

TAXANOMIC AND BEHAVIORAL SURVEY OF
ODONATA AT UNIVERSITY OF NOTRE DAME
ENVIRONMENTAL RESEARCH CENTER,
VILAS COUNTY, WISCONSIN

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ABSTRACT

In order to determine the species of Odonata present at the University of Notre Dame Environmental Research Center (UNDERC) a collection was made of dragonflies (Anisoptera) and damselflies (Zygoptera) of both adults and naiads, with an emphasis on dragonflies. *Basiaeschna janata*, *Dromogomphus spinosis*, *Celithemis elisa*, and *Plathemis lydia* were four species collected which were not reported by E. R. Kormondy (1958), whose list of odonates of Gogebic County, Michigan was used for comparison. I began a mark/recapture study of *Gomphus spicatus* (Gomphidae) and *Epitheca spinigera* (Corduliidae), attempting to record the distance each species of dragonfly traveled over time (observing whether or not the species were territorial). None, however, were recaptured in the one week period of marking. Behavioral observations of dragonflies were also recorded.

Odonates (dragonflies and damselflies) are aquatic insects, though often seen flying some distances from bodies of fresh water during warm sunny days. During the immature (nymphal) stage the odonates are aquatic. This stage can last from a few weeks to five years, depending on the species (Westfall 1984). The naiads are carnivorous (Westfall 1984), but are not active hunters (Needham and Westfall 1955). After a number of instars the odonates then emerge from the water as adults. At this stage they are also carnivorous, hunting and catching their prey in flight. Their diet consists mainly of mosquitoes and flies. The huge jaws of the dragonfly enables it to catch and eat flies about as big as its own head.

The goals of my study were to survey the different species of

odonates present on the property (by collecting different species and recording times of the summer which they were observed) and to study behavioral characteristics of different species of dragonflies, especially those of territoriality (by a mark/recapture study).

A study by E. J. Kormondy (1958) resulted in a list of Odonata found in Gogebic County, Michigan. Gogebic County borders the University of Notre Dame Environmental Research Center (UNDERC), and thus is a useful guide to what species may be present on the property. The species he found present in Gogebic County are listed in Appendix i.

METHODS AND MATERIALS

The University of Notre Dame Environmental Research Center (UNDERC) was the site of the study. The property lies on the Michigan / Wisconsin border, including parts of Gogebic County, Michigan and Vilas County, Wisconsin. The collecting sites are illustrated in Appendix ii. These sites are located on lakes, bogs, vernal ponds, different parts of a creek, and along the roads at UNDERC.

The taxonomic portion of the study employed E. J. Kormondy's study of Odonata in Gogebic County, Michigan, as a guide to my own survey.

I used an aerial net to capture adult dragonflies and damselflies. In some cases when an aerial net was not available towels or bare hands were substituted. After I caught the dragonflies I placed them in a large mason jar

with cotton rags in the bottom onto which I had poured ether or acetone. After the insects were killed, I then pinned the odonates to styrofoam placed in cardboard boxes with insect pins. When beetle larvae invaded the boxes and ate the the pinned odonates, moth balls were used to prevent unwanted insects from entering the boxes. I then identified the adults using keys by Westfall (1984), Needham and Westfall (1955), and Walker (1953).

To capture the naiad odonates I used a delta net, a dipper, and large-mouthed pipettes (for removing very small odonates from the water). The naiads were then placed in 70% ethanol in small jars. I also identified the naiads collected by class members of the Entomology course at UNDERC, using Westfall (1984), Needham and Westfall (1955) and Hilsenhoff (undated).

In the mark-recapture portion of the experiment, I captured adult *Epiheca spinigera* and *Gomphus spicatus* using an aerial net. I chose these particular species because they were the most abundant species at the time and both were easy to capture. Initially, I intended to run the experiment on alternate weeks for six weeks. I intended to mark for four days of the week and recapture two and four days after marking. At first due to at weather conditions and then to the lack of abundance of individuals of the species, I only marked from June 13 to June 19. I used Testor's flourescent paint and one jar of Testor's dark red paint (with acetone used as a paint thinner) to mark the dragonflies in an identifying color code. The first color represented the site, the second the week and the third the individual code. I used the

following color code system:

Site code: (refer to map)

South gate: light orange

Plum Lake A: blue

Plum Lake B: red

Camp: pink

Boat house: yellow

Week code:

