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Scientific Facts in the Meme Age

Mark Jones

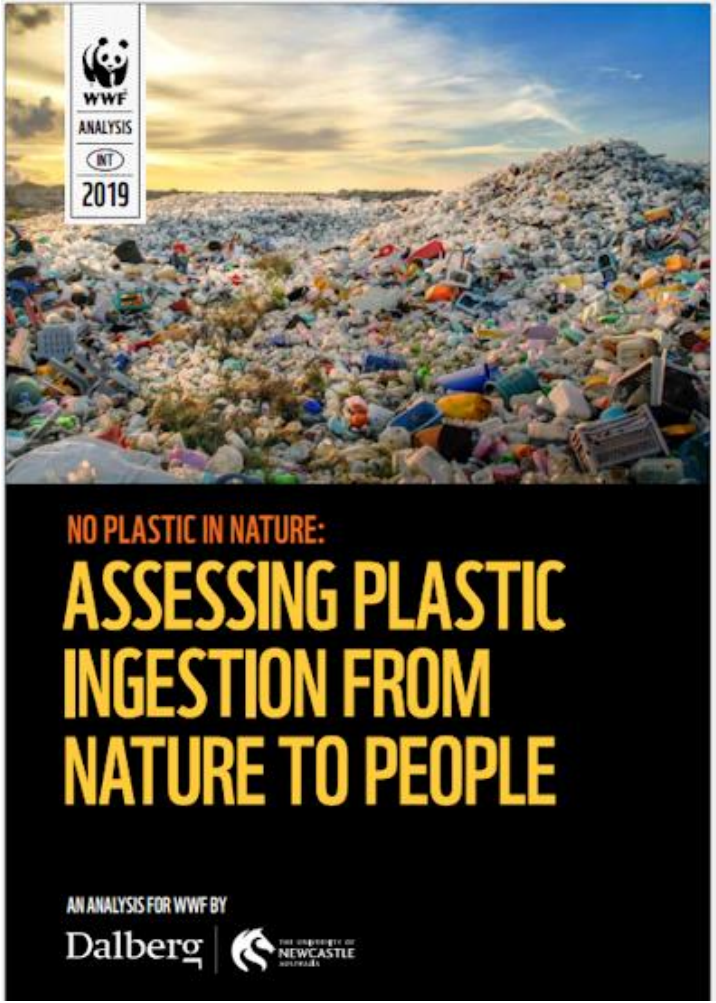
Creative Director

MJPhD, LLC

23 January 2024

Mid-Michigan AIChE® American Institute of Chemical Engineers

1. A widely reported fact about microplastic consumption is wrong.
2. Correction in the scientific literature is slow to correct public perception and the scientific literature.
3. Plastic particles are everywhere.



wwfint.awsassets.panda.org/downloads/plastic_ingestion_web_spreads.pdf

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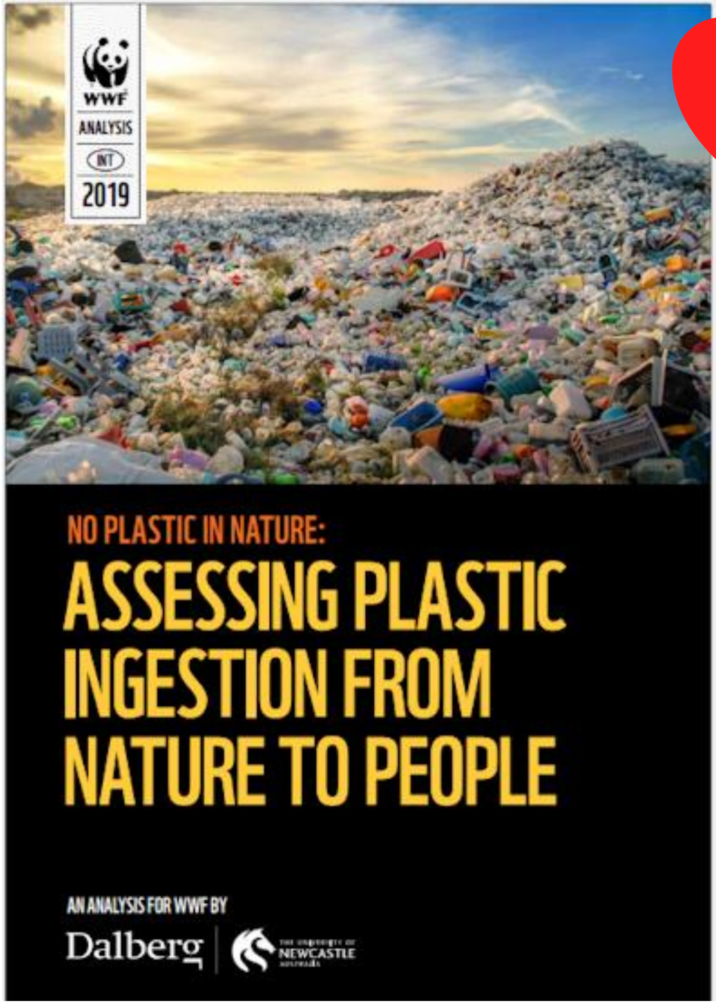


A new study by the University of Newcastle, Australia suggests that an average person could be ingesting approximately 5 grams of plastic every week. The equivalent of a credit card's worth of microplastics. This summary report highlights the key ways plastic gets into our body, and what we can do about it.

wwfint.awsassets.panda.org/downloads/plastic_ingestion_web_spreads.pdf

Plastic ingestion by people could be equating to a credit card a week

Wednesday, 12 June 2019

Tweet LinkedIn

A new study finds on average people could be ingesting approximately 5 grams of plastic every week, which is the equivalent weight of a credit card.

The analysis *No Plastic in Nature: Assessing Plastic Ingestion from Nature to People* prepared by Dalberg, based on a study commissioned by WWF and carried out by University of Newcastle, Australia, suggests people are consuming about 2000 tiny pieces of plastic every week. That's approximately 21 grams a month, just over 250 grams a year.

Dr Thava Palanisami

The University of Newcastle is the first to combine data from over 50 studies on the ingestion of microplastic by people. The findings are an important step towards understanding the impact of plastic pollution on humans. It also further confirms the urgent need

www.newcastle.edu.au/newsroom/featured/plastic-ingestion-by-people-could-be-equating-to-a-credit-card-a-week

wwf.panda.org/wwf_news/?348337/Revealed-plastic-ingestion-by-people-could-be-equating-to-a-credit-card-a-week

World

You may be eating a credit card's worth of plastic each week - study

Reuters

June 11, 2019 9:29 PM EDT · Updated 5 years ago

www.reuters.com/article/us-environment-plastic/you-may-be-eating-a-credit-cards-worth-of-plastic-each-week-study-idUSKCN1TD009/

www.cnn.com/2019/06/11/health/microplastics-ingestion-wwf-study-scn-intl/index.html per week

whole card = 5 g

per day

1/7 card = 710 mg

per meal

1/21 card = 240 mg

per bite

1/21 card = 20 mg

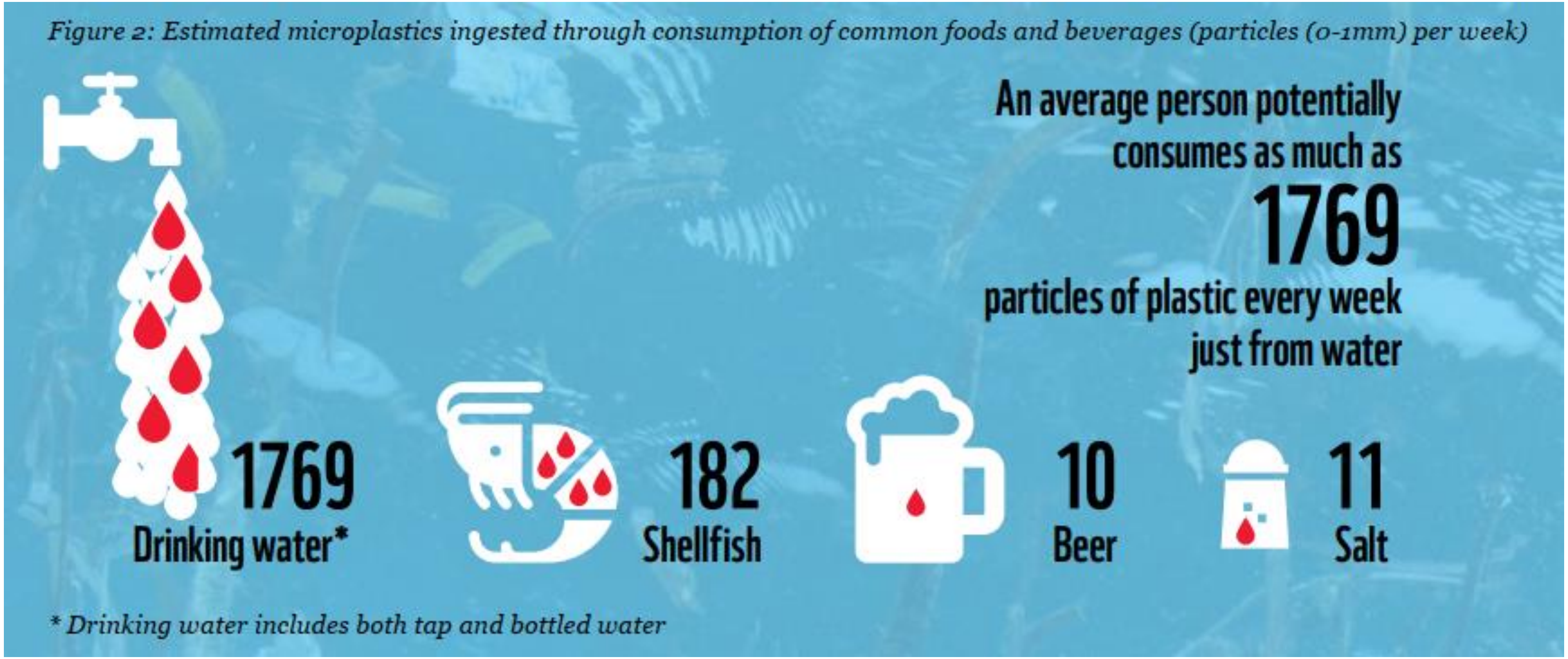


Figure 2: Estimated microplastics ingested through consumption of common foods and beverages (particles (0-1mm) per week)

