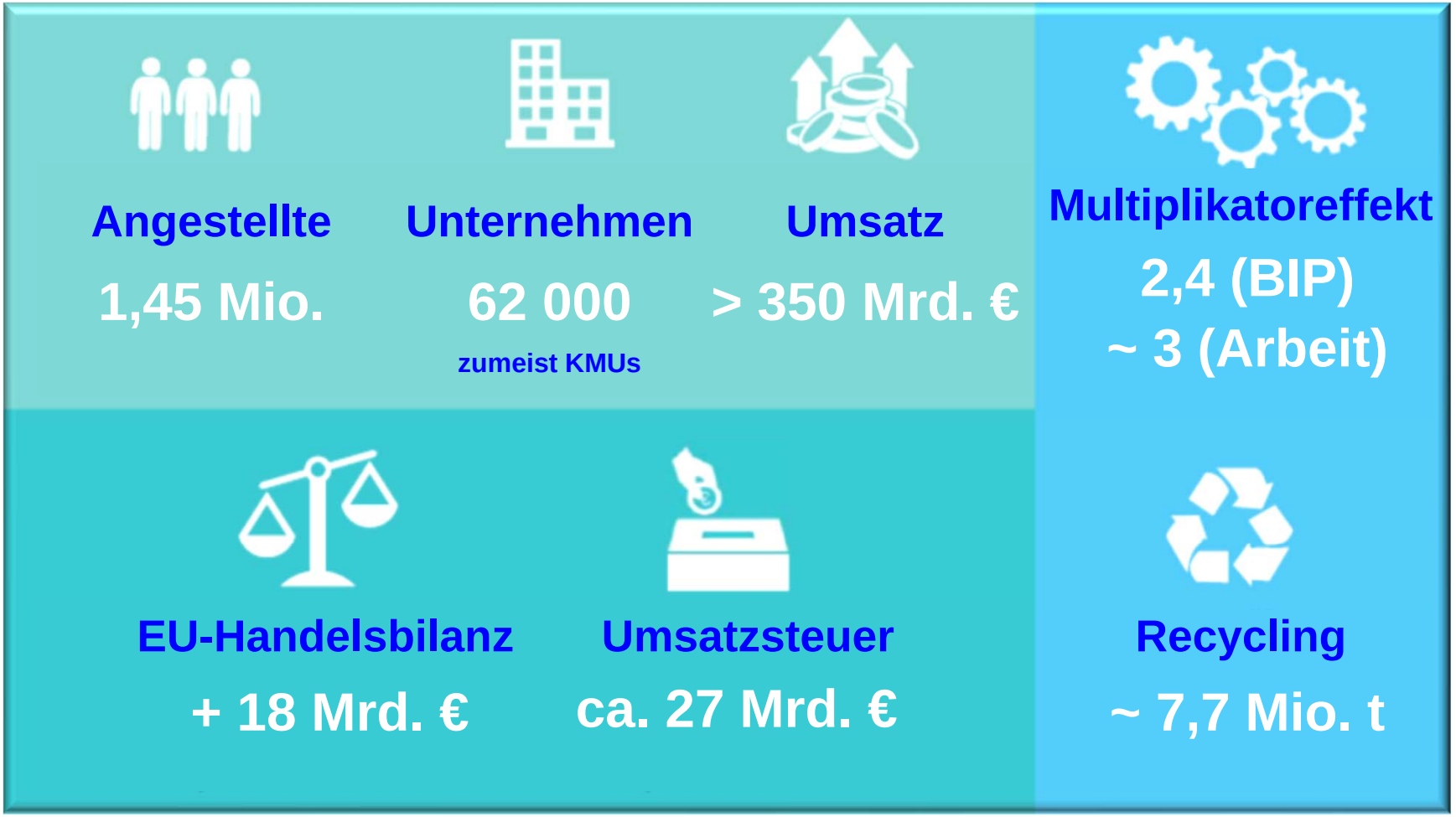
Wirkung von Mikroplastik:

Hype oder Herausforderung?

Thomas Braunbeck; Aquatox – COS – Univ. Heidelberg

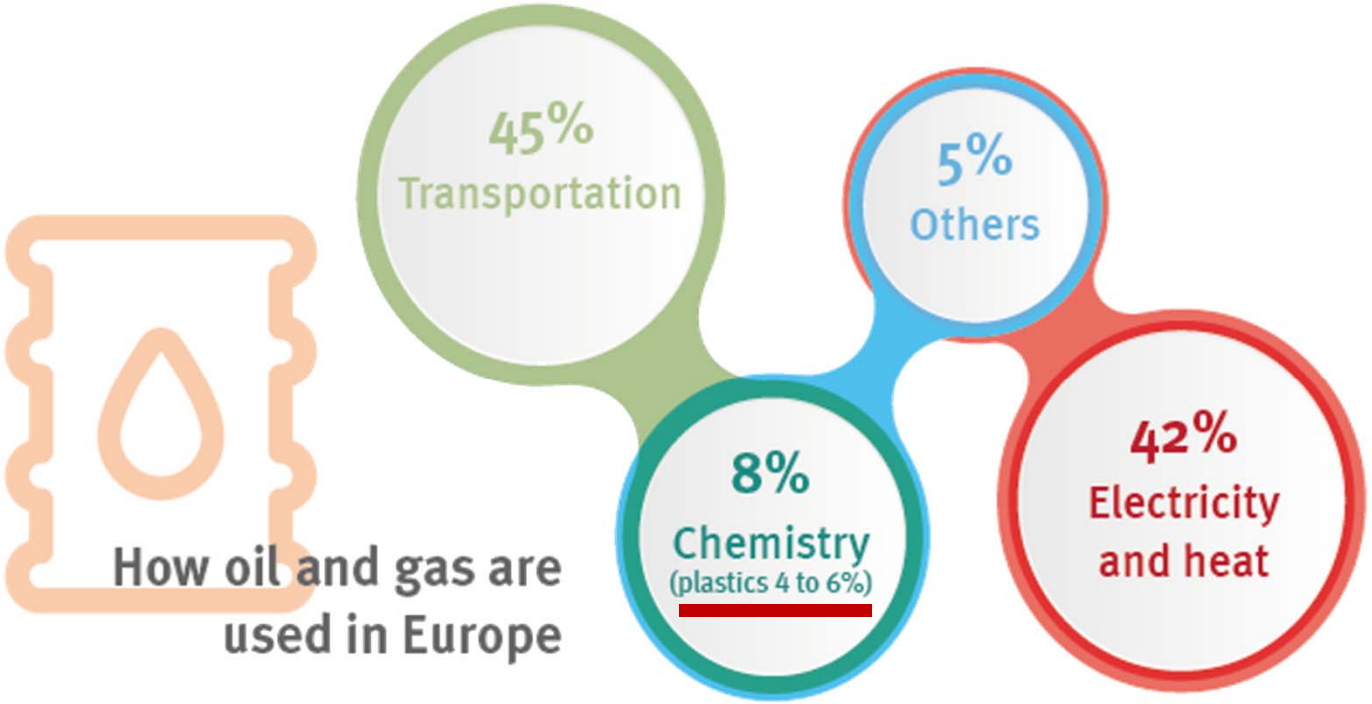
Die Dimension(en) der Plastikwirtschaft



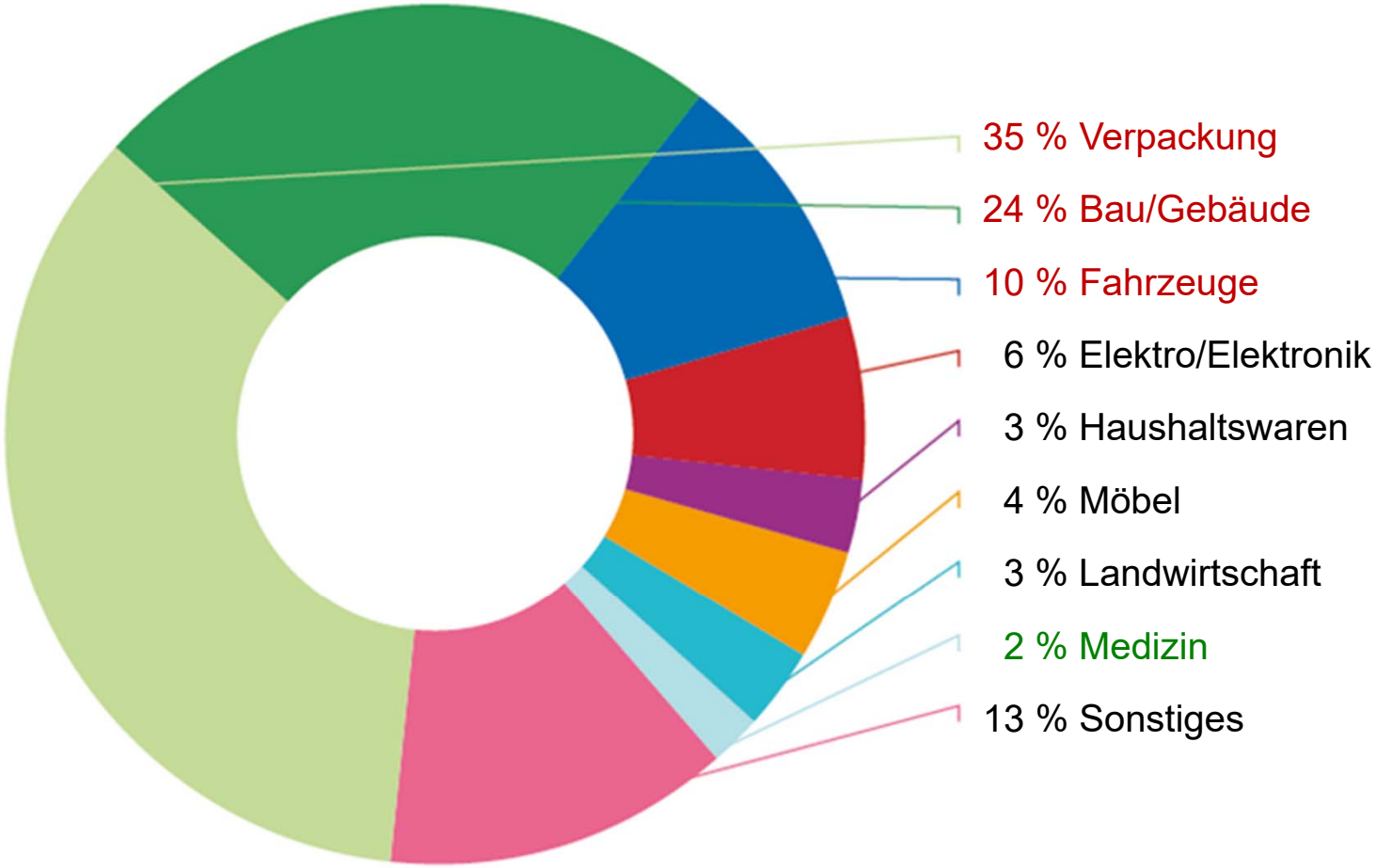
Quelle: Eurostat

Die Herkunft von Plastik

„Plastik leitet sich von organischen Produkten wie Zellulose, Kohle, natürlichem Gas, Salz und natürlich Rohöl ab. Es ist wichtig, darauf hinzuweisen, dass in Europa „nur“ 4 - 6 % des Öl und Gas für die Produktion von Plastik eingesetzt wird.“

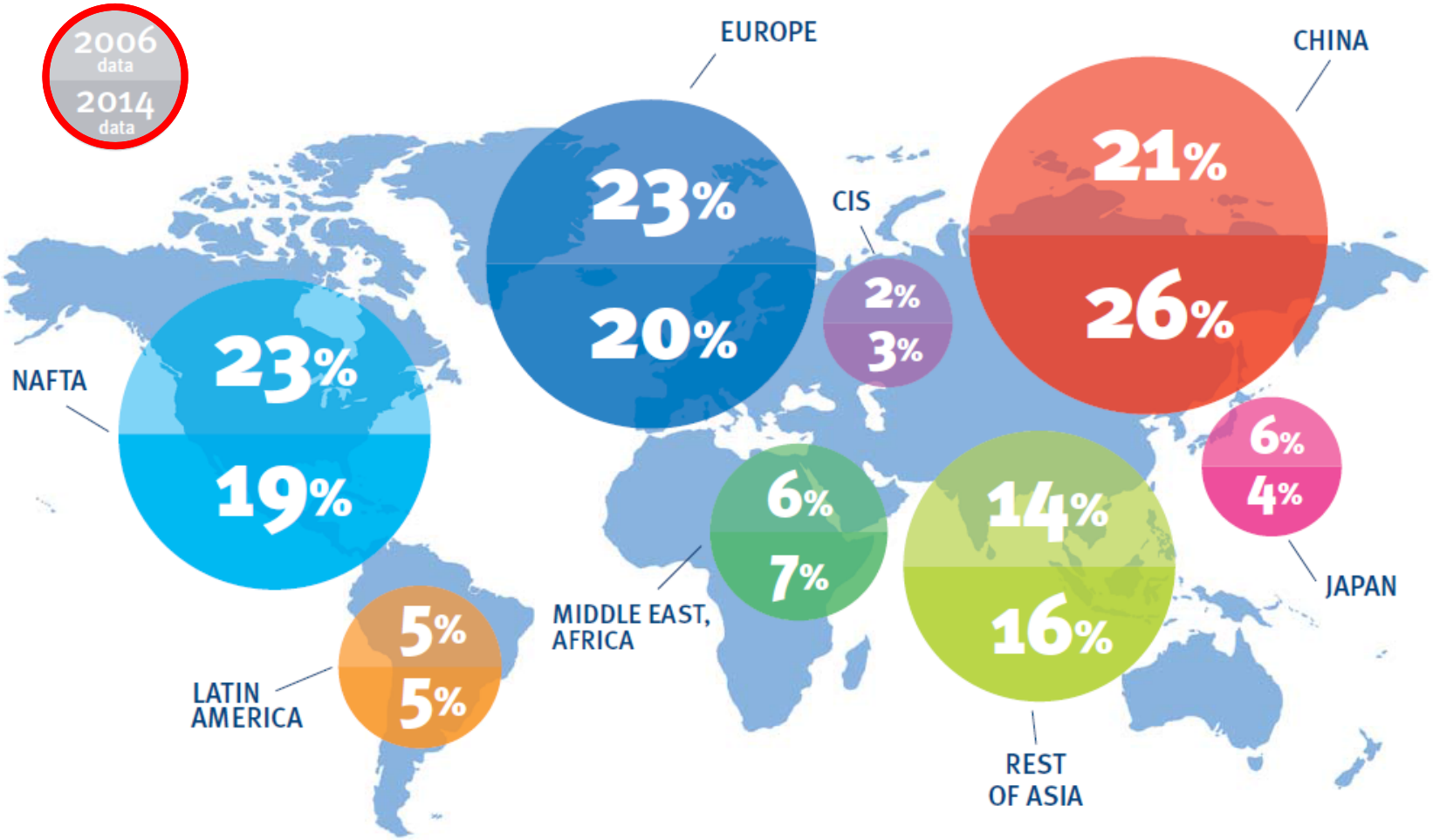


Plastik in unserer modernen Umwelt



Quelle: PlasticsEurope / Consultic

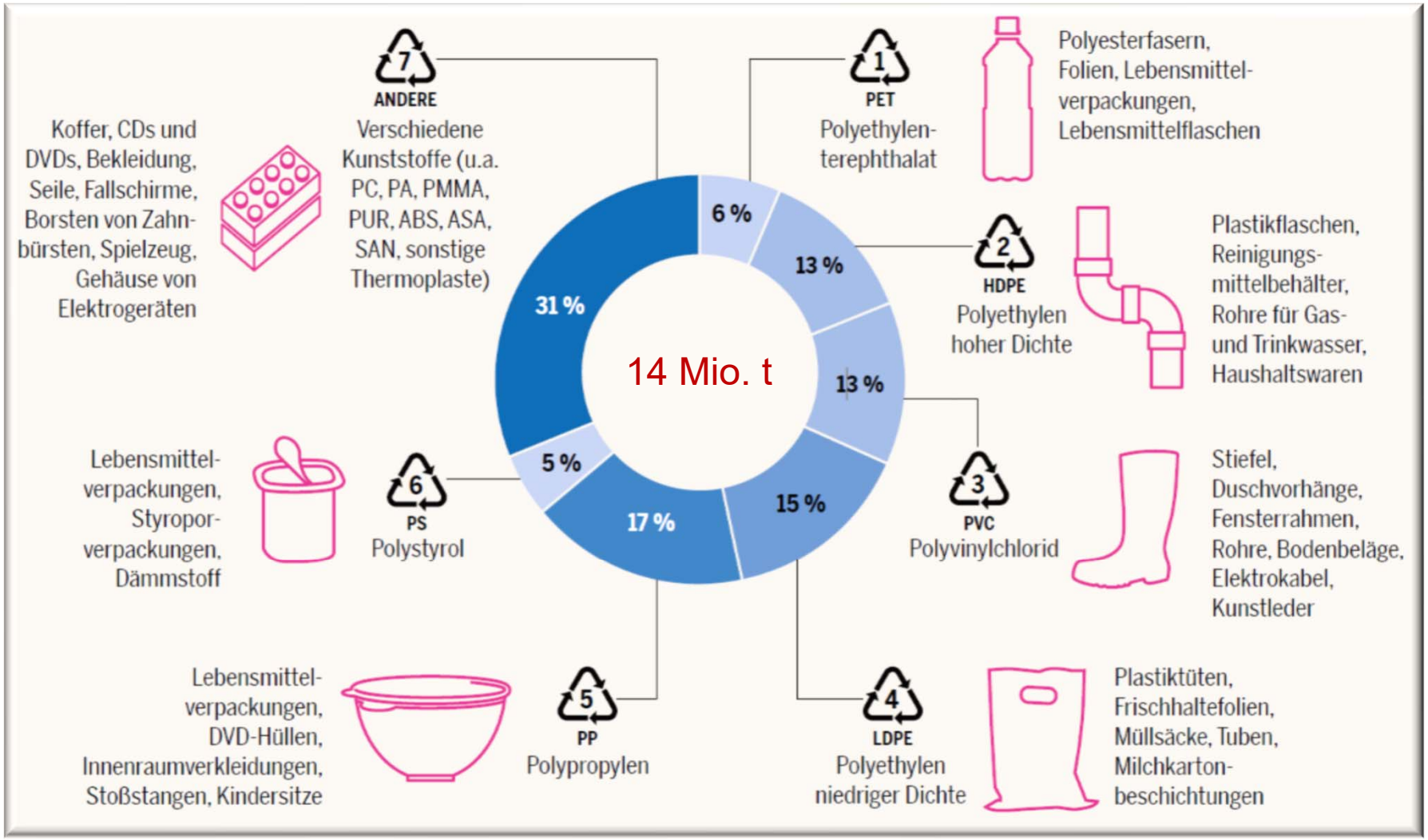
Die Produktion von Plastik



2014: Weltweite Plastikproduktion: 280 Mio. t

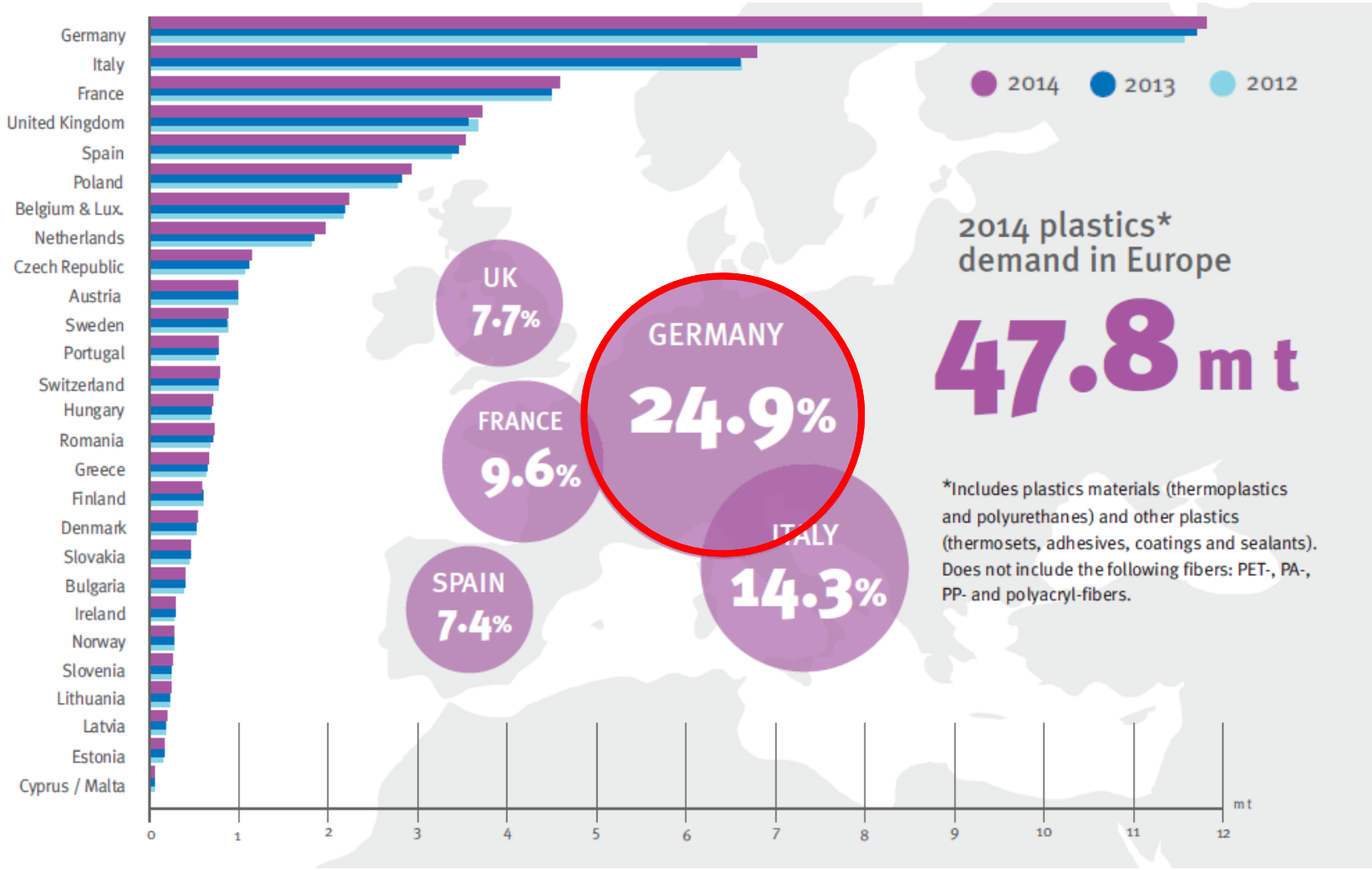
Quelle: PlasticsEurope (PEMRG) / Consultic / myCeppi

