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NATURAL HISTORY

URBANA, ILLINOIS, U. S. A.

STEPHEN A. FORBES, PH.D., LL.D.,
DIRECTOR

VOL. XII. JUNE, 1917 ARTICLE IV.

THE ZYGOPTERA, OR DAMSEL-FLIES, OF ILLINOIS

BY

PHILIP GARMAN, PH.D.

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ARTICLE IV.—*The Zygoptera, or Damsel-flies, of Illinois.** BY PHILIP GARMAN, PH.D.

INTRODUCTION

The order Odonata includes all insects known as dragon-flies in the broad sense of the term. The adults are characterized by the possession of four membranous, net-veined wings which are of nearly equal size. The mouth-parts are fitted for biting and the metamorphosis is incomplete. The males are distinguished by accessory genitalia on the second and third abdominal sterna. The nymphs are aquatic, and are recognizable and separable from other aquatic forms by the large hinge-like labium which folds beneath the head. The order is subdivided into two suborders, the Anisoptera and the Zygoptera. The adults of the Anisoptera have large, broad wings, but little contracted at the base and with numerous cross-veins. The wings of the Zygoptera are usually narrowed at the base and possess fewer cross-veins. The Anisoptera usually rest with wings spread horizontally; the Zygoptera usually with wings held vertically. The nymphs of the suborders are easily separated by means of the respiratory apparatus, the Zygoptera having three tracheal gills at the caudal end of the abdomen, and the Anisoptera having no caudal tracheal gills, being provided with rectal gills instead.

The Odonata form one of the strangest orders of insects with which an entomologist has to deal. Their bizarre form, striking colors, and peculiar habits make them an object of much curiosity on the part of the layman as well as the object of many studies on the part of the scientist. The prevalence of the popular terms, snake-feeders, snake-doctors, and similar names, shows that there are many superstitions concerning the group.

As is well known, the Odonata are predaceous, in all stages, upon other insects, particularly upon those insects annoying to man, the flies and mosquitoes, and in this rôle they must be classed as beneficial. Their harmful activities are few, but they sometimes destroy young fish, they occasionally injure plants by the insertion of eggs, and,

*Contributions from the Entomological Laboratories of the University of Illinois No. 53.

most serious of all, they do not discriminate between beneficial and noxious insects, but destroy both. An instance of the fact last mentioned is the recently reported feeding of *Anax junius* on the honeybee. In no case, however, is it probable that the harm done overbalances, or begins to counterbalance, the good which these insects do in the destruction of biting Diptera.

The classification of the nymphs of Zygoptera is in a backward state as compared with the classification of the adults. This is due especially to the fact that immature forms are not easily collected and that their classification is particularly difficult. An intensive study of the nymphal characters has shown that there are, within certain genera, groups of nymphs the species of which are much more closely related to each other than to the members of other groups of the same genus. These groups correspond to groups of adult species in the identification of which the characters of the anal appendages of the male are mostly relied upon. Little attention seems to have been given by taxonomists to the females, and where species are represented in collections by females only it is exceedingly difficult to determine them. Again, when studying nymphs, one is often successful in rearing a number of females, but almost any amount of painstaking work may fail to produce a male. In such cases still more inconvenience is experienced when it is found that the reared females can not be named because of the fact that the published synopses are based largely upon male characters.

It is with a view to clearing up some of the obscure features of the classification and lessening the labor of determination that nymphs and adults, including both sexes, have been considered together and tables prepared for the separation of both.

All obtainable biological data have been added for the sake of completeness; but it is fully realized that the data given here are incomplete, and can only be made complete after many years of diligent study.

Nymphs of several species which are apparently new have been reared in the course of the study and are described herein for the first time. Some of the remaining species which doubtless occur in Illinois but which have not been collected by the writer, have been obtained through the courtesy of various people, and the list has been completed as far as possible in this way.

Certain problems concerned with the nomenclature have presented themselves, the most important of which concerns the adoption of family names. According to the ruling of the International Commission on Zoological Nomenclature (Muttkowski, '10: 15) Agrion re-

places Calopteryx, and the family name Calopterygidae must be abolished. The change has caused much confusion because of the former application of the name Agrionidae; but it seems practically certain that further change would only result in still greater confusion, and the family names as used by Muttkowski are, therefore, adopted without change.

The use of the common names "dragon-fly" and "damsel-fly" in referring to the Anisoptera and Zygoptera respectively, causes no little confusion because of the frequent use of the term dragon-fly to denote the order as a whole. In the following pages, the words Anisoptera and Zygoptera will be used exclusively to designate the subdivisions of the order.

ACKNOWLEDGMENTS

I take pleasure at this point in expressing thanks for the valuable aid which Dr. A. D. MacGillivray has given by his careful supervision of work and thoughtful criticism during the course of the study. Thanks are also due to Dr. S. A. Forbes for granting financial support from the funds of the Illinois State Laboratory of Natural History as well as for the loan of the collection of Zygoptera belonging to that laboratory. I am especially indebted to Mr. E. B. Williamson for his kindness in permitting me to examine his collection of Odonata; and I further wish to thank Dr. E. M. Walker and Dr. J. G. Needham for the loan of specimens of zygopterous nymphs, and Dr. P. P. Calvert for the identification of material sent him.

Morphology

NYMPH

The nymphs are distinguishable from all other insects by the possession of three more or less flattened, caudal, tracheal gills. They are slender, delicate insects of the same color as the surrounding vegetation or environment in which they live and at first sight seem hardly capable of the predatory habits of the order. They are usually covered with fine hairs or spinules which collect an ambuscade of dirt and rubbish. Their slender cylindrical abdomens resemble the stems of plants and weeds, and the caudal gills remind one frequently of growths of algae. Such adaptations as these render the insect most inconspicuous in its natural habitat.

Head.—The head of the nymph is somewhat oval or pentagonal in outline when viewed from above, and is usually longer than wide. The sutures are indistinct even in full-grown nymphs with the excep-

tion of the epicranial suture, which is a Y-shaped line on the dorsum of the head, near the caudal margin. Sutures are wanting, separating vertex from occiput, occiput from postgenae, and postgenae from genae. The vertex occupies that part of the dorsum of the head capsule caudad of the arms of the Y; and the occiput and postgenae together, the portion of the caudal aspect of the head not occupied by the occipital foramen and the compound eyes. The genae are the areas mesad of the ventral margins of the compound eyes. They fuse with the postgenae (Fig. 7, pg) near the ventral margin of the head. Extending caudo-dorsad on the caudal aspect from the ventral articulations of each mandible, there is a distinct ridge which disappears near the middle of the head. The trochantins of the mandibles are present as indistinct triangular areas laterad of the bases of the mandibles (Fig. 7, tm).

Compound Eyes.—The compound eyes of the nymphs, like those of the adult, are very large. They occupy perhaps one-third of the dorsal surface of the head, nearly the whole of the lateral surface, and part of the ventral. The facets are hexagonal and similar to those of other insects.

Ocelli.—The ocelli are wanting during nymphal life, but in the later stages the adult ocelli may be seen through the transparent cuticle of the dorsum of the head. Thus it often appears as if the nymph had ocelli when in reality there are none present, as can be proved by an examination of the final exuvium, or by dissection.

Antennae.—The antennae, in all full-grown nymphs, consist of seven segments. The distal segment is short in most species and the connection between it and the preceding one is frequently obscure, so that it seems as if the appendage had only six segments. The first segment is usually thicker than the remaining ones, and in the Agrionidae is as long as all the rest of the segments together. In the Coenagrionidae, the third segment is the longest and each of the segments distad of it is shorter than the segment preceding. The two proximal ones are not constant in length but are always shorter than the third.

Mandibles.—The mandibles are normally hidden from sight by the large labium and the flap-like labrum. They are located on the ventral surface of the head and are well formed for mastication. They are irregular in outline, though somewhat rectangular, bearing four short, strong teeth along the distal margin and several smaller teeth mesad and proximad of these.

Maxillae.—The maxillae (Fig. 22) are attached to the ventral surface of the head and the following parts are distinguishable: a

triangular cardo (cd); a narrow sclerite which may be known as the cardella (cl); and a long, oblong stipes, to the distal end of which are attached two appendages representing palpus, lacinia, and galea. The lateral, narrower one of these (mxp), the palpus, bears on its surface a number of strong setae. There is sometimes a distinct swelling at the base of it but there is no distinct suture between the proximal and distal portions. The remaining process, regarded as the fused galea and lacinia (glc), is much broader at the base and tapers considerably at the apex, where it bears about five strong hooks. It is provided with two rows of weaker setae extending proximad from the hooks. The identification of this piece as fused galea and lacinia is due to the supposed occurrence, in adults of certain species, of a suture extending across it from the proximal to the distal end. So far no case has come to my notice in which this suture is present, but a study of Ephemerida (Morgan, '13) and Plecoptera (Fig. 31) on the other hand, proves conclusively that the piece has been correctly interpreted.

Labium.—The labium differs greatly from that of the ordinary insect in being free from the head at the point of articulation of the submentum, and in being folded so that mentum and submentum are approximated when the piece is at rest. It is applied to the ventral surface of the head, forming a sort of mask; and an idea of its general location and shape may be obtained from Figures 1–4, 6, and 7.

Several forms of labia occur in the suborder which, although similar in general construction, differ in certain particulars. The forms of the lateral arms or labial palpi, the mentum, and the submentum are different enough in different species to enable one to determine the family, and sometimes the genus, at a glance (Figs. 8–13). The submentum is a hollow tube of cuticle (Figs, 2, 4; sm) articulating at its proximal angles with the ventral wall of the head capsule. It is filled with muscles for the extension and retraction of the labium as a whole, and varies in shape from cylindrical to flat, and from comparatively short, hardly extending caudad of the posterior margin of the head, to long and slender, reaching caudad of the metacoxae. The mentum-ligula, or median lobe (Figs. 8, 9; ml), is likewise filled with heavy muscles which move the labial palpi. It varies in shape, in the degree of the contraction proximad, and, more important for purposes of classification, in the number of mental setae (Figs. 10, 12, 13; ms). The median lobe is sometimes notched or cleft at the apex but is more frequently without indentation. The glossae and paraglossae are present at the distal end of the labium, but the suture between them and the mentum is in

most cases indistinct. The latter, however, seems to be represented in species having the deeper median clefts. The palpi are present in the so-called "lateral arms", the distal segments being represented by the movable hooks (Figs. 8, 9; lp_2). The lateral arms also bear a number of raptorial setae in some species (Fig. 10). In capturing prey, which consists of mosquito and other soft aquatic larvae, the nymph swings out the hinged labium, opening and closing the lateral arms like a pair of jaws. The victim is then drawn back toward the mouth and the heavy maxillae and mandibles finish the work.

Labial Muscles.—The muscles operating the labium have been studied by few, and studies that have been made seem incomplete. It has therefore seemed advisable to examine them in detail. The structures have been determined by means of cross and longitudinal sections and verified as far as possible by gross dissections.

The median lobe (Figs. 1, 2; ml) contains four large muscles for operating the lateral arms. These are attached proximad directly to the dorsal wall of the submentum, dorsad of the hinge (Fig. 4). At the point of attachment to the labial palpi, the muscles are usually modified to form tendons. With the submentum there are also two pairs of muscles, which, though not as large as those of the median lobe, play an even more important part in the operation of the piece. The points of insertion of the mental muscles are of especial interest and give clues to the actual function of each muscle. The dorsal inner pair (Figs. 2, 4) is attached proximad to the tentorium and distad just above the hinge which is between the median lobe and the submentum. The remaining, or ventral, pair is attached to the chitinous ligament or rod described below—a structure present only in the Odonata. The rod (Figs. 3, 4, 7; cr) is unpaired and is attached to the ventral wall of the head just caudad of the hypopharynx. It extends obliquely caudad and dorsad in the plane of the meson and is attached again to the dorsal wall of the submentum, at which point it expands in such a way as to form the top of a T. The ventral pair of muscles are inserted on the base of the chitinous rod (Fig. 4). From this point they extend over the mento-submental hinge and attach themselves to the ventral wall of the median lobe. A third pair of muscles, present at the base of the submentum, is attached to the ventral wall of the head caudad of the hypopharynx, extends caudad and dorsad, and is inserted on or near the tentorium.

The exact function of each of the muscles contained in the submentum is difficult to explain, and it is probable that no single pair can be said to produce a given result with the exception of those operating the labial palpi. Thus it can be seen that the oblique muscles at

the base of the labium are important in throwing the submentum away from the head. In this, however, they are aided by the presence of the oblique, chitinous rod and by the contraction of the dorso-submental muscles. The action of the ventral pair seems reasonably clear, as it can, by contraction, swing the mentum back towards the submentum, and by action in conjunction with the chitinous rod, swing the submentum back towards the head. The mentum is swung out away from the submentum mainly by the action of the dorsal submental muscles which are attached to it above the hinge and in this capacity are aided to some extent by the contraction of the muscles within the mentum, especially those which operate the labial palpi.

Glossae and Paraglossae.—The glossae and paraglossae are fused and the suture is untraceable except in the embryo (Butler, '04). The nymph of Agrion shows a fold extending between the labial palpi beneath the median cleft. This fold probably represents all that is left of the suture between mentum and paraglossae. In other species the course of the suture is marked by a row of setae, the mental setae. The area occupied by the submentum is indefinite, but it is probable that the mental setae, even if secondary in origin and occurring only in the more specialized forms, are near the location of the original mento-paraglossal suture. The latter suture has been thought to become approximated to the distal border of the median lobe, but this seems doubtful after comparisons of nymphal and embryonic labia (Butler, '04).

Labial Palpi.—The palpi of the labium are represented by the lateral lobes, (Figs. 8, 9; lp_1, lp_2). These lobes bear at their distal ends a number of fixed hooks, which are simple in some cases, but may become modified in others, for instance in the Coenagrionidae, in which the middle hook is replaced by a blunt process with teeth at the apex. That the fixed hooks have not the same origin as the movable ones, is shown by the fact that the latter bear, in certain nymphs, a number of long setae. The movable hook has been considered (Butler, '04) as a modified palpal segment, and this interpretation is undoubtedly the correct one. The proximal segment or body of the lateral arms also bears in many species of nymphs a row of long setae, the number of which is used extensively in the classification of the group. In Agrion, however, this row of setae is wanting and the lateral lobe bears only two small setae near the base of the movable hook. The body of the mentum is also provided with rows of setae in all genera except Argia, Agrion, and Hetaerina, the bristles being in two divergent lines beginning near the meson slightly distad of the center and reaching nearly to the proximal end of the labial palpi.

Median Lobe.—This term is used for convenience and includes the fused glossae and paraglossae.

Hypopharynx.—Perhaps the most conspicuous portion of the hypopharynx is a circular pad between the tips of the maxillae, and easily seen on raising the mentum-ligula. It is covered with minute setae possibly indicating the location of sensory organs. The pad has been given the name laminula by Berlese, and corresponds to the lingua of other insects. However, it is somewhat difficult to homologize any part of it with other forms on account of the very great modification.

Propharynx.—The propharynx lies closely applied to the ental surface of the labrum, and has essentially the same shape as the latter. It possesses no features worthy of mention.

Prothorax.—The prothorax, the large segment just caudad of the head, is preceded by a smaller segment, the microthorax, which forms the neck. The sclerites of the microthorax are not well developed in the nymph. Most of the sutures of the prothorax are also indistinct and are represented by furrows in the cuticle. The pronotum (Fig. 23, pnc) is divided by depressions into caudal, mesal, and cephalic areas. The caudal lobe is, in most species, a narrow transverse area along the caudal margin; the mesal lobe comprises the larger part of the pronotum, and is usually divided by a median furrow into two lateral areas; and the cephalic lobe includes the transverse area cephalad of the median lobes and caudad of the cephalic margin. The furrow which marks the caudal boundary of the cephalic lobe and the median furrow of the pronotum form a Y, and at the point of union of the three arms there is usually an invagination. The proepimera and proepisterna are areas ventrad of the pronotum on either side and dorsad of the coxae, and are separated by furrows which are very distinct in some genera, especially Lestes. In this genus the furrow separating the two pieces extends dorsad a short distance from the point of articulation of the procoxae and the procoxal process (Fig. 25, pcxp), bends slightly cephalad and then caudad, extending to the caudal margin of the prothorax. In the Coenagrioninae there is often a secondary ridge extending dorsad from the procoxal process but this does not mark the boundary between proepisternum and proepimeron. The prosternum is the area between the procoxae, and is much broader than that of the adult. There is no indication of distinct areas or sclerites, but near the caudal margin of the prosternum and between the coxae are the two invaginations of the furca (Fig. 24, fi).

Mesothorax and Metathorax.—The mesothorax and metathorax are greatly different from the common type of thorax, in consequence of an approximation of the mesepisterna on the dorso-meson in the

mesothorax and an approximation of the epimera on the ventro-meson in the metathorax; all of which is accompanied by an enormous development of muscles within the thorax in preparation for the active life of the adult. The wing-cases, too, are early approximated, and there is a corresponding reduction in the size of the mesonotum and metanotum.

Mesonotum.—The mesonotum is divided into two regions by the closing together of the mesepisterna. The cephalic one, the prescutum, just caudad of the pronotum, is a shield-shaped plate with slightly projecting cephalo-lateral angles. On the cephalic margin of this piece on the meson there is an invagination, the prephragma, which, however, is usually not well developed in the nymph. The second portion of the mesoscutum lies between the cephalic pair of wing-cases. This represents combined scutum, scutellum, and postscutellum. It is narrowed cephalad, has a slight projection on each cephalo-lateral angle, the anterior wing-processes (Fig. 21, awp), and a similar, longer, one on each caudo-lateral angle, the posterior wing-processes (Fig. 21, pwp). Near the cephalic margin on the meson is an invagination indicating the location of the mesophragma. Immediately caudad of the mesoscutum and between the second pair of wing-cases is the metascutum. This is similar in shape to the caudal sclerite of the mesoscutum, though somewhat larger, and possesses similar wing-processes on its lateral angles. There is no subdivision of the metascutum, but there is a deep invagination on the meson near the cephalic margin—the metaphragma.

Mesothoracic Spiracles.—These are located just laterad of the prescutum and are always hidden to a greater or less extent by the overlapping pronotum. Large tracheae are connected with them and the spiracles are doubtless functional during nymphal life. The mesostigmal plates are wanting in the nymph, and their derivation will be discussed later, in the description of the adult.

Mesopleura.—These sclerites, occupying somewhat more than the cephalic half of the lateral aspects of the pleura, are approximate on their dorsal margin between the prescutum and the wing-cases. The dorsal border extends from the mesostigma caudad to the second pair of wing-cases. The cephalic margin follows the caudal margin of the pronotum and extends ventrad from the mesostigma to the mesocoxae. The ventral border follows the contour of the coxal cavity; and the caudal border, forming a suture which may be known as the interpleural suture (Fig. 25, insu), extends from between the mesocoxae and metacoxae dorso-caudad to near the base of the second pair of wings. The mesopleura are each divided by three furrows into three

areas, two of which, the cephalo-dorsal and cephalo-ventral (Fig. 25, seps, ieps), comprise the episterna, and the caudo-ventral, the epimera (Fig. 25, epm). The ventral areas of the episterna (ieps) are known to odonatologists as the infraepisterna, and the dorsal ones incorrectly as the episterna. For convenience in designating the parts the latter may be known as the supraepisterna (seps).

Mesosternum.—The mesosternum, that area between the meso-coxae, the caudal margins of the prosternum, and the cephalic margins of the metasternum, is not divided into separate areas, but the furcae are present and the deep furcal invaginations are very distinct (Fig. 24, fi).

Metapleura.—The boundaries of each metapleuron are the inter-pleural suture, the metacoxae, the metathoracic wing-cases, and the pleura and sternum of the first abdominal segment. The sclerites are each divided into three parts, the cephalic two comprising the metepisternum (supraepisternum and infraepisternum), and the caudal one, the metepimeron. The metathoracic spiracles are located on these pieces near the union of the dorsal border of the metinfraepisternum with the interpleural suture.

Metasternum.—The metasternum (Fig. 24, mtst) is similar in shape to the mesosternum, but is divided by sutures into three areas. The invaginations of the metafurcae are also prominent and a suture extends caudo-mesad from each. The two sutures unite on the meson, extend caudad for a short distance, separate again, and extend laterad and caudad of the coxae. The areas on each side of the mesal line are the two halves of the sternellum (mtsm). Caudad of the sternellum is a broad sclerite possibly representing the first abdominal segment. This may be known as the intersternum (Fig. 24, ints). There is no corresponding sclerite on the dorsum caudad of the thorax, but it may be that the latter portion has been lost. If, however, the intersternum be considered as a vestige of an abdominal segment, it will be found by actual count that there are twelve segments represented in the abdomen of the nymph, a fact which makes one skeptical of the above interpretation. In some species, the area is membranous, and it is possible that the sclerite is nothing more than accessory membrane which has subsequently become chitinized.

Trochantins.—The trochantins are wanting in the Zygoptera, and the mesal part of the coxae articulates directly with the sterna.

Legs.—The legs are usually slender and not well adapted for capturing prey, the labium being wholly relied upon for that purpose. The coxae are nearly spherical and slightly compressed. The trochanter consists of two segments. The proximal segment is narrow and

capable of being telescoped into the coxa. The second segment is longer, and its ventral length is greater than its dorsal. The femora are subequal in length, the posterior being slightly longer, especially in Argia and the Lestinae. The tibiae are also nearly equal in length and are slender and cylindrical. The tarsi have three segments. The proximal segment is short and is extended below the second segment so that its ventral length is greater than its dorsal. The second segment is usually about twice the length of the proximal but, like the proximal one, is extended on the ventral side. The third segment is longer than either of the two proximal ones, being in some cases nearly twice as long as the second and four times as long as the first. At the distal end of the third segment, on the ventral surface, there can be found a small sclerite which probably represents an extra tarsal segment and is known as the pretarsus (Fig. 19, pta). It is drawn out distally into a slender process. The tarsal claws vary to some extent in length but are always sharply pointed and somewhat swollen at base. They are never bifid at the tip as in the adult. The legs of the nymphs never bear the long spines characteristic of the adult but, instead, there are weak setae or short spinules which collect particles of dirt and enable the insect to hide with ease. In the Agrioninae, there are to be found short, minute, three-pointed scales at the ends of the tibiae, the function of which is obscure (Fig. 19). The tarsi in all species possess two to four rows of short setae on the ventral surface. The markings of the legs vary with the genus, but consist largely of black rings on the femora and tibiae. In Agrion, nearly the whole of the femur is dark except a whitish ring near the apex. The tibial bands are mostly restricted to the proximal third and are lacking in most species.

Wing-cases.—The wing-cases of Zygoptera appear early and at the completion of nymphal life usually extend as far caudad as the fifth or sixth abdominal segment (Fig. 25, wc). The tracheation of the pad is often obscure but the veins are sometimes plain enough to be of value in identification. Ontogenetic studies of the wings can only be made at intervals during the growth of the nymph, the obscure nature of the contents of the pad making such study difficult during the greater part of the time. In no case do we find the radial sector actually crossing over the media as in the Anisoptera, and, as pointed out by Needham ('03), the subnodal cross-vein formed by the proximal end of the radial sector has been reduced and lost. The distal portion, however, may be seen in Lestes, but not usually in other species, and branches from the second media a short distance from its separation from the first media (Fig. 14, Rs).

Abdomen.—The abdomen is always composed of ten complete body-rings. The eleventh segment, seen best in Lestes, is represented by the small basal processes (Figs. 5, 18; A_{11}) to which the caudal gills are attached. The twelfth segment, supposed to be present in the minute sclerites bounding the anus, is apparently wanting or indistinct. Each body-ring is without sutures but is roughly divided by the lateral carinae into sternal and tergal areas. In the Coenagrionidae, the lateral carinae of the first eight segments are known as lateral keels (Fig. 25, lk). In Lestes, the caudal extremity of each keel is sometimes drawn out into short setae and is setose or hairy along the margins. Marginal setae are also present in the Coenagrionidae but the heavy caudal setae are wanting.

Sexual Appendages.—It is claimed that the sexual appendages of the nymphs (Balfour-Browne, '09) can not be seen and differentiated until about the time of the seventh molt. From personal observations, however, it would seem that the appendages appear much earlier than this, and possibly as early as the fourth molt. The male genital appendages are located on the ninth abdominal sternum and consist of a simple pair of short, sharp, conical styli, near the ventro-meson. There is also an indication of the location of the male copulatory organs on the ventral surface of the second and third sterna (Fig. 24, ag), though nothing definite is formed there until the adult emerges. The ovipositor of the female is composed of six processes developing from the eighth and ninth sterna (Figs. 5, 18; oce, oca). Four of these are similar in appearance, being slender, curved, blunt projections extending commonly beyond the end of the ninth segment and frequently beyond the apex of the tenth. Laterad of this double pair of inner valves, can be found a pair of lateral styli which differ from the inner valves in being pointed at the tip and much broader at the base. The origin of the four median valves is partly from the eighth abdominal segment and partly from the ninth, the external ventral pair (oce) being derived from the eighth.

Caudal Gills.—The caudal tracheal gills are present in the earliest stages and are reported to have been seen in the embryo. They vary from linear to broadly obovate in outline and from triangular to linear in cross-section. Cuticular pigmentation, if any, is either in transverse bands or is diffused over the entire gill. In many cases the tracheae contain pigment, which causes them to stand out in marked contrast to the rest of the gill. Along the margin of the gills are rows of spines or setae, which differ in number and extent in different species. The lateral median ridges of the flat type of gills also possess rows of setae, but they are difficult to observe and are of little

importance in classification. Two or more main tracheal trunks enter each gill and send off branches towards the margins. The mode of branching of the trachea is characteristic of many species, as is also the degree of pigmentation.

A closed tracheal system has been considered possible and even probable in the Zygoptera, but thus far no connection has been traced by me, with the highest magnification obtainable, between the ends of the branches of the tracheae. The normal function of the gills is one of respiration, the minute tracheae being supposedly able to take up the oxygen from the water and to supply the animal with a sufficient quantity of the gas. Observations show, however, that complete loss of gills does not injure the insect to any appreciable extent; and it has been suggested that they also have cuticular and possibly rectal respiration, the latter thought to have been demonstrated in the Agrionidae. In young nymphs there is a pulsating movement in the region of the rectum, but cross-sections of the abdomen of *Ischnura verticalis* and several species of Enallagma show that there is no connection of the tracheal system with the alimentary tract other than a few small branches. What seems to be a more serious impairment of life activities in the loss of the gills is the decreased power of locomotion which the insect suffers, the gills having the same importance as the tail of a fish. Loss of gills frequently occurs, in which case new ones are produced; but these appear only after the insect has molted, always remain small, and are usually abnormal in figuration and tracheation (Fig. 77a). For different types of gills see Figures 48–72, 75–77a, and 80.

Cerci.—Anal appendages corresponding to cerci are present dorsolaterad of each lateral gill and vary in shape from tubercular to styliform (Figs. 5, 18; ci).

ADULT

The adults of Odonata are distinguishable from all other orders of insects by the type of their wing venation. The wing is characterized by the presence of a nodus and a stigma and a large number of secondary cross-veins. The presence of accessory genitalia on the second abdominal segment of the male is another unique feature. The Zygoptera are for the most part separated from the suborder Anisoptera by the habit of folding their wings vertically when at rest. The abdomen is much more slender than that of the Anisoptera, and the wings are different in being contracted or petiolate at the base.

Head.—In general appearance the head is wide and the eyes are very prominent, and as the head moves on a point of the microthorax its angle of rotation is very great. The epicranial furrow is present

on the dorsum near the caudal margin, similar in position to that of the nymph, and is, as a rule, indistinct unless the head is specially prepared in caustic potash. The furrow begins near the caudal margin of the dorsum, extends cephalad a short distance, forks, and extends latero-cephalad, caudad of the ocelli, to the margins of the compound eyes (Fig. 32, epcs). It can not be traced to the occipital foramen, but the homology of the furrow as a whole can not be doubted. There are three ocelli (o) cephalad of the Y, which are sometimes elevated above the surface of the head forming the so-called ocellar area. A furrow extends cephalad from the angle of the Y between the lateral ocelli and forks just caudad of the median ocellus. This furrow is present in many orders of insects, but its true homology is not known. The front includes that portion of the dorsal aspect cephalad of the epicranial Y, between the compound eyes and cephalo-ventrad to the fronto-clypeal suture (Fig. 32, f). Cephalad of the median ocellus there is always a short, deep, transverse furrow which, although present in most Odonata, must not be mistaken for a suture. The fronto-clypeal suture does not reach the margins of the compound eyes on either side. There is always a polished area on each side of the clypeus, which is a portion of the gena (Fig. 32, gn). The clypeus (Fig. 32, cly) extends ventrad of the fronto-clypeal suture and is divided into two parts by a transverse median ridge. The dorsal part, often dark and heavily chitinized, is the postclypeus; the ventral one, more weakly chitinized and often wrinkled, is the anteclypeus. The clypeo-labral suture separates the clypeus from the sclerite ventrad of it, the labrum (Fig. 32, lbr). This sclerite is only slightly bilobed in most species of Zygoptera, the ventral margin is directed caudad, and the lateral margins are convexly rounded. Laterad of the bases of the mandibles, which lie at either side of the clypeus and labrum, there are small semi-ovate sclerites, the trochantins of the mandibles (Fig. 32, tm). The fronto-genal sutures are indistinct, but are represented by furrows extending from the dorsal articulations of the mandibles to the antennal fossae and laterad to the compound eyes. That portion of the head on the dorsum and caudad of the arms of the epicranial Y, is the vertex (Fig. 32, vx), but it is not separated by a distinct suture from the occiput, which occupies the dorsal half or third of the caudal aspect (Fig. 30, oct). The postgenae, which occupy the ventral half of this aspect are separated from the genae by the oblique ridge mentioned above. There is another ridge starting from the ventral condyle of the mandibles (Fig. 30, ocr) but extending dorsad instead of latero-dorsad. This ridge disappears near the middle of the head.

Ocelli.—The location of the ocelli has already been described. They are moderately large, elliptical, and grouped in a triangle (Fig. 32, o).

Compound Eyes.—The compound eyes (Figs. 30, 32; ce) are large and contain a large number of ommatidia. They are located mostly on the lateral aspects of the head, but sometimes extend well onto the dorsum.

Antennae.—The antennae (Fig. 32, ant) are usually composed of four segments. The condyle of the scape is especially prominent. The two terminal segments are styliform and resemble a single segment. The greatest variation in the different segments lies in the length of the first, which ranges from hardly more than half that of the second segment, to an equal or greater length than that. There is also a less noticeable variation in the length of the third segment.

Labium.—The labium (Fig. 37) is the ventral movable appendage of the head. It is a broad flat piece and covers nearly one-fourth the entire ventral surface. The submentum (sm), the proximal sclerite, is attached to the head and neck and comprises that part of the labium dorsad of the hinge when the labium is at rest. Immediately cephalad of the hinge there is a small, almost linear, transverse area, the mentum (me). Beyond this there is a large subtriangular piece with a deep median, distal cleft and a suture-like furrow extending to the proximal end. This piece is the median lobe (ml) and represents fused glossae and paraglossae. On each side of this median lobe there are heavy blade-like lobes, the labial palpi, which connect with the proximal part of the median lobe. The fixed proximal segment is the palpiger (pl), the large movable distal portion is the proximal segment of the palpus, and the short blunt movable appendage borne by the proximal segment is the distal segment (lp_1, lp_2). There is a long, sharp, fixed hook mesad of the distal segment of the palpus, which in most cases is longer than the distal segment of the palpus.

Maxillae.—The maxillae are just above the labium, one on each side of the mouth-opening. When the labium is applied to the ventral surface of the head, the maxillae are hidden, except the cardines and the caudal half of the stipites. The cardo and cardella are bent at an angle to the stipes, but when removed from the head along with the rest of the maxilla they are seen as two small sclerites attached to the proximal end of the stipes, the cardo being triangular and attached to the stipes, and the mesal side of the triangle forming the suture between cardo and cardella. The cardella (Fig. 28, cl) is a very irregular sclerite which articulates with the head capsule. Attached to the distal border of the stipes, the quadrangular sclerite which forms the body of the maxilla, are two appendages, the lateral more slender two-

segmented appendage being the palpus, the broader one, the fused galea and lacinia. The palpus has a number of large setae scattered over the surface. The galea-lacinia is more or less compressed, and the distal margin has about six irregularly placed hooks arranged in two rows. A marginal fringe of heavy setae extends proximad from the hooks. In Hetaerina, if the galea-lacinia be placed on edge, there will be seen a strong indentation between the two rows of hooks, an indication of the fused condition of the piece. A study of Plecoptera (Fig. 31) and Ephemerida (Morgan, '13) offers convincing reasons for the interpretation of this piece as galea and lacinia fused, as compared with a belief in the reduction of the galea, or in the fusion of this with the palpus instead of the lacinia, or in the reduction of the palpus. All degrees of fusion, from complete separation (Fig. 31) to complete fusion and disappearance of the suture, may be had in series selected from these two orders.

Mandibles (Fig. 30, md).—All of each mandible is hidden beneath the labrum and labium except the lateral surface. The teeth are strong and heavily chitinized and the distal margins are divided into two projections, the cephalic one bearing a number of teeth, the caudal one with a number of teeth and cutting edges arranged in the shape of a Z.

Hypopharynx (Fig. 30, hp).—The visible portion of the hypopharynx appears as a semicircular part between the tips of the maxillae. It is much more heavily chitinized than that of the nymph, and usually has a number of long setae attached to each lateral surface.

Propharynx.—The propharynx is closely applied to the interior of the labrum and clypeus and presents no features of interest.

Microthorax (Figs. 27, 29, 36, 39).—The microthorax comprises the neck sclerites, and is much reduced in the Zygoptera. The dorsal and ventral sclerites (notum and sternum) and the episterna are wanting. The only portions remaining are the conspicuous lateral plates, the epimera (min). In many species the epimera are much widened on the caudal third, and this portion is almost completely divided by a deep cephalic indentation. The indentation separates from the main part of the epimera a bell-shaped dorsal part which serves as a buffer for the head and is to some extent freely movable. The ventral part is slightly larger than the dorsal buffer, but is thrown into folds, and the cephalic part of the ventral piece is drawn out into a long tapering point. The tips of the epimera are fastened together by ligaments and the head rotates upon the apices of the two together, which rest against the body of the tentorium.

Thorax.—The thorax comprises the three body-segments caudad of the microthorax. The first conspicuous ring is the prothorax. The

mesothorax and metathorax together form the division caudad of the prothorax and are so closely united that they appear as one segment.

Prothorax (Figs. 27, 29, 36, 39; 41, pn).—The lateral margins of the pronotum are usually indefinite because of the disappearance of the noto-pleural suture or because of excessive pigment. Lestes is probably the best form in which to study the prothorax on account of the clearly marked sutures between the sclerites. The caudal margin of the prothoracic dorsum extends caudad as a thin blade-like projection. There is a suture or furrow which extends cephalad from the lateral limit of the blade-like projection and marks the lateral extent of the pronotum (pn). Shortly cephalad of the caudal margin of the pronotum and parallel to it there is a deep furrow which resembles a suture and extends from one lateral margin to the other. The area between this fold and the caudal margin is the caudal lobe of the pronotum. Cephalad of the lateral extremities of the caudal lobe, the suture marking the lateral boundary of the pronotum arches dorsad a little and reaches the cephalic margin of the prothorax at the base of the microepimeron. At this point there is a second transverse fold in the pronotum which is, however, large and more irregular than the caudal one mentioned above. The area between it and the cephalic margin is the cephalic lobe. Near the dorso-meson, the cephalic fold bends caudad and there is a deep invagination here, the prophragma. Between the prophragma and the caudal lobe there is a furrow which separates the remaining portion of the notum, not included by the caudal and cephalic lobes, into two equal, mesal or median lobes (Figs. 36, 39; pme). The principal variations in the prothorax lie in differences in the caudal lobe and in the sculpturing of the dorsal surfaces of the mesal lobes. In Nehalennia the caudal lobe is deeply incised and in Chromagrion (Fig. 170) this lobe is not only incised, but there are also two flat points, projecting laterad, one on each mesal lobe. Many other modifications also occur, most of which are secondary sexual characters.

Propleura (Figs. 36, 39).—The propleura, those areas ventrad of the pronotum and dorsad of the coxae, are each subdivided into three areas. Extending dorsad from the lateral procoxal articulation (pcxp) there is a distinct suture which becomes indistinct before reaching the lateral margin of the pronotum. This suture (pps), the propleural suture, is usually depressed and the depression is continuous with that forming the cephalic fold of the pronotum. Caudad of the propleural suture there is a large, rounded area which forms the caudolateral angles of the prothorax, and ventrad of this is a small, falcate area. Both areas constitute the proepimeron (pepn), there being no

real suture between the two. Cephalad of the propleural suture is a somewhat triangular area, the proepisternum (peps), the cephalo-ventral angles of which are drawn out and extend ventrad in front of the procoxae. The cephalo-ventral arms of the proepisterna are fused with the propreepisterna. Between the dorsal triangular portion of the preepisterna and the microepimera is a small, much-wrinkled area, which appears to be composed of a number of sclerites. This, however, belongs to the proepisternum.

Prosternum (Figs. 27, 29).—The cephalo-ventral arms of the episterna, as described above, extend ventro-cephalad and become approximate but not quite contiguous on the ventro-meson. Caudad of the approximated ends of the episterna there is a large shield-shaped ventral sclerite the caudal margin of which is concave. This is the fused sternum and presternum (prst). The caudo-lateral angles are usually acute, and at the tips of these angles are found the deep invaginations of the furcae (fi). Caudad of the sternum and between the furcae is a heavily pigmented chitinized area, the sternellum, which extends about as far caudad as the caudal margins of the coxae. In some cases there is within the sternellum an elliptical or oval depressed area much resembling a true sclerite. This is a secondary formation. On each side of the meson, caudad of the sternellum, is a heavily chitinized bar which extends latero-caudad and is attached to the mesothorax. These bars represent the furcella (fl).

Mesothorax and Metathorax (Figs. 40–47).—This division of the thorax bears the two pairs of wings and the second and third pairs of legs. A glance at the mesothorax and metathorax of any dragonfly will show that the wings, instead of being borne on the mid-dorsum of the thorax, are situated far to the rear and are inserted just above the cephalic margin of the first abdominal segment. This change in wing position has brought changes in the structure of the thorax as a whole, including the reduction of primary sutures and the appearance of many secondary ones, and as a result the external thoracic skeleton of Odonata is as complex as that of the highly specialized Hymenoptera and Diptera.

Mesnotum (Figs. 41, 44, 46, 47).—As has been mentioned in the nymphal description, the mesepisterna are approximate on the dorso-meson. In the adult the two have united and fused, a single suture being left, extending from near the caudal margin of the pronotum to the wing bases. In some cases this suture is slightly elevated, forming a carina (dc), but it is often flattened at the point of fusion of the two pieces and the suture nearly obliterated. Cephalad of the dorsal carina there is a small somewhat rhomboidal area, the prescutum

(mscl). There is a deep invagination near its cephalic angle but no invaginations of the internal skeleton occur here. Caudad of the caudal extremity of the dorsal carina and adjacent to the wing bases there are two small, frequently subcrescentic pieces which are approximate on the mesal margins and extend well towards the first lateral suture of the thorax. These are the combined mesepisternal paraptera (p). Caudad of the mesepisternal paraptera, but on a distinctly lower level and between the first pair of wings, is the second portion of the mesonotum, which consists of a number of irregular hummocks separated by depressions, sutures, and ridges. Just caudad of the paraptera on the dorso-meson there is a very deep invagination of the mesaphragma, which is situated near the cephalic margin of the mesoscutum (mscc). At this point the mesoscutum is narrow, but widens soon after extending caudad a short distance and forms a process, the anterior wing-process. From this point the margin extends caudad and forms a similar process, the posterior wing-process. The caudal boundary of the scutum is formed by a heavy chitinous line, bent caudad and extending from side to side between the caudal wing-processes. From the caudal wing-processes the lateral margins of the mesonotum, now the scutellum, extend caudad to the point of entrance of the spring-vein (Figs. 46, 47; spn) which always marks the caudal margin of this sclerite. The central portion of the scutellum is elevated to form a sort of knob, which is heavily chitinized. The portions on either side of this are depressed and as a rule less heavily chitinized than the elevated portion. The area caudad of the spring-vein is the postscutellum (mopl), the latter extending as far as the deep fold which forms the cephalic border of the metaprescutum.

Metanotum (Figs. 46, 47).—The metaprescutum (psct) is a narrow, transverse, heavily chitinized sclerite forming the cephalic margin of the metanotum. It is in great part covered by the membranous postscutellum of the mesonotum but can usually be seen through the latter. On the lateral angles, there are slight ental projections. Caudad of the transverse prescutum, there are four large areas composing the scutum (mtsc) and three deep longitudinal folds which mark off the four areas, but no primary sutures. There is also a somewhat irregular area caudad of the four larger ones. The caudal margin of the scutum is depressed laterad, and the latero-caudal angles project and form the anterior wing-processes. The metascutellum (masl) is similar to the mesoscutellum (mosl), the caudal boundary being marked by a spring-vein (spn) and the sclerite, as in the former case, having a raised central portion and depressed lateral ones. The postscu-

tellum comprises the area caudad of the spring-vein and cephalad of the first abdominal segment.

Mesothoracic Spiracles and Mesostigmal Plates (Figs. 41, 43–45, 212–216).—The mesothoracic spiracles of Zygoptera are large and have exceedingly large tracheal trunks connected with them. As in the nymph, the spiracles have migrated dorsad and are located near the lateral angles of the mesoprescutum and beneath the projecting caudal margins of the pronotum. Adjacent to the spiracle on two sides, are two heavy plates, the ventral one of which is highly polished (Fig. 45, mstv), allowing the prothorax to play upon it to a certain extent. The caudal plates (mstg) are usually triangular and assume a variety of forms in different species. Both of these plates belong to the peritreme of the spiracle. The caudal plate has been assumed by Snodgrass ('09) to be homologous with the depressed area in Anisoptera which extends across the dorsum just caudad ot the pronotum. A study of the nymphs of Anisoptera proves conclusively that such is not the case, for in the nymph the depressed area may be observed to develop from the mesepisternum. Another possibility in the derivation of the caudal plates is that they have arisen from the mesoprescutum, and the wide depressed area of Anisoptera may also have had the same origin. This is strongly supported by the apparent disappearance of all traces of the prescutum in the adults. There is, however, a remnant of the prescutum in the adults of Gomphus where the area occupied by the prescutum lies entirely within the transverse depression and the true stigmal plate is closely applied to the stigma. From this it seems that the depressed area of Anisoptera can not be homologous with the spiracular plates of the Zygoptera, but that it must have developed simply from a depression of the mesepisterna.

Use has been made of the caudal stigmal plates in the classification, especially in the case of the females, of the genus Argia. Kennedy ('02a) and Calvert (Calvert and Hagen, '02:103) were the first to call attention to these plates in America, but their use was hinted at as long ago as 1865 by de Selys ('65: 381). In the genus Argia the caudomesal angles are the variable parts of the sclerites. There is considerable difference also in the plates of females of the Coenagrionidae, and individuals of this sex may often be separated by the use of this character. In the Lestinae and Agrionidae, the character seems to be without value, which fact makes the members of the genus Lestes, at least, one of the most difficult of all genera of Zygoptera to determine.

Mesopleura (Figs. 43, 45).—The mesopleura are closely united to the metapleura in most Zygoptera and the interpleural suture has been lost in many cases. This suture can be traced for its full length

only in the family Agrionidae (Fig. 45, insu), in which it extends from a point between the mesocoxae and metacoxae, caudo-dorsad to the caudal margin of the first pair of wings.

Mesepisterna (Figs. 43, 45).—The mesopleural suture, dividing the mesopleura into episterna and epimera, may be traced by locating the lateral articulation of the mesocoxae (Fig. 40, mcp) and the mesopleural wing-process (wp)—a heavily chitinized process extending from the caudo-dorsal margin of the thorax into the membrane at the base of the first pair of wings. The suture will be found to extend cephalad, beginning at the wing-process, parallel to the dorsal carina, as far as the cephalic third of the mesothorax, where it apparently forks, and sends one branch cephalad and the other ventrad to the coxal process (mcp). The horizontal fork is a secondary suture and separates the small sclerite above the coxae, the infraepisternum (ieps), from the rather large oblong sclerite, the supraepisternum (seps).

Mesepimera (Figs. 43, 45).—The mesepimera lie caudo-ventrad of the mesopleural sutures. In the Coenagrionidae they are fused with the metepisterna and the interpleural suture is obsolete except near the wing bases. In the Agrionidae the interpleural suture is distinct throughout its course, and the metepimera are then elongate sclerites with the dorso-cephalic angles considerably rounded.

Metapleura.—The key to the metapleura is the metapleural suture, which may be traced in a similar manner to the mesopleural suture. This may be done by finding the metacoxal articulation and the metapleural wing-process (wp), situated at the base of the second pair of wings, and following the suture between the two points.

Metepisterna (Figs. 43, 45).—The metepisterna are those portions of the metapleura cephalad and dorsad of the metapleural suture (Fig. 45, mtsu). Like the mesepisterna they are divided into two separate sclerites, a small one dorsad of and adjacent to the coxae, the metinfraepisternum, and a larger, elongate one dorsad of the metinfraepisternum and extending from the cephalic margin of the latter caudo-dorsad to the bases of the wings—the metasupraepisternum (seps). The latter is narrowed to about half its width above the infraepisternum and usually bears the metathoracic spiracles (Fig. 43, mtsl) within the constricted portion. In many species there is a secondary suture extending between the spiracle and the metapleural suture (Fig. 45).

Metepimera (Figs. 43, 45).—Caudo-ventrad of the metapleural suture is the metepimeron. The metepimera are contiguous on the ventro-meson. In the Agrionidae the boundaries of the sclerite, beginning with the metacoxal process (mtcp), may be indicated as fol-

lows:—The margin extends ventro-mesad (Fig. 40), meeting its fellow from the opposite side on the meson, then extends caudad halfway from the coxae to the first abdominal segment, bends laterad to the elevated lateral carina, caudad again to the abdomen, then dorsad (Fig. 45) along the wing bases to the metapleural suture (mtsu), which forms the dorso-cephalic border of the sclerite. At the caudo-ventral angles of the epimera there is a small triangular sclerite which is apparently cut off from the main portion of the epimeron. The primary suture follows the ventral margin of the deep fold which occurs at this point. The latero-ventral carina does not follow the ventral suture of the epimera all the way from the abdomen to the coxae, but, instead, follows a more direct line along the ventro-lateral margins of the thorax and diverges from the suture half-way from the abdomen to the coxae (Fig. 40). In the Coenagrionidae the sutures marking the ventral borders of the epimera are less distinct and do not follow quite the same course (Fig. 42).

