The Biogeography of Aquatic Insects in Vernal Ponds in the Upper Peninsula of Michigan

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ABSTRACT

Aquatic insects are important species to study for a number of reasons. They can be used as biological indicators of water quality, while some species transmit diseases or just generally become a nuisance to the population. Not much is known about the basic biology of aquatic insects. Life history traits such as habitat selection are important in understanding the ecology of these organisms. For this study, I looked at one specific habitat, vernal ponds in the Upper Peninsula of Michigan. A wide variety of chemical factors were analyzed, but any one factor does not seem to influence the biodiversity in the ponds studied. My final conclusion is that a combination of factors played a role and the interrelationship is very complex.

INTRODUCTION

There has been an increased interest in aquatic insects of late, primarily due to such diseases as West Nile Virus, which is carried by mosquitoes. Their use as environmental indicators of water quality is also important one, along with other minor uses in modern society. There is a need, therefore, for more studies on these insects, including basic life history traits. Mosquitoes are not the only objects of interest, however. Besides diseases, aquatic insects can cause nuisances through biting people and being attracted to lights and food. There are also some insects considered beneficial, such as dragonflies, because they eat other less desirable insects, such as mosquitoes. It would be helpful if we understood more about these aquatic insects and how they interact with their world.

A primary life trait of all animals is habitat selection. Habitat varies at all levels of organization. For instance, some orders of aquatic insects occupy a broad range of habitats within a water body. Aquatic Hemiptera, or true bugs, can be found in a variety of areas, including the water surface (Dolling 1991). Within this order, individual families or species occupy particular niches. Gerridae, or water striders, exist on the surface. In contrast, Belostomatidae, or giant water bugs, tend to stay in deeper depths (Hilsenhoff 1995). This example illustrates habitat selection within one order.

The most simple habitat selection is fairly obvious: terrestrial vs. aquatic, lentic vs. logic, lakes vs. ponds, etc. Although these seem clear cut, they are not. Many orders and even species occupy both sides of each of these spectrums. Some orders are entirely aquatic, such as Odonata, where as others have both terrestrial and aquatic representatives, such as Coleoptera. Many orders breach both lentic and lotic categories

as well. This study looks at a very particular habitat, vernal ponds, and attempts to classify the aquatic insects found there.

Vernal ponds can be defined as pools that form in the early spring from melting snow and rain that gradually dry up by mid-summer (Morrison 1992). They are common throughout most of the northern latitudes where a large amount of snow collects in depressions. They are found in depressions in the landscape, in this case caused by glaciers, that fill in high periods of water, mostly in the spring. As such, they depend heavily on precipitation and can vary due to changes in precipitation. They also vary in size due to the size of the depression and drainage patterns. There is a basic biogeographical principle that states a larger area supports more species (Oertli 2002). This isn't the only factor, however.

The vegetation that is found in them and around them also changes depending on the location of the pond. They lack true aquatic vegetation due to their instability. A study by Fairchild, Faulds, and Matta (2000) found that "an array of changes in available food resources are thus likely to influence species composition". Their chemical makeup, such as nitrate content and pH can also change. These and other factors relate to the biodiversity inside the ponds. The question is, which factor(s) contribute to the biodiversity of a pond? The purpose of this study is to find out how the biotic and abiotic factors relate to the biodiversity of aquatic insects in the vernal ponds studied.

MATERIALS AND METHODS

All of the research was conducted at the University of Notre Dame Environmental Research Center (UNDERC) in the Upper Peninsula of Michigan and Northern Wisconsin. 2 sample dates were used: June 14, 2002 and July 17, 2002. A total of ten ponds were used. These were all previously identified ponds, studied in previous years. In doing so, this allows for comparison over the years. The following ponds were used: 5, 7, 8, 16, 20, 24, 25, 29a, 29b, and 30. All of these ponds were roughly the same size, but varied in depth.

Collection was done in hour increments using D-framed nets with 1-mm mesh. The entire pond was swept through in most cases. In some of the larger ponds, sampling of all areas was attempted. The insects were immediately preserved in 70% ethanol and brought back to the laboratory where they were identified using a dissecting scope and Hilsenhoff's *Aquatic Insects of Wisconsin* identification guide (1995).

For the chemical analysis portion of the experiment, water samples were taken at the site and were analyzed within twenty-four hours of sampling using the Hach Water Chemistry Kit back at the laboratory. Six parameters were analyzed, including nitrate, iron, phosphorus, acidity, pH, and color. Depths were measured using a meter stick. Depths were an estimate, for relative size only. Depths were taken at both sampling periods to note the change in depth, whereas the chemical analysis was not. Only four of the ponds still had water in them by the middle of July: 5, 7, 24, and 30. Comparison between the dates could only be taken for these ponds.