Die Produktion von Plastik in Deutschland 2017



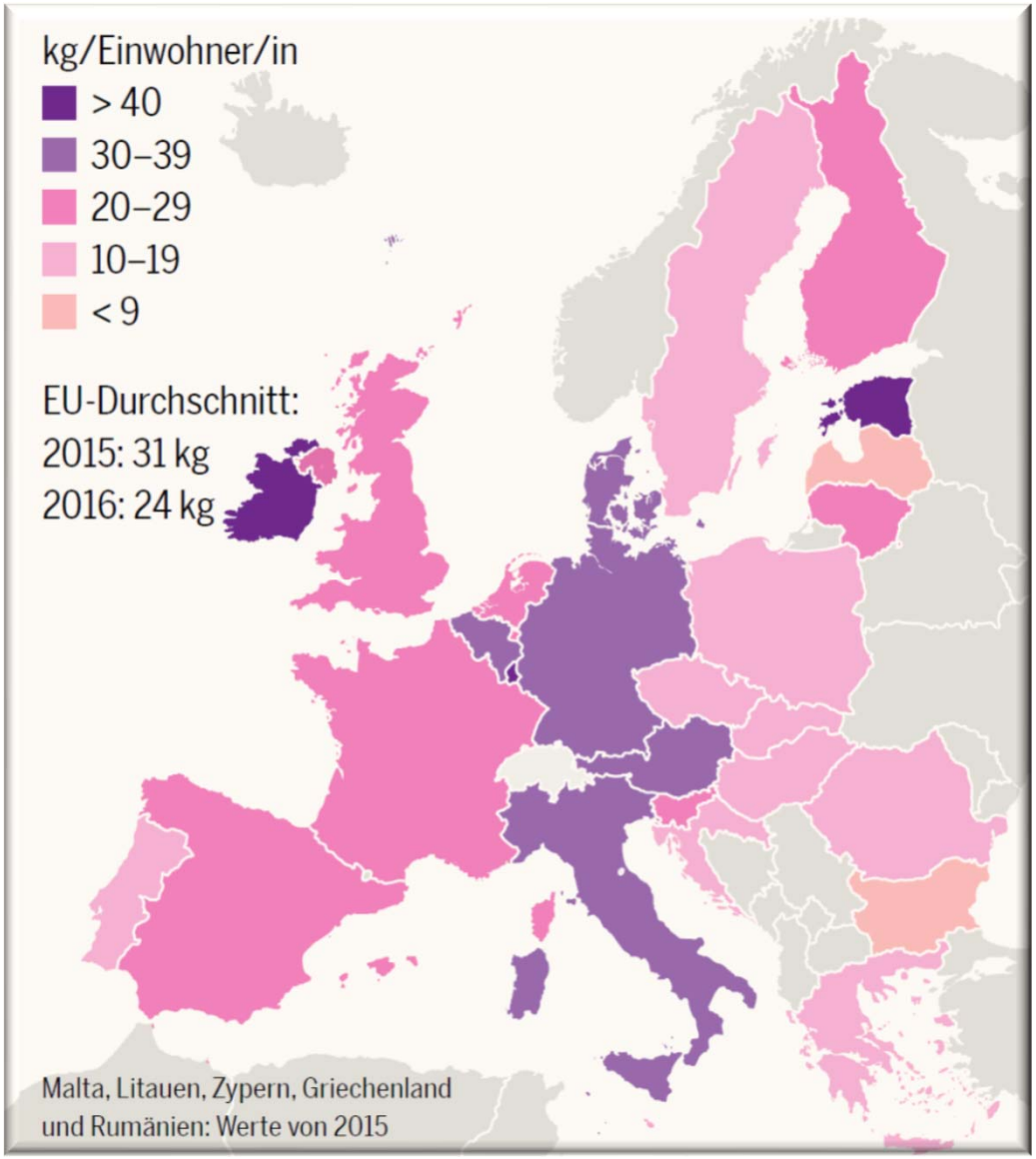
Quelle: Heinrich-Böll-Stiftung: Plastikatlas 2019 / UBA

Nutzung von Plastik: Geographische Verteilung in Europa



Quelle: PlasticsEurope (PEMRG) / Consultic / myCeppi

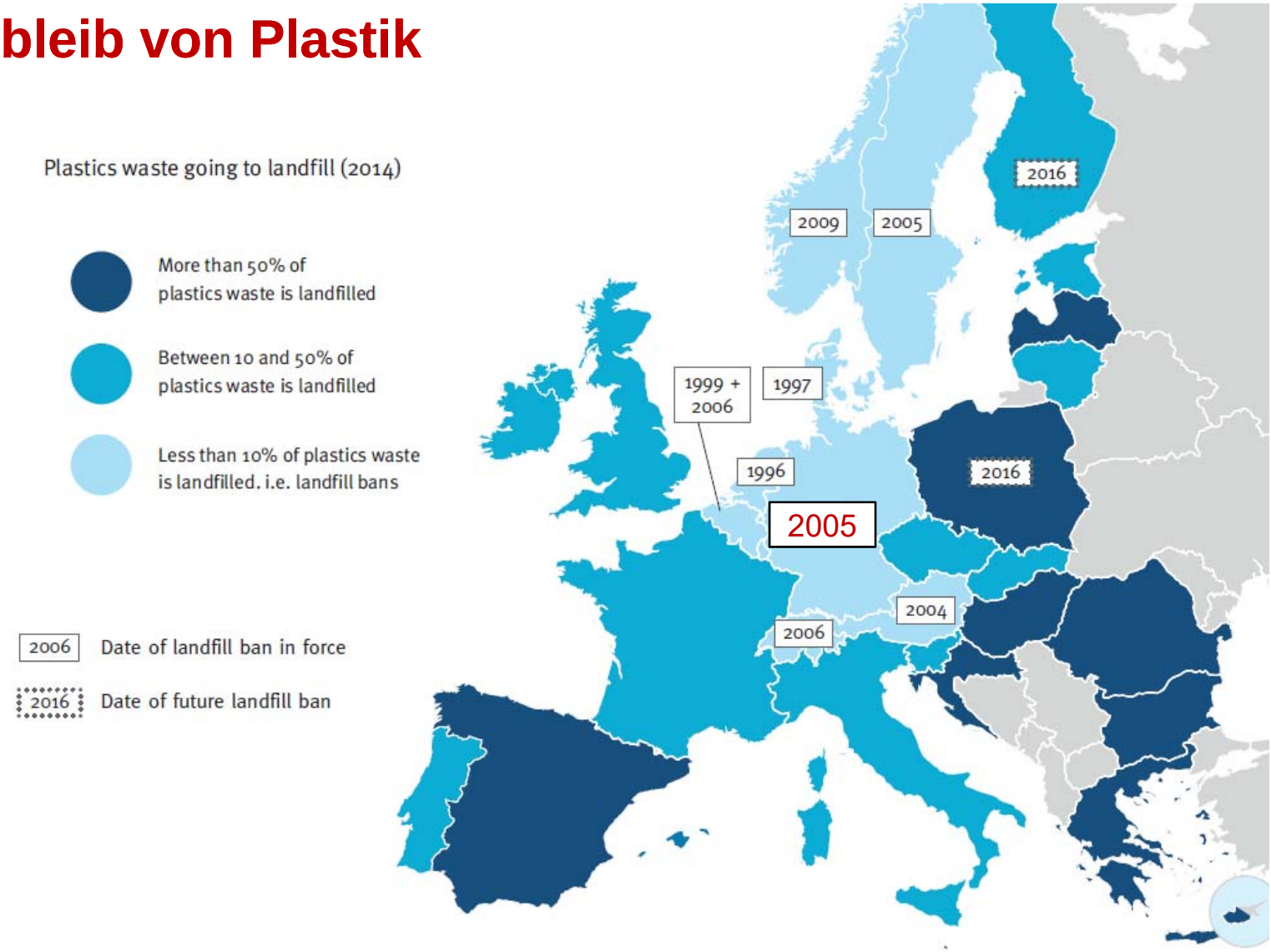
Plastikmüll in der EU (2016)



BRD: 38 kg/Kopf

Quelle: Heinrich-Böll-Stiftung: Plastikatlas 2019 / Statista

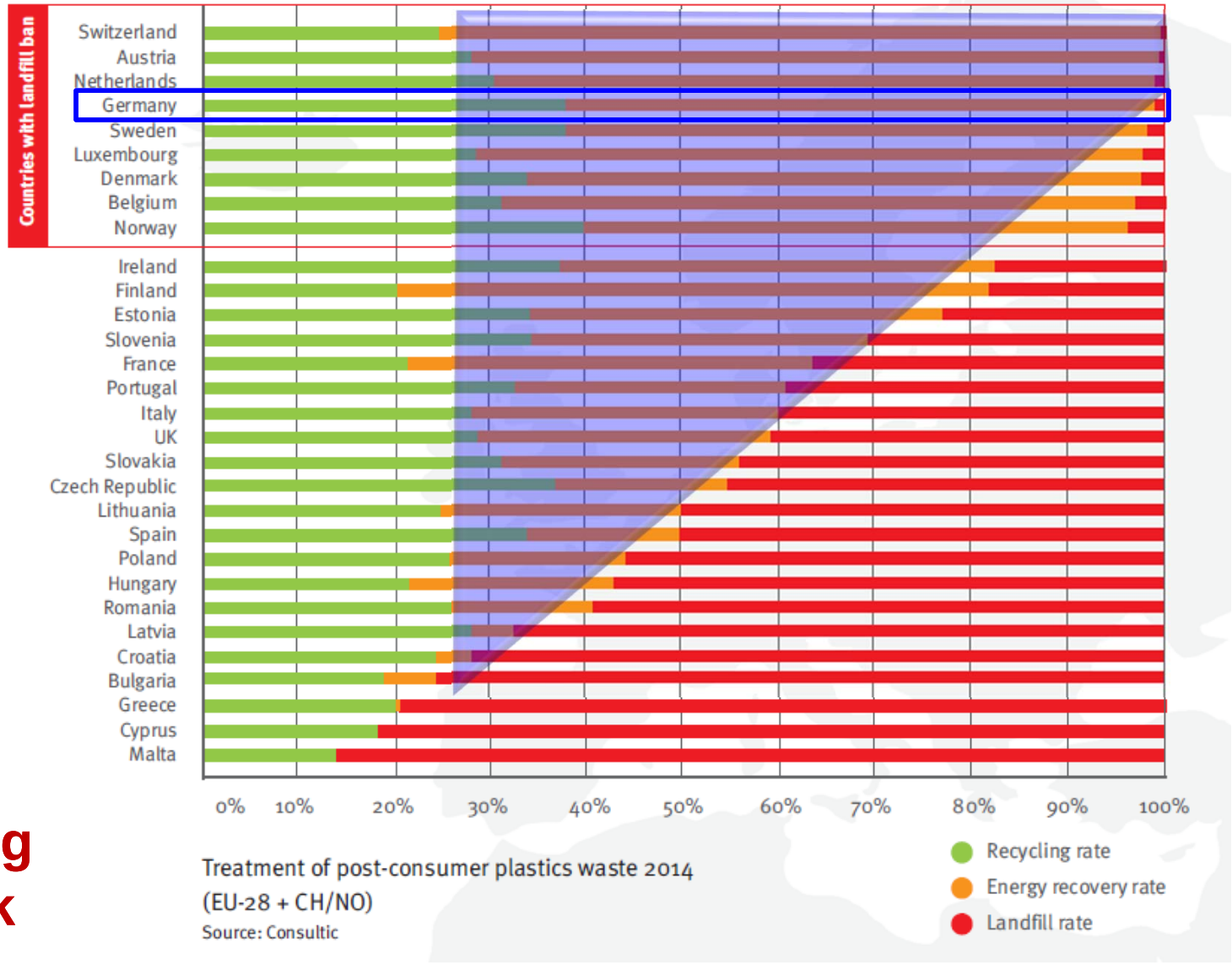
Der Verbleib von Plastik



2014

Quelle: Consultic

Entsorgung von Plastik



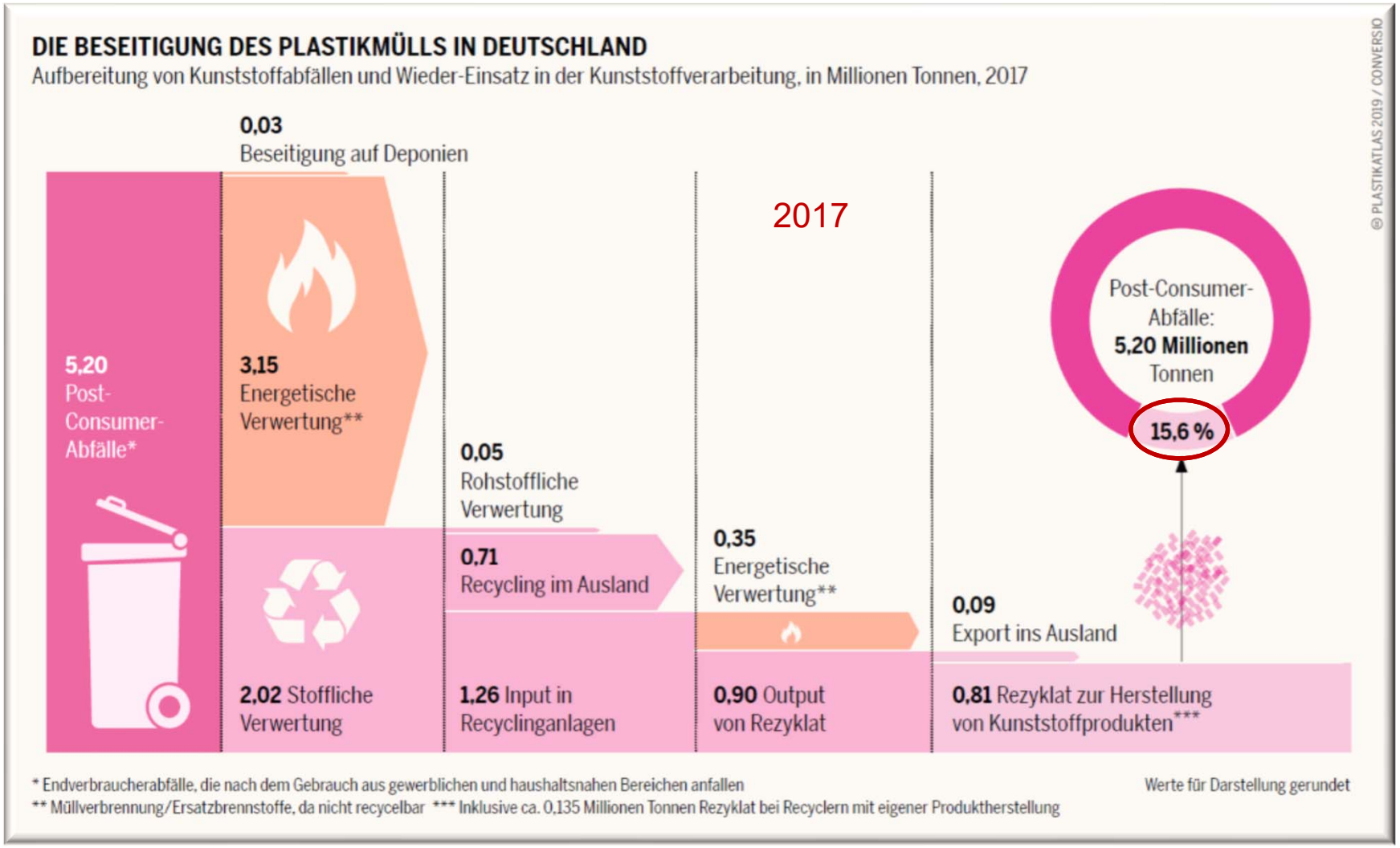
Treatment of post-consumer plastics waste 2014
(EU-28 + CH/NO)
Source: Consultic

Der Verbleib von Plastik: Trend 2006 → 2014

Recyclingrate 2015: 28 %

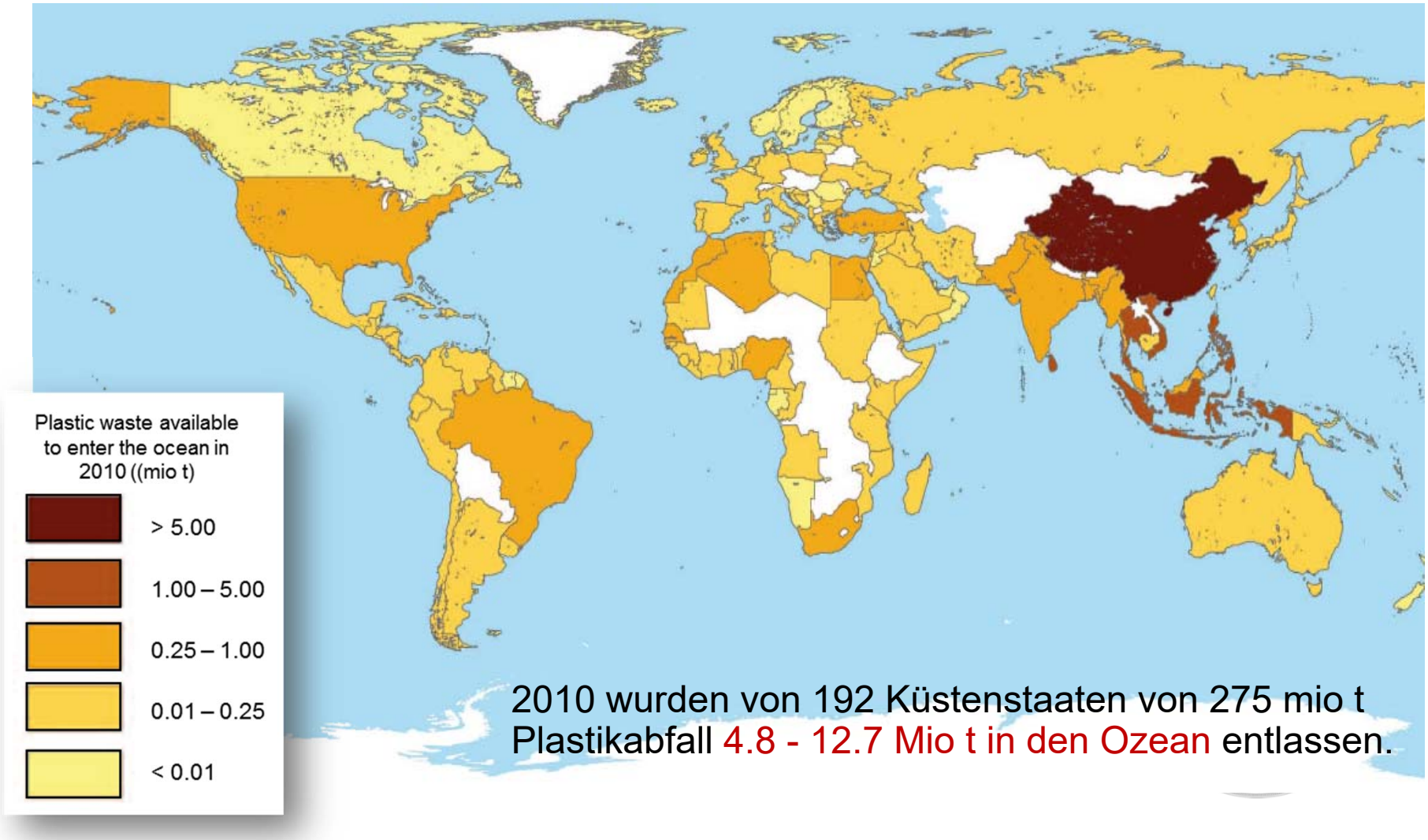
Quelle: Consultic

Plastikmüll in Deutschland?



