Microplastic is a Vehicle for Transporting Pharmaceutical-Transforming Microbiomes

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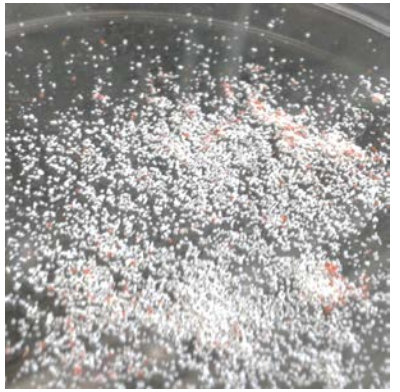
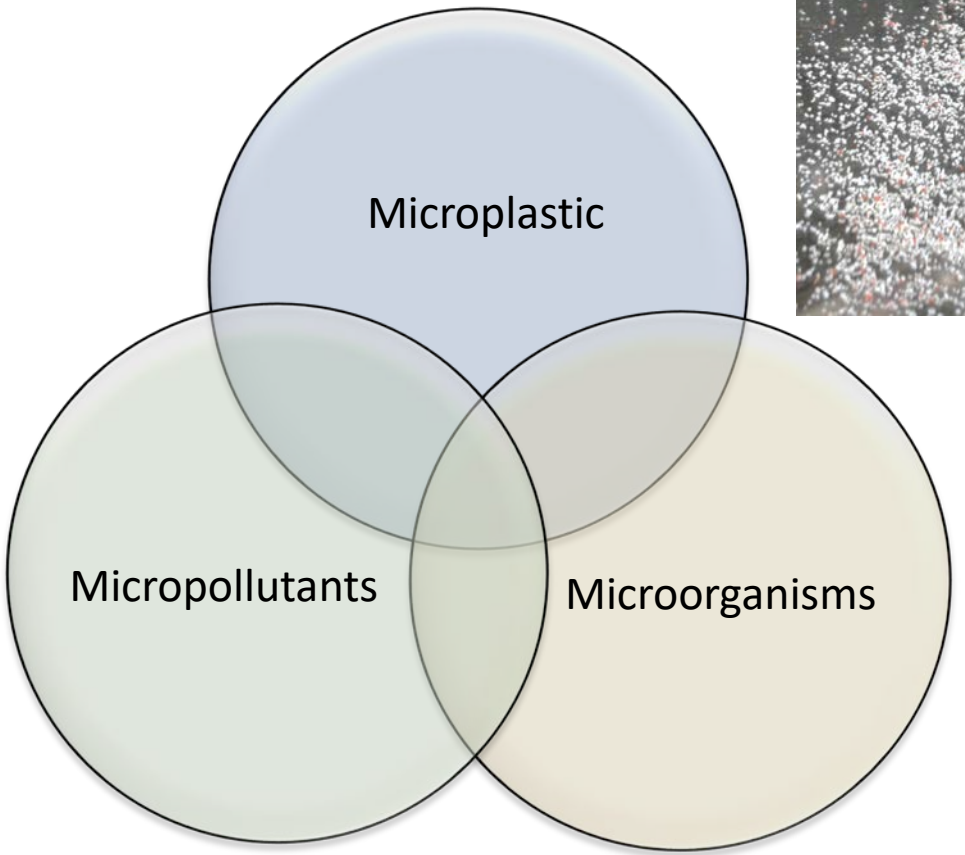
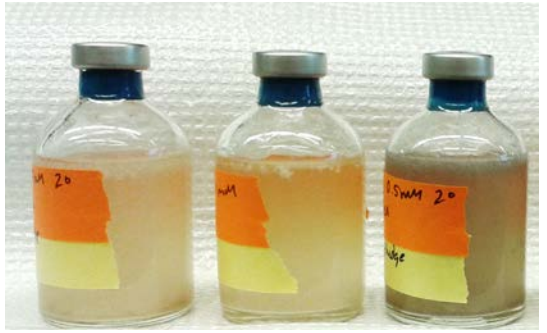
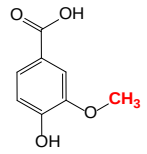
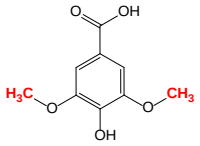
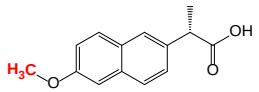
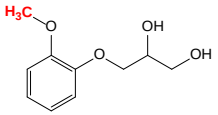
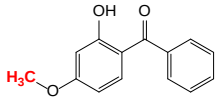
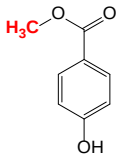


