Microzooplankton distribution, biomass and herbivory at the Iberian margin

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INTRODUCTION

Microzooplankton are tiny (<200µm in size), phagotrophic organisms that are common in marine surface waters. New enumeration techniques have recently shown that microzooplankton often dominate the grazing flux in surface waters and so are quantitatively important in biogeochemical cycles of C and N. This is particularly true of the export of particulate organic matter (POM) from the surface waters into deep ocean (Longhurst et al., 1989). Both processes of vertical migration and faecal pellet production provide mechanisms for the vertical export of POM from the surface mixed layer. The realisation that microzooplankton often dominate the grazing flux in surface waters suggests a contrasting situation to that of the copepod dominated system. Due to their small size, the microzooplankton are unable to vertically migrate across the surface mixed layer and into the deep ocean. Their faecal material is small and will not sink out in the surface waters. As a result, when microzooplankton grazing predominates over that of the larger zooplankton POM is maintained in the surface mixed layer (Longhurst & Harrison, 1989).

If microzooplankton herbivory formed a significant proportion of the primary production, this would suggest that phytogenic carbon could not fuel ocean margin sediments as proposed by the depocentre hypothesis of Walsh et al. (1991). Microzooplankton grazing was found to be significant in the Celtic Sea during OMEX I and it was anticipated that export of PMO to deep ocean was minimal in summer months. Published information on herbivory by microzooplankton communities in the Iberian Margin system and on their abundance, distribution and biomass is scarce. It is therefore the objective of this study to generate information on the role of microzooplankton and their herbivorous activity within the Iberian upwelling system.

METHODS

Quantifying microzooplankton herbivory

In the absence of any work package 1 cruise this year we participated in a WPII cruise onboard FS Poseidon during Feb/March in order to generate some WPI winter grazing data. A total of 12 microzooplankton grazing experiments were carried out using the dilution technique described by Landry & Hassett in 1982. Experimental water was collected pre-dawn from a depth of 10m. Half of this water was filtered through a 0.2µm capsule filter, which had been pre-rinsed in de-ionised water. The remaining water was pre-screened using a 200µm mesh bag to exclude larger predators. A series of dilutions were made up by gently combining the screened water with the filtered in 2 litre polycarbonate bottles. All incubations were carried out over a 24 hour period in an ambient temperature-cooled deck incubator screened to the 33% light level. Sub-samples were taken at T0 and T24 from each bottle for the determination of chlorophyll concentration and community structure. All chlorophyll samples were extracted with 90% acetone and analysed on board by fluorometry.
Microzooplankton grazing has been determined from measurements of the specific growth rate of phytoplankton that were made assuming the exponential growth equation of Landry & Hassett (1982):

$$1/t.\ln (Pt/P0)=k-c.g$$

where Pt = chlorophyll concentration at time t; P0 = initial concentration of chlorophyll, k and g are instantaneous coefficients of population growth and grazing-related mortality respectively, and c =relative concentration of the prey and predator population. Values of k and g were determined from linear regression of the specific phytoplankton growth rate against the fraction of undiluted seawater (c).

Microzooplankton abundance, biomass & community structure

Microzooplankton samples have been collected on 3 WPII cruises over the last year (Table 1). Samples were obtained from CTD water bottle casts in vertical profiles along onshore offshore transects across the ocean margin and adjacent shelf and ocean regions. Water samples were fixed in a) 1% Lugol's iodine (for organisms 20-200 µm) and b) 0.3% glutaraldehyde and stained with DAPI and proflavine using standard techniques given in Burkill et al., (1994). All samples have been returned to the laboratory for analysis using inverted microscopy linked to an image analysis system and epifluorescence microscopy. Measurements of each cell were used to determine volume, this in turn has been multiplied by relevant volume to carbon conversion factors to compute biomass. Biomass values will be converted to standing stocks by integration through the surface mixed layer.