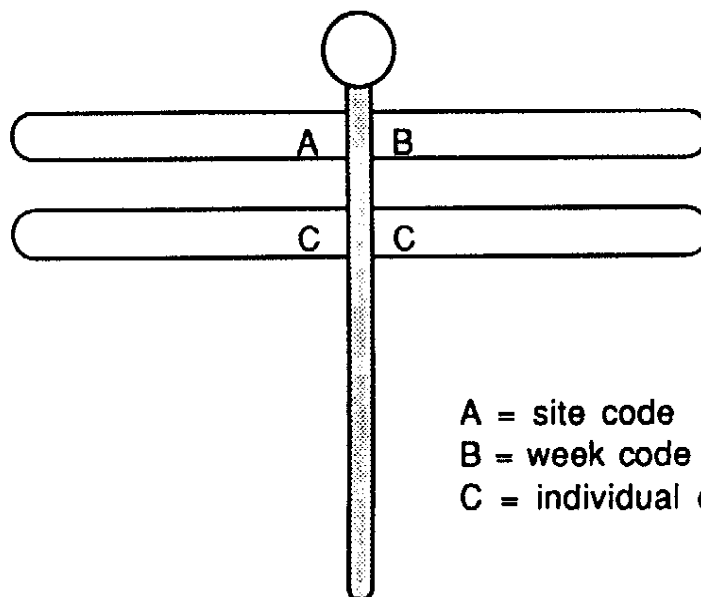
Week one: yellow

Week two: pink

Week three: red

For the individual code I used different combinations of three using the following colors: orange, red, blue, green, pink, and yellow.

In marking the dragonflies I held the tips of their wings gently to immobilize them while marking. I marked the dragonflies for the first day on the base of their wings as follows, using acetone as a paint thinner:



A = site code

B = week code

C = individual code

I chose the base of their wings rather than any other place because the weight placed here would have the least effect on wing movement and thus on the dragonflies' flying abilities. After I marked the first two dragonflies in this manner, I changed to marking on their thoraxes and first two abdominal segments, because their flying ability was severely impaired by the paint on their wings. Once marked I set the insect free, and recorded the date, code, species, and sex of the insect.

While collecting and marking the odonates, I kept a log of observations of both the odonates and weather conditions. Behaviors, relative population densities, and areas sighted were all recorded.

RESULTS

I. Taxonomic Survey

The dragonflies collected at UNDERC during the summer of 1987 are listed in Appendix iii. Many of the odonates previously found by Kormondy were collected at UNDERC. Among the dragonflies listed by Kormondy but not found during the summer were:

AESHNIDAE

Aeshna subarctica

Boyerea vinosa

CORDULEGASTRIDAE

Cordulegaster maculatus

CORDULIIDAE

Somatochlora walshi

GOMPHIDAE

Hylogomphus brevis

Ophiogomphus aspersus

O. colubrinus

(One unidentified species of

O. rupinsulensis

Ophiogomphus was collected.)

LIBELLULIDAE

Sympetrum costiferum

S. internum

(One unidentified species of

S. obstrusum

Sympetrum was collected.)

S. vicinum

However, a number of dragonflies not reported by Kormondy were collected on the property. An aeshnid, *Basiaeschna janata*, was present in both naiad and adult forms. From my observations it was not at all abundant on the property. In fact, the family Aeshnidae was not as abundant as some of the other species found. This particular species of aeshnid is reported by Needham and Westfall (1954) to occur in Michigan during the summer and by Hilsenhoff (undated) to occur in Wisconsin. A naiad of *Dromogomphus spinosis* was collected in North Tenderfoot Creek early in the summer. No adults of this species were found on the property. This is also reported to occur in Michigan and Wisconsin (Needham and Westfall 1954). *Celithemis elisa* was found in the adult form in mid-summer. Only one of this species was collected or sighted on the property. It was reported to occur in Baraga County, Michigan, in the Upper Peninsula (Sloan 1967). Another libellulid, *Plathemis lydia*, was not reported by Kormondy. Adults were abundant near North Tenderfoot Creek for a short time, but individuals were seen from late June to mid-July. It is reported to be widespread, occurring in both Wisconsin and Michigan (Needham and Westfall 1954), and specifically the Upper Peninsula (Sloan 1967).

I had much difficulty in identifying one particular species of Libellulid quite abundant at UNDERC, especially at Peter and Paul Lakes. Since there was a considerable amount of phenotypic variation within species, I collected several individuals, assuming that they were different species. Using the keys of Westfall (1984) and Needham and Westfall (1955), these individuals keyed out to *Libellula incesta*, *Ladona exusta*, and *Ladona julia*. *Libellula incesta*, once classified, did not fit the description in Needham and Westfall or Walker. Although the individuals classified as *Ladona exusta* fit the description, it was not reported to occur in Michigan or Wisconsin by any available keys. Therefore, all the individuals were considered to be of the same species, *Ladona julia*.

The times of the summer when I observed certain species of adult dragonflies were recorded (illustrated in Figure 1). I was only able to find approximate times for those species shown, because other species were not present in great enough numbers or for any observable length of time. Some species, such as *Plathemis lydia*, were observed some time before they were actually collected.