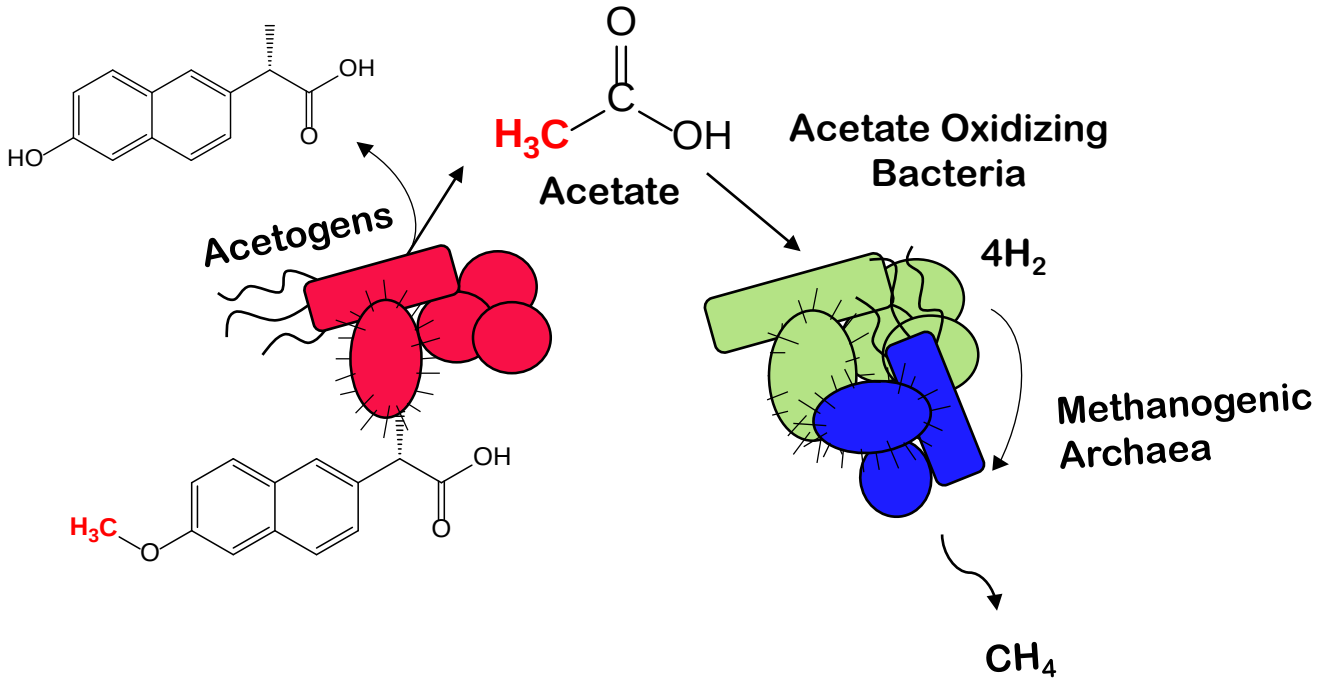

Microplastic
Micropollutants
Microorganisms



Pharmaceutical Transformation by Wastewater Microbiomes

Plant derived	**Vanillic Acid** Naturally occurring, plant derived compound	
	Syringic Acid Naturally occurring, plant derived compound	
Pharmaceuticals	**Naproxen** Over-the-counter Non-steroidal anti-inflammatory drug	
	Guaifenesin Expectorate	
Personal Care Products	**Oxybenzone** UV light absorber Found in sunscreens and plastics	
	Methylparaben Preservative in cosmetics, pharmaceuticals, and food	

