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PRELIMINARY DATA ON BENTHIC ASSEMBLAGE OF TRANSITIONAL WATERS IN A LAGOON OF THE NORTHERN ADRIATIC SEA

DATI PRELIMINARI DI POPOLAMENTI BENTONICI DI ACQUE DI TRANSIZIONE IN UNA LAGUNA DEL NORD ADRIATICO

Abstract - Transitional waters are important habitats for the ecological role they represent and for their associated biodiversity. Ten sampling stations were established in Laguna Vallona (Northern Adriatic Sea) in three different time periods: before, during and after an anthropogenic pressure. Benthic assemblages were collected and identified to the lowest taxonomic level. Univariate and multivariate analyses were carried out. Large heterogeneity among stations was observed, with the presence of few species with high abundance, typical features of transitional water, as the Polychaeta *Streblospio shrubsolii* (Buchanan, 1890), *Hediste diversicolor* (O.F. Müller, 1776) and the Crustacea *Gammarus insensibilis* Stock, 1966 and *Gammarus aequicauda* (Martynov, 1931). Human activities have generated modifications in the macrozoobenthic community; however, the resilience of these communities allowed a return to a community typical of coastal estuarine environments.

Keywords: macrozoobenthos, Adriatic Sea, transitional waters, benthic assemblages, anthropogenic pressure

Introduction - Transitional waters are important habitats for the ecological role they represent and for their biodiversity richness, providing valuable natural resources and relevant ecosystem services. However, they are highly susceptible to climate changes and anthropogenic pressures, which often cause biodiversity loss (Munari & Mistri, 2008; Trabucco *et al.*, 2012; Marusso *et al.*, 2013; Trabucco *et al.*, 2015; Trabucco *et al.*, 2021; Marusso & Trabucco, 2024). Benthic communities, which are recognized as important indicators to evaluate environmental conditions, are commonly monitored to assess the health of these environments. These communities live in close contact with the seabed, have a relatively long-life cycle and can reflect a seabed perturbation. Moreover, these animals play an important role in the marine food chain, as they constitute the food for many benthic fishes. The Vallona lagoon, the investigated area, is located in the Northern Adriatic Sea and is characterized by low average water depths (< 2.2 m), and the salinity of the lagoon (14–22 PSU) is mainly controlled by water exchange with the sea (Maggi *et al.*, 2017). The area was interested by a sediment perturbation due to human activities. A monitoring program was carried out for about 10 years, on different matrices (water, sediments, and biota), and divided into three time periods: before, during, and after sediment movement. In this study we evaluated the effects of sediment movement on the benthic community in the three different time periods.

Materials and methods - Ten sampling points (Fig. 1) were selected in Laguna Vallona (Porto Levante, Northern Adriatic Sea) at depths between 1-3 m, in three different time

periods: November 2005, before sediment movement (B); August 2008, during sediment movement (C); June 2011, after sediment movement (E).

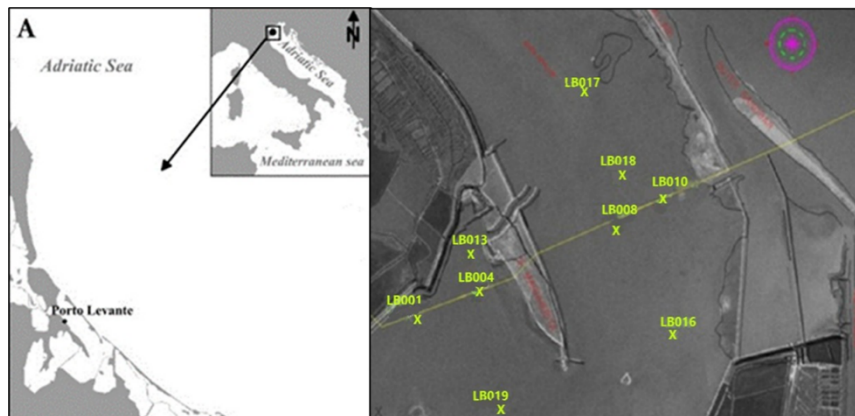


Fig. 1 - The ten sampling points selected in Laguna Vallona.
Le dieci stazioni selezionate nella Laguna Vallona.

