2023年(第32回)　ブループラネット賞
受賞者記念講演会

2023 Blue Planet Prize
Commemorative Lectures

リチャード・トンプソン教授
タマラ・ギャロウェイ教授
ペネロープ・リンデキュー教授
講演スライド集

マイクロプラスチックの発見―
環境への蓄積、影響、および対策

Professor Richard Thompson

Professor Tamara Galloway

Professor Penelope Lindeque

Slides for the Lecture

Discovering the Microplastic
Pollution on Marine Ecosystems

Discovering microplastics:
Their environmental accumulation, impacts and solutions

2023 Blue Planet Prize – Commemorative Lecture

1

Discovering microplastics:
Their environmental accumulation, impacts and solutions

Richard Thompson - Discovery, environmental distribution, sources and pathways
Tamara Galloway - Environmental impacts and consequences for human health
Pennie Lindeque – Delivering evidence, raising awareness and evaluating solutions

2

Prof Richard Thompson @ProfRThompson

Discovery, environmental distribution, sources and pathways

International Marine litter Research Unit, University of Plymouth, UK

3

Marine Biologist to '*Godfather*' of Micropalstics

1994

4

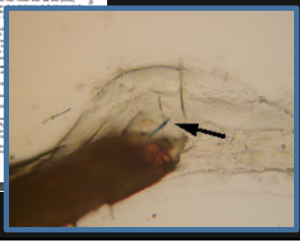
A paper describing microscopic pieces of plastic *'Microplastics'*


BREVIA

Lost at Sea: Where Is All the Plastic?

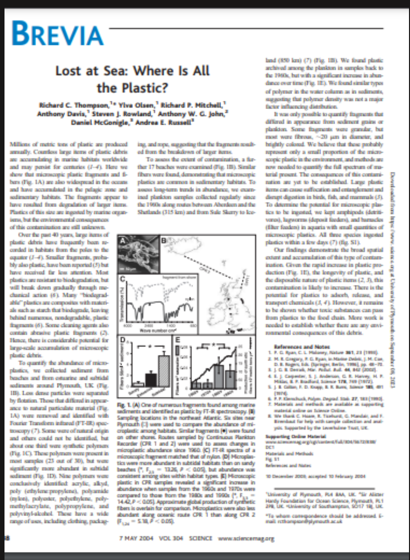
Richard C. Thompson, Ylva Olsen, Richard P. Mitchell, Anthony Davis, Steven J. Rowland, Anthony W. G. John, Daniel McGonigle, Andrea E. Russell

Thompson *et al.* 2004



- Mostly fibres, present in seawater and sediment around UK
- Abundance had increased over decades
- Eaten by a range of marine organisms
- Indicated potential global accumulation and possible physical and chemical toxicity

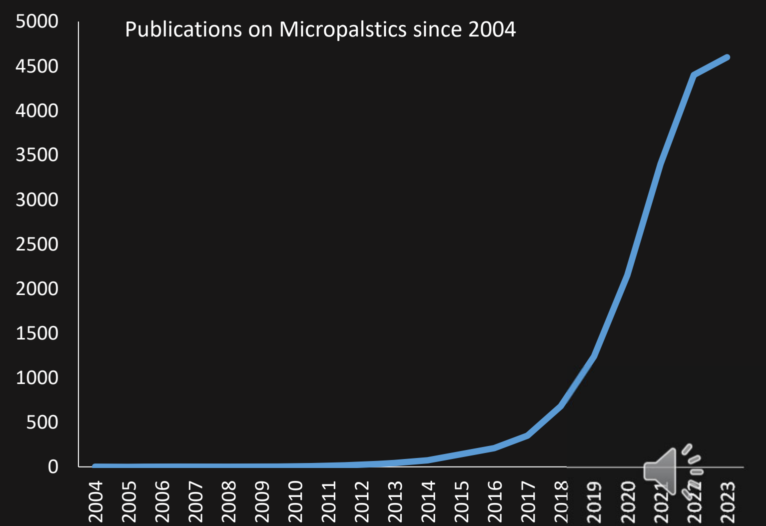
Microplastics - from discovery to a new field of research


BREVIA

Lost at Sea: Where Is All the Plastic?

Richard C. Thompson, Ylva Olsen, Richard P. Mitchell, Anthony Davis, Steven J. Rowland, Anthony W. G. John, Daniel McGonigle, Andrea E. Russell

Thompson *et al.* 2004



Global distribution on shorelines

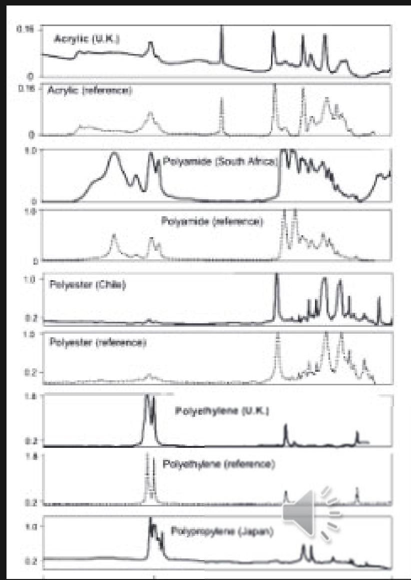

ENVIRONMENTAL Science & Technology

ARTICLE

pubs.acs.org/est

Accumulation of Microplastic on Shorelines Woldwide: Sources and Sinks

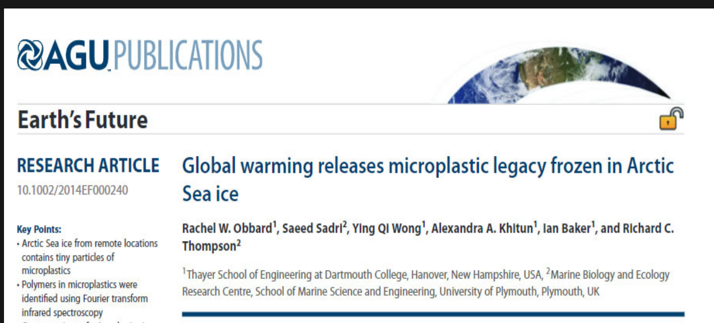
Mark Anthony Browne,*,†,‡,§ Phillip Crump,¶ Stewart J. Niven,§,∥ Emma Teuten,§ Andrew Tonkin,¶ Tamara Galloway,⊥ and Richard Thompson§



Browne, Crump, Niven, Tonkin, Galloway and Thompson 2011

7

Substantial accumulation in Arctic sea ice


AGU PUBLICATIONS

Earth's Future

RESEARCH ARTICLE

10.1002/2014EF000240

Global warming releases microplastic legacy frozen in Arctic Sea ice

Rachel W. Obbard[1], Saeed Sadri[2], Ying Qi Wong[1], Alexandra A. Khitun[1], Ian Baker[1], and Richard C. Thompson[2]

[1]Thayer School of Engineering at Dartmouth College, Hanover, New Hampshire, USA, [2]Marine Biology and Ecology Research Centre, School of Marine Science and Engineering, University of Plymouth, Plymouth, UK

Key Points:
- Arctic Sea ice from remote locations contains tiny particles of microplastics
- Polymers in microplastics were identified using Fourier transform infrared spectroscopy

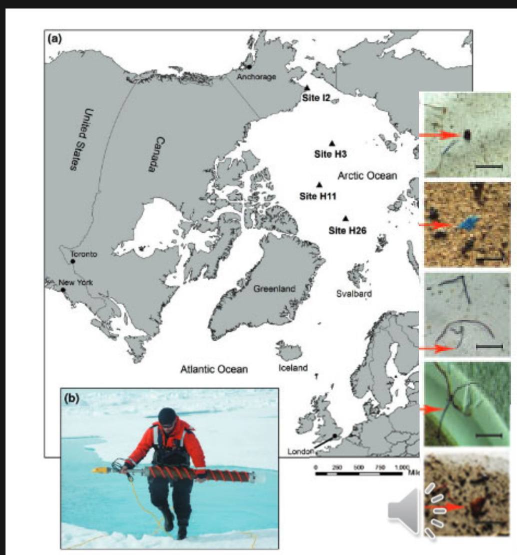


Figure 1. (a) Location of sea ice cores where microplastics, identified by Fourier transform infrared (FTIR) spectrometry, were found (map by R. Lieb Lappen, Thayer School of Engineering at Dartmouth College). (b) Sea ice core being collected during the NASA ICESCAPE expedition in July 2010 (photo courtesy of D. Perovich, CRREL).

Obbard, Sadri, Bakir, Thompson *et al.* 2014

8

Substantial global accumulation far from human sources

3500m below sea level

ROYAL SOCIETY OPEN SCIENCE

rsos.royalsocietypublishing.org

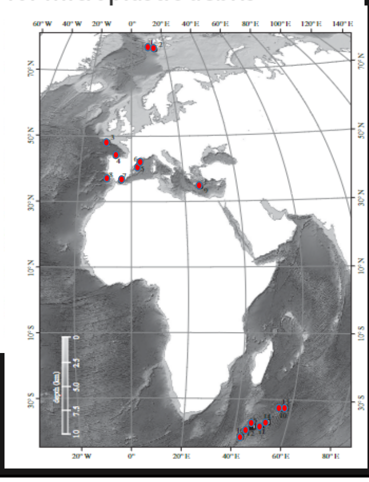
Research

Cite this article: Woodall LC *et al.* 2014 The deep sea is a major sink for microplastic debris. *R. Soc. open sci.* 1: 140317. http://dx.doi.org/10.1098/rsos.140317

Received: 18 September 2014
Accepted: 18 November 2014

Subject category:
Earth science

The deep sea is a major sink for microplastic debris



Woodall, Sleight, Coppock, Thompson *et al.* 2014

8400m above sea level

One Earth Article

Reaching New Heights in Plastic Pollution—Preliminary Findings of Microplastics on Mount Everest

Napper, Thompson *et al.* 2020

Accumulation in wild caught fish from UK waters

Marine Pollution Bulletin 67 (2013) 94–99

Contents lists available at SciVerse ScienceDirect

Marine Pollution Bulletin

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

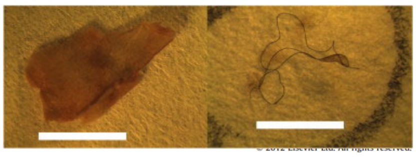
Occurrence of microplastics in the gastrointestinal tract of pelagic and demersal fish from the English Channel

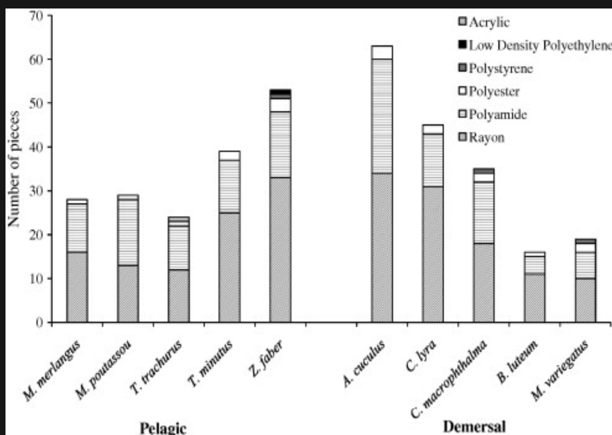
A.L. Lusher[a], M. McHugh[b], R.C. Thompson[a,*]

[a] School of Marine Science and Engineering, Plymouth University, Drake Circus, Plymouth PL4 8AA, UK
[b] Marine Biological Association of the United Kingdom, The Laboratory, Citadel Hill, Plymouth PL1 2PB, UK

ARTICLE INFO

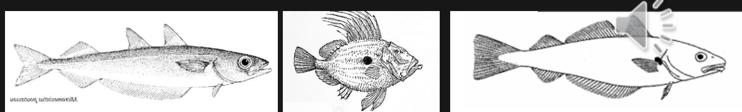
Keywords:
Marine debris
Plastic
Feeding
FT-IR
Polymer



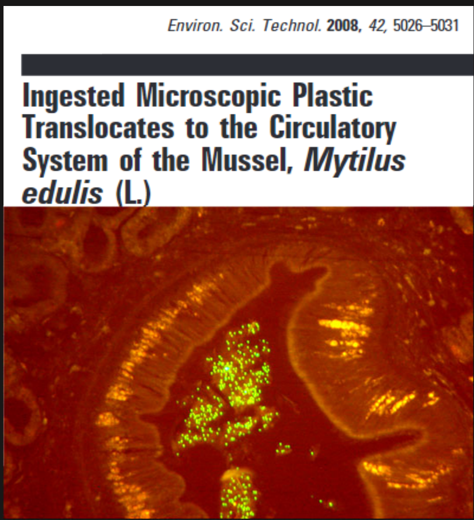


504 individuals, 10 species including those eaten by humans
Micropalstics in gut of 36.5 %

Lusher, Mc Hugh, Thompson, 2013

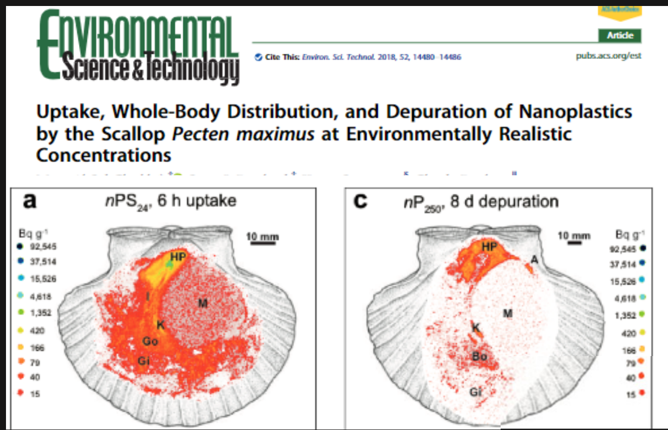


Transfer from intestine to circulatory system and retained in tissues for several weeks


Environ. Sci. Technol. 2008, 42, 5026–5031

Ingested Microscopic Plastic Translocates to the Circulatory System of the Mussel, *Mytilus edulis* (L.)