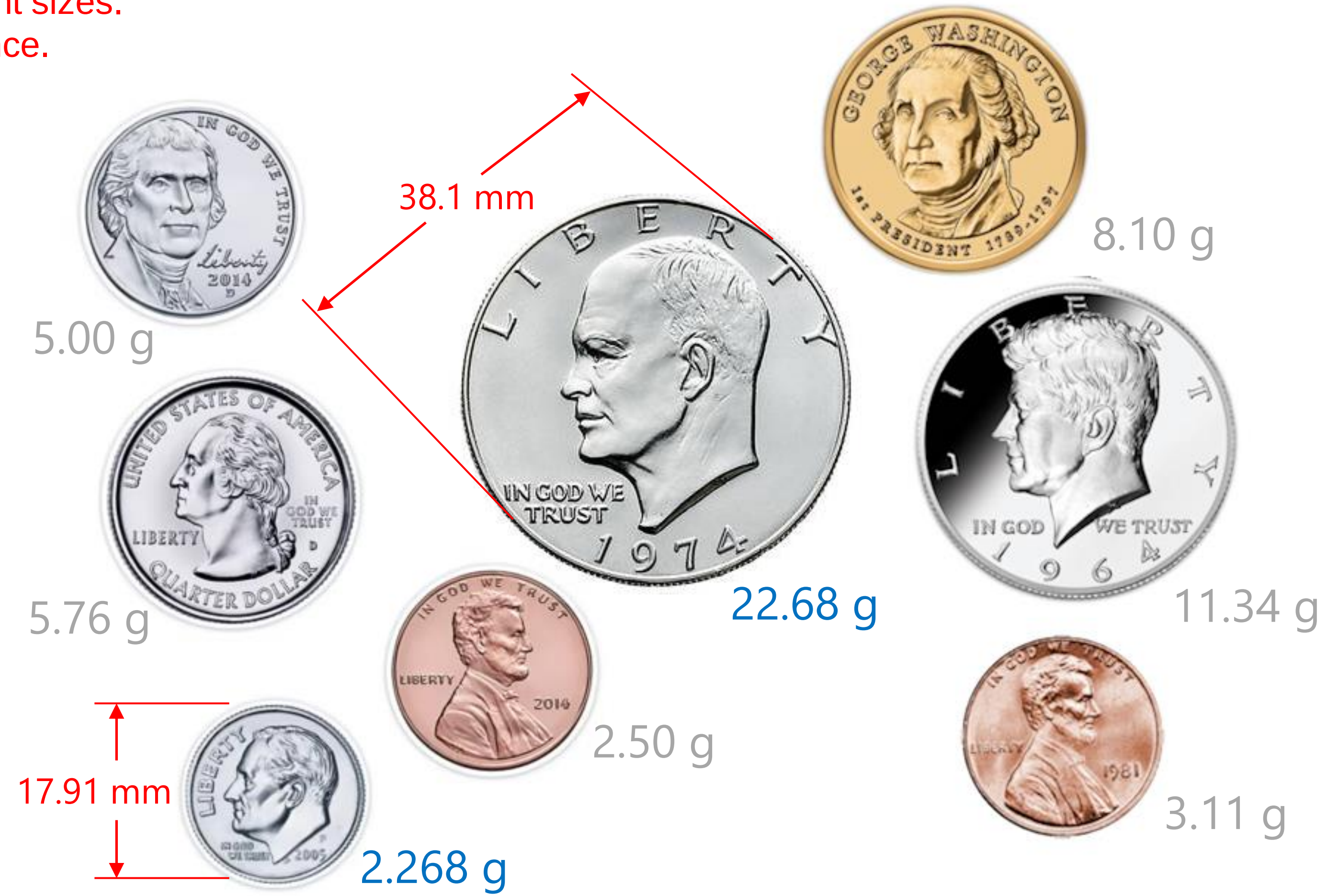
Dimes weigh 2.268 g

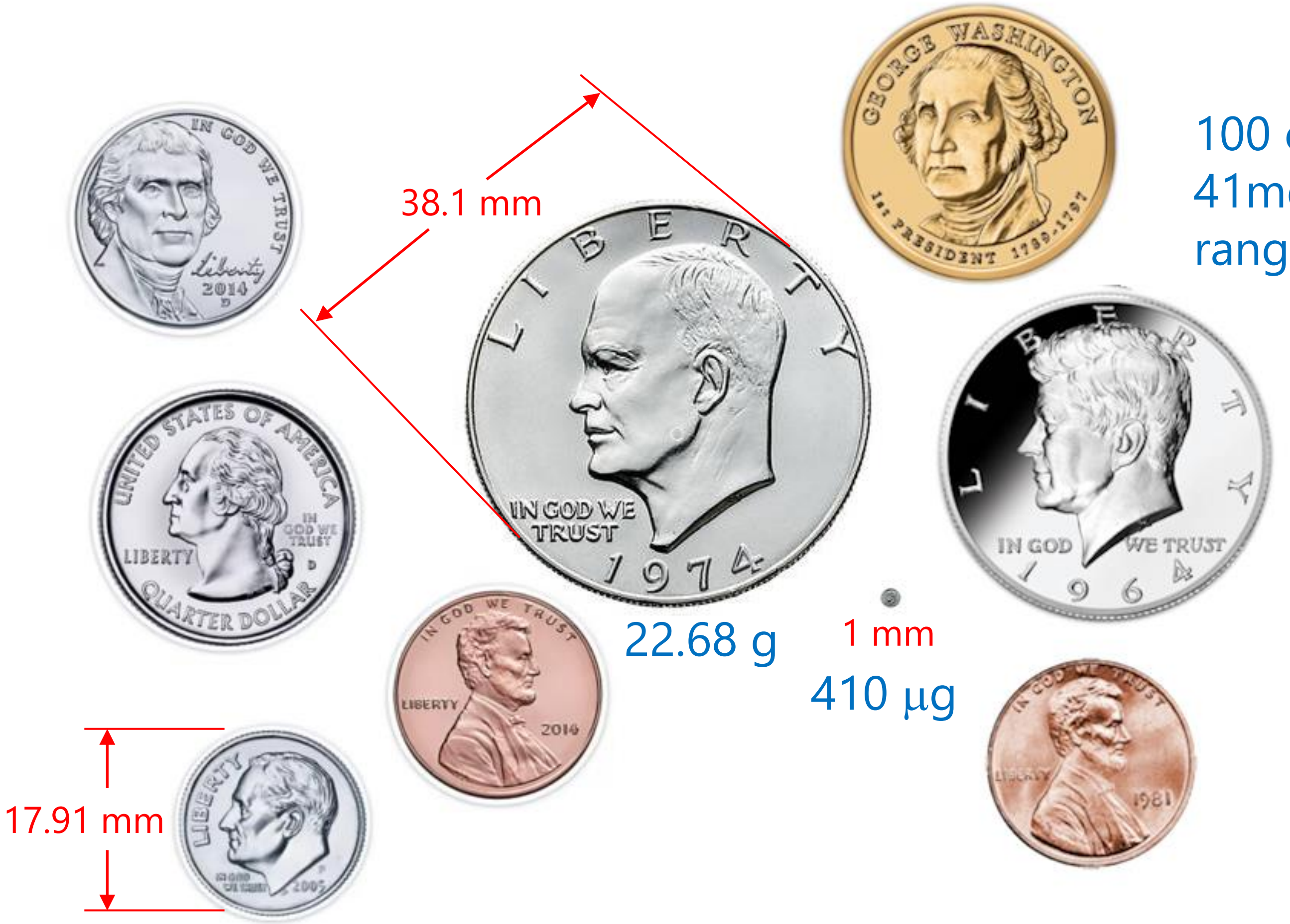
Diameter is 17.91 mm

dimes weigh 2.268 g

Coins of last 50 years
Pennies changed weight in 1982.

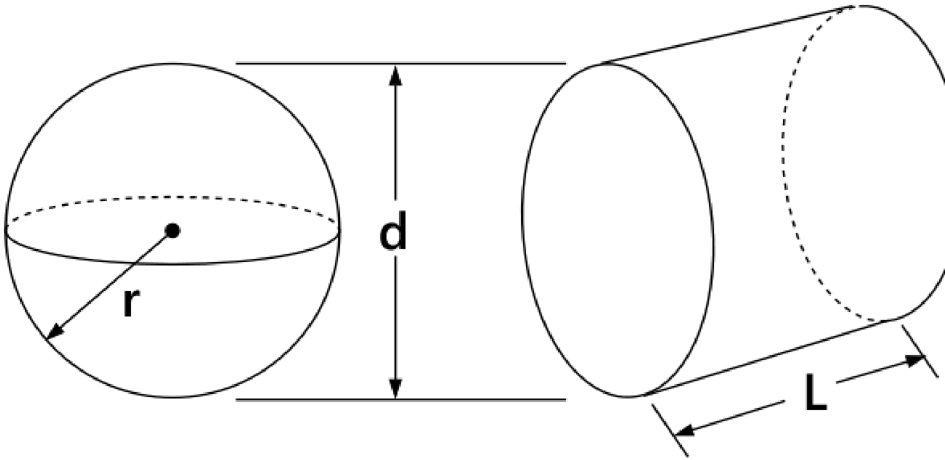
Only 8 different sizes.
2.13X difference.





100 coins:
41mg – 2.268 kg
range = ~55,000

GUESSING PARTICLE MASS



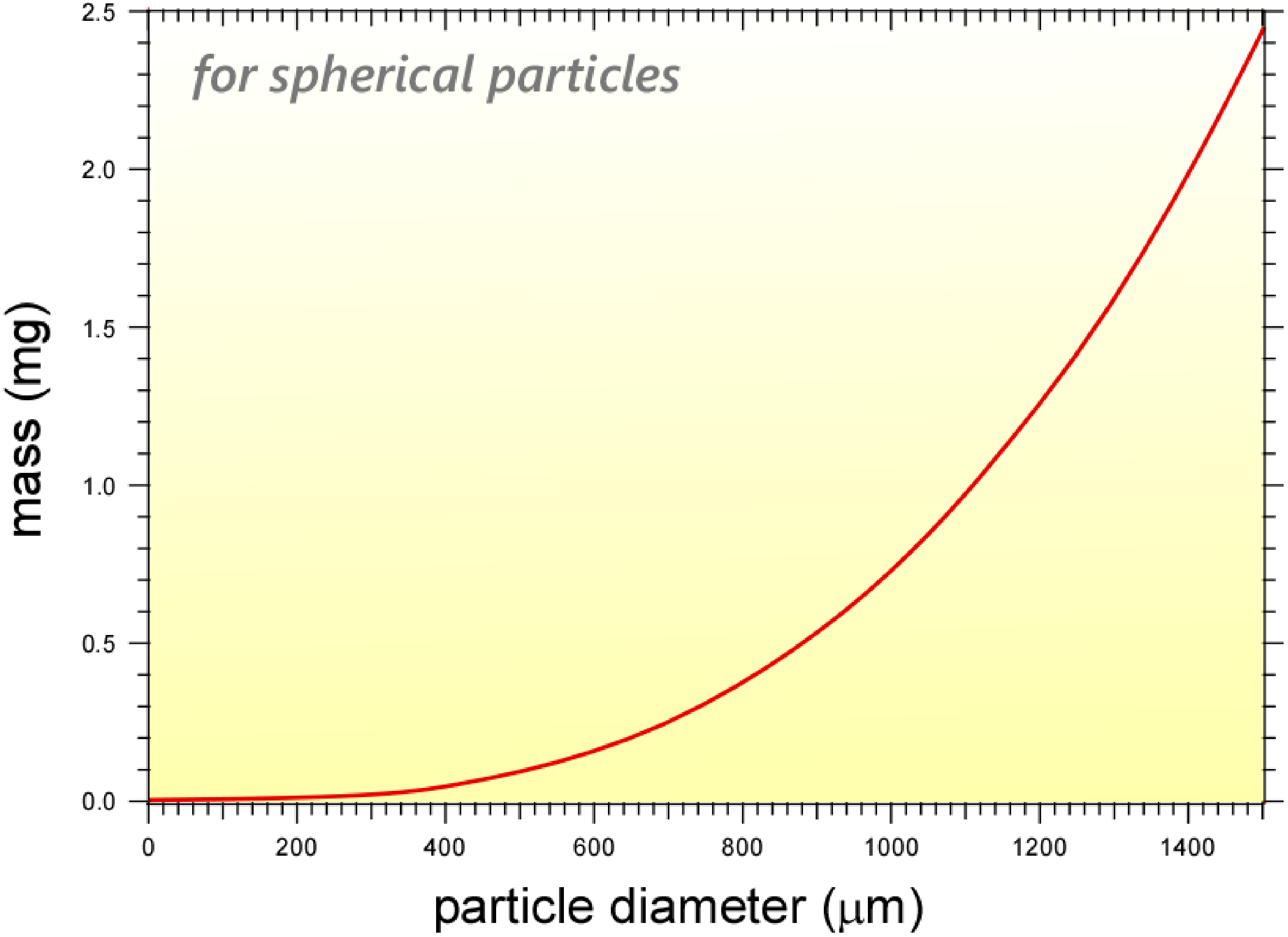
$$m = \rho V = \frac{\pi \rho d^3}{6}$$

$$m = \frac{\pi \rho d^2 L}{4}$$

$$\text{let } A = \frac{L}{d}$$

$$m = \frac{\pi \rho d^3 A}{4}$$

polymer	density(g/cc)
PE	0.92-0.97
PP	0.88-0.91
PET	1.30-1.40


for spherical particles
mass (mg)
0.0
0.5
1.0
1.5
2.0
2.5
0
200
400
600
800
1000
1200
1400
particle diameter (µm)

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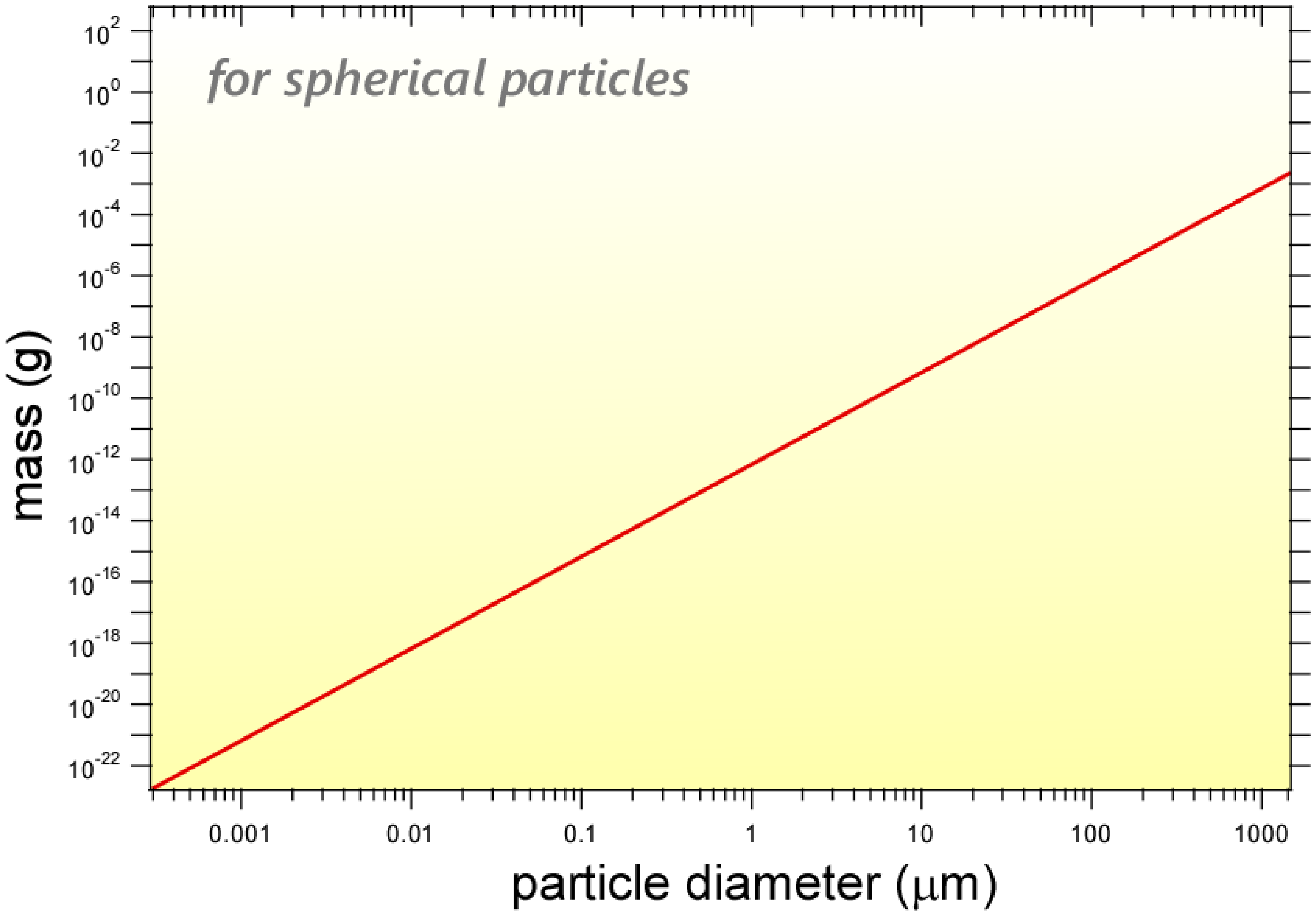
for spherical particles
mass (g)
10^{2}
10^{0}
10^{-2}
10^{-4}
10^{-6}
10^{-8}
10^{-10}
10^{-12}
10^{-14}
10^{-16}
10^{-18}
10^{-20}
10^{-22}
0.001
0.01
0.1
1
10
100
1000
particle diameter (μm)

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Journal of Hazardous Materials 404 (2021) 124004

Contents lists available at ScienceDirect

Journal of Hazardous Materials

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

Research paper

Estimation of the mass of microplastics ingested – A pivotal first step towards human health risk assessment

Kala Senathirajah [a], Simon Attwood [b], Geetika Bhagwat [c], Maddison Carbery [c], Scott Wilson [d], Thava Palanisami [a,*]

