Effect of prey species and concentration on the feeding rate of the dinoflagellate, *Oxyrrhis marina*

Kaylee DiPasquale[1], Gabriela Smalley, Ph.D.[1]

[1]Department of Geological, Environmental, and Marine Sciences, Rider University

Introduction

Phytoplankton are the basis of the marine food web, known to be the key producers contributing to primary production in the ocean. The microbial food web consists of phytoplankton (autotrophic producers) and the zooplankton who feed upon them (primary consumers). Prey species, prey size, and prey availability, can affect feeding rates of zooplankton on phytoplankton prey.

This study was conducted to improve the understanding of how prey species and concentration affect the feeding rate of *Oxyrrhis marina,* a heterotrophic dinoflagellate (Figure 1).

Objectives:

(1) measure the prey saturation of *Oxyrrhis marina* when feeding on *Isochrysis galbana* at different predator:prey ratios

(2) measure the feeding rates of *Oxyrrhis marina* on *Isochrysis galbana*, *Phaeocystis globosa,* and *Skeletonema marinoi*

Methods

Experiment 1: different predator:prey ratios

- Predator-to-prey ratios of 1:100, 250, 500, and 750
- Subsamples were removed every 20 minutes for two hours
- Preserved using glutaraldehyde (2% final concentration)

Experiment 2: different prey species

- Prey species *Isochrysis galbana*, *Phaeocystis globosa,* and *Skeletonema marinoi* were added at a predator:prey ratio of 1:500
- *S. marinoi* was sonicated for 3 seconds to break apart the chain structure of the organism before adding it to the experiment
- Samples were collected every 20 minutes for one hour

Sample analysis

- Feeding by *O. marina* was determined using florescent microscopy to count number of ingested prey over time (Figure 2)
- Feeding rate was calculated using linear regression
- Univariate General Linear Model was used to determine significant differences between rates (SPSS)

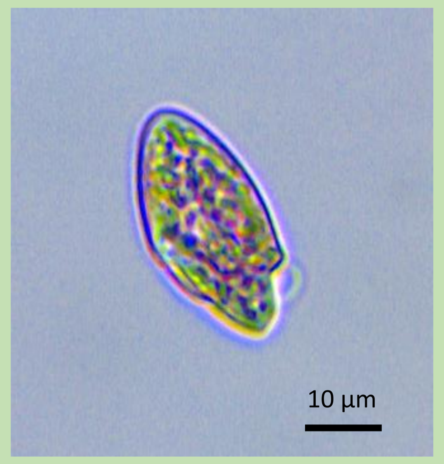

Figure 1. Predator species, *O. marina* (400x magnification)

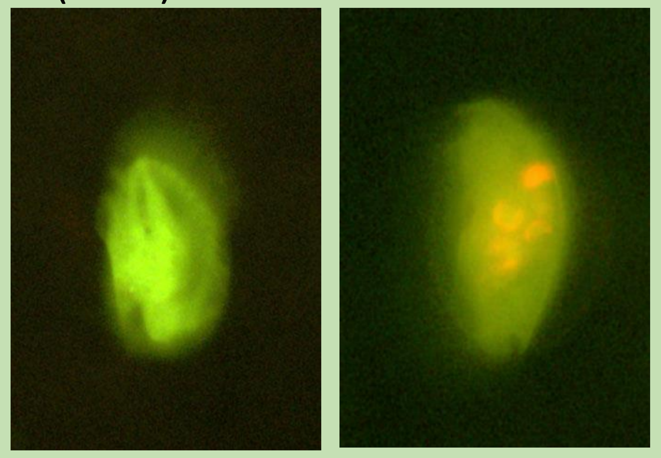

Figure 2. *Euplotes* under fluorescent microscope, pictured on the right with no food cells and on the left with five *I. galbana* cells in the food vacuole.

