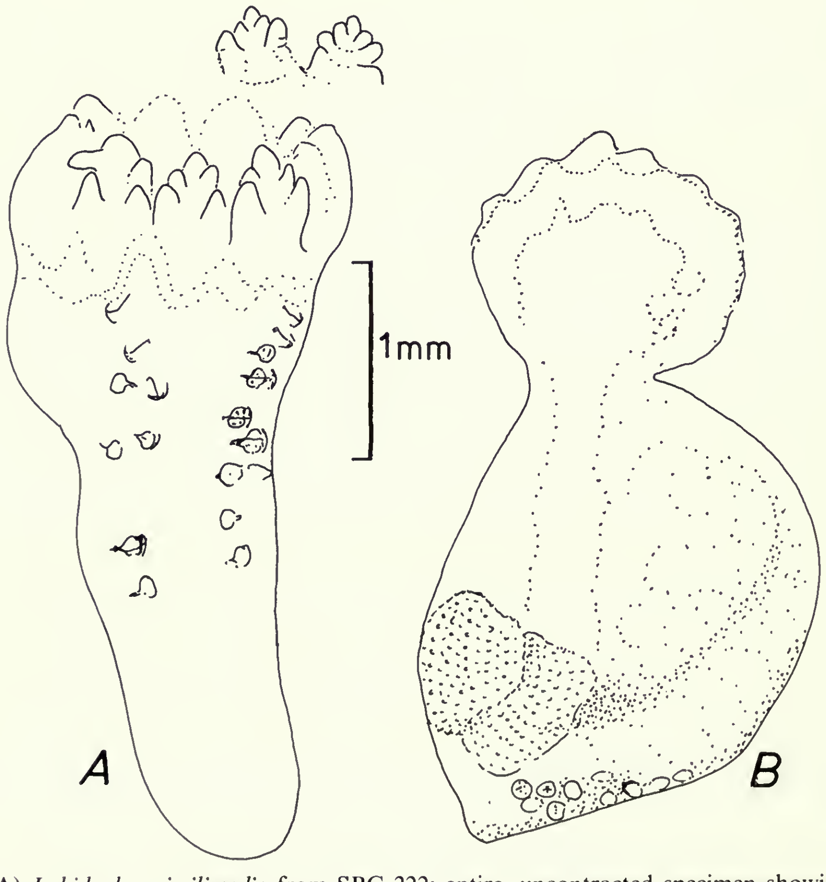

Fig. 3 (A) *Labidoplax similimedia* from SBC 222: entire, uncontracted specimen showing pinnate tentacles and position of plates and anchors in body wall; (B) *Prototrochus zenkevitchi rockallensis* from SBC 220: entire specimen showing sac-like body distended with sediment. Scale bar = 1 mm.

Labidoplax similimedia Gage, 1985

SAMPLES. ES 118(1), ES 129(2), ES 137(4), ES 143(?1), ES 164(87), ES 169(4), ES 185(4), ES 218(?2), SBC 222(8), ES 244(1), ES 283(6), ES 285(1), ES 289(2). [1101–2946 m]

DISTRIBUTION. The new records provide an upward extension of the bathymetric range by *c.* 1100 m, and also an extension of the lower bathymetric limit.

REMARKS. Several of the specimens from SBC 222 are complete (Fig. 3A), with the skin deposits scattered in the body wall rather than crowded together and overlapping as described by Gage (1985), and as found in the other material from epibenthic sled hauls. This is no doubt because the specimen is not severely contracted as material usually is when collected by the epibenthic sledge. The plates and anchors have a lateral orientation in the body wall (Fig. 3A) similar to that of other synaptids. The tentacles are clearly pinnate with two pairs of rounded lateral, and a single terminal, digit (Fig. 3A).

Leptosynapta decaria (Östergren, 1905)

See: Östergren, 1905: 146–148, fig. 1B; Clark, 1907: 93; Mortensen, 1927: 431, fig. 262, 3.

SAMPLE. SBC 210(1 + frag.). [401 m]

DISTRIBUTION. Hitherto known only from the Trondheim Fjord to the Kattegat, 40–70 m depth.

