TG ENVIRONMENTAL RESEARCH

Microplastic Particle Effects and Risks

-

The way forward

Todd Gouin

Characterizing associated hazards

- Ecotoxicological testing (PNEC/SSD)
  - Freshwater / Marine
  - Acute / Chronic
  - Pelagic / Benthic
  - Growth dilution / Translocation


Environmental Pollution 325 (2023) 121445
Contents lists available at ScienceDirect
Environmental Pollution
journal homepage: www.elsevier.com/locate/envpol

On the probability of ecological risks from microplastics in the Laurentian Great lakes☆

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[b] IMDEA Water Institute, Science and Technology Campus of the University of Alcalá, Avenida Punto Com, 2, 28805, Alcalá de Henares, Madrid, Spain
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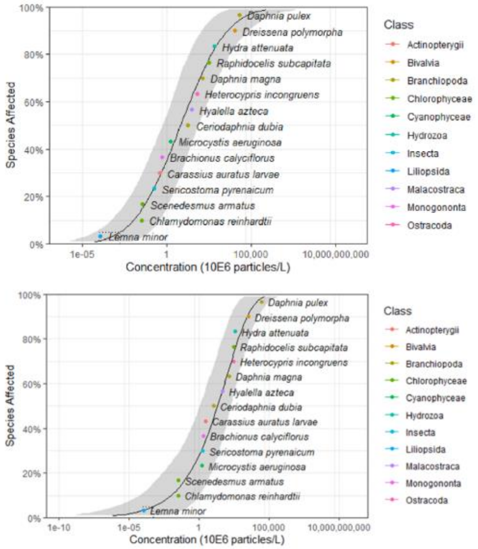


- Increasing pressure towards precautionary approaches
  - Persistence
  - Bioaccumulation
  - Toxic with link to chemicals


Environmental Science & Technology
pubs.acs.org/est
Viewpoint

A Call to Include Plastics in the Global Environment in the Class of Persistent, Bioaccumulative, and Toxic (PBT) Pollutants

Juan José Alava,* Annika Jahnke, Melanie Bergmann, Gabriela V. Aguirre-Martínez, Leah Bendell, Paola Calle, Gustavo A. Domínguez, Elaine M. Faustman, Jill Falman, Tamara N. Kazmiruk, Natasha Klasios, Maria T. Maldonado, Karly McMullen, Marcia Moreno-Báez, Gunilla Öberg, Yoshitaka Ota, Dana Price, Won Joon Shim, Ana Tirapé, Jessica M. Vandenberg, Zeinab Zoveidadianpour, and Judith Weis

Cite This: https://doi.org/10.1021/acs.est.3c02476
Read Online

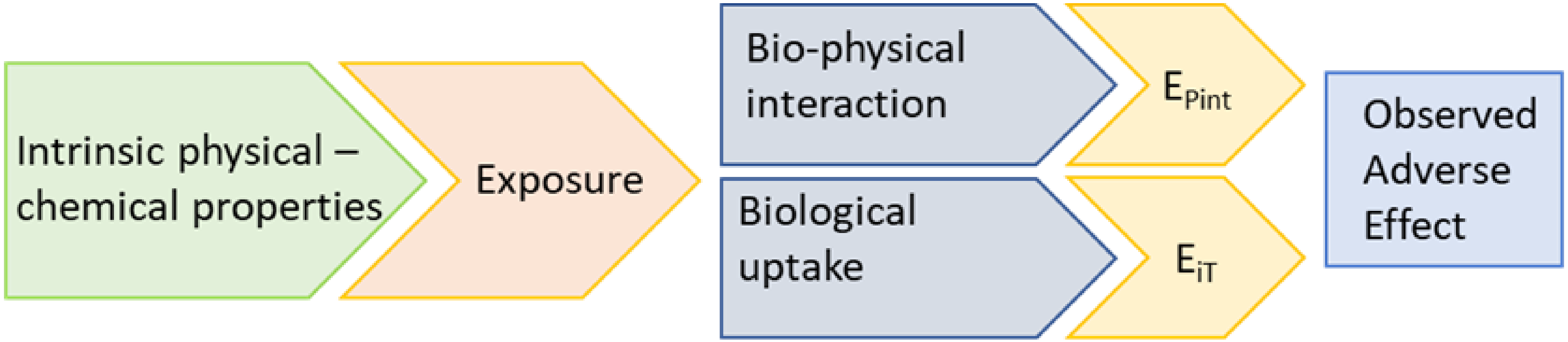
Nano- and microplastic particles: Is there an intrinsic hazard?

Intrinsic

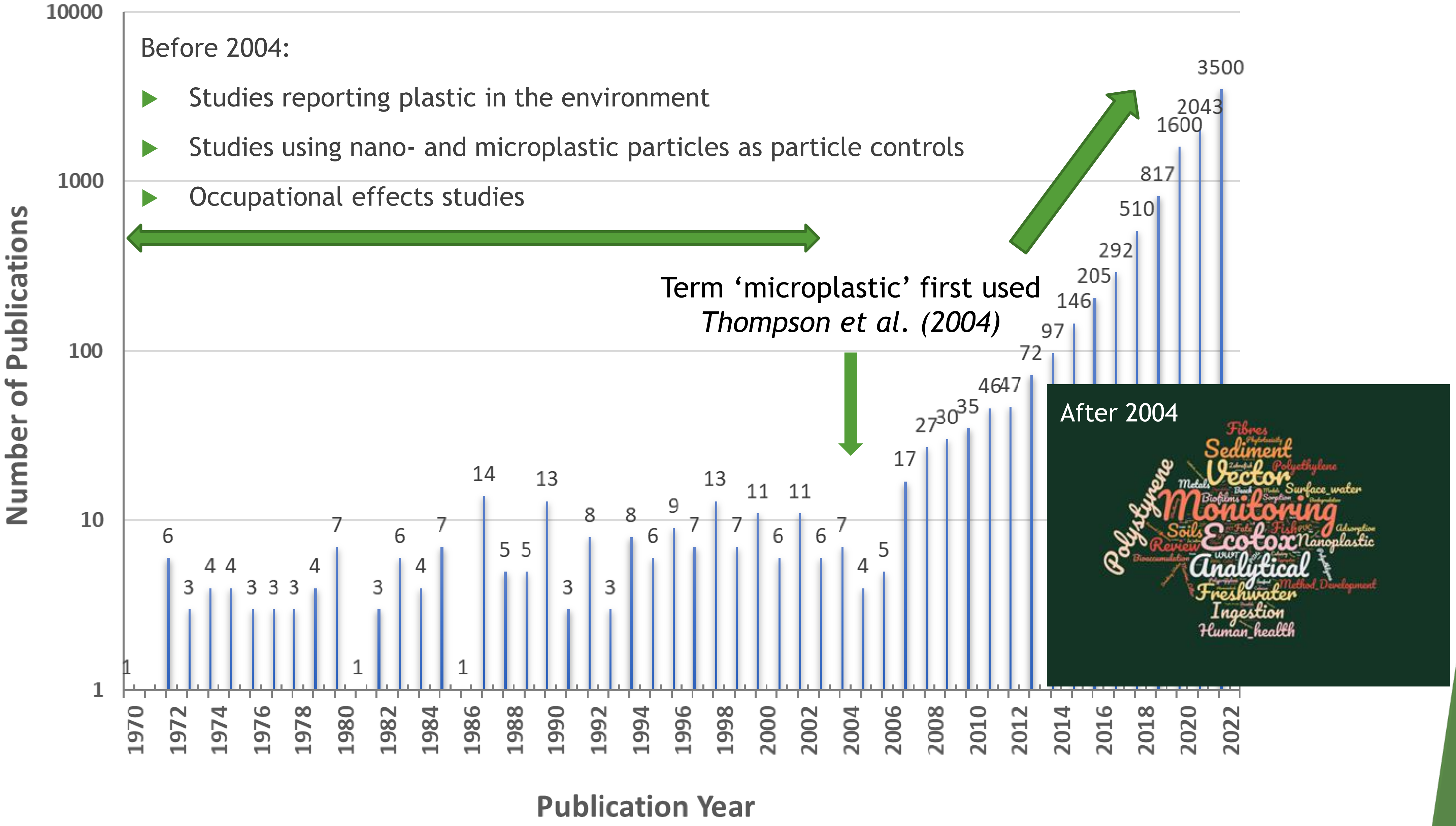
- System **INDEPENDENT**
  - Physical state, melting point, density, molecular weight

