OXO-BIODEGRADABLE PLASTICS ASSOCIATION

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THE EUNOMIA REPORT

This is a 192-page report ("the Report") commissioned by the EU Commission to examine the impact of the use of oxo-biodegradable (OBP) plastic carrier bags on the environment. The Report refers to OBP as PAC (Pro-oxidant Additive Containing) plastic.

The Report introduces the subject as follows:

"The high molecular weight and hydrophobic nature of conventional plastic lends the material high resistance to biological attack. However, for situations where biodegradation is a desirable attribute, the second half of the 20th century saw attempts to develop the first plastics deliberately engineered to age upon the application of heat and light.

Within the current century, the focus has shifted to materials marketed as "oxo-degradable" or "oxo-biodegradable" plastics. [They are **not** marketed as oxo-degradable] *These are plastics which contain additives intended to initiate degradation as well as stabilisers (anti-oxidants) intended to delay this effect until it is desired to occur if, and when, an item is discarded in the natural environment. These plastics are intended to go through both abiotic degradation (for instance embrittlement and mechanical damage) and biotic degradation processes (i.e. biodegradation), accelerated by light and/or heat, until they are, ultimately, fully bio-assimilated.*

The debate around the biodegradability of PAC plastic is not finalised, but ***should move forward from the assertion that PAC plastics merely fragment, towards confirming whether the timeframes observed for total biodegradation are acceptable from an environmental point of view and whether this is likely to take place in natural environments."*** [1] We agree, and there should be no change in legislation until this work is completed.

There is no longer any justification for anyone to refer to OBP as "oxo-degradable" or "oxo-fragmentable." *Oxo-biodegradation is clearly defined in CEN/TR 15351:200611 as "degradation resulting from oxidative and cell-mediated phenomena, either simultaneously or successively."*

LANDFILL

OBP is not designed to biodegrade in landfill. As the Report confirms, *"aerobic degradation produces CO_2 whereas anaerobic degradation produces methane—a greenhouse gas 25 times more harmful (on a 100 years' time horizon) than CO_2"* and plastics which contain a proportion of vegetable-sourced material suffer from this disadvantage in landfill. We will refer to these plastics as hydro-biodegradable plastics ("HBP") - (also loosely known as "bio-based plastics" or "bioplastics" or "compostable plastics"). OBP do not suffer from this important disadvantage.

The Report concludes *"Whilst PAC plastic may biodegrade in the upper levels of a landfill in aerobic conditions and therefore produce CO_2, it has already been demonstrated that this*

[1] Para 5.2

happens at a very slow rate, and only if abiotic degradation has already occurred. The limited evidence that is available suggests that deeper in landfill under anaerobic conditions there will be little or no biodegradation taking place. In this case, the carbon is effectively sequestered, avoiding the direct release of GHGs to the atmosphere."

COMPOSTING

OBP is **not** marketed for composting, and it is surprising therefore that the authors of the Report have taken so much time to consider it. By contrast, HBP is marketed as "compostable" but the relevant standard (EN13432 or ASTM D6400) requires it to convert rapidly not into compost but into CO_2 gas, which contributes to climate-change but does nothing for the soil. This process cannot therefore be described as "packaging recoverable through composting" or "organic recycling."

The main purpose of HBP is to make bags which carry compostable material to an industrial composting plant and which do not have to be emptied there. OBP has in fact been trialled for this purpose in the UK and was found satisfactory by industrial composters, but it is not marketed for composting because it does not produce CO_2 gas quickly enough to pass EN13432, (which makes no allowance for the period of useful life during which OBP is designed NOT to degrade). The carbon in OBP therefore remains as a nutrient for the soil until it is returned to nature by the action of micro-organisms.

EN13432 is a standard written by the HBP industry representatives on CEN for their particular technology, and is not relevant to OBP (except that OBP meets the same non-toxicity criteria). In fact the desirability of this standard, and the products to which it relates, must be questioned in an age where great efforts are being made to reduce CO_2 emissions. HBP is also sometimes used for packaging and carrier bags, in the mistaken belief that it is better to make plastic from crops instead of oil – See "Fossil Resources" below.

