The waste in our waste:
Microplastics contaminate organic wastes destined for land application in Aotearoa

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Supervised by

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University of Canterbury

Dr Olga Pantos

The Institute of Environmental Science and Research, ESR

ESR Science for Communities

AIM² Aotearoa Impacts & Mitigation of Microplastics

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Land Remediation
Power Generation
Biogas
Digesters
Odour Control
Your Home
Biosolids Drying Machine
Trickling Filters
Sedimentation Tanks
Aeration Tanks
Grit Removal
Screens
Clarifiers
Pump Stations
Oxidation Ponds
Ocean Outfall

How many microplastics are released per day?

How many microplastics are released per day?

- Christchurch WWTP: **230 million particles**
- Kaiapoi WWTP: **8.6 million particles**
- Lyttelton WWTP: **1.5 million particles**
- Governors Bay WWTP: **344,000 particles**

NEW ZEALAND JOURNAL OF MARINE AND FRESHWATER RESEARCH
https://doi.org/10.1080/00288330.2021.1988647

Taylor & Francis
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Wastewater treatment plant effluents in New Zealand are a significant source of microplastics to the environment

Helena Ruffell [a], Olga Pantos [b], Grant Northcott [c] and Sally Gaw [a]

[a]School of Physical and Chemical Sciences, University of Canterbury, Christchurch, New Zealand; [b]Institute of Environmental Science and Research, Christchurch, New Zealand; [c]Northcott Research Consultants Ltd, Hamilton, New Zealand


CMC SF 300


Municipal biowaste from WWTPs

Biosolids

- Treated sludge
- Dry or low water content
- Final stage before disposal/reuse

Effluent-irrigated soil

- Treated effluent
- Reference site included
- Irrigated continuously

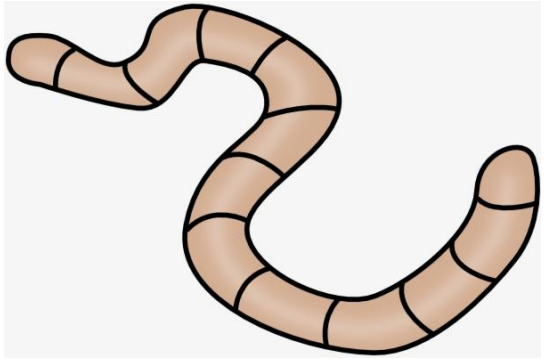
Composts

Bulk compost

- Commercial facilities or community initiatives
- Has food scraps

Bagged compost

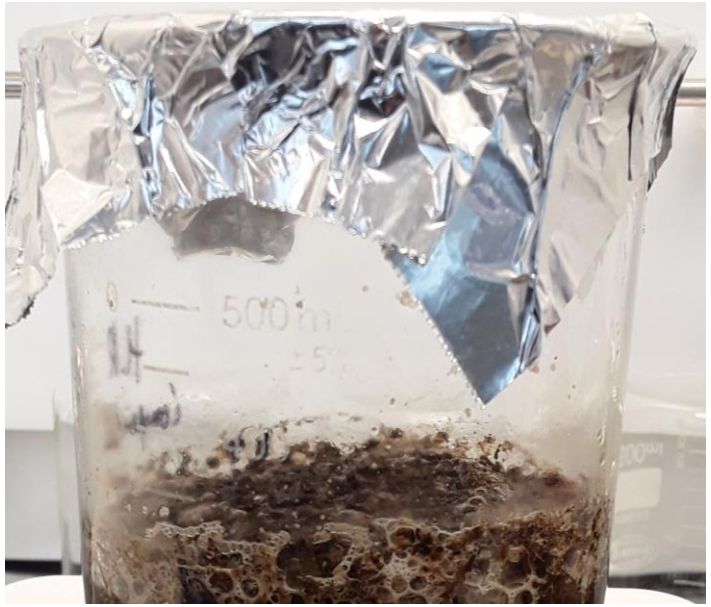
- Mainly woodchip, manure, green waste
- Available to purchase from garden centres

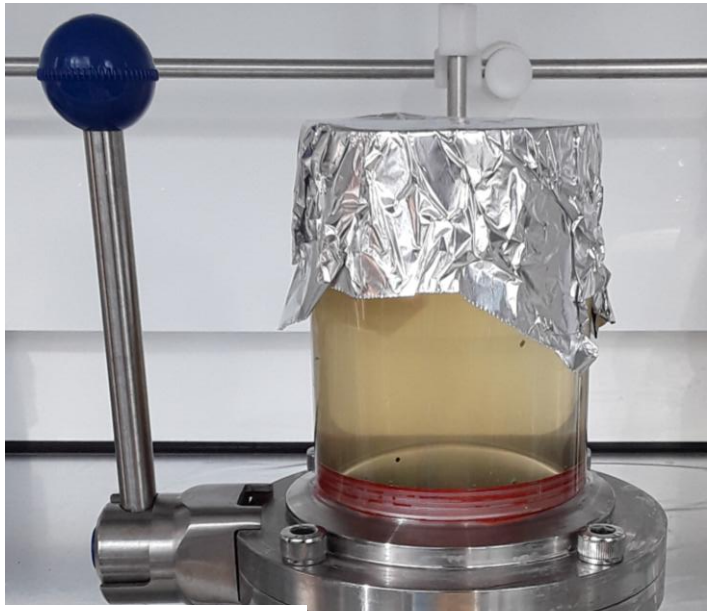


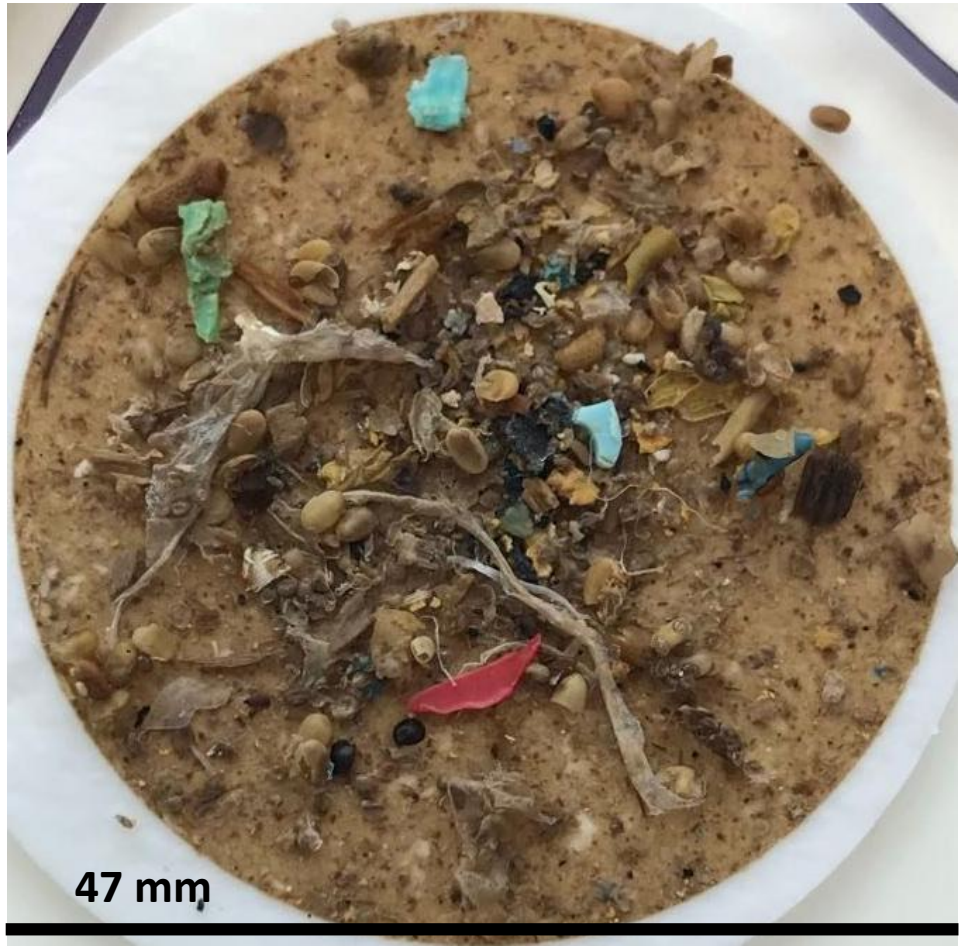
Vermicompost

- Feedstocks include food scraps, biosolids, paper pulp, dairy processing waste, septic tank waste

Protocol to extract microplastics from biowastes







Contents lists available at ScienceDirect

MethodsX

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

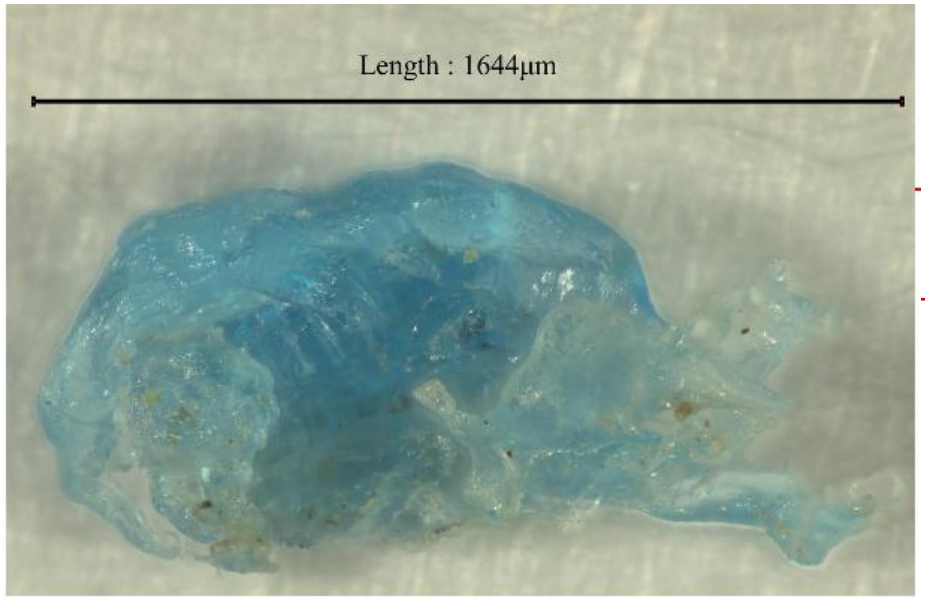
A method for the extraction of microplastics from solid biowastes including biosolids, compost, and soil for analysis by μ-FTIR

