Corso di Dottorato di Ricerca in Scienze della Vita e dell'Ambiente - Ciclo XXXVI

Relationships among phytoplankton, nutrient concentration and hydrology in the northern Adriatic Sea based on a Long-Term historical data set.

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Introduction

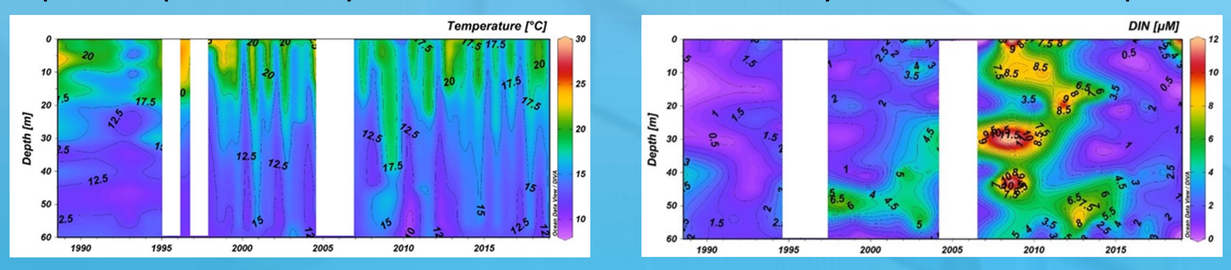
Phytoplankton community dynamics are considered as a key indicator to detect changes in the marine ecosystems as they show a rapid turnover, and they are directly related to the abiotic parameters. The Northern Adriatic Sea, represents one of the most productive areas of the Mediterranean Sea, due to the shallow depth and high riverine inputs. The objective of the research is to evaluate the potential changes in terms of physico-chemical parameters and phytoplankton community abundances and composition in Long-Term Ecological Research (LTER) marine areas, and to depict a detailed information on the community structure and composition of phytoplankton community as well as the main constraints affecting their trends.

Keywords: long term ecological research; phytoplankton; big data; meteoclimatic and anthropogenic effect

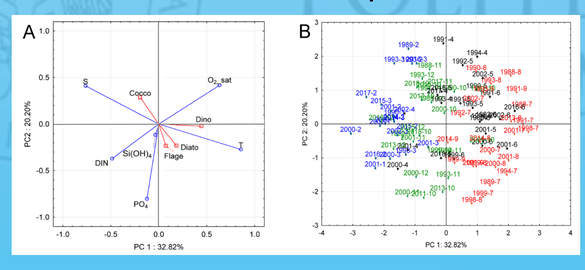
Northern Adriatic Sea (down left) and Senigallia-Susak Transect (upper right) with red circles indicating coastal and offshore sampling stations.

Study 1

The aim of this study was to analyse a big data set (1988-2018) referred to a LTER station located at 15 nM in the Senigallia-Susak Transect (LTER site), beyond the border of the Western Adriatic Current, and therefore not directly affected by coastal nutrient input, to highlight the effect of meteoclimatic trend without the anthropogenic disturbance. Nutrient sources in the photic layer were both allochthonous (spreading of the Po River waters in stratified conditions) and autochthonous (regeneration and resuspension processes). Phytoplankton annual maximum was observed in summer and was mainly related to allochthonous input. IndVal analysis was used to study the phytoplankton community, revealing the seasonal species of the offshore site.
Principal Component Analysis showed a marked seasonality and the relationships between phytoplankton and environmental parameters.



Vertical and temporal (1988-2018) of temperature (°C) and Dissolved Inorganic Nitrogen (µM)

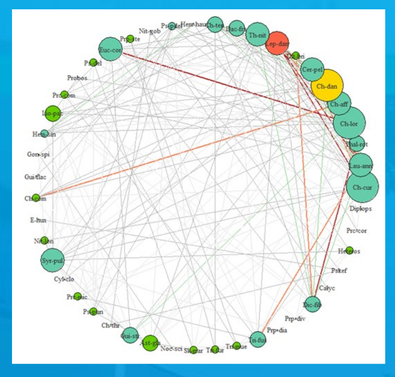


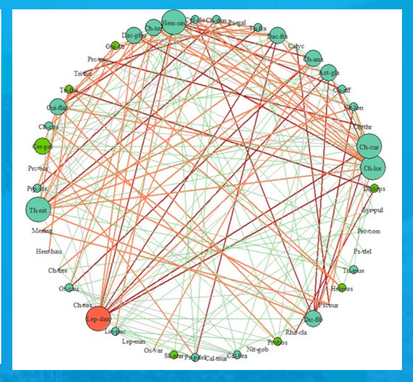
Loading plot (A) and score plot (B) of the Principal Component Analysis (PCA) of ranked environmental variables and main phytoplankton group abundances (as supplementary variables)

Neri et al., 2022. Phytoplankton and environmental drivers at a long-term offshore station in the northern Adriatic Sea (1988–2018). *Continental Shelf Research* 242, 104746. https://doi.org/10.1016/j.csr.2022.104746

