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THE DEER FLIES OF INDIANA
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The great majority of specimens, over 12,000 out of 13,185, which form the basis of this study, were collected by the writer during the flight season of the summer of 1963. These are on deposit in the Museum of the Department of Entomology, Purdue University, West Lafayette, Indiana. Other specimens in the collections of the Indiana Department of Natural Resources, Indianapolis, Indiana, of Purdue, and of Earlham College, Richmond, Indiana are incorporated herein. Most specimens in the latter museum were collected, some by the writer, during an earlier general insect survey of the Whitewater River watershed.

In the selection of collecting sites, a serious attempt was made to include areas of the state as diverse as possible, always with the availability of water breeding areas in mind. Thus, sites were chosen in a wide variety of situations with respect to vegetation, geology, and activities of man; and water conditions within them ranging in speed and quality from stagnant pools to swift, clear creeks, and in quantity from small drainage ditches to the Ohio River. Species distributions are presented here in the form of dot maps. Solid dots are centered over definite localities. Stars show undefined county records in counties for which no defined records exist. Specimens collected or seen before 1964 were tabulated in the original thesis (Burton, 1964), showing locality, date, number of specimens, sex, collector, and depository. Persons interested in these details may apply to the Purdue University Entomology Library for loan of the thesis. Other incorporated records, including those from the more recent Cummings material in the collection of the Indiana Department of Natural Resources, are listed in the files of Dr. L. L. Pechuman, Department of Entomology, Cornell University. Previously published records are not included, but specimens of all 17 species previously recorded from the state were collected during this study. Seven more species are reported herein for the first time from Indiana, and four more as yet unknown from the state but which may occur in it are included in the key and discussed briefly.

Deer flies are attracted to movement and prefer shaded situations such as pastured woods near breeding areas. The most efficient single method of collecting females was with the use of an aerial net swung constantly in a figure-8 pattern around the head while walking, with the collector serving as bait. Recent advances in mechanical trapping techniques for Tabanidae (Thompson, 1969) may also be helpful, but dry ice baited traps are clearly not as efficient in collecting *Chrysops* as in collecting *Tabanus* and allies (Wilson & Richardson, 1970).

The fact that only the female sex sucks blood explains why males are so poorly represented in museum collections. Dry ice baited traps do nothing to alter this imbalance in representation. Males generally live on plant juices, and "wild" (unreared) specimens usually must be sought through sweeping vegetation and Malaise-type trapping.

Teskey (1969:113) found that larvae of "...most *Chrysops* spp. were more prominent on the margins of streams or ponds in a substratum containing a moderate to high amount of mineral soil ingredients. Members of the Tabaninae were, on the other hand, collected more frequently in swamps and marshes away from running water." I made no attempt to recover larvae during this study. Although the adults are strong fliers

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and may be encountered in a wide variety of situations, it is clearly most efficient to seek them in areas adjacent to the breeding sites.

TABANID INCIDENCE IN INDIANA

Indiana is well characterized in the state's sesquicentennial volume, "Natural Features of Indiana" (Lindsey, 1966). This book is highly recommended, and would be of interest to anyone whose involvement with natural history includes this state. Of the greatest concern here are the chapters on "Physiography" by Schneider, "Climate" by Schaal, and the "Origin and Composition of the Insect Fauna" by Chandler. A chapter on the state's natural divisions and a wealth of information on specific areas was published in a companion volume (Lindsey, Schmelz & Nichols, 1969). In view of the accessibility of these sources, I shall limit comment here to those features which have a direct bearing on tabanid incidence.

The overall mean annual rainfall for the state is 100 cm. Until the beginning of this century, a great deal of northern Indiana existed in a boggy or marshy condition. The area was then drained by ditches and converted to agricultural use. Numerous lakes and ponds almost entirely of glacial origin remain, especially in the northeast, and the marshy margins of these basins are so suitable for tabanid breeding that the northern area is clearly the most heavily populated with these flies.

The greatest number of species at a single locality occurred in the vicinity of the great marsh at Jasper-Pulaski State Game Farm and Preserve. This state-owned parcel, divided by the Jasper-Pulaski County line, yielded ten species on each of two consecutive days in July, and an eleventh species on a later date, for a total representation of 46 per cent of the state's known species. Some other species are also expected to occur there. A good series of *Chrysops pudicus*, one of the few Indiana deer fly species for which the immature stages remain undescribed, were obtained there without difficulty. This locality would also have been the leader in numbers of specimens per day if it had not been exceeded by an eastern LaPorte County locality (Mill Creek), where the *vittatus* population was overwhelming. Nine species were taken in a few days at this latter locality. For the several localities where great numbers of species were taken, one species sometimes predominated (e.g., *vittatus* above, and *univittatus* at the Daviess County locality in the southwest), but the Jasper-Pulaski locality had several dominants. Polluted northwestern industrial areas, such as the vicinity of the Calumet River, showed very little deer fly activity.

Central Indiana is covered with the Tipton till plain, a Wisconsin glacial ground moraine, characteristically flat and hence not very well drained. However, wet spots, other than the banks of watercourses, are commonly only temporary in nature and insufficient for larval development, since Indiana tabanids are believed to have only one generation per year. Thus, this area tends to have relatively modest tabanid population densities. The unglaciated portion of south central Indiana has the most rugged topography in the state, and is more deeply dissected by erosion. Creeks often flow over bedrock. A large part of it is underlain by limestone and displays karst topography. The south is well drained owing to the combination of added relief overall and porous substrate in some areas, so natural breeding sites are relatively few and tabanid populations are correspondingly low. However, the margins of numerous manmade farm ponds in many areas provide suitable, though limited, sites.

Total altitudinal range for the state is from 95 meters in the southwest corner to 382 meters at a point in Wayne County. This small range is seen as insignificant to tabanid incidence, i. e. it is not in itself believed to be a factor influencing the geographic distribution of species within the state, with the possible exception of *Chrysops reicherti*. However, the span of almost exactly 4° latitude does contribute to some of the difference in species composition between north and south (see under "Total Geographic Ranges of Species", below).

Hays (1956), in commenting on the geographic groups represented by the Michigan tabanid fauna, noted that they do not conform to any accepted life zones or biotic provinces. The Indiana deer fly fauna at first glance appears to lend some support to the

Life Zone concept as recognized by Blatchley (1909) or Deam (1925), because many of the species appear to fall into one or another of their zones. I believe it is a question of more localized habitat factors and not of true Life Zones. For example, almost all of the extensive northern marshland falls in Deam's Transition Zone, and the Tipton till plain, characterized above, is roughly coincident with the Upper Austral Zone.

Siverly (1972:9-12) has given an interesting review of the natural divisions of Indiana with special reference to the mosquito fauna.

Indiana's tabanid fauna is not one of the richest in terms of numbers of species since it lacks some of the specialized habitats of some other northeastern or north central states (e.g., salt marshes, higher altitudes, boreal forests). The 28 species (24 known and four likely) of deer flies considered herein contrast with 35 reported by Hays (1956) from Michigan and 41 reported by Pechuman (1972) from New York.

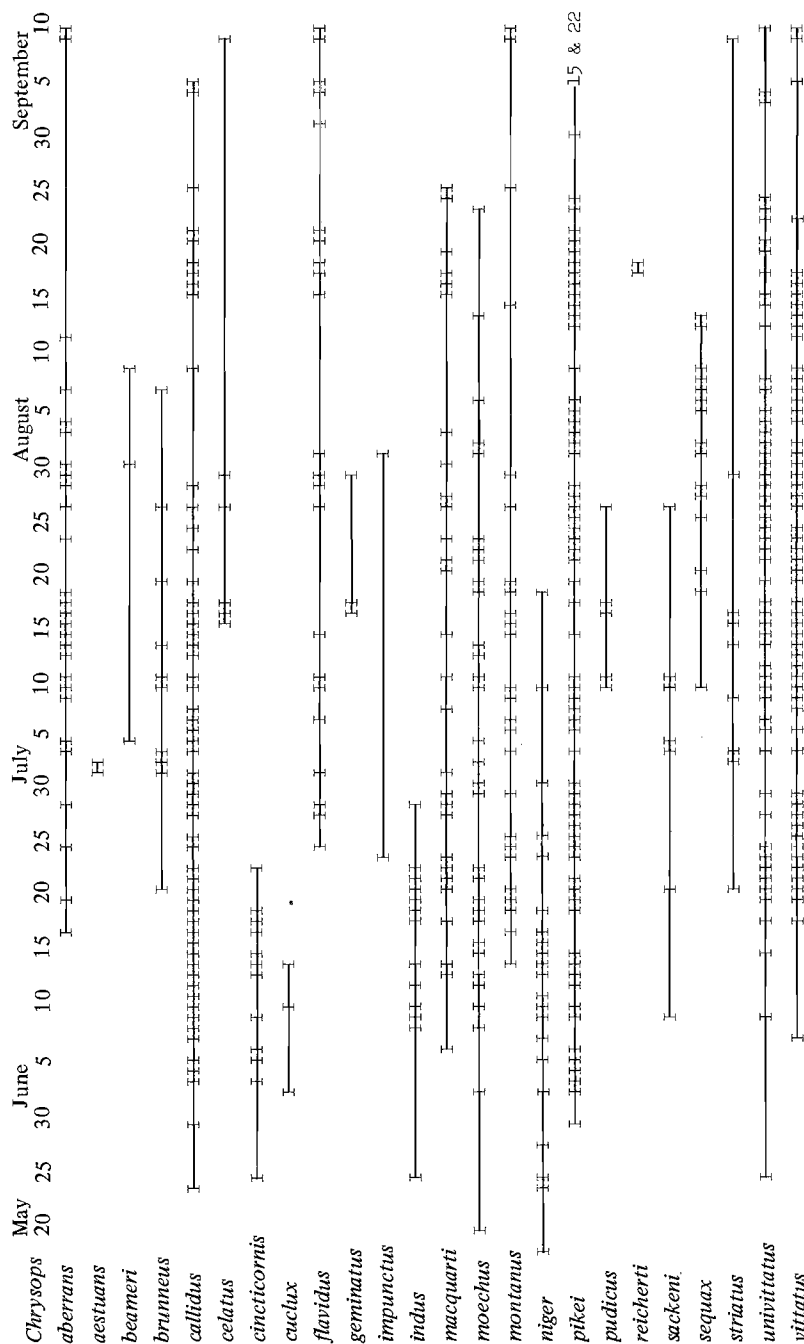
An ample quantity of domestic bovines and equines, and a limited number of white-tailed deer, are present throughout the state to support the blood sucking habit of female tabanids. Even if this were not the case, in recent years it has been shown (Anderson, 1971) that some species, and quite possibly it may someday be found that even the majority of species, are capable of surviving indefinitely without the benefit of a vertebrate blood meal, because the protein food which a given tabanid is able to acquire in the larval stage suffices to see the adult through the production of one batch of viable eggs. Thus, at least a low population density of these flies may potentially be present every summer. In any case, physiography and climate rather than food supply are seen as the major limiting factors.

