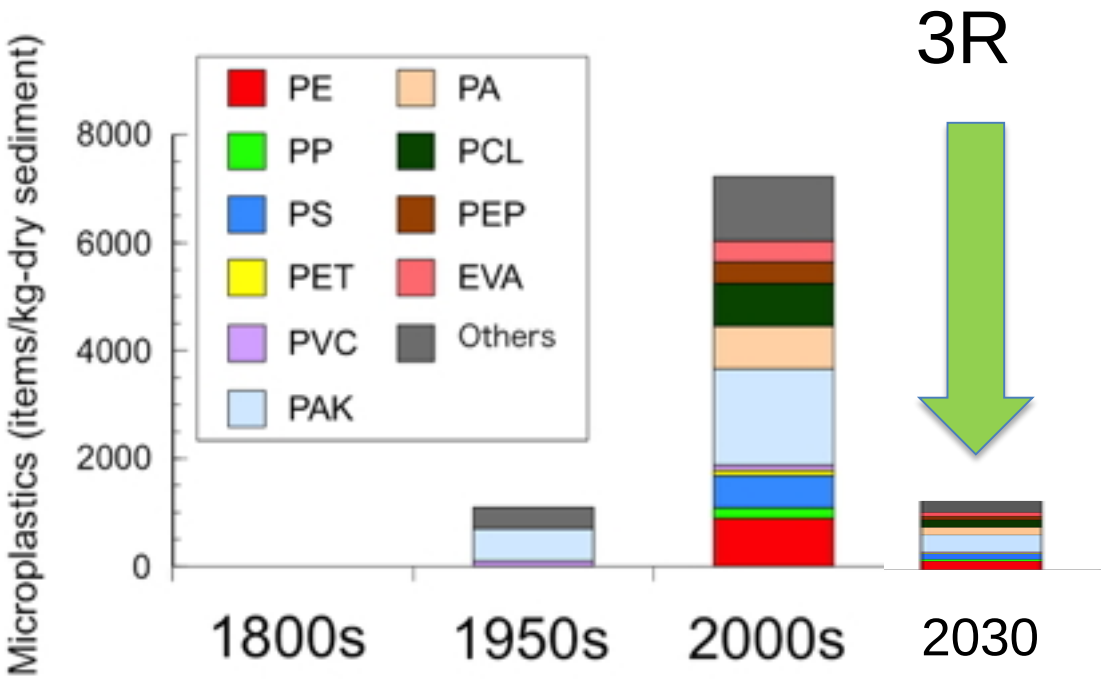
Issue of microplastics in the coastal and marine environment and 3R solutions



Shige Takada

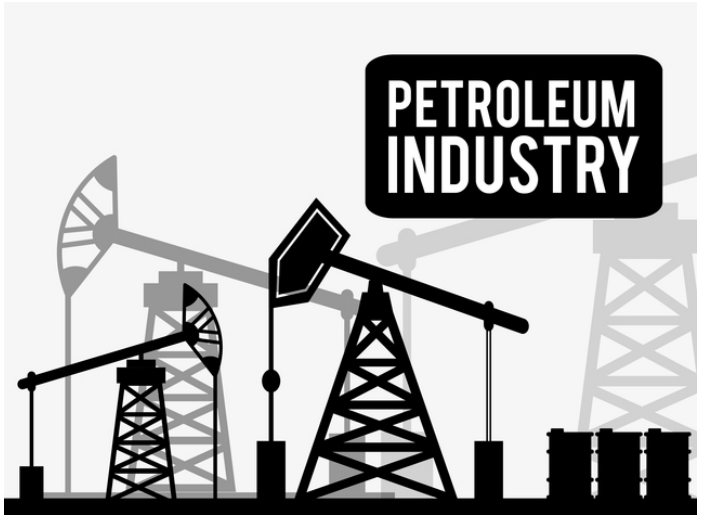
Tokyo University
of Agriculture and Technology

Continuous increase in plastic production

8% of global oil production

4% : raw material

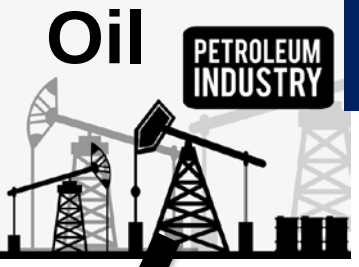
4% : energy



1933:Production of Polyethylene started.

Thompson et al., 2009

Plastics are fragmented into microplastics



Synthesize

Waste management

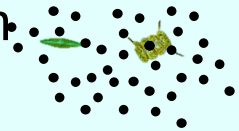
UV

UV

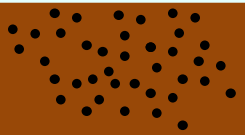
Fragmentation

Fragmentation

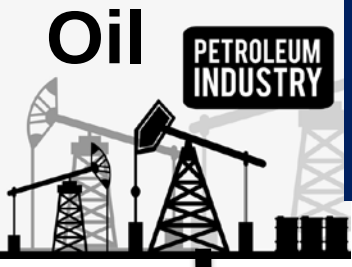
Microplastics



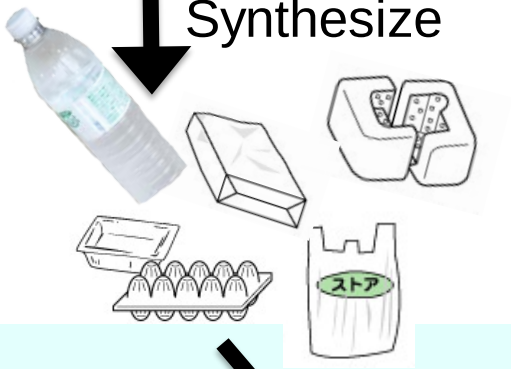
Bottom sediment



A portion of microplastics is settled to sea floor and stored in bottom sediment



Synthesize



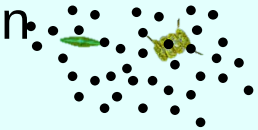
UV

Fragmentation

UV

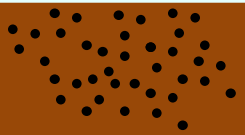
Fragmentation

Microplastics



Sinking to bottom

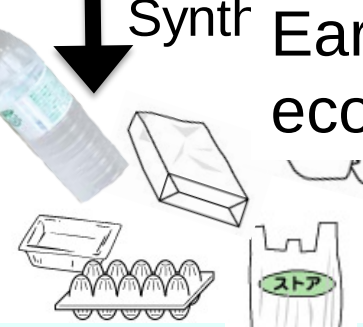
Bottom sediment



Increasing trend : Microplastic pollution is getting serious

Synth

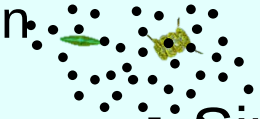
Anthropocene : an epoch when human activities significantly impacted Earth's geology, atmosphere, and ecosystems



