DIATOM BLOOMS AND PLANKTONIC PRODUCTION IN THE NW MEDITERRANEAN

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Summary
This contribution discusses the occurrence of diatom proliferations in western Mediterranean waters, with emphasis on the stratification period, and considers the composition of the planktonic food web of the NW Mediterranean within a general framework. The data are based on studies carried out in the Catalano-Balearic sea by the Pelagic Ecology Group of the ICM, largely as part of MTP-MAST projects.

Key-words : diatoms, primary production, food webs, Western Mediterranean

When globally considered, the Mediterranean can be characterized as an oligotrophic sea. The negative estuarine circulation in the strait of Gibraltar and Sicily appears to be one of the major causes of the proggressive decrease of nutrient concentrations in Mediterranean deep waters, along a gradient going from the Atlantic, through the straits of Gibraltar, to the eastern part of the basin. In addition, the Mediterranean lacks extensive upwelling regions comparable to those of the major oceans.

However, the Mediterranean planktonic production is not as low as could be expected from the manifest nutrient scarcity. This so-called "paradox of the Mediterranean" (1) can be extended to the consideration of living resources. The Mediterranean seems to produce more exploitable fish than can be predicted by simple usual models (2).

There are several possible explanations for this paradox. One is that the Mediterranean is far from being uniformly oligotrophic and presents a number of hydrographic features which contribute to increase its potential fertility, specially in its western basin (3). Another is the episodic character of many fertilisation events (including atmospheric inputs), which may have eluded observation. In addition, it could be that food chains in oligotrophic systems function in a more efficient manner than in eutrophic ones (4, 5).

The production of living resources in a pelagic area is related to the amount of new production and the structure and function of the planktonic food web. As a simplification it is usual to consider two extreme types of trophic pathways, the herbivorous (or "classical") trophic chain, with transfer from nano-microphytoplankton to metazoan zooplankton and other trophic levels, and the microbial food web, based on small phytoplankton, in which a large part of the synthesised organic matter cycles through bacteria, small flagellates and protozoan predators. The general oligotrophy of the Mediterranean and the dominance of stratification during much of the year favour an important role of the microbial food web. Another particular feature of the Mediterranean planktonic food web is the possibility of phosphate limitation of both heterotrophic bacteria and autotrophic plankton.

Recent technological developments including epifluorescence microscopy and cytofluorometry have helped in the study of the distribution of the smaller components of the plankton, from heterotrophic bacteria to autotrophic prokariotes and picoeukariotes. These organisms, as parts of the microbial food web, may account for a large part of the total carbon flux in oligotrophic situations. However, when considering exportable biogenic carbon fluxes, it is important to ascertain the contribution of the larger components of the phytoplankton. Among them, diatoms tend to show the faster response after fertilisation events and represent major contributors to new production and to export of biogenic C, as pointed out by studies of sediment trap samples.

This contribution attempts to consider 1) the conditions of appearance of diatom proliferations in western Mediterranean waters, with emphasis on the stratification period, and 2) to evaluate macroscopic characteristics of the composition of the NW Mediterranean food web within a general framework. The study will be based on data from surveys carried out in the Catalano-Balearic sea by the Pelagic Ecology Group of the ICM, largely as part of MTP-MAST projects (6).

The alternance of mixing and stratification periods confers strong seasonal variability to the magnitude of phytoplankton biomass in the Mediterranean. Diatoms are characteristic of the seasonal phytoplankton maxima which occur typically in autumn and late winter or early spring. These blooms are associated with the breakdown of the thermocline in late autumn, which facilitates input of nutrients into the upper layers, and with the stabilization of the water column in late winter-early spring. However, the occurrence of phytoplankton blooms is not limited to the autumn and winter seasonal maxima. During the stratification period, patches of high diatom concentration occur in the deep chlorophyll maximum (DCM), in frontal areas and in other ergoclines. Multivariate analyses show that these high phytoplankton biomass patches are dominated by a few diatom genera (Chaetoceros, Pseudo-nitzschia, Thalassiosira). However, not all relatively large diatoms are associated with high production conditions. Some diatom genera, like Rhizosolenia (with or without symbiotic cyanobacteria) may be found in the nutrient limited upper water layers. The localized character of the diatom patches found at the DCM and the other ergoclines suggests that they are the result of episodic fertilization events, probably related to phenomena like internal wave breaking or instabilities at fronts. The intermittent nature of such events makes it difficult to collect evidence of their effects on other trophic levels. However, there are examples of DCM diatom blooms accompanied by dense populations of mesozooplankton and high phaeophytin concentrations, presumably as a result of grazing activity. In the Catalan front, the presence of diatom populations of relatively large size (>5 m) has been associated with enhanced mesozooplankton production.

Current hypotheses suggest that the relative contribution of heterotrophs to total planktonic biomass decreases with increasing phytoplankton biomass and primary production (4, 5). Thus, oligotrophic marine areas would be characterized by a higher ratio of heterotrophic to autotrophic biomass than more eutrophic regions. The studies of the pelagic Ecology Group of the ICM indicate that this is indeed the case in the NW Mediterranean ecosystem. Theses differences in ecosystem structure could have important implications concerning the potential production of renewable resources in oligotrophic marine areas.

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