

The Distribution and Relative Seasonal Abundance of the Indiana Species of Agrionidae (Odonata: Zygoptera)

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In a previous paper (Montgomery, 1942) the relative seasonal abundance of the adults of the 16 species of *Enallagma* known from Indiana, based upon the frequency of collection during 41 years (1900-1940 inclusive) was indicated. That study is extended here to include the remaining 16 species of the family Agrionidae recorded from the state.

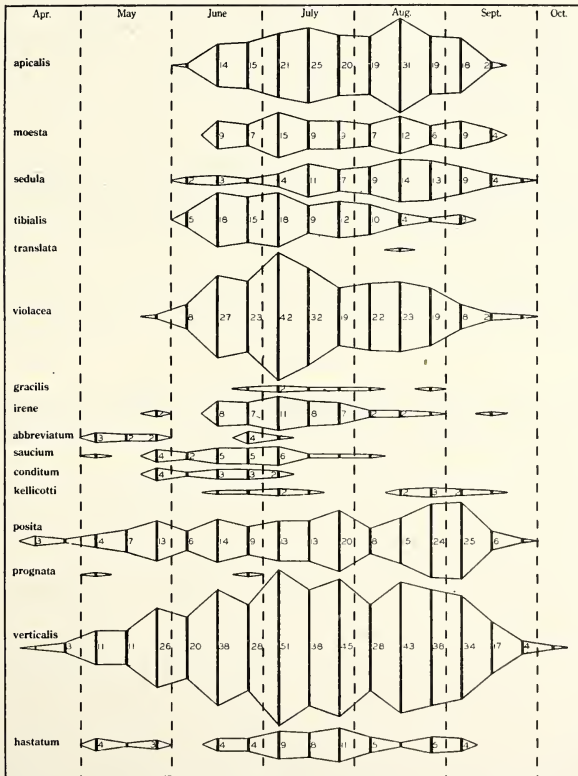


Fig. 1. The range of the flight season (or period of adult life) and the relative seasonal abundance of 16 species of Agrionidae (genera *Argia*, *Nehalonia*, *Amphiagrion*, *Chromagrion*, *Ischnura* and *Anomalagrion*) in Indiana. Collections made from 1900 to 1940 inclusive were tabulated by thirds of months and the graphs constructed from the resulting frequency distributions. Numbers near each bar indicate the number of collections of each species in each third of a month; where no number is given the number of collections is one.

Records of almost all Odonata collected or observed in Indiana since 1900 have been preserved in the note books of the late E. B. Williamson and of the author. The records for the species of the genera *Argia*, *Nehalennia*, *Amphiagrion*, *Chromagrion*, *Ischnura*, and *Anomalagrion* have been tabulated and the accompanying chart (Figure 1) indicates the relative abundance of the different species throughout the season of adult flight. As this study applies only to adults, all references to seasonal range and abundance in this paper refer to the period of adult flight.

The records of captures (or observations) were tabulated by thirds of months and the time-frequency graph for each species was constructed by plotting the frequency for each third at the midpoint (5th, 15th and 25th of the month, respectively) of the third of the time axis.

The records are based upon collections and observations from 1900 to 1940 inclusive, almost all of which have been published (Williamson, 1917 and 1920; Montgomery, 1925-1941). During the present season (1943) later records have been obtained for *Argia violacea* (Oct. 7), *Ischnura posita* (Oct. 10 and 20) and *I. verticalis* (Oct. 10 and 20). However, all records since 1940 were excluded from the tabulations to make the chart showing relative abundance directly comparable with the one in the study of the species of *Enallagma* (Montgomery, 1942). There are no records for 1923 and no species is listed for all of the other years, although both *Argia violacea* and *Ischnura verticalis* are recorded for 39 years. The number of years for which each species has been recorded is indicated immediately following the species name in the list below.

List of species with notes on distribution and an indication of the number of years each species was collected from 1900 to 1940 inclusive

- Argia apicalis* (Say)—33. Eastern states from Texas and North Dakota to Florida and New York, but has not been found in Canada except in southern Ontario and is not known from New England.
- A. moesta* (Hagen)—26. From eastern Canada into Mexico, although not recorded from western Canada and the northwestern states. However, the forms from the northeastern and the southwestern portions of the range differ considerably in coloration and frequently have been considered as separate species, subspecies or varieties. Williamson (1912) studied a rather limited amount of material from several localities from Ontario and Maine to Texas and concluded that *putrida* (Hagen) is a synonym of *moesta*. However, his study showed some geographical differentiation and it is probable that two (or more) subdivisions of the species exist. The eastern form includes that portion of the range from Texas and Oklahoma northeastward.
- A. sedula* (Hagen)—24. Ontario, eastern half of the United States, southwestern states to the Pacific coast and northern states of Mexico.

