Full-depths zooplankton composition at two deep sites in the western and central Arabian Sea

Heiner Fabian*, Rolf Koppelmann & Horst Weikert
Institut für Hydrobiologie und Fischereiwissenschaft, Zeiseweg 9, D-22765 Hamburg, Germany
*{fabian@ftz-west.uni-kiel.de}

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The temporal distribution and faunistic composition of zooplankton was studied by means of fine stratified oblique tows with a 1 m² MOCNESS at one station in the western and central Arabian Sea, each. The 333 µm net samples covered the whole water column down to ca. 4000 m, commencing 50 m above bottom, during three monsoon periods: the fall intermonsoon in October 1995, the spring intermonsoon in April 1997 and the NE monsoon in February 1998. Copepods were most abundant at both stations, ostracods ranked next, followed by malacostraceans, and chaetognaths. Total numerical standing stocks varied at the western site between 35 500 and 93 100 no./m² and at the central site between 27 300 and 65 800 no./m². In the epipelagic zone (0-150 m), only calanoid copepods, chaetognaths and gelatinous zooplankton showed an in-phase coupling with the seasonal pattern of primary production, with lowest concentrations during the spring intermonsoon; for all other groups the coupling is not clear. In the mesopelagic zone (150-1050 m), characterized by a pronounced oxygen minimum zone (OMZ), distinct changes in the faunistic composition were found: In the core of the OMZ (O₂ below 0.15 mg/l), the relative abundance of calanoid copepods rose up to 95%, whereas non-calanoid copepods and chaetognaths nearly disappeared. The vertical distributions of selected copepod taxa are discussed in relation to the oxygen profiles. Below the core of the OMZ several groups showed a subsurface peak in abundance. In the bathypelagic zone, below 1050 m, 4-11% of the water column zooplankton standing stock was found.

Key words: Zooplankton, copepoda, Indian Ocean, Arabian Sea

Introduction

Zooplankton is an important component of the pelagic community since it includes the major consumers of primary production. It plays an active role in the modification and remineralization of particulate organic matter in the water column, one major issue which was investigated in the course of the Joint Global Ocean Flux Study1. Systematic investigations of Indian Ocean zooplankton were done during the International Indian Ocean Expedition2. In the last decade, several studies in the course of JGOFS have improved the knowledge on zooplankton distribution and ecology of the Arabian Sea3, 6, 7.

The Arabian Sea zooplankton is influenced by the biannual reversal of the monsoon wind system which results in a pronounced seasonality and forms spatial patterns in primary production8 and zooplankton biomass. During both, SW monsoon (June-September) and NE monsoon (November – February), the zooplankton biomass in the epipelagic zone increases compared to the relatively calm intermonsoon periods6, 7. The productivity pattern results in a well-marked onshore/offshore gradient visible in decreasing zooplankton biomass and total individual numbers6, 9, 10. During the NE monsoon surface cooling drives convection processes in the northeastern part of the Arabian Sea that lead to the injection of nutrients into surface waters, causing the "zooplankton paradox11" with high stocks of phyto- and zooplankton in winter4. The decomposition of the large amount of organic material produced during the monsoon period contributes to the formation of a layer of low oxygen in the mesopelagic zone.

This oxygen minimum zone (OMZ) exists over a vast area in the Arabian Sea, extending from just below the mixed layer down to over 1000 m depth and was first described by Sewell and Fage12. The suboxyc core of the OMZ is defined by Morrison et al.13 as the region where oxygen is ≤ 0.15 mg O₂/l. The influence of the oxygen minimum zones on the distribution of zooplankton is discussed in several papers for the Arabian Sea6, 13–16.
This paper will show how selected major groups of zooplankton, larger than 333 µm, reflect the spatial and seasonal relations found in zooplankton biomass and total individual numbers over the full depth of the water column including the bathypelagic zone (>1000 m). Two oceanic stations marking different points of the onshore/offshore gradient in the central and western Arabian Sea were chosen for this study (Fig. 1). The investigations were carried out during three cruises, reflecting different monsoon periods. Additionally, we will describe the nocturnal distribution of some copepod taxa throughout the water column, exemplified for the central Arabian Sea station during the NE monsoon. This descriptive account contributes to the so far sparsely known distribution of deep-sea zooplankton in the Arabian Sea, for which a fine-scaled vertical distribution is presented for the first time.

