Effects of Motion and Closure on Ecological Systems

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INTRODUCTION

This experiment was designed to test the effect of constant motion on closed ecological freshwater algae-*Daphnia magna* systems. Movement of water is a typical component of natural aquatic systems, and we hypothesized that motion would be beneficial to the closed systems because both species of algae used were non-mobile and tended to settle. There have been studies that show the benefits of motion in freshwater systems.

> *All forms of mixing accelerate chemical and therefore biological processes up to a certain saturation point beyond which other factors (light intensity, temperature, chemical concentration, etc.) begin to be limiting. Thus, waves, currents, and tides should not be omitted from the ecosystem model any more than from the wild community.*
>
> ~ W.H. Adey and K. Loveland, 1998

Our experiment was intended to simulate a lake environment, which is greatly effected by movement from wind and temperature fluctuations (Adey & Loveland, 1998). We studied the closure, or isolation from the atmosphere, in motile and non-motile conditions.

We tested the hypothesis that a more natural state with movement and water flow allows for more efficient nutrient suspension and cycling.

METHODS

Stationary Treatments

Eighteen, 60 mL tissue-culture flasks were filled with a solution consisting of 810 mL Kent Water (45 mL per container) and 270 mL T82-LoSi (15 mL per container). The alga to support the *Daphnia magna* was also added at the start. The algae consisted of 21.6 mL *Ankistrodesmus* (1.2 mL per container) and 21.6 mL *Scenedesmus* (1.2 mL per container). The flasks were then allowed to sit for seven days under cool white fluorescent light that cycled (on/off) every 12 hours. This allowed for sufficient alga growth before the *Daphnia magna* were added. Three adults and two young were added into each flask.

Our eighteen flasks were equally divided into three treatment groups:

- **open and stationary, SO (control)**
- **closed and stationary, SC (control)**
- **closed and in motion, M (variable)**

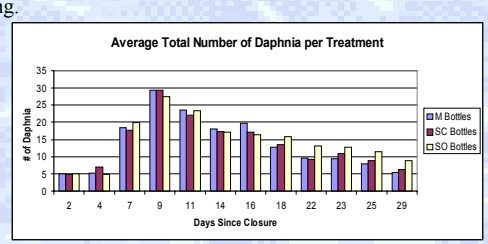
The flasks were in constant motion attached to a Cell Culture Roller Drum that completed one full revolution every five minutes.

Population counts of the *Daphnia magna* were taken three times a week, at two to three day intervals. With these counts the number of small (<1mm), medium (1-2mm), and large (>2mm) *Daphnia magna* in each flask were counted. The chlorophyll levels in each flask were also measured once a week during the experiment with a plant stress meter.

Motion Flasks on Cell Culture Roller Drum

RESULTS

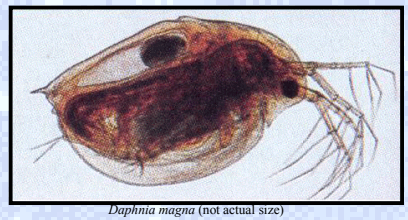
The sizes of *Daphnia magna* transitioned from small size to the larger size, during the first two weeks. However, as the experiment progressed, the populations tended to consist of mainly medium sized *Daphnia magna*, as the algae were depleted. This prevented *Daphnia magna* from reaching larger sizes and from having large amounts of offspring.



In all the treatment groups, the *Daphnia magna* populations increased from the original 5 animals to a maximum of 27-29 by day 9 of the experiment. Thereafter, the *Daphnia magna* populations slowly decreased until day 29 (end of observations). Motion did not have an effect, just as closure did not have an effect on the *Daphnia magna* populations. In fact, the flasks that have been closed approximately 5 months still have a few *Daphnia magna* surviving, while the open flasks are overgrown with algae.

DISCUSSION

Although our experiment did not show significant differences between stationary closed (SC), stationary open (SO), and motion (M) treatments, the fact that there was no difference between the treatments shows that motion (or lack of motion) is not detrimental to the systems. Nutrient cycling does not seem to be effected by motion in this short time span. This may be because the amount of movement was not sufficient enough to inhibit or encourage changes in the cycling rates. The fact that closure did not effect the ecosystems allows us to infer that atmospheric mixing is not the limiting factor in closed ecological systems. As stated before, the systems that have remained closed since the beginning of the experiment are still supporting both algae and *Daphnia magna*.

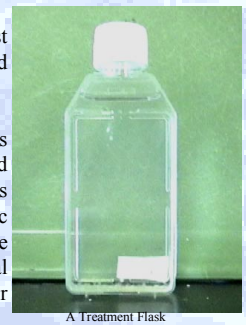


Daphnia magna (not actual size)

Although we did not notice differences in population sizes, we did notice differences in the amount of *Daphnia magna* carapaces between treatments. The motion treatment (M) had fewer carapaces and the carapaces that were present were suspended. The stationary treatments (SO, SC) both had an accumulation of carapaces, some of which were growing algae, at the bottom of the flasks.

At this time, the treatments have just reached a point to where the algae and *Daphnia magna* can co-exist.

The fact that *Daphnia magna* populations did equally as well in the open and closed systems throughout the duration of this experiment, indicates that atmospheric exchange was not necessary for the ecosystem to function. The initial conditions of the flask were adequate for survival.



A Treatment Flask

Some sources of error in our experiment may have come from varying sources. One is light intensity approximation. Another source of error occurred when for approximately a week, the roller drum was connected to the timer for the light and was stationary at night. One more source of error could be human calculation and judgment error. Three people did the population counts and there could be personal bias as to the size of the Daphnia and other aspects of measurement.

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