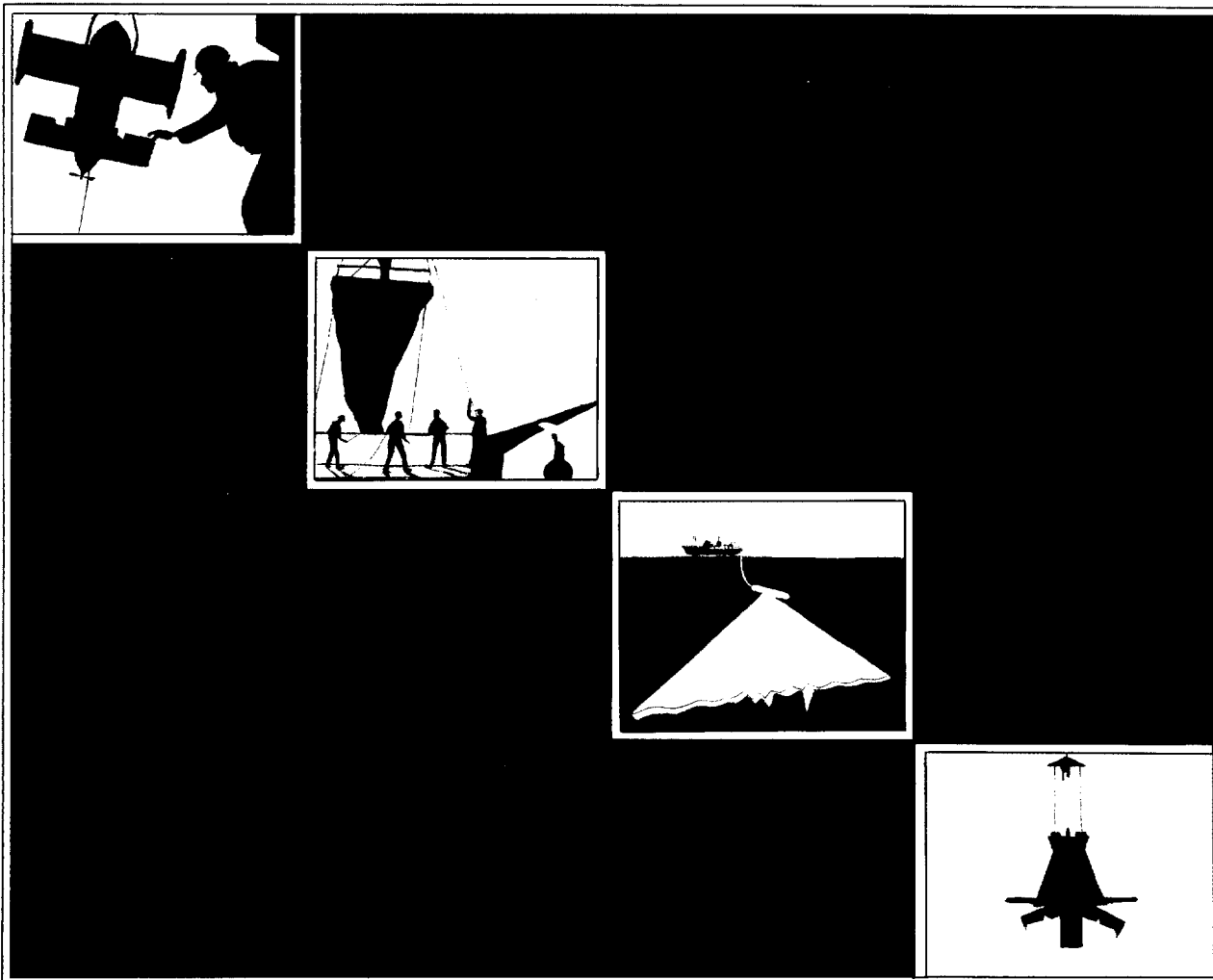




Biological collections made during Discovery CR 175 to BIOTRANS Site (c.47°N,20°W)

P R Pugh

Report No 277 1990



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DURING DISCOVERY CR. 175 TO
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ABSTRACT <p>The structure and composition of the biological communities inhabiting the water column have been analysed from a series of samples collected during <i>Discovery</i> Cruise 175 to the BIOTRANS site (c. 47°N, 20°W). This site has been chosen as one of the primary sampling sites of the BOFS (Biogeochemical Ocean Flux Study) programme. The macroplankton and micronekton communities were sampled using the IOS multiple Rectangular Midwater Trawl (RMT1+8M). Biomass and biovolume analyses were carried out on the RMT1 samples, as well as a preliminary taxonomic sort, and an assessment of the size structure of the copepod populations in the top 1000m of the water column. Eight major micronektonic taxa were investigated from the RMT8 catches; namely medusae, siphonophores, chaetognaths, euphausiids, mysid, decapods and fish. Specific identifications were made for most of these groups. Day and night samples were analysed in order to investigate the potential significance of diel vertical migrations.</p> <p>For the micronekton samples, the amphipod <i>Themisto compressa</i> dominated the catches in the top 200-300m of the water column. From 300-500m depth siphonophores, particularly <i>Rosacea plicata</i>, predominated, while at greater depths gelatinous organisms usually comprised more than 50% of the biovolume of the catches. Major diel vertical migrations were limited to a few species of euphausiid, decapod and fish, although it was possible that the amphipod, <i>T. compressa</i>, undertook a small-scale migration. The latter is potentially significant for biogeochemical fluxes of the transport of material down through the water column.</p> <p>These analyses represent a preliminary survey of the biological oceanography of the BIOTRANS site and should serve as a baseline for subsequent sampling at this site as part of the BOFS programme.</p>	
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INTRODUCTION

'Discovery' Cruise 175, June/July 1988, was planned to be a prelude to and test run for parts of the BOFS (Biogeochemical Ocean Flux Studies) sampling programme. It encompassed a multidisciplinary approach to the study of the flux of biogeochemical material and its transformations by the midwater biota. Sampling was carried out at the BIOTRANS site (ca. 47°N, 20°W), as this had been chosen as one of the primary sampling areas for the actual BOFS experiments. Cruise details are contained in IOS Cruise Report No.204 (PUGH *et al*, 1988).

Included in the various experiments carried out during the cruise were ones to assess the vertical distribution of the major plankton and micronekton faunal groups throughout the water column, and to investigate the extent of any diel vertical migrations in the top 1500m of the water column. Some of the results from these studies are reviewed here.

METHODS

The IOS Multiple Rectangular Midwater Trawl (RMT1+8M) (ROE & SHALE, 1979) was used to fish a day and night series of hauls in the top 1500m of the water column. The depth horizons were approximately 100m, except for the top 100m which, by day, was subdivided into two 50m bands. A 4.5mm mesh sieve was placed in the entrance to the cod-end of the RMT1 net in order to remove the larger, contaminating animals from the catch. No further in situ splitting of the RMT1 catch was undertaken as this would have complicated the subsequent analyses of the size-structure of the copepod population.

After retrieval of the nets, the RMT8 catches were preserved immediately in 5% buffered formalin. The RMT1 catches, however, were first divided in half. To speed up this processing a simple splitting method, described by GUELPHEN, MARKLE & DUGGAN (1982) as the Huntsman Marine Laboratory beaker technique, was used. One half of the RMT1 catch was then preserved in 5% buffered formalin, while the other was thoroughly drained and then frozen. The displacement volumes of the preserved catches were measured after a few days, and again after return to the laboratory. Back in the laboratory, wet, dry and ash-free dry weight measurements were made on the frozen RMT1 material. A small sample of ground pre-ashed material was removed for CHN analysis.

For reasons that were never resolved, on three occasions much of the catch in the RMT1M-2 net was found to have hung-up in the mouth of the net. On these occasions the net was washed down thoroughly, but it is likely that part of the catch was lost. The loss appeared to be most significant in the 900-1000m day, and 1300-1400m night hauls. The latter haul was later repeated, using the IOS RMT1+8 combination net (BAKER, CLARKE & HARRIS, 1973), but time constraints prevented the day haul from being repeated. The washing-down process for the third haul, 50-100m by day, appeared to have been largely successful. In addition, the roller came off the bottom bar of the RMT1 net fished between 2750 and 3010m, resulting in the net being

partially open on recovery. For this reason the catch was not sorted, and it would explain the unusually high biovolume found in the catch (see later).

The major micronekton groups were sorted from the RMT8 samples, and the displacement volume of all component parts measured. Specific identifications were then carried out on siphonophores, medusae, amphipods, euphausiids, decapods, mysids and fish. Counts were made of amphipods, euphausiids, decapods, mysids, chaetognaths, ostracods and copepods in the RMT1 preserved fractions, and the size-distribution of the copepods was investigated. However, it is likely that many of the smallest animals, particularly chaetognaths and larval amphipods, were not included in these counts.

Below 1500m depth, the RMT1+8M multiple net was used to sample over depth horizons of approximately 250m down to a depth of 3500m. Additional hauls were then made between 3490-3800, 3800-4085 and 4085-4450m, the last depth being approximately 100m off the bottom. It was planned to carry out some further near-bottom hauls, but because of slack wire on the storage drum, it was considered too dangerous to pay out any further wire and so the required depths could not be reached.

The ship's track during the relevant RMT1+8M deployments is shown in Figure 1, and the relevant station data are given in Table 1.

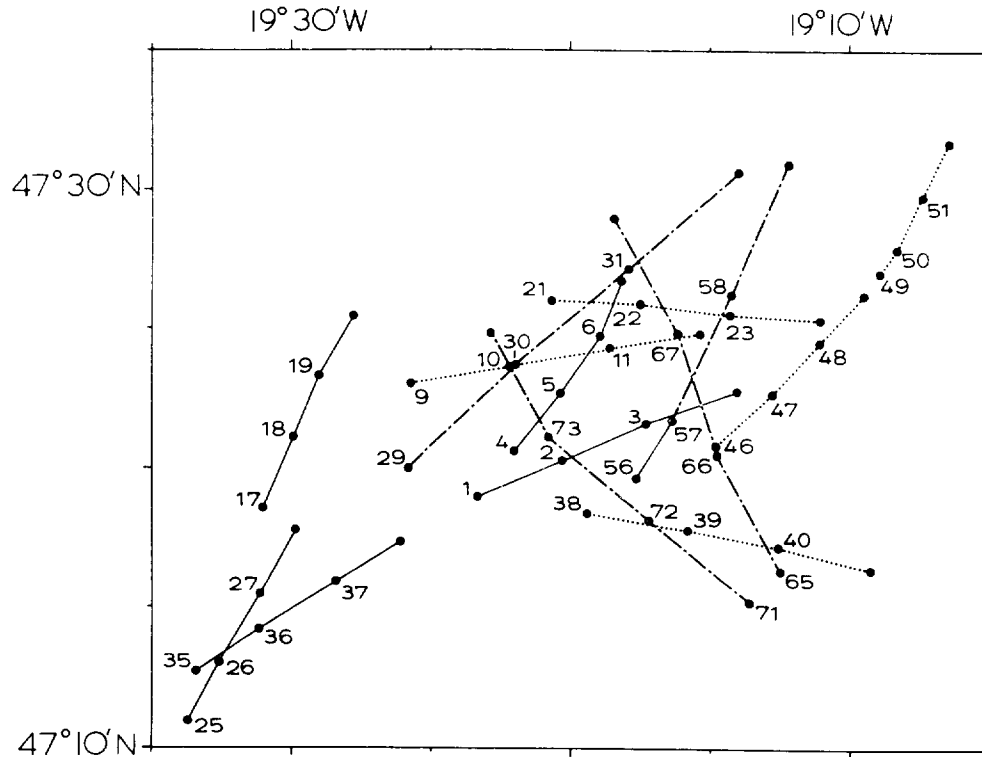


Figure 1. Ship's track during RMT1+8M deployments.
(Depth ranges for Series nos. - see Table 1)
Day (solid line); Night (dot/dashed); Deep (dotted).

TABLE 1.

Station data for RMT1+8M hauls at Station 11794.

DAY				NIGHT			
Series	Date	Depth Range (m)	Times	Series	Date	Depth Range (m)	Times
4	23/6	0-50	1231-1331				
5	23/6	50-100	1331-1431	49	28/6	20-110	0154-0227
6	23/6	100-195	1431-1531	50	28/6	110-205	0227-0324
25	25/6	200-305	1404-1504	51	28/6	200-300	0324-0424
26	25/6	300-400	1504-1604	46	27/6	300-405	2216-2316
27	25/6	400-490	1604-1704	47	27/6	405-505	2316-0016
17	24/6	500-600	1647-1747	48	28/6	500-600	0016-0116
18	24/6	600-700	1747-1847	38	26/6	600-700	2248-2348
19	24/6	700-800	1847-1947	39	26/6	700-795	2348-0048
1	23/6	800-900	0700-0800	40	27/6	795-900	0048-0148
2	23/6	900-1000	0800-0900	9	24/6	890-1000	0004-0104
3	23/6	1000-1100	0900-1000	10	24/6	1000-1115	0104-0204
35	26/6	1100-1200	1710-1810	11	24/6	1115-1200	0204-0304
36	26/6	1200-1300	1810-1910	21	24/6	1210-1315	2321-0021
37	26/6	1300-1400	1910-2010	22	25/6	1305-1400	0021-0121
56	28/6	1400-1500	1900-2000	23	25/6	1400-1500	0121-0221

DEEP

Series	Date	Depth Range (m)	Times
57	28/6	1500-1750	2000-2200
58	28/6	1730-2000	2200-2400
29	25/6	2000-2300	2101-2301
30	25/6	2275-2505	2301-0101
31	26/6	2500-2750	0101-0301
65	29/6	2750-3010	2138-2338
66	29/6	3010-3255	2338-0138
67	30/6	3255-3500	0138-0338
71	30/6	3490-3800	2247-0047
72	1/7	3800-4085	0047-0247
73	1/7	4085-4450	0247-0447

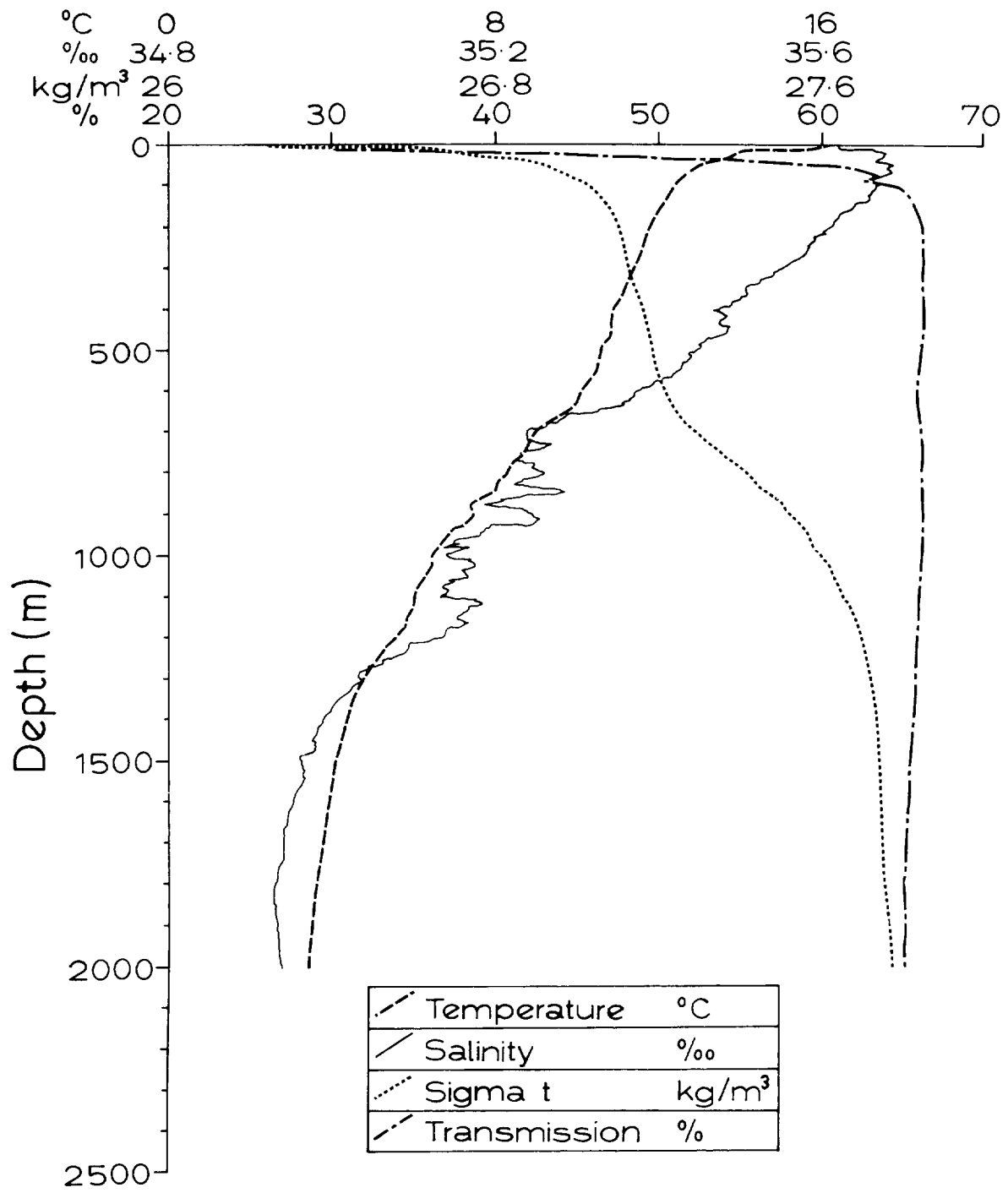


Figure 2. CTD and Transmission profiles for 'Discovery' St.11792.

RESULTS

Physical Background

Deep CTDs

CTD casts were made throughout the cruise. The majority of these were restricted to the top 300m of the water column in order to measure the chlorophyll a fluorescence and light attenuation. Occasional deeper casts were made to a maximum depth of 2000m. The data to be presented here are uncorrected. This is unlikely to have much effect on the temperature measurements, but the salinity and pressure ones may be slightly inaccurate.

The profiles of temperature, salinity, density, and % transmission with depth for a cast made at the beginning of the cruise (St. 11792) are shown in Figure 2. At this time there was a very shallow thermocline, at c. 10m, with a surface temperature of 16.17°C. After a mid-cruise storm, the top mixed layer was deepened to c. 40m, and at the end of the cruise it had a temperature of c. 15.28°C. Any particulate maximum lay in and above the thermocline, as reflected by the rapid change in % transmission.

The Temperature/Salinity (T/S) relations of the water column changed little during the cruise, and Figure 3 shows those from a cast towards the end (St. 11794#141). The interpretation of these data is based on the discussion of ARHAN *et al* (1989). Above c. 600m the profile showed the presence of North Atlantic Central Water (NACW) that was slightly modified by Sub-Arctic Intermediate Water (SAIW). At 20°W, the influence of the latter is expected to be small, but some small "glitches" in the raw data may be indicative of its presence. The NACW can be comprised of several mode waters, particularly sub-polar mode water, with temperatures between 10 and 14°C, and densities of 27.0-27.2 kg/m³.

Beneath the sub-polar mode water, in the 650 to c. 1300m depth range, the water at 20°W was influenced by northward flowing Mediterranean Water (MW). At 1500m, ARHAN *et al* (1989) found mainly low salinity Labrador Sea Water (LSW) to be present. This water spreads throughout most of the North Atlantic at 48°N, with an eastern boundary at c. 18°W. However, their data indicated that occasionally patches of Mediterranean Water crossed through 20°W at this depth. By a depth of 2500m, The LSW had been replaced by either Iceland-Scotland Overflow Water (ISOW) or by deep Mediterranean Water. These two waters could be distinguished on the basis of their dissolved oxygen levels. The boundary between them was found to lie somewhere between 45 and 48°N, which would be in the vicinity of the BIOTRANS site. Finally, the bottom waters in the eastern basin of the North Atlantic contained a strong component of Antarctic Bottom Water (AABW), which entered the basin through the Romanche Fracture Zone, and has a general northward flow.

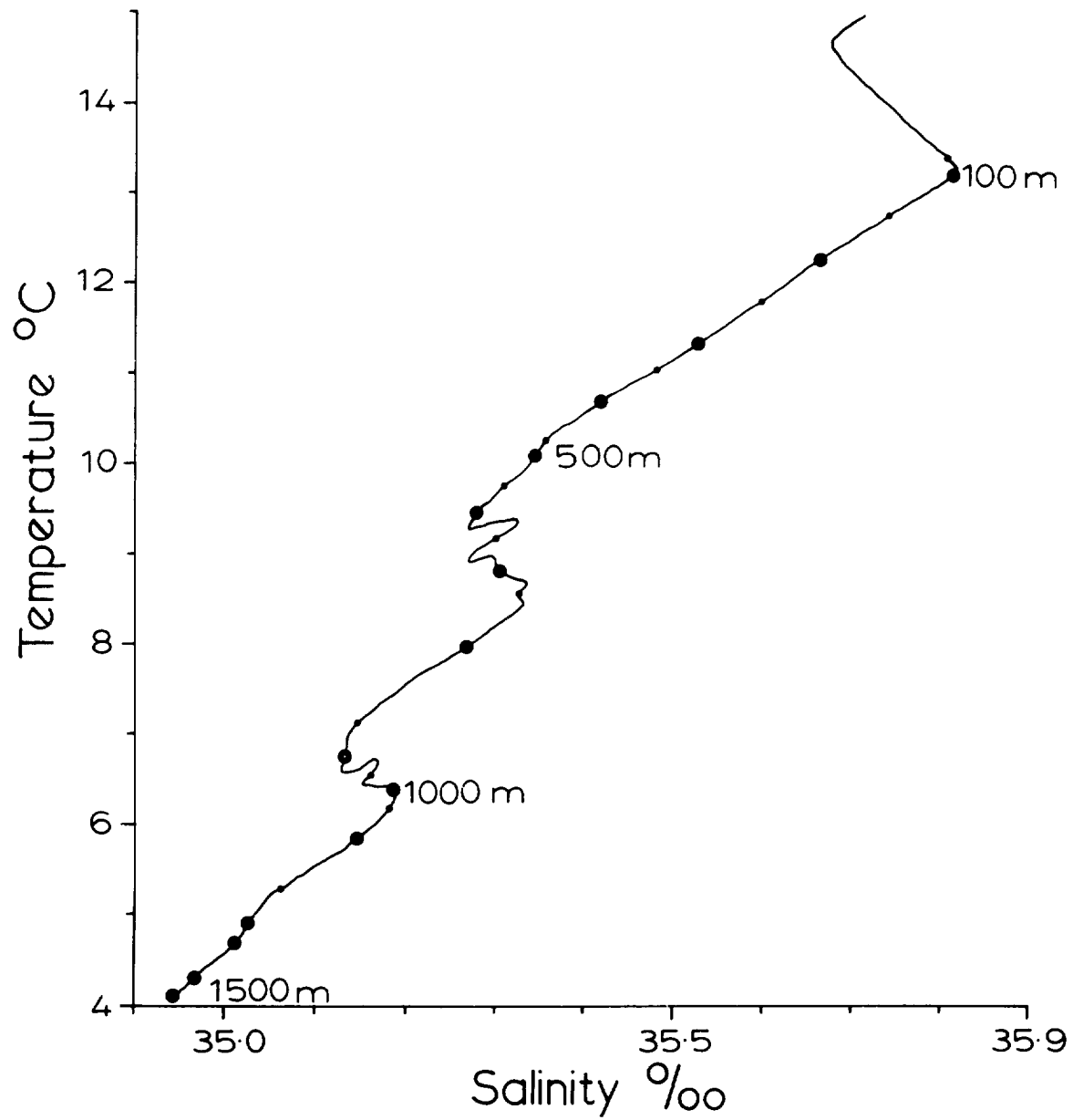


Figure 3. T/S relations at 'Discovery' St.11794#141.

XBT Survey

At the beginning of the cruise a triangular XBT survey was made of the proposed sampling area in order to investigate mesoscale variability. The XBTs were kindly donated by the Navy. The results and the positions of the XBT launches are shown in Figure 4. The results show that there was little variability in the surface 50m, but below this there were significant changes in the depths of the 11 and 12°C isotherms. Thus, at the south-west corner of the survey area, these isotherms were c. 185 and 115m, respectively, deeper than at the northern tip. The boundary lay somewhere between XBT nos. 19 and 20, and 23 and 25. It is suggested later that these differences in the thermal structure of the water column may have had an effect on the relative abundance of certain species. This question arose because, in certain circumstances, the specific populations in the 100-500m depth range showed large disparities in numbers between the day and night samples. The approximate region where the 11°C isotherm was found, from the XBT survey, to lie at 200m is shown in Figure 1, so that it can be related with the RMT1+8M sampling. Nonetheless, there are many reasons why such disparities could occur, and M.J.R. Fasham (personal communication) has pointed out that, since there was no indication of any mesoscale variability in the 10°C isotherm, then there was no evidence for the presence of a deep cold-core eddy of the sort observed previously, in 1985, in the area.

Shallow CTDs

M.J.R. Fasham (personal communication) has provided the following information. As mentioned above, at the beginning of the cruise the thermocline, at the BIOTRANS site, was very shallow, c. 10m. The chlorophyll concentrations in the top mixed layer were c. $1\text{mg}\cdot\text{m}^{-3}$, with nitrate and silicate concentrations in the ranges 0.2-0.6 and 0.1-0.4 $\text{mMol}\cdot\text{m}^{-3}$, respectively. The chlorophyll maximum lay between 15 and 30m, with a magnitude of 2-4 $\text{mg}\cdot\text{m}^{-3}$, and the nitrate-cline began at similar depths. In the middle of the cruise a gale deepened the mixed layer to c. 40m, and caused the subsurface chlorophyll maximum to be eroded. Although this maximum was clearly delineated, both by *in situ* fluorescence and from water bottle samples, the profiles of attenuation obtained from the transmissometer tended to show either no maximum or a much reduced one. This suggested that the top mixed layer contained a large population of small particles, presumably either bacteria or detritus, that did not fluoresce.

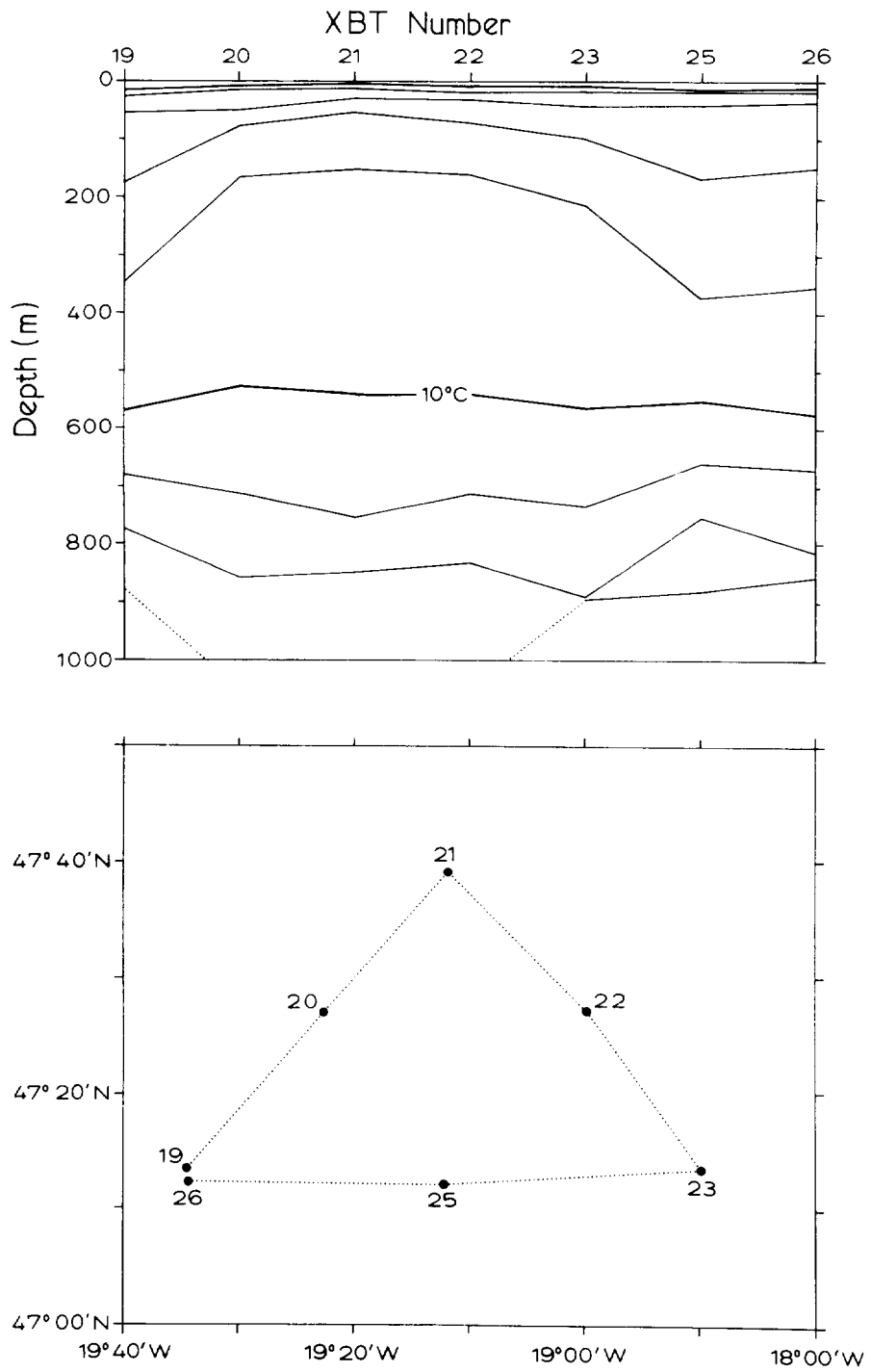


Figure 4. XBT Survey at the BIOTRANS site.
 Temperature profiles and Launch positions.

