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Superworms can Help Reduce Plastic Pollution by Being Capable of Eating Through Plastic Waste

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Abstract - *There is a major crisis facing the world today, which is the massive disposal of plastic waste. To make matters worse, landfills take approximately hundred years to decompose waste. Zophobas morio-better known as the Superworm-can survive by eating only plastic, according to Australian scientists. Mealworms and superworms eat plastic waste, according to many studies. As a result, the bacteria in its gut are able to decompose plastic waste into smaller molecular components. Is it possible for these superworms to save us from the plastic pollution that is building up in our oceans? Scientists recently discovered a creature that can be the hero we need but not the one we deserve. The superworm is commonly known as Zophobas morio. Scientists might be able to make enzymes that decompose plastic waste in recycling plants by using mechanical shredding followed by biodegradation by enzymes. Polystyrene is shredded with mouth, fed to bacteria, like a mini recycling plant. Because of this reaction, other microbes can make compounds of high value, like bioplastics. In the future, scientists want to grow these gut bacteria in the lab and test how well they can break down various kinds of plastic waste. If these initiatives prove successful, plastic recycling on a massive scale could finally become a viable option for reducing plastic pollution. According to a new study, the rapid degradation of PS in the larval gut reveals a new pathway for plastic waste to be disposed of in the environment. This article will provide more information about the Superworms and how they can help reduce plastic waste in our environment by recycling plastic waste.*

***Keywords*:** Zophobas morio, Superworms, Plastic waste, Bacteria, Mealworms, Polystyrene, gut bacteria, recycling, Bioplastics.

1.INTRODUCTION

The advantages of plastic products include their light and flexible nature, strength, and long-lasting nature. In our daily lives, plastic has been used in many industries due to its low cost and easy production, resulting in huge amounts of waste. In nature[1], the degradation of plastic occurs at an extremely slow rate. In the end, plastic waste builds up everywhere, including in the ocean, and has become an extremely serious problem. It is true that many physical and chemical techniques have been developed for removing plastic waste, but such methods often result in secondary pollution issues as well[2]. The microplastics produced from landfilled plastic eventually flow into the oceans via erosion, causing damage to marine organisms. It is dangerous for people's health to burn plastic waste because of the serious air pollution it causes. Therefore, harmless plastic waste removal is urgently needed. The Zophobas morio, commonly called superworm, has been found to survive on polystyrene diets. Over a gut enzyme, they believe the beetles digest the plastic[3]. As a result, it could have a significant impact on the development of recycling applications; this article explains how superworms can be used as mini recycling plants for shredding polystyrene with the mouth and then feeding it to the bacteria in their gut in order to recycle it. The team also discovered that several enzymes found in the guts of superworms could degrade polystyrene and styrene. Takeaway

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containers, insulation, and car parts typically contain both materials. Despite this, worm farms that serve double duty as recycling plants are unlikely to be created by this research [4]. In order to create bioplastics in large quantities, they want to find the enzyme that works best for recycling. There is a possibility that other microbes may be able to utilize the breakdown products that result from this reaction.

Fig -1: Superworm Zophobas morio

2.THE ENVIRONMENT IS BEING POLLUTED BY PLASTICS

2.1 Pollution caused by plastics can have an adverse effect on the environment

Many hazardous and ecologically damaging effects are caused by plastic pollution in the environment. It was documented that plastic debris poses a direct threat to the earth, its inhabitants, as well as all living creatures [5]. Most species face two main dangers associated with plastic objects: entanglement and ingestion. Here are just a few of the species documented as being adversely affected by plastic debris. Birds mistake plastic objects for food, making them vulnerable to ingestion. It is vital to note that plastic that is ingested by these animals persists in the digestive system and can lead to a decrease in feeding stimuli, gastrointestinal blockage, a decrease in gastric enzyme secretion, and a decrease in steroid hormone levels, eventually leading to problems during reproduction. Organic pollutants have been found on high levels in plastic particles. Plastic debris in the ocean contains toxic chemicals. Also, many of these compounds have a high biomagnification potential and could directly harm human health if wildlife eats them. In addition to neurological problems, abnormal growth, and hormonal imbalances, these toxic agents have been linked to and are linked to many other health problems, such as cancer, endocrine disruption, changes in behavior, arthritis, breast cancer, diabetes, and hypomethylation of DNA. Debris such as plastic provides an influx of potentially destructive or invasive fauna [6]. There have been many reports of marine species colonizing plastic debris and subsequently dispersing it. Additionally, terrestrial animals may be able to ride marine debris to new locations. People claim that ants travel to San Sebastian Island on trash several kilometers from the Brazilian mainland. Additionally, it has been noted that iguanas travel from the Brazilian mainland to new Caribbean islands on trash.

