CONICYT
Ministerio de Educación
Gobierno de Chile
FONDECYT 11160019
Fondo Nacional de Desarrollo Científico y Tecnológico

Effects of micro plastic exposure on marine fish and invertebrates

Mauricio Urbina

Mayo 2018

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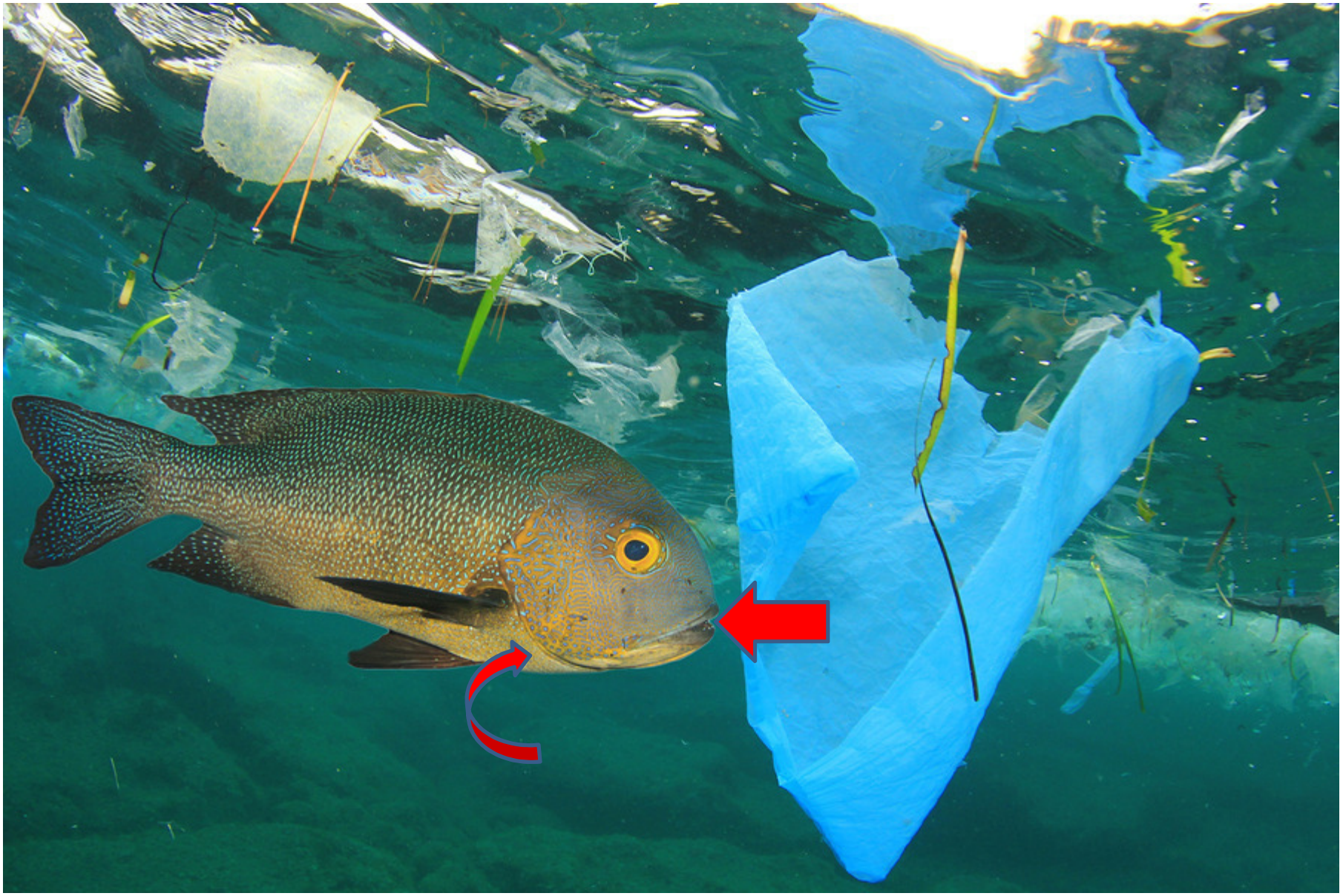
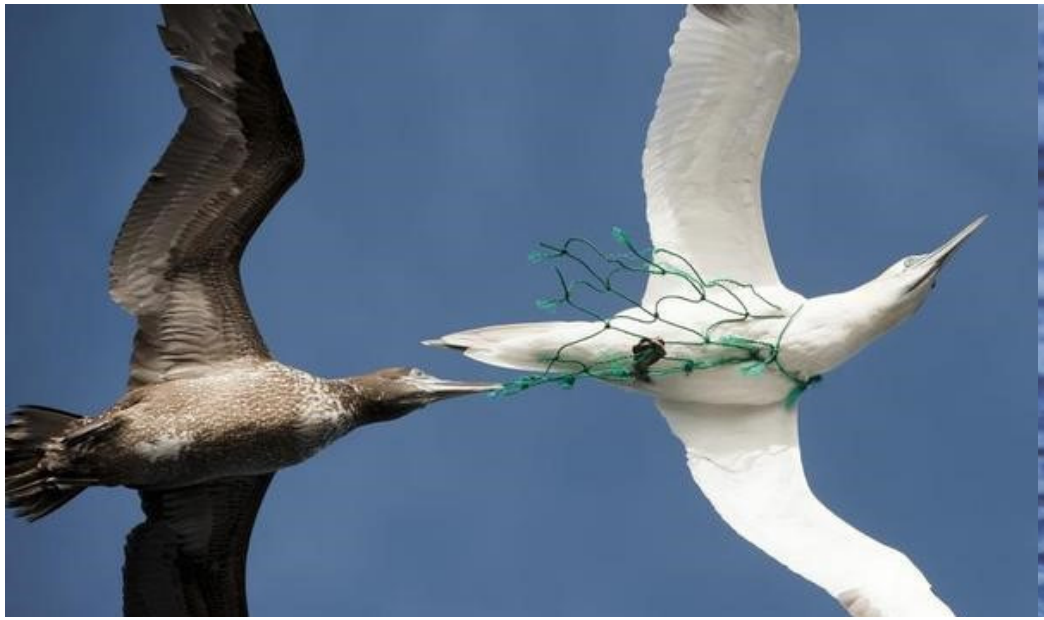
322 MT 2015


SOURCES OF MARINE LITTER
1 SEWAGE RELATED DEBRIS
2 LITTER DROPPED IN TOWNS AND CITIES
3 POORLY MANAGED BINS AND LANDFILL SITES NEAR THE COAST
4 LOST FISHING EQUIPMENT
5 SHIPPING MATERIALS LOST OVERBOARD
6 POORLY MANAGED INDUSTRIES
7 LITTER DROPPED AT THE BEACH
Own Brand
SHIPPING

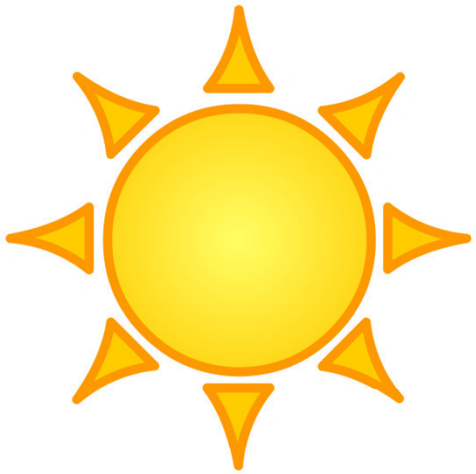



DOES
SIZE
MATTER?



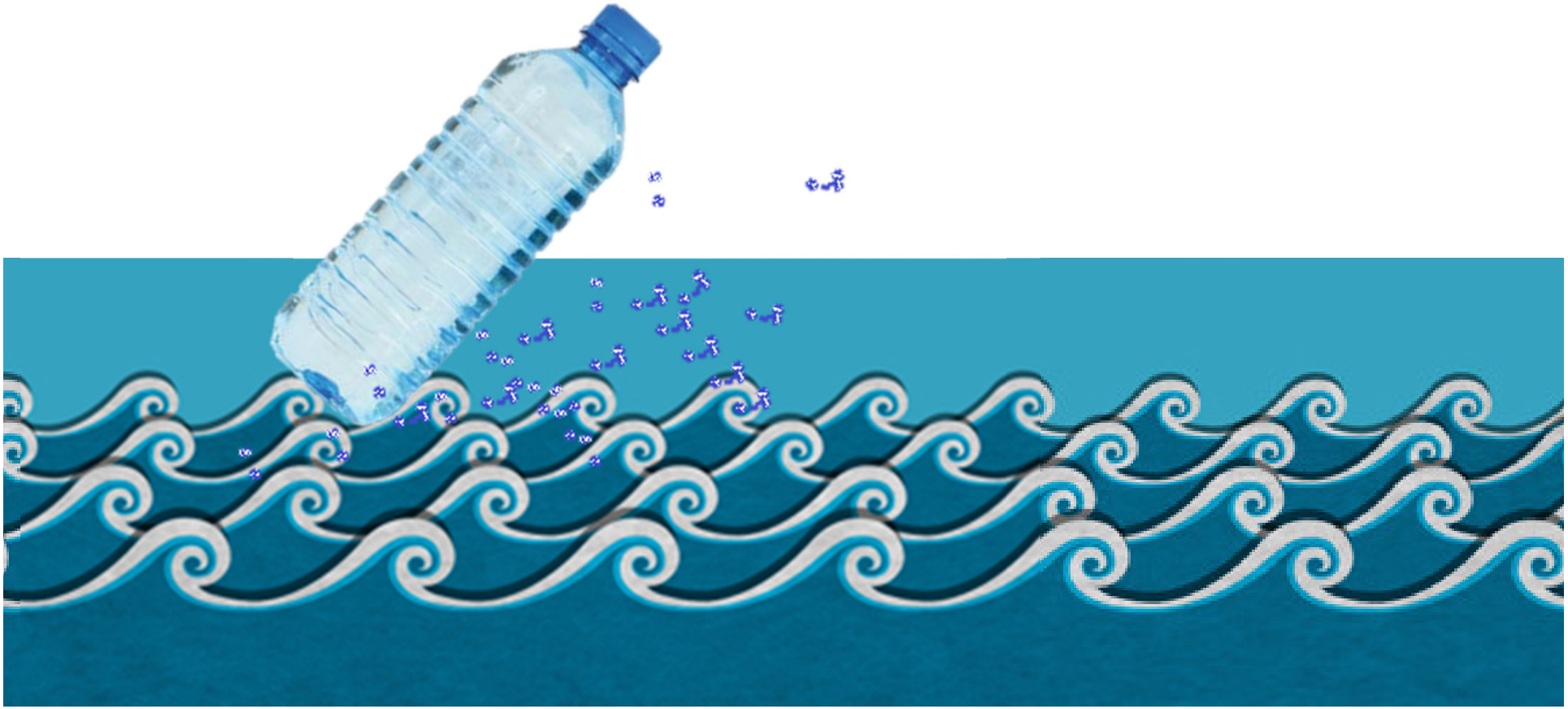
But……smaller particles are also a problem for smaller organisms

Figure 3. Copepod and diatom next to a microplastic fibre. Photo: SAHFOS (2008)

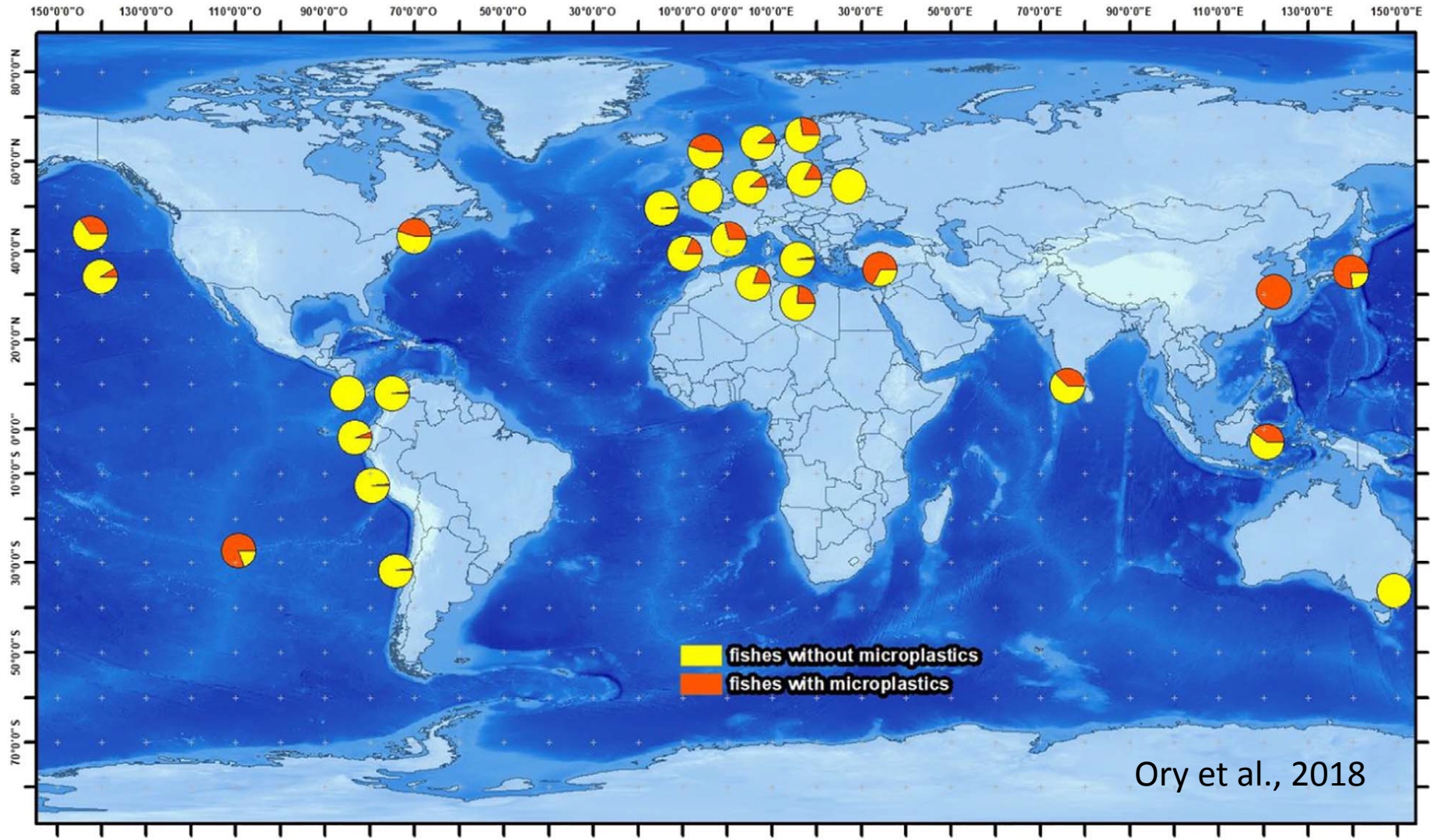


Micro plásticos (< 5 mm)