Materials and Methods
Zooplankton was sampled in the Arabian Sea at the two open-ocean stations, WAST and CAST (Western and Central Arabian Sea Sediment Trap Station, respectively). WAST (St. 1) is a 4050 m deep site located at 16°15' N, 060°20' E, the position of CAST (St. 2) is 14°30' N, 064°30' E with a depth of 3950 m (Fig. 1). Three cruises were carried out covering different monsoon periods: the fall intermonsoon in October 1995, directly following the high productive SW monsoon (RV Meteor cruise 33/1), the spring intermonsoon in April 1997 (RV Sonne cruise 118), and the NE monsoon in February 1998 (RV Sonne cruise 129). Although our data from the three monsoon periods were collected in different years, and interannual variability exists in atmospheric forcing, the seasonal change from the SW monsoon, blowing from May to September, to the less intensive and reverse in direction NE monsoon, blowing from November to February/March, is a stable component in the Arabian Sea and provides a strong trigger signal for biological reactions.

The zooplankton samples were taken by oblique hauls using a 1 m² MOCNESS (Multiple Opening/Closing Net and Environmental Sensing System) equipped with 9 nets (M33/1) and a 1 m² Double-MOCNESS with 20 dark colored nets (two 1 m² MOCNESS systems side-by-side; So118 and So129) of 333 µm mesh aperture. The volume of water filtered at a ship's speed of ca. 2 knots (ca. 1.0 m/s) was measured by a calibrated flowmeter. Fine stratified profiles were taken at both stations from 50 m above bottom to the surface in 18 to 24 layers with steps from 50 to 250 m in February 1998 and April 1997 and 150 to 500 m in October 1995. In the upper 1000 m one night profile was analyzed for each station and cruise. Below 1000 m, two or three repeated tows for each layer and cruise were analyzed at St. 1 (WAST) and one or two at St. 2 (CAST). Overall 211 samples were investigated. Detailed information providing date, time, and depth of the sampled layer is given in Koppelmann et al. In addition to the zooplankton samplings, dissolved oxygen was measured using a CTD in April 1997 and February 1998. The oxygen profiles are presented together with the concomitantly taken zooplankton profiles. The OMZ at Sts. 1 and 2 started at around 200 m and extended down to approximately 900 m. Especially the western station (St. 1) showed filaments with an elevated oxygen content within the OMZ.

Immediately after recovering and rinsing the nets, the samples were preserved in a 4% formaldehyde-seawater solution buffered with sodiumtetraborate. In the laboratory on shore, the zooplankton was fractionated through a set of sieves, resulting in fractions of <500, 500-1000, 1000-2000, 2000-5000, and >5000 µm, weighed, and sorted under a binocular microscope at magnifications from 6 to 40 times in a formaldehyde-free fluid, consisting of 0.5% propylene-phenoxetol, 5.0% propylene glycol and 94.5% water. Only the sum of fractions < 5000 µm is treated in this study. Data on the fractions are given...
by Koppelmann et al.\textsuperscript{7}. Samples containing a high number of individuals were split before sorting using a 10 times whirling vessel\textsuperscript{21} or a 2 times Folsom divider\textsuperscript{22} for samples which were less rich but yet too numerous to be counted completely. Metazoans were sorted into 11 major groups: calanoid copepods, non-calanoid copepods, ostracods, chaetognaths, malacostraceans, molluscs, salps, jellyfish, polychaets, fish, and remainder. Carcasses and exoskeletons were discriminated according to Weikert\textsuperscript{23}. Siphonophora were not counted; these fragile organisms break into pieces in the nets and are supposed to belong to the size fraction > 5000 µm. A taxonomic analysis of the copepods was performed using one night profile from February 1998 at St. 2 (CAST, hauls 5 and 8). Among the copepods the calanoid families Metridinidae, Euchaetidae, Lucicutiidae and Augaptilidae and the non-calanoid taxa Oncaeidea, Oithonidae, Corycaeidae, Mormonillidae and Aegistidae were numerically assessed.

The term "standing stock" stands for the numerical quantity in the water column below one square meter (no./m\textsuperscript{2}) for the whole water column or a given depth range. Numerical abundance was related to a volume of 1000 m\textsuperscript{3} (no./1000m\textsuperscript{3}). To enable the plotting of data sets at the midpoints of the sampling intervals including zero values on a logarithmic scale “+1” was added.