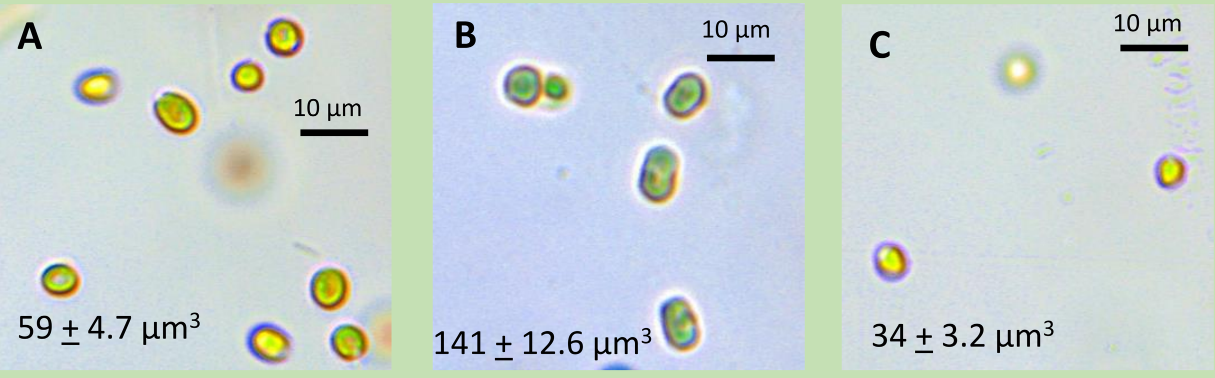

Figure 3. Prey species used for feeding experiments. **A.** *I. galbana,* **B.** *S. marinoi,* **C.** *P. globosa* (numbers represent cell volume ± SE; 400x magnification)

Results

Experiment 1: different predator:prey ratios

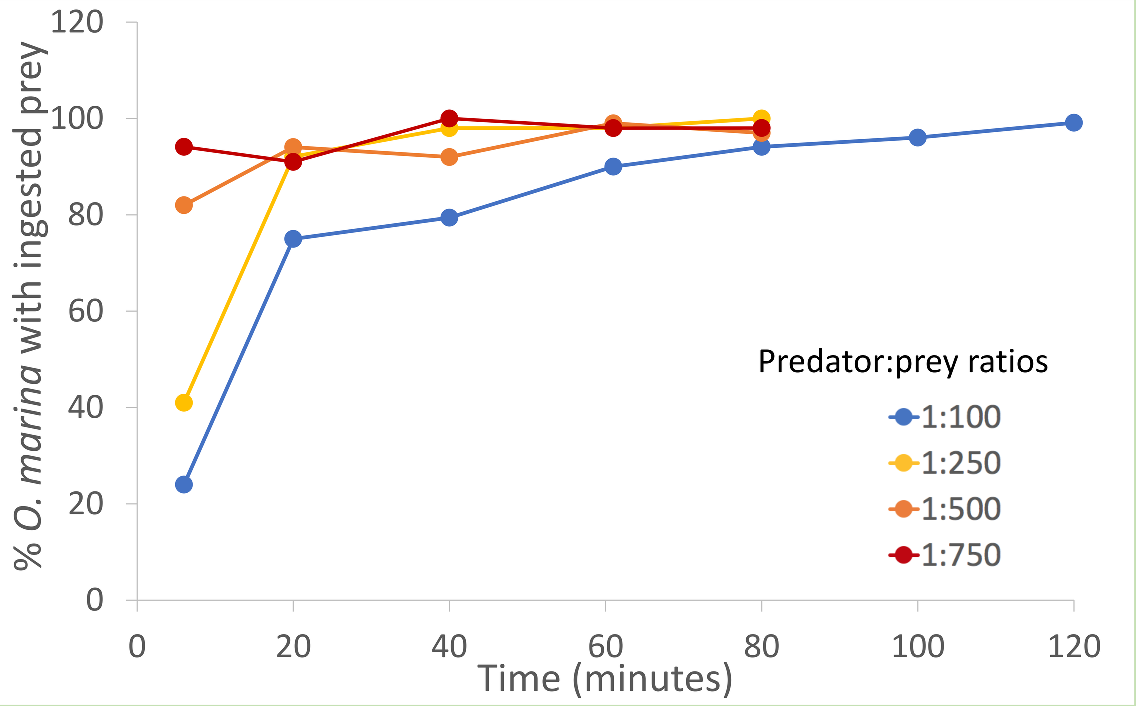

Figure 4. Percentage of *O. marina* that fed on *I. galbana* over time at different predator:prey ratios.