Anisoptera Species Lifespan Summer, 1987

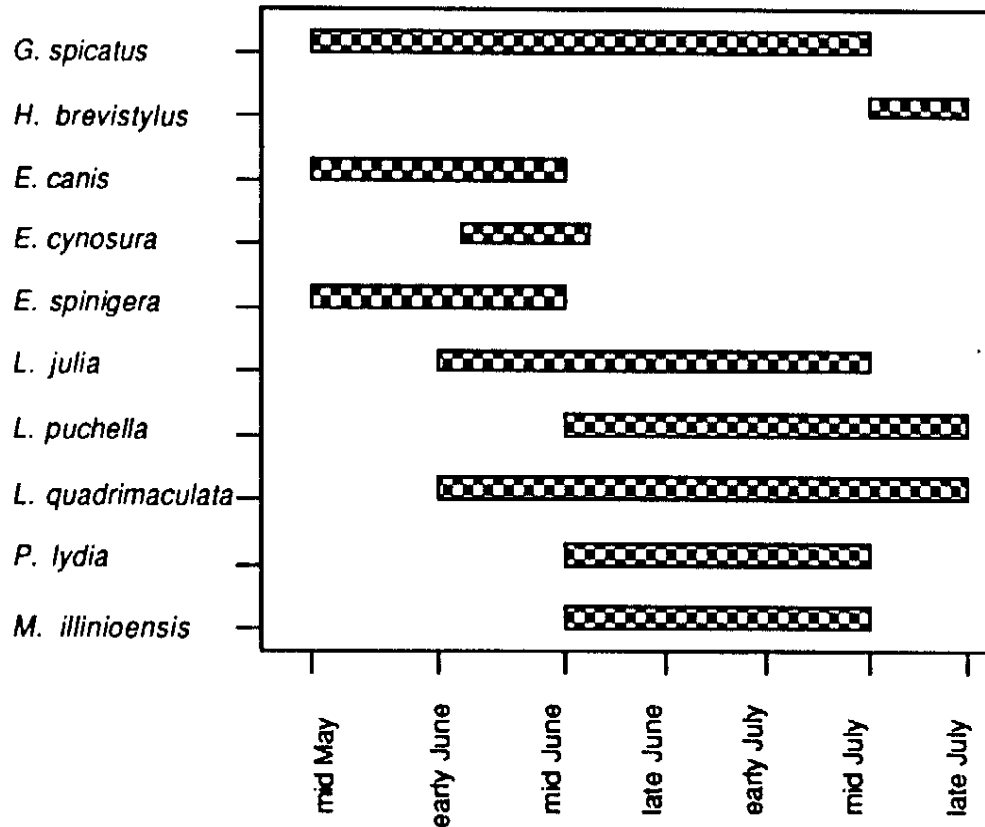


Figure 1. Span of time that individual species were present in adult form at UNDERC.

A number of naiad Zygoptera (damselflies) were also collected. These included the family Coenagrionidae: *Enallagma* (two specimens), *Nehallenia*, and *Ischnura* or *Anomalagrion* (not specified by Hilsenhoff). Among these were also *Lestes* from the family Lestidae (four specimens collected). Among the adult damselflies collected were *Calopteryx maculata* (family Calopterygidae, two adults caught in tandem) and four specimens of *Nehallenia irene* (family Coenagrionidae). Thirteen damselflies (family Coenagrionidae) remain to be identified.

Dragonflies were observed to be very hardy insects. After keeping the insects in a killing jar with acetone between 30 minutes to an hour, I would pin the insects, presuming them to be dead. Occasionally one would begin to move his wings and legs, sometimes up to a half an hour after being pinned.

Many species lost their color a very short time after preserving them. Species of the family Aeschnidae lost most of their color on their thorax within two days after their death. I observed drastic color changes in *Leucorrhina glacialis*, a vibrant red species. White pruinosity was not lost in *Ladona julia* and *Plathemis lydia* over time. This fading of the dragonflies' colors presented minor problems in identifications, especially of the Aeschnids. Boole *et al* (1974) also found the color fading of Aeschnids to be a problem in identification (mainly of the females).

II. Behavioral studies

None of the dragonflies marked in the mark/recapture part of the project were recaptured. The marked individuals with their codes are listed in Appendix iv. The first few dragonflies marked, as mentioned before, were not able to fly due to the excess weight on their wings from the paint. After the method was changed to marking on the thorax and abdomen, the dragonflies were able to fly without any difficulties. They could be recaptured a few minutes after marking, but were never recaptured after a day or more. The

dragonflies were marked from June 13 through June 19. This was the time when the dragonflies were most abundant. The species *Epitheca spinigera* and *Gomphus spicatus* were especially abundant at this time. The weather at the time was mostly warm and sunny, which may have accounted for their abundance.

I experienced no difficulties in capturing the dragonflies. The gomphids would fly for short distances and then stop and remain on the ground (often in the middle of the dirt roads) until disturbed, and that is when I would attempt to catch them. The *Epitheca spinigera* did not remain on the ground for as long of a time, but they did not fly very quickly or very high, so they too were relatively easy to catch.

