The role of mesozooplankton in the flux of carbon at the NW shelf off Spain

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Objectives
The objectives of partner UiTØ-b are 1) to quantify the copepod community in terms of biomass and standing stock during short time Lagrangian experiments, and 2) to quantify the role of mesozooplankton herbivorous grazing for the carbon flux in the area.

The work present here was completed during the 1998 summer cruise of *Charles Darwin* (*CD114*) on which a drifter was followed on the shelf (leg 1), and in a cold water filament (leg 2) off western Spain (see figure 1). Mesozooplankton abundance, vertical distribution and grazing rates are presented.

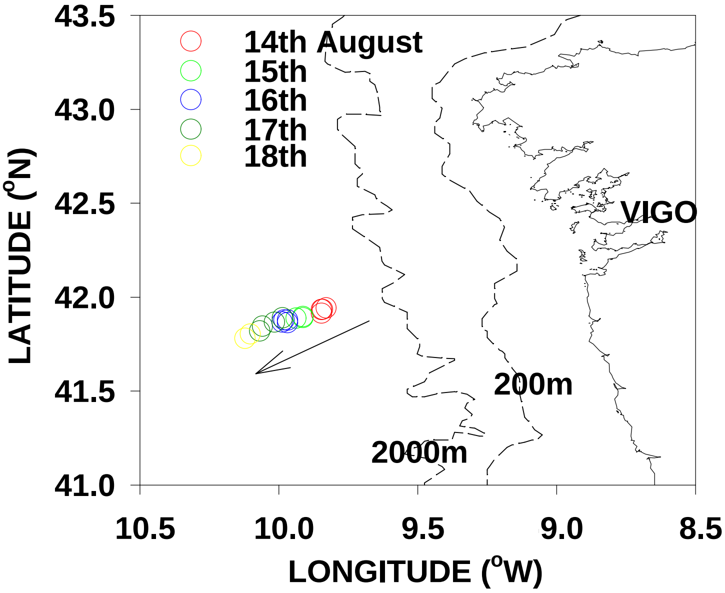


Figure 1. Map of the study area, indicating the position of sampling stations during leg 2.

Mesozooplankton abundance, species composition and vertical distribution

Material and Methods
Mesozooplankton was collected with a WP-2 plankton net, approximately every six hours for the dates sampled. (Due to problems with the cable, the MOCNESS could not be applied during this cruise). For leg 1 (shelf), 3 integrated hauls were made at each station (bottom-surface, 100 m - surface and 50 m - surface) in order to assess the vertical distribution of the copepods. For leg 2 (filament), one integrated haul was made at each station (200 m - surface). The samples were size fractionated into three size groups: 'large' (1000-2000 μm), 'medium' (500-1000 μm), and 'small'

(200-500 μm). Each was then preserved in 4 % formaldehyde buffered with borax for later enumeration and species determination.

Results and Discussion

Species abundance over the course of the investigation is indicated in figures 2 and 3. The total abundance (averaged over the top 200 m) of 'small' sized species known to feed on phytoplankton varied between 49 to 113 ind. m^{-3} (shelf) and 101 and 544 ind. m^{-3} (filament). In the small fraction the *Clauso*/*Calo*/*Cteno*/*Paracalanus* species contributed ~60% of the individuals, whereas *Oithona* spp. and *Acartia clausi* made up around 20 and 30%, respectively (figure 4). In the 'medium' size fraction abundances were between 4 and 13 individuals m^{-3}, with *Pleuromamma* spp. contributing between 20 and 50% in terms of abundance, together with *Calanus helgolandicus* (10-40%) and *Calanus tenuicornis* (10-30%) these were dominant. Abundance of 'large' species ranged between 0 and 0.24 individuals m^{-3}, with *Euchirella curticauda* and *Heterorhabdus spinifrons* dominating. Our results also give weight to the idea that even when following a drifter it is not possible to follow a unified body of water and the organisms which live within it. The vertical distribution on the shelf is indicated in figure 5, and shows that most of the copepods are concentrated in the upper 100 m of the water column at all times.

