

THE ODONATA OF BAYS MOUNTAIN PARK, SULLIVAN COUNTY, TENNESSEE

DAN M. JOHNSON AND C. C. CONEY

East Tennessee State University  
Johnson City, Tennessee 37601

and

MINTER J. WESTFALL  
University of Florida  
Gainesville, Florida 32611

ABSTRACT

Bays Mountain Park is a forested mountaintop watershed with numerous small streams, a 0.58 ha pond, and an 15 ha shallow eutrophic lake. Since April 1977, we have collected 46 species of Odonata during regular field trips to this location. These include 25 new records for Sullivan County, and 2 species not previously reported from Tennessee: *Celithemis verna* Pritchard (Anisoptera, Libellulidae) and *Lestes eurinus* Say (Zygoptera, Lestidae). We have also recorded 25 extensions of published flight-seasons for Tennessee. Seasonal segregation of life histories is a potentially important aspect of niche partitioning for certain sets of species.

INTRODUCTION

Bays Mountain Park is a 525 ha (1300 acre) forested mountaintop watershed owned by the City of Kingsport, Sullivan County, Tennessee which operates it as a nature preserve and educational facility. The following major aquatic habitats are found within its boundaries:

- 1) Several small spring-fed sandy-bottomed streams.
- 2) Ecology Pond, a 0.58 ha (1.4 acre) man-made pond with a vertical outflow pipe so that fish cannot colonize it.
- 3) Bays Mountain Lake (formerly Kingsport Reservoir), an 15 ha (37 acre) shallow eutrophic lake at an elevation of 550 m (1800 ft.) which was formed by construction of a dam across Dolan Branch in 1916. Having a stable water level and a history of fertilization (1969-1974), this is one of the few lakes in Tennessee with a well-developed littoral zone. It also supports reproducing populations of largemouth bass, *Micropterus salmoides* (Lacepede), bluegill sunfish, *Lepomis macrochirus* Rafinesque, and channel catfish, *Ictalurus punctatus* (Rafinesque).
- 4) Dolan Branch is a steep, rocky stream receiving water from the dam's spillway and carrying it down the mountain toward the nearby Holston River.

This paper represents a first step toward understanding the ecology of the odonate assemblage at Bays Mountain Park—a list of species present and some notes on adult flight seasons.

METHODS AND RESULTS

Researchers made more than 80 field trips to Bays Mountain Park between April 1977 and December 1978, during which they focused most of their attention on the lentic habitats. They collected or recorded sightings of adult odonates on nearly every trip; and took monthly sweep-net samples of odonate larvae from each of 10 regular stations representing 6 distinct

habitat types. The distribution of larvae by habitat will be presented elsewhere (see also Johnson and Crowley 1979). Adults and late instar larvae have been identified using several available keys (Garman, 1927; Needham and Heywood, 1929; Needham and Westfall, 1955; Gloyd and Wright, 1959; Johnson and Westfall, 1970; Johnson, 1972; Westfall, 1978). Several Zygoptera larvae were reared by Philip Crowley (University of Kentucky) to determine their identities. At least one specimen of each species has been examined and identified by Minter Westfall. Table 1 presents a list of 46 odonate species collected at Bays Mountain Park as well as adult flight seasons reflected in our collections and field observations.

DISCUSSION

Among the 46 odonate species collected at Bays Mountain Park (Table 1) are 25 new records for Sullivan County including two not previously reported from Tennessee (Trogon, 1961; Goodwin, 1968). One, *Celithemis verna*, is near the northern edge of its

