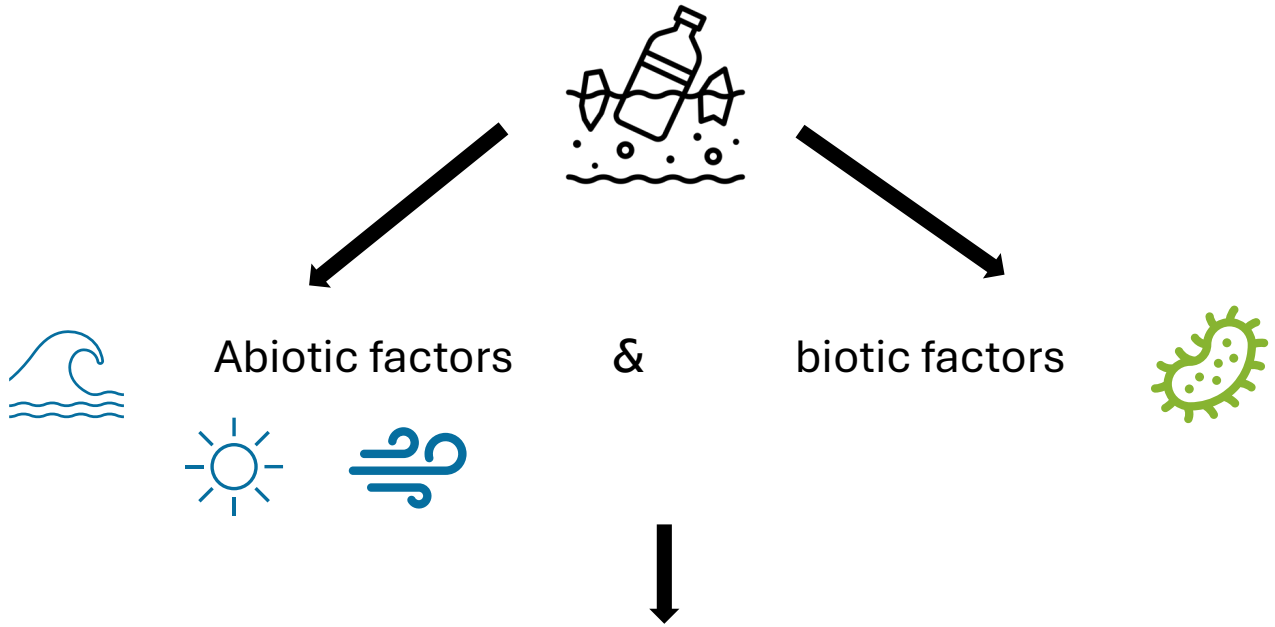
Microplastics on the menu; exploring interactions between two mosquitoes species and microplastics

Léa Poirier

Introduction

- Plastics: a global threat (Geyer *et al.*, 2017)
- Plastics in the environment come in all shapes and sizes (Andrady., 2011):



Microplastics (<5mm) and nanoplastics (1<µm) (Hidalgo-Ruz *et al.*, 2012)

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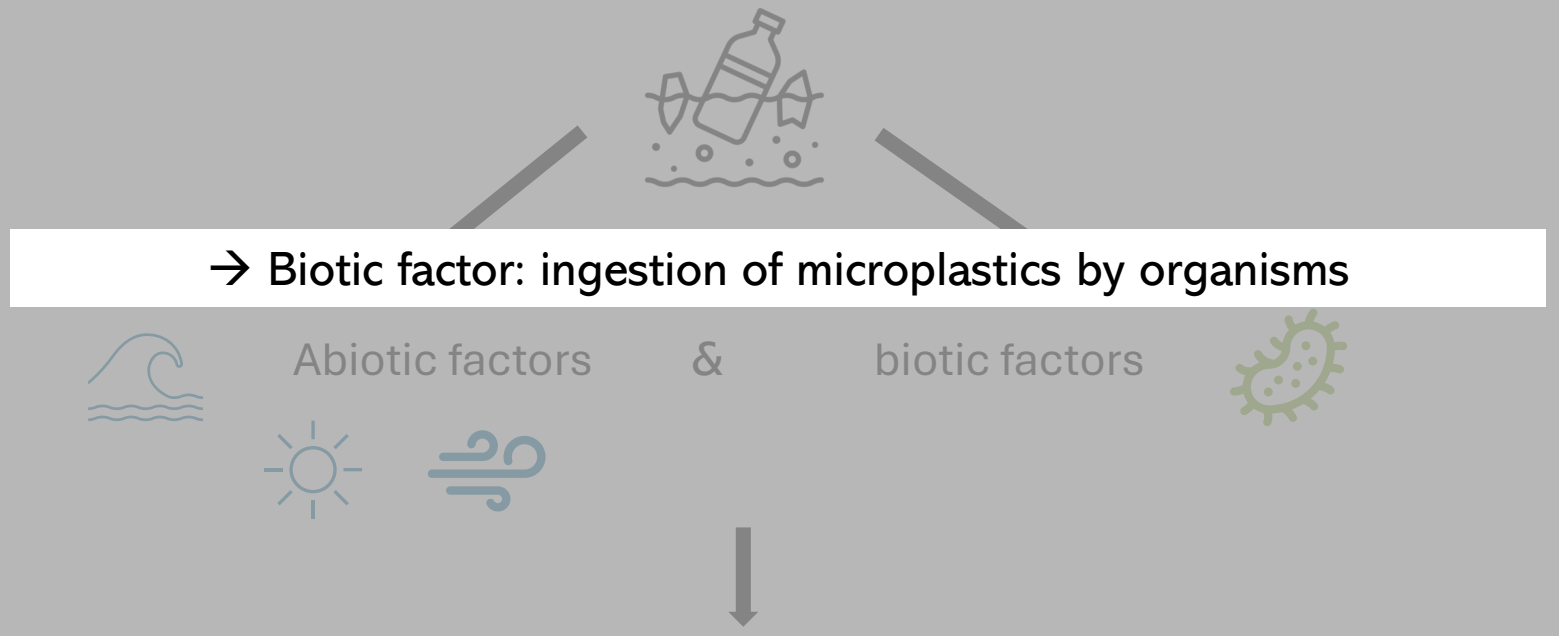

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Introduction

Ingestion

Impact of microplastics on organisms:

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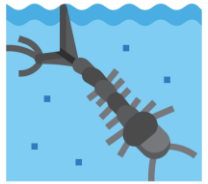
Introduction

Ingestion

Impact of microplastics on organisms:

- immunity
- Physical damage
- Oxidative stress
- Life story traits
- growth



Impact of organisms on microplastics :

(Sanchez-Hernandez,. 2021)

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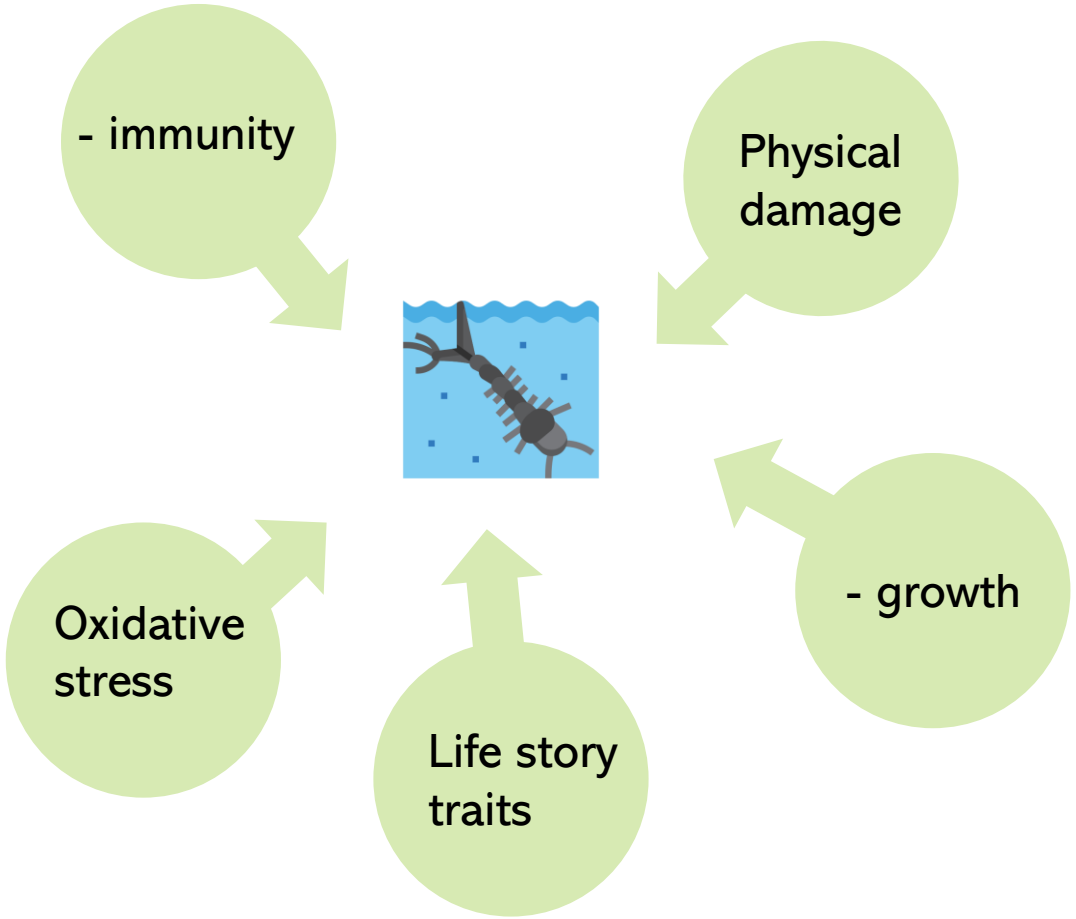

