Deborah Meaden
@DeborahMeaden

A grieving pilot whale carrying her dead baby for days.... oh I can't bear it. We have to change. #BluePlanet2
8:52 PM - Nov 19, 2017

aisha.
@avocadamn

my tears are indistinguishable from the ocean at the moment
#BluePlanet2
8:52 PM - Nov 19, 2017

Ashleigh 🏖️🍴כול
@fitasfudge

Anyone who thinks animals don't have emotions needs to watch that poor pilot whale, carrying her dead baby for weeks, refusing to let it go. 😢🐋 #BluePlanet2 #emosh

Thomas Ling, Radio Times 20 Nov, 2017
Available on iPlayer

Drowning in Plastic

Wildlife biologist Liz Bonnin discovers the true dangers of plastic in our oceans.

BBC One  90 MINS
Available for 21 days  First shown: 1 Oct 2018
Entanglement
Ingestion
Fishing and livelihoods
Eriksen et al., 2014 Plastic pollution in the world’s oceans: more than 5 trillion pieces weighing over 250,000 tons afloat at sea. PLoS One, e111913
Jambeck et al., 2015 Plastic waste inputs from land into the ocean. Science, 347, 768-771
Zalasiewicz et al., 2016 The geological cycle of plastics and their use as a stratigraphic indicator of the Anthropocene. Anthropocene, 13, 4-17.
Rafting and dispersal

...and the introduction of alien species
Biofilm formation

1. Attachment to surface
2. Formation of monolayer and production of matrix
3. Microcolony formation, multi-layer
4. Mature biofilm, with characteristic “mushroom” formed of polysaccharide
5. Detachment and reversion to planktonic growth, starting a new cycle

Birte Hollmann, Mark Perkins, (University of Nottingham); British Society for Immunology
Plastic marine debris collected at multiple locations in the North Atlantic

- Scanning electron microscopy to visualise microbial community

- Next generation DNA sequencing to characterise the community compared to the surrounding seawater
Figure 2. SEM images showing examples of the rich microbial community on PMD: (a) pennate diatom on sample C241_07 with possible prosthecate filaments produced by *Hyphomonas*-like bacteria; (b) filamentous cyanobacteria on sample C230_01; (c) stalked predatory suctorian ciliate in foreground covered with ectosymbiotic bacteria (inset) along with diatoms, bacteria, and filamentous cells on sample C230_01; (d) microbial cells pitting the surface of sample C241_12. All scale bars are 10 μm.
Fig. 1. Impacts and interactions of marine plastic debris. Solid black arrows indicate known effects; dotted black arrows indicate the yet unexplored effects/interactions as mediated by marine plastic debris.
Do pathogens bind to marine plastics...?
Evidence from DNA sequencing

Human exposure routes
Does marine plastic debris influence the persistence of pathogens at bathing beaches?


_E. coli_ is a faecal indicator organism (FIO) used as a compliance parameter in the EU Bathing water Directive.
Nurdles on bathing beaches...

...16% colonised by E. coli

Quilliam et al., (in review). Colonisation of plastic pellets (nurdles) by E. coli at bathing beaches. Marine Environmental Research
Microplastics ( < 5 mm)
Waste water treatment works

An opportunity for pathogen colonisation...?
Biofilms and gene exchange

Microplastic pollution increases gene exchange in aquatic ecosystems

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ARTICLE INFO

Article history:
Received 1 December 2017
Received in revised form 26 January 2018
Accepted 19 February 2018
Available online 28 February 2018

ABSTRACT

Pollution by microplastics in aquatic ecosystems is accumulating at an unprecedented scale, emerging as a new surface for biofilm formation and gene exchange. In this study, we determined the permissiveness of aquatic bacteria towards a model antibiotic resistance plasmid, comparing communities that form biofilms on microplastics vs. those that are free-living. We used an exogenous and red-fluorescent E. coli donor strain to introduce the green-fluorescent broad-host-range plasmid pKJK5 which encodes for trimethoprim resistance. We demonstrate an increased frequency of plasmid transfer in bacteria associated
Do plastics serve as a possible vector for the spread of antibiotic resistance? First insights from bacteria associated to a polystyrene piece from King George Island (Antarctica)

Pasqualina Lagana, Gabriella Caruso, Ilaria Corsi, Elisa Bergami, Valentina Venuti, Domenico Majolino, Rosabruna La Ferla, Maurizio Azzaro, Simone Cappello

**ARTICLE INFO**

Keywords: Plastic, Polystyrene, Plastisphere, Antibiotic resistance, Vector, Antarctica

**ABSTRACT**

The retrieval of a polystyrene macro-plastic piece stranded on the shores in King George Island (South Shetlands, Antarctica) gave the opportunity to explore the associated bacterial flora. A total of 27 bacterial isolates were identified by molecular 16S rRNA gene sequencing and 7 strains were selected and screened for their ability to produce biofilm and antibiotic susceptibility profiles. All the bacterial isolates were able to produce biofilm. The Kirby-Bauer disk diffusion susceptibility test to 34 antibiotics showed multiple antibiotic resistances against the molecules cefuroxime and cefazolin (belonging to cephalosporins), cinoxacin (belonging to quinolones) and ampicillin, amoxicillin + clavulanic acid, carbencillin and mezlocillin (belonging to beta-lactams). The obtained results suggest that plastics can serve as vectors for the spread of multiple resistances to antibiotics across Antarctic marine environments and underline the relevance of future studies on this topic.

**1. Introduction**

To date, a plethora of studies are documenting the ubiquitous occurrence in diverse environmental matrices of different and relatively new plastic polymers, including low and high density polyethylene transport of land litter by wind, represent important routes through which plastic pollution reaches marine environments ([Ryan et al., 2009; Jambeck et al., 2015]). Sludge amendment or plastic mulching are relevant sources for plastic contamination in continental systems ([Stabila et al., 2015]).
Discharge and transport to human receptors
Microplastics can accumulate in mussel flesh


Fig. 3. Polarized-light microscopy images showing the presence of plastic particles in haemolymph (A), gills (B), gut lumen and epithelium (C), digestive tubules (D).
Toxicology of plastics

• Plasticisers (mainly phthalates) are sometimes added to plastics to increase the plasticity, but can leach out over time
• Persistent organic pollutants (POPs) can bind to plastics
  – e.g. PAHs and PCBs

Bioaccumulation of toxins in the food chain
• Most laboratory-based absorption-desorption studies use non-colonised plastic...
• ...however, microbes in the plastisphere may either mitigate toxicity through biodegradation, or enhance it by increased biofilm binding

What are the multi-pollutant and multi-scale effects of microplastics in the environment...?
Plastics are not just a marine issue
Microbial Biodegradation...?

Are microbes the solution...?