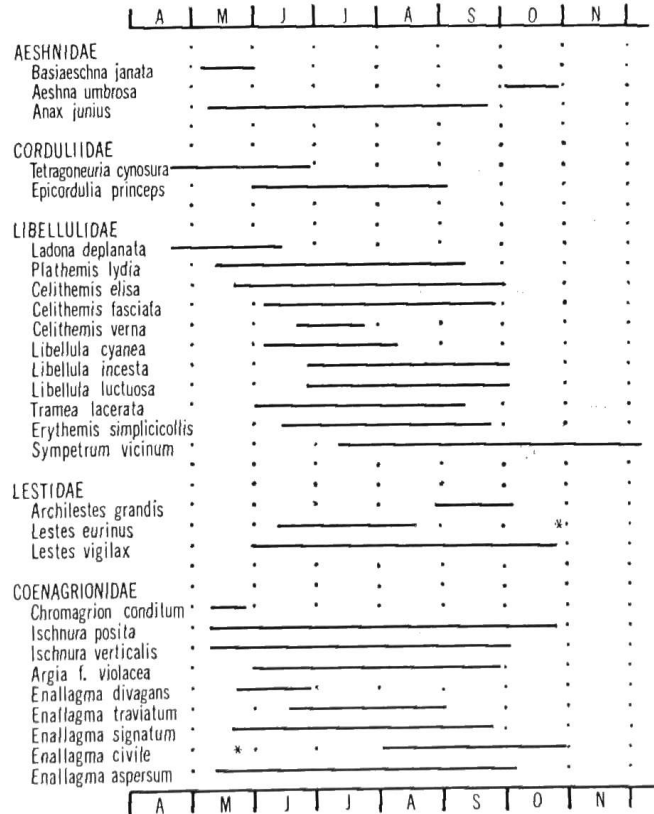


FIG. 1. Adult flight seasons of the more common Odonata based on collections and sight records made from April 1977 through December 1978 at Bays Mountain Park. Asterisks indicate exceptional captures of individual specimens.

TABLE 1: Odonata collected at Bays Mountain Park, Sullivan County, Tennessee (April 1977-December 1978): \*New county and \*\*new state records; 1 = larvae; a = adults; / or a indicates that species determinations have been confirmed by M. J. Westfall; 1<sup>1</sup> = larvae reared to adults by P. Crowley (U. Ky.); adult flight season extensions for Tennessee are marked with plus signs (+).

ANISOPTERA			
CORDULEGASTRIDAE			
<i>Cordulegaster maculata</i> Selys	*	/	
GOMPHIDAE			
<i>Dromogomphus spinosus</i> Selys		1	a 15 Aug.
<i>Hagenius brevistylus</i> Selys	*		a 11 July
<i>Stylogomphus albistylus</i> (Hagen)	*	/	
<i>Progomphus obscurus</i> (Rambur)	*	1	a 21 July-9 Aug.
AESHNIDAE			
<i>Aeshna umbrosa</i> Walker	*	/	a 3 Oct.-29 Oct.
<i>Anax junius</i> (Drury)		1	a 9 May-24 Sept. +
<i>Anax longipes</i> Hagen	*	1	a 5 July-28 July
<i>Basiaeschna janata</i> (Say)	*	1 <sup>1</sup>	a 6 May-1 June
MACROMIIDAE			
<i>Macromia alleghaniensis</i> Williamson	*	/	a 17 July-14 Sept. +
CORDULIIDAE			
<i>Epicordulia princeps</i> (Hagen)		1	a 30 May-4 Sept. +
<i>Somatochlora</i> sp.	*	/	
<i>Tetragoneuria cynosura</i> (Say)	1 <sup>1</sup>	a	21 Apr. +28 June
LIBELLULIDAE			
<i>Celithemis elisa</i> (Hagen)	*	1	a 22 May-2 Oct. +
<i>Celithemis fasciata</i> Kirby	*	1	a 6 June-27 Sept. +
<i>Celithemis verna</i> Pritchard	**	1	a 22 June-24 Sept.
<i>Erythemis simplicicollis</i> (Say)	*	1	a 14 June-24 Sept.
<i>Ladona deplanata</i> (Rambur)	*	1	a 21 Apr.-14 June
<i>Libellula cyanea</i> Fabricius		1	a 6 June +9 Aug. +
<i>Libellula incesta</i> Hagen	*	1	a 27 June-2 Oct. +
<i>Libellula luctuosa</i> Burmeister		1	a 27 June-3 Oct. +
<i>Pachydiplax longipennis</i> (Burmeister)		1	a 24 July-28 Aug.
<i>Perithemis tenera</i> (Say)	*	1	a 31 July-24 Sept.
<i>Plathemis lydia</i> (Drury)		1	a 28 Apr.-12 Sept.
<i>Sympetrum vicinum</i> (Hagen)	*	1	a 11 July-6 Dec. +
<i>Tramea carolina</i> (Linnaeus)	*	1	a 28 July-18 Aug. +
<i>Tramea lacerata</i> Hagen		1	a 1 June-12 Sept. +
ZYGOPTERA			
CALOPTERYGIDAE			
<i>Calopteryx maculata</i> (Beauvois)		a	1 June-5 July
LESTIIDAE			
<i>Archilestes grandis</i> (Rambur)	*	1	a 28 Aug.-4 Oct.
<i>Lestes eurinus</i> Say	**	1	a 12 June +29 Oct. +
<i>Lestes rectangularis</i> Say	*	1	a 18 July-28 Aug. +
<i>Lestes vigilax</i> Hagen	*	1	a 30 May +25 Oct. +
COENAGRIONIDAE			
<i>Amphiagrion saucium</i> (Burmeister)		a	30 May
<i>Anomalagrion hastatum</i> (Say)		a	12 Sept.
<i>Argia fumipennis violacea</i> (Hagen)	1 <sup>1</sup>	a	30 May-28 Sept. +
<i>Argia moesta</i> (Hagen)		a	26 June-31 July
<i>Chromagrion conditum</i> (Hagen)	*	1	a 9 May-26 May
<i>Enallagma aspersum</i> (Hagen)	*	1 <sup>1</sup>	a 12 May +4 Oct. +
<i>Enallagma basidens</i> Calvert	1 <sup>1</sup>	a	28 Aug.
<i>Enallagma civile</i> (Hagen)		a	22 May-29 Oct. +
<i>Enallagma divagans</i> Selys	/	a	22 May +27 June
<i>Enallagma exulans</i> (Hagen)		a	5 July
<i>Enallagma signatum</i> (Hagen)	1 <sup>1</sup>	a	12 May-24 Sept.
<i>Enallagma triviatum</i> Selys	*	1 <sup>1</sup>	a 17 June-1 Sept. +
<i>Ischnura posita</i> (Hagen)	1 <sup>1</sup>	a	9 May-25 Oct.
<i>Ischnura verticalis</i> (Say)	1 <sup>1</sup>	a	9 May-2 Oct. +