(Sanchez-Hernandez,. 2021)

Impact of organisms on microplastics :

- Biofragmentation by macroinvertebrates (gammarids, krill, chironomids)
- Creation of nanoscopic fragments
- 2 alterations: chemical or mechanical
- But little information on the role of macroinvertebrates

(Dawson et al., 2018)

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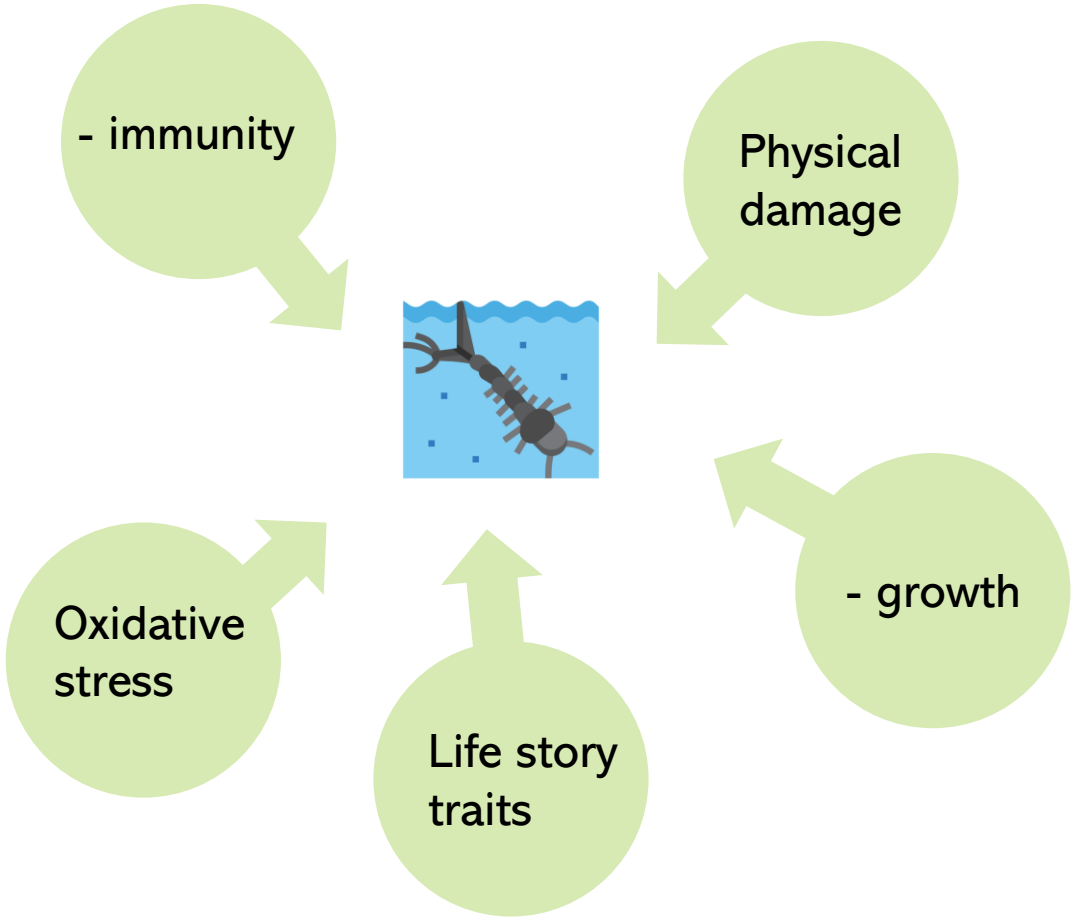

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→ **What about mosquitoes?**

Introduction

Arthropods, disease vectors

Females lay eggs on surface water (Yee *et al.*, 2004)

Anopheles gambiae

Aedes albopictus

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Development: 4 larval instars and a pupal instar

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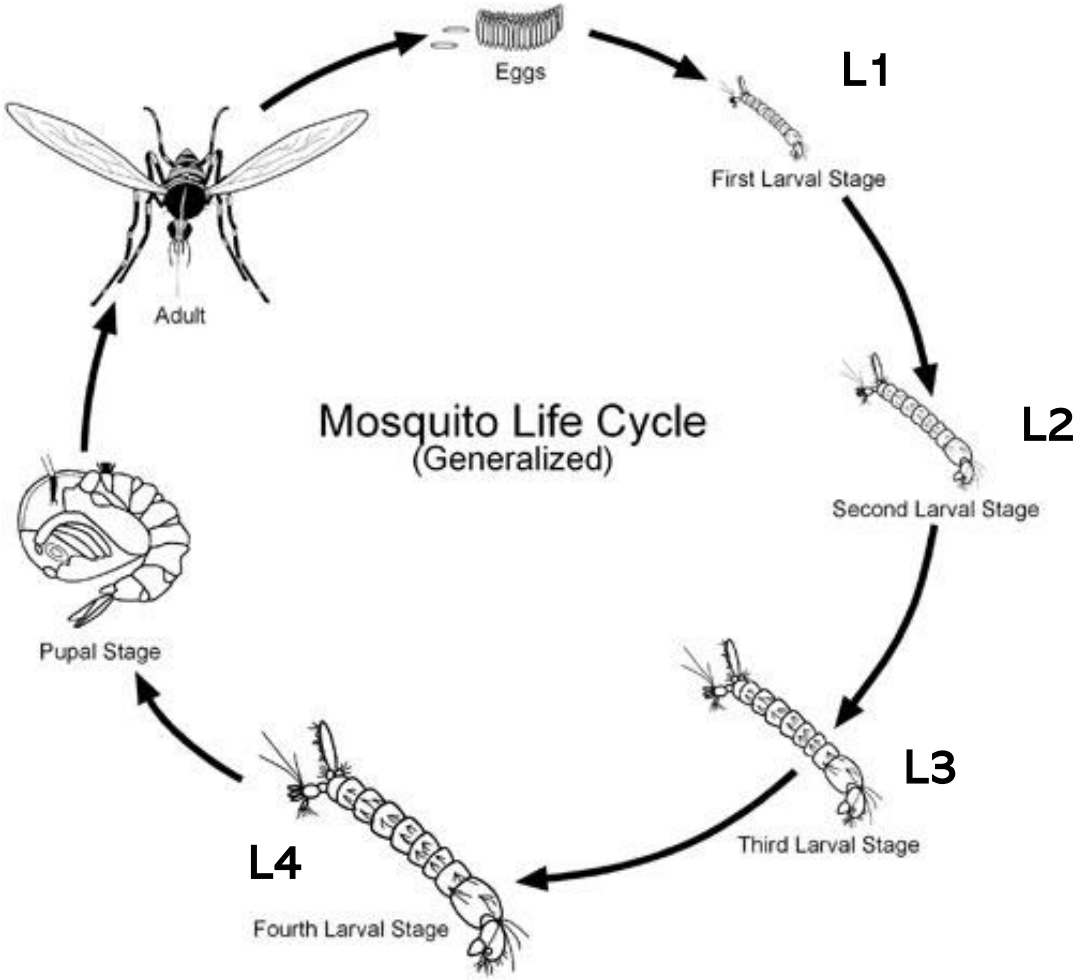
Aedes albopictus



(Illustration by: Scott Charlesworth, Purdue University)

Introduction

Arthropods, disease vectors

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- → Filter feeders & grazers: *Ae. albopictus*

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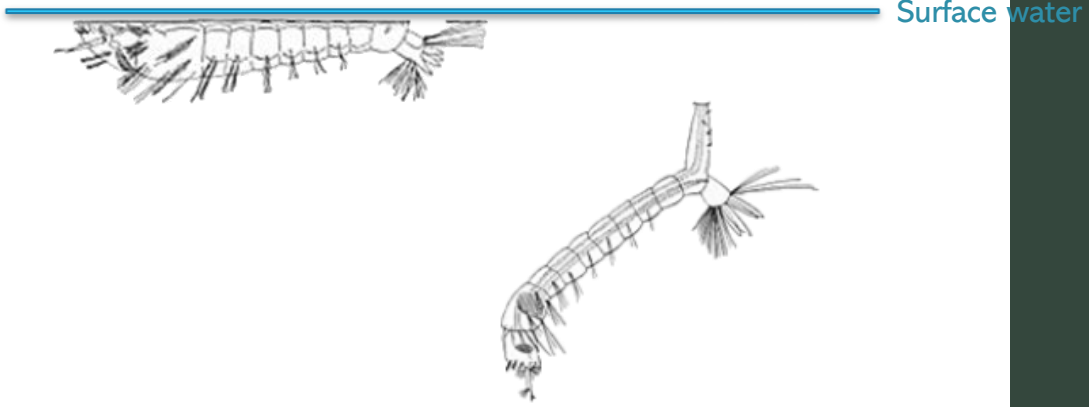
Aedes albopictus



