The Presence of Microplastics in Hydrozoa and Ctenophora in Friday Harbor, WA

Julia Knopf[1,2]

Zoobot FHL 470: Research in Marine Biology
Spring 2024

[1]Friday Harbor Laboratories, University of Washington, Friday Harbor, WA 98250

[2]Department of Marine Biology, University of Washington, Seattle, WA, 98105

Contact Information:
Julia Knopf
Marine Biology Department
University of Washington
1410 NE Campus Pkwy
Seattle, Washington 98105
jaknopf@uw.edu

Keywords: Hydrozoa, *Clytia gregaria*, Ctenophora, *Pleurobrachia bachei*, Microplastics

Abstract

Plastics are an essential material for everyday life due to their durability and versatility but can break down into smaller pieces termed microplastics (<5mm). These fragments end up throughout the water column of the ocean and are consequently ingested by a variety of species leading to physical harm to the organism and introduction into the marine food web. Microplastics that float on the surface often cohabit with jellies, specifically hydrozoans and ctenophores. This study aims to observe whether hydrozoans, *Clytia gregaria*, and ctenophores, *Pleurobrachia bachei,* ingest microplastics which may indicate another pathway into the food web. Three experiments were conducted to test if the jellies would 1) ingest microplastic present exclusively, 2) ingest copepods, their natural food source, in a laboratory setting, and 3) ingest microplastics even in the presence of copepods. The results of the experiments showed that the jellies did ingest microplastics when presented to them. When there was a presence of microplastics and copepods, both species still ingested microplastics. Overall, this study demonstrates that *Clytia gregaria* and *Pleurobrachia bachei* will ingest microplastics, even in the presence of their natural prey. This thus illustrates these two species of jellies are a potential route for microplastics to enter the food web.

Introduction

It has been estimated that 10 million tons of plastic enter the global marine environment annually due to mismanagement of waste (Boucher and Billard, 2019). Of this amount, an average of approximately 6,300 microplastics/km^2 float on the surface of the oceans (Choy et al., 2019; Bohdan, 2022). The term “microplastics” is used to categorize plastics of less than 5mm in diameter that are derived from the fragmentation of larger plastic debris. This includes polyester

fibers from fabrics and polyethylene fragments from plastic bags which are two resources that many use daily (Cole et al., 2011).

The small size of microplastics makes them an environmental concern as they can be ingested by a large range of marine organisms. Studies done with mussels, *Mytilus edulis*, have already demonstrated that ingestion of microplastics can result in adverse biological effects such as physically limiting food intake as well as eventually translocating from the gut into the circulatory system, both of which can cause death (Browne et al., 2007; Harris and Carrington, 2021). Also, microplastics may introduce or concentrate environmental toxins such as PCBs into affected organisms and human food webs (Van Cauwenberghe and Janssen, 2014).

Though the effects of microplastics have been documented in a variety of marine organisms, there has been less research into how these contaminants may impact jellies, which make up an important percentage of ocean biomass as necessary planktonic consumers (Cole et al., 2011). The large abundance of both jellies and microplastics in the water column results in a high probability of interactions between the two as both have been sampled together in ocean surface trawls (Collignon et al., 2012; Devereux et al., 2021). Jellies like hydrozoans and ctenophores are important contributors to trophic interactions since they display a wide range of feeding mechanisms including filter feeding, suspension feeding, and predation (Ates, 2017).

This study aims to observe whether the hydrozoan species, *Clytia gregaria* (*C. gregaria*) and the ctenophore species, *Pleurobrachia bachei* (*P. bachei*) willingly consume or confuse microplastics with prey, resulting in another route of toxins into the marine food web. Feeding experiments were performed to compare whether 1) the jellies readily ingest microplastics if present exclusively in the water column, and 2) if they ingest microplastics in the presence of their natural prey, copepods. A control experiment was also performed in which the copepods

were the only factor introduced to the hydrozoans and ctenophores. It is predicted that both *C. gregaria* and *P. bachei* will ingest microplastics as they are voracious and opportunistic suspension feeders irrespective of different modes of feeding behavior i.e. *C. gregaria* acting as a cruising predator while *P. bachei* as a passive sit-and-wait predator (Mataskis, 1993; Yip, 1984). However, if copepods are present, they will not ingest microplastics as it is likely that they will prefer what they normally eat.

Materials and Methods

Collection and Maintenance of Experimental Organisms

A total of 36 *C. gregaria* ranging in size up to 2.5 cm and 36 *P. bachei* up to 2 cm were collected from the University of Washington Friday Harbor Laboratories' (FHL) dock (48.54542°N, -123.01218°W) (Figure 1).