range, but has been reported from both Kentucky (Resener, 1970) and Virginia (Carle, 1978). Tennessen (1979) has reared this species from a larva collected in Sequatchie Co., Tn. The other, *Lestes eurinus*, is near the southern edge of its range but has been reported from North Carolina (Cuyler, 1968; Ingram, 1976). Thus neither record is particularly surprising.

Most species we have collected as adults are characteristic of lentic habitats (Westfall, 1978) and have been found as larvae in the littoral zone of Bays Mountain Lake or Ecology Pond. Those not yet found as larvae are presumed to be transients whose larvae inhabit nearby streams or rivers. Williamson (1932) describes four of them (*Hagenius brevistylus*, *Calopteryx maculata*, *Argia moesta* and *Enallagma exulans*) as lotic species that tend to wander far. Some species found as larvae in Bays Mountain Lake are usually associated with lotic habitats (Westfall, 1978). Four of these (*Cordulegaster maculata*, *Dromogomphus spinosus*, *Stylogomphus albistylus* and *Progomphus obscurus*) have been found only in sand-bar habitats near inlet streams; but *Basiaeschna janata* and *Macromia alleghaniensis* have been collected elsewhere in the lake.

It is not unusual to find many odonate species coexisting in one area (Bick and Bick, 1958; White, 1963; Kormondy and Gower, 1965; Benke and Benke, 1975; Voshell and Simmons, 1978); but when one does, he cannot fail to be intrigued by questions pertaining to niche differentiation. Seasonal segregation of life histories is a potentially important phenomenon reducing niche overlap among species adapted to similar habitats (Corbet, 1962; Van Noordwijk, 1978; Johnson and Crowley, 1979). We may judge its potential importance within the lentic odonate assemblage at Bays Mountain Park by comparing the observed flight seasons of the more common species (Figure 1).

Two aeshnid species found in Bays Mountain Lake differ dramatically with respect to flight season: *Basiaeschna janata* flies in May; *Aeshna umbrosa*, in October. Paulson and Jenner (1971) report similar differences between these species in neighboring North Carolina where both exhibit 2 year life cycles (at least in the mountains). *Anax junius* flies throughout the summer as reported by Paulson and Jenner (op. cit.). Since we have observed adults ovipositing before emergence begins, we suspect that there is a migratory component to this population as described by Trotter (1971) and Kime (1974).

Among the corduliids, *Tetragoneuria cynosura* is a synchronously emerging "spring" species (Corbet 1954). The mechanisms responsible for synchronous development in this species have been elucidated by Lutz and Jenner (1964); and its ecological relationships with "summer" species (especially *Celithemis fasciata*) have been studied (Benke and Benke, 1975; Benke, 1978). Our other common member of this family is *Epicordulia princeps*, a typical "summer" species (Paulson and Jenner 1971); which is considered congeneric with *T. cynosura* (in *Epitheca*) by Walker (1966).

Most of our libellulids exhibit long, overlapping summer flight seasons with little evidence of seasonal seg-

regation; but *Ladona deplanata* is a conspicuous exception, emerging synchronously in early spring. Paulson and Jenner (1971) reached the same conclusions for North Carolina libellulids. *Ladona* has received considerable attention as a "spring" species (Benke, 1970; Benke and Benke, 1975; Benke, 1978). It may also be significant that one libellulid, *Sympetrum vicinum* flies much later in the fall than any other odonate at Bays Mountain Park. Seasonal regulation in this species has been studied by Boehms (1971).

