Mikroplastik und seine Plastisphäre

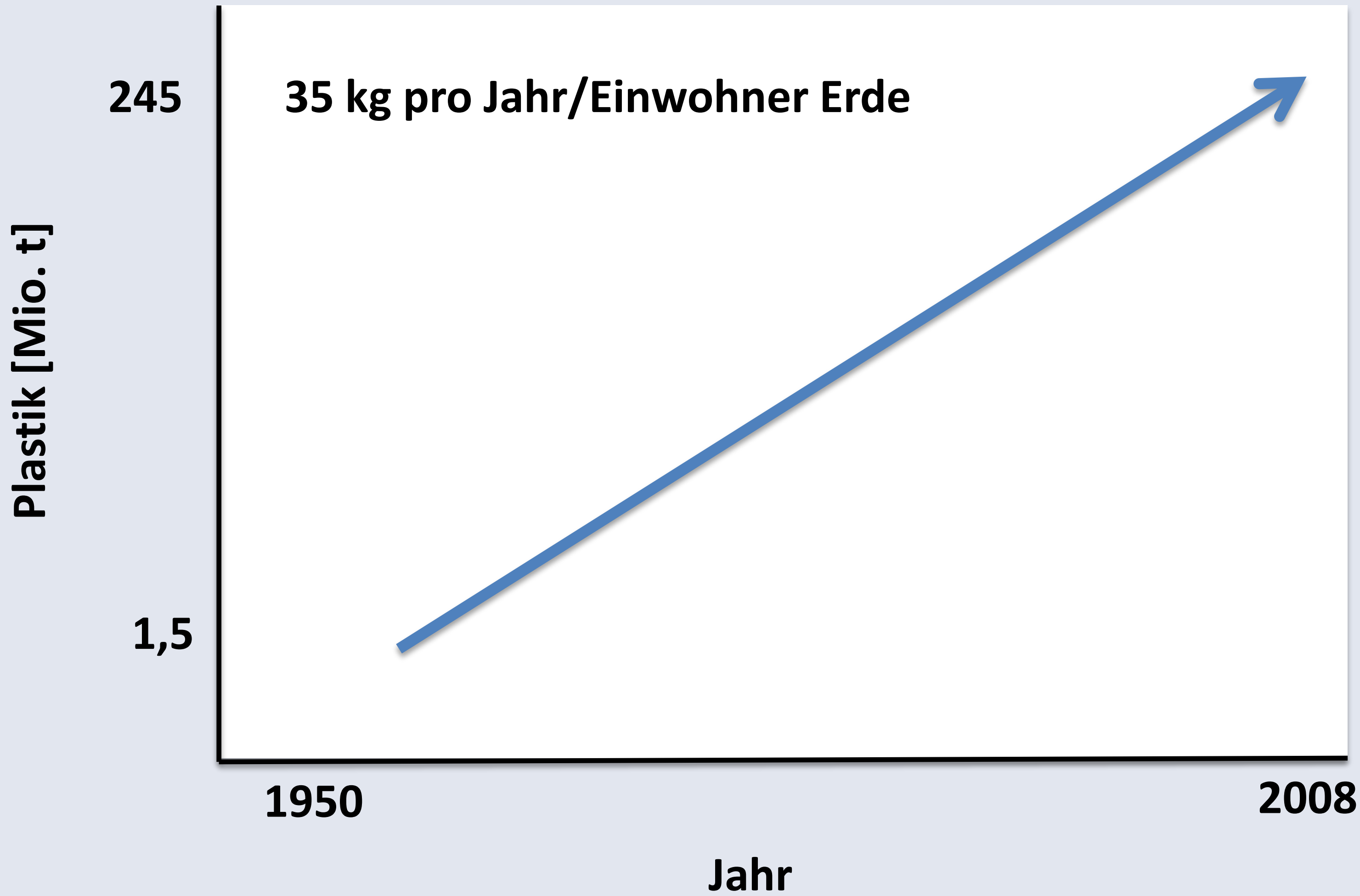
Matthias Labrenz

Umweltmikrobiologie

Leibniz-Institut für Ostseeforschung Warnemünde (IOW)

Weltweite Produktion von Kunststoffen

Makroplastik pro Jahr



Zarfl & Matthies 2010; Zettler et al., 2013

Leibniz-Institut für Ostseeforschung Warnemünde

Plastik in der marinen Umwelt

Polyethylen, Polypropylen, Polystyren, Polyamid, Polyester, Poly(vinyl)chlorid

100 – 142 Mio. Tonnen in Weltmeeren (UBA, 2013)

Abbau: physikalisch, chemisch, biologisch

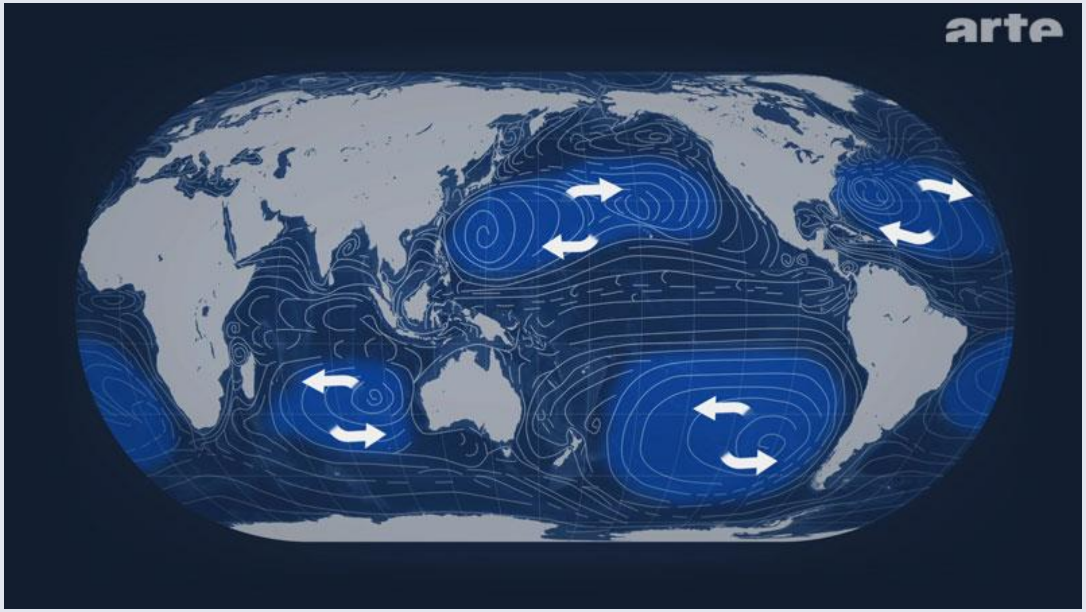
Deutsche Ostsee:

- **2 – 328 kg bzw. 4 – 181 Müllteile auf 500 m Küstenabschnitt**
- **Müll an der Meeresoberfläche korreliert mit Schiffsdichte und Verkehrstrennungs gebieten**

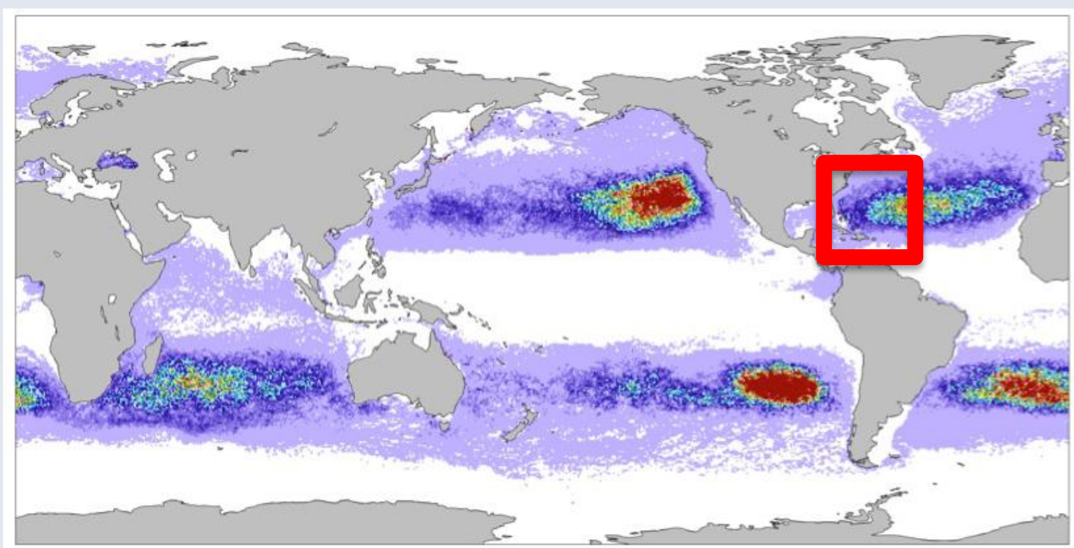
Quelle: Umweltbundesamt

Plastik

Anreicherung in subtropischen Wirbeln



Subtropische Wirbel



Nikolai Maximenko and Jan Hafner 2010, International Pacific Research Center, Science