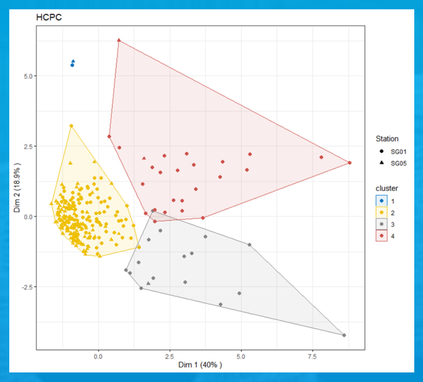
Study 2

The aim of this study was to compare the trends observed at a coastal (SG01) and offshore (SG05) LTER stations. Several statistical approaches were used: PCA, HCPC, NMDS, diversity indices, IndVal and Graph-Network Analysis. The mean annual cycle of physico-chemical parameters and main phytoplankton groups abundances revealed a different seasonality between the two stations. In SG01 the annual maximum was observed in winter, due to shallow depth and mixing conditions, whilst in the offshore station it was observed in summer, mainly related to the spreading south-eastwards of the riverine waters in stratified conditions. NMDS on mean seasonal abundances, showed differences between the two stations in winter and autumn, when the Western Adriatic Current is stronger. Higher abundances and lower diversity were observed in the coastal station than offshore. PCA and HCPC highlighted that SG05 is less variable than SG01 and less influenced by changes in the environmental parameters. IndVal and network analysis based on the significant interactions among taxa, highlighted that indicator species are related to specific environmental conditions of a certain season, whilst the others are homogeneously distributed throughout the year and have more interactions among the community.

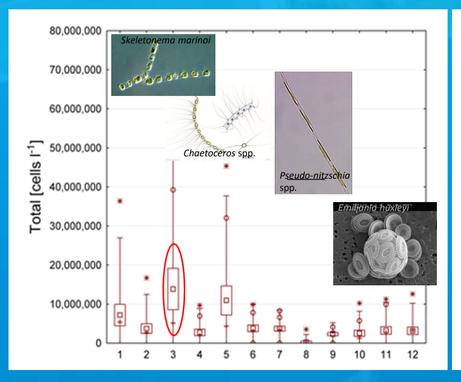


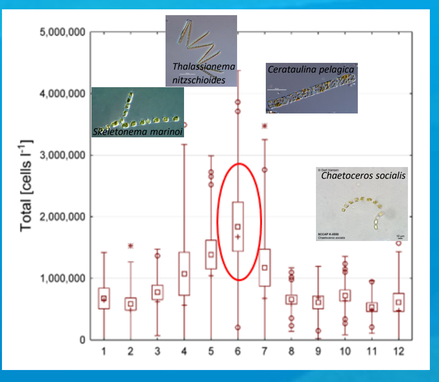


Winter networks of the coastal (left) and offshore (right) sites. The dimension of the circles is proportional to the degree, whilst the different colours are related to closeness (red (maximum), yellow, aquamarine, green (minimum). Line colours depend on the strength of the interaction.



HCPC of physico-chemical parameters. SG05 clustered almost in one group (yellow-coloured), whilst SG01 in three, highlighting the higher variability.

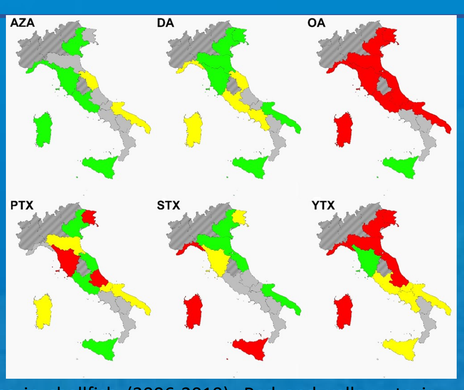




Mean annul cycle of total phytoplankton in the coastal (left) and offshore (right) sites, with the red circle indicating the maximum.

Study 3

The aim of this study was to depict potential changes in terms of both abundances of potential toxic phytoplankton species and occurrence of poisoning events (such as diarrhetic and paralytic shellfish poisoning). Data from 2006 to 2019, of phytoplankton abundances, toxin concentrations and shellfish poisoning events from the ARPAs and IZSs of different Italian regions were analyzed. Heatmap of abundances, toxin concentrations and presence/absence of toxins (AZA = Azaspiracids; DA = Domoic Acid; OA = Okadaic Acid and analogs, PTX = Pectenotoxins, STX = Saxitoxins, YTX = Yessotoxins) and shellfish poisoning events were created. Two databases (one with species abundances and one with toxins and shellfish poisoning events) were created, to allow future studies of these changes and the better understanding of the factors influencing these important phenomena.



Microalgal toxins in shellfish (2006-2019). Red and yellow: toxin concentrations at least once above and below the EU limits, respectively. Green: no toxins recorded. Grey: data not available.