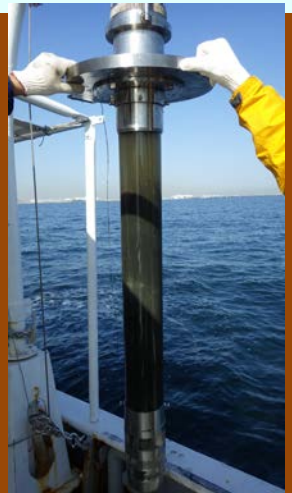
Fragmentation

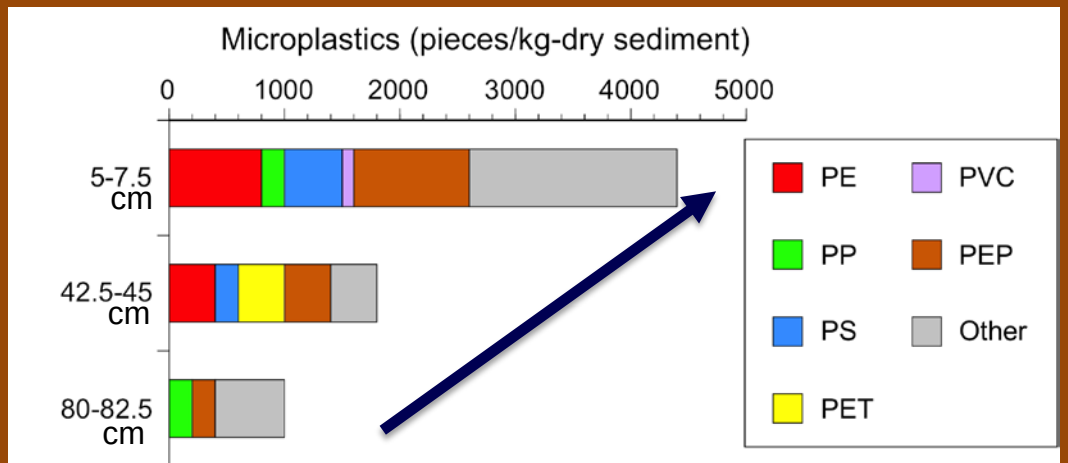
Fragmentation

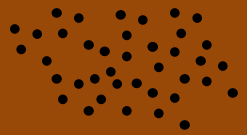
Microplastics



Sinking to bottom



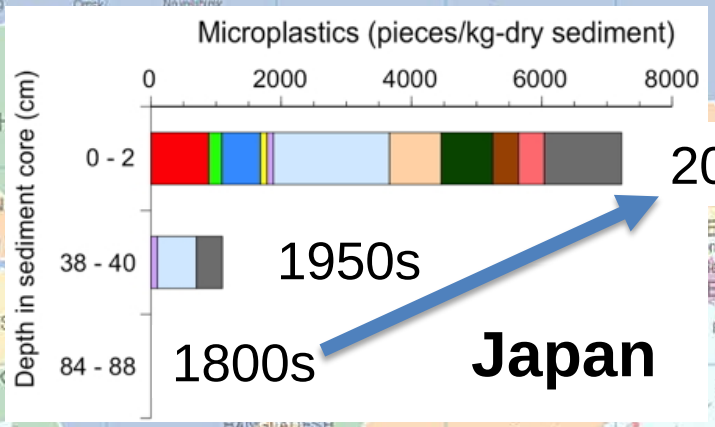


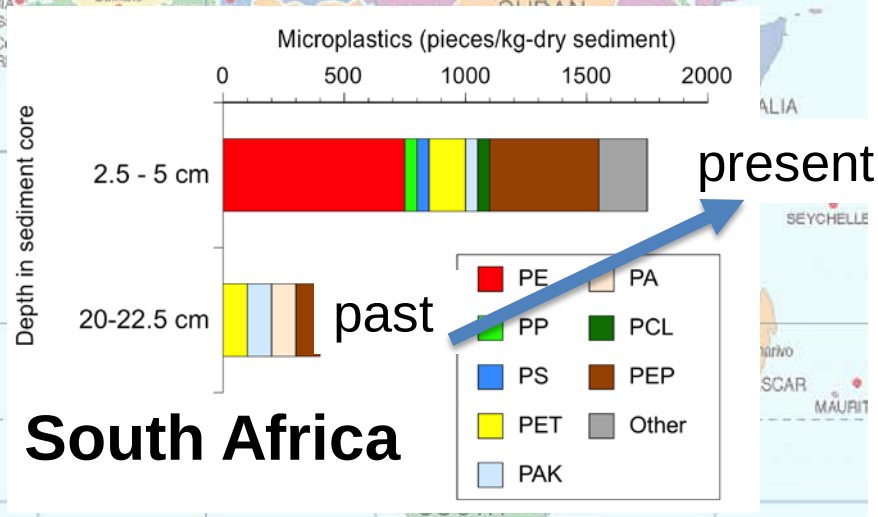


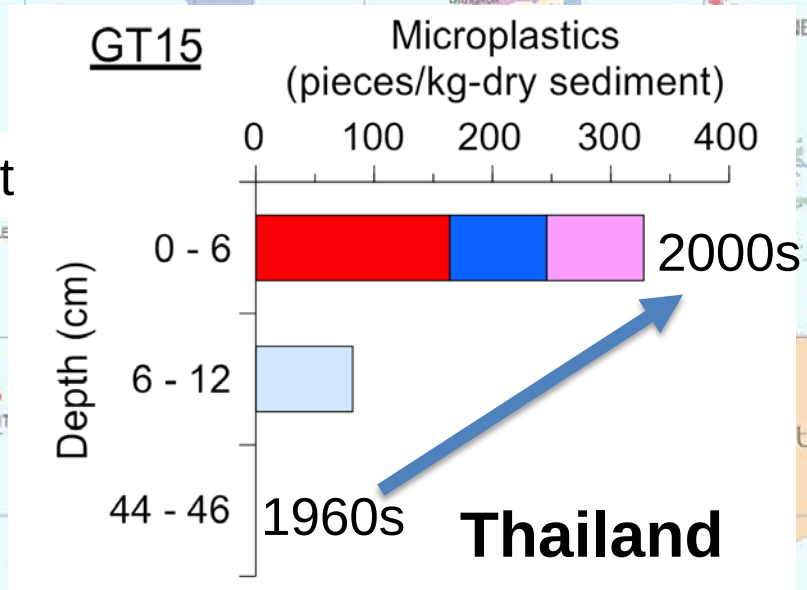
Cosmopolitan phenomena : increasing trend in microplastics in sediment cores from Asian and African waters

Vertical profiles of microplastics in sediment cores from Asian and African waters.

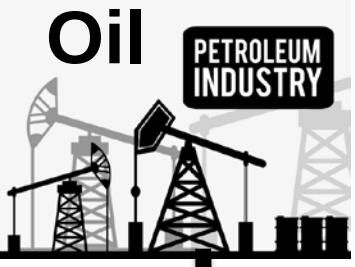
After Matsuguma et al. (2017)
Archives of Environ. Contam. Toxicol.