Mesosternum and Metasternum.—The approximation of the coxae in the adults of Zygoptera has brought about profound changes in the mesosterna and metasterna.

Mesosternum (Figs. 40, 42; mst).—The key to the mesosternum lies in the invaginations of the furca (mfi) which mark the caudal limits of the sternum. In the Agrionidae the elevated parts of the sternum and sternellum form a distinct hour-glass figure with the furca on either side of the contracted portion. The margins of the sclerites are, however, parallel to the elevated portions, but are somewhat depressed. If the cephalo-lateral angles of the sternum are followed to the sides of the thorax they will be found to extend nearly as far dorsad as the dorsal margins of the mesinfraepisterna. The cephalo-lateral arms are expanded dorsad, and there are apparently several sclerites represented in the upper portions, possibly the remnants of the mesopresternum (Figs. 43, 45; pst). Along the lateral margins of the sternum cephalad of the furcae there are obscure invaginations which represent the prefurcae (mpf). These are difficult to see from the exterior unless the cuticle is cleared.

Mesosternellum (Figs. 40, 42; mstm).—The mesosternellum is similar in shape to the sternum except that the caudal margin is convex and heavily chitinized in some groups, notably the Agrionidae. The chitinized portions represent furcellae. From the caudal margin of the mesosternellum there extends a short, heavy, chitinous projection which sinks into the metathorax, and is lost from sight beneath the metasternella. This is a part of the metasternum (Figs. 40, 42).

Metasternum (Figs. 40, 42).—This sclerite is even more profoundly modified and distorted than the mesosternum. The metacoxae are almost contiguous and the muscles attached to the metasternum along the meson have drawn it well into the interior. The metafurcae can only be seen upon dissection of the thorax, and are to be found closely approximated along the ventro-meson. The prefurcae (mtpf) are a short distance cephalad of the furcae (mtfi). The presternum and sternum are fused, and the cephalo-lateral arms extend around the cephalic margins of the coxae and unite with the metinfraepisterna. The sternellum is represented in each sclerite mesad of the caudal half of the metacoxae, the caudal boundary being marked by two nearly contiguous chitinized spots on the meson (Figs. 40, 42).

Intersternum (Figs. 40, 42; ints).—The closing together of the metepimera has apparently resulted in the isolation of a portion of the sternum, near the abdomen. Comparisons with the thorax of Orthoptera and other orders show that this may be a portion of the abdomen, but in this case it is probably the cuticular membrane developed between the abdomen and thorax. The possibility that this sclerite represents an extra abdominal segment has already been discussed under the description of the nymphal thorax. The name intersternum has been applied to this area.

Postcoxal Area.—The area on the thoracic venter between the lateral carinae, caudad of the metacoxae and cephalad of the first abdominal sternum, is the postcoxal area.

Legs.—The legs are long and comparatively slender, and have long setae arranged regularly in rows (Fig. 35). They are not adapted for walking or running.

Coxae (Fig. 35, cx).—The coxae are large and globular, and there are prominent ridges on the lateral surfaces of the procoxae and the caudo-lateral surfaces of the mesocoxae and metacoxae.

Trochanters (Fig. 35, tr).—The trochanters are much smaller than the coxae and are divided into two short pieces in all families. The ventral length of both portions is much greater than the dorsal.

Femora (Fig. 35, fe).—The femora are long and cylindrical and without carinae except in a few genera. The ventral surface is provided with two rows of long black setae (fs), varying in number from three or four on the fore tibiae to as many as sixteen or seventeen on the hind tibiae.

Tibiae (Fig. 35, ti).—The tibiae are likewise long and slender and have a double row of setae on the ventral surface. In the fore tibiae of most species the setae of the cephalo-ventral row are conspicuously

flattened. The comb (tic) formed by these closely placed setae is probably used for cleansing the mouth-parts or the antennae. There is a great deal of variation in the length of the tibial setae and also in the number present in different subfamilies.

Tarsi.—The tarsi are always composed of three segments, the segments increasing in length from the proximal to the distal end (Fig. 35, ta). They are also provided with a double row of setae beneath, but these are never as long as the tibial or femoral setae.

Pretarsus.—The pretarsus (Fig. 19, pta) is beyond the end of the third tarsal segment and consists of a small shield-shaped piece on the ventral surface just beneath the bases of the claws. It extends back into the third segment, and in order to be seen best the claws should be pulled outward a little. There is also a small projection attached to the tip of this sclerite, but this is not homologous with the empodium of other insects. The ventral apical margin of the last segment of the tarsus is deeply emarginate on each side of the pretarsus.

Claws.—The claws are long and slender and the tips are always notched or bifid (Fig. 35, cw). The rays are seldom equal in length, and in some species the notch is far proximad of the apex.

Wings (Figs. 73, 74, 78, 81-90).—All Zygoptera have four similar membranous wings. In respect to venation and shape, the genus Hetaerina may be said to have the most primitive wing of any zygopteron found in Illinois (Figs. 74, 78). The position and course of the veins in the wings of this genus are as follows:—The costa, first longitudinal vein, forms the cephalic margin of the wing. The subcosta, second longitudinal vein, extends half the length of the wing from the base and ends abruptly in a short fork which marks an indentation in the margin. The two forks of the tip of this vein are in line with a heavy cross-vein caudad of it, and the brace formed by the alignment of the cross-vein and the subcostal forks is known as the nodus. The third longitudinal vein extends from base to apex of the wing and is composed of fused radius (R) and media (M) as far distad as the nodus and first radius (R_1) plus the second subcosta from nodus to apex. There are a number of cross-veins extending between costa and subcosta from the base of the wing to the nodus—the antenodal cross-veins. Between costa and radius, distad of the nodus and proximad of the stigma—the heavily chitinized spot near the apex of the wing—are the postnodal cross-veins. The remaining branches of the radius are united, forming the radial sector (R_S), and separate from the main trunk at the nodus. The course of the radial sector is difficult to follow because of its crossing one or two of the median veins. In Hetaerina the radial sector branches from the radius

at the nodus, crosses the first median vein, the first vein caudad of it, at the point where the second median vein separates from the first, follows the second vein for a short but indefinite distance, being fused with it, and then crosses over to the longitudinal vein caudad of the second media, and continues its course to the margin of the wing (Fig. 74). The point of separation of the radial sector from the second media is not evident, there being no oblique cross-vein as in the Anisoptera. The vein uniting the caudal end of the cross-vein over which the radial sector crosses, to the main radio-medial trunk is known as the bridge (seen in Lestes and Ischnura, Figs. 81, 85; br), and is secondary in origin. In Hetaerina the trachea of the bridge is fully as strongly developed in the nymph as any other of the main tracheal trunks. Such a feature would perhaps throw some doubt on the actual formation of the bridge in this suborder were it not for the strong comparative evidence present in the Anisoptera. The bridge reaches R-plus-M about half-way between the nodus and the base of the wing. About one-third of the distance from the base to the nodus is a strong, oblique cross-vein, the arculus (Figs. 81, 85; arc), from the middle of which two longitudinal veins arise. These veins are the third and fourth median veins (M_3 and M_4), respectively, the cephalic one being M_3. A short distance from the arculus there is another heavy cross-vein connecting M_4 with the longitudinal vein caudad of it. The cross-vein probably represents the medio-cubital cross-vein. The four-sided area enclosed by this vein, the portions of M_4 and the longitudinal vein caudad of it (the cubitus) and distad of the arculus, forms what is known as the quadrangle (qd), and corresponds to the cell first M_4. The cubitus extends from the base of the wing to the distal side of the quadrangle, where it forks and sends out two longitudinal branches caudo-laterad to the margin of the wing. The forks are Cu_1 and Cu_2, or first and second cubitus. The anal vein (A) consists of a single heavy trunk extending from the base of the wing and apparently connecting with the cubitus at the point where the latter forks. The different anal veins can not be traced because of numerous secondary cross-veins.

Many variations occur in the above wing-venation, but instead of a discussion of each in detail the reader is referred to figures 73 and 81–90 which show the types of venation occurring in the remaining genera of Zygoptera found in Illinois.

Abdomen (Figs. 91–100, 104).—The abdomen of all Zygoptera is cylindrical and composed of ten complete segments. In all of the segments the sterna are much reduced and hidden by the overlapping terga. The pleura are still more reduced, so that no portion of them

can be seen in the normal insect. If the body be softened and the lateral margin of the terga extended, the pleura appear as membrane between the margins of the terga and the sterna. In this membrane, near the cephalic-lateral margin of the first eight segments, the abdominal spiracles are found. The terga of all the segments are always large, are bent around from the dorsum onto the lateral aspect of the abdomen, and usually extend slightly onto the venter. A single tergum, then, has a dorsum and pleuron of its own. The terga are usually transversely rugose on the dorsum, and the lateral margins are always paler than the dorsum, and finely pilose. The apical margins of all except the last segment have elevated subapical chitinous rings which are frequently provided, especially in the terminal segments, with a number of short, heavy setae. The apical margin of the tenth segment may bear a long spine at the apex (Fig. 110), or the apical margin may have a long, subapical, blunt process (Figs. 166, 167), or it may be simply emarginate. The sterna are narrow transversely, with the exception of the first two and the last two, and are more or less hidden by the margins of the terga. The first sternum (Figs. 40, 42) is usually subtrapezoidal with the cephalic margin concave. The second sternum of the male is developed into an accessory copulatory apparatus which will be described later. In the female this sternum is similar to sterna three to eight and consists of an oblong plate of chitin, slightly wider cephalad, and having small ental projections at the cephalo-lateral angles. The eighth sternum of the female is divided into three sclerites (Figs. 109, 116), a single large proximal one and two small, sometimes obsolete, ones which are intimately connected with the first pair of gonapophyses. The ninth sternum (Figs. 109, 116) is greatly reduced in the female, being represented by narrow sclerites along the margins of the tergum extending from the proximal end to about the distal third or half of the segment. The ninth sternum of the male bears the genital opening, and on each side of this, and covering it, there is a more or less oval plate. These plates are known as the parameres (pa, Figs. 118, 121, 147, 165, 171, 172, 183). The tenth sternum is fused with the tergum on the lateral aspect.

Abdominal Appendages.—This term includes the accessory genitalia and anal appendages of the male, and the ovipositor of the female.

Accessory Genitalia (Figs. 33, 97, 98, 101, 105, 107, 108, 120, 122).—The accessory genitalia of the male are derived from the second and third sterna, and a portion sometimes from the second tergum. The sperm duct opens in the ninth sternum and spermatozoa are transferred to the accessory pouch or vesicle by doubling the abdomen upon

itself. The sternum of the second segment forms two heavily chitinized hamules (Fig. 33, hm) which serve as covering plates. The membranes immediately below these form a sheath for the penis (Fig. 33, ps). The latter is very heavily chitinized and is bent entad, extending to about the middle of the abdomen, and at the ental end are attached heavy muscles which operate the organ. The tip of the penis is largely membranous and flexible, and exhibits modifications which appear to be of specific value in classification, at least in some genera. The tip fits behind a heavy cephalic projection of the third sternum, the seminal vesicle, when not in use (Fig. 33, sv). Small knob-like projections may be seen extending ventrad from the lateral margins of the second tergum and just caudad of the hamules. These are frequently concealed in the Zygoptera but are large and conspicuous in the Anisoptera where they are known as the genital lobes (Fig. 33, gb). The cephalic third or less of the third sternum is elevated, heavily chitinized except at the tip, and extends some distance cephalad of the cephalic margin of the segment. In a few Anisoptera this part is reported as functioning as the penis, the parts already described for Zygoptera being unimportant.

The variations occurring in this organ throughout the suborder are marked and are in all cases of generic rank as diagnostic characters. In closely related specific groups, however, it can not be relied upon, and recourse must be had to the anal appendages.

Anal Appendages (Figs. 34, 38, 109; aas, aai).—At the caudal extremity of the abdomen of the male there are always four appendages; an upper dorsal pair, the superiors (aas), and a lower, the inferiors (aai). Of these, the upper is more often the longest, but it may be reduced and shorter than the ventral pair. The anus opens between and slightly dorsad of the bases of the mesal lobes of the ventral pair. The dorsal pair of appendages is frequently forcipate, and the tips are often contiguous and sometimes have between their bases a knob-like projection.

Ovipositor (Figs. 109–116).—The ovipositor of the female consists of three pairs of valves or gonapophyses. The ventral, mesal pair are slender and heavily chitinized, and are transversely ridged at the tip and usually provided with a saw-tooth edge. The cephalic pair of gonapophyses (oce) is derived from the eighth segment; the median pair (not shown in the figures) and the broad caudal pair (oca) from the ninth segment. The caudal pair of gonapophyses differ much in shape from the cephalic and median pairs. They are very broad at the base, somewhat contracted at the apex, and bear short, chitinized, curved subapical rods, the prostyles (prs). The ventral margins of

the caudal valves are always serrate.

Variations in the ovipositor of the female are seemingly of little importance in classification although there is enough difference in the apical sternites (sti_8) of the eighth segment alone to facilitate the separation of genera.

Life History and Habits

The metamorphosis of all Odonata is incomplete and the life history relates to the egg, nymph, and adult.

EGG

The eggs of Zygoptera are elongate and ovoidal, their length being much greater than their transverse diameter. In length they average about one millimeter; in diameter usually about one-fourth of this. They are inserted either above or below the surface of the water in the stems of plants. Lestes and related genera insert the eggs considerably above the level of the water, and several instances are recorded in which the plants suffer from excessive oviposition. Most of the Coenagrioninae oviposit beneath the water upon the submerged parts of plants. To accomplish this, the female with the male clinging to her alights on a projecting part of a plant and backs down into the water dragging the male with her. She often goes so far beneath the surface that both are completely submerged. Kellicott ('99: 24) observed the females of *Argia mocsta putrida* descend into the water in this fashion; and I have frequently seen *Enallagma signatum* descend into the water to oviposit and, less frequently, *Ischnura verticalis* and *Enallagma antennatum*. It is probable that many more of the subfamily Coenagrioninae enter the water to find a suitable place for oviposition. The egg-laying habits of the Agrionidae have not been extensively studied; but Kennedy ('15: 339) reports that *Agrion aequabile* variety *yakima* deposits the eggs beneath the surface of the water upon willow roots, and is unaccompanied by the male. Needham also says that *Agrion maculatum* oviposits just beneath the surface of the water, but Wesenberg-Lund ('13) observed a European species depositing eggs above the water. In all cases the female was unaccompanied by the male.

The number of eggs laid by a single female has been but partially investigated, owing to the great difficulty of inducing the female to lay in captivity. A number of adults were dissected with a view to discovering the egg-laying capacities of the group. Several reared specimens which had no chance to deposit eggs were found to contain as many

as 1000 ova but only 60 or 70 of them were of normal size and considered mature. Another female, *Ischnura verticalis*, contained 203 mature ova, while a third teneral female of *Enallagma hageni* contained 290 mature ova. Calvert ('93) says that the average dragonfly probably lays between two and three hundred eggs, and this statement seems to coincide with that above.

The length of time spent in the egg stage is also imperfectly known. Lucas ('00: 18) reports that *Sympetrum striolatum* spends a month in this stage. Balfour-Browne ('09:256) says that eggs of *Ischnura elegans* and *Enallagma pulchellum*, laid at the beginning of August at East Norfolk, England, required from four to five weeks to develop. The temperature relations are not mentioned, but it is probable that this period varies to some extent. Needham ('03) calls attention to the fact that the eggs of Lestes, which are laid above water late in July, develop to a certain point, apparently ready to hatch, and await submergence before eclosion. The water does not reach them until late in fall; and this means that at least several months are spent in the egg stage. Brandt ('69) reported the development of *Agrion (Calopteryx) virgo* in three weeks during a hot summer.

In the final stages of embryonic development the head is directed towards the small end of the egg. This end is always nearest the cuticle of the plant, and the nymph consequently emerges head first.

NYMPH

Growth.—Immediately after hatching, the nymph is helpless and unable to move about actively. In this condition it is known as the pronymph (Balfour-Browne, '09:258). A few minutes afterward the skin of the pronymph splits and the true nymph escapes. During the second nymphal stage the nymph is a minute insect, hardly longer than the egg from which it hatched. The antennal segments are three and there are no wings or sexual appendages. From this stage the nymph grows and molts at intervals, the time between molts depending largely upon the temperature and the amount of food which it is able to capture. The antennae increase in number of segments until six are present, in which condition they remain until the last nymphal stage, when there are seven. The wings appear as ridges during the fourth stage, but the sexual appendages do not appear until the seventh stage, according to Balfour-Browne ('09). This seems to be contradicted by the rather frequent observance of nymphs without wing-cases and fairly well-developed appendages. There is great variation in the time between molts, due primarily to temperature. It often happens

that when nymphs are brought into the warm laboratory they molt within a few days. Balfour-Browne found surprising differences in the time between molts in nymphs kept at constant temperatures, so that it would seem probable that other factors enter into the problem besides temperature. He was able, however, to reduce the length of the stages by raising the temperature, and found that in some cases these lasted, in low temperatures, for 150 days, while in others they lasted only five days at higher temperatures. The number of molts varies from ten to fifteen in the Coenagrionidae, and the length of the nymphal life may range from 229–624 days (Balfour-Browne, '09).

Habitat.—In nature, the nymphs are most often found hiding among the weeds and rubbish along the margins of lakes, ponds, and streams. A few have been taken under rocks in swift currents, among them *Argia putrida* (Needham, '03) and *Argia tibialis*. The Agrionidae frequent the swifter currents, and seem to prefer these situations to any others. They are never found in stagnant ponds. Nymphs of Lestes, on the other hand, do not occur except in stagnant woodland pools, and are never taken along the banks of streams unless a stagnant condition is present. They prefer the shade, and hide among the broad-leaved types of small water-weeds, being rarely found among the narrow-leaved rushes and saw-grass. Riley ('12) says that the nymphs of Zygoptera react negatively to light from a projection lantern but that such a reaction is often inhibited by the habit of clinging to objects. He was unable, however, to obtain similar reactions to moderately strong daylight. Reactions to heat have not been studied, but the nymphs are able to withstand temperatures near the freezing-point and may be collected during the winter from beneath the ice. They readily succumb when the temperature of the water rises much above 70°F., but flourish well at 66.2°F. or 19°C. (Balfour-Browne, '09). Lestes is particularly sensitive to high temperatures, and when in captivity considerable care must be taken to keep the temperature low enough for them.

Food.—The food of the nymphs consists almost entirely of Crustacea, the larvae of nematocerous Diptera, such as mosquitoes and chironomids, and ephemerids. Very young nymphs have been known to thrive on Paramecium and other Protozoa. Of a large number of Lestes which were dissected, nearly all contained Daphnia and Cyclops, while the coenagrionines dissected contained many heads of chironomids and only occasionally small Crustacea. However, a single small *Ischnura verticalis* nymph contained eight specimens of Daphnia, and it seems highly probable that other insects are also taken when the normal food supply is scarce. Diatoms and other minute organisms

are frequently found in the alimentary tract, but this is due to the fact that other insects have been eaten which feed upon these organisms. The following is a list of the kinds of food known to be eaten by zygopterous nymphs.

Protozoa	Paramecium.
Crustacea	
Copepoda	Cyclops.
Anemopoda	Daphnia.
Arthropoda	
Arachnida	Hydrachnidae (rare).
Insecta	Diptera—Chironomidae, Culicidae.
	Odonata—Zygoptera.
	Ephemerida—Ephemeridae.
Vertebrata	Very young fish.

Color Adaptations.—In almost any collection of live zygopterous nymphs, there will be found brown and green individuals of the same species. When collected from localities with abundant green vegetation, nearly all the nymphs will be green; when taken from situations where little green vegetation occurs, the nymphs are brown or dark in color. Furthermore, as has been observed in rearing specimens, green nymphs placed in a jar without green plants become brown after a few molts, and thus seem to be able to adapt themselves to the color of the surroundings. The color of the nymph, contrary to what might be expected, seems to have no influence upon the color of the adult.

Enemies.—The nymphs of Zygoptera are preyed upon by a number of enemies, the most formidable of which are fishes. Forbes ('88) reported that odonate nymphs formed ten to thirteen per cent. of the food of *Perca flavescens*—the common perch, *Aphredoderus sayanus*—the pirate perch, and *Pomoxis annularis*, the crappie; and twenty-five per cent. of the food of the grass pickerel, *Esox vermiculatus*. Riley ('12) says that *Lepomis gibbosus*, a common sunfish, and the yellow perch, *Perca flavescens*, commonly feed upon agrionid (coenagrionid) nymphs.

Among the predaceous aquatic Hemiptera, the genera Ranatra, Belostoma, and Notonecta, and probably others, feed upon the nymphs.

A mite, *Arrhenurus* sp., is a common external parasite of the nymph. At the time of emergence of the adult, the mite migrates from

the nymph to the adult and is carried about by the latter until it is nearly mature, when it escapes again into the water for the final stage. Another mite has been reported to feed upon the eggs of Anisoptera, but this statement has not been verified for the Zygoptera. Needham ('03) says that a large number of hymenopterous parasites prey on the eggs of Lestes, left exposed above the water-line, and he reared the following species: *Brachista pallida* Ashm., *Centrobia odonatae* Ashm., and *Polynema needhami* Ashm. Brandt ('69) also reports rearing *Polynema ovulorum* from the eggs of Agrion (Calopteryx) and says that as many as fifty per cent. of the eggs were sometimes destroyed by this parasite.

A fungus belonging to the Saprolegniales frequently attacks the nymphs, especially if enfeebled from any cause. Sometimes it becomes very difficult to rear specimens, and if the rearing-jars become infected nothing short of thorough sterilization will be of any avail. This fungus is related to the one attacking fish and causing great damage in hatcheries. It is also known to attack the larvae of Corydalis.

Emergence of Adult.—When the nymph has molted a stated number of times, somewhere between ten and fourteen, and has become full-grown, it crawls out of the water, dries its cuticle, which soon splits along the mid-dorsum of the thorax and head, and the adult emerges. The nymphs of Zygoptera usually seek the sunlight to transform and emerge early in the morning, the greater number being clear of the skin before eight o'clock. A much smaller number have been seen to emerge after six o'clock in the evening or late in the afternoon, but very few, if any, emerge during the heat of the day. The emergence follows a more or less definite schedule. When first out of the nymphal skin, the parts of the body are no larger than the parts of the foregoing nymph, and the insect is yellowish green in color. Great changes soon begin, including an elongation of the abdomen and wings as well as enlargement of other parts, and within an hour the insect is ready to take flight. At this time it may show mature coloration or the color may still be incompletely developed, and in this condition the adult is known as teneral. The teneral state may last for several days or longer, depending somewhat upon the amount of sunlight to which the insect is subjected, or there may be no further change after the power of flight is attained. *Enallagma exsulans*, *E. geminatum*, and the male of *Ischnura verticalis* are examples of species which apparently have no teneral state. *Enallagma carunculatum*, and *Ischnura verticalis*, female, are examples of species which apparently have a long teneral period. The change from

teneral to full adult coloration is a phenomenon which is not well understood. Just why the thoracic stripes of *Enallagma signatum,* for instance, should change from a pale but distinct blue to a bright orange in the course of development, while the stripes of the same region in *Lestes rectangularis* change from a dull brown to pale blue, is impossible to explain without a more thorough knowledge of the chemical nature of the pigments which undergo the changes.

The following observations were made upon the emergence of *Ischnura verticalis.* The rate of development is approximately similar to that of all Coenagrionidae. The rearing-jar was kept in the laboratory on the west side of the building and hence did not get the early morning sun. This accounts for the late emergence of the nymph.

9:30 A. M. The nymph crawled out upon the weeds within the jar and seemed about ready to emerge. The nymph when removed was dissatisfied and restless and tried to get a firm hold on something with its claws.

9:35. Body nearly dry.

9:45. The thorax suddenly splits and the insect rapidly emerges from the skin; color mostly light green and pale yellow; dorsal portion of the eyes dark; sides of the thorax darker.

9:50. Clear of the skin; wings 4 mm. in length, abdomen 10 mm.; general color becoming darker; greens becoming brown; wings increasing in length; insect restlessly moving about on the support.

9:55. Eyes plainly striped with brownish bands; abdomen 11 mm. in length, wings 4 mm.; wings suddenly elongating near the proximal end.

9:57. Wings 7 mm. in length.

10:00. Wings 8 mm., abdomen 12 mm. in length.

10:01. Wings 9 mm., abdomen 12 mm. in length.

10:03. Wings 11 mm., abdomen 12 mm.; wings pale light green, thorax and head brownish green; abdomen pale green at base, darker at apex.

10:06. Wings 13 mm., abdomen 12 mm.

10:07. Wings 15 mm., abdomen 12 mm.

10:09. Wings 15 mm., abdomen 13 mm.; abdomen suddenly elongating at the base.

10:14. Wings 15 mm., abdomen 15 mm.

10:18. Wings 15 mm., abdomen 15 mm.

10:20. Wings 15 mm., abdomen 16 mm.

10:24. Wings 16 mm., abdomen 20 mm.

10:28. Wings 16 mm., abdomen 24 mm.

10:30. Wings 16 mm., abdomen 24 mm. Thorax grayish green; abdominal segments two to six nearly transparent; wings becoming transparent; stigma faint, hardly noticeable.

10:35. No increase in length of the abdomen or wings; abdominal segments becoming dark near the sutures; stigma of the wings darker, now plainly noticeable; thorax olive-green; pronotum black.

10:40. First two segments of the abdomen dark green; segments three to six pale green, the apical segments the same as the proximal ones; thorax becoming steadily darker; first trial of the wings; the insect is nearly ready to fly.

10:45. Fully able to fly, but still delicate and without full adult coloration; no further increase in size of the abdomen or wings, but growing steadily darker in color and indications of permanent adult coloration becoming evident.

10:55. Stripes of the thorax very distinct, though no blue or other bright color has appeared; very active and using its wings frequently.

12:00 M. Not yet fully colored, the two apical segments of the abdomen beginning to show blue; the thoracic stripes of green not fully developed.

2:00 P. M. Postocular spots distinct; dorsum of abdominal segments eight and nine showing signs of the blue coloration.

3:00. Insect fully colored and perfectly developed in every way.

ADULT

Habitat.—The adult Zygoptera are most frequently encountered flying along the streams or about the lakes, ponds, or marshes in which the nymphs abound. Lestes is a frequenter of the thick woods near woodland marshes; Hetaerina and Argia are most commonly encountered near rapid streams, while the remainder of the Illinois representatives of the suborder may usually be found near small lakes, ponds, or sluggish streams.

Flight.—The flight is slow and uncertain, though frequently rapid enough to enable the insect to avoid the collector with surprising regularity. The vibration of the wings is much slower than that of the Anisoptera, and is more like that of a butterfly.

Mating Habits.—In summer, pairs of Zygoptera may be frequently found flying together. The male grasps the female just behind the prothorax by means of the anal appendages. The female then doubles the body beneath the body of the male bringing the ovipositor in contact with the accessory genitalia of the second abdomi-

nal segment of the male. After fertilization of the female the two continue to fly together and the female is refertilized at intervals during the egg-laying period. At the time of oviposition the two often remain together and the eggs are frequently laid while the pair are still in copula.

The time elapsing from emergence to egg-laying is not known with any certainty. The egg-laying period also, has been little studied, but it is thought to last for several weeks.

Food.—Many records have been made of the destruction of mosquitoes by Anisoptera, but no one seems to have observed or attempted to determine the feeding habits of the adults of Zygoptera. Dissection of a number of specimens revealed the fact that the Zygoptera prefer small Diptera to most other food. Many remains of nematocerous Diptera were found, as the following table will show, but very few remains of other insects.

	Name	*Food eaten*	*Date of coll.*	*Locality*
1.	*Hetaerina americana*, ♂	Hymenoptera (?)	Oct. —, 1915	Muncie, Ill.
2.	*Ischnura verticalis*, ♀	Diptera—abundant remains	June 23, 1915	Havana, Ill.
3.	*Ischnura verticalis*, ♂	Alimentary canal empty	June 23, 1915	Havana, Ill.
4.	*Ischnura verticalis*, ♀	Many small Diptera	June 23, 1915	Havana, Ill.
5.	*Argia apicalis*, ♂	Diptera—Nematocera	June —, 1915	Clear L., Ky.
6.	*Enallagma civile*, ♂	Diptera	June 18, 1915	Urbana, Ill.
7.	*Lestes vigilax*, ♂	Diptera—Nematocera	.....	Bluffton, Ind.
8.	*Enallagma hageni*, ♀	Diptera—Nematocera	July 18, 1915	Orono, Me.
9.	*Enallagma antennatum*	Diptera—Nematocera	July 18, 1915	Urbana, Ill.
10.	*Ischnura verticalis*	Large number of butterfly scales	July 13, 1915	Lake Villa, Ill.

The most common food of the adult apparently consists of small flies. No remnants were found which resembled mosquitoes, and the hymenopterous insect reported is questionably identified as such. The specimens of lepidopterous scales found in number ten were unmistakable, and it is, therefore, evident that other insects are sometimes eaten besides Diptera*. They have also been reported to eat aphids.

Enemies.—The adult Zygoptera are troubled by few enemies of any sort. Birds are perhaps the most important, but even these are not to be considered as serious enemies. Several species of hydrachnid mites have been found attached to the adult, the most common of which are species of Arrhenurus. The mites are often conspicuous on account of their orange or reddish color, and large numbers often attach themselves to a single individual. However, they seem to cause the insect but little inconvenience.

*Poulton ('06) reports that both Ephemeridae and Lepidoptera are sometimes eaten.

History of the Zygoptera

PALEONTOLOGY

The oldest records of insects which resembled Odonata are found in the upper Carboniferous. The wings are the only parts which are well preserved, but these are very different from the wings of living Odonata. The fossil species are termed Protodonata by Handlirsch and are thought to be connected with the still more ancient forms, the Paleodictyoptera, which are the most primitive of all fossil insects. The features which distinguish the Protodonata from the Paleodictyoptera and link them to the true Odonata include the fusion of the longitudinal veins at the base of the wing; the presence of numerous orderly arranged cross-veins; the appearance of interposed veins or sectors between the longitudinal veins; and, finally, the approximation of the wings themselves at the base. The protodonate wing, however, differs from that of true Odonata in the lack of stigma and nodus and in the supposed absence of that typical feature, the crossing of the radial sector over media. It is unfortunate that more of the bodies of these interesting forms have not been preserved, for it would be advantageous to know what types of head, thorax, and abdomen they possessed.

The next remains of importance are found in the Jurassic Lias of England and are much more closely related to living species than the Protodonata. They are classed as Odonata and divided into two suborders, the Anisozygoptera and Archizygoptera. There is a single living representative of the Anisozygoptera in Epiophlebia (Paleophlebia) of Japan, but the Archizygoptera have no living representative, and seem to be merely an offshoot from the Protodonata which apparently disappeared after a short stay in geological history. The archizygopterous wings show marked deviations from the original type of the Protodonata, and a very near approach to some of the zygopterous wings of today. The reduction in number of cells and cross-veins is characteristic of both ancient and modern forms, but the absence of the arculus and the separation of media and radius to the very base of the wing, distinguish the fossil species from any living forms. The Anisozygoptera have characters common to both Gomphidae and Agrionidae, the oldest fossils being perhaps more closely related to the Gomphidae. The wings have nodus and stigma, and the radial sector plainly crosses the median vein. The degree of obliquity of the quadrangle and the presence of many interposed sectors between the longitudinal veins place them with the Agrionidae. The head and the wings resemble those of Gomphidae in shape,

but the thorax and abdomen of the fossil suborder are variable and resemble both families to some degree.

The true Zygoptera make their appearance in the Jurassic period. The oldest of these, comprising the families Epallagidae and Steleopteridae, have been found in the lithographic quarries of Bavaria. The majority of species from this source belong to the Epallagidae and are fortunately in a good state of preservation. The wings are not petiolate, the nodus and stigma are present, the nodus being situated near the middle of the wing and the stigma being long and narrow. There is an oblique arculus and a more or less oblique triangle; the radial sector and the second median vein arise far distad of the nodus; and the costal field contains more than ten cross-veins proximad of the nodus. The abdomen is not greatly lengthened and the legs are also normal in this regard. In the Steleopteridae the wing is distinctly petiolate; there are about five antenodal cross-veins; and the veins M_3 and the radial sector arise proximad of the nodus. The arculus and quadrangle are similar to those of the Agrionidae (Calopterygidae). The family Steleopteridae is considered to be the forerunner of the Coenagrionidae.

The Tertiary deposits furnish us with the next oldest representatives of the group. True Zygoptera, Anisoptera, and a single family of Anisozygoptera have been found in the Florissant of Colorado and in the Tertiary deposits of Baden, Germany. Many of the species are referable to extant genera. More than eleven genera of Zygoptera have been found in these strata.

The first nymphs to appear in the geological record are described by Hagen from the Baltic amber and from the Tertiary of Rheinland and Baden, Germany. Many of these forms had caudal tracheal gills and were apparently true Zygoptera. Scudder ('90) has also figured and described a nymph from the Florissant which doubtless belongs to the Zygoptera.

The following tabular summary gives the characters which have been developed successively in the past, beginning with the family Dictyoneuridae of the Paleodictyoptera from which the Protodonata are thought to have been derived.

TABULAR SUMMARY

PALEODICTYOPTERA	PROTODONATA	ODONATA	
Dictyoneuridae	Meganeuridae Protagrionidae Paralogidae	Anisozygoptera Archizygoptera	Zygoptera Anisoptera
Wings moderately broad at base	Wings moderately broad at base	Wings broad or narrow at base	Wings broad or narrow at base.
Large number of irregular cells	Large number of polygonal cells	Reduction in the number of polygonal cells	Still greater reduction in number of polygonal cells in Zygoptera.
Subcosta ending in costa beyond the middle of the wing; not forked; no nodus	Subcosta ending about the middle of the wing; not forked; no nodus	Subcosta ending at middle of the wing; forked; nodus present	Subcosta often ending proximad of the middle; forked; nodus present.
	Cross-veins between costa and subcosta 22–50 or more	Antenodal cross-veins much reduced, usually more than two in number	Antenodal cross-veins often reduced to two in Zygoptera; more than two present in Anisoptera.
Radial sector not crossing media	Radial sector apparently not crossing media	Radial sector crossing media	Radial sector crossing media.
Radius and media not fused at base and no arculus formed	Radius and media fused but no arculus formed	Radius and media fused and arculus frequently formed	Radius and media fused and arculus always formed.
		Arculus near the base of the wing	Arculus further distad from the base.
Stigma absent	Stigma absent	Stigma sometimes present	Stigma only occasionally absent.
		Stigma not supported by oblique cross-veins or supplementary sectors	Stigma supported by oblique cross-veins, supplementary sectors, or both.
	M_2 arising proximad of end of subcosta	M_2 arising near the subnodus, often slightly proximad	M_2 arising at the subnodus or considerably beyond.
		Stigma cells numerous	Stigma cells few in Zygoptera.

TABULAR SUMMARY—*continued*

PALEODICTYOPTERA	PROTODONATA	ODONATA	
Dictyoneuridae	Meganeuridae Protagrionidae Paralogidae	Anisozygoptera Archizygoptera	Zygoptera Anisoptera
No quadrangle or triangles	No quadrangle or triangles	Quadrangle and sometimes triangles present	Quadrangle always present; triangles sometimes present.
Three simple anal veins present	Anal veins represented by a single vein	Anal veins represented by a single vein	Anal veins represented by a single vein.
Anal field not extensively developed	Anal field not extensively developed	Anal field often extended, but not braced by loop	Anal field extensively developed or reduced; when extended often braced by loop.
	Large numbers of rows of cells between all longitudinal veins, the rows extending far proximad	Decided reduction in number of rows and a decided retreat distad, leaving but few rows between the proximal portions	Still further reduction and retreat distad.
Head rounded; of considerable size	Not known	Head rounded and of considerable size	Head angular; often widened.
Not known	Not known	Eyes dichoptic in all families	Eyes dichoptic or holoptic.
Not known	Not known	Labium cleft	Labium cleft or entire.
Not known	Not known	Abdomen slender, occasionally swollen at tip; superiors leaf-like or forcipate	Abdomen slender, Zygoptera, or thickened, Anisoptera; superiors leaf-like, forcipate, or reduced to tubercles.
Not known	Not known	Inferior anal appendages separate	Inferior anals frequently united in Anisoptera.

The various parts of the body will now be considered with reference to their form during the different periods of development.

Head.—The compound eyes during the life of the embryo are small and dichoptic and situated on the lateral aspect of the head. After eclosion they become larger, are sometimes expanded dorsad, but never become holoptic until the adult stage. The embryonic antennae are composed of three segments, the second segment being longer than all the others together, and the third segment nothing more than a spur at the tip of the second. The increase in number of segments takes place by division of the second, which continues to divide until the antenna has seven segments in all. There is little, if any, variation in the diameter of the different segments of most nymphal antennae, but the proximal segments of a few are sometimes greatly developed and much larger than any of the distal ones. In the adult antennae, the apical segments are setiform and the number of segments varies from four to six. The labial palpi and the median lobe are without setae or fixed hooks. The cleft is usually obliterated after eclosion, but remains practically unchanged in the nymphs of some species. The labial palpi of the young nymph are soon after eclosion provided with fixed hooks, and the median lobe is furnished with rows of setae. The adults have no rows of labial setae, but these are scattered promiscuously over the surface. The condition of the mandibles and maxillae is not known for the embryonic stages, but the nymphal condition is much simpler than that of the adult. In this stage the mandible is not biramous except in a few cases. The adult mandible, however, is divided into two parts, one composed of a number of teeth and the other of several cutting edges forming a Z when viewed from the edge. The galea-lacinia of the nymphal maxilla is not as specialized as that of the adult, which bears a greater number of fixed hooks and setae.

Thorax.—The thorax of the embryo consists of three equal segments, each with a pair of appendages. Very little can be said of the sclerites in the embryonic stages, but the segments of the nymph are all about equal in size. The legs are widely separated and the invaginations of all furcae are usually prominent. The suture separating the proepimeron from the proepisternum is indistinct in the earlier nymphal stages, but becomes more distinct with age. In the mesothorax and metathorax, the interpleural suture is distinct in all zygopterous nymphs and in the adults of the family Agrionidae. In the Anisoptera it is indistinct in all stages. The infraepisterna and supraepisterna are separated by furrows in the nymph, but there are no definite sclerites formed until the adult stage. The mesonotum is

always divided in the nymph as in the adult, but seems to be simpler in structure in the nymph. The mesostigmal plates of Zygoptera are not developed until the adult stage, but the depressed area caudad of the mesoscutum in the Anisoptera is frequently present in the nymphal stages, especially in the Libellulidae. The nymph molts several times after eclosion before the rudiments of the wings appear as minute ridges on the dorsum of the mesothorax and metathorax. They develop subsequently like the wings of heterometabolous insects in general. As already noted, the crossing of the radial sector over the media can not be followed, and in only one genus, Lestes, is there any recognizable portion of the radial sector. The character of the tracheation of the wing-cases of several zygopterous nymphs is shown in Figures 14–17.

Abdomen.—Very little can be said of the abdomen except that in both the embryo and nymph the segments are about equal in length and more or less cylindrical. Reduction in size, lengthening of the segments, and flattening of the abdomen, together with the appearance of dorsal and lateral spines, seem to be the developmental tendencies in the nymph. The accessory genitalia of the adult show no signs of development until near the last nymphal stage, but the ovipositor of the female appears early, at least in the Zygoptera. This organ undergoes great modifications and specialization in the adult Zygoptera, but in the Anisoptera it is probably in the process of reduction and degeneration. The caudal tracheal gills of the Zygoptera are present in the embryo, and at hatching they appear as cylindrical, jointed, cerciform appendages. Brandt ('69) says that at a still earlier stage the lateral pair of gills are fused, but this observation has not been verified. There is also a pair of smaller cerci dorsolaterad of the lateral gills, making five caudal abdominal appendages in all. All five of these are represented in the Anisoptera by short cerciform appendages which are frequently triquetal and often sharply pointed at the apex. It is important to note that these appendages are never united in the nymphs of Anisoptera or in Zygoptera, but that in the adults of Anisoptera the ventral pair is sometimes fused. In all families of Zygoptera, the superior abdominal appendages, which replace the lateral gills, are greatly reduced, but in some Anisoptera, family Aeshnidae, the lateral appendages are replaced in the adult by long, lateral, superior appendages resembling gills. A fact which sheds light on the origin of the Odonata as a whole, is the presence of lateral abdominal gills in the genus Cora of Central America and Euphea of the Old World. The rectal gills of Anisoptera have been thought to originate in the forms having tracheae which anastomose on entering the walls of the rectum as in

most Agrionidae; but it is doubtful whether this fact is really important.

Some of the most interesting modifications of structure for comparison are found in the proventriculus. These were first investigated by Ris ('96), who discovered interesting correlations between the number of teeth and folds present and their supposed specialization in the different families. Conditions were simplest in the nymphs of Agrionidae; more highly specialized in the Coenagrionidae, Aeshnidae, Gomphidae, and Libellulidae. The adult structures were much more complicated than those of the nymphs of the same families.

The following table will suffice to show the important ontogenetic tendencies of living forms.

TABLE SHOWING ONTOGENETIC TENDENCIES OF ZYGOPTERA AS COMPARED WITH ANISOPTERA

EGG		NYMPH		ADULT	
Anisoptera	Zygoptera	Anisoptera	Zygoptera	Anisoptera	Zygoptera
Eyes dichoptic	Eyes dichoptic	Eyes dichoptic	Eyes dichoptic	Eyes sometimes dichoptic, usually holoptic	Eyes dichoptic.
Labium cleft	Labium cleft	Labium sometimes slightly cleft, never deeply	Labium sometimes deeply cleft	Labium sometimes slightly cleft	Labium usually deeply cleft.
		Mandibles not divided at tip	Mandibles always divided at tip	Mandibles always divided at tip	Mandibles always divided at tip.
Labial palpus without fixed hooks	Labial palpus without fixed hooks	Labial palpus without fixed hooks	Labial palpus with two fixed hooks	Labial palpus with one fixed hook	Labial palpus with one fixed hook.
Median lobe without setae	Median lobe without setae	Median lobe with or without setae in rows	Median lobe with or without setae in rows	Median lobe with setae, but not in rows	Median lobe with setae, but not in rows.
Labial palpi without setae	Labial palpi without setae	Labial palpi with or without setae	Labial palpi with or without setae	Labial palpi without setae	Labial palpi without setae.
Antennae with three segments	Antennae with three segments	Antennae with 3–7 segments	Antennae with 3–7 segments	Antennae with 4–7 segments	Antennae with 4–7 segments.
		Epicranial suture traceable	Epicranial suture traceable	Epicranial suture traceable with difficulty	Epicranial suture traceable with difficulty.
		Furcae of metasternum often indistinct	Furcae of metasternum never indistinct	Furcae of metasternum concealed	Furcae of metasternum concealed.
		Interpleural suture indistinct	Interpleural suture never indistinct		

TABLE SHOWING ONTOGENETIC TENDENCIES OF ZYGOPTERA AS COMPARED WITH ANISOPTERA—*continued*

EGG		NYMPH		ADULT	
Anisoptera	Zygoptera	Anisoptera	Zygoptera	Anisoptera	Zygoptera
Mesepisterna usually separated	Mesepisterna adjacent or separated	Mesepisterna usually separated	Mesepisterna adjacent or separated	Mesepisterna adjacent and fused	Mesepisterna adjacent and fused.
		Wing-cases unequal in size	Wing-cases unequal in size	Wings unequal	Wings unequal.
		Trachea of radial sector crossing media	Trachea of radial sector not crossing media	Radial sector crossing media	Radial sector crossing media.
Abdomen cylindrical and about equal in diameter throughout; of the same diameter as the thorax		Venter flattened, abdomen much broader than thorax	Abdomen of the same diameter as the thorax	Abdomen widened at different points, usually of smaller diameter than thorax	Abdomen equal throughout; always of smaller diameter than thorax.
No tracheal gills but a long caudal projection	Tracheal gills present	No tracheal gills	Tracheal gills present	No tracheal gills	No tracheal gills.
		Ovipositor developed late or wanting	Ovipositor developed early	Ovipositor sometimes well developed; usually wanting	Ovipositor always well developed.
		Rectal gills present	Rectal gills absent	Rectal gills absent	Rectal gills absent.
		Folds of proventriculus: 4 large; 4 small	Folds: 4 large, 4 small; or 8 large, 8 small	Folds: 4 large, and 4 small	Folds: 8 large, and 8 small.

PHYLOGENETIC COMPARISON OF ZYGOPTERA AND ANISOPTERA

Several important theories and rules of procedure should be mentioned before undertaking a discussion of the suborders from a phylogenetic standpoint.

I.—*Ontogeny repeats phylogeny.* This is a well-recognized principle and is the foundation of much phylogenetic work.

II.—*All testimony should be corroborative* if properly understood; or in other words, there should be no real conflict in the phylogenetic evidence obtained from different sources.

III.—*The stem must be determined.* Before an agreement can be reached as to the phylogenetic status of any form, there must be agreement as to what constitutes specialization, and what generalized conditions. Suppose, for example, that within an order of insects there are species with two types of wings—one having numerous cross-veins and the other but few; which is the more specialized? It is possible for either type to have been derived from the other or both to have arisen from a third extinct form. One may have become specialized "by addition" and the other "by reduction". In this case it is evident that the stem must first be determined before the degree of specialization of either form can be stated with accuracy.

IV.—*All possible characters should be taken into account,* and a decision concerning the rank of the group should be based on a study of the whole organism. This method should be followed in view of the fact that the same degree of specialization in structure is not usually found simultaneously in different parts of the body, and it is always to be preferred to the method of determining specialization or generalization of a group of organisms by the study of a few characters.

V.—*The forces which produce modification in structure should be recognized if possible* and their effect upon structure determined.

In the following comparisons the various characters will be considered separately and, where possible, the stem form will be mentioned and the reasons given for so regarding it. For convenience, the division of the suborders into families as outlined by Handlirsch ('06-'08) and Muttkowski ('10) will be followed, the Zygoptera being divided into the Agrionidae and Coenagrionidae; the Anisoptera, into the Aeshnidae, Gomphidae, and Libellulidae.

