CHAPTER 5

**Distribution and trophic implications between MNC and zooplankton
in the subarctic Pacific: Predation and food web connections**

INTRODUCTION

Food webs describe the trophic relations, usually from "bottom to top" – that is from primary producers up through successional trophic level to top carnivores. However, one problem with many food web descriptions is that while some levels are very well understood, others are only vaguely known. This creates a problem when trying to describe the networks connecting the various members of a food web, since only the connections between very well studied members are sufficiently quantified. This is mainly due to the extremely complex relationships within food webs, combined with the fact that very few ecologies are sufficiently well studied. Therefore, although they are a major difficulty, the "gaps" within present food web studies can help identify those links that need attention, and further study. The food web of the subarctic North Pacific (SAP) is such an example, where intensive study of endemic zooplankton and nekton species over the years has immeasurably helped in defining the links between these groups. While the importance of minor constituent groups as predators or prey may not be as important in the overall food web, due to ontological shifts in diet expressed by many predator species, these "minor" constituent groups may have greater impact during relatively short periods in the life span and development of predator species. Quantitative data regarding predation rates and quantity of food consumed helps clarify the connections between and among a community, but for many species, these data are not usually available. Because of this, some studies rely on presence of prey species or taxa rather than quantitative data. Conventionally, primary producers are assigned trophic level 1 (TL1), and successional predatory species are assigned progressively higher and higher trophic levels. Most studies have examined the interactions between the prey of the animal of investigation (usually fishes), and its predators. Midwater fishes, myctophids in particular, have been intensively investigated in the subarctic Pacific and other areas, but mainly in relation to macrozooplankton, i.e. copepods. Moku *et al,* (2002) examined predation on zooplankton by micronekton, focusing on myctophids, and showed a schematic of the general food web. Brodeur *et al,* (1999), using data from commercial gillnet fishery catches, presented a detailed subarctic Pacific food web, but only identified linkages for euphausiids and sergestid shrimp. There are few studies examining the trophic roles of MNC (Hopkins, 1994; Cartes, 2001), and virtually none for the subarctic Pacific. Evaluating the feeding of micronektonic crustaceans (MNC) presents unique difficulties, since the maceration of prey during feeding and digestion limits the use of quantitative studies. Therefore, studies of dietary impact through analysis of gut contents are inherently flawed: "hard" substances (bones, teeth, shells, carapaces, etc.) are heavily over represented while "soft" substances (muscle, body fluids, gelatinous tissues, etc.) are severely

under represented.   Bearing these arguments in mind, feeding studies of MNC have struggled to compensate for these biases.

There have been many studies examining food web interactions of midwater animals in the subarctic Pacific, but the contributions of mysids and shrimps other than sergestiids have not been closely examined.   The previous chapters have identified the horizontal and vertical assemblages of the MNC, and examined gut contents of numerically dominant shrimps and mysids.   A detailed estimate of daily ration based on the relative abundance of different food gut items within the guts of dominant shrimps and mysids in relation to their vertical distribution was presented in Chapter 4.

This chapter combines the results of the previous chapters.   Comparisons of MNC and zooplankton depth distributions in the SAP and BS are made to explore connections between feeding patterns and the distribution of possible prey.   The food web implications of feeding strategies of MNC in relation to ecological life-strategies, i.e. within and between the epi- and mesopelagic zones, are also discussed.

METHODS

Sampling

Zooplankton biomass and constituent taxa and/or classes were collected concurrently with micronekton via the RMT 1+8 nets.   Samples were collected with an RMT 8+1 (see Fig. 1, Chapter 3 for details) at 4 stations during the summer, 1997 cruise of the RV Hakuho-Maru (see Nishikawa *et al*, 2001).   These data included samples from 0 - 1000 m, in 12 discrete sampled layers at each station (see Chapter 3, Table 3-1).

Statistics

Distributions of zooplankton were analyzed via single-factor ANOVA to examine differences in day and night abundance and biomass values among regions.   Differences between day and night in each region were also examined via Kruskal-Wallis test.   Hierarchical clustering and multivariate analysis of distribution by depth of zooplankton and MNC abundances were obtained according to the same methodology outlined in Chapter 4.   Data from the previous chapters regarding the vertical and horizontal abundance and biomass patterns are revisited to enable comparisons between the zooplankton and micronektonic crustaceans in this chapter.

RESULTS

Zooplankton taxa - abundance and biomass

Abundance in the 0 - 1000 m depth column, day and night are shown in Table 5-1 (top).
Abundance distribution in the SAP & BS differed from that of biomass in that it was highest in the
BS, but the lowest abundance was recorded in the WSA, similar to biomass. There was no
significant difference in either mean abundance or biomass among regions, day or night (Kruskal-
Wallis; P=0.0429). The three taxa consistently dominant in terms of abundance throughout the
study area were copepods, chaetognaths and ostracods, both day and night. Cnidarians were
important contributors to abundance in all regions but the WSA.

Biomass in the 0 - 1000 m depth column, day and night are shown in Table 5-1 (bottom).
Biomass distribution in the SAP & BS was highest in the CSA and ESA, both day and night, and
lowest in the WSA. These regions were characterized by high biomasses of cnidarians (CSA) and
thaliaceans (ESA), which accounted for approximately one-third of the CSA biomass and one-half
of the ESA biomass, respectively. Copepods, cnidarians and chaetognaths were the three main
contributors to biomass (day and night) in all regions but the ESA. Copepods comprised the
major portion of biomass at all stations except in the ESA. In the ESA, thaliaceans were
dominant in terms of biomass, especially at night.

Vertical distribution patterns of zooplankton abundance and biomass are shown (Fig. 5-1).
Abundance peaks were centered around 200 m during the day. At nighttime in the WSA and
CSA there were bimodal peaks: one in the 0 – 100 m depth layers and another at 200 – 300 m.
Upward shifts in abundance were clear in the WSA and ESA, but less clear in the BS and missing
from the CSA. Biomass shifts into shallower waters at night were clearer than those found in
abundance. Daytime biomass peaks in the WSA and CSA were below 150 m and in the 90 – 120
m layer in the ESA and 20 – 80 m layer in the BS. Except for the CSA, nighttime biomass peaks
were higher in the water column compared to the daytime. These peaks were in the 0 – 20 m
depth layer, except for the aforementioned CSA.

Abundance and biomass by major taxa groups

In terms of abundance, 4 groups comprised over 90% of the relative abundance, while 3 groups
comprised over 80% of relative biomass. These groups were relatively consistent across regions
for both abundance and biomass, and consisted of the following groups: cnidarians, copepods and
chaetognaths. There was a difference in major groups per regions when abundance and biomass

Table 5-1.   Zooplankton abundance (top, Ind/m²) and biomass (bottom, g/m²), collected via RMT 1, KH 97-2.   Data is summed over the 0 – 1000 m water column.

