Atmospheric CO_2 Enrichment and Foraging Preference in the Detritivorous Isopod, *Armadillidium vulgare*

by

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Fig. 1: Examples of *Armadillidium vulgare*. Specimens were obtained through Carolina Biological Supply Company and maintained in optimal habitat terraria before being used in trials.

Abstract

Atmospheric CO_2 enrichment may have impacts on foraging detritivores, such as woodlice (*Armadillidium vulgare*), by altering the chemical composition of leaf material in detritus-forming plants. Atmospheric CO_2 levels have risen from pre-industrial concentrations of about 275-285 ml L^{-1} to present levels of about 400 ml L^{-1} increasing C:N ratios and resulting in a lower quality food source for saprophagous isopods and potentially altering their food preferences. This in turn could affect detritus decomposition and nutrient and carbon turnover. In this study, the feeding preferences of *A. vulgare* between naturally senesced *Liquidambar styraciflua* leaves grown in FACE (free-air CO_2 enrichment) and ambient conditions were assessed. *A. vulgare* where placed in choice chambers with equal amounts of *L. styraciflua* leaf material grown under the two conditions. FACE leaves had a significantly higher C:N ratio (67.9 ± 2.24 SE) than did ambient grown leaves (59.2 ±1.47). Feeding preference was estimated by measuring the mass of FACE or ambient-grown leaf matter consumed. Our results showed no significant difference in feeding choices made between leaves grown under the two conditions (P = 0.961). Since detritivores such as *A. vulgare* already feed on low quality food sources with a relatively high C:N ratio, elevated CO_2-induced changes in the C:N ratio of the leaves, although significant, may have no effect on foraging preferences. *A. vulgare* may be unable to distinguish among foods with high C:N ratios.

Introduction

The elevated amount of CO_2 currently in our atmosphere has been shown in laboratory as well as field studies to increase the photosynthetic rate of plants, causing them to accumulate more carbon in their biomass, particularly the leaves (Cotrufo et al, 1998; Norby et al, 2001). This alteration in foliar C:N ratio results in the leaf litter being a lower quality food resource for detritivores such as *Armadillidium vulgare* (Fig. 1) thus potentially altering their foraging preferences (Norby, et al, 2009). It has been well established in the literature that isopods can and do show preferential feeding behaviors, which can be influenced by a number of factors including leaf senescence, leaf nutrient and mineral content, leaf microbial colonization, as well as the presence of unpalatable compounds in the leaf. If a factor deters isopods from feeding it could effect decomposition as well as nutrient and carbon turnover in the leaf litter layer, especially in the future when CO_2 levels are predicted to be much higher. The purpose of this study was to determine if *A. vulgare* showed a preference between *Liquidambar styraciflua* leaves grown under ambient and elevated CO_2 conditions.

Methods

Liquidambar styraciflua grown under enriched CO_2 conditions were obtained from the Oak Ridge National Laboratory (ORNL) Free-Air CO_2 Enrichment (FACE) facility (Fig. 2). Prior to the trials, ambient and FACE *L. styraciflua* leaves were cut into 2 cm squares, oven-dried (60° C, 48 hours), cooled to room temperature in a desiccator for 24 hours, and weighed. Leaves were then remoistened by full submersion in deionized water for 24 hours and placed into Carolina™ Large Choice Chamber Kits (Fig. 3). For each replicate, four chambers were used: two chambers with FACE leaves and two with ambient leaves. To control for leaf mass changes due to factors other than feeding, woodlice were denied access to one FACE and one ambient chamber in each replicate. Each chamber contained three leaf squares on top of 0.5 cm of sand moistened with approximately 50 ml of water. The chambers were covered with mesh material to simulate litter cover. Ten *A. vulgare* were placed into each choice chamber kit and allowed to feed *ad libitum* for six days. Trials were run in a Scitech Percival-Intellus Control System incubator kept on a 12:12 hour photoperiod at 18.5°C. After completion of the trials the leaves where removed, dried in the same manner described above, and reweighed to determine the amount consumed by *A. vulgare*. Amount of leaf consumed was taken to reflect preference.

