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Potential role of plastic waste as an artificial substrate for the settlement of benthic organisms

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1. INTRODUCTION

1.1 MARINE LITTER POLLUTION

In recent decades, marine litter has been recognised as one of the greatest global environmental threats. It is no coincidence that this problem has attracted increasing attention from scientific community and political sphere. This is due to significant impacts they have on ecosystems, inevitably also affecting human health (Beaumont et al., 2019). Marine litter is defined as 'any persistent solid material, whether produced or processed, discarded, disposed of or abandoned in the marine and coastal environment' (UNEP, 2009). Since the 1960s, research efforts on marine litter have grown exponentially; likewise, the amount of litter in the Oceans has increased (Bergmann et al., 2015). Recent estimates have shown that between 5 and 12 million tons of litter are dumped into the marine environment every year (Jambeck et al., 2015). Marine debris, such as aluminium, glass, plastic and rubber, most of which is derived from everyday items, is often abandoned in coastal/marine environments (Bergmann et al., 2015; Coe & Rogers, 1997; Thompson & Gall, 2014) or disposed of improperly. In this way, increasing amounts of litter are entering into the Oceans from urban litter streams (Barnes et al., 2009). Furthermore, they may enter the sea indirectly, through river estuaries or wind action (Aragaw, 2021; Jambeck et al., 2015; Lima et al., 2014). Marine litter can be found on different substrates, marine domains and depths. According to Galgani, 2015, marine litter is abundant and ubiquitous on beaches, surface waters, in the water column and the deep ocean floor. The main reasons for accumulation of litter in the sea are the increasing use of single-use products, disposal problems and sub-optimal recycling practices. The accumulation of litter in the sea (Fig. 1) and along coastlines around the world and potential effects on human health and marine wildlife have raised public awareness, stimulating scientific research and initiated policy action to address this environmental problem (UNEP, 2014).

Figure 1. Marine litter on the seafloor (Šibenik, 2023).

1.2 Marine plastic pollution

Marine litter is mainly constituted by plastic objects, which represent 80% of the total (Battaglia et al., 2019; UNEP, 2014). The first reports on the diffusion of plastics in marine environment date back to 1970s. Edward Carpenter was the first to suggest that aforementioned problem would probably worsen in the following years and that additives used in plastics to improve their properties, called plasticisers, could interact with the physiology of marine organisms (Bergmann et al., 2015). The rapid expansion of the use of synthetic polymers over the last century has been such that the characterisation of current era as the ‘Age of Plastic’ seems appropriate. Understanding the reasons why plastic has become the most popular material in the last century is very comprehensible; this material, in its countless variants, is extremely versatile and can be used in practically all industrial fields, even replacing metals in specific applications. For this reason, plastics industry shows no signs of slowing down to the present; on the opposite, it is constantly on the rise (Porta, 2021). Therefore, considering the extensive use of plastics in every field and human activity, including developing countries, the consequences of plastic pollution in marine environment are constantly being studied worldwide. In this perspective, the role of each individual citizen in documenting local events is becoming crucial to collecting valuable data to support science; this is possible because identification and sampling of plastic litter does not require specific scientific skills, so citizens are contributing substantially to collecting of data on marine litter pollution and, consequently, increasing perception of the problem (Smith & Edgar, 2014). It has been estimated that about 10 % of all plastic debris ends up in the Oceans (Thompson, 2006); it has also been estimated that a minimum of 5.25 trillion plastic particles weighing a total of about 270 tons float on the sea surface, however, these numbers do not take into account debris that is found on the seafloor or that reaches beaches (Eriksen et al., 2014). The incidence of plastic litter in the sea is widely illustrated by many images of floating debris from the famous oceanic litter islands (Fig. 2), some as large as entire countries; these generally tend to form due to currents, which converge and accumulate litter in specific locations. Several reports from different parts of the Oceans suggest that plastic litter is present on coastlines (Behera et al., 2021; Fruegaard et al., 2023; Van der Mheen et al., 2020; Subías-Baratau et al., 2022), and throughout the water column, from pelagic to benthic domain, even in remote areas and in polar environments (Barnes, 2005; Barnes et al., 2010; Bergmann & Klages, 2012), including the deepest seafloor (Chiba et al., 2018; Woodall et al., 2014); these, given their great depth and geological conformation, could become definitive collection points for marine litter (Pham et al., 2014). To try to understand the size of this impact, it is enough to focus only on the daily production in countries bordering the Mediterranean Sea basin, which is estimated at several hundred tons. The high human pressure, combined with characteristics of Mediterranean Sea (it is a semi-enclosed basin), leads to a significant accumulation of litter, both on the seafloor and the surface (Cincinelli et al., 2019; Cózar et al., 2015; Fortibuoni et al., 2019; Palatinus et al., 2019; Pierdomenico et al., 2020; Pierdomenico et al., 2023; Suaria et al., 2016).

This, as mentioned earlier, has meant that interest in this issue has grown exponentially in recent years, not only because of the consistent work of the scientific community, which has focused a lot of effort on studying this phenomenon that affects every part of the globe, but also because of the strategies that the governments of many countries are implementing, to find solutions in an attempt to stem the problem.

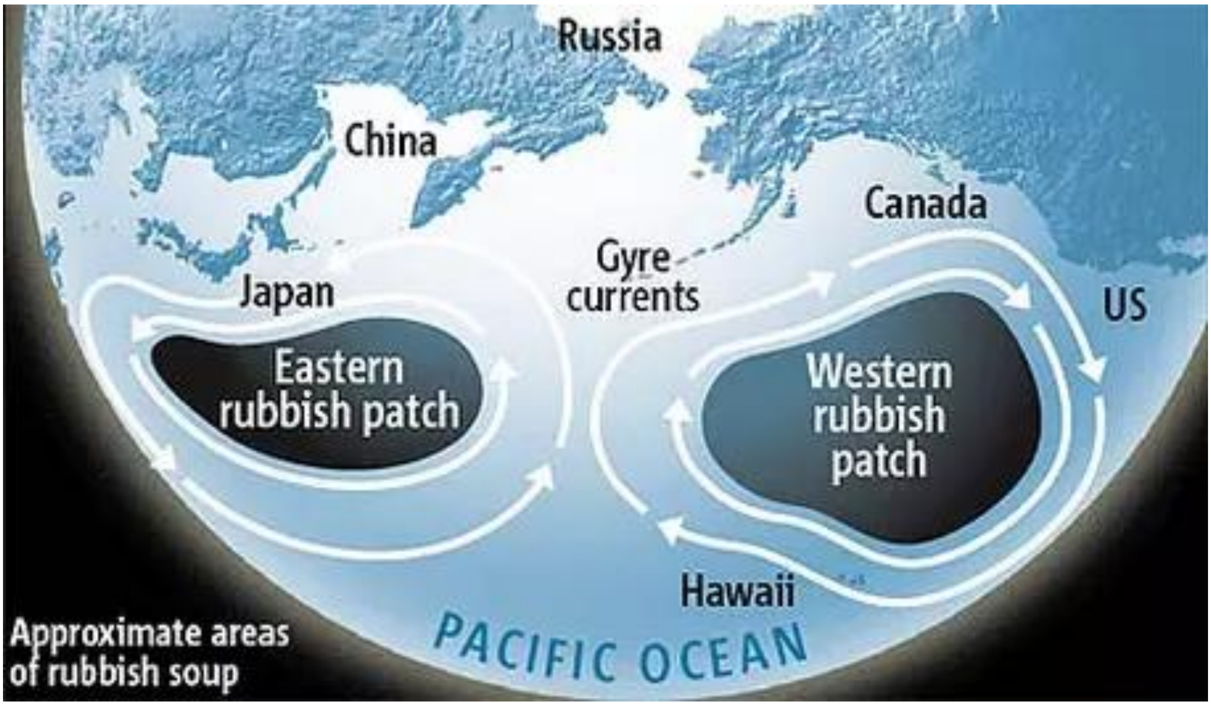

Figure 2. Location of plastic island in Pacific Ocean. Photocredit: earthly issues, charles welch, photo http://www.earthlyissues.com/plastic.htm.

1.3 PLASTIC POLYMERS

Polymers are substances obtained mainly from oil, through a process known as polymerisation. These substances consist of long chains of molecules and are called monomers (Bayo et al., 2018). They can be of two types: thermostable or thermoplastic (Bayo et al., 2018). Thermoplastic polymers are easily malleable by means of heat and/or pressure and are the most widespread, so this name is nowadays used to refer to all polymers: it is no coincidence that they are commonly referred to as plastics. According to the classification of plastics, they can be placed in six main groups: PET, PEAD, PEBD, PVC, PP and PS (Bayo et al., 2018). Annual global consumption of plastic is currently 300 million tons and polyethylene (PET) is the most widely used polymer (Bayo et al., 2018). Its annual production is about 80 million tons, and its main use is packaging. The second most widespread is polypropylene (PP), with an annual production of 55 million tons. This plastic, compared to polyethylene, can withstand higher temperatures and is more resistant. It is followed by polyvinyl chloride (PVC), with an annual production of 30 million tons; it is one of the most versatile plastics, as it is used in many sectors, from construction to plumbing (Bayo et al., 2018).

Table 1. Comparison of the main plastic polymers and their characteristics. Source: https://allamericancontaiers.net/helpful-hints/resin-comparison-chart/

	PETE	HDPE	V	LDPE	PP	PP	PS	OTHER
PROPERTIES	**Polyethylene Terephthalate**	**High Density Polyethylene**	**Polyvinyl Chloride (PVC)**	**Low Density Polyethylene**	**Polypropylene**	**Bio-Based Biopropylene®**	**Polystyrene**	**Other Plastics**
Clarity	Clear	Translucent	Clear	Translucent	Translucent	Opaque	Clear	Varies
Moisture Barrier	Fair to Good	Good to Excellent	Fair	Good	Good to Excellent	Fair to Good	Poor to Fair	Varies
Oxygen Barrier	Good	Poor	Good	Poor	Poor	Poor	Fair	Varies
Distortion Temperature	145°F	160°F	150°F	160°F	212°F	160°F	150°F	Varies
Rigidity	High	Moderate	High	Low	Moderate	Low	High	Varies
Resistance to Impact	Excellent	Excellent	Good	Excellent	Fair	Fair to Good	Poor	Varies
Resistance to Cold	Good	Excellent	Fair	Excellent	Poor to Fair	Excellent	Poor	Varies
Resistance to Sunlight	Good	Fair	Poor to Good	Fair	Fair	Fair	Poor to Fair	Varies
Resistance to Acids	Fair	Good	Good	Medium	Good	Medium	Medium	Varies
Resistance to Alcohol	Good	Good	Very Good	Good	Good	Good	Fair	Varies
Resistance to Alkalis	Poor	Very Good	Good	Very Good	Very Good	Very Good	Good	Varies
Resistance to Solvents	Good	Poor	Good	Poor	Poor	Poor	Poor	Varies

1.4 INTERACTIONS BETWEEN PLASTIC AND MARINE ORGANISMS

The amount of plastic litter in Ocean waters has increased massively and the toxic additives contained in plastic have been found and documented in many marine species (Hermabessiere et al., 2017). Organisms of different sizes and habits can be in contact with plastics, giving rise to a wide range of interactions (Canals et al., 2021). Specifically, plastic litter of different sizes (from nanoplastics to macroplastics), shape and composition (such as Nylon, Polyethylene, PVC) can accidentally be ingested by marine organisms at different trophic levels, consequently causing alterations along the food chain (Bottari et al., 2019; D'Iglio et al., 2019; Farrell & Nelson, 2013; Savoca et al., 2019; Setälä et al., 2014). This aspect should not be underestimated for more than one reason: first, it can cause relevant damage to the environment, altering the ecosystem and, furthermore, it represents a potential risk to human health (Bakir et al., 2014; Browne et al., 2013; De Witte et al., 2014; Naidoo et al., 2020; Van Cauwenberghe & Janssen, 2014), both directly and indirectly. Directly, as the fish used for human consumption can potentially contain plastics; indirectly, as plastics, can be a vector of pathogens or chemical substances, often causing more or less severe disorders (Andrady et al., 2019). Several research studies deal with this aspect in various fish species and beyond, as the ingestion and interaction between biota and meso-microlitter are associated with the degradation of marine litter (Cocci et al., 2022; Miccoli et al., 2022; Piazzolla et al., 2020; Santonicola et al., 2024; Sbrana et al., 2020; Scacco et al., 2022).

Large plastic litter has to be considered too, such as "ghost nets", which are the remains of lost or abandoned fishing gears (nets), settled on the seafloor potentially causing various negative effects: on the one hand they can continue to be traps for fauna, from small fishes to large mammals, even reptiles and seabirds (Azzarello & Van Vleet, 1987; Bjorndal et al., 1994; Boren et al., 2006; Derraik, 2002; Kühn et al., 2015; Kühn et al., 2020; Mascarenhas et al., 2004; Nelms et al., 2016; Panti et al., 2019; Salazar-Casals et al., 2022; Sazima et al., 2002; Roman et al., 2019; Wilcox et al., 2015) on the other hand they can "suffocate" the seafloor, inevitably causing suffering and in the most severe cases the death of all those sessile and benthic organisms that, due to physiological characteristics, are unable to move or that lead habits strictly linked to the substrate, whether sandy or rocky(Singh & Devi, 2019).

1.5 PLASTISPHERE: HOW BIOTA EXPLOIT PLASTIC

Regardless of specific polymer examined, plastics have a peculiar characteristic: the surface of this artificial material, in fact, is hydrophobic (Cai et al., 2019). This allows colonization by living organisms micro and macro ones; such colonization also depends on various factors, such as the roughness and hardness of the plastic surfaces. The first colonizers are bacteria and fungi, which form biofilms and promote the settlement of algae, micro and macroinvertebrates, belonging to numerous Phylum: among the main ones there are Annellida, Arthropoda, Briozoa, Cnidaria, Echinodermata and Mollusca (Battaglia et al., 2019). Over time, if environmental conditions allow it and with the establishment of increasingly complex balances, it is possible to observe the appearance of small-scale biotopes (Wright et al., 2020; Wright et al., 2021) in which each organism, from the simplest to the most structured, plays a very specific trophic role, from primary producers to secondary or tertiary consumers. The time required for a significant colonization to occur is influenced by both physical and chemical factors; the intensity of the currents, temperature, pH, salinity, depth, the amount of light that manages to penetrate along the water column and the more or less marked presence of dissolved nutrients play a fundamental role; furthermore, the intrinsic characteristics of plastic litter such as shape, density, composition, porosity and degree of aging are of particular importance in the evolution of the process. As above mentioned, the first organisms capable of colonizing the surface of plastic litter are bacteria and fungi, which lay the foundations for subsequent settlements. In fact, they contribute to the formation of a gelatinous layer called biofilm, which adheres tenaciously to the plastic surface. The term biofilm (O'Toole et al., 2000) refers to an aggregation of bacterial and/or fungal cells firmly adhered to a surface (in this specific case plastic) and incorporated into an adhesive polysaccharide matrix secreted by the cells themselves; this provides them with protection and considerable resistance.

This first stage is essential for the entire colonization process to take place. In fact, it is precisely the biofilm layer that promotes the settlement of micro and macroalgae first and, subsequently, of micro and macroinvertebrates that will find support, protection and food in them. In this way, a series of ecological relationships are established between the species present, both intraspecific and interspecific. To emphasize this ecological aspect, which has irreversibly become part of everyday life, the term “Plastisphere” has recently been coined (Amaral-Zettler et al., 2020; Cesarini et al., 2022; Wang et al., 2021). This word is intended to highlight the inevitable and continuous adaptation of many organisms to the considerable presence of plastic litter in the environment, specifically in the marine environment, managing in some cases to exploit it to their advantage, as if it were a natural resource. When plastic litter, depending on its intrinsic characteristics such as shape, size, density and composition, is deposited on the seafloor, it can increase the structural complexity of habitats, paradoxically promoting a local increase in biodiversity (Katsanevakis et al., 2007; Song et al., 2021). It is specifically at the seafloor level that the greatest quantity of plastic is found; this can accumulate in a more or less marked manner based on the conformation of the seafloor; in case of deep canyons, the amount of litter (not only plastic) that will accumulate over time will be greater. If, for example, a medium-large plastic litter reaches a seafloor mainly made up of fine sand, this can potentially be exploited by benthic and sessile organisms as if it were a natural rocky support. This can facilitate, in a certain time-frame, the settlement of species that, due to physiological characteristics, would not otherwise find a suitable substrate for their growth (Katsanevakis et al., 2007; Song et al., 2021). To better understand this concept, think of the concrete structures artificially created by man to reduce the impact of trawling, preventing the passage of boats through areas with precarious ecological balances. In these areas, these agglomerations represent real "oases in the desert" for many living organisms (Crocetta et al., 2020; Mancini et al., 2021). In addition to above, plastic litter of the right shape and density, called floating plastics, are able to float on the surface of the sea and be transported for considerable distances by currents (Aliani & Molcard, 2003; Barnes & Milner, 2005; Battaglia et al., 2019; Póvoa et al., 2021), creating in the best-known cases the large floating islands in the Oceans. In some cases, they can be transported even for hundreds of kilometres, before settling along the coast or sinking due to variations in density caused by the increase of encrusting organisms on the surface. This may imply the emergence of a further closely related problem, namely a potential spread of Non Indigenous Species (NIS) and/or invasive species (Kiessling et al., 2015; Mghili et al., 2023; Rech et al., 2016) in habitats even very far from their original ones. However, these species must adapt to the chemical-physical conditions of the new environment (mainly temperature, salinity, pH, depth, amount of light). These are generally euryvalent species, able to tolerate large variations and less susceptible to alterations in environmental parameters (on the contrary, in the case of stenovalent species, they will hardly be able to adapt). Furthermore, it has been seen how the floating plastics, when sufficiently colonized, increase their density until sinking; this, due to the different environmental conditions caused primarily by the variation in depth and intensity of light, will lead to the death of the colonizing species and the settlement of new organisms, with different characteristics compared to previous ones. One of the most impressive cases, which best helps to understand the importance of the Plastisphere occurrence, concerns the colonization of plastic substrates by *Corallium rubrum* Linnaeus, 1758, the famous red coral of the Mediterranean Sea, reported in several sites in the waters of Sardinia. In this regard, studies have been carried out under controlled conditions which have confirmed that plastic can provide an adequate substrate favourable to the settlement and growth of the species, suggesting a possible use in repopulation activities. Excessive collection (and often illegal since in many cases without authorization), in fact, has brought this fragile species to the brink of extinction over the last few decades, and the use of appropriately positioned plastic substrates of the right shape/composition could represent a valid solution in order to repopulate the species in those areas where, nowadays, it has disappeared (Carugati et al., 2021); such a strategy could, of course, be applied in order to promote the repopulation of other benthic and sessile organisms whose populations are at risk due to pollution or overfishing. A similar situation occurred in the waters of the Strait of Messina, where several deep-sea coral species were found attached to remains from floating fishing gear (Battaglia et al., 2019). Several cases have also been reported in other parts of the world, not only in Mediterranean Sea (Kannan et al., 2023; Snigirova et al., 2020). In this regard, a technique used in different parts of the world, especially in recent years, known as 'restoration' (Bracho-Villavicencio et al., 2023) has been developed; artificial substrates composed of various types of material, including some types of plastic (Knoester et al., 2023), are used to promote the restoration of particularly vulnerable ecosystems such as coral reefs. It is evident how necessary it is to expand our currently limited knowledge about the impact of plastic in the marine environment and its role as a possible resource to be exploited. Usually, when talking about plastic impact in the sea, in fact, in most cases we refer to the ingestion of microplastics or to all those accidental interactions that can cause the death of pelagic and benthic organisms. These issues are relevant, as countless studies have shown, but certainly on a par with the Plastisphere. Indeed, plastics could be a useful support for the settlement of a wide range of benthic organisms (Fig. 3), which would increase biodiversity in environments that have declined in terms of species over time. This aspect is particularly interesting to evaluate and assess what could be the possible positive, negative or null effects generated by accumulation of plastic litter on the seafloor and specifically on local biodiversity. It will be important to study the intraspecific and interspecific interactions that will be established within the newly formed habitat, as well as the adaptation strategies of species that will colonize plastic substrates. Still, suitably adapted plastic substrates could be further exploited in the farming of edible species of high commercial value, such as various species of bivalve molluscs, or in the farming of sponges, which are heavily exploited and harvested for the cosmetics industry. At the same time, attention must be paid to floating plastic litter, as it is one of the main causes of the dispersal of species at considerable distances from their areas of origin, which can therefore lead to the spread of NIS (Mancini et al., 2021), with sometimes serious consequences for ecosystems. This could help to understand whether it is possible to exploit plastics, universally recognised as a major cause of pollution in the marine environment and beyond, in order to take advantage of a highly negative situation, from which there is unlikely to be a recovery.

Figure 3. Example of a heavly colonised plastic substrate (pet) bottle from Faro Canal.

1.6 Natural substrates for the settlement of benthic organisms: *Pinctada radiata* Leach, 1814

Pinctada radiata Leach, 1814 is a bivalve native to the Indo-Pacific area, belonging to family Margaritidae. It is a Lessepsian species, being one of the first organisms to have reached Mediterranean Sea through Suez Canal (Monterosato, 1878). It lives on hard substrates, to which it attaches itself by the byssus; it generally ranges in size from 50 to 70 mm in length but may exceed 100 mm in some cases. It is a species that shows proterandric hermaphroditism, with sexual inversion occurring when the size of the valves is between 32 and 57 mm in length. Temperature also plays a key role in the physiology of this animal, as the stage of maturity of the gonads depends on it (Tlig-Zouari & Zaouali, 1994). This oyster pearl has adapted well to the physical and chemical characteristics of Mediterranean Sea, colonising it entirely (Galil & Zenetos, 2002; Gofas & Zenetos, 2003), sometimes forming conspicuous populations (Tlig- Zuari, 1993). This is possible because it can tolerate wide variations in salinity (Moussa, 2018) and because of its resistance to chemical contamination, allowing it to spread even in closed and polluted basins (Zenetos et al., 2007). These characteristics make *P. radiata* an invasive species, considering that its spatial distribution is increasing (Zenetos et al., 2004; Zenetos et al., 2005; Zenetos et al., 2007). Due to these peculiarities, and to the rough and irregular shape of its valves, it seems to be an ideal candidate to be evaluated as a natural substrate useful for settlement of benthic organisms. Indeed, from preliminary observations, it can be seen that surfaces of both valves are more or less uniformly covered with a wide range of benthic invertebrates (Fig. 4): Anellida, Arthropoda, Bryozoa, Cnidaria, Echinodermata, Mollusca and others. In this way, it is possible to compare a natural type of substrate with a synthetic one, such as plastic, helping to obtain more information and highlighting the main differences.

Figure 4. ***P. radiata*** **in natural environment (from Faro Lake); it is possible to observe a remarkable quantity of epibionts that have colonised the surface, in particular Anellida Polychaeta and Cnidaria.**

2. GOALS OF THESIS PROJECT

The aim of this research project is to investigate and extend knowledge about the role of plastic litter in the sea as a possible artificial substrate useful for the settlement of benthic, encrusting and sessile organisms in the Natural Oriented Reserve of Capo Peloro Lagoon (Messina, Italy) and in Šibenik (Croatia) areas, assessing the potential positive effects on local biodiversity. Potential negative effects generated by plastic substrates on small populations and as possible vectors of NIS and/or invasive species were analysed, with consequent alterations to endemic species. The structure of benthic communities was analysed, focusing on species associated with plastic litter and, in particular, benthic macroorganisms belonging to different Phyla. The establishment of new potential intra- and interspecific relationships and the consequent adaptation strategies implemented by species adhering to plastic substrates were assessed. Furthermore, plastic polymers composing the marine litter found within the Natural Oriented Reserve of Capo Peloro Lagoon (Messina) and in Šibenik (Croatia) were identified; this was made possible by the indications in literature regarding the characteristics of polymers (Bayo et al., 2018) and the information printed directly on the litter by producers. Finally, a comparison was carried out between substrates of artificial origin (plastic litter) with substrates of natural origin, in order to assess which is the most suitable to host benthic organisms and any differences in community structure. For this purpose, the surface of pearl oyster *P. radiata*, a species of Indo-Pacific origin that has now colonised the entire Mediterranean Sea, was examined.

The objectives of research are listed more specifically as follows:

- Evaluate the negative effects of plastic substrates in relation to increase of predatory, NIS and/or invasive species and the potential consequences for small endemic populations
- Evaluate the possible absence of effects on benthic organisms
- Monitoring the formation of new benthic communities
- Evaluate which of different plastic polymers are most suitable to host benthic and/or sessile organisms
- Comparing colonised plastic substrates from different areas
- Comparing an artificial substrate (plastic) with a natural one (oyster pearl *P. radiata*) in the same areas, in order to assess which is the most suitable for hosting benthic organisms, evaluating possible differences in community structure.

3. Materials and methods

3.1 Preliminary investigations

The first step of the present research involved a meticulous and thorough literature study to understand as much as possible the mechanisms underlying the interaction between plastic litter and organisms that colonize it, as well as the conditions essential for this process to occur, from the formation of the bacterial biofilm to the arrival of invertebrates. Particular attention was paid to the ecological aspect and how population dynamics are influenced by the presence of plastic material and chemical and physical parameters of the environments examined. Still, useful information was collected for the next experimental phase, which will be described in detail below. The second step was characterized by a preliminary field study; site surveys were carried out at the sites of interest and within them, using visual census technique (De Girolamo & Mazzoldi, 2001), the most scientifically relevant study areas were identified (Fig. 5). Two macro-areas of central Mediterranean were selected which, although radically different, have some essential characteristics in common; indeed, these areas are highly anthropized and characterised by freshwater inputs. These are the Natural Oriented Reserve of Capo Peloro Lagoon located in proximity to the Strait of Messina in Italy and the area near city of Šibenik, located in Dalmatian region of Croatia, along Adriatic Sea.

Figure 5. Picture taken during the visual census at Faro Lake; a bycicle almost entirely colonised by sessile organisms can be seen.

3.2 Study areas: Natural Oriented Reserve of Capo Peloro Lagoon (Messina, Italy) and Šibenik (Croatia)

The Natural Oriented Reserve of Capo Peloro Lagoon is a protected area located in the municipality of Messina and occupies an area of approximately 68 ha (EUAP, Official Gazette No. 125, 31.05.2010) In addition, it is a Special Protected Area (SPA) (Capillo et al., 2018) and a priority habitat listed in Annex I of the Habitats Directive (1992) (Region of Sicily, n.d.; European Community, 1979; Ec, 2007). It is a site of high cultural, economic and ecological interest. Its importance from a cultural and economic perspective is linked to the centuries-old shellfish farming activity carried out in this area since the late 1700s; this activity is still ongoing, representing one of the most important traditions linked to the area and guaranteeing an appreciable contribution to the local economy, thanks to farming of bivalves of high commercial value such as mussels, oysters and clams [Mazzola et al., 2010; Manganaro et al., 2012]. The area is located near the Strait of Messina, on the north-eastern side of Sicily. The Strait of Messina is a Site of Community Importance (SIC) (Savoca et al., 2020), established by European Directive No. 92/43 EEC (Habitats Directive), according to the criteria set out in Annex III of the Habitats Directive. It represents a particularly interesting area from an ecological and zoological point of view, due to its bathymetry and geomorphology, and has always been known for its characteristic marine habitats (Spanò, 1998; Spanò & De Domenico, 2017; D'Iglio et al., 2023; D'Iglio et al., 2024). It is characterised by a submarine profile that, at its shallowest point (3.2 km wide), shows a depth of between 80 and 120 m. On the Tyrrhenian side, seabed tends to slope slightly, unlike on the Ionian side where slope appears very steep, reaching a depth of about 500 m after only a few kilometres (Abate et al. 2011). The Strait demarcates physiographic boundary between the central-southern Tyrrhenian Sea and the Ionian Sea, representing a morphological barrier for exchange between the two basins. The fluctuations of the Atlantic-Ionian Current (AIS) generate a unique internal dynamic inside the Strait; moreover, although the tidal excursions in the Mediterranean are relatively small, in the Strait of Messina they become significant, as the semidiurnal tides in the Tyrrhenian and Ionian are generally in opposition (Abate et al. 2011). This generates strong vertical and horizontal gradients, so that Ionian waters enter the Tyrrhenian Sea at the surface during the tidal flow from the north and, conversely, Tyrrhenian waters enter the Ionian Sea at depths of about 100 m during the flow from the south (Brandt et al. 1999). The upwelling processes bring deep waters to the surface, resulting in considerably colder surface waters in Strait than those in other areas of the Ionian Sea at the same depth; the nitrogen and phosphorous salts, transported to surface layers by the Ionian deep waters, allow a higher growth rate and abundance of primary producers, with consequent benefits along the trophic chain (Abate et al. 2011). Capo Peloro Lagoon is located near the Strait of Messina, and its hydrography is strongly influenced by it, and this can be seen in constant instability of water level. The area includes two brackish lagoon, Ganzirri Lake and Faro Lake, whose salinity is influenced by both sea water, rainfall and groundwater. A system consisting of four canals connects lakes to the sea: Catuso (covered) and Due Torri canals connect Ganzirri Lake to Ionian Sea, Faro and Inglesi canals connect Faro Lake to Ionian Sea and Tyrrhenian Sea respectively; however, the last one is only open during the summer for a short period. There is also a fifth canal, called Margi, that connects two lakes (D'Iglio et al., 2021) (Fig. 6). Ganzirri Lake has a total surface area of 0.338 km^2, reaching a maximum depth of approximately 7 metres, a sainity of between 29 and 34 PSU and a temperature that can vary between 11 and 31 °C. The relationship between lake's size and shallow depth, together with high groundwater input compared to the small amount of water it contains, means that salinity levels are lower than those of Faro Lake (Giuffré & Pezzani, 2005) and that physicochemical conditions depend significantly on weather conditions. The northernmost part of the lake is strongly characterised by the massive presence of the green alga *Chaetomorpha linum* (O.F.Müller) Kützing, 1845, which decomposing leads to regular eutrophication events. Concerning Faro Lake, it is markedly deeper than the former, reaching a maximum depth of 29 m and a total surface area of 0.263 km². The salinity is between 26 and 36 PSU and the temperature can vary between 10 and 36 °C. Due to its conformation, it represents an uncommon example of a meromictic basin, as there is a stratification of water masses. Furthermore, the entire basin is characterised by the massive development of sulphobacteria; the complex relationships established with other bacterial populations intervene in biogeochemical cycle of sulphur, making it a particularly relevant biotope (Raffa et al., 2019).

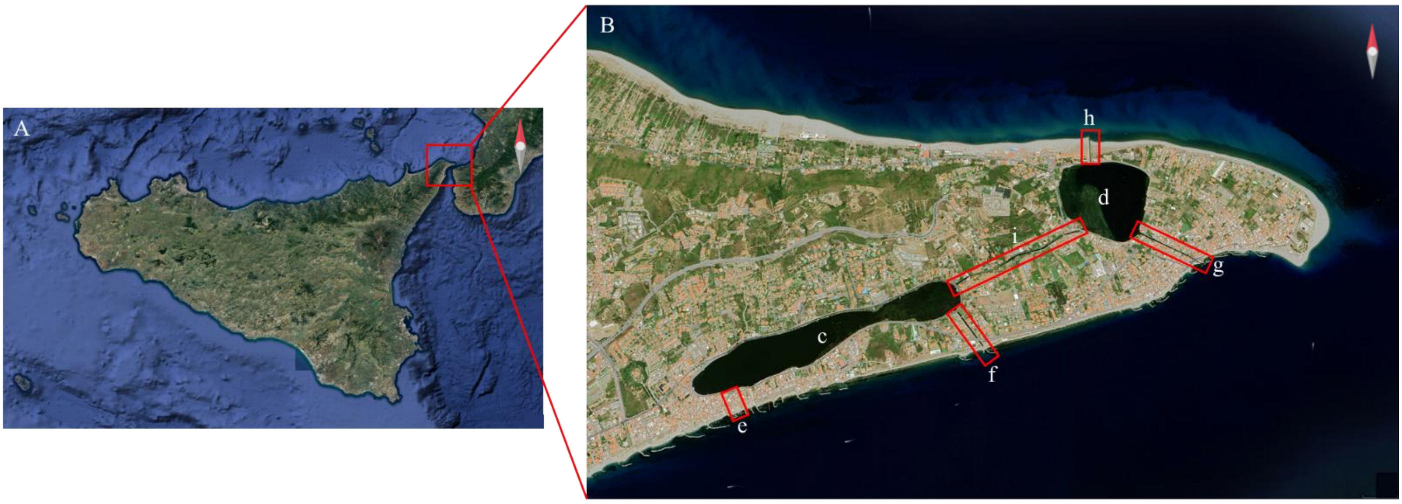

Figure 6. Satellite image of the Sicily, with the Strait of Messina highlighted (A); Satellite image of the Natural Oriented Reverve of Capo Peloro Lagoon (B), with the Ganzirri Lake (c), the Faro Lake (d), the Catuso Canal (e), the Due Torri Canal (f), the Faro Canal (g), the Inglesi Canal (h) and the Margi Canal (i).