Nearly 100% of *O. marina* contained food after 40 min at ratios of 1:250, 1:500, and 1:750 and after 120 min for 1:100.

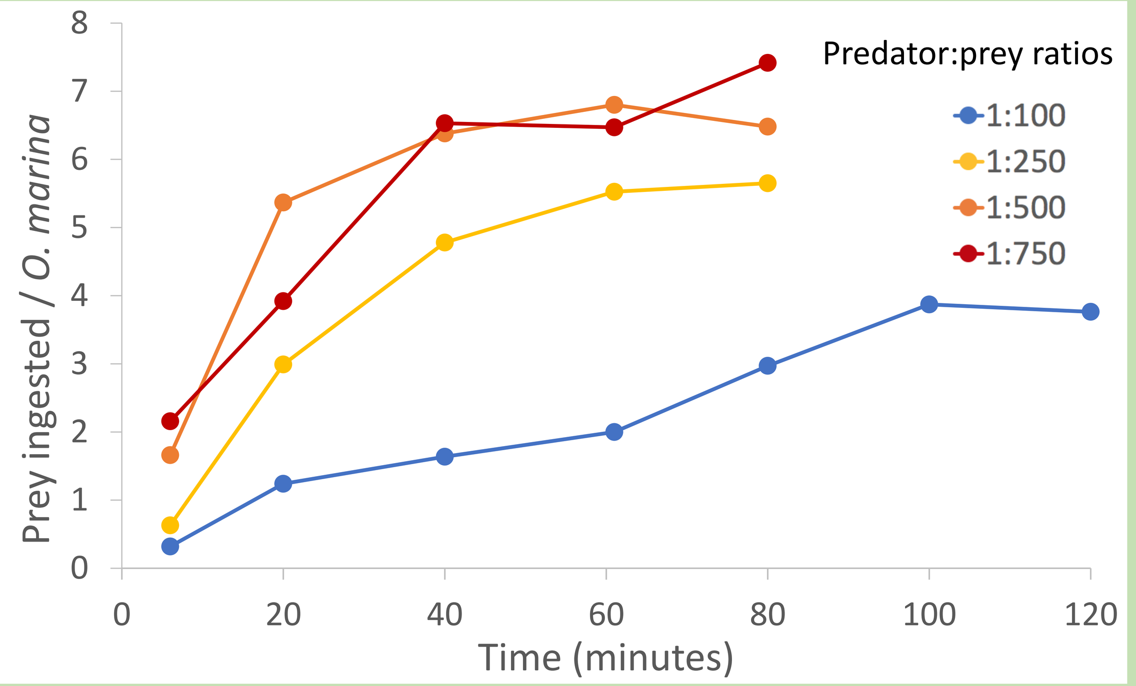

Figure 5. *Isochrysis galbana* cells consumed by *O. marina* over time at different predator:prey ratios.