2.2 The Impact of Plastic Waste on the Oceans

Increasingly, plastic waste is affecting the biomes of the oceans [11]. The ocean contains thirteen million tons of plastic [12]. It is common for plastics to release chemicals into the water, which can cause cancer and other health issues. However, animals often eat plastic, which is one of the most common problems with it. Fisheries, turtles, and ocean birds are most affected by plastic waste. A considerable number of marine animals die each year directly from plastic waste consumption. In many cases, these animals consume plastic that cannot be digested by their bodies. By blocking their digestive tract, they die. People eat a lot of fish, so if fish have consumed plastic, people end up eating it as well. Plastic has a particularly negative impact on turtles. Some turtles eat plastic bag because they think they

are jellyfish [9], which they eat often. It is estimated that half of all sea turtles consume plastic during their lifetimes [10]. For many people throughout the world, the oceans are an essential resource. There is a lot of evidence suggesting that plastic waste is carried extremely far from its initial source of pollution by ocean currents, which results in pollution in different regions around the globe.

2.3 Pollution caused by plastics - a threat to the environment

There is no protection for even plants from the harm caused by plastics as they are unable to adapt to them, so they are at risk of being damaged. During the breakdown of plastic in soil, a chemical called BPA-Bisphenol A is released, which is harmful to microorganisms. In addition [8], some plastic bags can end up being trapped on plants, which prevents them from receiving enough light or nutrients. There is a threat to ecosystems from natural cycles that are being damaged. Due to plastic usage, environmental issues affect all parts of the planet. People and all living things suffer from the devastating effects of plastic. There is a risk that many natural cycles that have been in balance for thousands of years may become off balance due to our reckless behavior today, causing unknown issues for future generations who are going to have to deal with the negative consequences of plastic pollution that will take place.

2.4 Animals suffer negative effects because of plastic waste

Land animals consume plastic waste just like ocean animals. The waste from food packaging, food wastes, and plastic wastes are eaten by animals, causing digestive problems in them. Animals can also get suffocated by the bags. Animals suffer huge consequences from plastic waste.

2.5 Impact on the environment of plastic bags

Land is also polluted by plastic, in addition to plastic bags [7]. Since plastic bags are simply blown away, by the wind and carried by currents for miles, they accumulate in trees and clog up storm drains. As a result of plastic bags ending up in storm drains, there are two outcomes: In either case, they are taken to sea or contribute to drain clogging [8]. Standing water can serve as fertile ground for disease-carrying insects when storm drains are clogged by heavy rainfall. The disposal of plastic bags in landfills is often ineffective, despite the proper disposal practices. In landfills, degradation can take up to four hundred years. As plastic bags degrade, landfills accumulate increasingly of them.

2.6 Plastic Degradation in the Environment

Plastics don't naturally break down much in the environment. One of the major reasons polymers are so popular and used in so many places is their durability and stability. Photodegradation [17], thermooxidative degradation [18], hydrolytic degradation [19], as well as biodegradation by microorganisms are the four main ways in which plastics breakdown in the environment. The degradation of plastic generally begins with photodegradation, then thermooxidation. In order for the polymer to start putting oxygen atoms in, it needs ultraviolet radiation from the sun. When the polymer chains become so low that microorganisms can break them down, plastic becomes brittle and breaks into getting smaller pieces. By the time these microbes are able to take advantage of carbon into polymer chains, they turn it into carbon dioxide or add it to biomolecules. Despite this, plastic can take fifty years or more to completely degrade. As a result, photodegradation in seawater is much slower since the temperature is lower, oxygen is less, and most polymers don't breakdown very fast in the sea.

