Built2Biodegrade

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Current results suggest that temperature may not be the only dominant factor determining environmental degradation rates of biodegradable plastics, and that more emphasis should be put on the combination of environmental factors within habitats and climate zones, as well as material type and sample history.

Biodegradable plastics can be part of the solution to reduce the accumulation of plastic in nature. Some biodegradable plastics are built to biodegrade in the open environment. Being biodegradable means that microorganisms can biodegrade the plastic and through that process completely transform it to CO_2 and new biomass.

Live Experiment at Bergen Aquarium

In June 2021, we started an experiment at the Bergen Aquarium to find out how long it takes for biodegradable plastics to disappear under typical Nordic conditions. Imagine that biodegradable plastic ends up in the Bergen fjord, how long will it take before marine microbes biodegrade it?

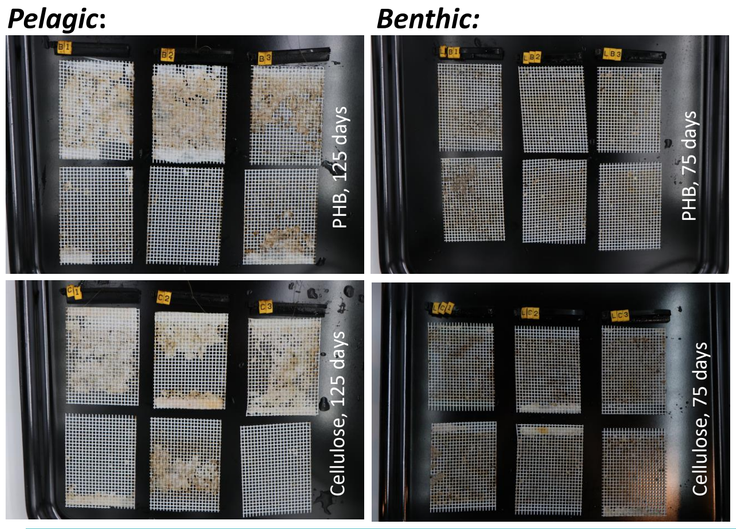
We assessed the biodegradation rate of biodegradable plastics polyhydroxy butyrate (PHB MIREL) and starch-based Mater-Bi when floating in the water (pelagic) or lying on the sediment (benthic) in a experiment tank at the Bergen Aquarium. Positive control was cellulose and negative control HDPE.

Test conditions: The experiment tank (500L) is flushed with a constant flow of natural seawater from 140 meters depth in the Bergen fjord (9°C/water exchanged 3 times/day). The sediment is native shell sand (grain size to be determined). Tank water conditions: Temperature, 11-12°C; pH 7.7-8.2; PO_4^{3-}, 16 µg/L; NH_4^+, 56 µg/L; NO_2^-/NO_3^-, 52 µg/L.

Disintegration over time

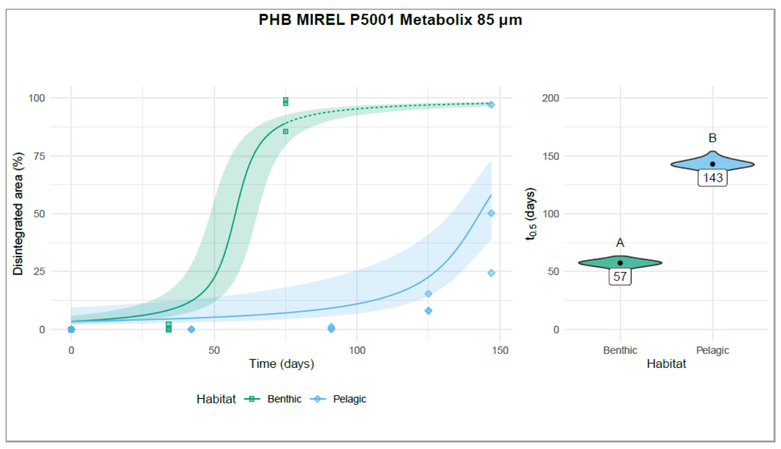
Photographical documentation of the disintegration of test samples with increasing time of incubation was the basis for calculating biodegradation rates.

