

**The Emergence and Flight Seasons of Different Odonata Species in Particular
Aquatic Habitats**

Bios 569 – Practicum in Aquatic Biology

**Rhiana Saunders
418 Pasquerilla West
Dr. Ronald Hellenthal
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ABSTRACT

Becoming more popular in aquatic research studies, Odonata are excellent models for interpreting behavioral interactions between and among species. After carefully referencing past research experiments, I designed an experimental survey to discover the flight seasons for diverse species living on the University of Notre Dame Environmental Research Center property in Michigan. Through a period of ten weeks, I collected and identified as consistently as possible the adult Odonata species in four different aquatic habitats. Through careful evaluation of my results, I was able to conclude that certain species preferred specific habitats and that, for the most part, adult species exist in the same areas of their larvae species. However, due to a lack of significant and accurate collections, I was unable to determine the major flight seasons for different species.

The Emergence and Flight Seasons of Different Odonata Species in Particular Aquatic Habitats

INTRODUCTION

In more recent years of aquatic ecology, researchers have been drawn to study the influence of aquatic insects on viable ecosystems. Because they are excellent models for interpreting behavioral interactions between and among species, Odonata (or dragonflies) are specifically becoming increasingly popular in aquatic studies. Generally, Odonata occupy conventional aquatic habitats that differ variably among species. In many cases, a suitable habitat is determined by temperature and water chemistry--which is then influenced by rainfall, watershed and aquatic vegetation. An other important factor influencing habitat selection is predation. Most Odonata larvae will occupy areas that provide concealment from predators such as newts, fish and grasshoppers. By doing so, they might remain at the base of an emergent plant or burrow in the soil. It has been noted that predation and cannibalism also occurs between and among Odonata species.

Although there have not been many studies, researchers believe that territorial behavior of Odonata larvae may regulate the population density in specific aquatic habitats. It has also been noted that aggressive behaviors (specifically within a single species) of the male adults play a major role in territoriality and reproduction.

Unfortunately, it is difficult to link a suitable habitat for a specific larvae species to the preferred adult habitat within that same species simply because once the larvae have emerged, their new adult forms are capable of flying far away from the freshwater larvae habitat. Hence a new habitat selection can be inferred from the distribution of adult species (Corbet 1980).

In a 27year experiment in England, 23 ponds that differed in their aquatic vegetation proved to contain similar Odonata faunas. Results showed that no specific plant species was necessary for larval development. Upon studying larval emergence, the researchers underwent methodical searching for exuviae. However, this became time-taking and so they collected data by counting larvae in their early teneral stages at the water's edge. It was noted that periods of emergence overlapped such that the different Odonata species had opportunities to interact--however, there were no signs of significant interaction. In discussion, the researchers claimed that, in an ideal study, the changes in dragonfly numbers should include daily counts of adult dragonflies and daily collections of exuviae. However, they found it difficult to make accurate counts of adults because certain species were harder to identify, others flew too high or too fast to identify, and there was always the danger of miscounting the adults in highly populated areas (Moore, 1990).

A test of particular importance on the position and duration of adult flight seasons was performed by several researchers in North Carolina (Paulson and Jenner, 1970). The results of this test showed that the emergence period and seasonal length of the adult Odonata was effected by the larval development. The scientists found that the spring species possessed highly synchronized emergence periods and shorter flight seasons; whereas, the summer species were characterized by less synchronized emergences and longer flight seasons (some lasting up to four months). For almost all collected species, the length of the flight season and the emergence period were directly proportional. According to the experiment, larval synchrony (or lack there of) between species may be of great importance in reducing the inter-specific predation competition

between summer and spring species. Unfortunately, the researcher believe that their small sample sizes may have significantly hampered their material interpretation; and consequently, there is a lack of assurance that the collected data was truly representative of the population (Paulson and Jenner, 1970).

A similar experiment of Odonata flight seasons was performed at Bays Mountain Park (Johnson and Coney, 1980). Here researchers collected and recorded sightings of adult Odonates and sweep net samples of larvae. The studies showed that it was not unusual to find many species coexisting in one area. The *C. corduliiis*, for example, was a synchronously existing species. Even so, the researchers inferred that perhaps seasonal segregation was potentially important in reducing niche overlap among species adapted to similar habitats. For example, two species collected, *Basiaeschna janata* and *Aeshna umbrosa*, existed in the same area but their flight seasons differed by five months (Johnson and Coney, 1980).

During another study, 18 Odonata species were observed in the months of June and July of 1968. The researcher studied the influences of environmental factors such as the time of day, ambient temperature, and light intensity on the flight activities of each species. The scientists concluded that, in certain species, activity was controlled by either one factor or by a combination of factors. Specifically, the study showed that some species terminated flight activity when the weather dramatically changed or when cloudiness increased (Lutz and Pittman, 1969).

All of these previously performed experiments have sought to understand the differences in Odonata flight seasons and the factors, behavioral or environmental, that influence them. While at the University of Notre Dame Research Center in Michigan, I

will combine the information from these references into an experimental survey on the flight seasons for diverse species of Odonata living on the property. More importantly, however, I aim to take this study one step further by comparing the abundance of each species at particular aquatic habitats. By doing so, I can not only observe the overlapping or segregated flight seasons for each species, but also the degree to which different habitats affect adult flight seasons. Although keeping quantitative records for each species may be greatly effected by sampling error or unexpected factors, I believe that by keeping sampling charts I will have a relative representation of the most abundant species living in specific areas during a specific time period. Inferring from the data of other experiments, the results should show certain species with overlapping flight seasons and emergence periods as well as species with completely different flight seasons.

