

DOC production rates by plankton

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Introduction

Primary producers constitute the main source of potentially labile dissolved organic carbon (DOC) to the euphotic ocean (eg. Kirchman et al., 1991). Fluxes of organic carbon from phytoplankton to the dissolved pool are a significant component of the biogeochemical cycling of carbon in the upper ocean, typically representing between 5 and 30 % of total carbon fixation into the particulate fraction in various marine environments (see Norrman et al., 1995 and references therein), although much higher rates have been also measured (eg. Guillard and Hellebust, 1971)

The rate of DOC production under natural conditions depends largely on phytoplankton species composition (Mykkestad, 1995), the physiological state of the cells (eg. Lancelot, 1983 and references therein), and the activity of grazers (Hygum et al., 1997). Little is known on the functional dependence between these processes, specially as far as zooplankton grazing ("sloppy feeding") is concerned. However, herbivorism has been repeatedly reported in the literature as a significant source of DOC (eg. Jensen, 1984 ; Kirchman et al., 1993). As a result of the combined action of these factors DOC concentrations generally increase during the declining phase of phytoplankton blooms.

The production of dissolved organic carbon by microplankton in coastal and upwelling systems has been recognized as a relevant flux in the general framework of carbon cycling through the pelagic food web (Anderson and Zeutschel, 1970; Smith et al., 1977). It can thus be hypothesized that the high primary production rates generated by the upwelling of deep, nutrient rich waters, might lead to enhanced rates of DOC production mainly during the relaxation phase of the advection event when phytoplankton blooms became senescent (Kepkay et al., 1993, Norrman et al., 1995). Rapid cycling of labile DOC derived from upwelling-driven outburst of phytoplankton biomass is likely to be a key component of the carbon cycle in this region. In addition, primary production rates estimated without taking into consideration DOC production would lead to significant underestimations of actual carbon incorporation by phytoplankton thereby affecting the calculation of the global carbon budget for the upwelling region.

Method

DOC production rates were measured following the acidification and bubbling method by Mague et al. (1980). A series of modifications were carried out with the aim of reducing the variability associated with the decontamination procedure. The analytical protocol performed is summarized in Figure 1.

Four 35 ml water samples were inoculated with 35 μCi of NaHCO_3 and incubated for 2 hours to prevent, to a certain extent, recycling of recently produced DOC through the microbial compartment. An additional bottle containing 0.2 μm filtered seawater processed in the same way as described above was used as a blank. Two 10 ml subsamples were drawn from each replicate and filtered through GF/F glass fiber filters under extremely low vacuum pressure (< 75 mm Hg). Filters were decontaminated by fuming with concentrated HCl for 24 h. The filtrate was acidified with 75 μl of 6N HCl and bubbled with CO_2 free air for 24 h. Scintillation

cocktail was then added to both filters and filtrates and the radioactivity determined with a β scintillation counter. The variation coefficient calculated for series of blanks were always lower than 8 %.

Results and discussion

Rates of dissolved organic carbon released by plankton assemblages at shelf and shelf-edge waters of the NW Iberian Peninsula during winter ranged from about 0.1 to 2.2 mg C m⁻³ h⁻¹ (Table 1).

Table 1.- Rates of DOC production (mg C m⁻³ h⁻¹), standard deviation (s.d) and percentage of extracellular release (PER) at stations sampled during cruise CD110.

Station	Depth	DOC Production	s.d	PER
V110	8	2,084	0,542	45,2
V110	26	2,231	0,288	51,6
V110	51	1,148	0,139	55,1
V110	75	0,316	0,049	52,8
P200	8	0,116	0,028	6,7
P200	26	0,132	0,036	7,9
P200	52	0,126	0,035	25,7
P200	76	0,095	0,029	40,5
P1000	9	0,991	0,160	49,0
P1000	29	0,750	0,303	41,0
P1000	52	0,700	0,167	62,5
P1000	78	0,207	0,031	71,6

Sharp variations were detected between stations. The shallowest stations (st. V110; 110 m depth) showing the highest rates of DOC production. The rate of DOC released typically accounted for 40-50 % of total photosynthetically incorporated carbon by phytoplankton (PER). These percentages, although relatively high, are not exceptional as similar relative rates have been measured previously in other coastal areas (see eg. Anderson and Zeutschel, 1970; Lancelot, 1983). An exception to this pattern was found at station P200 where PER was lower than 10 % in the upper 30 m of the water column, then increasing progressively downwards. To our knowledge, these are the first data on rates of DOC release by plankton assemblages available for North-western Iberian waters. Further progress is expected when new sets of data, either already gathered or those to be collected in future cruises, would allow us the study of seasonal changes in rates of DOC production in the context of hydrographic variability.

