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TWO LARVAL ODONATE COMMUNITIES OF THE EDWARD J. MEEMAN BIOLOGICAL STATION IN WESTERN TENNESSEE

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ABSTRACT--We sampled larval dragonflies (Odonata) in two ponds of the Edward J. Meeman Biological Station, Shelby Co., Tennessee, from July 1990 to March 1992. Species found in both ponds were *Tetragoneuria* (= *Epitheca*) *cynosura*, *Plathemis* (= *Libellula*) *lydia*, *Libellula vibrans*, *Perithemis tenera*, *Dromogomphus spinosus*, *Epicordulia princeps*, *Gomphus submedianus*, and *Boyeria* sp. These species comprised 99.7% of the 3,556 individuals collected. Headwidths of the same species collected at the same time were often significantly greater in one pond (pond A) than the other (pond B). Comparisons of cumulative size-frequency distributions showed significant differences between ponds for *T. cynosura*, *L. lydia*, *L. vibrans*, and *P. tenera* but not for *D. spinosus*. Fish were more abundant and longer and had higher condition indices in pond B. This may explain the higher larval mass in pond A for *T. cynosura* and *L. vibrans* and indirectly explain the higher larval mass of *D. spinosus* in pond B. We hypothesize that the success of *D. spinosus* in pond B may be due to its avoidance of predation by burrowing and associated differences in feeding behavior.

Surveys of aquatic insects are important and useful. Communities of odonate larvae are relatively diverse, thus posing potential questions about resource partitioning, life-history differences, and predator-avoidance strategies. These biotic organizing forces are just now being described (e.g., Benke et al., 1982; Wissinger, 1988, 1989; Van Buskirk, 1989; Mahato and Johnson, 1991; Martin et al., 1991; Butler et al., 1992). Before such studies can be performed, however, initial surveys such as have been conducted in eastern Arkansas (Harp and Harp, 1980; Farris and Harp, 1982; Cochran and Harp, 1990) need to be made.

Our goal was to describe two larval odonate communities upon which future research could be based. We chose to study larval odonate communities because these larvae were abundant and large. With the exceptions of the few species listed for Reelfoot Lake area by Koen (1937) and Wright (1938, 1943), our study is the first description of larval odonate communities in western Tennessee.

MATERIALS AND METHODS

All sampling was performed in two ponds which were part of Memphis State University's Edward J. Meeman Biological Station in northern Shelby Co., Tennessee. This station was about 3 km east of the Mississippi River on the narrow transition zone between the Mississippi River Valley and the West Tennessee Plain physiographic regions.

Pond A was surrounded by a mixed oak-hickory forest, and its near-shore sediment contained allochthonous material primarily in the form of partially decomposed leaves. It had a surface area of 0.31 ha, z_{max} of 1.8 m, and an average depth of 0.8 m.

Pond B was surrounded by kudzu (*Pueraria lobata*) and was not covered by a forest canopy. It had a surface area of 0.21 ha, z_{max} of 3.8 m, and an average depth of 1.8 m. The near-shore sediment was silt-clay with little particulate allochthonous material.

Relative fish abundance in the two ponds was determined by seining. Both ponds were sampled three times from March to June 1993 using a 15-m seine with a 5-mm mesh. The standard lengths and masses of the largest 40 fish in each sample were determined.

Odonate larvae in these two ponds were sampled monthly to biweekly from June 1990 to March 1992. All sampling was performed with a 35- by 20-cm sweep net having a 2.5-mm, circular mesh. Thirty uniformly-spaced sweeps were taken around the perimeter of each pond. Each sweep was 2 m long and perpendicular to shore, a total area of 21 m^2 being swept clear from each pond on each date. This technique has been used effectively in other studies of odonates (e.g., Johnson, 1986; Martin et al., 1991). Material collected after each sweep was sorted, and all odonate larvae were preserved in 70% ethanol. All larval identifications were made using Needham and Westfall (1954). Larval headwidths were measured from the outside of the eyes using a dissecting microscope, drawing tube, and a digitizing pad.

We were interested also in how larval mass compared between the two ponds for each species. While larval mass was not measured on all individuals, larval mass was proportional to headwidth cubed. Measurements of headwidths were, therefore, used instead of mass because they were more precise. In addition, all of these measurements had already been made. The slopes of log-transformed mass versus headwidth regressions were near 3.0. While this relationship is certainly not the same for all species, the estimate of mass was used to make intraspecific comparisons between ponds.

