Phytoplankton size-structure in relation to carbon and oxygen fluxes through microplankton in the NW Iberian upwelling region

Emilio Fernández, Eva Teira, Pablo Serret, Cristina Panete

Facultad de Ciencias del Mar, Universidad de Vigo
Campus Lagoas-Marcosende, E - 36200 Vigo, Spain

Objectives:

1. To determine distribution patterns and primary production rates of different phytoplankton size-classes in the NW Iberian region during the upwelling season.

2. To quantify the fraction of photoassimilated carbon flowing to the DOC pool and rates of net community production in relation to phytoplankton size structure

Sampling and methods

Sampling was carried out during *OMEX-0898* cruise (between 1 and 11 August 1998). Size-fractionated chlorophyll *a* and primary production rates, DOC production rates, and rates of oxygen production and respiration by microplankton were measured at several stations located along three sections perpendicular to the coast (Fig. 1). Sampling and analytical methods used in this investigation are detailed in the *OMEX-0898* cruise report.

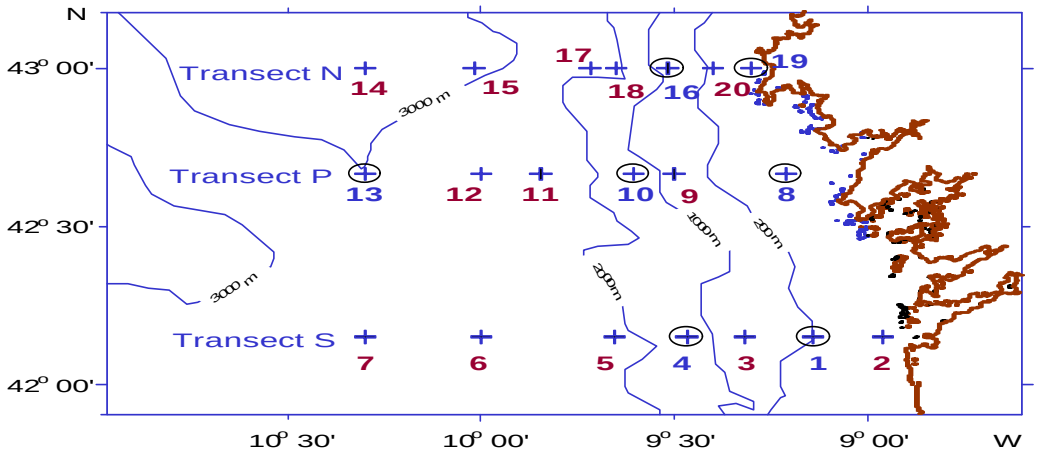

Fig. 1 Map of sampling stations. Biological stations are encircled.

Size-fractionated chlorophyll *a* and primary production

The physical and chemical conditions prevailing during *OMEX-0898* have been described in the cruise report as well as in the IEO contribution to this scientific report. As expected, clear differences in size-fractionated chlorophyll *a* were found between upwelled and off-shelf stations. Large-sized phytoplankton (>5 µm) accounted for more than 80% of total chlorophyll *a* at coastal upwelled stations. The contribution of >5 µm cells was also relevant (>40%) at the deep chlorophyll *a* maximum of transect N. This percentage decreased from coastal to open oceanic waters as well as with depth. An opposite pattern was found for the small phytoplankton size fractions, being the <2 µm fraction the dominant at oceanic stations.

The contribution of the different phytoplankton size fractions to primary production displayed a very similar pattern to that of phytoplankton biomass (Fig. 2). Rates of primary production were higher in coastal upwelled stations with a maximum value exceeding 20 mg-C m^{-3} h^{-1} at station 8. This maximum rate was coincident with the maximum concentration of chlorophyll *a*. The spatial distribution of chlorophyll *a* was well correlated with the rate of primary production, except at station 10, where maximum values of phytoplankton biomass were found at deeper levels than the maximum rate of photosynthetic carbon incorporation. Such observation agrees with the downwelling of subsurface waters in shelf-break stations of transect P. The lowest rates of primary production were measured in transect S, where upwelling conditions were less intense.