Egg

1.—Eggs of the Odonata are of two types; one long and somewhat cylindrical in shape, the other ellipsoidal and short. The differences in shape are the result of different methods of oviposition. The ellipsoidal form would seem to be the more primitive, judging from a general knowledge of the eggs of various orders of insects. No definite proof of this can be given, but a comparison with the eggs of the Apterygota and the lower Arthropoda indicates that the ellipsoid is probably the stem type. This is, however, in direct contradiction to the argument found in the reduction of the ovipositor, since the species with specialized or reduced ovipositors lay ellipsoidal eggs. Disregarding the latter argument and considering the ellipsoi-

dal egg as the primitive type, the series from lowest to highest would be something like the following: Libellulidae, Gomphidae, Aeshnidae, Agrionidae, and Coenagrionidae.

Nymph

2.—The most striking differences in nymphal characters are found in the shape of the body. Zygoptera are without doubt nearest the primitive Campodea type, and Anisoptera show a marked deviation which is possibly due to the habits of life. This interpretation is supported by the embryonic stage, in which the body shape is essentially campodeiform in both suborders.

3.—The compound eyes of all forms are specialized, but the line of descent is not difficult to follow. The primitive type is found in the embryo, which has small circular eyes on the lateral aspects of the head. The nearest approach to this is found in the eyes of zygopterous nymphs; the farthest away from it, in the Anisoptera, where the eyes show a tendency to become dorsal in position. The cause of the modification is unknown, but may be due in part to their habits, the Anisoptera being mud-inhabiting to a large extent and needing eyes on the dorsum of the head. Another cause may possibly be found in the accelerated development of the greatly enlarged eyes of the adult. In respect to shape and position of the compound eyes, then, the Anisoptera should be regarded as the more highly specialized group.

4.—The antennae show important lines of development. The primitive antennae of the embryo consist of three segments, the second segment being the longest. A great lengthening of the first segment is the main line of specialization, and this occurs only in Zygoptera in the family Agrionidae. The antennae nearest the embryonic type are found in the Gomphidae; next in order are the Aeshnidae, then the Libellulidae, and, finally, the Coenagrionidae and the Agrionidae.

5.—The labium shows the more primitive condition in Zygoptera, where the median lobe is deeply cleft in the family Agrionidae. Gradations in complexity are found in a reduction in the depth of the cleft, and the line of specialization may be followed through the following series, beginning with the least specialized: Agrionidae, Coenagrionidae; Gomphidae, Aeshnidae and Libellulidae.

6.—Mental setae are lacking in the embryo and also in the nymphs of Aeshnidae, Gomphidae, Agrionidae, and a few Coenagrionidae. The cause of the production of mental setae is unknown. There

seems to be greater specialization in the shape of the labial palpi or lateral arms in the Coenagrionidae, notably the Lestinae, than in any other group. The simpler types are found in the Aeshnidae, Gomphidae, and Agrionidae, and a highly specialized form again in the Libellulidae.

7.—The condition of the maxillae and the mandibles in species existing prior to the present time can only be surmised, since there are no embryological or paleontological data on the subject. These appendages are so nearly alike in shape in the two suborders that no comparison can be profitably made.

8.—The primitive prothorax, according to both paleontological and embryological evidence, was a simple ring of the same size as the mesothorax and metathorax. Specialized conditions are found in the Anisoptera where, owing to the size of the head and the growth of the compound eyes, the cephalic part of the pronotum is depressed. The condition of the prothorax is probably primitive in Zygoptera. The sclerites are not as distinct in the Anisoptera as in the Zygoptera, indicating that obsolescense of the sutures has begun in this suborder.

9.—The next feature of note is found in the interpleural suture. Stages of disappearance occur in all Anisoptera, the suture being completely lost in the Libellulidae and perfectly distinct in all nymphs of Zygoptera. The cause of this modification is unknown, but it is probably due to the excessive development of the wing muscles within the thorax. In respect to this feature, then, the primitive forms are found in the Zygoptera; the specialized, in the Anisoptera.

10.—Another modification is found in the disappearance in the Libellulidae of the metafurcal invaginations. The primitive condition or stem form is unknown, as is also the cause of the disappearance. It is probable, however, that the type with distinct invaginations is the more generalized, which places the Zygoptera, the Aeshnidae, and the Gomphidae much below the Libellulidae in position.

11.—In the shape of the wing-pads, the Anisoptera show more conformity to the generalized types occurring in Plecoptera and Orthoptera than do the Zygoptera; and they must be regarded as generalized in this respect.

12.—The simplest abdomen, judging from embryological studies, is a cylindrical portion of about the same diameter as the thorax. The abdomen is much modified in all Anisoptera, where it is enlarged and the venter flattened. The Zygoptera are generalized in this respect, and a series showing progressive specialization in this single feature would be as follows: Agrionidae, Coenagrionidae, Aeshnidae, Gomphidae, Libellulidae.

13.—The caudal tracheal gills of Zygoptera must be considered a simple or stem character. This view is supported by much evidence from embryological studies and the presence of one or two living forms in which the gills are decidedly cerciform and cylindrical. The modification into flat plates is undoubtedly specialization, but the reduction of the abdominal appendages in the Anisoptera indicates further specialization of a different kind. Changes in shape of the zygopterous appendages are probably due to a change from terrestrial to aquatic habits very early in the history of the group. If we consider that the anisopterous appendage has been derived by progressive reduction, the following should be the order of development: cylindrical cerci, flattened cerci, and reduction of cerci to short appendages similar to those in all Anisoptera. If, however, the gills be regarded as derived from shorter caudal appendages, the Anisoptera have the primitive types and the Zygoptera are highly specialized in their elongate, flattened appendages. The presence of cylindrical cerci as a primitive character seems to have the greatest amount of embryological evidence to support it.

14.—The abdominal gills of Cora and Euphea of the Zygoptera also afford comparative evidence as to the age of this suborder. Here there are remnants of lateral, cylindrical gills on the abdominal segments. There seem to be embryological data sufficient to prove that these lateral gills represent the appendages of forms more primitive even than the Insecta.

15.—The oldest fossil Odonata showing ovipositors had the characters of both Zygoptera and Anisoptera, and it is probable that the stem forms had true ovipositors. The simplest type of ovipositor among living Odonata is found in the nymphs of Zygoptera and consists of a number of similar valves. The reason for the reduction of the ovipositor in the adults of Anisoptera lies in the acquisition of the aquatic habit and the consequent difficulty of depositing eggs in plant tissue. It is reported that some Zygoptera do not insert the egg in the plant but merely press it against the plant and allow it to drop to the bottom; and this appears to be a transition stage from the endophytic to the exophytic method of oviposition. Reduction of the gonapophyses, then, means specialization, and the order would be—Zygoptera, generalized; Anisoptera, specialized.

Adult

16.—So many different lines of specialization seem to have taken place in the development of the head capsule of the adult that it is

almost impossible to arrive at any conclusion as to its simplicity or complexity. Suffice it to say that paleontological and embryological data prove that there are primitive types in both Zygoptera and Anisoptera. In the holoptic condition of the compound eyes, however, there is a more definite character. As already stated, the primitive type is dichoptic; and beginning with this condition, which we find most closely approximated in the Zygoptera, there are all degrees of dichoptic and holoptic states. The cause of the modification is probably due, in the adult, to the increased power of vision made necessary by the greatly increased powers of flight and the fact that the insect captures its prey while on the wing. An excellent series of specializations is to be had in the following families, the Zygoptera being the more generalized: Agrionidae, Coenagrionidae; Gomphidae, Aeshnidae, and Libellulidae.

17.—The antennae, as already noted, show marked reduction in size from those of the nymphs. The nearest approaches to the primitive, seven-segmented condition are found in the Libellulidae and some of the Aeshnidae, where six segments are often encountered. Most representatives of the remaining families have the segments quite consistently reduced to four. The adults of the Agrionidae have the most highly specialized antennae; and in a series showing increasing specialization the Libellulidae would be the more generalized. The following is such a series based upon antennal structure: Libellulidae, Aeshnidae, Gomphidae, Coenagrionidae, and Agrionidae.

18.—The front shows great deviation from the simpler forms in the majority of the Anisoptera, and the mound-like elevation of this part is characteristic of most families of this suborder.

19.—The mandibles of the adult have apparently undergone no modification of importance in the different families. They are so nearly alike in all groups that a comparison will not be attempted.

20.—The maxillae of the adult have likewise undergone little modification in the different families, but the form nearest the primitive type present in Plecoptera nymphs is found in the Gomphidae.

21.—The labium shows the same deviations from the primitive condition as were described for the nymph. Looking upon the depth of the median cleft as a measure of generalization, the Agrionidae would be considered as the more generalized. Next in order are the Coenagrionidae and, following these, the Aeshnidae, Gomphidae, and Libellulidae. The labial palpi retain about the same degree of specialization that occurs in the nymphs; and the same sequence of family specialization as has been described for the nymphs is present in the adults.

22.—As regards the form of the microthorax, no stem can be determined, but it is probable that there has been much more specialization in the Anisoptera than in the Zygoptera.

23.—The degree of complexity of the prothorax as a whole is difficult to determine. Many sexual modifications occur in the adults which must be considered as secondary characters having little bearing on phylogeny. The distinctness of the propleural suture, however, is of some value. In Zygoptera, this suture is most distinct in the Coenagrionidae (Lestinae) and is moderately so in the Agrionidae. In the Anisoptera it is most distinct in the Aeshnidae, but is as a rule indistinct in other families. According to this character the Zygoptera seem to be generalized; the Anisoptera specialized.

24.—In the mesothorax and metathorax the most important feature, aside from the wing structure, is to be found in the interpleural suture. As already mentioned, this suture shows no sign of disappearance in any of the nymphs of Zygoptera, and still remains undiminished in distinctness in the adults of the family Agrionidae. In the Coenagrionidae, however, the interpleural suture becomes obsolete in great measure. In both nymphs and adults of Anisoptera, it is indistinct. The degree of its distinctness is therefore an excellent character for determining the degree of specialization or generalization of the species and consideration of this fact alone leads to the conclusion that the Zygoptera are the more generalized.

25.—The varying degrees of approximation of the mesepisterna and the metepimera indicate an entirely different line of development from that shown in 24. The primitive condition is one in which the two mesepisterna and metepimera are separated by considerable intervals, as has been shown for the nymphs. The approximation of the metepimera on the ventro-meson is a much later development and does not appear until the adult stage. Nevertheless, nearly the same line of specialization occurs as in the former case, the simplest conditions being found in the Aeshnidae and the Agrionidae, the more complex in the Gomphidae, Libellulidae, and Coenagrionidae.

26.—The development of the mesothoracic spiracles indicates that the Libellulidae, again, are the most specialized, with the Agrionidae and Aeshnidae at the bottom of the series. The size of the spiracles in Libellulidae and the degree of their approximation on the dorsomeson warrant this assumption, the primitive types being small in size and rather widely separated, as in Zygoptera and some Aeshnidae.

27.—A line of specialization is found in the length of the thorax caudad of the metacoxae. In this the Coenagrionidae and Agrionidae are decidedly the more specialized.

28.—More use has been made of the wings and wing venation in following out genealogical development than of any other single portion of the body of the dragon-fly. The evidence is conflicting in many respects, and in coming to conclusions all characters must be taken into account. The most noticeable feature of the wing venation is the crossing of the longitudinal veins Rs and M. This condition is so unique that it was doubted or denied for a long time, and not until it was traced from its beginning in the tracheae of the nymph was it generally accepted as true. Many of the changes in the wing venation may be considered as the result of stress on particular portions of the wing surface. The development has followed two lines of specialization; one of them a reductive process, exemplified in the Zygoptera, the other additive, exemplified in the acquisition of important wing-braces in the wings of Anisoptera.

The main points regarding the specialization of the odonate wing are stated in the following tabulation.

Generalized conditions	*Developmental tendencies*	Supported by paleontology	Supported by ontogeny
1. Wings of equal size and venation.	Wings of unequal size and venation.	Yes	Yes
2. Wings not petiolate.	Wings petiolate.	Yes	Yes
3. Nodus not retracted; near the middle.	Retraction of the nodus towards the base.	Yes	Yes
4. No reduction in number of cross-veins.	General reduction in number of cross-veins.	Yes	?
5. Arculus near the base of the wing.	Retreat of the arculus distad from base.	Yes	Yes
6. No reduction in the number of antenodals.	Reduction in number of antenodal cross-veins.	Yes	?
7. No reduction in the number of postnodals.	Reduction in number of postnodal cross-veins.	Yes	?
8. Rs traceable throughout its course.	Rs not traceable throughout its course.	No	Yes
9. M_2 not arising distad of the nodus.	M_2 arising distad of the nodus.	Yes	?
10. Rs separating from M_2 near the nodus.	Rs separating from M_2 distad of the nodus.	Yes	?

Generalized conditions	*Developmental tendencies*	Supported by paleontology	Supported by ontogeny
11. Quadrangle triangular.	Quadrangle rectangular.	Yes	No
12. M_3 and M_4 not uniting distad of the arculus.	M_3 and M_4 uniting distad of the arculus.	Yes	Yes
13. Media at the top of the arculus.	Media descending the arculus.	Yes	Yes
14. No development of the anal loop.	Development of the anal loop.	Yes	Yes
15. No matching of the transverse cross-veins.	Matching of the transverse cross-veins.	Yes	Yes
16. Pentagonal cells numerous.	Reduction in number of pentagonal cells.	Yes	Yes
17. Little reduction in the number of rows of cells and little retreat distad.	Reduction in the number of rows of cross-veins between all longitudinal veins and retreat distad of the rows.	Yes	Yes
18. Nodus and arculus not approximated.	Approximation of the nodus and arculus.	Yes	Yes
19. Stigma long.	Stigma short.	Yes	Yes
20. Stigma sometimes absent.	Stigma always present.	Yes	Yes

The different families are specialized in the characters listed under the figures following them: —

Coenagrionidae.—2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 16, 17, 18, 19, 20.
Agrionidae.—11, 15, 16.
Aeshnide.—2, 5, 11.
Gomphidae.—1, 5, 7, 11.
Libellulidae.—1, 12, 13, 14.

From the above it will be seen that in wing venation the family Coenagrionidae is by far the most highly specialized, while the Agrionidae, Aeshnidae, and Gomphidae are about equally specialized, and the Libellulidae are intermediate in position.

29.—The primitive abdomen consisted of a cylindrical portion of the same diameter as the thorax; and the same is now essentially true of the nymphs of Zygoptera. In the adults, however, the diameter

of the segments has been reduced as compared with that of the thorax. In the Anisoptera there are other modifications besides the reduction in diameter. Here, the abdomen is sometimes triangular in cross-section, and different portions of the abdomen of the same species have different diameters. Considering shape alone, the following line of development may be recognized, beginning with the more generalized: Agrionidae, Coenagrionidae, Aeshnidae, Libellulidae, and Gomphidae. This order of specialization is followed throughout in the abdomen.

30.—The approximation of the terga on the ventro-meson, is a mark of specialization most frequently found in the Anisoptera, as is also the appearance of the secondary ridges on the terga.

31.—The anal appendages of the abdomen are interesting, and the line of specialization indicated by them seems to coincide in general with that already outlined for the suborders in 29 and 30. The series has already been given for the two groups in paragraph 13. Within the Anisoptera, two different lines are found, both probably representing specialization. In one of these the inferiors are fused, as in the Libellulidae; in the other the superiors are enlarged and expanded, as in the Aeshnidae. In the Zygoptera the forcipate appendages of the Agrionidae probably represent the most primitive forms, and the short and frequently greatly modified appendages of the Coenagrionidae, the more highly specialized.

32.—Accessory male genitalia of the second segment are important. The statement that this organ has been derived from the sexual organs of the progoneates is substantiated by the reported connection of the proximal end of the penis with the visceral cavity. This occurs in Zygoptera and seems not to have been observed in the Anisoptera, the connection supposedly having been lost through specialization. Further specialization has been suggested in the tracheation of the appendages, which occurs in some Anisoptera according to Backhoff ('10) but not in Zygoptera. Other differences indicating specialization in Anisoptera are to be noted in the segmentation of the penis and in the position and connection of the seminal vesicle with the latter. The structure of the hamules and the genital lobes, and of the portions of the genitalia arising from the third abdominal segment, seems to be simpler in the Zygoptera and not so much reduced or changed from the original plan of the sterna of these segments. The tip of the intromittent organ is much simpler in structure in the families of Zygoptera.

33.—As mentioned in paragraph 15, the presence of the ovipositor in the early stages of the nymphs of Zygoptera and its absence in the nymphs of Anisoptera suggest that the anisopterous appendages have

been reduced from a primitive form similar to that of Zygoptera. This, together with the evidence furnished by extinct species where adults with wing venation similar to that of the Anisoptera had ovipositors, proves fairly conclusively that the extant species without ovipositors have undergone specialization by reduction.

34.—One of the most complete lines of specialization has been determined by Ris ('96) for the structure of the proventriculus. He found what he considered a primitive condition in the Zygoptera (Agrionidae) in which there are sixteen internal folds. Specialization takes place by reduction, and there are eight folds in the Lestinae, four in Gomphus and Aeshna, and none in Libellulidae, there being instead four large symmetrical teeth.

35.—Specialization among the Anisoptera seems to be still further indicated by the habits of the group, especially their habits of migration. The mere fact of migration is not important; but the method of flying in companies and particularly of so flying that there are regularly spaced intervals between the individuals is something which, if true, is unique in this order and in the class Insecta.

Considering the preceding characters as a whole, it will be found that there are two orders of specialization which apparently proceed in opposite directions. One of these begins with the Agrionidae of the suborder Zygoptera and ends with the Libellulidae of the Anisoptera; and the other begins with the Libellulidae and ends with the Agrionidae. The characters mentioned in the various paragraphs will now be assembled for a comparison of the number of generalized features in each family. The families are listed below, and are usually or frequently generalized in the characters discussed in the paragraphs the numbers of which are placed opposite.

Agrionidae.—2, 3, 5, 6, 8, 9, 10, 12, 13, 14, 15, 16, 18, 21, 22, 23, 24, 25, 28, 29, 30, 31, 32, 33, 34, 35.

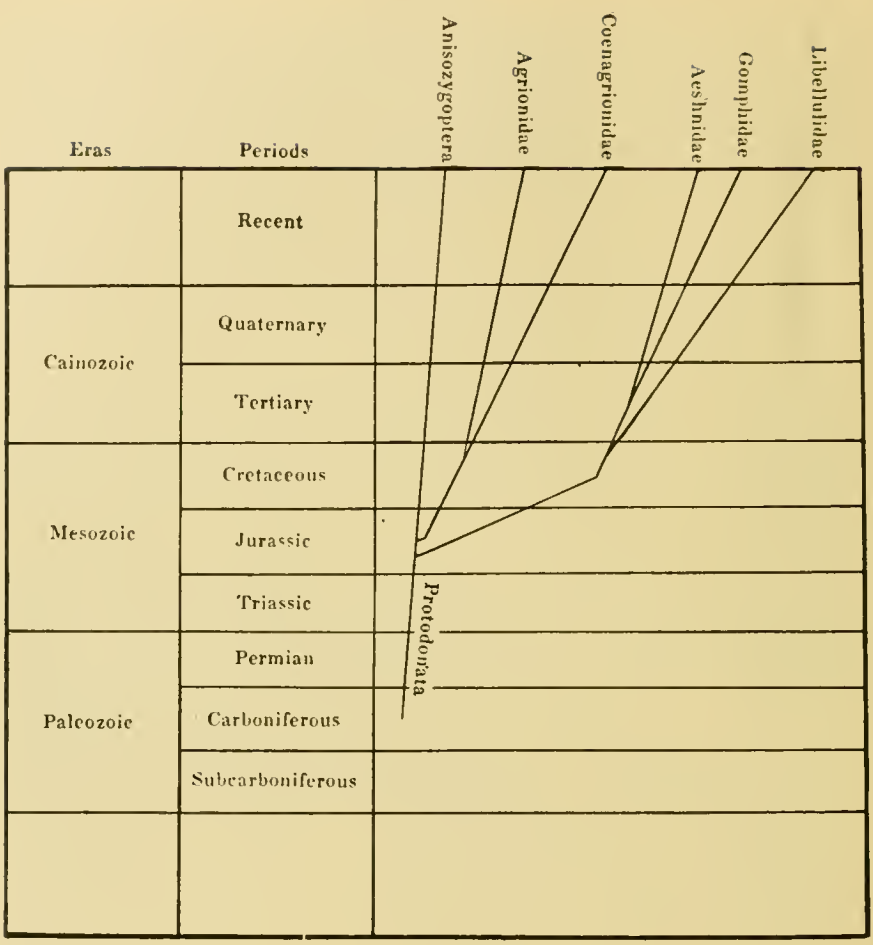
Coenagrionidae.—2, 3, 5, 8, 9, 10, 12, 13, 14, 15, 16, 18, 21, 22, 23, 24, 26, 29, 30, 31, 32, 33, 34, 35.

Aeshnidae.—1, 4, 6, 10, 11, 15, 17, 25, 27, 28.

Gomphidae.—1, 4, 6, 10, 11, 17, 20, 27, 28.

Libellulidae.—1, 11, 17, 27, 28.

From this it will be seen that the most generalized family is the Agrionidae. The evidence is such that it can not be doubted, and it points to some form of the Agrionidae or related family as the stem type. The following genealogical tree, based partly on Handlirsch ('06–'08), has been constructed after taking into account all existing evidence. Distance to the right indicates specialization; vertical distance, time.



Classification

Some of the more important features used in the classification of the nymphs of Zygoptera include the characters of the labium and antennae, the nature of the caudal gills, and the armature of the lateral keels. The classification of the adults depends upon the wing venation and the anal appendages of the male, as well as on such characters as the mesostigmal plates of the female, color, and the like.

The number of species occurring, or probably occurring, within the state is forty-two, as follows. Those without asterisk have been taken in adjoining states by other collectors; those with one have

been reported from Illinois; and those with two have been collected by the writer or seen in collections actually made within the state.

****Agrion aequabile** (Say)
****Agrion maculatum** Beauvais
****Hetaerina americana** (Fabricius)
****Hetaerina titia** (Drury)
***Lestes congener** Hagen
***Lestes disjunctus** Selys
Lestes eurinus Say
****Lestes forcipatus** Rambur
***Lestes inaequalis** Walsh
****Lestes rectangularis Say**
****Lestes uncatus** Kirby
****Lestes unguiculatus** Hagen
****Lestes vigilax** Hagen
****Argia apicalis** (Say)
Argia fumipennis (Burmeister)
****Argia moesta putrida** (Hagen)
***Argia sedula** (Hagen)
****Argia tibialis** (Rambur)
****Argia violacea** (Hagen)
****Enallagma antennatum** (Say)
***Enallagma aspersum** (Hagen)
****Enallagma calverti** Morse
****Enallagma carunculatum** Morse
****Enallagma civile** (Hagen)
Enallagma cyathigerum (Charpentier)
Enallagma divagans Selys
Enallagma doubledayi Selys
****Enallagma ebrium** (Hagen)
****Enallagma exsulans** (Hagen)
****Enallagma geminatum** Kellicott
****Enallagma hageni** (Walsh)
Enallagma piscinarium Williamson
****Enallagma pollutum** (Hagen)
****Enallagma signatum** (Hagen)
****Enallagma traviatum** Selys
****Nehalennia irene** Hagen
****Amphiagrion saucium** (Burmeister)
****Chromagrion conditum** (Hagen)
Ischnura kellicotti Williamson
****Ischnura posita** (Hagen)
****Ischnura verticalis** (Say)
****Anomalagrion hastatum** (Say)

The division of the suborder into families and the arrangement of genera followed by Muttkowski ('10) have been adopted and are herewith reproduced, including only the genera that occur in Illinois.

Family	*Subfamily*	*Genus*
Agrionidae	Agrioninae	Agrion
		Hetaerina
Coenagrionidae	Lestinae	Lestes
	Coenagrioninae	Argia
		Enallagma
		Nehalennia
		Amphiagrion
		Chromagrion
		Ischnura
		Anomalagrion

In the following descriptions "length" refers to the length of the body without appendages, and does not include caudal gills, anal appendages, or antennae. In the color descriptions, where suitable material was at hand, the colors were matched with colors given by Ridgway in his "Color Standards and Color Nomenclature" ('12), and the names of colors which appear in parentheses are from that author.

Family *AGRIONIDAE*

The nymphs of this family are easily distinguished from those of the Coenagrionidae. The three-sided gills, the deeply cleft median lobe of the labium, the large basal segments of the antennae, the unequal length of the gills, and the heavy and sprawling appearance of the legs are characteristic.

The adults are, as a rule, bright or strikingly colored, such colors as metallic green and carmine being common. A large number of antenodal cross-veins between costa and subcosta and the presence of a distinct interpleural suture are also diagnostic.*

Subfamily AGRIONINAE

Key to Genera

NYMPHS

a. Median cleft of median lobe of labium extending proximad of the articulations of the labial palpi; body color usually dark.....*Agrion.*

aa. Median cleft not extending proximad of the articulations of the labial palpi; body color usually light.....*Hetaerina.*

ADULTS

a. Wings with the basilar space, cell first M, without cross-veins; metapleural suture only with a pale stripe.....*Agrion.*

aa. Wings with a basilar space provided with cross-veins; mesopleural, interpleural, and metapleural sutures with pale stripes....*Hetaerina.*

Genus Agrion Fabricius

In the nymph the median lobe of the mentum is provided with a deep cleft which extends far proximad of the articulations of the

*Only one genus in this family is known in which the interpleural suture is not well developed, and since that genus does not occur in the United States, this character has been included in the family description.

labial palpi. The caudal gills are dark, with a light transverse band about the middle of their length. The caudo-lateral margins of the head are elevated to form a short, sharp tubercle. The nymph of but one species has been available, and a study of this, together with a comparison with Hetaerina, has afforded possible generic characters.

The adults are uniform in color, usually dark metallic green or blue, and black, and the wings are broad, with a large number of cross-veins, the basilar space, however, being free from them. The legs are provided with a double row of ventral setae which are usually several times longer than the spaces between their bases.

Key to Species

a. Intersternum metallic green; wings of male smoky only on the apical third; female with a sharp spine on the dorso-apical margin of the tenth abdominal segment; latero-ventral margins of thorax pale..... .....*aequabile.*

aa. Intersternum entirely black; wings of male wholly dark; female with only a short blunt projection on the dorso-apical margin of segment ten; latero-ventral margins of thorax dark.....*maculatum.*

Agrion aequabile (Say)

Nymph.—The nymph of *aequabile* has not been available for study, but this species and its variety *yakima* have been described by Needham ('03: 223,224) and Kennedy ('15: 338). It seems to be nearly identical with *maculatum.* The length of the basal segment of the antenna is used by Needham for its separation from *maculatum,* but this character can not be used for the separation of the variety *yakima.* The length is somewhat greater and the gills somewhat longer than those of *maculatum,* but this character also is of doubtful importance, and further study of the two species should be made to determine the essential differences.

Adult; Male.—Color, metallic green and blue.

Head: mouth-parts black, median lobe of the labium triangular in outline, basal segment of the palpus very broad, distal segment small, cylindrical, longer than the fixed hook of the first; palpiger about one-third the length of the first segment; antennae entirely black; clypeus and labrum black; the front and genae metallic green and thinly clothed with dark hairs.

Thorax metallic green, black and green below; pronotum with the caudal margin entire, the caudal lobe convex and projecting caudo-dorsad; proepimeron distinct; cephalic portion of the prescutum large,

subtriangular, and depressed; paraptera subtriangular, each half with the caudal margin sinuate and slightly emarginate on the lateral half; intersternum green; legs entirely black, the ventral setae much longer than the distances between their bases, the setae of the front femora twelve to fourteen in each row; wings transparent, except the apical third (Fig. 73), which is smoky, about one-third as broad as long, slightly narrower than the wings of *A. maculatum;* stigma wanting, antenodals of the front wing thirty-two.

Abdomen green and blue; sternum of segment ten and the apical third of sternum nine buff-colored; anal appendages (Fig. 117) mostly black, the superiors wholly black, long and curved, tuberculate on the lateral surfaces, and slightly emarginate on the mesal margins at the middle; inferiors black at the apex, paler at the base, nearly as long as the superiors, and provided with a minute apical point directed mesad; parameres of the ninth segment small (Fig. 118).

Female.—Color, metallic green.

Head: proximal half of the second antennal segment with a pale lateral spot; labrum buff-colored on each side, and with a median hour-glass-shaped black mark; exposed portions of the mouth-parts, including the mandibles and their trochantins, buff.

Thorax: latero-ventral margins pale, including the cephalo-ventral margins of the mesepisternum, caudal half of the mesinfraepisternum, a stripe along the metapleural suture extending more than half-way from the cephalic margin to the wing bases, and the ventral and cephalic margins of the metepimera; intersternum green; wings slightly smoky, but not darker on the apical third, stigma present, white.

Abdomen metallic green and black, the apical portion dull and paler below; tergum of segment ten with a prominent mesal ridge which is produced into a long spine at the apex (Fig. 110); anal appendages consisting of conical superiors, double the length of the blunt inferiors; ovipositor reaching to the middle of the tenth segment, the prostyles extending to its apex (Fig. 110).

Measurements

Length, ♂	49 mm.
Length, ♀	44 mm.
Length of abdomen, ♂	38 mm.
Length of abdomen, ♀	34 mm.
Length of hind wings, ♂	32 mm.
Length of hind wings, ♀	29 mm.
Width of hind wings, ♂	9 mm.
Width of hind wings, ♀	8 mm.

The species is apparently rare in Illinois though reported from this state by Williamson ('00). The above description was made from three specimens in the collection of the Illinois State Laboratory of Natural History, two of which bear the label "Mass.". I have not seen the species within the state.

Agrion maculatum Beauvais

Nymph.—Color, dark brown.

Head pentagonal, little contracted behind the eyes; eyes black, a black stripe nearly the width of the eye extending to the caudal margin of the head, and another stripe extending from the antennal fossae to the eyes; proximal segment of the antennae thick, about as long as the head, and usually slightly longer than all the remaining segments together; labium with the median lobe deeply cleft, the cleft extending proximad of the articulations of the labial palpi (Fig. 8); proximal segment of the palpus with three immovable end-hooks and two small setae near the base of the distal segment of the palpus.

Thorax: prothorax with a broad dark line on each lateral margin which is continuous with the dark line on the side of the head; legs slender, the femora with a whitish band on the apical third, with a narrower brownish band proximad of the white one, and a distal brownish band extending to the apex of the segment; tibiae without heavy setae; tarsi short; wing-cases broad and extending in full-grown nymphs as far as the fourth abdominal segment.

Abdomen subcylindrical, dark, and without distinct lateral keels; apical margins of the terga with about four dark spots on the dorsum; lateral tracheal gills three-sided, somewhat blunt, with a white transverse band near the middle of their length; median gill flat, shorter, with a similar cross-band at the middle and another faint band beyond; marginal setae of the median gill long and slender, extending entirely around the gill.

Measurements

Length	20 mm.
Length of abdomen	15 mm.
Length of lateral gills	10–12 mm.
Length of metathoracic wing-cases	6 mm.
Length of median lobe	4.5 mm.
Width of median lobe	1.3–3 mm.

Adult; Male.—Color, metallic green or blue.

Head green; labium black, the median lobe subtriangular in outline, the cleft extending slightly less than half the distance from apex

to base; proximal segment of the labial palpus broad, black, the palpiger short, about one-half the length of the first segment measured from the point of articulation to the base of the second segment, the fixed hook nearly as long as the distal segment of the palpus; antennae black; clypeus and labrum metallic green or black; front, together with the clypeus and labrum, thinly clothed with black setae; eyes black or slate-colored.

Thorax green above, black below; pronotum with the caudal margins entire, the caudal lobe convex and projecting caudad and dorsad; proepimeron distinct; cephalic portion of the mesoprescutum subtriangular, depressed; dorsal carina distinct, black; paraptera subquadrangular, the caudal margins emarginate on the lateral third; metepimera broader adjacent to the wings; ventral portion of the metepimera and the intersternum wholly black and subshining; legs black, the setae also black and longer than the space between their bases; anterior femoral setae fourteen or fifteen on each side; tarsi black; wings very dark, almost opaque, and about one-third as wide as long; stigma wanting; antenodal cross-veins twenty-seven.

Abdomen nearly cylindrical, glabrous and faintly striated transversely; superior anal appendages long and black, the lateral surfaces tuberculate, the mesal surfaces emarginate at about the middle; inferiors nearly as long as the superiors, straight and with a small apical hook directed mesad (Figs. 139,139a).

Female.—Color, metallic green.

Head not essentially different from that of the male.

Thorax: wings pale brown, darker at the tips, transparent; stigma present, white; antenodal cross-veins 23 to 24.

Abdomen much shorter than that of the male; anal appendages consisting of conical superiors more than twice the length of the blunt inferiors; ovipositor (Fig. 109) with broad lateral valves reaching about to the apex of segment ten, the prostyles rod-like and slightly curved.

Measurements

Length, ♂	1.46 mm.
Length, ♀	41 mm.
Length of abdomen, ♂	38 mm.
Length of abdomen, ♀	32 mm.
Length of hind wings, ♂	29 mm.
Length of hind wings, ♀	30 mm.
Width of hind wings, ♂	10 mm.
Width of hind wings, ♀	10 mm.

The nymphs of this species may be taken in the clearer and swifter streams of Illinois, though not often in very great numbers. The adults do not wander far from the habitat of the nymphs and their period of flight seems to be largely limited to a short time in early summer. The species is supposed to have a northerly distribution, but has been taken near the southern boundary of the state. Several nymphs taken at Urbana early in June emerged June 10, 1915, and subsequent collections of adults show that the insect flies until early fall, although the period of maximum abundance lies between the middle of June and the middle of July.

Specimens have been seen from Havana, Muncie, Oregon, Peoria, Urbana, Cook County, and McHenry County.

Genus Hetaerina Hagen

The nymphs of this genus have shallow mental clefts, and have the margins of the pronotum prominently elevated, and the margins of the lateral gills marked with black or dark spots.

The adults are characterized by cross-veins within the basilar space and by pale stripes on all of the pleural sutures of the thorax.

Key to Species

MALES

a. Bases of hind wings tinted with carmine similar to that of the front wings; legs striped, buff and black or dark brown..... *americana.*

aa. Bases of hind wings tinted with brown; legs entirely dark, not striped ..... *titia.*

FEMALES

a. Mesepisterna and mesepimera of the thorax without elongate spots of green; uniform bronze..... *americana.*

aa. Mesepisterna and mesepimera of the thorax with elongate spots of green ..... *titia.*

Hetaerina americana Fabricius

Nymph.—Color, brown or greenish.

Head pentagonal, about as long as broad; proximal segments of the antennae nearly twice as long as all the remaining ones together; eyes black or dark; labium (Fig. 9) thickset, the cleft of the median lobe hardly extending proximad of the articulations of the labial palpi; labial palpi with three end-hooks and five or six small setae at the

base of the distal segment; caudo-lateral margins of the head forming a blunt tubercle.

Thorax twice as long as broad, a dark lateral line occurring in some individuals, extending from the eyes to the bases of the second pair of wing-cases, though, as a rule, this is much less distinct than in Agrion; lateral margins of the pronotum distinctly elevated, scalloped, and the margins produced at two points on each side to form tubercles (Fig. 23); legs without heavy setae, usually light in color. In younger and more plainly marked specimens the proximal half of the femur is dark brown; this is followed by a light band, beyond which the femur is again brown to the apex; tibiae with three faint, dark rings, the bases and apices also dark; tarsi light in color except the apical half of the third segment and the tarsal claws, which are usually black.

Abdomen: lateral keels feebly developed, not armed with setae though ending abruptly on the apex of segment nine in a short blunt tubercle; ovipositor short and extending hardly caudad of the apex of the ninth abdominal segment; lateral gills three-sided, the median one flat and considerably shorter than the lateral ones; median gill dark along the axis nearly to the apex and with three dark cross-bands; axes of lateral gills sometimes dark, though more frequently the whole gill is light brown or buff and the three margins are each marked with three dark spots (Fig. 79).

Measurements

Length	23 mm.
Length of abdomen	12 mm.
Length of lateral gills	9–10 mm.
Length of metathoracic wing-cases	6 mm.
Length of median lobe	4 mm.
Width of median lobe	1.3–3 mm.

There seems to be a great deal of variation in the color markings of the nymph, especially in the amount of dark pigment, and specimens may be taken which are either practically without body markings of any sort or are so dark and plainly marked as to make the collector think he has taken another species.

Adult; Male.—Color, bronze and metallic green; bases of the wings carmine.

Head metallic bronze; median lobe of the labium subtriangular in outline; labial palpi broad, the terminal segment black and as long as the fixed hook of the first segment; front, vertex, clypeus, and

labrum, thinly pilose; postclypeus metallic green with a small buff spot on the dorso-lateral margin, the anteclypeus with a triangular, median light spot, the remainder dark; labrum buff, but provided with a median, circular, black spot; exposed portions of the mandibles and their trochantins buff; eyes uniform brown.

Thorax: prothorax bronze and black, thinly pilose; caudal lobe of the pronotum convex and projecting caudo-dorsad, the caudal margin entire; proepimeron distinct; pleural sutures all marked with buff-colored stripes, the interpleural suture distinct, cephalad of the metathoracic spiracle; metepimera largely buff but with a median longitudinal stripe of bronze; intersternum with two dark spots on the cephalic border which unite with a dark line covering the suture caudad of it and between the epimera; paraptera subtriangular, black, the caudal margins nearly straight; legs striped, buff and black, the coxae and trochanters buff with a few darker spots, the femora and tibiae mostly dark with lighter stripes on the caudal surfaces, the front femora with nine or ten setae in each row, and the tarsi and claws black; wings clear, the basal fourth, or more, bright carmine, antenodals of the front wing nineteen or twenty, the stigma much longer than the cell caudad of it (Fig. 78).

Abdomen metallic green or reddish brown, dull with age; segments three to seven with pale basal rings, interrupted on the dorsomeson, the lateral surfaces of terga two to seven with a pale longitudinal stripe from base to near apex; first tergum with a pale lateral apical spot; anal appendages (Figs. 34,38) with the superiors twice as long as the inferiors, curved and somewhat expanded at the apex, the lateral margins tuberculate, the mesal margins with two rounded knobs.

Female.—Color, metallic green and in general lighter than that of the male.

Head as in the male except that the antennae have the basal segment entirely pale; postclypeus with a large transverse green spot, and the labrum with a black mesal spot on the dorsal margin.

Thorax with the dorsal carina lined with buff, the pleural sutures with much broader stripes than those of the male; wings (Fig. 74) without carmine at the base, but slightly smoky on the basal third and along the costal margin; stigma white, and the antenodal crossveins about twenty-one in number.

Abdomen metallic green above, the lateral surfaces of the terga with darker apical spots on segments one to nine, and terga two to seven with narrow basal rings of paler color which are interrupted on the dorso-meson; anal appendages of the usual type; ovipositor

(Fig. 112) with broad lateral valves, which are serrate on the ventral margin and extend to the apex of segment ten; prostyles slender, rod-like and bent ventrad at the apex (Fig. 41).

Measurements

Length, ♂	44 mm.
Length, ♀	42 mm.
Length of abdomen, ♂	36 mm.
Length of abdomen, ♀	32 mm.
Length of hind wings, ♂	28 mm.
Length of hind wings, ♀	29 mm.
Width of hind wings, ♂	6 mm.
Width of hind wings, ♀	6 mm.

This species is common along the drainage ditch north of Urbana. Nymphs collected May 27 and 29, 1915, emerged June 19. The species flies until late in October and specimens have been taken as late as October 22. It is apparently limited to the northern half of the state, though probably occurring wherever conditions are favorable.

Specimens have been seen from Galena, Havana, Muncie, Oregon, Peoria, Savanna, Urbana, and McHenry County.

Hetaerina titia (Drury)

Nymph.—Unknown.

Adult; Male.—Color, very dark green and brown.

Head dark brown, faintly metallic; labium with subtriangular median lobe, the palpi with broad black proximal segments, and black distal segments about as long as the fixed hook of the proximal segment; antennae brown; clypeus and labrum shining; front with a broad transverse buff stripe immediately above the clypeus, the front, vertex, clypeus, and labrum pilose, the setae brown.

Thorax black and brown, slightly bronzed; pronotum with the caudal lobe somewhat pointed, convex, and projecting caudo-dorsad; proepimera distinct; interpleural suture distinct cephalad of the spiracle; mesinfraepisternum buff, with a dorsal dark stripe; cephalic shoulder of the mesepimeron light brown, the mesepisternum with a greenish longitudinal stripe extending from the caudal margin nearly to the spiracle; metepimeron with a median black stripe; intersternum with two faint black spots near the cephalic margin; legs uniform dark brown, the tibiae lighter in color than the femora, the setae of the front femora in eleven or fourteen rows, tarsi and claws black;

wings clear, the front wings carmine, and the hind wings brown at base, the color, however, not occupying as much as one-fourth the length of the wing; apices of the wings brown; stigma brown and not longer than the cell caudad of it; front wings with about twenty-four antenodal cross-veins.

Abdomen dark brown; second tergum marked with a paler transverse band beyond the middle, the lateral margins also pale; terga three to six paler along the lateral margins, with narrow basal rings interrupted on the dorso-meson; segments seven to nine inclusive all dull black, the sternum of the tenth buff; anal appendages (Fig. 119) consisting of heavy black superiors, more than twice as long as the inferiors, and having a few tubercles on the lateral surfaces of the apical half, the mesal surfaces with basal knobs and thick subapical projections; inferiors dark brown, reddish at base, short, and with small apical points directed dorsad.

Female.—Color similar to that of the male.

Head similar to that of the male.

Thorax pale brownish, yellow, and green, the dorsal carina black, the supraepisterna of the mesothorax with a median elongate spot extending cephalad from the wing bases half-way to the cephalic margin, the cephalo-dorsal angles being also green; mesepimera with elongate spots about the middle and nearer the ventral than the dorsal margin; wings without carmine, the bases with only a slight tinge of brown; stigma nearly white, and surmounting one to one and a half cells; antenodal cross-veins of the front wing twenty-one, postnodal cross-veins twenty-six.

Abdomen similar in general color to that of the male, but the lateral margins of terga eight to ten yellowish brown; dorsal carina of the tenth tergum produced into a long blunt spine, beyond the apex of the segment; ovipositor short, brownish yellow, the prostyles slender and the caudal sternites of the eighth segment large and contiguous on the meson as in *americana,* Figure 41.

Measurements

Length, ♂	51 mm.
Length, ♀	44 mm.
Length of abdomen, ♂	41 mm.
Length of abdomen, ♀	34 mm.
Length of hind wings, ♂	30 mm.
Length of hind wings, ♀	29 mm.
Width of hind wings, ♂	6–7 mm.
Width of hind wings, ♀	6–7 mm.

There are two representatives of this species in the collection of the Illinois State Laboratory of Natural History, both of which were collected at Havana, Illinois. There are also three specimens in the Bolter Collection of the University of Illinois, which are without locality or date labels.

H. tricolor Burmeister is a synonym of *H. titia* (Williamson, '12).

Family *COENAGRIONIDAE*

The nymphs of this family possess flattened gills, the lateral ones being flattened as well as the median. The median lobe of the labium does not have a deep cleft, and the basal segment of the antenna is small and does not exceed the second in length.

The adults are often brightly colored, frequently marked with bright blue or green, but the wings are mostly clear and without smokiness or tints of any kind. The antenodal cross-veins are few, never more than two in number in Illinois species, and the postnodals are also much reduced and fewer in number than in the Agrionidae. The interpleural suture is never distinct as far cephalad as the metathoracic spiracle.*

Key to Subfamilies

NYMPHS

a. Median lobe of labium spoon-like (Fig. 10), the narrowed portion usually much longer than the expanded portion; gills (Figs. 48–52) more or less spatulate, the margins nearly parallel and the tips blunt..... .....Lestinae.

aa. Median lobe of labium not spoon-like (Figs. 11–13), the narrowed portion not much longer than the expanded portion; gills lanceolate, acutely pointed at the tip, the margins not parallel..Coenagrioninae.

ADULTS

a. M_3 arising much nearer the arculus than the nodus (Fig. 85); front without pale color immediately above the clypeus.....Lestinae.

aa. M_3 arising much nearer the nodus than the arculus (Figs. 81–84, 87–90); front with a pale stripe immediately above the clypeus..... .....Coenagrioninae.

*The use of the accessory genitalia in separating the males of closely allied members of this family has failed to prove entirely satisfactory for such species as *Lestes forcipatus* and *disjunctus* and the Enallagma group composed of *E. calverti, carunculatum, civile, divagans,* and *doubledayi.* The structure of the penis in the Enallagma group (Figs. 97,99,101,107,108) is so uniform that the advantage gained by using the character is slight. It may be found that many of these species interbreed —a condition already known to be true of *carunculatum* and *civile*—and it seems almost certain that future investigators will unite *L. forcipatus* and *disjunctus* when more complete biological data are in hand.

Subfamily LESTINAE

The nymphs of this subfamily are long, slender insects with very slender legs. The median lobe of the labium is much contracted at the base, the contracted portion being usually longer than the expanded distal portion. The lateral keels of the abdomen are frequently produced at the apex into a short spinule, and the gills are long, spatulate, and usually without heavy marginal setae and with more or less brown pigment.

In the adults the nature of the wing venation is important. The third median vein and the bridge unite with the R-M trunk nearer the arculus than the nodus, and the stigma always surmounts two or more cells. The long tibial and femoral setae, which are longer than the distance between their bases, as well as the forcipate character of the anal appendages of the male and the presence of a large ovipositor with conspicuous sternites at the base of the cephalic pair of gonapophyses, are also important as diagnostic features.

As a rule the adults are dull in color as compared with the Coenagrioninae and match the color of their usual environment extremely well.

Genus Lestes Leach

The subfamily Lestinae is represented in Illinois by a single genus, Lestes. The nymphs of this genus are recognizable by the character of the labium. The proximal segment of the labial palpus always has two processes mesad of the distal palpal segment, one of them resembling a fork with the median tines broken off, the remaining process consisting of a long non-bifurcate projection with a short heavy hook at the distal end and minute teeth along the mesal margins, (Fig. 10).

The adults are larger than most Coenagrioninae. Vein M_2, of both wings, always arises distad of the second postnodal cross-vein and the stigma rarely surmounts more than three cells. The arculus is one-third or one-fourth the length of the caudal side of the quadrangle. The wings are commonly held horizontally when the insect is at rest.