Paired *t*-tests were used to compare numbers of the five most common species in the two ponds on each date. Likewise, five paired *t*-tests were used to compare mean mass of these common species in the two ponds on each date. Kolmogorov-Smirnov tests were used to compare headwidth size distributions. Mean total lengths and condition indices of fish were compared between ponds with Student's *t*-tests. Unless otherwise specified, significance for both tests was determined at $P \leq 0.05$.

RESULTS

Abundances--Almost all odonates collected were anisopterans. Anisopteran species found in both ponds were *Tetragoneuria cynosura*, *Plathemis lydia*, *Libellula vibrans*, *Perithemis tenera*, *Dromogomphus spinosus*, *Epicordulia princeps*, *Gomphus submedianus*, and *Boyeria* sp. These species comprised 99.7% of the 3,556 individuals collected (1,849 from pond A and 1,707 from pond B).

Abundances over time are given in Fig. 1 for the five most abundant species. In both ponds, peak numbers were observed in late summer and early fall in 1990 and 1991. Comparisons of numbers collected in the two ponds on the same dates showed significant differences for two species; *L. vibrans* was more abundant in pond A, while *D. spinosus* was more abundant in pond B. *Gomphus submedianus* also was more abundant in pond B.

Headwidths--Headwidths were used to compare species between the ponds. Size distributions were compared from aggregate headwidth size-frequency distributions created using data gathered over the 22-month collection period. These are given in Fig. 2. Points above the diagonal lines indicate larger sizes in pond A for that percentile. These data show how the size distributions were skewed to the larger sizes in pond A. Comparisons of the size distributions of each species from each pond were significantly different except for *D. spinosus*.

Mass--Values for mass were distinctly higher in the summer and fall in pond B. These values were more uniform in pond A. The mass of *T. cynosura* and *L. vibrans* were significantly greater in pond A, while the mass of *D. spinosus* was significantly greater in pond B.

Fish Populations--While both ponds contained bluegill (*Lepomis macrochirus*), it is our impression from several seine hauls that these fish were clearly more abundant in pond B. They also were significantly longer in pond B (Fig. 3) with significantly higher condition indices.

DISCUSSION

Abundances--The odonate communities of these ponds were similar in that they both lacked zygopteran larvae. The lack of emergent vegetation, which is required by zygoterans for oviposition (D. Johnson, pers. comm.), could partly explain low numbers of zygopterans. They also were similar in that the eight species found in both ponds comprised 99.7% of all individuals collected. The ponds differed in that *L. vibrans* was more abundant in pond A and *D. spinosus* was more abundant in pond B.

Headwidths--Comparisons of headwidth frequency distributions showed larvae of each species except *D. spinosus* to be significantly larger in pond A. Since these frequency distributions were the aggregates of a 22-month period, all instars retained in the net should have been represented. Because sampling times and effort were equal for both ponds, there should not have been any bias due to collection timing or technique. The tendency for larger larvae in pond A, relative to pond B, could have been due to faster development and greater emergence in pond B. Less time spent in the final instars would mean lower chances of these larvae being collected. If this were the case, *D. spinosus* was less affected than the other species. Another explanation for the size distributions to be skewed toward larger larvae in pond A is higher size-selective predation pressure in pond B.

Mass--The pattern of mass was not the same in both ponds. Mass values in pond B were more seasonal with high mass observed in summer and fall. High values of mass (dry weight per square meter) during late fall also were observed by Benke and Benke (1975). The low values of mass for summer in pond B and overall lower values in that pond compared to pond A could reflect higher mortality in summer due to predation or greater emergence in pond B.