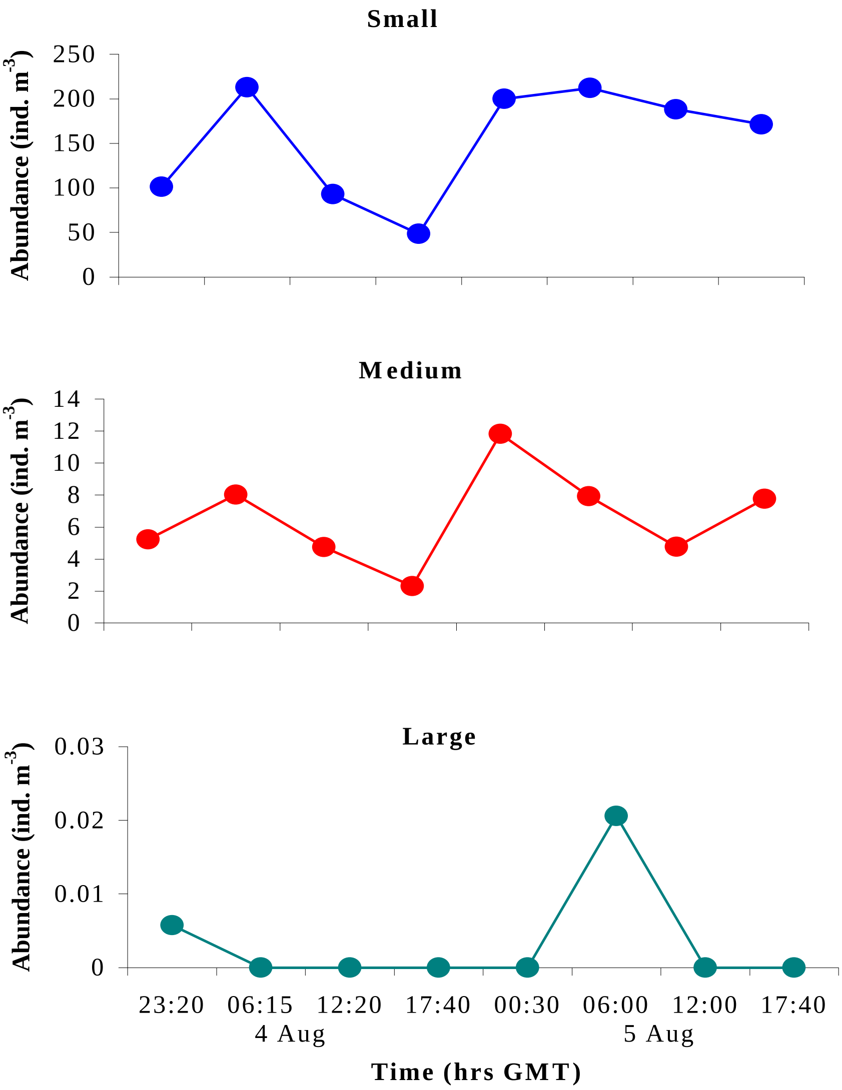


Figure 2. Variation in total abundance (ind. m^{-3} averaged over the top 250-330 m of the water column) of herbivorous and omnivorous copepods of three size fractions from 4th to 5th August (shelf)

