Scaling of respiration across various sizes of *Crepidula fornicata*

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1) INTRODUCTION

Aquatic organisms experience many environmental factors, such as availability of nutrients, that can determine their physical traits. Suspension feeding and deposit feeding mechanisms within marine species, as in some gastropods, are interchangeable according to location of food sources. The size of a gastropod has also been hypothesized to determine whether it will filter the water column or become benthic feeders based on metabolic demand. Other work on changes in metabolic rate with size has suggested a scaling constant amongst all organisms, the "3/4 –Power law", however, this has hot been tested for many invertebrates (Glazier 2005).

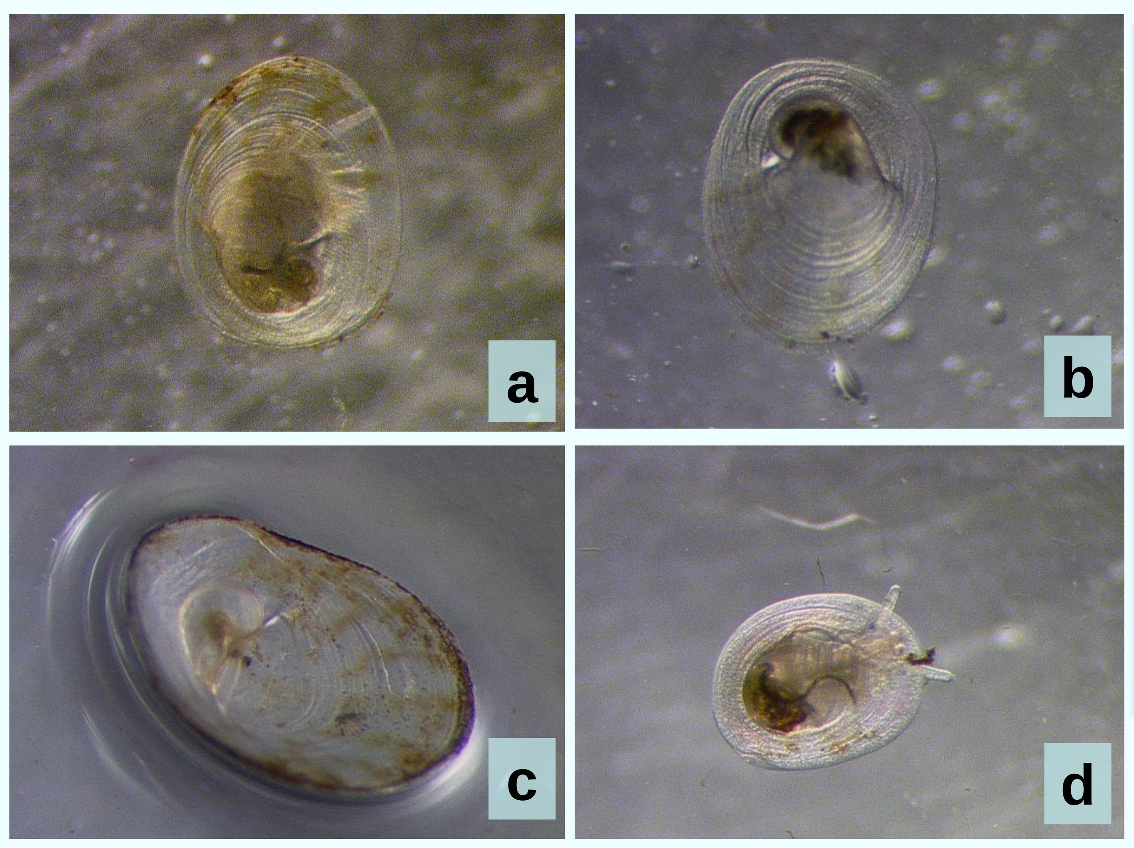

Figure 1 a,b,c,d: (a,d): *Crepidula fornicata* in shell, (b) upper side of empty shell, (c) underside of empty shell

Crepidula fornicata, also known as the Atlantic slipper snail, is a gastropod, which shows phenotypic plasticity in feeding by facultative suspension feeding mechanisms (Figure 1). Juvenile *C. fornicata* often bottom-feed due to the high energy expenditure relative to their smaller size. Previous research has found a scaling constant of 0.6 across all sizes of gastropods, but significant differences among gastropods that feed in different ways (Marsden et al. 2011). This follows the "metabolic-level boundaries hypothesis" where environmental differences alter the expected ratio of scaling to a true measurement (Glazier 2005, 2010).

