New GEOTRACES or GEOTRACES relevant scientific results

Also this year most of the research was oriented into the study of stable isotopes of light and heavier isotopes such as mercury (Hg) in marine ecosystems.

- In collaboration with the Institute Nazionale di Oceanografia e Geofisica Sperimentale – OGS Trieste, Italy a mesocosmos experiment was performed in order to decode how different sources (natural, anthropogenic) of CO2 influence biological systems (phytoplankton) using stable carbon isotopes. The experiments prove that phytoplankton isotopic composition quickly responds to changes in the δ13C of the medium, making this approach a promising and low-impact tool for detecting CO2 submarine leakages from carbon capture sites (CCS).

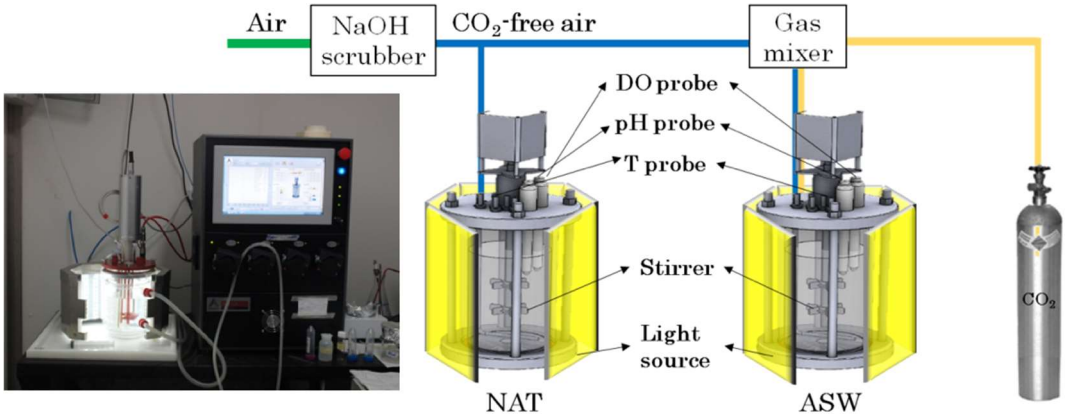

Figure 1. *Schematic description of photobioreactors used for the three T. rotula culture experiments. NAT: natural seawater medium; ASW: artificial seawater medium. During algal growth, only CO_2-free air was used (on:off cycle: 10:50 min) in both media. Note that $CO_{2(g)}$ from cylinder was only supplied during ASW medium preparation. Dissolved oxygen (DO; % sat), temperature (T; °C) and pHNBS were recorded by on-line probes. Light:dark regime: 14:10 h; continuous gentle stirring. Photobioreactor outline modified from Kbiotech®.*

- In order to collect evidences of the possible occurrence of anaerobic oxidation of methane (AOM) at the sediment-water interface and infer the entity of the associated methane flux, the analyses of bulk sulphide minerals δ34S, total organic carbon and redox-sensitive elements were combined. The research was performed in the drift area of Kveithola trough, a glacially-carved depression located in north-western Barents Sea, where active fluid escapes have been recently recognised. According to the negative values of δ34S within the extracted solid sulphur phases (up to −49.1‰ for pyritic sulphur), organoclastic sulphate reduction and/or disproportionation of sulphur intermediates result to be the only active processes in the near-surface sediments of the study area. However, moderate to strong enrichments of Mo detected in the relatively organic carbon-poor intervals of both the two cores suggests that the sulphidic conditions favouring Mo enrichments have been produced by AOM. Therefore, we can infer that the Kveithola trough experienced high methane

fluxes that occasionally moved upward the sulphate-methane transition zone, inducing intense AOM in proximity of its sediment-water interface.

The research conducted in the Gulf of Trieste, N Adriatic is a part of the joint collaboration between National Institute of Oceanography and Experimental Geophysics (OGS) in Italy, Jožef Stefan Institute (JSI), Ljubljana, Slovenia and the Institute of Hydrobiology, the Chinese Academy of Sciences (IHB-CAS). The main objective of this study is to investigate the effects of allochthonous nutrients inputs and the sediment-water interaction on the nutrient availability for primary producers. All results from 5 sampling campaign are colleceted in the report: Giani, M., Cabrini, M., Bazzaro, M., Cataletto, B., Cerino, F., Cibic, T., Cociancich E., De Vittor C., France, J., Fornasaro, D., Franzo A., Krajnc B., Kralj M., Ogrinc N., Relitti F., Urbini L. Mechanisms of red tides and hypoxia as ecological marine disasters and technologies for its early warning and emergency security along the sea of 'Belt and Road' countries; Testing and Analyzing, Report, December 2020.

