## **We’ve talked about plastics quite a bit on this channel over the years. It is of course one of the most versatile and useful material groups known to humankind, without which our modern world would simply not exist.**

**But they’re also a huge source of CO2 emissions in production, which is a problem still requiring a robust and workable solution, AND, largely as a result of human inability to give a damn about where plastic products go after we’ve used them and tossed them away, they’re also clogging up river systems in certain parts of the world and eventually making their way into our oceans to cause even more damage there. They take decades or centuries, or in some cases even MILLENNIA to break down, and as they physically disintegrate they form microplastics that get into the marine food chain and eventually into human beings who choose to eat seafood. I realise you know all that stuff already, but it never hurts to remind ourselves of these sorts of things, does it?**

## **According to Statista, we humans produced more than four hundred million metric tonnes of new plastics in twenty-twenty-two, and that number could be as high as one point two BILLION metric tonnes by twenty sixty.**

**The plastics that do get into the oceans tend to move around in the currents and then get caught up in so-called sub-tropical gyres which concentrate large quantities of the garbage swirling round and round, like water circling a plughole, eventually taking it down to the depths. Perhaps the best known of these is the North Pacific Garbage Patch which is reckoned to contain more than eighty-thousand metric tonnes of floating plastic debris. We humans have made a few well meaning, but ultimately a bit half-arsed attempts at cleaning it all up, so most of it is still there.**

**Now though, new research has discovered that nature has got bored waiting for us to sort it out and has started to find its own solutions to the ocean plastics problem.**

**Hello and welcome to Just Have a Think.**

**The study in question comes from a group of scientists at the Royal Netherlands Institute for Sea Research in conjunction with colleagues from Utrecht University, the Ocean Cleanup Foundation and research institutes in Paris, Copenhagen and St Gallen, Switzerland.**

**One important characteristic that ties the majority of man-made plastics together is that they consist of polymer chains made from oil-based hydrocarbons, and that’s where it gets interesting, because that means plastics are a potential carbon and energy source for microbes that exist on land AND in the sea. The challenge those microbes have is finding a way to break down the intentionally robust and strong bonds in the polymer chains that we humans have so cleverly constructed, so that they can get at the constituent monomers they can use.**

**Ultraviolet light from the sun starts to do that job very slowly as plastics bob around on the ocean surface, but what this latest research paper found was a type of ocean fungus called Parengyodontium Album, or P.album for short, that can essentially consume POLYETHYLENE, which makes up the bulk of marine plastics, biodegrade it and convert it into carbon dioxide.**

**Now you might be thinking, oh well that’s just great Dave. We’ve discovered something that takes one problem and turns into another one! Brilliant! But bear with me here. The science bods measured the CO2 being produced and they reckon it’s about the equivalent of the low amount produced when humans breathe.**

**Scientists are already aware of the amazing ability of land-based fungi to degrade vast amounts and varieties of compounds including complex hydrocarbons like lignin and cellulose, and pollutants like DDT, and EVEN environmentally hazardous compounds like TNT. They do that with a bunch of powerful digestive enzymes, and in fact several land-based fungal species are already known to degrade plastic polymers. Much less is known about marine-based fungi though, so this new discovery represents something of a breakthrough.**

**The team travelled to the North Pacific garbage patch to do their research. Having scooped up a decent representative sample of floating plastics they isolated the marine fungus from the microbial film covering the waste and took it back to the lab to grow it in properly controlled conditions and on specific plastic types.**

**The important breakthrough here was that the researchers were able to put some numbers to how quickly the fungus was able to break down the PE plastic.**

**In lab conditions that rate was around zero-point-zero-five percent per day. That might not sound particularly rapid to you and me, but it equates to full consumption in two-thousand days or about five and a half years.**

**On a ‘plastics degradation’ timescale that’s like lighting fast!**

**One major caveat is that the P.album fungi was tested under two different conditions – one in the presence of UV light and one without any light. The results showed that there does need to be at least a little bit of UV degradation first, even for just a few days, before the fungus could get to work.**

**For surface plastics that‘s not a problem, but of course plastics are now being found at greater depths, and even right down on the seabed.**

