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PLASTIC EATING INSECTS- A VIABLE STRATEGY FOR TACKLING THE PROBLEM OF WHITE (PLASTIC) POLLUTION

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INTRODUCTION

Plastic-eating insects, a novel frontier in ecological innovation, have emerged as potential allies in the global battle against plastic pollution. These remarkable organisms possess the unique ability to degrade and metabolize various types of plastic, offering a promising avenue for addressing the environmental scourge posed by plastic waste. As humanity grapples with the escalating challenges of plastic pollution, the discovery of plastic-consuming insects heralds a glimmer of hope for sustainable solutions.

These insects, through their enzymatic processes, break down complex polymers found in plastics into simpler compounds, facilitating their biodegradation into harmless byproducts. This phenomenon not only presents an intriguing scientific phenomenon but also holds immense promise for practical applications in waste management and environmental remediation. However, while the potential of plastic-eating insects is tantalizing, further research is imperative to fully understand their mechanisms and optimize their utilization.

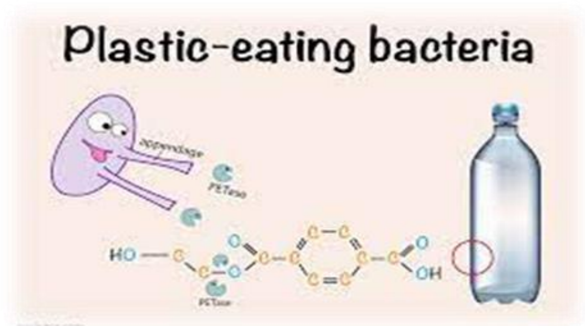
Plastic degradation by biological systems with re-utilization of the by-products could be a future solution to the global threat of plastic waste accumulation. In 2015, global plastic waste was 322 Mega Tons (Mt), reached to 368 Mega Tons (Mt) in 2019.

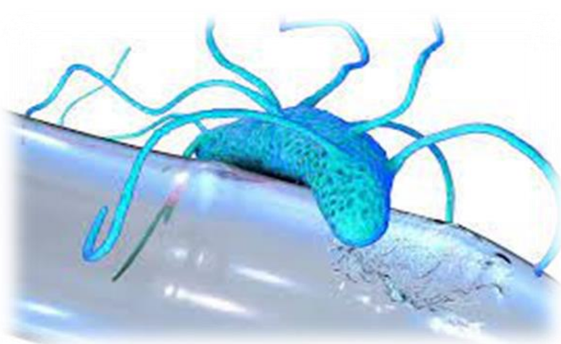
Asia dominated plastic production with 51%. Along China accounting for 31%, followed by NAFTA countries at 19%, Europe at 16%, Middle East and Africa at 7%, Latin America at 4%, and CIS countries at 3%. Current recycling methods include mechanical recycling and chemical recycling. Thermoplastics, including polyethylene (PE), polypropylene (PP), and polystyrene (PS), commonly undergo mechanical recycling. Hardy plastics like polyurethane, HDPE undergo chemical recycling. According to the OECD, only 9% of plastic waste is recycled globally. The remaining 22% is mismanaged, with half of the world's plastic ending up in landfills.

PLASTIC DEGRADING LIVING ORGANISMS

Plastic-degrading living organisms are a breakthrough in environmental science, offering a natural solution to the global plastic pollution crisis. These remarkable organisms possess enzymes capable of breaking down synthetic polymers found in plastics into simpler compounds, facilitating biodegradation. From bacteria to fungi and insects, these organisms demonstrate the potential to transform plastic waste into harmless byproducts, reducing environmental harm and promoting sustainability.

Bacteria and fungi associated with soil, including Bacillus brevis, *Brevibacillus borstelensis, Pseudomonas stutzeri, Rhizopus delemar, Mucor sp., Paecilomyces sp.,* and *Thermomyces sp.,* have shown the potential to consume various plastics (PE, PP, PS, PVC).





PLASTIC-EATING INSECTS

A groundbreaking discovery in environmental science, present a formidable solution to combat plastic pollution. These remarkable creatures possess a unique ability to consume and break down various types of plastic, offering a natural remedy to the global plastic waste crisis.

The potential of harnessing these insects for large-scale waste management holds promise for a more sustainable future.