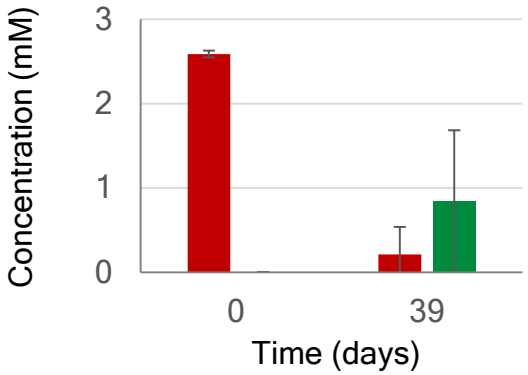
Model System for Naproxen Transformation

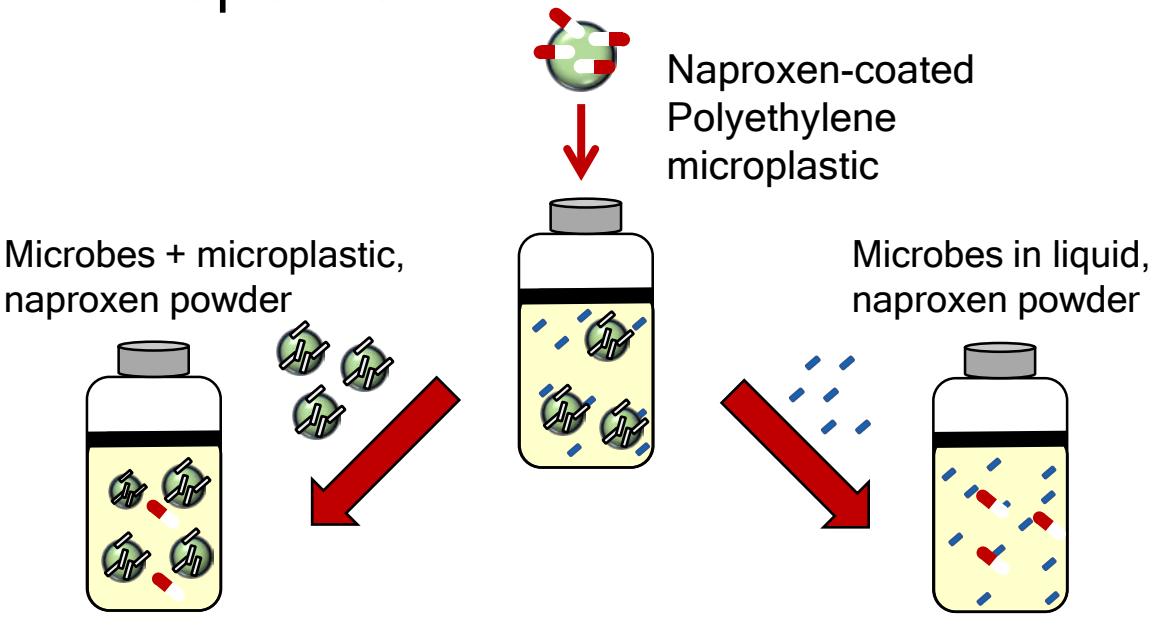


Wolfson et al. 2018 Microbial Ecology; Wolfson et al., 2019 Environ. Toxicol. Chem.

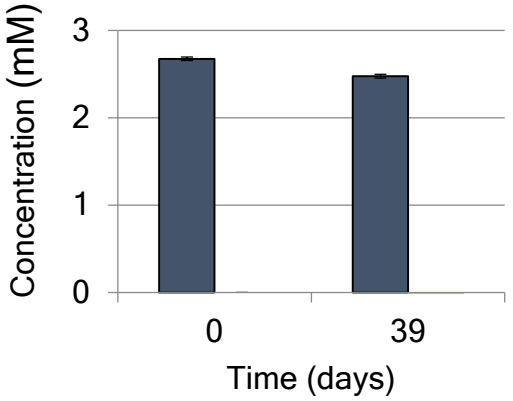
Hypothesis: Naproxen transformation activity can be transported by wastewater microbiomes growing on microplastic

