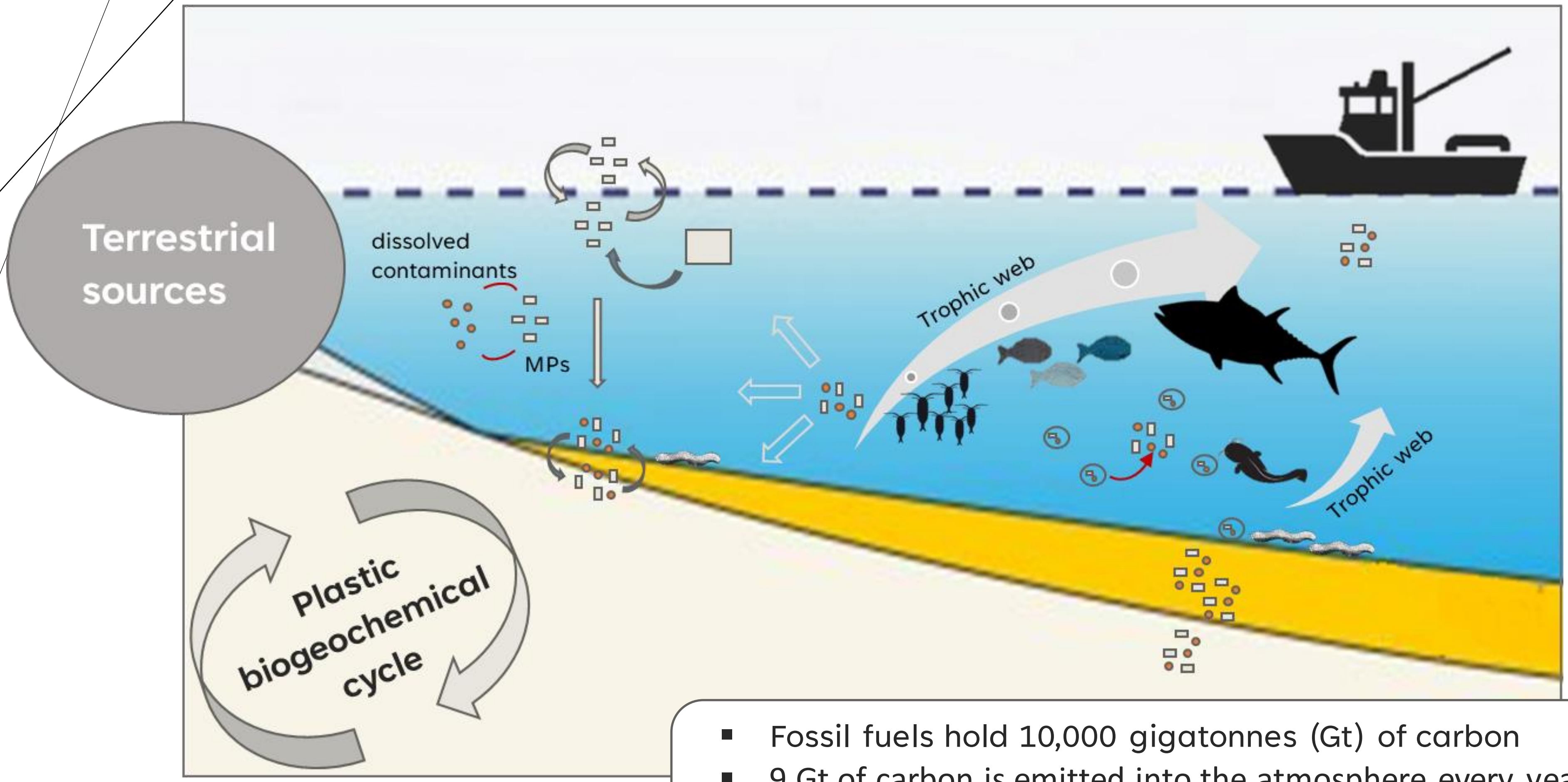
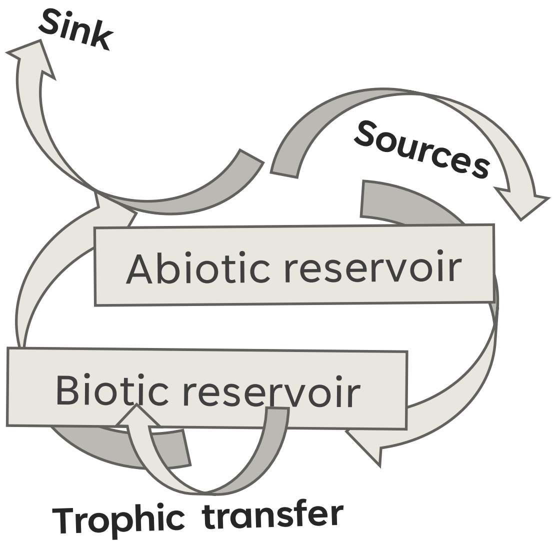
COPEPODS AS POTENTIAL MICROPLASTIC RESERVOIRS IN GLOBAL OCEANS: INTEGRATING EMPIRICAL DATA AND SYSTEMATIC REVIEW ANALYSIS.

Valentina Fagiano, Montserrat Compa, Carme Alomar, M.L. Fernández de Puelles and Salud Deudero

1. INTRODUCTION



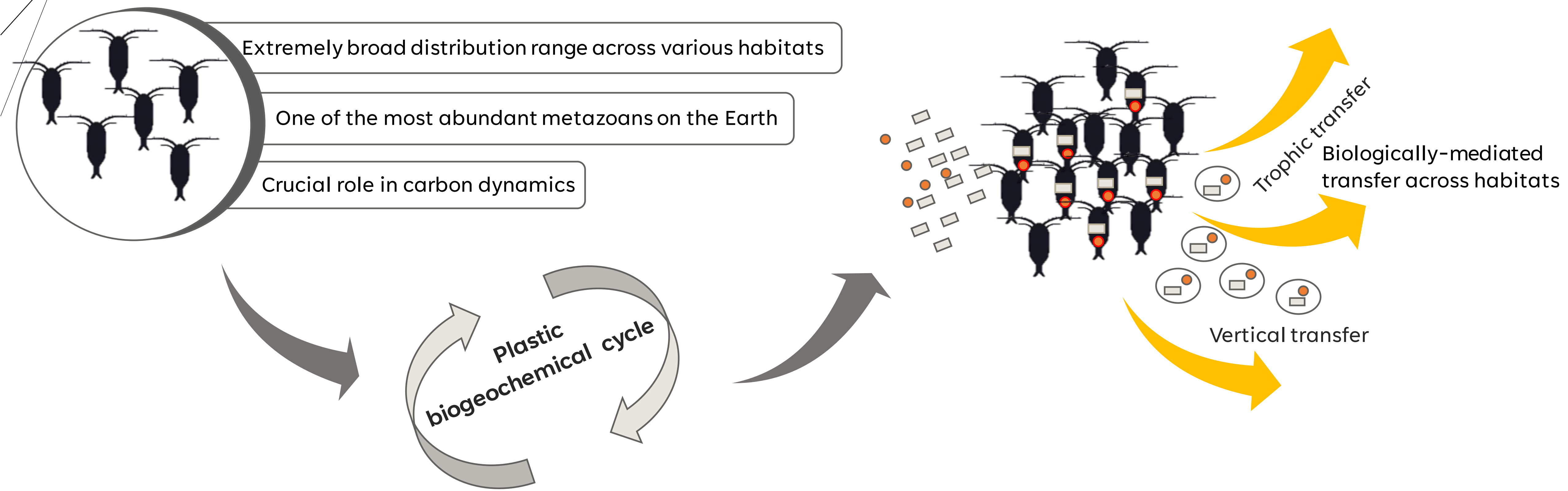


- Fossil fuels hold 10,000 gigatonnes (Gt) of carbon
- 9 Gt of carbon is emitted into the atmosphere every year
- 7 Gt of that fossil carbon is now in the form of plastic

(Zhu et al.2021 Front. Mar. Sci)

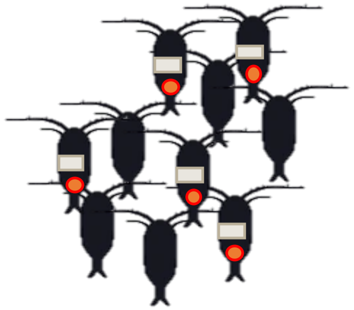
1. INTRODUCTION

Are Copepods good candidates as a microplastic reservoir within the plastic biogeochemical cycle?



Are Copepods good candidates as microplastic reservoir within the plastic biogeochemical cycle?