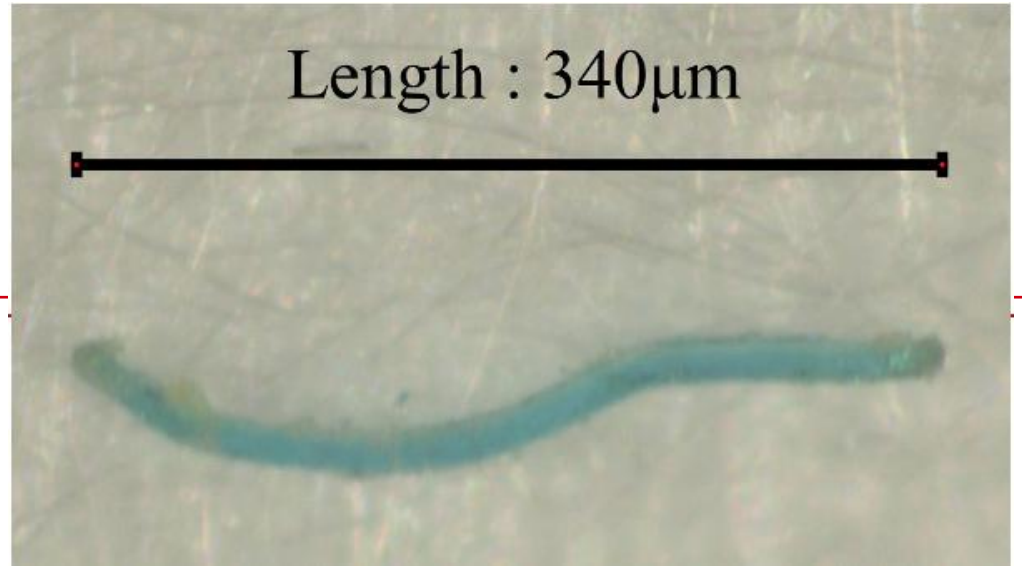
Helena Ruffell[a,*], Olga Pantos[b], Brett Robinson[a], Sally Gaw[a]

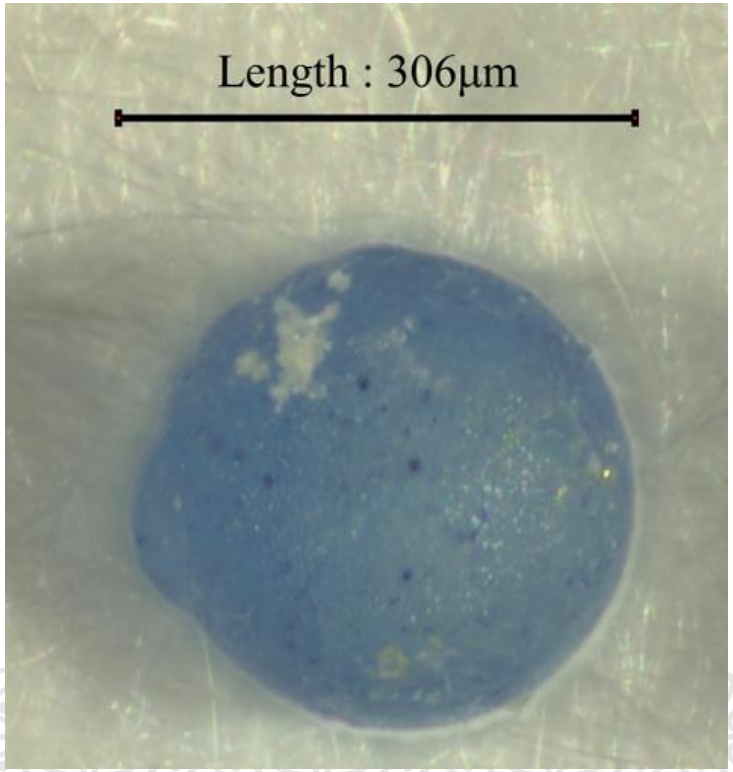
[a] School of Physical and Chemical Sciences, University of Canterbury, Christchurch, New Zealand
[b] Institute of Environmental Science and Research, Christchurch, New Zealand


1000 µm


1000 µm







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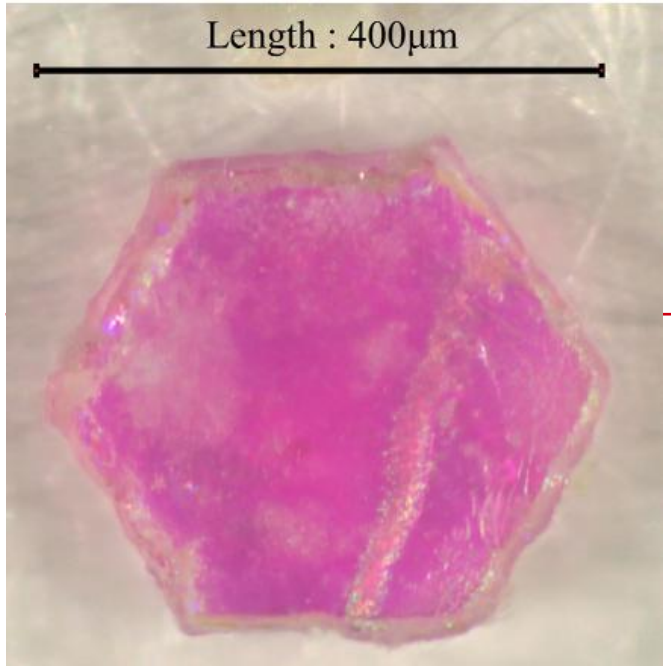
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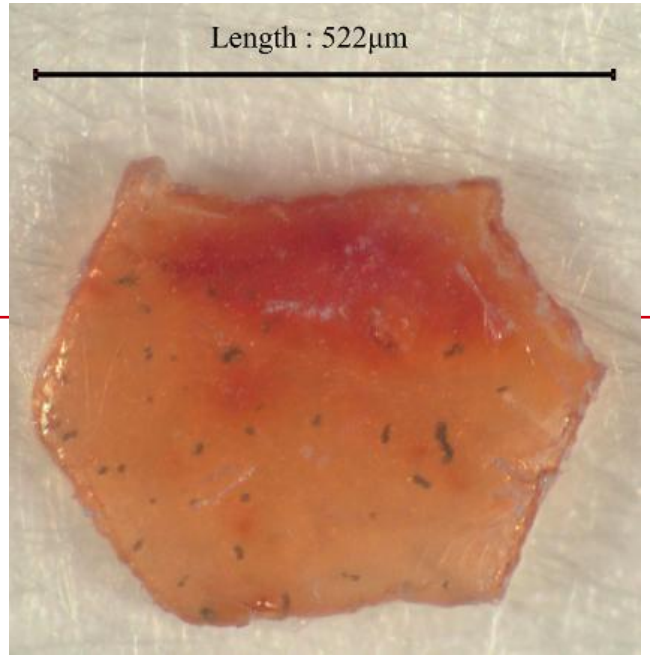
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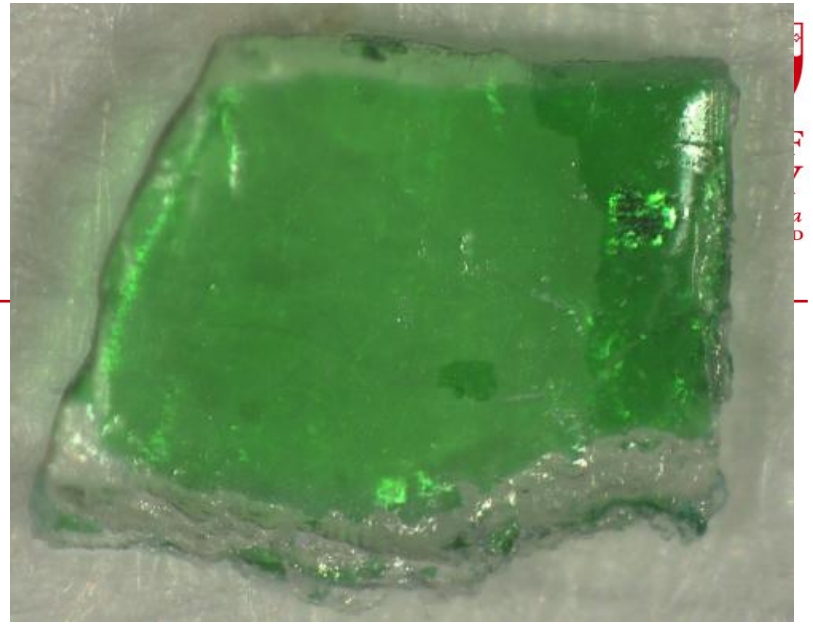


