The Effects of Salinity on Freshwater Copepods

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Zoology BIO-245

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November 19, 2016

Abstract

Calcium chloride, among other sources of nonpoint source pollution, can be detrimental to aquatic species in rivers and streams. Calcium chloride ($CaCl_2$) enters waterways primarily through runoff from impervious surfaces such as roads and storm drains in the form of road deicer. The purpose of this study was to examine the effects of salinity on freshwater copepod survival under laboratory conditions. Over a 7-day study period under lab conditions, 3 groups of copepods were exposed to 2 PSU (Practical Saline Units), 4 PSU and 6 PSU $CaCl_2$ solutions. Survival rates were recorded and analyzed using Microsoft Excel running paired, one-tailed t-tests. It was hypothesized that as calcium chloride concentrations increased there would be a lower survival rate between days 1 and 3 when compared to days 3 through 7, relative to controls. Although the data did not support the hypothesis that survival rate would be lower within the first three days, increased salinity negatively affected survival rates in both time distributions.

Introduction

The introduction of chemical stressors and alterations to the environment can inadvertently disrupt the dynamics of food webs in aquatic ecosystems. (Van Meter, Swan, Leips, & Snodgrass, 2011) Non pointsource pollution, such as road salt, enters water systems as runoff from impervious paved surfaces and other drainage structures. Understanding the ecotoxicological impacts that nonpoint source pollution has on aquatic microorganisms is important to predict the dynamics of food webs in affected areas. The undesirable effects of increasing salinity on particular taxa may influence broader ecosystem processes in aquatic systems related to primary productivity, decomposition, nutrient cycling and the trophic complexity of food webs. (Kaushal, 2005)

In order to gain insight as to the health of these ecosystems, bioindicators such as copepods are often studied due to their sensitivity to pollution. Furthermore, survival rates of copepods exposed to increasing chloride concentrations in lab conditions can provide insight into their osmoregulatory abilities and tolerance levels in waters affected by salinization. (Wilson, 2016) The purpose of this study was to examine the direct effects of salinity on freshwater copepod survival under laboratory conditions. Over the seven-day study, it was predicted that as chloride concentrations increased there would be a lower survival rate between days 1 and 3 when compared to days 3 through 7, relative to controls.

Materials and Methods

In this experiment, freshwater copepods were immersed in calcium chloride ($CaCl_2$) solutions over a seven day observation period. Calcium chloride was procured from commercially available sources and was provided by the biology department at MCLA. Copepods that were provided for this study were acquired commercially with no background information other than that they were freshwater copepods. Due to the limited available specimens, sample sizes for each series was limited. There were four salinity test groups including control. Each group contained three sample dishes of copepods which were exposed to $CaCl_2$ concentrations equaling 2, 4 and 6 PSU. (Equivalent factor of 1 PSU to 1 Part Per Thousand) To prepare the solutions, 100mg, 200mg, and 300mg, respectively, were added to 50mL of distilled water. A discrete number of copepods were pipetted into the test dishes after visually locating them using a dissecting microscope. The approximate volume of copepod-containing water was 4 mL. In each trial dish, approximately 10 mL of prepared $CaCl_2$ solution was added. Data was analyzed using Microsoft Excel. Using paired t-tests, it was assessed whether the survival rates of copepods in each salinity test group was statistically significant between day 1 and 3, and between day 3 and 7. Throughout the trial, the level of significance was $\alpha = 0.05$.

Results

The highest survival rate between day 1 and 3 was observed in the 4 PSU group at 73% ± 12% P=0.028. The lowest survival rate was observed in the 6 PSU group at 47% ± 12% P=0.007 (*Figure 1)*. Between day 3 and 7, the highest survival rate was observed in the 2 PSU group at 27% ± 23% P=0.000 The lowest survival rate was observed in the 6 PSU group with 0% P=0.009 *(Figure 2).*

