The Effect of Habitat Conditions on the Abundance of Freshwater Copepods

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Introduction

Understanding the density-independent factors (e.g., weather-related disturbances) that assist in determining the size of a given population is central to further studies of density-dependant factors that affect populations of meiofauna in Michigan streams. In this study, we monitored populations of benthic copepods throughout a summer season at the Pierce Cedar Creek Institute in Hastings, Michigan. We chose to study copepods because their rapid development rate (egg to adult in 1-3 weeks) makes it possible to study multi-generational dynamics in a single season. As primary and secondary consumers, as well as a major food source for larger invertebrates, they play a pivotal role in aquatic food systems.

Our study focused on three main copepod species common in southwest Michigan streams; *Eucyclops elegans, Eucyclops prionophorus, Boeckella poppei,* and at least one Harpacticoid species. In addition to determining the common copepod species present in Cedar Creek, we focused on how these populations change according to environmental conditions. In addition to the identification of each individual, we monitored population densities, stream velocity, temperature, compaction and substrate composition in Cedar Creek from May to August.

Methods

To examine the environmental factors surrounding large populations of stream dwelling copepods, population densities were estimated with sufficient frequency to allow basic vital rates (e.g., population growth rate [*r*] and per capita birth and death rates). The study was conducted within the Pierce Cedar Creek Institute property, within a 100-m reach of Cedar Creek. Sampling began in early May and continued through the month of August on a weekly basis. On each sampling date, a stratified random sampling design was employed to estimate copepod population densities within the reach. On these days 20 samples were taken from randomly selected locations in each reach. Each sample consisted of a 4.4-cm inner diameter acrylic core tube pushed vertically into the substrate to a depth of 5 cm. Core contents were emptied into a beaker and several mL of $MgCl_2$ was be added to anaesthetize the organisms. The sample was then stirred and left to sit for ca. 5 min, and then transferred to a 60-µm sieve and rinsed with stream water. The contents of the sieve were rinsed into a plastic bag with deionized water and preserved with formalin (7% final concentration). At each of the random locations current velocity was measured and substrate composition and compaction were observed and recorded. Temperature readings were taken every day from May through August.

In the laboratory, copepods in each sample were separated from inorganic material (sand, gravel) by elutriation, identified, and counted by species using a dissecting microscope. For samples containing large amounts of organic debris (e.g., silts), we used density gradient centrifugation with Ludox TM-50 to separate copepods from other materials. We also determined, for each species, the number of females, the number of females carrying eggs, and the average number of eggs per female. From these data, the population growth rate (r) between sampling dates can be estimated by $r = (\ln N_t - \ln N_o)/t$, where N_o is the population density on the first sampling date, N_t is the population density on the next sampling date, and t is the number of days between samples. The birth rate (b) can be estimated from the egg ratio (E) and the egg development time (*D*) as $b = (\ln[E + 1])/D$, where E is the number of female eggs in the population (assuming a 1:1 sex ratio in the eggs) divided by the number of adult females in the population . The death rate (*d*) can then be estimated from $d = b - r$.

Results

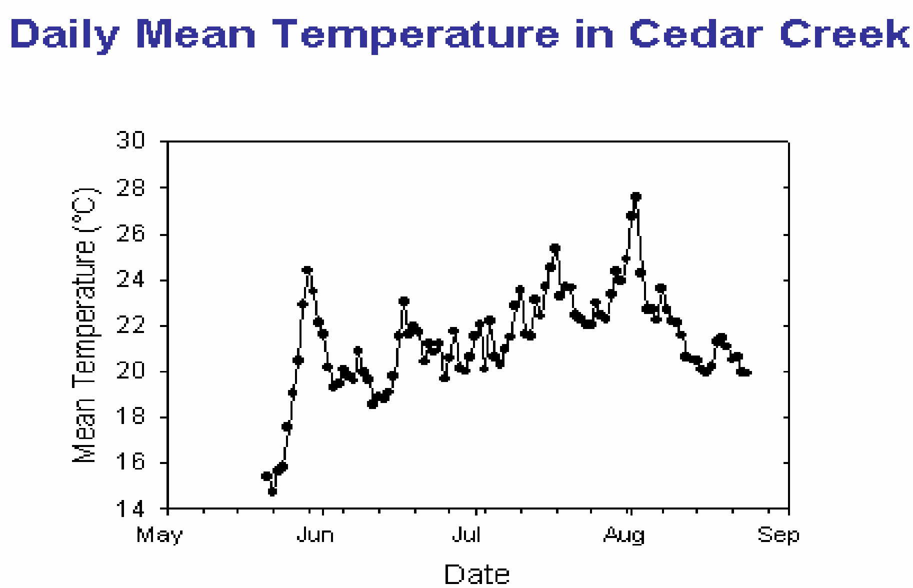

Figure 1: Daily Mean Temperature in Cedar Creek from May to August

Figure one shows the average daily range in temperature in Cedar Creek from May until August was 5.8 degrees C, which is fairly representative of streams of this size in Southwest Michigan. It was important to record daily temperature because the developmental rate, or the time from egg to adult, of copepods declines with increasing water temperature. These data show that water temperature was fairly stable throughout the study, which suggests there should not have been substantial variation in developmental rate during this time.