Keys to Species

NYMPHS

a. Second segment of the labial palpus with three or four setae; labium broad at the proximal end, the contracted portion of the median lobe hardly longer than the expanded portion and about one-third as broad as the latter..... *congener.*

aa. Second segment of the labial palpus with only two setae or very rarely three *(uncatus);* labium narrow at the proximal end, the con-

tracted portion much longer than the expanded portion and less than one-third the width of the latter.

b. Gills pointed at tip (Figs. 51,52); venter of abdomen without a median row of black spots.

c. Ovipositor of female not extending caudad of the eleventh segment; lateral gills not conspicuously contracted beyond the middle . . . . . *unguiculatus.*

cc. Ovipositor of female extending caudad of the eleventh segment; lateral gills conspicuously contracted beyond the middle.. *uncatus.*

bb. Gills not sharply pointed (Fig. 49); venter of abdomen with or without a median row of black spots.

c. Lateral keels of segments 1–9 or 2–9 with long apical spines; venter of abdomen without a median row of black spots; gills not conspicuously narrowed beyond the middle . . . . . *vigilax.*

cc. Lateral keels of segments 3–9 or 4–9 with apical spines; gills (Fig. 49) conspicuously narrowed beyond the middle; venter of abdomen with a median row of black spots . . . . . { *forcipatus.* / *rectangularis.*

ADULTS

Females

a. Dorsum of thorax green.

b. Wings flavescent . . . . . *eurinus.*

bb. Wings not flavescent.

c. Occiput and postgenae pale . . . . . *inaequalis.*

cc. Occiput and postgenae black.

d. Basal half of first abdominal segment yellow; stigma always surmounting less than three cells; length usually about 35 mm. . . . . *uncatus.*

dd. Basal half of first abdominal segment black; stigma usually surmounting three or more cells; length 43–47 mm . . . . *vigilax.*

aa. Dorsum of thorax black or dark brown, never green.

b. Metepimera with a black spot above and below the latero-ventral carina . . . . . *congener.*

bb. Metepimera without a black spot above and below the latero-ventral carina.

c. Occiput and postgenae pale buff or yellow; abdomen with a greenish tint . . . . . *unguiculatus.*

cc. Occiput and postgenae black or very dark brown; abdomen never with a greenish tint.

d. Tarsi black above . . . . . { *forcipatus.* / *disjunctus.*

dd. Tarsi with more or less pale yellow above . . . . . *rectangularis.*

Males

a. Dorsum of the thorax and usually the abdomen metallic green.
  b. Inferiors more than half the length of the superiors, but never longer than the superiors.
    c. Inferiors long and slender; stigma usually surmounting three cells . . . . . *vigilax.*
    cc. Inferiors broad and flat; stigma usually surmounting less than three cells . . . . . *uncatus.*
  bb. Inferiors either longer than superiors or less than half their length.
    c. Inferiors less than half the length of the superiors; wings flavescent . . . . . *eurinus.*
    cc. Inferiors longer than superiors; wings not flavescent. . *inaequalis.*
aa. Dorsum of the thorax and abdomen black or dark brown.
  b. Inferiors shorter than half the length of the superiors; metepimera with black spots near the latero-ventral carina. . . . . *congener.*
  bb. Inferiors more than half the length of the superiors; metepimera without black spots near the latero--ventral carina.
    c. Inferiors sigmoid, the apical two-thirds curved in an opposite direction to the superiors. . . . . *unguiculatus.*
    cc. Inferiors not sigmoid, the apical two-thirds not curved in an opposite direction to the superiors.
      d. Metapleural suture covered with a sooty black stripe. . . . . *disjunctus.*
      dd. Metapleural suture not covered with a sooty black stripe.
        e. Basal tooth of the mesal margin of the superior appendages longer than the tooth of the distal third. . . . . *forcipatus.*
        ee. Basal tooth of the mesal margin of the superior appendages shorter than the tooth of the distal third. . . . . *rectangularis.*

Lestes congener Hagen

Nymph.—Color, pale brown or greenish.

Head twice as broad as long, the caudo-lateral angles not projecting strongly and provided with few setae; antennae long and slender; labium with the median lobe comparatively broad at the base, one-third as broad as the expanded portion and about as long as the latter; mental setae six and sometimes a small seventh on each side, lateral setae four or five, three or four of which are located on the distal segment; inner, mesal lobe of the proximal segment of the palpus as broad as the fork-like process between it and the distal segment of the palpus; labium, when folded, extending caudad between the metacoxae.

Thorax slender; the distances between procoxa and mesocoxa, and between mesocoxa and the metacoxa nearly equal; front femora about half the length of the hind femora and all femora with faint preapical rings of brown; wing-cases short and extending hardly caudad of the second abdominal segment.

Abdomen with poorly developed lateral keels which are provided with apical spines on segments 5–9; gills (Fig. 50) broad, bluntly pointed, and provided with three conspicuous cross-bands of dark pigment, the length of the median gill about four times its greatest width; ovipositor of the female reaching slightly beyond the apex of the tenth segment.

Measurements

Length	16 mm.
Length of abdomen	12 mm.
Length of gills	8 mm.
Width of gills	2 mm.
Length of metathoracic wing-cases	5 mm.
Length of median lobe	3 mm.
Width of median lobe	1.5 mm.

Described from three nymphs received from Dr. E. M. Walker and taken at Prince Edward Island, Canada, Aug. 1, 1915.

Adult; Male.—Color, dull brown and buff or yellow.

Head black, buff below; median lobe of the labium subquadrangular, the median cleft shallow, the labial palpi broad, the distal segments much shorter than the fixed hook, and brownish at the tips; antennae uniform black, the first segment pale at the apex; postclypeus black or dark brown, the anteclypeus, labrum, and genae to the level of the fronto-clypeal suture yellow; lateral ocelli with small yellow spots laterad of them; front, remainder of the vertex, occiput, except occasionally a transverse yellow stripe from the occipital foramen to the compound eyes, black.

Thorax dark brown and yellowish buff, the prothorax dark brown, the median lobes of the pronotum with pale lateral margins, and spots on the meson near the caudal margin; caudal lobe of the pronotum black; proepimeron black; mesostigmal plates with pale lateral angles; dorsal carina usually with a pale line, the mesepisterna, except the ventral half of the infraepisternum, black or dark brown; caudo-dorsal angle of the metepisterna dark brown or black; metepimera with an elongate black spot near the ventro-lateral carina and a similar spot just ventrad of the carina; legs striped, the coxae buff, trochanters black above, the femora black with a narrow pale stripe including the ceph-

alo-ventral row of setae, and a broad dorsal stripe, frequently divided by a faint line or row of spots; tibiae yellow, with a dark stripe including the cephalo-ventral setae; tarsi and claws shining black; wings clear, with eleven postnodals in the front wing and nine or ten in the hind; stigma pale brown, surmounting about one and one-half to two and one-half cells; M_2 arising between the third and fourth postnodal cross-veins in the front wing and between the second and third in the hind wing; paraptera brown, caudal margins black.

Abdomen black and buff; terga 1–10 with broad black longitudinal stripes, the lateral margins with broad pale stripes, the pale color extending well to the dorso-meson in the form of basal rings on segments three to seven inclusive; first tergum with a black spot near the latero-ventral margin, terga three to eight with narrow apical black rings reaching their lateral margins; anal appendages black (Figs. 123, 124) and reddish, the superiors compressed, the ventro-mesal margins with large subbasal teeth and a few setae beyond these to the apical third; inferiors shorter than the superiors, usually less than half the length of the latter and provided with a fine brush of silken hairs; sterna 2–9, inclusive, black, the tenth being pale and the first with a black median spot.

Female.—Color similar to that of the male.

Head and thorax similar to those of the male.

Abdomen with interrupted basal rings on terga 3–6, inclusive, the lateral stripes broader than those of the male; sterna 2–7 black, one with a black median spot and eight with a median black stripe; anal appendages of the usual type; superiors black; ovipositor with a black line along the ventral margin, the margins serrate; prostyles dark, long, and nearly straight; ventral margins of the ninth tergum black immediately dorsad of the ovipositor.

Measurements

Length, ♂	34–35 mm.
Length, ♀	32–36 mm.
Length of abdomen, ♂	28 mm.
Length of abdomen, ♀	24–29 mm.
Length of hind wings, ♂	19–20 mm.
Length of hind wings, ♀	19–22 mm.
Width of hind wings, ♂	4 mm.
Width of hind wings, ♀	4 mm.

This species is distinguishable from *disjunctus,* to which it seems most closely related, by the metepimeral spots; the males, by the shortness of the inferior appendages. The compound eyes are blue in life.

It appears on the wing late in summer and may be taken during August and September.

Described from a large series of specimens in the collection of E. B. Williamson. Probably occurs in Illinois.

Lestes disjunctus Selys

Nymph.—Not available for study.

Adult; Male.—Color, blackish brown and yellow.

Head blackish brown above, pale yellow below; median lobe of the labium pale, subquadrangular, the median cleft shallow, but with the usual dark line extending to the base of the piece; antennae black, the two proximal segments very short, much shorter than the two distal ones, the apex of segment two slightly paler; postclypeus almost black, the anteclypeus, labrum, trochantins of the mandibles, and genae, yellowish green; occipital and postgenal regions black, becoming pollinose with age; eyes brownish.

Thorax: prothorax black, largely pollinose in older individuals; proepimera and proepisterna distinct; caudal lobe of the pronotum black, cephalic lobe black, median lobes black, the furrow separating them indistinct; mesostigmal plates black; mesinfraepisterna black or largely black, the supraepisterna blackish brown with the exception of a narrow yellow stripe on the ventro-lateral margins; mesepimera dark brown with the exception of the cephalo-ventral shoulders, which are yellow; metepisterna largely yellow, becoming more or less black with age from the spreading of the black stripe on the metapleural suture; stripes of the metapleural sutures covering about two-thirds of the metepimeron, the remainder of that sclerite yellow; postcoxal areas buff, without black markings; legs slender, pale, the coxae black and pale yellow; femora striped, the hind femora with three black stripes, the middle and front femora with two each; tibiae with a single dark stripe which diffuses over the segment on the distal third; rows of setae of the front femora composed of two and nine setae respectively; wings clear, the antenodal cross-veins two, postnodals about eleven, and M_2 arising between the second and third postnodal cross-veins in both wings; stigma dark brown, surmounting two cells.

Abdomen brown to black, and yellow; first tergum black with the exception of a very narrow apical ring; dorsum of the second tergum dark brown, the lateral margins marked by a narrow longitudinal yellow stripe, the dorsum of 3–6 dark brown, the stripe widened subapically; segment seven black, with a pale lateral stripe; segments eight, nine, and ten black; anal appendages (Fig. 133) blackish brown,

the superiors with tuberculate lateral surfaces, the mesal margins with two nearly equal teeth; inferiors flat, placed horizontally, and slightly swollen at the base and apex.

Female.—Color similar to that of the male.

Head similar to that of the male.

Thorax without the black stripe on the metapleural suture, and the mesinfraepisternum largely pale.

Abdomen similar to that of the male except that the dorsal brown stripes of the terga are more confined to the dorsal surface and the lateral surfaces are mostly yellow or buff; ovipositor of the female pale except the brown prostyles, extending caudad of the apex of segment ten; anal appendages of the usual type; dorsad of the superiors and between them there is commonly an unpaired blunt process extending conspicuously beyond the apex of the tenth tergum.

Measurements

Length, ♂	32–37 mm.
Length, ♀	35 mm.
Length of abdomen, ♂	25–30 mm.
Length of abdomen, ♀	27 mm.
Length of hind wings, ♂	17–20 mm.
Length of hind wings, ♀	19 mm.
Width of hind wings, ♂	4–4.5 mm.
Width of hind wings, ♀	4.5 mm.

There is great variation in the size of this species as well as in its coloration. The black wash on the metapleural suture is a distinctive character of the older males, but the younger males and the females are not easily separated from *forcipatus* and it is possible that this species is a synonym of the latter. The nymphs are also reported to be nearly identical with *forcipatus*.

Not common in Illinois though occurring in certain localities probably with *forcipatus* and *rectangularis*.

Lestes eurinus Say

Nymph.—Not available for study.

Adult; Male.—Color, metallic green and yellowish buff.

Head metallic green; mouth-parts buff, the median lobes of the labium subquadrangular, with a shallow cleft and a dark line extending proximad to the base; distal segment of the labial palpus dark brown, shorter than the fixed hook; antennae uniform dark brown, the

slender terminal segments long, aristiform; postclypeus black, anteclypeus, exposed portions of the mandibles, and genae brown or greenish yellow, the front, vertex, and all of the occiput and postgenae, metallic green; eyes dark brown.

Thorax metallic green and buff; pronotum metallic green, sometimes pollinose, the caudal and cephalic lobes becoming black with age; proepimeron and proepisternum distinct, black and green; mesostigmal plates black; dorsal carina brown, the mesosupraepisterna metallic green; mesopleural suture brownish, the dorsal half of the mesinfraepisterna, black; mesepimera black or green, the dark color sometimes extending ventrad onto the metepisterna or epimera; remainder of the metapleura and the intersternum yellow, pollinose with age; legs striped, dark brown and buff; coxae buff and dark brown; middle and hind femora with two broad, dorsal, brown or black stripes and a narrow, dorsal, pale one, the apices of the femora dark; front femora without the dorsal, pale, longitudinal line, the entire dorsum being dark brown; tibiae with broad, ventral, brown stripes including the setal rows, the tips dark; tarsi dark brown, the claws deeply notched at the apex, the two teeth nearly equal in length; wings usually flavescent and with fourteen or fifteen postnodal cross-veins in the front wing and twelve to fifteen in the hind; M_2 arising between the third and fourth postnodals in the front wing and between the second and third in the hind; stigma long and narrow, surmounting two and one-half to three and one-half cells in both wings.

Abdomen metallic green and black and buff; dorsum of terga 1–8 inclusive, green, the lateral margins of the same terga buff, the buff stripe becoming dark brown or black on the apices of 4–8; venter of 3–8, and all of segments nine and ten and sometimes seven and eight black, the terminal segments pollinose with age; anal appendages black, the superiors long and curved, the dorso-lateral margins coarsely tuberculate at the apices, the meso-ventral margins with a single sharp basal tooth, and a median projection which has several smaller teeth at the apex; inferiors blunt at the apices and each with a brush of fine setae.

Female.—Color, metallic green, and yellow and black.

Head similar to that of the male.

Thorax: prothorax similar to that of the male; mesothorax with a very broad brownish stripe covering the dorsal carina and a green longitudinal stripe in the middle of each mesosupraepisternum; mesopleural suture with a broad brownish stripe which extends across the dorsal portion of the infraepisternum; metepimera with indefinite, brown, oblique stripes.

Abdomen similar in general color to that of the male; anal appendages largely black or dark brown, the process immediately above and between the superiors projecting as in *disjunctus;* ovipositor with broad lateral valves, the ventral margins coarsely toothed, the distal portion separated from the tenth segment by a considerable interval; more than the ventral half of the lateral valves black; eighth sternites large, conspicuous, nearly black, and contiguous on the meson.

Measurements

Length, ♂	48–49 mm.
Length, ♀	47 mm.
Length of abdomen, ♂	39 mm.
Length of abdomen, ♀	36 mm.
Length of hind wings, ♂	29 mm.
Length of hind wings, ♀	28 mm.
Width of hind wings, ♂	6.5 mm.
Width of hind wings, ♀	5.5 mm.

Described from two males in the Bolter collection of the University of Illinois and a number of females in the collection of E. B. Williamson.

The species is closely related to *vigilax* and *inaequalis,* but both sexes may be distinguished by the flavescent wings; the males, by the short inferior anal appendages.

Probably occurs in Illinois.

Lestes forcipatus Rambur

Nymph.—Color, buff or green.

Head brown and buff; labium, when folded, extending just caudad of the mesocoxae; mental setae six, the lateral setae three, two of which are located on the distal segment of the palpus; antennae of the usual Lestes type.

Thorax about as long as broad, brown; legs slender, the femora all with faint subapical rings and several rows of small setae; tibiae with dark brown apices and with a few three-pointed subapical scales; tarsi with the apical half of the last segment and the tarsal claws dark brown; metathoracic wing-cases extending to the middle of the third abdominal segment.

Abdomen long and slender; lateral keels with heavy setae at the apices on segments five to nine, and a single row of smaller ones from the bases to the apices of the keels of the same segments; terga all with

much more pigment than the sterna, and with small setae distributed evenly over the surfaces; sternum of segment ten with long hair-like setae; gills (Fig. 49) spatulate, broadest just proximad of the middle, three or four times as long as broad; tips rounded or obtusely pointed, black, and two rather indistinct dark cross-bands proximad of the tip; gills sometimes nearly black.

Measurements

Length	19–20 mm.
Length of abdomen	14 mm.
Length of gills	8.5–9 mm.
Width of gills	2–3 mm.
Length of median lobe	2.4 mm.
Width of median lobe	.5–1.7 mm.

Adult; Male.—Color, dark brown and yellow.

Head brown and buff, the median lobe of the labium pale or nearly white, subquadrangular in outline, the median cleft shallow and narrow but apparently extending well towards the base of the piece; proximal segment of the palpus pale, except the distal half of the fixed hook which is black; antennae dark brown with a short basal segment, a much longer second segment, and two terminal aristiform segments which together are much longer than the two basal ones; clypeus and labrum pale yellow or greenish; exposed portions of the mandibles, their trochantins, and the genae as far dorsad as the fronto-clypeal suture, pale; front and vertex brown; occipital and postgenal regions largely dark brown or black, becoming pollinose with age.

Thorax brown and yellow; prothorax brown above, pale below, the proepimera distinct, pale, with a dark dorsal border; caudal lobe of the notum not especially prominent or convex, the cephalic lobe with a median circular black spot and the median lobes each with an irregular H-shaped dark mark; cephalic portion of the prescutum triangular, not deeply depressed; stigmal plates brown and black; pleural sutures and the dorsal carina pale, the pale stripe of the mesopleural suture becoming bluish with age; legs striped, yellow and black, the coxae and trochanters entirely pale, the femora and tibiae striped and the tarsi and claws entirely black; wings with ten to eleven postnodal cross-veins and with M_2 arising between the third and fourth postnodals in the front wing and between the second and third in the hind wing.

Abdomen dark brown, often with a trace of metallic green; sterna of segments three to nine black; dorsum of terga 1–10 with

brown longitudinal bands which are considerably narrowed basally on segments three to seven and conspicuously widened subapically on segments 2–6, the apically widened portion enclosing a lateral yellow spot on segments 3–6; segment nine completely black except a small lateral yellow spot; lateral surfaces of terga 1–8 and ten, yellow; anal appendages (Fig. 137) consisting of broad superiors which are coarsely tuberculate on the lateral surfaces and have two strong, mesal teeth; inferiors nearly as long as the superiors, not laterally compressed, but flattened and placed horizontally.

Female.—Color similar to that of the male.

Head and thorax not appreciably different from those of the male.

Abdomen without the yellow lateral spots of the male; ovipositor extending caudad of the tenth segment, the lateral valves serrate on the apical two-thirds of the ventral margins (Fig. 114).

Measurements

Length, ♂	44 mm.
Length, ♀	41 mm.
Length of abdomen, ♂	30 mm.
Length of abdomen, ♀	32 mm.
Length of hind wings, ♂	23–24 mm.
Length of hind wings, ♀	24 mm.
Width of hind wings, ♂	5 mm.
Width of hind wings, ♀	5 mm.

One of the commonest of the Lestinae in Illinois. The nymphs usually occur along with *rectangularis* in shady stagnant pools. The species is on the wing from early June well into September, and nymphs have been taken at Urbana late in July and at Lexington, Ky., late in August. It seems probable that there is more than one brood of the species per year.

The nymph is inseparable from *rectangularis* and there seems to be no noticeable difference in the length of the developing ovipositor of the female as Walker inferred there might be ('14: 197).

The adult females are also inseparable from *rectangularis* except by the comparatively shorter length and the black tarsal segments. As already mentioned, the females have no important characters which differentiate them from the species *disjunctus*.

Lestes inaequalis Walsh

Nymph.—Unknown.

Adult; Male.—Color, metallic green and black; or bronze and black above, yellow or buff below.

Head green and yellow; labium buff, subquadrangular, the shallow cleft apparently extending to the base of the piece; palpi broad; antennae dull brown, the first segment much shorter than the second and with a pale ring at the distal end; postclypeus metallic green or black, the anteclypeus and labrum, except a small short black stripe on the lateral margins, pale yellowish green; exposed portions of the mandibles, the genae as far dorsad as the fronto-clypeal suture, yellow, the remainder of the front and the vertex, metallic green; occiput and postgenae largely yellow; compound eyes brown.

Thorax metallic green above, yellow or buff below, the pronotum usually black, including the cephalic, median, and caudal lobes, the proepimera black on the dorsal half, the ventral half buff; mesosupraepisterna metallic green, the infraepisterna black on the dorsal half, the remainder yellow; mesepimera metallic green except the cephalo-ventral shoulder, which is yellow; dorso-caudal angles of the metepimera with a triangle of green, remainder of the metapleura and the intersternum pale yellow; legs striped, black and yellow; coxae entirely buff, trochanters, at least the middle and hind ones, with a black dorsal stripe; middle and hind femora with three black stripes, a ventral and two dorsal, and three yellow stripes, the front femora, however, with two black stripes, the cephalic one including the cephalo-ventral row of setae; tibiae with a single ventral black stripe including the cephalo-ventral row of setae; tarsi black, the claws long, black, and deeply bifid at the tip; wings clear, with sixteen postnodal cross-veins in the front wing and thirteen to fourteen in the hind; M_2 arising between the fourth and fifth postnodals in the front wing and between the third and fourth in the hind; stigma surmounting from slightly less than two to two and one-half cells.

Abdomen with the dorsum of terga 1–10 dark, the basal segments metallic green, the apical segments dull black; lateral margins of terga 1–8 pale yellow or buff, the color extending well towards the meson on the base of segments 3–6; sterna one and ten yellow, 3–9 inclusive, black, shining; anal appendages long, black, the superiors pale at the base, the meso-ventral margins with a large basal tooth (Figs. 131, 132) and a number of smaller ones distad of this; dorso-lateral surfaces of the appendages coarsely tuberculate; inferiors longer than the superiors, the tips bent mesad, approximate and finely pilose; parameres of the eighth sternum small, subquadrangular; bases of the inferiors large and apparently fused.

Female.—Color similar to that of the male.

Head similar to that of the male.

Thorax similar to that of the male excepting that the dorsal carina and mesopleural suture show distinct brown; legs with one dorsal black stripe, frequently reduced to a row of spots; wings with the stigma surmounting slightly less than three cells.

Abdomen with lateral, marginal, pale stripes on all terga, the stripes as a rule broader than those of the male; anal appendages of the usual type, the superiors pale, slightly darker at the tips; ovipositor long, the lateral valves widely separated from the tenth segment at the apex, the ventral half, or more, black; prostyles slender, bent ventrad at the tips, and with a black dorsal stripe; sternites of the eighth segment large, the caudo-dorsal angles acute.

Measurements

Length, ♂	54 mm.
Length, ♀	49 mm.
Length of abdomen, ♂	43 mm.
Length of abdomen, ♀	38.5 mm.
Length of hind wings, ♂	29 mm.
Length of hind wings, ♀	28 mm.
Width of hind wings, ♂	6.5 mm.
Width of hind wings, ♀	5.5 mm.

Described from two males and two females in the collection of Mr. E. B. Williamson.

Not taken in Illinois by the writer, but reported by Walsh ('62) from the vicinity of Rock Island. The species is closely related to *vigilax,* but is distinguishable from the latter by the pale occiput and the long inferior anal appendages of the male.

Lestes rectangularis Say

Nymph.—Color, buff or pale green.

Head elliptical, the width much greater than the length; eyes dark; caudo-lateral margins of the head without setae; labium extending caudad between the metacoxae; mental setae six; lateral setae three, two being on the distal segment of the palpus.

Thorax: mesothorax and metathorax much wider than the prothorax; legs slender, the femora with longitudinal rows of minute setae, the apices of all the femora fuscous and with a subapical dark ring; tibiae with small setae arranged in rows and with fuscous apices; tarsi with the apical half of the third segment and the claws dark brown, the hind tarsi with a very long apical segment and a very short proximal one.

Abdomen: cuticle provided with minute setae and somewhat heavily pigmented with brown; lateral keels with heavy apical setae on segments 5–9 and with about nine smaller setae along the keels to their bases; sterna with a double row of median spots, two to each segment; segment ten hairy beneath; gills similar to those of *forcipatus,* with a row of short setae on both margins, the extreme tips being usually free; the portions of the eleventh segment proximad of the lateral gills bear five or six small setae on the ventral surface; the pigmentation of the gills is usually brownish, though frequently black, but the gill is not as a rule as black as the gill of *forcipatus;* female ovipositor extending to the apex of the tenth abdominal segment.

Measurements

Length	22 mm.
Length of abdomen	17 mm.
Length of gills	9.5 mm.
Width of gills	2.3 mm.
Length of median lobe	4 mm.
Width of median lobe	.5–2.0 mm.

Adult; Male.—Color, dark brown to black, and sulphur-yellow.

Head brown and yellow; labium pale, the median lobe subquadrangular, with a shallow cleft and darker stripe extending proximad to the base; palpi rather short; antennae entirely brown, the first segment much shorter than the second, and the third and fourth much longer than the first two together; postclypeus dark brown, shining, the anteclypeus, labrum, exposed portions of the mandibles, their trochantins, and the genae, shining yellow; front and vertex, dull brown, nearly black, the preocellar furrow very deep and extending laterad nearly to the bases of the antennae; occiput and postgenae black, pollinose with age.

Thorax brown and yellowish; pronotum yellowish buff, the cephalic lobe with a large median brown spot, the median lobes each with an irregular H-shaped mark which covers a large portion of the lobe in the older specimens; caudal lobe blackish brown, the caudo-lateral margins pale; supracpisterna of the mesothorax with a broad, brown, longitudinal stripe from cephalic to caudal margins, covering about three-fourths of the sclerites, the lateral margins of the stripe irregular; mesopleural suture covered by a broad yellow stripe which is widest cephalad, narrowed near the wing bases, and becomes bluish with age; mesepimera with longitudinal median brown stripes extending from near the caudal margin to the cephalic shoulder, widened considerably

caudad and in contact with the mesopleural suture adjacent to the wing bases, narrowed cephalad, and coming to a rather abrupt end on the cephalic shoulder; margins of the stripe irregular; metepisterna pale yellow with a triangular brown spot on the caudo-dorsal angle; remainder of the pleura and the intersternum pale yellow or buff; legs buff and black or dark brown, the coxae and trochanters pale, the femora with two brown stripes each, a cephalo-dorsal one and a ventral one between the rows of setae; tibiae with a single, cephalo-ventral brown stripe including the cephalic row of setae; tarsi and claws brown, the dorsum of the tarsal segments usually more or less yellow; wings with eleven to twelve postnodal cross-veins, M_2 arising between the third and fourth postnodals in the front wing and between the second and third in the hind wing; stigma surmounting slightly more than two cells in both wings.

Abdomen brown and yellowish, long and slender; terga one and two brown on the dorsum, pale on the sides, the stripe on two contracted near the middle; terga 3–7 with yellow lateral margins, narrow interrupted basal rings and longitudinal brown stripes on terga eight and ten, and a triangular, lateral, apical, spot on nine; anal appendages (Fig. 128) brown or blackish, the superiors mostly smooth and not coarsely tuberculate on the lateral surfaces, the basal, mesal tooth small, and much smaller than the tooth at the distal third of each superior; inferiors more than half the length of the superiors, black, the tips laterally compressed.

Female.—Color the same as that of the male.

Head and thorax not appreciably different from those of the male, with the exception of the slightly wider pale stripes on the mesopleural suture.

Abdomen shorter than that of the male; anal appendages of the usual type (Fig. 115); ovipositor extending as far caudad as the apices of the anal appendages or beyond, the lateral valves broad, and with serrated ventral margins, the ventral half being usually black.

Measurements

Length, ♂	50–52 mm.
Length, ♀	46.5 mm.
Length of abdomen, ♂	33–42 mm.
Length of abdomen, ♀	31–34.5 mm.
Length of hind wings, ♂	18.5–24 mm.
Length of hind wings, ♀	20–23 mm.
Width of hind wings, ♂	5 mm.
Width of hind wings, ♀	5 mm.

This species occurs in the same localities in which *forcipatus* is found. Nymphs taken at Urbana emerged as early as May 29 and as late as July 17, the species having a considerable range in the period of emergence. There is a possibility that this species has a two-brooded life cycle.

Specimens have been seen from Urbana, Galena, Lake Villa, Oregon, Savanna, and McHenry County.

Lestes uncatus Kirby

Nymph.—Color, buff or green.

Head broad, the caudo-lateral margins not projecting and without heavy setae; antennae of the usual Lestes type; mental setae six or seven on each side; lateral seta three, two of which are located on the distal segment; marginal setae of the mentum extending to the base of the expanded portion of the median lobe; labium, when folded, extending caudad of the metacoxae.

Thorax: legs very long and slender, the apices of the femora and the apices of the tibiae and the distal half of the third tarsal segments brown; wing-cases extending to the middle of the fourth abdominal segment.

Abdomen with well-developed lateral keels which are provided with short spines on the apices of segments 5–9; cuticle uniform in color, the dorsum of segments nine and ten and the venter of segment ten with long, fine, silken hairs; ovipositor of the female long and extending beyond the apex of the eleventh segment; gills conspicuously contracted beyond the middle as in *rectangularis* and *forcipatus*, rather sharply pointed at the apex, the point similar to that of *unguiculatus*.

Measurements

Length	18 mm.
Length of abdomen	11 mm.
Length of gills	8 mm.
Width of gills	2 mm.
Length of median lobe	5.5 mm.
Width of median lobe	3–1.6 mm.

Described from a single specimen collected by Dr. Edna Mosher in July, 1915, at Orono, Maine.

Adult; Male.—Color, metallic green and pale yellow.

Head dark green above, pale below; occiput black, the median lobe of the labium pale and subquadrangular with a typical cleft;

palpiger short and indistinct; fixed hook of the proximal segment longer than the distal segment, black at the tip; antennae black, the second segment pale at the distal end; postclypeus black; the anteclypeus, labrum, exposed portions of the mandibles, their trochantins and the genae, pale yellow; front, vertex, clypeus, and labrum thinly pilose, the setae pale; eyes pale yellow.

Thorax metallic green, black, and yellow; pronotum green, the caudal lobe narrow, the median lobes not distinctly separated, proepimeron and proepisternum black, pollinose with age, the suture between the epimeron and notum indistinct; dorsal carina of the mesothorax black; mesosupraepisternum green, the mesinfraepisternum and the mesopleural suture black; mesepisternum green with the exception of the cephalo-ventral shoulders; metapleural suture usually black, the stripe indefinite, increasing in extent with age and covering a large portion of the metepimera; postcoxal areas buff; legs black and buff, the coxae pale and black, femora with three black stripes alternating with three buff-colored ones; tibiae, tarsi and claws black; setal rows of the front femora composed of two and nine setae respectively; wings clear, the antenodal cross-veins two in number, postnodal cross-veins ten to eleven; stigma of the front wing surmounting two cells; stigma of the hind wing slightly smaller than that of the front wing; M_2 originating between the third and fourth postnodal cross-veins in the front wing and between the second and third in the hind wing.

Abdomen metallic green; first tergum green on the dorsum and with a small, black, lateral basal spot on each side; dorsum of the second tergum green, the green extending well onto the sides, the latero-ventral margins, however, being pale; terga 3–7 with broad, longitudinal green stripes, widened subapically, and with narrow basal, dorsally interrupted, yellow rings and longitudinal lateral stripes; all of segments eight, nine, and ten green above, black or pollinose below; sternum of segment one with a median black spot at the caudal end, 3–10 black; superior anal appendages (Figs. 135, 136) black at the tip, brownish at the base, the lateral surfaces tuberculate, the mesal margins with a large basal tooth and a row of small ones beyond to the distal third; inferiors broad, black and distinctly expanded at the apex.

Female.—Color, metallic green and yellow.

Head similar to that of the male.

Thorax with pale dorsal carina and mesopleural sutures, and usually lacking the black stripe on the metapleural suture.

Abdomen: proximal half of the first tergum with a pale dorsum; terga 8–10 with broad lateral stripes of yellow; first sternum without the black spot and the eighth, instead of being all black, has a mesal

stripe; superior anal appendages black at the tips, slightly longer than the inferiors; ovipositor with the lateral valves black on the ventral half, the apex extending well caudad of the tenth segment; prostyles black at the tip and on the dorsal surfaces, the tips extending beyond the apices of the anal appendages.

Measurements

Length, ♂	34 mm.
Length, ♀	39 mm.
Length of abdomen, ♂	26–28 mm.
Length of abdomen, ♀	29 mm.
Length of hind wings, ♂	21 mm.
Length of hind wings, ♀	23 mm.
Width of hind wings, ♂	4.5 mm.
Width of hind wings, ♀	4.5 mm.

A moderately common species though not as common as either *rectangularis* or *forcipatus*. Taken at Oregon July 1, 1915, at Freeport July 8, and at Urbana.

Lestes unguiculatus Hagen

Nymph.—Color, light brown or green.

Head about twice as broad as long, subelliptical, the caudo-lateral angles not projecting, and provided with a few weak setae; antennae slender, entirely pale, the third segment longest, segment two longer than one; labium slender, and extending caudad of the mesocoxae; mental setae seven, lateral setae three, two of which are located on the distal segment of the palpus; lateral marginal setae of the mentum about twelve, the row extending from the articulation of the palpus to the base of the expanded portion.

Thorax slender, much contracted behind the head, about as broad as long; legs slender, the femora with rows of short setae and faint preapical rings of brown; tibiae with rows of setae, the apices brown; tarsi pale except the apical half of the third segment which is brown; metathoracic wing-cases extending caudad to the middle of the third abdominal segment.

Abdomen long and slender, the lateral keels moderately well developed and possessing spines at the apices of segments 5–9; venter of the abdomen usually much paler than the dorsum though sometimes with faint median stripe and stripes just ventrad of the lateral keels; caudo-lateral angles of terga 1–8 sometimes with darker spots; gills

widest near the base, and gradually tapering to a point at the apex, not conspicuously contracted beyond the middle (Figs. 51, 52).

Measurements

Length	19 mm.
Length of abdomen	14 mm.
Length of gills	9 mm.
Width of gills	1.5 mm.
Length of median lobe	2 mm.
Width of median lobe	.5–1.5 mm.

Adult; Male.—Color, dull brown or metallic green and yellow.

Head metallic green and brown, often more or less bronze; median lobe of the labium subquadrangular, with the usual cleft; proximal segment of the antennae with pale spot at the distal end, the remaining segments dark; postclypeus dull metallic brown, the anteclypeus, labrum, and the exposed portions of the mandibles, their trochantins, and the genae, shining yellow; eyes slate-gray; occipital and postgenal regions wholly yellow.

Thorax dull brown and yellow; caudal margin of the pronotum entire, the caudal lobe narrow and not convex; cephalic lobe much longer and possessing a median, circular, black spot; median lobes with irregular H-shaped black or dark marks, one to each lobe; proepimeron distinct, pale brown, black on the dorsal margin; mesosupraepisterna dull metallic brown, sometimes greenish, with the lateral fourth yellow; mesopleural suture with a broad yellow stripe; mesepimeron almost entirely brown, with the exception of the cephalic shoulder; mesinfraepisternum with the dorsal half brown or greenish in older specimens and with a median spot in younger individuals, the remainder of the sclerite pale; metepisterna with triangular brown spots adjacent to the wing bases; metapleural suture and the metepimera pale buff; postcoxal areas pale yellow, without dark spots; paraptera crescentic, the caudal margins faintly emarginate; legs striped, the coxae and the trochanters buff, the femora pale yellow with two black or dark brown stripes; tibiae with a single brown stripe including one of the two rows of setae; tarsi and claws black; front femoral rows of setae containing three and eight setae respectively; wings clear, the postnodal cross-veins about eleven, and M_2 originating between the second and third in the front wing and between the first and second, usually near the second, in the hind wing.

Abdomen mostly yellow in recently emerged specimens, dark metallic green or brown in older ones; dorsum of the first tergum brown

on the caudal half; terga 2–10 all with brown, dorsal, longitudinal bands, extending from the cephalic nearly to the caudal margins, the bands being slightly enlarged at the caudal ends; terga 2–10 with narrow rings of brown on the caudal margins; sterna 3–8 black; nine and ten, pale; anal appendages (Figs. 125, 126) consisting of strong superiors, coarsely tuberculate on the lateral surfaces and hairy at the apices, the mesal margins possessing a large basal tooth and a number of smaller ones beyond this to about the distal third; inferior appendages sigmoid, the distal two-thirds curved in an opposite direction to the superiors.

Female.—Color similar to that of the male.

Head and thorax identical with those of the male.

Abdomen similar to that of the male with the exception of the dorsa of the cephalic terga, which are as a rule paler in color, and terga nine and ten, which possess a mesal dark line; ovipositor reaching apex of tenth segment, the lateral valves black below, the ventral margins serrate or coarsely toothed.

Measurements

Length, ♂	39 mm.
Length, ♀	35 mm.
Length of abdomen, ♂	27 mm.
Length of abdomen, ♀	27 mm.
Length of hind wings, ♂	21 mm.
Length of hind wings, ♀	22 mm.
Width of hind wings, ♂	5 mm.
Width of hind wings, ♀	5 mm.

A very common species at Urbana, occurring in abundance in pools north of town. The nymph is easily separated from *rectangularis* and *forcipatus* by means of the shape of the gills. The adult is also easily separated from *rectangularis* and *forcipatus* and seems to be most closely related to *uncatus*, from which species it differs mainly in color though also in the shape of the anal appendages of the male and the length of the ovipositor of the female. The nymph is more closely related to *uncatus* than to any other species.

The species has a wide distribution in Illinois and flies from early June to August.

Lestes vigilax Hagen

Nymph.—Color, light brown or green.

Head broad, about twice as broad as long, the caudo-lateral angle not projecting and without setae; antennae slender and of the usual

Lestes type; labium very slender and when folded extending caudad about to the metacoxae; mental setae five or six; lateral setae three, two of which are located on the distal segment of the palpus; marginal mental spinules apparently wanting or few in number and not extending proximad to the base of the expanded portion; the teeth of the mesal margins of the mesal lobe of the proximal segment of the palpi are large and square and the furrow representing the median cleft of the median lobe is conspicuous and extends proximad one-third the length of the expanded portion.

Thorax slender; legs very slender, the femora and tibiae with rows of short setae; femora with subapical rings of brown, the tips of the tibiae and the distal half of the third tarsal segment also dark brown; wing-cases extending about to the middle of the third abdominal segment; lateral keels with strong apical spines on segments 1–9 inclusive, the seta at the apex of nine especially long; gills (Fig. 48) very long and slender and of about equal width throughout, the apices bluntly pointed; ovipositor of the female nearly reaching the apex of segment ten.

Measurements

Length	21–30 mm.
Length of abdomen	17–22 mm.
Length of gills	13 mm.
Width of gills	1.25–1.75 mm.
Length of median lobe	3.3–4 mm.
Width of median lobe	1.5–2 mm.

The nymph is the longest of any species of Lestes. It is easily recognizable by the slender gills (Fig. 48) and the apical setae of the lateral keels.

Described from a single exuvium obtained from Dr. E. M. Walker and several specimens in the collection of the Illinois State Laboratory of Natural History from Grass Lake and Havana, Ill.; dates of collection of the specimens from Grass Lake June 23, 24, 1892.

Adult; Male.—Color, dull metallic green and buff.

Head dull greenish black or black; median lobe of the labium subquadrangular, the median cleft shallow; fixed hook of the palpus black at the apex; antennae black, the tip of the first segment slightly pale, the second segment twice as long as the first; postclypeus black, the anteclypeus brown; labrum pale green; exposed portions of the mandibles, their trochantins, and the genae, pale brown; front and vertex metallic green.

Thorax metallic green, prothorax largely black, becoming pollinose with age; suture between pronotum and the proepimeron indistinct; caudal lobe of the notum much narrower than the cephalic lobe and considerably widened on the meson; furrow separating the median lobes obscure; cephalic portion of the prescutum small, triangular, and little depressed; mesosupraepisterna and mesepimera green, the mesopleural suture and the dorsal carina with pale lines which become dark with age; mesinfraepisternum black, the metapimera, metepisterna and intersternum pale at first but black or pollinose with age; legs buff and black; coxae pale and black, femora almost entirely black, with a narrow pale stripe between the setal rows on the ventral surface, and a short stripe on the dorsal surface of the hind femora; rows of front femoral setae consisting of two and eight setae respectively; tibiae and tarsi black; wings clear, the antenodal cross-veins two, postnodals fifteen to seventeen in the front wings and twelve to thirteen in the hind wings; M_2 arising between the fourth and fifth postnodal cross-veins in the front wings and between the third and fourth in the hind wings; stigma usually surmounting three cells, light brown or nearly white in color.

Abdomen metallic green and black; terga 1–6 with narrow lateral stripes, 7–10 black; sterna of all segments black, the first sometimes light, but black in older specimens; superior anal appendages black, the lateral surfaces tuberculate and the mesal margins with a basal hook and two indentations between this and the apical third; inferiors long and slender, not dilated at the apex (Figs. 129, 130).

Female.—Color, metallic green and black.

Head and thorax similar to those of the male.

Abdomen long and very slender, the dorsum of terga 1–10 and apical rings on all terga except the two caudal ones dull brown or greenish; sterna 2–8 mostly black, ovipositor long and slender, the prostyles long and the eighth sternites at the base of the cephalic pair of gonapophyses with a long dorso-caudal projection.

Measurements

Length, ♂	43–47 mm.
Length, ♀	43–45 mm.
Length of abdomen, ♂	34–38 mm.
Length of abdomen, ♀	34–36 mm.
Length of hind wings, ♂	21–25 mm.
Length of hind wings, ♀	26–27 mm.
Width of hind wings, ♂	5 mm.
Width of hind wings, ♀	6 mm.

Males possessed by the Illinois State Laboratory of Natural History were collected at Cedar Lake, Ill.,—Lake Villa—August 3, 1887. The female was described from material obtained from Mr. E. B. Williamson.

The species has not been seen as far south as Urbana.

Subfamily COENAGRIONINAE

The nymphs have short labia, gradually contracted proximad and not at all spoon-like. The gills are more or less lanceolate, acutely pointed at the tip, and the smaller tracheae are commonly well developed, pigmented, and visible to the naked eye. The abdomen is short in proportion to its diameter.

The adults are distinguished from the Lestinae by means of the wing venation, M_3 arising nearer the nodus than the arculus. The femoral and tibial setae are much shorter than those of the Lestinae and the coloration of the body is frequently bright, the yellows, blues, and reds being often conspicuous. The anal appendages of the male are short and the eighth sternites at the base of the cephalic pair of gonapophyses of the female are reduced to small triangles or are wanting.

Key to Genera

NYMPHS

a. Gills half as broad as long (Figs. 58, 63, 67, 68); labium without mental setae; proximal segment of the labial palpus with two similar fixed hooks ..... *Argia.*

aa. Gills not more than one-third as broad as long; labium provided with mental setae; proximal segment of the palpus with a single, sharp, fixed hook, and a truncate process with teeth at the apex.

b. Caudo-lateral angles of the head projecting and forming a blunt tubercle, the margins of the head much contracted between the tubercles and the eyes.

c. Gills (Fig. 59) without cuticular pigment, one-third as broad as long, the margins thickly provided with setae which extend from the base to the apex of the gills..... *Amphiagrion.*

cc. Gills with cuticular pigment, not more than one-sixth as broad as long, the margins sparsely setose..... *Chromagrion.*

bb. Caudo-lateral angles of the head not projecting and forming a blunt tubercle, the margins of the head not contracted between the tubercles and the eyes.

c. Gills with the tracheal branches much more numerous at the widest portion of the gill..... *Nehalennia.*

cc. Gills with the tracheal branches equally distributed throughout the length of the gill.

d. Gills with long, tapering points, the cuticular pigment, if present, always in cross-bands; mental setae of the labium usually four.

e. Gills without cuticular pigment (Fig. 60); lateral keels without setae; nymphs of small size, full-grown individuals rarely more than 14 mm. in length including gills..... .....*Anomalagrion.*

ee. Gills usually with cuticular pigment in the form of arcuate cross-bands; lateral keels with several rows of small setae; nymphs larger, when full-grown 18–20 mm. in length including gills .....*Ischnura.*

dd. Gills with blunt points (Figs. 56, 57, 70–72, 75–77a, 80), or if with long points, then with cuticular pigment other than in cross-bands; mental setae usually three (four in *E. calverti* and *E. cyathigerum)* .....*Enallagma.*

ADULTS

a. Cephalic row of setae of all tibiae twice as long as the spaces between their bases; postnodal cross-veins of the front wings twelve or more in number; M_2 arising between postnodal cross-veins five and nine in the front wing .....*Argia.*

aa. Cephalic row of setae of all tibiae less than twice as long as the spaces between their bases; postnodal cross-veins of the front wings usually less than twelve in number; M_2 arising between the third and fifth, rarely sixth, postnodal cross-veins in the front wing.

b. Dorsum of the thorax metallic green or bronze; female pronotum with the caudal lobe trilobed.....*Nehalennia.*

bb. Dorsum of the thorax not metallic green or bronze; female pronotum not with the caudal lobe trilobed.

c. Postocular spots wanting; mesopleural suture without a distinct black stripe, the stripe not wider than the suture itself.

d. Dorsum of abdominal terga 1–6 reddish or buff; width of the stigma measured between costa and Sc_2+R_1 much greater than its length; female with a heavy spine on the caudal margin of the eighth sternum.....*Amphiagrion.*

dd. Dorsum of abdominal terga 1–6, black; width of the stigma measured between costa and Sc_2+R_1 not greater than its length; female without a heavy spine on the caudal margin of the eighth sternum .....*Chromagrion.*

cc. Postocular spots present; mesopleural suture usually with a distinct black stripe, the stripe wider than the suture itself.

d. M_2 arising between the fourth and sixth postnodal cross-veins in the front wing and between the third and fourth in the hind . . . . . *Enallagma.*

dd. M_2 arising between the third and fourth postnodal cross-veins in the front wing and between the second and third in the hind.

e. Dorsum of the fourth abdominal tergum black, except a narrow basal ring; stigma of the front wing of the male not remote from the margin . . . . . *Ischnura.*

ee. Dorsum of the fourth abdominal tergum orange or yellow with the exception of a basal and apical spot in the male and a small apical spot in the female; stigma of the front wing of the male remote from the margin (Fig. 83) . . . . . *Anomalagrion.*

Genus Argia Rambur

The nymphs are characterized by the short thickset form, the abdomen being as a rule much shorter than that of closely allied genera. The labium is broad at the proximal end of the median lobe and the median process of the proximal palpal segment consists of a simple hook similar to the mesal hook of the same segment. The gills are broad and oval to elliptical in outline, are heavily pigmented, and the legs are long and slender, with a number of dark brown rings on the femora and tibiae. The body is dark in color for the most part, and the species live either in the mud on the bottom of sluggish streams or under rocks or debris in the swifter currents.