	WSA		CSA		ESA		BS		Total	
	Day	Night	Day	Night	Day	Night	Day	Night	Day-total	Night-total
Cnidaria	6.31	8.67	1029.15	935.75	430.95	840.28	1392.08	1110.29	2858.49	2894.99
Ctenophora	0.51	0.32		3.21					0.51	3.53
Nemertina	4.66	3.55	44.28	81.26	27.97	35.58	38.02	13.31	114.94	133.70
Polychaeta	66.52	55.75	526.65	563.86	126.67	111.98	702.32	501.55	1422.16	1233.13
Copepoda	840.75	814.97	24717.85	31834.09	10117.44	12029.04	78731.41	45872.11	114407.46	90550.22
Chaetognatha	322.59	313.54	4510.06	9254.30	3758.59	2758.98	6561.48	6287.93	15152.72	18614.75
Pteropoda	6.40	5.81	194.43	384.95	157.80	254.10	262.73	155.54	621.36	800.39
Nudibrachia	0.08	0.04							0.08	0.04
Cephalapoda	0.08	0.27	3.81	1.41	2.31	1.50	2.41	4.37	8.62	7.55
Ostracoda	165.55	256.43	2192.32	2870.54	1487.67	1951.28	2865.05	4526.62	6710.59	9604.88
Mysidacea	2.93	8.14	55.69	46.53	6.11	25.81	55.14	18.93	119.87	99.40
Euphausiacea	1.30	0.73	53.29	158.82	73.15	484.97	87.63	51.78	215.36	696.30
Decapoda	0.30	0.35	4.30	10.76	2.33	4.91	16.75	5.50	23.68	21.52
Euphausiid nauplii			7.39	27.68	20.19	22.57	2.91	4.17	30.50	54.42
Copepod nauplii	0.35		39.61	75.38	70.29	29.63	160.13	314.17	270.38	419.18
Thaliacea	45.55	46.38	155.16	375.29	641.10	1784.04	509.56	652.39	1351.36	2858.11
Appendiculata	7.98	14.18	45.21	203.31	19.69	29.42	164.96	394.90	237.84	641.81
Vertebrata	0.52	0.70	25.92	14.40	2.57	34.05	1.01	1.60	30.02	50.76
Total	1472.38	1529.83	33605.12	46841.54	16944.82	20398.15	91553.59	59915.18	143575.91	128684.70