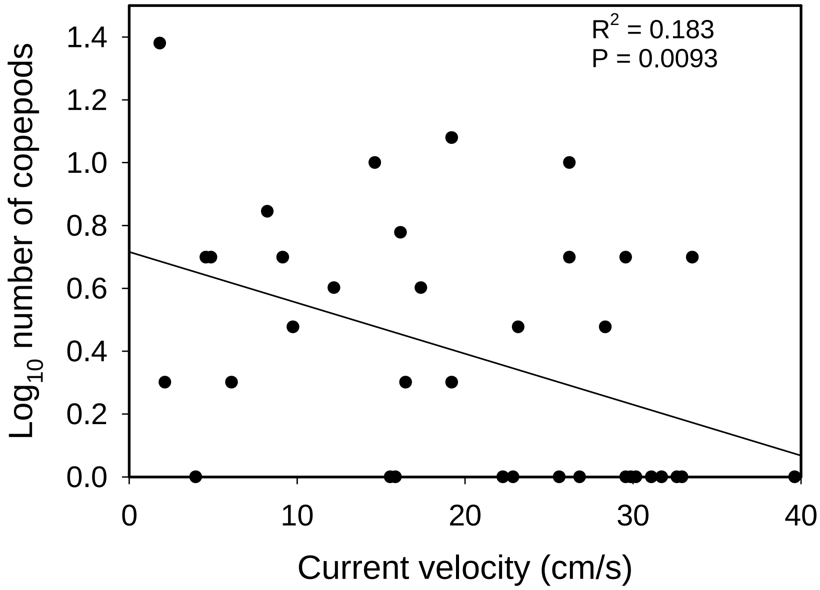

Figure 2: Relationship of current velocity and number of copepods

Figure two displays the results of a stepwise multiple regression analysis, in which the independent variable was current velocity and the dependent variable was number of copepods. This analysis detected a significant negative relationship between current velocity and the log-transformed number of copepods in a sample.

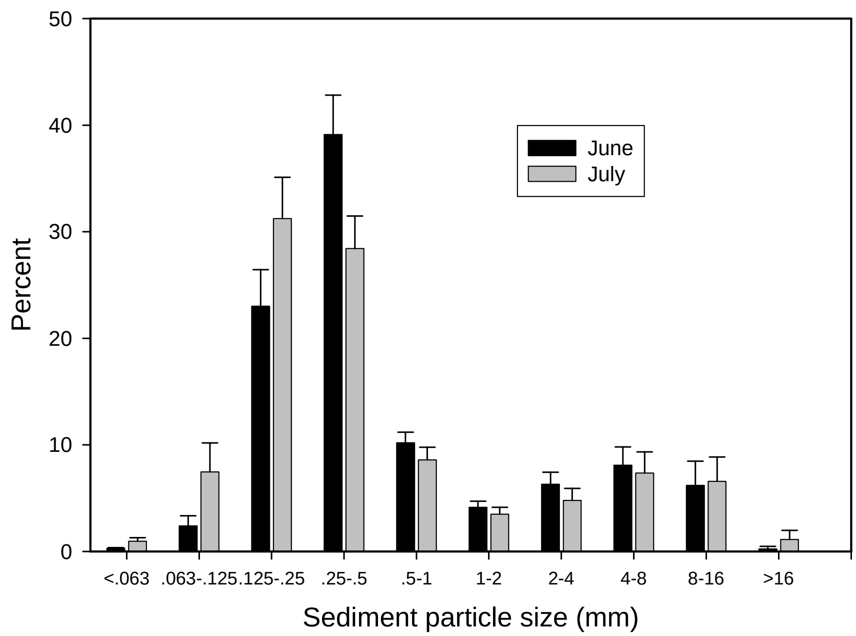

Figure 3: Distribution, by mass, of sediment particle sizes in the samples

Figure three shows the distribution, by mass, of sediment particle sizes in the samples. The data are presented as the mean percent of the total mass in each size class ± 1 SE (standard error). In general, the samples were dominated by fine sand (0.125 - 0.25 mm) and medium sand (0.25 - 0.5 mm). There were strong correlations among the percent of sediment in the various size classes. The percent of course sand (0.5 - 1 mm) in a sample tended to be positively correlated with the percent of courser material (i.e., > 1 mm) and negatively correlated with percent of finer sediment. Because of this, we performed a principle components analysis (PCA) on the sediment size classes and the compaction scores to create a set of variables that were independent. Unfortunately, the multiple regression analysis detected no significant relationship between the abundance of copepods in a sample and its sediment composition.

Discussion

Our initial hypothesis was that many environmental factors, such as sediment composition, compaction and stream velocity would play an important role in the abundance of benthic copepods in the randomly sampled locations. Our initial data suggests that the only environmental factor (that we measured) that appeared to significantly influence the abundance of copepods was the free stream current velocity. However, further analysis of the collected samples will provide more information regarding the accuracy of the above results and the habitat conditions that affect copepod population densities throughout the summer season in Cedar Creek.