

8.4 RADIALES Gijón/Xixón Station 2 (Site 52)

Xosé Anxelu G. Morán and Renate Scharek

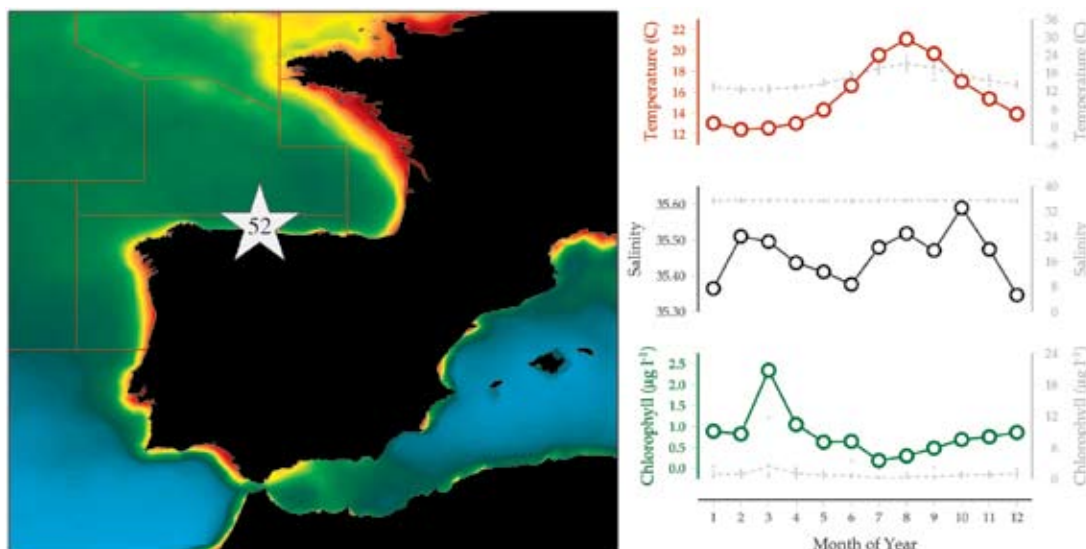


Figure 8.4.1
Location of the RADIALES Gijón/Xixón Station 2 plankton monitoring area (Site 52), plotted on a map of average chlorophyll concentration, and its corresponding environmental summary plot (see Section 2.2.1).

Sampling at the Gijón/Xixón transect started in March 2001, shortly after the opening of the Oceanographic Center of Gijón/Xixón, the latest laboratory of the Spanish Institute of Oceanography (IEO) to be built. Picoplankton began to be collected one year later. The Gijón/Xixón oceanographic time-series is part of the IEO programme RADIALES (<http://www.seriestemporales-ieo.com/>) and comprises three stations in the central Cantabrian Sea (southern Bay of Biscay) located over the ca. 37 km wide continental shelf off the city of Gijón/Xixón (Asturias, Spain). Only Station 2 data were used for this site summary.

Water samples are collected monthly on board RV “José de Rioja” from Niskin bottles in a rosette sampler attached to a CTD probe. The three stations are sampled for picoplankton at 10 m intervals from the surface down to 50 m, and additionally at 5 m at Station 1, at 75 and 100 m at Station 2, and at 75, 100, and 150 m at Station 3. Larger phytoplankton (nano- and microphytoplankton) is sampled at 0, 30, and 75 m at Station 2. Autotrophic and heterotrophic picoplanktonic groups are distinguished by flow cytometry analysis of 1% paraformaldehyde plus 0.5% glutaraldehyde preserved, ultrafrozen samples. Autotrophic picoplankton groups or picophytoplankton (*Synechococcus* and *Prochlorococcus* cyanobacteria and two groups of picoeukaryotes) are distinguished by red and orange fluorescence and size signals of thawed, unstained samples, whereas heterotrophic bacteria are first dyed with SYTO

13 fluorochrome. Nano- and microphytoplankton are fixed with acetic-acid Lugol’s solution (1% final concentration). Qualitative and quantitative analysis of nano- and microplankton is performed with an inverted microscope using the Utermöhl technique (Utermöhl, 1958). Cells are classified to species or genus level if possible or assigned to higher taxonomic levels divided into size classes.

The site displays the typical oceanographic conditions of a temperate shelf sea, with a well-mixed water column from November through April, broken occasionally by the presence of low-salinity water at surface layers and conspicuous stratification in late spring and summer, with a pycnocline usually developing at 10–20 m depth (Calvo-Díaz and Morán, 2006). Other hydrographic features include the presence of a saline and warm poleward slope current, especially during winter (Pingree and Le Cann, 1990; Álvarez-Salgado *et al.*, 2003) and short-lived, upwelling pulses more frequently found in late summer and early autumn (McClain *et al.*, 1986; Llope *et al.*, 2006). Warming trends have been described for the region for both surface (deCastro *et al.*, 2009) and deeper waters (González-Pola *et al.*, 2005), similar to those described for the whole North Atlantic basin (e.g. Johnson and Gruber, 2007).