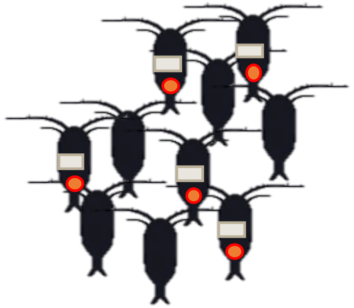
Experiments in laboratory-controlled conditions



Low microplastic ingestion and low frequencies of ingestion

1. INTRODUCTION

Are Copepods good candidates as microplastic reservoir within the plastic biogeochemical cycle?



Experiments in laboratory-controlled conditions

Low microplastic ingestion and low frequencies of ingestion

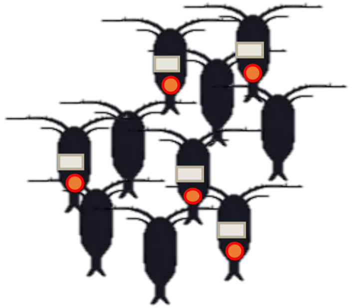
Studies under field conditions

Generally high retention values and percentages

1. INTRODUCTION

Are Copepods good candidates as microplastic reservoir within the plastic biogeochemical cycle?

Experiments in laboratory-controlled conditions



Studies under field conditions

Low microplastic ingestion and low frequencies of ingestion

High retention values and percentages

Hypothesis

Although marine copepods are at low risk of ingesting microplastics, their vast abundance in the marine environment potentially positions them as a significant biotic reservoir of microplastics within the 'biogeochemical' plastic cycle

2. EXPERIMENTAL STUDY - OBJECTIVES

EXPERIMENTAL STUDY

2. EXPERIMENTAL STUDY - OBJECTIVES

EXPERIMENTAL STUDY

To assess APs ingestion in *P. mediterranea*, and to evaluate its potential as a reservoir of APs within the Sea Surface Microlayer (SML)

Determine the abundance and population structure of this copepod specie in the study area

Evaluate the occurrence of ingestion and composition of the MPs ingested by *P. mediterranea*

Assess the number of MPs retained by this copepod per cubic meter

3. EXPERIMENTAL STUDY - MATERIAL AND METHODS

EXPERIMENTAL STUDY

Sampling

- **Horizontal tows (0-12 cm)**
- (Manta trawlHydro-Bios manta net; mesh size: 335 μm)

Abundance and characterization

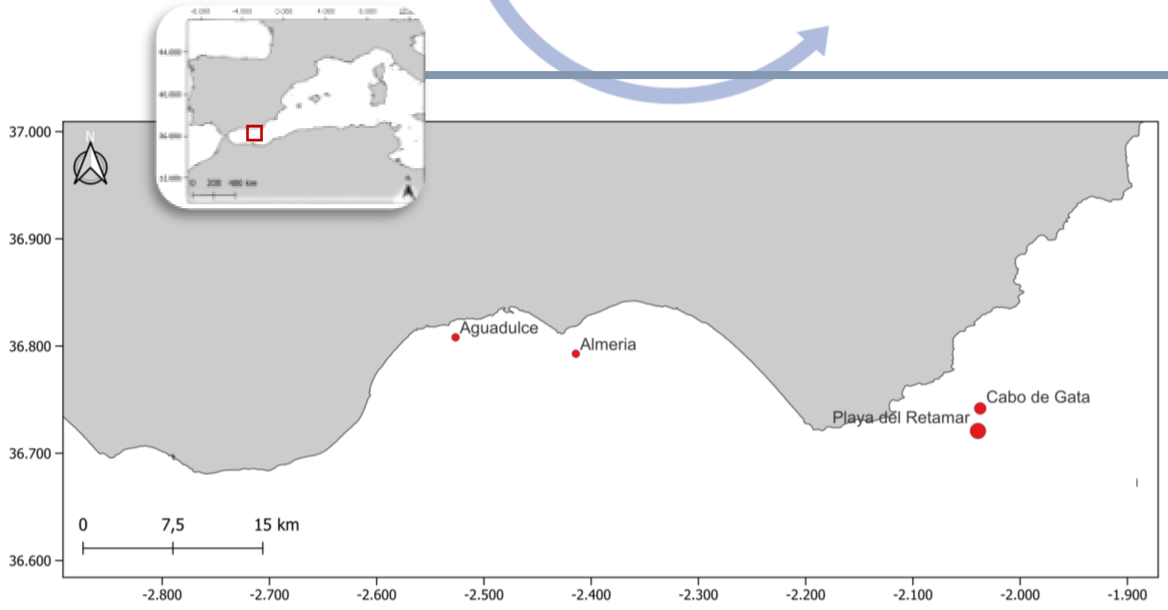
- Copepods abundance (ind/m^3)
- Proportion of adults to copepodites

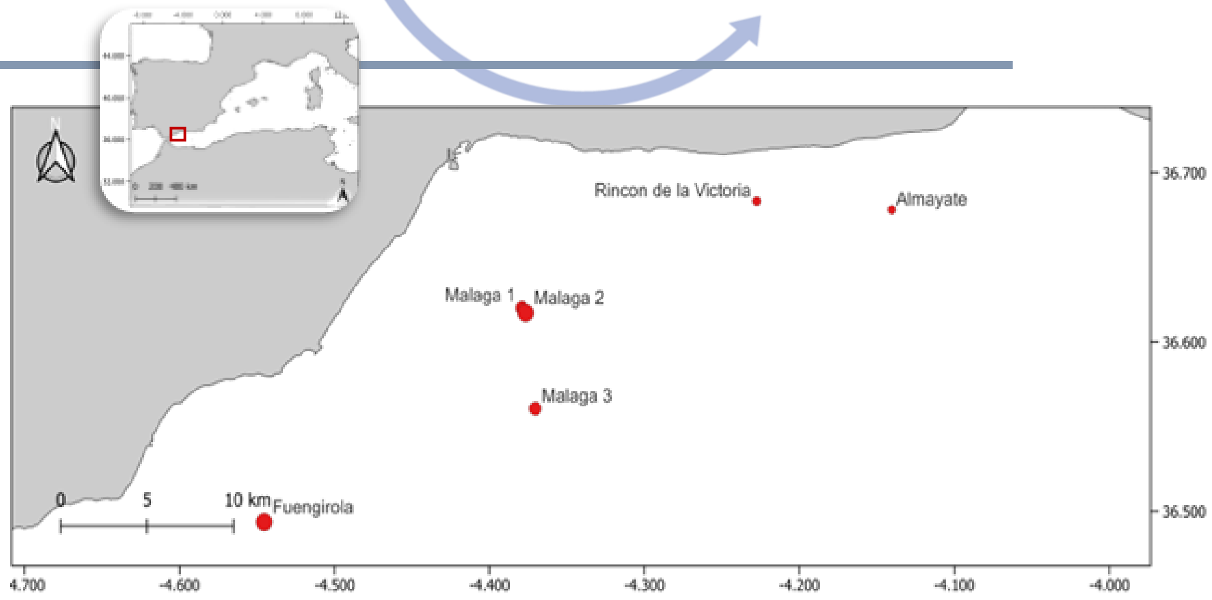
MPs ingestion

- Sampling effort: 2793 individuals (2400 adults - 393 copepodites).
- Sampling effort per sampling site: 80 ≥ - ≤320.
- Enzymatic digestion of 20 individuals per batch.

MPs retention

- The number of retained MPs for m^3 (MPs/m^3) was calculated multiplying the mean ingestion (MPs/ind) by the abundance of copepods (ind/m^3) found at each sampling site.





EXPERIMENTAL STUDY

ABUNDANCE OF *Pontella mediterranea* IN THE ALBORAN SEA

Abundance: ↑ 1174.83 ↓ 41.67 ind/m^3
mean: 358.23 ind/ m^3

Proportion of adults to copepodites : 75:25

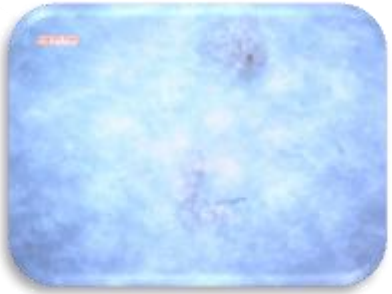
INGESTION AND RETENTION OF MICROPLASTICS

Microplastic ingestion: ↑ 0.19 ↓ 0.05 MPs/m^3
mean: 0.11 ± **0.05** MPs/ m^3

Not influenced by copepod abundance (lm, p>0.05)

Microplastic retention: ↑ 220.28 ↓ 3.69 MPs/m^3
mean: 45.15 ± **65.54** MPs/m^3

influenced by copepod abundance (lm, p<0.05)



Contents lists available at ScienceDirect
Science of the Total Environment
journal homepage: www.elsevier.com/locate/scitotenv
ELSEVIER

First assessment of anthropogenic particle ingestion in Pontellid copepods: *Pontella mediterranea* as a potential microplastic reservoir in the Neuston

V. Fagiano*, C. Alomar, A. Ventero, M.L. Fernández de Puelles, M. Iglesias, S. Deudero

5. SYSTEMATIC REVIEW ANALYSIS OF EXPERIMENTAL STUDIES - OBJECTIVES

SYSTEMATIC REVIEW

To assess the ecological role of copepods in microplastic pollution and to explore their potential as a reservoir within the biogeochemical cycle of plastics.