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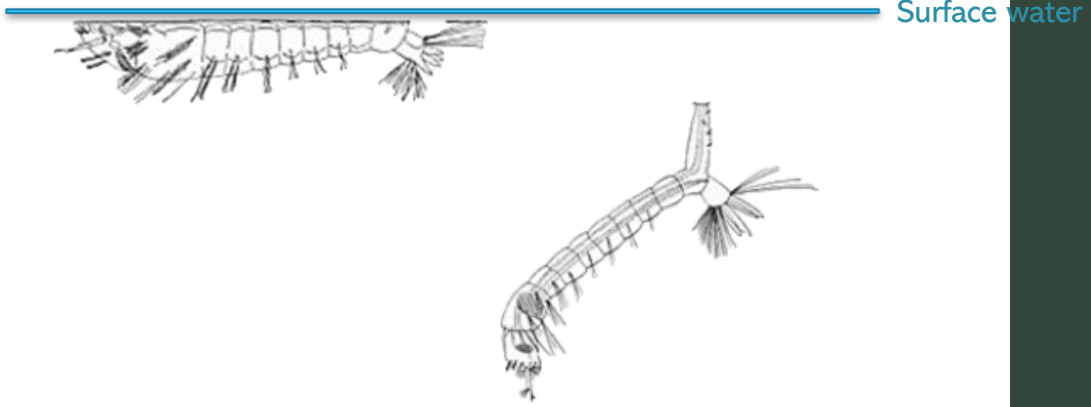
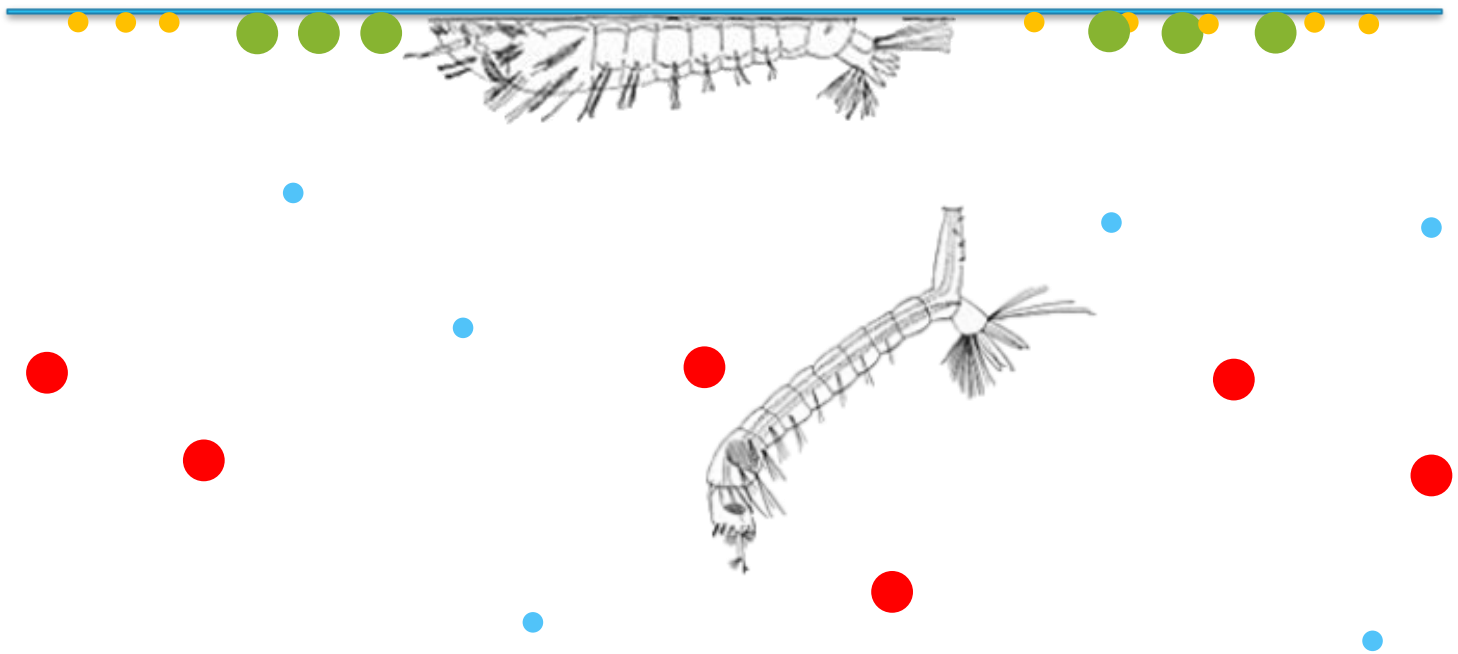


<u>Ingestion of microplastics by mosquito larvae:</u>
Larvae able to ingest microplastics
Effects still poorly understood (Griffin *et al.*, 2021)

Problems

Experiment 1: Who eats what?

Axis 1	Axis 2
Species with different feeding behavior are exposed to the same risk of ingestion?	Impacts of microplastics on life-history traits (survival, sex ratio and size)



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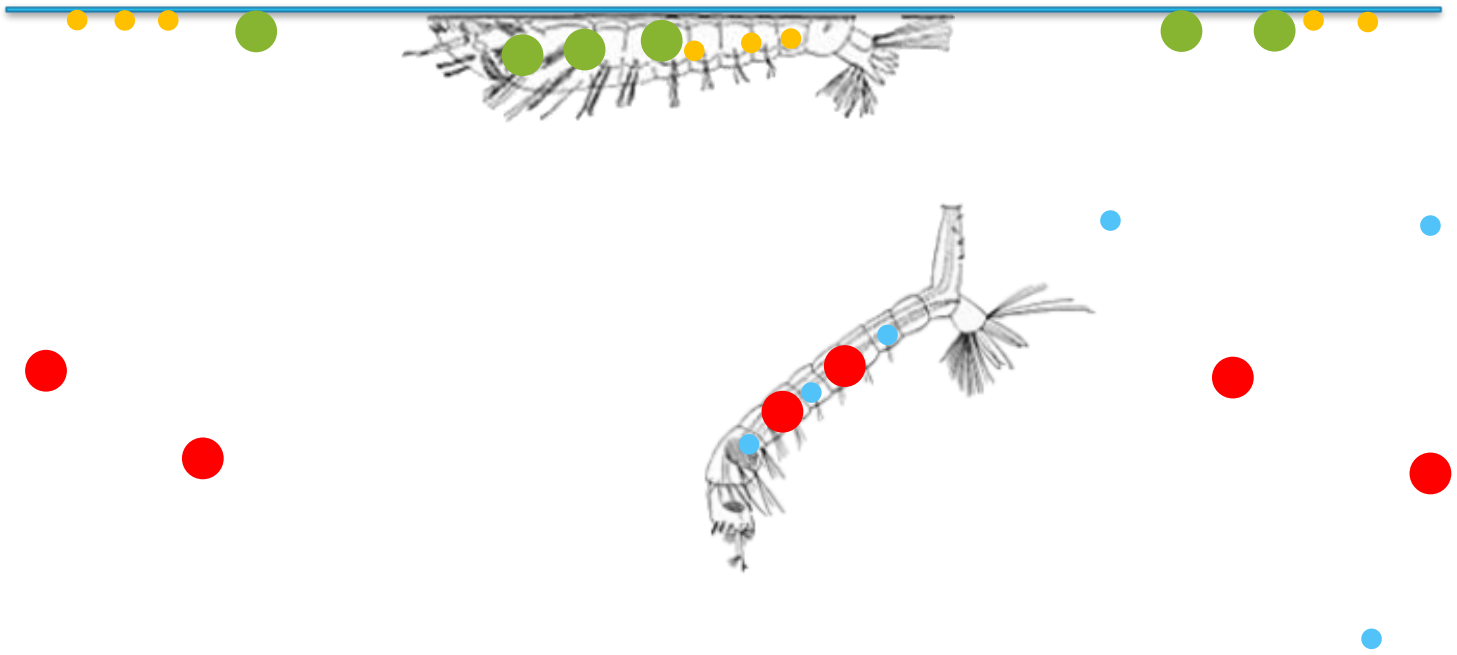

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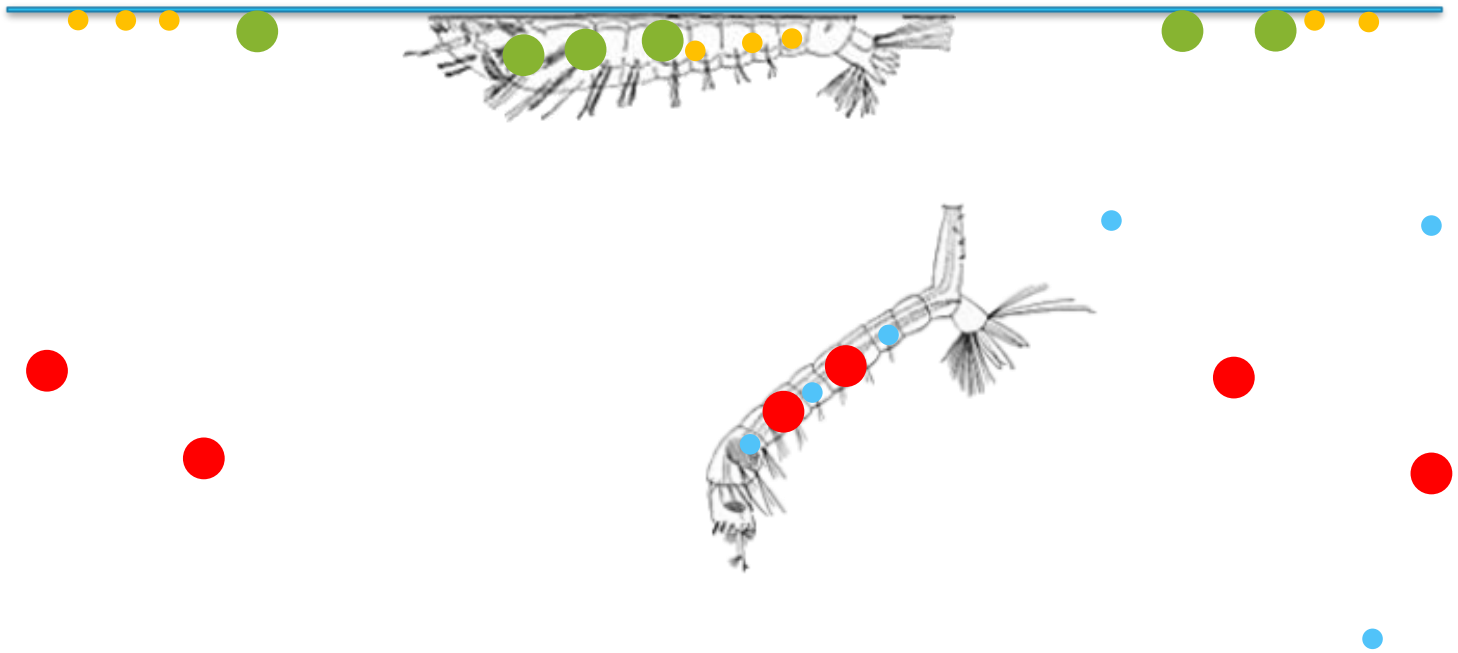
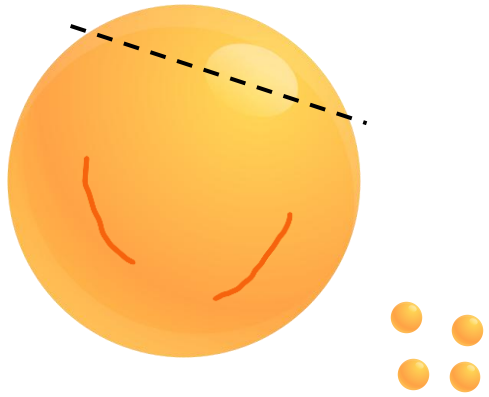


Experiment 2: digestion

Axis 3

Biofragmentation of microplastics by mosquito larvae?