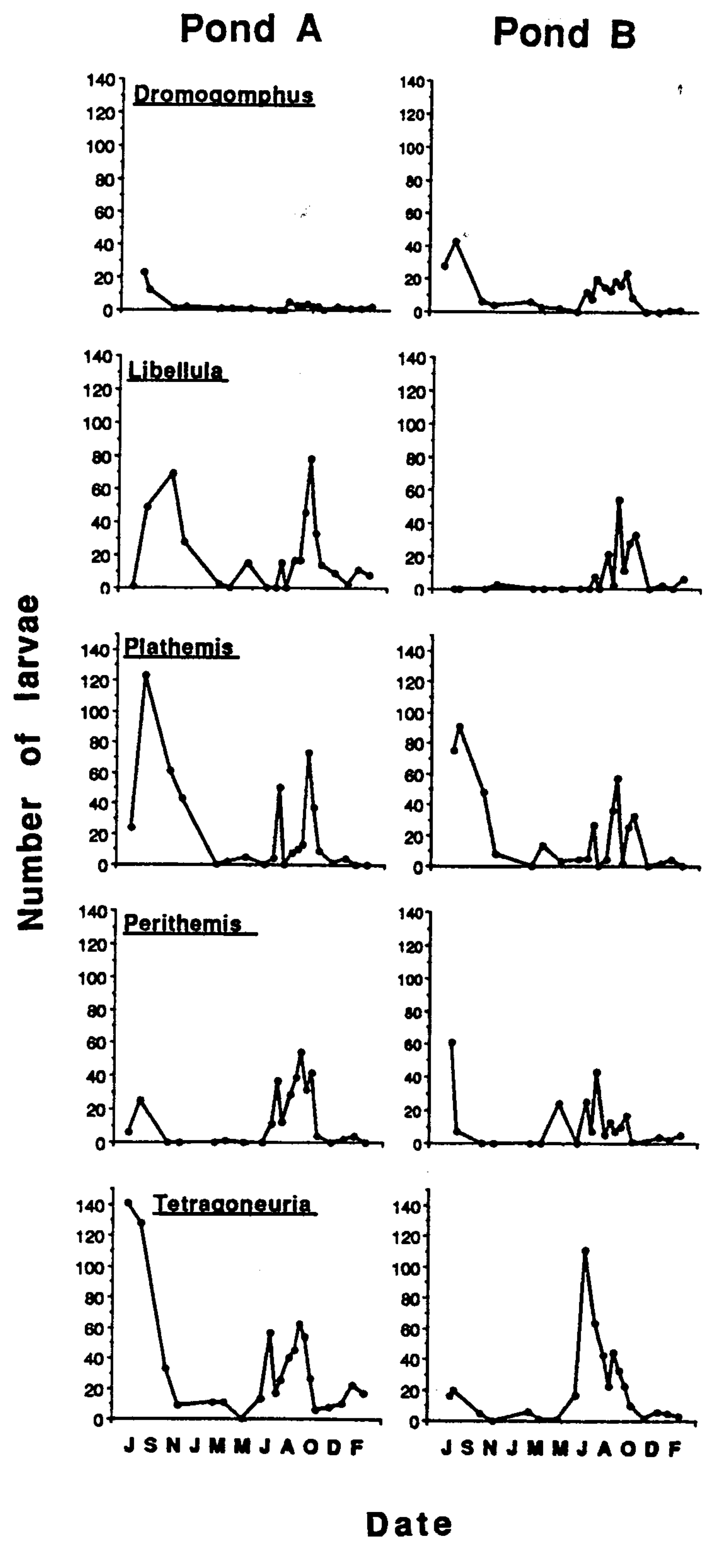

FIG. 1. Total number of the five most common anisopteran larvae collected in ponds A and B from June 1990 to March 1992. Letters on the x-axis indicate alternate months.