Extrinsic

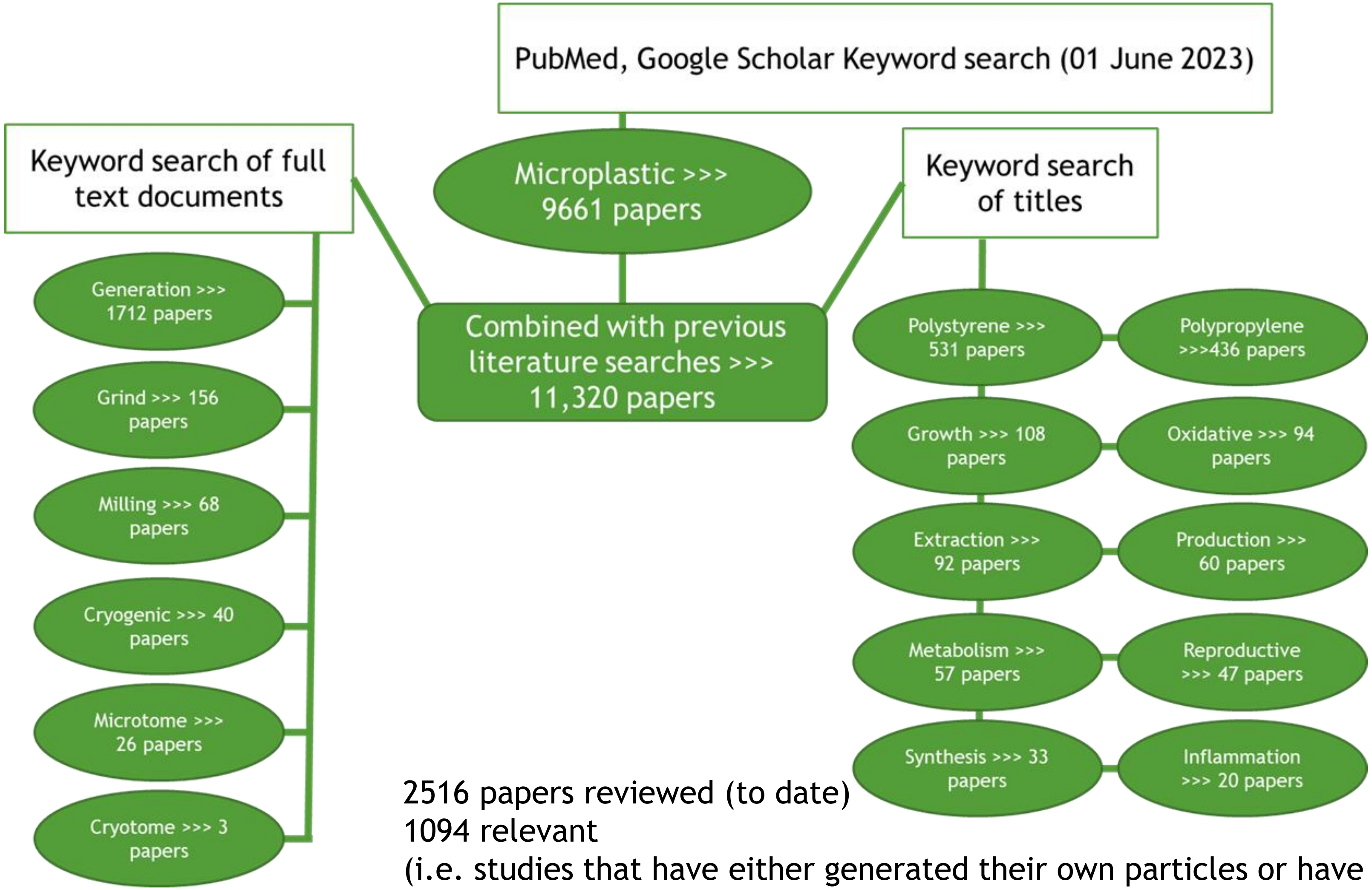
- System **DEPENDENT**
  - Particle concentration



Exponential growth in the scientific literature



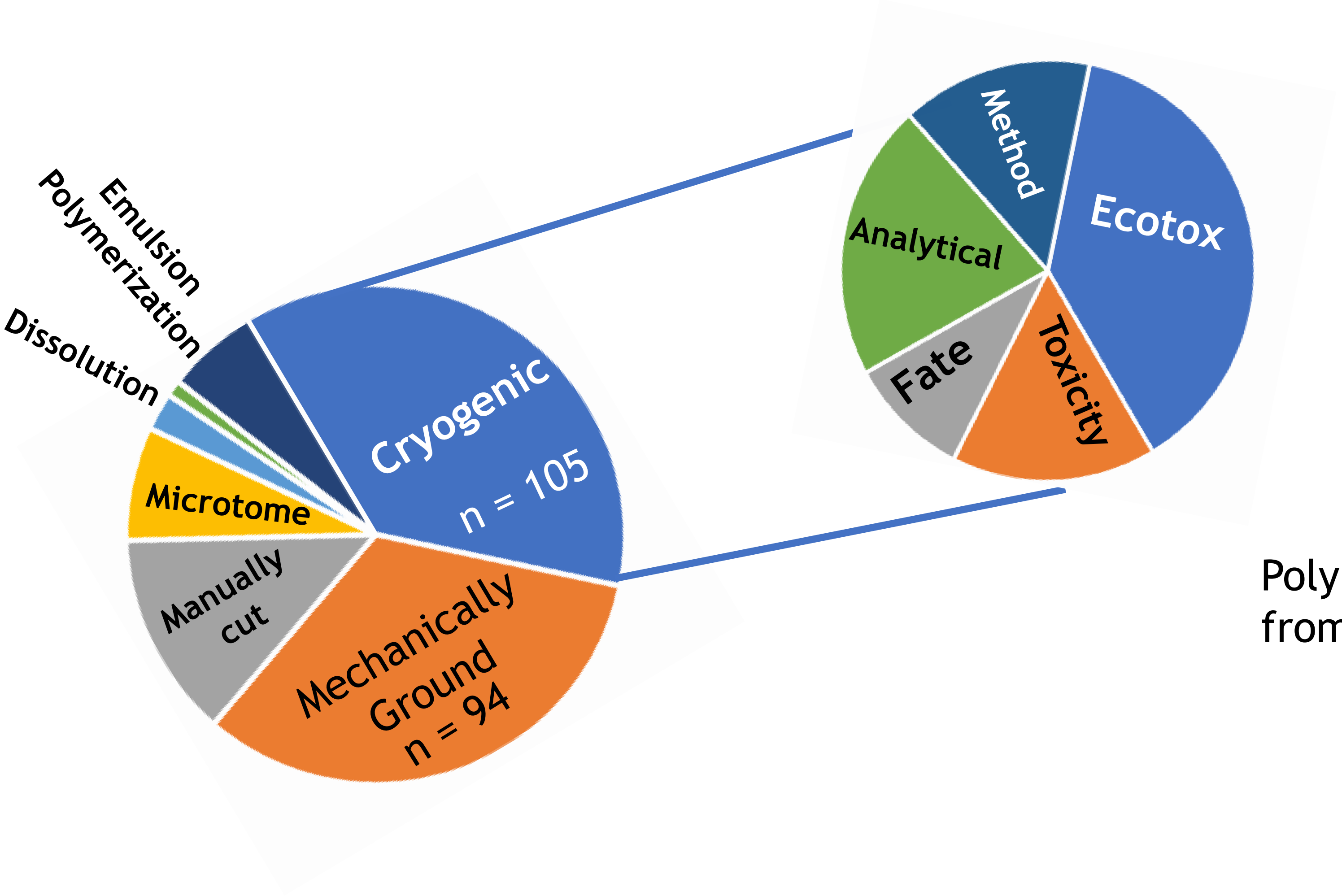
Literature review



2516 papers reviewed (to date)
1094 relevant
(i.e. studies that have either generated their own particles or have purchased from a supplier for purposes of studying:

- Ecotoxicological effects
- Toxicological effects (mammalian in vivo or in vitro)
- Environmental fate
- Chemical sorption/leaching