|	WSA		CSA		ESA		BS		Total	
	Day	Night	Day	Night	Day	Night	Day	Night	Day-total	Night-total
Cnidaria	2.10	1.98	5.93	15.14	3.59	13.29	13.24	12.41	24.86	42.83
Ctenophora	0.003	0.002		0.041					0.003	0.04
Nemertina	0.02	0.02	0.22	0.32	0.06	0.30	0.29	0.04	0.60	0.68
Polychaeta	0.06	0.05	0.41	0.43	0.19	0.19	0.59	0.31	1.25	0.97
Copepoda	2.46	2.64	39.57	47.54	14.80	16.05	32.15	27.05	88.99	93.28
Chaetognatha	1.12	1.06	10.61	12.72	6.12	8.60	9.24	7.80	27.09	30.18
Pteropoda	0.04	0.03	0.13	0.80	0.19	0.258	1.23	0.36	1.59	1.44
Nudibrachia	0.0005	0.001							0.00	0.00
Cephalapoda	0.02	0.03	0.30	0.01	0.02	0.031	0.07	0.25	0.40	0.33
Ostracoda	0.09	0.09	0.71	0.90	0.37	1.16	1.37	1.19	2.55	3.34
Mysidacea	0.12	0.13	0.82	1.30	0.49	1.26	0.79	0.20	2.21	2.89
Euphausiacea	0.08	0.12	0.97	3.01	1.48	5.00	0.83	1.09	3.37	9.22
Decapoda	0.11	0.16	1.41	1.22	0.18	1.11	1.01	0.35	2.70	2.84
Euphausiid nauplii			0.001	0.002	0.001	0.002	0.0002	0.0003	0.002	0.004
Copepod nauplii	0.00004		0.01	0.01	0.01	0.004	0.02	0.04	0.03	0.05
Thaliacea	0.45	0.48	0.66	3.60	19.28	49.52	0.45	1.66	20.84	55.26
Appendiculata	0.002	0.003	0.02	0.21	0.0005	0.0007	0.37	0.01	0.40	0.23
Vertebrata	0.25	0.95	0.66	4.50	0.25	12.55	0.89	0.84	2.05	18.83
Total	6.92	7.74	62.45	91.76	47.04	109.32	62.55	53.60	178.96	262.42
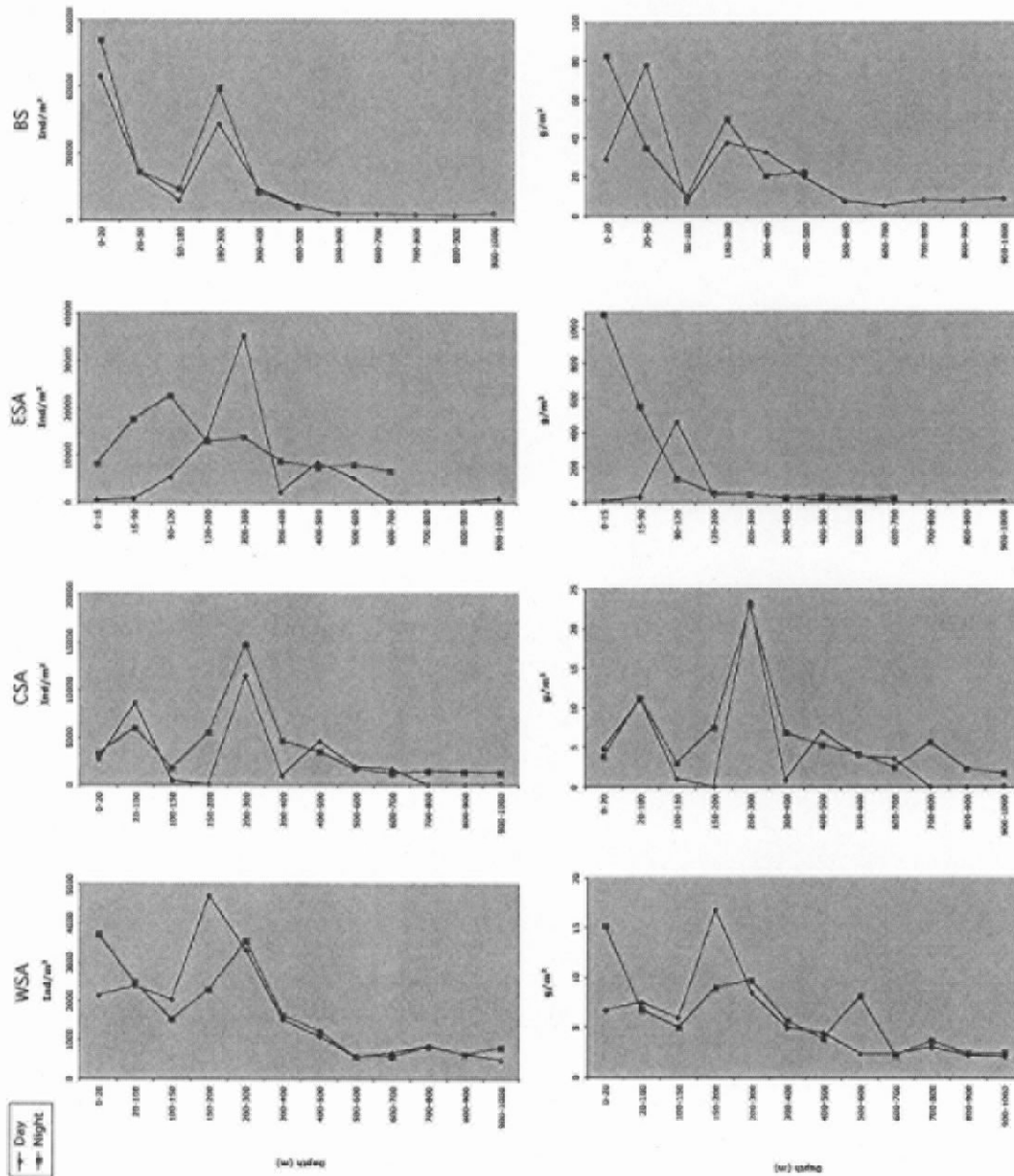
Fig. 5-1. Total zooplankton abundance (top) and biomass (bottom) for all regions of the SAP and BS. Day and night values are shown in legend. N.B. Cnidarian abundance and biomass is not included.
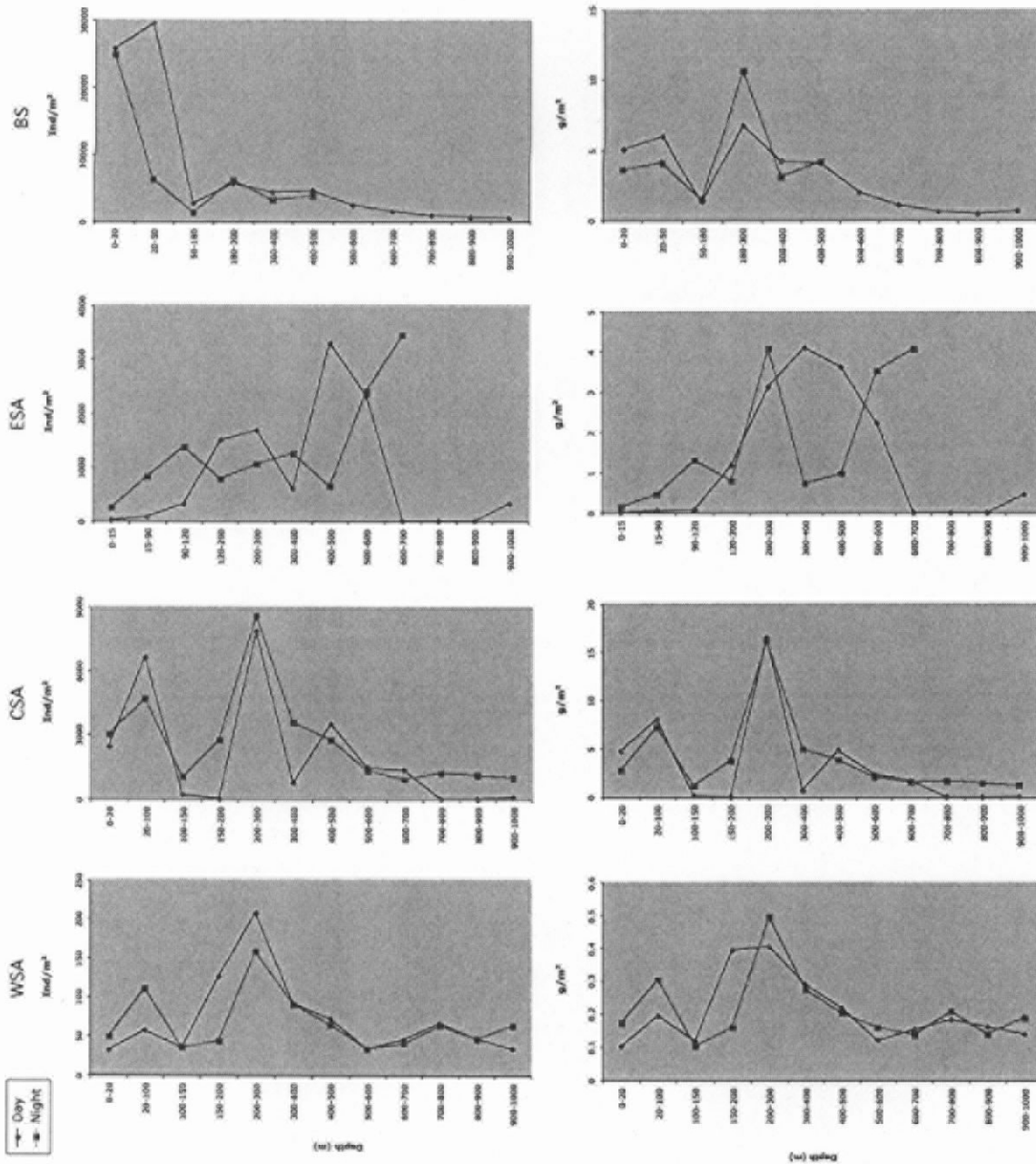
Fig. 5-2. Copepod abundance (top) and biomass (bottom) for all regions of the SAP and BS. Day and night values are shown in legend.
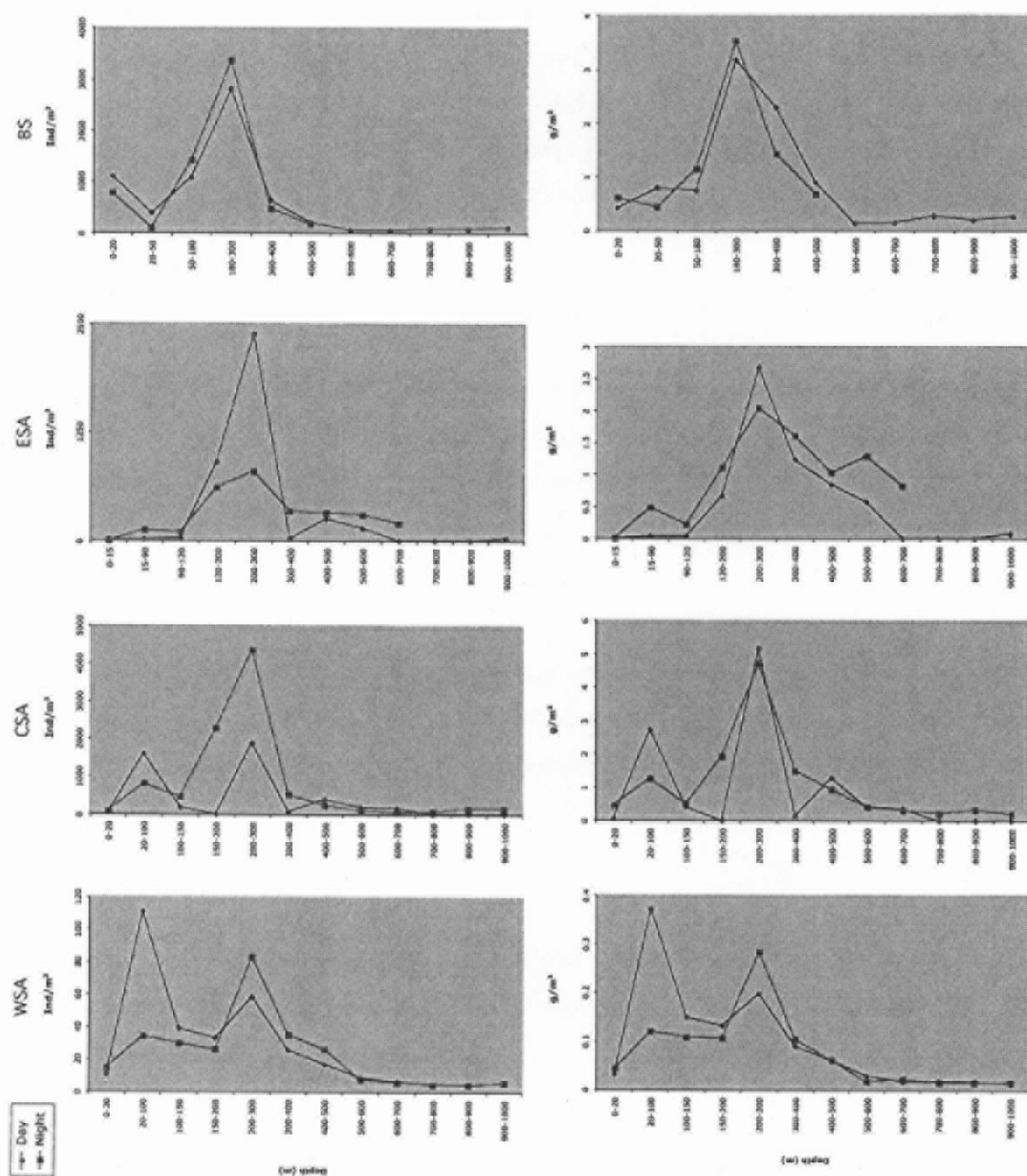
Fig. 5-3. Chaetognath abundance (top) and biomass (bottom) for all regions of the SAP and BS. Day and night values are shown in legend.