Šibenik is a city in Croatia, the capital of the Šibenik and Tenin region, located in the historical region of Dalmatia along Adriatic Sea, near the mouth of the Krka River in a natural bay that is connected to sea by the St. Anthony's canal (Fig. 7). Off the city is Šibenik Archipelago, a group of islands located in Adriatic Sea west of Šibenik. Administratively, the islands belong to Šibenik and Tenin region. The largest islands of the archipelago are: Murter, Žirje, Kakan, Kaprije, Zmajan, Tijat, Prvić , Zlarin and Krapanj. The presence of the mouth of Krka River ensures a significant inflow of freshwater, which, due to the different density, causes a distinct stratification of the water; the surface meters (first 5 m) consist of fresh water, below which the water becomes saline.

Figure 7. Satellite image of the Dalmatia region in Croatia, with the Šibenik area highlighted (A); Satellite image of the city of Šibenik and the Šibenik Archipelago (B).

3.3 Sampling designs in the Natural Oriented Reserve of Capo Peloro Lagoon (Messina) and in Šibenik (Croatia)

Regarding the Natural Oriented Reserve of Capo Peloro Lagoon, a series of periodic preliminary surveys were carried out during 2022 using the visual census technique in order to identify the most suitable areas for study. At the end of these surveys, four transects were identified: the Faro Canal (400 m. Start point: 38°15’53.85’’N – 15°38’36.11’’E, End point: 38°16’00.02’’N – 15°38’21.63’’E), a transect within the Faro Lake (350 m. Start point: 38°16'03.17"N - 15°38'03.99"E, End point: 38°16'14.49"N - 15°38'02.83"E), the Margi Canal (900 m. Start point: 38°16’00.74’’N - 15°38’06.80’’E, End point: 38°15’48.84’’N - 15°37’33.38’’E) and the Due Torri Canal (300 m. Start point: 38°15’35.92’’N - 15°37’41.33’’E, End point: 38°15’43.78’’N - 15°37’33.96’’E) (Fig. 8). The identified sites were georeferenced using a Garmin GPS, GPSMAP 65 model. The Inglesi canal and Ganzirri Lake were excluded from the study. The Inglesi Canal because it is closed for most of the year whit very limited water exchange and absence of marine litter; the Ganzirri Lake because, from the visual census carried out, really few plastics litter objects were present.

Figure 8. Satellite view of the Natural Oriented Reserve of Capo Peloro Lagoon highlighting the four transects where sampling was carried out: the Faro Canal (A), the Faro Lake (B), the Margi Canal (C) and the Due Torri Canal (D).

At the same time, in September 2023 and by means of the same methods described above, two transects were identified within Šibenik area: the first in front of the city, near the mouth of the river Krka, specifically in the locality of Martinska (150 m. Start point: 43°44'09.90‘’N - 15°52'35.91‘’E, End point: 43°44'05.22‘’N - 15°52'34.12‘’E); the second in the natural bay of the uninhabited island of Tijat (350 m. Start point: 43°42'57.13‘’N - 15°46'16.58‘’E, End point: 43°43'06.64‘’N - 15°46'07.74‘’E) (Fig. 9). The choice fell on these two transects as they are areas characterised by freshwater inflows from Krka River, as well as for their marked anthropisation (despite Tijat is an uninhabited island, it is a place heavily frequented by many boats during summer period). Although there have been reports of *P. radiata* in the Adriatic Sea and along Croatian coasts (Bratoš Cetinić et al., 2023), visual census and subsequent sampling have not confirmed this.

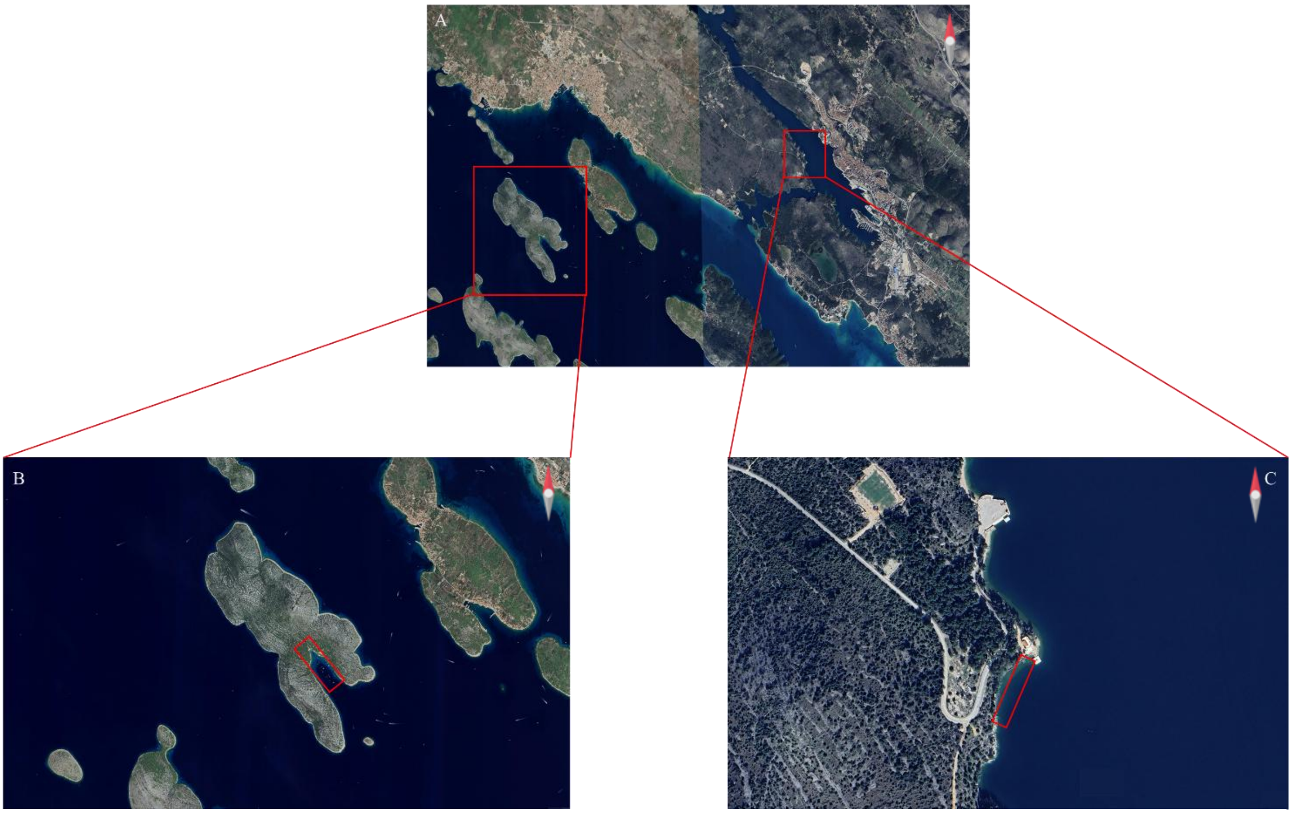

Figure 9. Satellite view of the Sibenik city area (A) highlighting the two transsects where sampling was carried out: the bay of the island of Tijat (B) and the locality of Martinska (C).

3.4 SAMPLING AND PROCESSING IN THE NATURAL ORIENTED RESERVE OF CAPO PELORO LAGOON (MESSINA) AND IN ŠIBENIK (CROATIA)

Between January 2024 and September 2024, sampling was carried out monthly within the Natural Oriented Reserve of Capo Peloro Lagoon, in the four transects examined (Fig. 10), at a depth between 0.3 m and 5 m. At the same time, during each individual sampling, the main physicochemical parameters of water (temperature, pH, salinity) were recorded using a Hanna Instruments HI 9829 - IT multiparametric probe. The plastic litter was collected manually along each transect with the aid of an hand net; the subsequent transport of samples to the "Emilio De Domenico" laboratory of the University of Messina took place in shortest possible time in buckets filled with water and equipped with aerators, in order to keep organisms in best possible conditions and separated from each other by individual bags. In the laboratory, each plastic was photographed and measured using a precision calliper in order to accurately calculate the colonised surface area (Fig.11). In addition, plastic polymers in each sample were identified from the literature (Bayo et al., 2018) and information printed by producers on the litter.

Figure 10. Views of the sampling areas inside the Natural oriented Reserve of Capo Peloro Lagoon (Messina): the Faro Canal (A), the Faro Lake (B), the Margi canal (C) and the Due Torri canal (D).

Figure 11. Some of plastic litter found within the Natural oriented Reserve of Capo Peloro Lagoon: it can be seen that many benthic organisms have colonised the surfaces.

The subsequent sorting steps (Fig. 12) were carried out on the same day as the respective sampling, to preserve the integrity of the organisms as much as possible, using precision forceps, scissors and spatulas. In case of litter consisting of different materials, only the plastic part was taken into account for sorting of organisms. The organisms thus sampled were preserved in 70% ethanol for subsequent identification. Identification of the organisms was carried out down to the lowest possible taxonomic level, compatible with the conditions of organisms themselves, with the aid of a Motic Panthera C2 light microscope connected to the Moticam 1080N camera and a Carl Zeiss Discovery V8 stereomicroscope, and using taxonomic keys and atlases of the different Phyla, useful for recognition (Baldacconi & Trainito, 2013; Bianchi, 1981; Faciai & Minervini, 1992; Costa et al., 2022; Ferrero-Vicente et al., 2016; Giannuzzi-Savelli et al., 2001; Gosner, 1971; Hayward & Ryland, 2017; Martìn et al., 2004; Martin et al., 2014; Naylor & Brandt, 2015; Parapar et al., 2012; Parapar et al., 2015; Parapar, 2018; Riedl, 2010; Ruffo, 1982; Ruffo, 1989; Ruffo, 1993; Ruffo, 1998; San Martìn, 2003; Trainito & Baldacconi, 2016; Young et al., 2001). The WoRMS database (https://www.marinespecies.org) was used to validate the species. It should be noted that where there were protected species, as listed in the "Register of Italian Protected Fauna" released by the Ministry of the Environment and Energy Security), they were promptly released still alive in the sampling environments after identification.

Figure 12. Some of the organisms sampled by sorting, belonging to the species *Aiptasia mutabilis* Gravenhorst, 1831, *Eurythoe complanata* Pallas, 1766 and *Sabella discifera* Grube, 1874.

Between July and September 2022, in the same way as described above for plastic litter and in the same transects, monthly sampling of pearl oyster *P. radiata* was carried out (Fig. 13), at a depth between 0.3 m and 3 m. The Margi Canal was excluded from the sampling, as *P. radiata* is not present in this area. Again, the samples were transported to the laboratory and processed as quickly as possible. Each *P. radiata* specimen was weighed and both valves were measured (height, length, width, hinge length) with a precision calliper, in order to calculate the colonised surface area. Sorting of the epibionts was carried out in the same way as for plastic litter and organisms preserved in 70% ethanol for subsequent identification.

Figure 13. Specimen of *P. radiata* ready for sorting; note the epibionts that have colonised almnost the entire surface.

Between September 2023 and December 2023, monthly sampling was carried out in the two transects examined (Fig. 14), at a depth between 1 m and 14 m, in the same manner as in the Natural Oriented Reserve of Capo Peloro Lagoon. Sampled plastic litter (Fig. 15) was transported from Šibenik to Ruđer Bošković Institute in Zagreb (in large drums filled with water and with a constant supply of oxygen), where it was processed no later than following day.

Figure 14. Views of the sampling areas near the city of Šibenik (Croatia): the locality of Martinska (A) and the Tijat island (B).

Figure 15. Some of marine litter found within the areas near Šibenik (Croatia).

Note: pictures of all plastic litter sampled in different areas can be accessed in the appendix (see Supplementary material 1 and 2).

3.5 Data analisys

Data analysis was performed using a combination of univariate and multivariate statistical methods. The macrobenthic community on plastic substrate (from Messina and Sibenik) and natural substrate (Pinctada radiata from Messina) was explored considering the number of taxa (S), abundance (N) (individuals/cm2), Pielou's equitability index (J′) and Shannon-Wiener's species diversity index (H loge'), Simpson's index (1-Lambda'). These biological parameters were calculated using PRIMER-e V6 on each sample. To investigate the differences occurring between study area, sampling period, month and polymer types the diversity indices were tested by one-way ANOVA, performing a Tukey's Honestly Significant Difference (HSD) post-hoc test when significant differences ($p < 0.05$) were found across spatial and temporal scales, and based on the substrate tested (Prism V.8.2.1. Graph-pad Software Ltd., La Jolla, CA 92037, USA). Additional plastisphere information was extracted by multivariate data analysis. First, a square root transformation was applied to the abundance matrix, and then Bray-Curtis similarities were calculated. Differences in community composition based on imposed factors (substrate, polymers, sampling period and sampling site) were evaluated by means of analysis of similarity (ANOSIM). The SIMilarity PERcentages (SIMPER) routine was used to determine which species contributed most to the observed differences in the data. All multivariate statistical analyses were performed using PRIMER6-E.

4. RESULTS

A total of 224 plastic litter were sampled within the Natural Oriented Reserve of Capo Peloro Lagoon (Messina), distributed as follows (Fig. 16):

- Faro Canal: 70
- Faro Lake: 51
- Margi Canal: 52
- Due Torri Canal: 51

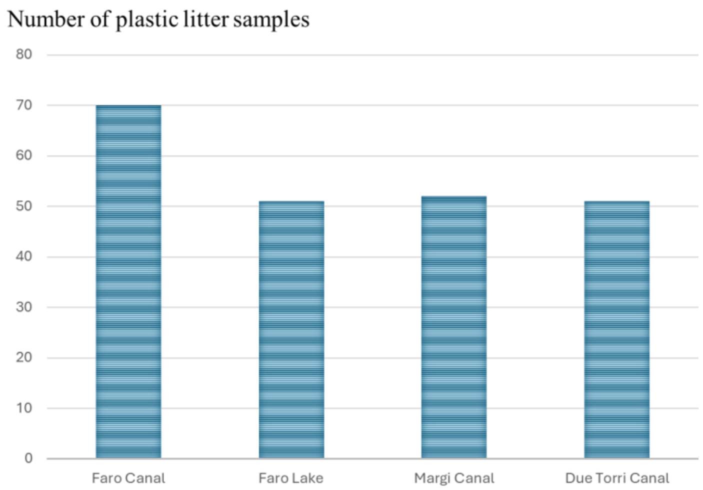

Figure 16. Distribution of plastic litter within the Natural Oriented Reserve of Capo Peloro Lagoon (Messina).

A total of 115 *P. radiata* specimens were sampled within the Natural Oriented Reserve of Capo Peloro Lagoon (Messina), distributed as follows (Fig. 17):

- Faro Canal: 64
- Faro Lake: 19
- Due Torri Canal: 32

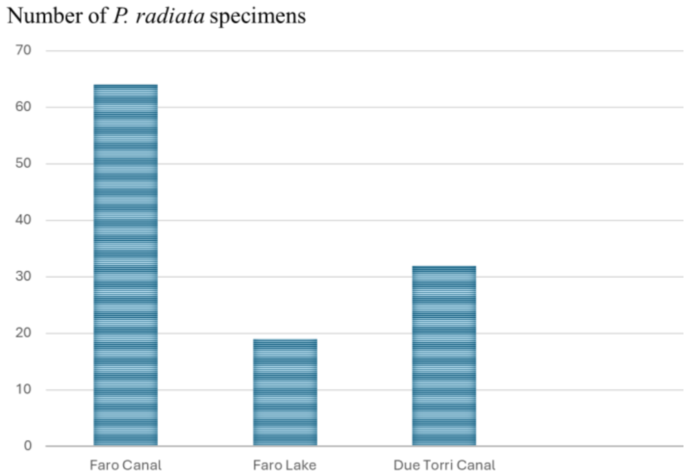

Figure 17. Distribution of *P. radiata* within the Natural Oriented Reserve of Capo Peloro Lagoon (Messina).

A total of 55 plastic litter were sampled within the Šibenik area (Croatia), distribuited as follows (Fig. 18):

- Martinska locality: 26 (2 samples had no organisms)
- Tijat Island: 32 (6 samples had no organisms)

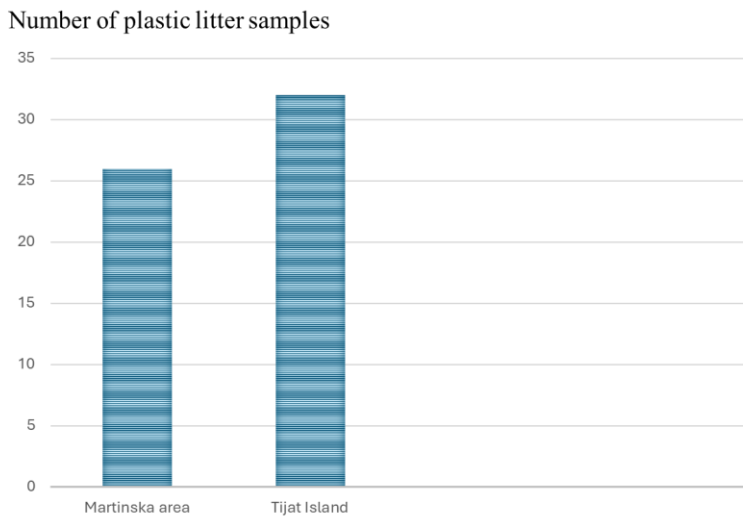

Figure 18. Distribution of plastic litter within the Šibenik area (Croatia).

Environmental parameters (pH, salinity, temperature) were recorded monthly, both in the areas within the Natural Oriented Reserve of Capo Peloro Lagoon (from January to September) and in the Sibenik area (from October to December). This is summarized in the following figures (Fig. 19-20-21-22-23-24):

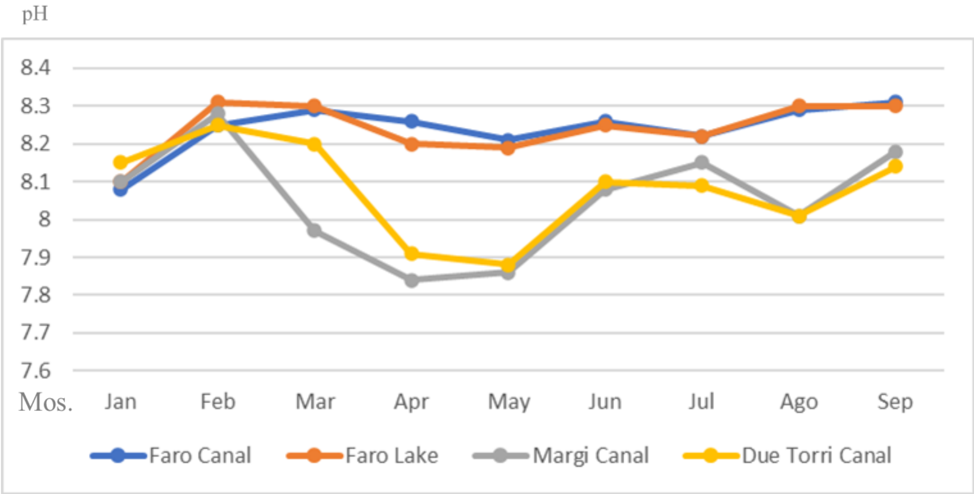

Figure 19. pH within the Natural oriented Reserve of Capo Peloro Lagoon (Messina).

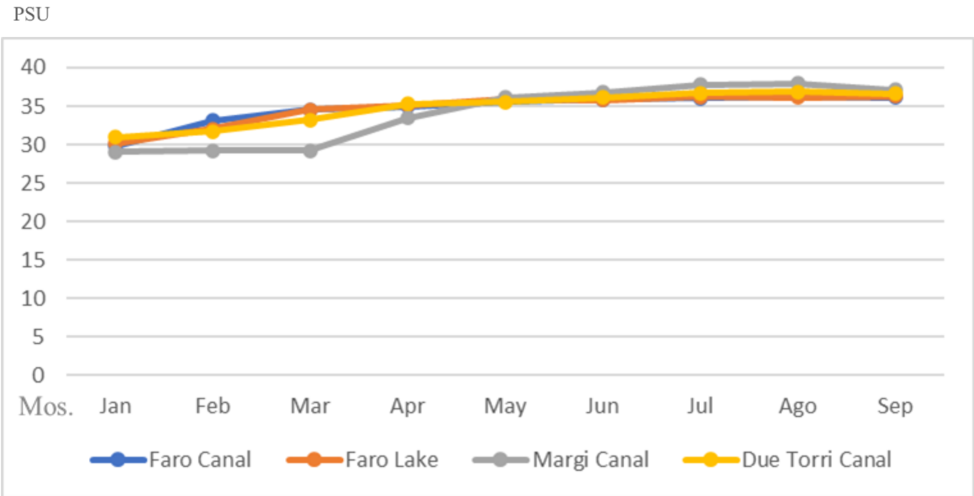

Figure 20. Salinity (PSU) within the Natural oriented Reserve of Capo Peloro Lagoon (Messina).

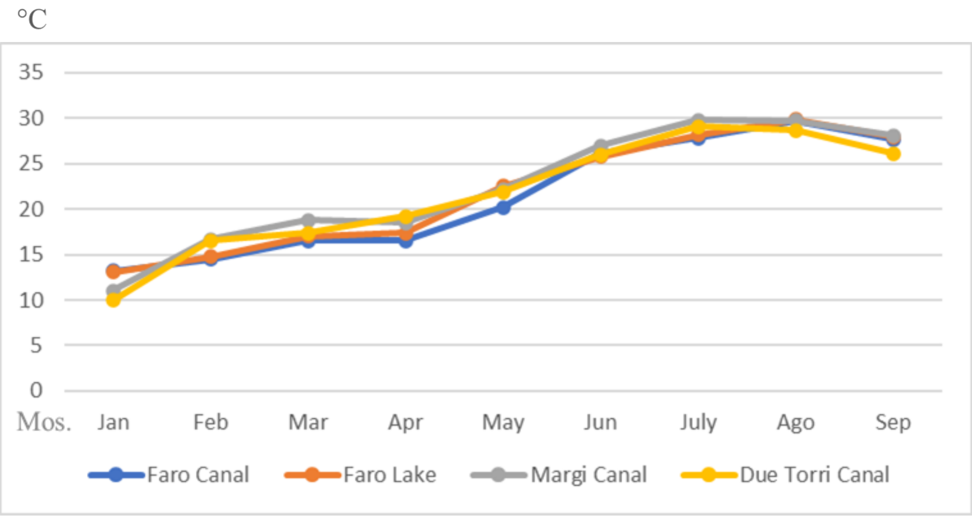

Figure 21. Temperature (°C) within the Natural oriented Reserve of Capo Peloro Lagoon (Messina).

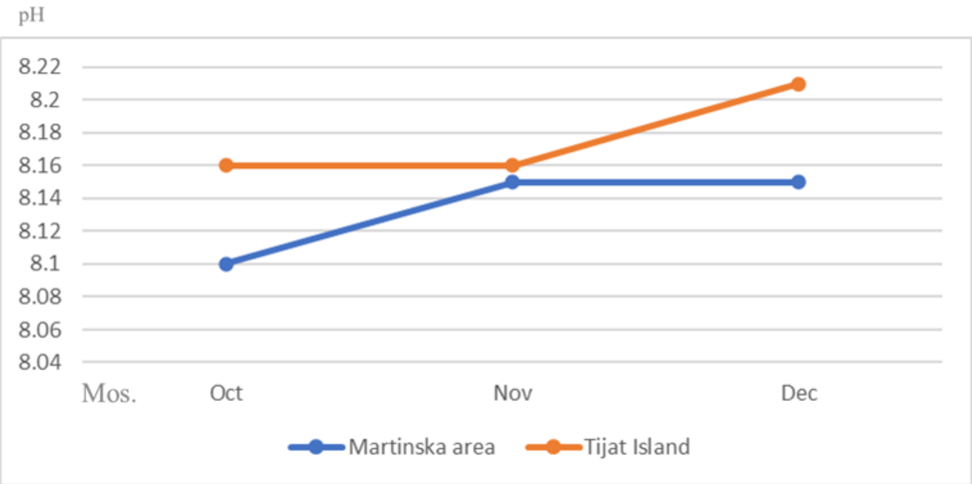

Figure 22. pH within the Šibenik area (Croatia).

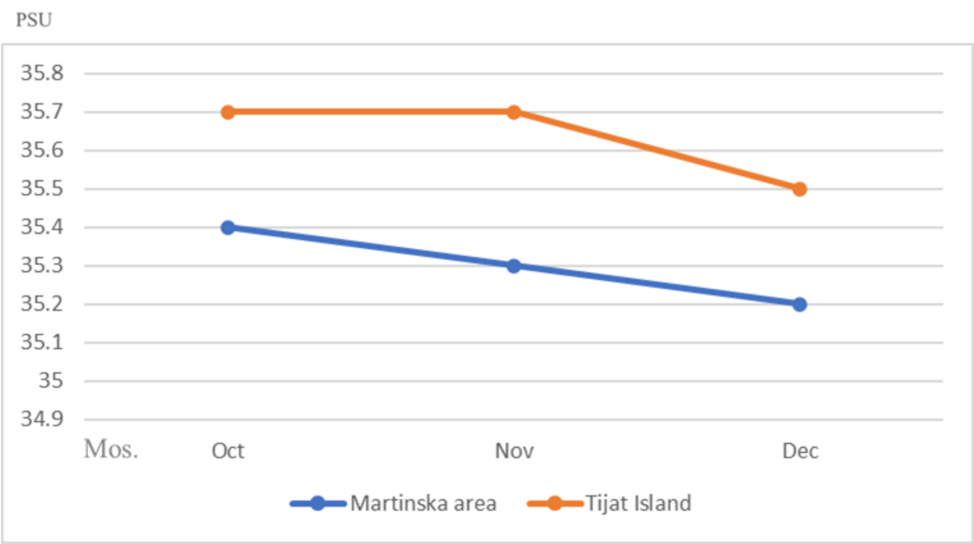

Figure 23. Salinity (PSU) within the Šibenik area (Croatia).

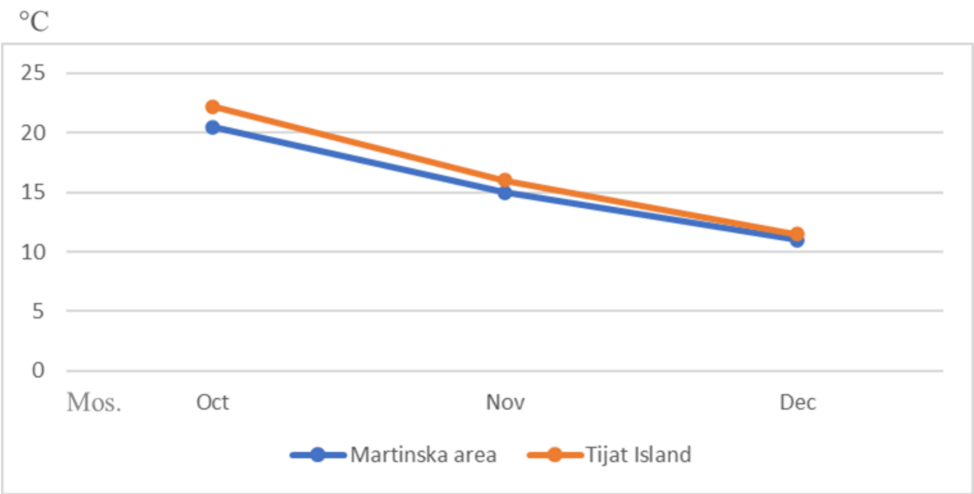

Figure 24. Temperature (°C) within the Šibenik area (Croatia).

4.1 Benthic community structures

The complete information on the individual plastic litter samples, the number of individuals of each species, the sampling areas and periods, has not been included in the text for logistical reasons. They are shown in the Appendix (see Supplementary material 3, 4 and 5). Regarding the structure of benthic communities found, a subdivision of the species detected was carried out according to Phyla and their trophic regimen (Filter feeder species, Herbivorous species, Parasyte species, Predator species, Deposit feeder-Detritivorous-Scavenger species), summarized and categorised by area in the following tables:

Table 2. Filter feeder species associated with plastic in the Faro Canal (NIS are indicated with*).

Phylum	Family	Species
Anellida	Sabellidae	*Bispira viola* Grube, 1863
Anellida	Sabellidae	*Branchiomma bairdi* McIntosh, 1885*
Anellida	Serpulidae	*Hydroides dianthus* Verrill, 1873*
Anellida	Serpulidae	*Hydroides elegans* Haswell, 1883*
Anellida	Serpulidae	*Hydroides nigra* Zibrowius, 1971
Anellida	Serpulidae	*Hydroides pseudouncinata* Zibrowius, 1968
Anellida	Serpulidae	*Hydroides stoichadon* Zibrowius, 1971
Anellida	Serpulidae	*Janita fimbriata* Delle Chiaje, 1822
Anellida	Serpulidae	*Janua heterostropha* Montagu, 1803
Anellida	Serpulidae	*Neodexiospira pseudocorrugata* Bush, 1905
Anellida	Serpulidae	*Pileolaria militaris* Claparède, 1870
Anellida	Sabellidae	*Sabella discifera* Grube, 1874
Anellida	Serpulidae	*Serpula vermicularis* Linnaeus, 1767
Anellida	Serpulidae	*Simplaria pseudomilitaris* Thiriot-Quievreux, 1965
Anellida	Serpulidae	*Vermiliopsis infundibulum* Philippi, 1844
Anellida	Serpulidae	*Vermiliopsis striaticeps* Grube, 1862
Chordata	Cionidae	*Ciona intestinalis* Linnaeus, 1767
Chordata	Pyuridae	*Microcosmus vulgaris* Heller, 1877
Chordata	Styelidae	*Styela plicata* Lesueur, 1823*
Mollusca	Arcidae	*Anadara inaequivalvis* Bruguière, 1789
Mollusca	Anomiidae	*Anomia ephippium* Linnaeus, 1758
Mollusca	Arcidae	*Arca noae* Linnaeus, 1758
Mollusca	Arcidae	*Barbatia barbata* Linnaeus, 1758
Mollusca	Isognomonidae	*Isognomon bicolor* Gmelin, 1791*
Mollusca	Pectinidae	*Mimachlamys varia* Linnaeus, 1758
Mollusca	Modiolidae	*Modiolus barbatus* Linnaeus, 1758
Mollusca	Mytilidae	*Mytilus galloprovincialis* Lamarck, 1819
Mollusca	Ostreidae	*Ostrea edulis* Linnaeus, 1758
Mollusca	Margaritidae	*Pinctada radiata* Leach, 1814*
Porifera	Crambeidae	*Crambe crambe* Schmidt, 1862
Porifera	Halichondriidae	*Halichondria (Halichondria) panicea* Pallas, 1766
Porifera	Thorectidae	*Scalarispongia scalaris Schmidt, 1862*

Table 3. Herbivorous species associated with plastic in the Faro Canal (NIS are indicated with*).

Phylum	Family	Species
Echinodermata	Arbaciidae	*Arbacia lixula* Linnaeus, 1758
Echinodermata	Toxopneustidae	*Sphaerechinus granularis* Lamarck, 1816
Mollusca	Acanthochitonidae	*Acanthochitona fascicularis* Linnaeus, 1767
Mollusca	Callostomatidae	*Calliostoma laugieri* Payraudeau, 1826
Mollusca	Columbellidae	*Columbella rustica* Linnaeus, 1758
Mollusca	Fissurellidae	*Diodora italica* Defrance, 1820
Mollusca	Haminoeidae	*Haminoea hydatis* Linnaeus, 1758
Mollusca	Columbellidae	*Mitrella scripta* Linnaeus, 1758
Mollusca	Trochidae	*Phorcus turbinatus* Born, 1778
Mollusca	Chitonidae	*Rhyssoplax olivacea* Spengler, 1797
Mollusca	Trochidae	*Steromphala adansonii* Payraudeau, 1826

Table 4. Parasite species associated with plastic in the Faro Canal (NIS are indicated with*).

Phylum	Family	Species
Arthropoda	Phoxichilidiidae	*Anoplodactylus pygmaeus* Hodge, 1864

Table 5. Predator species associated with plastic in the Faro Canal (NIS are indicated with*).