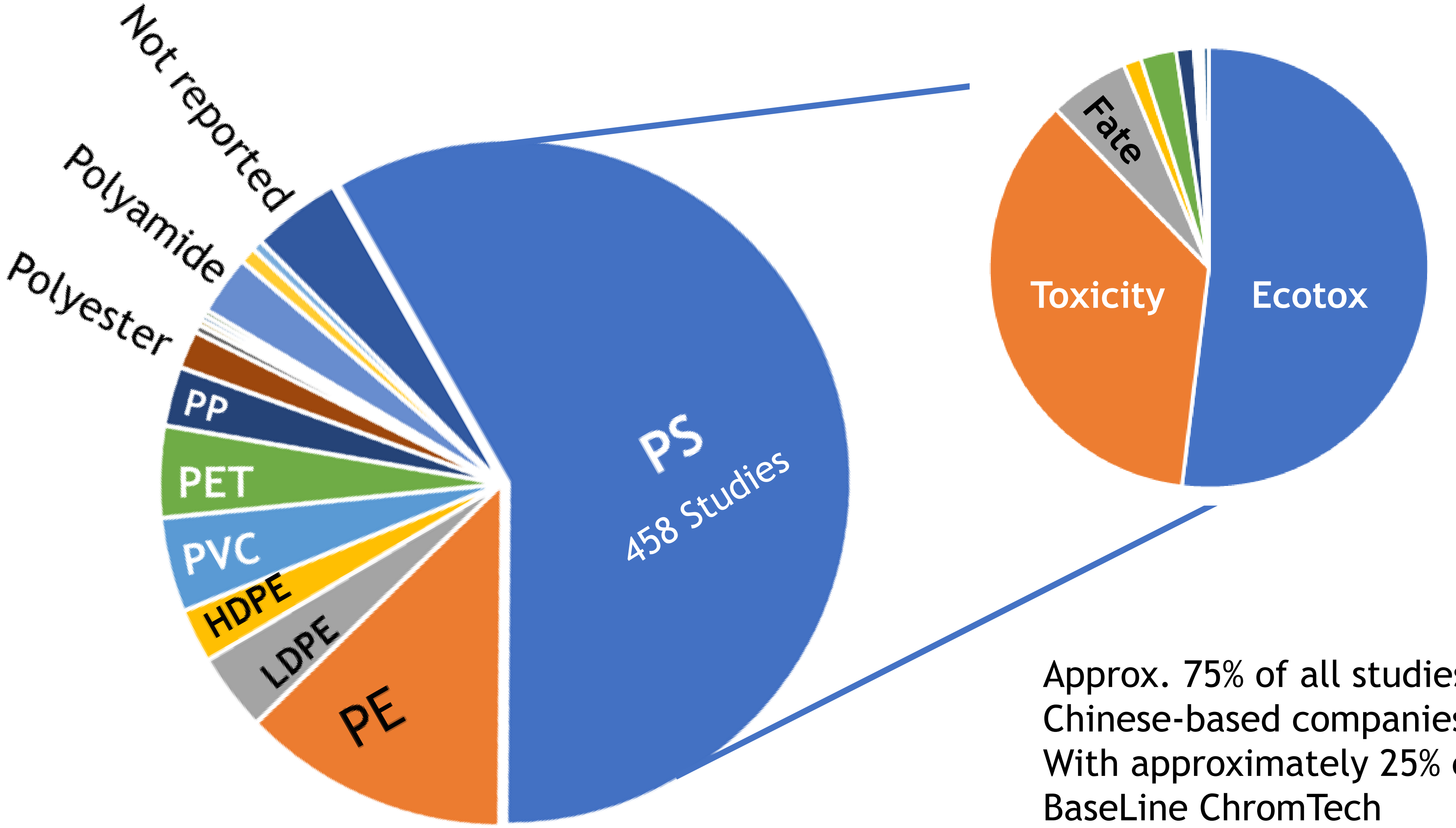
Generated particles (285 studies)



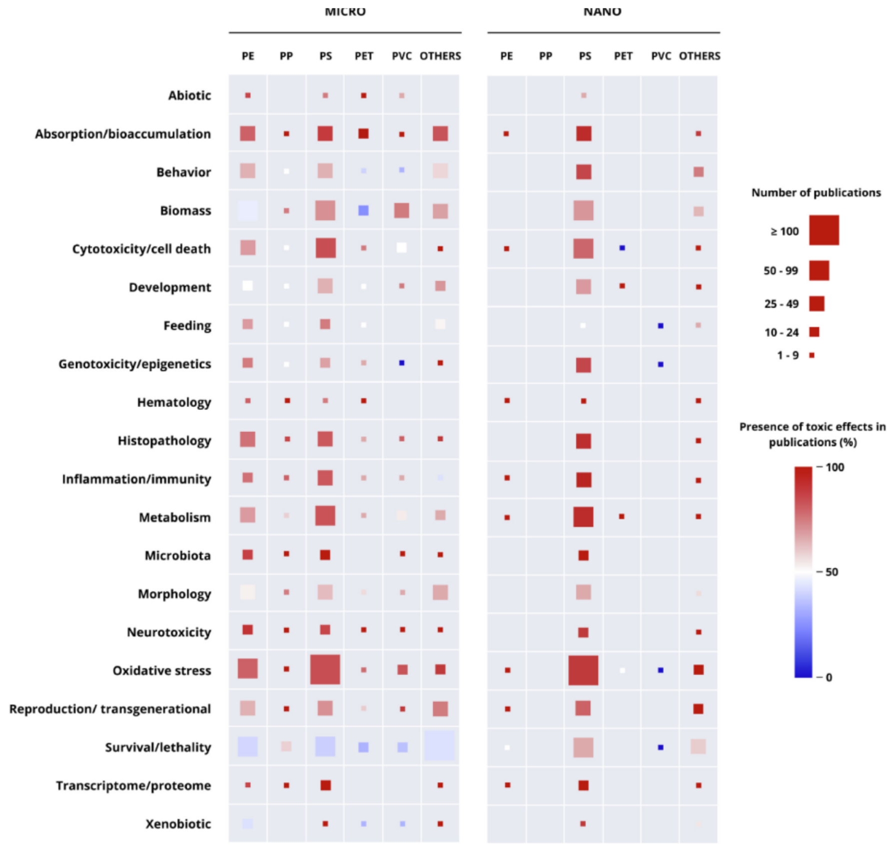
Polymers with origin dominated from various consumer products:

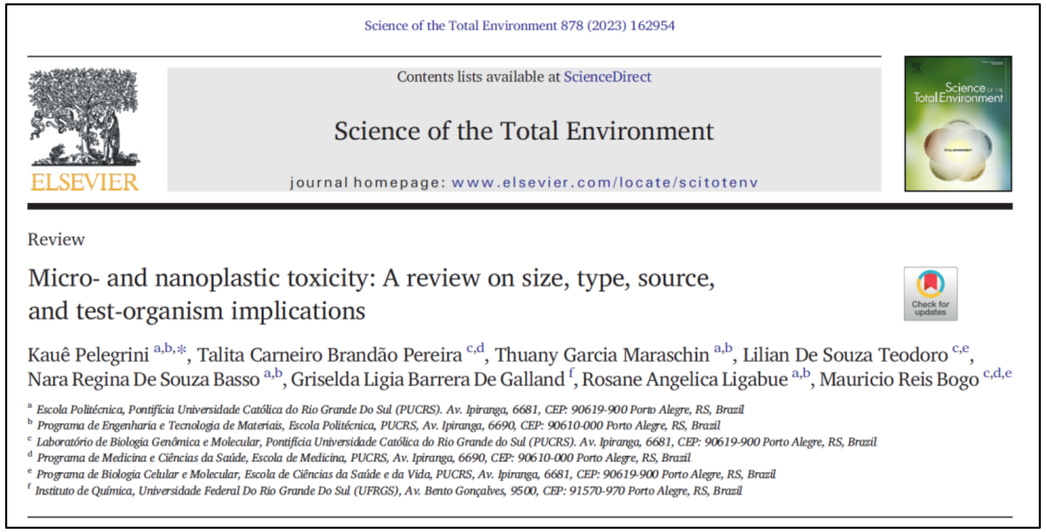
- PS
- PE
- PP
- PET
- PVC

Purchased particles (single polymer; 785 studies)



Approx. 75% of all studies sourced PS from Chinese-based companies
With approximately 25% coming from BaseLine ChromTech





Science of the Total Environment 878 (2023) 162954

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Review

Micro- and nanoplastic toxicity: A review on size, type, source, and test-organism implications

Kauê Pelegrini [a,b,*], Talita Carneiro Brandão Pereira [c,d], Thuany Garcia Maraschin [a,b], Lilian De Souza Teodoro [c,e], Nara Regina De Souza Basso [a,b], Griselda Ligia Barrera De Galland [f], Rosane Angelica Ligabue [a,b], Mauricio Reis Bogo [c,d,e]