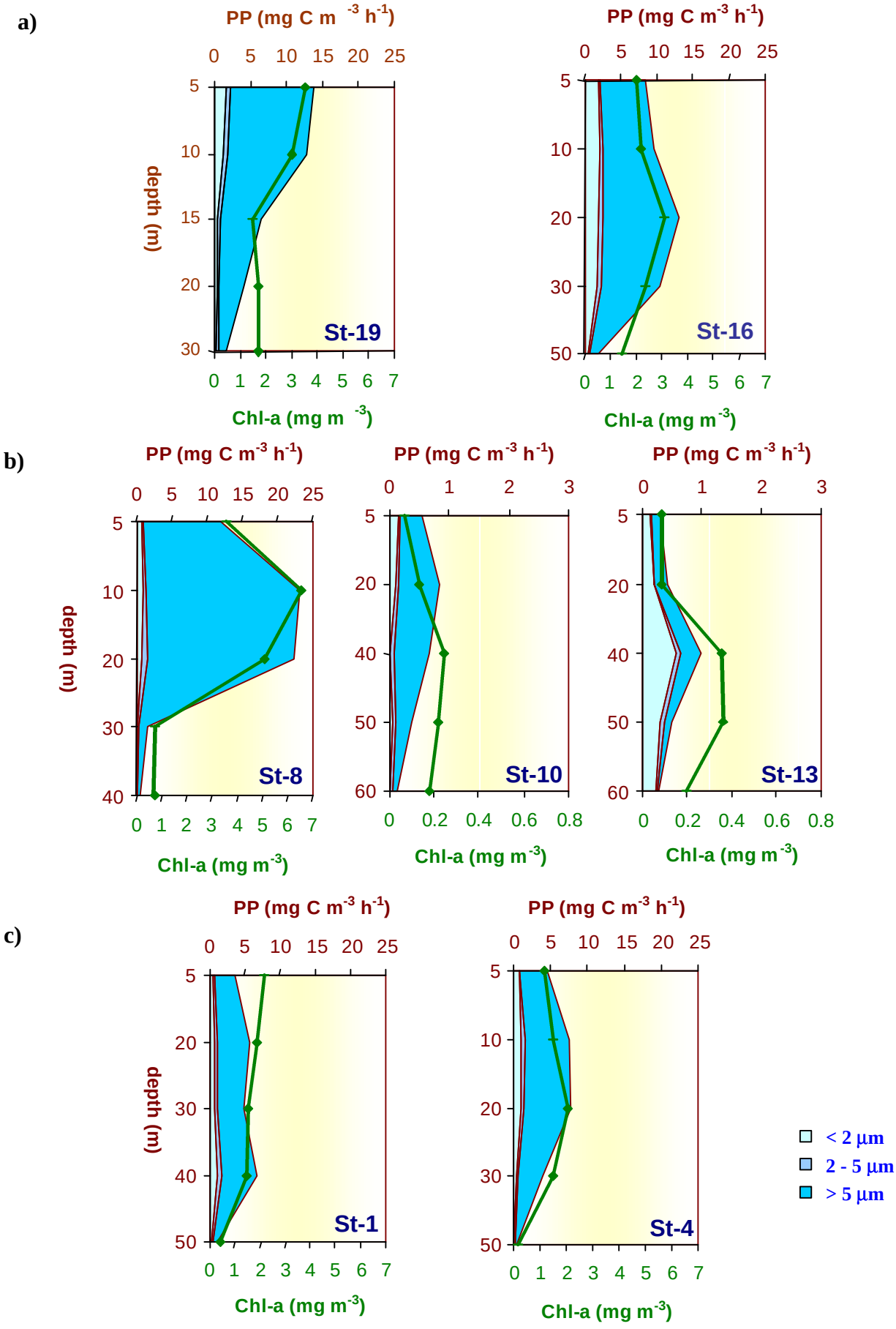

Fig. 2.- Vertical profiles of chlorophyll *a* and size-fractionated primary production at: a) transect-N, b) transect-P and c) transect-S. Note the different scales for st-10 and st-13.