Benthic assemblages were collected using a box corer and fixed in buffered 4% formaldehyde and identified at the lowest taxonomic level by using a stereomicroscope. Univariate analyses on structural indices (abundance, number of species, d Margalef, J' Pielou, and H' Shannon) and multivariate analysis (ANOSIM, nMDS, and CCA) were carried out. The total organic carbon (TOC) concentration and sediment grain size (silt, clay and sand content) were analysed for each station and at each survey.

Results – A total of 5805 individuals and 150 species were counted. The total abundance (Fig. 2a) shows a progressive increase from before (B) to after (E) sediment movement, with the lowest values in survey B. As for the number of species, similar values were observed in the survey B and during the sediment movement (C), while the highest value was recorded during survey E. The d, J and H' indices present the lowest values in survey C (Fig 2b).

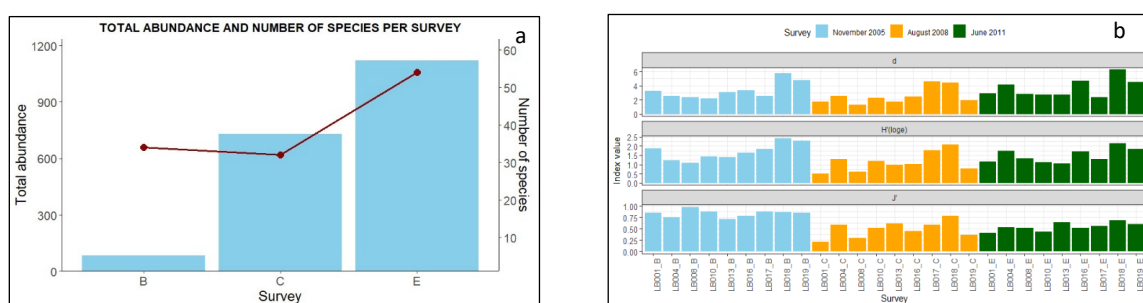


Fig. 2 - (a) Total abundance and Number species observed at the three surveys (B, C, E); (b) d, J and H' indices calculated at the three surveys (B, C, E) in each sampling station.
(a) Abbondanza totale e numero di specie osservate nelle tre campagne (B, C, E); (b) indici d, J e H' calcolati nelle tre campagne (B, C, E) in ciascuna stazione di campionamento.

The ANOSIM (Fig. 3a) similarity test with $R=0.5573$ and $p<0.001$ indicates a moderate but significant difference between the three surveys: in particular, the lowest intra-survey variability was observed in the survey B. The nMDS analysis (stress 0.19) shows differences among the three surveys: the communities observed in B and E are more similar than those observed in survey C. The graph shows the TOC concentrations

recorded in the three surveys, with the highest values observed in the stations of the survey C (Fig. 3b).

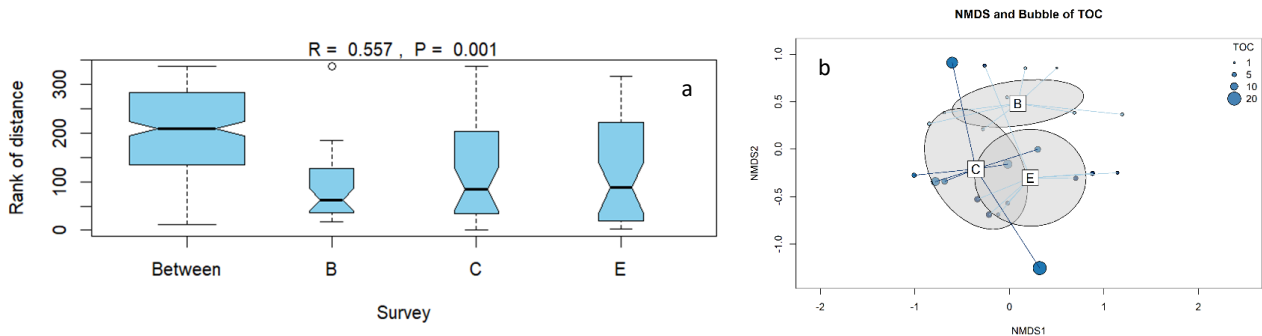


Fig. 3 - (a) ANOSIM and (b) nMDS analyses carried out at the three surveys (B, C, E).
 (a) Analisi ANOSIM e (b) nMDS effettuate nelle tre campagne (B, C, E).