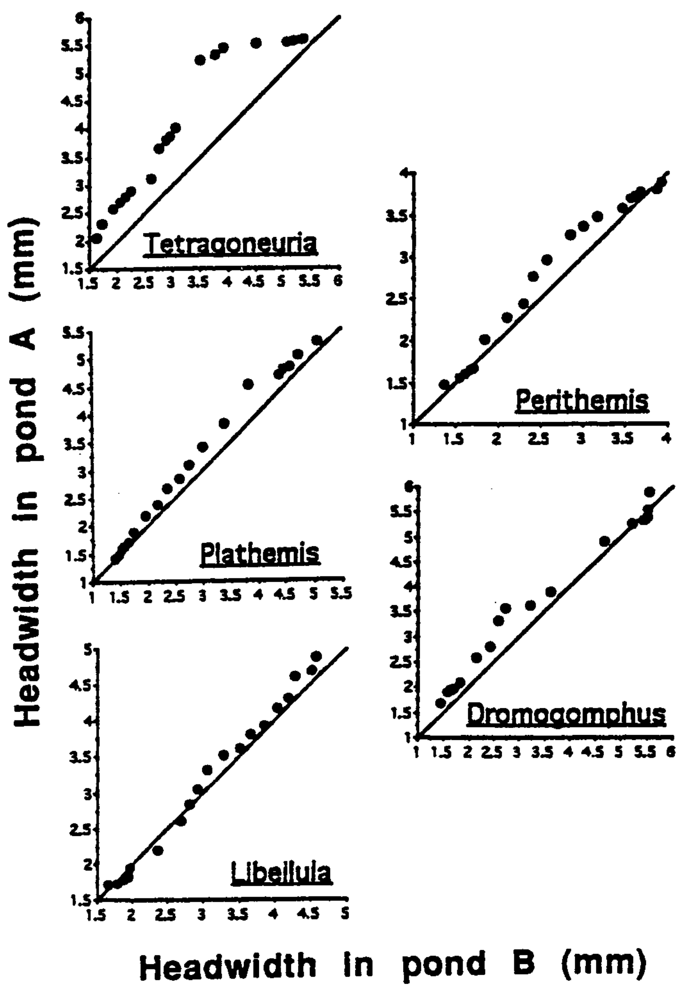

FIG. 2. Headwidth (in millimeters) percentile comparisons of aggregate size-frequency distributions for the five most common anisopteran larvae collected in ponds A and B from June 1990 to March 1992. Points above the diagonal line indicate smaller headwidths in pond B.

Proposed Role of Predation--Predation upon odonates by sunfishes (*Lepomis*) has been well documented (e.g., Sadzikowski and Wallace, 1976; Benke, 1978; Morin, 1984). *Lepomis macrochirus* were larger and more abundant in pond B. If predation by fish was greater in pond B than in pond A, odonate species which are less vulnerable to this predation should be favored, e.g., those which can burrow in the mud or are small. The gomphids, *Dromogomphus* and *Gomphus*, were more abundant in pond B than in pond A and are burrowing species (Westfall, 1984). By bending their long abdomens, these gomphids can exchange gases at the mud-water interface. Other adaptations for moving through sediment include wedge-shaped heads, short, thick close-laid antennae, and flattened, scrapper-like, front tibiae (Needham and Heywood, 1929). The gomphids are unique among the odonates in the two ponds in that they possess a spatulate labium most appropriate for capturing burrowing chironomids and oligochaetes (Pritchard, 1964). This labium is inappropriate for capturing planktonic microcrustacean prey, unlike the spoon-shaped labia of libellulids (Pritchard, 1964). Mahato (1990) found redear sunfish (*Lepomis microlophus*) to have consumed many fewer *Dromogomphus* than *Tetragoneuria*. A laboratory experiment using bluegill and *D. spinosus* and *T. cynosura* from ponds A and B revealed significantly greater predation upon *T. cynosura* (Montgomery and Kason, 1994). These observations support the idea that burrowing species like *D. spinosus* are less vulnerable to predation by sunfish than sprawling species.

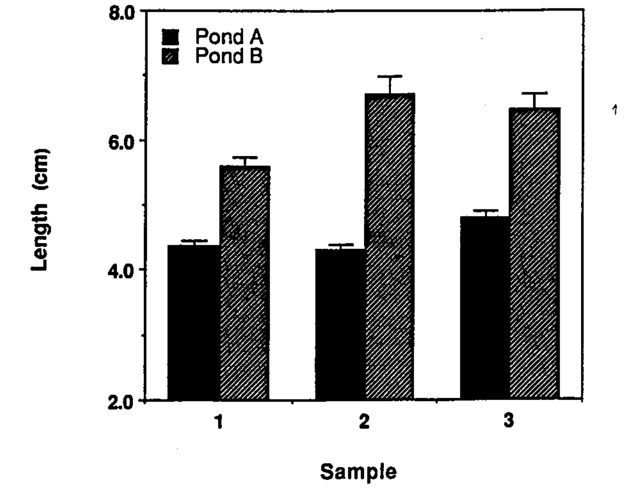

FIG. 3. Mean total lengths of bluegill (*Lepomis macrochirus*) collected by seine from ponds A and B. Error bars are standard errors.

Our data support the hypothesis that predation by bluegill influenced the differences in dragonfly larvae we observed in ponds A and B. *Dromogomphus* was significantly more abundant in pond B, the pond with more and larger fish, than in pond A. Greater mass of *Dromogomphus* also was observed in pond B than in pond A. The libellulid *L. vibrans* was significantly less abundant in pond B, and both *T. cynosura* and *L. vibrans* had smaller masses in pond B. The smaller size distributions for all common species, except *D. spinosus*, in pond B also is consistent with higher size-selective predation upon more vulnerable species in pond B.

Fish also may affect odonate communities by directly competing for microcrustacean prey (Morin, 1984). Reductions in this prey type would negatively affect *T. cynosura*, as has been described by Martin et al. (1991), and presumably other larvae with spoon-shaped labia.

Through this study, we have quantitatively described two communities of larval odonates in western Tennessee over a 22-month period. We have proposed a tentative hypothesis for the differences in species abundances, headwidths, and mass. Future studies to test this hypothesis should include the removal and addition of fish predators and the monitoring of gomphid larvae.

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