ECONOMIC IMPORTANCE

Deer flies, *Chrysops*, are well known as nuisances of man. During the summer months, anyone who ventures near the larval breeding sites is likely to be attacked. By contrast, horse flies, *Tabanus* and allies, are larger, generally drabber, and local species only infrequently attempt to suck human blood, although they may alight on humans. The principal importance of tabanids is clearly the harassment and blood sucking activity by all major genera on domestic livestock, resulting in serious meat and milk losses where flies are numerous; and the annoyance to man by *Chrysops*. Tabanids and other flies on livestock may be partially though only temporarily controlled by the application of preparations containing pyrethrins. Humans may or may not obtain relief with commercial repellents. Tularemia, "rabbit fever," may be mechanically transmitted to man by deer flies, though such transmission is probably very rare, and human cases of this disease are probably almost always the result of direct handling of an infected vertebrate. Tabanids have been proven experimentally to transmit equine infectious anemia, and are suspected of being efficient mechanical vectors of this virus disease. Seriousness of symptoms and per cent fatality are highly variable from one outbreak to another. Of the 617 Indiana horses tested for one reason or another at Purdue from July 1971 to June 1972, 11 were found positive (Dr. M. Kemen, Cornell University, personal communication). Elsewhere in the United States and abroad, tabanids have been shown to transmit a variety of protozoan, filarial, viral, bacillary and rickettsial diseases to animals and man by both mechanical and biological modes. Reviews of these diseases may be found in many references (e.g., James & Harwood, 1969). Recent work by Tidwell et al. (1972) in North Carolina has added hog cholera to the list. Hogs are not one of the preferred hosts of tabanids, but the importance of the swine industry to Indiana may make this research significant for the state. Several North American workers have estimated the amount of blood loss sustained by livestock as a result of tabanid attacks, and the results are reviewed by Anthony (1962:93-94). Wounds inflicted by tabanid feeding can become sites of secondary infection.

SEASONAL DISTRIBUTION

Figure 1 indicates seasonal distribution of all Indiana deer flies. The horizontal lines show total known season statewide; vertical lines show daily collecting records as taken

Fig. 1. Known seasonal distribution of Indiana *Chrysops* species, showing consolidated daily records.

from specimen labels seen from all sources. Seasonal extremes for many or most species will in time be extended, for as they are now known they may reflect collecting efforts more than natural realities. A more accurate picture can be gained by sampling selected single localities throughout the adult season. Figure 1 does give a general indication of season, and displays some results which were predictable on the basis of what is known about incidence of some species elsewhere. For example, the black species which lack an apical infuscation (*cincticornis*, *cuclux*, *niger*) as well as *indus* were all known from earlier studies to have generally northern ranges and a corresponding tendency to begin and end their season earlier than most species. This is reconfirmed.

ABUNDANCE AND RARITY

No attempt was made to formally quantify populations. However, some good evidence about the relative abundance of species can be obtained from a combination of factors: (1) The total numbers of specimens reported herein under each species range from three (*aestuans*, *impunctus*, *reicherti*) to nearly 6,000 (*vittatus*). The species can be measured against these extremes, with the understanding that the result is only a statewide indication and may bear very little relationship to the situation at any given locality. (2) Those species which were collected on many different days over a long season are considered the most common (Fig. 1). (3) In general, those species with the widest distributions in the state (see maps) also tend to be the most common.

It should be explained here that the distribution maps reveal a sampling bias. The productivity of the northern counties made them attractive to sample more intensively, and, with the R. B. Cummings material added, there is no doubt that the north is the best sampled part of the state. Earlham College's collecting efforts have been concentrated in the southeast (Wayne County and south), and will partly explain the heavy representation of some species from that area. The southwestern quarter has not been so intensively sampled.

TOTAL GEOGRAPHIC RANGES OF SPECIES

The overall geographic ranges of most species were taken from Philip (1965) and sometimes supplemented by more recent references. Indiana's position may thereby be viewed in the perspective of the total range of each of the members of its fauna. In some cases, Indiana is believed to form part of the range limit of a species. No species is restricted to Indiana, and indeed none but *C. luteopennis* Philip (not an Indiana species) is restricted to the area of the Great Lakes states or provinces, though a few are characteristically midwestern. Distributions of some species generally coincide with broad patterns which recur frequently throughout terrestrial Nearctic Biota, and these can be categorized as having "geographic affinities". Thus, "northern species" are generally transcontinental, and commonly do not dip very far south in the United States except along major mountain ranges. "Northeastern species" occur in the area east of the 100th meridian and mostly north of about 40°N latitude except along the Appalachian chain. "Eastern species" are usually widely distributed throughout the United States and southern Canada east of the 100th meridian. "East coastal" species are characteristic of the Atlantic and Gulf coasts, but may extend inland to the Great Lakes at their latitude, and up the lower Mississippi Valley. The majority of species considered herein clearly fall into the "eastern" category, and, if their distribution within Indiana is limited, it is the result of habitat factors and not major climatic barriers. For most of the remaining species, the state probably forms part of the range limit.

WATER MOVEMENT

The dichotomy between standing and flowing water is important to deer fly breeding. The lotic environment, as defined by Welch (1952), includes all forms of inland waters in which the entire body of water moves continuously in a definite direction, i.e., the brook-creek-river series. The lentic environment includes all forms of inland water in which the water motion is not that of a continuous flow in a definite direction, or the

lake-pond-swamp or marsh series. My collecting localities for each *Chrysops* species were examined, and, if a pattern of predomination by running or standing water was evident, the species has been scored as lotic or lentic, respectively. Some species were taken about as readily at both types. Of course the running and standing water series intergrade, and in any case fidelity of a species to one of the types is generally a matter of degree. As regards this dichotomy, I have, wherever appropriate, compared the larval findings of Teskey (1969), and occasionally Philip (1931) and Stone (1930), with the present adult material. Teskey's work was undertaken mostly in Ontario and upstate New York, none in Indiana; but larval habitats for any given species can be expected to correspond.

EXTENSIONS OF RANGE

Some species may now be in the process of range extension. It is reasonable to guess that species which are primarily coastal (e.g., *pudicus*) have relatively recently expanded their range into the Great Lakes region through such favorable routes as the Mohawk Valley in central New York, or the Mississippi Valley, finding favorable breeding conditions in the marshlands of the region. Another theory holds that such populations are relicts of a former, post-glacial, much more generalized inland distribution; though in the case of *pudicus* it is difficult to imagine why it was able to maintain itself in only the two known Indiana localities and not elsewhere in the state. Some other species appear to be indigenous to this area, and are presently moving outward. Pechuman (1957a:28) noted of *pikei* . . . "This is a midwestern form which is expanding its range eastward. It is now found in western New York and probably is present in a number of localities in southern Ontario." Even since that writing, he has observed its eastward progress in the western counties of New York (personal communication).

Another more local form of range expansion is now expected and at this writing may already have taken place to some extent. The recent dam-building activity in Indiana will in all probability enable lentic habitat species to populate the Tipton till plain by breeding at the margins of new reservoirs. Various changes in local species composition may be expected to occur at all such sites.

INTERSPECIFIC COMPETITION

It has already been said that availability of vertebrate hosts for female tabanid blood feeding activity is not considered to be a major limiting factor in Indiana as far as species distribution is concerned, though it may influence population densities. The adults of different species do not appear to be in direct competition for a food supply. Host specificity seems minimal, though in this regard it is curious that horse flies, *Tabanus* and allies, tend to reject man while *Chrysops* attacks aggressively. The same vertebrate hosts are of course available to the adults throughout their season of activity. Frost & Pechuman (1958) noted the attacks of 15 species of *Chrysops*, all of which were observed on man, while nine of them were also seen on cattle, and six on horses and mules in addition to man and cattle.

Some species may utilize "unusual" hosts in addition to livestock and deer, e.g., DeGiusti, Sterling & Dobrzecowski (1973) have done research on *Chrysops callidus* biting turtles in southeastern Michigan.

However, competition is surely reduced as a result of other factors. One of these is seasonal variation in adult species composition. This was observed to some extent during this study (Fig. 1), but is more striking in the presentations of workers elsewhere who have studied the question on a quantitative, local basis. Various larval requirements (e.g., the lotic vs. lentic dichotomy) may also reduce interspecific competition among larvae and adults as well, as adult *Chrysops* probably do not normally stray very far from the site of development and subsequent oviposition.

SOME PERTINENT REFERENCES

Osten Sacken's works (1875, 1876) were really the starting point of tabanid taxonomy in this country, and seven of the *Chrysops* species now known from or

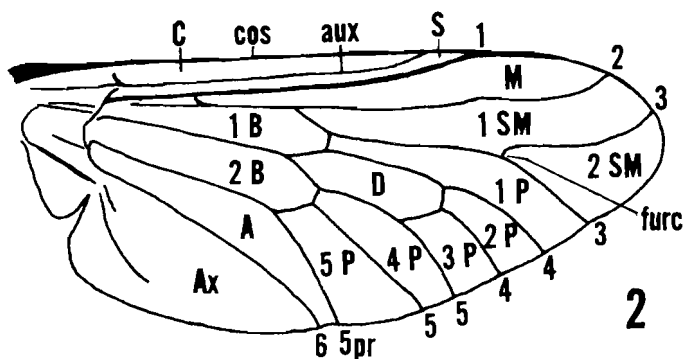


Fig. 2. *Chrysops* wing vein and cell terminology. A-anal cell; aux-auxiliary vein; Ax-axillary cell; B-basal cells (1st and 2nd); C-costal cell; cos-costal vein; D-discal cell; furc-furcation of 3rd vein; M-marginal cell; P-posterior cells (1st to 5th); S-subcostal cell; SM-submarginal cells (1st and 2nd). Longitudinal veins identified by number where they reach wing margin (5pr-proximal branch of 5th vein).

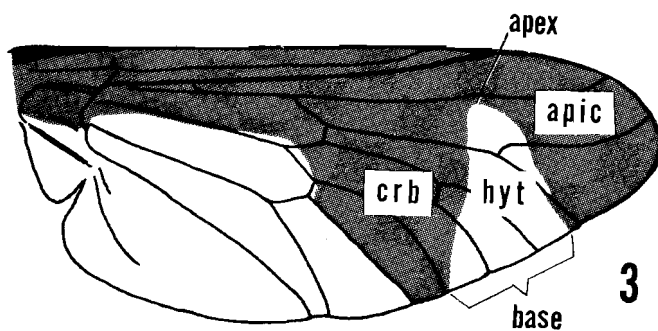


Fig. 3. *Chrysops* wing infuscation terminology. Apex-apex of hyaline triangle; apic-apical infuscation; base-base of hyaline triangle; crb-crossband; hyt-hyaline triangle.

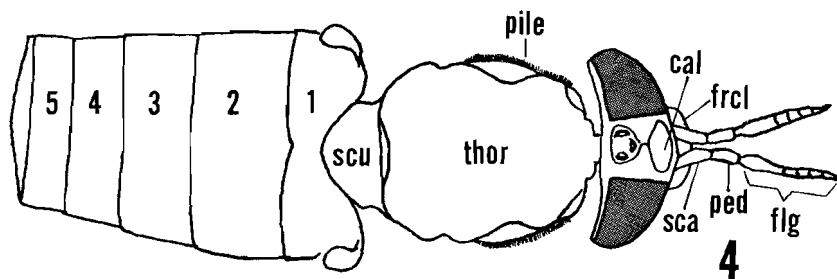


Fig. 4. Dorsal aspect of *Chrysops* head, thorax, and abdomen, showing some key terminology. Cal-frontal callus; flg-flagellum; frcl-frontoclypeus; ped-pedicel; pile-pile of pleuron; sca-scape; scu-scutellum; thor-thorax; first five abdominal tergites numbered.

expected to occur in Indiana were originally described in Part I (1875). He subsequently published a catalog (1878) covering the known North American species of all Diptera. Most recently, the Nearctic tabanid cataloging chores have been in the hands of Philip (1947 and sequel 1950; 1965). The 1965 version updated, but did not replace, the 1947 version. The earlier work is a true catalog containing thorough reference lists for each taxon, names which were published as lapses, indications of reconstituted species, depositories of type specimens, and much other useful information. World lists have also been compiled. The most recent covering *Chrysops* is by Moucha (1969). There have been two full revisions of North American *Chrysops*. The first was by Kröber (1926), and, although thorough, had the relative disadvantages for the North American public of being somewhat inaccessible and was written in the German language. This was rather quickly superceded by Brennan (1935), and his work remains a good base-line reference today. Philip (1955) published a key to the North American species, and a taxonomic discussion of some of them. Mackerras (1954, 1955a, 1955b) has provided a worldwide zoogeographic view of Tabanidae as well as generic and supergeneric positioning within the family. Teskey (1969) has published a fine treatise on the known larvae and pupae of eastern North American Tabanidae, including 18 of the species of *Chrysops* which are known to occur in Indiana.