Phylum	Family	Species
Anellida	Dorvilleidae	*Dorvillea similis* Crossland, 1924*
Anellida	Lumbrineridae	*Lumbrineris latreilli* Audouin & Milne Edwards, 1833
Anellida	Syllidae	*Opisthosyllis brunnea* Langerhans, 1879*
Anellida	Syllidae	*Syllis amica* Quatrefages, 1866
Anellida	Syllidae	*Trypanosyllis zebra* Grube, 1860
Arthropoda	Paranthuridae	*Paranthura japonica* Richardson, 1909*
Cnidaria	Aiptasiidae	*Aiptasia mutabilis* Gravenhorst, 1831
Mollusca	Conidae	*Conus ventricosus* Gmelin, 1791
Mollusca	Tudiclidae	*Euthria cornea* Linnaeus, 1758
Mollusca	Flabellinidae	*Flabellina affinis* Gmelin, 1791
Mollusca	Muricidae	*Hexaplex trunculus* Linnaeus, 1758
Mollusca	Cymatiidae	*Monoplex corrugatus* Lamarck, 1816
Mollusca	Cymatiidae	*Monoplex parthenopeus* Salis Marschlins, 1793
Mollusca	Cypraeidae	*Naria spurca* Linnaeus, 1758
Mollusca	Naticidae	*Naticarius hebraeus* Martyn, 1786
Mollusca	Pisaniidae	*Pisania striata* Gmelin, 1791
Nemertea	Valenciniidae	*Baseodiscus delineatus* Delle Chiaje, 1822*

Table 6. Deposit feeder-Detritivorous-Scavenger species associated with plastic in the Faro Canal (NIS are indicated with*).

Phylum	Family	Species
Anellida	Terebellidae	*Amphitritides gracilis* Grube, 1860
Anellida	Cirratulidae	*Aphelochaeta marioni* Saint-Joseph, 1894
Anellida	Cirratulidae	*Chaetozone caputesocis* Saint-Joseph, 1894

Anellida	Spionidae	*Dipolydora coeca* Örsted, 1843
Anellida	Amphinomidae	*Eurythoe complanata* Pallas, 1766*
Anellida	Polynoidae	*Harmothoe impar* Johnston, 1839
Anellida	Orbiniidae	*Naineris laevigata* Grube, 1855
Anellida	Terebellidae	*Nicolea venustula* Montagu, 1819
Anellida	Aphroditidae	*Pontogenia chrysocoma* Baird, 1865
Anellida	Polynoidae	*Subadyte pellucida* Ehlers, 1864
Anellida	Terebellidae	*Thelepus setosus* Quatrefages, 1866
Arthropoda	Anthuridae	*Anthura gracilis* Montagu, 1808
Arthropoda	Corophiidae	*Apocorophium acutum* Chevreux, 1908
Arthropoda	Apseudidae	*Apseudopsis latreillii* Milne Edwards, 1828
Arthropoda	Alpheidae	*Athanas nitescens* Leach, 1814
Arthropoda	Caprellidae	*Caprella acanthifera* Leach, 1814
Arthropoda	Diogenidae	*Clibanarius erythropus* Latreille, 1818
Arthropoda	Sphaeromatidae	*Cymodoce truncata* Leach, 1814
Arthropoda	Dexaminidae	*Dexamine spiniventris* A. Costa, 1853
Arthropoda	Sphaeromatidae	*Dynamene bidentata* Adams, 1800
Arthropoda	Maeridae	*Elasmopus rapax* A. Costa, 1853
Arthropoda	Eriphiidae	*Eriphia verrucosa* Forskål, 1775
Arthropoda	Gammaridae	*Gammarus aequicauda* Martynov, 1931
Arthropoda	Epialtidae	*Herbstia condyliata* Fabricius, 1787
Arthropoda	Ischyroceridae	*Jassa marmorata* Holmes, 1905
Arthropoda	Leucothoidae	*Leucothoe* Leach, 1814
Arthropoda	Leucothoidae	*Leucothoe venetiarum* Giordani Soika, 1950
Arthropoda	Xanthidae	*Lophozozymus incisus* H. Milne Edwards, 1834
Arthropoda	Lysianassidae	*Lysianassa pilicornis* Heller, 1866
Arthropoda	Sphaeromatidae	*Paracerceis sculpta* Holmes, 1904*
Arthropoda	Maeridae	*Quadrimaera inaequipes* A. Costa in Hope, 1851
Echinodermata	Amphiuridae	*Amphipholis squamata* Delle Chiaje, 1828
Echinodermata	Amphiuridae	*Amphiura chiajei* Forbes, 1843
Echinodermata	Asterinidae	*Asterina gibbosa* Pennant, 1777
Echinodermata	Ophiotrichidae	*Ophiothrix fragilis* Abildgaard in O.F. Müller, 1789
Mollusca	Nassariidae	*Tritia corniculum* Olivi, 1792
Mollusca	Nassariidae	*Tritia corrugata* Brocchi, 1814
Mollusca	Nassariidae	*Tritia incrassata* Strøm, 1768

Table 7. Filter feeder species associated with plastic in the Faro Lake (NIS are indicated with*).

Phylum	Family	Species
Anellida	Sabellidae	*Branchiomma bairdi* McIntosh, 1885*
Anellida	Sabellidae	*Branchiomma bombyx* Dalyell, 1853
Anellida	Serpulidae	*Hydroides dianthus* Verrill, 1873*
Anellida	Serpulidae	*Hydroides elegans* Haswell, 1883*
Anellida	Serpulidae	*Hydroides nigra* Zibrowius, 1971
Anellida	Serpulidae	*Hydroides pseudouncinata* Zibrowius, 1968
Anellida	Serpulidae	*Janua heterostropha* Montagu, 1803
Anellida	Serpulidae	*Neodexiospira pseudocorrugata* Bush, 1905
Anellida	Serpulidae	*Pileolaria militaris* Claparède, 1870
Anellida	Serpulidae	*Protula* Risso, 1826
Anellida	Sabellidae	*Sabella discifera* Grube, 1874
Anellida	Serpulidae	*Serpula vermicularis* Linnaeus, 1767
Anellida	Serpulidae	*Simplaria pseudomilitaris* Thiriot-Quievreux, 1965
Anellida	Serpulidae	*Vermiliopsis infundibulum* Philippi, 1844
Arthropoda	Balanidae	*Perforatus perforatus* Bruguière, 1789
Bryozoa	Bitectiporidae	*Pentapora fascialis* Pallas, 1766
Chordata	Styelidae	*Botrylloides niger* Herdman, 1886*
Chordata	Cionidae	*Ciona intestinalis* Linnaeus, 1767

Chordata	Pyuridae	*Microcosmus vulgaris* Heller, 1877
Chordata	Styelidae	*Styela plicata* Lesueur, 1823*
Mollusca	Arcidae	*Anadara gibbosa* Reeve, 1844
Mollusca	Arcidae	*Arca noae* Linnaeus, 1758
Mollusca	Mytilidae	*Brachydontes pharaonis* P. Fischer, 1870*
Mollusca	Chamidae	*Chama gryphoides* Linnaeus, 1758
Mollusca	Isognomonidae	*Isognomon bicolor* Gmelin, 1791*
Mollusca	Modiolidae	*Modiolus barbatus* Linnaeus, 1758
Mollusca	Mytilidae	*Mytilaster lineatus* Gmelin, 1791
Mollusca	Mytilidae	*Mytilus galloprovincialis* Lamarck, 1819
Mollusca	Ostreidae	*Ostrea edulis* Linnaeus, 1758
Mollusca	Ostreidae	*Ostrea stentina* Payraudeau, 1826
Mollusca	Margaritidae	*Pinctada radiata* Leach, 1814*
Porifera	Crambeidae	*Crambe crambe* Schmidt, 1862
Porifera	Halichondriidae	*Halichondria (Halichondria) panicea* Pallas, 1766
Porifera	Chalinidae	*Haliclona (Reniera) cinerea* Grant, 1826
Porifera	Spirastrellidae	*Spirastrella cunctatrix* Schmidt, 1868

Table 8. Herbivorous species associated with plastic in the Faro Lake (NIS are indicated with*).

Phylum	Family	Species
Mollusca	Acanthochitonidae	*Acanthochitona fascicularis* Linnaeus, 1767
Mollusca	Haminoeidae	*Haminoea hydatis* Linnaeus, 1758
Mollusca	Haminoeidae	*Haminoea navicula* da Costa, 1778
Mollusca	Trochidae	*Steromphala adansonii* Payraudeau, 1826
Mollusca	Trochidae	*Steromphala albida* Gmelin, 1791
Mollusca	Trochidae	*Steromphala varia* Linnaeus, 1758

Table 9. Parasite species associated with plastic in the Faro Lake (NIS are indicated with*).

Phylum	Family	Species
Mollusca	Muricidae	*Coralliophila meyendorffii* Calcara, 1845

Table 10. Predator species associated with plastic in the Faro Lake (NIS are indicated with*).

Phylum	Family	Species
Anellida	Nereididae	*Composetia costae* Grube, 1840
Anellida	Dorvilleidae	*Dorvillea similis* Crossland, 1924*
Anellida	Eunicidae	*Eunice pennata* Müller, 1776
Anellida	Glyceridae	*Glycera* Lamarck, 1818
Anellida	Eunicidae	*Lysidice* Lamarck, 1818
Anellida	Lumbrineridae	*Lumbrineris latreilli* Audouin & Milne Edwards, 1833
Anellida	Lumbrineridae	*Ninoe armoricana* Glémarec, 1968
Anelllida	Eunicidae	*Paucibranchia fallax* Marion & Bobretzky, 1875
Anellida	Nereididae	*Perinereis cultrifera* Grube, 1840
Anellida	Nereididae	*Platynereis dumerilii* Audouin & Milne Edwards, 1833
Anellida	Lumbrineridae	*Scoletoma laurentiana* Grube, 1863
Anellida	Syllidae	*Streptosyllis bidentata* Southern, 1914
Anellida	Hesionidae	*Syllidia armata* Quatrefages, 1866

Anellida	Syllidae	*Syllis amica* Quatrefages, 1866
Anellida	Syllidae	*Syllis armillaris* O.F. Müller, 1776
Anellida	Syllidae	*Syllis rosea* Langerhans, 1879
Anellida	Syllidae	*Trypanosyllis zebra* Grube, 1860
Arthropoda	Anthuridae	*Mesanthura romulea* Poore & Lew ton, 1986*
Arthropoda	Paranthuridae	*Paranthura japonica* Richardson, 1909*
Cnidaria	Aiptasiidae	*Aiptasia mutabilis* Gravenhorst, 1831
Cnidaria	Actiniidae	*Anemonia sulcata* Pennant, 1777
Cnidaria	Actiniidae	*Anemonia viridis Forsskål, 1775*
Cnidaria	Cerianthidae	*Cerianthus membranaceus* Gmelin, 1791
Echinodermata	Asteriidae	*Coscinasterias tenuispina* Lamarck, 1816
Mollusca	Discodorididae	*Baptodoris cinnabarina* Bergh, 1884
Mollusca	Muricidae	*Hexaplex trunculus* Linnaeus, 1758
Mollusca	Naticidae	*Naticarius hebraeus* Martyn, 1786
Mollusca	Discodorididae	*Paradoris indecora* Bergh, 1881
Nemertea	Valenciniidae	*Baseodiscus delineatus* Delle Chiaje, 1822*
Platyhelminthes	Stylochidae	*Stylochus pilidium* Goette, 1881

Table 11. Deposit feeder-Detritivorous-Scavenger species associated with plastic in the Faro Lake (NIS are indicated with*).

Phylum	Family	Species
Anellida	Terebellidae	*Amphitritides gracilis* Grube, 1860
Anellida	Cirratulidae	*Aphelochaeta marioni* Saint-Joseph, 1894
Anellida	Cirratulidae	*Chaetozone caputesocis* Saint-Joseph, 1894
Anellida	Terebellidae	*Dodecaceria concharum* Örsted, 1843
Anellida	Amphinomidae	*Eurythoe complanata* Pallas, 1766*
Anellida	Lumbrineridae	*Gallardoneris nonatoi* Ramos, 1976
Anellida	Polynoidae	*Harmothoe impar* Johnston, 1839
Anellida	Cirratulidae	*Kirkegaardia* Blake, 2016
Anellida	Orbiniidae	*Naineris laevigata* Grube, 1855
Anellida	Aphroditidae	*Pontogenia chrysocoma* Baird, 1865
Anellida	Orbiniidae	*Scoloplos armiger* Müller, 1776
Anellida	Polynoidae	*Subadyte pellucida* Ehlers, 1864
Anellida	Terebellidae	*Thelepus setosus* Quatrefages, 1866
Arthropoda	Acidostomatidae	*Acidostoma obesum* Spence Bate & Westwood, 1861
Arthropoda	Anthuridae	*Anthura gracilis* Montagu, 1808
Arthropoda	Corophiidae	*Apocorophium acutum* Chevreux, 1908
Arthropoda	Apseudidae	*Apseudopsis latreillii* Milne Edwards, 1828
Arthropoda	Alpheidae	*Athanas nitescens* Leach, 1814
Arthropoda	Dexaminidae	*Dexamine spiniventris* A. Costa, 1853
Arthropoda	Diogenidae	*Diogenes pugilator Roux,* 1829
Arthropoda	Sphaeromatidae	*Dynamene bidentata* Adams, 1800
Arthropoda	Maeridae	*Elasmopus rapax* A. Costa, 1853
Arthropoda	Eriphiidae	*Eriphia verrucosa* Forskål, 1775
Arthropoda	Corophiidae	*Laticorophium baconi* Shoemaker, 1934*
Arthropoda	Leucothoidae	*Leucothoe* Leach, 1814
Arthropoda	Lysianassidae	*Lysianassa pilicornis* Heller, 1866
Arthropoda	Maeridae	*Maera* Leach, 1814
Arthropoda	Ischyroceridae	*Microjassa cumbrensis* Stebbing & Robertson, 1891
Arthropoda	Grapsidae	*Pachygrapsus marmoratus* Fabricius, 1787
Arthropoda	Sphaeromatidae	*Paracerceis sculpta* Holmes, 1904*
Arthropoda	Processidae	*Processa edulis* Risso, 1816
Arthropoda	Maeridae	*Quadrimaera inaequipes* A. Costa in Hope, 1851
Arthropoda	Unciolidae	*Unciolella lunata* Chevreux, 1911
Echinodermata	Amphiuridae	*Amphipholis squamata* Delle Chiaje, 1828
Echinodermata	Amphiuridae	*Amphiura chiajei* Forbes, 1843
Echinodermata	Asterinidae	*Asterina gibbosa* Pennant, 1777

Echinodermata	Holothuriidae	*Holothuria (Holothuria) tubulosa* Gmelin, 1791
Echinodermata	Ophiotrichidae	*Ophiothrix fragilis* Abildgaard in O.F. Müller, 1789

Table 12. Filter feeder species associated with plastic in the Margi Canal (NIS are indicated with*).

Phylum	Family	Species
Anellida	Sabellidae	*Branchiomma bairdi* McIntosh, 1885*
Anellida	Serpulidae	*Hydroides dianthus* Verrill, 1873*
Anellida	Serpulidae	*Hydroides elegans* Haswell, 1883*
Anellida	Serpulidae	*Hydroides nigra* Zibrowius, 1971
Anellida	Serpulidae	*Hydroides stoichadon* Zibrowius, 1971
Anellida	Serpulidae	*Janua heterostropha* Montagu, 1803
Anellida	Serpulidae	*Neodexiospira pseudocorrugata* Bush, 1905
Anellida	Serpulidae	*Pileolaria militaris* Claparède, 1870
Anellida	Sabellidae	*Sabella discifera* Grube, 1874
Anellida	Serpulidae	*Serpula vermicularis* Linnaeus, 1767
Anellida	Serpulidae	*Simplaria pseudomilitaris* Thiriot-Quievreux, 1965
Anellida	Serpulidae	*Vermiliopsis infundibulum* Philippi, 1844
Arthropoda	Verrucidae	*Verruca stroemia* O.F. Müller, 1776
Chordata	Styelidae	*Botrylloides niger* Herdman, 1886*
Chordata	Cionidae	*Ciona intestinalis* Linnaeus, 1767
Chordata	Pyuridae	*Microcosmus vulgaris* Heller, 1877
Chordata	Styelidae	*Styela plicata* Lesueur, 1823*
Mollusca	Arcidae	*Arca noae* Linnaeus, 1758
Mollusca	Mytilidae	*Brachydontes pharaonis* P. Fischer, 1870*
Mollusca	Modiolidae	*Modiolus barbatus* Linnaeus, 1758
Mollusca	Mytilidae	*Mytilaster minimus* Poli, 1795
Mollusca	Mytilidae	*Mytilus galloprovincialis* Lamarck, 1819
Mollusca	Ostreidae	*Ostrea edulis* Linnaeus, 1758

Table 13. Herbivorous species associated with plastic in the Margi Canal (NIS are indicated with*).

Phylum	Family	Species
Mollusca	Acanthochitonidae	*Acanthochitona fascicularis* Linnaeus, 1767
Mollusca	Haminoeidae	*Haminoea hydatis* Linnaeus, 1758
Mollusca	Haminoeidae	*Haminoea navicula* da Costa, 1778
Mollusca	Trochidae	*Phorcus turbinatus* Born, 1778
Mollusca	Chitonidae	*Rhyssoplax olivacea* Spengler, 1797
Mollusca	Trochidae	*Steromphala adansonii* Payraudeau, 1826
Mollusca	Trochidae	*Steromphala varia* Linnaeus, 1758

Table 14. Predator species associated with plastic in the Margi Canal (NIS are indicated with*).

Phylum	Family	Species
Anellida	Dorvilleidae	*Dorvillea rubrovittata* Grube, 1855
Anellida	Eunicidae	*Eunice pennata* Müller, 1776
Anellida	Lumbrineridae	*Lumbrineris latreilli* Audouin & Milne Edwards, 1833
Anellida	Nereididae	*Neanthes acuminata Ehlers, 1868*
Anellida	Nephtydae	*Nephtys* Cuvier, 1817

Anellida	Nereididae	*Perinereis cultrifera* Grube, 1840
Anellida	Nereididae	*Platynereis dumerilii* Audouin & Milne Edwards, 1833
Anellida	Lumbrineridae	*Scoletoma funchalensis* Kinberg, 1865
Anellida	Lumbrineridae	*Scoletoma laurentiana* Grube, 1863
Anellida	Syllidae	*Syllis amica* Quatrefages, 1866
Anellida	Syllidae	*Syllis armillaris* O.F. Müller, 1776
Anellida	Syllidae	*Syllis rosea* Langerhans, 1879
Anellida	Syllidae	*Trypanosyllis zebra* Grube, 1860
Cnidaria	Aiptasiidae	*Aiptasia mutabilis* Gravenhorst, 1831
Cnidaria	Actiniidae	*Anemonia sulcata* Pennant, 1777
Mollusca	Discodorididae	*Baptodoris cinnabarina* Bergh, 1884
Mollusca	Muricidae	*Hexaplex trunculus* Linnaeus, 1758
Nemertea	Valenciniidae	*Baseodiscus delineatus* Delle Chiaje, 1822

Table 15. Deposit feeder-Detritivorous-Scavenger species associated with plastic in the Margi Canal (NIS are indicated with*).

Phylum	Family	Species
Anellida	Terebellidae	*Amphitritides gracilis* Grube, 1860
Anellida	Cirratulidae	*Aphelochaeta multibranchis* Grube, 1863
Anellida	Cossuridae	*Cossura* Webster & Benedict, 1887
Anellida	Terebellidae	*Dodecaceria concharum* Örsted, 1843
Anellida	Maldanidae	*Euclymene lombricoides* Quatrefages, 1866
Anellida	Orbiniidae	*Naineris laevigata* Grube, 1855
Anellida	Terebellidae	*Nicolea venustula* Montagu, 1819
Anellida	Paraonidae	*Paradoneis lyra* Southern, 1914
Anellida	Aphroditidae	*Pontogenia chrysocoma* Baird, 1865
Anellida	Terebellidae	*Terebella lapidaria* Linnaeus, 1767
Anellida	Terebellidae	*Thelepus setosus* Quatrefages, 1866
Arthropoda	Corophiidae	*Apocorophium acutum* Chevreux, 1908
Arthropoda	Apseudidae	*Apseudopsis latreillii* Milne Edwards, 1828
Arthropoda	Sphaeromatidae	*Cymodoce truncata* Leach, 1814
Arthropoda	Sphaeromatidae	*Dynamene bidentata* Adams, 1800
Arthropoda	Maeridae	*Elasmopus rapax* A. Costa, 1853
Arthropoda	Maeridae	*Maera* Leach, 1814
Arthropoda	Sphaeromatidae	*Paracerceis sculpta* Holmes, 1904*
Arthropoda	Maeridae	*Quadrimaera inaequipes* A. Costa in Hope, 1851
Arthropoda	Tanaididae	*Tanais dulongii* Audouin, 1826
Echinodermata	Amphiuridae	*Amphipholis squamata* Delle Chiaje, 1828
Echinodermata	Ophiotrichidae	*Ophiothrix fragilis* Abildgaard in O.F. Müller, 1789
Mollusca	Hydrobiidae	*Hydrobia acuta* Draparnaud, 1805

Table 16. Filter feeder species associated with plastic in the Due Torri Canal (NIS are indicated with*).

Phylum	Family	Species
Anellida	Sabellidae	*Branchiomma bairdi* McIntosh, 1885*
Anellida	Serpulidae	*Hydroides dianthus* Verrill, 1873*
Anellida	Serpulidae	*Hydroides elegans* Haswell, 1883*
Anellida	Serpulidae	*Hydroides nigra* Zibrowius, 1971
Anellida	Serpulidae	*Hydroides pseudouncinata* Zibrowius, 1968
Anellida	Serpulidae	*Hydroides stoichadon* Zibrowius, 1971
Anellida	Serpulidae	*Janita fimbriata* Delle Chiaje, 1822
Anellida	Serpulidae	*Janua heterostropha* Montagu, 1803
Anellida	Serpulidae	*Neodexiospira pseudocorrugata* Bush, 1905

Anellida	Serpulidae	*Pileolaria militaris* Claparède, 1870
Anellida	Sabellidae	*Sabella discifera* Grube, 1874
Anellida	Serpulidae	*Serpula vermicularis* Linnaeus, 1767
Anellida	Serpulidae	*Simplaria pseudomilitaris* Thiriot-Quievreux, 1965
Anellida	Serpulidae	*Vermiliopsis infundibulum* Philippi, 1844
Arthropoda	Verrucidae	*Verruca stroemia* O.F. Müller, 1776
Chordata	Styelidae	*Botrylloides leachii* Savigny, 1816
Chordata	Cionidae	*Ciona intestinalis* Linnaeus, 1767
Chordata	Styelidae	*Botrylloides niger* Herdman, 1886*
Mollusca	Arcidae	*Arca noae* Linnaeus, 1758
Mollusca	Carditidae	*Cardita calyculata* Linnaeus, 1758
Mollusca	Chamidae	*Chama gryphoides* Linnaeus, 1758
Mollusca	Isognomonidae	*Isognomon bicolor* Gmelin, 1791*
Mollusca	Mytilidae	*Mytilus galloprovincialis* Lamarck, 1819
Mollusca	Ostreidae	*Ostrea edulis* Linnaeus, 1758
Mollusca	Margaritidae	*Pinctada radiata* Leach, 1814*
Porifera	Halichondriidae	*Halichondria (Halichondria) panicea* Pallas, 1766
Porifera	Thorectidae	*Scalarispongia scalaris Schmidt, 1862*
Porifera	Suberitidae	*Terpios* Duchassaing & Michelotti, 1864

Table 17. Herbivorous species associated with plastic in the Due Torri Canal (NIS are indicated with*).

Phylum	Family	Species
Echinodermata	Arbaciidae	*Arbacia lixula* Linnaeus, 1758
Echinodermata	Parechinidae	*Paracentrotus lividus* Lamarck, 1816
Mollusca	Columbellidae	*Columbella rustica* Linnaeus, 1758
Mollusca	Fissurellidae	*Diodora italica* Defrance, 1820
Mollusca	Haminoeidae	*Haminoea navicula* da Costa, 1778
Mollusca	Trochidae	*Phorcus turbinatus* Born, 1778
Mollusca	Chitonidae	*Rhyssoplax olivacea* Spengler, 1797

Table 18. Parasite species associated with plastic in the Due Torri Canal (NIS are indicated with*).

Phylum	Family	Species
Arthropoda	Callipallenidae	*Callipallene emaciata* Dohrn, 1881

Table 19. Predator species associated with plastic in the Due Torri Canal (NIS are indicated with*).

Phylum	Family	Species
Anellida	Dorvilleidae	*Dorvillea similis* Crossland, 1924*
Anellida	Nereididae	*Nereis rava* Ehlers, 1868
Anellida	Phyllodocidae	*Phyllodoce maculata* Linnaeus, 1767
Anellida	Phyllodocidae	*Phyllodoce madeirensis* Langerhans, 1880
Anellida	Nereididae	*Platynereis dumerilii* Audouin & Milne Edwards, 1833
Anellida	Lumbrineridae	*Scoletoma funchalensis* Kinberg, 1865
Anellida	Hesionidae	*Syllidia armata* Quatrefages, 1866
Anellida	Syllidae	*Syllis compacta* Gravier, 1900
Anellida	Syllidae	*Syllis rosea* Langerhans, 1879
Anellida	Syllidae	*Trypanosyllis zebra* Grube, 1860

Arthropoda	Leptocheliidae	*Chondrochelia savignyi* Kroyer, 1842
Arthropoda	Anthuridae	*Mesanthura romulea* Poore & Lew ton, 1986*
Arthropoda	Paranthuridae	*Paranthura japonica* Richardson, 1909*
Cnidaria	Aiptasiidae	*Aiptasia mutabilis* Gravenhorst, 1831
Mollusca	Conidae	*Conus ventricosus* Gmelin, 1791
Mollusca	Muricidae	*Hexaplex trunculus* Linnaeus, 1758
Mollusca	Cypraeidae	*Naria spurca* Linnaeus, 1758
Mollusca	Discodorididae	*Baptodoris cinnabarina* Bergh, 1884
Mollusca	Discodorididae	*Paradoris indecora* Bergh, 1881
Mollusca	Pisaniidae	*Pisania striata* Gmelin, 1791
Nemertea	Valenciniidae	*Baseodiscus delineatus* Delle Chiaje, 1822*

Table 20. Deposit feeder-Detritivorous-Scavenger species associated with plastic in the Due Torri Canal (NIS are indicated with*).

Phylum	Family	Species
Anellida	Terebellidae	*Amphitritides gracilis* Grube, 1860
Anellida	Cirratulidae	*Aphelochaeta multibranchis* Grube, 1863
Anellida	Aspidosiphonidae	*Aspidosiphon (Aspidosiphon) misakiensis* Ikeda, 1904
Anellida	Cirratulidae	*Chaetozone caputesocis* Saint-Joseph, 1894
Anellida	Cirratulidae	*Dodecaceria concharum* Örsted, 1843
Anellida	Orbiniidae	*Naineris laevigata* Grube, 1855
Anellida	Phascolosomatidae	*Phascolosoma (Phascolosoma) granulatum* Leuckart, 1828
Anellida	Aphroditidae	*Pontogenia chrysocoma* Baird, 1865
Anellida	Opheliidae	*Polyophthalmus pictus* Dujardin, 1839
Anellida	Terebellidae	*Streblosoma pseudocomatus* Lezzi & Giangrande, 2019
Anellida	Polynoidae	*Subadyte pellucida* Ehlers, 1864
Anellida	Terebellidae	*Thelepus setosus* Quatrefages, 1866
Anellida	Terebellidae	*Thelepus triserialis* Grube, 1855
Arthropoda	Alpheidae	*Alpheus dentipes* Guérin, 1832
Arthropoda	Anthuridae	*Anthura gracilis* Montagu, 1808
Arthropoda	Aoridae	*Aora gracilis* Spence Bate, 1857
Arthropoda	Corophiidae	*Apocorophium acutum* Chevreux, 1908
Arthropoda	Apseudidae	*Apseudopsis latreillii* Milne Edwards, 1828
Arthropoda	Alpheidae	*Athanas nitescens* Leach, 1814
Arthropoda	Caprellidae	*Caprella acanthifera* Leach, 1814
Arthropoda	Caprellidae	*Caprella scaura* Templeton, 1836*
Arthropoda	Diogenidae	*Clibanarius erythropus* Latreille, 1818
Arthropoda	Sphaeromatidae	*Cymodoce truncata* Leach, 1814
Arthropoda	Sphaeromatidae	*Dynamene bidentata* Adams, 1800
Arthropoda	Maeridae	*Elasmopus rapax* A. Costa, 1853
Arthropoda	Eriphiidae	*Eriphia verrucosa* Forskål, 1775
Arthropoda	Gammaridae	*Gammarus aequicauda* Martynov, 1931
Arthropoda	Ischyroceridae	*Jassa marmorata* Holmes, 1905
Arthropoda	Corophiidae	*Laticorophium baconi* Shoemaker, 1934*
Arthropoda	Xanthidae	*Lophozozymus incisus* H. Milne Edwards, 1834
Arthropoda	Maeridae	*Maera grossimana* Montagu, 1808
Arthropoda	Grapsidae	*Pachygrapsus marmoratus* Fabricius, 1787
Arthropoda	Sphaeromatidae	*Paracerceis sculpta* Holmes, 1904*
Arthropoda	Gammaridae	*Pectenogammarus planicrurus* Reid, 1940
Arthropoda	Pilumnidae	*Pilumnus villosissimus* Rafinesque, 1814
Arthropoda	Maeridae	*Quadrimaera inaequipes* A. Costa in Hope, 1851
Arthropoda	Tanaididae	*Tanais dulongii* Audouin, 1826
Echinodermata	Amphiuridae	*Amphipholis squamata* Delle Chiaje, 1828
Echinodermata	Amphiuridae	*Amphiura chiajei* Forbes, 1843
Echinodermata	Asterinidae	*Asterina gibbosa* Pennant, 1777
Echinodermata	Holothuriidae	*Holothuria (Holothuria) tubulosa* Gmelin, 1791

Table 21. Filter feeder species associated with *Pinctada radiata* in the Faro Canal (NIS are indicated with*).

Phylum	Family	Species
Anellida	Sabellidae	*Bispira viola* Grube, 1863
Arthropoda	Serpulidae	*Ficopomatus enigmaticus* Fauvel, 1923*
Anellida	Serpulidae	*Hydroides dianthus* Verrill, 1873*
Anellida	Serpulidae	*Hydroides elegans* Haswell, 1883*
Anellida	Serpulidae	*Hydroides nigra* Zibrowius, 1971
Anellida	Serpulidae	*Hydroides norvegica* Gunnerus, 1768
Anellida	Serpulidae	*Hydroides pseudouncinata* Zibrowius, 1968
Anellida	Serpulidae	*Hydroides stoichadon* Zibrowius, 1971
Anellida	Serpulidae	*Janua heterostropha* Montagu, 1803
Anellida	Serpulidae	*Neodexiospira pseudocorrugata* Bush, 1905
Anellida	Serpulidae	*Pileolaria militaris* Claparède, 1870
Anellida	Sabellidae	*Sabella discifera* Grube, 1874
Anellida	Serpulidae	*Serpula concharum* Langerhans, 1880
Anellida	Serpulidae	*Serpula lobiancoi* Rioja, 1917
Anellida	Serpulidae	*Serpula vermicularis* Linnaeus, 1767
Anellida	Serpulidae	*Simplaria pseudomilitaris* Thiriot-Quievreux, 1965
Anellida	Serpulidae	*Spirorbis (Spirorbis) cuneatus* Gee, 1964
Anellida	Serpulidae	*Spirorbis (Spirorbis) marioni* Caullery & Mesnil, 1897*
Anellida	Serpulidae	*Vermiliopsis infundibulum* Philippi, 1844
Chordata	Styelidae	*Styela plicata* Lesueur, 1823*
Mollusca	Arcidae	*Arca noae* Linnaeus, 1758
Mollusca	Chamidae	*Chama gryphoides* Linnaeus, 1758
Mollusca	Isognomonidae	*Isognomon bicolor* Gmelin, 1791*
Mollusca	Modiolidae	*Modiolus barbatus* Linnaeus, 1758
Mollusca	Mytilidae	*Musculus costulatus* Risso, 1826
Mollusca	Mytilidae	*Mytilaster lineatus* Gmelin, 1791
Mollusca	Mytilidae	*Mytilaster minimus* Poli, 1795
Mollusca	Mytilidae	*Mytilus galloprovincialis* Lamarck, 1819
Mollusca	Ostreidae	*Ostrea edulis* Linnaeus, 1758
Mollusca	Ostreidae	*Ostrea stentina* Payraudeau, 1826
Mollusca	Margaritidae	*Pinctada radiata* Leach, 1814*
Mollusca	Anomiidae	*Pododesmus patelliformis* Linnaeus, 1761
Mollusca	Veneridae	*Polititapes aureus* Gmelin, 1791
Mollusca	Veneridae	*Ruditapes decussatus* Linnaeus, 1758
Mollusca	Veneridae	*Ruditapes philippinarum* A. Adams & Reeve, 1850
Porifera	Crambeidae	*Crambe crambe* Schmidt, 1862

Table 22. Herbivorous species associated with *Pinctada radiata* in the Faro Canal (NIS are indicated with*).