[a] Global Innovative Centre for Advanced Nanomaterials(GICAN), Faculty of Engineering and Built Environment, The University of Newcastle, Callaghan, NSW 2308, Australia
[b] The World Wide Fund for Nature (WWF), 354 Tanglin Road, Singapore, Singapore
[c] School of Environmental and Life Sciences, The University of Newcastle, Callaghan, NSW 2308, Australia
[d] Department of Environmental Science, Macquarie University, Sydney, Australia

ARTICLE INFO

Keywords:
Exposure pathways
Human health
Ingestion
Microplastics
Plastic pollution
Risk

ABSTRACT

The ubiquitous presence of microplastics in the food web has been established. However, the mass of microplastics exposure to humans is not defined, impeding the human health risk assessment. Our objectives were to extract the data from the available evidence on the number and mass of microplastics from various sources, to determine the uncertainties in the existing data, to set future research directions, and derive a global average rate of microplastic ingestion to assist in the development of human health risk assessments and effective management and policy options. To enable the comparison of microplastics exposure across a range of sources, data extraction and standardization was coupled with the adoption of conservative assumptions. Following the analysis of data from fifty-nine publications, an average mass for individual microplastics in the 0–1 mm size range was calculated. Subsequently, we estimated that globally on average, humans may ingest 0.1–5 g of microplastics weekly through various exposure pathways. This was the first attempt to transform microplastic counts into a mass value relevant to human toxicology. The determination of an ingestion rate is fundamental to assess the human health risks of microplastic ingestion. These findings will contribute to future human health risk assessment frameworks.

https://doi.org/10.1016/j.jhazmat.2020.124004

" humans may ingest 0.1-5 g of microplastics weekly through various exposure pathways "

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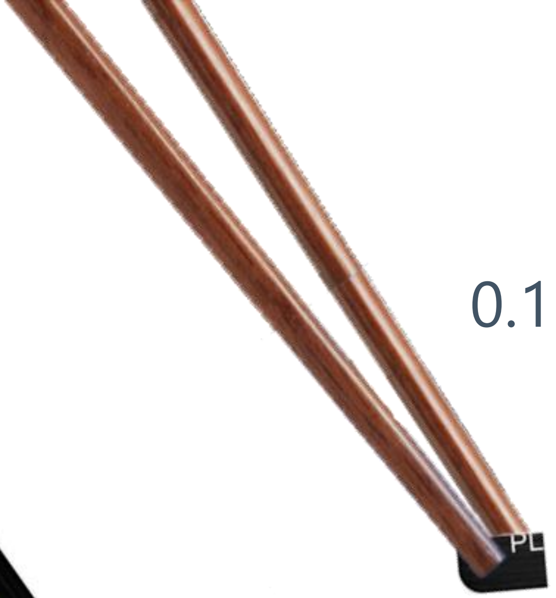
5 g



0.1 g

0.02 credit cards worth

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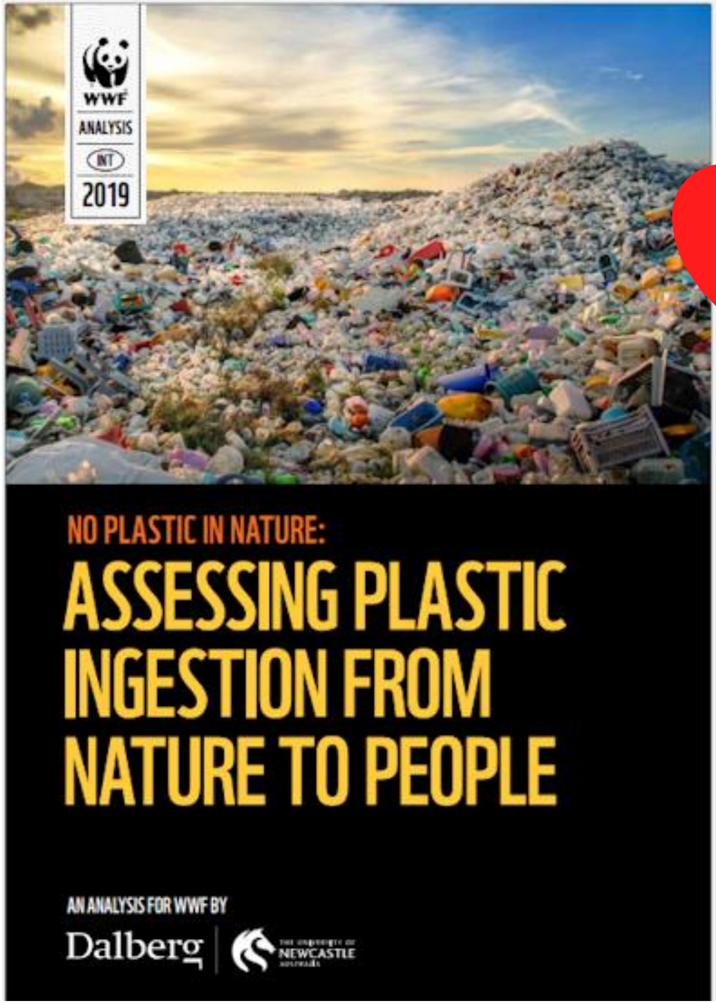

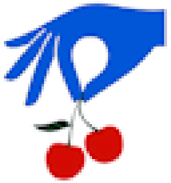

"an average person could be ingesting approximately 5 grams of plastic every week."

wwfint.awsassets.panda.org/downloads/plastic_ingestion_web_spreads.pdf

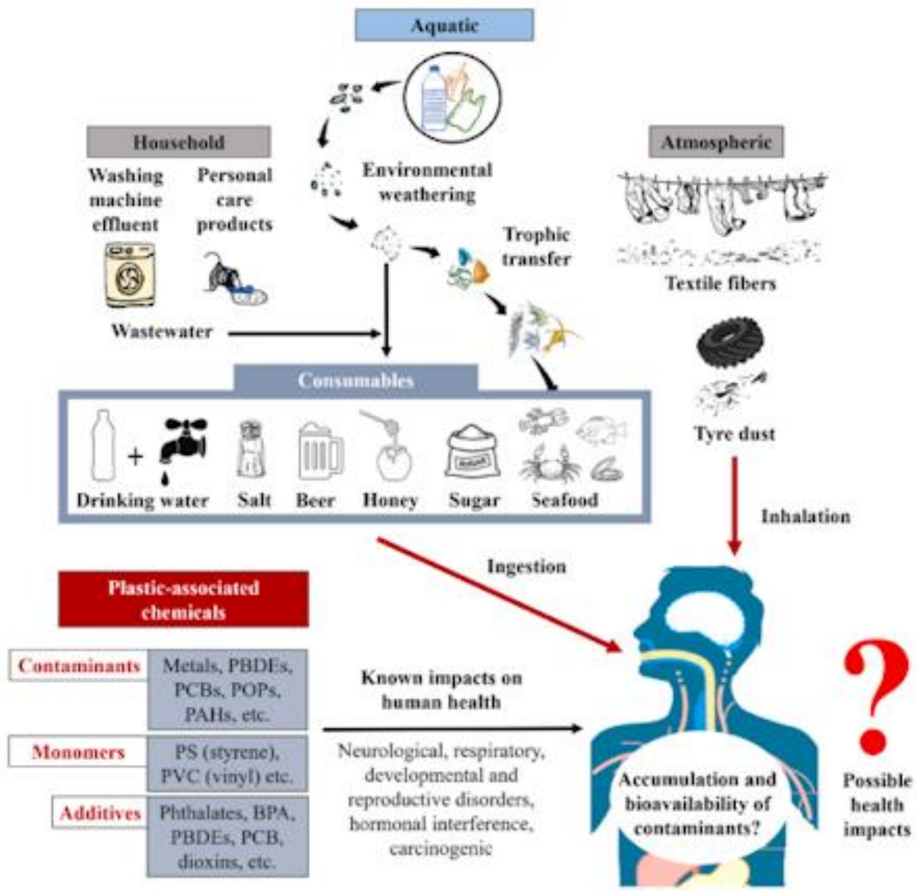

Fig. 1. Drivers for this study.

https://doi.org/10.1016/j.jhazmat.2020.124004

Table 6
Summary of the annual average number of microplastics (particles) ingested (particles), and global average rate of microplastics ingested (g) per person per year.

Source of particles	$ANMP_{ingested}$ (particles)	GARMI (0–1 mm) Scenario 1 (g)	GARMI (0–1 mm) Scenario 2 (g)	GARMI (0–1 mm) Scenario 3 (g)
Shellfish	9,445	26.4	0.0	0.0
Salt	565	1.6	7.4	14.2
Beer	523	1.46	0.3	0.5
Drinking water	91,994	257.5	0.0	0.0
Total (per year)	**102,527**	**287.0**	**7.7**	**14.7**
TOTAL (PER WEEK)	*1,972*	*5.5*	*0.1*	*0.3*

https://doi.org/10.1016/j.jhazmat.2020.124004

Environmental Science & Technology

pubs.acs.org/est

Article

Lifetime Accumulation of Microplastic in Children and Adults

Nur Hazimah Mohamed Nor,* Merel Kooi, Noël J. Diepens, and Albert A. Koelmans

Cite This: *Environ. Sci. Technol.* 2021, 55, 5084−5096

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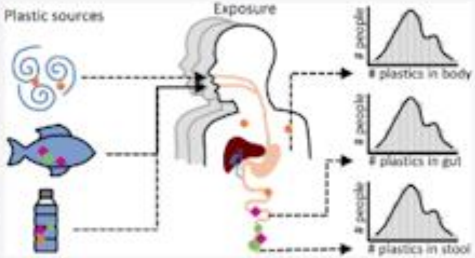
ABSTRACT: Human exposure to microplastic is recognized as a global problem, but the uncertainty, variability, and lifetime accumulation are unresolved. We provide a probabilistic lifetime exposure model for children and adults, which accounts for intake via eight food types and inhalation, intestinal absorption, biliary excretion, and plastic-associated chemical exposure via a physiologically based pharmacokinetic submodel. The model probabilistically simulates microplastic concentrations in the gut, body tissue, and stool, the latter allowing validation against empirical data. Rescaling methods were used to ensure comparability between microplastic abundance data. Microplastic (1−5000 μm) median intake rates are 553 particles/capita/day (184 ng/capita/day) and 883 particles/capita/day (583 ng/capita/day) for children and adults, respectively. This intake can irreversibly accumulate to 8.32×10^3 (90% CI, 7.08×10^2–1.91×10^6) particles/capita or 6.4 (90% CI, 0.1–2.31×10^3) ng/capita for children until age 18, and up to 5.01×10^4 (90% CI, 5.25×10^3–9.33×10^6) particles/capita or 40.7 (90% CI, 0.8–9.85×10^3) ng/capita for adults until age 70 in the body tissue for 1−10 μm particles. Simulated microplastic concentrations in stool agree with empirical data. Chemical absorption from food and ingested microplastic of the nine intake media based on biphasic, reversible, and size-specific sorption kinetics, reveals that the contribution of microplastics to total chemical intake is small. The as-yet-unknown contributions of other food types are discussed in light of future research needs.



“

883 particles per person per day

583 ng/person/day

”

https://pubs.acs.org/doi/full/10.1021/acs.est.0c07384

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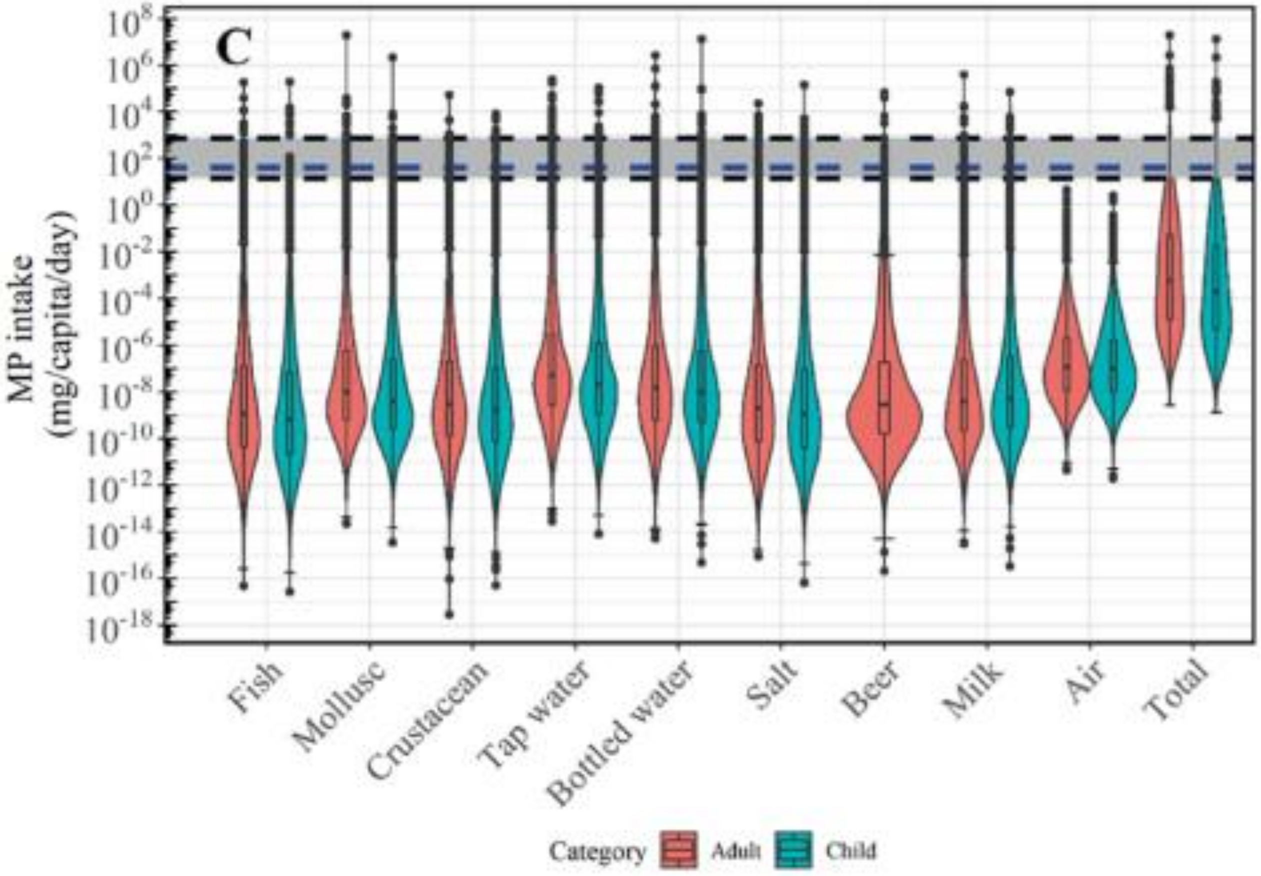

https://pubs.acs.org/doi/full/10.1021/acs.est.0c07384

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Bert Koelmans makes point that a week’s ingestion is like a grain of salt between chopsticks – mere micrograms.