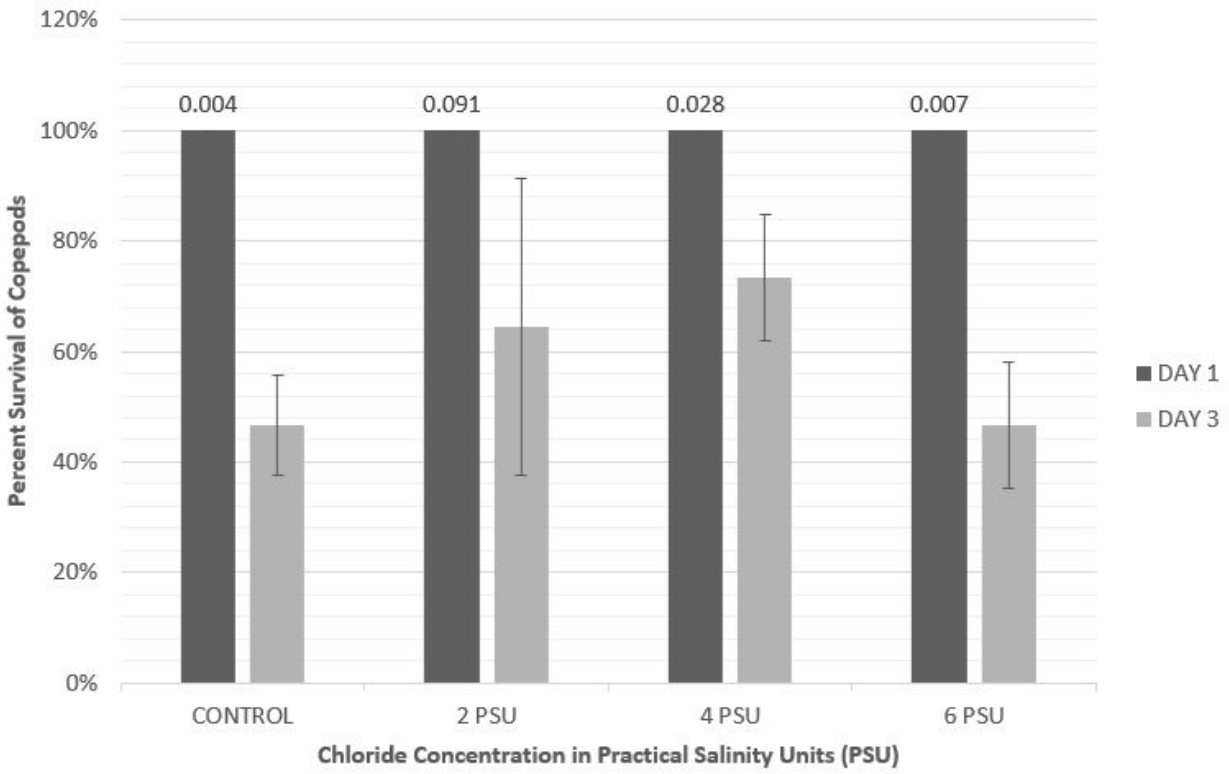

Figure 1 Percent survival of copepods vs. salinity measured in PSU's observed on day 1 (dark bars) and 3 (light bars). Copepods were exposed to $CaCl_2$ at the concentrations indicated. Error bars indicate standard deviation. N=3.

