Biomass, grazing and regeneration of nutrients mesozooplankton in the Iberian upwelling region

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Task II.6.2 Planktonic production of DOC

To estimate the herbivorism effect by copepods upon DOC production rates, one experiment was performed with *Calanus helgolandicus* and *Calanoides carinatus* collected from station 16. 5 replicates were carried out incubating 3 individuals on each flask (125 ml), and other 5 flasks were used as control, without copepods.

The variables measured are summarised in Table 1. There is no significative differences on DOC production rates between control and treatment (with copepods) flasks, but if we consider the percentage of DOC production respect to total production (DOC + POC), this value is significatively higher in the flasks with copepods, due to their herbivory activity. In Table 3, we can see the copepods feeding effect on chlorophyll stock.

Variable	**Without copepods**	**With copepods**	**p**
Photosynthesis (mg C m^{-3} h^{-1})	8.79 ± 0.18	7.51 ± 0.19	< 0.01
DOC production (mg C m^{-3} h^{-1})	0.22 ± 0.02	0.26 ± 0.01	0.12
Total production (mg C m^{-3} h^{-1})	9.02 ± 0.18	7.77 ± 0.19	< 0.01
% DOC released (*)	2.59 ± 0.11	3.27 ± 0.16	< 0.01

(*) : proportion of DOC production respect to total C incorporation

Table 1. Average values of POC, DOC and TOC production in control and treatment flasks.

	t = 0	**t = end of incub.**	**p**
Without copepods	0.91 ± 0.01	0.91 ± 0.07	0.04
With copepods	0.91 ± 0.01	0.62 ± 0.11	0.37

Table 2. Differences in chlorophyll *a* (mg Chl *a* m^{-3}) between the start and the finish of the incubation in control and treatment flasks.

Task II.10.1 Zooplankton distribution and seasonality

Mesozooplankton samples to estimate abundance and biomass were taken at 20 stations by means of vertical hauls from 200 m (or near the bottom at coastal stations) to the surface. The samples were collected with a WP2 net triple of 40-cm diameter and fitted with 200-µm nylon netting. All the samples were fractionated on three size classes: small (200-500 µm), medium (500-1000 µm) and large (> 1000 µm).

Biomass

High values of phytoplankton biomass are observed at coastal areas (more than 90 mg-Chl *a* m^{-2} at stations 2, 3, 8 and 19), decreasing towards the oceanic stations (Fig. 1).

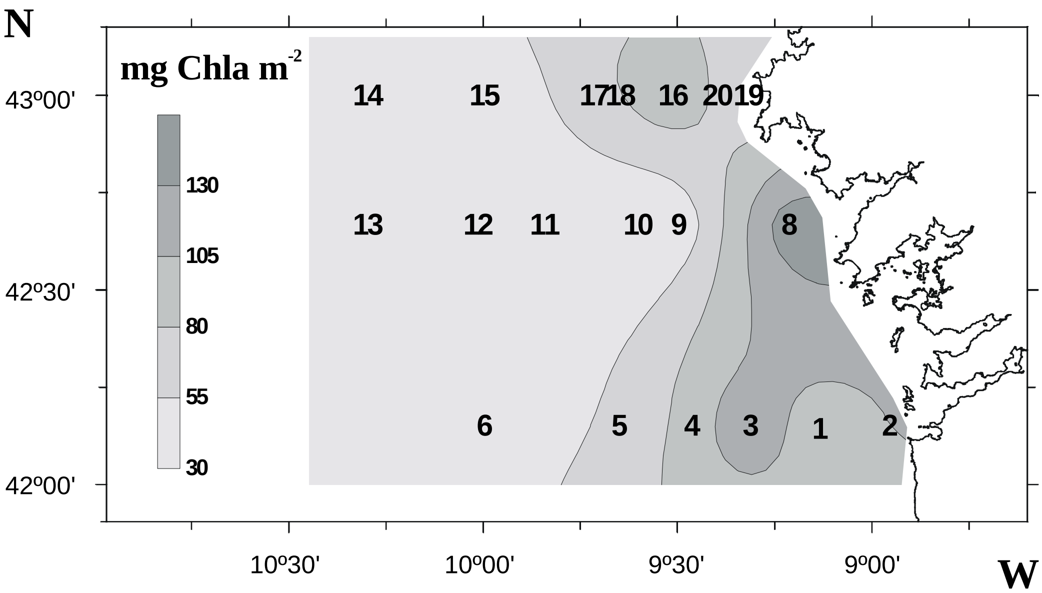


Fig. 1. Phytoplankton biomass during *OMEX-0898* cruise.

