

The Distribution and Relative Seasonal Abundance of the Indiana Species of Cordulidae and Libellulidae (Odonata)

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The relative seasonal abundance of the adults of the Indiana species of the Agrionidae, based upon the frequency of records for 41 years (1900-1940 inclusive) has been indicated in previous papers (Montgomery, 1942, 1944). A similar summary of the records for the Cordulidae and Libellulidae is presented here.

Records of captures (or observations), preserved in note books of the late E. B. Williamson and of the author, were tabulated by thirds of months and a 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). These graphs, formed into two charts (Fig. 1 and 2) show the relative abundance of the different species throughout the recorded season of flight (adult life).

Fifteen species of Cordulidae and 33 species of Libellulidae have been recorded from Indiana. One of these, *Neurocordulia obsoleta* (Say), was not recorded from Indiana during the period of this study, or in fact, since the time of the original description, although it has been found a few times in neighboring states. Three other species of Cordulidae and one of Libellulidae were each recorded in only one year during the period of 1900 to 1940 inclusive. No species was recorded for all of the 41 years; *Libellula pulchella* Drury was reported for 38 years, *L. luctuosa* Burmeister for 36, and three other species for 33 years each. The number of species of these two families recorded each year has varied from three, in 1923, to 25, in five different years; the average number per year has been approximately 18, of which 14.5 were Libellulidae, 3.5 Cordulidae. No Cordulidae were recorded during three years, 1916, 1920, and 1923, and only one species in each of four years; the greater numbers of species of this family to be reported was nine, in 1922. Only three species of Libellulidae were taken in 1923, and only four in 1918; the greatest number of species of this family to be recorded in any year was 20, in both 1914 and 1927. The number of years in which each species was found 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 Cordulidae

Didymops transversa (Say)—7; Maritime Provinces and Michigan to Florida and Oklahoma.

Macromia georgina (Selys)—1; Indiana to North Carolina, Georgia, and Texas. *M. illinoensis* Walsh—13; Nova Scotia and Wisconsin to South Carolina and Kansas. *M. pacifica* Hagen—14; Ohio, Wisconsin, and Nevada to Texas and California. *M. taeniolata* Rambur—18; New York, Wisconsin, and Kansas to Florida and Oklahoma. *M. wabashensis* Williamson—7; Wells County, Indiana.

Epicordulia princeps (Hagen)—25; Maine, Quebec, and North Dakota to North Carolina and Texas.

Neurocordulia obsoleta (Say)—0; Maine and Michigan to North Carolina and Louisiana.

Tetragoneuria cynosura (Say)—21; Maine, Quebec, and Minnesota to Florida and Louisiana. *T. simulans* Muttkowski—10; Maritime Provinces and Wisconsin to North Carolina and Indiana. *T. spinigera* Selys—1; Maritime Provinces and British Columbia to Connecticut, Indiana, and California.

Dorocordulia libera (Selys)—4; Maritime Provinces, Quebec, and Wisconsin to New Jersey and Indiana.

Somatochlora ensigera Martin—7; Manitoba and Saskatchewan to Indiana, Oklahoma, and Colorado. *S. hineana* Williamson—0; Logan County, Ohio. *S. linearis* (Hagen)—15; Maine, Quebec, and Illinois to Georgia and Missouri. *S. tenebrosa* (Say)—4; Nova Scotia, Quebec and Illinois to South Carolina and Tennessee.

Libellulidae

Libellula cyanea Fabricius—24; New Hampshire and Kansas to Georgia and Oklahoma. *L. julia* Uhler—2; transcontinental, Quebec and Connecticut to British Columbia. *L. incesta* Hagen—19; Maine and Wisconsin to Florida and Oklahoma. *L. luctuosa*—Burmeister—36; Maine and North Dakota to Florida and northern Mexico. *L. vibrans* Fabricius—10; Maine and Wisconsin to Florida and Oklahoma. *L. quadrimaculata* Linné—5; circumpolar; in the Old World, England and Spain to Japan; in the New World, Newfoundland and Alaska to North Carolina and California; northern Indiana is probably the southern limit of the range outside of the mountains. *L. semifasciata* Burmeister—12; Maine and Wisconsin to Florida and Texas. *L. pulchella* Drury—38; transcontinental, Quebec and British Columbia to Florida and California. *L. lydia* Drury—32; transcontinental throughout southern Canada and the United States.

Nannothemis bella (Uhler)—5; Maine and Michigan to Florida.