O. marina reached prey saturation after 40 min at ratios of 1:250, 1:500, and 1:750 and after 100 min for 1:100.

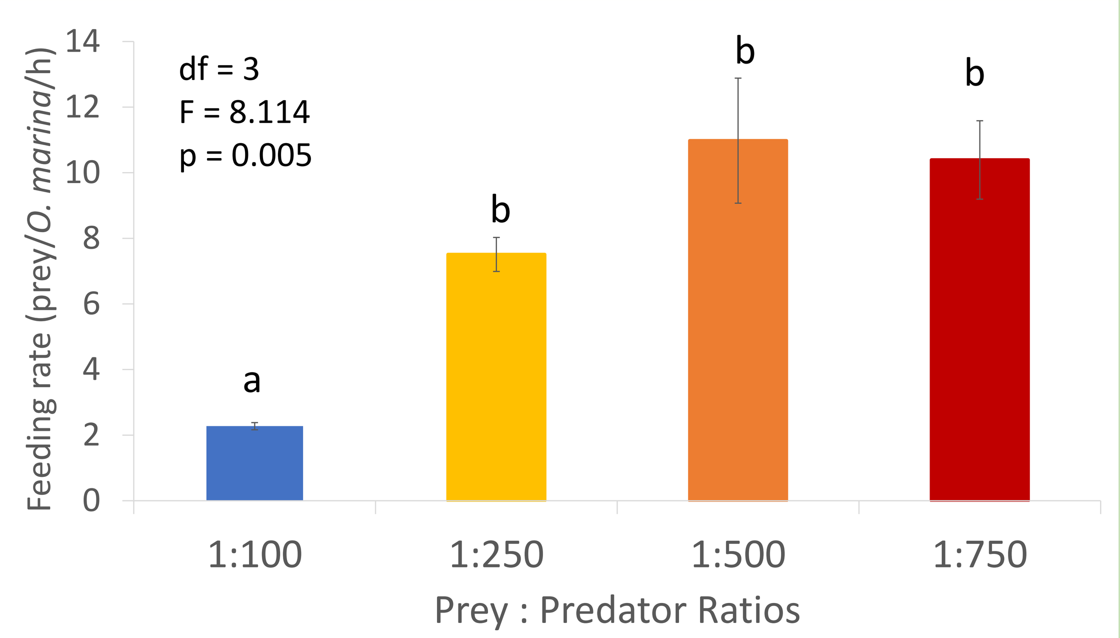

Figure 6. Feeding rates of *O. marina* on *I. galbana* at different predator:prey ratios. Different letters indicate significant differences at the 0.05 level.

Feeding rate was significantly lower at a ratio of 1:100 and plateaued at a ratio of 1:500 or higher.

Experiment 2: different prey species

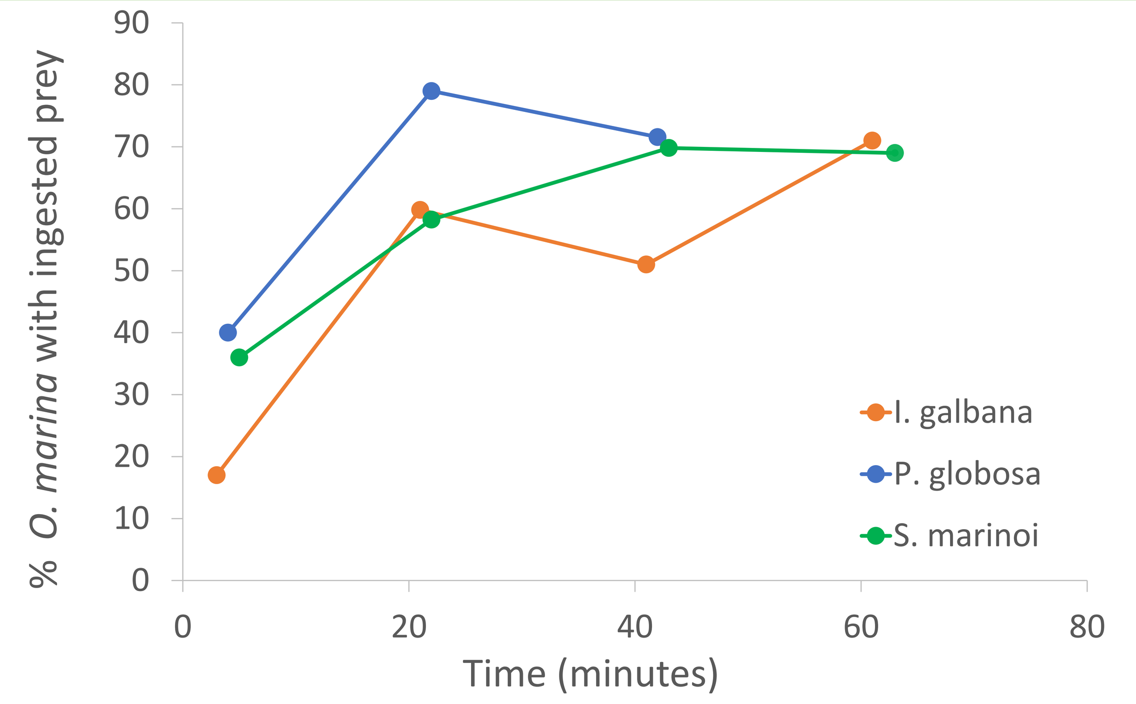

Figure 7. Percentage of *O. marina* that fed on three different prey species over time (predator:prey ratio 1:500 for all species).