Here only the summary of research is presented. Overall in the water column there is a P limitation due to the reduced input of river borne P. This P limitation reduced the phytoplankton biomass that in the most recent year is again increasing both in the Gulf of Trieste (and in the western Northern Adriatic Sea. The offshore waters are more strongly affected by seasonal oxygen depletion with respect to the coastal waters, this is due to the confinement of bottom waters in the deeper part of the Gulf of Trieste not easily affected, during the stratified period, by the mixing induced by wind.

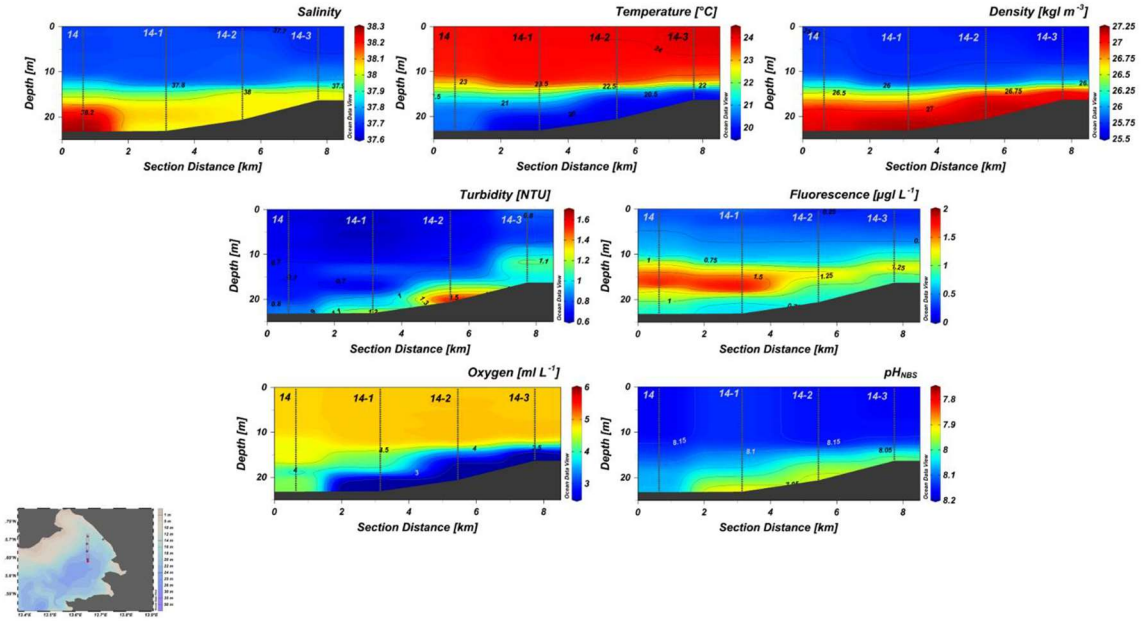

Figure 2. *September 2019. Water column physical and chemical characterisation (temperature, salinity, density, turbidity, fluorescence, dissolved oxygen, pH) along a transect from off-shore towards the coast.*

The regenerated nutrients in bottom waters in the deeper station are not available for the phytoplankton growth in the whole water column till the late autumn/winter mixing induced by cooling and the heat loss that drives the dense water formation. The most elevated oxygen depletion was registered in the bottom offshore waters in September 2018. During 2019 the lowest oxygen concentrations were encountered in June 2019 but then a

reoxygenation occurred due to wind induced mixing. Therefore in late summer/autumn 2019 there was not a seasonal marked oxygen depletion. The inorganic DIN/PO4 ratio in the study period resulted smaller than in the previous period (1999-2010). This could be due to the increase of riverine discharges whose mean value varied from 86 m3 s-1 in the period 1999-2010 to 129 m3 s-1 in 2019: The overall trend of DIN/PO4 ratio in the Gulf of Trieste shows anyway a positive slope (1992-2018). The Gulf of Trieste is characterised by the overall prevalence of dissolved organic matter over inorganic constituents, and by an excess of carbon and nitrogen over phosphorus in all compartments, as demonstrated by C:P ratios higher than Redfield.

The stoichiometric ratios of the dissolved organic matter in the water overlying the sediment are quite similar for the DOC/DON and DOC/DOP but show an increase for the DON/DOP both at the coastal and offshore stations with respect to the 1999-2010 period. A marked increase of the incidence of DOP contribution to TDP is evident particularly in the offshore stations where the highest DIN/PO4 ratio is observed. This could indicate a more intense remineralisation of a fraction of the organic bound P and/or a higher diffusion of inorganic P from the sediments pore waters in the coastal station. The sediment oxygen consumption resulted, in 2018-19, 3-5 fold lower than at the beginning of 1990s and this is potentially attributable to a lower primary production and organic matter sedimentation in bottom waters caused by the reduction of riverine P discharge and to the consequent P limitation. Also the benthic primary production seem reduced with respect to previous measurements. Our result show that DOM degradation in the water column is strongly affected by seasonal warming. However although if the warming counteracts the O2 reduced consumption for OC oxidation by increasing deoxygenation and hetrotrophic respiration still it does not cause hypoxia or anoxia as in the past.