REMARKS. The material consists of an anterior end with the oral ring measuring 1.41 mm in diameter along with a posterior end, quite possibly from the same specimen, around 0.6 mm wide. Both fragments were whitish in colour with no trace of pigmentation when examined from spirit. There are 10 tentacles, each with a short terminal digit and three pairs of short rounded digits, increasing in size distally. Deposits consist of plates and anchors, which are found in the skin of both fragments, and rods present only in the tentacles. The rods, which are slightly curved and possess enlarged, branched ends (Fig. 4), are numerous and present throughout the tentacles, increasing in size distally. Skin deposits (Fig. 4) consist of plates typical in form of *Leptosynapta,* with nine toothed holes, the outermost and central holes being the largest. In the anterior fragment the plates have a mean length of 124·8 μm, range 116–138 ($n = 28$) and mean width of 99·1 μm, range 90–113 ($n = 14$). This agrees well with the values of 126·5 and 97·5 μm, respectively, given by Östergren (1905) for the deposits from the anterior of the animal. The anchors agree well with Östergren's description; resembling those of *Leptosynapta inhaerens* but being smaller and possessing up to 5 (usually 3) teeth on each fluke. Anchors are slightly longer but narrower than the plates, mean length 144 μm, range 127–160 μm ($n = 23$), mean width 73·1 μm, range 70–75 ($n = 8$). These values are also reasonably close to the values given by Östergren (149 × 97 μm). Besides the fully developed plates and anchors there are a number of developmental stages of both deposits present (Fig. 4).

The deposits in the posterior end are similar to those in the anterior fragment, but slightly larger (plates, mean length 130 μm, mean width 98 μm; anchors, mean length 143, mean width 72 μm $n = 4$). Assuming that the two fragments belong to the same animal, it is pertinent to note that in *Leptosynapta*, it is usual for the deposits to increase in size posteriorly (Östergren, 1905; Cherbonnier, 1953, 1963). Both the whitish colour and diameter of the head-end fragment (1·4 mm) is similar to that (1·5–3 mm) described by Östergren for *L. decaria*, and the three pairs of tentacle digits present is within the range of 2–4 pairs on each tentacle described by Östergren (1905).

Only two European species of *Leptosynapta* are known to possess 10 rather than the 12 tentacles typical of other species of the genus; *L. minuta* (Becher), a tiny viviparous species known from shallow water off NW Europe, and *L. decaria.* Both species are small and appear to lack pigmentation. The present specimen differs from *L. minuta* in possessing tentacle digits, in having anchors clearly longer than the plates (Fig. 4), and in having at the basal (articular) end of the plate small irregularly arranged holes, typical of most *Leptosynapta* species, rather than the regular slit-like holes of *L. minuta.* Östergren (1905) found specimens of *L. inhaerens* with 10, 11 or 13 tentacles, this possibly influencing Clark (1907) to suggest that '. . . it is not impossible that this [*L. decaria*] is

