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How Low Are Dragonflies Willing to Go?

The Effects of Water Depths on Dragonfly Naiads Abundance

Abstract

Water depth is known to have a significant effect on a habitat's conditions as it can influence the supply of sunlight, oxygen, nutrients and the growth of aquatic organisms. However, there is still a debate on whether deep or shallow water is a more sustainable habitat for dragonfly naiads. Our study examines the naiads' preference for deeper or shallower waters by considering the abundance of naiads in varying depths of ponds. We show that as depth increases, the number of dragonfly naiads found increases, meaning they prefer living in deeper waters to living in shallower waters. This indicates their habitat preference in which they can avoid predators, tolerate low oxygen and sunlight levels, and thrive in sparse vegetation.

Introduction

Previous scientific studies have found that the variations in the depth of pond or lake waters can affect the characteristics of the water habitat and thus influence the behaviors of dragonfly naiads. However, they are divided on whether the naiads prefer deeper water or shallower water. At first glance, the deeper water seems less advantageous a habitat than the shallow water in terms of availability of sunlight, oxygen and nutrients. The deeper part of a pond is further away from the surface, so it receives less sunlight; the oxygen is blocked by the upper surface waters from dissolving into the deeper water (Lubnow 2015). These leave an "negative impact" on "the lake's nutrient (generally nitrogen and phosphorus) loads" (Lubnow 2015). However, the more

sunlight and nutrients that the shallow water receives can induce denser growth of aquatic plants and planktonic algae (Lubnow 2015), which can potentially contaminate the water habitat and pose negative effects on aquatic organisms. Deep water also provides the dragonfly naiads protection from predators such as raccoon (Berger, Hansen 2004). On a side note, the deeper water also has a pH lower than 7 due to its containing a high concentration of carbon dioxide ("Physical Circulation").

Our study aims to examine whether the dragonfly naiads have any specific habitat preferences, specifically if differences in lake depths have any effects on the distribution of naiads. We took dragonfly naiads samples from three of the ponds in Earlham back campus, in which the depths vary in different parts of the ponds. We predicted that number of dragonfly naiads would increase with increasing water depths due to better protection from the predators and the naiads' tolerance to low light and nutrients level.

Methods

We conducted our experiment in the three ponds of close proximity within each other near the football field in Earlham College's back campus, namely Murvel Garner, James B. Cope, and Gertrude "Lucky" Ward ponds. The ponds were surrounded by mostly grasses and low vegetation in an open space. Thus, the ponds were fully exposed to sunlight which facilitated the growth of aquatic species that live in the ponds.

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Determination of the sample size

We divided Gertrude "Lucky" Ward Pond into four sectors: north, south, west, east. We measured an area of four meters long and two meters wide in each sector using a measuring tape. Next, we divided each sector into eight quadrats. Since James B. Cope Pond was too small to divide into sectors, we measured a single sector of four meters long and two meters wide and divided it into eight quadrats. In Murvel Garner Pond, the developed plant life obstructed the east side of the lake. Hence, instead of dividing the pond into north, south, east and west sectors, we divided it into northwest, west and southwest sectors and conducted the same measurements as above. Each sector has four quadrats that are nearer to the edge of the pond and four quadrats that are further. According to Figure 1., numbers 1, 2, 3 and 4 are the nearer quadrats while numbers 5, 6, 7 and 8 are the further quadrats.

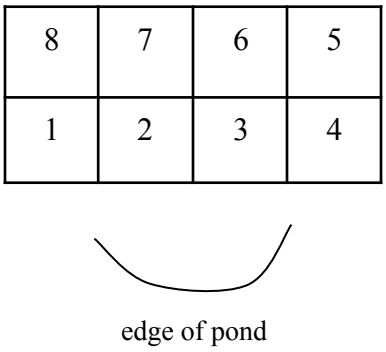

Figure 1. The positions of each sector relative to the edge of the pond

Collection, counting of naiads and measurement of water depth

We placed the end of the net on the upper edge of a nearer quadrat, for example number 1. Then, we pressed the net down until it hit the bottom and took five swipes of naiads. After each swipe,

we counted the number of naiads and kept them in a tube, then repeated the process for subsequent swipes. After having tallied the total number of naiads we found in a quadrat, we measured the depth of the quadrat using a meter rule. We repeated the process of taking five swipes for each quadrat, counting and keeping the naiads and measuring the water depth for the rest of the quadrats. After having finished collecting and counting the naiads in all sectors in a pond, we released the naiads back into the pond.

