I.O.S.

EUPHAUSIIDS OF THE NORTH-EAST ATLANTIC

BY

P.T. JAMES

REPORT NO. 240

1987

NATURAL ENVIRONMENT RESEARCH COUNCIL

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ABSTRACT

The geographic and vertical distributions of euphausiid species at six sampling positions in the north-east Atlantic are described. Most samples were taken with Rectangular Midwater Trawls 1+8. Generally sampling horizons extended down to at least 1500-2000m but with few exceptions most species occurred in greatest numbers well above 1000m and many were diel migrants. Where possible different life history stages are identified and their distributions given.

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INTRODUCTION

The present report is one of a series describing the vertical distribution of plankton and micronekton in the North-east Atlantic Ocean. This report describes the geographic and vertical distributions of euphausiids caught at six sampling positions in the North-east Atlantic between latitudes 10°-11°N and 60°N and close to the 20°W meridian. Previous descriptions of the distribution of macroplankton and micronekton from the IOS transect of stations along 20°W were given by Angel and Fasham (1975), Fasham and Angel (1975) Badcock and Merrett (1976) and Pugh (1977). Data on the distributions of euphausiid species close to the sampling area include those of Hansen (1905a), Ruud (1936) and Baker (1970). With the advent of sophisticated opening/closing net systems it is now possible to provide additional information on this important group of micronekton.

Avoidance of oncoming nets by euphausiids is well-known (e.g. Brinton, 1967; Wiebe et al. 1982). Avoidance is thought to be visual and may therefore result in larger catches being taken by night than by day. Swarming in euphausiids has been recorded (e.g. Baker, 1970; Brown et al., 1978; Zelikman et al., 1978; Thomas, 1980; Evans and Hopkins, 1981). In the present report there are instances where the numbers in the day hauls are comparatively low compared to numbers in the night hauls. Subjective judgements have been made as to whether this disparity has arisen because of the occurrence of swarming, net avoidance or diel migration.

MATERIALS AND METHODS

The overall sampling methods used in the 20°W series are described in a companion report in preparation (Institute of Oceanographic Sciences (IOS) Report, In prep.). Most of the euphausiids were caught by the standard IOS midwater trawl (RMT 1+8 - Baker, Clarke and Harris 1973, Roe et al., 1980), which simultaneously collects macroplanktonic and micronektonic samples. The RMT 1 has a nominal mouth area of $1m^2$ and a mesh size of 0.32mm; the RMT 8 a nominal

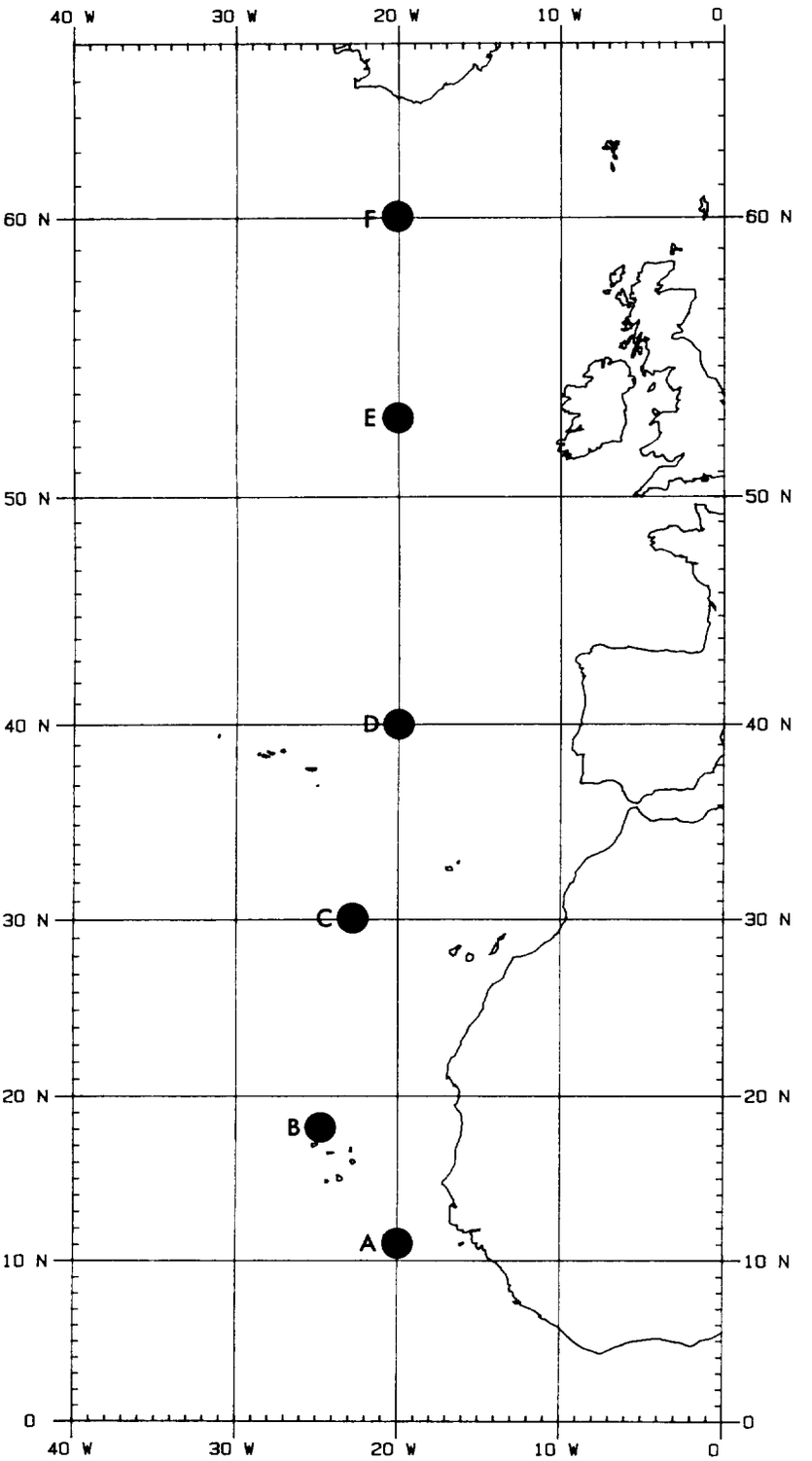

Fig. 1 Station positions close to the 20°W transect.

mouth area of $8m^2$ and a mesh size of 4.5mm. The earliest position sampled (11°N) predated the development of the RMT 1+8 and so the sampling methodology was somewhat different. The larger net fished was an RMT 8 used on its own. The finer net samples were collected some days later using an N113. This was a modified Indian Ocean Standard Net, a conical net with a $1m^2$ mouth area and a mesh size of 0.32mm. Its cod-end was fitted with a catch dividing bucket which separated the catch caught during the deep part of the tow from that taken during paying out and hauling in.

The samples were taken between 1968 and 1972 (Table 1, Fig. 1). Each station was usually occupied once only at whatever time of the year was convenient but usually in spring (i.e. April/May). At each station samples were taken systematically from the surface down to maximum depths of up to 2500m so that the whole water column was sampled. The depth of the deepest haul represented the state of the sampling art at that time. Sample horizons were repeated by day and by night, except at a few stations where some hauls from below 1000m were only sampled once. The depth horizons were increased with depth and the details are summarized in Table 1. Occasional duplicate samples were taken when time allowed; data from these are included in the presentation where appropriate. At each station complementary Conductivity/Temperature/Depth (CTD) or Temperature/Salinity/Depth (TSD) data were obtained and these data are given in a companion IOS Report (in prep.).

Where possible different life-history stages were identified i.e. adults (including subadults) adolescents and larvae (see Baker, 1970; James, 1983), and the data are described separately for each species. Because of the differences in mesh size, the RMT 8 samples generally yielded the best data on adult and subadults whose body length exceeded 15mm whereas the RMT 1 samples yielded the best data on adolescent and larval distributions. The best data being considered to be those giving the higher standardised abundances at each sampling depth. Table 2 shows whether data for different maturity stages were obtained from the RMT 1 catches or from the RMT 8s.

The vertical and zoogeographical distributions of 40 species are described here. These species are the commonest euphausiids taken in this series of stations.

Vertical distributions at each station are illustrated by histograms of standardized abundances. Night data are shown in black. The abundances are expressed as numbers caught per 1000m^3 of water filtered for RMT 1 samples and numbers per 10000m^3 of water filtered for RMT 8 samples. In some of the earlier samples precise flow measurements were not made and flow has been standardised for time alone. N113 data are included with RMT 1 data. The abundance scales for each histogram varies according to the numbers caught; rare occurrences are indicated with a + sign. For most species the vertical axes of the histograms extend only down to 1000m but for three deep-living species they have been extended to 2000m.

No attempt has been made to evaluate (and exclude) contaminants . Although the euphausiids were caught with opening/closing trawls, contamination of deep samples can occur by leakage as the nets are towed closed through shallow zones of abundance en route to or from their fishing depth. It is possible that some of the deep 'tails' to the essentially shallow distributions presented here are artefacts resulting from contamination.

The body lengths of the different stages of each species are given in appendix 1 and 2.,

The sampling procedures adopted did not permit adequate sampling in the surface 10m where nets towed astern of the research vessel are strongly influenced by the wake. Consequently any species with maximum abundances in the surface layers is likely to have been seriously understimated and this may have been particularly serious with species which migrate right to the surface at night (e.g. Euphausia krohnia).

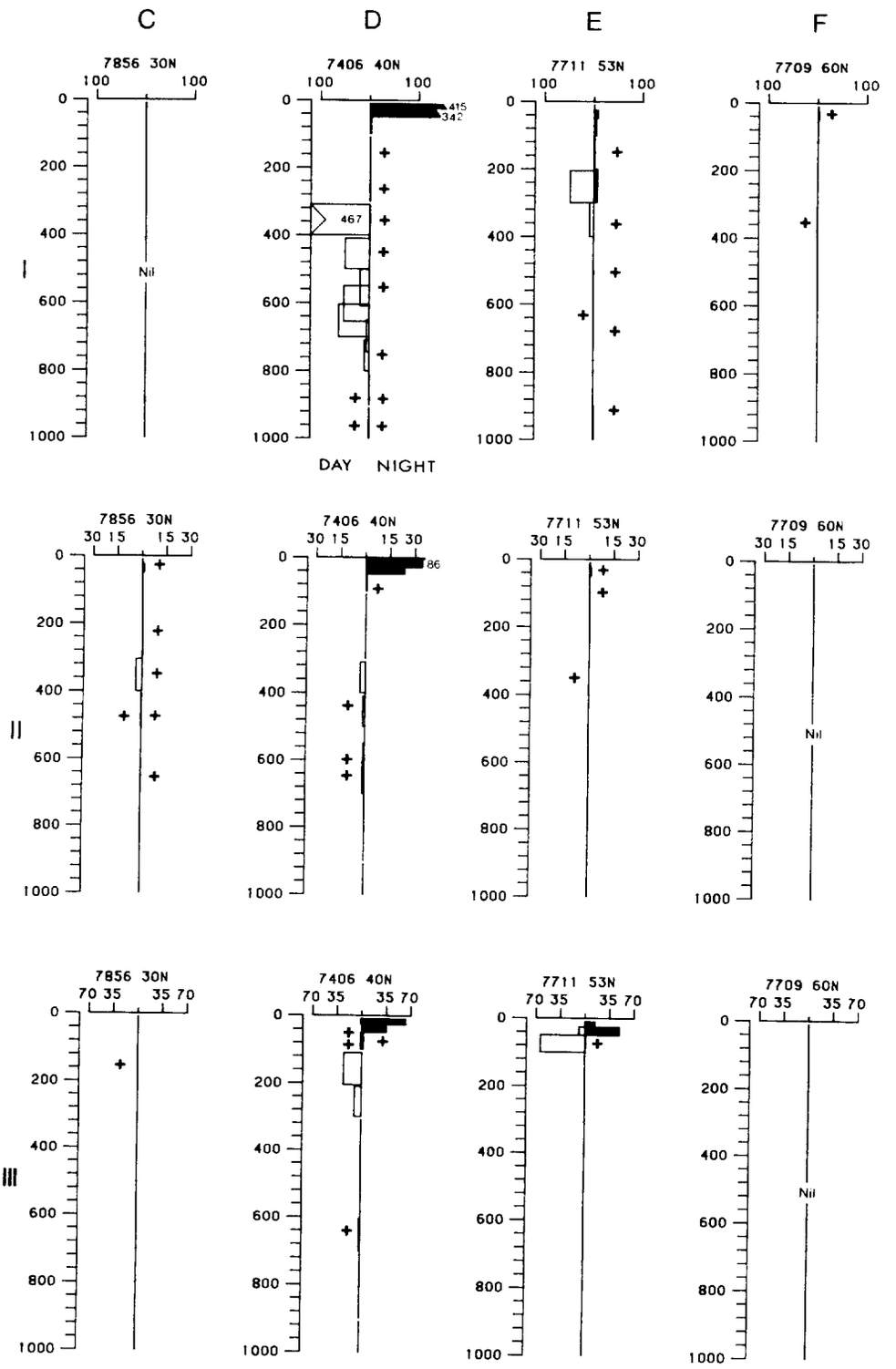

Fig. 2 Geographic and vertical distribution of Euphausia krohnii close to the 20°W meridian. I. Adults and subadults (RMT 8), numbers per $10^4 m^3$ water filtered. II. Adolescents (RMT 1), III. Larvae (RMT 1), numbers per 10^3 m^3 water filtered

DISTRIBUTION PATTERNS

Euphausia krohnii (Fig. 2)

This species occurred at 30°N, 40°N, 53°N and 60°N; it was very abundant at 40°N and scarce at 30°N and 60°N.

Adults and subadults (RMT 8)

By day specimens occurred at 200-2000m with maximum numbers at 300-400m (40°N) and at 200-300m (53°N). At night although specimens occurred at 10-2500m the maxima at 10-25m (40°N, 53°N) indicated this species was an extensive vertical migrant as previously observed by Mauchline and Fisher (1969) and Baker (1970).

Adolescents (RMT1)

By day the depth range of adolescents was between 310-700m with maximum numbers at 300-400m (30°N, 40°N). By night most specimens occurred at 0-50m (40°N). Baker (1970) recorded adolescents between the surface and 300m at night in the region of the Canary Islands (28°N).

Larvae (RMT 1)

At 40°N and 53°N most specimens occurred by day at 10-700m with maximum numbers at 110-205m (40°N) and at 50-100m (53°N). By night most specimens occurred in the top 10-50m, so even the larvae vertically migrate.

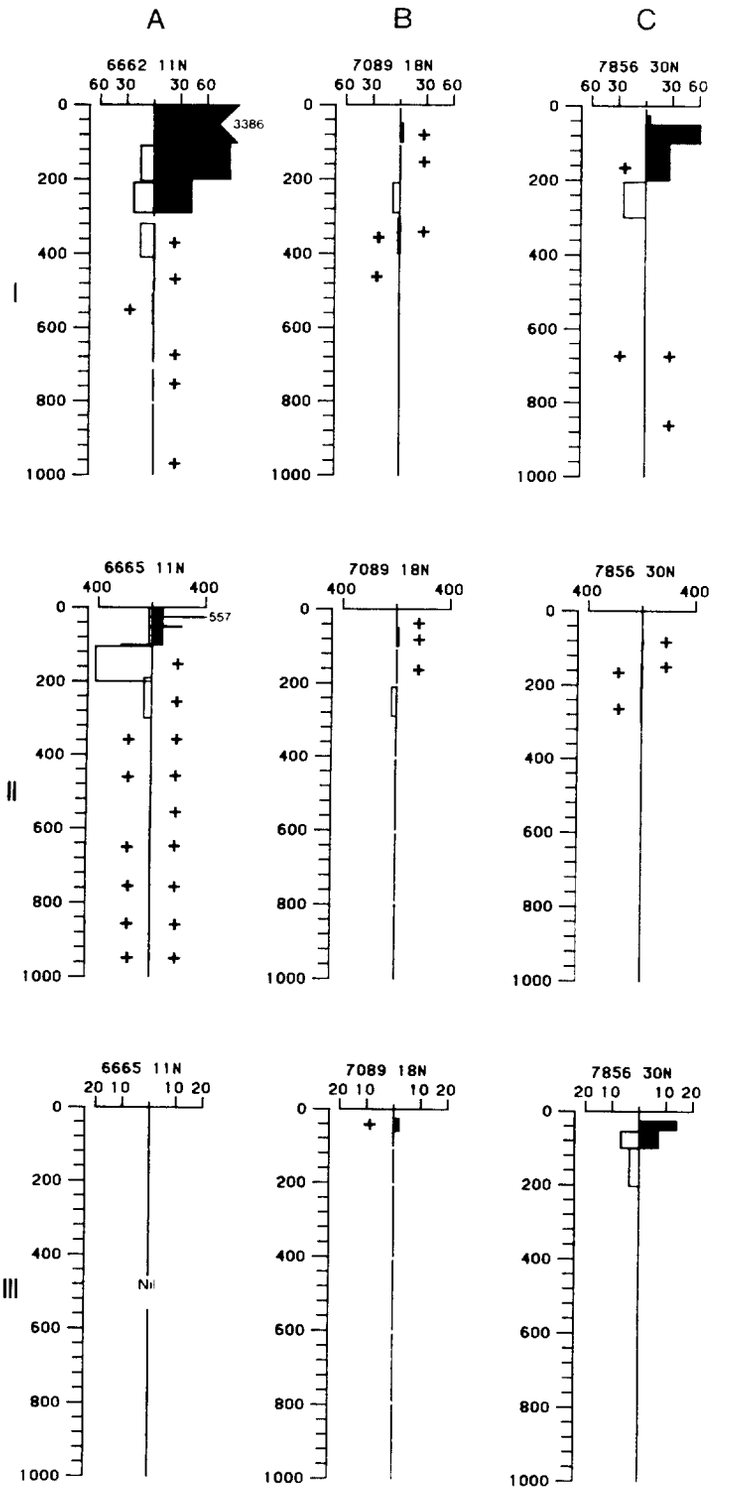

Fig. 3 Geographic and vertical distribution of Euphausia gibboides close to the 20°W meridian. I. Adults and subadults (RMT 8), numbers per $10^4 m^3$ water filtered. II. Adolescents (RMT 1). III. Larvae (RMT 1), numbers per $10^3 m^3$ water filtered

Euphausia gibboides (Fig. 3)

This species occurred at 11°N,18°N and 30°N but was most abundant at 11°N.

Adults and subadults (RMT 8)

By day the depth range was between 100-2000m with maximum numbers at 100-300m (11°N) and 200-300 (18°N, 30°N). By night the depth range extended from the surface to 1250m, with maximum numbers in the surface 100m at 11°N (where a swarm occurred) and at 50-100m at 30°N. Similar diel migratory behaviour was also recorded by Lewis (1954). At both 11°N and at 30°N more individuals were caught by night than by day suggesting that by day E. gibboides avoids nets. Brinton (1967) also observed net avoidance by this species.

Adolescents (RMT 1)

Specimens occurred between the surface and 2000m. By day maximum numbers occurred at 100-200m (11°N) and at 200-300m (18°N, 30°N). By night most specimens occurred in the top 100m (11°N), at 49-100m (18°N) and at 50-100m (30°N). These results agree with those of Baker (1970) who recorded specimens at 50-70m by night off the Canary Islands and with Brinton (1962) who recorded specimens at 25m by night in the Pacific.

Larvae (RMT 1)

In contrast to the adults larvae were most abundant at 30°N. By day they occurred at 55-200m, and part of the population migrated at night to depths of 25-60m.

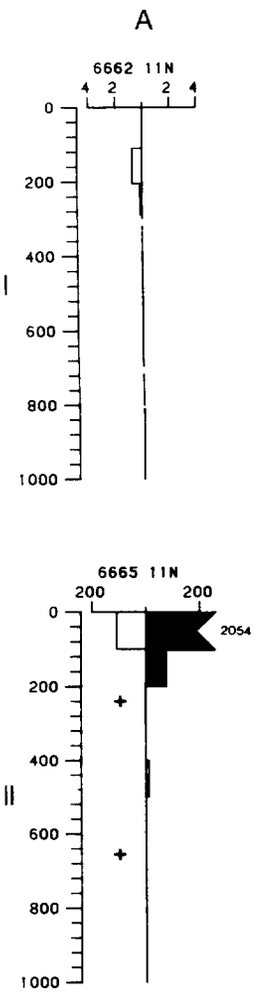

Fig. 4 Vertical distribution of Euphausia hanseni close to the 20°W meridian. I. Adults and subadults (RMT 8), numbers per $10^4 m^3$, II. Adolescents (RMT 1), numbers per $10^3 m^3$ water filtered.

Euphausia hanseni (Fig. 4)

This species occurred only at 11°N, which agrees with the record of Weigmann-Hass (1976).

Adults and subadults (RMT 8)

Adults and subadults were taken at 100-300m by day but most abundantly at 100-200m. By night no specimens occurred in the RMT 8 catches but specimens were caught in the top 100m in the N113, probably because most of the population had migrated above the effective sampling range of the larger net.

Adolescents (RMT 1)

These occurred only at 11°N where they remained as non-migrants in the top 100m.