Erythrodiplax minuscula (Rambur)—2; Maryland and Oklahoma to Florida and Texas. *E. umbrata* (Linné)—1; Ohio and Indiana, through West Indies, Mexico and Central America, to Argentina.

Perithemis tenera (Say)—31; Massachusetts and Kansas to South Carolina and Mexico.

- Erythemis simplicicollis* (Say)—32; Quebec and British Columbia to West Indies and Mexico.
- Pantala flavescens* (Fabricius)—17; circumequatorial and ranging to approximately 40° north and south. *P. hymenaea* (Say)—11; southern Canada to Chile.
- Tramea carolina* (Linné)—11; Massachusetts to Florida and Kansas. *T. lacerata* Hagen—29; Massachusetts and California to Florida and Mexico, Hawaiian Islands. *T. onusta* Hagen—10; Ohio and Nevada to West Indies and Mexico.
- Sympetrum ambiguum* (Rambur)—22; Massachusetts and Kansas to Georgia and Texas. *S. corruptum* (Hagen)—11; New England and British Columbia to Florida, Mexico, and British Honduras. *S. internum* Montgomery—1; Canada and Alaska to Indiana and California. *S. obtrusum* (Hagen)—28; Quebec and British Columbia to North Carolina and California. *S. rubicundulum* (Say)—33; Quebec and Wyoming to Maryland, Kentucky, and Nevada. *S. semicinctum* (Say)—7; transcontinental from southern Canada to North Carolina and California. *S. vicinum* (Hagen)—29; transcontinental in southern Canada, southward to North Carolina and Oklahoma.
- Pachydiplax longipennis* (Burmeister)—33; Massachusetts, Ontario, and Montana to Florida and Mexico; Bermuda and Bahama Islands.
- Leucorrhinia frigida* Hagen—3; Maine, Quebec, and Manitoba to Connecticut and Indiana. *L. intacta* (Hagen)—25; transcontinental in southern Canada, southward to New Jersey, Tennessee, and Nevada.
- Celithemis elisa* (Hagen)—32; Maine and Wisconsin to South Carolina and Oklahoma. *C. eponina* (Drury)—33; Massachusetts, Ontario, and North Dakota to Florida and Texas; Cuba. *C. fasciata* Kirby—2; Indiana and Oklahoma to North Carolina and Florida. *C. monomelaena* Williamson—12; Connecticut and Wisconsin to New Jersey and Missouri (Oklahoma?).

Kennedy (1928) studied the relation of evolutionary level to geographic and seasonal distribution in the Anisoptera. He found "a distinct tendency for primitive groups to reach their maximum number of species in cool regions while the insects of the modern groups reach their maximum number of species on the hot equator" and a tendency for "the most active insects to occupy the midseason while the less active or more primitive types occupy the early and late seasons." The data for Kennedy's study of seasonal distribution were obtained from Williamson's records to 1917, and, thus, consist of approximately the first half of the data summarized in the graphs of this paper. The groups used by Kennedy for comparisons were, for the most part, families.

Even with the present more complete seasonal data, few, if any, relations between evolutionary level and seasonal distribution, on a specific or generic level in the Cordulidae and Libellulidae can be deter-

mined. Too small a number of the total unit in a group—genera in a family, or species in a genus—are found in Indiana to provide a proper comparison. This is especially true if there is much relation between geographic distribution and evolutionary level, as the result of such correlation would be a homogeneous fauna within an area as small and uniform as that of the state. Furthermore, there has been little significant work on the relative evolutionary level of the genera of these two families, and, with a few exceptions, almost none on that of the different species of the several genera.

