Ending Plastic Waste Symposium 2023

Biorecycling – a promising plastic waste innovation

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Plastic recycling rates remain low in Australia, mainly due to a lack of know-how to convert plastic waste into valuable end products. Our research aims to provide well-characterized, and efficient plastic degrading enzymes for the recycling industry.

The problem

Despite recent efforts to increase plastic recovery from waste, the plastic recycling rates have remained below 15% in Australia. A main obstacle is the lack of efficient and economical methods to break down and recycle plastics. Current approaches employ mechanical recycling, i.e., grinding and remelting of plastic waste. This so-called "down-cycling" creates less-recyclable and lower value products.

The solution

Biorecycling (*Peng et al. 2023*) provides an innovative and valuable solutions to incentivize plastic waste recovery. Biorecycling utilizes natures micro-chemical factories, i.e., microbes, and screens their arsenal of enzymes for plastic degrading properties. For example, we have shown that the gut microbiome of superworms on a polystyrene diet (**Fig. 1**) contains a range of bacteria with the potential to degrade this plastic (*Sun et al. 2022*). We inferred several plastic degrading enzymes, including hydrolases and lipases, in these microbes.

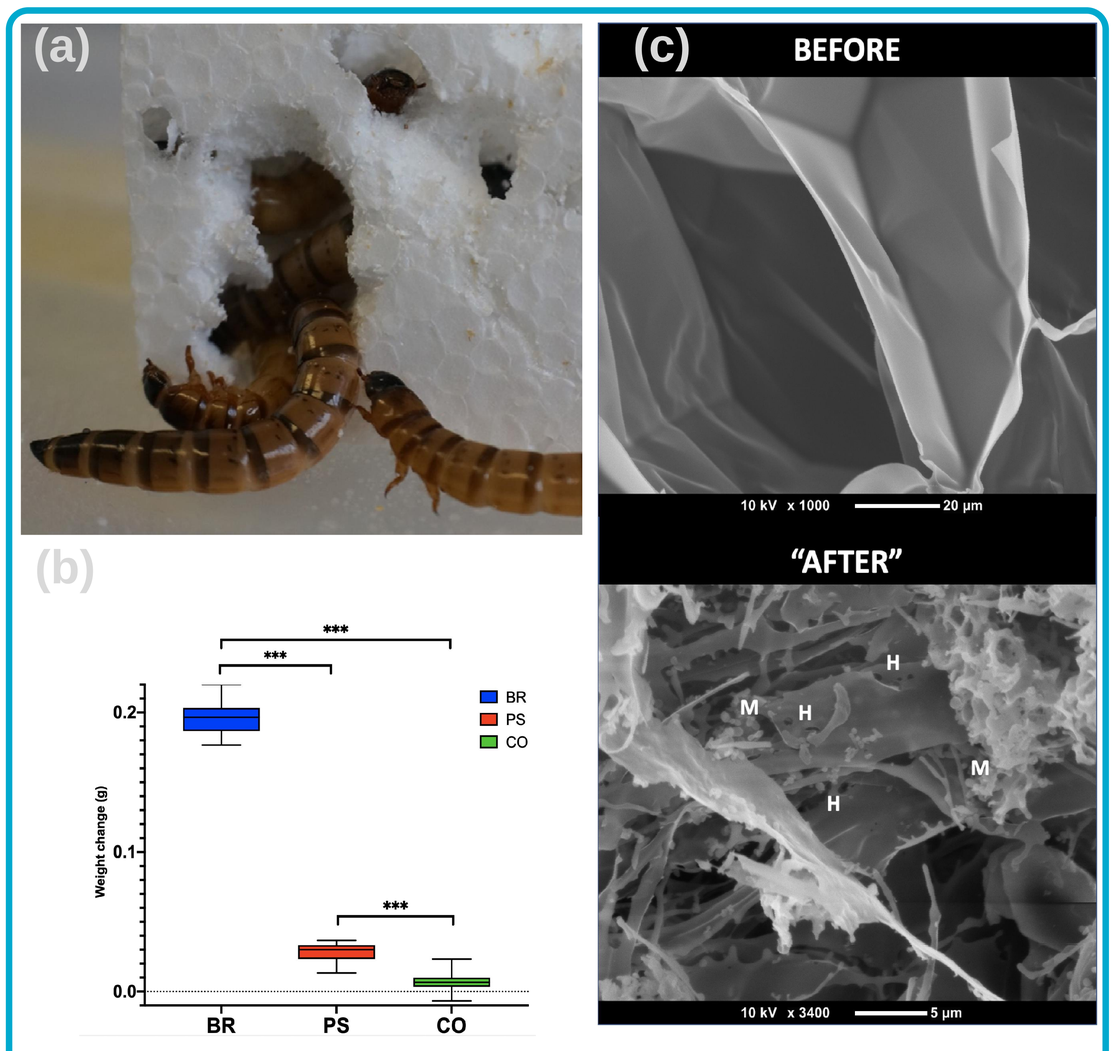

Figure 1 | Superworm polystyrene (PS) foam feeding trial. **(a)** A group of superworms eating their way into a PS block. **(b)** Weight change of the superworms in three feed groups, showing groups fed on wheat bran (BR), polystyrene (PS), and the control group without feed (CO). **(c)** Scanning electron microscopy image of the virgin PS (BEFORE) compared to PS recovered from the gut of a superworm "AFTER".