More complex organisms like insects, including *Tenebrio molitor, Galleria mellonella, Zophobas atratus, Tenebrio obscurus, Plodia interpunctella, Tribolium castaneum, Lasioderma serricorne, Rhyzopertha dominica,* and *Sitophilus oryzae*, exhibit the ability to feed on, degrade, and mineralize plastics.

The larvae of the beetle *T.confusum* and the *Z. atratus* have been identified for their role in the biodegradation of PE and PS. Also some of the studies shown that *Corcyra cephalonica* rice moth larvae have proven that they have the ability to degrade low density PE. These are examples of entoremediation which is a new subtype of bioremediation. The eating and degradation of plastics by insect larvae is a new way to solve "white pollution.

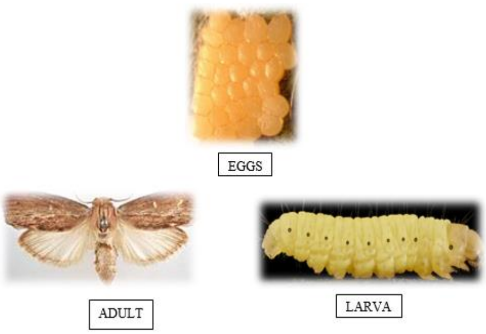
The breakout led Bertocchini, a researcher at the Spanish National Research Council, and scientists at Cambridge University, to investigate the feeding habits of *Galleria mellonella* grubs. In lab tests, they discovered that 100 worms can devour 92 milligrams of polyethylene in as little as 12 hours in 2017.

A plastic bottle crafted from polyethylene terephthalate (PET) requires approximately 450 years to decompose naturally. In contrast, microbial degradation expedites this process significantly, reducing the decomposition time to around 50 years. Surprisingly, insects exhibit even greater efficiency, taking merely 25 years to degrade plastic materials. These contrasting rates underscore the diverse mechanisms and agents involved in the breakdown of plastic waste, highlighting the potential of microbial and insect-mediated degradation as promising avenues for addressing the persistent challenge of plastic pollution.

POLYETHYLENE DEGRADERS

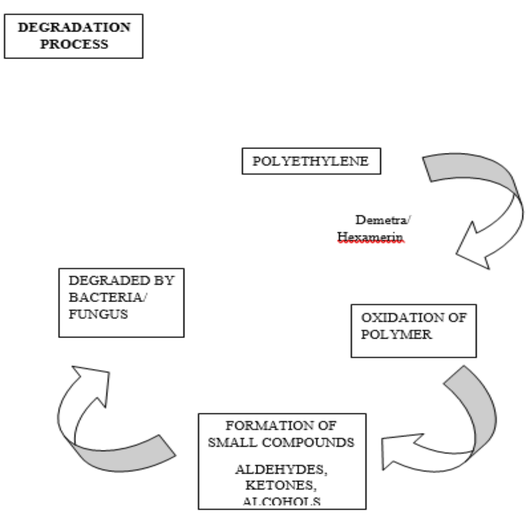
Galleria mellonella, the greater wax moth or honeycomb moth Family: Pyralidae,

Order : Lepidoptera



Galleria mellonella, as a wax moth, has demonstrated the capability to degrade polyethylene (PE). *Galleria mellonella*, has the enzymes belonging to the family phenoloxidases. The two enzymes viz., Demetra, Hexamerin helpful in degrading the polyethylene. The oxidation of polymers leads to degradation and formation of smaller compounds i.e., aldehydes, ketones, alcohols.

These smaller compounds are further degraded by bacteria and fungus.