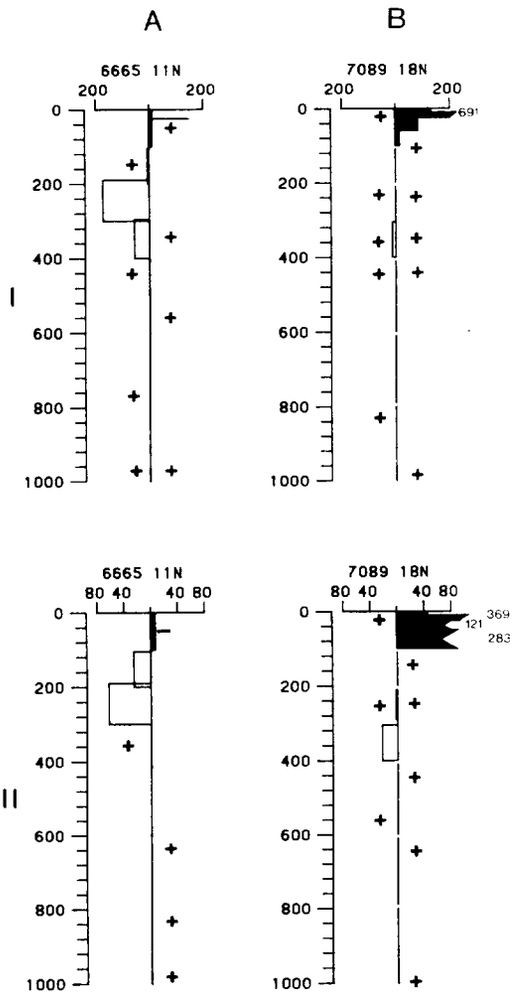

Fig. 5 Geographic and vertical distribution of Euphausia americana close to the 20°W meridian. I. Adults and subadults (RMT 1), II. Adolescents (RMT 1), numbers per $10^3 m^3$ water filtered.

Euphausia americana (Fig. 5)

E. americana occurred at 11°N and 18°N but was more abundant at the latter station.

Adults and subadults (RMT 1)

The depth range was from the surface to 2000m with maximum numbers by day at 190-300m (11°N). A similar distribution was previously recorded by Lewis (1954) in the Florida Current region. The species was a strong diel migrant at 18°N with maximum numbers occurring in the top 25m by night, and the disparity between day and night numbers suggest that E. american avoids nets. Baker (1970), Tattersall (1926) and Weigmann-Hass (1976) all recorded this species in the surface or near-surface layers.

Adolescents (RMT 1)

These occurred at similar depths to the adults although at 18°N by day maximum numbers occurred deeper between 300-400m. Diel migration occurred and by night maximum numbers were found at 25m and between 10-25m at 11°N and 18°N respectively.

No larvae were identified.

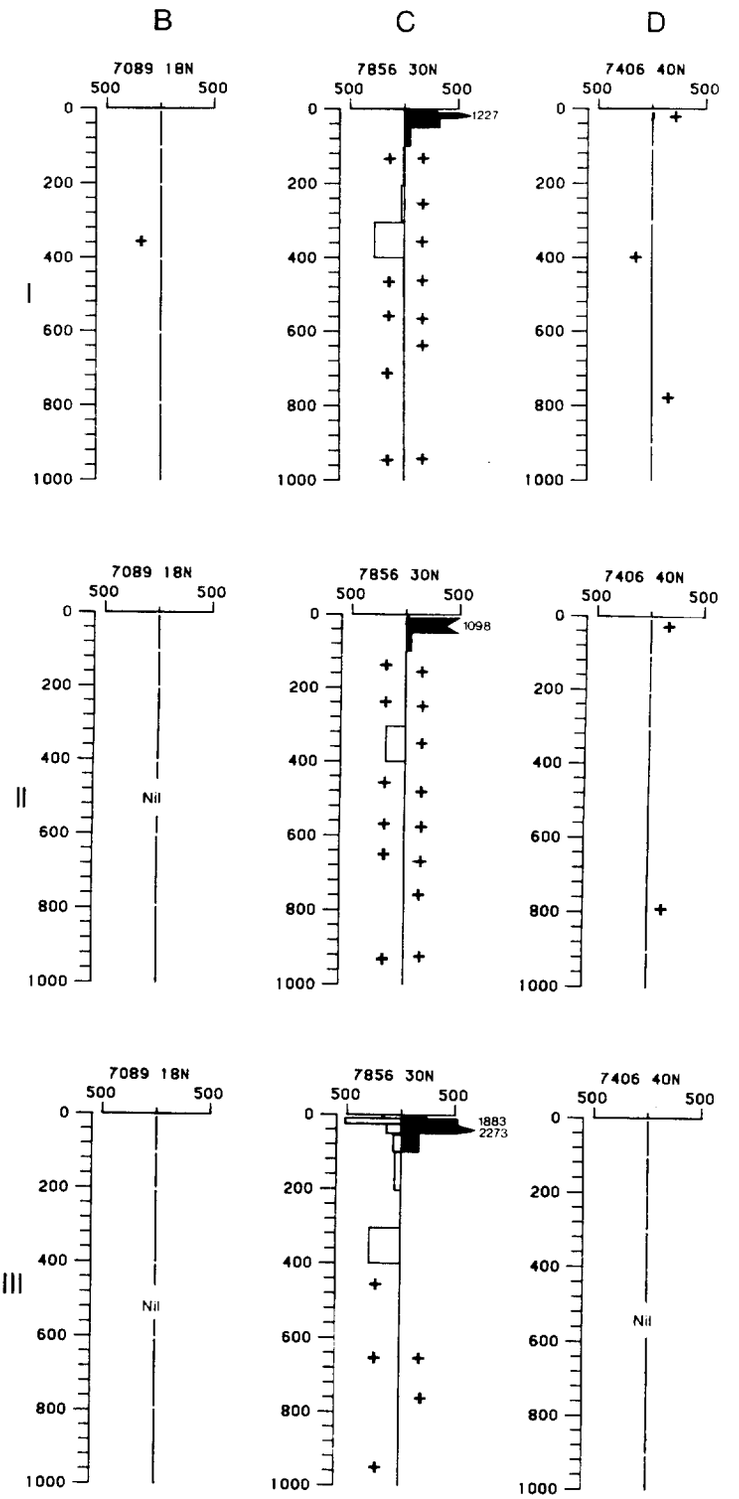

Fig. 6 Geographic and vertical distribution of Euphausia brevis close to the 20°W meridian. I. Adults and subadults (RMT 1). II. Adolescents (RMT 1), III. Larvae (RMT 1), numbers per $10^3 m^3$ water filtered.

Euphausia brevis (Fig. 6)

This species occurred at all stations between 18°N and 40°N, but it was abundant only at 30°N.

Adults and subadults (RMT 1)

At 30°N, by day and night the observed depth range extended down to 1500-2000m, but maximum numbers occurred at 300-400m by day and at 10-25m by night - thus diel migration occurred. These data agree with those of Moore (1949), Lewis (1954), Baker (1970) and Brinton (1967). Many more specimens were caught by night than by day suggesting that daytime avoidance occurred.

Adolescents (RMT 1)

The distribution of adolescents was similar to that of the adults and subadults.

Larvae (RMT 1)

Larvae were abundant at 30°N and most specimens occurred above 400m by day and above 200m by night. Maximum numbers occurred within the upper 100m by day and night.

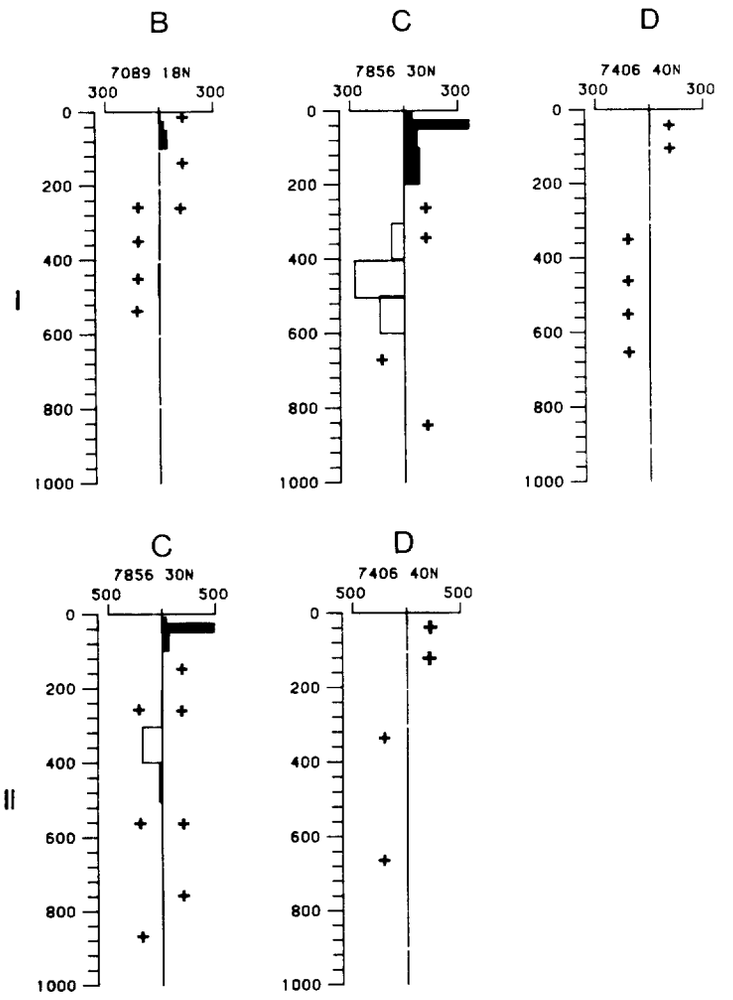

Fig. 7. Geographic and vertical distribution of Euphausia hemigibba close to the 20°W meridian. I. Adults and subadults (RMT 1), II. Adolescents (RMT 1), numbers per $10^3 m^3$ water filtered.

Euphausia hemigibba (Fig. 7)

This species occurred at 18°N, 30°N and 40°N; it was most abundant at 30°N.

Adults and subadults (RMT 1)

By day, the total depth range was between 210-700m with maximum numbers at 410-500m (18°N, 30°N) and at 500-600m (40°N). By night it ranged between the surface and 2000 but with maximum numbers at 50m-100m (18°N) and at 25-50m (30°N), so it is quite a strong vertical migrant. These data agree with those of Brinton (1967), Baker (1970) and Michel and Foyo (1976).

Adolescents (RMT 1)

Only specimens from 30°N and 40°N were easily identifiable. Those from 18°N were difficult to differentiate from Euphausia pseudogibba and are not included. By day they occurred at 200-900m with maximum numbers at 300-400m (30°N). By night specimens occurred between the surface and 800m with maximum numbers at 25-50m so like the adults the adolescents migrate vertically.

Larvae (RMT 1)

Data on larvae were limited mainly to the 30°N station. By day specimens occurred at 10-300m and by night between the surface and 100m.

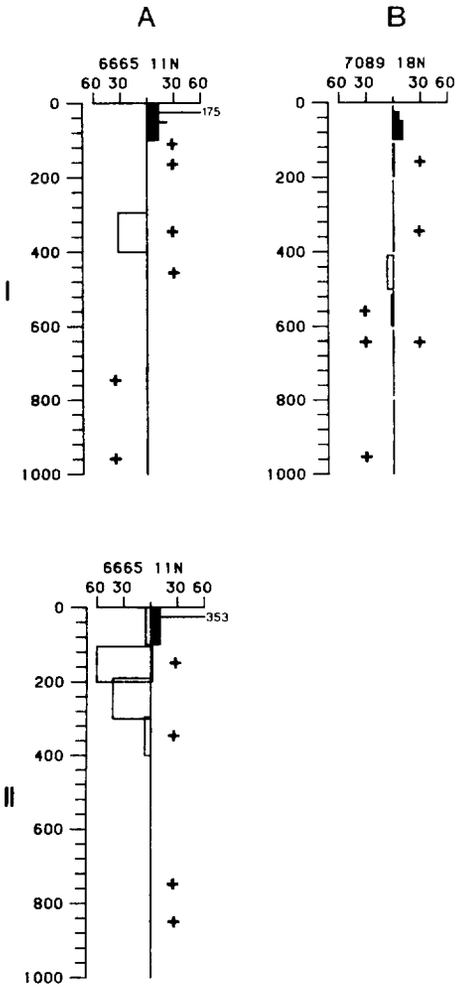

Fig. 8 Geographic and vertical distribution of Euphausia pseudogibba close to the 20°W meridian. I. Adults and subadults (RMT 1), II. Adolescents (RMT 1), numbers per $10^3 m^3$ water filtered.

Euphausia pseudogibba (Fig. 8)

This species occurred at 11°N and at 18°N but was most abundant at 11°N.

Adults and subadults (RMT 1)

By day the depth range of adults and subadults was 295-2000m with maximum numbers occurring at 295-400m (11°N) and 100m deeper at 18°N. By night the range was between the surface and 2000m. Diel migration towards the surface had occurred with maximum numbers occurring in the surface 100m (11°N) and at 25-100m (18°N). These data are in broad agreement with those of Mauchline and Fisher (1969) and Michel and Foyo (1976). Diel migration to the surface was recorded previously by Griffiths (1979).

Adolescents (RMT 1)

Specimens were difficult to separate from adolescent E. hemigibba so only data from the 11°N position are given where no adult E. hemigibba were caught. By day the depth distribution extended from the surface to 400m with maximum numbers at 100-300m. By night adolescents occurred in the top 1000m with maximum numbers at about 25m.

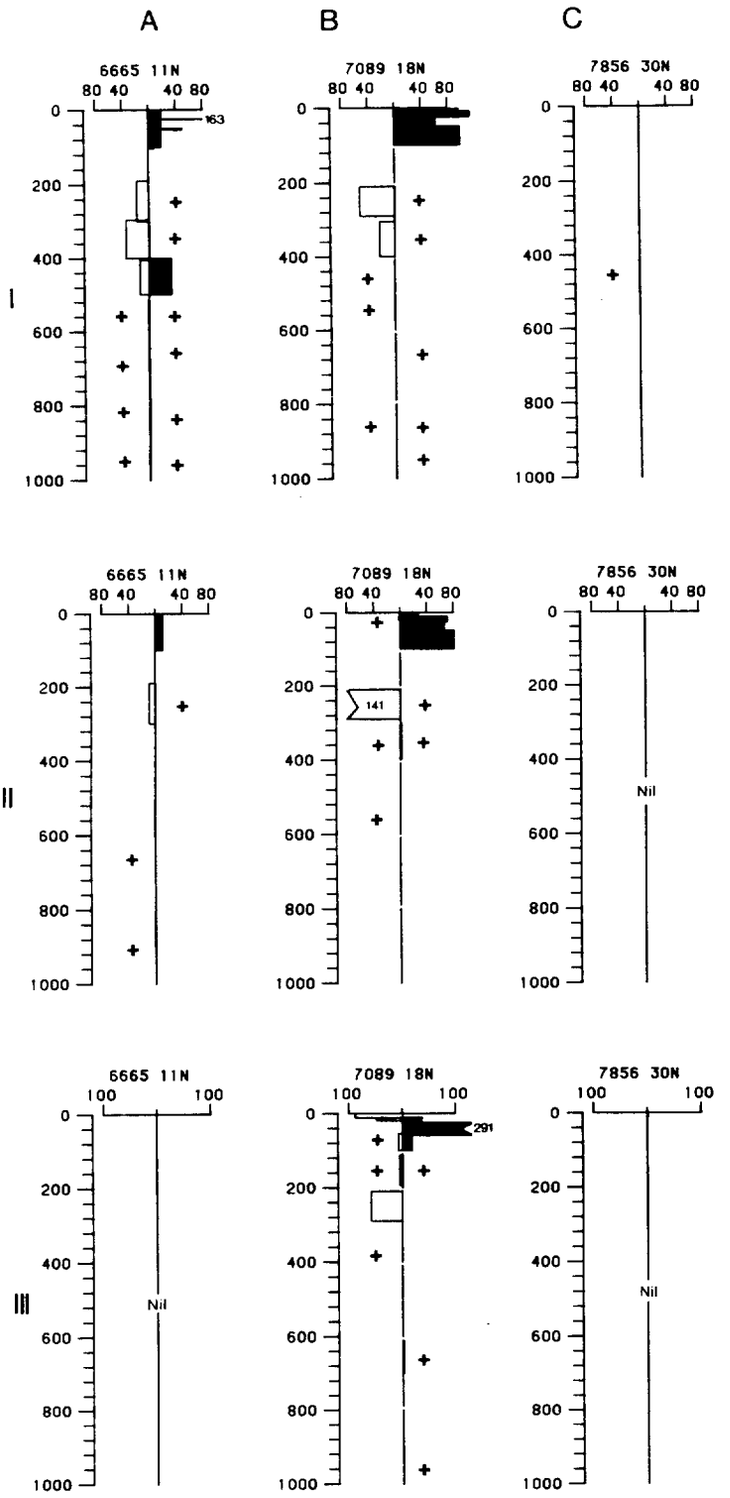

Fig. 9 Geographic and vertical distribution of Euphausia tenera close to the 20°W meridian. I. Adults and subadults (RMT 1), II. Adolescents (RMT 1), III. Larvae (RMT 1), numbers per $10^3 m^3$ water filtered.

Euphausia tenera (Fig. 9)

This species occurred at 11°N, 18°N and 30°N but was sparse at 30°N.

Adults and subadults (RMT 1)

By day the depth range was 190-2000m with maximum numbers at 295-400m (11°N) and at 210-290 (18°N). By night the species migrated so that maximum numbers occurred at about 25m at 11°N and in the top 100m at 18°N. At 11°N the occurrence of moderate numbers of specimens at 400-500m at night suggests that only part of the population migrated, similar partial non-migratory behaviour in euphausiid populations has been recorded previously by Hirota et al. (1983). Diel migration in this species has been recorded by Youngbluth (1975), Roger (1978), Brinton (1962), and Griffiths (1979).

Adolescents (RMT 1)

At 11°N and at 18°N by day the adolescents had similar vertical ranges to those of the adults but with maximum numbers at 200-300m. The adolescents carried out diel migrations so that by night they occurred mainly in the surface 100m.

Larvae (RMT 1)

Data were available only for the 18°N position. By day specimens occurred in the top 400m with maximum numbers in the surface 10m. By night maximum numbers occurred at 25-60m.

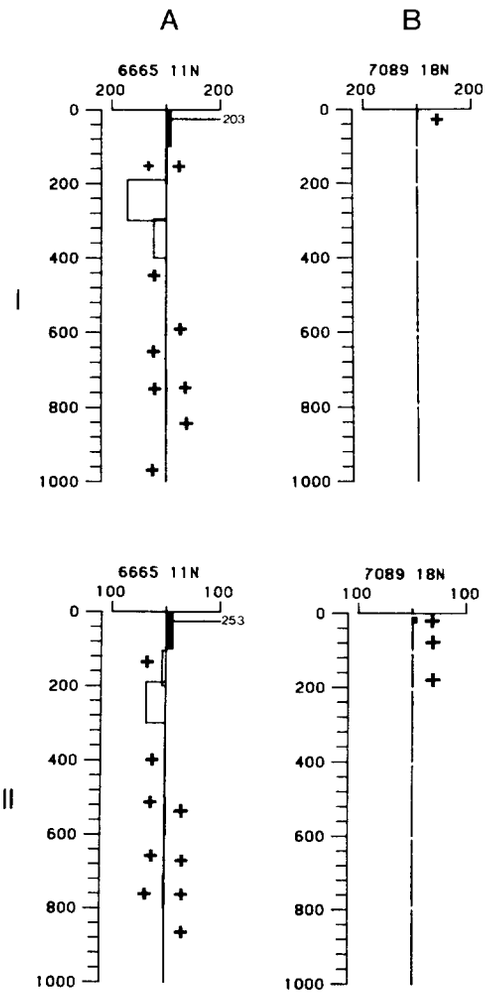

Fig. 10 Vertical distribution of Euphausia mutica close to the 20°W meridian. I. Adults and subadults (RMT 1), II. Adolescents (RMT 1), numbers per $10^3 m^3$ water filtered.

Euphausia mutica (Fig. 10).

This species occurred at 11°N and at 18°N but was most abundant at 11°N.

Adults and subadults (RMT 1)

By day the depth range of adults and subadults was 105-2000m with maximum numbers occurring at 200-300m (11°N). By night some migration into the top 25m occurred. These data agree with those of Lewis (1954) and Michel and Foyo (1976).

Adolescents (RMT 1)

Adolescents had similar distributions to those of the adults. By day maximum numbers occurred at 200-300m (11°N) and by night migration to the near surface layers occurred. No larvae were identified.

Nematobrachion sexspinosus

This species occurred at 18°N and 30°N but more abundantly at the latter. The total numbers caught were small, 10°N - 15 adults/subadults, 0 adolescents; 30°N - 79 adults/subadults, 10 adolescents, so the vertical profiles have not been illustrated.