Quelle: Heinrich-Böll-Stiftung: Plastikatlas 2019 / CONVERSIO

Das weitere Schicksal von Plastik

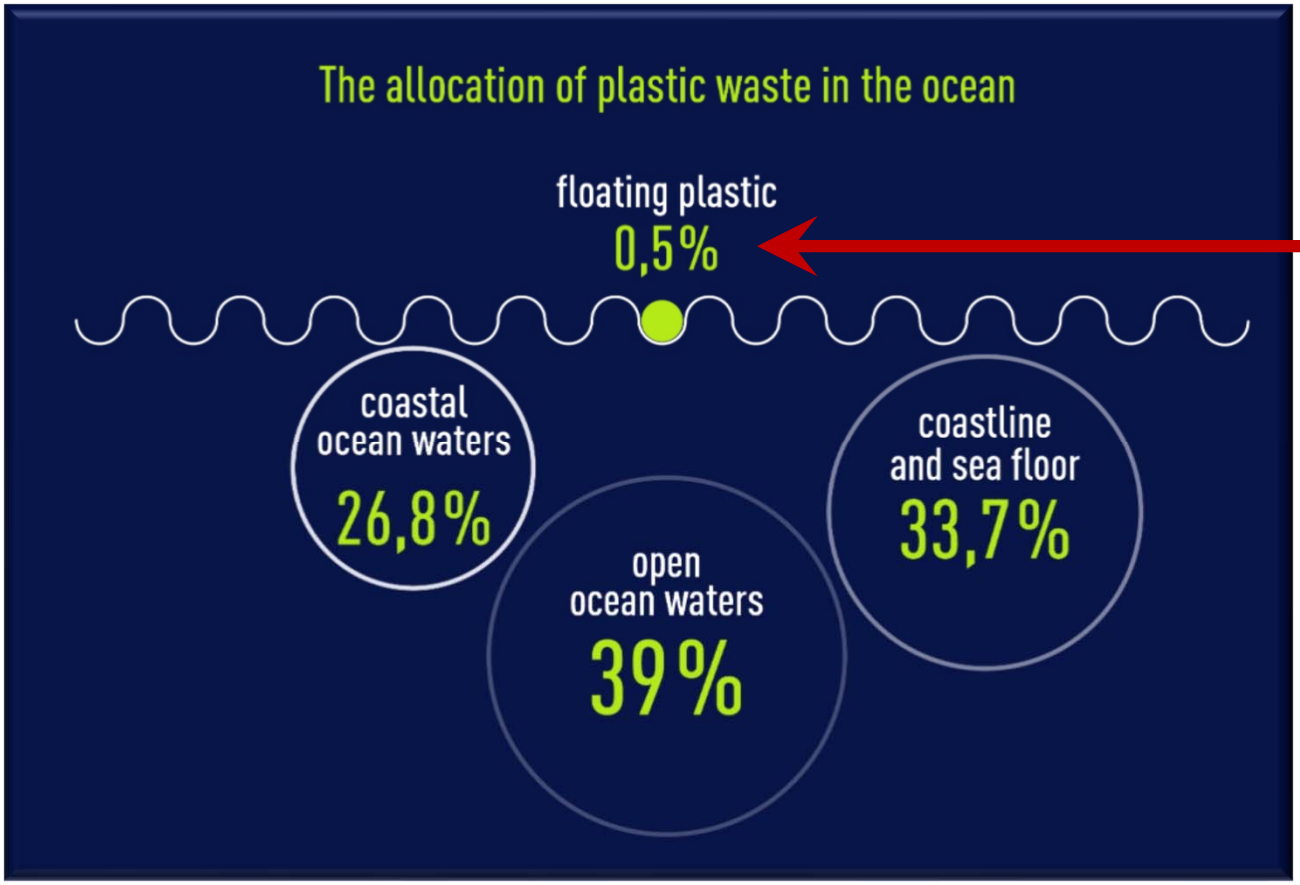


2010 wurden von 192 Küstenstaaten von 275 mio t Plastikabfall 4.8 - 12.7 Mio t in den Ozean entlassen.

Das Schicksal von Plastik

Quelle: PlasticsEurope (PEMRG) / Consultic / myCeppi

Der Verbleib von Plastik im Ozean



Das sehen wir

PNAS PNAS PNAS

Exceptional and rapid accumulation of anthropogenic debris on one of the world's most remote and pristine islands

Jennifer L. Lavers[a,b,1] and Alexander L. Bond[b]

[a]Institute for Marine and Antarctic Studi
for the Protection of Birds, Sandy, Bedfo

Edited by David M. Karl, University of H

**In just over half a century plastic prod
society and have infiltrated terrest
in every corner of the globe. The
biodiversity is well established, but m
hampered by a lack of quantitative
Here we document the amount of de
Henderson Island, a remote, uninhab
The density of debris was the high
world, up to 671.6 items/m^2 (mean ±
the surface of the beaches. Approx
4,496.9 pieces/m^2) on the beach was
An estimated 37.7 million debris iten
are currently present on Henderson
accumulating daily. Rarely visited by
other remote islands may be sinks for some of the world's increasing volume of waste.**

Society

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(18, 19).
islands,
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nderson
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s within
s of pol-
rom the

global disposal and dispersal of waste. Here we summarize the limited data available for remote, uninhabited islands and provide quantitative data on the accumulation of debris on Henderson

Was ist daran eigentlich neu?

Lavers & Bond (2017) PNAS 114: 6052-6055

Plastik in unserer modernen Umwelt

- Nur ein ästhetisches Problem?
- Plastik statt Nahrung → Verhungern?
- Verfangen in Plastik → Ertrinken, Ersticken, Verletzungen?

- **Mikroplastik??**

Quelle: PlasticsEurope / Consultic

Was ist Mikroplastik?

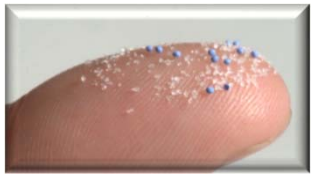
Plastikpartikel kleiner 5 mm

Das weitere Schicksal von Plastik

Makroplastik
(Tüten, Flaschen etc.)

UV / Mechani-
sche Degradation

Mikroplastik
(< 5 mm)

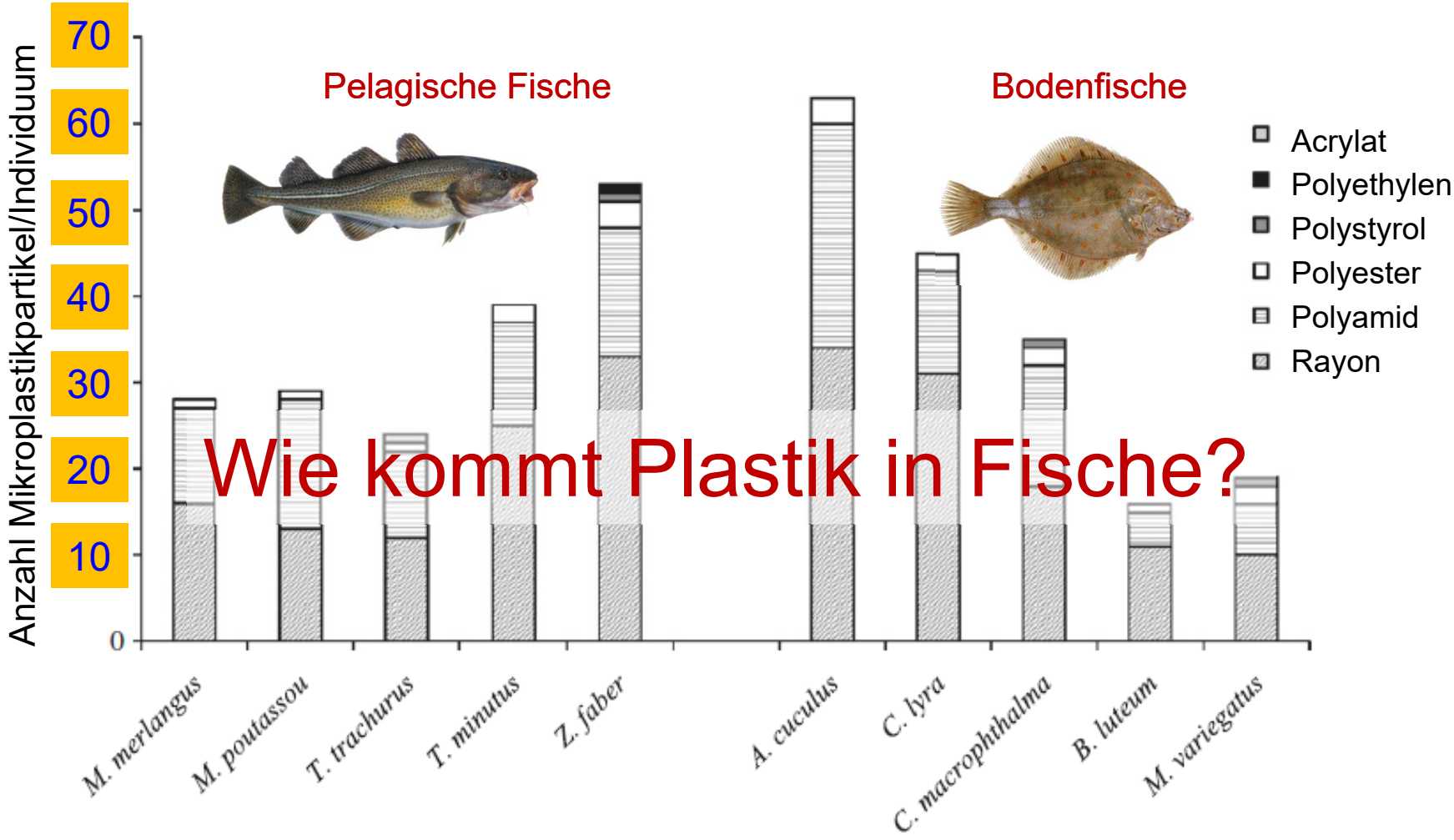


Industrie, Kosmetik
(Peelings, Zahnpasta)

Sekundäres Mikroplastik | Primäres Mikroplastik

- Was geschieht mit Mikroplastik in der aquatischen Umwelt?
- Akkumuliert Mikroplastik in Organismen?
- Interagiert Mikroplastik mit aquatischen Organismen?
- Wirkt Mikroplastik als Vehikel für Schadstoffe?

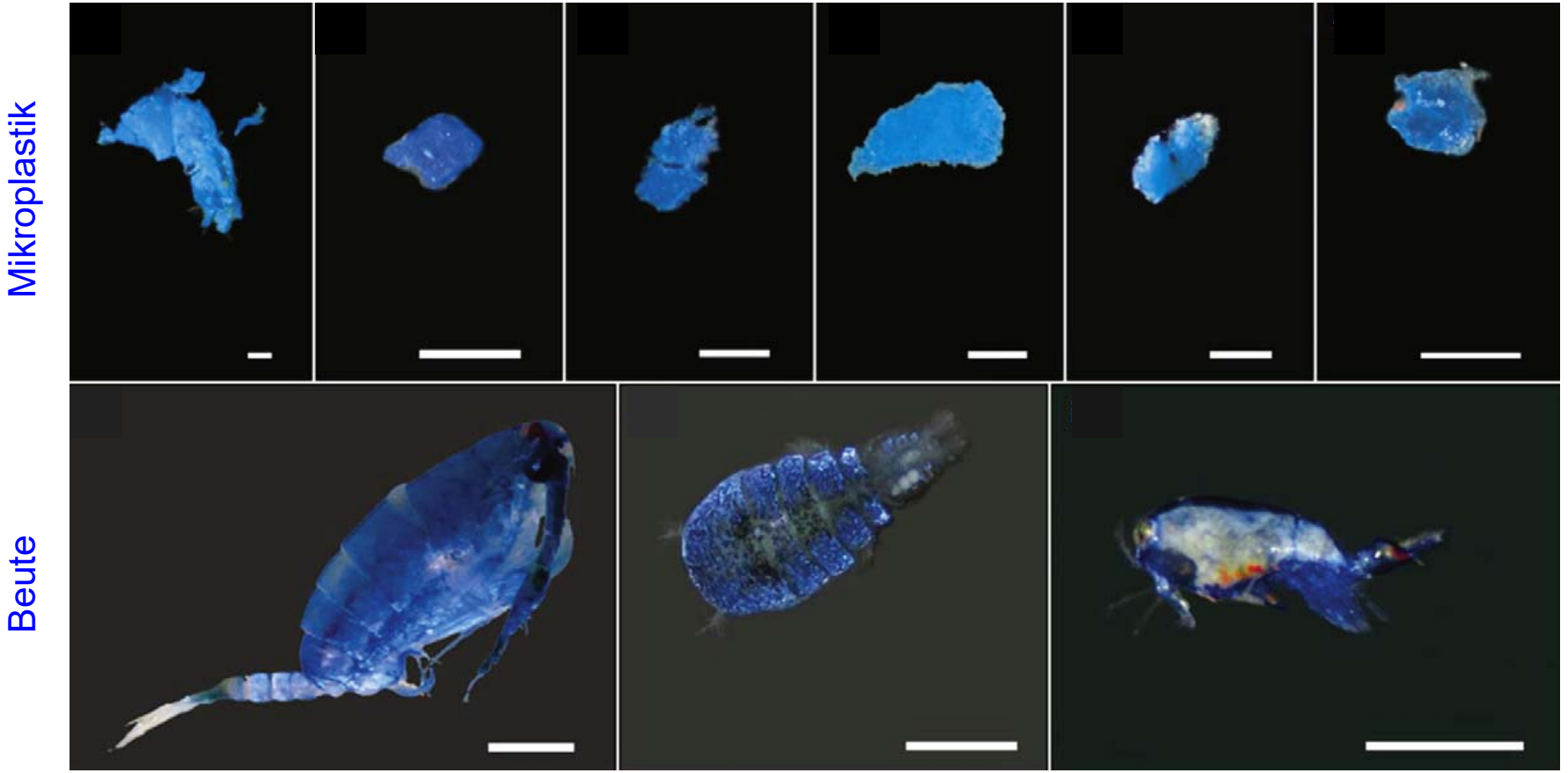
Mikroplastik in Fischen?



Wie kommt Plastik in Fische?

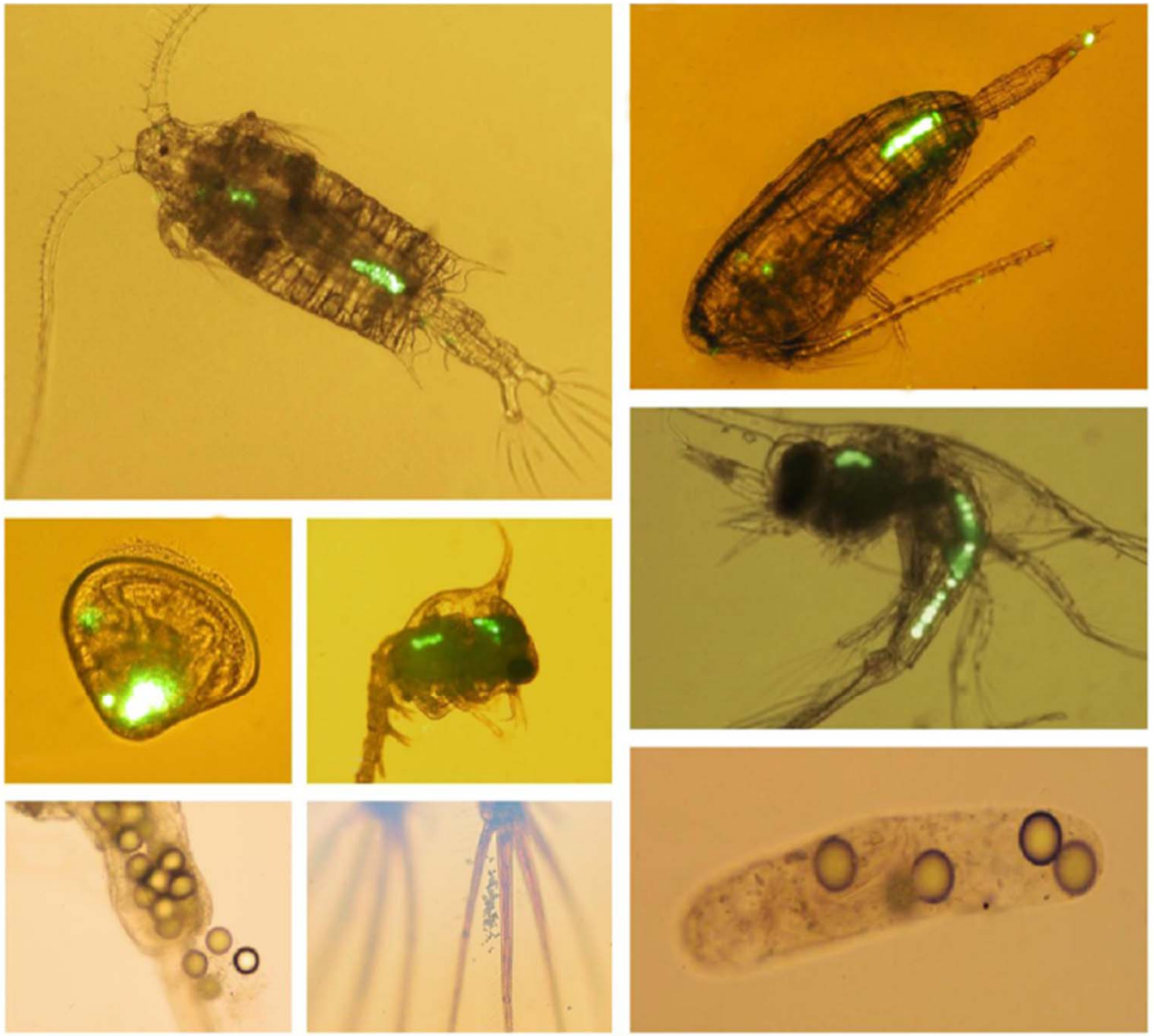
Lusher et al. (2013) Mar. Poll. Bull. 67: 94-99

Wie gelangt Mikroplastik in Organismen?