By 40 minutes, 50% or more of *O. marina* contained food across all prey species.

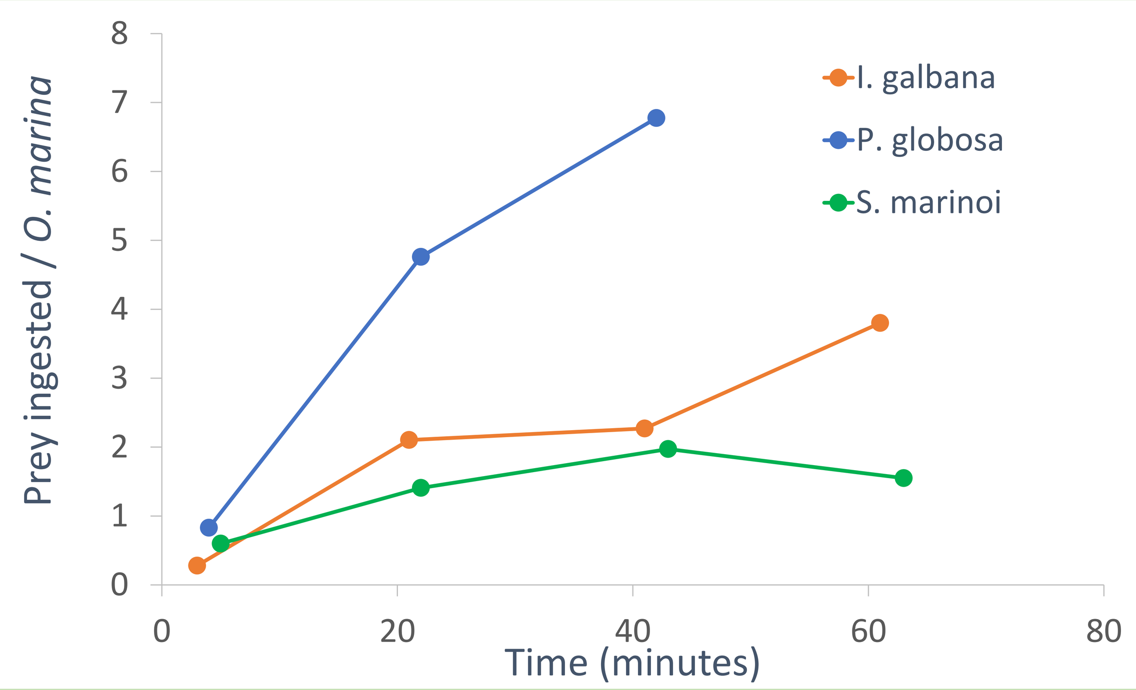

Figure 8. Cells of different prey species consumed by *O. marina* over time (predator:prey ratio 1:500 for all species).