Figure 1 Map of the University of Washinton's Friday Harbor Labs

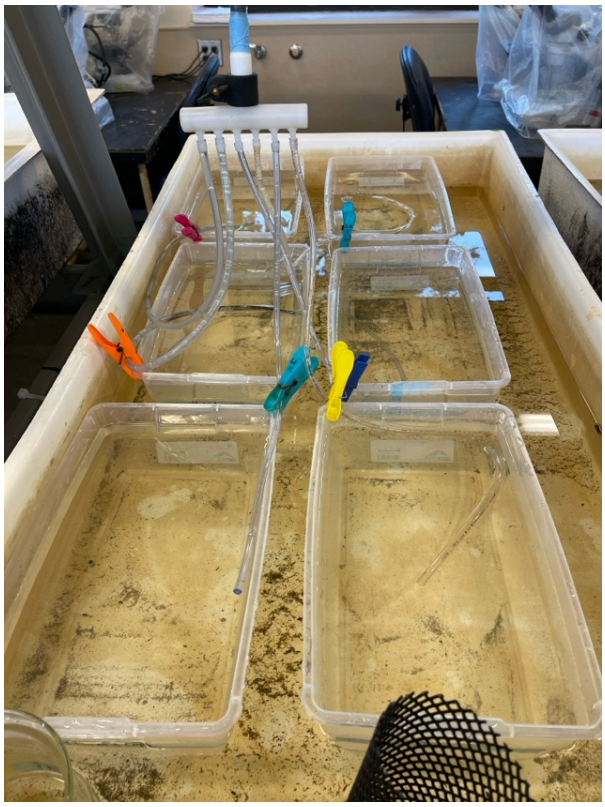


Figure 2 Tank Set-up

Both species were collected in increments of 12 as each experiment was to be repeated three times to ensure accurate results (4 organisms per test treatment x 3 trials). A 400 mL plastic beaker attached to a pole was used to collect each individual from the water's surface and then they were held in a plastic bucket filled ¾ of the way with seawater. The organisms were transported to a large tank located in one of FHL's lab facilities. The large tank providing a continuous water flow of 11°C, held six smaller 5.7 L plastic containers to be later used for the experiments. Each plastic container had two holes drilled into it to be an exit for the continuous water flow. A 720-micron filter covered each of these holes to ensure that only water would exit (Figure 2). The hydrozoans and ctenophores were transferred from the dock collection bucket by use of a 100 mL glass beaker into groups of four of each species within labeled plastic containers filled with a continuous flow of filtered seawater. The containers were labeled according to the treatment and which particular species was located there. As they were being separated, each individual was examined under a dissection microscope to see if any copepods were stuck to them. If there was, a Dumont Tweezer #5 was used to remove them. This was to ensure that their gastrovascular cavity, in which digestion occurs, was empty before the treatment trials began. The organisms were held in the experimental containers for a period of 6 hours to acclimate to the laboratory environment (Scoulardi et al., 2006). Copepods (*Calanus sp*.) used

for feeding trials were also collected from the FHL dock using a 3mm mesh phytoplankton net and placed in a separate bucket from the ctenophores and hydrozoans. They were then also transported to the lab's larger tank and placed in their own smaller plastic container until experiments were ready (Figure 3).

Test Variables: Microplastic and Copepod Preparation

As copepods have a high density on the surface of the ocean, it was determined to introduce approximately 1000 copepods to each tank involved in the experiments (Tang et al., 2022). The weights of single copepods were measured and averaged to 0.0184 g per organism, so 18.4 g of copepod solution was generated for each trial due to the estimation that it would provide approximately 1000 copepods. The 18.4 g was weighed out using an 80 mL beaker in which 20 mL of solution was measured.

Given the published statistic of microplastic density by Bohdan (2022) of 6,300 microplastics/km^2, a relative density for the experimental test tanks would be $4.6x10^{-4}$ microplastics/tank. Given the result is not a testable amount of microplastics per tank, it was decided to increase the microplastic density to a higher amount that would allow for measurable events to be recorded during the allotted experimental time. Given that approximately, 1000 copepods were

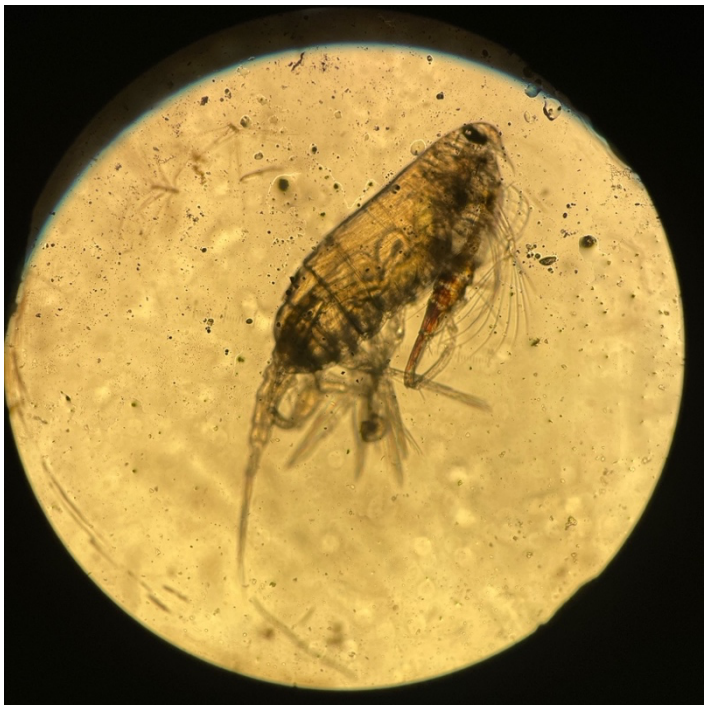


Figure 3 Copepod (*Calanus sp.)* under a microscope of 20x magnification

being used for each experimental tank, it was decided that also 1000 pieces of microplastics would be used. The microplastics used were cut from a polyethylene plastic container top of 1 mm thickness to a size of 2mm x 2mm to approximate be the same dimensions as their prey, copepods. Then 100 pieces were counted and weighed to be approximately 0.3 g. A total of 3 g was then weighed out to result in about 1000 pieces of microplastics introduced per trial.