RECYCLING

The best option for recycling is conventional plastic, but this has a serious disadvantage if it gets into the open environment as litter. Thousands of tons of conventional plastic are getting into the open environment every day, where they will lie or float around and will accumulate for decades, and this is no longer acceptable.

The Report says *"The evidence available does not support the suggestion that PAC plastic can be identified and sorted separately by reprocessors with the technology that is currently available. Furthermore, manual sorting would be time-consuming and is unlikely to be economically viable."*

We are not aware of any such suggestion. Separation is a problem with all types of plastic film, and is one reason why post-household plastic film is not attractive to recyclers. Other reasons are that the material is often contaminated and it would not be cost-effective to clean it, given that the material from which it is made is inexpensive and readily available.[2] It is also too costly in financial and environmental terms to collect it, transport it, sort it, bail it, store it, and reprocess it, so – as the report confirms – it is generally exported as mixed plastic for low grade uses (not for long life uses such as building films or pipes, which are normally made from virgin polymer or used-plastics of known type and provenance). The separation of OBP film derived from carrier bags is therefore a non-issue, but a marker could easily be included if separation were desired.

OBP has however been designed to be recyclable during its useful life, and scientific tests have proved that it can be safely recycled together with conventional plastic, so that separation from conventional polymers is not necessary.

[2] and does not cause depletion of fossil-resources – see "Fossil Resources" below.

The Report continues *"Evidence suggests that the impacts of prodegradant additives on recyclates can under certain circumstances be avoided with the inclusion of stabilisers. The appropriate quantity and chemistry of stabiliser would depend on the concentration and nature of the prodegradants in the feedstock."* However, the Eunomia report misunderstands the role of stabilisers. It is clear from the scientific reports made available to Eunomia that it is not necessary to add stabilisers unless the recyclate is being used to make long-life products, in which case the manufacturer of those products would be adding stabilisers anyway. These stabilisers are in a quantity and with a chemistry which he would normally use, and no special arrangements are necessary for recyclate containing OBP.

"Evidence suggests that oxidised PAC plastic can significantly impair the physical qualities and service life of the recycled product." This is true of HDP, but not of OBP. Most waste plastics of all kinds will have been exposed to UV radiation - and in particular agriculture film, and may have oxidised to some extent. Recyclers of mixed plastic wastes have no way of knowing which have been exposed and for how long. It is also known that printing inks, and other chemicals will affect the recycling process. Therefore, the industry already has the problem of identification when dealing with post-consumer plastic films, and deals with it by using those materials for low-value/short-life applications such as carrier bags and garbage sacks, or by adding fresh stabilisers if used for longer-life applications.

If an OBP carrier bag is going to be collected for recycling at all it is likely to be collected during its useful life. During that time it will not have oxidised because the stabilisers in the OBP masterbatch are designed to ensure a minimum useful life (typically 18 months) before oxidation commences, even with exposure to sunlight during use. It will have been stored before use in light-proof boxes or wrappers. If collected for recycling very late and if the plastic had oxidised, it would have generated a strong odour and would be falling apart and would not be used for recycling. Oxidised polymer would in any event have to form a substantial proportion of the feedstock to have any effect at all.

"Recyclate made from mixtures containing unknown PAC plastic should not be used for long-life products, due to the lack of evidence surrounding the long-term impact in secondary products." There is no lack of evidence. The TCKT report dated 27th July 2016 considered this very issue, and concluded that provided a UV-stabiliser has been included (which the Report says should always be the case with plastic products intended for outdoor use) there will be no negative effects from the inclusion of oxo-biodegradable recyclate. These studies also demonstrate that even without UV stabiliser the presence of oxo-biodegradable recyclates has no effect within the body of thick cross-section plastic, where oxygen is not available, nor when the plastic is buried or otherwise enclosed with no access to oxygen. (The authors of the Report have read the 17th March 2016 TCKT report, but have not cited the 27th July 2016 report).

