

Records and Observations of Indiana Odonata

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Abstract

The development of the knowledge of the dragonflies of Indiana is traced from its beginning over 130 years ago. The first American paper on the Odonata, Say's "Neuropterous Insects", published posthumously in 1839, listed 17 species for the state. Our knowledge of this fauna has grown by the publication of many papers of records, notes and observations, especially from 1897 to 1954. A bibliography of 43 entries documents the review of this development.

Records and notes on 69 species, compiled from records of 2556 specimens of 87 species obtained or studied since 1954, and from "rearings" of over 8300 naiads from 1961 to 1968 are included in this paper. Most of these show extension of the range of species in the state in the form of new county records. One species, *Sympetrum costiferum* (Hagn), is recorded from the state for the first time.

Information of seasonal life histories has been compiled from identification of instars included in the collections of naiads for rearing. *Ischnura verticalis* (Say) and *Erythemis simplicicollis* (Say) appear to breed throughout the flight season which for both of these species extends from April to October; *Neotetrum pulchellum* (Drury) and *Holotania luctuosa* (Burmeister) do not show as even a distribution of different instars throughout the year, but all four species pass the winter in many different instars. Experiments with the effects of temperature on rate of growth indicate that *Pantala* spp., are not permanent residents of the state, since naiads show no development and survive only a few days at temperatures of 65° F, and below. Development is rapid enough to allow two or three generations to develop in the state after adults fly in from the south each season.

Historical Development of the Knowledge of Indiana Odonata

The odonata fauna of Indiana has been studied for a fairly extended period and the literature is rather extensive. The first American paper on the Odonata was written in the state some time before Thomas Say's death in 1834. It was presented posthumously at a meeting of the Academy of Natural Sciences of Philadelphia, July 12, 1836, and was published three years later (19). This paper recorded only 17 species for Indiana without details further than "inhabits Indiana" with one exception. *Gomphus externus* was noted as "common in June on the banks of the Wabash." Five other species now on the state list were described by Say in this paper from other areas or without specific (state) localities. A list of 17 species does not seem impressive if compared with the present state list of 148 nominal species, but Say was a general collector and probably made little attempt to secure specimens of this order. Furthermore, very little was known of the group in Say's time; none of the classics on dragonflies had been published. The Science of Odonatology may be said to have had its origin in 1839-1842 with the publication of the classical books by Burmeister (1), Hagen (3), Selys (21), and Rambur (16), at least 5 to 8 years (and possibly longer) after Say's paper was written. The first of these, that of Burmeister, described only 159 species for the entire world!

The second paper dealing directly with Indiana Odonata (4), a local list of 14 species from Turkey Lake (now known as Lake Wawasee) did not appear until more than 60 years after Say's work. "Indiana was too far west to be visited by the eastern entomologists and too far east to share in the great western explorations of the period" (37). Following Kellicott's Turkey Lake paper, the accumulation of information on Indiana dragonflies was quite rapid and more or less continuous for almost 50 years. Williamson prepared a list of 25 species from Round and Shriner lakes in 1897 (27) and described a new species (*Ischnura kellicotti*) from the same locality the following year (28). The excellent treatise, "Dragonflies of Indiana," with descriptions, measurements, distributions, figures and keys for 84 species then known for the state, and 41 others which were regional, was published in 1900 (29). Two papers containing additions and corrections appeared almost immediately—the same and the following years (30, 31). Weith added four species in a note in 1900 (25), and the following year published (as co-author with Needham) an excellent life history of *Nannothemis bella* based on observations around the lakes of Elkhart County (26). Kennedy published two papers in these *Proceedings* in 1902, one a list of species from Lake Winona (5), the other a discussion of specific characters of the species of *Argia* known from Indiana (6).

From the time the list for the Whitley County lakes was prepared in 1897 until his death in 1933, Williamson continued his collection and study of the dragonflies of Indiana (as well as those of the Neotropical and other areas). He kept detailed notes of collection data, distributed duplicate specimens to students of the order and museums throughout the world, published faunistic (36, 37, 39, 40, 41, 42), biological (33) and systematic (32, 38) lists and notes, and revisional papers (34, 35, 43) and encouraged other students of the order. Indiana specimens were used extensively in papers by Garman (2), Ris (17, 18), Walker (22, 23, 24) and many others. His extensive collection records formed a considerable portion of the data used by this author in a series of papers (11) on the distribution and relative seasonal abundance of the Indiana species, the chief features of which were time-frequency graphs.

