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**Research Project Proposal**

# Do microplastic fragments present a hazard to marine life?

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**A call for project / funding partners in conjunction with KIMO International**

Plastics have brought many societal benefits and are hugely important in modern life. As a consequence annual production has increased from 5 million tonnes in the 1950s to over 230 million tonnes today. Because of their durability, discarded plastic items are accumulating in landfill and as litter in terrestrial and aquatic habitats. This debris poses a global environmental problem and has been identified as one of the most important pollution-related issues in the UK. Since most plastics are buoyant the problems associated with this debris are particularly evident in marine habitats where over 180 species including mammals, birds, fish and invertebrates are known to ingest plastic. The incidence of ingestion can be extremely high. For example, in the North Sea over 95% of Fulmars (*Fulmarus glacialis*) were found to have plastic in their guts (Fig. 1). There is increasing concern that ingestion of plastic debris presents a hazard to wildlife and could lead to the transfer toxic chemicals to the food chain.

Fig. 1) Plastic from the stomach of a Fulmar

Our research, at the University of Plymouth, has shown that plastic debris is fragmenting in the environment and that microscopic pieces of common polymers (microplastics, Fig. 2 A) including polyethylene, polyvinyl chloride and polypropylene are now present on shorelines and in the water column throughout the North East Atlantic. Pieces as small as 2µm have been identified and their abundance has increased over the last 40 years (Fig. 2A - E). Some samples of strandline material now contain more that 10% plastic and because conventional polymers will not biodegrade it seems inevitable that the abundance of these fragments will continue to increase. Their abundance together with their size mean that such fragments could be ingested by a wide range of organisms including birds, fish and small invertebrates (Fig. 3).

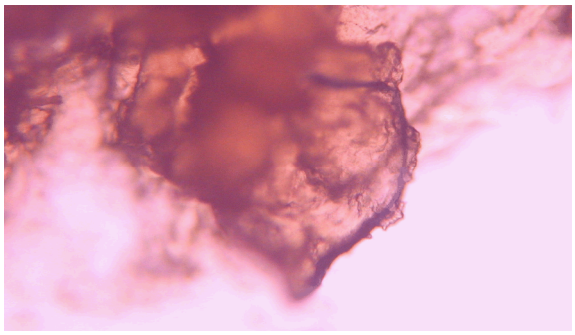

Fig. 3) Microscopic fragment of plastic in gut of a Sand hopper (*Orchestia gammarellus).*

Fragments of plastic have been shown to concentrate pollutants that have arisen in the environment from other sources. This effect can be substantial with persistent organic pollutants such as PCBs, DDE, nonylphenols and phenanthrene becoming 5 to 6 orders of magnitude more concentrated on plastic debris than in the surrounding seawater. Some plastics also contain potentially harmful substances that are incorporated during manufacture as flame-retardants, plasticisers and antimicrobials. Research in our laboratories, using the lugworm, *Arenicola Marina* (a common deposit feeder eaten by numerous species of birds and fish), has shown that ingestion of plastic could provide a mechanism facilitating the transport of these pollutants to the food chain.

Given the quantities of plastic waste that are discarded annually it is now essential to establish the full environmental significance of plastic debris in the transport of pollutants to marine life. We have developed a research programme to address this using a range of differing polymer types (including plastics of differing size and age) and contaminants. Uptake of contaminants together with any associated biological consequences will be evaluated using deposit and filter feeding marine organisms. Experiments will be run alongside appropriate controls, using natural particulates, to establish the extent to which ingestion of plastic fragments results in an

additional burden of contaminants in animal tissues. The outcomes of these experiments will then be modelled to give a risk assessment of the types, quantities and condition of plastic debris that would be required to cause detrimental effects on natural populations.

