Organic matter origin and distribution in sediments and suspended particulate matter in a coastal lagoon (Pialassa Baiona, NW Adriatic Sea, Italy)

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Background

Organic matter composition and its distribution in coastal lagoons are influenced by the relative contribution of both terrestrial and marine matter sources, and by several processes including hydrodynamism, autotrophic production and remineralization, taking place in the lagoon water column and sediments. Human activities are often responsible for affecting different organic matter sources and related dystrophic processes due to eutrophication. A deep knowledge of the organic matter origin and the occurring dynamic processes is essential in order to implement correct policies for management and protection of these habitats.
In this work, carbon stable isotope C (δ13C) was evaluated in suspended particulate matter to characterize sources of organic matter in surface waters of Pialassa Baiona lagoon. In parallel, vertical sediment profiles taken in control and impacted sites of the lagoon were investigated to establish source characteristics of sedimentary organic matter.

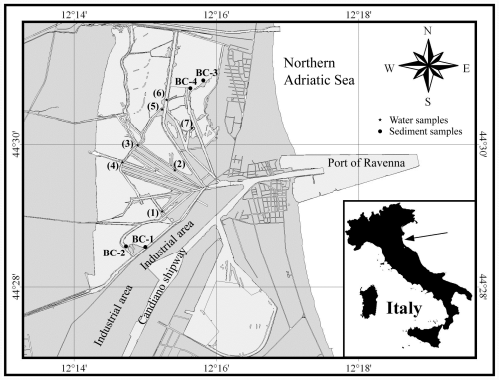

Figure 1. Location of the sampling stations for sediment cores (BC-1-BC-4) and water samples (1-8) in the Pialassa Baiona lagoon. Geographic coordinate in ED50).

Materials and methods

The Pialassa Baiona is an eutrophic microtidal lagoonal system located in the northwestern coastal area of Adriatic Sea (Italy). The area is protected under the Ramsar Convention (1981) and the Habitat Directive 92/43/EEC.
Surface water samples were collected on a monthly basis from November 2007 to October 2008 at eight stations located throughout the lagoon (Fig.1, Sts 1-8). Chlorophyll *a* was determined spectrophotometrically after overnight extraction with 90% acetone.
Sediment sampling was performed at impacted (Sts BC-1 and BC-2) and control areas (Sts BC-3 and BC-4; Fig. 1). Sediment cores were collected by a plexiglass hand-corer. Organic carbon (OC) and total nitrogen (TN) in suspended particulate matter (SPM) and in sediments were determined using a FISONS NA2000 Element Analyzer. Stable isotopic analyses of organic C (δ13C) were carried out on the same samples using a FINNIGAN Delta Plus mass spectrometer directly coupled to the FISONS NA2000 EA.

Results and Discussion

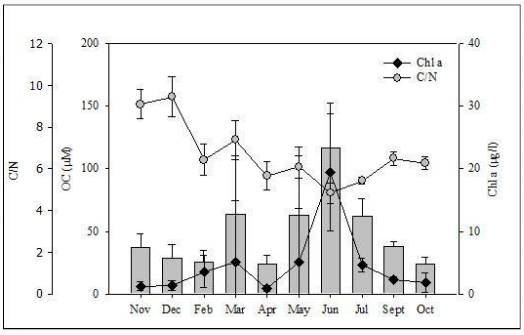

Figure 2. Temporal changes of OC (grey bars), chlorophyll a, and C/N molar ratio in SPM from Pialassa Baiona.