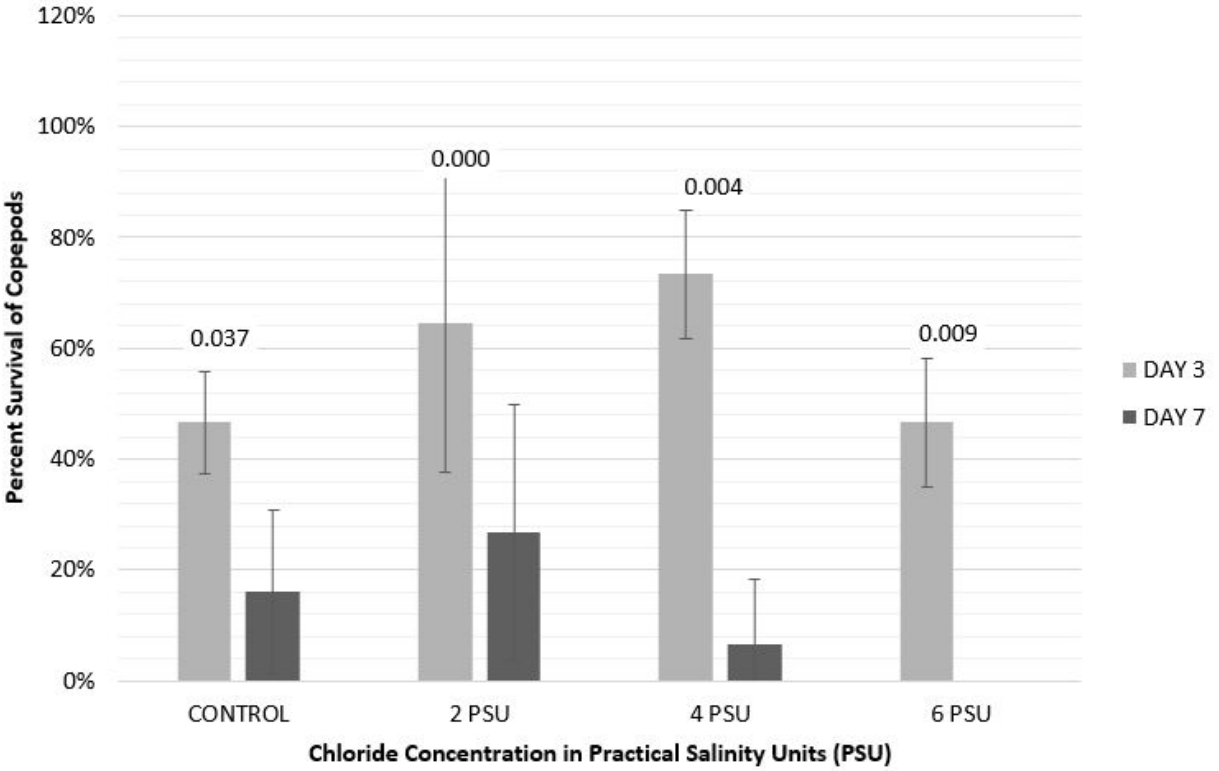

Figure 2 Percent survival of copepods vs. salinity measured in PSU's observed on day 3 (light bars) and 7 (dark bars). Copepods were exposed to CaCl2 at the concentrations indicated. Error bars indicate standard deviation. N=3..

Discussion

In this study, it was expected that the greatest mortalities to copepods would happen relatively quickly due to the inability of copepods to osmoregulate in an increasingly saline environment. It was hypothesized that as chloride concentrations increased there would be a lower survival rate between days 1 and 3 when compared to days 3 and 7, relative to controls. Although the data did not support the hypothesis that survival rate would be lower within the first three days, the data did show that increased salinity negatively affected survival rates.

The highest average survival rate was observed between days 1 and 3 and the lowest average survival rate was observed between day 3 and 7. In each time distribution, there were observed decreases in survival when exposed to higher salinities. The 6 PSU groups had the lowest survival rates relative to the other salinities for both time distributions.

Our observations agree with those published in a similar study comparing copepod survival exposed to elevated chloride concentrations. (Van Meter, Swan, Leips, & Snodgrass, 2011) In *Van Meter et al.* copepod populations decreased in the elevated chloride treatments. Although the sample size was considerably larger (N=10) in *Van Meter et al.,* the inability of the copepods to survive the elevated chloride concentrations in both studies are worth noting.

Sources of error in this study can be partly attributed to the laboratory technique and skill level of various team members. With a wide variety of lab experience and knowledge, confidence in the level of data accuracy is less than ideal. In addition, the methods employed to record the data were not standardized and was subject to inaccuracies during recording and reporting.

Based on the observations in this study, a prudent approach for a follow-up study would likely include similar experimental design but with increased sample sizes and more precise methods of obtaining survival data. In addition, a preliminary study to establish local levels of nonpoint source road

salt runoff would highly improve the data quality and relevance of a study of this type. By incorporating known levels of local pollution into a follow-up study, predictions can be made about the data concerning direct and indirect food web interactions. (Rohr, Kerby, & Sih, 2006)

Although this study had flaws in design and methods which could have affected the quality of the data, the observations were significant and did agree with similarly designed publications. Due to the lack of regulation regarding road salt application across vast areas of the country, studies of this nature highlight the detrimental effects that nonpoint source pollution has on aquatic species.

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