MATERIALS AND METHODS

The UNDERC property is located between the border of Wisconsin and Michigan's Upper Peninsula. Among the twenty-six aquatic habitats on the property are nine dystrophic bogs, many permanent ponds and small lakes, marshes and streams. This study was conducted in four various aquatic habitats located in all areas of the property: Tender Bog, Crampton Lake, Morris Lake and Trout Pond. During my first few days on the property I explored the areas of each of my chosen habitats to make note of different abiotic and biotic factors influencing that particular habitat. Crampton Lake was noted as an oligotrophic lake with moderate emergent vegetation along the shoreline. Morris Lake was also oligotrophic, however, it had a larger amount and a wider variety of vegetation types as well as softer soil. Trout Pond was more like a swamp than pond. It contained

no lily pads—simply long grass-like plant-life and free emergent bushes. Tender Bog was noted as a dystrophic lake with typical sphagnum moss and leather leaf plant-life.

I was able to obtain data concerning water chemistry on all of these habitats. The pH and average temperature that I was given for the all habitats are as follows:

Crampton Lake.....	pH 5.7, 25.0 degrees Celsius
Morris Lake.....	pH 8.4, 25.2 degrees Celsius
Trout Pond.....	pH 5.5, 22.4 degrees Celsius
Tender Bog.....	pH 3.8, 24.3 degrees Celsius

Once I had determined the differences in my habitats, I began to pre-sample for both Odonata larvae and adults in those habitats. (I also sampled for adults in other areas on the property to get an idea of what species had already emerged and were well in their flight season). The larvae were obtained wearing waders and using a dip net to scoop up soil in the littoral zone from each site. The water seeped through the net leaving the larvae crawling around in the mud. Each immature was then removed with forceps and put in to jars with ninety- percent alcohol. The adults were obtained using a mesh net. As I walked along the shores of each site, I tried to scoop up the adults that I saw--note that this was not as easy as it may sound. With time and practice, I learned to develop more efficient techniques to catch the adults. Such techniques would be to stand very still and allow the dragonflies to fly around me before I tried to catch them. Another technique would be to simply to sneak up on a dragonfly sitting on a branch or on the ground.

Once I finished with three days of pre-sampling, I began to make a notebook and chart of the actual sampling data. I only needed to get an idea of the species of larvae at each lake so I stopped collecting the immatures and focused on the adults and exuviae. I devised a schedule of sampling for adults for at least 2 hours each day between the hours

of 11 AM and 4 PM during the allotted research weeks. During the class weeks I was forced to sample for adults during times between class lunch breaks for only about half an hour and maybe again in the evenings or early mornings (May 18-31, June 8-14, June 22-28, July 6-8). I would try to sample on the days with bad weather but sometimes the sampling periods were cut short due to storms. When I sampled the habitats I would make note of any species that I could identify by sight as well as the weather and time of sampling. After about half an hour I would continue to sample until I stopped seeing different species flying in the area or until my collected species roughly represented the population around me. Then I would move to the next site (rotating each of the four sites).

In addition to the sampling with a mesh net, I also used emergence traps/cages to try and capture newly emerging species. These cages were made of wooden stick-like pieces that formed the boundaries of a three-sided pyramid. All sides of the pyramid were made of net material except the bottom side--such that the trap looked like a pyramid-shaped funnel. The tip of the pyramid was sealed shut with staples and extra net material. Each Sunday I would take seven of the fourteen traps to one of the four chosen sites and place each trap along the shallow areas (open bottom down) near or among emergent vegetation. Once this was done I took the remaining seven traps to another site. (The idea behind using this contraption was that should any larvae climb out of the water to emerge, they would climb up along the net material on the traps and leave their exuviae behind, or perhaps even become trapped inside the cage). After one week, I would check up on the cages and collect any exuviae or trapped adults. I would then move the traps to the other two sites--alternating sites each week.

Once the adults were collected, they were put into labeled jars and then into a freezer to preserve them until they were identified. The process of species identification included placing the specimen on a dissecting microscope and then going through multiple Odonata keys and a reference collection previously established by students at UNDERC. Once the species were known, the dragonflies were carefully placed into clear plastic envelopes that were labeled with an index card stating the species type, gender, date of collection, location of collection and any other special information. Once I had run out of envelopes, I began pinning the rest of the dried adults down into boxes.

The actual sampling period was ended on July 12, 1998. After that day, I began to organize my data and create charts and graphs to display important the collection information.

RESULTS

My first table, Table 1, displays all of the Odonata larvae collected with in the first few weeks of sampling. The information of this table was obtained from my own sampling as well as from a fellow classmate, Meghan Marcus, whose research strictly pertained to larval Odonata. I felt that by using her data in addition to my own, I would have a more accurate representation of the larvae population. The table is organized in such a way to show the four sites of collection, the type of species collected at each site, and the actual number of species collected.

Throughout the summer I kept a detailed journal that daily recorded my process of adult sampling. It is from this journal that I was able to create the rest of my tables, and graphs. Table 2 is a actually more like a chart. It collectively displays each successful

day of adult collection (by successful I mean at least one species collected), the location of collection, the type and total number of species collected, and also the observed weather at the time of collection. I also noted on this table the species that I was not able to collect but could accurately identify. From Table 2, I created four more tables that were specific to each collection site. Table 3, for example, displays the total number of species collected at **Trout Pond** and their flight periods from June 1 to July 12, 1998. Tables 4, 5 and 6 follow for the other three sites. The last table, Table 7, combines all of the information from each site. It shows the combined number of each species collected throughout the collection period.