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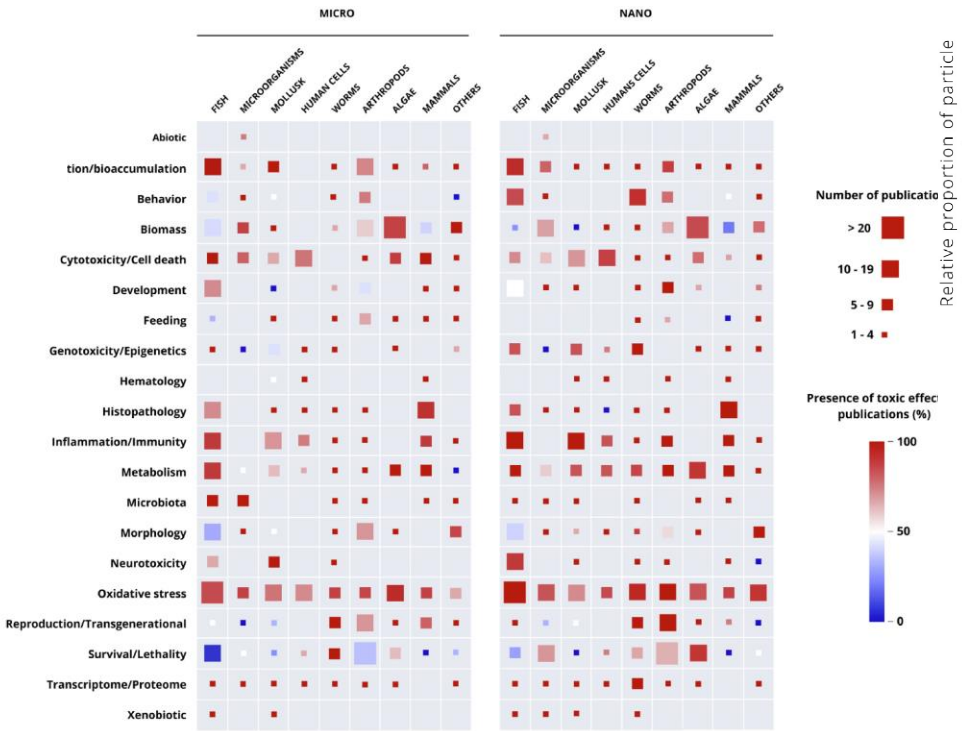
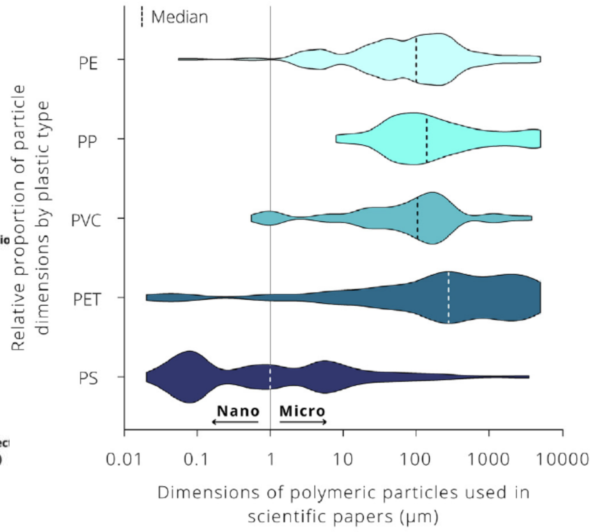
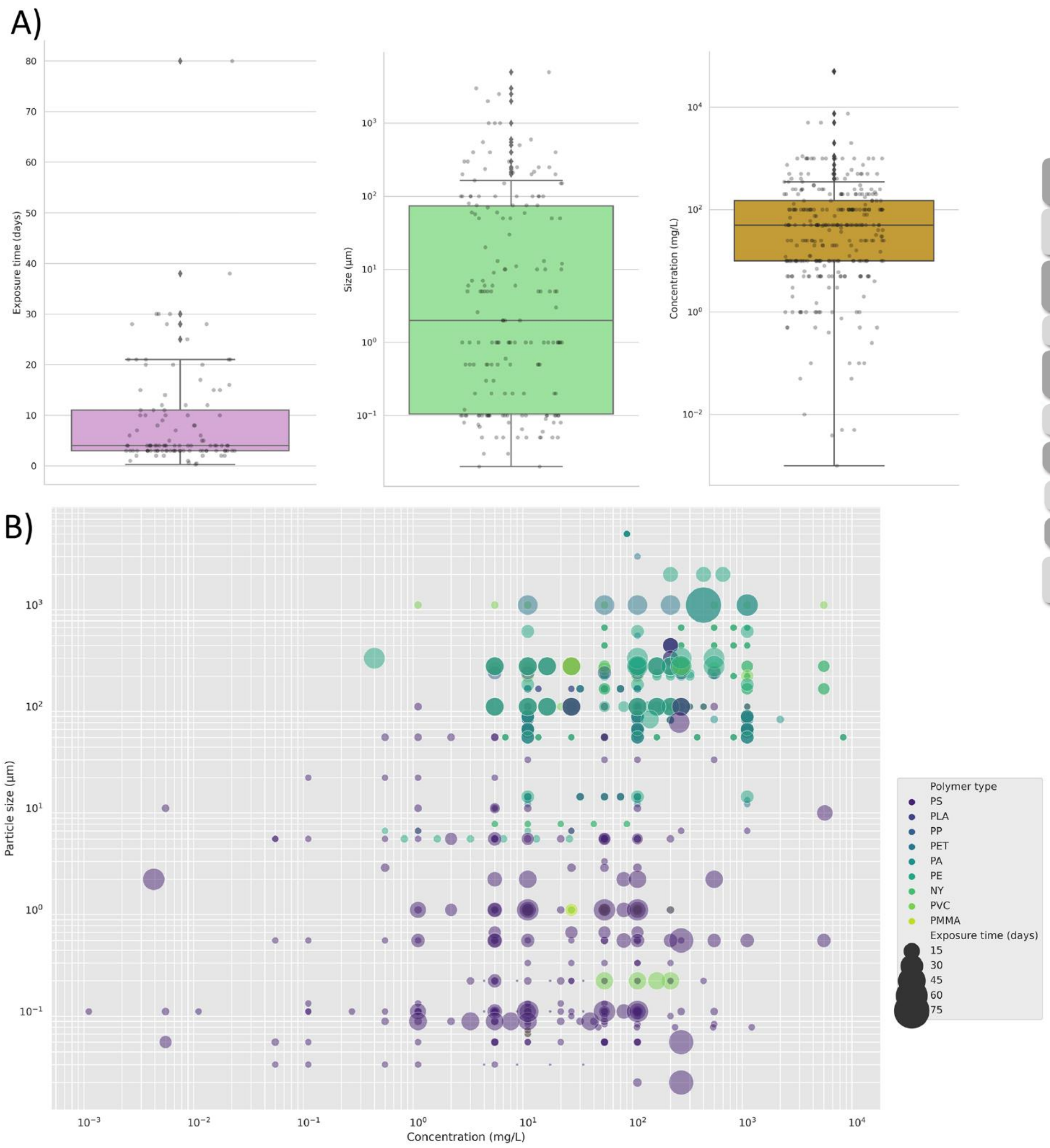
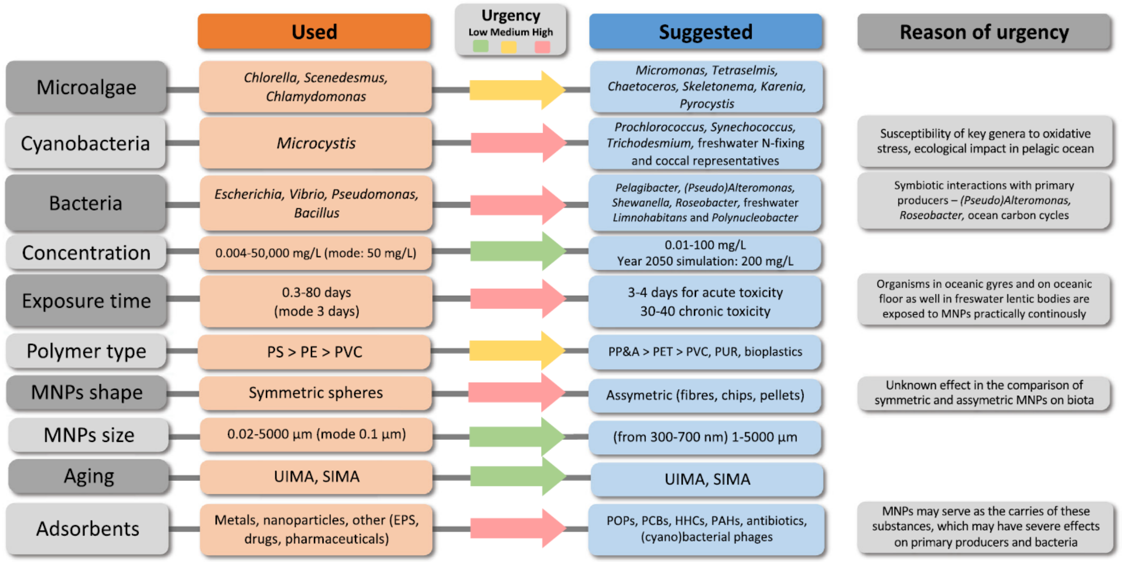








