Biodegradable Plastics Association

A not-for-profit Association limited by Guarantee

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Biodegradable Plastic

1. INTRODUCTION

1.1 Coronavirus has made everyone realise that plastic is very useful to protect us from the spread of disease, and it is in use today for a wide variety of personal protective equipment and packaging. This is not a temporary phenomenon, because people are never going to forget the need to protect themselves and their food from microbial attack. Also, plastic has a better LCA than many other packaging materials (See below).

1.2 Plastic is one of the few materials in common use which can be made antimicrobial, and plastic made with antimicrobial technology has been tested according to ISO 21072 to destroy 99.9% of viruses within one hour of coming into contact with it. All single-use plastics should now be made with anti-microbial technology. (see https://www.symphonyenvironmental.com/wp-content/uploads/2020/09/Antimircobial-Optimised.pdf.pdf)

1.3 They should also be made with biodegradable technology at little or no extra cost because, for the foreseeable future, a significant amount of the plastic will get into the open environment after its useful life. The problem with plastic is litter.

1.4 The reason why single-use plastics have attracted so much opposition is because the plastics industry has failed to offer policymakers a way to deal with the single-use plastic products which get into the open environment all over the world, where they lie or float around for decades. It is the sight of animals and birds entangled with plastic which has generated monumental public concern and has created plastiphobia, leading to outright bans.

1.5 It was to address the problem of plastic litter that biodegradable plastic was invented and patented fifty years ago by the scientists who had themselves created plastics and who realised that the durability which they had achieved could actually be a problem. If their invention had been widely adopted there would be no ocean garbage patches today, but instead the plastics industry continued to make conventional plastic, which started to accumulate in the oceans and has now become a serious problem. If the invention is adopted today the accumulation of plastic in the oceans will be reduced and eventually reversed.

1.6 Those scientists knew that the molecular-weight of plastic was too high for it to be bioassimilated by micro-organisms, so they found a way to cause the plastic to convert automatically by oxidation into low molecular-weight materials which are biodegradable. They called this process “biodegradation”, and it occurs anywhere in the open environment where oxygen is present, without any need to take the plastic to a composting facility. Light and heat will accelerate the process, but they are not essential.

2. A CIRCULAR ECONOMY FOR PLASTICS

2.1 The OPA would agree that plastic is a resource which should not be wasted, and that it should therefore be re-used and recycled where it makes economic and environmental sense to do so, but this makes more sense for some of types of plastic (e.g. PET) than for others (e.g. PE and PP). See below as to Recycling.

2.2 However, no government in the western world has a policy for dealing with plastic waste which has escaped into the open environment, and cannot therefore fit into a circular economy. Their blind spot is that despite their best efforts a significant amount of plastic will continue to get into the open environment for the foreseeable future, which cannot be collected for recycling, composting, or anything else.

2.3 Biodegradable technology is specifically designed to deal with this problem, by causing the plastic to become biodegradable much more quickly if it gets into the open environment. It will degrade in landfill if oxygen is present and will then biodegrade. It is not designed for composting, and ASTM D6400 and European Standard EN13432 are not therefore relevant. It can be recycled if collected during its useful life.

2.4 The plastics industry could have addressed this environmental problem, to the great benefit of themselves and the environment, by making everyday plastic products with biodegradable technology so that they would become biodegradable much more quickly and would be recycled back into nature by bacteria and fungi. However, most of them have ignored this technology instead of engaging with the experts in the biodegradable plastics industry and seeking to understand it better and to explain it to their customers and to the public.

2.5 They have concentrated instead on redesign and recycling, but it must be obvious to them that this cannot deal with the plastic which escapes into the open environment from which it cannot be collected. Nor can the plastics marketed as compostable deal with the problem, for they have to be collected and taken for composting. The OPA does not consider that there is in fact any useful role for plastics in composting (see https://www.biodeg.org/subjects-of-interest/composting/).

2.6 Governments now have an opportunity to adopt a policy for dealing with plastic which has escaped into the open environment, and especially the oceans, from which it cannot realistically be collected and without banning items which are useful to its citizens. For the reasons mentioned below, governments should not place any reliance on the European Union on this matter.

3. BIODEGRADABLE PLASTIC

3.1 It is essential to distinguish between degradable and biodegradable plastics.

"Degradation" is defined in CEN TR15351 as "degradation resulting from oxidative cleavage of macromolecules." This describes ordinary plastics, which degrade by oxidation under the influence of light and heat in the open environment and create microplastics, but do not become biodegradable except over a very long period of time.

3.2 degradable (as distinct from biodegradable) plastic has been banned for good reason in Saudi Arabia, the UAE, and elsewhere for a wide range of everyday plastic products, and it should also be banned in the US.

3.3 "Biodegradation" is defined by CEN as "degradation resulting from oxidative and cell-mediated phenomena, either simultaneously or successively." This means that the plastic degrades by oxidation until its molecular weight is low enough to be accessible to bacteria and fungi, who then recycle it back into nature by cell-mediated phenomena. It does not create microplastics.