2) QUESTIONS:

Using various sizes of *C. fornicata,* we ask:

- As body size (length and mass) increases will metabolic rate increase?

- And will suspension feeding alter the metabolic rate of the slipper snail?

3) METHODS:

Study Organisms:

-11 *C. fornicata* juveniles raised from larvae in the lab.
- 2 *C. fornicata* juveniles collected from Flax Pond Old Field, NY.
- Wet mass, shell length, and width were measured for each snail (Figure 2)

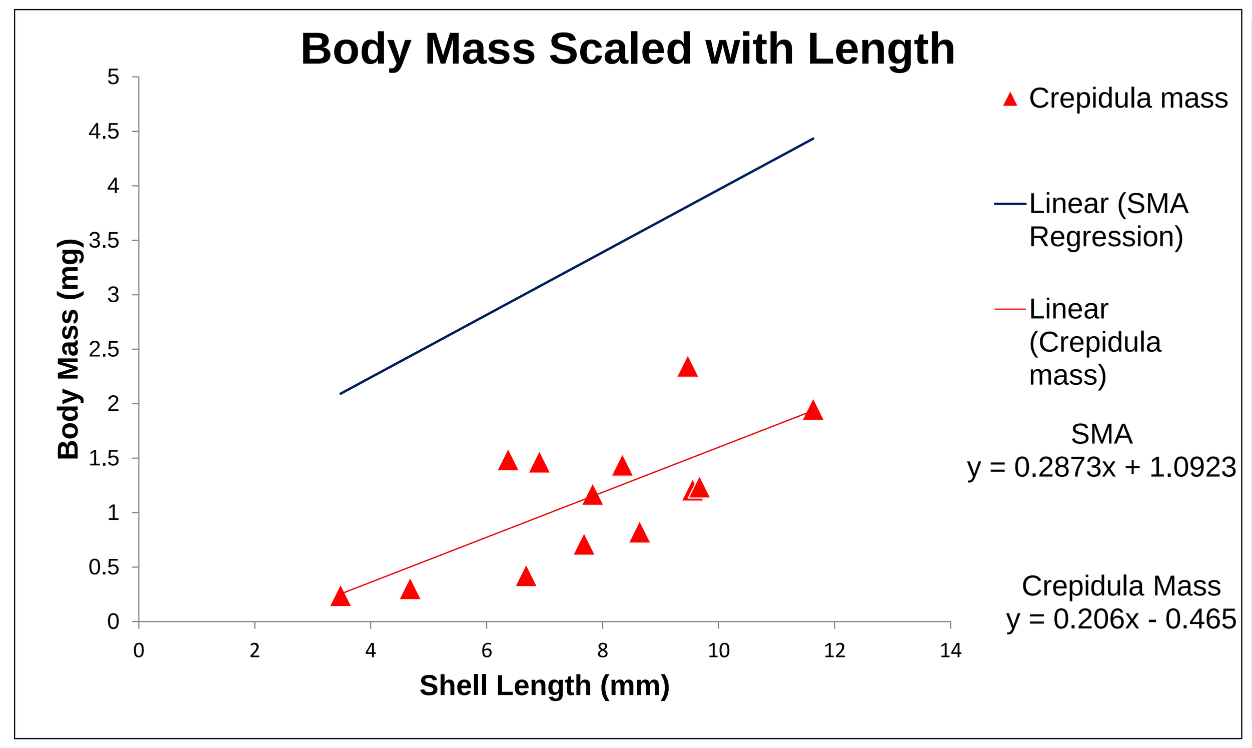

Figure 2: Body mass and shell length graphed using standard major axis regression (SMA). SMA slope of 0.2873 was higher than ordinary least squares (OLS) slope of 0.2066

Metabolic Rate Measurements:

- Qubit dissolved oxygen (DO) respirometry chambers; 4ml, 30 ml, or 100 ml volumes(Qubit model OX1LP) (Figure 3 a,b,c) .
- Metabolic rate measured as change in DO concentration over a 20 minute trial (mg O2 / ml / hr)
- A chamber without *Crepidula* was used as a control.
- For each snail, respiration was measured when microalgae, *Isochrysis galbana* (20,000 cells/mL) was added to the chamber, with a light blocking cloth to prevent photosynthesis
- Snails dry mass was measured.