Journal of Hazardous Materials 454 (2023) 131476

Contents lists available at ScienceDirect

Journal of Hazardous Materials

journal homepage: www.elsevier.com/locate/jhazmat

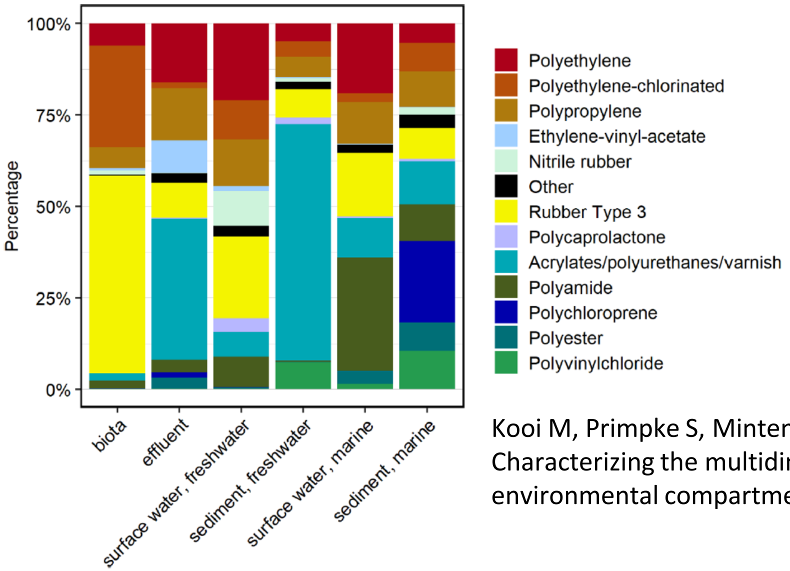
Review

Microplastics and nanoplastics toxicity assays: A revision towards to environmental-relevance in water environment

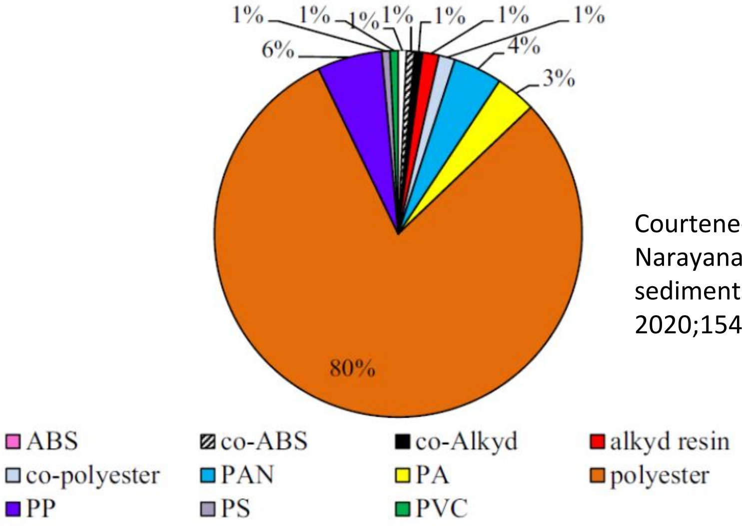
Ondrej Pencik[a,1], Michaela Durdakova[a,2], Katarina Molnarova[a,3], Attila Kucsera[b,4], Daniel Klofac[c,5], Martina Kolackova[a,6], Vojtech Adam[a,7], Dalibor Huska[a,*,8]

[a] Department of Chemistry and Biochemistry, Mendel University in Brno, Zemědělská 1665/1, 613 00 Brno, Czech Republic
[b] Department of Molecular Biology and Radiobiology, Mendel University in Brno, Zemědělská 1665/1, 613 00 Brno, Czech Republic
[c] Department of Agrochemistry, Soil Science, Microbiology and Plant Nutrition, Zemědělská 1665/1, 613 00 Brno, Czech Republic

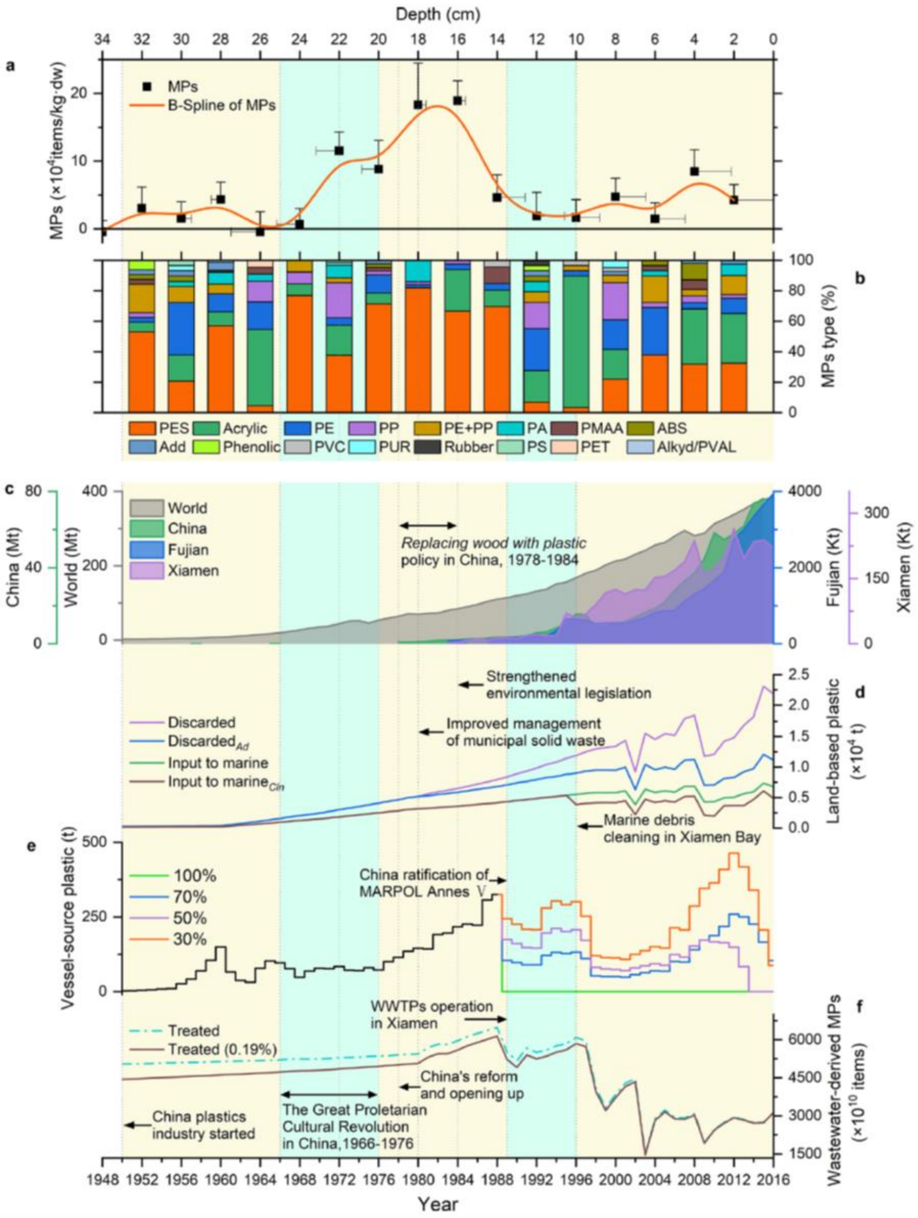
Environmental data



Kooi M, Primpke S, Mintenig SM, Lorenz C, Gerdts G, Koelmans AA. Characterizing the multidimensionality of microplastics across environmental compartments. Water Res. 2021;202:117429.



Courtene-Jones W, Quinn B, Ewins C, Gary SF, Narayanaswamy BE. Microplastic accumulation in deep-sea sediments from the Rockall Trough. Mar Pollut Bull. 2020;154:111092



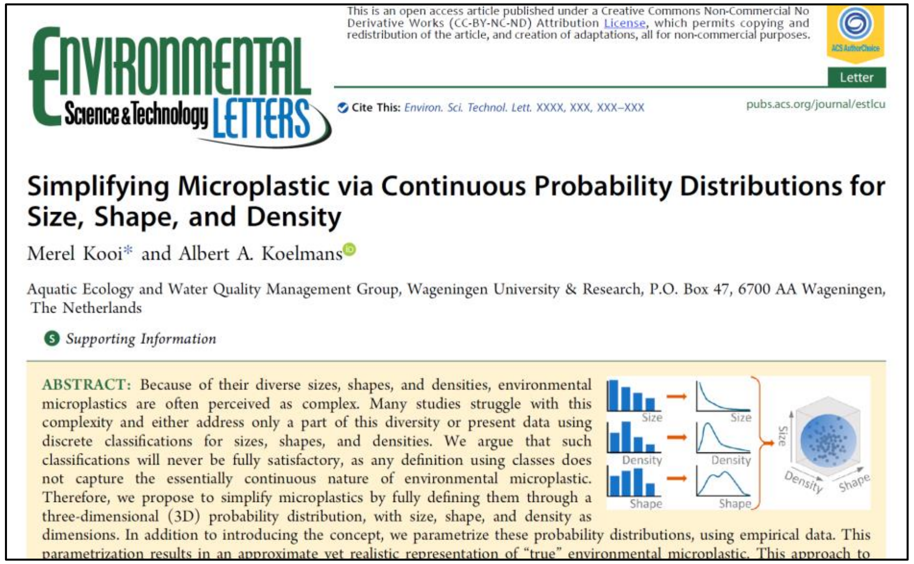
Long Z, Pan Z, Jin X, Zou Q, He J, Li W, et al. Anthropocene microplastic stratigraphy of Xiamen Bay, China: A history of plastic production and waste management. Water Res. 2022;226:119215

Size, shape and density – is this sufficient?

