# THE NEAR-BOTTOM DISTRIBUTION OF THE GENUS *BOREOMYSIS* (CRUSTACEA: MYSIDACEA) IN THE PORCUPINE SEABIGHT, NORTH-EASTERN ATLANTIC

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HARGREAVES, P.M. 1997. The near-bottom distribution of the Genus *Boreomysis* (Crustacea: Mysidacea) in the Porcupine Seabight, North-eastern Atlantic. *Arquipélago*. Life and Marine Sciences 15A: 51-64. Ponta Delgada. ISSN 0873-4704.

The near-bottom vertical distribution of eight species of the mysid genus *Boreomysis* (Crustacea) over slope areas of the Porcupine Seabight in the North-eastern Atlantic is described. The numbers of *Boreomysis* individuals were greatest between 300 m and 1000 m, exceeding 100 per 1000 $m^3$ in three hauls at 400-500 m and 60 per 1000 $m^3$ at 500-1300 m. Below 1300 m numbers decreased rapidly down to the limit of sampling at approximately 3800 m. Within the bathymetric range 300-1300 m each of three numerically dominant suprabenthic *Boreomysis* species, tended to occupy different optimum depth strata at 400-520 m, 700-950 m and 520-1330 m respectively but overlapped slightly in distribution. In contrast four deeper-living *Boreomysis* species occurred intermittently near-bottom in the Seabight in the bathymetric range 1300-4000 m. Species distribution over a wide area of the temperate North-eastern Atlantic is discussed.

HARGREAVES, P.M. 1997. Distribuição vertical próxima do fundo do género *Boreomysis* (Crustacea: Mysidacea) em "Porcupine Seabight", Atlântico nordeste. *Arquipélago*. Ciências Biológicas e Marinhas 15A: 51-64. Ponta Delgada. ISSN 0873-4704.

Descreve-se a distribuição vertical próxima do fundo de oito espécies de misidáceos do género *Boreomysis* (Crustacea) sobre zonas de vertente do "Porcupine Seabight" no Atlântico nordeste. Os números de indivíduos de *Boreomysis* foram maiores entre os 300 m e os 1000 m, excedendo 100 indivíduos por 1000 $m^3$ em três arrastos a 400-500 m e, 60 indivíduos por 100 $m^3$ a 500-1300 m. Abaixo dos 1300 m o número de indivíduos decresce rapidamente até ao limite de amostragem, a 3800 m. Entre os níveis batimétricos de 300-1300 m cada uma das três espécies suprabênticas de *Boreomysis* numericamente dominantes tende a ocupar diferentes estratos óptimos de profundidade, a 400-520 m, 700-950 m e 520-1330 m respectivamente, embora haja ligeira sobreposição na distribuição. Em contraste, quatro espécies de *Boreomysis* que vivem a maior profundidade ocorreram intermitentemente próximas do fundo em "Seabight", nos níveis de profundidade de 1300-1400 m. Discute-se a distribuição das espécies numa vasta área no Atlântico nordeste temperado.

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## INTRODUCTION

The geographic distribution of mesopelagic mysids in the North-eastern, open Atlantic Ocean is reasonably well-known, mysid distributions having been summarised by numerous authors including NOUVEL (1942, 1943), TATTERSALL & TATTERSALL (1951), MAUCHLINE & MURANO (1977), MAUCHLINE (1980). In the open ocean mysids are found

mainly at depths below 600 m by day, many species following a suprabenthic existence. Several studies have centred on near-bottom mysid distributions. These include studies to the west of Ireland (TATTERSALL & TATTERSALL 1951), European coastal areas e.g. Bay of Biscay (LAGARDERE & NOUVEL 1980; LAGARDERE 1985; ELIZALDE et al. 1991). Data have also been made available on the vertical distribution of deep-living mysids in northern fjords (FOSSÅ 1985; KAARTVEDT 1985,1989; FOSSÅ & BRATTEGARD 1990) and in the Rockall Trough (e.g. MAUCHLINE 1986). Several studies on the distribution of mysids are based on fish stomach contents as they are an important food source (e.g. MAUCHLINE 1982)

Although mysids have been recorded near-surface as well as in deeper regions of the Porcupine Seabight between 49°N and 54°N, 10°W and 16°W relatively little is known about the bathymetric distribution of those adopting a suprabenthic existence (i.e. living just above the sea-floor) in that area. TATTERSALL & TATTERSALL (1951) described mysid species, many of which were thought to be suprabenthic, from slope areas to the west of the British Isles but at that time there were relatively few data on the zonation of such species. As a result of the extensive near-bottom sampling in the vicinity of the Porcupine Seabight, funded during the past decade as part of the Natural Environment Research Council's biology programme, it has been possible to gain further information on the distribution of numerically important species of micronekton and macroplankton including the mysid genus *Boreomysis* G.O. Sars, 1869 which is distributed over a wide bathymetric range in the Seabight. Additional data on this genus, obtained as a result of sampling with rectangular midwater trawls in areas within the Seabight and to the north and south of it, held on the biological data base at Southampton Oceanography Centre (SOC), are now also available.

The aims of this paper are to examine, describe in detail and interpret patterns of distribution of the genus *Boreomysis* found near-bottom over slope and bathypelagic regions within the Porcupine Seabight and to relate this information to environmental factors.

## MATERIALS AND METHODS

Sixty-five hauls were made in the Seabight within the area 49°27'N-52°01'N, 10°21'W-14°16'W at 60 cm-120 cm above the sea-floor using opening/closing suprabenthic (SBN) plankton nets (0.5 $m^2$ mouth area, 0.32 mm mesh). All SBN station positions are given in Table 1 (158 m - 1535 m) and Table 2 (1970 - 4080 m). Each net was mounted on top of an epibenthic sledge fitted with an odometer wheel which gave an estimate of distance travelled (see RICE et al. 1982). This distance was checked against geographic coordinates of gear positions derived via satellite navigation. Full details of SBN stations are given in (JACKSON et al. 1991).

During the past two decades samples of micronektonic and macroplanktonic mysid species were also obtained with opening/closing Rectangular Midwater Trawls (RMT1+8M) described by ROE & SHALE (1979). The RMT1M, mesh size 0.32 mm, mouth area 1 $m^2$, samples juvenile and adult *Boreomysis*, while the RMT8M, mesh size 4.5 mm, mouth area 8 $m^2$, samples mainly adults. Samples were taken either in the deep-water column and/or within 200 m of the bottom in the Porcupine Seabight and to the north and south of this area. The RMT1+8M midwater data can be compared to those obtained from the SBN net.