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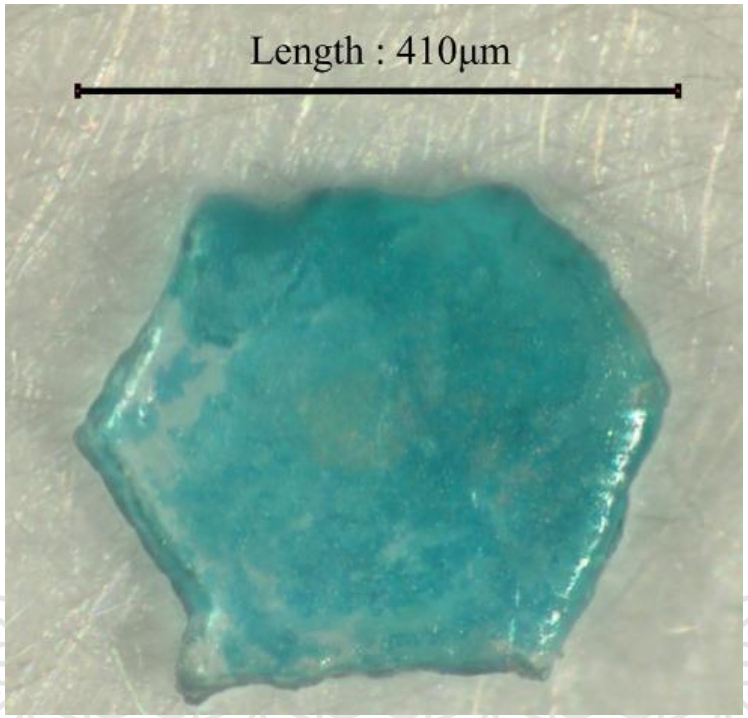
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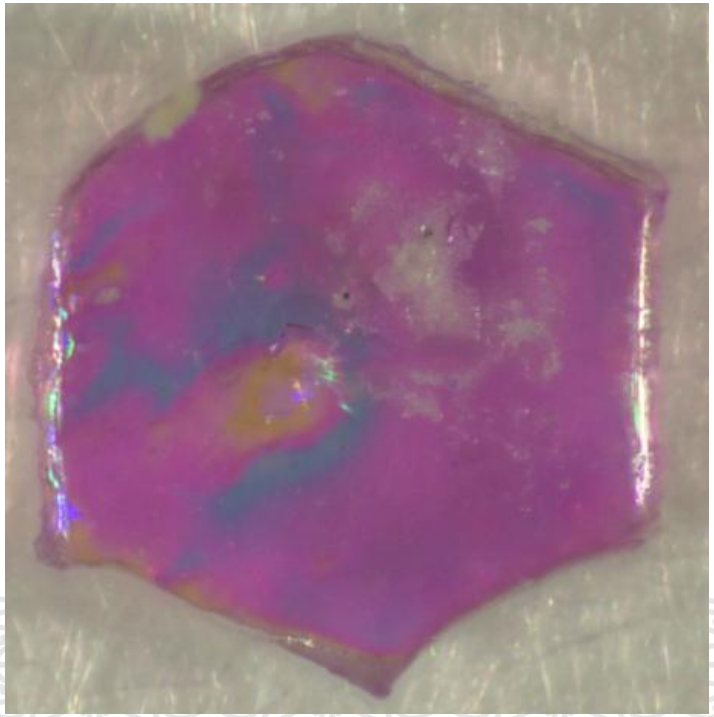

