1. Introduction

Plastics are synthetic organic compounds produced by polymerization of petrochemicals. Due to its mechanical properties and durability, plastic debris accumulates and persists in the environment over long time. Since the mid-XX century, production and disposal of plastic has increased dramatically, and nowadays plastic debris is ubiquitous in the marine environment. The accumulation of marine litter and plastics has increased, likely due to their chemical structure and/or surface properties. Our study provides evidence that biofouling may play a role in the sinking of plastic debris, as the most abundant fouled plastics had lower densities than seawater, and all bryozoan species were characteristic of shallower depths than those sampled. More studies at low taxonomic level are needed in order to detect new species introduction and potential invasive species associate with plastic debris.

As the different plastic polymers have different density and buoyancy, there is heterogeneity of plastic types in different marine environments (e.g., sea surface, seafloor): plastic less dense than seawater such as polyethylene and polypropylene (density 0.85–0.98 g cm⁻³) may float, while higher density polymers such as polyester or polyamide (density 1.1–1.4 g cm⁻³) sink. However, colonization and biofouling of low-density floating plastic debris may decrease its buoyancy causing it to sink (Kaiser et al., 2017; Kooi et al., 2017). Biofouling communities include a variety of organisms from bacteria to algae, barnacles, bryozoans, molluscs and polychaetes (Oberbeckmann et al., 2015; Flemming and Wurtz, 2019; see review in Povoai et al., 2021), and may also include macro-organisms that may use plastic debris for their dispersal (e.g., cephalopods) (Gündoğdu et al., 2017).

The impact of plastic debris on marine wildlife through ingestion, entanglement and suffocation (Gregory, 2009; Capillo et al., 2020; Mancia et al., 2020) is well documented, as it is the release and transfer of organic pollutants and heavy metals (Nakashima et al., 2016; Cole et al., 2016; Cole et al., 2011). However, plastic debris also provides long-lasting substrates, allowing diversity of organisms to disperse widely (Barnes and

**A R T I C L E  I N F O**

**Keywords:** Microplastics

**A B S T R A C T**

Plastic debris provides long-lasting substrates for benthic organisms, thus acting as a potential vector for their dispersion. Its interaction with these colonizers is, however, still poorly known. This study examines fouling communities on beached, buoyant and benthic plastic debris in the Catalan Sea (NW Mediterranean), and characterizes the plastic type. We found 14 specimens belonging to two phyla (Annelida and Foraminifera) on microplastics, and more than 400 specimens belonging to 26 species in 10 phyla (Annelida, Arthropoda, Bryozoa, Chordata, Cnidaria, Echinodermata, Mollusca, Porifera and Sipuncula) on macroplastics. With 15 species, bryozoans are the most diverse group on plastics. We also report 17 egg cases of the catshark *Scyliorhinus* sp., and highlight the implications for their dispersal. Our results suggest that plastic polymers may be relevant for distinct fouling communities, likely due to their chemical structure and/or surface properties. Our study provides evidence that biofouling may play a role in the sinking of plastic debris, as the most abundant fouled plastics had lower densities than seawater, and all bryozoan species were characteristic of shallower depths than those sampled. More studies at low taxonomic level are needed in order to detect new species introduction and potential invasive species associate with plastic debris.
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Milner, 2005; Masó et al., 2003; Lastras et al., 2016). Therefore, rafting species have the potential of widening their original distributional ranges, and become non-native or even invasive species (Aliani and Molcard, 2003; Barnes et al., 2009; Rech et al., 2016). While the role of floating plastics as artificial substrates has been extensively documented (Aliani and Molcard, 2003; Bravo et al., 2011; Reisser et al., 2014), the role of seafloor plastic litter is still largely unexplored (Katsanevakis et al., 2007; Galgani, 2015; Masó et al., 2016; Miralles et al., 2018; Garcia-Gómez et al., 2021; Mancini et al., 2021). This may be particularly important as benthic plastic debris substrates may have the potential to change biodiversity and structure of benthic communities (Aliani and Molcard, 2003; Katsanevakis et al., 2007; Ramirez-Llodra et al., 2012; Sánchez et al., 2013). In addition, only a few studies have identified the fouling organisms to species level, and even less have characterized the plastics on which these organisms were attached (Povoà et al., 2021).

Here, we report on biofouling communities of beached, buoyant and benthic plastic debris, including micro- (<5 mm) and macroplastics (≥5 mm), collected in the NW Mediterranean. The aim is to decipher whether there is any specific interaction between the plastic debris, based on size and composition (polymer type), and the biofouling community assemblage.