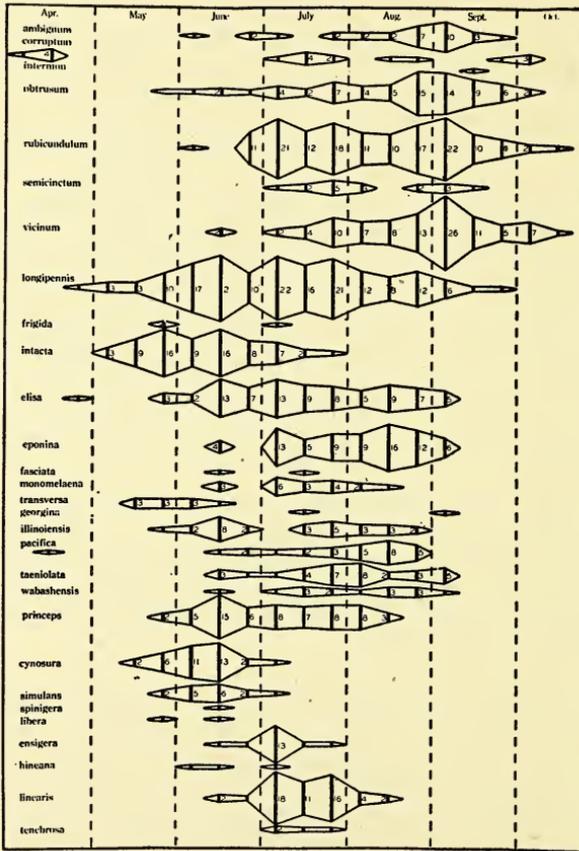


Fig. 1. The range of the flight season (or period of adult life) and the relative seasonal abundance of species of Libellulidae (genera *Sympetrum*, *Pachdiplax*, *Leucorrhinia*, and *Celithemis*) and of Cordulidae (genera *Didymops*, *Macromia*, *Epicordulia*, *Tetragoneuria*, *Dorocordulia*, and *Somatochlora*) in Indiana. Numbers near each bar indicate the number of collections of each species in each third of a month during the period of 1900 to 1940 inclusive; where no number is given the number of collections is one. The range for *S. vicinum* extends beyond the limit of the chart; there were two collections in the first third of November and one collection in each of the other thirds of that month.

Of the seven genera of Cordulidae represented in Indiana, one (*Macromia*) is cosmopolitan, one (*Somatochlora*) is circumpolar, and the remainder are Nearctic, mainly confined to eastern United States and Canada.

Didymops is a genus of two species. The non-regional species is known only from Florida.

The cosmopolitan genus *Macromia* contains about 80 nominal species, of which ten occur in the United States and Canada. The more or less compensating graphs of the several Indiana species, forming a somewhat even total band throughout the season for the genus as a whole, would seem to be of interest but there appears to be no explanation for it. *Macromia* and *Didymops* are rather distinctly separated from the other genera of the family found in Indiana, and are sometimes placed in a separate subfamily. The seasonal ranges and the species of *Macromia* are in marked contrast to those of the other Cordulidae, with the possible

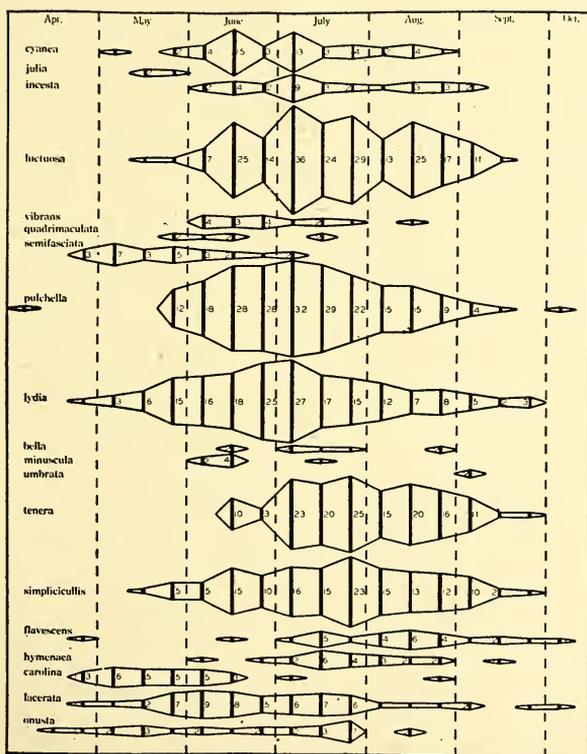


Fig. 2. The range of the flight season (or period of adult life) and the relative seasonal abundance of species of Libellulidae (genera *Libellula*, *Nannothemis*, *Erythrodiplax*, *Perithemis*, *Erythemis*, *Pantala*, and *Tramea*) in Indiana. Numbers near each bar indicate the number of collections of each species in each third of a month during the period of 1900 to 1940 inclusive; where no number is given the number of collections is one.

exception of *E. princeps*. This would seem to be in line with the more extensive range of the genus, although the individual species do not range over much greater areas than those of the other genera.

Epicordulia is a genus of two species and has a range almost duplicating that of *Didymops*, except that the non-Indiana species has a somewhat greater range through the Gulf states than that of *D. floridensis*. *E. princeps* is, by far, the most common cordulid in Indiana and is usually conspicuous, although not especially numerous, at any lake, gravel pit, or large pond throughout its season. Its abundance as compared with other species of the family is not adequately shown by the graphs. Species of *Macromia* and *Somatochlora* have been the objects of special search over the years, but *princeps*, a common species but very difficult to capture, has usually been disregarded in collecting.