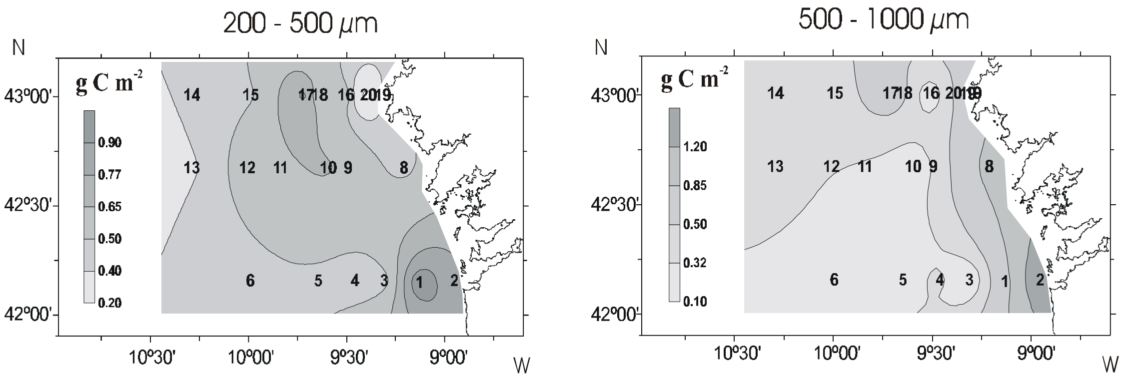
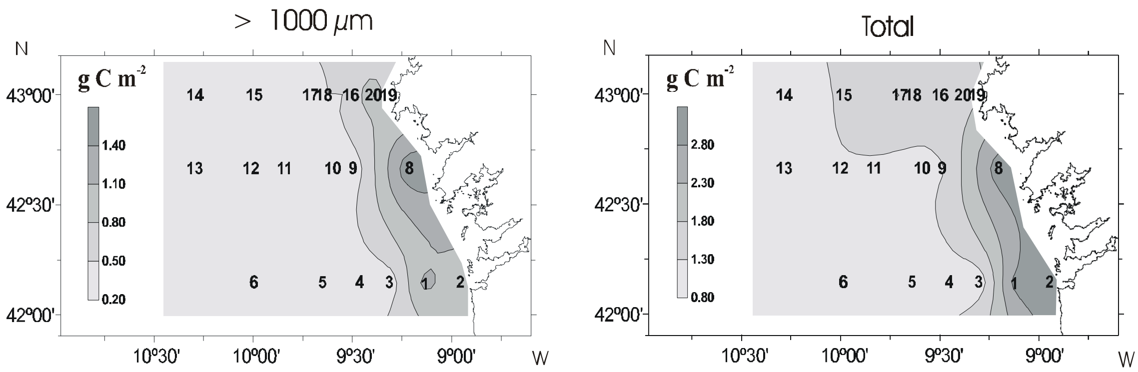


Fig. 2. Mesozooplankton size-fractionated biomass (mg C m^{-2}) during *OMEX-0898* cruise.