Phylum	Family	Species
Mollusca	Acanthochitonidae	*Acanthochitona crinita* Pennant, 1777
Mollusca	Acanthochitonidae	*Acanthochitona fascicularis* Linnaeus, 1767
Mollusca	Fissurellidae	*Diodora italica* Defrance, 1820
Mollusca	Trochidae	*Phorcus turbinatus* Born, 1778
Mollusca	Chitonidae	*Rhyssoplax olivacea* Spengler, 1797
Mollusca	Trochidae	*Steromphala adansonii* Payraudeau, 1826
Mollusca	Trochiade	*Steromphala varia* Linnaeus, 1758

Table 23. Parasite species associated with *Pinctada radiata* in the Faro Canal (NIS are indicated with*).

Phylum	Family	Species
Arthropoda	Ammotheidae	*Ammothella longipes* Hodge, 1864
Arthropoda	Ammotheidae	*Tanystylum conirostre* Dohrn, 1881
Arthropoda	Halacaridae	*Thalassarachna basteri* Johnston, 1836

Table 24. Predator species associated with *Pinctada radiata* in the Faro Canal (NIS are indicated with*).

Phylum	Family	Species
Anellida	Dorvilleidae	*Dorvillea rubrovittata* Grube, 1855
Anellida	Dorvilleidae	*Dorvillea similis* Crossland, 1924*
Anellida	Phyllodocidae	*Nereiphylla rubiginosa* Saint-Joseph, 1888
Anellida	Syllidae	*Odontosyllis fulgurans* Audouin & Milne Edwards, 1833
Anellida	Nereididae	*Platynereis coccinea* Delle Chiaje, 1822
Anellida	Nereididae	*Platynereis dumerilii* Audouin & Milne Edwards, 1833
Anellida	Syllidae	*Salvatoria vieitezi* San Martín, 1984
Anellida	Hesionidae	*Syllidia armata* Quatrefages, 1866
Anellida	Syllidae	*Syllis armillaris* O.F. Müller, 1776
Anellida	Syllidae	*Syllis compacta* Gravier, 1900
Anellida	Syllidae	*Syllis rosea* Langerhans, 1879
Anellida	Syllidae	*Trypanosyllis aeolis* Langerhans, 1879
Anellida	Syllidae	*Trypanosyllis zebra* Grube, 1860
Arthropoda	Anthuridae	*Cyathura carinata* Krøyer, 1847
Arthropoda	Anthuridae	*Mesanthura romulea* Poore & Lew Ton, 1986*
Arthropoda	Paranthuridae	*Paranthura japonica* Richardson, 1909*
Cnidaria	Aiptasiidae	*Aiptasia mutabilis* Gravenhorst, 1831
Cnidaria	Actiniidae	*Anemonia vridis* Forsskål, 1775
Nemertea	Valenciniidae	*Baseodiscus delineatus* Delle Chiaje, 1822*

Table 25. Deposit feeder-Detritivorous-Scavenger species associated with *Pinctada radiata* in the Faro Canal (NIS are indicated with*).

Phylum	Family	Species
Anellida	Cirratulidae	Not identified
Anellida	Aspidosiphonidae	*Aspidosiphon (Aspidosiphon) muelleri* Diesing, 1851
Anellida	Cirratulidae	*Aphelochaeta filiformis* Keferstein, 1862
Anellida	Amphinomidae	*Eurythoe complanata* Pallas, 1766*
Anellida	Microphthalmidae	*Hesionides* Friedrich, 1937
Anellida	Amphinomidae	*Linopherus canariensis* Langerhans, 1881*
Anellida	Spionidae	*Malacoceros* Quatrefages, 1843
Anellida	Amphinomidae	*Notopygos* Grube, 1855
Anellida	Spionidae	*Paraprionospio pinnata* Ehlers, 1901
Anellida	Phascolosomatidae	*Phascolosoma (Phascolosoma) granulatum* Leuckart, 1828
Anellida	Phascolosomatidae	*Phascolosoma (Phascolosoma) perlucens* Baird, 1868
Anellida	Spionidae	*Prionospio* Malmgren, 1867
Anellida	Orbiniidae	*Protoaricia oerstedii* Claparède, 1864
Arthropoda	Corophiidae	*Apocorophium acutum* Chevreux, 1908
Arthropoda	Ampithoidae	*Biancolina algicola* Della Valle, 1893
Arthropoda	Caprellidae	*Caprella acanthifera* Leach, 1814
Arthropoda	Cheirocratidae	*Cheirocratus assimilis* Lilljeborg, 1852
Arthropoda	Sphaeromatidae	*Cymodoce truncata* Leach, 1814

Arthropoda	Maeridae	*Elasmopus rapax* A. Costa, 1853
Arthropoda	Ischyroceridae	*Ericthonius brasiliensis* Dana, 1853
Arthropoda	Ischyroceridae	*Ericthonius punctatus* Spence Bate, 1857
Arthropoda	Gammaridae	*Gammarus crinicornis* Stock, 1966
Arthropoda	Gammaridae	*Gammarus subtypicus* Stock, 1966
Arthropoda	Ischyroceridae	*Jassa marmorata* Holmes, 1905
Arthropoda	Corophiidae	*Laticorophium baconi* Shoemaker, 1934*
Arthropoda	Sphaeromatidae	*Lekanesphaera monodi* Arcangeli, 1934
Arthropoda	Lysianassidae	*Lysianassa costae* H. Milne Edwards, 1830
Arthropoda	Ischyroceridae	*Microjassa cumbrensis* Stebbing & Robertson, 1891
Arthropoda	Corophiidae	*Monocorophium acherusicum* A. Costa, 1853
Arthropoda	Sphaeromatidae	*Paracerceis sculpta* Holmes, 1904*
Arthropoda	Maeridae	*Quadrimaera inaequipes* A. Costa in Hope, 1851
Arthropoda	Stenothoidae	*Stenothoides* Chevreux, 1900
Arthropoda	Tanaididae	*Tanais dulongii* Audouin, 1826
Echinodermata	Amphiuridae	*Amphipholis squamata* Delle Chiaje, 1828
Echinodermata	Amphiuridae	*Amphiura filiformis* O.F. Müller, 1776
Echinodermata	Asterinidae	*Asterina gibbosa* Pennant, 1777
Echinodermata	Ophiotrichidae	*Ophiothrix fragilis* Abildgaard in O.F. Müller, 1789

Table 26. Filter feeder species associated with *Pinctada radiata* in the Faro Lake (NIS are indicated with*).

Phylum	Family	Species
Anellida	Sabellidae	*Bispira viola* Grube, 1863
Anellida	Sabellidae	*Branchiomma bairdi* McIntosh, 1885*
Anellida	Serpulidae	*Hydroides dianthus* Verrill, 1873*
Anellida	Serpulidae	*Hydroides elegans* Haswell, 1883*
Anellida	Serpulidae	*Hydroides stoichadon* Zibrowius, 1971
Anellida	Serpulidae	*Janua heterostropha* Montagu, 1803
Anellida	Serpulidae	*Neodexiospira pseudocorrugata* Bush, 1905
Anellida	Serpulidae	*Pileolaria militaris* Claparède, 1870
Anellida	Serpulidae	*Serpula concharum* Langerhans, 1880
Anellida	Serpulidae	*Serpula vermicularis* Linnaeus, 1767
Anellida	Serpulidae	*Simplaria pseudomilitaris* Thiriot-Quievreux, 1965
Arthropoda	Chthamalidae	*Chthamalus stellatus* Poli, 1791
Mollusca	Ostreidae	*Ostrea edulis* Linnaeus, 1758
Mollusca	Patellidae	*Patella caerulea* Linnaeus, 1758
Porifera	Crambeidae	*Crambe crambe* Schmidt, 1862

Table 27. Herbivorous species associated with *Pinctada radiata* in the Faro Lake (NIS are indicated with*).

Phylum	Family	Species
Mollusca	Chitonidae	*Rhyssoplax olivacea* Spengler, 1797

Table 28. Parasite species associated with *Pinctada radiata* in the Faro Lake (NIS are indicated with*).

Phylum	Family	Species
Arthropoda	Ammotheidae	*Ammothella longipes* Hodge, 1864

Table 29. Predator species associated with *Pinctada radiata* in the Faro Lake (NIS are indicated with*).

Phylum	Family	Species
Anellida	Nereididae	*Composetia costae* Grube, 1840
Anellida	Syllidae	*Brania pusilla* Dujardin, 1851
Anellida	Dorvilleidae	*Dorvillea similis* Crossland, 1924*
Anellida	Lumbrineridae	*Lumbrineris latreilli* Audouin & Milne Edwards, 1833
Anellida	Phyllodocidae	*Phyllodoce* Lamarck, 1818
Anellida	Nereididae	*Platynereis dumerilii* Audouin & Milne Edwards, 1833
Anellida	Hesionidae	*Syllidia armata* Quatrefages, 1866
Anellida	Syllidae	*Syllis* Lamarck, 1818
Anellida	Syllidae	*Trypanosyllis zebra* Grube, 1860
Arthropoda	Anthuridae	*Mesanthura romulea* Poore & Lew Ton, 1986*
Arthropoda	Paranthuridae	*Paranthura japonica* Richardson, 1909*
Cnidaria	Aiptasiidae	*Aiptasia mutabilis* Gravenhorst, 1831
Cnidaria	Actiniidae	*Anemonia vridis* Forsskål, 1775
Nemertea	Valenciniidae	*Baseodiscus delineatus* Delle Chiaje, 1822*

Table 30. Deposit feeder-Detritivorous-Scavenger species associated with *Pinctada radiata* in the Faro Lake (NIS are indicated with*).

Phylum	Family	Species
Anellida	Terebellidae	Not identified
Anellida	Terebellidae	*Amphitritides gracilis* Grube, 1860
Anellida	Cirratulidae	*Cirratulus cirratus* O. F. Müller, 1776
Anellida	Cirratulidae	*Cirriformia tentaculata* Montagu, 1808
Anellida	Cirratulidae	*Dodecaceria* Örsted, 1843
Anellida	Amphinomidae	*Eurythoe complanata* Pallas, 1766*
Anellida	Amphinomidae	*Linopherus canariensis* Langerhans, 1881*
Anellida	Orbiniidae	*Naineris laevigata* Grube, 1855
Anellida	Terebellidae	*Nicolea venustula* Montagu, 1819
Anellida	Opheliidae	*Polyophtalmus pictus* Dujardin, 1839
Anellida	Aphroditidae	*Pontogenia chrysocoma* Baird, 1865
Anellida	Cirratulidae	*Protocirrineris chrysoderma* Claparède, 1868
Anellida	Terebelidae	*Thelepus* Leuckart, 1849
Arthropoda	Corophiidae	*Apocorophium acutum* Chevreux, 1908
Arthropoda	Caprellidae	*Caprella mitis* Mayer, 1890
Arthropoda	Cheirocratidae	*Cheirocratus assimilis* Lilljeborg, 1852
Arthropoda	Sphaeromatidae	*Dynamene bicolor* Rathke, 1836
Arthropoda	Sphaeromatidae	*Dynamene bidentata* Adams, 1800
Arthropoda	Sphaeromatidae	*Dynamene edwardsi* Lucas, 1849
Arthropoda	Maeridae	*Elasmopus rapax* A. Costa, 1853
Arthropoda	Ischyroceridae	*Ericthonius brasiliensis* Dana, 1853
Arthropoda	Ischyroceridae	*Ericthonius punctatus* Spence Bate, 1857
Arthropoda	Gammaridae	*Gammarus aequicauda* Martynov, 1931
Arthropoda	Gammaridae	*Gammarus* Martynov, 1931
Arthropoda	Sphaeromatidae	*Lakenesphaera rugicauda* Leach, 1814
Arthropoda	Corophiidae	*Laticorophium baconi* Shoemaker, 1934*
Arthropoda	Sphaeromatidae	*Paracerceis sculpta* Holmes, 1904*
Arthropoda	Maeridae	*Quadrimaera inaequipes* A. Costa in Hope, 1851
Arthropoda	Tanaididae	*Tanais dulongii* Audouin, 1826
Echinodermata	Amphiuridae	*Amphipholis squamata* Delle Chiaje, 1828

Table 31. Filter feeder species associated with *Pinctada radiata* in the Due Torri Canal (NIS are indicated with*).

Phylum	Family	Species
Anellida	Sabellidae	*Amphicorina armandi* Claparède, 1864
Anellida	Sabellidae	*Bispira viola* Grube, 1863
Anellida	Sabellidae	*Branchiomma bairdi* McIntosh, 1885*
Anellida	Serpulidae	*Hydroides dianthus* Verrill, 1873*
Anellida	Serpulidae	*Hydroides elegans* Haswell, 1883*
Anellida	Serpulidae	*Hydroides nigra* Zibrowius, 1971
Anellida	Serpulidae	*Hydroides pseudouncinata* Zibrowius, 1968
Anellida	Serpulidae	*Hydroides stoichadon* Zibrowius, 1971
Anellida	Serpulidae	*Josephella marenzelleri* Caullery & Mesnil, 1896
Anellida	Serpulidae	*Neodexiospira pseudocorrugata* Bush, 1905
Anellida	Serpulidae	*Pileolaria militaris* Claparède, 1870
Anellida	Serpulidae	*Serpula lobiancoi* Rioja, 1917
Anellida	Serpulidae	*Serpula vermicularis* Linnaeus, 1767
Anellida	Serpulidae	*Simplaria pseudomilitaris* Thiriot-Quievreux, 1965
Anellida	Serpulidae	*Vermiliopsis infundibulum* Philippi, 1844
Anellida	Serpulidae	*Vermiliopsis monodiscus* Zibrowius, 1968
Anellida	Serpulidae	*Vermiliopsis striaticeps* Grube, 1862
Mollusca	Modiolidae	*Modiolus barbatus* Linnaeus, 1758
Porifera	Crambeidae	*Crambe crambe* Schmidt, 1862

Table 32. Herbivorous species associated with *Pinctada radiata* in the Due Torri Canal (NIS are indicated with*).

Phylum	Family	Species
Mollusca	Acanthochitonidae	*Acanthochitona fascicularis* Linnaeus, 1767
Mollusca	Trochidae	*Phorcus turbinatus* Born, 1778
Mollusca	Trochidae	*Steromphala adansonii* Payraudeau, 1826

Table 33. Parasite species associated with *Pinctada radiata* in the Due Torri Canal (NIS are indicated with*).

Phylum	Family	Species
Arthropoda	Ammotheidae	*Ammothella longipes* Hodge, 1864

Table 34. Predator species associated with *Pinctada radiata* in the Due Torri Canal (NIS are indicated with*).

Phylum	Family	Species
Anellida	Dorvilleidae	*Dorvillea similis* Crossland, 1924*
Anellida	Nereididae	*Platynereis coccinea* Delle Chiaje, 1822
Anellida	Syllidae	*Syllis amica* Quatrefages, 1866
Anellida	Syllidae	*Syllis* Lamarck, 1818
Anellida	Syllidae	*Syllis rosea* Langerhans, 1879
Anellida	Syllidae	*Trypanosyllis zebra* Grube, 1860
Arthropoda	Anthuridae	*Cyathura carinata* Krøyer, 1847
Arthropoda	Anthuridae	*Mesanthura romulea* Poore & Lew Ton, 1986*
Arthropoda	Paranthuridae	*Paranthura japonica* Richardson, 1909*

Cnidaria	Aiptasiidae	*Aiptasia mutabilis* Gravenhorst, 1831
Mollusca	Conidae	*Conus ventricosus* Gmelin, 1791
Nemertea	Valenciniidae	*Baseodiscus delineatus* Delle Chiaje, 1822*

Table 35. Deposit feeder-Detritivorous-Scavenger species associated with *Pinctada radiata* in the Due Torri Canal (NIS are indicated with*).

Phylum	Family	Species
Anellida	Cirratulidae	Not identified
Anellida	Terebellidae	*Amphitritides gracilis* Grube, 1860
Anellida	Cirratulidae	*Aphelochaeta* Blake, 1991
Anellida	Cirratulidae	*Aphelochaeta marioni* Saint-Joseph, 1894
Anellida	Cirratulidae	*Chaetozone caputesocis* Saint-Joseph, 1894
Anellida	Cirratulidae	*Chaetozone* Malmgren, 1867
Anellida	Cirratulidae	*Cirratulus cirratus* O. F. Müller, 1776
Anellida	Cirratulidae	*Cirratulus* Lamarck, 1818
Anellida	Cirratulidae	*Dodecaceria* Örsted, 1843
Anellida	Amphinomidae	*Eurythoe complanata* Pallas, 1766*
Anellida	Golfingiidae	*Golfingia (Golfingia) vulgaris vulgaris* de Blainville, 1827
Anellida	Amphinomidae	*Linopherus canariensis* Langerhans, 1881*
Anellida	Phascolosomatidae	*Phascolosoma (Phascolosoma) granulatum* Leuckart, 1828
Anellida	Phascolosomatidae	*Phascolosoma (Phascolosoma) perlucens* Baird, 1868
Anellida	Terebellidae	*Rhinothelepus* Hutchings, 1974
Anellida	Terebellidae	*Thelepus triserialis* Grube, 1855
Arthropoda	Alpheidae	*Alpheus dentipes* Guérin, 1832
Arthropoda	Corophiidae	*Apocorophium acutum* Chevreux, 1908
Arthropoda	Sphaeromatidae	*Dynamene bidentata* Adams, 1800
Arthropoda	Sphaeromatidae	*Dynamene edwardsii* Zibrowius, 1968
Arthropoda	Maeridae	*Elasmopus rapax* A. Costa, 1853
Arthropoda	Sphaeromatidae	*Paracerceis sculpta* Holmes, 1904*
Arthropoda	Maeridae	*Quadrimaera inaequipes* A. Costa in Hope, 1851
Arthropoda	Tanaididae	*Tanais dulongii* Audouin, 1826
Echinodermata	Amphiuridae	*Amphipholis squamata* Delle Chiaje, 1828
Echinodermata	Asterinidae	*Asterina gibbosa* Pennant, 1777
Echinodermata	Ophiotrichidae	*Ophiothrix fragilis* Abildgaard in O.F. Müller, 1789

Table 36. Filter feeder species associated with plastic in the Martinska locality (NIS are indicated with*).

Phylum	Family	Species
Anellida	Serpulidae	*Ficopomatus enigmaticus* Fauvel, 1923*
Anellida	Serpulidae	*Neodexiospira pseudocorrugata* Bush, 1905
Anellida	Serpulidae	*Pileolaria militaris* Claparède, 1870
Anellida	Serpulidae	*Serpula vermicularis* Linnaeus, 1767
Anellida	Serpulidae	*Spirobranchus triqueter* Linnaeus, 1758
Arthropoda	Balanidae	*Perforatus perforatus* Bruguière, 1789
Chordata	Pyuridae	*Microcosmus vulgaris* Heller, 1877
Chordata	Ascidiidae	*Phallusia nigra* Savigny, 1816*
Mollusca	Anomiidae	*Anomia ephippium* Linnaeus, 1758
Mollusca	Cardiidae	*Cerastoderma glaucum* Bruguière, 1789
Mollusca	Hiatellidae	*Hiatella rugosa* Linnaeus, 1767
Mollusca	Modiolidae	*Modiolus adriaticus* Lamarck, 1819
Mollusca	Modiolidae	*Modiolus barbatus* Linnaeus, 1758
Mollusca	Mytilidae	*Musculus costulatus* Risso, 1826

Mollusca	Mytilidae	*Mytilaster lineatus* Gmelin, 1791
Mollusca	Mytilidae	*Mytilus galloprovincialis* Lamarck, 1819

Table 37. Parasite species associated with plastic in the Martinska locality (NIS are indicated with*).

Phylum	Family	Species
Arthropoda	Gnathiidae	*Paragnathia formica* Hesse, 1864

Table 38. Predator species associated with plastic in the Martinska locality (NIS are indicated with*).

Phylum	Family	Species
Anellida	Nereididae	*Composetia costae* Grube, 1840
Anellida	Lumbrineridae	*Lumbrineris latreilli* Audouin & Milne Edwards, 1833
Anellida	Nereididae	*Neanthes rubicunda* Ehlers, 1868
Anellida	Nereididae	*Platynereis dumerilii* Audouin & Milne Edwards, 1833
Arthropoda	Apseudidae	*Apseudopsis latreillii* Milne Edwards, 1828
Arthropoda	Leptocheliidae	*Chondrochelia savignyi* Kroyer, 1842
Cnidaria	Aiptasiidae	*Aiptasia mutabilis* Gravenhorst, 1831
Cnidaria	Dendrophylliidae	*Balanophyllia (Balanophyllia) europaea* Risso, 1827
Cnidaria	Cladocoridae	*Cladocora caespitosa* Linnaeus, 1767
Mollusca	Cerithiidae	*Bittium latreillii* Payraudeau, 1826
Mollusca	Raphitomidae	*Leufroyia concinna* Scacchi, 1836

Table 39. Deposit feeder-Detritivorous-Scavenger species associated with plastic in the Martinska locality (NIS are indicated with*).

Phylum	Family	Species
Anellida	Maldanidae	*Maldane glebifex* Linnaeus, 1758
Arthropoda	Porcellanidae	*Pisidia longicornis* Linnaeus, 1767
Arthropoda	Corophiidae	*Apocorophium acutum* Chevreux, 1908
Arthropoda	Alpheidae	*Athanas nitescens* Leach, 1814
Arthropoda	Varunidae	*Brachynotus gemmellari* Rizza, 1839
Arthropoda	Diogenidae	*Diogenes pugilator* Roux, 1829
Arthropoda	Maeridae	*Elasmopus rapax* A. Costa, 1853
Arthropoda	Melitidae	*Melita hergensis* Reid, 1939
Arthropoda	Munididae	*Munida sp.* Leach, 1821
Arthropoda	Pilumnidae	*Pilumnus villosissimus* Rafinesque, 1814
Arthropoda	Rissoidae	*Pusillina radiata* R. A. Philippi, 1836
Arthropoda	Tanaididae	*Tanais dulongii* Audouin, 1826
Arthropoda	Xanthidae	*Xantho pilipes* A. Milne-Edwards, 1867
Echinodermata	Ophiodermatidae	*Ophioderma longicaudum* Bruzelius, 1805

Table 40. Filter feeder species associated with plastic in the Tijat Island (NIS are indicated with*).

Phylum	Family	Species
Anellida	Serpulidae	*Ficopomatus enigmaticus* Fauvel, 1923*
Anellida	Serpulidae	*Neodexiospira pseudocorrugata* Bush, 1905

Anellida	Serpulidae	*Pileolaria militaris* Claparède, 1870
Anellida	Serpulidae	*Semivermilia crenata* O. G. Costa, 1861
Anellida	Serpulidae	*Serpula vermicularis* Linnaeus, 1767
Anellida	Serpulidae	*Simplaria pseudomilitaris* Thiriot-Quievreux, 1965
Anellida	Serpulidae	*Spirobranchus triqueter* Linnaeus, 1758
Anellida	Serpulidae	*Vermiliopsis infundibulum* Philippi, 1844
Anellida	Serpulidae	*Vermiliopsis striaticeps* Grube, 1862
Mollusca	Cardiidae	*Acanthocardia echinata* Linnaeus, 1758
Mollusca	Anomiidae	*Anomia ephippium* Linnaeus, 1758
Mollusca	Modiolidae	*Modiolus barbatus* Linnaeus, 1758
Mollusca	Mytilidae	*Mytilaster lineatus* Gmelin, 1791
Mollusca	Mytilidae	*Mytilus galloprovincialis* Lamarck, 1819

Table 41. Herbivorous species associated with plastic in the Tijat Island (NIS are indicated with*).

Phylum	Family	Species
Echinodermata	Parechinidae	*Paracentrotus lividus* Lamarck, 1816
Mollusca	Trochidae	*Gibbula guttadauri* R. A. Philippi, 1836
Mollusca	Tonicellidae	*Lepidochitona caprearum* Scacchi, 1836
Mollusca	Chitonidae	*Rhyssoplax olivacea* Spengler, 1797
Mollusca	Trochidae	*Steromphala varia* Linnaeus, 1758

Table 42. Predator species associated with plastic in the Tijat Island (NIS are indicated with*).

Phylum	Family	Species
Cnidaria	Aiptasiidae	*Aiptasia mutabilis* Gravenhorst, 1831
Mollusca	Cerithiidae	*Bittium latreillii* Payraudeau, 1826
Mollusca	Raphitomidae	*Leufroyia concinna* Scacchi, 1836

Table 43. Deposit feeder-Detritivorous-Scavenger species associated with plastic in the Tijat Island (NIS are indicated with*).

Phylum	Family	Species
Anellida	Glyceridae	Not identified
Anellida	Maldanidae	*Maldane glebifex* Linnaeus, 1758
Anellida	Terebellidae	*Nicolea venustula* Montagu, 1819
Anellida	Phascolosomatidae	*Phascolosoma (Phascolosoma) stephensoni* Stephen, 1942
Anellida	Terebellidae	*Thelepus setosus* Quatrefages, 1866
Arthropoda	Pontarachnidae	Not identified
Arthropoda	Corophiidae	*Apocorophium acutum* Chevreux, 1908
Arthropoda	Alpheidae	*Athanas nitescens* Leach, 1814
Arthropoda	Sphaeromatidae	*Dynamene bidentata* Adams, 1800
Arthropoda	Porcellanidae	*Pisidia longicornis* Linnaeus, 1767
Mollusca	Rissoidae	*Rissoa variabilis* Megerle von Mühlfeld, 1824

Some teleost specimens were found in some plastic litter, all within the Natural Oriented Reserve of Capo Peloro Lagoon (Messina) (Fig. 25). There were no Teleost associated with plastic litter at the Šibenik area (Croatia).

Table 44. Teleost species associated with plastic in the Faro Lake.

Phylum	Family	Species	Type of litter
Chordata	Gobiidae	*Gobius niger* Linnaeus, 1758	Transparent PET bottle
Chordata	Blenniidae	*Salaria pavo* Risso, 1810	Black PP toy

Table 45. Teleost species associated with plastic in the Due Torri Canal.

Phylum	Family	Species	Type of litter
Chordata	Muraenidae	*Muraena helena* Linnaeus, 1758	White HDPE tank

Figure 25. Detail of *Muraena helena* Linnaeus, 1758 specimen found inside a bin in the Due Torri Canal. Note: the Teleost specimens were promptly released into the wild after identification.

Some protected species listed in the Bern Convention were found to the surface of some plastic litter, within the Natural Oriented Reserve of Capo Peloro Lagoon Reserve (Messina) and in Šibenik area (Croatia). No protected species were found on the surface of *P. radiata* specimens.

Table 46. Protected species associated with plastic in the Faro Canal.

Phylum	Family	Species	Type of litter
Mollusca	Cypraeidae	*Naria spurca* Linnaeus, 1758	Grey PP locker light

Table 47. Protected species associated with plastic in the Due Torri Canal.

Phylum	Family	Species	Type of litter
Echinodermata	Parechinidae	*Paracentrosus lividus* Lamarck, 1816	Green PP box
Echinodermata	Parechinidae	*Paracentrosus lividus* Lamarck, 1816	Transparent PET bottle
Echinodermata	Parechinidae	*Paracentrosus lividus* Lamarck, 1816	White LDPE bottle
Echinodermata	Parechinidae	*Paracentrosus lividus* Lamarck, 1816	Black MIX shoes
Echinodermata	Parechinidae	*Paracentrosus lividus* Lamarck, 1816	White HDPE toy
Echinodermata	Parechinidae	*Paracentrosus lividus* Lamarck, 1816	White PP unidentified litter
Echinodermata	Parechinidae	*Paracentrosus lividus* Lamarck, 1816	Grey HDPE unidentified litter
Echinodermata	Parechinidae	*Paracentrosus lividus* Lamarck, 1816	Transparent PET bottle
Mollusca	Cypraeidae	*Naria spurca* Linnaeus, 1758	Withe HDPE tank
Mollusca	Cypraeidae	*Naria spurca* Linnaeus, 1758	Transparent PET bottle
Mollusca	Cypraeidae	*Naria spurca* Linnaeus, 1758	Black PP unidentified litter

Table 48. Protected species associated with plastic in the Tijat Island.

Phylum	Family	Species	Type of litter
Echinodermata	Parechinidae	*Paracentrosus lividus* Lamarck, 1816	Brown PP unidentified litter
Echinodermata	Parechinidae	*Paracentrosus lividus* Lamarck, 1816	Black MIX shoes
Echinodermata	Parechinidae	*Paracentrosus lividus* Lamarck, 1816	Trasparent LDPE bag

The two protected species under examination, *Naria spurca* Linnaeus, 1758 and *Paracentrotus lividus* Lamarck, 1816 (Fig. 26), are included into annexes II (strictly protected animal species) and III (protected animal species) of the Bern Convention, respectively.

Figure 26. Protect species found. ***P. lividus*** **(A);** ***N. spurca*** **(B). Note: all protected specimens were promptly released into the wild after identification.**

4.2 Non Indigenous Species (NIS) and/or invasive species

In total 22 NIS were found (Fig. 27), summarized and categorized by area in the following tables:

Table 49. NIS associated with plastic in the Faro Canal.

Phylum	Family	Species
Anellida	Sabellidae	*Branchiomma bairdi* McIntosh, 1885
Anellida	Dorvilleidae	*Dorvillea similis* Crossland, 1924
Anellida	Amphinomidae	*Eurythoe complanata* Pallas, 1766
Anellida	Serpulidae	*Hydroides dianthus* Verrill, 1873
Anellida	Serpulidae	*Hydroides elegans* Haswell, 1883
Anellida	Syllidae	*Opisthosyllis brunnea* Langerhans, 1879
Arthropoda	Sphaeromatidae	*Paracerceis sculpta* Holmes, 1904
Arthropoda	Paranthuridae	*Paranthura japonica* Richardson, 1909
Chordata	Styelidae	*Styela plicata* Lesueur, 1823
Mollusca	Margaritidae	*Pinctada radiata* Leach, 1814
Mollusca	Isognomonidae	*Isognomon bicolor* Gmelin, 1791
Nemertea	Valenciniidae	*Baseodiscus delineatus* Delle Chiaje, 1822

Table 50. NIS associated with plastic in the Faro Lake.

Phylum	Family	Species
Anellida	Sabellidae	*Branchiomma bairdi* McIntosh, 1885
Anellida	Dorvilleidae	*Dorvillea similis* Crossland, 1924
Anellida	Serpulidae	*Hydroides dianthus* Verrill, 1873
Anellida	Serpulidae	*Hydroides elegans* Haswell, 1883
Arthropoda	Corophiidae	*Laticorophium baconi* Shoemaker, 1934
Arthropoda	Anthuridae	*Mesanthura romulea* Poore & Lew ton, 1986
Arthropoda	Sphaeromatidae	*Paracerceis sculpta* Holmes, 1904
Arthropoda	Paranthuridae	*Paranthura japonica* Richardson, 1909
Chordata	Styelidae	*Botrylloides niger* Herdman, 1886
Chordata	Styelidae	*Styela plicata* Lesueur, 1823
Mollusca	Mytilidae	*Brachidontes pharaonis* P. Fischer, 1870
Mollusca	Margaritidae	*Pinctada radiata* Leach, 1814
Mollusca	Isognomonidae	*Isognomon bicolor* Gmelin, 1791
Nemertea	Valenciniidae	*Baseodiscus delineatus* Delle Chiaje, 1822

Table 51. NIS associated with plastic in the Margi Canal.

Phylum	Family	Species
Anellida	Sabellidae	*Branchiomma bairdi* McIntosh, 1885
Anellida	Serpulidae	*Hydroides dianthus* Verrill, 1873
Anellida	Serpulidae	*Hydroides elegans* Haswell, 1883
Arthropoda	Sphaeromatidae	*Paracerceis sculpta* Holmes, 1904
Chordata	Styelidae	*Botrylloides niger* Herdman, 1886
Chordata	Styelidae	*Styela plicata* Lesueur, 1823
Mollusca	Mytilidae	*Brachidontes pharaonis* P. Fischer, 1870
Nemertea	Valenciniidae	*Baseodiscus delineatus* Delle Chiaje, 1822

Table 52. NIS associated with plastic in the Due Torri Canal.

Phylum	Family	Species
Anellida	Sabellidae	*Branchiomma bairdi* McIntosh, 1885
Anellida	Dorvilleidae	*Dorvillea similis* Crossland, 1924
Anellida	Serpulidae	*Hydroides dianthus* Verrill, 1873
Anellida	Serpulidae	*Hydroides elegans* Haswell, 1883
Arthropoda	Caprellidae	*Caprella scaura* Templeton, 1836
Arthropoda	Corophiidae	*Laticorophium baconi* Shoemaker, 1934
Arthropoda	Anthuridae	*Mesanthura romulea* Poore & Lew ton, 1986
Arthropoda	Sphaeromatidae	*Paracerceis sculpta* Holmes, 1904
Arthropoda	Paranthuridae	*Paranthura japonica* Richardson, 1909
Chordata	Styelidae	*Botrylloides niger* Herdman, 1886
Mollusca	Margaritidae	*Pinctada radiata* Leach, 1814
Mollusca	Isognomonidae	*Isognomon bicolor* Gmelin, 1791

Table 53. NIS associated with *Pinctada radiata* in the Faro Canal.

