Ocean Surface Currents
Plastic does not biodegrade—it photo-degrades breaking down into small particles that wreck havoc with marine life.
Unfortunately, marine creatures mistake plastics in the ocean for food.
Unfortunately, marine creatures mistake plastics in the ocean for food

- turtles
Presence of plastic debris in loggerhead turtle stranded along the Tuscany coasts of the Pelagos Sanctuary for Mediterranean Marine Mammals (Italy)

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

Keywords: Marine debris; Loggerhead turtle; Plastic; Tyrrhenian Sea

A B S T R A C T

This work evaluated the presence and the frequency of occurrence of marine litter in the gannet nesting tract of St. Ciriaco on the island of San Domino in the Tyrrhenian Sea. Marine debris was present in 71% of specimens and were subdivided in different categories according to Polman Protocol (2006). The main type of marine debris found was plastic debris, with the main occurrence of plastic waste plastic. The small juveniles showed a mean ±SD of marine debris items of 19.0 ± 23.6, while the adult specimens showed higher values of marine litter if compared with the juveniles (28.8 ± 35.8). The occurrence of marine debris observed in this work confirmed the high impact of marine-debris in the Mediterranean Sea in term of other seas and oceans, and highlighted the importance of C. caretta caretta as good indicator for marine litter in the Marine Strategy Framework Directive (MSFD) of European Union.

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1. Introduction

Plastic marine debris accumulation and dispersal is a growing problem on a global scale, affecting all marine environments (Murphy, 2006; Gregory, 2009). Marine debris, defined as any manufactured or processed solid waste imported into the marine environment (Cox and Rogers, 1991), is proving to have a widespread negative impact on marine wildlife. Although there are various types of debris, plastics (synthetic organic polymers) make up most of the marine litter worldwide. The main sources of marine debris are litter from ships, fishing and recreational boats, and garbage carried into the sea from land-based sources in industrialized and highly populated areas (Cerriulli, 2002). The threat of marine debris to the marine environment has been ignored for a long time and only in the last decades it has been given serious attention.

Marine organisms may be impacted by litter in various ways. At least 40% of existing vertebrate species, all species of marine turtles, approximately 30% of the world’s sealid species, and many species of fish have been reported to ingest marine litter (Katsurada, 2008). The entanglement of marine species, especially fish (Sarina et al., 2020), turtles (Carret, 1987), birds (Arnould and Consoli, 1995) and mammals (Shapiro, 1986; Beck and Barros, 1991; Arnould and Consoli, 1995), has been frequently described as a serious mortality factor. Ingestion of debris (mainly plastics) in sea turtles, seabirds and marine mammals has often harmful effects, such as a worsening physical condition (Spear et al., 1995), diminished food stimuli (Ryan et al., 1986), blockage of the digestive system, lowered steroid hormone levels, delayed ovulation and reproductive failure (Azzurro and Van Vlier, 1987), internal injuries and death following blockage of the intestinal tract (Ryan et al., 1988; Beck and Barros, 1995).

Loggerhead turtles (Caretta caretta) are carnivorous, foraging primarily on benthic invertebrates throughout their distribution range. The high diversity in the type of prey demonstrated versatility in foraging behavior, suggesting that the loggerhead is a generalist (Plaistow and Ansens, 1990). On the basis of these considerations the loggerhead turtles can ingest large quantity of plastic debris that can be mistaken for food.
Unfortunately, marine creatures mistake plastics in the ocean for food

- fish
Plastic debris ingestion by marine cetaceans: An unexpected fisheries impact

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ARTICLE INFO

Keywords:
- North Atlantic
- Fisheries
- Marine debris
- Plastic

ABSTRACT

Plastic marine debris is a pervasive type of pollution. River basins and estuaries are a source of plastics pollution for coastal waters and oceans. Erratic beaches therefore exposed to chronic plastic pollution. These important cetacean species (e.g., killer whales, bottlenose dolphins, and humpback whales) are typically found in these areas. Although plastic debris is a growing concern, little is known about the fate of plastic debris in marine environments. This study aimed to investigate the presence of plastic debris in a coastal area of the North Pacific Ocean. The results of this study indicate that plastic debris is becoming a significant concern for marine animals. Understanding the impacts of plastic debris on marine ecosystems is crucial for developing effective conservation strategies. The authors call for increased research efforts to address the challenges posed by plastic debris in marine environments.

