cubic meter of seawater have been reported in an area adjacent to a polyethylene production plant (Wright et al. 2013) and 33 particles per cubic meters in the north Pacific tropical gyre (Goldstein et al. 2012).

The risk to marine fauna

Information of the ecological consequences of microplastic pollution is nascent; however, there is increasing evidence of direct and indirect effects associated with the ingestion by organisms and the toxic responses from inherent contaminants leaching from the microplastics and from extraneous pollutants that adhere to them (Cole et al. 2011; Teuten et al. 2009). The size of microplastics is equivalent to many plankton species and it has been hypothesised that planktivores, filter feeders and suspension feeders passively ingest microplastics during normal feeding patterns (Wright et al. 2013). Once microplastics settle into sediments, they also become available for incidental ingestion by detritus feeding organisms (Murray and Cowie 2011; Thompson et al. 2004), including sea cucumbers (Graham and Thompson 2009). The ingestion of microplastics is hypothesised to have the same effect as that observed for ingestion of macroplastics in vertebrates, including internal and/or external abrasions and ulcers, and blockages of the digestive tract, resulting in reduced reproductive fitness, and increases in natural mortality rates due to increased potential for drowning, diminished predator avoidance and impairment of feeding ability (Wright et al. 2013).

The manufacture of many plastics often includes additives (e.g. polybrominateddiphenyl ethers, nonylphenol, triclosan) to extend the longevity of the product, and these additives are potentially toxic to biota if they leach out during ingestion (Barnes et al. 2009; Browne et al. 2007; Thompson et al. 2009b). Microplastics also provide surfaces for the attachment of other waterborne pollutants, including metals (Ashton et al. 2010; Holmes...
et al. 2012), and POPs (persistent organic pollutants) (Hirai et al. 2011; Mato et al. 2001; Rios et al. 2007; Teuten et al. 2009), some of which are endocrine-disrupting chemicals (Rochman et al. 2014). POPs are hazardous humanmade chemicals such as polychlorinated biphenyls (PCBs), different sorts of organochlorine pesticides (e.g. DDTs and HCHs) and brominated flame-retardants. All of these toxins can impact the mobility, reproduction and development, and immune responses and carcinogenesis in wildlife and humans (Barnes et al. 2009; Cole et al. 2011; Teuten et al. 2009). POPs accumulate in fatty tissues of marine organisms. Although bioaccumulation has been detected in marine organisms (Cole et al. 2011; Besseling et al. 2013; Teuten et al. 2009) the importance of microplastics as a vector for magnification of persistent, bioaccumulative and toxic substances in higher trophic organisms remains uncertain (Gouin et al. 2011).

Microplastics may also act as a vector for more indirect ecosystem change. Species that were once restricted by a lack of hard substrate are potentially able to proliferate from the increase in surfaces for attachment (Goldstein et al. 2012; Gregory 2009). The consequences to industries that are reliant upon current ecosystem structures (e.g. some mariculture businesses) may be detrimental if such species are invasive.

The international response

The prevalence of microplastics in the marine environment is likely to increase in the immediate future given the rising consumption of plastics worldwide (Thompson et al. 2009a). International awareness and response on microplastics, however, is gaining momentum. Global initiatives such as the Global Programme of Action for the Protection of the Marine Environment from Land based Activities, the International Convention for the Prevention of Pollution from Ships, and the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter have been in existence for several decades. More recently national initiatives have been initiated. For example, in the United States, legislation banning microbeads has been introduced to the US House of Representatives. Similar legislation has also been introduced to legislators in New York, and recently passed in Illinois and California. The European Parliament has also voted to phase out plastic bags that fragment rather than degrade.

The implications of microplastics for Pacific fisheries

The implications for fisheries from microplastics are poorly understood and largely speculative due to a lack of knowledge in key areas for policy formation. The prevalence of microplastic pollution across the Pacific needs to be clarified. There is sufficient evidence to indicate higher densities in the north Pacific tropical gyre and the coastal habitats of Asia, Japan and the Americas, although information on the prevalence of microplastics in the coastal regions of the Pacific Island countries and other oceanic habitats is missing. Based on observations from other oceans and modelling, microplastics can be expected to be present in those areas as well. A surveillance programme for Pacific Island countries would resolve this data gap but also identify which fisheries are most likely to be impacted. For example, a better understanding of microplastic distribution may assist with planning for sea cucumber aquaculture and/or mariculture investments in the region to avoid potential for lowered performance or product contamination.

Similarly, initiatives to improve food security through increases in fish consumption in the region may be compromised from bioaccumulation of toxins in coastal and oceanic fishes. Designing a surveillance program that establishes a baseline reference of toxin accumulation in food security species would determine the potential for acute or chronic health consequences for Pacific Island communities from exposure to this pollutant.

A better understanding of the spatial distribution of microplastics and the bioaccumulation in higher order predators may also assist with the trade associated with the region’s tuna fisheries. Opportunities may exist to obtain a higher price for products that come from areas with very low or zero prevalence of microplastic pollution.

The longevity and buoyancy of microplastics means that pollutants can cross several jurisdictional boundaries before they settle into sediments. The transboundary nature of the pollutant calls for both regional and national policies to minimise impacts. Developing a regional strategy for microplastics would be an important first step that would guide the development and implementation of surveillance activities, identify risk to industry and trade (e.g. invasive species), and guide the development of appropriate national policies on this topic.

References


In a nutshell: Microplastics and fisheries


