Size-fractionated planktonic nitrogen regeneration in the Iberian upwelling region

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Summary:

During the second year of the project efforts have been directed to the planning, preparation and realisation of cruise, specifically devoted to the measurement of the excretion of DOC and DON in the OMEX study area during an upwelling event in summer. In addition, basic hydrographic, chemical and pigment data have been collected during the cruise. Preliminary results were presented at OMEX II-II Annual Workshop. These activities correspond to project **Tasks II.2.1**, **II.4.1**, **II.9.2** and **II.10.2** of the Technical Annex. Also, parallel samples for CTD nutrient and DON intercalibration exercises were collected during the cruise as part of IEO contribution to **Tasks IV.2** and **IV.3**.

Descriptive:

Cruise *OMEX-0898* was organized by IEO on board the rented ship R/V *Professor Shtokman*. The cruise started on 1st August 1998 at La Coruña and ended at 11, August 1998 at the same port. The main objective of the cruise was the study of physical, chemical and biological properties in the continental shelf and shelf-break zone of the Galician coast near the Rias Baixas (NW Spain) during summer. The results obtained will be used as input data to models and biogeochemical budgets to determine the exchange of matter between the continental shelf and the ocean. The cruise was intended specifically to measure DOC and DON production rates, bacterial production and zooplankton excretion rates in the study area. Also, basic and complementary measurements and observations were collected to facilitate the interpretation of the measured rates and to improve the OMEX II-II, WP II database. In the cruise participated members of OMEX II-II research groups from Universidad de Vigo (Uvigo, Partner No. 21), Universidad de Oviedo (UOviedo, Partner No. 19) Universidade do Algarve (UAL, Partner No. 14a) and Plymouth Marine Laboratory (PML, Partner No. 4a). The specific objectives included:

1.- Physical and chemical oceanography:
1.1.- Measurement of vertical profiles of temperature, salinity and fuorescence in OMEX II-II reference stations (IEO).
1.2.- Measurement of dissolved inorganic nutrient concentration in coastal upwelling stations and oligotrophic oceanic stations (IEO).
1.3.- Measurement of dissolved organic carbon (DOC) and total dissolved nitrogen (PML).

2.- Phytoplankton:
2.1.- Study of distribution patterns of different size-classes of phytoplankton in the area (IEO, UVI).
2.2.- Comparative study of carbon and oxygen fluxes through phyto and microplankton in coastal upwelling stations and oligotrophyc oceanic stations (UVI).
2.3.- Study of the photosyntheticaly derived carbon fraction that fuels the microbial food-web in selected stations (UVI).
2.4.- Characterization of the dissolved organic matter (DOM) by chemical and optical methods (UVI).

3.- Microplankton:
3.1.- Measurement of the abundance of taxonomic and trophic groups of bacteria, flagellates and ciliates (UAL, IEO).
3.2.- Measurement of bacterial production rates in selected stations (UAL).
3.3.- Measurement of bacterial DOC consumption rates in selected stations (UAL, PML).
3.4.- Measurement of bacterial respiration rates in selected stations (UAL).
3.5.- Measurement of ammonium and dissolved organic nitrogen (DON) excretion rates of microplankton in selected stations (IEO).
3.6.- Measurement of production and respiration rates of the microplankton community in selected stations (UVI).

4.- Zooplankton
4.1.- Measurement of mesozooplankton abundance and biomass (UOv).
4.2.- Measurement of herbivory rates of copepods in selected stations (UOv).
4.3.- Measurement of copepod respiration rates in selected stations (UOv).
4.4.- Measurement of ammonium excretion rates of copepods in selected stations (UOv).
4.5.- Measurement of DOC and DON production rates in presence of copepods in selected stations (Uov, IEO, UVI).
4.6.- Determination of egg and feces production rates of copepods in selected stations (UOv).