RESULTS

In total, over 300 aquatic insects were founds between all the ponds. Most of the orders in the area were found in each, namely Odonata, Trichoptera, Coleoptera, and Diptera. However, individual ponds varied in their diversity and number. For analysis purposes, I used the number of species represented, or the biodiversity of each pond. The most diverse ponds included 7 and 24, which happened to be the deepest of the ponds. You can see this in Figure 2. However, as Figure 2 also shows, this did not measure out for the other depths. There was no strict correlation between depth and biodiversity. On average, the depth changed by about 58 cm between the two sample periods, where as the diversity dropped by about 5 species on average.

Biodiversity compared to a number of chemical factors were also analyzed. A summary of the averages of these parameters is illustrated in Figure 1. pH levels were very similar, as you can see in Figure 3. There was no correlation between pH and diversity however. As you can see, the levels of nitrate, iron, and phosphorus were all pretty low. I compared one of these, phosphate in Figure 4. There was no significant correlation between depth and phosphate level. All of the other chemicals had similar results.

Parameter	Average
Depth 1 (cm)	81
Depth 2 (cm)	23
Diversity 1	8.8
Diversity 2	4
Depth change (- cm.)	58
Diversity change	-4.8
pH	6.08
color	348.2
Iron (mg/L)	0.091
Nitrate (mg/L)	1.17
Phosphorus (mg/L)	0.74
Acidity (mg/L)	78

Figure 1. Averages of all the parameters analyzed.