All samples were preserved initially in alcohol or in 5% neutralized formalin in seawater. Specimens from all hauls were identified to species and the maturity stage assessed. Individuals were classified into:- a. Juveniles (no fully developed sexual characteristics), b. Males and females (sexual characteristics well developed). All numerical data were standardised to numbers of individuals per 1000 $m^3$ water filtered.

Table 1

SBN near-bottom station positions in order of increasing depth and standardised abundances (ind. per 1000 $m^3$ numbers of numerically dominant *Boreomysis* species at depths <1700m).

| Mid-depth of haul (m) | Station position | | Day/night | Date | *Boreomysis megalops* | *Boreomysis arctica* | *Boreomysis tridens* | *Boreomysis microps* |
|---|---|---|---|---|---|---|---|---|
| 158 | 50° 35'N | 10° 20'W | N | Jul. 1982 | | | | |
| 400 | 49° 27'N | 11° 21'W | N | Sept. 1979 | 62.89 | | | |
| 400 | 51° 39'N | 14° 16'W | N | Aug. 1979 | 731.18 | | | |
| 497 | 52° 01'N | 13° 31'W | N | Mar. 1982 | 10.73 | 27.27 | | |
| 510 | 51° 19'N | 14° 22'W | Dusk | Jul. 1979 | 4.32 | 4.32 | | |
| 522 | 51° 26'N | 13° 58'W | D | May 1981 | | 37.16 | | |
| 525 | 52° 02'N | 13° 27'W | D | May 1981 | 4.56 | 16.72 | | |
| 555 | 51° 25'N | 13° 57'W | D | May 1981 | | 64.21 | | |
| 700 | 51° 01'N | 14° 06'W | D | Jul. 1979 | | 1.56 | 4.68 | |
| 925 | 49° 18'N | 11° 42'W | D | Sept. 1979 | | 97.67 | 1.16 | |
| 940 | 51° 47'N | 13° 13'W | D | May 1981 | | 1.46 | 24.78 | |
| 955 | 51° 48'N | 13° 09'W | D | May 1981 | | 6.41 | 83.33 | |
| 980 | 51° 26'N | 13° 24'W | D | Jul. 1979 | | | 1.97 | |
| 1081 | 51° 23'N | 13° 22'W | D | Mar. 1982 | | | 78.47 | |
| 1097 | 51° 30'N | 13° 12'W | D | May 1983 | | | 1.12 | |
| 1115 | 50° 40'N | 14° 10'W | N | Jul. 1979 | | | 40.00 | |
| 1125 | 49° 11'N | 12° 19'W | D | Sept. 1979 | | | 3.60 | |
| 1130 | 50° 43'N | 13° 56'W | D | Jul. 1979 | | | 34.11 | |
| 1142 | 51° 41'N | 13° 00'W | N | Sept. 1981 | | | 28.90 | |
| 1160 | 51° 41'N | 12° 58'W | N | May 1983 | | | 4.64 | |
| 1201 | 51° 41'N | 12° 59'W | N | Sept. 1981 | | | 52.08 | 0.74 |
| 1286 | 51° 37'N | 12° 59'W | D | Mar. 1982 | | | 2.00 | |
| 1293 | 51° 38'N | 12° 59'W | Dawn | Mar. 1982 | | | 4.50 | |
| 1295 | 51° 37'N | 12° 59'W | D | Apr. 1982 | | | 7.81 | |
| 1300 | 51° 37'N | 12° 59'W | D | Apr. 1982 | | | 2.82 | |
| 1300 | 51° 18'N | 13° 25'W | N | May 1983 | | | 33.41 | |
| 1303 | 51° 38'N | 13° 00'W | D | Mar. 1982 | | | 7.15 | |
| 1306 | 51° 37'N | 12° 59'W | N | Apr. 1982 | | | 2.82 | |
| 1335 | 51° 37'N | 12° 59'W | N | Mar. 1982 | | | | |
| 1380 | 51° 25'N | 13° 03'W | N | May 1981 | | | | |
| 1500 | 51° 20'N | 13° 05'W | D | Mar. 1982 | | | | |
| 1517 | 51° 33'N | 12° 54'W | D | Jul. 1982 | | | | |
| 1535 | 51° 15'N | 13° 12'W | N | May 1981 | | | | |

Two-sample t-tests (RYAN et al. 1985) were performed to test the null hypothesis that at the 95% level of confidence the abundances of *Boreomysis* specimens in day and night hauls were similar. Similar t-tests were also performed on totals, males, females and juveniles of *B. tridens*.

## HYDROGRAPHY

During the past few decades various data have become available on the hydrography of the Porcupine Seabight and Rockall Trough (e.g. COOPER 1952; TULLOCH & TAIT 1959). Further data have been obtained by direct conductivity, temperature, depth (CTD) measurements made during 'RRS Discovery' investigations. For example during Autumn 1979, hydrographic data were obtained in the Seabight centred on 49°40'N, 14°06'W (to a maximum depth of 1980 m). From 100 m to 750 m the characteristics were similar to those of North Atlantic Central water (NACW - see SVERDRUP et al. 1942) with a potential temperature >8.5°C, salinity >35.45 ppt. at 750 m. Below 320 m the salinity increased and from 750 to 1140 m T-S characteristics were close to those of highly saline Gulf of Gibraltar (GG) Water (COOPER 1952; WRIGHT & WORTHINGTON 1970). Salinity values declined to <35.4 ppt. at 7°C and at 1900 m the T-S

Table 2

SBN near-bottom station positions in order of increasing depth and standardised abundances (ind. per 1000 m$^3$ of numerically dominant *Boreomysis* species at depths >1700.