To evaluate the current knowledge of microplastic ingestion and retention in copepods under field conditions through a systematic review

To assess the variability in microplastic ingestion by copepods across different studies, taxonomic aggregation levels, and habitats through a meta-analysis

To explore the potential role of copepods as a reservoir of microplastics in the marine environment through a semi-quantitative analysis of microplastic retention

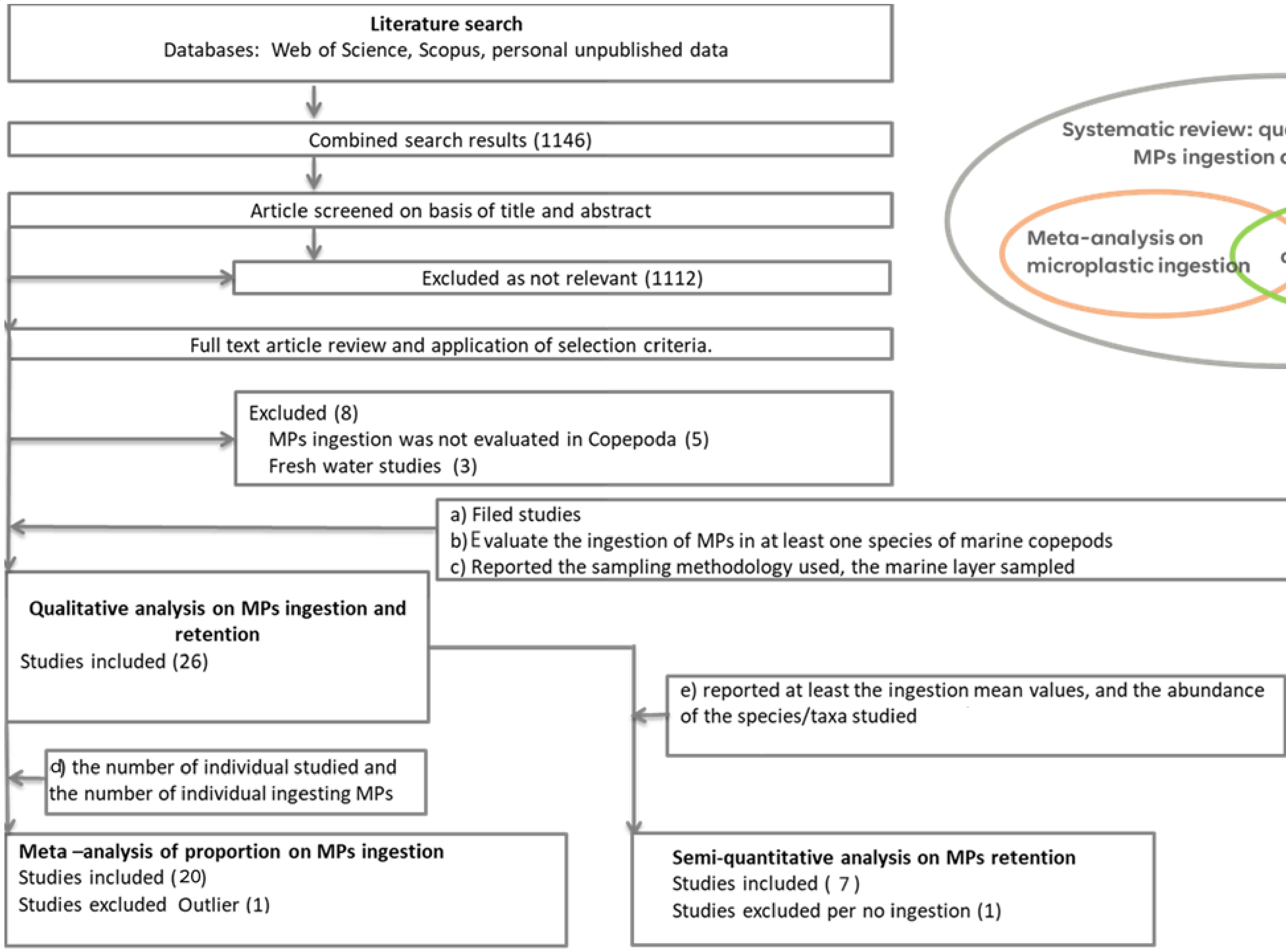
To examine, from an ecological perspective, the consequences of the interaction between microplastics and copepods in the marine environment

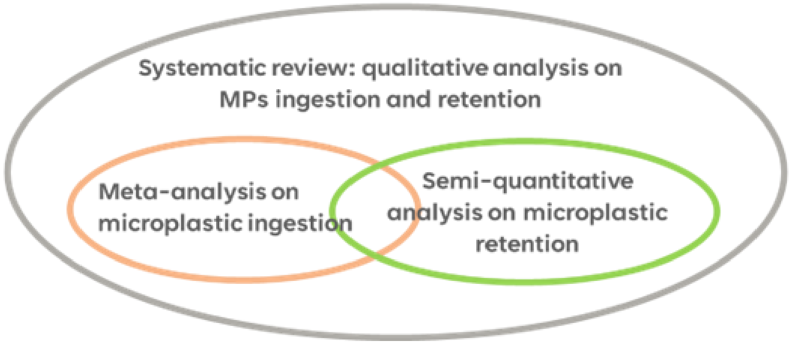
To provide a framework for data analysis and reporting on microplastic pollution and copepods.

SYSTEMATIC REVIEW

5. SYSTEMATIC REVIEW ANALYSIS OF EXPERIMENTAL STUDY – WORKFLOW

((microplastic* OR anthropogenic AND particle * OR fiber*) AND (zooplankton OR copepod*))





Study: Each manuscript, identified by its author and the year of publication.

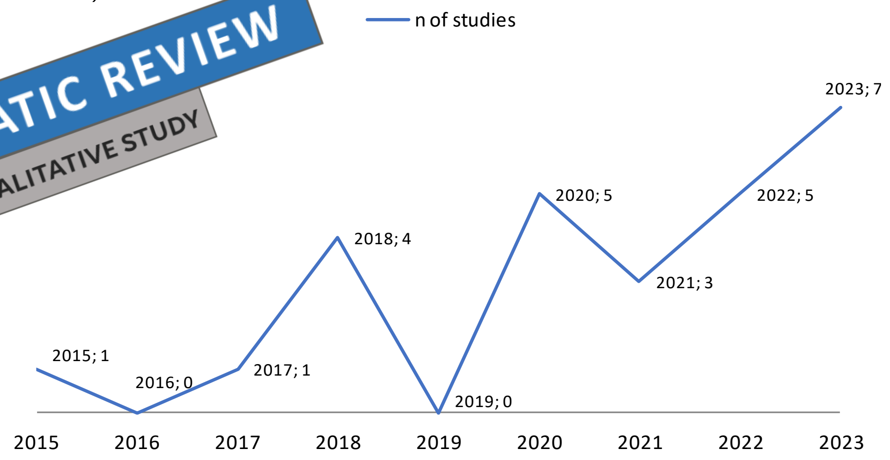
Observation: Data related to each taxa included in a Study

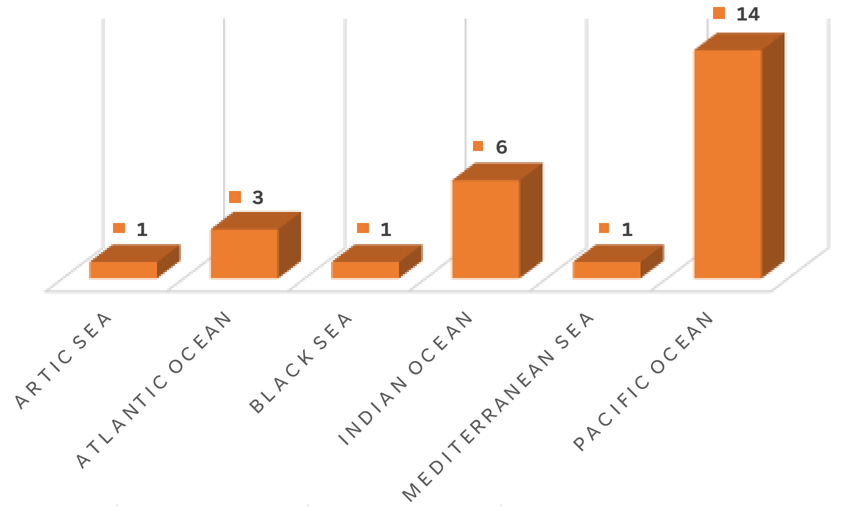
(Fagiano et al., 2024 under review)