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Ingestion of plastic marine debris by longnose lancetfish (Alepisaurus ferox) in the North Pacific Ocean

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ARTICLE INFO

Keywords:
- Oceanic longnose lancetfish
- Alepisaurus ferox
- Plastic

ABSTRACT

Plastic debris affects species on multiple trophic levels, including pelagic fish. While plastic ingestion impacts the ecology of pelagic species, little is known about the ecological implications of plastic debris ingestion on pelagic fish. The objectives of this study were to determine the frequency of occurrence and the composition of ingested plastic debris in longnose lancetfish (A. ferox). A total of 90 fish were collected in the North Pacific Ocean, and 67% of these fish were found to contain at least one plastic debris item. The results of this study highlight the potential for plastic debris to impact the health of pelagic fish populations. Understanding the impacts of plastic debris on pelagic species is crucial for developing effective conservation strategies. The authors call for increased research efforts to address the challenges posed by plastic debris in marine environments.

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Unfortunately, marine creatures mistake plastics in the ocean for food

- Whales

Dwarf sperm whale
Evaluating the impacts of marine debris on cetaceans

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ARTICLE INFO

Keywords:
Marine debris
Cetaceans
Entanglement
Ingestion
Plastic

ABSTRACT

Global in its distribution and pervading all levels of the water column, marine debris poses a serious threat to marine habitats and wildlife. For cetaceans, ingestion or entanglement in debris can cause chronic and acute injuries and increase pollution loads, resulting in morbidity and mortality. However, knowledge of the severity of effects lies behind limitations of other species groups. This literature reviews examines the impacts of marine debris on cetaceans reported to date. It finds that ingestion of debris has been documented in 46% of cetacean species, with rates of ingestion as high as 31% in some populations. Debris-induced mortality rates of 6–23% for stranded animals were documented, suggesting that debris could be a significant conservation threat to some populations. We identify key data that need to be collected and published to improve understanding of the threat that marine debris poses to cetaceans.

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1. Introduction

The continued accumulation of debris in the marine environment is a growing global concern and is now considered a major threat to marine biodiversity (Sterfies et al., 1995; Macpherson et al., 2009; Saffran and Pyman, 2010; CDE, 2012). An estimated 6.4 million tonnes of marine litter is dumped in oceans every year (2007; 2008) and in hotspots of accumulation more than 3.5 million pieces of litter can occur per square kilometre (Yamasita and Teramura, 2009). As well as being a problem of checking magnitude it is also one which will be long-lived. Plastics, which constitute between 60% and 80% of marine debris, may fragment but does not biodegrade and can persist in the marine environment for hundreds to thousands of years (Derelinka, 2002; Barnes et al., 2009). A widespread variety of marine habitats and fauna are now under pressure from its effects and quantities of marine debris are increasing even in the most remote areas, far removed from source locations (Derelinka, 2002; Barnes et al., 2009).

For marine fauna, the primary impacts of marine debris are from ingestion or entanglement (Gregory, 2009). Ingestion may cause blockage of the digestive tract leading to starvation, whilst entanglement can result in drowning or strangulation (Laws, 1997). Sub-lethal effects may also occur; entanglement or ingestion of debris can compromise feeding capacity and digestion and thereby cause malnutrition, disease, and reduced reproductive output, growth rates and longevity (Mccarthy and Bjorndal, 1998; Katsarouvalis, 2008). In addition to the risk of physical trauma, when ingesting plastics animals are exposed to an additional source of toxins (Tymien et al., 2008; Andreoudi, 2011). The chemical additives in plastics and persistent, bioaccumulative and toxic (PBT) chemicals which adsorb and concentrate on plastic in the water column can leach into the body following ingestion (Ingling, 2012; Fossi et al., 2012). This further amplifies pollutant burdens within individuals and through transfer from prey to predator, within food chains (Eklund and Botten, 2003).

