

Theme Session F

Zooplankton community structure and biomass in the mesopelagic and deeper layers

ICES CM 2007/F:01

Seasonal abundance and development of krill in the Faroe-Shetland Channel

Høgni H. Debes

Samples of krill were collected at three stations crossing the Faroe-Shetland Channel during the season from May 2001 until July 2002. Samples were collected throughout the water column down to a maximum depth of 900 m using a MIK-net. Of the ten krill species encountered in the area the large nordic krill *Meganyctiphanes norvegica* and the somewhat smaller *T. longicaudata* dominated the population throughout the research period. Seasonal variability in temperature, salinity, chlorophyll a, and abundance of krill as well as data on krill egg and larvae is presented, and related to the environmental conditions in the area. Length-frequency histograms of the two dominating species showed the 0-group to appear in the samples in June. Based on larvae and 0-group appearance and the ambient seawater temperature, the main time of spawning is estimated to be in early April. In addition, the seasonal development in maturity of both males and females of the two dominating krill species is presented.

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Distribution of bioluminescence and plankton in a deep Norwegian fjord measured using an ISIT camera and the digital Underwater Video Profiler

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Bioluminescence and plankton profiles were obtained using a downward-looking ISIT low-light camera and the Underwater Video Profiler system in Sognefjord, Norway. The profiling systems were lowered by CTD wire and recorded continuously from the surface to a depth of 1000 m. The former system delivered the vertical distribution of mechanically stimulated bioluminescent signals while the second provided the vertical distribution of undisturbed marine snow and zooplankton. The number of recorded bioluminescent events showed a maximum of 36.3 mean counts for a 50 m depth segment between 450 and 500 m during a continuous measurement from 150 to 1000 m. The number of bioluminescent events was positively correlated with the vertical distribution of copepods and negatively with density of marine snow particles (<0.5 mm). The most likely cause of the bioluminescence was the presence of bioluminescent metridiid copepods. Use of imaging techniques in conjunction with bioluminescence measurements provides a useful tool for studying the sources and roles of bioluminescence in these otherwise dark habitats.

Keywords: bioluminescence, marine snow, copepods, imaging technology.

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Vertical distribution and nutritional behaviour of *Cyclothone bauerii*, *Nematoscelis megalops*, *Meganyctiphanes norvegica* and *Salpa fusiformis* in the NW Mediterranean mesopelagic zone

W. D. Yoon, P. Nival, S. M. Choe, M. Picheral, and G. Gorsky

Vertical distribution and migration, stomach content and population structure of four characteristic macrozooplanktonic species were determined during 4 cruises in the Ligurian Sea, NW Mediterranean. Two instruments were used : the BIONESS multiple net system for the sampling and the Underwater Video Profiler for the “in situ” estimations. The non migrating gonostomatiid *Cyclothone braueri* forms the main biomass from 300 to 600 m deep at the studied stations. Its stomach content shows that it is a carnivore, feeding efficiently on migrating mesozooplanktonic populations. Although the euphausiid *Nematoscelis megalops* can be observed between the surface and the depth of 800 m the major part of its population lives also in the 300 - 600m layer. Only one part of the population is migrating. In the aphotic layer its nutritional behaviour is mainly carnivorous, while in the subsuperficial layer *N. megalops* is omnivorous. *Meganyctiphanes norvegica* displays a strong migrating behaviour and feeds intensely during the night in the superficial layer both on animal prey and on phytoplanktonic/detritic material. During the daytime *M. norvegica* seems to be dispersed in the mesopelagic layer. *Salpa fusiformis* is a filter feeding tunicate. The

oozoids and the large blatozoids seem to migrate while the small blastozoids remain in the superficial layer during the day. The role of these organisms in the mesopelagic food web and in the carbon cycling will be discussed.

Keywords: mesopelagic zooplankton, vertical distribution, nutritional behaviour.