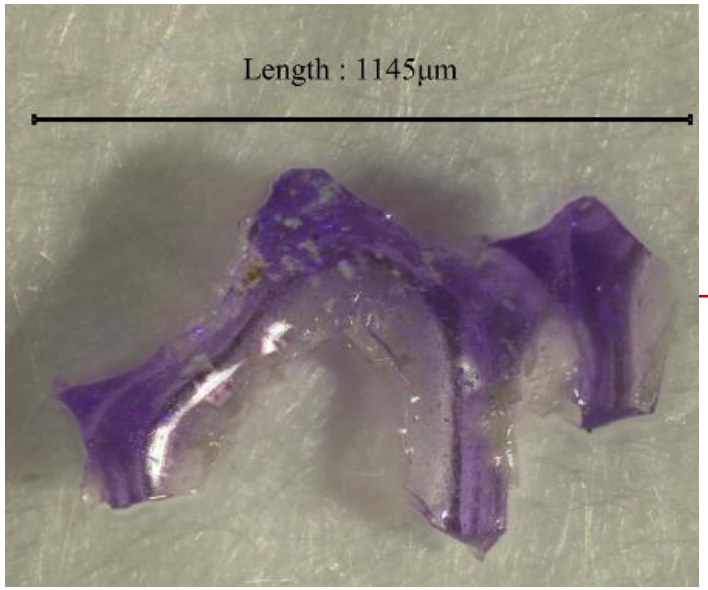

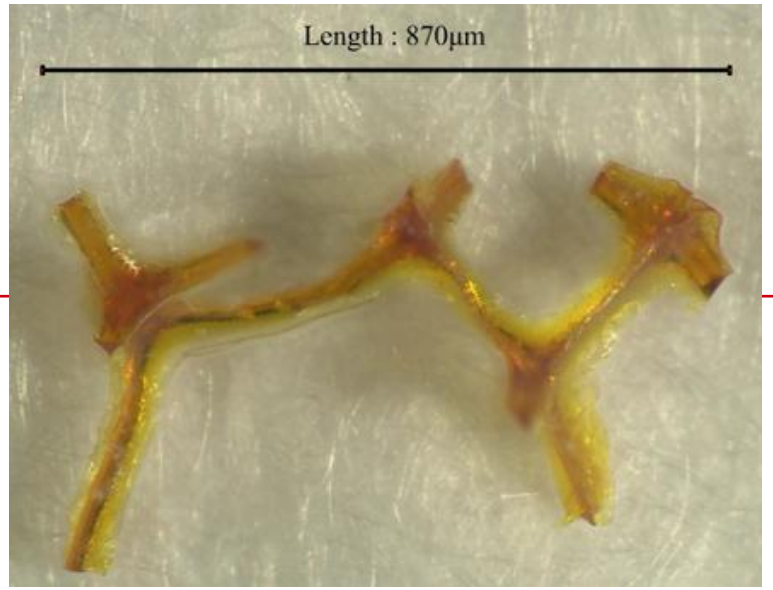

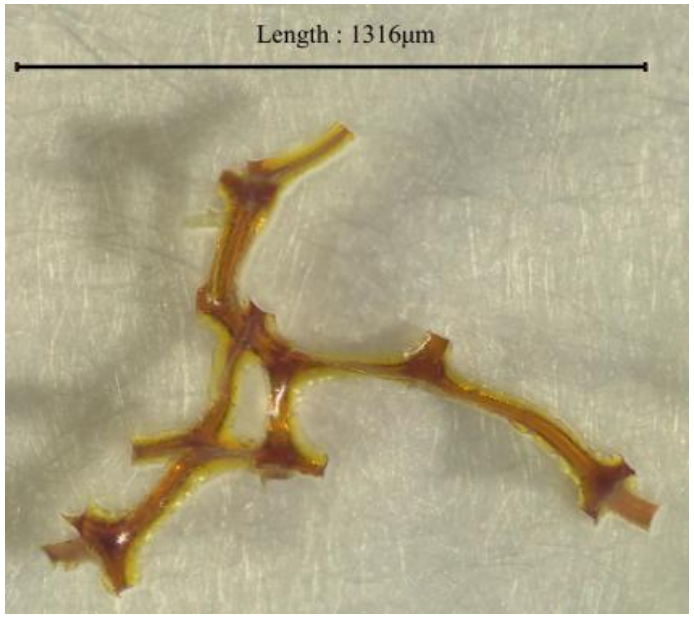

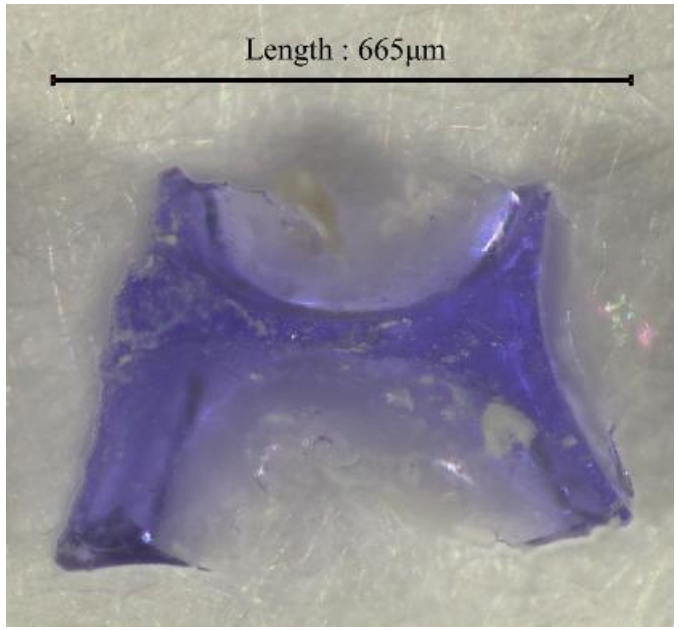

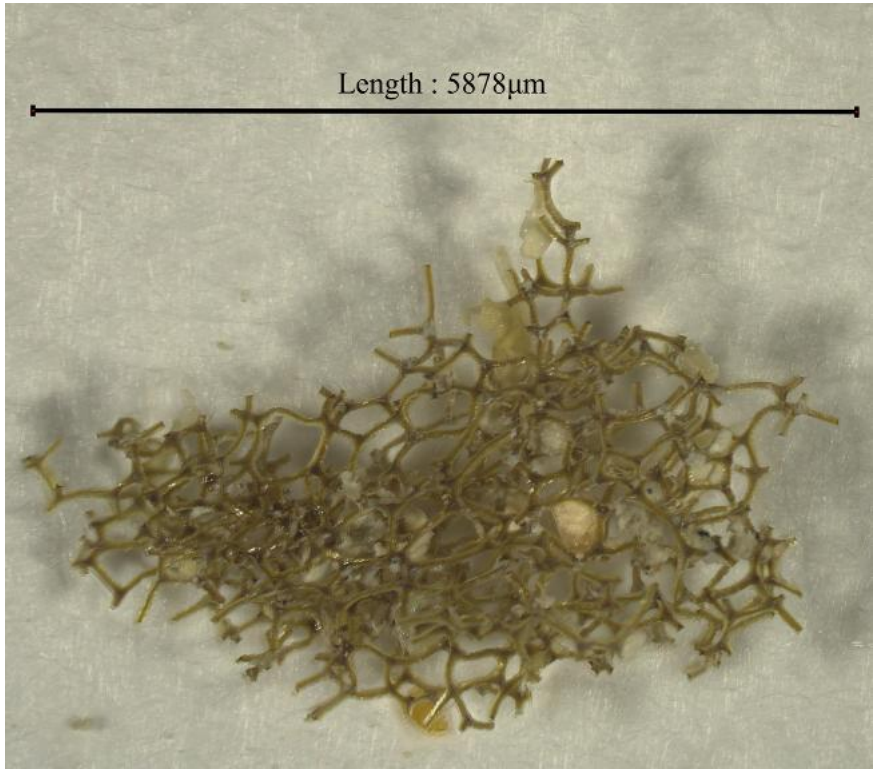

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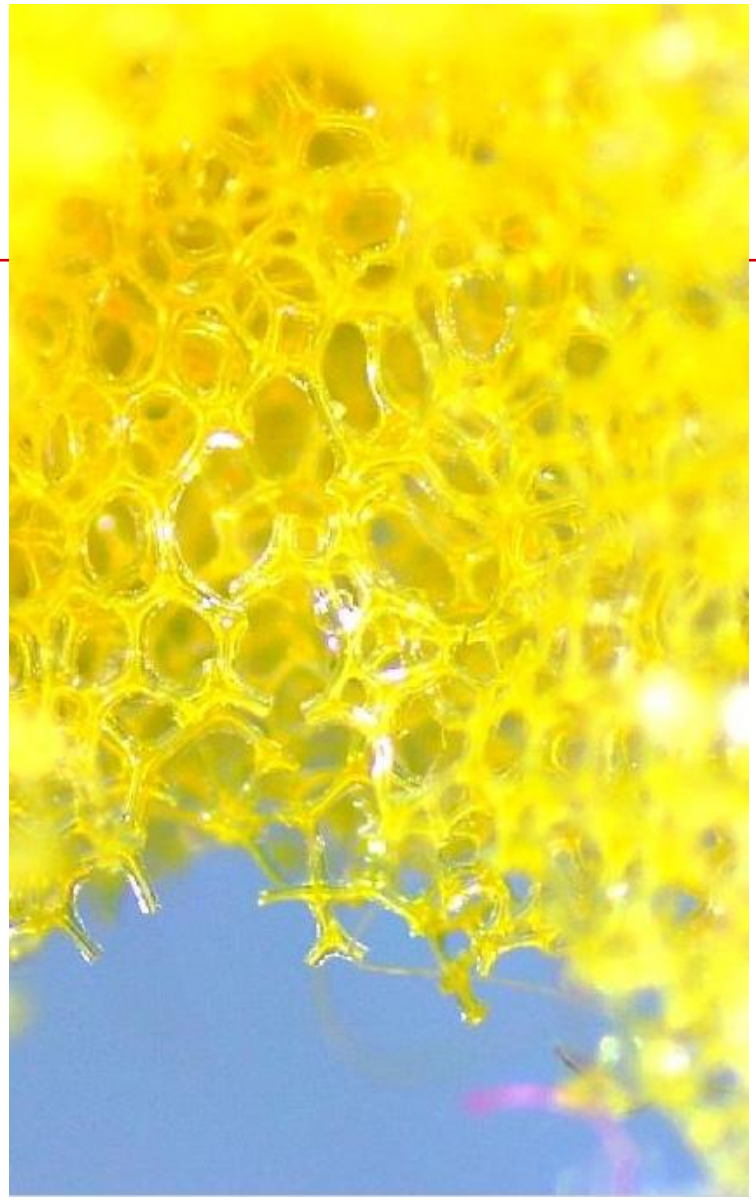

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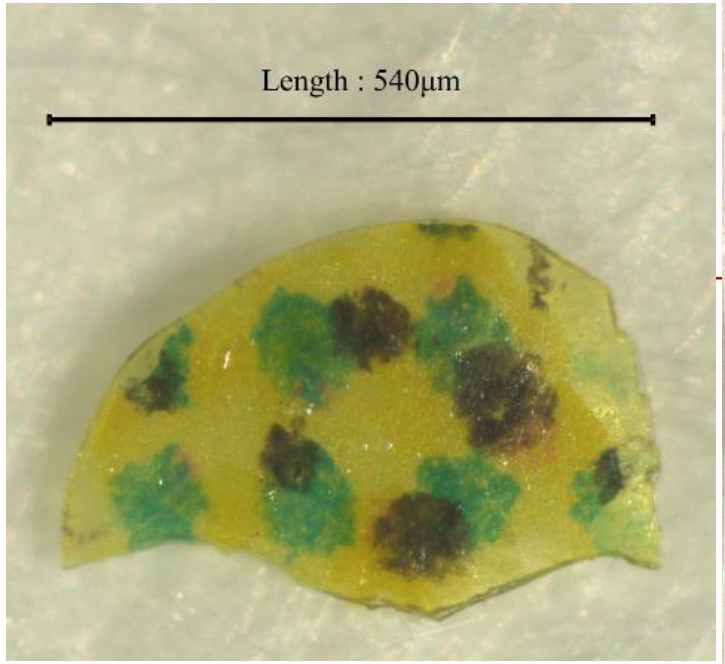
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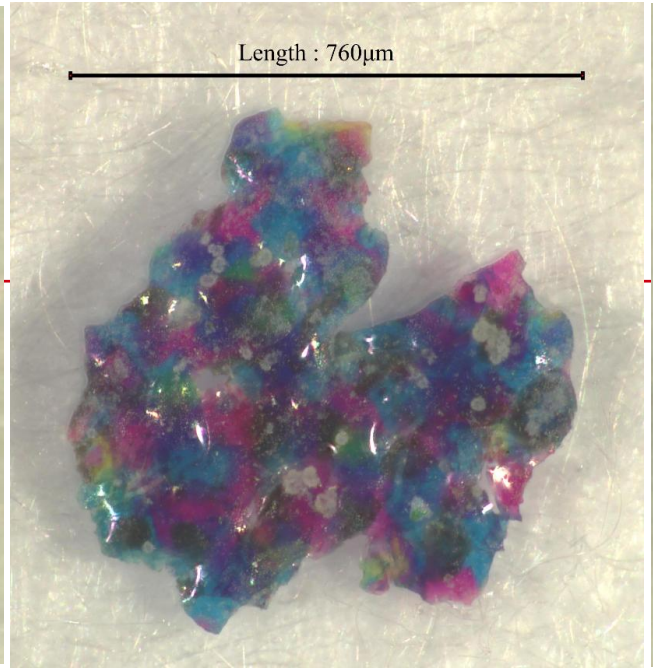
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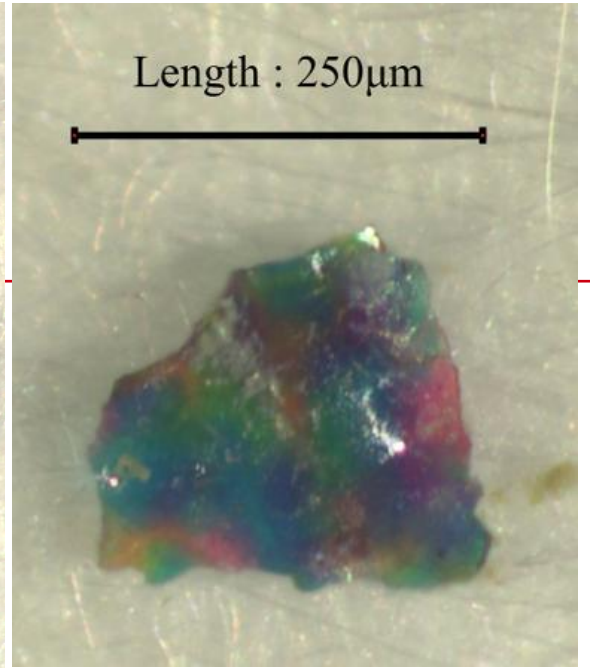
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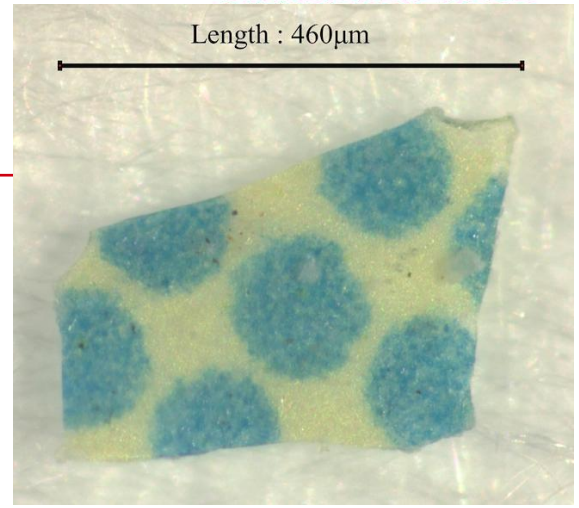
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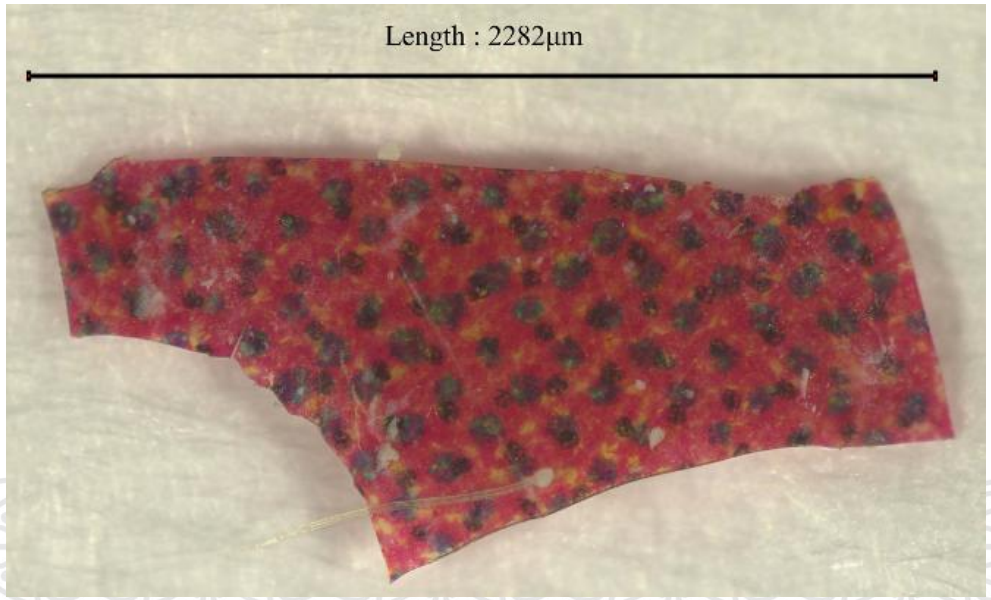
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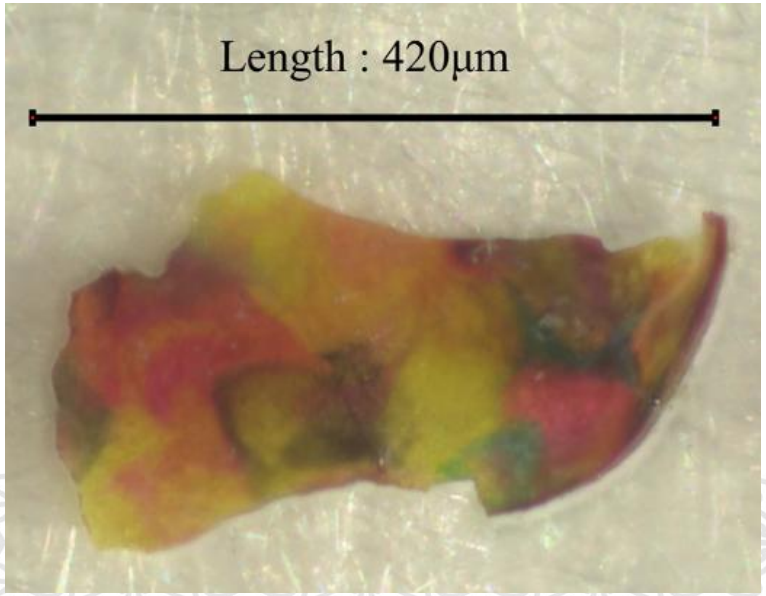
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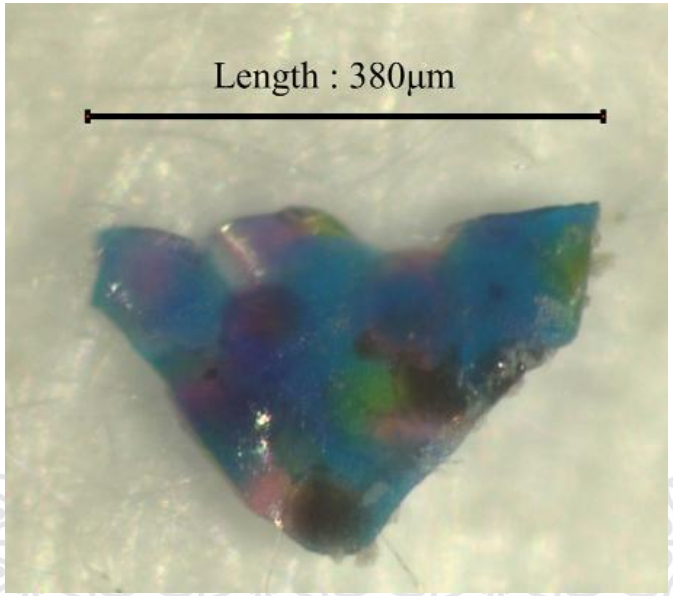
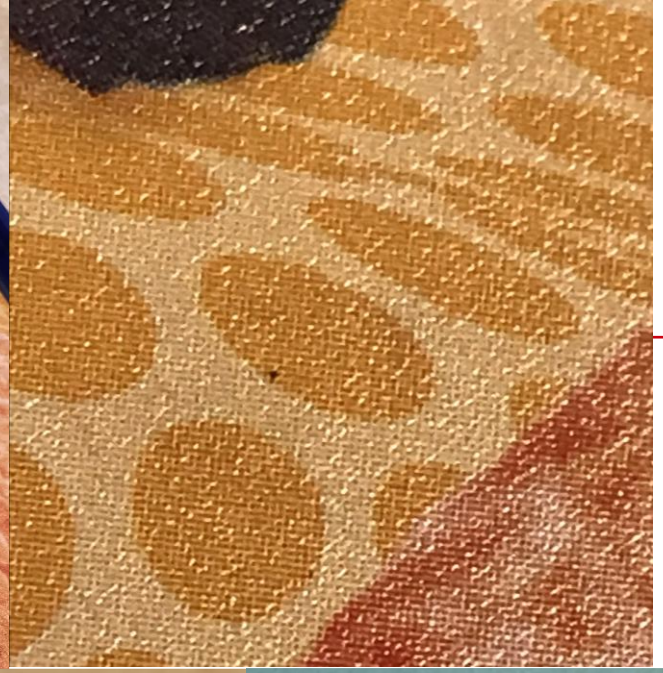