From Tables 1 and 2, I was able to display two graphs (Graph 1 pertaining to larvae and Graph 2 pertaining to adults) that showed the total number of collected species verses the sites of their collection. Note: The larvae species did not completely reflect the same adult species. The information on these two graphs is particularly important in allowing me to make a distinction between the preferred habitats of the larvae and adult species. Graphs 3 and 4 show the flight periods of ten of the most abundant species collected. (Instead of displaying ten different lines on one confusing graph, I split up the data into two graphs). The x-axis data points represent each week of collection from June 1 to July 12, 1998. The y-axis displays the total number of **each species** collected during that week. All of this data was obtained from Table 2. Finally, Graph 6 displays a single species, *Ladona julia*, and its flight period according to each collection site. The x-axis represents the sampling weeks (just like Graphs 3 and 4) and the y-axis represents the total number of *L. julia* collected **at each site** during that week.

DISCUSSION and CONCLUSION

As I looked back over my journal, I realized there were many important findings that the table and graphs could not show. Without looking through my notebook, one might never know or understand why some of my collected data was not completely representative of the actual adult populations. For instance, on July 6, 1998, I noted that many *Ladona julia* had disappeared when the weather changed from sunny to overcast conditions. Although this helped me to make the observation that adults tend to prefer sunny, fair weather conditions, I could not accurately account for the actual population of adults in their flight season when the weather changed from fair to poor.

Perhaps more importantly, the weather conditions as a whole were unusually warm for so early into the summer season. Many think the strange weather conditions were in part due to the effects of El Nino. In any case, since the adult flight season is greatly influenced by changes in weather, my data collected can only be representative of a particularly unusual year. In a normal year, the adult dragonflies do not emerge until the later months of summer. However, by the time I arrived at UNDERC, most species had already emerged and were well into their flight seasons. Consequently, I was unable to record the beginning stages of flight seasons for the species that I collected. Also, the period in which I did collect adults was not long enough for me to find any ending or declining stages of flight periods. As a result, I was not able to make an emergence table showing the beginning and ending time periods for specific species flight seasons. Should I have been able to stay at the UNDERC property longer, I probably would have been able to see a definite decline in certain adult species abundance by early September.

There were many cases, as seen in the journal, where the adults flew too high or too far for me to make an accurate species identification. On June 27, 1998, for example, I noted that there were some species that were harder to catch than others—thus, causing my collection bottles to be predominantly composed of the easily collected species. On some days, I found swarms of dragonflies at the collection sites. Since there were so many adults to choose from, perhaps there was a subconscious bias in which adults to collect and identify. If so, this also would have influenced my data on population representation.

As for the sampling locations, I found that some sites were easier to collect than others. Tender Bog, for example, provided only a small area in which to stand while chasing the dragonflies; whereas, Trout Pond had a much larger area along its shore. Therefore, it is hard to make any kind of accurate assumptions when comparing the abundance of dragonflies between each habitat. One must also take into consideration that my collection techniques improved with time—therefore, my inconsistency more than likely causes my first sampling attempts to be less accurate than my last ones.

In respect to the allotted time for daily sampling, I encountered many unavoidable inconsistencies. Due to the fact that only some of the weeks were research weeks, I could not keep a consistent schedule of sampling periods. During the class weeks I had to sample for adults in the evenings or early mornings or for only a half an hour during mid-day. Because of this, I was able to observe that the adults were more active during mid-day. However, this caused an obvious inaccuracy of the representative populations in respect to flight seasons. Again, because I could not test during the day-time for the same length of time everyday throughout the summer, I could not get an accurate account of the

species in specific stages of their flight seasons.

As for the emergence traps, they were a definite failure in this experiment. First of all, I made the cages out of a material that floats—wood. I had to try and weigh down the cages using rocks. Unfortunately that cages would sometimes float up and tip over. Also, throughout the weeks, some of the cages kept breaking and I had to remove them from their location to be fixed. Although the use of the cages was a was mini-trial experiment that showed no result, I think that if I had more time to focus on them and strategically place them in better locations, they might have been beneficial to my experiment. Not only would I remake the cages out of other non-floating materials, I would make more of them while hoping to get more representative results.

As I have clearly stated, there are too many factors influencing my data to make any kind of accurate assumptions. However, I would like to make note of some particular observations concerning my data and graphs. For the most part, Graphs 1 and 2 show that the habitats for the adults species closely correlated with the same juvenile species. Many of adults were found in the same habitat of their juvenile species. However, the abundance of the adults did not fully represent or correlate the abundance of their juvenile species. Also, in some habitats, certain adult species were never observed were their juvenile species were collected. (Morris Lake, for instance contained *E. canis* larvae but *E. canis* adults were never found near Morris Lake).

One thing I can make note of for sure is that certain habitats had a greater amount of certain species than others did. For example, I was able to capture many *Leucorrhinia glacialis* and *L. proxima*, *L. julia*, and *E. cynosura* at Tender Bog. This habitat was the most limited in its abundance of various species types—every species besides the ones

mentioned was rarely found there. Trout Pond had many different *Leucorrhinia*, *Cordulia*, *Epitheca* species as well as many *L. quadrimaculata*. It did not, however, have many *Gomphus* or *P. lydia* species. Crampton Lake, on the other hand, mainly supported *Gomphus* and *L. julia*, and several *C. elisa*; but it did not have many *Leucorrhinia* or *P. lydia*. Morris Lake was probably the most variable and abundant in that it contained many *P. lydia*, *L. julia*, *G. spicatus* and *exilis*, and even several *E. cynosura*, *C. shurtleffi*, *L. quadrimaculata* and *Leucorrhinia*. Coincidentally, Morris Lake was the most basic of all of the lakes with a pH of 8.4. Tender Bog, the least abundant lake, had the lowest pH of 3.8. Perhaps there is a correlation between water acidity and adult habitat preference. (The temperatures for each of the lakes were some what similar, so it is hard to make any inference as to temperature's affect on habitat preference).