Phylum	Family	Species
Anellida	Dorvilleidae	*Dorvillea similis* Crossland, 1924
Anellida	Amphinomidae	*Eurythoe complanata* Pallas, 1766
Anellida	Serpulidae	*Ficopomatus enigmaticus* Fauvel, 1923
Anellida	Serpulidae	*Hydroides dianthus* Verrill, 1873
Anellida	Serpulidae	*Hydroides elegans* Haswell, 1883
Anellida	Amphinomidae	*Linopherus canariensis* Langerhans, 1881
Anellida	Serpulidae	*Spirorbis (Spirorbis) marioni* Caullery & Mesnil, 1897
Arthropoda	Anthuridae	*Mesanthura romulea* Poore & Lew Ton, 1986
Arthropoda	Sphaeromatidae	*Paracerceis sculpta* Holmes, 1904
Arthropoda	Paranthuridae	*Paranthura japonica* Richardson, 1909
Chordata	Styelidae	*Styela plicata* Lesueur, 1823
Mollusca	Margaritidae	*Pinctada radiata* Leach, 1814
Mollusca	Isognomonidae	*Isognomon bicolor* Gmelin, 1791
Nemertea	Valenciniidae	*Baseodiscus delineatus* Delle Chiaje, 1822

Table 54. NIS associated with *Pinctada radiata* in the Faro Lake.

Phylum	Family	Species
Anellida	Sabellidae	*Branchiomma bairdi* McIntosh, 1885
Anellida	Dorvilleidae	*Dorvillea similis* Crossland, 1924
Anellida	Amphinomidae	*Eurythoe complanata* Pallas, 1766
Anellida	Serpulidae	*Hydroides dianthus* Verrill, 1873
Anellida	Serpulidae	*Hydroides elegans* Haswell, 1883
Anellida	Amphinomidae	*Linopherus canariensis* Langerhans, 1881
Arthropoda	Anthuridae	*Mesanthura romulea* Poore & Lew Ton, 1986
Arthropoda	Sphaeromatidae	*Paracerceis sculpta* Holmes, 1904
Arthropoda	Paranthuridae	*Paranthura japonica* Richardson, 1909
Nemertea	Valenciniidae	*Baseodiscus delineatus* Delle Chiaje, 1822

Table 55. NIS associated with *Pinctada radiata* in the Due Torri Canal.

Phylum	Family	Species
Anellida	Sabellidae	*Branchiomma bairdi* McIntosh, 1885
Anellida	Dorvilleidae	*Dorvillea similis* Crossland, 1924
Anellida	Amphinomidae	*Eurythoe complanata* Pallas, 1766
Anellida	Serpulidae	*Hydroides dianthus* Verrill, 1873
Anellida	Serpulidae	*Hydroides elegans* Haswell, 1883
Anellida	Amphinomidae	*Linopherus canariensis* Langerhans, 1881
Arthropoda	Anthuridae	*Mesanthura romulea* Poore & Lew Ton, 1986
Arthropoda	Sphaeromatidae	*Paracerceis sculpta* Holmes, 1904
Arthropoda	Paranthuridae	*Paranthura japonica* Richardson, 1909
Nemertea	Valenciniidae	*Baseodiscus delineatus* Delle Chiaje, 1822

Table 56. NIS associated with plastic in Martinska locality.

Phylum	Family	Species
Anellida	Serpulidae	*Ficopomatus enigmaticus* Fauvel, 1923
Chordata	Ascidiidae	*Phallusia nigra* Savigny, 1816

Table 57. NIS associated with plastic in Tijat Island.

Phylum	Family	Species
Anellida	Serpulidae	*Ficopomatus enigmaticus* Fauvel, 1923

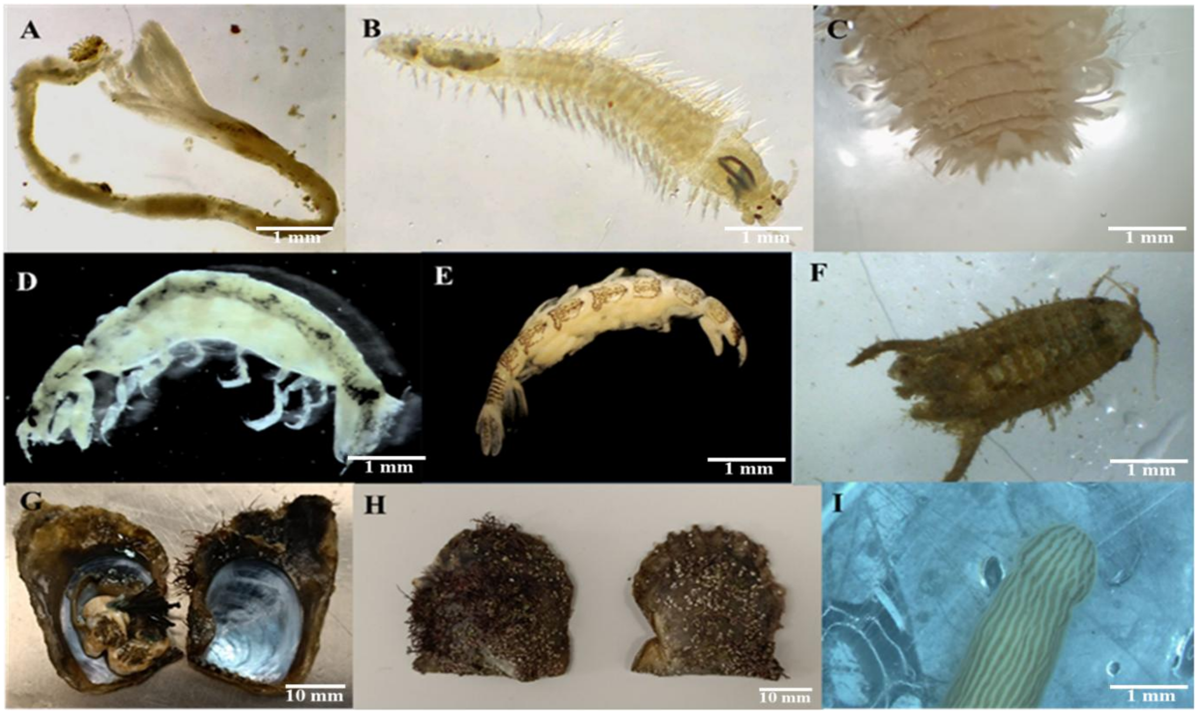

Figure 27. Some of the NIS species found. *Hydroides elegans* Haswell, 1883 (A); *Dorvillea similis* Crossland, 1924 (B); *Eurythoe complanata* Pallas, 1766 (C); *Paranthura japonica* Richardson, 1909 (D); *Mesanthura romulea* Poore & Lew Ton, 1986 (E); *Paracerceis sculpta* Holmes, 1904 (F); *Isognomon bicolor* Gmelin, 1791 (G); *P. radiata* (H); *Baseodiscus delineatus* Delle Chiaje, 1822 (I).

4.3 Plastic polymers detected

Through literature (Bayo et al., 2018) and information printed directly on the litter by producers, it was possible to identify in the polymers that make up the plastic litter found in the study areas. A total of 9 different types of plastic polymers were identified: ABS (Acrylonitrile butadiene styrene), HDPE (High Density Polyethylene), LDPE (Low Density Polyethylene), MIX (Mixture of different polymers), PA (Polyamide), PET (Polyethylene terephthalate), PP (Polypropylene), PS (Polystyrene), PVC (Polyvinyl chloride). This is summarized in the following figures (Fig. 28-29):

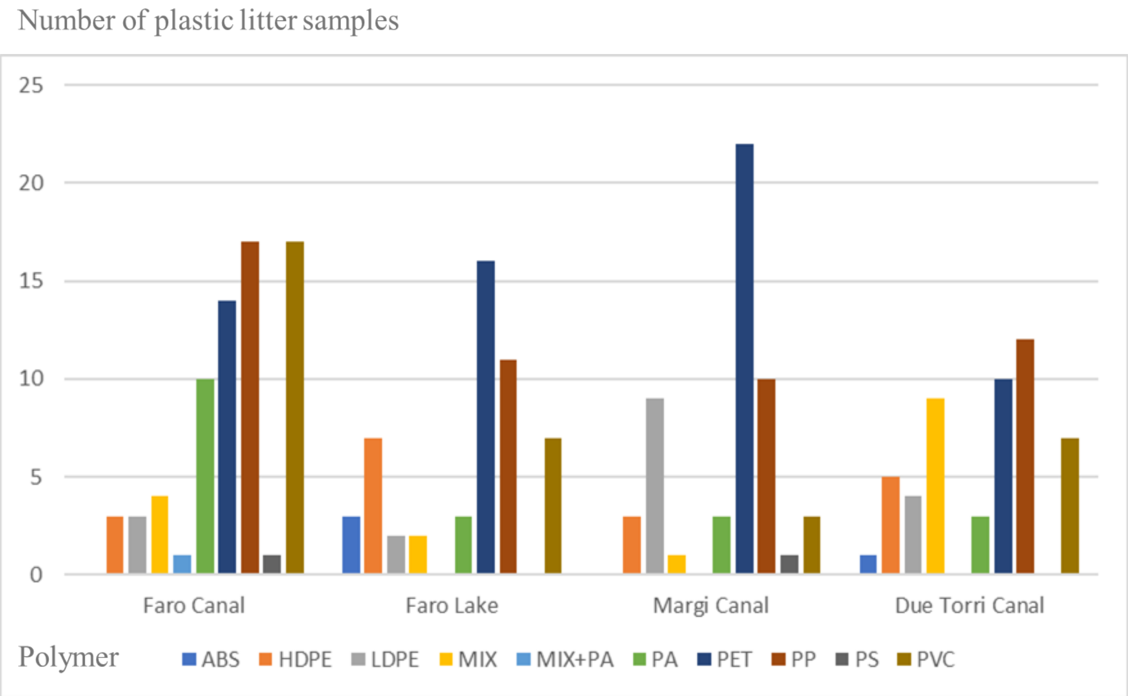

Figure 28. Distribution of plastic polymers within the Natural oriented Reserve of Capo Peloro Lagoon (Messina).

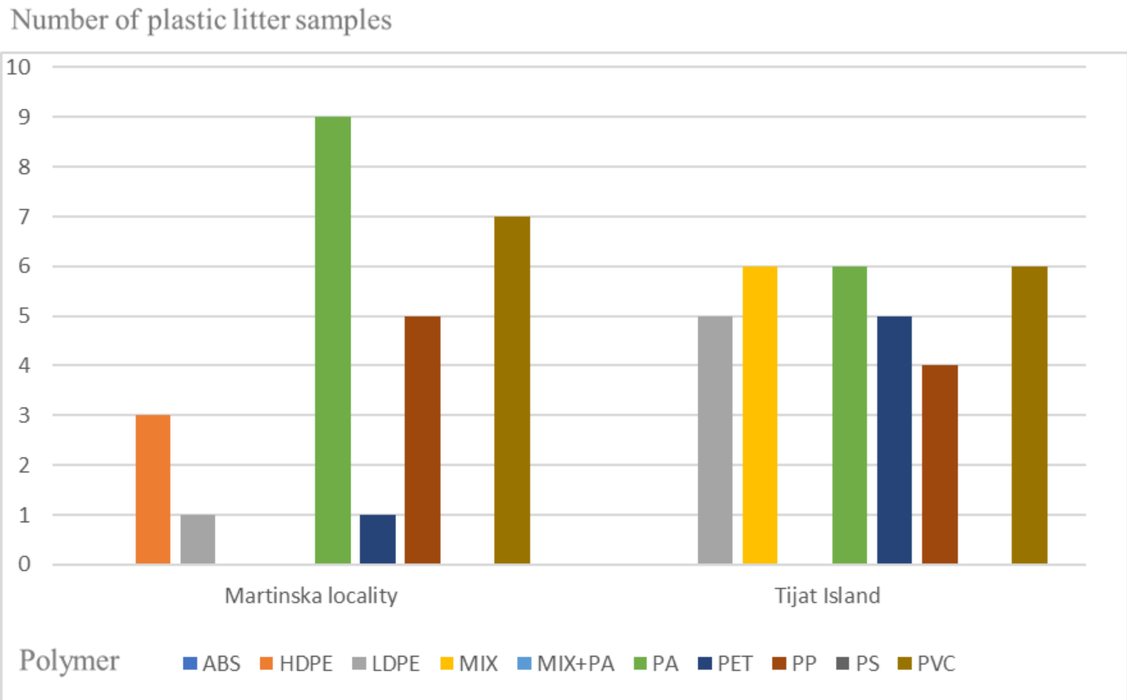

Figure 29. Distribution of plastic polymers within the Šibenik area (Croatia).

A further classification of plastic litter was made according to color, as shown in the following figures (30-31):

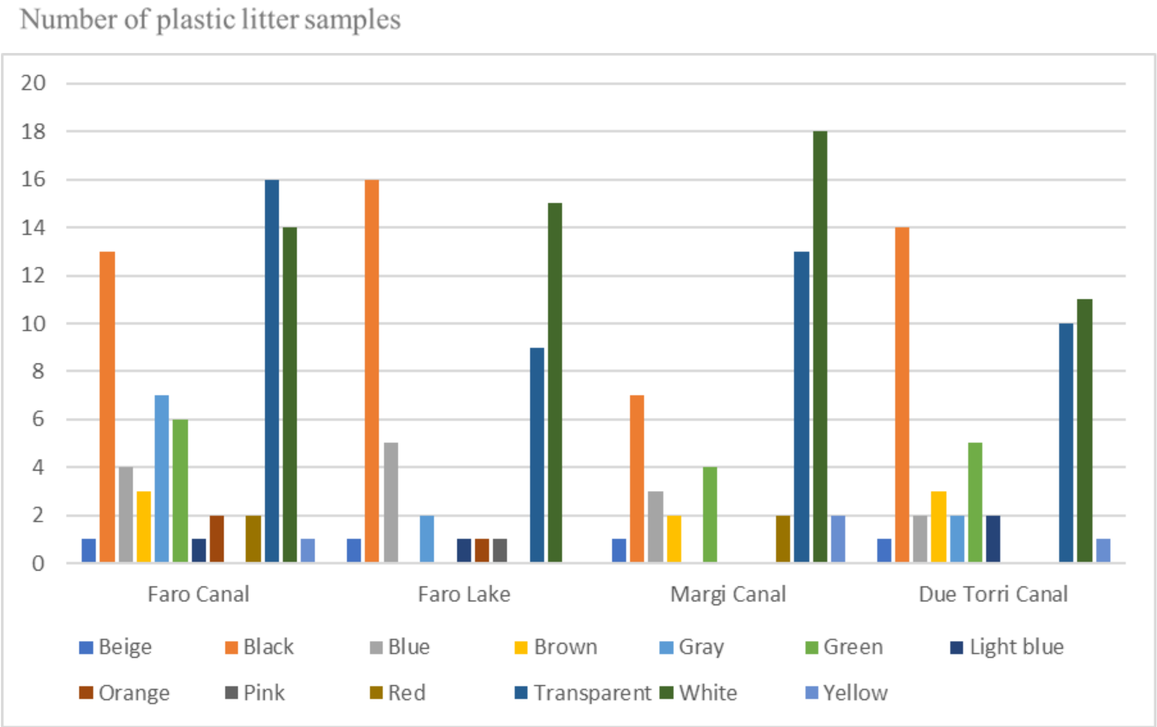

Figure 30. Distribution of plastic colours within the Natural oriented Reserve of Capo Peloro Lagoon (Messina).

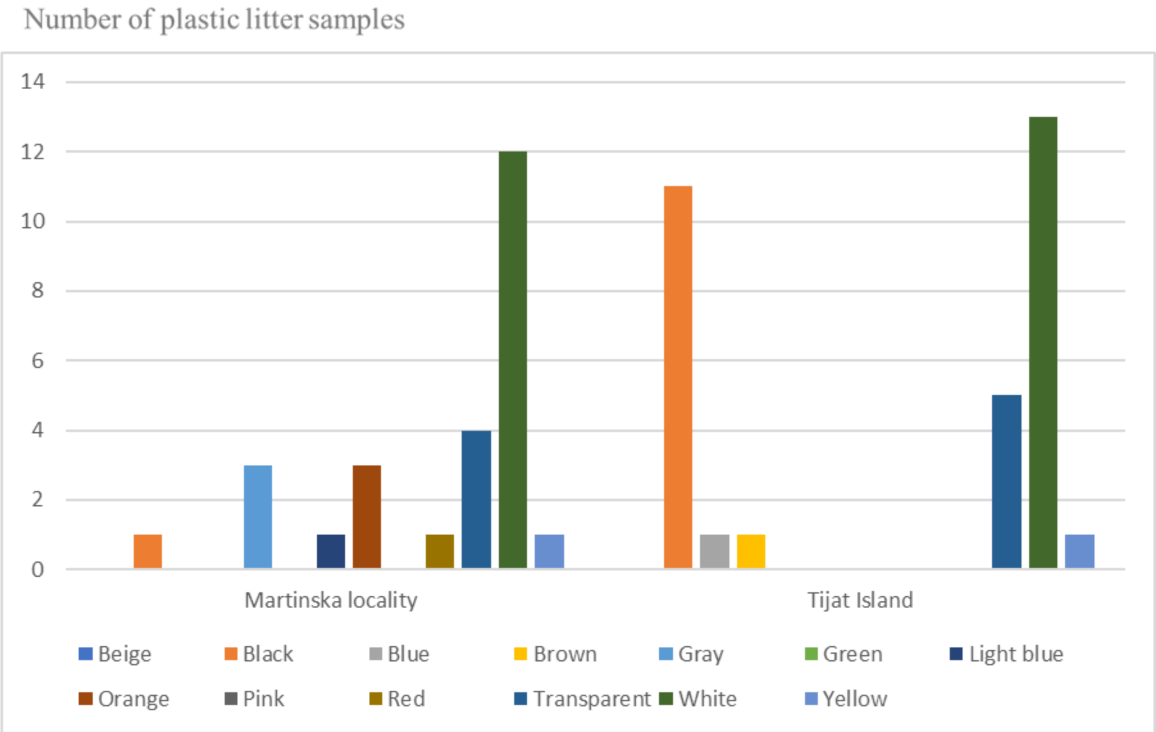

Figure 31. Distribution of plastic colours within the Šibenik area (Croatia).

4.4 EGG DEPOSITION

In some cases Gasteropod ovatures were found attached to the surface of some plastic litter, all within the Natural Oriented Reserve of Capo Peloro Lagoon (Messina) (Fig. 32). In most cases, adult specimens were also found in the immediate proximity of the eggs. No ovatures associated with plastic litter were found in the Šibenik area (Croatia), as well as associated with *P. radiata* specimens.

Table 58. Gasteropod ovatures associated with plastic in the Faro Canal.

Phylum	Family	Species	Type of litter
Mollusca	Unidentified	Unidentified	Green PVC tube
Mollusca	Unidentified	Unidentified	Grey PVC tube
Mollusca	Unidentified	Unidentified	Green PP unidentified litter
Mollusca	Discodorididae	*Platydoris argo* Linnaeus, 1767	Transparent PET bottle
Mollusca	Muricidae	*Hexaplex truculus* Linnaeus, 1758	Transparent PET bottle

Table 59. Gasteropod ovatures associated with plastic in the Faro Lake.

Phylum	Family	Species	Type of litter
Mollusca	Discodorididae	*Baptodoris cinnabarina* Bergh, 1884	Blue PA work glove
Mollusca	Muricidae	*Hexaplex truculus* Linnaeus, 1758	White PET dish
Mollusca	Muricidae	*Hexaplex truculus* Linnaeus, 1758	White PP plant pot
Mollusca	Discodorididae	*Platydoris argo* Linnaeus, 1767	White HDPE bottle
Mollusca	Discodorididae	*Platydoris argo* Linnaeus, 1767	White PET bottle

Table 60. Gasteropod ovatures associated with plastic in the Margi Canal.

Phylum	Family	Species	Type of litter
Mollusca	Unidentified	Unidentified	White LDPE bag
Mollusca	Discodorididae	*Baptodoris cinnabarina* Bergh, 1884	Transparent PA net
Mollusca	Muricidae	*Hexaplex truculus* Linnaeus, 1758	White PET cup
Mollusca	Muricidae	*Hexaplex truculus* Linnaeus, 1758	Brown PET umbrella
Mollusca	Muricidae	*Hexaplex truculus* Linnaeus, 1758	White LDPE bag
Muricidae	Muricidae	*Hexaplex truculus* Linnaeus, 1758	Brown PP plant pot
Mollusca	Discodorididae	*Platydoris argo* Linnaeus, 1767	Brown PP plant pot

Table 61. Gasteropod ovatures associated with plastic in the Due Torri Canal.

Phylum	Family	Species	Type of litter
Mollusca	Unidentified	Unidentified	Black PVC car mat
Mollusca	Aplysiidae	*Aplysia* Linnaeus, 1767	Light blue LPDE bag
Mollusca	Aplysiidae	*Aplysia* Linnaeus, 1767	Green LDPE bag
Mollusca	Muricidae	*Hexaplex truculus* Linnaeus, 1758	Transparent PET bottle
Mollusca	Muricidae	*Hexaplex truculus* Linnaeus, 1758	White PET cup
Mollusca	Discodorididae	*Platydoris argo* Linnaeus, 1767	White HDPE tank

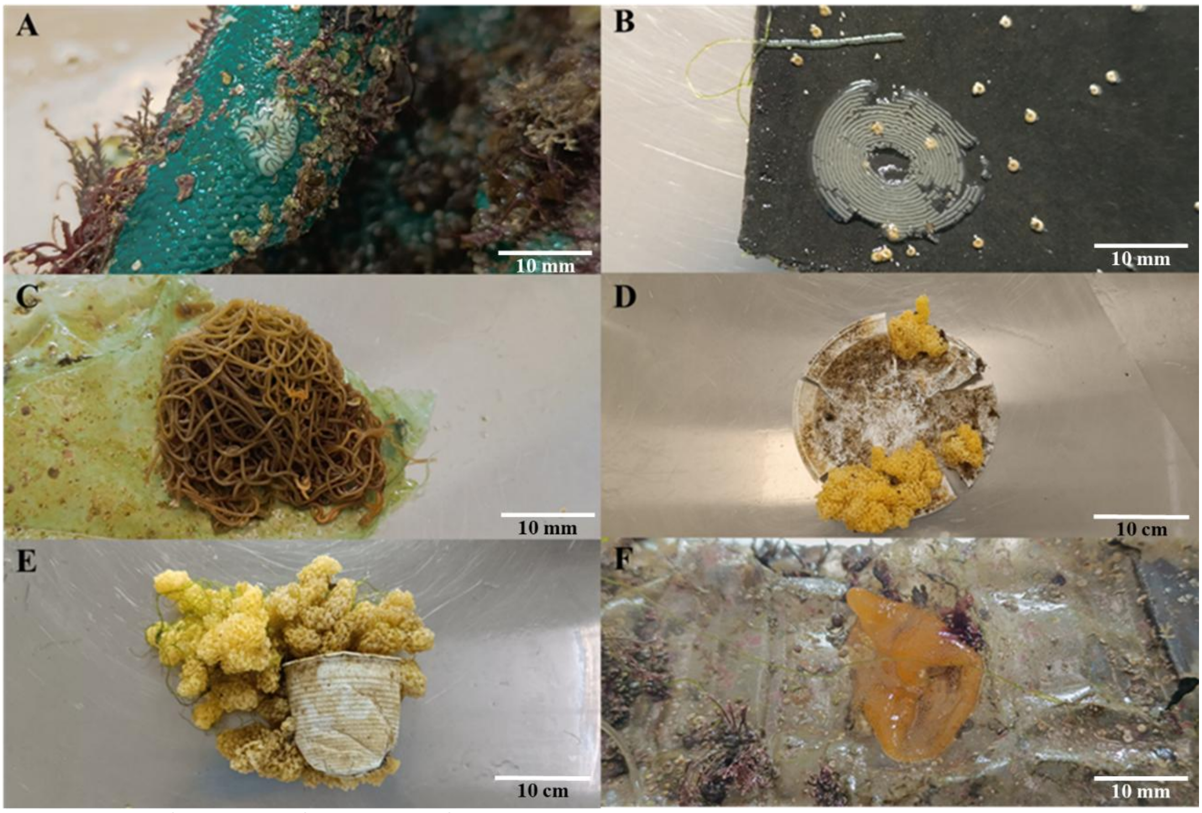

Figure 32. Some of the ovatures found. Unidentified species (A, B); *Aplysia* Linnaeus, 1767 (C); *Hexaplex trunculus* Linnaeus, 1758 (D, E); *Platydoris argo* Linnaeus, 1767 (F).

4.5 Plastisphere community Messina

Macrobenthic community associed with plastic litter is described as mean±SD, see Table 62.

Table 62. Macrobenthic community associed with plastic litter in Messina.

	Number of values	Minimum	Maximum	Range	Mean	Std. Deviation	Std. Error of Mean	Lower 95% CI of mean	Upper 95% CI of mean	Sum
CF01	267	0	0.02946	0.02946	0.0004199	0.002586	0.0001583	0.0001083	0.0007315	0.1121
CF02	267	0	0.09086	0.09086	0.0007522	0.006473	0.0003962	-0.0000278	0.001532	0.2008
CF03	267	0	0.01469	0.01469	0.0001582	0.001121	0.00006857	0.00002319	0.0002932	0.04224
CF04	267	0	0.3679	0.3679	0.003279	0.02632	0.001611	0.0001079	0.006451	0.8756
CF05	267	0	1.809	1.809	0.01913	0.1554	0.009512	0.0004014	0.03786	5.107
CF06	267	0	0.1757	0.1757	0.001183	0.01292	0.0007905	-0.0003738	0.002739	0.3157
CF07	267	0	0.1961	0.1961	0.002859	0.01744	0.001067	0.0007577	0.004961	0.7634
CF08	267	0	10.04	10.04	0.08701	0.7208	0.04411	0.0001594	0.1739	23.23
CF09	267	0	0.3474	0.3474	0.002673	0.02368	0.001449	-0.0001807	0.005526	0.7136
CF10	267	0	0.07752	0.07752	0.001277	0.008817	0.0005396	0.0002151	0.00234	0.3411
CF11	267	0	0.1818	0.1818	0.001022	0.01199	0.0007337	-0.0004229	0.002466	0.2728
CF12	267	0	0.2555	0.2555	0.001818	0.01893	0.001159	-0.000463	0.004099	0.4855
CF13	267	0	1.011	1.011	0.007113	0.08134	0.004978	-0.002687	0.01691	1.899
CF14	267	0	4.525	4.525	0.03676	0.3592	0.02198	-0.006525	0.08004	9.814
CF15	267	0	0.05584	0.05584	0.0003438	0.003553	0.0002175	-0.00008436	0.000772	0.09179
CF16	267	0	0.05151	0.05151	0.0004812	0.003891	0.0002381	0.00001239	0.00095	0.1285
CF17	267	0	0.009399	0.009399	0.00008448	0.0006452	0.00003948	0.000006742	0.0001622	0.02256
CF18	267	0	0.165	0.165	0.0009626	0.01102	0.0006743	-0.0003651	0.00229	0.257
CF19	267	0	0.04762	0.04762	0.0004013	0.003321	0.0002032	0.000001153	0.0008014	0.1071
CF20	267	0	0.2941	0.2941	0.001696	0.01849	0.001131	-0.000531	0.003924	0.4529
CF21	267	0	0.1447	0.1447	0.001057	0.01007	0.0006162	-0.0001566	0.00227	0.2821
CF22	267	0	0.07202	0.07202	0.0003129	0.004419	0.0002704	-0.0002195	0.0008453	0.08354
CF23	267	0	0.25	0.25	0.0009363	0.0153	0.0009363	-0.0009072	0.00278	0.25
CF24	267	0	0.01052	0.01052	0.0001153	0.000804	0.0000492	0.00001847	0.0002122	0.0308
CF25	267	0	0.02337	0.02337	0.0003236	0.002087	0.0001277	0.00007211	0.0005751	0.08641
CF26	267	0	0.02351	0.02351	0.0003929	0.002139	0.0001309	0.0001352	0.0006506	0.1049
CF27	267	0	0.01401	0.01401	0.0001312	0.001039	0.00006359	0.000005997	0.0002564	0.03503
CF28	267	0	0.008322	0.008322	0.00008571	0.0006815	0.00004171	0.000003588	0.0001678	0.02289
CF29	267	0	0.02778	0.02778	0.0002341	0.002029	0.0001241	-0.00001035	0.0004785	0.0625
CF30	267	0	0.008488	0.008488	0.0001669	0.0009263	0.00005669	0.00005529	0.0002785	0.04456
CF31	267	0	0.04348	0.04348	0.000456	0.003562	0.000218	0.00002671	0.0008852	0.1217
CF32	267	0	0.02096	0.02096	0.0001864	0.001504	0.00009203	0.000005222	0.0003676	0.04978
CF33	267	0	0.1569	0.1569	0.001175	0.01122	0.0006864	-0.0001765	0.002527	0.3137

CF34	267	0	0.03906	0.03906	0.0006145	0.004373	0.0002676	0.00008751	0.001141	0.1641
CF35	267	0	0.1299	0.1299	0.001459	0.01093	0.0006691	0.0001419	0.002777	0.3896
CF36	267	0	0.01472	0.01472	0.00008431	0.0009248	0.00005659	-0.00002712	0.0001957	0.02251
CF37	267	0	0.1399	0.1399	0.001257	0.01134	0.0006937	-0.0001087	0.002623	0.3357
CF38	267	0	0.009688	0.009688	0.0001296	0.0008926	0.00005463	0.00002202	0.0002371	0.0346
CF39	267	0	0.008375	0.008375	0.00009567	0.0006481	0.00003966	0.00001758	0.0001738	0.02554
CF40	267	0	0.003322	0.003322	0.00003733	0.0003508	0.00002147	-0.000004945	0.0000796	0.009967
CF41	267	0	0.03889	0.03889	0.0004578	0.003199	0.0001958	0.00007232	0.0008432	0.1222
CF42	267	0	0.01591	0.01591	0.0001787	0.001225	0.00007497	0.00003113	0.0003263	0.04772
CF43	267	0	0.003959	0.003959	0.00002118	0.0002492	0.00001525	-0.000008841	0.00005121	0.005656
CF44	267	0	0.01728	0.01728	0.0001017	0.001151	0.00007042	-0.00003692	0.0002404	0.02716
CF45	267	0	0.02083	0.02083	0.0001951	0.001678	0.0001027	-0.00000718	0.0003973	0.05208
CF46	267	0	0.106	0.106	0.0007467	0.008297	0.0005078	-0.0002531	0.001746	0.1994
CF47	267	0	0.03216	0.03216	0.0003172	0.002535	0.0001551	0.00001181	0.0006226	0.0847
CF48	267	0	0.04333	0.04333	0.0006762	0.004064	0.0002487	0.0001864	0.001166	0.1805
CF49	267	0	0.01307	0.01307	0.0002588	0.00158	0.00009668	0.00006842	0.0004491	0.06909
CF50	267	0	0.02315	0.02315	0.0002449	0.002034	0.0001245	-2.124E-07	0.0004901	0.06539
CF51	267	0	0.05208	0.05208	0.0004584	0.00381	0.0002331	-6.212E-07	0.0009174	0.1224
CF52	267	0	0.2544	0.2544	0.00147	0.01648	0.001009	-0.0005164	0.003456	0.3924
CF53	267	0	2.194	2.194	0.009674	0.1356	0.008297	-0.006662	0.02601	2.583
CF54	267	0	0.01304	0.01304	0.0001334	0.001036	0.00006342	0.00000852	0.0002583	0.03562
CF55	267	0	0.7619	0.7619	0.004298	0.05205	0.003186	-0.001974	0.01057	1.148
CF56	267	0	0.01563	0.01563	0.0002341	0.001777	0.0001087	0.00001997	0.0004482	0.0625
CF57	267	0	0.5517	0.5517	0.002721	0.03478	0.002128	-0.00147	0.006911	0.7264
CF58	267	0	0.2339	0.2339	0.001533	0.01611	0.0009857	-0.0004075	0.003474	0.4094
CF59	267	0	0.4429	0.4429	0.003594	0.03701	0.002265	-0.0008654	0.008053	0.9596
CF60	267	0	0.006504	0.006504	0.00007552	0.0005994	0.00003668	0.000003292	0.0001477	0.02016
CF61	267	0	0.03333	0.03333	0.000362	0.002556	0.0001564	0.00005411	0.00067	0.09667
CF62	267	0	0.04193	0.04193	0.0009736	0.004567	0.0002795	0.0004233	0.001524	0.26
CF63	267	0	0.05172	0.05172	0.0005231	0.003777	0.0002311	0.00006796	0.0009781	0.1397
CF64	267	0	0.1442	0.1442	0.0007923	0.009022	0.0005521	-0.0002948	0.001879	0.2115
CF65	267	0	0.8333	0.8333	0.007007	0.0651	0.003984	-0.0008374	0.01485	1.871
CF66	267	0	1.552	1.552	0.008621	0.09909	0.006065	-0.00332	0.02056	2.302
CF67	267	0	0.008503	0.008503	0.0001019	0.000668	0.00004088	0.00002142	0.0001824	0.02721
CF68	267	0	0.002632	0.002632	0.0000345	0.0002463	0.00001507	0.000004825	0.00006418	0.009212
CF69	267	0	0.2222	0.2222	0.001859	0.01788	0.001094	-0.0002951	0.004013	0.4963
CF70	267	0	0.03194	0.03194	0.0002127	0.002223	0.000136	-0.00005515	0.0004805	0.05678
LF01	267	0	0.02546	0.02546	0.0001609	0.001621	0.00009917	-0.00003432	0.0003562	0.04297
LF02	267	0	0.1344	0.1344	0.001334	0.01039	0.000636	0.0000819	0.002586	0.3562
LF03	267	0	0.0151	0.0151	0.0001584	0.001114	0.00006815	0.0000242	0.0002926	0.04229
LF04	267	0	0.1258	0.1258	0.0006503	0.007808	0.0004778	-0.0002906	0.001591	0.1736
LF05	267	0	0.002375	0.002375	0.00003781	0.0002521	0.00001543	0.00000744	0.00006818	0.0101
LF06	267	0	0.03215	0.03215	0.0002679	0.002105	0.0001288	0.00001422	0.0005216	0.07153