Browne, Dissanayake, Lowe, Galloway, Thompson *et al.* 2008


Article

Cite This: Environ. Sci. Technol. 2018, 52, 14480−14486

pubs.acs.org/est

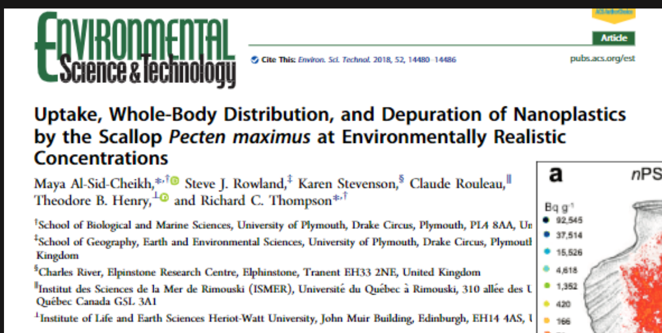
Uptake, Whole-Body Distribution, and Depuration of Nanoplastics by the Scallop *Pecten maximus* at Environmentally Realistic Concentrations

Nanoplastic had moved throughout the body in 6 hours

Al Sid Cheick, Rowland, Thompson *et al.* 2018

11

Nano plastics transfer from intestine throughout the body of a scallop in 6 hours and retained in tissues for several weeks


Article

Cite This: Environ. Sci. Technol. 2018, 52, 14480−14486

pubs.acs.org/est

Uptake, Whole-Body Distribution, and Depuration of Nanoplastics by the Scallop *Pecten maximus* at Environmentally Realistic Concentrations

Maya Al-Sid-Cheikh,[*,†] Steve J. Rowland,[‡] Karen Stevenson,[§] Claude Rouleau,[∥] Theodore B. Henry,[⊥] and Richard C. Thompson[*,†]

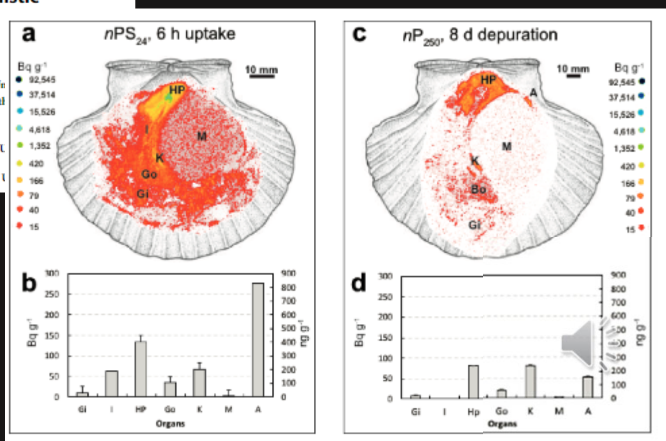
[†]School of Biological and Marine Sciences, University of Plymouth, Drake Circus, Plymouth, PL4 8AA, Un

[‡]School of Geography, Earth and Environmental Sciences, University of Plymouth, Drake Circus, Plymouth Kingdom

[§]Charles River, Elpinstone Research Centre, Elphinstone, Tranent EH33 2NE, United Kingdom

[∥]Institut des Sciences de la Mer de Rimouski (ISMER), Université du Québec à Rimouski, 310 allée des Québec Canada G5L 3A1

[⊥]Institute of Life and Earth Sciences Heriot-Watt University, John Muir Building, Edinburgh, EH14 4AS,



Al Sid Cheick, Rowland, Thompson *et al.* 2018

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Cosmetics as a source of microplastics
Marine Pollution Bulletin 99 (2015) 178–185
Contents lists available at ScienceDirect
Marine Pollution Bulletin
journal homepage: www.elsevier.com/locate/marpolbul
ELSEVIER
Characterisation, quantity and sorptive properties of microplastics extracted from cosmetics
Imogen E. Napper, Adil Bakir, Steven J. Rowland, Richard C. Thompson
A paper that led to worldwide legislation
A triumph and a frustration
SEI 15kV WD11mm SS40 x35 500μm
Plym EMC
Napper, Bakir , Rowland and Thompson, 2015

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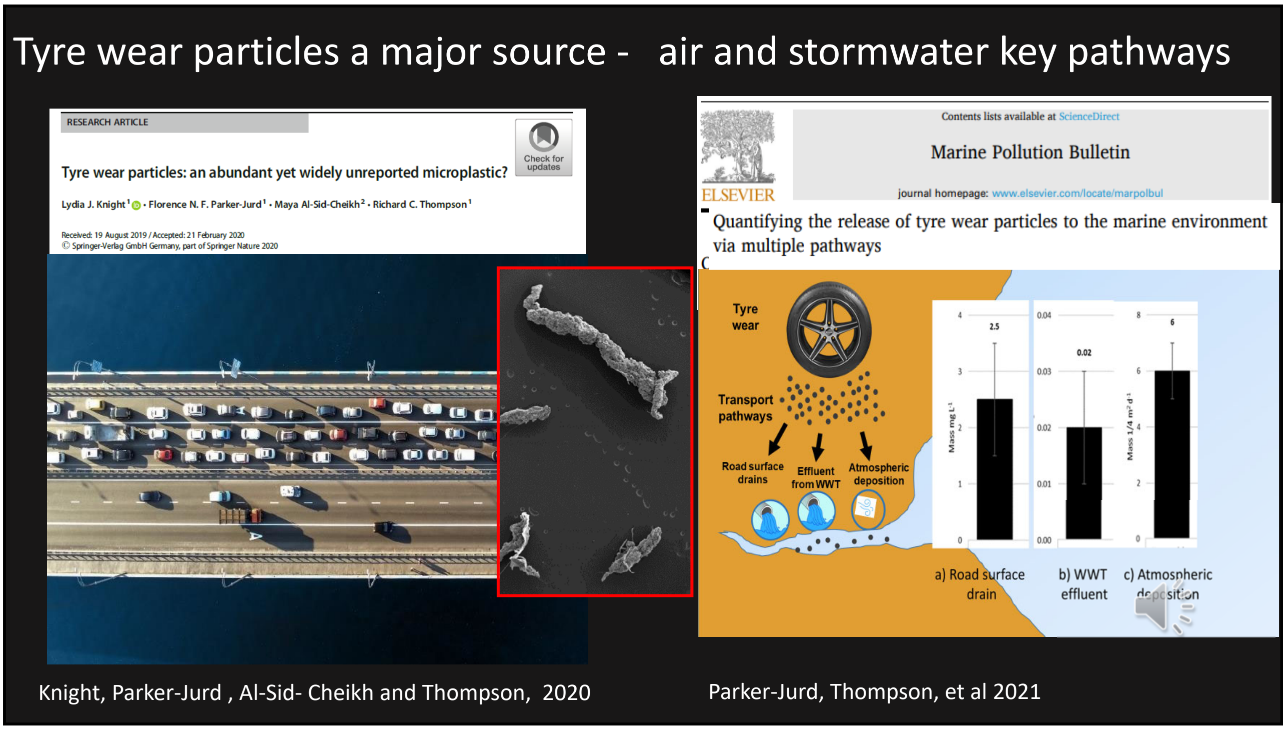
Tyre wear particles a major source - air and stormwater key pathways
RESEARCH ARTICLE
Tyre wear particles: an abundant yet widely unreported microplastic?
Lydia J. Knight · Florence N. F. Parker-Jurd · Maya Al-Sid-Cheikh · Richard C. Thompson
Received: 19 August 2019 / Accepted: 21 February 2020
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Check for updates
Contents lists available at ScienceDirect
Marine Pollution Bulletin
journal homepage: www.elsevier.com/locate/marpolbul
ELSEVIER
Quantifying the release of tyre wear particles to the marine environment via multiple pathways
Tyre wear
Transport pathways
Road surface drains
Effluent from WWT
Atmospheric deposition
a) Road surface drain
b) WWT effluent
c) Atmospheric deposition
Knight, Parker-Jurd , Al-Sid- Cheikh and Thompson, 2020
Parker-Jurd, Thompson, et al 2021

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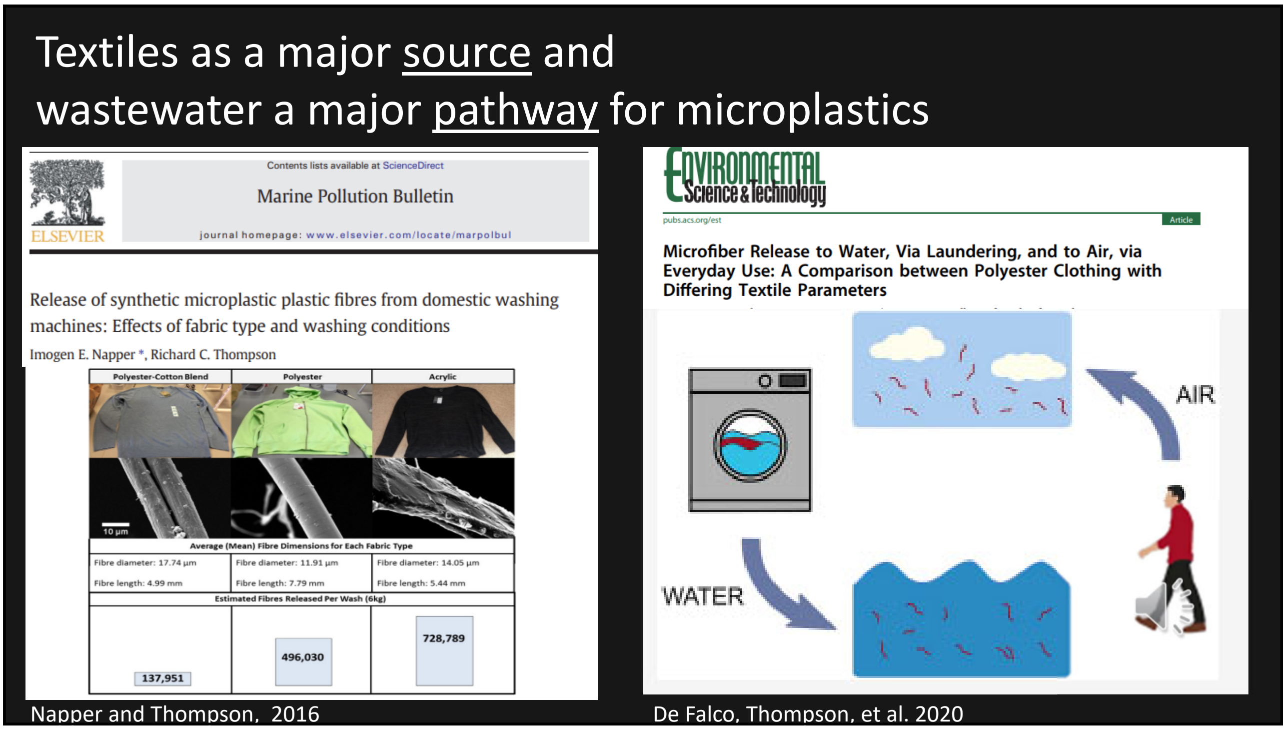
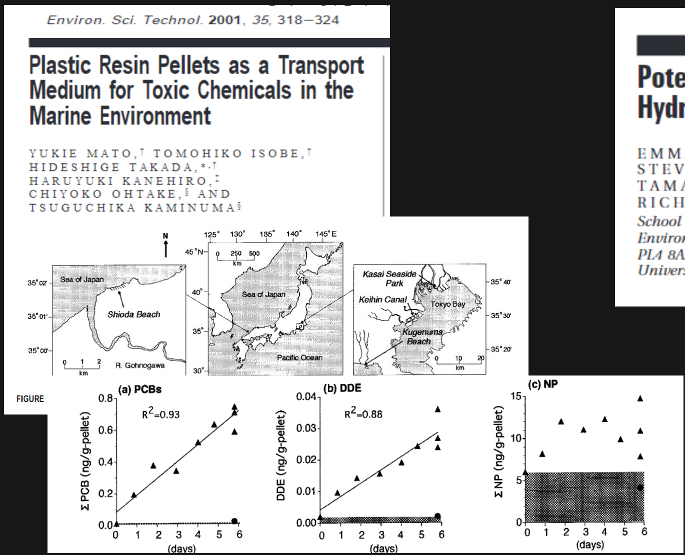

Textiles as a major source and
wastewater a major pathway for microplastics
Contents lists available at ScienceDirect
Marine Pollution Bulletin
journal homepage: www.elsevier.com/locate/marpolbul
ELSEVIER
Release of synthetic microplastic plastic fibres from domestic washing machines: Effects of fabric type and washing conditions
Imogen E. Napper *, Richard C. Thompson
Polyester-Cotton Blend
Polyester
Acrylic
10 µm
Average (Mean) Fibre Dimensions for Each Fabric Type
Fibre diameter: 17.74 µm
Fibre length: 4.99 mm
Fibre diameter: 11.91 µm
Fibre length: 7.79 mm
Fibre diameter: 14.05 µm
Fibre length: 5.44 mm
Estimated Fibres Released Per Wash (6kg)
137,951
496,030
728,789
Napper and Thompson, 2016
Environmental Science & Technology
pubs.acs.org/est
Article
Microfiber Release to Water, Via Laundering, and to Air, via Everyday Use: A Comparison between Polyester Clothing with Differing Textile Parameters
AIR
WATER
De Falco, Thompson, et al. 2020