3.4 Biodegradable plastics are tested according to ASTM D6954; BS 8472, and similar Standards, which prescribe tests for biodegradation as well as for abiotic degradation. They also include tests to ensure that there is no toxicity, and no prohibited metals or gel content above the prescribed level. Recent tests for OPA members by Eurofins Laboratories according to ASTM D6954 show 88.9% biodegradation

within 121 days. This technology is suitable for almost all products made with polyethylene or polypropylene, but is not used for Polyethylene Terephthalate (PET) or Polyvinylchloride (PVC).

3.5 It is possible for enforcement authorities to ascertain quickly, using a portable xrf device, whether a product sold as biodegradable is actually biodegradable, but this cannot be done with other forms of biodegradable or "compostable" plastic.

3.6 Microplastics are seen today as the main problem with plastics. They are tiny pieces of plastic, which are being found on land, in the sea, and now even in the air we breathe. Most of them are created by the fragmentation of ordinary plastics caused by the effects of uv light and mechanical stress. The problem is that although these plastics are fragmenting, their molecular-weight remains too high for biodegradation, so they persist in the environment, getting smaller and smaller over a period of many decades.

3.7 However, if plastic products are made with biodegradable technology, and get into the open environment intentionally or by accident, the molecular-weight of the plastic will reduce much more quickly and it will become a waxy substance which is no longer a plastic. It will then have become a source of nutrition for naturally-occurring micro-organisms. Professor Ignacy Jakubowicz, one of the world's leading polymer scientists has described the process as follows: "The degradation process is not only a fragmentation, but is an entire change of the material from a high molecular weight polymer, to monomeric and oligomeric fragments, and from hydrocarbon molecules to oxygen-containing molecules which can be bioassimilated."
http://www.biodeg.org/Reply%20to%20Ellen%20MacArthur%20Foundation%20from%20Prof%20Ignacy%20Jakubowicz%20-%2021-8-17.pdf

3.8 Because conditions in the open environment are variable, a broad indication only can be given as to timescale. It is however possible to say with certainty that at any given time and place in the open environment an biodegradable plastic item will become biodegradable significantly more quickly than an ordinary plastic item.

3.9 It is not important how long a specific piece of plastic in a particular place will take to biodegrade – the importance of biodegradable technology is that it will reduce the dwell-time and therefore the overall burden of plastic in the environment much more quickly than would otherwise be the case. Of course, we don't want plastic in the environment at all, but that is not the present reality.

3.10 There is resistance to this technology from some large companies who make "bio-based plastics" and see it as a competitor, and from other large companies who will not spend an extra 1% on biodegradable technology to protect the environment from their products, which everyone can see with their name on them, littered all over the globe. There are also crusaders against plastic who do not understand (and perhaps do not want to understand) that there is a better kind of plastic which does not cause the environmental problem to which they have drawn public attention.

3.11 There has been aggressive lobbying of governments and international institutions against biodegradable plastic, coming especially from Germany and Italy, and the EU Commission itself. One of the lobbying organisations, the BBIA has recently lobbied the UK government in a letter which contains many misleading allegations see https://bioplasticsnews.com/2020/06/04/battle-biodegradable-oxo-compostable-industry/

3.12 For the OPA Response to the report of the Ellen MacArthur Foundation, see https://www.biodeg.org/wp-content/uploads/2020/05/emf-report-3.pdf

3.13 Policymakers know that thousands of tons of plastic are getting into the open environment every day, and that we may soon have more plastic in the ocean than fish, but what are they doing about it? They are trying to reduce the amount of plastic we use, and to recycle as much of it as possible, but they know that a significant amount of it will still get into the open environment.

3.14 Biodegradable plastic will prevent plastic lying or floating around for decades, and it has been used successfully around the world for more than 20 years. It has been used by the largest bakery in the western world[1] for more than 10 years with no problems relating to the environment or to recycling, and some governments in the Middle East[2] have actually made it compulsory.

4 THE SCIENCE

4.1 Foremost among the scientists who invented biodegradable plastics was Professor Gerald Scott, who was Professor of Chemistry at Aston University, and was in later years the Chief Scientific Adviser to the OPA. He published the results of his work in many scientific publications including "Polymers and the Environment" - Royal Society of Chemistry 1999 and "Degradable Polymers: Principles and Applications"- Kluwer Academic Publishers 2002. He was also the holder of several patents for the technology. All of Professor Scott's published work, and that of many other scientists on this subject, both published and unpublished, can be made available to the Government on request.

4.2 In these publications the polymer scientists have made it clear that biodegradable plastic will degrade and then biodegrade in the open environment very much more quickly than ordinary plastic, leaving no persistent fragments and no toxicity. Polymer scientists were the authors of the standards for biodegradable plastics (ASTM D6954 and BS 8472) and it is not correct for anyone to say that there is insufficient evidence, or that there are no relevant standards.

4.3 In 2018 the scientific evidence was reviewed by a distinguished former deputy judge of the High Court in England. https://www.biodeg.org/uk-judge-find-the-case-for-oxo-biodegradable-plastic-proven/ This has been confirmed by later research published by Queen Mary University London in February 2020. https://www.biodeg.org/wp-content/uploads/2020/05/published-report-11.2.20-1.pdf

4.4 Life-cycle analyses have been done, which show that biodegradable plastics have better environmental credentials than the other materials used for packaging. See below.