Faunistic surveys of the adult Tabanidae of many politically defined areas of North America have been published since the turn of the century. Those written on the states and provinces which adjoin the Great Lakes are: Philip (1931) for Minnesota; Roberts & Dicke (1958) for Wisconsin; Hays (1956) for Michigan; Hine (1903) for Ohio; Frost & Pechuman (1958) for Pennsylvania; Pechuman (1957b, 1972) for New York, and Pechuman, Teskey & Davies (1961) for Ontario. There have been a number of smaller papers detailing localized faunas in some of these areas, but Indiana has heretofore received no concentrated attention. An indication of this lack of attention during the early period is the fact that no species of *Chrysops* has its type locality in Indiana. Townsend (1955) has published a short list of Kentucky records.

Genus *CHRYSOPS* Meigen, 1803

Indiana *Chrysops* can be distinguished from other genera of Tabanidae in the state by a combination of: two apical spurs on hind tibiae, and an antennal flagellum (=third segment) with five annuli. All of the state's species have a distinctly infuscated pattern on the wing, though it is weaker in *cuclux*. The two compound eyes are widely separated in the female, contiguous in the male. In all but one species the male is very similar in general appearance to the female. In *moechus* the sexes are highly divergent in coloration.

Characters of individual species are not figured here, but in view of the importance of the wing infuscation pattern to correct identification of *Chrysops*, a number of authors have illustrated them. Especially recommended is Pechuman (1972), which contains high quality photographs of the wings of every species considered herein except for *impunctus*, *reicherti*, and *sequax*.

Synonymies and original reference citations are omitted from the species accounts, as these are almost all available from the Philip catalogs.

KEY TO FEMALES OF INDIANA *CHRYSOPS*

- | | | |
|--------|---|---------------------|
| 1. | Wing beyond crossband hyaline | 2 |
| 1'. | Wing with apical infuscation | 5 |
| 2(1). | Pile of pleurae bright orange | <i>cincticornis</i> |
| 2'. | Pile of pleurae grayish to whitish | 3 |
| 3(2'). | Dull yellow lateral spots present on second tergite | <i>cuclux</i> |
| 3'. | Abdomen all black | 4 |
| 4(3'). | Second basal cell hyaline; frontoclypeus yellow in middle | <i>niger</i> |
| 4'. | Second basal cell partly infuscated; frontoclypeus black with median pollinose stripe | <i>carbonarius</i> |

- 5(1'). Apical infuscation narrow, concentrated along costal vein, entering second submarginal cell only narrowly 6
- 5'. Apical infuscation wider, either at least half filling second submarginal cell, or crossing upper branch of third vein over more than half its distance 14
- 6(5). Blackish species with a mid-dorsal yellow abdominal stripe and sometimes with shorter stripes on each side *univittatus*
- 6'. Abdomen with a different pattern and showing more yellow or brown 7
- 7(6'). Scutellum at least partly brown (not entirely gray to black); stripes on thoracic dorsum usually alternating light (brownish yellow) and dark brown 8
- 7'. Scutellum gray to black, or occasionally brown; stripes on thoracic dorsum usually alternating bluish gray and black 10
- 8(7,16). Scape of antenna swollen; dorsum of abdomen deep brown with little contrast between basal and apical tergites; wing beyond crossband tinted brownish except for a narrow subhyaline band along outer margin of crossband *brunneus*
- 8'. Scape not distinctly swollen; first tergite and base of second tergite much paler than most of area of remaining tergites 9
- 9(8'). Outer margin of wing crossband not convex; full latitude range in Indiana (occasional *celatus*: see diagnosis) *flavidus*
- 9'. Outer margin of wing crossband at least slightly convex; first tergite and broad base of second tergite unusually pale and translucent; SW Indiana only. . . . *reicherti*
- 10(7'). Darker pattern of abdominal tergites brown *celatus*
- 10'. Darker pattern of abdominal tergites black 11
- 11(10'). Black figure of second tergite clearly separated from dark area of first tergite; infuscation of fifth posterior cell tightly confined along proximal branch of fifth vein *pudicus*
- 11'. Black figures of first and second tergites joined or only very narrowly separated; infuscation of fifth posterior cell usually more extensive than above, especially near base of cell 12
- 12(11'). Apical infuscation just beyond the point at which it leaves the crossband slightly wider than marginal cell; frontal callus almost as high as wide, often yellow bordered with black or brown, occasionally black *sackeni*
- 12'. Apical infuscation at base no wider than marginal cell; frontal callus black and usually considerably wider than high 13
- 13(12'). Apical infuscation of same density as crossband; pale markings of abdomen yellow and often quite bright; second tergite may or may not have a black marking on each side of the median dark marking, but it is not distinctly in the form of a triangle *callidus*
- 13'. Apical infuscation paler than crossband; pale markings of abdomen usually grayish or dull yellow; second tergite with a distinct black triangle on each side of the median dark marking *aestuans*
- 14(5'). Frontoclypeus bare, lacking median pollinose stripe 15
- 14'. Frontoclypeus with median pollinose stripe or projection below antennae . . 30
- 15(14). Abdominal pattern indistinct, tan to brown 16
- 15'. Abdominal pattern distinct, black and yellow. 17
- 16(15). Frontal callus yellow to dark brown 8
- 16'. Frontal callus black *dacne*
- 17(15'). First basal cell more than half hyaline 18
- 17'. First basal cell entirely or almost entirely infuscated 22
- 18(17). Blackish species with first and second tergites usually showing more black than yellow; black on second tergite not in the form of an inverted V. *univittatus*
- 18'. First and second tergites show more yellow than black; second tergite often with a black inverted V 19
- 19(18'). Hyaline triangle rises above second vein and is crescent shaped with a narrow base; small species 20

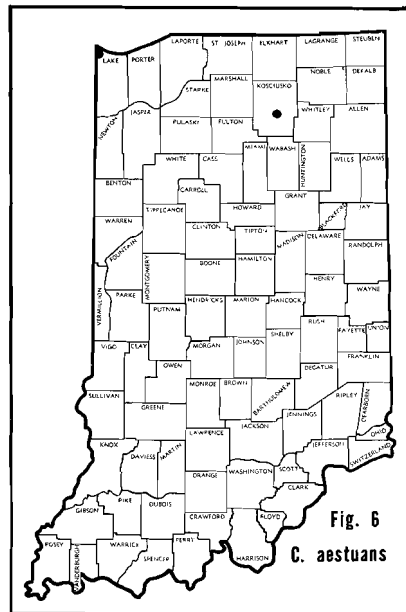
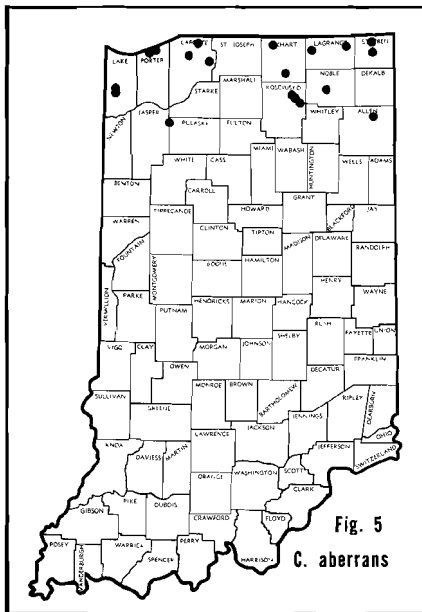
- 19'. Hyaline triangle may rise to, but not above, second vein, and is relatively broad at base compared to height 21
- 20(19). Second tergite with two diagonal black lines which converge anteriorly, and may be joined through a round central dot *geminatus*
- 20'. Second tergite yellow, lacking black markings *impunctus*
- 21(19'). Dorsum of abdomen beyond second tergite a spotted pattern of black and yellow *montanus*
- 21'. Dorsum of abdomen beyond second tergite black except for yellow median triangles and lateral and posterior margins of tergites *dimmocki*
- 22(17'). Hyaline triangle confined to second and third posterior cells *moechus*
- 22'. Hyaline triangle more extensive than above 23
- 23(22'). Dorsum of abdomen with four dark stripes on yellow ground color, though extent of the stripes may be quite variable, the lateral ones usually tending to be reduced 24
- 23'. Dorsum of abdomen otherwise marked 29
- 24(23). Hyaline triangle appears narrow, its total height greater than its width at the base; its apex at least closely approaches second vein 25
- 24'. Hyaline triangle appears relatively broad at base as compared to its height, its apex not closely approaching or crossing second vein 27
- 25(24). Dark lateral abdominal stripes lacking on first and second tergites; apex of hyaline triangle appears rounded *pikei*
- 25'. Dark lateral abdominal stripes complete on first and/or second tergites . . . 26
- 26(25'). Frontal callus usually dark; small vertical plate at upper lateral margins of frontoclypeus darkened or black *sequax*
- 26'. Frontal callus yellow; small vertical plate at upper lateral margins of frontoclypeus yellow *beameri*
- 27(24'). Scutellum entirely yellow; yellow stripes present on thorax; frontal callus always yellow *vittatus*
- 27'. Scutellum at least anteriorly blue-gray or black; stripes on thorax blue-gray; frontal callus variable, yellow to black 28
- 28(27'). Apex of hyaline triangle barely rises above furcation; apical infuscation nearly fills second submarginal cell *aberrans*
- 28'. Apex of hyaline triangle reaches noticeably forward of furcation; apical infuscation only about half fills second submarginal cell; two black central abdominal stripes usually join on second tergite *striatus*
- 29(23'). Apical infuscation extends below posterior branch of third vein . . . *macquarti*
- 29'. Apical infuscation does not extend below posterior branch of third vein . . *indus*
- 30(14'). Abdominal pattern in form of black and yellow stripes; frontoclypeus yellow. *sequax*
- 30'. Abdominal pattern not in form of longitudinal stripes; frontoclypeus black *frigidus*

SPECIES ACCOUNTS

Chrysops aberrans Philip, 1941. (Fig. 5). Hyaline triangle barely rises above furcation of third vein; second submarginal cell almost entirely infuscated. Owing to light apical infuscation in some specimens, these criteria may not appear to be satisfied except by close examination. Frontal callus variable, usually mostly yellow. Thorax with alternating blue-gray and black stripes; scutellum anteriorly blue-gray even if posterior margin is yellow. Yellow abdomen with four black stripes.

C. striatus is very similar in appearance to this species, but the hyaline triangle of *striatus* rises farther and the posterior margin of the second submarginal cell is not infuscated. In *aberrans*, the black, central abdominal stripes rarely join on the second tergite, and the frontal callus is usually yellow. The black stripes of *striatus* usually join on the second segment, and the frontal callus is usually black.

C. aberrans was taken from 17 June to 10 September, with a population peak in July. Fairly large numbers were collected at several sites, up to 242 in a day at



Jasper-Pulaski Game Preserve. Its distribution in Indiana seems clearly limited to the northern part, and it was not taken south of the three northern tiers of counties. The total range is Minnesota to New Brunswick and south to Kansas and New Jersey (Philip, 1965), and is thus a northeastern species with Indiana forming part of its southern range limit. Adult collecting sites were characteristically lentic, and this agrees with the larval findings of Teskey (1969).

Indiana specimens examined: 1084.