Methods:

Sampling was made using CTD-Rossette casts and plankton hauls using nets. Stations were distributed in three transects normal to the coast, following the strategy adopted in OMEX II-II Workpackage 2 cruises (Figure 1). Transect N was located in the vicinity of Cape Finisterre. Transect P was located near Ria de Muros, and Transect S was at the latitude of Ria de Vigo. In all stations a CTD cast to the bottom was made, and water samples were collected by the Rossette bottles at standard depths to analyse inorganic nutrients. Zooplankton was also collected in all stations by vertical net hauls (WP_2) from 200 m (or near the bottom at coastal stations) to the surface. Irradiance vertical profiles and additional water samples for dissolved carbon and nitrogen determination, photosynthetic pigment analysis and plankton for on board experimentation were obtained in selected stations (Biological Stations). Each Biological Station was occuppied between 00:00 and 12:00 h (local time = GMT + 2) and there were made experimental measurements of primary production and DOC excretion, ammonium and DON regeneration, bacterial production and respiration, oxygen production and consumption by microplankton, and herbivory, ammonium excretion, egg and fecal pellet production rates of zooplankton. Details of analytical methods for the variables measured are listed in the cruise report (Bode, 1998).

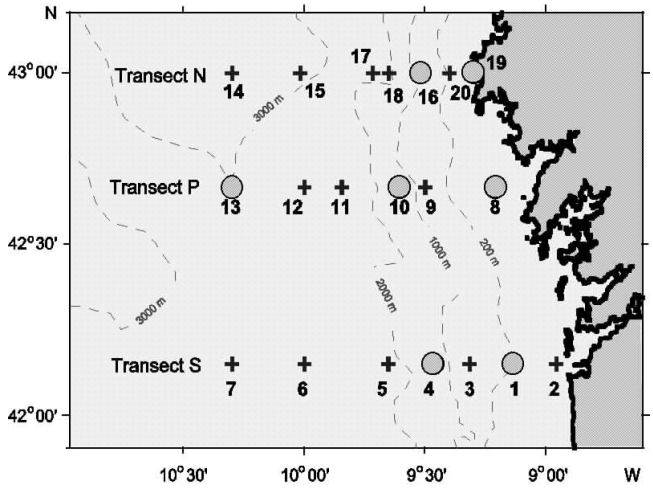

Figure 1. Position of sampling stations during *OMEX-0898* cruise. Biological stations are encircled.

Data for some variables were already processed and sent to BODC for storage and dissemination among OMEX II-II partners, particularly CTD data, dissolved nutrients and chlorophyll. Phytoplankton species abundance was also completed and distributed, along with a historical review of phytoplankton studies in the area (Varela *et al.*, 1999). A summary of the main results concerning oceanographic conditions, nutrients and chlorophyll-a found during the cruise was presented during OMEX II-II Annual Workshop from 25 to 27 April 1999 (Bode *et al.*, 1999). Details of the state of processing of most variables can be found in the reports for other participants and in their presentations during the referred Workshop (Galvao and Barbosa, 1999, Teira *et al.*, 1999, Isla *et al.*, 1999, Spyres *et al.*, 1999). Samples for DON measurements are being processed using the method of Slawyk and Raimbault (1995) and definitive results will be available during summer 1999.

Results:

During *OMEX-0898* cruise, upwelling occurred near the coast in all sections, where surface water temperature was < 15°C. In contrast, surface temperature of oceanic waters was near 20°C (Figure 2).