| Depth of haul (m) | Position | | Day / Night | Date | *B. microps* | *B. richardi* | *B. inermis* | *B. bispinosa* | *B. incisa* | *B. sp.* |
|---|---|---|---|---|---|---|---|---|---|---|
| 1970 | 51° 01'N | 13° 06'W | Dusk | Jul. 1979 | | | | | | |
| 1985 | 51° 06'N | 12° 54'W | N | Apr. 1983 | | | | | | |
| 1990 | 51° 05'N | 12° 58'W | D | May 1981 | | | | | | |
| 2000 | 51° 04'N | 12° 56'W | N | Mar. 1982 | 1 | | | | | |
| 2020 | 51° 04'N | 12° 53'W | D | May 1981 | | | | | | |
| 2440 | 50° 29'N | 13° 02'W | N | Jul. 1979 | | | 1.48 | | | |
| 2495 | 50° 27'N | 12° 59'W | N | Mar. 1982 | | | | | | |
| 2515 | 50° 29'N | 13° 06'W | D | May 1981 | | | 2.08 | | 2.08 | |
| 2540 | 50° 29'N | 13° 10'W | D | Nov. 1980 | | | 5.56 | 1.39 | 5.56 | |
| 2620 | 50° 23'N | 13° 20'W | N | May 1981 | | | 2.43 | 2.43 | | |
| 2645 | 50° 25'N | 13° 20'W | N | Sept. 1979 | | | | | | |
| 2650 | 50° 25'N | 13° 19'W | N | Sept 1979 | | 0.64 | 2.55 | | | |
| 2665 | 50° 21'N | 13° 23'W | N | May 1981 | | 1.05 | | | | |
| 2735 | 50° 18'N | 13° 24'W | D | Jul. 1982 | | | | | | |
| 2736 | 50° 14'N | 13° 27'W | Dawn | May 1981 | | | 0.95 | | | |
| 2747 | 50° 19'N | 13° 26'W | N | Sept. 1979 | | | 6.09 | 2.20 | | 1 |
| 2758 | 50° 16'N | 13° 31'W | D | Sept. 1979 | | | | | | 2.20 |
| 2775 | 50° 16'N | 13° 29'W | N | Mar. 1982 | | | | 0.61 | | |
| 2780 | 50° 10'N | 13° 22'W | N | Apr. 1982 | | | | | 9.11 | |
| 2790 | 50° 16'N | 13° 31'W | N | May 1981 | | 1.06 | 1.25 | | 1.25 | |
| 2875 | 50° 11'N | 13° 32'W | N | Jul. 1979 | | | 1.46 | | 4.88 | |
| 2900 | 50° 15'N | 13° 38'W | N | Jul. 1982 | | | 1.25 | 1.25 | | 1.25 |
| 3020 | 50° 11'N | 13° 40'W | D | Nov. 1980 | | | | 0.95 | | 0.95 |
| 3490 | 50° 07'N | 13° 53'W | D | Mar. 1982 | | | | | | 1.91 |
| 3520 | 50° 07'N | 13° 53'W | Dusk | Jul. 1979 | | | | | | |
| 4035 | 49° 50'N | 14° 05'W | D | Sept. 1981 | | | | | | |
| 4050 | 49° 45'N | 14° 08'W | N | Sept. 1979 | | | | 1.76 | | 1.76 |
| 4050 | 49° 45'N | 14° 08'W | D | Sept. 1981 | | | | | | |
| 4070 | 49° 48'N | 14° 10'W | N | Sept. 1981 | | | | | | |
| 4080 | 49° 47'N | 14° 10'W | N | Mar. 1982 | | | | | | |

characteristics were close to those of Labrador Sea Water (LSW) and North Atlantic Deep Water (NADW), (Potential Temperature =< 3.0°C, S = 35 ppt.).

Further south at latitude 42°N, 17°W where some comparative biological samples were also obtained (during 1978), mixed NACW/GG water (Potential Temperature 5-7°C), lying below highly saline GG water, was prevalent at depths between 1100 m and 1900 m. Below 2100 m at approximately 3°C there was a slight change in the T-S slope which was indicative of mixed LSW and NADW.

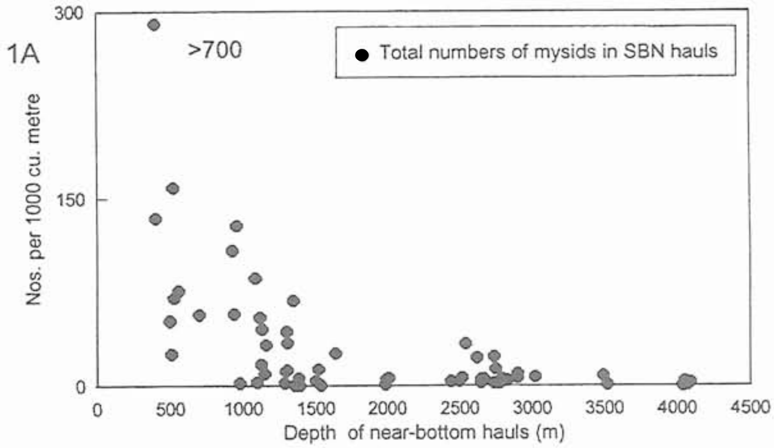
Further CTD sampling during 1994 in the Seabight at 49°08'-49°25'N, 12°14'-12°48'W confirmed the presence of Gulf of Gibraltar water between 500 and 1000 m. T-S profiles taken over slope areas in the region of 49°30'N, 11°-11°30'W during spring 1994 were typical of NACW (Potential Temperature 10.5-11.5°C, salinity 35.5 ppt) throughout most of the water column. There was less evidence of the highly saline Gulf of Gibraltar water found at 49°08'N, 12°14'W.

As expected, further north in the Rockall Trough (centred at 54°30'N, 13°W) the temperature and salinity in the 0-50 m near-surface water layer were lower than in the Seabight. At depths between 60 and 200 m T-S values fell close to the mixing line for NACW but the salinity content was slightly higher due to some continued influence of Gulf of Gibraltar mixed water which was still detectable down to at least 1250 m. Below this depth it had combined with NADW (see COOPER 1952) which at 53°N arises partly from LSW water and Norwegian Sea Deep water (LEE & ELLETT 1967).

## RESULTS

### SUPRABENTHIC NET SAMPLES

A summary of total abundances of mysids sampled near-bottom with the suprabenthic net (SBN) is presented in Fig. 1a. Mysid abundances were variable but tended to be greatest in the shallowest position sampled at 50°35'N, 10°20'W, centred over the 158 m isobath where specimens of *Mysideis* were numerically dominant. No specimens of the genus *Boreomysis* were recorded at this position but they were numerically dominant in the bathymetric range 400-1000 m where they averaged 56% of the total mysid catch (Fig. 1b). Other mysid genera, widely distributed within the depth range 500-1000 m, included *Amblyops* and *Pseudomma*. At depths below 1000 m total numbers of mysids were relatively low and the numerically dominant genera were