The large lestid damselfly *Archilestes grandis* is another species with an autumn flight season. This species is known to overwinter in the egg stage in North Carolina (Ingram, 1976) but as a larva in Oklahoma (Bick and Bick, 1970). Both *Lestes eurinus* and *Lestes vigilax* overwinter as larvae in North Carolina (Lutz, 1968; Paulson and Jenner, 1971; Ingram, 1976). Though *L. eurinus* seems to have a relatively restricted flight season in our study, mid-June to mid-August, we did collect one specimen flying in late October 1978. Lutz (1968) found that some *L. eurinus* larvae reached the penultimate instar in October, but failed to molt into the final instar until the following spring. We suspect that the lone, late-flying individual in our collections is one that was able to complete its development and emerge within one season. It may have been aided by an unusually warm September in 1978 (NOAA/EDIS 1978).

Among the coenagrionids, *Chromagrion conditum* is the quintessential spring species (Paulson and Jenner, 1971). Some *Ischnura* also emerge early, but they are not synchronized and continue to emerge and fly throughout the summer. Jenner (1958), cited by Paulson and Jenner (1971), found that *I. posita* differed from other species studied in that it continued to grow and molt throughout the winter. A really interesting case of seasonal segregation among congeneric species seems to exist in the *Enallagmas*. Like Paulson and Jenner (op. cit.), we find that *E. divagans* precedes *E. triviatum* and that both species are relatively synchronized (i.e. have restricted flight seasons). *Enallagma signatum* is less well synchronized, but is not seen flying in abundance until August, when *E. triviatum* numbers decline. *Enallagma civile* flies later still, dominating the scene during September and into October, though we have not yet found its larvae in our samples. The one species of *Enallagma* that does not fit into such a sequence is *E. aspersum*, a species that appears to be restricted to Ecology Pond (Johnson and Crowley, 1979). Ingram and Jenner (1976) found *E. aspersum* emerging later than *E. hageni* (Walsh), a coexisting congener, in the mountains of North Carolina. They also found that some *E. aspersum* larvae were able to complete development and emerge within one summer season.

Research in progress will help to determine whether life history differences inferred from flight-season observations result in maintenance of sufficient size differentials to reduce larval diet overlap among potentially competitive species.

#### ACKNOWLEDGEMENTS

We wish to acknowledge financial support provided by the Research Development Committee, East Tennessee State Uni-

versity and by the National Science Foundation (DEB 78-17518). Our collaborator Philip Crowley (University of Kentucky) reared several larvae to adult stages to determine their identities. The staff at Bays Mountain Park, especially Tom Bowman, Joe Taft, Tony Baird and Dave Taylor, have assisted our endeavor in many ways.