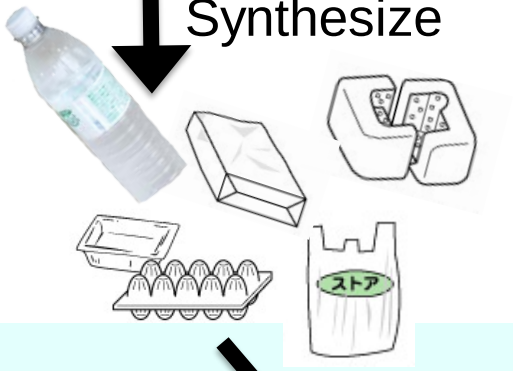




Various sizes of marine plastics are ingested by various sizes of marine organisms



Synthesize



UV

Ingestion

UV

Fragmentation

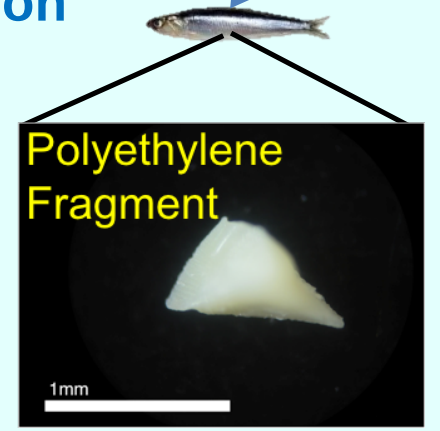
Fragmentation

Microplastics

Uptake

Ingestion

Ingestion



Plastics in fish digestive tract

Increasing trend in plastic ingestion by seabirds

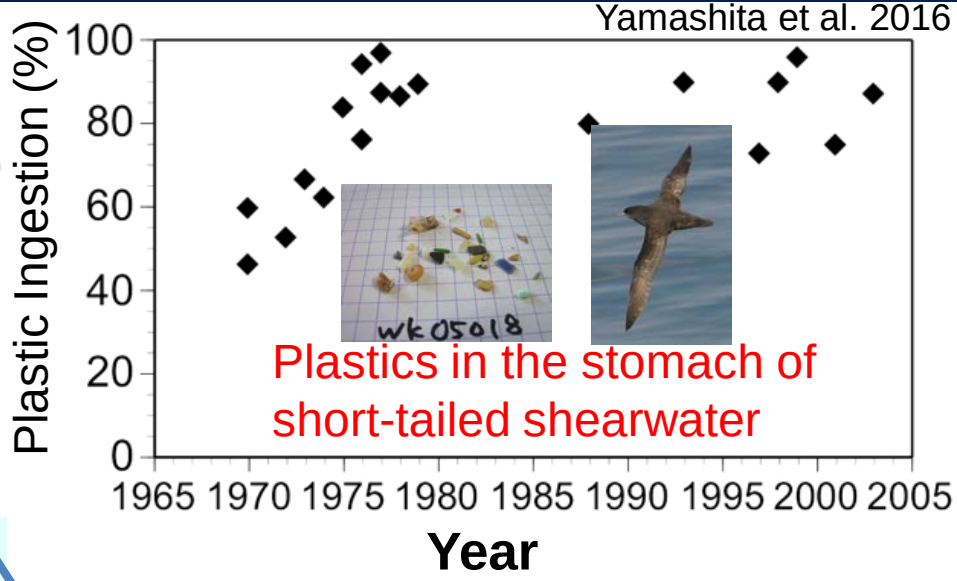
Oil

PETROLEUM INDUSTRY

Synthesize

UV

Yamashita et al. 2016



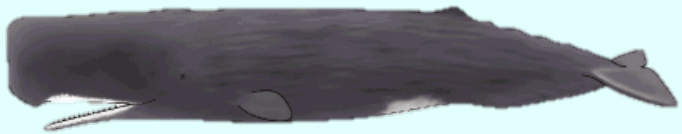
Fragmentation

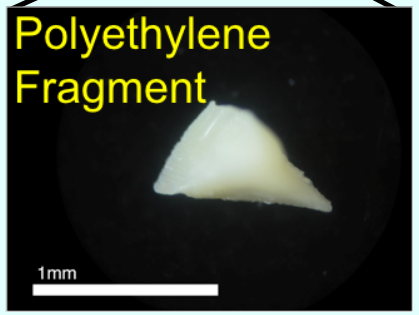
Fragmentation

Uptake

Ingestion

Ingestion





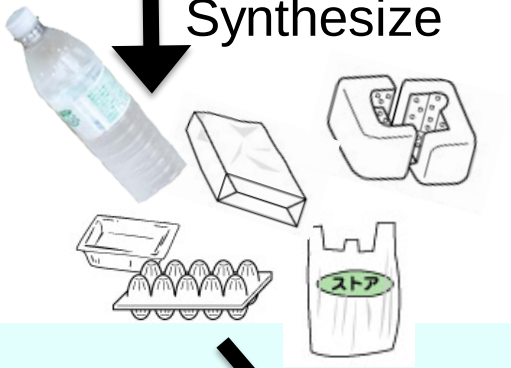
Plastics in fish digestive tract

Microplastics are ingested by fish and shellfish

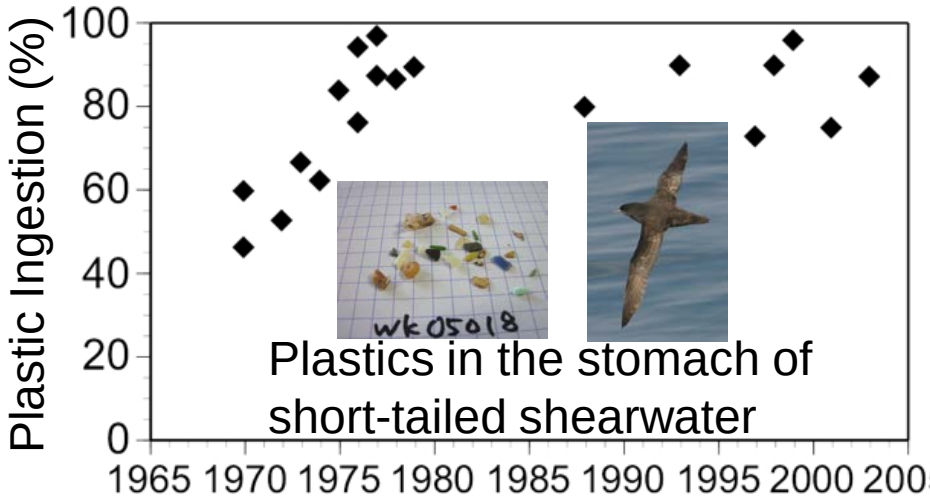
Oil

PETROLEUM INDUSTRY

Synthesize

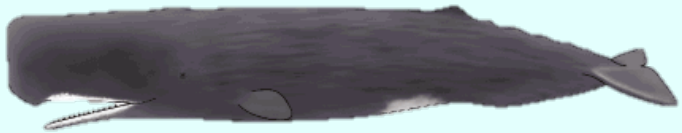


UV

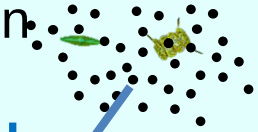


Fragmentation

Ingestion

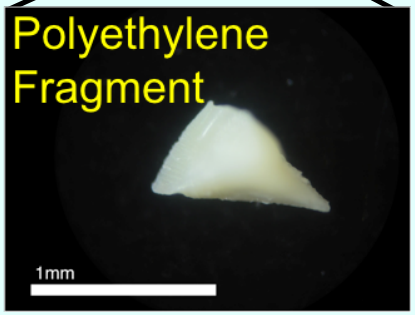


Fragmentation



Uptake

Ingestion



Plastics in fish digestive tract

Plastic fragments were dominant over fiber and beads among the microplastics in digestive tracts of **anchovy**