were considered: thaliaceans were more numerically important while ostracods were more important component in terms of biomass.

The vertical distribution patterns of copepods in the SAP and BS are shown in Fig. 5-2. Daytime and nighttime biomass peaks coincided in the WSA and CSA. Upward movement at night was clearest in the WSA and ESA. Vertical distribution patterns in the ESA, both day and night, were vertically depressed when compared to other regions in the SAP and BS. Abundance in the BS, both day and night, were concentrated in the 0 – 100 m depth layers. Biomass patterns were similar to those of abundance in the WSA and CSA. There was a depression in the vertical distribution patterns in the ESA. The biomass patterns in the BS were quite different from those of abundance. Both day and night biomass peaks were in the 180 – 300 m depth layer.

Chaetognath abundance peaks in the SAP and BS were slightly bimodal in the WSA and CSA (Fig. 5-3). These occurred in the 20 – 100 m and 200 – 300 m depth layers, both day and night. These peaks showed that abundance was higher in the water column by day and lower by night. Although chaetognaths were slightly more abundant near the surface at night, peak abundance was in the 200 – 300 m depth layer, day and night. The day and night abundance patterns in the BS were similar, peaking in the 180 – 300 m depth layer. Biomass patterns were very similar to those of abundance, particularly in the WSA, CSA and BS. The ESA biomass patterns differed mainly in that there was a considerable portion of biomass below 300 m.

Co-dominant zooplankton included thaliaceans and euphausiids. Ostracods, however, were not always part of the majority of abundance or biomass. In terms of biomass, thaliaceans were important in the WSA and ESA, while euphausiids were important in the CSA and ostracods were important in the BS (Fig. 5-4). In the WSA, thaliaceans were primarily located within the 150 – 200 m depth layer, day and night. However, in the ESA, there was a distinct upward movement of both abundance and biomass at night. Peak nighttime abundance and biomass were both within the 15 – 90 m depth layer. The euphausiids also exhibited very clear upward movement of both abundance and biomass to the nighttime 20 – 100 m depth layer from the daytime 200 – 300 m depth layer. Ostracods exhibited very little vertical migration at night, in terms of either abundance or biomass. Peak values were present in the 180 – 300 depth layer, day or night.
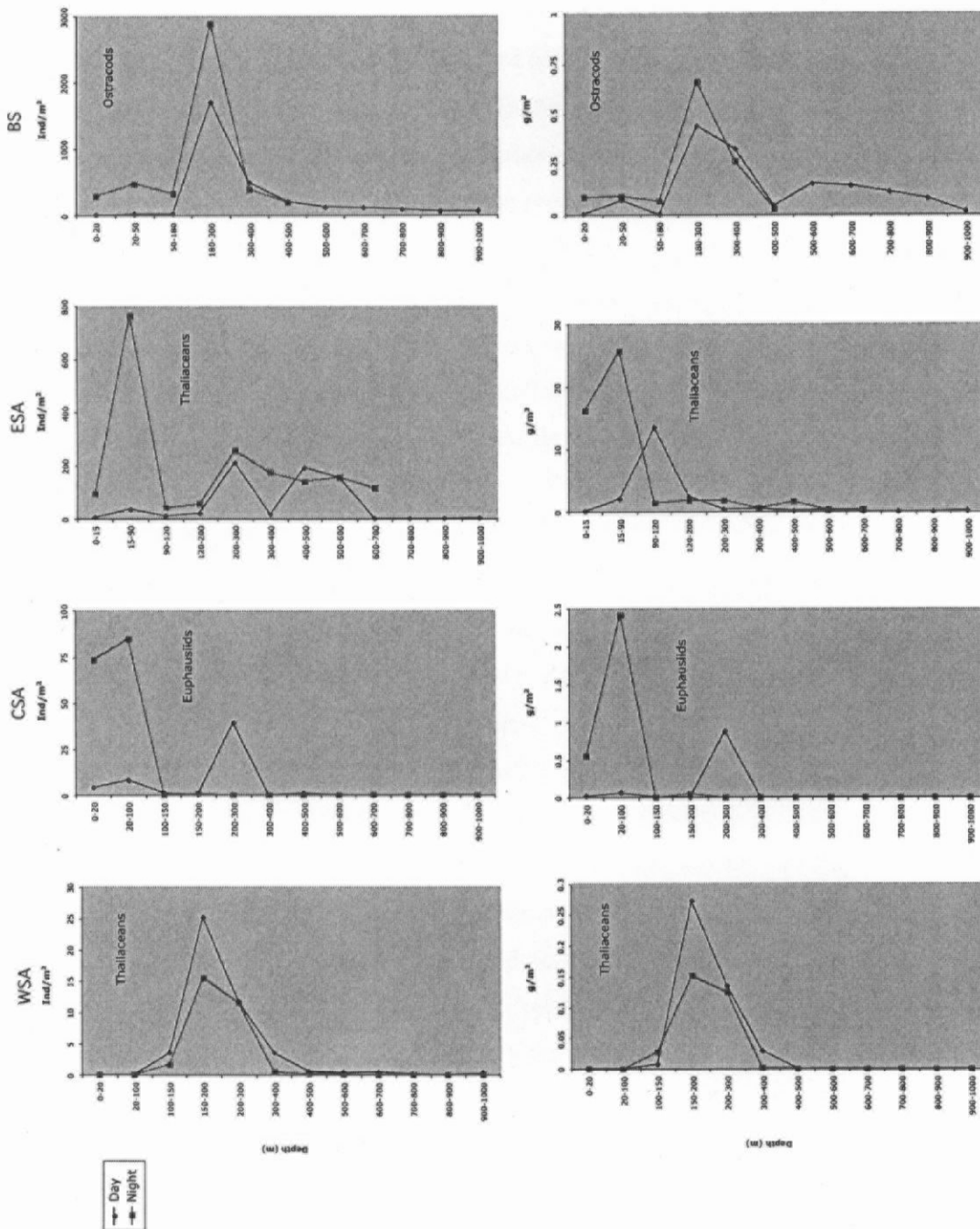
Fig. 5-4. Co-dominant zooplankton abundance (top) and biomass (bottom) for all regions of the SAP and BS. Day and night values are shown in