Our preliminary experiments have shown, that superworms also feed on polyethylene (PE), and other plastics, suggesting that their gut microbes might be able to degrade a range of plastics. Furthermore, our initial genomic survey revealed that a range of habitats around the globe contain microbes with plastic degrading capabilities (**Fig. 2**). However, this potential remains mostly untapped as of to date.

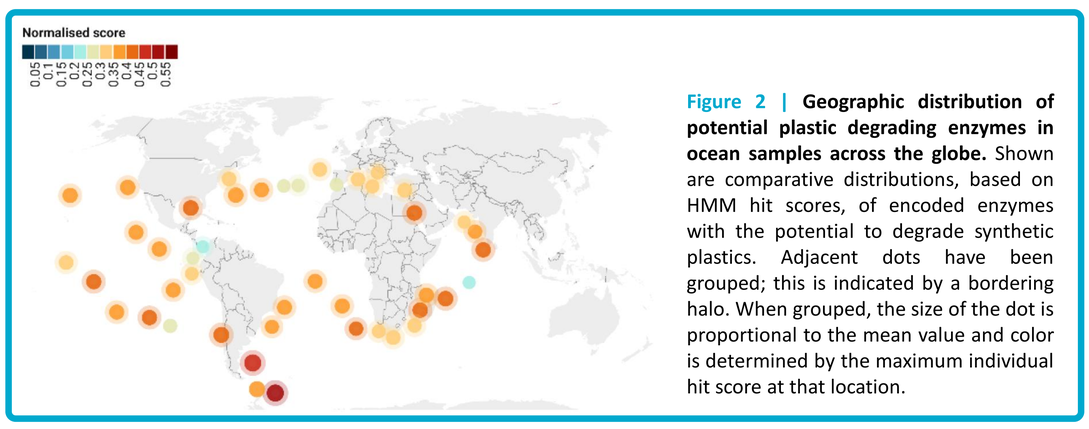

Figure 2 | Geographic distribution of potential plastic degrading enzymes in ocean samples across the globe. Shown are comparative distributions, based on HMM hit scores, of encoded enzymes with the potential to degrade synthetic plastics. Adjacent dots have been grouped; this is indicated by a bordering halo. When grouped, the size of the dot is proportional to the mean value and color is determined by the maximum individual hit score at that location.

We aim to change the status quo and to provide experimentally verified, well-characterized, and efficient plastic degrading enzymes for the recycling industry. We use advanced microbial genomics, molecular biology, and metabolic engineering workflows to discover, characterize, and optimize microbial proteins for plastic depolymerization.

The optimized enzymes will be applied to break down plastics into their building blocks, followed by the production of new plastic products, that are equal in quality to fossil-fuel derived virgin plastics. Alternatively, this biorecycling approach can be combined with the microbial biosynthesis of high-value chemicals, such as **bioplastics**, to support a transition to the use of natural polymers. Overall, enzyme based biorecycling will help to valorize plastic waste and will allow us to move closer to a circular economy. In combination with reduced plastic production and consumption, biorecycling has the potential to solve our plastic waste crisis (**Fig. 3**).

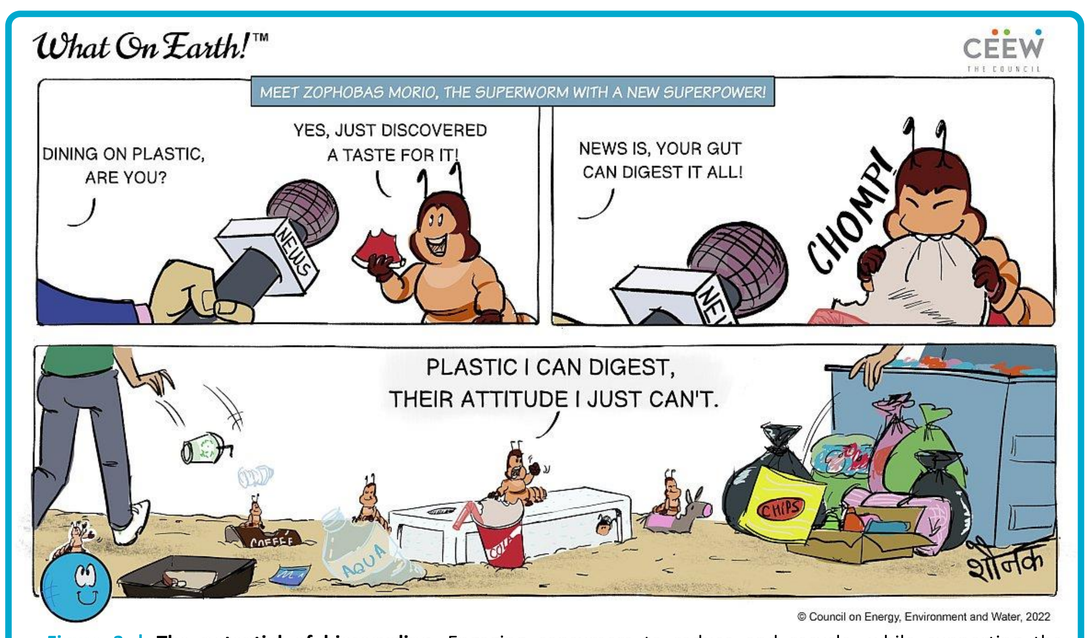

Figure 3 | The potential of biorecycling. Engaging consumers to reduce and recycle, while supporting the development of plastic biorecycling approaches has the potential to solve our plastic waste crisis.

FOR FURTHER INFORMATION

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