Diameter reduction?
Fragments?
Marks?

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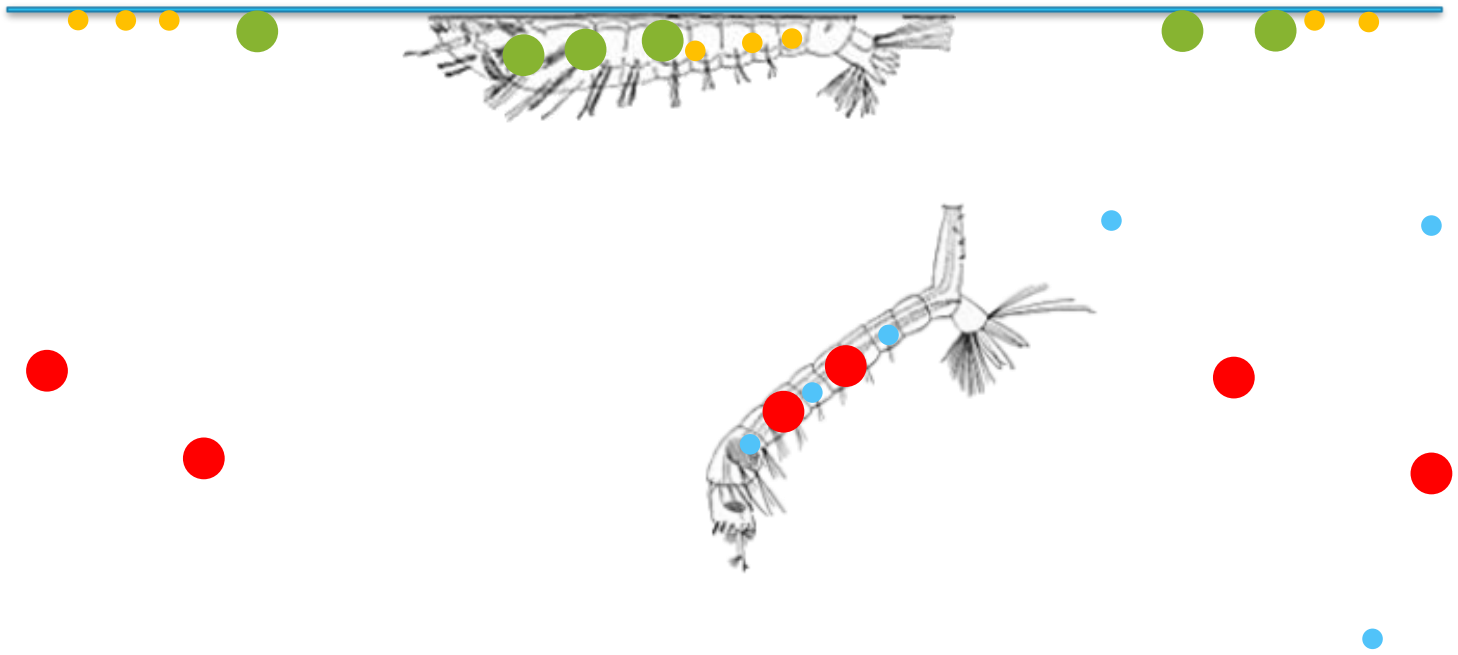
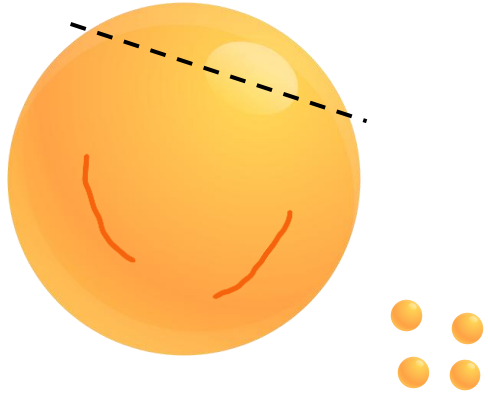




Diameter reduction?
Fragments?
Marks?

Materials and Methods

Experiment 1: Who eats what? | **Experiment 2: digestion**

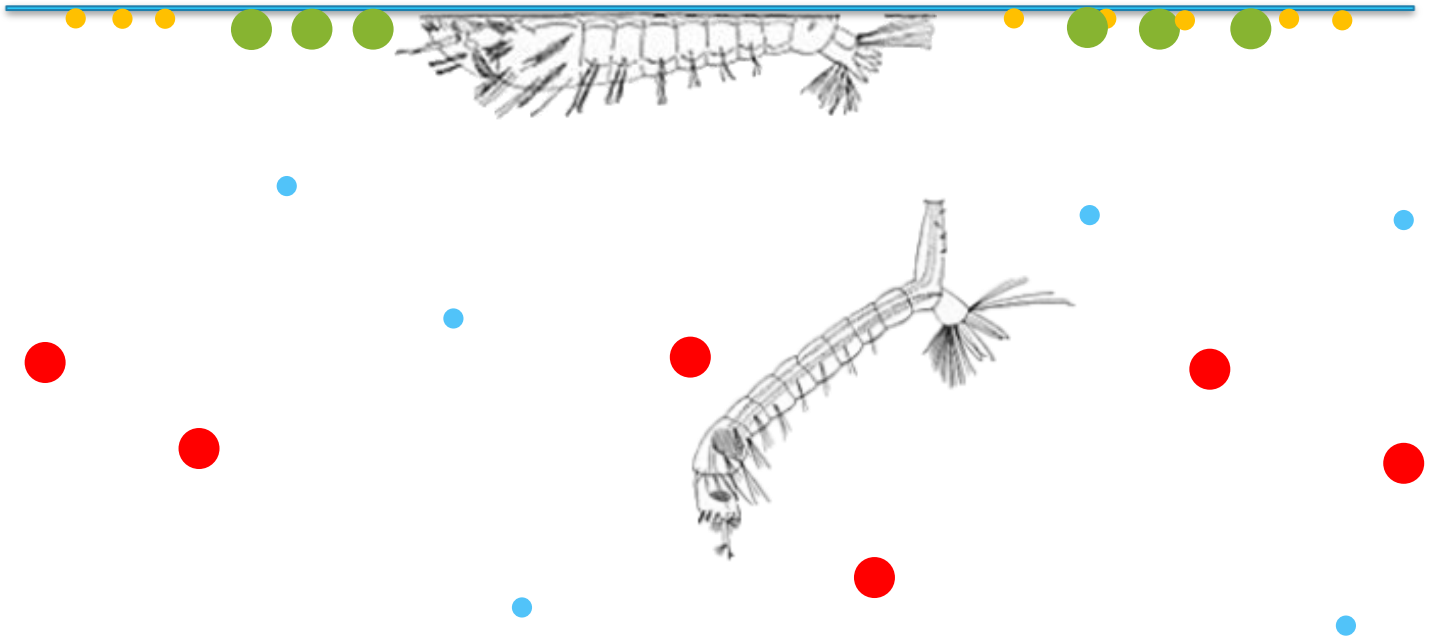
2 species:
Surface filter feeders: *An. gambiae*
Filter feeders & grazers: *Ae. albopictus*

Polystyrene (PS)

- Polystyrene 50µm (PS50)
- Polystyrene 15µm (PS15)

Polyethylen (PE)

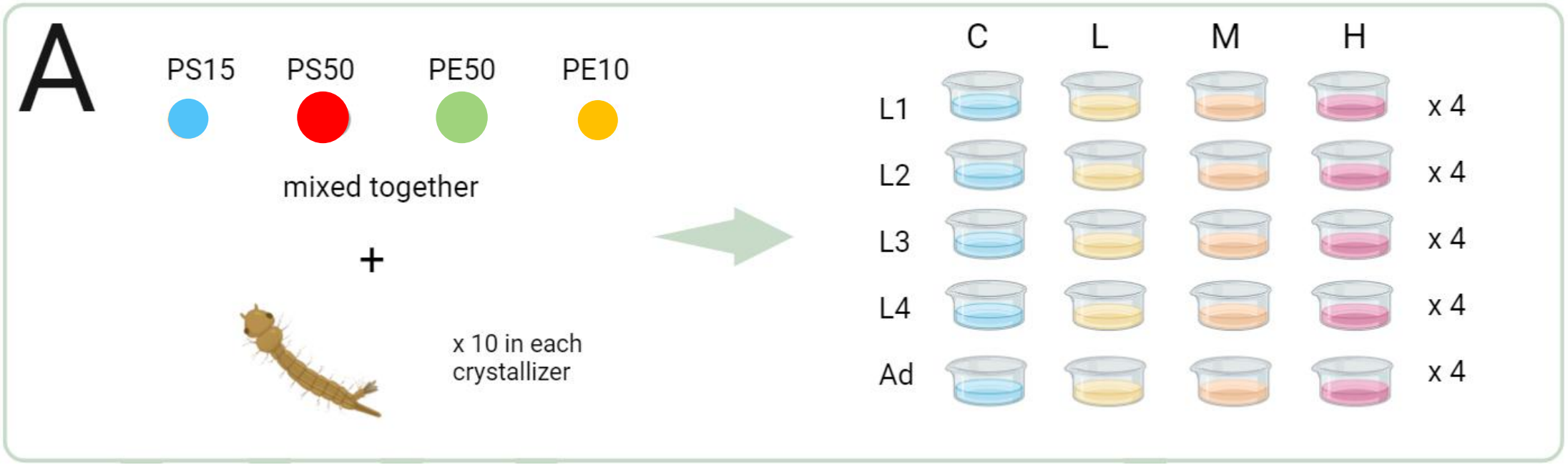
- Polyethylene 50µm (PE50)
- Polyethylene 10µm (PE10)



Materials and Methods

Experiment 1: Who eats what?

