MICROPLASTIC CONTAMINANTS IN SURFACE WATERS AROUND THE ANTARCTIC PENINSULA: THE IMPORTANCE OF QUALITY CONTROL AND ASSURANCE

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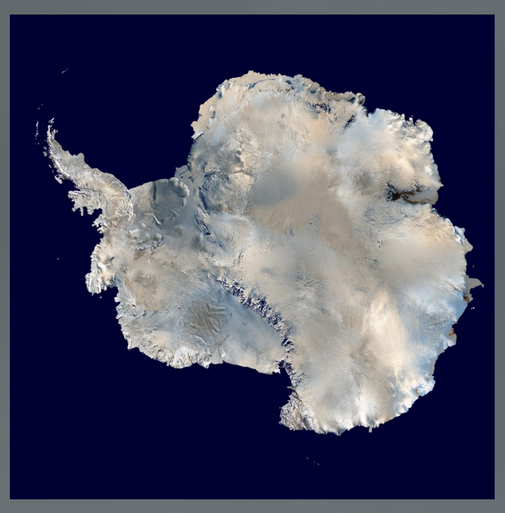
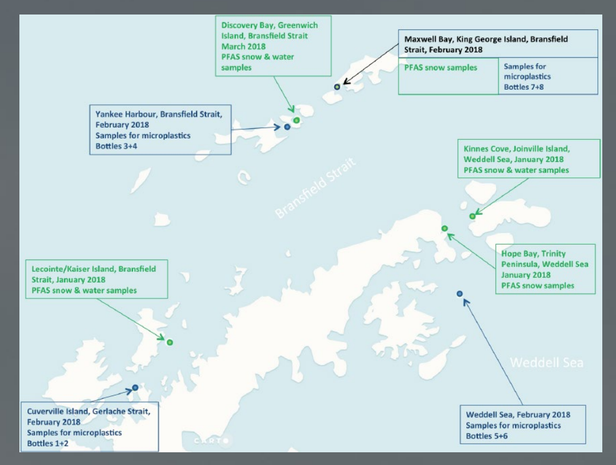
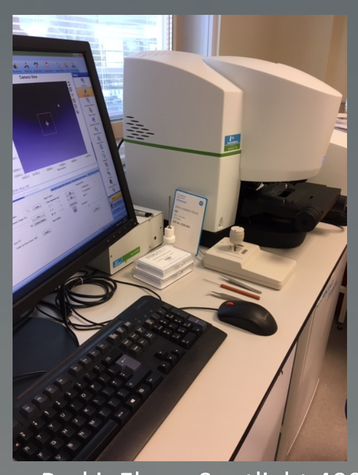


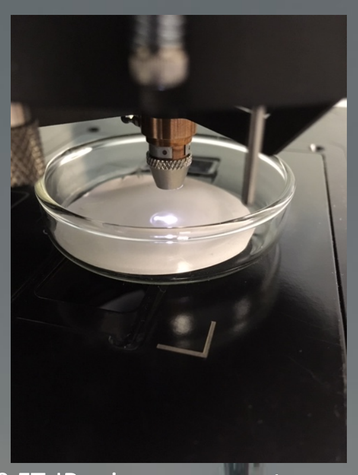
Introduction:

- Microplastics have been identified as contaminants in all ocean areas, but remarkably few data are available on their distribution in Antarctic waters.
- Alongside need for more research on the distribution of microplastics in the region, there are calls for greater standardisation of methods and detailed description of quality control measures to enable comparison of findings between studies.
- Measures to avoid contamination and cross contamination are especially important when sampling for the presence of the smaller size fractions of microplastics, including synthetic fibres, from vessels operating in remote environments.
- **In February 2018, researchers and crew of the Greenpeace vessel MV Arctic Sunrise collected duplicate surface seawater samples from 4 locations close to the Antarctic Peninsula, using as stringent contamination avoidance protocols as possible.**



Locations for microplastics samples (in blue)