Primarios
Secundarios



Fish around the world



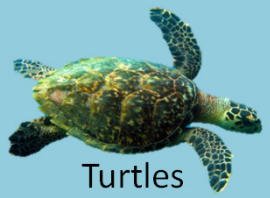
Microplastics in animals

Northan Fulmar
Avery-Gomm et al (2012)

Shore Crabs
Farrell & Nelson (2013)
Watts et al (2014)

Common Mussel
Browne et al (2008)

Zooplankton
Cole et al (2013)
Setala et al (2014)



Turtles
Tourinho et al (2010)

Oysters
Sussarellu et al (2016)

Lug worms
Wright et al (2013)

Pelagic and demersal fish
Lusher et al (2013),
Ory et al 2018

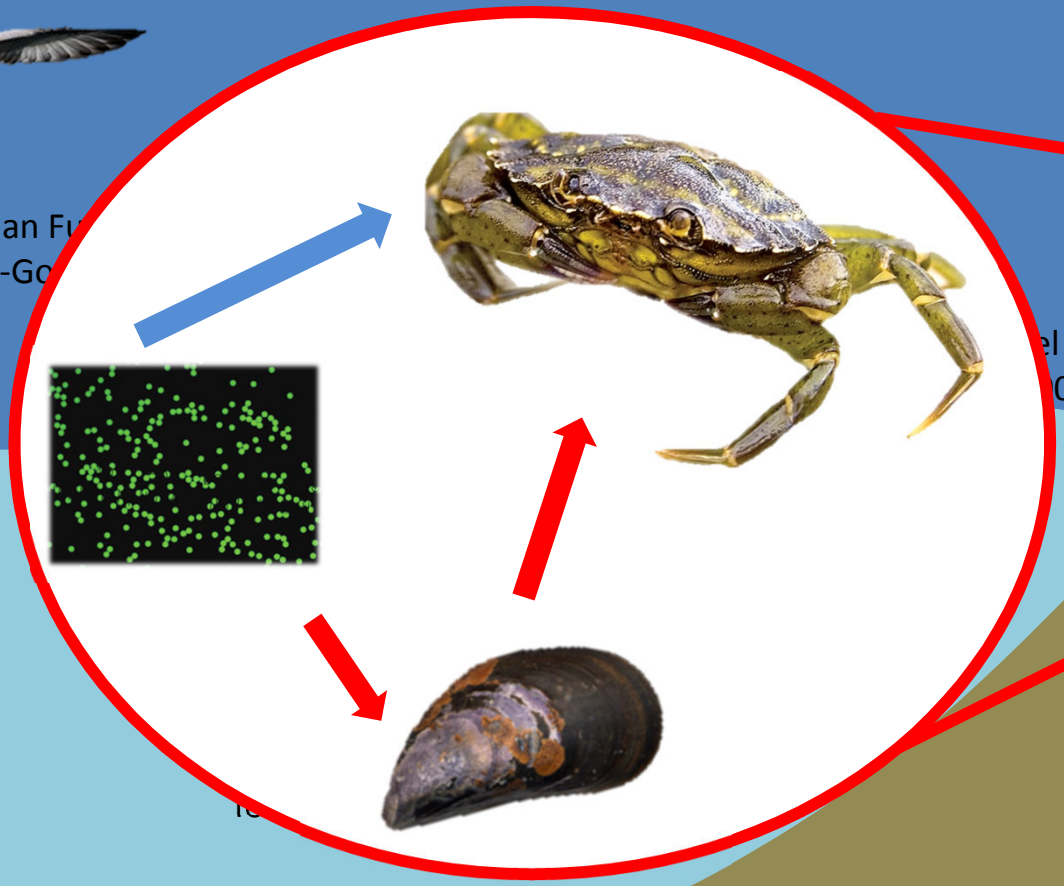
Sea cucumbers
Graham and Thompson (2009)

Langoustines
Murray and Cowie (2011)

But do you know how I feel……..?

Microplastics in animals

Northan Fu
Avery-Go



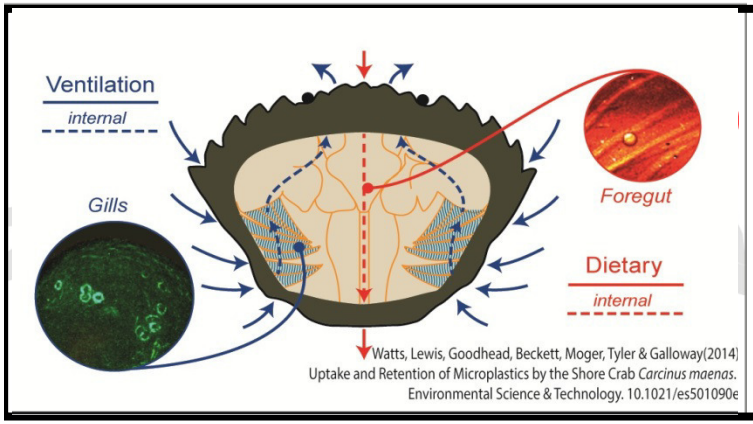
Shore Crabs
Farrell & Nelson (2013)
Watts et al (2014)

el
08)

Lug worms
Wright et al (2013)

Pelagic and demersal fish
Lusher et al (2013)

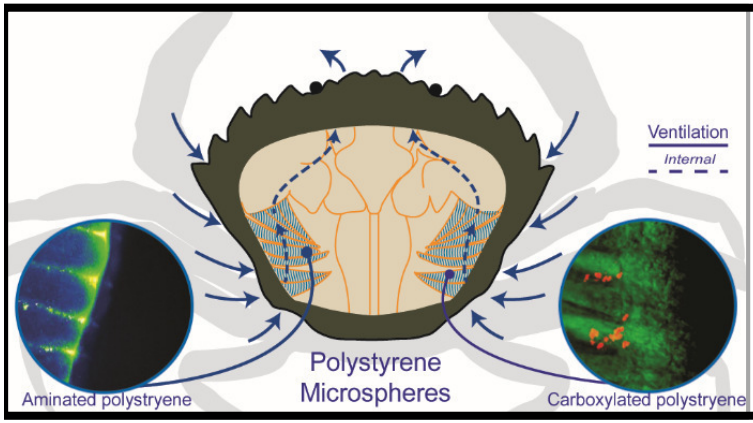
Langoustines
Murray and Cowie (2011)



①

Routes of uptake, inhalation and ingestion of microplastic

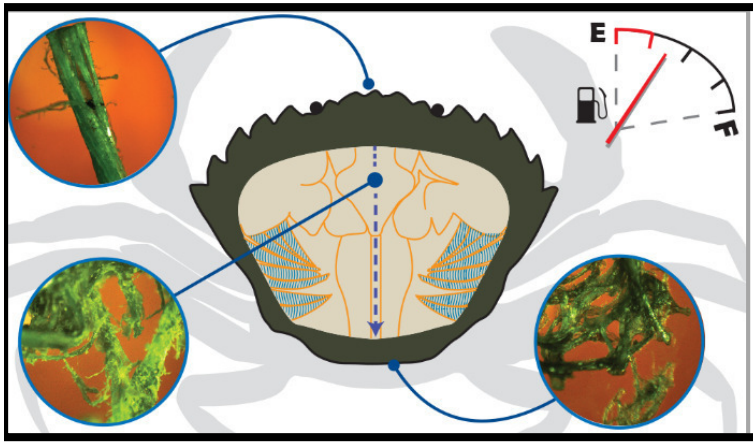
Watts A.J.R. et al (2014)



②

What is the biological consequences of inhaled microspheres?

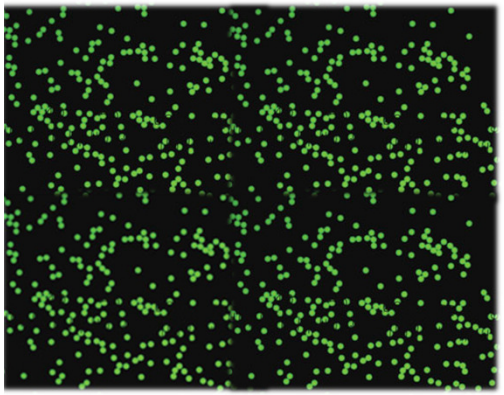
Watts A.J.R. et al (2016)



③

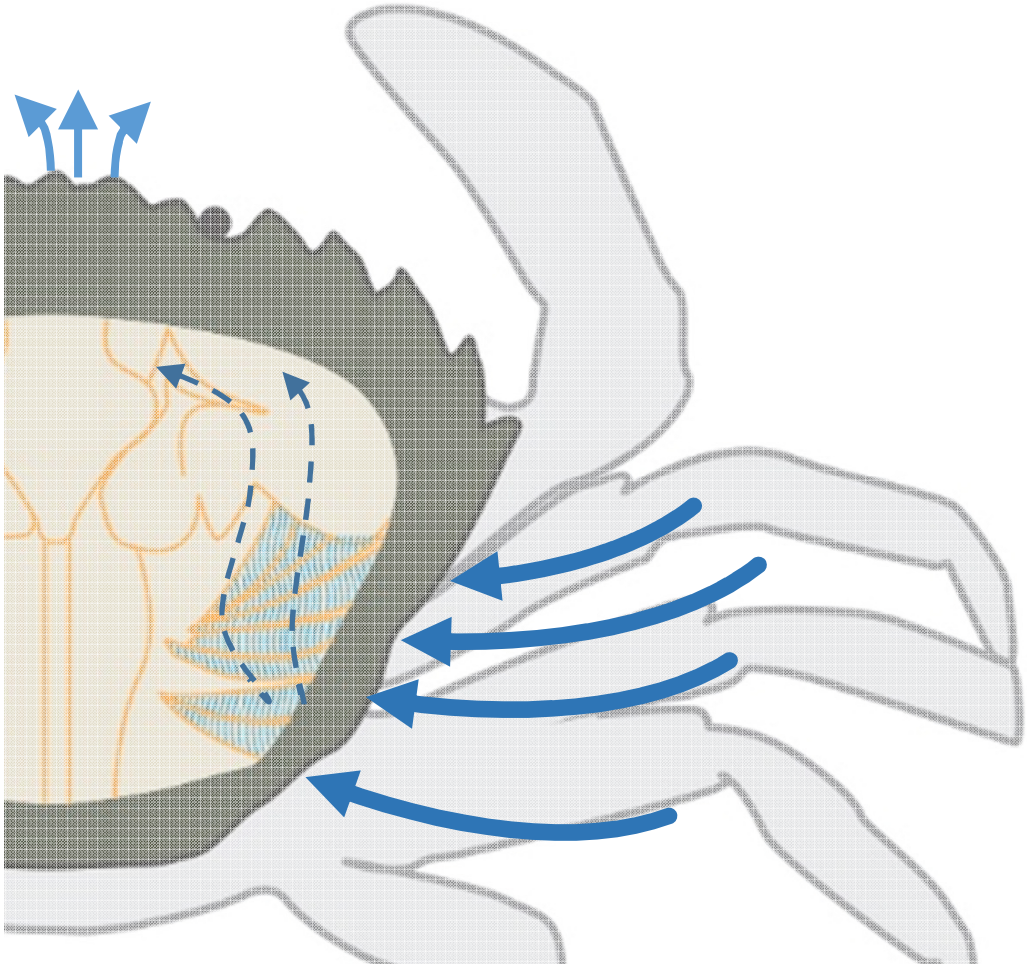
What is the biological consequences of ingested microfibres?