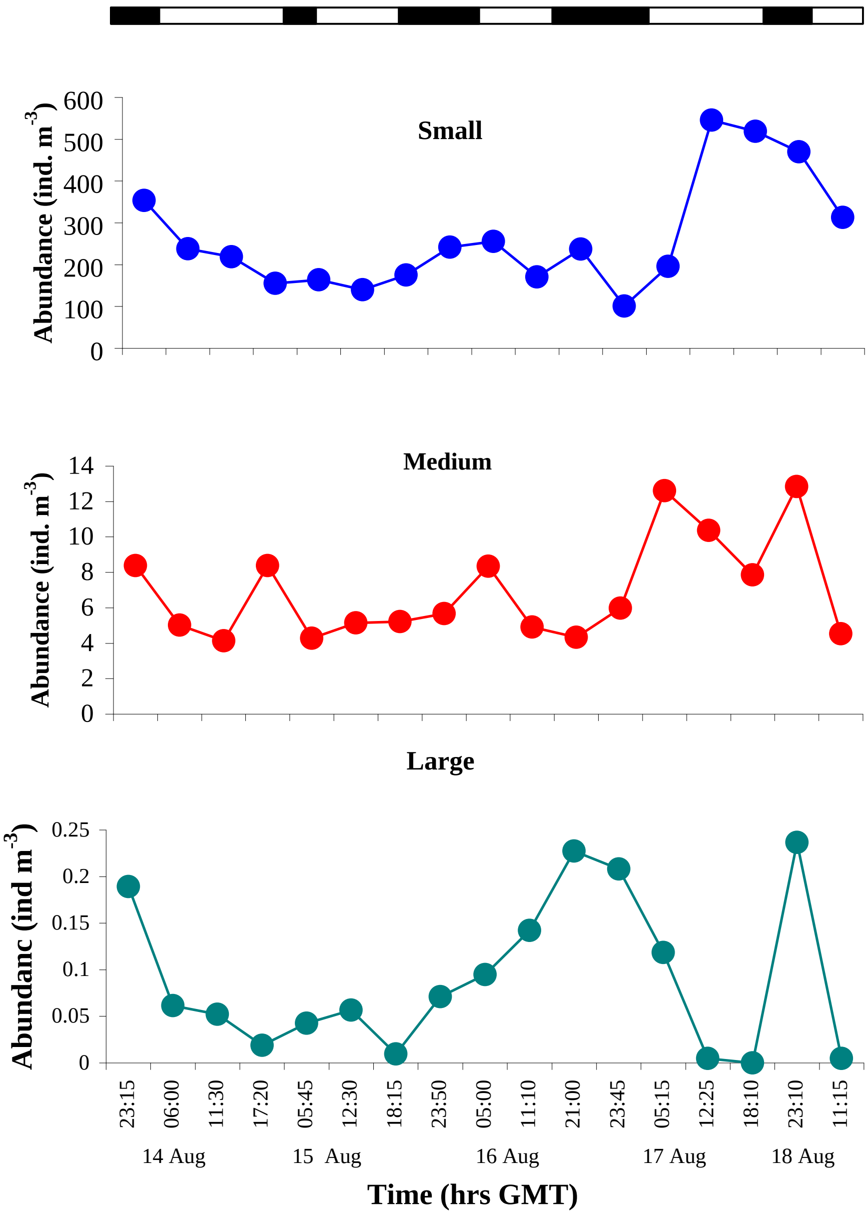
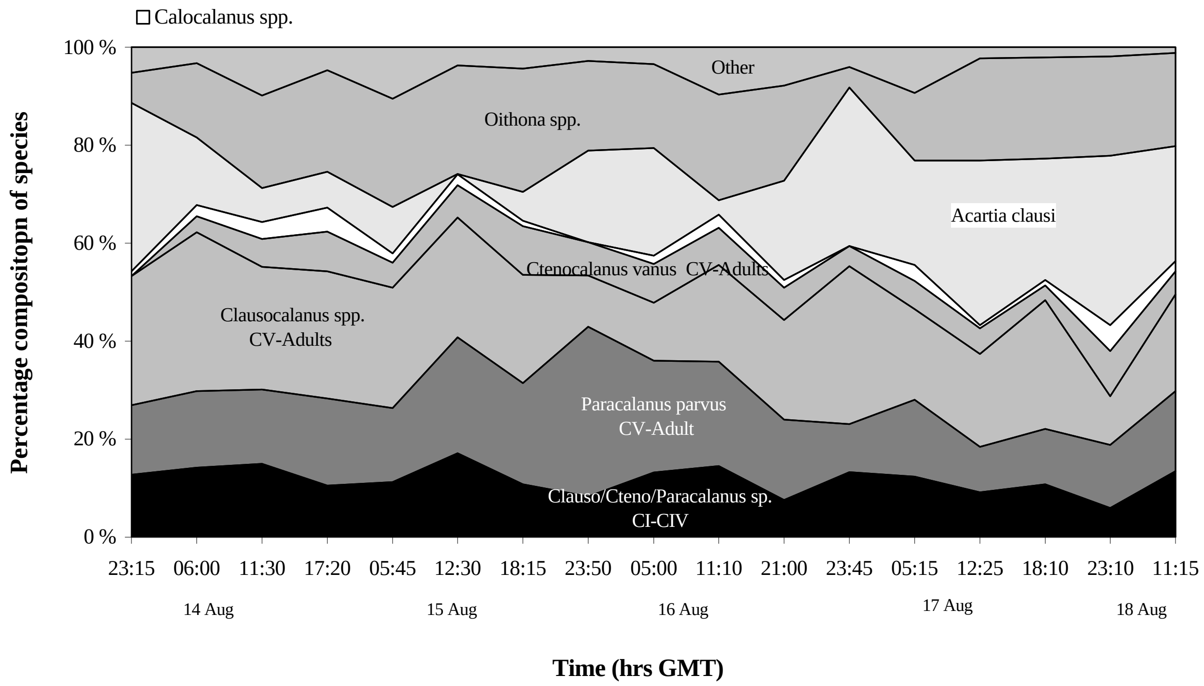


Figure 3. Variation in total abundance (ind. m^{-3} averaged over the top 200 m of the water column) of herbivorous and omnivorous copepods of three size fractions from 14th to 18th of August 1998 (filament). Top horizontal bar indicates day (light) and night (dark).