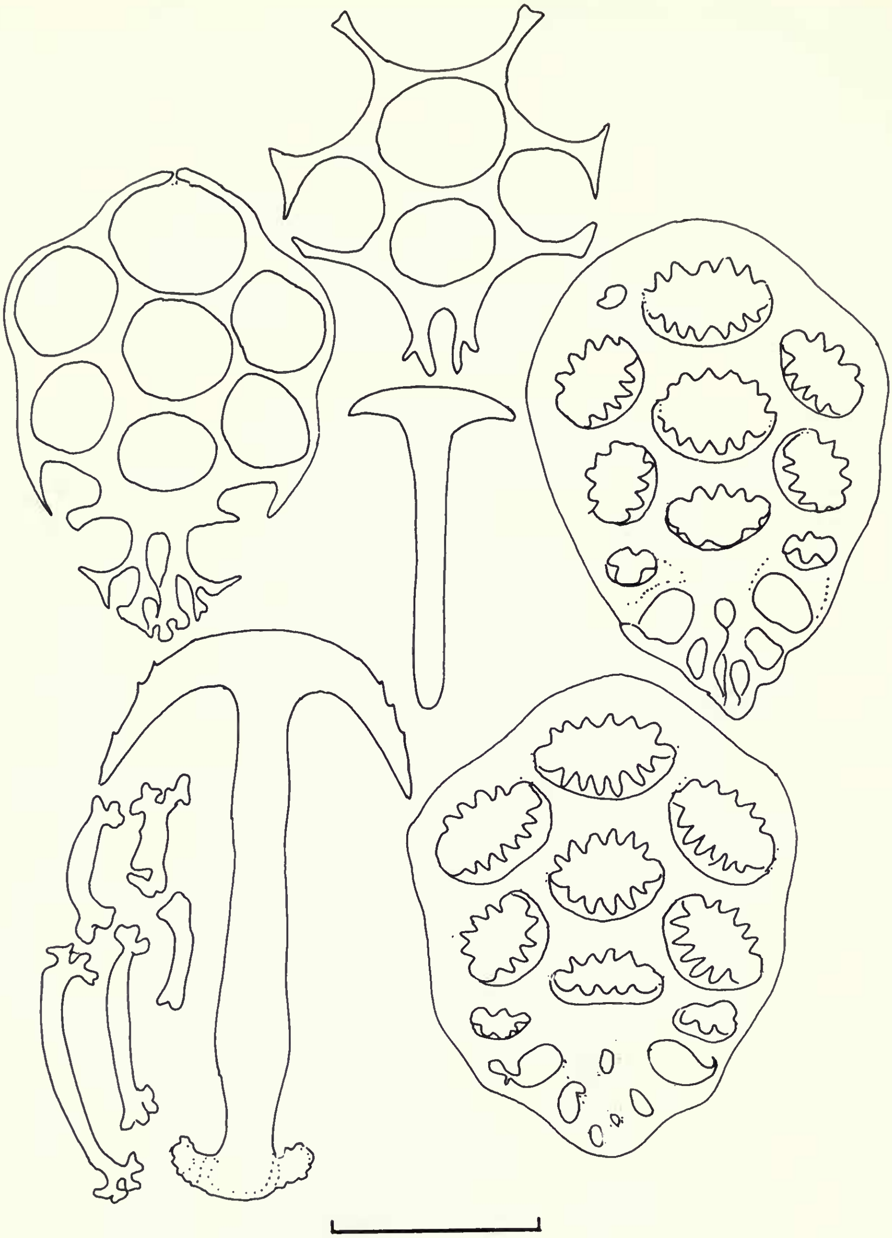

Fig. 4 Skin deposits from anterior fragment of *Leptosynapta decaria* from SBC 210. Fully developed (middle and lower right) and developing plates (upper left); fully developed (lower left) and developing (centre) anchor; rods from tentacles, lower left. Scale bar = 50 μm.

only the young of *inhaerens*. There is a striking similarity in the calcareous particles and in the tentacles, the differences in number of digits being simply a matter of age.' Dr Bent Hansen of the Zoological Museum, University of Copenhagen has confirmed (unpublished communication to J.D.G) that there appears to be no published record of *L. decaria* subsequent to Östergren's (1905) paper. Dr Hansen very kindly re-examined Norwegian material from Tromso and Oslo, including