Even though my data could have been affected my many variables, there are some definite patterns shown in the flight season Graphs 3, 4 and 5. In Graph 3, there is a distinct decline of all five species during the last week of sampling. The abundance of the collected specimens of *Gomphus spicatus* remains pretty steady throughout the sampling weeks; however, since the abundance of *Gomphus exilis* is unstable I am drawn to make the conclusion that data presented is unreliable. In Graph 4, the line representing the *L. julia* species is rather unstable compared to the line of *C. elisa*. The line representing the flight season of *L. glacialis*, however, shows a definite increase in the last two weeks of sampling. Perhaps this is the height of its flight season.

Even though the results of this experiment seem to be inaccurate and unreliable, it seems as though they have brought to mind different observations that could be further tested. The flight seasons for *L julia* in Graph 5, for example, varies greatly between

collection sites. Perhaps this indicates that species do not only contain different flight periods in relation to different species—maybe there are different flight periods within a single species in relation to the type of habitat chosen. Perhaps one could design an interesting experiment to test the validity of this observation. Or maybe one could focus in on the flight periods of just a few of the abundant species on the property. By doing so, more time would be available to ensure accuracy. Perhaps, the study could even be drawn out longer to get a full and complete record of the flight seasons from beginning to end. Another experiment could expand on the idea that different adult species seemed to prefer different habitats. Or maybe one could accurately test the difference between adult and larval representation in just one habitat.

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Table 1.

Collection Site	Species Collected	Total Collected
Crampton Lake	<i>Ladona julia</i>	12
	<i>Cordulia shurtleffi</i>	5
	<i>Leucorrhinia frigida</i>	2
	<i>Boyeria vinosa</i>	2
	<i>Epiaeschna heros</i>	2
	<i>Gomphus exilis</i>	10
Morris Lake	<i>Aeshna ocanadensis</i>	1
	<i>Ladona julia</i>	14
	<i>Aeshna eremita</i>	3
	<i>Anax junius</i>	2
	<i>Somatochlora williamsoni</i>	2
	<i>Leucorrhinia frigida</i>	4
	<i>Cordulia shurtleffi</i>	8
	<i>Epitheca canis</i>	2
	<i>Boyeria vinosa</i>	3
	<i>Epitheca cynosura</i>	1
	<i>Aeshna clepsydra</i>	1
	<i>Gomphus exilis</i>	1
Tender Bog	<i>Cordulia shurtleffi</i>	23
	<i>Leucorrhinia hudsonica</i>	64
	<i>Aeshna clepsydra</i>	2
Trout Pond	<i>Leucorrhinia frigida</i>	63
	<i>Epitheca canis</i>	26
	<i>Cordulia shurtleffi</i>	16
	<i>Leucorrhinia hudsonica</i>	2
	<i>Epitheca cynosura</i>	2
	<i>Libellula quadrimaculata</i>	2

Table 2.

