PHOTOSYNTHETIC PROKARYOTES (*PROCHLOROCOCCUS, SYNECHOCOCCUS*) IN THE WESTERN MEDITERRANEAN SEA IN SUMMER.

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INTRODUCTION

During the course of the EROS program, we have investigated in detail the structure of the photosynthetic picoplankton community in the NW Mediterranean Sea. In particular, we established the presence of the recently discovered prokaryote *Prochlorococcus* both in winter (Vaulot et al. 1990) and in summer (Vaulot and Partensky 1992b). Moreover we proved that *Prochlorococcus* growth was under the control of nitrogen in winter (Vaulot and Partensky, 1992a). Finally, the Valdivia cruise allowed to follow the development of a spring picoplankton bloom in the Alboran Sea (Vaulot and Marie, 1994).

The July 1993 Discovery cruise offered an excellent opportunity to obtain an image of the whole Western basin. In this paper, we restrict ourselves to the analysis of the two major photosynthetic prokaryotes, *Prochlorococcus* and *Synechococcus*, and show that their relative abundances reflect varying degrees of oligotrophy.

MATERIAL AND METHODS

Samples were collected during both legs of cruise 203 of the RRS Discovery (July 1993). Samples were fixed with 0.1 % glutaradehyde (modified from Vaulot et al. 1989) and stored at -80 °C until flow cytometric analysis that was performed according to the same protocol than described previously (Vaulot et al. 1990). For each cell, five parameters were determined: cell concentration, forward and right angle light scatter, orange (phycoerythrin) and red (chlorophyll) fluorescences (all four parameters normalised to 0.95 µm beads, lot G). This allowed us to discriminate three picoplanktonic populations: *Prochlorococcus* (small scatter and red fluorescence only), *Synechococcus* (medium scatter, orange

and red fluorescence), and picoeukaryotes (large scatter and red fluorescence only).

RESULTS AND DISCUSSION

1. NW Basin

During the July 1989 Bannock cruise, we established some of the major features of the summer picoplankton community in the NW basin: *Synechococcus* dominates and exhibits a deep maximum especially off-shore; *Prochlorococcus* occurs at lower concentrations than *Synechococcus*; picoeukaryotes reach high concentrations nearshore.

Results from the July 1993 Discovery cruise confirm these data (Table 1). In fact, the concentrations of the three major picoplankton groups are surprisingly similar between the two cruises, pointing to a remarkable year-to-year stability of the system. The occurence of a deep *Synechococcus* maximum is confirmed (Fig. 1, Rhône and NW gyre stations). This maximum deepens in the offshore direction (Fig. 2). *Prochlorococcus* concentrations are low nearshore and increase offshore (Fig. 2). The larger range of concentrations for *Prochlorococcus* in 1993 is explained by the fact that they were detected in a much larger number of samples (206 vs. 23).

Table 1: Comparison of picoplankton cell concentrations in the NW Mediterranean Sea in summer 1989 (Bannock cruise) and summer 1993 (Discovery cruise, only MA to MF stations from second leg are considered)

Population		July 1989	July 1993
Prochlorococcus	Mean	24 145	10 326
	Max	48 873	63 481
	n	*23*	*206*
Synechococcus	Mean	24 130	18 624
	Max	110 170	114 572
	n	*80*	*206*
Eukaryotes	Mean	2 991	2 724
	Max	15 997	15 150
	n	*80*	*206*

2. SW Basin

The major interest of the Discovery cruise lies in the extensive coverage of the SW Basin. The D transect between Gibraltar and the Strait of Sicily (Fig. 3) clearly shows that in this region *Synechococcus* does not dominate any more over *Prochlorococcus*, in contrast to what happens in the NW Basin. Vertical profiles (Fig. 1, stations Alboran and Sicily) indicate the presence of a very sharp

Prochlorococcus maximum between 50 and 70 m, and fairly uniform *Synechococcus* concentrations in the surface mixed layers. Both features are reminescent of what is observed in other very oligotrophic areas, such as the Sargasso Sea in summer. Moreover, both in the Strait of Sicily and in the Alboran Sea, two populations of *Prochlorococcus* with different red chlorophyll fluorescence were observed at depth: a similar feature has been observed in the tropical Pacific (Campbell and Vaulot, 1993). The facts point out the oliogtrophic nature of the SW Basin, in particular in the middle of the Alboran gyres and in the south Tyrrhenian area (Fig. 3).

