Microplastic ingestion: the role of taste

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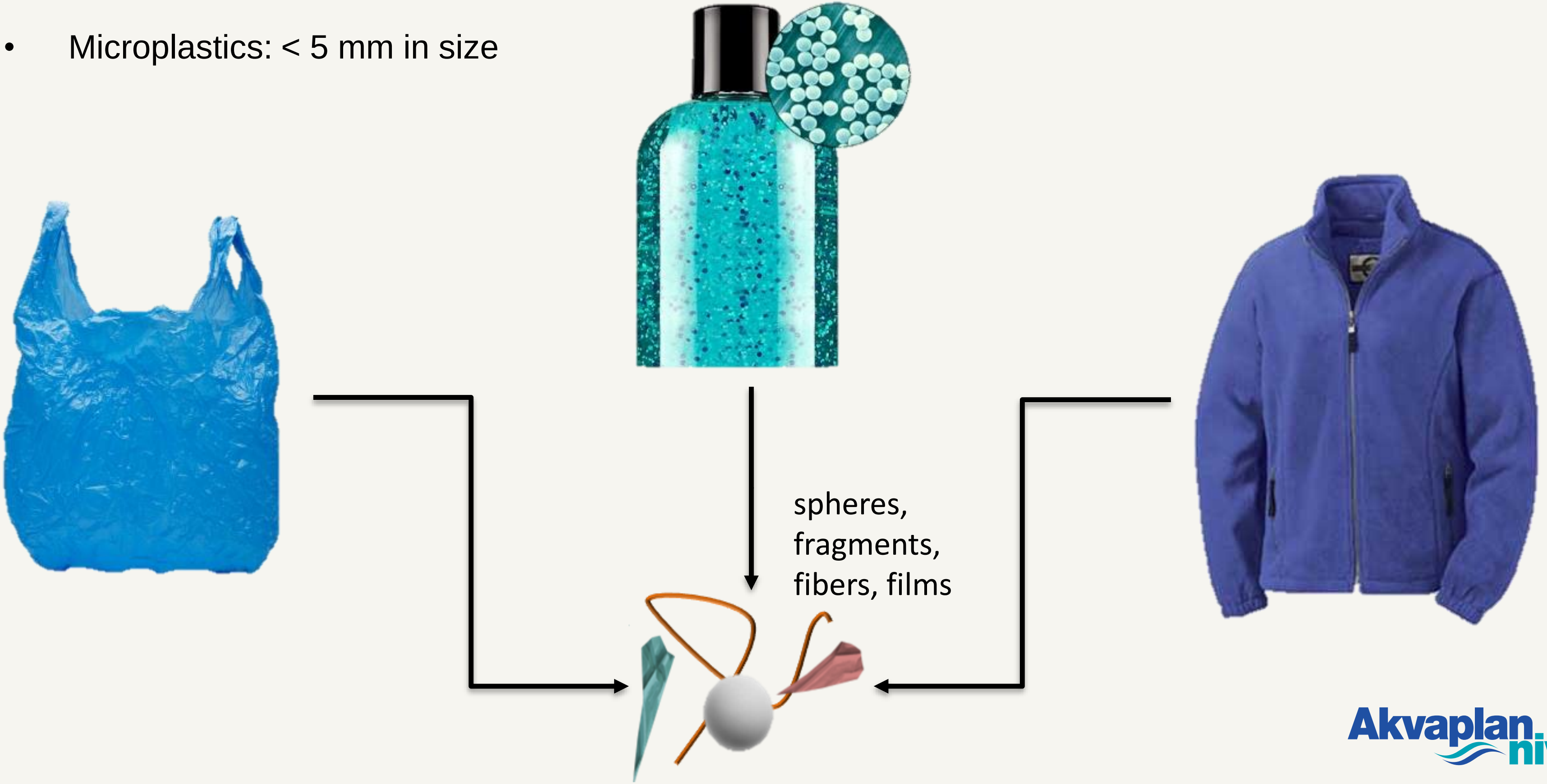
Sources of microplastics