Seasonal changes in phytoplankton chlorophyll *a* (Chl *a*) concentration occurred in surface waters of Pialassa Baiona lagoon, with mean values ranging from 0.88 ± 0.41 to 19.45 ± 9.31 μg L^{-1} (Fig. 2). Temporal trends for OC and TN (not shown) concentrations in SPM reflected that one found for chlorophyll *a*, with the lowest values observed in autumn-winter period and the highest ones occurring in early summer (Fig. 2, i.e. June; C/N ratio: 4.8 ± 0.5).
The suspended material displayed a broad range of δ13C values (from -18.3 to -26.9 ‰, Fig. 3a). Figure 3b shows the elemental and isotopic compositions of Pialassa Baiona sediments.
Sediment OC values were typically between 0.2 and 1.4 % (mean value: 0.7 ± 0.4 %) in control stations, and between 2 and 4 % (mean value: 3 ± 0.3 %) in the impact stations of the lagoon, with a C/N ratio of 8.8 ± 1.1 and 9.1 ± 2.2, respectively (Fig. 3b). A strong linear relationship was detected between the OC and TN contents in all sediments ($r^2 = 0.95$, $p < 0.0001$) and suspended material ($r^2 = 0.92$, $p < 0.0001$). The x-intercepts of these regressions were close to zero, which indicate that the majority of nitrogen in these sediments was associated with organic matter.
C/N ratios and δ13C have been widely used to identify the multiple sources of organic matter in estuarine and coastal areas. Allochthonous sources of organic matter include terrestrial matter (vascular detritus or soil) and estuarine phytoplankton biomass.

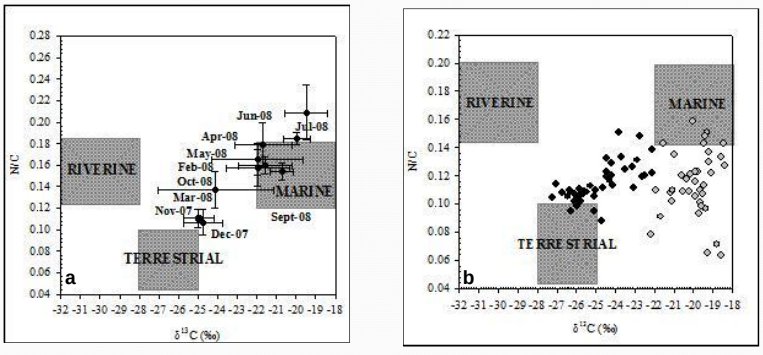

Figure 3. (a) Average values (+/- SD) for δ13C vs. N/C ratio for water sample suspended particulate matter. (b) δ13C vs. N/C ratio for sediment cores collected at control (gray diamonds) and impacted areas (black diamonds) in the Pialassa Baiona lagoon. Gray boxes represent the compositional ranges of three organic matter sources: riverine phytoplankton (RIVERINE), marine phytoplankton (MARINE), terrestrial organic matter (TERRESTRIAL).

Autochthonous sources of organic matter consist in coastal biological production by phytoplankton, microphytobenthos and higher plants, and chemoautotrophic production. Typical δ13C values range from -19 to -21 ‰ [1] and from -30 to -25 ‰ [2, 3] for marine and estuarine phytoplankton, respectively, and from -25 to –28 ‰ for C3 plant-derived carbon [1].
The observed δ13C values for sediment cores from the control area (-20.6 ± 0.9 ‰ and -19.3 ± 0.7 ‰, St. BC-3 and BC-4, respectively) matched with values reported for marine phytoplankton and zooplankton (-20.6 and -20.8 ‰, respectively) sampled in a coastal area of the NW Adriatic Sea [4], suggesting an important contribution of phytoplankton biomass to the organic matter pool.
On the other hand, δ13C values found in cores from the impacted area (-24.4 ± 1.4 ‰ and -25.1 ± 1.3 ‰, St. BC-1 and BC-2, respectively) would suggest that the sedimentary organic matter in this area had a clear allochthonous imprint. Similar values were found for suspended matter of the Po River plume in the NW Adriatic continental shelf [5].
Conversely, the average composition of SPM collected in Pialassa Baiona lagoon is closer to the marine end-members (Fig. 3a).

These findings would suggest a partial different approach for assessing nature and degree of the anthropogenic impact, and for consecutive bioremediation procedures for the two different areas of the lagoon.

References

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