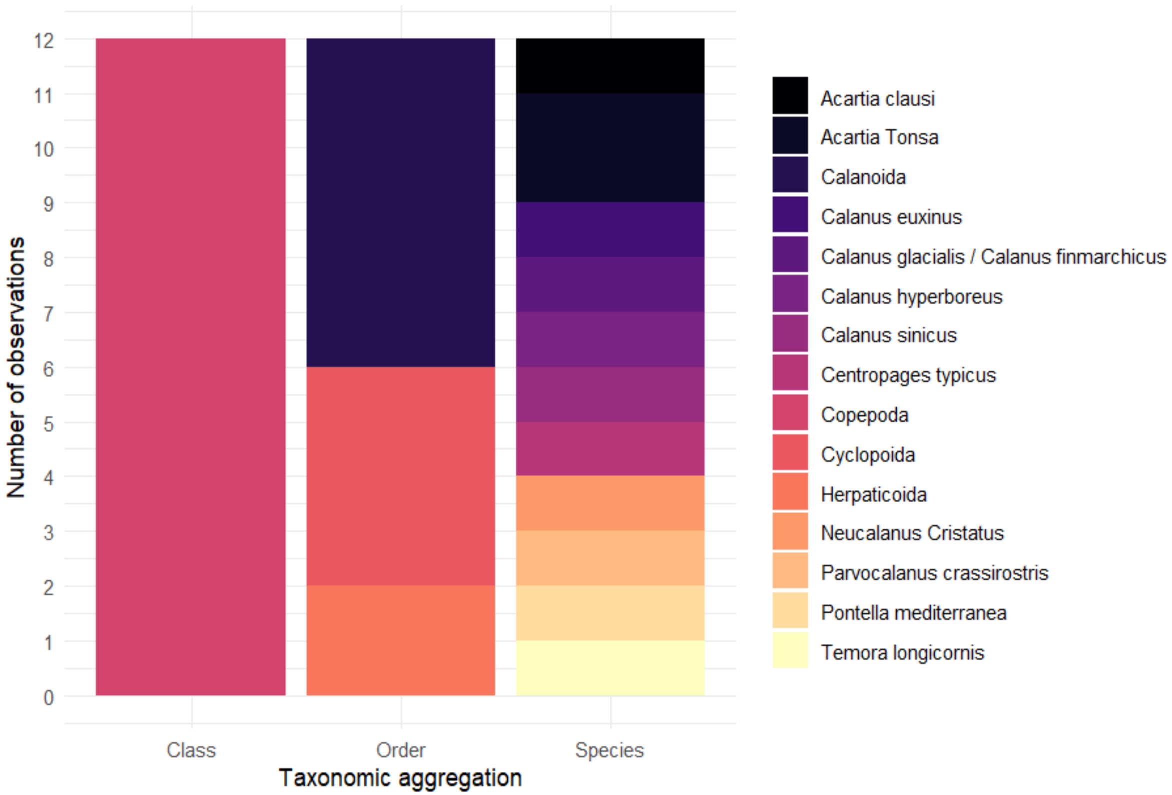
6. QUALITATIVE ANALYSIS – SUMMARY

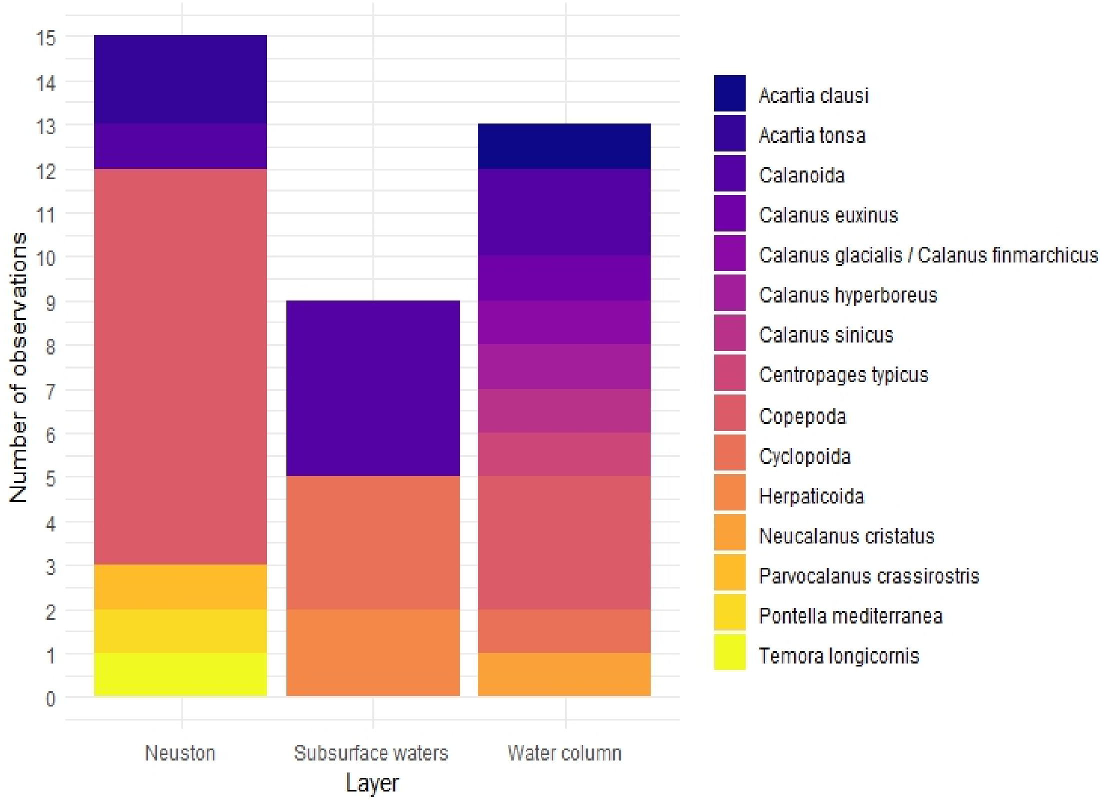
SYSTEMATIC REVIEW

QUALITATIVE STUDY









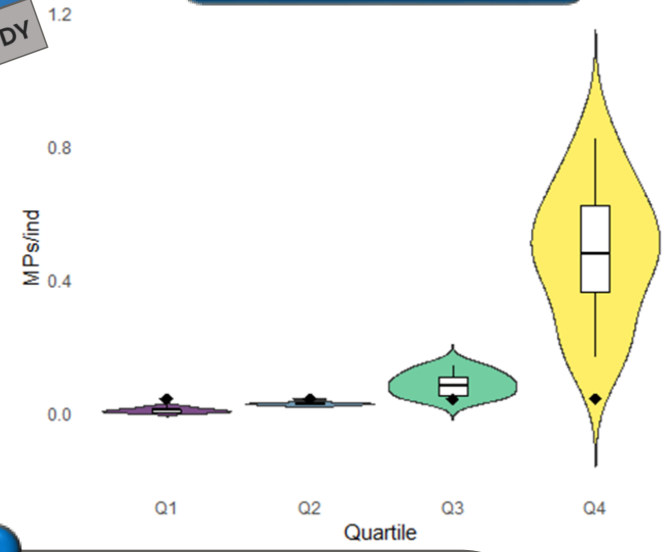
7. QUALITATIVE ANALYSIS: MICROPLASTIC INGESTION