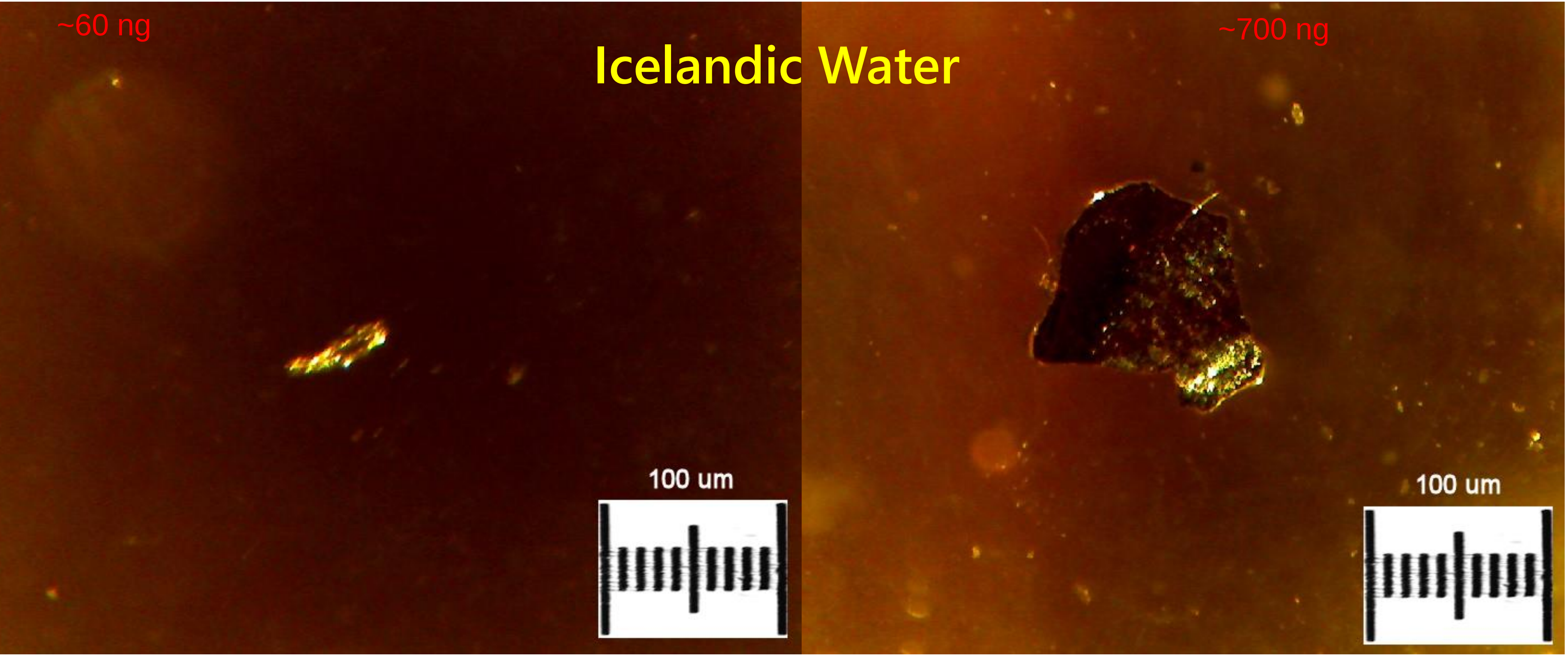
Plastic microparticles, 0.65 grams consisting of 523 particles, in a liter of water equaling the concentration in order to ingest 5 grams per week. Such a high concentration is easily seen both in water and upon drying. The particles are cut from 1.5 mm plastic monofilament.

iPhone Video

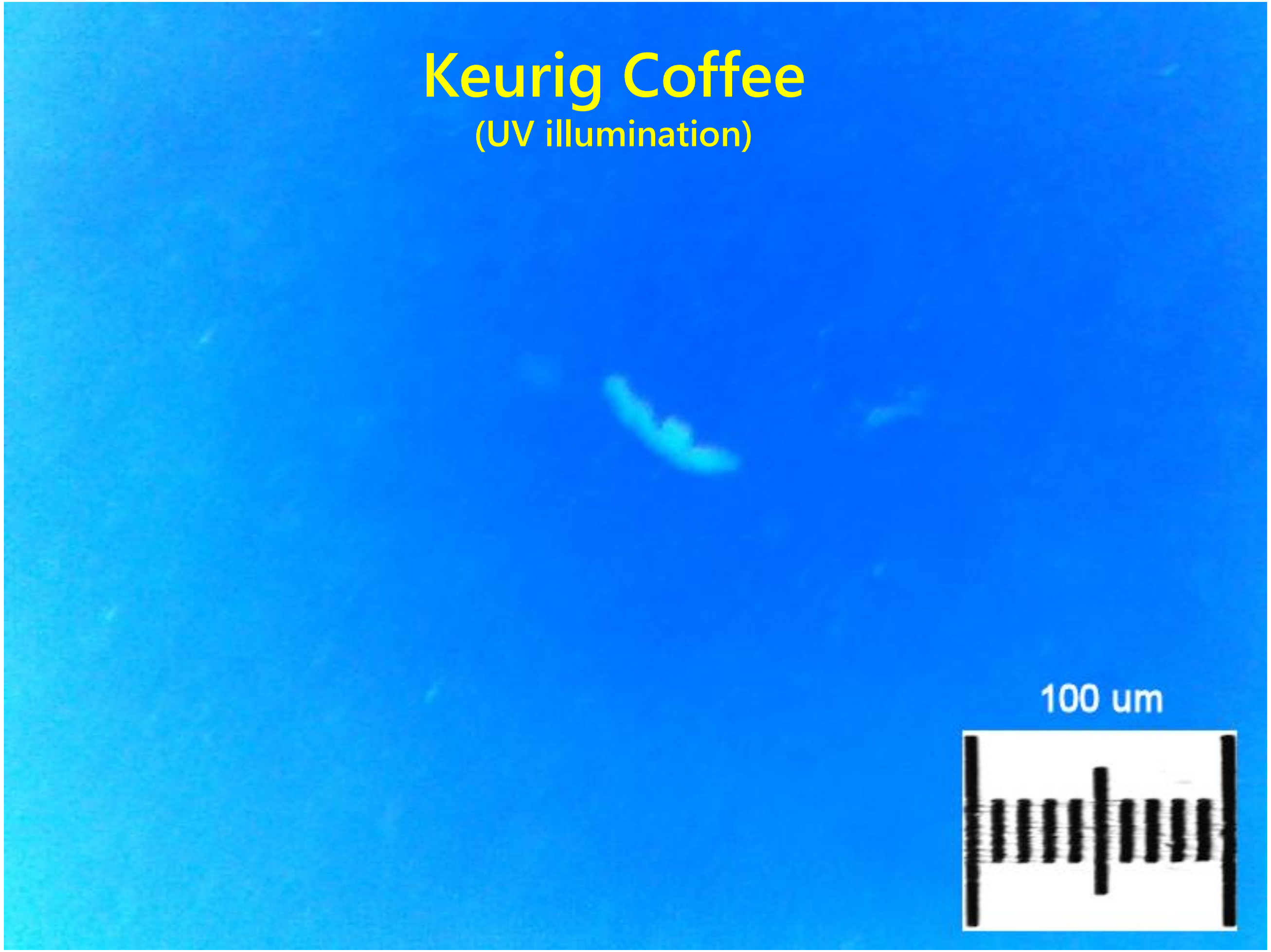
of

Unopened Water Bottles

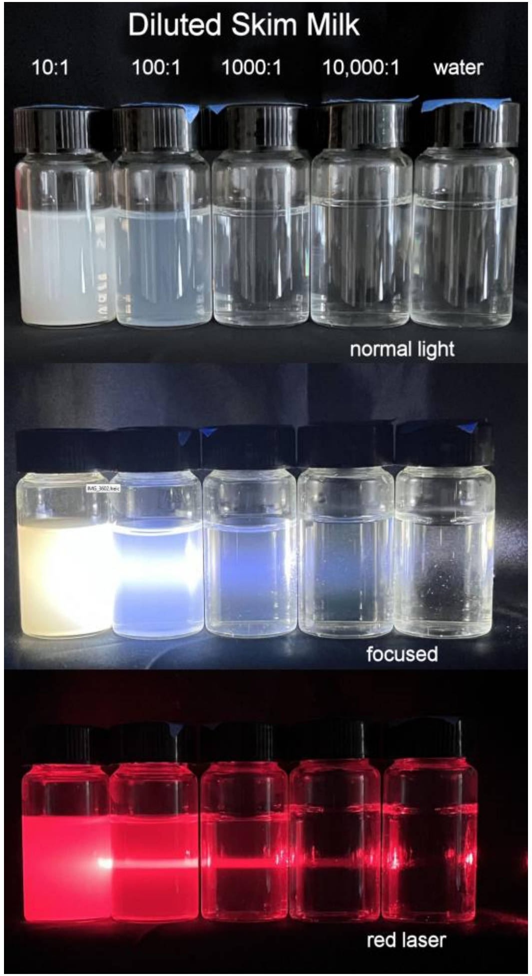
Icelandic Water



Keurig Coffee
(UV illumination)



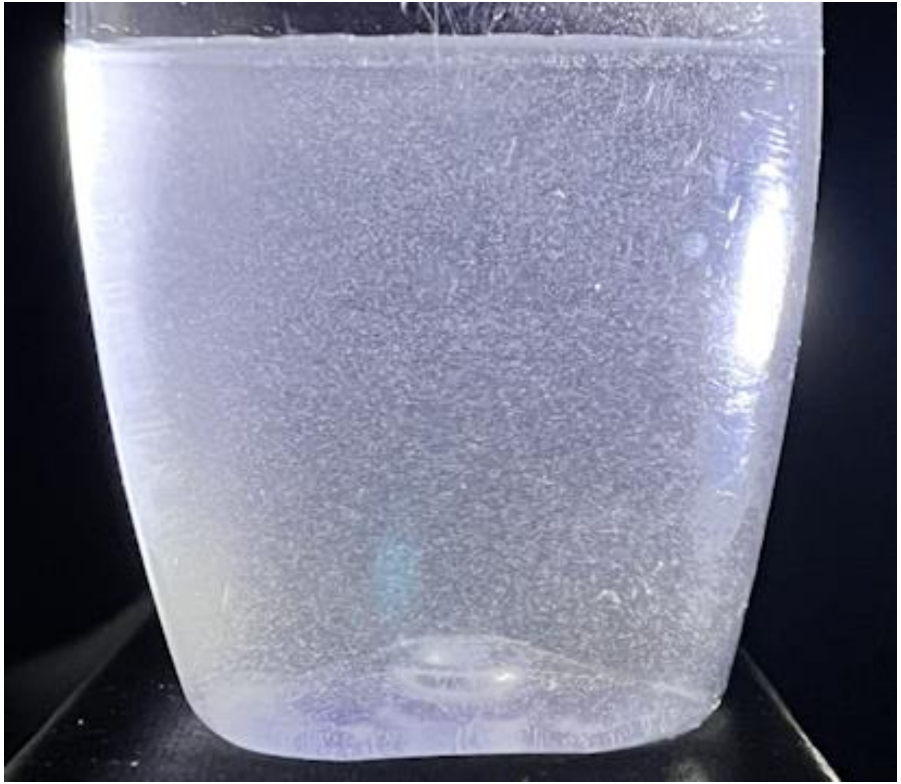
skim milk ~3.5%
whey particles



10,000 dilution still visible

350μg/L


½″



~0.17 g/L 200 mesh

10 particles in 5 mL

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Exposure and Health (2023) 15:33–51
https://doi.org/10.1007/s12403-022-00470-8

REVIEW PAPER

To Waste or Not to Waste: Questioning Potential Health Risks of Micro- and Nanoplastics with a Focus on Their Ingestion and Potential Carcinogenicity

Elisabeth S. Gruber[1] · Vanessa Stadlbauer[2,3] · Verena Pichler[4] · Katharina Resch-Fauster[5] · Andrea Todorovic[5] · Thomas C. Meisel[6] · Sibylle Trawoeger[7] · Oldamur Hollóczki[8] · Suzanne D. Turner[9,10] · Wolfgang Wadsak[3,11] · A. Dick Vethaak[12,13] · Lukas Kenner[3,14,15,16]

Received: 8 October 2021 / Revised: 30 December 2021 / Accepted: 11 February 2022 / Published online: 22 March 2022

Abstract
Micro- and nanoplastics (MNPs) are recognized as emerging contaminants, especially in food, with unknown health significance. MNPs passing through the gastrointestinal tract have been brought in context with disruption of the gut microbiome. Several molecular mechanisms have been described to facilitate tissue uptake of MNPs, which then are involved in local inflammatory and immune responses. Furthermore, MNPs can act as potential transporters ("vectors") of contaminants and as chemosensitizers for toxic substances ("Trojan Horse effect"). In this review, we summarize current multidisciplinary knowledge of ingested MNPs and their potential adverse health effects. We discuss new insights into analytical and molecular modeling tools to help us better understand the local deposition and uptake of MNPs that might drive carcinogenic signaling. We present bioethical insights to basically re-consider the "culture of consumerism." Finally, we map out prominent research questions in accordance with the Sustainable Development Goals of the United Nations.