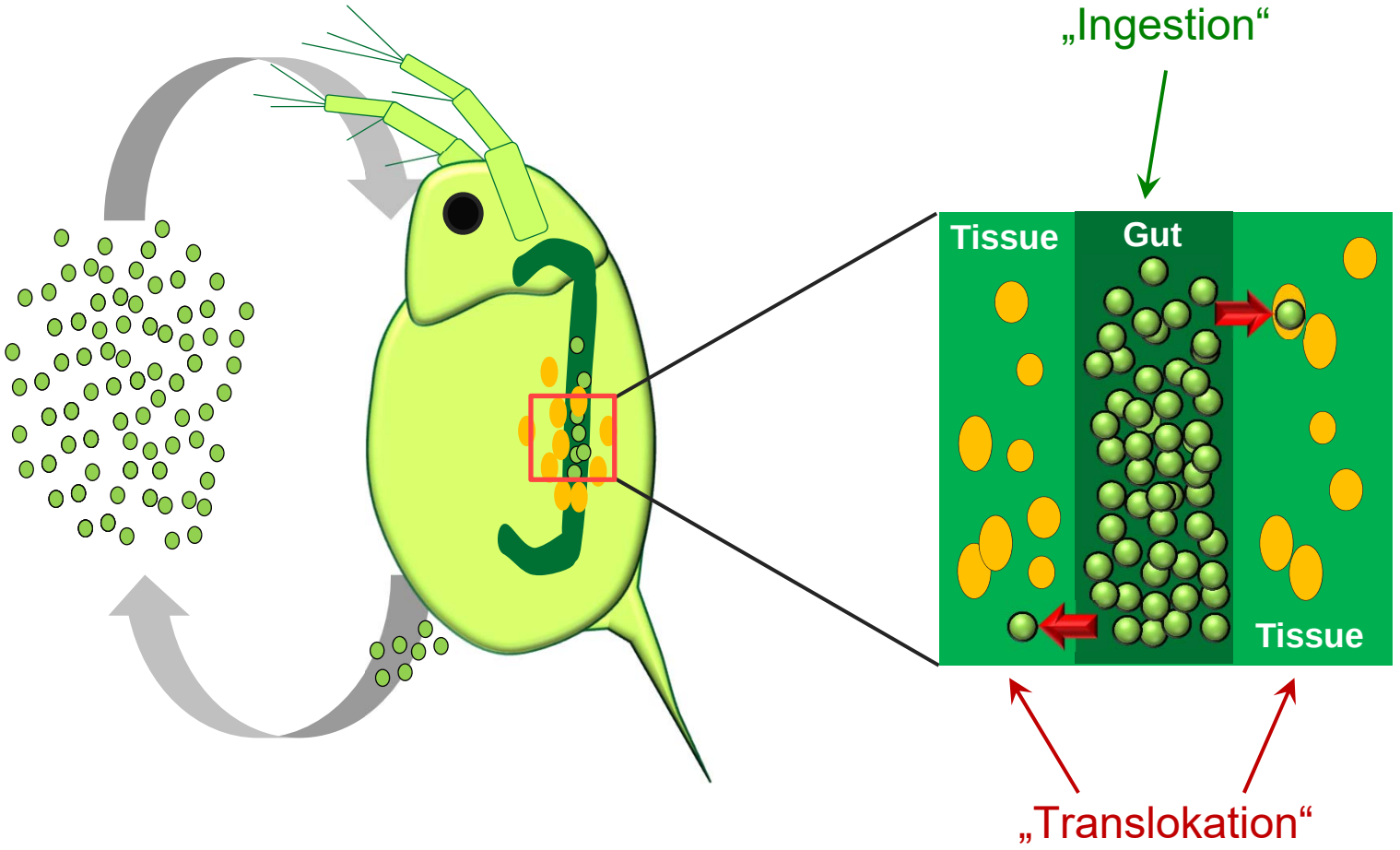
Ory et al. (2017) Sci. Total Environ. 586, 430-437

Mikroplastik in Organismen (Labor)

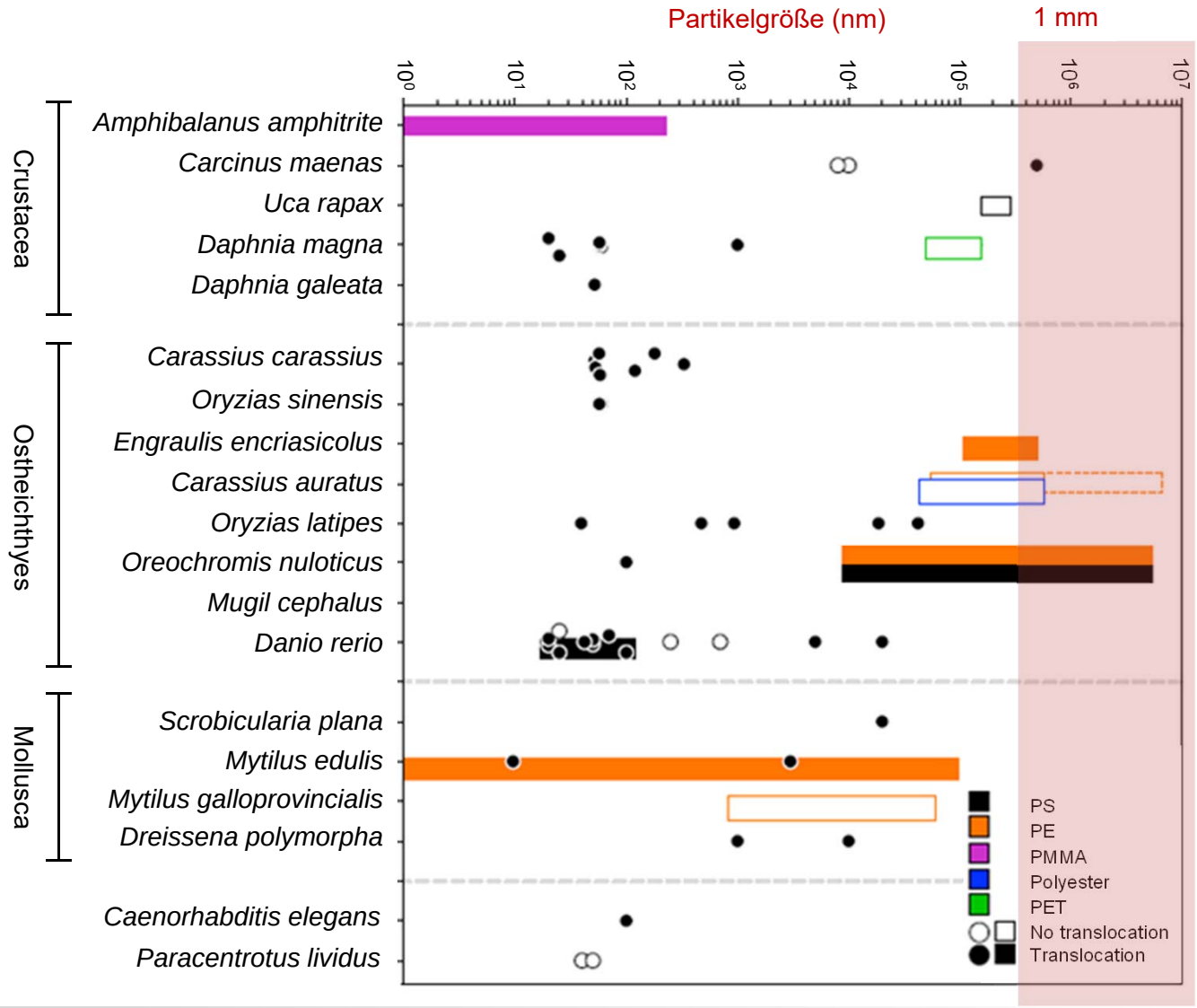


Cole et al. (2013) Environ. Sci. Technol. 47, 6646-6655

Nomenklatur: Aufnahme von Mikroplastik in Organismen



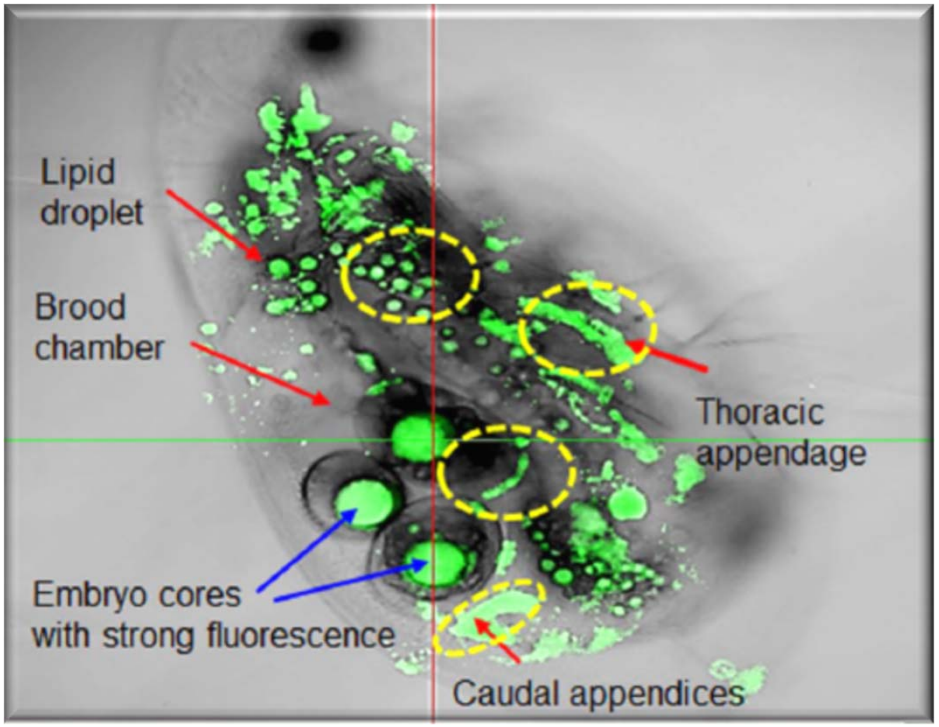
Aufnahme von Mikroplastik in Süßwasserorganismen



31 Studien
18 Arten
5 Polymere
22 Translokation

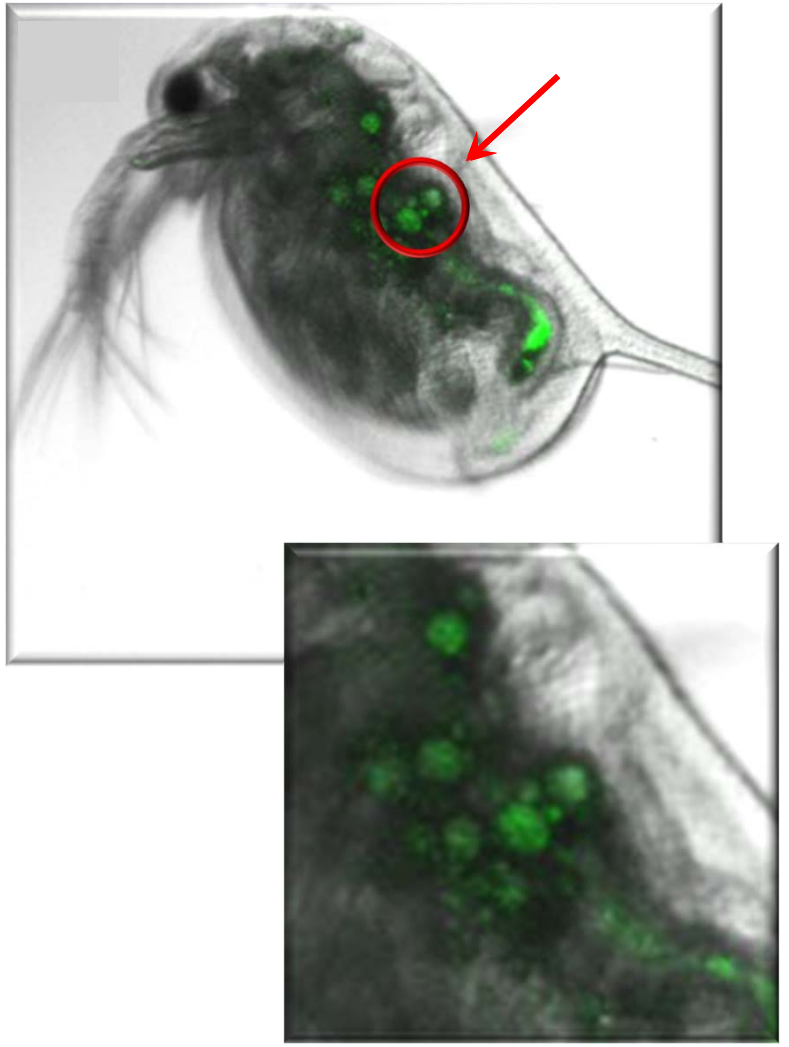
Triebskorn et al. (2019) TrAC 110: 375-392

„Translokation“ von Mikroplastik



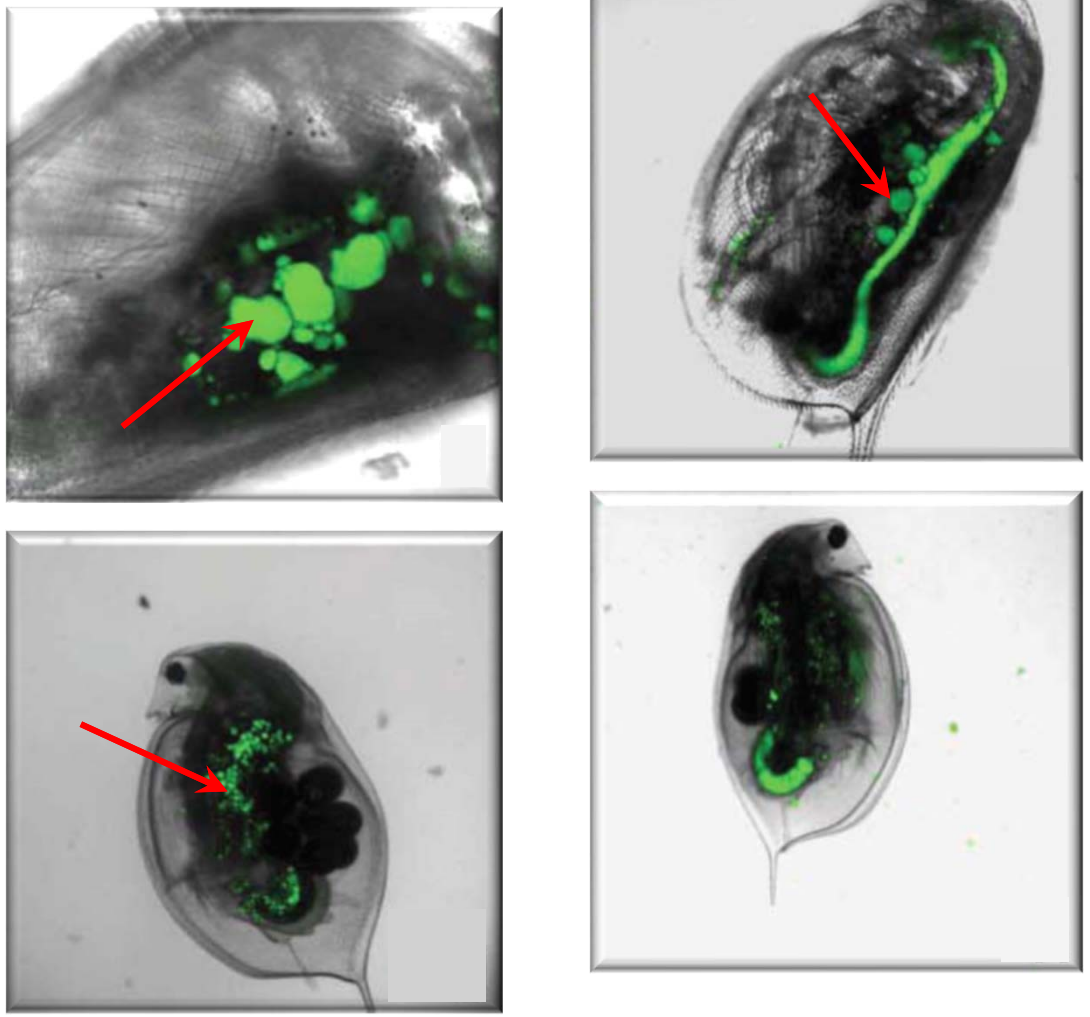
Cui et al. (2017) Sci. Rep. 8: 284

Chae et al. (2018) Sci. Rep. 7: 12095



„Translokation“ von Mikroplastik

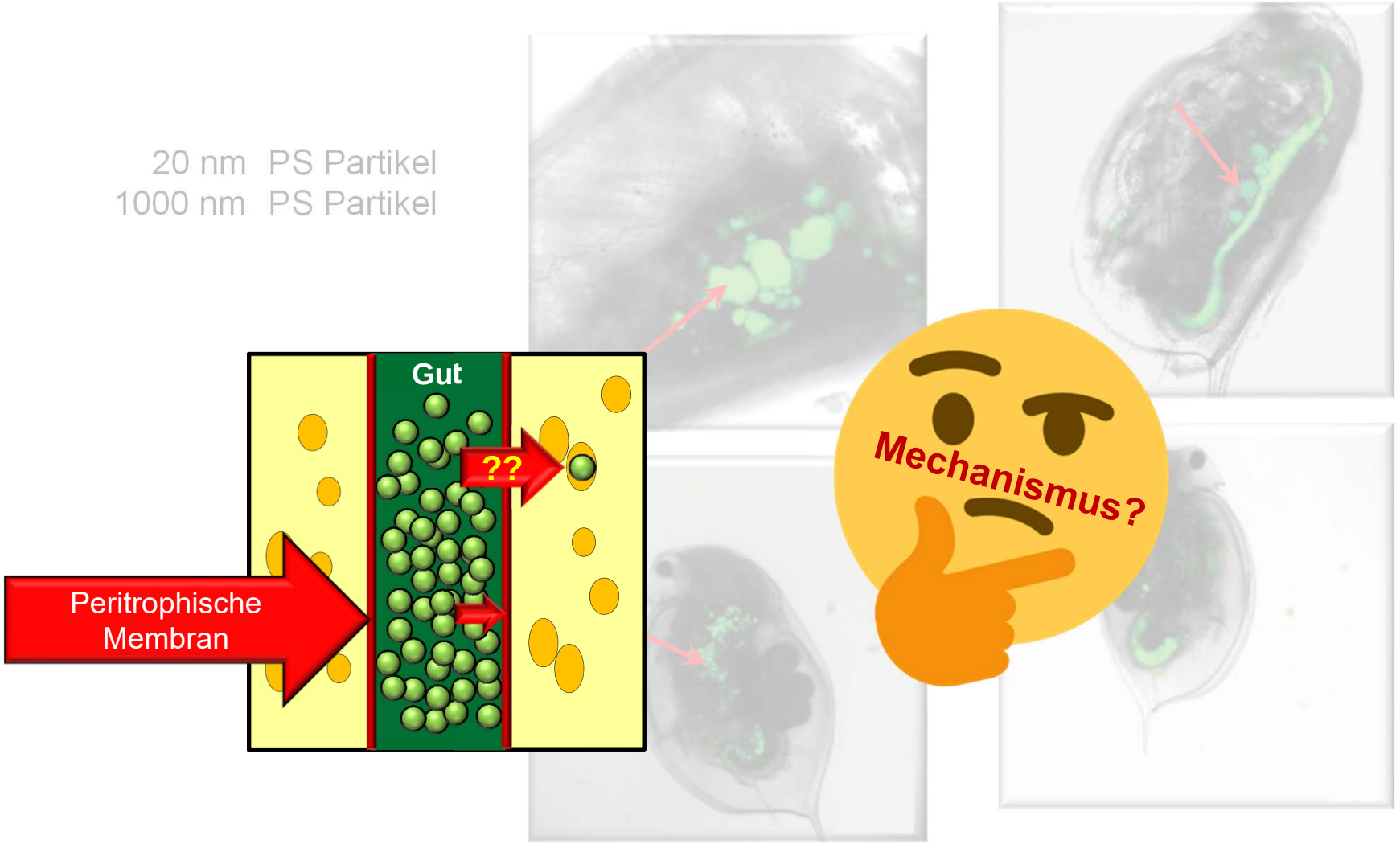
20 nm PS Partikel
1000 nm PS Partikel



Rosenkranz et al. (2009) Environ. Toxicol. Chem. 28: 2142-2149

„Translokation“ von Mikroplastik?