O. marina consumed significantly more *P. globosa* cells than any other prey species.

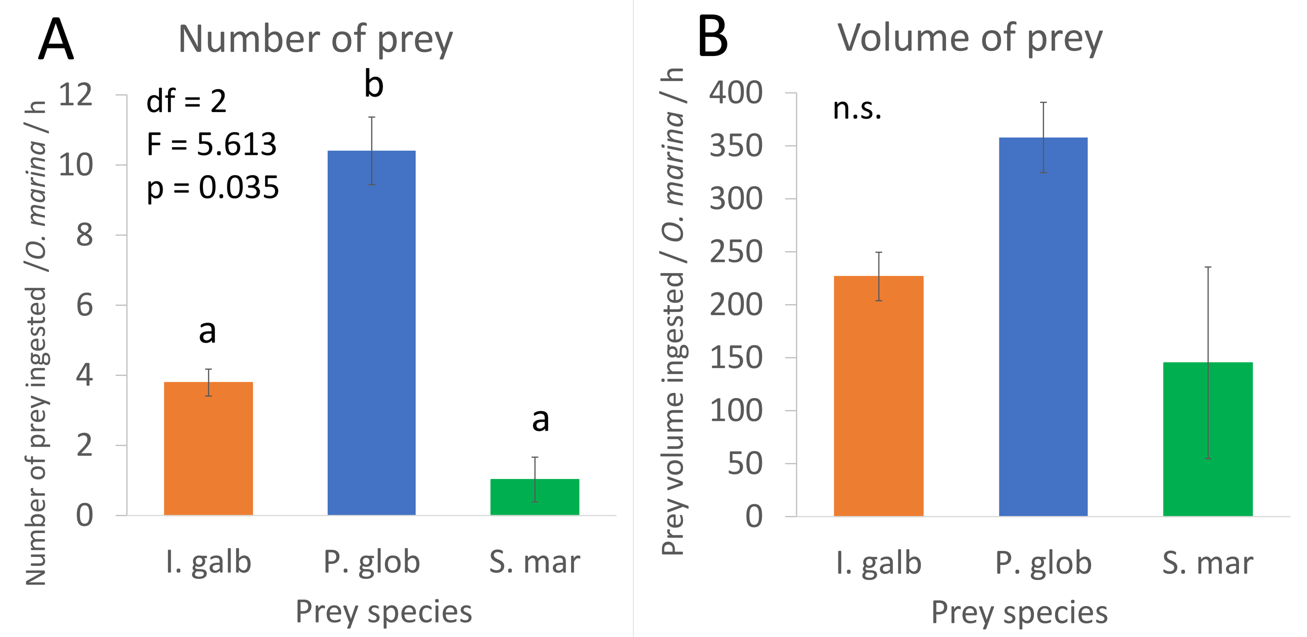

Figure 8. Feeding rates of *O. marina* on different prey species. Ingestion rate based on: number of prey ingested (**A**) and cell volume of prey (**B**). Different letters indicate significant differences at the 0.05 level; n.s. = not significant.

O. marina consumed significantly more *P. globosa* than *S. marinoi* or *I. galbana* (A). There was no significant difference between feeding rates based on volume ingested (B).

Conclusions

Experiment 1

- Prey availability influenced feeding rates up to a certain point, after which feeding plateaued
- Increased feeding due to increased encounter rates of prey
- Plateaued due to limits on prey handling and ingestion time

Experiment 2

- *O. marina* feed on all three species but feeding rates differed
- Differences could be due to prey size, difficulties handling/ingesting prey, or chemical feeding deterrents
  - Prey size: data adjusted for prey volume showed no significant differences in feeding amongst prey species; size definitely plays a role!
  - Difficulties handling prey: *S. marinoi* has silica shell and spines
  - Feeding deterrents: *S. marinoi* (and possibly *P. globosa*) produces polyunsaturated aldehydes PUAs); *P. globosa* produces DMSP (dimethylsulfoniopropionate)

Future studies

- Use staining techniques to improve counting of the food cells
  - For *S. marinoi* which did not have strong fluorescence under the microscope
  - For *P. globosa* which had two chloroplasts, making food vacuole counts difficult
  - For all species when number of food vacuoles is high (>15)
- Assess prey nutrition values between species to evaluate which prey would be most nutritionally significant for *O. marina* to feed on
  - Conduct growth experiments on different prey over several days
- Study effects of feeding deterrents such as PUA and DMSP on feeding by *O. marina*

References

Li, A., Stoecker, D.K., Coats, D.W., Adam, E.J. (1996) Ingestion of fluorescently labeled and phycoerythrin-containing prey by mixotrophic dinoflagellates. Aquat Microb Ecol 10:139-147

Caldwell, G.S. (2009) The influence of bioactive oxylipins from marine diatoms on invertebrate reproduction and development. Mar Drugs 7:367-400.

Flynn, K.J., Irigoien, X. (2009) Aldehyde-induced insidious effects cannot be considered as a diatom defense mechanism against copepods. Mar Ecol Prog Ser 377:79-89.