The next week that I had intended to mark, June 29-July 3, was generally cloudy, and thus not very many dragonflies were seen, especially of the species I intended to mark. Other species were also not in great enough numbers to mark. Since no marked dragonflies were ever recaptured, there was the possibility that the paint was inhibiting their respiration, so I intended to thin the paint even further and resume marking on their wings. During the final week I had intended to mark, July 13-18, although it was less cloudy, there was no abundance of dragonflies of any species, so the mark/recapture portion of the project was abandoned entirely.

NATURAL HISTORY NOTES

Dragonflies, as is commonly known, love the sun. During the summer, they would be out in great numbers when the sun was out, but once it was cloudy, most of the dragonflies could not be seen. On heavily overcast days it was almost impossible to spot dragonflies, except for a few larger aeschnids and gomphids. I never sighted a flying dragonfly during a rain during the entire summer. I did see one perched under a leaf off the side of the road, however, suggesting that they perhaps seek refuge from the rain in this way.

Very few dragonflies were seen when it was cold outside. In the early morning right as the sun was coming up dragonflies would be lying in the grass moving their wings rapidly in an attempt to fly. After a few seconds of this movement they would fly off. Fewer dragonflies than normal were also seen in intense heat. July 13th and 14th were the only days which were hot enough to make an observable difference.

Different species were observed to have different flying habits. *Gomphus spicatus* remained on the ground in the sun until disturbed. They would then fly for a short distance and return to the ground. Another member of the family Gomphidae, *Hagenius brevistylus*, was a little faster in flight and reactions to being disturbed. It also flew for greater distances than *Gomphus spicatus*. Most of the Libellulids flew rather slowly and rather close to the ground, except *Plathemis lydia*, which flew very quickly. All the Corduliidae

observed would remain in flight for most of the time, but did not fly very high in the air, generally about six or seven feet. The Aeschnids, on the other hand, seldom were seen to land, and flew at great and varying heights. They were the quickest of all the species observed, and the most difficult to catch, except for *Plathemis lydia*.

Large numbers of *Ladona julia* were observed at Peter, Paul, and Raspberry Lakes in early June. On June 4, I observed that all but one of the dragonflies which were remaining on the ground were male. Of the twenty-six *L. julia* caught, only one was female. Many other dragonflies of the same species were flying over the lake, so perhaps these were the females. I also noticed that these individuals seemed not to have much of a required individual distance. They would remain as close as wings-distance apart from each other. This lack of individual distance is also true of *Gomphus spicatus*.

I observed another interesting behavior on June 4. An Aeschnid, *Aeshna umbrosa*, was caught while eating another dragonfly, *Epitheca canis*. The head of the victim was already off the body when caught.

DISCUSSION

I. Taxonomic survey

The results of the taxonomic survey of odonates did not vary to any great extent from Kormondy's study. The deviations from his list might

simply be due to the failure to capture certain species of odonates. They might not have been in great enough abundance to have been captured, or their flight habits and/or specific habitats might have prevented their capture. Aeschnids in particular flew especially high in the air, making it harder to catch very many of many different species. That could explain my lack of many different Aeschnid species. Most of those Odonata collected which were not reported by Kormondy (1958) have been reported in both Michigan and Wisconsin by Needham and Westfall (1955).

The short period of abundance of some species of dragonflies, like *Gomphus spicatus* and *Epitheca spinigera* (abundant only in the early summer) and *Plathemis lydia* (abundant in late June) may have been due to smaller mosquito populations. The individuals of the same species probably emerged at roughly the same time, increasing competition between the dragonflies for the limited resources and thus resulting in the deaths of many of the newly emerged dragonflies.

II. Behavioral studies

Regarding the mark/recapture experiment, the failure to recapture any dragonflies may be due to a number of factors. No dead marked dragonflies were seen, so it may have simply been a result of a very large total population of dragonflies. It is also possible, however, that these dragonflies might have died later in the woods, away from view. By painting the thoraxes

and abdomen, the paint may have inhibited their respiration, resulting in death. The acetone used as a solvent may have also resulted in the same outcome. Without additional testing, it cannot be known for certain which factor caused the complete lack of dragonfly recaptures. However, the relative hardness of the dragonflies, seen in the difficulty in killing them, suggests that perhaps they were not affected by the marking. In that case, the complete lack of recaptures indicates an extremely large sample size.

An alternate method of marking would be with an indelible marker. Fincke (1986) successfully used this method in his study on *Enallagma hageni*, a damselfly in the family Coenagrionidae. Since the marker had no reported effect on the damselflies' flying capabilities, and since damselfly wings are considerably smaller and more fragile than dragonfly wings, I assume the marker would impose no additional weight upon the dragonflies' wings. This would eliminate the necessity of marking the thorax and abdomen, thus avoiding the possible difficulties in respiration.