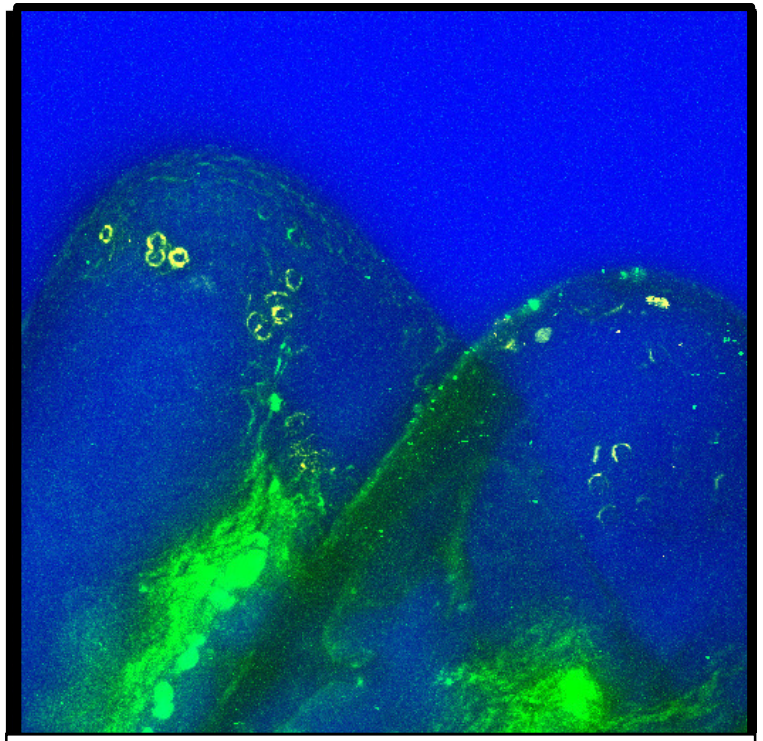
Watts A.J.R. et al (2015)



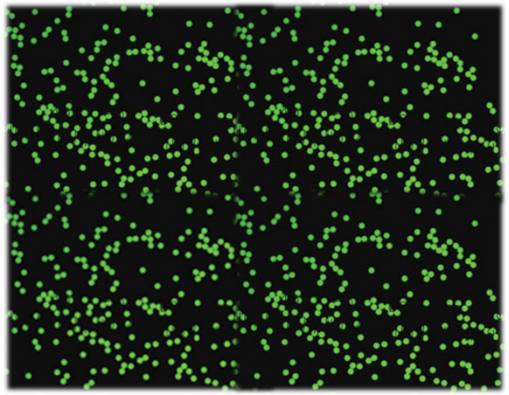
1. Route of uptake: Ventilation

8-10 µm polystyrene Microspheres

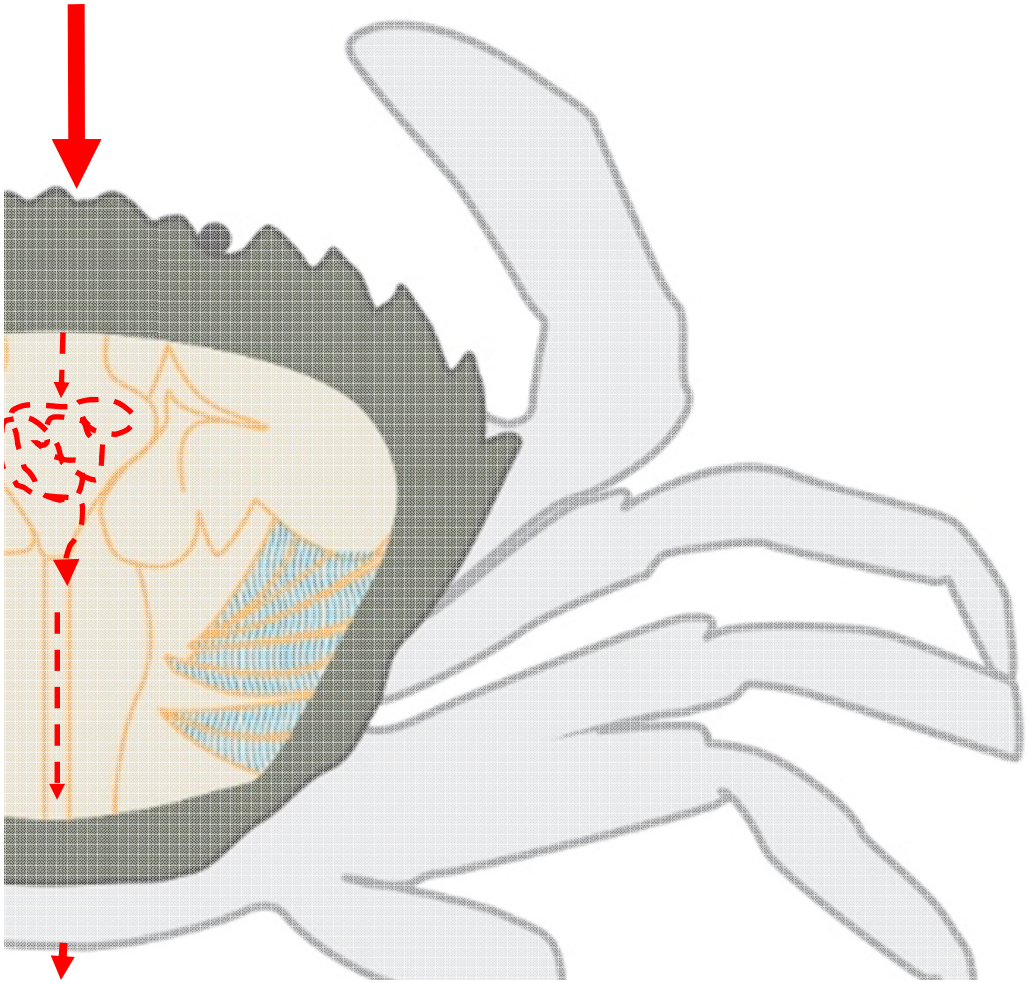


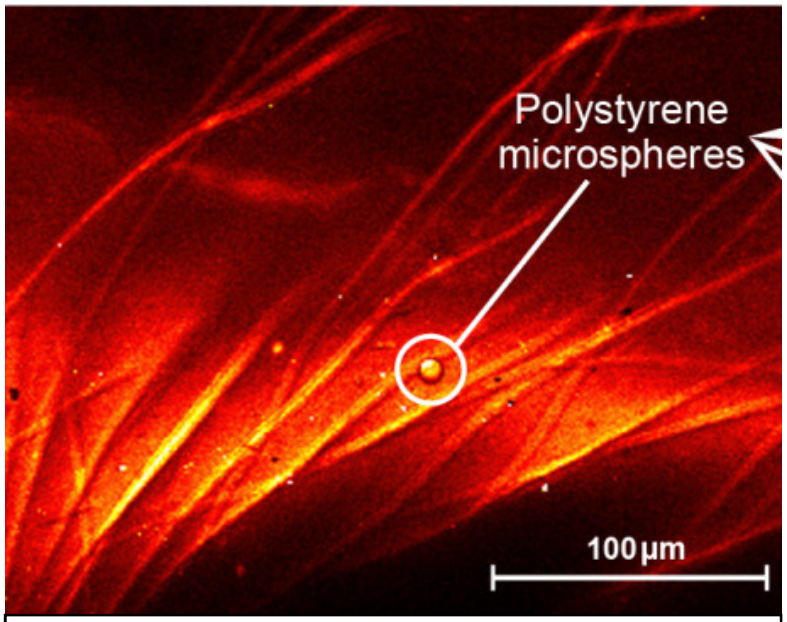


All 11 crabs were still expiring microspheres after 21 days



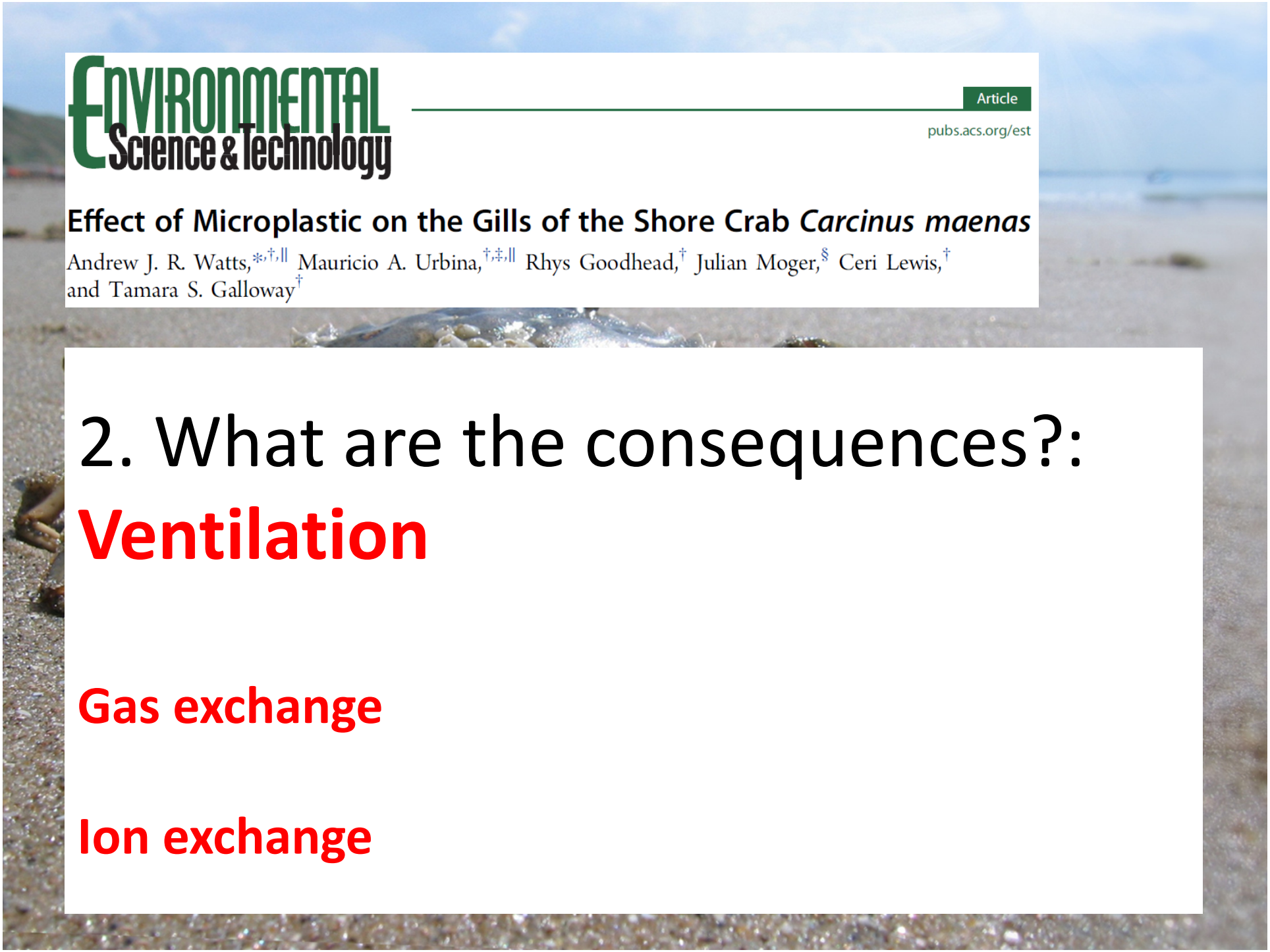
1. Route of uptake: Ingestion





Still within foregut 14 d post feed

Watts A.J.R. et al (2014)
Enviro Sci & Tech 48(15):8823-30



ENVIRONMENTAL Science & Technology

Article

pubs.acs.org/est

Effect of Microplastic on the Gills of the Shore Crab *Carcinus maenas*

Andrew J. R. Watts,[*,†,∥] Mauricio A. Urbina,[†,‡,∥] Rhys Goodhead,[†] Julian Moger,[§] Ceri Lewis,[†] and Tamara S. Galloway[†]