Biomass

Biovolume - RMT8

The displacement volumes for the various micronekton groups sorted from the RMT8 catches, and standardized to $\text{cm}^3 \cdot 104\text{m}^{-3}$, are shown in Table 2, and the percentage contribution of each group to the total volume of each catch is shown in Figure 5. The latter shows the almost total preponderance of amphipods, almost exclusively *Thermisto compressa* (*Parathermisto gaudichaudi*), in the top 200m of the water column, by day. In the top 100m the total displacement volume of amphipods was roughly the same by day and night, but at night the total volume of the catch was doubled due to the presence of diel vertical migrants, particularly euphausiids. By day euphausiids were most abundant in the 200-300m depth range, although their total displacement volume was less than that at night. This was probably caused by day-time net avoidance, which is a considerable problem when interpreting euphausiid data (WIEBE *et al*, 1982).

A single, large cephalopod contributed almost half of the total displacement volume of the 100-200m nighttime haul.

The amphipod swarm extended down into the 200-300m depth band, but at greater depths amphipods contributed very little to the total displacement volume of the catches. The 300-500m depth range was dominated by siphonophores, which contributed 53-86% to the total displacement volume. *Rosacea plicata* was the predominant siphonophore species. Below 500m the percentage contribution of siphonophores was lower, while that of medusae was greatly enhanced. These two gelatinous taxa formed more than 49% of the total displacement volume in all but four (3 day, 1 night) of the hauls fished between 300 and 1500m. Within this latter depth range, the remainder of the displacement volume was largely made up of chaetognaths, decapods, mysids and fish.

Although, in general, the vertical distribution of displacement volume is similar by day and night, there are some obvious differences. The enhanced biovolume in the top 100m, at night, was caused mainly by the diel migration into that zone of euphausiids. The large day-time peak between 100 and 200m is wholly due to an increased number of amphipods, for which there is no corresponding nighttime population. The same was true in the 400-500m depth zone, except that it was caused by differences in the siphonophore population. The reverse, but corresponding situation appertained between 700 and 800m, and was caused by medusae; while the nighttime peak in the 1200-1300m zone could have been caused by a deep diel migration of fish. However, as is discussed later, these day/night differences in biovolume, particularly the three deeper ones, may be associated with some slight differences in the thermal structure of the water column over the area where fishing was carried out.

TABLE 2
Cruise 175 RMT8 Displacement Volumes ($\text{cm}^3 \cdot 10^4 \text{m}^{-3}$)

DEPTH	DAY											TOTAL
	SIPHON	MEDUSA	CHAET	AMPH	EUPH	DECAPOD	MYSID	FISH	CEPH	RESIDUE		
0-50	0.00	0.31	0.15	51.52	0.00	0.00	0.00	0.00	0.00	0.00	0.15	52.14
50-100	0.00	0.16	0.47	68.63	0.00	0.00	0.00	0.00	0.31	0.16	0.16	69.73
100-195	0.00	0.00	0.00	261.09	0.34	0.00	0.00	0.07	0.00	0.17	0.17	261.67
200-305	12.37	1.34	3.34	10.37	15.38	0.33	0.00	3.34	0.00	2.01	2.01	48.49
300-400	50.37	7.65	1.91	6.85	3.83	0.16	0.00	20.72	0.00	2.23	2.23	93.73
400-490	577.71	38.40	1.57	1.92	6.28	4.54	0.17	33.16	1.05	10.47	10.47	675.28
500-600	13.22	20.12	3.16	1.44	4.60	4.02	0.29	40.24	0.00	5.75	5.75	92.84
600-700	8.85	10.43	3.79	0.79	2.53	11.06	0.63	31.60	0.95	7.27	7.27	77.89
700-800	24.00	41.29	3.18	0.71	2.12	20.82	3.53	28.23	1.41	6.00	6.00	131.29
800-900	1.34	107.02	5.02	0.33	2.01	56.85	6.35	25.08	0.00	5.52	5.52	209.52
900-1000	2.94	79.51	8.51	0.82	0.65	29.45	6.54	11.45	0.33	6.54	6.54	146.75
1000-1100	9.02	24.29	9.72	1.04	1.39	18.39	8.68	24.29	0.00	3.47	3.47	100.29
1100-1200	5.79	70.22	13.76	1.63	2.17	19.55	26.06	9.05	1.09	4.71	4.71	154.02
1200-1300	9.70	70.91	6.69	0.84	1.34	15.05	13.71	11.71	0.33	5.69	5.69	135.98
1300-1400	12.62	171.07	2.80	0.53	1.40	8.76	6.66	42.07	0.53	5.26	5.26	251.69
1400-1500	11.29	52.44	3.28	1.82	1.46	12.38	6.92	3.64	0.73	6.19	6.19	100.14

NIGHT

DEPTH	SIPHON	MEDUSA	CHAET	AMPH	EUPH	DECAPOD	MYSID	FISH	CEPH	RESIDUE	TOTAL
20-110	0.30	0.00	0.90	46.24	54.05	9.01	0.00	9.01	0.30	3.60	123.41
110-205	4.98	0.17	0.66	46.49	3.99	5.15	0.00	8.30	56.46	1.00	127.19
200-300	4.94	0.18	1.76	38.12	7.76	9.88	0.00	15.88	0.00	1.76	80.29
300-405	95.66	24.78	2.51	1.25	1.25	9.41	0.31	7.84	0.00	2.51	145.53
405-505	117.08	21.81	3.85	1.44	3.21	4.17	0.48	35.28	0.00	2.56	189.90
500-600	32.03	32.79	3.96	0.94	2.26	4.33	0.94	32.03	0.00	5.65	114.94
600-700	2.57	28.91	7.07	0.48	3.85	9.64	2.57	12.85	0.64	7.07	75.64
700-795	4.94	201.02	3.30	0.49	1.98	11.53	3.62	46.14	0.00	8.57	281.59
795-900	6.65	83.95	6.30	0.87	2.80	12.59	6.65	34.98	1.05	7.00	162.82
890-1000	2.00	75.51	12.64	1.16	2.00	8.98	8.32	28.28	0.33	6.65	145.87
1000-1115	9.01	46.58	12.02	0.75	0.60	10.82	7.21	11.42	0.00	6.61	105.02
1115-1200	10.46	109.32	11.81	0.84	0.67	7.76	9.45	25.31	0.00	10.12	185.74
1210-1315	18.06	98.31	10.77	0.87	0.69	7.30	11.81	83.38	0.00	3.47	234.67
1305-1400	17.34	66.75	2.94	0.82	0.65	15.38	9.16	4.91	0.00	1.31	119.27
1400-1500	19.90	44.68	1.92	1.22	0.70	18.15	9.42	7.68	0.00	13.44	117.11

DEEP

DEPTH	SIPHON	MEDUSA	CHAET	AMPH	EUPH	DECAPOD	MYSID	FISH	CEPH	RESIDUE	TOTAL
1500-1750	9.60	12.36	1.22	0.00	0.65	5.85	2.28	35.78	0.00	3.09	70.83
1730-2000	13.49	10.89	0.86	0.00	0.35	4.32	1.21	27.66	0.00	1.04	59.82
2000-2300	18.33	7.72	0.96	0.58	2.89	5.02	0.77	38.59	0.00	3.18	78.04
2275-2505	7.63	2.71	0.68	0.00	0.34	2.54	1.02	17.81	0.00	0.85	33.58
2500-2750	2.51	11.47	0.99	0.00	0.36	1.79	1.25	1.79	0.00	3.23	23.39
2750-3010	0.09	15.89	0.55	0.00	0.18	1.10	1.28	0.18	0.00	0.55	19.82
3010-3255	0.16	6.72	0.08	0.00	0.33	0.57	0.82	0.25	0.00	1.15	10.08
3255-3500	1.26	4.31	0.27	0.00	0.09	0.90	0.00	5.38	0.00	4.49	16.69
3490-3800	1.49	1.07	0.21	0.00	0.00	1.07	0.54	0.32	0.00	3.20	8.01
3800-4085	4.07	9.26	0.37	0.00	0.00	0.93	1.11	1.85	0.00	0.93	18.52
4085-4450	2.48	8.03	0.57	0.00	0.19	0.19	0.19	0.96	0.00	2.87	15.48

CRUISE 175

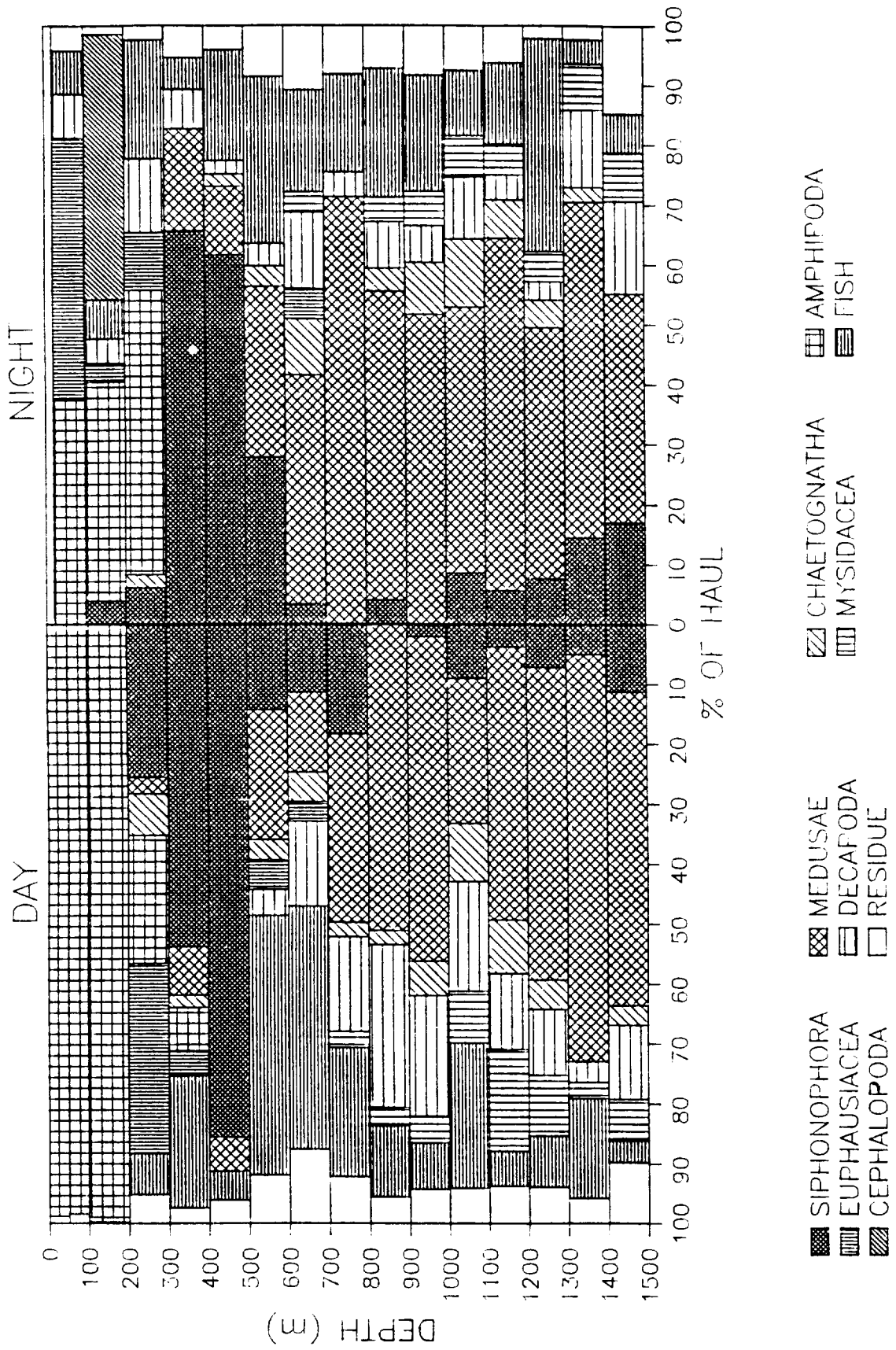


Figure 5. Percentage Biovolume of various Taxa in RMT8 catches.

Between 1500 and 2500m fish contribute about 50% to the biovolume, while at greater depths gelatinous organisms again predominated, although the displacement volumes themselves were relatively small.

At depths greater than 1000m there is a typical logarithmic decrease in biomass which corresponds well with that found at 42°N, 17°W by ANGEL & BAKER (1982) (Figure 6). There was an increase in biovolume in the two deepest hauls which may be associated with proximity to the bottom. Unfortunately, however, the inability to fish the near-bottom tows prevented further study of this phenomenon.

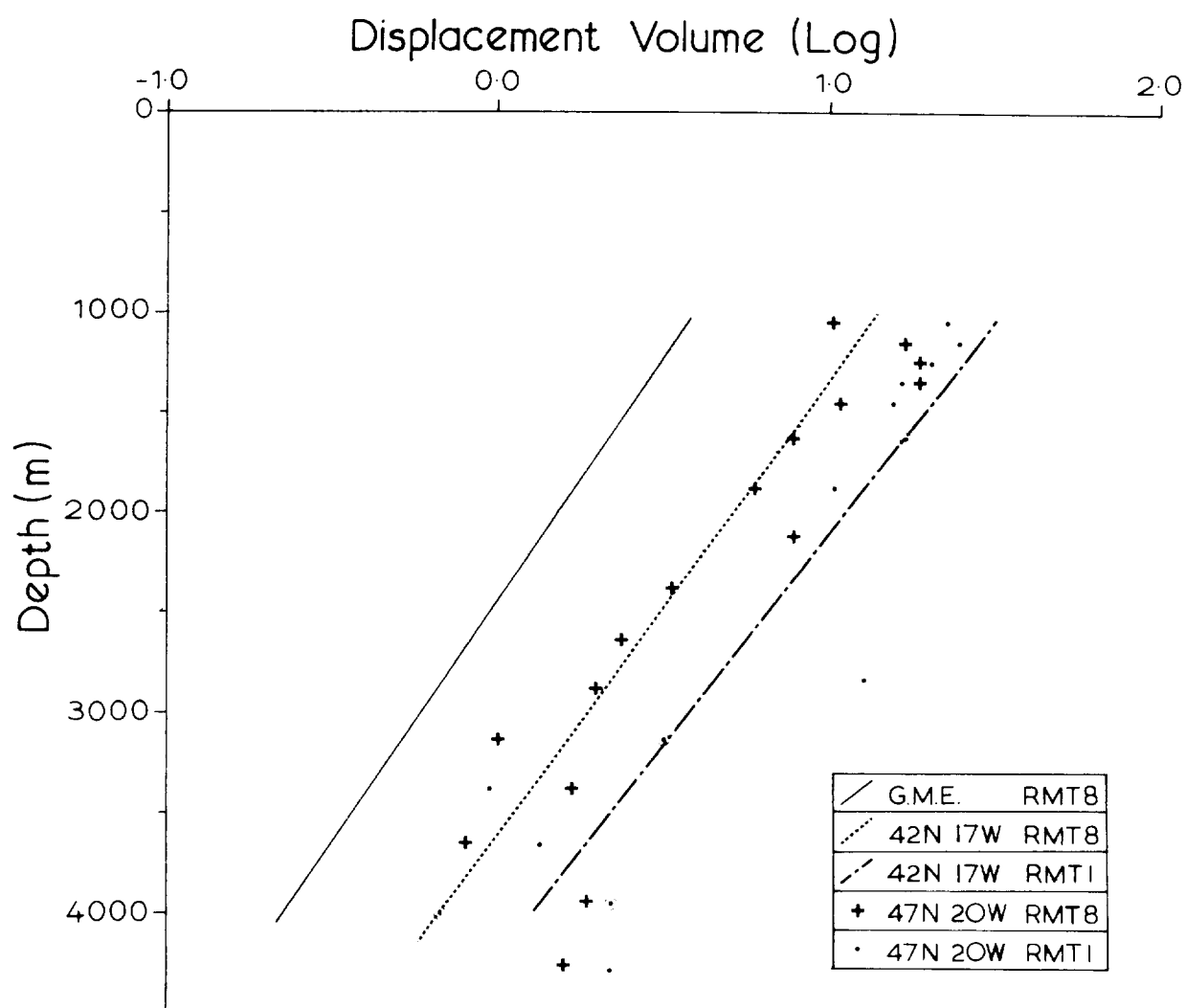


Figure 6. Comparisons of the biovolume profiles for the RMT1 and RMT8 nets with those from 42°N, 17°W ('Discovery' St.9801) and Great Meteor East (31°17'N, 25°24'W)

Biovolume - RMT1

The profiles of biovolume with depth (Figure 7) indicate a possible diel vertical migration of part of the plankton population from day-time depths of 200-600m to the top 200m at night. Below 600m depth the day and night biovolumes are very similar, especially if the two RMT1M-2 hauls, where hang-up was a problem, are ignored. Below 1000m the plankton biovolumes again parallel those found by ANGEL & BAKER (1982) (Figure 6), but generally have slightly lower values. The displacement volume of the haul between 2750 and 3000m appears to be anomalous. At greater depths the biovolumes were very low, and the measurements were thereby subject to greater errors. However, the increase in biovolume in the two deepest hauls reflects that found for the RMT8 samples.

Biomass - RMT1

The depth distribution of wet weight for the RMT1 catches (Figure 7, Table 3), by day and night, appears to be similar to that of the biovolume, but there is a considerable variability in the ratio of the two parameters, ranging from 1.07 to 2.66 (Vol:WW). The mean value was 1.743. However, measurements of displacement volume and wet weight are both liable to vary considerably depending on the methods used. Such variability is largely caused by the varying amounts of interstitial water retained within the sample. The amount of interstitial water generally varies inversely with the amount of biomass present (NAKAI & HONJO, 1962). However, the situation is complicated further when the fauna is dominated by gelatinous organisms, as they retain relatively large volumes of such water. Nevertheless, some variability might be expected due to the crudeness of the splitting method. For future use it might be advisable to measure the displacement volume of both fractions before they are frozen or preserved.

The dry to wet weight ratio also varies considerably, from 0.13 to 0.23, with a mean value of 0.158, as does the ash-free dry weight to dry weight ratio (mean 0.243, range 0.17-0.36) (Figure 7). However, the regression equations for the log transformed data (Table 4) show a high degree of correlation between the various parameters. The regression lines are remarkably similar, within the range of values measured, to the corrected equations presented by WIEBE (1988), although the slopes are slightly different. Thus, despite initial misgivings, the data appear to be both internally consistent and comparable with those previously published, despite the inherent inaccuracies in the methodology.

The Carbon and Nitrogen values, from the CHN analyses, also are shown in Table 3, together with the C:N ratio. The regression equation, for the log transformed data, is shown in Table 4. The slope of the regression differs slightly from that presented by WIEBE (1988), but within the range of values there is a close similarity between the results of both studies. The data also are in close agreement with those found by ROE *et al* (1987) whose data were derived from samples collected at a more southerly site (GME, ca. 31° 17', 25° 24'W). The C:N ratio, which averaged 4.58 ± 0.76 , was slightly higher than that found at the GME site (4.25 ± 0.40) and that found by WIEBE (1988), namely 4.30.

TABLE 3.

Biomass and Biovolume data for the RMT1 hauls.

(All values are per 10³m³)

DAY							
Depth	Volume cm ³	Wet Wt. g	Dry Wt. g	Ash Free g	C g	N g	C:N
0-50	14.031	8.782	1.355	0.458	0.4096	0.1076	3.805
50-100	13.949	10.138	1.343	0.442	0.5668	0.1324	4.281
100-195	32.660	15.481	2.363	0.565	0.9060	0.2092	4.332
200-305	32.821	20.497	4.273	1.545	1.2407	0.2877	4.313
300-400	32.172	22.919	3.515	0.806	1.1819	0.2904	4.070
400-490	28.847	19.319	2.933	0.695	1.0618	0.2583	4.111
500-600	26.160	12.755	1.876	0.509	0.7950	0.2152	3.694
600-700	21.829	11.787	2.082	0.454	0.8278	0.1563	5.296
700-800	22.381	15.001	2.551	0.559	0.9229	0.1905	4.845
800-900	18.319	9.155	1.485	0.357	0.5709	0.1238	4.611
900-1000	8.801	4.507	0.670	0.218	0.2400	0.0524	4.581
1000-1100	20.617	8.931	1.514	0.343	0.7494	0.1563	4.795
1100-1200	24.604	11.529	1.996	0.377	0.9594	0.1341	7.154
1200-1300	20.343	11.281	1.566	0.268	0.7423	0.1430	5.190
1300-1400	16.327	9.123	1.469	0.267	0.7232	0.1800	4.019
1400-1500	13.537	6.870	1.021	0.208			
NIGHT							
Depth	Volume cm ³	Wet Wt. g	Dry Wt. g	Ash Free g	C g	N g	C:N
20-110	26.225	17.564	3.033	0.653	1.1060	0.2537	4.360
110-205	18.033	12.770	1.875	0.451	0.7150	0.1722	4.153
200-300	14.175	9.992	1.738	0.463	0.5629	0.1431	3.935
300-405	9.672	8.998	1.258	0.341	0.4244	0.1227	3.459
405-505	22.072	10.618	1.657	0.381	0.6319	0.1481	4.265
500-600	18.095	10.398	1.645	0.392	0.7271	0.1394	5.214
600-700	18.763	10.501	1.576	0.363	0.4992	0.1152	4.333
700-795	21.720	18.726	3.182	0.612	1.3901	0.2603	5.341
795-900	15.558	10.638	1.814	0.353	0.7644	0.1427	5.355
890-1000	17.514	13.927	2.010	0.518			
1000-1115	24.083	16.301	2.443	0.584	1.0433	0.2045	5.102
1115-1200	14.426	10.777	1.565	0.399	0.7187	0.1661	4.328
1210-1315	22.533	7.583	1.199	0.233	0.5624	0.1345	4.181
1305-1400	7.201	3.437	0.439	0.131	0.1766	0.0448	3.944
1400-1500	17.012	6.542	1.167	0.265	0.5322	0.0917	5.807

TABLE 4

Regression equations for biomass and biovolume parameters for RMT1 catches

$$\begin{aligned} \text{Log(DV)} &= -0.30001 + 0.72878 \cdot \text{Log(WW)} \quad r^2=0.688 \\ \text{Log(DV)} &= -1.88623 + 0.67744 \cdot \text{Log(DW)} \quad r^2=0.731 \\ \text{Log(WW)} &= -2.16849 + 0.88363 \cdot \text{Log(DW)} \quad r^2=0.959 \\ \text{Log(DW)} &= 0.58847 + 0.9136 \cdot \text{Log(AFDW)} \quad r^2=0.846 \\ \text{Log(N)} &= -0.67278 + 0.89598 \cdot \text{Log(C)} \quad r^2=0.888 \end{aligned}$$

Where displacement volume(DV) is $\text{cm}^3 \cdot \text{m}^{-3}$; Wet weight (WW) is $\text{g} \cdot \text{m}^{-3}$, and Dry weight (DW), Ash-Free Dry Weight (AFDW), Carbon (C) and Nitrogen(N) are $\text{mg} \cdot \text{m}^{-3}$. WIEBE (1988) did not consider the DW/AFDW regression.

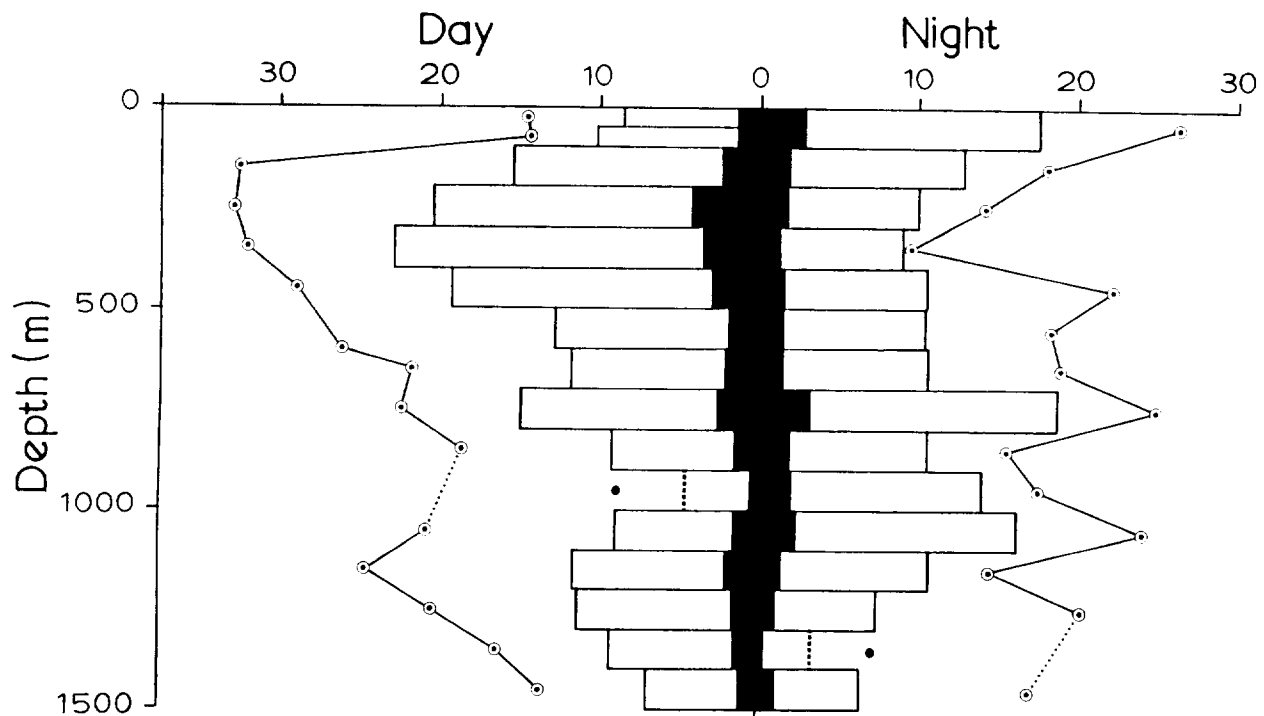


Figure 7. Biomass and Biovolume profiles for the RMT1 catches (0-1500m).
Wet (open) and Dry (shaded histograms) weights (units $\text{mg} \cdot \text{m}^{-3}$)
Biovolume (lines with circles) (units $\text{cm}^3 \cdot 103 \text{m}^{-3}$)
The two hauls where hang-up occurred are indicated by solid dots

Vertical Distribution of Major Taxa

RMT1

The vertical distribution of the major taxa found in the RMT1 catches, as no.103m-3, are shown in Table 5. Ostracod and copepod data are available only for the 0-1000m depth range, while the data for the other taxa are based on a preliminary sort which may not have extracted every specimen. This is particularly true for amphipods and chaetognaths as, in the former case, many larval specimens remain in the residues of the near-surface hauls.