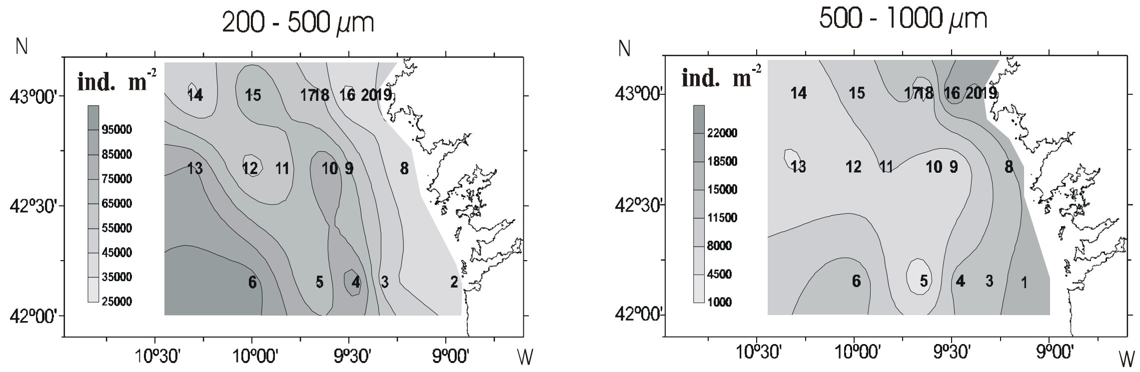
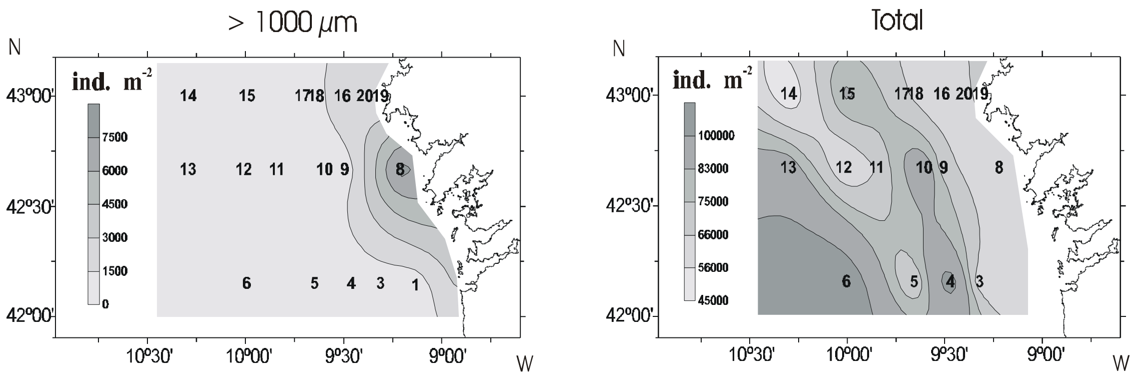


Fig. 3. Copepods size-fractioned abundance (ind. m^{-2}) during *OMEX-0898* cruise



Mesozooplankton biomass follows in general the same pattern of spatial distribution. For the smallest size class (200-500 µm) there is a maximum associated to the shelf-break at the northern transects, but for the fractions medium and large there is a gradient of biomass from coastal to oceanic stations, and this is the pattern when we consider the sum of the three size classes (Fig. 2). High values of mesozooplankton biomass were measured on coastal stations, reaching more than 2.80 mg C / m^2 on this area.

Total mesozooplankton biomass is dominated by the large fraction, as we can see in the scale in Fig. 2.

Abundance

The values of abundance are referred only to copepods, which is the more abundant group of mesozooplankton.

The numeric distribution shows the highest levels for the small fraction on the shelf-break area, whereas the other two size classes follow the same pattern of spatial distribution that we saw in the case of biomass: the highest values near the coast, decreasing towards the outer stations (Fig. 3).

Considering total copepod abundance, the highest values are reached on the shelf-break area because of the contribution of the smallest size class. We can see the relative importance of each fraction regarding to the graphics scales in Fig. 3.

The unbalance between copepods abundance and mesozooplankton biomass could be also affected by a higher relative importance of meroplankton and gelatinous zooplankton in coastal areas off NW Spain, specially during summer (Bode *et al*., 1998).

Thus, the small fraction seems to be associated to a front on the shelf-break area, whereas the spatial distribution of the medium and large size classes is coupled with the phytoplankton biomass distribution.

TASK II.10.2 Zooplankton Grazing, Exudation & Faecal Export

Copepod ingestion rates were estimated on 18 stations, using the gut fluorescence-evacuation method (Mackas and Bohrer, 1976). Each sample was divided on three size classes: small (200-500 µm), medium (500-1000 µm) and large (>1000 µm). We took only daytime samples, and thus the values of gut contents could be underestimated. Six gut evacuation experiments were performed, taking subsamples every 5 min during half an hour approximately.

The highest values of gut contents were observed at coastal stations (Fig. 4), as is expected in an area affected by upwelling, because of more available source of food (*e.g.*, Dagg *et al.*, 1980). The copepod gut contents ranged from 0.10 to 2.19 ng Chla-eq / ind for the small fraction, from 0.23 to 3.04 ng Chla-eq / ind for the medium fraction, and from 0.71 to 3.14 ng Chla-eq / ind for the large fraction.

