Odonate Distribution in Lakes of Varying Water Chemistry

BIOS 569 - Practicum in Aquatic Biology

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ABSTRACT

The University of Notre Dame Environmental Research Center is home to a great diversity and number of *Odonata*. Odonate naiads, which are relatively large, slow, and easily identified provide and attractive model taxa for understanding the effects of water chemistry on aquatic insects, and if they display sensitivity to water chemistry a good potential indicator species. Dissolved Oxygen, pH, color, total alkalinity, total hardness, and conductivity were measured. Ten different aquatic habitats on the UNDERC property were surveyed for water chemistry and Anisoptera naiads. While statistical analysis was not possible, some visible trends existed at the family level. *Libellulidae* were the dominant family in nearly every habitat, followed in most habitats by *Cordulidae*. *Libellulidae* were most dominant in habitats with dark color, low pH, and low Dissolved Oxygen (DO) concentrations. The clearest pattern was *Libellulidae* abundance as a function of DO. *Cordulidae* exhibited most dominance in waters of intermediate DO, but did not exceed *Libellulidae* densities. These patterns should encourage further investigation of the effects of DO, pH, and color on Odonate naiads

INTRODUCTION

Understanding the reaction of a group of organisms to environmental change offers an attractive method of monitoring that environment. The term indicator species refers to a species that is sensitive to certain environmental characteristics and thus can be used to monitor an environment. An indicator species should respond in an easily measurable way to changes in its environment (Kremen *et al* 1993). Other desirable characteristics are ease of capture and identification and abundance. Odonate larvae are relatively large and easily captured and identified, making them a attractive candidate for use as an indicator group. A remarkable abundance and variety of Odonates are found on the UNDERC property (Dept. of Biological Sciences, 1993). I predict that competition among this great abundance of Odonates cause some species to show prominent reactions to environmental variation.

Odonate larvae inhabit a wide variety of aquatic habitats ranging from lake and stream bottoms to leaf bases (Corbet, 1962). Larvae are predators that tend to stay at one perch or burrow for extended periods of time and can exhibit territorial behavior in some cases (Rowe, 1978). Wandering occurs at night and when hungry or feeding (Corbet, 1962).

Relatively little data is available regarding the reaction of Odonates to water chemistry variability. Hudson and Berrel found that Odonate eggs were relatively unaffected by low pH. Odonate distribution in Kruger National Park, South Africa were shown to be significantly affected by shade cover, permanency, and flora, but were judged to be of only moderate utility as an indicator species.

MATERIALS AND METHODS

Site Descriptions:

The University of Notre Dame Environmental Research Center is a 7345 acre site on both sides of the Upper Peninsula Michigan, Wisconsin border. It is bordered on three sides by Ottawa National Forest and has over 30 lakes and bogs within. During the months of May through July of 1998 ten aquatic habitats on the UNDERC property were surveyed for water chemistry parameters and odonate naiads.

Crampton Lake: Located at eastern border of the property, this lake covers 72 acres. It is rather deep and very clear. The littoral zone bottome is gravelly and quite firm.

Bay Lake: The largest lake in the study, at 170 acres, it is comprised of a number of long narrow bays. Littoral zone bottom is relatively soft with a great deal of deadfall.

Morris Lake: A relatively shallow lake covering 12 acres. The littoral zone has a variety of emergents and a great deal of spatial heterogeneity. The bottom is quite soft organic matter.

Bog Pot Lake: This is a very shallow (2 m), oblong body of water adjacent to one of the roads on the property. On one end is a floating Sphagnum island. Sampling was done in a moderately soft littoral zone with a great deal of emergent grass.

Trout Pond: This is a very shallow marshy habitat with a soft bottom and a great deal of emergent vegetation.

Reddington Lake: Part of this lake is a shallow marshy habitat interrupted by hummocky emergent vegetation. This is connected to a deeper more open habitat surrounded by sphagnum.

Ward Lake: This lake covers 2.7 acres with a depth of 7 m. There is some sphagnum surrounding the lake, under which sampling was done.

Ed's Bog: This is a small bog surrounded closely by forest. It has a well developed mat all around. Sampling was done under the mat.

Tender Bog: This bog covers about 2.5 acres with a max depth of 15 m. It has a well developed bog mat surrounded by coniferous forest.

Unnamed: A shallow stagnant marshy habitat adjacent to on of the roads on the property.

Sampling and Analysis:

Each habitat was analyzed for pH, conductivity, and DO on site. Duplicate 500ml. water samples were taken from epilimnion within 10 meters of shore and transported to the laboratory in tightly capped plastic bottles for further chemical analysis. Plastic bottles were pre-rinsed in lake water three times prior to sample collection. Analysis of true color, total alkalinity, and total hardness were performed on each duplicate with the Hach chemical analysis products.

