Speaking of science — Plastic waste: What man has wrought the bugs try to solve

Toxic: Ruminants like cow and buffalo unknowingly devour plastic material and end up dying a slow and painful death. | Photo Credit: M_Karunakaran

The tiny landlocked African country Rwanda has banned plastic bags since a few years. The ban has made this war-torn nation much cleaner. Kenya has just announced a ban on plastic bags, and a fine of 4 years in prison and/or $40,000. The Kenyan seacoast has mountains of plastic waste, making life on land, and in the sea, difficult. Another African nation, Morocco, with a coastline of 1,800 km, has had such a ban for almost a decade. It is time that India, with its 7,500-km coastline, learns from these Africans and bans plastic bags and related stuff before we too choke our seacoasts—and land, too—into a man-made disaster.

The Task Force on plastic pollution, set up by the Planning Commission in 2014, estimated that 60 cities across the country generate over 15,000 tons of plastic waste every day—almost 6 million tons per year. This is what we see daily as we walk around the streets. And cattle and other animals, which freely move around the streets, unknowingly devour some of this plastic material, which is not digested but stays put in their stomachs. Ruminants like the cow and buffalo end up dying a slow and painful death. The holy cow meeting an unholy end!

This dump we see daily is just part of the problem. A much greater, and not so visible disaster looms underwater, a lot of this plastic waste from across the world eventually ends up in the oceans, which cover over 70% of the earth's surface and hold 97% of the earth's water. The amount of plastic rubbish reaching the oceans is 8 million tons per day—that is, one truckload every minute. This would mean that by 2050, there will be more plastic in the world's oceans than fish!

What can science do about it? An interesting theoretical analysis was recently made by Professor Richard Sole of the Pompeu Fabra University in Barcelona, Spain. He estimated that of the huge amounts of plastic thrown in the oceans, the amount floating around is hardly 1%. The rest is sunk way down and/or slowly being degraded or broken down. Which plant, animal or microbe in the ocean might be doing this? And if we identify them, we may have a biological solution to at least part of the problem. The site http://www.dailymail.co.uk/sciencetech/article-4555014/Plastic-eating-microbes-evolved-ocean.html#ixzz4r7uHOSH2 is well worth visiting to learn more.

There is some interesting research being done towards identifying, isolating and studying the biological species that seem to degrade plastics into small molecules that are usable for safer purposes. The species identified so far are some fungi and bacteria. An elementary review on such 'biodegradation of plastics' by A. Muthukumar and S. Veerappanpillai of VIT Vellore lists as many as 32 species of microbes which degrade a variety of plastics which go to make water bottles, carry bags, industrial material and such (see their paper in *Intl. J. Pharm. Sci. Rev. Res.* 2015; 31 (2:, 204-209; free access). And of immediate relevance to the Indian coastline is a report by Sangeetha Devi and others from Bharathidasan University, Tiruchi, also in 2015 (*Marine Pollution Bulletin,* 2015; 96: 32-40, no free access). They found that two strains of the fungus *aspergillus* spp, found in the waters of the Gulf of Mannar degrade the plastic HDPE (which is used to make milk and fruit juice bottles, grocery bags and such).

These fungi seem to release some enzymes which degrade HDPE, essentially breaking up the polymeric molecule into smaller pieces; these enzymes are being studied in some detail by the Tiruchi group. It is clear that further research work from marine organisms will reveal more microbes that are capable of degrading polymeric and plastic wastes. It would also be possible to find their cousins on earth which can degrade these wastes. And, once we study the basic biology

and genetics of these plastic-eating bugs, we can genetically modify them in order to make them more efficient and versatile in handling a variety of wastes.

And more data is becoming available on the types of wastes that are being handled by these microbes. In March 2016, a group from Kyoto University found an two enzymes from the microbe they named as *Ideonella sakainesis* (after the town Sakai in Japan), capable of breaking down the polymer PET (polyethylene terephthalate, used in making packaging trays, polyester clothing and others) into its basic monomeric molecules terephthalic acid and ethylene glycol (S. Yoshida et al., *Science* 2016; 351: 1196), which are used as building blocks for a variety of chemicals. The microbe is found in soil, sediment, waste water and similar material.

Most recently, a group of Pakistani, Sri Lankan and Chinese scientists together showed that the fungus *Aspergillus tubigensis* can degrade yet another major plastic material called polyurethane or PU (Sehroon Khan et al, Environmental Pollution, 2017; 225: 469-480). PU is used in the manufacture of car tyres, gaskets, bumpers, fibres, plastic foam, synthetic leathers and so on. The group found this bug in a general city waste disposal site in Islamabad, which suggests that it would very likely be found at several places in India too.

A cynical wag once said: what science made, let it unmake. It appears that whether it be in water or land (maybe even in the sky), if we work with focus, we would be able to find such plastic waste degrading organisms, and thus try to ‘unmake’ the problem. We can even genetically modify them to suit the purpose. This type of research will bring a great deal of benefit to not only terrestrial life forms but those living under water as well. Ironically enough, work of this kind could even fetch a Nobel Prize for safely breaking down plastics, just as Nobels were given for making plastics in the first place.

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A study of nearly 300 people living in different parts of India found that nine single-base variants (single-nucleotide polymorphisms or SNPs) account

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