Fig. 1. Map of the study area showing the location of sampling areas for: A) Benthic plastic debris; B) beached plastic debris; C) buoyant plastic debris.

Fig. 2. Stereo-microscope images showing polychaete species attached on diverse floating plastic debris. A) The spirorbid species forming closely coiled tubes (referred here as Spirorbis sp. 1); B) coiled tubes of Spirorbis sp. 1 and a tube of another spirorbid species (Spirorbis sp. 2) and C) the benthic foraminifer Tretomphalus sp.
2. Materials and methods

2.1. Plastic debris sampling

Floating plastic debris was collected along five transects positioned at a distance between 100 and 200 m from the shoreline off the beach of Sant Sebastià (Barcelona, Spain) on the 14th and 17th of October 2020 (Fig. 1A). NE-SW oriented, Sant Sebastià is the longest beach in the city of Barcelona (660 m long × 89 m wide). The beach is bordered by the harbour breakwater to the SW and the gas breakwater to the NE. It is one of the most crowded beaches in the city, and marine litter easily accumulates on the breakwater of the harbour (Camins et al., 2020). Plastics were sampled using a manta trawl adapted to be towed from light boats (kayak and paddle surf) following the methodology described in Camins et al. (2020). Each transect was 500 to 1000 m long and followed a coast-parallel course. After each transect, the manta trawl was rinsed thoroughly with freshwater to ensure that all plastic debris ended up into the collector bag.

Benthic plastic debris was collected offshore Palamós by the vessel “La Perla de Palamós”, a 23-meter length trawler fishing vessel, in December 2020 (Fig. 1A). Depths of collections ranged from 100 to 366 m, and the transects were performed parallel to the shoreline and perpendicularly to the La Fonera submarine canyon, habitat of the valuable red shrimp Aristes antennatus (Risso, 1816).

Beached plastic debris was collected after storms in the wrack line (i.e. line of debris left on the beach by high tide) of the Llevant Beach, located in Premià de Mar, and the Ponent Beach, located in Vilassar de Mar (Fig. 1B), on the 11th and 22nd of January 2021. Both beaches are contiguous and NE-SW oriented; the Llevant Beach is 595 m long × 88 m wide, and the Ponent Beach is 1160 m long × 55 m wide. These beaches are bordered by the Premià de Mar harbour to the SW and the Astillero Beach, located in Vilassar de Mar, to the NE.

All samples with biofouling organisms were preserved in 70% ethanol for the posterior identification.

2.2. Species identification and plastic characterization

Floating plastic debris, which was mostly microplastics, was filtered through a 1 mm stainless steel sieve and disposed on a 90 mm Petri dish to be observed and photographed on a white background scale, using a Nikon SMZ1000 stereo-microscope coupled with a DS-Fi2 camera to detect any biofouling organisms. Fouling organisms attached to macro- and mesoplastics were identified to the lowest taxonomic level possible, using the same stereo-microscope. Scanning electron microscopy (SEM) was conducted on an uncoated specimen of each bryozoan species using a Hitachi TM4000plus Tabletop at the Natural History Museum in Oslo.

All plastic debris with biofouling organisms was chemically characterized using a Perkin Elmer Frontier Infrared Spectrometer (FT-IR) at the Scientific and Technological Centres of the University of Barcelona (CCITUB). FT-IR spectroscopy allowed the identification of the polymer composition of each item, based on the well-known infrared absorption bands that represent the presence or absence of specific functional groups in the material. Each spectrum was compared with known spectrums using the Systematic Identification of Micro Plastics in the Environment (SIMPLE) program developed by Aalborg University (Denmark) and the Alfred Wegener Institute (Germany) (Primpke et al., 2019).

2.3. Statistical analysis

To analyse the difference among fouling communities of the three sampling areas and the eight polymer types, Bray-Curtis similarity indices were calculated for all samples and visualized by non-metric multidimensional scaling (nMDS) based on species presence/absence data. All statistical analyses were performed using the R package Vegan (Oksanen, 2020) in R version 3.5.0 (R Core Team, 2018).

3. Results

3.1. Fouling organisms

In the five transects performed, only four floating microplastics were encrusted by biofouling organisms, with a total of 14 specimens in two phyla (Annelida and Foraminifera). In three microplastics, 12 specimens of the polychaete worm Spirobranchus sp. were found (Fig. 2A–C), while the remaining piece was encrusted by two benthic foraminifera, one specimen identified as Tretomphalus sp. (Fig. 2C).