Species with different feeding behavior are exposed to the same risk of ingestion?



→ Mixed microplastics

→ Different concentrations (high (H), medium (M) and low (L) + control (C))

→ 10 larvae/ critallisoir from hatching

→ Exposure: hatching to larval instar of interest or until emergence

→ 4 replicates/ concentration

Materials and Methods

Experiment 1: Who eats what?

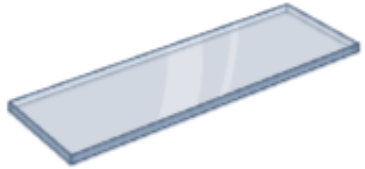
Species with different feeding behavior are exposed to the same risk of ingestion?

Larvae dissection

Larvae washed 2 times in reverse osmosis water before dissection

x 30 larvae dissected/ concentration/ treatment

Microscopy



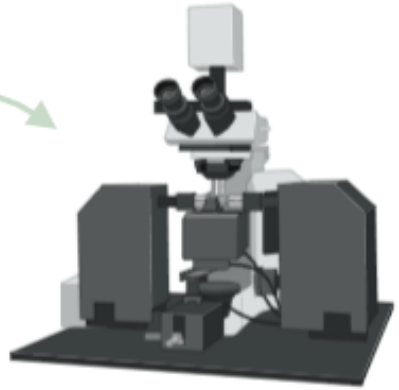


Photo of MPs by using Zeiss Axiozoom V.16

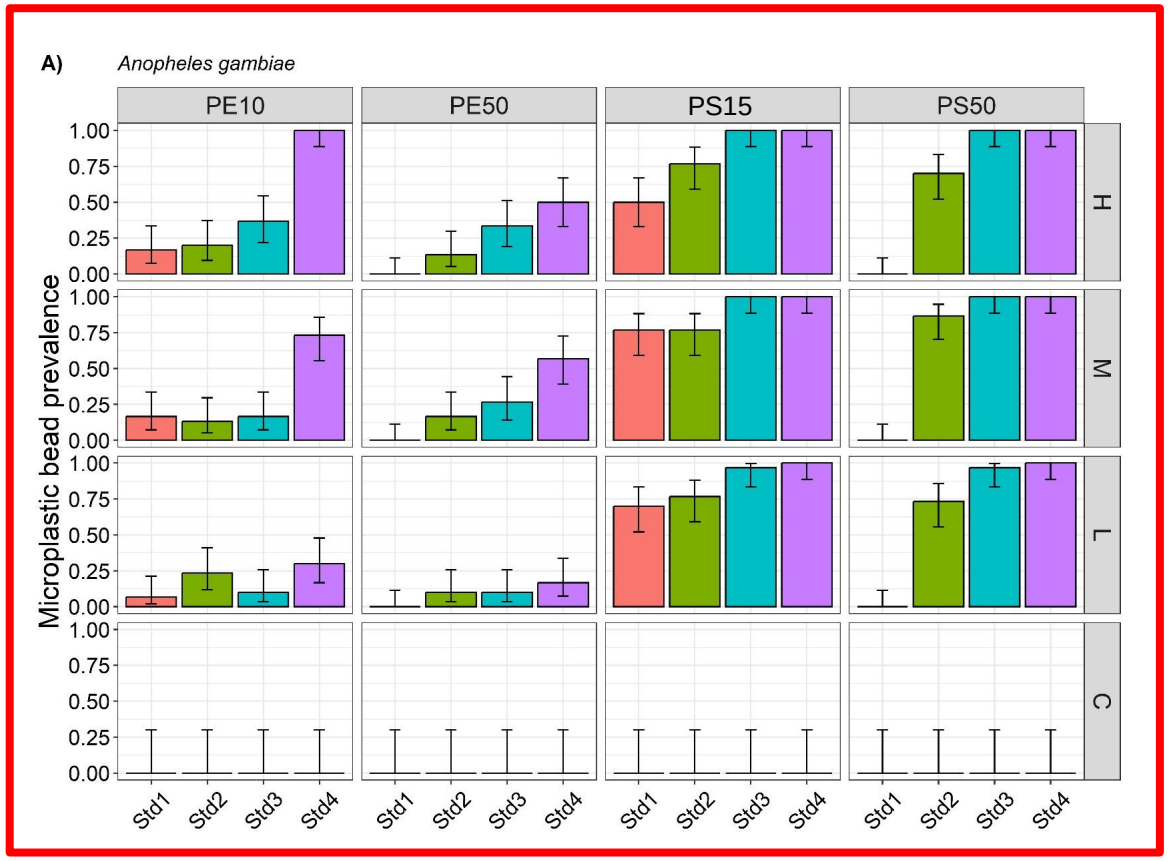
→ Rinsing larvae

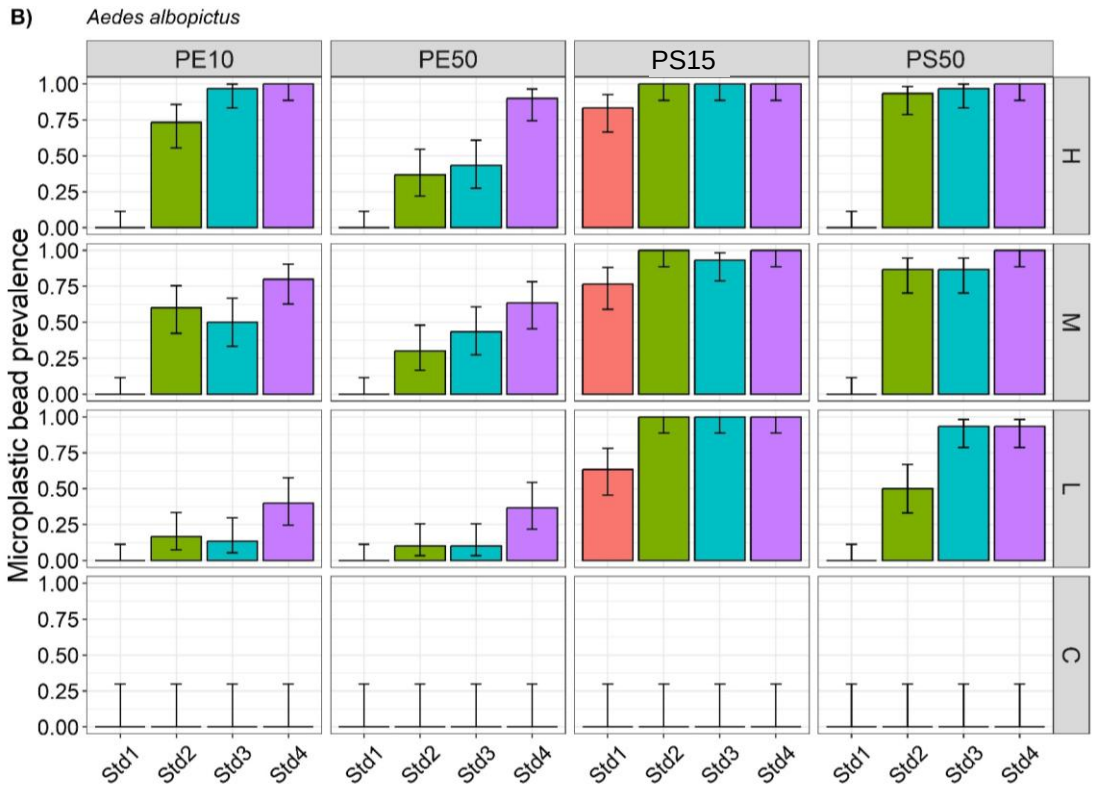
→ Dissection on slide

→ Microsplastic counting

Results/ Discussion

Experiment 1: Who eats what?