**In a recent interview with the online journal Phys dot org, the paper’s lead author, Annika Vaksmaa said**

**"Marine fungi can break down complex materials made of carbon. There are numerous amounts of marine fungi, so it is likely that in addition to the four species identified so far, other species also contribute to plastic degradation. There are still many questions about the dynamics of how plastic degradation takes place in deeper layers,"**

**Scientists are not resting on their laurels though, or relying solely on nature for all the answers. In fact, this latest paper comes hot on the heels of an earlier study, focussed on a polymer called Nylon-6, which is typically found in cheap carpets and clothing, and most significantly is the chief component of the huge catch nets used in the modern-day fishing industry.**

**Fishing nets are routinely discarded at sea by unscrupulous operators, and they’ve become the scourge of the oceans, polluting water bodies, damaging coral reefs, and endangering birds and marine animals.**

**A team at Northwestern University in Illinois has been developing a new catalyst that they reckon can completely break down the polymer chains in Nylon 6 in just a matter of minutes. Their tests also show that there are no harmful by-products produced as a result of the reaction, and perhaps most importantly of all, their new process doesn’t involve any nasty toxic chemicals, to make it work, and the reaction happens at a much lower temperature than previous methods.**

**And to cap it all, at the end of the process you actually get a workable product that can be upcycled into new Nylon6 polymers.**

**The most common method of dealing with Nylon6 at the moment is simply to bury it in land fill or burn it, releasing CO2, toxic pollutants and nitrogen oxides that cause all sorts of health problem.**

**Previous attempts at breaking down this tough polymer have involved temperatures as high as three hundred and fifty degrees Celsius, plus high-pressure steam, which of course requires huge amounts of energy to produce, or basically melting it with strong acid, which is not ideal, and doesn’t produce anything that you can re-use afterwards.**

**The Illinois team achieved their improved result using Yttrium and lanthanide metals as a catalyst. Yttrium is a cheap and abundant element found in the transition metals section of the periodic table, and the lanthanide metals sit right underneath with similar chemical compositions**

**Samples of Nylon6 were heated up to just above it’s melting point of two hundred and fifteen degrees Celsius in the presence of only a very tiny amount of the Yttrium lanthanide catalyst, and ninety-ninety percent depolymerisation was achieved. In other words, the Nylon6 literally fell apart in a matter of minutes.**

**When they analysed what had happened during the reaction , the scientists found that the Yttrium Lanthanide catalyst was able to chemically unzip the Nylon chains and cause parts of the chain to jump from one to another in a process called inter-chain hopping. Precisely how and why that effect occurs is a bit outside the scope of my limited brain I’m afraid,**

**but the important thing is the result. Which is that this process was found to be particularly effective on those pesky fishing nets, as well on cheap nylon carpets and clothing.**

**One of the most encouraging advantages of this new process is the fact that the catalyst is highly selective. It only attacks Nylon-6 polymers and doesn’t do any damage to surrounding materials. That’s great news for the recycling industry because it means they can apply the method to large volumes of unsorted waste and selectively target the Nylon-6 products.**

**In an ideal world we would have already found robust alternatives to oil based plastics, but the reality is that most of the options, including bioplastics, have their own challenges like cost, energy consumption and land use, so even after we finally wake up and stop burning oil, we will still be processing it in refineries to make the solid materials that have become indispensable to modern western life. Finding ways to recycle that plastic without degrading it has become something of a holy grail.**

**The authors of this report point out that recycled Nylon6 for example, is actually more valuable than virgin nylon, largely due to the high demand for recycled materials in the fashion industry. If processes like this can be developed at scale for all plastic types then it would represent a very significant reduction in the carbon footprint of producing virgin monomers from crude oil.**

**And, you know, every little helps doesn’t it?**

**The Illinois team have already filed patents on their procedure and are already getting interest from industrial partners, so hopefully it won’t be long before we see this process in a commercial environment helping to solve our global plastics problem.**

**That’s it for this week. A massive thank you, as always, to our amazing Patreon supporters who keep this channel completely independent AND enable me to keep ads and sponsorship messages out of your way. And an extra special ‘thank you’ to the folks whose names are scrolling up the screen beside me here, all of whom celebrate an anniversary of Patreon support in August.**

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**As always, thanks very much for watching! Have a great week, and remember to just have a think.**

**See you next week.**