Müllinseln

Subtropischer Wirbel des Nordatlantischen Ozeans

Anreicherung von fragmentiertem Plastik

BREVIA

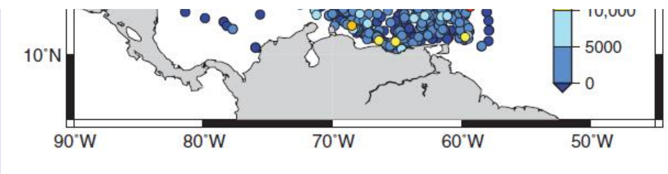
Lost at Sea: Where Is All the Plastic?

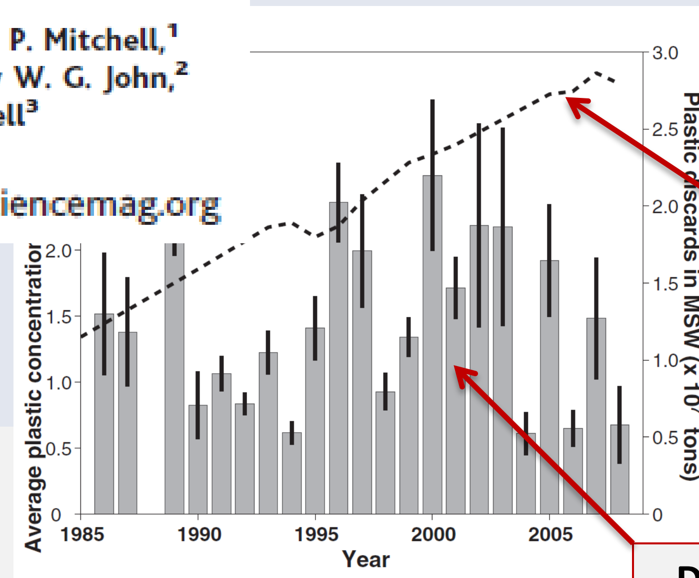
Richard C. Thompson,[1*] Ylva Olsen,[1] Richard P. Mitchell,[1] Anthony Davis,[1] Steven J. Rowland,[1] Anthony W. G. John,[2] Daniel McGonigle,[3] Andrea E. Russell[3]

7 MAY 2004 VOL 304 SCIENCE www.sciencemag.org

ahme: 335-µm Netz, 23 Jahre

0 mm





Plastik-Eintrag

Durchschnittliche Plastikkonzentration

Gründe für Stagnation:

- Sedimentation?
- Abbau?
- Aufnahme über marine Organismen?
- Weitere Fragmentierung < 300 µm?

Bedeutung Plastikpartikel?

Law et a., Science 2010

Mikroplastik

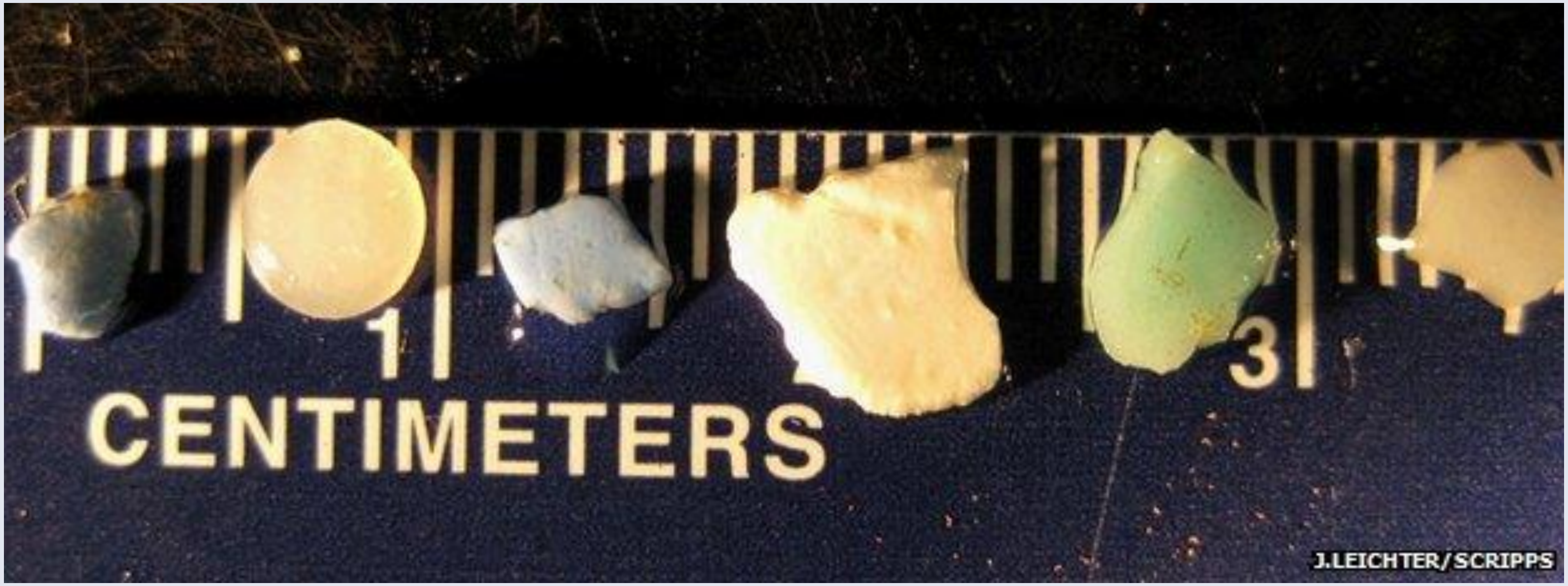
Definitionen

Mikroplastik

Plastikpartikel < 5 mm (praktisch bis in Nanometer-Bereich)

Sekundäres Mikroplastik

Fragmentiertes Makroplastik (physikalisch, chemisch, biologisch)



Leibniz-Institut für Ostseeforschung Warnemünde

Mikroplastik

Definitionen

Mikroplastik

Plastikpartikel < 5 mm

Primäres Mikroplastik

- Basispellets
- Granulate in Kosmetik, Hygieneprodukten


M. Erbse Huth


dpa

Beispiele Partikelanzahlen primäres Mikroplastik:

1.900 Kunstfasern aus Fleece (Polyester oder Polyacryl) pro Waschmaschinengang

Ein Transportcontainer mit Industriepellets aus Kunststoff: 50 Milliarden Pellets

Brown et al. 2013


FlickR


Zeevogelgroep, Jan v. Franeker

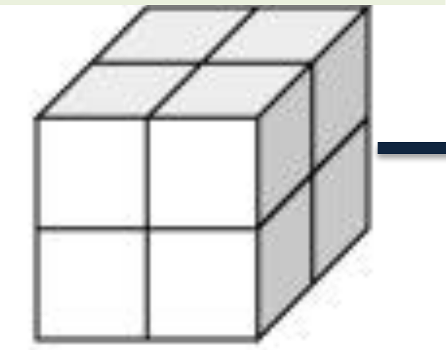
Leibniz-Institut für Ostseeforschung Warnemünde