The position of the OBP industry is based on scientific reports by specialist researchers. See http://www.biodeg.org/recycling.html and we have seen no evidence of any deleterious effect on any product made from recyclate containing OBP.

The Eunomia Report is concerned with plastic film used to make carrier bags, not with PET packaging or bottles, for which OBP is not sold.

Anyone who wants to promote recycling should certainly be concerned about HBP, because it cannot be recycled together with oil-based plastic waste, and separation would be required. Some of it will get into the plastic waste recycling stream – especially as it is being promoted for carrier bags and packaging - but we are not aware of any proposal to restrict the marketing of HBP for that reason.

DEGRADATION

One of the key findings of this report is that, *"without exception, the scientific evidence suggests that the conditions present during the abiotic stage (which in most studies is* *simulated by some form of accelerated pre-treatment) of degradation* ***will have a significant impact on the materials' ability to subsequently biodegrade."*** We agree.

Nobody doubts that all plastics (OBP, HBP and conventional) will fragment as they degrade, and micro-plastics are now seen as a serious problem, but OBP has been designed to convert rapidly at the end of its useful life into low molecular-weight materials in the outdoor environment with access to oxygen. Nobody doubts that this does occur, and the Report confirms it.

Similarly, nobody doubts that the length of time that this process takes will depend on conditions in the environment. It will take longer if (rarely) it is not exposed to any sunlight, but it is not correct to say that exposure to sunlight is essential. Equally, nobody doubts that under the same environmental conditions OBP will convert to low molecular-weight materials much more quickly than conventional or HBP plastic. However, questions have been raised as to whether the whole of the plastic will convert to low-molecular-weight materials, but this is well understood and the standards for OBP place limits on gel-formation.

The Report is meant to be concerned with carrier bags, but it also mentions plastic mulch films for agriculture at some length. These can be made from OBP but a reputable supplier will formulate the polymer and additive having regard to the particular circumstances on the particular farm, and to the particular type of crop and its growing-season. Allowance will be made for exposure to UV light on the surface of the field during the growing season, and for the edges which are tucked under the soil. It is not therefore useful to consider degradation times for unexposed material. Trials will also be done in situ with a range of formulations before an OBP mulch-film is supplied to a farmer in commercial quantity.

BIODEGRADATION

Nobody doubts that any plastic which has converted to low molecular-weight materials has become accessible to micro-organisms, who can use it as a food source, and that these types of micro-organisms exist on land and in the sea. The dispute is how quickly they will bioassimilate the material, and whether they will bioassimilate all of it.

The timescale for completion of biodegradation depends on how quickly the plastic has become biodegradable so that the process of biodegradation can begin. Conventional plastic undergoes the same process, and low molecular-weight residues of OBP will behave in the same way as low molecular-weight residues of conventional plastic, but **will have become capable of biodegradation much more quickly – within months or years instead of decades.**

Once the material has become biodegradable in the open environment it really does not matter how long it takes to biodegrade completely if it has been proved to be non-toxic. This would matter only in the unlikely situation that there were large quantities of plastic residues in the same place, and the Report acknowledges that this is not likely in the case of carrier bags.

As to whether the micro-organisms will bioassimilate the whole of the low molecular-weight material, biodegradation of 91% has been observed at the Technical Research Institute of Sweden and the Swedish University of Agricultural Sciences, and 88.9% at the Eurofins laboratory in Spain. This is complete biodegradation for all practical purposes. (the limit specified for HBP in EN13432 is 90% of the maximum degradation of a suitable reference material, which could be less than 90% of the actual material).