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46 Species of Odonata Recorded from Gogebic County, Michigan

(from Kormondy, E.J. 1958. Catalogue of the Odonata of Michigan.
Misc. Publ. U. Mich. Mus. Zool. 104: 43 pages.
150 species in state.)

I. Suborder Anisoptera

A. Family AESCHNIIDAE

Aeschna canadensis
subarctica
umbrosa

Boyerea vinosa

B. Family CORDULEGASTRIDAE

Cordulegaster maculatus

C. Family CORDULIIDAE

Cordulia shurleffi

Doracordulia libera

Somatochlora kennedyi
walshi
williamsoni

Epithea (= *Tetragoneuria*) *canis*
cynosura
spinigera

D. Family GOMPHIDAE

Hylogomphus brevis

Stylurus scudderi

Gomphus spicatus

Hagenius brevistylus

Ophiogomphus aspersus
colubrinus
rupinsulensis

E. Family LIBELLULIDAE

Ladona julia

Leucorrhia glacialis
hudsonica
intacta
proxima

Libellula puchella
quadrimaculata

Sympetrum costiferum
internum
obstrusum
vicinum

F. Family MACROMIIDAE

Macromia illinoensis

II. Suborder Zygoptera

A. Family CALOPTERYGIDAE

(= AGRIIDAE)

Calopteryx aequabilis
maculata

B. Family COENAGRIONIDAE

Argia violacea

Coenagrion resolutum

Enallagma boreale
carunculatum
ebrium
hageni

Ischnura verticalis

Nehalania irene

C. Family LESTIDAE

Lestes disjunctus
dryas
rectangularis
unguiculatus

Appendix I.

46 Species of Odonata Recorded from Gogebic County, Michigan

(from Kormondy, E.J. 1958. 150 species in state.)

I. Suborder Anisoptera

A. Family AESCHNIIDAE

Aeschna canadensis
subarctica
umbrosa

Boyerea vinosa

B. Family CORDULEGASTRIDAE

Cordulegaster maculatus

C. Family CORDULIIDAE

Cordulia shurleffi

Doracordulia libera

Somatochlora kennedyi
walshi
williamsoni

Epithea (= *Tetragoneuria*) *canis*
cynosura
spinigera

D. Family GOMPHIDAE

Hylogomphus brevis

Stylurus scudderi

Gomphus spicatus

Hagenius brevistylus

Ophiogomphus aspersus
colubrinus
rupinsulensis

E. Family LIBELLULIDAE

Ladona julia

Leucorrhia glacialis
hudsonica
intacta
proxima

Libellula puchella
quadrimaculata

Sympetrum costiferum
internum
obstrusum
vicinum

F. Family MACROMIIDAE

Macromia illinoiensis

II. Suborder Zygoptera

A. Family CALOPTERYGIDAE

(= AGRIIDAE)