Tanks and Trial Set-Up

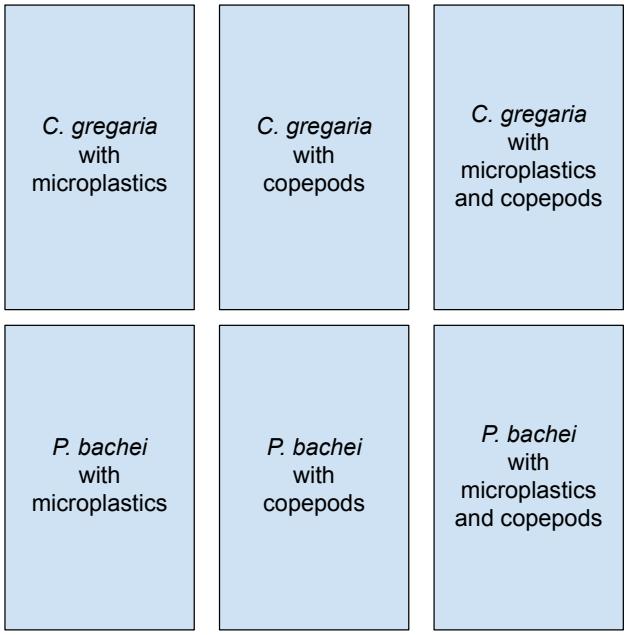


Figure 4 Experimental Tanks Layout

Six 5.7 L tanks were prepared for 3 different experiments of introducing 1) microplastics only with each species, 2) copepods only with each species, and 3) copepods and microplastics with each species (Figure 4). The first treatment of microplastics with each species was to test whether the plastics would be detected as a food source and attempted to be ingested. Two containers were used where one held four *C. gregaria* and the other held four *P. bachei.* The 3 g of 1000 microplastic pieces were then added to each of the tanks. The second treatment of copepods with each species was to test if the organisms still fed off their natural prey in an experimental condition. Two containers were also used for this experiment to test the difference between species in which four *C. gregaria* and four *P. bachei* were added. The 20 mL of copepod solution was added to the experimental tanks. The third treatment was to test if each species still ingested microplastics

even in the presence of copepods. This was done by adding the same amounts from experiments 1 and 2, of 3 g of microplastics and 20 mL of copepods into the third set of tanks.

Trials

Each experimental trial ran for 8 hours as this is the predicted amount of time for copepods and hydrozoans to capture and ingest their copepod prey (Tarí et al., 2019). After this period was complete, each individual jelly was separated and examined under a dissection microscope for ingestion of copepods and/or microplastics. The number of individual jellies that ingested microplastics and/or copepods as well as how many of each per jelly were counted and recorded. The gastrovascular cavities were then cleared, followed by the weighing of each individual jelly. After the completion of measurements, every jelly was released back to the same location off of FHL's dock where they were originally collected. Ingested as well as unused copepods were also released at the same collection location on the FHL dock. Plastic containers with microplastics were filtered using a 1mm strainer. The three experiments were then replicated twice more to ensure accurate results.

Data Analysis

For experiment 1, the number of jellies of each species that ingested microplastics in the absence of copepods was counted from the total of 12 tested to generate a percentage of microplastic ingestion. For experiment 2, the number of jellies of each species that ingested copepods was counted out of 12 and then converted into a percentage of copepod ingestion. For treatment 3, the number of jellies that ingested microplastics in the presence of copepods was counted and then converted into a percentage of microplastic ingestion as well as a percentage of

copepod ingestion. A chi-squared test was then used to compare experiment 1 and experiment 3 to see if the ingestion of microplastics in the presence or absence of copepods was related or independent.

Results

Experiment 1 showed that when *P. bachei* was exposed to just microplastics, 3 out of 12 or 25% ingested at least one piece. The number of ingested pieces ranged from 1 to 2 per individual. 9 individuals of this species didn't ingest any microplastics (Table 1, Figure 5). Additionally, when *C. gregaria* was exposed to just microplastics, 5 out of 12 or 42% ingested at least one piece. The range of microplastic pieces ingested included 1 to 2 per individual. 7 hydrozoans didn't ingest any microplastics (Table 1, Figure 5). This demonstrates that when microplastics are present, some jellies will catch and ingest them.

