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Project "Biodiversity MARE Tricase": biodiversity research, monitoring and promotion at MARE Outpost (Apulia, Italy)

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Abstract

The project "Biodiversity MARE Tricase" aims to research and promote coastal and marine biodiversity at the MARE Outpost (Avamposto MARE), a marine station established in Tricase (Lecce, Italy) in 2015. From March 2016 to September 2017, the first biodiversity inventory of the Tricase coastal area (Ionian Sea) was realized with the aid of citizen scientists (e.g. local fishermen, divers, bathers, and tourists). Preliminary results include 556 taxa, of which the 95% were identified at the species level. Despite the broad knowledge on Mediterranean coastal biodiversity, 71 species represented new records for the Ionian Sea. In parallel with the research activities, people's awareness of the value of biodiversity was raised with scientific dissemination initiatives, involving about 1700 people. The "Biodiversity MARE Tricase" project realized a first small-scale species inventory contributing to the distributional, taxonomic, and ecological knowledge of the present Mediterranean biota. The coastal area of Tricase will be soon included in a new Marine Protected Area and this project represents a step forward for the sustainable development of the community of this coast.

Keywords Biodiversity · Tricase · Species inventory · Mediterranean Sea · Avamposto MARE · Scientific dissemination

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Abbreviation

BMT Biodiversity MARE Tricase

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1 Introduction

"Biodiversity", or biological diversity, comprises the variety and variability of living organisms in all aspects, from genetic, morphological, to ecological ones (Grassle et al. 1991). In this one-size-fits-all scenario, however, biodiversity is mainly used to express the concept of species richness (Baltanas 1992). Nowadays, biodiversity is recognized as the main determinant of ecosystem functioning (Boero and Bonsdorff 2007; Heip et al. 2009). An optimal use of available resources is correlated with higher diversity of functional traits, increasing and stabilizing energy and matter flows (Bertness et al. 2014). In both terrestrial and aquatic ecosystems, biodiversity loss is correlated with a decrease in ecosystem productivity, stability, and recovery potential (Worm et al. 2006; Tilman et al. 2012).

Biodiversity can be, therefore, considered as the most valuable good on Earth, as it provides a large number of essential goods and services for humankind, such as oxygen, food, materials, energy, and wellness (Beaumont et al. 2007). Unfortunately, due to a thoughtless and unsustainable mode of development, this inestimable heritage is under threat (Chapin et al. 2000).

The importance of biodiversity is now recognized not only by academics but also by decision-makers and citizens (Rands et al. 2010; Francis 2015). The European Union, in its Marine Strategy Framework Directive, placed "Biodiversity is maintained" as the 1st descriptor of Good Environmental Status (EU Marine Strategy Framework Directive 2008), but the assessment of the state of biodiversity requires knowledge of species contingents (Boero 2013). Currently, several taxonomic lists are available for the Mediterranean Sea, along with an extensive literature on this biogeographic area, but there are still substantial gaps on the distribution of species at local scales and essential information on taxonomy, distribution, abundance, and temporal trends of most taxa (Coll et al. 2010). Lack of knowledge about local and small-scale biodiversity still affects regional-scale databases (Kim and Byrne 2006).

The Mediterranean Sea is a hotspot of biodiversity with up to 13,000 multicellular species (Coll et al. 2010). This number is particularly high considering that the Mediterranean Sea is only the 0.82% in surface area and the 0.32% in volume of the world oceans (Bianchi and Morri 2000). However, the Mediterranean biodiversity is experiencing rapid changes in response to a high number of stressors such as habitat loss, overfishing, pollution, climate change, and eutrophication (Coll et al. 2012). Long-term biodiversity monitoring at high taxonomical resolution is crucial to understand these patterns of change (Magurran et al. 2010).