With the above constraints in mind, the data indicate that copepods were by far the most abundant taxa, and made up more than 85% of the total numbers in the top 1000m of the water column. There was a considerable discrepancy between the day and night totals. A possible explanation of this may be that the copepod population in the top 300 to 400m underwent a considerable diel vertical migration into the near-surface layers at night and escaped capture as, unfortunately, the top 20m of the water column was not sampled at night. However, there are also similar discrepancies for other taxa, notably the amphipods in the RMT8 catches.

The size-structure of the copepod population was analysed by P. Green (Table 6). Only copepods with obvious tissue remains were measured and carcasses were ignored. The data indicate that, in the top 500m of the water column, the copepod population was dominated (>75% of total) by animals less than 1.5mm in standard length. This is an unusual situation as at lower latitudes, where the mean size of the copepod population is expected to be smaller, such a predominance of the very smallest size classes is not found. It appears that the amphipods are once again to blame for this situation. P. Green reported that a large number of carcasses of larger copepods were found in the hauls from the top 200m of the water column. It is suggested, therefore, that the amphipods had been feeding voraciously on the larger copepod population.

The ostracod population was concentrated in the 300-700m depth range by day, with some indications of a diel vertical migration for the upper part of the population into the 100-200m depth range at night. However, once again there was a considerable discrepancy between the day and night total numbers.

TABLE 5. Cruise 175 RMT1 taxon data (No.10³m⁻³)

DEPTH	OSTRACOD	COPEPOD	AMPHIPOD	EUPHS	DEC/MYS	CHAET
DAY						
0-50	7.38	1909.76	238.53	1.48	0.00	979.99
50-100	148.79	25939.24	197.61	0.00	0.00	208.46
100-195	487.72	20642.01	109.59	30.48	0.00	919.55
200-305	683.89	43891.16	7.63	334.31	0.00	1020.49
300-400	3615.82	31311.99	20.40	211.86	0.00	765.07
400-490	3503.09	18162.41	68.05	253.71	2.96	375.75
500-600	1685.86	7960.37	18.17	295.03	2.18	194.75
600-700	1537.38	8659.86	17.15	117.72	7.80	126.30
700-800	966.88	11013.63	8.95	114.15	20.89	194.72
800-900	286.99	3816.36	12.21	64.88	22.90	313.70
900-1000	139.22	949.71	4.80	5.60	10.40	70.41
1000-1100			2.95	7.36	16.94	426.33
1100-1200			5.56	8.73	22.22	252.39
1200-1300			21.16	0.81	13.83	171.69
1300-1400			10.39	2.97	4.45	74.95
1400-1500			4.78	2.39	4.78	118.64
NIGHT						
20-110	739.82	6398.90	249.83	287.09	6.90	307.80
110-205	1193.44	5450.49	246.72	39.34	0.82	931.97
200-300	435.69	2883.38	40.29	48.49	0.75	1481.65
300-405	868.98	7969.65	1.49	64.73	0.00	498.47
405-505	1185.56	13154.66	20.50	158.44	0.79	394.92
500-600	679.75	14425.87	0.00	132.96	6.29	170.72
600-700	996.70	9990.99	4.50	446.56	12.76	133.59
700-795	720.78	7027.59	0.00	493.12	15.28	181.80
795-900	580.83	5490.59	18.52	114.09	20.00	283.75
890-1000	450.79	3693.35	5.33	6.85	335.81	13.71
1000-1115			8.28	10.54	16.56	240.08
1115-1200			5.05	5.77	14.43	208.46
1210-1315			3.11	1.55	12.43	113.44
1305-1400			4.80	0.80	0.00	13.60
1400-1500			4.44	7.40	3.70	98.38
DEEP						
1500-1750			0.00	6.77	4.78	84.03
1730-2000			1.10	5.14	1.47	57.28
2000-2300			0.00	1.65	1.23	20.58
2275-2505			0.41	0.41	0.00	7.81
2500-2750			1.51	1.13	1.13	16.62
2750-3010				SAMPLE NOT SORTED		
3010-3255			1.60	1.20	2.80	9.61
3255-3500			1.89	0.00	1.51	13.61
3490-3800			0.44	0.00	1.76	7.91
3800-4085			3.09	0.00	1.77	15.89
4085-4450			1.99	0.80	0.80	30.65

TABLE 6
Size Structure of the Copepod Population from the RMT1 catches.

Depth	DAY													TOTAL					
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5		7.0	7.5	8.0	>8.5	
0-50	963.0	385.5	382.5	140.3	19.2	7.4	5.9	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1909.8
50-100	17036.6	6026.0	1859.9	669.6	173.6	124.0	0.0	24.8	0.0	24.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25939.2
100-200	16368.7	3585.9	390.2	223.0	37.2	0.0	18.6	18.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20642.0
200-300	17683.5	23374.4	1758.6	635.0	341.9	48.8	24.4	24.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43891.2
300-400	12203.4	11977.4	3490.3	2109.2	828.6	552.4	150.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31312.0
400-500	8457.9	3992.3	2114.5	1940.9	867.9	678.5	63.1	15.8	15.8	15.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18162.4
500-600	2805.9	1596.7	1364.2	1100.7	449.6	317.8	139.5	93.0	62.0	23.3	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7960.4
600-700	3224.4	2161.1	1422.0	895.0	290.0	255.7	146.6	90.4	84.2	65.5	15.6	6.2	0.0	3.1	0.0	0.0	0.0	0.0	8659.9
700-800	5772.1	2058.4	1496.1	1008.0	275.9	106.1	95.5	74.3	21.2	63.7	10.6	10.6	0.0	0.0	0.0	0.0	0.0	21.2	11013.6
800-900	906.8	1099.1	735.8	653.4	152.7	88.5	82.4	33.6	18.3	18.3	12.2	6.1	3.1	0.0	0.0	3.1	3.1	3.1	3816.4
900-1000	71.2	237.6	210.4	204.0	69.6	60.0	39.2	21.6	24.8	9.6	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	949.7

Depth	NIGHT													TOTAL					
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5		7.0	7.5	8.0	>8.5	
0-100	3627.3	1369.2	784.0	325.7	132.5	99.4	44.2	11.0	0.0	0.0	5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6398.9
100-200	3425.6	729.2	891.8	262.3	42.0	42.0	36.7	10.5	5.2	0.0	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5450.5
200-300	1368.7	453.6	655.2	267.9	42.4	37.1	8.0	10.6	5.3	5.3	10.6	8.0	5.3	2.7	2.7	0.0	0.0	0.0	2883.4
300-400	5338.9	1089.2	642.8	559.5	196.4	89.3	17.9	6.0	17.9	6.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7969.6
400-500	7353.0	2610.8	1400.0	1097.3	391.0	176.6	50.4	50.4	0.0	25.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13154.7
500-600	9302.5	2442.1	1095.2	994.5	327.3	151.1	25.2	12.6	12.6	50.4	0.0	0.0	12.6	0.0	0.0	0.0	0.0	0.0	14425.9
600-700	6119.5	1690.8	768.5	883.8	221.0	124.9	38.4	76.9	19.2	28.8	0.0	9.6	0.0	9.6	0.0	0.0	0.0	0.0	9991.0
700-800	3616.8	1203.4	875.2	791.6	180.2	122.3	83.7	64.4	38.6	25.7	19.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7027.6
800-900	2403.9	1071.6	943.5	682.8	113.8	113.8	61.6	61.6	9.5	14.2	0.0	4.7	0.0	4.7	4.7	0.0	0.0	0.0	5490.6
900-1000	1187.0	898.1	633.5	466.5	170.6	62.7	107.9	83.5	17.4	20.9	20.9	13.9	3.5	0.0	0.0	3.5	0.0	0.0	3693.3

RMT8

The vertical distribution of the eight major taxa found in the RMT8 catches, as the sum of the no. 10^4m^{-3} for each 100m depth range within the top 1500 m of the water column, are shown in Table 7. The rank order of abundance of the major taxa remains the same if either the total numbers throughout the water column or the no. m^{-2} in the 0-1500m depth range are considered.

	No. ⁻²		*Total. 10^4m^{-3}
	DAY	NIGHT	
1. Amphipods	43.08	16.38	5973.50
2. Medusae	24.14	25.31	5163.86
3. Chaetognaths	21.17	23.36	4589.27
4. Siphonophores	22.77	22.57	3811.31
5. Euphausiids	8.57	14.82	2374.46
6. Fish	5.98	5.14	1233.34
7. Mysids	5.51	5.36	1122.85
8. Decapods	3.07	3.40	688.46

* Corrected for average of 0-50 and 50-100m daytime hauls

The numbers for siphonophores refer only to calycophoran species (see below), which were considerably more abundant than the physonect ones. The numbers for the asexual (nectophores) and sexual stages (bracts) have been combined, except for prayid species. In these latter species, for instance *Rosacea plicata*, the sexual stage remains attached to the main stem and so should be considered as part of the same individual as the nectophores. Some attempt has been made to "quantify" the siphonophore numbers. Since each specimen of *Rosacea plicata*, the most abundant prayid, usually possesses two nectophores, the total number of the latter has been divided by two. This probably results in an underestimation of the population, as some loss of nectophores by extrusion through the meshes would be expected. Similarly, the total number of nectophores of hippopodiid species (genus *Vogtia*) have been divided by five. Each hippopodiid specimen may possess more than 10 nectophores but, since the smaller ones frequently are lost, a divisor of five seems a reasonable compromise. For the other calycophoran species, the number of anterior or posterior nectophores, whichever is greater, has been used.

The vertical distribution of the eight major taxa found in the RMT8 catches, as no. 10^4m^{-3} , are shown in Table 8.

TABLE 8

Cruise 175 RMT8 taxon data (No.10⁴m⁻³)

DEPTH	DAY											TOTALS	
	SIPHS	MEDUSA	CHAETS	AMPHS	EUPHS	DECS	MYSIDS	FISH					
0-50	0.00	5.21	3.37	779.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	788.18
50-100	0.00	0.31	44.19	1314.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1358.58
100-195	0.00	0.00	0.00	3066.38	3.06	0.00	0.00	0.00	0.00	0.00	0.00	0.34	3069.78
200-305	98.32	21.40	141.80	72.57	273.90	2.01	0.00	0.00	0.00	0.00	0.00	4.35	614.36
300-400	161.00	50.37	157.49	17.22	81.93	0.32	0.00	0.00	0.00	0.00	0.00	28.37	496.70
400-490	932.02	119.03	135.79	24.09	170.70	14.66	0.35	0.35	0.35	0.35	0.35	99.83	1496.47
500-600	58.92	105.78	151.19	15.52	118.42	21.84	1.15	1.15	1.15	1.15	1.15	103.76	576.59
600-700	61.93	60.99	122.60	9.48	48.66	6.64	2.84	2.84	2.84	2.84	2.84	68.57	381.72
700-800	125.64	215.63	98.82	11.29	58.94	33.17	37.41	37.41	37.41	37.41	37.41	81.17	662.07
800-900	37.12	176.58	305.67	4.01	30.43	39.13	70.23	70.23	70.23	70.23	70.23	73.91	737.09
900-1000	51.37	101.76	205.48	6.87	11.12	27.49	59.55	59.55	59.55	59.55	59.55	38.61	502.26
1000-1100	80.51	133.60	164.84	9.02	13.88	26.72	51.71	51.71	51.71	51.71	51.71	29.15	509.43
1100-1200	87.24	529.57	314.92	7.24	15.20	32.22	155.65	155.65	155.65	155.65	155.65	17.74	1159.76
1200-1300	132.13	343.87	159.89	5.02	10.37	43.15	86.64	86.64	86.64	86.64	86.64	27.09	808.16
1300-1400	236.27	255.90	29.80	5.26	8.41	24.89	46.27	46.27	46.27	46.27	46.27	15.42	622.22
1400-1500	214.11	297.14	104.87	7.28	12.38	21.12	38.96	38.96	38.96	38.96	38.96	9.47	705.33

NIGHT									
DEPTH	SIPHS	MEDUSA	CHAETS	AMPHS	EUPHS	DECS	MYSIDS	FISH	TOTALS
20-110	2.40	0.00	95.48	470.20	814.90	120.10	0.00	16.81	1519.90
110-205	2.66	0.33	14.61	558.92	37.19	9.96	0.00	5.65	629.33
200-300	15.53	1.76	151.05	482.79	82.58	8.82	0.00	9.18	751.72
300-405	328.38	58.34	232.09	12.23	66.18	7.53	0.94	29.80	735.48
405-505	199.52	69.93	138.89	9.62	81.48	8.98	0.96	92.38	601.77
500-600	230.26	131.90	127.38	12.81	81.02	3.77	14.70	68.97	670.81
600-700	128.15	68.73	139.07	7.71	157.70	6.42	28.91	36.61	573.31
700-795	150.93	104.13	121.93	4.94	126.54	17.47	38.56	54.37	618.87
795-900	127.67	217.56	137.46	11.89	75.20	23.79	59.11	60.51	713.20
890-1000	45.24	111.11	251.82	11.31	23.29	26.28	70.52	48.90	588.46
1000-1115	49.58	137.03	327.54	8.11	4.81	20.73	62.50	20.43	630.75
1115-1200	208.18	178.15	274.65	6.41	11.47	32.73	71.53	19.91	803.03
1210-1315	294.94	669.79	217.12	8.68	11.81	22.23	81.64	25.71	1331.93
1305-1400	263.07	465.94	58.90	22.90	9.49	23.97	53.66	11.45	909.38
1400-1500	210.84	315.91	47.82	9.77	7.68	22.34	53.41	13.26	681.04

DEEP									
DEPTH	SIPHS	MEDUSA	CHAETS	AMPHS	EUPHS	DECS	MYSIDS	FISH	TOTALS
1500-1750	31.88	67.17	28.95	2.76	4.72	7.48	13.01	14.64	170.60
1730-2000	46.51	17.46	24.90	5.71	4.32	5.19	1.73	20.06	125.87
2000-2300	33.18	3.86	18.14	2.32	3.67	3.28	0.77	54.02	119.23
2275-2505	13.40	3.90	11.36	0.17	2.04	3.73	1.87	23.23	59.70
2500-2750	5.20	13.44	11.11	3.05	3.76	4.84	2.15	1.61	45.16
2750-3010	2.37	45.11	17.17	1.64	3.65	1.83	0.55	1.10	73.42
3010-3255	5.41	25.89	2.29	1.80	1.64	2.46	4.10	0.49	44.08
3255-3500	8.97	11.31	4.13	1.97	0.18	4.13	3.59	1.08	35.35
3490-3800	6.83	4.70	4.48	4.27	1.71	2.56	1.92	1.07	27.55
3800-4085	11.67	10.93	5.37	1.48	0.37	4.07	4.82	2.59	41.30
4085-4450	13.95	15.10	8.60	1.91	1.34	1.91	1.15	1.72	45.68

The day and night centres of gravity (Table 9) for most of the groups are very similar. The main exceptions are euphausiids, which undertook a diel vertical migration into the top 100m at night, and the siphonophores, which appear to have a deeper distribution at night. However, these overall comparisons mask the behaviour of individual species within other taxa, some of which undergo diel vertical migrations. These are discussed in the sections dealing with each taxa.

TABLE 9

Centres of Gravity for major taxa in RMT8 catches.

	DAY			NIGHT		
	25%	50%	75%	25%	50%	75%
1. Amphipods	101.0	136.1	171.2	87.1	162.4	241.3
2. Medusae	715.6	1041.4	1185.3	790.8	1127.8	1232.0
3. Chaetognaths	446.5	774.2	1025.5	365.3	804.0	1003.1
4. Siphonophores	333.2	394.3	1110.2	406.9	755.5	1169.3
5. Euphausiids	177.1	340.9	495.9	45.5	90.9	435.6
6. Fish	416.0	590.8	783.8	372.6	593.4	822.9
7. Mysids	843.2	1056.8	1139.5	784.7	987.0	1166.9
8. Decapods	656.9	884.6	1131.3	70.8	627.7	1005.0

In the following sections, which deal with the vertical distribution of species within the various taxa, a summary table is given in each. Within these tables the total number of specimens per 10^4m^{-3} for each species is given. This number refers to the sum of the number of specimens per 10^4m^{-3} in each haul within the 0-1500 m depth range.

Siphonophores.

Forty species of siphonophore, including 6 physonects and 34 calycophorans, were identified from the RMT8 samples (Table 10). In this table the total number of nectophores (prayids) or the number of anterior or posterior nectophores, whichever is greater (other families), is used. (*) indicates sexual stages are included. N.P. indicates not present at depths less than 1500 m.

Rosacea plicata

As noted earlier, siphonophores were the predominant contributor to the displacement volume of the RMT8 catches in the 300-500m depth range, both by day and at night. This biovolume was made up mostly of large numbers of the voluminous prayid species *Rosacea plicata* (Figure 8), which was the predominant siphonophore at the BIOTRANS site. The daytime population was considerably larger than the nighttime one, with the former concentrated in the 400-500m depth zone. There was the suggestion of a diel vertical migration into the 300-400m depth zone at night. However, as mentioned above, this may be an artifact caused by the fact there were differences in the temperature structure of the water column at the positions where the relevant day and night hauls were fished.

The preponderance of *Rosacea plicata* in the 300-500m depth zone is well in keeping with previous data (PUGH, 1986), which also showed that this species is most abundant, in the N.E. Atlantic, between 42° and 53°N.

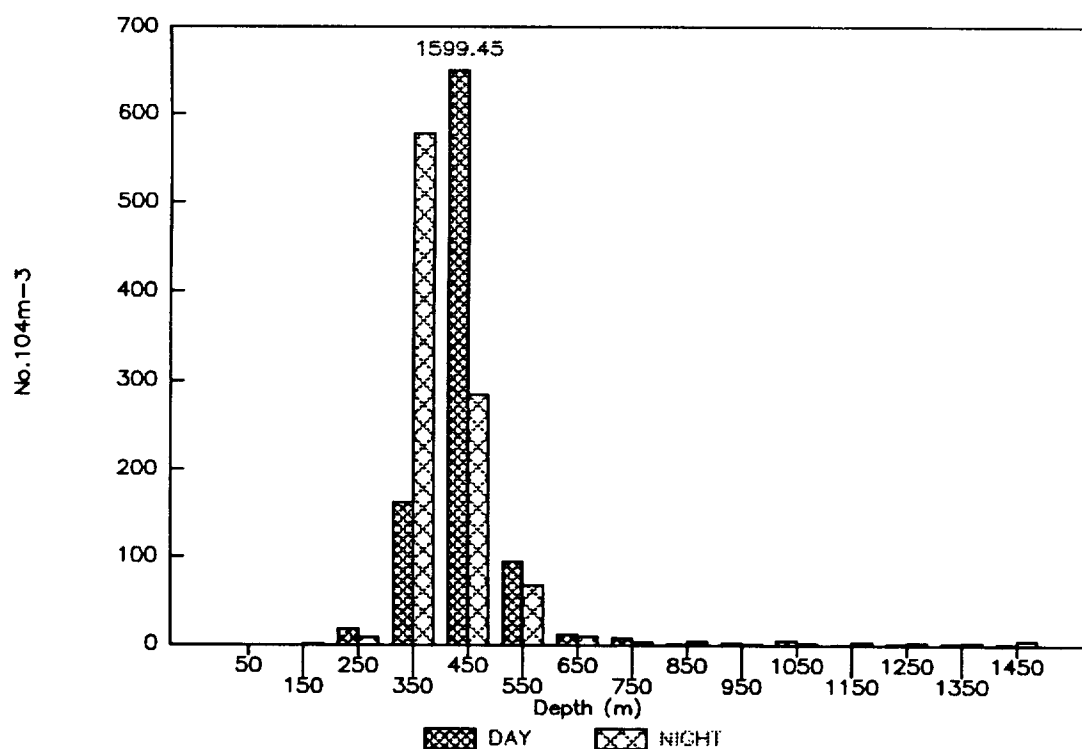


Figure 8. Depth distribution of *Rosacea plicata*

TABLE 10

Siphonophore species identified from the RMT8 samples.

	Presence No.Hauls	Total Numbers per 10^4m^{-3} (0-1500m)	
		DAY	NIGHT
<u>Physonectae</u>			
<i>Apolemia sp.</i>	5	0.36	7.71
<i>Halistemma transiratum</i>	8	47.19	26.19
<i>Bargmannia elongata</i>	4	12.46	0.0
<i>B. sp. nov.</i>	3	3.35	0.0
<i>Physophora hydrostatica</i>	2	0.0	0.31
<i>Forskalia sp.</i>	1	0.35	0.0
<u>Calycophorae</u>			
<i>Maresearsia praeclara*</i>	8	1.74	1.65
<i>Rosacea plicata</i>	38	1907.78	972.83
<i>Praya dubia</i>	3	0.63	1.00
<i>Desmophyes annectens</i>	2	0.64	0.35
<i>Nectopyramis thetis*</i>	12	20.44	23.53
<i>N. diomedea*</i>	2	0.0	0.33
<i>N. sp. nov.*</i>	8	3.40	2.73
<i>Vogtia glabra</i>	14	70.19	111.21
<i>V. spinosa</i>	15	71.45	100.38
<i>V. pentacantha</i>	9	83.94	148.60
<i>V. serrata</i>	19	148.60	248.23
<i>Lensia conoidea</i>	39	610.38	611.62
<i>L. multicristata</i>	23	131.46	49.44
<i>L. meteori</i>	2	0.0	0.64
<i>L. panikkari</i>	6	9.37	0.69
<i>L. fowleri</i>	1	0.0	0.35
<i>L. grimaldi</i>	3	0.32	1.27
<i>L. achilles</i>	19	11.95	11.22
<i>L. hostile</i>	16	6.29	11.34
<i>L. exeter</i>	4	1.21	0.72
<i>L. havock</i>	10	2.11	2.04
<i>L. reticulata</i>	2	0.0	0.35
<i>Dimophyes arctica</i>	35	29.49	48.09
<i>Chelophyes appendiculata</i>	6	35.23	2.75
<i>Eudoxoides spiralis</i>	1	0.35	0.0
<i>Clausophyes ovata</i>	29	72.51	101.87
<i>Cl. galeata</i>	2	N.P.	N.P.
<i>Cl. massiliana</i>	4	1.07	0.35
<i>Chuniphyes multidentata</i>			
Nectophores	34	138.33	163.68
Eudoxids	30	168.30	636.29
<i>Ch. moserae</i>	7	N.P.	N.P.
<i>Heteropyramis maculata*</i>	5	3.76	2.30
<i>Crystallophyes amygdalina</i>	7	0.33	1.07
<i>Thalassophyes crystallina</i>	2	0.0	0.34
<i>Enneagonum hyalinum</i>	2	0.35	0.33

Vogtia species

The four *Vogtia* species had similar depth distributions, occurring mainly in the 300-600m depth zone (Figures 9, 10, 11, and 12). *V. serrata* was about twice as abundant as the other three species. This co-occurrence is unusual as previous data (PUGH, 1974, 1984) indicated a depth stratification of the species, although there is always some overlap. However, it is possible that the overlapping depth distributions were caused by the presence of the amphipod swarm in the upper 200m of the water column, resulting in a downward displacement of the shallower living species, such as *V. spinosa*.

There are no obvious signs of a diel vertical migration for any of the species except, perhaps, for *V. glabra*. However, this may again be a feature of the hydrological conditions, as discussed above for *Rosacea plicata*. As PUGH (1984) noted, it is often difficult to establish small scale diel migrations when the sampling depth interval is of the order of 100m. He found, at 44°N, 13°W, that the apparent depth distribution of a species was different depending on whether the data derived from sampling over 100m depth bands (vertical series) or from sampling over 48h periods at a fixed depth. He suggested that the *Vogtia* species were undergoing slow, but continuous vertical migrations, with a sinusoidal pattern. Thus the exact timing of a haul in a vertical series would greatly affect where the main population was found.

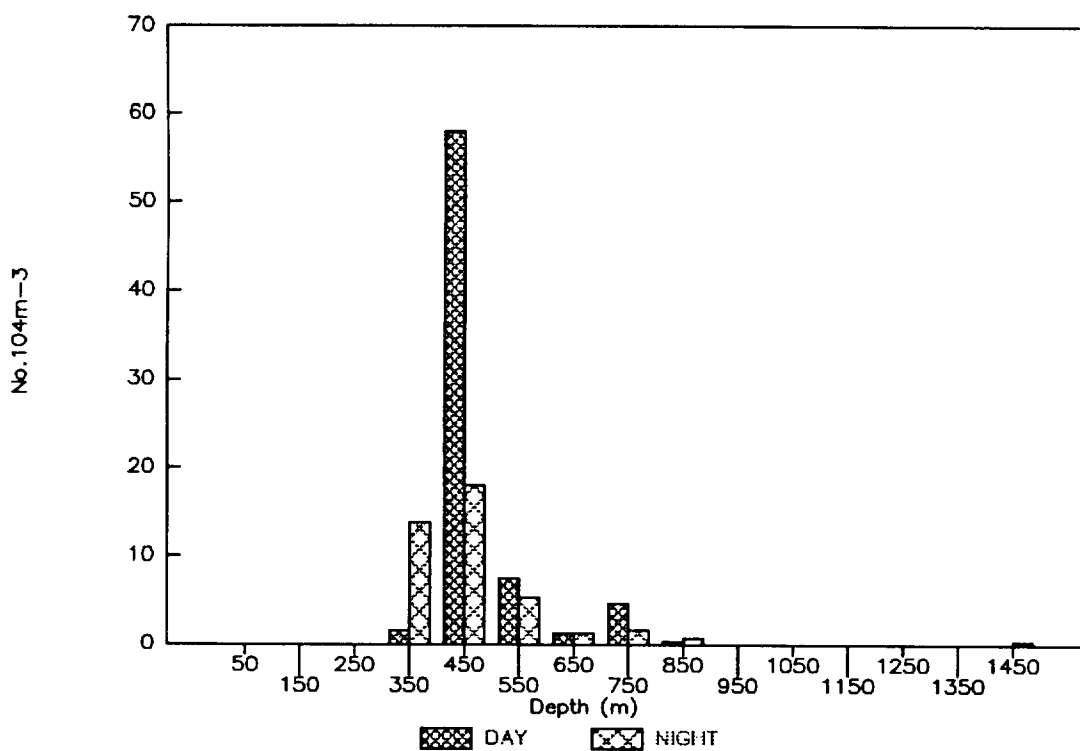


Figure 9. Depth distribution of *Vogtia glabra*

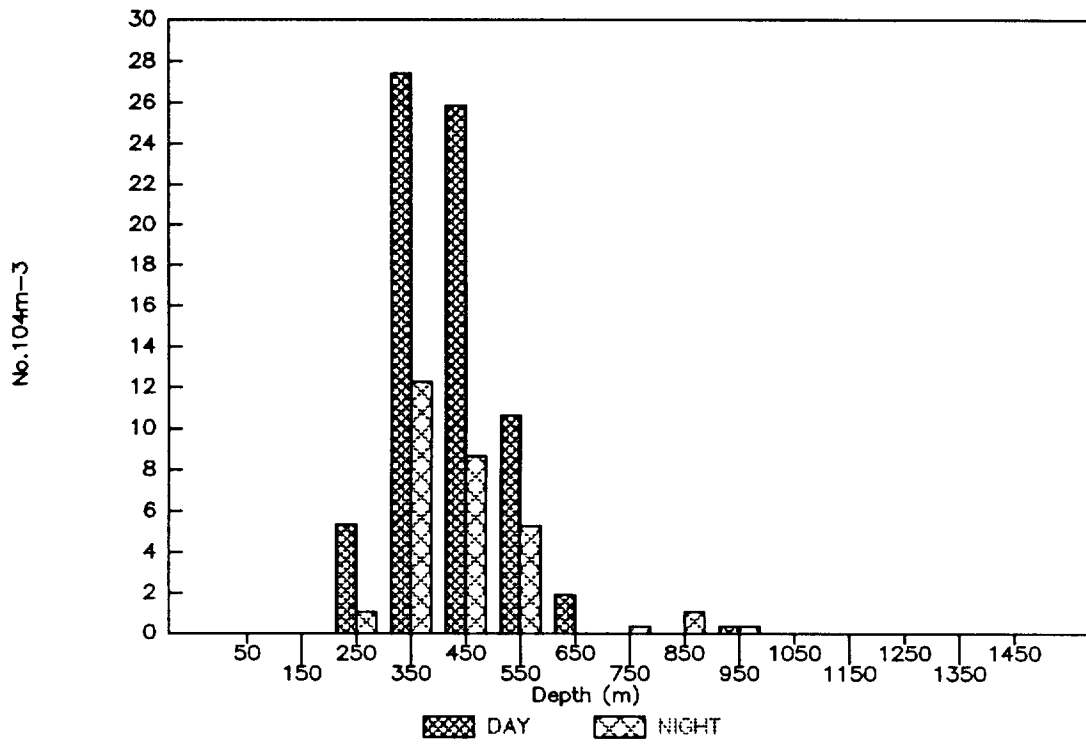


Figure 10. Depth distribution of *Vogtia spinosa*.