4.5 So why are all governments not making biodegradable plastic mandatory, and instead trying to ban it and allowing ordinary plastic (which they know causes microplastics) to continue in use? In some cases because they are under inappropriate pressure from multinational commercial interests, and in others because they see no complete consensus among the scientists. There is however sufficient consensus to enable a decision to be made. There is consensus on the following points:

- Ordinary plastics fragment into microplastics under the influence of weathering, but for many decades their molecular-weight remains too high to allow biodegradation.
- Adding a pro-degradant catalyst at manufacture reduces the molecular-weight much more quickly if the plastic escapes into the open environment.
- The only conditions necessary for biodegradation are oxygen and bacteria, both of which are ubiquitous in the open environment. No special conditions are necessary.
- Bacteria found on land and sea are able to consume the low molecular-weight residues of plastic.
- These residues have passed the OECD eco-toxicity tests
- There are already Standards in place which are suitable for testing biodegradable plastic.

Disagreement remains about:

4.6 *RATE*: How long it takes before the plastic becomes biodegradable. Timescale depends on the composition of the plastic, how old it is when it gets out into the environment, and the environmental

[1] Grupo Bimbo, whose HQ is in Mexico
[2] Saudi Arabia, the United Arab Emirates, Bahrain, and Jordan

conditions to which it is exposed. Sunlight and heat are not essential, but they will accelerate the process, and it is most unlikely that a piece of plastic litter will not be exposed to one or both of these.

4.7 Plastic litter tends to blow around on the surface of land or float on the surface of water, where oxygen and light are abundant but if exceptionally it gets quickly into cold, dark, conditions it will degrade more slowly but still more quickly than conventional plastic. The abiotic process of degradation is unstoppable unless the plastic is completely deprived of oxygen, which will not occur in the open environment. If of course the plastic is collected and taken to landfill or incinerated, it has been responsibly disposed of and is no longer a problem.

4.8 It is known that conventional plastic fragments do not become biodegradable for many decades, but it is possible to say with certainty that at any given time and place in the open environment an biodegradable plastic item will become biodegradable significantly more quickly than an ordinary plastic item. That is the point. - Do we want ordinary plastic which can lie or float around for decades, or biodegradable plastic which will be recycled back into nature much more quickly? Para. 2.3 of the Queen Mary University report shows that the biodegradation of LDPE was 90-fold greater than that of LDPE.

4.9 *EXTENT:* Will it fully biodegrade? It is well known that plastic whose molecular weight has been significantly reduced is biodegradable, and we have heard no reasons from any scientist why, once the process has commenced, it should not continue until biodegradation is complete, except in the very unlikely event that it is deprived of oxygen or bacteria.

4.10 *CONSENSUS*: In summary therefore, there is sufficient consensus to enable decision-makers to conclude that biodegradable plastic is better for the environment than ordinary plastic, and to decide to stop plastic accumulating in the environment, by requiring it to be biodegradable. Delay on this is no longer an option, because thousands of tons of plastic are getting into the open environment every day where they will lie or float around for decades.

5. THE MARINE ENVIRONMENT

OXOMAR

5.1 On 4th September 2020 scientists at the Laboratoire d'Océanographie Microbienne (LOMIC) reported on a four-year study (the OXOMAR project) sponsored by the French government, of biodegradable plastics in the marine environment, citing six earlier published reports. Their final report was published in March 2021[3]

5.2 The purpose of OXOMAR was to investigate whether biodegradable plastics will fully biodegrade in a reasonable time in the marine environment, and to investigate whether biodegradable plastic or its by-products create any toxicity in the marine environment. It involved the complementary expertise of four independent laboratories (CNEP, LOMIC, ICCF, and IFREMER).

A summary of the results says:

5.3 "We have obtained congruent results from our multidisciplinary approach that clearly shows that biodegradable plastics biodegrade in seawater and do so with a significantly higher efficiency than conventional plastics. The oxidation level obtained due to the d2w prodegradant catalyst was found to be of crucial importance in the degradation process. Out of the six-formulations tested, the Mn/Fe pro-oxidant was the most efficient, with no toxic effects under our experimental conditions. Biodegradability was demonstrated either by using the culture bacteria Rhodococcus rhodochrous or by a complex natural marine community of microorganisms."

5.4 According to Dr. Jean-François Ghiglione, the leader of the LOMIC scientists "Bio plastic will float and be at almost all times subjected to UV light, which accelerates the abiotic phase of degradation. This is not always the case on land, where plastic pieces are sometimes covered by soil, leaves etc. and are less

[3] https://anr.fr/Project-ANR-16-CE34-0007

exposed to UV light." He points out that "there are specific bacteria living in the "sea-surface microlayer" (the top millimetre of the ocean surface), where bacteria are different from those further below the surface. The bacteria in the sea-surface microlayer are particularly adapted to a hydrophobic environment (e.g. where oil materials are floating) and these bacteria are known to have a high capability for hydrocarbon degradation."