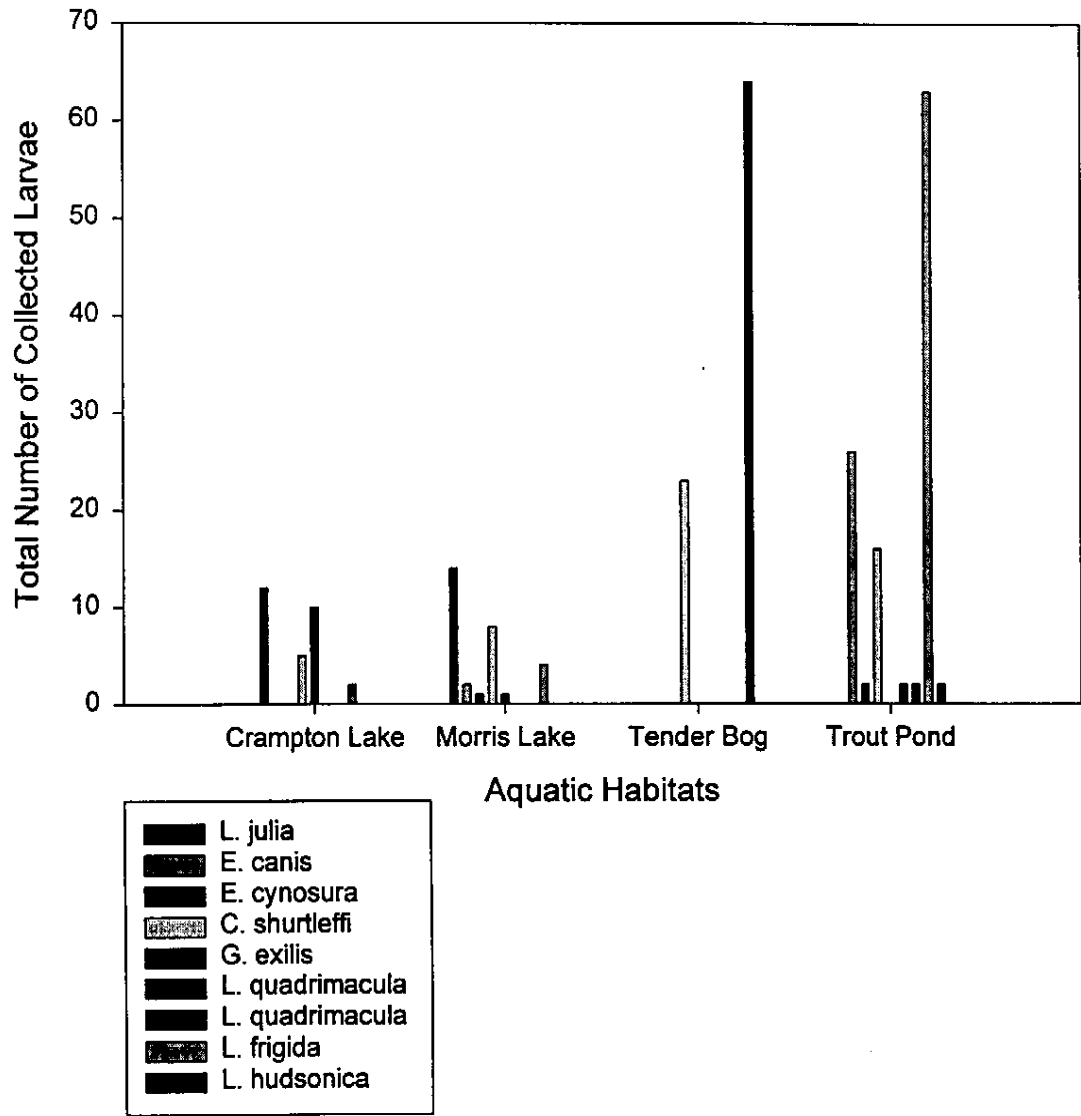
Date	Species	Location	Time/Weather
29 May 1998	<i>Ladona julia</i> <i>Gomphus spictacus</i> <i>Libellula quadrimaculata</i> <i>Leucorrhinia glacialis</i> <i>Leucorrhinia hudsonica</i> <i>Leucorrhinia proxima</i> <i>Cordulia shurtleffi</i>	Pre-sampling	-----
01 June 1998	1 <i>Libellula quadrimaculata</i> 4 <i>Eitheca spinigera</i> 1 <i>Plathemis lydia</i> 8 <i>Ladona julia</i>	Morris Lake	1245-2:30 pm 70's; sunny
	1 <i>Gomphus spictacus</i> 2 <i>Ladona julia</i> 1 <i>Cordulia shurtleffi</i> 4 <i>Eitheca spinigera</i> 1 <i>Leucorrhinia patricia</i> 1 <i>Leucorrhinia glacialis</i>	Trout Pond	
	1 <i>Eitheca cynosura</i> 3 <i>Celithemis elisa</i>	Crampton Lake	
03 June 1998	2 <i>Ladona julia</i>	Tender Bog	2 pm; 50's, cloudy
04 June 1998	1 <i>Ladona julia</i> 4 <i>Eitheca spinigera</i> 1 <i>Libellula quadrimaculata</i> 1 <i>Leucorrhinia proxima</i>	Crampton Lake	1:30 pm, 50's partly sunny
	1 <i>Ladona julia</i>	Tender Bog	
05 June 1998	<i>Cordulia shurtleffi</i>	Morris Lake	9 am; 50's; cloudy
06 June 1998	3 <i>Ladona julia</i> 1 <i>Gomphus spictacus</i> 1 <i>Cordulia shurtleffi</i> 1 <i>Eitheca spinigera</i>	Morris Lake	9 am-12:30 pm sunny, 60's
	2 <i>leucorrhinia proxima</i> 1 <i>Leucorrhinia glacialis</i>	Trout Pond	
	7 <i>Ladona julia</i> 1 <i>Libellula quadrimaculata</i> 2 <i>Cordulia shurtleffi</i> 4 <i>Gomphus spictacus</i> 4 <i>Eitheca spinigera</i>	Crampton Lake	
	3 <i>Ladona julia</i> 5 <i>Eitheca spinigera</i> 1 <i>Gomphus spictacus</i>	Tender Bog	
08 June 1998	4 <i>Eitheca spinigera</i>	Morris Lake	7 pm; 60's; cloudy
09 June 1998	1 <i>Gomphus exilis</i>	Crampton Lake	12 pm; 50's; cloudy
12 June 1998	1 <i>Ladona julia</i>	Morris Lake	1230 pm; drizzle
13 June 1998	<i>Celithemis elisa</i> 2 <i>Ladona julia</i> 1 <i>Gomphus spictacus</i>	Tender Bog	1230 pm; 60's; partly sunny
14 June 1998	5 <i>Ladona julia</i>	Trout Pond	1230 pm; 60's; sunny
15 June 1998	No species collected--I saw <i>P. lydia</i> , <i>L.julia</i> , <i>G.spictacus</i> and <i>Eitheca spinigera</i>	Tender Bog, Trout Pond and Morris Lake	9am-3pm; 60's; few clouds
16 June 1998	5 <i>Eitheca cynosura</i> 1 <i>Plathemis lydia</i> 2 <i>Cordulia shurtleffi</i> 5 <i>Ladona julia</i> 11 <i>Gomphus exilis</i>	Crampton lake	1230pm; 60-70's few clouds
17 June 1998	3 <i>Ladona julia</i> 1 <i>Macromia illoiensis</i> 2 <i>Leucorrhinia proxima</i>	Morris Lake	130 pm; 60's; cloudy
	3 <i>Cordulia shurtleffi</i>	Trout Pond	