Founded in 2015 in Tricase Porto (Lecce, Apulia, Italy), the MARE Outpost (Avamposto MARE) has been established to research and monitor the coastal and marine biodiversity in the Otranto channel. It was realised by the joint initiative of the Centre International de Hautes Etudes Agronomiques Méditerranéennes of Bari (CIHEAM Bari), the University of Salento, the Municipality of Tricase, the "Magna Grecia Mare" association, and the Regional Natural Park "Costa Otranto, Santa Maria di Leuca and Wood of Tricase". The MARE Outpost is situated in front of an almost uncontaminated rocky shore in the middle of a Natural Park, and a recently proposed Marine Protected Area (Capo d'Otranto—grotte Zinzulusa e Romanelli—Capo di Leuca). The considerable biological interest of the area has been recognized since the 1970s and recent faunistic findings confirm this (Parenzan 1983; Beli et al. 2018). The MARE Outpost is both a marine station, devoted to in situ and in vivo biodiversity studies, and a place of cooperation between Mediterranean institutions, social and cultural organizations, associations and individuals, all engaged in a smart and sustainable growth of coastal communities. The MARE Outpost is open to the general public and, due to the large numbers and types of visitors, is also an ideal place where to implement scientific outreach activities (Strano 2016).

Following the institution of the MARE Outpost, the "Biodiversity MARE Tricase" project (http://www.biodiversitymaretricase.org) has been launched to inventory the coastal and marine biodiversity of the area and to promote knowledge and public awareness of the local environmental assets (Micaroni et al. 2018). The collaboration with citizens and stakeholders has been crucial for the project. Fishermen, divers, bathers, local citizens, and tourists have all been involved in both the collection of specimens and research activities. A mutual flux of information has been established between scientists and citizens, with mutual benefits.

The aim of this paper is to give a preliminary overview of the collected data and a summary of the scientific dissemination activities carried out by the BMT project.

2 Materials and methods

2.1 Biodiversity inventory

The study area is located along the south-eastern coast of Apulia (Italy) in the Otranto channel (Ionian Sea), along the coastline of Tricase (Fig. 1). Samplings were carried out over an 18-month period, from March 2016 to September 2017. The biodiversity inventory focused on the following ecological categories: hard and soft bottom phyto- and zoobenthos, nekton, gelatinous plankton, and terrestrial near-shore vegetation. Organisms were collected by selective and qualitative samplings and collected physically and/or photographed using Sony Rx100, Canon Power-Shot D30,

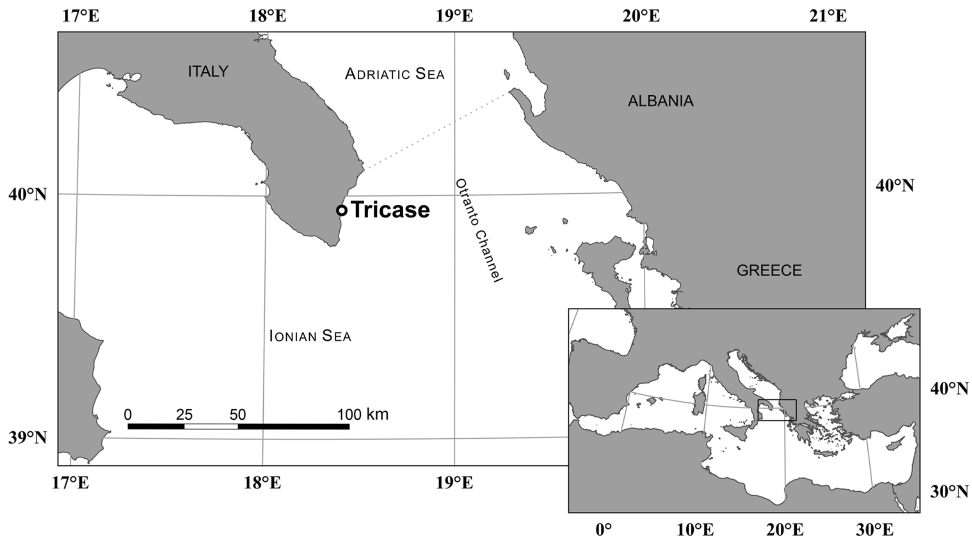

Fig. 1 Map of the Otranto channel and the north Ionian Sea. The dotted line indicates the boundary between the Ionian Sea and the Adriatic Sea. In the bottom right corner: the Mediterranean Sea

and Nikon AW130 cameras. For all sampled organisms, phenological traits, such as seasonality, reproductive state, and behaviour, were recorded.