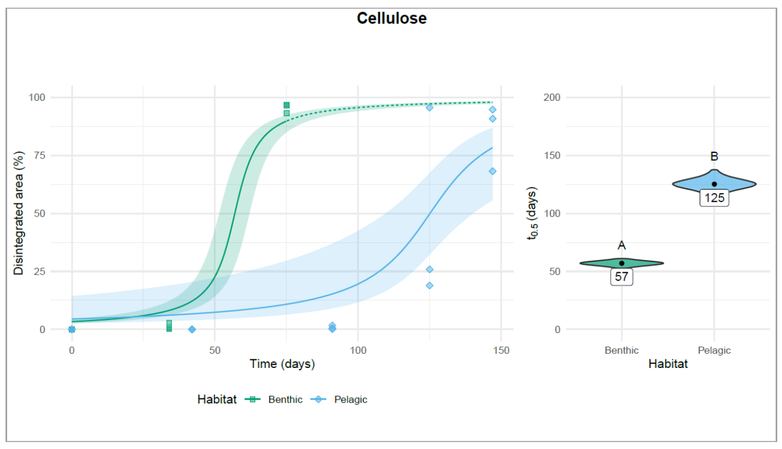
Pelagic*:** ***Benthic:



Biodegradation rates

Image analysis of the % disintegration as a function of time was used to calculate biodegradation rates expressed and model half-life ($t_{0.5}$) in days. Biodegradable PHB and cellulose have shown signs of biodegradation so far (147 days pelagic and 97 days benthic). The half-life of both PHB and cellulose was 57 days for benthic samples, which is much faster than expected and a similar biodegradation rate to that observed on SE Asian marine sediment (54 days, 29°C), and much faster than observed in Mediterranean benthic environments (357 days, 21°C (mesocosm) and 654 days (field), 12-30°C) (Lott et al. 2021). Half-life of pelagic PHB was 143 days and cellulose 125 days, which is significantly faster than observed in pelagic mesocosm tests performed in the Mediterranean (1247 days, 21°C) (Lott et al. 2021). After this promising pilot study, the findings are to be substantiated in a comprehensive study.





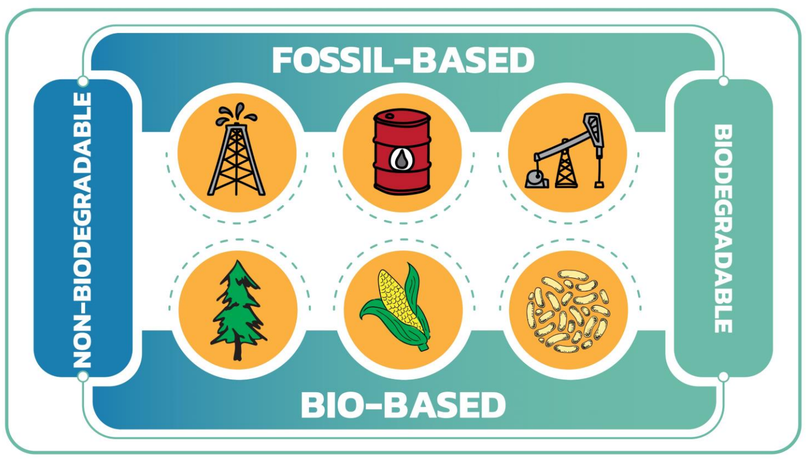
Ecological risks?