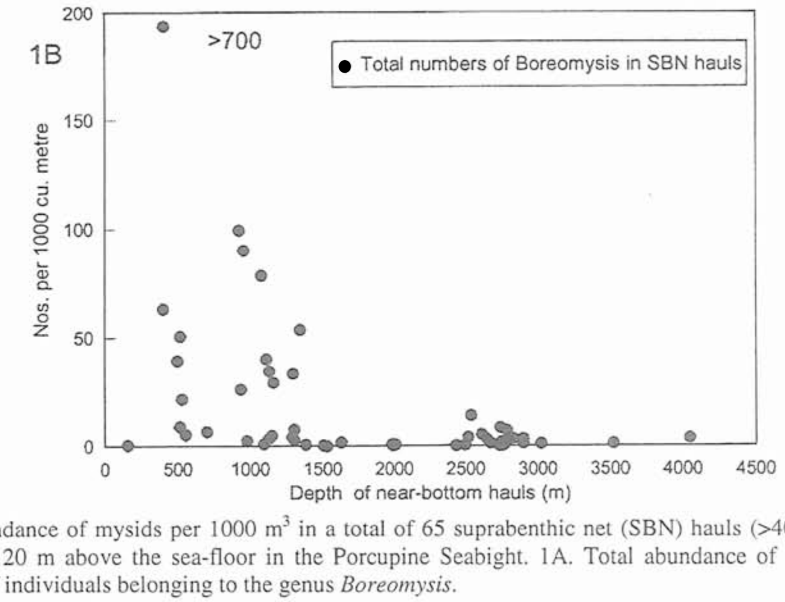




Fig. 1. Abundance of mysids per 1000 $m^3$ in a total of 65 suprabenthic net (SBN) hauls (>400 m water depth) taken at 60-120 m above the sea-floor in the Porcupine Seabight. 1A. Total abundance of mysids; 1B. Total abundance of individuals belonging to the genus *Boreomysis*.

represented by *Dactylerythrops*. The contribution of *Boreomysis* species to the total mysid catch below 1000 m averaged only 14%. Three species were found in the bathymetric range 400-1300 m (Table 1, Fig. 2). *B. megalops* was recorded at 400-525 m, mainly by night. Unusually large numbers of 731 individuals per 10000 $m^3$ were recorded in September 1979. *Boreomysis arctica* was recorded mainly by day at 497-955 m with maxima at 555 m and 925 m (64 and 97 individuals per 1000 $m^3$ in May and September respectively). *B. tridens* occurred in day and night hauls mainly at 700-1300 m with maxima of 83 and 78 individuals per 1000 $m^3$ at 955 m and 1081 in May and March respectively (Table 1, Fig. 2) but there were several deeper occurrences which might have been due to contamination from mid-water.

Several deeper living species i.e. *B. microps* and *B. richardi* occurred intermittently near-bottom at 1280-2000 m and 2650-2790 m respectively (Table 2, Fig. 2). *B. inermis* (= *B. scyphops*) was found mainly between 2400 m and 3000 m while *B. bispinosa* occurred between 2500 m and 4050 m. *Boreomysis incisa* was recorded intermittently below 2400 m. The bathymetric and topographic distribution of the eight *Boreomysis* species recorded in the Seabight is given in Fig. 3. This shows a clear relationship between depth and the distribution of the suprabenthic *Boreomysis* species. In addition there were several other damaged *Boreomysis* specimens found. One specimen at depths >2000 m had some morphological features similar to those of *B. sibogae* but was too damaged to identify with certainty. There were several other specimens which broadly resembled *B. tridens* but which had a lobate anterior carapace rather than the characteristic tridentate type. Two further specimens were damaged but had an anterior carapace which resembled that of *B. atlantica*. A full list of *Boreomysis* species together with authorities is given in Appendix I.

The distribution of females, males and juveniles of the numerically dominant *B. arctica* and *B. tridens* is summarised in Table 3. The data were insufficient to be able to comment on ontogenetic migration, though there was some indication of seasonal reproductive activity in *B. tridens* in that juveniles were numerous during May, thus supporting MAUCHLINE'S (1986) view that it is a winter to spring breeder.

A comparison of day and night mean abundances of *Boreomysis* is given in Table 4. T-tests showed that there was no significant difference between day and night mean values for adults, juveniles or totals ($p$ = 0.21). Similar t-tests were also performed on the frequently occurring species *B. tridens* but no

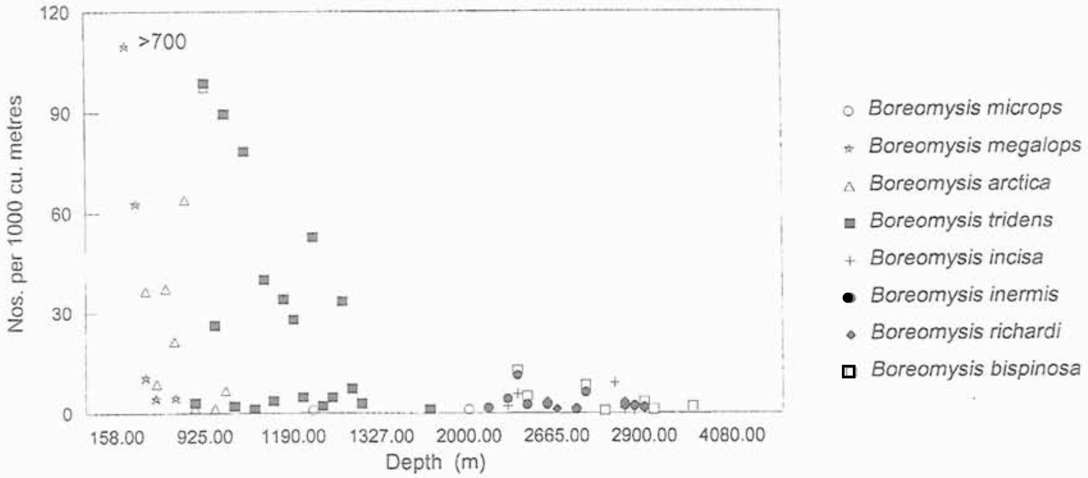



Fig. 2. Abundance of eight species of *Boreomysis*, caught with the SBN, plotted against the depth of capture

significant differences were found between day and night samples ($p$ = 0.34-0.54 - see Table 4). There were too few day data from depths above 700 m to comment on the vertical migration patterns of *B. megalops* or *B. arctica*.