15

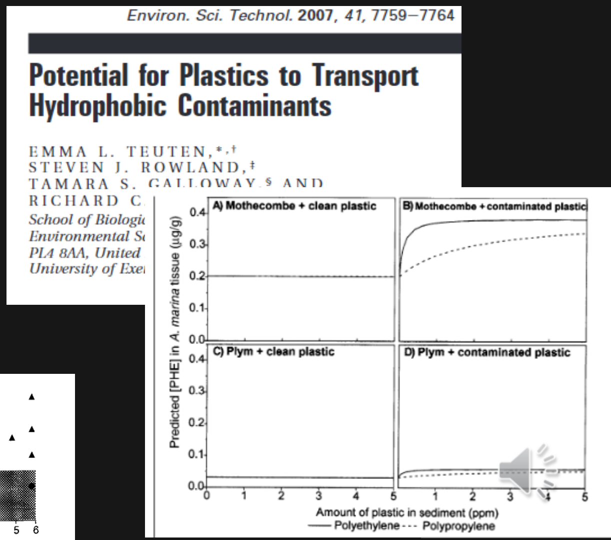

Rivers as a key pathway to the ocean
WATER RESEARCH 75 (2015) 63–82
Available online at www.sciencedirect.com
ScienceDirect
journal homepage: www.elsevier.com/locate/watres
ELSEVIER
Review
Microplastics in freshwater systems: A review of the emerging threats, identification of knowledge gaps and prioritisation of research needs
Dafne Eerkes-Medrano a,*, Richard C. Thompson b, David C. Aldridge a
a Aquatic Ecology Group, Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, United Kingdom
b Marine Biology and Ecology Research Centre (MBERC), School of Marine Science and Engineering, Plymouth University, Drake Circus, Plymouth, Devon PL4 8AA, United Kingdom
Eerkes-Medrano,, Thompson, Aldridge, 2015
Contents lists available at ScienceDirect
Environmental Pollution
journal homepage: www.elsevier.com/locate/envpol
ELSEVIER
The abundance and characteristics of microplastics in surface water in the transboundary Ganges River
Imogen E. Napper a,*, Anju Baroth b, Aaron C. Barrett c, Sunanda Bhola b,
Gawsia W. Chowdhury d,e, Bede F.R. Davies f, Emily M. Duncan g, Sumit Kumar b,
Sarah E. Nelms
Richard C. Thom
Napper, Thompson, Nelms, Duncan, Koldeway et al, 2021

16

Key work in Japan influenced our thinking on the transport of toxic chemicals by plastics



Mato, Isobe, Takada, Kanehiro, Ohtake and Kaminuma; 2001



Teuten, Rowland, Galloway and Thompson; 2007

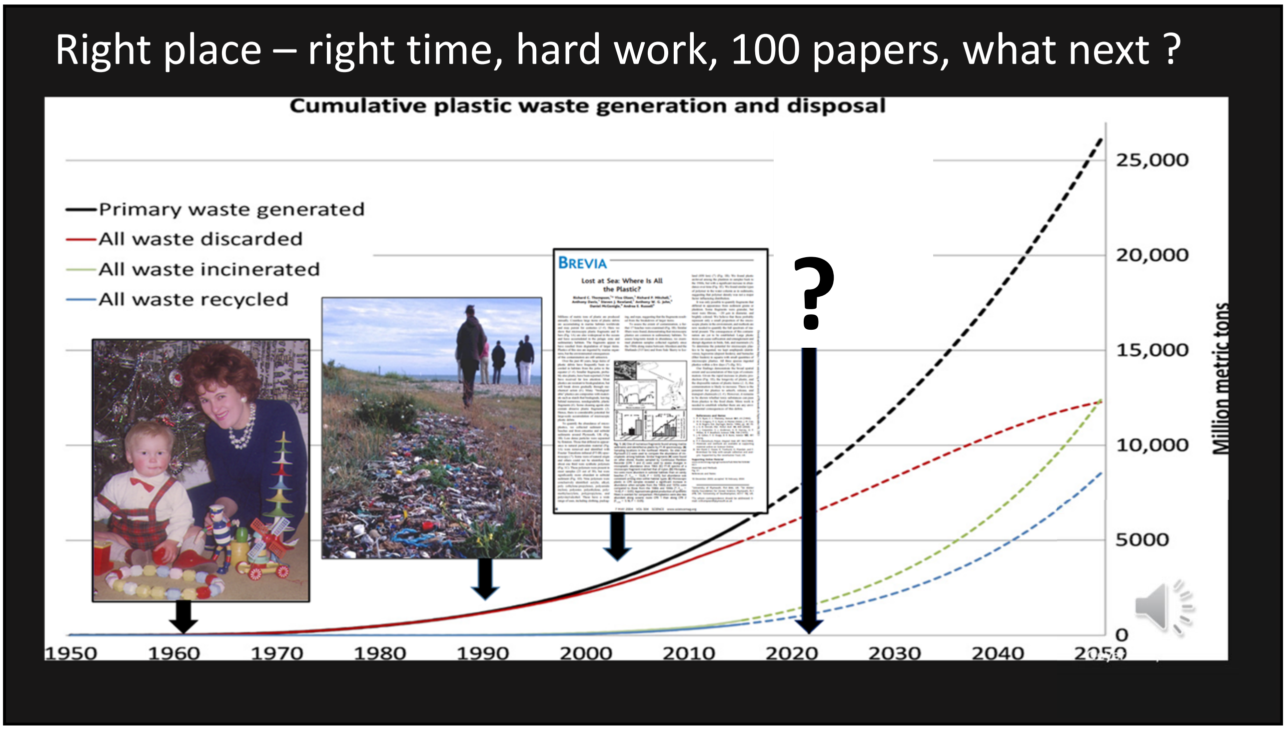
17

Marine Biologist to '*Godfather*' of Micropalstics

1994

Mary Greagh, MP, 2016

18


Right place – right time, hard work, 100 papers, what next ?
Cumulative plastic waste generation and disposal
Primary waste generated
All waste discarded
All waste incinerated
All waste recycled
BREVIA
Lost at Sea: Where Is All the Plastic?
?
25,000
20,000
15,000
10,000
5000
0
Million metric tons
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050

19


Right place – right time, hard work, 100 papers, what next ?
Cumulative plastic waste generation and disposal
Primary waste generated
All waste discarded
All waste incinerated
All waste recycled
BREVIA
Lost at Sea: Where Is All the Plastic?
UN Plastic Pollution Treaty
25,000
20,000
15,000
10,000
5000
0
Million metric tons
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
Our Blue Planet - its future and ours - is in our hands!

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Prof Tamara Galloway OBE
Environmental impacts and consequences for human health

University of Exeter

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University of Exeter

Environmental impacts and consequences for human health

Prof Tamara Galloway OBE
t.s.galloway@exeter.ac.uk

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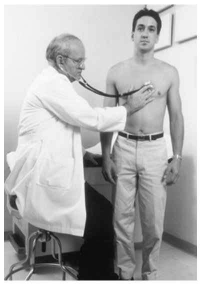
Ecotoxicology research group

How does pollution damage living things?

What makes some species more vulnerable?

How can we use this knowledge to protect the environment and human health?



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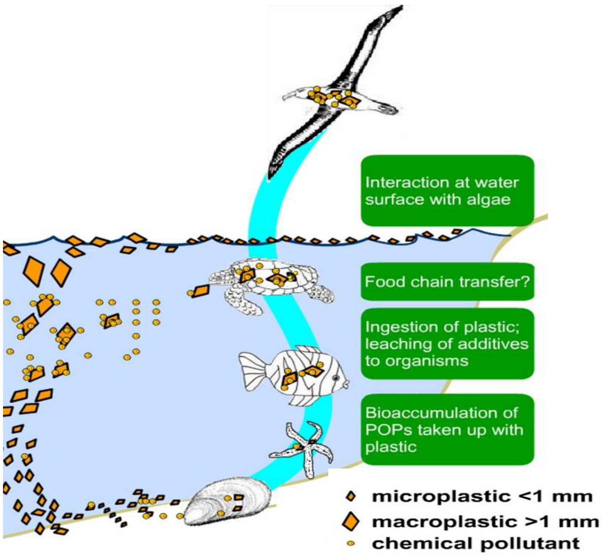
Which species to study?



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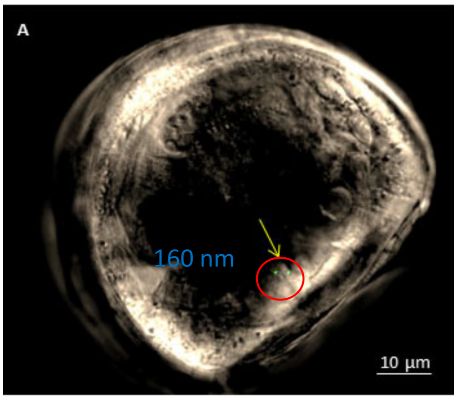
Microplastics enter the food web

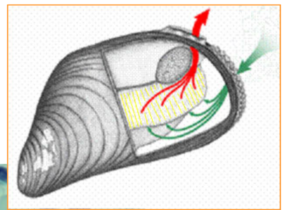
Centropages typicus marine copepod

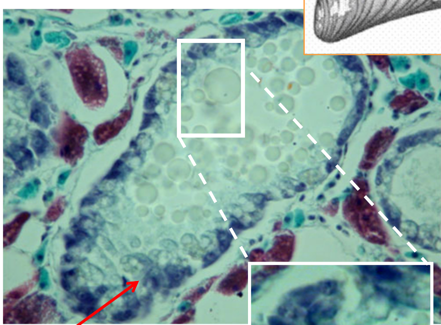


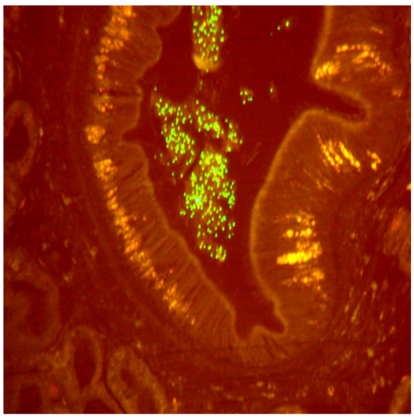
Crassostrea gigas: edible oyster

Cole and Galloway, ES&T 2015, Cole et al ES&T 2013

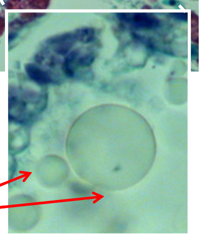
Particles are ingested and pass to the digestive tubules







3 µm fluorescent polystyrene in gut cavity of *M. edulis*



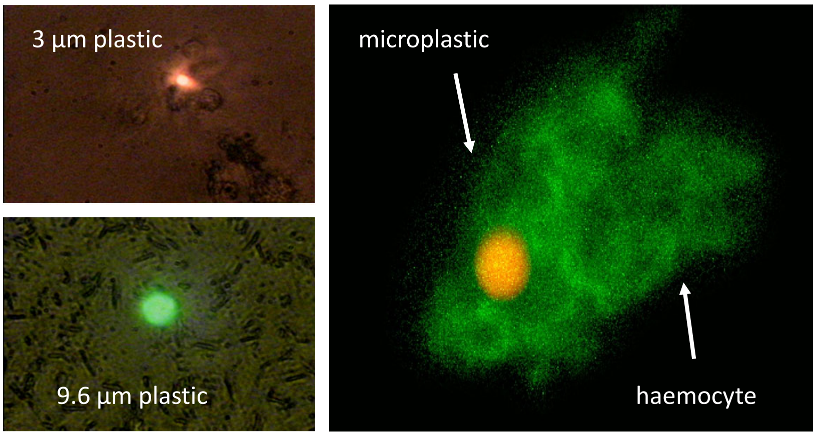
Digestive tubule

3-10 µm polystyrene

Browne et al., 2007 ES&T

And accumulate in haemolymph

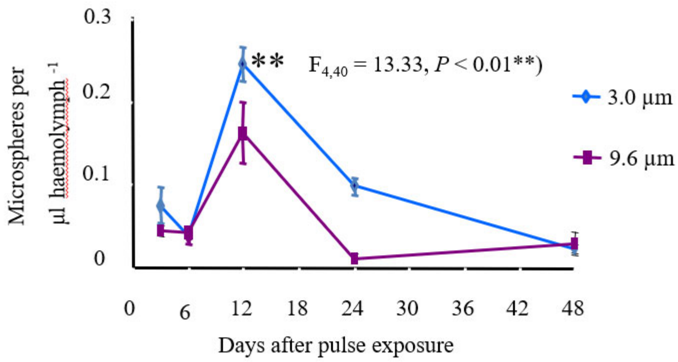
University of Exeter



Browne et al 2007 ES&T

Particles are retained for up to 48 days

University of Exeter

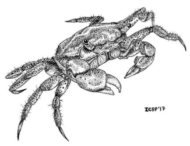


3.0 > 9.6 µm ($F_{1,40}$ = 9.87, P < 0.01 **)

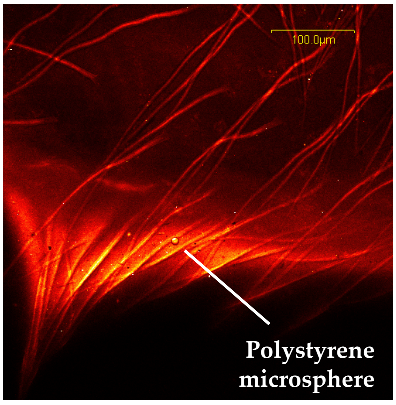
Browne et al 2007 ES&T

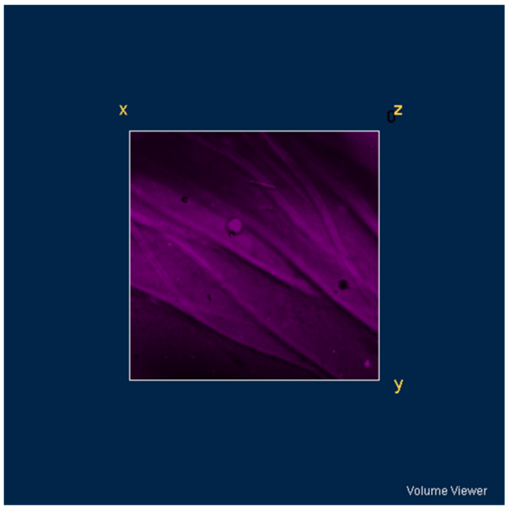
Microplastics retained by foregut setae

University of Exeter



Raman scattering image at 2845 cm^{-1}
(C-H bond resonance)



