# **Supplement for: The relationship between primary production and primary consumer growth when consumers rely on concurrent resource growth**

Jamieson C. Botsch1\* (<https://orcid.org/0000-0003-0670-9785>), K. Riley Book1, Joseph S. Phillips1,2 (<https://orcid.org/0000-0003-2016-1306>), Anthony R. Ives1

1Department of Integrative Biology, University of Wisconsin-Madison, Madison, Wisconsin 53706, USA

2Department of Biology, Creighton University, Omaha, Nebraska 68178, USA

\* Corresponding author. Email: [jcbotsch@gmail.com](mailto:jcbotsch@gmail.com)

***Supplemental Methods and Results***

**Midge Stage Structure**

While we observed larger midges in the microcosms with higher initial algal abundances, it is not inherent that growth was associated with faster development. To assess this, we performed generalized linear models (GLMs) to determine whether there were differences in the stage structure of midges in microcosms with different algal abundance, we fit a quasi-binomial GLM to the proportion of second instar midges in a microcosm. We chose second instar because it reflected the earliest instar of larvae used to stock the experiment. Lower numbers of second instar in one treatment, therefore, suggests a faster increase in the development from second to third and fourth instar midges. We found few fourth instars (n = 8). All but one of those midges were in the two highest initial algal abundance treatments.

This analysis parallels the results of the analysis on midge length. We found fewer second instar larvae in microcosms with higher initial algal concentrations (Fig. S5, Table S1). Additionally, microcosms stocked with midges generally had fewer second instar midges, although there was not strong statistical support for this.

***Supplemental Tables***

**Table S 1: Results of a quasibinomial glmm on the proportion of midges in second instar. Since that is the smallest size used to stock the experiment, a reduction in second instars corresponds to an increase in stage structure.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | Type II |  | Type III |  |
|  | Estimate | t | P | t | P |
| Day 14 |  |  |  |  |  |
| Initial Algal Abundance | -0.116 | -0.355 | 0.725 | -2.559 | 0.017 |
| Midges Stocked | -0.919 | -1.154 | 0.259 | -1.215 | 0.235 |
| Water Bath | 0.934 | 2.264 | 0.032 | 2.374 | 0.025 |
| Initial Algal Abundance x Midges Stocked | -0.137 | -0.401 | 0.692 |  |  |
| Day 22 |  |  |  |  |  |
| Initial Algal Abundance | -0.189 | -0.772 | 0.444 | -2.594 | 0.013 |
| Midges Stocked | -1.739 | -1.550 | 0.128 | -1.940 | 0.058 |
| Water Bath | -0.6187 | -1.175 | 0.246 | -1.304 | 0.199 |
| Initial Algal Abundance x Midges Stocked | -0.181 | -0.630 | 0.532 |  |  |

***Supplemental FiguresA picture containing indoor, open, appliance, white goods

Description automatically generated***

**Figure S 1:** The setup of the microcosms in the incubation chamber with the actinic lights off. Water baths were rotated 180° periodically throughout the experiment. Water bath 2 spent the first 14 d of the experiment on the bottom level and was transferred to the top level on 19 August. The light and temperature logger was positioned on the outside of water bath 2 and can be seen on the left side of the lower water bath.

Chart, scatter chart

Description automatically generated

**Figure S 2**: (a) Chlorophyll-a (corrected for phaeophytin) and (b) percent organic content of the sediment used to stock microcosm taken at day 0. Initial Algal Abundance describes the amount of surface sediment used, where 0 is no surface sediment and 1 is ambient amount of surface sediment. Both chlorophyll-a and the organic content increased linearly with our Initial Algal Abundances, suggesting that our manipulation generated a range in algal abundance. The organic content even when no surface sediment was added remained above zero, indicating the presence of organic material (e.g., detritus).

Diagram

Description automatically generated

**Figure S 3:** Light and air temperature inside the incubation chamber as recorded by a logger. The logger was affixed to the outside of water bath 2. We rotated the position of the water baths multiple times during the experiment. After the first incubation (19 August), we switched the positions so that water bath 1 which spent the first 14 days at the top of the incubation chamber (Figure S1) was at the bottom. The logger remained on the southeastern side of water bath 2 for the entire duration of the experiment. There may have been a difference in light between water baths or a difference in logger positioning. The longer duration that water bath 1 spent under the higher light conditions during the first 14d of the experiment may explain the differences between them in our analyses. The incubation period is demarcated by a yellow shaded region during the light incubation and a purple shaded region during the dark incubation.

Chart, histogram

Description automatically generated

**Figure S 4:** The distribution of head widths of larvae collected from Lake Mývatn between 2013 and 2020. We used this histogram to determine the instar of midges in our experiment. The area between the first and second lines are the head sizes of first instars, the area between the second and third lines are the second instar, the area between the third and fourth lines are the third instar, and the midges between the fourth and fifth are fourth instar.

Chart, diagram

Description automatically generated

**Figure S 5:** Higher initial algal abundances were associated with fewer second instar midges. Because second instar midges are the smallest instar introduced into the experiment, reductions in the proportion of second instars suggests that midges developed faster in the microcosms which received higher initial algal abundances. Golden lines show the proportion of larvae in second instar in three replicates taken at time 0.

Diagram

Description automatically generated

**Figure S 6:** Comparison between model fit (lines) and data points (points). Panels contain different initial algal abundances. Midge data were set to 0 for the no midge treatment, despite some immigration. GPP data (points) on day 0 are estimated from the conversion factor between GPP and chlorophyll (g in table 4), while estimates on days 14 and 22 are the observed values (Fig. 1).

Chart, diagram

Description automatically generated

**Figure S 7:** Consumer growth along a range of consumption rates. Figure is equivalent to figure 3, but for T = 14.