Simper analysis (Fig.4a) shows that the survey B is characterized by the presence of *Streblospio shrubsolii* (Buchanan, 1890), *Polydora ciliata* (Johnston, 1838) and *Hydroides dianthus* (Verrill, 1873). Survey C is characterised by *Capitella capitata* (Fabricius, 1780), *S. shrubsolii* and *Siriella jaltensis* (Czerniavsky, 1868). The survey E is characterized by *Hediste diversicolor* (O.F. Müller, 1776), *Gammarus insensibilis* Stock, 1966 and *Abra segmentum* (Récluz, 1843). The species observed in the CCA plot (Fig.4b) during the three surveys are correlated with both the grain size and TOC concentration. It can be observed that the factors that mainly influence the presence of the species are the gradients of TOC and silt. The analysis shows as some species, such as *Upogebia pusilla* (Petagna, 1792), *Abra prismatica* (Montagu, 1808), *Gammarus aequicauda* (Martynov, 1931) and *Mytilaster minimus* (Poli, 1795), are positively correlated with the presence of silt, while *Hydrobia* spp. W. Hartmann, 1821, *Spio* cf. *filicornis* (Müller, 1776), and *Sphaeroma serratum* (J. C. Fabricius, 1787) prefer sediments with high TOC values. The plot shows that TOC and silt form an angle of 180°, indicating a strong negative correlation. TOC is positively correlated with sand and appears unrelated to the presence of clay.

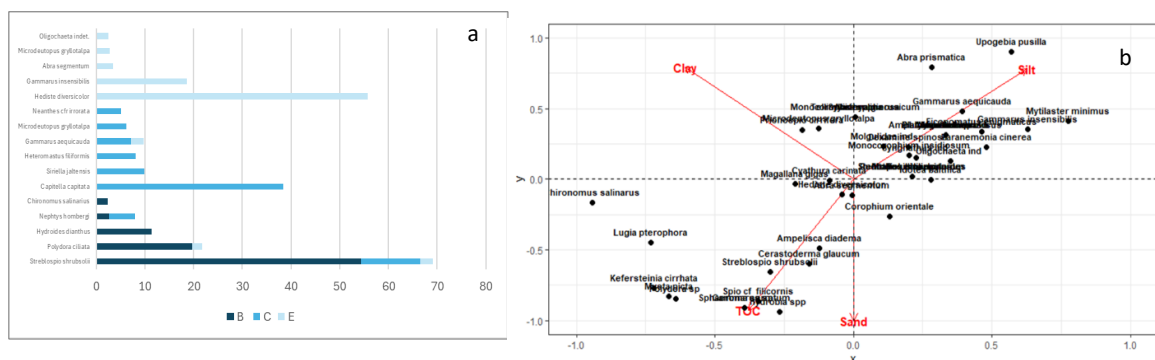


Fig. 4 - (a) Simper analysis: percentage contribution of the main species to the three surveys (B, C, E); (b) CCA analysis carried out among benthic assemblage, grain size and TOC concentration at the three surveys (B, C, E).
 (a) Analisi Simper: contributo percentuale delle specie principali nelle tre campagne (B, C, E); (b) Analisi CCA effettuata tra l'insieme bentonico, la granulometria e la concentrazione di TOC nelle tre campagne (B, C, E).

Conclusions - Transitional waters are characterized by organisms that tolerate variations in environmental parameters and are able to live in extreme environments (McLusky & Elliott, 2004). The community observed before the sediment movement