Seasonal and interannual trends (Figure 8.4.2)

Total phytoplankton biomass (chlorophyll) demonstrates a unimodal distribution, with the annual maximum associated with the spring bloom in March and April, and minimum values usually recorded in July. As previously described (Calvo-Díaz and Morán, 2006), a marked seasonality in picophytoplankton becomes evident, with late summer–early autumn maxima in abundance ($>10^5$ cells mL^{-1}) and predominance of cyanobacteria ($>80\%$ of total abundance), and minima in early spring ($<10^4$ cells mL^{-1}), coincident with very small numbers of *Synechococcus*. One prominent feature is the absence of *Prochlorococcus* for roughly half of the year (March–July), probably due to a combination of low temperatures and high mortality rates in winter, with water-mass advection playing a role in its reappearance in late summer (Calvo-Díaz *et al.*, 2008). The abundance of this cyanobacteria appears related to water temperature, consistent with the predicted increase in picophytoplankton absolute and relative abundance in a warmer North Atlantic (Morán *et al.*, 2010).

Diatom spring blooms occur around April and, in some years, late summer–autumn diatom blooms are also found, which can be as pronounced as or even more pronounced (in terms of cell abundance) than the spring bloom. As expected for an open coastal area, big dinoflagellates ($>20 \mu\text{m}$) do not form marked blooms. Small dinoflagellates ($<20 \mu\text{m}$) formed a bloom in late autumn 2006, and

during the spring bloom in April 2007, increased to nearly half of the cell concentration of diatoms. Representative diatom species forming spring or autumn diatom blooms are *Chaetoceros* spp., *Hyalochaete* spp., *Pseudo-nitzschia* spp., *Rhizosolenia setigera*, *Rhizosolenia pungens*, and *Guinardia delicatula*.

Unlike most autotrophs, heterotrophic bacteria ($0.2\text{--}2.7 \times 10^6$ cells mL^{-1}) show a clearly bimodal distribution, with peaks in April and October and relative minima in February and July. Highly consistent changes in the relative distribution of the flow cytometric groups of cells with low and high nucleic acid content probably reflect distinct species succession (Morán *et al.*, 2011). Bacterial abundance off Gijón/Xixón has increased since the beginning of the time-series. Although this trend is not significant (grey line in Figure 8.4.2), an analysis decomposing the monthly time-series variance has demonstrated a significant increase in integrated bacterial biomass, with the 2009 annual mean value being 30% higher than that of 2002 (Morán *et al.*, 2011).

By 2012, we will have completed a decade of microbial records in this site. Although it will probably still be too short to draw concluding associations with the observed increases in oceanic temperature, our working hypothesis is that small plankton will become increasingly important in the near future.

Figure 8.4.2 (continued on facing page)
Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of select cosampled variables at the RADIALES Gijón/Xixón Station 2 plankton monitoring site. Additional variables from this site are available online at <http://wgpme.net/time-series>.

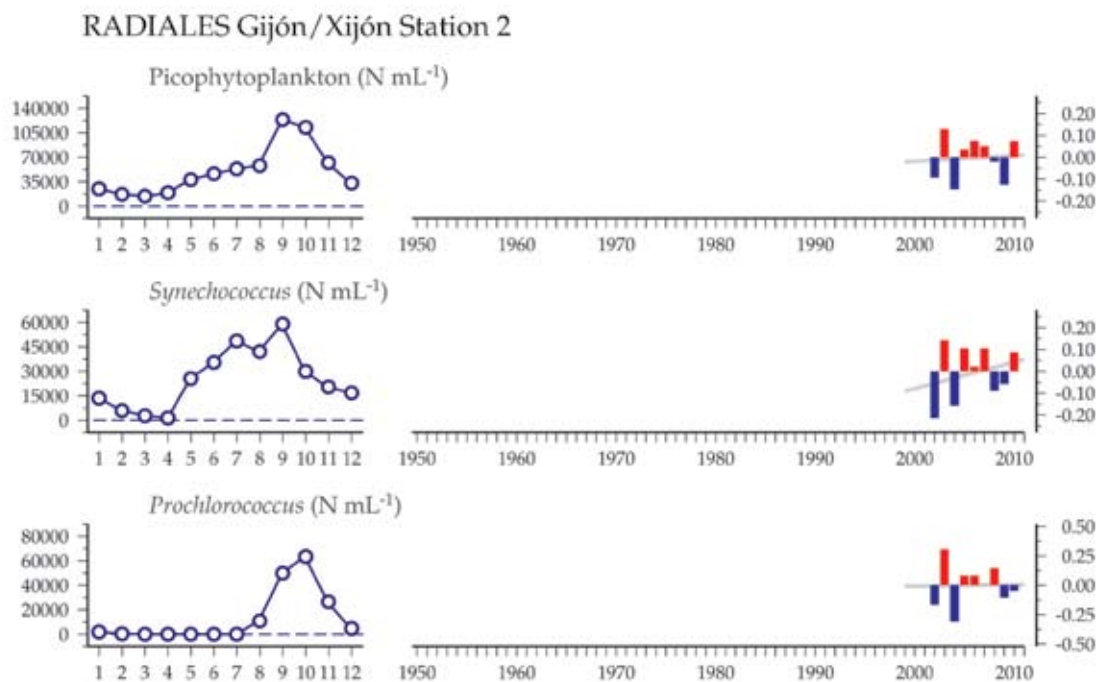


Figure 8.4.2 continued.