Table 1 Experiment 1 data

	Species	Weight of Jelly (g)	Ingestion (Y/N)	Microplastic Pieces
Trial 1				
	Pleurobrachia 1	1.3701	N	0
	Pleurobrachia 2	1.1433	N	0
	Pleurobrachia 3	0.783	Y	1
	Pleurobrachia 4	0.6887	N	0
Trial 2				
	Pleurobrachia 1	0.9528	N	0
	Pleurobrachia 2	1.1563	N	0
	Pleurobrachia 3	1.3625	N	0
	Pleurobrachia 4	0.8235	N	0
Trial 3				
	Pleurobrachia 1	1.4251	Y	2
	Pleurobrachia 2	0.6284	N	0
	Pleurobrachia 3	0.735	N	0
	Pleurobrachia 4	0.9482	Y	1
Trial 1	Clytia 1	0.6781	Y	1
	Clytia 2	0.7923	Y	1
	Clytia 3	0.5324	N	0
	Clytia 4	0.3263	N	0
Trial 2				
	Clytia 1	0.4634	N	0
	Clytia 2	0.5043	Y	1
	Clytia 3	0.349	N	0
	Clytia 4	0.5246	N	0
Trial 3				
	Clytia 1	0.6923	Y	2
	Clytia 2	0.5692	Y	1
	Clytia 3	0.5241	N	0
	Clytia 4	0.4623	N	0

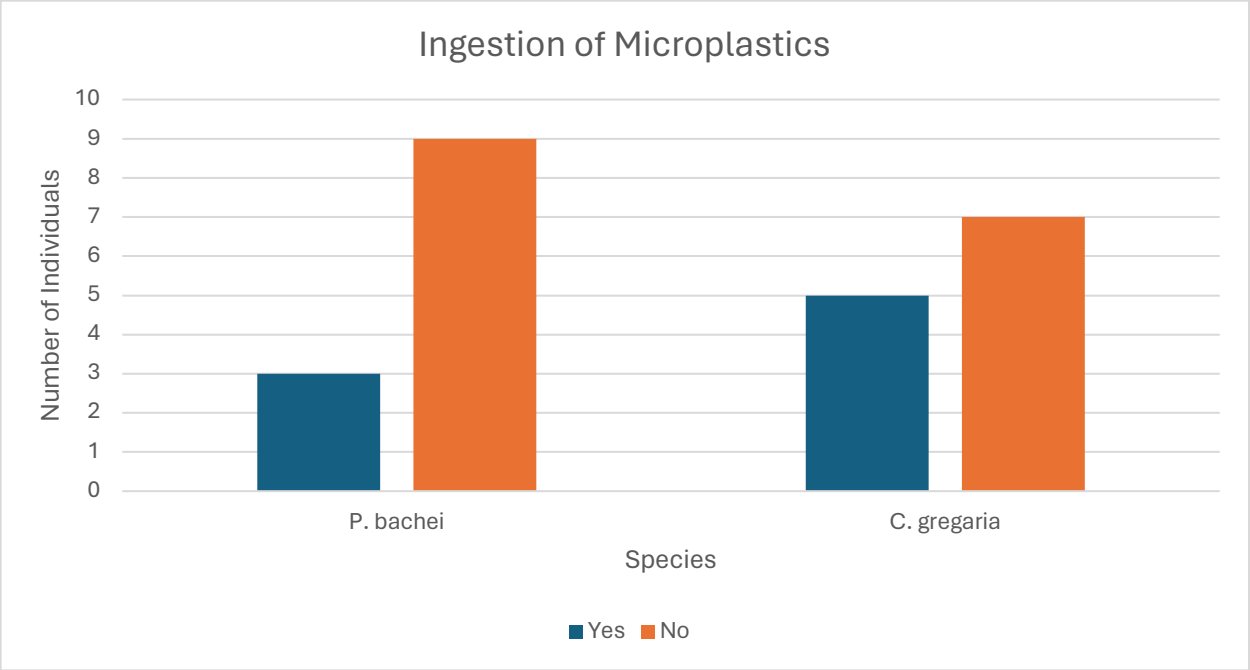


Figure 5 Number of individuals for each species that did or did not ingest microplastics

Experiment 2 revealed that when *P. bachei* was exposed to just copepods, 7 out of the 12, or 58% ingested at least one. The range in the number of copepods was 1 to 3 per individual. 5 individuals out of the 12 did not ingest any copepods. Similarly, for *C. gregaria*, identical results were obtained where 7 out of 12, or 58% also ingested at least one copepod again ranging from 1 to 3 per individual (Figure 6, Table 2). This data confirms that even in the experimental conditions used in the present study, jellies continue to consume their usual prey.

Table 2 Experiment 2 data

	Species	Weight of Jelly (g)	Ingestion (Y/N)	Copepods
Trial 1				
	Pleurobrachia 1	0.4306	N	0
	Pleurobrachia 2	1.0306	Y	1
	Pleurobrachia 3	0.8158	N	0
	Pleurobrachia 4	0.753	N	0
Trial 2				
	Pleurobrachia 1	0.6492	Y	1
	Pleurobrachia 2	0.9832	Y	1
	Pleurobrachia 3	0.8424	Y	1
	Pleurobrachia 4	1.2334	Y	3
Trial 3				
	Pleurobrachia 1	1.3622	Y	2
	Pleurobrachia 2	1.0324	Y	1
	Pleurobrachia 3	0.7834	N	0
	Pleurobrachia 4	0.8934	N	0
Trial 1				
	Clytia 1	0.4924	N	0
	Clytia 2	0.5692	Y	2
	Clytia 3	0.7342	Y	3
	Clytia 4	0.4892	N	0
Trial 2				
	Clytia 1	0.7234	N	0
	Clytia 2	0.6245	Y	1
	Clytia 3	0.4562	Y	1
	Clytia 4	0.3942	N	0
Trial 3				
	Clytia 1	0.8234	Y	3
	Clytia 2	0.4673	N	0
	Clytia 3	0.5734	Y	1
	Clytia 4	0.6843	Y	2