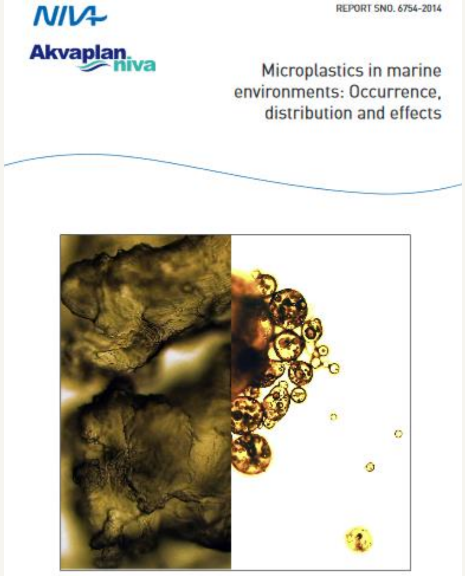
- Microplastics: < 5 mm in size



Microplastics in marine environments: occurrence, distribution and effects

- Plastics form the largest part of marine debris
- Distribution data sporadic and inconsistent
- Macrofauna + macroplastic: starvation, suffocation, entanglement
- Emerging knowledge on microplastics effects on organisms

Organism	Species	Polymer	Size (µM)	Concentrations	Duration	Ingestion (Y/N/NA)	Effect (L/S-L/N/NA	ze	Organ
Sea urchin (larva)	*T. gratilla*	PE (fluorescent)	10-40	1,10,100 and 300 particles/mL	5 days	Y	N		Gut WO
Polychaetes	*A. marina*	PVC (unplasticized)	Dust	0 - 5% sediment weight	4 weeks	Y	S-L		
Polychaetes	*A. marina*	PS (fluorescent) (-/+ PCB in sediment)	400-1,300	0 - 7.4% sediment weight	28 days	Y	S-L		WO
Blue mussel	*M. edulis*	PS (fluorescent)	3 and 9.6	15,000 individual spheres	3h and 2 h exposure	Y	S-L		
Barnacles Lugworms	*S. balanoides* *A. marina*	Natural occuring microplastics	NA	1g/L 1.5g/L	NA	Y	NA		Gut
Shore crab	*C. maenas*	Polystyrene (fluorescent)	8 - 10	$4.0 \times 10_{3}$ microspheres/·L	24 hours 21 days	Y	NA		
Blue mussel	*M. edulis*	High-density polyethylene (HD-PE)	0–80 µm	2.5 g HDPE-fluff	96 hours	Y	S-L		



Microplastics in arctic marine environments: ecosystem health implications

- Estimated flux to the Arctic: 62,000 – 105,000 tonnes year^{-1} (Zarfl & Matthies 2010)
- Role of zooplankton
    - ingestion/bioaccumulation
    - contaminant transfer (e.g. POPs to lipids)
    - food chain effects (biomagnification)
    - Vertical transport
    - C-flux perturbations