80 % of Anchovy contain plastics

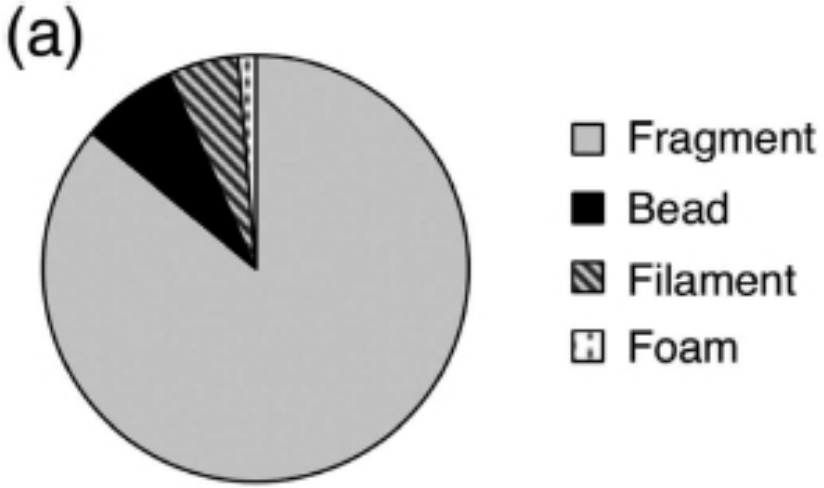
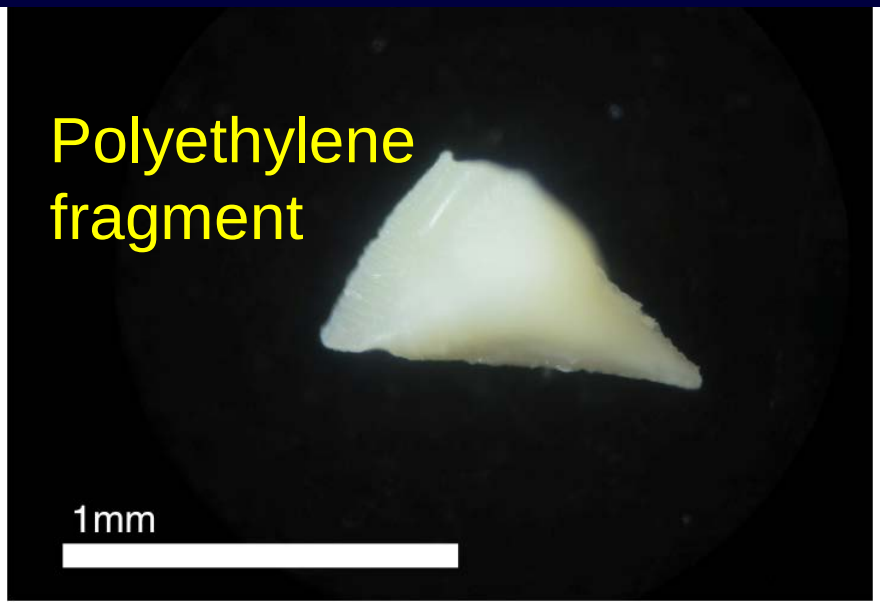
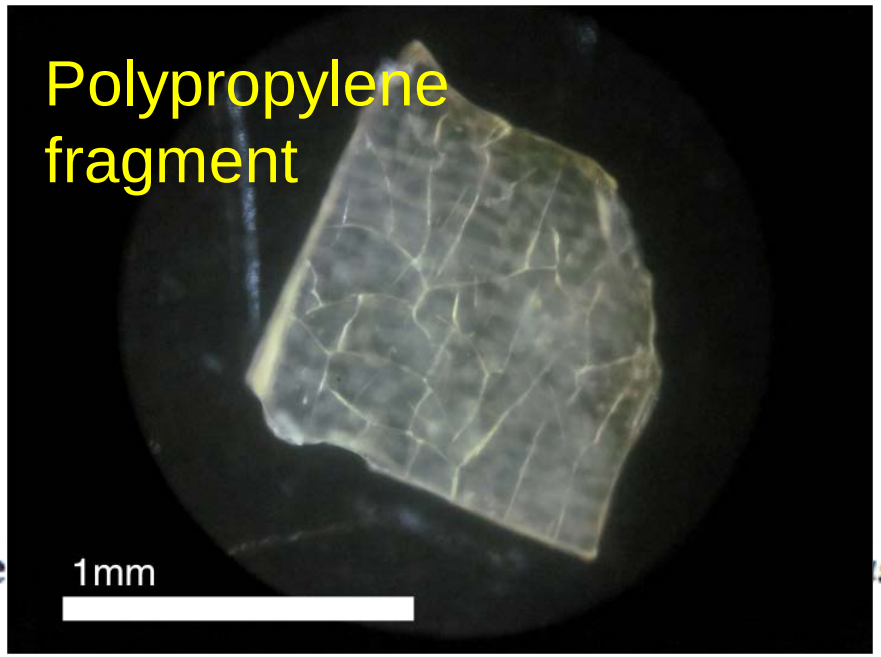
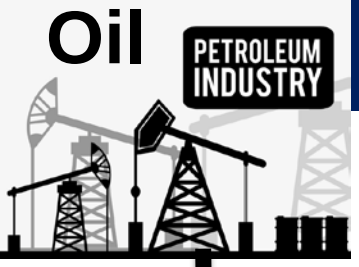


Figure 3. Types of plastics recovered from digestive …s)
(a) Percentage by shape. (b) Percentage by polymer.

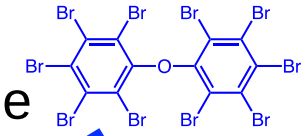




Plastics bring toxic chemicals to ecosystem



Synthesize



Additives

Additives

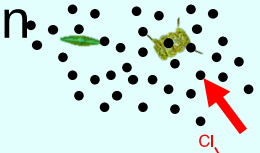
UV

UV

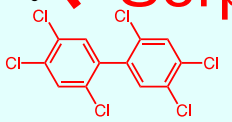
Fragmentation

Fragmentation

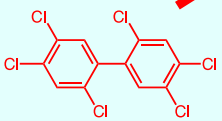
Microplastics



Sorption



Sorption



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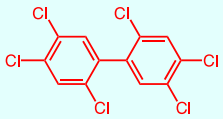
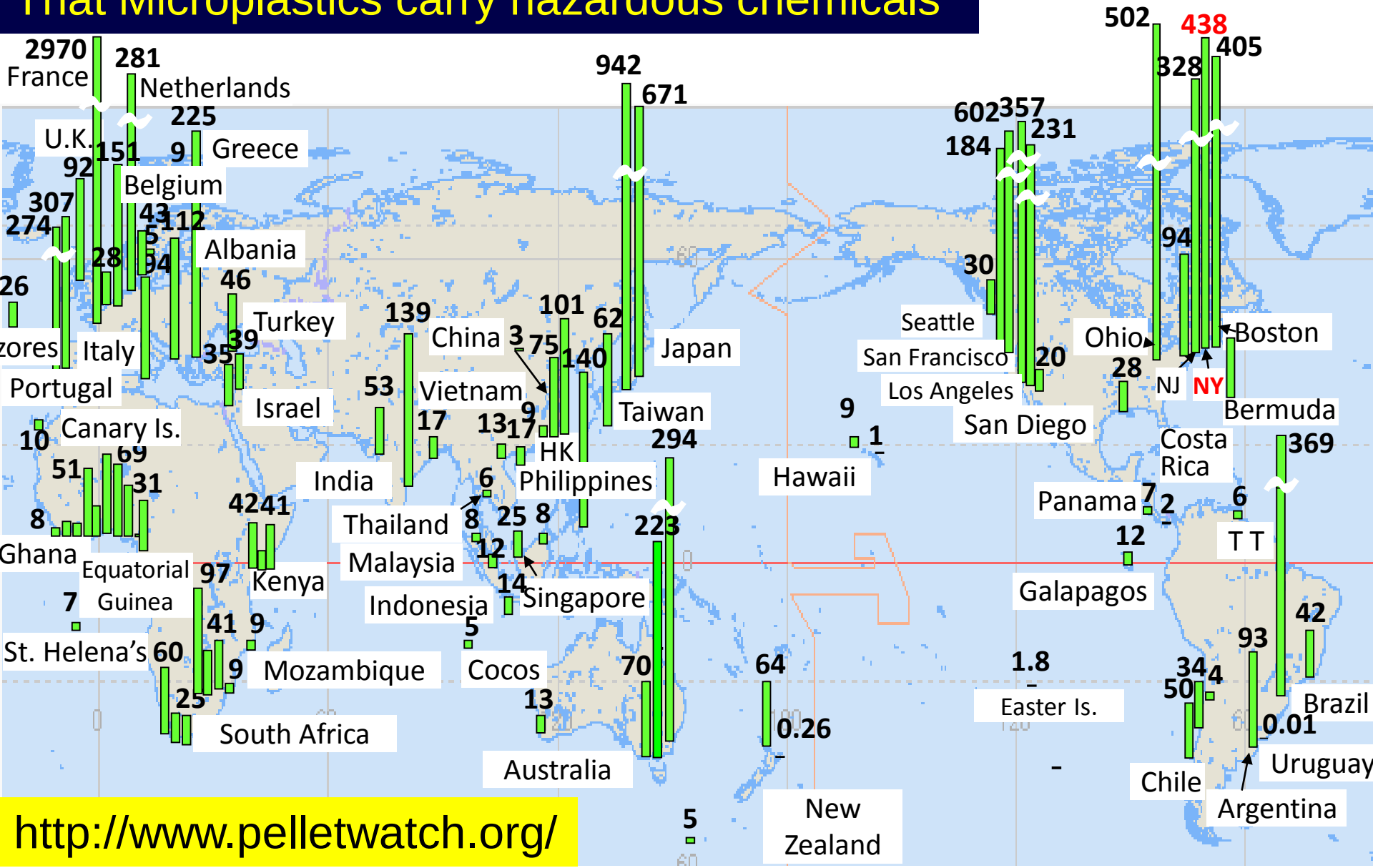