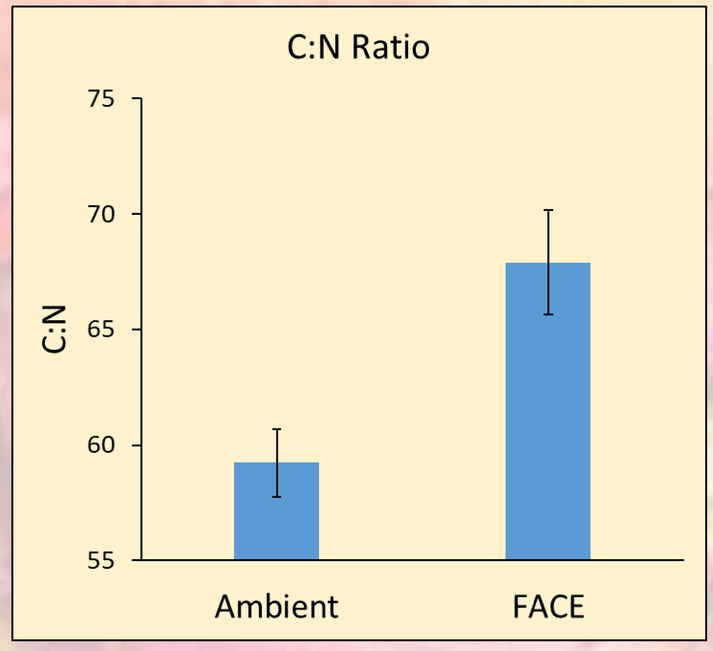

Fig. 4: C:N ratios of FACE *vs.* ambient *Liquidambar styraciflua* leaves.

Results

Enriched CO_2 grown leaves had a significantly higher C:N (67.9 ± 2.24 SE) than did ambient grown leaves (59.2 ±1.47) (Fig. 4; P = 0.001). Our results indicated that the CO_2 treatment had no significant effect on consumption rate; no significant difference in consumption was found among any of the trials or throughout the entire study (Fig. 5). ANOVA failed to reject the null hypothesis that there is no difference in feeding preferences of *A. vulgare* foraging on leaves grown under ambient or enriched CO_2 conditions (P = 0.961).

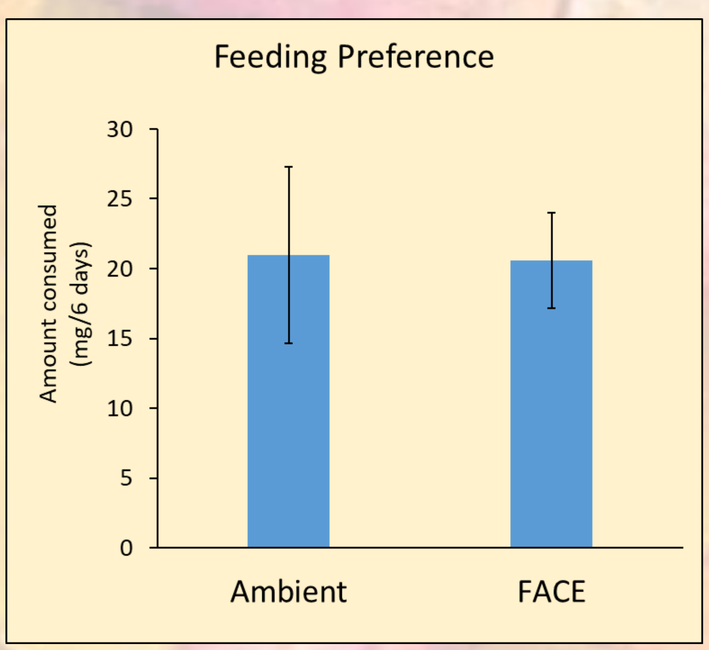

Fig. 5: Mean (± SE) feeding preferences of *A. vulgare* towards *L. styraciflua* grown in ambient vs. enriched CO_2 levels.

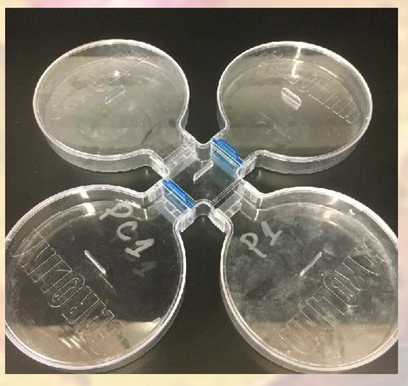

Fig. 3: Experimental Setup of Choice Chambers

Fig. 2: Experimental FACE stands at the Oak Ridge National Laboratory (top) and Sweet gum, *Liquidambar styraciflua (bottom).*

Discussion

Natural selection favors animals whose foraging behavior maximize their net energy intake per unit time spent foraging. For optimal foraging and increased fitness, animals must choose the highest quality food item available. However, detritus in general has the highest C:N ratio (*i.e.*, poor food quality) of available food sources (Abelho & Molles, 2009). Accordingly, this should make the FACE *L. styraciflua* leaves a less desirable food resource than the ambient leaves. However, in this study both sets of leaves had a relatively high C:N ratio regardless of CO_2-induced changes (Fig. 4). *Armadillidium vulgare* may not be able to distinguish between foods based on their C:N ratio when C:N ratios are relatively high. C:N ratios of 59:1 for the ambient leaves and 68:1 for the FACE leaves suggests both foods are of poor quality and little additional benefit may be gained by feeding on the food with the lower C:N ratio. These findings suggest that future CO_2 levels may have little affect on litter decomposition initiated by detritivores (David et al, 2001).

Acknowledgements

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