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Host-Parasite Interactions in the Presence of Microplastic Contamination

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Introduction:

- PES (polyester) microfibers are a common pollutant of freshwater systems.[1,2] Sources include textile washing processes, treated wastewater effluent, and the breakdown of larger particles.[3-5]
- Small water bodies (i.e. ponds and wetlands), contain large amounts of microplastics[6] relative to larger bodies of water (i.e. lakes and rivers).[7,8] Ponds and wetlands are home to a diverse community of aquatic organisms, including amphibians and their associated parasites.
- More studies are evaluating the effect of microplastics on wetland and pond aquatic organisms, but the effect on aquatic macroparasites has largely been ignored.

Questions:

1) Does the presence of PES microfibers affect parasite survival?
2) Does the presence of PES microfibers affect parasite's ability to infect a host?
3) Do we find plastic microfibers at wood frog breeding sites?

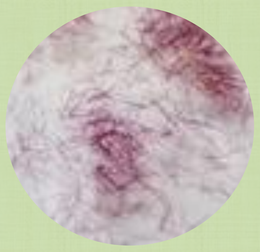
Model System:

Host
(Wood frog)

Disease

Parasite
(Trematode)

Environment
(MICROPLASTICS?)



Works Cited:

1. Wagner, et al. Envir*onmental Sciences Europe,* (2014), 26:12
2. Zhao, et al. *Environmental Pollution* 206, (2015) 597–604
3. Murphy, et al. *Environ. Sci. Technol.* 50, (2016) 5800–5808
4. DeFalco, et al. *Environmental Pollution* 236, (2018) 916-925
5. Hartline, et al. *Environ. Sci. Technol.* 50, (2016) 11532–11538
6. Hu, et al. *Environ. Sci. Technol.* 52, (2018) 8885–8893
7. Peng, et al. *Environmental Pollution* 234, (2017) 448–456
8. Wang, et al. *Sci. Total Environ* 575, (2017) 1369–1374
9. Erni-Cassola, et. al. *Environ. Sci. Technol*. 51, (2017), 13641–1364

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Methods:

Experiment 1

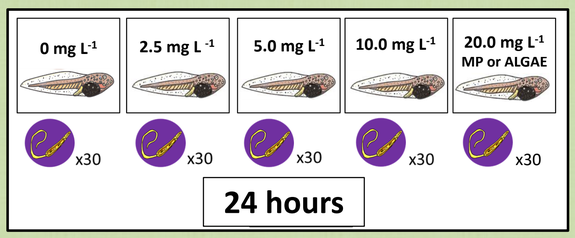
- Time-to-death assay: We individually placed trematode parasites in 30 ml water containing 0 (no fiber control), 2.5, 5, 10, 20 mg L^{-1} of PES microfibers and a "natural fiber" control- 20 mg L^{-1} fibrous algae.
- We recorded mortality every two hours until all cercariae died (30 hrs).

Experimental units for the time-to-death assay.

Trematode parasites and experimental PES microfibers under a microscope. Images captured at the Hua lab.

Experiment 2

- Infection assay: We placed a single tadpole in each of our 6 treatments, then added 30 trematode parasites per unit.



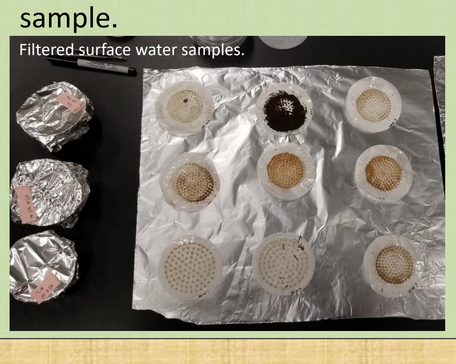
Experimental units for the parasite exposure assay.

- We terminated the experiment after 24 hours and counted the number of parasites that successfully encysted in the tadpole host.

Trematode encystment of the tadpole kidney. Photo captured by Vanessa Wuerthner in the Hua Lab.

Experiment 3

- We collected three 1 L surface water samples (0 to 10 cm in depth) from nine ponds utilized by amphibians in Pennsylvania, USA.
- Following methodologies validated by Erni-Cassola et. al. (2017)[9], we used a vacuum pump system, Nile Red fluorescent dye, and ImageJ to manually quantify and measure plastic microfibers in each sample.

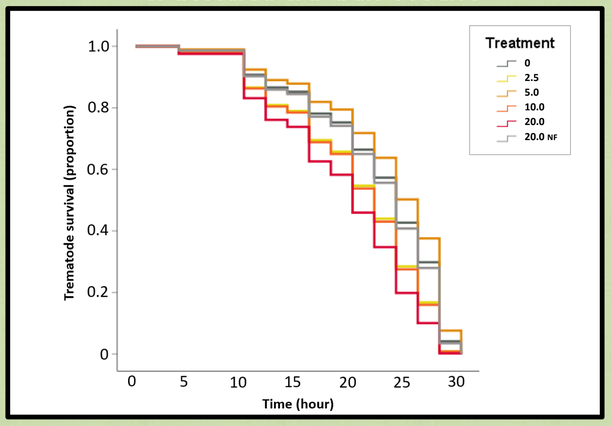


Filtered surface water samples.