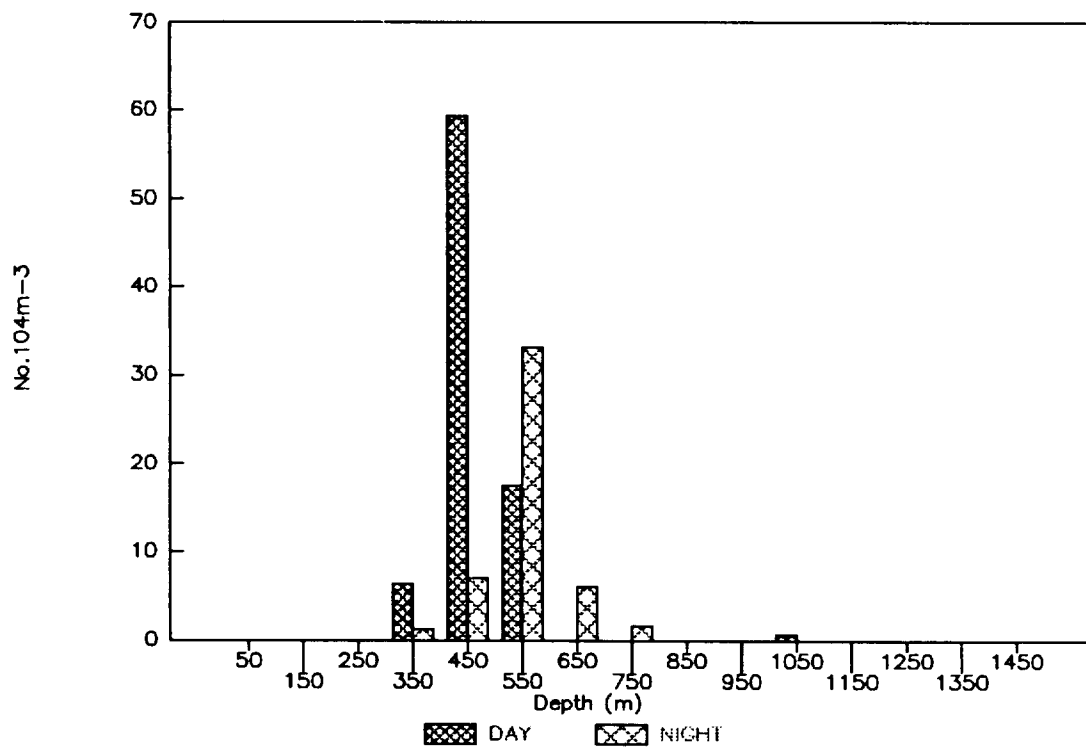


Figure 11. Depth distribution of *Vogtia pentacantha*

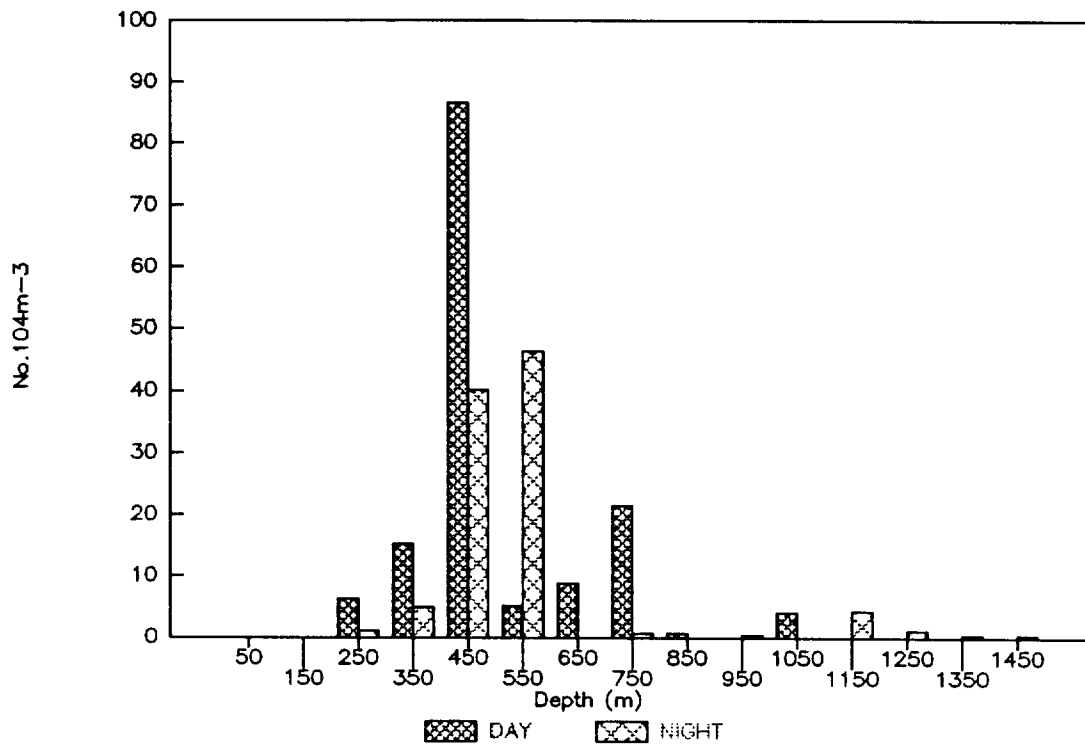


Figure 12. Depth distribution of *Vogtia serrata*

Lensia conoidea

This was the second most abundant species at the BIOTRANS site. Although it was present virtually throughout the water column (Figure 13), maximum numbers were found in the 1200-1500m depth range, with an abrupt decline in numbers at deeper depths. *L. conoidea* is a common siphonophore in the N.E. Atlantic at latitudes north of 40°N. It shows an interesting latitudinal change in depth distribution (MACKIE *et al*, 1987) which may be connected with the temperature structure of the water column. At 40°N, as in the present study, the bulk of the population was found between 1000 and 1500m, where the water temperature was between 5 and 8°C. There was also an element of mixing between Mediterranean and North Atlantic Central Water at those depths. However, at 42°N, 17°W ('Discovery' St. 9801) the population of *L. conoidea* was found to be fairly evenly spread throughout the 0-1500m depth range. Further to the north the population was found to be concentrated in the top few hundred metres of the water column, where the temperature was in the 10-12°C range. This was particularly true at 44°N, 13°W where peak numbers were found at ca. 100m, where the temperature was ca. 12°C (PUGH, 1984). Since there was a strong influence of Mediterranean water, between ca. 600 and 1000m, at that station, it would appear unlikely that the increased salinity of those waters was having any controlling effect on the distribution of *L. conoidea*. Thus it is unclear why at the BIOTRANS site this species still has such a deep depth distribution. It would seem very tenuous to blame it on the amphipods yet again!

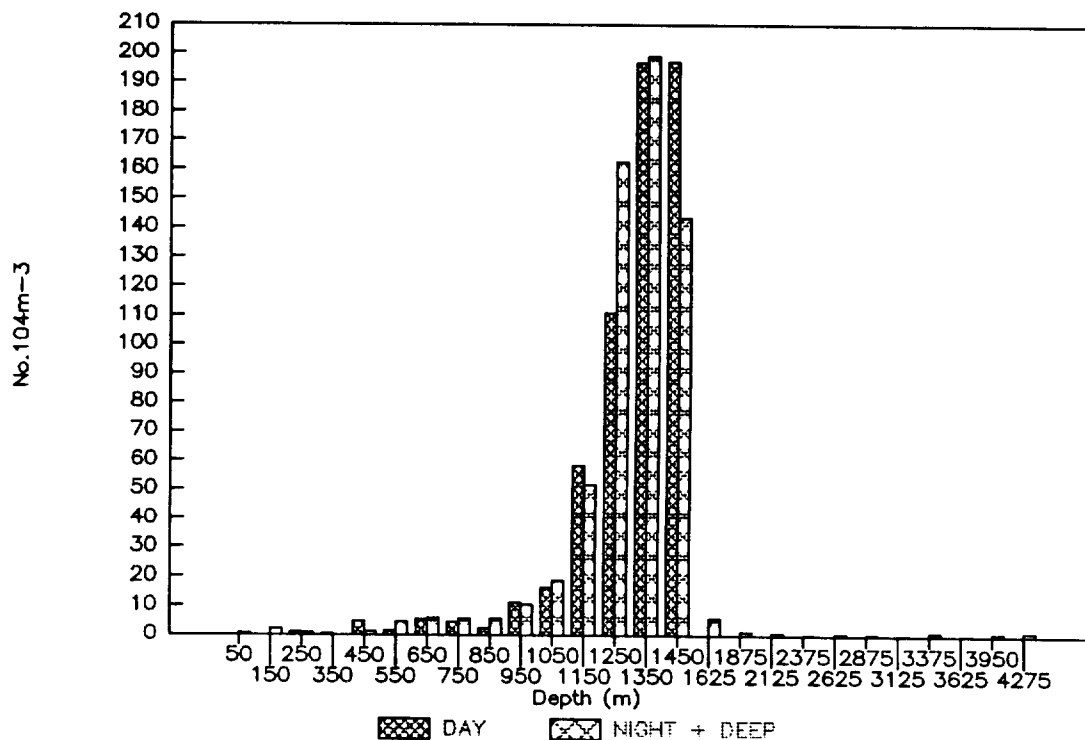


Figure 13. Depth distribution of *Lensia conoidea*

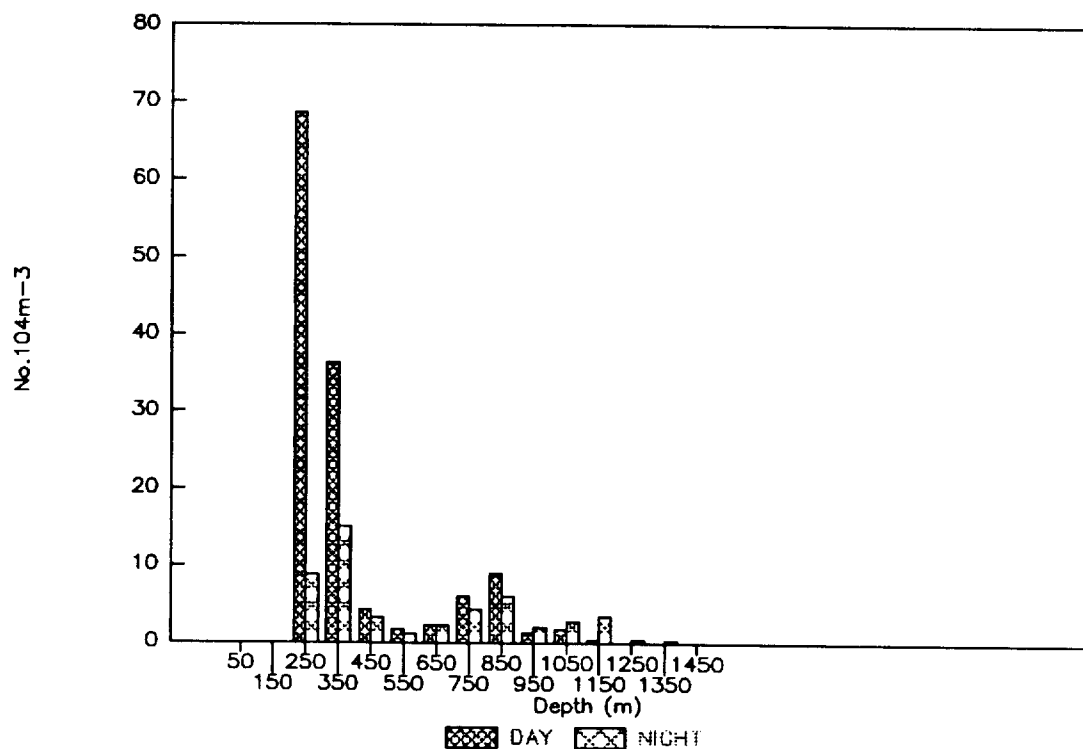


Figure 14. Depth distribution of *Lensia multicristata*

Lensia multicristata

This was the only other *Lensia* species, from a total of 11, to be common at the BIOTRANS site. Maximum numbers were found in the 200-400m depth range, but there was a long distributional tail down to a depth of 1400m (Figure 14). As with many other species, there was a great disparity between the day and night totals, and there were no indications of a diel vertical migration into the amphipod-infested near-surface waters. Previous data (PUGH, unpublished) show that this species is cosmopolitan in the N.E. Atlantic, occurring from the equator to 60°N, but most abundant between 18° and 49°N. It was generally found to occur in the 100-400m depth zone, as was the case at the BIOTRANS site, although occasionally a secondary peak occurred at depths between 600 and 1000m.

Chuniphyes multidentata

This was the third most abundant species at the BIOTRANS site. The majority of the population, particularly at night, consisted of eudoxids, which indicated that it was reproductively active (Table 10). The nectophores were fairly evenly distributed down through the water column between 400 and 2500m (Figure 15). At deeper depths it was found only rarely, and was largely replaced by its congener, *Ch. moserae*. The largest number of eudoxids were found in the 500-1300m depth zone, at night, with maximum numbers of ca. 120 gonophores per 10^4m^3 .

Although previous data (MACKIE *et al*, 1987) show that *Ch. multidentata* has a widespread latitudinal distribution in the N.E. Atlantic, it was found to be most abundant between 40° and 50°N, with numbers of nectophores in excess of $300 \cdot 10^4\text{m}^{-3}$. The numbers at the BIOTRANS site are, therefore, low in comparison, but the overall depth distribution pattern is very similar to that found at 42°N, 17°W.

Clausophyes ovata

This was the fourth most abundant siphonophore, and occurred mainly in the 600-1000m depth range (Figure 16), but was present in most of the deeper hauls. At the very deepest depths some very large nectophores were found which were similar in size to those of the congeneric species, *Cl. galeata*, which also was present. Although the posterior nectophores of the two species could easily be distinguished, this was not true for the anterior ones, and further studies need to be made.

Previous data (MACKIE *et al*, 1987) showed *Cl. ovata* to have a widespread latitudinal distribution in the N.E. Atlantic, with maximum abundances between 40° and 50°N. The present data are in good agreement with this, although, as with *Chuniphyes multidentata*, the species is less abundant than might be expected.

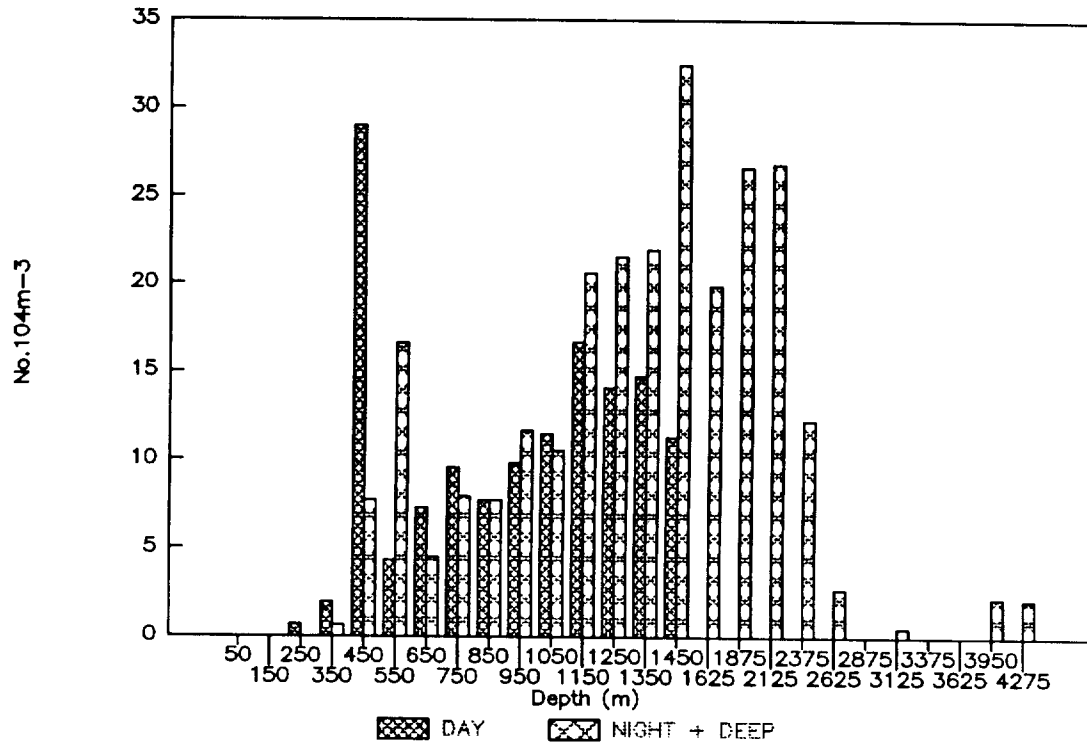


Figure 15a. Depth distribution of *Chuniphyes multidentata* nectophores.

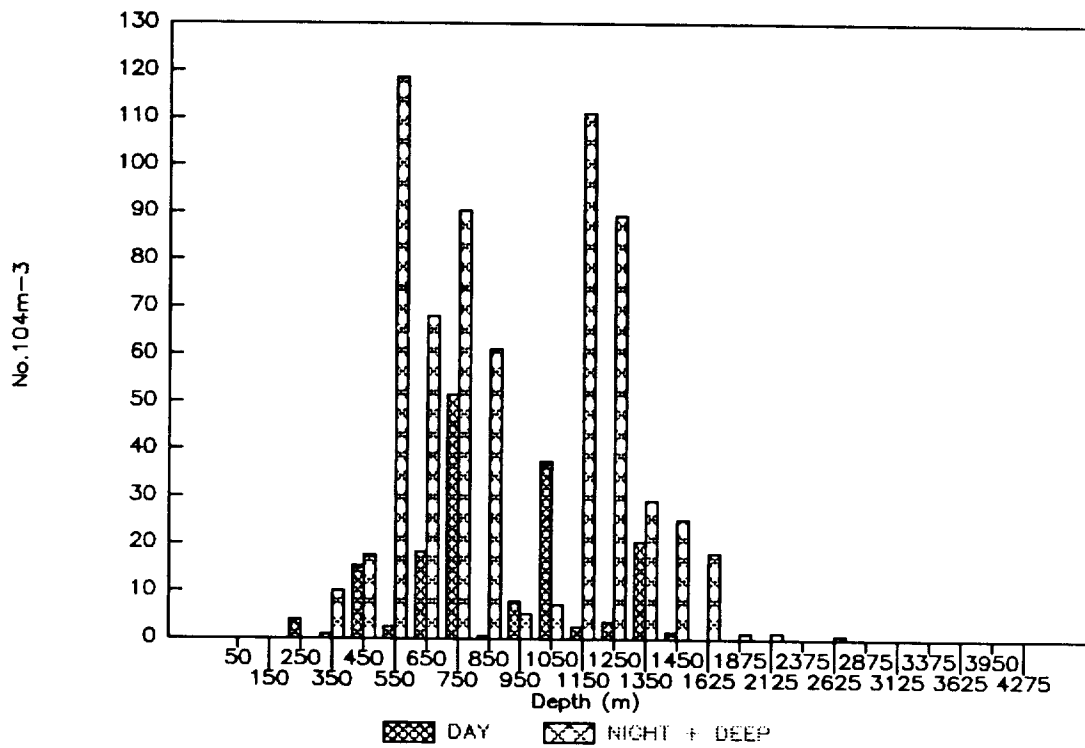


Figure 15b. Depth distribution of *Chuniphyes multidentata* eudoxids.

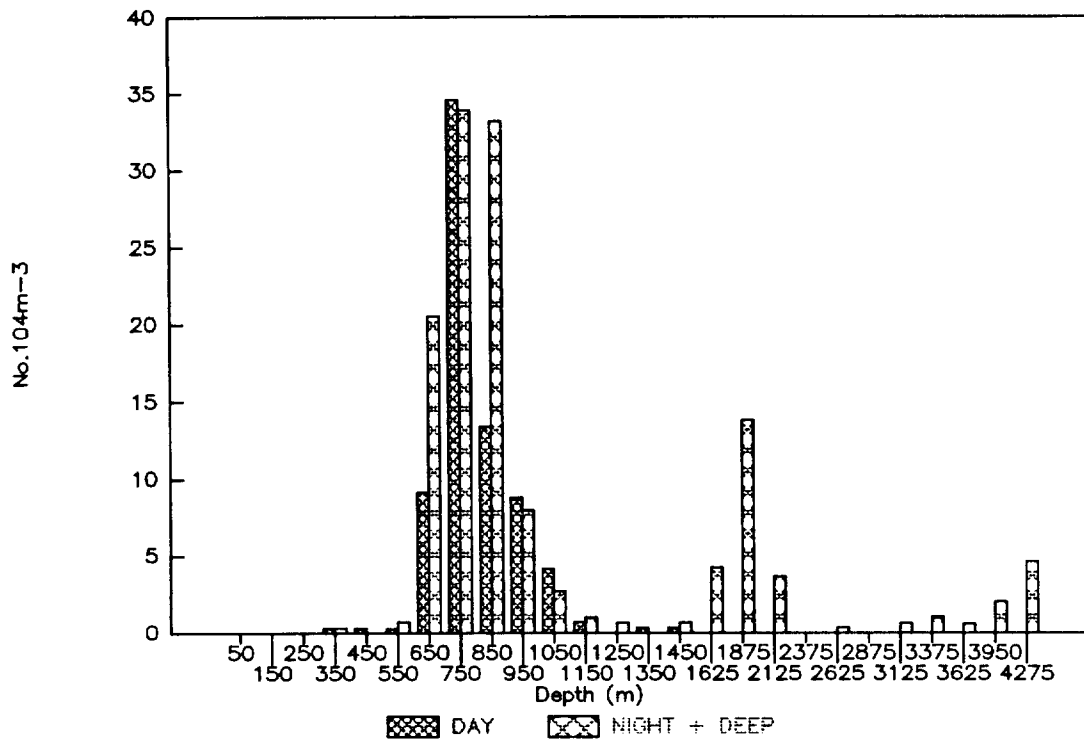


Figure 16. Depth distribution of *Clausophyes ovata*.

Dimophyes arctica

This species had an extensive depth distribution at the BIOTRANS site, ranging from 200 to 4450m. Peak abundances were reached in the 900-1500m depth zone. This is a cold-water species, and at higher latitudes is usually found in the top 500m of the water column. South of 50°N in the N.E. Atlantic the population is found at deeper depths, in accordance with the deepening of the isotherms (FASHAM & ANGEL, 1975), and it also shows a decline in numbers. The present data reflect this trend.

Chelophyes appendiculata

This is an epipelagic, warm-water species and its presence at the BIOTRANS site appears to be an example of how such species are carried northwards with the development of the seasonal thermocline. Its depth distribution was restricted to the top 500m, but almost 90% of the population was found in the day hauls between 200 and 400m. Again this seems to reflect the greater degree of stratification of the water in the S.W. sector of the sampling region in which the daytime hauls were fished. Presumably, the absence of this species in the top 200m of the water column again is a response to the bloom of amphipods.

Other Siphonophore Species

Most of the other siphonophore species were comparatively rare, with 28 occurring in less than 10 hauls (Table 10). Remark has been made already of the presence, in the very deepest hauls, of *Clausophyes galeata*. There are very few records for this species, most of which come from the Antarctic Ocean, and this appears to be the first record for the N. Atlantic, if not the Atlantic as a whole.

This is also the first time that *Halistemma transliratum*, recently described by PUGH & YOUNGBLUTH (1988), has been recorded in the N.E. Atlantic.

Summary

Overall, the species composition and abundance of the siphonophore population at the BIOTRANS site is in accord with that expected from previous information (MACKIE *et al*, 1987). There appears to be a greater similarity with the data from 'Discovery' St.9801 (42°N, 17°W) than with other more northerly stations, or the one at 44°N, 13°W (PUGH, 1984). The presence of relatively few species, and the preponderance of such species as *Rosacea plicata*, *Lensia conoidea* and *Chuniphyes multidentata*, typify the type of siphonophore population found at more northerly latitudes in the N.E. Atlantic. However, it is clear that the northward spreading of the seasonal thermocline introduces warm-water, epipelagic species, such as *Chelophyes appendiculata* and *Eudoxoides spiralis*, into the area. It must also be remembered that the presence of the amphipod bloom, in the top 200m of the water column, must have affected greatly the epipelagic populations of all taxa.

Medusae

Approximately 20 species of medusae have been identified from the RMT8 catches, as listed in Table 11. In this table (N.P.) indicates not present at depths less than 1500m.

	Presence No.Hauls	Total Numbers per 10^4m^{-3} (0-1500m)	
		DAY	NIGHT
<u>Order Anthomedusae</u>			
<i>Bythotiara murrayi</i>	1	0.0	0.71
<i>Tiaranna rotunda</i>	6	2.00	1.68
<i>Chromatonema rubrum</i>	4	2.42	0.30
<u>Order Trachymedusae</u>			
<i>Halicreas minimum</i>	30	52.29	52.40
<i>Haliscera bigelowi</i>	17	237.87	198.28
<i>Botrynema brucei</i>	21	53.20	37.53
? <i>B. ellinorae</i>	8	N.P.	N.P.
? <i>Rhopalonema funerium</i>	1	N.P.	N.P.
<i>Pantachogon haeckeli</i>	16	12.57	19.13
<i>Colobonema sericeum</i>	30	226.43	216.81
<i>Crossota alba</i>	2	0.35	0.33
<i>C. rufobrunnea</i>	7	19.56	12.09
<i>Aglantha digitale</i>	37	1292.25	1540.63
<u>Order Narcomedusae</u>			
<i>Aegina citrea</i>	17	6.68	6.32
<i>Aeginura grimaldi</i>	26	445.43	369.92
<i>Solmissus/Solmaris</i>	22	12.51	16.34
<u>Order Coronatae</u>			
<i>Nausithoe atlantica</i>	7	2.08	1.04
<i>N. globifera</i>	3	0.65	1.51
<i>Atolla wyvillei</i>	27	27.45	41.27
<i>A. vanhoeffeni</i>	9	12.51	4.50
<i>Periphylla periphylla</i>	19	8.11	9.82

KRAMP (1959) noted that the majority of oceanic medusae belong to the holoplanktonic hydromedusan orders Trachymedusae and Narcomedusae. In the present study, at least thirteen of the species identified belonged to these two orders, while five of the others belong to the scyphomedusan order Coronatae. This is also in accord with the results of THURSTON (1977) with which the present data will be compared. Thurston detailed the depth distribution, by day and night, of the medusae collected at 'Discovery' St. 7709 (60°N, 20°W).

Aglantha digitale

This was by far the most abundant medusa, with total numbers exceeding the remainder of the medusan population. It had a widespread depth distribution, occurring in almost all the hauls from 300-4450m (Figure 17). Maximum numbers were found between 1100 and 1500m, with an apparent, but most probably unreal, reverse diel migration at night. This distribution pattern is in marked contrast to that found by THURSTON (1977). Not only did he find this species to be much less abundant at 60°N, 20°W, but also maximum numbers were found in the top 400m of the water column. At the BIOTRANS site very few medusae were found in the top 200m of the water column, and *A. digitale* was absent. Presumably, once again, this was due to the bloom of amphipods within that depth range.