**Results**

**Calanoid copepods**

In the epipelagic zone (0-150 m), the largest standing stock of calanoid copepods (Table 1) was found at St. 1 in October 1995. The standing stock was about twice the value obtained at St. 2 during the same month, however, at this site, the highest value was found in February 1998. In the mesopelagic zone (150-1050 m) at St. 1, standing stocks of calanoid copepods were about three times higher in February 1998 and October 1995 than in April 1997, whereas temporal differences were not encountered at St. 2. In the bathypelagic zone (1050 m - 50 m above bottom), the standing stocks of calanoids were largest in October 1995 at both stations, with higher values at St. 1 than at St. 2 during all investigated periods.

At both stations and during any season all vertical profiles (Fig. 2) documented maximum numbers of calanoids in the epipelagic zone. The surface peak was followed by a sharp decline of up to three orders of magnitude, causing local minima in the upper mesopelagic zone, especially during February 1998 and October 1995 at St. 2. As an exception, no minimum of abundance was found in October 1995 at St. 1. Below the depths of minimum individual abundance, the gross pattern of the profiles showed a moderate decrease of numbers down to 1500 m in February 1998 to 2000 m in April 1997 and to about 3000 m in October 1995. At greater depths, the concentrations were fairly constant. The vertical distribution of relative abundance showed quite a different pattern. In general, calanoid copepods comprised 50-75% of the whole zooplankton throughout the water column. However, conspicuous high percentages of calanoids, amounting up to 95% appeared in the OMZ at 150-200 m. In April 1997, the layer of maximum relative abundance even extended into the upper bathypelagic zone at St. 1 and 2 (≤ 1500 m). This maximum was followed by a minimum, and, finally, increased percentages which varied around 75% at depths below 2500 m, or below 3000 m in October 1995.

**Non-calanoid copepods**

In the epipelagic zone, distinct differences in the standing stocks of this group existed between both stations during all investigated periods. At St. 1, the largest standing stock was found during October 1995, whereas at St. 2 it was highest in February 1998 (Table 1). In the mesopelagic zone, conspicuous small standing stocks were found in February 1998 and April 1997 at St. 1 and in April 1997 at St. 2. The largest standing stock in the mesopelagic zone was found in October 1995 at St. 2. The vertical profiles of this group (Fig. 3) showed the highest absolute abundances in the upper 100 m, while relative abundances showed a conspicuous peak only in February 1998 (St. 2) and April 1997 (St. 1). Throughout the mesopelagic zone, the counts were low, usually <100 no./1000 m\textsuperscript{3}, as was the contribution to the total zooplankton (usually below 5%). Between 1000 and 3000 m, non-calanoid copepods were abundant again with fairly constant numbers, while relative abundance increased up to 40% of the zooplankton between 1500 m and 2750 m as compared to 10-20% at greater depths.

**Distribution of different copepod taxa**

The vertical distribution patterns of calanoid copepod taxa were exemplarily studied based on the samples taken at St. 2 in February 1998 at night (Fig. 4). Six families were assessed which showed an
extended vertical distribution. They comprised 36% of the total standing stock of the copepod fauna. Among them, Metridinidae (*Pleuromamma* spp: 6950 no./m²; *Metridia* spp: 472 no./m²) contributed with 14.5% to the copepods. Both genera (Fig. 4 A, B) showed varying values in the water column, with a local minimum between 150 and 300 m, but high numbers in the lower part of the OMZ. Of the two genera, *Pleuromamma* was sparse below 3500 m, whereas *Metridia* was not found in the upper 50 m.

Euchaetidae amounted to 4543 no./m², representing 8.9% of the copepods. Most of the animals (Fig. 4 C) were found in the epipelagic zone, while none were found in the core of the OMZ, between 300 and 450 m. Below this depth, abundances increased up to 20 no./1000 m³, but no animals were collected in the deepest layer (3750-3900 m). The Eucalanidae yielded 3203 no./m², comprising 6.2% of the copepods. The genus *Eucalanus* was predominant with 3086 no./m². Except of a minimum in abundance in the upper mesopelagic zone, *Eucalanus* spp. (Fig. 4 D) showed a more or less steady decrease with increasing depth down to about 2400 m. Below this depth, a second peak in abundance was found.

Table 1—Standing stocks (no/m²) of zooplankton (333-5000 µm) major groups at two oceanic stations in the Arabian Sea (WAST, 16°15' N, 60°20' E, 4050 m depth; CAST, 14°30' N, 64°30' E, 3950 m depth). Above 1050 m, only night data. Below 1050 m, day and night data are averaged.