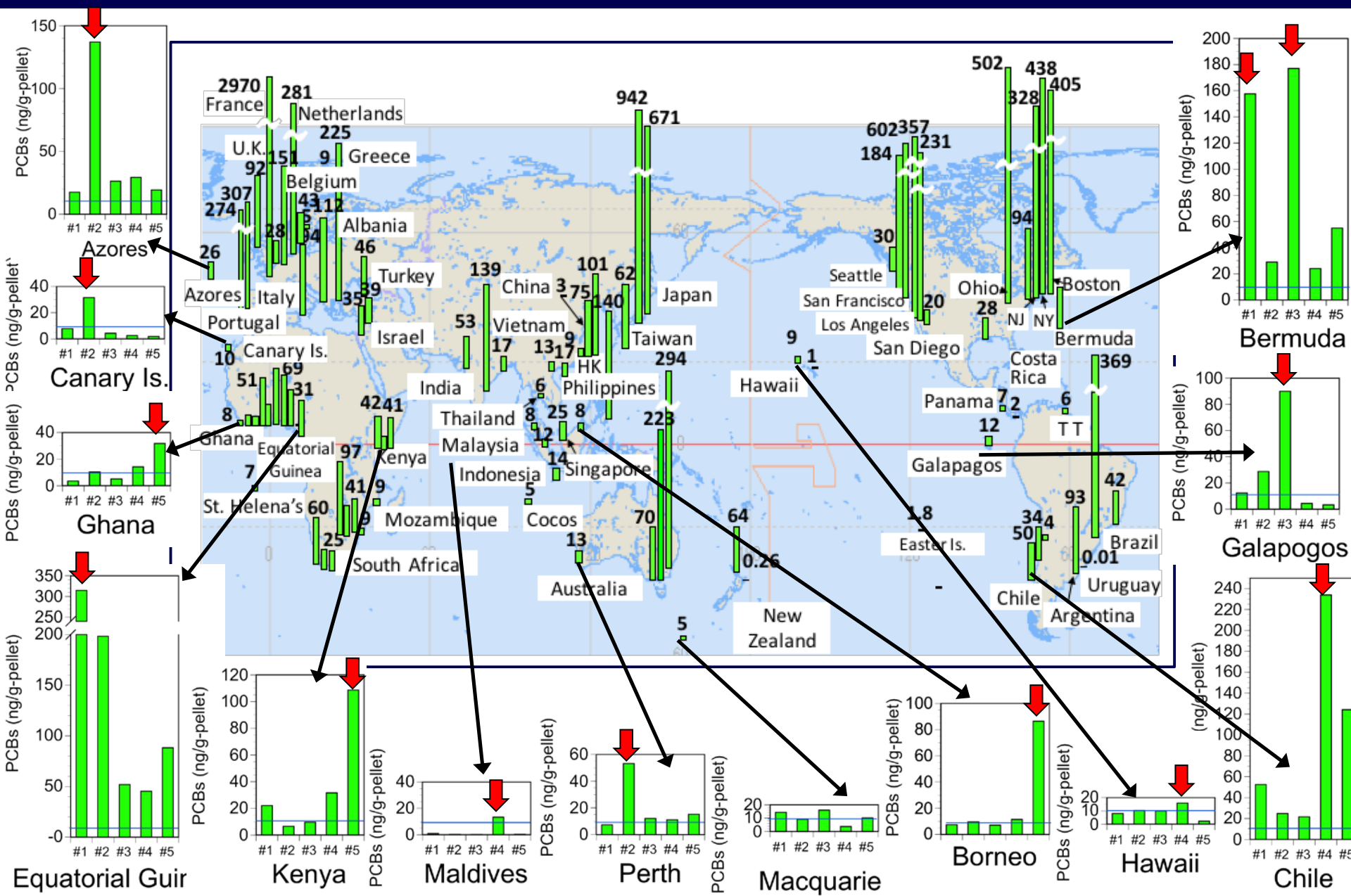
International Pellet Watch demonstrates That Microplastics carry hazardous chemicals



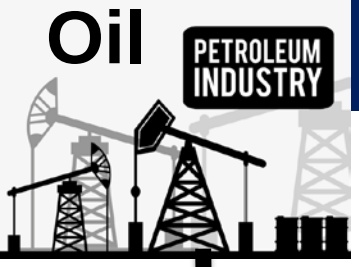
http://www.pelletwatch.org/

PCBs concentrations in beached plastic pellets (ng/g)

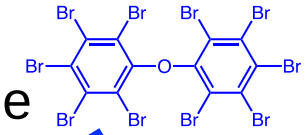
Sporadic high concentrations of PCBs found in pellets from remote areas :
Microplastics carry contaminants to remote areas



Plastics bring toxic chemicals to ecosystem

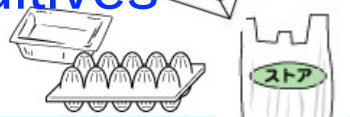


Synthesize



Additives

Additives



UV

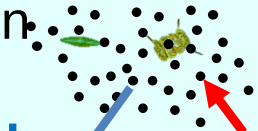
Ingestion

UV

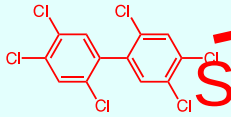
Fragmentation

Fragmentation

Microplastics



Sorption



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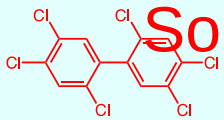
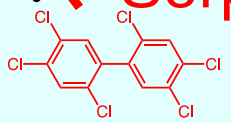