Micronekton and zooplankton clustering

Clusters resulting from analysis of vertical distribution patterns of MNC species from Chapter 3 and zooplankton taxa identified from MNC guts in Chapter 4 or from previous records in the literature are described for each region, day and night.   All regions showed 2 clusters of associations between the zooplankton taxa and MNC and those compared to depth distribution. The first apparent difference between the epipelagic and mesopelagic communities was in comparing day and nighttime vertical distribution patterns.   Nighttime epipelagic communities were distinctly narrower in vertical depth than mesopelagic communities.   In the daytime, these two communities were more evenly distributed, primarily around 500 m.   Despite separation of the epi- and mesopelagic communities, each region had groups or species that were common to both, but the constituent members differed from region to region.   The most significant distribution/depth layer associations are marked deep red, deep green marks the most significant depth layer associations, white represents least significant associations and black represents 100% association.

There were very similar clustering patterns among the 3 SAP stations, day and night.   If the clustering of daytime communities in the WSA (Fig. 5-5) is examined as representative of the whole, we see that there was a separation of the two daytime communities at around 400 m, although the community within the 100 - 150 m depth layer was clustered not with the epipelagic community, but in the mesopelagic community.   Groups that were found within both the epi- and mesopelagic clusters included fish, chaetognaths and *Sergestes similis*, showing their importance within each community.   