Microplastics in arctic waters

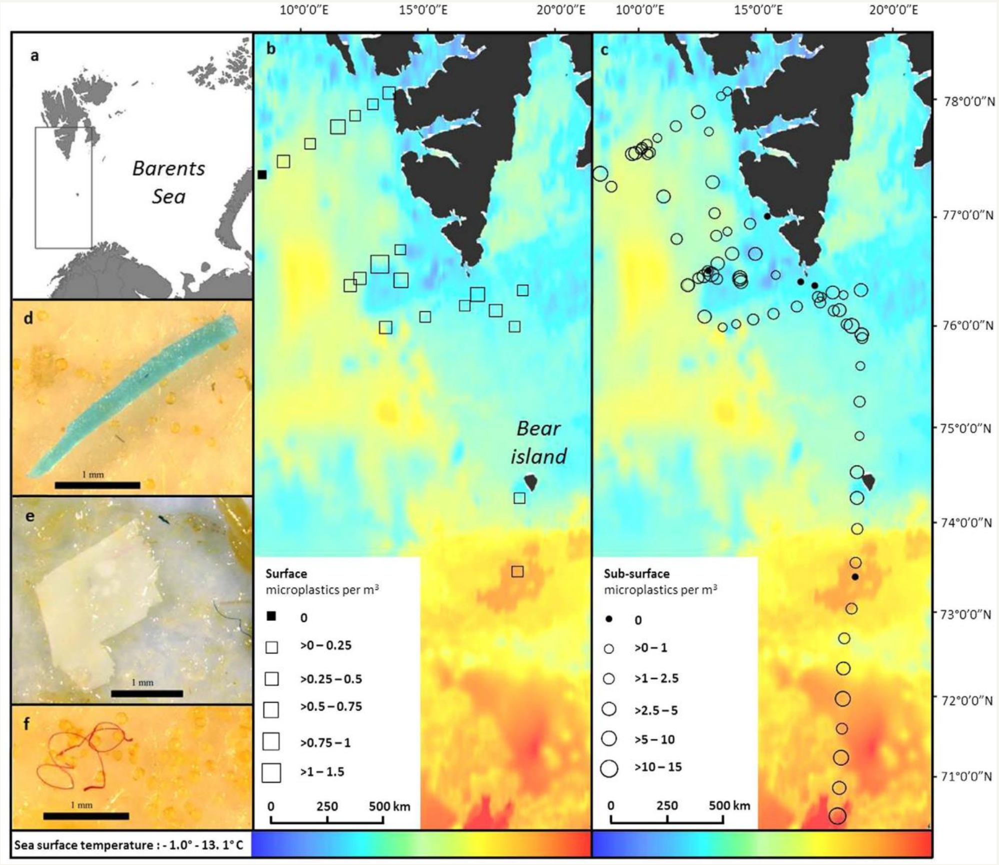
Lusher et al. 2015

- 0 – 11.5 particles m^{-3}
  (Lusher et al. 2015)

- 38 – 234 particles m^{-3} in ice cores
  (Obbard et al. 2014)

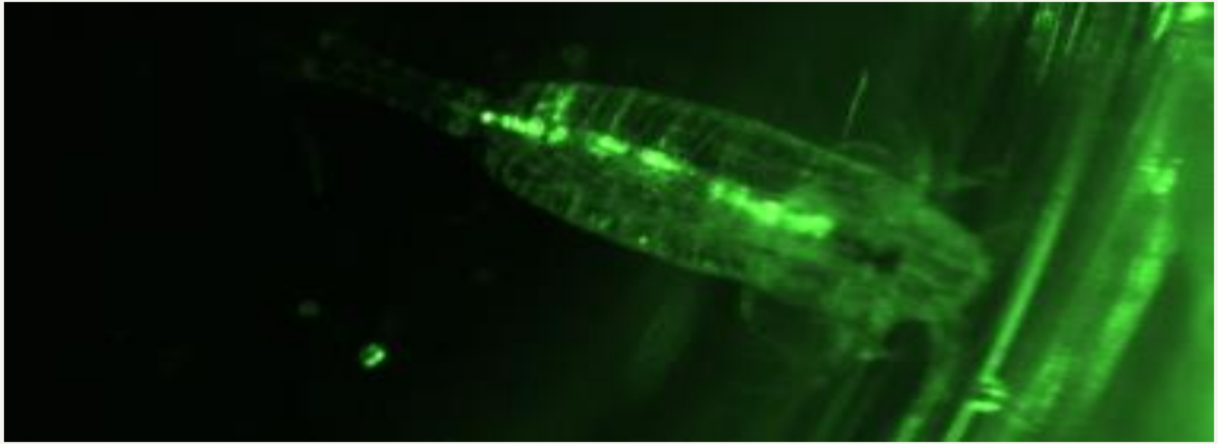
- human activities increase: shipping, tourism, offshore industries

→ more microplastics (?)