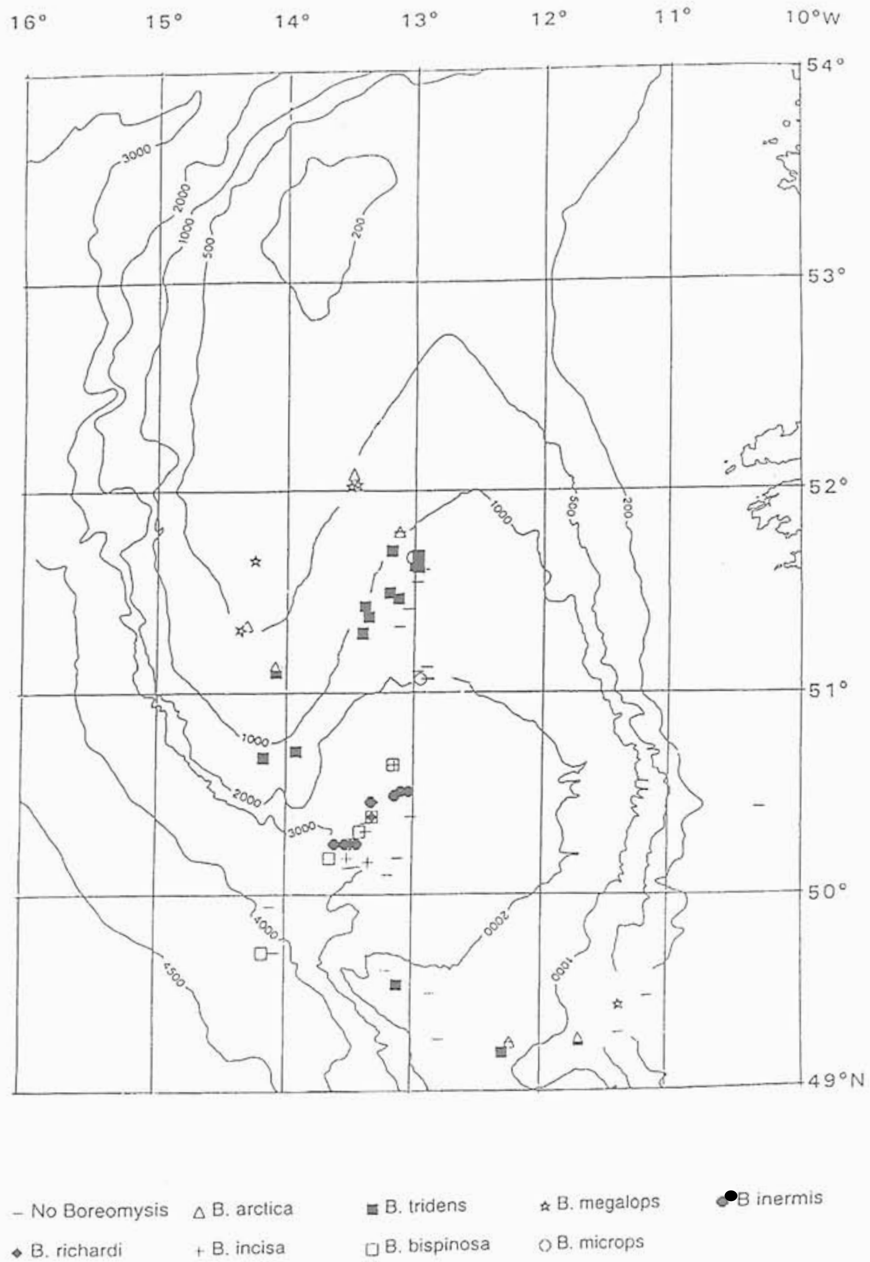



Fig. 3 Summary of the horizontal and bathymetric distribution of eight species of the genus *Boreomysis* sampled during SBN hauls. Contours in metres.

### Vertical Distribution in the Water Column

Recent data held in the SOC database obtained as a result of midwater and near-bottom sampling with Rectangular Midwater Trawls, are compared to the present SBN data. The SBN and RMT8 data may be split broadly into two categories based on depth distribution of species:-

A. Those species which are relatively shallow-living at varying depths between 300 m and 1300 m i.e. *B.megalops*, *B. arctica* and *B. tridens*. Some examples of occurrences in RMT8 hauls are shown in Table 5a.

B. Those species which are deep-living at 1000-4000 m, e.g. *B. microps, B. richardi, B. bispinosa.* Some examples of occurrences in RMT8 hauls are shown in Table 5b.

Although there were several occurrences of *B. arctica* and *B. tridens* in midwater in the Seabight (Table 5a), hardly any of the three shallow-living species were caught by the RMT8 in midwater at depths >200 mab (metres above the bottom) except during April 1994 when several specimens of *B. arctica* and *B. tridens* were recorded by night at different stations approximately 220 mab and *B. megalops* at 300 mab.

Table 3

Summary of the numbers of males, females and juveniles of *B.arctica* and *B. tridens* from SBN samples at given depth ranges in the Seabight.

| Depth Range (m) | >4 mm sample | | | 2-4 mm sample | | |
|---|---|---|---|---|---|---|
| | Males | Females | Juveniles | Males | Females | Juveniles |
| *B. arctica* | | | | | | |
| 400-600 | 8 | 15 | 77 | - | | 41 |
| 600-800 | 1 | - | - | - | - | - |
| 800-1000 | 16 | 51 | 5 | - | 3 | 15 |
| Totals | 25 | 66 | 82 | - | 3 | 56 |
| *B. tridens* | | | | | | |
| 600-800 | | 1 | 1 | - | - | - |
| 800-1000 | 10 | 5 | 23 | - | - | 19 |
| 1000-1200 | 31 | 55 | 42 | - | - | 16 |
| 1200-1400 | 24 | 25 | 88 | - | - | 89 |
| 1600-1800 | - | 1 | - | - | - | - |
| Totals | 65 | 87 | 154 | - | - | 124 |

Table 4

Statistical comparison of diurnal and nocturnal abundances (ind. per 1000 m$^3$) of *Boreomysis* spp. and *B. tridens* from SBN hauls taken between 400 m and 1300 m. Dusk and dawn hauls are excluded from the analysis.

| | Day Mean Nos. | Day S.Dev. | Night Mean Nos. | Night S.Dev. | P. value |
|---|---|---|---|---|---|
| Total *Boreomysis* * | 36.8 | 37.08 | 35.1 | 36.45 | 0.21 |
| Male *B. tridens* | 2.9 | 5 | 5.67 | 5.19 | 0.34 |
| Females *B. tridens* | 4.78 | 8.97 | 7.51 | 6.81 | 0.54 |
| Juvenile *B. tridens* | 11.54 | 19.07 | 17.97 | 15.15 | 0.36 |

Comparative midwater and near-bottom RMT8 data on the deeper living *Boreomysis* species i.e. *B. microps*, *B. bispinosa* and *B. richardi* at latitudes 31°N-55°N, (SOC Biological Database; HARGREAVES 1984, 1985; HARGREAVES & MURANO 1996) summarised in Table 5b, show that three of the deep-living species recorded were broadly bathypelagic though sometimes adopting a suprabenthic existence. Because there are relatively few data available on the distribution of these deep-living species, it is not clear whether they inhabit overlapping depth zones. A fourth species *B. inermis* has been found previously in relatively large numbers near-bottom and in several benthic samples so it may be primarily suprabenthic but also bathypelagic for part of its life-cycle. Additional sampling with the RMT1M which samples *Boreomysis*, albeit in low numbers, confirmed the distribution of numerically dominant species such as *B. microps*.