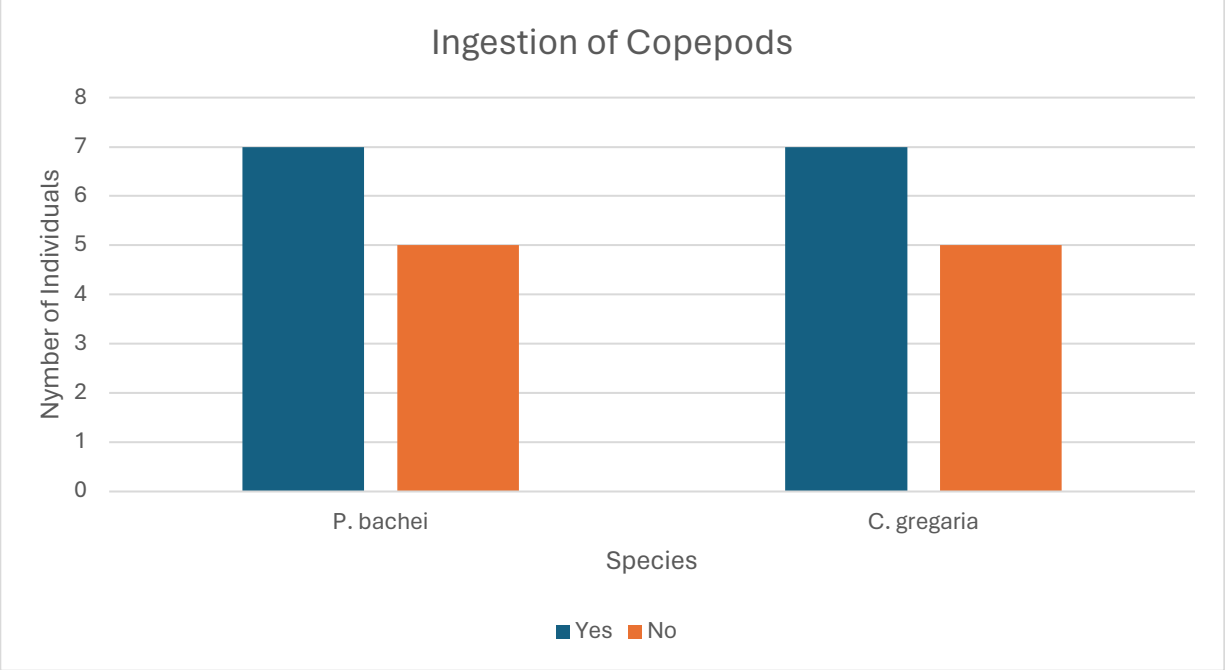


Figure 6 Number of individuals for each species that did or did not ingest copepods

Experiment 3 determined if *P. bachei* and *C. gregaria* would consume microplastics when copepods were present. It was found that when copepods were present, 5 out of 12 or 62.5% of *P. bachei* ingested microplastics. 4 jellies ingested copepods and 3 didn't ingest either the microplastics or copepods. For *C. gregaria,* 7 out of 12 or 67% ingested microplastics. Four ingested copepods, 1 didn't ingest either the microplastics or copepods and 1 ingested both. (Table 3, Figure 7). These statistics describe that even if copepods were present, so jellies still ingest microplastics.

Table 3 Experiment 3 data

	Species	Weight of Jelly (g)	Microplastics	Copepods
Trial 1				
	Pleurobrachia 1	1.4552	2	0
	Pleurobrachia 2	0.8258	1	0
	Pleurobrachia 3	0.6173	0	0
	Pleurobrachia 4	0.7743	0	1
Trial 2				
	Pleurobrachia 1	0.5683	0	0
	Pleurobrachia 2	0.9343	0	2
	Pleurobrachia 3	1.4523	3	0
	Pleurobrachia 4	1.0324	0	1
Trial 3				
	Pleurobrachia 1	0.9251	0	0
	Pleurobrachia 2	0.8732	0	1
	Pleurobrachia 3	1.2931	2	0
	Pleurobrachia 4	1.1452	2	0
Trial 1				
	Clytia 1	0.7839	3	0
	Clytia 2	0.5671	0	2
	Clytia 3	0.6213	0	2
	Clytia 4	0.6241	1	0
Trial 2				
	Clytia 1	0.7823	2	1
	Clytia 2	0.5628	2	0
	Clytia 3	0.5294	3	0
	Clytia 4	0.4804	0	1
Trial 3				
	Clytia 1	0.6821	1	0
	Clytia 2	0.6924	0	0
	Clytia 3	0.5783	2	0
	Clytia 4	0.7843	4	0