Keywords Microplastic · Nanoplastic · Carcinogenesis · Human health · Bioethics issue

"Translated into more imaginable numbers, on average we ingest five grams of MPs per week per person (roughly corresponding to the mass of a credit card)."

https://link.springer.com/article/10.1007/s12403-022-00470-8

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Menu

Health risk due to micro- and nanoplastics in food

Home › About us › News › 2022 › Health risk due to micro- and nanoplastics in food

‹ All News

2022-03-24 – MEDICINE & SCIENCE

(Vienna, 24-03-2022) Five grams of plastic particles on average enter the human gastrointestinal tract per person

www.meduniwien.ac.at/web/en/ueber-uns/news/default-0f889c8985-1/gesundheitsrisiko-durch-mikro-und-nanoplastik-in-lebensmitteln/

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Science News *from research organizations*

Health risk due to micro- and nanoplastics in food

Date: March 24, 2022

Source: Medical University of Vienna

Summary: Five grams of plastic particles on average enter the human gastrointestinal tract per person per week. This is roughly equivalent to the weight of a credit card. Whether ingested micro- and nanoplastics pose a health risk is being investigated in numerous studies but is largely unknown to date. A research team has now summarized the current state of scientific knowledge.

www.sciencedaily.com/releases/2022/03/220324130253.htm

NEW YORK POST

READ THE LATEST ON Page Six

HEALTH

You're eating a credit card's worth of plastic a week — and it's killing your gut

By Brooke Kato

Published March 30, 2022 | Updated March 30, 2022, 4:47 p.m. ET

nypost.com/2022/03/30/youre-eating-a-credit-cards-worth-of-plastic-a-week-and-its-killing-your-gut/

Junk Food and Tainted Water: People Ingest a Credit Card Worth of Nanoplastics Weekly, Study Says

Mar 31, 2022 at 5:09 PM EDT

Bottled water or tap?

How you answer that question could have some major implications for your long-term health, a new study into the health effects of ingested plastic particles shows.

That study also contained this startling fact: People are eating the equivalent of one plastic credit card every week in their diet. The plastic particles enter the human food chain through plastic waste contained in fish, sea salt and drinking water, the study shows.

Scientists say such nanoplastics disrupt the human gut bacteria and can lead to killer diseases like cancer and diabetes.

www.newsweek.com/junk-food-tainted-water-people-ingest-credit-card-worth-nanoplastics-weekly-study-says-1693970

TastingTable. RECIPES NEWS EXCLUSIVES RESTAURANTS COOK DRINK

COOK

You Probably Eat A Credit Card's Worth Of Plastic Every Week

BY GILLIE HOUSTON / UPDATED: OCT. 19, 2022 6:53 PM EST

www.tastingtable.com/1062298/you-probably-eat-a-credit-cards-worth-of-plastic-every-week/

Journal of Hazardous Materials Letters 3 (2022) 100071

Contents lists available at ScienceDirect

Journal of Hazardous Materials Letters

journal homepage: www.sciencedirect.com/journal/journal-of-hazardous-materials-letters

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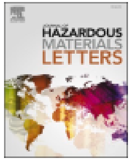

Ingested microplastics: Do humans eat one credit card per week?

Martin Pletz

Designing Plastics and Composite Materials, Department of Polymer Engineering and Science, Montanuniversitaet Leoben, Austria

ARTICLE INFO

Keywords:
Microplastics
Size distribution
Ingestion
Human health

ABSTRACT

Ingested Microplastic (MP) particles can harm the human body. Estimations of the total mass of ingested MP particles correspond to 50 plastic bags per year (Bai et al., 2022), one credit card per week (Gruber et al., 2022), or a median value of 4.1 µg/week for adults (Mohamed Nor et al., 2021). The first two estimations are based on an analysis (Senathirajah et al., 2021) that predicts a total ingested mass of MP particles $m_{I,MP}$ of 0.1–5 g/week. This work revisits and evaluates this calculation and compares its results and methods to Mohamed Nor et al. (2021). Senathirajah combines data of averaged MP particle masses $\bar{m}_{MP}$ from papers that reported MP particle sizes and MP particle counts n_{MP} in shellfish, salt, beer, and water based on other papers that detected MP particles. Combined with the estimated weekly consumption of those consumables, they compute $m_{I,MP}$. This work raises some serious issues of Senathirajah in the way they combine data and they obtained particle sizes. It concludes that Senathirajah overestimates $m_{I,MP}$ by several orders of magnitude and that $m_{I,MP}$ can be considered as a rather irrelevant factor for the toxic effects of MP particles on the human body.

> a human eats a credit card worth of MPs not every week but every 23 thousand years.

https://www.sciencedirect.com/science/article/pii/S2666911022000247?via%3Dihub

Chapter 10

Emerging Aquatic Contaminants

One Health Framework for Risk Assessment and Remediation in the Post COVID-19 Anthropocene

Book • 2023

Sources, consequences, and control of nanoparticles and microplastics in the environment

A. Guhananthan[a], Aswin Kuttykattil[b], Thavamani Palanisami[b] and Selvakumar Rajendran[a,b]

[a] *Department of Nanobiotechnology, PSG Institute of Advanced Studies, Coimbatore, Tamil Nadu, India,* [b] *Environmental Plastic and Innovation Cluster (EPIC), Global Innovation Centre for Advanced Nanomaterials (GICAN), University of Newcastle, Callaghan, NSW, Australia*

10.1 Introduction

Nanoparticles (NP) and microplastics (MPs) are the most recent anthropogenic contaminants which pose threat to the environment and health. Both NPs and MPs from various sources interact with water, air, and soil in a complex way affecting aquatic and terrestrial ecosystems (Fred-Ahmadu et al., 2020). Their bioaccumulation leads to, cytotoxicity, genotoxicity, organ failure, and sometimes death in living organisms. Nanoparticles can be classified into different types based on their origin (natural nanoparticles (NNPs) and engineered nanoparticles (ENPs)), dimension, size, and chemical composition (Ealia and Saravanakumar, 2017). Fig. 10.1 illustrates various sources of nanoparticles.

“Senathirajah and Palanisami (2019) estimated that on average, humans may consume 5 g of MPs per week”

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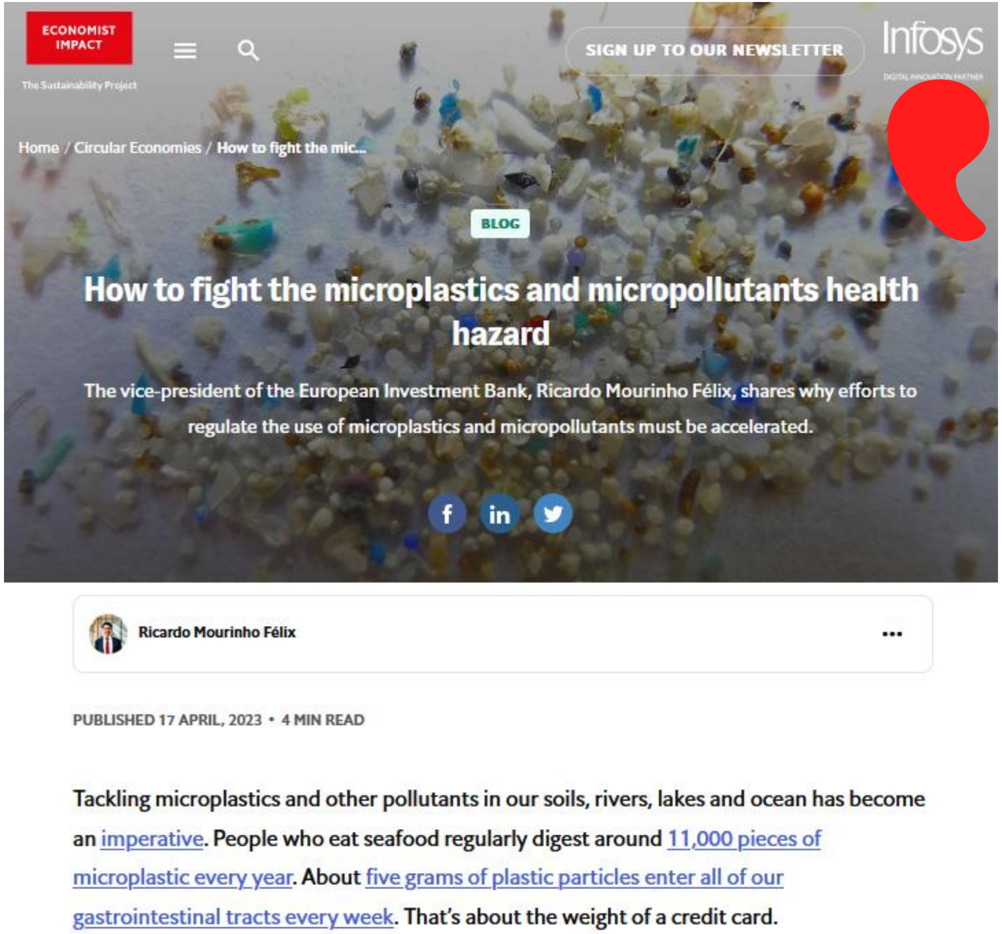
ECONOMIST IMPACT

The Sustainability Project

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BLOG

How to fight the microplastics and micropollutants health hazard

The vice-president of the European Investment Bank, Ricardo Mourinho Félix, shares why efforts to regulate the use of microplastics and micropollutants must be accelerated.

Ricardo Mourinho Félix

PUBLISHED 17 APRIL, 2023 • 4 MIN READ

Tackling microplastics and other pollutants in our soils, rivers, lakes and ocean has become an imperative. People who eat seafood regularly digest around 11,000 pieces of microplastic every year. About five grams of plastic particles enter all of our gastrointestinal tracts every week. That's about the weight of a credit card.

impact.economist.com/sustainability/circular-economies/how-to-fight-the-microplastics-and-micropollutants-health-hazard

"About five grams of plastic particles enter all of our gastrointestinal tracts every week."

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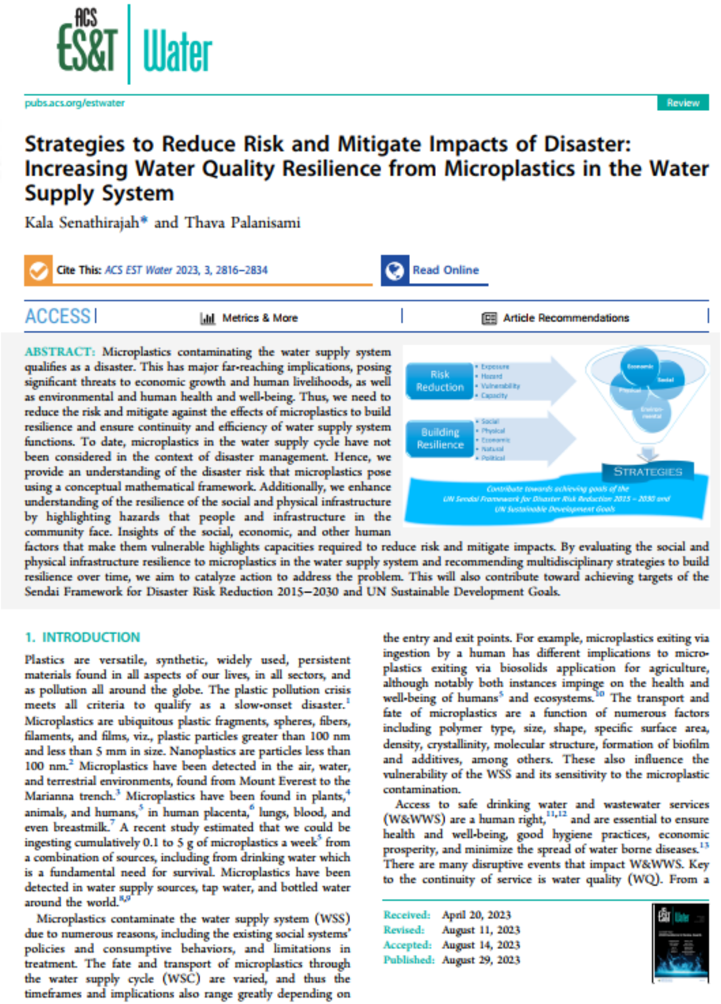

ACS ES&T Water

pubs.acs.org/estwater — Review

Strategies to Reduce Risk and Mitigate Impacts of Disaster: Increasing Water Quality Resilience from Microplastics in the Water Supply System

Kala Senathirajah* and Thava Palanisami

Cite This: *ACS EST Water* 2023, 3, 2816−2834 — Read Online

ACCESS | Metrics & More | Article Recommendations

ABSTRACT: Microplastics contaminating the water supply system qualifies as a disaster. This has major far-reaching implications, posing significant threats to economic growth and human livelihoods, as well as environmental and human health and well-being. Thus, we need to reduce the risk and mitigate against the effects of microplastics to build resilience and ensure continuity and efficiency of water supply system functions. To date, microplastics in the water supply cycle have not been considered in the context of disaster management. Hence, we provide an understanding of the disaster risk that microplastics pose using a conceptual mathematical framework. Additionally, we enhance understanding of the resilience of the social and physical infrastructure by highlighting hazards that people and infrastructure in the community face. Insights of the social, economic, and other human factors that make them vulnerable highlights capacities required to reduce risk and mitigate impacts. By evaluating the social and physical infrastructure resilience to microplastics in the water supply system and recommending multidisciplinary strategies to build resilience over time, we aim to catalyze action to address the problem. This will also contribute toward achieving targets of the Sendai Framework for Disaster Risk Reduction 2015−2030 and UN Sustainable Development Goals.