The last few years have seen the impacts of marine debris documented in a wide range of species, from plankton (Thompson et al., 2004; Cade et al., 2011) and fish (Bucher et al., 2013) to marine megafauna (Boers et al., 2006; Fossi et al., 2012; Simmonds, 2012). Marine debris interactions are now known to be both widespread within the marine food web (Frei de Sou e Costa, 2013) and occurring at high rates in some species groups (CDE, 2012). However, for cetaceans the rates of mortality, morbidity and the population-level consequences remain poorly understood (Williams et al., 2011; Simmonds, 2012).

Detection of debris interactions in cetaceans largely depends on data collected from the small sample sizes provided by stranded animals, presenting only a snapshot of the impacts occurring unseen at sea. From the point at which an interaction occurs a series of events must take place in order for it to be detectable – an animal must strand, be found, and then reported to the appropriate authority. Relatively few cetacean deaths are therefore documented; studies in the northern Gulf of California found that as few as one in every 200–2000 (range: 8–62%) cetaceans are recovered from cetacean strandings at sea, with high inter-specific variability in recovery rates (Williams et al., 2011a). Even when an animal does strand, only a fraction are subject to a full necropsy and in even fewer cases can a cause of death be established and it is the data subsequently published. The decomposition or condition of the
Unfortunately, marine creatures mistake plastics in the ocean for food

- Seabirds
Prevalence of marine debris in marine birds from the North Atlantic

Jennifer F. Provencher, Alexander L. Bond, April Heed, William A. Montecchi, Sabir Bin Musaffar, Sarah J. Courchene, Grant Gilchrist, Sarah E. Jamieson, Flemming R. Møller, Knud Falk, Jan Durinck, Mark L. Malloky

1. Introduction

Plastic pollution is a major emerging problem facing the environment. In 2011, over 30 metric tons of plastic debris are dumped into the world's oceans. This plastic debris can grow in size and become more hazardous as it travels through the marine environment. In this study, we investigated the prevalence of plastic debris in marine birds from the North Atlantic ocean. We found that plastic debris is present in every sample we examined, and that its prevalence is increasing over time. This is a serious problem that needs to be addressed immediately.

2. Methods

2.1. Study sites

Ashmore Reef, Commonwealth Marine Reserve (12°30'S, 12°30'S) lies within Australian Commonwealth waters, approximately 630 km north of Brisbane, Western Australia (Fig. 1). The reef contains four lightly vegetated islands (East, Middle, and West Islands and Slinging Creek) on a total land area of 17 ha and is home to some of the most important seabird colonies in the North West Shelf (Clarke et al., 2012). In this study, we investigated the prevalence of plastic debris in samples collected from Ashmore Reef, with the intention of understanding the extent of this problem.

Many marine birds are susceptible to plastic ingestion, particularly those that consume small prey on the surface of the water, as this is where plastic tends to float and accumulate. The prevalence of plastic debris in marine birds from the North Atlantic is of concern, as this may indicate that the problem is becoming worse over time.
Unfortunately, marine creatures mistake plastics in the ocean for food.

- And the list goes on and on and on....
Evidence of microplastics in samples of zooplankton from Portuguese coastal waters

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A R T I C L E  I N F O
Article history:
Received 20 October 2015
Received in revised form 27 December 2015
Accepted 8 January 2016

Keywords:
Microplastics
Plastics
Zooplankton
MDS
PTU
Portugal

A B S T R A C T

Records of high concentrations of plastic and microplastic marine debris floating in the ocean have led to investigate the presence of microplastics in samples of zooplankton from Portuguese coastal waters. Zooplankton samples collected at three offshore sites, in surveys conducted between 2003 and 2006, with these different sampling methods, were used in this preliminary study. A total of 172 samples were processed and microplastics were identified in 10 of these, corresponding to 61% of the total. Costa Vicentina, followed by Lousa, were the regions with higher microplastic concentrations (0.03 and 0.01 m², respectively). Microplastics accumulations were also higher in these two regions, which is probably related to the proximity of densely populated areas and inputs from the Tajo and Sado rivers estuaries. Microplastics polymers were identified using Thermo Fisher Transform infrared Spectroscopy (μFTIR), as polyethylene (PE), polypropylene (PP) and polyurethane (PU). This paper is the first report on the composition of microplastic particles collected with plankton nets in Portuguese coastal waters. Plankton surveys from regular monitoring campaigns conducted worldwide may be used to monitor plastic particles in the oceans and constitute an important and low-cost tool to address marine litter within the scope of the Marine Strategy Framework Directive (2008/56/EC).

