ECOMADR,
Ecological role of key components in the “end to end” trophic food web of North Adriatic Sea

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Nowadays oceanographic community is devoting significant attention to the integration of nutrient cycling and microbial processes to dynamic of higher predators into a common picture of the system. The topic is key because of the need for a holistic view of marine (eco)systems in which all components and interactions are simultaneously considered. This is critical also for policy makers, who require comprehensive assessment of ecosystem response to changes in environmental forcing and anthropogenic stressors, with particular regard to global changes. Given the demand for predictive capabilities, the development of reliable numerical models of “end to end food web” are particularly sought. The topic is challenging. Many different processes occurring at widely different temporal and spatial scales need to be simultaneously addressed and integrated in a common frame. This calls for a multifaceted approach to research including the use of a hierarchy of models and the identification of the appropriate scales for integration. There also exist parameters and processes that we are not able to measure as precisely and accurately as we would like. Most importantly, there still are many aspects of ecosystem functioning - including kinetics, functional response, causal relationships, key species - which are not fully understood or poorly quantified, and hence are difficult to incorporate into models.

The Northern Adriatic Sea (NAS) is a shallow bay that can show eutrophic and oligotrophic conditions within small temporal and spatial scales. It is enclosed on three sides and opened to the Mediterranean Sea. Several marine institutions are located in the countries surrounding the NAS. This has led to intensive national and international studies in this area. As a consequence, a remarkable amount of data, general knowledge, conceptual and mathematical models is available about both the physical and ecological features of this area. Particularly in the Gulf of Trieste, a long term ecological research lasted for more than 30 years, and important insight on nutrient cycling, microbial dynamic and plankton trophodynamics has been gained (Cossarini and Solidoro, 2006; Fonda Umani and Beran, 2003; Fonda Umani et al. 2004, 2005, 2006; Querin et al., 2006; Solidoro et al. 2006;).

Over the last decade, researches on pelagic environment focussed mainly on defining the biological climatology, to assessing trophic status of the system, and on identifying the main processes leading to gel mass accumulation (mucilage). Beside the year-to-year variability, results revealed the existence of a clear seasonal dynamic, with a late winter diatom bloom followed by autotrophic nanoplankton prevalence and by the dominance of cyanobacteria in late summer. Concurrently, heterotrophic community evolves from a microzooplankton dominated plankton community to the dominance of larger mesozooplankton in summer. Experimental assessments demonstrated that whereas in the spring all available autotrophic biomass is grazed by zooplankton, in autumn the low primary production still fuels both micro and mesozooplankton food webs but far less efficiently, and in late winter a large fraction of autotrophes is exported to the bottom. The planktonic system is prevalently heterotrophic, i.e. most of the time respiration exceeds primary production. Furthermore the uncoupling between primary production and bacterial carbon demand, which leads to accumulation of dissolved organic carbon (DOC), occurs each year, though it is clearer in the years when mucilages form (fig. 1)

ECOMADR builds on this knowledge, and - while providing continuity to it - broadens the aim of the research by including dynamic and ecological role of small pelagic fishes and of suspended filter feeders. In particular, sardines and anchovies - planktivorous feeders that feed mainly on copepods and represent the target of the most important fishery in the Gulf of Trieste - and mediterranean mussels - which are massively cultured in a large part of the Gulf - are considered. In fact they constitute significant components in the carbon and nutrient cycles in the system. This will allow the derivation of better assessments of carbon budget and of carrying capacity of the area, as well as the evaluation of the relative importance of

top-down versus bottom-up control in plankton dynamic and generation, composition and accumulation of DOC.

ECOMADR experimental design includes monthly sampling of physical parameters on a regular grid of 20 points, and of chemical and water quality parameters along two orthogonal transects (9 stations, 3 depths). Structural and functional biological parameters are collected at one station, including the identification of viral abundances, abundance and composition of autotrophic and heterotrophic pico, nano, and microplankton fractions and of mesozooplankton, the determination of primary and secondary production, respiration, and bacterial activity. Furthermore, we determine the yearly variation of diet and daily ration of sardines and anchovies, by simultaneously sampling fish and prey every 4-6 hours over 24 hours. The analysis of stomach contents provides specific information about the predator-prey relationship. Mussel dynamic is investigated by monthly monitoring biometric parameters of 2 cohorts, displaced in experimental ropes in an aquaculture farm. Analysis of stomach content of mussel provide information on their diet, and enable estimate of their energetic requirement.. Since water column is not very deep, upper sediment is considered too, by measuring nutrients and DOC fluxes, primary production, respiration, bacterial production and esoenzymatic activity, as well as abundance and composition of microphytobenthos, meio and macro zoo-benthos. Specific experiments are planned to investigate short-term variability of specific plankton components, including microbial diversity by means of genetic methodologies.