The occurrence and local distribution of species within the state has been extensively recorded and analyzed. In 1917 Williamson published an annotated list of 125 species indicating seasonal distribution, by thirds of months, of the flight period and the counties in which each had been found (37). A paper with additions (39) was published 4 years later. This author was encouraged by Williamson to publish a similar paper, based upon collections and records from other collectors and collections obtained by both workers in 1925 (10). This practice was continued in several series of papers (10, 11, 12, 13) until 15 years ago when the author's research activities were diverted more or less exclusively to other areas. However, many interesting records have been accumulated during this period and are presented here.

Continued study of the local occurrence and/or disappearance of species of dragonflies would appear to have very relevant connections with changes in the environment and possible pollution of bodies of water in which they are found. Since the Odonata occupy a position at the apex of the predator-prey pyramid of invertebrate life they reflect any disturbance in these faunae and act as final accumulators of persistent toxins in ponds, lakes and streams.

Study of the dragonflies of the state is much handicapped by the scattered literature and the lack of readily available keys or other means of identification of the species. Publications containing keys are too expensive and too extensive for use by most students and non-specialists. They are either very technical papers difficult for a beginner, or an "amateur" to use, or manuals covering so wide a territory (United States, Canada and portions of Mexico and the West Indies) that many non-regional forms, confusing to a non-expert, are included.

The references included in "Literature Cited" form a rather complete bibliography of the literature on Indiana Odonata. The author has developed keys to most groups of Indiana dragonflies and it is hoped that these may be published in the *Proceedings*, or separately, soon.

Records and Notes

The records offered here have been selected from the identifications of 2556 specimens of 87 species. Only new state and county records (starred, *) or those of special interest for other reasons are included. One species, *Sympetrum costiferum*, new to the state, is recorded, bringing the state list of species to 148.

During the period of 1960 to 1968 extensive collections of naiads (over 8300 individuals) were made for use in experiments on the rate of growth as influenced by variations in photoperiod and temperature. As these were collected throughout the year, and naiads of different instars were included, a great amount of information on the seasonal life history of the species studied should be available from this mass of material. However, only a small portion of the collections have been fully studied or even identified to species and instar. Most collections consisted primarily of a few "test" species and were from a limited number of localities (lakes in strip mine pits at Ashboro, Clay County; lakes at Boonville, Warrick County; pools in a gravel pit, a temporary pond in the Purdue Research Park, and Kolb Pond, in Tippecanoe County). Thus, the data available are limited. However, almost all notes on seasonal life history previously reported for the state (and for most other areas) have been based upon the collection of adults and last instar naiads, or records of exuvia. Consequently, the seasonal occurrence and distribution of any instar(s) of most species make a contribution to our knowledge of the length of the life history, the over-wintering stage(s), rapidity of development, overlapping broods and number of generations per year. Such data as are readily available have been summarized under the species

listings. Because of lack of information in the literature of the number of instars in many species, including the amount of variation in such number, and, especially any characteristics by which the different instars may be identified, only the instars from which individuals have been reared to adult emergence are considered in these compilations. The instars are identified by name or number backward from the last: 1) ult, 2) penult, 3) antepenult, 4) quartult, 5) quintult, 6) sextult, 7) septult, 8) octult, etc.

The numbers used in the "List of Species" are those of Williamson (37) and later interpolations.