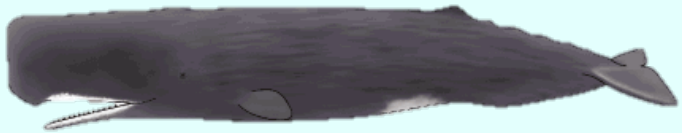
Sorption

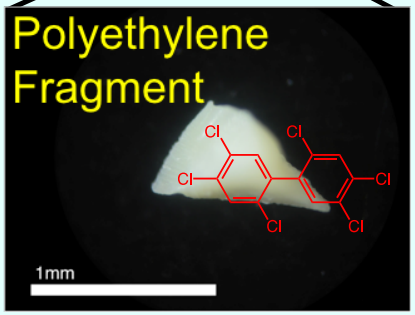
Uptake



Ingestion

Ingestion





Plastics in fish digestive tract

Laboratory experiments suggest adverse effects of plastic-derived chemicals on aquatic organisms

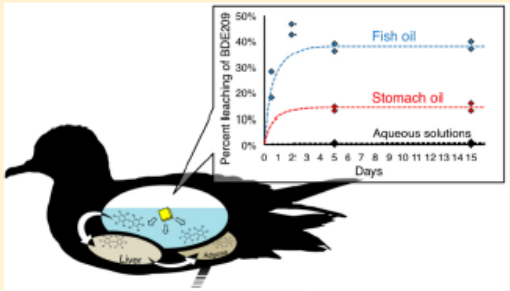
Facilitated Leaching of Additive-Derived PBDEs from Pla Seabirds' Stomach Oil and Accumulation in Tissues

Kosuke Tanaka,[†] Hideshige Takada,*[,†] Rei Yamashita,[†] Kaoruko Mizukawa,[†] Masa-aki and Yutaka Watanuki[§]

[†]Laboratory of Organic Geochemistry, Tokyo University of Agriculture and Technology, Fuchu, Tokyo 183-
[‡]Hokkaido National Fisheries Research Institute, Fisheries Research Agency, Kushiro, Hokkaido 085-0802, Ja
[§]Faculty of Fisheries, Hokkaido University, Hakodate, Hokkaido 041-8611, Japan

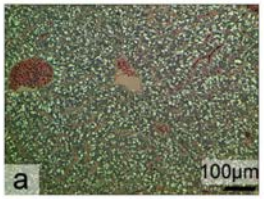
Supporting Information

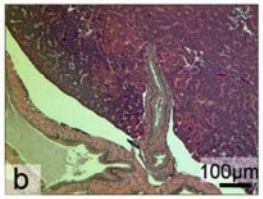
ABSTRACT: Our previous study suggested the transfer of polybrominated diphenyl ether (PBDE) flame retardants from ingested plastics to seabirds' tissues. To understand how the PBDEs are transferred, we studied leaching from plastics into digestive fluids. We hypothesized that stomach oil, which is present in the digestive tract of birds in the order Procellariiformes, acts as an organic solvent, facilitating the leaching of hydrophobic chemicals. Pieces of plastic compounded with deca-BDE were soaked in several leaching solutions. Trace amounts were leached into distilled water, seawater, and acidic pepsin solution. In contrast, over 20 times as much material was leached into stomach oil, and over 50

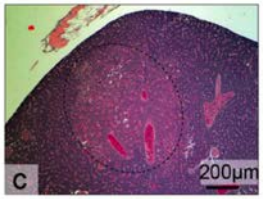


Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress

Chelsea M. Rochman[1], Eunha Hoh[2], Tomofumi Kurobe[1] & Swee J. Teh[1]







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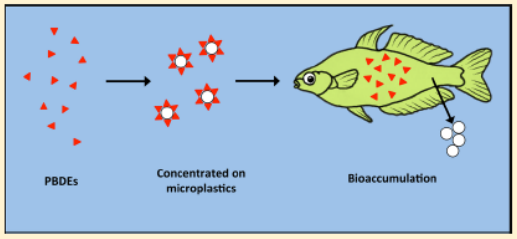
Chemical Pollutants Sorbed to Ingested Microbeads from Personal Care Products Accumulate in Fish

Peter Wardrop,[†] Jeff Shimeta,[†] Dayanthi Nugegoda,[†] Paul D. Morrison,[†] Ana Miranda,[†] Min Tang,[‡] and Bradley O. Clarke*[,†]

[†]Centre for Environmental Sustainability and Remediation, RMIT University, GPO Box 2476, Melbourne, Victoria 3001, Australia
[‡]Key Laboratory of Advanced Materials of Tropical Island Resources, Ministry of Education; School of Materials and Chemical Engineering, Hainan University, Haikou, Hainan 570228, China

Supporting Information



Oyster reproduction is affected by exposure to polystyrene microplastics

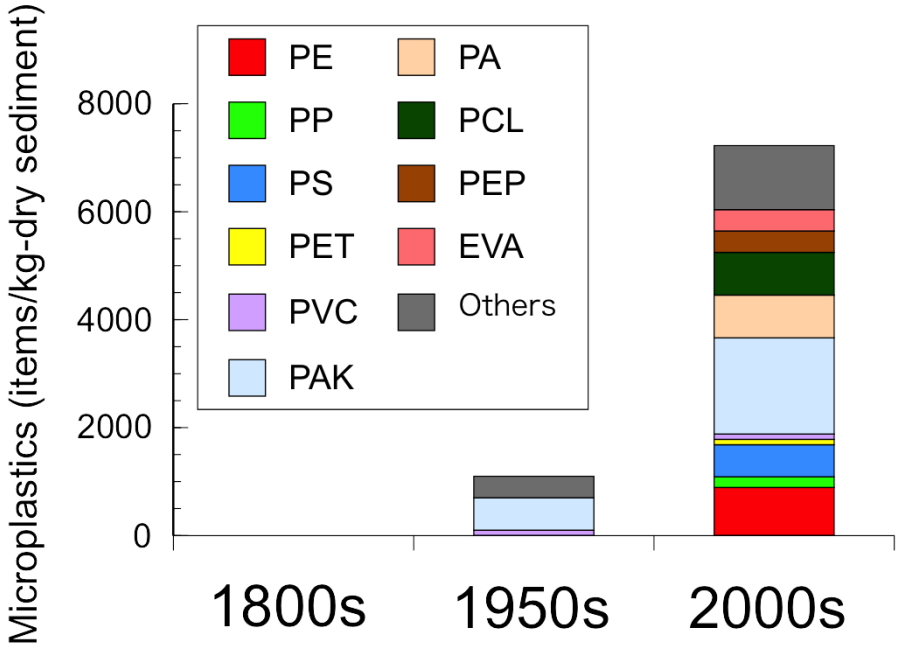
Rossana Sussarellu[a,1], Marc Suquet[a], Yoann Thomas[a], Christophe Lambert[a], Caroline Fabioux[a], Marie Eve Julie Pernet[a], Nelly Le Goïc[a], Virgile Quillien[a], Christian Mingant[a], Yanouk Epelboin[a], Charlotte Corporeau[a], Julien Guyomarch[b], Johan Robbens[c], Ika Paul-Pont[a], Philippe Soudant[a], and Arnaud Huvet[a,2]

Microplastic Moves Pollutants and Additives to Worms, Reducing Functions Linked to Health and Biodiversity