More than 400 specimens belonging to 26 species in 10 phyla (i.e. Annelida, Arthropoda, Brachiopoda, Bryozoa, Chordata, Cnidaria, Echinodermata, Mollusca, Porifera and Sipuncula) were found in beached and benthic plastic debris (Tables 1 and 2; Figs. 3–5). Annelida and Bryozoa were the most abundant phyla, both present with >100 specimens in 47.7% of the benthic biofouled plastics (Table 1), and >100 specimens of Annelida and 14 specimens of Bryozoa found in the 57.1% and the 71.4% of the biofouled beached plastic debris, respectively.

The most common benthic fouling species were: the annelid Spirobranchus triqueter (Linnaeus, 1758) (45.5%), the brachiopod Novocrania sp. (29.5%), the bryozoan Chorizopora branchiartii (Audouin, 1826) (22.7%), the bryozoans Arbo-percula tenella (Hincks, 1880) (19.2%), Cryptosula pallastana (Moll, 1803) (11.5%), ?Annectocyema sp. (11.5%), Fenestrulina maluissi (Audouin, 1826) (11.5%), and Aetea sita (Couche, 1844) (11.5%), the chordate Phallosia mammilata (Cuvier, 1815) (9.1%), the echinoderm Ophiomastia fragilis (Aaldergaard, 1789) (6.8%), and the mollusc Barbatia barbatia (Linnaeus, 1758) (4.5%). These taxa represented also the 45.2% of all species (Table 2). Fifteen out of the 26 species identified (61.5% of the total) were shallow-water bryozoans (Figs. 4 and 5), the 87.5% of which belongs to the order Cheilostomatida and the 12.5% to the order Cyclostomatida.

Specimens belonging to Annelida, Brachiopoda, Bryozoa and Chordata were found at all depths. Chordata were the most abundant at 350
and 366 m depths, while bryozoans and annelids at 100 and 293 m depths (Table 3). Cnidaria and Mollusca were found at 100 and 350 m depths, while Arthropoda were only found at 293 m depth; Echinodermata, Porifera and Sipuncula were only found at 100 m depth.

### 3.2. Plastic characterization

Benthic and beached plastic debris colonized by organisms was composed of different polymers including polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PET), chlorinated polyethylene (CPE), polyurethane (PU), polyvinyl chloride (PVC) and polyamide (PA) (Table 4). PE debris was the most abundantly found, representing the 47% of the samples. The remaining samples were composed of PP (13.7%), PET (11.8%), CPE (9.8%), PS (7.8%), PU (3.9%), PVC (3.9%), and PA (2.0%). Plastic composed of PET, PE and PS showed the highest diversity of biofouling organisms, with nine, eight and seven phyla, respectively (Table 4). Annelid specimens were found attached to each plastic type except for PA.

### 3.3. Variations in the fouling communities

Non-metric multidimensional scaling (nMDS) showed that fouling communities grouped separately according to the sampling area (Fig. 6). PET/PS and PU/PVC fouling communities had a similar grouping, while communities grouped separately according to the sampling area (Fig. 6).

### 4. Discussion

In this study, we have found a diverse range of phyla (i.e. Annelida, Arthropoda, Brachiopoda, Bryozoa, Chordata, Cnidaria, Echinodermata, Mollusca, Porifera and Sipuncula) attached on floating, benthic and beached plastic substrates ranging in size from a few mm to 40 cm. This adds to the growing body of evidence that plastics function as substrates for colonization by a great number of marine organisms, and therefore can act as potential vector for their dispersion (Barnes, 2002; Maso et al., 2003; Zettler et al., 2013).

Some of the phyla and the species identified in this study have been already reported on benthic plastic debris in the Mediterranean Sea. This is, for example, the case of the annelid Spirorbanchus triqueter, the arthropod Lepas anatifera, the bryozoan Arbopercula tenella, the chordate Phallusia mammillata, the cnidarians Alcyonium palmatum and Eunicella verrucosa, the mollusc Neopycnodonte cochlear and the phylum Porifera (Hincks, 1880; Rosso, 1994; Thessalou-Legaki et al., 2012; Gündoğdu et al., 2017; Ferrario et al., 2018; Crocetta et al., 2020; Carugati et al., 2021). This study adds three new phyla to the previous records, i.e. Brachiopoda, Echinodermata and Sipuncula.