List of Species

- 1) *Calopteryx aequabilis* Say. Elkhart: Solomon Creek, July 27, 1967-quite rare in comparison with *C. maculata*. Fulton: Mud Creek, July 28, 1966.
- 2) *C. maculata* (Beauvois). Harrison: Blue River, near Harrison County State Forest, July 26, 1967¹. *Marshall: Tippecanoe River, east of Rochester, Aug. 13, 1959. Orange: Raccoon Creek, Green Bluffs, June 21 & 24, 1967¹. Parke: Sugar Creek, Turkey Run State Park, June 27, 1967¹. Porter: Little Calumet River, east of Chesterton, Aug. 8, 1967¹; Billington Lake, Aug. 8, 1967¹. *Vigo: pond, Pimento, Aug. 16, 1966.
- 4) *Hetaerina americana* (Fabricius). *Carroll: Rock Creek, July 28, 1966. Harrison: Blue River, near Harrison County State Forest, July 25, 1967¹. *Marshall: Tippecanoe River, northeast of Rochester, Aug. 13, 1959.
- 5a) *Archilestes grandis* (Rambur). *Allen: wooded city lots at north edge of Ft. Wayne, Aug. 8 & 26, Sept. 9 & 17, 1966, James Wappes and/or BEM. Union: tributary of Hannah Creek, near Burnside Park, Sept. 13, 1952.
- 6) *Lestes congener* Hagen. St. Joseph: McClain Pond, South Bend, Aug. 24, 1965, G. H. Bick. *Wayne: Copes Pond, Oct. 2, 1961, L. C. Cox²; swamp, Washington Creek, near Burnside Park, Sept. 13, 1952.
- 8) *L. eurinus* Say. *St. Joseph: McClain Pond, South Bend, July 15, 1965, G. H. Bick.
- 9) *L. forcipatus* Rambur. *Delaware: swamp, Cowan, July 11, 1926. *Gibson: pond near Patoka, July 24, 1927. *Huntington: Wabash River, Aug. 1927, Paul Cook. *Knox: pond near Decker, July 15 & 27, 1924. *Lawrence: Troth orchard, Mitchell, June 22, 1935, John M. Amos. *Wayne: swamp, Washington Twp., Aug. 6, 1967, R. Hart².
- 10) *L. inaequalis* Walsh. *Kosciusko: North Webster, June 25, 1961².
- 11) *L. rectangularis* Say. Porter: Billington Lake, Aug. 8, 1967¹.
- 15) *Argia apicalis* (Say). *Franklin: New Trenton, July 4, 1961, F. G. Mark.² *Fulton: Tippecanoe River, Aug. 19, 1959. *Lagrange: Pigeon River, west of Howe, July 27, 1967. *Noble: Elkhart River, Ligonier, July 27, 1967. *Vanderburg, Bayou Creek Road, July 7, 1965, R. T. Everly.
- 16) *A. moesta* (Hagen). *Franklin: Brookville, June 26, 1961, T. G. Marsh²; St. Marys, July 17 & 18, 1961². *Union: Brownsville, July 25, 1961².
- 17) *A. sedula* (Hagen). *Clay: strip mine pits, Ashboro, Sept. 7, 1968. *Fayette: Connersville, Aug. 4, 1961, T. Marsh². *Fountain: Sugar Mill Creek, near Wallace, Aug. 23, 1970.
- 18) *A. tibialis* (Rambur). *Franklin: New Trenton, July 11, 1961, T. G. Marsh².
- 20) *A. violacea* (Hagen). *Franklin: Mt. Carmel, June 30, 1961, T. G. Marsh². *Owen: McCormick's Creek State Park, July 8, 1967. *Porter: Billington Lake, Aug. 8, 1967¹. A number of naiads, all in the penult, were obtained at the mine pits, Ashboro, Clay Co., Jan. 22, 1964.
- 21) *Enallagma antennatum* (Say). *Fountain: Sugar Mill Creek, near Wallace, Aug. 23, 1970. *Kosciusko: Milford, July 11, 1962. *Union: Liberty, June 28, 1961². *Wayne: Dalton, June 22, 1960, T. G. Marsh².

22a) *E. basidens* Calvert. *Vanderburg: Lake Hodoval, Evansville, July 29, 1967, Samuel Fishman. *Wayne: Green Twp., June 16, 1960, T. E. Marsh²; Economy, July 7, 1960, T. E. Marsh², Richmond, July 20, 1959, Hanum².

25) *E. civile* (Hagen). *Crawford: Wyandotte Lake, July 27, 1967¹. Naiads of this species were collected in great numbers from a pond in Crawford County in the spring of 1966, and at a pond in West Lafayette in the late autumn of the same year. It appears to breed continuously throughout the warm seasons. It was reared from egg to adult in our laboratories by Dr. Jerry M. Macklin and a complete life history study is now being prepared for publication.