In the Gibraltar area, vertical profiles are very different: picoplankton populations are restricted to the surface layer and dominated by *Synechococcus*, a probable consequence of stratification in the Strait.

3. Summary

These data indicate that the structure of the picoplankton community vary markedly within the West Basin. While *Synechococcus* dominates over the *Prochlorococcus* in the North part (especially close to shore), it is the converse in the South part. Campbell and Vaulot (1993) have showed that the relative importance of these two prokaryotes is related to the degree of oligotrophy: *Synechococcus* dominates in the less oligotrophic areas. The present data confort this hypothesis since satellite observations (Morel and André, 1991) clearly show that the North basin is less oligotrophic than the South Basin. Whether this is due to the influence of large rivers such as the Rhône river or to the general circulation, in particular to the presence of the deep water formation zone off the Gulf of Lions, remains an open question.

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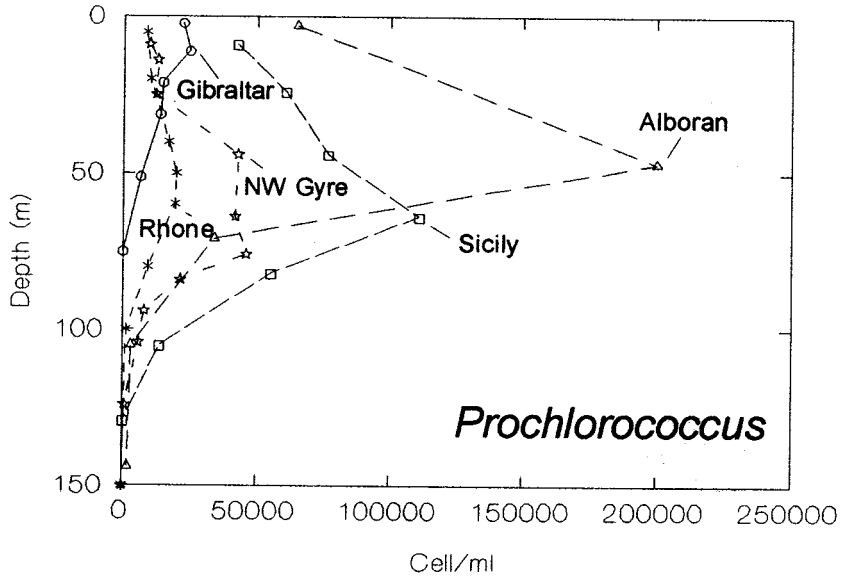
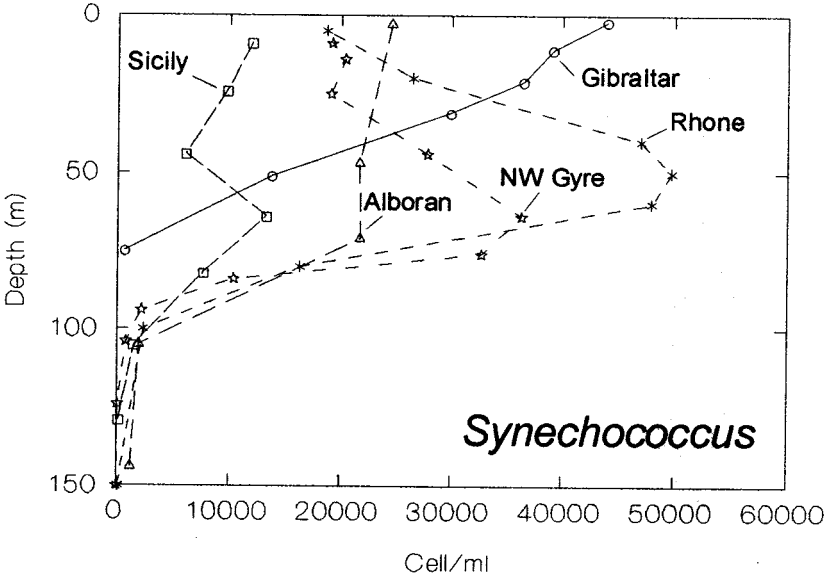
FIGURE LEGENDS