Odonate sampling was done with triangular dip net in good prospective habitats less than 1m depth. Samples were taken from areas with and without emergent vegetation, and from any apparently different micro-habitats. Live odonate naiads were picked from net debris and placed in 70% EtOH. Naiads were identified upon return to the laboratory.

RESULTS

Water chemistry analysis indicated what was expected from the habitats (Table 1.). Bog like habitats showed the lowest pHs as well as low indicators of buffering capacity. These habitats also had darkly colored water. Also as expected, the shallowest most stagnant bodies of water had relatively low DO. Other habitats varied greatly in all parameters.

Composition of odonates varied greatly throughout the habitats, but there were some strong patterns (Fig. 1.) At the species level there was much variability from lake to lake, but one or two species typically dominated the composition (Fig 1. A). At the genus level we see the same situation, but the dominant genera are more conservative from lake to lake (Fig. 1 B). If we generalize even more to families, we see that *Libellulidae* is the dominant family in nearly every habitat, followed in most cases by *Cordulidae* (Fig. 1 C).

The most interesting patterns are found when we look at family composition as a function of some of the water chemistry parameters. Of the two dominant families, *Libellulidae* shows the strongest relationship to water color (Fig. 2). *Libellulidae* show a general increase in percent composition in darker water. *Cordulidae* do not show any strong response to color. *Libellulidae* also show a simple pattern in relation to pH, increasing their percent composition in more acidic waters (Fig. 3). Again, *Cordulidae,* do not show any strong pattern here. The most interesting patterns are found when we look at DO. *Libellulidae* make up the vast majority of individuals in the lakes with the lowest DO (Fig 4.) They show a steady decline in their dominance as DO increases. *Cordulidae* composition peaks in the mid range of DO but does not exceed Libellulidea here. *Aeshnidae* are appreciably present only in waters with high DO.

Water Chemistry

SITE	pH	DO	Color	Hardness	Tot Alk	Conductivity
Bay Lake	8.1	18	17	7	20	14.3
Bog Pot	6.3	8.8	101	5	3	12.6
Crampton Lake	8.9	10.4	0	4	4	13
Ed's Bog	5.2	4.4	86	3	3	10.6
Morris Lake	7.5	10.7	42	56	72	100.5
Pond by the Rock	6.4	1.2	111	68	64	29.7
Reddington Lake	6.3	8.4	130.5	15	10	20.7
Tender Bog	4.9	4.8	157	4	0	10.6
Trout Pond	7.1	8	145.5	47	46	88.4
Ward Lake	8.1	11.4	19.5	77	84	152

Table 1. Means values of various chemical parameters of duplicate water samples.