LF07	267	0	0.01613	0.01613	0.0003987	0.001735	0.0001062	0.0001897	0.0006077	0.1065
LF08	267	0	0.08367	0.08367	0.0004361	0.005166	0.0003161	-0.0001863	0.001059	0.1164
LF09	267	0	0.1211	0.1211	0.0006479	0.007526	0.0004606	-0.0002589	0.001555	0.173
LF10	267	0	0.0075	0.0075	0.00007803	0.0006436	0.00003939	4.763E-07	0.0001556	0.02083
LF11	267	0	0.1329	0.1329	0.0005805	0.008182	0.0005007	-0.0004053	0.001566	0.155
LF12	267	0	0.009105	0.009105	0.00006431	0.0006032	0.00003692	-0.000008379	0.000137	0.01717
LF13	267	0	0.03955	0.03955	0.0002128	0.002454	0.0001502	-0.00008293	0.0005085	0.05681
LF14	267	0	0.03271	0.03271	0.0002007	0.0021	0.0001285	-0.0000523	0.0004538	0.0536
LF15	267	0	0.001898	0.001898	0.00004263	0.0002094	0.00001282	0.0000174	0.00006787	0.01138
LF16	267	0	0.0117	0.0117	0.0001351	0.0009744	0.00005963	0.00001765	0.0002525	0.03606
LF17	267	0	0.01657	0.01657	0.0001817	0.001195	0.00007313	0.00003774	0.0003257	0.04852
LF18	267	0	0.01158	0.01158	0.00009544	0.0008895	0.00005443	-0.00001174	0.0002026	0.02548
LF19	267	0	0.0144	0.0144	0.0002156	0.001212	0.00007415	0.00006965	0.0003616	0.05758
LF20	267	0	0.01368	0.01368	0.000149	0.001215	0.00007438	0.000002568	0.0002955	0.03979
LF21	267	0	0.0196	0.0196	0.0001868	0.001386	0.00008482	0.00001977	0.0003538	0.04987
LF22	267	0	0.008268	0.008268	0.0001316	0.0008399	0.0000514	0.0000304	0.0002328	0.03514
LF23	267	0	0.008074	0.008074	0.0000432	0.0005179	0.00003169	-0.0000192	0.0001056	0.01153
LF24	267	0	0.09404	0.09404	0.0005577	0.005864	0.0003589	-0.0001489	0.001264	0.1489
LF25	267	0	0.06201	0.06201	0.0003406	0.003841	0.0002351	-0.0001222	0.0008035	0.09095
LF26	267	0	0.003748	0.003748	0.00003509	0.0002895	0.00001772	1.984E-07	0.00006997	0.009368
LF27	267	0	0.01474	0.01474	0.0002375	0.00165	0.000101	0.00003868	0.0004362	0.0634
LF28	267	0	0.006513	0.006513	0.00003252	0.000409	0.00002503	-0.00001676	0.0000818	0.008684
LF29	267	0	0.03824	0.03824	0.0001647	0.002345	0.0001435	-0.0001178	0.0004472	0.04397
LF30	267	0	0.227	0.227	0.001067	0.01395	0.0008536	-0.000614	0.002748	0.2848
LF31	267	0	0.03801	0.03801	0.0001423	0.002326	0.0001423	-0.0001379	0.0004226	0.03801
LF32	267	0	0.003508	0.003508	0.00002956	0.0002672	0.00001635	-0.000002638	0.00006176	0.007893
LF33	267	0	0.006056	0.006056	0.00003213	0.0003763	0.00002303	-0.00001321	0.00007748	0.008579
LF34	267	0	0.01051	0.01051	0.00009843	0.0007493	0.00004586	0.000008137	0.0001887	0.02628
LF35	267	0	0.006947	0.006947	0.00004731	0.0004687	0.00002868	-0.000009165	0.0001038	0.01263
LF36	267	0	1.111	1.111	0.006242	0.07342	0.004493	-0.002605	0.01509	1.667
LF37	267	0	0.7381	0.7381	0.004285	0.05047	0.003089	-0.001796	0.01037	1.144
LF38	267	0	0.01851	0.01851	0.0001624	0.001248	0.0000764	0.00001197	0.0003128	0.04336
LF39	267	0	0.01624	0.01624	0.0001541	0.001261	0.00007715	0.000002196	0.000306	0.04114
LF40	267	0	0.006316	0.006316	0.00005204	0.0004808	0.00002943	-0.000005902	0.00011	0.01389
LF41	267	0	0.03503	0.03503	0.0001431	0.002152	0.0001317	-0.0001162	0.0004024	0.03822
LF42	267	0	0.04208	0.04208	0.0001655	0.002576	0.0001576	-0.0001449	0.0004758	0.04418
LF43	267	0	0.2222	0.2222	0.001436	0.01434	0.0008773	-0.0002917	0.003163	0.3833
LF44	267	0	0.3058	0.3058	0.001993	0.021	0.001285	-0.0005374	0.004523	0.5321
LF45	267	0	0.02457	0.02457	0.000289	0.002069	0.0001266	0.00003973	0.0005383	0.07716
LF46	267	0	0.106	0.106	0.0005776	0.006641	0.0004064	-0.0002226	0.001378	0.1542
LF47	267	0	0.006632	0.006632	0.00004967	0.0005047	0.00003089	-0.00001114	0.0001105	0.01326
LF48	267	0	0.01665	0.01665	0.0001178	0.001148	0.00007023	-0.00002051	0.000256	0.03144
LF49	267	0	0.01293	0.01293	0.00006751	0.000799	0.0000489	-0.00002877	0.0001638	0.01802

LF50	267	0	0.0381	0.0381	0.0002854	0.002539	0.0001554	-0.00002054	0.0005913	0.07619
LF51	267	0	0.009259	0.009259	0.0000578	0.000625	0.00003825	-0.00001751	0.0001331	0.01543
CM01	267	0	0.02899	0.02899	0.0001475	0.001783	0.0001091	-0.00006737	0.0003623	0.03937
CM02	267	0	0.0679	0.0679	0.0003688	0.004297	0.000263	-0.000149	0.0008865	0.09846
CM03	267	0	0.02214	0.02214	0.0001603	0.001466	0.00008969	-0.00001631	0.0003369	0.0428
CM04	267	0	0.01484	0.01484	0.0001751	0.00125	0.00007651	0.00002444	0.0003257	0.04674
CM05	267	0	0.02822	0.02822	0.000218	0.002024	0.0001239	-0.00002594	0.0004619	0.0582
CM06	267	0	0.02103	0.02103	0.0001079	0.001309	0.00008012	-0.00004984	0.0002657	0.02881
CM07	267	0	0.04547	0.04547	0.000289	0.002978	0.0001822	-0.00006981	0.0006478	0.07716
CM08	267	0	0.05556	0.05556	0.0004023	0.003833	0.0002346	-0.00005955	0.0008641	0.1074
CM09	267	0	0.04805	0.04805	0.0003213	0.003168	0.0001939	-0.00006039	0.0007031	0.0858
CM10	267	0	0.06345	0.06345	0.0007288	0.005903	0.0003613	0.00001744	0.00144	0.1946
CM11	267	0	0.01579	0.01579	0.000162	0.001283	0.00007853	0.000007403	0.0003167	0.04326
CM12	267	0	0.02078	0.02078	0.0001492	0.00149	0.0000912	-0.00003041	0.0003287	0.03983
CM13	267	0	0.1212	0.1212	0.0005372	0.007436	0.0004551	-0.0003588	0.001433	0.1434
CM14	267	0	0.006018	0.006018	0.00004007	0.0004232	0.0000259	-0.00001092	0.00009107	0.0107
CM15	267	0	0.004688	0.004688	0.00004682	0.0003554	0.00002175	0.000003995	0.00008964	0.0125
CM16	267	0	0.002043	0.002043	0.00005069	0.0002468	0.0000151	0.00002095	0.00008043	0.01353
CM17	267	0	0.01975	0.01975	0.0001356	0.001319	0.0000807	-0.00002325	0.0002945	0.03621
CM18	267	0	0.02432	0.02432	0.0001821	0.00165	0.000101	-0.00001667	0.0003809	0.04863
CM19	267	0	0.0008984	0.0008984	0.000008924	0.00006476	0.000003963	0.000001121	0.00001673	0.002383
CM20	267	0	0.0009091	0.0009091	0.000008512	0.00007324	0.000004482	-3.133E-07	0.00001734	0.002273
CM21	267	0	0.2362	0.2362	0.001587	0.01804	0.001104	-0.0005871	0.003761	0.4237
CM22	267	0	0.01547	0.01547	0.0001449	0.001325	0.0000811	-0.0000148	0.0003046	0.03868
CM23	267	0	0.003263	0.003263	0.00006875	0.0003966	0.00002427	0.00002096	0.0001165	0.01836
CM24	267	0	0.01412	0.01412	0.0001982	0.00143	0.00008749	0.00002599	0.0003705	0.05293
CM25	267	0	0.00156	0.00156	0.0000263	0.0001704	0.00001043	0.00000576	0.00004684	0.007022
CM26	267	0	0.01541	0.01541	0.00006529	0.0009451	0.00005784	-0.00004859	0.0001792	0.01743
CM27	267	0	0.02289	0.02289	0.0001091	0.001428	0.0000874	-0.00006297	0.0002812	0.02914
CM28	267	0	0.001625	0.001625	0.00001826	0.0001716	0.0000105	-0.000002419	0.00003893	0.004875
CM29	267	0	0.005266	0.005266	0.00002761	0.0003466	0.00002121	-0.00001416	0.00006938	0.007372
CM30	267	0	0.01763	0.01763	0.0001321	0.001372	0.00008395	-0.00003322	0.0002974	0.03526
CM31	267	0	0.03061	0.03061	0.0002675	0.002408	0.0001474	-0.00002266	0.0005577	0.07143
CM32	267	0	0.01323	0.01323	0.00004954	0.0008096	0.00004954	-0.000048	0.0001471	0.01323
CM33	267	0	0.006821	0.006821	0.000115	0.0007386	0.0000452	0.00002597	0.000204	0.03069
CM34	267	0	0.01852	0.01852	0.000111	0.001196	0.00007322	-0.0000332	0.0002551	0.02963
CM35	267	0	3.474	3.474	0.0159	0.2157	0.0132	-0.01009	0.04189	4.246
CM36	267	0	0.07643	0.07643	0.0004294	0.005222	0.0003196	-0.0001998	0.001059	0.1146
CM37	267	0	0.02105	0.02105	0.0001478	0.001449	0.00008868	-0.00002677	0.0003225	0.03947
CM38	267	0	0.008026	0.008026	0.00009619	0.0006662	0.00004077	0.00001592	0.0001765	0.02568
CM39	267	0	0.001764	0.001764	0.00001487	0.0001288	0.000007885	-6.571E-07	0.00003039	0.00397
CM40	267	0	0.01105	0.01105	0.00008693	0.0007707	0.00004717	-0.00000594	0.0001798	0.02321
CM41	267	0	0.0003537	0.0003537	0.000002649	0.00002643	0.000001617	-0.000000535	0.000005833	0.0007073

CM42	267	0	0.009885	0.009885	0.00004443	0.0006165	0.00003773	-0.00002986	0.0001187	0.01186
CM43	267	0	0.01646	0.01646	0.0002004	0.001436	0.00008785	0.00002739	0.0003733	0.0535
CM44	267	0	0.004423	0.004423	0.00004142	0.0004047	0.00002477	-0.000007347	0.00009018	0.01106
CM45	267	0	0.002526	0.002526	0.00003574	0.0002294	0.00001404	0.000008102	0.00006339	0.009544
CM46	267	0	0.007479	0.007479	0.00004818	0.0004812	0.00002945	-0.000009797	0.0001062	0.01286
CM47	267	0	0.003135	0.003135	0.00003229	0.0002656	0.00001625	2.862E-07	0.00006429	0.008621
CM48	267	0	0.1358	0.1358	0.001202	0.009393	0.0005748	0.00007042	0.002334	0.321
CM49	267	0	0.004331	0.004331	0.00001622	0.000265	0.00001622	-0.00001572	0.00004816	0.004331
CM50	267	0	0.01083	0.01083	0.00008582	0.0007578	0.00004638	-0.000005493	0.0001771	0.02291
CM51	267	0	0.02155	0.02155	0.0001863	0.001475	0.00009029	0.000008514	0.000364	0.04974
CM52	267	0	0.01587	0.01587	0.0001152	0.001027	0.00006286	-0.000008585	0.000239	0.03075
CDT01	267	0	0.02106	0.02106	0.000229	0.001728	0.0001058	0.00002074	0.0004373	0.06114
CDT02	267	0	0.005208	0.005208	0.00009363	0.0004941	0.00003024	0.0000341	0.0001532	0.025
CDT03	267	0	0.005467	0.005467	0.00005733	0.0003896	0.00002384	0.00001039	0.0001043	0.01531
CDT04	267	0	0.1748	0.1748	0.001283	0.01371	0.0008389	-0.0003683	0.002935	0.3427
CDT05	267	0	0.009947	0.009947	0.0001366	0.0009653	0.00005908	0.00002028	0.0002529	0.03647
CDT06	267	0	0.1071	0.1071	0.0005618	0.006916	0.0004232	-0.0002715	0.001395	0.15
CDT07	267	0	0.2846	0.2846	0.001784	0.0209	0.001279	-0.0007344	0.004302	0.4763
CDT08	267	0	0.002547	0.002547	0.00004451	0.0002616	0.00001601	0.00001299	0.00007604	0.01188
CDT09	267	0	0.008242	0.008242	0.00005556	0.0005244	0.00003209	-0.000007622	0.0001187	0.01484
CDT10	267	0	0.001396	0.001396	0.00001674	0.000107	0.000006548	0.000003844	0.00002963	0.004469
CDT11	267	0	0.05584	0.05584	0.0009203	0.005898	0.000361	0.0002095	0.001631	0.2457
CDT12	267	0	0.002841	0.002841	0.00007803	0.0004031	0.00002467	0.00002946	0.0001266	0.02083
CDT13	267	0	0.008529	0.008529	0.00008784	0.0007226	0.00004422	7.786E-07	0.0001749	0.02345
CDT14	267	0	0.1364	0.1364	0.0008682	0.008845	0.0005413	-0.0001976	0.001934	0.2318
CDT15	267	0	0.04444	0.04444	0.0005077	0.003808	0.000233	0.00004886	0.0009665	0.1356
CDT16	267	0	0.008443	0.008443	0.0001344	0.0007284	0.00004458	0.00004662	0.0002222	0.03588
CDT17	267	0	0.03377	0.03377	0.0002071	0.00232	0.000142	-0.00007248	0.0004867	0.0553
CDT18	267	0	0.0004222	0.0004222	0.000001581	0.00002584	0.000001581	-0.000001532	0.000004694	0.0004222
CDT19	267	0	0.001689	0.001689	0.00001107	0.0001123	0.000006872	-0.000002462	0.0000246	0.002955
CDT20	267	0	0.0008443	0.0008443	0.00001107	0.00008513	0.00000521	8.101E-07	0.00002133	0.002955
CDT21	267	0	0.01364	0.01364	0.0001929	0.001252	0.00007663	0.00004206	0.0003438	0.05152
CDT22	267	0	0.007705	0.007705	0.0001113	0.0007277	0.00004454	0.00002362	0.000199	0.02972
CDT23	267	0	0.1299	0.1299	0.001435	0.01194	0.000731	-0.000003815	0.002875	0.3833
CDT24	267	0	0.006499	0.006499	0.00006086	0.0005236	0.00003205	-0.00000224	0.000124	0.01625
CDT25	267	0	0.02431	0.02431	0.0006112	0.003016	0.0001846	0.0002478	0.0009747	0.1632
CDT26	267	0	0.03478	0.03478	0.0005428	0.003192	0.0001954	0.0001581	0.0009275	0.1449
CDT27	267	0	0.03036	0.03036	0.0003488	0.002633	0.0001611	0.00003147	0.000666	0.09312
CDT28	267	0	0.1484	0.1484	0.001838	0.01358	0.0008308	0.0002023	0.003474	0.4908
CDT29	267	0	0.1128	0.1128	0.001145	0.009266	0.0005671	0.00002861	0.002262	0.3058
CDT30	267	0	0.2183	0.2183	0.001501	0.01723	0.001054	-0.0005746	0.003577	0.4008
CDT31	267	0	0.04001	0.04001	0.0003334	0.00346	0.0002117	-0.00008353	0.0007503	0.08902
CDT32	267	0	0.09942	0.09942	0.0005476	0.006228	0.0003811	-0.0002028	0.001298	0.1462

CDT33	267	0	0.6494	0.6494	0.00456	0.04468	0.002735	-0.0008243	0.009944	1.218
CDT34	267	0	0.01442	0.01442	0.0003151	0.001657	0.0001014	0.0001154	0.0005148	0.08413
CDT35	267	0	0.006154	0.006154	0.00007683	0.0006113	0.00003741	0.000003164	0.0001505	0.02051
CDT36	267	0	0.009524	0.009524	0.00007134	0.0008227	0.00005035	-0.0000278	0.0001705	0.01905
CDT37	267	0	0.01165	0.01165	0.0001346	0.0009291	0.00005686	0.00002269	0.0002466	0.03595
CDT38	267	0	0.1176	0.1176	0.001113	0.008529	0.000522	0.00008488	0.00214	0.2971
CDT39	267	0	0.05774	0.05774	0.0004974	0.00425	0.0002601	-0.00001467	0.001009	0.1328
CDT40	267	0	0.1553	0.1553	0.001896	0.01436	0.0008787	0.0001659	0.003626	0.5062
CDT41	267	0	0.01991	0.01991	0.0002657	0.00161	0.0000985	0.00007177	0.0004596	0.07094
CDT42	267	0	0.01997	0.01997	0.0002581	0.001662	0.0001017	0.00005775	0.0004584	0.0689
CDT43	267	0	0.04831	0.04831	0.000591	0.003915	0.0002396	0.0001193	0.001063	0.1578
CDT44	267	0	0.04385	0.04385	0.000438	0.003538	0.0002165	0.0000117	0.0008643	0.1169
CDT45	267	0	0.07136	0.07136	0.0007952	0.006016	0.0003681	0.00007033	0.00152	0.2123
CDT46	267	0	0.1399	0.1399	0.001301	0.01025	0.0006276	0.0000649	0.002536	0.3473
CDT47	267	0	0.06993	0.06993	0.0006024	0.004908	0.0003004	0.00001102	0.001194	0.1608
CDT48	267	0	0.02467	0.02467	0.000246	0.002038	0.0001247	4.246E-07	0.0004916	0.06568
CDT49	267	0	0.06957	0.06957	0.0008918	0.005741	0.0003513	0.0002001	0.001584	0.2381
CDT50	267	0	0.007893	0.007893	0.0001829	0.0008384	0.00005131	0.00008189	0.0002839	0.04884
CDT51	267	0	0.04301	0.04301	0.0006337	0.003577	0.0002189	0.0002026	0.001065	0.1692

The ANOVA performed on the abundance data of the macrobenthic community associated with plastic waste showed differences both in spatial and temporal terms in the Capo Peloro lagoon (see Appendix Table 1). The diversity indices calculated on the plastic samples showed variable trends, based on the sampling area, the sampling period and the plastic polymer analyzed. The results of the indices are shown in Table 63.

TABLE 63. Diversity indices on the plastic samples in Messina.

Sample	S	N	d	J'	Brillouin	Fisher	H'(loge)	1-Lambda'
CF01	19	0	****	0.7723	****	****	2.274	****
CF02	26	0	****	0.5199	****	****	1.694	****
CF03	9	0	****	0.868	****	****	1.907	****
CF04	16	1	****	0.6533	0	****	1.811	****
CF05	17	5	9.812	0.5661	0.8189	****	1.604	0.9325
CF06	16	0	****	0.3668	****	****	1.017	****
CF07	22	1	****	0.7167	0	****	2.215	****
CF08	11	23	3.179	0.7027	1.281	8.17	1.685	0.7735
CF09	18	1	****	0.5611	0	****	1.622	****
CF10	14	0	****	0.7297	****	****	1.926	****

CF11	5	0	****	0.5385	****	****	0.8667	****
CF12	6	0	****	0.5987	****	****	1.073	****
CF13	11	2	15.59	0.32	0.3466	****	0.7673	1.074
CF14	25	10	10.51	0.3497	0.7832	****	1.126	0.7125
CF15	22	0	****	0.4826	****	****	1.492	****
CF16	12	0	****	0.6879	****	****	1.709	****
CF17	11	0	****	0.7959	****	****	1.908	****
CF18	4	0	****	0.6414	****	****	0.8892	****
CF19	7	0	****	0.8372	****	****	1.629	****
CF20	10	0	****	0.566	****	****	1.303	****
CF21	7	0	****	0.7029	****	****	1.368	****
CF22	5	0	****	0.3681	****	****	0.5924	****
CF23	1	0	****	****	****	****	0	****
CF24	11	0	****	0.8326	****	****	1.996	****
CF25	22	0	****	0.7467	****	****	2.308	****
CF26	21	0	****	0.8169	****	****	2.487	****
CF27	9	0	****	0.7969	****	****	1.751	****
CF28	6	0	****	0.8897	****	****	1.594	****
CF29	5	0	****	0.8867	****	****	1.427	****
CF30	16	0	****	0.8658	****	****	2.401	****
CF31	12	0	****	0.7217	****	****	1.793	****
CF32	8	0	****	0.8195	****	****	1.704	****
CF33	4	0	****	0.875	****	****	1.213	****
CF34	7	0	****	0.8993	****	****	1.75	****
CF35	15	0	****	0.6883	****	****	1.864	****
CF36	7	0	****	0.6298	****	****	1.226	****
CF37	8	0	****	0.6806	****	****	1.415	****
CF38	7	0	****	0.9308	****	****	1.811	****
CF39	11	0	****	0.8428	****	****	2.021	****
CF40	3	0	****	1	****	****	1.099	****
CF41	9	0	****	0.8725	****	****	1.917	****
CF42	9	0	****	0.8902	****	****	1.956	****
CF43	4	0	****	0.6784	****	****	0.9404	****
CF44	8	0	****	0.4854	****	****	1.009	****
CF45	4	0	****	0.961	****	****	1.332	****
CF46	6	0	****	0.4982	****	****	0.8927	****
CF47	12	0	****	0.6929	****	****	1.722	****
CF48	14	0	****	0.8252	****	****	2.178	****
CF49	13	0	****	0.835	****	****	2.142	****
CF50	8	0	****	0.74	****	****	1.539	****
CF51	13	0	****	0.665	****	****	1.706	****
CF52	10	0	****	0.4397	****	****	1.012	****
CF53	10	3	9.484	0.2416	0.3662	****	0.5564	0.4299
CF54	11	0	****	0.7481	****	****	1.794	****
CF55	3	1	14.53	0.6015	0	****	0.6608	3.491
CF56	5	0	****	0.969	****	****	1.56	****
CF57	8	1	****	0.367	0	****	0.7632	****
CF58	6	0	****	0.6265	****	****	1.123	****

CF59	4	1	****	0.7527	0	****	1.043	****
CF60	10	0	****	0.7387	****	****	1.701	****
CF61	13	0	****	0.7778	****	****	1.995	****
CF62	22	0	****	0.8691	****	****	2.686	****
CF63	15	0	****	0.7564	****	****	2.048	****
CF64	6	0	****	0.6243	****	****	1.119	****
CF65	20	2	30.33	0.4479	0.3466	****	1.342	1.448
CF66	7	2	7.197	0.5222	-1.16E-17	****	1.016	0.8898
CF67	9	0	****	0.9147	****	****	2.01	****
CF68	7	0	****	0.9107	****	****	1.772	****
CF69	8	0	****	0.5423	****	****	1.128	****
CF70	8	0	****	0.5285	****	****	1.099	****
LF01	9	0	****	0.6566	****	****	1.443	****
LF02	19	0	****	0.6298	****	****	1.854	****
LF03	13	0	****	0.805	****	****	2.065	****
LF04	6	0	****	0.5681	****	****	1.018	****
LF05	8	0	****	0.9163	****	****	1.905	****
LF06	21	0	****	0.6985	****	****	2.127	****
LF07	24	0	****	0.9003	****	****	2.861	****
LF08	17	0	****	0.4383	****	****	1.242	****
LF09	9	0	****	0.5319	****	****	1.169	****
LF10	6	0	****	0.8403	****	****	1.506	****
LF11	3	0	****	0.4634	****	****	0.5091	****
LF12	12	0	****	0.6161	****	****	1.531	****
LF13	10	0	****	0.5273	****	****	1.214	****
LF14	16	0	****	0.5087	****	****	1.411	****
LF15	14	0	****	0.947	****	****	2.499	****
LF16	10	0	****	0.8204	****	****	1.889	****
LF17	18	0	****	0.7861	****	****	2.272	****
LF18	7	0	****	0.7103	****	****	1.382	****
LF19	13	0	****	0.9123	****	****	2.34	****
LF20	10	0	****	0.7386	****	****	1.701	****
LF21	15	0	****	0.7263	****	****	1.967	****
LF22	8	0	****	0.9407	****	****	1.956	****
LF23	3	0	****	0.7298	****	****	0.8018	****
LF24	12	0	****	0.5887	****	****	1.463	****
LF25	10	0	****	0.5627	****	****	1.296	****
LF26	8	0	****	0.7799	****	****	1.622	****
LF27	14	0	****	0.7286	****	****	1.923	****
LF28	3	0	****	0.6696	****	****	0.7356	****
LF29	6	0	****	0.3297	****	****	0.5908	****
LF30	10	0	****	0.3993	****	****	0.9193	****
LF31	1	0	****	****	****	****	0	****
LF32	4	0	****	0.9183	****	****	1.273	****
LF33	6	0	****	0.6023	****	****	1.079	****
LF34	8	0	****	0.8614	****	****	1.791	****
LF35	5	0	****	0.7672	****	****	1.235	****
LF36	3	2	3.915	0.7312	0.3466	****	0.8033	1.2

LF37	3	1	14.86	0.6904	0	****	0.7585	3.801
LF38	15	0	****	0.7408	****	****	2.006	****
LF39	8	0	****	0.7828	****	****	1.628	****
LF40	4	0	****	0.895	****	****	1.241	****
LF41	2	0	****	0.4138	****	****	0.2868	****
LF42	4	0	****	0.1758	****	****	0.2438	****
LF43	9	0	****	0.6395	****	****	1.405	****
LF44	7	1	****	0.5328	0	****	1.037	****
LF45	15	0	****	0.734	****	****	1.988	****
LF46	9	0	****	0.5101	****	****	1.121	****
LF47	3	0	****	0.9206	****	****	1.011	****
LF48	8	0	****	0.638	****	****	1.327	****
LF49	9	0	****	0.5271	****	****	1.158	****
LF50	11	0	****	0.6801	****	****	1.631	****
LF51	3	0	****	0.865	****	****	0.9503	****
CM01	14	0	****	0.4567	****	****	1.205	****
CM02	13	0	****	0.4128	****	****	1.059	****
CM03	10	0	****	0.6857	****	****	1.579	****
CM04	17	0	****	0.709	****	****	2.009	****
CM05	7	0	****	0.7203	****	****	1.402	****
CM06	6	0	****	0.5396	****	****	0.9669	****
CM07	8	0	****	0.6142	****	****	1.277	****
CM08	6	0	****	0.7297	****	****	1.307	****
CM09	7	0	****	0.7008	****	****	1.364	****
CM10	6	0	****	0.8582	****	****	1.538	****
CM11	13	0	****	0.6922	****	****	1.775	****
CM12	5	0	****	0.7372	****	****	1.187	****
CM13	10	0	****	0.3162	****	****	0.7282	****
CM14	5	0	****	0.6692	****	****	1.077	****
CM15	8	0	****	0.8351	****	****	1.736	****
CM16	16	0	****	0.9164	****	****	2.541	****
CM17	6	0	****	0.7378	****	****	1.322	****
CM18	6	0	****	0.8052	****	****	1.443	****
CM19	11	0	****	0.8128	****	****	1.949	****
CM20	4	0	****	0.961	****	****	1.332	****
CM21	5	0	****	0.4925	****	****	0.7927	****
CM22	6	0	****	0.7529	****	****	1.349	****
CM23	12	0	****	0.8902	****	****	2.212	****
CM24	8	0	****	0.8493	****	****	1.766	****
CM25	7	0	****	0.9708	****	****	1.889	****
CM26	8	0	****	0.2562	****	****	0.5327	****
CM27	3	0	****	0.5971	****	****	0.656	****
CM28	3	0	****	1	****	****	1.099	****
CM29	2	0	****	0.8631	****	****	0.5983	****
CM30	3	0	****	0.8869	****	****	0.9743	****
CM31	4	0	****	0.9212	****	****	1.277	****
CM32	1	0	****	****	****	****	0	****
CM33	9	0	****	0.8985	****	****	1.974	****

CM34	4	0	****	0.7744	****	****	1.074	****
CM35	3	4	1.383	0.5246	0.3466	4.554	0.5764	0.4054
CM36	2	0	****	0.9183	****	****	0.6365	****
CM37	4	0	****	0.8555	****	****	1.186	****
CM38	11	0	****	0.8077	****	****	1.937	****
CM39	5	0	****	0.8867	****	****	1.427	****
CM40	6	0	****	0.8154	****	****	1.461	****
CM41	3	0	****	0.9464	****	****	1.04	****
CM42	2	0	****	0.65	****	****	0.4506	****
CM43	6	0	****	0.9554	****	****	1.712	****
CM44	3	0	****	0.9602	****	****	1.055	****
CM45	11	0	****	0.8623	****	****	2.068	****
CM46	9	0	****	0.6464	****	****	1.42	****
CM47	5	0	****	0.9122	****	****	1.468	****
CM48	11	0	****	0.7728	****	****	1.853	****
CM49	1	0	****	****	****	****	0	****
CM50	5	0	****	0.8794	****	****	1.415	****
CM51	9	0	****	0.8159	****	****	1.793	****
CM52	14	0	****	0.6651	****	****	1.755	****
CDT01	12	0	****	0.7248	****	****	1.801	****
CDT02	13	0	****	0.9337	****	****	2.395	****
CDT03	13	0	****	0.8361	****	****	2.145	****
CDT04	5	0	****	0.6204	****	****	0.9985	****
CDT05	6	0	****	0.9601	****	****	1.72	****
CDT06	3	0	****	0.6617	****	****	0.727	****
CDT07	3	0	****	0.6338	****	****	0.6963	****
CDT08	10	0	****	0.9416	****	****	2.168	****
CDT09	10	0	****	0.7027	****	****	1.618	****
CDT10	12	0	****	0.8687	****	****	2.159	****
CDT11	7	0	****	0.9752	****	****	1.898	****
CDT12	12	0	****	0.9521	****	****	2.366	****
CDT13	5	0	****	0.9122	****	****	1.468	****
CDT14	10	0	****	0.6072	****	****	1.398	****
CDT15	9	0	****	0.7982	****	****	1.754	****
CDT16	18	0	****	0.8566	****	****	2.476	****
CDT17	4	0	****	0.6471	****	****	0.897	****
CDT18	1	0	****	****	****	****	0	****
CDT19	4	0	****	0.8322	****	****	1.154	****
CDT20	5	0	****	0.963	****	****	1.55	****
CDT21	11	0	****	0.8646	****	****	2.073	****
CDT22	10	0	****	0.8748	****	****	2.014	****
CDT23	14	0	****	0.6219	****	****	1.641	****
CDT24	4	0	****	0.961	****	****	1.332	****
CDT25	15	0	****	0.9257	****	****	2.507	****
CDT26	11	0	****	0.9143	****	****	2.192	****
CDT27	9	0	****	0.7916	****	****	1.739	****
CDT28	14	0	****	0.7257	****	****	1.915	****
CDT29	10	0	****	0.7042	****	****	1.621	****

CDT30	3	0	****	0.6707	****	****	0.7369	****
CDT31	9	0	****	0.5196	****	****	1.142	****
CDT32	8	0	****	0.5581	****	****	1.16	****
CDT33	7	1	30.48	0.6323	0	****	1.23	3.571
CDT34	14	0	****	0.9136	****	****	2.411	****
CDT35	5	0	****	0.935	****	****	1.505	****
CDT36	2	0	****	1	****	****	0.6931	****
CDT37	14	0	****	0.7637	****	****	2.016	****
CDT38	13	0	****	0.7329	****	****	1.88	****
CDT39	11	0	****	0.6481	****	****	1.554	****
CDT40	16	1	****	0.6857	0	****	1.901	****
CDT41	17	0	****	0.8227	****	****	2.331	****
CDT42	13	0	****	0.8184	****	****	2.099	****
CDT43	12	0	****	0.8215	****	****	2.041	****
CDT44	9	0	****	0.7425	****	****	1.631	****
CDT45	11	0	****	0.7454	****	****	1.787	****
CDT46	13	0	****	0.7176	****	****	1.841	****
CDT47	8	0	****	0.8126	****	****	1.69	****
CDT48	17	0	****	0.6306	****	****	1.787	****
CDT49	16	0	****	0.7645	****	****	2.12	****
CDT50	21	0	****	0.896	****	****	2.728	****
CDT51	14	0	****	0.8858	****	****	2.338	****

The ANOVA results showed that the species richness (S) varied significantly between the Canale Faro and the Canale Margi ($p<0.001$) and between the Canale Margi and the Canale Due Torri ($p<0.001$). Furthermore, the S values varied significantly between January and July ($p<0.001$) and between September and July ($p<0.001$). However, the species richness did not show variations based on the polymer of which plastic fragment was composed. The number of individuals (N) did not show significant differences for any of the investigated factors ($p>0.05$). Pielou's equitability index (J′) showed spatial variability, highlighting significant differences between Canale Due Torri and Lago Faro ($p=0.015$), and between Canale Due Torri and Canale Faro ($p=0.025$), with marked differences between April and January ($p=0.020$), and no differences based on the polymeric composition of the plastic samples ($p>0.05$). Shannon-Wiener's species diversity index (H loge') showed the greatest spatial variability between the Canale Due Torri and Canale Margi sites ($p=0.002$) and between Canale Due Torri and Lago

Faro ($p=0.024$). No differences in H loge’ values were detected based on sampling period or nature of the polymer of the samples examined. Simpson’s index (1-Lambda’) did not show significant differences for any of the investigated factors ($p>0.05$).

