Benthic foraminifera and ostracoda as palaeoecological proxies from modern to fossil river-influenced shelves: the case of the North Adriatic area

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The North Adriatic area represents an excellent location for the study of present-day and fossil meiofauna, since wide, detailed databases of benthic foraminifera and ostracoda are available for the modern North Adriatic Sea as well as for the nearby late Quaternary succession of the Po coastal plain. In this setting, benthic foraminifera and ostracoda were applied as facies indicators in a sequence stratigraphic perspective during the last years. However, such palaeoenvironmental reconstructions did not meet the requirements of modern palaeoecology, which aims to discriminate with quantitative methods significant abiotic factors influencing the faunal assemblages in order to quantify palaeoenvironmental changes through time.

To improve the palaeoenvironmental resolution within the Holocene shallow-marine deposits of the Po coastal plain, the first step was the analysis of the most reliable modern analog: the North Adriatic shelf. We separately analyzed published databases on modern benthic foraminifera and ostracoda, focusing on the shallow (i.e. <40 m water depth) North Adriatic Sea, with the aim to find independent connections between single faunal groups and controlling factors. Through a set of multivariate statistical analyses, we identified five benthic foraminiferal biofacies mainly controlled by organic matter concentration and seven ostracod biofacies driven by grain-size (sand concentration) and bathymetry. The integration of benthic foraminiferal and ostracod biofacies allowed the distinction of five depositional environments on the modern North Adriatic shelf, determined by the relative position with respect to the Po Delta outlets. More specifically, the distribution of depositional environments from coastal to offshore locations reflects three macro-areas subject to low, moderate and high riverine inputs.

In order to test the palaeoenvironmental resolution of benthic foraminifera and ostracoda, the 21 m-thick shallow-marine, fine-grained succession of core EM13 was quantitatively analyzed and its fossil content compared to the modern North Adriatic fauna by means of statistical techniques. The good chronological constraints available for the evolution of the Po Delta represent a solid framework to test the meiofaunal response to coastal and deltaic dynamics. Benthic foraminifera from the study succession clearly marks the transition from open marine to prodelta conditions linked to the coastal progradation after the last maximum marine transgression (ca. 7000 yr BP). This faunal group also highlights cycles of organic matter fluxes within prodelta sediments, chronologically in accordance with the main phases of Po Delta progradation. On the other hand, ostracoda indicate three phases of progressive increase of sediment supply: the first when the drainage system was stable until the demise of the Roman Empire (ca. 1500 yr BP), the second during the progradation of the Ariano and Volano mouths (ca. 1500-800 yr BP) and the last one after the Ficarolo avulsion (798 yr BP), when the Po Delta started to prograde very rapidly in its present-day position. This study case indicates that benthic foraminifera and ostracoda represent excellent and complementary palaeoecological indicators on river-influenced shelf settings. Nevertheless, an accurate interpretation of shallow-marine successions can be obtained exclusively through their integration.