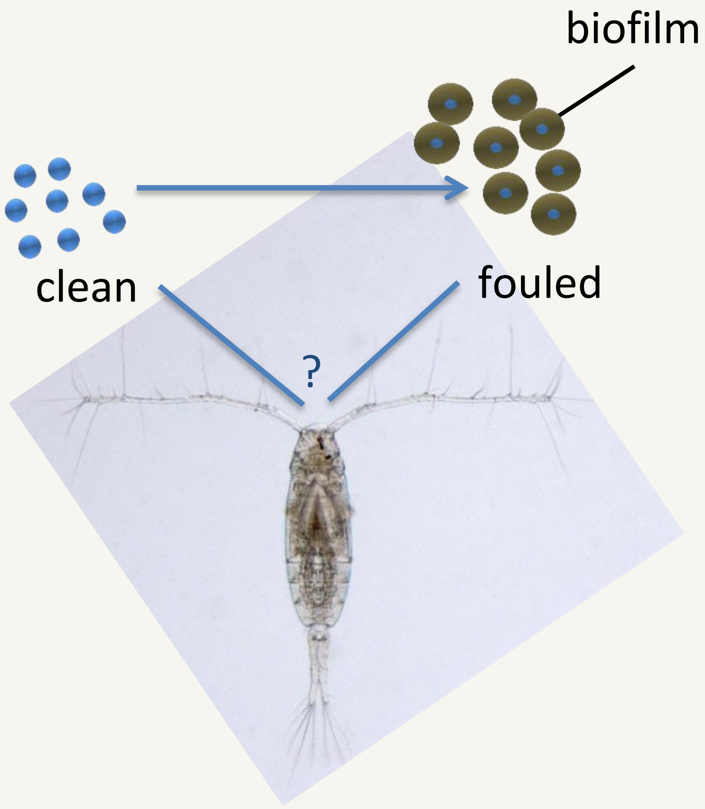


Microplastics and zooplankton

- Overlap in size between microplastics and typical food items (µm range)
- Plastic ingestion is experimentally confirmed (Cole et al. 2013, Setälä et al. 2014)
- Impacts on survival, feeding and fecundity (Cole et al. 2015, Lee et al. 2013)