5.5 "Some marine bacteria, such as Alcanivorax borkumensis and R. rhodochorous are noted for their ability to biodegrade hydrocarbons and they are ubiquitous in the oceans. They occur in low concentrations in unpolluted seas but are observed to accumulate in waters polluted by oil spills. When presented with a source of carbon which is recognisable to the microorganisms as food, it seems therefore that they will respond with increased populations. The relatively low concentrations of microorganisms found in unpolluted oceans is not therefore a reason for expecting slow biodegradation."

5.6 Evidence is available - from tests done in real time at the Bandol research station on the coast of France that bio plastic will degrade to low molecular-weight materials under natural conditions in water, and samples aged under those conditions were studied at Queen Mary University London[4] where the abiotically degraded plastic was presented as the only source of carbon available to the bacteria.

5.7 The samples were proved to be biodegraded by bacteria commonly found in the oceans, and separate samples were biodegraded by bacteria commonly found on land. The degraded plastic was also proved to be non-toxic to those bacteria.

5.8 " For the OPA response to the Plymouth University report see https://www.biodeg.org/wp-content/uploads/2020/05/opa-comments-on-plymouth-10.pdf

5.9 What happens to the plastic product with OBD additive when it sinks in the ocean or is covered by soil, and has limited access to oxygen and sunlight?

5.10 This is possible, but not very likely. OBD is designed to deal with the problem of plastic litter, which blows or floats around in the open environment and is not usually buried or occluded from oxygen or sunlight. It will degrade in landfill if oxygen is present and will then biodegrade, but if it has been taken to landfill it has been responsibly disposed of and is no longer a problem.

5.11 Polyolefins have a density lower than water (especially seawater, which has a higher density than freshwater), so polyolefin products float and remain exposed to oxygen, heat and UV radiation[5]. In the unlikely event that the plastic is buried, or is weighted down and sinks immediately after entering the ocean, the degradation process will be slower but the degradation will still take place more quickly than for conventional plastic, as the prodegradant catalyst will still be effective. Once sufficiently degraded, the microorganisms (bacteria, fungi) will consume the short-chain molecules of the residues.

5.12 In the case of conventional plastic which does not contain d_2w, conditions in the environment are conducive to the initial degradation of conventional plastic articles[5] leading to embrittlement and fragmentation in as little as 4-8 weeks[6], particularly when exposed to sunlight on land or when floating on the ocean. Fragmented conventional polymers are more likely to be occluded from sunlight by burial in topsoil or to be susceptible to biofouling over time, resulting in a reduced rate of degradation**Error! Bookmark not defined.**. This ultimately results in very slow degradation of these plastics after fragmentation - resulting in persistent particulate litter which takes many decades to degrade enough to permit biodegradation.**Error! Bookmark not defined.,Error! Bookmark not defined.**

[4] https://www.biodeg.org/wp-content/uploads/2020/05/published-report-11.2.20-1.pdf

[5] Gewert, B., Plassmann, M. M., & MacLeod, M. (2015). Pathways for degradation of plastic polymers floating in the marine environment. Environmental Sciences: Processes and Impacts, 17(9), 1513–1521. https://doi.org/10.1039/c5em00207a

[6] Karlsson, T. (2018). Influence of thermooxidative degradation on the in situ fate of polyethylene in temperate coastal waters. Marine Pollution Bulletin, 135, pp.187-194.

5.13 This is why OBD was invented. The prodegradant catalyst in the d_2w masterbatch accelerates oxidative degradation, but also – critically – removes the dependence of this process on sunlight so that, unlike conventional plastics or photo-degradable plastics, degradation will continue in darkness until biodegradability[7] is achieved.

6. RE-USABLE BAGS AS AN ALTERNATIVE?

6.1 It is obvious that a new single-use bag or package is much less likely to spread disease than one which has been re-used a dozen times.

6.2 Re-usable bags are rarely, if ever, washed, and are often stored in a cupboard or trunk of the car where germs can multiply. Deadly micro-organisms such as Coronavirus, E.coli and Campylobacter can be transferred to food inside the bag.

6.3 On 18th August 2020 the London Daily Telegraph wrote "The bag for life is not a synthetic comrade with you until your last breath, it turns out - more an acquaintance briefly entertained before being roundly ditched. Or so say Morrisons supermarket, who have begun phasing out their plastic offerings in favour of reusable paper ones over concerns that a bag for life had in fact become a 'bag for a week' habit among British shoppers."

6.4 With regard to their environmental credentials, scientists at RMIT University, Melbourne found that reusable shopping bags are only beneficial to the environment if they are used at least 104 times. This is because thicker plastic bags require more plastic and more energy to produce than lightweight bags. Also, they will create greater plastic pollution, including microplastics, if they escape at the end of useful life, unless they are made with biodegradable technology, which can be programmed to start degrading in whatever timescale is required.

6.5 There is therefore a solution for those who still prefer re-usable bags. They can be made with both biodegradable and anti-microbial technology which can be incorporated into the polymer used for making the bags, and can also be incorporated into the laminate coating inside jute or cloth bags.

7. PAPER AS AN ALTERNATIVE?

Isn't it better to use paper instead of plastic?