	2 <i>Leucorrhinia proxima</i>		
18 June 1998	1 <i>Gomphus exilis</i>	Crampton Lake	11 am; cloudy; 60's
19 June 1998	1 <i>Ladona julia</i>	Tender Bog	1 pm; 70's; sunny
	1 <i>Epiptera cynosura</i>		
	1 <i>Ladona julia</i> 1 <i>Cordulia shurtleffi</i> 4 <i>Epiptera spinigera</i>	Crampton Lake	
	1 <i>Epiptera cynosura</i> 4 <i>Epiptera spinigera</i> 3 <i>Ladona julia</i> 2 <i>Gomphus exilis</i>	Morris Lake	
21 June 1998	1 <i>Gomphus spictacus</i> 3 <i>Ladona julia</i> 1 <i>Leucorrhinia intacta</i> 1 <i>Leucorrhinia proxima</i>	Morris Lake	1030 am; 80's windy; partly sunny
	I saw <i>L. quadrimaculata</i>	Tender Bog	
22 June 1998	1 <i>Gomphus spictacus</i> I saw <i>Ladona julia</i>	Morris Lake	2 pm; sunny; 70's
	1 <i>Libellula quadrimaculata</i> 1 <i>Cordulia shurtleffi</i> 1 <i>Leucorrhinia proxima</i>	Trout Pond	
	1 <i>Libellula quadrimaculata</i> 1 <i>Epiptera princeps</i> 2 <i>Epiptera cynosura</i> 5 <i>Epiptera spinigera</i>	Between Morris and Trout	
23 June 1998	1 <i>Ladona julia</i> I also saw <i>Leucorrhinia glacialis</i>	Tender Bog	1030 am; cloudy; 60's
26 June 1998	1 <i>Celithemis elisa</i> 1 <i>Leucorrhinia hudsonica</i>	Trout Pond	2 pm; 70's sunny
	2 <i>Ladona julia</i> 1 <i>Leucorrhinia proxima</i>	Morris Lake	
27 June 1998	1 <i>Ladona julia</i> 3 <i>Leucorrhinia glacialis</i>	Tender Bog	1245-2:45 pm; humid 80's; sunny
	9 <i>Leucorrhinia proxima</i> 2 <i>Cordulia shurtleffi</i>	Trout Pond	
	1 <i>Epiptera spinigera</i> 1 <i>Leucorrhinia proxima</i>	Morris Lake	
	1 <i>Gomphus exilis</i>	Crampton Lake	
29 June 1998	2 <i>Ladona julia</i> 1 <i>Nasiaesha pentacantha</i> 8 <i>Gomphus exilis</i>	Crampton Lake	12:45-2 pm; windy cloudy; 70's
30 June 1998	4 <i>Ladona julia</i> 2 <i>Libellula quadrimaculata</i> 2 <i>Epiptera spinigera</i> 2 <i>Leucorrhinia proxima</i> 2 <i>Cordulia shurtleffi</i> I also saw <i>Epiptera cynosura</i> <i>Plathemis lydia</i> , & <i>A. juncea</i>	Morris Lake	1:30-3:45 pm; cloudy very windy; 60's
	1 <i>Ladona julia</i> 10 <i>Leucorrhinia glacialis</i> 1 <i>Nannothemis bella</i>	Tender Bog	
01 July 1998	2 <i>Ladona julia</i> 1 <i>Epiptera spinigera</i> 3 <i>Epiptera cynosura</i> 1 <i>Aeshna juncea</i> 1 <i>Cordulia shurtleffi</i>	Crampton Lake	12-2 pm; clear skies 80's
	1 <i>Cordulia shurtleffi</i> 1 <i>Libellula quadrimaculata</i> 4 <i>Leucorrhinia glacialis</i>	Trout Pond	
	5 <i>Leucorrhinia glacialis</i>	Tender Bog	
02 July 1998	4 <i>Ladona julia</i>	Crampton Lake	12:30-3 pm; overcast

	2 <i>Gomphus exilis</i>		windy; 80's
	3 <i>Libellula quadrimaculata</i>	Morris Lake	
	3 <i>Leucorrhinia proxima</i>		
	1 <i>Ladona julia</i>	Tender Bog	
	12 <i>Leucorrhinia glacialis</i>		
03 July 1998	4 <i>Leucorrhinia proxima</i>	Morris Lake	12-2 pm; overcast;
	1 <i>Epiptera spinigera</i>		70's
	2 <i>Leucorrhinia proxima</i>	Trout Pond	
	1 <i>Sympetrum rubicundulum</i>		
	2 <i>Leucorrhinia glacialis</i>	Tender Bog	
	1 <i>Libellula pulchella</i>		
04 July 1998	2 <i>Leucorrhinia proxima</i>	Morris Lake	11 am-12:30 pm
	3 <i>Leucorrhinia proxima</i>	Trout Pond	partly sunny; 70's
	1 <i>Libellula quadrimaculata</i>		
	1 <i>Celithemis elisa</i>		
05 July 1998	4 <i>Gomphus exilis</i> (seen)	Crampton Lake	1:30 pm; partly sunny
	2 <i>Ladona julia</i>		windy; 70's
	1 <i>Libellula quadrimaculata</i>	Trout Pond	
	3 <i>Leucorrhinia glacialis</i>	Tender Bog	
	1 <i>Ladona julia</i>		
06 July 1998	I saw 5 <i>Leucorrhinia glacialis</i>	Tender Bog	12:30; Showers; 60's
07 July 1998	2 <i>Ladona julia</i>	Tender Bog	1:45-2:50 pm; showers
	2 <i>Leucorrhinia glacialis</i>		
	I saw several <i>Leucorrhinia proxima</i> and a few <i>Cordulia shurtleffi</i>	Trout Pond	
	1 <i>Leucorrhinia proxima</i>	Morris Lake	
	2 <i>Ladona julia</i>		
	1 <i>Gomphus exilis</i>		
	1 <i>Celithemis elisa</i>		
10 July 1998	6 <i>Leucorrhinia glacialis</i>	Tender Bog	2:30 pm; partly sunny
	I saw <i>L. julia</i> , <i>E. cynosura</i> , <i>A. juncea</i>		
	1 <i>Gomphus exilis</i>	Crampton Lake	
	I saw <i>L. julia</i> & <i>E. cynosura</i>		
	2 <i>Ladona julia</i>	Morris Lake	
	2 <i>Leucorrhinia proxima</i>		
	I saw <i>A. juncea</i> and <i>P. lydia</i>		
	1 <i>Leucorrhinia proxima</i>	Trout Pond	
	I saw <i>E. spinigera</i> , <i>C. shurtleffi</i> , <i>L. quadrimaculata</i>		
11 July 1998	1 <i>Gomphus exilis</i>	Crampton Lake	1:30-3:05 pm; 80's
	I saw <i>C. elisa</i> , <i>A. juncea</i> and <i>L. julia</i>		partly sunny
	4 <i>Leucorrhinia proxima</i>	Morris Lake	
	I saw <i>A. juncea</i> , <i>P. lydia</i> and <i>L. pulchella</i>		
	1 <i>Cordulia shurtleffi</i>	Trout Pond	
	1 <i>Leucorrhinia proxima</i>		
	I saw <i>L. quadrimaculata</i>		
	I saw <i>L. leucorrhinia glacialis</i>	Tender Bog	
12 July 1998	I saw <i>G. exilis</i> , <i>L. julia</i> and <i>Celithemis elisa</i>	Crampton Lake	12-2:30 pm; sunny
	I saw <i>Leucorrhinia glacialis</i> and <i>C. shurtleffi</i>	Tender Bog	80's, windy
	I saw <i>L. quadrimaculata</i> and <i>Leucorrhinia proxima</i> and <i>Cordulia shurtleffi</i>	Trout Pond	