→ Results were the same for both species

Results/ Discussion

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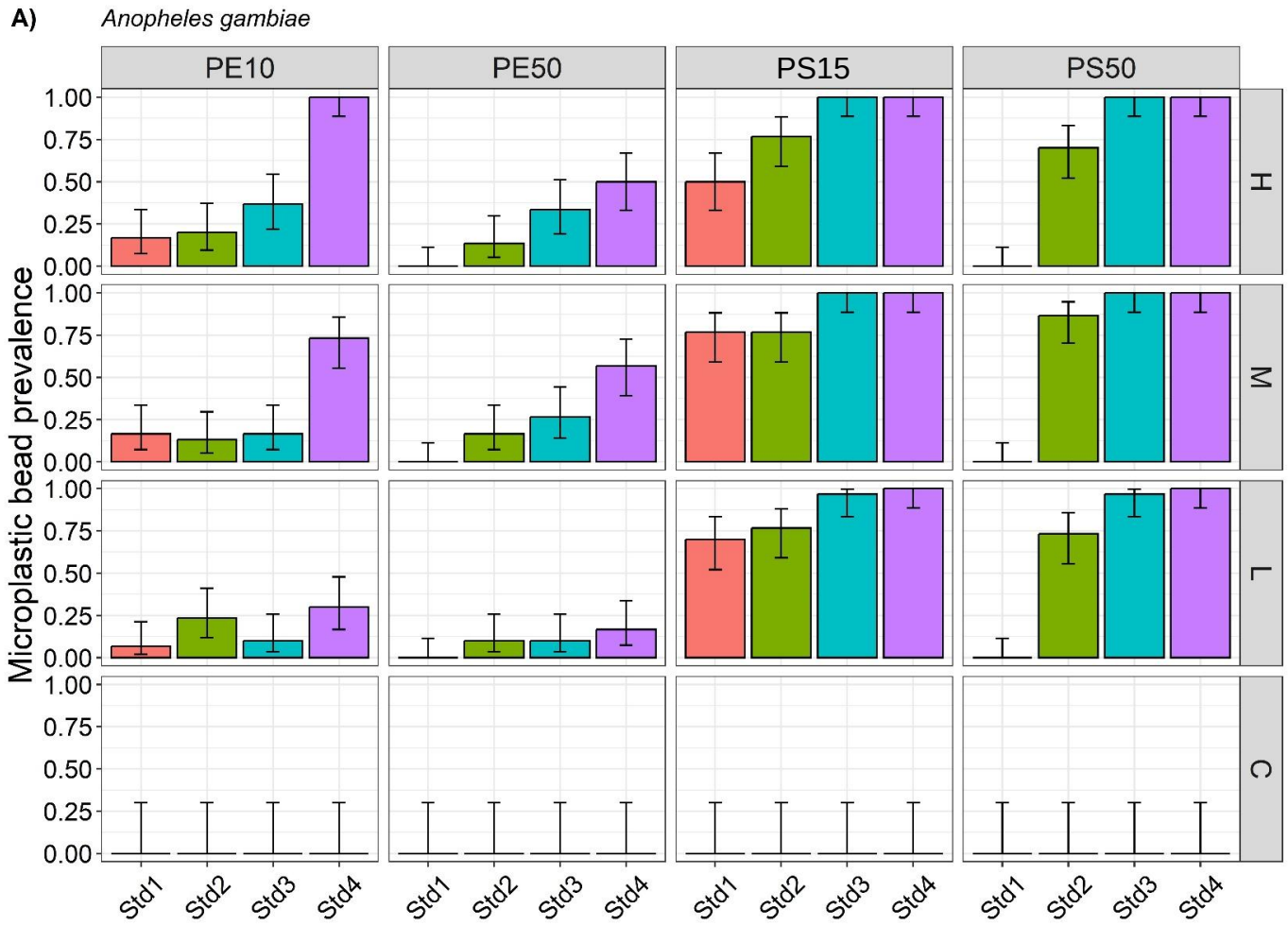

Figure 1: Microplastic bead prevalence, expressed as the proportion of larvae with a least one ingested bead, for each type of microplastic (PE10, PE50, PS10, PS50), concentration (H: high, M: medium, L: low, C: control) and larval stage (L1, L2, L3 and L4) of Anopheles gambiae.

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- **Lower prevalence for PE50 > PE10 > PS50 > PS15**

Results/ Discussion

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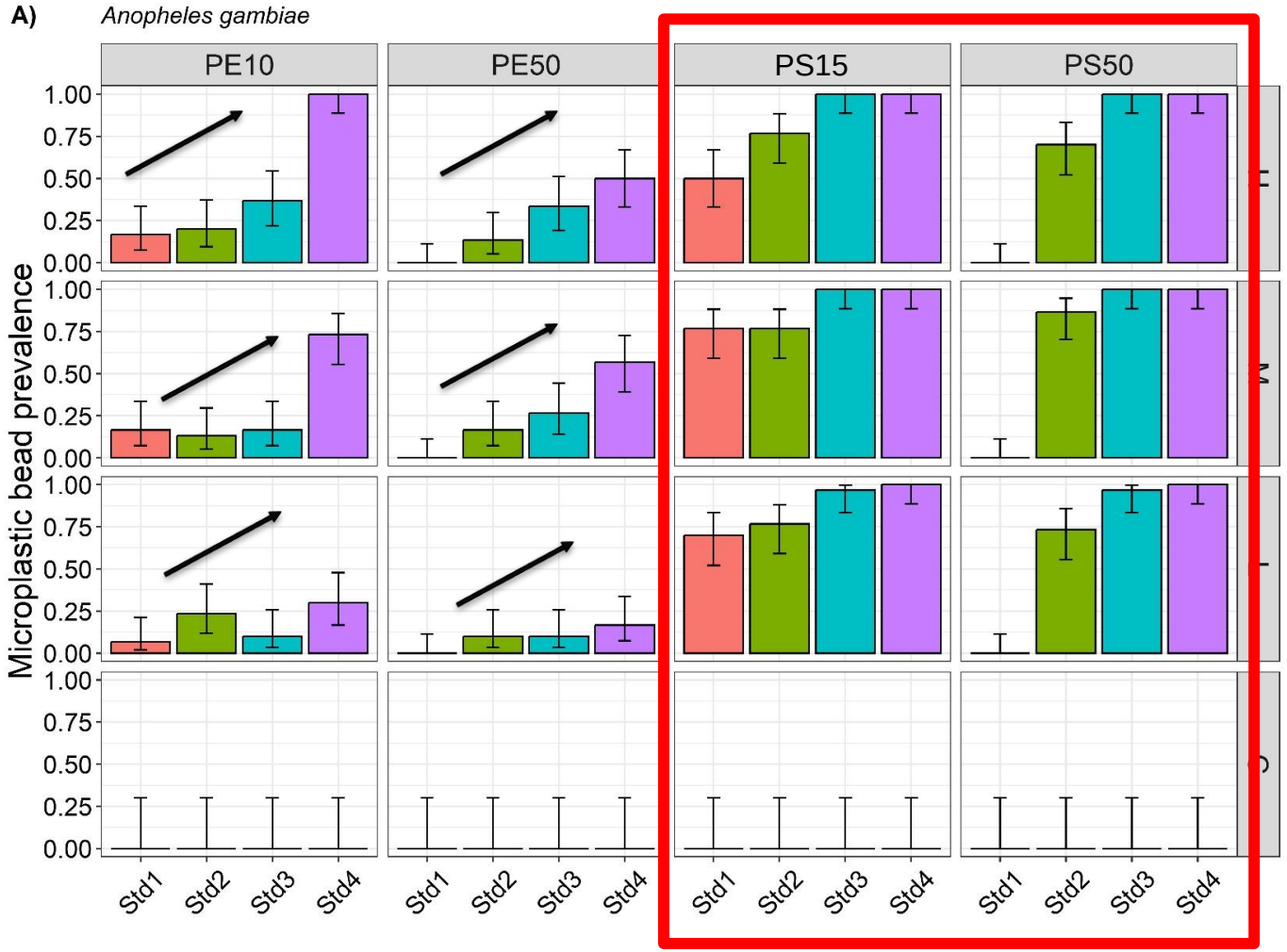

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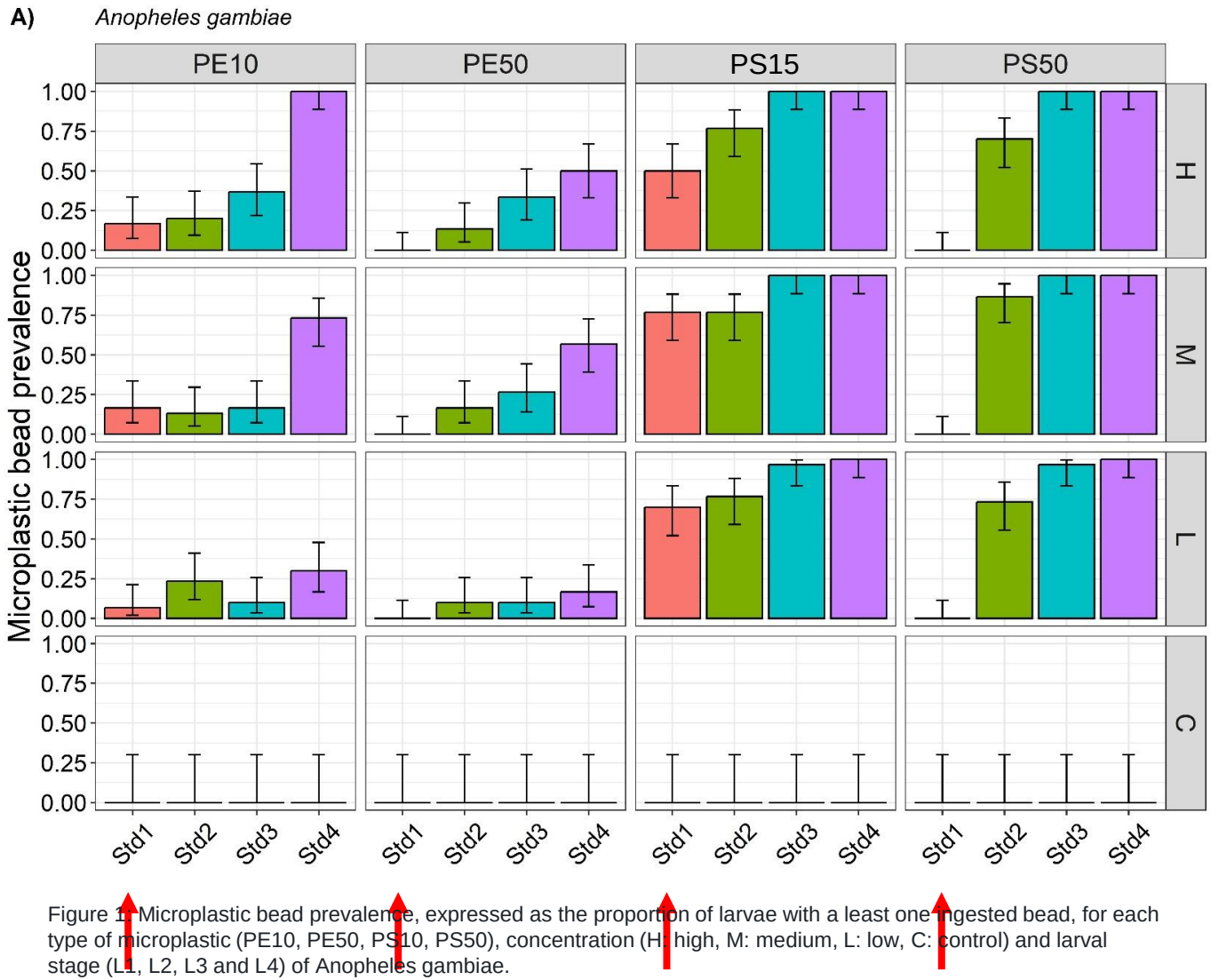