7.1 Some supermarkets (most recently Morrisons and Waitrose in the UK) have shifted to single-use paper bags, but this is a worrying trend, as paper bags can have much higher environmental impacts. A 2011 study for the Northern Ireland Assembly found that paper bags generally require four times as much energy to manufacture as plastic bags, and cause 70% more atmospheric pollution. The process uses huge amounts of water and creates unpleasant organic waste. Recycling of paper is often uneconomic and uses toxic chemicals. When it degrades, paper will emit methane in anaerobic conditions. Manufacturing paper requires trees to be cut down, but plastic is made from a by-product of oil refining, which will be available until the day when no engines are driven or lubricated by petroleum resources.

7.2 A stack of 1,000 new plastic carrier bags would be around 2 inches high, but a stack of 1,000 new paper grocery bags could be around 2 feet high. It would take at least seven times the number of trucks to deliver the same number of bags, creating seven times more pollution and road congestion.

7.3 Also, because paper bags are not as strong as plastic, people may use two or three bags inside each other. Paper bags are not normally re-used, and are useless if they get wet.

7.4 A February 2018, Life cycle assessment of carrier bags in Denmark concluded that "When factors like ozone depletion, human and ecosystem toxicity and water and air pollution are accounted for, paper bags

[7] Vogt, N. B., & Kleppe, E. A. (2009). Biodegradable polyolefins show continued and increased thermal oxidative degradation after exposure to light. Polymer Degradation and Stability. https://doi.org/10.1016/j.polymdegradstab.2009.01.002

would need to be reused 43 times to have a lower impact than the average plastic bag." They are not of course durable enough to do this.

7.5 "There have been unforeseen consequences in the Irish Experience [taxing plastic bags] resulting in an increase in the use of paper bags which are actually worse for the environment …" … (Ben Bradshaw, UK Environment Minister, 4 August 2006).

7.6 plastic straws are a much better alternative to paper, provided that they are biodegradable.

8. REFILLABLES?

8.1 Concern with the in-store refill model is the reduction in shelf-life for products. Some fresh drinks would last just two days if poured into a customer's own bottle, compared to 20 to 30 days in a factory-sealed container.

9. LIFE CYCLE ASSESSMENTS

9.1 Plastic is actually the best material for a wide range of everyday uses. Not only is it much the best for protecting our food from contamination and preventing food-waste and disease, but it also has a much lower global-warming potential than other materials used for packaging, according to LCA's performed by Intertek, and Franklin Associates. https://www.biodeg.org/subjects-of-interest/life-cycle-assessments/

9.2 Plastic is made from a by-product of refining oil, which is extracted to make fuels, and these fuels would be made whether plastic existed or not, so plastic is not itself causing any depletion of fossil-resources. When the plastic becomes waste, its calorific value can be used to generate heat and electricity if, instead of being sent to landfill or if unsuitable for recycling, it is sent to modern, non-polluting, thermal-recycling units.

9.3 A Life-cycle Assessment by Intertek shows that when the litter metric is included, OBP is the best material for making carrier bags. See https://www.biodeg.org/wp-content/uploads/2020/09/intertek-final-report-15.5.121.pdf

9.4 The only problem with plastics is the length of time they can lie or float around if they escape into the open environment, but this problem can now be solved as explained above.

10. "COMPOSTABLE" PLASTIC AS AN ALTERNATIVE?

10.1 "Compostable" plastics are not relevant to the main problem facing governments today – ie plastic waste which has escaped into the open environment, from which it cannot realistically be collected and taken to a composting facility. https://www.biodeg.org/subjects-of-interest/composting/

10.2 A "Grocer" magazine survey of more than 1,000 individuals in 2019 found that "consumers think that plant-based compostable plastics are the most environmentally friendly packaging materials," but most consumers don't realise that "compostable" plastic does not convert into compost. It is required by ASTM D6400 and EN13432 to convert rapidly into CO_2 gas, and the last thing the planet needs is more CO_2. Further, if you can collect a piece of plastic there are better things to do with it than waste it by turning it into CO_2.

10.3 The German courts in Güthoff v Deutsche Umwelthilfe (2014) decided that it is deceptive to market plastic as "compostable."

10.4 Also, many consumers do not know that "compostable" plastic is tested to biodegrade in an industrial composting facility – not in the open environment. In November 2019 a Danish court ruled in Ellepot v Sungrow that "compostable" PLA plastic plant pots must not be described as biodegradable.

10.5 These plastics are often marketed as renewable, but this ignores the fossil fuels used in the agricultural production process by the machines which clear the land, plough the land, bring the seeds to

the farm and sow them, harrow the land, bring the fertilisers and pesticides to the farm and spread them, harvest the crop and transport it to the factory, and by the machines which polymerise the raw material.

10.6 This marketing claim also ignores the land and water resources devoted to producing the raw materials, which could be used for growing food. EASAC (March 2020 report) says that "replacing PE by a bio-PE would require almost all (93.5%) of global wheat production" which would of course be completely unsustainable.

10.7 Although these plastics are marketed as "bio-based" they can contain up to 60% oil-based material, but this is hardly ever mentioned in the marketing material.

10.8 As mentioned above, conversion of organic materials to CO_2 at a rapid rate during industrial composting does not create compost, and is not "recovery." Nature's lignocellulosic wastes do not behave in this way, and if they did, they would have little value as soil improvers and fertilisers, having lost most of their substance and their carbon.