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Rhincalanus nasutus (Fig. 4 E) was represented by 112 no./m$^2$. This species had its main distribution within the mesopelagic zone, but it was nearly absent in the bathypelagic zone. Some individuals of \textit{R. rostifrons} were found between 300 and 450 m.

\textit{Lucicutia} spp. (2357 no./m$^2$, 4.5\%) were mainly distributed in the epi- and mesopelagic zones (Fig. 4 F), however, the genus showed a distinct minimum in its abundance between 150 and 300 m. Below 1500 m, the counts ranged between 10 and 100 no./1000m$^3$. Augaptilidae (488 no./m$^2$, 1.0\%) were most abundant between 50 and 150 m and between 500 and 1000 m (Fig. 4 G). Also, Heterorhabdidae (417 no./m$^2$, 0.8\%) had its main abundance in the mesopelagic zone (Fig. 4H). But different to the previous taxon, maximum values were found at about 400 m, and no specimens were collected in the epipelagic zone.

Fig. 2—Nocturnal vertical distribution of calanoid copepods and oxygen concentrations at both Arabian Sea stations examined during three investigations: February 1998 (late NE monsoon), April 1997 (spring intermonsoon) and October 1995 (fall intermonsoon). Points = values of repeated measurements in the bathypelagic zone. (* = no zooplankton data)
Among the non-calanoids, Oncaeidae were most abundant (4582 no./m²) comprising 8.9% of all copepods, with highest values in the epipelagic zone and in the deep water between 900 and 2500 m in February 1998 at St. 2 (Fig. 4 I). Within the Oncaeidae, *Conea rapax* attained a standing stock of 360 no./m², comprising most of the deep-living specimens. Like Böttger-Schnack\(^4\), we found maximum abundances of this large non-calanoid in the lower mesopelagic and the upper bathypelagic zones, i.e. between 600 and 2750 m (Fig. 4 J). The highest concentration of Corycaeidae and Oithonidae (Fig. 4 K, L) was found in the top 100 m. Both groups contributed 6% to the copepods (3079 and 3176 no./m², respectively). *Mormonilla* spp. and Aegisthidae (417 and 127 no./m², respectively) were missed in the epipelagic zone (Fig. 4 M). The former were most abundant at about 1000 m, while Aegisthidae, which

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Fig. 3—Nocturnal vertical distribution of non-calanoid copepods and oxygen concentrations at both Arabian Sea stations examined during three investigations: February 1998 (late NE monsoon), April 1997 (spring intermonsoon) and October 1995 (fall intermonsoon). Points = values of repeated measurements in the bathypelagic zone. (* = no zooplankton data)
Fig. 4—Nocturnal vertical distribution of selected taxa of copepods and oxygen concentrations at Station 2 (CAST, 14°30' N, 64°30' E) in February 1998 (late NE monsoon). (Note the different scaling of the x-axes.)
appeared below 600 m, had their maximum at 1500 m. Sapphirinidae (not presented) were found almost exclusively in the epipelagic zone; the standing stock was 933 no./m² (1.8% of the copepods).

Ostracods

In the epipelagic zone the largest standing stock of ostracods (Table 1) was found at St. 1 in April 1997 and at St. 2 in February 1998. In the mesopelagic zone, the standing stock was largest in October 1995 at St. 1 and in April 1997 at St. 2. Temporal differences could not be detected in the bathypelagic zone, but the values at St. 1 were generally higher than at St. 2. All vertical profiles of ostracods (Fig. 5) showed a more or less distinct minimum between 200 and 600 m. Below, the absolute numbers decreased with increasing depth, or they remained at a rather constant level (St. 1: February 1998, April 1997). There was the tendency of increased relative...
abundance at ca. 200 m depth, i.e. below the epipelagic zone, except in October 1995 at St. 2. The maximum was most accentuated in April 1997 at St. 1 and St. 2 and less evident in February 1998 at both stations. Noteworthy is an increase in relative abundance with depth at St. 1 in February 1998 and April 1997 from less than 2% in 600 m depth to more than 20% in the deepest sampled layer, 50 m above bottom.