3.THE BLOOD OF HUMANS CONTAINS MICROPLASTICS

Last year, an Australian scientist discovered the cheapest fish-stick microplastic by testing it under a microscope. It was found that popular frozen foods contained a significant amount of microplastics, and it was reported that if eaten, they could enter and affect organs in the human body. Microplastic pollution was first detected in March this year. A now debunked figure is currently circulating on the internet indicating that, on average, people use the equivalent of a plastic credit card every week. A study of blood samples collected from twenty-two anonymous donors [13], all healthy adults[14], discovered plastic particles in 17 out of 22 samples. Half of the test samples contained p-e-t plastic, which is used extensively in drink bottles; the second contained 33% PS and the third 25% LDPE. When scientists examined blood samples from babies, they found that microplastics are present in infants in amounts 10 times higher than adults, and babies fed microplastic bottles are likely to ingest Microplastic particles numbering in the millions every day. They are the 21st century symbols of the coming plastic apocalypse. But while our bodies can't break down microplastics, researchers from the University of Queensland recently announced their discovery that there is a creature that can. A hero is needed, but it is not the one who deserves it. Learn how super worms can prevent plastic waste in our article.

4. WHAT ARE MICROPLASTICS

But let's start with some background on what microplastics are. For starters, they are a type of polymer made up of repeating unit chains that can be partially organic or fully synthetic, but They are usually made from oil or natural gas Micro plastics are tiny pieces of plastic defined as anything less than five millimeters in length. They are broken into two categories They are intentionally made in the size of a microplastic for use as industrial abrasives in sandblasting or microbeads in cosmetics and skin care products, or they are secondary microplastics. Which are formed because of the weathering of larger plastic items, particularly after those large plastic items have been released into the environment. Plastic was and continues to be regarded as a wonder material by many because it is inexpensive to produce strong and durable materials [15]. The features that we prize it for are the features that make it so difficult to deal with. As tiny particles abrade from plastic containers or packaging material, they enter the environment and they become lodged in the organs of small organisms. There are larger organisms that consume these small organisms and so on until, they are eaten by us. There is no doubt that these particles can travel around the body and lodge themselves in our organs, as we have only recently learned. The effect of microplastics on our health is as yet unknown, but researchers are concerned because they can damage human cells in lab settings as well as be similar to air pollution, particles that are already known to enter the body each year and are responsible for millions of early deaths. Considering the projected increase in plastic pollution over the next decade, it is imperative that sustainable recycling and upcycling processes be developed for this waste. This waste includes a variety of commonly used materials, such as polystyrene, which can be found in everything from styrofoam cups to packaging peanuts. These measures are fine for slowing down the rate at which plastic enters our environment, but who or what is going to reverse the damage that has already been done.

5. THE SUPERWORM -ZOPHOBAS MORIO CAN SURVIVE ON POLYSTYRENE

Recent study by scientists showed that superworms are capable of surviving on a diet made up of pure polystyrene plastic. A team of researchers split one seventy one superworms into three groups with different diets to come up with this conclusion [16]. There have been cases in which only wheat bran has been fed, in which only polystyrene has been fed, as well as in which a strict fasting or starving

diet has been administered. On a more morbid note, the study found that some of the fasting superworms ate each other. The researchers changed their experiment so that the control group animals were kept hungry while the animals from the other two groups were kept together during the feeding trial at the end of the trial. The gut microbiome of the bran-fed worms was the most diverse of the three groups when nine out of ten were transformed into beetles [15]. The big surprise was that the worm larvae fed bran had a significantly better quality of life than their counterparts who were fed plastic or starved. During the three weeks following their follow-up, their weight had more than doubled. Despite less impressive gains, plastic-fed larvae still gained weight, and two thirds turned into beetles. Although polystyrene isn't good for larvae, it gives them enough energy to grow and turn into beetles. We found out more about these superworms.

6. THE PROCESS BY WHICH SUPERWORMS BREAK DOWN PLASTIC

The real hero is the bugs that live inside the box, the microbiome present in the digestive system of these super worms, because it's the bacteria that makes itself at home in the worms' gut that actually does the majority of the breaking down or hydrolysis of these microplastics. Plastic is made from long chains of repeating units of carbon and hydrogen monomers, which contain a lot of useful energy but are difficult to break down due to the strong carbon bonds that give plastic its durability and strength. The way the body [20], or in this case, the bacteria's body, accesses this stored energy is with a specially designed class of proteins called enzymes that have a particular shape and a particular function depending on the type of cleaving or breaking action that they are trying to do on a particular polymer. So, these enzymes in the gut of these super worms have probably evolved specifically to help

Fig -2: Superworm Eating Plastic

the worms break down polystyrene. The scientific team has made some initial guesses as to what those enzymes that are helping these super worms break down the microplastics are, but there's been some pushback from the scientific community suggesting that the proposed mechanisms wouldn't quite do the job, so some further work is currently being undertaken to actually understand the enzymes that are taking action, so instead let's look at some general enzymes.