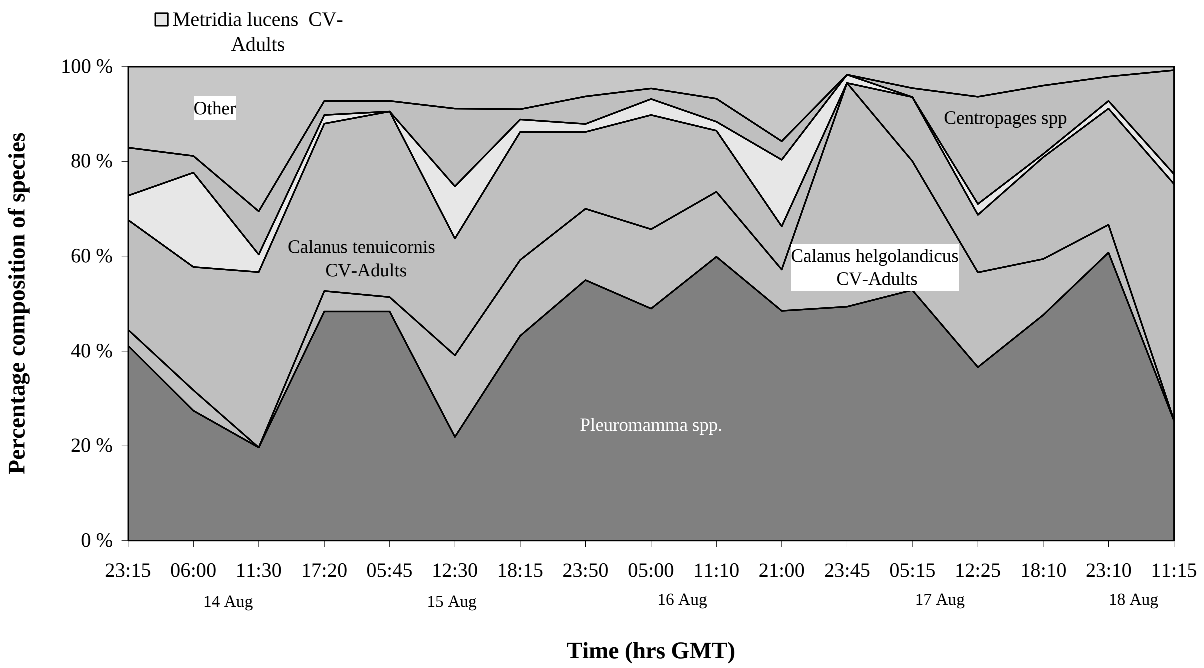


Figure 4. Species composition of copepods in the small (upper) and medium (lower) size groups from the filament, 14th to 18th of August 1998.