SYSTEMATIC REVIEW

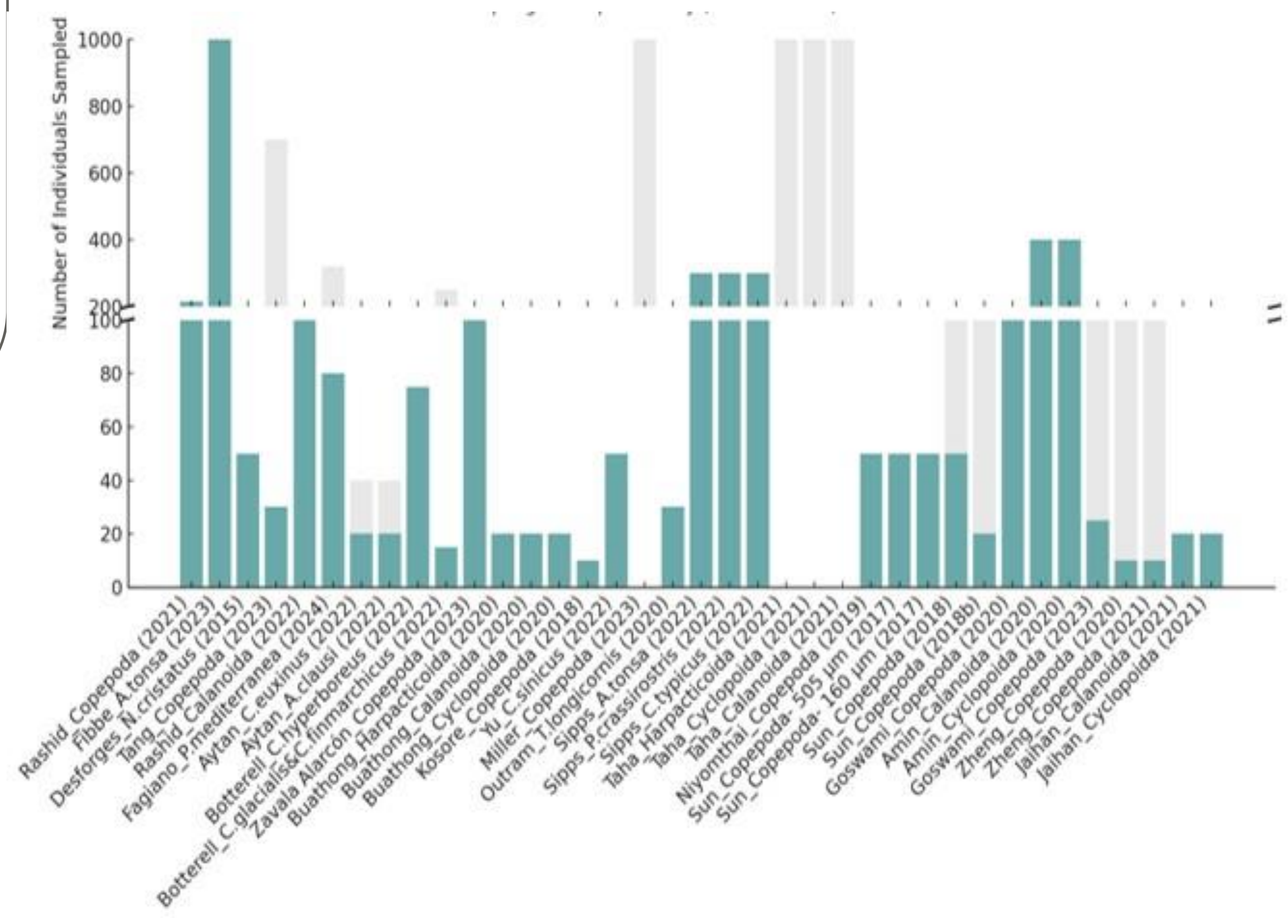
QUALITATIVE STUDY

Mean ingestion values: from 0.00 to 0.82 MPs/ind
median: 0.04 MPs/ind

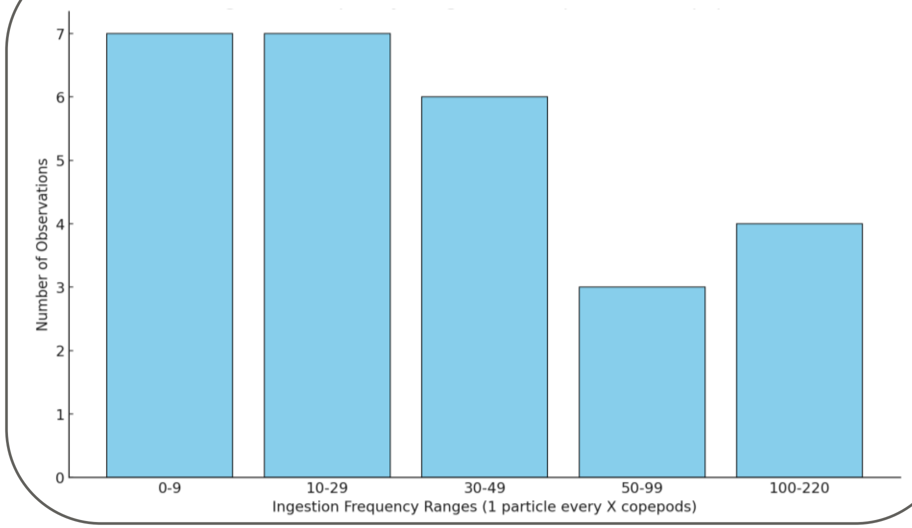
Mean values distribution



Sampling effort



Frequencies of ingestion

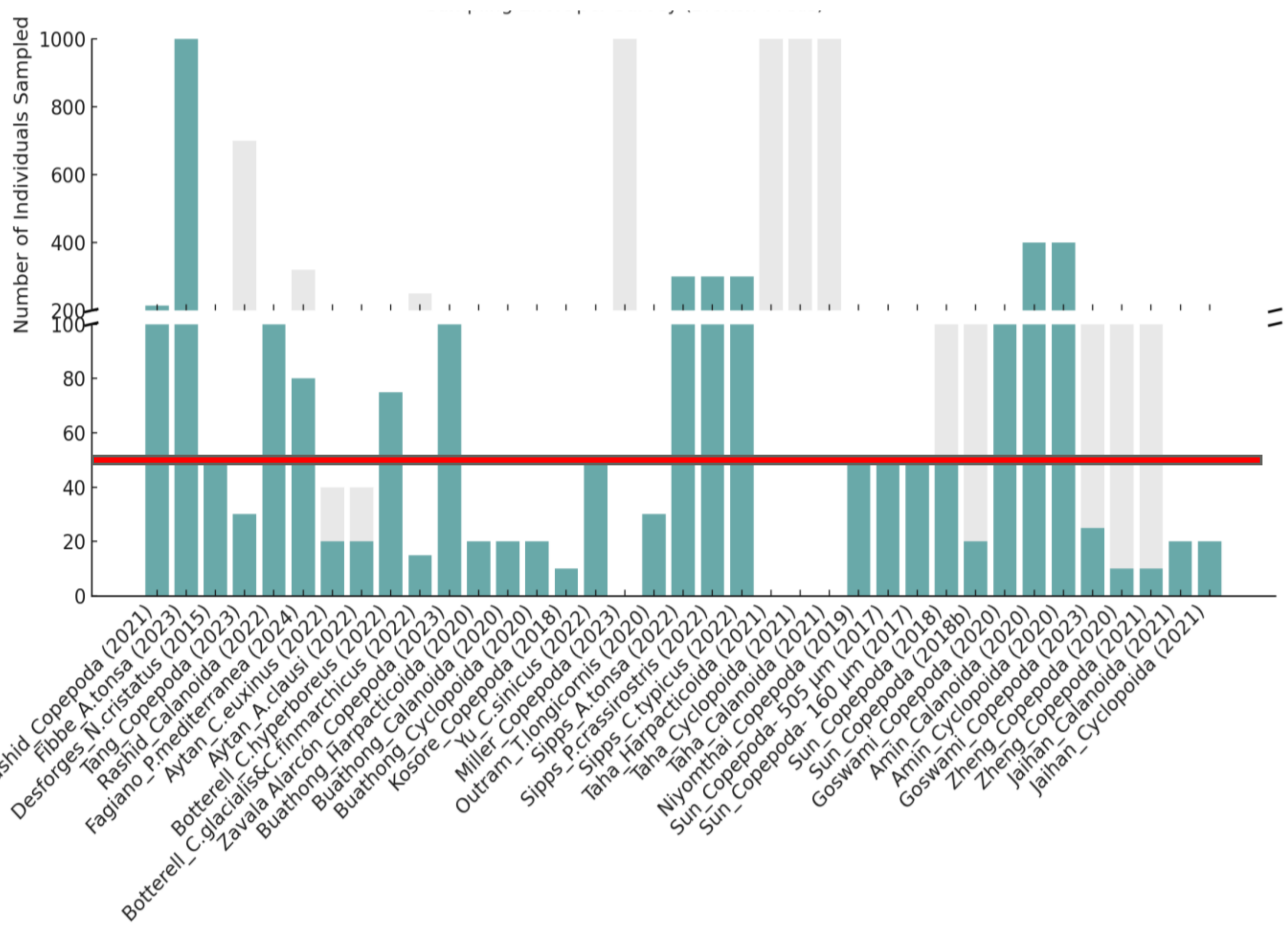


7. QUALITATIVE ANALYSIS: MICROPLASTIC INGESTION

SYSTEMATIC REVIEW

QUALITATIVE STUDY