20 nm PS Partikel
1000 nm PS Partikel

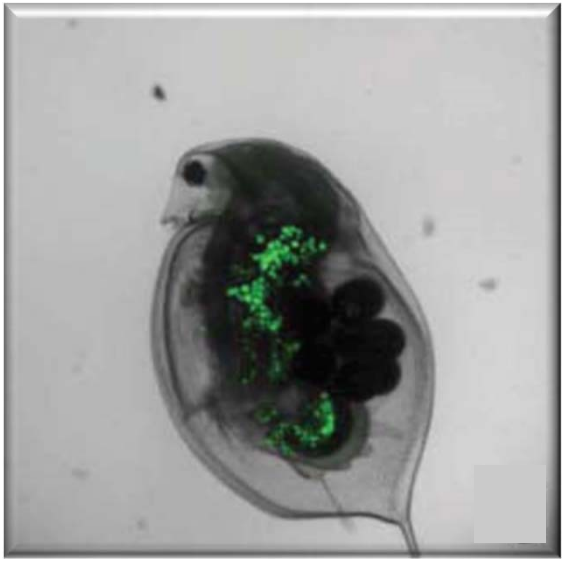


„Translokation“ von Mikroplastik

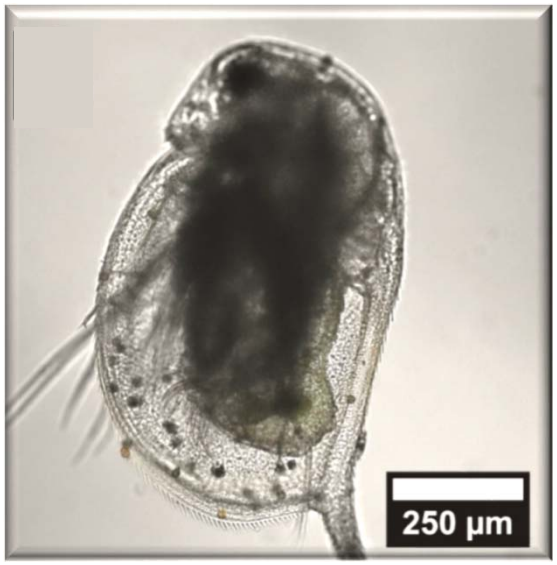
GOETHE UNIVERSITÄT FRANKFURT AM MAIN

Christof Schür

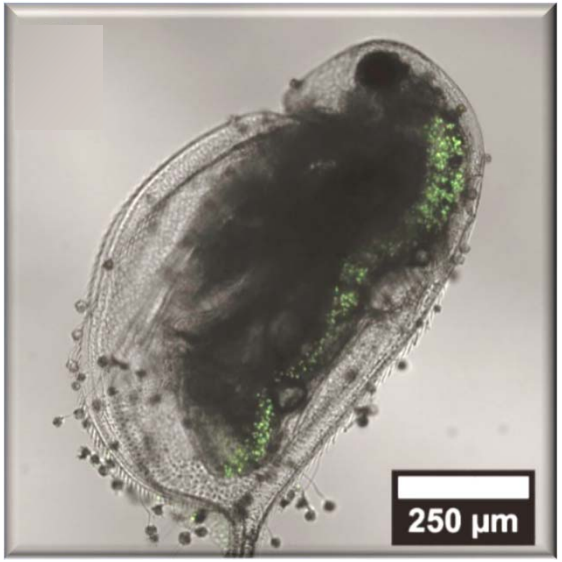
Rosenkranz et al. (2009)



20 nm Schürr



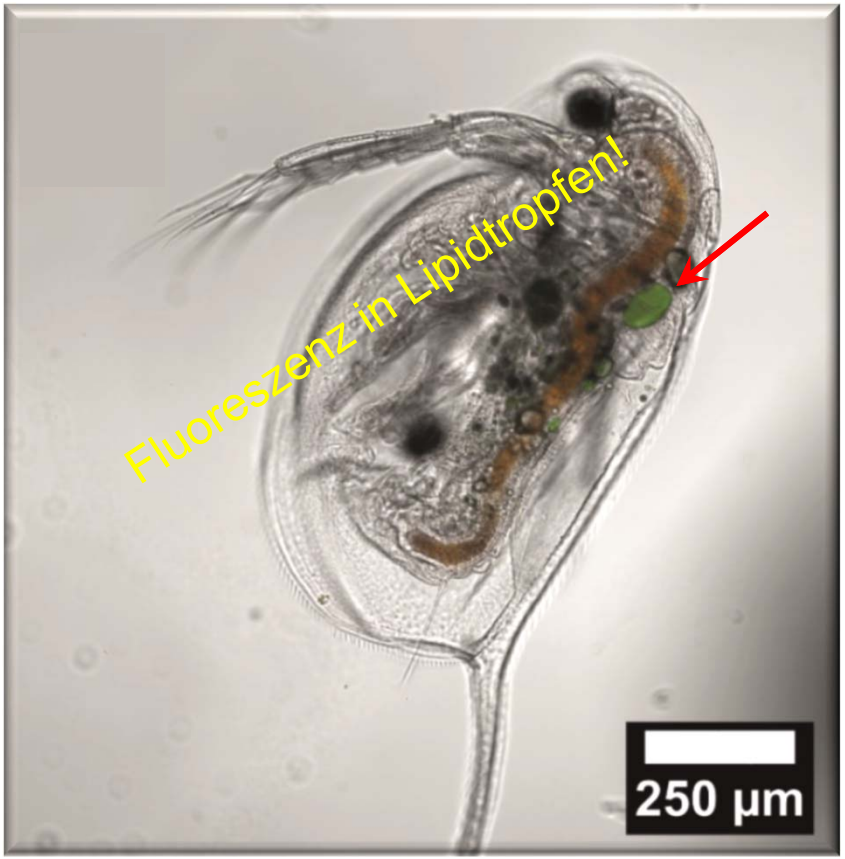
1000 nm Schürr



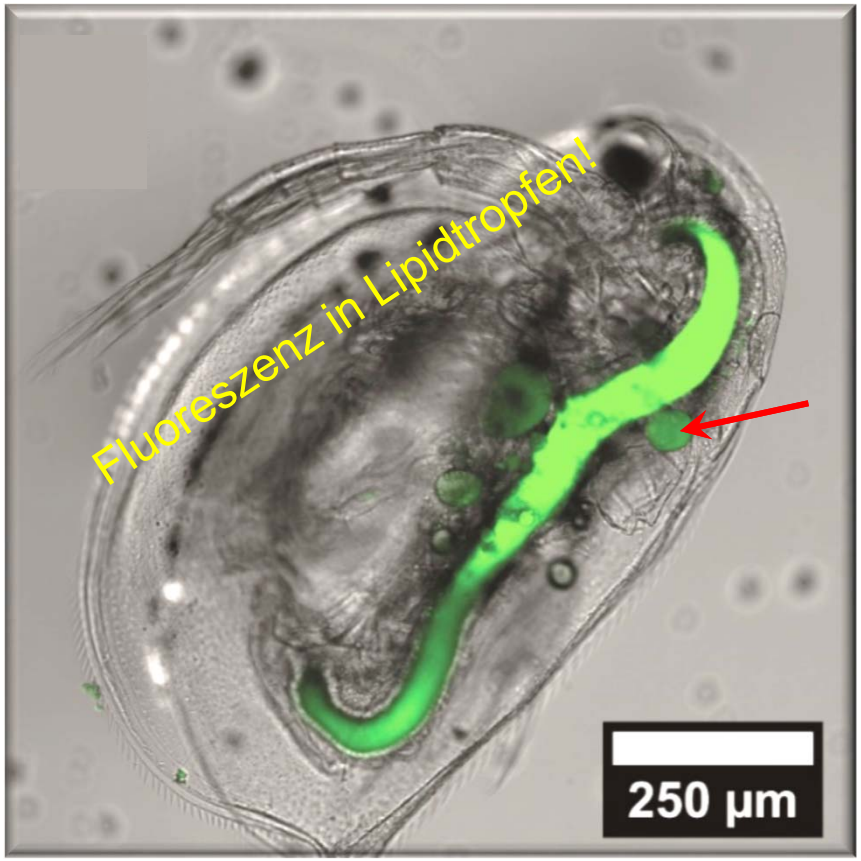
MiWA

„Translokation“ von Mikroplastik

20 nm



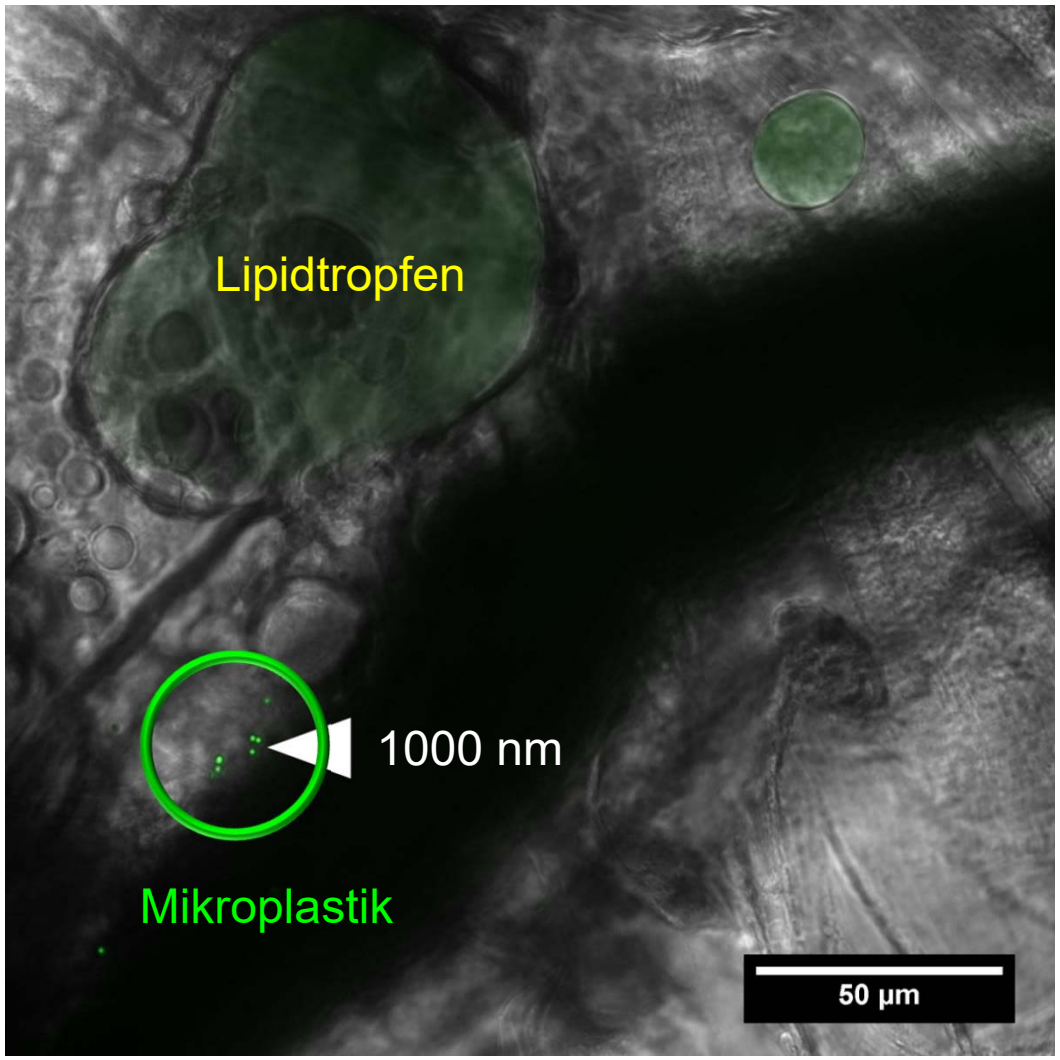
1000 nm



MiWA

„Translokation“ von Mikroplastik

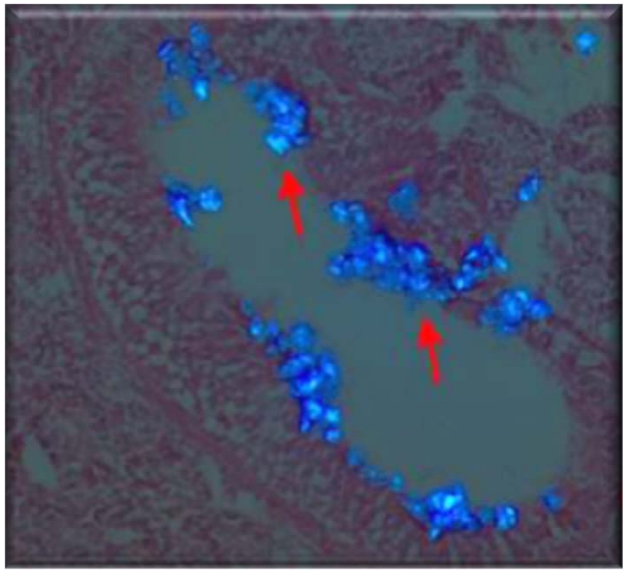
- nicht reproduzierbar unter Bedingungen im Paper
- produzierbar mit 1000× höheren Konzentrationen
- Fluoreszenz unabhängig von Partikeln
- nicht alles, was leuchtet, ist ein Partikel
- biologische Plausibilität??

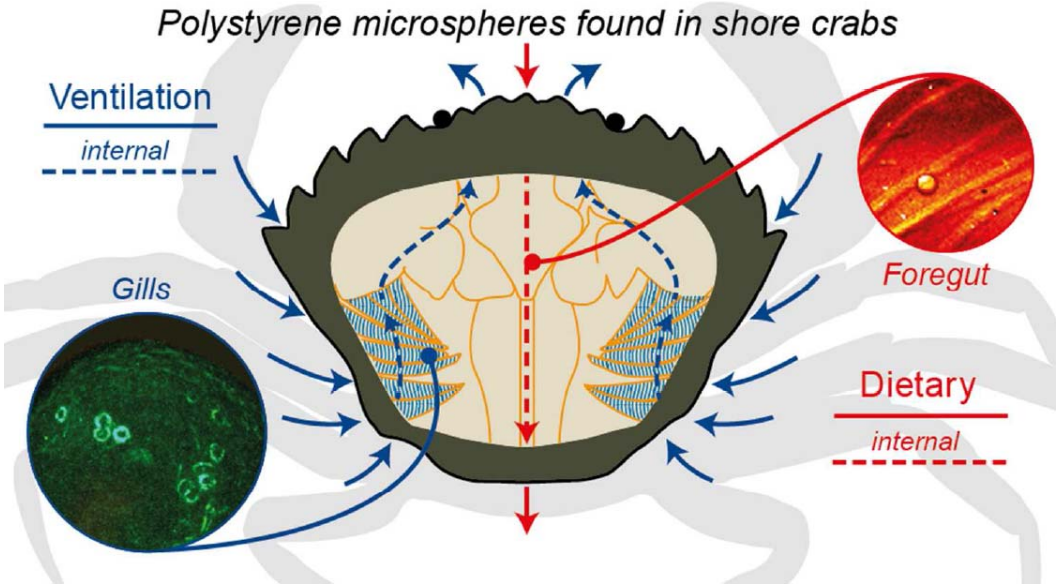


Schür et al. (2019) Environ. Toxicol. Chem. 38: 1495-1503

Mikroplastik in Organismen

- Moos et al. (2012): Hämolymphe von Miesmuscheln (*Mytilus edulis*)
- Teuthen et al. (2009): Wattwurm (*Arenicola marina*)
- Watts et al. (2014): Trophischer Transfer von Miesmuscheln auf Strandkrabben (*Carcinus maenas*)
- Chua et al. (2009): Aufnahme in Amphipoden und Transfer von Flammschutzmitteln



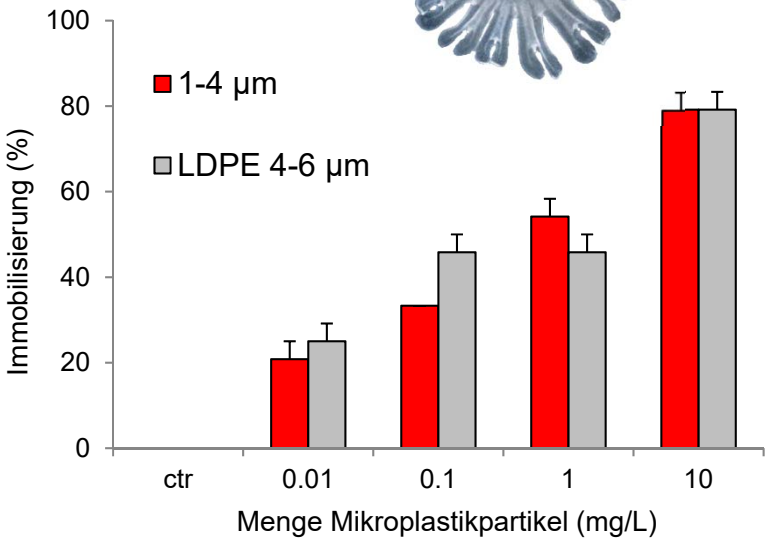


Mikroplastik in Organismen: Der Fall der Ephyra von *Aurelia aurita*

EPHEMARE
ECOTOXICOLOGICAL EFFECTS OF MICROPLASTICS IN MARINE ECOSYSTEMS
JPI OCEANS

Immobilisierung

der Larven von *Aurelia aurita*



ISMAR

Wirkung von Mikroplastik: Weitere Untersuchungen an Wirbellosen

Marine Pollution Bulletin 138 (2019) 58–62

Contents lists available at ScienceDirect

Marine Pollution Bulletin

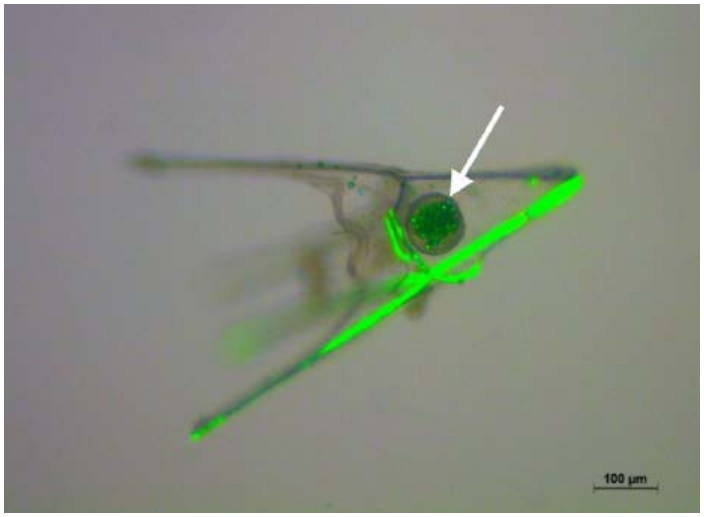
journal homepage: www.elsevier.com/locate/marpolbul

Microplastics do not increase toxicity of a hydrophobic organic chemical to marine plankton

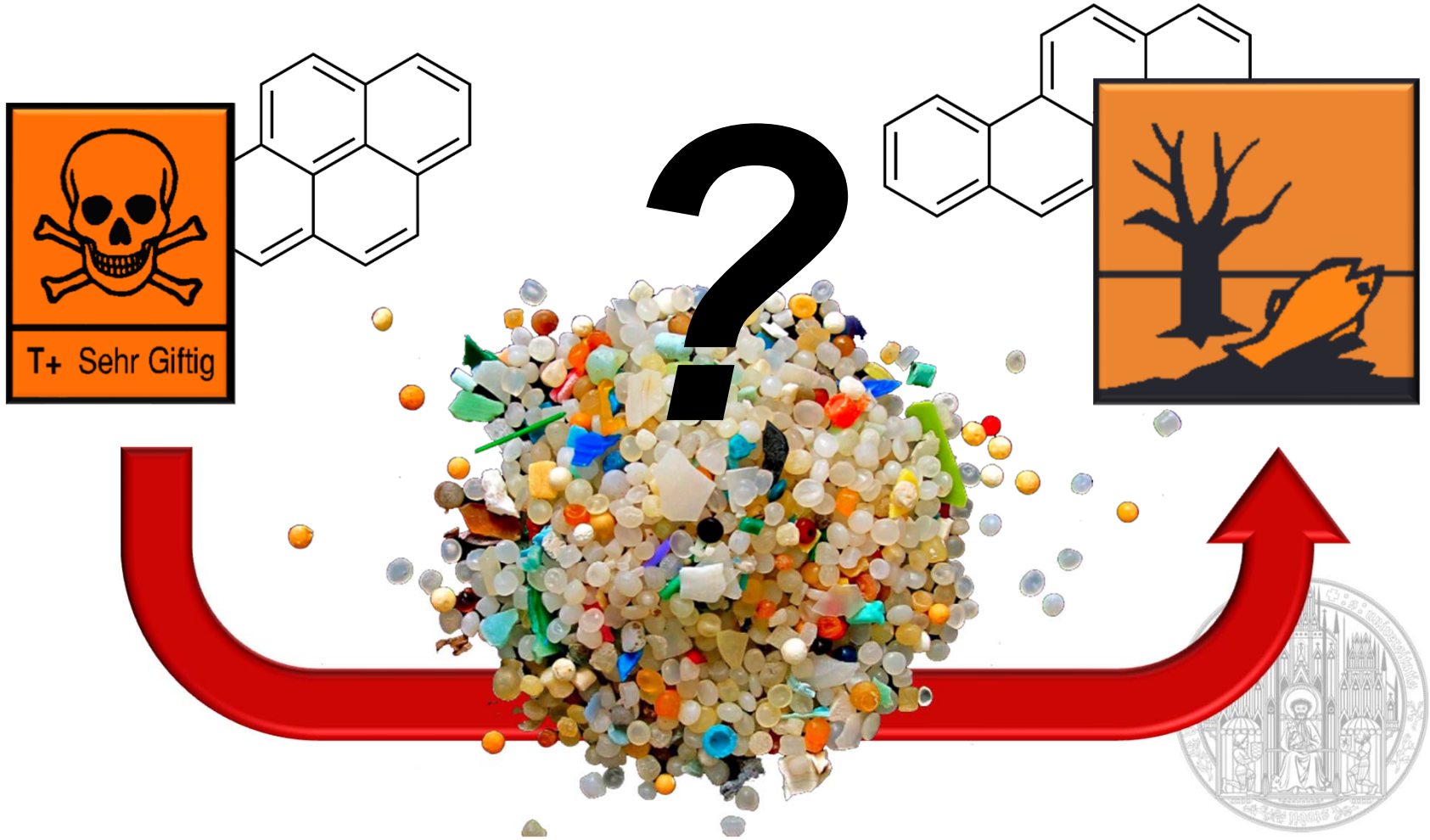
Ricardo Beiras[a,b], Tania Tato[a,*]

[a] ECIMAT, Universidade de Vigo, Illa de Toralla, E-36331 Vigo, Galicia, Spain
[b] Departamento de Ecoloxía e Bioloxía Animal, Universidade de Vigo, Campus Lagoas-Marcosende, E-36200 Vigo, Galicia, Spain

„These results challenge the hypothetical role of MP as vectors of organic contaminants to marine food webs“

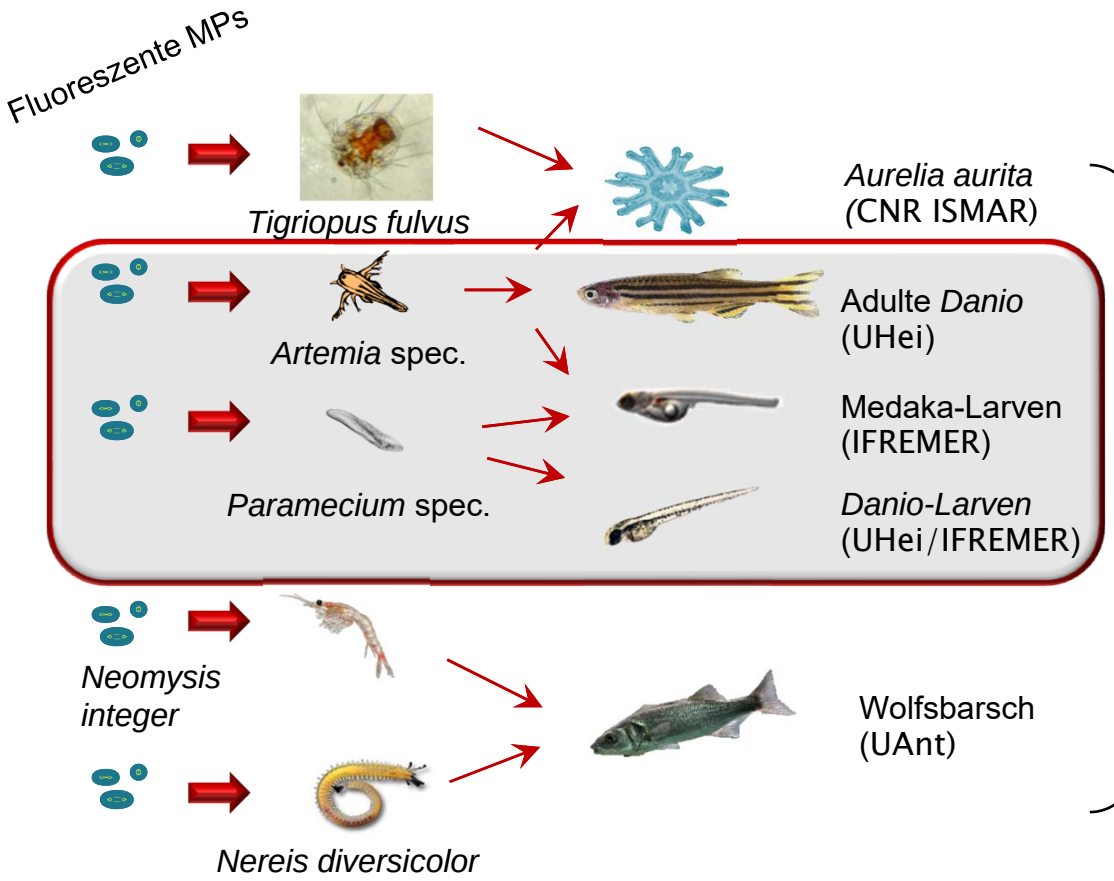


Mikroplastik als Vektor für persistierende organische Schadstoffe?