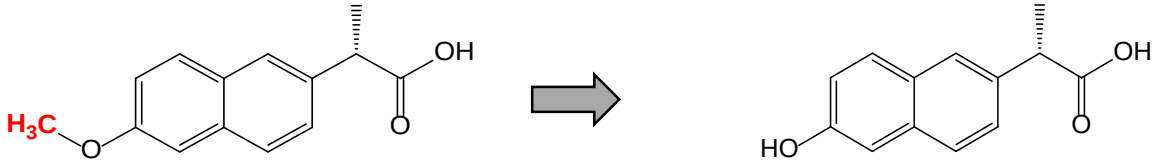
Complete naproxen loss, 6-O-desmethylnaproxen formation





Negligible naproxen loss, no detectable transformation products





Naproxen

Microplastic fraction

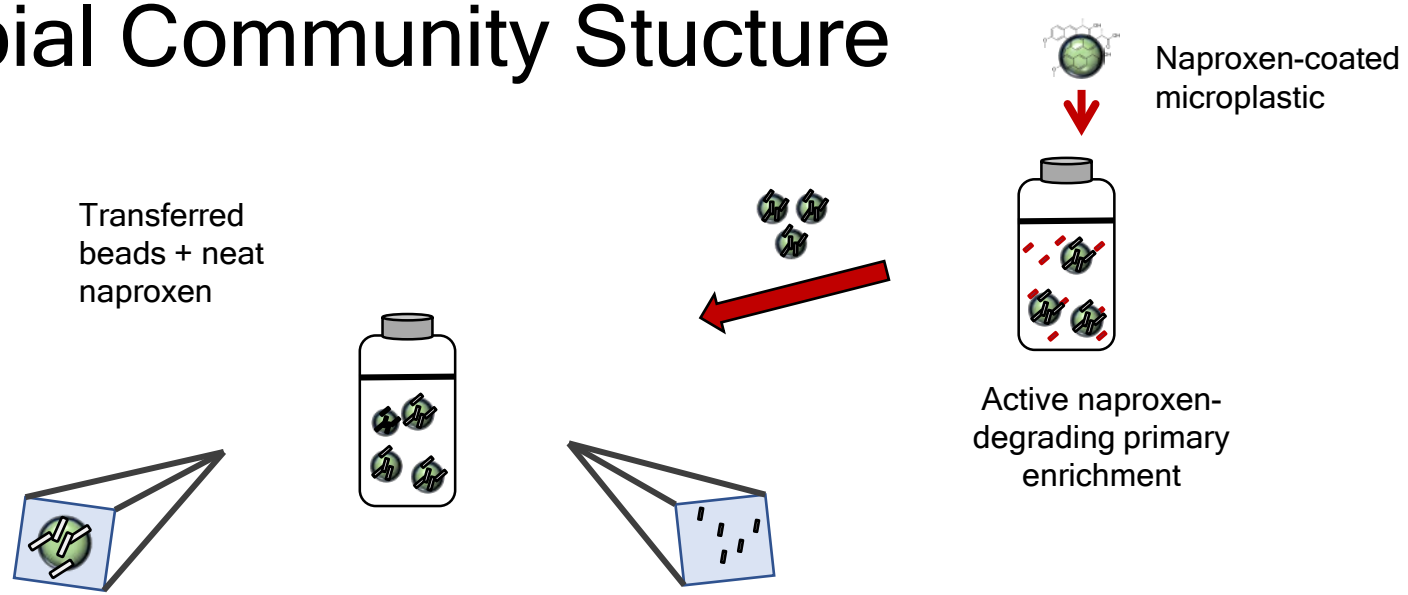
Planktonic fraction

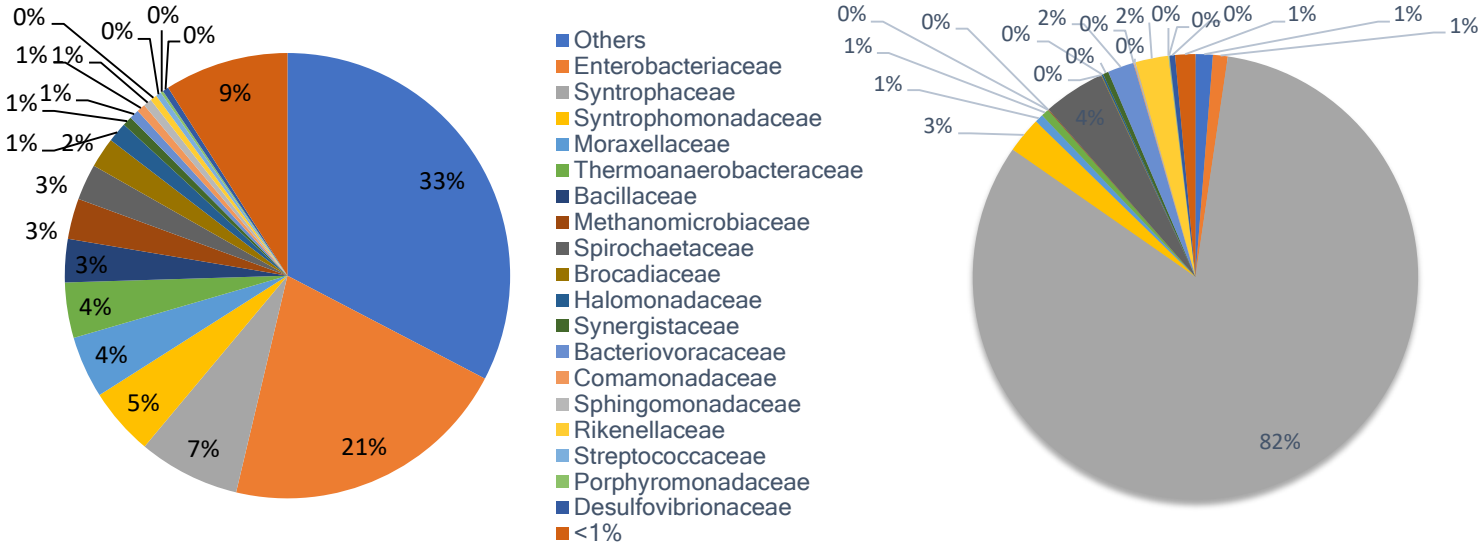
6-O-Desmethylnaproxen

Microplastic Fraction

Planktonic fraction (not detected)