Calopteryx aequabilis
maculata

B. Family COENAGRIONIDAE

Argia violacea

Coenagrion resolutum

Enallagma boreale
carunculatum
ebrium
hageni

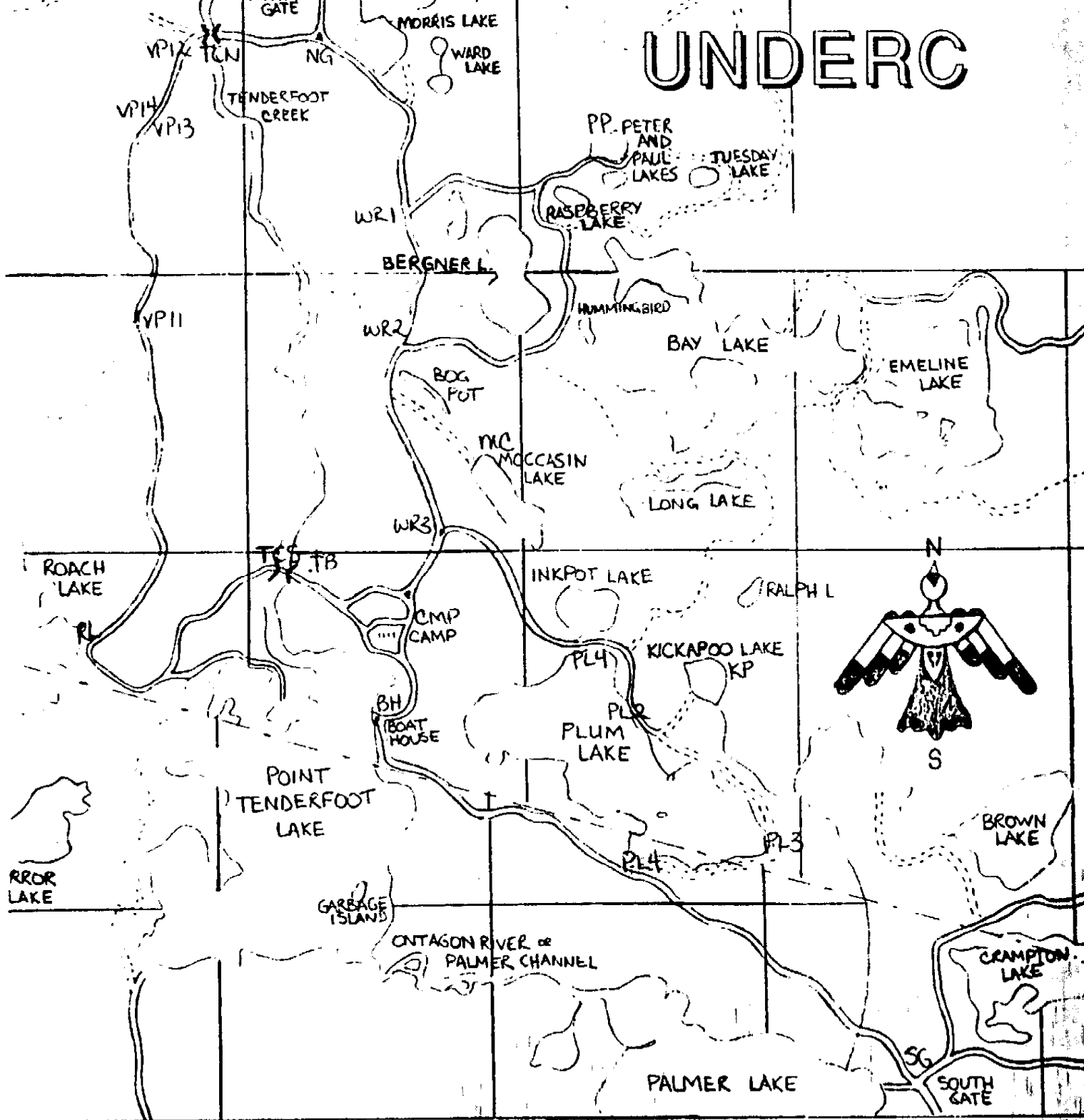
Ischnura verticalis

Nehallenia irene

C. Family LESTIDAE

Lestes disjunctus
dryas
rectangularis
unguiculatus

UNDERC



LEGEND

- Improved light duty road
- Unimproved dirt road
- Bridge X X
- Section line, U.S. land survey

SCALE

1 : 31248



one mile

Appendix III.

List of Anisoptera Collected on UNDERC Property
Summer, 1987

<u>Family</u>	<u>Species</u>	<u>Site</u>	<u>Date</u>	<u>Naiad/ Adult</u>
AESHNIDAE	<i>Aeshna</i>	TCN	5/30	naiad
	<i>A. umbrosa</i>	NG	5/26	naiad
		PP	6/4	adult
		CMP	7/16	adult
		WR2	7/16	adult
	<i>A. canadensis</i>	TB	6/24	naiad
		BH	7/16	adult
	<i>Basiaeschna janata</i>	TCN	5/26	naiad
		PL2	6/2	adult
	GOMPHIDAE	<i>Dromogomphus spinosis</i>	TCN	5/26
<i>Gomphus spicatus</i>		PL4	6/2	adult
		PP	6/4	adult
		PL1	7/15	adult
<i>Hagenius brevistylus</i>		TCN	5/26	naiad
		TCN	7/9	naiad
		PL2	7/16	adult
<i>Ophiogomphus</i>		PL3	7/26	adult
<i>Stylurus scudderi</i>		TCS	5/26	naiad
CORDULIIDAE		<i>Cordulia shurtleffi</i>	TCN	5/30
		PP	6/4	adult
	<i>Dorocordulia libera</i>	BH	6/13	adult
	<i>Epitheca canis</i>	TCN	5/26	naiad
		CMP	6/14	naiad
		VP11	6/4	adult
	<i>E. cynosura</i>	KP	7/6	naiad
	<i>E. spinigera</i>	NG	5/28	adult
		CMP	6/1	adult
		BH	6/2	adult
		PL4	6/2	adult
		BH	6/4	adult
	<i>Somatochlora kennedyi</i>	VP6	5/26	naiad
	<i>S. williamsoni</i>	VP12	7/3	naiad

Appendix III. (cont.)