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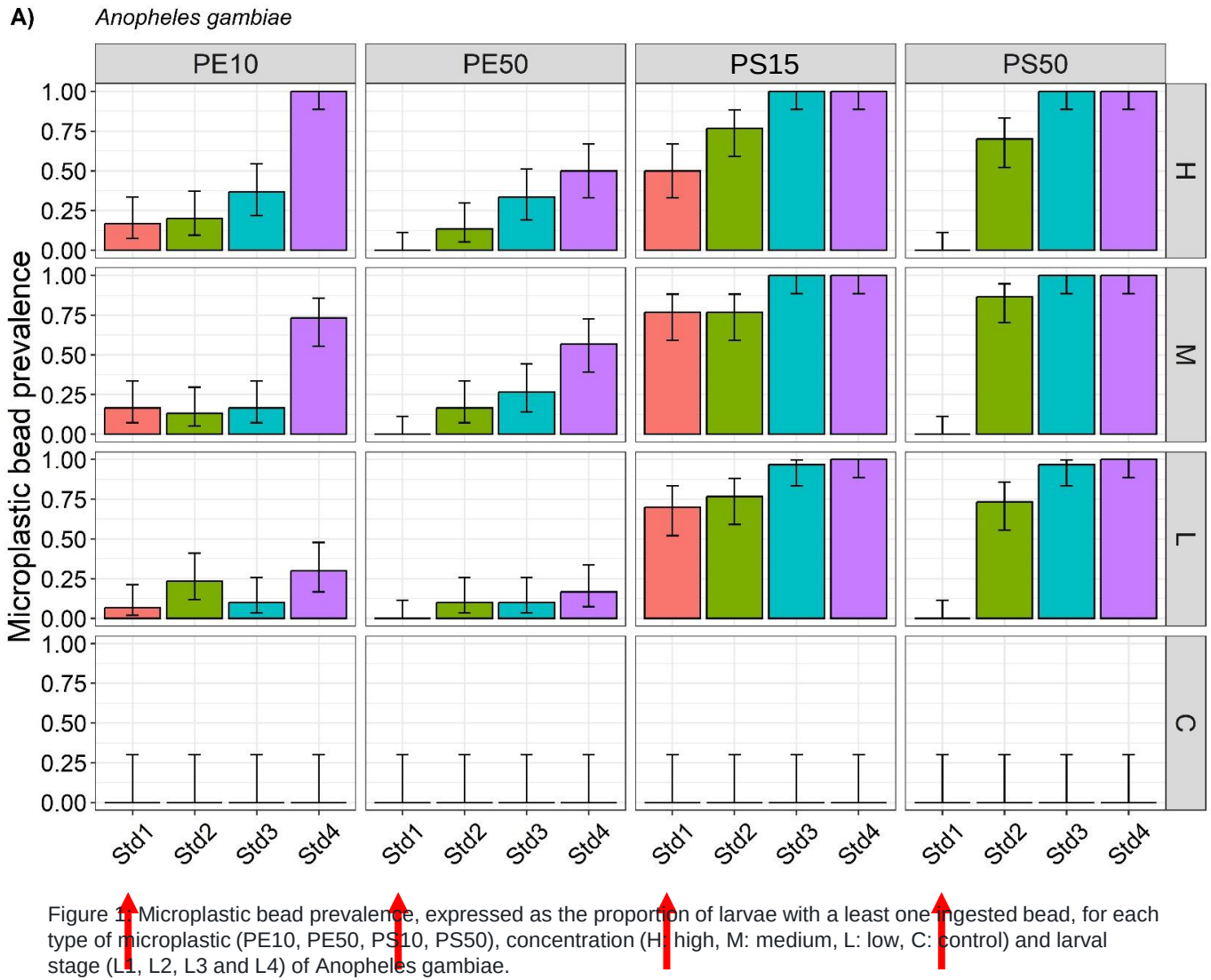

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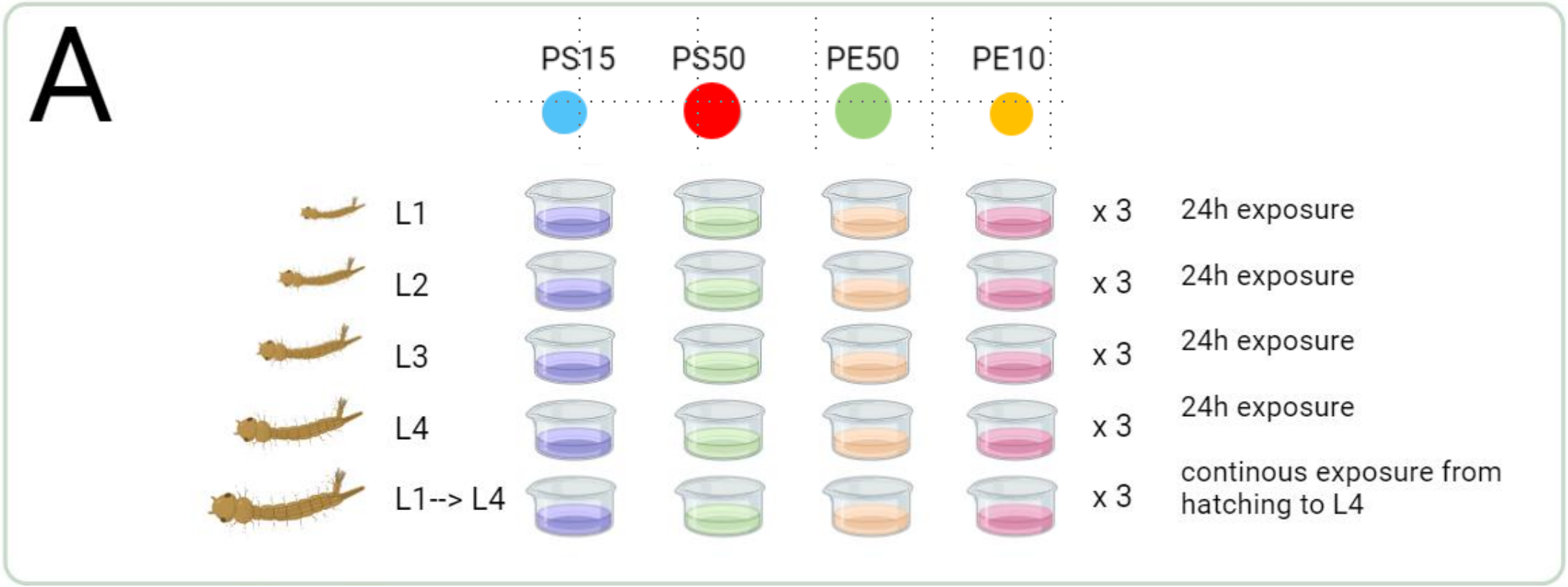
→ polystyrene was more likely to be ingested than polyethylene

→ same pattern of ingestion observed

Materials and Methods

Experiment 2: digestion

Biofragmentation of microplastics by mosquito larvae?



→ Microplastics exposed individually for 24 hours to each larval instar

→ Microplastics exposed for the entire duration of larval development (hatching → L4)

Materials and Methods

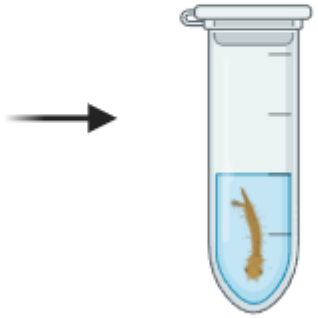
Experiment 2: digestion

Biofragmentation of microplastics by mosquito larvae?