2. What are the consequences?:

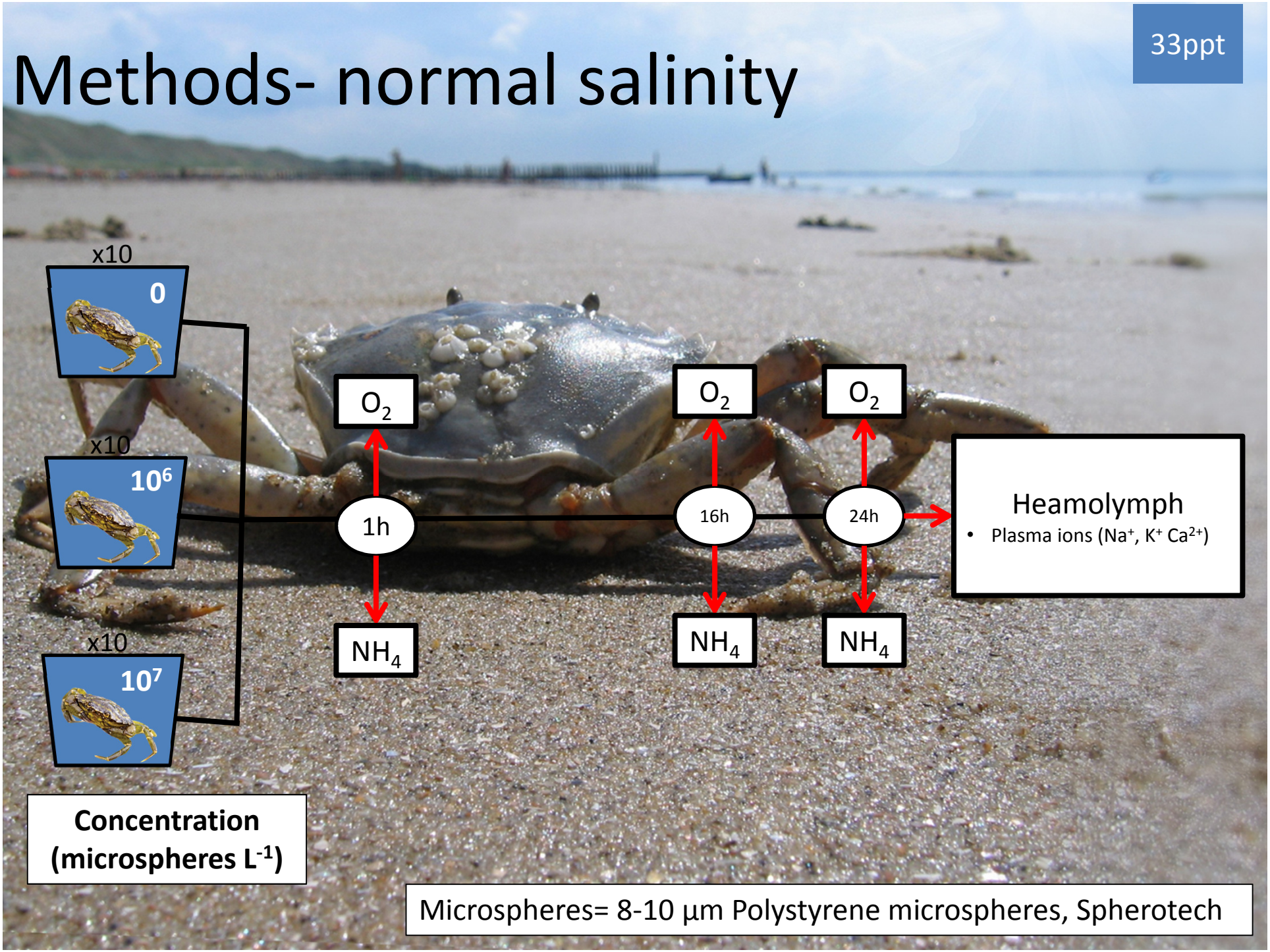
Ventilation

Gas exchange

Ion exchange

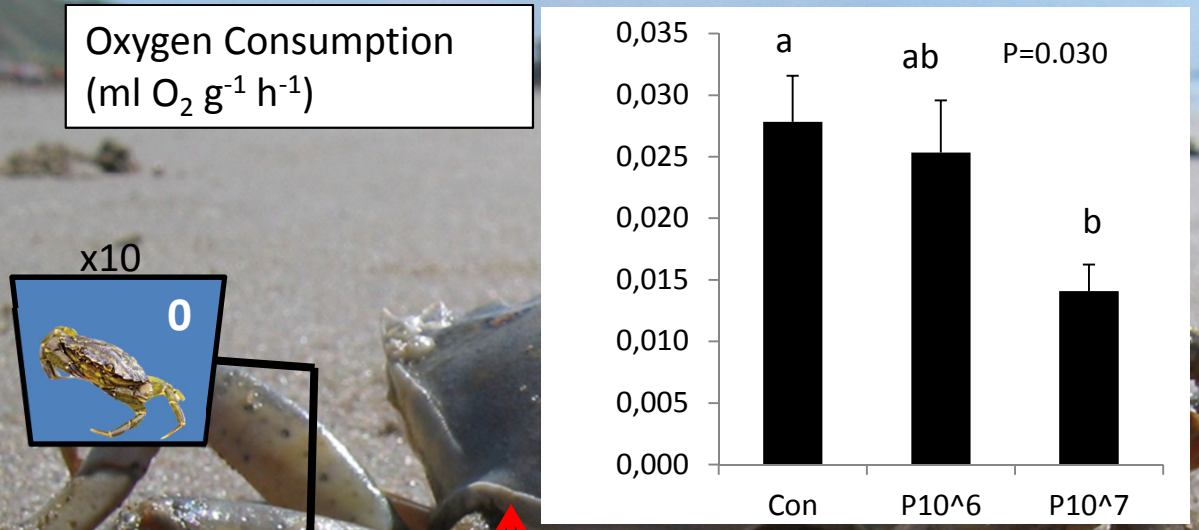
Methods- normal salinity

33ppt



Results- normal salinity

Oxygen Consumption
(ml O_2 g^{-1} h^{-1})



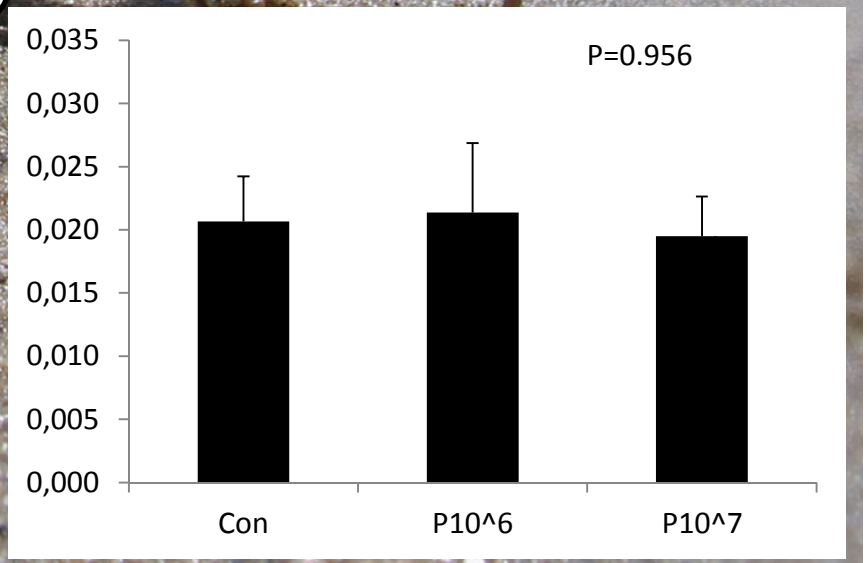
x10
0

x10
10^6

x10
10^7

1h

16h



Results- normal salinity

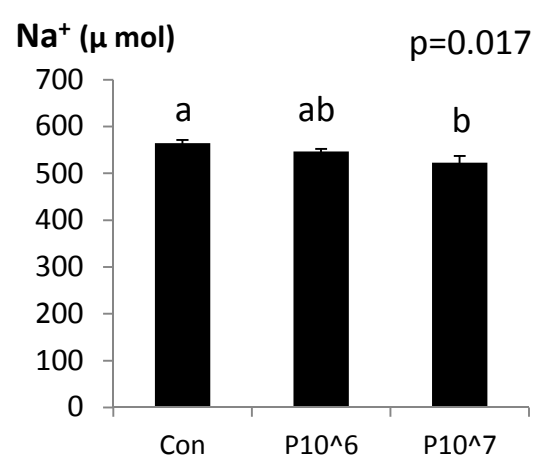
Haemolymph plasma ions (mmol)

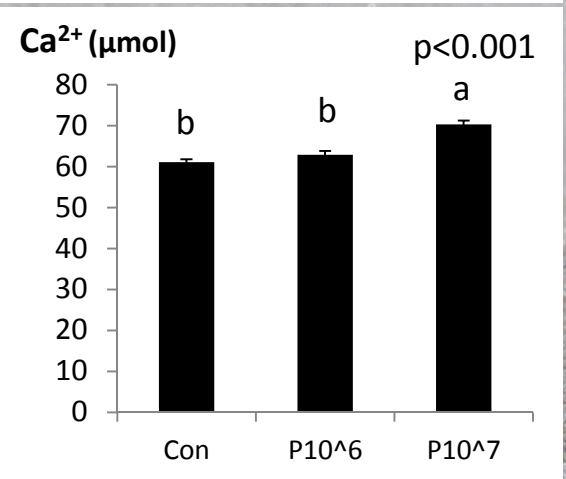
x10 0

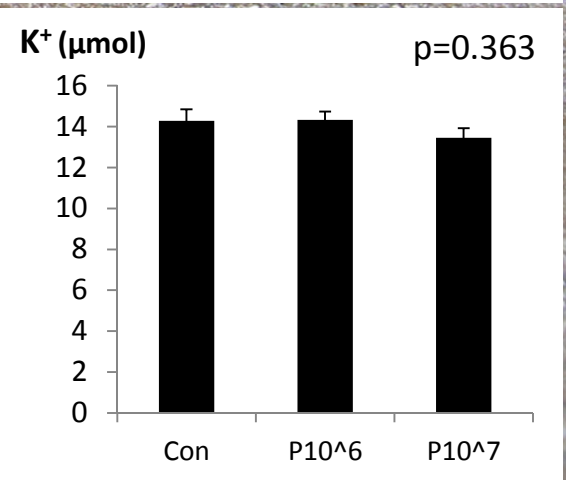
x10 10^6

x10 10^7

24h

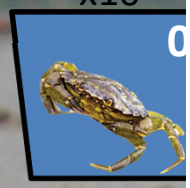




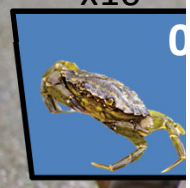


Methods- reduced salinity

x10



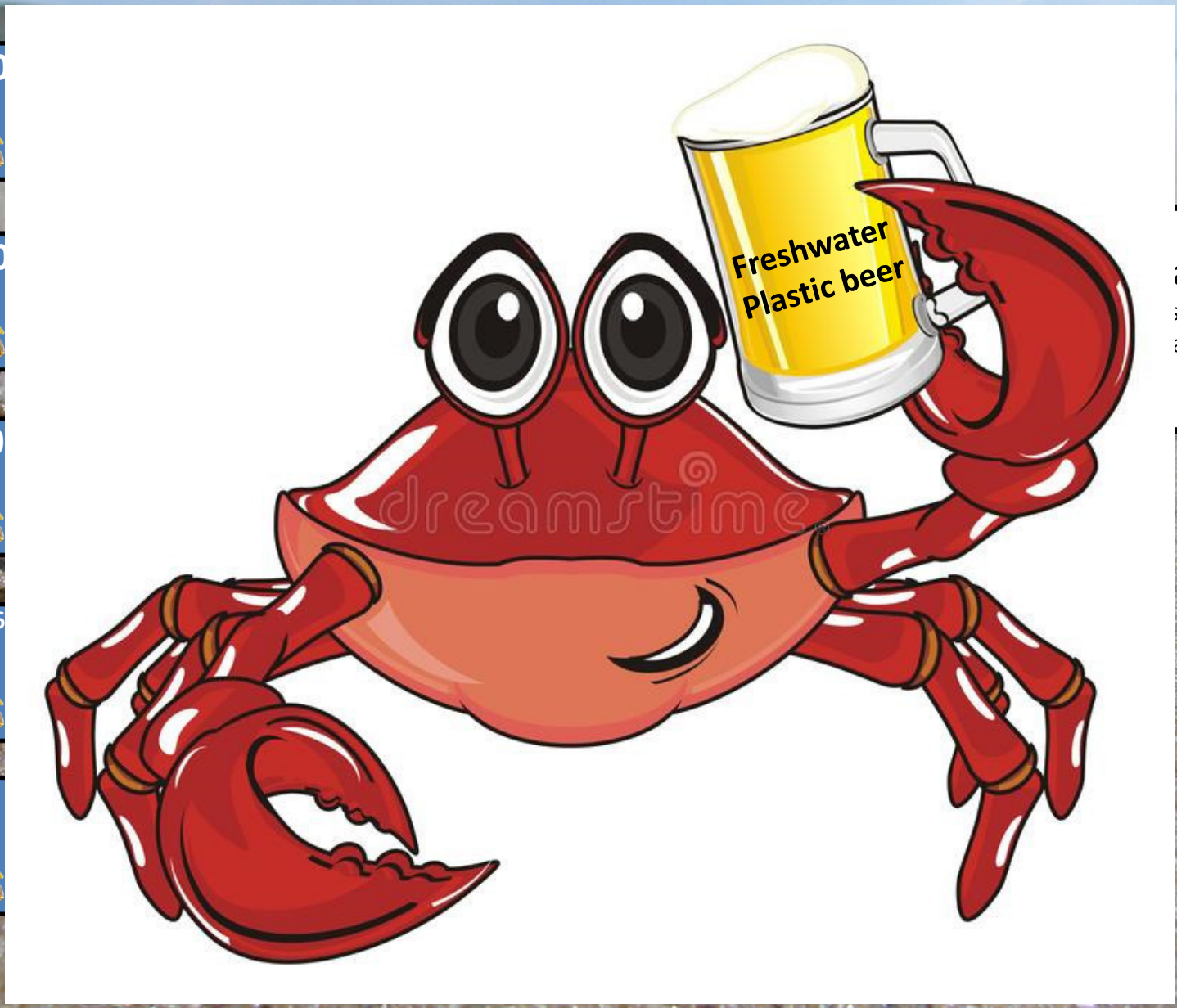
x10



x10

x10

x10

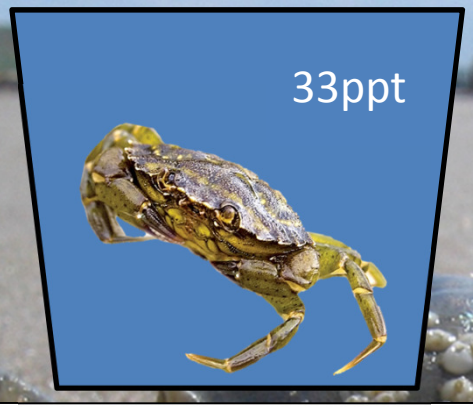


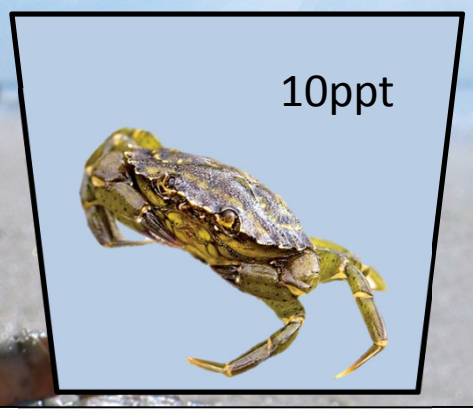
amolymph
smolality
asma ions
- Na^+, K^+ Ca^{2+}

33ppt

10ppt

Summary





Crab in normal salinity with increasing plastic concentration

- O_2 consumption
  - Reduced short term
  - Recovers
- Ions in heamolymph
  - Slight increase Ca^{2+} ions
  - Slight reduction Na^{+} ions

Crab in reduced salinity with increasing plastic concentration

- The need to osmoregulate out weighs any effect of plastic

But C.maenas is an excellent osmoregulator, what about other spp?

