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These Very Hungry Caterpillars Can Eat Your Plastic Trash

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Is the real solution to our rapidly growing mountains of plastic trash lurking in the guts of the caterpillars that we feed to our pet birds and lizards?

Plastic drinking straws are some of the most common plastic

Plastic trash is everywhere, and since it has a half-life of *at least* 450 years, every

piece of plastic that has ever been made is still on the planet with us today, except for the tiny amount that we've burned. Plastics are man-made materials comprising long strings of molecules, known as polymers, derived from fossil fuels. Due to the length and configuration of their molecular bonds, plastics are resistant to being composted or to otherwise being broken down into smaller component molecules by exotic and specialised microbeasties, such as bacteria or fungi. Of all sorts of plastics, polyethylene is one of the most resistant to degradation. This plastic is used for packaging, representing roughly 40% of the total annual plastic output. Because stores provide their customers with more than one *trillion* polyethylene plastic bags *every year*, these nearly indestructible plastics are piling up everywhere. Yes, a large number (38%) do end up in landfills, or are recycled (26%), but many (36%) are burned -- and this, too, has serious environmental consequences.

Predictably, plastics also end up in marine environments: for example, the infamous "Great Pacific garbage patch", which contains tiny particles of plastics and other rubbish, is twice the size of Texas. Further, more-or-less intact plastic bags floating in the sea are mistaken for jellyfish and choke the life out of thousands of seabirds, sea turtles and whales every year. In short, people have created a terrible mess, so we are responsible for finding workable solutions for fixing it.

Seaturtle with a half-eaten plastic bag in its mouth. (Credit: Yamamoto Biology / Creative Commons.)

Since bacteria and fungi are quite adept at exploiting unusual energy sources, scientists look to them for potential solutions. After a lot of trial and error, some methods for degrading polyethylene have been developed, and since one of polyethylene's component molecules is ethylene glycol -- antifreeze -- biodegradation produces other useful chemicals. But all of the methods developed so far are quite slow and not very effective. For example; only modest degradation resulted after treatment of polyethylene with nitric acid followed by incubation for 3 months in a liquid culture of a fungus (ref). Exposure to a specific bacterium resulted in slow polyethylene degradation, a process that took between 4 and 7 months (ref).

But help may have arrived, courtesy of Mother Nature herself, in the form of an easily-overlooked moth.

"We have found that the larva of a common insect, *Galleria mellonella*, is able to biodegrade one of the toughest, most resilient, and most used plastics: polyethylene," said developmental biologist Federica Bertocchini, a Ramón y Cajal researcher at the Institute of Biomedicine and Biotechnology at the Universidad de Cantabria in Spain. *Galleria mellonella*, whose larvae are known as waxworms by those who feed

these pale, hairless and chubby caterpillars to their pet birds and reptiles, is also known as the honeycomb moth in recognition of its caterpillars' specialized diet on honeycombs within bumblebee and wasp nests. This drab little moth is native to Europe and Eurasia, where it can be seen flying around from May until October.

Honeycomb moth (Galleria mellonella), mounted, dorsal view. (Credit: Simon Hinkley & Ken Walker / Museum Victoria / CC BY 3.0 au.)

Honeycomb moth caterpillars actually break down polyethylene plastics

This discovery was accidental. In a moment of serendipity, Dr. Bertocchini noticed that plastic bags containing waxworms quickly became riddled with holes.

"Generally speaking I love nature," Dr. Bertocchini elaborated in email.

"[I]n fact, as a hobby, I am a beekeeper. And that is where it all started. I store beehives at home (empty of bees, of course). In cleaning them, I realized they were full of wax worms, and I put them in a plastic bag. In a little while, the worms were all around and the plastic bag was full of holes."

Larva, or caterpillar, of the honeycomb moth, on a piece of polyethylene plastic that it has been eating. (Credit: Cesar Hernández / CSIC.)

Further observation revealed that waxworms can do a lot of damage to a plastic bag in less than an hour. But were the caterpillars actually *digesting* the polyethylene, or were they merely chewing it up into smaller pieces that passed through their guts unaltered, sort of like waxworm roughage?

"Me and my collaborators had been talking about plastic bio-degradation for a while, a few years in fact, although each of us was following a different line of research," Dr. Bertocchini said.

"So, once we saw the holes, that was it, we decided to carry on the investigation."

Lab tests detected the presence of ethylene glycol in the waxworms' guts, confirmation that the waxworms were indeed digesting polyethylene.

But how is it possible that waxworms can digest polyethylene, a polymer they've never before been exposed to until people started to manufacture it, only recently in evolutionary history?

The answer may lie in the ecology of the waxworm itself.

"Wax worms are a pest for beekeepers; they grow and feed on wax and honey," Dr. Bertocchini said in email.

The honeycomb moth lays its eggs inside beehives, and its caterpillars live in honeycombs, eating constantly and

watching the bees work, until they spin a cocoon and transform into adult moths.

"Wax is a polymer, a sort of 'natural plastic,' and has a chemical structure not dissimilar to polyethylene," Dr. Bertocchini points out.

Beeswax itself is composed of a highly diverse mixture of compounds constituting a variety of chemical bonds, although the most common is the carbon-carbon single bond -- the same as that found in polyethylene plastics. Thus, it is likely that the carbon-carbon single bond is one of the targets of digestion.

But is polyethylene digestion something that the waxworm itself does, or is it relying upon one or more of the microbeasties within its gut to carry out the relevant biochemistry? A previous study suggests that several bacterial species in the waxworm's microbiome may actually be biodegrading polyethylene (ref).

At least two bacterial species may living in the guts of waxworms may biodegrade polyethylene (PE) plastics. (Credit: Jun Yang et al., doi:10.1021/es504038a)

As researchers learn more about the precise biochemistry underlying this degradation process from the waxworms' gut flora, we may be able to adapt this process into a practical biotechnological solution for managing polyethylene waste.

"We are planning to implement this finding into a viable way to get rid of

plastic waste, working towards a solution to save our oceans, rivers, and all the environment from the unavoidable consequences of plastic accumulation," said Dr. Bertocchini.

"However," Dr. Bertocchini adds, "we should not feel justified to dump polyethylene deliberately in our environment just because we now know how to bio-degrade it."

Source:

Paolo Bombelli, Christopher J. Howe and Federica Bertocchini (2017). **Polyethylene bio-degradation by caterpillars of the wax moth *Galleria mellonella***, *Current Biology*, **27**, R1–R3, published online on 24 April 2017 before print. doi:10.1016/j.cub.2017.02.060

Also mentioned:

Keiko Yamada-Onodera, Hiroshi Mukumoto, Yuhji Katsuyaya, Atsushi Saiganji, and Yoshiki Tani (2001). **Degradation of polyethylene by a fungus, *Penicillium simplicissimum* YK**, *Polymer Degradation and Stability*, **72**(2):323–327 doi:10.1016/S0141-3910(01)00027-1

S Bonhomme, A Cuer, A-M Delort, J Lemaire, M Sancelme, G Scott (2003). **Environmental biodegradation of polyethylene**, *Polymer Degradation and Stability*, **81**(3):441–452 doi:10.1016/S0141-3910(03)00129-0

Jun Yang, Yu Yang, Wei-Min Wu, Jiao Zhao, and Lei Jiang (2014). **Evidence of Polyethylene Biodegradation by Bacterial Strains from the Guts of Plastic-Eating Waxworms**, *Environmental and Science Technology*, **48**(23):13776–13784 doi:10.1021/es504038a

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