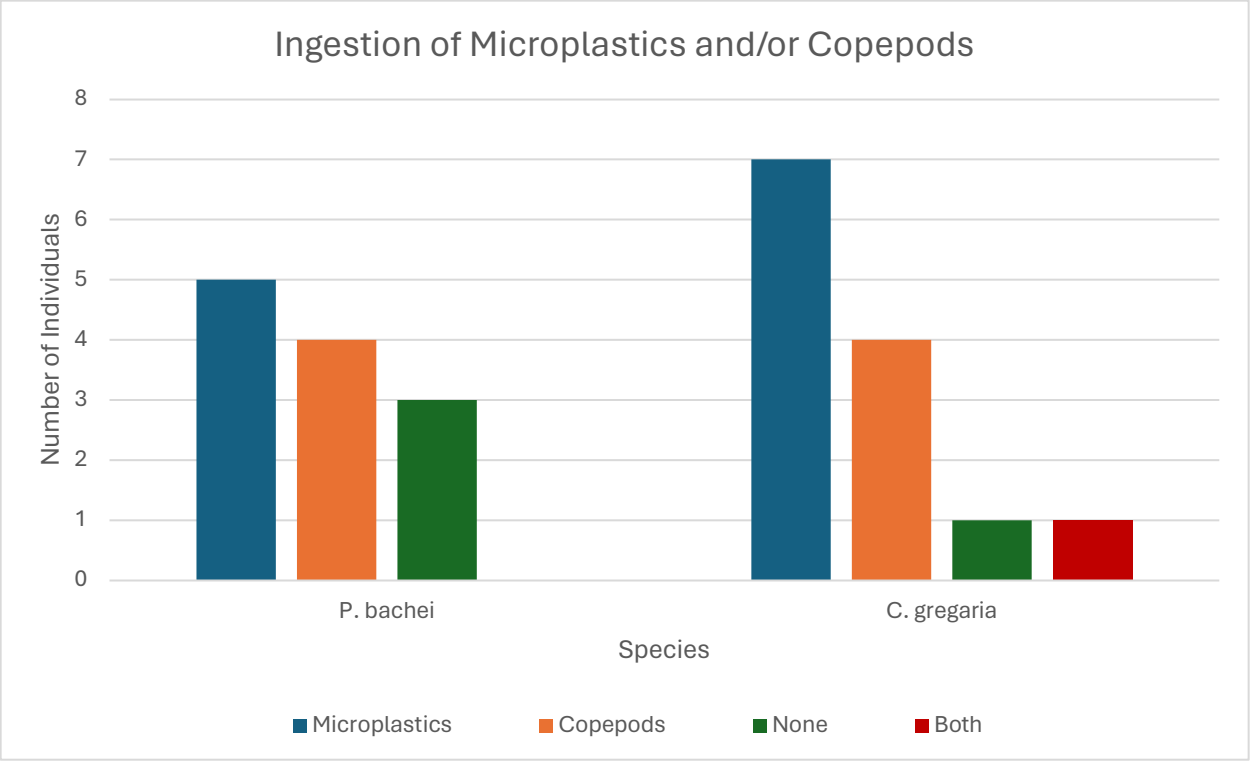


Figure 7 Number of individuals that ingested microplastics and/or copepods

A chi-square test was conducted to see if actual data matched the null hypothesis that both species of jellies would not eat microplastics in the presence of copepods in which expected values of 100% of both species would eat microplastics if copepods were absent and 100% of both species would not eat microplastics. The p-value for *P. bachei* was < 0.05 demonstrating that this data is statistically significant, and the null hypothesis should be rejected (Table 4). The p-value for *C. gregaria* was < 0.05 showing that this data is statistically significant, and the null hypothesis should be rejected (Table 5).

Table 4 Chi-square test for *P. bachei*

P. bachei					
	Actual				
		Jellies with MP	Jellies w/o Microplastics		P-value
	Copepods Present	0.625	0.375		6.817E-209
	Copepods Absent	0.25	0.75		
	Expected				
		Jellies with MP	Jellies w/o Microplastics		
	Copepods Present	0.001	1		
	Copepods Absent	1	0.001		

Table 5 Chi-square test for *C. gregaria*

C. gregaria					
	Actual				
		Jellies with MP	Jellies w/o Microplastics		P-value
	Copepods Present	0.67	0.33		1.998E-172
	Copepods Absent	0.42	0.58		
	Expected				
		Jellies with MP	Jellies w/o Microplastics		
	Copepods Present	0.001	1		
	Copepods Absent	1	0.001		

Discussion

The feeding behavior of *P. bachei* can be termed "sit-and-wait" due to their passive predatory method which they extend their two tentacles until something becomes ensnared (Haddock, 2007; Gibbons and Painting, 1992). This method was successful as the data supports that *P. bachei* ingested microplastics and/or copepods. However, their feeding behavior also depends on the motion of their prey as they prefer slower swimming speeds (Greene et al., 1986). This is consistent with the result that 62.5% of *P. bachei* ingested microplastics even in the presence of copepods as microplastics move at the same speed as the water's current. Copepods create water flows through the beating of their antennae providing additional

propulsion to the water current's speed resulting in faster swimming speeds than the microplastics (Jiang and Osborn, 2004).