The nighttime clusters (Fig. 5-6) were separated at 150 m, and connecting groups were primarily the chaetognaths and thaliaceans. The daytime clustering in the BS (Fig. 5-7) revealed that the community within the 180 - 300 m depth layer clustered independently from all other depth layers, and was distinguished by strong correlations among thaliaceans, euphausiids, and two groups of juvenile shrimps.   Amphipods, chaetognaths and *Thysanoessa longipes* were the groups linking the two clusters in terms of vertical displacement. The nighttime BS mesopelagic community (Fig. 5-8) was separated from the epipelagic at the 300 m depth layer.   The groups within the nighttime epipelagic were similar to those of the daytime, but also included amphipods and *Sergestes similis*.
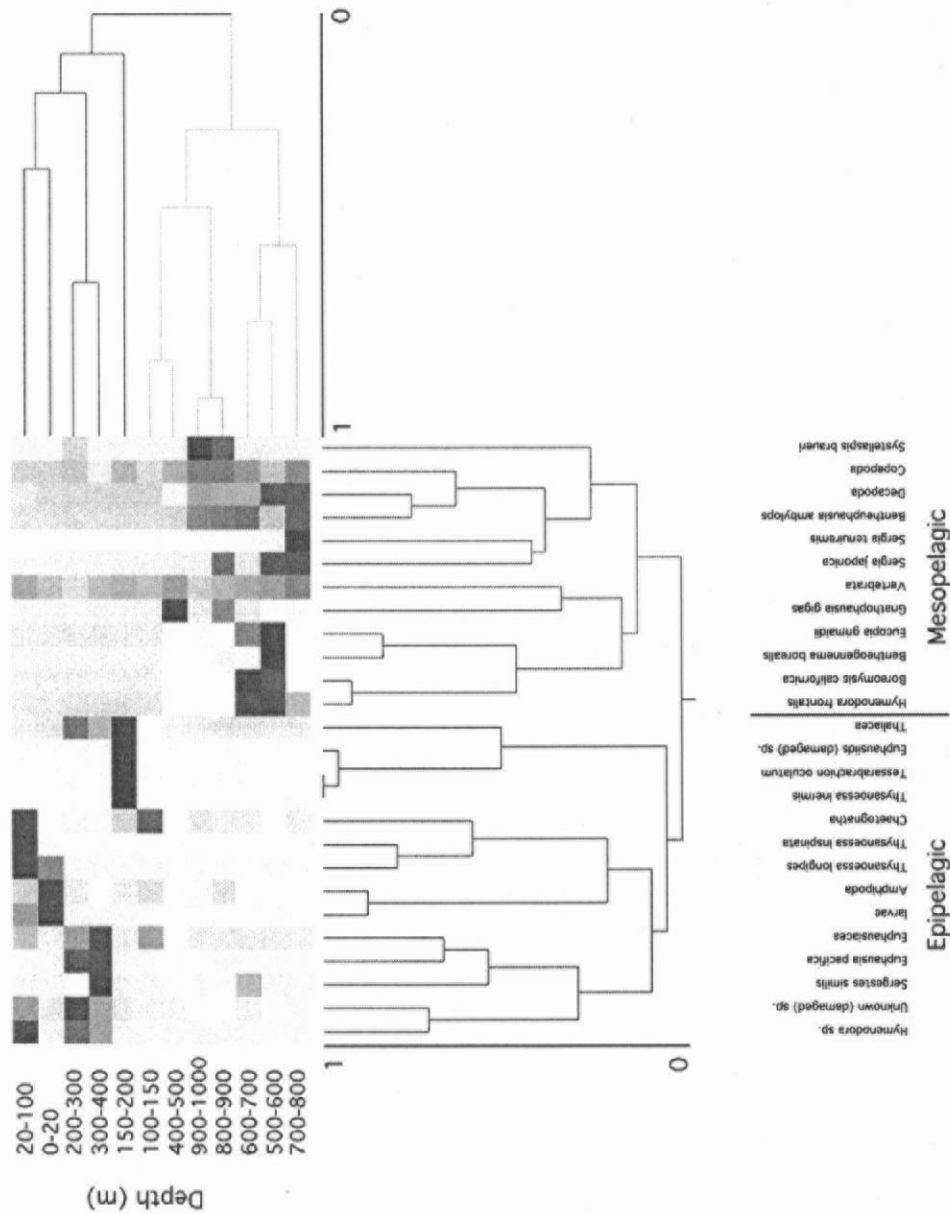
Fig. 5-5. Daytime WSA depth layers and 2-way clustering of relative abundance for micronektonic crustaceans and mesozooplankton (RMT 1+8 nets). The red squares represent species to species correlations, strongest being deep red. Green squares represent species correlation with depth, strongest being deep green. White squares represent no correlation, either with depth or other species.
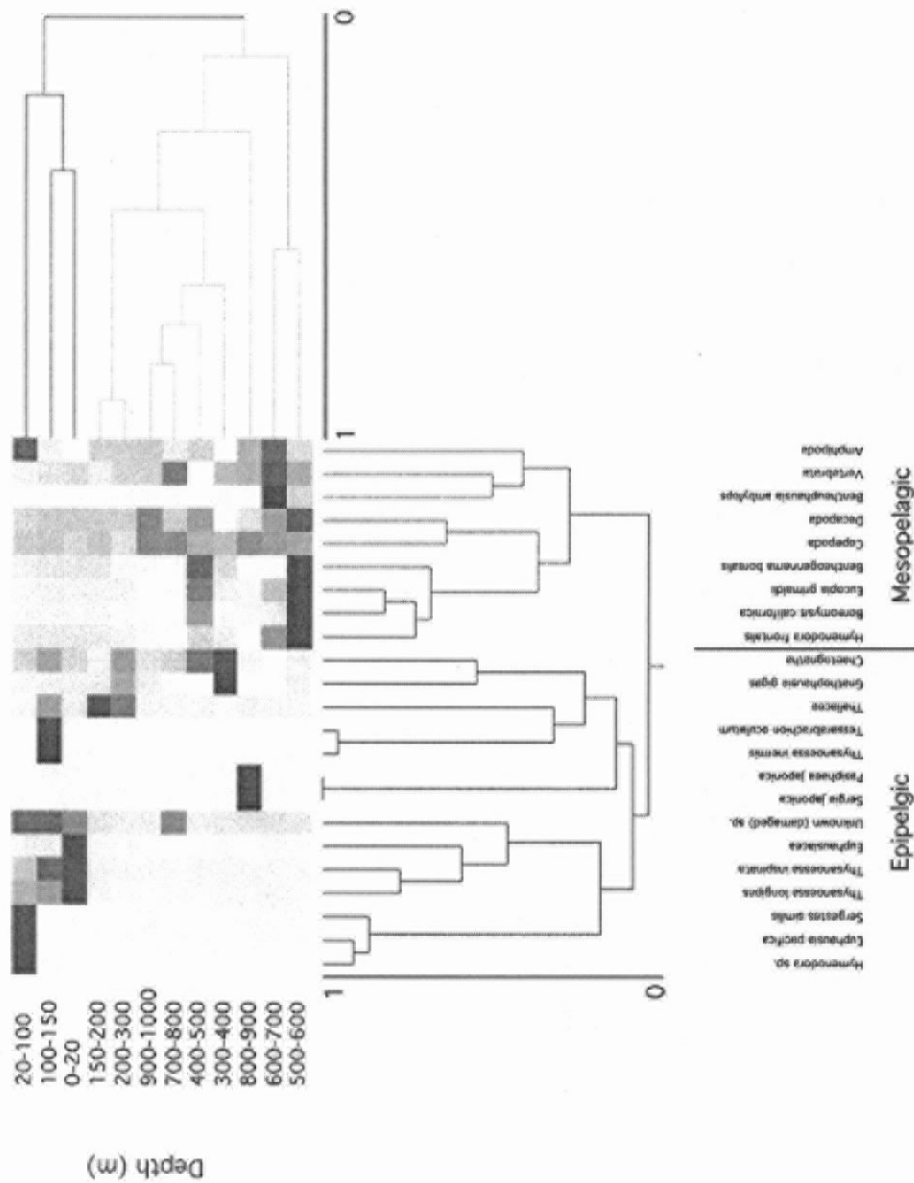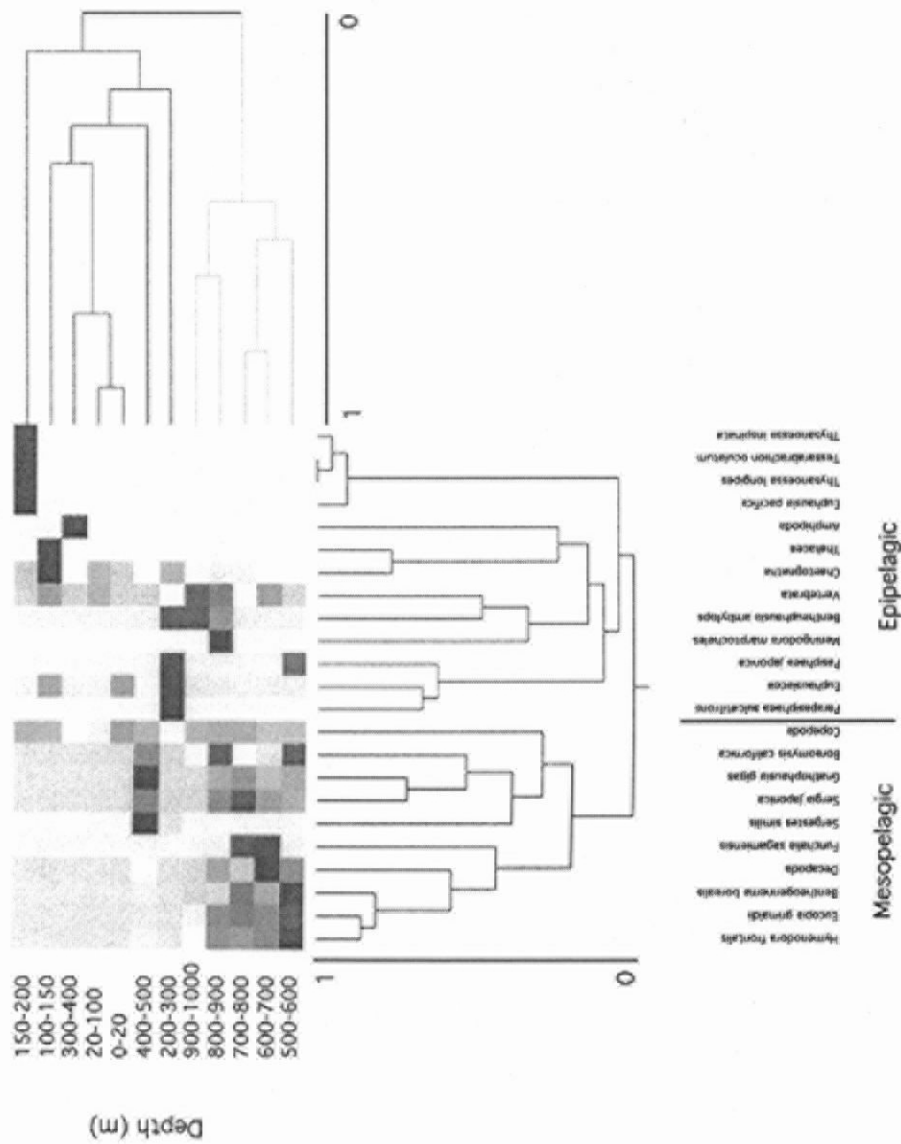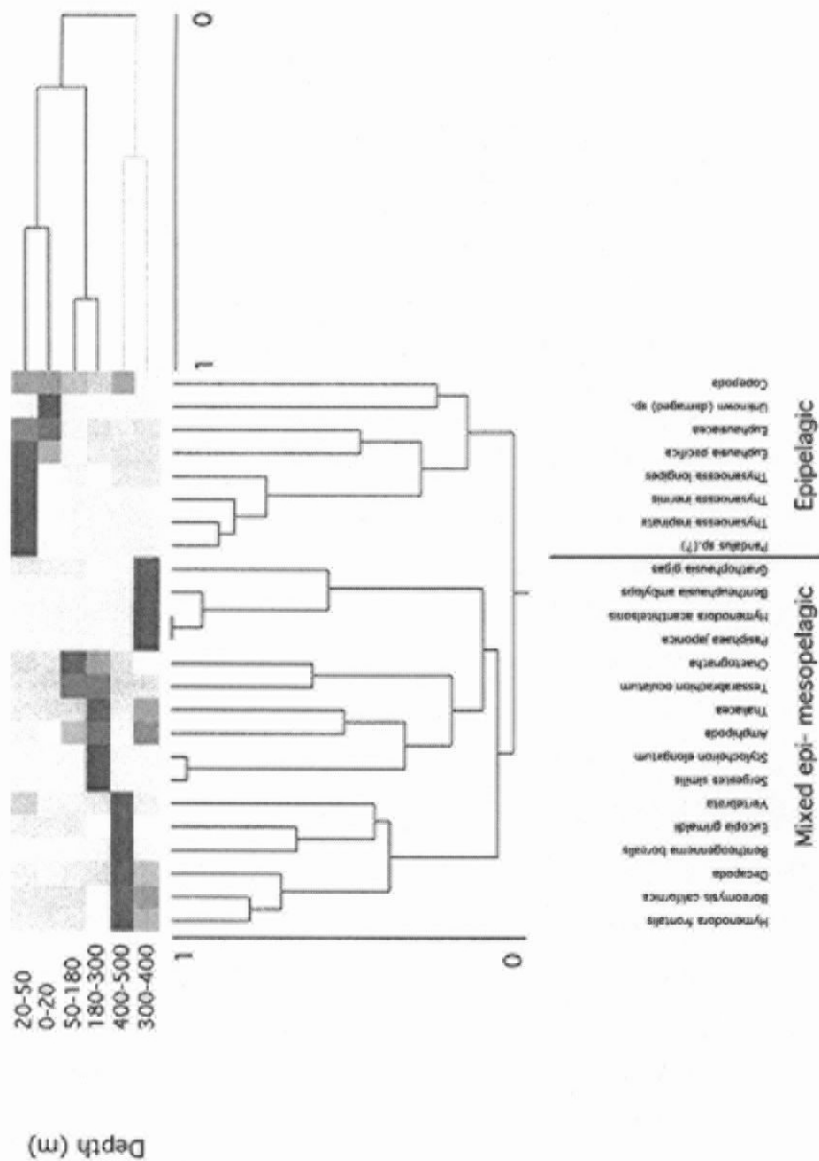
Fig. 5-6. Nighttime WSA depth layers and 2-way clustering of relative abundance for micronektonic crustaceans and mesozooplankton (RMT 1+8 nets). The red squares represent species to species correlations, strongest being deep red. Green squares represent species correlation with depth, strongest being deep green. White squares represent no correlation, either with depth or other species.