7.ZOPHOBAS MORIO SUPERWORM-SAVE US FROM PLASTIC EAT EVERYTHING

However, there are some benefits to living with worms. There are some creatures that sacrifice themselves to save humans, like the Zophobas morio superworm. As the superworm consumed and degraded plastic, it was discovered to have astounding capabilities. There is no doubt that Zophobas morio is commonly known as the superworm, but this is actually a species of insect larvae which eventually metamorphoses into a darkling beetle species. It was because of their moderately large size, incredible appetite, and impressive mouth parts that scientists became interested in them. They all knew they were machine-eaters. In their larval state, they eat as much as they can. Additionally, they don't have a lot of preferences. Their diet is mainly decayed material, such as leaves, wood, and animal

carcasses. Because they eat everything, researchers thought they'd probably eat polystyrene too.

8. BREAKING DOWN A DIFFERENT SORT OF PLASTIC

A different type of plastic, p-e-t or pet was discovered in some bacteria in a landfill in Japan. This article breaks it down. Petas breaks down the pet to its monomers by first breaking it down at specific points in the chain. Several possible outcomes can be anticipated in this scenario. This is either split by enzymes or it is used as raw materials to make new plastic.

9. THE PROBLEM WITH POLYMER BREAKDOWN-IS IT REALLY POSSIBLE

An economy based on circularity would be created if this process could be made fully efficient, in effect resulting in a very sustainable economy. It might work better to hope the polymer breaks down and the energy inside is absorbed by the bacteria and the superworm or whatever organism it's feeding. Plastic carries a risk that some of the chemicals won't fully break down and are absorbed into bacteria and superworms, but early indications seem to show it doesn't happen now before you get grand fantasies.

10. POLLUTION CAUSED BY PLASTIC: HOW TO STOP IT

This is a future world where valuable substances are excreted and harvested by a band of roving super worms, which sounds like it would make a great story. It's very unlikely that these worms will be the most efficient way to solve our plastic pollution problem. Instead, researchers are likely to try to find the enzymes that are involved in the process, grow a lot of them in a lab, and then add these enzymes to bulk plastic collection and recycling processes to help deal with the problem on a large scale. Another thing to keep in mind is that these enzymes work for polystyrene and polystyrene alone, so we need to find or engineer other enzymes for our other types of plastic waste. Once we find them, or at least early versions of them that seem to work, they will likely go through rounds of optimization, where genetic evolution or possibly artificial intelligence is used to make an enzyme that works as well as possible. This is partly to deal with the amount of waste we have, but mostly to make the whole process cost-effective, since most recycling isn't. Approaches have low uptake and, ultimately, burying plastic in the landfill kicks the problem a little bit down the line for future generations to deal with, which has been a past time of humanity for a while now. Having said this, it does seem like nature does its best to give us answers to this plastic invader. Back in 2012 [21], A rare mushroom species has been discovered by Yale University students [22], the pestilettiopis microspora, that may eat plastic This fungi consumes polyurethane, one of the main ingredients in plastic products, and breaks it down, converting it to organic matter.

11. CONCLUSIONS

Increasing amounts of plastic are causing environmental concerns across the world. Nevertheless, a word of warning should be offered to individuals who believe that nature's efforts to resolve the problem for us should serve as a sign that everything will turn out alright in the long run. Even optimistic projections suggest that plastic pollution will increase 2.8 times in terrestrial ecosystems by 2040, and 2.6 times in aquatic ecosystems. Despite the fact that the full portfolio approach attempts to deal with plastic waste by using a variety of different solutions, and even though the super worm and mushroom are placed in our hopes for the future, we need to find innovative solutions for these kinds of problems as well. Is it possible, however, that

the process is relatively efficient? People can also afford to invest in recycling facilities because the process is cheap. You can recycle plastic waste with the Superworm, and it's good for the environment. As of now, there's no commercial solution to it. Although there are still a lot of research studies going on in this field, it is expected that it is only a matter of time until it will be possible to find practical methods that work.

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