Experimente zum “Trophischen Transfer”

EPHEMARE
ECOTOXICOLOGICAL EFFECTS OF MICROPLASTICS IN MARINE ECOSYSTEMS



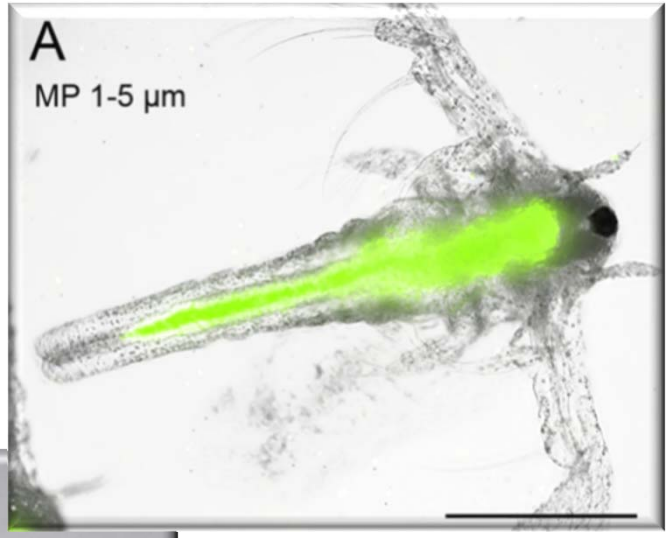
- Aufnahme-, Transfer- und Akkumulationsmuster
- Histologische Analyse
- Fluoreszenzmikroskopie
- Transferkinetik
- Fütterung mit POP-beladenen MPs

Die Modellnahrungskette Krebslarven → Zebrafische

Krebslarven (*Artemia*)

Mikroplastikpartikel 1 - 5 µm:

nach 3 Std. 95 % aufgenommen



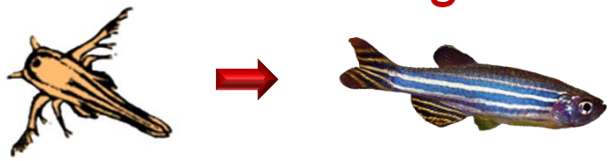
Mikroplastikpartikel 10 - 20 µm:

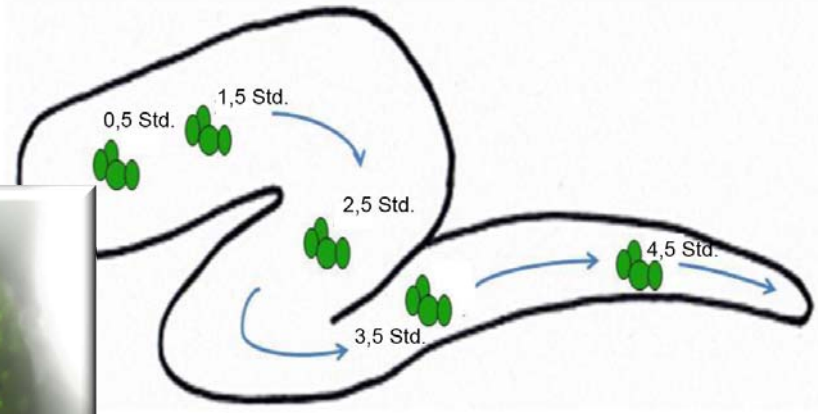
nach 3 Std. 80 % aufgenommen

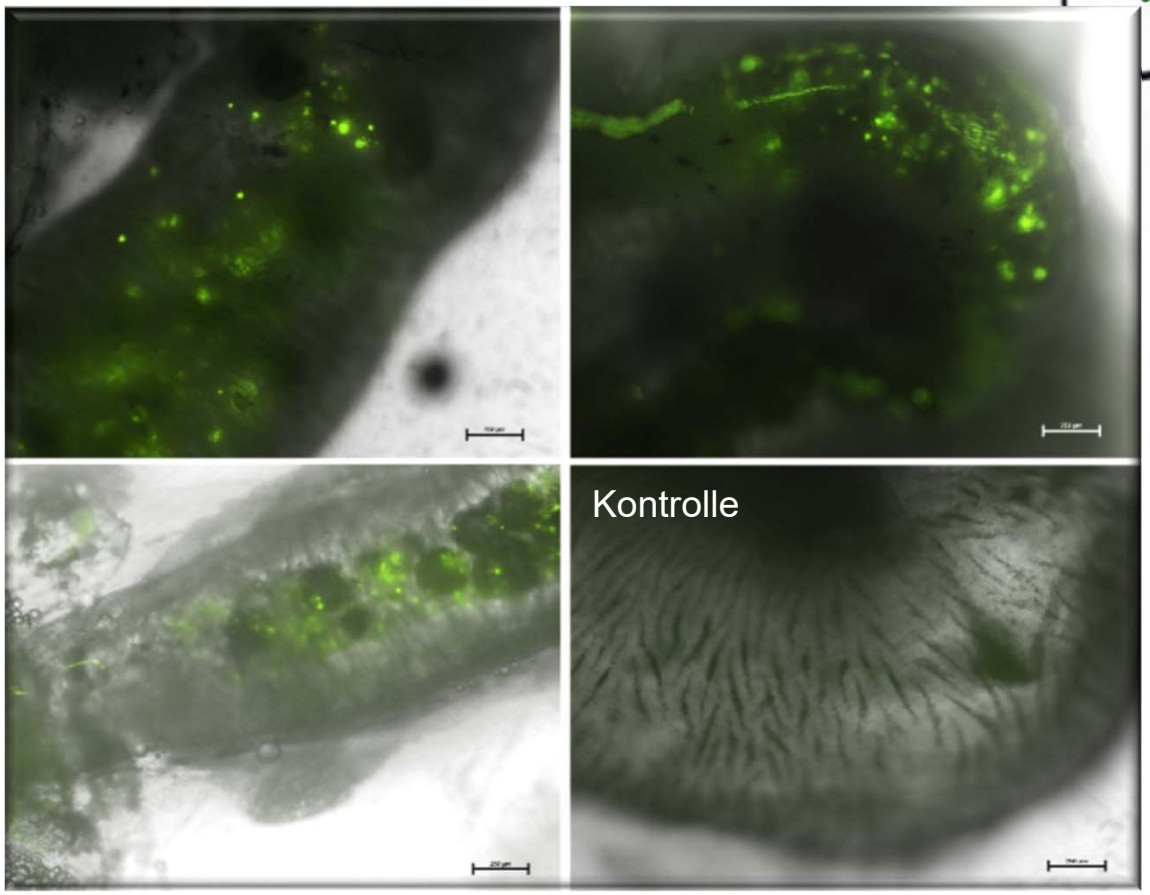
nach 24 Std. 95 % aufgenommen

Batel et al. (2016) Environ. Toxicol. Chem. 35, 1656-1666

Die Modellnahrungskette Krebslarven → Zebrafische





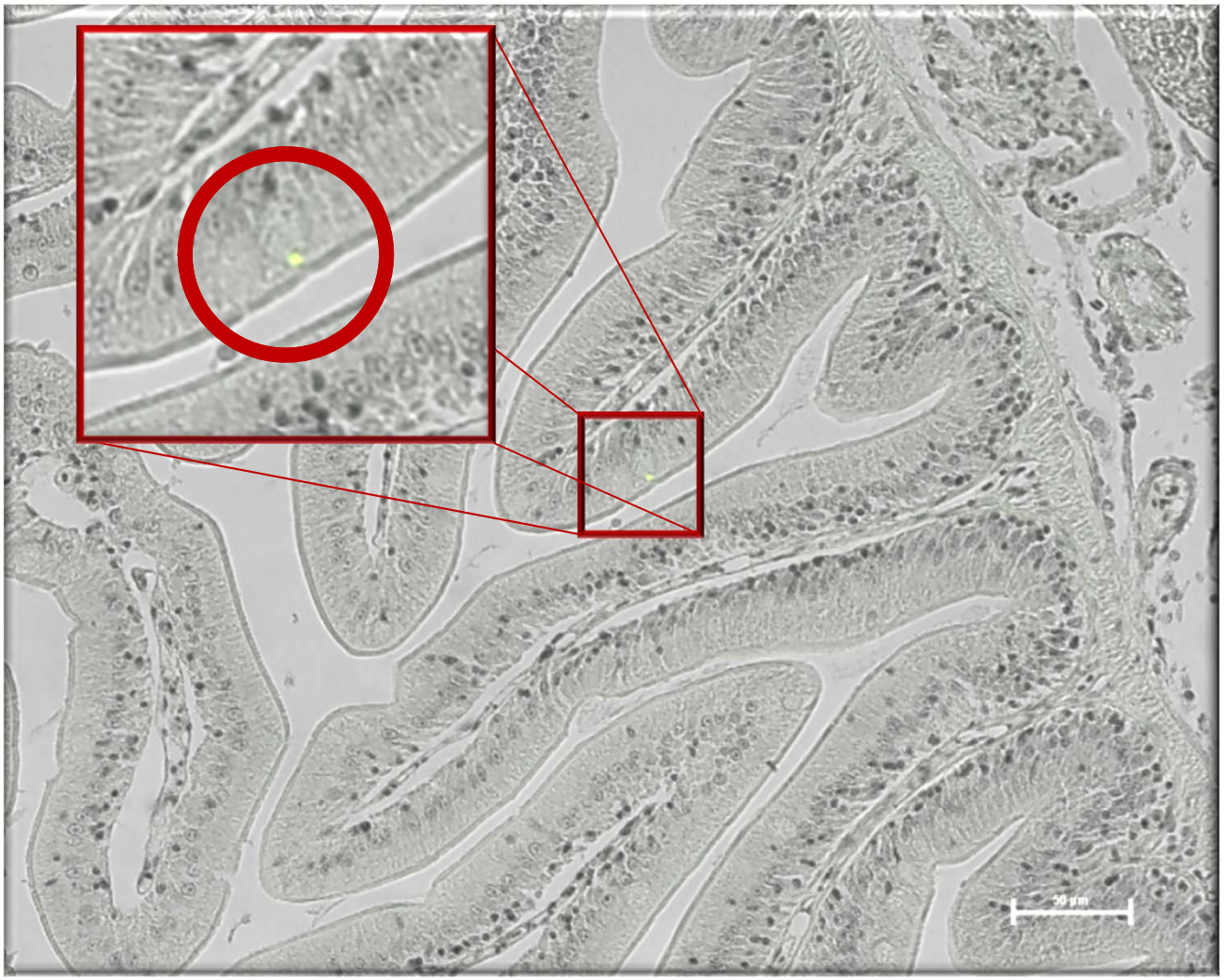


Darmtrakt Zebrabärbling nach Fütterung mit *Artemia*-Nauplien (mit Mikroplastikpartikeln)

Adulte Zebrafische: Mikroplastik nach 4 - 6 h ausgeschieden

Batel et al. (2016) Environ. Toxicol. Chem. 35, 1656-1666

Die Modellnahrungskette Krebslarven → Zebrafische



Nur sehr wenige Mikroplastikpar-tikel werden von den Darmzellen aufgenommen.

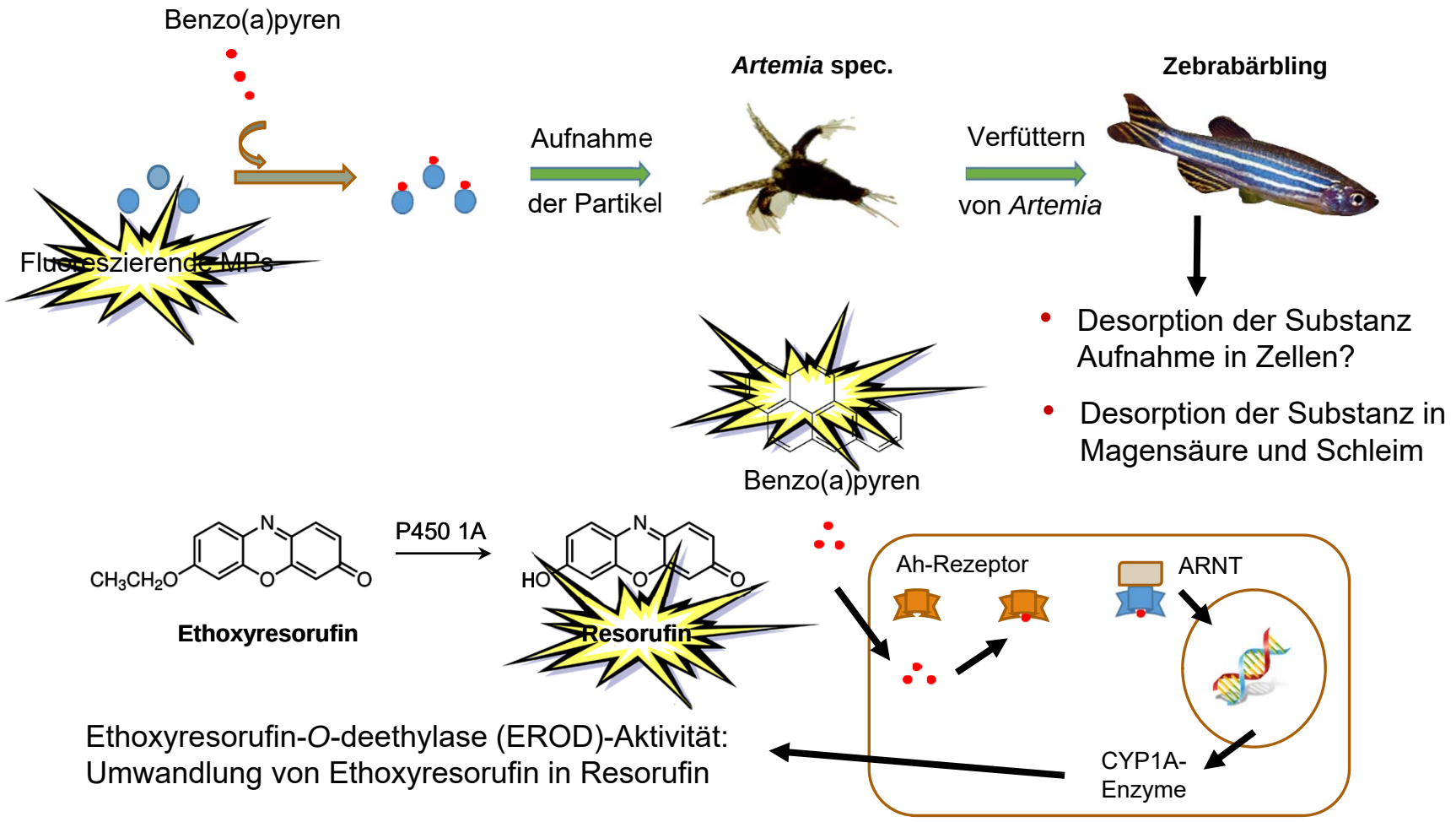
Mikroplastik *per se* ist zumindest bei Fischen relativ unkritisch.

Nanoplastik??

(Partikel < 1 µm)

Batel et al. (2016) Environ. Toxicol. Chem. 35, 1656-1666

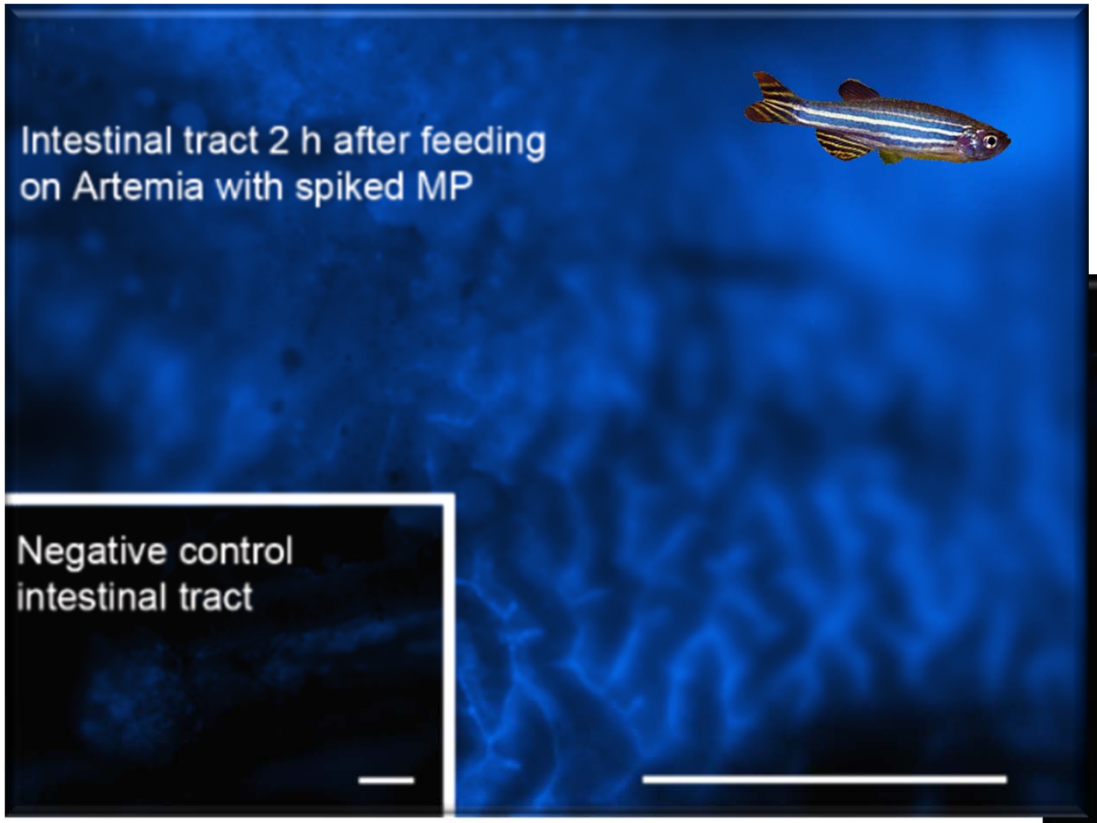
Mikroplastik als Vektor für Schadstoffe: Benzo[a]pyren



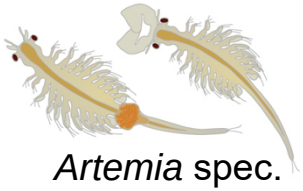
Ethoxyresorufin-*O*-deethylase (EROD)-Aktivität:
Umwandlung von Ethoxyresorufin in Resorufin