Sampling effort

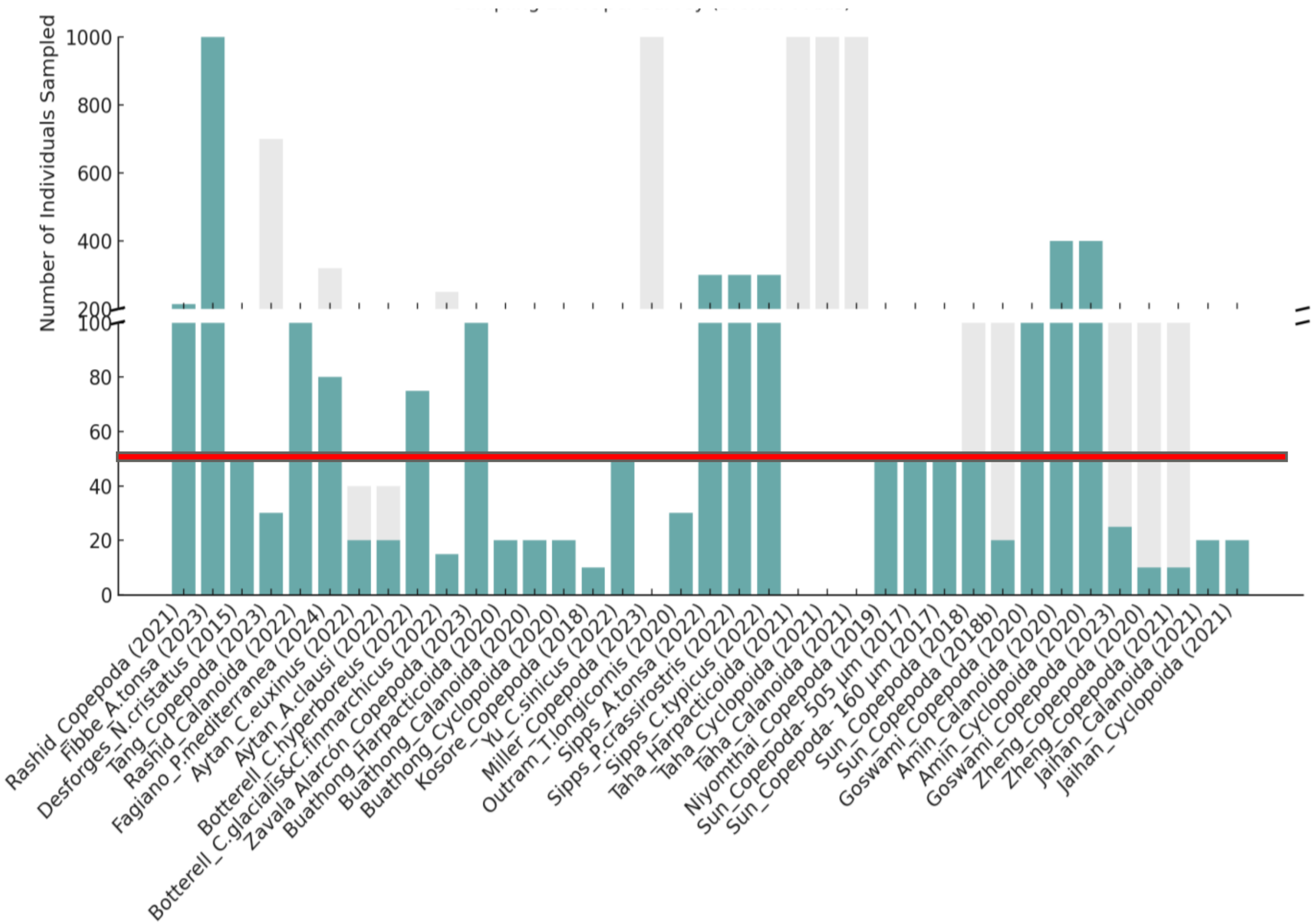


7. QUALITATIVE ANALYSIS: MICROPLASTIC INGESTION

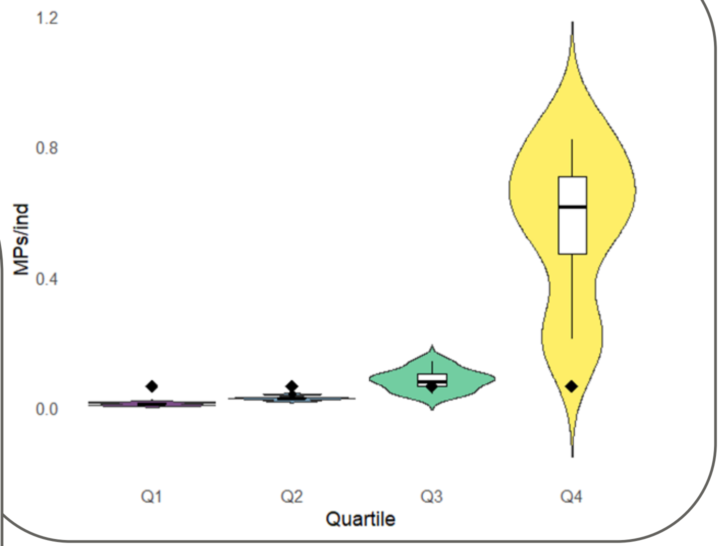
SYSTEMATIC REVIEW

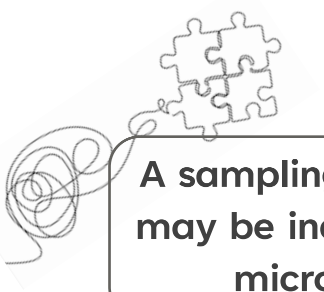
QUALITATIVE STUDY

Sampling effort



Mean values distribution





A sampling effort smaller than 50 individuals may be inadequate for accurately estimating microplastic ingestion in copepods