The adults are distinguishable from other genera by the dorsal carinae of the femora and the long setae of the front tibiae; by the point of origin of vein M_2, which is always beyond the fifth postnodal cross-vein, and by the number of postnodal cross-veins of the front wing, the latter ranging from twelve to seventeen in number. The parameres of the ninth sternum of the male extend caudad to the apex of the segment, and the sternites at the base of the cephalic pair of gonapophyses are distinct and subtriangular.

Key to Species

NYMPHS

a. Labial palpi with a single weak seta on the proximal segment; gills broad at the tip (Fig. 58), the margins parallel for a considerable distance, and without light cross-bands and not coarsely spotted with dark pigment . . . . . *mocsta putrida.*

aa. Labial palpi with two or more setae on the proximal segment; gills tapering to a point, the margins not parallel or parallel for only a

short distance (Figs. 63, 67, 68), and frequently with one or more light cross-bands and coarsely spotted with dark pigment.

b. Gills broadest beyond the middle, decidedly ovate (Fig. 63) and frequently with a V-shaped cross-band near the apex; median lobe projecting between and distad of the articulations of the labial palpi much less than one-third the length of the proximal segment of the palpi (Fig. 11) ..... *violacea.*

bb. Gills broadest at middle, elliptical (Figs. 67, 68) and never with a V-shaped mark near the apices; median lobe of the labium projecting between and distad of the articulations of the labial palpi one-third or more of the length of the latter ..... { *apicalis.* / *tibialis.*

ADULTS

Females

a. Wings smoky ..... *fumipennis.*

aa. Wings not smoky.

b. Stigma surmounting more than one cell in the hind wing; mesepimera without a broad dark stripe on each, ventrad of the mesopleural suture; mesostigmal plates (Fig. 154) with a sharp median projection on the caudal margin ..... *moesta putrida.*

bb. Stigma surmounting a single cell or less in the hind wing; mesepimera with or without *(apicalis)* a broad dark stripe on each, ventrad of the mesopleural suture; mesostigmal plates without a sharp median projection on the caudal margins.

c. Front, vertex, and occiput wholly brown; caudal margins of the mesostigmal plates forming a thin blade which projects dorsad... ..... *sedula.*

cc. Front, vertex, and occiput with more or less black pigment; caudal margins of the mesostigmal plates not forming a thin blade which projects dorsad.

d. Black stripe of the mesopleural suture extending more than half-way to the wing bases from the infraepisternum.

e. Caudal margins of the mesostigmal plates (Fig. 140) not projecting caudad at the caudo-mesal angles; terga 1–5 of the abdomen with the mesal pale line narrower than the black lines on either side ..... *tibialis.*

ee. Caudal margins of the mesostigmal plates projecting caudad at the caudo-mesal angles and forming a rounded lobe (Fig. 142); terga 1–5 with the pale mesal stripe much broader than the black stripe on either side ..... *violacea.*

dd. Black stripe of the mesopleural suture extending less than half-way to the wing bases from the infraepisternum ..... *apicalis.*

Males

a. Wings smoky ..... *fumipennis.*

aa. Wings not smoky.

b. Stigma surmounting more than one cell in both wings; abdominal terga 8–10 black with dorsal spots of brown, or entirely black ..... *moesta putrida.*

bb. Stigma surmounting one cell or less; terga 8–10 inclusive or nine and ten, blue, never black except the eighth, and never with brown markings.

c. Terga nine and ten blue ..... *sedula.*

cc. Terga eight, nine, and ten blue.

d. Black stripe of the mesopleural suture extending from the mesinfraepisternum to the wing bases.

e. Terga 1–5 with the pale color of the dorsum limited to a very narrow mesal line and narrow basal rings ..... *tibialis.*

ee. Terga 1–5 with the pale color of the dorsum occupying the greater portion of the segments, the black confined to small, apical, lateral spots on 1–4 and an apical ring in addition on the fifth ..... *violacea.*

dd. Black stripe of the mesopleural suture extending much less than half-way from the mesinfraepisternum to the wing bases.. ..... *apicalis.*

Argia apicalis (Say)

Nymph.—Color, dark brown.

Head one-third wider than long, pentagonal, the caudo-lateral angles strongly projecting and armed with heavy setae; eyes black; antennae dark brown except the first and the last two or three segments; labium very broad, the median lobe dark in color, without mental setae but with about twelve marginal setae; labial palpi with three or four setae on the proximal segment and with a long movable distal segment much longer than the fixed hooks; labium, when folded, extending caudad of the procoxae, but not reaching the mesocoxae.

Thorax dark in color; legs conspicuously banded, the dark portions consisting of the second segment of the trochanters, two broad bands on each femur and three on each tibia, the proximal one on the tibiae being narrow, the next one slightly broader and located about the middle, and the third nearly equal in width to the median band and covering the apex; tarsi of the usual form, dark brown in color; wing-cases extending caudad to the middle of the fifth abdominal segment.

Abdomen half as broad as long, dark brown in color, the dorsum with a pale median stripe which widens noticeably on segments eight, nine, and ten; gills (Fig. 67) elliptical, smoky, frequently possessing one or two pale transverse bands and usually with a number of coarse spots of pigment; apices of the gills bluntly pointed, the margins hairy, but without heavy setae; ovipositor of the female extending to the apex of segment ten.

Measurements

Length	14 mm.
Length of abdomen	8 mm.
Length of gills	6 mm.
Width of gills	3 mm.
Length of metathoracic wing-cases	4.5 mm.
Length of median lobe	3 mm.
Width of median lobe	1–2 mm

Adult; Male.—Color, light blue (light amparo blue), or buff (warm buff) and black.

Head: exposed portions of the mouth-parts buff or light blue, the median lobe of the labium subtriangular, the cleft shallow and obtuse at the proximal end; proximal segment of the labial palpus about three times as long as the distal segment; fixed hook only slightly longer than the distal segment, black; distal segment black; antennae black with the exception of the first segment which has a pale lateral stripe; clypeus and labrum, genal region, exposed portions of the mandibles, and the front dorsad to the level of the lateral ocelli, blue; vertex black; ocellar area black, the latter sending a black line ventrad to each antenna; postocular spots present, circular, blue or brown; occiput and postgenae yellow with the exception of small black spots on the postgenae, near the ventral margins of the compound eyes.

Thorax light blue or buff, black, and sulphur yellow; prothorax black and blue; caudal lobe of the pronotum black, median lobes with circular blue spots; noto-epimeral suture indistinct; procpimera blue or buff, the dorsal margins black; mesopleura and metapleura blue or olive-buff, and without black markings except a short stripe covering the dorsal half of the mesinfraepisternum, which extends caudad on the mesepimeron for about one-fifth of the length of that sclerite; postcoxal areas buff or yellow; legs striped with black and yellow, a stripe on each side of the femoral carinae and one on each tibia enclosing the cephalo-ventral row of setae; tarsi black, the second and

third segments frequently yellow above; wings with twelve to fourteen postnodal cross-veins, the stigma surmounting a single cell or less, and M_2 arising between the seventh and eighth, or eighth and ninth, postnodal cross-veins in the front wing and between the sixth and seventh in the hind wing.

Abdomen blue or buff and black, the black placed as follows—a spot on the first tergum, longitudinal dorsal stripes on 1–7 which extend well onto the lateral surfaces of terga 3–7 at their apices, and the lateral margins of terga 8–10 inclusive; the yellow or blue forms lateral stripes of pale color on terga 1–7, narrow basal rings on 3–7 inclusive, and narrow apical ring on one; dorsum of terga 8–10 blue; anal appendages (Figs. 151, 152) consisting of short black superiors and longer bifurcate inferiors, the dorsal emargination of the tenth tergum about one-third the length of the segment; sterna 2–10 black, one, pale buff.

Female.—Color similar to that of the male.

Head: cephalic aspect entirely blue or buff with the exception of black spots ventrad and dorsad of the lateral ocelli and black rings around the postocular spots.

Thorax as in the male, though usually somewhat lighter in color; mesostigmal plates as shown in Figure 153 with a very small caudal projection near the caudo-mesal angles; caudal lobe of the pronotum with more or less blue or buff and the mesopleural dark stripes of the infraepisternum and epimeron paler than those of the male.

Abdomen with the dorsum of the eighth and ninth terga black with a dorsal yellow stripe and with dark brown or yellow on the lateral surfaces; tenth tergum dark brown above, paler on the sides, the dorsal, median emargination extending nearly to the base of the segment; anal appendages of the usual form and pale in color; ovipositor with light brown lateral valves, the prostyles darker.

Measurements

Length, ♂	38 mm.
Length, ♀	36 mm.
Length of abdomen, ♂	30 mm.
Length of abdomen, ♀	28 mm.
Length of hind wings, ♂	24 mm.
Length of hind wings, ♀	23 mm.
Width of hind wings, ♂	5.5 mm.
Width of hind wings, ♀	5.5 mm.

A common species along all large-sized streams in Illinois. The nymphs live in the mud at the bottom, but when mature approach the

banks and hide among dead submerged weeds or rubbish. The eggs are deposited below the water on driftwood, and large numbers of females may sometimes be seen congregated about an old log at the water's edge depositing eggs.

Argia fumipennis (Burmeister)

Nymph.—Unknown.

Adult; Male.—Color, dull brown and black.

Head: dark brown and black; median lobe of the labium buff, subtriangular; antennae brown, the first segment nearly globular, the second segment about twice as long as the first; clypeus, labrum, exposed portions of the mandibles and their trochantins, genae, and the front dorsad of the clypeus to the median ocellus, dark brown or buff; vertex with a transverse black stripe which includes the ocellar area; there is, however, a large brown spot ventrad of each lateral ocellus and a narrow median stripe between them; postocular spots large, contiguous with the margins of the compound eyes and connected by means of a broad stripe caudad of the ocelli; occiput and postgenae buff; compound eyes brown.

Thorax dark brown, black, and buff; pronotum dark, the cephalic lobe buff, the median lobes with large, pale, lateral spots; caudal lobe dark, with a paler spot on each lateral angle; proepimeron and proepisternum of the propleura not distinct, brown in color, the dorsal border darker; dorsal carina of the mesothorax covered by a broad black stripe which also covers about half of each mesosupraepisternum; mesepimera with a broad dark stripe ventrad of the mesopleural suture, the stripe extending cephalad across the infraepisterna and forking about half-way from the infraepisternum to the wing bases; margins of the paraptera dark brown, the remainder buff; metapleural suture with a dark line; remainder of the meso- and metapleura and the postcoxal areas buff; femora each with a broad dark brown or blackish line, the remainder buff; tibiae pale buff above, darker below, the dark brown color including the cephalo-ventral row of setae; wings distinctly tinged with brown; postnodal cross-veins sixteen in the front wing and fifteen in the hind; M_2 arising between the seventh and eighth postnodal cross-veins in the front wing and between the sixth and seventh in the hind wing; stigma surmounting a single cell or less.

Abdomen dark brown; dorsum of terga 1–7 dark brown, the lateral margins paler in color; narrow basal rings on the cephalic margins of terga 3–6; terga 8–10 bluish green; sternum one buff, 3–10 brown; anal appendages (Figs. 143, 144) with the superiors shortest, inferiors longer, thickset.

Female.—Color similar to that of the male.

Head and thorax similar to those of the male except that the color is paler.

Abdomen: terga 8–9, inclusive, brown with a median buff stripe and a lateral stripe on each side; tergum ten, buff; ovipositor buff, the prostyles short and extending caudad of the anal appendages.

Measurements

Length, ♂	33 mm.
Length, ♀	34 mm.
Length of abdomen, ♂	27 mm.
Length of abdomen, ♀	28 mm.
Length of hind wings, ♂	20 mm.
Length of hind wings, ♀	23 mm.
Width of hind wings, ♂	5.0 mm.
Width of hind wings, ♀	5.5 mm.

This species has not been reported from Illinois but has been reported from Kentucky, and may possibly be taken in southern Illinois.

Described from specimens in the Bolter Collection of the University of Illinois and others in the collection of Mr. E. B. Williamson,—all from Florida.

Argia moesta putrida (Hagen)

Nymph.—Color, dark brown.

Head broad and flat, pentagonal, the caudo-lateral angles projecting caudad and possessing a few short sētae; antennal segments dark except the first, which is pale; labium very broad, the median lobe but slightly narrowed at the base and projecting strongly between the labial palpi; mental setae wanting, the lateral marginal setae about twelve; labial palpi with two fixed hooks, both shorter than the sharp distal segment, the one adjacent to that segment shortest; setae of the labial palpi reduced to a single weak hair-like one.

Thorax brown; the pronotum projecting strongly laterad; legs not conspicuously banded as in *apicalis*, but possessing a faint preapical ring and with the proximal two-thirds evenly infuscated; tibiae with dark apices; tarsi mostly pale; femora with indefinite rows of short heavy setae; wing-cases extending to the middle of the fourth abdominal segment or beyond.

Abdomen uniform brown, the lateral keels feebly developed and without setae; styli of the male very long, nearly reaching the apex of

the tenth abdominal segment and setose on the ventral margin; apical margin of the tenth abdominal tergum cleft nearly to the base, the margin thickly beset with short spines; gills (Fig. 58) uniform dark gray or nearly black, paler at the tip, long, broad, and bluntly pointed, the margins parallel for a considerable distance.

Measurements (young nymphs)

Length	14 mm.
Length of abdomen	9 mm.
Length of gills	5–6 mm.
Width of gills	3 mm.
Length of metathoracic wing-cases	4 mm.
Length of median lobe	3.5 mm.
Width of median lobe	1.5–3 mm.

Described from a male specimen in the collection of the Illinois State Laboratory of Natural History taken from the Kankakee River six miles below Kankakee, June 1, 1901, and several specimens obtained from Dr. E. M. Walker.

Adult; Male.—Color, black and cinnamon-buff.

Head: median lobe of the labium buff, subtriangular; distal segment of the palpus dark at the tip; antennae black, first two segments nearly equal, the first pale at the apex, the third segment longest; clypeus and labrum buff, the postclypeus with two indefinite black spots near the fronto-clypeal suture; labrum with a mesal spot on the dorsal margin; front and genae buff, the pale color extending dorsad to the ocelli, the black confined to an indefinite ring around the median ocellus and wedge-shaped marks on the vertex; occiput black; the surface of the head dorsad of the postclypeus and the occiput often becomes pollinose and obscures the original coloration.

Thorax: prothorax dark brown or black, more or less pollinose with age; caudal lobe of the pronotum black, median lobes each with a large, pale, circular, median spot which often becomes pollinose before the rest of the notum; proepimeron pale, the noto-epimeral suture indistinct though marked by a black stripe; dorsal carina black and a black stripe on each side one-half the width of the mesepisterna; mesopleural suture lined with black; mesepimera with a broad sooty line extending the entire length of the sclerite and more than half as wide; metapleural suture lined with black, the metepisterna and metepimera and the postcoxal areas usually buff; legs rather short, striped, the dorsum of all femora with a broad stripe including the cephaloventral row of setae; tarsi and claws black; wings clear, the stigma

surmounting one and one-half to two cells, the postnodal cross-veins of the front wing sixteen or seventeen, of the hind wing fourteen or fifteen; M_2 arising between the sixth and seventh or seventh and eighth postnodals in the front wing and between the fifth and sixth in the hind wing.

Abdomen black, with pale basal rings on segments 3–7 inclusive, faint dorsal and lateral stripes on one and two, and obscure brownish marks on the last two segments; anal appendages (Figs. 157, 158) consisting of short club-like superiors and broad inferiors with a tubercle on the dorsal margin.

Female.—Color, light blue (etain blue) or olive-buff, and black.

Head, with front, genae, and vertex pale blue or buff.

Thorax light blue or buff; pronotum blue and black, the propleura with indistinct noto-epimeral suture and without the dorsal marginal line of brown; median lobes of the notum with a large pale spot on each, and another spot about the same size covering the caudo-mesal angles of the median lobes and the median portion of the caudal lobe; mesostigmal plate (Fig. 154) with a short, median, acute process which projects caudad over the cephalic margin of the mesepisternum; mesepimera without the broad, longitudinal, dark stripe of the male, usually blue except the cephalic shoulder which is buff and frequently pollinose; all of the pleural sutures and the dorsal carina lined with black.

Abdomen black and blue, the black confined to rather broad dorsal stripes on terga 1–9, black spots on the caudo-lateral margins of 2–6 and the whole of sterna 1–8; segments nine and ten, with the exception of a dorsal brown stripe, and the lateral valves of the ovipositor yellowish; dorsal margin of the tenth tergum with a deep mesal emargination extending nearly to the base of the segment; superior anal appendages, short, dark, and scarcely longer than the blunt inferiors; ovipositor with broad ventrally serrated, lateral valves, the prostyles short and dark.

Measurements

Length, ♂	42 mm.
Length, ♀	41 mm.
Length of abdomen, ♂	33 mm.
Length of abdomen, ♀	31–32 mm.
Length of hind wings, ♂	26 mm.
Length of hind wings, ♀	26 mm.
Width of hind wings, ♂	5.5 mm.
Width of hind wings, ♀	5.5 mm.

Adults of this species have been taken at Oregon in Ogle County, at Mahomet in Champaign County, and at Muncie and Oakwood in Vermilion County, but the species is not especially abundant in any of these localities. The nymphs are reported by Needham ('03) as living under stones in swift currents and by Kellicott ('99) as living on the piles of docks in Lake Erie.

Argia sedula (Hagen)

Nymph.—Unknown.

Adult; Male.—Color, blue and black.

Head black and blue, the labium pale blue and buff; palpi narrow, the second segment dark and shorter than the fixed hook, the cleft of the median lobe obtuse at the base and shallow; postclypeus pale except a black transverse stripe along the dorsal margin; anteclypeus, labrum, exposed portions of the mandibles, a transverse area above the clypeus, and a spot latero-cephalad of each antenna blue; lateral ocelli with small yellow spots laterad of each, the remainder of the front and vertex being black; postocular blue spots large and contiguous with the margins of the compound eyes; occiput and postgenae, with the exception of rather narrow black stripes caudad of each postocular spot, yellowish buff.

Thorax: pronotum largely black, the median lobe with large subcircular spots and the caudal lobe with a pale spot on the extreme lateral angles, blue; proepimera and episterna blue; mesostigmal plates subtriangular, not projecting caudad; dorsal carina of the mesothorax covered by a broad black stripe which also covers about one-half of each mesepisternum and is followed by a broad blue stripe which covers the rest of the mesepisterna; the blue mesopleural stripe is wider adjacent to the mesostigma and is gradually narrowed caudad; the mesopleural suture is covered by a broad black stripe which also covers most of the mesepimera except the cephalo-ventral shoulders, and is considerably widened adjacent to the wing bases, enclosing a small blue spot; ventral half of the mesinfraepisterna yellow, the remainder black; metapleural suture with a narrow black line from wing bases to the metathoracic spiracles; remainder of the pleura and the postcoxal areas pale blue or buff; legs blue and black, the coxae pale, the trochanters black above, the femora black above and pale below, the front femora, however, with more or less black between the rows of setae; tibiae black below, pale above; tarsi dark brown, the claws bifid at the tip; wings with twelve to fourteen postnodal cross-veins in the front wing and eleven to twelve in the hind; M_2 arising between the sixth and seventh

postnodals in the front wing and between the fourth and fifth in the hind wing, usually nearer the fifth; stigma surmounting a single cell; paraptera dull velvety black.

Abdomen blue and black; basal half and a spot on the sides of the first tergum black, the remainder blue; dorsum and apex of the second black, the lateral margins blue; basal rings, and lateral marginal stripes, extending one-half to three-fourths the length of segments 3–6, inclusive, blue; the remainder of these terga, black; tergum seven except a small basal ring, black; dorsum of terga eight, nine, and ten blue, the lateral margins sometimes darker; first sternum with a black, median spot, 3–10 entirely black; anal appendages short, black, the inferiors longest and bifurcate (Figs. 149, 150).

Female.—Color, brown and black.

Head: front, vertex, occiput, and postgenae dull brown.

Thorax brown, the mesostigmal plates usually black and the caudal margins forming a thin blade which projects dorsad; black spots present on the mesopleural and metapleural sutures adjoining the wing bases; legs similar to the male except that the hind pair are almost entirely pale brown.

Abdomen dull brown, with indistinct touches of blue, very similar to that of the male except that the basal rings are not as broad or as well defined; terga 6–10, inclusive, entirely dull brown; anal appendages short; ovipositor long and slender, extending caudad of the anal appendages, pale brown in color.

Measurements

Length, ♂	30–40 mm.
Length, ♀	34 mm.
Length of abdomen, ♂	24–27 mm.
Length of abdomen, ♀	27 mm.
Length of hind wings, ♂	18–19 mm.
Length of hind wings, ♀	21 mm.
Width of hind wings, ♂	4–4.5 mm.
Width of hind wings, ♀	5 mm.

Described from a large series of males and females in the collection of Mr. E. B. Williamson.

This species has been reported from Illinois.

Argia tibialis (Rambur)

Nymph.—Color, very dark brown.

Head about as long as broad, pentagonal; eyes black; antennae with all segments except the last two dark on the basal three-fourths,

the remainder pale; third antennal segment longest, the second and fourth about equal, and the first, fifth, sixth, and seventh successively shorter; caudo-lateral margins of the head without heavy setae; labium, when folded, extending caudad between the first and second pair of coxae; median lobe nearly as broad as long, and with about twelve marginal setae; lateral setae of the labial palpi two or three.

Thorax about as broad as long; legs with conspicuous brown bands, the femora possessing two—a broad basal one and a narrower preapical one—the tibiae three, one on base, one on apex, and a broader one just proximad of the middle; tarsi with the usual ventral setae and mostly dark; metathoracic wing-cases reaching the apex of the fifth abdominal segment in mature nymphs.

Abdomen dark, almost black; lateral keels feebly developed, hairy; dorsum of the first to the tenth terga with a pale mesal stripe which widens slightly caudad though not as conspicuously as in the nymph of *violacea* or *apicalis;* gills elliptical, sometimes wholly dark, or smoky, often possessing a broad, transverse, whitish band about the middle and a narrower subapical one; margins densely pilose but without heavy setae and the gills frequently coarsely spotted; female ovipositor extending to the apex of segment ten.

Measurements

Length	12.5 mm.
Length of abdomen	7 mm.
Length of gills	6.5 mm.
Width of gills	3 mm.
Length of metathoracic wing-cases	3.5 mm.
Length of median lobe	2.5 mm.
Width of median lobe	1.25–2 mm.

Adult; Male.—Color, dark purple or warm brown, sulphur-yellow, and black.

Head blue or brown; median lobe of the labium brown, the median cleft short, obtuse at the base; proximal segment of the palpus rather narrow, the apical segment black and slightly shorter than the black fixed hook; antennae black with the exception of the apices of segments one and two, which are pale; fronto-clypeal suture lined with brown; clypeus, labrum, exposed portions of the mandibles and their trochantins, genae, and front to the level of the median ocellus brown or blue; ocellar triangle, vertex, and the occiput, black, the black area sending a black stripe ventrad from the vertex to each antenna, and another enclosing the median ocellus and extending a short distance

ventrad where it meets a short transverse black line at right angles; clypeus and labrum, front and vertex, thinly pilose, the setae whitish; compound eyes slate-colored.

Thorax brown or purple and black; pronotum with black caudal lobe; median and cephalic lobes also black, the median lobes each with a small lateral brown spot; proepimera brown, with a broad black stripe above; mesostigmal plates black; dorsal carina covered by a black stripe, the lateral halves of the stripe covering about one-fifth of each mesepisternum, the stripes widened at the caudal and cephalic ends and covering the stigmal plates and paraptera; mesopleural suture covered with a broad black stripe which is frequently forked near the wing bases, extends cephalad, and covers all of the mesinfraepisterna except the caudo-ventral angles and one-third of each mesepimeron; metapleural suture with a narrow line of black, the metepisterna and epimera brown or buff; postcoxal areas buff, but frequently with darker lateral margins and a pair of median spots on the intersternum; legs mostly black, the coxae yellowish, with black cephalic surfaces, the femora black with the exception of the dorsal carinae which sometimes have a pale stripe; tibiae with a paler dorsal line; tarsi and claws black; anterior femoral setae eight or nine in the cephalic row, two large and usually two small ones in the caudal row; wings clear, the postnodal cross-veins twelve to thirteen in the hind wing and fifteen to sixteen in the front; M_2 arising between the seventh and eighth postnodal cross-veins in the front wing and between the sixth and seventh in the hind wing.

Abdomen black, with sulphur-yellow and blue; terga 1–8, inclusive, black, the yellow confined to lateral spots, narrow basal rings on 2–7, an apical ring on one, and narrow lines on the lateral margins of terga 2–7 which extend about one-half the length of each segment from the base and unite with the basal rings in segments three, four, and five; in older specimens, however, the lateral stripes are obscured by more or less brown; dorsum of the eighth and ninth terga, with the exception of the black apical margin of nine, pale blue; anal appendages (Figs. 155, 156) black, the superiors small and black, the inferiors black but with a paler dorsal spot.

Female.—Color, pale blue (pale methyl-blue) or buff (ochraceous buff), and black.

Head as in the male but lighter in color, the front lacking the vertical lines above the antennae and the transverse line below the median ocellus; postocular spots present and a pale transverse line, with more or less yellow, on the caudo-dorsal margins of the head; postgenae with yellow adjacent to the compound eyes.

Thorax blue or brown and black; caudal and cephalic lobes of the pronotum with more or less blue or brown; mesostigmal plates (Fig. 140) without projections on the caudal margins; mesopleural stripe of black, somewhat narrower than that of the male, separating more distinctly from the suture at the caudal third, the ventral branch frequently stopping short of the caudal margin of the sclerite; legs paler than those of the male, the femora usually with two dark stripes one on each side of the carina, the remainder pale blue or brown; tibiae with a black ventral stripe between the rows of setae which frequently includes one of the rows; tarsi often with the proximal segments pale.

Abdomen: lateral surfaces, apical ring, and narrow mesal lines of the first tergum pale, the black confined to two dorsal basal spots; second tergum with broad lateral blue stripes and a dorsal stripe greatly contracted and then widened again shortly before the apex, the black limited to a narrow apical ring and a dorso-lateral stripe on each side; segments 3–7 as in the male with the exception of a narrower mid-dorsal pale line; tergum nine black with a paler narrow apical line, the tenth yellowish or blue, with a narrow basal ring, the segment usually dark below; anal appendages of the usual type, the superiors black or dark, the inferiors slightly paler in color; ovipositor, except the extreme tip and the prostyles, dark brown or black.

Measurements

Length, ♂	34–37 mm.
Length, ♀	35–37 mm.
Length of abdomen, ♂	26–30 mm.
Length of abdomen, ♀	28 mm.
Length of hind wings, ♂	20–22 mm.
Length of hind wings, ♀	24 mm.
Width of hind wings, ♂	4.5 mm.
Width of hind wings, ♀	5 mm.

The nymphs of this species have been taken beneath rocks in swift currents. A single specimen has been reared and a comparison of the nymph with the nymph of *apicalis* shows them to be almost identical. Needham ('03) separates the two species on the character of the lateral setae, but there is so much variation in *apicalis* that the character seems without value.

The adults are common throughout the state and may be found at almost any point along the banks of clear, swift streams.

Argia violacea (Hagen)

Nymph.—Color, very dark brown.

Head pentagonal, the caudo-lateral angles nearly rectangular and provided with a few weak setae; antennal segments all dark except the proximal one, which is light in color; third segment longest and the second longer than the first; labium short and broad, the width about two-thirds the length; lateral setae two or three.

Thorax short, dark brown, with a black stripe on each side; legs with dark coxae and trochanters, a narrow proximal ring on each femur which is followed by two broad brownish rings, the three dividing the femur into fourths; tibiae with narrow proximal rings and rings of similar size shortly before the middle, the apices dark; tarsi dark, though not as dark as the rings of the femora and tibiae.

Abdomen dark brown with a paler mesal stripe on the dorsomeson; lateral keels feebly developed and without setae on their lateral margins; gills ovate, more than half as broad as long, uniform brown or sometimes having paler V-shaped marks near the apices, the margins thickly covered with setae arranged irregularly; ovipositor of the female with sharply pointed lateral valves which extend beyond the tenth abdominal segment.

Measurements

Length	17 mm.
Length of abdomen	7 mm.
Length of gills	4.5 mm.
Width of gills	2.5 mm.
Length of metathoracic wing-cases	5 mm.
Length of median lobe	3 mm.
Width of median lobe	1.25–2 mm.

Adult; Male.—Color, dark brown or purple (Matthew's purple).

Head: median lobe of the labium pale; distal segment of the labial palpi black at the tip; antennae black or dark brown except the basal segment, which is buff; clypeus and labrum pale brown, the front, vertex, and postocular regions also largely pale but becoming violet with age, the black confined to a broad transverse band embracing the two lateral ocelli, a T-shaped mark ventrad of the median ocellus, and narrow lines extending from the ends of the transverse band to the compound eyes and to the caudal margins of the head; caudo-dorsal margins of the head with a black line; occipital and postgenal regions largely yellow; compound eyes, slate-gray.

Thorax brown or violet and black; caudal lobe of the pronotum black and brown, the brown in lateral spots on the lateral margins and in a very small median spot; median lobes each with a large subcircular, lateral buff spot; proepimera buff, with dark lines marking the dorsal border; mesothorax with a black line on the dorsal carina and another just ventrad of the mesopleural suture and contiguous with the longitudinal portion of the suture for more than one-half its length; dorsal third of the mesinfracpisternum black; metapleural suture with a black line; metepimera and postcoxal areas buff; legs striped, all the femora with a black stripe on each side of the dorsal carina and the tibiae with a ventral stripe including one of the rows of setae; tarsi dark brown or black, the claws also black; wings clear, the stigma surmounting a single cell or less, the postnodal cross-veins of the front wing thirteen to fourteen, of the hind wing ten to eleven; M_2 arising between the fifth and sixth postnodal cross-veins in the front wing and between the fourth and fifth in the hind wing.

Abdomen purple and black, or brown and black; first tergum with a narrow, basal, black, transverse stripe, the second with large lateral spots extending from the cephalic margin nearly to the apex; terga three and four brown or purple, with the exception of a caudo-lateral spot on each side; tergum five with a dark apical ring and narrow lateral black stripes, the sixth with the purple confined to a dorsal stripe and a basal ring, the remainder of the tergum black or dark brown; seventh tergum entirely black, eighth, ninth, and tenth blue on the dorsum, black on the lateral surfaces; sterna 1–10 black; anal appendages (Figs. 145, 146) consisting of short blunt superiors and longer bifurcate inferiors.

Female.—Color, dark brown or dull violet.

Head similar to that of the male.

Thorax: dorsal mesostigmal plates (Fig. 142) with large rounded lobes at the caudo-mesal angles.

Abdomen with more black than the male; terga 2–9 with dorso-lateral stripes which are broad enough on the seventh and eighth terga to fuse on the meson; lateral surface of tergum nine and all of ten buff, dorsal emargination of the tenth nearly reaching the base of the segment; anal appendages and ovipositor of the usual type, the lateral valves of the ovipositor being serrate on the ventral margin, the prostyles, dark.

Measurements

Length, ♂	32 mm.
Length, ♀	31 mm.
Length of abdomen, ♂	24 mm.

Length of abdomen, ♀ .....20 mm.
Length of hind wings, ♂ .....20 mm.
Length of hind wings, ♀ .....20 mm.
Width of hind wings, ♂ .....4 mm.
Width of hind wings, ♀ .....5 mm.

This species is common at times along the Drainage Ditch north of Urbana, and the nymphs may be taken at almost any season in the black mud on the bottom of the stream. The species has not been collected elsewhere in the state and it does not seem to be as common as reported to be in Indiana. The nymphs emerge throughout June and the adults fly as late as the first of September.

Genus Enallagma Charpentier

The nymphs of this genus are characterized by the presence of three, rarely four, mental setae, and five lateral setae. The gills are variable but do not possess the long tapering points of Ischnura and Anomalagrion, being relatively blunt at the tip. The lateral keels are well developed and setose and in some cases present characters of diagnostic value for the species.

The adults in all cases have vein M_2 arising between the fourth and sixth, usually fourth and fifth, postnodal cross-veins in the front wing and between the third and fifth in the hind wing. The number of postnodal cross-veins varies from seven to twelve, and the female always has a long apical seta on the eighth sternum. The eighth sternites at the base of the cephalic pair of gonapophyses of the female are visible and are small and subtriangular.

The genus is represented in Illinois by more species than any other genus of Zygoptera.

Key to Species

NYMPHS

a. Gills without pigment except in the tracheae.
  b. Dark tracheal branches in alga-like patches (Fig. 76) .....*hageni.*
  bb. Dark tracheal branches not in alga-like patches.
    c. Lateral keel of the first abdominal segment without setae; axis of the gills clear.
      d. Dorsal marginal setae of the median gill less than twenty in full-grown nymphs; all of the third antennal segment dark brown; gills rarely more than 4.5 mm. in length (Fig. 72) ....
      .....*geminatum.*

dd. Dorsal marginal setae of the median gill more than twenty in full-grown nymphs; only the proximal third of the third antennal segment dark brown; gills commonly 5.5–6 mm. in length.. ..... *civile.*

ee. Lateral keel of the first abdominal segment with two to four heavy setae; axis of the gills opaque or slightly smoky.

d. Dorsal setae of the median gill extending beyond the middle; mental setae four, the meso-caudal seta in each row one-half as long or nearly as long as the remaining setae.. { *cyathigerum.* / *calverti.*

dd. Dorsal setae of the median gill not extending to the middle of the gill; mental setae three, the meso-caudal seta in each row representing a small fourth, but minute and always less than one-half the length of the three larger setae. *caruncula tum.*

aa. Gills with pigment other than in the tracheae.

b. Tracheal branches of the gills in alga-like patches; distance from the caudal margins of the compound eyes to the caudo-lateral angles of the head greater than half the distance between the antennal fossae. Abdomen without a median, ventral, black line.

e. Dark portion of the base of the gills extending less than half their length (Fig. 55) ..... *traviatum.*

ee. Dark portion of the base of the gills extending more than half their length.

d. Length of the gills less than eight times the greatest width; gills of mature nymphs with a prominent hinge just caudad of the middle (Fig. 53) ..... *exsulans.*

dd. Length of the gills eight times the greatest width; gills of mature nymphs without a prominent hinge caudad of the middle (Fig. 54) ..... *antennatum.*

bb. Tracheal branches of the gills not in alga-like patches; distance from the caudal margins of the compound eyes to the caudo-lateral angles of the head less than half the distance between the antennal fossae. Abdomen with a median, ventral, black line.

e. Median gill with a bunch of setae proximad of the first dark transverse cross-band; distal cross-bands of the same degree of blackness as the proximal ones (Fig. 56); median gill not greatly expanded distad of the first cross-band; dorsal setae of the apical margins of the abdominal terga not prominent ..... *signatum.*

ee. Median gill without a bunch of setae proximad of the first dark transverse cross-band; distal cross-bands faint, and lighter in color than the proximal ones (Fig. 57); median gill much expanded distad of the first cross-band; dorsal setae of the apical margins of the abdominal terga very prominent ..... *pollutum.*

ADULTS

Females

a. Eighth abdominal tergum with a large blue or pale spot on each side side of the meson.

b. Dorsum of the seventh tergum black (Fig. 96) ..... *geminatum.*

bb. Dorsum of the seventh tergum blue, never with more than a line of black on the meson (Fig. 95) ..... *aspersum.*

aa. Eighth abdominal tergum without a large blue or pale spot on each side of the meson.

b. Longitudinal dark stripe on the dorsum of the second abdominal tergum dumb-bell shaped; caudal half of the eighth tergum black or dark ..... *traviatum.*

bb. Longitudinal stripe on the second abdominal tergum not dumb-bell shaped; apical half of the eighth black or dark.

c. Proximal two-thirds of the second antennal segment pale.

d. Dark stripe of the mesopleural suture reduced in width to a mere line and much less distinct than the dorsal stripe covering the carina; color of the thorax above faint blue (teneral) or lemon-yellow (mature) and black..... *pollutum.*

dd. Dark stripe of the mesopleural suture not reduced in width to a mere line and as distinct as the dorsal stripe covering the carina; color of the thorax above blue (teneral) or orange (mature) and black ..... *signatum.*

cc. Proximal two-thirds of the second antennal segment brown or black.

d. Dorsum of the tenth tergum dark; mesopleural black stripe of the suture not divided by a brown stripe immediately above the suture; caudal lobe of the pronotum without a median mound-like elevation.

e. M_2 arising beyond the fourth postnodal cross-vein in the hind wing.

f. Mesostigmal plates with a diagonal ridge from the caudo-mesal to the cephalo-lateral angles..... *caruncula tum.*

ff. Mesostigmal plates without a diagonal ridge from caudo-mesal to cephalo-lateral angles.

g. Black color of dorsum of abdominal terga 4–7 always reaching the cephalic margins (Fig. 92).

h. Mesal half of the caudal margins of the mesostigmal plates convex (Fig. 212)..... *civile.*

hh. Mesal half of the caudal margins of the mesostigmal plates concave (Fig. 226)..... *doubledayi.*

gg. Black color of the dorsum of abdominal terga 4–7 never reaching the cephalic margins.

h. Cephalo-mesal angles of the mesostigmal plates rounded and hollowed out (Fig. 213) . . . *cyathigerum.*

hh. Cephalo-mesal angles of the mesostigmal plates not rounded or hollowed out (Fig. 223) . . . . . *calverti.*

ee. M_2 arising between the third and fourth postnodal crossveins in the hind wings.

f. Mesostigmal plates narrowed at middle (Fig. 227) . *ebrium.*

ff. Mesostigmal plates considerably widened at the middle (Fig. 221) . . . . . *hageni.*

dd. Dorsum of the tenth tergum pale; mesopleural black stripe divided by a brown stripe immediately above the suture; caudal lobe of the pronotum with a median mound-like elevation (Figs. 219, 220).

e. Caudal margin of the mesostigmal plates at right angles to the dorso-meson . . . . . *exsulans.*

ee. Caudal margin of the mesostigmal plates not at right angles to the dorso-meson . . . . . { *antennatum.* / *divagans.*

Males

a. Dorsum of the second abdominal tergum with an apical spot occupying at most half of the segment; remainder of the tergum blue.

b. Lateral surface of the second abdominal tergum with a short longitudinal brown or black stripe . . . . . *geminatum.*

bb. Lateral surface of the second abdominal tergum without a short longitudinal brown or black stripe.

c. Caudal half of the seventh abdominal tergum blue; postocular spots connected with the blue of the occiput . . . . . *aspersum.*

cc. Caudal half of the seventh abdominal tergum black; postocular spots not connected with the blue of the occiput.

d. Dorsum of the fourth and fifth abdominal terga more than half black . . . . . *carunculatum.*

dd. Dorsum of the fourth and fifth abdominal terga less than half black.

e. Superior anal appendages bifurcate . . . . . *ebrium.*

ee. Superior anal appendages not bifurcate.

f. Inferior anal appendages longer than the superiors.

g. M_2 arising between the third and fourth postnodal crossveins in the hind wings . . . . . *hageni.*

gg. M_2 arising between the fourth and fifth postnodal crossveins in the hind wings.

h. Superior anal appendages blunt; lateral profile as shown in Fig. 200 ..... *calverti.*

hh. Superior anal appendages acute; lateral profile as shown in Fig. 201 ..... *cyathigerum.*

ff. Inferior anal appendages shorter than the superiors.

g. Superior anal appendages with the apical tubercles projecting noticeably beyond the dorso-caudal angles when viewed from the side (Fig. 175) ..... *doubledayi.*

gg. Superior anal appendages with the apical tubercles not projecting noticeably beyond the dorso-caudal angles when viewed from the side (Fig. 198) ..... *civile.*

aa. Dorsum of the second abdominal tergum wholly black.

b. Second antennal segment pale except the distal third, which is dark brown or black.

c. Dark stripe of the mesopleural suture paler in color than the dorsal stripe covering the carina and often reduced to a mere line ..... *pollutum.*

cc. Dark stripe of the mesopleural suture not paler in color than the dorsal stripe covering the carina and never reduced to a line ..... *signatum.*

bb. Second antennal segment entirely dark brown or black.

c. Front with the blue color extending dorsad to the median ocellus; postocular spots forming an equilateral triangle; black stripe of the mesopleural suture indistinct or wanting ..... *traviatum.*

cc. Front with the blue or pale color not extending dorsad to the median ocellus, not dorsad of the antennal fossae; postocular spots forming a wedge-shaped figure; black stripe of the mesopleural suture distinct, never wanting.

d. Superior anal appendages bifurcate.

e. Dorsal arm of the superior appendages shortest; arms not widely divaricate (Figs. 203, 210) ..... *exsulans.*

ee. Dorsal arm of the superior appendages as long as the ventral; arms widely divaricate (Figs. 202, 209) ..... *antennatum.*

dd. Superior anal appendages not bifurcate (Figs. 190, 197) ..... *divagans.*

Enallagma antennatum (Say)

Nymph.—Color, brown or greenish.

Head about half as long as wide, the caudo-lateral angles projecting strongly caudad and thickly studded with setae; second antennal segment slightly shorter than the first, the first two segments dark and pilose; labium with three mental setae, four or five lateral ones, and

with seven or eight setae on the lateral margins of the median lobe; labium extending just caudad of the first pair of coxae.

Thorax about half as wide as the head; the femora all with preapical rings on the distal third; tibiae with the usual apical scales; tarsi pale; metathoracic wing-cases extending beyond the cephalic margin of the fourth abdominal segment.

Abdomen slender, the lateral keels well developed on segments 1–8 but almost wholly lacking in setae except the seventh, which sometimes possesses a single weak one; gills (Fig. 54) long and slender, somewhat lanceolate, with a gradually tapering tip; the smaller tracheae are collected in alga-like patches, and the gills are always provided with some dark cuticular pigment; there is a light spot on the apical third or fourth of the gill on each side of the axis as in *exsulans* which is often followed by two dark cross-bands, the extreme tip, however, being light in color; female ovipositor extending to the middle of the tenth sternum.

Measurements

Length	13–14 mm.
Length of abdomen	9 mm.
Length of gills	7–8 mm.
Width of gills	1–1.3 mm.
Length of metathoracic wing-cases	.4 mm.
Length of median lobe	1.6 mm.
Width of median lobe	.5–1.2 mm.

The nymph is very similar to *exsulans* but may be distinguished from that species by means of the more slender gills, the cross-bands at the tip in older individuals, and by the absence of a hinge beyond the middle.

Adult; Male.—Color, blue or greenish yellow and black.

Head black and orange; mouth-parts buff, the median lobe of the labium subtriangular, the median cleft shallow, acute; proximal segment of the palpus comparatively narrow, the apical half of the distal segment dark; antennae dark, the apex of the first two segments sometimes lighter in color; a large portion of the postclypeus and a dorsomesal spot on the labrum, black; anteclypeus, the remainder of the labrum, exposed portions of the mandibles, their trochantins, the genae, and a transverse stripe above the clypeus orange; remainder of the front and vertex dull black; postocular spots cuneiform, connected with the narrow stripe of the caudo-mesal margin; occiput and postgenae yellow except a black stripe caudo-ventrad of the postocular spots; compound eyes slate-gray.

Thorax yellow or blue, and black; pronotum blue and black, the cephalic lobe largely blue, the median lobes black with small lateral blue spots and with median spots, but only in very recently emerged specimens; caudal lobe of the pronotum with a small, pale, mesal spot, the remainder black; mesostigmal plate with a pale lateral spot and a smaller spot on the caudo-mesal angle; dorsal carina lined with blue, on each side of which there is a broad black stripe occupying about half or more of each mesepisternum; beyond these dorsal stripes on the mesepisterna there are narrow, pale stripes; mesopleural suture covered by a broad black stripe which extends cephalad onto the mesinfraepisternum and covers one-third of it; interpleural fold with a black dash near the wing bases; remainder of the thorax pale greenish yellow.

Abdomen black, greenish yellow, and blue; terga 1–8, inclusive, and ten with black dorsal longitudinal stripes, the stripes widened subapically on segments 2–5, inclusive, and narrowed to the meson at the apex of eight; apical black rings on terga 2–5 and on eight; lateral surfaces of terga 1–8, inclusive, with basal interrupted rings except on the first, which has an apical pale yellowish green ring; lateral surface of the eighth tergum and all of the ninth blue; sterna 2–8 with a black ventral mesal line; superior anal appendages (Figs. 202, 209) black, bifurcate, the arms about equal and widely divaricate; the inferiors shorter, directed obliquely dorsad, mostly buff, the tips black.

Female.—Color similar to that of the male.

Head similar to that of the male.

Thorax similar in color to that of the male; prothorax with a small spot on each median lobe near the meson, besides the lateral ones, and the mesopleural black stripe more commonly divided by a brown line immediately over the suture.

Abdomen: terga 1–10 with broad dorsal brown or black stripes, the stripes widened subapically on segments two to six and continuous with a dark apical ring on the same segments; tergum nine with a narrow pale line, sometimes diamond-shaped; lateral surfaces of terga 2–7 inclusive, greenish yellow; sterna 1–7 or 1–8 with a black mesal line; eighth sternum with a very long and heavy apical seta and the anal appendages of the usual type; ovipositor including the prostyles not extending caudad of the anal appendages, the ventral margins of the lateral valves serrate; eighth sternites small, triangular.

Measurements

Length, ♂	34 mm.
Length, ♀	32 mm.

Length of abdomen, ♂ .....28 mm.
Length of abdomen, ♀ .....25 mm.
Length of hind wings, ♂ .....19 mm.
Length of hind wings, ♀ .....19 mm.
Width of hind wings, ♂ .....4 mm.
Width of hind wings, ♀ .....4 mm.

A relatively rare species which has not been collected outside of Champaign County. The nymphs are to be found in the same locality where *exsulans* is abundant and the two are frequently taken together.

ENALLAGMA ASPERSUM (Hagen)

Nymph.—Unknown.