Batel et al. (2016) Environ. Toxicol. Chem. 35, 1656-1666

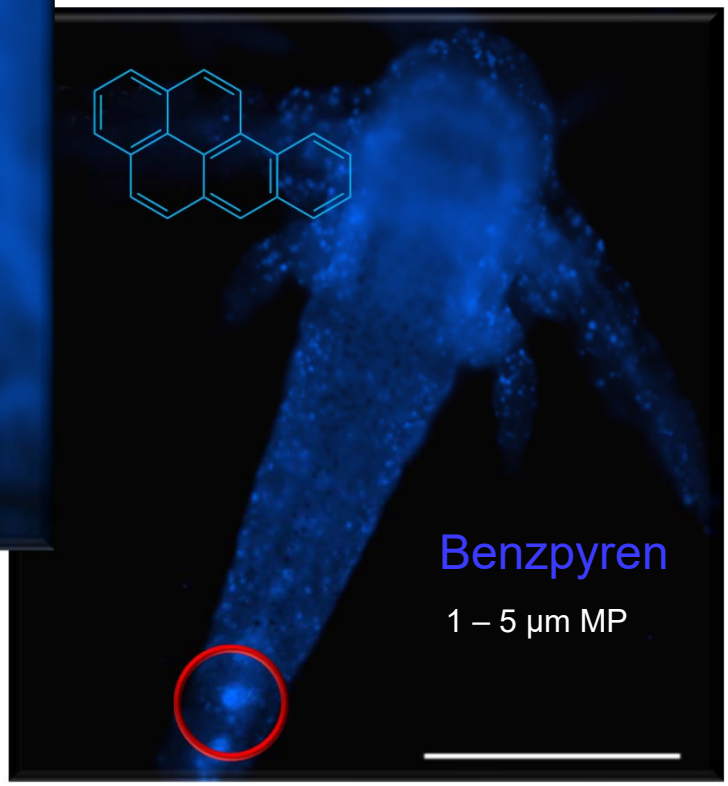
Fluoreszenz-Tracking von Benzpyren auf Mikroplastikpartikeln



Darm Zebrabärbling (*Danio rerio*)

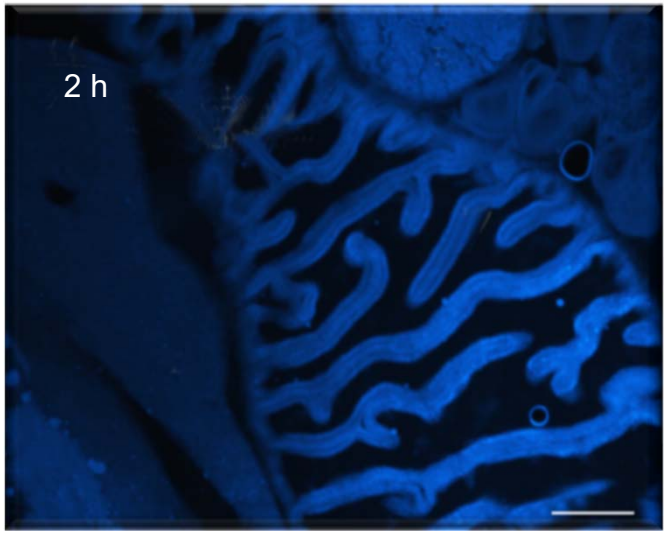


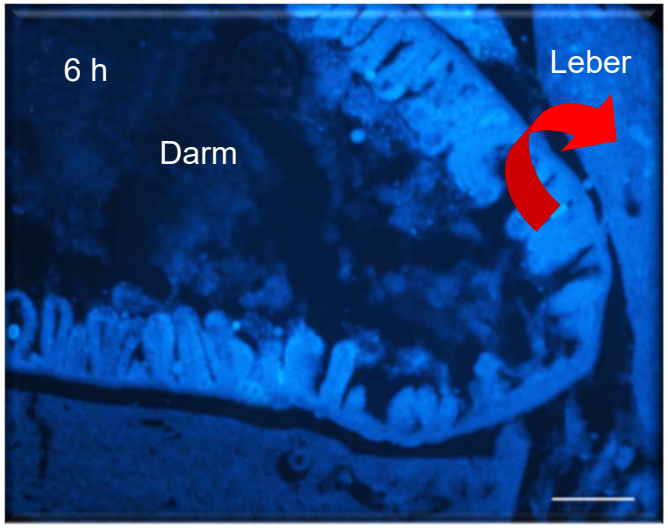
Artemia spec.



Batel et al. (2016) Environ. Toxicol. Chem. 35, 1656-1666

Fluoreszenz-Tracking von Benzpyren auf Mikroplastikpartikeln





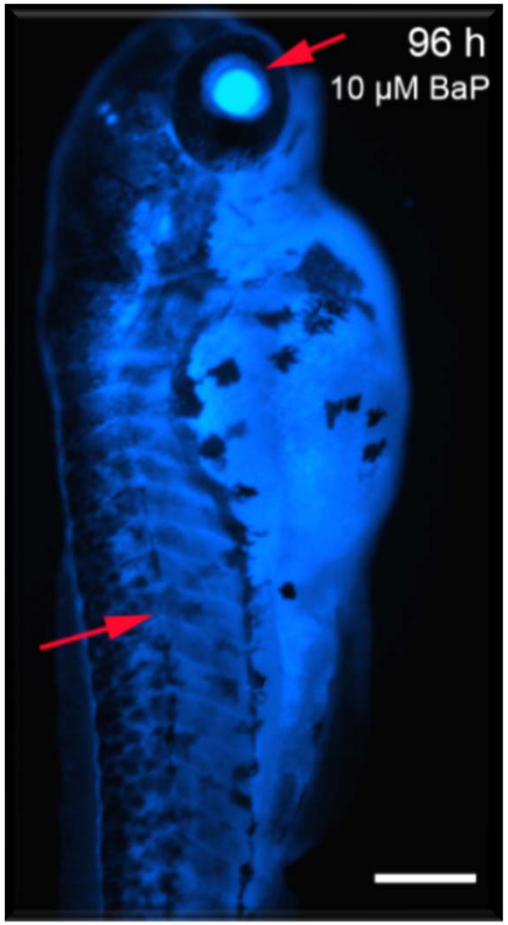
Mikroplastikpartikel wirken als Vektor für Schadstoffe.

Fütterung mit Nauplien, die mit BaP-beladenen Mikroplastikpartikeln gefüttert worden waren

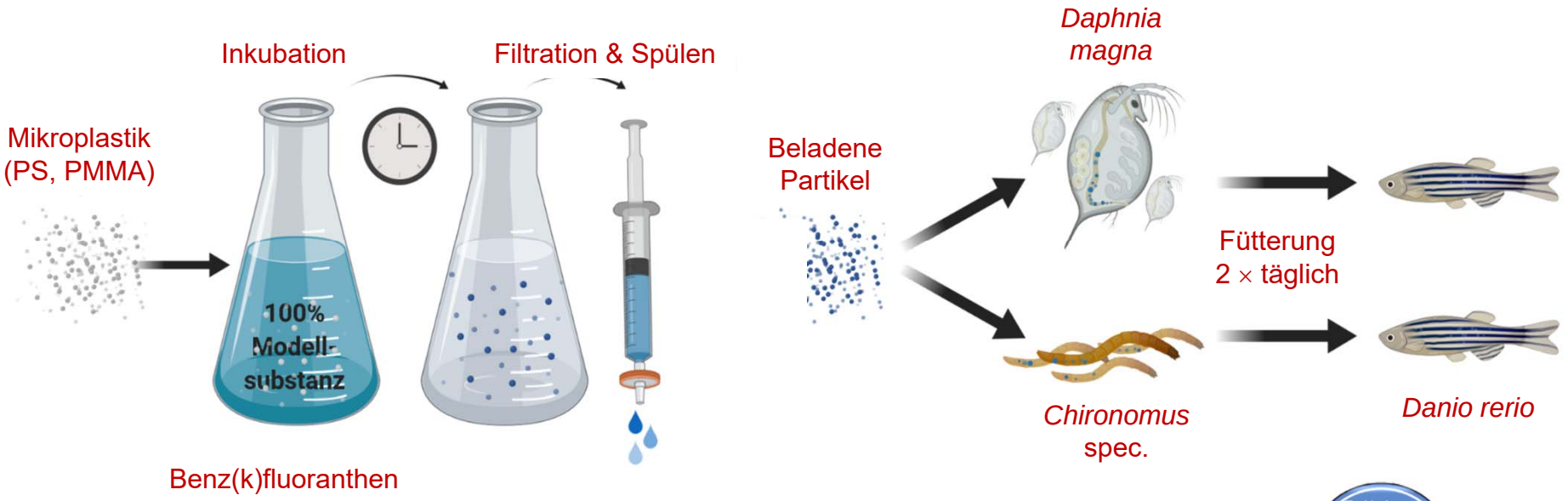
Batel et al. (2016) Environ. Toxicol. Chem. 35, 1656-1666

Was bedeutet nun Mikroplastik für den Menschen?

- Mikroplastik wird **über Nahrungsnetze an höhere Organismen weitergegeben**
- Mikroplastik *per se* stellt **für den Menschen zunächst keine große Gefahr** dar
- Aber: **Schadstoffe** lagern sich in (sehr) hoher Konzentration auf Mikroplastik an und **können weitergeben werden**

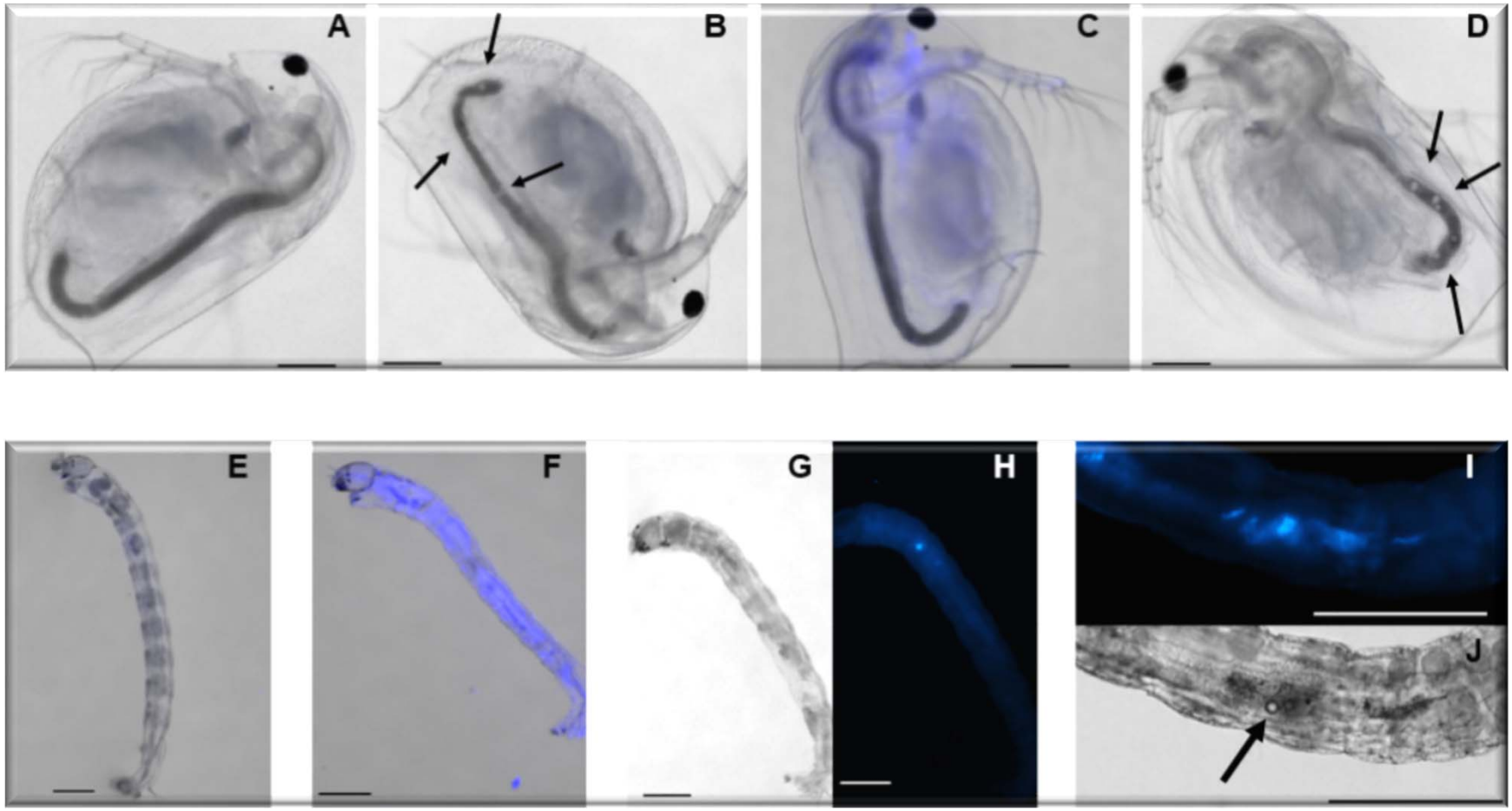


Transfer von Mikroplastik in Nahrungsnetzen

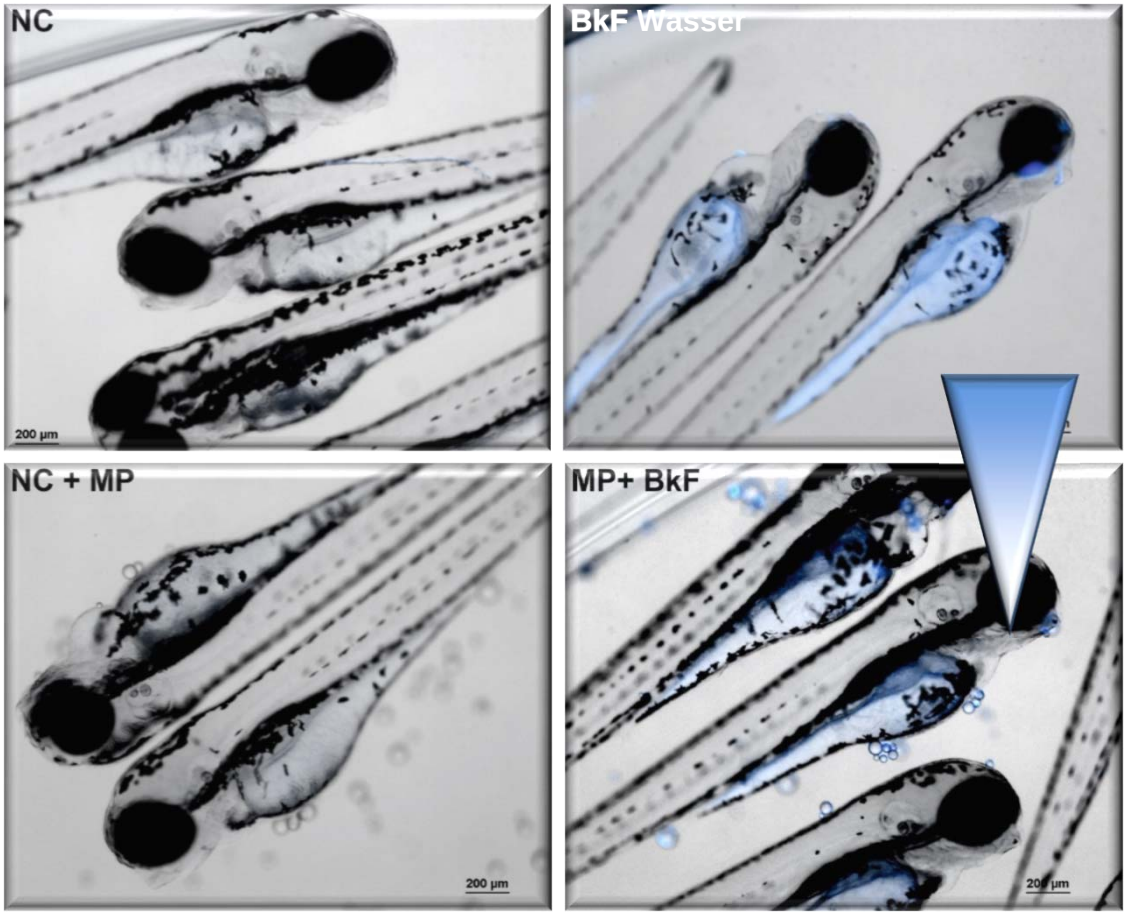


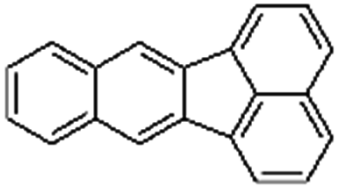
Visuelle Detektion *via* Fluoreszenz von Benz(k)fluoranthen

Transfer von Mikroplastik → Wirbellose



Anteil des Transfers von Schadstoffen an der Toxizität





Benz[k]fluoranthen:

Log K_{OW} 6,11; 403 nm

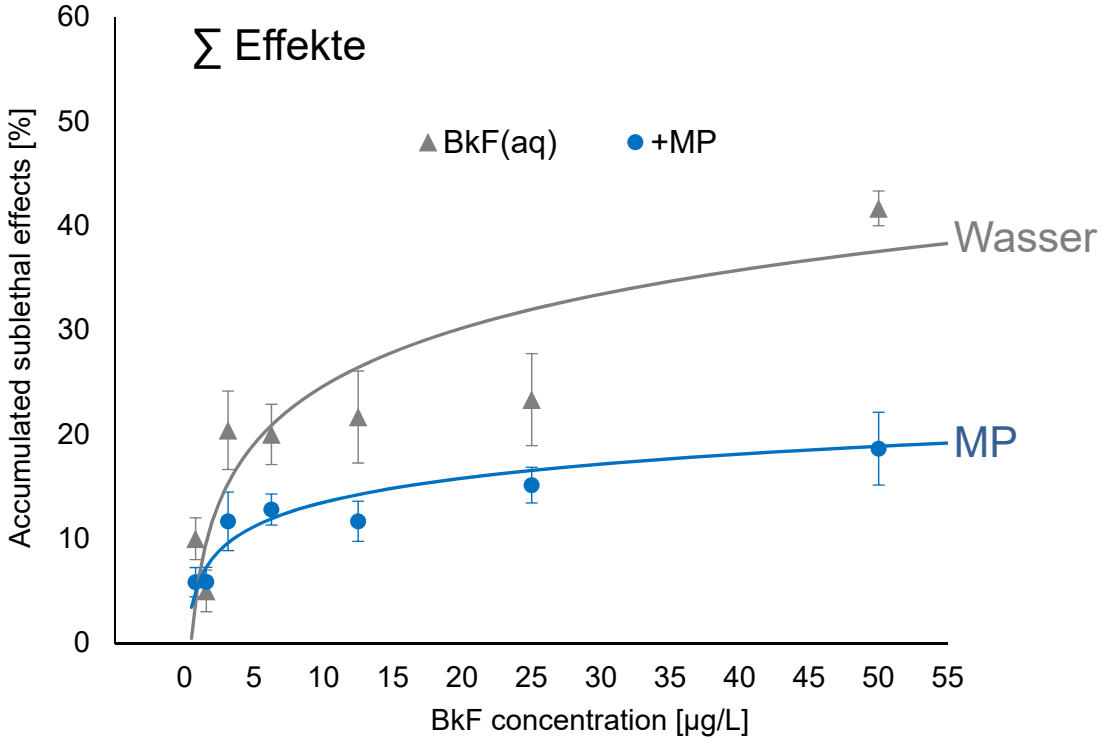
GC-MS-Analytik:

- 80 % BkF auf Mikroplastik
- 10 % in der Wasserphase
- 10 % an der Glaswand

HOCHSCHULE FRESENIUS
UNIVERSITY OF APPLIED SCIENCES

MiWA

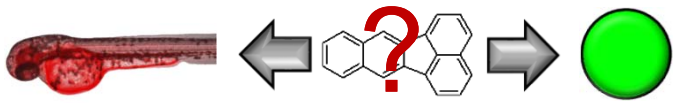
Anteil des Transfers von Schadstoffen an der Toxizität



Toxizität Benz[k]fluoranthen:

- EC_{10} = 15 µg/L *via* Mikroplastik
- EC_{10} = 1,4 µg/L *via* Wasser

Mikroplastik konkurriert mit Organismen um Schadstoffe



Transfer von Schadstoffen über Mikroplastik

Environmental Research 167 (2018) 411–417

Contents lists available at ScienceDirect

Environmental Research

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

Short communication

Ingested microplastic as a two-way transporter for PBDEs in *Talitrus saltator*

Costanza Scopetani[a,*], Alessandra Cincinelli[a,*], Tania Martellini[a], Emilia Lombardini[a], Alice Ciofini[b], Alessia Fortunati[a], Vittorio Pasquali[c], Samuele Ciattini[d], Alberto

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[b] Department of Biology, University of Florence, Via Romana 17, 50125 Florence, Italy
[c] Psychology Department—Neuroscience Section Medicine and Psychology Faculty, "Sapienza" University, Vi
[d] Centro di Cristallografia, University of Florence, Via della Lastruccia 3, I-50019 Sesto Fiorentino, Fl

ARTICLE INFO

Keywords:
Microplastics
PBDEs
Talitrus saltator
Key species
POPs

ABSTR

ation of plastic waste into the marine environment are well known environmental (MPs) end up in sea waters and, due to their hydrophobicity and high surface/volume ratio, sorb and accumulate to their surface. The supralittoral amphipod *Talitrus saltator (T. saltator)* was d to study the role of MPs in the transfer of organic pollutants and to investigate if ingested MPs could either transfer contaminants to biota or clean it adsorbing pollutants taken from the diet. *T. saltator* is an established POPs (Persistent Organic Pollutants) biomonitor in coastal environments and it is able to swallow microplastics in natural condition.