8. META-ANALYSIS - RESULTS

SYSTEMATIC REVIEW

META-ANALYSIS

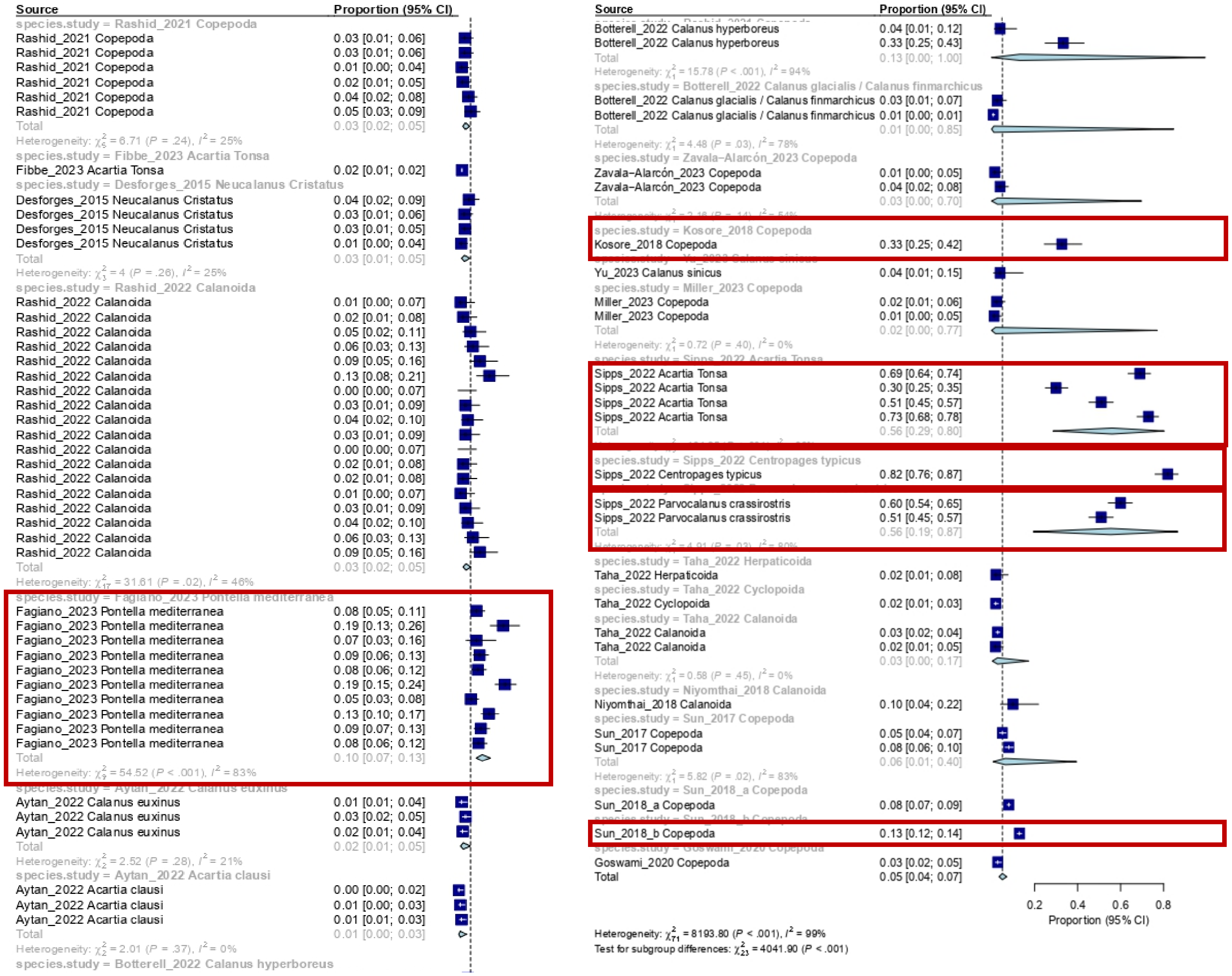
8. META-ANALYSIS - RESULTS

SYSTEMATIC REVIEW

META-ANALYSIS

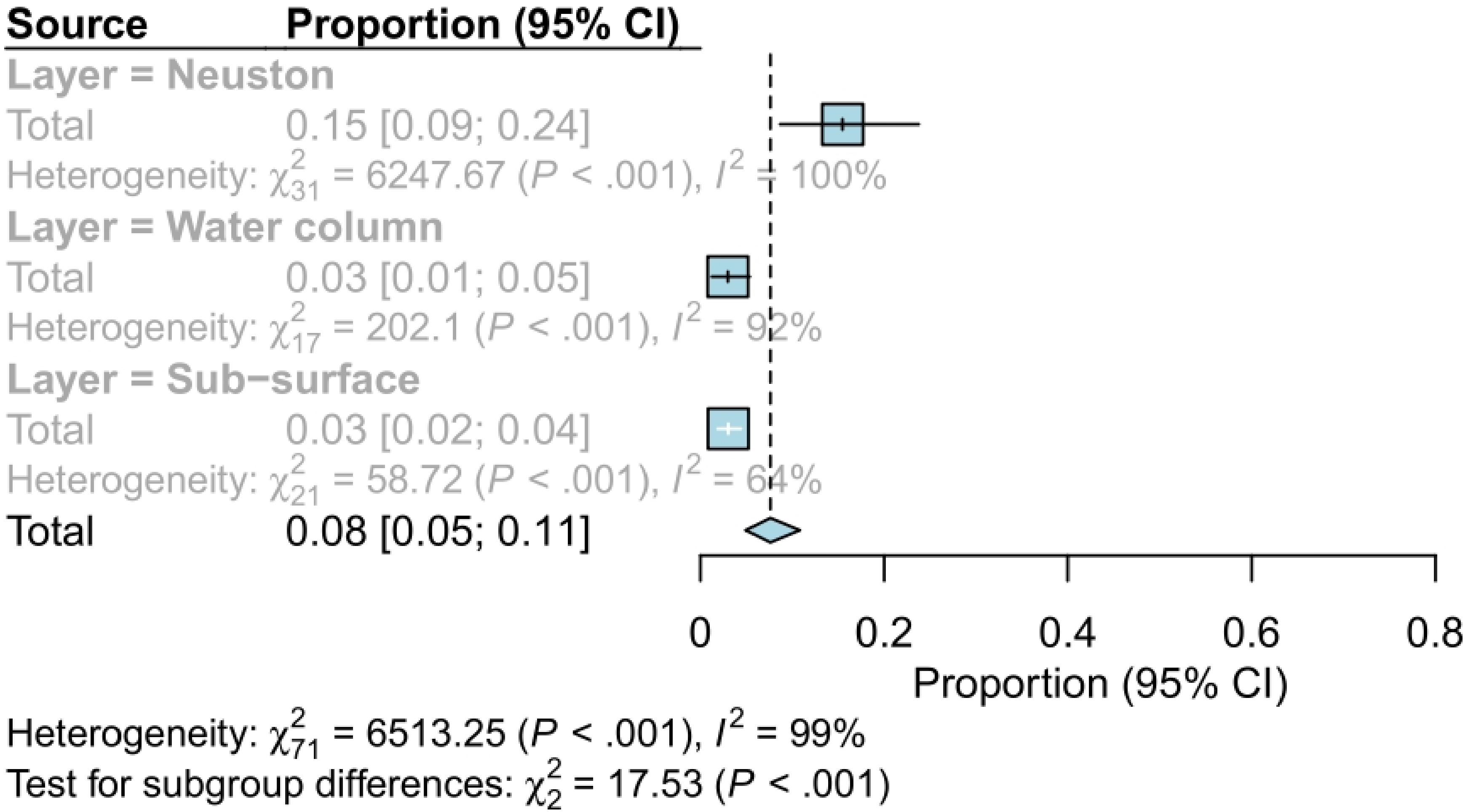
Combined estimate proportion: 0.0501 (0.0351 – 0.0711)

(I² 99.1%, tau² 2.2899, tau 1.5132, H 10.74)



8. META-ANALYSIS – RESULTS

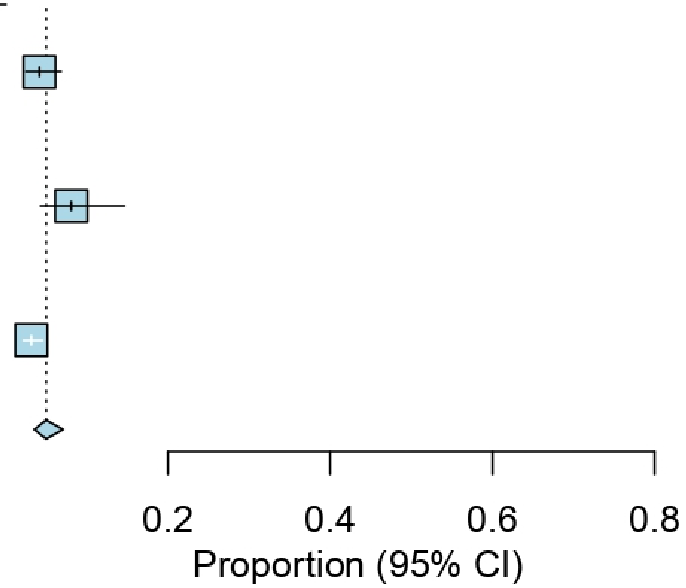
SYSTEMATIC REVIEW
META-ANALYSIS



8. META-ANALYSIS – RESULTS

SYSTEMATIC REVIEW
META-ANALYSIS

Source	Proportion (95% CI)
Level_classification = Class	
Total	0.04 [0.03; 0.07]
Heterogeneity: $\chi^2_{15} = 262.9$ ($P < .001$), $I^2 = 94\%$	
Level_classification = Species	
Total	0.08 [0.04; 0.15]
Heterogeneity: $\chi^2_{32} = 7438.34$ ($P < .001$), $I^2 = 100\%$	
Level_classification = Order	
Total	0.03 [0.02; 0.05]
Heterogeneity: $\chi^2_{22} = 61.3$ ($P < .001$), $I^2 = 64\%$	
Total	0.05 [0.04; 0.07]



Heterogeneity: $\chi^2_{71} = 8193.80$ ($P < .001$), $I^2 = 99\%$
Test for subgroup differences: $\chi^2_{2} = 6.99$ ($P = .03$)

9. QUALITATIVE ANALYSIS: MICROPLASTIC RETENTION

SYSTEMATIC REVIEW

QUALITATIVE STUDY

Mean retention values: from 0.4 to 2775 MPs/m^3
median: 8.7 MPs/ind

MICROPLASTIC ENCOUNTER RATES

Copepods (5%) → Chaetognaths (15%) → Jellyfish (34%) → Shrimps (49%) → Fish larvae (120%)

MICROPLASTIC RETENTION

Jellyfish (0.12) → Fish larvae (0.29) → Chaetognaths (0.67) → Shrimps (0.81) → Copepods (2.19) (54%)

Mesh size 160 μm

Encounter rates in copepods: 8%

Microplastic retention: 103.49 (MPs/m^3) or 79%

(Elaboration based on data published by Sun et al., Mar Pollut Bull 2017)