## DISCUSSION

The data from the SBN and RMT8 hauls provide substantial complementary information particularly about the distribution of eight numerically dominant *Boreomysis* species recorded in the Porcupine Seabight. The abundance values (individuals per 1000 $m^3$) of the shallow-living *B. megalops*, *B. arctica* and *B. tridens* and their depth distributions in the Seabight are broadly in agreement with values given by ELIZALDE et al. (1991) for the Bay of Biscay, FOSSÅ & BRATTEGARD (1990) (*B. megalops* and *B. arctica* in Norwegian fjords) as are those of the deeper-living species previously recorded in the Atlantic (HARGREAVES 1985; HARGREAVES & MURANO 1996).

Although population fluctuations as a result of aggregations and migrations are common among mysids (MAUCHLINE 1980), the present data suggest that in the genus *Boreomysis*, species separation related to depth is prevalent in some suprabenthic species inhabiting bathymetric ranges between 200 m and 1000 m. ELIZALDE et al. (1991) also found that species separation occurs in several suprabenthic species, including *B. megalops* and *B. tridens* at depths between 300 m and 1000 m over the continental slope in the Bay of Biscay. However, they found that B. *arctica* had a broad, less well-defined depth range which sometimes overlapped with that of *B. tridens*. Our data suggest that *B. megalops* and *B. arctica* tend to be found in slope areas, often adopting a suprabenthic existence though sometimes undertaking excursions several hundred metres up into midwater. Certainly *B. megalops* and *B. arctica* are known to inhabit the mesopelagic zone, at least part of the population undertaking upward diel vertical migrations by night (MAUCHLINE & MURANO 1977; BRATTEGARD 1984; KAARTVEDT 1989). *B. megalops* has also been recorded near-bottom mainly at depths <250 m in a Norwegian fjord during most of the year, juveniles tending to remain closer to the bottom than adults (FOSSÅ 1985). Previous data suggests that *B. tridens* is primarily a lower meso- and bathy- pelagic species (BRATTEGARD 1984).

The present data are ambivalent for deep-living *Boreomysis* species found over 1500-4000 m depths. *B. microps* is known to be meso- or bathypelagic having been found in midwater and also in fish stomachs from approximately 225 m depth to the west of Iceland (ASTTHORSSON 1985; MAUCHLINE 1986). Species such as *B. incisa*, *B. richardi* and *B. bispinosa* tend to inhabit greater depths in the Seabight. It seems that they are not restricted to a suprabenthic existence having been recorded also in bathypelagic zones in open oceanic areas (SOC biological data Base; HARGREAVES & MURANO 1996). These deep-living species may be opportunistic, impinging on the sea-floor if food is readily available there. Although our data suggest that suprabenthic species of *Boreomysis* at depths <1000 m make excursions up into the water column, the timing and extent of their migrations and the percentage of the population involved is unclear. FOSSÅ (1985) examining near-bottom vertical zonation during daytime of suprabenthic mysids found that different species may occupy different

Table 5a

Depth distribution of three relatively shallow-living *Boreomysis* species recorded in RMT8 and suprabenthic samples in the North-eastern Atlantic between 49°N and 56°N (mab: metres above bottom)

| Station Position | Depth range (m) | Day/Night | Date | *Boreomysis megalops* | *Boreomysis tridens* | Source |
|---|---|---|---|---|---|---|
| **Rect. Midwater Trawl (8)** | | | | | | |
| 49°20'N, 11° 22'W | 10-300 m (slope) | N | May 1994 | + | | SOC Biological Data Base |
| 51°38'N, 14° 20'W | 380-395 (within 20 m.a.b.) | N | July 1979 | + | | " |
| 49°30'N, 11° 30'W | 400-600 (within 220 m.a.b.) | N | May 1994 | | | " |
| 49°30'N, 11° 30'W | 500-600 ( within 19 m.a.b.) | D | May 1994 | | | " |
| 56°23'N, 09° 09'W | 560-690 (10-49 m.a.b.) | D | Nov. 1984 | | + | " |
| 51°03'N, 14° 14'W | 655-680 (within 20 m.a.b.) | D | July 1979 | | + | " |
| 56°34'N, 09° 13'W | 800-900 (10-44 m.a.b.) | D | Nov. 1984 | | + | " |
| 49°14'N, 12° 15'W | 900-1000 (300-40 m.a.b.) | N | April 1994 | | + | " |
| 56°44'N, 09° 11'W | 1030-1105 (11-38 m.a.b.) | D | Nov. 1984 | | + | " |
| 56°20'N, 09° 31'W | 1340-1390 (10-40 m.a.b.) | N | Nov. 1984 | | + | " |
| **Macer-Giroq sledge** | | | | | | |
| Cap Ferret Trench (Biscay) (Approx. 44°N, 2° 10'W) | 0-420 m (within 0.4-1.5 m.a.b.) | Day and Night | Apr., May, July 1989 | + | | Elizalde, Dauvin & Sorbe (1991) |
| " | 0-1100 m (within 0.4-1.5 m.a.b.) | Day and Night | Apr., May, July 1989 | | | " |
| " | 600-1000 m (within 0.4-1.5 m.a.b.) | Day and Night | Apr., May 1989 | | + | " |