Malacostraceans

Malacostraceans (decapods, isopods, amphipods, and euphausiids) were mainly found in the epipelagic and upper mesopelagic zones at depths shallower than 300 m (Table 1, Fig. 6), in absolute and relative terms. In the upper 50 m, both euphausiids and decapods, especially the genus *Lucifer*, were dominant; below this depth only euphausiids were collected in higher numbers. At both stations, the...
largest standing stocks (Table 1) were found in February 1998, whereas lowest standing stocks were measured in April 1997 and October 1995 (St. 2).

**Chaetognaths**

The standing stocks (Table 1) of this carnivorous taxon were largest in October 1995 at St. 1 and in February 1998 at St. 2. At both sites lowest numbers were recorded in April 1997. Seasonal differences between the standing stocks appeared almost exclusively in the epipelagic zone, whereas the standing stocks were almost constant in the deeper water column, except at St. 2. Here, the bathypelagic standing stock was higher by a factor of two as compared to the mesopelagic zone. The vertical distribution of the chaetognaths (Fig. 7) showed some similarities to the pattern of the non-calanoid copepods. The abundance was low in the mesopelagic zone between 300 to 800 m, shown by absolute and relative numbers.
Other zooplankton groups

The remaining major zooplankton taxa molluscs, salps, polychaets, jellyfish, teleost fish and the collecting group “other zooplankton” (Table. 1), had relatively small standing stocks. The last group comprised small and undefined forms. The contribution of all these groups together never exceeded 5% to the total zooplankton. An exception was in October 1995 when an extraordinarily large standing stock of salps was found in the epipelagic zone at St. 2. The salps contributed 10.4% to the zooplankton in the epipelagic zone and surpassed the stocks of February 1998 and April 1997 at St. 2 by more than one order of magnitude. Except of salps and polychaets at St. 1 in October 1995, when these groups were found in higher numbers in the mesopelagic zone, all the groups had their maximum abundance in the epipelagic zone. All groups were of minor relevance in the bathypelagic zone.

Discussion

The Arabian Sea is influenced by changing monsoon winds which cause higher productivity during the monsoon periods and less productivity during the intermonsoon phases, especially during the spring intermonsoon in the western part of the basin. This change in phytoplankton abundance is also reflected in zooplankton biomass and abundance. The objectives of this paper were to investigate the contribution of different zooplankton groups to these temporal changes and the effect of the OMZ on these groups as exemplified by night profiles. Clearly this observation will be changed to some extent by daily vertical migration of zooplankton which even can migrate into the OMZ. However, night samples are not influenced by visual net avoidance and are considered representative of the population of interest at all depths sampled. Apart from depths deeper than 1050 m, the zooplankton data presented here are based on single catches only. This drawback is somewhat reduced due to the large volumes filtered per sample. The filtered volumes vary from 3000 to 4300 m³ for profiles from the surface down to 1050 m. In comparison to vertical hauls by multinets (262.5 m³) with an opening of 0.25 m², the MOCNESS filtered 11-16 times more water. Also, the MOCNESS integrates over patchy distribution of meter scales, so that the catch will not be affected by small-scale variability.

The epipelagic zone

According to Koppelmann et al., the largest standing stocks of total zooplankton (Table. 1) were found at St. 1 in October 1995. The NE monsoon period of February 1998 reflected intermediate values, and smallest standing stocks were observed during the intermonsoon in April 1997. At St. 2, the total standing stock was largest in February 1998, intermediate in October 1995 and lowest in April 1997. These general findings were reflected by the calanoid copepods, the most abundant group in the epipelagic zone (45-72% of the total standing stock). Also, the carnivorous chaetognaths and jellyfishes paralleled this pattern. Malacostraceans, however, indicated slightly higher values in February 1998 than in October 1995 at St. 1. Non-calanoid copepods did not follow this pattern. In February 1998, abundances were lowest at St. 1 and highest at St. 2. The interpretation of this result is difficult since most of the organisms are smaller than 1 mm in body-length and are not retained quantitatively by the 333 µm mesh size. This sampling bias probably caused also the dominance of the relatively large Conea rapax within the deep-sea non-calanoids.