SCIENTIFIC RESULTS & DISCUSSION

WP1

Data from grazing studies carried out at sea suggest that microzooplankton grazing was high with up to 75% of the phytoplankton population being turned over per day. Examples of dilution plots obtained from experiments are shown in Figure 1. Using a chlorophyll to carbon conversion factor of 35 this is equivalent to up to 40mg C m^{-3} grazed daily by the microzoopankton in surface waters (Figure 2). Lowest grazing was found at offshore stations and highest grazing was found at the 100m station on the P-transect. Corresponding phytoplankton growth rates determined from dilution experiments were lowest at the shelf station P100 and highest at oceanic station P3000. This is interesting as it suggests that there was an inverse relationship between growth and grazing at that time. One explanation for this could be the high chlorophyll concentrations at station P100 and low nutrient levels i.e. large numbers of cells competing for resources.

As well as participation in Poseidon cruise this year WPI activities have involved participation in two workshops to discuss the WPI field programme and to decide on a clear, and integrated work schedule for the WPI cruise on Charles Darwin in August 1998. Discussions of WPI grazing activities at the Paris workshop in November 1997 were co-ordinated by Elaine Edwards. Information on these discussions can be found in the WP1 workshop report, compiled by Paul Wassman.

WPII

Task 5.5 : Carbon biomass

Microzooplankton biomass has been determined for some 20-200µm samples collected during March 1998. Biomass in surface waters ranged from 0.8 to 6.8mgC m^{-3}. Highest biomass was found at shelf stations. This value of 6.8mgC m^{-3} for the shelf waters is higher than expected for supposedly winter conditions. However, chlorophyll concentrations were also higher at this station and diatoms were abundant indicating that the spring bloom had already begun.

Task 9.1: Distribution of bacteria & microzooplankton

Preliminary analysis of Lugols fixed samples show microzooplankton to be abundant during March particularly at the shelf stations with abundance of 20-200µm size class ranging from 0.6 to 10 cells ml^{-1} in surface samples. Lowest abundance was found at oceanic deep water stations. There was a distinct shift in the microzooplankton community composition which appeared to be as a result of changes in the composition of the phytoplankton community. In

shelf waters where diatoms were the main phytoplankter, heterotrophic dinoflagellates comprised 60% of the total biomass. In deeper water stations the phytoplankton community was dominated by smaller picoplankton and the microzooplankton community comprised smaller oligotrich ciliates and very few heterotrophic dinoflagellates.

The results from our first sample analysis of microzooplankton suggest that they are abundant in surface waters particularly on the shelf. Their distribution varies spatially across the shelf and this distribution is likely to be associated with variation in the phytoplankton community. Our WPII activities over the past year have mostly involved sample collection and participation in Poseidon cruise 237/1. Analysis of samples is now underway and will continue into year 2. Our plan for year 2 involves collection of more samples on two cruises during the summer. Firstly the Belgica, cruise 98/15 (June/July), these samples will allow us to generate information on the inter-annual variation of microzooplankton abundance and biomass. Secondly, on an August cruise on a Russian research vessel we will obtain samples which will complement work to be carried out during the WPI Charles Darwin cruise.

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TABLE 1: Microzooplankton and heterotrophic nanoplankton samples have been collected on the following WPII cruises during Year 1.

CRUISE	DATE	STATION	DEPTH PROFILE
CD 105	10/6/97	N-30	0-30
	11/6/97	N100	0-100
	11/6/97	N1600	0-200
	11/6/97	N2300	0-100
	12/6/97	O2650	0-100
	13/6/97	P2000	0-100
	14/6/97	V3100	0-100
	15/6/97	V1150	0-100
	15/6/97	V160	0-70
	15/6/97	V55	0-50
	17/6/97	S130	0-100
	19/6/97	S2600	0-100
CD 110	14/1/98	P2800	0-155
		P200	0-180
	15/1/98	P100	0-100
		P1000	0-205
Poseidon 237/1	28/2/98	P2000	0-120
	1/3/98	P1650	0-80
	2/3/98	P100	0-80
	5/3/98	S100	0-100
	6/3/98	N200	0-100
	7/3/98	N3000	0-180
	8/3/98	P1500	0-180
	9/3/98	S1000	0-150
	10/3/98	S2756	0-150
	11/3/98	P1500	0-150
	12/3/98	Q500	0-150
	13/3/98	P200	0-180

Figure 1: Examples of dilution plots obtained from grazing experiments carried out during Poseidon cruise 237/1 Feb/March 1998.