Table 5b

Depth distribution of four relatively deep-living *Boreomysis* species recorded in RMT8 samples in the North-east Atlantic between 31°N and 56°N (mab: metres above bottom)

| Position | Sampling depth | Date | *Boreomysis microps* | *Boreomysis inermis* | *Boreomysis richardi* | *Boreomysis bispinosa* | Source |
|---|---|---|---|---|---|---|---|
| 56° 44'N, 09° 11'W | 1030-1105 (11-38 m.a.b.) | Nov. 1984 | + | | | | SOC Database |
| 50° 39'N, 13° 59'W | 1090-1160 (within 20 m.a.b.) | July 1979 | + | | | | " " |
| 50° 06'N, 13° 12'W | 2640-2750 (within 20 m.a.b.) | July 1979 | | + | | | " " |
| 49° 53'N, 14° 04'W | 3500-3710 (within 20 m.a.b.) | July 1979 | + | | | | " " |
| 49° 53'N, 12° 49'W | 1100-1425 (within 22 m.a. b.) | Sept. 1979 | + | | | | " " |
| 49° 53'N, 14° 35'W | 1000-1155 (within 20 m.a.b.) | Sept. 1979 | + | | | | " " |
| 49° 53'N, 13° 09'W | 1480-1670 (within 17 m.a.b.) | Sept. 1979 | + | | | | " " |
| 42° 00'N, 21° 00'W | 3976-3991 (40-55 m.a.b) | June 1984 | + | + | | | " " |
| 31° 30'N, 25° 30'W | 5415-5430 (10-25 m minimum a.b.) | June 1984 | | + | | | " " |
| 42° 00'N, 17° 00'W | 4300-4500 (near-bottom) | May 1978 | | + | | | " " |
| 49° 40'N, 14° 06'W | 700-1900 midwater | Sept. 1979 | + | | | | " " |
| 42° 00'N, 17° 00'W | 900-2000 midwater | May 1978 | + | | | | Hargreaves (1984) |
| 42° 00'N, 17° 00'W | 2000-3000 midwater | May 1978 | | | | + | " |
| 42° 00'N, 17° 00'W | 2790-3500 midwater | May 1978 | | + | | | Hargreaves and Murano (1996) |
| 42° 00'N, 21° 00'W | 3480-3530 midwater | June 1984 | | + | | | " |
| 42° 00'N, 21° 00'W | 3470-3530 midwater | June 1984 | | | + | | " |

heights above the bottom at different localities. Differences in the amount of swimming activity between juveniles and adults may also affect their preferred heights above the sea-floor.

Two shallow-living species in the Seabight i.e. *B. megalops* and *B. arctica* were found in water with T-S characteristics close to that of NACW or mixed NACW/GG water rather than in highly saline GG water or cold NADW. On the other hand it is known that they are well able to tolerate highly saline Gibraltar water (ELIZALDE et al. 1991) and also the cool, low salinity water of Norwegian Fjords (FOSSÅ 1985; KAARTVEDT 1989) as shown in Table 6 which provides some examples of temperature and salinity ranges in the north-eastern Atlantic at which *Boreomysis* species have been recorded.

It is likely that advection may also be a factor in the dispersion of shallow-living species on the upper slopes of the Seabight. On the other hand, observations suggest that some species of mysid are able to maintain a population partly by behavioural mechanisms. KAARTVEDT (1989) examining distribution patterns of mysids including *B. megalops* in Norwegian fjords concluded that during periods of strong currents, maintenance of a suprabenthic mysid population within a given locality is not possible if individuals, performing upward diel migrations by night, drift passively in the pelagic zone. Behavioural adaptations resulting in a reduction in diel migratory activity during such periods may reduce the possibility of advection and dispersion. These findings support the previous observations that mysid species may show a strong orientation to water currents and that advection of populations is reduced if individuals remain close to the sea-floor. (e.g. CLUTTER, 1967, 1969; MAUCHLINE 1980; FOSSÅ 1985; JAHN & LAVENBERG (1986)). Indeed CLUTTER, (1967) concluded that mysid zonation entails competition for space rather than food.

O'BRIAN (1988) suggests that clustering may not only help some mysid species to maintain their position in the environment but also act as an antipredation measure, the maintenance of the position of the cluster varying with substrate attraction and hydrographic conditions. Indeed, LAGARDERE (1985) and also ELIZALDE et al. (1991), examining samples from the continental slope of the Bay of Biscay, found some correlation with the distribution of suprabenthic mysids and the type of sedimentation of the sea-floor.

Table 6

Some examples of the temperature and salinity values in the North-eastern Atlantic at which given *Boreomysis* species have been recorded previously.

| Species | Gear | Month/ year | Day/ Night | Optimum depth (m) | Temp °C | Salinity (ppt) | Location | Source |
|---|---|---|---|---|---|---|---|---|
| *B. megalops* | Midwater trawl | May 1994 | N | 200-300 | 10.6 | 35.507 | Seabight | SOC data base |
| " " | Epibenthic sledge | May-July 1980 | D/N | 210 | 6.3-7.7 | 34.75-35.1 | 60°25'N, 5°06'E | Fosså (1985); Kaartvedt (1989) |
| *B. arctica* | Midwater trawl | May 1994 | D | 520-602 | 10.1 | 35.47 | Seabight | SOC data base |
| " " | Epibenthic sledge | May-July 1989 | D/N | 346-1099 | 10-11 | 35.6-35.75 | Biscay | Elizalde et al. (1991) |
| " " | Epibenthic sledge | May-July 1980 | D/N | 210 | 6.3 | 34.83-35.0 | 60°25'N, 5°06'E | Fosså (1985) |
| *B. tridens* | Midwater trawl | May 1994 | N | 900-1000 | 9.1-9.3 | 35.50-35.60 | Seabight | SOC data base |
| " " | Epibenthic sledge | | D/N | 740-1099 | 9.5-10 | 35.75-35.78 | Biscay | Elizalde et al. (1991) |

Deep-living species such as *B. richardi*, *B. bispinosa* and *B. inermis*, although relatively sparse (<10 individuals per 1000 $m^3$ in any haul) were present in bathypelagic realms across a wide area from 42°17'N to 50°30'N 13°30'W at depths >2000 m, a region characterised by cool mixed NADW. There was is little evidence of a strong vertical separation of species. These species may not be primarily suprabenthic, having been sampled relatively frequently in midwater trawls.

## ACKNOWLEGEMENTS

I am grateful for the help of numerous colleagues who assisted with the collection and curating of material. I also acknowledge the valuable input of the referees who provided constructive comments.

## REFERENCES

ASTTHORSSON, O.S. 1985. Mysids occurring in the stomachs of cod caught in the Atlantic water south and west of Iceland. *Sarsia* 70: 173-178.

BRATTEGARD, T. 1984. Crossing the border between pelagos and benthos: on the ecology of supposedly mesopelagic and bathypelagic species of *Boreomysis* (Crustacea: Mysidacea). *19th European Marine Biological Symposium. Plymouth, September.*

CLUTTER, R.I. 1967. Zonation of near-shore mysids. *Ecology* 48: 200-208.

CLUTTER, R.I. 1969. The microdistribution and social behaviour of some pelagic mysid shrimps. *Journal of Experimental Marine Biology and Ecology* 3: 125-155.