The substrate of the investigated area, from the shoreline down to ~ 18 m depth, mainly consists of limestone layers deposited during the period between the Cretaceous and the Oligocene (Ricchetti et al. 1988). Because of the pervasive presence of limestone substrate, the area is karstified and several caves and springs occur. The study area also includes the small port of Tricase, which is composed by an exposed natural inlet and a semi-closed artificial harbour, both characterized by the presence of many freshwater springs. Noticeably for the general ecological aspects of the study site, patches of coralligenous concretions emerging from sandy and muddy sediment are documented from 18 to 70 m water depth (Parenzan 1983; Onorato et al. 1999).

Sampling sessions were 134, using: (1) skin diving to sample gelatinous plankton, benthos, and nekton from 0 to 20 m depth; (2) scuba diving, partially made in collaboration with local divers, to sample benthos and nekton between 0 and 30 m depth; (3) fishing gear (pole and line, long line, nylon gillnet, and trammel) in collaboration with local fishermen to sample nekton, benthos, and substrates from both catch and bycatch between 0 and 30 m depth; (4) bathers samplings between the intertidal and 4 m depth.

Sampled organisms were immediately brought to the laboratory of the MARE Outpost, kept in aerated tanks, and photographed in vivo. The presence of reproductive structures and behaviour was verified and recorded. Organisms were either released alive in the sea or fixed and preserved following the protocols of the Smithsonian National Museum of Natural History (2016). Rare and unidentified organisms were fixed in alcohol 80% to preserve their DNA for molecular analysis. A preliminary identification of taxa was made using available monographs (Zariquiey Alvarez 1968; Boillon et al. 2004; Pansini et al. 2011; Cormaci et al. 2012, 2014; Chimenz Gusso et al. 2014; Gravili et al. 2015; Brunetti and Mastrototaro 2017), specific literature and original descriptions. In a second phase, a number of experienced taxonomists provided more reliable species identifications.

2.2 Outreach

The dissemination strategy was implemented with the following actions: (1) citizens were involved in samplings and species identification in both field and laboratory activities; (2) the realization of a high-definition photographic species inventory, freely accessible and downloadable at http://www.biodiversitymaretricase.org; (3) 12 workshops with 23 classes of primary and secondary school with an average duration of 2 h each, eight marine biodiversity courses for children of a duration of 9 h each, two marine science courses for schools lasting 3 h, five public conferences and seminars, four open days and guided visits, and information service to visitors at the MARE Outpost almost every day; (4) two national TV programs: "Linea Blu" and "Speciale TG1" gave media coverage to the BMT project. All dissemination activities have been supported by educational and promotional materials (as booklets, leaflet, postcards, stickers, stationery, etc.) realised by the BMT project and by further EU projects (e.g. MED-JELLYRISK, VECTORS, CoCoNet, and Merces).

3 Results

3.1 Biodiversity inventory

Overall, regarding the aquatic organisms, 911 specimens were sampled and recorded, 556 taxa were identified, 526 of these at species level (representing roughly the 95% of the total dataset), 27 at genus level, and 3 at family level. Of these, 71 were not reported from this biogeographical area (sector 6, corresponding to the Ionian Sea) in the "Checklist of flora and fauna of Italian seas" (Relini 2008, 2010), 2 species are new records for the Italian fauna and 1 is new to science. Most of the new records belong to the phyla Cnidaria (25 species), Mollusca (20 species), and Platyhelminthes (6 species). The species list includes eight non-indigenous species, already known in the area (Gravili et al. 2010). Furthermore, 52 phenological events were recorded: 20 occurrences of seasonal organisms, 26 presences of reproductive structures, and 5 reproductive behaviours.

The most represented kingdom was Animalia, with 470 species, 416 genera, 302 families, and 16 phyla, the most represented one being Mollusca (134 species), followed by Chordata (101 species) and Cnidaria (81 species) (Fig. 2).

Macrophytes, comprising Planta (phylum Chlorophyta, phylum Rhodophyta, and phylum Tracheophyta) and Chromista (phylum Ochrophyta, class Phaeophyceae) were represented by 62 species, 50 genera, 35 families, and 4 phyla. The most represented phylum was Rhodophyta (35 species), followed by Chlorophyta (15 species), and Ochrophyta (9 species).

The list of unicellular organisms comprises six taxa and four species belonging to four phyla: Cyanobacteria, Ciliophora, Foraminifera, and Radiozoa.

Regarding the terrestrial near-shore vegetation, 44 species were found, all referred to the Magnoliophyta phylum.