- A. tibialis* (Rambur)—30. Southern Ontario and eastern United States from Texas and Minnesota to the Atlantic coast, except New England.
- A. translata* Hagen—1. From Connecticut and North Carolina southwest to Oklahoma and Texas, through Mexico and Central America into South America at least as far as Ecuador.
- A. violacea* (Hagen)—39. From the Maritime Provinces and the Carolinas to Minnesota and Arizona.
- Nehalennia gracilis* Morse—4. Eastern states, Missouri to New Brunswick and Florida.
- N. irene* Hagen—24. Eastern states, Iowa and South Carolina northward into Canada, transcontinental in southern Canada.
- Amphiagrion abbreviatum* (Selys)—7. United States and southern Canada west of the Mississippi, and eastward at least to Indiana.
- A. saucium* (Burmeister)—16. Eastern states from Indiana to Quebec and South Carolina.
- Chromagrion conditum* (Hagen)—9. Northeastern states; east of the Mississippi River from South Carolina and Tennessee to Ontario, Quebec and New Brunswick, known only from Missouri west of the Mississippi.
- Ischnura kellicotti* Williamson—9. Oklahoma and Iowa to Maine and South Carolina.
- I. posita* (Hagen)—32. Eastern United States as far west as Oklahoma and Iowa, also Quebec and Nova Scotia.
- I. prognata* (Hagen)—2. Indiana and Ohio southeastward to Florida.
- I. verticalis* (Say)—39. Maritime Provinces and South Carolina to Manitoba and Oklahoma.
- Anomalagrion hastatum* (Say)—19. From Maine, Ontario and Iowa southward through the West Indies, Mexico and Central America to Venezuela and the Galapagos Islands.

Kennedy (1928) pointed out relations between zoogeographical distribution and evolutionary level and between seasonal distribution (of adults) and evolutionary level of anisopterous dragonflies. The data for the study of seasonal distribution were taken directly from Williamson's Indiana records, although only those to 1916, published in the annotated list of 1917 (Williamson, 1917), were used. Kennedy showed seasonal distribution by simple bar graphs, giving no indication of relative seasonal abundance, although he indicated a probable middle of the flying season for each species. He did not include any study of possible relations between the seasonal and geographical distributions of the Indiana species.

Relations between the geographical distribution and the seasonal abundance (or occurrence) of the Indiana species of *Enallagma* were

indicated by Montgomery (1942). Only the faintest traces of any such relations are evident on an intrageneric level among the species included in the present study. Genera included here are either small or have a small number of species (occurring in Indiana) with similar geographical ranges.

Chromagrion and Anomalagrion are monotypical genera. *C. conditum* has a rather short seasonal range in Indiana, late May to early July, and a limited geographic range in northeastern America. *A. hastatum* has a comparatively long seasonal range, early May to early September, and a very extensive geographical range (for a species of Odonata), from Maine and Ontario to the Galapagos Islands. *Hastatum* is frequently exceedingly abundant, but as it is local in distribution the rather narrow graph is probably a true representation of its total relative abundance (as compared with the sometimes locally less numerous but more generally occurring *Ischnura posita* and *I. verticalis* for example).

Amphiagrion is a North American genus ranging across the continent in southern Canada and the United States as far south as South Carolina in the east and the southwestern border states in the west. (South American species described in this genus are now generally recognized as being generically distinct from the North American forms.) Although the eastern and western forms were described as separate species many authors have considered *abbreviatum*, the western form, as a synonym of a variety of *saucium*, the eastern form. For this reason records in the literature cannot be properly assigned. All specimens of Amphiagrion taken in northwestern Indiana (Fountain, Tippecanoe and Carroll counties and northward) are *abbreviatum*, those from elsewhere in the state *saucium*. It is reasonable to assume that *abbreviatum* ranges westward from Indiana, *saucium* eastward, although a thorough study may reveal some overlapping or irregularities, or even more than two species. Both species are early summer forms, from May to July or August.

Nehalennia is a genus of about eight species, mostly Holarctic, although one species (*selysi* Kirby) was described from Brazil. Of the seven Holarctic species, three are found in the old world, four in the new. Of the old world species one (*speciosa* (Charpentier)) extends across Eurasia from Belgium and the Netherlands to Japan, one (*atrinuchalis* Selys) is known from Shanghai, and the other (*arakawai* Matsumura) was described from Japan. The four American species are primarily eastern, although *irene* is transcontinental in southern Canada; the two species not found in Indiana are limited to the Atlantic coastal area—*integricollis* Calvert, New Jersey to Florida, and *pallidula* Calvert, Florida. American species of Nehalennia inhabit bog and swamp areas, and are generally quite rare, although *irene* has been found very abundant locally in Iowa by the author. *Irene* has been taken throughout most of the season of usual adult odonate occurrence, and may be said to be somewhat "common" from mid-June through July; *gracilis* is always rare.

Argia and Ischnura are both large genera, each with more than 100 nominal species; allowing for synonyms and subspecific forms each prob-

ably contains more than the approximately 70 valid species in *Enallagma* (Montgomery, 1942).