Analyses

In each sector of the ponds, we calculated the average depth of the four nearer quadrats and the sum of dragonfly naiads found in all four nearer quadrats, then did the same for the four further quadrats. This means for each sector, we were able to calculate two values of average pond depths that correspond to two values of total dragonfly naiads per four quadrats. We repeated this step for all four sectors in Gertrude "Lucky" Ward Pond, three sectors in Murvel Garner Pond, and one sector from James B. Cope Pond. In total, we calculated sixteen values of average water depths and total dragonfly naiads for each average water depth. We presented our data using a linear regression of total number of dragonfly naiads against the average water depth.

Results

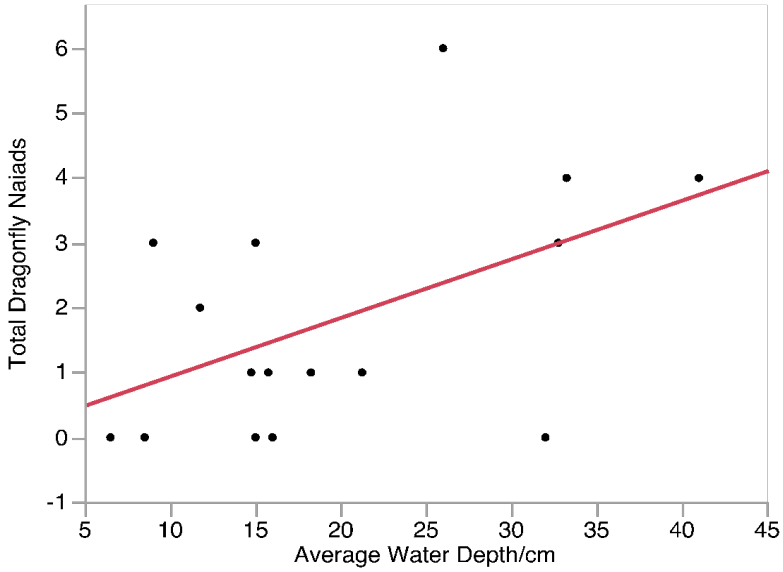

Figure 2. Total dragonfly naiads as a function of average water depth (in centimeters). More dragonfly naiads were discovered as the pond depth increased ($y = 0.02 + 0.09x$, $F_{1,15} = 4.81$, $P = 0.0457 < 0.05$, $R^2 = 0.255$).

Most of the dragonfly naiads collected lived in water depths as shallow as 15 centimeters to as deep as 41 centimeters. Below 15 centimeters of water depth, we found only five naiads out of the total 29 naiads found within the sampled area. We found no naiads below the 9 centimeter water depth, which means 9 centimeters is the minimum depth to sustain a naiad's survival.

We found a positive correlation between the total number of dragonfly naiads and average water depth in centimeters (Figure 2). Since $F_{1,15}$ value of 4.8069 is greater than F value at 95% confidence intervals[1] and P value is lower than 0.05, we concluded that there is a significantly positive relationship between the number of dragonfly naiads and average water depth in

[1] Statistical Table. Available at https://home.ubalt.edu/ntsbarsh/Business-stat/StatistialTables.pdf.

centimeters. Though the F value indicates a significant relationship, R^2 value of 0.255 is low, indicating a weak positive relationship between the number of dragonfly naiads and average water depth in centimeters. A reason for the low R^2 value could be because of other factors we did not account for such as the temperature of the water and the sediments deposited in the pond.

Discussion

Dragonfly naiads are carnivorous generalists who eat a great range of food from insects such as mosquito larvae and small worms to small vertebrates such as tiny fish and tadpoles. Since these preys probably prefer different depths of water, there could be not much of a difference in food source availability between shallower water and deeper water, and food source availability is probably not one of the reasons why dragonfly naiads prefer deeper water. Instead, their relatively large size leading to their low ratio of surface area to volume allowed them to reduce thermal exchange with the environment, which is probably their behavioral response to the lower intensity of sunlight in the deeper water. The data also implied that dragonfly naiads are tolerant of the low dissolved oxygen levels in the deeper parts of the ponds. Moreover, we speculated from the data that the naiads prefer deeper water as it could have been an advantageous hiding place for dragonfly naiads from predators such as raccoons, who cannot swim really deep into the water. The sparser distribution of vegetation in the deeper water compared to the denser vegetation in the shallow water could also suggest that dragonfly naiads thrive in environment with low density of vegetation.

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