<u>Family</u>	<u>Species</u>	<u>Site</u>	<u>Date</u>	<u>Naiad/ Adult</u>	
LIBELLULIDAE	<i>Celithemis elisa</i>	VP11	7/1	adult	
	<i>Ladona</i>	VP14	7/5	naiad	
	<i>L. julia</i>	BH	6/2	adult	
		PL1	6/2	adult	
		PL2	6/2	adult	
		PL3	6/2	adult	
		PL4	6/2	adult	
		PP	6/4	adult	
		TCS	7/1	adult	
		PL4	6/2	adult	
		PP	6/4	adult	
		<i>Leucorrhinea glacialis</i>	TB	5/26	naiad
			TB	6/30	adult
		<i>L. hudsonica</i>	MC	5/11	adult
			PL2	6/2	adult
			PL3	6/2	adult
			PL4	6/2	adult
			PP	6/4	adult
			CMP	6/30	adult
			VP11	7/1	adult
			PL2	7/16	adult
			MR	7/26	adult
		<i>L. intacta</i>	VP11	7/1	adult
			MR	7/26	adult
			WD	7/26	adult
		<i>Libellula</i>	TCN	5/26	naiad
		<i>L. luctuosa</i>	NG	5/26	naiad
		<i>L. puchella</i>	BH	6/13	adult
			CMP	6/16	adult
			CMP	7/13	adult
	<i>L. quadrimaculata</i>	PL3	6/2	adult	
		VP11	6/14	adult	
		VP11	7/1	adult	
		WR2	7/1	adult	

Appendix III. (cont.)

<u>Family</u>	<u>Species</u>	<u>Site</u>	<u>Date</u>	<u>Naiad/ Adult</u>
LIBELLULIDAE	<i>Plathemis lydia</i>	TCN	7/1	adult
		WR3	7/16	adult
	<i>Sympetrum</i>	NG	5/26	naiad
MACROMIIDAE	<i>Macromia illinoiensis</i>	TCN	5/26	naiad
		CMP	6/30	adult

Appendix IV.

Record of Marked Dragonflies
Summer, 1987

Date	Marking Codes			Species	Male/ Female
	Site	Week	Indiv.		
6/13	Y	Y	OOO	<i>E. spinigera</i>	F
	Y	Y	OOR	<i>E. spinigera</i>	M
	Y	Y	OOB	<i>E. spinigera</i>	M
	Y	Y	OOG	<i>E. spinigera</i>	M
	Y	Y	OOP	<i>E. spinigera</i>	M
	Y	Y	OY	<i>E. spinigera</i>	F
	Y	Y	ORR	<i>E. spinigera</i>	M
	Y	Y	ORB	<i>G. spicatus</i>	F
	Y	Y	ORG	<i>E. spinigera</i>	M
	Y	Y	ORP	<i>E. spinigera</i>	M
	Y	Y	ORY	<i>E. spinigera</i>	M
	Y	Y	OBO	<i>E. spinigera</i>	M
	Y	Y	OBR	<i>E. spinigera</i>	M
	Y	Y	OBB	<i>G. Spicatus</i>	F
	Y	Y	OBG	<i>E. spinigera</i>	M
	Y	Y	OBP	<i>E. spinigera</i>	M
	Y	Y	OBY	<i>E. spinigera</i>	M
6/14	G	Y	OGO	<i>G. spicatus</i>	M
	G	Y	OGR	<i>G. spicatus</i>	M
	G	Y	OGB	<i>G. spicatus</i>	M
	G	Y	OGG	<i>G. spicatus</i>	M
6/16	P	Y	OGP	<i>G. spicatus</i>	F
	P	Y	OGY	<i>G. spicatus</i>	F
	P	Y	OPO	<i>G. spicatus</i>	M
	P	Y	OPR	<i>G. spicatus</i>	F
	P	Y	OPB	<i>G. spicatus</i>	F
	P	Y	OPG	<i>G. spicatus</i>	F
	P	Y	OPP	<i>G. spicatus</i>	F
	P	Y	OPY	<i>G. spicatus</i>	F
	P	Y	OYO	<i>G. spicatus</i>	F
	P	Y	OYR	<i>G. spicatus</i>	F
	P	Y	OYB	<i>G. spicatus</i>	F
	P	Y	OYG	<i>G. spicatus</i>	F
	P	Y	OYP	<i>G. spicatus</i>	F
P	Y	OYY	<i>G. spicatus</i>	F	

Appendix Iv. (cont.)

Date	Marking Codes			Species	Male/ Female
	Site	Week	Indiv.		
6/17	R	Y	ROR	<i>G. spicatus</i>	F
	R	Y	ROB	<i>G. spicatus</i>	M
	R	Y	ROG	<i>G. spicatus</i>	F
	R	Y	ROY	<i>G. spicatus</i>	M
	R	Y	RRO	<i>G. spicatus</i>	M
	R	Y	RRR	<i>G. spicatus</i>	F
	R	Y	RRB	<i>E. spinigera</i>	M
	R	Y	RRG	<i>G. spicatus</i>	M
	R	Y	RRP	<i>G. spicatus</i>	M
	R	Y	RRY	<i>G. spicatus</i>	M
	R	Y	RBO	<i>G. spicatus</i>	F
	R	Y	RBR	<i>G. spicatus</i>	M
	R	Y	RBB	<i>G. spicatus</i>	M
	R	Y	RBG	<i>E. spinigera</i>	M
	R	Y	RBP	<i>E. spinigera</i>	M
	R	Y	RBY	<i>E. spinigera</i>	M
	R	Y	ROO	<i>E. spinigera</i>	F
	R	Y	RGR	<i>E. spinigera</i>	M
	R	Y	RGB	<i>E. spinigera</i>	M
	R	Y	RGG	<i>E. spinigera</i>	M
	R	Y	RGP	<i>G. spicatus</i>	M
	R	Y	RGY	<i>E. spinigera</i>	M
	R	Y	RPO	<i>G. spicatus</i>	M
	R	Y	RPR	<i>G. spicatus</i>	M
	R	Y	RPB	<i>E. spinigera</i>	M
	R	Y	RPG	<i>G. spicatus</i>	M
	R	Y	RPP	<i>G. spicatus</i>	M
	R	Y	RPY	<i>G. spicatus</i>	M
	R	Y	RYO	<i>G. spicatus</i>	M
	R	Y	RYR	<i>G. spicatus</i>	M
R	Y	RYB	<i>G. spicatus</i>	M	
R	Y	RYG	<i>G. spicatus</i>	M	
R	Y	RYP	<i>E. spinigera</i>	M	
R	Y	RYY	<i>E. spinigera</i>	M	