10.9 Another problem with polymers manufactured from crops, is that they not only use scarce land and water resources, but they have significant impacts upon eutrophication due to the application of fertilizers to land.

10.10 On 15th July 2020 a report appeared in "Waste Management" Vol. 113, Pages 312-318. The conclusions were:

- In many cases, plastic bags are being replaced with compostable plastic bags.
- Industrial composting processes do not completely remove film fragments.
- Compost is thus a potential source of fragments from plastic bags.
- Compostable plastic fragments are then deteriorated in soil to microplastics.
- Compostable microplastic results in an increased number of aflatoxigenic fungi.

10.11 Moreover, plastics marketed as compostable are far too expensive for everyday use, and there are few industrial composting facilities available. In any event the industrial composters do not want plastic of any kind. In January 2020, the industrial composters of Oregon gave 9 reasons why they did not want it: https://bioplasticsnews.com/wp-content/uploads/2019/04/Oregon-composters-dont-want-Compostable-Packagine.pdf

10.12 Then the City of Exeter UK rejected it. https://www.biodeg.org/rejects-compostable-plastic-and-paper/

10.13 In the Borough of Epsom & Ewell in the UK their municipal website says "When you use plastic bags in your food waste caddy you're simply using them to contain the food, and keep your caddy clean. They don't get recycled. In fact, the first thing that happens when your food waste gets to the recycling plant is the plastic bags are all dredged out. They're sent off for burning along with normal refuse to generate electricity. After that, the food waste can be recycled."

10.14 "We used to ask you to use bio-liners to line your food waste caddy, but the food waste recycling companies found that bio-liners compost down much more slowly than the food. That slowed the recycling process and made it much more expensive. They tried dredging the bio liners out of the food waste, but the sticky bio-liners got tangled around the dredging equipment. Cleaning them off was very expensive. So they found that using plastic bags was, overall, much more cost-effective. They're not recycled but good stuff still happens to them. And you can use old bags like bread-bags or carrier bags if you like." https://www.epsom-ewell.gov.uk/why-it-ok-put-plastic-bags-food-waste-not-green-recycling-bin

10.15 Then the City of Toronto, Canada https://www.cbc.ca/news/technology/plastic-packaging-compostable-plastic-marketplace-1.5487617

10.16 Then the SUEZ waste-management company https://www.usinenouvelle.com/article/sacs-plastiques-compostables-le-grand-malentendu.N926789

10.17 Then a devastating exposé on Netherlands television https://bioplasticsnews.com/2020/02/17/the-composting-fairy-tale/

10.18 And another TV exposé in Canada about how compostable plastics are typically not being composted but instead sent to landfill or incineration. https://www.cbc.ca/news/technology/plastic-packaging-compostable-plastic-marketplace-1.5487617

10.19 Many areas do not have industrial composting plants, and the Welsh Government has refused to invest in them. https://www.bbc.co.uk/news/uk-wales-47238220

10.20 Plant-based compostable plastics are going to landfill rather than recycling because so many local authorities are unable or unwilling to deal with them.

10.21 "Compostable" resins are worse than conventional or biodegradable plastics when it comes to oxygen transmission-rate or moisture vapour transmission-rate. These resins are also water sensitive, and their physical, optical, mechanical, and chemical properties are inferior.

10.22 There are actually at least 21 reasons why "Compostable" plastic is not useful https://www.biodeg.org/wp-content/uploads/2020/05/21-reasons-why-1.pdf

11. HOME COMPOSTING

11.1 Not only does plastic not convert into compost, but home composting of plastic is dangerous and should not be encouraged. This is because householders are unlikely to be aware of any Standard for composting, and would probably not understand it anyway. Home composting is not therefore likely to be conducted by a process appropriate for plastic and will create microplastics.

11.2 A study for the French government at https://www.ademe.fr/sites/default/files/assets/documents/compostage-domestique-industriel-sacs-plastiques-papier_2019.pdf says that "composting management must be in line with good practices recommended by ADEME (weekly brews for one month and then every 1 to 2 months, humidity control), - the average ambient temperature over the first three months of composting must be close to that of the standard: outside temperature of 25oC - 50oC, but is unlikely that all of these conditions will be met by individuals."

11.3 The study also shows that "plastic bags are poorly disintegrated and biodegraded if good domestic composting practices are not applied. It also shows that, even when good practices are followed, there are still a few pieces of plastic bags of micrometric or even millimetre size in composts beyond the standard year of home composting."

11.4 In addition, the study says "it appears that the biodegradation of plastic bags suitable for domestic composting makes little or no contribution to the formation of humus because, in accordance with the biodegradation tests of these materials according to the NF T 51-800 standard, at least 90% of the carbon organic dioxide is converted into carbon dioxide."

11.5 Worse still, there is a danger that the plastic may have been contaminated by pathogens e.g. from putrefying food, and that the temperature in a home compost may not be high enough to kill those pathogens before they are spread on land where food-crops are being grown.