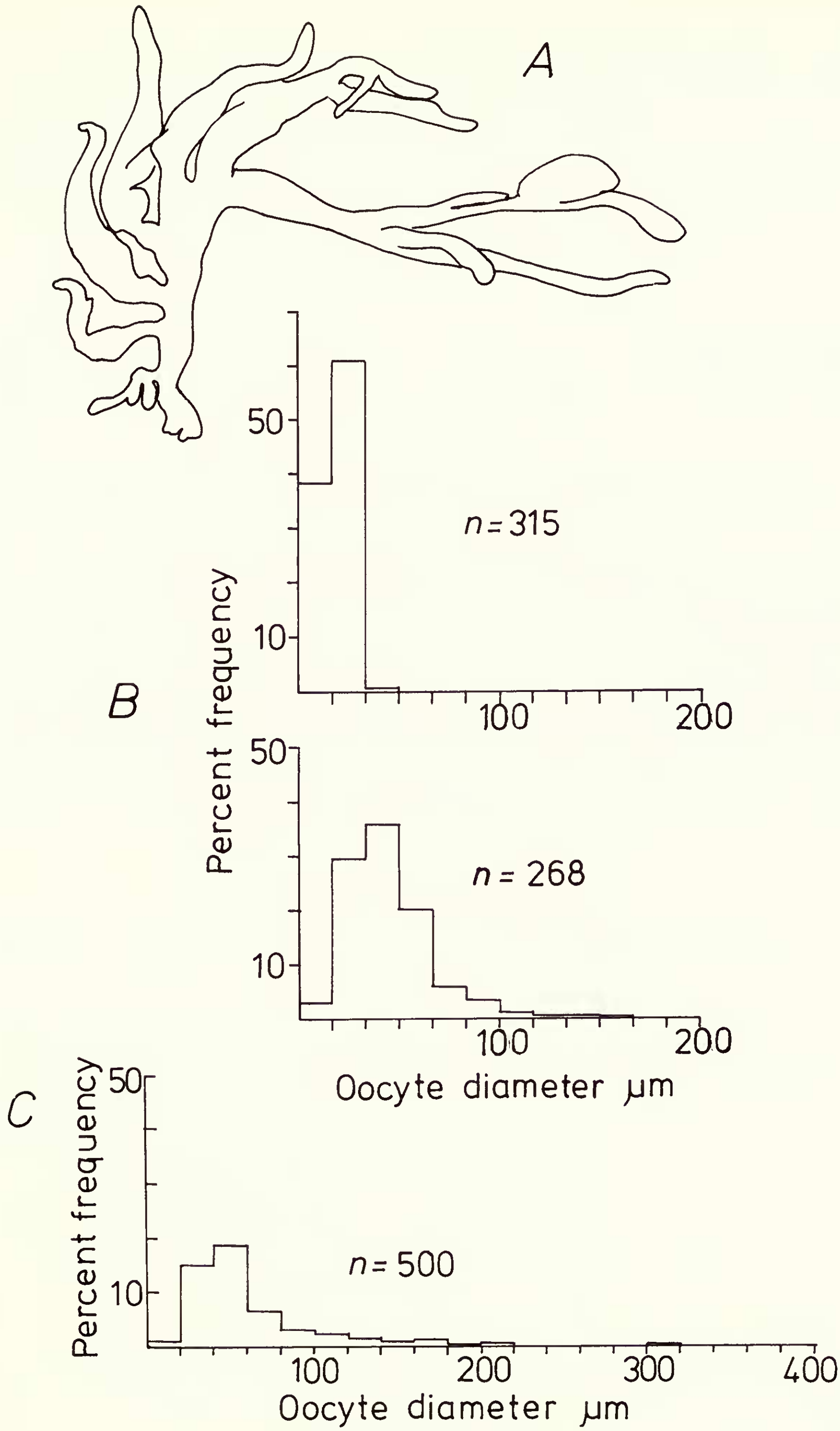

Fig. 5 (A) Ovary dissected from a female *Myriotrochus bathybius* from ES 207 with a calcareous ring diameter of 4·5 mm; (B) oocyte diameter frequencies from this specimen (lower) and from a smaller *M. bathybius* from ES 207 (upper); (C) oocyte diameter frequencies from a female of *Myriotrochus giganteus* from ES 207.

specimens examined by Östergren, held in the Zoological Museum and also informs us that he considers that *L. decaria* is a valid species. He has also drawn our attention to a single record of *L. decaria* from 1 fathom depth in Port Erin Harbour in the Isle of Man dated 1933 that he was also able to re-examine and confirm as conforming to Östergren's description of *L.* decaria. With the present record from 401 m depth we conclude that *Leptosynapta decaria* exists as a distinct species with a rather wide bathymetric distribution in muddy sediments of the continental shelf and adjacent upper slope of the more northerly areas of Europe. It is a small form that may well have been overlooked or lost when sieving benthic samples.

Protankyra brychia (Verrill, 1885)

Sample. ES 118(1). [2871–2925 m]

Distribution. No change.

Family **MYRIOTROCHIDAE**

Myriotrochus bathybius H. L. Clark, 1920

See: Gage & Billett, 1986: 234–239, figs 1, 3–6, 7A, B, 9A, B, 18B.

Samples. ES 152(2), ES 185(3), ES 231(6), AT 267(1), AT 282(3), ES 283(2), ES 289(1). [1800–2946 m]

Distribution. The combined bathymetric data for samples of *M. bathybius* taken in the Rockall Trough and on the Porcupine Abyssal Plain gives a total bathymetric range of 1800 to 4310 m (Gage & Billett, 1986).

Reproduction. The reference in Part 2 to Gage & Billett (in press) for details of the reproduction of this species was incorrect, and further information is therefore provided here. One of the pair of branched ovaries is shown in Fig. 5A from an incomplete female specimen with a calcareous ring diameter of 4·5 mm. It contained previtellogenic oocytes measuring up to 160 µm in longest diameter (Fig. 5B). In a smaller specimen from the same sample (ES 207) the maximum oocyte size did not exceed 60 µm (Fig. 5B).

Myriotrochus giganteus H. L. Clark, 1920

See: Gage & Billett, 1986: 239–247, figs 1, 7C, 8, 9C, 10–12, 24B.

Samples. ES 169(1), ES 231(1), ES 283(1). [2898–2946 m]

Distribution. The new records provide a slight extension of the lower bathymetric limit within the Trough. The total known bathymetric range is 2898 to 3800 m.

Reproduction. The maximum dimension of the irregularly shaped, vitellogenic oocytes of the specimen from ES 207 referred to by Gage *et al.* (1985*a*) is 320 µm and not 211 × 169 µm as given. However, the overall size distribution of the oocytes was, like those for *M. bathybius*, markedly skewed to the left, with the size frequencies peaking in the intervals between 20–60 µm (Fig. 5C).