Mikroplastik versus Makroplastik

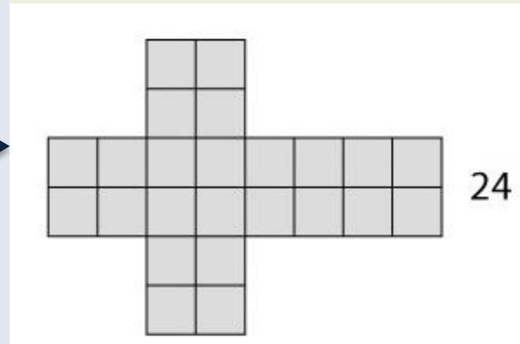
Größe hat Konsequenzen

Oberflächenvergrößerung

Volumen: 1 x 8

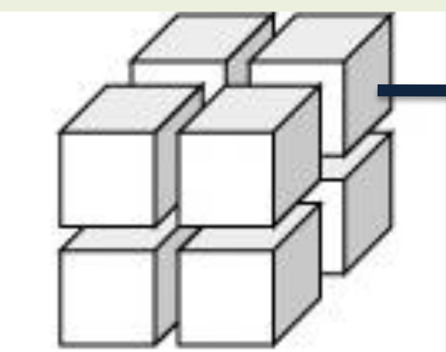


Oberfläche: 24

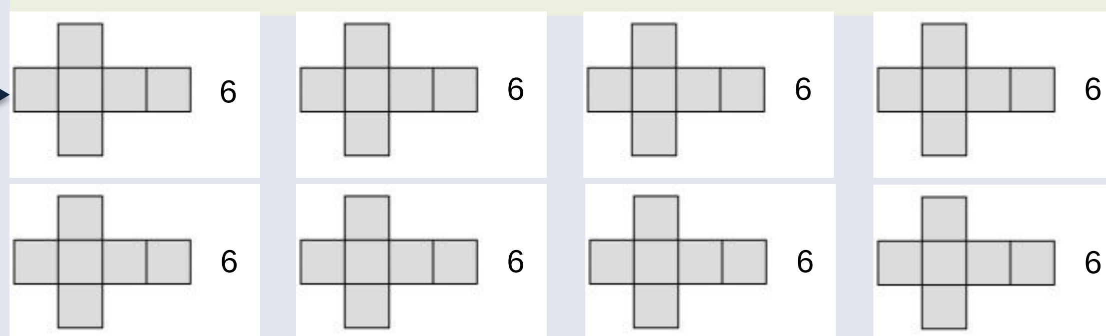


- → **Anstieg Plastikoberfläche über sekundäres Mikroplastik**
- → **Anstieg hydrophober (wasserabweisender) Oberflächen**

Volumen: 8 x 1



Oberfläche: 48



Modifiziert nach biologieunterricht.info

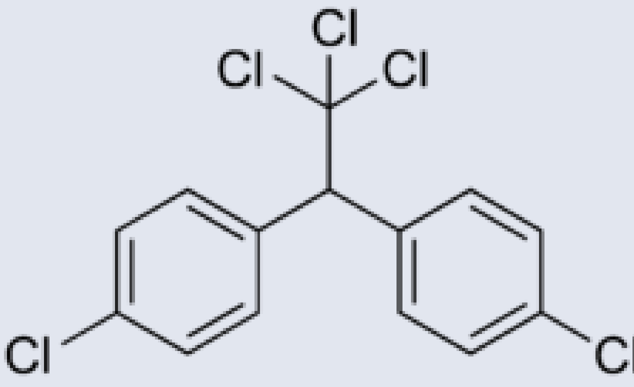
Mikroplastik

Größe (und Hydrophobie) hat Konsequenzen

Anreicherungen/Adsorption an Plastikoberflächen

Persistente toxische Schadstoffe
(Persistent Organic Pollutants , POP)

Folgen der Malariabekämpfung



Dichlordiphenyltrichlorethan (DDT)

DDT Nordpazifischer subtropischer Wirbel:

22 - 7100 ng/g Plastik

(Rios et al., 2007)

Mikroplastik

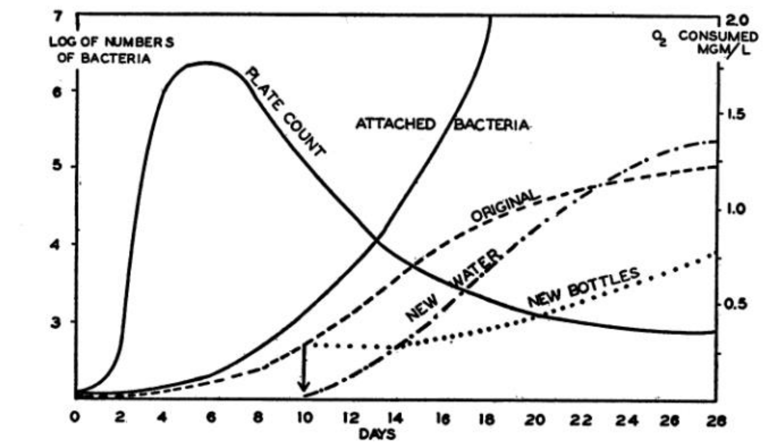
Größe (und Hydrophobie) hat Konsequenzen

Anreicherungen/Adsorption an Plastikoberflächen

Mikro-Nährstoffe
Mikroorganismen

→ Biofilm-Bildung (Plastisphäre)
→ Erhöhte Abundanz, Aktivität

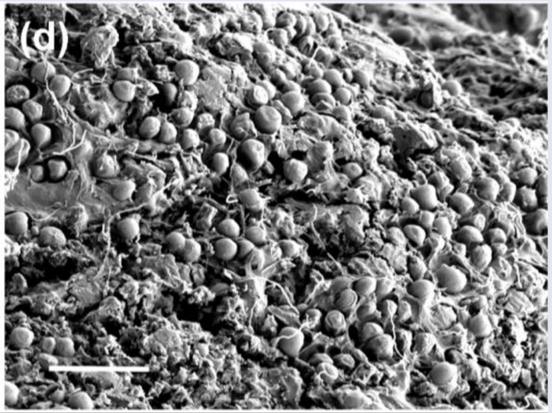
Zobell-Effekt



Claude E. Zobell (1943). The effect of solid surfaces upon bacterial activity.
J Bacteriol. 46: 39–56.

Änderung Schwimmeigenschaft

→ Mikroplastik als Vektor für Mikroorganismen und POPs



Biofilm auf Plastik (Zettler et al., 2013)

Mikroplastik und Plastisphäre

Früh entdeckt – lange vergessen

Polystyrene Spherules in Coastal Waters

Abstract. *Polystyrene spherules averaging 0.5 millimeter in diameter (range 0.1 to 2 millimeters) are abundant in the coastal waters of southern New England. Two types are present, a crystalline (clear) form and a white, opaque form with pigmentation resulting from a diene rubber. The spherules have bacteria on their surfaces and contain polychlorinated biphenyls, apparently absorbed from ambient seawater, in a concentration of 5 parts per million. White, opaque spherules are selectively consumed by 8 species of fish out of 14 species examined, and a chaetognath. Ingestion of the plastic may lead to intestinal blockage in smaller fish.*

Carpenter et al. (Science 1972): Bakterien, Diatomeen

APPLIED AND ENVIRONMENTAL MICROBIOLOGY, Jan. 2008, p. 52–60 Vol. 74, No. 1
0099-2240/08/$08.00+0 doi:10.1128/AEM.01400-07
Copyright © 2008, American Society for Microbiology. All Rights Reserved.