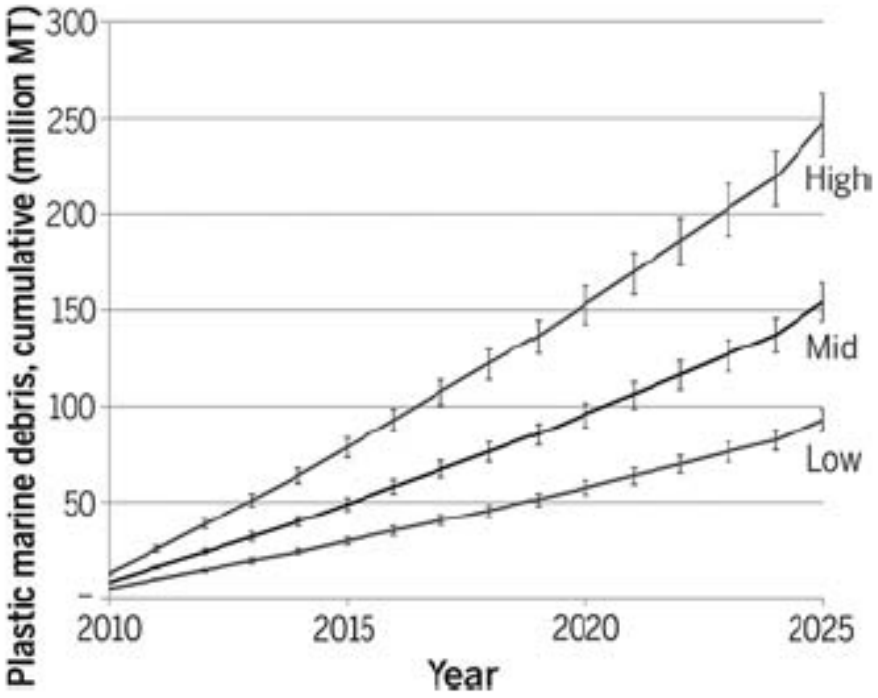
Mark Anthony Browne,[1,2,*] Stewart J. Niven,[1,3,4] Tamara S. Galloway,[5] Steve J. Rowland,[4] and Richard C. Thompson[1]

Animals from sedimentary h
plastic can accumulate conce
times greater than those in s

Plastic pollution has been getting serious
Plastic waste inputs to the sea will increase by a factor of 10 in coming 20 years, if no action will be taken.

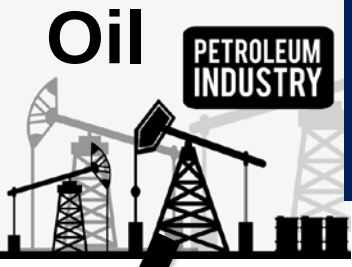


Microplastics in geological eras



Jamebeck et al. (2015), Science

3R (Reduce, Reuse, Recycle) of plastic waste is the key

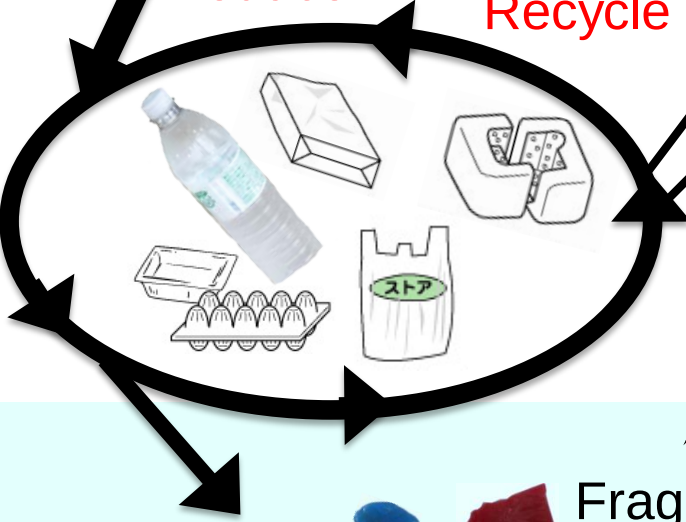


Reduce

Reuse
Recycle

landfill

incineration



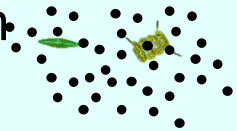
UV

UV

Fragmentation

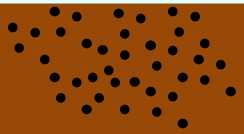
Fragmentation

Microplastics

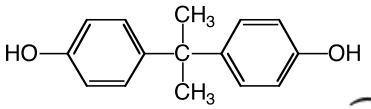


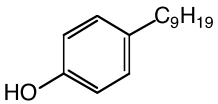
Sinking to bottom

Bottom sediment

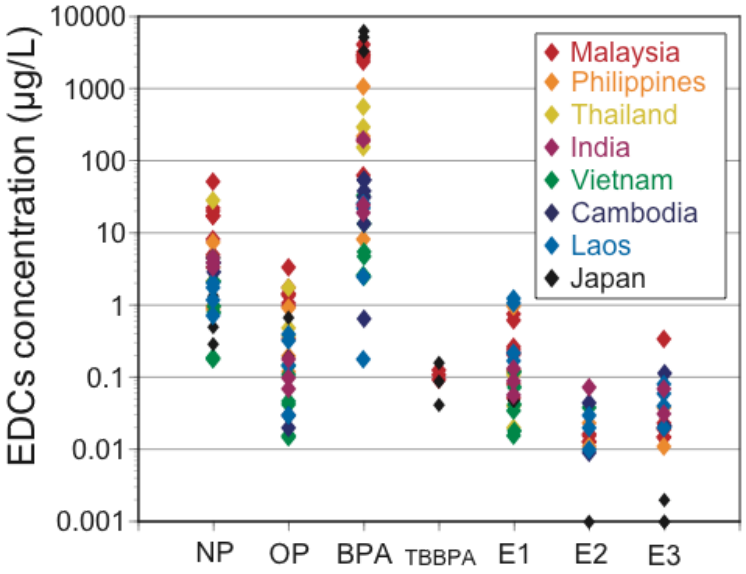


Landfill release hazardous chemicals from plastics to surface water and groundwater