Myriotrochus clarki Gage & Billett, 1986

See: Gage & Billett, 1986: 247–252, figs 1, 7D, 9D, 13–17, 18A; also Gage *et al.* 1985*a*: 203 (as *Myriotrochus* sp.)

Samples. ES 90(1), ES 185(1), ES 218(1), SBC 222(?1), ES 231(2, ?1), ES 232(1), ES 255(1). [*c.* 1040–2907 m]

Distribution. These new records increase the previously known bathymetric range of 1605–2515 m given in part 2.

Prototrochus zenkevitchi rockallensis Gage & Billett, 1986

See: Gage & Billett, 1986: 252–259, figs 1, 7E, F, 18C–E, 19–23, 24A; Gage *et al.*, 1985*a*: 204 (as *P. zenkevitchi* subsp.)

SAMPLES. ES 56(1), ES 118(3), ES 129(7), ES 135(15), ES 147(2), SBC 156(2), SBC 159(1), SBC 160(1), SBC 163(1), SBC 168(3), ES 176(23), ES 184(1), ES 185(3), ES 197(36), ES 204(3), SBC 215(?1), SBC 216(2), ES 218(8), SBC 220(3), SBC 222(2), ES 231(1), ES 232(3), SBC 275(1), SBC 276(1), ES 283(15), ES 285(2), ES 289(5). [*c*. 1000–2946 m]

DISTRIBUTION. The new records provide a slight increase in the lower bathymetric limit. Other subspecies of *P. zenkevitchi*, however, occur much deeper at between 7400 and 9735 m. A bathymetric range of 1000–9735 m is unprecedented in deep-sea holothurians. Gage & Billett (1986) suggest that the wide geographic and bathymetric separation of such records of myriotrochid species results from the problems of sampling infauna in the deep sea. Possibly, characterisation of separate species will be possible given more material.

REMARKS. Developing wheels, still lacking the rim, and with developing, spike-like spokes, have been found amongst the fully developed wheels on a specimen from SBC 220. The largest of the specimens from SBC 220 is complete, the sac-like body, length 2·36 mm, being distended with sediment (Fig. 3B); some of these being calcareous particles that are quite large compared to the size of the animal.

REPRODUCTION. Gonads have not been found in any of the specimens examined by us, perhaps indicating that they are immature.

Parvotrochus belyaevi Gage & Billett, 1986

See: Gage & Billett, 1986: 262–266, figs 1, 24C–F, 26, 27; Gage *et al.*, 1985*a*: 204 (as Myriotrochidae gen. et sp.)

SAMPLES. ES 99(2), ES 147(2), ES 152(3), ES 172(3), ES 204(2), SBC 220(1), ES 285(4). [1160–2921 m]

DISTRIBUTION. These new records are mainly from the type locality at *c*. 2900 m depth in the southern Rockall Trough. The record from ES 99 in 1160 m extends the known bathymetric range upwards by more than 500 m.

Order **MOLPADIIDA**

Family **MOLPADIIDAE**

Cherbonniera utriculus Sibuet, 1974

SAMPLES. ES 27(242), ES 56(218), ES 111(183), ES 118(74), ES 129(151), SBC 174(1), ES 185(544), ES 190(161), ES 204(144), ES 231(667), ES 283(1180), ES 285(116). [2515–2946 m]

DISTRIBUTION. The records from ES 283 provide a slight extension of the lower bathymetric range within the Trough. The total bathymetric range is 2039–4251 m.

REPRODUCTION. The oocytes grow to a maximum diameter of 200 μm, and Tyler *et al.* (1987) suggest that development may be planktotrophic. Too few specimens were examined to determine any possible periodicity in reproduction.

Molpadia blakei (Théel, 1886)

SAMPLES. ES 283(1), AT 288(2), 3/85/5 OTSB(1). [1991 m to 2970—2980 m]

DISTRIBUTION. These records extend the lower bathymetric limit slightly within the Trough and also provide a slight extension northwards.

Molpadia borealis M. Sars, 1858

SAMPLE. AT 107A(1 [No. of specimens omitted in Part 2]). [*c*. 2000 m]

Family **CAUDINIDAE**

Hedingia albicans (Théel, 1886)

See: Heding, 1935: 65–67, figs 18, 19, pl. 4, fig. 9, pl. 5, fig. 17, pl. 8, fig. 10 (as *Haplodactyla albicans*).