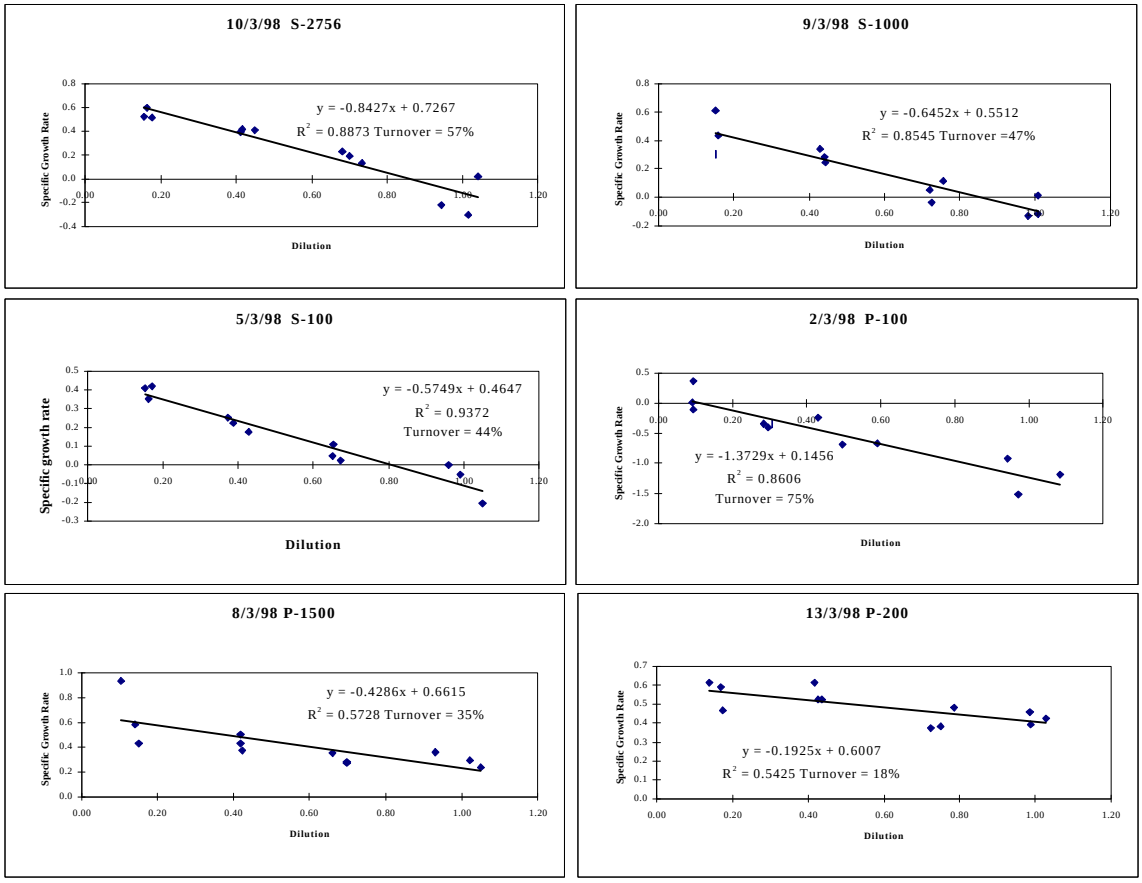

Figure 2: Microzooplankton grazing at different stations (depicted by water depth) during Poseidon cruise 237/1 Feb/March 1998.