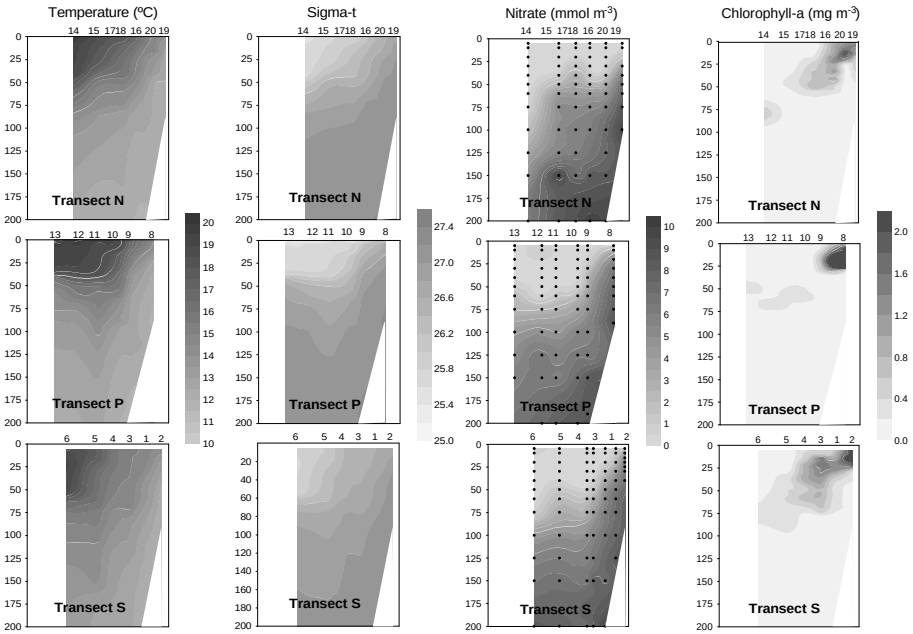

Figure 2. Distribution of temperature, sigma-t, nitrate and Chlorophyll *a* in OMEX II-II reference transects N, P and S during *OMEX-0898* cruise.

The distribution of isopycnals, almost coincident with that of temperature, indicated higher upwelling intensity in section N compared with the southern sections P and S. In the later sections, deepening of isotherms and isopycnals near the shelf-break suggested downwelling in this region. Nutrient concentrations (as exemplified by nitrate) reached highest concentrations in subsurface and deep waters of section N. Phytoplankton biomass (indicated by chlorophyll-a concentrations) increased near the surface in coastal stations, where maximum concentrations were found at < 20 m depth. The layer of maximum chlorophyll concentration deepened towards oceanic stations, where it reached depths > 75 m. The distributions of chlorophyll-a concentrations of sections N and S were similar, but section P resulted with a patchy pattern, with maximum values up to 7 mg m^{-3} near the coast. Upwelling greatly affected most concentrations (Bode *et al.*, 1999, Spyres *et al.*, 1999) and biological rates measured (Galvao and Barbosa, 1999, Teira *et al.*, 1999, Isla *et al.*, 1999).

Specific contributions to Work Package II and Work Package IV Tasks:

Task II.2.1. *Hydrography and water masses:* CTD data from *OMEX-0898* cruise have been processed and submitted to BODC. This is a voluntary contribution of IEO to OMEX II-II project.
Task II.4.1. *Nutrient oceanography*: Dissolved inorganic nutrients (nitrate, nitrite, ammonium, phosphate and silicate) were analysed at the laboratory of IEO-La Coruña from samples frozen on board during *OMEX-0898* cruise. Analytical procedures used at IEO-A Coruña were tested regularly in QUASIMEME intercomparisons. Parallel samples were collected and distributed to IIM (Partner No. 13) for intercalibration (**Task IV. 3**).
Task II.9.2. *Nitrogen regeneration*: Experimental incubations of microplankton with ^{15}N have been made during *OMEX-0898* cruise at 7 stations to determine DON production rates. Samples are being processed in the laboratory at IEO-La Coruña and results are expected to be available to OMEX II-II partners by the end of summer 1999.
Task II.10.2. *Zooplankton exudation*. An experiment to determine the role of copepods in the rate of DON production was conducted in collaboration with UOv and UVI during *OMEX-0898* cruise. Samples from this experiment are being processed and results are expected to be available to OMEX II-II partners by the end of summer 1999.
Task IV.1. *Water budget and circulation*: CTD data from *OMEX-0898* cruise were sent to BODC. Results of salinity measurement from water samples collected during this cruise are being processed and will be sent shortly.
Task IV.3. *Nutrients, trophodynamics and fertility*: Parallel samples for the determination of dissolved nutrients were sent frozen to IIM (Partner No. 13) for intercalibration. DON concentrations derived from the DON production rate measurement using ^{15}N will be compared with DON concentrations measured by IIM and PML when available.

Plans for the next year:

During the last year of the project analysis of *OMEX-0898* samples will continue to compute DON production rates during upwelling. Intercalibration of CTD, nutrients and DON measurements for this cruise will also be terminated. A cruise is already scheduled for DON excretion measurements in non-upwelling conditions. The cruise (*OMEX-1099*) will take part on R/V *Thalassa* from 13 to 21 October 1999 under the direction of IEO-La Coruña. The objectives of the cruise and planned measurements are identical to those of *OMEX-0898* cruise. An additional effort will be made to ensure that all data from this and past cruises will be delivered to BODC by the end of December 1999.

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