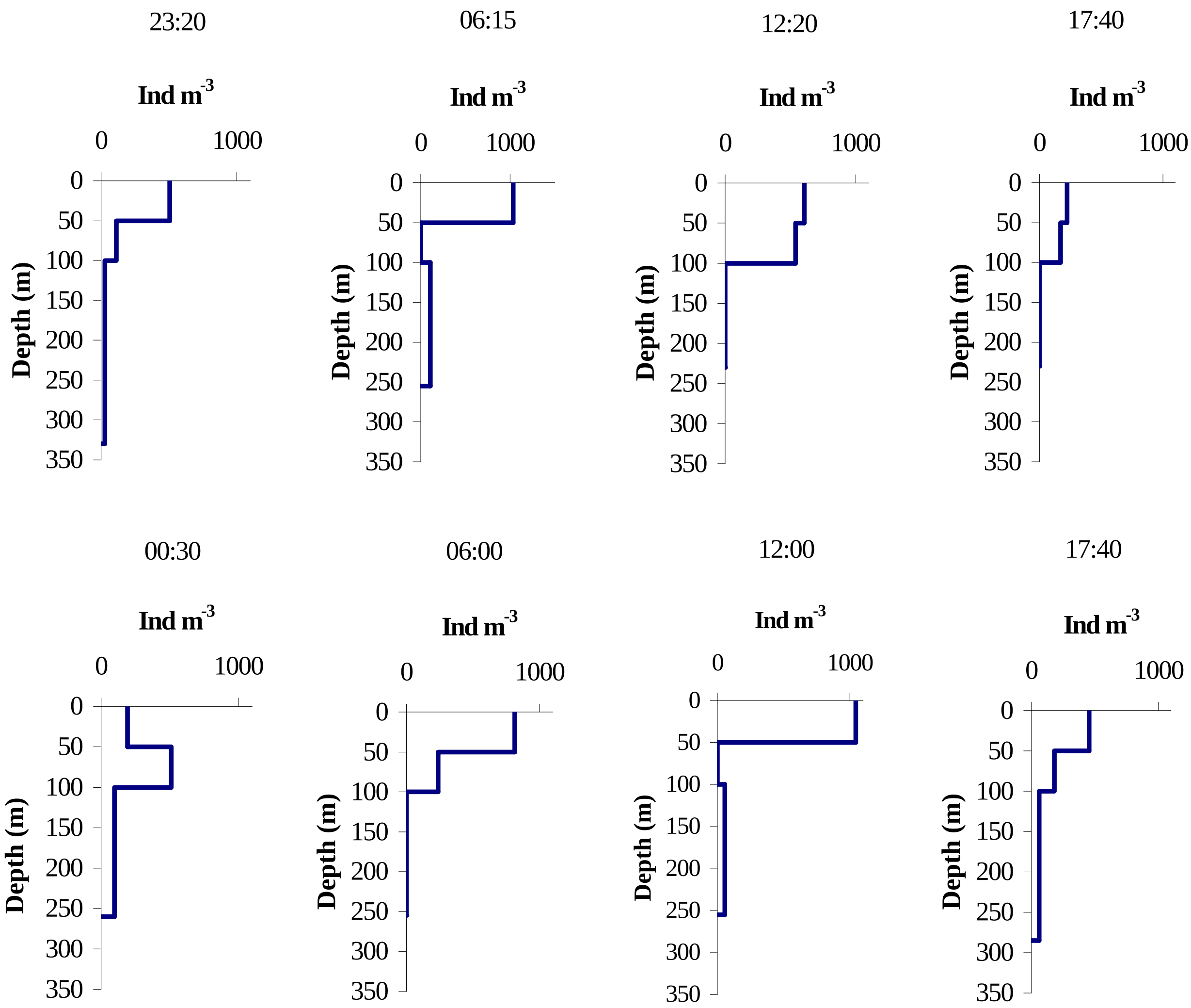


Figure 5. Vertical distribution of copepods on the shelf at four different times on the 4th August (upper panel) and 5th August (lower panel).

Mesozooplankton herbivorous grazing

Material and Methods

Mesozooplankton samples were taken at approximately six hour intervals whilst closely following the drifting buoy. For quantitative analysis of species composition and abundance vertically integrated net samples were collected over the top 200 m of the water column, and size fractionated into three groups: ‘large’ (1000-2000 μm), ‘medium’ (500-1000 μm), and ‘small’ (200-500 μm). Live copepods were also collected using a gentle technique, and the animals were anaesthetised, gently size fractionated and frozen on GF/C filters. In the laboratory these animals were analysed for gut chlorophyll a and phaeo-pigment content.

For gut fluorescence analysis, copepods were picked from the filters under a low-light microscope. Dominating species were selected, although when there was no obvious dominance, herbivorous or omnivorous species were randomly taken. Between 50 and 70 individuals were pooled for gut content measurements for the small size fraction, and 10 to 50 in the medium size fraction. Measures for fluorescence before and after acidification was carried out on extracts in MeOH (24 hours at 5°C in the dark) with a Turner Designs 10-AU fluorometer, and gut content derived in terms of ng Chlorophyll a equivalents per animal. Ingestion rates (I) were calculated from:

$$I = G \times k$$

where G is an average of the gut pigment content and k the evacuation rate constant (min^{-1}), with the latter derived from the published predictive equation of Irigoien (1998): $k = 0.0017\ T + 0.015$, T is the environmental temperature (^{o}C). Copepod herbivorous grazing was derived by combining ingestion rates and abundance values for each of the size fractions.

Results and Discussion

Mean gut contents were almost an order of magnitude greater in the 'medium' sized copepods in comparison to the 'small' species. The average contents were 0.234 and 1.713 ng Chl a $copepod^{-1}$ in the 'small' and 'medium' groups respectively, and there was also no clear diel signal in these values (see figure 6).