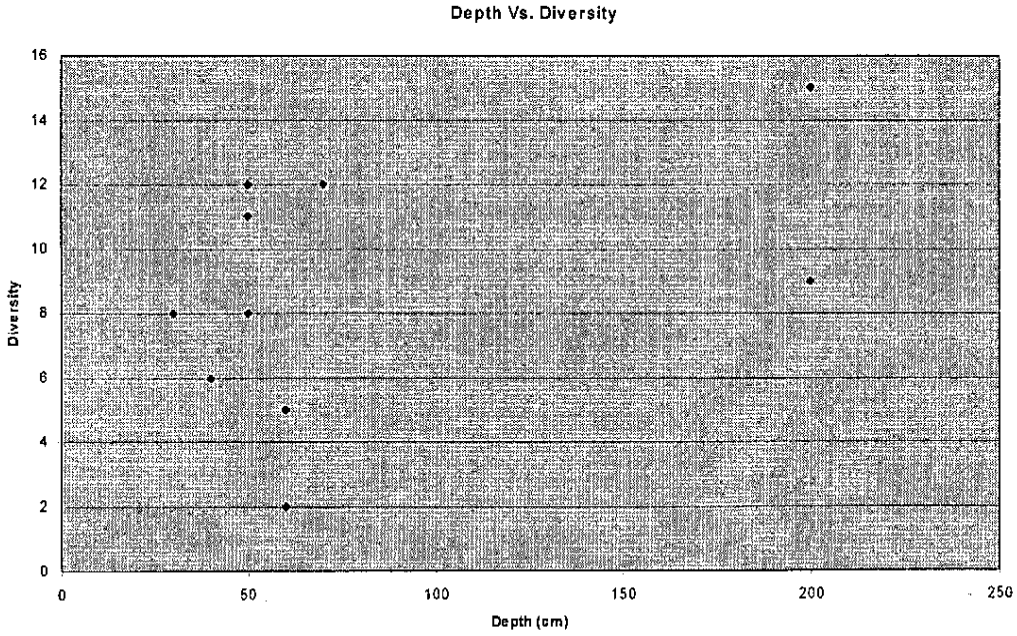

Figure 2. Depth (in cm) vs. Diversity

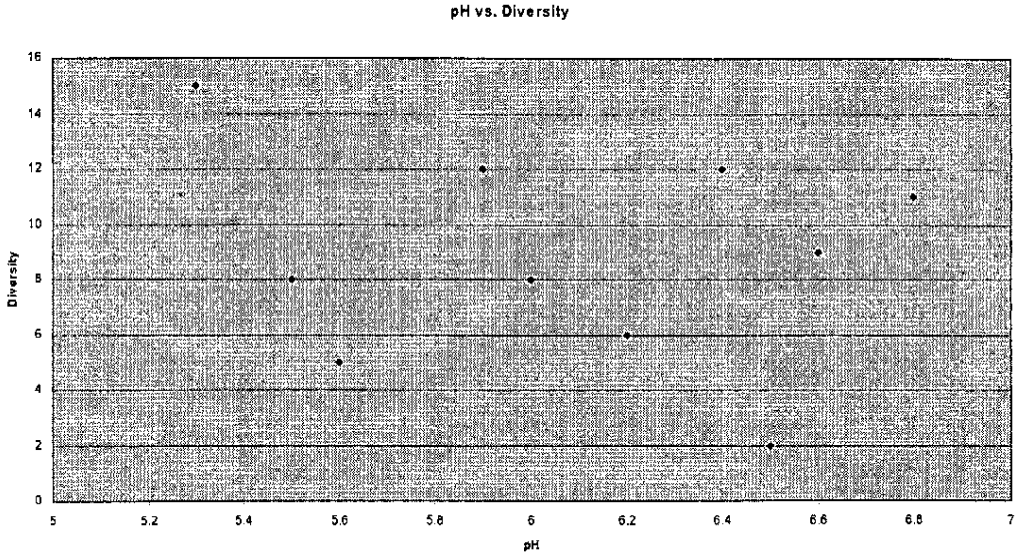

Figure 3. pH vs. Diversity

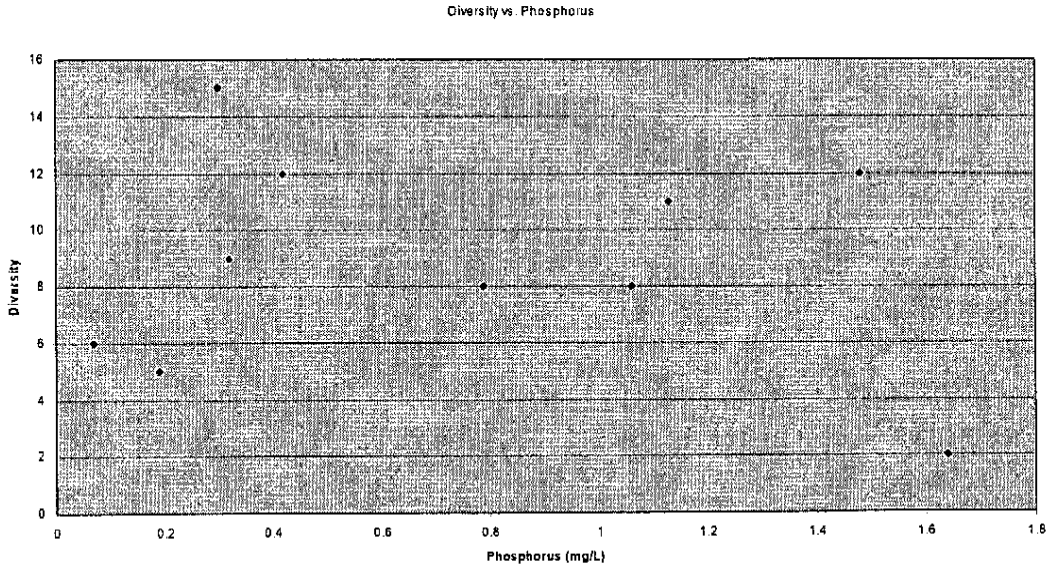

Figure 4. Phosphorus (mg/L) vs. Diversity

DISCUSSION

The results indicate that one factor alone is not responsible for the biodiversity of aquatic insects in vernal ponds. Not one of the six factors I looked at had a direct correlation with number of species. This could mean that the factors behind composition are complex. I did not look at all the possible affects on the system, only a select group of larger effects that were easier to identify and measure. Other factors that could have been looked at include vegetation composition, temperature, dissolved oxygen, and total volume.

There may have also been problems with the experiment design. For example, it was difficult to analyze all of the aquatic insects in a given area due to time constraints. There was an attempt to budget the time among all the separate areas of each pond, but this wasn't systematically controlled. Better experiment design could have resulted with more accurate results. More ponds being sampled and more sampling times in general could have also yielded better results. All of these were cut short due to time constraints, however.

Future experiments could include changing the research methods and including more factors in analysis. Based on the research presented here, however, biodiversity does not seem to be linked with any one biotic or abiotic factor. Rather, a combination of factors plays a role in the aquatic insect makeup of a vernal pond. This illustrates the complexity of ecosystems and the difficulty in managing ponds like these.

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