Ostracods are known for a strong mesoscale variability, which may blur the seasonal pattern. This omnivorous group occasionally builds spectacular swarms which dominate the zooplankton in the northern areas of the Arabian Sea. Madhupratap et al. reported for the upper 500 m of the water column a relative abundance of ostracods of 0.1% at 15° N, 064° E during the fall intermonsoon of 1992 and a percentage of 62.5% at 17° N, 064° E during the fall intermonsoon of 1993. Noteworthy are the large amounts of salps caught in October 1995 at St. 2. The bulk of the salp swarm was in bad condition, suggesting that we caught a swarm that was going numb. Large swarms of salps can reduce the phytoplankton stock markedly. In the Arabian Sea, Naqvi et al. reported a substantial decrease in chlorophyll in the mixed layer within 14 days in the course of a massive swarm of salps during the NE monsoon in 1997 at about 21° N, 064° E. As a consequence, the development of other herbivorous plankton, mainly crustaceans, can be suppressed by competition, which may explain the relatively small total standing stock of zooplankton at St. 2 in October 1995.

The mesopelagic zone

Several authors stated that seasonality in mesopelagic zooplankton is weak in the Arabian Sea,
especially with increasing distance from the upwelling areas in the western part of the Arabian Sea. Present zooplankton data showed temporal changes for calanoid copepods at St. 1 only. At any season, however, the concentrations of all major groups were reduced in the OMZ. Among them, the non-calanoid copepods (Fig. 3), the chaetognaths (Fig. 7) and the calanoid family Euchaetidae (St. 2, February 1998; Fig. 4 C) showed the widest vertical extension of decreased abundance in the OMZ. Chaetognaths, Euchaetidae and many species of non-calanoid copepods are supposed to be carnivorous; possibly the oxygen demands of these predators cannot be fulfilled in the OMZ. In turn, this might explain that non-calanoid copepod and chaetognath abundance often markedly increased just below the OMZ (Figs. 3 and 7). The existence of enhanced individual concentrations at the lower boundary of the OMZ was first suggested by Vinogradov & Voronina for the Arabian Sea. Also Morrison et al. observed such an increase for some zooplankton groups. The authors opine that there is some evidence that the increase is correlated with increased oxygen values close to the base of the OMZ, allowing the mentioned groups to satisfy their oxygen requirements.

Calanoid copepods reached a relative abundance of up to 95% in the OMZ (Fig. 2). An increase of calanoid copepods in oxygen minimum zones was also reported from the SE Arabian Sea and the tropical eastern Pacific. Present results (Figs. 2 and 4) are similar to Sameoto who found copepod abundances of 6600-6800 no./1000m³ (night values) in the core of the OMZ at two stations in the eastern tropical Pacific. For the Arabian Sea, Vinogradov & Voronina remarked that Rhincalanus nasutus was common at oxygen concentrations lower than 0.2 mg O2/l. The regional analysis of the present study indicates that a broader spectrum of copepod groups (Pleuromamma spp., Metridia spp., Eucalanus spp., Rhincalanus nasutus, Lucicutia spp., Augaptilidae, Heterorhabdidae and Conea rapax; Fig. 3) may survive in low oxygen concentrations. Ostracods (Fig. 6) were also found in relative high abundances at low oxygen concentrations. Weikert stated that R. nasutus represented 20% of the copepods in the core of the OMZ (1.3-1.9 mg O2/l) in the Red Sea. Longhurst and Judkins found Calanus and Eucalanus to be abundant in the OMZ (0.3-0.7 mg O2/l) off Baja California in the Pacific. Wishner et al. reported Lucicutia grandis as a typical inhabitant of the OMZ of the Arabian Sea living in the depth range of 300-1000 m and representing 12.8% of all calanoid copepods as an average. Probably L. grandis contributes to the increased abundances between 150 and 1500 m in the vertical profile of the genus Lucicutia at St. 2 in February 1997 (Fig. 4).

The bathypelagic zone

The relative contribution of bathypelagic zooplankton to the total standing stock was small, 5-11% at ST. 1 and 4-7% at St. 2. These values are similar to relative portions in other oceanic regions. However, due to temporal enhancements, the bathypelagic standing stock can reach around 50% of the total water column standing stock as found in summer 1992 in the NE Atlantic and in summer 1993 in the eastern Mediterranean. In both cases, the increase was due to high reproduction rates of some calanoid copepods. Differences between seasons observed by this study are possibly reactions on an increased or modified particle flux. Such a change in the structure of an ecosystem may act as a mechanism which modifies the organic carbon flux to the deep-sea. It is known that the biological activity of the midwater fauna at mesopelagic depths is likely to exert a significant control on the fluxes of material from the euphotic zone into the deeper water and the seabed. Carbon, released by the respiratory activity of deep-sea organisms, will be stored in the deep water for several hundreds of years. Therefore, there is the need to study the metabolic activity of different taxa in the deep-sea.

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