C. gregaria can be described as cruising predators as they create feeding currents around themselves due to their movement pattern of contracting their bell. Additionally, the nematocysts, stinging cells, located on their tentacles assist with the capture of moving prey such as copepods through the injection of venom causing paralysis (Costello and Colin, 2002). This reasoning supports the results showing copepods were ingested by *C. gregaria* even in a lab setting. *C. gregaria* also are more active feeders than *P. bachei* which possibly explains why they caught either the same amount or more copepods and microplastics.

The chi-square test returned a value less than 0.05 in the test trials of experiment 3 for *P. bachei*, implying that the experimental results are statistically significant. Additionally, the chi-square test of the test trials for *C. gregaria* also returned a value less than 0.05, again indicating that these results are also statistically significant. In summary, the result that each species ingested microplastics even in the presence of copepods is significant. This may be due to the chemical and physical properties of the polyethylene microplastics causing nematocysts of *C. gregaria* and colloblasts of *P. bachei* to mistake it as food (Macali et al., 2018).

Even though the chi-square test showed that the data was statistically significant, the expected values were based on background reasoning instead of preliminary experiments. Preliminary experiments could provide more accurate data, but due to a constraint of time, a prediction for expected values was used. Another possible source of error could be due to the initial test conditions introducing four organisms into the test tanks, where predation behaviors and interactions between individuals could have affected feeding activity. Also, this study had a

relatively small sample size and number of trials therefore increasing sample size and trial number would provide more accurate results.

The data highlights the vulnerability of jellies to plastic pollution especially to microplastics found floating on the ocean's surface. This is especially relevant as it was discovered that jellies would still ingest microplastics when copepods were present, given this is a realistic representation of their natural environment. There is also a great diversity of other hydrozoans and ctenophores located at the surface of the ocean, indicating this study could be extended to include additional species of ctenophores and hydrozoans. Additionally, the question of how early microplastics could enter the food web, i.e. within the jellies' prey such as copepods could also be tested for ingestion. Further research is needed to understand the extent of trophic transfer of microplastics as this study has shown the potential for jellies like hydrozoans and ctenophores to be a reasonable source of entry.

Acknowledgments

I would like to thank the University of Washington's Friday Harbor Laboratories for providing me with an opportunity and space to conduct this research project. I would also like to thank Jack Bell, Lyda Harris, Emily Carrington, Megan Dethier, and Claudia Mills for mentoring me throughout this project. Also, thank you to Spencer Fire for guiding me through my research, especially with the writing of this report. Finally, I would like to thank Grace Fujita and Aakriti Vijay for their help in collecting the hydrozoans and ctenophores.

References

Bohdan, K. (2022). Estimating global marine surface microplastic abundance: Systematic literature review. *Science of The Total Environment*, *832*, 155064. https://doi.org/10.1016/j.scitotenv.2022.155064

Boucher, J., & Billard, G. (2019). The challenges of measuring plastic pollution. *Field Actions Science Reports. The Journal of Field Actions*, (Special Issue 19), 68-75.

Browne, M. A., Galloway, T., & Thompson, R. (2007). Microplastic—An Emerging Contaminant of Potential Concern? Integrated Environmental Assessment and Management, 3(4), 559–561. https://doi.org/10.1002/ieam.5630030215

Choy, C.A., Robison, B.H., Gagne, T.O. *et al.* The vertical distribution and biological transport of marine microplastics across the epipelagic and mesopelagic water column. *Sci Rep* 9, 7843 (2019). https://doi.org/10.1038/s41598-019-44117-2

Cole, M., Lindeque, P., Halsband, C., & Galloway, T. S. (2011). Microplastics as contaminants in the marine environment: A review. Marine Pollution Bulletin, 62(12), 2588–2597. https://doi.org/10.1016/j.marpolbul.2011.09.025

Collignon, A., Hecq, J., Glagani, F., Voisin, P., Collard, F., & Goffart, A. (2012). Neustonic microplastic and zooplankton in the North Western Mediterranean Sea. *Marine Pollution Bulletin*, *64*(4), 861-864. https://doi.org/10.1016/j.marpolbul.2012.01.011

Costello, J. H., & Colin, S. P. (2002). Prey resource use by coexistent hydromedusae from Friday Harbor, Washington. *Limnology and Oceanography*, *47*(4), 934-942. https://doi.org/10.4319/lo.2002.47.4.0934

Devereux, R., Hartl, M. G., Bell, M., & Capper, A. (2021). The abundance of microplastics in cnidaria and ctenophora in the North Sea. *Marine Pollution Bulletin*, *173*, 112992. https://doi.org/10.1016/j.marpolbul.2021.112992

Gibbons, M., & Painting, S. (1992). The effects and implications of container volume on clearance rates of the ambush entangling predator Pleurobrachia pileus (Ctenophora: Tentaculata). *Journal of Experimental Marine Biology and Ecology*, *163*(2), 199-208. https://doi.org/10.1016/0022-0981(92)90049-G