Chrysops aestuans van der Wulp, 1867. (Fig. 6). Apical infuscation paler (more dilute) than crossband, and is very narrow, not exceeding width of marginal cell, and entering second submarginal cell only slightly. Thoracic dorsum usually with alternating blue-gray and black stripes; scutellum black or nearly so. Abdominal dorsum predominantly black, but with row of pale yellow or grayish middorsal triangles; first and second tergites with large yellow area laterally, a distinct black triangle present on each side of median dark marking of second tergite.

This species is very similar to *callidus*; but in the latter, the apical infuscation has the same density as the crossband, the yellow markings of the abdomen are usually brighter, and if a black marking is present on each side of the median dark marking, it may assume various shapes, but is not distinctly in the form of a triangle.

Only two specimens were collected by me, on 2 and 3 July at Wolf Lake, just north of Hammond and within the city complex of far northwestern Indiana. A third specimen is present in the Department of Natural Resources collection, from Winona Lake, August 1901. Brennan (1935) reported two collections from Indiana on 9 July. The Wolf Lake (Hammond) locality was a lake-marginal marsh with an almost pure stand of cattail, and the name of the other known locality suggests that it too was a lentic environment. This agrees with the larval findings of Teskey (1969). The total range of *aestuans* is Alaska to Nova Scotia and south to California, Oklahoma, and Pennsylvania (Philip, 1965), i.e., a northern species. Thus the fact that the Indiana records are northern is in agreement with this pattern, and the state might reasonably be expected to lie on the southern range limit. However, Townsend (1955) has listed two Kentucky records. These would seem to need reconfirmation.

Indiana specimens examined: 3.

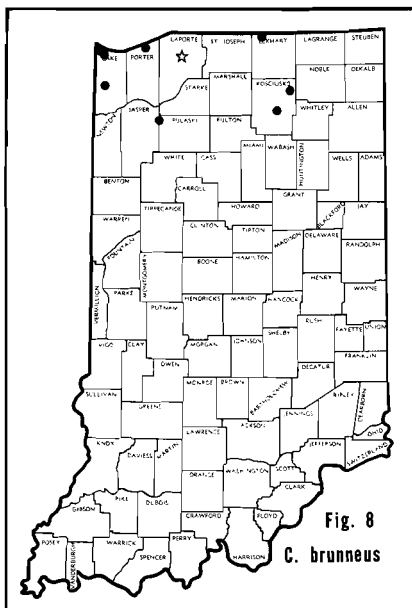
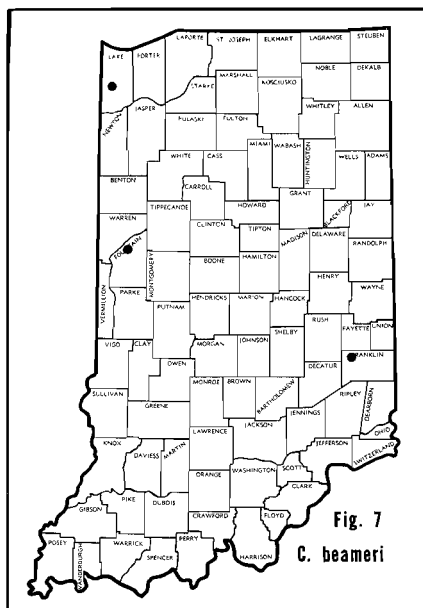
Chrysops beameri Brennan, 1935. (Fig. 7). Hyaline triangle appears narrow, its total height greater than its width at base, its apex approaches or crosses second vein; first basal cell infuscated. Majority of facial structures yellow, including most or all of frontal callus and hemi-elliptical plate at upper lateral margins of frontoclypeus. Stripes on thoracic dorsum with alternating yellow- to blue-gray and black stripes; scutellum at least anteriorly blue-gray. Yellow abdominal dorsum with four dark stripes, the lateral pair present in some degree on first and second segments, even if much reduced.

This species is strikingly similar to *sequax*, but the latter usually has the frontal callus and the marginal frontoclypeal plates darkened or black. In view of the fact that these are easily confused, I have asked Dr. Pechuman to recheck the specimens collected by me (three specimens from Fountain and Lake Counties). In reply (personal communication), he noted that they "should be described as keying out to *beameri*, and therefore best included in this species, but possessing unusual characteristics." Various authors have also noted the difficulty in separating *beameri* from *hinei* Daecke in Atlantic and Gulf coast states (not an Indiana species).

This is the first report of *beameri* from the state. It was taken at three disjunct localities from 5 July to 9 August. The Lake County (Cedar Lake S) collection was made within and adjoining an extensive cattail marsh, but the Fountain and Franklin County specimens were taken at creek habitats in areas that were topographically more dissected. Thus it appears that both lotic and lentic environments are satisfactory. There is no larval substantiation data, as apparently the larva remains unknown.

In addition to the striking similarity between adult females of *beameri* and *sequax*, it is notable that both were taken in the same collection at the Fountain County (Rob Roy) site, and the *beameri* specimen from Franklin County (Laurel W) was taken within 19 kilometers of, and in circumstances ecologically similar to, two *sequax* sites. The type locality of *beameri* is in south central Kansas, and the reported distribution extends east to Massachusetts and Florida and south to Louisiana, but some of these records may have been generated by misinterpretations.

Indiana specimens examined: 4.



Chrysops brunneus Hine, 1903. (Fig. 8). Apical infuscation along anterior margin of wing of same density as crossband, but remainder of area beyond crossband covered with lighter infuscation; narrow area immediately adjacent to distal margin of crossband very pale. Scape and pedicel of antenna distinctly swollen; frontal callus yellow to brown. Abdomen almost uniformly brown, but sometimes with traces of lighter middorsal triangles or a stripe. Thoracic dorsum striped with alternating light and dark brown; scutellum at least partly brown.

This species is a member of the *flavidus* group, and workers in Atlantic and Gulf coast states have noted its convergence with species in these areas (e.g., see discussion under *atlanticus* Pechuman by Tidwell (1973)). But in Indiana *brunneus* is distinct and can be distinguished from other members of the group by its swollen antennal scape and brownish tinted apical area of the wing.

C. brunneus was taken from 21 June to 7 August, always in small numbers. Up to 13 were taken in a day at a lake-marginal marsh just north of Hammond in the northwestern city complex of Lake County. The localities were lentic, and I feel that this apparent requirement or preference explains why it was taken only in the northern counties, as marshes are not so extensively developed elsewhere in the state. There is no larval data available for confirmation, but adult records are concentrated along and near the shores of bodies of water including the lower Great Lakes and in the lowland marshes of the Atlantic and Gulf coastal plains from New Jersey to Texas.

Indiana specimens examined: 50.

Chrysops callidus Osten Sacken, 1875. (Fig. 9). Apical infuscation very narrow, but of same density as crossband. Just beyond point at which it leaves crossband, it varies from one half to full width of marginal cell, but does not exceed width of that cell, and enters second submarginal cell only slightly at costal vein. Frontal callus black and usually considerably wider than high. Thoracic dorsum with alternating blue-gray and black stripes; scutellum black. Abdomen black and yellow, with yellow as follows: large area on sides of first and second tergites, middorsal triangles on second, third, and fourth tergites, which do not form a stripe, and narrow bands along posterior margins of tergites; second tergite may or may not have black marking at or extending laterally from median dark marking, but if present, it is not distinctly triangular.

This species is distinguished from *sackeni* in having the apical infuscation as it leaves the cross band confined within the marginal cell; and by the black, vertically more compressed frontal callus. From *aestuans*, *callidus* is distinguished by the nondilute condition of the apical infuscation, the more brilliant yellow markings on the abdomen, and by the lack of distinct black triangles laterally on the second tergite.

C. callidus was taken from 24 May to 5 September, and is clearly one of the more widely distributed species in the state. As many as 194 specimens were taken in a day (at Jasper-Pulaski Game Preserve), but commonly the number of individuals per locality was not large. Differences in collecting localities indicate a considerable range of ecological tolerance for this species. Teskey (1969) found the larvae in both pond margins and slow-flowing stream banks. The breadth of the overall range is also an indication of tolerance: British Columbia to Maine and south to Texas and Florida (Philip, 1965). The species has been found feeding on turtles in Michigan (DeGiusti, Sterling & Dobrzecowski, 1973) and in Louisiana (Tidwell, 1973).

Indiana specimens examined: 756.

Chrysops carbonarius Walker, 1848. Wing beyond crossband has no more than a trace of infuscation, and may be considered hyaline; second basal cell infuscated over basal half. Frontoclypeus with median pollinose stripe. Frontal callus, frontoclypeus, thorax except for a trace of blue-gray central stripes, scutellum and abdomen black. Pile of pleurae grayish to whitish.

This species has not yet been found in Indiana. Though its occurrence at least in the northern part of the state (and early in the season) is considered likely. Hays (1956) reported a widespread distribution in Michigan, including Berrien and Branch

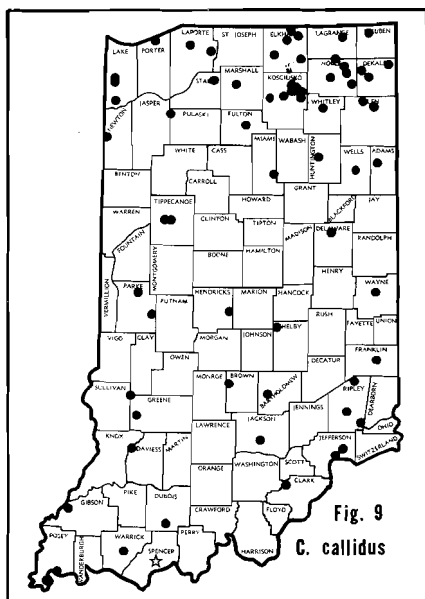


Fig. 9

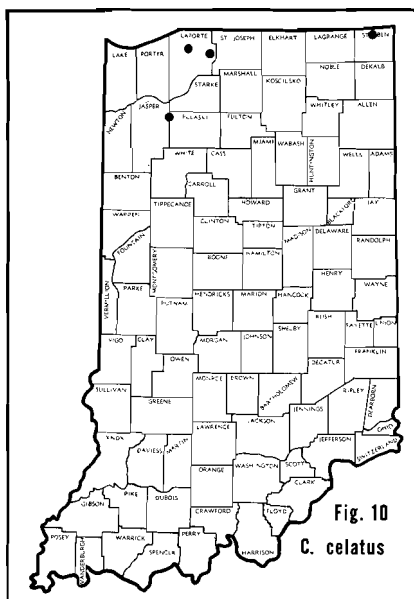
C. callidus

Fig. 10

C. celatus

Counties which adjoin Indiana. This is principally a northern species, but with occasional records dipping all the way down into the southern states including Louisiana and Florida.

Chrysops celatus Pechuman, 1949. (Fig. 10). A member of the *flavidus* complex, and very much like *flavidus*, which see. The thoracic dorsum (mesonotum) in *celatus* usually has alternating blackish brown and bluish gray stripes, while in *flavidus* and *reicherti* the stripes are alternating brown and brownish yellow. (An occasional *celatus* may also have the thorax brown and yellow striped, in which case the separation becomes a very subjective question of the intensity of the striping.) The scutellum of *celatus* is highly variable from orange to mostly blackened, but in most specimens at least the basal corners are darkened. The outer margin of the crossband is more uneven than in *flavidus*.

This is the first report of *celatus* from Indiana. The species has a primarily Atlantic and Gulf coastal distribution, though there are a few other (unpublished) records in the lower Great Lakes area. Its limits to dispersion in Indiana are a puzzle. The known seasonal range is 16 July to 9 September, and all but two of the specimens were collected in LaPorte County.

Before Pechuman's (1949) description of this population as a subspecies of *flavidus*, it had no separate nomenclatural identity from the latter. Teskey (1969) elevated it to a full species after studying the immatures.