B

Digestion

all larvae were washed twice



1mL H2O2 30%

digestion conditions: 72h, 50°C

→Larvae rinsed and digested in H2O2 to extract microplastics

Materials and Methods

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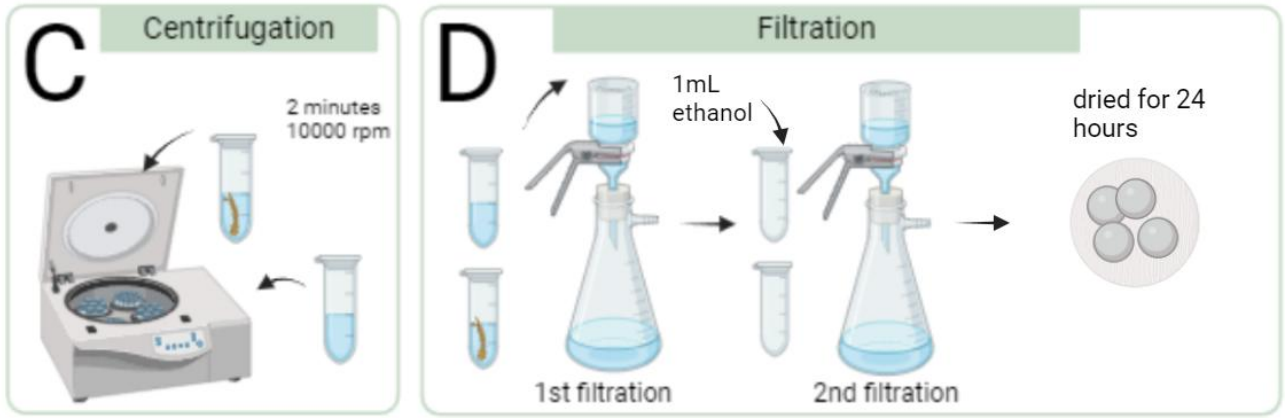
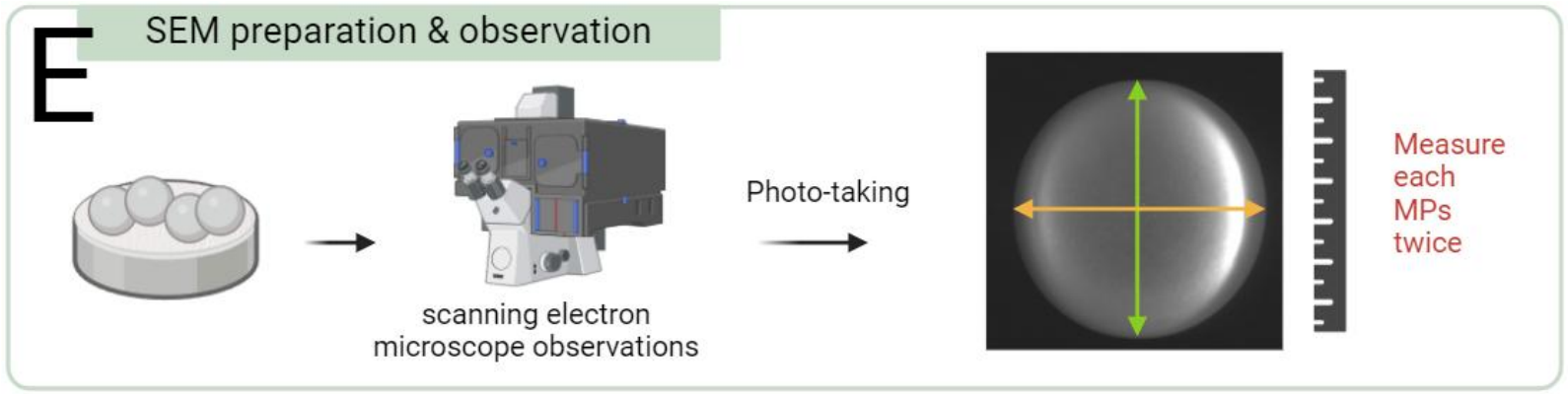


→ Centrifugation

→ Filtration



→Observations scanning electron microscope

→ Microplastics measurement

Results/ Discussion

Experiment 2: digestion

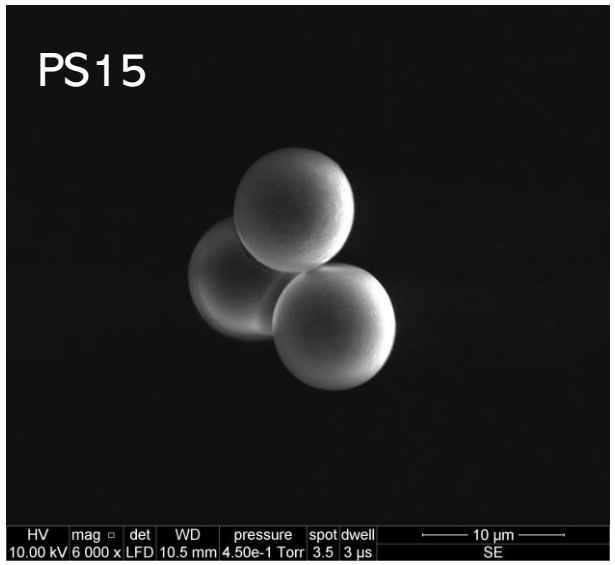
1. Chemical digestion :

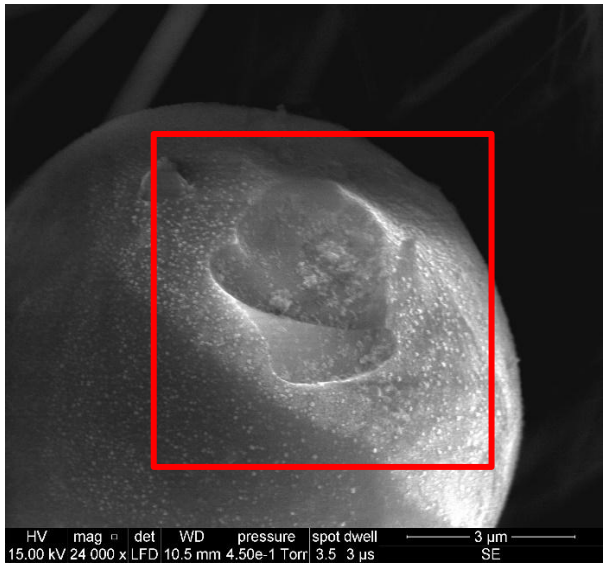
→ For both species: no size reduction observed

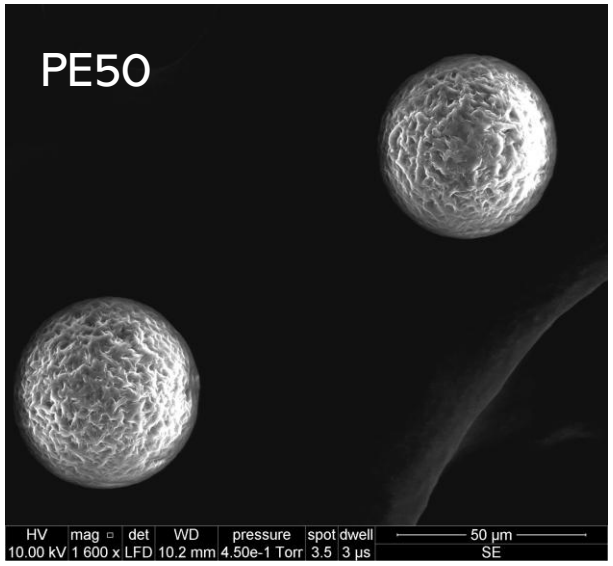
→ Chemical digestion has no effect on microplastics

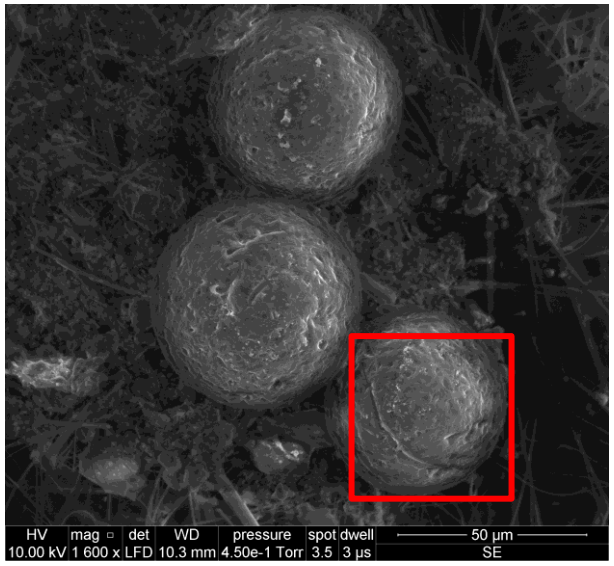
Results/ Discussion

Experiment 2: digestion









2. Mechanical digestion:

No fragments observed

Rare marks :
→ 2 observations out of 229 PE50
→ 1 observation out of 295 PS10

Difficult to attribute to larval action as no regular pattern observed.

Results/ Discussion

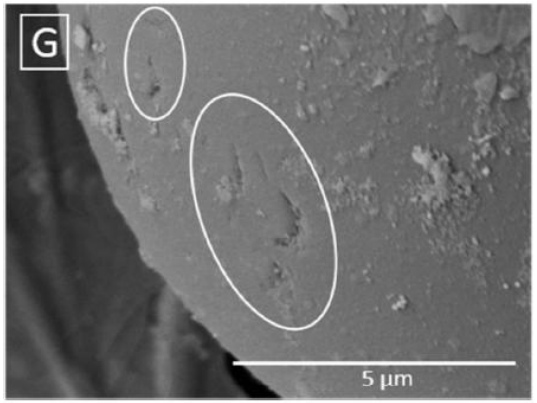
Experiment 2: digestion

What about other macroinvertebrates?

Krill, gammarids, daphnia and chironomids
→ breaking down microplastics into smaller particles
→ reduce their diameter

(Dawson et al., 2018)

Chironomids mark microplastics on the surface



(Queiroz *et al.*, 2024)

→ Mosquito larvae have the same chitinized mouthparts as the other macroinvertebrates mentioned.
→ Many similarities between their digestive enzymes

Surprising result ?

Estimate the transit time in the digestive tract

Thanks