12. RECYCLING

12.1 Users of any plastic recyclate cannot assume that the recyclate does not contain pro-oxidants.

12.2 This is because conventional plastics may contain pro-oxidant additives that were added for different intended purposes. Moura et al. (1997) described that colorants in general can act as pro-oxidants. If they

partake in the creation of radicals or reactive oxygen species, such as singlet oxygen (1Δg), they can trigger photo-degradation of the polymer matrix." "Conventional plastic products (n = 23) were found to regularly contain Fe, Ba, Ti, Zn, Cu and V. Some individual conventional plastic bag samples also contained Cr and Pb" "Thus, a potentially much higher number of plastics on the market may match the current legal definition of degradable plastics without being advertised or intended as such."

12.3 Further, the Austrian specialist laboratory TCKT said in para. 1 of its March 2016 report. https://www.biodeg.org/wp-content/uploads/2020/06/TCKT-Report-17.3.161.pdf that "long-life films should be made with virgin polymer, or be stabilized to deal with loss of properties caused by the recycling process, whether or not any pro-degradant additive is present. Such stabilization would effectively neutralize the effect of any pro-degradant additive."

12.4 Although biodegradable plastic is used for low-value items which are not worth recycling, the experts in Austria (TCKT Report para. 4) and South Africa (Roediger Report May 2012 page 3 https://www.biodeg.org/wp-content/uploads/2020/12/ROEDIGER-REPORT-21-May-2012.pdf have confirmed that if anyone wished to recycle them, they may be recycled without any significant detriment to the newly formed recycled product.

12.5 This accords with the experience of OPA members who have recycled many thousands of tons of biodegradable plastic over the past 20 years without any adverse effects.

12.6 The experts also found that "compostable" plastics are not recyclable in a conventional plastic waste-stream. This is well known, but is seldom heard as an objection to that type of plastic.

12.7 Having considered all the issues mentioned above policymakers have to decide whether recycling is any reason to object to biodegradable technology and continue therefore to allow ordinary plastic to be used for short-life packaging, which could get into the open environment and lie or float around for many decades. In our view it is not.

13. STANDARDS

13.1 We sometime hear it said that there are no robust standards for testing biodegradable plastics.

13.2 The main Standards for testing biodegradable plastic are ASTM D6954 (USA); BS8472 (UK); AFNOR AC T51-808 (France); and SPCR 141 (Sweden). Variants of these standards have also been adopted in other countries, such as SASO 2879 in Saudi Arabia, and 5009/2009 in the UAE

13.3 ASTM D6954 contains six pass/fail criteria. 1. For the abiotic phase of the test (6.3 - 5% e-o-b and 5,000DA) 2. The tests for metal content and other elements (6.9.6), 3. Gel content (6.6.1), 4. Ecotoxicity (6.9.6 -6.9.10), 5. PH value (6.9.6) and 6. For the biodegradation phase (for unless at least 60% of the organic carbon is converted to carbon dioxide the test cannot be considered completed).

13.4 One of the US authors of ASTM D6954 has given evidence about the Standard to the UK government at https://www.biodeg.org/wp-content/uploads/2021/02/Swift-evidence-to-BEIS.pdf

13.5 It is for customers and governments to decide what timescales are acceptable to them.

13.6 ASTM D6400 and EN 13432 apply to biodegradation of plastic packaging under industrial composting conditions, but they are not appropriate for testing biodegradable plastics because they require the emission of CO_2 (a greenhouse gas) at a very high rate. If a leaf were subjected to the CO_2 emission tests included in these Standards it would not be considered biodegradable or compostable.

13.7 EN 13432 does not apply at all to applications other than composting of packaging, and para. 1 makes it clear that it does not apply to packaging waste which may end up in the environment through uncontrolled means, i.e. as litter.

14. NON-TOXICITY

14.1 The biodegradable industry is as much concerned as anyone that its products should not introduce toxicity into the environment, and for this reason the Standards for bio mentioned above require testing according to OECD Standards to confirm that the residues are harmless. They have to pass the same tests as "compostable" plastic to ensure that there is no toxicity and no metals exceeding the prescribed limits.

15. AGRICULTURE

15.1 Biodegradable plastic mulching films have been successfully trialled in Wales, and are being used commercially in Ireland[8] and elsewhere. For the report of the trials see https://www.biodeg.org/wp-content/uploads/2020/09/Pembroke-Mulch-Film-Trial-Report-30.09.13V1.pdf

15.2 The commercial benefit of using biodegradable plastic film is that the farmer will no longer have the costs of having acres of contaminated plastic removed from the farm. The environmental benefit is that heavy vehicles will no longer have to drive around the country roads collecting contaminated plastic, consuming fossil fuels, emitting pollutants, and occupying road space.

16. PROPENSITY TO LITTER?

16.1 It is sometimes claimed that biodegradable plastics are likely to encourage littering, but if true, this also applies to bio-based plastics.

16.2 However, much of the littering is done by accident. In the case of deliberate littering if there were a label describing a product as biodegradable, it is unlikely that the people who deliberately cause litter will read the label before deciding to throw a plastic item out of a car window. Further, even if it were true that biodegradability encourages littering, and supposing for the sake of argument that there would be 10% more litter - is it preferable to have 110 plastic items in the environment which will degrade and biodegrade in a few years or even months, or 100 plastic items which will lie or float around for many decades?

16.3 It is not acceptable to continue debating this speculative proposition any longer, while thousands of tonnes of conventional plastic are getting into the environment every day, which will accumulate and pollute the environment for decades into the future.