- Create an environmentally relevant mixture in test systems:
  - Size
  - Shape
  - Density (polymer composition)

But

- Exposure in the environment is not necessarily consistent:
  - Heterogeneous mixture of particles various in space and time.
  - Not possible to test all possible combinations of environmentally relevant mixtures of particles
- Multifaceted problem – does it matter?



Environmental Science & Technology Letters

Letter

Cite This: Environ. Sci. Technol. Lett. XXXX, XXX, XXX−XXX

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Simplifying Microplastic via Continuous Probability Distributions for Size, Shape, and Density

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Aquatic Ecology and Water Quality Management Group, Wageningen University & Research, P.O. Box 47, 6700 AA Wageningen, The Netherlands

Supporting Information

ABSTRACT: Because of their diverse sizes, shapes, and densities, environmental microplastics are often perceived as complex. Many studies struggle with this complexity and either address only a part of this diversity or present data using discrete classifications for sizes, shapes, and densities. We argue that such classifications will never be fully satisfactory, as any definition using classes does not capture the essentially continuous nature of environmental microplastic. Therefore, we propose to simplify microplastics by fully defining them through a three-dimensional (3D) probability distribution, with size, shape, and density as dimensions. In addition to introducing the concept, we parametrize these probability distributions, using empirical data. This parametrization results in an approximate yet realistic representation of "true" environmental microplastic. This approach to

Problem formulation – Is there an intrinsic hazard?

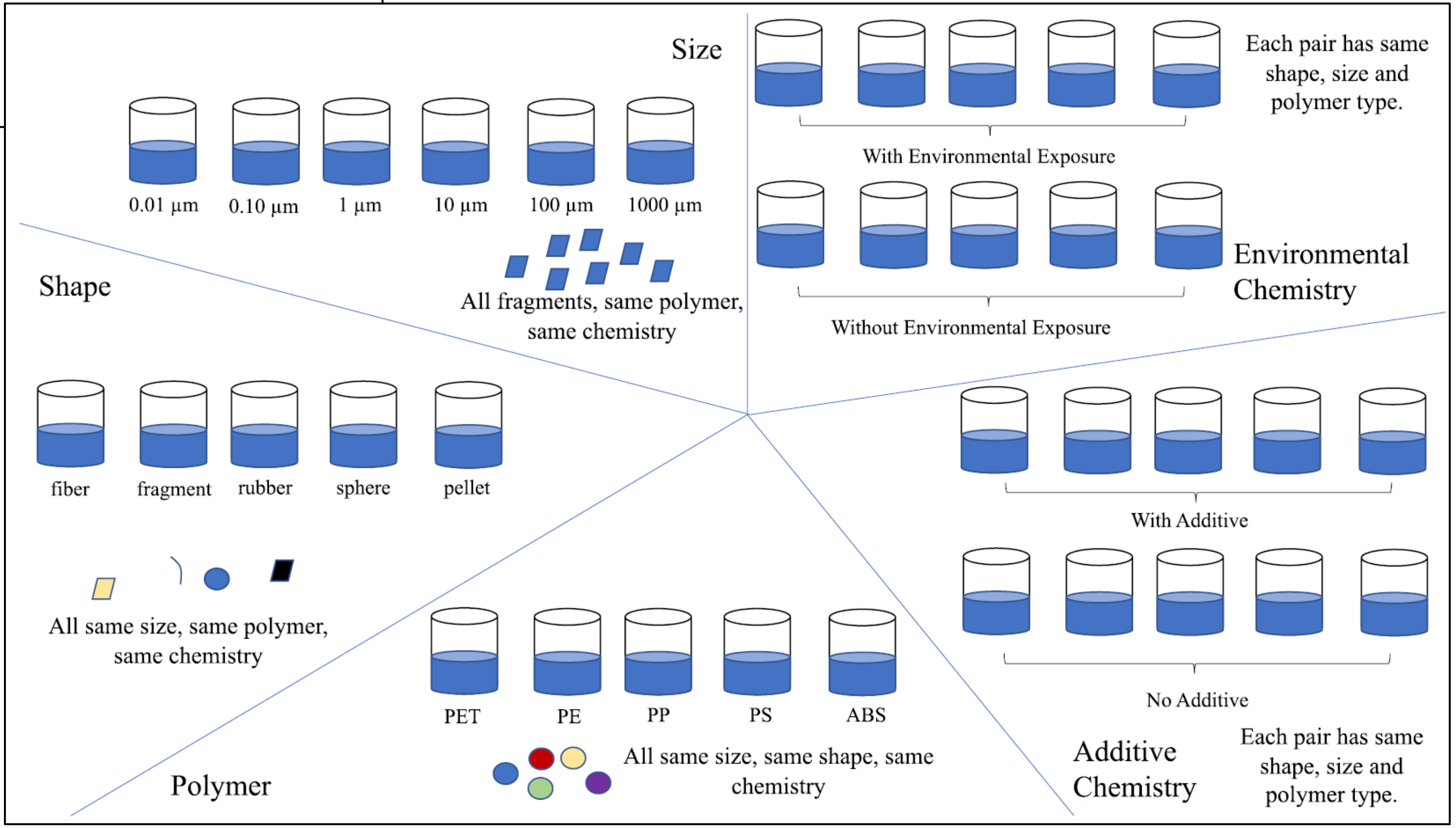
Bucci and Rochman
Microplastics and Nanoplastics (2022) 2:7
https://doi.org/10.1186/s43591-022-00028-0