activities shows a population with relatively high biodiversity, typical of these environments, with the presence of *S. shrubsolii*, *P. ciliata*, *H. dianthus*, *Nephtys hombergii* Savigny in Lamarck, 1818. After the sediment movement a change in the community was observed. The presence of opportunistic species such as *C. capitata* and *Microdeutopus gryllotalpa* A. Costa, 1853 or species that increase their abundance with the increase of organic matter, such as *S. shrubsolii*, has been observed. During this period the amphipod crustacean *G. aequicauda*, adapted to wider environmental variations (Kevrekidis *et al.*, 2009), and the opportunistic polychaete *Heteromastus filiformis* (Claparède, 1864) have been detected. The community observed after the sediment movement appears modified compared to the one before the sediment movement, with the presence of species linked to organic enrichment, such as *G. aequicauda*, and species with different ecological values, such as *G. insensibilis* typical of stable environments (Ruffo, 1982-1998) and other species typical of transitional environments, such as *A. segmentum* and *H. diversicolor*. Human activities have generated modifications in the macrozoobenthic community observed during the first survey, making the environment suitable for the opportunistic species. Indeed, there has been an increase in the abundance and number of species, the disappearance of opportunistic species, and the appearance of species typical of these environments. However, the resilience of these communities allowed a return to a community typical of coastal estuarine environments, even if partially different from that observed before the anthropogenic pressure (Borja *et al.*, 2010).

REFERENCES

- BORJA Á., DAUER D.M., ELLIOTT M., SIMENSTAD C.A. (2010) - Medium-and long-term recovery of estuarine and coastal ecosystems: patterns, rates and restoration effectiveness. *Estuar. Coasts*, **33** (6): 1249-1260.
- KEVREKIDIS T., KOURAKOS G., BOUBONARI T. (2009) - Life history, reproduction, growth, population dynamics and production of *Gammarus aequicauda* (Crustacea: Amphipoda) at extremely low salinities in a Mediterranean lagoon. *Int. Rev. Hydrobiol.*, **94** (3): 308-325.
- MAGGI C., BERDUCCI M.T., DI LORENZO B., DATTOLO M., COZZOLINO A., MARIOTTI S., FABRIZI V., SPAZIANI R., LAMBERTI, C.V. (2017) - Temporal evolution of the environmental quality of the Vallona Lagoon (Northern Mediterranean, Adriatic Sea). *Mar. Poll. Bull.*, **125** (1-2): 45-55.
- MARUSSO V., TRABUCCO B., NONNIS O., MAGGI C., CECCHETTI S., NASCETTI G., ANGELETTI D., CIMMARUTA R. (2013) - Effects of sediment management on the Amphipod community off the Latium coasts (Tyrrhenian Sea) and preliminary DNA barcoding data on *Ampelisca* (Amphipoda). *Crust.*, **86** (7-8): 871-889.
- MARUSSO V., TRABUCCO B. (2024) - The Amphipoda and Cumacea assemblage response to LNG terminal installation in Adriatic Sea (Mediterranean Sea). *Tenth International Symposium Monitoring of Mediterranean Coastal Areas: Problems and Measurement Techniques*, ISSN 2975-0288.
- MCLUSKY D.S., ELLIOTT M. (2004) - The Estuarine Ecosystem; ecology, threats and management, 3rd edition, OUP, Oxford, 216 pp.
- MUNARI C., MISTRI M. (2008) - Biodiversity of soft-sediment benthic communities from Italian transitional waters. *J. Biog.*, **35** (9): 1622-1637.
- RUFFO S. (1982-1998). The Amphipoda of the Mediterranean. Part 1-4. *Mémoires de l'Institut océanographique*, Monaco, **13**: 1-950
- TRABUCCO B., MAGGI C., MANFRA L., NONNIS O., DI MENTO R., MANNOZZI M., VIRNO LAMBERTI C., CICERO AM., GABELLINI M. (2012) - Monitoring of impacts of offshore platforms in the Adriatic Sea (Italy). Natural Gas – Advances in Natural Gas Technology, H. Al-Megren (Ed.), ISBN: 978-953-51-0507-7, InTech.
- TRABUCCO B., GROSSI L., MARUSSO V., BACCI T., BERTASI F., CERACCHI S., LOMIRI S., VANI D., VIRNO LAMBERTI C. (2015) - Macrozoobenthic assemblages around a marine terminal for re-gasifying liquefied natural gas (LNG) in the north Adriatic Sea (Italy). *J. Mar. Biol. Ass. UK*, **95** (8): 1-13.
- TRABUCCO B., CERACCHI S., GABELLINI M. AND VIRNO LAMBERTI C. - (2021). Ecological note about the impact on the marine ecosystem of an underwater pipeline for the transport of natural gas. *IJESNR* **29** (2): 556259.