Adults and subadults (RMT 8)

The depth range by day was 305-1250m with maxima at 305-400m at both positions. By night diel migration occurred, the depth range extended to 110-1000m with maximum abundance at 200-300m (18°N) and at 100-200m (30°N). At 30°N part of the adult population remained at depth during the night. Roger (1978) also recorded diel migration in this species. Once again more specimens were taken by night than by day suggesting that this species also avoids nets.

Adolescents (RMT 8)

Adolescents were scarce in the RMT 1 samples so these data have been supplemented by RMT 8 data. At 30°N by day, adolescents ranged from 100-910m with maxima at 100-200m, however the night-time data were insufficient to determine whether migration had occurred or not.

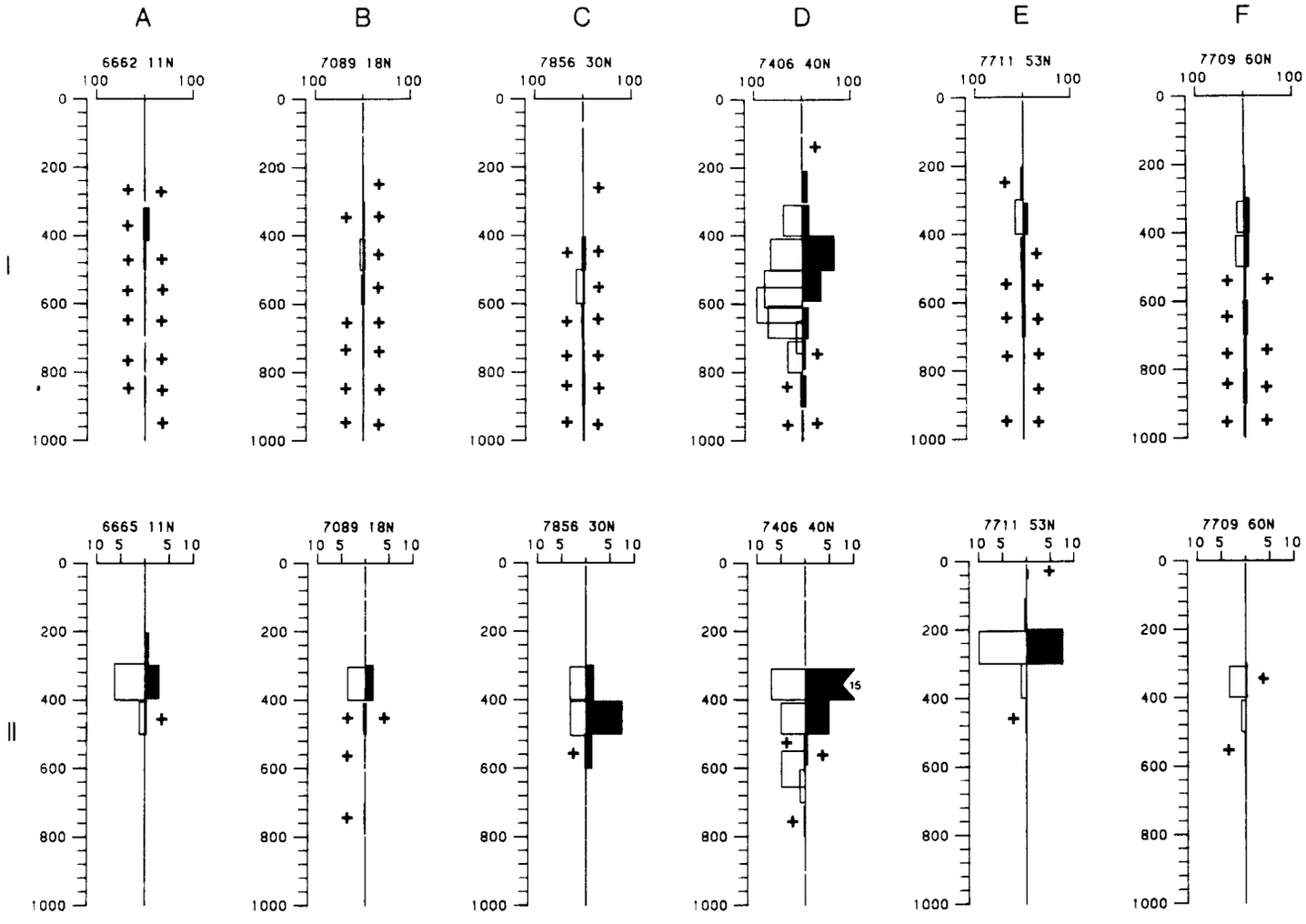

Fig. 11 Geographic and vertical distribution of Nematobrachion boopis close to the 20°W meridian. I. Adults and subadults (RMT 8), numbers per $10^4 m^3$ water filtered. II. Adolescents (RMT 1), numbers per $10^3 m^3$ water filtered.

Nematobrachion boopis (Fig. 11)

This species occurred at all stations between 11°N and 60°N. It was most abundant at 40°N but scarce at the more southerly station.

Adults and subadults (RMT 8)

Day and night ranges were 110-2000m with maximum numbers occurring at 300-800m. There was no evidence of diel vertical migration except at 40°N where some adults apparently undertook a limited upward migration at night. Previous observations suggest that the species is a non-migrant (Mauchline 1980). However, at 44°N 13°W a part of the population did have a limited migration (Roe, James and Thurston, 1984), so migration in this species may occur either during a very limited seasonal period, or for a very limited part of the life cycle.

Adolescents (RMT 1)

Adolescents had similar distributions to the adults except at 53°N, where the adolescents had a daytime maximum centred at 200-300m. But there was no evidence for diel migration - confirming observations by Brinton (1962) and Baker (1970).

Larvae (RMT 1)

Almost all the larvae collected were at 18°N where a few occurred at 400-700m both by day and by night.

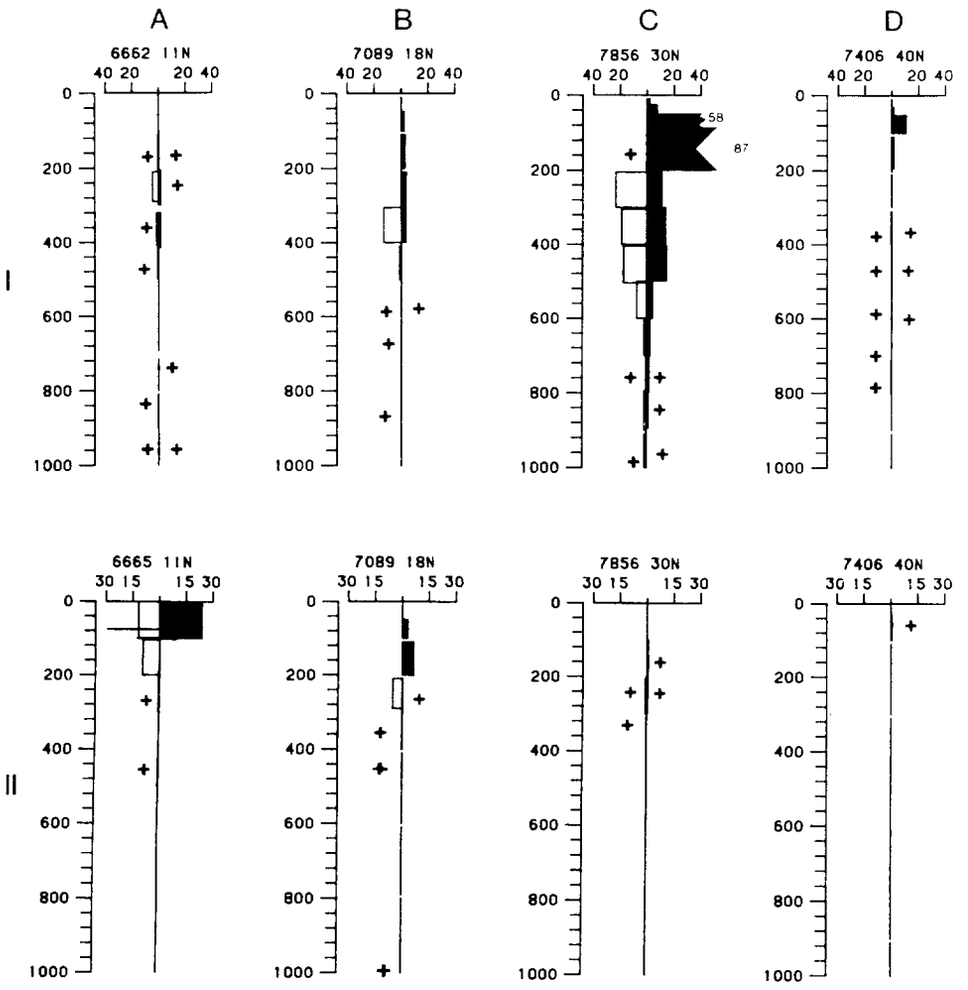

Fig. 12 Geographic and vertical distribution of Nematobrachion flexipes close to the 20° meridian. I. Adults and subadults (RMT 8), numbers per $10^4 m^3$ water filtered, II. Adolescents (RMT 1), numbers per $10^3 m^3$ water filtered.

Nematobrachion flexipes (Fig. 12)

This species occurred from 11°N to 40°N but was most abundant at 30°N.

Adults and subadults (RMT 8)

The depth range by day was 100-2000m with maxima at 305-400m (18°N and 40°N) and 200-300m (11°N and 30°N). By night the observed range was 10-2020m, and there was evidence of limited diel migration at all positions except at 11°N. At 18°N, night-time maximum numbers occurred at 100-400m whilst at 30°N and 40°N maxima occurred at 100-200m and 50-100m respectively. Thus the data agree with observations by Nemoto (1965) from Japanese waters and also suggest that there was some daytime net avoidance particularly at 30°N.

Adolescents (RMT 1)

Adolescents occurred by day from near-surface to 1020m with maximum numbers at about 75m (11°N) and 200-300m (18°N, 30°N). At night specimens occurred throughout the surface 500m with a maximum either at 0-100m (11°N) or at 100-200m (18°N and 30°N), so limited diel migration may have occurred. No larvae were found.

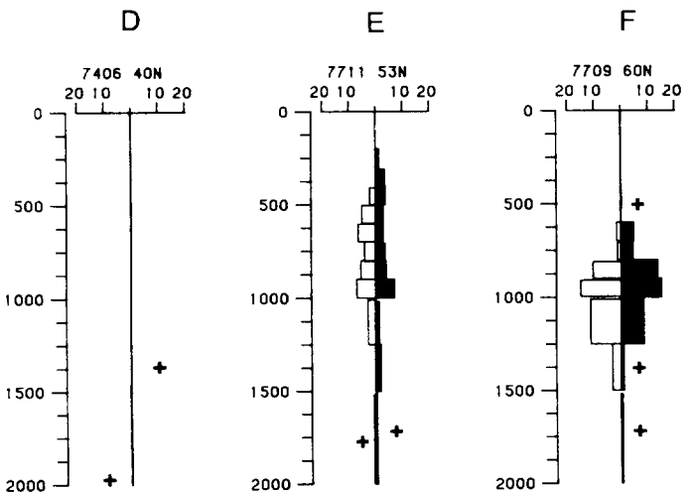

Fig. 13 Vertical distribution of Thysanopoda acutifrons close to the 20°W meridian. Adults and subadults (RMT 8) numbers per $10^4 m^3$ water filtered.

Thysanopoda acutifrons (Fig. 13)

This species occurred at 40°N-60°N but most abundantly at 53°N and 60°N.

Adults and subadults (RMT 8)

By day the vertical range was 400-2000m with maximum numbers at 900-1000m (53°N-60°N). Night-time vertical ranges were 200-2000m and the patterns of vertical distributions were similar to daytime so there was little evidence of diel migration. However, Waterman et al. (1939) on the basis of rather limited data concluded that some diel vertical migration occurred in this species.

Adolescents (RMT 8)

Relatively few specimens were taken, 40°N - none, 53°N - 6, 60°N - 6, ranging by day between 400m and 1500m. By night there was some evidence of diel migration and the depth ranges extended up to 200m with maximum numbers at 200-300m at 53°N but remaining deep at 800-900m at 60°N.

Very few larvae were identified.

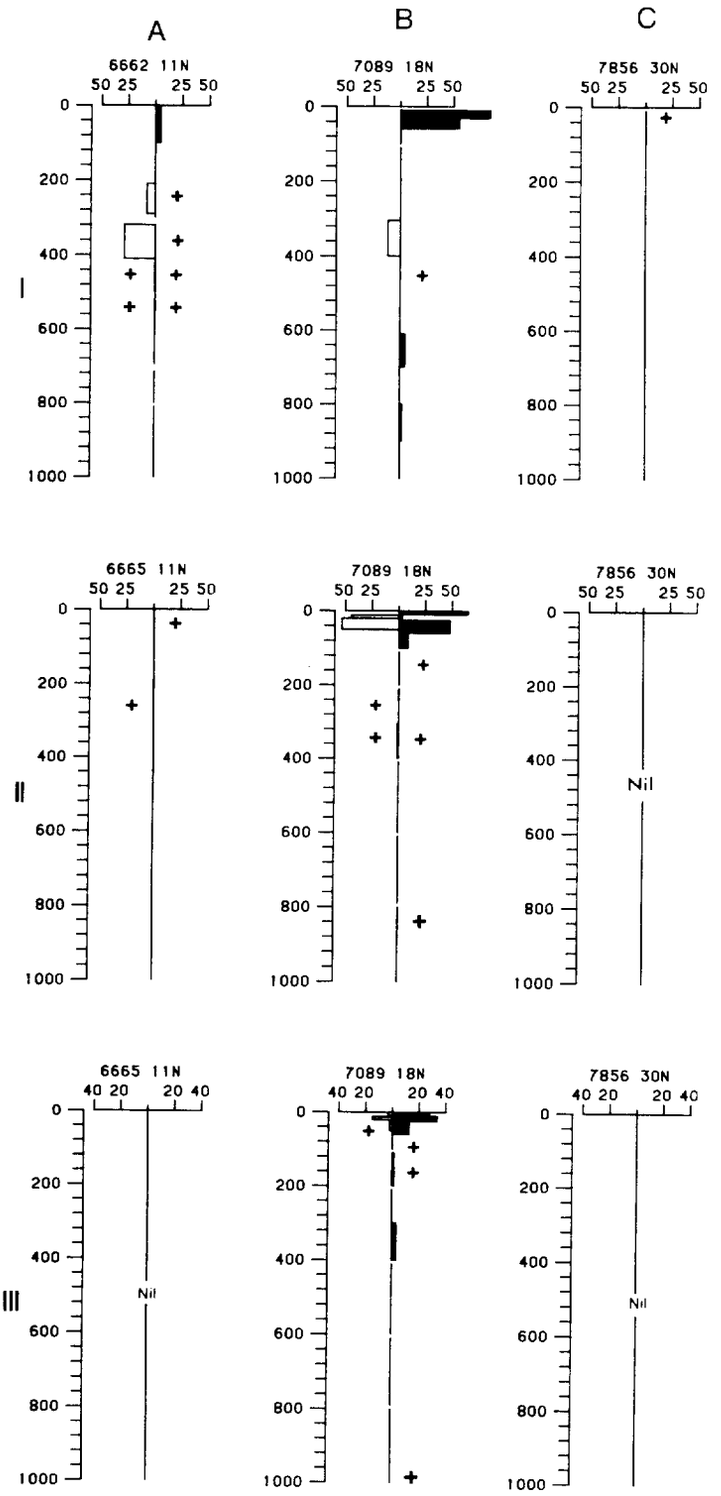

Fig. 14 Geographic and vertical distribution of Thysanopoda tricuspidata close to the 20°W meridian. I. Adults and subadults (RMT 8), numbers per $10^4 m^3$ water filtered, II. Adolescents (RMT 1), III. Larvae (RMT 1), numbers per $10^3 m^3$ water filtered.

Thysanopoda tricuspidata (Fig. 14)

Specimens occurred mainly at 11°N and 18°N, and one individual was caught at 30°N.

Adults and subadults (RMT 8)

At 11°N specimens occurred by day at 200-600m with maximum numbers at 300-400m which was the only depth at which they were caught by day at 18°N. By night they ranged between the surface and 900m with maximum numbers at 0-100m (11°N) and 10-60m (18°N), thus there was evidence of diel migration. Diel migration has been previously recorded in this species by Tattersall (1926), Brinton (1962), Nemoto (1965) and Roger (1978).

Adolescents (RMT 1)

Specimens were abundant only at 18°N where they occurred by day at 10-400m with maximum numbers at 20-50m. By night most occurred in the surface 100m.

Larvae (RMT 1)

Specimens were most abundant at 18°N. They occurred by day between the surface and 50m with maxima at 10-20m, and by night from the surface to 1200m with a maximum at 10-25m. The deep night-time tail to the distribution is probably an artefact resulting from contamination.

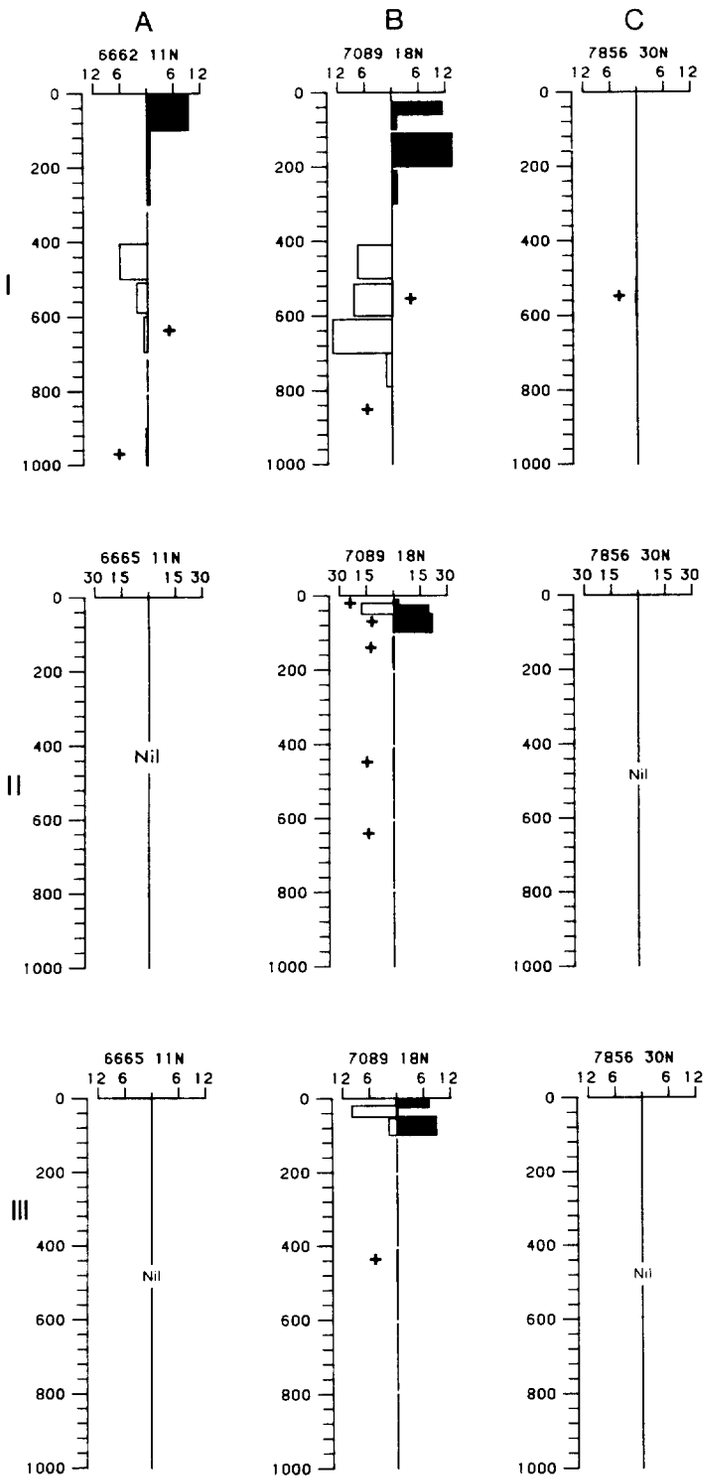

Fig. 15 Geographic and vertical distribution of Thysanopoda monocantha close to the 20°W meridian. I. Adults and subadults (RMT 8) numbers per $10^4 m^3$ water filtered, II. Adolescents (RMT 1), III. Larvae (RMT 1) numbers per $10^3 m^3$ water filtered.

Thysanopoda monocantha (Fig. 15)

The species occurred at 11°N, 18°N and 30°N but was most abundant at 18°N.

Adults and subadults (RMT 8)

By day specimens occurred at 400-1000m with maximum numbers at 400-500m (11°N) and at 600-700m (18°N). By night there was evidence of diel migration with maximum numbers occurring in the top 100m (11°N) and 100-200m (18°N). Brinton (1962) and Roger (1978) also described this species as being a diel migrant.

Adolescents (RMT 1)

Specimens were relatively rare with maximum numbers occurring at 18°N, where the daytime depth range was 10-700m with maximum numbers at 20-50m. By night most specimens were caught at 25-100m, so there was little evidence for any vertical migration.

Larvae (RMT 1)

These were caught mainly at 18°N where their distributions were similar to those of the adolescents, being most abundant at 20-50m by day and at 50-100m by night.