Adult; Male.—Color, blue and black.

Head blue and black; mouth-parts buff, the median lobe subtriangular and with a shallow acute cleft; palpi narrow, the distal segment pale; antennae black; postclypeus black, anteclypeus and the labrum brown or buff and a blue transverse stripe above the clypeus to the level of the antennal fossae; remainder of the front and vertex black; postocular spots blue, the blue connected with the blue of the occiput and postgenae.

Thorax blue and black; pronotum black except the narrow cephalic lobe, which is blue; proepimera black above, blue or pale below; mesostigmal plate narrow and about half blue; mesothorax with a broad dorsal stripe, covering the carina and also half of the mesosupraepisterna on either side; this is followed by a blue stripe which occupies most of the remaining portion of the mesosupraepisternum; mesopleural suture covered with a black stripe which is considerably widened near the caudal margin of the mesinfraepisternum and extends cephalad over that sclerite, covering the dorsal half or third; remainder of the thorax blue or buff; paraptera entirely black; legs black and buff, the coxae and the trochanters pale, the femora with a stripe on the cephalic surfaces including one row of setae; tarsi and claws black, shining; wings with nine postnodal cross-veins in the front wing and eight in the hind wing; M_2 arising between the fourth and fifth postnodal cross-veins in the front wing and between three and four in the hind wing.

Abdomen blue and black; terga mostly blue, but a very narrow basal spot on the first tergum, a dorsal apical spot and ring on the second, the apical three-fourths of the dorsum of the third, dorsum of the fourth, all of five and six except narrow basal rings, the proximal half of seven, and all of the dorsum of ten, are black; lateral margins

of the fourth, fifth, and sixth terga are mostly pale yellow; anal appendages (Fig. 195) black, the superiors much longer than the inferiors and with a ventral basal tubercle, the apices blunt and directed ventrad; inferiors conical, sharply pointed, and directed obliquely dorsad.

Female.—Color similar to that of the male.

Head similar to that of the male except that the postocular spots are not connected with the blue of the caudal portion of the occiput.

Thorax similar to that of the male; mesostigmal plates black.

Abdomen (Fig. 95) with terga 1–6 as in the male, seven with dorsal stripe reduced to a mesal line on the basal three-fourths, suddenly widened at the apex; eighth tergum black, with a pair of pale basal spots connecting with the pale lateral margins; dorsum of nine and ten black, the lateral surfaces pale; ovipositor short, the prostyles blunt and dark, the ventral margins of the lateral valves serrate.

Measurements

Length, ♂	27–32 mm.
Length, ♀	34 mm.
Length of abdomen, ♂	22–25 mm.
Length of abdomen, ♀	26 mm.
Length of hind wings, ♂	16–18 mm.
Length of hind wings, ♀	20 mm.
Width of hind wings, ♂	3–3.7 mm.
Width of hind wings, ♀	4 mm.

Described from a specimen taken at Lexington, Ky., August, 1915, and a number of both sexes in the collection of E. B. Williamson.

Reported from Illinois.

Enallagma calverti Morse

Nymph.—Color, buff.

Head subelliptical, the caudo-lateral margins projecting a little caudad and with a few setae; antennae of the usual form, the third segment longest, the second longer than the first; labium extending caudad to the second pair of coxae; mental setae four, lateral setae six, and the marginal setae on the margin of the median lobe five or six.

Thorax: legs with rows of heavy setae, especially prominent on the femora, which have several rows and a group of longer setae near the apices; tibiae with two ventral rows of long setae, and a thick bunch of scales at the apices; tarsi of the usual form and with thick ventral

rows of setae; metathoracic wing-cases extending caudad to the middle of the fourth abdominal segment.

Abdomen long and slender, uniform buff, the cuticle provided with minute setae; segments 3–10 with dorsal transverse rows of setae at the caudal margins and segments 3–7 with similar ventral rows, the setae grouped somewhat conspicuously on the meson; lateral keels strongly developed, setose, the keel of the first segment with a number of heavy setae, usually three, that of the second with a row of eight or nine, and keels of the third to the eighth segments with a row of ten or twelve, and with groups of two or three at the apices; ninth segment with a lateral row of setae in line with the lateral keels; gills (Fig. 80) very long, somewhat spatulate, the points mostly blunt, and the dorsal marginal row of setae of the median gill extending much beyond the middle; three narrow transverse bands sometimes occur just beyond the middle; they are placed closely together as a rule, but the bands may be reduced to one or may be wanting.

Measurements

Length	15 mm.
Length of abdomen	9 mm.
Length of gills	7 mm.
Width of gills	1.8 mm.
Length of median lobe	2.3 mm.
Width of median lobe	.8–1.6 mm.

Described from three specimens in the collection of the State Laboratory of Natural History, collected at Havana, Ill., June 30, 1897.

The nymph has not been reared, but the specimens were determined from a description given by Walker.

Adult; Male.—Color, blue and black.

Head blue and black, buff below; labium buff, the median lobe subtriangular, the apical cleft narrow; distal segment of the labial palpi pale; postclypeus black except the lateral margins, anteclypeus, labrum, mandibles, their trochantins, genae, and the transverse area above the clypeus blue; lateral ocelli with a small blue spot cephalad of each, the remainder of the front and vertex black; pale line caudad of the ocellar area distinct, the ends narrowly separated from the large blue, cuneiform postocular spots; occiput pale except a transverse black line bordering the postocular spots.

Thorax blue and black; pronotum mostly black, with a large blue spot on each median lobe, the caudal margin of the caudal lobe and

most of the cephalic lobe blue; proepimera blue, the dorsal border with a broad black stripe; mesothorax with a blue dorsal carina, the black stripe on each side occupying about half of each supraepisternum; mesopleural suture covered by a black stripe which is suddenly widened caudad of the infraepisterna; dorsal third of the mesepimeron black; metapleural suture with a black spot adjacent to the wing bases; paraptera black, the cephalic margins blue; remainder of the pleura blue; postcoxal areas buff; legs striped black and blue, the coxae largely blue; trochanters blue, dark above; femora with black stripes occupying the whole of the dorsum, but not extending ventrad far enough to include either row of setae; cephalic margins of all femoral black stripes emarginate at the proximal end; cephalic half of the tibiae black, the stripe including the cephalo-ventral row of setae; tarsi uniform brown, the segments darker at the distal end; wings with 12–13 postnodal cross-veins in the front wing and 10–11 in the hind; M_2 arising between the fifth and sixth postnodal cross-veins or near the fifth in the front wing, and between the fourth and fifth in the hind; stigma small, pale brown, and surmounting slightly less than a single cell.

Abdomen blue and black; terga 1–5 inclusive, blue with the exception of a black spot on the dorsum of one, a subapical dorsal spot and apical ring on two, and apical spots and rings on 3–5; caudal half of the dorsum of six and caudal three-fourths of seven, black; terga eight and nine blue; tenth tergum black above, pale buff on the lateral margins; first sternum pale; sterna 3–8 black; parameres black and not reaching the apex of the segment; anal appendages short (Figs. 200, 207), the superiors blunt, shorter than the inferiors, but without the conspicuous tubercle of *civile* and *caruncula tum;* inferiors slender, acute and black at the tips.

Female.—Color, blue, but paler than that of the male.

Head: the blue of the male is replaced by brown or buff.

Thorax similar to that of the male, but the blue is frequently replaced by brown or buff.

Abdomen blue and black, the first tergum with a black basal spot as in the male, spot of the second tergum connected with the apical ring and a line on the meson extending to the base of the sclerite; terga 3–6 with narrow dorsal black lines widened suddenly near the apices of the segments and occupying the caudal three-fourths; seventh tergum with a similar but broader dorsal line; caudal half of the dorsum of the eighth, and all of the ninth and tenth black; lateral margins of all terga pale; sterna 3–7 black; one, two, eight, and ten pale; ovipositor pale, the lateral valves broad.

Measurements

Length, ♂	33–35 mm.
Length, ♀	34 mm.
Length of abdomen, ♂	26 mm.
Length of abdomen, ♀	26 mm.
Length of hind wings, ♂	19 mm.
Length of hind wings, ♀	21 mm.
Width of hind wings, ♂	4 mm.
Width of hind wings, ♀	4–4.5 mm.

This species is closely related to *caruncluatum, civile, doubledayi,* and *cyathigerum.* The adult male is easily distinguished from those species by means of the anal appendages; the female, less easily, by means of the mesostigmal plates.

Illinois is within the range of the species and it probably occurs within the state although there seems to be no record of its presence.

A large number of adults of both sexes have been examined, all in the collection of Mr. E. B. Williamson.

Enallagma caruncluatum Morse

Nymph.—Color, green or buff.

Head about twice as broad as long, the caudo-lateral margins not projecting strongly, but with a few strong setae; antennae with the third segment longest, the second longer than the first, the first two and the proximal portion of the third darker than the rest; mental setae of the median lobe three, and sometimes a small fourth on each side; lateral setae six; marginal setae of the median lobe eight or nine on each side; labium extending caudad between the first and second pair of coxae.

Thorax: legs pale, the femora with very faint or no preapical rings and distinct rows of moderately heavy setae; tibiae and tarsi with the usual apical scales and ventral setae; metathoracic wing-cases extending about to the middle of the fourth abdominal segment.

Abdomen with well-developed lateral keels, the keel of the first segment with three or four setae; the second, with eight to twelve; third, with about eleven; fourth, with thirteen to fifteen; fifth, eighteen to twenty; sixth, eighteen to twenty; seventh, twelve to fourteen; and the eighth with about fourteen; on the fifth and sixth keels the setae are bunched at the apex, with sometimes as many as three together; venter of the abdomen entirely without small setae on the cephalic segments, but usually with long hair-like setae on the dorsum of segments

two, three, and four. In mature nymphs there is an indefinite, dark dorsal stripe extending from near the apex of the third segment to the seventh or eighth; gills (Fig. 70) transparent, lanceolate, with a broad, usually pale, opaque stripe along the axis from the base to near the tip; dorsal marginal setae of the median gills usually more than twenty in number and extending one-third the length of the gill from the base, the ventral setae of the same gill consisting of only a few setae and extending half as far as the dorsal row; ventral marginal setae of the lateral gills of similar extent to the dorsal setae of the median gill; apical margins usually without setae or hairs; ovipositor of the female extending to the middle of the tenth abdominal segment and the lateral valves with about four heavy setae on the ventral margin.

Measurements

Length	13.5–14 mm.
Length of abdomen	8–9 mm.
Length of gills	5.5–6 mm.
Width of gills	1.2 mm.
Length of metathoracic wing-cases	3.6 mm.
Length of median lobe	2.5 mm.
Width of median lobe	.5–2 mm.

Adult; Male.—Color, dark blue or buff and black.

Head blue or buff and black, the labium buff, the median lobe subtriangular, the palpus moderately narrow; antennae entirely black, the first segment paler at the apex; postclypeus with a large, shining black spot, the ventro-lateral margins pale; anteclypeus, and labrum except a dorso-mesal black spot and a dorso-lateral spot on each side, pale; exposed portions of the mandibles, their trochantins, the genae, and a transverse stripe above the clypeus, pale; remainder of the front and vertex dull black; postocular spots oval, buff or blue, and not usually connected with the stripe caudad of the ocellar area; occiput and postgenal regions pale except a black stripe caudo-ventrad of the postocular spots.

Thorax blue or buff and black, the pronotum dull black with a transverse median stripe on the cephalic lobe, the caudal margin of the caudal lobe and small crescentic spots on the lateral margins of the median lobe buff or blue; dorsal third of the proepimera black, the dorsal suture indistinct, the remainder of the sclerite buff or blue; cephalo-lateral angles of the mesostigmal plates elevated, the elevated portion pale; pale stripe of the mesosupraepisternum regular, the margins parallel and straight, the stripe extending from the cephalic margin

nearly to the paraptera; black stripe of the mesopleural suture widest just caudad of the mesinfraepisternum, extending onto and covering about the dorsal third of that sclerite, the stripe continuous at the caudal extremity with a narrow stripe extending ventrad along the caudal margin of the mesepimeron to the interpleural fold; metapleural suture with a black spot adjacent to the wing bases; remainder of the thorax buff or blue; legs striped, buff and black, the coxae and trochanters usually pale, the femora with broad dorsal stripes from bases to apices; tibiae with dorsal stripes covering about half the dorsal surface and including the cephalo-ventral row of setae; tarsi and claws pale, black at the tips, the claws very long; wings with nine to eleven postnodal cross-veins and with M_2 arising near the fifth postnodal cross-vein in the front wing and between four and five in the hind wing.

Abdomen black and blue or buff; terga 1–6, inclusive, blue or buff, except a small black basal spot on one, a black apical ring and dorsal spot occupying half the second and third terga, another covering slightly more than half the fourth, two-thirds of the fifth and sixth, and all of the seventh except the narrow lateral marginal stripes and a basal ring; dorsum of the tenth tergum black; eighth and ninth terga entirely blue or buff; sterna one and 3–8 with a median black line; anal appendages (Figs. 194, 205) short, the superiors usually black, blunt, and with a narrow notch on the dorsum cephalad of but near the dorsocaudal angle; inferiors paler, the black apices directed strongly dorsad and frequently in contact with the superiors.

Female.—Color similar to that of the male.

Head similar to that of the male; the postocular spots are, however, considerably smaller.

Thorax similar to that of the male.

Abdomen with the dorsum of terga 1–10 with broad, dorsal dark stripes, widened subapically on segments 2–4 inclusive, the pale color occupying the larger part of the lateral surfaces of all terga as lateral stripes which are continuous with the broad uninterrupted basal rings on segments 4–7 and the interrupted ring of the third tergum; sterna 1–8 with a mesal black line from the bases to near the apices, the eighth sternum with a long apical seta; lateral valves of the ovipositor broad, pale, the ventral margins serrate from apex nearly to base, the prostyles darker on the apical half.

Measurements

Length, ♂	33 mm.
Length, ♀	32 mm.

Length of abdomen, ♂ .....26 mm.
Length of abdomen, ♀ .....25 mm.
Length of hind wings, ♂ .....19 mm.
Length of hind wings, ♀ .....19 mm.
Width of hind wings, ♂ .....4 mm.
Width of hind wings, ♀ .....4 mm.

An inhabitant of the lake regions of Illinois, the nymphs preferring floating vegetation or rank growth along the banks of ponds or lakes of considerable size, though they are occasionally to be encountered in the larger and clearer streams.

The color of the recently emerged adult is buff or cream-color and black, and the blue is much slower in appearing than in other species.

Enallagma civile (Hagen)

Nymph.—Color, green or buff.

Head about twice as broad as long, the caudo-lateral angles not projecting caudad or laterad, but armed with short setae; antennae with the third segment longest, the first shorter than the second, the first two segments and the proximal portion of the third dark brown, the remainder of the third and the distal segments pale; labium extending just caudad of the first pair of coxae, the median lobe with three or four mental setae, the labial palpi with five or six lateral setae and a row of seven or eight small setae on the margin of the median lobe.

Thorax pale buff or green; legs very pale, the preapical femoral rings indistinct, the femora with a dorsal and lateral row of setae and scales near the tips; metathoracic wing-cases extending caudad to the middle of the fourth abdominal segment.

Abdomen pale buff or green, frequently with an indefinite darker stripe on the dorsum of segments 3–7, the cuticle sparsely provided with minute setae, which are usually lacking on the venter of the cephalic segments; dorsum of two, three, and four with long hair-like setae; lateral keels well developed and setose, the first without setae, the second with a row of about eleven, the third with twelve, the fourth with sixteen, fifth with eighteen to twenty, sixth with fifteen to sixteen, seventh with twelve to fourteen, and the eighth with a straight row of about nine setae; gills (Fig. 75) lanceolate, colorless and usually without pigment except in the smaller tracheae, the margins very transparent; dorsal marginal setae of the median gill extending less than half the length of the gill from the base, and composed of more than twenty setae; ventral row of the lateral gills slightly longer

and about half the length of the gills; female ovipositor extending to the middle of the tenth abdominal segment, the ventral margins of the lateral valves setose, the row consisting of about eight stout setae and a number of hair-like ones.

Measurements

Length	15 mm.
Length of abdomen	10 mm.
Length of gills	6 mm.
Width of gills	1.8–2.1 mm.
Length of metathoracic wing-cases	4.5 mm.
Length of median lobe	3.1 mm.
Width of median lobe	.8–2.3 mm.

Adult; Male.—Color, dark blue and black.

Head blue and black; mouth-parts buff, the median lobe of the labium subtriangular, with a shallow, acute, median cleft, the labial palpi much broader at the proximal end than at the apex; antennae dark brown or black; postclypeus with a shining black spot on the meson; anteclypeus shining yellow; labrum shining yellow with a black dorso-mesal spot; exposed portions of the mandibles, trochantins, and genae pale, and a pale stripe above the clypeus extending dorsad to the level of the antennal fossae; remainder of the front and vertex dull black; postocular spots oval or subcuneiform, the pale line caudad of the ocellar area not distinct; occiput and postgenae yellow, except a transverse black stripe caudo-ventrad of the postocular spots; compound eyes dark brown or black.

Thorax blue and black, the black usually metallic; pronotum black, the cephalic lobe with a pale transverse line, the median lobe with a pale spot on the lateral margins and the caudal lobe also with pale margins; procpimera with black dorsal borders, pale below; mesostigmal plates subquadrangular, the cephalo-lateral angles somewhat elevated, though not as much so as in *caruncidatum*, and the lateral half covered by a yellow spot; dorsal black stripe regular and covering nearly half of each supraepisternum; pale stripe of the supraepisterna broadest dorsad of the mesinfraepisterna, extending nearly to the paraptera; mesopleural black stripe of the suture narrowed cephalad of the wing bases, broadest shortly caudad of the mesinfraepisterna and extending across and covering about one-third of the latter; caudal margin of the mesepimera black to the level of the interpleural suture; metapleural suture with a black spot cephalad of the wing bases; remainder of the pleura blue, the postcoxal areas buff, becoming pollinose; paraptera black, the cephalic margins pale and a pale spot below the lateral angles; legs striped, the coxae and trochanters pale, the

femora with stripes on the dorsum, the tibiae with black stripes occupying half the dorsa, but not reaching the apices of the segments; tarsi and claws pale, dark at the tip, the claws notched at a considerable distance proximad of the tip; wings with nine or ten postnodal cross-veins, the vein M_2 arising between the fourth and fifth postnodal cross-veins, usually near the fifth, in the front wing, and between the fourth and fifth in the hind wing.

Abdomen blue and black, the cephalic terga largely blue, the caudal ones darker and frequently becoming pollinose with age; terga 1–6, inclusive, blue except a small basal spot on the dorsum of one and black shield-shaped apical spots and apical rings on 2–6; dorsal black spot of the sixth tergum occupying about half the dorsum, those of 2–5 about one-fourth; dorsum of the seventh and tenth terga black except the lateral margins and a narrow, basal, interrupted ring on the seventh; all of the eighth and ninth terga blue; sterna 2–10 with a black median line; anal appendages (Figs. 198, 103) short, the superiors blunt, with a narrow cleft or notch just ventrad of the apex; inferiors usually black and shorter, the black tips directed obliquely caudad and dorsad and frequently in contact with the superiors.

Female.—Color similar to that of the male.

Head similar to that of the male.

Thorax similar to that of the male except in the color of the legs, which are usually lighter, the dorsal stripes of the femora never extending to the proximal ends of those segments.

Abdomen: the dorsum of all terga have a black longitudinal stripe from the bases to the apices and a short, narrow, apical, black ring; margins of all terga yellow or blue, the pale color extending onto the dorsum at the bases of segments 2–6, but always forming interrupted rings and never connected across the dorsum (Fig. 92) as in *caruncilatum* (Fig. 91); sterna 1–8 with a mesal line from bases to apices, the apex of the eighth sternum with a heavy seta which is darker at the tip than at the base; anal appendages of the usual form, the ovipositor with yellow lateral valves, the ventral margins of which are serrate from the apex to near the base; prostyles brown, dark at the tip.

Measurements

Length, ♂	29–32 mm.
Length, ♀	30–32 mm.
Length of abdomen, ♂	23–24 mm.
Length of abdomen, ♀	23–24 mm.
Length of hind wings, ♂	17 mm.
Length of hind wings, ♀	19–20 mm.
Width of hind wings, ♂	3.5–4 mm.
Width of hind wings, ♀	3.5–4 mm.

A common species at Urbana. It was not taken at Havana, where *carunculatum* was abundant, nor at Lake Villa, where both *carunculatum* and *hageni* were common. The females of these closely allied species have been determined from material collected in the above localities. A study has also been made of specimens taken in copula, in the collection of Mr. E. B. Williamson.

The imago emerges at Urbana as early as June 13 and apparently continues to emerge throughout the season. Nymphs taken late in July emerged shortly after, and another lot, collected at Lexington, Ky., emerged as late as August 18, 1915. There is a possibility that the species has two broods a year.

Enallagma cyathigerum (Charpentier)

Nymph.—Color, buff.

Head elliptical, the caudo-lateral angles rounded and sparsely setose; antennae of the usual form, the second segment slightly longer than the first; labium broad, and extending caudad to the mesocoxae; mental setae four, the proximal seta of both rows more than half as long as the remaining ones; lateral setae five or six; marginal setae of the median lobe four or five.

Thorax: femora without conspicuous rows of small setae; wing-cases extending caudad to the middle of the third abdominal segment.

Abdomen with distinct lateral keels all of which are setose including those of the first segment; the size of the setae gradually increases caudad, and on each lateral surface of the ninth segment there is a row of setae in line with the lateral keels with two or more setae grouped together at the caudal end of the row; gills (Fig. 71) clear and without cuticular pigmentation though reported by Lucas ('00: 103) to have one or more narrow cross-bands beyond the middle; dorsal and lateral gills with closely placed marginal setae which extend more than half-way from the bases to the apices of the gills; tracheal branches few in number and usually larger than are found in *civile* or *carunculatum;* ovipositor of the female extending caudad to the caudal margin of the tenth abdominal segment.

Measurements

Length	14 mm.
Length of abdomen	9 mm.
Length of gills	5 mm.
Width of gills	1.5 mm.
Length of metathoracic wing-cases	4 mm.
Length of median lobe	2.5 mm.
Width of median lobe	.75–2 mm.

Described from three nymphal exuvia from France (Martin), obtained from Mr. E. B. Williamson.

Adult; Male.—Color, pale blue and black.

Head black, blue, and buff; mouth-parts buff; median lobe subtriangular, the proximal segment of the labial palpi broad, the distal segment pale; antennae dark, the second segment much longer than the first; postclypeus black except the lateral margins and the ventral margin, the anteclypeus, labrum, mandibles, and the transverse stripe above the fronto-clypeal suture blue; genae, pale yellow; remainder of the front and vertex black; postocular spots large, blue, the margins of the spots irregular and the spots narrowly separated from the narrow stripe caudad of the ocellar area; occiput, except a stripe caudad of the postocular spots and the postgenae, pale blue.

Thorax: pronotum largely black, the cephalic lobe with the cephalic half blue, median lobes with large oval blue spots; proepimera and episterna blue with black dorsal borders; mesostigmal plates narrow and more than half pale; dorsal carina with the black stripe which covers it also covering one-half of each supraepisternum; black stripe of the mesopleural suture narrowed considerably caudad and covering about one-third of the mesinfraepisterna; remainder of the mesopleura, except a small spot on the mesopleural suture near the wing bases, pale blue; postcoxal areas yellowish blue; legs with blue coxae and trochanters, the trochanters dark on the dorsum; femora with a single black stripe on each dorsum, the stripe broken by a small spot at the base; cephalic half of the dorsum of the tibiae with black longitudinal stripes; tarsi pale yellow, darker at the distal ends; wings with twelve postnodal cross-veins in the front wing and ten in the hind; stigma surmounting less than a single cell, pale.

Abdomen blue and black; first tergum with small basal and smaller lateral black spots; second tergum blue with a subelliptical apical spot and an apical ring; terga three, four, and five with apical spots connected with the apical rings; apical half of the sixth and about four-fifths of the dorsum of the seventh with broad black stripes expanded caudad but not reaching the margins of the terga; terga eight and nine pale; dorsum of ten black, the caudal margin distinctly incised on the meson, the lateral surfaces of the segment pale yellow; first sternum pale, 3–8, inclusive, black; anal appendages (Figs. 201, 208) black and brown, the superiors short, bent ventrad and somewhat acute at the apex; inferiors much longer than the superiors and black at the tips.

Female.—Color in general similar to that of the male, the blue, however, replaced by yellow.

Head and thorax similar to those of the male except that they are somewhat lighter in color; mesostigmal plates as shown in Figure 213.

Abdomen with broad longitudinal stripes on the second tergum which are much expanded near the caudal margin; terga 3–7 with narrow longitudinal stripes, all of which are expanded near the caudal margin, the longitudinal stripe of eight much reduced near the cephalic margin (Fig. 93); anal appendages of the usual type; ovipositor short, the lateral valves pale, ventral margins slightly serrate; prostyles short and blunt.

Measurements

Length, ♂	31–32 mm.
Length, ♀	31–32 mm.
Length of abdomen, ♂	24 mm.
Length of abdomen, ♀	26 mm.
Length of hind wings, ♂	19–21 mm.
Length of hind wings, ♀	20 mm.
Width of hind wings, ♂	4 mm.
Width of hind wings, ♀	4 mm.

This species is most closely related to *calverti,* from which the female differs in having more black on the dorsum of the eighth tergum and in the characters of the mesostigmal plates. The male may be distinguished by means of the anal appendages.

Described from a number of both sexes in the collection of Mr. E. B. Williamson. The species has not been reported from Illinois, but probably occurs here.

Enallagma divagans Selys

Nymph.—Unknown.

Adult; Male.—Color, blue and black.

Head blue and black; labium pale, median lobe subtriangular, the labial palpi including the distal segment pale, the proximal segment narrow; antennae dark, the first two segments subequal, the first pale at the tip; postclypeus black, anteclypeus except a small dorsomesal black spot, the mandibles, their trochantins, genae, and a transverse area above the fronto-clypeal suture pale blue; remainder of the front black; vertex with pale subcuneiform postocular spots, the remainder of the dorsal portion black; occiput and postgenae pale blue or buff with the exception of a large black spot laterad of the occipital foramen on each side.

Thorax blue and black; pronotum black, cephalic lobe largely blue, the median lobes with large spots adjacent to the proepimera, and the caudal lobe with small spots on the lateral angles and one on the meson; proepimera distinct blue and with a dorsal, crescentic, black spot; mesostigmal plates largely blue, the mesal angles black; mesosupraepisterna black, with blue longitudinal stripes from the cephalic margins to the wing bases, the stripe slightly widened cephalad, narrowed at the middle, and widened again caudad; mesopleural suture covered by a black stripe which occupies a portion of the supraepisterna and the epimera, being widest about the middle, narrowed near the wing bases, extending cephalad across the infraepisterna and covering about one half of those sclerites; remainder of the pleura blue, with the exception of spots on the interpleural fold and metapleural suture adjacent to the wing bases; legs buff or pale blue and black; coxae blue with a black basal spot on the cephalic surfaces; dorsum of the trochanters dark, remainder pale; femora with slight dorsal carina, the dorsal longitudinal stripes usually covering the carinae, but the stripes sometimes divided by a pale line on the carina, and emarginate at the proximal end; tibiae mostly pale with faint cephalo-dorsal stripes or row of dashes, the ventral surfaces with black spots at the base and apex; tarsi pale, the segments darker at the distal end; wings with twelve postnodal cross-veins in the front wing and ten in the hind wing; stigma pale, surmounting less than a single cell; M_2 arising near the fifth postnodal cross-vein in the front wing and between three and four in the hind wing.

Abdomen blue and black with a touch of bronze; first and second terga blue, with black, dorsal, longitudinal stripes, the first with a very narrow subapical ring of black which does not reach the lateral margins; longitudinal stripe of the second tergum expanded subapically and the tergum with a broader apical ring extending from the meson half-way to the lateral margins; terga 3–7 with dorsal longitudinal stripes which are contracted to the meson near the cephalic margin, but widen subapically and unite with the black apical rings; terga eight and nine entirely blue; dorsum of the tenth tergum entirely black, the venter pale blue or buff; anal appendages (Fig. 190) short, black, the superiors bilobed, the dorsal arm knob-like, the ventral lobe more slender; inferiors slender, directed obliquely dorsad and frequently in contact with the ventral arm of the superiors; first sternum pale, 3–9 black.

Female.—Color similar to that of the male.

Head similar to that of the male.

Thorax: black stripe of the mesopleural suture divided by a line of brown; mesostigmal plates as shown in Figure 224.

Abdomen: terga 1–7, inclusive, similar to corresponding terga of the male, the lateral blue stripes of the margin becoming dull brown on the apical segments; eighth tergum black, with pale blue lateral spots on the caudal margin; tergum nine blue, with two short dorso-lateral black stripes which fuse at the base of the meson; tergum ten blue; anal appendages dark brown, ovipositor pale buff, the prostyles short and blunt.

Measurements

Length, ♂	29–33 mm.
Length, ♀	32 mm.
Length of abdomen, ♂	24-28 mm.
Length of abdomen, ♀	26 mm.
Length of hind wings, ♂	17–18 mm.
Length of hind wings, ♀	18 mm.
Width of hind wings, ♂	3.5 mm.
Width of hind wings, ♀	3.5 mm.

This species is very closely related to *exsulans*, the male differing principally in the possession of blue on the eighth tergum and in the character of the anal appendages. The female can not be separated from *exsulans* except by the mesostigmal plates. It is, however, a much more slender and delicate insect.

Described from eighteen males and one female in the collection of Mr. E. B. Williamson.

A rare species, reported from Ohio, but not yet taken in Illinois by collectors.

Enallagma doubledayi Selys

Nymph.—Unknown.

Adult; Male.—Color, light blue and black.

Head blue and yellowish and black; antennae uniform brown, the second segment slightly longer than the first; anteclypeus and labrum shining yellow; exposed portions of the mandibles, their trochantins, genae, and the front dorsad of the clypeus to the level of the antennal fossae pale; remainder of the front black; postocular spots small, the narrow stripe caudad of the ocelli distinct; occiput and postgenae pale; compound eyes dark brown.

Thorax black, blue, and yellowish green; pronotum black, the cephalic lobe, a small spot on each median lobe, and the caudal margin of the caudal lobe pale; proepimera and episterna pale, the notoepimeral suture indistinct; paraptera black; mesothorax with a broad black dorsal stripe, the stripe covering about one-third of the mesosupraepisterna on each side; remainder of the thorax, including the postcoxal areas, buff with the exception of small dark spots on the metapleural sutures near the wing bases; legs black and yellow, the coxae and trochanters pale, darker on the cephalic surfaces; femora each with a broad black dorsal stripe which frequently includes one row of setae; tibiae with longitudinal stripes on the cephalic surfaces; wings with about ten postnodal cross-veins in the front wing and eight in the hind one; M_2 arising between the fifth and sixth postnodal cross-veins in the front wing and between the fourth and fifth in the hind wing.

Abdomen blue and black; terga 1–10 blue except a small basal spot on the first, a hastate spot on the second, an apical spot and marginal ring on the second to the fifth, the apical half or two-fifths of the dorsum of the sixth, dorsum of the seventh (excepting a narrow interrupted basal ring), and the tenth, which are pale; anal appendages (Figs. 169,175) similar to those of *carunculatum* and *civile*, but the superiors differ (compare Fig. 169 with Figs. 176 and 179) in having a smaller pale tubercle at the end and in being much wider proximad of the tubercle.

Female.—Color, similar to that of the male.

Head similar to that of the male.

Thorax: mesostigmal plates (Fig. 226) similar to those of *civile*, but the caudal margins concave, instead of convex as in the latter.

Abdomen: terga 1–10 with broad dorsal dark stripes and basal interrupted rings, the lateral margins pale; anal appendages of the usual type and the ovipositor pale, the ventral margins of the lateral valves serrate.

Measurements

Length, ♂	31 mm.
Length, ♀	31 mm.
Length of abdomen, ♂	25 mm.
Length of abdomen, ♀	24 mm.
Length of hind wings, ♂	17 mm.
Length of hind wings, ♀	18 mm.

Described from a number of specimens in the collection of E. B. Williamson.

This species has not been reported from Illinois. It has been collected in Ohio and was originally described from Florida. It is possible that it may occur occasionally in southern Illinois.

Enallagma ebrium (Hagen)

Nymph.—Not available for study.

Adult; Male.—Color, blue and black.

Head black and blue; mouth-parts pale, the labium with a subtriangular median lobe; labial palpi buff, the distal segment dark at the apex; antennae black except the tips of the first and second segments; postclypeus black; anteclypeus, labrum, exposed portions of the mandibles, their trochantins, genae, and a transverse stripe above the clypeus, pale; remainder of the front and vertex black; postocular spots large, subcuneiform, the margins irregular; occiput and postgenae pale except a transverse black stripe caudo-ventrad of the postocular spots.

Thorax blue and black; pronotum black, the cephalic lobe with a pale transverse stripe, median lobes with pale spots on the lateral and caudal margins of the caudal lobe; dorsal border of the proepimera black, the ventral two-thirds pale; mesostigmal plates elongate, the lateral angles covered with a pale spot and slightly elevated, though not as much as in *carunculatum* or *civile;* dorsal mesothoracic stripe occupying about one-third of each supraepisternum, the lateral margins parallel; pale stripe of the supraepisterna extending from the cephalic margin to near the paraptera, widest above the infraepisternum; black stripe of the mesopleural suture widest just caudad of the infraepisternum, and extending across and occupying about one-half of that sclerite; caudal margin of the metepisterna black and a black spot on the metapleural sutures cephalad of the wing bases; remainder of the pleura blue, the postcoxal areas buff; paraptera black, trapezoidal, the cephalic margins and a spot just below the lateral angles pale; legs striped, black and buff, the femora and coxae pale, the entire dorsum of the femora black except a small spot near the base, frequently appearing as an emargination of the black dorsal stripe; tibiae with a black stripe from base to near the apex, occupying half or less of the dorsal aspect and often including the cephalo-ventral row of setae; tarsi and claws pale, dark at the tips; wings with nine to ten postnodal cross-veins in the front wing; vein M_2 arising between the

fourth and fifth postnodal cross-veins in the front wing and between three and four in the hind wing.

Abdomen blue and black; terga largely blue, with black spots on the base of the first and the apices of 2–6 inclusive, all of the dorsum of seven blue except a basal interrupted ring, and all of ten blue; terga eight and nine blue; sterna 3–8 with mesal lines of black from the cephalic to near the caudal margins; anal appendages (Figs. 189, 196) short, pale, the superiors bifid, the two arms equal in length; dorsal arm of the superior appendages black at the tip and forming a blunt hook; ventral arm pale and nearly straight; inferior appendages pale, dark at the tips and about as long as the superiors.

Female.—Color, black and yellow or blue.

Head similar to that of the male, the blue, however, sometimes replaced by yellow.

Thorax similar to that of the male; mesostigmal plates as shown in Figure 227.

Abdomen with broad dorsal stripes on segments 2–10, the stripes contracted to the meson on the bases of terga 3–7 inclusive, and widened subapically on segments 2–7, the widened portion not reaching the lateral margins; first tergum pale, with a black spot at the base; sterna 1–8 with black median stripes; ovipositor of the usual form and not reaching caudad of the tenth segment, the ventral margins of the lateral valves feebly serrate.

Measurements

Length, ♂	29 mm.
Length, ♀	29 mm.
Length of abdomen, ♂	23–25 mm.
Length of abdomen, ♀	24 mm.
Length of hind wings, ♂	16–17 mm.
Length of hind wings, ♀	18 mm.
Width of hind wings, ♂	4 mm.
Width of hind wings, ♀	4 mm.

The anal appendages of the male distinguish the species from closely allied members of the genus, and the mesostigmal plates of the females are also characteristic.

Described from a number of males from Illinois in the collection of the State Laboratory of Natural History, and from females in the collection of E. B. Williamson.

Enallagma exsulans (Hagen)

Nymph.—Color, dark brown or greenish.

Head slightly broader than long, the caudo-lateral angles projecting caudad and provided with heavy setae; second antennal segment shorter than the first, the first two darker than the remaining ones and pilose; labium extending just caudad of the procoxae, mental setae three in number; lateral setae four or five, and six or seven marginal setae on the median lobe.

Thorax: legs with a few hair-like setae, the femora each with a preapical ring of brown and the tibiae with the usual scales at the tip; apices of the third tarsal segments and the apices of the claws dark; metathoracic wing-cases extending caudad to the fourth abdominal segment.

Abdomen slender, the cuticle provided with minute setae and minute brown spots; lateral keels well developed on segments 1–8, the keels on segments 4–8 and the lateral apex of segment nine with small groups of two to five setae; gills (Figs. 53, 77, 77a) broadly lanceolate, broadest beyond the middle, usually heavily pigmented on the proximal two-thirds, the area of infuscation being followed by two large clear spots on each side of the axis, the distal end of the gill being dark, the extreme tip white; marginal setae of the median gill consisting of a dorsal row extending from the base to the light spots, or nearly two-thirds the length of the gills, and ventral marginal setae of the lateral gills of similar extent; apical margins of all gills hairy; smaller tracheae forming alga-like patches; ovipositor extending to the middle of the tenth abdominal segment.

Measurements

Length	12–13.5 mm.
Length of abdomen	9–10 mm.
Length of gills	5.5–7 mm.
Width of gills	1.8–2 mm.
Length of median lobe	2 mm.
Width of median lobe	.6–1.8 mm.

Adult; Male.—Color, pale blue, black, and brown.

Head pale blue and black; median lobe of the labium buff, subtriangular, the cleft obtuse at the base; antennae entirely black; postclypeus black, shining, the anteclypeus pale and the labrum with a transverse black stripe on the dorsal margin; exposed portions of the mandibles, their trochantins, genae, and a transverse area between

the compound eyes and above the clypeus, pale blue; remainder of the front, and the vertex, black; postocular spots and the postgenae and occiput yellow.

Thorax blue and black; pronotum largely black, the cephalic lobe blue; large spots on each mesal lobe and a smaller one on each, near the meson, blue, and a blue triangular mesal spot on the caudal lobe; proepimera largely blue, the dorsal sutures indistinct and covered with black; mesostigmal plates elongate, the lateral angles covered by a blue spot; dorsal carina with a broad, black stripe, which covers also about one-half of the mesosupraepisterna on each side; the dorsal stripe is followed on each supraepisternum by a narrower blue stripe extending from the cephalic margin caudad to near the paraptera, the stripe being narrowed at both ends; the black stripe of the mesopleural suture is broad, extends ventrad well onto the metepimera, and in younger specimens is divided by a brown line which is directly over the suture; dorsal third of the mesinfraepisterna, and spots on the metapleural sutures near the wing bases, dark brown or black; remainder of the pleura blue, postcoxal areas brownish or buff; legs pale blue, or brown and black, the coxae and trochanters pale, the femora each with a faint dorsal carina on one side of which is an indefinite line and on the other a row of spots, the hind femora, however, often entirely pale; tarsi and claws pale, dark at the tips; wings with ten to eleven postnodal cross-veins and M_2 arising between the fourth and fifth postnodal cross-veins in the front wings and between three and four in the hind wing.

Abdomen blue and black, the dorsum of terga 1–9 and ten with longitudinal black stripes from base to apex, widened subapically on segments 2–7 and narrowed to the meson on the apex of the eighth tergum; lateral surfaces of terga 1–8 and ten, all of nine, narrow apical ring on one, narrow basal ring on three, and a broad basal ring on four, five, and six, blue or pale; anal appendages (Figs. 203, 210) black, the superiors bifurcate, the dorsal arms shortest and with minute points directed mesad; inferiors paler and shorter than the superiors.

Female.—Color, pale green (pale viridine green), black, and brown, tip of the abdomen blue.

Head similar to that of the male except that the postocular spots are connected with the narrow stripe caudad of the ocelli, and the genae and stripe above the clypeus are usually more or less orange in color.

Thorax with the brown of the mesopleural dark stripe covering the suture more conspicuous and persistent than it is in the male; mesostigmal plates as shown in Figure 220.

Abdomen with broad dorsal stripes on segments 1–8, the stripe on nine being reduced to two triangular spots at the base of the tergum, the remainder being blue in color; tergum ten blue; lateral surfaces of terga 2–8 and narrow interrupted basal rings on segments 3–8 pale green; sterna 2–8 with black mesal lines, the eighth with a long apical seta; ovipositor and anal appendages of the usual form, the lateral valves of the ovipositor blue or pale and serrate on the ventral margins; prostyles dark brown.

Measurements

Length, ♂	35 mm.
Length, ♀	32 mm.
Length of abdomen, ♂	29 mm.
Length of abdomen, ♀	26 mm.
Length of hind wings, ♂	19 mm.
Length of hind wings, ♀	20 mm.
Width of hind wings, ♂	4 mm.
Width of hind wings, ♀	5 mm.

One of the most common and wide-spread species of the state. The nymphs prefer meadow brooks, but also inhabit small lakes and ponds. In numbers this species is equal to *signatum*. The adults emerge early and fly throughout the summer.

Specimens have been seen from Dubois, Carbondale, Carmi, Golconda, Lake Villa, Oregon, and Cook County.

Enallagma geminatum Kellicott

Nymph.—Color, usually green.

Head about three times as broad as long, elliptical, the caudolateral angles not projecting caudad or laterad, evenly rounded, and possessing only a few setae; third segment of the antennae longest and the second segment decidedly longer than the first; segments 1–3 or 1–4, dark in color; labium extending slightly caudad of the procoxae; median lobe with three mental setae and sometimes a minute fourth; lateral setae five; median process of the labial palpi with only two teeth; lateral margins of the median lobe with three or four small setae caudad of the articulations of the labial palpi.

Thorax: legs without dark rings near the apex or with very faint ones, the femora provided with rather long setae; tarsal claws dark at

the tips; metathoracic wing-cases extending to the caudal margin of the fourth abdominal segment.

Abdomen with moderately well-developed lateral keels on segments one to eight inclusive, the first without setae, the second with a bunch of three or four, the third with an irregular double row, and the fourth to the eighth possessing irregular single rows, with sometimes two setae at the apices; segment nine, although possessing no keel, has an irregular double row of setae in line with the keels of the preceding segments; gills spatulate to lanceolate (Fig. 72), without pigment except in the smaller tracheae and sometimes a trace along the axis; dorsal marginal row of setae of the median gill extending much less than half the length of the gill and containing seventeen or eighteen setae, the ventral row of the same gill short and composed of only a few setae; ventral marginal row of the lateral gills also less than one-half the length of the gills; the black tracheae of the gills differ greatly from those of other clear-gilled species in being fewer in number and branching from the axis more nearly at right angles; ovipositor extending caudad to the apex of the tenth abdominal segment.

Measurements

Length	11–12 mm.
Length of abdomen	9 mm.
Length of gills	4.7 mm.
Width of gills	1.3 mm.
Length of metathoracic wing-cases	2 mm.
Length of median lobe	2 mm.
Width of median lobe	.6–1.5 mm.

Adult; Male.—Color, pale blue (pale methyl-blue), black, and buff.

Head blue and black, the mouth-parts buff, with a tinge of blue; median lobe of the labium subtriangular, the cleft shallow and rounded at the proximal end; labial palpi with slender distal segments, pale, and not darker at the tip; antennae dark brown or black, the tips of the first and second segments sometimes pale; postclypeus shining black except the latero-ventral angles, which are blue; anteclypeus and labrum except a small dorso-mesal black spot, blue; exposed portions of the mandibles, their trochantins, genae, and a transverse area dorsad of the clypeus blue; remainder of the front black; postocular spots large, blue, rather irregular and frequently serrate on the margins; pale stripe caudad of the ocelli wanting; occiput and postgenae buff,

except a transverse stripe caudad of each postocular spot; compound eyes dark brown above, the brown area including a crescent-shaped paler stripe, the eyes pale yellow below.

Thorax blue and black, buff below; pronotum black, the narrow cephalic lobe and the caudal lobe largely blue, the median lobes entirely black; procpimera largely blue; mesostigmal plates narrow, the lateral angles and the caudal margin with a broad blue stripe; black stripe of the dorsal carina covering one-third to one-half of each mesosupraepisternum; supraepisternal blue stripe somewhat irregular, not reaching the caudal margin of the sclerite, contracted at the caudal third or fourth, and occasionally interrupted, forming an exclamation point; mesopleural black stripe of the suture widest adjacent to the infraepisternum and covering the dorsal third of that sclerite; at the caudal extremity the stripe extends ventrad along the caudal margin of the mesepimera to the interpleural fold; metapleural suture with a black line; remainder of the pleura, including the ventral half of the mesepimera, all of the metepisterna, and the epimera, blue; postcoxal areas pale or buff; legs striped, black and blue or buff, the coxae and the trochanters mostly pale, the coxae sometimes with dark spots; femora each with a broad dorsal stripe from base to the apex and the tibiae with a brown or black stripe occupying half the dorsum and frequently including the cephalo-ventral row of setae; tarsi and claws black, the claws deeply bifid at the tip; wings with seven to nine postnodal cross-veins and with M_2 arising between the fourth and fifth postnodal veins in the front wing and between three and four in the hind wing.

Abdomen blue, buff, and black; first tergum blue, a black basal spot occupying half the dorsum, and the caudo-lateral margin black; second tergum blue except a subapical dorsal spot, an apical ring, and a longitudinal stripe near the lateral margin, which are black; segments 3–7 with longitudinal black stripes on the dorsum from near the bases to the apices, the stripes widened subapically, connecting with the apical rings and extending to the lateral margin of the terga; entire dorsum of tergum ten and a narrow lateral marginal stripe from bases to apices of terga eight and nine black or dark brown, the whole of the dorsum of the eighth and ninth terga pale blue; lateral margins and basal rings of terga 3–6 pale yellow or blue, the lighter color connecting across the dorsum on the bases of the third and fourth terga and extending onto the dorsum but interrupted on the meson in terga 5–7; anal appendages (Figs. 204, 211) black and buff, the superiors black, with paler tips, and curved ventrad and caudad;

inferiors slightly longer than the superiors, yellowish buff with black tips, the tips directed mesad.

Female.—Color, similar to that of the male.

Head similar to that of the male except that the dorsal half or third of the labrum is usually brown.

Thorax similar in all respects to that of the male; mesostigmal plates as shown in Figure 216.