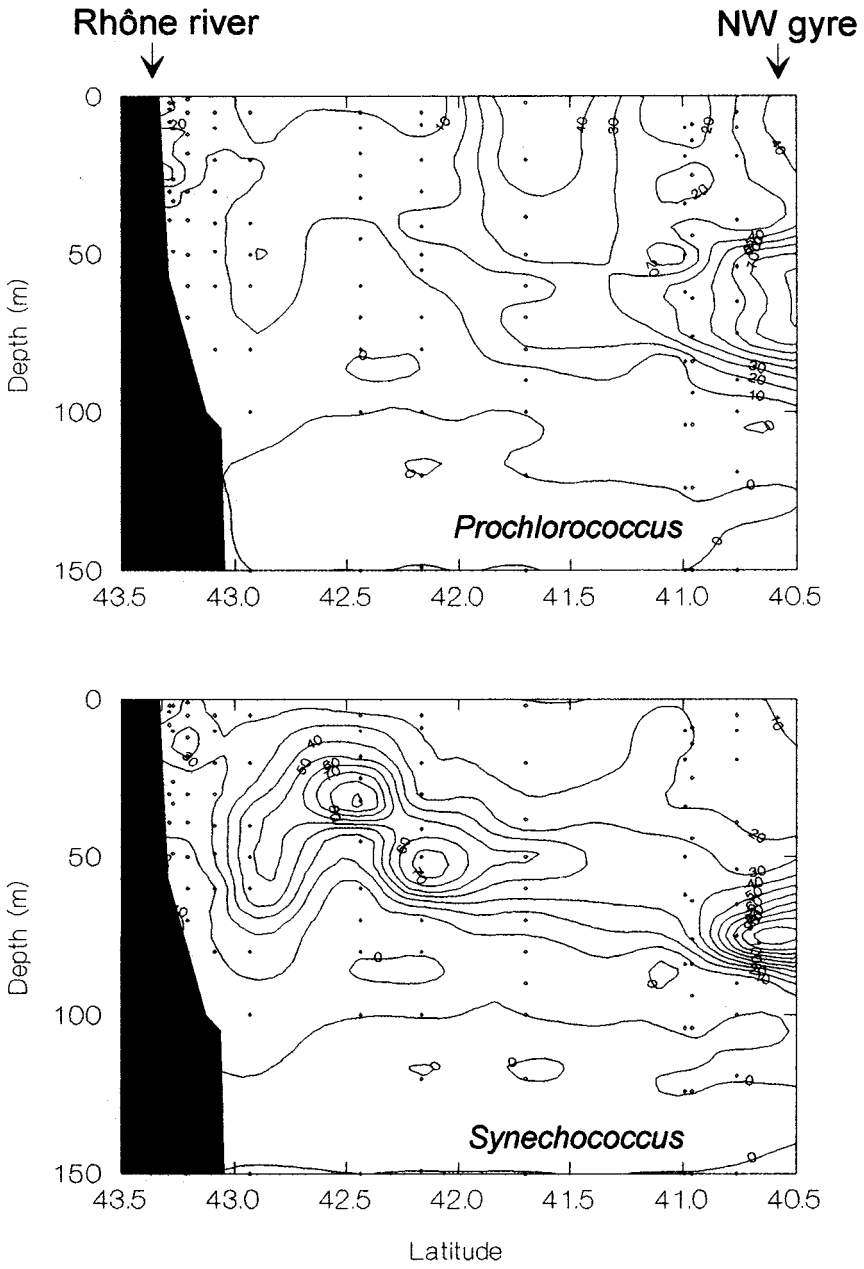
Fig. 1: Western Mediterranean Sea, July 1993 Discovery cruise 203. Vertical distributions of cell concentrations (expressed in 10^3 cell ml^{-1}) for *Prochlorococcus* (top) and *Synechococcus* (bottom) at selected stations. O Gibraltar (Leg 1, D2), Δ Alboran Sea (Leg 1, D7), □ Sicily (Leg 1, D11), ☆ NW Gyre (Leg 2, MA1-7), ✶ Rhône (Leg 2, MA6).