The Eunomia Report comments on the Swedish study that *"with the results of the laboratory study showing over 91% conversion to CO2, the [Swedish] author contends that the "risk of plastic fragments remaining in soil indefinitely is very low." Nowhere is such a claim for complete bio-assimilation proven in practice though." "Although it can be believed that biodegradation can be facilitated by careful engineering of the chemical package in*

PAC plastic, evidence is not available to definitively conclude that this will happen in real world situations with PAC plastic products being placed on the market."

The opinion of the distinguished academic team in Sweden cannot be so easily dismissed, having regard also to the scientific studies in Spain and elsewhere. What does the author of the Report mean by "proven in practice?" Evaluation of biodegradation has to be done in laboratory conditions (as is also the case with HBP) – it cannot be done in a field or an ocean or a compost heap. These tests are very expensive and are not done for the amusement of scientists. They are designed to replicate conditions in the real world. There is no reason to think that in the open environment the micro-organisms will stop before they have consumed all of the available material, and it is for those who think so to provide some credible reasons.

The Eunomia Report itself refers to the work being done at Queen Mary University London which shows *that "small levels of biodegradation were observed which if left to continue at the same rate would lead to full biodegradation in around 2 years."* This is perfectly consistent with the expectation of the OBP industry and its customers.

The Report continues *"It is, however, unclear how these results can be translated to behaviour in the real world. One strain of bacteria is used in the test whereas in the open environment there may be many more, as well as fungi which may also attack and break down the plastic—**and therefore it may biodegrade quicker.**" "From the information studied, the authors of this report can believe that **it is possible for a PAC plastic to fully mineralise in an open environment, with the prodegradant additives encouraging this action, and thus the polymers and entrained substances can be assimilated into the natural environment**."*

The chemical package in OBP is indeed carefully engineered, and that is a skill acquired from tests and experiments carried out over twenty years by reputable suppliers and academics. If the Report is suggesting that only OBP placed on the market by reputable suppliers can be relied upon, we would agree, and this is the same in any industry and for any product.

When comparing the performance of OBP with conventional plastic, the conventional plastic will not biodegrade at all until it has acquired biodegradability after exposure for very many years, and then its performance will be much the same as the degraded residues of OBP. The purpose of OBP is therefore to reduce very significantly the period of time that the plastic is lying or floating around, and accumulating, in the environment before it becomes biodegradable.

MARINE ENVIRONMENT

The Report says, *"Evidence is not available to properly understand the fate of PAC plastic in marine environments, and thus there remains a risk that plastic fragments may remain either indefinitely, or for long enough to cause significant environmental damage."* Actually, although conventional plastic fragments will remain in the marine environment for a very long time, nobody thinks that plastic fragments of any kind will remain in the environment indefinitely.

Evidence is certainly available that conventional plastic may remain in the marine environment for long enough to cause significant environmental damage. Most of the microplastics found in the sea are from conventional plastic, and this is the reason why OBP was invented.

The Report acknowledges that abiotic degradation of OBP occurs in the natural environment, but speculates that that if marine biodegradation does not occur rapidly enough, this will result in an increase in fragments of plastic in a given area. However, the currents in oceans and rivers will ensure rapid dispersion. It is true that bacterial biomass and diversity are lower in seawater compared to soil, but it does not follow that biodegradation will be less efficient in marine waters.

According to Dr. Jean-François GHIGLIONE[3] "OBP 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 often covered by soil, leaves etc and are less exposed to UV light. He points out that there are specific bacteria living in the "seasurface microlayer" (the top millimetre of the ocean surface), where bacteria are different from those further below the surface. The bacteria in the seasurface 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. These bacteria are therefore potential OBP-degraders, and such an environment does not exist at the surface of soil. These bacteria are probably less abundant and less diverse in the ocean than in soil, but probably more effective to degrade OBP.

Therefore, if abiotic degradation of OBP is found to generate biodegradable material at a rate that cannot be immediately consumed by marine microorganisms, the process will contribute materials which closely resemble products of organic materials naturally present in the environment (eg fragments of seaweed), and are recognisable to microorganisms as an accessible source of food - not fragments of plastic.