Only in a few studies bryozoans on plastics are identified to species level (Hincks, 1880; Rosso, 1994; Thessalou-Legaki et al., 2012; Sololover et al., 2016; Ferrario et al., 2018), likely due to the lack of taxonomic expertise. It is in fact representatives of the phylum Bryozoa the most commonly found attached to plastic debris, being the most species-rich and the most abundant in specimen number, as resulted in this study. This is expected as bryozoans are abundant and diverse worldwide (>6000 living species; Bock and Gordon, 2013), including the Mediterranean (>550 species; Rosso and Di Martino, 2016), almost exclusively sessile and ubiquitous, being present from the tropics to the intertidal to the deep sea (e.g. Figueroa et al., 2012, 2018; Almeida et al., 2021). Previous studies also confirm bryozoans as ubiquitous organisms on plastic and other floating debris in the sea (e.g.
Watts et al., 1998; Thiel and Gutow, 2005; Ferrario et al., 2018; Rech et al., 2018). For instance, 49 bryozoan species were reported on 317 objects that drifted across the N Pacific Ocean after the Tsunami of 2011 (McCuller and Carlton, 2018). Here, we have also found a non-indigenous bryozoan species (*A. tenella*), that was previously reported on plastics in other sectors of the Mediterranean Sea (Hincks, 1880; Rosso, 1994; Thessalou-Legaki et al., 2012; Thessalou-Legaki et al., 2012; Ferrario et al., 2018; Orfanidis et al., 2021). Our findings thus suggest that the increasing introduction of plastic debris might increase the chances for the introduction of non-indigenous species in different sectors of the Mediterranean, an issue that needs to be addressed for instance increasing the number of surveys that characterize biofouling organisms at species level. Specifically, in the case of *A. tenella* further future sampling should be promoted to confirm its establishment on natural and/or artificial habitats. In the current study, we did not find any invasive species although other studies worldwide reported some invasive species belonging to different phyla (Annelida, Bryozoa, Cnidaria, Mollusca and Porifera) on a variety of different floating objects.
substrates, including macroalgae (e.g. Avila et al., 2020) and plastic items (e.g. Barnes, 2002; Kiessling et al., 2015).

It is known that biofouling can be influenced by the size and composition (polymer) of plastic debris apart from season, geographic location (proximity to propagule sources), water temperature, nutrient levels and the velocity and turbulence of the surrounding water flow (Becker and Wahl, 1991; Melo and Bott, 1997; Callow and Callow, 2002; Kerr and Cowling, 2003). Based on our data, we found a clear separation of fouling communities according to the sampling area, as expected from previous studies. The limited number of species found on floating plastic debris, probably due to the limited colonization surface available given to to the size of microplastics, explains part of the difference in the fouling composition between sampling areas. In addition, the high proportion of egg cases of Scyliorhinus sp. found attached to the benthic plastic debris (22.7%) partly explain the difference between the benthic plastic fouling communities and those on beached and floating plastics. We highlight that this finding may have implications for egg transport and dispersal, but further research is needed to assess the possible impact on the geographical and habitat distribution of this catshark species.

Biofouled plastic debris were mostly composed of PE > PET > PP. However, PET > PE > PS seems to favour the colonization by a greater variety of organisms (Table 4). Regardless of the polymer type, most plastics in our study shared the most abundant species (e.g. the non-indigenous bryozoan A. tenella (PE, PP); the bryozoan Chorizopora brunniartii (PET, PS, CPE), the brachiopod Novocrania sp. (PE, PP, PET, PS, PU, PVC), and the annelid Spirobranchus triqueter (PE, PP, PET, PS, CPE, PVC)), suggesting that these particular species have no substrate preference for a plastic type. However, our results also suggest that plastic polymers may be relevant for distinct fouling communities except for some specific polymers (PET vs PS and PU vs PVC), likely due to their chemical structure and/or surface properties, as seen in microbial assemblages in PS vs PE and PVC (Vaksmaa et al., 2021). A more exhaustive assessment is, however, needed to confirm that specific polymers have a role in selecting for a specific fouling community.