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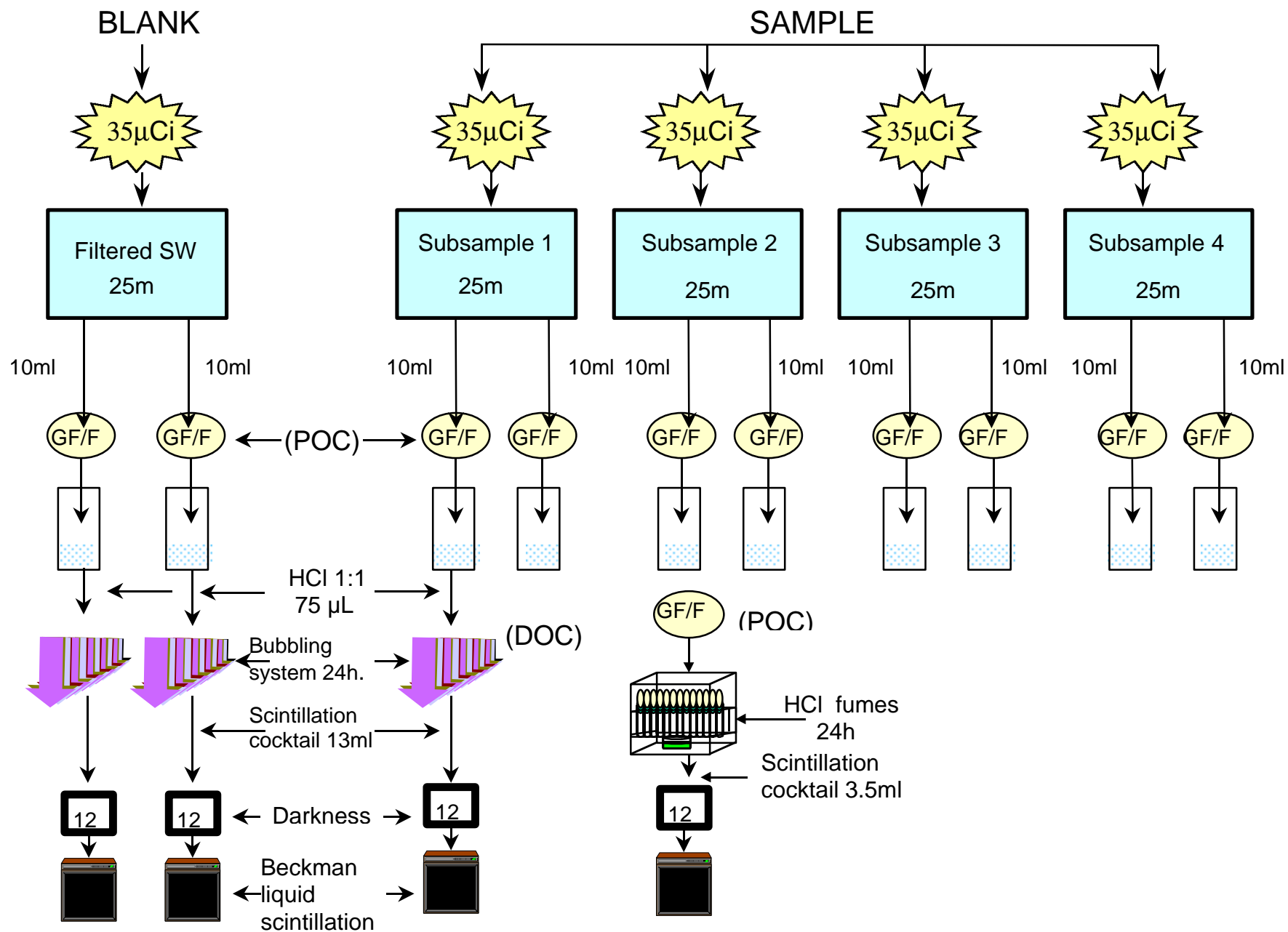


Figure 1.- Experimental protocol for the determination of dissolved organic carbon production rates in OMEX-II.