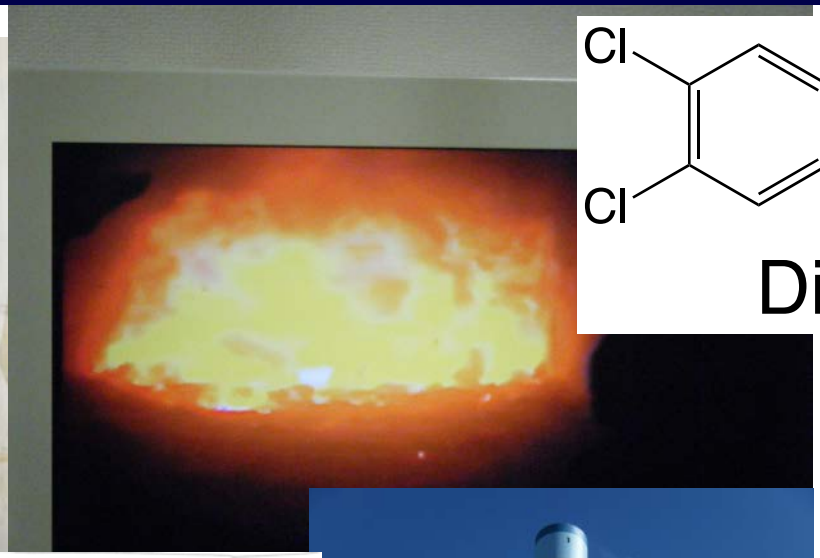


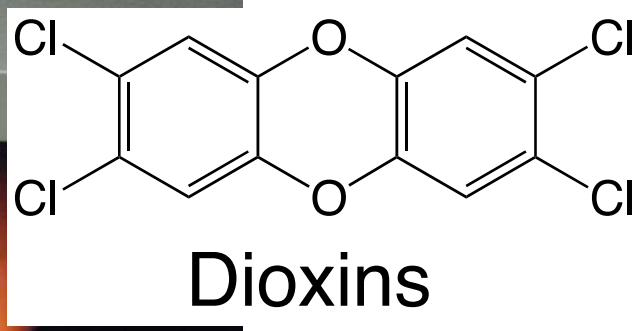


Plastic-derived chemicals

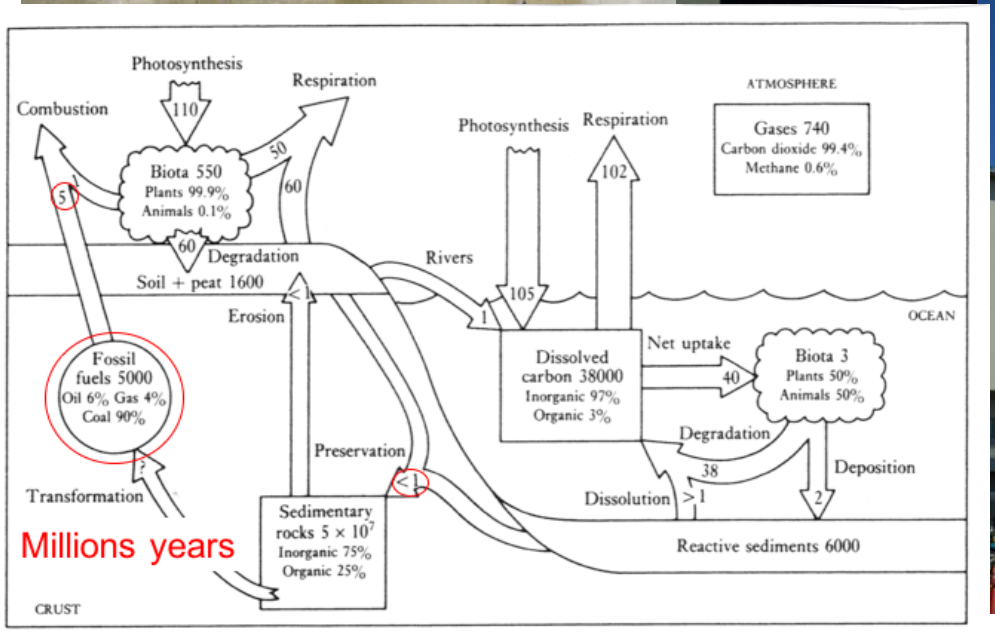


Incineration of plastic waste release toxic chemicals and CO_2



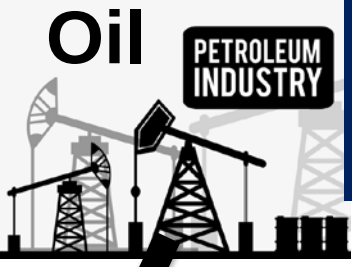


Dioxins



Incineration of plastic : net emission of CO_2

Inconsistent with Paris Agreement



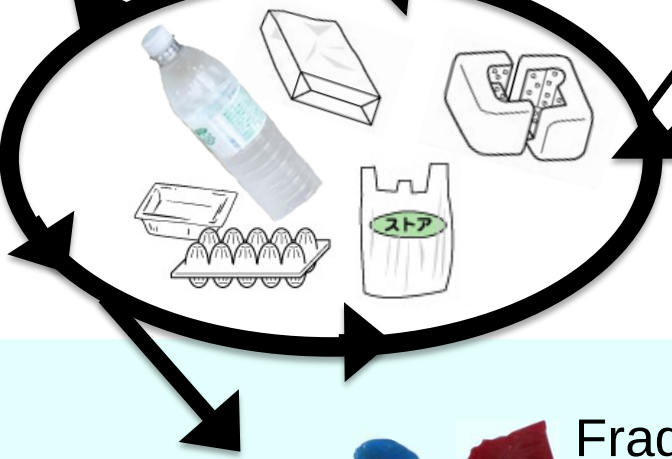
3R (Reduce, Reuse, Recycle) of plastic waste is the key

Reduce

Reuse
Recycle

landfill

incineration



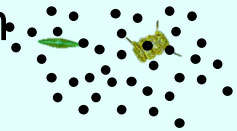
UV

UV

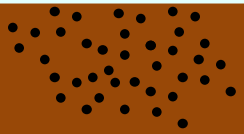
Fragmentation

Fragmentation

Microplastics



Sinking to bottom



Bottom sediment

3R (Reduce, Reuse, Recycle) of plastic waste is the key

Oil

PETROLEUM INDUSTRY

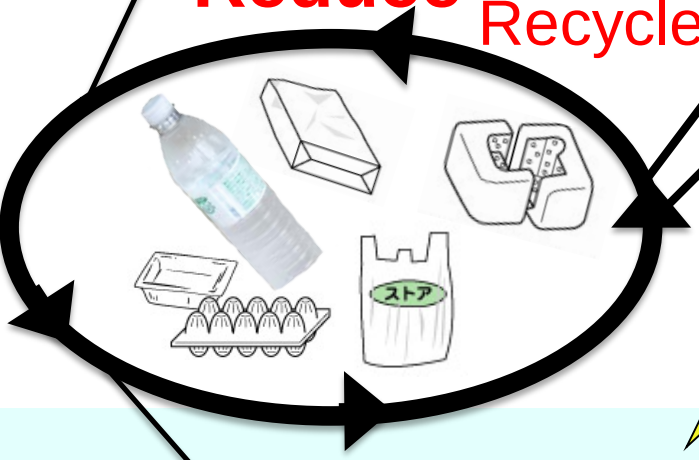
Reduce

Reuse

Recycle

landfill

incineration



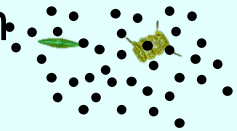
UV

UV

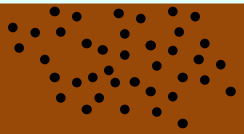
Fragmentation

Fragmentation

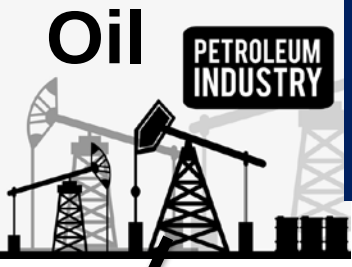
Microplastics



Sinking to bottom



Bottom sediment



3R (Reduce, Reuse, Recycle) of plastic waste is the key

Reduce

Reuse

Recycle

landfill ✗

incineration ✗

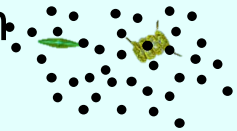
UV

UV

Fragmentation

Fragmentation

Microplastics



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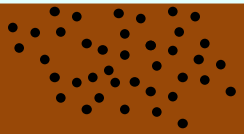

Bottom sediment

Promotion of waste management based on 3R (Reduce, Reuse, Recycle)

- Regulation of single-use plastics, e.g., **plastic shopping bag**.
- Establishment of social system and increase in public awareness to efficiently collect and segregate garbage.
- Innovation of product and package design to facilitate reuse and recycle.
- Promotion of utilization of biomass and biomass-based polymers. (Replace plastic with biomass)
- Establishment of social system to facilitate the recycling of plastics.
- Development of biodegradable plastics together with their treatment in closed system.
- Activating beach-cleanup
- Increasing public awareness on plastic pollution

Toward “circular economy”