Risk Reduction: Exposure, Hazard, Vulnerability, Capacity
Building Resilience: Social, Physical, Economic, Natural, Political
STRATEGIES
Contribute towards achieving goals of the UN Sendai Framework for Disaster Risk Reduction 2015 – 2030 and UN Sustainable Development Goals

1. INTRODUCTION

Plastics are versatile, synthetic, widely used, persistent materials found in all aspects of our lives, in all sectors, and as pollution all around the globe. The plastic pollution crisis meets all criteria to qualify as a slow-onset disaster.[1] Microplastics are ubiquitous plastic fragments, spheres, fibers, filaments, and films, viz., plastic particles greater than 100 nm and less than 5 mm in size. Nanoplastics are particles less than 100 nm.[2] Microplastics have been detected in the air, water, and terrestrial environments, found from Mount Everest to the Marianna trench.[3] Microplastics have been found in plants,[4] animals, and humans,[5] in human placenta,[6] lungs, blood, and even breastmilk.[7] A recent study estimated that we could be ingesting cumulatively 0.1 to 5 g of microplastics a week[5] from a combination of sources, including from drinking water which is a fundamental need for survival. Microplastics have been detected in water supply sources, tap water, and bottled water around the world.[8,9]

Microplastics contaminate the water supply system (WSS) due to numerous reasons, including the existing social systems' policies and consumptive behaviors, and limitations in treatment. The fate and transport of microplastics through the water supply cycle (WSC) are varied, and thus the timeframes and implications also range greatly depending on the entry and exit points. For example, microplastics exiting via ingestion by a human has different implications to microplastics exiting via biosolids application for agriculture, although notably both instances impinge on the health and well-being of humans[5] and ecosystems.[10] The transport and fate of microplastics are a function of numerous factors including polymer type, size, shape, specific surface area, density, crystallinity, molecular structure, formation of biofilm and additives, among others. These also influence the vulnerability of the WSS and its sensitivity to the microplastic contamination.

Access to safe drinking water and wastewater services (W&WWS) are a human right,[11,12] and are essential to ensure health and well-being, good hygiene practices, economic prosperity, and minimize the spread of water borne diseases.[13] There are many disruptive events that impact W&WWS. Key to the continuity of service is water quality (WQ). From a

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A recent study estimated that we could be ingesting cumulatively 0.1 to 5 g of microplastics a week

https://pubs.acs.org/doi/abs/10.1021/acsestwater.3c00206

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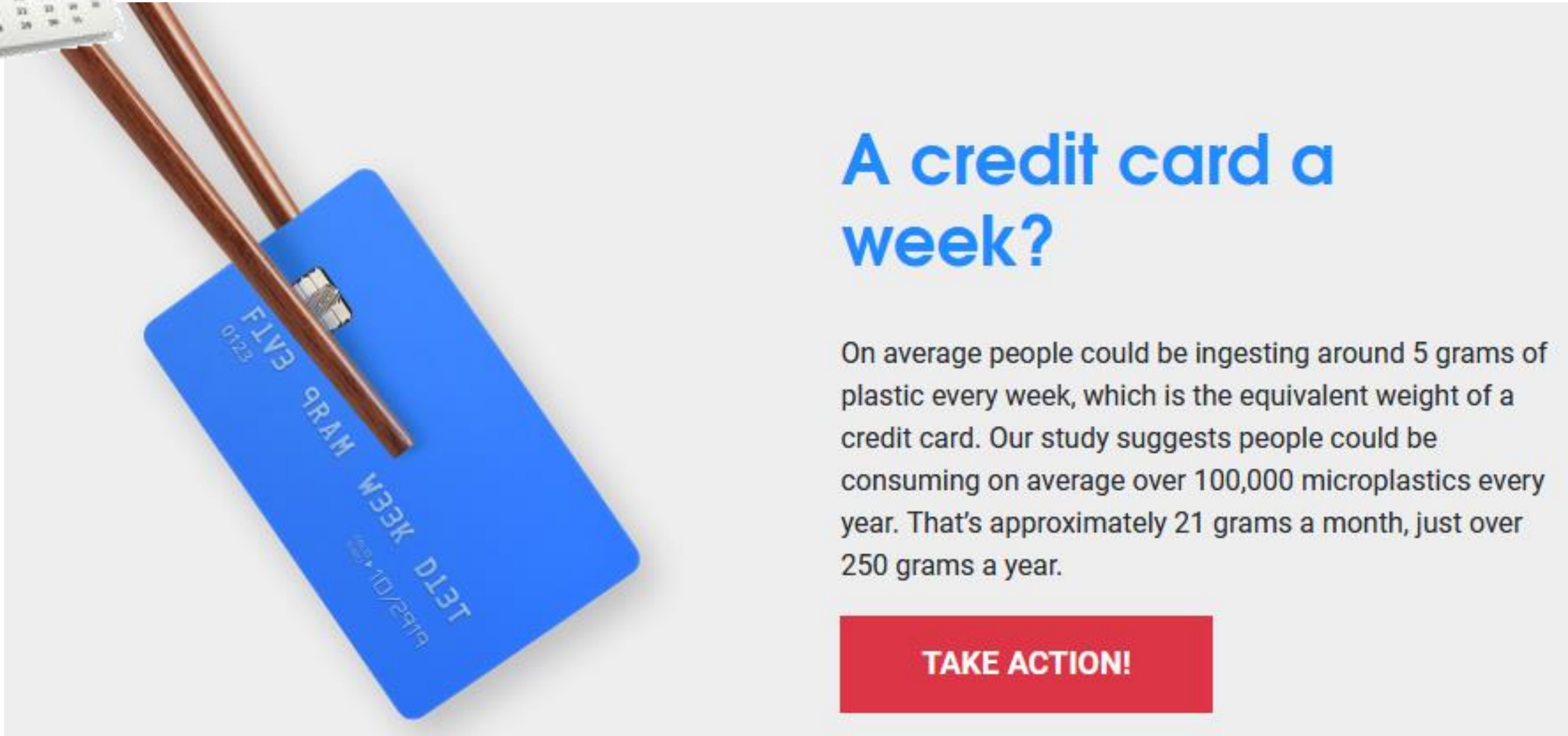
https://yourplasticdiet.org/



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Does it matter that 5 grams per week is wrong?

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Research paper

Estimation of the mass of microplastics ingested – A pivotal first step towards human health risk assessment

Kala Senathirajah [a], Simon Attwood [b], Geetika Bhagwat [c], Maddison Carbery [c], Scott Wilson [d], Thava Palanisami [a,*]

[a] *Global Innovative Centre for Advanced Nanomaterials(GICAN), Faculty of Engineering and Built Environment, The University of Newcastle, Callaghan, NSW 2308, Australia*

[b] *The World Wide Fund for Nature (WWF), 354 Tanglin Road, Singapore, Singapore*

[c] *School of Environmental and Life Sciences, The University of Newcastle, Callaghan, NSW 2308, Australia*

[d] *Department of Environmental Science, Macquarie University, Sydney, Australia*

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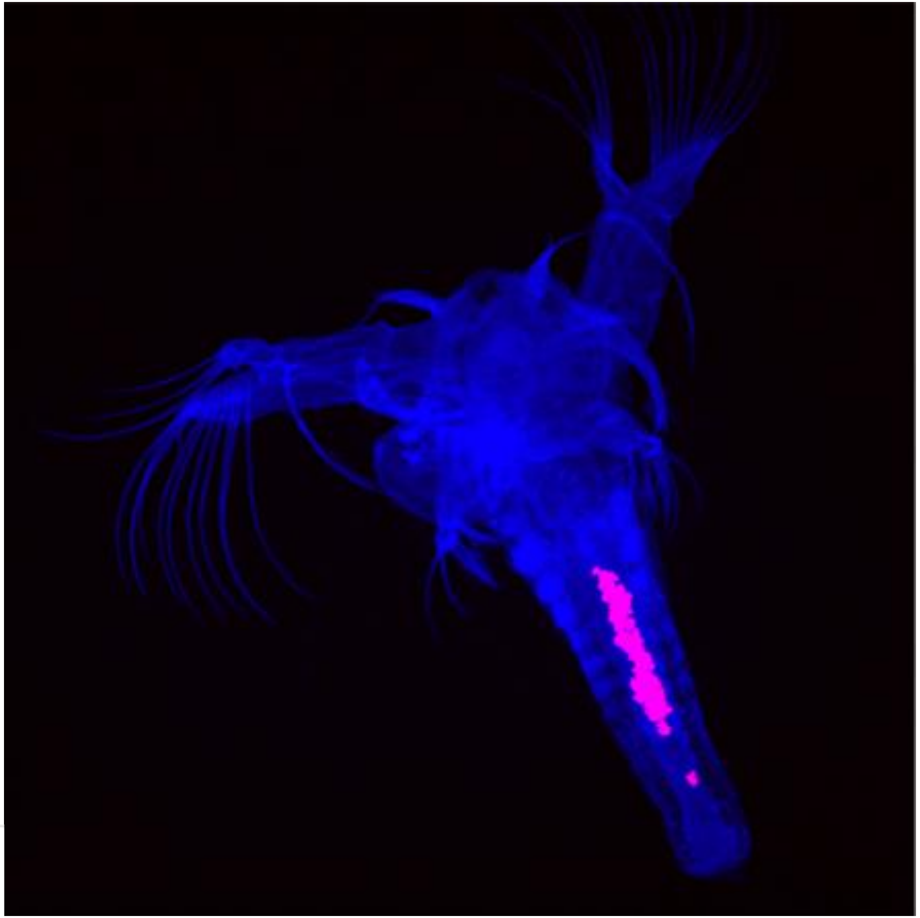


Figure 6. Image of polyurethane microplastics (<53μm) ingested by brine shrimp nauplii (Artemia sp., length ~500μm). Microplastics were present at a concentration of 100 mg/L. Fluorescent microplastics (pink) are evident at a high density within the shrimp's digestive tract. These were egested within 48 hr after cessation of exposure. *Some of the additives within the microplastics likely leached out of the plastic during its residence in the digestive tract and exposure water (see Figure 8).* Imaged on an OlympusFV1200 laser scanning confocal microscope. Credit: Hamish Small (VIMS) and Virginia Worrell (Virginia Governor's School).

Hale, Robert C., Meredith E. Seeley, Mark J. La Guardia, Lei Mai, and Eddy Y. Zeng. "A global perspective on microplastics." Journal of Geophysical Research: Oceans 125, no. 1 (2020): e2018JC014719. https://doi.org/10.1029/2018JC014719

Streamed live on Apr 28, 2022

California Attorney General Rob Bonta makes a major announcement on the California Department of Justice’s efforts to protect the environment from plastic pollution.

https://www.youtube.com/watch?v=fhaURS9U04s

The New York Times

Researchers don’t have strong evidence yet for how these particles affect our health.

https://www.nytimes.com/2024/01/11/well/live/bottled-water-nanoplastics.html

The Washington Post

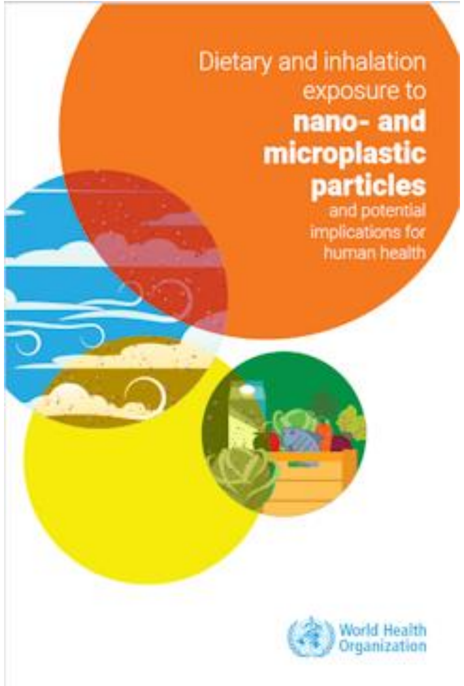
Researchers don’t yet know how dangerous tiny plastics are for human health.

https://www.washingtonpost.com/climate-environment/2024/01/08/microplastics-nanoplastics-bottled-water-study/

IBWA

There currently is both a lack of standardized methods and no scientific consensus on the potential health impacts of nano- and microplastic particles. Therefore, media reports about these particles in drinking water do nothing more than unnecessarily scare consumers.

https://bottledwater.org/nr/ibwa-responds-to-new-nanoparticle-imaging-study/



The weight of the scientific evidence provided by current data on adverse effects of NMP on human health is low,

https://iris.who.int/bitstream/handle/10665/362049/9789240054608-eng.pdf

Green | Greener Living

Bottled Water Contains More Plastic Particles Than Previously Thought

Researchers found hundreds of thousands of plastic particles in one-liter bottles of water sold in the US, 90% of them small enough to enter the human bloodstream.

https://www.bloomberg.com/news/articles/2024-01-08/bottled-water-contains-previously-undetected-nanoplastics

U.S. ›

Bottled water contains up to 100 times more plastic than previously estimated, new study says

By Aliza Chasan
Updated on: January 9, 2024 / 7:52 PM EST / CBS News

PNAS RESEARCH ARTICLE | CHEMISTRY ENVIRONMENTAL SCIENCES OPEN ACCESS

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Rapid single-particle chemical imaging of nanoplastics by SRS microscopy

Naixin Qian[a], Xin Gao[a], Xiaoqi Lang[a], Huiping Deng[b], Teodora Maria Bratu[b], Qixuan Chen[c], Phoebe Stapleton[d], Beizhan Yan[b,1], and Wei Min[a,e,1]

Edited by Eric O. Potma, University of California, Irvine, CA; received January 11, 2023; accepted October 24, 2023 by Editorial Board Member Shaul Mukamel

Plastics are now omnipresent in our daily lives. The existence of microplastics (1 µm to 5 mm in length) and possibly even nanoplastics (<1 µm) has recently raised health concerns. In particular, nanoplastics are believed to be more toxic since their smaller size renders them much more amenable, compared to microplastics, to enter the human body. However, detecting nanoplastics imposes tremendous analytical challenges on both the nano-level sensitivity and the plastic-identifying specificity, leading to a knowledge gap in this mysterious nanoworld surrounding us. To address these challenges, we developed a hyperspectral stimulated Raman scattering (SRS) imaging platform with an automated plastic identification algorithm that allows micro-nano plastic analysis at the single-particle level with high chemical specificity and throughput. We first validated the sensitivity enhancement of the narrow band of SRS to enable high-speed single nanoplastic detection below 100 nm. We then devised a data-driven spectral matching algorithm to address spectral identification challenges imposed by sensitive narrow-band hyperspectral imaging and achieve robust determination of common plastic polymers. With the established technique, we studied the micro-nano plastics from bottled water as a model system. We successfully detected and identified nanoplastics from major plastic types. Micro-nano plastics concentrations were estimated to be about $2.4 \pm 1.3 \times 10^5$ particles per liter of bottled water, about 90% of which are nanoplastics. This is orders of magnitude more than the microplastic abundance reported previously in bottled water. High-throughput single-particle counting revealed extraordinary particle heterogeneity and nonorthogonality between plastic composition and morphologies; the resulting multidimensional profiling sheds light on the science of nanoplastics.