MICROPLASTIC INGESTION

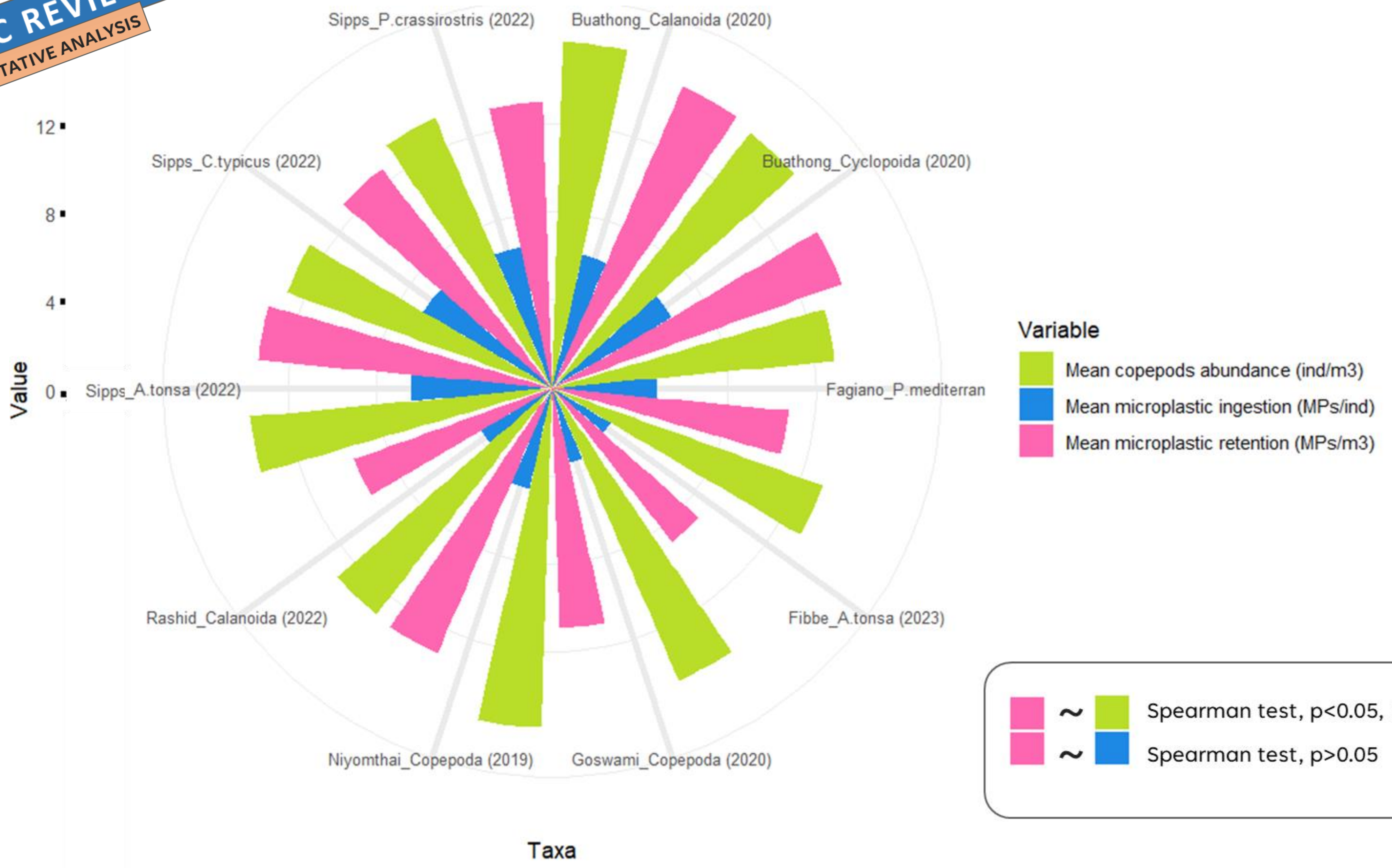
Copepods → • • •

MICROPLASTIC RETENTION

• • • → Copepods

10. SEMIQUANTITATIVE ANALYSIS: MICROPLASTIC RETENTION

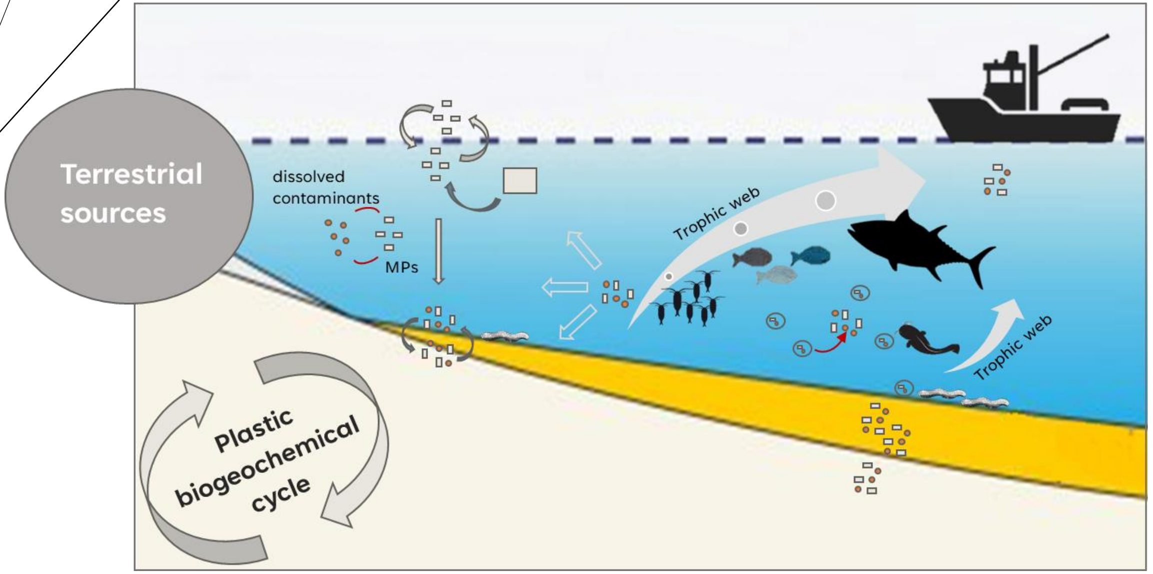
SYSTEMATIC REVIEW
SEMI QUANTITATIVE ANALYSIS



~ Spearman test, $p<0.05$, $R= 0.72$

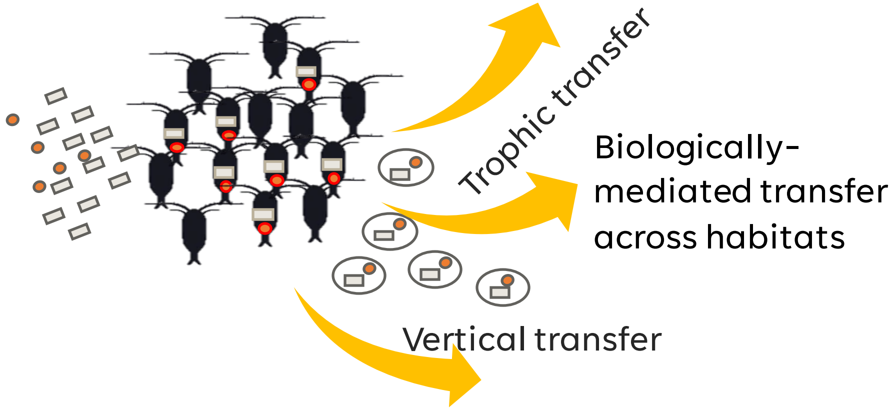
~ Spearman test, $p>0.05$

11. CONCLUSION



From an ecological perspective

Copepods could represent an extent and transferable biotic revoir of microplastics along with Oceans



From a methodological perspective

Abundance and retention are key permeameters to evaluate the interaction between copepods and MPs under field conditions

Retention is correlated to abundance

A sampling effort of more than 100 individuals per survey could be considered prudent to evaluate microplastic retention in copepods.

The size fraction of the copepod community and the bathymetric distribution of the taxa studied, relative to the sampled layer, could affect the assessment of microplastics retained by different copepod taxa and communities.

Thanks


S. Deudero


C. Alomar


M. Compa


M.L. Fernández de Puelles

CSIC
Superior de Investigaciones Científicas

ICES-PICES 7th International New Horizons Zooplankton Production Symposium

MINISTERIO
DE CIENCIA, INNOVACIÓN
Y UNIVERSIDADES

GOIB
CONSELLERIA
FONS EUROPEUS,
UNIVERSITAT I CULTURA

UIB Universitat de les Illes Balears
Càtedra de la Mar Iberostar Foundation
IBEROSTAR FOUNDATION

Impact@sea plastics

S. Deudero
C. Alomar
B. Rios-Fuster
I. Bernal
E. Cajellas
N. Sánchez


M. Iglesias


A. Ventero


R. Santiago


M. Gaza