29) *E. exsulans* (Hagen). *Owen: Green's Bluff, June 21 & July 24, 1967¹.

35) *E. traviatum* Selys. *Pike: roadside pool, June 23, 1967. *St. Joseph: Bass Lake, Lydick, July 18, 1965, G. H. & J. Bick. *Warrick: water supply lake, Boonville, June 23, 1967.

36) *Nehalennia gracilis* Morse. *Wayne: Richmond, Aug. 7, 1959, G. L. Ward².

37) *N. irene* Hagen. *Greene: fish pond, near Bloomfield, July 12, 1967.

38) *Amphiagrion saucium* (Burmeister). *Wayne: Richmond, June 30, 1959, J. C. B.²

41) *Ischnura posita* (Hagen). *Porter: Billington Lake, Aug. 8, 1967¹.

43) *I. verticalis* (Say). This species has been used very extensively in photoperiod-temperature experiments and two brief studies have been published (14, 15). The numbers of naiads of each instar collected at different seasons, shown in Table 1, would seem to indicate that it breeds continuously throughout the warm months.

TABLE 1. Numbers of naiads of each instar of *Ischnura verticalis* found during certain months.

	Instar					
	6	5	4	3	2	1
February					3	1
March				4	34	22
April			1	1	35	20
May						41
June	3	2	7	11		
July	4	5	12	22	44	62
August		1	4	3	9	35
September		1	4	17	36	9
November		2	5	5	60	16
December			10	24	51	16

46) *Cordulegaster diastatops* (Selys). *Fayette: Connersville, June, 1957².

49) *Progomphus obscurus* (Rambur). *Fountain: Sugar Mill Creek, near Wallace, July 13, 1969.

53) *Gomphus crassus* Hagen. *Hamilton: July, 1949, Max Kingsolver. *Tippecanoe: Lafayette, June 20, 1957.

55) *G. exilis* Selys. Steuben: Trailing Lake, Winghaven, June 8, 1967¹. Naiads in the ult were obtained in *Clay and Dubois counties, April 23, Oct. 14, and Nov. 13.

56) *G. fraternus* (Say). *Wayne: Abington, June 15, 1961, T. G. Marsh².

58) *G. grasilinellus* Walsh. *Franklin: Brookville, June 21, 1961, T. G. Marsh².

59) *G. lividus* Selys. *Wayne: Hagerstown, June 19, 1961, G. L. Ward²; Webster, June 8, 1960, T. G. Marsh².

61) *G. spicatus* Hagen. *Noble: Bear Lake, June 4, 1967¹.

66) *G. villosipes* Selys. *Lawrence, a naiad in the ult was collected from a stream at Avoca, April 10, 1966.

68) *Dromogomphus spinosus* Selys. *Crawford: Wyandotte Lake, July 27, 1967¹.

69) *D. spoliatus* (Hagen). *Vigo: conservation club pond, Farmersburg, Aug. 10, 1966.

70) *Boyeria vinosa* (Say). *Owen: Green's Bluff, near Freeman, July 16, 1955, Frank N. Young.

71) *Basiaeschna janata* (Say). *Brown: May 6, 1950, Gerdson (ex: Frank N. Young). Ultimate instar naiads were collected from Hannah Creek, *Union County, Aug. 30, 1966, and from mine pits at Ashboro, *Clay County, March 3, 1964 and April 23, 1965.

72) *Anax junius* (Drury). *Union: pond, 5 miles southeast of Liberty, Aug. 5, 1959.

72a) *A. longipes* Hagen. Individuals of this species were seen on several occasions during the summers of 1966 and 1967 at Kolb Pond, *Tippecanoe County, and at the ponds on the P. U. Forage Farm, *Dubois County.

73) *Aeshna umbrosa* Walker. *Henry: Liberty Twp., Sept. 15, 1957². Naiads in the quartult and quintult were obtained in Hannah Creek, *Union County, Aug. 26, 1966.

79) *A. verticalis* Hagen. *Wayne: Washington Twp., Sept. 24, 1967, R. Hart².

86) *Macromia wabashensis* Williamson. *Wayne: Whitewater, July 28, 1959². This specimen is the first example of this species known outside of the area of Wells County, Indiana and Paulding County, Ohio.