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Vertical distribution (0–1000 m) of gelatinous zooplankton in different hydrological regions along the Mid Atlantic ridge in the North Atlantic

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The vertical distribution (0-1000 m depth) of macrozooplankton along the northern portion of the Mid-Atlantic Ridge (59°58N, 25°53W to 41°29N, 28°19W) was investigated during the MARECO program (June and July 2004) using the Underwater Video Profiler (UVP). Twelve relatively large (> 1 cm) groups were selected from the recorded images: sarcodines (with two sub-groups), crustaceans (excluding copepods), chaetognaths, ctenophores (with two sub-groups cydippids and lobates), siphonophores, medusae (with three subgroups *Aeginura grimaldii*, *Aglantha* spp. and all other medusae), appendicularians, and thaliaceans. The numerically dominant groups over the whole area were crustaceans (26%), medusae (20%) and appendicularians (17%). The gelatinous fauna were consistently most numerous between 400-900 m. Appendicularians, ctenophores and *A. grimaldii* occurred mostly below 300 m (maximum concentrations of 75, 58, and 30 individuals 100m⁻³, respectively). Siphonophores, *Aglantha* spp. and the other medusa were more uniformly distributed in the water column (maxima of 42, 42 and 300 individuals 100m⁻³, respectively). The macrozooplankton community below 200 m varied with the spatial distribution of the water masses, suggesting that the Sub-Polar Front restricts the mixing of macrozooplankton communities down to 1000 m depth.

Keywords: Gelatinous zooplankton, mesopelagic zooplankton, Sub Polar Front, North Atlantic, Underwater Video Profiler, MARECO .

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Two-year temporal variability of small hyperbenthos collected 4 m above the bottom in the deep (2347 m) NW Mediterranean

Guidi-Guilvard, L.D., D. Thistle, and A. Khripounoff

The hyperbenthic community in the deep sea is generally difficult to sample, particularly on a temporal basis. The presence of sediment traps at the DYFAMED-BENTHOS station (43° 24.61' N – 7° 51.67' ; 2347 m) (Guidi-Guilvard, 2002) gave us the opportunity to analyse a continuous collection of the small hyperbenthos trapped as "swimmers" in formalin-filled cups 4 m above the bottom, between January 1996 and April 1998. Sampling resolution varied between 5.5 and 21 days and servicing of the mooring was every 1.5 to 3.5 months. A total of 55 samples were sieved and the "swimmers" larger than 100 µm were picked and identified. On the whole, the flux of "swimmers" varied between 26 and 361 individuals m⁻² d⁻¹. Copepods (including nauplii) largely dominated and represented on the average 87% of the organisms collected. Annelids were the next most abundant group (mean 7.8%), followed by Nematodes and Bivalves (mean 1.8% each). Ostracods, Isopods, and Amphipods were more or less equally represented and made up 1.5% of the organisms on the average. Fluxes of the most abundant organisms (Copepods) showed strong temporal variation. Numbers peaked in May-June and in September of both years, however interannual variation was high and overall numbers in 1997 were twice those measured in 1996. Current velocities measured 12 m above the bottom were much higher in 1996 (peaks between 13 and 21 cm s⁻¹ in April) than in 1997. This physical disturbance could be responsible for the observed interannual differences, given that the organic carbon input was equivalent in both years (1.7 g m⁻² y⁻¹). Of the 3930 copepods (excluding nauplii) examined, 4% were Cananoids, 15% were Harpacticoids, and 81% were Cyclopoids. Further examination of Podopleid copepods showed that 2 species largely dominated the community, i.e. the Cyclopinidae belonging to the genus *Barathricola* represented more than 89% of the Cyclopoids, and the Tisbidae belonging to the genus *Tisbe* represented 57% of the Harpacticoids.

Keywords: swimmers, hyperbenthos, deep sea, copepods, sediment traps, time series.