COOPER, L.H.N. 1952. The Physical and Chemical Oceanography of the waters bathing the continental slope of the Celtic Sea. *Journal of the Marine Biological Association of the United Kingdom* 30: 465-510.

ELIZALDE, E., J.C. DAUVIN & J.C. SORBE 1991. Les Mysidacés suprabenthiques de la marge sud du canyon du Cap Ferret (golfe de Gascogne): répartition bathymétrique et activié natatoire. *Annales de l'Institut Océanographique, Paris.* 67: 129-144.

FOSSÅ, J.H. 1985. Near-bottom vertical zonation during day-time of deep-living hyperbenthic mysids (Crustacea: Mysidacea). *Sarsia* 70: 297-307.

FOSSÅ, J.H. & T. BRATTEGARD 1990. Depth distributions of mysids in fjords of western Norway. *Marine Ecology Progress Series* 67: 7-18.

HARGREAVES, P.M. 1984. Vertical distribution of Decapoda Euphausiacea and Mysidacea at 42°N, 17°W. *Biological Oceanography* 3: 431-464.

HARGREAVES, P.M. 1985. The distribution of Mysidacea in the open ocean and near-bottom over slope regions in the northern North-east Atlantic Ocean during 1979. *Journal of Plankton Research* 7:241-161.

HARGREAVES, P.M. & M. MURANO 1996. Mysids of the genus *Boreomysis* from abyssopelagic regions of the North-eastern Atlantic. *Journal of the Marine Biological Association of the United Kingdom* 76: 605-674.

JACKSON, P.A.B., M.H. THURSTON & A.L. RICE 1991. Station data for the IOS Benthic Biological Survey of the Porcupine Seabight region (NE Atlantic) 1977-1989. *Institute of Oceanographic Sciences Deacon Laboratory Report* No. 281, 88 pp.

JAHN, A.E. & R.J. LAVENBERG 1986. Fine-scale distribution of nearshore, suprabenthic fish larvae. *Marine Ecology Progress Series* 31:223-231.

KAARTVEDT, S. 1985. Diel changes in small-scale vertical distribution of hyperbenthic mysids. *Sarsia* 70: 287-295.

KAARTVEDT, S. 1989. Retention of vertically migrating suprabenthic mysids in fjords. *Marine Ecology Progress Series* 57: 119-128.

LAGARDERE, J.-P. 1985. Biogéographie et composition taxonomique du peuplement abyssal de Mysidacés. Pp. 425-428 in: LAUBIER L. & C. MONNIOT (Eds). *Peuplements profonds du Golfe de Gascogne: campagnes Biogas* Brest: IFREMER.

LAGARDERE, J.-P. & H. NOUVEL 1980. Les Mysidacés du talus continental du Golfe de Gascogne. II. Familles des Lophogastridae, Eucopiidae et Mysidae (Tribu des Erythropini exceptée). *Bulletin du Museum National d'Histoire Naturelle, Paris.* (Serie 4) 2: 375-412.

LEE, A. & D. ELLETT 1967. On the water masses of the Northwest Atlantic Ocean. *Deep Sea Research* 14: 183-190.

MAUCHLINE, J. 1980. The Biology of Mysids and Euphausiids. *Advances in Marine Biology* 18:1-681.

MAUCHLINE, J. 1982. The predation of mysids by

fish of the Rockall Trough, northeastern Atlantic Ocean. *Hydrobiologia* 93: 85-99.

MAUCHLINE, J. 1986. The biology of the deep-sea species of Mysidacea (Crustacea) of the Trough. *Journal of the Marine Biological Association of the United Kingdom* 66: 803-824.

MAUCHLINE, J. & M. MURANO 1977. World List of Mysidacea, Crustacea. *Journal of the Tokyo University of Fisheries* 64: 39-88.

NOUVEL, H. 1942. Diagnoses préliminaires de Mysidacés nouveaux provenant des Campagnes du Prince Albert I$^{er}$ de Monaco. *Bulletin de l'Institute oceanographique* No. 831: 12 pp.

NOUVEL, H. 1943. Mysidacés provenant des campagnes du Prince Albert I$^{er}$ de Monaco. *Résultats des Campagnes Scientifiques accomplies sur son Yacht par Albert I Monaco* pp: 1-128.

O'BRIAN, D.P. 1988. Direct Observations of Clustering (schooling and swarming) behaviour in mysids (Crustacea:Mysidacea). *Marine Ecology Progress Series* 42: 235-246.

RICE, A.L., A.G. ALDRED, E. DARLINGTON & R.A. WILD 1982. The qualitative estimate of the deep-sea megabenthos: a new approach to an old problem. *Oceanologia Acta* 5: 63-72.

ROE, H.S. J. & D.M. SHALE 1979. A new multiple rectangular midwater trawl (RMT1 + RMT8M) and some modifications to the Institute of Oceanographic Sciences' RMT 1 + 8. *Marine. Biology* 50: 283-288.

RYAN B.F., B.L. JOINER & A.T. RYAN 1985. *Minitab Handbook*. 2nd. edition. Boston: Duxbury Press.

SVERDRUP, H.U., M.W. JOHNSON & R.H. FLEMING 1942. The Oceans: Their physics, chemistry and general biology. New York: Prentice -Hall. 1087 pp.

TATTERSALL, W. M. & O.S. TATTERSALL 1951. *The British Mysidacea*. Ray Society. 460 pp.

TULLOCH D.S. & J.B. TAIT 1959. Hydrography of the North-western approaches to the British Isles. *Marine Research* 1: 32 pp.

WRIGHT, W.R. & L.V. WORTHINGTON 1970. The water masses of the North Atlantic Ocean: a volumetric census of temperature and salinity. *Serial Atlas of the Marine Environment*. American Geophysical Society. Folio 19: 8 pp.

*Accepted 3 July 1997.*

## APPENDIX I

LIST OF MYSID SPECIES DISCUSSED, TOGETHER WITH THEIR AUTHORITIES.

Mysida

*Boreomysis arctica* Krøyer, 1861
*Boreomysis atlantica* Nouvel, 1942
*Boreomysis bispinosa* O.Tattersall, 1955
*Boreomysis incisa* Nouvel 1942
*Boreomysis inermis* (Willemoes-Suhm, 1874)
*Boreomysis megalops* G.O. Sars, 1872
*Boreomysis microps* G.O. Sars, 1883
*Boreomysis richardi* Nouvel, 1942
*Boreomysis sibogae* Hansen, 1910
*Boreomysis tridens* G.O. Sars, 1870