BIODEGRADABLE PLASTICS IN AQUATIC ENVIRONMENT

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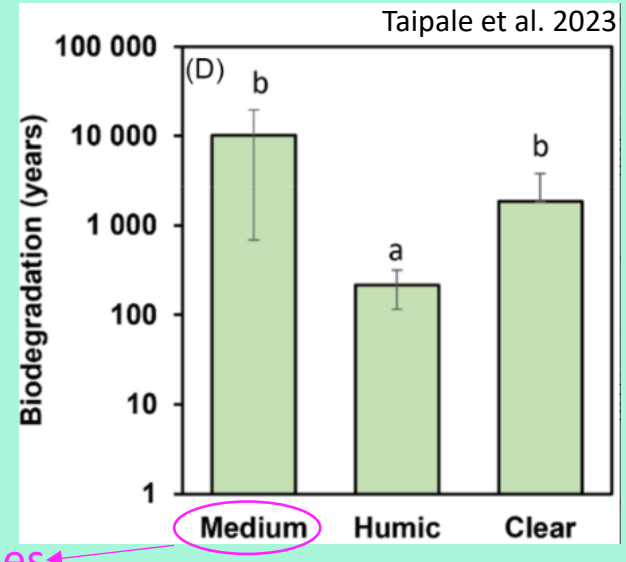
BACKGROUND

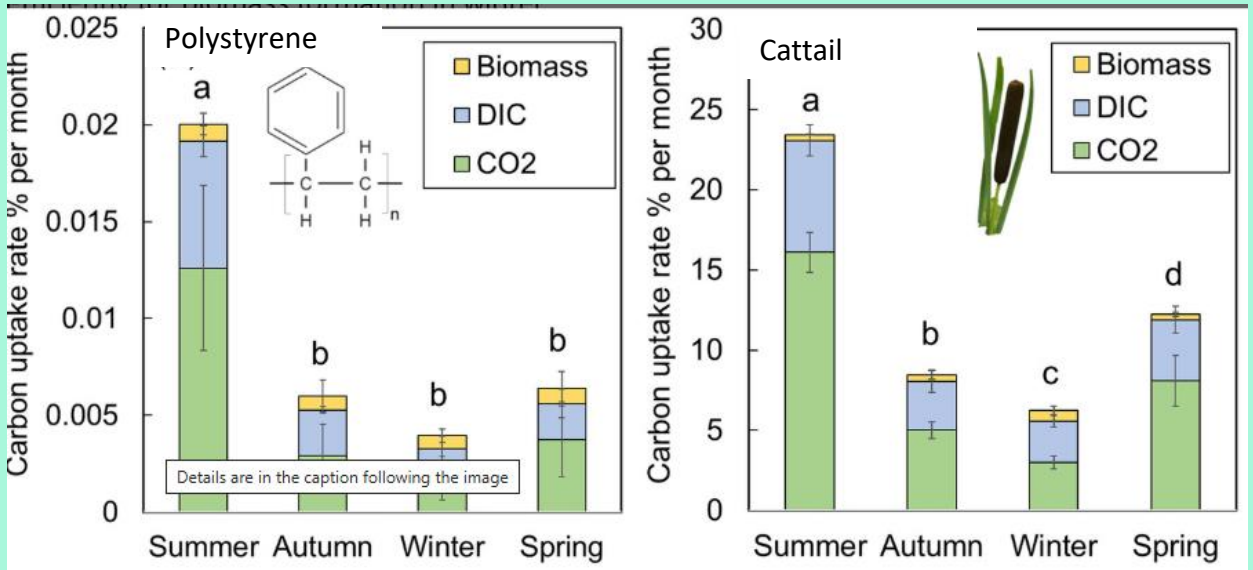
- From the perspective of water protection, it is important that plastics entering the environment do not contain chemicals that are harmful to organisms and, in the best-case scenario, degrade relatively quickly:
    - These objectives may conflict with each other, as the same chemicals are added to biodegradable plastics as to conventional plastics.
    - To reduce environmental risks, the amount of chemicals added to plastics should be reduced: adding bio-fillers such as cellulose or structural cellulose (a by-product of the paper industry) => accelerates the decomposition of plastics and reduces the amount of chemicals used.

LAKES AND BIODEGRADATION

- **Biodegradability in water bodies is affected by the amount of UV radiation (chemical degradation) and the microbial community, which varies geographically and by water body type (salinity, amount of humus and nutrients, and temperature).**
- **Traditional plastics take hundreds to thousands of years to decompose due to microbial communities.**



Without microbes



Vesamäki et al. 2024

- **The seasons and temperature affect the biodegradability of plastics and natural materials in the lake => 3x faster in summer temperatures than in other seasons.**
- **Tree leaves decompose in 8 to 20 months, i.e. less than two years in lake water, taking into account the four seasons.**

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BIODEGRADATION of PLASTICS

(%/month)	Mass loss		Carbon mineralization		CO_2-production (ISO 23977-1:2021)	
Material	**Baltic Sea**	**Lake**	**Baltic Sea**	**Lake**	**Baltic Sea**	**Lake**
CA	12.4±2.5	16.6±2.8	1.0±0.2	3.1±0.2	<0.01	<0.01
PHB-PHV	11.3±6.8	15.8±11.6	0.4±0.3	2.6±0.9	<0.01	0.3±0.4
Biowaste bag	1.7±1.8	13.1±6.3	0.4±0.3	0.6±0.2	<0.01	<0.01
PLLA	<0.01	4.8±5.8	1.6±0.1	0.2±0.1	<0.01	<0.01
Nylon 6	2.9±2.2	4.1±1.7	0.6±0.4	0.6±0.0	<0.01	<0.01
Cellulose	<0.01	2.1±1.2	<0.01	0.7±0.1	<0.01	<0.01

	Degraded
	Might degrade
	Low possibility to degrade
	Slower than 2 years degradation

Cellulose is a useful reference material in seawater, but not in lake or brackish water.

(%/month)	Carbon mineralization, without net (deduction of control respiration)	
Material	**Baltic Sea**	**Lake**
CA	7.8±0.7	6.3±0.2
PHB-PHV	8.9±0.5	7.2±1.8
Biowaste bag	8.6±0.6	4.3±0.02
PLLA	8.0±0.4	3.5±0.3
Nylon 6	10.3±1.5	4.4±0.5
Cellulose	7.9±0.5	4.6±0.3

- **The criterion for biodegradability is considered to be two years or faster than the reference material, but different methods and reference materials may give different results => a standardized method is needed that offers realistic results, and there is consensus on its use.**
- **The biodegradability of plastics also varies depending on the type of water body**
  - **Cellulose acetate and PHB/PHV degrade relatively well in lake and brackish water, but PLLA, for example, only degrades in lake water when the criterion is faster than the standard material (cellulose < 4 years).**

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THANK YOU!

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