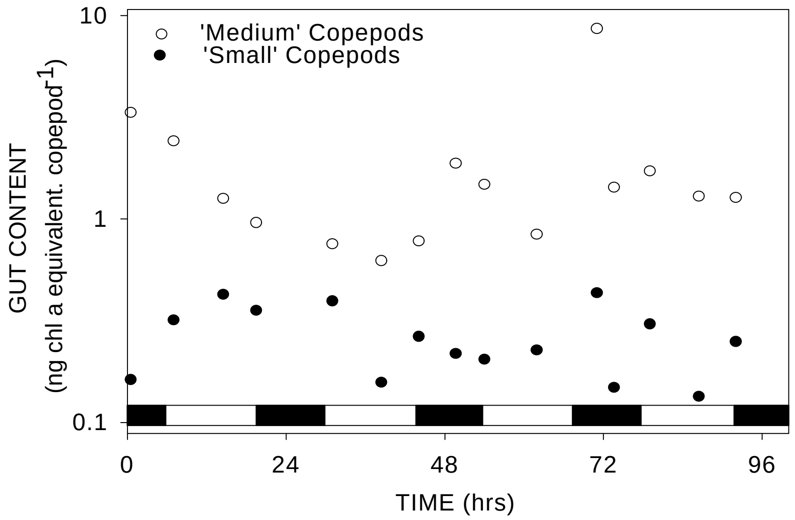


Figure 6. Gut pigment content for the small (closed circles) and medium (open circles) sized copepods from the 14th to 18th August 1998. Horizontal bar indicates day (light) and night (dark).

Estimates of total phytoplankton consumption by the copepod community over the top 200 m of the water column calculated from our herbivorous ingestion and abundance values varied from 660 to 1123 μg Chl *a* m^{-2} day^{-1}. The variability in grazing impact over the course of this study was predominantly attributable to differences in abundance of the small copepods, which had the greatest overall impact throughout the study period at 521 to 954 μg Chl *a* m^{-2} day^{-1} (figure 7).

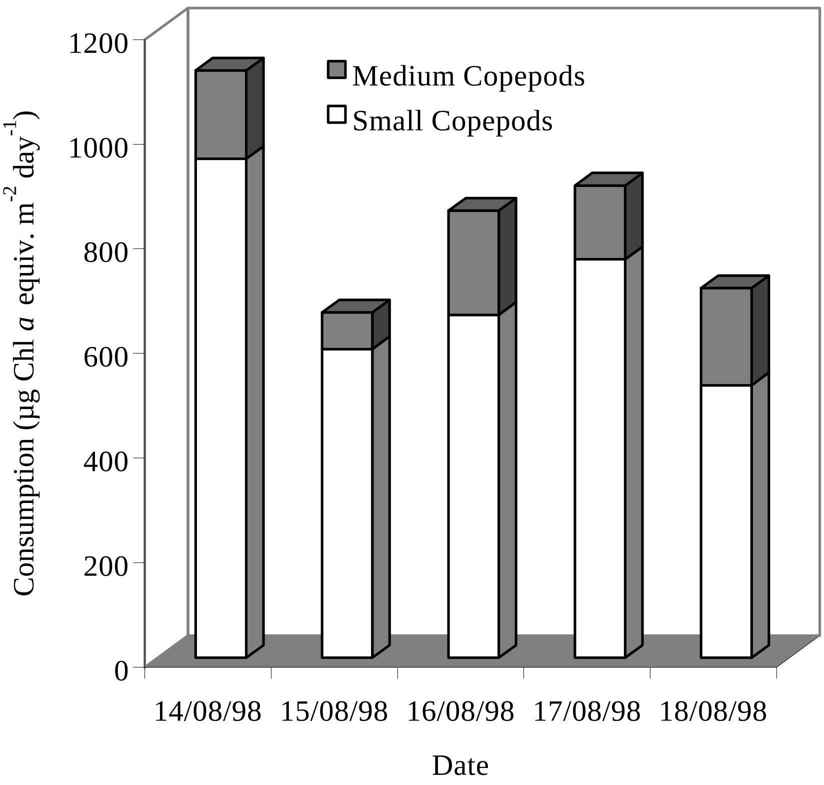


Figure 7. Copepod community grazing rates integrated over the top 200 m of the water column

Acknowledgements
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References

Irigoien X (1998). Gut clearance rate constant, temperature and initial gut contents: a review. *Journal of Plankton Research* 20: 997-1003.

Morales CE, Bedo A, Harris RP, Tranter PRG (1991). Grazing of copepod assemblages in the north-east Atlantic: the importance of the small size fraction. *Journal of Plankton Research* 13: 455-472.