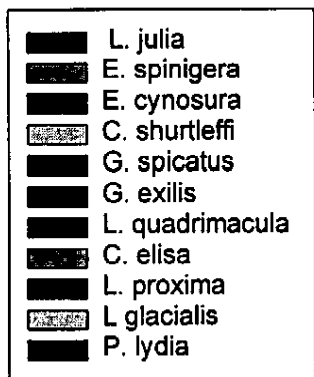
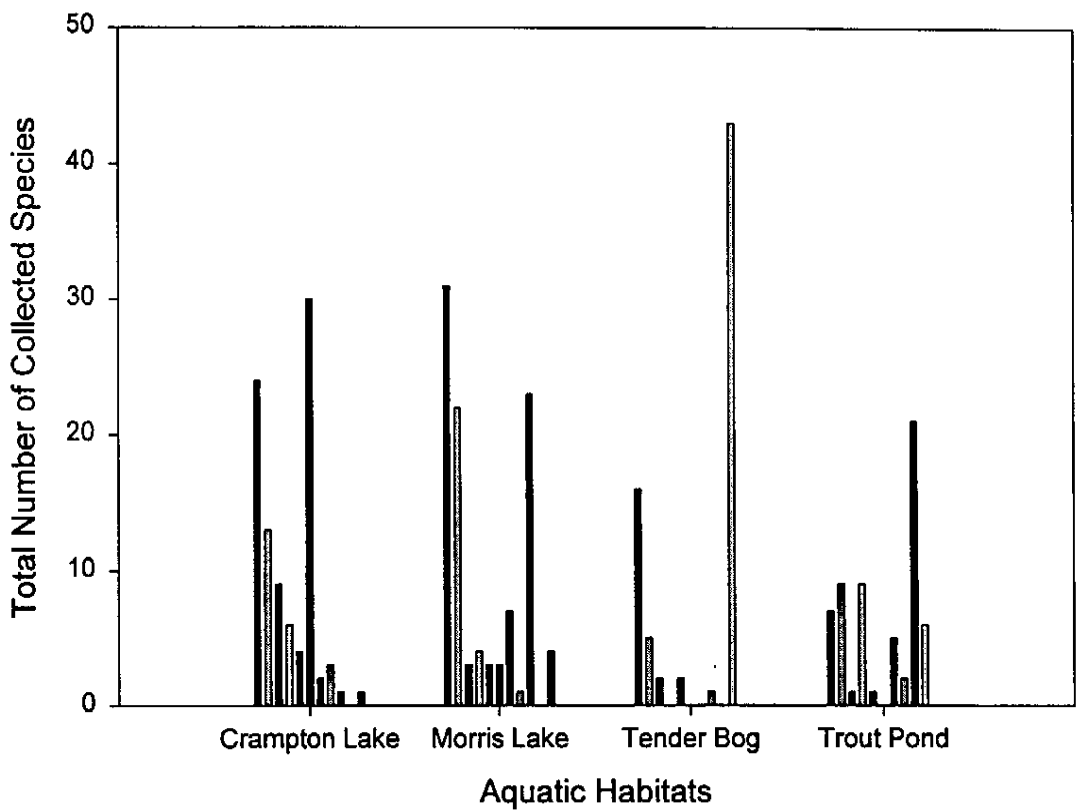
Graph 1