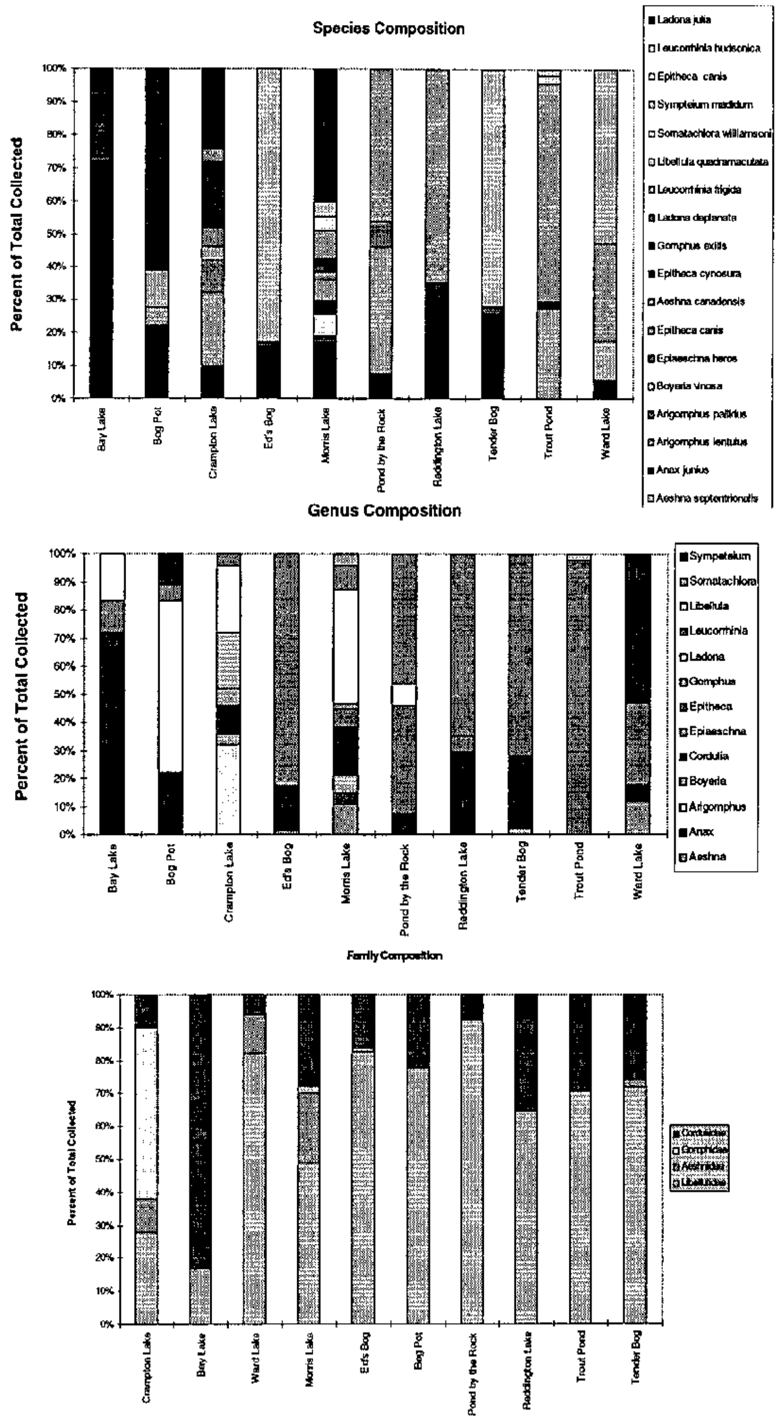

Fig. 1. Percentage of total odonates sampled occupied by: A.each species. B. each genus. C. each family.

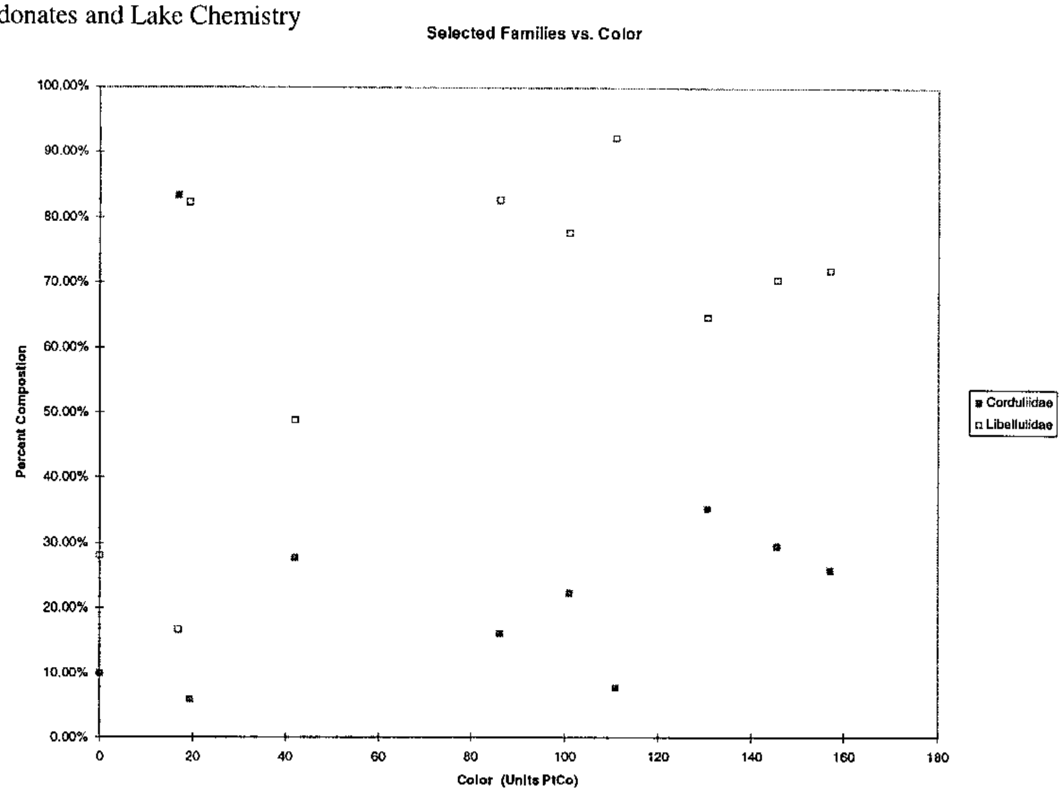

Fig. 2. *Cordulidae* and *Libellulidae* percent compositions as a function of Color.