#### LITERATURE CITED

- Benke, A. C. 1970. A method for comparing individual growth rates of aquatic insects with special reference to the Odonata. *Ecology* 51:328-331.
- Benke, A. C. 1978. Interactions among coexisting predators—a field experiment with dragonfly larvae. *J. Anim. Ecol.* 47:335-350.
- Benke, A. C. and S. S. Benke. 1975. Comparative dynamics and life histories of coexisting dragonfly populations. *Ecology* 56:302-317.
- Bick, G. H. and J. C. Bick. 1958. The ecology of the Odonata at a small creek in southern Oklahoma. *J. Tenn. Acad. Sci.* 33:240-251.
- Boehms, C. N. 1971. The influence of temperature upon embryonic diapause and seasonal regulation in *Sympetrum vicinum* (Hagen) (Odonata: Libellulidae). Ph.D. Dissertation, Univ. of North Carolina at Chapel Hill. 153 p.
- Carle, F. L. 1978. Preliminary species list of Virginia Anisoptera. *Selysia* 8(1):7-8.
- Corbet, P. S. 1954. Seasonal regulation in British dragonflies. *Nature* 174:655.
- Corbet, P. S. 1962. *A Biology of Dragonflies*. Witherby Ltd., London. 247 p.
- Cuyler, R. D. 1968. Range extensions of Odonata in south-eastern states. *Ent. News* 79:29-34.
- Garman, P. 1927. Guide to the insects of Connecticut, Part V, The Odonata or Dragonflies of Connecticut. *Conn. Geol. Nat. Hist. Surv.* 39. 331 p.
- Gloyd, L. K. and M. Wright. 1959. Odonata. In *Freshwater Biology*, 2nd. Edition (W. T. Edmondson, editor). John Wiley and Sons, Inc. 1248 p.
- Goodwin, J. T. 1968. Additions to the list of Odonata from Tennessee. *J. Tenn. Acad. Sci.* 43:27.
- Ingram, B. R. 1976. Life histories of three species of Lestidae in North Carolina (Odonata: Zygoptera). *Odonatologica* 5: 231-244.
- Ingram, B. R. and C. E. Jenner. 1976. Life histories of *Enallagma hageni* (Walsh) and *E. aspersum* (Hagen) (Zygoptera: Coenagrionidae). *Odonatologica* 5:331-345.
- Jenner, C. E. 1958. The effect of photoperiod on the duration of nymphal development in several species of Odonata. *Quart. Publ. Assoc. Southeast. Biol., Philadelphia*, 6:26.
- Johnson, C. 1972. The damselflies (Zygoptera) of Texas. *Bull. Fla. State Mus. Biol. Sci.* 16 (2):55-128.
- Johnson, C. and M. J. Westfall, Jr. 1970. Diagnostic keys and notes on the damselflies (Zygoptera) of Florida. *Bull. Fla. State Mus. Biol. Sci.* 15 (2):45-89.
- Johnson, D. M. and P. H. Crowley. 1979. Odonate "hide-and-seek": habitat-specific rules? In the *Evolution and Ecology of Zooplankton Populations* (W. C. Kerfoot, editor). Special Symposium 3. American Society of Limnology and Oceanography. University Press of New England, Hanover, N.H. (in press)
- Kime, J. 1974. Ecological relationships among three species of aeshnid dragonfly larvae (Odonata: Aeshnidae). Ph.D. Dissertation, Univ. Washington, Seattle, Wash. 142 p.
- Kormondy, E. J. and J. L. Gower. 1965. Life history variations in an association of Odonata. *Ecology* 46:882-886.
- Lutz, P. E. 1968. Life history studies on *Lestes eurinus* Say (Odonata). *Ecology* 49:576-579.
- Lutz, P. E. and C. E. Jenner. 1964. Life history and photoperiodic responses of nymphs of *Tetragoneuria cynosura* (Say). *Biol. Bull.* 127:304-316.
- Needham, J. G. and H. B. Heywood. 1929. *A Handbook of the Dragonflies of North America*. C. C. Thomas, Springfield, Ill. 378 p.
- Needham, J. G. and M. J. Westfall, Jr. 1955. *A Manual of the Dragonflies of North America* (Anisoptera). Univ. Calif. Press, Berkeley. 615 p.
- National Oceanic and Atmospheric Administration/Environmental Data and Information Service. Local Climatological Data, Bristol-Johnson City-Kingsport, Tenn., Tri-City Airport, Monthly Summary, September 1978.
- Paulson, D. R. and C. E. Jenner. 1971. Population structure in overwintering larval Odonata in North Carolina in relation to adult flight season. *Ecology* 52:96-107.
- Resener, P. L. 1970. An annotated check list of the dragonflies and damselflies (Odonata) of Kentucky. *Trans. Ky. Acad. Sci.* 31:32-44.
- Tennessen, K. J. 1979. New records of Odonata for Alabama and Tennessee with significant range extension for many species. *Ent. News* 90(2):118-120.
- Trogdon, R. 1961. A survey of the adult Odonata of Tennessee. Ph.D. Dissertation, Univ. of Tennessee. 268 p.
- Trottier, R. 1971. Effect of temperature on the life-cycle of *Anax junius* (Odonata: Aeshnidae) in Canada. *Can. Ent.* 103: 1671-1683.
- Van Noordwijk, M. 1978. A mark-recapture study of coexisting zygopteran populations. *Odonatologica* 7:353-374.
- Voshell, J. R. and G. M. Simmons. 1978. The Odonata of a new reservoir in the southeastern United States. *Odonatologica* 7:67-76.
- Walker, E. M. 1966. On the generic status of *Tetragoneuria* and *Epicordulia* (Odonata: Corduliidae). *Can. Ent.* 98:897-902.
- Westfall, M. J., Jr. 1978. Odonata. In *An Introduction to the Aquatic Insects of North America* (R. W. Merritt and K. W. Cummins, editors). Kendall/Hunt, Dubuque, Iowa. 441 p.
- White, H. B. 1963. Seasonal distribution and abundance of Odonata at a large pond in central Pennsylvania. *Proc. North Central Branch, Ent. Soc. Amer.* 43:120-130.
- Williamson, E. B. 1932. Dragonflies collected in Missouri. *Occ. Pap. Mus. Zool., Univ. Michigan.* 240:1-40.