3. What are the effects?:

Ingestion

Environmental Science & Technology

Article

pubs.acs.org/est

Ingestion of Plastic Microfibers by the Crab *Carcinus maenas* and Its Effect on Food Consumption and Energy Balance

Andrew J.R. Watts,[*,†] Mauricio A. Urbina,[†,‡] Shauna Corr,[†] Ceri Lewis,[†] and Tamara S. Galloway[†]

+ N_2 +

= 500 μm microfibers

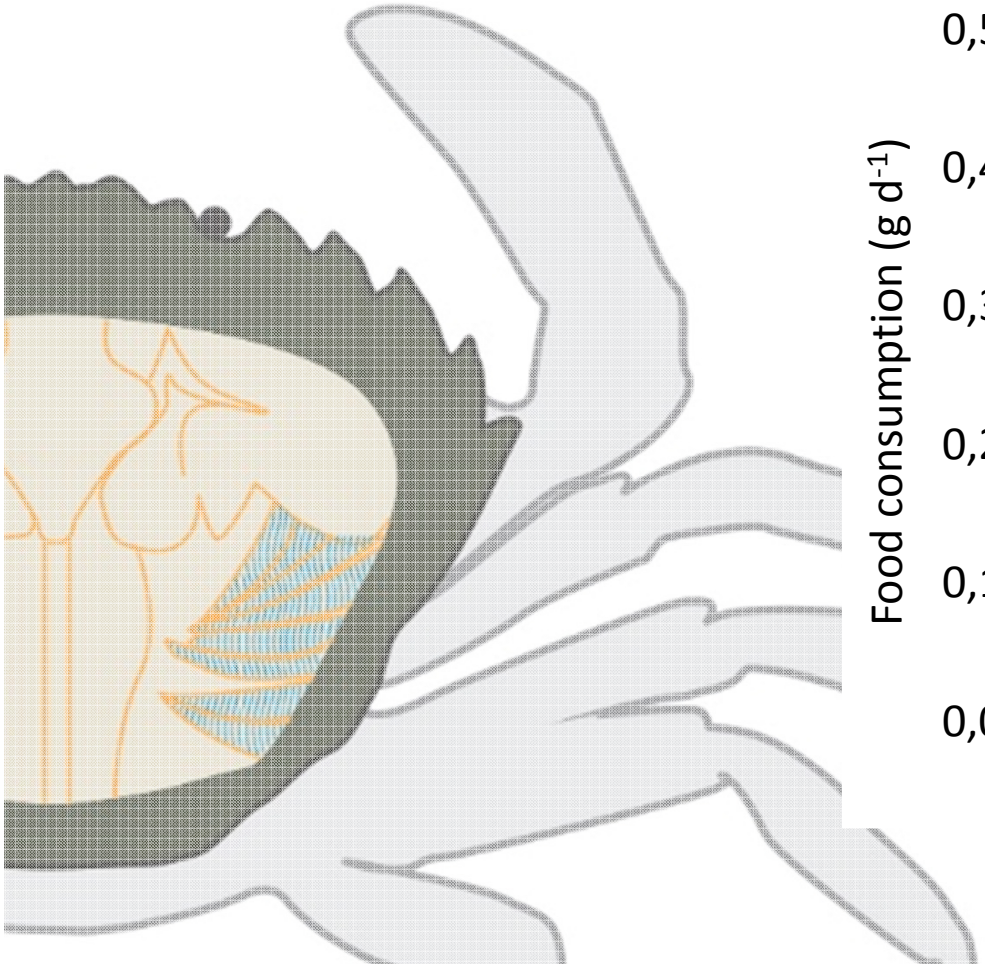
0% (0 mg)

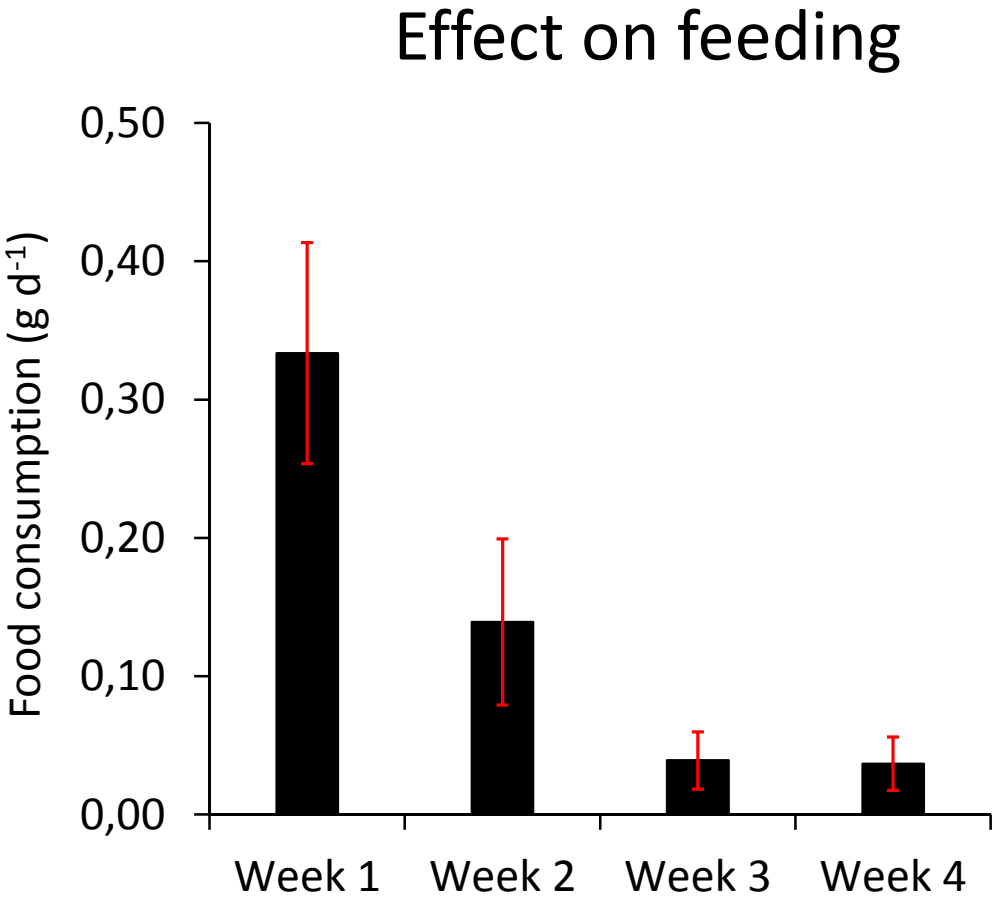
0.3% (0.6 mg)

0.6% (1.2 mg)

1% (2.0 mg)

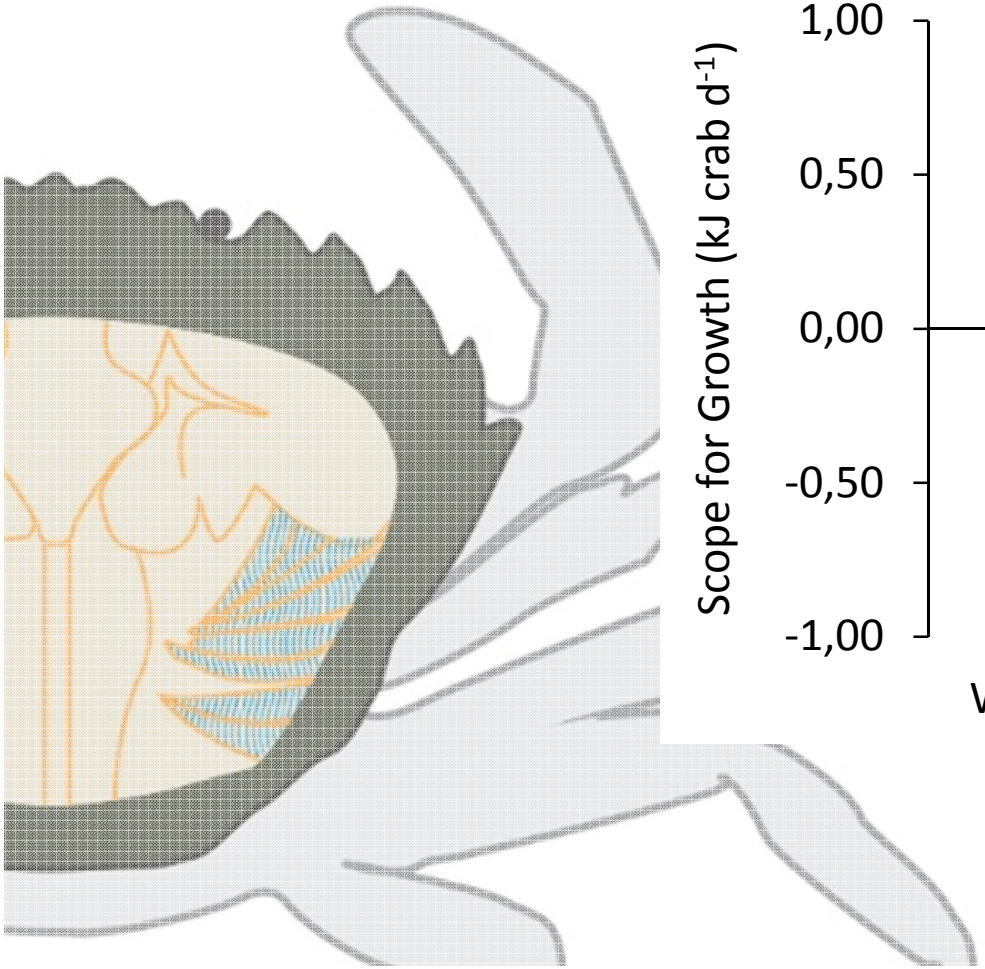
3. What are the effects?: Ingestion

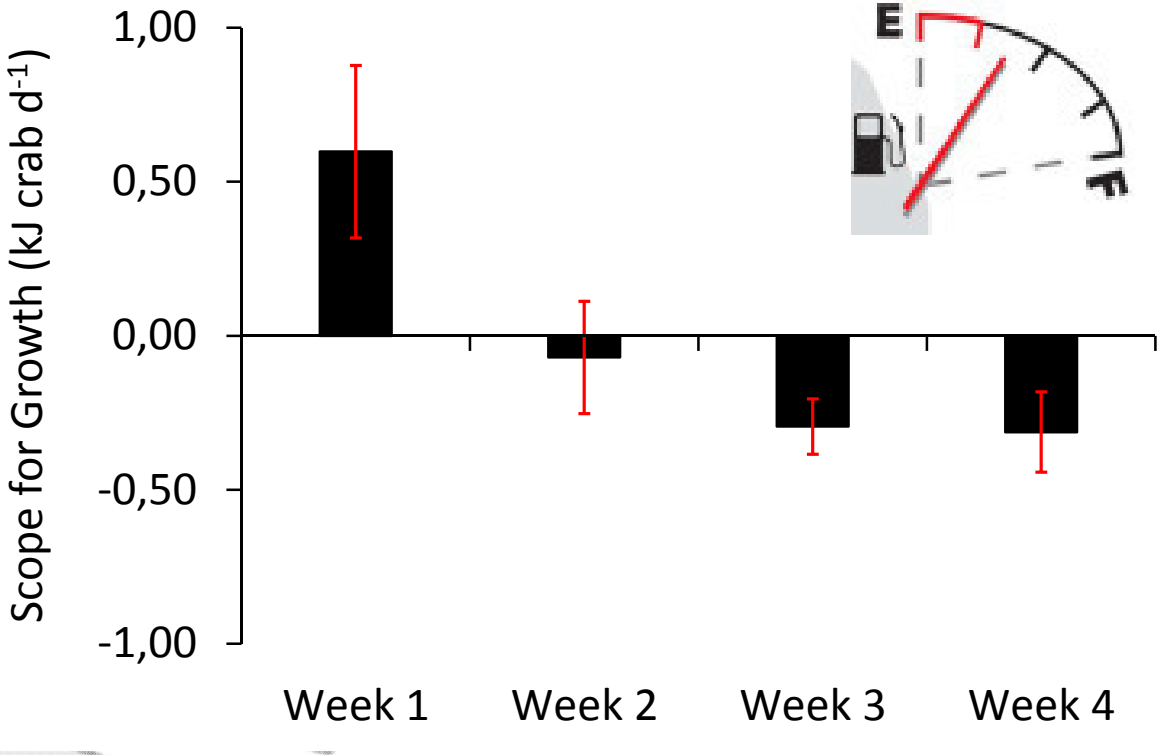




Ingestion: rope fibres

Effect on scope for growth





Other energy related consequences…..