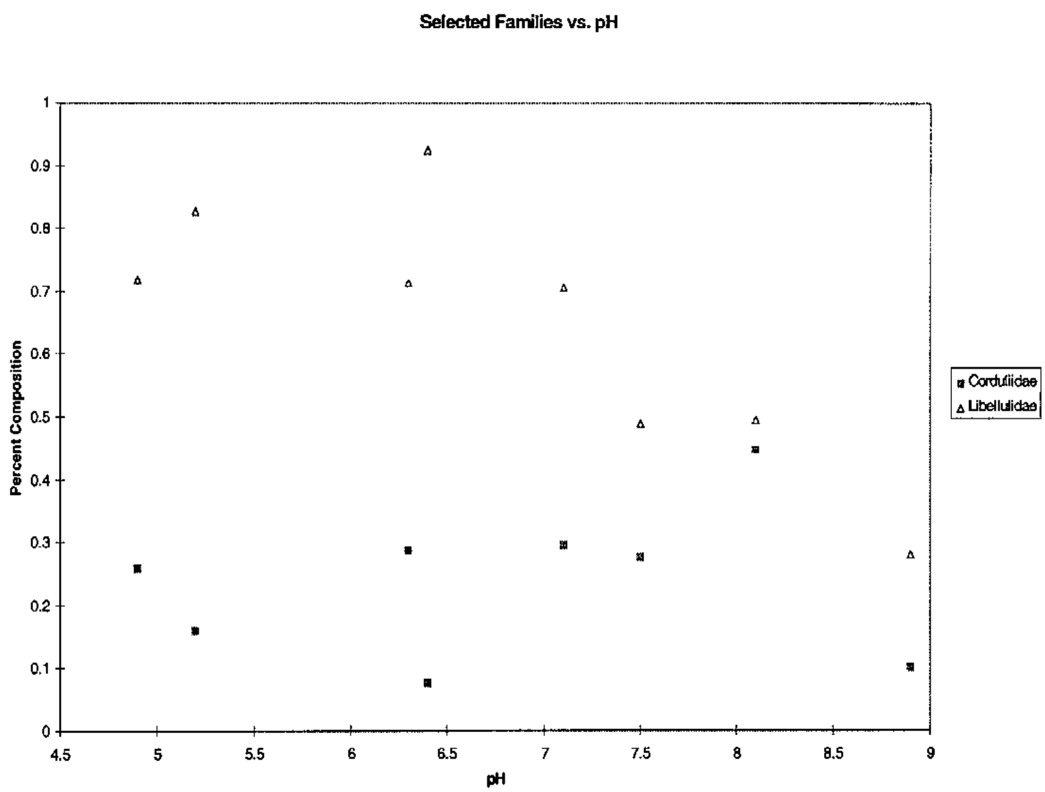

Fig. 3. *Libellulidae* and *Cordulidae* percent compositions as a function of pH

Odonates and Lake Chemistry

Examination of species composition shows a great deal of variation from lake to lake, but no noticible patterns with any water chemistry parameters. The same is true at genus level.

Discussion

While it was impossible to do any statistical testing of the results due to the non random sampling methods, the results do provide a preliminary glimpse at the relationships between odonate success and water chemistry. The results should encourage further study of the effects of DO concentrations, color, and pH on odonates.

The dominant family in nearly every habitat varied with both pH and color, thriving in darkly colored, acidic habitats. It is not certain, however which, if either, of these chemical factors was responsible. Low pH and dark color are both typical of bog habitats and it is reasonable to believe that some other aspect of this habitat may favor the dominance of *Libellulidae.*

The strongest patterns are seen in the relationship between family compositions and DO concentration. *Libellulidae* are most dominant in waters with low DO concentrations. This appears to be independent of pH, as Libelulidae are most dominant in the only mildly acidic pond by the rock. *Cordulidae* also appear to be affected by this parameter, being most abundant in intermediate DO concentrations.

We are unable to see any patterns at the lower taxonomic levels. Members of the same genus and species are not present consistently enough from lake to lake to show any patterns. It is still reasonable to believe that water chemistry could affect odonates on the family level and these effects not be apparent at the genus and species level. While DO concentrations may affect all members of a family similarly, there could be other features of a habitat that have effects more apparent at the genus or species level, masking the effects of DO.

Future studies should employ random sampling methods and try to reduce the biases inherent in this study. Sampling was performed in areas that appeared to be good dragonfly habitats. This was necessary in order to get an acceptable volume of data, but poses the risk of inflating the numbers of a species by repeatedly sampling in similar areas. It is likewise possible to ignore a less obvious habitat. Random sampling alone should eliminate this bias. The method of removing live odonate naiads from the sampling net was certainly biased towards larger more active taxa. Use of sugar floatation or a variety of methods might help reduce this bias.

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