Indiana specimens examined: 28.

Chrysops cincticornis Walker, 1848. (Fig. 11). Black species, readily identified by lack of apical infuscation and presence of a yellow to bright orange pile on the pleurae. The black thorax, scutellum, abdomen, frontal callus, and frontoclypeus with median pollinose stripe are shared with *carbonarius*, but the latter lacks the orange pile and averages a smaller size.

Specimens seemed quite variable even in a short series. The pleural pile of several was fairly pale, but their larger size and the fact that the upper part (i.e., the base) of the fifth posterior cell was infuscated caused them to fall into *cincticornis*. (In *carbonarius*, this cell is hyaline at the base.) But even here, one of the two Millersburg

(Elkhart County) specimens did have a hyaline spot at the base of the fifth posterior cell, but was otherwise a *cincticornis*.

C. cincticornis is clearly an early season species, with a known range from 25 May to 23 June. This correlates with the concentration of collection reports, which lie in the northern states and provinces from Saskatchewan to Nova Scotia, though the species is also represented in the southern states including Louisiana and Florida. In Indiana collecting sites are concentrated in the north, though this may be due only to a lack of early season collecting in the south. Teskey (1969) found the larvae both at pond margins and along slow-flowing streams.

Indiana specimens examined: 26.

***Chrysops cuclux* Whitney, 1879.** (Fig. 12). Black species with no apical infuscation of wing. Wing pattern as a whole quite pale; first basal cell tinted over basal half; second basal cell only slightly tinted basally. Median pollinose stripe present on fronto-clypeus. Frontal callus black. Pile of pleurae grayish to whitish. Thoracic dorsum black. Separated from related species especially by the presence of a dull yellowish to whitish spot on the basal corners of the second abdominal tergite and sometimes also expanded over onto the adjacent area of first tergite; remainder of abdomen black.

This is the first Indiana record for the species. The specimens were collected from 2 to 14 June by R. B. Cummings, and are in the collection of the Indiana Department of Natural Resources. The species might be present in a number of northern counties, but is probably restricted to an early flight season. Geographic affinities are northeastern, as it is known to occur from Wisconsin to Nova Scotia and south to North Carolina (Philip, 1965). Teskey (1969) found the immatures almost exclusively in stream habitats.

Indiana specimens examined: 6.

***Chrysops daene* Philip, 1955.** Hyaline triangle narrow and somewhat crescent shaped (similar to that of *sequax*), sometimes rising to second vein; first basal cell completely infuscated, second basal cell hyaline. Thorax gray to black, with blue-gray middorsal stripes. Abdomen brown with usually indistinct pattern; paler areas and middorsal stripe may be present.

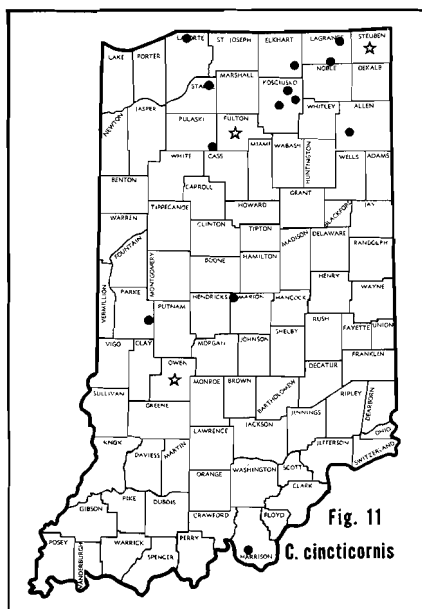


Fig. 11

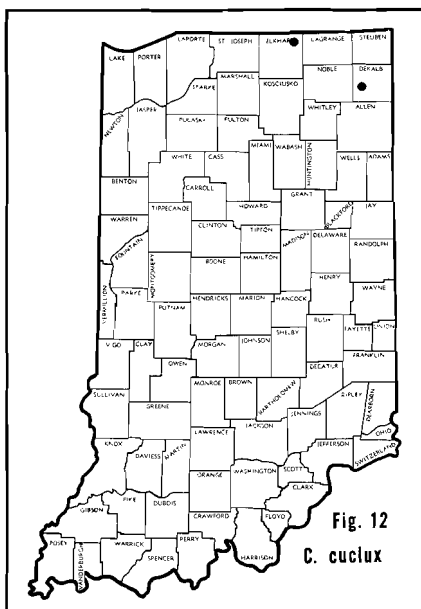
C. cincticornis

Fig. 12

C. cuclux

This species is not yet known from Indiana. Its reported range is Manitoba to New Brunswick and south to eastern Texas and Florida (Philip, 1965). It is commonest in lowland situations along the Atlantic and Gulf coasts, but scattered inland localities have also been reported including Illinois, Michigan, and Ohio. The Michigan locality of Hays (1956) was Berrien County, which is adjacent to Indiana on Lake Michigan. *Chrysops dimmocki* Hine, 1905. Apical infuscation crosses upper branch of third vein over more than half its distance; first basal cell more than half hyaline, but infuscated basally. Stripes on thoracic dorsum alternating blue-gray and black. First two abdominal tergites mostly yellow, with black figure on second tergite usually forming an inverted V which usually reaches the anterior margin; beyond, dorsum black with yellow posterior and lateral margins of tergites, and middorsal triangles.

Various authors (e.g. Brennan, 1935) have noted some intergradation of characters with *pudicus*.

This species has not yet been reported from Indiana. States in which it occurs lie along the Atlantic and Gulf coasts, with the exceptions of Michigan and Ohio. Its existence in Indiana is considered possible on the basis of these records.

Chrysops flavidus Wiedemann, 1821. (Fig. 13). Apical infuscation generally narrow but somewhat variable in extent within second submarginal cell; hyaline triangle clear or with a light brownish tint; distal margin of crossband fairly straight or somewhat concave. Frontal callus yellow to brown. Stripes on thoracic dorsum alternating light and dark brown, scutellum light brown. Abdomen with first tergite and base of second tergite dull yellow; remainder of abdominal dorsum mostly brown but with a highly variable amount of pale patterning which often takes the form of median triangles.

Several authors have noted a convergence of *flavidus* with *brunneus* in some coastal localities, but this presents no real problem in Indiana. *C. flavidus* lacks the swollen antennal scape of *brunneus*, and has a large apical wing triangle which is more hyaline.

Concepts regarding the morphological limits of this species have been in a state of flux in recent years, and as now constituted the species is considerably more compact. *C. celatus* and *reicherti*, both formerly regarded as subdivisions of *flavidus*, have since been removed from it (see separate accounts), and *atlanticus* Pechuman, 1949, was described for a major Atlantic coastal element which was formerly incorporated in *flavidus*.

I thank Dr. Pechuman for reviewing all of my material in the *flavidus* species complex, and segregating *flavidus*, *celatus*, and *reicherti* therefrom. For a recent discussion of the taxonomic difficulties involved in this complex, see Tidwell (1973:40-41, 45-46, 49, 58-60).

C. flavidus was taken in Indiana from 25 June to 10 September, never in abundance. A lentic environment is apparently almost a requirement. Local evidence for this is the fact that during this study all specimens were taken in the vicinity of a lake, pond, marsh, or swamp. Furthermore, records of the species are virtually absent from the Tipton till plain, though it is closely approached both in the north and in the south. I think that its absence from this physiographic unit is due to the dearth of year-round standing water. Elsewhere, the heaviest concentrations seem to be in the Atlantic and Gulf coastal lowlands. The total known range is southern Iowa to Massachusetts and south to Mexico and Cuba, so Indiana is "pushing" the northern limit of the distribution. This may explain its lack of representation in the northeastern lakes area, which would otherwise be expected to be quite suitable for breeding. The Michigan records of Hays (1956) are all close to the southeastern corner of that state.

Indiana specimens examined: 205.

Chrysops frigidus Osten Sacken, 1875. Apical infuscation broadly joined to crossband, crossing upper branch of third vein over most of its distance, but filling little of second submarginal cell. Frontal callus black; frontoclypeus black with median pollinose stripe. Thoracic dorsum black with at least a partially complete blue-gray

median stripe; pile of pleurae yellow; scutellum black. Abdomen patterned in orange or yellow and black, may be somewhat indistinct and can be very highly variable from almost completely black to almost completely orange yellow. Usually the dark figure of second tergite occupies only upper half of segment and is often somewhat rectangular.

C. frigidus has not yet been reported from Indiana. It occurs from British Columbia to Labrador and south to Oregon, Colorado, and New Jersey (Philip, 1965). Hays (1956) reported a fairly widespread distribution in Michigan, including the southern counties of Berrien, Oakland, and Washtenaw. It may someday be found in Indiana in northern bog situations.

***Chrysops geminatus* Wiedemann, 1828.** (Fig. 14). Hyaline triangle crescent-shaped, relatively narrow at base compared to its height, rising distinctly above second vein. Frontal callus black. Thoracic dorsum with alternating black and green-gray stripes; scutellum black. Abdomen patterned in black and yellow, the first tergite yellow except for a blackened spot under the scutellum in Indiana specimens; second tergite yellow but with two diagonal black lines which converge anteriorly toward, and may touch, a rounded central dot (the extent of these black markings is quite variable); third tergite and beyond mostly black with middorsal yellow stripe.

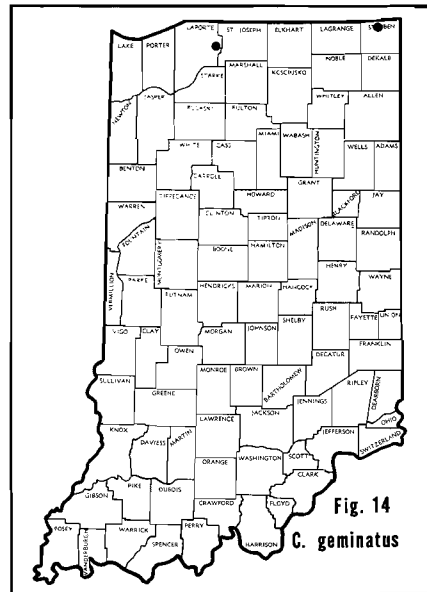
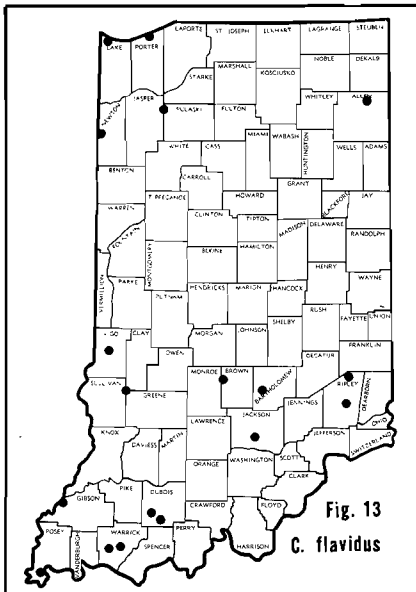
This is the first record of *geminatus* from Indiana. Date range represented is from 17-30 July. Both collecting localities (Mill Creek in LaPorte County and Pokagon State Park in Steuben County) contained marshland, though running water was also present. The species is eastern, occurring from Wisconsin to Quebec and south to Oklahoma, Louisiana and Florida.

See below under *impunctus* for further discussion. *C. geminatus* is reinterpreted as monotypic.

Indiana specimens examined: 6.

***Chrysops impunctus* Kröber, 1926, new status.** (Fig. 15). *Chrysops geminatus* var. *impunctus* Kröber, 1926, Stettin. Entomol. Zeit. 87:301-302.

Agrees with diagnosis given above for *geminatus*, but second tergite lacks the black markings of *geminatus*, and at least in the Indiana specimens the first tergite is not blackened under the scutellum.