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1. Introduction

In recent years, the presence and impacts of plastic marine debris (PMD) have been documented throughout the world in all oceans. Plastic debris, which may be unintentionally lost or deliberately discarded, tend to accumulate in coastal areas, posing a direct threat to marine fauna through ingestion and entanglement (Crittenden et al., 2002; Allen et al. 2012; Côté et al., 2013; Wetzel et al., 2015). It is estimated that 80% of PMD derive from land sources (Althaus et al., 2009), being transported by water courses (river streams, drainage systems, ocean currents) and atmospheric forcing (Guerra et al., 2009; Perasso, 1983; Last, 1887; Andrady, 1989; Aller et al., 2009; and) or migratory animals (birds, turtles, dolphins, seals, among others) (Dias et al., 2009; Travieso et al., 2009; Frey et al., 2011), enabling PMD to travel great distances, being found in remote regions far away from any known source (Dias et al. and Coasta, 2007; Barnes et al., 2009; Martins and Sobral, 2011; Hedrick et al., 2012). PMD concentration increase in the oceans is linked to human consumption behaviour, industrial activities and poor waste management. This includes the widespread dispersion of PMD in the open ocean, as plastic floats and is transported by surface currents. High concentrations of plastics and microplastics accumulate in convergence zones known as ocean gyres (Pitch et al., 2007). Reports of the high incidence of PMD in the North Pacific Central Gyre (Moore et al., 2001, 2002; Moore, 2008; Calabrese et al., 2011) and in other places of the world, have raised concern and an unprecedented interest for research on the topic in the areas of marine sciences (Derraik, 2002; Arthur et al., 2007; Thompson et al., 2004) as well as in social sciences (Thibet et al., 2007; Bravo et al., 2009; Wong and Thibet, 2010; Sias and Spalding, 2010).

Microplastics, defined as plastic materials or fragments with a diameter below 5 mm (Arthur et al., 2007), have also the tendency to increase concentration over time as result of plastic degradation, factors like solar radiation, abrasion, water and wind movements cause PMD to break into progressively smaller pieces without...
Marine Debris also creates navigational hazards.

Radar bar deliberately cutoff from a large vessel.
Collecting samples using a manta trawl

- 1 meter X .5 meter
- 330 micron net
- 2-3 knots
- Varied time from
  15 minutes to 1 hr
The Plastic Ocean Project

http://www.plasticoceanproject.org/

Underwater look at the trawl
Samples from the North Atlantic Gyre (Bermuda Atlantic Time Series Station (BATS))
Results from first set of samples in the North Atlantic Sargasso Sea

Separated samples by size, type, and color (1-2.36 mm, most fragments are white)

Rough Estimate from study
Sargasso Sea is 3,520,000 km² = 3,440 tonnes of plastic
Data comparison 2009 and 2010 surveys

<table>
<thead>
<tr>
<th>Trawl</th>
<th>Sample Distance (m)</th>
<th>Plastic Sample Weight (g)</th>
<th>Plastic (g/m²)</th>
<th>Plastic (g/km²)</th>
<th>Plastic (kg/km²)</th>
<th>North Atlantic Sub-Tropical Gyre* Tonnes</th>
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<tr>
<td>Mean by weight</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>3440</td>
</tr>
</tbody>
</table>

| July 2010 |                     |                           |                |                |                 |                                       |
| 1     | 3401                | 1.9                       | 0.000559       | 559            | 0.559           | 1966                                  |
| 3     | 1986                | 0.46                      | 0.000232       | 232            | 0.232           | 815                                   |
| 4     | 1921                | 1.383                     | 0.000720       | 720            | 0.720           | 2534                                  |
| 5     | 2658                | 0.488                     | 0.000184       | 184            | 0.184           | 646                                   |
| 6     | 1475                | 1.846                     | 0.001250       | 1250           | 1.250           | 4405                                  |
| 7     | 3004                | 1.234                     | 0.000411       | 411            | 0.411           | 1446                                  |
| 8     | 2486                | 1.948                     | 0.000784       | 784            | 0.784           | 2758                                  |
| 9     | 1711                | 1.457                     | 0.000852       | 852            | 0.852           | 2997                                  |
| 10    | 2199                | 3.365                     | 0.001530       | 1530           | 1.530           | 5386                                  |
| 11    | 747                 | 1.717                     | 0.002300       | 2300           | 2.300           | 8091                                  |
| 12    | 935                 | 3.015                     | 0.003230       | 3230           | 3.230           | 12534                                 |
| Mean by weight |               |                           |                |                |                 | 3854                                  |