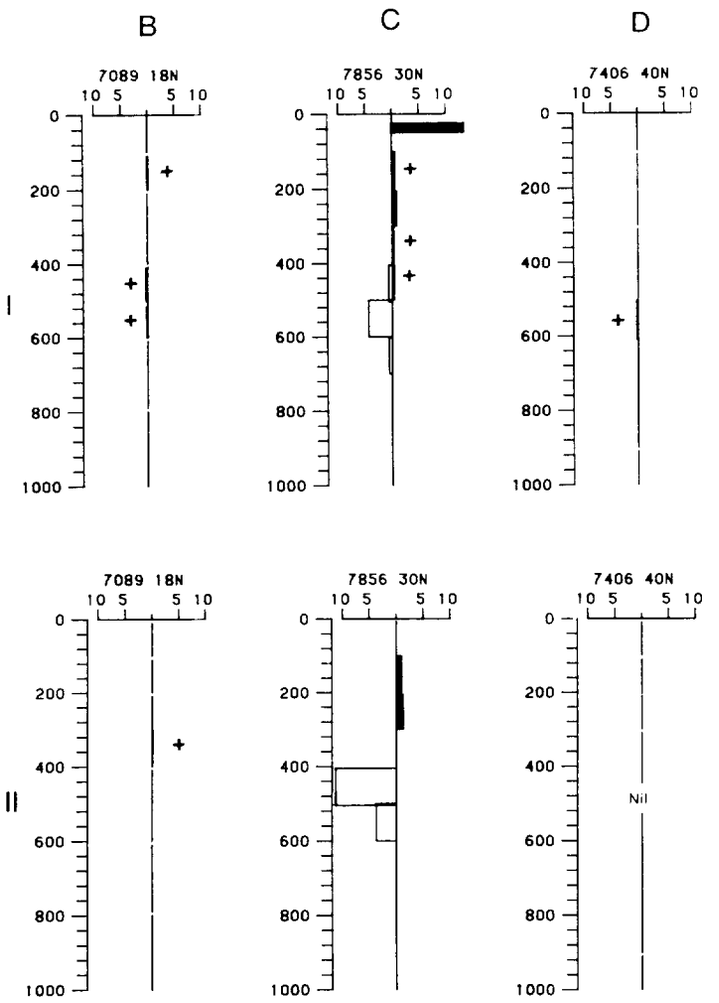

Fig. 16 Geographic and vertical distribution of Thysanopoda obtusifrons close to the 20°W meridian. I. Adults and subadults (RMT 1), II. Adolescents (RMT 1), numbers per $10^3 m^3$ water filtered.

Thysanopoda obtusifrons (Fig. 16)

This species occurred between 18°-40°N but in greatest numbers at 30°N.

Adults and subadults (RMT 1)

By day their depth range was 400-700m with maximum numbers occurring either at 400-600m (18°N) or at 500-600m (30°N). By night the depth range was 25-500m, with maximum numbers at either 110-200m (18°N) or 25-50m (30°N). Similar diel migration has been recorded by Moore (1949), Brinton (1962), Nemoto (1965), Baker (1970), Michel and Foyo (1976) and Roger (1978).

Adolescents (RMT 1)

Only the data from 30°N were extensive enough to be meaningful and there by day specimens occurred at 405-600m and by night at 100-300m.

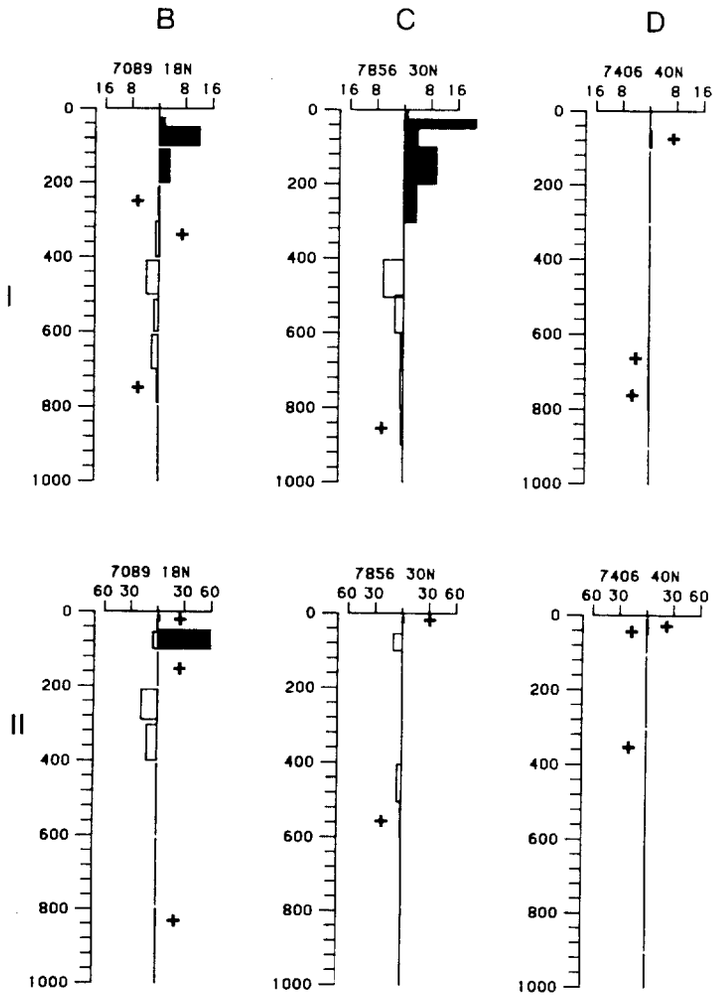

Fig. 17 Geographic and vertical distribution of Thysanopoda aequalis close to the 20°W meridian. I. Adults and subadults (RMT 1), II. Adolescents (RMT 1), numbers per $10^3 m^3$ water filtered.

Thysanopoda aequalis (Fig. 17)

This species occurred at 18°N, 30°N and 40°N. It was most abundant at 30°N and scarce at 40°N.

Adults and subadults (RMT 1)

By day most specimens occurred at 210-800m with maximum numbers at 400-500m (18N, 30N) and 605-800m (40°N). By night the range was mainly 25-300m with maxima at 50-100m (18°N), 25-50m (30°N) and 52-100m (40°N), so some diel vertical migration occurred. These data agree with those of Moore (1949), Brinton (1962), Baker (1970)and Roger (1978). At least at 18°N and 30°N some net avoidance seems to have occurred by day.

Adolescents (RMT 1)

By day maximum numbers of adolescents occurred at 200-300m (18°N) and at 55-100m (30°N). At 18°N some migration into the 50-100m zone occurred but at 30°N diel migration was not apparent.

Larvae (RMT 1)

Larvae were difficult to differentiate from those of T. obtusifrons and were not distinguished.

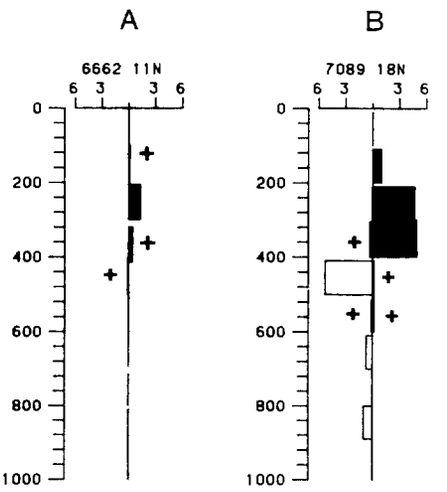

Fig. 18 Geographic and vertical distribution of Thysanopoda orientalis close to the 20°W meridian. I. Adults and subadults (RMT 8), numbers per $10^4 m^3$ water filtered.

Thysanopoda orientalis (Fig. 18)

This species occurred at 11°N and 18°N but was scarce at 11°N.

Adults and subadults (RMT 8)

By day adults occurred at 300-900m with maximum numbers at 410-500, whereas by night the depth range was 100-600m with maximum numbers at 205-400m so diel vertical migration occurred confirming the earlier report by Roger (1978). There were too few data to comment on the distribution patterns of adolescents and larvae.

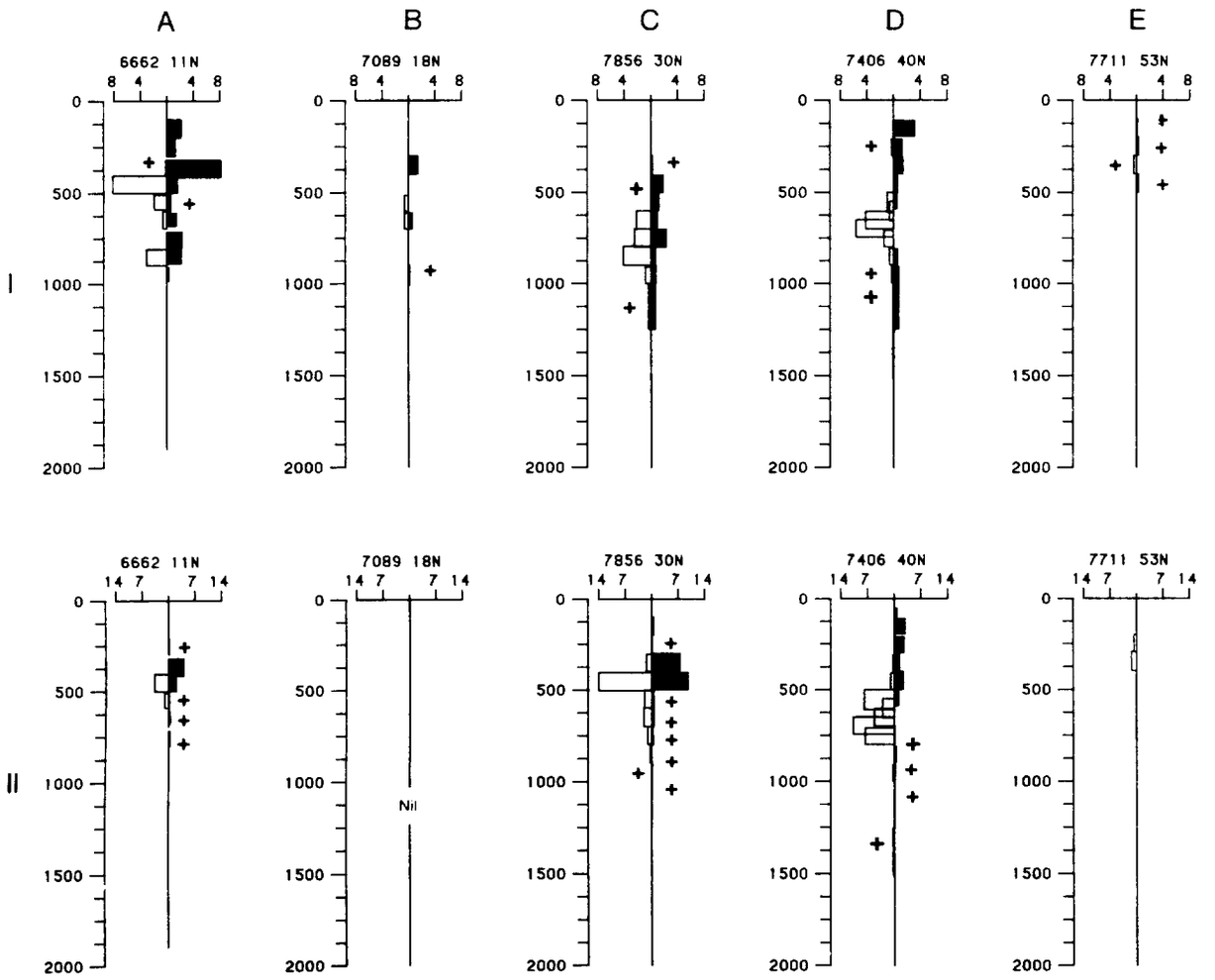

Fig. 19 Geographic and vertical distribution of Thysanopoda microphthalma close to the 20°W meridian. I. Adults and subadults (RMT 8), II. Adolescents (RMT 8) numbers per $10^4 m^3$ water filtered.

Thysanopoda microphthalma (Fig. 19).

This species was most abundant at 11°N, 30°N and 40°N but was scarce at 18°N, 53°N and 60°N.

Adults and subadults (RMT 8)

By day specimens occurred at 200-1250m with maximum numbers at 400-500m (11°N), 500-700m (18°N), 800-900m (30°N) and 600-700m (40°N). Night hauls showed evidence of diel migration and the respective maxima occurred at 320-415m (11°N), 400-500m, 700-800m (30°N) and 100-200m (40°N). Baker (1970) found evidence of slight diel migration off the Canary Islands at 28°N but the present data indicate that a proportion of the population were non-migrants remaining at depth during the day.

Adolescents (RMT 8)

By day these occurred at 200m-1500m with maximum numbers at 400-500m (11°N, 30°N) and 500-745m (40°N) By night they were caught at 100m-1500m with maxima at 300-415m (11°N), 300-500m (30°N) and 110-300m (40°N). Diel migration probably occurred.

Larvae

Very few specimens were identified.

Thysanopoda egregia

This is a rare species and very few were caught:- 11°N - 2 adults, 2 adolescents; 18°N - 2 adults/subadults, 2 adolescents and 24 larvae; 30°N - 0 adults/subadults, 12 adolescents, 3 larvae.

Adults and subadults (RMT 8)

The few adults caught (at 11°N, 18°N and 30°N) were by day at between 800-900m and by night at 600-900m.

Adolescents (RMT 8 and RMT 1)

These were taken at 112-1220m (RMT 1 hauls); 100-200m (RMT 8 day) and 200-300m (RMT 8 night).

Larvae (RMT 1)

Larvae occurred at 112-1120m at 18°N. At 30°N specimens were at 200-800m with maximum numbers at 200-300m by night (RMT 8).

Thysanopoda pectinata

Another rare species of which specimens occurred at 11°N, 18°N and 40°N but most abundantly at 18°N.

Adults and subadults (RMT 8)

Few were caught:- 11°N - 1 adult/subadult; 1 adolescent, 18°N - 16 adults/subadults, 40°N - 6 adults/subadults. Their range was 500-800m with maximum numbers at 500-600m (18°N) and 600-700m (40°N). There was evidence of diel migration since at night the zone of maximum abundance rose to 100-200m (18°N) and 200-300m (40°N). Diel migratory behaviour was recorded previously by Brinton, (1962); Youngbluth (1975) and Roger (1978).

Adolescents and larvae (RMT 1/8)

Few adolescents occurred in the RMT 8 or the RMT 1. Only nine adolescents were recorded by day (100-200m, 30°N) and only six by night (25-500m, 30°N). Similarly very small numbers of larvae occurred between 102-200m, (Day, 10°N).

Thysanopoda cornuta

This rare species was caught only at 18°N and at 30°N.

Adults and subadults (RMT 8)

At 18°N one specimen occurred by day at 910-1020m, and one occurred by night at 1000-1250m. At 30°N two specimens were taken by day at 1250-2000m, and 2 were caught at night at 1250-1500m.

Adolescents (RMT 8)

21 specimens were caught at 30°N below 700m (day and night).

Larvae (RMT 1/8)

Relatively few larvae were taken:- 18°N - 3; 30°N - 12. In the RMT 1 hauls most specimens occurred below 900m, but in the RMT 8 hauls specimens occurred by day at 800-900m at 18°N, and at 600-1000m at 30°N.

Thysanopoda cristata

This species was uncommon - as previously reported by Brinton (1962), Baker (1970) and Youngbluth (1976). It occurred in small numbers at 18°N and 30°N:- 18°N - 4 adults/subadults, 12 adolescents; 30°N - 1 adult/subadult,28 adolescents.

Adults and subadults (RMT 8)

Most specimens occurred in night hauls from 110-500m.

Adolescents (RMT 8)

The RMT 8 net provided the best information on the distribution of the adolescents. At 18°N they occurred at 100-200m by day and at 110-400m by night - thus there was no evidence for diel migration.

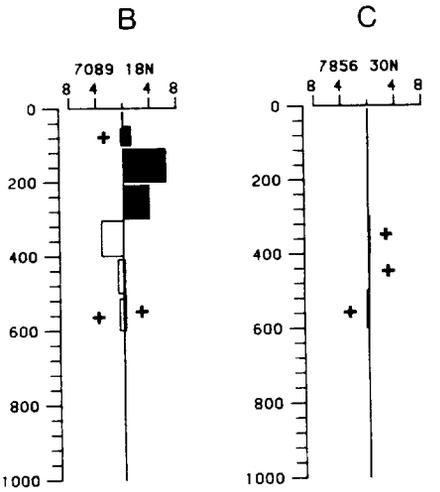

Fig. 20 Geographic and vertical distribution of Stylocheiron robustum close to the 20°W meridian. Adults and subadults (RMT 8), numbers per $10^4 m^3$ water filtered.

Stylocheiron robustum (Fig. 20)

Specimens occurred mainly at 18°N with a few at 30°N.

Adults and subadults (RMT 8)

By day and night their range was 50-600m with maximum numbers at 300-400m by day and at 110-200m at night (18°N) - thus there was some evidence of diel migration.

Adolescents (RMT 8)

Specimens were abundant only at 18°N where they occurred by night mainly at at 49-100m. No larvae were identified.

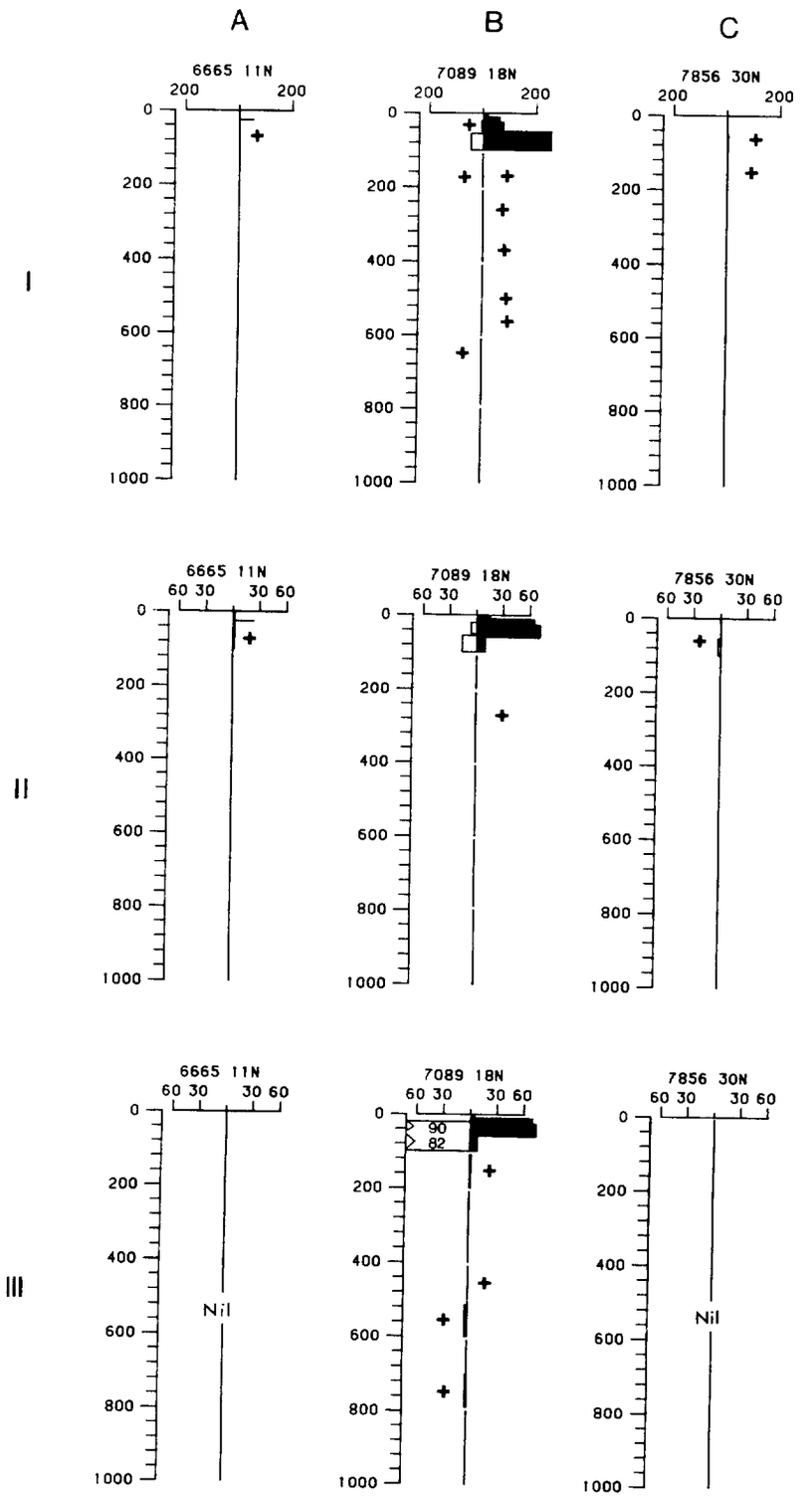

Fig. 21 Geographic and vertical distribution of Stylocheiron carinatum close to the 20°W meridian. I. Adults and subadults (RMT 1), II. Adolescents (RMT 1), III. Larvae (RMT 1), numbers per $10^3 m^3$ water filtered.