Ischnura is cosmopolitan with 16 new world species, of which 12 are North American, three South American, and one (*ramburii* Selys) is found from Ontario and New England to Paraguay. In contrast to *Enallagma*, of which almost five-sixths (26 of 33) of the species occurring north of Mexico are eastern, *Ischnura* is mainly western; of 12 species occurring north of Mexico only five are found east of the Mississippi River. *Prognata* and *kellicotti* have been taken too infrequently in Indiana to furnish much information on any seasonal variation in their abundance. *Prognata* is probably not a permanent resident of Indiana, which is the northwestern borderland of its range, invaded only at intervals of favorable climatic conditions. *Kellicotti* is a species of rather strict habitat requirements—"found only about the beds of white water-lilies, resting on the floating leaves" (Williamson, 1900). On the other hand *posita* and *verticalis* are not limited in Indiana by such strict habitat requirements or borderland climatic conditions. They are among the most common and have almost the longest season of adult flight of any of the species of Odonata in the state. Although *verticalis* is probably the more abundant of the two species everywhere in Indiana, *posita* becomes relatively more abundant from north to south, a reflection of its distribution which extends several hundred miles farther south than than of *verticalis*. The three peaks of abundance so prominent in the seasonal distribution of the species of *Enallagma* and recognized in that of the species of *Argia*, are not evident in the graphs for these species. However, there is a regular alternation of peaks and valleys in the abundance of *verticalis* and, with slight irregularities and to a somewhat lesser degree, of *posita* and *Anomalagrion hastatum* from mid-May to early September. No explanation can be given at this time for these regular oscillations in abundance, almost perfectly correlated in the three species.

Argia is a New World genus, distributed from southern Canada (eight species) to Argentina (three species). A few non-American species have been described in this genus but all of them are probably misplaced either generically or geographically. Gloyd (1941) has shown that species formerly ascribed to the Kurile Islands and the Cape of Good Hope were based upon specimens from California and the Lesser Antilles, respectively. A rough estimate of the distribution of the genus was obtained by dividing its range into seven regions and tabulating the number of the 124 nominal species, subspecies and varieties of the genus recorded for each. (No attempt was made to work the synonymy of all names, but those generally recognized as synonyms were excluded from separate consideration. The division of the range into seven regions is based upon convenience and may not be well correlated with any definite climatic divisions.) In the following list the regions are arranged from north to south, and for each are indicated the total number of species recorded, the number indigenous, and the number ranging southward from the particular region to each of the more southern regions:

- I. Eastern United States and Canada (to the Dakotas, Oklahoma and Texas)—total-8, indigenous-5, ranging to region II-1, region III-1, and region VI-1.
- II. Western United States and Canada—total-16, indigenous-6, ranging to region III-6, and region IV-1.
- III. Mexico—total-36, indigenous-15, ranging to region IV-4, region V-5, and region VI-3.
- IV. Central America, including Panama—total-28, indigenous-9, ranging to region V-4, and region VI-1.
- V. Colombia, Venezuela, Guiana, Trinidad and the Lesser Antilles—total-34, indigenous-22, ranging to region VI-1.
- VI. Ecuador, Peru, Bolivia, Brazil and Paraguay—total-42, indigenous-34, and ranging to region VII-1.
- VII. Uruguay and Argentina—total-4, indigenous-3.

In Canada and the northern United States the group is very rare or entirely absent in the central plains area. All of the six species found in Indiana have been recorded from Ontario (mostly from the southern portion only), and two occur in the Maritime Provinces. Of the other two species, one (*bipunctulata* (Hagen)) extends northward in the Atlantic coastal area as far as New York and the other (*fumipennis* (Burmeister)) was once recorded from Kentucky. In the west two species range into Canada—*vivida* Hagen which occurs southward to Mexico and eastward to Missouri is known from British Columbia and Alberta, and *emma* Kennedy has been found from California and Nevada to British Columbia.

The seasonal distribution of the Indiana species is, no doubt, a reflection of the tropical origin and essential character of the genus. Only one of the five common species has been taken before June, but most of them reach almost full abundance soon after their first appearance. The season of the several species in Ontario (Walker, 1941) is well within the plotted seasonal range for Indiana, except *moesta* was once found very numerous ("thousands of teneral were flying in the river valley" at Erindale near Grand Forks) June 7 and the single record for *translata* was along the Thames River near Chatham on June 25. Three peaks of abundance almost identical with those found in the species of *Enallagma* may be noted. The first, more or less discernible in all five of the common species, occurs in mid-June, soon after the initial appearance of the species, the second appears in early July for three species (*moesta*, *tibialis* and *violacea*) but in mid-July for the other two (*apicalis* and *sedula*), the third apparent in all of these except *tibialis* is in mid-August which is the date of our only record of *translata*.

Although the species treated in this study are too scattered to illustrate more than traces of the correlations between seasonal abundance or occurrence and geographical distribution noted to a limited extent among the Indiana species of *Enallagma*, a few such relations on a generic level seem to exist.

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