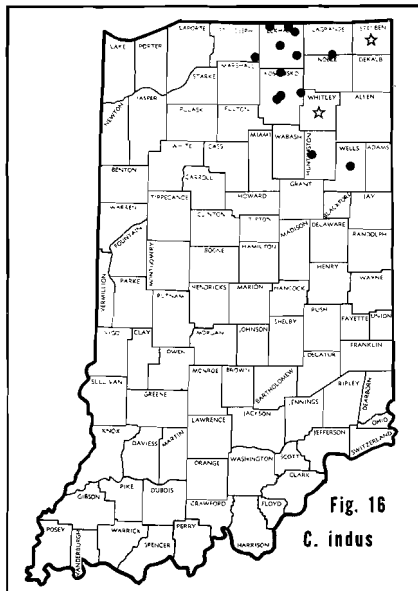
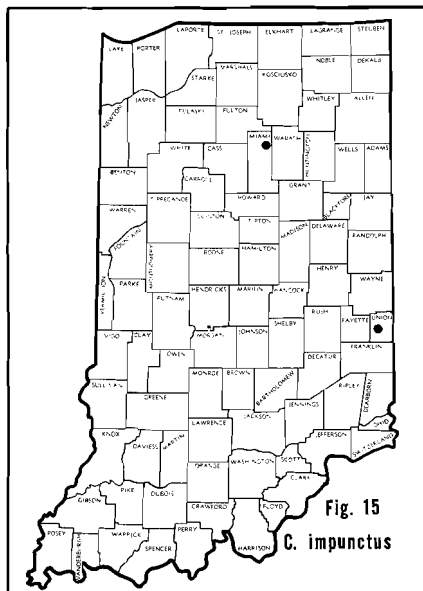


This is the first record of *impunctus* from Indiana. Three specimens were taken at two localities on 24 June and 1 August. The two Miami County (Roann SW) specimens were taken in the vicinity of a sluggish creek, while the Union County locality (Whitewater State Park) had both marshland and running water present. This uncommon species may be characterized in a sense as "midwestern", as it is known to occur in a band from Ontario and Michigan south to Alabama and Louisiana.

This taxon is herewith elevated to full specific rank. I am taking this action not on the grounds of any new information which has not formerly been available to other workers, but rather on the grounds of an apparent difference of opinion about the subspecies concept. Kröber (1926:301-302) originally described *impunctus* as a "var." (=variety) of *geminatus* Wied. As a result of decisions by the International Congress of Zoology, varietal status has become untenable as a taxonomic rank deserving recognition through a formal trinomen. Those entities described as varieties before 1961 have been (and are still being) reassigned to specific or subspecific rank or sunk as synonyms, depending on the circumstances of each individual case. Taken as a whole (and not just from an Indiana standpoint), *impunctus* is separated from true *geminatus* neither by geographic range nor by seasonal distribution, nor, for that matter, by any aspect of life style as far as known. It can therefore not be assigned to subspecific rank, as it has not met subspecies criteria (e.g., see Mayr, 1969:41-46). The two are sympatric, with the known range of *geminatus* embracing that of *impunctus*. Two choices remain: placing *impunctus* as a full synonym of *geminatus*, or according it full specific rank. The short series of Indiana adults of both species are certainly distinct from each other, and Dr. Pechuman (personal communication) has presented to me his entirely persuasive morphological case that the two taxa are not full synonyms. It seems to me that this combination of factors leaves no choice but to recognize *impunctus* at the species level.

Indiana specimens examined: 3.

Chrysops indus Osten Sacken, 1875. (Fig. 16). Apical infuscation crosses upper branch of third vein over most of its distance, but does not extend to lower branch, filling only upper part of second submarginal cell; first basal cell infuscated except for hyaline spot near distal end; second basal cell infuscated except for hyaline. Frontal callus black. Thoracic



dorsum with alternating dark and blue-gray or brown-gray stripes. Abdomen with middorsal yellow stripe of variable width beginning on second tergite, bordered laterally by black of highly variable extent. Black area of first tergite undivided, figure on second tergite somewhat resembling inverted U or V; beyond, yellow displayed as narrow posterior margins of tergites, and is usually present at lateral margins.

C. indus was taken from 25 May to 29 June, thus clearly an early season species. This is consistent with its total range, which is northeastern: Minnesota and northeastern Iowa east to Quebec and south to northern Virginia. The species is not common in Indiana, though it is sometimes quite common in areas to the east, e.g. western New York (Pechuman, 1972). It was found narrowly confined to the northeastern part of Indiana, though there is no apparent reason why it should not also be present in low numbers in the northwestern part. In the localities in which I collected this species, running water in various degrees from small drainage ditches to rivers were present at each site, though a lake was also present at one. Teskey (1969) considered the larvae "almost ubiquitous" with reference to water movement, water quality, and substrate properties.

Indiana specimens examined: 29.

Chrysops macquarti Philip, 1961. (Fig. 17). Hyaline triangle rises to vicinity of furcation of third vein, but is fragmented: a narrow ribbon of infuscation in first posterior cell usually connects crossband with apical infuscation; small hyaline patch present in second submarginal cell at furcation; base of hyaline triangle limited to second and third posterior cells; first basal cell almost entirely infuscated. Thoracic dorsum with alternating blue-gray and black stripes; scutellum yellow to black. Abdomen with middorsal yellow stripe of variable width, bordered laterally by black of highly variable extent, which may be limited to narrow stripes or may almost completely cover remainder of dorsum.

The abdominal pattern is so variable that it may resemble that of several other species, but the configuration of the hyaline triangle, as noted above, is distinctive.

C. macquarti was taken from 6 June to 26 August in small numbers. Records were sparse except in the Whitewater River drainage. Most localities from which it was taken contained running water, and further evidence of a lotic requirement was provided by Teskey (1969), who found his larvae associated with "small, usually rather slow flowing, streams." Larvae also appear to prefer an acid substrate (Pechuman, 1972). The species is eastern, with a known range of Nebraska and Minnesota to Maine south to Louisiana and Florida (Philip, 1965).

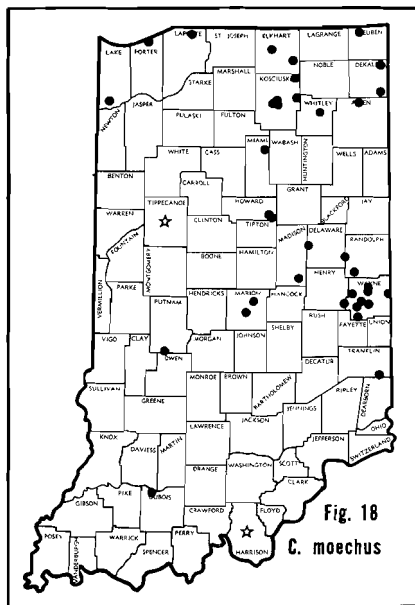
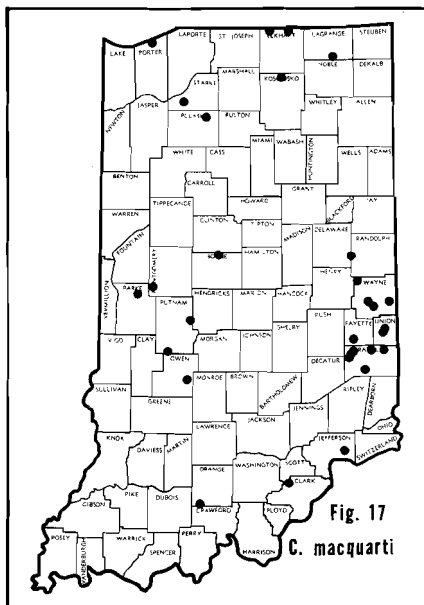
C. macquarti is the same species as that reported in the literature before 1961 as "*Chrysops univittatus* Macquart." It is not to be confused with the true *univittatus* of Macquart (Philip, 1961), which is another common Indiana species.

Indiana specimens examined: 82.

Chrysops moechus Osten Sacken, 1875. (Fig. 18). Hyaline triangle confined to second and third posterior cells, occasionally a small subhyaline patch present in first posterior cell near upper branch of fourth vein; first basal cell almost entirely infuscated. Thoracic dorsum with alternating green- or blue-gray and black stripes; scutellum yellow to blue-gray. Abdomen has yellow middorsal stripe of variable width, bordered laterally by a black stripe which may be complete or dashed. Remainder of dorsum shows variable amount of yellow and black.

The abdominal pattern may be very similar to that of *macquarti*, but the small hyaline triangle of the wing is unmistakable. This is also true of the blackened male sex. One specimen in the Earlham College collection shows an aberrant wing pattern with a much-reduced infuscation.

C. moechus was taken from 20 May to 24 August in small numbers. Most were collected in the vicinity of running water, and Teskey's (1969) larvae were also collected in lotic situations. He associated the elongation of larval pseudopodia in this species with the streambed habitat. Pechuman (1972) observed the distinctive egg masses always over moving water. Thus it would almost seem safe to regard a lotic environment as a requirement, but this is at odds with the findings of Stone (1930) in



Ithaca, New York, all of whose 12 larvae were collected "at the margin of a small artificial lake and at the margin of a muddy backwater above a dam." There is no apparent reason why the species is so poorly represented in southern Indiana. Its total distribution is eastern, occurring from Minnesota to Quebec and south to Louisiana and Florida (Philip, 1965).

Indiana specimens examined: 165.

Chrysops montanus Osten Sacken, 1875. (Fig. 19). Hyaline triangle usually rises to second vein, but not above, and is relatively broad at base compared to its height; apical infuscation broadly crosses upper branch of third vein; first basal cell more than half hyaline but infuscated at both ends. Frontal callus black to yellow. Thoracic dorsum with alternating blue-gray and black stripes; scutellum blue-gray. First and second abdominal segments mostly yellow; second tergite almost always with black inverted V, though it may be reduced to two convergent dashes; beyond, dorsum shows extremely variable spotted pattern of black and yellow, but usually resembles a striped condition.

Philip (1955) and other authors have commented on the variation in specimens placed in this species over the total range.

C. montanus was taken from 14 June to 10 September. Although in absolute numbers this appears to be one of the state's commonest deer flies, the distribution is highly uneven. Eighty-two per cent of the total catch came from Jasper-Pulaski State Game Preserve, where up to 465 specimens were collected in a day. Only 24 specimens were collected below the northern area of the state. The environment of all of my collecting sites for this species was predominantly lentic, and I consider this factor to be the explanation for its near absence on the Tipton till plain. (Only three specimens were collected in this physiographic unit, around the lake in Whitewater State Park, Union County.) The lentic characterization agrees with the larval findings of Philip (1931), and several authors have reported related observations on adult incidence. Teskey's (1969) two larvae were collected in a stream bank, thus differing from the anticipated habitat; Teskey acknowledged this and suggested that they might have originated in a lake about three kilometers upstream. The species is eastern, with

a known range from Manitoba to New Brunswick and south to Texas and Florida (Philip, 1965).

Indiana specimens examined: 934.