POLYETHYLENE, POLYURETHANE AND POLYSTYRENE DEGRADERS

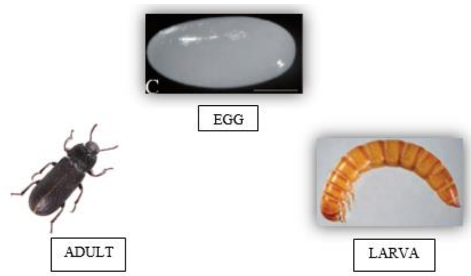
Tenebrio molitor, a darkling beetle

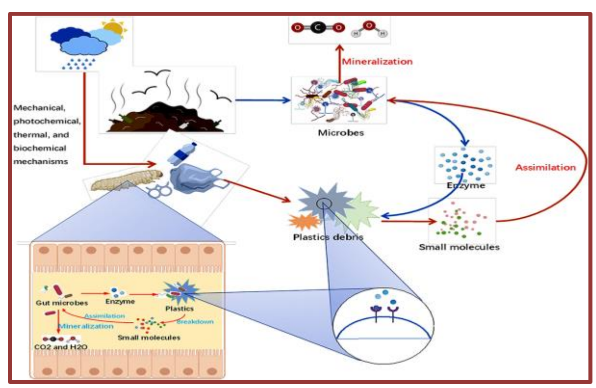
Family: Tenebroinidae

Order: Coleoptera

Mealworms, omnivores, harbor gut bacteria crucial for plastic degradation.

Bacterial concentrations range from 10^5 to 10^6 CFUs per gut. Lactococcus, Pantoea, and Bacillaceae dominate the anterior gut on a standard diet, while the posterior gut hosts *Spiroplasma, Clostridium*, and *Enterobacter*. Notable microbes include *Spiroplasma sp.,* and *Enterococcus sp.,* common in the *T. molitor* gut microbiome.





DEGRADATION

Plastic waste undergoes degradation through physical, mechanical, biochemical, and microbial processes. Notably, microbes from the families Lactococcus, Pantoea, and Bacillaceae, residing in the gut of *Tenebrio molitor*, play a crucial role. These microbial communities aid in breaking down plastic debris into smaller fragments, facilitating their assimilation and eventual mineralization. Through enzymatic activity and metabolic processes, these microbes effectively contribute to the biodegradation of plastic, thus aiding in the reduction of plastic pollution and promoting environmental sustainability.

Zophobas atratus, blind click beetles,

Family: Tenebroinidae.

Order: Coleoptera

The larvae of *Z. atratus* are commonly referred to as super worms, resembling meal worms with very dark ends.

Z. atratus, Z. morio or Z. rugipes, are capable of consuming expanded polystyrene (EPS) and low-density polyethylene (LDPE) foams. The gut of superworm larvae contains PS-degrading bacteria, specifically identified as a strain of *Pseudomonas. Pseudomonas* has been reported for its role in degrading High Impact PS (HIPS), a polymer of PS and poly butadiene. Additionally, *Pseudomonas aeruginosa* has been utilized in the degradation of a polymer composed of poly lactic acid (PLA) and PS.

CONCLUSION

Discovery of plastic-eating insects represents a potential breakthrough in addressing the global plastic pollution crisis. These remarkable creatures have demonstrated an ability to consume and degrade various types of plastic waste, offering a natural solution to the growing environmental challenge posed by plastic accumulation. By harnessing the unique enzymes or gut bacteria present in these insects, researchers have opened new avenues for bioremediation strategies aimed at mitigating the harmful effects of plastic pollution.

However, while the prospect of using plastic-eating insects to degrade plastic waste is promising, several challenges and considerations remain. Further research is needed to fully understand the mechanisms by which these insects degrade plastic and to optimize their efficiency in real-world conditions. Additionally, questions regarding the ecological implications of introducing plastic-eating insects into ecosystems must be carefully addressed, including potential impacts on food webs, biodiversity, and ecosystem dynamics.

Ultimately, plastic-eating insects should be viewed as one component of a comprehensive approach to tackling plastic pollution, alongside efforts to reduce plastic consumption, improve recycling systems, and develop more sustainable alternatives to plastic materials. With continued scientific investigation and responsible implementation, plastic-eating insects have the potential to contribute significantly to the restoration and preservation of our planet's ecosystems.

Plastic-eating insects offer a promising solution to the growing problem of plastic pollution. These insects possess unique enzymes or gut bacteria that enable them to break down various types of plastic waste, potentially reducing the environmental impact of plastic accumulation. However, further research is needed to fully understand their mechanisms and optimize their efficiency for large-scale plastic degradation. Additionally, careful consideration must be given to the ecological implications and potential unintended consequences of introducing plastic-eating insects into ecosystems.

100 wax worms can break down 92 milligrams of plastic in one night. That means it would take 100 wax worms about a month to break down a 5.5 gram plastic bag.