Fig. 2: Western Mediterranean Sea, July 1993 Discovery cruise 203. MA transect (NW to SE) in the NW Mediterranean Sea. Contour plots of cell concentrations (expressed in 10^3 cell ml^{-1}) for *Prochlorococcus* (top) and *Synechococcus* (bottom). Dots correspond to sampling depths.

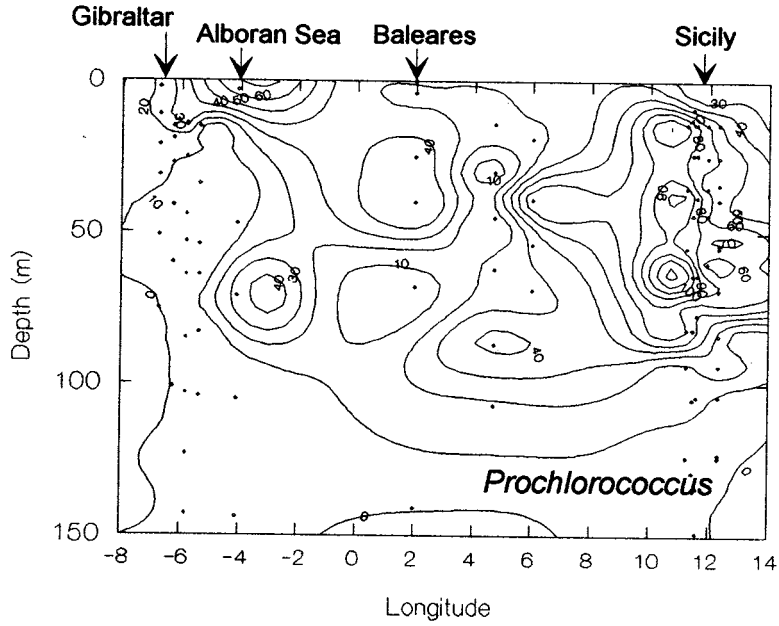
Fig. 3: Western Mediterranean Sea, July 1993 Discovery cruise 203. D transect (E to W) in the Western Mediterranean Sea. Contour plots of cell concentrations for *Prochlorococcus* (top) and *Synechococcus* (bottom).

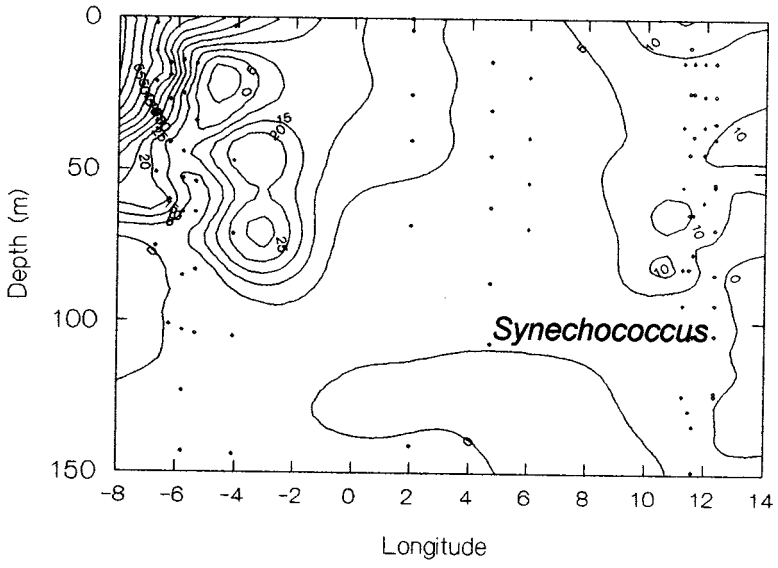

0
50
100
150
Depth (m)
Gibraltar
Alboran
NW Gyre
Rhone
Sicily
Prochlorococcus
0
50000
100000
150000
200000
250000
Cell/ml


0
50
100
150
Depth (m)
Sicily
Gibraltar
Rhone
NW Gyre
Alboran
Synechococcus
0
10000
20000
30000
40000
50000
60000
Cell/ml


MA transect - July 93
Rhône river
NW gyre
Depth (m)
0
50
100
150
Prochlorococcus
Synechococcus
43.5
43.0
42.5
42.0
41.5
41.0
40.5
Latitude

Leg 1 - D stations - July 93





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