Abdomen with broader dorsal stripes on terga 2–7, all of which extend to the bases of the segments; terga nine and ten entirely brown except the pale lateral margins; tergum seven brown, with large blue spots occupying the larger portion of the sclerite and separated from one another only by a mesal line of black; dorso-apical margin of seven and eight blue; sterna 2–8 with a black mesal line, the eighth with a long apical seta; anal appendages of the usual type, the lateral valves of the ovipositor broad and serrate on the ventral margins; prostyles dark brown, short.

Measurements

Length, ♂	26–27 mm.
Length, ♀	26–27 mm.
Length of abdomen, ♂	21 mm.
Length of abdomen, ♀	21 mm.
Length of hind wings, ♂	15 mm.
Length of hind wings, ♀	16 mm.
Width of hind wings, ♂	3.5 mm.
Width of hind wings, ♀	4 mm.

This species is characteristic of the smaller lakes and larger ponds, the nymphs inhabiting floating vegetation, and the adults flying near the surface of the water close to the habitat of the nymphs. The nymphs do not live in meadow brooks or swift streams.

Both nymphs and adults were taken at Havana, Illinois, and at Lake Villa during the latter part of June and the first of July.

Enallagma hageni (Walsh)

Nymph.—Color, buff or greenish.

Head subelliptical, the caudo-lateral angles projecting slightly caudad and armed with a few heavy setae; antennae with the third segment longest, the second longer than the first; labium, when folded, extending caudad to the second pair of coxae, the mental setae of the median lobe three, the lateral setae usually five, and the marginal setae of the median lobe usually three or four.

Thorax nearly uniform in diameter throughout, the prothorax somewhat smaller; legs with faint preapical femoral rings of brown, and the usual apical scales present on the tibiae; tarsi and claws pale; metathoracic wing-cases extending to the middle of the fourth abdominal segment.

Abdomen slender, and with a row of spots on the cephalo-lateral angles of the terga and sterna of segments 2–9; lateral keels strongly developed, setose, the first keel usually without setae, the second, third, and fourth with a bunch of four or five at the apices, the fifth with about five apical setae and a weaker row extending to the base of the segment; sixth, seventh, and eighth keels with six setae at the apices and a proximal row of about nine setae on each; segment nine without lateral keel, but with a row of setae along the line of the lateral keels, composed of two heavy setae near the caudal margin and a straight row of six smaller setae extending cephalad to the margin of the segment; cuticle of the abdomen without dark spots at the bases of the minute setae which cover the surface; dorsum of segments two and three and the base of four with long hairs; gills (Fig. 76) lanceolate, almost colorless, widest beyond the middle and rather obtusely pointed; tracheae pigmented in certain areas which form about twelve alga-like patches around the margins of the gills; dorsal marginal setae of the median gill extending half-way from the base to the tip and composed of more than twenty setae; ventral setae of the lateral gills extending more than half-way from the base to the tips of the gills; apical margins of all gills with a few scattered hairs.

Measurements

Length	14–15 mm.
Length of abdomen	9 mm.
Length of gills	5 mm.
Width of gills	1.8 mm.
Length of metathoracic wing-cases	3.6 mm.
Length of median lobe	2 mm.
Width of median lobe	.7–1 mm.

Several specimens obtained from Dr. E. M. Walker have been studied. Specimens of this species are also present in the collection of the Illinois State Laboratory of Natural History and have been identified by comparison.

Adult; Male.—Color, pale blue and black.

Head black and yellowish, the mouth-parts buff, the median lobe of the labium subtriangular; antennae black or very dark brown;

postclypeus largely black, the anteclypeus and the labrum shining yellow; exposed portions of the mandibles, their trochantins, genae, and a transverse stripe dorsad of the clypeus yellow; remainder of the front black; the oval postocular spots and the narrow transverse stripe caudad of the ocelli green; occiput and postgenae pale; compound eyes dark brown.

Thorax black, blue, and yellowish green; pronotum dull black, the cephalic lobe, a small spot near the lateral margin of each median lobe, and the caudal margin of the caudal lobe yellowish green; proepimera pale, the noto-epimeral sutures indistinct; mesostigmal plates with a pale lateral spot; paraptera black; mesothorax with the usual dorsal stripe, a broad pale stripe on each supraepisternum, and a black stripe covering the mesopleural suture, extending over the infraepisternum, and covering about one-third of that sclerite; remainder of the thorax, including the postcoxal areas, yellowish green or blue with the exception of a small dark spot on the metapleural suture just cephalad of the wing bases; legs black and yellow, the coxae and trochanters pale, the femora each with a broad black dorsal stripe from base to apex, and the tibiae with a similar stripe on the cephalic surfaces, which frequently includes one of the rows of setae; tarsi and claws brown, black at the apices; wings with ten postnodal cross-veins in the front wing and about eight in the hind one; M_2 arising between the fourth and fifth postnodal cross-veins in the front wing and between the third and fourth in the hind wing.

Abdomen blue and black; terga 1–10 blue except a small black basal spot on the first, an apical spot and marginal ring on the second to the fifth, the apical half or two fifths of the dorsum of the sixth, the dorsum of the seventh except a narrow interrupted basal ring, and the dorsum of the tenth, which are black; anal appendages (Figs. 161,162) short, the inferiors subconical, the superiors slightly shorter, broad and flat, subquadrangular when seen from above, pointed, and similar in appearance to the inferiors when seen in lateral profile.

Female.—Color, yellowish green and black.

Head similar to that of the male.

Thorax also like that of the male; the mesostigmal plates (Fig. 221) are characteristic, being short and broad and having the caudolateral angles distinctly elevated; the blue of the male thorax is usually replaced by a yellowish green.

Abdomen black and yellow; terga 1–10 black except the lateral surfaces and an apical ring on the first, lateral surfaces of 2–10, and interrupted basal rings on 3–6 inclusive, which are pale blue or green-

ish; anal appendages of the usual type; the lateral valves of the ovipositor are pale yellow, the prostyles light brown; apex of the eighth sternum with a long seta.

Measurements

Length, ♂	30 mm.
Length, ♀	30 mm.
Length of abdomen, ♂	23–24 mm.
Length of abdomen, ♀	23–24 mm.
Length of hind wings, ♂	17 mm.
Length of hind wings, ♀	17 mm.
Width of hind wings, ♂	3.5 mm.
Width of hind wings, ♀	4 mm.

A common species in the lake region of Illinois, but not observed as far south as Urbana. The adult female is closely related to *carunculatum* and *civile*, from which it may be separated by means of the wing venation, the vein M_2 usually arising between the third and fourth postnodal cross-veins, by the narrower pale abdominal rings at the bases of the terga, and by the character of the mesostigmal plates. The males are easily separated from *carunculatum* and *civile* by means of the anal appendages.

Enallagma pollutum (Hagen)

Nymph.—Color, pale green or buff.

Head elliptical, about twice as broad as long, the caudo-lateral angles slightly projecting and furnished with but few setae; antennae of the usual form as regards length of the segments, the first two segments, however, being much thicker than the distal ones and the second usually shorter than the first; first antennal segment dark in color, the remaining ones paler; labium extending slightly caudad of the first pair of coxae, with three mental setae; five lateral setae and three or four marginal setae on the median lobe.

Thorax about twice as long as broad; legs light in color, with a few scattered setae, the femora with preapical rings of brown, the tibiae sometimes with a dorsal row of black dashes; metathoracic wing-cases reaching the middle of the third abdominal segment.

Abdomen slender, the lateral keels strongly developed and setose, the setae being grouped conspicuously near the apices of the keels, especially on segments 2–6; dorsa of segments 4–10 with apical transverse rows of small setae, the row on the tenth interrupted on the line of the meson, and those on 2–5 irregular, and consisting of several

rows together; ovipositor extending to the middle of the tenth abdominal segment, the ventral margins of the lateral valves with a single row of setae; venter of the abdomen without the median black stripe of *signatum*, but with a double row of black spots near the apical margins, two on each of segments one to six and sometimes on seven also; gills (Fig. 57) lanceolate, frequently much and suddenly widened beyond the middle, conspicuously banded, usually with two darker cross-bands (more or less fused) near the proximal third and three lighter crescentic ones which are sometimes wanting, axis dark, the median gill without dorsal marginal setae, the ventral margins of the lateral gills with a thick row extending slightly more than one-third the length of the gills from their bases, or extending from the base to the point where the first dark cross-band reaches the margin.

Measurements

Length	15.5 mm.
Length of abdomen	9 mm.
Length of gills	5.5 mm.
Length of metathoracic wing-cases	4.1 mm.
Length of median lobe	1.8 mm.
Width of median lobe	.5–1.5 mm.

Adult; Male.—Color, lemon-yellow (strontian yellow) or very pale blue, and black; the majority of specimens are yellow, the blue tenerals being infrequent.

Head yellow and black; labium pale yellow, median lobe subtriangular; antennae brown and pale, the first segment and basal two-thirds of the second pale, the remainder dark brown; postclypeus with a large black spot occupying almost the whole of it and within which are two small yellow spots; anteclypeus and labrum yellow except a median, dorsal, brown spot on the labrum; exposed portions of the mandibles, trochantins, genae, and a transverse area above the clypeus extending dorsad to the level of the median ocellus, yellow; remainder of the front black except a small transverse stripe cephalad of the median ocellus and small spots cephalo-ventrad of the lateral ocelli; postocular spots large, cuneiform, connected with the narrow stripe caudad of the ocellar area; the black of the vertex extends along the margin of the compound eyes a short distance caudad and ventrad of the postocular spots and sends mesad a broad, short band; remainder of the occiput and postgenae pale yellow.

Thorax yellow and black; pronotum yellow and black, the broad cephalic lobe mostly yellow, the median lobes each with a large yellow

spot and a smaller one mesad of it; caudal lobe with a yellow caudal margin; proepimera yellow, with very little black or brown; mesostigmal plates subtriangular, yellow, with a small brown spot near the mesal margin, the caudo-mesal angles slightly elevated, dorsal carina covered by a broad black stripe, the lateral margins of which fade into brown; black stripe of the mesopleural suture reduced to an indefinite pale brownish area near the middle of the horizontal portion of the suture; black spots adjacent to the dorsal margin of the mesinfraepisterna and small spots just cephalad of the wing bases; dorsal third of the mesinfraepisterna marked with small, crescentic, black spots; metapleural sutures with small black spots just cephalad of the wing bases; remainder of the mesopleura yellow; paraptera black with yellow cephalic margins and pale spots ventrad of the lateral angles; legs mostly yellow, the coxae and trochanters pale, the femora with a faint dorsal line, the tibiae with a faint indefinite dorsal line or row of dashes, and the tarsi and claws tipped with brown; wings with nine to eleven postnodal cross-veins and with M_2 arising between the fourth and fifth postnodal veins in the front wing and between three and four in the hind wing.

Abdomen yellow and black, the dorsum of terga 1–8, inclusive, with black longitudinal stripes from near the base to the apex of each; lateral stripes on terga 1–7, narrow basal rings on 3–7, and a very narrow apical ring on the first tergum, yellow; all of the ninth and tenth terga blue except a narrow mesal line on the tenth; sterna 3–8 with a mesal line of black; anal appendages (Figs. 186, 193) brown, the superiors much longer than the inferiors, broad at the apices, and with the caudo-dorsal and caudo-ventral angles folded mesad; inferiors small and yellow, the black apices directed mesad.

Female.—Color, lemon-yellow or very pale blue, and black.

Head similar to that of the male.

Thorax of slightly paler tint than in the male; mesostigmal plates (Fig. 225) with a large lateral black spot, the lateral margins rounded, and the plates contiguous with the mesinfraepisterna.

Abdomen yellow and black, the terga similar to those of the male with the exception of nine and ten, which are usually yellow, the ninth having a triangular black spot at the base; sterna 2–8 with a mesal line of black, the eighth with a long seta at the apex; lateral valves of ovipositor yellowish, serrate on the ventral margins, the prostyles brown.

Measurements

Length, ♂ .....34 mm.
Length, ♀ .....34 mm.

Length of abdomen, ♂ .....28 mm.
Length of abdomen, ♀ .....27 mm.
Length of hind wings, ♂ .....19 mm.
Length of hind wings, ♀ .....21 mm.
Width of hind wings, ♂ .....4 mm.
Width of hind wings, ♀ .....3.5 mm.

A species of apparently local distribution, occurring in the lake region of Illinois. Several collections of nymphs and adults were made at Lake Villa, July 13 and 14, 1915, and a number of adults were reared from the nymphs.

While closely related to *signatum*, the nymph shows a great difference in the gills, making it recognizable at sight. It is quite different from the species figured by Walker as *pollutum* ('13; pl. 1, fig. 10), and his description also differs from the specimens obtained at Lake Villa.

Enallagma signatum (Hagen)

Nymph.—Color, buff or greenish.

Head elliptical in outline, the caudo-lateral angles not projecting strongly, but thickly studded with short setae; first two segments of the antennae dark in color, nearly equal in length, the second slightly shorter, the third longest, and the remaining ones decreasing successively in length; labium, when folded, extending just caudad of the procoxae, with three mental setae, five lateral, and three or four smaller ones on the margin of the median lobe.

Thorax: legs light in color except a dark ring on the apical third of each femur and the tips of the third tarsal segments; femora with a few small setae and scattered hairs; metathoracic wing-cases extending nearly to the fourth abdominal segment.

Abdomen: the segments of the abdomen appear to have a greater transverse diameter near the apical fourth on account of the projecting lateral keels; the keels are well developed and setose, the setae being grouped mainly at one point near the apex of the keel; dorsum of segments 4–8 with short apical rows of small, heavy setae, terga nine and ten with longer rows, usually extending onto the venter; sterna two, three, and four with a cluster of small thick setae on the apical third, and the venter with a black line extending from the basal segment to segment nine; gills (Figs. 56, 69) lanceolate, the dorsal marginal setae of the median gill grouped mainly at one point, usually just proximad of the point where the first transverse band reaches the margin; beyond the ventral marginal row of setae the margins of the lateral gills are distinctly emarginate; the pigmentation of the

gills consists of three to five broad, black cross-bands and a broad axial band from the bases to the apices; ovipositor extending to the middle of the tenth abdominal segment.

Measurements

Length	16–18 mm.
Length of abdomen	10.5–12.5 mm.
Length of gills	5.5 mm.
Width of gills	1.6 mm.
Length of metathoracic wing-cases	4 mm.
Length of median lobe	2 mm.
Width of median lobe	.5–1.8 mm.

Adult; Male.—Color, pale blue or orange, and black.

Head blue or orange, and black; mouth-parts buff, the median lobe of the labium subtriangular, the palpi pale; first two segments of the antennae pale, at least much paler than the distal ones, the second segment darker at the tip; postclypeus black, sometimes with a pair of median pale spots, one on each side of the meson; anteclypeus pale; labrum pale, the dorsal margin with a mesal black spot and two lateral ones, or with a transverse stripe of black including the three spots; exposed portions of the mandibles, their trochantins, genae, and a transverse stripe above the clypeus extending slightly dorsad of the antennae, orange or blue; remainder of the front and vertex black; postocular spots large, cuneiform, and yellow or blue; postgenae and the occiput largely yellow.

Thorax orange or blue, and black; pronotum black, the cephalic lobe, a subcircular spot on each median lobe, and the entire caudal lobe blue or yellow; the spots on the median lobes are variable, being frequently subcircular with an emargination on one side; in younger individuals there are also two smaller spots mesad of the large spots on each mesal lobe; proepimera blue or yellow, the dorsal margins covered by a black stripe; stigmal plates triangular, the caudo-mesal angles elevated, and the caudal margins with a blue or yellow stripe; dorsal carina covered by a black stripe, the margins of which are parallel and very straight; mesopleural suture also with a broad stripe which is widest just caudad of the mesinfraepisternum and extends cephalad and covers the dorsal third of that sclerite; remainder of the thorax pale blue or orange, buff-colored below; paraptera trapezoidal, black, the cephalic margins and a spot below the lateral angles pale; legs usually buff, the femora with an indefinite dorsal brown line and a row of spots, the tibiae with a faint dorsal line or row of dashes;

tarsi pale, darker at the apices; wings with ten postnodal cross-veins in the front wing and eight in the hind one; M_2 arising near the fifth postnodal vein in the front wing and between the fourth and fifth or between the third and fourth, usually near the fourth, in the hind wing.

Abdomen orange or blue and black; dorsum of terga 1–8 inclusive, black, except interrupted basal rings on 3–7, lateral surfaces of one and two, and the lateral margins of 3–8; all of tergum nine and the lateral surfaces of the tenth orange or blue, the dorsum of ten being black; anal appendages (Figs. 185,192) dark brown, the superiors much longer than the inferiors, blunt at the apices, the lateral surfaces convex, the mesal surfaces somewhat concave; inferiors about half as long as the superiors and subconical, the tips black and directed mesad.

Female.—Color, pale blue or orange, and black.

Head similar to that of the male.

Thorax similar in all particulars to that of the male; the orange-colored females are, however, less frequent; mesostigmal plates (Fig. 214) long, the lateral margins rounded, and a diagonal pale stripe crossing the plates.

Abdomen blue or orange, and black; terga 1–9 with black, dorsal, longitudinal stripes from the bases to the apices, the stripes widened near the apex on 2–7 and narrowed on the apex of nine; lateral surfaces of all terga, basal rings on 3–7, and an apical ring on one, yellow or bluish; all of segment ten yellow or blue; sterna 3–8 black; anal appendages of the usual form; ovipositor with the lateral valves pale and serrated on the ventral margins, the prostyles brown.

Measurements

Length, ♂	34–35 mm.
Length, ♀	34–35 mm.
Length of abdomen, ♂	26–28 mm.
Length of abdomen, ♀	28 mm.
Length of hind wings, ♂	17 mm.
Length of hind wings, ♀	20 mm.
Width of hind wings, ♂	3.5 mm.
Width of hind wings, ♀	4 mm.

One of the commonest species in Illinois, occurring in all localities. Next to *Ischnura verticalis* it may be considered as the most abundant.

The nymphs may be collected in slow streams, permanent ponds, or lakes, and prefer the clear water. They emerge in central Illinois

as early as the tenth of May and the greatest number of adults appear on the wing about June 1. The latest emergence which is recorded is one on June 25, 1915. This gives a period of emergence of at least a month and a half.

Specimens have been seen from Havana, Lake Villa, Muncie, Peoria, and Urbana.

Enallagma traviatum Selys

Nymph.—Color, very dark brown.

Head about one-third as long as broad, dark in color; caudolateral margins projecting caudad, studded with short setae; antennae very slender, the first two segments with setae and of much greater diameter than the remaining ones, the third segment longest, the second decidedly shorter than the first; labium extending slightly caudad of the first pair of coxae; mental setae two, with sometimes a rudimentary third, lateral setae four; marginal setae of the median lobe six or seven.

Thorax: lateral portions of the prothorax and the metapleura darker than the dorsum of the thorax; legs slender, the coxae dark brown, femora almost wholly devoid of setae, but with very distinct preapical brown rings; tibiae with setae which are rather closely set, especially towards the apices; tarsi pale.

Abdomen brown, darker immediately above and below the lateral keels; cuticle with a few minute setae, but lacking minute black spots entirely; lateral keels feebly developed and without heavy setae, there being instead a few setae near the apices of the keels; gills (Fig. 55) rather narrowly lanceolate, the median gill entirely without heavy setae on the dorsal margin; lateral gills with the ventral marginal row of setae extending one-half or less of the length of the gills; basal two-fifths or one-half of the gills uniform dark brown, the pigmented area followed by a broad white or clear band extending from margin to margin and including the axes; beyond the clear portions there are frequently one or two brown transverse stripes, the apex of the gills being without pigment; ovipositor extending caudad to the apex of the tenth sternum, the ventral margins of the lateral valves with one or two heavy setae and a number of hairs.

Measurements

Length	11 mm.
Length of abdomen	8 mm.
Length of gills	6 mm.
Width of gills	1 mm.

Length of metathoracic wing-cases...3.5 mm.
Length of median lobe .....2 mm.
Width of median lobe..... .5–1.3 mm.

Adult; Male.—Color, pale blue and black.

Head blue and black; labium buff, the median lobe with a broad median cleft; distal segment of the labial palpi pale; antennae brown, the first segment sometimes with the cephalic half blue; postclypeus blue with a small black spot on each side; anteclypeus blue; labrum blue with a black dorso-mesal spot; exposed portion of the mandibles, their trochantins, genae, and the front from the fronto-clypeal suture dorsad to the median ocellus, blue; lateral ocelli with small blue spots ventrad of them, and a similar spot between the ocelli; remainder of the front black; postocular spots very large, forming equilateral triangles and occupying most of the dorsal portion of the occiput, the spots bounded caudad by a very narrow black band and separated from the compound eyes by a band of similar width; the narrow stripe caudad of the ocellar area is indistinct; occiput and postgenae pale blue.

Thorax blue and black; pronotum blue and black, the cephalic lobe with a transverse line of blue on the caudal margin, the median lobes with elongate blue spots, contiguous on the meson, and semicrescentic spots of the same color; proepimera and proepisterna brown or pale; mesothorax with the narrow black stripe covering the dorsal carina but frequently divided there by a line of brown; black stripe of the mesopleural suture reduced to a line on the suture; mesinfraepisterna with black crescentic marks on the dorsal borders; remainder of the pleura blue with the exception of small spots on the interpleural folds and metapleural sutures adjacent to the wing bases; postcoxal areas pale; paraptera black, crescentic, the cephalic margins and lateral angles blue; legs striped, pale blue or buff and black, the coxae and trochanters blue, the femora blue with broad dorsal black stripes which are frequently interrupted at the base by a pale spot; tibiae pale blue and buff with a short dorsal black stripe or none, the tarsi pale, black at the tips; claws deeply bifid and black at the tips; wings with ten postnodal cross-veins in the front wing and eight in the hind one; M_2 arising between the fourth and fifth postnodal cross-veins in the front wing and between three and four in the hind one; stigma small, subelliptical, and surmounting less than a single cell.

Abdomen blue and metallic black, the dorsum of the first tergum with a small black basal spot about half the length of the tergum; second tergum with a black, apical, shield-shaped spot, the spot extending to the cephalic margin and narrowed at this point to a line on the me-

son; terga 3–7, inclusive, with longitudinal black stripes widened subapically and narrowed basally, the lateral margins of the terga pale; terga eight and nine usually entirely blue, the eighth sometimes with a basal spot on the dorsum; tenth tergum black; anal appendages (Figs. 199, 206) short and black, the superiors slightly longer than the inferiors and appearing slightly knobbed at the apices when seen in lateral profile; viewed from above, the superior appendages are seen to have broad basal lobes which are often contiguous on the meson; inferior appendages short, subconical, and directed obliquely dorsad; first sternum pale, 3–8 black, the tenth pale.

Female.—Color similar to that of the male.

Head similar to that of the male except that the front is paler and the spots ventrad of the lateral ocelli are larger and connect with the pale color of the ventral portions of the front; the black borders of the postocular spots are narrower than those of the male.

Thorax: dorsal stripe divided by a line of brown on the carina; mesostigmal plates pale blue, the lateral angles elevated (Fig. 214), and a sinuate dark stripe on the supraepisterna just caudad of the plates; mesopleural suture with a distinct spot cephalad of the wing bases and the black of the infraepisterna reduced to narrow dorsal lines; postnodal cross-veins of the front wing ten to eleven, of the hind wing nine to ten.

Abdomen: dorsum of the first tergum with a black basal spot, 2–7, inclusive, with narrow dorsal longitudinal stripes, widened suddenly near the caudal margins and narrowed to the meson near the cephalic margins; tergum eight blue with a narrow dorsal stripe extending a little over half the length of the tergum from the base, (Fig. 94); ninth and tenth terga blue; anal appendages of the usual form; ovipositor with broad, blue, lateral valves; first and second sterna pale, with black mesal lines, 3–8, inclusive, black.

Measurements

Length, ♂	31 mm.
Length, ♀	31 mm.
Length of abdomen, ♂	25 mm.
Length of abdomen, ♀	25 mm.
Length of hind wings, ♂	17 mm.
Length of hind wings, ♀	18.5 mm.
Width of hind wings, ♂	3.25 mm.
Width of hind wings, ♀	3.5 mm.

This species was collected at Carbondale, Ill., June, 1915, and was reared at that time. It has not been reported elsewhere in the state but doubtless occurs about glacial lakes and ponds.

The nymph differs from that of *exsulans* chiefly in the darker color. In all the specimens studied the labium has only two mental setae as compared with three in *exsulans*. The gills show considerable difference in the shape and pigmentation, particularly of the apical portions.

The adult is most closely related to *exsulans*, but both sexes may be distinguished by the reduced amount of black on the mesopleural suture, the greater amount of blue on the front, and the exceedingly large postocular spots.

Genus Nehalennia Selys

The nymph of the only representative of this genus occurring in Illinois is characterized by its peculiar type of gills, in which the tracheae are much more numerous near the widest portion of the gill than elsewhere.

The dominant color of the adult is metallic green or bronze, the mesepisterna being entirely without pale stripes and the pronotum without pale spots. The female has the caudal lobe of the pronotum trilobed and the eighth sternum is without the ventral apical seta. The sternites at the base of the cephalic pair of gonapophyses are minute and scarcely visible.

Nehalennia irene Hagen

Nymph.—Color, brown or green.

Head oval in outline, the caudo-lateral angles with but few setae; antennae with the second segment longer than the first, the second segment and proximal third of three dark in color; labium, when folded, extending nearly to the mesocoxae, with a single large mental seta and a smaller one alongside; lateral setae five, and the lateral margins of the median lobe with about five small setae.

Thorax: femora and tibiae with rows of sparsely placed setae, the preapical rings of brown on the femora very indistinct; apical tibial scales present; wing-cases extending nearly to the apex of the fourth abdominal segment.

Abdomen slender, with feeble lateral keels, the cephalic two or three without setae, the caudal ones with not more than six or seven; cuticle of the abdomen with small whitish spots on a darker background; gills (Fig. 61) much broader beyond the middle, the lateral

gills with ten to twelve black cuticular spots on the margins and a distinct arcuate cross-band just beyond the middle; tracheal branches much more numerous beyond the middle of the gill; marginal setae large and widely separated, the ventral row of the lateral gills extending about half the length of the gill from the base and the distal setae much farther apart than the proximal; ovipositor usually extending beyond the apex of the tenth segment.

Measurements

Length	10–11 mm.
Length of abdomen	8 mm.
Length of gills	4–4.5 mm.
Width of gills	1 mm.
Length of median lobe	1.5–1.7 mm.
Width of median lobe	1.25 mm.

Described from three specimens obtained from Dr. E. M. Walker, and labeled Toronto, Ont., May 31, 1913.

Adult; Male.—Color, metallic green and pale blue.

Head metallic green above, buff below; median lobe buff, the cleft large and rounded at the base; distal segments of the labial palpi dark at the tips; antennae black, the second segment with a pale ring at the middle; postclypeus shining black, the anteclypeus buff; labrum pale yellow with a dorsal, transverse, shining black stripe about one-third the width of the piece; exposed portions of the mandibles, the trochantins, genae, and the front from the fronto-clypeal suture dorsad to the antennal fossae, shining yellow; remainder of the front, vertex, and a large portion of the occiput, metallic green; postgenae black, with a pale stripe beneath the compound eyes which is continuous with the yellow of the genae; compound eyes brown.

Thorax metallic green and pale blue; pronotum metallic green without paler spots, the margin of the caudal lobe entire; proepimera buff-colored; dorsal carina and the mesopleural suture lined with black; mesosupraepisterna and the mesepimera except the cephalo-ventral shoulders metallic green; dorsal margin and about the ventral half of the mesinfraepisterna pale, the remainder metallic green; remainder of the mesopleura and metapleura except a green triangle adjacent to the wing base on the metepimera, buff or pale blue; postcoxal areas buff or pale blue; legs pale, striped with black; coxae and trochanters pale, all the femora with dorsal stripes extending from the apices nearly to the bases, and the front femora with a short cephalo-

ventral stripe including the cephalo-ventral row of setae; tibiae with long dorsal stripes extending from a point slightly distad of the femora to near the apices of the segments; tarsi and claws pale except at the apices; wings short, the postnodal cross-veins ten in the front wing, nine in the hind wing; M_2 arising between the fourth and fifth postnodal cross-veins in the front wing and between three and four in the hind wing.

Abdomen metallic green and pale blue; terga 1–7, inclusive, metallic green above, with broad, lateral, pale stripes on one and two, and narrow lateral stripes and interrupted basal rings on 3–7; eighth tergum green on the dorsum except at the apex, where there is a triangle of blue, the lateral angles of which are continuous with the broad blue stripes on the lateral surfaces; ninth and tenth terga blue with green basal triangles on each side of the meson; anal appendages (Figs. 159,160) with the superiors small and tuberculate, the inferiors much larger than the superiors and toothed at the apices.

Female.—Color, metallic green or bronze, and yellow.

Head similar to that of the male except that within the dark area of the front there is a pale spot ventrad of each antennal fossa.

Thorax differing from that of the male in having the caudal lobe of the pronotum emarginate on each side of the meson, the piece being trilobed; the mesostigmal plates (Fig. 182) have the mesal margins strongly elevated and projecting dorsad; the front wings have nine to ten postnodal cross-veins, the hind wings usually nine.

Abdomen with terga 1–8, inclusive, greenish bronze, the lateral margins pale; ninth tergum green above, with an apical blue triangle and blue lateral stripes; tergum ten blue, with two small green triangles at the base; anal appendages of the usual type; ovipositor, including prostyles, extending beyond the apices of the anal appendages, the prostyles dark.

Measurements

Length, ♂	27 mm.
Length, ♀	26 mm.
Length of abdomen, ♂	21.5 mm.
Length of abdomen, ♀	21 mm.
Length of hind wings, ♂	15 mm.
Length of hind wings, ♀	15 mm.
Width of hind wings, ♂	4 mm.
Width of hind wings, ♀	4 mm.

The species is apparently limited to the northern third of the state. It was abundant at Lake Villa, July 13, 1915, and was also taken at Freeport July 8, 1915.

Genus Amphiagrion Selys

The nymph of the only species of the genus known to occur in Illinois is easily distinguished from other genera by means of the projecting caudo-lateral angles of the head. The gills are without cuticular pigment and are decidedly ovate in shape.

The adults are red or brown in color. The stigma of both front and hind wings is turned obliquely to the long axis of the wing and the width is much greater than its length. The eighth sternum of the female possesses a long seta, and the sternites at the base of the cephalic pair of gonapophyses are small but visible with moderate magnification. The superior anal appendages of the male are much shorter than the inferiors and the parameres of the ninth sternum do not reach the apex.

Amphiagrion saucium (Burmeister)

Nymph.—Color, dark brown.

Head pentagonal and characterized by having the caudo-lateral angles projecting strongly and forming a short blunt tubercle; antennae composed of seven segments, the distal segments being short and similar to those of the nymphs of the genus Argia; labium broad, when folded extending to the metacoxae, the median lobe with three or four mental setae and six lateral setae, and the margins of the median lobe with ten to twelve setae.

Thorax brown; legs without brown rings and uniform in color; femora indistinctly carinate; tibiae with rather closely set slender setae; wing-cases extending caudad to the fourth or fifth abdominal segment.

Abdomen thickset, the lateral keels absent or feebly developed and without setae; ovipositor of the female nearly reaching the apex of the tenth segment in full-grown nymphs; caudal gills (Fig. 59) transparent, ovate-lanceolate, the apices gradually narrowed to a sharp point; margins of the gills setose from the proximal to the distal end, the setae placed closely together and increasing in length towards the apices; tracheal trunks sometimes subdividing and forming a number of large branches near the proximal fourth of the gill.

Measurements

Length	11–14 mm.
Length of abdomen	7–10 mm.
Length of gills	4.5 mm.
Width of gills	1.5 mm.

Length of metathoracic wing-cases...3.5 mm.
Length of median lobe.....1.75–2.0 mm.
Width of median lobe .....1.25–1.5 mm.

Described from a single specimen taken at Muncie, Ill., April 25, 1914, and several specimens obtained from Dr. J. G. Needham, collected at Galesburg, Ill., June 3, 1897.

Adult; Male.—Color, very dark brown and deep orange-red.

Head black or dark above, pale below; labium pale, the median lobe subtriangular, the cleft shallow and broad at the base; antennae dark brown, the first two segments subequal in length, the first with a pale apical ring; postclypeus dark brown; anteclypeus, labrum, exposed portions of the mandibles, their trochantins, genae, and a transverse stripe on the front above the fronto-clypeal suture, pale buff, the pale area of the front extending dorsad along the margins of the compound eyes to the level of the antennal fossae; remainder of the front and vertex very dark brown, nearly black; occiput and postgenae pale.

Thorax dark brown to brick-red and yellowish buff; pronotum dark; proepimera also dark, nearly black; dorsum of the mesothorax, including the supraepisterna and the epimera and the caudo-dorsal angles of the metepisterna, black or dark brown; remainder of the meso- and metathorax yellowish red; intersternum projecting ventrad, conspicuous from the side, and provided with long black setae; legs yellowish buff, the coxae and trochanters yellowish, the femora slightly darker above but without distinct stripes; tibiae entirely pale and the tarsi pale except at the tips; femora with rounded dorsal carinae; wings with ten postnodal cross-veins in the front wing and about eight in the hind wing; M_2 arising between the fourth and fifth postnodal cross-veins in the front wing and between the third and fourth in the hind one; stigma reddish, small, surmounting a single cell.

Abdomen red and black; terga 1–6 dull red, with the exception of small caudo-lateral black spots on the dorsum of 1–6 inclusive, and subapical spots on five and six; terga 7–10 black on the dorsum, the lateral margins and a broad basal ring on seven reddish; anal appendages (Figs. 174,178) reddish, the superiors shorter than the inferiors, flat and the dorsal surface depressed; inferiors longer, acute, subconical, the tips directed dorso-mesad; apical margins of the tenth tergum emarginate on the dorso-meson and depressed at this point, forming a deep rounded pit.

Female.—Color in general similar to that of the male but usually considerably lighter.

Head similar to that of the male but lighter in color.

Thorax buff, and not blackish on the dorsum as in the male; mesostigmal plates as shown in Figure 181.

Abdomen: terga 1–4 red; terga 5–7 red with two black spots on each near the caudal fourth; terga eight and nine with two longitudinal black stripes extending from the cephalic margins to within a very short distance of the caudal margins; tergum ten pale buff; sterna 1–10 buff; eighth sternum with a long seta; ovipositor with broad, buff, lateral valves, the ventral margins serrate; prostyles short, brown.

Measurements

Length, ♂	26 mm.
Length, ♀	26 mm.
Length of abdomen, ♂	21 mm.
Length of abdomen, ♀	21 mm.
Length of hind wings, ♂	16 mm.
Length of hind wings, ♀	16 mm.
Width of hind wings, ♂	3.5 mm.
Width of hind wings, ♀	3.5 mm.

Adults have been collected at Urbana during the latter part of May and early part of June, but the species has at no time appeared in great abundance, and attempts to secure the nymphs from this locality have failed.

Genus Chromagrion Needham

The nymphs of this genus are characterized by the projecting caudo-lateral angles of the head and the extremely long and slender gills, which are without conspicuous marginal setae. The median lobe of the mentum is provided with mental setae and the proximal segments of the labial palpi have a single sharp fixed hook and a blunt process with teeth at the apex. The lateral keels are not well developed and are without heavy setae.

The adult is characterized by the absence of postocular spots, by the long, somewhat forcipate, anal appendages of the male, and by the peculiar formation of the pronotum of the female—as shown in Figure 170. The parameres of the male extend to the apex of the ninth sternum.

The genus is represented in North America by a single species.

Chromagrion conditum (Hagen)

Nymph.—Color, dark brown.

Head half as long as wide, the caudo-lateral angles projecting strongly; labium, when folded, extending caudad to the procoxae; mental setae three and sometimes a small fourth; lateral setae five; proximal segment of the palpus with a distinct hook at the apex of the mesal process and the median lobe with a slight notch at the apex.

Thorax: femora with two dark rings and a double row of setae on the ventral surfaces; tibiae with a single basal ring of brown; wing-cases reaching caudad to the fifth abdominal segment.

Abdomen slender; lateral keels feebly developed and without setae; gills long and slender, widening gradually to near the apices, then suddenly contracted, the margins setose, the setae far apart and increasing in size distad; color of gills uniform dark brown, except that the tips are light; indistinct blotches of darker pigment occur around the margins of the gills; smaller tracheae transparent and indistinct.

Measurements

Length	17 mm.
Length of abdomen	10 mm.
Length of gills	6 mm.
Width of gills	1 mm.
Length of median lobe	2 mm.
Width of median lobe	.6–1.6 mm.

Described from fragments of several exuvia obtained from Dr. J. G. Needham, and the description completed from data given by Needham in his description of the species ('03: 247).

Adult; Male.—Color, blue, black, and yellowish orange.

Head black and dark brown and buff; mouth-parts yellowish, the labium pale, the median lobe subtriangular in outline, the cleft broad and deep; labial palpi pale, the distal segment also pale; antennae nearly black, the first segment nearly as long as the second; postclypeus black, the anteclypeus, labrum, mandibles, their trochantins, genae, and the front above the clypeus to the level of the antennal fossae, greenish blue; remainder of the vertex, occiput, and postgenae black.

Thorax black and blue, the pronotum largely black, the cephalic lobe, a small spot on the lateral margins of the median lobes, and the lateral margins of the caudal lobe, pale; proepimera and proepisterna bluish green, the dorsal borders black; mesostigmal plates long and triangular, the lateral angles pale; mesepisterna with a

broad black stripe which, adjoining the wing bases, is exactly the width of the two mesepisterna together, but contracts suddenly shortly cephalad of this, and again about half-way to the cephalic margin of the mesothorax; mesinfraepisternum with an indefinite black spot on the cephalic border; caudal margins of the mesepimera and metepisterna black, shining, the sclerites themselves pale blue; metepimera lemon-yellow, the cephalic half of the ventral margins frequently dark; post-coxal areas yellowish buff, lateral margins of the intersternum darker; legs black and greenish buff, the coxae usually black on the cephalic surfaces; trochanters black on the dorsum, the femora with a broad, shining black, dorsal stripe, which encircles the segment at the apex and is narrowed basally on the front femora; femoral setae of the front femora, seven and four in the two rows respectively; tibiae pale buff, with a darker stripe on the ventral surfaces between the rows of setae, the tips dark; tarsi shining black; wings with eleven postnodal cross-veins in the front wing and ten to eleven in the hind one; stigma surmounting a single cell and much longer than broad.

Abdomen blue and black, the first tergum with a short basal black spot on the dorsum and latero-cephalic angles; terga 2–6, inclusive, blue with cephalo-lateral spots of black; second tergum with an apical shield-shaped spot and an apical ring; terga 3–6 with dorsal longitudinal stripes, narrowed to a line at the cephalic margins and widened to the lateral margins at the caudal end of the segment; terga eight and nine blue, with narrow lateral stripes on the lateral margins and mesal stripes from the base to the distal fourth and small spots on each side of the distal extremity of the lines; tenth segment entirely black except the small blue spots on the dorsum, one on each side of the meson; first sternum pale, with a black median spot, 2–9 black; anal appendages (Figs. 102,106) black, the superior appendages longer than the inferiors, slightly swollen at the apices, and the mesal surfaces densely hairy; inferiors short, pointed at the tip, the dorsal surface flat, the ventral surfaces convex.

Female.—Color: the blue of the male is replaced by yellowish buff; the yellow is the same as that of the male.

Head similar to that of the male.

Thorax: pronotum curiously modified, the caudal margins of the caudal lobe not continuous (Fig. 170) and the median lobe with a flat lateral projection on each side; proepimera entirely pale; meso-stigmal plates broad, the caudal margins convex, the lateral angles more or less acute, and the latero-caudal margins slightly elevated.

Abdomen buff and black, the first tergum with a black basal spot and a cephalo-lateral spot on each side; dorsum of the second tergum

with a broad black band from the base to the apex which is widened subapically, and a narrow apical ring; terga 3–7 with small dark spots near the cephalo-lateral angles, broad dorsal longitudinal stripes, narrowed at the base but not to a line, and widened at the apex but not reaching the lateral margins of the sclerites except on terga five, six, and seven; terga 7–10 with pale lateral margins and black dorsal stripes, the stripes narrowed at the caudal end; anal appendages of the usual type; ovipositor short, brown, the prostyles short and blunt, the eighth sternites at the base of cephalic pair of gonapophyses large and subtriangular; sterna 2–7 black, the eighth with a black median line but without an apical spine.

Measurements

Length, ♂	35 mm.
Length, ♀	36 mm.
Length of abdomen, ♂	29 mm.
Length of abdomen, ♀	30 mm.
Length of hind wings, ♂	21 mm.
Length of hind wings, ♀	22 mm.
Width of hind wings, ♂	4 mm.
Width of hind wings, ♀	4 mm.

Described from a number of specimens in the collection of Mr. E. B. Williamson. Reported from northern Illinois by Needham ('03: 247).

Genus Ischnura Charpentier

The nymphs of this genus have gills with long tapering points and one or more arcuate cross-bands. The labium is moderately broad and the median lobe possesses four or five setae and five or six, usually six, lateral setae.

The adults may be distinguished from other genera by the presence of postocular spots, by the origin of vein M_2, which is between the third and fourth postnodal cross-veins in the front wing and between the second and third in the hind wing, and by the presence in the males of a short apical projection of the dorsum of the tenth tergum, which is, however, not as long as the segment. The sternites at the base of the cephalic pair of gonapophyses of the female are very small and do not project beyond the caudal margin of the large basal sternite of the eighth segment. The parameres of the male do not extend caudad to the margin of the ninth segment and the anal appendages are short, the superiors being about as long as, or shorter than, the inferior appendages.

Key to Species

NYMPHS

a. Gills with four distinct arcuate cross-bands and a blotch on the tip of the gill; dorsal marginal setae of the median gill extending one-third the length of the gill from the base; lateral setae of the labium, five . . . . . *posita.*

aa. Gills with one or two cross-bands or none, never with four; dorsal marginal setae of the median gill extending one-half the length of the gill from the base; lateral setae of the labium usually six. . *verticalis.*

ADULTS

a. Mesopleural pale stripe of the supraepisterna interrupted at the caudal third and forming a distinct exclamation point; eighth sternum of the female with a long spine. . . . . *posita.*

aa. Mesopleural pale stripe of the supraepisterna not interrupted at the caudal third and not forming a distinct exclamation point; eighth sternum of the female without a long spine.

b. Seventh tergum with more or less blue on the dorsum. . . . *kellicotti.*

bb. Seventh tergum black on the dorsum. . . . . *verticalis.*

Ischnura kellicotti Williamson

Nymph.—Unknown.

Adult; Male.—Color, blue and black.

Head blue and black; labium pale buff, the median lobe subtriangular; labial palpi broad, the second segment pale; antennae dark brown, with a small pale blue spot on the condyle of the scape; postclypeus black, anteclypeus blue; labrum blue except a black dorsal marginal line; exposed portions of the mandibles, their trochantins, genae, and the front above the fronto-clypeal suture to the antennal fossae, blue; the blue area of the front is divided by a short black line on the meson and the blue color extends dorsad above the genae to the antennal fossae; remainder of the front and the vertex black; postocular spots large and blue and connected with the blue of the occiput; occiput and postgenae except medium-sized black spots on each side of the occipital foramen, pale blue.

Thorax blue and black; pronotum largely black, the cephalic lobe, caudal margin of the caudal lobe, and four small spots on the median lobe, near the meson, blue; procpimera blue and black, the caudal half being largely blue; mesostigmal plates with blue lateral angles; mesothorax with black supraepisterna which possess narrow longitudinal blue stripes, the stripes narrowed conspicuously at the middle

and widened at both ends but not extending caudad to the paraptera; dorsal half of the mesepimera black, the black stripe covering that portion suddenly widened by a ventral projection just caudad of the mesinfraepisternum; mesinfraepisterna black except the caudo-ventral angles; remainder of the pleura blue, the interpleural fold and the metapleural suture, however, lined with black; postcoxal areas mostly pale; legs blue and black; coxae largely blue, the cephalic surfaces sometimes spotted with black; trochanters blue, black above; femora with broad dorsal stripes, blue beneath; tibiae, tarsi, and claws brown and without stripes; wings with eight or nine postnodal cross-veins in the front wing and seven in the hind wing; stigma subelliptical, black or blue in the front wing, pale in the hind wing; M_2 arising between the third and fourth postnodal cross-veins in both wings.

Abdomen black, blue, and buff; first tergum blue with the cephalic half black; second, blue with a broad black lateral stripe on each side and a narrow apical ring, the stripes extending from the base of the segment to the caudal third and the two uniting on the meson at the caudal ends; terga 3–6 black, with narrow, blue, interrupted basal ring and lateral marginal stripes; seventh tergum black with pale lateral stripes and a blue apical spot on the dorsum; eighth and ninth terga blue with broad, black, lateral stripes; tenth tergum black, occasionally with indefinite blue dorsal spots; anal appendages dark, the superiors broad, laterally compressed and the ventro-mesal angles hook-like; inferiors slightly longer than the superiors, subconical, the tips black; sterna 1–10 black.

Female.—Color similar to that of the male.

Head similar to that of the male except that the pale area of the front is not divided by the mesal black line.

Thorax: the blue of the male is replaced by buff; pale spots of the pronotum large and occupying nearly the whole of it; pale stripe of the mesosupraepisterna extending caudad to the paraptera; legs similar to those of the male, but usually paler in color; stigma of both wings brown.

Abdomen: first tergum similar to that of the male; second, blue, with a dorsal black spot near the caudal margin and the lateral margins pale; terga 3–6 black with pale lateral margins; terga 7–10 pale blue with black lateral margins; anal appendages of the usual type; ovipositor with broad lateral styles.

Measurements

Length, ♂ .....32 mm.
Length, ♀ .....31 mm.

Length of abdomen, ♂	25 mm.
Length of abdomen, ♀	25 mm.
Length of hind wings, ♂	27 mm.
Length of hind wings, ♀	28 mm.
Width of hind wings, ♂	3.5 mm.
Width of hind wings, ♀	3.5 mm.

This species has not been taken in Illinois, but has been collected in Indiana by Mr. Williamson, and the above description has been made from specimens in his collection.

Ischnura posita (Hagen)

Nymph.—Color, usually dark brown.

Head oval or elliptical in outline, the caudo-lateral angles not projecting and with only a few setae; antennae of the usual form, the first two segments dark in color, the second light at the tip; labium extending between or slightly caudad of the procoxae; mental setae four and sometimes a small fifth on each side; lateral setae five; lateral marginal setae of the median lobe four.

Thorax about equal in diameter throughout; femora with rows of setae which become heavier towards the apices; tarsi pale, the apices of the third segments brown; metathoracic wing-cases extending caudad to the fourth abdominal segment.