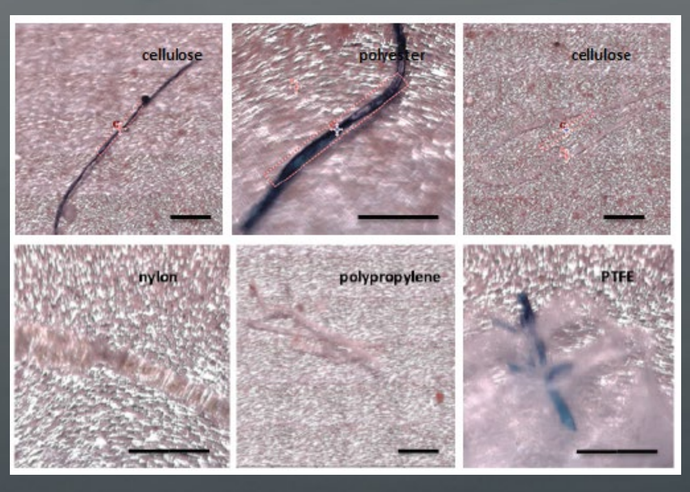




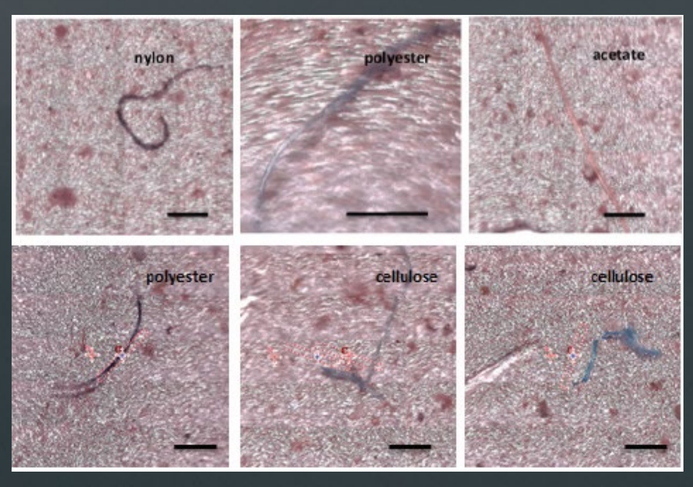
PerkinElmer Spotlight 400 FT-IR microscope system

Quality control:

1. All bottles detergent washed, rinsed 3 times with DI water & 3 times with 5µm filtered DI water before being sealed wet to avoid dust deposition in drying. Lab glassware prepared in same way immediately before use.
2. Samples collected in 500ml bottles held on 3m stainless steel pole, up-current from the RHIB, transferred immediately to Winchester & sealed until filtration in lab.
3. Samples filtered in a pre-cleaned fume cabinet with air flow turned off.
4. Internal surfaces of glass petri dishes and surfaces of silver filters were carefully inspected under dissecting microscope and cleaned of any fibres or dust before use.
5. External surfaces of petri dishes and all tools (forceps, needles) were cleaned with ethanol and treated with an anti-static 'gun' before each handling.
6. Nitrile gloves and cotton lab coats worn at all times during sample handling.
7. Candidate microplastics were marked immediately after filtration using a needle to scratch the surface of the silver filter, so that any airborne fibres could be excluded.
8. Fragments or fibres yielding spectral match qualities <70% were 'unidentified'; matches above this threshold were only accepted following expert interpretation, with any remaining uncertainty leading to 'tentative' identification only.
9. Any fibres or fragments with spectra matching those in additional custom libraries of laboratory contaminants (e.g. tissues, gloves, lab coats) or shipboard contaminants (e.g. safety clothing, ropes, paint fragments) were rejected.
10. **Procedural blanks:** 2 x 2.5 litre of 5 µm filtered DI water were transferred from one Winchester to a 500 ml glass bottle and back to another pre-cleaned Winchester in an outdoor urban environment, before filtration and inspection as above; only 2 small amorphous dust particles (no fibres) were found in one of the two blanks.



Weddell Sea (63°54.053 S; 056°42.496 W) 22/02/18
2.8 - 3.2 fibres/litre



King George Island (62°12.145 S; 058°56.488 W) 26/02/18
2.8 - 5.6 fibres/litre

Results:

- All 8 samples (4 location duplicates) contained at least one man-made fibre, at densities of between **0.8 and 5.6 fibres per litre**, and with at least one of those fibres confirmed by FT-IR as microplastic in 7 of the 8 samples.
- Brightly coloured (especially blue, red or black) fibres nonetheless identified as cellulose were common to all samples (as reported for surface seawater and biota in other regions); most probably these are synthetic regenerated cellulosic fibres such as those used in textiles.
- A number of other fibres and fragments appeared to be of natural origin, including irregular, transparent cellulose fibres, chitin fragments and inorganic matter. These are not included in the counts. A minority of fibres could not be identified to sufficient match quality against library spectra.

Conclusions:

- Microplastics and other synthetic materials can be found contaminating even some of the remotest surface waters on the planet
- This indicates the need for further research into the scale of the problem and its potential impacts, as well as closer investigation of possible sources.
- Conspicuous presence of brightly coloured, uniform cross-section modified cellulosic material in this and other studies also deserves further investigation
- Low overall abundances highlight **vital importance of strict contamination control procedures at all stages**, from equipment preparation through sample collection and storage to sample handling and analysis in the laboratory.
- Detailed QA/QC procedures are shared as a contribution to the development of standardised methods that minimise contamination artefacts.