Microplastics and zooplankton: the role of taste



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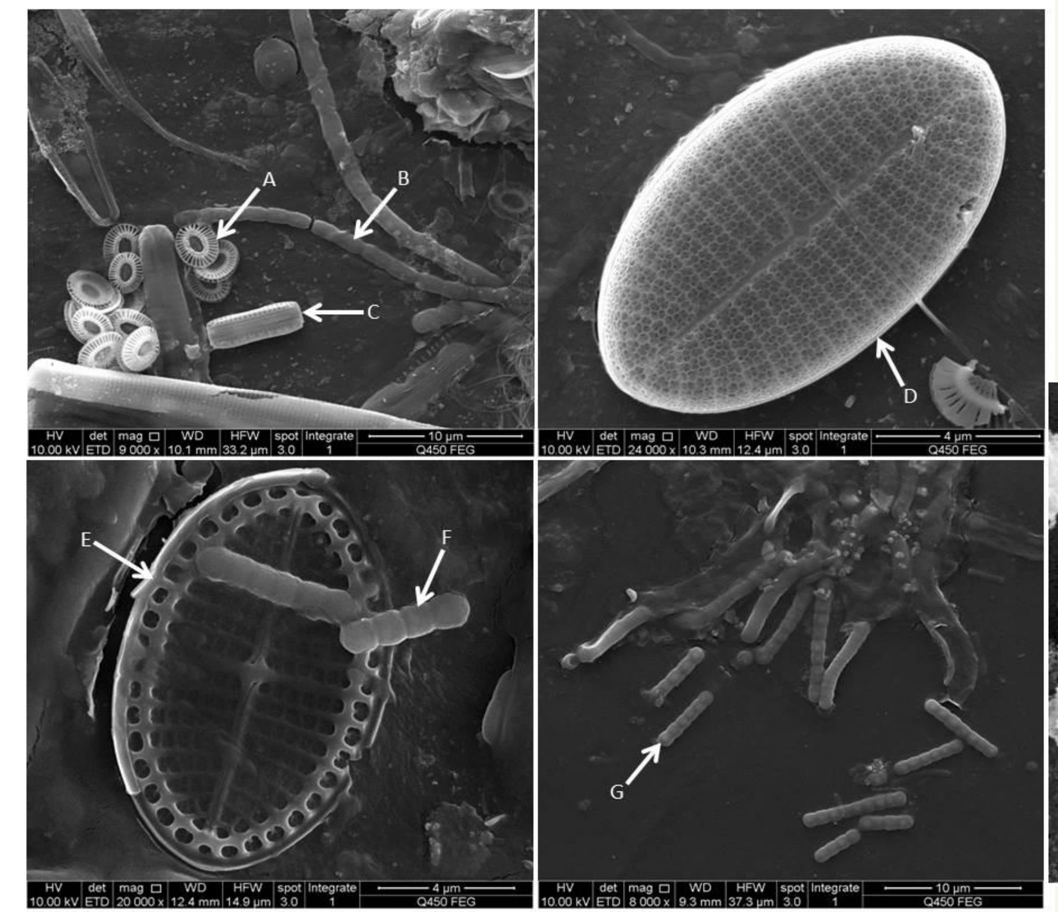
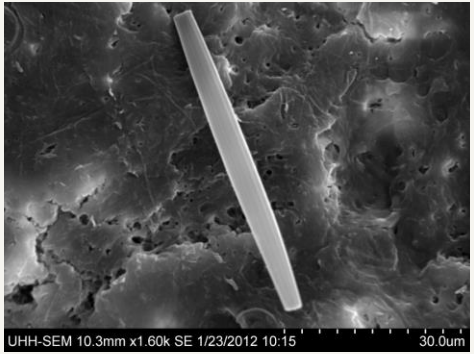
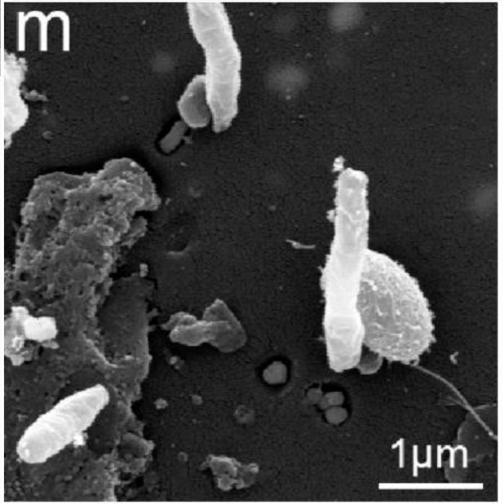
Microplastics and zooplankton: the role of taste







Photos: Nerheim et al. in prep, Carson et al. 2013, Reisser et al. 2014

"epiplastic diatoms"

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Microplastics and zooplankton: the role of taste

- Plankton sampling in Håkøybotn, Tromsø (Norway)

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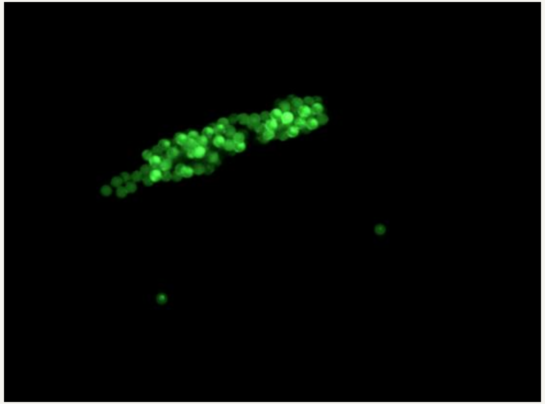
Microplastics and zooplankton: the role of taste

