Effects of Nitrogen and Phosphorus Enrichment on Population Recovery Dynamics of the Harpacticoid Copepod *Tisbe biminiensis* in Simulated Estuarine Microcosms

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Tisbe Biminiensis Reef Copepods. (2017). Pod Your Reef.

Introduction

The Indian River Lagoon (IRL), which covers six counties and accounts for 40% of Florida's coastline, is home to over 4,000 species of plants and animals. However, the IRL is heavily impacted by anthropogenic nutrient pollution from agricultural and urban runoff, leading to eutrophication, algal blooms, and hypoxia that disturb coastal food webs (Diaz & Rosenberg, 2008; Paerl et al., 2018). Prior research has shown that increased nitrogen and phosphorus can alter primary production levels and oxygen dynamics in estuarine systems, with nitrogen often causing intensified eutrophication responses in coastal waters (Howarth & Marino, 2006; Paerl, 2006). Benthic harpacticoid copepods such as *Tisbe biminiensis* serve as a trophic link between primary producers and higher trophic levels, as such, their reproductive success is considered a key indicator of estuarine ecosystem health, as both the primary consumers of phytoplankton and primary food source for larval and juvenile fish, meaning changes in abundance can directly affect fish recruitment success (Turner, 2004; Roman et al., 1993). We hypothesized that nitrogen-heavy fertilizer exposure will cause the greatest reduction in *T. biminiensis* population density and the slowest recovery over time, with success defined as significantly lower post-exposure recovery rates compared to phosphate-heavy and control treatments.

Materials & Methods

A 28-day microcosm experiment was conducted using a completely randomized design with three fertilizer treatments (balanced 20-20-20, nitrogen-heavy 46-0-0, phosphate heavy 0-46-0) and 3 replicates each (n = 9) to determine copepod recovery time, defined as days required to return to return to ≥90% of pre-treatment density. Jars containing IRL water were inoculated with 39.4 mL of *T. biminiensis* and maintained under ambient laboratory temperature, RGB LED lighting, and gentle aeration. Dissolved fertilizer treatments were applied four times over this period to simulate runoff events. Water quality (pH, ammonia, nitrite/nitrate, phosphate) was measured ~1 week after each treatment. Population density was determined using 1 mL samples counted under 4x magnification with a 3x3 grid, recording nauplii, juveniles, and adults, with numbers averaged across fields of view.

Results

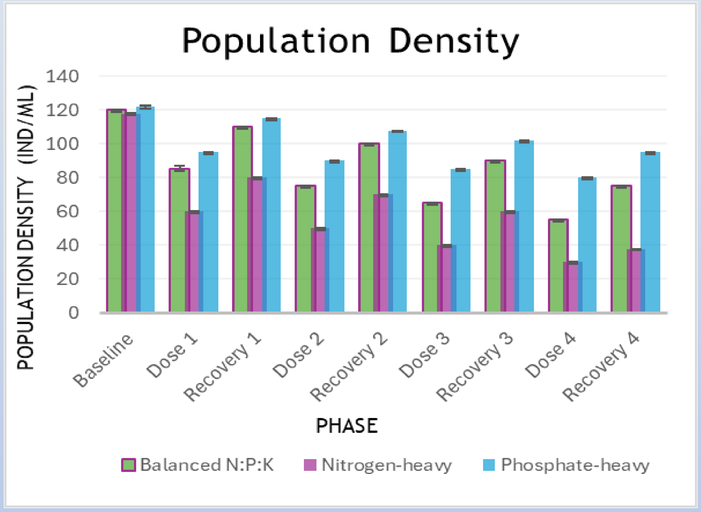
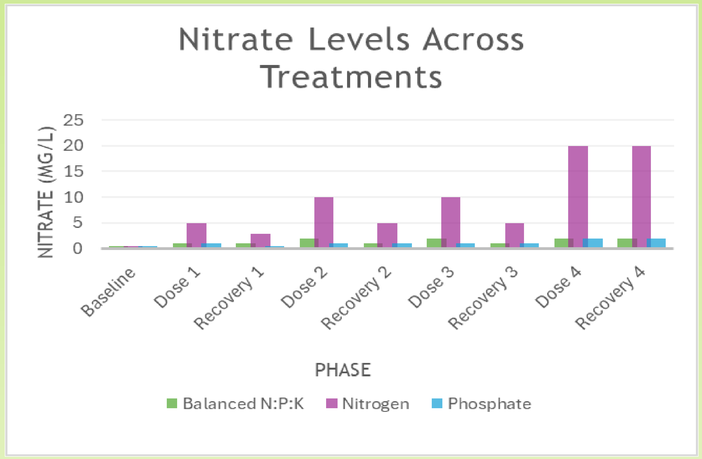
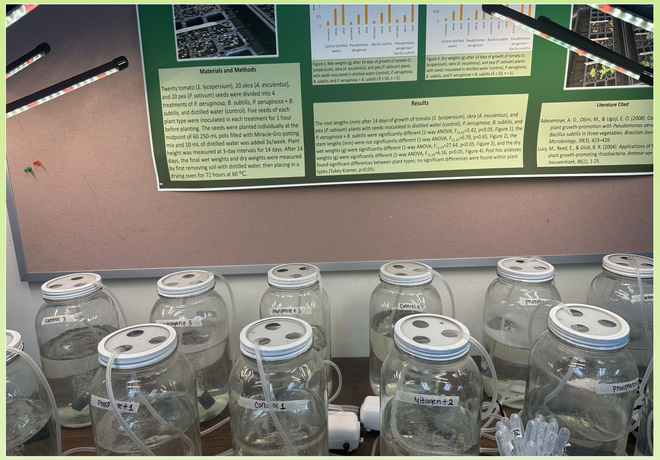


Figure 1. Mean (± SD) copepod densities (individuals mL^{-1}) declined following each dose and exhibited partial recovery between exposures among all treatments. Baseline values were 120 ± 2.00 (Balanced N:P:K), 117.67 ± 0.58 (Nitrogen), and 121.67 ± 0.58 (Phosphate), with final values being 75.33 ± 0.58, 38 ± 0.00, and 95 ± 0.00, respectively. Additionally, one-way ANOVA indicated a significant effect of treatment ($F = 7.59$, $p = 0.0028$).





All about Tisbe pods. (2022). AlgaeBarn.

Discussion

The data supports the hypothesis that nitrogen-heavy fertilizer causes the greatest and most persistent declines in *T. biminiensis*, along with reduced recovery and increasingly adult-skewed populations. These effects are likely driven by nitrogen-induced eutrophication, which increases microbial activity, oxygen demand, and hypoxic stress in nitrogen-limited coastal systems (Diaz & Rosenberg, 2008; Howarth & Marino, 2006; Paerl, 2006). The steep reduction in nauplii suggests impaired reproduction, consistent with the sensitivity of early life stages to environmental stress (Roman et al., 1993; Stalder & Marcus, 1997). In contrast, phosphate-heavy treatments showed greater stability and recovery. Because nitrogen fertilizers are widely used in Florida and can enter waterways through runoff, these findings have direct ecological relevance. Copepods are key links in aquatic food webs, transferring energy from primary producers to higher trophic levels and supporting larval fish during critical early life stages (Turner, 2004). Reduced copepod recovery under repeated nitrogen exposure may therefore limit food availability for larval fish, potentially decreasing survival and fish recruitment in systems such as the IRL. Future studies should measure microbial activity, chlorophyll-a, and DO, and expand to field-based research for better accuracy in recovery trends.

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