optical microscopy | nanoplastics | Raman imaging | single particle analysis | Stimulated Raman Scattering

Plastic pollution has been a rising global concern, with increasing plastic consumption

Significance

Micro-nano plastics originating from the prevalent usage of plastics have raised increasingly alarming concerns worldwide. However, there remains a fundamental knowledge gap in nanoplastics because of the lack of effective analytical techniques. This study developed a powerful optical imaging technique for rapid analysis of nanoplastics with unprecedented sensitivity and specificity. As a demonstration, micro-nano plastics in bottled water are analyzed with multidimensional profiling of individual plastic particles. Quantification suggests more than 10^5 particles in each liter of bottled water, the majority of which are nanoplastics. This study holds

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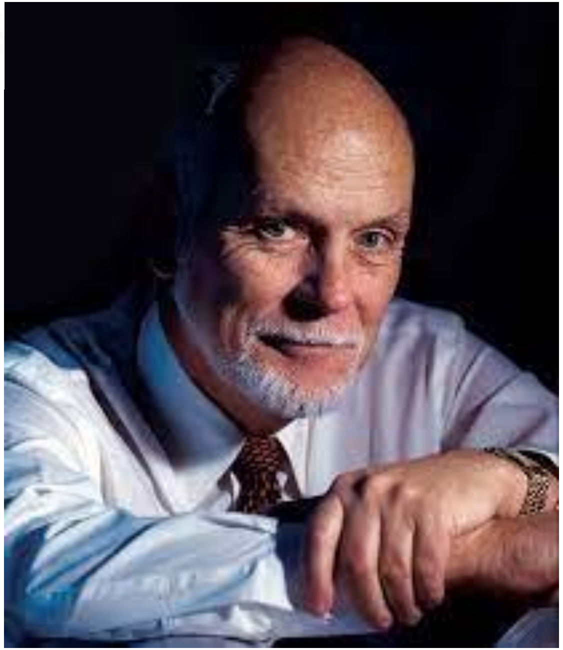
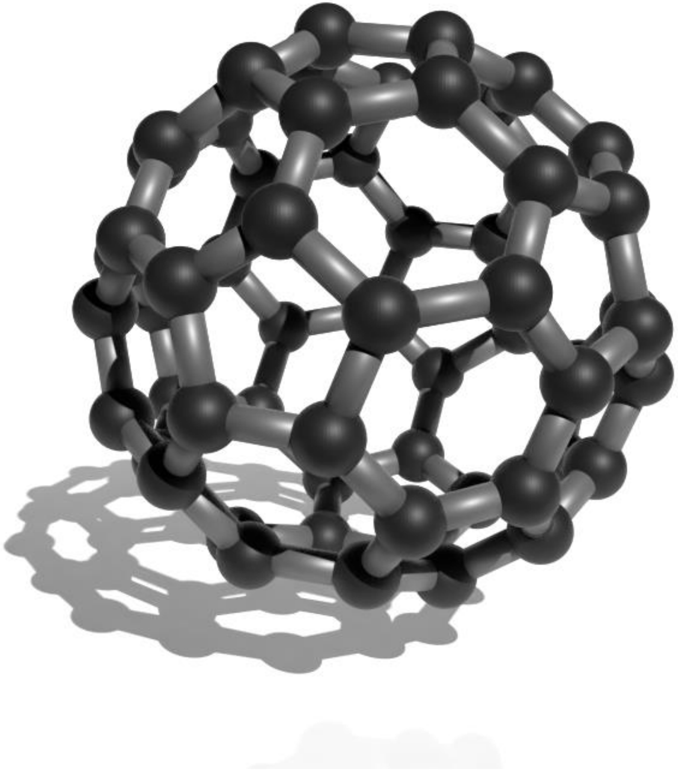
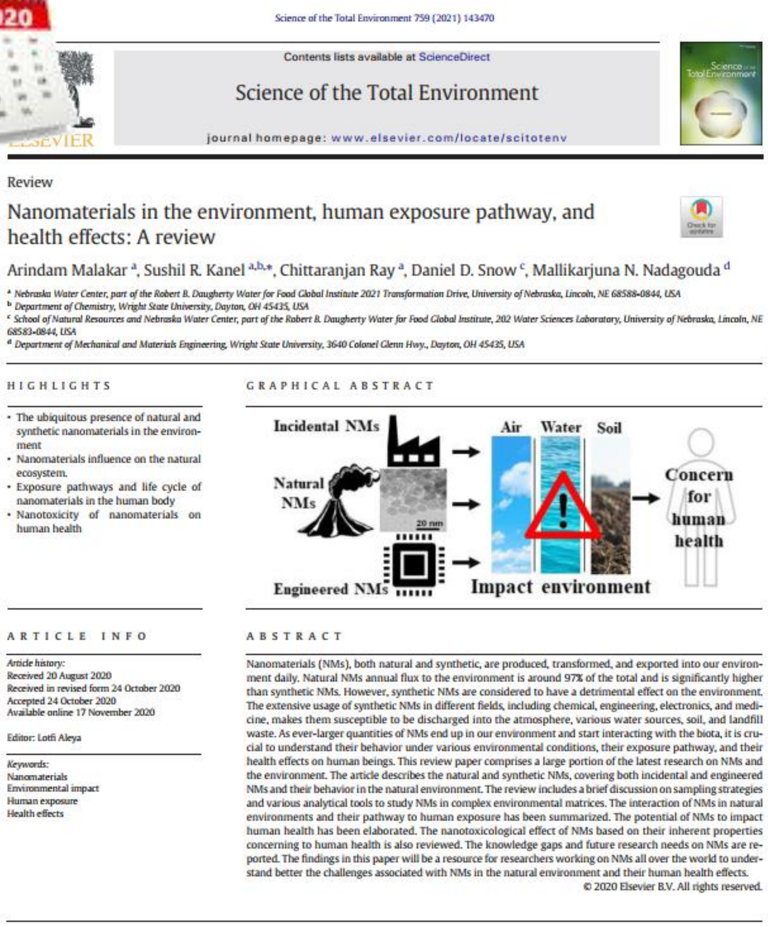
https://www.pnas.org/doi/10.1073/pnas.2300582121

https://www.reddit.com/r/nostalgia/comments/ekfuxs/original_plastic_coke_bottles_with_weird_bottom/


November 1985







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Review

Nanomaterials in the environment, human exposure pathway, and health effects: A review

Arindam Malakar [a], Sushil R. Kanel [a,b,*], Chittaranjan Ray [a], Daniel D. Snow [c], Mallikarjuna N. Nadagouda [d]

[a] Nebraska Water Center, part of the Robert B. Daugherty Water for Food Global Institute 2021 Transformation Drive, University of Nebraska, Lincoln, NE 68588-0844, USA
[b] Department of Chemistry, Wright State University, Dayton, OH 45435, USA
[c] School of Natural Resources and Nebraska Water Center, part of the Robert B. Daugherty Water for Food Global Institute, 202 Water Sciences Laboratory, University of Nebraska, Lincoln, NE 68583-0844, USA
[d] Department of Mechanical and Materials Engineering, Wright State University, 3640 Colonel Glenn Hwy., Dayton, OH 45435, USA

HIGHLIGHTS

- The ubiquitous presence of natural and synthetic nanomaterials in the environment
- Nanomaterials influence on the natural ecosystem.
- Exposure pathways and life cycle of nanomaterials in the human body
- Nanotoxicity of nanomaterials on human health

GRAPHICAL ABSTRACT

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ABSTRACT

Nanomaterials (NMs), both natural and synthetic, are produced, transformed, and exported into our environment daily. Natural NMs annual flux to the environment is around 97% of the total and is significantly higher than synthetic NMs. However, synthetic NMs are considered to have a detrimental effect on the environment. The extensive usage of synthetic NMs in different fields, including chemical, engineering, electronics, and medicine, makes them susceptible to be discharged into the atmosphere, various water sources, soil, and landfill waste. As ever-larger quantities of NMs end up in our environment and start interacting with the biota, it is crucial to understand their behavior under various environmental conditions, their exposure pathway, and their health effects on human beings. This review paper comprises a large portion of the latest research on NMs and the environment. The article describes the natural and synthetic NMs, covering both incidental and engineered NMs and their behavior in the natural environment. The review includes a brief discussion on sampling strategies and various analytical tools to study NMs in complex environmental matrices. The interaction of NMs in natural environments and their pathway to human exposure has been summarized. The potential of NMs to impact human health has been elaborated. The nanotoxicological effect of NMs based on their inherent properties concerning to human health is also reviewed. The knowledge gaps and future research needs on NMs are reported. The findings in this paper will be a resource for researchers working on NMs all over the world to understand better the challenges associated with NMs in the natural environment and their human health effects.

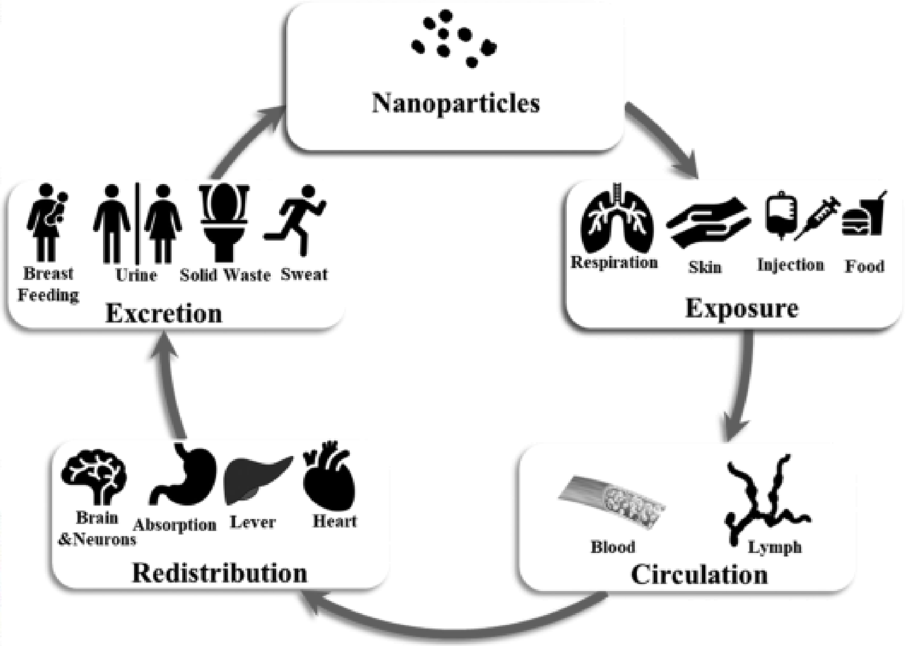

Fig. 7. Exposure pathway, circulation, redistribution, and final excretion of nanomaterials inside the human body.

https://doi.org/10.1016/j.scitotenv.2020.143470

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ORIGINAL RESEARCH
published: 11 September 2018
doi: 10.3389/fchem.2018.00407

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Synthetic Polymer Contamination in Bottled Water

Sherri A. Mason*, Victoria G. Welch and Joseph Neratko

Department of Chemistry, State University of New York at Fredonia, Fredonia, NY, United States

Eleven globally sourced brands of bottled water, purchased in 19 locations in nine different countries, were tested for microplastic contamination using Nile Red tagging. Of the 259 total bottles processed, 93% showed some sign of microplastic contamination. After accounting for possible background (lab) contamination, an average of 10.4 microplastic particles >100 um in size per liter of bottled water processed were found. Fragments were the most common morphology (66%) followed by fibers. Half of these particles were confirmed to be polymeric in nature using FTIR spectroscopy with polypropylene being the most common polymer type (54%), which matches a common plastic used for the manufacture of bottle caps. A small fraction of particles (4%) showed the presence of industrial lubricants. While spectroscopic analysis of particles smaller than 100 um was not possible, the adsorption of the Nile Red dye indicates that these particles are most probably plastic. Including these smaller particles (6.5–100 um), an average of 325 microplastic particles per liter of bottled water was found. Microplastic contamination range of 0 to over 10,000 microplastic particles per liter with 95% of particles being between 6.5 and 100 um in size. Data suggests the contamination is at least partially coming from the packaging and/or the bottling process itself. Given the prevalence of the consumption of bottled water across the globe, the results of this study support the need for further studies on the impacts of micro- and nano- plastics on human health.