DOC production by microplankton

The rates of DOC production by microplankton are shown in table 1. In upwelling stations, rates of DOC production ranged from 0.10 to 2.81 mg C m^{-3} h^{-1}, representing from 4% to 46 % of total primary production (TPP). Relatively high percentages of DOC production with respect to total primary production (35% and 46%) were found at deeper samples where TPP was significantly lower. Unfortunately, reliable measurements of DOC production at offshore oligotrophic stations were not obtained.

Carbon and oxygen fluxes through the microplankton community

A tentative budget of carbon flow through microplankton was built up using all the data collected in this cruise (Fig. 3). At coastal upwelled stations, larger than >5 µm phytoplankton was the most important size-fraction in terms of biomass and accounted for ca. 80 % of primary production. About 13 % of the amount of photosynthetically incorporated carbon flowed to the DOC pool. Microplankton respiration rates represented 37 % of primary production, thus indicating an autotrophic metabolism for the coastal area.

By contrast, small-sized primary producers were the most abundant size-fraction at the off-shelf station 13, accounting for almost 55 % of total primary production. The very high respiration rates measured at this station as compared to carbon incorporation rates were indicative of the heterotrophic behaviour of the stratified region.

Specific contributions to Work Packages II and IV

Task II.6.2. Planktonic production of DOC. As reflected in Table 1, experiments for the determination of DOC production rates were carried out during cruise OMEX898. Delivery of the data set to BODC will be done before the end of July 99. One experiment was carried out to assess the effect of mesozooplankton grazing upon DOC production rates. The result of that experiment is shown in the scientific report corresponding to the University of Oviedo.

Task II.8.1. Spatial and temporal distribution of phytoplankton biomass, species, pigments and their remote sensing. Size-fractionated chlorophyll *a* concentrations were determined at 15 stations during cruise OMEX898. The data set will be delivered to BODC before the end of July 1999.

Task II.8.6. Spatial and seasonal distribution of primary and new production. Size-fractionated primary production rates were measured at 7 stations during cruise OMEX898. In addition, the rates of microbial O_2 production and respiration were quantified at 4 stations during the cruise mentions above. The data set will be delivered to BODC before the end of July 1999.

Plans for next year

The University of Vigo will take part on cruise *OMEX-1099* that will be carried out on board RV Thalassa from 13 to 21 October 1999. UVI scientists will measure the same variables as on the previous cruise (*i.e.*, Size-fractionated chlorophyll *a* and primary production, rates of DOC production and microbial O_2 production and respiration rates) with the aim to comparatively investigate the patterns of carbon cycling through microbial populations during upwelling and downwelling hydrographic situations. The date set expected to be collected on this cruise will allow us to build up budgets for different temporal periods.