WILLIAMS & CONWAY (1981) described the depth distribution (0-500m) and seasonal abundance of this species at a site, 59°N, 19°W, close to that studied by THURSTON (1977). They described *A. digitale* to be one of the commonest coelenterates in the North Atlantic Ocean north of 35°N. They found that, seasonally, the species was virtually absent from the top 500m of the water column until early April, but reached maximum numbers of up to 40 individuals m⁻³ in June. This seasonality could explain the low numbers found by THURSTON (1977), since the sampling at 60°N took place in April/early May, presumably before the population bloom. Like THURSTON (1977), WILLIAMS & CONWAY (1981) found maximum numbers to occur in the surface 100m, although small numbers of larger specimens were found at deeper depths. However, the latter authors sampling was limited to a depth of 500m.

The depth distributions of *A. digitale* at the BIOTRANS site was very different from that found by THURSTON (1977) and WILLIAMS & CONWAY (1981), and the maximum numbers, 0.06 individuals m⁻³, were much less than those found by the latter authors. However, the change over in depth distribution between the BIOTRANS site and 60°N is very similar to that described above for the siphonophore *Lensia conoidea*. In addition, ROE *et al* (1984) found that, at 44°N 13°W, *A. digitale* was mainly found at a depth of 100m, as PUGH (1984) found for *L. conoidea*. It is concluded that hydrological conditions, particularly the thermal structure of the water column, again are playing an important role in determining the depth distribution of this species.

Aeginura grimaldi

This was the second most abundant species of medusa, representing about 15% of the total numbers. It was one of the few medusae found to occur within the surface 200m, but only in relatively small numbers. It mainly occurred in the 600-1400m depth range, with a maximum between 700 and 900m (Figure 18). Occasional specimens were found at deeper depths. These data are in accord with those of THURSTON (1977), who also noted that previous information indicated that this species was an abundant medusan in the North Atlantic Ocean.

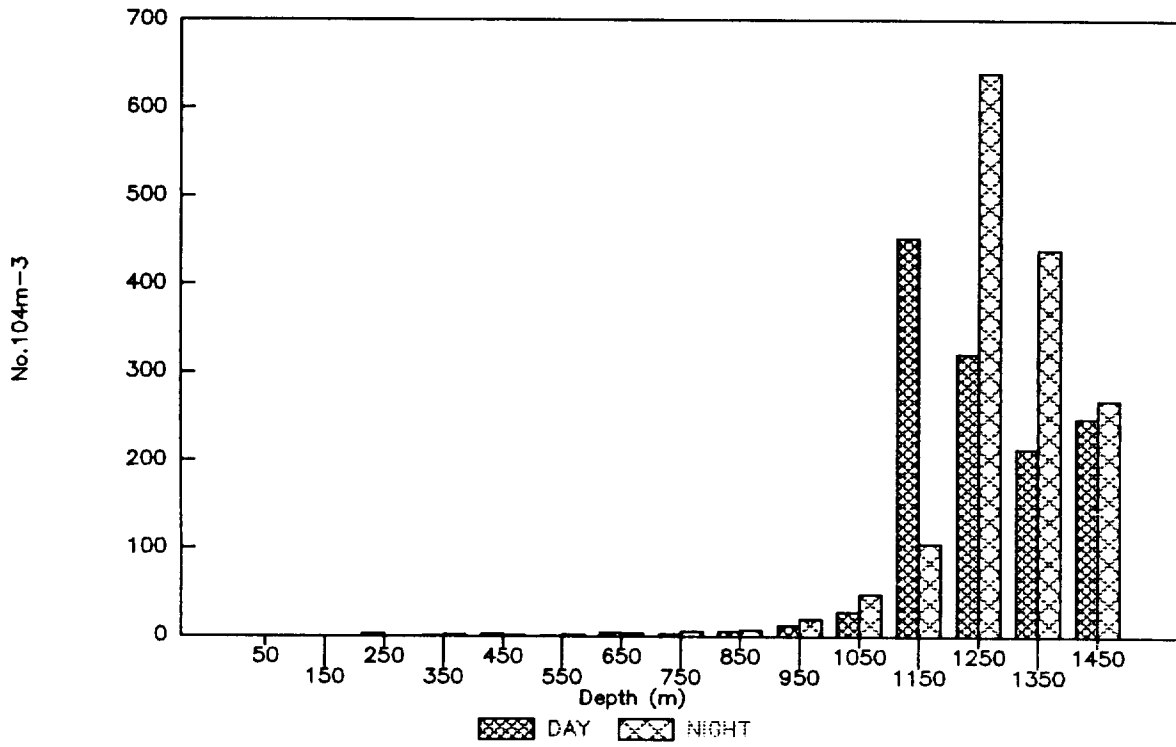


Figure 17. Depth distribution of *Aglantha digitale*.

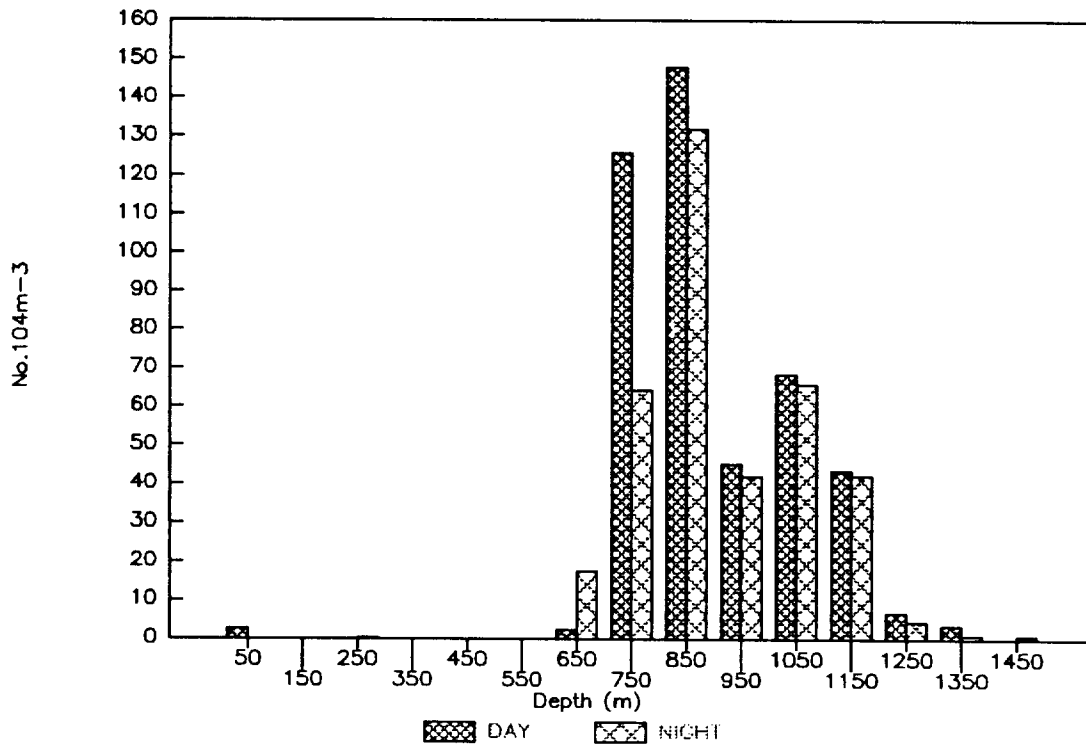


Figure 18. Depth distribution of *Aeginura grimaldi*.

Colobonema sericeum

This, the third most abundant medusan species at the BIOTRANS site, had a widespread depth distribution, with maximum numbers found in the 700-800m day and 800-900m night hauls (Figure 19). It is thought unlikely that this indicates a reverse diel vertical migration.

THURSTON (1977) found this species to be relatively rare at 60°N, with maximum numbers in the 400-600m depth range. Similarly, ROE *et al* (1984) found this species to be most abundant, albeit in relatively low numbers, at 450m at 44°N, 13°W. However, other data from this position (PUGH, unpublished) showed this species to be relatively common in the 300-600m depth range at certain times of the year. Previous data indicated that this species was common in deep water at lower latitudes.

Haliscera bigelowi

This species represented about 8% of the total number of medusae. It occurred only within the relatively narrow depth range of 200-1100m, with maximum numbers between 300 and 600m (Figure 20). As with all of the hydromedusan species found at the BIOTRANS site, there was no clear indication of a diel vertical migration. The data are broadly in agreement with those of THURSTON (1977) although he suggested that the species might undergo a small-scale diel migration at 60°N.

Halicreas minimum

This was the fifth most abundant medusan species in the 0-1500m depth range, but ranked sixth overall, after *Botrynema brucei*. It had a widespread depth distribution, but mainly occurred between 800 and 3000m (Figure 21). There were no obvious signs of a diel vertical migration. The data agree with those of THURSTON (1977).

Botrynema brucei

Apart from one haul, between 500 and 600m, all the specimens were found at depths below 1000 (Figure 22). There appeared to be two maxima, one at ca. 1500m and the other between 2750 and 3250m. The upper maximum is in agreement with that found by THURSTON (1977), but his sampling was restricted to a depth of 2000m. He commented that this is a widely distributed, bathypelagic species.

It appears that a congener, *B. ellinorae*, was present in the deepest hauls, at depths below 2250m. However, because of the poor state of the specimens, this identification must remain tentative. KRAMP (1959) described *B. ellinorae* as a bathypelagic species occurring in high Arctic waters, in Baffin Bay and between Spitzbergen and East Greenland. He suggested that its restricted distribution might be the result of geographical isolation due to the surrounding submarine ridges. However, with the dearth of accurate information on the distribution of deep-living medusae one cannot be certain that this is indeed the case.

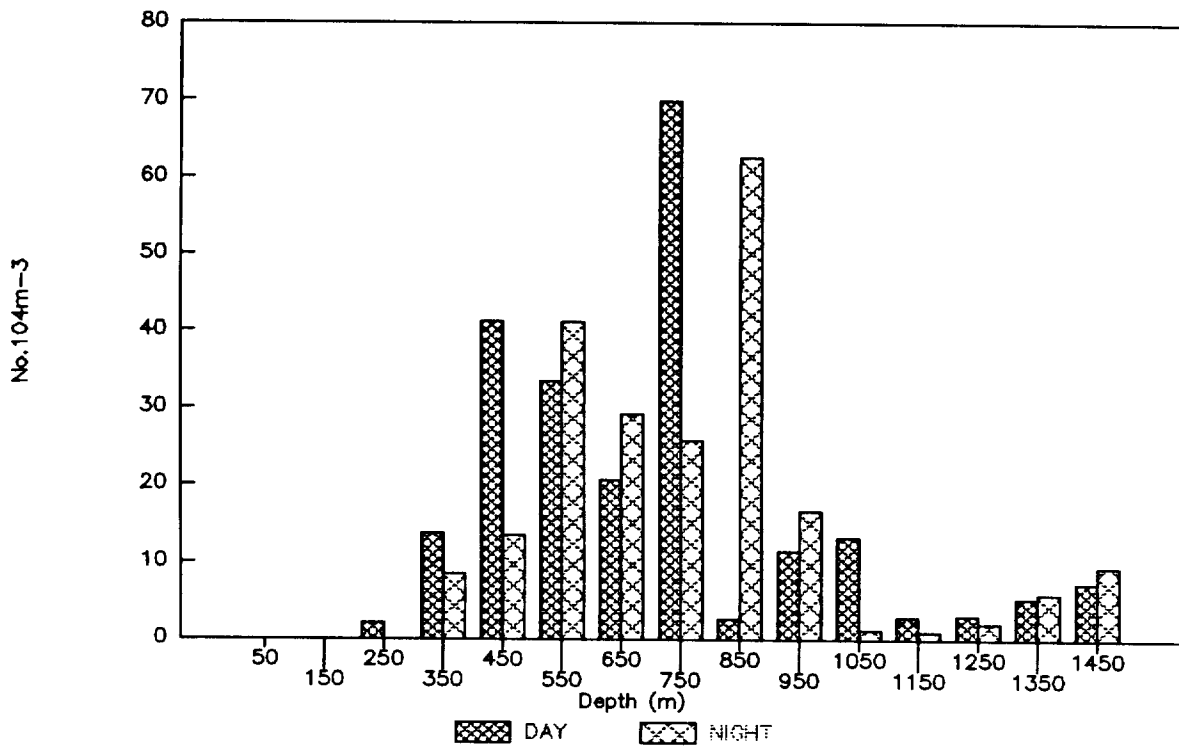


Figure 19. Depth distribution of *Colobonema sericeum*.

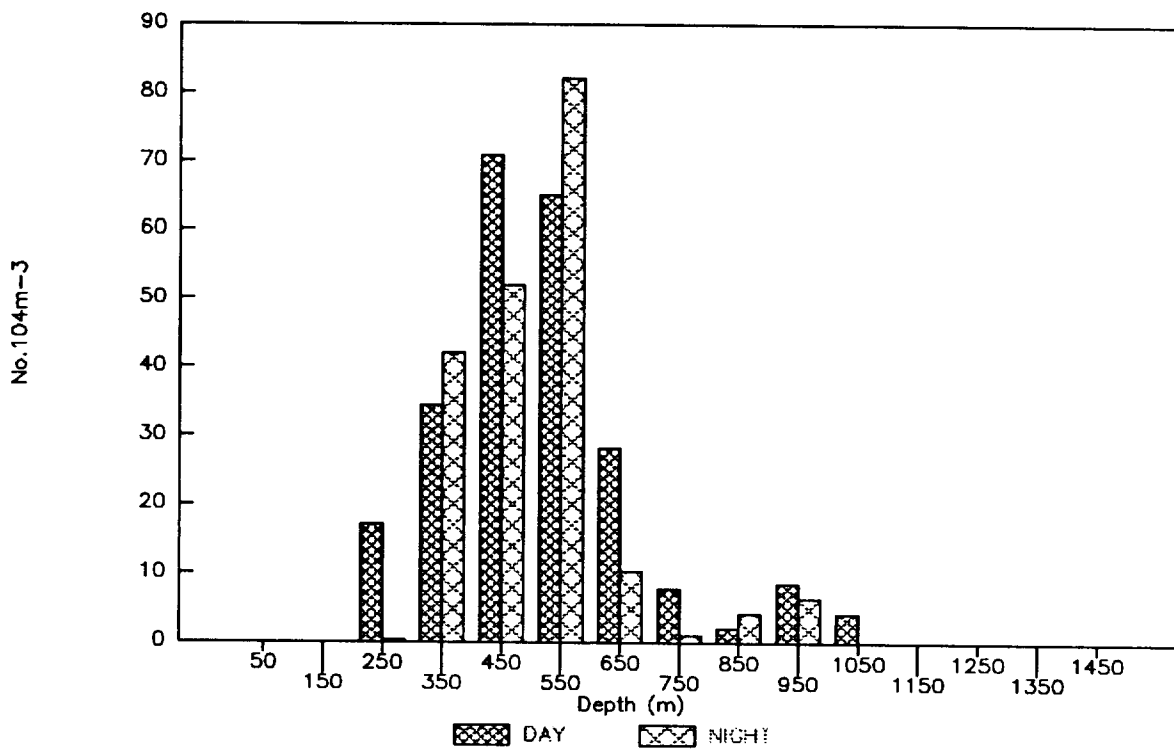


Figure 20. Depth distribution of *Haliscera bigelowi*.

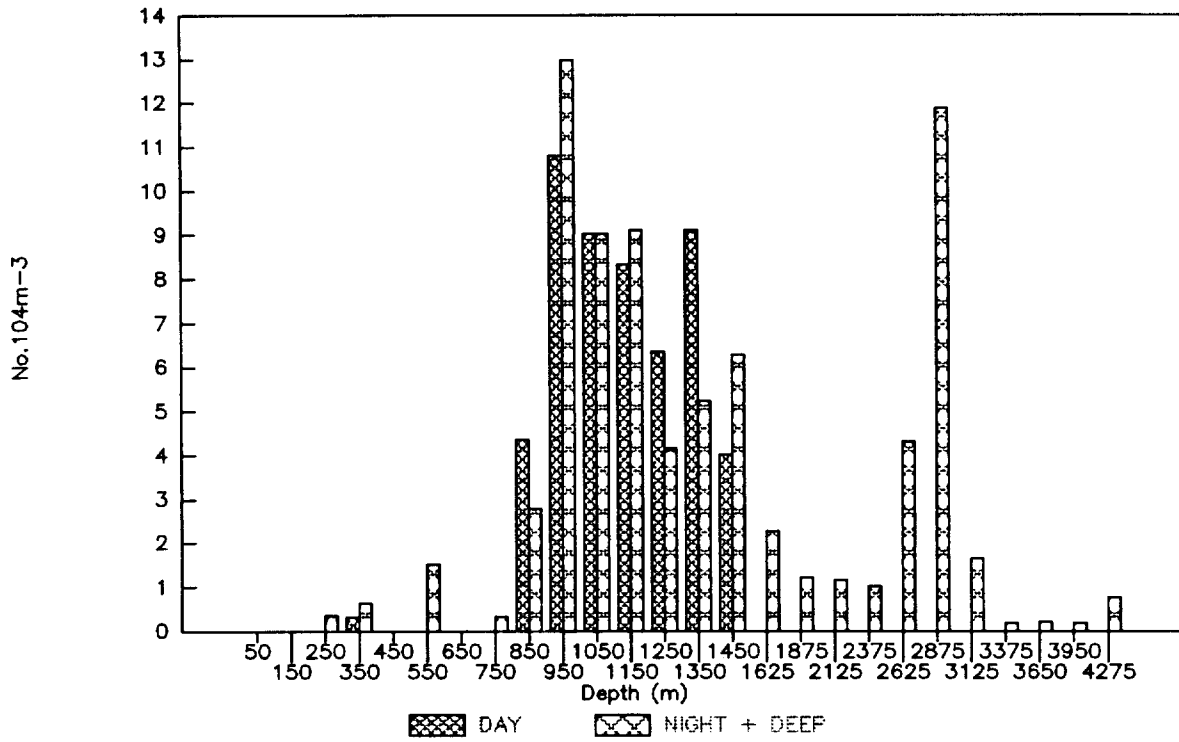


Figure 21. Depth distribution of *Halicreas minimum*.

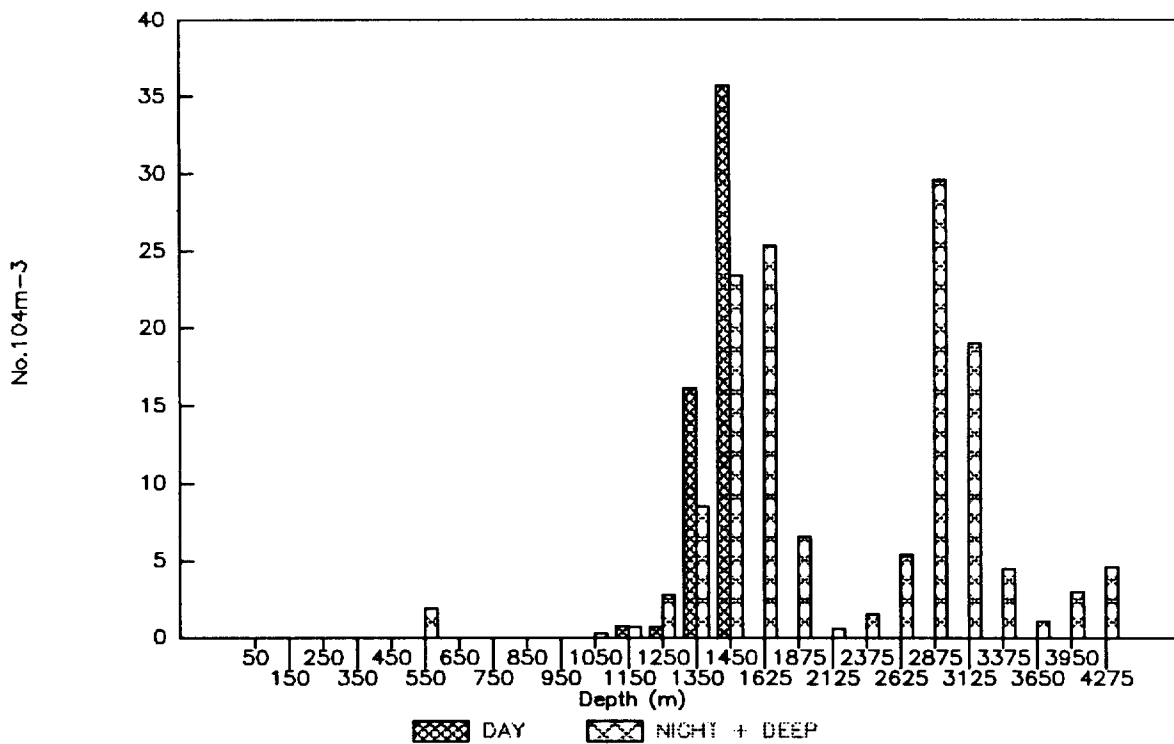


Figure 22. Depth distribution of *Botrynema brucei*.

Atolla spp.

The large scyphomedusan species *A. wyvillei* was fairly common and, because of its generally large size, it contributed significantly to the overall medusan biovolume. It had a widespread depth distribution, although mainly concentrated in the 800-1200m depth range (Figure 23). It is possible that some of the smallest specimens attributed to this species, might be *A. parva*, but none were sexually mature as might be expected if they belonged to the latter species. These smaller specimens tended to occur at the shallower end of the depth range.

Occasional specimens of *A. vanhoeffeni* were found in the hauls between 300 and 1000m. The depth distribution data for both species are broadly in agreement with those presented by THURSTON (1977).

Periphylla periphylla

This species occurred over an extensive depth range, but only in small numbers. Nonetheless, as with *A. wyvillei*, the relatively large size of the specimens meant that they contributed considerably to the medusan biovolume. The data are in marked contrast to those of THURSTON (1977) who found this species to be the third most abundant. He summarized the earlier data on the depth and geographical distribution of this species, noting that it had a widespread distribution in the deep mesopelagic zone.

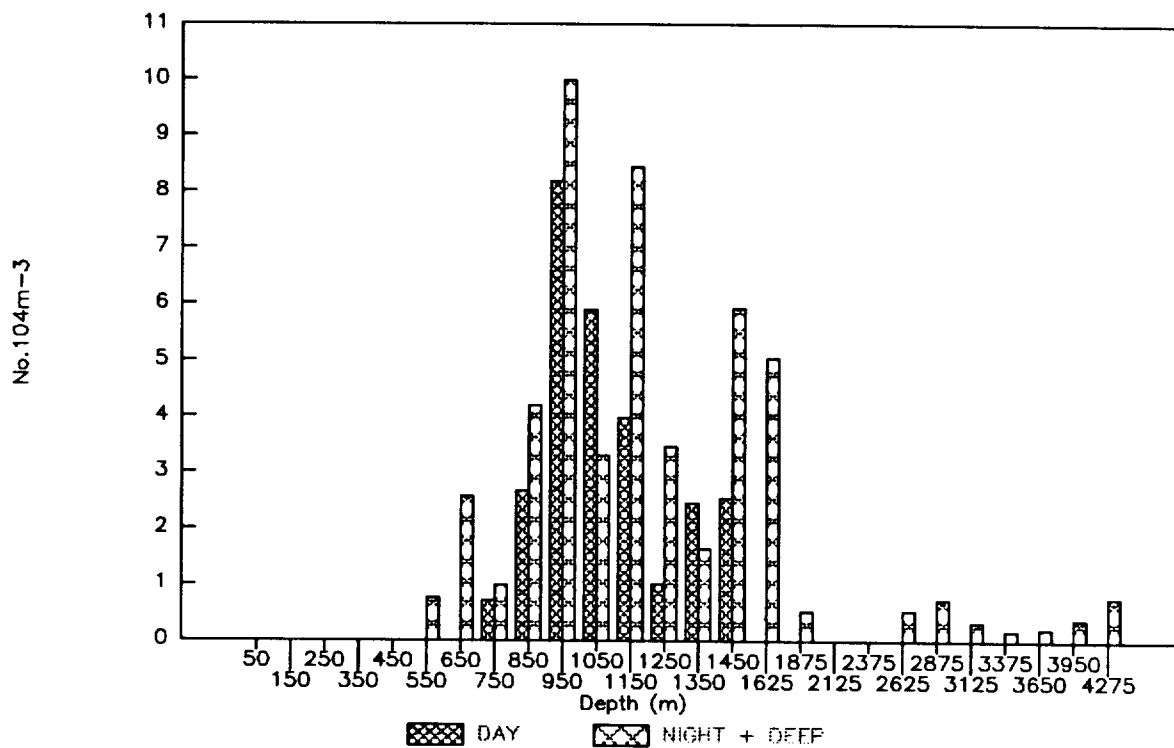


Figure 23. Depth distribution of *Atolla wyvillei*.

Other Medusan Species

The depth distributions of the rarer medusan species are broadly in agreement with those presented by THURSTON (1977). However, both *Pantachogon haeckeli*, with maximum numbers in the 700-1300m depth range, and *Crossota rufobrunnea*, only found in the hauls between 1000 and 1400m, were much less common at the BIOTRANS site than at 60°N, 20°W.

Summary

At the BIOTRANS site, medusae were the major contributor to the biovolume of the RMT8 catches at depths between 600 and 1500m, averaging 43.6 and 50.2% of the total displacement volume by day and night respectively. However, although large numbers of small medusae were present in the catches from this depth range, in most cases the large biovolume is the result of the presence of a few large specimens of either *Atolla wyvillei* or *Periphylla periphylla*. For instance, about 90% of the biovolume of medusae in the 700-800m night haul was contributed by a single specimen of the latter species. Nonetheless it is clear that the smaller medusae, such as *Aglantha digitale* and *Aeginura grimaldi* were numerically important.

THURSTON (1977), who studied the depth distribution of medusae and the amphipod *Hyperia spinigera* at 60°N, 20°W, noted that there was a striking change in the relative abundance and species composition of the medusan population between 500 and 600m. This was linked to the hydrographical change-over, within this depth range, from the well mixed North Atlantic surface and central waters, with a temperature of ca. 9.1°C, to central waters, with temperatures below 9°C, mixed with some North Atlantic Deep Water (FASHAM & ANGEL, 1975). At that position there was very little indication of a salinity maximum resulting from the presence of Mediterranean water.

The hydrographic situation at the BIOTRANS site was somewhat different, as has been discussed above, and consequently the depth distribution of several medusan species is different. This is particularly true for the predominant species, *Aglantha digitale*, which had a much deeper depth distribution than that found by THURSTON (1977). No species was found to occur exclusively above 600m depth, but one, *Haliscera bigelowi*, was commoner at these shallower depths. Most species showed maximum abundances at depths between 600 and 1500m, and the data indicated that none undertook a diel vertical migration of any magnitude.

Chaetognaths

No specific identifications were made for chaetognaths. The depth distribution of the overall population found in the RMT8 catches is shown in Figure 24. This indicates that chaetognaths were most abundant in the 200-1300m depth range, and especially at the deeper end of this range. It would be futile to speculate on whether the population underwent a diel vertical migration, but none is apparent.