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Vertical distribution and seasonal dynamics of mesozooplankton in the Iceland Basin

Astthor Gislason

The abundance and seasonal vertical distribution of dominant zooplankters in the Iceland Basin was studied from data collected on four cruises between November 1996 and June 1997. Five taxa constituted >90% of the copepod biomass, *C. finmarchicus*, *P. norvegica*, *Oithona* spp., *M. lucens* and *Oncaea* spp. A seasonal migration pattern was evident in *C. finmarchicus*, *P. norvegica*, *Oithona* spp. and *M. lucens*: From December to February they inhabited the deeper layers, whereas from April to June they were most abundant in the upper layers. *Oncaea* spp. also stayed deep during winter, but only a limited part of the population rose to upper waters during the summer. The reproduction of *C. finmarchicus* took place in May in the surface layers and it was linked to the phytoplankton spring bloom. In contrast, the reproduction of *P. norvegica* occurred at depth in February and was uncoupled to the spring bloom. As judged by the incidence of adults of both sexes the reproduction of *M. lucens* took place from February to June. The data on *Oithona* spp. and *Oncaea* spp. indicate that the former group reproduces between April and June in the upper layers, whereas the latter appears to reproduce year-round at depth.

Keywords: zooplankton, vertical distribution, Iceland basin.

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Vertical distribution and population structure of copepods along the northern mid-Atlantic ridge

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The Mid-Atlantic Ridge (MAR) between 40°N (Azores) and 63°N (Iceland) is the largest topographic feature in the North Atlantic Ocean. Despite generally limited surface production, there is evidence that the mid-ocean ridges are ecologically important for higher trophic levels relative to the surrounding open ocean. Vertical migrations of zooplankton are one of the primary mechanisms for the vertical transfer of carbon from surface waters to the deeper waters and sediments. The complicated topography of the MAR influences local and regional circulation patterns, which in turn are likely to affect the distribution of the zooplankton fauna. The crest of the MAR rises to 1000 m, thus intersecting the meso- and bathypelagic layers.

In this paper we explore the vertical distribution and population structure of selected copepod species on the northern MAR, with the goal of better understanding the nature of the interactions between zooplankton and a mid-ocean ridge system. Zooplankton were sampled on the ridge from Iceland to the Azores (~60-41°N, 25-35°W) in June 2004. Depth stratified sampling revealed information on vertical distributions from surface down to 2500 m. The Subpolar Front is the major biogeographic boundary in the studied area. Species with a wide vertical range also had a wide geographical distribution, occurring both north and south of the SPF. Several species were observed to change their vertical distributions along the transect, becoming deeper on the southern stations. Factors influencing vertical distributions are evaluated and relationships between zooplankton, water masses, and ridge topography are discussed.

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Deep-sea holozooplankton species diversity in the Sargasso Sea, Northwestern Atlantic Ocean

Peter H. Wiebe, Ann Bucklin, Laurence Madin, Martin V. Angel, Tracey Sutton, Francesc Pagés, and Russell R. Hopcroft.

The deep-sea zooplankton assemblage is hypothesized to have high species diversity, with low abundances of each species. However, even rare species may have huge population sizes and play a critical role in the dynamics of deep-sea environments. This study sought to accurately assess zooplankton diversity in the mesopelagic and bathypelagic zones of the Sargasso Sea (Northwest Atlantic Ocean), using integrated morphological and molecular analysis of large-volume sampling to depths of 5,000 m. The field survey in April 2006 included scientists, staff, and students associated with the Census of Marine Zooplankton (CMarZ). The cruise field work entailed at-sea analysis of samples and identification of specimens by expert taxonomists, with at-sea DNA sequencing to determine a barcode (i.e., short DNA sequence for species recognition and discovery) for each species. Environmental data and zooplankton samples were collected with a 102-m opening/closing MOCNESS (5,000 – 1,000 m), with sampling by two smaller MOCNESS above 1,000 m. More than 500 species were identified, with ~1,500 specimens placed in a queue for barcoding; 87 species were barcoded at sea. For several taxonomic groups, a significant fraction of the

region's known species were collected and identified. For example, 65 of 140 known ostracod species for the Atlantic Ocean were collected, 6 undescribed species were found, and the first DNA barcode for a planktonic ostracod was obtained. Also identified were >40 molluscs, >100 species of cnidarians, several hundred species of copepods, and >100 species of fish. At least 12-15 new species will be described from this effort.