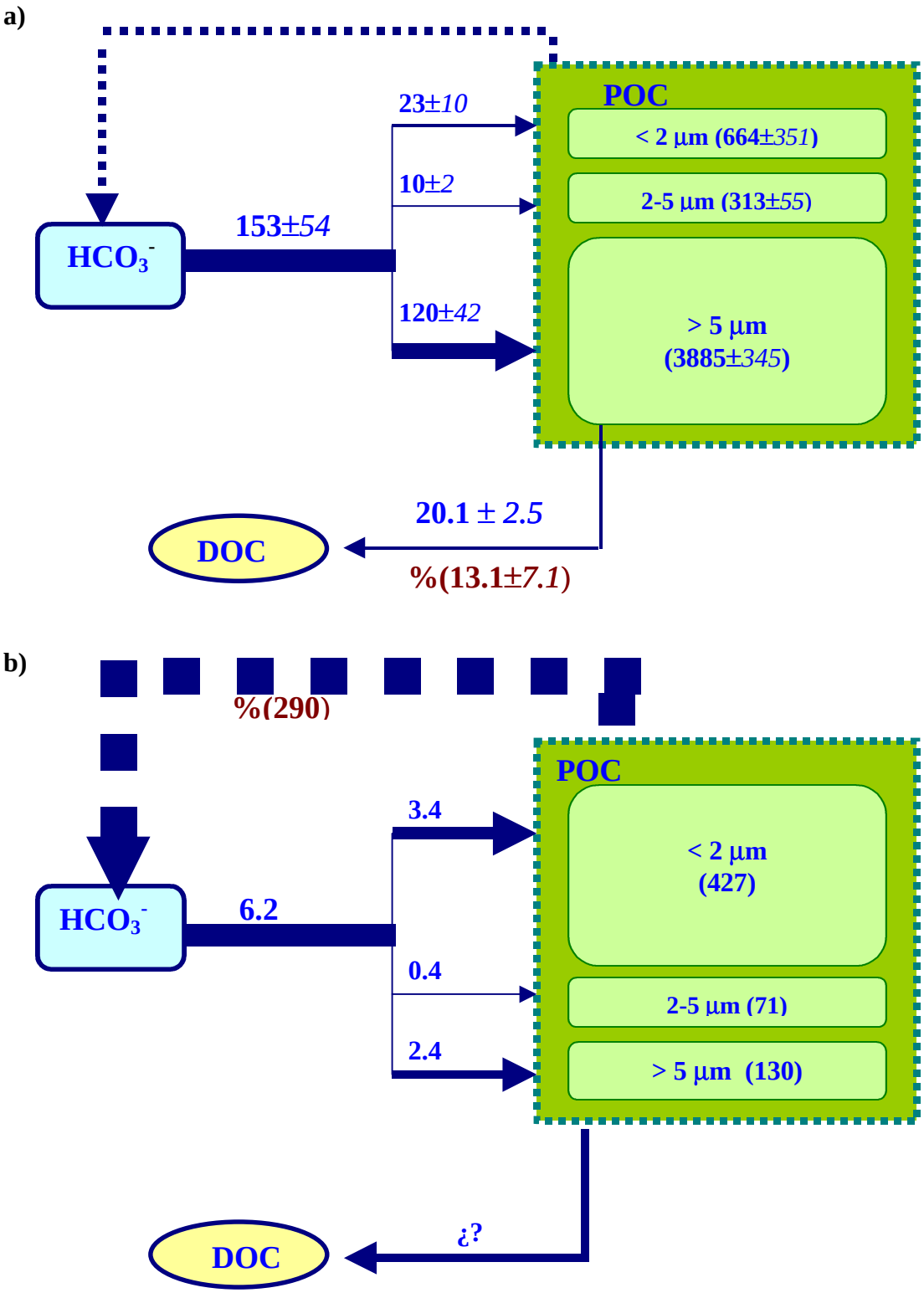

Fig. 3.- Tentative carbon balance for the upwelling region (a) and the off-shelf station (b). Photic-zone integrated values of carbon fixation, DOC production and respiration rates (both in mg C m^{-2} h^{-1}), as well as phytoplankton carbon biomass, estimated assuming a C/Chl *a* ratio of 50, are presented. The results shown in the diagram for upwelling regions were averaged data for stations 1 and 16. Those for the off-shelf region corresponded to station 13.

Table 1. Rates of DOC production by microplankton (DOCp; mg C m^{-3} h^{-1}) ± S.E and relative contribution of DOCp to total carbon incorporation (%DOC).

	St-1		St-4		St-8		St-16		St-19	
Depth (m)	DOCp	% DOC	DOCp	%DOC	DOCp	%DOC	DOCp	%DOC	DOCp	%DOC
5	0.48±0.01	8.8±0.6	0.27±0.02	4.3±0.2	1.22±0.08	5.5±0.3	0.45±0.03	3.3±0.2	1.74±0.21	6.4±0.7
10			0.46±0.02	5.3±0.6						
15									0.43±0.05	6.3±1.1
20			0.33±0.06	5.2±0.7	2.81±0.19	5.8±0.7	0.61±0.03	4.0±0.2	0.18±0.03	7.2±1.9
30	0.58±0.04	9.0±0.6								
40					0.37±0.04	34.9±3.1		5.4±0.4		
50	0.10±0.01	15.1±0.8	0.16±0.02	46.2±5.1			0.13±0.01			