Decreased food consumption, weight loss and energy depletion (Besseling *et al*., 2013; Wright *et al*., 2013)

Decreased fecundity and negative impacts on subsequent generations (Sussarellu *et al*., 2016).

Increased immune response
(von Moos, Burkhardt-Holm and Kohler, 2012)

Lugworm

Oysters

Copepods

Mussels

Increases in inflammation, oxidative stress and disrupted energy metabolism (Lu *et al*., 2016)

Zebra fish

Sea bass

Intestinal tract alterations and compromised intestinal function (Peda *et al*., 2016)

Reduced predatory performance, abnormal swimming behaviour and lethargy
(De Sa, Luis and Guilhermino, 2015;
Ferreira P. *et al*., 2016; Oliveira *et al*., 2013)

Common goby

Signs of liver toxicity, hepatic stress and changed endocrine function, as well as gene expression (Rochman *et al.*, 2013; 2014)

Japanese medaka

…**But no effects on rainbow trout (Rummel *et al*. (2016)**

What do we know from SE organisms?

Science of the Total Environment 586 (2017) 430–437

Contents lists available at ScienceDirect

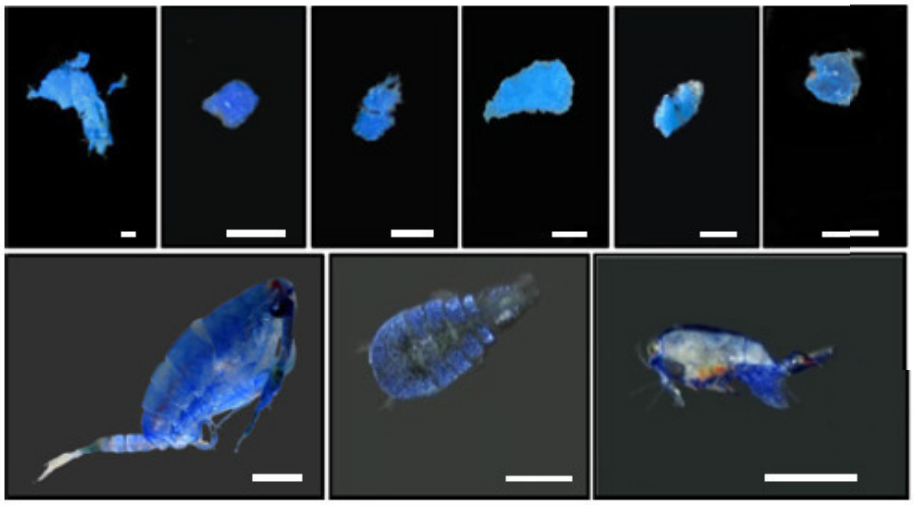
Science of the Total Environment

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

Short Communication

Amberstripe scad *Decapterus muroadsi* (Carangidae) fish ingest blue microplastics resembling their copepod prey along the coast of Rapa Nui (Easter Island) in the South Pacific subtropical gyre

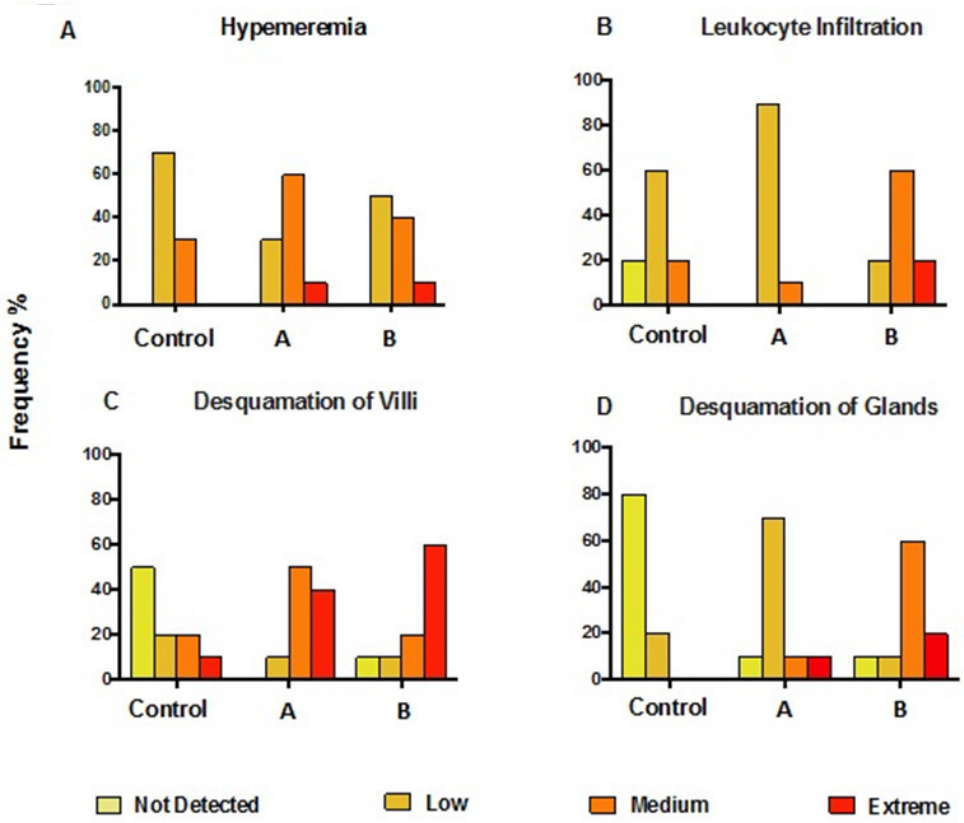
Nicolas Christian Ory [a,b,*], Paula Sobral [c], Joana Lia Ferreira [d], Martin Thiel [a,b,e]



Fish confuse blue microplastics with their prey (blue copepods) of similar sizes and shapes

Impact of nanoplastic consumption on the histological intestinal tract of *Girella laevifrons*

Ahrendt, C[1]., Perez-Venegas, D.J[1,2]., Vargas, J[1]., Urbina, M[3]., Pulgar, J[1*]., Gonzalez, C., Galbán-Malagón, C[1,4*],.

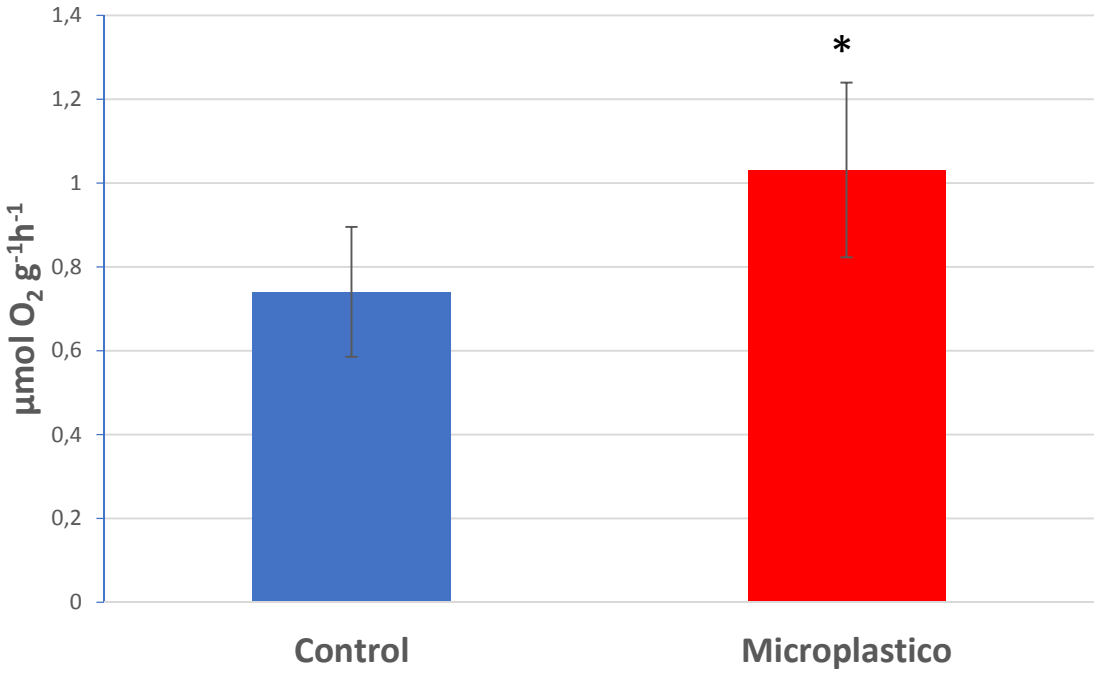


But all of them……

at concentrations higher than what has been found in the environment

Efectos crónicos y agudos a la exposición de microplásticos en el cangrejo intermareal *Petrolisthes laevigatus* (Guérin, 1835).

