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Plastic biodegradation in arctic, a source of uncertainty in plastic contamination

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The Arctic is subject to plastic contamination via global transport, but local contamination in communities is also significant. Indeed, due to a lack of resources, waste management is mainly carried out through incineration and long-term open-air storage. Microorganisms can colonize those plastics, and potentially degrade it, releasing nanoplastics to free molecules (additives or depolymerization products).

To have a better understanding of the plastic end-of-life cycle and the associated ecotoxicological issues in order to optimize waste management, it is necessary to detect plastic along the size continuum and their transformation products. A method allowing detection of the various degradation products was first developed using thermodesorption-pyrolysis-gas chromatography-mass spectrometry (TD-Py-GCMS). In this objective, plastics found in landfills in two Arctic communities: Cambridge Bay, Nunavut, Canada, and Ittoqqortoormiit, Greenland were collected as well as the snow surrounding these locations. The plastic was cultivated in carbon-free media for a period of one year. The culture medium was then analyzed and compared with on-site snow.

Of the sixty cultures examined, 12 exhibited biological growth, thereby demonstrating that microorganisms could develop consuming carbon from plastic. The presence of nanoplastics was detected in both the associated snow and the cultures. In addition, a variety of molecules were identified, including additives such as phthalates, dyes, antioxidants, and degraded additives, along with depolymerization molecules. Despite the presence of common molecules, significant variations were observed, highlighting the multiple sources of contamination present in the environment or modification of equilibrium in controlled condition. Furthermore, DNA analyses have demonstrated the substantial diversity both between and within cultures. This phenomenon has yielded encouraging results, indicating the potential for adaptation of Arctic microorganisms to plastic contamination.

These results demonstrate that, although it remains minimal, the adaptation of microorganisms to this novel substrate constitutes a uncertainty in the process of contamination that is influenced by numerous factors that remain to be fully elucidated. At present, the phenomenon appears to be negligible; however, it is probable that it will increase in scale in the coming decades as microorganisms adapt to these conditions.