Microplastics – a scourge stalks the sea

Asia's voracious appetite for disposable plastics and poor waste management systems are devastating the marine environment

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Sometime in 2009, Bindu Sulochanan, a marine ecologist at Mangalore's Central Marine Fisheries Research Institute (CMFRI), was dissecting sardines in her laboratory. Scientists at the CMFRI have been doing this for decades, to study the feeding behaviour of various ocean-dwelling fish. As Dr. Sulochanan peered at the contents of the fish's gut under a microscope, she noticed something unusual - bright unnatural shades such as yellow, instead of the drab colours of the semi-digested plankton that sardines eat. She was looking at plastic. From litter thrown on beaches by people, the plastic had entered the water, and the fish had mistaken it for food. "We were shocked," Dr. Sulochanan says. In some samples, the plastic was shredded and unrecognisable, but in larger fish, the source was obvious. Some plastics had readable print on them, linking them to branded milk packets and blister packs of medicines.

Up to 90% of albatross chicks had plastic pieces in their stomach

It was just the beginning. Since 2009, CMFRI's scientists have recovered plastic from the gut of dozens of species: mackerel near Mangalore, yellowfish tuna near Kochi and anchovies off the coast of Alappuzha, among them. In 2014, researchers from Gujarat's Sasan Gir Forest Department did a post-mortem on the 1-ton carcass of a Longman's Beaked Whale on a beach in the Sutrapada municipality. They found four large plastic bags in the whale's stomach. It appeared that the plastic had blocked the whale's digestive system.

Using less, wasting more

Plastics are widespread in the marine ecosystem today, and countries across the globe are contributing to it. But several estimates suggest that Asia is the larger debris-producer. Even though the U.S. and Europe manufacture most of the plastic, Asia seems to be leading in marine debris because of its population density and poor waste management.

In a 2015 *Science* study, the researchers estimated that India had dumped 0.6 million tonnes of plastic into the ocean in 2010. China was the top dumper, while India ranked 12th and the US ranked 20th. This was despite the fact that Indians generated only around 0.34 kg of waste per person per day (ppd), while Americans threw away 2.58 kg ppd. The problem was that India was mismanaging over 80% of its waste, while in the U.S. it was only 2%. "If you look at packaging of FMCG goods, the US and Europe are the manufacturers. But we are buying it and polluting the environment, because there is no awareness that what we throw comes back to us," says Dr. Sulochanan.

The impact of plastic debris on marine life is just emerging. The commonest way in which plastic hurts is entanglement. Fishing nets lost at sea, and plastic bags can trap fish and mammals, preventing them from swimming, foraging for food and mating. In October 2011, CMFRI researchers on-board the research vessel FORV *Sagar Sampada* sighted a group of about 400 Olive Ridley turtles at sea, likely travelling towards their mass nesting sites on the Odisha coast. One of the turtles was entangled in a plastic buoy, while another had a plastic bag around its neck. While swimming, Olive Ridley turtles dive periodically to find food, but the plastic was preventing them from doing so. "The ultimate fate of these turtles may be death by starvation," the CMFRI researchers wrote on the website of the Marine Biological Association of India.

The biggest culprit in entanglement is "ghost nets", says Vasant Kripa, the head of the Fisheries Environment Management Division at CMFRI, who was aboard the Sagar Sampada when the Olive Ridley sighting occurred. Ghost nets are nylon fishing nets that are either deliberately discarded, or lost. They remain in the water for years. Ironically, fisherfolk are not spared the impacts of plastic debris either. A major problem they face when using stake nets - a vertical mesh in the water that intercepts fish and guides them to traps - is plastic litter. Bags, bottles and other items get caught in the net, reducing the catch. Fishermen throw the litter back into the sea, says Dr. Kripa.

In 2017, the Kerala government began a programme called Suchitwa Sagaram to prevent dumping of nets, and to bring back plastic litter as well. Fishermen can now sell their damaged nets in a buy-back programme. Also, when nets trap litter, the fishermen bring it back to the shore. Until June this year, 28 tonnes of plastic was recovered and used for surfacing roads. Unfortunately, few such programmes exist in India.

Ocean Cleanup Project

In September 2018, an NGO called Ocean Cleanup launched a device to remove half of the plastic in the Great Pacific Garbage Patch within five years. But ecologists warn that it could do more harm than good, by killing marine animals in the process

1. The Great Pacific Garbage Patch has 80,000 tonnes of plastic
2. A 2000-ft cylinder with a 10-ft skirt will be deployed to capture plastic
3. The problem is that the device cannot distinguish between animals and plastic
4. Also, there are fears that greenhouse gas emissions from the project could outweigh the costs
5. Proper management of plastic waste is the only solution to the issue

Blocks digestive tract

If entanglement with plastic hurts marine species, so does ingestion. Plastic can block and perforate the digestive tract. This gives the animal a feeling of fullness, reduces its immunity and leads to starvation. Some of the earliest reports of this phenomenon come from large seabirds called Laysan Albatrosses in the North Pacific Ocean's Midway Island. Researchers found that up to 90% of the albatross chicks had plastic pieces in their stomach. Adult albatrosses normally collect floating fish eggs from the ocean's surface and regurgitate them to feed their chicks. But by the eighties, albatrosses were also plucking bottle caps and cigarette lighters out of the sea, and their chicks were gorging on them. The researchers found no obvious health effects in chicks which ate little plastic, but those which ate over 150 gm had partially blocked digestive systems.

If large birds eat larger plastic pieces, small fish tend to swallow microplastic: particles measuring less than 5 mm, which large plastic disintegrates into. Microplastics settle in phytoplankton, or the microscopic organisms at the base of the marine food chain. So, phytoplankton-eating fish are at risk. CMFRI researchers have found such particles in the guts of anchovies and sardine. These fish are filter feeders: they eat by keeping their mouth open, so that phytoplankton in the flowing water is trapped in filter-like structures called gill-rakers.

The problem is that microplastics are under-researched. One reason is that it is hard to identify them. "You can't recognise them with the naked eye. Sophisticated instruments like spectrophotometers are needed," says Dr. Kripa. As a result, the answers to key questions are unclear.

Estimating the number of individuals exposed is tough, because this would require systematic sampling, which is not common. But CMFRI has begun astudy involving food pellets containing plastic in fish and whether it can damage the intestine.

But there is evidence from elsewhere showing that microplastics hurt species. For example, in one experiment, algae, which are at the base of the food chain, were not able to photosynthesise efficiently when exposed to 20 nanometre polysterene beads. Higher up in the food chain, mussels, when fed microplastics in a lab, developed a type of inflammation called granuloma, and grew slower than usual. Still higher, the Japanese Medaka, a fish species, has been shown to suffer from liver stress when it ingests marine microplastics. In the experiment, the researchers fed the fish three types of food - regular food, virgin microplastic and microplastic that had been left in the San Diego bay for three months. The researchers found that marine microplastics had higher levels of pollutants such as polychlorinated biphenyls than the virgin ones. Further, when the fish were fed all three feeds, the ones that ate plastic ended up with liver damage.

Plastic gives the animal a feeling of fullness, leading to starvation

What next?

Microplastics are as big a worry as macroplastics, says Mark Browne, an ecologist at the University of California, Santa Barbara. Plus, microplastics are more abundant in the water. Yet, few countries, including India have policies to minimise microplastic waste. Most Indian bans focus on large plastics.

What's the best way to target microplastics? In a 2011 study, Dr. Browne showed that synthetic clothing was the largest contributor, given that each garment shed over 1900 fibres per wash. Yet, the U.S. plans to phase out microbeads in cosmetics by 2019, but has no policy on clothing yet.