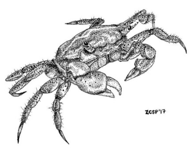


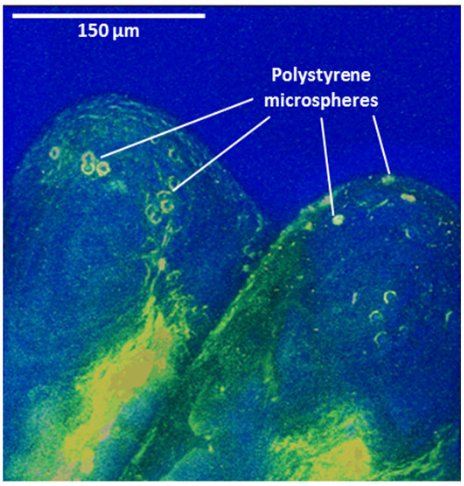
Watts et al., 2014 ES&T

29

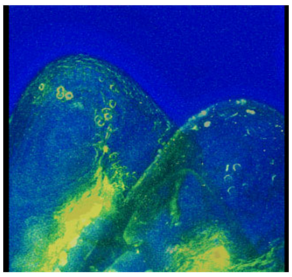
.. and adhered to gill lamellae

University of Exeter





Resonance tuned to 803.2 nm (Aromatic C-H)



Watts et al., 2014 ES&T

30

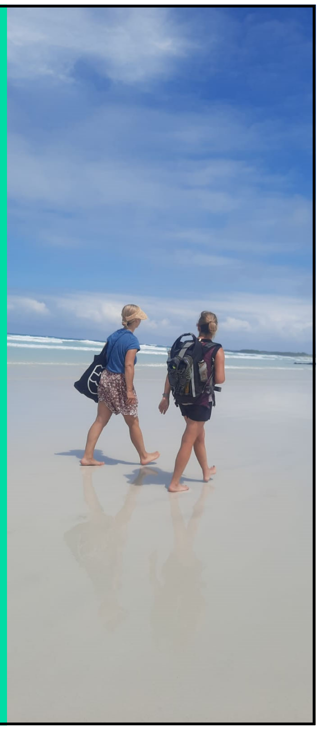
Reaching higher trophic levels

Duncan et al (2018)Global Change Biology

31

University of Exeter

What harm do they cause?



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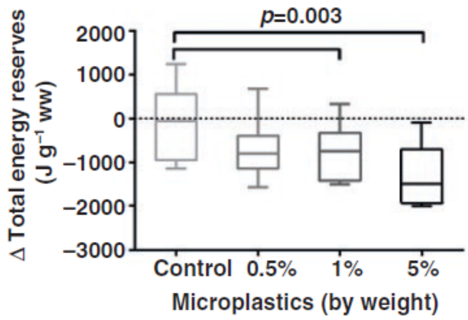
theguardian

Mounting microplastic pollution harms 'earthworms of the sea' – report

University of Exeter

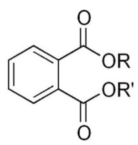


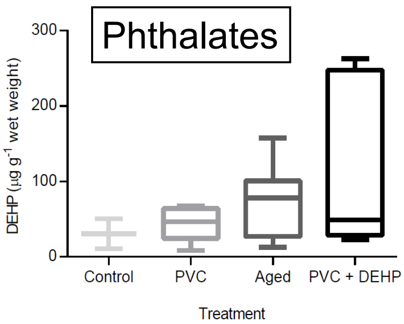
Worms cultured for 1 month in sediment with 1% pristine PVC

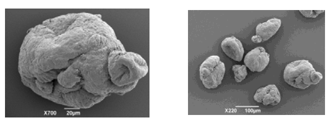
Wright et al Current Biology 2013

33

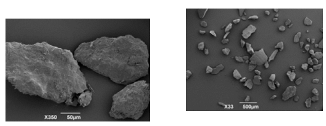
Transfer of intrinsic chemicals?







PVC particles 150- 250 µm



sediments < 250 µm

Worms cultured for 1 month in sediment with 1% plasticised PVC

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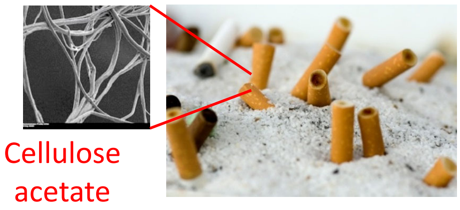
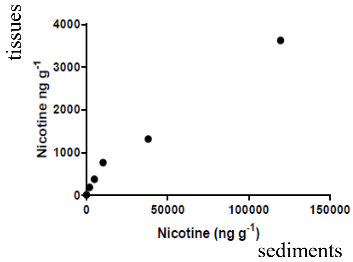
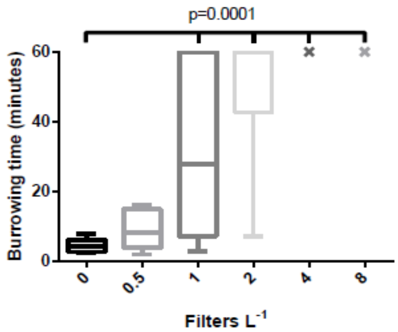
Wright et al unpublished

34

Transfer of adhered pollutants?







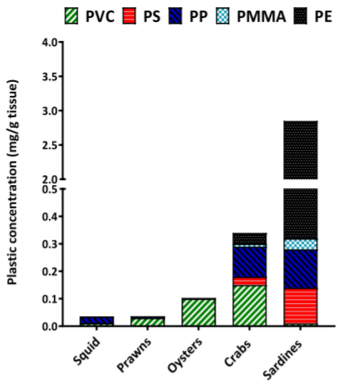
University of Exeter

Wright et al., 2015. *Scientific Reports*

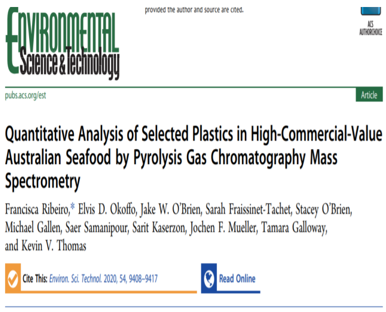
University of Exeter

Are humans exposed to microplastics?

Microplastics in seafood



Eviscerated fillets: flesh and skin only


ENVIRONMENTAL Science & Technology

pubs.acs.org/est

Article

Quantitative Analysis of Selected Plastics in High-Commercial-Value Australian Seafood by Pyrolysis Gas Chromatography Mass Spectrometry

Francisca Ribeiro,* Elvis D. Okoffo, Jake W. O'Brien, Sarah Fraissinet-Tachet, Stacey O'Brien, Michael Gallen, Saer Samanipour, Sarit Kaserzon, Jochen F. Mueller, Tamara Galloway, and Kevin V. Thomas

Cite This: Environ. Sci. Technol. 2020, 54, 9408–9417

Read Online

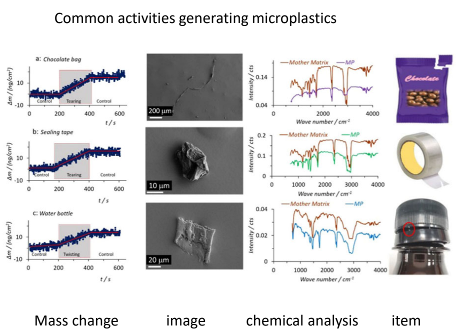
Human consumption:
Average meal of 3 sardines = 30mg plastic

University of Exeter

Ribiero et al ES&T 2020

Modelled exposure estimates

Average person consumes
- 11,000 particles per year from seafood (7µg)
- 0.1-5g/week* from all food sources
- 22 million microplastics/year through inhalation



0.4 – 250 particles / cm²

University of Exeter

Sobhaniea et al 2020 Sci Rep

Open Access Research

BMJ Open

An engaged research study to assess the effect of a ‘real-world’ dietary intervention on urinary bisphenol A (BPA) levels in teenagers

Tamara S Galloway,[1] Nigel Baglin,[2] Benjamin P Lee,[3] Anna L Kocur,[3] Maggie H Shepherd,[4,5] Anna M Steele,[4,5] BPA Schools Study Consortium,[6,7,8,9,10,11] Lorna W Harries[3]

To cite: Galloway TS, Baglin N, Lee BP, *et al.* An engaged research study to assess the effect of a ‘real-world’ dietary intervention on urinary bisphenol A (BPA) levels in teenagers. *BMJ Open* 2018;**8**:e018742. doi:10.1136/

ABSTRACT
Objective Bisphenol A (BPA) has been associated with adverse human health outcomes and exposure to this compound is near-ubiquitous in the Western world. We aimed to examine whether self-moderation of BPA exposure is possible by altering diet in a real-world setting.
Design An Engaged Research dietary intervention study

Strengths and limitations of this study

- This study represents the largest assessment to date of the potential for moderating one’s own bisphenol A (BPA) exposure through diet.
- The study was carried out in a ‘real-world’ setting rather than a regulated, controlled environment

Prof Pennie Lindeque

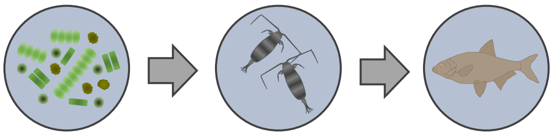
Delivering evidence, raising awareness and evaluating solutions

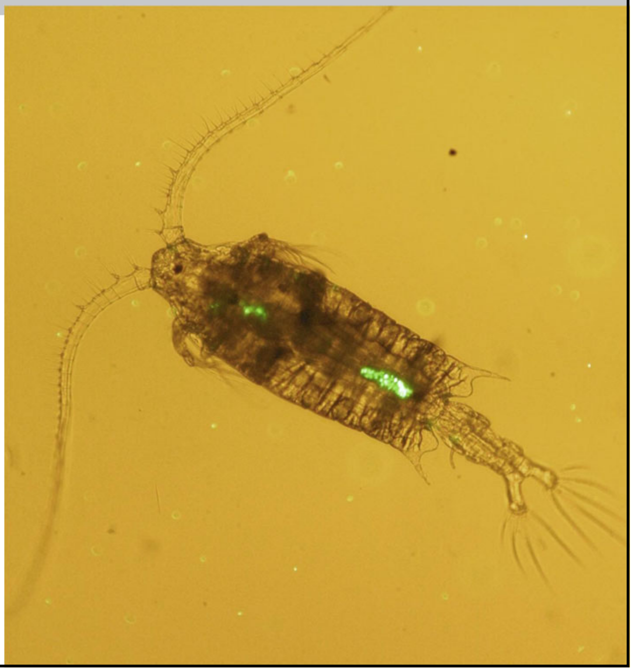
@LindequePk

PML Plymouth Marine Laboratory

Zooplankton and microplastic

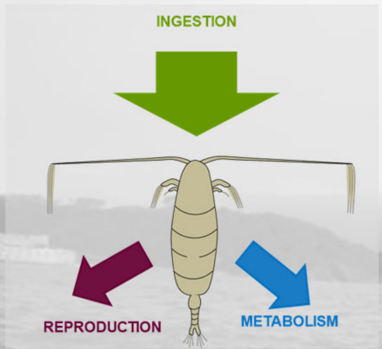
- Zooplankton are common to marine ecosystems across the globe.
- Provide a key link in the marine food web and play vital roles in marine processes.
- Copepods play an important role in regulating Earth's climate





41

Zooplankton and microplastic - Summary

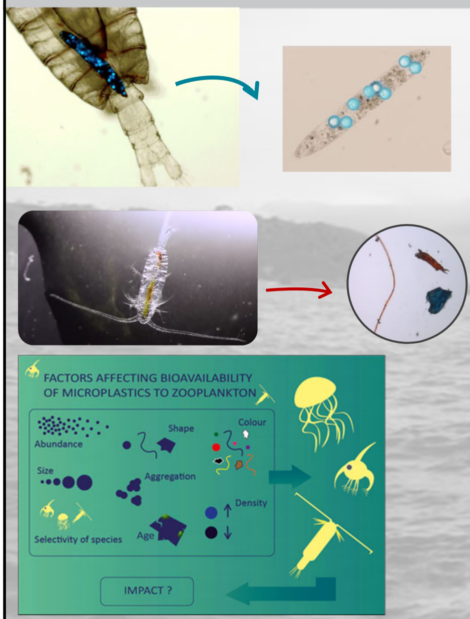


Copepods spend more energy than they consume: ENERGETIC SHORTFALL.