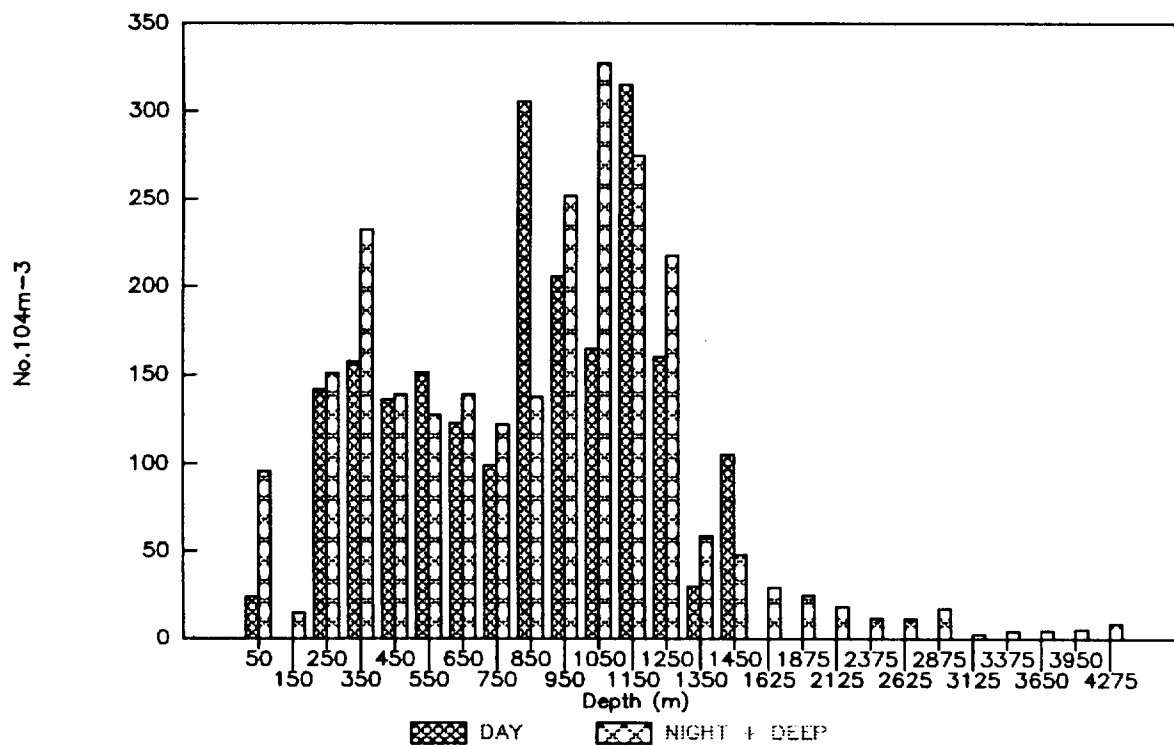


Figure 24. Depth distribution of Chaetognaths.

Amphipods

The amphipods from the RMT8 catches were identified by M.H. Thurston and the species are listed in Table 12. In this table N.P. indicates that the species was not found shallower than 1500m. CDT complex refers to a group of species within the genera *Chevreuxiella*, *Danaella* and *Thoriella*.

TABLE 12

Species of Amphipods identified from the RMT8 samples.

	Presence No.Hauls	Total Numbers per 10^4m^{-3} (0-1500m)	
		DAY	NIGHT
Hyperiidea			
<i>Scina spp.</i>	18	3.76	4.65
<i>Microphasma spp.</i>	1	N.P.	N.P.
<i>Lanceola spp.</i>	28	10.10	7.72
<i>Megalanceola spp.</i>	1	N.P.	N.P.
<i>Metalanceola spp.</i>	1	N.P.	N.P.
<i>Scypholanceola spp.</i>	18	2.05	4.48
<i>Vibilia spp.</i>	14	6.91	3.54
<i>Cystisoma spp.</i>	6	2.08	0.97
<i>Hyperia medusarum</i>	1	0.0	0.33
<i>H. spinigera</i>	5	1.00	1.00
<i>Themisto compressa</i>	40	5287.16	1581.77
<i>Pegohyperia spp.</i>	1	0.35	0.0
<i>Phronima spp.</i>	13	19.80	16.47
<i>Primno spp.</i>	2	0.70	0.38
Gammaridea			
<i>Harlede curvidactyla</i>	1	0.0	0.35
<i>Cyphocaris anonyx</i>	16	9.07	9.70
<i>C. faurei</i>	1	N.P.	N.P.
<i>C. richardi</i>	4	0.0	0.35
<i>Eurythenes gryllus</i>	2	0.33	0.0
<i>E. obesus</i>	11	3.97	3.67
<i>Metacyphocaris helgae</i>	5	1.79	1.66
CDT complex	4	0.33	0.99
<i>Thoriella islandica</i>	1	0.0	0.30
<i>Halice aculeata</i>	1	N.P.	N.P.
<i>H. macronyx</i>	1	N.P.	N.P.
<i>Euandania gigantea</i>	3	N.P.	N.P.
<i>Parandania boeckii</i>	1	N.P.	N.P.

Over 98% of the amphipods collected belong to one species, *Themisto compressa*, and almost 98% of the population of this species was confined to the top 300m of the water column (Figure 25). The long distributional tail, in that specimens appeared in almost all of the hauls, may well be an artifact due to the high concentrations in surface waters. However, THURSTON (personal communication) has noted this feature to occur in regions where the surface population is much smaller. There was a considerable disparity between the day and night populations of this species, with many more specimens being present by day. This does not appear to be a reflection of differing hydrographical conditions as the day and night near-surface hauls were fished in close proximity. Whether the data reflect a diel vertical migration also is questionable. However, because the top 20m of the water column was not sampled at night, it is possible that the disparity in day/night numbers might be a result of migration into these near-surface waters at night. In this case, there would also appear to be a small-scale reverse migration of part of the population, as much higher numbers were found in the 200-300 m depth range at night than by day.

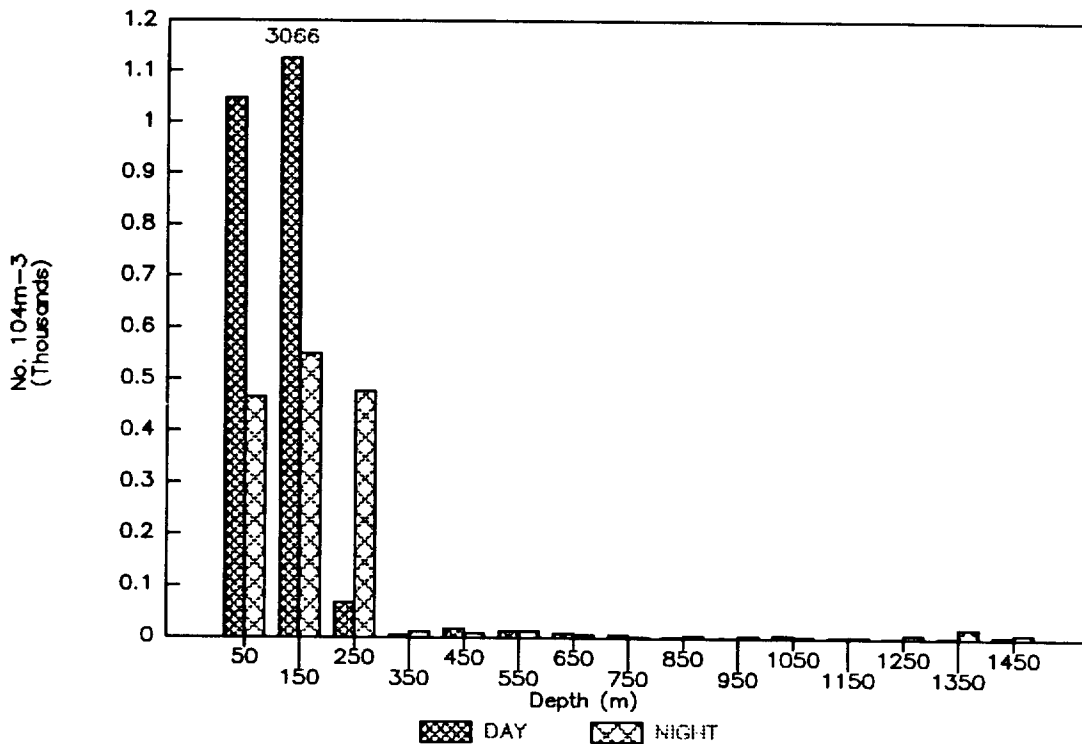


Figure 25. Depth distribution of *Themisto compressa*.

The vertical distribution and seasonal variability in abundance of *T. compressa* (*Parathemisto gaudichaudi*) has been reviewed by WILLIAMS & ROBINS (1981). They found it to have a widespread distribution in the northern North Atlantic, with peak abundances in the Labrador/Greenland current system

and in the oceanic regions to the west of the U.K.. They found that there were considerable diel changes in the vertical distribution of the species, but that this migration was only apparent if the population was divided into various size categories. This may also be the case at the BIOTRANS site where overall no diel migration was observed. Unfortunately time has not allowed an analysis of the size structure of the population. WILLIAMS & ROBINS (1981) found, as is the case here, that the bulk of the population was concentrated in the top 200m of the water column, although there was some ontogenetic migration, with the adults moving to greater depths, as the season progressed. They also found the species to be a voracious predator, with the gut contents generally reflecting the composition of the zooplankton. The very low concentrations of other plankton in the surface waters, particularly by day, are a reflection of the impact that this vast swarm of amphipods has had on the ecosystem.

A few specimens of *Vibilia* spp. were found at various depths. These species normally are associated with salps, but the population of salps found in the catches was virtually nonexistent. As commented on above, prior to the cruise a swarm of salps had been found, by "Meteor", to be present in the area. Presumably in the intervening period these salps had fallen prey to the amphipods. The small *Vibilia* population is probably a relic of that salp swarm. Similarly, the presence of *Phronima* spp. may indicate that specimens of *Pyrosoma* had been present, as the former species usually make their 'barrels' from the latter.

The most abundant, but relatively rare, gammarid species was *Cyphocaris anonyx*. According to THURSTON (personal communication) this is a typical deep mesopelagic amphipod of more northerly waters in the N.E. Atlantic. During the day, all the specimens were found at depths between 500 and 1300m. A few specimens appeared to undergo a diel vertical migration to shallower depths, although the bulk of the population remained within the same depth range.

Euphausiids

The euphausiids in the RMT1 and RMT8 catches were identified by P.T. James. Fourteen species were found to be present (Table 13), although four were rare and occurred in five or less hauls. Undoubtedly there are errors in the data, and so the following interpretations should be treated with some caution. In addition there seemed to be some confusion in the identifications of *Thysanopoda acutifrons* and *T. microphthalma* and so the data for these two have been combined.

TABLE 13
Species of Euphausiids identified from the
RMT1 and RMT8 samples.

	Presence No.Hauls	Total Numbers per 10^4m^{-3} (0-1500m)	
		DAY	NIGHT
<i>Euphausia krohnii</i>	15 32	762.45 41.86	53.18 66.45
<i>E. hemigibba</i>	1 3	0.74 0.09	0.0 0.04
<i>Nematobrachion boopis</i>	14 26	41.56 12.57	27.60 13.71
<i>N. flexipes</i>	1	0.76	0.0
<i>Thysanopoda acutifrons</i>)	12	45.29	28.60
<i>T. microphthalma</i>)	32	5.18	3.75
<i>Stylocheiron elongatum</i>	5	4.62	3.06
<i>S. longicorne</i>	12 12	44.53 0.37	42.89 0.60
<i>S. maximum</i>	5 13	4.43 1.03	9.86 2.27
<i>Thysanoessa longicaudata</i>	34 34	523.75 15.00	1604.69 33.04
<i>Bentheuphausia ambylops</i>	10 19	3.17 0.94	1.61 1.01
<i>Nematoscelis atlantica</i>	1	0.07	0.0
<i>N. megalops</i>	6 19	2.32 2.69	10.96 9.27
<i>Meganyctiphanes norvegica</i>	2 9	0.0 0.87	5.52 9.45

Thysanoessa longicaudata

This small species was overall the most abundant euphausiid at the BIOTRANS site although, because of its size, it was better sampled by the RMT1 (Figure 26) than RMT8 net. The population consisted mostly of adolescents which, although they had a widespread depth distribution, showed a definite population maximum in the 500-900m depth range by day. At night, there was a slight spreading of the population into shallower depths, as well as a secondary maximum in the top 100m of the water column. The adult and sub-

adult population, although much less abundant, showed a similar diel change in depth distribution. The ratio of daytime to nighttime populations, in the top 1500m of the water column, was ca. 1:3, indicating a high degree of daytime net avoidance. Overall, it appears that the majority of the population only underwent a small-scale diel vertical migration, although a small proportion migrated into the top 100m at night.

JAMES (1987) found this species to be most abundant at 60°N, 20°W, with very few present at more southerly stations. At 60°N, he found that there was considerable daytime net avoidance, as the present data also indicate. At night, the adults and sub-adults were either concentrated in the top 50m, or between 100 and 400m. The adolescent population had a similar depth distribution except that its lower limit was 300m. The adult and sub-adult population were considerably more abundant than the adolescents, which is the reverse of the situation found at the BIOTRANS site. This, perhaps, indicates a recent spawning at the latter site.

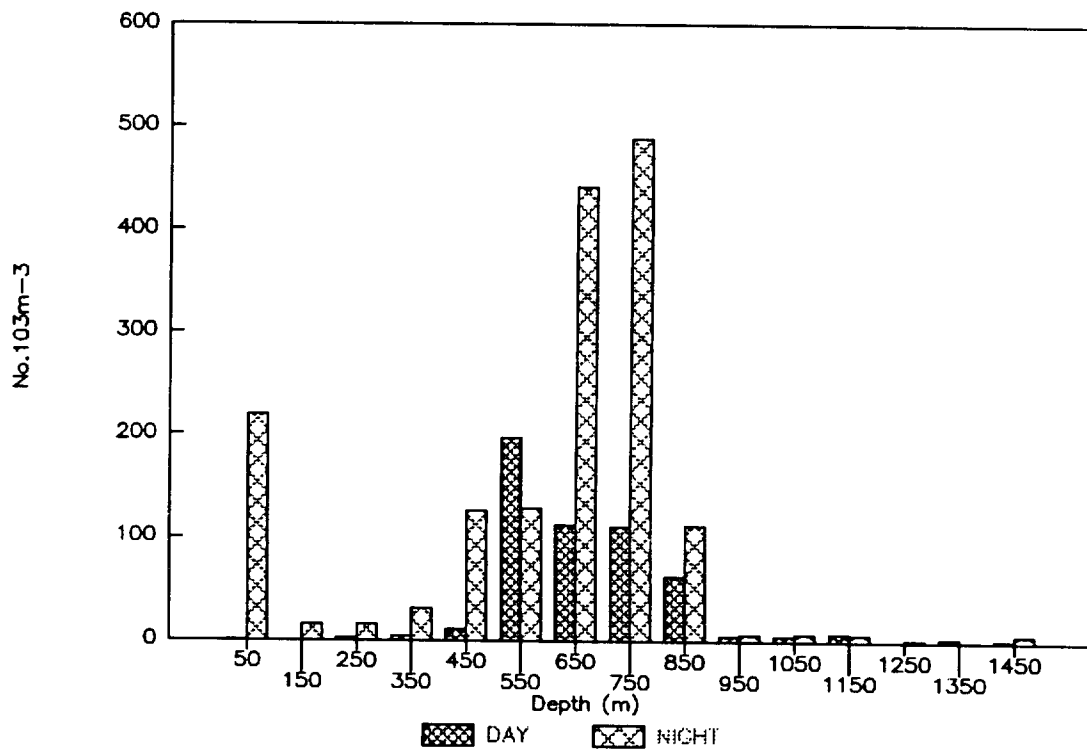


Figure 26. Depth distribution of *Thysanoessa longicaudata*.

Euphausia krohnii

Although this, the second most abundant euphausiid species, had a widespread depth distribution at the BIOTRANS site, the vast majority of the specimens were caught in the top 600m of the water column, with a distinct maximum between 200 and 500m (RMT1 data shown in Figure 27). The ratio of daytime to nighttime catches was very different for the RMT1 and RMT8 catches, being 14.6 and 0.64 respectively. This disparity was largely the result of differences between the RMT1 and RMT8 catches obtained during the

nighttime haul in the 20-110m depth range. The RMT8 catch was totally dominated by adult specimens, particularly females, and adolescents were comparatively rare. The RMT1 catch contained very few specimens of any stage. One explanation of the discrepancies may lie in the fact that the top 20m of the water column were not sampled at night, and that the bulk of the population may have been concentrated therein. However, this does not explain the large number of adults found in the RMT8 catch, unless the normal escape reaction of these animals is to swim rapidly downwards.

JAMES (1987) found *E. krohnii* to be most abundant at the 40°N, 20°W site, with much reduced numbers both to the north and south. At 40°N, adults and adolescents were found mainly in the 300-700m depth range by day, with a distinct maximum between 300 and 400m. At night the populations became concentrated within the top 25m of the water column. The above interpretation of the present data would be in accord with this, in that the majority of the population was concentrated close to the surface and consequently was not sampled by the 20-110m nighttime haul. With this in mind, it appears that there is a close similarity between the present data and that presented by JAMES (1987) for the 40°N site.

E. krohnii was the species that contributed most to the enhancement of the biovolume in the top 100m of the water column at night. It would seem from the above discussion that this enhancement was underestimated due to the failure to sample close to the surface.

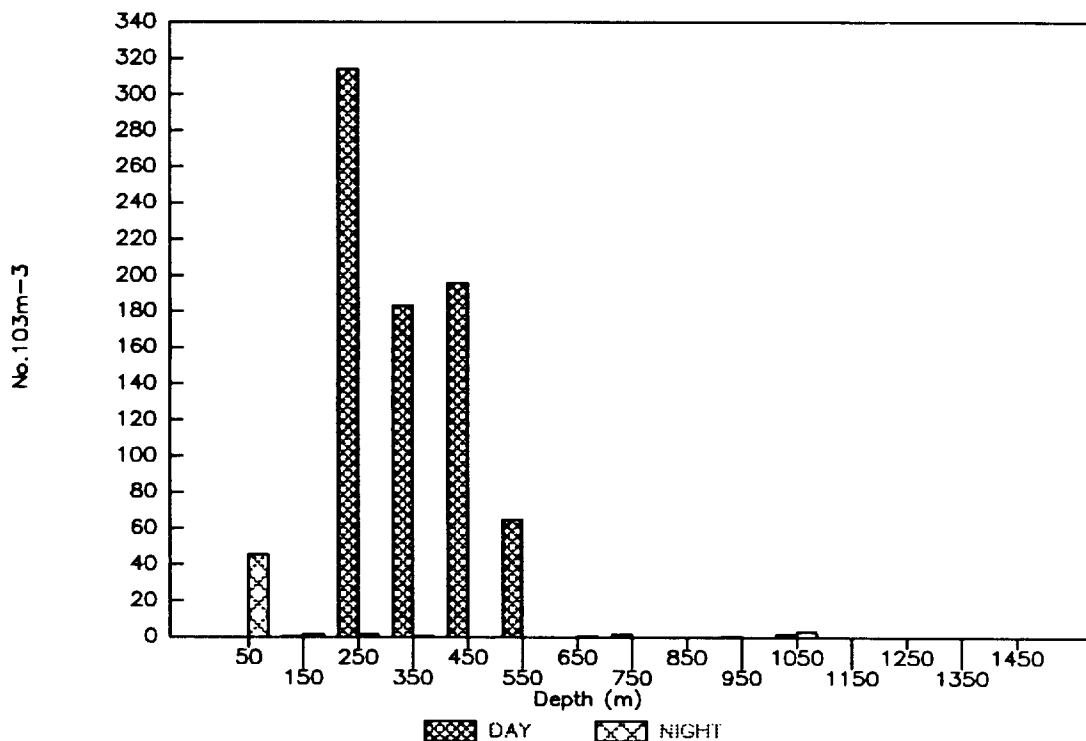


Figure 267. Depth distribution of *Euphausia krohnii*.

Other Euphausiid species

The remaining euphausiid species were comparatively rare. Both long and short forms of *Stylocheiron longicorne* were present, but since the majority of specimens were adolescents, it was difficult to distinguish between them. They were largely confined in the 100-300m depth range by day, with a small part of the population spreading up into the top 100m at night.

None of the widely distributed species, *Thysanopoda microphthalma/acutifrons*, *Nematobrachion boopis* and *Stylocheiron maximum*, appeared to undergo a diel vertical migration. However, the rare species *Meganyctiphanes norvegica* migrated from the 200-400m depth range by day into the top 100m at night. Similarly, *Nematoscelis megalops* was found over a wide depth range (100-1100m) by day, but became concentrated in the top 300m at night. However, there was a considerable disparity between the day and night abundances, which makes any interpretation difficult. Finally, *Bentheuphausia ambylops* was found in several of the hauls at depths below 700m. Between 700 and 1300m only adolescent stages were found, while at greater depths adults and sub-adults occasionally occurred.

Summary

In general the abundance and species composition of the euphausiid population at the BIOTRANS site is in accord with what would be expected from the data of JAMES (1987), particularly for his 40°N, 20°W station. The only species that was not present, but might have been expected, was *Stylocheiron abbreviatum*. JAMES (1987) found this species to occur as far north as 60°N, although it was rare north of 30°N. A diel vertical migration was apparent for only a few species. The enhancement of the euphausiid biovolume, in the top 100m of the water column at night, was due to the migration of *Euphausia krohnii*. The commonest species, *Thysanoessa longicaudata*, appeared to undergo only a partial migration into the surface waters at night.

Decapoda

The decapods in the RMT8 catches were identified by P.M.D. Hargreaves. A species list is presented in Table 14. N.P. indicates not present in hauls from < 1500m.

	Presence No.Hauls	Total Numbers per 10^4m^{-3} (0-1500m)	
		DAY	NIGHT
<i>AcanthePHYra purpurea</i>	13	10.53	8.83
<i>A pelagica</i>	17	15.14	22.67
<i>Systellaspis debilis</i>	12	13.64	6.58
<i>S. braueri</i>	2	0.36	0.0
<i>Hymenodora glacialis</i>	7	N.P.	N.P.
<i>H. gracilis</i>	18	79.64	61.62
<i>Ephyrina hoskyni</i>	1	N.P.	N.P.
<i>E. bifida</i>	8	1.79	3.33
<i>Meningodora miccyla</i>	2	0.71	0.0
<i>Pasiphaea sp.</i>	1	0.0	0.33
<i>Parapasiphaea sulcatifrons</i>	18	42.37	34.50
<i>Eupasiphaea sp.</i>	1	N.P.	N.P.
<i>Bentheogennema intermedia</i>	3	N.P.	N.P.
<i>Gennadas valens</i>	5	0.65	3.31
<i>G. elegans</i>	24	70.21	64.39
<i>G. tinayrei</i>	2	N.P.	N.P.
<i>Sergia japonicus</i>	12	3.50	1.57
<i>S. robustus</i>	8	7.35	5.41
<i>Sergestes arcticus</i>	18	29.38	128.59
<i>Funchalia sp.</i>	1	0.29	0.0

None of the decapod species was particularly abundant if one contrasts their numbers with those of the dominant species in other groups. Nonetheless the species assemblage and relative abundances are broadly similar to those found by HARGREAVES (1985) at 'Discovery' St. 9801 (42°N, 17°W), and also at 'Discovery' St.7711 (HARGREAVES, personal communication), with the possible exception of *Hymenodora glacialis* in the latter case. This was also true for the 40°N, 20°W station, except that *Sergestes arcticus* and *Ephyrina bifida* were not present there. The presence, in the 600-700m day haul at the BIOTRANS site, of a single adult *Funchalia sp.* was, however, somewhat unusual as this genus is rarely recorded in northern waters.

Acanthephyra purpurea

This species was mainly found between 700 and 1100m by day. It showed a marked diel vertical such that the bulk of the population was found in the 100-600m depth range at night, with a maximum between 100 and 300m (Figure 28). Most of the population consisted of adult stages. These data are very similar to those presented by HARGREAVES (1985) for the 42°N, 17°W station, and confirm that this species is a strong diel migrant.

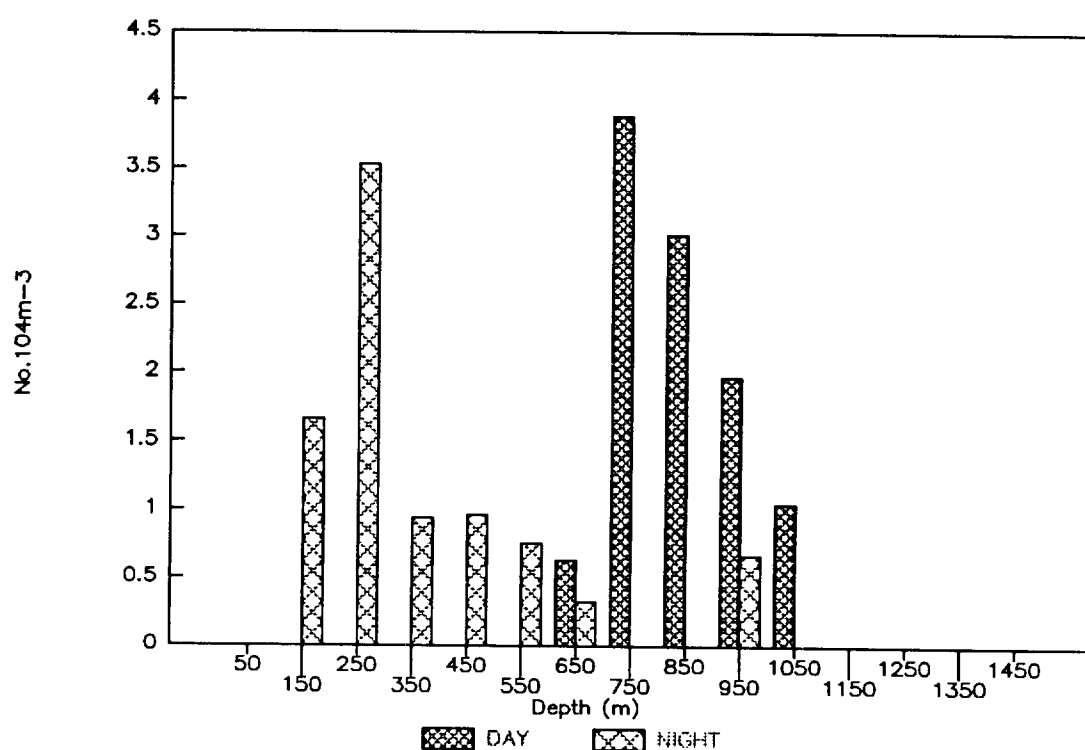


Figure 28. Depth distribution of *Acanthephyra purpurea*.

Acanthephyra pelagica

This species was found slightly deeper than its congener, occurring between 700 and 1500m by day, with a maximum in the 900-1200m depth range (Figure 29). There were signs for a small-scale diel vertical migration up to c. 600m at night. The juvenile stages tended to live at shallower depths than the adults. HARGREAVES (1985) similarly found a nocturnal peak in depth distribution between 600 and 900m, the latter being the maximum depth of nighttime sampling.

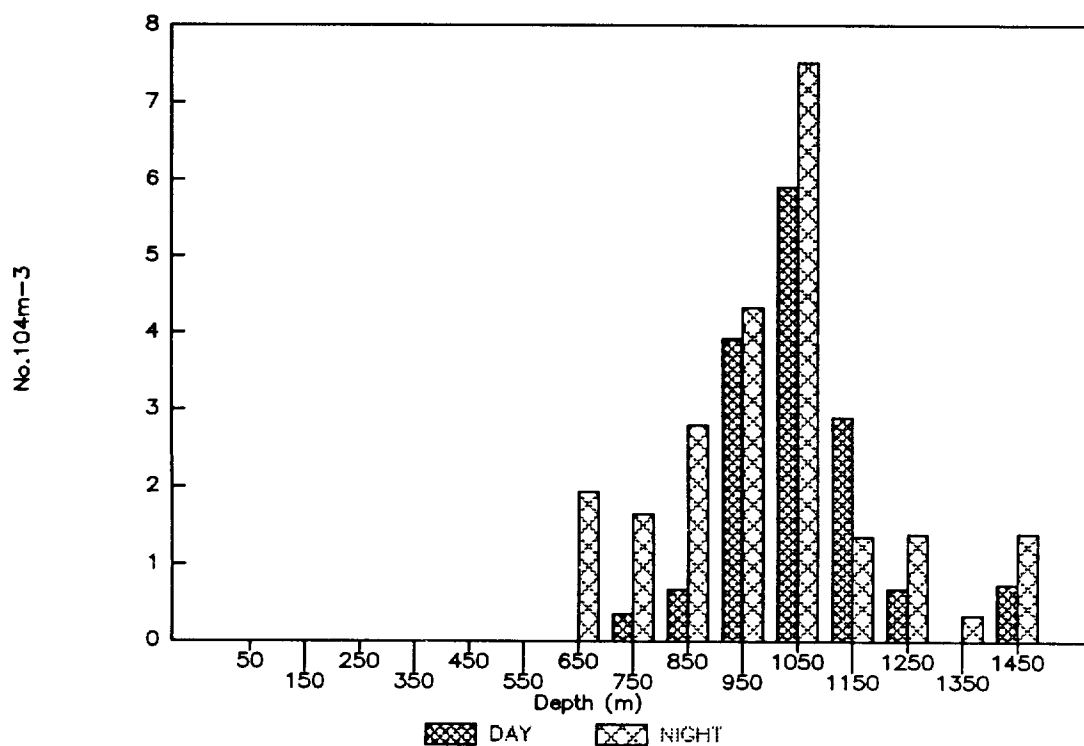


Figure 29. Depth distribution of *Acanthephyra pelagica*.