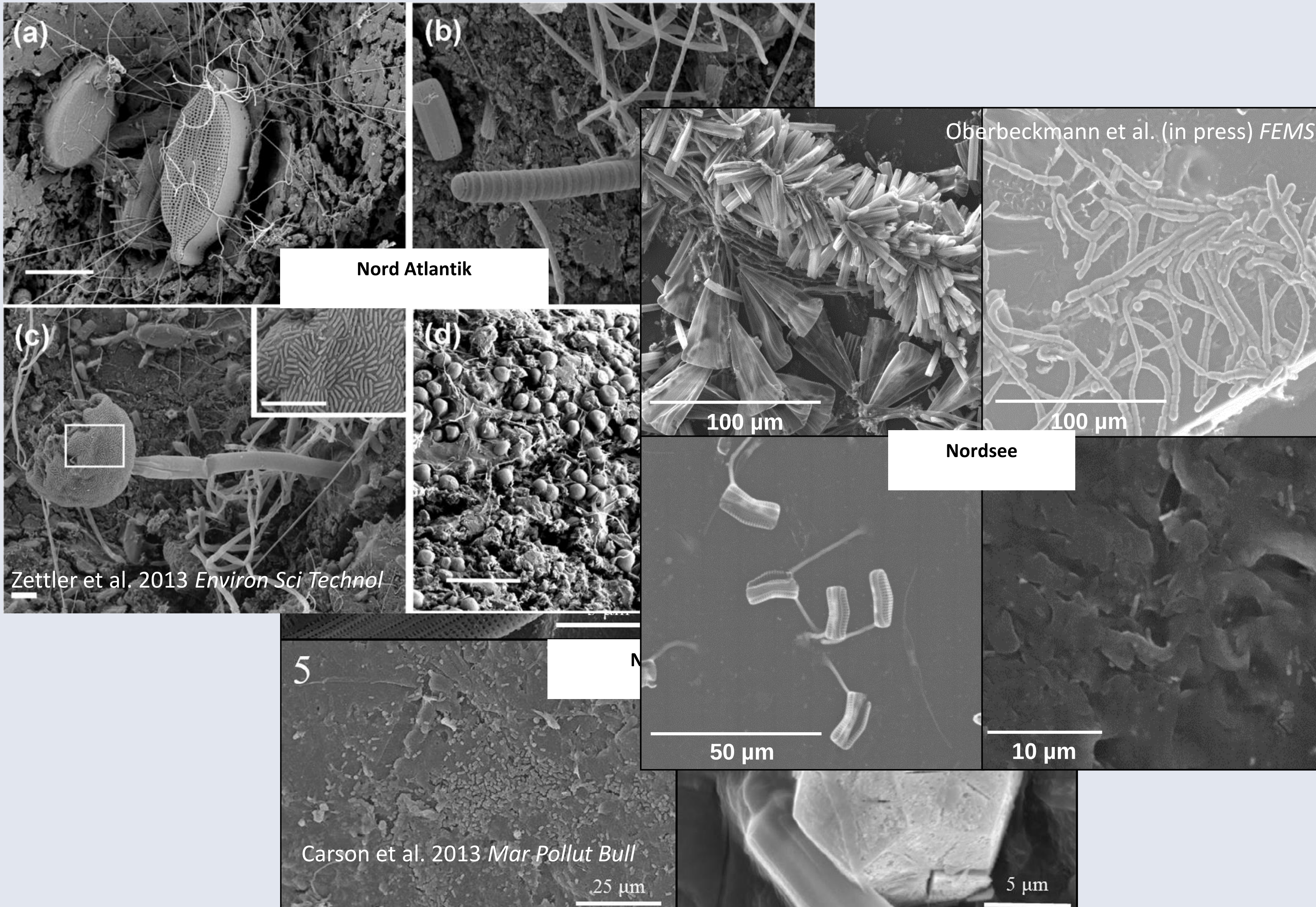
Cross-Ocean Distribution of *Rhodobacterales* Bacteria as Primary Surface Colonizers in Temperate Coastal Marine Waters$^{\nabla}$†

Hongyue Dang,[1]* Tiegang Li,[1] Mingna Chen,[1] and Guiqiao Huang[2]