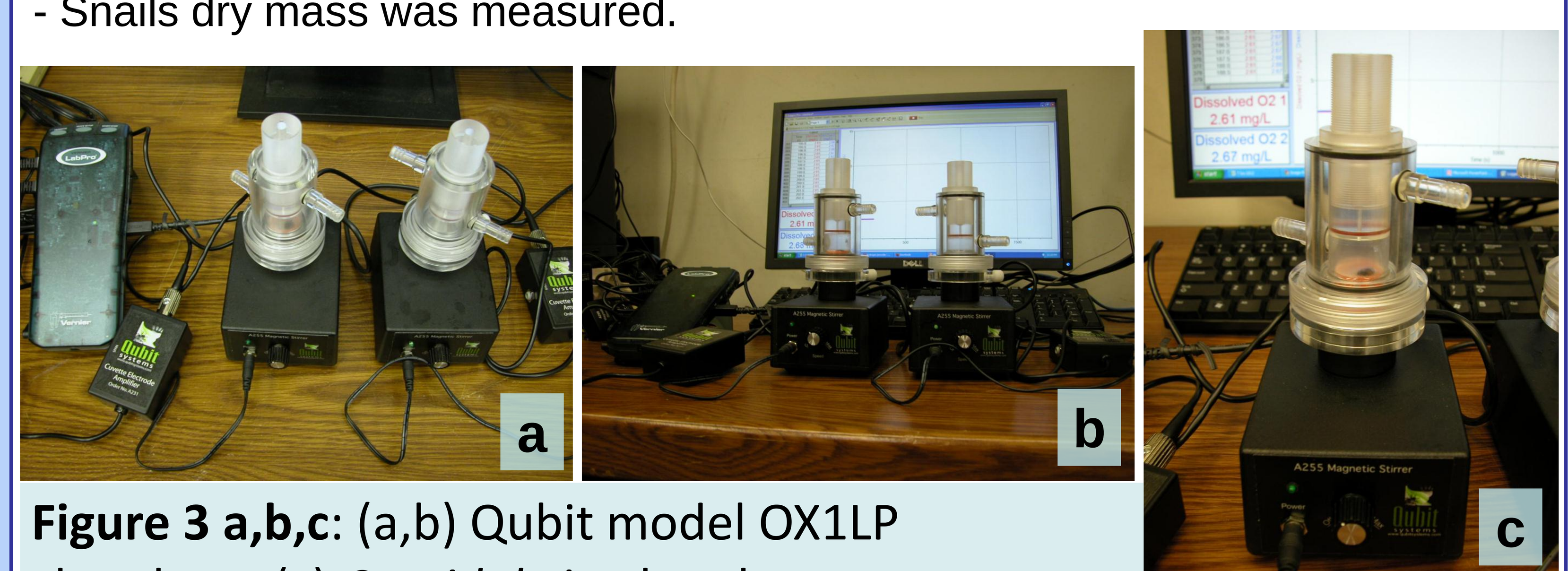

Figure 3 a,b,c: (a,b) Qubit model OX1LP chambers, (c) *Crepidula* in chamber

4) RESULTS:

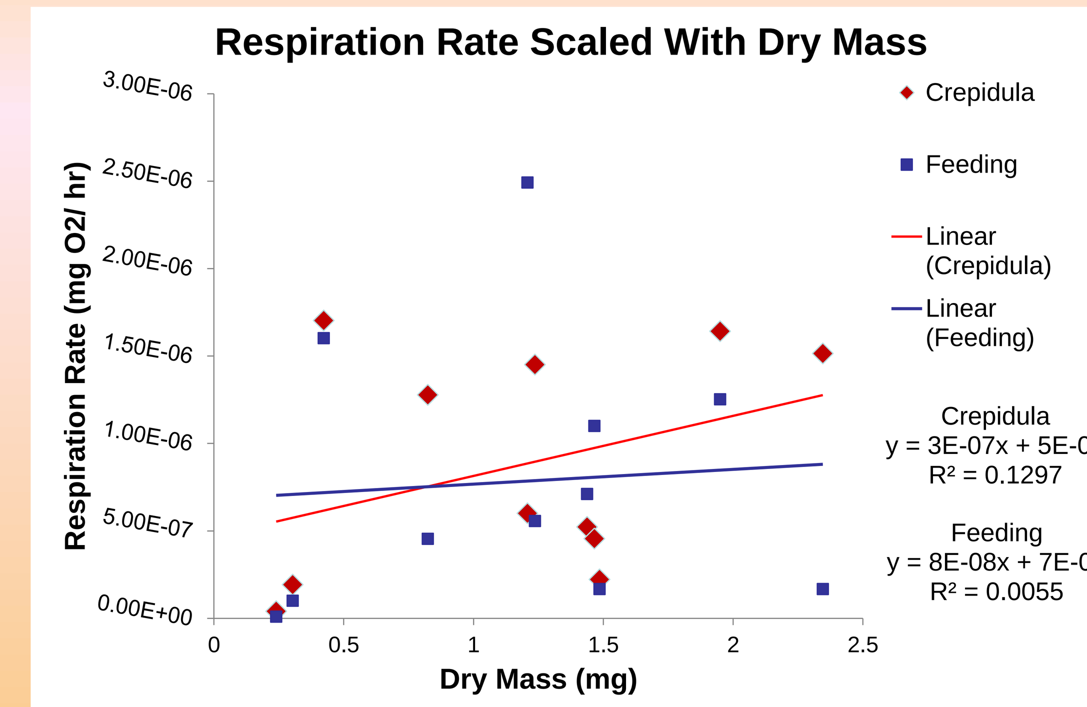

Figure 4: Respiration rate was not correlated with dry mass. When feeding, respiration rate was 6.37E-2 mg O2/hr. When not feeding, 1.87E-2 mg O2/hr. Masses ranged from 0.24 mg to 2.345 mg.

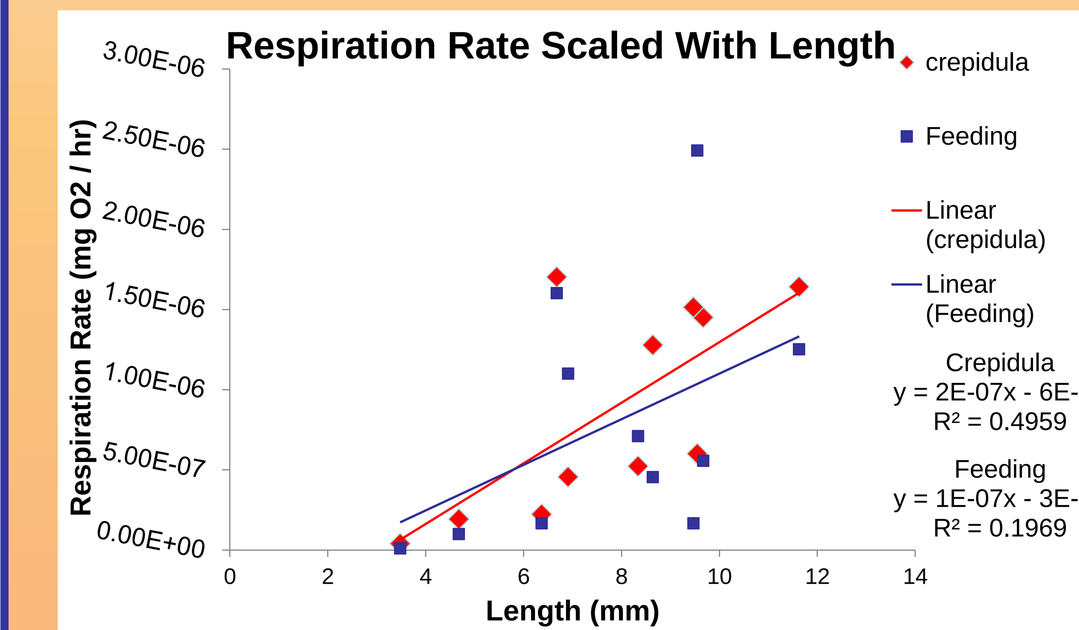

Figure 5: Shell lengths ranged from 3.48 mm to 11.93 mm and . Scaling of length was similar to scaling of mass. Longer snails had slightly higher respiration rates than shorter snails.