Combined Estimate of the Plastic Pollution in the NASTG

- combined average NA subtropical gyre surface waters
  ~3200 tonnes of plastic
- plastic distribution is highly variable- some of this can be associated with eddies
- association between plastic distribution and Sargassum mats is not strong

*3,520,000 square kilometers
Findings

- Every Sargasso trawl contained plastic
- Plastics were extremely heterogeneous
- Preliminary data suggests there is an increase in accumulation
- Plastics washed out to sea appear to photo-degrade, fragment, and wash up on Bermuda’s beaches
PROCESSING THE SAMPLES
Life in the “Plastisphere”: Microbial Communities on Plastic Marine Debris

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Supporting Information

ABSTRACT: Plastics are the most abundant form of marine debris, with global production rising and documented impacts in some marine environments, but the influence of plastic on open ocean ecosystems is poorly understood, particularly for microbial communities. Plastic marine debris (PMD) collected at multiple locations in the North Atlantic was analyzed with scanning electron microscopy (SEM) and Next-Generation sequencing to characterize the attached microbial communities. We unraveled a diverse microbial community of bacteria, archaea, and eukaryotes, with 16S rDNA gene surveys identifying several hydrocarbon-degrading bacteria, supporting the possibility that microbes play a role in degrading PMD. Some Plastisphere members may be opportunistic pathogens (the authors, unpublished data) such as specific members of the genus Vibrio that dominated one of our plastic samples. Plastisphere communities are distinct from surrounding surface waters, implying that plastic serves as a novel ecological habitat in the open ocean. Plastic has a longer half-life than most natural floating marine substrates, and a hydrophobic surface that promotes microbial colonization and biofilm formation, differing from autoclaved substrate in the upper layers of the ocean.

INTERVIEW: Plastic has become the most common form of marine debris since it entered the consumer arena less than 60 years ago, and presents a major and growing global pollution problem.1-3 The current global annual production, estimated at 245 million tonnes, represents 33 kg of plastic produced annually for each of the 7 billion humans on the planet, approximating the total human biomass. Some fraction of the increasing amount of postconsumer plastic trash inevitably escapes the recycling and waste streams and makes its way to the global oceans. Additionally, trash and storms can result in large piles of plastic entering the ocean from coastal areas. Plastic accumulates not only on beaches worldwide, but also in remote open ocean ecosystems.4-7 Dotted frays and physical oceanographic models have shown that surface particles such as PMD can passively migrate from Eastern Seaboard locations all the way to the interior of the North Atlantic Subtropical Gyre in less than 60 days.8,9 Examining how quickly humans generated debris can impact the gyre interior that is more than 1000 km from land. Plastic debris in the North Atlantic Subtropical Gyre8 and North Pacific Subtropical Gyre is well-documented8,10 and models and limited sampling confirm that accumulations of PMD have formed in five of the world’s subtropical gyres.2,11-12 The effects of plastic debris on animals such as fish, birds, sea turtles, and marine mammals as a result of ingestion,13-14 and marine entanglement15-16 are well documented, but studies of plastic-associated microbial communities are lacking and we know little about the impact of this anthropogenic substrate and its attached community on the oceanographic open ocean. As a relatively new introduction into the marine ecosystem, plastic debris provides a substrate for microbes that last much longer than most natural floating substrates and has been implicated as a vector for transportation of harmful algal species17 and persistent organic pollutants (POPs).18-20 With a hydrophobic surface rapidly stimulating biofilms formation in the water column, PMD can function as an artificial “microbial reef,” PMD at concentrations of up to 5 x 10^6 pieces/m^3 in the North Atlantic Subtropical Gyre2 represents a new floating...
THANK YOU!