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 justification for expecting slow rates of biodegradation of OBP.

Evidence is available - from Station d'essais de Vieillissement Naturel de Bandol on the coast of France that oxo-biodegradable plastic will degrade to low molecular-weight materials under natural conditions in water, and samples aged under those conditions in real-time have been studied at Queen Mary University London where the abiotically degraded plastic was presented as the only source of carbon available to the bacteria. The samples were proved to be biodegraded by bacteria commonly found in the oceans, and separate samples by bacteria commonly found on land. The degraded plastic was also proved to be non-toxic to those bacteria.

Commenting on these two pieces of work the Eunomia Report notes that *"during pre-ageing under water, PAC plastic is **much more susceptible to UV degradation than conventional plastic** (as demonstrated by the large difference in molecular weight). The biodegradation tests also indicate that **bacteria can feed off plastic** measured with a higher molecular weight than the 5,000 limit often used to characterise this."*

The Report says that ***"should full biodegradation on land occur, this would reduce the quantity that may otherwise transfer to the marine environment."*** We agree.

The Report continues *"It is not possible to conclude whether PAC plastic would increase or decrease absolute quantities of plastic in marine environments."* We think it is perfectly possible to conclude that degradation which is much more rapid than for conventional plastic, and biodegradation which proceeds at the same rate as conventional plastics after they have become biodegradable, would decrease absolute quantities. The "ocean garbage patches" have been accumulating for decades, and this would not have happened had all the plastics been OBP. The problem is getting worse every day while Europe debates, but governments in other parts of the world have studied the technical evidence in detail and have already made OBP mandatory. The latest country to do this is Saudi Arabia – one of the world's largest producers of plastic.

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[3] Directeur adjoint de l'Observatoire Océanologique de Banyuls

A piece of OBP which degrades and becomes fragmented might be carried more easily into the sea by rainwater if it is near the sea or a watercourse, but an undegraded piece of conventional plastic is more likely to be blown into the sea or a river. If it remains on the land it will eventually behave after many years in the same way as OBP.

The Report continues *"It seems likely that the fragmentation behaviour of PAC plastics will exacerbate issues related to microplastics."* However, the truth is the exact opposite. Microplastics have become a problem because conventional plastic has been eroding and fragmenting for decades, and the fragments are still fragments of plastic because their molecular weight has not sufficiently reduced. This is not the case with OBP.

Plastic fragments are not the final products of abiotic degradation of OBP. As noted above, the inclusion of a prodegradant additive will accelerate the observable fragmentation of plastic in the environment, compared to an equivalent non-degradable plastic product, but degradation continues until the material has become low molecular weight oxidised materials which no longer resemble a polymer. These are water soluble and biodegradable, and this abiotic degradation will proceed without the involvement of microorganisms. By contrast, conventional plastics can be observed to fragment in a relatively short time-frame, but will remain in the environment for a long period of time as high molecular-weight microplastics.

"Working under the assumption that PAC plastic in marine environments will be more fragmented, the effect may be to reduce the impacts on wildlife in some respects (such as entanglement)." Correct

"but to increase the impacts in others (such as physical ingestion of microplastics)." Thousands of tonnes of microplastics formed from conventional plastics are already being ingested. If these are causing harm as they pass through the digestive system, or are getting into the food-chain with undesirable consequences, the response must be to ban plastics of all kinds – but this is clearly disproportionate, as one has always to balance the advantages and disadvantages of any technology. The answer is to make the plastics with oxo-biodegradable technology.

"The PAC plastic is more likely to fragment quicker so the impacts associated with microplastics are concentrated within a shorter period of time." "this could ultimately be worse than spreading out the impacts over a longer period of time due to an increase in the proportion of individuals, species and habitats affected, as well as the burden of impacts for an individual of a species." In our view the opposite would be the case. Fragments of conventional plastic will exist as a problem for decades, but OBP rapidly becomes a food source for micro-organisms.