The most abundant benthic and beached plastic debris found colonized by organisms were made of polymers with lower densities than seawater (Table 4), suggesting that biofouling may play an important role in the transport of plastic debris to the seafloor. This is also supported by the fact that all the bryozoan specimens found attached to benthic plastic were shallow-water species but were instead found at depths of 100 m or more. Therefore, the deposition of low-density plastic debris in the benthic environment may be facilitated by biofouling, which increases the density of plastic debris (and decreases buoyancy), and thus forces them to sink below the surface (Kowalski et al., 2016). This sinking may not be immediate, as when fouled debris sink, changes...
in the fouling community caused by predation or a lack of light below
the euphotic zone may cause plastic to drift up and down in midwaters
(Ye and Andrady, 1991; Andrady, 2011). Eventually plastic debris may
be fouled so heavily that their density is sufficient to remain on the
seafloor (Ye and Andrady, 1991; Andrady, 2011; Ryan, 2015; Fazey and
Ryan, 2016a, 2016b). The differences found here in the fouling
composition between sampling areas reinforces the existence of these
community changes during sinking or transport of plastic debris. Our
data also suggest that this deposition is not permanent. The presence of
several species (e.g. *S. triqueter*) in biofouled beached plastic debris
obtained from the wrack line suggest that plastic debris in coastal en-
vironments are resuspended by bottom currents and transported and
beached during storms. This supports the idea of a significant amount of
plastic entering the ocean being temporary trapped in the coastal zone
(Lebreton et al., 2018; Li et al., 2020), though may be eventually
funnelled to the deep sea when high energy downslope hydrodynamic
processes occur (Tubau et al., 2015; Dominguez-Carrío et al., 2020).

**Fig. 5.** SEM micrographs of some bryozoan species found encrusting benthic plastic debris. A) *Fenestrulina malusi*; B) *Hagiosynodos latus*; C) *?Plagioecia* sp.; D) *Reptadeonella violacea*; E) *Schizomavella cornuta* and F) *Schizoporella dunkeri*.

5. Conclusions

Our findings show that buoyant and benthic plastic debris provides
habitat for a diverse range of marine organisms. The high number of
bryozoan species identified, including a non-indigenous species,
attached to plastic debris highlights the need for further studies of
fouling communities at the lowest taxonomic level possible in order to
detect non-native and invasive species, confirm their establishment on
natural and/or artificial habitats and, consequently, changes of their
distributional range. Our findings also suggest that the transport of low-
density plastic debris (i.e. PE and PP) to the seafloor, and their posterior
deposition in benthic environments, may have been facilitated by the
biofouling. In addition, the species found attached to beached plastic
debris also suggest that these debris may move to deeper areas due to
bottom currents, or even return to the shoreline as a result of wave ac-
tion during storms. Biofouling may thus be one mechanism responsible
for the substantial proportion of the plastic that is ‘missing’ from the
ocean surface. With an increasing arrival of plastic waste in the ocean in
the coming years, plastic debris will become progressively a more common substrate for marine organisms. Therefore, these phenomena have considerable ecological ramifications and consequences that deserve further research.

CRediT authorship contribution statement

Arnau Subías Baratau: Data curation, Formal analysis, Investigation, Methodology, Writing – original draft. Anna Sanchez-Vidal: Conceptualization, Data curation, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. Emanuela Di Martino: Investigation, Methodology, Writing – review & editing. Blanca Figuerola: Conceptualization, Data curation, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Table 3
Trawl depth, phyla and species found, and number of plastic debris with that species.

| Trawl  | Average depths (m) | Phyla              | Species                      | Number of debris |
|--------|--------------------|--------------------|------------------------------|------------------|
| Trawl 1| 366                | Chordata           | Scyliorhinus sp.             | 4                |
|        |                    | Bryozoa            | Arborecula tenella           | 1                |
|        |                    | Annelida           | Spirobranchus triqueter      | 1                |
|        |                    | Brachiopoda        | Novocrania sp.               | 1                |
| Trawl 2| 350                | Chordata           | Scyliorhinus sp.             | 5                |
|        |                    | Annelida           | Spirobranchus triqueter      | 2                |
|        |                    | Brachiopoda        | Novocrania sp.               | 2                |
|        |                    | Cnidaria           | Unidentified species         | 1                |
|        |                    | Mollusca           | Cephalopoda eggs             | 1                |
| Trawl 3| 293                | Bryozoa            | Arborecula tenella           | 3                |
|        |                    | Annelida           | Spirobranchus triqueter      | 4                |
|        |                    | Brachiopoda        | Novocrania sp.               | 3                |
|        |                    | Chordata           | Scyliorhinus sp.             | 1                |
|        |                    | Arthropoda         | Lepas anatifera              | 1                |
| Trawl 4| 100                | Annelida           | Spirobranchus triqueter      | 14               |
|        |                    | Bryozoa            | Aetea sica                   | 3                |
|        |                    | Chordata           | Phallusia mammillata         | 4                |
|        |                    | Cnidaria           | 5 indeterminate species      | 5                |
|        |                    | Mollusca           | 8 indeterminate species      | 5                |
|        |                    | Echinodermata      | Novocrania sp.               | 7                |
|        |                    | Mollusca           | Ophiuroides fragilis         | 4                |
|        |                    | Arthropoda         | Neopneshordite coeruleum     | 1                |
|        |                    | Cnidaria           | 3 indeterminate species      | 3                |
|        |                    | Echinodermata      | 3 indeterminate species      | 3                |
|        |                    | Mollusca           | Neopneshordite coeruleum     | 1                |
|        |                    | Echinodermata      | 3 indeterminate species      | 3                |
|        |                    | Mollusca           | Neopneshordite coeruleum     | 1                |
|        |                    | Echinodermata      | 3 indeterminate species      | 3                |
|        |                    | Mollusca           | Neopneshordite coeruleum     | 1                |
|        |                    | Echinodermata      | 3 indeterminate species      | 3                |
|        |                    | Mollusca           | Neopneshordite coeruleum     | 1                |