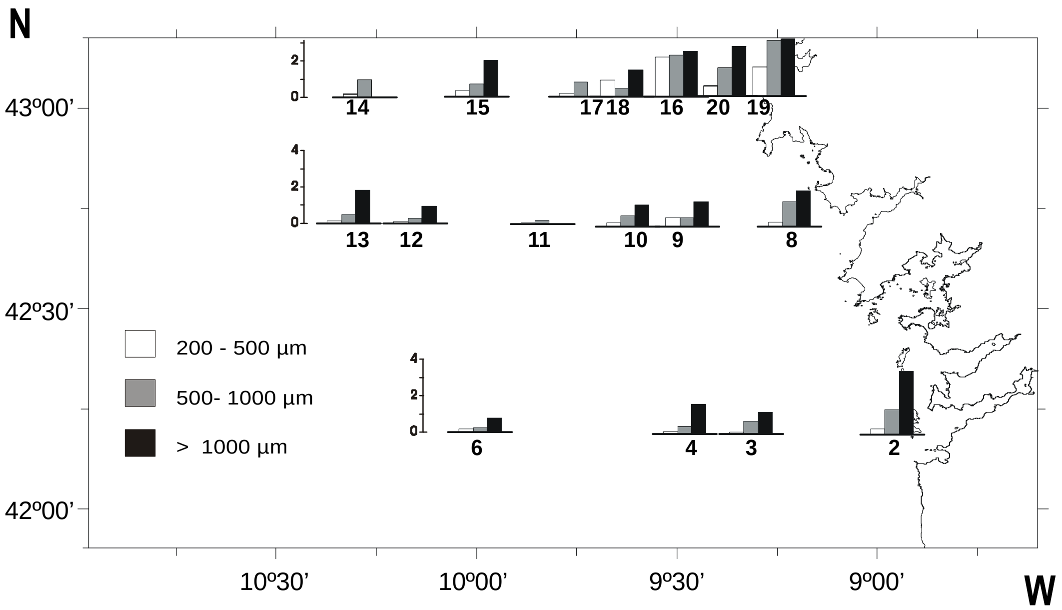


Fig. 4. - Copepods gut contents (ng Chla-eq / ind) during *OMEX-0898* cruise.

Station	Fraction (µm)	k	r^2
4	200 - 500	0,0141	0,51
	500 - 1000	0,0190	0,50
	> 1000	0,0564	0,82
7	200 - 500	0,0204	0,33
	500 - 1000	0,0209	0,52
	> 1000	0,0491	0,72
8	200 - 500	0,0361	0,83
	500 - 1000	0,0345	0,91
	> 1000	0,0285	0,55
10	200 - 500	0,0262	0,52
	500 - 1000	0,0204	0,74
	> 1000	0,0533	0,60
16	200 - 500	0,0338	0,55
	500 - 1000	0,0403	0,76
	> 1000	0,0428	0,88
19	200 - 500	0,0387	0,77
	500 - 1000	0,0403	0,88
	> 1000	0,0428	0,94

Table 1. Gut evacuation constants k (min^{-1}) calculated on six gut evacuation experiments performed during the *OMEX-0898* cruise.

The gut evacuation constants obtained from the gut evacuation experiments are showed in Table 1. No differences were found in gut evacuation constants by size or location (test of slope parallelism, p >0.05), and thus we took the mean value (0.036 min^{-1}).

From gut contents, gut evacuation rates and copepods abundance, we can estimate the community ingestion and their impact on phytoplankton biomass. The higher values were reached for the small fraction, due to its higher abundance (Fig. 5).

