9. PHYTOPLANKTON AND MICROBIAL PLANKTON OF THE MEDITERRANEAN SEA

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Although located within a narrow latitudinal range (less than 3°), the seven western Mediterranean sites included in this report (from west to east: Blanes Bay, Thau, Lazaret, Diana, Naples, Kastela Bay, and Stončica) vary widely morphologically (from one offshore site to more or less open bays, gulfs, and lagoons) and in trophic status (from oligotrophic to eutrophic). Coverage in time ranges from 18 to 38 years for physical variables such as water temperature and salinity, and from 26 to 35 years for biological variables such as total diatoms and total dinoflagellates. Three sites (Blanes, Kastela, and Stončica) also report bacterial counts and production, but for more limited time-spans.

In situ water temperature increases significantly with time at Thau (1972 on), but not at the other four sites where data are available. *In situ* salinity increases significantly with time at three sites (Blanes, Lazaret, Diana), but not at the other sites where data were available. Concerning chemical variables such as nutrients, the only significant changes have been observed in Thau lagoon, with significant decreases in ammonium, nitrate, and phosphate, although a tendency towards oligotrophication is reported to occur at several sites (Blanes, Kastela).

As for biological variables, total diatoms increased at Lazaret (1987 on) and Naples (1984 on) and decreased in Thau lagoon (1975 on). Total dinoflagellates decreased at Diana (1987 on). Total flagellates (not dinoflagellates) increased at Naples (1984 on).

The picocyanobacteria *Synechococcus* are reported for two sites only, with a significant increase at Thau (1991 on) and no change in Blanes Bay (1997 on). Picoeukaryotes are also reported for these two sites only. Their cell densities are approximately an order of magnitude higher at Thau than in Blanes Bay. In addition, there is a striking contrast in the seasonal cycle, with minimum densities in August for Blanes and January for Thau, and maximum densities in February for Blanes and August for Thau, which probably indicates that we are pooling together as"picoeukaryotes"taxonomically different types of organisms.

Bacteria, either measured by DAPI or by flow cytometry, are seen to decrease in Blanes Bay, Kastela Bay, and Stončica. Bacterial heterotrophic production is also showing a tendency to decrease with time at these sites, which are the only ones for which a time-series exist. Heterotrophic nanoflagellates are decreasing at the two Croatian sites sites, with a similar tendency shown at the Catalan Blanes Bay site.

Figure 9.1
Locations of the Mediterranean Sea monitoring areas (Sites 55–61) plotted on a map of average chlorophyll concentration. The star for Site 61 is not visible as it is beneath the star for Site 60.

Previous attempts to synthesize phytoplankton trends in the Mediterranean indicate a decrease in phytoplankton biomass (chlorophyll *a*) over time-scales of two decades (CIESM, 2003, 2010) and an increase in cell numbers. This apparent contradiction is the result of a decrease in phytoplankton average cell size, a decrease determined using data primarily from coastal sites. The only offshore data used in the study indicated a general increase in phytoplankton biomass, mainly due to pico- and nanoplankton over a 9-year period (CIESM, 2010).

Data available in this report originate mostly from coastal sites, with influences from terrestrial environments that might induce site-specific variability. In addition, sites harbouring aquaculture (Leucate, Thau, Diana) represent high grazing environments where phytoplankton blooms may be "erased" by grazing pressure on time-scales of days/weeks and may mask relationships between phytoplankton standing stock and bottom–up processes. Still, large perturbations, such as the decrease in soluble reactive phosphorus in Thau lagoon, could be related to significant changes in phytoplankton community structure (emergence of picocyanobacteria and *Alexandrium catenella/tamarense*). Such dominance of coastal site features is likely to be the reason why no within-basin synchrony is apparent, in contrast to zooplankton studies based on more open-ocean time-series (Mackas *et al.*, 2012).