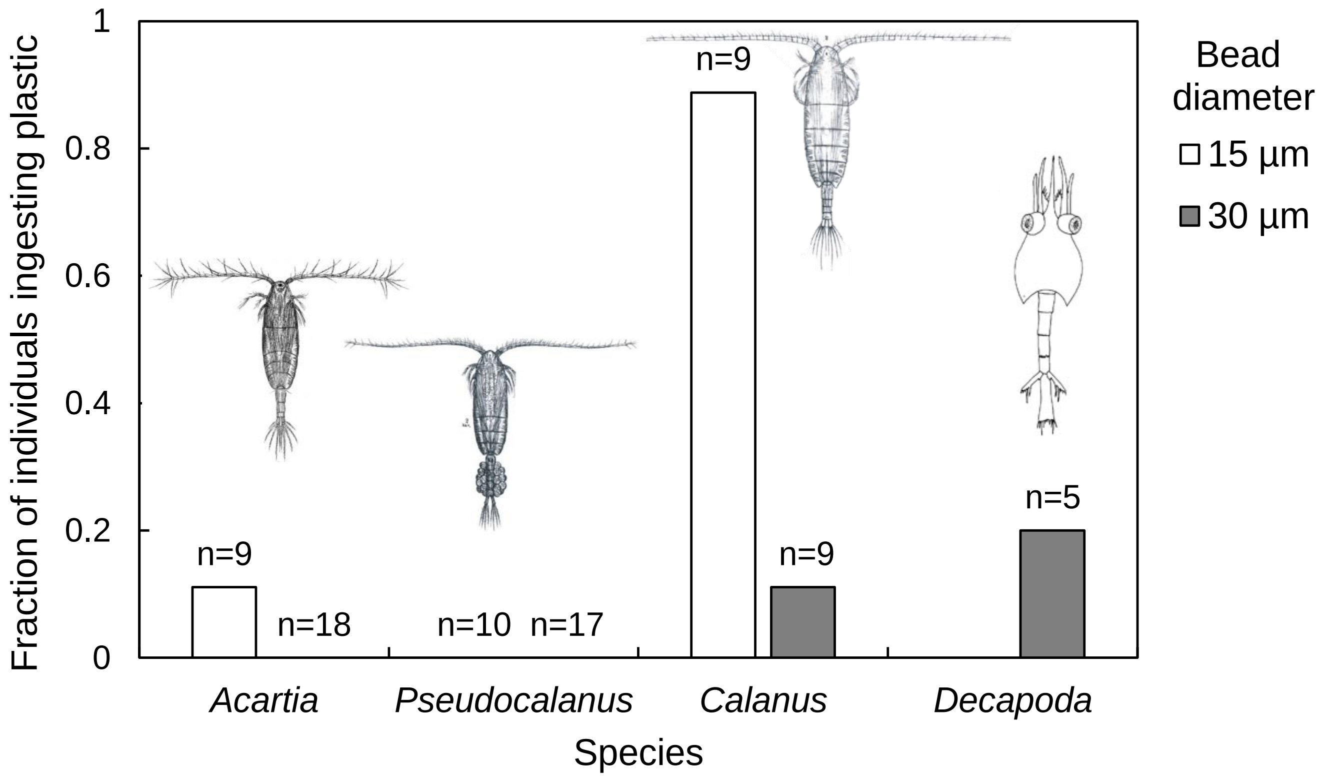
- Fluorescent polystyrene (PS) beads, 15 and 30 µm diameter
- Fouled particles: soaking 3 weeks in native seawater
- Incubation in filtered (1 µm) seawater in 0.5 L glass bottles
- Rotating plankton wheel
- Observations with a fluorescence stereoscope



Microplastics and zooplankton: zooplankton taxa and plastic size

- 4 species:
    - Small copepods: *Acartia longiremis*, *Pseudocalanus* spp.
    - Large copepod: *Calanus finmarchicus*
    - Decapod larvae
- 15/30 µm PS beads, control without microplastics
- 10 individuals per bottle
- 24h exposure
- 0.333 mg L^{-1} = 23/148 beads mL^{-1}