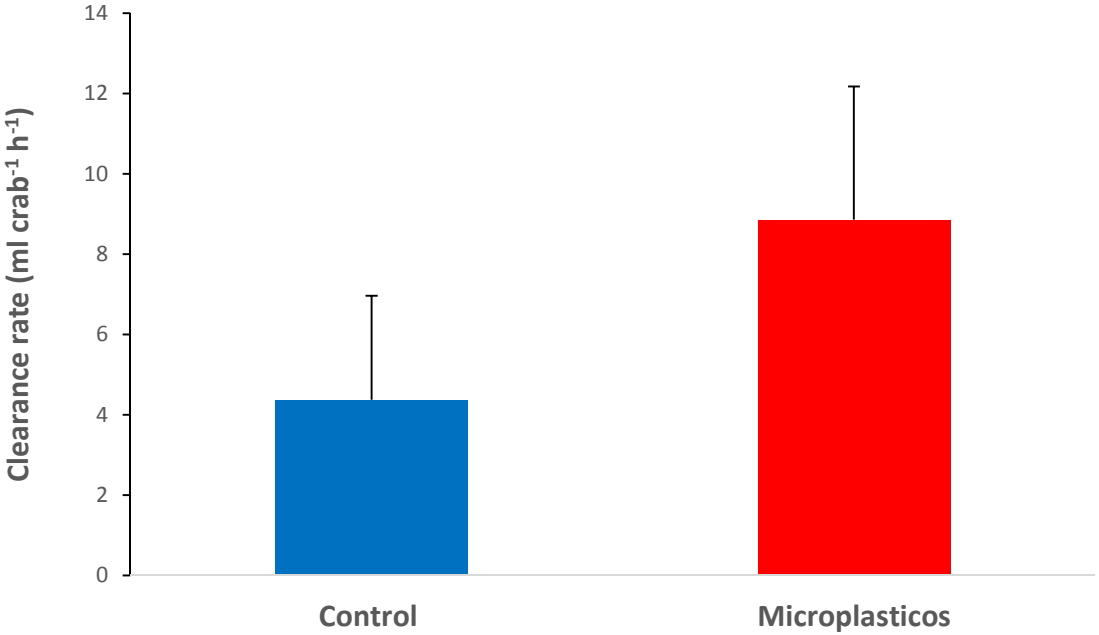
Schafer A., Lagos M., Urbina M



5 months
at 5 particles ml^{-1}

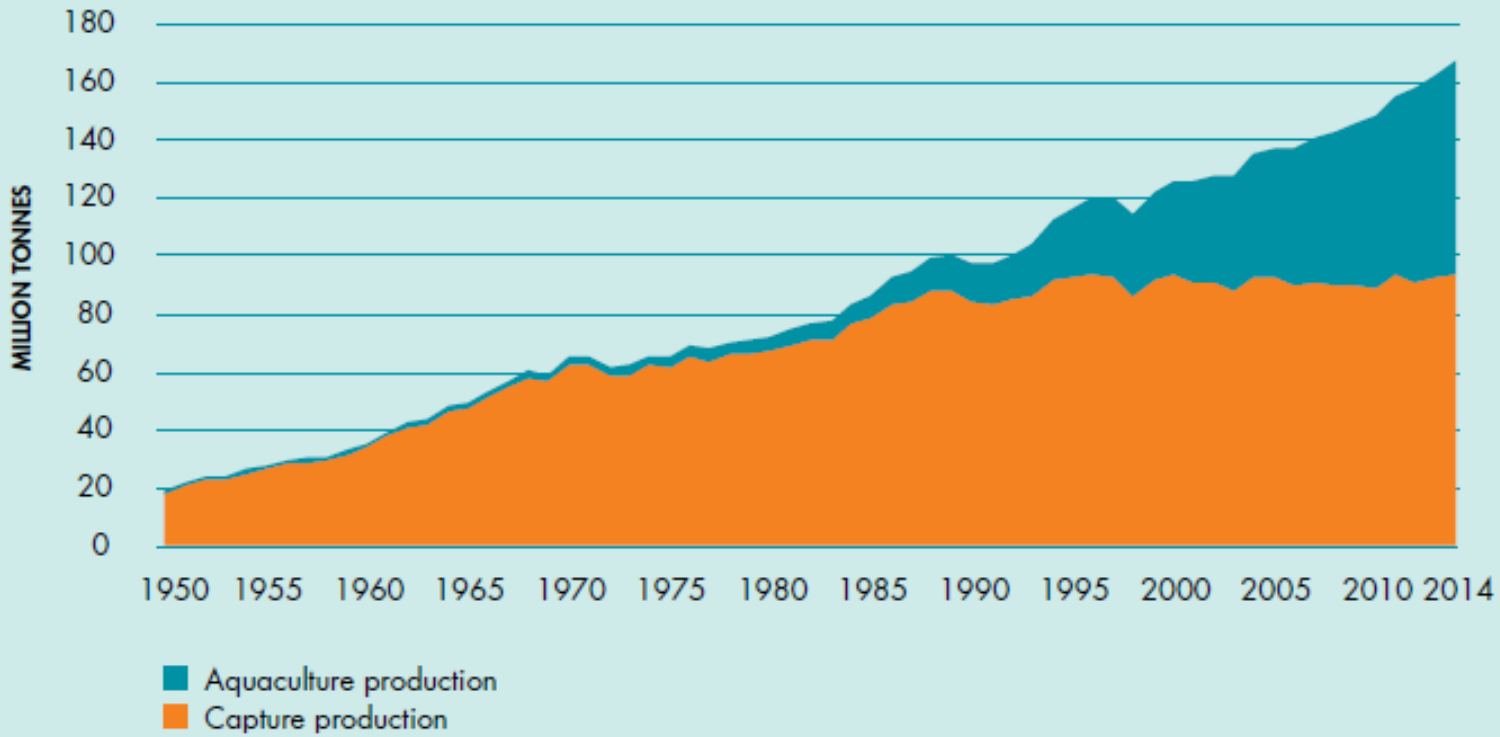
Efectos crónicos y agudos a la exposición de microplásticos en el cangrejo intermareal *Petrolisthes laevigatus* (Guérin, 1835).

Schafer A., Lagos M., Urbina M



Should aquaculture and fisheries be concerned?

WORLD CAPTURE FISHERIES AND AQUACULTURE PRODUCTION

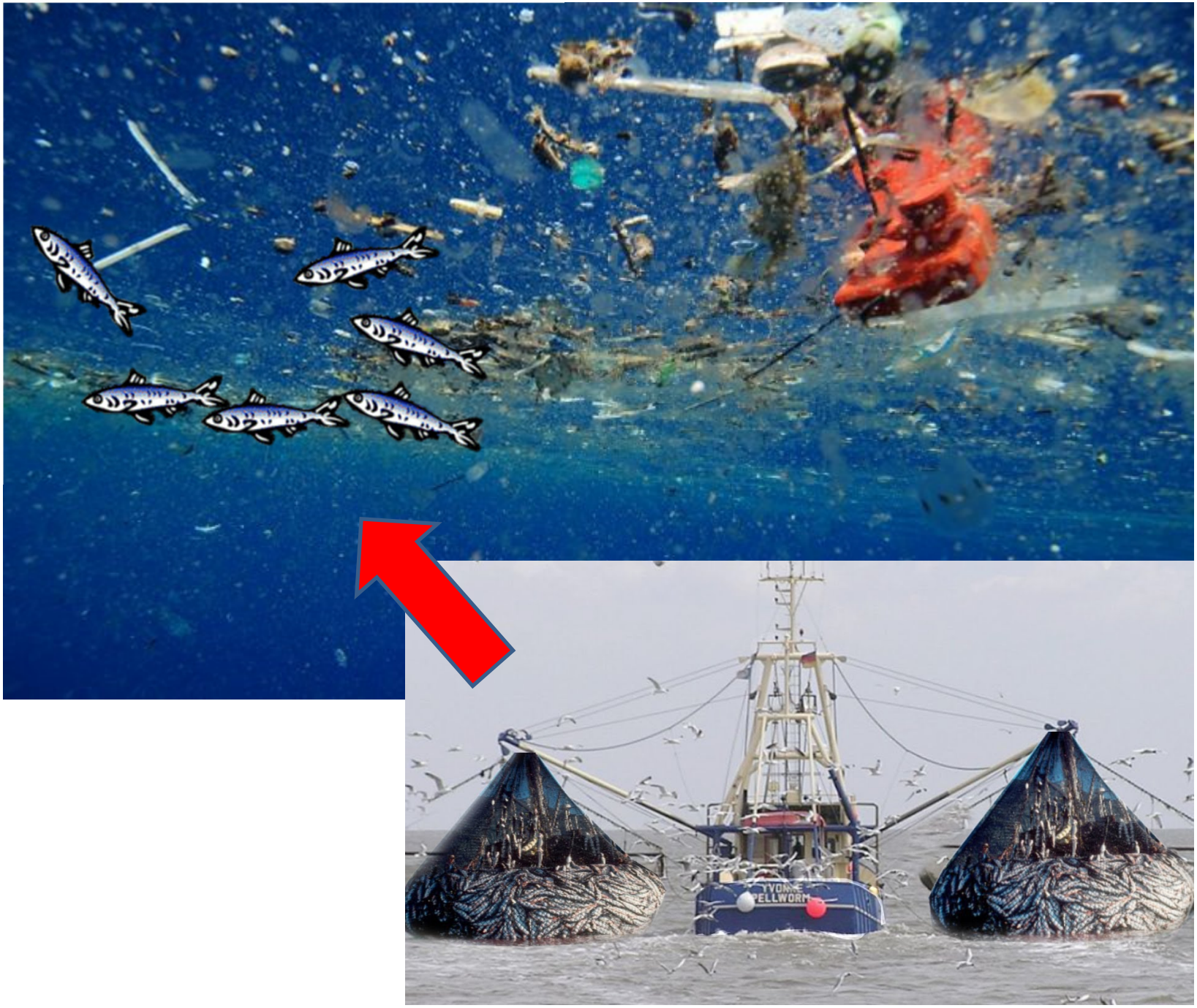


TOP 25 PRODUCERS AND MAIN GROUPS OF FARMED SPECIES IN 2014

MAJOR PRODUCERS	FINFISH		MOLLUSCS	CRUSTACEANS	OTHER AQUATIC ANIMALS	TOTAL AQUATIC ANIMALS	AQUATIC PLANTS	TOTAL AQUACULTURE PRODUCTION
	INLAND AQUACULTURE	MARINE/ COASTAL AQUACULTURE						
				(Thousand tonnes)				
China	26 029.7	1 189.7	13 418.7	3 993.5	839.5	**45 469.0**	13 326.3	**58 795.3**
Indonesia	2 857.6	782.3	44.4	613.9	0.1	**4 253.9**	10 077.0	**14 330.9**
India	4 391.1	90.0	14.2	385.7	...	**4 881.0**	3.0	**4 884.0**
Viet Nam	2 478.5	208.5	198.9	506.2	4.9	**3 397.1**	14.3	**3 411.4**
Philippines	299.3	373.0	41.1	74.6	...	**788.0**	1 549.6	**2 337.6**
Bangladesh	1 733.1	93.7	...	130.2	...	**1 956.9**	...	**1 956.9**
Republic of Korea	17.2	83.4	359.3	4.5	15.9	**480.4**	1 087.0	**1 567.4**
Norway	0.1	1 330.4	2.0	...	...	**1 332.5**	...	**1 332.5**
Chile	68.7	899.4	246.4	...	...	**1 214.5**	12.8	**1 227.4**
Egypt	1 129.9	...	...	7.2	...	**1 137.1**	...	**1 137.1**

…beyond farming or fishing…….

Is that all??



Environmental Pollution 193 (2014) 65–70

Contents lists available at ScienceDirect

Environmental Pollution

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

Microplastics in bivalves cultured for human consumption

Lisbeth Van Cauwenberghe*, Colin R. Janssen

Ghent University, Laboratory of Environmental Toxicology and Aquatic Ecology, Jozef Plateaustraat 22, 9000 Ghent, Belgium

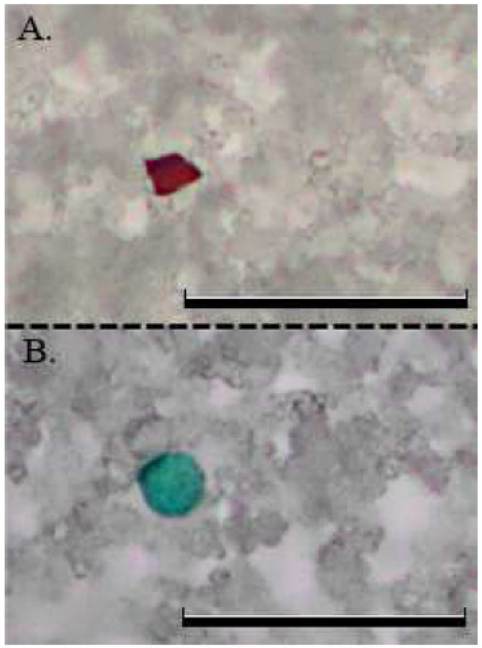


Fig. 1. Microplastics detected in the acid digested *Mytilus edulis* and *Crassostrea gigas*. A. Red particle recovered from *Mytilus edulis*; B. Green sphere detected in the soft tissue of *Crassostrea gigas*. (Scale bar: 50 µm). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

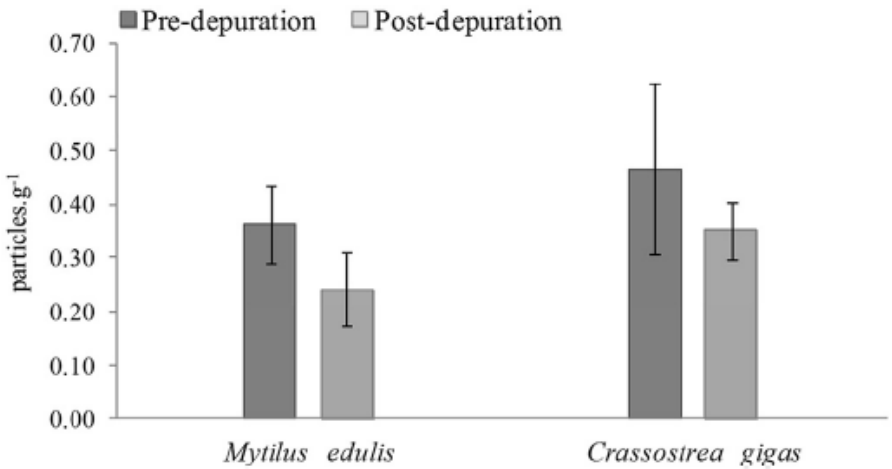
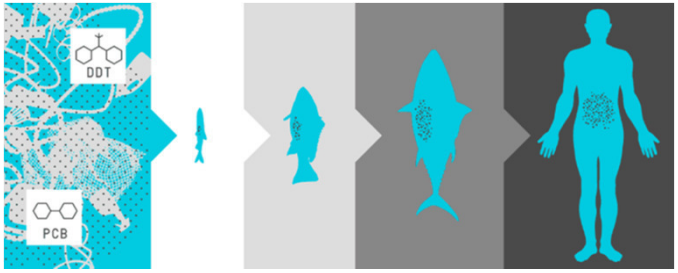


Fig. 2. Average microplastic concentration (particles g^{-1} ww) in the tissues of digested organisms. Before and after a three day depuration period. (Bars represent standard deviation).