Length : 380µm


Top

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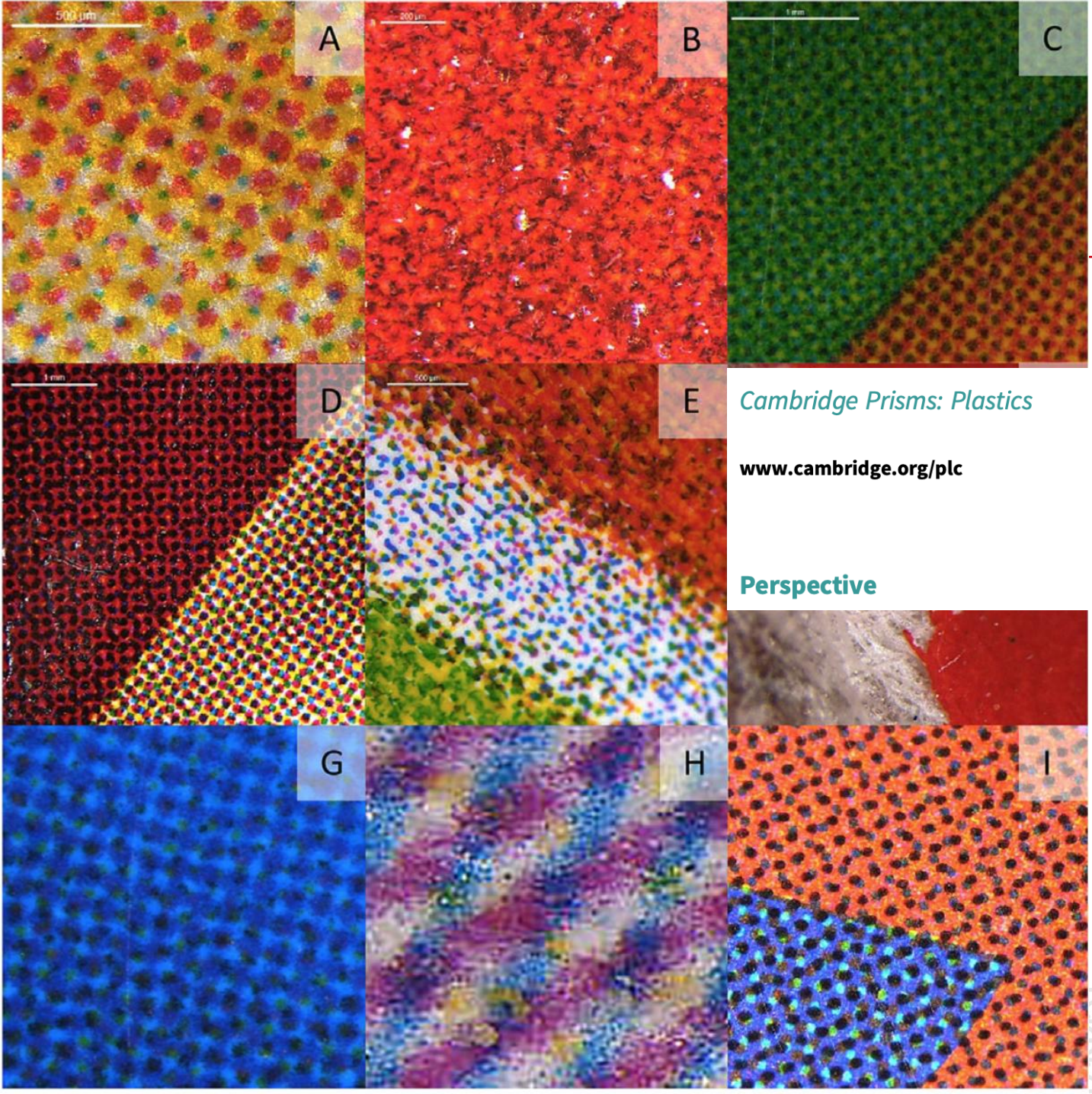