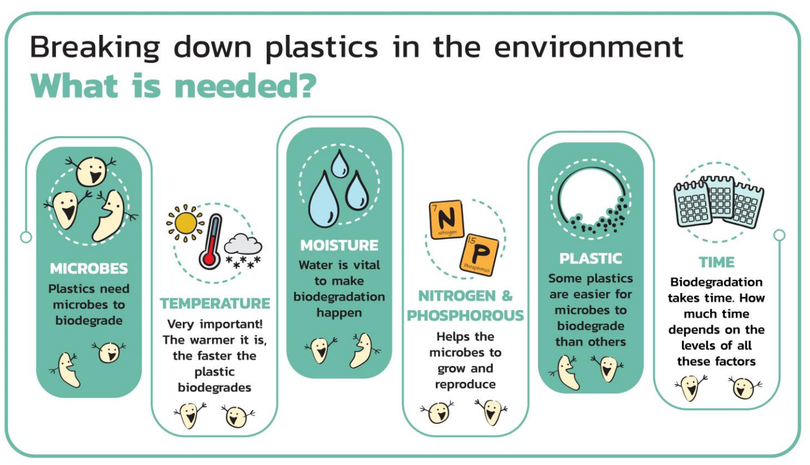
Biodegradation of PHB was accompanied by a discolouration of the sediment – most likely a result of high oxygen consumption followed by anaerobic respiration producing hydrogen sulphide that reacted with sediment minerals forming a black-coloured precipitate.

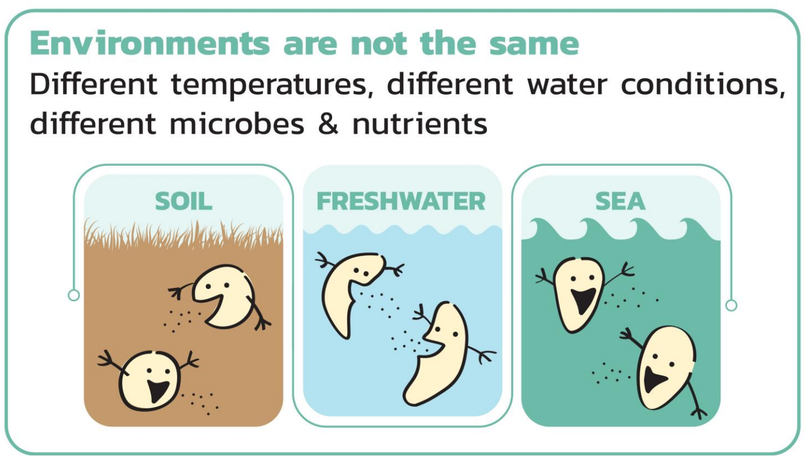
Further investigations on the potential effects and impact of the biodegradation process are in progress.

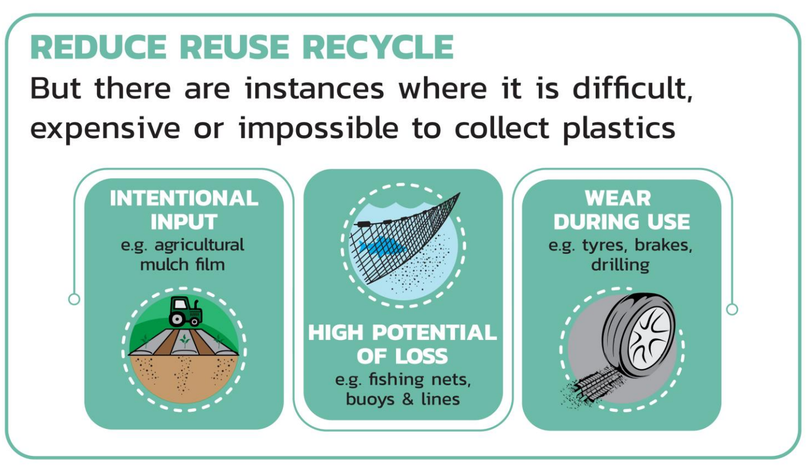
Biodegradability of plastics in the open environment. SAPEA report published December 2020.

Plastic pollution is a worldwide problem, and it is still growing. Each year, more and more plastic ends up in the natural environment, raising concerns of risk to the environment, animal and human health. Biodegradable plastics have a specific role to play in reducing the accumulation of plastics in the environment. But biodegradable plastics are not a 'silver bullet' to solve the problem of plastic pollution. For the majority of applications, including most single-use packaging and plastic bags, it would be better to reduce the amount of plastic we use, or to promote reuse and recycling.









References:
Lott et al. (2021) Half-life of biodegradable plastics in the marine environment depends on material, habitat, and climate zone.

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