Total Amounts of the Major Collected Larvae Species in Each of the For Habitats



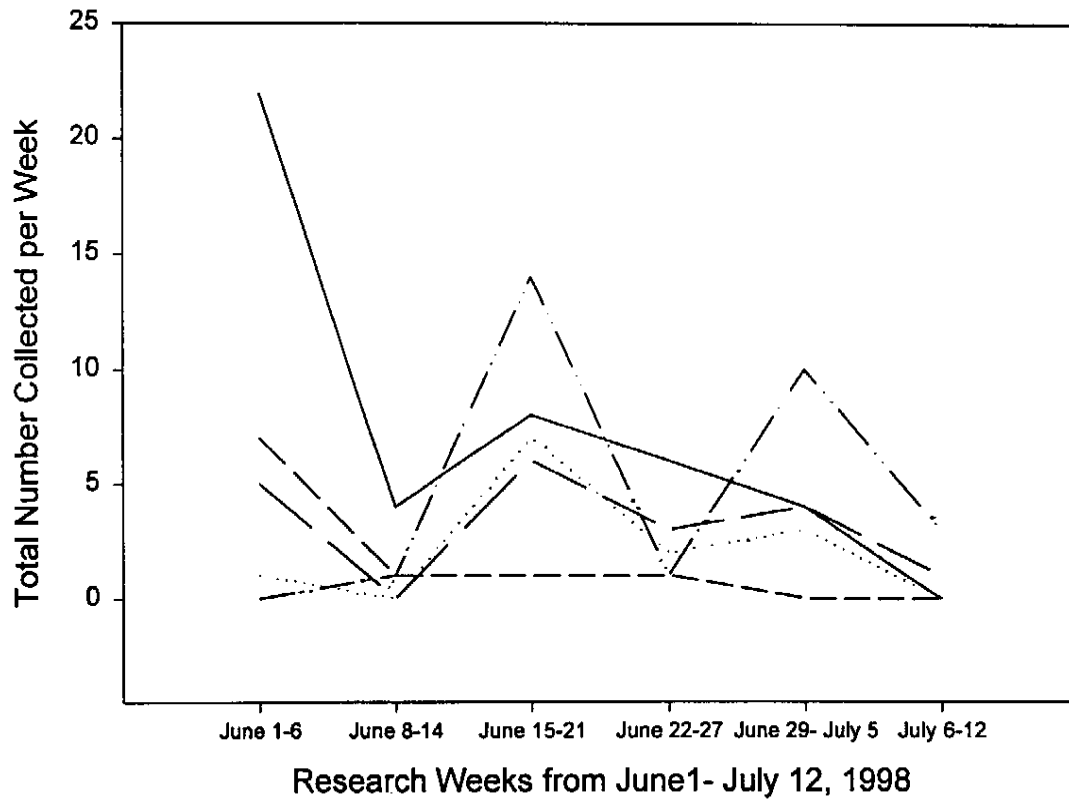
Graph 2

Total Amount of the Major Collected Adult Species in Each of the Four Habitats



Graph 3

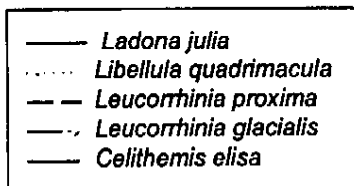
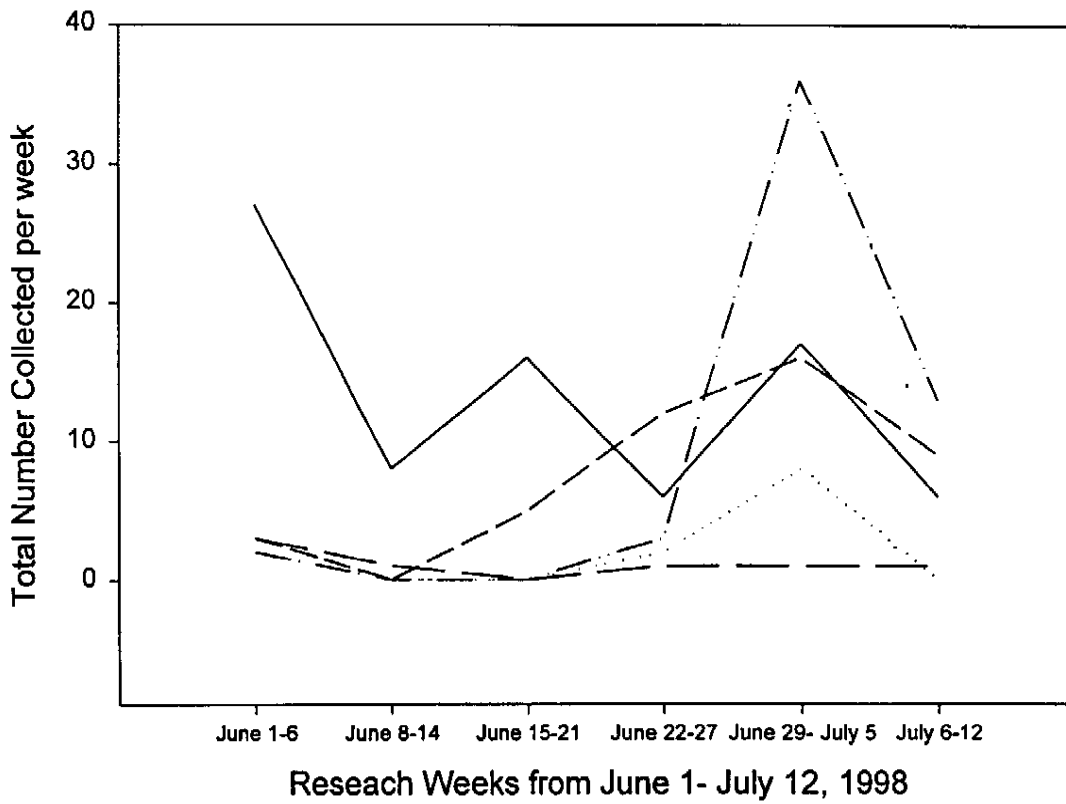
**Abundance of Five of the Major Adults at UNDERC
From June 1--July 12, 1998**



- *Epitheca spinigera*
- *Epitheca cynosura*
- - - *Gomphus spicatus*
- · - · *Gomphus exilis*
- - - - *Cordulia shurtleffi*

Graph 4

Abundance of Five of the Major Adults at UNDERC
From June 1--July 12, 1998



Graph 5

The Total Number of *Ladona julia* Collected per Habitat per Week
From June 1--July 12, 1998