Microplastics and Nanoplastics

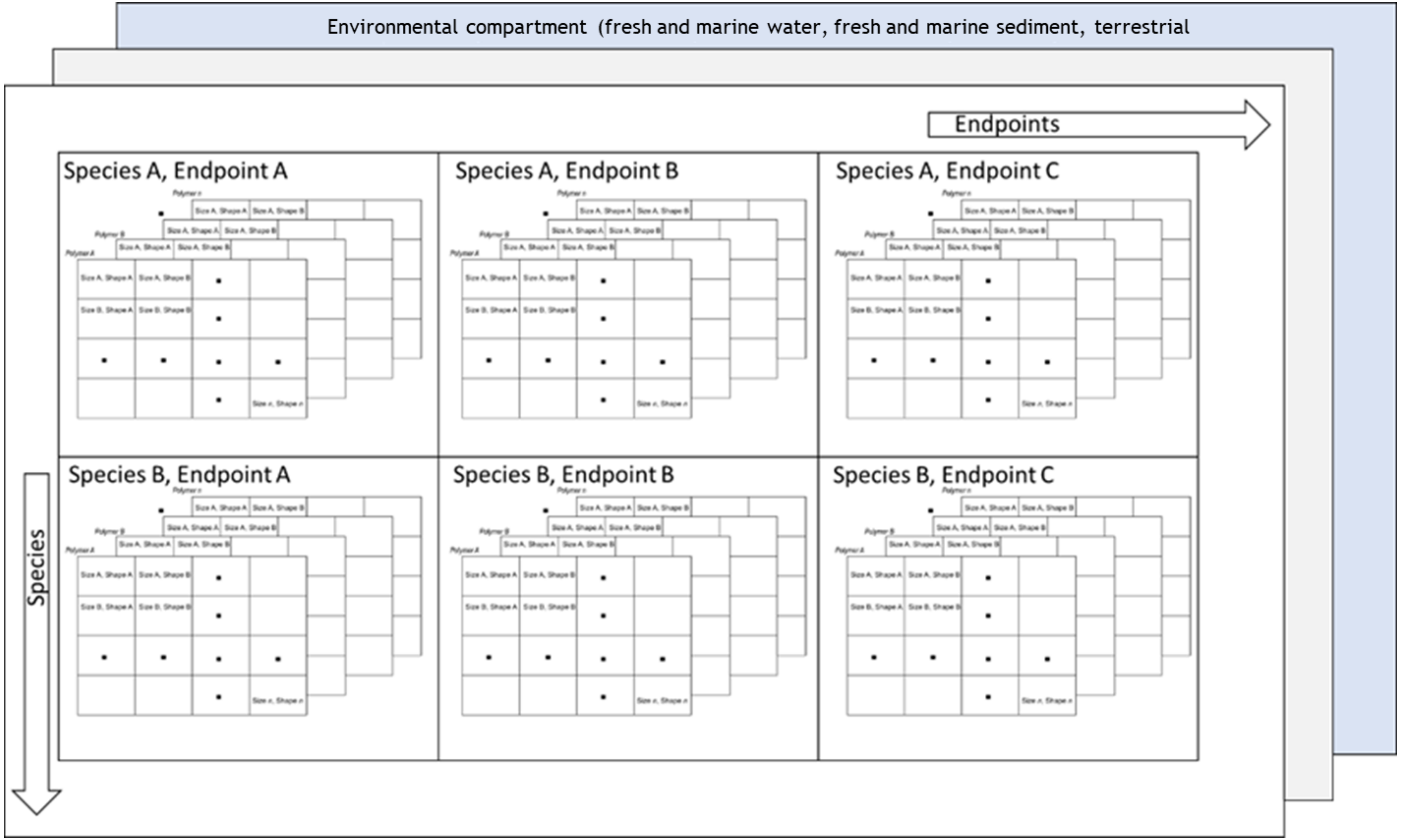
PERSPECTIVE Open Access

Microplastics: a multidimensional contaminant requires a multidimensional framework for assessing risk

Kennedy Bucci* and Chelsea M. Rochman*



Standardized Testing - Challenges and Limitations



Plastic and plastic associated chemicals

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IPEN's Toxic Plastics Campaign

Every stage of the life-cycle of plastic involves toxic chemicals, which threaten human health, the env
biodiversity, and the climate.

IPEN's work aims to reveal the toxic threats to health and the environment in each stage of plastics' l
to:

- Curb the production of toxic oil, natural gas, and petrochemicals.
- Eliminate and substitute the most toxic chemicals used in the production of plastic.
- Strengthen global policies related to plastic waste controls and incineration.
- Promote environmental justice.

TOWARD A PLASTICS TREATY

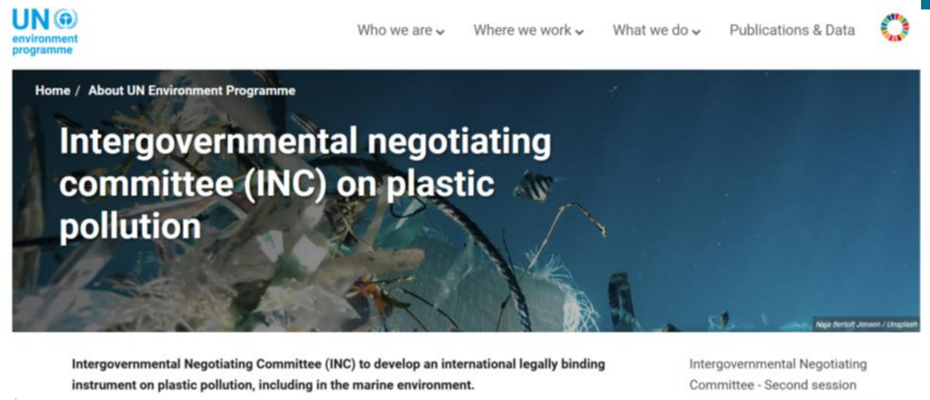
TOXIC PLASTICS REPORTS

View Media on Toxic Plastics

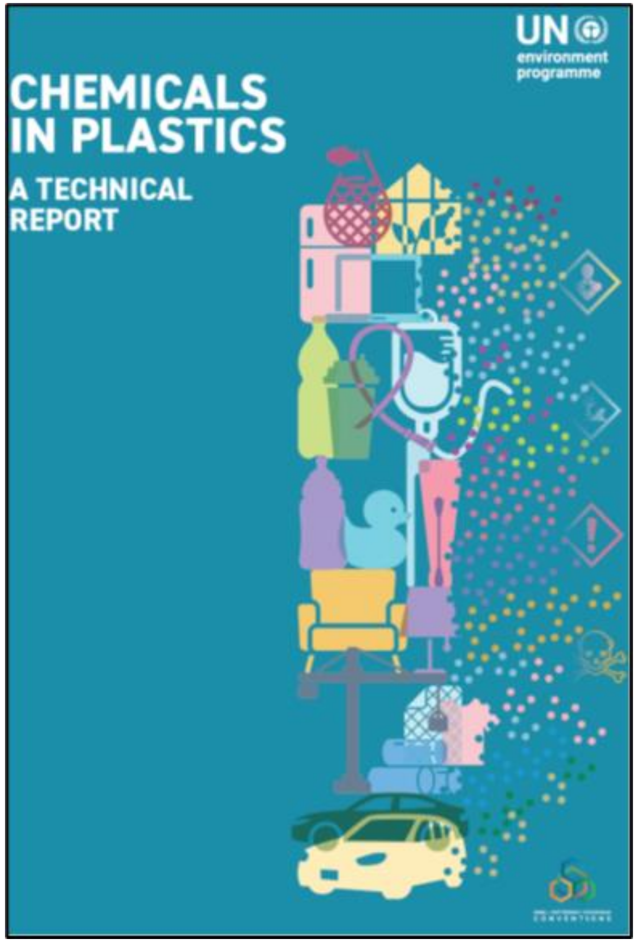
IPEN is calling for an international plastics treaty that:

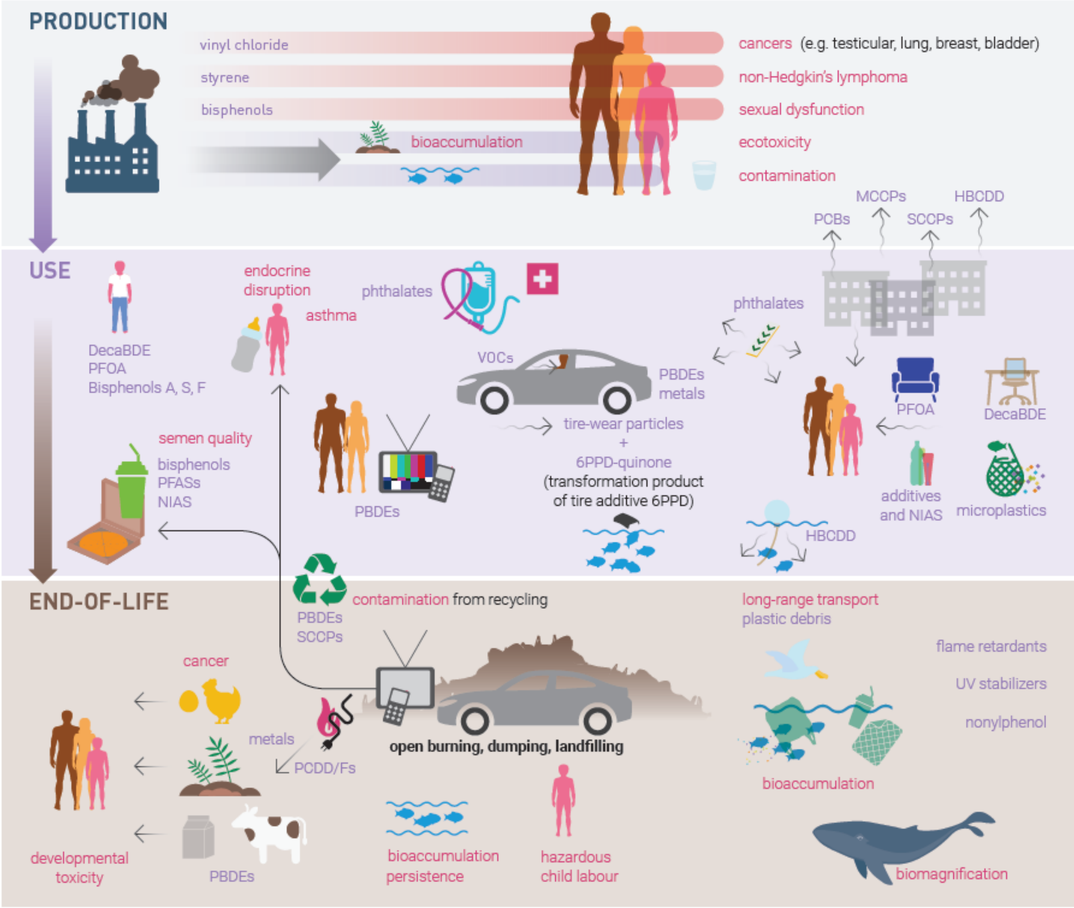
- Protects health and the environment
- Ends the production and use of toxic chemicals in plastics
- Removes toxic impacts at all stages of the lifecycle of plastics
- Bans recycling of plastics containing hazardous chemicals
- Protects the public's right to know about chemicals in plastics and information on plastic production and waste exports
- Charges plastic producers to finance the treaty
- Promotes safer sustainable materials for a toxics-free circular economy
- Curbs toxic and climate pollutants

In the meantime, greater transparency on toxic chemical additives used in plastics is needed, along with data on the quantities of plastics made, traded, and disposed of. For more information see our **Plastics Treaty** page.