SAMPLES. ES 252(1), ES 255(2), AT 256(1). [1510–1706 m]

Distribution. Eastern and western Atlantic from off NW. Africa (3200 m), southwest of Iceland (1590–1628 m) and the eastern seaboard of N. America (1600–2423 m). Also known in the Mediterranean, off southern India and in the Bay of Bengal (484–814 m). A variety, var. *glabra* Théel, 1886*a* is known from off New Zealand (1280 m). The present material increases the upper bathymetric limit in the Atlantic to 1510 m, with the total worldwide range 494–3200 m.

Remarks. Only a few specimens are known from each of these widely separated localities. This may be the result of inefficient sampling of large infaunal animals by trawls and epibenthic sledges. The specimen from AT 256 measures *c.* 27 mm in length. Specimens measuring up to 45 mm in length were found by Heding (1935) to have undeveloped gonads and were hence probably juveniles. The deposits in the body wall of our 27 mm specimen lacked both the trilobed appearance and the thorny spines on the column of some of those figured by Heding (1935, fig. XVIII), possibly because of the relatively small size of the present specimen. It is possible however, that distinct sub-species may be recognisable when more material becomes available.

Discussion

Gage *et al.* (1983, 1985*a*) found a higher species richness amongst the relatively small number of samples taken on the western side of the Trough, despite the much higher sampling effort on the eastern side. This was thought to be related to stronger currents in the west (Jones *et al.*, 1970; Ellett & Roberts, 1973; Roberts, 1975; Lonsdale & Hollister, 1979) favouring microphagous suspension feeders. Many of the species found only in the west, particularly ophiuroids and asteroids, were inferred to feed on current-borne particles. In general these distributions have been confirmed by subsequent sampling but the following species have now been found to have a wider distribution: *Hoplaster spinosus, Psilaster andromeda, Ophiacantha crassidens* and *Amphiophiura saurura.*

Bathymetric zonation for the most abundant echinoderm species in the samples covered by Parts 1 & 2 is summarised by Gage *et al.* 1985*b*. These authors also employed the coincidence-of-range statistic of Backus *et al.* (1965) to describe the rate of change in the joint bathymetric ranges of these species at 100-m depth intervals along a notional transect encompassing most of the sampling effort in the east of the Trough. Peaks in the value of this statistic occur at around 800–1200 and 1800 m depth and were thought to be related to discontinuities in hydrodynamic and water-mass properties.

Despite the frequent sampling in the Rockall Trough since 1973, the echinoderm fauna is still imperfectly known, particularly on the southern Feni Ridge on the west side of the Trough from which only one sample has been taken. Interestingly, seven of the taxa recorded in this series of papers were only found at this station. From a total of 164 echinoderm taxa listed in Parts 1–3, 66 are recorded from less than 10 specimens and 22 of these are from single specimens. Some of these 'rarities' can be explained by the wide depth and geographic distribution of our samples, coupled with a low sampling effort at most stations. It is clear, however, from the more heavily sampled stations where the bottom is thought to be relatively homogeneous, that there are a number of relatively rare species which are widely distributed in the Atlantic e.g.*Hymenaster gennaeus.* The additional species recovered on the Hebridean Slope in 1985 with the semi-balloon otter trawl may reflect the greater catching power of this gear, with an estimated swept path width of 8·5 m compared with either the Agassiz Trawl (3 m) or the epibenthic sledge (1 m).

Given the high diversity in the echinoderm fauna from the Feni Ridge revealed by the relatively low sampling effort so far, it is clear that further sampling is necessary. The clearer picture of echinoderm distribution resulting from this would help in evaluating the relative importance of sedimentary and hydrographic features in bringing about the contrasts in the echinoderm faunas of the eastern and western margins of the Trough. Until this can be accomplished, the echinoderm fauna, and its zonation on the relatively well sampled and comparatively gently sloping Hebridean Slope, should not be viewed as being typical of the margins of the Trough as a whole.

Summary

Five species of crinoids, eleven asteroids, eight ophiuroids, two echinoids and eight species of

holothurian are identified, mainly from sampling carried out between 1983 and 1985 in the deep water areas to the west of the British Isles. The following echinoderm species have not been recorded previously from this area of the NE. Atlantic.

Cheiraster sepitus
Mediaster bairdi
Pteraster (Apterodon) sp.
Hymenaster regalis
Ellipinion delagei
Leptosynapta decaria

Of these, *Mediaster bairdi* and *Hymenaster regalis* are new records for the eastern Atlantic, while the *Pteraster (Apterodon)* sp. is probably new to science.