87) *Epicordulia princeps* (Hagen). Naiads in the penult and quartult were found January 25, 1966, and in the ult November 13, 1965, at the farm ponds in Dubois County, in the ult May 27, 1966 at Avoca, *Lawrence County, and Oct. 14, 1966, at the mine pits, Ashboro, *Clay County.

89) *Tetragoneuria cynosura* (Say). *Steuben: Trailing Lake, Winghaven, June 8 & 12, 1967¹.

94) *Somatochlora linearis* (Hagen). *Hamilton: July 1, 1949, Max Kingsolver.

96) *Holotania cyanea* (Fabricius). *Dubois: P. U. Forage Farm, abundant during summers of 1966 and 1967, especially in July, at ponds. *Greene: Bloomfield, July 12, 1967. Lagrange: Beaver Dam Lake, June 13, 1967¹. *Pike: roadside pool, June 23, 1967.

96a) *Ladona deplanata* (Rambur). *Dubois: common during May, 1966 and 1967, at farm ponds. Naiads in the ult were found Jan. 25, 1966, and in the antepenult July 9, 1965.

98) *Holotania incesta* (Hagen). *Jackson: lake, Starved Valley State Park, Aug. 9, 1961.

99) *H. luctuosa* (Burmeister). *Delaware: Muncie, Aug. 7, 1956, Austin Frishman. *Crawford: Wyandotte Lake, July 27, 1967¹. *Monroe: Cedar Bluff area, Clear Creek, June 20, 1967¹. *Newton: Willow Slough Fish and Game Preserve, July 1, 1967¹. *Union: Whitewater State Park, Aug. 26, 1966. This species has been used in considerable numbers in our rate of growth experiments. The data summarized in Table 2, show the relative numbers of naiads of each instar found in our collections made in spring, autumn and winter. The winter is passed in many instars, although we found naiads in the ult only in the spring.

100) *Neotetrum pulchellum* (Drury). *Hamilton: July 9, 1949, Max Kingsolver. *Newton: Willow Slough Fish and Game Preserve, July 2, 1967¹. This species was used in the first tests in the rate of growth experiments (15, 9). Almost all of the naiads were collected in the later instars, but some information on seasonal life history is furnished by the compilation of the numbers of the different instars collected (Table 3).

103) *Holotania vibrans* (Fabricius). *Posey: Hovey Lake area, near dam, June 18, 1959, R. T. Everly.

104) *Plathemis lydia* (Drury). *Hamilton: July 1947, and July 16, 1949, Max Kingsolver. *Vermillion: Wabash River, south of Perrysville, July, 1967¹.

105) *Perithemis tenera* (Say). *Crawford: Wyandotte Lake, July 27, 1967¹. *Vanderburg, Lake Hodoval, Evansville, July 29, 1967, Samuel Fishman; Perry Twp., July 8, 1966, R. T. Everly.

TABLE 2. *Numbers of naiads of each instar of Holotania luctuosa found in spring, autumn and winter.*

	Instars					
	6	5	4	3	2	1
January	1	5	16	9		
March				7	5	
April			2	4	24	38
September	1	2	6	8	3	
October			2	3		
November		9	9		3	
December		2	10	8	9	

TABLE 3. *Numbers of naiads of each instar of Neotetrum puchellum collected.*

	Instars						
	8	7	6	5	4	3	2
March					1	2	29
April					1	4	68
August	1		11	29	7	1	
September					1	2	1
October				1	1	4	1
November							3
December				1		21	19

107) *Erythemis simplicicollis* (Say). *Cass: Lake Cicott, June 28, 1961, July 14, 1963, Aug. 13 & 19, 1959. *Clay: mine pits, Ashboro, Sept. 7, 1968 (also naiads collected on many dates throughout the year). *Jackson: Starved Valley State Park, Aug. 9, 1961. *Montgomery: muck area, southeast of Linden, July 12, 1963. *Spencer: Sept. 6, 1961, Austin Frishman. *Union: pond, 5 miles southeast of Liberty, Aug. 5, 1959; lake, Whitewater State Park, Aug. 26, 1966; Liberty, Sept. 1, 1955². *Wayne: Aug. 13, 1950². Several hundred naiads of this species have been used in the rate of growth experiments, but many of the series have not been studied yet. However, enough data are available (Table 4) to indicate that the species breeds continuously throughout the flight season, which is very long, and that winter is passed in many instars.