Dang et al. (AEM 2008): Rhodobacterales nach bis zu 72 h

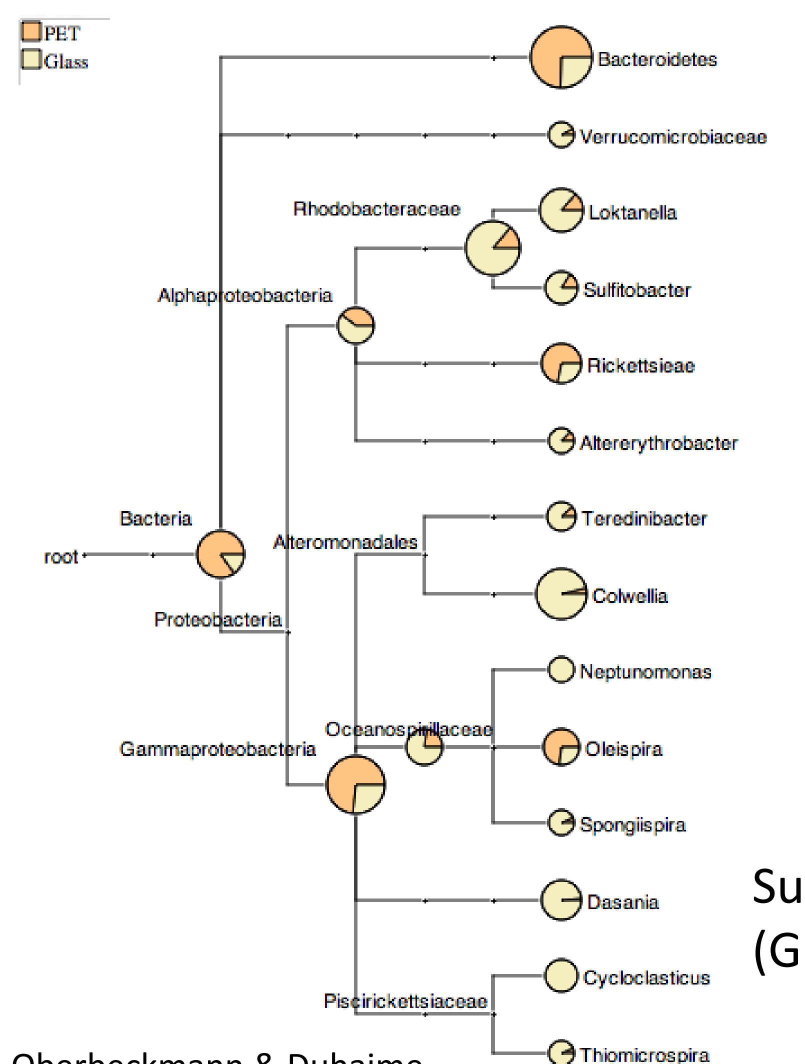
Mikroplastik und Plastisphäre

Biofilme

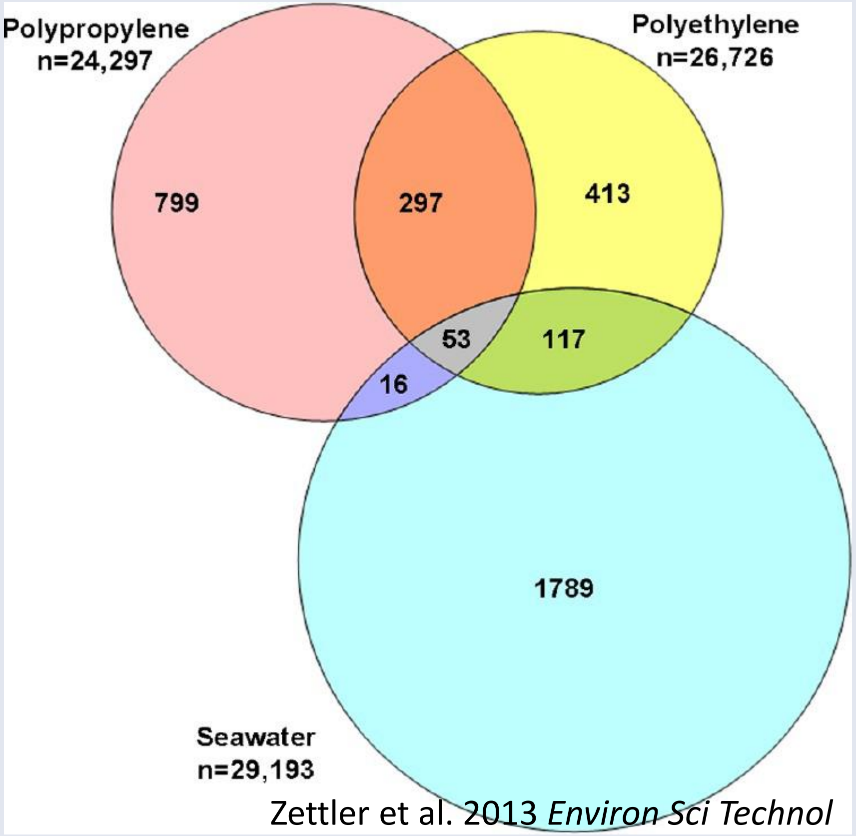


Mikroplastik und Plastisphäre

Biofilme Plastik/Substrat-spezifisch



Oberbeckmann & Duhaime



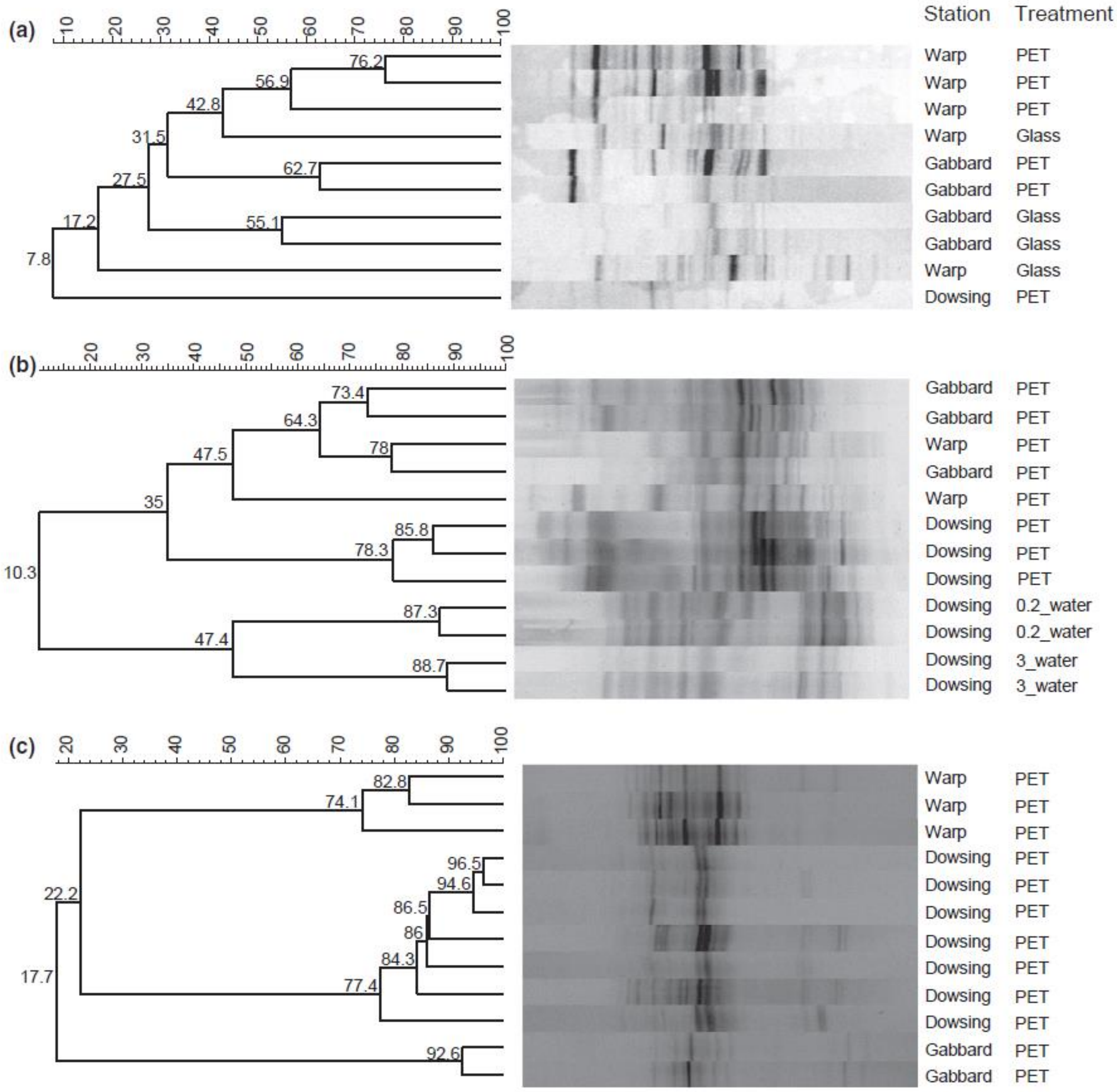
Zettler et al. 2013 *Environ Sci Technol*

Substrat beeinflusst Biofilm-Struktur
(Glass, verschiedene Plastikpolymere)

Häufig in Plastik-Biofilmen:
Diatomeen, Cyanobakterien, Bacteriodetes, Rhodobacterales

Mikroplastik und Plastisphäre

PET-Experiment in Nordsee



Plastisphäre verändert sich:

- **Saisonal**
- **Lokal**

Frühjahr

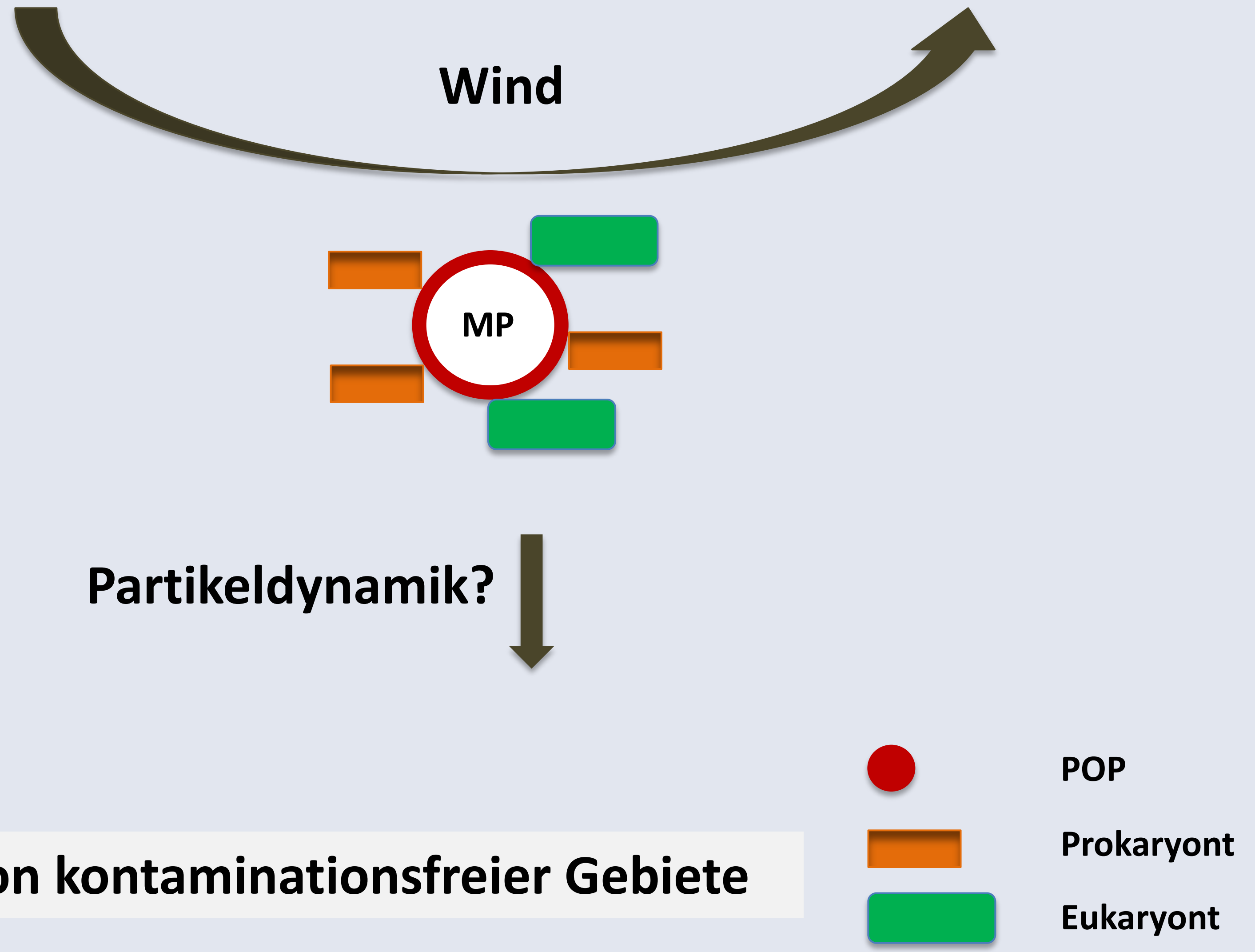
Sommer

Winter

Oberbeckmann et al. 2014, FEMS, in press

Änderung Verdriftung und Sedimentation

Veränderte Verbreitung von Toxinen, mikrobieller Funktionen



→ Invasion kontaminationsfreier Gebiete

Relevanz für Küste und Gesellschaft?