This study confirms the generally higher species richness along the western margin of the Trough noted in earlier papers in this series and the tendency for juveniles of many species to be distributed at the lower end of the bathymetric range of those species. Extensions to the bathymetric and geographic ranges of several species are provided by these records.

Acknowledgements

We again express our gratitude to the officers and crew of RRS *Challenger*, and to colleagues too numerous to name individually who participated in cruises and helped with the processing of samples. We are particularly indebted to Miss B. Rae of Dervaig, Isle of Mull, for her help in sorting sled and box-core samples; to Mr G. Davies and Mr A MacArthur for the sorting of other samples as summer students in the years 1983–85, and to Mrs Margaret Pearson for her valuable help in sorting and careful curation of the collections up to 1983. Dr J. D. M. Gordon of SMBA kindly provided additional material from fishing cruises in which the authors did not participate. We also thank Dr J. M. Graham of SMBA for constructing a digitising caliper used to measure echinoids. The Scottish Marine Biological Association is grant-aided by the Natural Environment Research Council who have been generous in allocating cruise time on which the present records were made.

Station List

Only details of stations yielding records of echinoderms not listed by Gage *et al.* (1983, 1985*a*) are given below.

Station No.	Date	Position (at mid-point of track on bottom if applicable)	Depth (m)
Benthic stations			
SBC 156	5 Aug. 1979	48°27′N, 10°21′W	1310
SBC 159	8 Aug. 1979	50°55′N, 12°21′W	2036
SBC 160	8 Aug. 1979	50°55′N, 12°20′W	2030
SBC 168	13 Aug. 1979	56°44′N, 09°13′W	1206
ES 231	17 May 1983	54°42′N, 12°12′W	2898
ES 232	19 May 1983	57°17′N, 10°16′W	2195
AT 233	19 May 1983	57°17′N, 10°12′W	2180
RMT 234	20 May 1983	57°12′N, 09°54′W	c. 2000
AT 239	24 July 1983	57°07′N, 09°23′W	1047
ES 244	25 July 1983	57°23′N, 10°20′W	2150
AT 245	26 July 1983	57°21′N, 10°21′W	2165
AT 247	27 July 1983	59°02′N, 10°55′W	2084
AT 248	27 July 1983	59°59′N, 10°33′W	1150
AT 249	28 July 1983	59°44′N, 12°36′W	1265
ES 250	28 July 1983	59°43′N, 12°33′W	1270

Station No.	Date	Position (at mid-point of track on bottom if applicable)	Depth (m)
AT 251	30 July 1983	58°52′N, 12°56′W	1530
ES 252	30 July 1983	58°52′N, 12°53′W	1510
AT 254	31 July 1983	58°26′N, 12°35′W	1595
ES 255	31 July 1983	58°26′N, 12°42′W	1595
AT 256	31 July 1983	57°56′N, 12°21′W	1705
ES 257	31 July 1983	57°55′N, 12°18′W	1700
RD 258	1 Aug. 1983	57°56′N, 13°24′W	135
AT 259	1 Aug. 1983	57°27′N, 12°52′W	1041
ES 261	1 Aug. 1983	57°24′N, 12°05′W	1824
ES 264	2 Aug. 1983	56°26′N, 13°31′W	2144
ES 266	3 Aug. 1983	56°24′N, 11°59′W	2591
AT 267	3 Aug. 1983	56°24′N, 11°58′W	2605
AT 271	4 Aug. 1983	56°39′N, 10°35′W	2255
SBC 272	5 Aug. 1983	56°40′N, 10°30′W	2250
AT 273	5 Aug. 1983	56°05′N, 10°28′W	2185
SBC 275	6 Aug. 1983	56°13′N, 10°06′W	1961
SBC 276	6 Aug. 1983	56°14′N, 09°51′W	1792
SBC 278	6 Aug. 1983	56°15′N, 09°46′W	1631
AT 282	14 April 1985	55°06′N, 11°22′W	c. 2760
ES 283	15 April 1985	54°39′N, 12°15′W	2946
AT 284	15 April 1985	54°40′N, 12°12′W	2906
ES 285	15 April 1985	54°39′N, 12°14′W	2906
AT 286	16 April 1985	54°44′N, 12°17′W	2896
AT 287	18 April 1985	56°43′N, 09°21′W	1383
AT 288	20 April 1985	57°18′N, 10°22′W	2190
ES 289	21 April 1985	57°19′N, 10°25′W	2190
AT 290	26 April 1985	56°28′N, 09°16′W	970
AT 291	27 April 1985	56°22′N, 09°12′W	775
AT 292	27 April 1985	56°23′N, 09°08′W	525