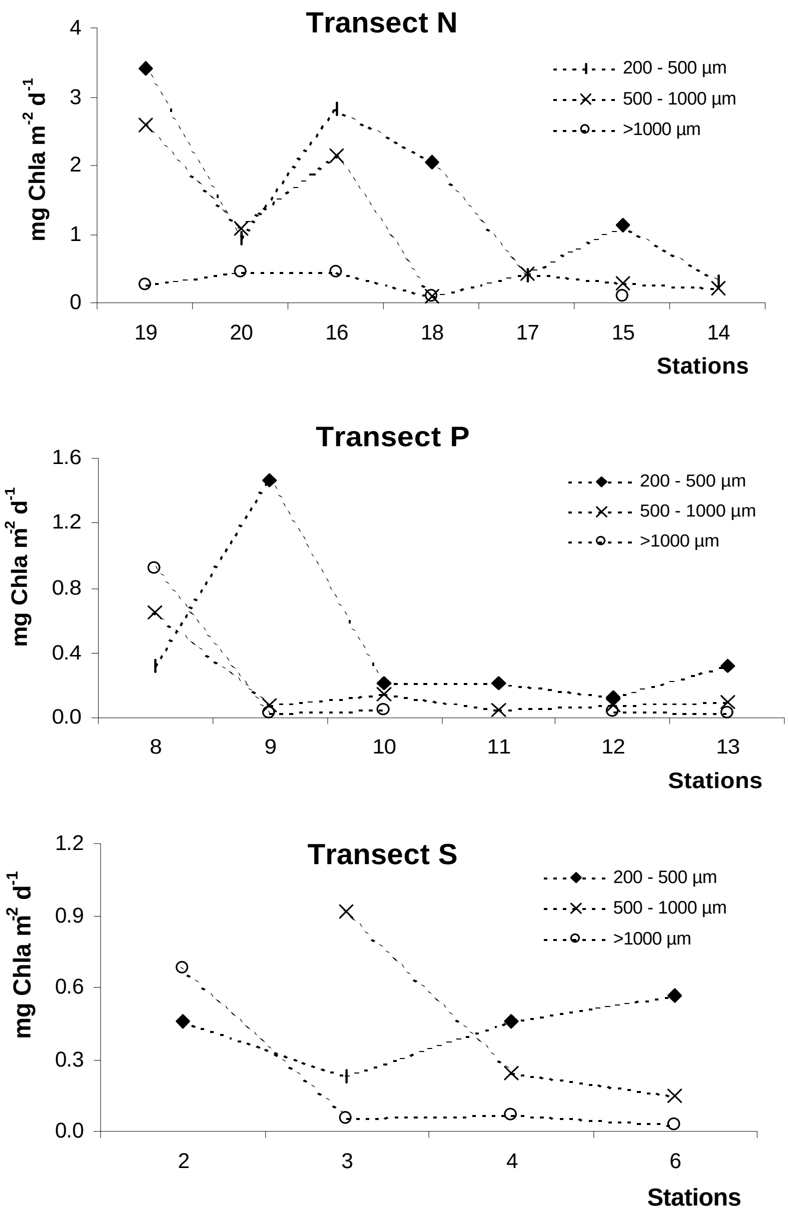


Fig. 5.- Total copepods size fractionated daily ingestion (mg Chl *a* / m^2 day).

The average value of percentage of phytoplankton biomass grazed daily by copepods was 5.52 % of chlorophyll stock. If we consider only the phytoplankton greater than 5 µm, the percentage grazed by copepods rise to 13.68 %. This higher value is due to the fact that copepods are not able to efficiently graze particles below 5 µm (Berggreen *et al*., 1988).

The percentages of phytoplankton biomass grazed by copepods at the different stations are showed in Fig. 6.

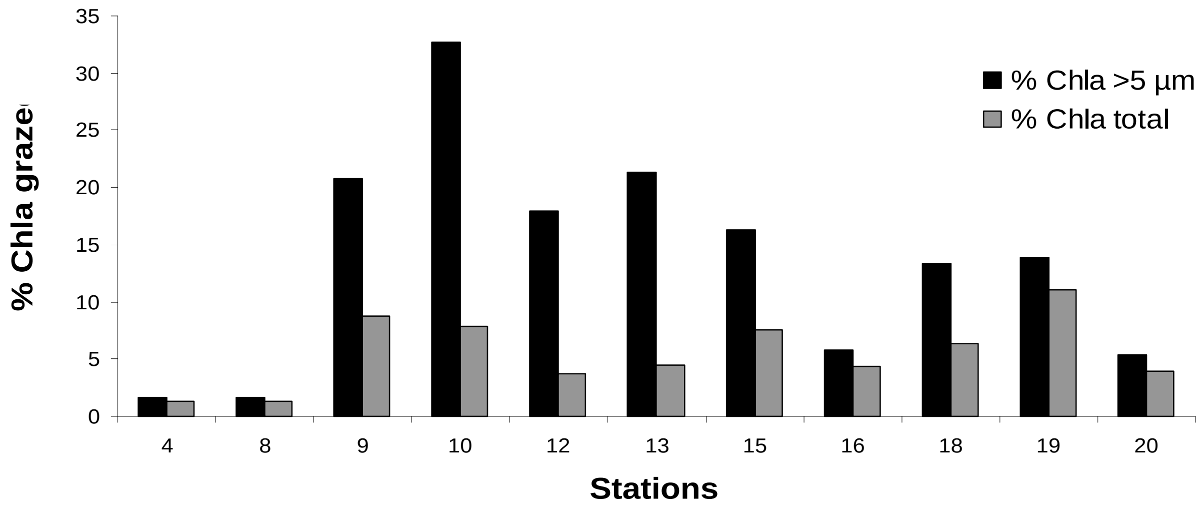


Fig. 6.- Copepod grazing impact on chlorophyll stock.

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