Neurocordulia is a genus of four species which are found in the area from Louisiana and Missouri to the Atlantic coast. All of the species are quite rare.

Tetragoneuria is an American genus of 11 species and three subspecies or varieties, mostly eastern, although two are transcontinental, and one is probably confined to the central plains. Indiana appears to be at, or near, the southern limit of the range for two species, and all three Indiana species are spring and early summer forms. However, Indiana is near the the middle, or somewhat north of the middle, of the range of the third species, *cynosura*, and there are about as many southeastern as northeastern species in the genus.

Somatochlora is a large Holarctic genus, whose species range, for the most part, over territories of more northern latitude than Indiana. Walker (1925) recognized about 36 species—20 North American, 15 Eurasian, and one known from both hemispheres. Since 1925 three species have been described from each hemisphere. All of the species found in Indiana have been taken farther to the south, although some of their more southern range is in the mountains. Although *linearis* has been taken in August, and rather frequently in late July, the Indiana species may be called early season forms. One species, *hineana*, known only from the type series from Logan County, Ohio, has been included in the chart.

The distribution and the number of species (including subspecies) of each of the genera of Libellulidae represented in Indiana are given in the list below. The sequence is from primitive to specialized as indicated by Ris (1909-1918). While recognizing the limitations of a linear arrangement, Ris used this as the only practical method of showing evolutionary level, and divided the genera of Libellulidae into ten groups, although certain pairs of these were parallel Old and New World series. The Roman numerals in parenthesis following the subfamily names, indicating the groups, and the Arabic numerals before the generic names, indicating rank among the 120 libellulid genera, are indices of Ris' opinion of the relative evolutionary level of the several genera.

Libellulidae (II): 31.*Libellula*—33 species; Holarctic and Neotropical.

Palpopleurinae (III): 39.*Perithemis*—11 species; Neotropical (8) and Nearctic (4).

Brachydiplacinae (V): 51. *Nannothemis*—1 species; Nearctic.

Sympetrinae (VI): 65. *Erythrodiplax*—51 species; Neotropical (50). and Nearctic (5). 75. *Erythemis*—8 species; Neotropical (7) and Nearctic (2). 79. *Sympetrum*—about 60(?) species; chiefly Holarctic, but extending into bordering realms. 81. *Pachydiplax*—1 species; Nearctic.

Leucorrhiniinae (VII): 82. *Leucorrhinia*—17 species; Holarctic. 83: *Celithemis*—9 species; Nearctic and Cuba.

Trameinae (X): 108. *Pantala*—two species; cosmopolitan. 113. *Tramea*—11 species; cosmopolitan except Europe.

Although no close correlation between the seasonal range of the species in Indiana and their geographic range (or their evolutionary level) can be shown, certain tendencies and some individual cases of apparent correlation may be pointed out. Northern forms, for the most part, tend to occur, or to reach their maximum abundance, in Indiana, during the early season. More southern forms, those of wide range, or even more local species of genera with wide distribution, occur in mid-season, or have a long seasonal range. Any correlation between seasonal and geographic distribution is not causal *inter se*, but is due to a common effect of adaptiveness and activeness, both of which may have a close correlation with evolutionary level (Kennedy, 1928).

The evolutionary development of the species of *Libellula* has been studied by Kennedy (1922) who placed *semifasciata* as the most primitive, and *quadrimaculata* as the most specialized. *Semifasciata* has an early seasonal range in Indiana although the state is near the northern limit of its geographic distribution. *Quadrimaculata* also has a limited seasonal range in Indiana, but reaches its southern limit (outside of the mountains) here. *Julia* is very definitely northern in distribution and has a very short early seasonal range in Indiana.

The long seasonal ranges (although interrupted in some species) of the species of *Pantala* and *Tramea* is matched by the world wide distribution of these genera. *T. carolina*, evidently an early season form, in spite of two records in July and August, has the most limited geographic range of any species of these two genera.

The species of *Sympetrum* are the only late season forms among the Indiana representatives of the Libellulidae. Although Ris (1909-1918) placed this genus rather high in the evolutionary scale, Kennedy (1928) questioned this position. The genus is probably a complex group and may include several series of species of varying evolutionary development. Needham and Fisher (1936) have placed *corruptum* (and other species) in a separate genus, *Tarnetrum*. The pattern of the seasonal range of this species in Indiana is certainly different from that of the other species. It should be noted that *internum*, which was recorded from the state only once during the period of 1900 to 1940, was found to be abundant in Tippecanoe County in 1943 and 1944.

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