4.6 PLASTISPHERE COMMUNITY ŠIBENIK

Macrobenthic community associed with plastic litter is described as mean±SD, see Table 64.

TABLE 64. Macrobenthic community associed with plastic litter in Šibenik.

	Number of values	Minimum	Maximum	Range	Mean	Std. Deviation	Std. Error of Mean	Lower 95% CI of mean	Upper 95% CI of mean	Sum
MT1-01	267	0	0.002199	0.002199	0.00001922	0.000173	1E-05	-1.63E-06	4E-05	0.005132
MT1-02	267	0	0.6009	0.6009	0.002462	0.03693	0.0023	-0.001988	0.0069	0.6573
MT1-03	267	0	0.01029	0.01029	0.00007706	0.000783	5E-05	-1.73E-05	0.0002	0.02058
MT1-04	267	0	0.1065	0.1065	0.0004521	0.006541	0.0004	-0.000336	0.0012	0.1207
MT1-05	267	0	0.08771	0.08771	0.0007039	0.006057	0.0004	-2.59E-05	0.0014	0.1879
MT1-06	267	0	0.1819	0.1819	0.0009794	0.01189	0.0007	-0.000454	0.0024	0.2615
MT2-01	267	0	0.01872	0.01872	0.0001666	0.001312	8E-05	8.403E-06	0.0003	0.04447
MT2-02	267	0	0.01556	0.01556	0.0002842	0.001658	0.0001	8.433E-05	0.0005	0.07587
MT2-03	267	0	0	0	0	0	0	0	0	0
MT2-04	267	0	0.009191	0.009191	0.00006885	0.000794	5E-05	-2.68E-05	0.0002	0.01838
MT2-05	267	0	0.2653	0.2653	0.001339	0.01696	0.001	-0.000704	0.0034	0.3576
MT2-06	267	0	0	0	0	0	0	0	0	0
MT2-07	267	0	0.1153	0.1153	0.0005615	0.007151	0.0004	-0.0003	0.0014	0.1499
MT3-01	267	0	0.002407	0.002407	9.016E-06	0.0001473	9E-06	-8.74E-06	3E-05	0.002407
MT3-02	267	0	0.05714	0.05714	0.0004708	0.004351	0.0003	-5.34E-05	0.001	0.1257
MT3-03	267	0	0.05915	0.05915	0.0002565	0.00364	0.0002	-0.000182	0.0007	0.06849
MT3-04	267	0	0.01411	0.01411	0.0001498	0.001112	7E-05	1.581E-05	0.0003	0.03999
MT4-01	267	0	0.02017	0.02017	0.0001117	0.001366	8E-05	-5.3E-05	0.0003	0.02981
MT4-02	267	0	0.007879	0.007879	0.00002951	0.0004822	3E-05	-2.86E-05	9E-05	0.007879
MT4-03	267	0	0.01172	0.01172	0.0001756	0.001426	9E-05	3.706E-06	0.0003	0.04688
MT4-04	267	0	0.1835	0.1835	0.0008492	0.01144	0.0007	-0.000529	0.0022	0.2267
MT5-01	267	0	0.004268	0.004268	0.00004796	0.0004507	3E-05	-6.35E-06	0.0001	0.0128
MT5-02	267	0	0.03465	0.03465	0.0001947	0.002367	0.0001	-9.06E-05	0.0005	0.05198
MT5-03	267	0	0.2468	0.2468	0.001463	0.01601	0.001	-0.000465	0.0034	0.3907
MT5-04	267	0	0.001705	0.001705	0.00001277	0.0001473	9E-06	-4.98E-06	3E-05	0.00341
MT5-05	267	0	0.004615	0.004615	0.00003073	0.0003033	2E-05	-5.82E-06	7E-05	0.008205
TJ1-01	267	0	0.00681	0.00681	0.00005101	0.0005088	3E-05	-1.03E-05	0.0001	0.01362

TJ1-02	267	0	0	0	0	0	0	0	0	0
TJ1-03	267	0	0	0	0	0	0	0	0	0
TJ1-04	267	0	0.006369	0.006369	0.00002386	0.0003898	2E-05	-2.31E-05	7E-05	0.006369
TJ1-05	267	0	0.001639	0.001639	0.00001227	0.0001224	7E-06	-2.48E-06	3E-05	0.003277
TJ1-06	267	0	0	0	0	0	0	0	0	0
TJ1-07	267	0	0.001986	0.001986	7.439E-06	0.0001215	7E-06	-7.21E-06	2E-05	0.001986
TJ1-08	267	0	0.001825	0.001825	6.835E-06	0.0001117	7E-06	-6.62E-06	2E-05	0.001825
TJ2-01	267	0	0.003351	0.003351	0.00001255	0.0002051	1E-05	-1.22E-05	4E-05	0.003351
TJ2-02	267	0	0.00493	0.00493	0.00001847	0.0003017	2E-05	-1.79E-05	5E-05	0.00493
TJ2-03	267	0	0.003173	0.003173	0.00002377	0.0002741	2E-05	-9.26E-06	6E-05	0.006346
TJ2-04	267	0	0.006866	0.006866	0.00005143	0.0005931	4E-05	-2E-05	0.0001	0.01373
TJ2-05	267	0	0.001489	0.001489	0.00001952	0.0001355	8E-06	3.186E-06	4E-05	0.005211
TJ2-06	267	0	0.01622	0.01622	0.00006075	0.0009927	6E-05	-5.89E-05	0.0002	0.01622
TJ2-07	267	0	0	0	0	0	0	0	0	0
TJ2-08	267	0	0.05389	0.05389	0.0002018	0.003298	0.0002	-0.000196	0.0006	0.05389
TJ2-09	267	0	0.00476	0.00476	0.00001783	0.0002913	2E-05	-1.73E-05	5E-05	0.00476
TJ3-01	267	0	0.007981	0.007981	0.00003139	0.0004889	3E-05	-2.75E-05	9E-05	0.00838
TJ3-02	267	0	0.00985	0.00985	0.00003689	0.0006028	4E-05	-3.58E-05	0.0001	0.00985
TJ3-03	267	0	0.00577	0.00577	0.00006483	0.0004807	3E-05	6.908E-06	0.0001	0.01731
TJ3-04	267	0	0.002165	0.002165	8.107E-06	0.0001325	8E-06	-7.86E-06	2E-05	0.002165
TJ3-05	267	0	0.004822	0.004822	0.0000301	0.0003254	2E-05	-9.12E-06	7E-05	0.008036
TJ3-06	267	0	0.009986	0.009986	0.0000374	0.0006111	4E-05	-3.62E-05	0.0001	0.009986
TJ3-07	267	0	0.007143	0.007143	0.00004161	0.0004649	3E-05	-1.44E-05	1E-04	0.01111
TJ4-01	267	0	0	0	0	0	0	0	0	0
TJ4-02	267	0	0.001515	0.001515	0.00001135	0.0001309	8E-06	-4.42E-06	3E-05	0.003031
TJ4-03	267	0	0.001665	0.001665	0.00001871	0.0001758	1E-05	-2.48E-06	4E-05	0.004995
TJ5-01	267	0	0.0133	0.0133	0.00007115	0.0008369	5E-05	-2.97E-05	0.0002	0.019
TJ5-02	267	0	0.001578	0.001578	0.00001773	0.0001666	1E-05	-2.35E-06	4E-05	0.004733
TJ5-03	267	0	0	0	0	0	0	0	0	0
TJ5-04	267	0	0.002623	0.002623	0.00002947	0.0002526	2E-05	-9.62E-07	6E-05	0.007869
TJ5-05	267	0	0.002506	0.002506	0.00003285	0.0002527	2E-05	2.405E-06	6E-05	0.008772

ANOVA performed on the abundance data of the macrobenthic community associated with plastic waste showed differences on the spatial-temporal scale in Šibenik (see Appendix Table 2). The diversity indices calculated on the plastic samples showed variable trends, based on the sampling area, the sampling period and the plastic polymer analyzed. The results of the indices are shown in Table 65.

TABLE 65. Diversity indices on the plastic samples in Šibenik.

Sample	S	N	d	J'	Brillouin	Fisher	H'(loge)	1-Lambda'
MT1-01	4	0	****	0.9212	****	****	1.277	****
MT1-02	2	1	****	0.422	0	****	0.2925	****
MT1-03	3	0	****	0.9206	****	****	1.011	****
MT1-04	5	0	****	0.3035	****	****	0.4885	****
MT1-05	7	0	****	0.8121	****	****	1.58	****
MT1-06	3	0	****	0.673	****	****	0.7393	****
MT2-01	8	0	****	0.8413	****	****	1.749	****
MT2-02	11	0	****	0.9027	****	****	2.165	****
MT2-03	0	0	****	****	****	****	0	****
MT2-04	2	0	****	1	****	****	0.6931	****
MT2-05	5	0	****	0.4313	****	****	0.6941	****
MT2-06	0	0	****	****	****	****	0	****
MT2-07	9	0	****	0.3976	****	****	0.8737	****
MT3-01	1	0	****	****	****	****	0	****
MT3-02	4	0	****	0.895	****	****	1.241	****
MT3-03	4	0	****	0.3727	****	****	0.5166	****
MT3-04	8	0	****	0.8523	****	****	1.772	****
MT4-01	2	0	****	0.9082	****	****	0.6295	****
MT4-02	1	0	****	****	****	****	0	****
MT4-03	4	0	****	1	****	****	1.386	****
MT4-04	9	0	****	0.2814	****	****	0.6184	****
MT5-01	3	0	****	1	****	****	1.099	****
MT5-02	2	0	****	0.9183	****	****	0.6365	****
MT5-03	6	0	****	0.6249	****	****	1.12	****
MT5-04	2	0	****	1	****	****	0.6931	****
MT5-05	6	0	****	0.7427	****	****	1.331	****
TJ1-01	3	0	****	0.9464	****	****	1.04	****
TJ1-02	0	0	****	****	****	****	0	****
TJ1-03	0	0	****	****	****	****	0	****
TJ1-04	1	0	****	****	****	****	0	****
TJ1-05	3	0	****	0.9464	****	****	1.04	****
TJ1-06	0	0	****	****	****	****	0	****
TJ1-07	1	0	****	****	****	****	0	****
TJ1-08	1	0	****	****	****	****	0	****
TJ2-01	1	0	****	****	****	****	0	****
TJ2-02	1	0	****	****	****	****	0	****
TJ2-03	2	0	****	1	****	****	0.6931	****
TJ2-04	2	0	****	1	****	****	0.6931	****

TJ2-05	6	0	****	0.9755	****	****	1.748	****
TJ2-06	1	0	****	****	****	****	0	****
TJ2-07	0	0	****	****	****	****	0	****
TJ2-08	1	0	****	****	****	****	0	****
TJ2-09	1	0	****	****	****	****	0	****
TJ3-01	2	0	****	0.2762	****	****	0.1914	****
TJ3-02	1	0	****	****	****	****	0	****
TJ3-03	7	0	****	0.8901	****	****	1.732	****
TJ3-04	1	0	****	****	****	****	0	****
TJ3-05	3	0	****	0.865	****	****	0.9503	****
TJ3-06	1	0	****	****	****	****	0	****
TJ3-07	4	0	****	0.715	****	****	0.9911	****
TJ4-01	0	0	****	****	****	****	0	****
TJ4-02	2	0	****	1	****	****	0.6931	****
TJ4-03	3	0	****	1	****	****	1.099	****
TJ5-01	4	0	****	0.6784	****	****	0.9404	****
TJ5-02	3	0	****	1	****	****	1.099	****
TJ5-03	0	0	****	****	****	****	0	****
TJ5-04	4	0	****	0.9591	****	****	1.33	****
TJ5-05	5	0	****	0.963	****	****	1.55	****

It was not possible to calculate N due to the very small abundance numbers, caused by the calculation of the analysis area, and it was not possible to calculate Simpson's index (1-Lambda') due to the small number of specimens in the samples. Species richness (S) varied significantly between the two study sites investigated ($p=0.002$), but no differences were found according to sampling period and polymers type ($p>0.05$). Pielou's equitability index (J′) showed spatial variability, highlighting significant differences between Tijat and Martinska ($p=0.044$), but no differences were found according to sampling period and polymers type ($p>0.05$). Shannon-Wiener's species diversity index (H loge') showed spatial variability, highlighting significant differences between Tijat and Martinska ($p=0.022$), but no differences were found according to sampling period and polymers type ($p>0.05$).

4.7 Macrobenthic community on natural substrate Messina

Macrobenthic community associed with natural substrate is described as mean±SD, see Table 66.

TABLE 66. Macrobenthic community associed with natural substrate in Messina.

	Number of values	Minimum	Maximum	Range	Mean	Std. Deviation	Std. Error of Mean	Lower 95% CI of mean	Upper 95% CI of mean	Sum
1	267	0	5.124	5.124	0.04736	0.4372	0.02676	-0.00533	0.1	12.65
2	267	0	4.636	4.636	0.0275	0.3062	0.01874	-0.00939	0.0644	7.344
3	267	0	2.464	2.464	0.02013	0.1639	0.01003	0.000372	0.03988	5.374
4	267	0	1.967	1.967	0.02067	0.1719	0.01052	-4.2E-05	0.04138	5.518
5	267	0	1.786	1.786	0.01389	0.135	0.00826	-0.00237	0.03015	3.708
6	267	0	4.131	4.131	0.02286	0.2798	0.01712	-0.01085	0.05657	6.103
7	267	0	2.876	2.876	0.02043	0.1891	0.01157	-0.00235	0.04321	5.454
8	267	0	2.867	2.867	0.01663	0.1818	0.01113	-0.00528	0.03853	4.439
9	267	0	2.171	2.171	0.01802	0.1787	0.01094	-0.00352	0.03956	4.811
10	267	0	0.6175	0.6175	0.002769	0.03849	0.002356	-0.00187	0.00741	0.7392
11	267	0	1.164	1.164	0.005074	0.07169	0.004387	-0.00356	0.01371	1.355
12	267	0	3.207	3.207	0.0122	0.1963	0.01201	-0.01145	0.03585	3.259
13	267	0	4.856	4.856	0.01889	0.2973	0.01819	-0.01693	0.05471	5.043
14	267	0	7.452	7.452	0.0313	0.4566	0.02794	-0.02372	0.08632	8.357
15	267	0	1.221	1.221	0.008534	0.08012	0.004904	-0.00112	0.01819	2.279
16	267	0	0.3407	0.3407	0.002126	0.02252	0.001378	-0.00059	0.00484	0.5676
17	267	0	0.7856	0.7856	0.004001	0.04918	0.00301	-0.00193	0.00993	1.068
18	267	0	2.737	2.737	0.01087	0.1678	0.01027	-0.00934	0.03108	2.903
19	267	0	3.532	3.532	0.02244	0.229	0.01401	-0.00515	0.05004	5.993
20	267	0	4.129	4.129	0.03562	0.2914	0.01783	0.000503	0.07073	9.51
21	267	0	2.598	2.598	0.014	0.1612	0.009863	-0.00542	0.03342	3.737
22	267	0	1.212	1.212	0.01328	0.1073	0.006566	0.000353	0.02621	3.546
23	267	0	1.856	1.856	0.01617	0.1471	0.009	-0.00155	0.03389	4.317
24	267	0	3.088	3.088	0.01626	0.1918	0.01174	-0.00686	0.03937	4.341
25	267	0	5.6	5.6	0.03173	0.3547	0.02171	-0.01101	0.07448	8.472
26	267	0	0.9343	0.9343	0.008962	0.07675	0.004697	-0.00029	0.01821	2.393
27	267	0	7.39	7.39	0.03799	0.4589	0.02808	-0.0173	0.09328	10.14

28	267	0	6.928	6.928	0.08328	0.6583	0.04029	0.003947	0.1626	22.23
29	267	0	1.564	1.564	0.01423	0.13	0.007958	-0.00144	0.0299	3.799
30	267	0	20.43	20.43	0.08026	1.25	0.07652	-0.0704	0.2309	21.43
31	267	0	8.271	8.271	0.06894	0.6853	0.04194	-0.01363	0.1515	18.41
32	267	0	4.226	4.226	0.02383	0.263	0.01609	-0.00785	0.05552	6.364
33	267	0	14.68	14.68	0.06505	0.9012	0.05515	-0.04354	0.1736	17.37
34	267	0	1.239	1.239	0.01467	0.1154	0.007059	0.000769	0.02857	3.917
35	267	0	2.539	2.539	0.02467	0.1903	0.01165	0.001742	0.04761	6.588
36	267	0	7.843	7.843	0.03279	0.4811	0.02944	-0.02518	0.09076	8.754
37	267	0	4.768	4.768	0.0317	0.3065	0.01876	-0.00523	0.06863	8.463
38	267	0	3.466	3.466	0.02486	0.2362	0.01446	-0.0036	0.05332	6.638
39	267	0	0.152	0.152	0.002151	0.01591	0.000974	0.000233	0.00407	0.5743
40	267	0	1.816	1.816	0.01612	0.1453	0.008894	-0.00139	0.03363	4.304
41	267	0	4.785	4.785	0.02562	0.2983	0.01826	-0.01032	0.06157	6.842
42	267	0	8.121	8.121	0.03721	0.4979	0.03047	-0.02278	0.0972	9.935
43	267	0	2.375	2.375	0.02158	0.1909	0.01169	-0.00143	0.04459	5.763
44	267	0	2.691	2.691	0.01209	0.1659	0.01015	-0.00789	0.03208	3.229
45	267	0	1.807	1.807	0.01156	0.1142	0.006991	-0.00221	0.02532	3.086
46	267	0	3.299	3.299	0.02498	0.2157	0.0132	-0.00102	0.05097	6.669
47	267	0	2.435	2.435	0.01317	0.152	0.009305	-0.00515	0.03149	3.517
48	267	0	5.635	5.635	0.02872	0.3498	0.02141	-0.01342	0.07087	7.67
49	267	0	4.513	4.513	0.02633	0.2824	0.01728	-0.0077	0.06036	7.03
50	267	0	3.205	3.205	0.02148	0.2163	0.01324	-0.00458	0.04754	5.736
51	267	0	4.729	4.729	0.02184	0.2908	0.01779	-0.0132	0.05688	5.832
52	267	0	5.889	5.889	0.04206	0.4092	0.02505	-0.00725	0.09138	11.23
53	267	0	12.68	12.68	0.05436	0.7771	0.04756	-0.03928	0.148	14.51
54	267	0	2.888	2.888	0.01635	0.1784	0.01092	-0.00515	0.03785	4.366
55	267	0	6.597	6.597	0.04111	0.4185	0.02561	-0.00932	0.09154	10.98
56	267	0	2.535	2.535	0.02472	0.1794	0.01098	0.003099	0.04634	6.6
57	267	0	5.047	5.047	0.0266	0.3129	0.01915	-0.01111	0.06431	7.102
58	267	0	9.649	9.649	0.04138	0.5911	0.03617	-0.02984	0.1126	11.05
59	267	0	7.072	7.072	0.0304	0.4333	0.02652	-0.02181	0.08261	8.117
60	267	0	4.721	4.721	0.02837	0.3012	0.01843	-0.00792	0.06467	7.576
61	267	0	11.2	11.2	0.05405	0.6895	0.04219	-0.02903	0.1371	14.43
62	267	0	2.319	2.319	0.01664	0.1557	0.00953	-0.00213	0.0354	4.443
63	267	0	10.37	10.37	0.04291	0.6351	0.03886	-0.03362	0.1194	11.46

64	267	0	1.856	1.856	0.01448	0.1456	0.008908	-0.00305	0.03202	3.867
65	267	0	5.098	5.098	0.02568	0.3167	0.01938	-0.01248	0.06383	6.855
66	267	0	2.919	2.919	0.01962	0.1889	0.01156	-0.00314	0.04237	5.238
67	267	0	0.9855	0.9855	0.01162	0.08816	0.005396	0.000999	0.02225	3.103
68	267	0	4.873	4.873	0.02735	0.3191	0.01953	-0.0111	0.06581	7.304
69	267	0	0.9223	0.9223	0.01459	0.09723	0.005951	0.002872	0.02631	3.895
70	267	0	2.883	2.883	0.02028	0.1961	0.012	-0.00335	0.04391	5.415
71	267	0	1.456	1.456	0.01686	0.1328	0.008126	0.000862	0.03286	4.502
72	267	0	5.787	5.787	0.02649	0.3554	0.02175	-0.01634	0.06931	7.072
73	267	0	10.07	10.07	0.04709	0.6184	0.03785	-0.02742	0.1216	12.57
74	267	0	11.45	11.45	0.04629	0.7008	0.04289	-0.03816	0.1307	12.36
75	267	0	17.82	17.82	0.1095	1.161	0.07103	-0.03038	0.2493	29.23
76	267	0	4.797	4.797	0.04554	0.3559	0.02178	0.002652	0.08842	12.16
77	267	0	12.7	12.7	0.06006	0.7841	0.04799	-0.03443	0.1545	16.03
78	267	0	5.616	5.616	0.03536	0.3634	0.02224	-0.00843	0.07916	9.442
79	267	0	8.576	8.576	0.04783	0.5701	0.03489	-0.02086	0.1165	12.77
80	267	0	15	15	0.05979	0.9185	0.05621	-0.05088	0.1705	15.96
81	267	0	12.74	12.74	0.0619	0.7886	0.04826	-0.03312	0.1569	16.53
82	267	0	14.75	14.75	0.05865	0.903	0.05526	-0.05015	0.1675	15.66
83	267	0	8.717	8.717	0.03493	0.5336	0.03265	-0.02936	0.09923	9.327
84	267	0	6.932	6.932	0.0311	0.4273	0.02615	-0.02038	0.08259	8.305
85	267	0	11.04	11.04	0.07397	0.739	0.04523	-0.01508	0.163	19.75
86	267	0	5.765	5.765	0.02522	0.3538	0.02165	-0.01742	0.06785	6.732
87	267	0	10.98	10.98	0.04796	0.6736	0.04122	-0.0332	0.1291	12.81
88	267	0	7.825	7.825	0.04515	0.5159	0.03157	-0.01701	0.1073	12.05
89	267	0	6.817	6.817	0.04085	0.4754	0.02909	-0.01643	0.09813	10.91
90	267	0	3.315	3.315	0.01925	0.212	0.01297	-0.00629	0.0448	5.141
91	267	0	3.688	3.688	0.01552	0.226	0.01383	-0.0117	0.04275	4.145
92	267	0	1.442	1.442	0.01109	0.1016	0.006216	-0.00115	0.02333	2.962
93	267	0	1.826	1.826	0.01811	0.1372	0.008396	0.001582	0.03465	4.836
94	267	0	3.229	3.229	0.02141	0.205	0.01255	-0.0033	0.04611	5.716
95	267	0	11.03	11.03	0.09524	0.8578	0.0525	-0.00813	0.1986	25.43
96	267	0	2.148	2.148	0.03703	0.2095	0.01282	0.01179	0.06227	9.887
97	267	0	0.2616	0.2616	0.003277	0.02417	0.001479	0.000366	0.00619	0.8751
98	267	0	1.987	1.987	0.01872	0.1578	0.009659	-0.0003	0.03774	4.999
99	267	0	3.827	3.827	0.03281	0.3308	0.02025	-0.00705	0.07267	8.76

100	267	0	3.523	3.523	0.02304	0.2379	0.01456	-0.00562	0.0517	6.151
101	267	0	0.7307	0.7307	0.009903	0.06445	0.003944	0.002137	0.01767	2.644
102	267	0	16.44	16.44	0.07454	1.019	0.06235	-0.04822	0.1973	19.9
103	267	0	5.902	5.902	0.0302	0.3724	0.02279	-0.01468	0.07507	8.063
104	267	0	2.353	2.353	0.01346	0.149	0.009116	-0.00449	0.03141	3.594
105	267	0	6.481	6.481	0.05521	0.4698	0.02875	-0.0014	0.1118	14.74
106	267	0	3.899	3.899	0.01923	0.2408	0.01473	-0.00979	0.04824	5.133
107	267	0	8.322	8.322	0.04253	0.5213	0.0319	-0.02028	0.1053	11.36
108	267	0	2.753	2.753	0.02267	0.1953	0.01195	-0.00086	0.0462	6.053
109	267	0	1.744	1.744	0.01347	0.1173	0.007181	-0.00067	0.02761	3.597
110	267	0	1.317	1.317	0.00861	0.08893	0.005443	-0.00211	0.01933	2.299
111	267	0	1.812	1.812	0.01266	0.1239	0.00758	-0.00227	0.02758	3.38
112	267	0	3.803	3.803	0.01779	0.234	0.01432	-0.0104	0.04598	4.75
113	267	0	2.38	2.38	0.01904	0.1715	0.0105	-0.00163	0.0397	5.084
114	267	0	2.29	2.29	0.01959	0.1621	0.009922	5.12E-05	0.03912	5.23
115	267	0	3.949	3.949	0.02871	0.2728	0.01669	-0.00416	0.06157	7.664

The results of the ANOVA highlighted the absence of significant variations in the abundance data of the organisms associated with the 115 specimens of *Pinctada radiata* ($p>0.05$). The diversity indices calculated on natural substrate and in this study selected as *Pinctada radiata* valves, showed variable trends, based on the sampling area and the sampling period. The results of the indices are shown in Table 67.

Table 67. Diversity indices on the natural substrate samples in Messina.

Sample	S	N	d	J'	Brillouin	Fisher	H'(loge)	1-Lambda'
1	21	10	8.583	0.834	1.372	****	2.539	0.9752
2	9	6	4.577	0.8168	0.981	****	1.795	0.9411
3	24	8	10.83	0.906	1.239	****	2.879	1.049
4	13	7	6.375	0.8922	1.218	****	2.288	1.029
5	6	4	3.628	0.8841	0.7945	****	1.584	1.022
6	2	3	0.81	0.9757	0.3662	2	0.6763	0.6816
7	16	7	7.989	0.8541	1.119	****	2.368	1.03
8	9	5	5.1	0.8657	0.8189	****	1.902	1.02
9	7	5	3.944	0.8536	0.9575	****	1.661	0.9857

10	2	1	7.914	0.8902	0	****	0.617	3.588
11	3	2	3.785	0.8262	0.3466	****	0.9077	1.289
12	2	2	1.424	0.5079	-1.16E-17	110.8	0.3521	0.3963
13	3	3	1.937	0.608	0.3662	****	0.6679	0.56
14	6	5	3.185	0.7632	0.5991	****	1.367	0.8058
15	9	4	6.052	0.9103	0.7945	****	2	1.143
16	4	1	9.11	0.9404	0	****	1.304	2.517
17	5	2	6.296	0.8667	0.3466	****	1.395	1.489
18	2	2	1.382	0.7169	-1.16E-17	33.21	0.4969	0.6156
19	9	6	4.649	0.8545	0.981	****	1.878	0.9843
20	13	9	5.53	0.8952	1.345	****	2.296	0.9889
21	12	5	6.967	0.8756	0.8189	****	2.176	1.06
22	9	5	5.108	0.9161	0.9575	****	2.013	1.068
23	11	5	6.007	0.8773	0.9575	****	2.104	1.043
24	10	5	5.771	0.8536	0.8189	****	1.966	1.023
25	10	7	4.761	0.8426	1.119	****	1.94	0.9503
26	6	3	4.09	0.9268	0.5973	****	1.661	1.123
27	14	8	6.42	0.8168	1.102	****	2.155	0.9484
28	12	12	4.413	0.8418	1.343	761.4	2.092	0.9244
29	10	4	6.005	0.8271	0.7945	****	1.905	1.044
30	10	7	4.58	0.613	0.534	****	1.412	0.6735
31	10	9	4.05	0.7831	1.024	****	1.803	0.8792
32	14	7	6.767	0.8843	1.119	****	2.334	1.012
33	8	8	3.388	0.7988	0.9283	****	1.661	0.8259
34	12	5	6.492	0.8947	0.9575	****	2.223	1.063
35	13	7	6	0.8998	1.119	****	2.308	1.017
36	9	5	4.958	0.6918	0.5991	****	1.52	0.815
37	13	8	5.805	0.8818	1.239	****	2.262	0.9897
38	12	7	5.861	0.8567	1.119	****	2.129	0.9971
39	5	2	7.655	0.9969	0.3466	****	1.605	1.961
40	8	5	4.413	0.9024	0.9575	****	1.877	1.031
41	7	6	3.507	0.8856	0.981	****	1.723	0.9479
42	12	7	5.587	0.8414	0.9619	****	2.091	0.9371
43	9	6	4.522	0.8963	0.981	****	1.969	1.004
44	4	3	2.836	0.8265	0.3662	****	1.146	0.9355
45	14	5	8.088	0.8976	0.9575	****	2.369	1.096
46	15	8	6.833	0.9011	1.239	****	2.44	1.021
47	12	5	7.196	0.8647	0.8189	****	2.149	1.066
48	9	6	4.482	0.8403	0.981	****	1.846	0.9421
49	13	7	6.159	0.8802	1.119	****	2.258	0.9997
50	9	5	4.711	0.8586	0.8189	****	1.887	0.9888
51	11	5	6.11	0.8099	0.8189	****	1.942	0.9674
52	14	9	6.047	0.8355	1.268	****	2.205	0.9594
53	13	8	5.915	0.7525	0.9283	****	1.93	0.8625
54	19	6	9.672	0.8949	0.981	****	2.635	1.059
55	15	9	6.255	0.8867	1.223	****	2.401	0.9796
56	13	8	5.827	0.9264	1.239	****	2.376	1.023
57	12	7	5.875	0.8602	1.119	****	2.138	0.9833

58	9	6	4.319	0.7949	0.7979	****	1.747	0.8635
59	10	6	5.247	0.7849	0.7979	****	1.807	0.899
60	14	7	6.56	0.8645	1.119	****	2.282	0.993
61	14	9	5.873	0.8384	1.223	****	2.213	0.9291
62	15	6	7.85	0.8772	0.981	****	2.375	1.051
63	7	6	3.464	0.7364	0.7979	****	1.433	0.7795
64	9	4	5.418	0.8439	0.7945	****	1.854	1.035
65	10	6	5.152	0.8348	0.981	****	1.922	0.9589
66	14	6	6.997	0.8877	0.981	****	2.343	1.034
67	8	4	4.704	0.9326	0.7945	****	1.939	1.087
68	8	5	4.189	0.7927	0.8189	****	1.648	0.9135
69	16	6	8.087	0.9148	1.097	****	2.536	1.072
70	11	6	5.701	0.8643	0.981	****	2.073	1.013
71	10	6	5.233	0.9089	1.097	****	2.093	1.042
72	11	6	5.76	0.8139	0.981	****	1.952	0.9473
73	16	9	7.001	0.8178	1.223	****	2.267	0.9368
74	9	6	4.533	0.6884	0.7979	****	1.513	0.7694
75	20	14	7.118	0.8035	1.444	****	2.407	0.9236
76	17	11	6.794	0.8704	1.465	****	2.466	0.9839
77	9	8	3.861	0.7888	0.9283	****	1.733	0.853
78	11	7	4.987	0.8498	1.119	****	2.038	0.9578
79	6	6	2.76	0.7274	0.6824	153.5	1.303	0.7876
80	4	6	1.751	0.6769	0.5669	6.439	0.9383	0.5866
81	14	9	5.846	0.7994	1.069	****	2.11	0.9043
82	6	6	2.86	0.6288	0.5669	****	1.127	0.636
83	8	5	4.393	0.6876	0.5991	****	1.43	0.7715
84	8	5	4.26	0.7423	0.5991	****	1.544	0.8548
85	11	10	4.33	0.7931	1.193	****	1.902	0.8939
86	9	5	5.061	0.7633	0.8189	****	1.677	0.9
87	13	7	6.068	0.7539	0.9619	****	1.934	0.8759
88	7	6	3.228	0.7518	0.6824	****	1.463	0.8377
89	6	6	2.913	0.7036	0.6824	****	1.261	0.7897
90	9	5	4.986	0.8383	0.8189	****	1.842	0.9916
91	11	4	7.419	0.7491	0.6212	****	1.796	0.9731
92	13	5	7.853	0.8759	0.9575	****	2.247	1.099
93	19	7	9	0.908	1.218	****	2.674	1.054
94	19	8	8.927	0.8914	1.239	****	2.625	1.037
95	5	10	1.723	0.9178	1.013	3.88	1.477	0.8375
96	16	11	6.262	0.9416	1.591	****	2.611	1.01
97	10	3	9.473	0.937	0.5973	****	2.157	1.417
98	13	6	6.577	0.8871	1.097	****	2.275	1.037
99	15	7	7.013	0.8186	1.02	****	2.217	0.9702
100	12	6	6.34	0.7969	0.981	****	1.98	0.9818
101	19	6	10.38	0.9166	1.097	****	2.699	1.114
102	7	8	2.956	0.7255	0.8417	42.3	1.412	0.7559
103	8	6	4.082	0.7966	0.981	****	1.656	0.901
104	13	5	7.752	0.8477	0.8189	****	2.174	1.064
105	14	10	5.553	0.8542	1.193	****	2.254	0.9554

106	9	5	5.039	0.8508	0.8189	****	1.869	0.9874
107	8	7	3.728	0.7813	0.9619	****	1.625	0.867
108	9	6	4.487	0.8764	0.981	****	1.926	0.9964
109	17	6	9.009	0.9013	1.097	****	2.554	1.08
110	9	3	6.475	0.8586	0.5973	****	1.886	1.136
111	13	5	7.552	0.8807	0.9575	****	2.259	1.08
112	9	5	5.305	0.8311	0.8189	****	1.826	0.9854
113	13	6	6.732	0.8637	0.981	****	2.215	1.029
114	16	7	7.669	0.9052	1.119	****	2.51	1.043
115	11	7	5.251	0.8477	1.119	****	2.033	0.9752

The analysis of the natural substrate selected for the study, in this case the valves of specimens of *Pinctada radiata*, showed significant variations in the species richness (S) values of the associated benthic community, between the sites Canale Faro and Lago Faro ($p=0.002$), but no temporal variability ($p>0.05$). Similar results were obtained for the N values, with $p=0.001$ obtained in the comparison between Canale Faro and Lago Faro, while no difference was found on a temporal scale ($p>0.05$). Pielou's equitability index (J′) did not show significant spatial variability ($p>0.05$) but showed a marked variation between the periods of September and July 2022 ($p=0.009$). Shannon-Wiener's species diversity index (H loge') showed spatial variability, highlighting significant differences between Canale Faro and Lago Faro ($p=0.015$), but no differences were found according to sampling period ($p>0.05$). Simpson's index (1-Lambda') did not show significant spatial variability ($p>0.05$) but showed a marked variation between September and July 2022 ($p=0.005$).