Microplastics and zooplankton: zooplankton taxa and plastic size

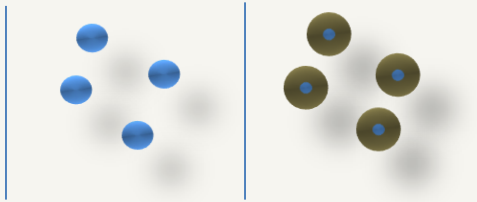


Microplastics and biofouling: effect on ingestion

- *Acartia longiremis* ♀
- 200 particles mL^{-1}
- 5 replicates @ 10 individuals
- 24 hours

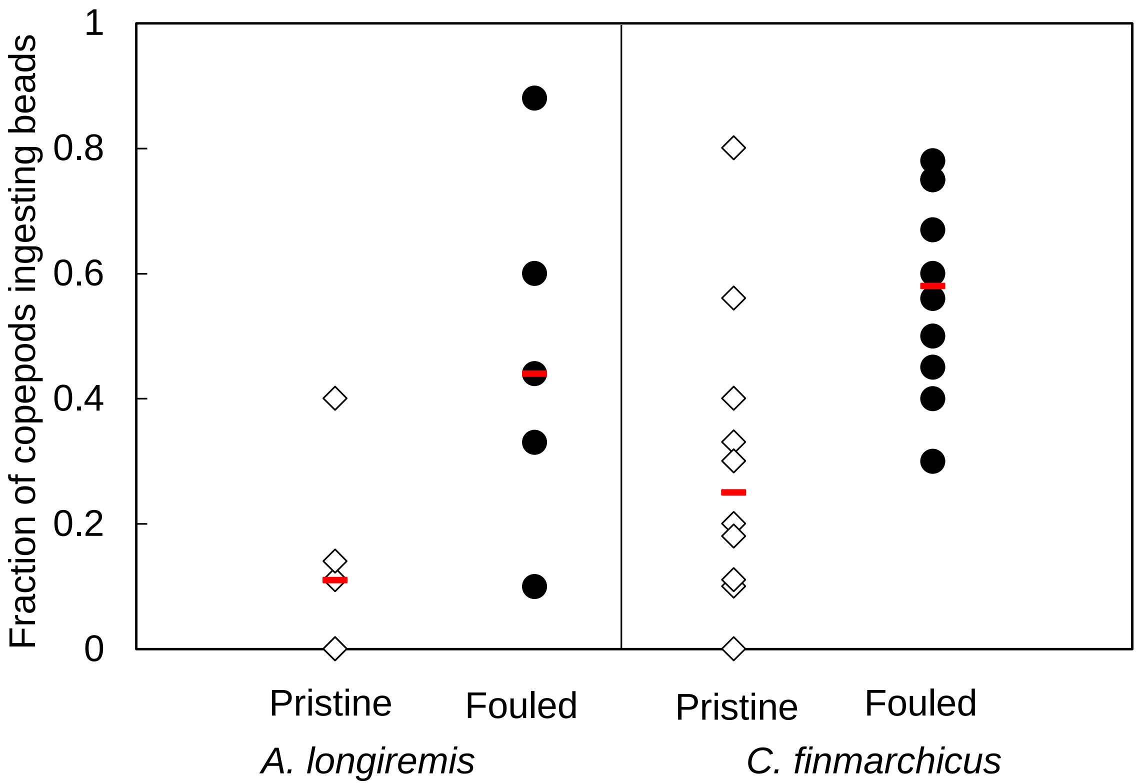
- *Calanus finmarchicus* CV
- 100 particles mL^{-1}
- 10 replicates @ 10 individuals
- 4 hours