Mikroplastik als Vektor pathogener Mikroorganismen?


SCI. MAR., 67 (1): 107-111 — SCIENTIA MARINA — 2003

NOTE

Drifting plastic debris as a potential vector for dispersing Harmful Algal Bloom (HAB) species*

MERCEDES MASÓ, ESTHER GARCÉS, FRANCESC PAGÈS and JORDI CAMP

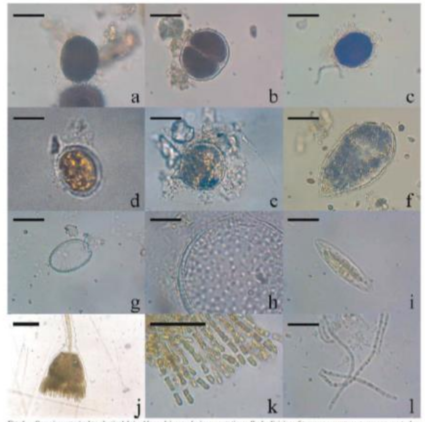


FIG. 1. – Organism attached to plastic debris.

nature — International weekly journal of science

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comments on this story

Published online 28 March 2011 | Nature | doi:10.1038/news.2011.191

News

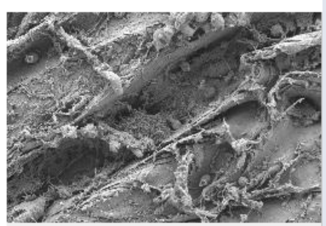
Marine microbes digest plastic

A 'little world' eating ocean garbage might be a mixed blessing.

Gwyneth Dickey Zaikab

Specialist bacteria seem to be eating the plastic garbage we throw into the ocean. But whether they're cleaning up our poisons or just passing them back up the food chain remains to be seen.

The ocean contains vast amounts of plastic, mostly as tiny shards floating just beneath the surface. Under an electron microscope, each scrap of "plastic confetti" becomes "an oasis, a reef of biological activity," says marine microbiologist Tracy Mincer of the Woods Hole Oceanographic Institution in Massachusetts.


Electron microscopy reveals the inhabitants of a plastic bag fished from the Sargasso Sea.

T. Mincer/G. Proskurowski

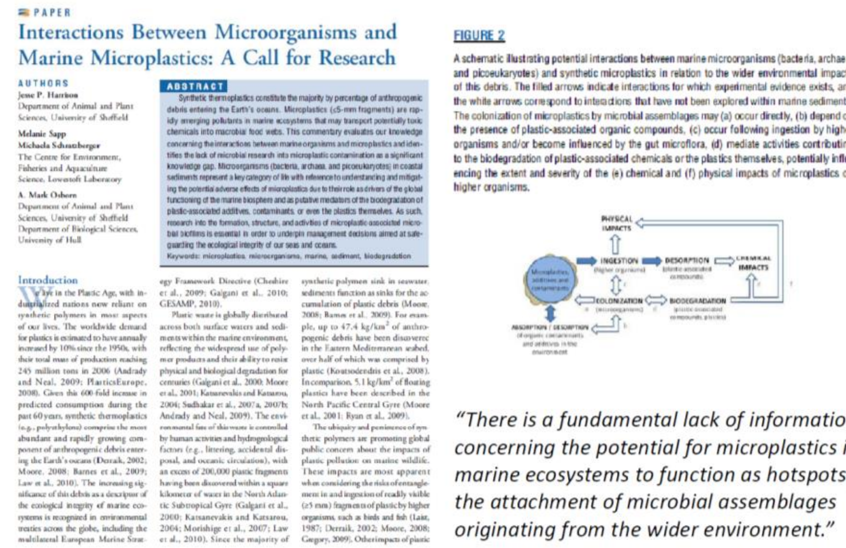
Stories by subject
- Ecology
- Environmental Science
- Microbiology

Stories by keywords
- Great Pacific Garbage Patch
- Sargasso
- plastic
- marine debris
- ocean
- bacteria
- digestion
- pollution
- gyre

This article elsewhere

Blogs linking to

Microplastik – ein komplexes Habitat: Vektor-Funktion?


PAPER

Interactions Between Microorganisms and Marine Microplastics: A Call for Research

AUTHORS

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Melanie Sapp

Michaela Schratzberger, The Centre for Environment, Fisheries and Aquaculture Science, Lowestoft Laboratory

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ABSTRACT

Introduction

FIGURE 2

A schematic illustrating potential interactions between marine microorganisms (bacteria, archaea, and picoeukaryotes) and synthetic microplastics in relation to the wider environmental impacts of this debris. The filled arrows indicate interactions for which experimental evidence exists, and the white arrows correspond to interactions that have not been explored within marine sediments. The colonization of microplastics by microbial assemblages may (a) occur directly, (b) depend on the presence of plastic-associated organic compounds, (c) occur following ingestion by higher organisms and/or become influenced by the gut microflora, (d) mediate activities contributing to the biodegradation of plastic-associated chemicals or the plastics themselves, potentially influencing the extent and severity of the (e) chemical and (f) physical impacts of microplastics on higher organisms.

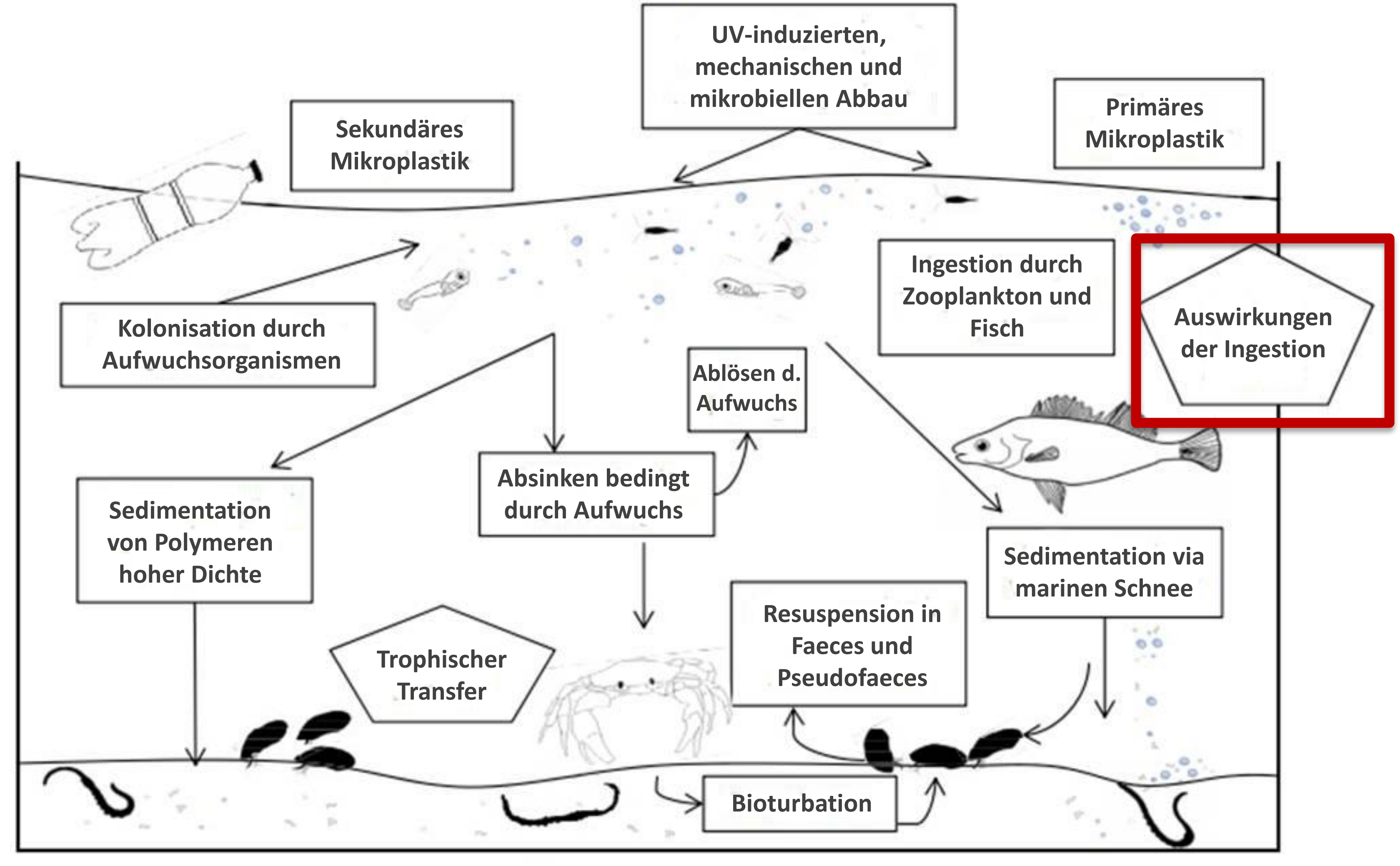
"There is a fundamental lack of information concerning the potential for microplastics in marine ecosystems to function as hotspots fo[r] the attachment of microbial assemblages originating from the wider environment."