Stylocheiron carinatum (Fig. 21)

This species occurred at 11°N, 18°N and 30°N but most abundantly at 18°N.

Adults and subadults (RMT 1)

Specimens occurred between the surface and 1000-1200m. At 18°N both by day and by night maximum numbers occurred between 50-100m. There was some evidence of partial diel migration with some specimens occurring in the top 25m by night, but Lewis (1954) found that this species migrated to deeper water some time after midnight, so these data could be misleading. At 30°N specimens were caught only at night (50-100m) so daytime net avoidance may have occurred. Generally these data agree with those previously published by Leavitt (1935), Lewis (1954), Brinton (1962; 1967) and Roger (1978).

Adolescents (RMT 1)

Generally adolescent distributions were similar to those of the adults. By day maximum numbers occurred at 55-100m and by night maximum numbers occurred at 10-60m.

Larvae (RMT 1)

Specimens occurred only at 18°N. By day maximum numbers occurred at 20-100m, and by night specimens occurred mainly at 10-60m.

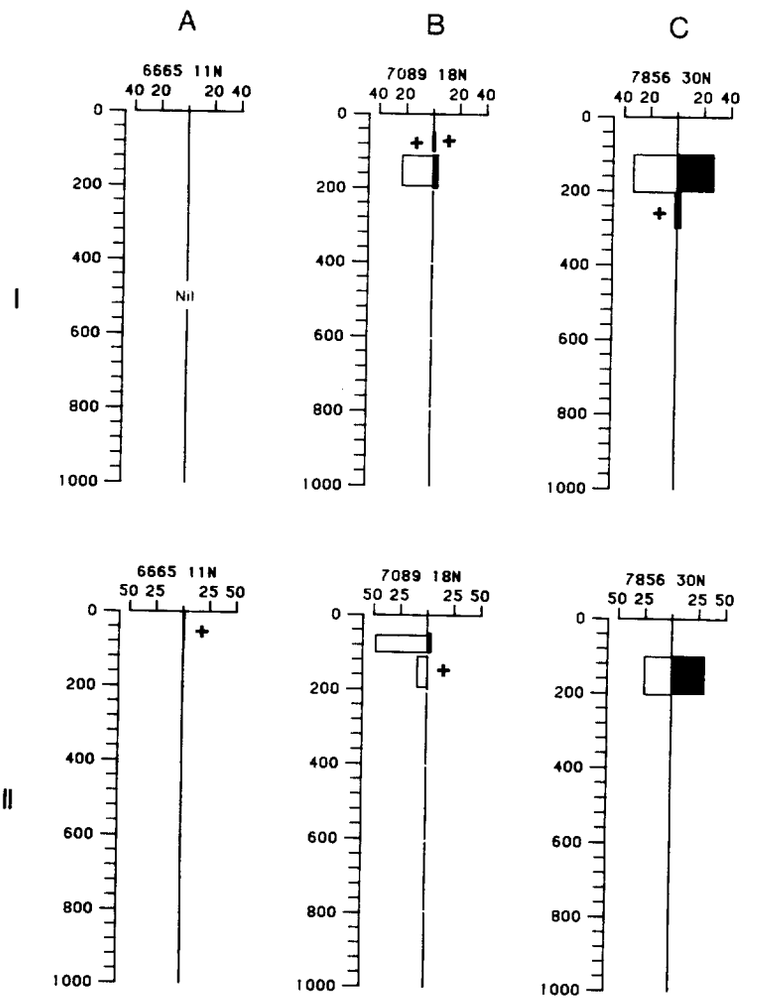

Fig. 22 Geographic and vertical distribution of Stylocheiron affine close to the 20°W meridian. I. Adults and subadults (RMT 1), II. Adolescents (RMT 1), numbers per $10^3 m^3$ water filtered.

Stylocheiron affine (Fig. 22)

This species occurred at 11°N, 18°N and 30°N.

Adults and subadults (RMT 1)

Specimens occurred by day and night between 50m and 300m with maximum numbers at 100-200m. These data agree with previous observations (Brinton 1962; Mauchline and Fisher 1969; Baker 1970; Youngbluth 1976 and Roger 1978).

Adolescents and larvae (RMT 1)

Adolescent distributions were similar to those of the adults. By day and night maximum numbers occurred at 100-200m (30°N) and at 50-100m (18°N). No larvae were recorded.

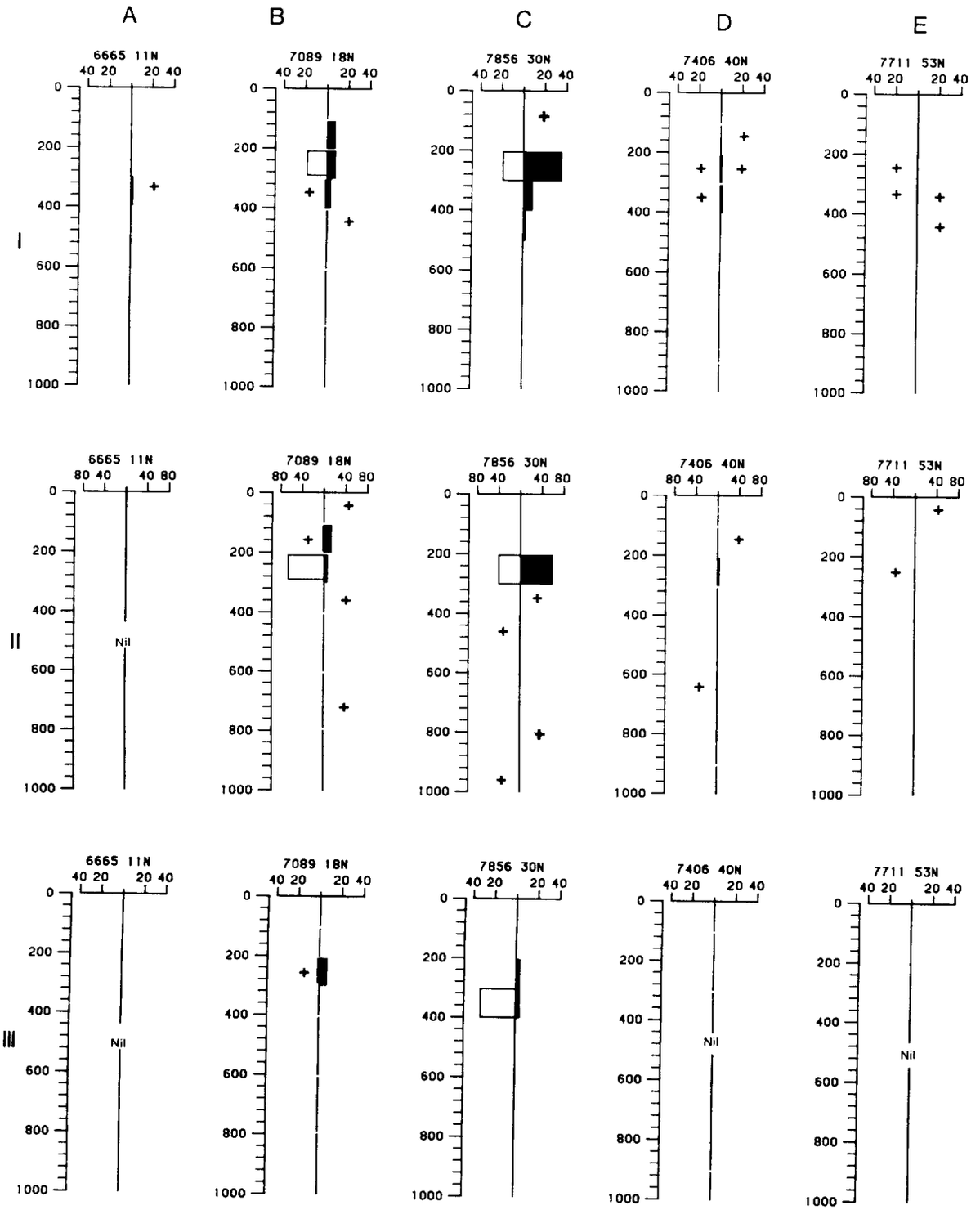

Fig. 23 Geographic and vertical distribution of Stylocheiron elongatum close to the 20°W meridian. I. Adults and subadults (RMT 1), II. Adolescents (RMT 1), III. Larvae (RMT 1), numbers per $10^3 m^3$ water filtered.

Stylocheiron elongatum (Fig. 23)

This species occurred at all positions except 60°N but was most abundant at 30°N.

Adults and subadults (RMT 1)

By day specimens occurred between 200m and 1500m with maximum numbers at 200-300m (18°N, 30°N). By night maxima occurred at 100-400m (18°N) and at 200-300m (30°N). Limited diel migration may have occurred at 18°N but not at 30°N. Baker (1970) found that adult S. elongatum were non-migrants.

Adolescents (RMT 1)

By day specimens occurred at 100-1000m and by night in the top 800m, but with maximum numbers in the range 200-300m. Distributions were generally similar to those of the adults. There is no clear evidence for diel migration.

Larvae (RMT 1)

Specimens occurred only at 18°N (200-300m day and night) and at 30°N (300-400m day, 200-400m night).

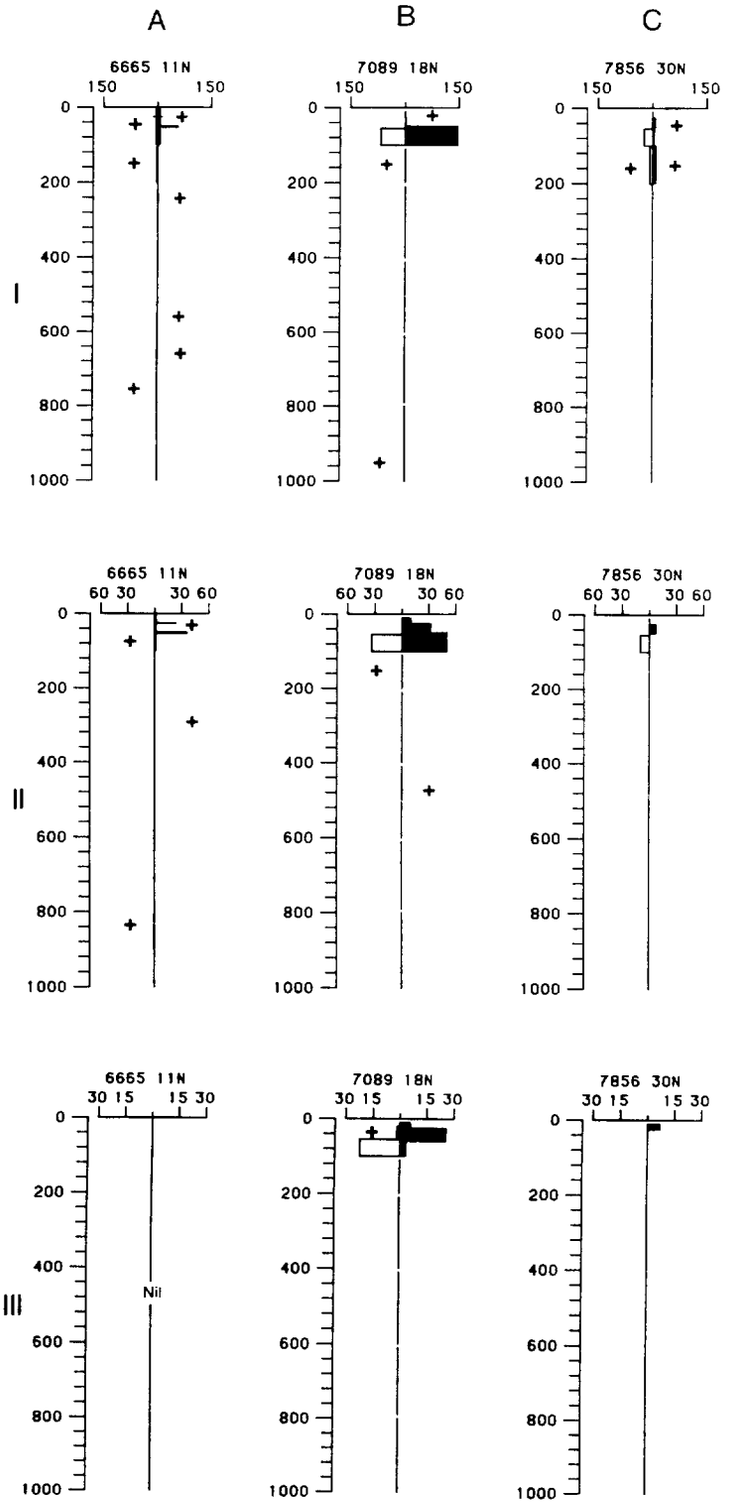

Fig. 24 Geographic and vertical distribution of Stylocheiron suhmii close to the 20°W meridian. I. Adults and subadults (RMT 1), II. Adolescents (RMT 1), III. Larvae (RMT 1), numbers per $10^3 m^3$ water filtered.

Stylocheiron suhmii (Fig. 24)

This species occurred at 11°N, 18°N and 30°N and was most abundant at 18°N.

Adults and subadults (RMT 1)

By day and night specimens occurred mainly in the top 200m. Maximum numbers by day were at 25m (11°N), 55-100m (18°N, 30°N) and by night at 50m (11°N), 50-100m (18°N) and at 100-200m (30°N). These data agree with those of Brinton (1962, 1967); Baker (1970); Youngbluth (1975) and Roger (1978) who generally considered the species to be a non-migrant.

Adolescents (RMT 1)

Specimens occurred mainly in the top 200m. By day maximum numbers occurred at 55-100m (18°N, 30°N). By night, at 30°N, there was evidence of slight diel migration towards the surface with maximum numbers at 25-50m. At 11°N specimens were scarce.

Larvae (RMT 1)

Specimens occurred mainly at 18°N at 10-100m. By day maximum numbers occurred at 55-100m and by night at 25-60m - thus there was slight evidence of diel migration.

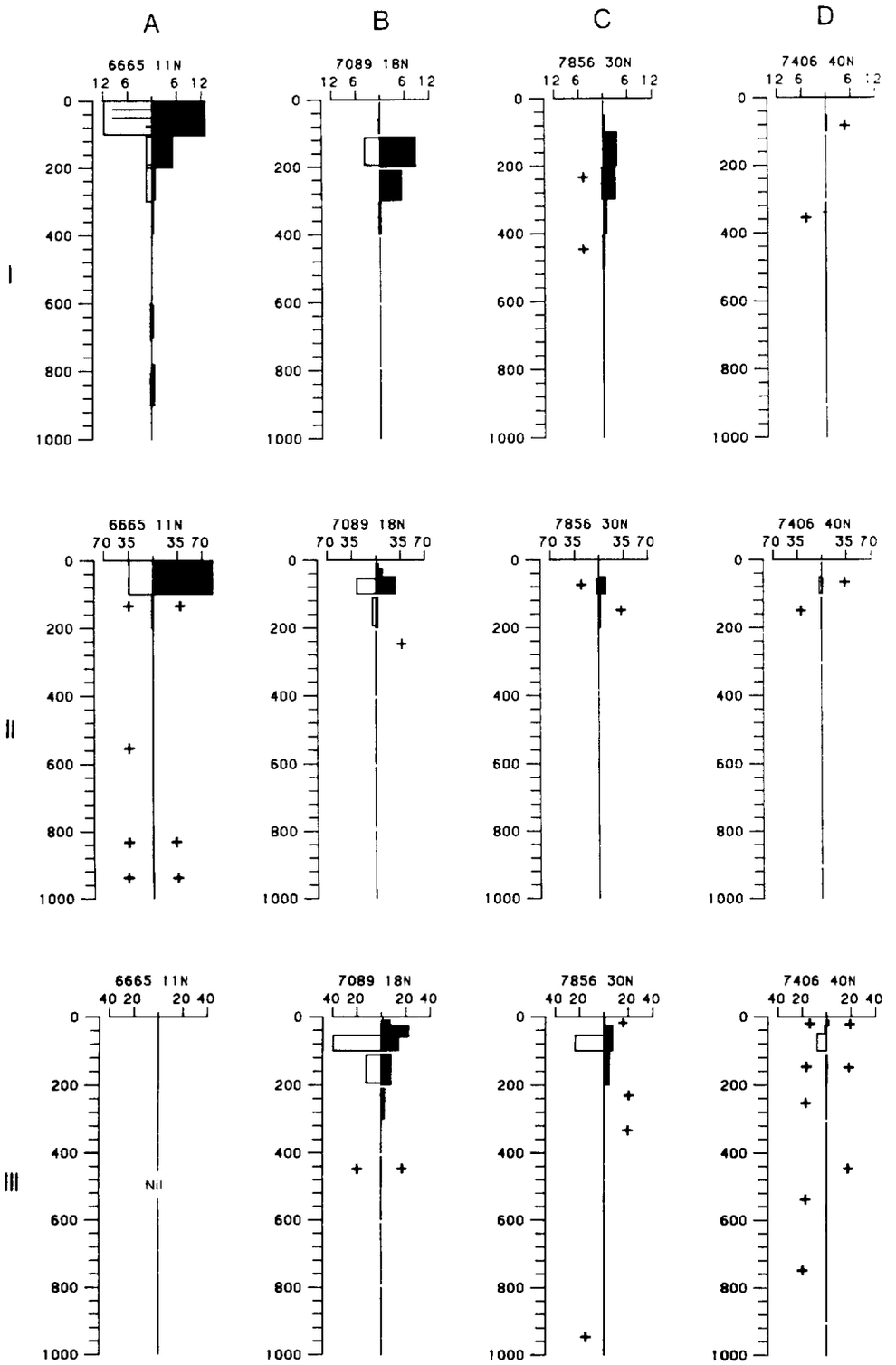

Fig. 25 Geographic and vertical distribution of Stylocheiron abbreviatum close to the 20°W meridian. I. Adults and subadults (RMT 1), II. Adolescents (RMT 1), III. Larvae (RMT 1), numbers per $10^3 m^3$ water filtered.

Stylocheiron abbreviatum (Fig. 25)

The species was most abundant at 11°N, 18°N and 30°N, and was rare further north at 40°N, 53°N and 60°N.

Adults and subadults (RMT 1)

Generally specimens occurred in the top 1200m. By day maximum numbers occurred in the surface 100m (11°N), 112-194m (18°N), 200-300m (30°N). By night specimens occurred at 25-1250m but most abundantly at 0-100m (11°N), 110-200m (18°N) and 110-300m (30°N). This species seems to have been a non-migrant - as found by Brinton (1962), Nemoto (1965) and Youngbluth (1975), except at 30°N where more specimens occurred closer to the surface by night than by day. However, this observation could have been caused as much by net avoidance as by migration. Net avoidance has been described in this species by both Baker (1970) and Brinton (1967).

Adolescents (RMT 1)

Most specimens occurred at 11°N and 18°N more abundantly both by day and by night in the top 100m (11°N) and at 55-100m (18°N). At 30°N and 40°N the few specimens taken occurred at about 100m.

Larvae (RMT 1)

Most specimens occurred at 18°N and 30°N with maximum numbers at 50-100m by day. By night there was some evidence for diel migration with maximum numbers occurring at 25-60m (18°N).

Stylocheiron longicorne (Figs. 26 & 27)

In this paper, Brinton's (1962) differentiation of long and short forms is followed. This separation is particularly difficult for adolescents and larvae and so these were not differentiated in 30°N and 18°N material.

Short form adults and subadults (RMT 1)

The majority of specimens were the short form. These occurred throughout the sampling area except at 60°N. They were most abundant at 30°N and were most scarce at 53°N. Depth ranges were similar by day and night with maxima occurring at 100-300 (11°N, 18°N, 30°N) and 50-100m (40°N). It was probably a non-migrant - as shown previously by Brinton (1962).

Short form adolescents (RMT 1)

Most specimens were caught in the top 100m by both day and night.

Short form larvae (RMT 1)

Specimens occurred mainly at 40°N. By day a maximum occurred at 50-100m and by night at 10-27m.

Long form adults and subadults (RMT 1)

Adults of this form were most abundant at 18°N where they mainly occurred both by day and by night at 110-400m. No juveniles were identified.

Undifferentiated forms. (RMT 1)

In addition, many adolescent and larval stages occurred at 18°N and 30°N which were not differentiated into long or short forms. Adolescents occurred between 100-300m by day and night and larvae were within the top 200m.