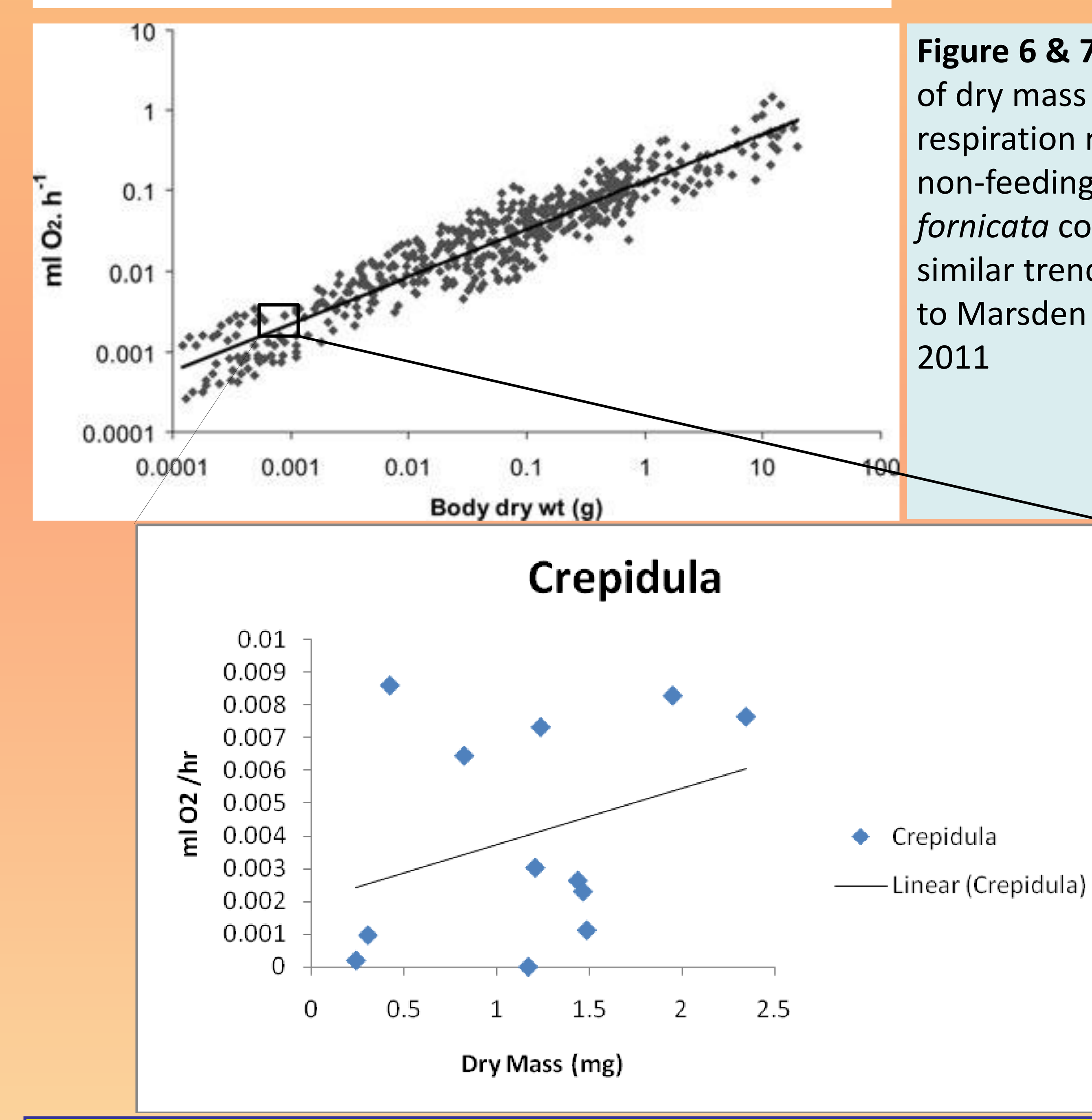

Figure 6 & 7: Graph of dry mass and respiration rate of non-feeding *C. fornicata* contains similar trend lines to Marsden et al. 2011

5) SUMMARY – CONCLUSIONS:

- No relationship between body mass and respiration rate in snails (Figure 4).
  - May be due to the small size range of snails used.
  - Prior studies used larger snails, contributing to greater differences in respiration rate across body sizes.

- The scaling of respiration rate with body mass in *C. fornicata* matches results for other gastropods (Marsden et al. 2011) (Figure 6,7).

- No correlation found between dry mass, shell length and respiration rates, consistent with the metabolic-level boundaries hypothesis (Glazier 2005, 2010).

- While feeding, there was a better relationship between shell length and respiration rate than body mass and respiration rate (Figures 4,5)
  - Body length determines food capture relating to Reynolds number, which scales with size and impacts suspension feeding.

- Total oxygen consumption was greater when not feeding; unexpected as snails should expend more energy while suspension feeding under high fluid viscosity.
  - Algal photosynthetic production of oxygen may have caused this finding.

6) RECOMMENDATIONS FOR FURTHER STUDIES:

Greater sample size and size range of *C. fornicata* is needed for further exploration of scaling between oxygen consumption, length, and mass. Comparison of snails from exclusively the lab or wild environments can contribute to less error from the metabolic-level boundaries hypothesis. Proper calibration of chambers leads to accurate values in DO readings. These changes can further lead to support results of Marsden et al. 2011 or the ¾ scaling law.

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