4.8 Comparison between Plastisphere from Messina vs Šibenik vs benthic community associated with *Pinctada radiata* valves

From the ANOSIM analysis, it emerged that the community composition varied significantly according to the substrate analyzed (Gloal R:0.638; significance level of sample statistic: 0.1%). A moderate variability of the community was observed based on the polymers analyzed (Gloal R:0.429; significance level of sample statistic: 0.1%), sampling period (Gloal R:0.469; significance level of sample statistic: 0.1%), and (Gloal R:0.428; significance level of sample statistic: 0.1%). The SIMPER analysis highlighted which species contributed to the greatest dissimilarities observed for the following factors: substrate/polymers, sampling period and sampling site. The SIMPER analysis is shown in tables 3, 4 and 5 of the Appendix.

The ecology of some of the most abundant and/or significant species is briefly discussed below.

Janua eterostropha Montagu, 1803 (Fig. 33) is an Anellida Polychaeta belonging to the family Serpulidae. It is widespread in tropical and temperate seas all over the world. It appears to be native to Western Europe, from where it has spread to many areas by passive transport on the keel of ships. It is very common in various littoral biotopes, from the surface to depths of over 50 meters. It can be found on algae and seagrasses, stones and shells, but also on the carapace of Decapod Crustaceans. It is a eurytherm and euryhaline species, can be found in ports and lagoons, and is considered a pioneer species in substrate colonisation. Reproduction occurs throughout the year, especially in Spring and Autumn (Bianchi, 1981).

Figure 33. Specimen of *J. heterostropha* found on plastic litter. Note the right-handed course, one of the main taxonomic characters examined for identification.

Pileolaria militaris Claparède, 1870 (Fig. 34) is an Anellida Polychaeta belonging to the family Serpulidae. It is a cosmopolitan species, widespread mainly in tropical regions. It is common throughout the Mediterranean Sea and the Black Sea. It has a wide bathymetric and ecological distribution; indeed, this species can be found on infralittoral algal stands, seagrass beds, coral reefs and even underwater caves. It may occasionally be found in port areas. Reproduction occurs throughout the year, especially in Autumn (Bianchi, 1981).

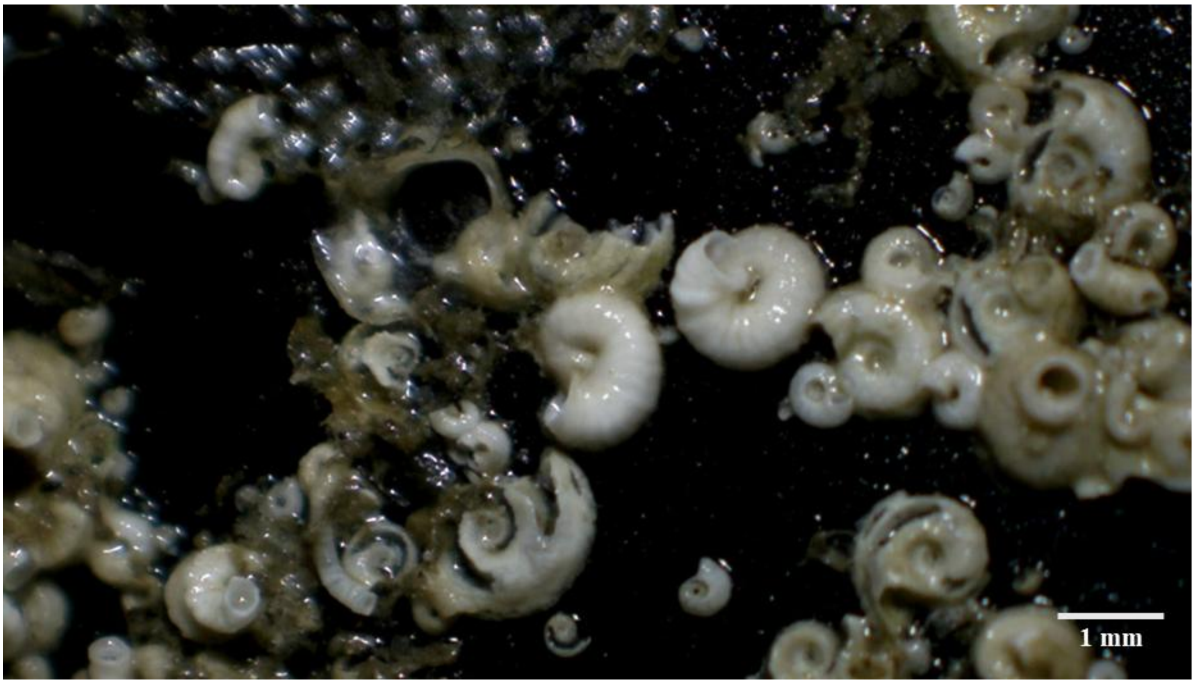

Figure 34. Specimens of *P. militaris* found on plastic litter. Note the left-handed course, one of the main taxonomic characters examined for identification.

H. elegans (Fig. 35) is an Anellida Polychaeta belonging to the family Serpulidae. It is a cosmopolitan species of warm and temperate seas, widespread and introduced into the Mediterranean Sea by passive transport on the keel of ships. It is very common in port fouling, where it can proliferate forming thick and fragile clusters on any surface. It can also be found in shallow infralittoral biotopes, but is less common. It tolerates pollution and wide variations in salinity, so it also adapts well to lagoon and estuarine environments. In substrate colonisation it assumes the role of pioneer species and reproduction occurs almost all year except in spring, with a maximum in late summer (Bianchi, 1981).

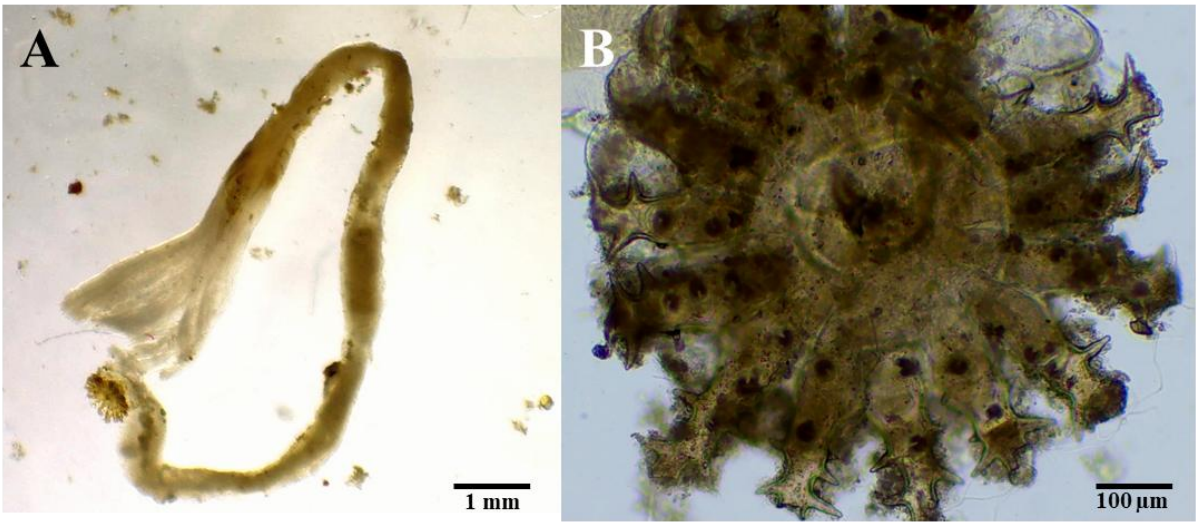

Figure 35. Specimens of *H. elegans* found on plastic litter (A). Detail of the structure of the whorl, one of the main taxonomic characters examined for identification (B).

E. complanata (Fig. 36) is an Anellida Polychaeta belonging to the family Amphinomidae. It is a species widespread in the tropical and subtropical zones of the Atlantic, Pacific and Indian Oceans, but also in the Mediterranean Sea. According to some authors (Barroso et al. 2010), it is a species complex consisting of at least three cryptic species. It is found in the coral reefs of tropical seas and has sciaphilous and nocturnal habits; for this reason, it can be found under stones in the mesolittoral and infralittoral zone, in muddy, sandy or rocky substrates. It can reproduce both sexually and asexually, by fragmentation. (Parapar et al., 2012).

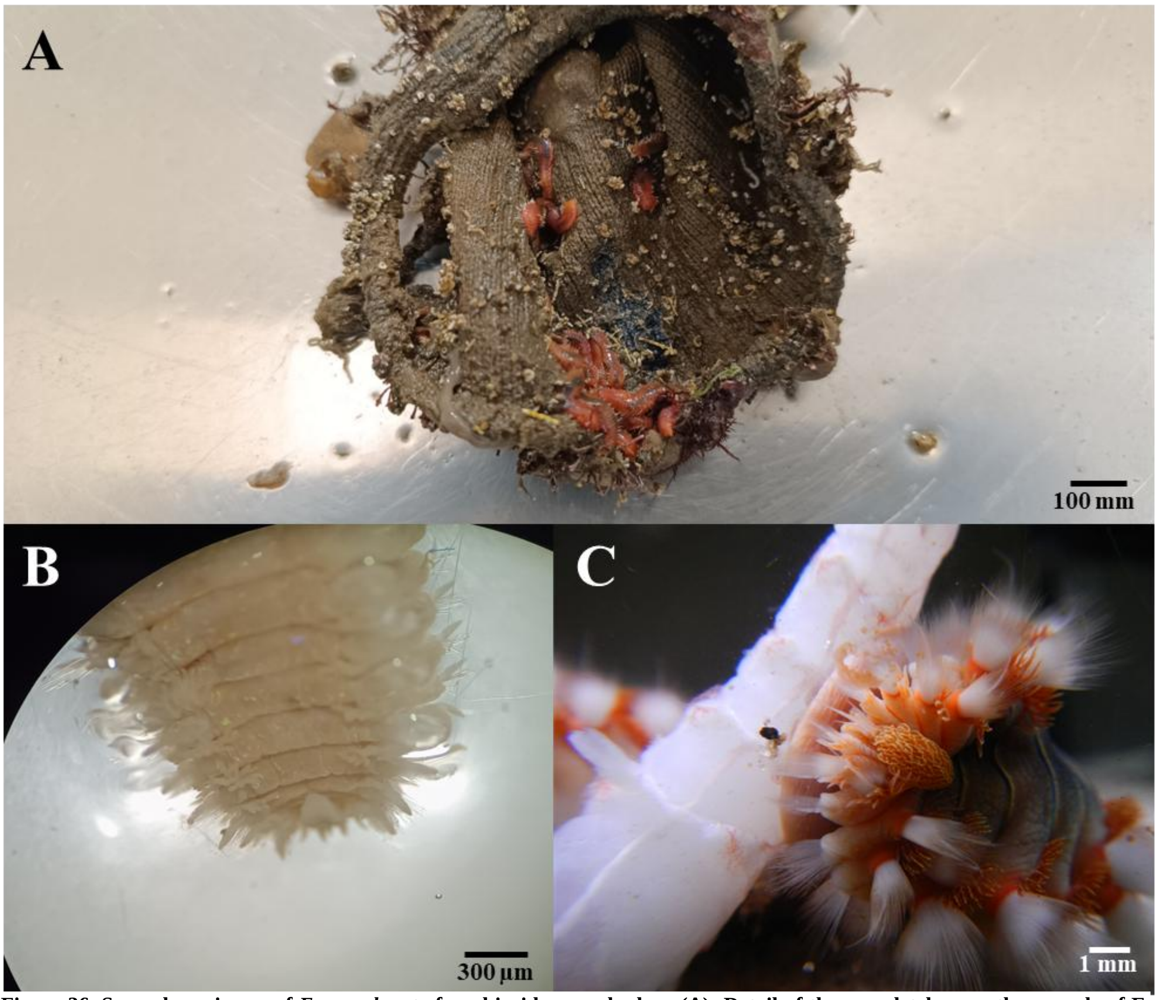

Figure 36. Several specimens of *E. complanata* found inside a work glove (A); Detail of the completely smooth caruncle of E. complanata (B), compared with the caruncle of *Hermodice carunculata* Pallas, 1766, which has a wrinkled appearance (C): this is one of the main taxonomic characters that allows the distinction between the two species.

P. sculpta (Fig. 37) is an Isopod belonging to the family Sphaeromatidae. It is a species whose native range includes California and Mexico, but now has a cosmopolitan distribution, including the Mediterranean Sea, as a result of passive transport on the keel and ballast water of ships. It lives mainly in intertidal and subtidal habitats, often associated with rocky substrates, algae and sponges. It feeds on decaying organic matter and detritus, playing an important role in the nutrient cycle of coastal ecosystems. In this species, reproduction is sexualised and there is marked sexual dimorphism (Ariyama & Otani, 2004; El Kamcha et al., 2021).

Figure 37. Male specimen of *P. sculpta* found on plastic litter.

5. Discussions

5.1 Benthic community structures

In this study, the attention has been given to the colonisation of plastic litter by benthic organisms in two areas in the Natural Oriented Reserve of Capo Peloro Lagoon (Messina, Italy), and an area near the city of Šibenik (Croatia) with the locality of Martinska and the Island of Tijat. Although deeply different, these two areas located within the Mediterranean Sea are united by the significant freshwater inputs that considerably influence the chemical and physical characteristics of these environments, known as transitional (Bassett et al., 2006; Chapman et al., 2013; McLusky & Elliott, 2007; Povilanskas et al., 2014; Povilanskas et al., 2024; Reizopoulou et al., 2014; Sfriso et al., 2021). A further aspect was considered, the colonisation in the same areas of a natural type of substrate, which was identified in the pearl oyster *P. radiata* (which, however, was not found in the Šibenik area, although this bivalve has been reported in Croatian waters (Bratoš Cetinić et al., 2023). A considerable number of Phyla associated with plastic substrates have been identified: Anellida, Arthropoda, Bryozoa, Chordata Cnidaria, Echinodermata, Mollusca, Nemertea, Porifera. The organisms, identified where possible at species level and subdivided according to their trophic regime (Filterers, Herbivorous, Parasites, Predators and Scavengers), allow us to obtain information on the structure of the community and how it is balanced. From results obtained and summarised in the tables above, the communities are well-structured both at the level of the Natural Oriented Reserve Capo Peloro Lagoon, (both on artificial substrates, regardless of the type of polymer, and on natural ones represented by *P. radiata*) and in the Šibenik area, where the largest number of species belongs to the Deposit feeder-

Detritivorous-Scavenger group, followed by the filter feeders. Deposit feeders, Detritivorous and Scavengers in particular, assume a primary role in detritus chain, becoming prey for secondary consumers (Chaumot et al., 2015). The results show that most of plastic litter (except for 8 litters, all from the Šibenik area) had a more or less marked colonisation by benthic invertebrates. It should be noted that none of the litter was floating; all the litter was found at the seabed. This may be caused by both the shape and density of the litter material itself; the density, in particular, may depend on the polymer or mix of plastic polymers from which the sample is composed, but also on the biofouling that, over time, accumulates on the surface, causing it to sink, as hypothesised by Subías-Baratau et al. (2022). The main Phyla found were Arthropoda, Annelida and Mollusca, in line with some previous work, where the main Phyla found in plastic litter in the sea were Arthropoda, Annelida and Mollusca (Astutillo et al., 2009; Garcìa-Gomez et al, 2021). The presence of species belonging to Bryozoa, Chordata, Cnidaria, Echinodermata, Nemertea and Porifera is still recorded. In addition, 3 specimens of benthic Teleost were found inside 3 plastic litter, all coming from the Oriented Reserve of Capo Peloro Lagoon (2 from the Faro Lake and 1 from the Due Torri Canal), which due to their shape and size were exploited as a refuge. There does not appear to be a preference for a particular colour and/or plastic polymer, as the 3 litter are all different (white HDPE tank, transparent PET bottle, black PP toy). These findings suggest that vertebrate such as fish may also exploit plastic litter for their needs, but this needs to be investigated further to understand whether there are preferences towards a specific material, colour or shape. Two protected species, specifically *N. spurca* and *P. lividus*, have been found on the surface of plastic litter, both within the Natural Oriented Reserve of Capo Peloro Lagoon (particularly in the Faro Canal and the Due Torri Canal) and in the Šibenik area (on Tijat Island). Again, the choice of plastic litter appears to be entirely random, as there does not seem to be a marked preference for a specific type of plastic polymer and/or colour. In this regard, further studies and investigations are needed to understand whether it is possible to use plastic as a support for those protected and/or endangered benthic species that have suffered a decrease in populations in certain areas, and if so, which plastic polymers, shapes and/or colours are most suitable for this purpose. Confirming this possible employment, two Anthozoa species, *B. europaea* and *C. caespitosa* were found attached to plastic sublayers in the Šibenik area (both in locality of Martinska), confirming that plastic is able to support sessile and fragile organisms such as corals, as already reported in previous studies (Battaglia et al., 2019; Carugati et al., 2021; Mancini et al., 2021). It should be noted that no protected species were found associated with the surface of *P. radiata,* but this is most likely due to a random factor. Overall, there are no marked differences in either species richness or abundance between the natural and artificial substrates examined within the Capo Peloro area. Apparently, the only substantial difference between the two types of substrate is that, while the surface of *P. radiata* appears naturally 'rough' and immediately suitable to host benthic organisms, the surface of the plastics will take some time to assume characteristics suitable for the purpose; it will be the action of chemico-physical agents in combination with bacteria action first, and of some macroinvertebrates later, that will transform it over time into a substrate similar to any other substrate of natural origin. In particular, Polychaete species belonging to the Serpulidae family contribute to increasing the complexity of the plastic, in some cases almost entirely covering its surface; these are believed to be among the first sessile organisms to intervene in biofouling processes (Bastida-Zavala et al., 2017; Smirnova et al., 2021; Tovar-Hernàndez et al., 2009;). In previous investigations, Serpulidae have often been reported on a variety of artificial substrates, from boat hulls to oil platforms, but also on everyday objects such as ropes, food plastics and buoys (Astudillo et al., 2009; Bottari et al., 2024; Crocetta et al., 2020; Mancini et al., 2021; Mghili et al., 2022). While all litter from Capo Peloro was found to be colonised, 6 plastic litter from Šibenik did not show any association with benthic organisms; more generally, a higher species richness and abundance was found in the Capo Peloro area; this was probably due to the higher amount of dissolved nutrients in the lagoon environment. The plastic litter found in the Capo Peloro area is also four times as numerous as that found in Šibenik, presumably due to greater anthropisation. Considering the discovery of species of potential commercial value associated with plastic litter, it is suggested that more use be made of these materials to implement specific structures for the breeding of species such as Bivalve Molluscs (as already occurs within the Capo Peloro area itself with mussel farming) or Porifera; this could be a useful solution to decrease the exploitation of wild populations. Further studies are suggested in order to identify the most suitable plastic polymers for this purpose and assess their possible effects on the organisms' development. The results obtained confirm that plastic litter dispersed in aquatic environments acts as a substrate allowing rapid colonisation by numerous species, both at sea (Astudillo et al., 2009; Mghili et al., 2022; Fazey & Ryan, 2016; Zettler et al., 2013) and in freshwater environments (Gallitelli et al., 2023; Wilson et al., 2021). Statistical analysis and calculation of diversity indices applied to plastic litter from the Natural Oriented Reserve of Capo Peloro Lagoon showed varying trends, depending on the sampling area, sampling period and plastic polymer analyzed. The greatest variations in species richness (S) occur with respect to the Margi Canal; this can be attributed due to the Margi Canal, not being directly connected to the sea, is characterized by a greater instability of chemico-physical parameters than the other areas. There are no significant seasonal differences in diversity, but these do not vary according to the polymer of which the plastic wastes are composed. A similar point can be made regarding the Šibenik area. Again, the diversity indices calculated on the plastic litter showed variable trends, depending on the sampling area, sampling period, and plastic polymer analyzed. There is a significant difference between the two study areas (Tijat Island and Martinska locality) in S; this can certainly be attributed to the higher freshwater inputs in the Martinska locality, due to KrKa River located in the immediate proximity. It should be noted that even in this macroarea there are no significant differences in terms of species diversity according to the polymer of the plastic waste: this aspect deserves attention with targeted studies. Regarding the natural substrate represented by the valves of the oyster peal *P. radiata*, the diversity indices applied also showed variable trends, depending on area and sampling period. The greatest differences in S were shown between Faro Canal and Faro Lake, despite these two areas are directly connected, but in general, no significant differences in terms of temporal scale are shown. With the present work, it is confirmed that colonisation of plastic substrates can occur in brackish lagoon environments, as well as in the sea, as reported in previous study (Bottari et al., 2024).

5.2 Non Indigenous Species (NIS) and/or invasive species

NIS invertebrates associated with plastic litter were found both within the Natural Oriented Reserve of Capo Peloro Lagoon and in the Šibenik area. These species belong to the Phyla Anellida, Arthropoda, Chordata, Mollusca and Nemertea. Almost all of them have been recorded at the level of the Capo Peloro area, mainly with Anellida and Arthropoda. Most of the species found here have well-established populations, suggesting that they have been present for a long time and that plastic polymers do not interact negatively on their development. The results obtained show how some allochthonous species can locally replace native ones, almost completely supplanting them and becoming invasive. This is the case of *M. romulea* and *P. japonica*, Isopods belonging to the Anthuroidea superfamily of Indo-Pacific origin that have, probably, almost completely replaced *A. gracilis*, an Anthuridae common throughout the Mediterranean Sea, in the Capo Peloro area. This is probably due to *M. romulea* and *P. japonica* have adapted better to the particular chemico-physical conditions of this lagoon environment. The same applies to the Isopod *P. sculpta*, belonging to the Sphaeromatidae family, which has become invasive and numerically outnumbers the other native species belonging to the same family. The results obtained thus show that, over time, plastic litter can represent a useful substrate for the transport and development of NIS, assuming an important role in their dispersal (Kiessling et al., 2015; Mancini et al., 2021; Rech et al., 2016). The same pearl oyster *P. radiata*, examined in this study as an example of natural substrate, was found in association with plastic substrates, confirming its status as an invasive, as well as NIS (Tlig-Zouari et al., 2009). Interesting is the case of *E. complanata*, a Polychaete Annelid belonging to the Amphinomidae family, of Indo-Pacific origin very similar to the much better-known *H. carunculata*, a species common throughout the Mediterranean Sea, especially in the last years (Righi et al., 2020; Tiralongo et al., 2023). This species has been found within the Capo Peloro area, both at the level of plastic litter, and (although to a minor extent) associated with the shells of *P. radiata*. The peculiarity lies in the observation that *E. complanata*, especially at the level of the Faro Canal, has become an invasive species and is much smaller in size (maximum size ~ 40 mm) than the populations present in the sea (Parapar, 2018); this could be an adaptation of the population to the chemico-physical conditions present in the lagoon, but specific studies and examinations are essential to understand the causes. NIS belonging to the Phyla Anellida, Arthropoda, Chordata, Mollusca and Nemertea, whose main taxa are represented by Anellida and Arthropoda, were also found at the level of the *P. radiata* valves. In terms of specific richness and abundance, there are no marked differences between this natural substrate and the artificial (plastic) one. The obtained results, therefore, confirm what has been pointed out in previous works (Katsanevakis & Crocetta 2014; Mghili et al., 2023), supporting the thesis that plastic substrates can act as a support that can significantly contribute to the spread and dispersion of NIS, especially with regard to those plastic litter that, due to their shape and density, are able to float for considerable distances (Mancini et al., 2021). As already mentioned in the previous section, all the litter sampled was at seabed level; however, this does not exclude the possibility that at least some of it was previously floating, and that it only sank at a later stage following the increase in density due to massive colonisation.

5.3 Plastic polymers

Based on the characterisation of plastic polymers performed on litter found in both the Natural Oriented Reserve of Capo Peloro Lagoon and the Šibenik area, the same types were found in both areas. Furthermore, the main plastic polymers found in both areas are PET, PP and PVC, which, as confirmed by previous studies (Bajt, 2021), are the most common in the sea. The colonization of these polymers by benthic organisms, in consoderation of the results obtained, appears to be entirely random, as there is no marked preference for one or more specific materials; further investigations are needed to obtain more information on the differences in colonisation patterns between the different polymers.

5.4 Eggs on marine litter

The eggs of Gastropods belonging to at least 5 different species were found (unfortunately, it was not possible to identify all species due to the scarce information available in the literature on the subject) associated with 23 plastic litter, all coming from the Natural Oriented Reserve of Capo Peloro Lagoon, suggesting that plastic litter is exploited by various organisms, particularly Molluscs, as a useful surface for spawning. This is confirmed by several previous studies (Mancini et al., 2021; Rizzo et al., 2022; De La Torre et. al., 2022), where spawning by Cephalopod Molluscs and Gasteropods were found on plastic litter, as well as by Teleost. This study showed that, in most cases, adult specimens were also found in the immediate proximity of the eggs. Further investigations will be necessary to assess the possible effects that the different plastic polymers in the litter may have on the normal and physiological development of the eggs. No depositions were recorded on any litter from the Šibenik area. The results show a preference for PET plastic litter (8 out of 23) but, in light of the results obtained, this is to be attributed to a random occurrence; not even the color, shape or width of the surface influence the choice of litter, which appears to be entirely random. These results suggest a possible use of specially made plastic substrates as nursery areas for those species that, for several reasons, have shown a decline in population levels in recent years, or more generally to encourage an increase in biodiversity in depauperated areas, thus increasing the structural complexity of the habitat (Bracho-Villavicencio et al., 2023; Knoester et al., 2023; Leonard et al., 2022; Spieler et al., 2001; Vivier et al., 2021). No eggs deposition on *P. radiata* was detected, suggesting a possible preference for artificial substrates over natural ones. Further studies will be needed to better understand this aspect and the possible reasons why organisms prefer a plastic substrate to a natural one, in addition to the high availability of such substrates in the environment.

6. CONCLUSIONS

This study expands the present knowledge about faunal colonization of plastic litter in the marine environment, by assessing the interactions between benthic organisms and plastic litter of different shape, colour and composition, found in brackish environments. As far as we know, this is the first study that, compare different anthropised transitional areas (the Natural Oriented Reserve of Capo Peloro Lagoon (Messina) and Šibenik (Croatia). The study tries also to evaluate if plastic litter is colonisable as a natural substrate, by the means of a comparison with the surface of the pearl oyster *P. radiata*, which was chosen as an example of a natural substrate because. Based on the results achieved, it can be asserted that there are no marked differences in terms of colonisation between artificial (plastic litter) and natural (*P. radiata* valves) substrates. Plastic litter in particular proved to be able to act as nursery areas for several species, as evidenced by the spawning of Gastropod Molluscs, and even to host Teleost species, becoming true refuges. On the other hand, the numerous NIS associated with them confirm that plastics can contribute considerably to the potential spread of NIS and/or invasive species. Further investigations will be necessary to understand if and which plastic polymers can be exploited to create supports specifically designed to breed species of high commercial interest such as Molluscs and Porifera, to install nursery/support areas for vulnerable species, or to increase the structural complexity of habitats in those areas depauperated by anthropogenic impacts. Furthermore, it will be relevant to understand how the age and degree of degradation of marine litter impacts the associated macrozoobenthic communities.

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APPENDIX

Supplementary material 1. Pictures of plastic litter from Messina

https://e.pcloud.link/publink/show?code=kZbrxwZOXUFw8hBsH7v30XWR77F1Ldk4fH7

Supplementary material 2. Pictures of plastic litter from Šibenik

https://e.pcloud.link/publink/show?code=kZqRwwZ7t139R7QBQkCUM41U6m0SXHnf770

Supplementary material 3. Capo Peloro litter sampling

https://e.pcloud.link/publink/show?code=XZBqAKZc2ajcRzAKaSMSQtBf4SxhXzQfgYy

Supplementary material 4. Šibenik litter sampling

Download:
https://e.pcloud.link/publink/show?code=XZWqAKZyMQdU8JvuYpCxqRVX5L4afCOAi0y

Supplementary material 5. *Pinctada radiata* sampling
Download:
https://e.pcloud.link/publink/show?code=XZDqAKZpkD7vWu1rXJ96hO1WGjleHyhnkLV

Table 1. ANOVA Abundance in Messina
Download:
https://e.pcloud.link/publink/show?code=XZERwwZsbRRc35cVKk9mjCWi6T6i4CpQkR7

Table 2. ANOVA Abundance in Šibenik
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https://e.pcloud.link/publink/show?code=XZ3RwwZOBBUH8FJG18TaB0YH6T1Lhu0iWaX

Table 3. SIMPER Analysis Polymer substrate

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Table 4. SIMPER Analysis Sampling period

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Table 5. SIMPER Analysis Sampling site

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