"…almost 25% of the bacteria on one polyethylene surface were vibrios, bacteria from the same group as the cholera bacterium…"

Substratspezifische Anreicherung oder auch Einfluss des marinen Nahrungsnetzes (anthropogener Einfluss)?

Mikroplastik und das marine Nahrungsnetz

Aufnahme + Ausscheidung Mikroplastik



Modifiziert nach Wright et al. 2013 *Environ Pollut*

Eukaryonten als Reservoir pathogener Mikroorganismen

Die Rolle der Vibrionen

The ISME Journal (2009) 3, 1082–1092

www.nature.com/ismej

ORIGINAL ARTICLE

Plankton composition and environmental factors contribute to *Vibrio* seasonality

Jeffrey W Turner[1,2], Brooks Good[3], Dana Cole[2,4] and Erin K Lipp[2]
[1]*Odum School of Ecology, University of Georgia, Athens, GA, USA;* [2]*Department of Environmental Health Science, University of Georgia, Athens, GA, USA;* [3]*Coastal Research Division, Georgia Department of Natural Resources, One Conservation Way, Brunswick, GA, USA and* [4]*Division of Public Health, Georgia Department of Human Resources, Atlanta, GA, USA*

Plankton represent a nutrient-rich reservoir capable of enriching *Vibrio* species, which can include human pathogens, at higher densities than the surrounding water column. To better understand the relationship between vibrios and plankton, the partitioning of culturable vibrios, on TCBS, between free living and plankton associated (63–200- and >200-μm-size fractions) was monitored over a 1-year period in coastal waters of Georgia, USA. Seasonal changes in the total *Vibrio* concentration were then compared with changes in environmental parameters as well as changes in the relative composition of the plankton community. Using univariate analyses, *Vibrio* concentrations were strongly associated with temperature, especially when those vibrios were plankton associated (R^2 = 0.69 and 0.88 for the water and both plankton fractions; respectively) (P<0.01). Multivariate general linear models revealed that *Vibrio* concentrations in the plankton fractions were also correlated to shifts in the relative abundance of specific plankton taxa. In the 63–200-μm fraction, *Vibrio* concentrations were inversely associated with copepods, cyanobacteria and diatoms. In the >200-μm fraction, *Vibrio* concentrations were positively associated with copepods and negatively associated with decapod larvae. Our results confirm the role of temperature in *Vibrio* seasonality and highlight an important and independent role for plankton composition in explaining seasonal changes in *Vibrio* concentration.
The ISME Journal (2009) 3, 1082–1092; doi:10.1038/ismej.2009.50; published online 7 May 2009
Subject Category: microbial ecology and functional diversity in natural habitats
Keywords: copepods; plankton; seasonality; *Vibrio*

Environmental Microbiology (2005) **7**(6), 761–772 doi:10.1111/j.1462-2920.2005.00792.x

Minireview

Persistence of vibrios in marine bivalves: the role of interactions with haemolymph components

Carla Pruzzo,[1]* Gabriella Gallo[1] and Laura Canesi[2]
[1]*Dipartimento di Biologia, Università di Genova, Genova, Italy.*
[2]*Istituto di Scienze Fisiologiche, Università di Urbino, Urbino, Italy.*

Summary

Marine bivalves are widespread in coastal environments and, due to their filter-feeding habit, they can accumulate large numbers of bacteria thus acting as passive carriers of human pathogens. Bivalves possess both humoral and cellular defence mechanisms

rounding waters. Two general groups of pathogenic bacteria may be present in coastal seawater and may be entrapped by bivalves: the former group includes non-indigenous bacterial pathogens (e.g. *Salmonella* and *Shigella*) that are shed into the water from infected animals and humans, the latter includes bacteria indigenous to the marine environment, predominantly members of the family *Vibrionaceae* (Potasman *et al.*, 2002).

The genus *Vibrio* includes more than 30 species, and many are pathogenic to humans and/or have been associated with food-borne diseases (Chakraborty *et al.*, 1997). Among these species, *Vibrio cholerae* is not only the most feared but also the most extensively studied

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RESEARCH ARTICLE OPEN ACCESS

Fish as Reservoirs and Vectors of *Vibrio cholerae*

Article Metrics Related Content Comments: 0

Yigal Senderovich[1], Ido Izhaki[1], Malka Halpern[1,2*]
1 Department of Evolutionary and Environmental Biology, Faculty of Science and Science Education, University of Haifa, Mount Carmel, Haifa, Israel, 2 Department of Biology Education, Faculty of Science and Science Education, University of Haifa, Oranim, Tivon, Israel

To **add a note**, highlight some text. Hide notes
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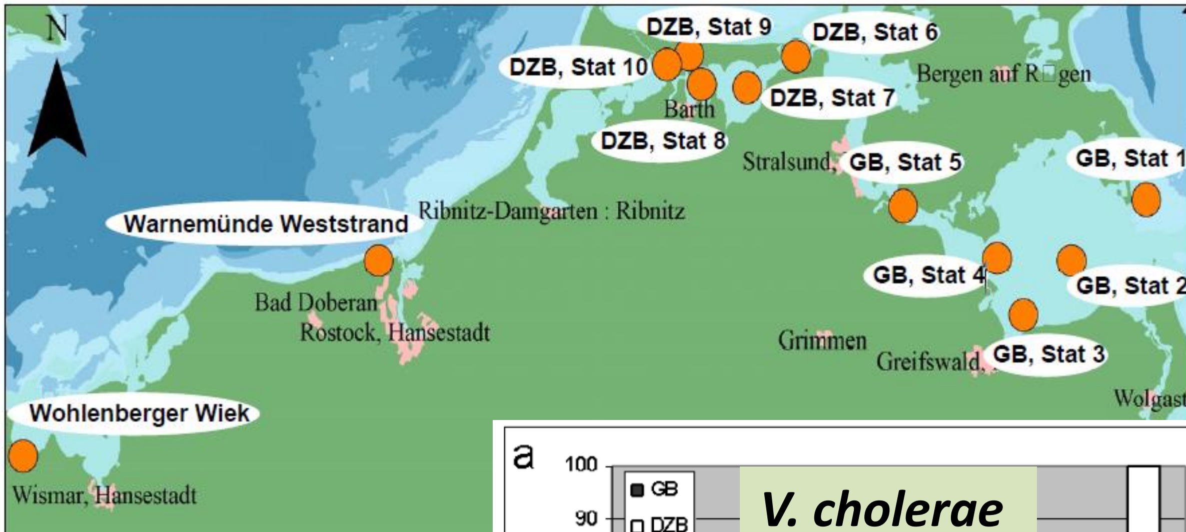
Abstract Top