- Zooplankton have the capacity to ingest microplastics
- Reduced feeding capacity
- Decline in energy reserves
- Lower reproductive output
- Direct relevance to animal populations and communities
- Chemical profile of microplastic ingested may act as endocrine disruptors and impact moulting

42

Zooplankton and microplastic - Summary



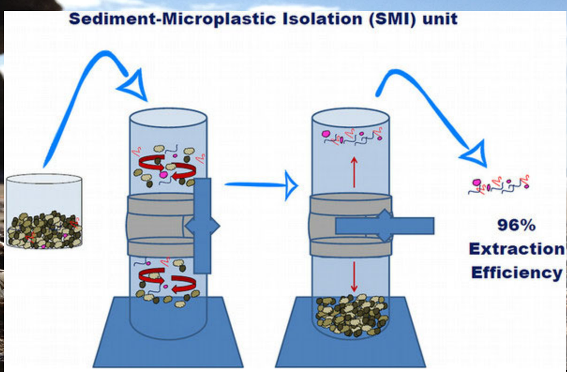
Botterell *et al*., 2020. Environmental Science and Technology

- MP are egested in faecal pellets, alter the properties and sinking rates
- MP have been shown to be consumed by zooplankton in the natural environment
- May select what plastics they eat
- Lab based studies confirm shape of MPs influence their uptake
- Infochemical DMS increases ingestion of MP by zooplankton

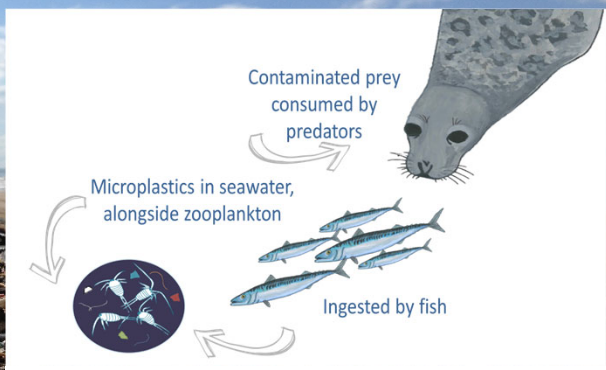
43

Interdisciplinary work

Sediment-Microplastic Isolation (SMI) unit



Coppock RL, Cole M, Lindeque PK, Queirós AM, Galloway TS, 2017. Environmental Pollution



Nelms, SE, Galloway TS, Godley BJ, Jarvis DS, Lindeque PK, 2018. Environmental Pollution

Our work is highly interdisciplinary

Chemistry | Remote sensing | Mathematical modelling | Socioeconomics

44

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Research excellence supporting a sustainable ocean

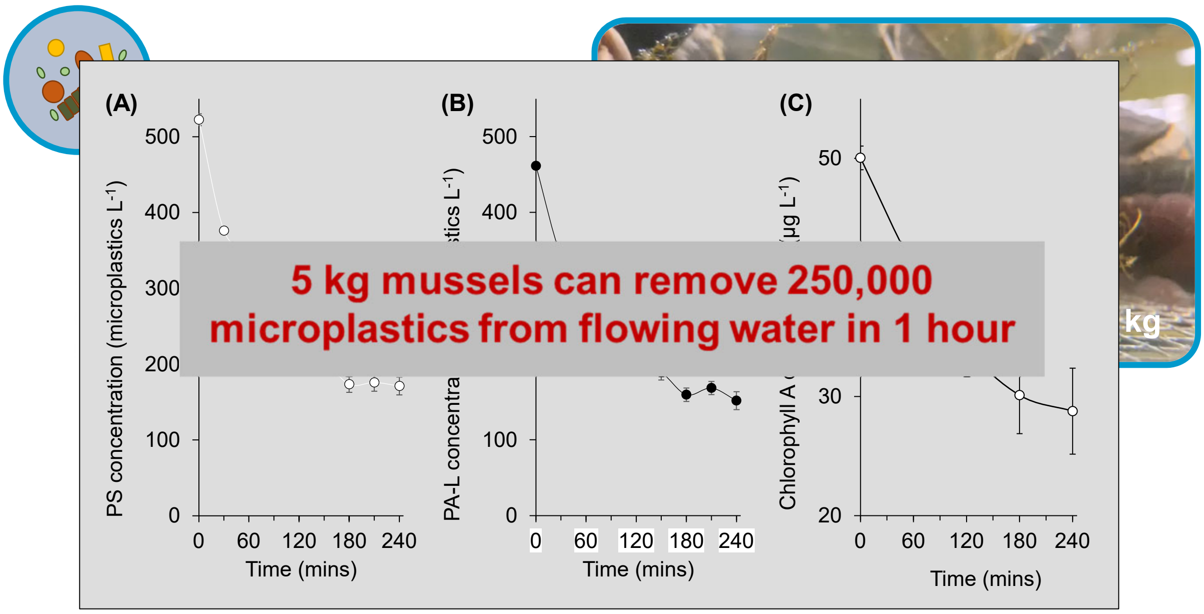
Solutions – Nature Based Solution

- Mussels are pollution tolerant bivalve shellfish
- Voracious filter-feeders
- Natural biofilters that can improve water quality
- Widely evidenced to ingest microplastics

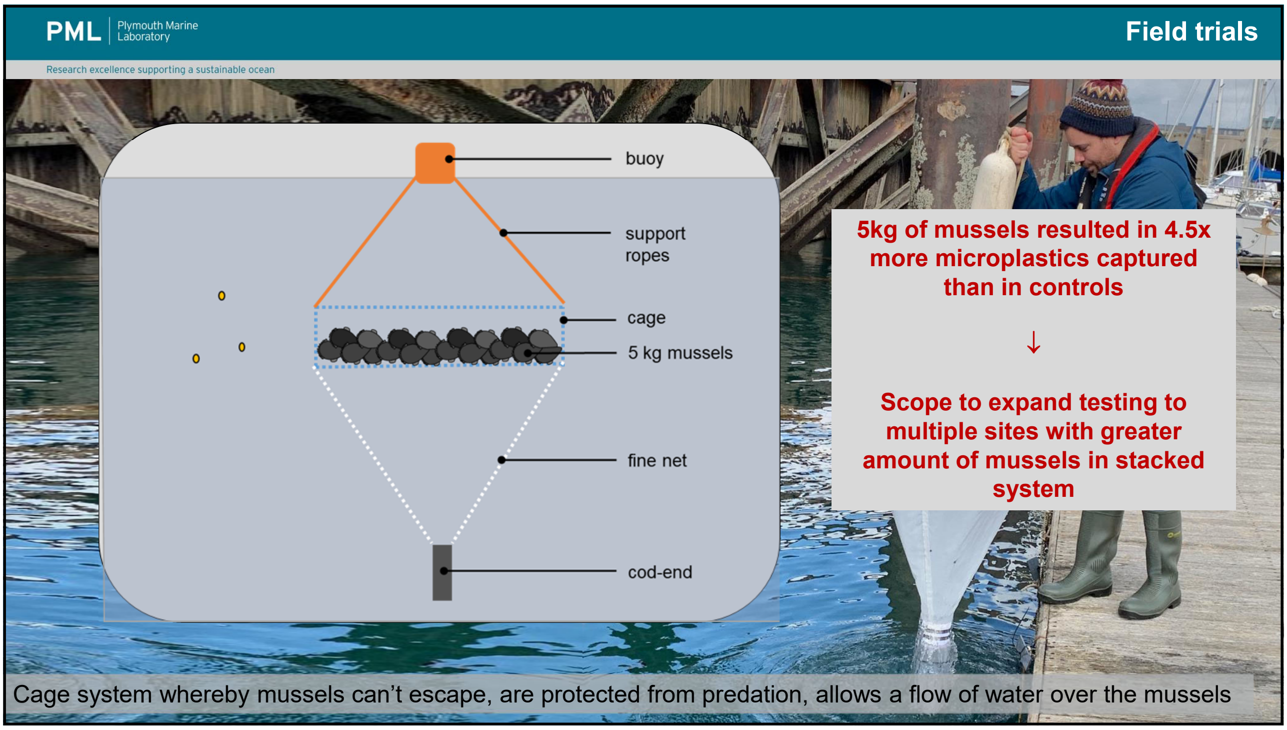
PML | Plymouth Marine Laboratory

Research excellence supporting a sustainable ocean

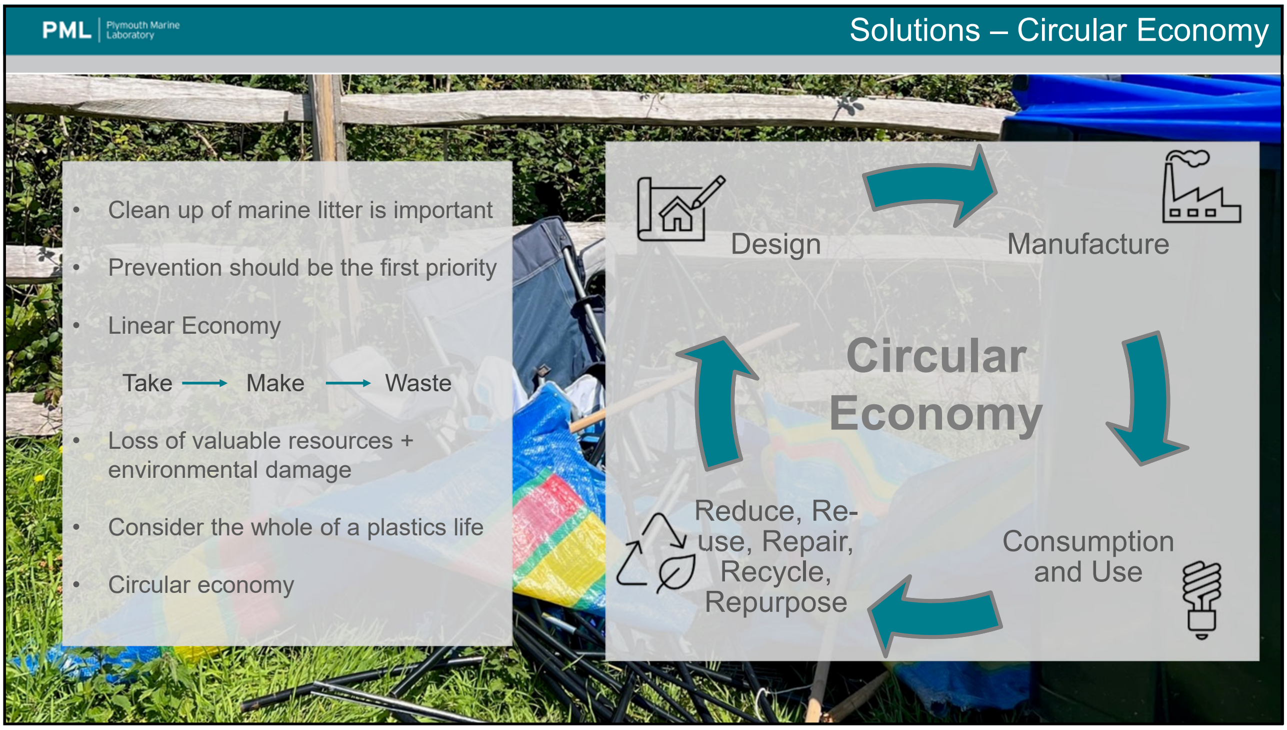
Flume Tank



5 kg mussels can remove 250,000 microplastics from flowing water in 1 hour


PML Plymouth Marine Laboratory
Field trials
Research excellence supporting a sustainable ocean
buoy
support ropes
cage
5 kg mussels
fine net
cod-end
5kg of mussels resulted in 4.5x more microplastics captured than in controls
↓
Scope to expand testing to multiple sites with greater amount of mussels in stacked system
Cage system whereby mussels can't escape, are protected from predation, allows a flow of water over the mussels

47

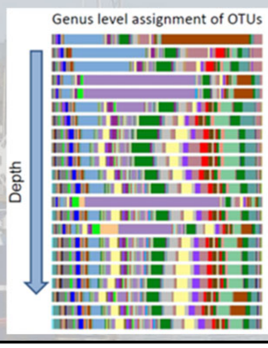

PML Plymouth Marine Laboratory
Solutions – Circular Economy
Clean up of marine litter is important
Prevention should be the first priority
Linear Economy
Take → Make → Waste
Loss of valuable resources + environmental damage
Consider the whole of a plastics life
Circular economy
Design
Manufacture
Circular Economy
Consumption and Use
Reduce, Re-use, Repair, Recycle, Repurpose

48

Solutions – Safer-by-design; Biodegradable Bioplastics

- Biodegradable bioplastics (BBPs) offer a possible solution
- Renewable carbon feedstock
- Enhanced biodegradation
- Applications with substantive pathways to the natural environment
- Need to improve our understanding of the fate and impact of BBPs
- Help guide development of innovative plastics
- Reduction in fossil fuels, environmentally safe.



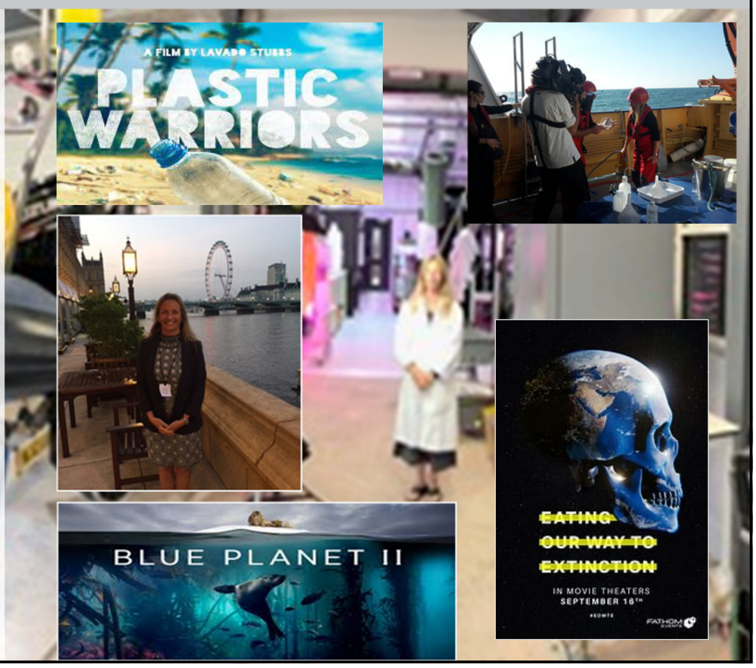



Solutions – Raising Awareness and Giving Evidence

Raising Awareness:

- We are passionate about disseminating our research to a wide audience
- Our pioneering work has reached a global audience:

Eating our way to extinction, Plastic Warriros, Inside Out Southwest, The One Show, Food Unwrapped, Springwatch, BBC and ITN news, El Jazeera – Earthrise program, 'Plastic Britain' documentary and Blue Planet II



PML | Plymouth Marine Laboratory

Solutions – Raising Awareness and Giving Evidence

Giving Evidence

- Successful in highlighting the risks MP pose to marine life contributing to introduction of plastic bag levy and ban of cosmetic microbeads:

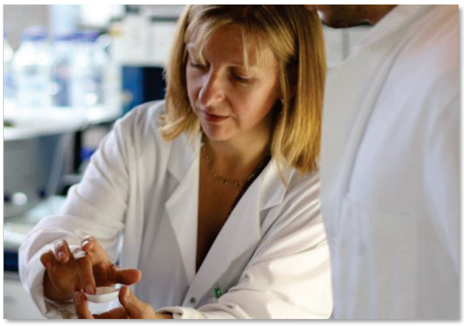
House of Lords, Parliamentary and Scientific Committee, National and International regulatory bodies, Environmental Audit Committee's collection of written and oral evidence on the Environmental Impact of MP, United Nations hearings on MP