Cambridge Prisms: Plastics

www.cambridge.org/plc

Perspective

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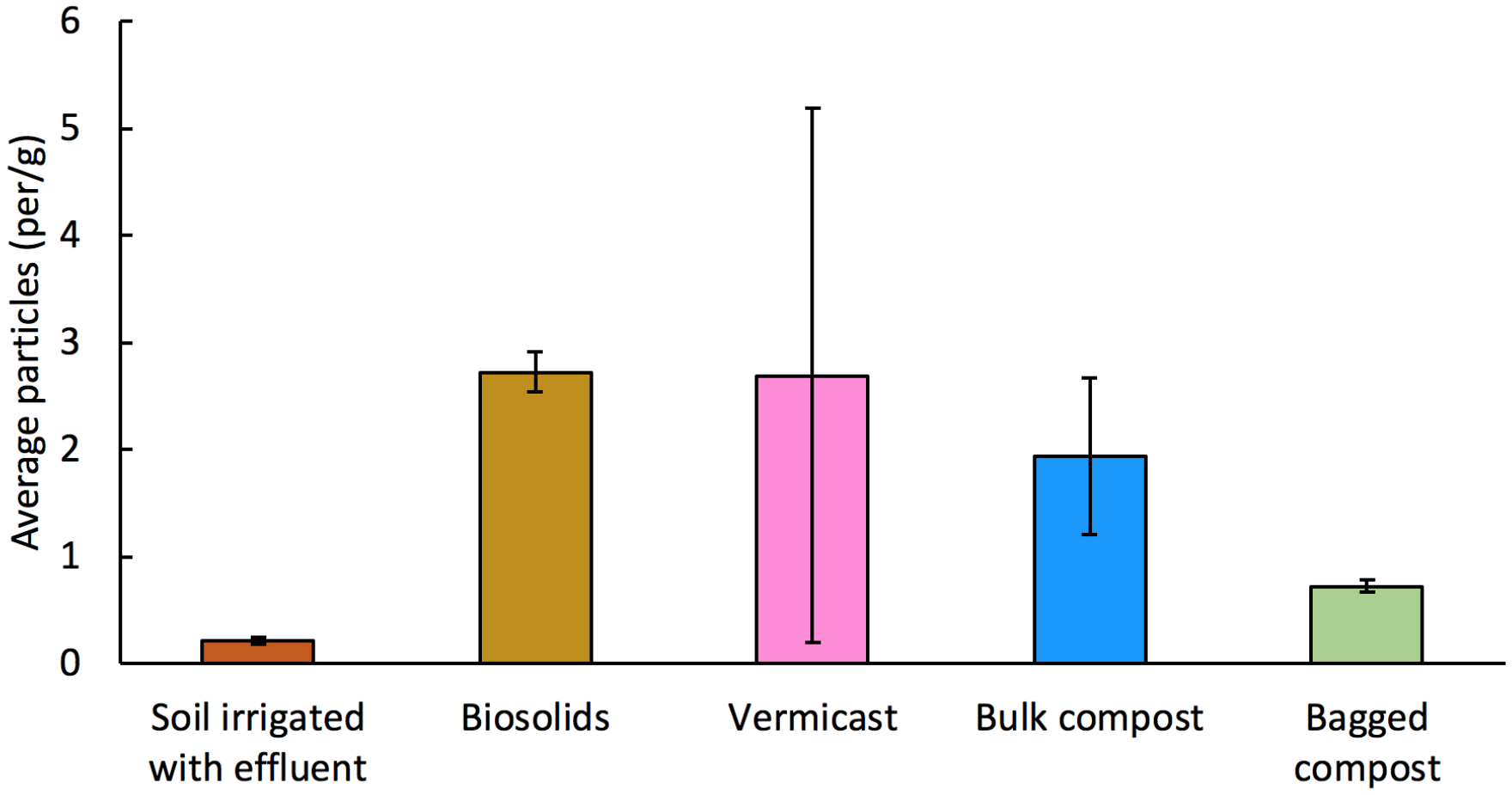
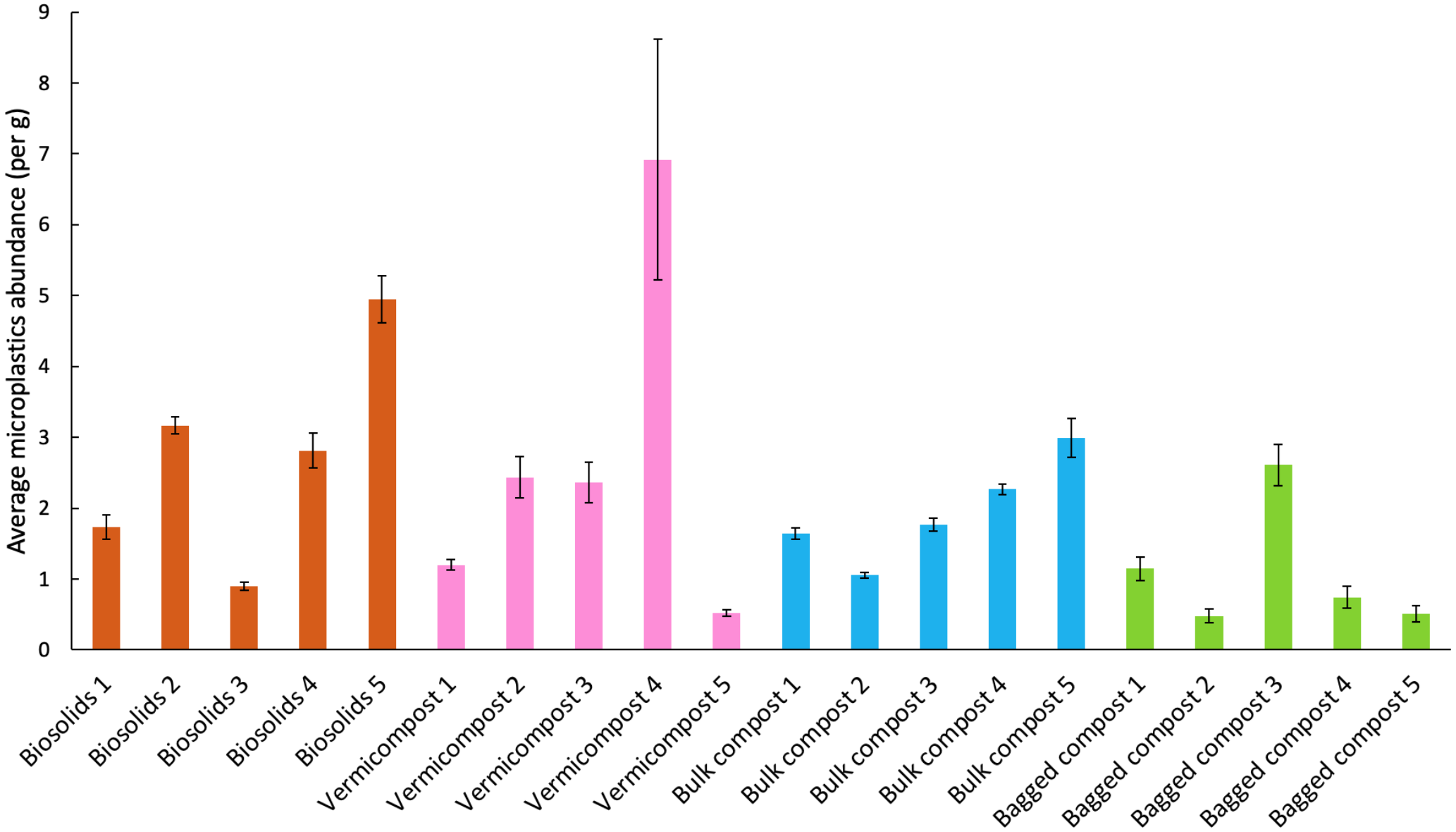
Sources of nanoplastic and microplastic pollution which are hidden in plain sight

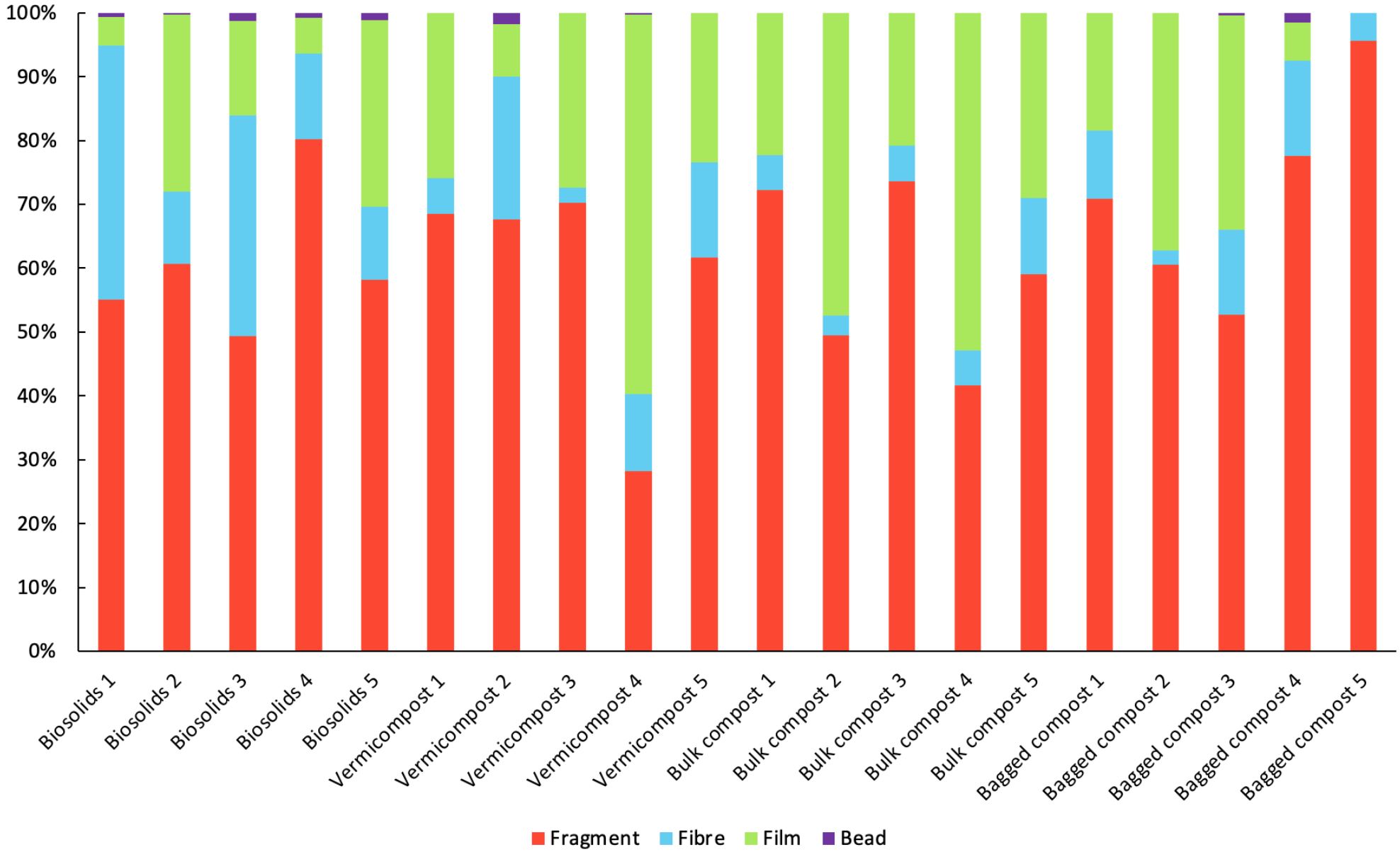
Olga Pantos[1], Hayden Masterton[1] and Helena Ruffell[2]

[1]Institute of Environmental Science and Research, Christchurch, New Zealand and [2]School of Physical and Chemical Sciences, University of Canterbury, Christchurch, New Zealand

Total average abundance of microplastics in biowaste




Average microplastics abundance (per g)
0
1
2
3
4
5
6
7
8
9
Biosolids 1
Biosolids 2
Biosolids 3
Biosolids 4
Biosolids 5
Vermicompost 1
Vermicompost 2
Vermicompost 3
Vermicompost 4
Vermicompost 5
Bulk compost 1
Bulk compost 2
Bulk compost 3
Bulk compost 4
Bulk compost 5
Bagged compost 1
Bagged compost 2
Bagged compost 3
Bagged compost 4
Bagged compost 5