Plastic and plastic associated chemicals: Exposure pathways





Way forward

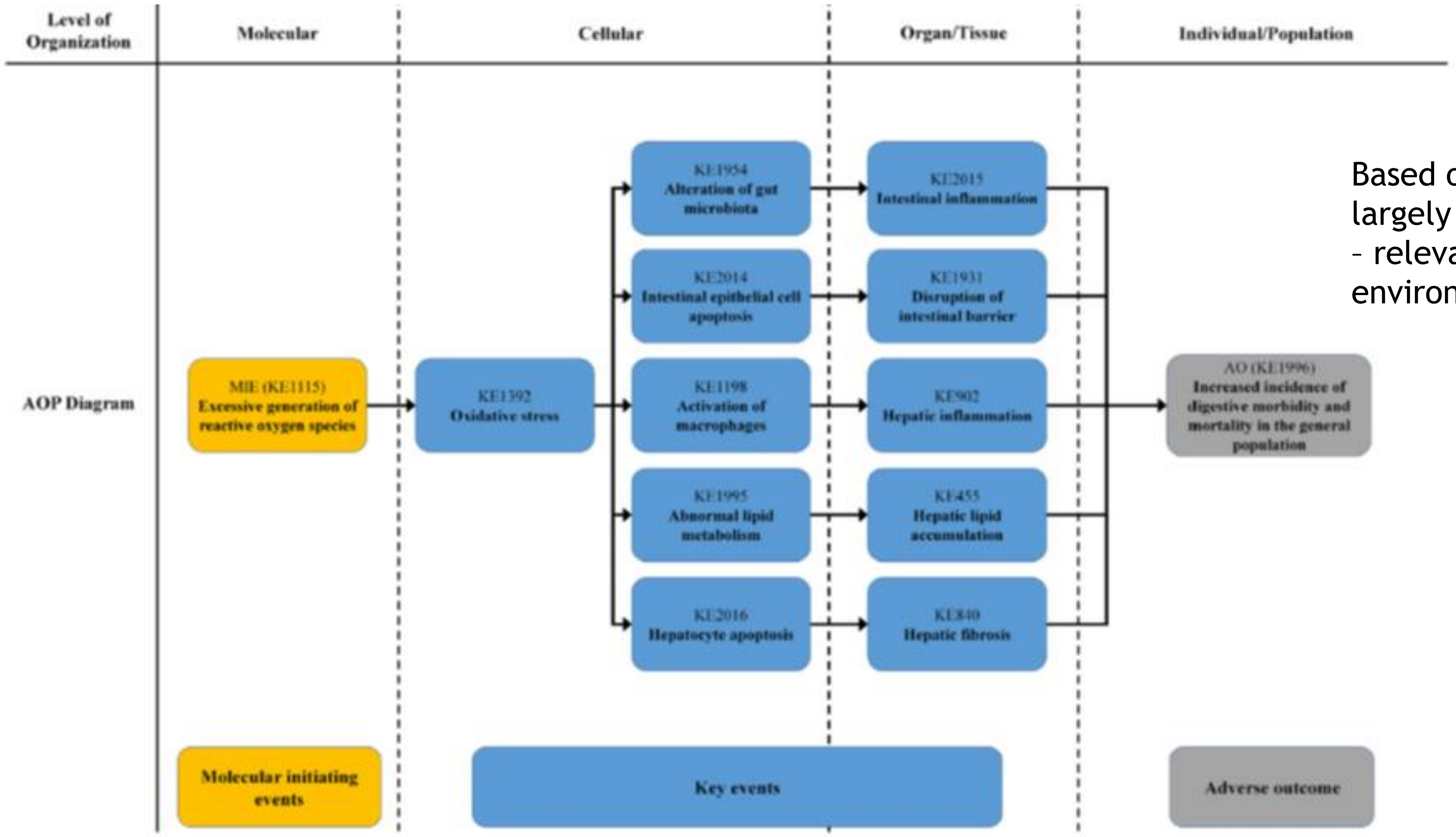
- Optimistic perspective:
  - Mechanistic understanding can greatly strengthen understanding of true ‘hazard’.
    - Supports robust science-based decision making
    - Prioritization of risk mitigation initiatives

- Pessimistic perspective
  - Limited number of groups (scientific and regulatory) critically evaluating the literature:
    - Resource limitations
  - Increasing number of studies reporting adverse effects
    - System artifacts versus true ‘hazard’ poorly addressed
    - Lack of standard methods
    - Lack of particle characterization
    - Heavy reliance on polystyrene as model microplastic particle

  - Growing arguments that critical assessments are representative of a Conflict of Interest

- How to address communication moving forward to ensure robust science is used to support decision making

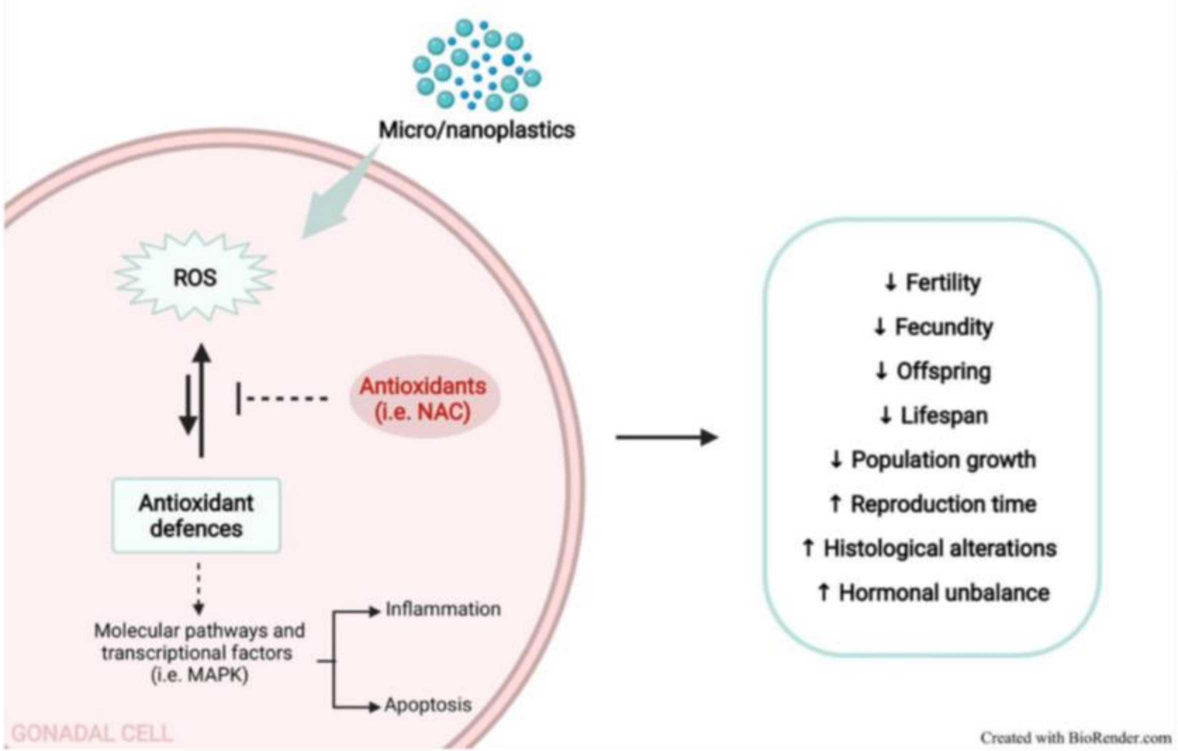
Literature review – Plastic and AOPs



Based on results reported largely for polystyrene spheres – relevance towards environmental exposure?

Ding R, Ma Y, Li T, Sun M, Sun Z, Duan J. The detrimental effects of micro-and nano-plastics on digestive system: An overview of oxidative stress-related adverse outcome pathway. Sci Total Environ. 2023;878:163144

ROS leads to Reproductive effects (?)



Based on results reported largely for polystyrene spheres – relevance towards environmental exposure?

Ferrante MC, Monnolo A, Del Piano F, Mattace Raso G, Meli R. The Pressing Issue of Micro- and Nanoplastic Contamination: Profiling the Reproductive Alterations Mediated by Oxidative Stress. Antioxidants (Basel). 2022;11(2).