Nile Red fluorescent dye.

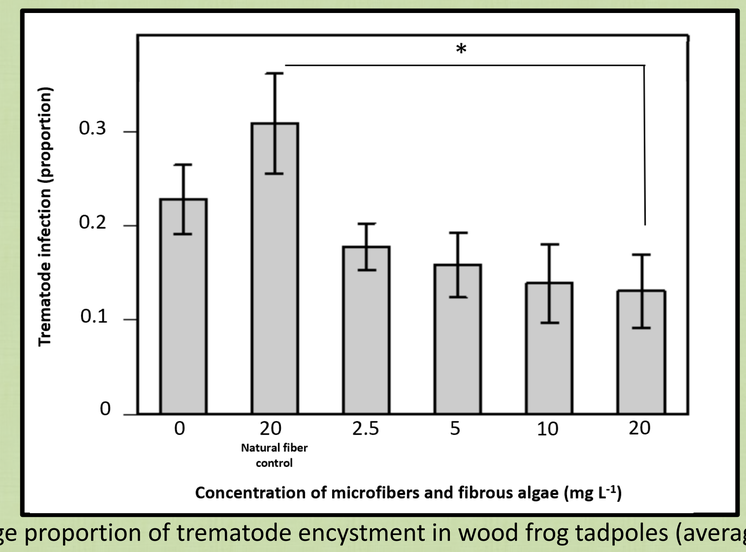
Results:

Q1: Does the presence of microplastics affect trematode survival?



Survival curve showing the proportion of survival across time of trematode cercariae exposed to four concentrations of PES microfibers (2.5, 5, 10 and 20 mg PES microfibers L-1), 20 mg L-1 natural fibers, and a water control.

Q2: Does the presence of microplastics affect trematodes ability to infect a host?

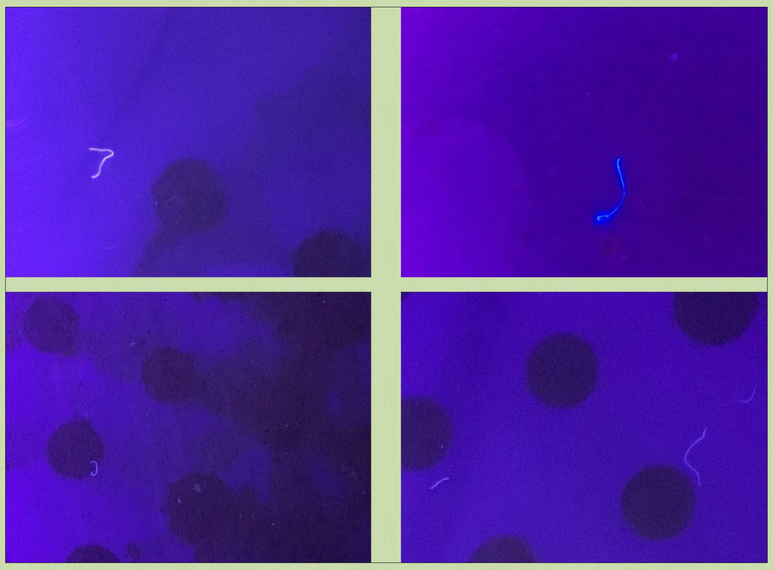


Average proportion of trematode encystment in wood frog tadpoles (average ± 1 SE) when both host and parasite are exposed to PES microfibers (2.5, 5, 10 and 20 mg PES microfibers L^{-1}), 20 mg L^{-1} natural fiber, and a water control.

Q3: Do we find plastic microfibers at wood frog breeding sites?

Site	Coordinates	Total number of fibers (3 L)	Average length (mm)	SE length (mm)
SQR	41°50.5′,80°14.4’	9	0.86	0.20
BJ	41°39.9′,80°30.8’	10	0.52	0.14
LOG	41°58.1′,79°36.1'	12	1.02	0.20
SKN	41°59.9′,79°46.5'	15	1.25	0.30
MIN	41°41.2’,80°25.6’	16	0.96	0.19
MAL	41°41.5′,80°30.1’	28	0.78	0.17
TRL	41°34.1′,81°27.1'	34	0.73	0.10
BOW	41°55.6′,79°48.2'	38	1.05	0.14
HOP	41°52.1′, 80°28.0′	47	0.82	0.08

Coordinates and microfiber data for nine ephemeral wetlands (wood frog breeding sites) in Pennsylvania, USA.



Up-close images of fluorescing microplastics found in water samples dyed with Nile Red, taken in the Hua Lab.

Conclusions:

- Microplastic presence does not affect trematode survival.
- The highest microplastic treatment reduced the ability for trematodes to infect their host compared to the natural fiber control.
- Plastic microfibers are ubiquitous in wood frog breeding sites.