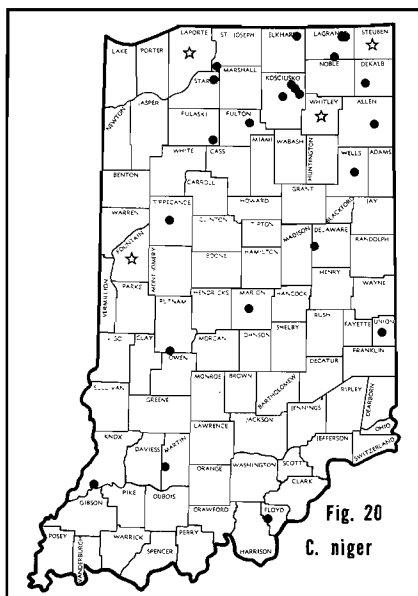
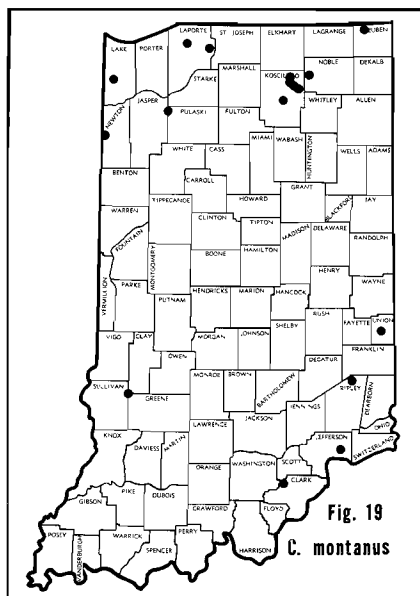
Chrysops niger Macquart, 1838. (Fig. 20). Black species with wing beyond crossband hyaline; second basal cell hyaline; first basal cell mostly infuscated, but with hyaline area near distal end. Frontal callus black; frontoclypeus yellow in middle. Thoracic dorsum with alternating blue-gray and black stripes; scutellum black; pile of pleurae grayish to whitish. Abdomen entirely black.

This species is separated from the other three (known or expected) Indiana black species which lack apical infuscation by the yellow frontoclypeus which lacks a median pollinose stripe, and by the lack of infuscation in the second basal cell. It is further separated from *cincticornis* by the grayish to whitish color of the pleural pile, and from *cuclux* by the total blackness of the abdomen.

A new species, *Chrysops calvus* Pechuman & Teskey, 1967, has been described for a population which was formerly incorporated in *niger*. Dr. Pechuman has kindly rechecked all of my *niger* material and found no *calvus* among them. Therefore, *calvus* remains unknown from Indiana, though its presence may eventually be detected as it is known to occur in several upper Great Lakes states (Pechuman, personal communication). In the present key to species it would key down to *niger*, but differs from *niger* in that there is no pollinose interruption of the bare integument which runs from the ocellar area to the occiput (it is interrupted in *niger*), and the sublateral thoracic stripes are more distinct in *calvus*.

C. niger was taken in small numbers from 18 May to 19 July, with most records in June. It is thus essentially an early season species. Records are distributed widely though sparsely in Indiana, and it is likely that detecting its presence in any given county is contingent primarily upon the earliness of the attempt and not on any restrictive habitat requirements or range limits. Total known range is Montana to Nova Scotia and south to Oklahoma and Florida (Philip, 1965). Teskey (1969) and other authors have found the larvae in a very wide variety of situations including the margins of small rivers, streams, lakes, ponds, and bogs.

Indiana specimens examined: 46.



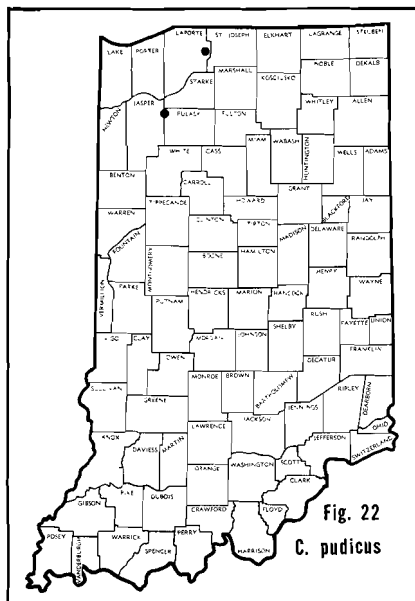
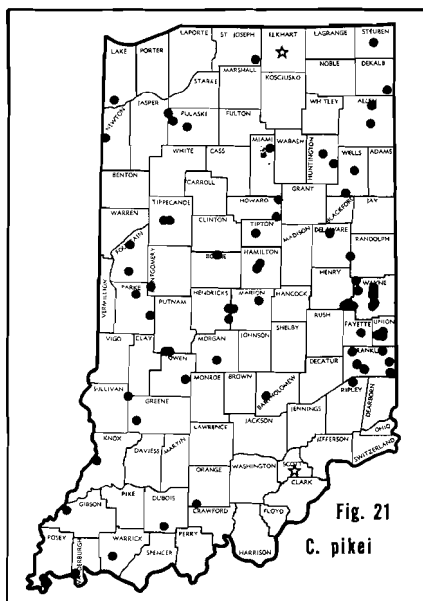
Chrysops pikei Whitney, 1904. (Fig. 21). Hyaline triangle appears narrow and somewhat crescent-shaped, total height greater than its width at base, its somewhat rounded apex approaches or rises to second vein; proximal margin of apical infuscation usually paler than crossband, and broken by hyaline strip along lower branch of third vein; first basal cell almost entirely infuscated. Thoracic dorsum with alternating green- or yellow-gray and black stripes. Yellow abdominal dorsum with four dark stripes of variable extent; the dorsal stripes often appear tapered and are always wider than lateral pair, which are entirely lacking on first and second segments, and may be reduced to very inconspicuous spots on remaining segments.

Specimens have occasionally been taken which totally lack the lateral dark stripes. Although this is a distinctive species, variable characters in some specimens of this and other species may lead to confusion. It is separated from *sequax* and *beameri* by the lack of dark lateral stripes on the first and second abdominal tergites, and from *macquarti* by the much greater extent of the upper part of the hyaline triangle.

C. pikei was taken from 30 May to 22 September with frequent records throughout June, July, and August. It thus has the longest known season of any deer fly in Indiana, and is one of the most regularly encountered as well. Collecting sites were partially to entirely lotic, and the species seems especially well represented on the Tipton till plain. Most of the localities contained little or no standing water, and some were along rivers. Teskey (1969) found all three of his larvae in a creek bank, though comments by other authors (e.g., Pechuman, 1972) suggest that the species is not restricted to the lotic habitat. Known range is Nebraska to western New York and south to Texas and Florida, and so is essentially midwestern and southern. The Michigan county records of Hays (1956) all fall on or below the 44th parallel, so Indiana is somewhat near the northern limit. Pechuman (1972 and personal communication) has observed its steady eastward progress in western New York in recent years.

Indiana specimens examined: 743.

Chrysops pudicus Osten Sacken, 1875. (Fig. 22). Apical infuscation narrow, concentrated along coastal vein, filling little of second submarginal cell, but may occasionally broadly cross upper branch of third vein; hyaline triangle rises to second vein; first



basal cell mostly hyaline; infuscation of fifth posterior cell narrowly confined along proximal branch of fifth vein. Frontal callus yellow. Thoracic dorsum and scutellum black or nearly so. Dark figure of second abdominal tergite roughly an inverted V, and clearly separated from dark area of first tergite by yellow band; beyond, dorsum mostly black but with variable yellow, ranging in extent from entirely lacking to fairly extensive along tergite margins and as middorsal triangles. The clear separation of the dark figures on the first and second tergites and the narrow infuscation of the fifth posterior cell along the proximal branch of the fifth vein usually suffice to separate this species from other Indiana forms with a narrow apical infuscation. Dr. Pechuman (personal communication) has observed that Indiana specimens, like inland populations from other states, have the apical infuscation narrower at the base than coastal specimens, including the holotype.

This is the first report of *pudicus* from Indiana. It was collected from 10 to 27 July. The two localities at which it was taken are both northern, and both included extensive areas of marshland. This was surrounded at the Jasper-Pulaski State Game Preserve by sand hills, and interfingered at the LaPorte County (Mill Creek) site by glacial eskers. This incidence is thought to be explained by a combination of chance and by the great suitability of the habitat at these two sites. The known range is Wisconsin to Massachusetts and south to Oklahoma, Louisiana, and Florida, with the largest concentration of records in the Atlantic and Gulf coastal lowlands. This suggests that it had a coastal origin and may have colonized the Great Lakes area in relatively recent times. Michigan records (Hays, 1956) are all from the southern part of that state, so Indiana is close to the northern edge of the range.

Indiana specimens examined: 60.

Chrysops reicherti Fairchild, 1937. (Fig. 23). A member of the *flavidus* complex, and so similar to *flavidus* that they can be distinguished only with difficulty (see under *flavidus*). The first and second abdominal segments of *reicherti* are said to be paler (more translucent) than those of *flavidus*, and the distal margin of the crossband is slightly convex over most of its length.

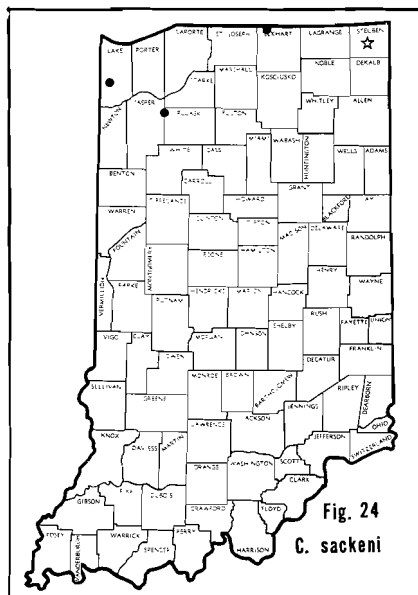
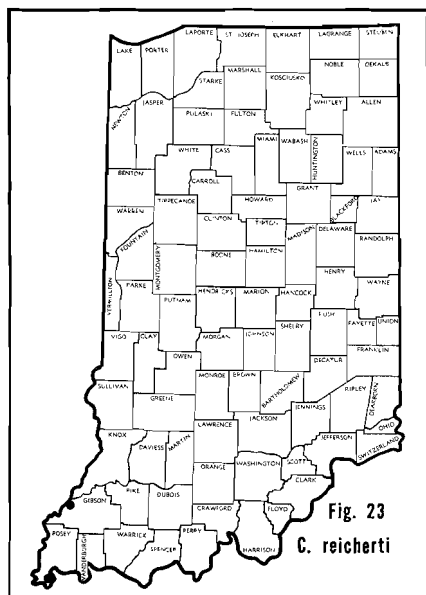
This is the first report of *reicherti* from Indiana. It was taken in only two southwestern river-dominated localities, on 18 and 19 August. Hovey Lake State Fish & Game Area in Posey County is bald cypress lowland subject to flooding by the Ohio River, and the other locality, south of East Mt. Carmel in Gibson County, is in the lowlands of the lower Wabash River. Both the distribution and the habitat found in Indiana are very much in keeping with what is known of the species elsewhere. It has been reported only from southern states (Tennessee and Virginia south to Louisiana and Florida), and its occurrence up the Mississippi watershed as far as southwestern Indiana is probably the northern limit of its range. Tidwell (1973), working in Louisiana, found it "most common in the swamps of the mixed bottomland hardwood forests."

C. reicherti has had several changes of taxonomic status over the years, and has been returned (Tidwell, 1973) to full specific rank where it was originally described. Varietal status is no longer recognized in nomenclature, and subspecific status under *flavidus* is not appropriate since the range of *flavidus* entirely overlaps the range of *reicherti*. The two species were taken together at the Gibson County locality.

Indiana specimens examined: 3.

Chrysops sackeni Hine, 1903. (Fig. 24). Apical infuscation narrow, concentrated along costal vein, but is slightly wider than marginal cell just beyond the point at which it leaves crossband; fifth posterior cell partly or entirely infuscated at base (next to second basal cell); first basal cell mostly hyaline. Frontal callus almost as high as wide, often yellow bordered by black or brown, occasionally black. Thoracic dorsum with alternating blue-gray and black stripes; scutellum black. Black figures of first and second tergites joined or only very narrowly separated; figure on second tergite roughly an inverted V; remaining tergites have yellow posterior margins, with third and fourth tergites usually showing yellow lateral margins and middorsal triangles.