17. THE EU SINGLE-USE PLASTICS DIRECTIVE

17.1 The EU has a well-established procedure, set out in the REACH regulation 2006/1907, for determining whether substances should be banned. This procedure was designed to avoid arbitrary and commercially-motivated bans.

17.2 Accordingly and in compliance with the REACH procedure. The EU Commission requested the European Chemicals Agency ("ECHA") under Article 69 of REACH to investigate its concerns regarding microplastics. The OPA and many other stakeholders submitted scientific evidence to ECHA on BIOdegradable plastic and on 30 October 2018 ECHA informed the OPA that they were not convinced that it created microplastics. If they are not convinced, then on what basis can anyone else be convinced?

17.3 The EU did not allow ECHA any more time, and closed their investigation. The Parliament then made the extraordinary decision to insert a few words (which had not been in the Commission's draft) into Art 5 of the draft Directive to impose a ban as from 3 July2021, citing microplastics as a reason, and the Commission terminated ECHA's investigation. The Commission's proposal to the Parliament had not mentioned a ban on "degradable" plastic, and the amendment seems to have been the work of

[8] See eg https://www.samco.ie/

lobbyists acting for rival commercial interests. Never before has an ECHA investigation been circumnavigated by legislation.

17.4 Only if ECHA had recommended a restriction, supported by the detailed dossier prescribed by Annex XV of REACH, their recommendation would have had to be considered by two committees under Articles 70 and 71 of REACH, and also by a stakeholder consultation under Article 71(1), before any restriction could be proposed. None of these procedures prescribed by EU law have been complied with.

17.5 An OPA member, Symphony Environmental Technologies Plc has therefore commenced an action in the General Court of the EU challenging the legality of Article 5 of the Directive. The case is expected to be heard in Q3 or Q4 of 2022.

17.6 Symphony received a letter on 29th October 2020 from the Rt. Hon. Theresa Villiers MP., the immediate past secretary of State for the Environment of the UK in which she says "We are all aware that plastic which has escaped into the open environment as litter is causing a serious problem, and that governments are taking measures to reduce the amount. Nevertheless, it is realistic to expect that despite those measures a significant amount of plastic will continue to get into the open environment from which it cannot easily be collected for recycling or anything else."

17.7 "I gather that your company has sought to address this problem by developing a type of plastic known as "biodegradable," which converts into non-toxic biodegradable materials if it gets into the open environment, without any need to collect it and take it to a composting facility."

17.8 "I am also aware that by Directive 2019/904 the EU has banned "degradable" plastic as from July 2021 because they think it creates microplastics, but have not distinguished degradable from BIOdegradable plastic. I am concerned that having commenced the process required by REACH before any substance can be banned, the EU did not complete the process and imposed the ban notwithstanding that their own scientific experts (ECHA) advised that they are not convinced that microplastics are formed."

17.9 "I am writing to say that as a former UK Secretary of State for the Environment I see no justification for banning BIOdegradable plastic. In fact I consider this technology can play a positive role in tackling plastics pollution because it enables everyday plastics to biodegrade safely and quickly if they get into the open environment."

18. GENERAL ISSUES

18.1 For the reasons given above, the OPA would not wish it to be thought that we agree with the proposition that single-use plastics should be banned. However, we do consider that they should no longer be made with conventional plastic.

18.2 In January 2020 a report was published by the Green Alliance https://www.green-alliance.org.uk/plastic_promises who had interviewed representatives from five of the UK's major supermarkets as well as from major consumer goods and beverage companies. One of them had received complaints saying that "plastic is evil and has no place, regardless of any positives it might have in addressing food waste and what not… the complaints have been ferocious."

18.3 However, the report finds that "Worryingly, the brands report that decisions to switch away from plastic are often made without considering the environmental impact of the substitute materials chosen." Multiple interviewees indicated the desire to avoid "kneejerk reactions" and another noted: "there's a lot of pressure to move to alternatives, which aren't necessarily better from an environmental and climate-impact point of view."

18.4 The Report says that some decisions have been taken knowing it could actually increase environmental burdens. One supermarket representative was frank: "We are aware that [by switching from plastic to other materials] we may, in some cases, be increasing our carbon footprint" and a brand representative bluntly complained about misinformation being spread about the environmental credentials of non-plastic single use packaging formats:

18.5 "The past year has really annoyed me with companies coming out and boasting about not using plastic, even when they're in single use glass, and their carbon emissions are going to be off the scale."

19. CORONAVIRUS

19.1 The virus, and other dangerous microbes, have shown that they can defeat the defences of the human body unless immunised, so it is essential to destroy them before they get into the body. The pandemic has made everyone realise that single-use plastic is essential to protect us from the spread of disease, and plastic can be made with anti-microbial properties.

19.2 The most effective way to protect against microbes is not by spraying or wiping, but by making surfaces in contact with microbes permanently lethal to bacteria and viruses. This can be done simply and at reasonable cost with plastic, but not with any of the alternative materials such as paper, carboard, cloth, jute, glass, or metal (except silver, which is too expensive).

London 31st August 2021.

For audio-visual interview see https://youtu.be/UkGOk0akyf0