Greene, C. H., Landry, M. R., & Monger, B. C. (1986). Foraging Behavior and Prey Selection by the Ambush Entangling Predator Pleurobrachia Bachei. *Ecology*, *67*(6), 1493-1501. https://doi.org/10.2307/1939080

Haddock, S. H. (2007). Comparative feeding behavior of planktonic ctenophores. *Integrative and Comparative Biology*, *47*(6), 847-853. https://doi.org/10.1093/icb/icm088

Harris, L. S., Gill, H., & Carrington, E. (2021). Microplastic changes the sinking and resuspension rates of marine mussel biodeposits. *Marine Pollution Bulletin*, *165*, 112165. https://doi.org/10.1016/j.marpolbul.2021.112165

Jiang, H., Osborn, T.R. Hydrodynamics of Copepods: A Review. *Surv Geophys* **25**, 339–370 (2004). https://doi.org/10.1007/s10712-003-1282-6

Macali, A., Semenov, A., Venuti, V., Crupi, V., Rossi, B., Corsi, I., & Bergami, E. (2018). Episodic records of jellyfish ingestion of plastic items reveal a novel pathway for trophic transference of marine litter. *Scientific Reports*, *8*. https://doi.org/10.1038/s41598-018-24427-7

Matsakis, S. (1993). Growth of Clytia spp. Hydromedusae (Cnidaria, Thecata): Effects of temperature and food availability. *Journal of Experimental Marine Biology and Ecology*, *171*(1), 107-118. https://doi.org/10.1016/0022-0981(93)90143-C

Ates, R. (2017) Benthic scavengers and predators of jellyfish, material for a review, Plankton and Benthos Research, Volume 12, Issue 1, Pages 71-77, https://doi.org/10.3800/pbr.12.71

Scolardi, K. M. , Daly, K. L. , Pakhomov, E. A. and Torres, J. J. (2006): Feeding ecology and metabolism of the Antarctic cydippid ctenophore Callianira antarctica , Marine Ecology Progress Series, 317 , pp. 111-126

Tang, Q., Yang, J., & Sun, D. (2022). Functional diversity of copepod assemblages along a basin-scale latitudinal gradient in the North Pacific Ocean. *Ecological Indicators*, *141*, 109112. https://doi.org/10.1016/j.ecolind.2022.109112

Tarí, J., Herrera, A., Gómez, M., Martínez, I., & Bondyale-Juez, D. R. (2019). Impact of microplastics in jellyfish.

Van Cauwenberghe, L., & Janssen, C. R. (2014). Microplastics in bivalves cultured for human consumption. Environmental Pollution, 193, 65–70. https://doi.org/10.1016/j.envpol.2014.06.010

Yip, S. Y. (1984). The Feeding of Pleurobrachia pileus Müller (Ctenophora) from Galway Bay. *Proceedings of the Royal Irish Academy. Section B: Biological, Geological, and Chemical Science*, *84B*, 109–122. http://www.jstor.org/stable/20494438

University of Washington Libraries Non-Exclusive Distribution License

In order for the University of Libraries to reproduce, translate and distribute your submission worldwide your agreement to the following terms is necessary. Please take a moment to read the terms of this license, fill in the information requested, and sign and submit this license to the University Libraries.

By signing and submitting this license, you (the author(s) or copyright owner) grant to the University of Washington (UW) the non-exclusive right to reproduce, translate (as defined below), and/or distribute your submission (including the abstract) worldwide in print and electronic format and in any medium, including but not limited to, audio or video.

You agree that the UW may, without changing the content, translate the submission to any medium or format for the purpose of preservation.

You also agree that the UW may keep more than one copy of this submission for the purposes of security, backup and preservation.

You represent that the submission is your original work, and that you have the right to grant the rights contained in this license. You also represent that your submission does not, to the best of your knowledge, infringe upon anyone's copyright.

If the submission contains material for which you do not hold copyright, you represent that you have obtained the unrestricted permission of the copyright holder to grant UW the rights required by this license, and that such third-party owned material is clearly identified and acknowledged within the text or content of the submission.

The UW Libraries reserves the right to add or edit metadata for the purpose of access, clarification and/or preservation.

IF THE SUBMISSION IS BASED UPON WORK THAT HAS BEEN SPONSORED OR SUPPORTED BY AN AGENCY OR ORGANIZATION OTHER THAN THE UW, YOU REPRESENT THAT YOU HAVE FULFILLED ANY RIGHT OR REVIEW OR OTHER OBLIGATIONS REQUIRED BY SUCH CONTRACT OR AGREEMENT.

UW will clearly identify your name(s) as the author(s) or owner(s) of the submission, and will not make any alteration, other than allowed by this license, to this submission.

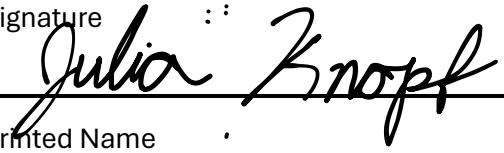
Licensor:

University of Washington

Title of work

The Presence of Microplastics in Hydrozoa and Ctenophora in Friday Harbor, WA

Signature



Date

5/28/24

Printed Name

Julia Knopf