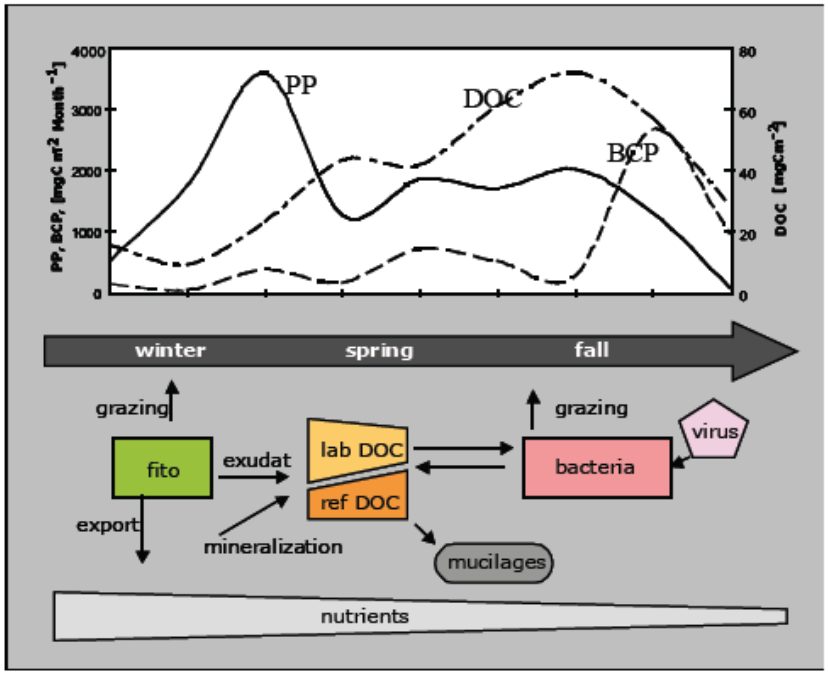
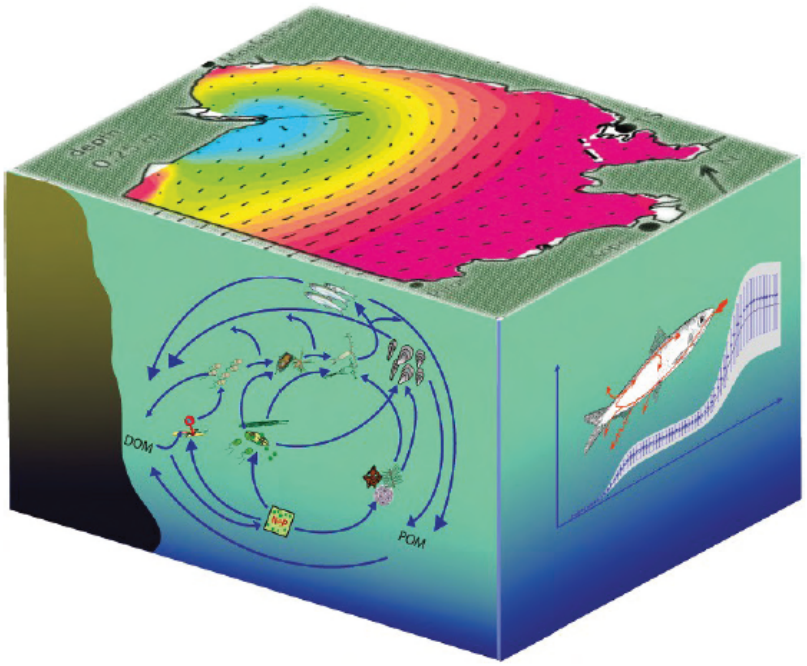


FIGURE 1. The uncoupling between PP and BCD leads to the accumulation over spring and summer of Dissolved Organic Carbon, which is the source of the polysaccharidic material undergoing aggregation processes (redrawn from Fonda Umani et al., in press).

The integration of numerical models, satellite images and geostatistical analysis of observed data, provides a characterization of the sampling area. A combination of statistical analysis (artificial neural network, geostatistic and standard multivariate techniques such as ordination and cluster analysis) and coupled transport-biogeochemical model simulations contributes to the analysis of space and time variability of the major biogeochemical properties. Bioenergetic models for small pelagic fishes and mussels, and a mass balanced food web model are additional tools under development (fig. 2).

The integration of these models, statistical analysis and empirical observations will provide a means of interpretating ecosystem dynamic, framing and integrating our findings in the context of pre-existing knowledge, and possibly in speculating about likely responses of this ecosystem to variations in anthropogenic stressors or external forcing.



The project aims to the identification of ecological role of key components of the 'end to end' trophic web of North Adriatic Sea by integrating observed data, results of statistical analysis, and simulations performed with a hierarchic set of models (transport, biogeochemical, bioenergetics, mass balanced food web).

The project will end in September 2007 and hopefully evolve into an IMBER North Adriatic Study.

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