Fig. 5-7. Daytime BS depth layers and 2-way clustering of relative abundance for micronektonic crustaceans and mesozooplankton (RMT 1+8 nets). The red squares represent species to species correlations, strongest being deep red. Green squares represent species correlation with depth, strongest being deep green. White squares represent no correlation, either with depth or other species.

Fig. 5-8. Nighttime BS depth layers and 2-way clustering of relative abundance for micronektonic crustaceans and mesozooplankton (RMT 1+8 nets). The red squares represent species to species correlations, strongest being deep red. Green squares represent species correlation with depth, strongest being deep green. White squares represent no correlation, either with depth or other species.

DISCUSSION

As was mentioned in Chapter 3, the zooplankton analyses were affected by the lack of data in the nighttime lower mesopelagic zone in the ESA and BS. The RMT1 nets also captured specimens that would otherwise be considered micronekton (e.g. decapods and mysids) or nekton (fishes). However, for the purposes of this chapter, since they were captured by the finer mesh of the RMT1 nets these taxa have been included within the zooplankton, and also because depending on their size and life stage, these taxa have been considered members of different planktonic and nektonic classes.

Vertical distribution patterns

It's apparent that the distribution patterns of epipelagic zooplankton were affected by some factors present within the top 500 m of the ocean in the SAP and BS, most apparent in the ESA. Patterns of nighttime migration into upper layers at night were not clear in many of the regions examined, possibly explained in part by the broad scale resolution of the zooplankton groups examined here and the inclusion of non- semi- and active migrators. Resolution of these groups to species level may help resolve this. Further study to examine the fine detail of zooplankton diel vertical distribution is needed, and will be the subject of a future study.

Micronekton and zooplankton clustering

The clustering results suggest that the composition of communities in the upper and lower portions of the water column differ between day and night and between regions. There were some very strong correlations of abundance and depth layer of some groups of zooplankton and MNC species. However, these correlations were not as clear for the zooplankton groups. Since different species within the same taxon can express very different vertical distribution patterns, very different associations may be revealed by further, more detailed, analysis. However, this analysis shows that the correlations of epipelagic and mesopelagic MNC species are closely linked to restricted strata, and include species with different feeding preferences, differing body sizes, and differing mandible morphology. There was considerable overlap in vertical distributions of some groups of zooplankton, MNC and nekton, with indications that different predators may be feeding on similar groups, albeit at different depths (*i.e.* vertical partitioning).

The majority of gut contents examined in Chapter 4 were either copepod remains or "crustacean" remains. These were predominantly chitinous bits and pieces, which due to their highly macerated state could not be assigned to any specific taxon. It is therefore reasonable to assume that, with reference to previous studies, that "crustacean" remains may include amphipods, copepods, mysids, decapods, or other pelagic animals possessing chitinous parts. Copepods, for example, were not strongly correlated with any one group or MNC species in the study area. In conjunction with depth occurrences of known copepod feeders such as *Hymenodora frontalis, Bentheogennema borealis, Sergia* spp., and *Systellaspis braueri*, there were weak correlations spread over a wide vertical range. There seemed to be correlations with depth and abundances of other MNC species, fishes and zooplankton, but what these correlations represent between these associated groups is unknown.