Microbial Community Stucture

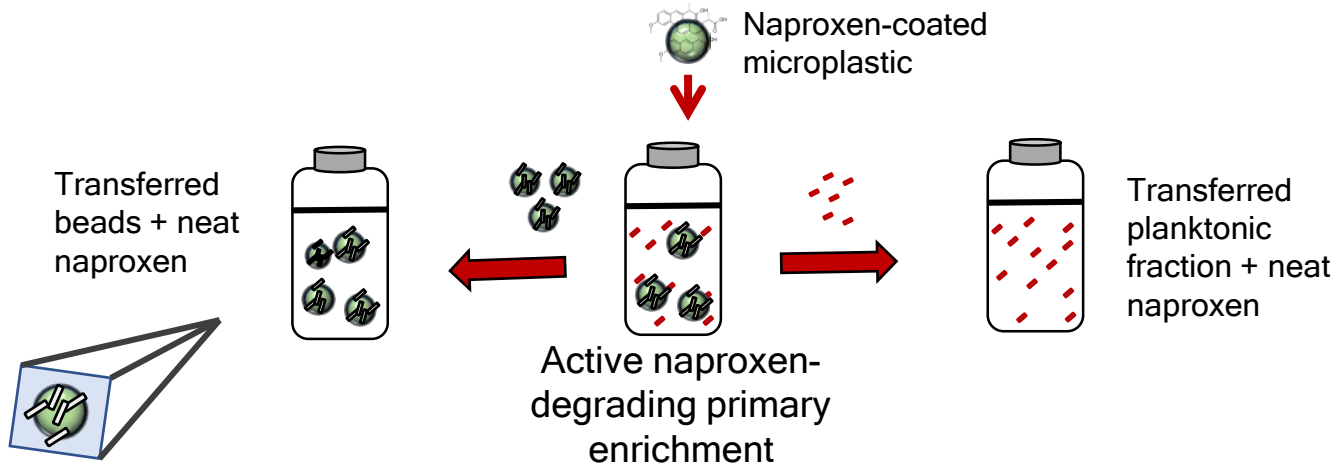


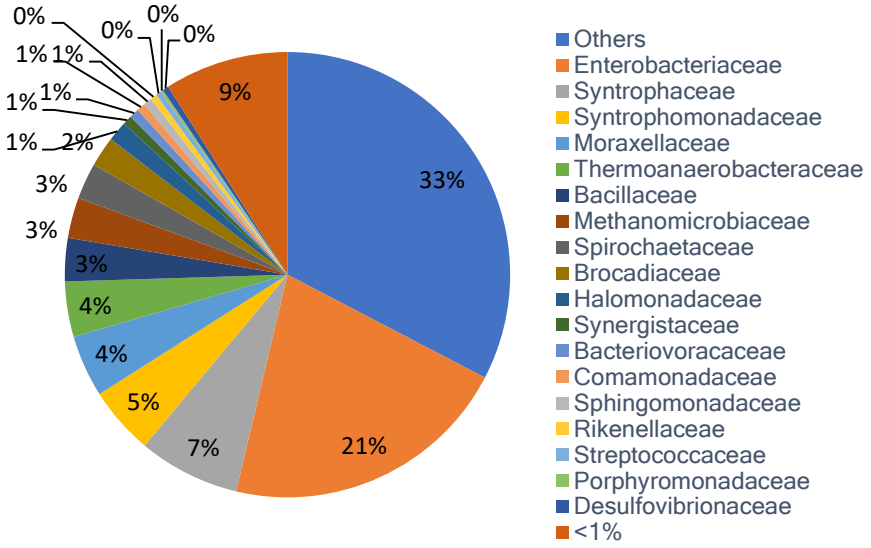


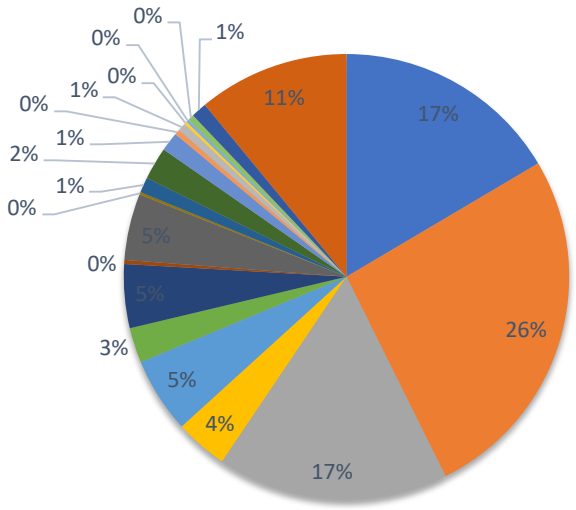
Results:

- Planktonic fraction dominated by single DNA sequence, *Smithella* genus.
- Microplastic microbiome is very different from the microbiome that is not attached to plastic.

Microbial Community Structure



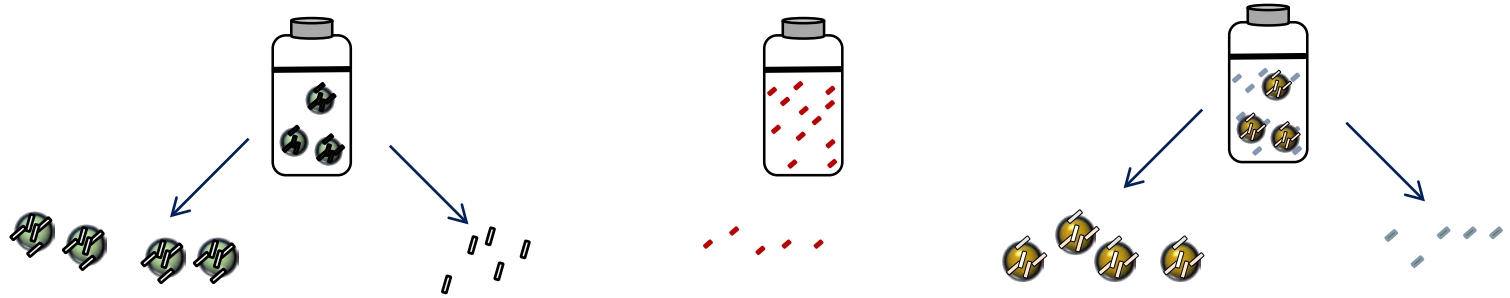




Results:

- Colonized beads had a sequence represented by an unidentified Proteobacterial strain (30% compared to 2% in planktonic)
- Planktonic transfer had a 2-fold increase in *Syntrophaceae*, namely related to *Smithella*
- Colonized beads had greater abundance of *Methanomicrobiaceae*, a family of methanogens
  - Naproxen transformation slows when methanogenesis is inhibited (Wolfson et al., 2018)

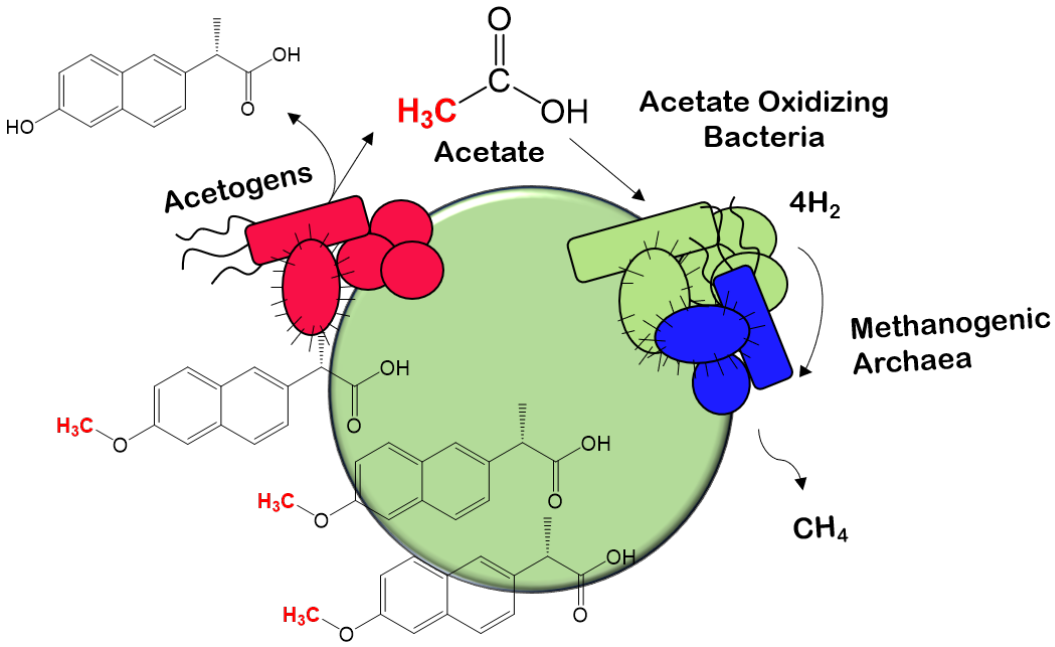
Differences in the functional profiles associated with microplastic



	Microplastic Transfer, Microplastic	Microplastic Transfer, Planktonic	Planktonic Transfer, No Microplastic	No Naproxen Control, Microplastic	No Naproxen Control, Planktonic
Acetogenesis *acsB*	+	+	+	-	-
Acetogenesis *fhs*	+	+	+	+	+
Methanogenesis *mcrA*	+	+	-	+	+
Anaerobic biodegradation *bssA*	+	-	-	+	-

Implications

- Microplastic is a surface that facilitates interactions that are part of the naproxen-transforming food web.
- This complex community of microbes can be transported together on the microplastic to new environments.
- This may allow transformation of other emerging contaminants (eg pharmaceuticals, personal care products) with shared chemical structures
- Microbial communities are dynamic. Changes to the types of microbes present may lead to changes in potential metabolic functions.



RUTGERS

Thank you!

- Sarah J. Wolfson, Ph.D.
- Lily Y. Young, Ph.D.
- Maria D. Rivera

USDA Hatch MultiState

NSF IGERT