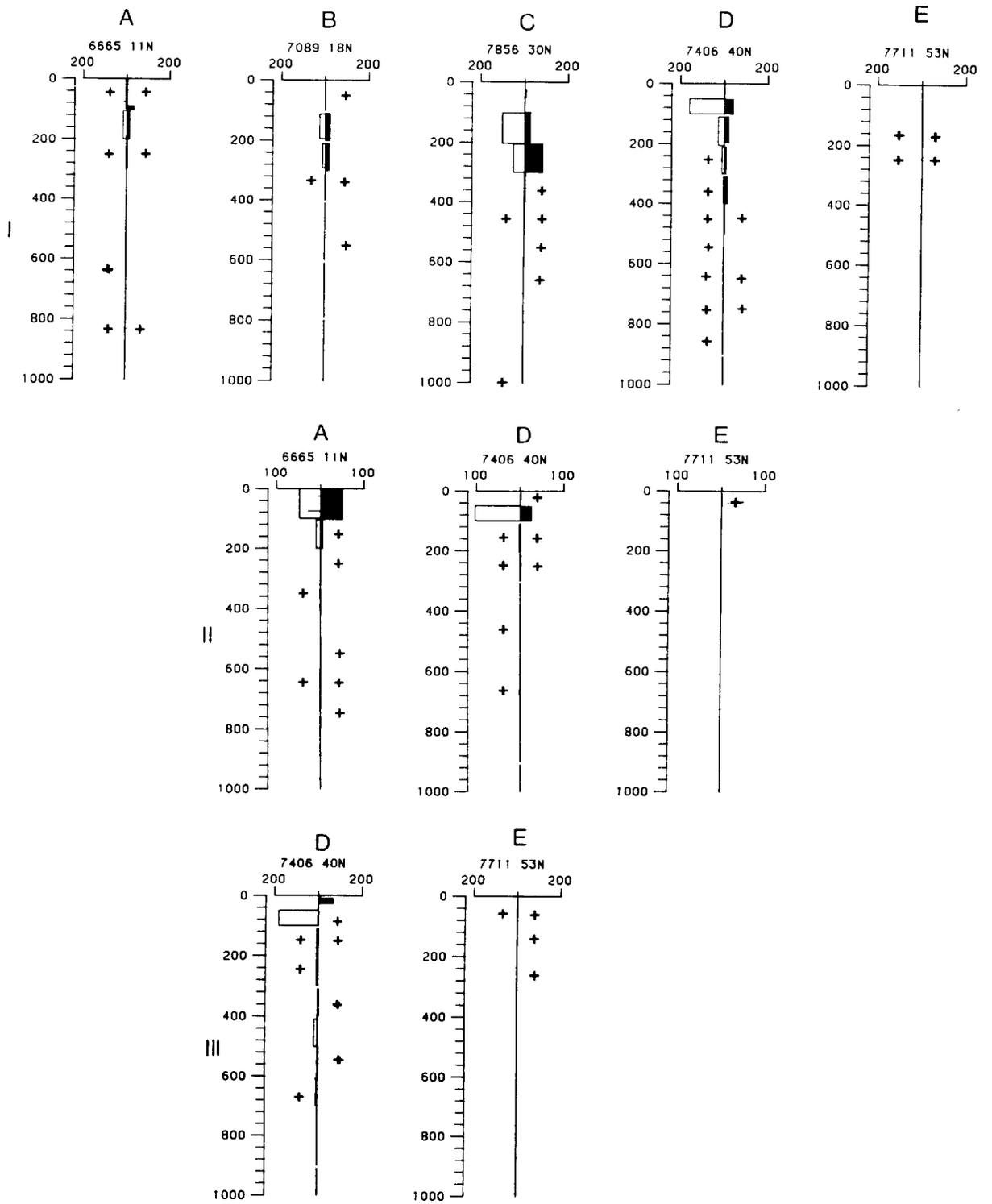

Fig. 26 Geographic and vertical distribution of Stylocheiron longicorne close to the 20°W meridian. I. Adults and subadults short form (RMT 1), II. Adolescents short form (RMT 1), III. Larvae short form (RMT 1), numbers per $10^3 m^3$ water filtered.

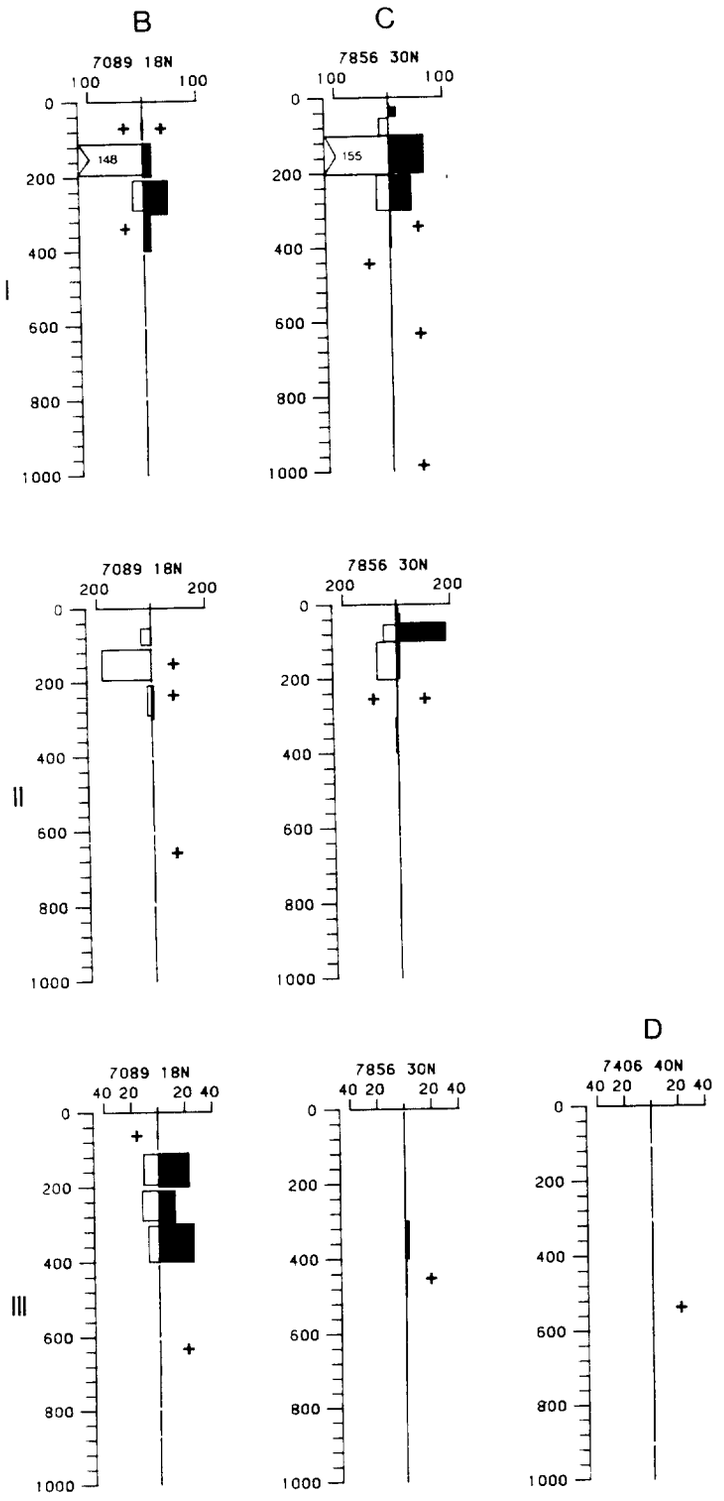

Fig. 27 Geographic and vertical distribution of Stylocheiron longicorne close to the 20°W meridian. I. Adolescents long/short form (RMT 1), II. Larvae long/short form (RMT 1), III. Adults and subadults long form (RMT 1), numbers per $10^3 m^3$ water filtered.

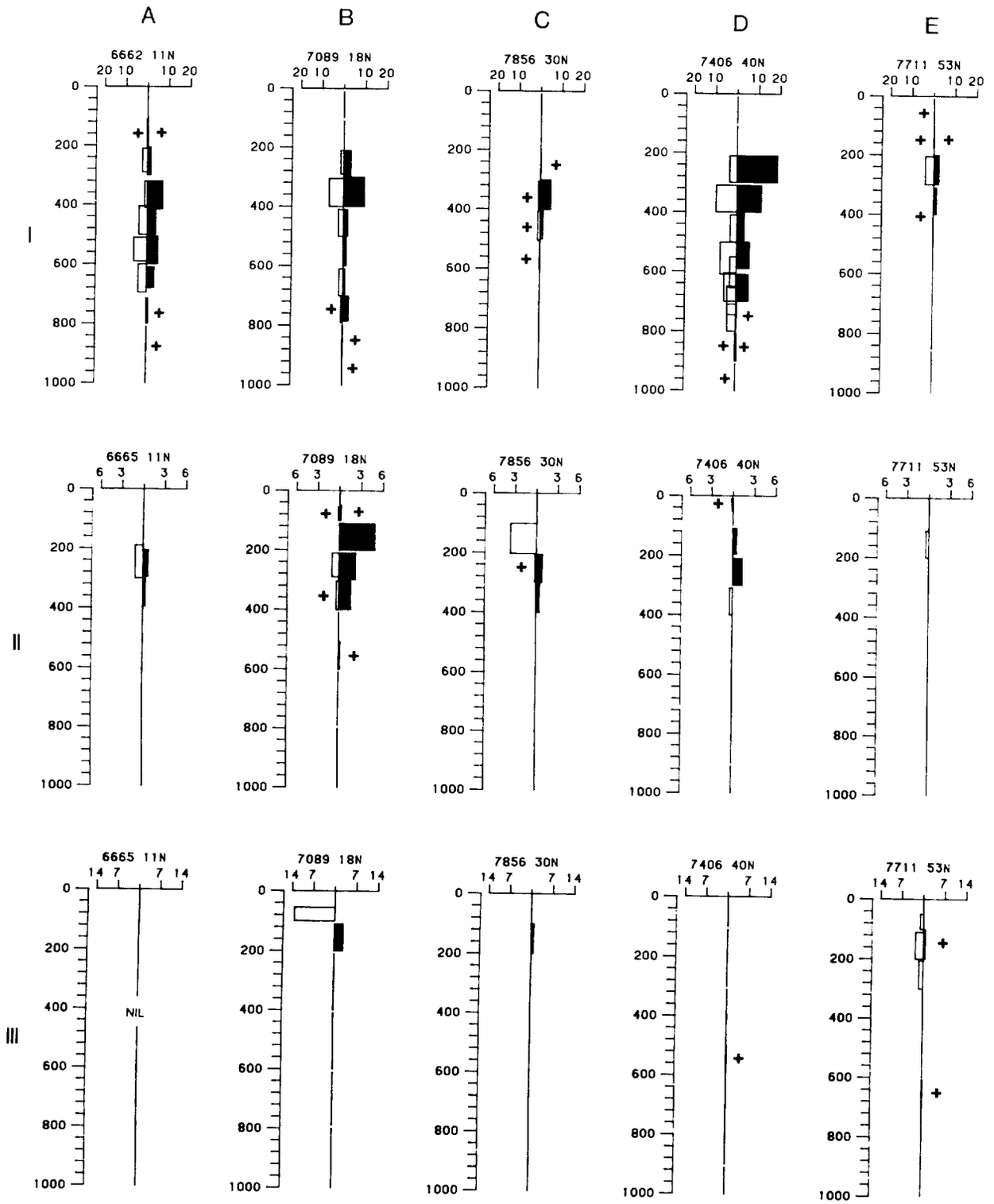

Fig. 28 Geographic and vertical distribution of Stylochiron maximum close to the 20°W meridian. I. Adults and subadults (RMT 8) numbers per $10^4 m^3$, II. Adolescents (RMT 1), III. Larvae (RMT 1), numbers per $10^3 m^3$ water filtered.

Stylocheiron maximum (Fig. 28)

This species occurred between 11°N - 60°N and was most abundant at 40°N and rare at 60°N.

Adults and subadults (RMT 8)

Specimens occurred between 100m and 2000m. By day maximum numbers occurred at 500-600m (11°N), 300-400m (18°N, 40°N), 200-300m (53°N) and 200-500 (60°N). By night depth distributions were similar to those by day, and there was no evidence of diel migration. The data agree with those of Brinton (1962) and Roger (1978). There was some evidence of net avoidance by day especially at 30°N.

Adolescents (RMT 1)

By day specimens occurred between 55m and 400m with maximum numbers at 200-300m (11°N, 18°N), 100-200m (30°N) and 300-400m (40°N). By night specimens occurred between 50m and 600m with maxima at 100-200m (18°N) and 200-300m (30°N, 40°N). Diel migration may have occurred at 18°N but net avoidance by day may have affected observed distribution patterns.

Larvae (RMT 1)

Specimens were relatively rare, occurring mainly at 18°N and 53°N. By day maximum numbers occurred at 55-100m (18°N) and 100-200m (53°N). There was little evidence of diel migration.

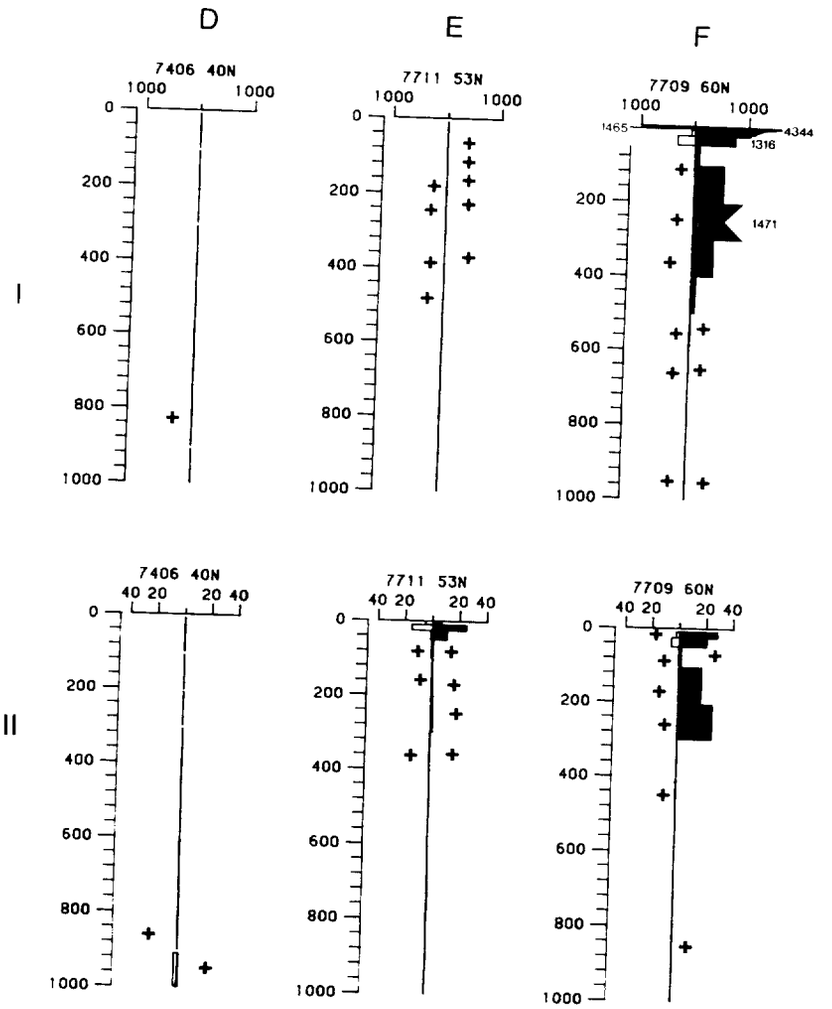

Fig. 29 Geographic and vertical distribution of Thysanoessa longicaudata close to the 20°W meridian. I. Adults and subadults. (RMT 1), II. Adolescents (RMT 1), numbers per $10^3 m^3$ water filtered.

Thysanoessa longicaudata (Fig. 29)

This species was most abundant at 60°N and was present in progressively lower numbers at 53°N and 40°N.

Adults and subadults (RMT 1)

At 60°N by day it occurred mainly in the top 1000m with maximum numbers in the top 10m while at 53°N most of the population occurred at 100-300m. At 40°N a few specimens occurred at 800-1250m suggesting that this species was either showing latitudinal submergence or it underwent extensive seasonal migrations. By night specimens occurred in the top 1500m with maxima at 10-25m and 300-400m (53°N) and at 0-25m and 200-300m (60°N). Some diel migration may have occurred at 53°N but the distributions might have been influenced by daytime net avoidance. Mauchline and Fisher (1969) also concluded that this species occurred both at shallow and deep depths. Kulka et al. (1982) showed that this species carried out limited diel migrations.

Adolescents (RMT 1)

The adolescents had similar distributions to adults and subadults. By day maximum numbers occurred at 910-1000m (40°N), 0-25m (53°N) and the surface 50m (60°N). Similarly at night most of the population remained near to the surface at 53°N and 60°N. Daytime net avoidance is also likely to have occurred in the adolescents.

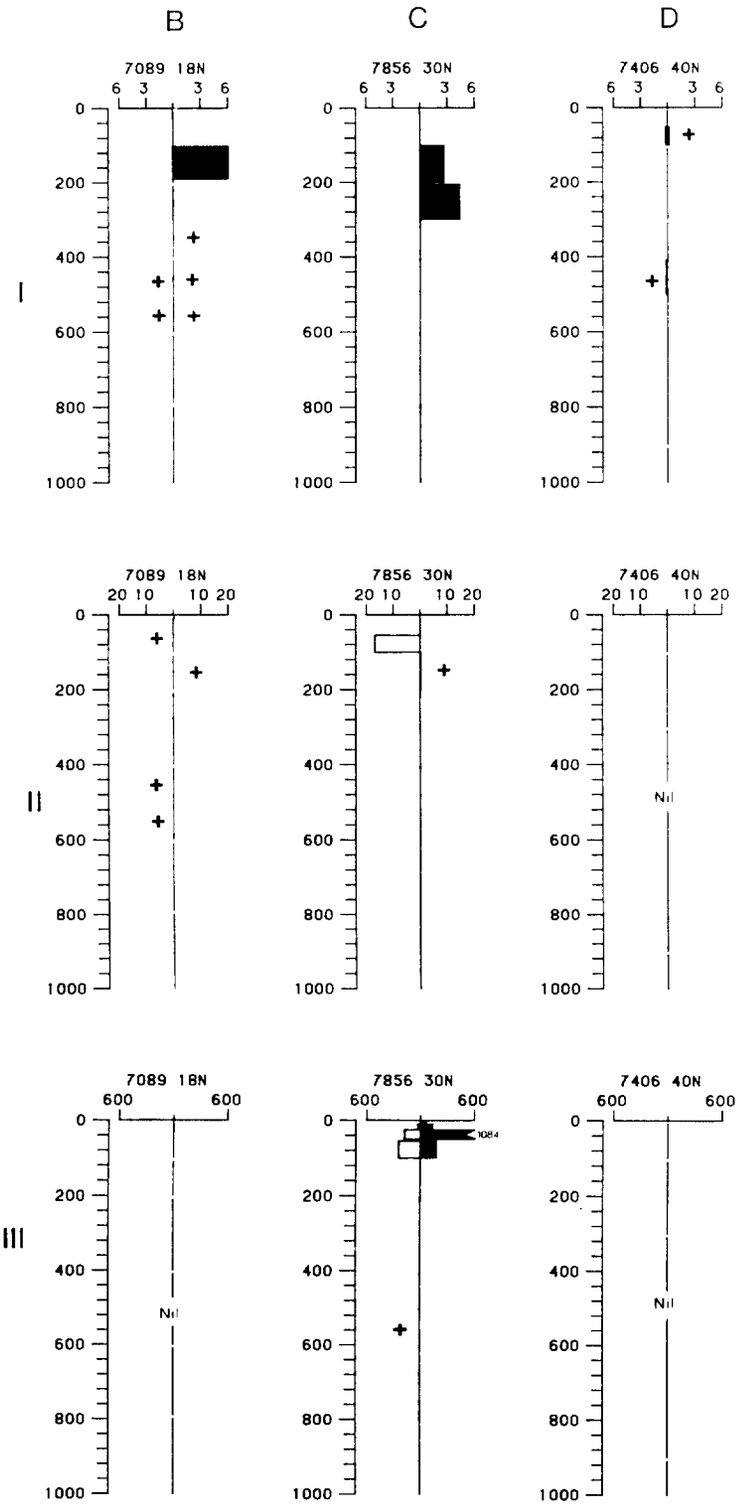

Fig. 30 Geographic and vertical distribution of Thysanoessa gregaria close to the 20°W meridian. I. Adults and subadults (RMT 1), II Adolescents (RMT 1), III. Larvae (RMT 1), number per $10^3 m^3$ water filtered.

Thysanoessa gregaria (Fig. 30)

This species occurred mainly at 18°N and 30°N and rarely at 40°N

Adults and subadults (RMT 1)

By day a few were taken at 410-600m at both 18°N and 40°N, but none was caught at 30°N. By night the depth ranges were from 100-600m at (18°N) and 100-300m at 30°N. Weigmann-Hass (1976) had previously described the species as a surface-dweller. These data indicate that the species does occur in deeper water and the relatively few specimens caught in daytime hauls imply that net avoidance occurred (see also Brinton, 1967 and Baker, 1970).

Adolescents (RMT 1)

Specimens were comparatively rare. By day they occurred mainly between 50m and 600m (18°N) and at 55-100m (30°N). By night one specimen occurred in each of the 100-200m hauls at 18°N and 30°N.

Larvae (RMT 1)

Specimens occurred only at 30°N with maxima by day at 10-100m and by night at 25-50 m.

Thysanoessa parva

This species occurred in small numbers at 18°N and 40°N:- 18°N - 5 adults/subadults, 3 adolescents, 40°N - 42 adults/subadults, 50 adolescents. Its absence from 30°N is unexplained. However, it has subsequently been taken in large numbers in the vicinity of the Azores front around 30°N, 30°W, so a possible explanation that needs further investigation is that this species is associated with oceanographic fronts.