Several studies have been done, including those by Pascall et al, Takada et al, Mato et al and Teuten et al, which demonstrate that *conventional* polymers such as polyethylene and polypropylene will readily adsorb PCB and other toxins. This is because the polymers are inherently non-polar and hydrophobic in nature, and with a low Tg (glass transition temperature), their rubbery nature allows for greater segmental mobility, pore-size, free volume, diffusion and partition coefficients. This means that hydrophobic organic toxins such as PCB can in theory adsorb to the polymers (through Van Der Waals attractive forces) from the aqueous environment.

The increased pore-size and free volume also means that if the toxin is adsorbed to the conventional polymer, it will not readily desorb, and thus over long periods of time the polymer will break down by friction, shear, and weathering, and the potential for the plastic material to adsorb toxins increases. Takada et al demonstrated in a field experiment in Tokyo Bay that conventional plastic fragments collected from the bay had adsorbed up to 892 ng/g. This suggested that the plastic had persisted in that area for at least twenty-seven years (assuming a linear uptake profile).

Pascall et al included polyvinyl chloride and polystyrene in their study. The results from their field-experiments demonstrated a significantly lower adsorption uptake of PCB toxin. The difference in chemical structure resulting in differing polarity of the polymer, more rigid packing (demonstrated by higher Tg) resulting in restricted segmental mobility, and restricted pore size explains the reduced adsorption observed.

This information helps to build a picture of what would be expected for oxo-biodegradable polymer materials in the oceans. Under the action of oxygen, UV light, and ambient heat, polyethylene and polypropylene containing oxo-biodegradable additives will change their molecular structure and break down.

Hydroperoxy intermediates are readily formed in the initial phase of degradation, and immediately there is a change in chemical structure and increase in polarity. The formation of these oxygenated species already makes the polymer less susceptible to adsorption of PCB and related hydrophobic toxins. Lower diffusion and partition coefficients result from increased cohesive forces, reducing segmental mobility and pore-size. The highly polar functional groups that are formed will not interact with the non-polar toxins, either through chemical reaction or intermolecular interaction.

The second stage of degradation is the molecular-weight reduction of the hydroperoxy intermediates (with the vicinal form proceeding more rapidly) to intermediate and short-chain aldehydes, ketones, esters, and hydroxyl and hydrocarbon radicals. These will proceed further to carboxylic acids which will be readily bioassimilated by micro-organisms.

In summary, the constantly progressing chemical breakdown of the oxo-biodegradable polymer results in species with increased hydrophilic character that will readily solubilise and emulsify in the ocean environment. It would, therefore, not be possible for hydrophobic toxins such as PCB to accumulate on oxo-biodegradable plastic materials

STANDARDS

The principal Standards which have been written for testing OBP 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. There is no CEN standard for OBP because the technical committees of CEN are dominated by representatives of the HBP industry who do not wish to see a standard which might improve the acceptability of OBP in Europe. Accordingly, the OBP industry has worked at its own expense in the other standards organisations around the world to develop new and better standards.

If this obstruction in CEN could be overcome with the help of the Commission, the Oxo-biodegradable Plastics Association undertakes to draft a suitable European Standard and present it to CEN, and to establish a scheme for OBP similar to that operated by Vincotte for HBP. In the meantime, the American, British French and Swedish standard test methods can provide the information which customers and governments need to know.

ASTM D6954 contains no less than 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). It is for customers and governments to decide what timescales are acceptable to them.

NON-TOXICITY

The OBP industry is as much concerned as anyone that its products should not introduce toxicity into the environment, and for this reason the standards for OBP require testing to confirm that the residues are harmless, according to the same OECD eco-toxicity tests as are required by EN13432 for HBP.