- Endpoints: % ingesting ind., # ingested, survival



Control Pristine Fouled

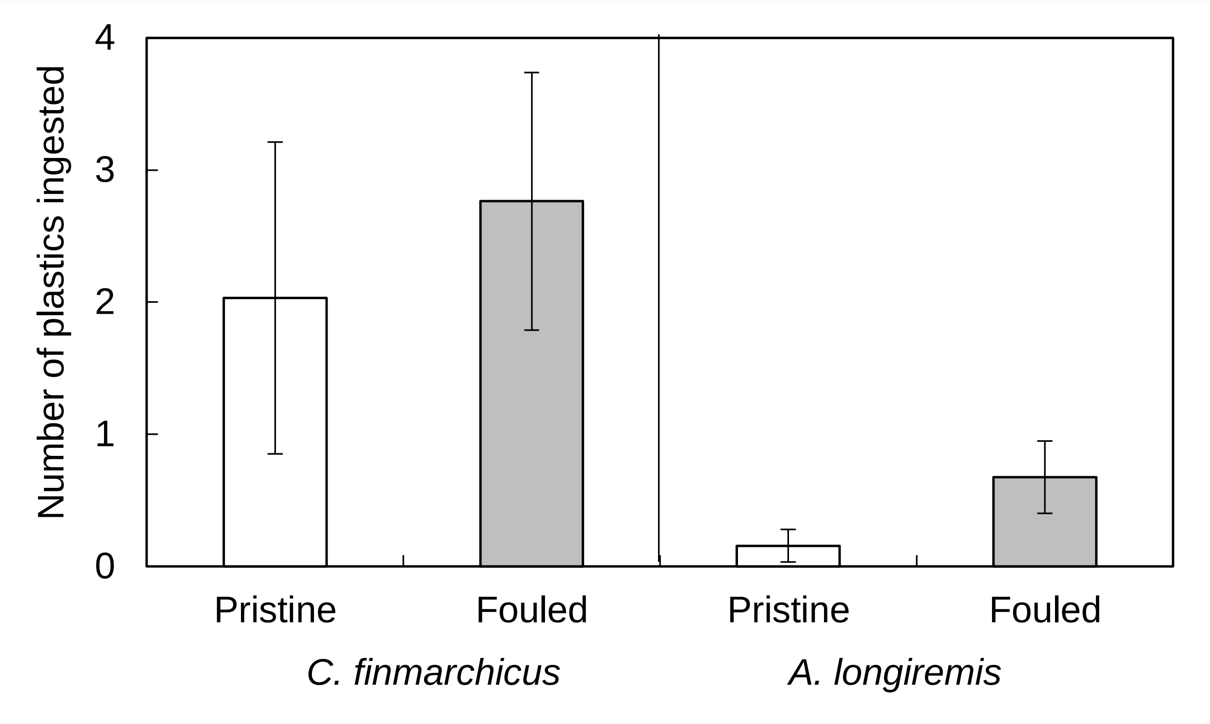
Microplastics and biofouling: effect on ingestion



Positive effect of biofouling

t-test:
Acartia p= 0.026
Calanus p= 0.007

Microplastics and biofouling: effect on ingestion



Positive effect of biofouling

t-test:
Acartia p= 0.032
Calanus n.s.

Error bars: 95% CI

Microplastics and biofouling: conclusions

- PS-bead ingestion is species-specific and bead size dependent
- Body size and filter mesh size of feeding apparatus are important
- Encounter and filtration rates determine plastic uptake

→ *Calanus* > *Acartia*

- Fouled beads were more frequently ingested than clean beads
- Selectivity difference between species: *Calanus* less selective than *Acartia*

→ Chemical perception: biofilms disguise plastic as nutritious food

- Survival was not affected (not shown, short-term experiment)
- High proportion of beads was egested after 4+ hours

Microplastics and biofouling: open questions

- What determines individual intra-specific differences (high variability)?
    - Why are some individuals more selective than others?
- How will varying plastic properties affect ingestion dynamics
    - Shape (beads vs. fragments vs. fibers)
- How can ingestion *in situ* at realistic concentrations be determined?
- Are there chronic and/or sublethal health effects on zooplankton?
- At what rates are microplastics transferred to the next trophic level
    - Planktivorous zooplankton (e.g. chaetognaths)
    - Fish larvae
    - seabirds

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Microplastics and biofouling: acknowledgements

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