Adults and subadults (RMT 1)

Relatively few specimens occurred. By day and by night the depth range was between 500m and 1500m with maximum numbers at 500-800m (18°N) and 800-900 (40°N). The 18°N data agree with those of Brinton (1962) and Baker (1970) who considered the species to be a non-migrant. It seems likely that net avoidance occurred at 40°N because more specimens occurred by night than by day.

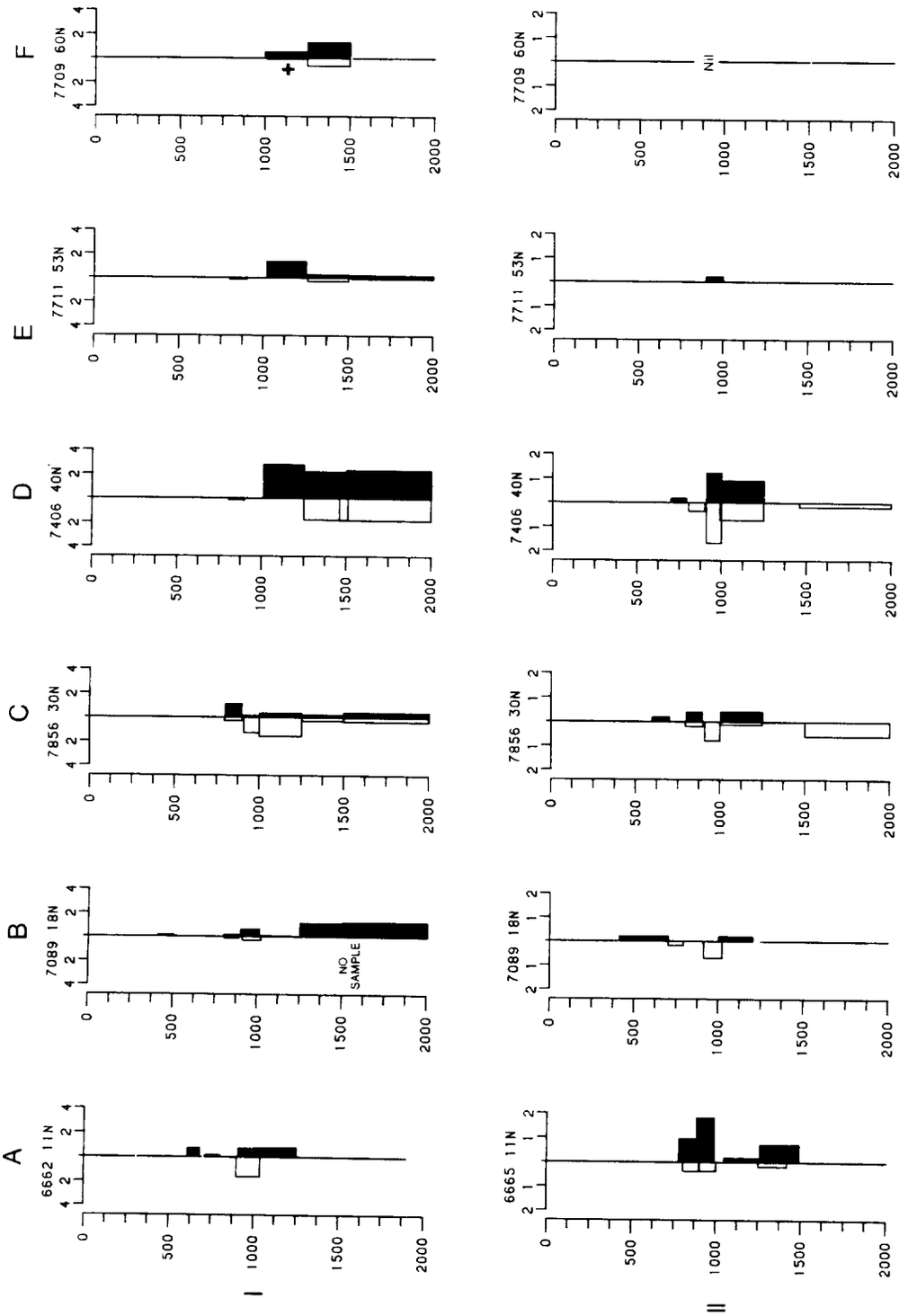

Fig. 31 Geographic and vertical distribution of Bentheuphausia amblyops close to the 20°W meridian. I. Adults and subadults (RMT 8), numbers per $10^4 m^3$, II. Adolescents (RMT 1), numbers per $10^3 m^3$ water filtered.

Bentheuphausia amblyops (Fig. 31)

This bathypelagic species occurred at all six positions between 11°N and 60°N.

Adults and subadults (RMT 8)

Relatively few specimens were taken. By day most were between 800m and 2000m with maximum numbers at 900-1000m (11°N), 900-1000m at (18°N), 900-1250m (30°N), 1250-2000m (40°N) and 1250-1500m (53°N, 60°N). By night although specimens occurred between 410m and 2500m maximum numbers were caught at 1000-1250m (11°N), 1000-1500m (60°N), 1250-2000m (18°N, 53°N) and 1000-2000m (40°N). The data are inadequate to confirm the existence of diel migration in this species, however, Roger (1978) recorded more convincing evidence for diel migration.

Adolescents and larvae (RMT 1)

Specimens occurred between 800m and 2020m. By day maximum numbers occurred at 800-1000m (11°N), 900-1000m (18°N), 900-1000m and 1500-2000m (30°N) and 910-1250 (40°N); none were recorded at 60°N. By night, there was slight evidence that diel migration was undertaken by part of the population but data were sparse. These data are, however, in agreement with those of Brinton (1962). Larvae were not identified.

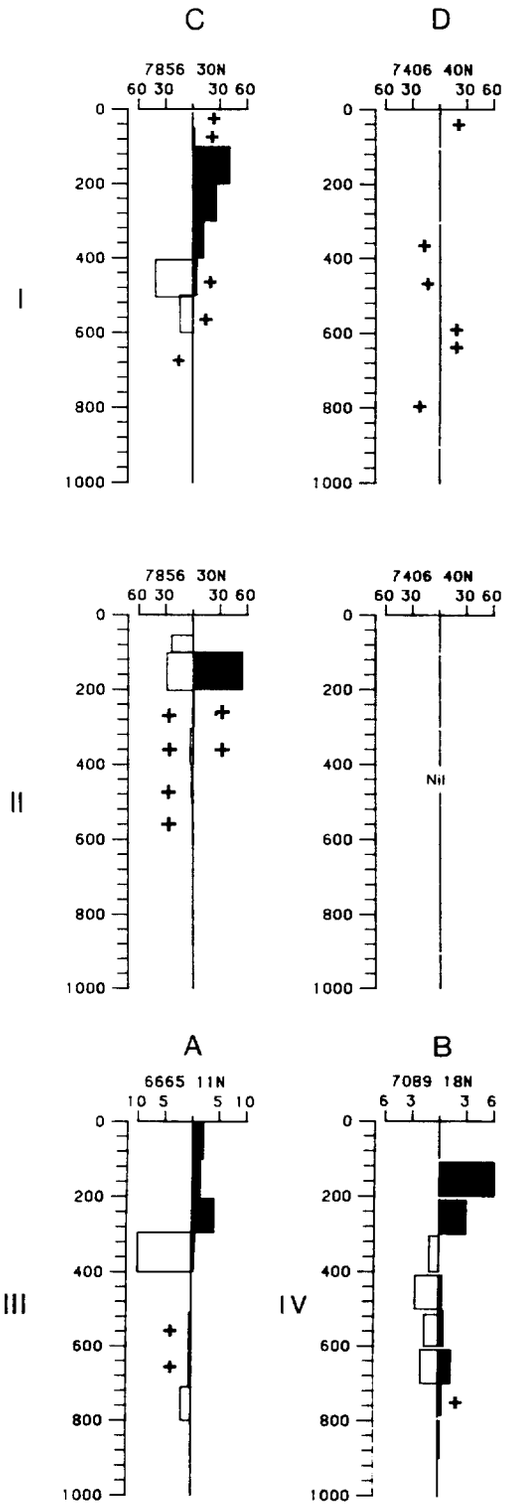

Fig. 32 Geographic and vertical distribution of Nematoscelis microps close to the 20°W meridian. I. Adults and subadults form 0,0 (RMT 1), II. Adolescents form 0,0 (RMT 1), III. Adults and subadults form 1,2 (RMT 1), IV. Adults and subadults form 1,2 and 0,0 (RMT 1), numbers per $10^3 m^3$ water filtered.

Nematoscelis microps (Fig. 32)

This species occurred at all positions except at 53°N and 60°N but it was most abundant at 30°N. Two forms of the species occurred - 1,2 and 0,0 (James 1973, Gopalkrishnan (1975) based on photophores and 'saddling' of the tergites.

Adults and subadults (RMT 1)

Form 0,0 occurred mainly at 30°N and a few were taken at 40°N. At 30°N by day it occurred between 400-700m with maximum numbers at 410-500m, and by night it occurred in the surface layers most abundantly at 110-200m.

Form 1,2 was the only one occurring at 11°N where most specimens were caught by day between 300-800m with a maximum at 295-400m, and by night in the surface 300m with a maximum at 205-295m. Both forms were caught together at 18N, between 300-700m by day with a slight maximum at 410-500m and between 100 and 900m by night with a maximum at 100-200m. These data suggest that the species is a diel migrant, but that part of the population may not migrate (see Hirota et al., 1983). Diel migration has been recorded in this species by Brinton (1962), Roger (1978) and Lewis (1954).

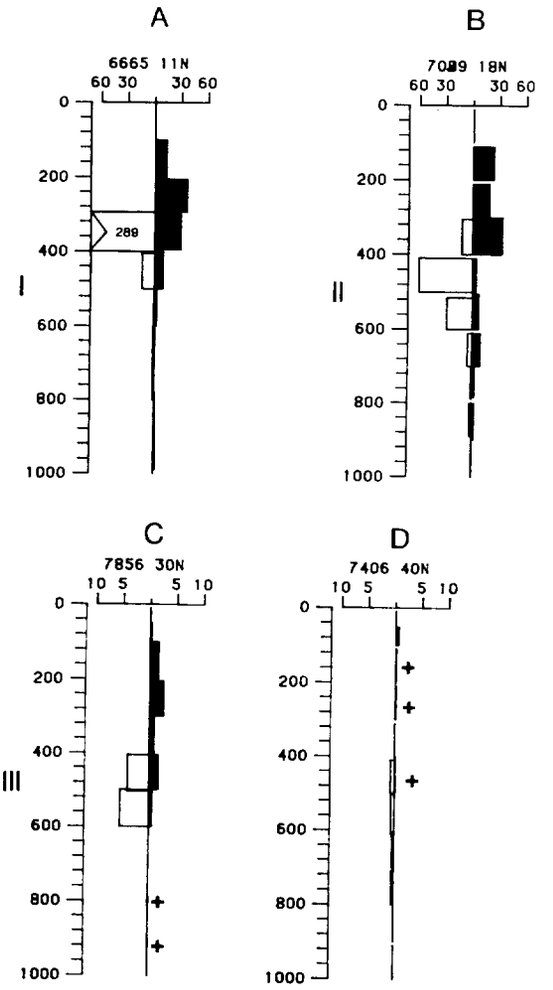

Fig. 33 Geographic and vertical distribution of Nematoscelis atlantica close to the 20°W meridian. I. Form 1,2/2,3 adults and subadults (RMT 1), II. Form 1,2/2,3 and 3,4 adults and subadults (RMT 1), III. Form 3,4, adults and subadults (RMT 1), numbers per $10^3 m^3$ water filtered.

Nematoscelis atlantica (Fig. 33)

This species occurred at 11°N-40°N, but it was most abundant at 11°N and scarce at 40°N. Two forms of the species occurred - 1,2/2,3 and 3,4 (James 1973); Gopalkrishnan 1975), which, as in N. microps are based on photophores and 'saddling' of the tergites.

Adults and subadults (RMT 1)

At 11°N only forms 1,2/2,3 occurred mainly by day between 295-800m with maxima at 295-400m, and by night between the surface and 700m with maxima at 205-295. Thus although there was clear evidence for diel migration part of the population remained as non-migrants at 400-500m, similar partial migration in Nematoscelis was reported by Hirota et al., (1983). Both forms occurred together at 18°N with similar vertical distributions. They were most abundant by day at 400-500m, but at night whereas a part of the population migrated up closer to the seasonal thermocline at 100-400m, a substantial portion did not migrate. Hence the vertical distribution patterns remain similar to those at other stations despite the co-occurrence of the two forms. Form 3,4 was the only one taken at 30°N and 40°N, and most abundantly at 30°N. There, by day it was concentrated at 400-600m, and once again although part of the population migrated up to 100-400m at night a large part appeared not to migrate.

Diel vertical migration had previously been reported in this species by Brinton (1962, 1967), Griffiths (1979) and Roger (1978).

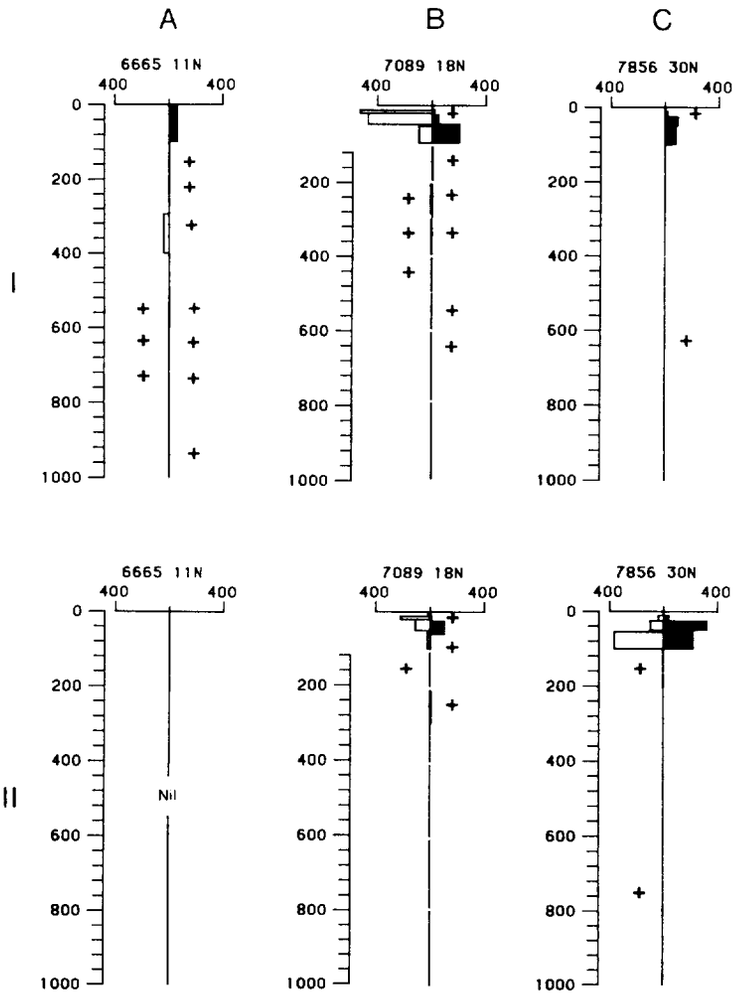

Fig. 34 Geographic and vertical distribution of Nematoscelis microps/ atlantica close to the 20°W meridian. I. Adolescents (RMT 1), II. Larvae (RMT 1) numbers per $10^3 m^3$ water filtered.

Nematoscelis microps/atlantica (Fig. 34)

Because of taxonomic difficulties no attempt was made to separate young specimens of the 'microps/atlantica' group.

Adolescents (RMT 1)

Specimens occurred at 11°N, 18°N and 30°N. By day their distributions ranged between 10m and 800m with maximum numbers at 300-400m (11°N), 12-20m (18°N). By night they occurred between the surface and 1500m with maxima at 0-100m (11°N) 49-100m (18°N) and 25-100m (30°N). There was inconclusive evidence for diel migration.

Larvae (RMT 1)

By day specimens occurred in the surface 800m with maximum numbers at 12-20m (18°N) and 55-100m (30°N). By night specimens occurred in the surface 300m with maximum numbers at 25-60m (18°N) and 25-100m (30°N).

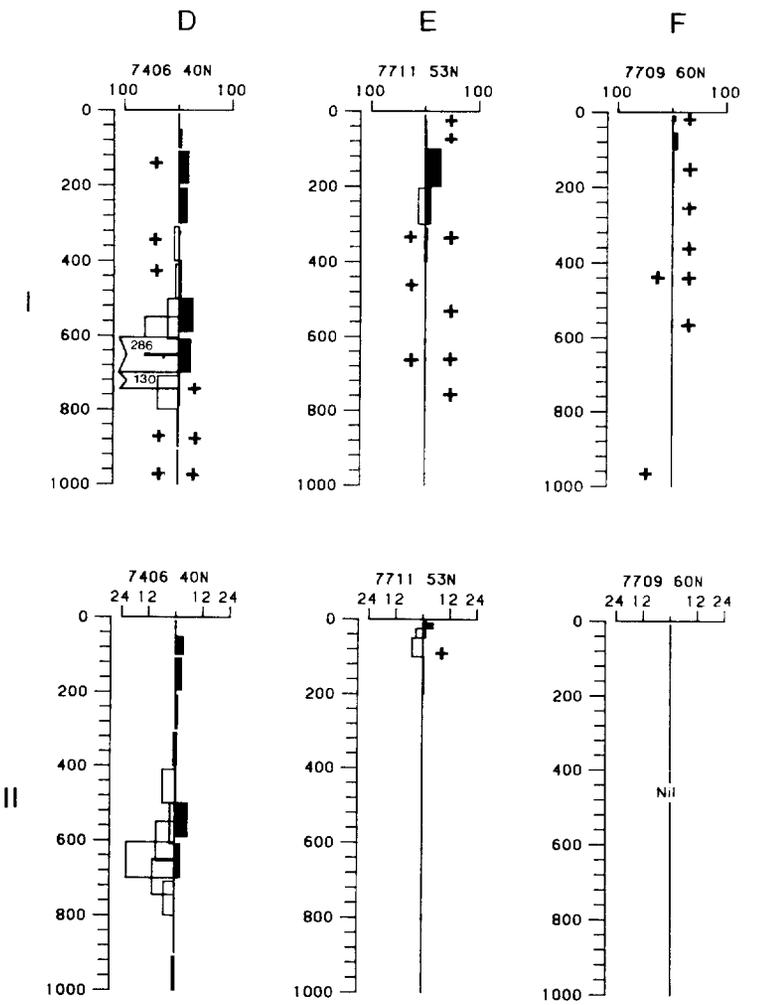

Fig. 35 Geographic and vertical distribution of Nematoscelis megalops close to the 20°W meridian. I. Adults and subadults (RMT 8), numbers per $10^4 m^3$ water filtered, II. Adolescents (RMT 1), numbers per $10^3 m^3$ water filtered.

Nematoscelis megalops (Fig. 35)

This species occurred at 40°N, 53°N and 60°N with greatest abundances at 40°N.

Adults and subadults (RMT 8)

Specimens ranged in depth between 52m and 2000m; maximum daytime abundances were at 600-745m (40°N) and 200-300m (53°N). At 60°N only a single specimen was taken above 500m, whereas at night most were caught at 50-100m. Part of the population carried out diel migration at both 40°N and 53°N confirming the observations of Waterman et al., (1939) and Roe et al., (1984). This species avoids nets (Wiebe and Boyd, 1978, Wiebe et al., 1982), so it is difficult to draw firm conclusions about the extent of diel migration.

Adolescents (RMT 1)

Generally the vertical distribution at 40°N was similar to that of the adults with maximum numbers at 600-700m by day and with some evidence of partial diel migration at night. At 53°N a few specimens occurred by day and night at about 10-100m but none occurred at 60°N.

Larvae (RMT 1)

Specimens occurred mainly at 53°N at 10-100m by day with a maximum at 50-100m, whereas by night most occurred at 10-300m with a maximum at 25-50m.