Table 4
Number of benthic and beached debris of each plastic type, and phyla found. CPE = chlorinated polyethylene; PA = polyamide; PE = polyethylene; PET = polyethylene terephthalate; PP = polypropylene; PS = polystyrene; PU = polyurethane; PVC = polyvinyl chloride; PP = polypropylene; PS = polystyrene; PU = polyurethane; PVC = polyvinyl chloride. Annelida (1); Arthropoda (2); Brachiopoda (3); Bryozoa (4); Chordata (5); Cnidaria (6); Echinodermata (7); Mollusca (8); Porifera (9); Sipuncula (10).

| Plastic type | Number of benthic debris | Number of beached debris | Density (kg/m³) | Phyla |
|--------------|--------------------------|---------------------------|-----------------|-------|
| PP           | 6                        | 1                         | 850–920         | 1, 3, 4, 5, 6 |
| PE           | 21                       | 3                         | 890–980         | 1, 2, 3, 4, 5, 6, 7, 8 |
| PE           | 4                        | 1                         | 930–960         | 1, 2, 4, 5, 6 |
| PE           | 2                        | 0                         | 960–1260        | 1, 3, 4 |
| PS           | 4                        | 0                         | 1040–1080       | 1, 3, 4, 5, 6, 7, 8 |
| PA           | 1                        | 0                         | 1120–1160       | 5     |
| PET          | 5                        | 1                         | 1380–1410       | 1, 3, 4, 5, 6, 7, 8, 9, 10 |
| PVC          | 1                        | 1                         | 1380–1410       | 1, 3  |
Fig. 6. Non-metric multidimensional scaling (nMDS) visualizing Bray-Curtis similarities of fouling communities from all sampling areas based on presence/absence data (stress value = 0).

Fig. 7. Non-metric multidimensional scaling (nMDS) visualizing Bray-Curtis similarities of fouling communities on all polymers based on presence/absence data (stress value = 0.0447). CPE = chlorinated polyethylene; PA = polyamide; PE = polyethylene; PET = polyethylene terephthalate; PP = polypropylene; PS = polystyrene; PU = polyurethane; PVC = polyvinyl chloride.
Acknowledgements

We thank M. Ramírez for collecting benthic samples on board the vessel La Perla de Palamós, L. de Haan from the Faculty of Earth Sciences for his help during the plastic characterization, and N. Ferrer from the Scientific and Technical Centres of the University of Barcelona for the technical assistance with the FT-IR spectrometer. BF was supported by the postdoctoral fellowships programme Beatriz de Pinós funded by the Secretary of Universities and Research (Government of Catalonia) and the Horizon 2020 programme of research and innovation of the European Union under the H2020 Marie Skłodowska-Curie Actions grant agreement no. 801370 (Incorporation grant 2019 BP 00183), and by the Juan de la Cierva programme funded by the Ministry of Science and Innovation (Incorporation grant IJCI-2017-31478). EDM was supported by the European Research Council (ERC) under the European Union’s Horizon 2020 - Research and Innovation Framework Programme (grant agreement no. 724324 to L.H. Liow) and the Research Council of Norway (grant 314499 to E. Di Martino). This research has received support through a Catalan Government Grups de Recerca Consolidats grant to GRC Geociencies Marines (ref. 2017 SGR 315) and the ‘Severo Ochoa Centre of Excellence’ accreditation (CEX2019-000928-S) to Institut de Ciències del Mar.

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