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Marine Littering **– an IfBB positioning paper**

Can bioplastics damp down marine littering?

In recent times the problem of marine littering gained worldwide attention becoming one of the greatest resource management challenges. Marine debris is reported to be gathering in vast masses in the oceanic gyres creating a grievous problem and serious threat to aquatic life and subsequently to humanity. Numerous papers describing and estimating occurrence, possible sources, sinks as well as forms and amounts of plastic debris polluting marine environment are being published. Approximately 280 Mt of variable types of plastic is produced annually around the globe (1). Existing estimations say that roughly 10% of annual plastic production could be entering into the sea, which greatly exceeds the mass of recycled plastic traded globally each year (2). Annually held coastal cleanups bring the information that substantial parts of the gathered plastic garbage are packaging products and food service items. Most abundant polymers found are mainly commodity plastics like PE, PP, PS and PET (3). The scientific community concentrates also on existence of microplastic parts (originated from e.g. scrubbers in cosmetics or straight as a plastic pellet substrate) in marine environment (4).

Until now no source has been able to research and publish full qualitative and quantitative insight into the issue of marine littering. This is due to the immense amounts of factors influencing the problem, with such vital information like the distribution between polymer types in marine debris and, as this subject´s derivation, possibility to apprehend and pin down most occurring applications there-in. Little information is known which factors and processes are most responsible for plastic degradation in marine environment, principal in gradual fragmentation of debris. Ongoing global efforts of various joint organizations established by plastic industry, governments, NGO's and many other stakeholders concentrate on six key objectives (5). Attainment of these should ultimately bring us closer to solve the described problem. First of these commitments is to work on education aimed at preventing marine litter by raising awareness of the problem and helping to change the

behavior leading to pollution of marine environment. Much effort is also committed to research in order to better understand the origins and impacts of the problem, and as a result offer appropriate solutions. Within the scope of this objective many surveys and monitoring projects are being undertaken (6) (7) (8). Researchers focus their work on quantification and characterization of marine debris as well as its origin, modelling of artificial neural networks to better understand beach litter abundance (9) and validation of debris tracking models (6). Biotechnological solutions aimed at isolation and selection of microorganisms and enzymes degrading synthetic polymeric materials are also assessed (10). Another objective is to promote science-based, effective and efficient policies preventing marine litter. As a vivid example may serve legislation, which ensures phasing out use of microbeads in personal care products in Illinois, USA, or European call-for-action to policy makers “Zero plastics to landfill by 2020 in Europe” objective. Commitments to share best practices regarding eco-efficient waste management and enhance opportunities to recover and recycle plastics (e.g. Identiplast – annually held conference) are also among key objectives. Finally, much work is devoted to steward the transport and distribution of plastic resin pellets, particularly to prevent its spillage (“Operation Clean Sweep” (11)). Independently of undertaken actions organizations tackling the problem now are dealing with its vast consequences. Bold undertaking known as “The Ocean CleanUp®” project plans to set up an array of floating barriers and platforms exploiting water currents to passively collect floating plastic (12).

Regardless of described above objectives and solutions still little research is directed to standardization and evaluation of conducted tests. Existing ASTM D7081 standard covers only non-floating products made from plastics that are designed to biodegrade in aerobic marine environment or anaerobic marine sediments. They must demonstrate disintegration and inherent biodegradation during marine water exposure and not exhibit any adverse environmental impacts on marine life. D6691 test method provides a description of the testing procedures that simulate the marine environment and a method by which to determine the degree and rate of aerobic biodegradation of materials exposed to the indigenous population of sea water. Both standards measure carbon dioxide formation and its evolution from plastic undergoing biodegradation. However, both require testing temperature at 30℃, which is a result of pragmatic approach needed to keep test evaluation in a reasonable time. Taking into consideration the fact, that global average sea surface temperature is around 16.3℃ (13) both standards ar e practically non-applicable to real life conditions and as such serve only as approximation. Scientists are developing also individual methods and make attempts to establish tests for the behavior of biopolymers in various conditions occurring at sea and seashore (14) (15) (16) (17).

Gathered information on marine debris, shortcomings of existing standards associated with the problem and still unanswered questions of biopolymers behavior while subjected to marine habitat, gives the IfBB sufficient reason to undertake steps towards answering these issues. Within the scope of our work we intend to expand existing knowledge on plastic products ending up their existence in marine environment as a dangerous waste concerning the amounts of the plastic types in different applications and their origins. Overmore we intend to develop a standard or individual method for testing the behavior of biopolymers in the sea. We are also eager to determine whether the utilization of biodegradable biopolymers could contribute as a part of a solution to the described problem of marine littering. Is their utilization as a substitution for commodity plastic products in applications that occur as marine litter possible and expedient? Therefore it has to be investigated if there are any biopolymers capable of undergoing degradation in marine environment at temperatures close to real life conditions, what chemical outputs result from such a degradation and the time elapsing while the degradation process takes place. A further field to investigate is what happens to biopolymers in the digestive system of fish and other aquatic organisms. These will be the topics the IfBB would like to face in its research work in order to help decreasing the plastic waste stream polluting our seas.

Literature

1. **Wright, SL, Thompson, RC and Galloway, TS.** The physical impacts of microplastics on marine organisms. *A review. Environ Pollut 178.* 2013, pp. 483-492.

2. **Velis, Costas A.** Plastic waste in marine litter: Action now and at the source. *Waste Manag Res 32.* April 2014, pp. 251-253.

3. **Greene, J.** *PLA and PHA biodergradation in the marine environment.* s.l. : California Department of Resources Recycling and Recovery, 2012.

4. **Ivar do Sul, J.A., et al.** Pelagic microplastics around an archipelago of the Equatorial Atlantic. *Marine Pollution Bulletin 75.* 2013, pp. 305-309.

5. **Global Plastics Associations.** *The Declaration of the Global Plastics Associations for Solutions on Marine Litter - Progress Report.* 2014.

6. www.projectkaisei.org. [Online]

7. *www.sea.edu/plastics.* [Online]

8. *www.rozaliaproject.org.* [Online]

9. **Schulz, Marcus and Matthies, Michael.** Artificial neural networks for modeling time series of beach litter in the southern North Sea. *Marine Environmental Research.* 2014.

10. *www.biocleanproject.eu.* [Online]

11. *www.operationcleansweep.org.* [Online]

12. **Slat, Boyan et al.** *How the oceans can clean themselves: A feasibility study.* 2014.

13. **National Oceanic and Atmospheric Administration.** *National Climatic Data Center.* [Online] www.ncdc.noaa.gov/sotc/.

14. **Guzman, A., et al.** Pilot study of the influence of thermoplastic starch based polymer packaging material on the growth of diatom population in sea water environment. *Pol.J.Chem.Tech. .* 2011, Vol. 13.

15. **Sekiguchi, Takayoshi, et al.** Biodegradation of aliphatic polyesters soaked in deep seawaters and isolation of poly(epsilon-caprolactone)-degrading bacteria. *Polymer Degradation and Stability.* 2011, Vol. 96.

16. **Tsuji, H and Suzuyoshi, K.** Environmental degradation of biodegradable polyesters 2. Poly(epsilon-caprolactone), poly [(R)-3-hydroxybutyrate], and poly(L-lactide) films in controlled static seawater. *Polymer Degradation and Stability.* 2002, Vol. 75.

17. **Tosin, Maurizio, et al.** Laboratory test methods to determine the degradation of plastics in marine environmental conditions. *Frontiers in Microbiology.* June 2012, Vol. 3.