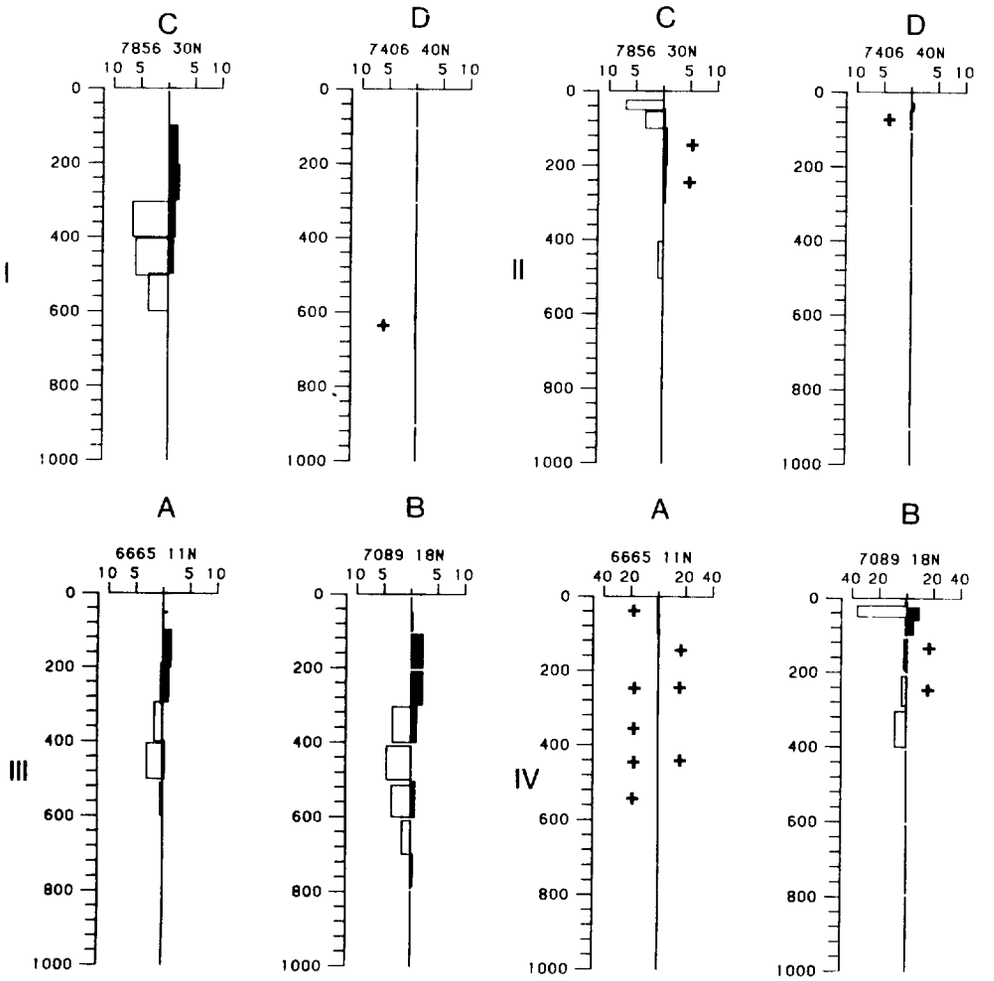

Fig. 36 Geographic and vertical distribution of Nematoscelis tenella close to the 20°W meridian. I. Form 1,2 2,3 adults and subadults (RMT 1). II. Adolescents (RMT 1). III. Form 3,4 adults and subadults (RMT 1). IV. Adolescents (RMT 1), numbers per $10^3 m^3$ water filtered.

Nematoscelis tenella (Fig. 36)

This species occurred at all positions except at 53°N and 60°N but it was most abundant at 18°N and 30°N. Two forms 1,2/2,3 and 3,4 (James 1973; Gopalkrishnan 1975) were distinguished depending on the disposition of photophores and 'saddling' on the tergites.

Adults and subadults (RMT 1)

Form 1,2/2,3 was the predominant form in the northern stations. The single specimen taken at 40°N and all those taken at 30°N were this form. At 30°N its daytime range was 305-600m with maximum abundances occurring at the top of the range at 305-400m. At night the range spread upwards and, although there was no well defined maximum, most specimens were taken at 100-300m.

At 11°N and 18°N Form 3,4 predominated. Its daytime vertical range at both positions was 190-700m with a maximum at 400-500m. There was again some diel vertical migration which involved an upward spread rather than a movement of the population as a whole. Diel migration has previously been reported in this species by Baker (1970), Brinton (1962), Lewis (1954) and Roger (1978).

Adolescents (RMT 1)

At 30°N specimens of form 1,2/2,3 occurred mainly at 25-100m by day with a maximum at 25-50m. Very few specimens were taken in night hauls, possibly because they migrated right up close to the surface. Specimens of form 3,4 were relatively abundant at 18°N. Most occurred by day at 12-400m with a maximum at 20-50m. By night there were very few specimens but there was a slight maximum at 25-60m.

No larvae were identified.

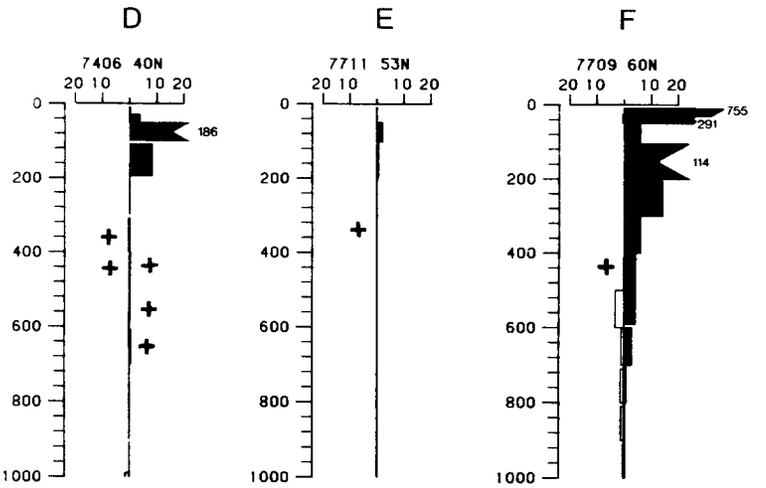

Fig. 37 Geographic and vertical distribution Meganyctiphanes norvegica close to the 20°W meridian. . Adults and subadults (RMT 8), numbers per $10^4 m^3$ water filtered.

Meganyctyphanes norvegica (Fig. 37)

This species occurred at 40°N, 53°N and 60°N but was most abundant at 60°N. Its low abundance at 53°N is puzzling, but is probably the chance combination of active daytime avoidance and a highly patchy distribution in oceanic waters (c.f. data at 44°N, 13°W reported by Roe et al., 1984).

Adults and subadults (RMT 8)

The depth range extended from 10-2000m. Since it swarms and also avoids nets by day, the depth distribution of this species is difficult to assess precisely. By day maximum numbers occurred at 500-600m (60°N). By night maxima occurred at 50-100m (40°N) and at 10-25m (60°N), thus there was evidence of diel vertical migration. Generally the data are in reasonable agreement with those of Berkes (1976), Kulka et al., (1982) and Roe et al. (1984).

Adolescents (RMT 8)

Most were taken in night hauls at 40°N, Where maximum numbers occurred at 50-100m.

SUMMARY

This report provides a general overview of the vertical and horizontal distributions of euphausiids in the north-east Atlantic ocean. More detailed investigations based on these data are in progress and this report serves as a basic data set for subsequent analyses.

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APPENDIX 1 Size distribution of euphausiids. Measurements taken from the tip of the rostrum to the tip of the telson. $\bar{X}$ = mean length, n = number measured. Sizes in mm.

	Adult ♂	$\bar{x}$	n	Adult ♀	$\bar{x}$	n	Subadult ♂	$\bar{x}$	n	Subadult ♀	$\bar{x}$	n
E. krohnii	13.5-19.5	16.4	120	12.5- 22.0	17.3	117	8.5-17.5	13.2	33	10.5-19.5	15.8	62
E. gibboides	14.5-25.0	17.7	57	13.5- 25.0	17.9	45	12.0-21.5	15.0	60	12.0-17.0	15.1	39
E. hanseni	18.6	18.6	2	18.6- 19.8	18.8	3	11.5-18.5	13.6	101	13.5-15.5	14.8	4
E. americana	7.5-14.0	11.0	30	9.0- 14.5	10.6	31	6.5- 9.0	7.5	31	9.0-11.0	9.3	32
E. brevis	7.0-10.5	8.5	11	6.5- 12.5	8.9	132	6.0-11.0	7.6	45	-	-	-
E. hemigibba	11.0-16.5	13.3	89	11.0- 19.0	12.5	114	7.0-11.5	9.6	46	10.0-12.5	10.5	18
E. pseudogibba	13.0-15.5	13.4	46	12.0- 16.0	14.3	31	4.5-12.5	9.3	14	7.5	7.5	1
E. tenera	7.0- 9.5	7.0	31	7.0- 9.5	8.5	28	5.0- 9.0	5.6	46	6.0- 9.0	7.4	6
E. mutica	7.0-10.5	9.4	7	8.0- 12.5	10.3	5	6.5- 7.0	6.7	3	-	-	-
N. sexspinosus	19.0-33.0	26.8	21	21.3- 22.0	28.2	21	15.0-20.0	17.8	14	19.0-20.0	19.7	2
N. boopis	14.5-26.0	19.8	294	14.0- 30.0	21.0	284	11.0-23.0	15.7	141	10.0-18.0	14.9	77
N. flexipes	16.0-26.0	18.7	164	18.0- 26.0	21.1	44	12.0-19.0	14.2	19	14.5-16.5	15.5	4
T. acutifrons	32.0-39.0	35.5	8	28.0- 45.0	41.7	9	23.0-38.0	27.9	247	24.0-23.0	29.1	91
T. tricuspidata	19.0-23.0	20.5	14	18.0- 25.0	19.9	30	14.0-18.0	16.8	29	16.0-19.0	17.6	7
T. obtusifrons	13.5-20.0	17.3	51	14.5- 23.0	19.7	41	11.0-16.0	13.4	38	12.0-16.0	14.1	20
T. aequalis	11.5-18.5	15.7	112	13.5- 23.0	17.4	127	9.0-13.0	11.9	31	11.5-15.0	13.4	15
T. orientalis	25.0-32.0	28.1	27	24.0- 37.0	27.7	27	18.0-29.0	22.3	7	25.0-28.0	26.5	2
T. microphthalma	20.0-23.0	27.1	65	23.0- 41.0	33.6	81	16.0-25.0	20.6	75	20.0-27.0	22.3	38
T. egregia	36.0-46.0	41.3	3	53.0- 59.0	56.2	5	-	-	-	-	-	-
T. pectinata	29.0-42.0	35.9	15	23.0- 46.0	34.3	46	26.0	26.0	1	30.0	30.0	1
T. cornuta	-	-	-	73.0-123.0	90.2	12	-	-	-	46.0-48.0	62.1	7
T. cristata	30.0-48.0	44.0	3	57.0	57.0	1	31.0	31.0	1	-	-	-
S. robustum	14.0-20.0	16.0	23	14.0- 23.0	18.7	37	15.0-19.0	17.0	2	12.0-20.0	15.1	4
S. carinatum	6.5- 7.5	7.3	20	7.5- 11.5	10.3	35	6.0- 8.5	7.0	29	6.5-10.5	8.2	36
S. affine	6.5- 8.5	7.5	14	6.0- 10.0	8.4	73	5.5- 8.0	6.8	39	6.5- 9.5	7.7	8
S. elongatum	9.0-12.0	10.2	64	10.0- 16.0	10.4	92	6.5-11.5	10.1	59	9.0-12.5	10.6	8
S. suhmii	6.0- 7.0	6.2	31	6.5- 7.5	4.6	37	5.5- 7.0	6.4	17	5.5- 6.0	5.8	2
S. abbreviatum	12.0-16.0	13.8	69	15.5- 22.0	17.2	84	9.0-16.0	12.5	46	11.0-17.0	13.2	13
S. longicorne short	6.0- 8.5	7.2	114	6.5- 10.0	8.3	257	6.0- 7.5	6.7	50	6.5- 7.5	6.7	10
S. longicorne long	10.0-10.0	10.0	1	9.0- 15.0	12.3	54	-	-	-	8.5-10.5	10.3	2
S. maximum	18.0-27.0	22.2	77	18.0- 34.0	25.9	168	16.0-25.0	21.1	116	17.0-25.0	21.9	31
T. longicaudata	-	-	-	-	-	-	9.0-11.0	10.4	5	10.0-10.5	10.3	2
T. gregaria	7.0-11.0	9.7	25	7.0- 11.5	10.2	26	5.5- 9.5	7.1	22	6.5- 7.5	7.2	22
T. parva	-	-	-	-	-	-	-	-	-	-	-	-
B. amblyops	16.0-29.0	19.3	76	16.5- 28.0	21.9	92	15.0-24.0	18.1	53	15.0-27.0	17.9	28
N. microps	12.5-18.0	13.9	113	13.0- 25.0	17.1	172	8.5-18.0	13.0	66	10.5-20.0	14.4	80
N. atlantica	10.5-13.0	11.9	80	11.0- 20.0	14.6	144	8.5-12.0	11.0	11	4.5-12.0	8.3	56
N. megalops	18.0-24.0	21.9	48	19.0- 29.0	22.9	111	18.0-22.0	20.9	100	18.0-25.0	19.7	113
N. tenella	11.5-14.5	12.8	67	13.0- 18.0	16.6	104	10.0-12.0	11.2	10	12.5-15.0	14.5	9
M. norvegica	22.0-38.0	30.3	73	21.0- 41.0	32.6	166	26.0-35.0	24.2	57	21.0-35.0	28.9	28

APPENDIX 2 Size distribution of euphausiids. Measurements taken from the tip of the rostrum to the tip of the telson.
$\bar{x}$ = mean length, n = number measured. Sizes in mm.

	Adolescents	$\bar{x}$	n	Larvae	$\bar{x}$	n
E. krohnii	4.0-17.5	7.8	118	1.5- 6.5	3.3	590
E. gibboides	4.5-16.0	9.6	87	2.5- 2.8	2.7	3
E. hanseni	11.0-16.0	12.9	156	-	-	-
E. americana	5.0- 8.0	8.8	64	-	-	-
E. brevis	4.5- 7.0	5.9	51	2.5- 5.0	3.8	118
E. hemigibba	4.5-11.5	7.5	49	1.0- 5.5	3.4	118
E. pseudogibba	6.0- 9.5	7.9	4	-	-	-
E. tenera	4.0- 8.5	5.8	34	2.5- 5.0	3.7	30
E. mutica	4.5- 7.5	6.0	23	-	-	-
N. sexspinosus	13.0-18.0	14.4	10	-	-	-
N. boopis	5.0-18.0	11.3	176	-	-	-
N. flexipes	6.0-16.0	10.7	81	4.0- 7.5	5.4	5
T. acutifrons	-	-	-	-	-	-
T. tricuspidata	7.0-19.0	12.3	62	6.5-11.5	8.9	58
T. monocantha	5.5-19.0	10.6	53	3.5- 5.5	4.6	39
T. obtusifrons	4.0-15.5	10.3	61	-	-	-
T. aequalis	4.0-13.5	13.4	15	-	-	-
T. aequalis/ obtusifrons	-	-	-	2.0- 5.5	3.9	15
T. microphthalma	9.0-25.0	17.0	138	4.5- 6.0	5.1	46
T. egregia	10.0-26.0	14.0	35	5.0-12.5	9.5	93
T. pectinata	-	-	-	-	-	-
T. cornuta	10.0-62.0	20.5	27	4.0-14.0	11.0	21
T. cristata	-	-	-	-	-	-
S. robustum	-	-	-	-	-	-
S. carinatum	4.0- 9.5	6.8	54	2.5- 4.0	3.0	47
S. affine	3.0- 7.0	4.3	73	-	-	-
S. elongatum	6.0-12.0	8.3	62	4.0- 4.5	4.1	12
S. suhmii	3.0- 6.0	4.1	58	2.5- 3.5	2.8	12
S. abbreviatum	4.0-14.0	9.4	64	-	-	-
S. longicorne short/long	2.5- 7.5	4.8	141	1.5- 4.5	2.5	535
S. maximum	5.5-21.0	15.0	53	-	-	-
T. longicaudata	4.0- 6.0	4.8	14	2.0- 4.5	3.1	106
T. gregaria	5.5- 8.5	6.3	9	-	-	-
T. parva	-	-	-	-	-	-
B. amblyops	7.0-28.0	14.7	174	-	-	-
N. microps	4.0-13.0	8.5	58	-	-	-
N. atlantica	4.5-11.5	7.7	59	-	-	-
N. microps/ N. atlantica	-	-	-	2.0-4.0	2.9	60
N. megalops	13.5-22.0	19.6	112	2.0-6.5	2.9	123
N. tenella	4.5-11.0	8.3	57	-	-	-
M. norvegica	-	-	-	-	-	-

Table 1. Sampling positions, nets used and sampling strategy for the 20°W series of stations.

Letters in brackets refer to station positions shown in the Figures.

Station	Position	Month/year	Net	Maximum depth sampled (m)	Depth interval (m) (approximate)
6662	11°N 20°W (A)	Feb 1968	RMT 8	1700 d 1900 n	100 between 0 & 1000 250 " 1000 " 1700 450 " 1500 " 1900
6665	11°N 20°W (A)	" "	N113	2000 d 2120 n	100 " 0 " 1000 250 " 1000 " 1500 500 " 1500 " 2120 (plus several day & night hauls at 25, 50, 75, 100m.
7089	18°N 25°W (B)	Nov 1969	RMT 1+8	1200 d 2000 n	
7856	30°N 23°W (C)	April 1972	RMT 1+8	3000 d 2020 n	* 10 between 0 & 10m 15 " 10 " 25 25 " 25 " 50 50 " 50 " 100 100 " 100 " 1000 250 " 1000 " 1500 500 " 1500 " 2500
7406	40°N 20°W (D)	Oct 1970	RMT 1+8	2000 d 2500 n	
7711	53°N 20°W (E)	May/June 1971	RMT 1+8	2000 d 2000 n	
7709	60°N 20°W (F)	April/May 1971	RMT 1+8	2000 d 2000 n	

RMT = Rectangular Midwater Trawl. d = day, n = night. *Except RMT 8 at 18°N-60°N.

TABLE 2 Nets used to determine distribution of species

	RMT 8	RMT 1
Euphausia krohnii		
Adults/subadults	*	
Adolescents		*
Larvae		*
Euphausia gibboides		
Adults/subadults	*	
Adolescents		*
Larvae		*
Euphausia hanseni		
Adults/subadults	*	
adolescents		*
Euphausia americana		
Adults/adults		*
Adolescents		*
Euphausia brevis		
Adults/subadults		*
Adolescents		*
Larvae		*
Euphausia hemigibba		
Adults/subadults		*
Adolescents		*
Larvae		*
Euphausia pseudogibba		
Adults/subadults		*
Adolescents		*

Table 2 (contd)	RMT 8	RMT 1
Euphausia tenera		
Adults/subadults		*
Adolescents		*
Larvae		*
Euphausia mutica		
Adults/subadults		*
Adolescents		*
Nematobrachion sexspinosus		
Adults/subadults	*	
Adolescents	*	
Nematobrachion boopis		
Adults/subadults	*	
Adolescents		*
Larvae		*
Nematobrachion flexipes		
Adults/subadults	*	
Adolescents		*
Thysanopoda acutifrons		
Adults/subadults	*	
Adolescents	*	
Thysanopoda tricuspidata		
Adults/subadults	*	
Adolescents		*
Larvae		*
Thysanopoda monocantha		
Adults/subadults	*	
Adolescents		*
Larvae		*

Table 2 (contd)	RMT 8	RMT 1
Thysanopoda obtusifrons		
Adults/subadults		*
Adolescents		*
Thysanopoda aequalis		
Adults/subadults		*
Adolescents		*
Larvae		*
Thysanopoda orientalis		
Adults/subadults	*	
Thysanopoda microphthalma		
Adults/subadults	*	
Adolescents	*	
Thysanopoda egregia		
Adults/subadults	*	
Adolescents	*	*
Larvae		*
Thysanopoda pectinata		
Adults and subadults	*	
Adolescents	*	*
Larvae	*	*
Thysanopoda cornuta		
Adults/subadults	*	
Adolescents	*	
Larvae	*	*
Thysanopoda cristata		
Adults/subadults	*	
Adolescents	*	

Table 2 (contd)	RMT 8	RMT 1
Stylocheiron robustum	*	
Adolescents	*	
Stylocheiron carinatum		
Adults/subadults		*
Adolescents		*
Larvae		*
Stylocheiron affine		
Adults/subadults		*
Adolescents		*
Stylocheiron elongatum		
Adults/subadults		*
Adolescents		*
Larvae		*
Stylocheiron suhmii		
Adults/subadults		*
Adolescents		*
Larvae		*
Stylocheiron abbreviatum		
Adults/subadults		*
Adolescents		*
Larvae		*
Stylocheiron longicorne		
Adults/subadults		*
Adolescents		*
Larvae		*

Table 2 (contd)	RMT 8	RMT 1
Stylocheiron maximum		
Adults/subadults	*	
Adolescents		*
Larvae		*
Thysanoessa longicaudata		
Adults/subadults		*
Adolescents		*
Thysanoessa gregaria		
Adults/subadults		*
Adolescents		*
Larvae		*
Thysanoessa parva		
Adults/subadults		*
Bentheuphausia amblyops		
Adults/subadults	*	
Adolescents		*
Larvae		*
Nematoscelis microps		
Adults/subadults		*
Nematoscelis atlantica		
Adults/subadults		*

Table 2 (contd)	RMT 8	RMT 1
Nematoscelis microps/atlantica		
Adolescents		*
Larvae		*
Nematoscelis megalops		
Adults/subadults	*	
Adolescents		*
Larvae		*
Nematoscelis tenella		
Adults/subadults		*
Adolescents		*
Meganyctiphanes norvegica		
Adults/subadults	*	
Adolescents	*	