108) *Sympetrum ambiguum* (Rambur). *Wayne: pond and swamp, Washington Twp., Sept. 21, 1968.

TABLE 4. *Tabulation of the number of naiads of each instar of Erythemis simplicicollis collected during the season of flight.*

	Instars						
	8	7	6	5	4	3	2
April					3	24	24
May				1	3	6	14
August	1	32	73	112	97	40	17
September			2	14	23	32	58
October		1	2	6	11	15	6

109) *Tarnetrum corruptum* (Hagen). Naiads in the ult were obtained at a pond in West Lafayette, Sept. 2, 1966.

*109a) **Sympetrum costiferum* (Hagen). *Tippecanoe: pond, Research Park, West Lafayette, Oct. 27, 1966, BEM, 8♂; Oct. 28, 1966, James Wappes and Cary Kerst, 5♀. This species has a transcontinental distribution in southern Canada and northern United States. It has been known previously in this area only from Michigan and Missouri.

110) *S. internum* Montgomery. Tippecanoe: Research Park, West Lafayette, Oct. 3, 1966.

111) *S. obtrusum* (Hagen). *Wayne: swamp and pond, Washington Twp., Sept. 21, 1968.

112) *S. rubicundulum* (Say). *Hamilton: July 14, 1950, Max Kingsolver. *Union: lake, Whitewater State Park, Aug. 26, 1966. *Wayne: swamp and pond, Washington Twp., Sept. 21, 1968.

113) *S. semicinctum* (Say). *St. Joseph: cattail swampy area, roadside, near Lakeville, July 29, 1966. *White: roadside, north of Monon, July 22, 1958.

114) *S. vicinum* (Hagen). *Clay: mine pits, Ashboro, Sept. 7, 1968. *Dubois: Farm ponds, P. U. Forage Farm, July 10-Sept. 7, 1966-67. (July specimens teneral). *LaPorte: LaPorte, Sept. 23, 1959, L. Chandler. *Porter: Billington Lake, Aug. 8, 1967¹; Morgan Lake, Aug. 9, 1967¹.

115) *Pachydiplax longipennis* (Burmeister). *Hamilton: July 4 & 25, 1949, Max Kingsolver. *Union: pond, 5 miles southeast of Liberty, Aug. 5, 1959; lake, Whitewater State Park, Aug. 26, 1966.

117) *Leucorrhinia intacta* (Hagen). Lagrange: Beaver Dam Lake, June 13, 1967¹. Steuben: Trailing Lake, Winghaven, June 8, 1967¹.

121) *Pantala flavescens* (Fabricius). *Wayne: Richmond, Oct. 1, 1957². Naiads of all sizes of this and the following species were collected in great numbers from the reflecting pool at the State Office Building in Indianapolis, during the summers of 1963-1965. It has been found impossible to date to separate naiads, or exuvia, except the last instar of the two species, as the "key" characters (number of labial spines—palpal and premental) increase in number during development. Naiads of the later instars cannot be separated into instars on size, and it has not been determined how the number of spines varies between instars of the same species and between the two species before the final instar. Attempts were made to "rear" naiads at temperatures from 60° to 90° F. No development occurred in naiads of any age and none lived more than a few days at 60° or 65° F. These species would appear to be summer residents only of this area; adults fly in from the south, oviposit (to a considerable extent in temporary bodies of water) and the naiads develop very rapidly so that there may be two or three generations each season. The flight season in Indiana extends from April to October (11).

122) *P. hymenaea* (Say). *Dubois: ponds, P. U. Forage Farm, July 12, 1967.

123) *Tramea carolina* (Linné). *Wayne: Richmond, Aug. 11, 1967, Whitaker².

124) *T. lacerata* Hagen. *Dubois: ponds, P. U. Forage Farm, July 9 to Sept. 7 (1965-1967).

125) *T. onusta* Hagen. *Dubois: pond, P. U. Forage Farm, July 9, 1965.

¹ Records from collections made by Martin Heatherington during the survey of "primitive areas" in 1967 (7).

² Records from specimens in the Earlham College Collection.
ton Twp., Sept. 2, 1967, J. W. Hart².

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