Essentially OBP are made from the same materials as conventional plastics, with the addition of only 1% of a masterbatch (most of which is itself ordinary polymer), and they have to pass the tests in EN 13432 to ensure that there are is no toxicity and no metals exceeding the limits prescribed in Annex A.1.2 of EN 13432 (and Art 11.1 of the EU Packaging Waste Directive 94/62/EC). Other ingredients which manufacturers may wish to include in plastic products (eg Bisphenol A), or which may be generated by the manufacturing process of plastic products, are not the responsibility of the OBP industry, and should be specifically regulated by government.

The Report says *"it does appear that* ***the PAC plastics industry can create products that have minimal toxic impact on flora and fauna****. …* ***and it is at least encouraging that almost all existing test standards for PAC plastic specify some form of toxicity test using established methods (such as germination and earthworm survival tests)."***

The Report continues*, "this does not mean that all products on the market avoid negative toxic effects, as there is no regulatory control currently exercised in this regard. Problems remain that accreditation is not mandatory for products on the EU market.* This is a criticism not of the OBP industry, but of CEN which has failed to write a standard for OBP, and of the regulatory authorities in Europe who have not sought to ensure that OBP is supplied only by reputable manufacturers, who can produce evidence that their products have been tested by recognised laboratories according to well established standards such as ASTM D6954. It is also a criticism of regulatory authorities who have not specified for all relevant tests what test results they would and would not find acceptable. (They have done so in the case of testing for metals by specifying in Art 11.1 of 94/62/EC the maximum concentration allowed).

The report also says that *"there remains uncertainty surrounding real world toxicological impacts."* This is also true of compostable and conventional plastic but nobody is trying to place restrictions upon them for that reason. Again, evaluation of toxicity has to be done in laboratory conditions (as is the case with HBP) – it cannot be done in a field or an ocean or a compost heap.

PROPENSITY TO LITTER

It is often claimed that biodegradable plastics are likely to encourage littering, but this is rarely advanced as an objection to HBP. The Eunomia Report says, *"rather than speculation, objective behavioural research is required to move this topic forward in a constructive manner."* We agree.

In our view, even if there were a label describing a product as oxo-biodegradable, the type of people who cause litter are not likely to look for 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 that there would be 10% more litter - is it preferable to have 110 plastic items which will degrade and biodegrade in a few years or even months, or 100 plastic items which will lie or float around for decades and create microplastics?

A Life-cycle Assessment by Intertek shows that when the litter metric is included OBP is actually the best material for making carrier bags. See http://www.biodeg.org/New%20LCA%20by%20Intertek%20%20-%20Final%20Report%2015.5.12(1)%20(1).pdf

OBP products, like all other plastic products, should be labelled to advise consumers that the product should be disposed of responsibly.

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.

FOSSIL RESOURCES

We find it difficult to understand (except that it shows the power of advertising and lobbying) the trend towards replacing conventional oil-based plastics with plastics derived partly or fully from crops. Although the Report does not deal specifically with this issue we think it important to understand it when considering the materials from which carrier bags and packaging could be made.

OBP and other oil-based plastics do not cause fossil resource-depletion. This is because they are made from ethylene – an inevitable by-product of oil which used to be wasted. The oil is extracted to make fuels and lubricants, and the same amount would be extracted even if oil-based plastics did not exist. Therefore, until other fuels and lubricants are found for vehicles, ships, aircraft, buildings, and factories, it makes sense to use this by-product instead of consuming large amounts of fossil fuel in the agricultural production, transport, and polymerisation of "crop-based" plastics. See http://www.biodeg.org/biobased.html

It would therefore be misleading to describe crop-based plastics as "renewable."

A consortium consisting of Friends of the Earth, Surfrider Foundation, Zero Waste Europe, Ecos, and the European Environmental Bureau published a paper in 2017 in which they say **"The bioplastics industry use their green-sounding credentials to position themselves as helping to speed the reduction in fossil fuel use and solving the ever-growing plastic pollution and marine litter issues. However, there is clear evidence that bioplastics do not solve many of these problems and in fact may create new ones."**