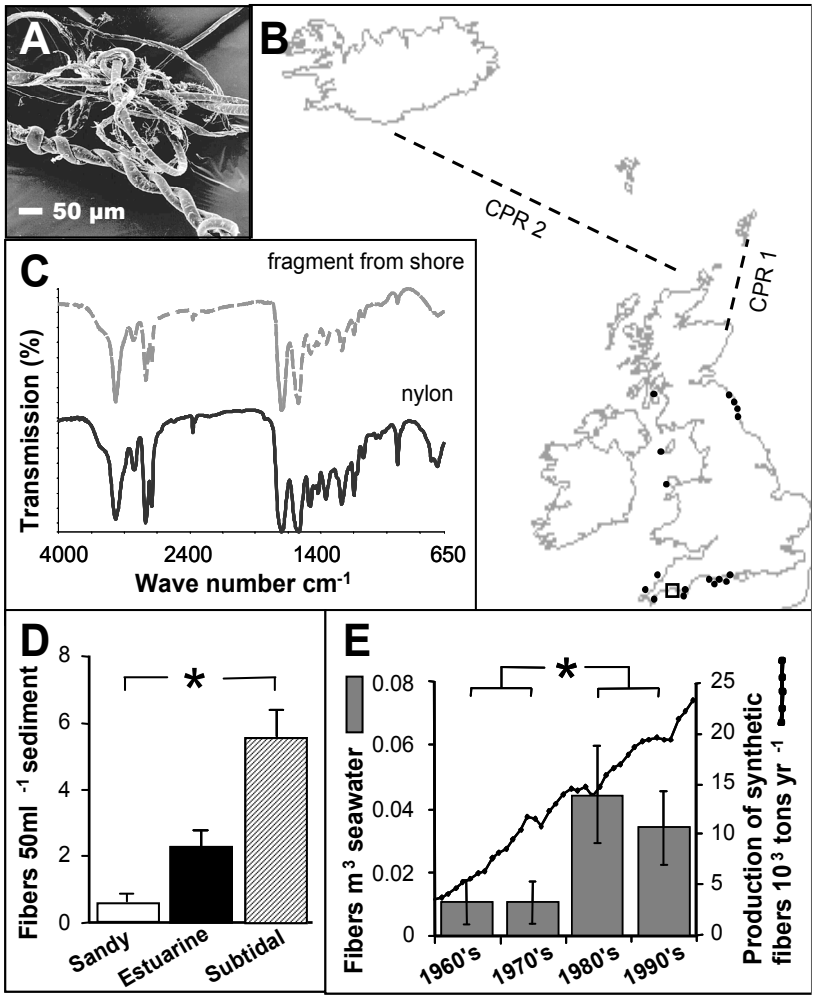


Fig. 2) (**A**) Fragment of microscopic plastic from shoreline. (**B**) Sampling locations in North-East Atlantic, showing Routes sampled by Continuous Plankton Recorder (CPR 1 and 2) since 1960 and used to assess the abundance of microplastics in the water column (Fig. 1E). Shores where similar fragments were found (●) and location of sites near Plymouth (□) used to compare the abundance of microscopic plastic among habitats (Fig. 1D). (**C**) Example showing how FT-IR spectroscopy was used to identify fragments from the environment. Here an unknown fragment is identified as nylon. (**D**) There were significant differences in abundance of microplastics between sandy beaches and subtidal habitats (ANOVA, $F_{2,3} = 13.26$, * = $P < 0.05$), but abundance was consistent among sites within habitat type. (E) Accumulation of microscopic plastic in CPR samples revealed a significant increase over time when comparing the 1960's and 1970's to the 1980's and 1990's (ANOVA $F_{3,3} = 14.42$, * = $P < 0.05$). Approximate figures for global production of synthetic fibres overlain for comparison. Microplastics were also less abundant along the oceanic route CPR 2 than CPR 1 ($F$ 1, 24 = 5.18, $P < 0.5$). Reproduced with permission from Thompson *et al.* (2004), Lost at sea where does all the plastic go? *Science,* 304, 838.

The proposed research will require a three-year position for an experienced postdoctoral researcher together with technical support for the numerous analyses and invertebrate trials. The University of Plymouth has all of the facilities to undertake the work, including a state of the art ISO 900-acredited radio-chemical facility. Costs for research staff, consumables and overheads are around £150,000 per year for three years (total £450,000). We are applying to the Natural Environment Research Council (NERC) for funding in the form of a partnership grant (deadline 1/12/08). These grants require a 25% external contribution with NERC covering the remaining 75% of the costs. We are therefore seeking partners to contribute some or all of the £112,500 external funding (£37,500 per year for three years).

Our work to date has attracted considerable interest from the general public, the media (New York Times, Washington Post, La Monde, El Pais, Guardian, BBC), government (Defra and Cefas in the UK and NOAA in the US) and non-government organisations including OSPAR, KIMO and Marine Conservation Society. The proposed work represents a major advancement in our knowledge about the effects of debris in the environment. KIMO, an international association of local authorities committed to reducing marine litter, have given full support to the proposal and agreed to facilitate discussions with potential project partners/funders. KIMO will subsequently act as an advisor on the steering committee and promote the project results to policy makers through their observer status at the OSPAR Commission. It may also be possible for other funders to join the steering committee. Further information on how to participate with KIMO as a project partner/funder can be obtained from John Mouat (john.mouat@kimo.shetland.org) or Dr Richard Thompson (rcthompson@plymouth.ac.uk).