Implications for the WSA, CSA, ESA and BS

The associations between depth distribution, while giving no definitive explanation regarding the exploitation of resources by taxa of higher trophic level upon those taxa of lower trophic levels, can be used in conjunction with previously established feeding data to draw inferences explaining these associations with depth. The euphausiid *Euphausia pacifica* has been reported as an important consumer of marine snow, anchovy eggs, copepods and phytoplankton, all depending upon availability. Diel periodicity feeding by *E. pacifica* (Nakagawa, 2003) and in four species of mesopelagic euphausiids off Oahu (Hu 1978) described low daytime feeding activity and increased nighttime stomach weight in relation to large changes in prey density between day and night. However, moderate vertical migrants, like *Thysanopoda pectinata* showed constant stomach weight day or night, while non-migrators like *Nematobrachion sexspinosum* showed increased stomach weight during the daytime (Brodeur and Yamamura 2005). MNC have been shown to be opportunistic feeders (Chapter 4), and the mechanism behind diel vertical migration has been connected to responses related to both feeding and escaping predation. Therefore, it may be inferred that concentrations of MNC, especially for decapods and mysids, are a result of exploiting abundant organic resources. The clustering of two vertically distinct communities, and their changes in composition and vertical position at night compared to daytime imply that the nighttime epipelagic community reforms every night after dispersing downwards during the day. Although the constituent species of the epi- and mesopelagic communities differed by region, and within regions by day and night, feeding intensity of dominant MNC species was relatively constant at all

depths where they occurred (Chapter 4). The clustering patterns of zooplankton and MNC showing strong associations of some groups may indicate preferential feeding, or some other factor(s) that these associations seem to prefer. Hopkins and Gartner (1992) found that when there was evidence of spatial overlap in the distribution of myctophids from the eastern Gulf of Mexico, that niche separation of resources (*i.e.* resource-partitioning) reduced competition. They suggested that a large degree of niche overlap allows for a large number of co-occurring midwater fish species. Moku *et al*, 2000 suggested that habitat segregation for myctophids in the western North Pacific was related to their resource partitioning. While there may be some resource partitioning via habitat segregation in decapods and mysids, the co-occurrence in space of many of the mesopelagic MNC and their zooplanktonic prey (*e.g.* copepods) may actually show preferences for differently sized prey.

The changes in vertical distribution patterns of zooplankton and MNC in the SAP and BS in the ESA caused by the 1997 ENSO may possibly temporarily affect on resource-partitioning, since MNC predators and prey that are usually spatially separated may become mixed. Cnidarians and thaliaceans were the only zooplankton present in appreciable amounts of biomass and abundance, day or night, while copepods and chaetognaths, normally abundant in this section of the water column in other regions of the SAP and BS, were absent from the surface waters of the ESA. Copepods and chaetognaths are well known as being sensitive to changes in water temperature and changes in DVM from changes in environmental conditions may adversely affect those species undergoing DVM as predator avoidance. Ontogenetic and seasonal migration also affects faunal composition and biomass of copepods in the subarctic Pacific (Miller, 1984; Odate 1994), and these changes have been reflected in gut content composition of myctophids (Brodeur and Yamamura, 2005). Events that adversely affect copepods may have significant "ripple" effects up the food web. The subarctic Pacific zooplankton community is dominated by the copepod genera *Eucalanus* and *Neocalanus*, both of which undergo ontogenetic and seasonal vertical migration (Miller, 1984; Mackas, 1999). The depth range of over wintering calanoid copepods in the SAP (400 – 1200 m) Miller 2005 overlaps with the vertical ranges of many MNC, suggesting that these copepods may provide an important food source for slight- or non-migratory MNC and other micronekton. Since these are important prey of the micronekton, changes in the vertical structure of zooplankton fauna are likely to result in changes in feeding behavior by micronekton. However, data regarding seasonal migration in MNC is extremely limited and the extent to which this resource is exploited by mesopelagic MNC is still unclear and remains an important topic for further research.

COMPARISON WITH MNC ASSEMBLAGES IN OTHER OCEANS

Northeast Atlantic

In a time-series examination of the mesopelagic community in the northeast Atlantic, Roe (1984) found that the pelagic mysid, *Eucopia unguiculata*, was the most common MNC at 600 m, day or night. Euphausiids were the dominant MNC in the 100 – 250 m water column, while the decapods were relatively minor members of the MNC community in the 100 – 250 and 600 m depths. One species of euphausiid, *Meganyctiphanes norvegica*, comprised 88% of total euphausiids caught at 100 m, while another species, *Nematobrachion boopis*, was the most common species below 100 m (Roe, 1984). Only in the 450 m hauls were decapods and mysids present in similar abundances, while euphausiids were much less common than in shallower depths. While *E. unguiculata* did engage in limited DVM and expressed some seasonal vertical migration, all decapods underwent extensive vertical migrations. Roe (1984) found some evidence of dietary changes linked with DVM, but was unable to determine whether feeding was selective. These migrations approximately followed the movements of isolumes in the water column. There were few abundant decapod species and their respective mean population depths were spatially and temporally distinct, and may provide a means of avoiding competition. He concluded that: "the combination of different sizes, different feeding habits and different migratory behavior makes it improbable that decapods and mysids" directly compete for food. This enables the groups to coexist as well as reduce competition among the several species of decapods.

Eastern Gulf of Mexico

A series of papers have steadily increased our understanding of species composition, vertical distribution, trophic ecology and resource partitioning within the MNC assemblage in the eastern Gulf of Mexico (Flock, 1992; Heffernan, 1981; Hopkins, 1994; Hopkins, 1989; Hopkins, 1998). The decapod assemblage is divided between migrators and non-migrators, of which the migrators (s pecies accounting for 90% of abundance and biomass) far outnumbered non-migrators. Mysids were again important in the lower mesopelagic zone, but only in terms of abundance, and mainly limited to species within the genus *Eucopia*. The eastern Gulf assemblages are characterized by large variations in vertical distribution and diets, and in combining decapod space and food resource partitioning they found that species which co-occurred in space significantly differed in terms of diet, and vice versa (Hopkins, 1994). They conclude that some of the primary considerations in

the evolution of the resource partitioning in low latitude oceanic environments are variations in the depth distribution of food, light and temperature (Hopkins, 1994).

FUTURE SCOPE

The results of the present study have expanded the work of Aizawa (1974), Omori (1974) and Nishida (1988) on feeding in pelagic decapods of the SAP and extended it into the BS. However, this qualitative analysis needs to be expanded into a more detailed quantitative analysis in order to resolve outstanding questions discussed above. In addition, this study has also expanded upon work defining vertical distribution patterns on MNC in the ESA (Krygier and Pearcy 1977, 1981) and WSA (Aizawa 1974; Kikuchi and Omori 1985, 1986) by reporting patterns from the CSA and BS, and expanding our knowledge of DVM patterns among a larger number of MNC species. Knowledge regarding community structure, abundance and biomass patterns have also been extended from work covering the SAP and BS (Wasmer, 1972, Iwasaki, 1985, 1987).

However, there are still many points that remain unclear and need clarification: (1) Are there any indications of preferential feeding by any species, and how intense is the resulting competition for food? (2) What are the contributions of the minor MNC species in the SAP and BS to trophic ecology? These points, and the ones outlined above, will necessitate a multidisciplinary approach, involving genetics, phylogeny, physiology and morphology. Due to the difficulty of *in situ* examination, some of these points will have to remain estimations based on laboratory evidence, until sampling techniques become sufficiently advanced.

Further points that need clarification are: (1) what physiological differences between and within these groups define their vertical diversification? (2) What are the phylogenetic relationships among these groups, and are there any genetic differences within species across the SAP and BS? (3) Are there any similar trends in physiological or morphological characteristics between groups that relate to the vertical partitioning of within-group speciation? (4) Are there any similar trends in morphology of feeding parts between groups with similar feeding preferences? (5) How do these trends compare or contrast with similar groups in other seas?

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