Systellaspis debilis

Although relatively uncommon, this species showed a marked diel vertical migration from a daytime peak between 400 and 600m into the top 200m of the water column at night (Figure 30). The majority of the specimens were juveniles. HARGREAVES (1985) found the great majority of the specimens, at 42°, 17°W, to be concentrated in the top 100m at night, having migrated from the 500-600m daytime depth zone.

Hymenodora gracilis

This was the most consistently abundant decapod species. It had a distinct population maximum in the 1000-1500m depth range, both by day and night, but with a long distributional tail, as it occurred in almost all the hauls below these depths (Figure 31). Many of the specimens were too damaged for their maturity stage to be assessed but, in general, it appeared that the males had a deeper depth distribution than the juveniles. This would be in accord with the findings of HARGREAVES (1985), who found the species to be most abundant in the 1100-1700m depth range, at 42°N, 17°W, with the larger specimens living deeper than the smaller ones.

Hymenodora glacialis occurred in small numbers at depths greater than 2000m.

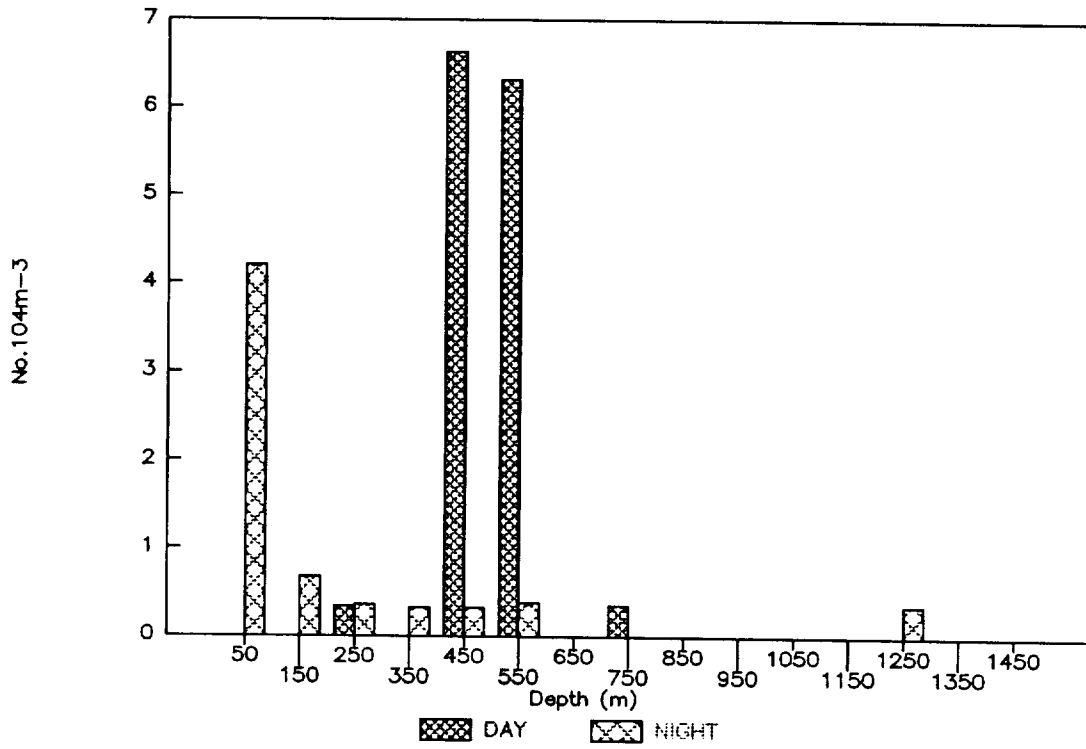


Figure 30. Depth distribution of *Systellaspis debilis*.

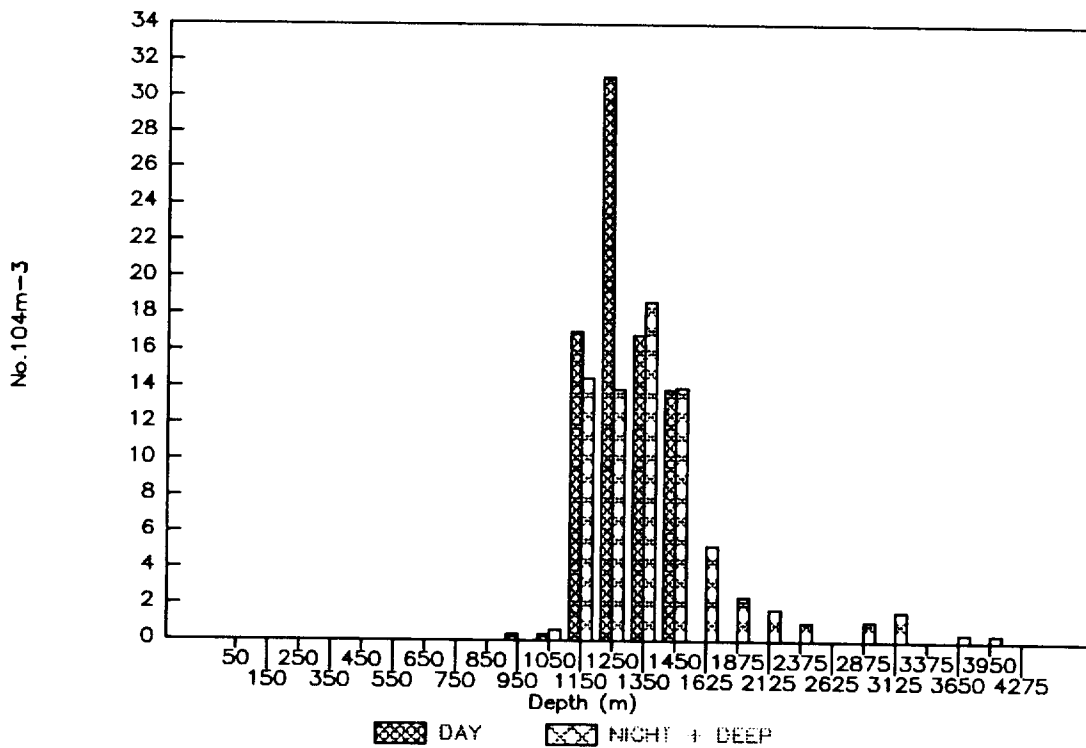


Figure 31. Depth distribution of *Hymenodora gracilis*.

Parapasiphaea sulcatifrons

This species was mainly recorded between 600 and 1750m, with the majority of specimens occurring at the upper end of this depth range (Figure 32). There was no evidence for a diel vertical migration. Most of the specimens were juveniles. These data are in accord with those of HARGREAVES (1985).

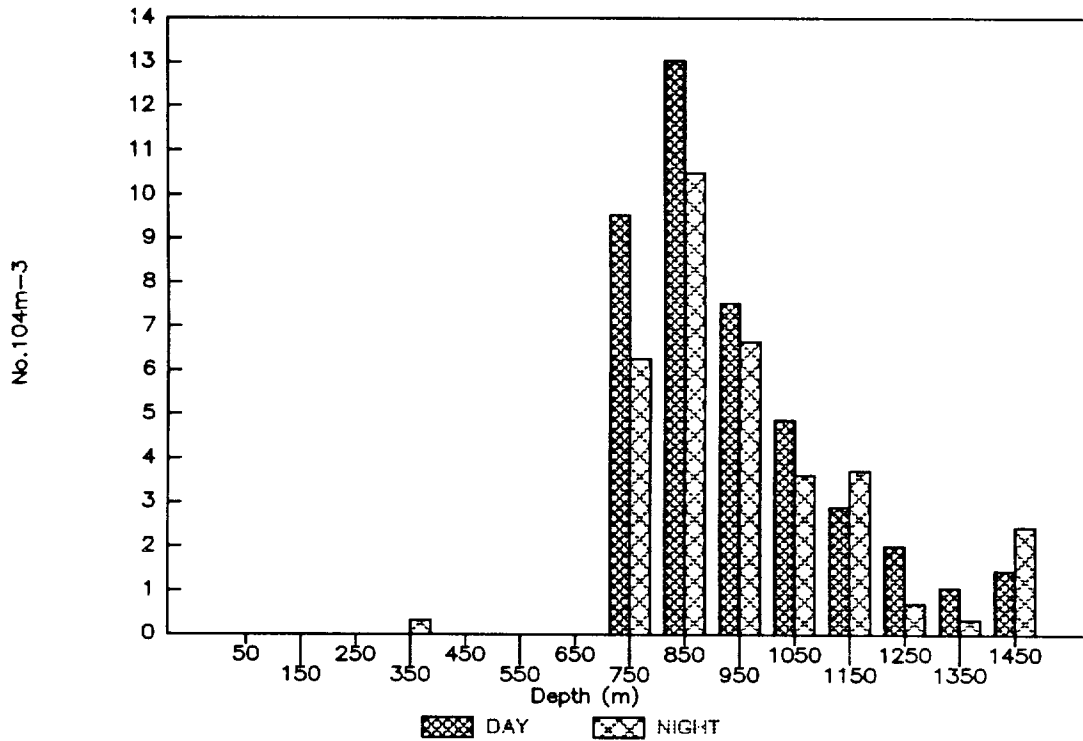


Figure 32. Depth distribution of *Parapasiphaea sulcatifrons*.

Gennadas elegans

This species was found mainly in the 500-1500m depth range by day, and the 400-1500m one by night (Figure 33). This may indicate a small-scale diel vertical migration, but it is by no means clear cut. The majority of specimens were adults, and males and females occurred in approximately equal numbers. Smaller specimens, however, tended to occupy the shallower parts of the depth range.

These data contrast somewhat with those of HARGREAVES (1985). She found, at 42°N, 17°W, that the population of this species mainly occurred between 700 and 1300m, by day, with a maximum in the 700-900m depth range. However, at night, the population was spread over the depth range 0-900m, although the maximum remained between 700 and 900m. No comparable nighttime hauls were made in the 900-1500m depth range.

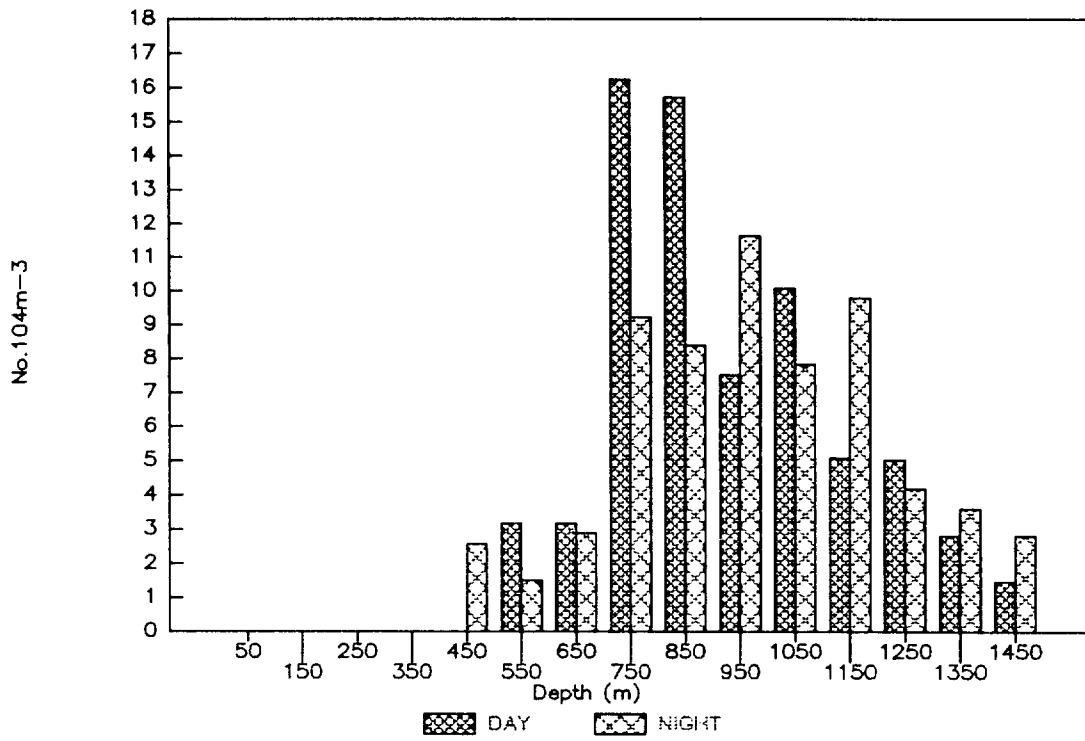


Figure 33. Depth distribution of *Gennadas elegans*.

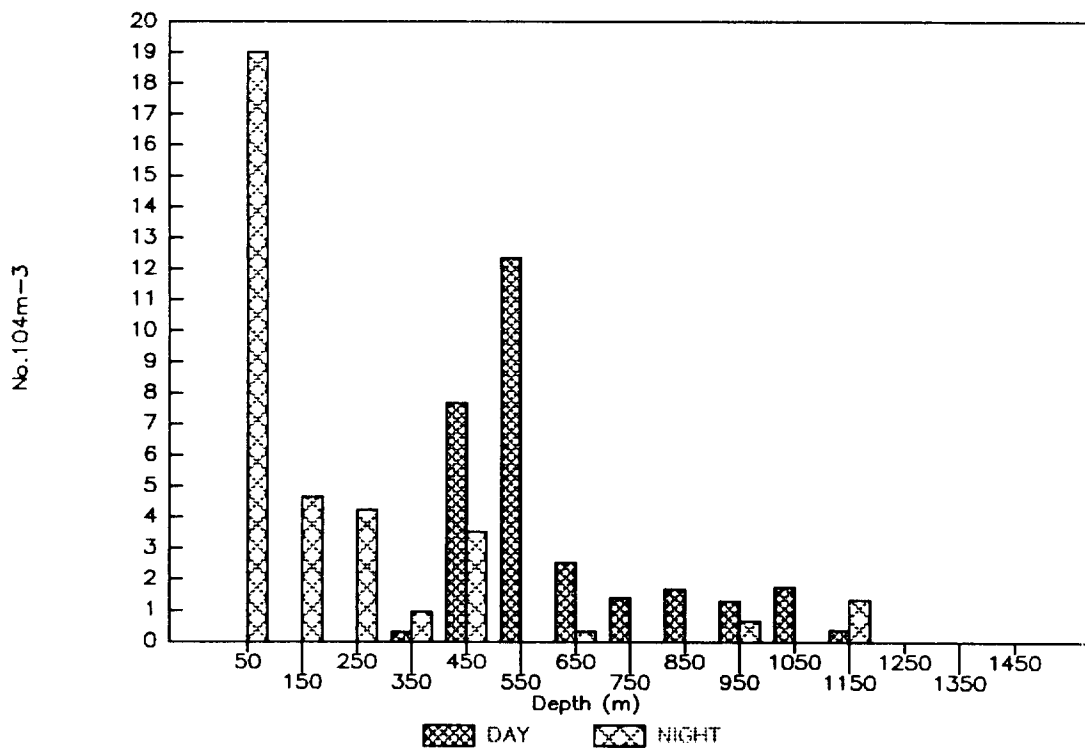


Figure 34. Depth distribution of *Sergestes arcticus*.

Sergestes arcticus

Overall, this was the most abundant decapod species; but there was a considerable disparity between the numbers caught by day and night. It occurred mainly between 400 and 600m, by day, but had a long distributional tail down to 1200m (Figure 34). There was a marked diel vertical migration such that the vast majority of the population ($>100 \cdot 10^4 \text{m}^{-3}$) was found in the top 100m of the water column. Juveniles were the predominant maturity stage.

HARGREAVES (1985) found, at 42°N, 17°W, that most of the population of *S. arcticus* was adult. There was a daytime population maximum in the 200-300m depth range, with a secondary maximum between 500 and 900m. At night the great majority of the population had migrated into the top 100m of the water column.

Summary

Numerically decapods were the least important micronektonic group of the eight considered here. The depth distribution of the species assemblage at the BIOTRANS site conformed with that expected from previous data (FASHAM & FOXTON, 1979; HARGREAVES, 1985). Only seven species were present in any numbers, and of these only three showed any marked degree of diel vertical migration. On average they contributed less than 10% of the biovolume of the catches in the top 1500m of the water column, although their percentage contribution was more significant at the deeper end of this depth range during the daytime.

The enhancement of the biovolume in the 20-100m haul at night was almost entirely due to the presence of a large number of juvenile *Sergestes arcticus*, for which there was no corresponding daytime maximum. In contrast the numbers of *Systellaspis debilis* found during the day, particularly in the 400-600m depth range, were considerably higher than those found in the nighttime catches. In this case it was clear that the majority of the population had migrated into the top 100m at night and so, perhaps, the disparity in numbers was a result of the failure to sample close to the surface at that time, as discussed earlier for certain euphausiids.

Mysids

Twelve species of mysid were identified from the RMT8 hauls by P.M.D. Hargreaves. These are listed in Table 15. (N.P. indicates not present at depths < 1500m). The taxonomy of the genus *Eucopia* was discussed by HARGREAVES (1985). The identifications of *E. unguiculata* and *E. grimaldii* were based partly on the arrangement of the dorsal spines arming the telson. In general this feature agreed with previous descriptions, but in a few specimens the number and type of spines was more variable.

TABLE 15

Species of Mysid identified from the RMT8 samples.

	Presence No.Hauls	Total Numbers per 10^4m^{-3} (0-1500m)	
		DAY	NIGHT
<u>Eucopiidae</u>			
<i>Eucopia unguiculata</i>	20	123.25	180.21
<i>E. grimaldii</i>	23	279.28	235.70
<i>E. sculpticauda</i>	13	11.00	11.57
<i>E. cf ausiralis</i>	5	0.0	0.60
<u>Lophogastridae</u>			
<i>Gnathophausia zoea</i>	8	1.75	1.60
<i>G. gigas</i>	8	0.70	1.65
<u>Other species</u>			
<i>Boreomysis microps</i>	21	86.56	73.07
<i>B. bispinosa</i>	1	N.P.	N.P.
<i>Katerythrops oceanae</i>	9	2.76	2.96
<i>Meterythrops picta</i>	3	0.0	1.00
<i>Longithorax fuscus</i>	11	5.62	6.55
<i>Petalophthalmus</i> sp.	1	N.P.	N.P.

Only three species were present in any numbers, and *Eucopia* species were predominant. In addition to these species, *Gnathophausia zoea* was present between 900 and 1200m by day, and 700-1100m at night, with two records at deeper depths, but because of the paucity of data this is not taken to indicate a diel vertical migration. *G. gigas* had a slightly deeper depth distribution, between 1000 and 1400m. *Longithorax fuscus* was present mainly between 1000 and 1750m, with no apparent diel vertical migration.

Overall, the relative abundances of the species assemblage were similar to those expected for more northerly latitudes in the North east Atlantic (HARGREAVES, 1985, 1989).

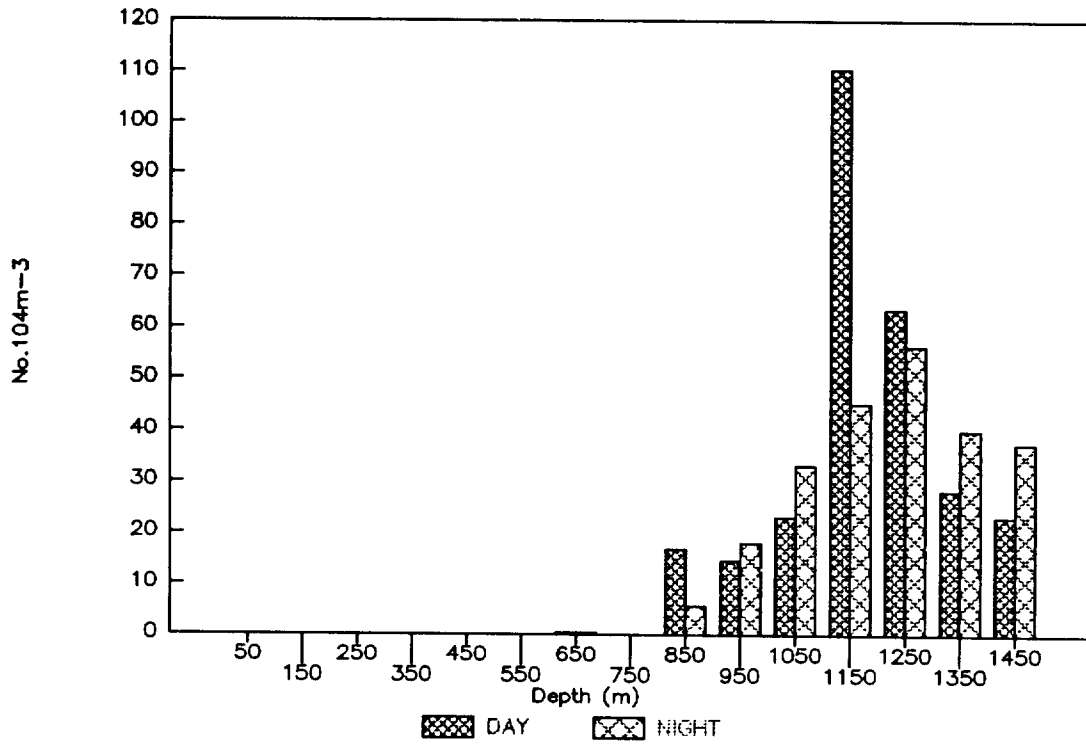


Figure 35. Depth distribution of *Eucopia grimaldii*.

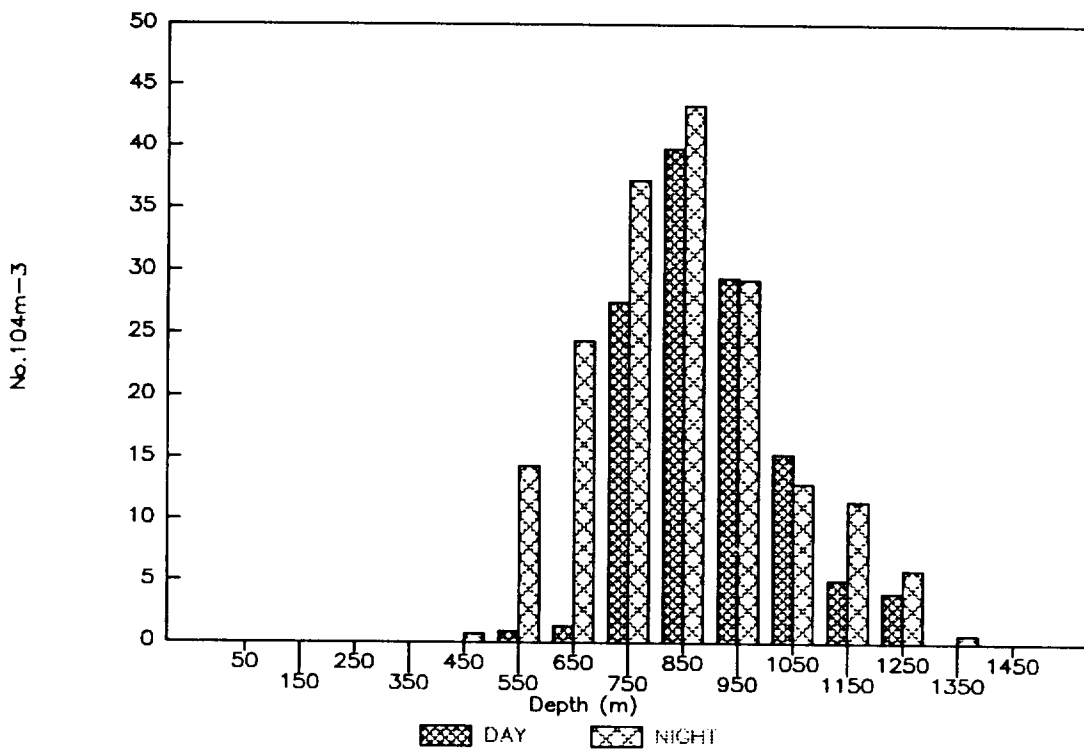


Figure 36. Depth distribution of *Eucopia unguiculata*.

Eucopia grimaldii

This, the most abundant mysid species, was mainly found between 800 and 1750m both by day and by night, with a maximum in the 1100-1300m depth range (Figure 35). There were differences between the depth distribution of the juveniles and the adults. Over 95% of the juveniles were found at depths <1300m, being evenly spread throughout the 800-1300m depth range. However, over 95% of the adults were found at depths >1100m, and there was some indication of a reverse migration as, by day, the most of the adults were found at the shallower end of the depth range, while at night they tended to be deeper. However, this may be an artifact resulting from an unusually large catch in the 1100-1200m day haul. Overall, females and males were present in a ratio of c. 2:1.

The present depth ranges are similar to given by HARGREAVES (1985) who found, at 42°N, 17°W, that this species occurred mainly in the 1100-1700m depth range. She also found that the juvenile stages tended to live at shallower depths than the adults. The possibility of a diel migration was not assessable from her data as sampling below 900m was carried out irrespective of the diel cycle. HARGREAVES (1989) noted that this species was most abundant at latitudes between 40 and 60°N, particularly the more northerly ones. There was no evidence for a diel vertical migration for any of the data.

Eucopia unguiculata

This species was found mainly in the 700-1300m depth range by day, and there was an indication of an upward spreading of part of the population into the 500-700m depth range at night (Figure 36). Both adults and juveniles participated in this migration. However, it should be noted that the total nighttime catches were 50% higher than the daytime ones. Juvenile stages again had a shallower depth distribution than the adults, with very few being found below 1000m, but the stage separation was not as marked as for *E. grimaldii*.

HARGREAVES (1985) found *E. unguiculata* to be the most abundant mysid at 42°N, 17°W, with *E. grimaldii* ranking second. She found that the juveniles occurred mainly between 400 and 900m, while the adults occupied the 700-1500m depth zone. Such a marked stage separation was not noted at the BIOTRANS site, but the overall depth ranges are very similar. HARGREAVES (1989) found this species to have a widespread latitudinal distribution in the North east Atlantic, being generally more common at more northerly latitudes, although also showing a peak of abundance at 11°N.

Other *Eucopia* species

Eucopia sculpticauda, a common species at lower latitudes, was found in small numbers at depths between 800 and 1500m both by day and by night. A few fragile specimens of *E. cf australis* were present in the deep hauls, generally below 2250m.

Boreomysis microps

This species was the third most abundant mysid, and occurred mainly in the 700-1750m depth range (Figure 37). There are some differences between the day and night depth distributions, but the data are insufficient to establish a pattern of diel vertical migration. The population of *B. microps* was dominated by adult stages, particularly females. The juvenile stages tended to be at the shallower end of the distribution range.

Below 1200m specimens of *Boreomysis* spp. occurred intermittently throughout the water column. Most of the specimens were too damaged for specific identification, although two specimens of *B. bispinosa* were found in the 2500-2750m haul.

HARGREAVES (1985) found *B. microps* to be concentrated in the 900-1500m depth range at 42°N, 17°W; while HARGREAVES (1989) found greatest numbers of this species, in the North east Atlantic, between 40 and 60°N, and in the depth range 600-1250m.