- **Global Plastics Treaty**. Providing evidence to on-going International Negotiating Committee

Discovering microplastics:
Their environmental accumulation, impacts and solutions

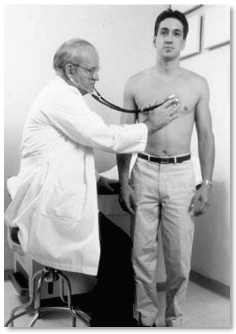
Thank you - 2023 Blue Planet Prize – Commemorative Lecture

Environmental impacts and consequences for human health



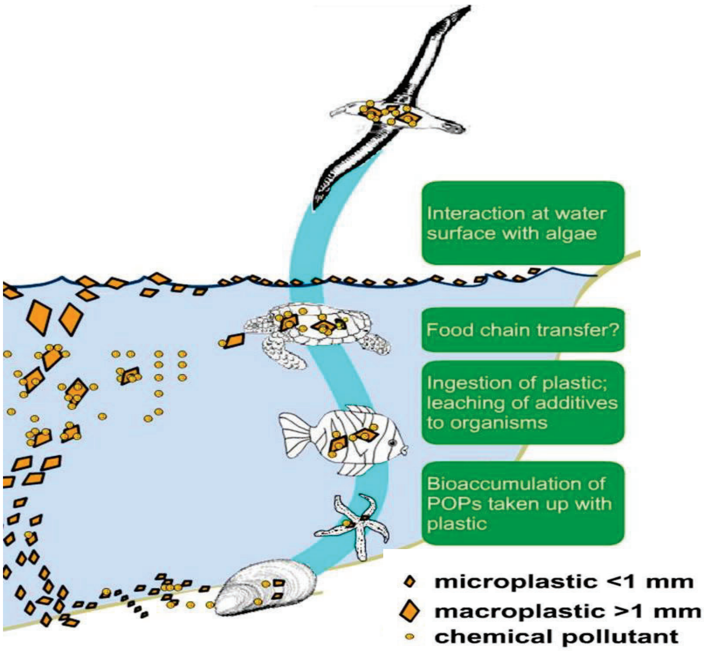
Prof Tamara Galloway OBE
t.s.galloway@exeter.ac.uk

Ecotoxicology research group

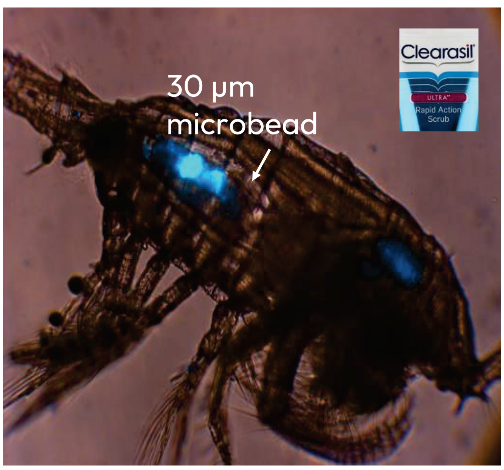


How does pollution damage living things?
What makes some species more vulnerable?
How can we use this knowledge to protect the environment and human health?

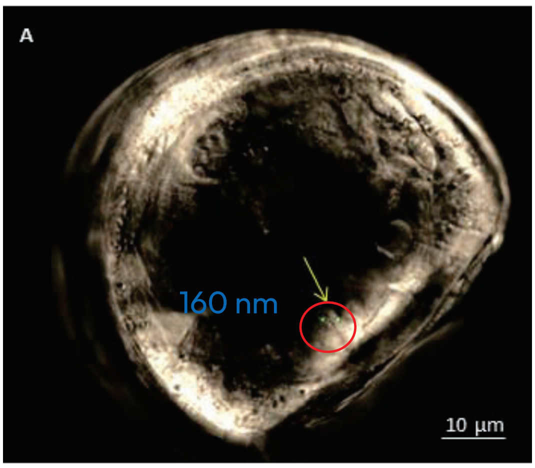
Which species to study?



Microplastics enter the food web



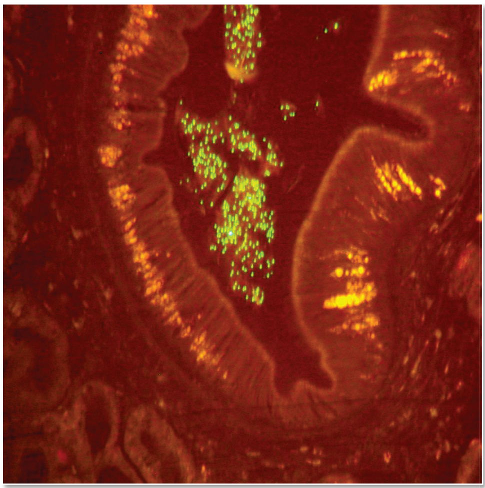
Centropages typicus
marine copepod



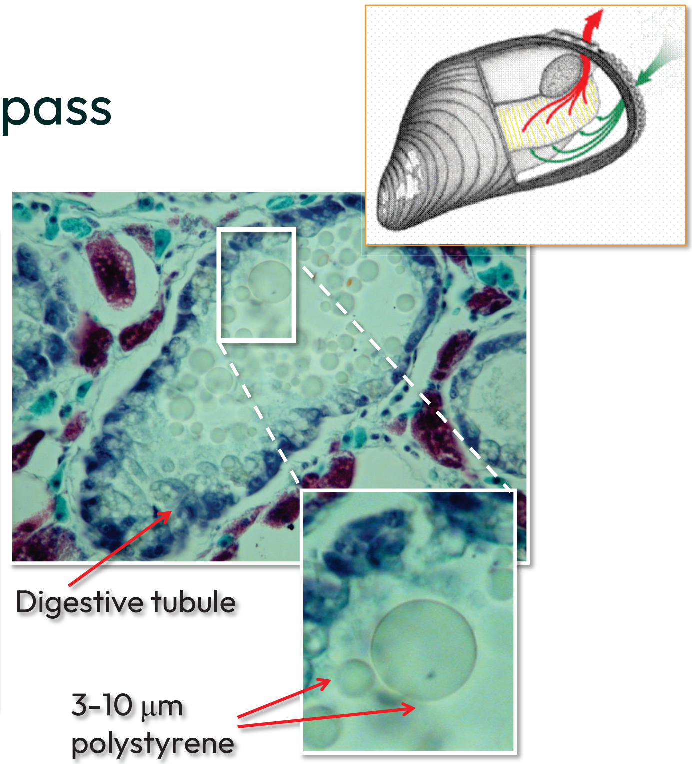
Crassostrea gigas:
edible oyster

Cole and Galloway, ES&T 2015, Cole et al ES&T 2013

Particles are ingested and pass to the digestive tubules

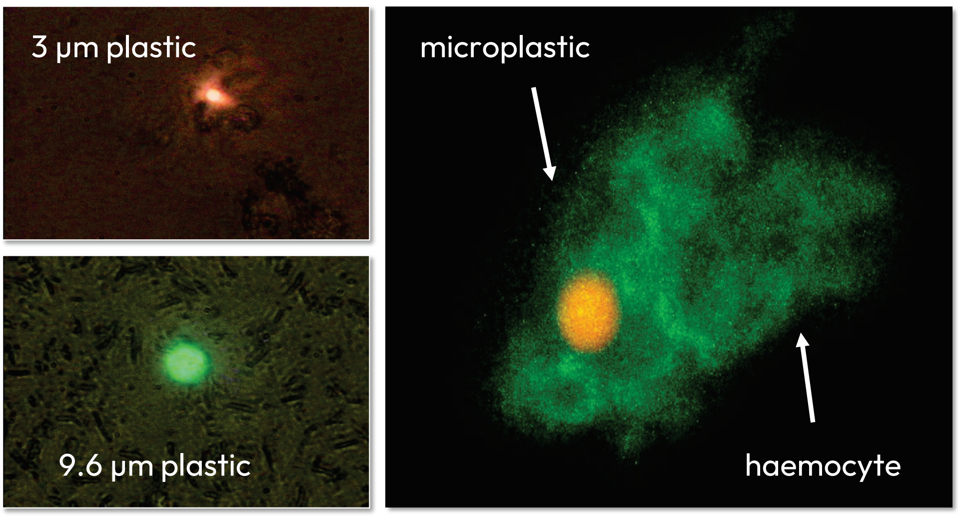


3 µm fluorescent polystyrene in gut cavity of *M. edulis*



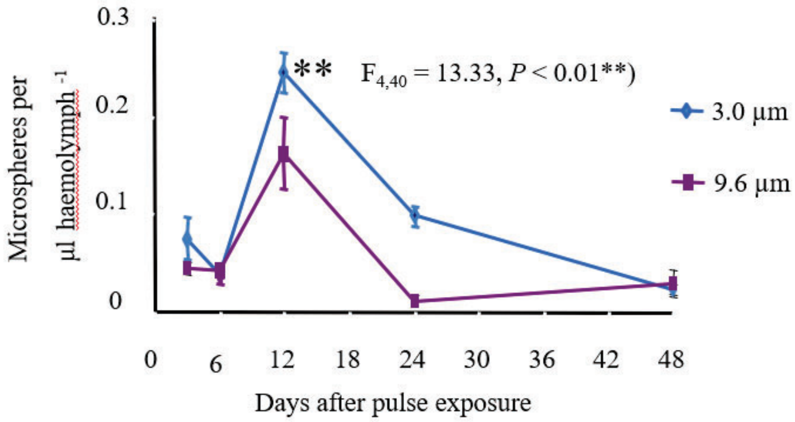
Browne et al., 2007 ES&T

And accumulate in haemolymph



Browne et al 2007 ES&T

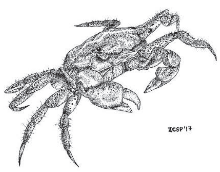
Particles are retained for up to 48 days



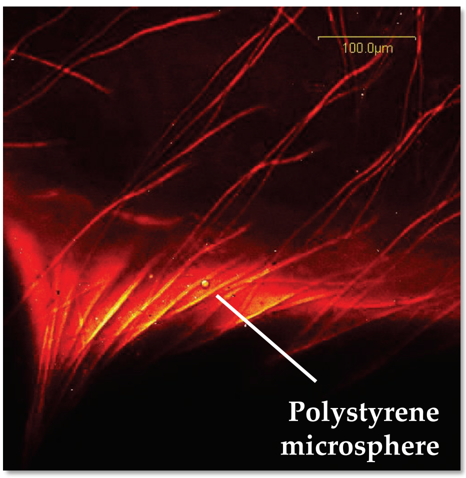
3.0 > 9.6 µm ($F_{1,40} = 9.87, P < 0.01$ **)

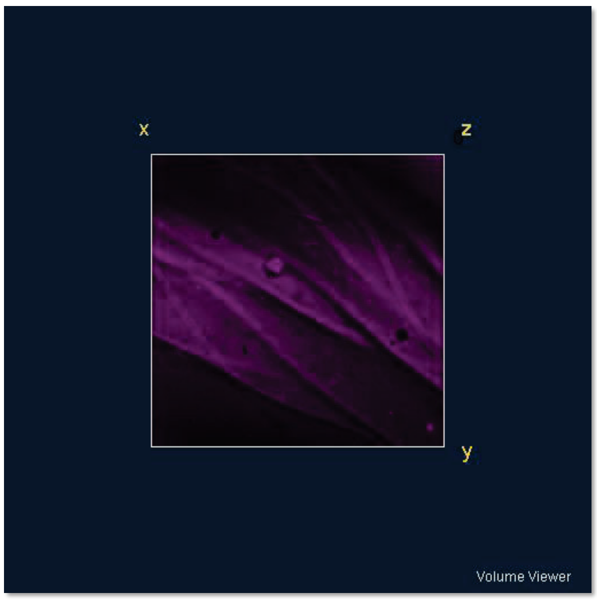
Browne et al 2007 ES&T

Microplastics retained by foregut setae



Raman scattering image at 2845 cm^{-1} (C-H bond resonance)





Watts et al., 2014 ES&T

.. and adhered to gill lamellae

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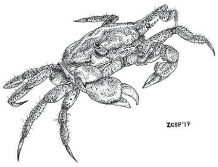
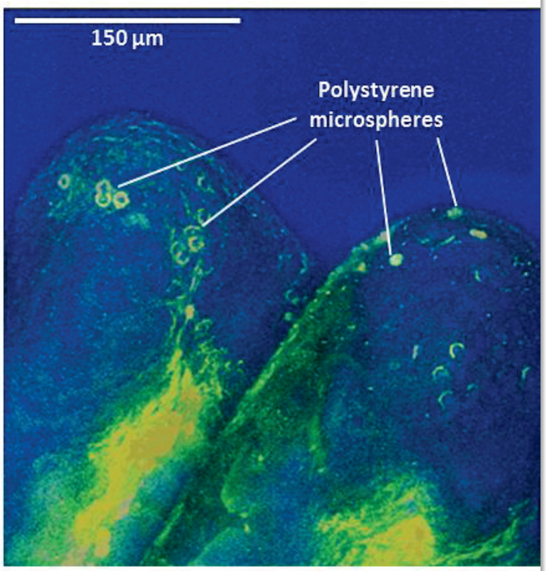
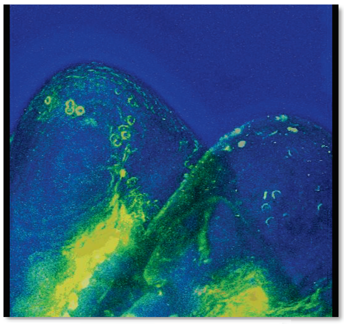




Resonance tuned to 803.2 nm (Aromatic C-H)



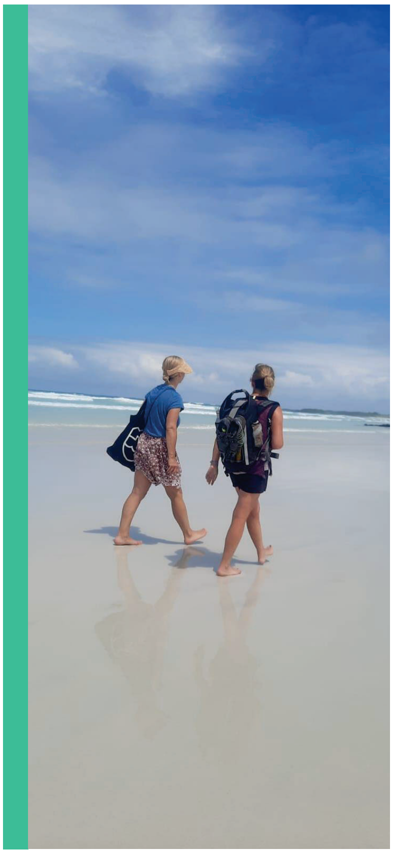
Watts et al., 2014 ES&T

Reaching higher trophic levels

Duncan et al (2018)Global Change Biology

University of Exeter

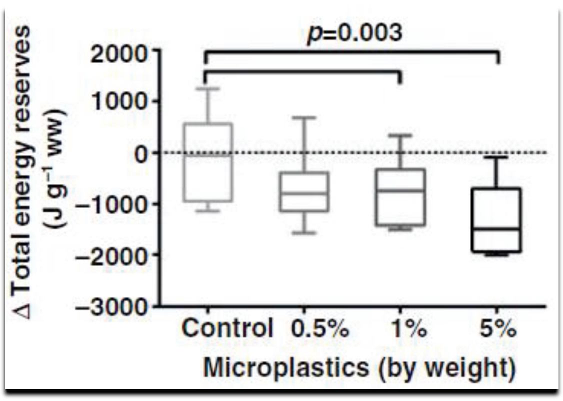
What harm do they cause?