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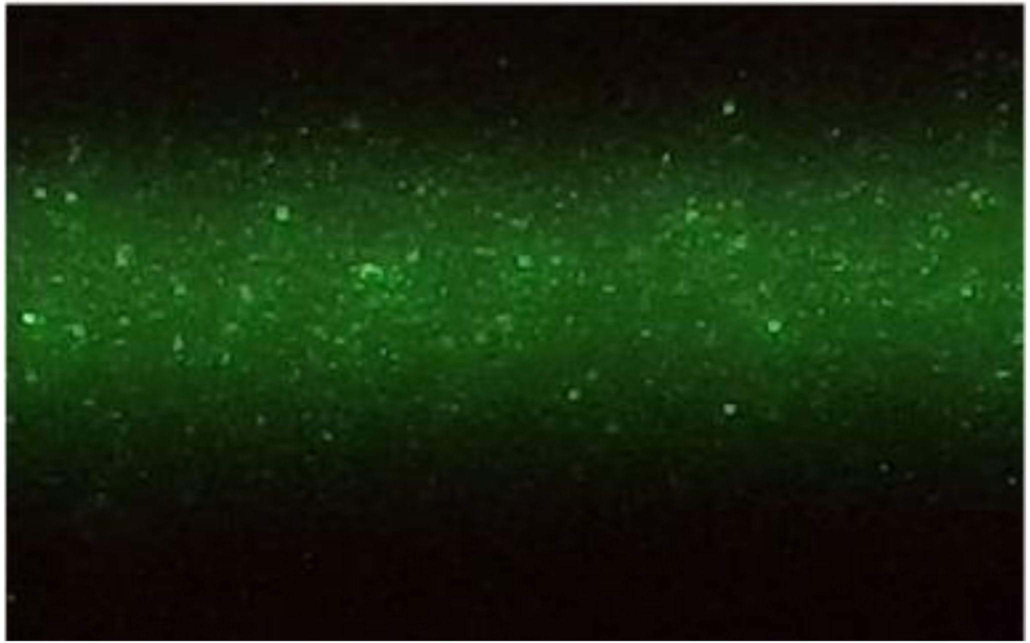
Detection of nanoparticles suspended in a light scattering medium

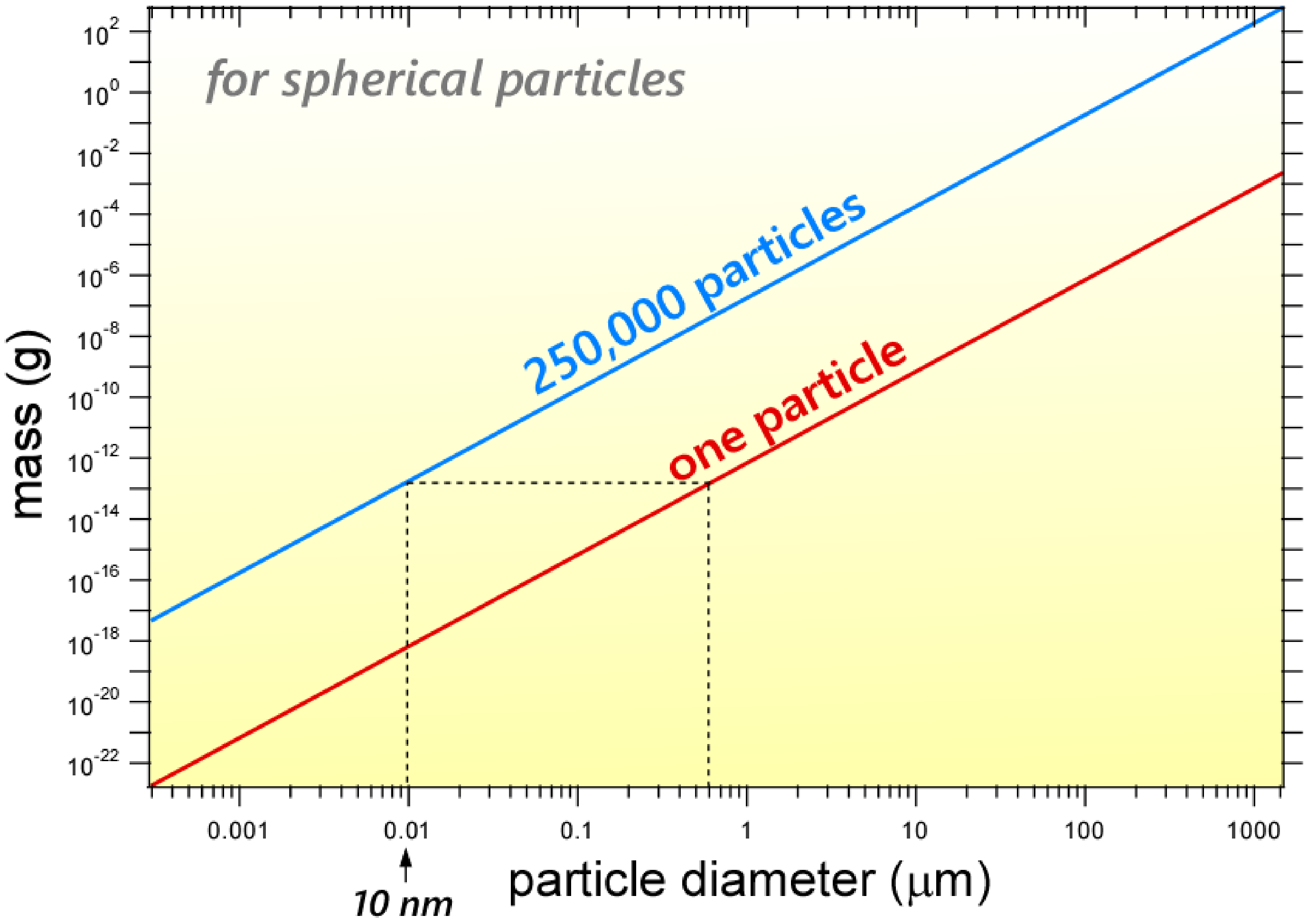
Yan Ye[1,2]✉ & David Y. H. Pui[2]

Intentionally intensifying the light scattering of medium molecules can allow the detection of suspended nanoparticles under conditions not suitable for conventional optical microscopies or laser particle counters. Here, we demonstrate how the collective light scattering of medium molecules and nanoparticles is imaged in response to the power, frequency, and oscillating direction of the incident light wave electric field, and how this response can be used to distinguish between nanoparticles and microparticles, such as viruses or bacteria. Under conditions that the medium light scattering is intensified, suspended nanoparticles appear as magnified shiny moving dots superimposed on the quasi-steady background of medium light scattering. Utilizing the visual enlargement resulted from the enhanced light scattering and possible light interference, we can detect directly suspended nanoparticles that are much smaller than visible light wavelengths even in unopened water bottles or other large containers. This suggests new approaches for detecting nanoparticles with many potential applications.

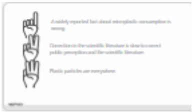
https://www.nature.com/articles/s41598-021-99768-x



https://www.nature.com/articles/s41598-021-99768-x



for spherical particles
250,000 particles
one particle
mass (g)
10^2
10^0
10^-2
10^-4
10^-6
10^-8
10^-10
10^-12
10^-14
10^-16
10^-18
10^-20
10^-22
0.001
0.01
0.1
1
10
100
1000
10 nm
particle diameter (μm)



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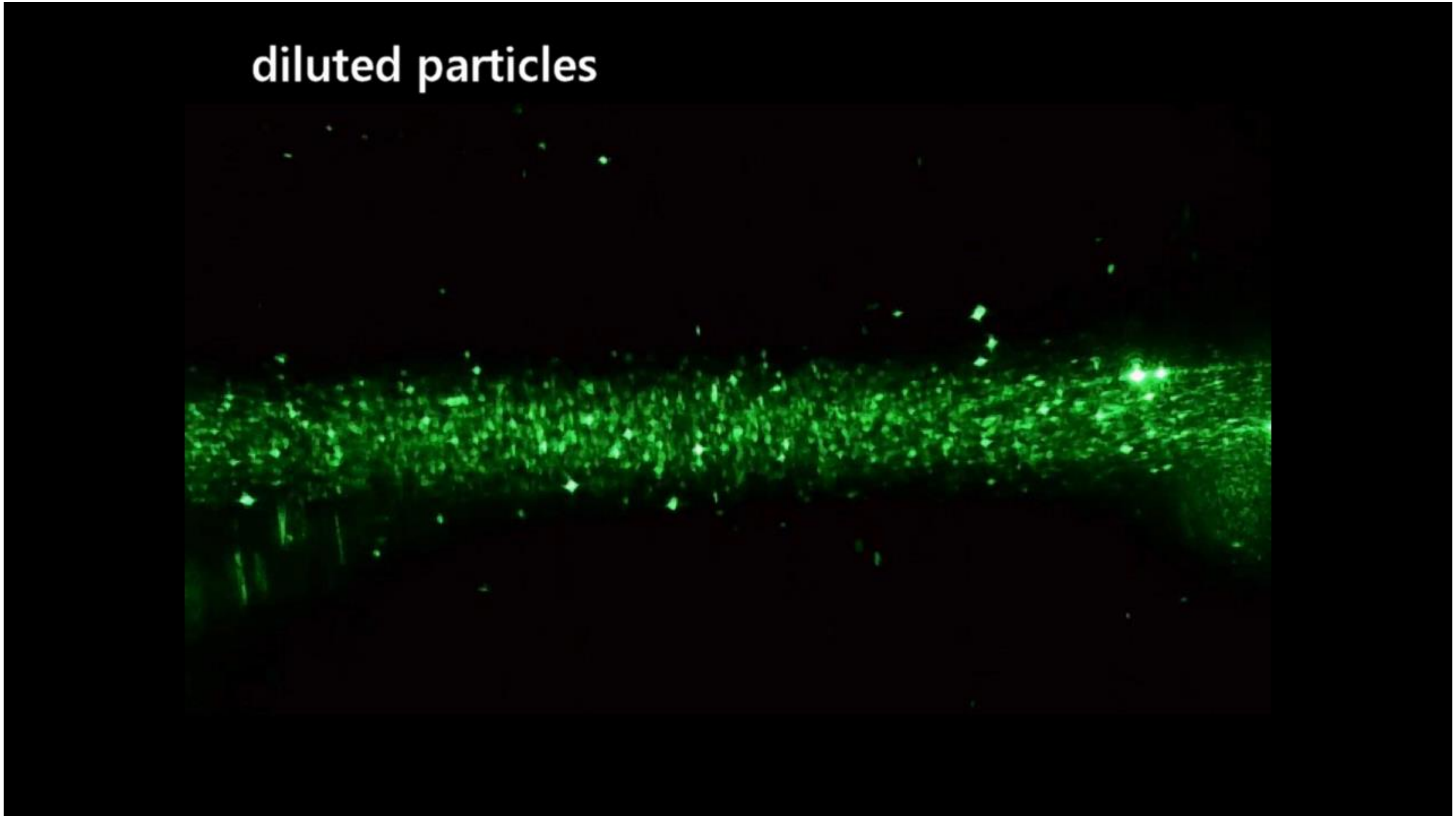

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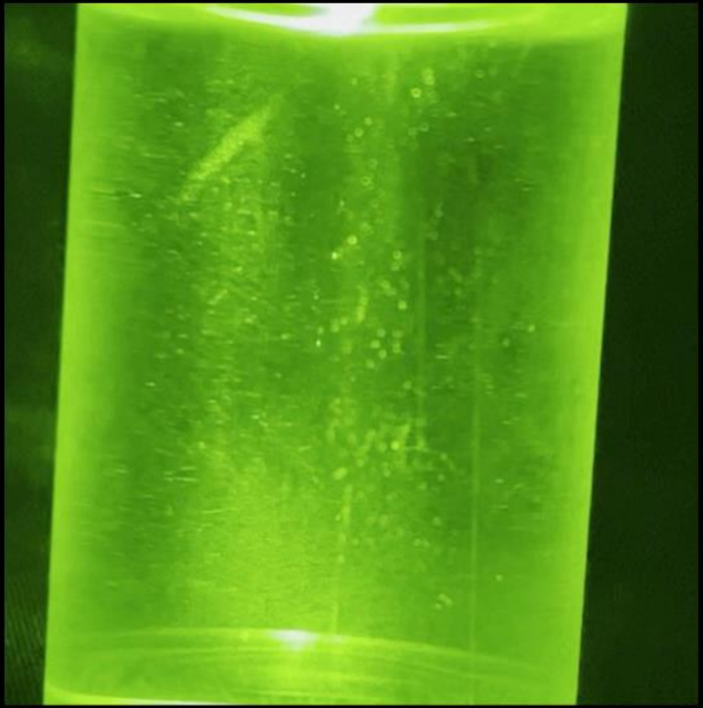
100% naturally
alkaline spring
water
8.1
flow
alkaline spring water

Flow brand water



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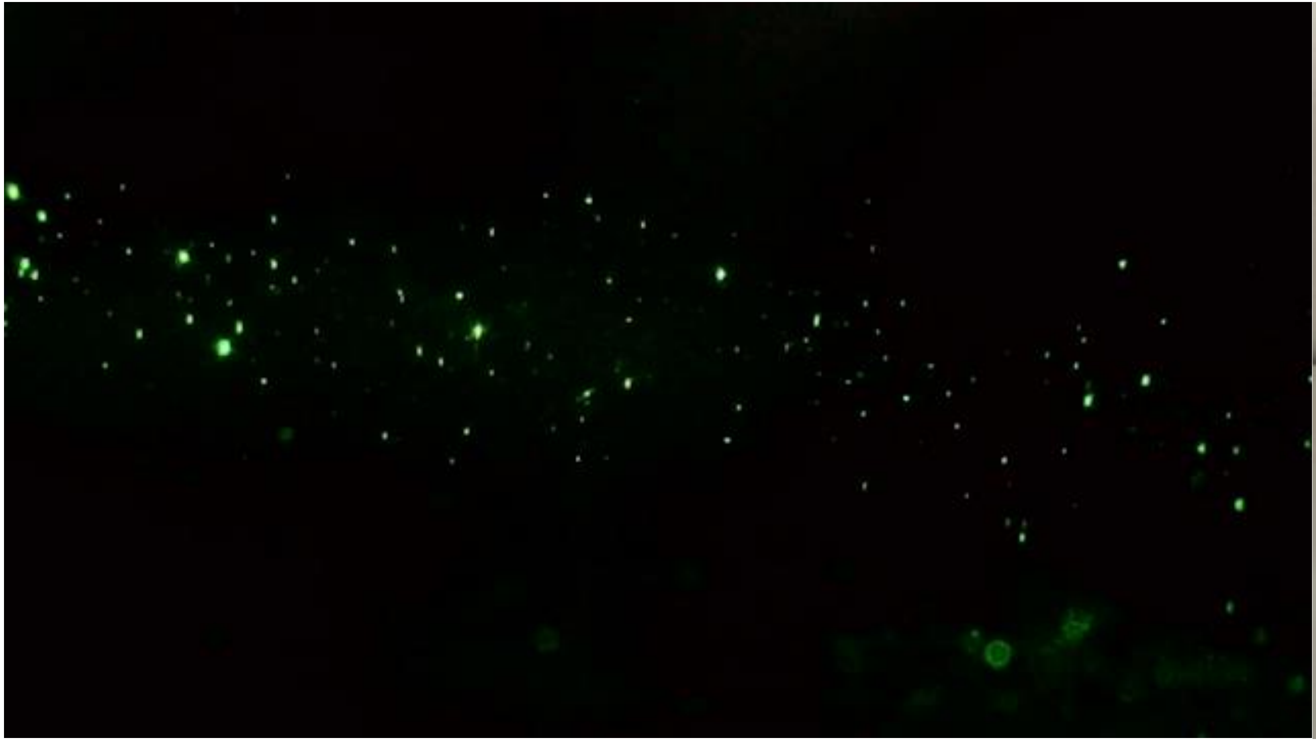


100% naturally alkaline spring water
8.1
flow
alkaline spring water

Meijer Spring Water

A widely reported fact about microplastic consumption is wrong.

Correction in the scientific literature is slow to correct public perception and the scientific literature.

Plastic particles are everywhere.

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