Appendix Iv. (cont.)

Date	Marking Codes			Species	Male/ Female
	Site	Week	Indiv.		
6/17	R	Y	BOR	<i>G. spicatus</i>	M
	R	Y	BOB	<i>E. spinigera</i>	M
	R	Y	BOG	<i>G. spicatus</i>	F
	R	Y	BOP	<i>E. spinigera</i>	M
	R	Y	BOY	<i>G. spicatus</i>	F
	R	Y	BRO	<i>E. spinigera</i>	M
	R	Y	BRR	<i>E. spinigera</i>	M
	R	Y	BRB	<i>G. spicatus</i>	M
	R	Y	BRG	<i>G. spicatus</i>	M
	R	Y	BRP	<i>G. spicatus</i>	F
	R	Y	BRY	<i>G. spicatus</i>	M
	R	Y	BBO	<i>G. spicatus</i>	F
	R	Y	BBR	<i>G. spicatus</i>	F
	R	Y	BBB	<i>E. spinigera</i>	M
	R	Y	BBY	<i>G. spicatus</i>	F
6/19	P	Y	BGO	<i>G. spicatus</i>	F
	P	Y	BGR	<i>G. spicatus</i>	F
	P	Y	BGB	<i>G. spicatus</i>	F
	P	Y	BGG	<i>G. spicatus</i>	F
	P	Y	BGP	<i>G. spicatus</i>	F
	P	Y	BGY	<i>G. spicatus</i>	F
	P	Y	BPO	<i>G. spicatus</i>	F
	P	Y	BPR	<i>G. spicatus</i>	F
	P	Y	BPB	<i>G. spicatus</i>	F
	P	Y	BPG	<i>G. spicatus</i>	F
	P	Y	BPP	<i>G. spicatus</i>	F
	P	Y	BPY	<i>G. spicatus</i>	F
	P	Y	BYO	<i>G. spicatus</i>	F
	P	Y	BYR	<i>G. spicatus</i>	F
	P	Y	BYB	<i>G. spicatus</i>	F
	P	Y	BYG	<i>G. spicatus</i>	F
	P	Y	BYP	<i>G. spicatus</i>	F
	P	Y	BYY	<i>G. spicatus</i>	F
	P	Y	GOO	<i>G. spicatus</i>	F
	P	Y	GOR	<i>G. spicatus</i>	F
P	Y	GOB	<i>G. spicatus</i>	F	
P	Y	GOG	<i>G. spicatus</i>	F	

Appendix Iv. (cont.)

Date	Marking Codes			Species	Male/ Female
	Site	Week	Indiv.		
6/19	Y	Y	GOP	<i>G. spicatus</i>	M
	Y	Y	GOY	<i>G. spicatus</i>	M
	Y	Y	GPO	<i>G. spicatus</i>	M
	Y	Y	GPR	<i>G. spicatus</i>	F
	Y	Y	GRB	<i>G. spicatus</i>	F
	Y	Y	GRG	<i>G. spicatus</i>	F
	Y	Y	GRP	<i>G. spicatus</i>	F
	Y	Y	GRY	<i>G. spicatus</i>	F
	Y	Y	GBO	<i>E. spinigera</i>	F
	Y	Y	GBR	<i>E. spinigera</i>	M
	Y	Y	GBB	<i>G. spicatus</i>	M
	Y	Y	GBG	<i>G. spicatus</i>	F
	Y	Y	GBP	<i>G. spicatus</i>	M
	Y	Y	GBY	<i>E. spinigera</i>	M
	Y	Y	GGO	<i>E. spinigera</i>	M
	Y	Y	GGR	<i>E. spinigera</i>	F
	Y	Y	GGB	<i>E. spinigera</i>	M
	Y	Y	GGG	<i>G. spicatus</i>	F
Y	Y	GGP	<i>G. spicatus</i>	F	