- **Potencial transferencia trófica**

- **Absorción de químicos y disrruptores Hormonales**



- **Biotransformación**

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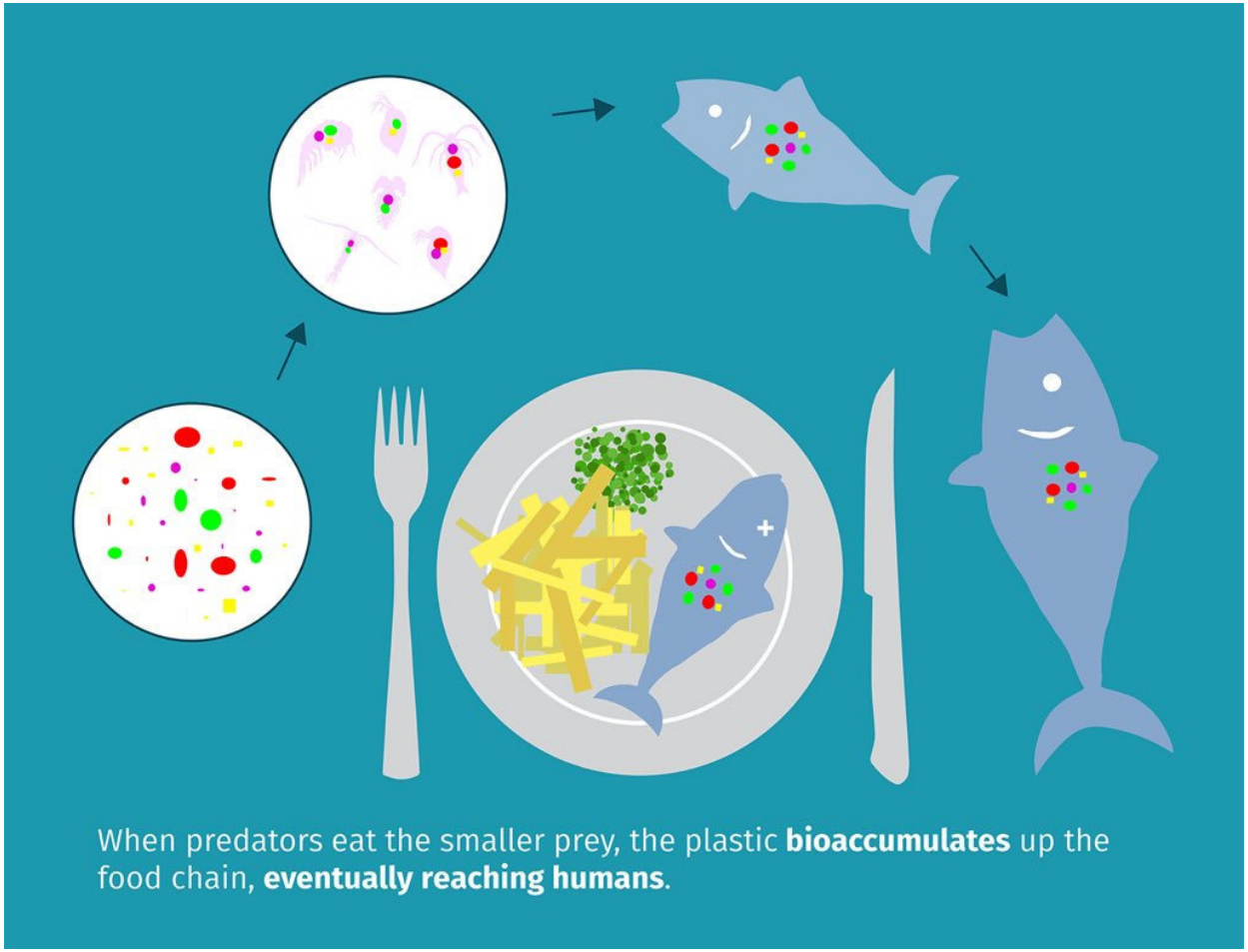
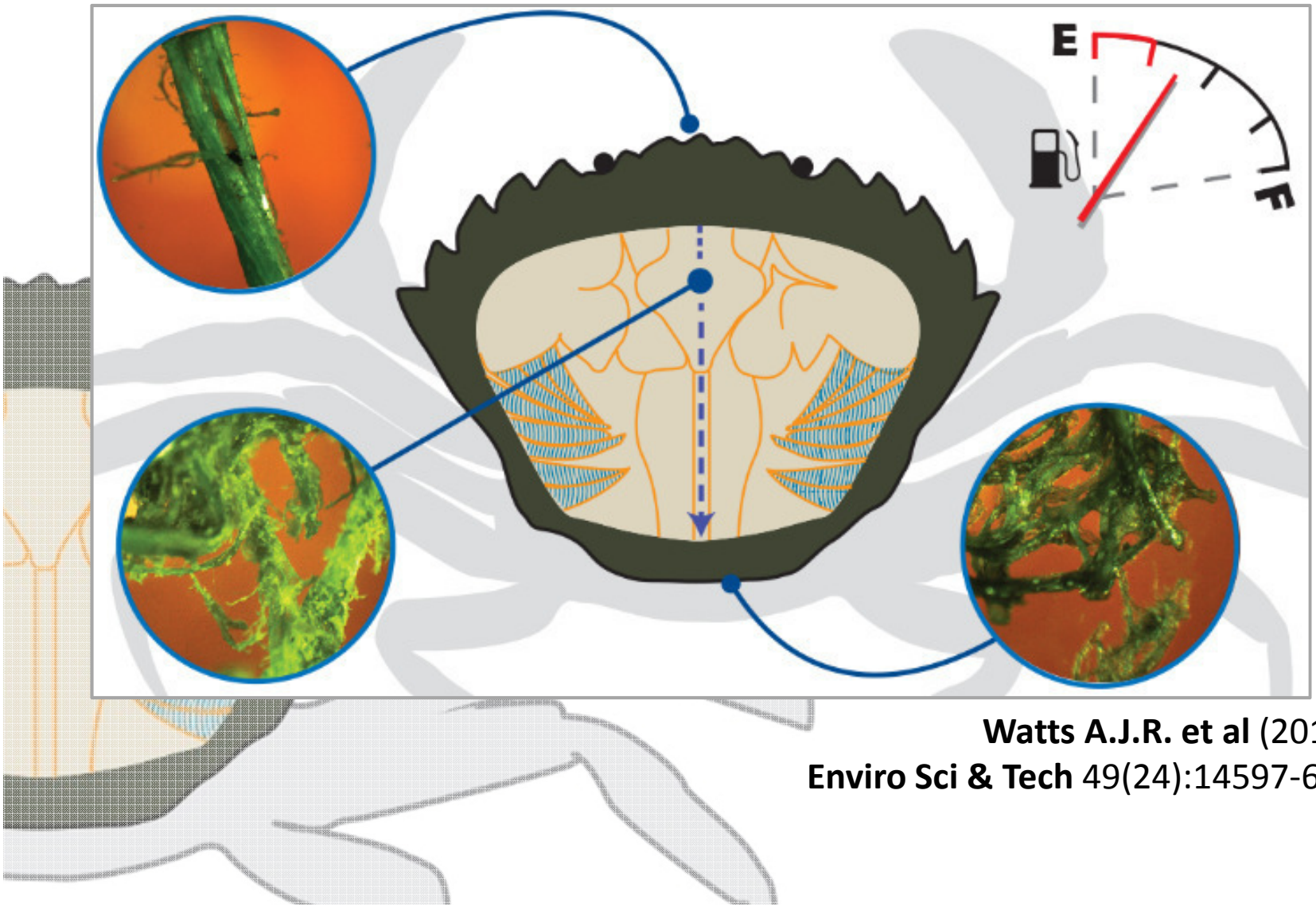
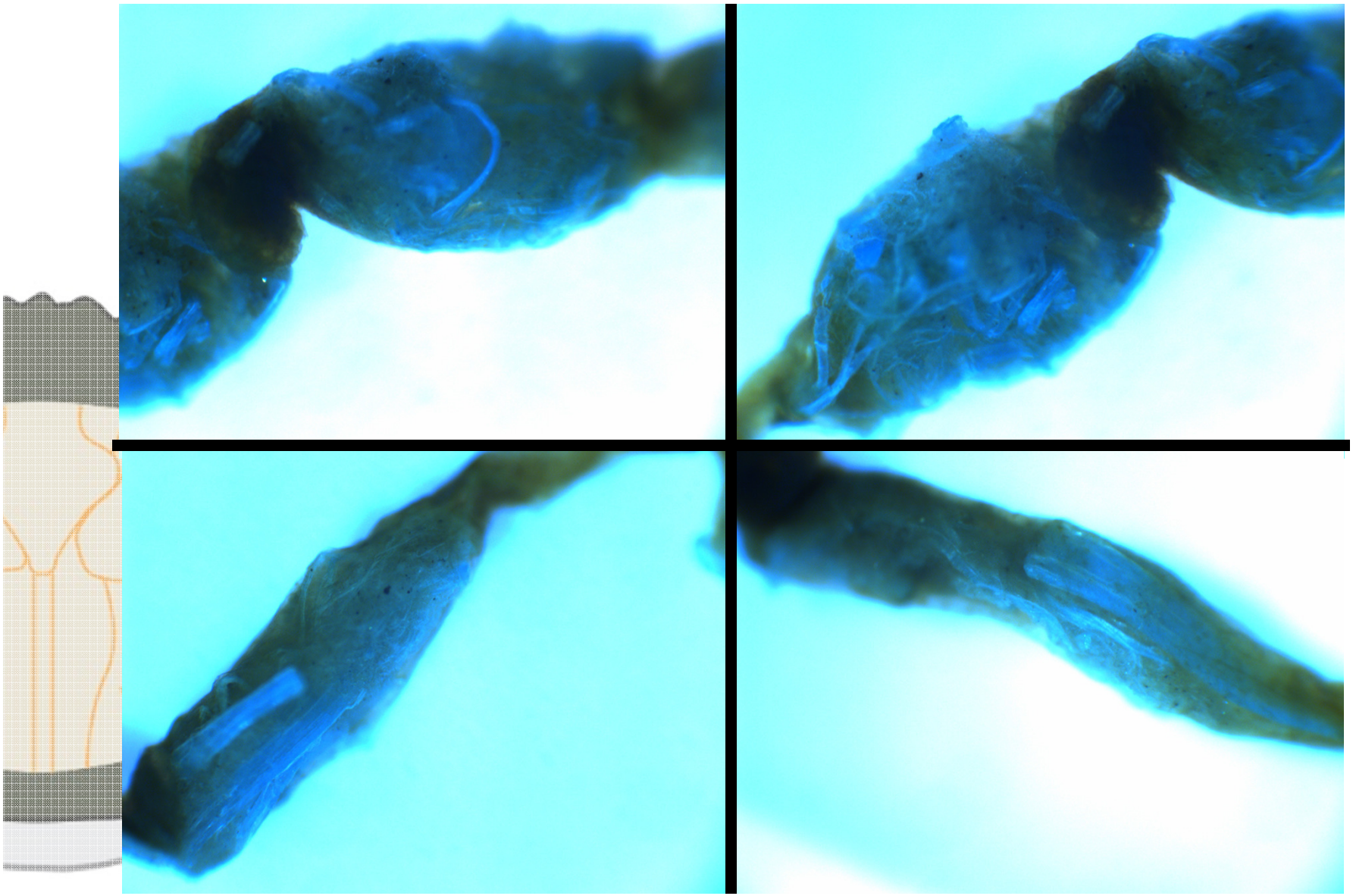

When predators eat the smaller prey, the plastic **bioaccumulates** up the food chain, **eventually reaching humans**.

Ingestion leads to biotransformation



Watts A.J.R. et al (2015)
Enviro Sci & Tech 49(24):14597-604

Ingestion leads to biotransformation



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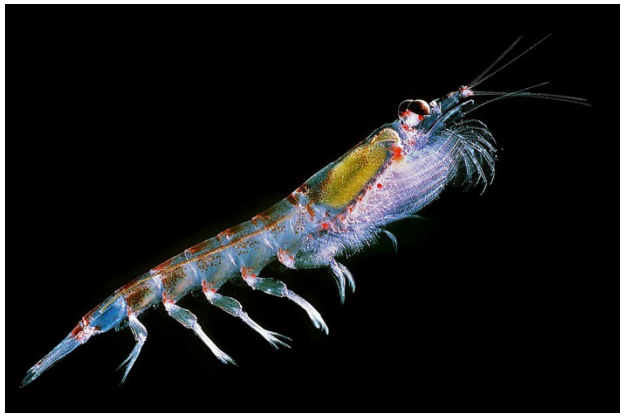

Turning microplastics into nanoplastics through digestive fragmentation by Antarctic krill

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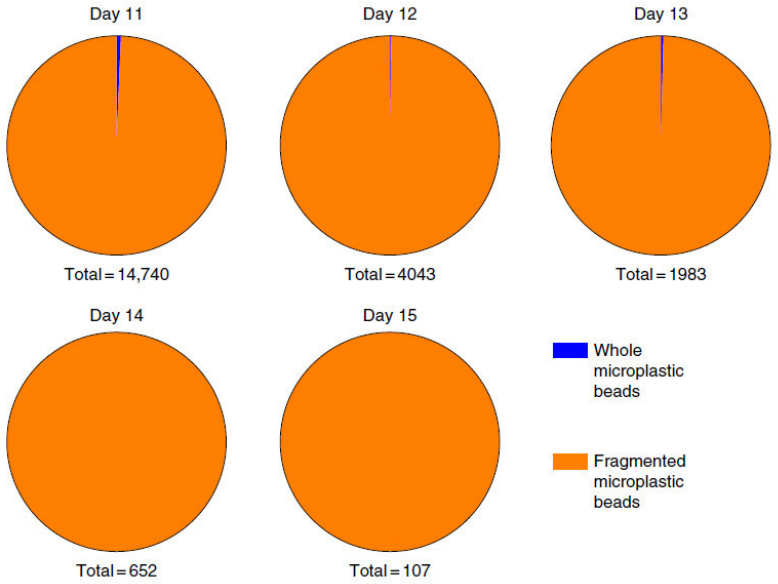

Fig. 4 The proportion of PE plastic fragments to whole beads isolated from Antarctic krill. Faecal material (from $n = 15$ krill) was collected over 5 days, after switching from 10 days of low dose microplastic exposure, with daily static renewal, to an uncontaminated algae diet. Total refers to the total number of particles measured in each 24 h period of faecal material. Fragments are shown in orange, while whole beads are shown in blue