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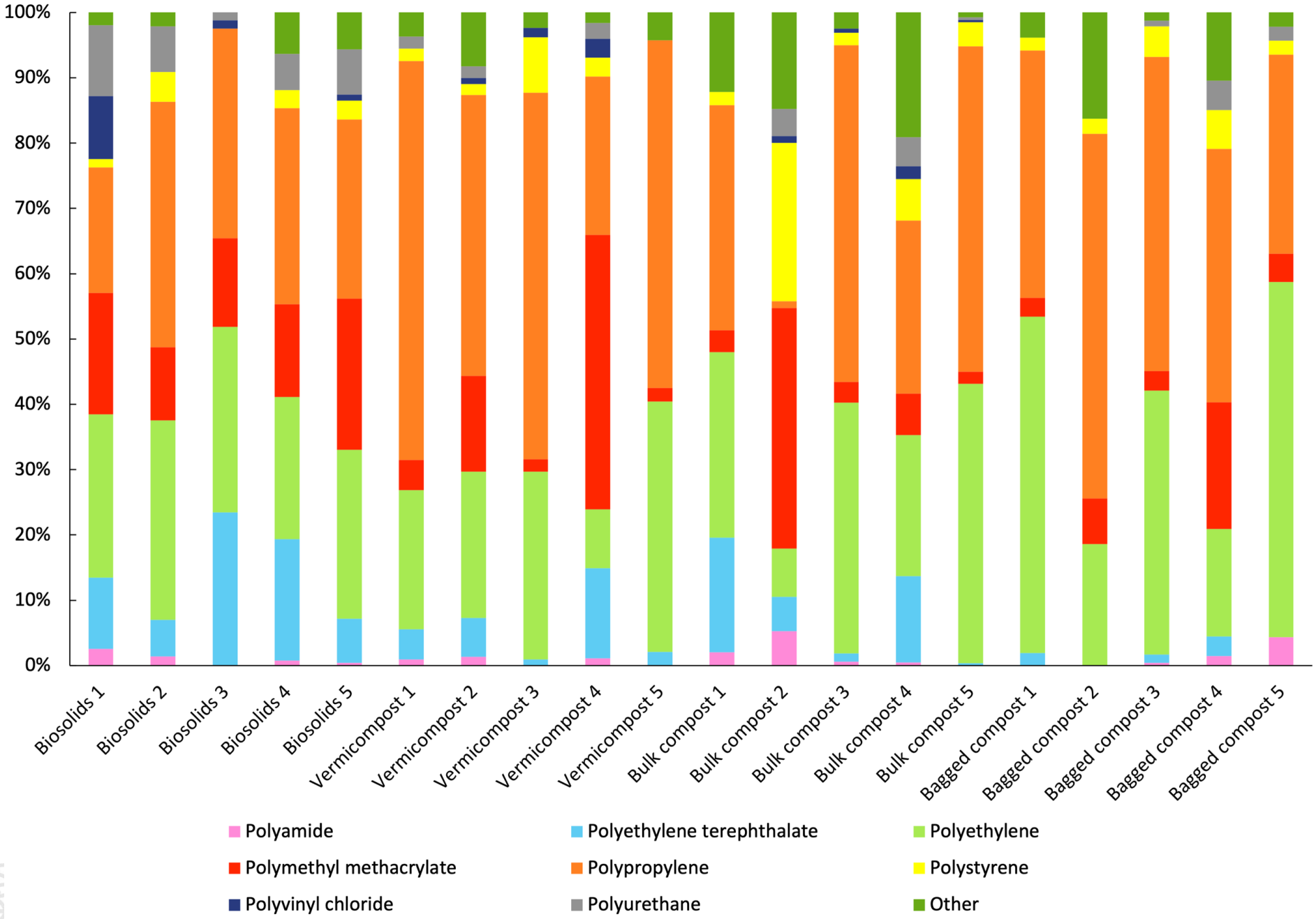

PLA and PBAT in mature compost samples!

Input to soil

- Biosolids: 2720 particles/kg
- Vermicast: 2690 particles/kg
- Bulk compost: 1940 particles/kg
- Bagged compost: 1100 particles/kg

Ruffell *et al. Water Emerg. Contam. Nanoplastics* **2025**, *4*, 1
DOI: 10.20517/wecn.2024.65

Water Emerging Contaminants & Nanoplastics

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Research Article

Open Access

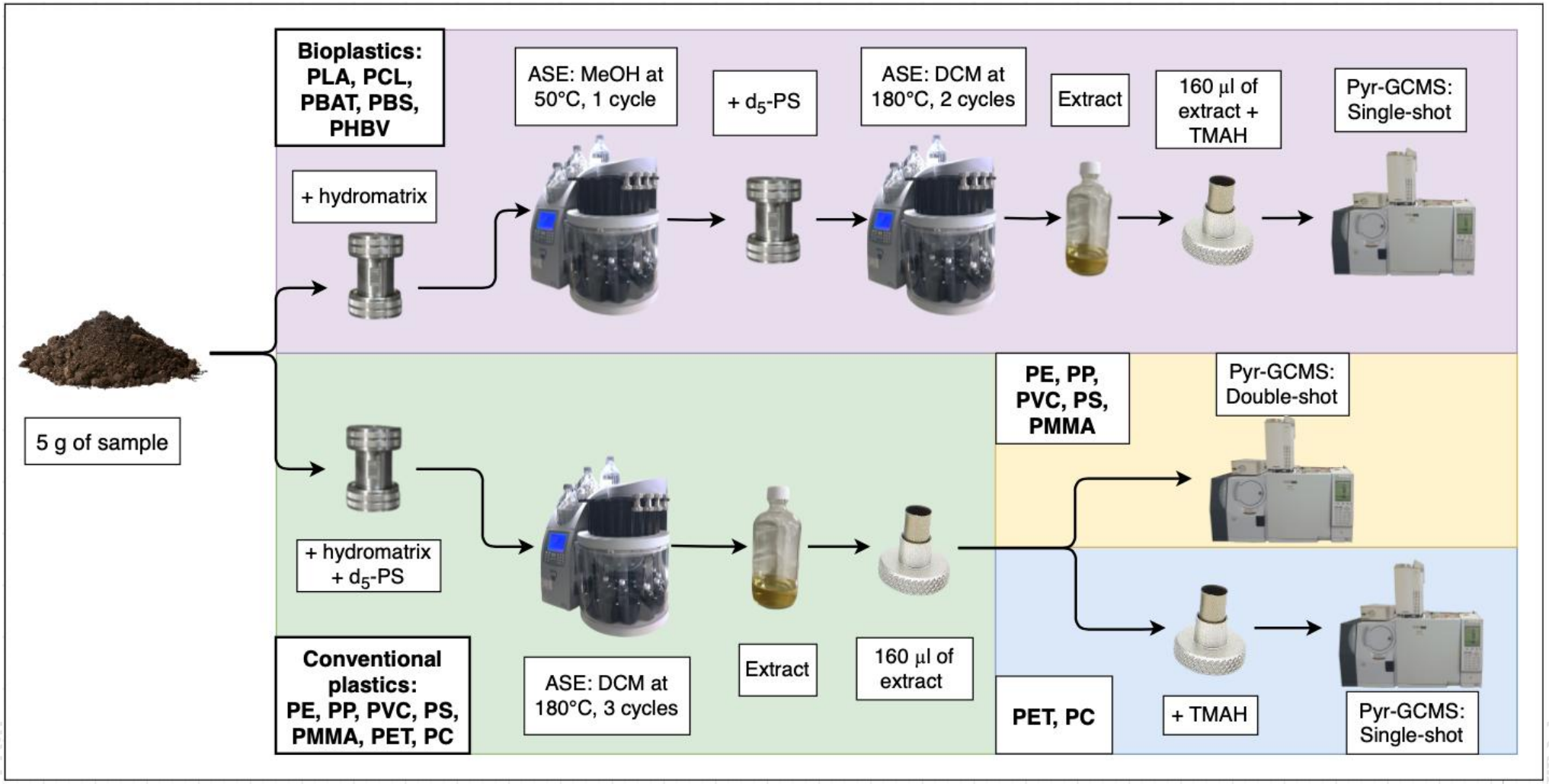
Quantification of microplastics in biowastes including biosolids, compost, and vermicompost destined for land application

Helena Ruffell[1], **Olga Pantos**[2], **Brett Robinson**[1], **Sally Gaw**[1]

[1]School of Physical and Chemical Sciences, University of Canterbury, Christchurch 8041, New Zealand.
[2]Institute of Environmental Science and Research, Christchurch 8041, New Zealand.