The MV Arctic Sunrise heading south to the Weddell Sea
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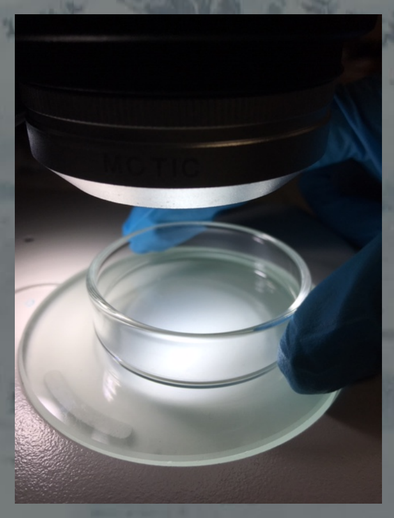
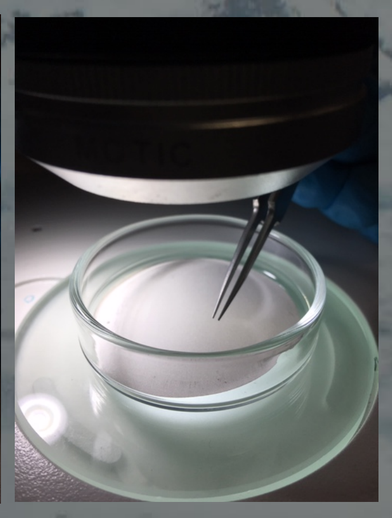
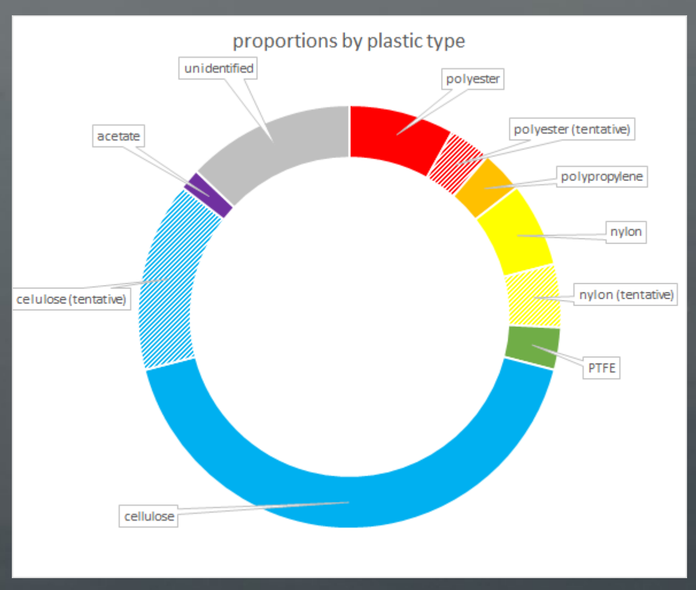
Methods:

- 2 x 2.5 litre samples of surface seawater (top 10 cm) were collected at each location (from a RHIB and using a 3m steel sampling pole) as composites of 5 x 500ml, each into pre-rinsed Winchester bottles.
- Samples were returned to the Greenpeace Research Laboratories at the University of Exeter for filtration through 47mm diameter, 5µm pore size silver membrane filters (Sterlitech®).
- Candidate microplastics (fibres and fragments) were identified using light microscopy (dissecting microscope) and marked for further analysis before drying filters (40°C for 24h).
- Material type (polymer or other material) was determined using Fourier-Transform Infrared (FT-IR) microscopy (PerkinElmer Spotlight 400, MCT detector) either in reflectance mode (4000 to 750 cm^{-1}) or using a micro-ATR accessory (4000 to 650 cm^{-1}) and accumulating 16-32 scans at a resolution of 4 cm^{-1}.
- Spectra were analysed using a combination of automated matching against spectral libraries (commercial & custom built) and expert interpretation of peak position & relative intensity.

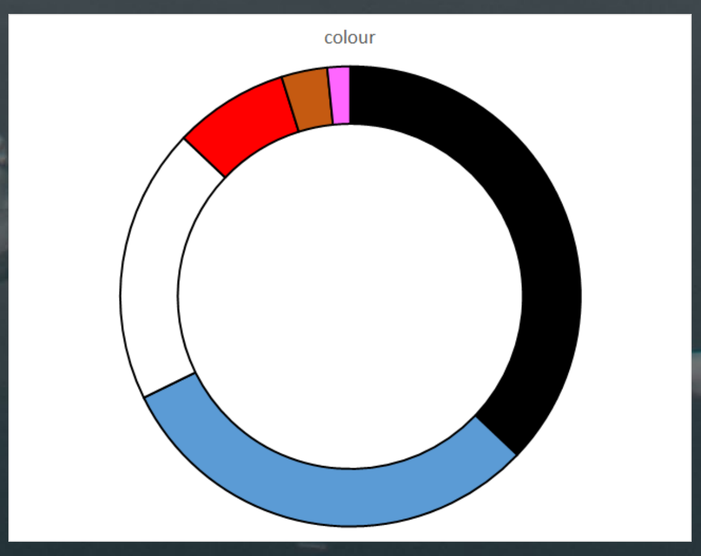




Dissecting microscope in use for contamination control



Proportions of man-made fragments and fibres found across all 8 samples



Frequency colour distribution for all man-made fragment and fibre colour across the samples

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This work would not have been possible without the patience and hard work of the crew of the Greenpeace vessel MV Arctic Sunrise. Availability of the Spotlight 400 imaging FT-IR microscopy system was made possible under a Research Partnership Agreement between the Greenpeace Research Laboratories and PerkinElmer.

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Full study available here