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Seasonal and interannual dynamics of a coastal ecosystem (Portofino, Ligurian Sea) in relation to meteorological constraints

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The marine coastal area of the Portofino Promontory, located in the Ligurian Sea, has been studied since many years to identify its main ecological characteristics. In particular, since 1999 the area is two-weekly monitored by collecting the principal parameters both physical (using a multiparametric CTD probe) and chemical-biological (inorganic nutrients, chlorophyll-a, particulate proteins and carbohydrates, particulate organic carbon and nitrogen, dissolved organic matter, phytoplankton and zooplankton).

In this work we analysed the ecosystem dynamics, focusing on the first trophic levels, together with the variability of the meteorological conditions, in order to find the driving forces influencing the development of biotic process. The climate of this region is characterized by a clear unimodal seasonality only for temperature, while most other forcing factors show a complex variance structure (e.g. rainfall), thereby limiting the predictability of the system. Nevertheless, the multi-annual serie of biological, chemical and physical data represents a powerful tool for the reliable reconstruction of seasonal cycles and allow the differentiation of regular and recurrent patterns from occasional and exceptional events.

The hydrological regime of the area varies from vertically isothermal winter conditions to strong thermal stratification in summer and fall. Nutrients are depleted in the surface layer during summer oligotrophic conditions and re-injected to the surface layer during winter mixing. Strong rainfall events can increase the nutrients availabil-

ity in the surface layer. The distribution of phytoplankton biomass follows the hydrographic stratification and nutrient structure and is characterized by a first growth phase in late winter, a second one in late spring, and a third one in autumn. Diatoms and dinoflagellates are the dominant groups throughout the year. The first annual bloom generally occurs in February-March prior to the establishment of thermal stratification and in this period the highest Chl a values are found (1-2 μg l^{-1}). The biomass increase is recorded over the major part or the water column, and it is mainly due to chain-forming diatoms. This bloom is very likely caused by a limited vertical diffusion, in conditions of calm and sunny weather. The late spring bloom is primarily due to the load of nutrients associated with pronounced rainfall events and is usually confined to the surface waters. During 2004, an intense bloom has been observed in May, with Chl a values (1.5 μg l^{-1}) in the surface water comparable to the usual winter maximum, while during 2002, the spring bloom has not been detected at all. Also during this peak, diatoms generally still dominate the phytoplankton populations, except when surface water temperature is exceptionally high, resulting in earlier than usual thermal stratification. In this case, dinoflagellates can become dominant as for example during 2003, when late spring and summer were exceptionally warm over almost all Europe, resulting in the establishment of a shallow mixed layer in Portofino already at the end of May. During summer, dinoflagellates generally show their annual biomass peak. However, we often observe a short-term alternation with diatom species, controlled by the highly dynamic coastal waters of the area. In autumn, the last annual growth phase of plankton is recorded. This bloom is normally triggered by the enhanced nutrient availability deriving from terrestrial sources. Meteorological factors and enhanced circulation allow phytoplankton growth over a greater depth range than in late spring, but generally with lower Chl a values.