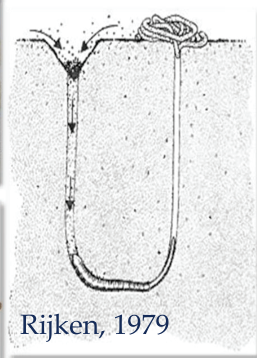
theguardian

Mounting microplastic pollution harms 'earthworms of the sea' – report

University of Exeter

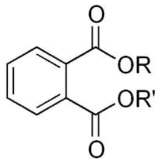


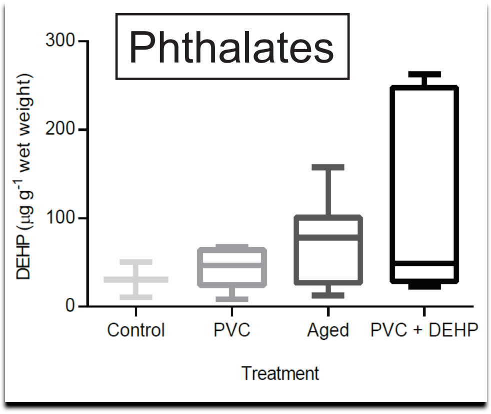
Worms cultured for 1 month in sediment with 1% pristine PVC



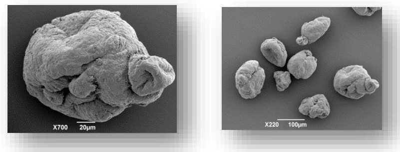
Wright et al Current Biology 2013

Transfer of intrinsic chemicals?

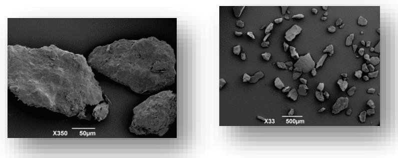




Worms cultured for 1 month in sediment with 1% plasticised PVC



PVC particles 150- 250 µm

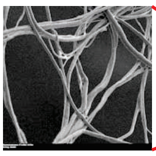


sediments < 250 µm

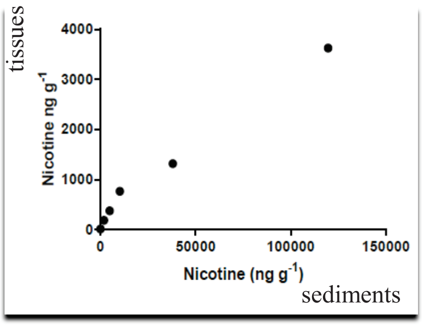
University of Exeter

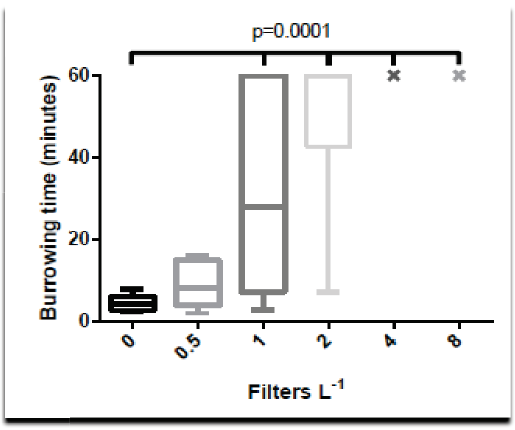
Wright et al unpublished

Transfer of adhered pollutants?



Cellulose acetate





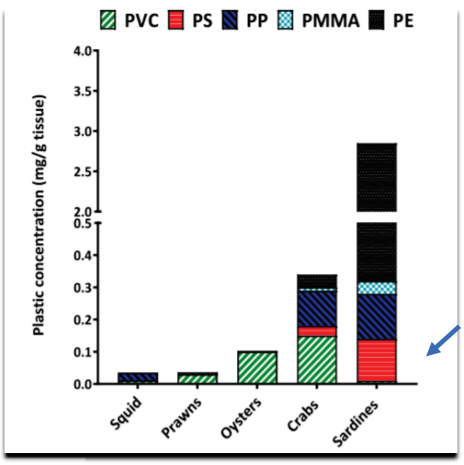
University of Exeter

Wright et al., 2015. *Scientific Reports*

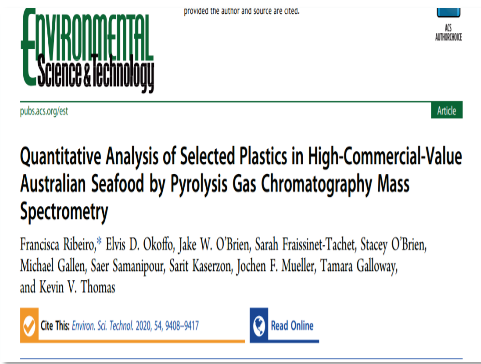
University of Exeter

Are humans exposed to microplastics?

Microplastics in seafood



Eviscerated fillets: flesh and skin only


Environmental Science & Technology

provided the author and source are cited.

pubs.acs.org/est

Article

Quantitative Analysis of Selected Plastics in High-Commercial-Value Australian Seafood by Pyrolysis Gas Chromatography Mass Spectrometry

Francisca Ribeiro,* Elvis D. Okoffo, Jake W. O'Brien, Sarah Fraissinet-Tachet, Stacey O'Brien, Michael Gallen, Saer Samanipour, Sarit Kaserzon, Jochen F. Mueller, Tamara Galloway, and Kevin V. Thomas

Cite This: *Environ. Sci. Technol.* 2020, 54, 9408−9417

Read Online

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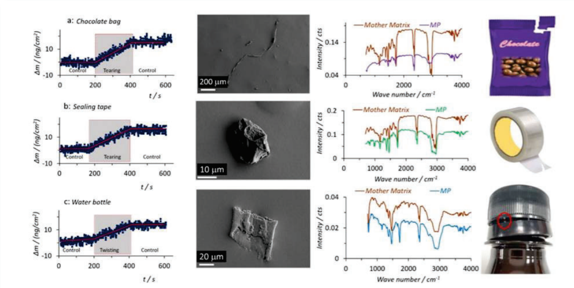
University of Exeter

Ribiero et al ES&T 2020

Modelled exposure estimates

Average person consumes
- 11,000 particles per year from seafood (7µg)
- 0.1-5g/week* from all food sources
- 22 million microplastics/year through inhalation

Common activities generating microplastics



Mass change image chemical analysis item

0.4 – 250 particles / cm²

University of Exeter

Sobhaniea et al 2020 Sci Rep

Open Access Research

BMJ Open An engaged research study to assess the effect of a ‘real-world’ dietary intervention on urinary bisphenol A (BPA) levels in teenagers

Tamara S Galloway,[1] Nigel Baglin,[2] Benjamin P Lee,[3] Anna L Kocur,[3] Maggie H Shepherd,[4,5] Anna M Steele,[4,5] BPA Schools Study Consortium,[6,7,8,9,10,11] Lorna W Harries[3]

To cite: Galloway TS, Baglin N, Lee BP, et al. An engaged research study to assess the effect of a ‘real-world’ dietary intervention on urinary bisphenol A (BPA) levels in teenagers. BMJ Open 2018;8:e018742. doi:10.1136/

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PML | Plymouth Marine Laboratory

Email: pkw@pml.ac.uk

Twitter: @LindequePk1

Listen to the ocean

Working towards solutions.

Prof. Pennie Lindeque

1

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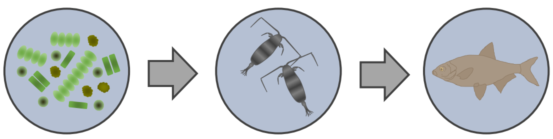
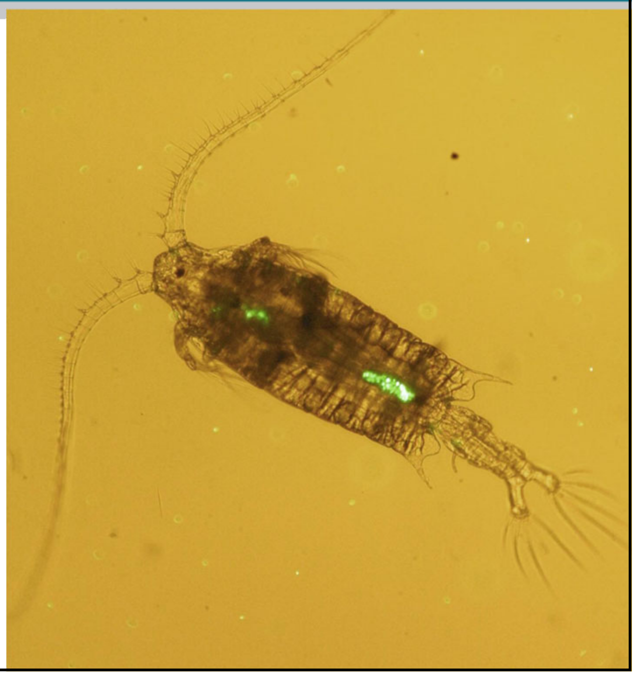
Zooplankton and microplastic

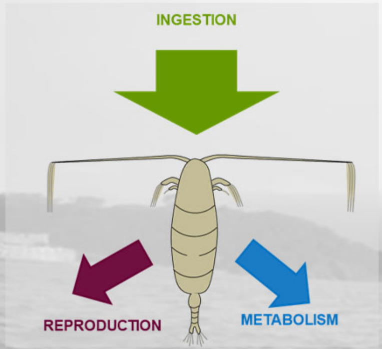
- Zooplankton are common to marine ecosystems across the globe.
- Provide a key link in the marine food web and play vital roles in marine processes.
- Copepods play an important role in regulating Earth’s climate





2

Zooplankton and microplastic - Summary

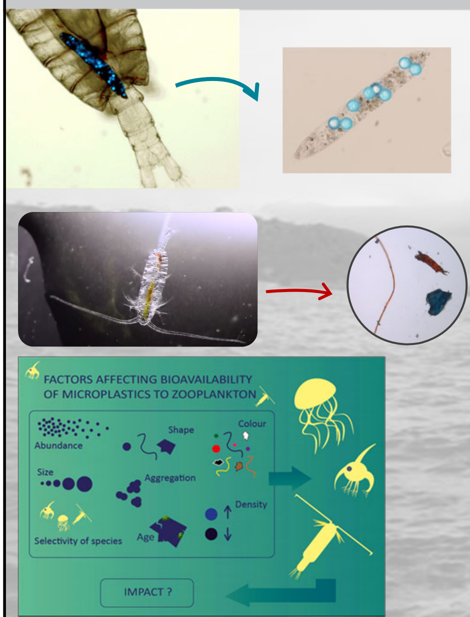


Copepods spend more energy than they consume: ENERGETIC SHORTFALL.