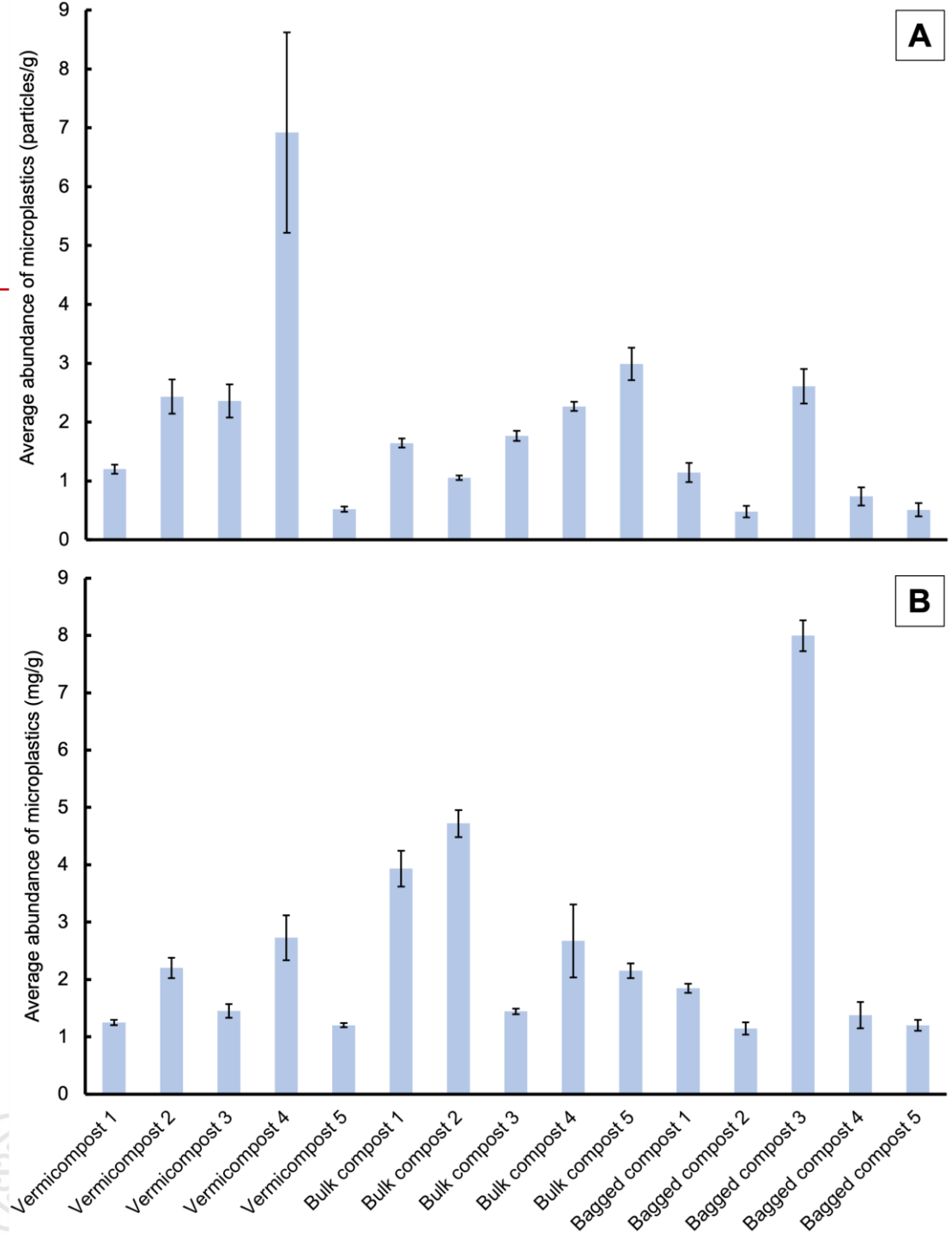

1000 µm

Protocol to extract microplastics for Pyr-GC/MS analysis

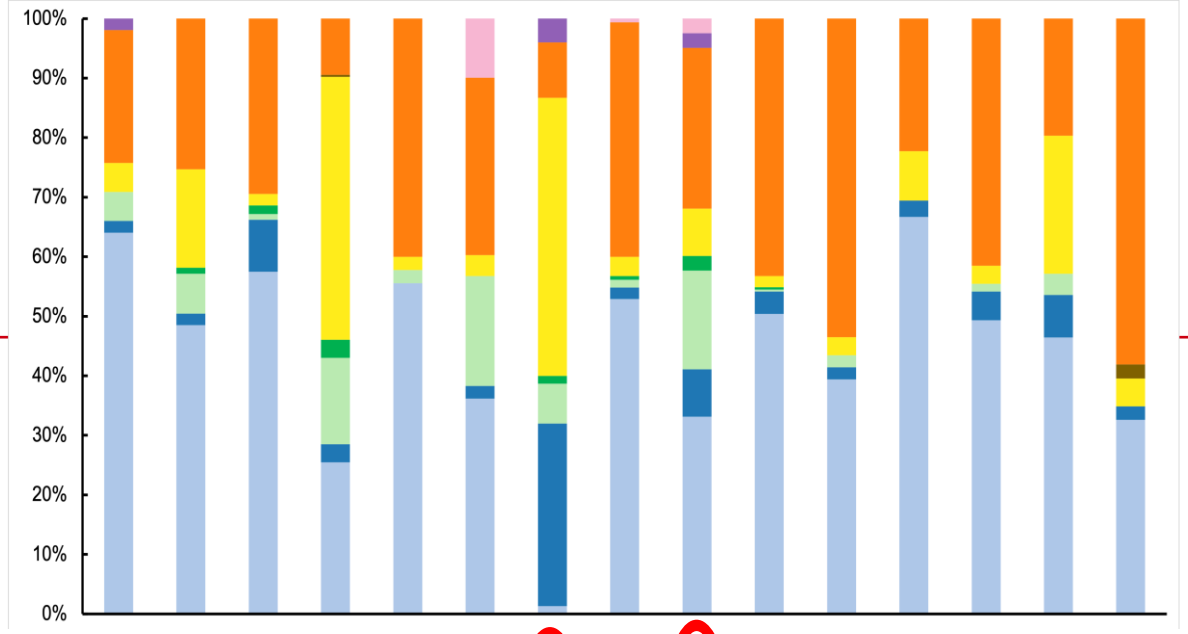


μ-FTIR results

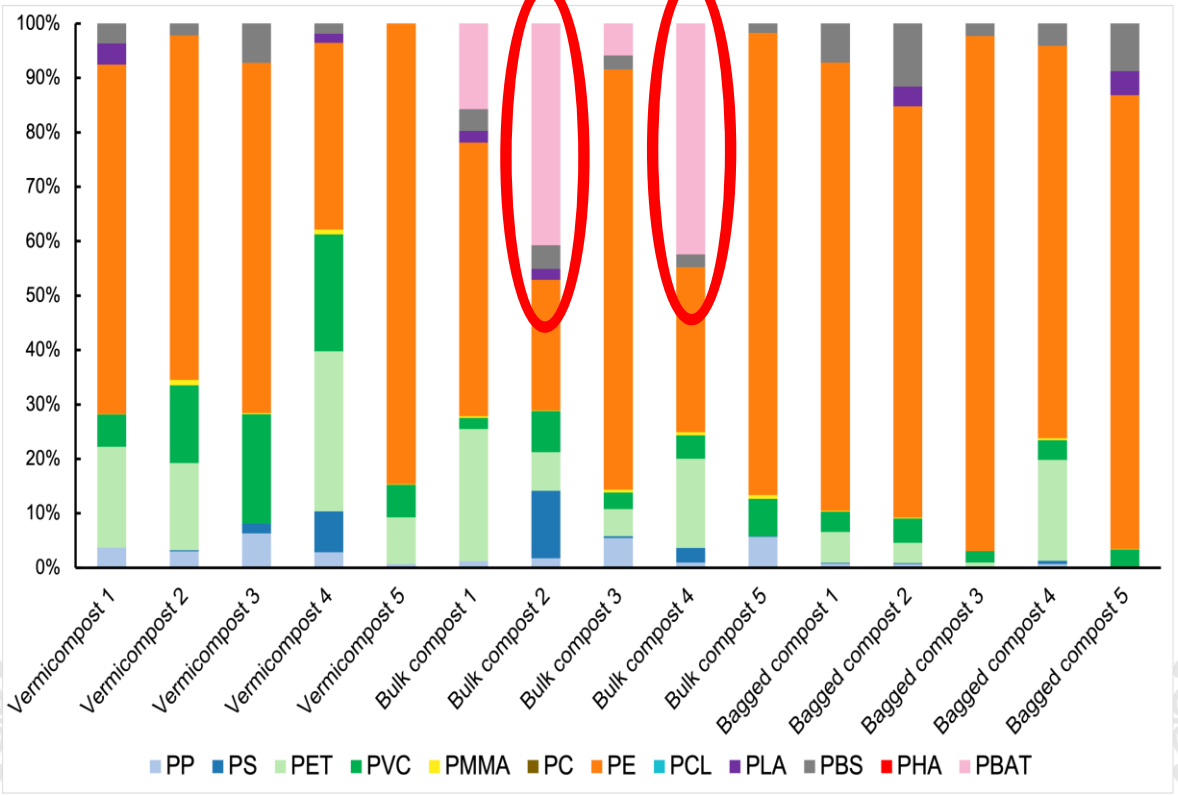
Pyr-GC/MS results



μ-FTIR results



Pyr-GC/MS results



Input to soil

- Biosolids: 2720 particles/kg

- Vermicast: 2690 particles/kg

1.79 g/kg

- Bulk compost: 1940 particles/kg

3.24 g/kg

- Bagged compost: 1100 particles/kg

2.74 g/kg


497

Full length article

Microplastics alter soil structure and microbial community composition

Lanfang Han [a 1], Liying Chen [a 1], Yanfang Feng [b], Yakov Kuzyakov [c d], Qi'ang Chen [a], Sibo Zhang [a], Liang Chao [a], Yanpeng Cai [a], Chuanxin Ma [a], Ke Sun [e], Matthias C. Rillig [f g]

Biodegradable microplastics affect tomato (*Solanum lycopersicum* L.) growth by interfering rhizosphere key phylotypes

Haoxin Fan [a], Xincheng Hong [a], Hehua Wang [a], Feng Gao [a b c], Ziqi Su [a], Huaiying Yao [a b c]

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Biodegradable microplastics pose greater risks than conventional microplastics to soil properties, microbial community and plant growth, especially under flooded conditions

Jie Wang [a b], Minghao Jia [a], Long Zhang [d], Xiaona Li [a], Xiaokai Zhang [a], Zhenyu Wang [a c]

Foliar exposure to microplastics disrupts lettuce metabolism and negatively interferes with symbiotic microbial communities

Ruiying Shi [a 1], Yuhang Lian [a 1], Aurang Zeb [a], Jinzheng Liu [a], Miao Yu [a], Qi Wang [a], Jianling Wang [a], Xiuping Fu [b], Weitao Liu [a]

RESEARCH ARTICLE | ENVIRONMENTAL SCIENCES

A global estimate of multiecosystem photosynthesis losses under microplastic pollution

Ruijie Zhu, Zhaoying Zhang, Naichi Zhang, +13, and Baoshan Xing Authors Info & Affiliations

Edited by Lewis H. Ziska, Columbia University, New York, NY; received November 17, 2024; accepted February 9, 2025 by Editorial Board Member Alan Hastings

March 10, 2025 | 122 (11) e2423957122 | https://doi.org/10.1073/pnas.2423957122

Microplastics Increase Soil pH and Decrease Microbial Activities as a Function of Microplastic Shape, Polymer Type, and Exposure Time

Tingting Zhao [1,2], Yudi M. Lozano [1,2†] and Matthias C. Rillig [1,2†]*

[1]Plant Ecology, Institute of Biology, Freie Universität Berlin, Berlin, Germany, [2]Berlin-Brandenburg Institute of Advanced Biodiversity Research (BBIB), Berlin, Germany

What do we need to do?

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- Advice from Louise Weaver (ESR), Jamie Bridson (Scion), Grant Northcott, Jamie Ataria (Cawthron)
- Sampling sites and mana whenua (people of the land)
- Technical staff and research group members at UC
- Project funded as part of the Aotearoa Impacts and Mitigation of Microplastics (AIM^2) Endeavour fund from the Ministry of Business, Innovation, and Employment (MBIE).

- **Additional questions? helenaruffell@gmail.com**