Two laboratory experiments were performed and *T. saltator* was exposed to a labelled polybrominated diphenyl ether (^{13}C-labelled BDE-47) to investigate the opposite gradient role of MPs. X Ray Micro-CT (*Micro-Computed Tomography)* analyses were also performed on sandhopper samples to evaluate the uptake of MPs via digestive tract. The results showed that MPs ingestion could whether transfer and remove contaminants from *T. saltator*, indicating a partial balance among positive and negative effects. This study has underlined MP potential double role demonstrating that MP can act both as a carrier and scavenger for the bioaccumulation of organic pollutants (i.e. PBDEs), suggesting that chemicals leaching from MPs could have a limited impact to biota.

whether transfer and remove contaminants

Environmental Toxicology and Chemistry—Volume 37, Number 11—pp. 2912–2918, 2018

Received: 24 May 2018 | Revised: 30 June 2018 | Accepted: 15 August 2018

Environmental Toxicology

No Evidence of Microplastic Impacts on Consumption or Growth of Larval *Pimephales promelas*

Timothy David Malinich,* Nathan Chou, Maria S. Sepúlveda, and Tomas O. Höök

Department of Forestry & Natural Resources, College of Agriculture, Purdue University, West Lafayette, Indiana, USA

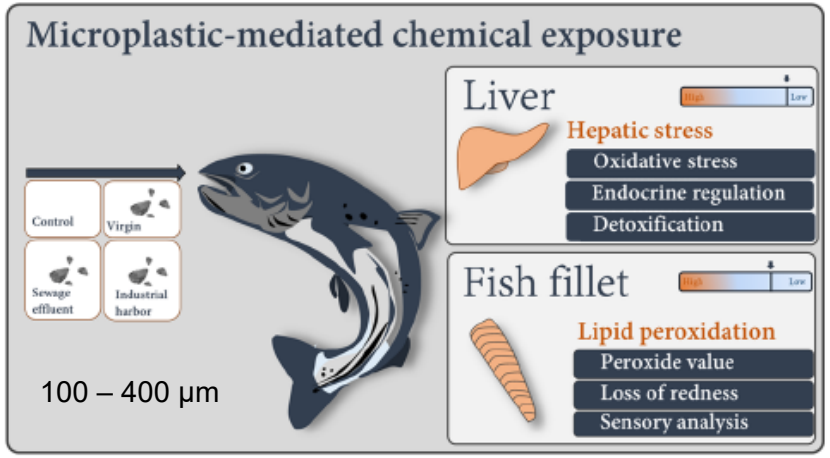
Abstract: Microplastics are an abundant pollutant in aquatic systems, but little is known regarding their effects on larval fish. We conducted foraging and growth experiments to observe how increasing densities of microplastics (polyethylene microspheres) impact the foraging and growth of *Pimephales promelas* larvae. We found minimal impacts on larval consumption of *Artemia* nauplii in the consumption study, as well as little impact on total length after 30 d of the growth experiment. *Environ Toxicol Chem* 2018;37:2912–2918. © 2018 SETAC

Keywords: Microspheres; Polyethylene; Larval fish; Freshwater toxicology; Behavioral toxicology; Microplastics

…kaum Effekte …

Was ist die Bedeutung von Mikroplastik?

…nichts zu befürchten…



Environmental Science & Technology

Article

Cite This: Environ. Sci. Technol. 2018, 52, 14381–14391

pubs.acs.org/est

Size Matters: Ingestion of Relatively Large Microplastics Contaminated with Environmental Pollutants Posed Little Risk for Fish Health and Fillet Quality

Giedrė Ašmonaitė,*[,†] Karin Larsson,[‡] Ingrid Undeland,[‡] Joachim Sturve,[†] and Bethanie Carney Almroth[†]

[†]Department of Biological and Environmental Sciences, University of Gothenburg, Medicinaregatan 18A, 413 90 Göteborg, Sweden

[‡]Department of Biology and Biological Engineering-Food and Nutrition Science, Chalmers University of Technology, Kemivägen 10, 412 96 Göteborg, Sweden

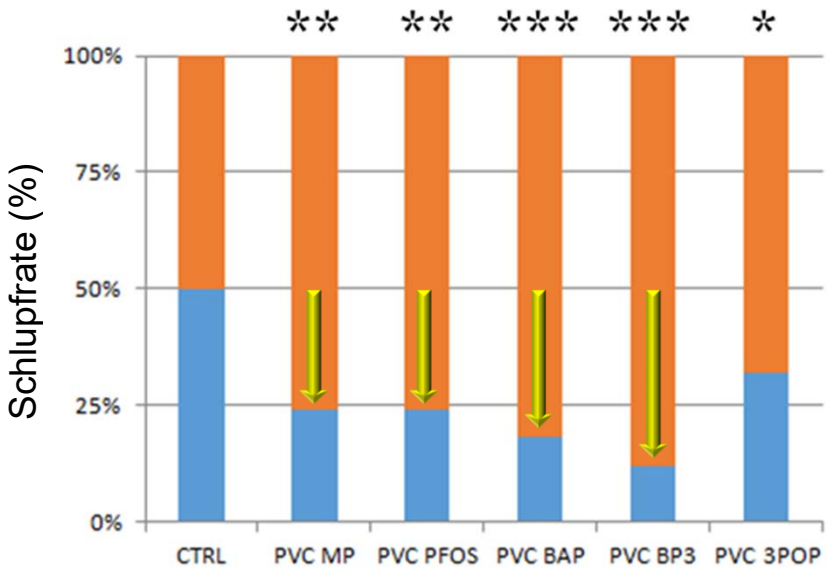
Langzeitexposition von Fischen?

Xavier Cousin

EPHEMARE
ECOTOXICOLOGICAL EFFECTS OF MICROPLASTICS IN MARINE ECOSYSTEMS

Ifremer

3 Monate



3 Monate

Mittel- und langfristige Belastung mit nativen MP, mit schadstoffbeladenen MPs sowie mit belasteten MPs aus dem Freiland reduzieren den Reproduktionserfolg von Fischen

Environmental Toxicology and Chemistry—Volume 37, Number 11—pp. 2776–2796, 2018

Received: 3 May 2018 | Revised: 30 May 2018 | Accepted: 4 September 2018

Critical Review

Microplastics in the Aquatic Environment: Evidence for or Against Adverse Impacts and Major Knowledge Gaps

…wenig Effekte in umwelt-relevanten Konzentrationen…

Emily E. Burns and Alistair B.A. Boxall*

Environment Department, University of York, Heslington, United Kingdom

Abstract: There is increasing scientific and public concern over the presence of microplastics in the natural environment. We present the results of a systematic review of the literature to assess the weight of evidence for microplastics causing environmental harm. We conclude that microplastics do occur in surface water and sediments. Fragments and fibers predominate, with beads making up only a small proportion of the detected microplastic types. Concentrations detected are orders of magnitude lower than those reported to affect endpoints such as biochemistry, feeding, reproduction, growth, tissue inflammation and mortality in organisms. The evidence for microplastics acting as a vector for hydrophobic organic compounds to accumulate in organisms is also weak. The available data therefore suggest that these materials are not causing harm to the environment. There is, however, a mismatch between the particle types, size ranges, and concentrations of microplastics used in laboratory tests and those measured in the environment. Select environmental compartments have also received limited attention. There is an urgent need for studies that address this mismatch by performing high quality and more holistic monitoring studies alongside more environmentally realistic effects studies. Only then will we be able to fully characterize risks of microplastics to the environment to support the introduction of regulatory controls that can make a real positive difference to environmental quality. *Environ Toxicol Chem* 2018;37:2776–2796. © 2018 SETAC

Keywords: Microplastics; Species sensitivity distribution; Risk; Persistent organic pollutants

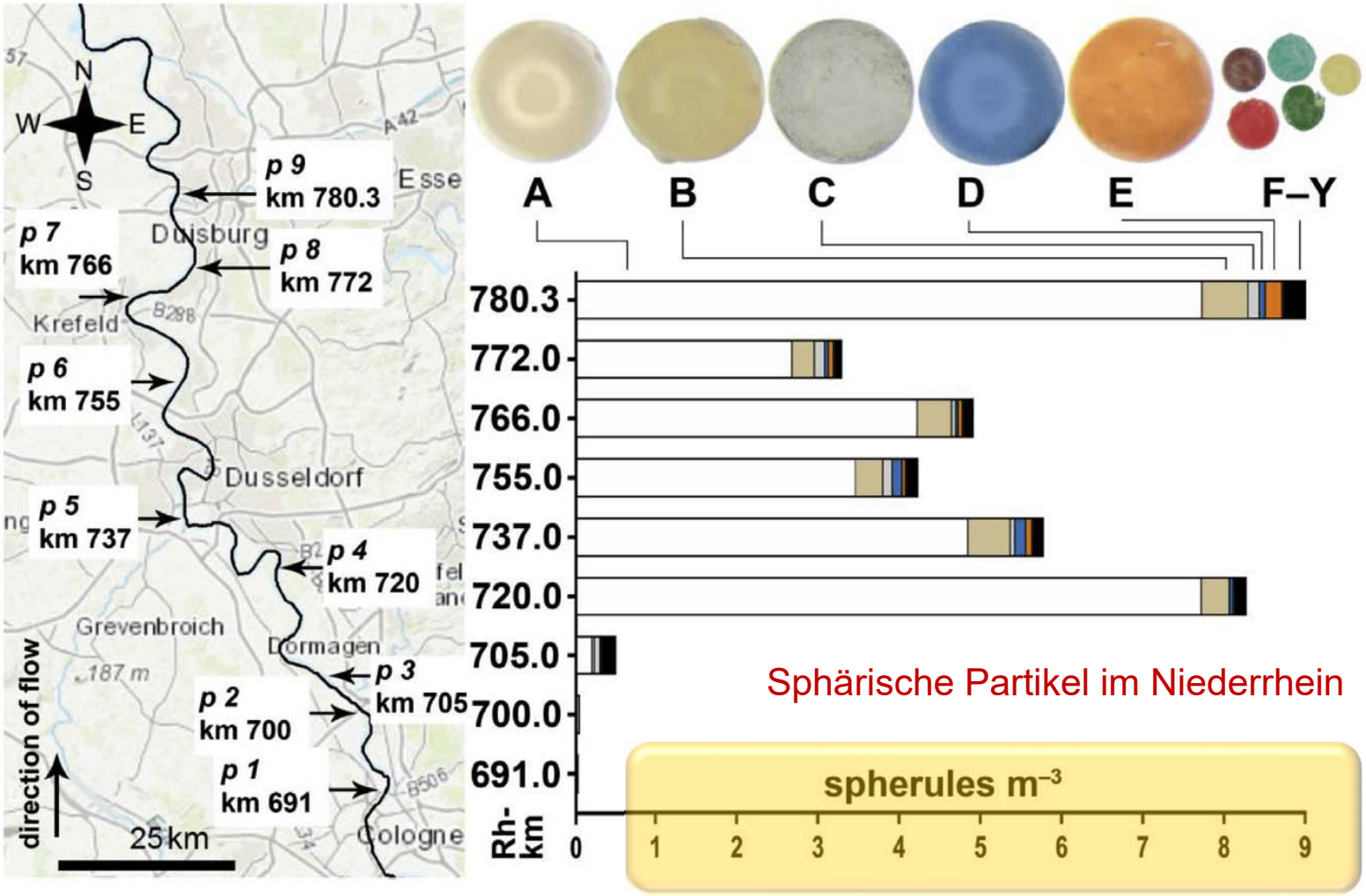
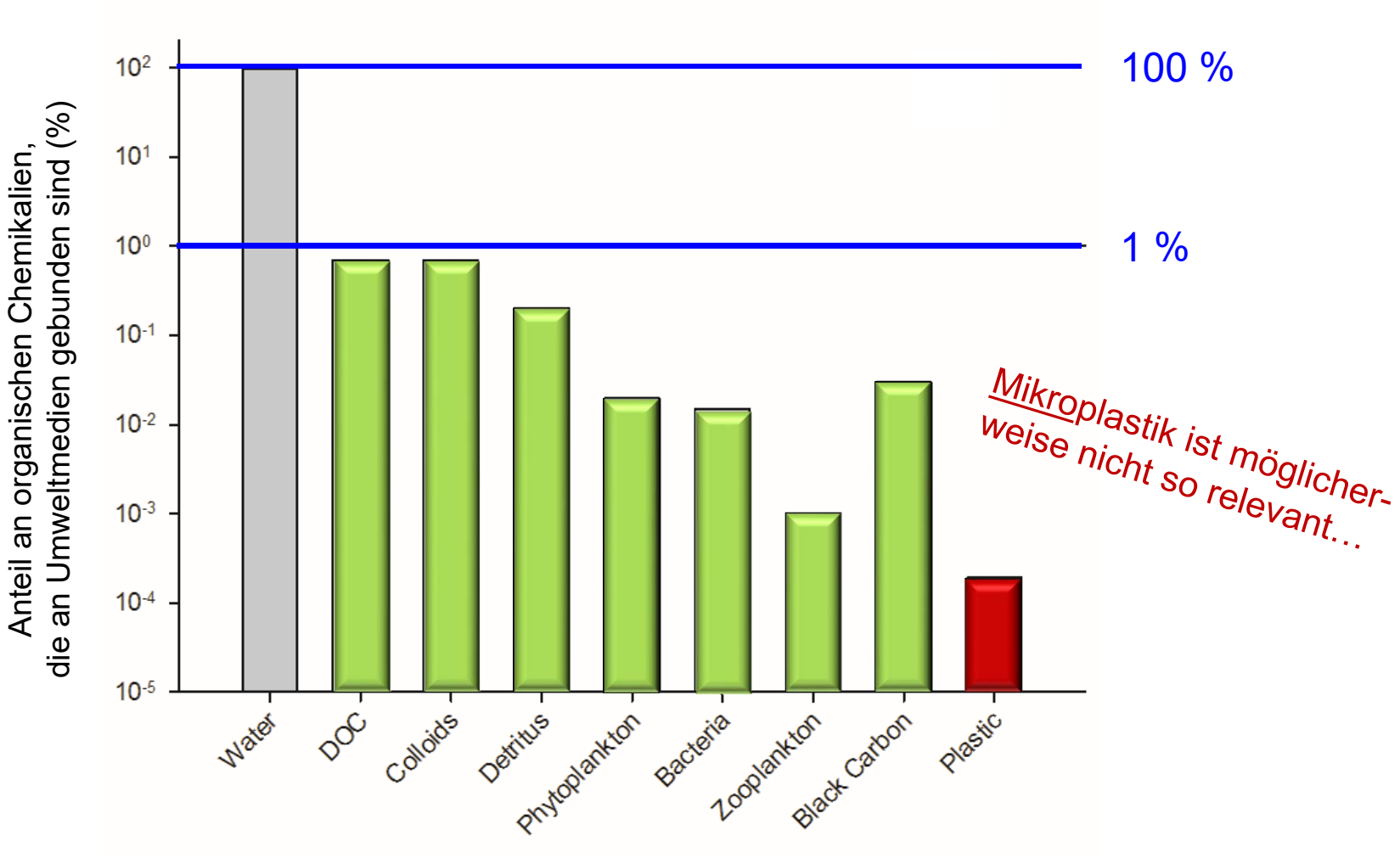


Fig. 1. Concentrations of plastic microbeads along the Cologne–Duisburg stretch of the Rhine River (Germany, Rh-km 691–780.3) in the *pearl* campaign. Sampling was carried out on 29.11.2016. Based on 218 microbeads (7.4% of the total 2944) from all 25 categories (A–Y), average microbead diameter was 497 µm. Bead photos indicate colour and translucency, the bead sizes are not to scale. The map was obtained from Arc Map 10.3. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Mikroplastik in aquatischen Ökosystemen



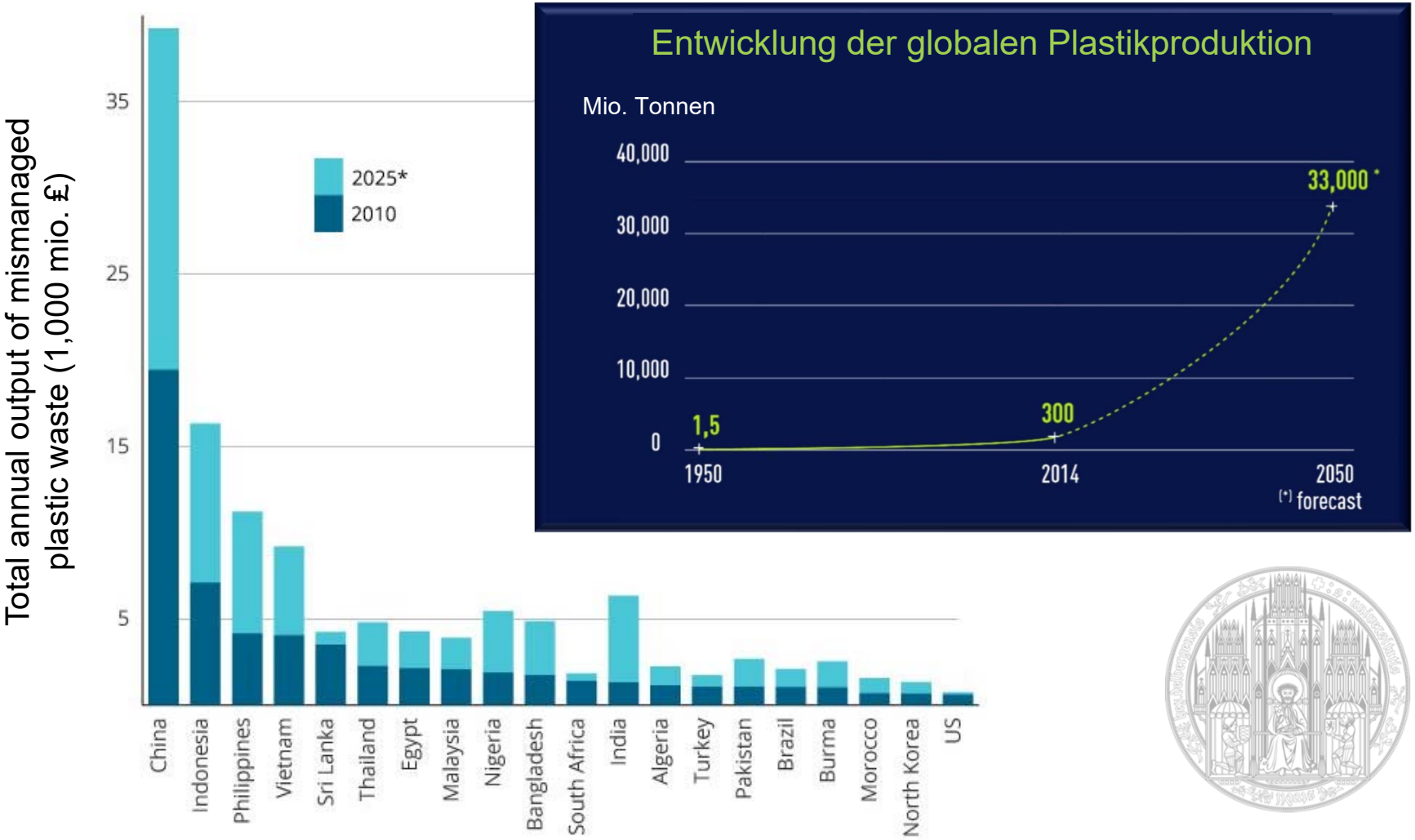
Koelmans et al. (2016) Environ. Sci. Technol. 50, 3315-3326


Verbraucher
Abwasser
Klär-
anlage
Oberflächen-
wasser
Meer
Kleinst-
lebewesen
Fische
Nanoplastik
+ Schadstoffe

Mikroplastik in aquatischen Ökosystemen ein Problem?

Wir sollten die wahren Kosten offenlegen…

Die Plastikproduktion wird weiter zunehmen …



Source: UNEP

Lösungen

Die Lösung

Designer

Juristen

Bildungssektor

Non-profit Organisationen

Wissenschaftler

Ingenieure

Konsumenten

Lösungsvorschläge

- sehr viel bewussterer Umgang mit Plastik
- Minimierung von Verpackungen, Verbot von Plastiktüten etc.
- Minimierung/Verbot von Mikroplastik in Kosmetika
- Minimierung von Mikroplastik in der Industrie
- ~~Abbaubares Plastik???~~

Mikroplastik in aquatischen Ökosystemen

Recycling is the preferred option for plastics waste. However, when recycling is no longer the most sustainable option, energy recovery is the alternative. Both options complement each other and help realise the full potential of plastics waste.

Auf jeden Fall ist das Problem lösbar, wenn wir endlich dazu bereit sind…