Fishing stations		Starting position	Depth range
13/83/1 OTSB	20 Sept. 1983	56°33′N, 09°40′W	1540–1550
13/83/2 OTSB	21 Sept. 1983	56°46′N, 09°15′W	1130–1265
13/83/3 GT	21 Sept. 1983	56°36′N, 09°02′W	220–270
13/83/4 GT	21 Sept. 1983	56°32′N, 09°05′W	230–380
13/83/5 OTSB	21 Sept. 1983	56°41′N, 09°47′W	1775–1835
13/83/6 OTSB	22 Sept. 1983	56°36′N, 09°17′W	980–1005
13/83/7 OTSB	22 Sept. 1983	56°27′N, 09°10′W	750–800
13/83/8 OTSB	22 Sept. 1983	56°20′N, 09°08′W	500–560
9/84/1 OTSB	2 Nov. 1984	56°32′N, 09°13′W	760–815
9/84/2 OTSB	2 Nov. 1984	56°34′N, 09°16′W	910–960
9/84/9 OTSB	4 Nov. 1984	56°47′N, 09°36′W	1750–1770
9/84/10 OTSB	4 Nov. 1984	56°16′N, 09°13′W	580–630
9/84/13 OTSB	5 Nov. 1984	56°25′N, 09°16′W	940–975
3/85/5 OTSB	15 April 1985	54°27′N, 12°25′W	2970–2980
3/85/7 OTSB	16 April 1985	55°47′N, 10°52′W	2500–2455
3/85/8 OTSB	17 April 1985	56°27′N, 09°17′W	970–1010
3/85/9 OTSB	17 April 1985	56°43′N, 09°11′W	945–1010
3/85/10 OTSB	17 April 1985	56°31′N, 09°13′W	795–805
3/85/11 OTSB	18 April 1985	56°33′N, 09°26′W	1250–1270
3/85/13 OTSB	18 April 1985	56°28′N, 09°17′W	960–995

Station No.	Date	Position (at mid-point of track on bottom if applicable)	Depth (m)
3/85/14 OTSB	18 April 1985	56°30′N, 09°12′W	720–775
3/85/17 OTSB	21 April 1985	56°54′N, 10°00′W	1955–1995
3/85/18 MBA	21 April 1985	56°27′N, 09°17′W	990–1020
3/85/19 MBA	22 April 1985	56°34′N, 09°18′W	1030–1035
3/85/20 OTSB	22 April 1985	56°34′N, 09°26′W	1225–1245
3/85/21 OTSB	22 April 1985	56°31′N, 09°39′W	1480–1500
3/85/22 MBA	22 April 1985	56°25′N, 09°17′W	995–1020
3/85/23 OTSB	23 April 1985	56°25′N, 09°18′W	995–1000
3/85/24 OTSB	23 April 1985	56°26′N, 09°17′W	980–990
3/85/25 OTSB	23 April 1985	56°25′N, 09°18′W	1000–1005
3/85/26 OTSB	23 April 1985	56°25′N, 09°16′W	940–985
3/85/27 OTSB	24 April 1985	56°24′N, 09°18′W	990–1000
3/85/28 OTSB	24 April 1985	56°35′N, 09°18′W	990–1075
3/85/29 OTSB	24 April 1985	56°50′N, 09°31′W	1690–1740
3/85/30 OTSB	24 April 1985	56°29′N, 09°38′W	1420–1480
3/85/31 OTSB	25 April 1985	56°24′N, 09°17′W	995–1020
3/85/32 OTSB	25 April 1985	56°25′N, 09°19′W	1055–1060
3/85/33 OTSB	25 April 1985	56°26′N, 09°18′W	985–1000
3/85/34 OTSB	25 April 1985	56°24′N, 09°18′W	980–990
3/85/36 OTSB	26 April 1985	56°24′N, 09°19′W	1000–1025
3/85/37 OTSB	26 April 1985	56°25′N, 09°18′W	945–985
3/85/38 OTSB	26 April 1985	56°23′N, 09°08′W	410–490
3/85/43 OTSB	27 April 1985	56°17′N, 09°12′W	565–700
3/85/44 OTSB	27 April 1985	56°18′N, 09°11′W	545–600
3/85/45 OTSB	28 April 1985	56°30′N, 09°38′W	1470–1500
3/85/46 OTSB	28 April 1985	56°25′N, 09°17′W	960–985

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