The stoichiometric ratio of the benthic fluxes show that inorganic nitrogen (mainly as ammonium) and phosphates are regenerated in a proportion near or higher than the Redfield ratio (median values: 17 and 28 at coastal and offshore station respectively) whereas silicates are regenerated in a much higher proportion as the Si(OH)4/PO4 median values range from 49 to 55, at coastal and offshore station respectively. It seems that a higher fraction of P remains trapped in the sediment with respect to N and Si, particularly at the offshore station. This can be due to the fact that in oxic condition phosphates are bound to iron oxides or can precipitate as authigenic carbonate fluorapatite whereas only in anoxic condition the release of P from sediments is favoured.

However as in the sediments, alkaline phosphatase showed a significant correlation with temperature the remineralization of P from organic matter could be enhanced in future due to warming.

Outreach activities conducted

- HORVAT, Milena. Deep ocean sediments, geochemistry and chemical contaminants in relation to project: Sargasso Sea European Eel Research Project Virtual Workshop, 5th May 2020: webinar.

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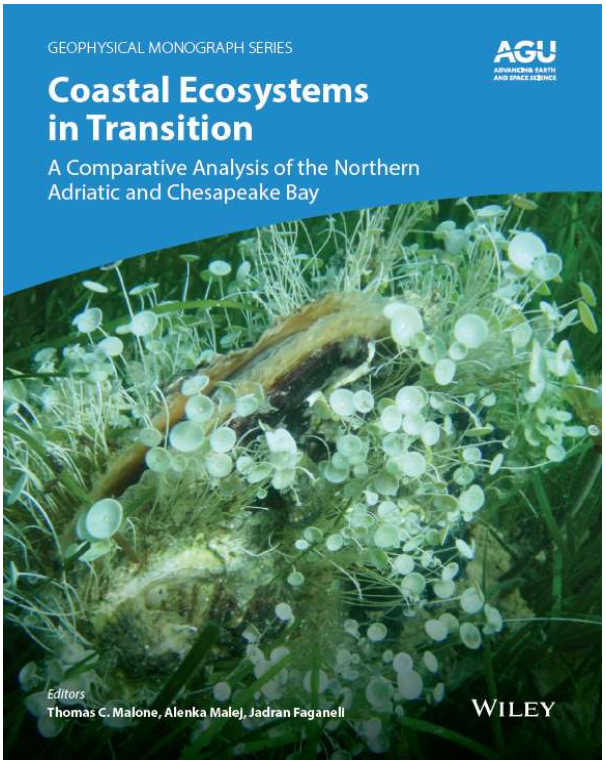

New book

Coastal Ecosystems in Transition: A Comparative Analysis of the Northern Adriatic and Chesapeake Bay

Editor(s): Thomas C. Malone, Alenka Malej, Jadran Faganeli

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Relevant chapters:

TESTA, Jeremy M., FAGANELI, Jadran, GIANI, Michele, BRUSH, Mark J., DE VITTOR, Cinzia, BOYNTON, Walter R., COVELLI, Stefano, WOODLAND, Ryan J., KOVAČ, Nives, KEMP, W. Michael. Advances in our understanding of pelagic-benthic coupling. In: MALONE, Thomas C. (ed.), MALEJ, Alenka (ed.), FAGANELI, Jadran (ed.). Coastal ecosystems in transition : a comparative analysis of the northern Adriatic and Chesapeake Bay. 1st ed. Hoboken: American Geophysical Union: Wiley, 2021. Str. 147-175. Geophysical monograph series. ISBN 978-1-119-54362-6.

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BRUSH, Mark J., GIANI, Michele, TOTTI, Cecilia, TESTA, Jeremy M., FAGANELI, Jadran, OGRINC, Nives, KEMP, W. Michael, FONDA UMANI, Serena. Eutrophication, harmful algae, oxygen depletion, and acidification. In: MALONE, Thomas C. (ed.), MALEJ, Alenka (ed.), FAGANELI, Jadran (ed.). *Coastal ecosystems in transition : a comparative analysis of the northern Adriatic and Chesapeake Bay*. 1st ed. Hoboken: American Geophysical Union: Wiley, 2021. Str. 75-104. Geophysical monograph series. ISBN 978-1-119-54362-6.
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