Most specimens were collected during spring, and in particular in May (219), April (158), and June (149). In 2016, 791 specimens were collected, and 121 in 2017; 337 specimens were collected by skin diving, 318 by fishing gear, 239 by scuba diving, and 17 by bathers (Fig. 3).

3.2 Outreach

In the course of the 18 months, ~1700 people visited the MARE Outpost and have been involved in the outreach activities of the BMT project. In particular, near 480 primary and secondary school students attended the workshops,

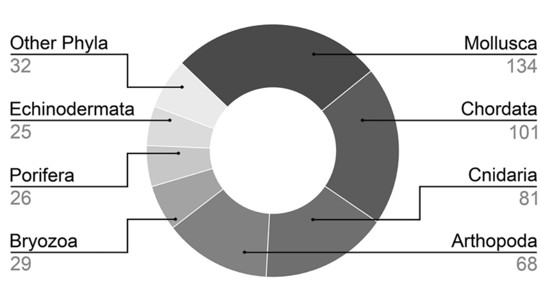

Fig. 2 Number of taxa belonging to the main phyla of the Animalia Kingdom composing the biodiversity inventory

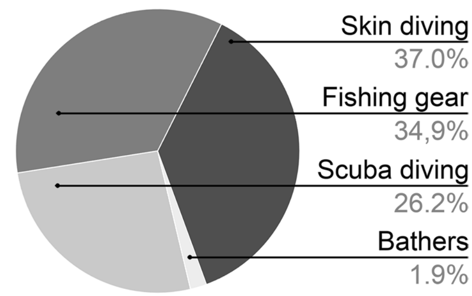

Fig. 3 Percentages of specimens sampled with each sampling method

while up to 250 children attended the biodiversity and the marine science courses. The public conferences and seminars attracted over 120 attendees while the open days and the free guided visits attracted ~850 people. Regarding the TV programs, total viewers were in excess of 3.4 million, which is a remarkable figure for natural history broadcasts (Auditel 2017).

4 Discussion and conclusions

In recent years, not only academics fully recognize the importance of biodiversity, but also the media, politicians, and the general public (Bianchi and Morri 2000). The new findings of this 18-month survey show, however, that the knowledge of Mediterranean biodiversity can be still significantly improved.

Some taxonomic groups are poorly investigated due to the lack of taxonomic experts, and this can lead to inaccurate estimates of species occurrences. In return, the lack of experts has negative cascading effects on publication rate of taxonomy and biodiversity studies, decreasing interest by the overall scientific community, and greatly reducing research and job opportunities in biodiversity science (Boero 2010). As a result, descriptive researches and biodiversity record publications are often overlooked (Boero 2013). In addition, this gap is enhanced by a lack of studies targeted to small-scale species (e.g. meiofauna) or to deep environments.

In contrast, data on species distribution and phenology are fundamental to understand and predict the effects of global and human-driven changes on ecosystems. For this reason, there is an urgent plea for long-term biodiversity monitoring and field observations. However, the value of biodiversity inventories depends mainly on their completeness and accuracy, so there is also a need of new taxonomists merging traditional and modern methodologies to properly identify taxa and address marine biodiversity and conservation biology issues (Giangrande 2003; Green et al. 2009; Boero and Bernardi 2014; Scorrano et al. 2017). Species inventories and taxonomy are also critical for biodiversity conservation since the unknown cannot be efficiently protected (Mace 2004). This includes a better appreciation of still poorly understood connectivity and connectance issues, currently still poorly understood but fundamental to a robust marine spatial planning and governance of marine protected areas (Boero et al. 2016).

Inspired by the seminal work of Salvatore Lo Bianco in the Gulf of Naples (Lo Bianco 1909), the BMT project joined scientific research and dissemination activities to investigate the Mediterranean biodiversity and to raise people's awareness of the value of biodiversity. The outcomes of the project confirmed the effectiveness of involving citizen scientists as tools for ecological data collection and environmental awareness enhancement (Dickinson et al. 2010). The BMT project carries on the idea that scientific dissemination and biodiversity promotion are both fundamental to raise people curiosity towards the marine environment and to produce a shift in people behaviour necessary to move from a consumer society to a society that preserves. This work represents a starting point for several new studies in the area and, at the same time, is a step forward to biodiversity conservation and sustainable development.

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