- Zooplankton have the capacity to ingest microplastics
- Reduced feeding capacity
- Decline in energy reserves
- Lower reproductive output
- Direct relevance to animal populations and communities
- Chemical profile of microplastic ingested may act as endocrine disruptors and impact moulting

3

Zooplankton and microplastic - Summary



Botterell *et al.*, 2020. Environmental Science and Technology

- MP are egested in faecal pellets, alter the properties and sinking rates
- MP have been shown to be consumed by zooplankton in the natural environment
- May select what plastics they eat
- Lab based studies confirm shape of MPs influence their uptake
- Infochemical DMS increases ingestion of MP by zooplankton

4

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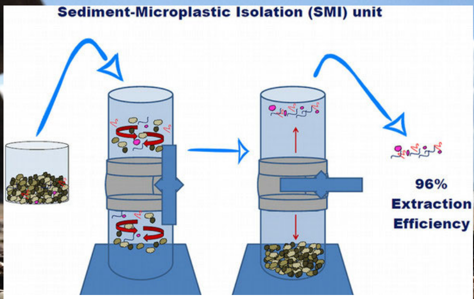
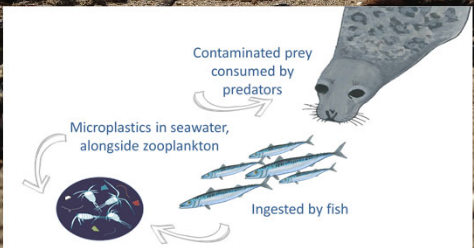
Interdisciplinary work



Coppock RL, Cole M, Lindeque PK, Queirós AM, Galloway TS, 2017. Environmental Pollution



Nelms, SE, Galloway TS, Godley BJ, Jarvis DS, Lindeque PK, 2018. Environmental Pollution

- Our work is highly interdisciplinary
  - Chemistry
  - Mathematical modelling
  - Remote sensing
  - Socioeconomics

- Our ecological team has **expertise** in:
  - Environmental sampling
  - Method development (e.g. SMI unit)
  - Exposure studies
  - Ecotoxicology
  - Nature-based solutions

5

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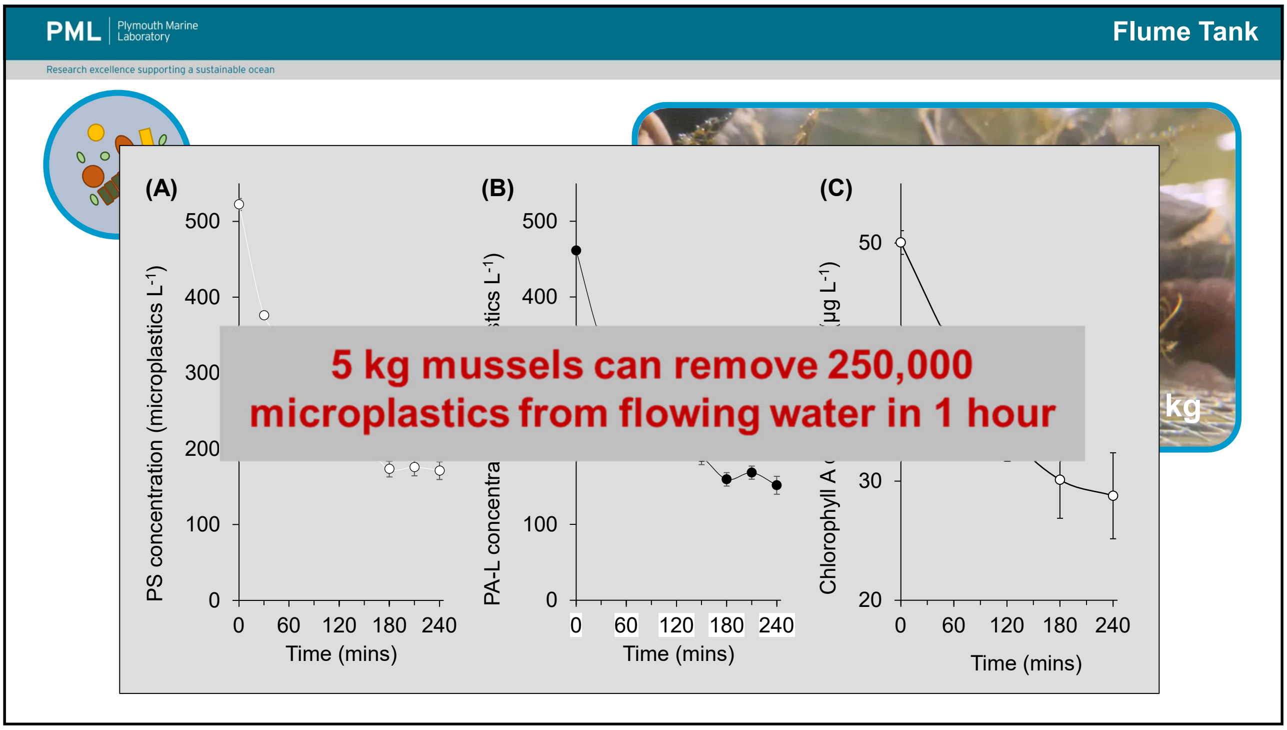
Research excellence supporting a sustainable ocean

Solutions – Nature Based Solution

- Mussels are pollution tolerant bivalve shellfish
- Voracious filter-feeders
- Natural biofilters that can improve water quality
- Widely evidenced to ingest microplastics

6



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Flume Tank
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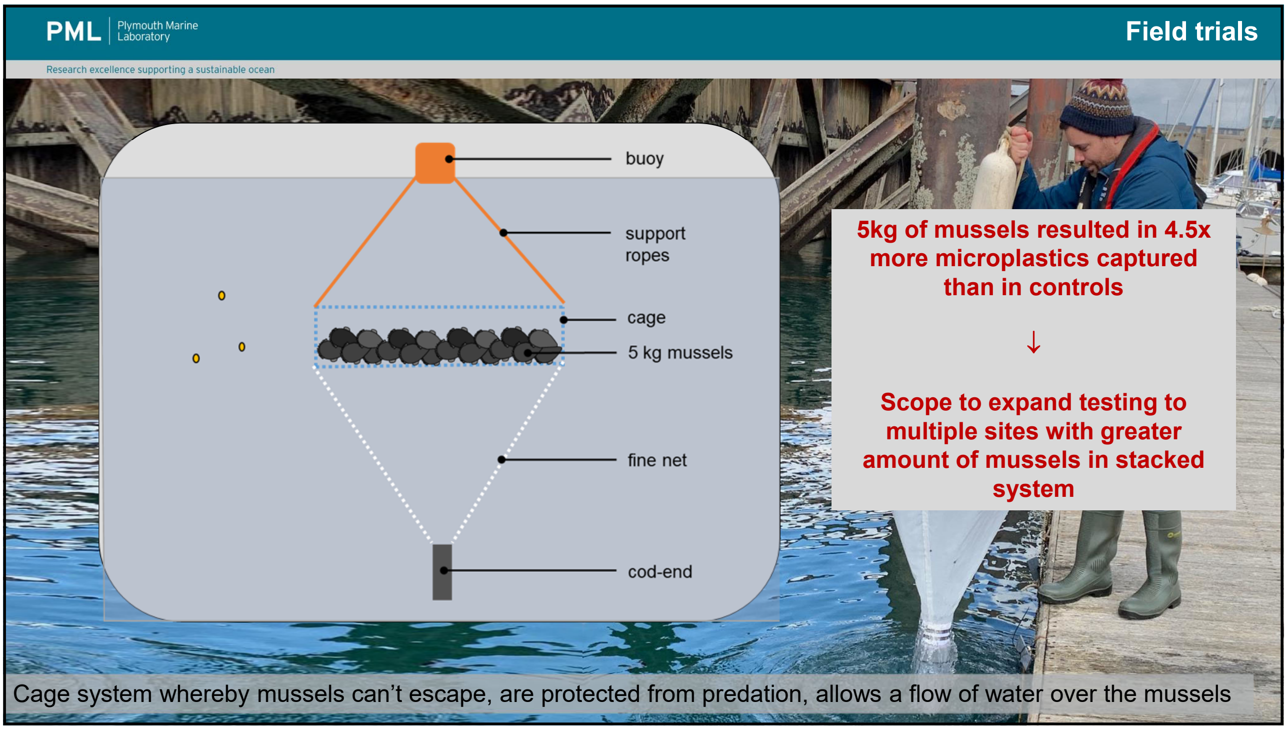
(A)
PS concentration (microplastics L⁻¹)
500
400
300
200
100
0
0 60 120 180 240
Time (mins)
(B)
500
400
100
0
0 60 120 180 240
Time (mins)
(C)
50
30
20
0 60 120 180 240
Time (mins)
5 kg mussels can remove 250,000
microplastics from flowing water in 1 hour
kg

7



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Field trials
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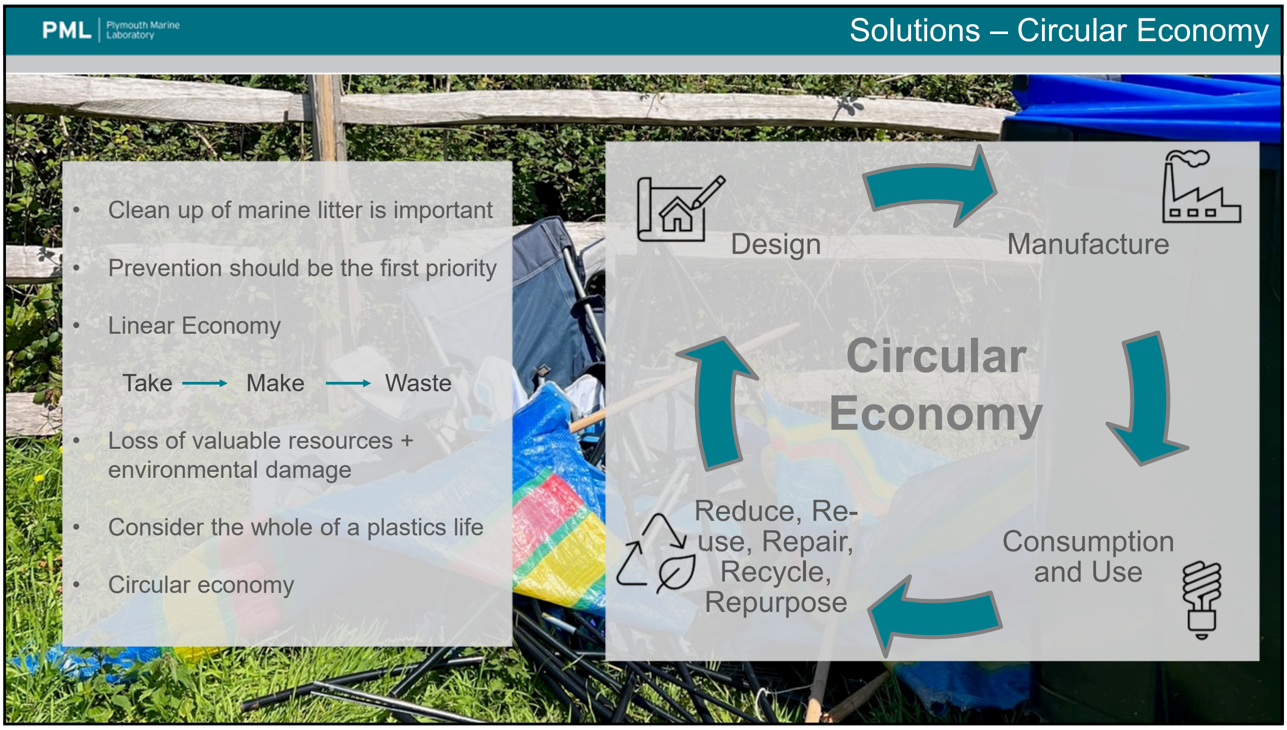
buoy
support ropes
cage
5 kg mussels
fine net
cod-end
5kg of mussels resulted in 4.5x more microplastics captured than in controls
↓
Scope to expand testing to multiple sites with greater amount of mussels in stacked system
Cage system whereby mussels can't escape, are protected from predation, allows a flow of water over the mussels

8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Solutions – Circular Economy
Clean up of marine litter is important
Prevention should be the first priority
Linear Economy
Take → Make → Waste
Loss of valuable resources + environmental damage
Consider the whole of a plastics life
Circular economy
Design
Manufacture
Circular Economy
Consumption and Use
Reduce, Re-use, Repair, Recycle, Repurpose

9


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Solutions – Safer-by-design; Biodegradable Bioplastics
Biodegradable bioplastics (BBPs) offer a possible solution
Renewable carbon feedstock
Enhanced biodegradation
Applications with substantive pathways to the natural environment
Need to improve our understanding of the fate and impact of BBPs
Help guide development of innovative plastics
Reduction in fossil fuels, environmentally safe.
Genus level assignment of OTUs
Depth

10

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Solutions – Raising Awareness and Giving Evidence

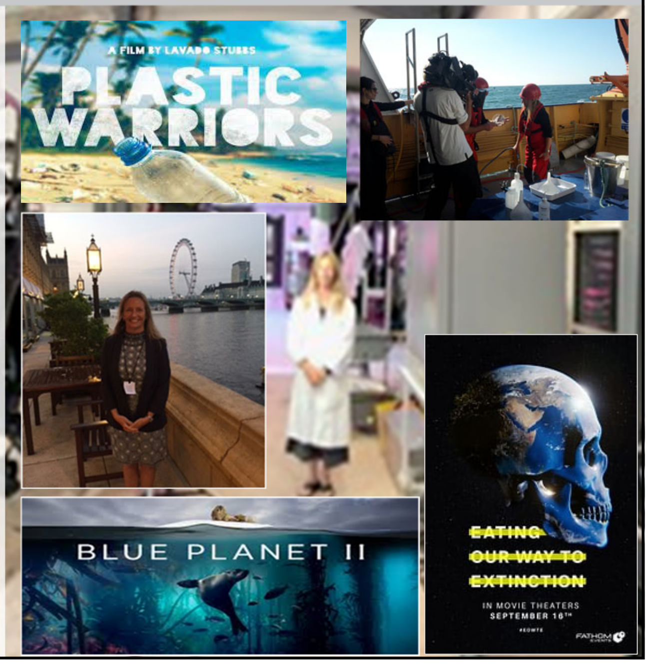
Raising Awareness:
- We are passionate about disseminating our research to a wide audience
- Our pioneering work has reached a global audience:

Eating our way to extinction, Plastic Warriros, Inside Out Southwest, The One Show, Food Unwrapped, Springwatch, BBC and ITN news, El Jazeera – Earthrise program, 'Plastic Britain' documentary and Blue Planet II

Giving Evidence
- Successful in highlighting the risks MP pose to marine life contributing to introduction of plastic bag levy and ban of cosmetic microbeads:

House of Lords, Parliamentary and Scientific Committee, National and International regulatory bodies, Environmental Audit Committee's collection of written and oral evidence on the Environmental Impact of MP,United Nations hearings on MP

- Global Plastics Treaty. Providing evidence to on-going International Negotiating Committee



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Thank you