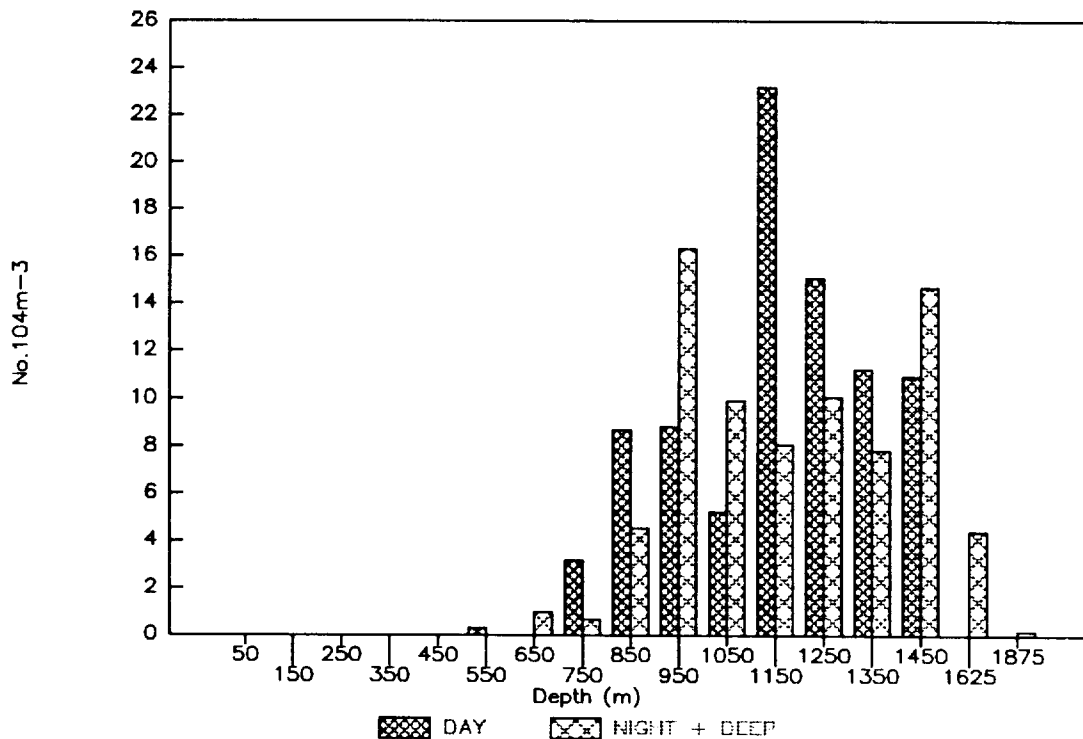


Figure 37. Depth distribution of *Boreomysis microps*.

Fish

A total of 4068 specimens of fish were identified from the RMT8 catches by P. Strang. The 69 categories, mainly species, are shown in Table 16, together with the total number of specimens of each. Numbers in brackets indicate where identifications were made only to genus.

As can be seen, only four species, excluding "*Cyclothone* spp." which larger consisted of specimens too damaged to be identified to species, were present in total numbers greater than 100. Overall, *Cyclothone* species contributed almost 80% of the specimens of fish caught at the BIOTRANS site. All the fish were measured, but time did not allow a study of the reproductive state of each.

Cyclothone microdon

This species had a widespread depth distribution from c. 600m to 2500m, with a few specimens being found at deeper depths (Figure 38). There were no indications for a diel vertical migration. This is in accord with BADCOCK & MERRETT (1977) who found that no *Cyclothone* species were vertical migrants. They found this species to have a widespread geographical distribution from 30-60°N, occurring at depths below 600m at 40°N, 20°W, and below 500m at 53°N, 20°W. The present data are well in accord with this. BADCOCK & MERRETT (1977) also considered this species to be geographically isolated from the group of more southerly *Cyclothone* species.

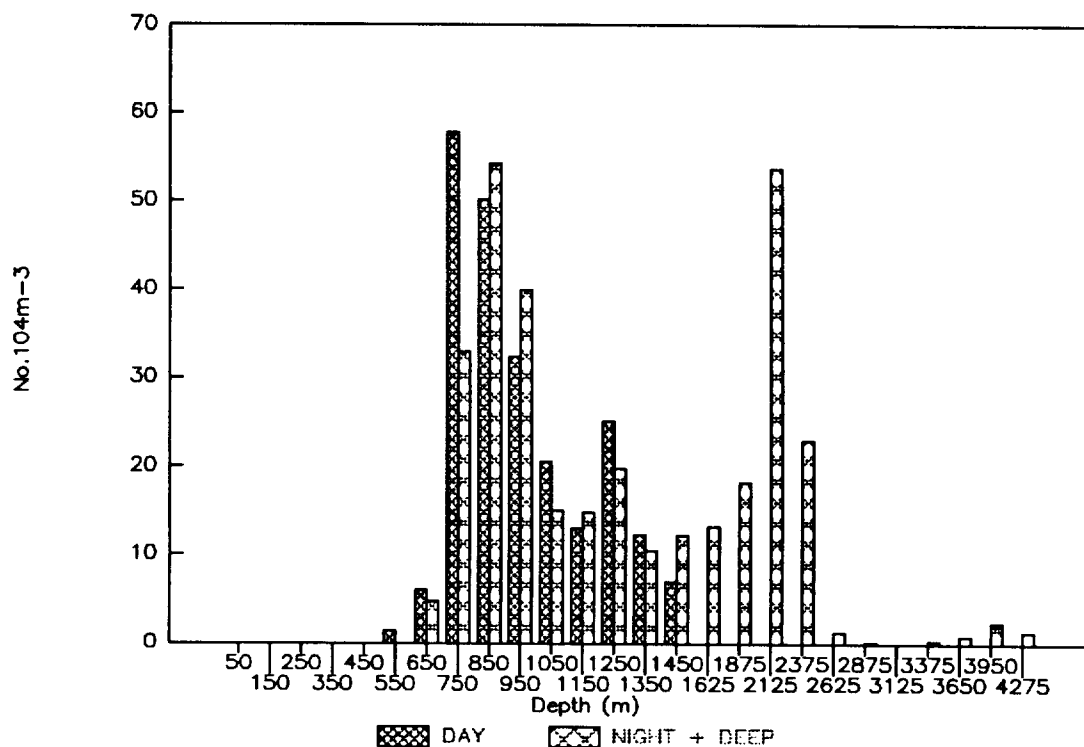


Figure 38. Depth distribution of *Cyclothone microdon*.

TABLE 16

Species of Fish found in the RMT8 hauls

	No. of Specimens
Alepocephalidae spp.	2
Argentinidae/Bathylagidae	1
<i>Argyropelecus hemigymnus</i>	212
<i>A. olfersi</i>	17
<i>Bajacalifornia megalops</i>	4(2)
<i>Bathylagus bericoides</i>	1
<i>B. europs</i>	11(3)
<i>Bellocia michaelisarsia</i>	1
<i>Benthabella infans</i>	1
<i>Benthoosema glaciale</i>	154(1)
<i>Borostomias antarcticus</i>	5
<i>Ceratias holboelli</i>	1
<i>Chauliodus sloani</i>	24(1)
<i>Cyclothone alba</i>	4
<i>C. braueri</i>	1075
<i>C. microdon</i>	1960
<i>C. pseudopallida</i>	11
<i>C. spp.</i>	201
<i>Derichthys serpentinus</i>	1
<i>Dolichopteryx sp.</i>	1
<i>Dolopichthys sp.</i>	1
<i>Eurypharynx pelecanoioides</i>	3
<i>Evermanella balbo</i>	1
<i>Gonostoma bathyphilum</i>	16(1)
<i>G. elongatum</i>	3
<i>Halargyreus johnsonii</i>	1
<i>Histiobranchus bathybius</i>	1
<i>Lampadena speculigera</i>	1
<i>Lampanyctus ater</i>	12
<i>L. crocodilus</i>	2
<i>L. intricarius</i>	2
<i>L. macdonaldi</i>	18
<i>L. photonotus</i>	29
<i>L. spp.</i>	6
<i>Leptocephalus sp.</i>	38
<i>Lobianchia dofleini</i>	4
<i>L. gemellarii</i>	2
Macrurid sp.	1
<i>Malacosteus niger</i>	1
Myctophid sp	41
<i>Myctophum nitidulum</i>	2
<i>M. punctatum</i>	7
<i>Nansenia groenlandica</i>	1
<i>Normichthys operosus</i>	1
<i>Notolychnus valdiviae</i>	3
<i>Notoscopelus notoscopelus kroeyeri</i> 19	(2)
<i>Oneiroides carlsbergi</i>	2
<i>Opisthoprocyus grimaldii</i>	4
<i>O. soleatus</i>	11

<i>Parabrotula plagiophthalmus</i>		7
Paralepididae sp.		20
<i>Paralepis harryi</i>		20(3)
<i>Photostomias guernei</i>		1
<i>Platyberyx opalescens</i>		1
<i>Poromitra crassiceps</i>		6
<i>P. megalops</i>		8
<i>Protomyctophum hierops arcticum</i>	5	
<i>Rondoletia loricata</i>		1
<i>Sagamichthys schnakenbecki</i>		3
<i>Scopeloberyx robustus</i>		1
<i>Scopelogadus beani</i>		15
<i>Searsia koefoedi</i>		28(17)
<i>Serrivomer beani</i>		1
Sternoptychidae sp.		1
Sternoptychidae/Photochthyidae sp.	1	
<i>Sternoptyx diaphana</i>		1
<i>S. pseudobscura</i>		1
<i>Stomias boa ferox</i>		20
<i>Thalassobathia pelagica</i>		1
<i>Valenciennellus tripunctulatus</i>	1	
<i>Xenodermichthys copei</i>		4

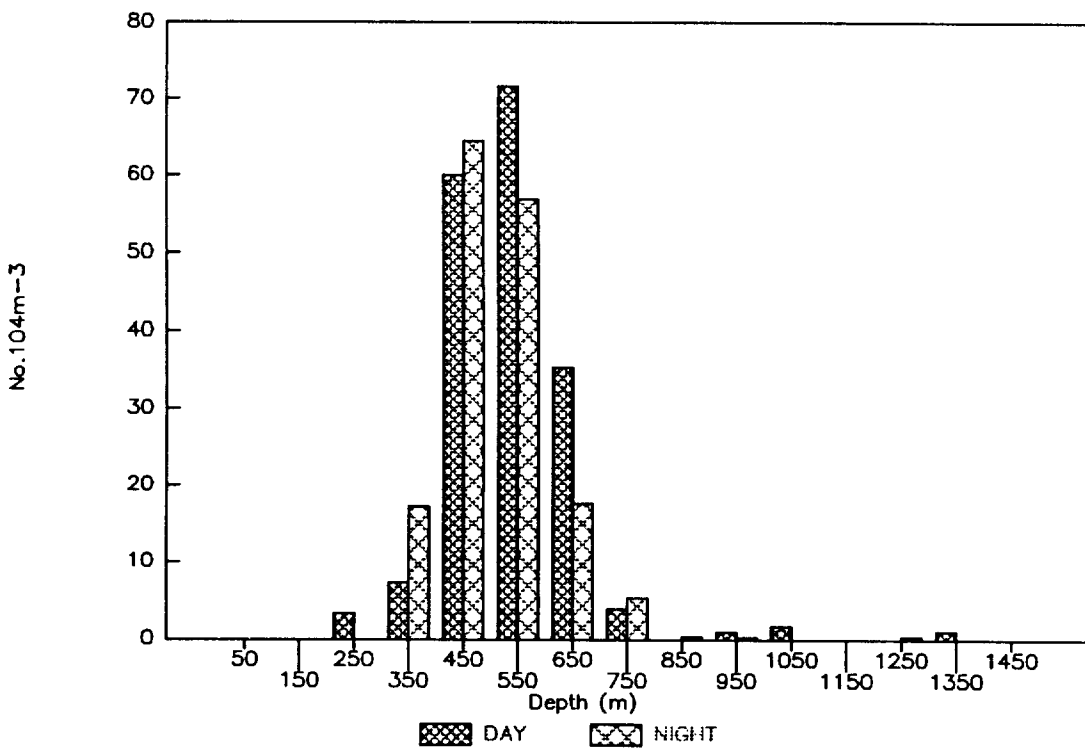


Figure 39. Depth distribution of *Cyclothone braueri*.

Cyclothone braueri

This species was mainly concentrated in the 300-800m depth zone, with maximum numbers between 400 and 700m (Figure 39), and no sign of a diel vertical migration. BADCOCK & MERRETT (1977) found *C. braueri* to have a similar geographical distribution to that of *C. microdon*, but to live at shallower depths. The present data are in agreement with this.

Argyrolepecus hemigymnus

This species was found mainly between 300 and 600m by day, with a maximum in the 400-500m depth range. There was some indication of a diel migration, with the population spreading up into the 200-300m zone at night, and a reduction in numbers between 500 and 600m. However, the bulk of the population remained in the 400-500m zone (Figure 40). BADCOCK & MERRETT (1977) found *A. hemigymnus* to have a broad geographical range in the North east Atlantic, occurring between 18° and 60°N, with peak abundance at 30°N, where breeding had begun. They found that, at 40°N, the species occurred mainly between 300 and 600m, as was the case at the BIOTRANS site, although they found no indication of a diel vertical migration. At 53°N, the species had a shallower distribution.

Benthoosema glaciale

This was the only common fish species to show a concerted diel vertical migration (Figure 41). By day, the bulk of the population was found in the 400-800m depth zone, whereas at night the shallower living part of the population appears to have migrated into the top 100m of the water column, and probably was the main contributor to the enhanced biovolume of fish found therein. BADCOCK & MERRETT (1977) found that, at c. 40°N, there was faunal change-over between *B. suborbitale*, which was found to the south, and *B. glaciale*, which was found mainly to the north. They found that, at 40°N, *B. glaciale* had a disjunct distribution by day, occurring in the 500-600m and 800-1000+m depth zones. At night, the shallower population migrated into the top 100m, while the deeper population remained static. A similar disjunct distribution was found at 53°N, by day, but with the entire population occurring in the top 500m of the water column. In this case it was the deeper part of the population that underwent a diel vertical migration. However, they noted that whereas the non-migratory portion of the population was large at 40°N, it was small at 53°N.

Summary

No fish were found in the top 200m of the water column by day, and the principal diel migrant into that depth range at night was *Benthoosema glaciale*. Other migrants included *Argyrolepecus offersi*, *Lampanyctus photonotus* and *Leptocephalus* sp. In general the results are in accord with those of BADCOCK & MERRETT (1977) and, as with other groups, the BIOTRANS data show greater similarities with data from 40/42°N, than with more northerly stations.

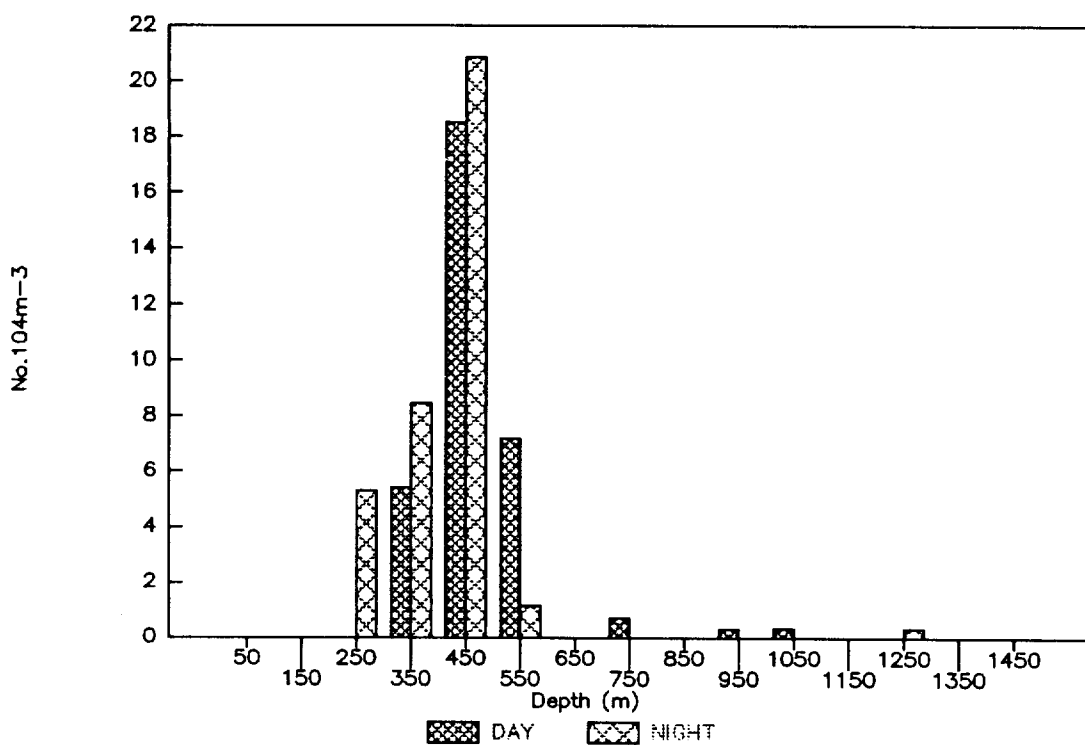


Figure 40. Depth distribution of *Argyropelecus hemigymnus*.

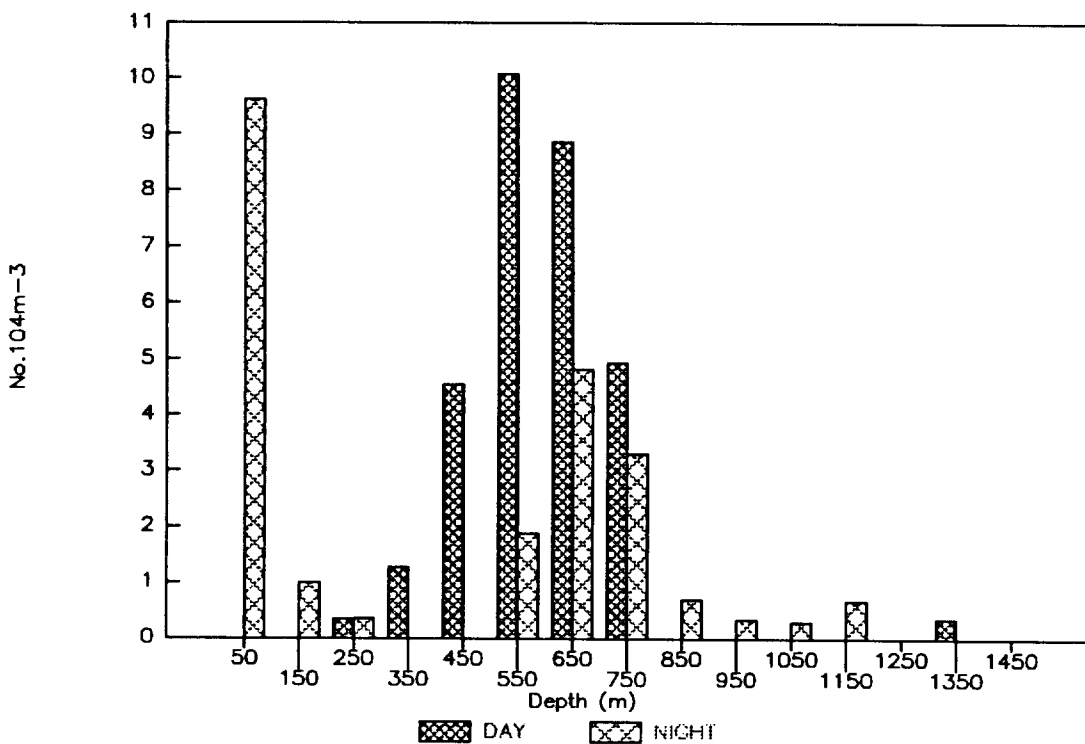


Figure 41. Depth distribution of *Benthosema glaciale*.

SUMMARY

The basic hydrography of the BIOTRANS site (47°N, 20°W) was typical of that expected for that geographical region. However, the XBT survey showed that, although there was no evidence for a deep cold-core mesoscale eddy in the region, there were considerable changes in the depths of the 11 and 12°C isotherms over the sampling area. It was thought initially that such changes in the thermal structure of the water column might have been the cause of some of the observed variability in certain specific populations of animals. However, the evidence is conflicting and it is concluded that many species, particularly the amphipod *Themisto compressa* and the siphonophore *Rosacea plicata*, had a patchy distribution. Other factors also were playing a role in causing disparities between the day and night population totals for certain species. For instance daytime net avoidance by certain euphausiid and decapod species. It is also probable that the failure to fish the top 20 m of the water column at night may have resulted in a significant part of the population of certain species not being sampled.

Analyses on the RMT1 samples were restricted largely to measurements of biomass and biovolume, although a preliminary sort of the material was undertaken, and the size structure of the copepod population was assessed in the top 1000m of the water column. The biovolume data (Table 3), together with the taxon data (Table 5), indicate that there was some degree of diel vertical migration of certain species from the 200-400 m depth range by day towards the surface at night. This was particularly apparent for the euphausiid, *Euphausia krohnii*, and probably for some copepod species. In both cases there was a considerable disparity in day/night numbers, which is probably the result for the failure to sample the top 20 m of the water column, as mentioned above.

The various biovolume and biomass parameters, for example dry, wet and ash free weights, were all significantly correlated, and their regression lines were very much in agreement with those found by WIEBE (1988). Thus, although the initial splitting method was relatively crude, and since the biovolume and biomass data were derived from each half of the resulting sub-samples, the data appear to be consistent with those expected. Similarly, carbon and nitrogen were significantly correlated and the C:N ratio averaged 4.58 ± 0.76 . Carbon and nitrogen respectively averaged $39.9 \pm 5.85\%$ and $8.83 \pm 1.39\%$ of the dry weight.

The size structure of the copepod population showed some surprising features, particularly the preponderance of animals less than 1.5mm in standard length. For more northerly latitudes one would expect a greater population of larger animals. The explanation appeared to lie with the enormous swarm of amphipods in near-surface waters, which appeared to have been feeding on the larger copepods, as a large number of carcasses were found.

The biovolume measurement on the RMT8 samples showed that the amphipod, *Themisto compressa*, completely dominated the top 200 m of the water column by day. While the biovolume of these animals within this depth range remained much the same at night, the overall biovolume was enhanced by a large influx of euphausiids, particularly *Euphausia krohnii*, into the top 100m of the water column; while a

single large cephalopod made up almost 50% of the nighttime biovolume in the 100-200m depth range. The amphipod swarm extended down into the 200-300m depth range, but below these depths amphipods were of little significance. The 300-500m depth range was dominated by siphonophores, of which the voluminous species *Rosacea plicata* played the greatest role. Below 500m, the percentage contribution of siphonophores was reduced, while that of medusae was greatly enhanced. Thus, these two gelatinous taxa formed more than 49% of the total biovolume in all but four of the hauls fished in the 300-1500m depth range

At depths greater than 1000m there was a typical logarithmic decrease in the biovolume of both the RMT1 and RMT8 catches. The regression lines for these decreases were very similar to those found by ANGEL & BAKER (1982) at a slightly more southerly station, namely 42°N, 17°W. There did appear to be a slight enhancement of the biovolume in the two deepest hauls, which may be associated with proximity to the bottom. However, the inability to fish further near-bottom tows prevented any further study of this phenomenon.

The order of dominance of the various taxa analysed from the RMT8 catches in the 0-1500m depth range was amphipods (although this dominance was restricted to the top 300m); medusae, chaetognaths, siphonophores, euphausiids, fish, mysids and decapods. As mentioned above, *Themisto compressa* was the dominant amphipod, and it comprised more than 98% of the total amphipod population.

Although medusae were a major contributor to the biovolume of the RMT8 catches, much of this volume was contributed by a few large specimens of *Atolla wyvillei* or *Periphylla periphylla*. However, the numerical importance of this group, particularly at deeper depths, was due to some smaller species, particularly *Aglanthe digitale* and *Aeginura grimaldi*. *A. digitale* was the most abundant medusa, reaching maximum numbers in the 1100-1500m depth range. This depth distribution was very different from that which has been found at more northerly stations, where maximum numbers were found within the top 100m of the water column. This change over in depth distribution was also noted for the siphonophore, *Lensia conoidea*. It is presumed that this is not due to the presence of the massive amphipod bloom in near-surface waters, but that it is controlled by the hydrological conditions, particularly the thermal structure of the water column.

No specific identifications were carried out on the chaetognath population. These animals were most abundant in the 200-1300m depth range, and especially at the deeper end of the range.

Siphonophores predominated in the 300-500m depth range where they averaged about two-thirds of the total biovolume of the RMT8 catches. The specific composition of the siphonophore population was much as would be expected, although there was a closer similarity with a more southerly 'Discovery' station, at 42°N 17°W, than with more northerly ones. None the less the presence of relatively few species, and the preponderance of species such as *Rosacea plicata*, *Lensia conoidea* and *Chuniphyes multidentata* typify the siphonophore populations found at more northerly latitudes in the N.E. Atlantic. However, the northward spreading of the seasonal thermocline has introduced several warm-water, epipelagic species, such as *Chelophyes appendiculata* and *Eudoxoides spiralis*, into the area.

There was very little indication of any marked diel vertical migration amongst any of the species in the four most abundant taxa, which made up approximately 80% of the total numbers per m^{-2} (0-1500m). However, judging by the discrepancy in the day/night totals of *Themisto compressa*, it is possible that this species became concentrated in the unsampled top 20m of the water column at night. However, there also was an indication that it also spread down to deeper depths at night. Whether any chaetognaths underwent a diel migration is unknown, as no specific identifications were made. Diel vertical migration patterns were, however, noted for certain species amongst the remaining four taxa which were studied

There was a large disparity between the day/night numbers of the commonest euphausiid, *Thysanoessa longicaudata*, which presumably was due to daytime net avoidance. This species showed a slight diel vertical migration, with the population spreading up into the top 100m at night. However, the most marked diel migrations were shown by the second most abundant euphausiid species, *Euphausia krohnii*. It is possible that this latter species actually was the most abundant euphausiid, as it was present in greater numbers during the day than *T. longicaudata*. However, its nighttime numbers were very low and, as with other species, it is presumed that it had migrated into the unsampled near-surface waters at night. None the less *E. krohnii* was the species that contributed most to the enhancement of the biovolume in the top 100m at night. In general the specific population of euphausiids, and their relative abundances, were in accord with previous data and were what would be expected for the area.

Fish also contributed to the enhancement of the biovolume in the top 100m at night, and the principal diel migrant was *Benthoosema glaciale*. However, the dominant species were *Cyclothone microdon* and *C. braueri*, both of which species, typically, showed no diel vertical migration. *Cyclothone* species contributed over 80% of the total fish population at the BIOTRANS site. The fish were, however, the most diverse taxonomic group studies, with over 65 species being present.

The mysid population was dominated by two *Eucopia* species, *E. grimaldii* and *E. unguiculata*. The latter species was the only one to show any marked diel vertical migration, with part of the population spreading up from below 700m into the 500-700m depth zone at night. Other species showed variations in their day/night depth distribution but, because of the paucity of data, these variations could not be interpreted as clear diel migrations.

The decapods were the least abundant of the eight taxonomic groups studied, but several species showed a marked diel vertical migration, although two of the more abundant species, *Hymenodora glacialis* and *Gennadas elegans* did not. The latter species, however, showed a small-scale upward spreading of the population at night. *Acantheephyra purpurea* underwent a large-scale diel migration from a daytime depth range of 700-1100m to a nighttime one of 100-600m, with most specimens being found between 100 and 300m. *Styellaspis debilis* and *Sergestes arcticus*, which was the most abundant species despite the apparent magnitude of daytime net avoidance, also showed marked diel vertical migrations. Juveniles of the latter species were the main contributor to the enhancement of the biovolume by decapods in the top 100m of the water column at night.

Overall, the specific composition and relative abundances of the populations of the various taxa studied at the BIOTRANS site (47°N 20°W) were what previous studies would have led us to expect. However, in all cases there was a greater similarity with an early 'Discovery' station at 42°N, 17°W than with other stations fished further to the north. This is consistent with the marked faunal boundary found to lie somewhere between 40° and 53°N in zoogeographic studies on ostracods (FASHAM & ANGEL, 1975), decapods (FASHAM & FOXTON, 1979), and siphonophores (MACKIE *et al*, 1987). FASHAM & FOXTON (1979) suggested that this boundary might represent the northern limit of the subtropical gyre, although that feature is rather ill-defined in the eastern North Atlantic.

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