This species is best separated from the related *pudicus* by the more extensive infuscation in the upper part of the fifth posterior cell, and by the union or very



narrow separation of the black figures on the first and second tergites. It is separated from *aestuans* and *callidus* by the greater height of the frontal callus, which is almost as high as wide, and by the width of the apical infuscation at its point of departure from the crossband, which exceeds the width of the marginal cell.

C. sackeni was taken at four northern localities from 9 June to 27 July. Each of the three localities known to me contained extensive marshland areas which were close to bodies of open water. The majority of situations in which Teskey (1969) obtained larvae were also lentic, though in one case it was "the cattail-overgrown margin of the stream". The northern range found in Indiana is consistent with expectations based on the great majority of known records from other states and provinces (Pechuman, personal communication). Only a few records farther to the south in other states suggest that the species could eventually be found farther to the south in Indiana. One specimen believed to be *sackeni* showed characteristics which were convergent with those of *pudicus*. The two species as well as the related *callidus* were all taken in the same collections at Jasper-Pulaski State Game Preserve.

Indiana specimens examined: 27.

Chrysops sequax Williston, 1887. (Fig. 25). Hyaline triangle appears narrow, its total height greater than its width at base, its somewhat pointed apex rises to, or at least closely approaches, second vein; first basal cell almost entirely infuscated. Frontal callus usually dark; small vertical plate at upper lateral margins of frontoclypeus darkened or black. Thoracic dorsum with alternating yellow- to blue-gray and black stripes; scutellum variable, entirely blue-gray to anteriorly blue-gray with yellow posterior margin. Abdominal dorsum has yellow ground color and four dark stripes, with lateral pair usually reduced but almost always present on first and/or second tergites.

Indiana specimens are separated from *beameri* by the dark frontal callus and vertical plate at the upper lateral margins of the frontoclypeus; and from *pikiei* by the presence of dark lateral stripes on the first and/or second tergites, and by the more pointed appearance of the apex of the hyaline triangle.

C. sequax was taken from 10 July to 14 August. All collecting localities known to me contained a creek or river, most of them slow-flowing at least at the time of

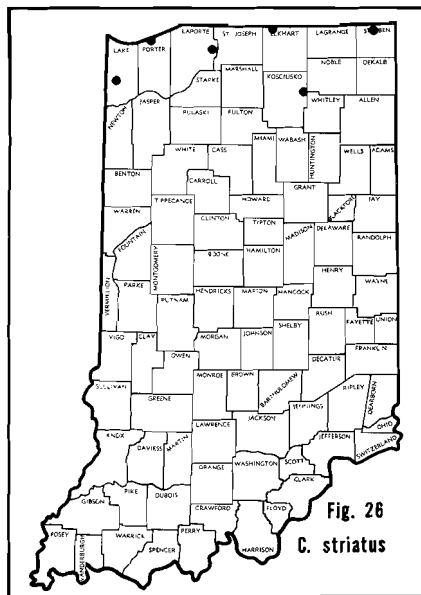
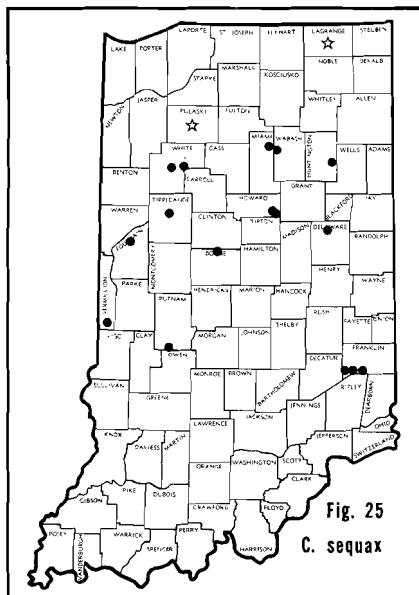
collecting. This strong preference (if not requirement) for a lotic environment probably explains the distinct concentration of records on the Tipton till plain. Population levels were low. Only one locality yielded more than ten specimens, a site with some vegetational diversity along the Mississinewa River in Delaware County, where 49 specimens were taken. This species may be called midwestern, as its known range is Colorado to Ohio and south to Oklahoma and Georgia (Philip, 1965). Philip (1947) reported it from Michigan but without further locality, and Hays (1956) could not add any specific localities there, so Indiana must be very close to the northern range limit.

Philip (1955) described *sequax tau* as a subspecies from Illinois, Ohio, and Arkansas, based on midfacial pollinosity not possessed by "typical" *sequax*. It was later demoted to a "variety", thus losing its nomenclatural standing and entering full synonymy under *sequax*. In view of this synonymy, I paid it no attention originally; but as a matter of interest, Dr. Pechuman has identified a recent specimen of the *tau* form in the Indiana Department of Natural Resources collection from Wabash County. An Indiana record of the form is therefore reported in case of any future reevaluation in status. The form runs to couplet 30 in the present key (instead of couplet 26).

Indiana specimens examined: 90.

***Chrysops striatus* Osten Sacken, 1875.** (Fig. 26). Hyaline triangle appears relatively broad at base compared to height, apex rises distinctly above furcation of third vein, but does not rise to second vein; apical infuscation usually fills about half of second submarginal cell, leaving broad hyaline area along lower branch of third vein; first basal cell almost entirely infuscated. Frontal callus usually black. Thoracic dorsum with alternating green- or blue-gray and black stripes; scutellum varies from entirely blue-gray or black to anteriorly blue-gray with yellow posterior margin. Yellow abdominal dorsum with four black stripes, the lateral pair usually much reduced, and dorsal pair usually merging anteriorly on second tergite.

C. striatus and *aberrans* may be highly convergent. The former is normally distinguished by a slightly higher rise in the apex of the hyaline triangle, lesser extent of infuscation in the second submarginal cell, dark frontal callus, and union of the dorsal dark stripes on the second tergite.

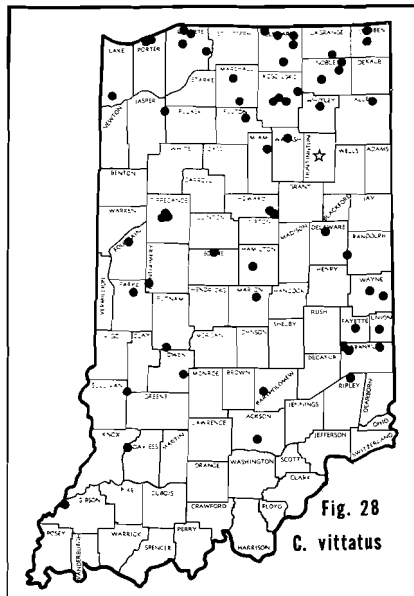
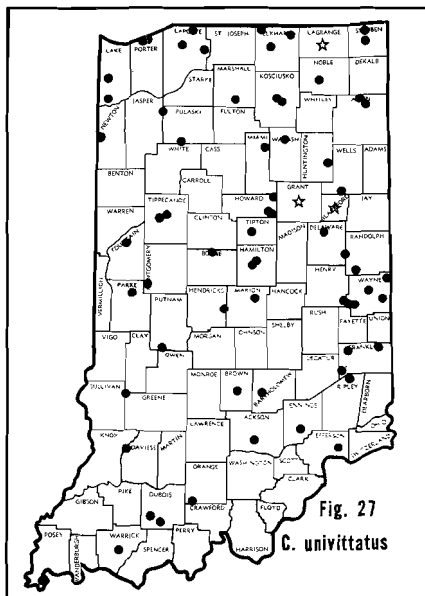


C. striatus was taken in low numbers from 21 June to 9 September, entirely in the northern counties. Each of the collecting localities contained extensive marshland, which in turn was adjacent to a body of open water except at the Porter County (Cowles Bog) site. I should therefore be inclined to suggest that a lentic habitat is required; however, Teskey (1969) found all of his four larvae in a creek margin. Its relative *aberrans* is confined to northern Indiana as part of a total range configuration, and in all probability the same is true of *striatus*. Lending substance to this argument is the fact that Pechuman (1972) found this species only in northwestern New York, and Richards & Knight (1967) found it only in northern Iowa. There is almost no doubt that records from the southern states are based on misinterpretations resulting in the lumping of one or more non-conspecific species into *striatus*, just as some northern records used to be based on specimens of *aberrans*. The east-west range is New Brunswick to North Dakota.

Indiana specimens examined: 51.

***Chrysops univittatus* Macquart, 1855.** (Fig. 27). Apex of hyaline triangle rises above second vein, entering marginal cell; apical infuscation becomes paler (more dilute) as it leaves costal vein, and it is often difficult to determine its limits; first basal cell mostly hyaline. Frontal callus black. Thoracic dorsum with alternating green- or blue-gray and black stripes; scutellum varies from entirely blue-gray or black to anteriorly blue-gray with a yellow posterior margin. Abdominal dorsum black with middorsal yellow stripe of variable width but tapering posteriorly. Some specimens also with a sublateral yellow stripe on each side of the median; if present, these sublateral stripes are usually much reduced but may occasionally be as broad as median stripe on first and second tergites. Occasional specimen with reddish cast replacing black parts.

C. univittatus was taken from 25 May to 10 September. It is both widespread and very common, producing more known county records than any other deer fly in the state. It occurred at river, lake, and marshland sites alike. Other workers have found the larvae in all such circumstances, but Teskey's (1969) long series were found almost exclusively in the banks of slow-flowing streams. The densest population in Indiana was encountered at the Daviess County (Graham NW) locality, in the vicinity of the junction of Old Smothers Creek with the West Fork of the White River, where



1189 specimens were netted within five man-hours. Much of the area appeared to be subject to annual flooding. The species is eastern, with a known range from Minnesota to Nova Scotia and south to Kansas, Louisiana, and Florida (Philip, 1965).

Philip (1961) clarified the status of the name *Chrysops univittatus*. Before his paper, the species being considered here was known as *C. wiedemanni* Kröber.

Indiana specimens examined: 2842.

Chrysops vittatus Wiedemann, 1821. (Fig. 28). Hyaline triangle rises to, or very little above, furcation of third vein; second submarginal cell mostly infuscated, also first basal cell; fifth posterior cell extensively infuscated except at base (near second basal cell). Frontal callus yellow. Thoracic dorsum with alternating yellow and blackish stripes, the median yellow stripes usually anteriorly tinted with green-gray; scutellum entirely yellow. Abdominal dorsum yellow with four dark stripes, the lateral pair usually much reduced, especially on first and second tergites. The extent of yellow on thorax including scutellum, and the greater extent of infuscation in the fifth posterior cell quickly distinguishes this species.

A notable aberrant was taken in Noble County (Wolf Lake N), in which the abdominal dorsum beyond the middle of the second tergite is almost entirely black except for a yellow middorsal stripe extending posteriorly to and across the fourth tergite.

C. vittatus was taken from 7 June to 10 September. A variety of habitats was represented, including river and creek sites, but the largest numbers were collected at marshland localities. The Mill Creek (LaPorte County) site yielded the phenomenal numbers of 1506 and 1725 specimens on two consecutive days of netting in mid-July. This was an extensive marshland area interfingered by glacial eskers which were wooded with oak and hickory. In absolute numbers it was found to be Indiana's commonest deer fly by a margin of over 2:1 over the next in rank (*univittatus*); but in a sense this was offset somewhat by having the densest populations localized in the northern, eastern, and central areas, while records and numbers in the southern counties were sparse. Teskey (1969) called the larvae "almost omnipresent" with respect to their occurrence in different types of wetland habitats. The species is eastern, with a known range from Minnesota to Nova Scotia and south to Texas and Florida (Philip, 1965).

Indiana specimens examined: 5962.

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