Keywords: zooplankton, mesopelagic, bathypelagic, DNA barcode, diversity.

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Gulf SERPENT: Development of a deep-sea plankton observation system in the Gulf of Mexico using industrial ROVs.

Mark C. Benfield

Increasing demand for petroleum combined with technological advances in deep-sea drilling capabilities have increased the numbers and depth ranges of drilling operations in the northern Gulf of Mexico (Gulf). Most of these deepwater (>200m) operations utilize semi-submersible rigs or drillships equipped with remotely operated vehicles (ROVs) capable of working throughout the mesopelagic zone. The SERPENT Project is an international program based in the UK, designed to facilitate scientific access to industrial ROVs. In 2006 Louisiana State University began a partnership with BP and Oceaneering to study the distribution and biodiversity of planktonic organisms in the Gulf as part of SERPENT. Since then the project has expanded to include additional industrial partners and locations and we are now routinely collecting data on gelatinous and other planktonic organisms in the from the surface to the upper bathypelagic zone. This presentation will summarize our approaches, findings and the potential to expand the Gulf SERPENT project.

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ICES CM 2007/F:10 Poster

Abundance and diversity of zooplankton communities in contrasting environments of the Algerian coasts

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We studied the zooplankton populations in three contrasting environments of the Algerian coasts (NW Mediterranean) by comparing the diversity and abundance using the multivariate analysis. Zooplankton communities were numerically different in the Inshore and Offshore stations.

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ICES CM 2007/F :11 Poster

Long-term dynamics of zooplankton community in the South-Eastern Baltic Sea (1998-2006)

Natalia Zhigalova, Sergey Aleksandrov, and Yana Parfenova

Long-term researches of the Baltic Sea revealed the basic trends of zooplankton community variations depending on oceanographic processes. Alteration of the periods increase and decrease in salinity Baltic Sea against the background of the climate changes (temperature increase) and eutrophication affect the whole Baltic ecosystem including zooplankton. From 1970s to the mid-1990s the period was observed in the Baltic Sea, characterized with increased river discharge, lower salinity and increase eutrophication. From the mid-1990s the Baltic Sea has entered the next period of increase in salinity. The dynamics of zooplankton in the Baltic Sea was analyzed for that transition period based on the results of regular researches in the south-eastern part of the Baltic Sea during 1998-2006. Totally 633 samples collected with Juday net by means of total netting the layer of 0-100 m (the bottom) were analyzed. Seasonal and inter-annual dynamics of zooplankton development was studied in relation to the environment abiotic factors variations. The close relationship between abundance and biomass of zooplankton and the surface temperature was demonstrated, as well as the less pronounced relationship with the water salinity. The maximum zooplankton development was observed in the years of most intense warming-up of water (2001 and 2005). The increase of brackish-water species of Cladocera (up to 70–80% of the total biomass) and eurythermal and thermophil Copepoda (*Acartia* spp., *Temora longicornis*, *Centropages hamatus*) was observed. At the same time the role of the earlier dominating Copepoda *Pseudocalanus elongatus* decreased (from 37% in 1998 to 17% in 2001–05), due to salinity reduction in the deep-water part of the Baltic Sea. In 2006 the transformation of zooplankton community state was observed, probably due to some changes in the Baltic Sea oceanographic situation

during the latest years. In particular, it was observed significant decrease of development brackish-water Cladocera (5 times less than in 2005) and increase of abundance marine Copepoda, especially *Pseudocalanus elongatus* (3 times more).

Keywords: zooplankton, Baltic Sea, climate change, eutrophication, water temperature, salinity.

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