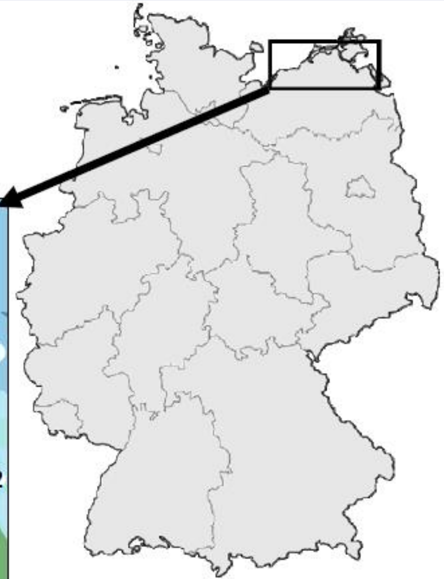
Vibrio cholerae, the etiologic agent of cholera, is autochthonous to various aquatic environments, but despite intensive efforts its ecology remains an enigma. Recently, it was suggested that copepods and chironomids, both considered as natural reservoirs of *V. cholerae*, are dispersed by migratory waterbirds, thus possibly distributing the bacteria between water bodies within and between continents. Although fish have been implicated in the scientific literature with cholera cases, as far as we know, no study actually surveyed the presence of the bacteria in the fish. Here we show for the first time that fish of various species and habitats contain *V. cholerae* in their digestive tract. Fish (n = 110) were randomly sampled from freshwater and marine habitats in Israel. Ten different fish species sampled from freshwater habitats (lake, rivers and fish ponds), and one marine species, were found to carry *V. cholerae*. The fish intestine of *Sarotherodon galilaeus* harboured ca. 5×10^3 *V. cholerae* cfu per 1 gr intestine content—high rates compared with known *V. cholerae* cfu numbers in the bacteria's natural reservoirs. Our results, combined with evidence from the literature, suggest that fish are reservoirs of *V. cholerae*. As fish carrying the bacteria swim from one location to another (some fish species move from rivers to lakes or sea and *vice versa*), they serve as vectors on a small scale. Nevertheless, fish are consumed by waterbirds, which disseminate the bacteria on a global scale. Moreover, *V. cholerae* isolates had the ability to degrade chitin, indicating a commensal relationship between *V. cholerae* and fish.

Vibrionen der Deutschen Ostseeküste

Häufigeres Auftreten im Sommer

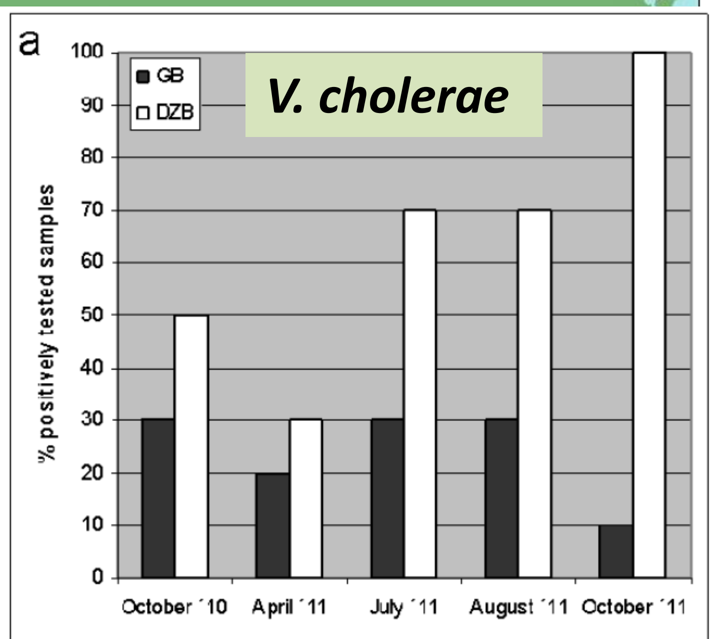
Häufigste Infektionen: östliches M-V

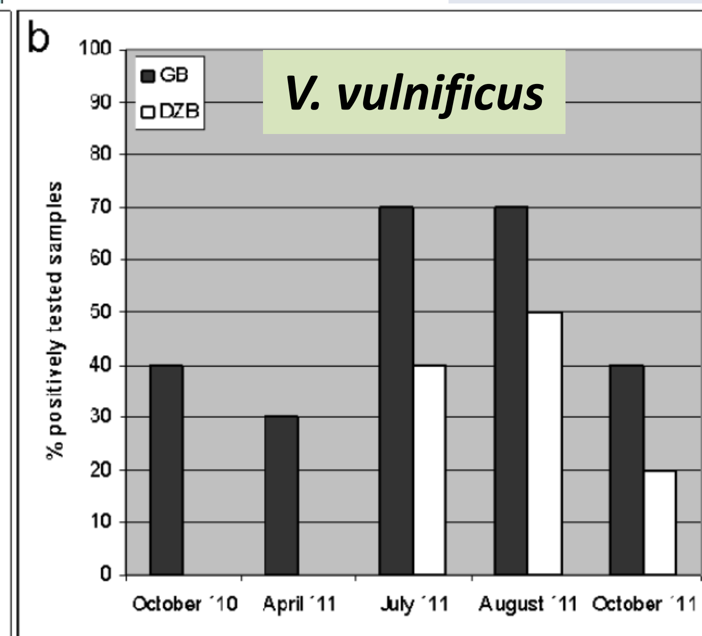




Abundant:

- *V. vulnificus*
- *V. cholerae*





Böer et al., BfG 4/12

Länder mit humanen Fällen

Vibrio-Infektionen seit 1985

Summe gesamte Ostsee: etwa 300 Fälle

Unterschiedliche *Vibrio*-Arten

Year	Countries reporting cases	Number of cases	Species of infections
1985-1993	Finland, Denmark, (Netherlands, Belgium)	9	*V. vulnificus*, *V. cholerae* (non O1)
1994	Germany, Sweden, Denmark, Finland	21	*V. vulnificus*, *V. cholerae* (non O1), *V. alginolyticus*
1995	Denmark, Finland, Estonia	8	*V. vulnificus*, *V. cholerae* (non O1)
1996	Denmark, Finland	2	*V. cholerae* (non O1)
1997	Sweden, Finland, Denmark	21	*V. vulnificus*, *V. cholerae* (non O1), *V. alginolyticus*, *V. damsela*
1998	Finland, Denmark	6	*V. cholerae* (non O1)
1999	Finland	8	*V. cholerae* (non O1), *V. fluvialis*
2000	Finland	5	*V. cholerae* (non O1), *V. parahaemolyticus*
2001	Finland, Sweden	11	*V. cholerae* (non O1), *V. parahaemolyticus*, *V. vulnificus*
2002	Germany, Finland	10	*V. cholerae* (non O1), *V. vulnificus*
2003	Finland, Germany, Sweden	19	*V. cholerae* (non O1), *V. vulnificus*
2004	Finland, Sweden	6	*V. cholerae* (non O1), *V. parahaemolyticus*, Vibrio spp*
2005	Finland, Sweden	9	*V. cholerae* (non O1), *V. parahaemolyticus*, Vibrio spp*
2006	Germany, Denmark, Sweden, Poland, Finland, Estonia, (Netherlands)	67	*V. vulnificus*, *V. cholerae* (non O1), *V. alginolyticus* *V. parahaemolyticus*, Vibrio spp*
2007	Finland, Sweden	14	*V. cholerae* (non O1), Vibrio spp*
2008	Sweden, Finland, (Netherlands)*	13	*V. vulnificus*, Vibrio spp*
2009	Finland, Sweden, Germany, (Netherlands)	15	*V. cholerae* (non O1), *V. parahaemolyticus*, *V. alginolyticus*, Vibrio spp.
2010	Finland, Sweden, Germany, (Netherlands)	36	*V. cholerae* (non O1), *V. parahaemolyticus*, *V. alginolyticus*, *V. vulnificus* Vibrio spp*.

Supplementary Table 2. *Vibrio* cases reported per year in the Baltic Sea region, 1985-2010.

Baker-Austin et al., Nature Climate Change, 2013

Vibrio vulnificus

Pathogene Eigenschaften bzw. Krankheitsverlauf

Infektion: Beim Baden/Waten/Kontakt Meeresfrüchte, über verletzte Haut (Abschürfungen, Wunden)

Department of Health and Human Services ,USA

Centers for Disease Control and Prevention (CDC)

Beziehung Vibrio – Mikroplastik?

- **Wundinfektion**
- **Bei schweren Verlauf Abszess-Bildung in allen Organen**
- **Tödliche Verläufe durch Blutvergiftung innerhalb weniger Tage**
- **Ältere und Immungeschwächte Menschen besonders betroffen**

Die Rolle von Mikroplastik als Träger mikrobieller Populationen in Ökosystemen der Ostsee

MikrOMIK

Fördervolumen 2014-2017: 1,3 Mio. EURO

MikrOMIK

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