Abdomen: cuticle provided with numerous black spots usually bearing a single minute seta; lateral keels without setae except those of the caudal segments; gills lanceolate (Figs. 64, 66), broadest beyond the middle, usually with four crescentic brownish bands of which the apical ones are somewhat paler than the proximal, the median gill with a dorsal row of about fourteen setae extending one-third the length of the gill from the base; ovipositor extending to the apex of the tenth abdominal segment.

Measurements

Length	11.5 mm.
Length of abdomen	7.5 mm.
Length of gills	5–5.5 mm.
Width of gills	1.6 mm.
Length of metathoracic wing-cases	3.0 mm.
Length of median lobe	2.0 mm.
Width of median lobe	.5–1.6 mm.

The nymph is very closely related to *verticalis* but may be separated from the latter by means of the shape and figuration of the

gills. The lateral setae of the labium do not often exceed five, whereas there are usually six in *verticalis*.

Adult; Male.—Color, black and sulphur-yellow.

Head black and yellow; mouth-parts buff, the median lobe subtriangular; palpi narrow, the distal segment pale; antennae uniform dark brown, the second segment considerably longer than the first; postclypeus shining black; anteclypeus pale, labrum pale, with a transverse dorsal black stripe which has a slight ventral projection on the meson; remainder of the labrum, exposed portions of the mandibles and their trochantins, genae, and the front dorsad of the fronto-clypeal suture to the level of the antennal fossae, shining yellow; remainder of the front and vertex black, the postocular spots yellow and circular; a short yellow line caudad of the ocelli; postgenae and occiput yellow.

Thorax black and yellow; pronotum black except the cephalic lobe, which is yellow; caudal lobe with yellow spots on the lateral angles; mesostigmal plates with large oval yellow spots; mesosupraepisterna with short yellow stripes and spots adjacent to the paraptera, the two together forming an exclamation point on each side of the dorsal carina; black stripe covering the mesopleural suture on each pleuron contracted near the wing bases; dorsal half of the mesinfraepisterna and a stripe on the metapleural sutures black, the remainder of the metathorax and the postcoxal areas yellow; legs black and yellow, the coxae, trochanters, and femora pale, the femora with a dorsal stripe on each from base to apex, the stripe widened subapically; tibiae with a dorsal black stripe from base to apex which fades into brown towards the apex; tarsi and claws pale, darker at the tips; wings short, the postnodal cross-veins six to eight and M_2 arising between the third and fourth postnodal cross-veins in the front wing and between the second and third in the hind wing.

Abdomen black and yellow; terga 1–10 dull black with the exception of a narrow basal ring on segments 3–7, the stripes narrowed conspicuously on two and widened on the apices of segments 3–6 inclusive; lateral margins of all terga pale yellow; sterna 3–8 lined with black on the meson; apex of the tenth tergum with a mesal elevation at the apex, the elevated portion forming two small tubercles; anal appendages (Figs. 173,177) small, orange, the superiors large and blunt and bent ventrad, the inferiors also large, blunt, and bifurcate, the arms feebly divaricate and the dorsal arm with a number of heavily chitinized teeth.

Female.—Color, pale blue and black.

Head similar to that of the male except that the postocular spots are blue.

Thorax pale blue and black, lacking the black stripes on the metapleural sutures, and the femoral black stripes almost wanting or reduced to short subapical lines.

Abdomen with the pale and black markings similar to those of the male; anal appendages of the usual type, the ovipositor with prostyles extending caudad to the apex of the anal appendages.

Measurements

Length, ♂	24 mm.
Length, ♀	29 mm.
Length of abdomen, ♂	19 mm.
Length of abdomen, ♀	18–22 mm.
Length of hind wings, ♂	12 mm.
Length of hind wings, ♀	13–16 mm.
Width of hind wings, ♂	2.5 mm.
Width of hind wings, ♀	2.5–3.5 mm.

A common species in southern and central Illinois, occurring in the same localities where *verticalis* is abundant. The adults appear usually somewhat later than *verticalis*, and the earliest reared specimens in my collection bear the date June 12, 1915.

Specimens have been seen from Havana, Peoria, and Urbana.

Ischnura verticalis (Say)

Nymph.—Color, pale green, buff, or dark brown.

Head broader than long, subelliptical, the caudo-lateral angles with strong setae; antennae with the first two segments and the proximal third of three dark, the remainder pale; first two segments subequal, the third as long as the first two together; labium, when folded, extending slightly caudad of the procoxae, with four or five mental setae and six lateral setae, the lateral marginal setae of the median lobe six or seven in number.

Thorax nearly equal in diameter throughout; front femora with a strong row of setae on the cephalic surface and all the femora with preapical rings of brown; tibiae with several rows of apical setae, two of which extend far proximad; wing-cases extending caudad to the fourth abdominal segment.

Abdomen cylindrical and with feeble lateral keels on segments 1–8, the margins and ventral surfaces being thickly studded with short setae; cuticle of the abdomen with small dark spots from which minute setae usually arise, one to each spot; gills (Figs. 62, 65) with long

tapering points, the dorsal marginal setae of the median gill usually extending nearly half the length of the gill from the base, the ventral row of the same gill consisting of about seven strong setae, considerably farther apart than those of the dorsal row; ventral marginal setae of the lateral gills extending slightly farther from the base of the gills than the dorsal row of the median gill; pigment of the gills in the form of one or two arcuate cross-bands near the middle of the gill; these, however, may be wanting; ovipositor extending to the middle of the tenth abdominal sternum.

Measurements

Length	13–14 mm.
Length of abdomen	9–10 mm.
Length of gills	6–7 mm.
Width of gills	1–1.3 mm.
Length of median lobe	1.8 mm.
Width of median lobe	.6–1.6 mm.

Adult; Male.—Color, black or dark metallic green and pale green.

Head black and yellowish green; mouth-parts buff, the median lobe of the labium subtriangular, the cleft short and acute at the proximal end; antennae black or very dark brown; postclypeus black, shining; anteclypeus, labrum, exposed portion of the mandibles and their trochantins, genae, and the front above the clypeus, yellow; postocular spots large and subcircular; vertex, and front except the stripe above the clypeus, dull black; occiput black and greenish yellow.

Thorax greenish black and greenish yellow; pronotum shining black with a transverse yellow stripe on the cephalic lobe; caudal lobe of the pronotum with a distinct transverse carina; noto-epimeral suture indistinct, the proepimera and episterna largely yellow; mesothorax shining black with a yellow stripe just above the mesopleural suture; ventral half and cephalic shoulder of the mesepimera yellow; paraptera trapezoidal, with a yellow spot just ventrad of the lateral angles, the remainder black; mesostigmal plates black, the caudal margins elevated and lined with yellow; metathorax including the postcoxal areas, pale green or yellowish; legs black and yellow, the coxae and trochanters pale with some darker marks on the sutures; femora all with a broad dorsal stripe, the tibiae with narrower dorsal stripes extending from near the bases to near the apices; tarsi and claws pale, dark at the tips; wings short, the postnodal cross-veins seven to nine, and M_2 arising between the third and fourth postnodal cross-veins in the front wing and between the second and third in the hind wing.

Abdomen shining black or green, and yellowish green; dorsum of terga 1–7, inclusive, shining black or green with narrow apical ring on the first, interrupted basal rings on 3–6, and the lateral margins of 1–6 yellow; dorsum of terga eight and nine blue, with short lateral black stripes on each side about half the length of the segment; tergum ten black, the lateral margins pale, the caudal margin with a short forked process on the meson; sterna 3–9 with a mesal line of black; anal appendages (Fig. 168) short, the superiors flat and placed nearly vertically; inferiors longer, and with a dorsal, basal knob and a larger, subconical ventral lobe.

Female.—Color, orange and black or entirely black.

Head similar to that of the male except that the yellowish green markings are replaced with orange.

Thorax orange and black; pronotum with an orange spot on each median lobe; margin of the caudal lobe with orange spots; mesostigmal plates (Fig. 180) with caudal elevated margins orange in color; mesopleural pale stripe of the supraepisterna orange and much broader than the pale stripe of the male; dorsal third and caudal margin of the mesinfraepisterna black, the remainder pale orange; metathorax orange; legs orange and black, the femora entirely pale except at the tips, the tibiae with the usual dorsal stripes.

Abdomen orange and black, the first two segments entirely pale except a narrow ring on the caudal margin of the second; terga three orange with an apical spot and ring; dorsum of terga 4–8 black, with pale basal rings on 4–6 and the apical third of eight also pale; terga nine and ten indefinitely marked with black, there being an orange spot and apical ring of orange on nine and a dorso-mesal line on the same; lateral margins of all the terga orange; sterna 1–8, inclusive, with a mesal black line, the eighth sternum with a heavy spine; anal appendages of the usual type; the ovipositor with dark brown prostyles and pale lateral valves.

In older specimens the orange color becomes black and pollinose so that it is difficult to distinguish the species on the wing from some of the Enallagmas which also have a tendency to become dark.

Measurements

Length, ♂	20 mm.
Length, ♀	30 mm.
Length of abdomen, ♂	22 mm.
Length of abdomen, ♀	23–24 mm.
Length of hind wings, ♂	14 mm.
Length of hind wings, ♀	17 mm.
Width of hind wings, ♂	3.5 mm.
Width of hind wings, ♀	3.5 mm.

The commonest species in Illinois, occurring practically wherever there is enough permanent water for the nymphs to live. The adults appear early in May and continue to emerge until September and possibly later.

Specimens have been seen from Dubois, Carbondale, Golconda, Havana, Lake Villa, Mahomet, Muncie, Peoria, Urbana, and Vienna.

Genus Anomalagrion Selys

The nymphs of this genus are characterized by their unusually small size, by the presence of a very slender tip to the gills, and by the absence of setae on the lateral keels.

The male adults are unique in having the stigma of the front wing removed from the margin and in the possession of a long process on the dorsum of segment ten. The sternites at the base of the cephalic pair of gonapophyses of the female are wanting, and the parameres of the ninth sternum of the male do not reach the apex of the segment.

Anomalagrion hastatum (Say)

Nymph.—Color, green or buff.

Head with the caudo-lateral angles rounded and without setae; antennae with the first two segments dark brown, the remaining ones light in color; second segment about as long as the first or slightly longer; labium not extending caudad of the procoxae and about as broad as long; mental setae four, lateral setae five.

Thorax narrower than the head; legs without dark rings and with few setae, the tibiae with the usual apical scales; wing-cases extending nearly to the fourth abdominal segment.

Abdomen uniform in color; lateral keels feebly developed and without setae; gills (Fig. 60) lanceolate, with a long point; marginal setae of the median gill consisting of a thick dorsal row, extending about one-third the length of the gill from the base, and a scattered ventral row at the base; ventral marginal row of setae of the lateral gills slightly longer than the dorsal row of the median gill; ovipositor extending to the caudal margin of the tenth abdominal sternum.

Measurements

Length	9.5 mm.
Length of abdomen	5.5 mm.
Length of gills	4.5 mm.
Width of gills	1.0 mm.
Length of median lobe	1.6 mm.
Width of median lobe	0.5–2.0 mm.

Adult; Male.—Color, pale lemon-yellow and black.

Head lemon-yellow and metallic black; mouth-parts buff, the median lobe with a wide cleft which is obtuse at the proximal end; antennae dark brown except the proximal segment, which has a pale stripe from the base to the apex; postclypeus shining black; anteclypeus pale; labrum with a transverse black stripe on the dorsal margin, the remainder yellow; exposed portions of the mandibles, their trochantins, the genae, and the front above the fronto-clypeal suture to the antennal fossae, yellow; remainder of the front and the vertex metallic bronze with the exception of very small postocular spots, a small yellow spot ventrad of the median ocellus, and a narrow yellow stripe caudad of the ocellar area.

Thorax greenish yellow and metallic black; cephalic lobe of the pronotum with a yellow transverse stripe; median lobes metallic black; caudal lobe black with three short marginal dashes; noto-epimeral suture indistinct; dorsal carina of the mesothorax feebly developed, the mesothorax largely black with a narrow yellow line just dorsad of the mesopleural suture; dorsal half of the mesosupraepisterna black; metepisterna and epimera yellow or buff; paraptera trapezoidal, the cephalic margins with a pale line; coxae pale yellow, the femora pale, with dorsal black stripes widened distad; tibiae pale, with short, proximal, dorsal and ventral dark stripes, the tarsi and claws pale except at the tips; setae of the front femora few, about three in each row, the distance between them much greater than their length; wings (Figs. 82, 83) very short; postnodal cross-veins six in the front wing and five in the hind; M_2 arising near the third postnodal vein in the front wing and between the second and third in the hind wing; stigma of the front wing ovoid, remote from the margin, the stigma of the hind wing rhomboidal and in contact with the margin of the wing.

Abdomen yellow and orange, the black confined to longitudinal dorsal bands on terga 1–3 and six, the stripe on three and the one on six being conspicuously widened subapically; basal and apical black spots present on the fourth and fifth terga, and a dorsal stripe on seven which is about three-fourths the length of the segment; the narrow basal ring on segments 1–7 is interrupted on the meson in all except the first; tenth tergum with a dorsal process about as long as the segment and bifurcate at the apex; anal appendages (Figs. 166, 167) small, the superiors bifurcate, and with a broad mesal lobe extending caudo-ventrad and a conical lateral one projecting caudad; inferiors conical, slightly longer than the superiors.

Female.—Color, orange and black or dark brown.

Head orange and black, differing from that of the male in having the black of the postclypeus reduced to a dorsal line and that of the labrum to lateral spots; postocular spots wanting, the caudal margins of the head with a broad orange stripe; occiput and postgenae pale.

Thorax: prothorax as in the male except that the black of the pronotum does not extend as far onto the lateral aspect; dorsal black stripe of the mesothorax extending on each side of the dorsal carina one-half the width of the supraepisterna; mesopleural suture with a black line, the remainder of the thorax orange and buff; mesostigmal plates as shown in Figure 164.

Abdomen orange, with narrow basal black rings on terga 2–4 inclusive, a longitudinal dark stripe on the caudal three-fourths of five, similar stripes extending the full length of six, seven, and eight, and two triangular spots at the base of the ninth; dorsum of the tenth tergum with a short blunt projection; anal appendages short; ovipositor long and extending caudad of the anal appendages; prostyles short and blunt.

Measurements

Length, ♂	23 mm.
Length, ♀	24.5 mm.
Length of abdomen, ♂	17 mm.
Length of abdomen, ♀	19 mm.
Length of hind wings, ♂	10.5 mm.
Length of hind wings, ♀	14 mm.
Width of hind wings, ♂	1 mm.
Width of hind wings, ♀	2–2.5 mm.

This species is rather more common in the southern half of the state than in the northern. It appears on the wing as early as June 20 at Urbana, but has been taken at Carmi, June 14, 1915.

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articles have appeared since that date, and an attempt has also been made to include these in this bibliography.

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ABBREVIATIONS USED IN LETTERING PLATES

A, anal vein
A_1–A_{11}, abdominal segments 1–11
aai, anal appendages of adult–inferior
aas, anal appendages of adult–superior
ag, accessory genitalia of male
anc, antenodal cross-veins
ant, antennae
arc, arculus
awp, anterior wing-process
br, bridge
bsp, basilar space
C, costa
cd, cardo
ce, compound eyes
ci, cerci
cl, cardella
cly, clypeus
cr, chitinous rod of the submentum
Cu_1, Cu_2, cubitus–branches of
cw, claws
cx, coxa
cxp, coxal process
dc, dorsal carina
epcs, epicranial furrow
epm, epimeron
f, front
fe, femur
fi, furcal invaginations
fl, furcella
fs, femoral setae
g, gills–caudal
ga, galea
gb, genital lobe
gd, gills–dorsal
glc, galea-lacinia
gn, genae
hm, hamules
hp, hypopharynx
ieps, infraepisternum
insu, interpleural suture
ints, intersternum
lb, labium
lbr, labrum
lc, lacinia
lk, lateral keel
lp, labial palpus
lp_1, lp_2, labial palpus–first and second segments
ls, lateral setae of labial palpus
M, media
M_1–M_4, media, branches of the
mapl, metapostscutellum
masl, metascutellum
mc, median cleft of the labium
mcp, mesocoxal process
md, mandible
me, mentum
mfi, mesofurcal invaginations
min, microthorax, epimeron of the
ml, median lobe of the labium
mopl, mesopostscutellum
mosl, mesoscutellum
mp, metaphragma
mpf, mesoprefurcal invaginations
mph, mesophragma
mpp, mesophragmal invaginations
ms, mental setae
msce, mesoscutum–caudal portion
mscl, mesoprescutum–cephalic portion of mesoscutum
msc, marginal setae of the median lobe
msp, mesothoracic spiracle
mssu, mesopleural suture
mst, mesosternum
mstg, mesostigmal plates (caudal)
mstm, mesosternellum
mstv, mesostigmal plates (ventral)
mtcp, metacoxal process
mtfi, metafurcal invaginations
mtn, metanotum
mtpf, metaprefurca
mtsc, metascutum
mtsl, metathoracic spiracle
mtsm, metasternellum
mtst, metasternum
mtsu, metapleural suture
mx, maxilla
mxp, maxillary palpus
nd, nodus
o, ocelli
oca, caudal valves or gonapophyses
occ, cephalic valves or gonapophyses
ocr, occipital ridge
oct, occiput
p, paraptera
pa, parameres
pcl, pronotum–caudal lobe
pcp, pronotum–cephalic lobe
pcxp, procoxal process
pepm, proepimeron
peps, proepisternum
pg, postgena
pl, palpiger
pme, pronotum–median lobe

pn, pronotum
pnc, postnodal cross-veins
pps, propleural suture
prs, prostyles
prst, presternum
ps, penis
pset, metapresentum
psl, prosternellum
pst, mesopresternum
pta, pretarsus
pwp, posterior wing-process
qd, quadrangle
R_1, radius–first branch
R_s, radial sector
Sc, subcosta
Sc_1, Sc_2, subcosta, branches of
seps, supraepisternum
sm, submentum
spn, spring-vein
st, stigma
sti_8, sternites (caudal) of the eighth abdominal segment
stp, stipes
sv, seminal vesicle
t, tentorium
ta, tarsus
ti, tibia
tic, tibial comb
tm, trochantin of mandible
tr, trochanter
ts, tibial setae
vx, vertex
we, wing-case
wp, wing process

Plate LVIII

Nymphal Structures

Fig. 1. *Enallagma* sp., cross-section of the head through the hypopharynx and maxillae.
Fig. 2. *Enallagma* sp., cross-section of the head caudad of the section shown in Figure 1.
Fig. 3. *Enallagma* sp., cross-section through the labium.
Fig. 4. *Enallagma* sp., longitudinal section of the head.
Fig. 5. *Lestes forcipatus*, anal segments and bases of gills.
Fig. 6. *Enallagma* sp., cross-section of labium near hinge.
Fig. 7. *Enallagma exsulans*, ventral aspect of the head with the labium folded back and the remaining mouthparts in position.
Fig. 8. *Agrion maculatum*, labium.
Fig. 9. *Hetaerina americana*, labium.
Fig. 10. *Lestes forcipatus*, labium.
Fig. 11. *Argia violacea*, labium.
Fig. 12. *Ischnura verticalis*, labium.
Fig. 13. *Enallagma carunculatum*, labium.

PLATE LVIII

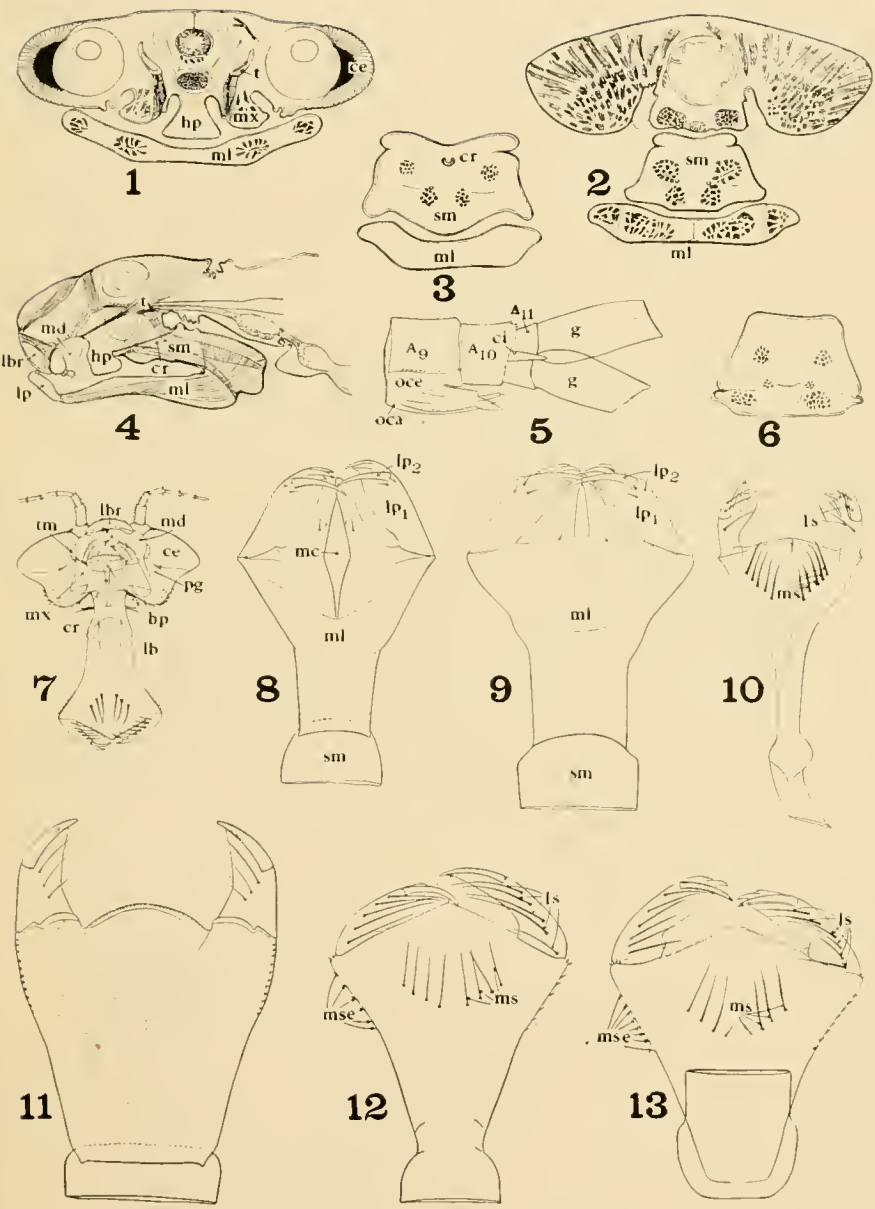
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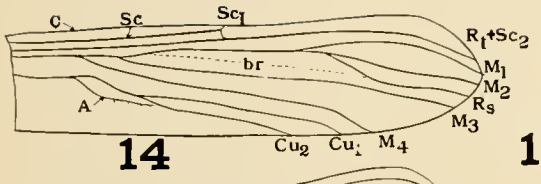
Plate LIX

Nymphal Structures

Fig. 14. *Lestes rectangularis*, wing-case.
Fig. 15. *Hetaerina americana*, wing-case.
Fig. 16. *Enallagma signatum*, wing-case.
Fig. 17. The same, young nymph, wing-case.
Fig. 18. *Ischnura verticalis*, caudal end of the abdomen with the two lateral gills removed.
Fig. 19. *Enallagma exsulans*, tarsus.
Fig. 20. The same, leg.
Fig. 21. *Ischnura verticalis*, dorsum of meso- and metathorax.
Fig. 22. *Agrion maculatum*, maxilla.
Fig. 23. *Hetaerina americana*, dorsum of the prothorax.
Fig. 24. *Ischnura verticalis*, ventral aspect of thorax and cephalic segments of abdomen.
Fig. 25. The same, lateral aspect of thorax and abdomen.
Fig. 26. *Enallagma* sp., cross-section of gills.



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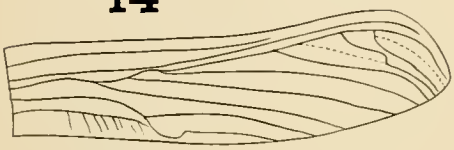

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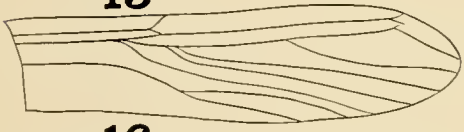

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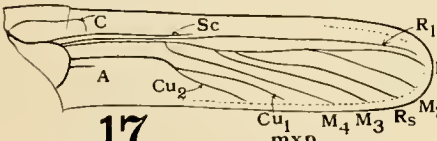

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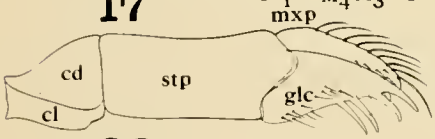

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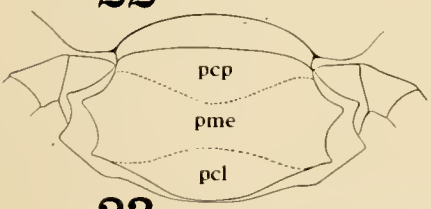

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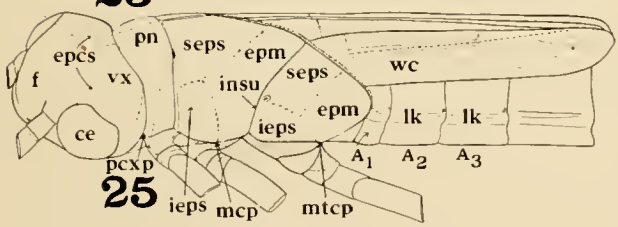

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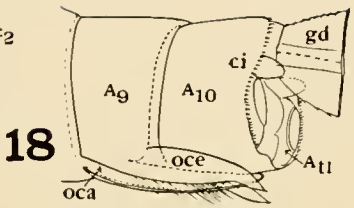

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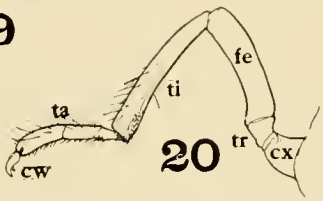

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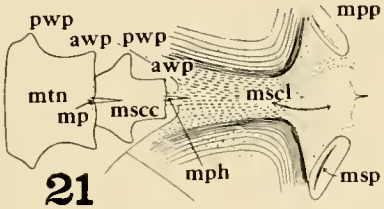

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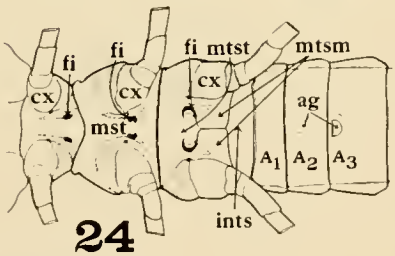

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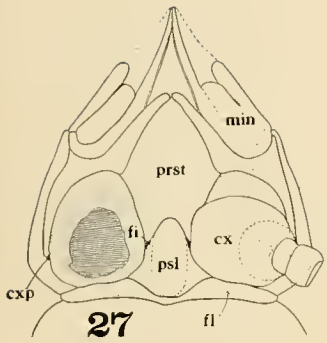
Plate LX

Nymphal and Adult Structures

Fig. 27. *Ischnura verticalis*, adult, ventral aspect of prothorax.
Fig. 28. The same, adult, maxilla.
Fig. 29. *Hetaerina americana*, adult, ventral aspect of prothorax.
Fig. 30. *Ischnura verticalis*, adult, caudal aspect of head.
Fig. 31. Plecoptera nymph, maxilla.
Fig. 32. *Ischnura verticalis*, adult, cephalic aspect of head.
Fig. 33. *Hetaerina americana*, adult, ventral view of the second abdominal segment of the male.
Fig. 34. The same, adult, anal appendages, dorsal view.
Fig. 35. *Ischnura verticalis*, adult, leg.
Fig. 36. The same, adult, lateral view of prothorax.
Fig. 37. The same, adult, labium.
Fig. 38. *Hetaerina americana*, adult, lateral view of anal appendages.
Fig. 39. The same, adult, lateral view of prothorax.

Plate LX



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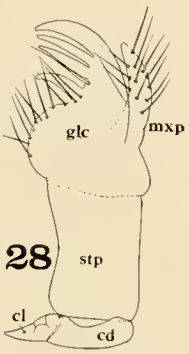

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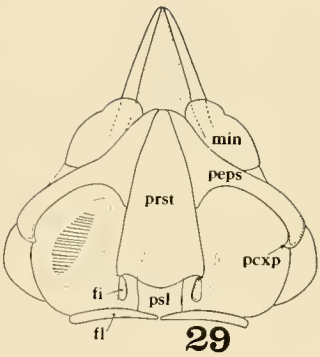

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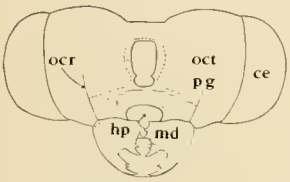

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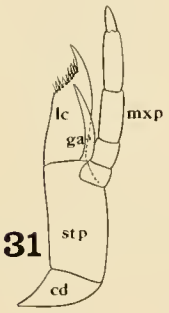

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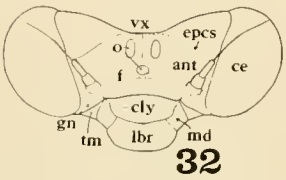

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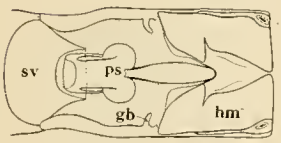

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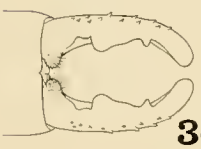
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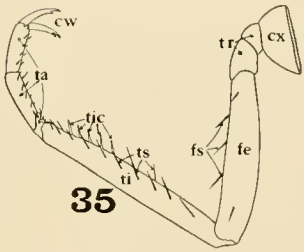

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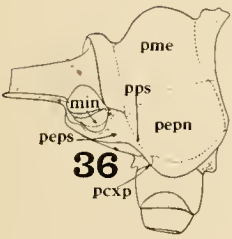

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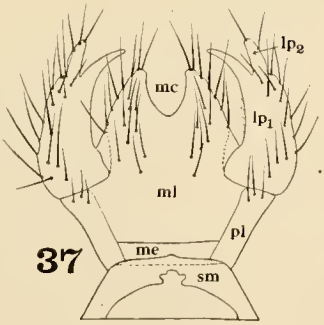

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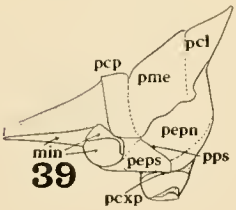

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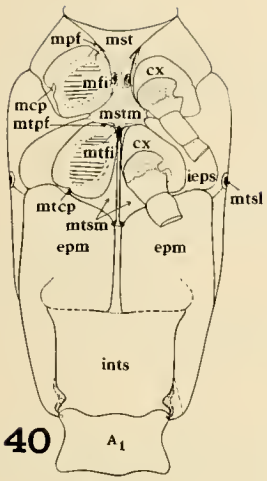
Plate LXI

Thoracic Structures of Adults

Fig. 40. *Hetaerina americana*, ventral aspect of the meso- and metathorax.
Fig. 41. *Hetaerina titia*, dorsal aspect of meso- and metathorax.
Fig. 42. *Ischnura verticalis*, ventral aspect of meso- and metathorax.
Fig. 43. The same, lateral aspect of meso- and metathorax.
Fig. 44. The same, dorsal aspect of meso- and metathorax.
Fig. 45. *Hetaerina americana*, lateral aspect of meso- and metathorax.
Fig. 46. The same, dorsal view of meso- and metaterga.
Fig. 47. *Ischnura verticalis*, dorsal view of meso- and metaterga.

Plate LXI



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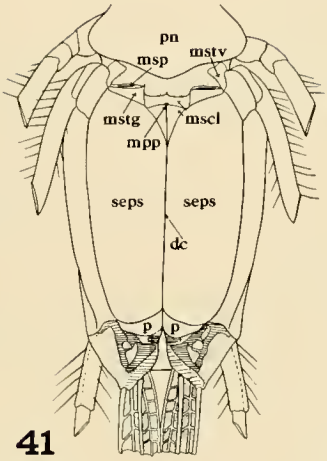

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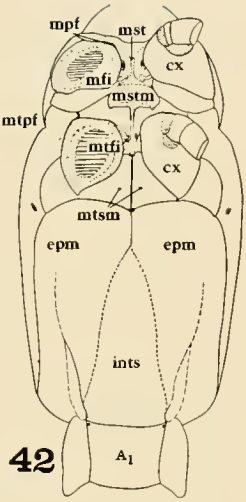

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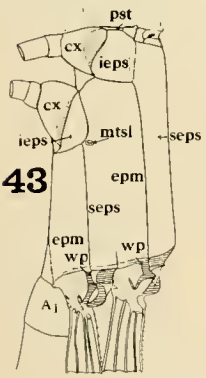

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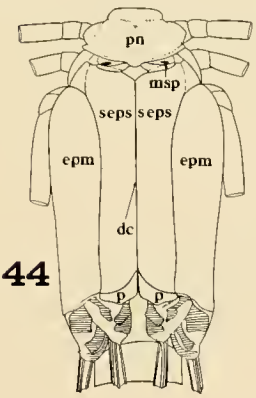

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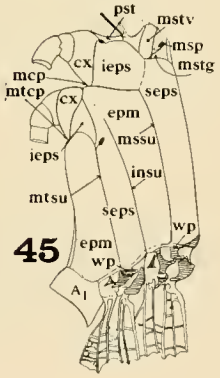

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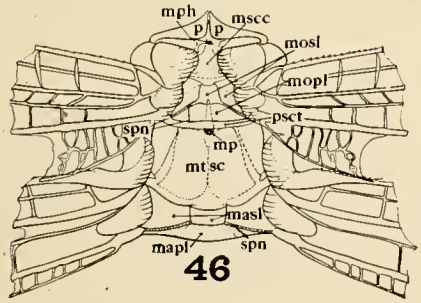

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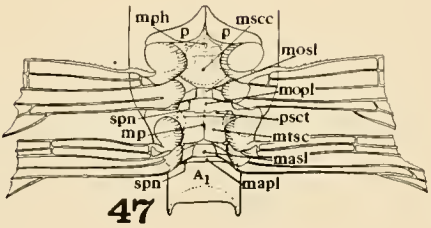

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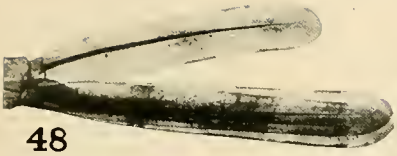
Plate LXII

*Caudal Gills of Nymphs**

Fig. 48. *Lestes vigilax.*
Fig. 49. *Lestes forcipatus.*
Fig. 50. *Lestes congener.*
Fig. 51. *Lestes unguiculatus*, normal gills.
Fig. 52. The same, dark gills.
Fig. 53. *Enallagma exsulans.*
Fig. 54. *Enallagma antennatum.*
Fig. 55. *Enallagma traviatum.*
Fig. 56. *Enallagma signatum.*
Fig. 57. *Enallagma pollutum.*

*One of the lateral gills removed in most cases.

PLATE LXII



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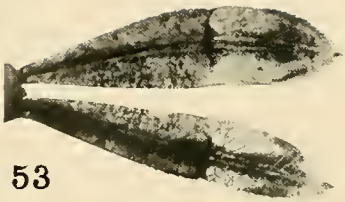

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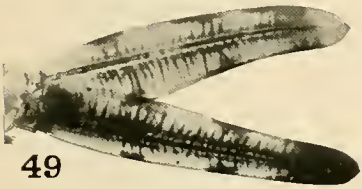

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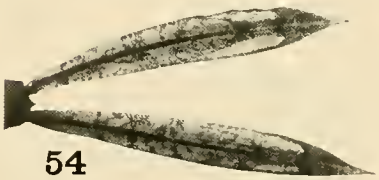

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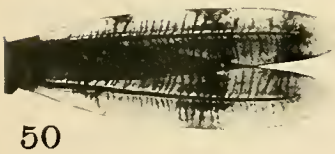

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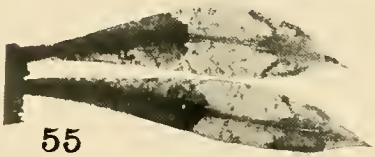

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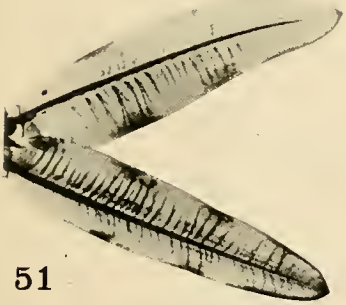

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Plate LXIII

*Caudal Gills of Nymphs**

Fig. 58. *Argia moesta putrida.*
Fig. 59. *Amphiagrion saucium.*
Fig. 60. *Anomalagrion hastatum.*
Fig. 61. *Nehalennia irene.*
Fig. 62. *Ischnura verticalis.*
Fig. 63. *Argia violacea.*
Fig. 64. *Ischnura posita.*
Fig. 65. *Ischnura verticalis*, young nymph.
Fig. 66. *Ischnura posita.*
Fig. 67. *Argia apicalis.*
Fig. 68. *Argia tibialis.*
Fig. 69. *Enallagma signatum*, variations in pigmentation.

*One of the lateral gills removed in cases where the gills are attached to the abdomen.

PLATE LXIII

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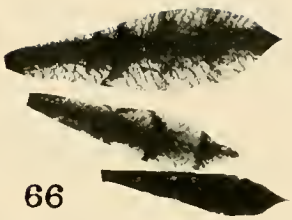

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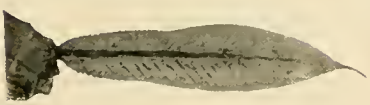

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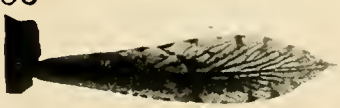

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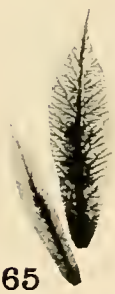

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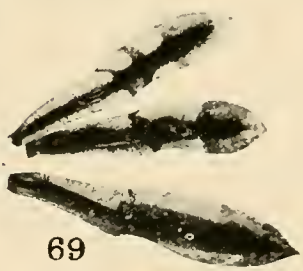

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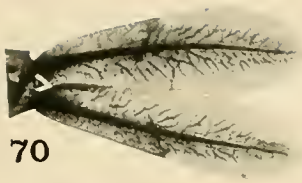
Plate LXIV

Caudal Gills of Nymphs and Wings of Adults*

Fig. 70. *Enallagma carunculatum*, gills.
Fig. 71. *Enallagma cyathigerum*, gills.
Fig. 72. *Enallagma geminatum*, gills.
Fig. 73. *Agrion aequabile*, wings.
Fig. 74. *Hetaerina americana*, wings.
Fig. 75. *Enallagma civile*, gills.
Fig. 76. *Enallagma hageni*, gills.
Fig. 77. *Enallagma exsulans*, dark and light gills.
Fig. 77a. The same, abnormal gills.
Fig. 78. *Hetaerina americana*, male, wings.
Fig. 79. The same, nymphal skin.
Fig. 80. *Enallagma* (?) *calverti*, lateral gill.

*One of the lateral gills removed in cases where the gills are attached to the abdomen.



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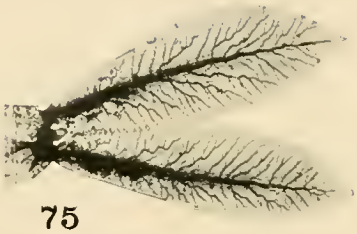

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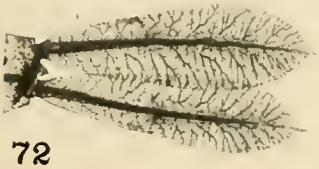

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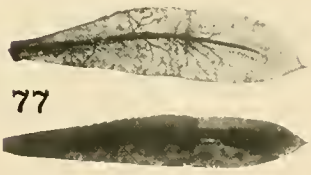

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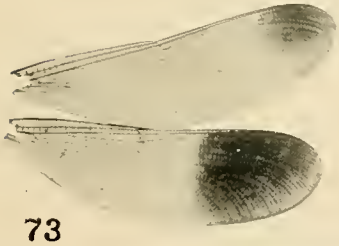

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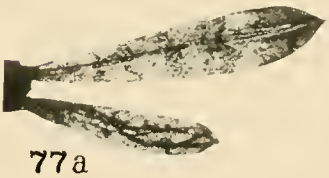

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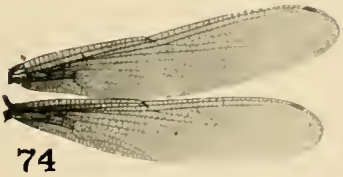

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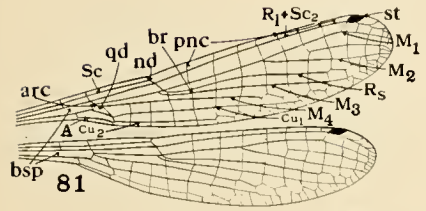
Plate LXV

Wings of Adults

Fig. 81. *Ischnura verticalis.*
Fig. 82. *Anomalagrion hastatum*, female.
Fig. 83. The same, male.
Fig. 84. *Chromagrion conditum.*
Fig. 85. *Lestes rectangularis.*
Fig. 86. *Ischnura posita.*
Fig. 87. *Enallagma hageni.*
Fig. 88. *Nehalennia irene.*
Fig. 89. *Amphiagrion saucium.*
Fig. 90. *Argia apicalis.*

Plate LXV



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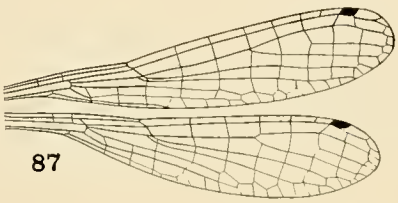

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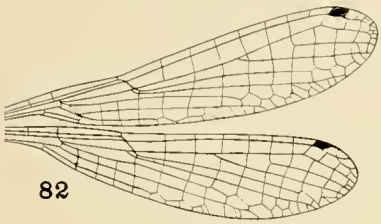

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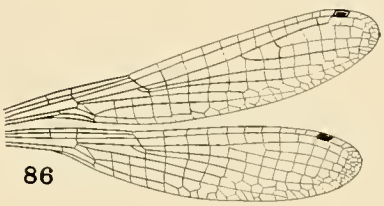

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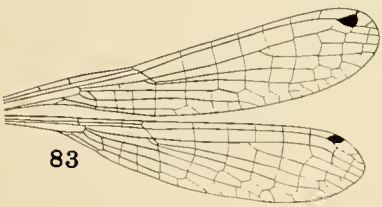

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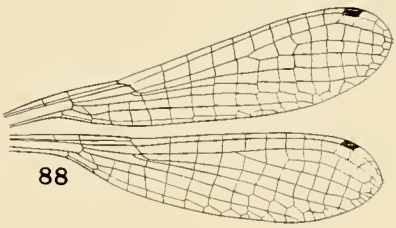

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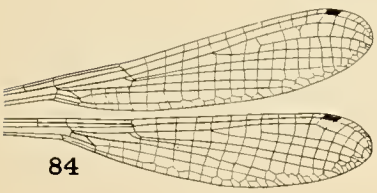

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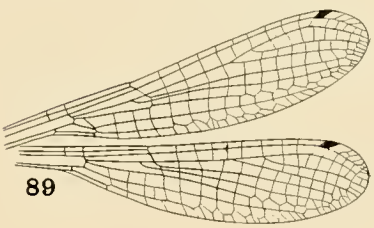

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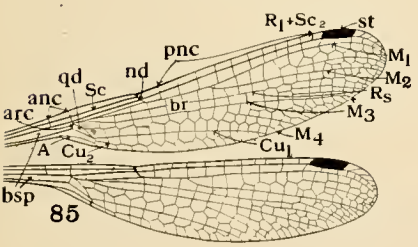

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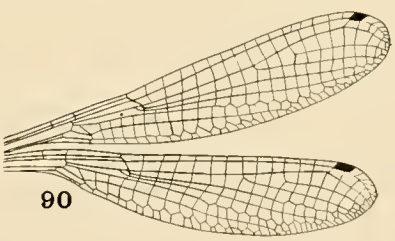

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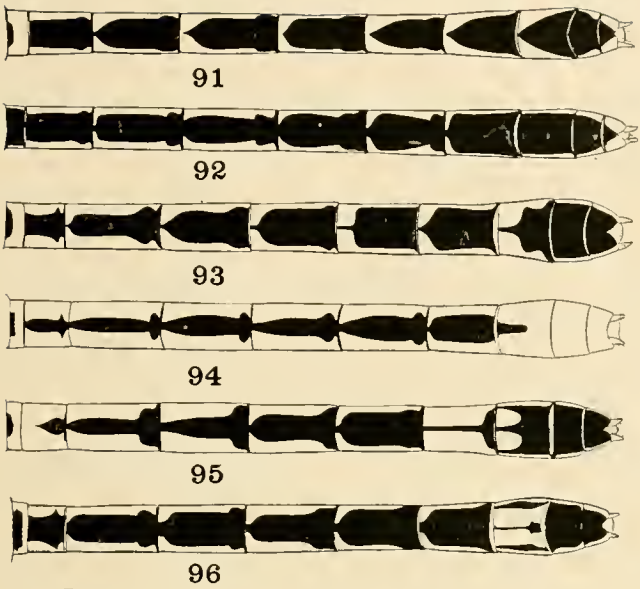
Plate LXVI

Abdominal Structures of Adults

Fig. 91. *Enallagma carunculatum*, female, dorsal view of abdomen.
Fig. 92. *Enallagma civile*, female, dorsal view of abdomen.
Fig. 93. *Enallagma cyathigerum*, female, dorsal view of abdomen.
Fig. 94. *Enallagma traviatum*, female, dorsal view of abdomen.
Fig. 95. *Enallagma aspersum*, female, dorsal view of abdomen.
Fig. 96. *Enallagma geminatum*, female, dorsal view of abdomen.
Fig. 97. *Enallagma carunculatum*, male, penis.
Fig. 98. *Enallagma cyathigerum*, male, penis.
Fig. 99. *Enallagma carunculatum*, female, caudal abdominal segments.
Fig. 100. *Anomalagrion hastatum*, female, caudal abdominal segments.
Fig. 101. *Enallagma hageni*, male, penis.
Fig. 102. *Chromagrion conditum*, male, anal appendages.
Fig. 103. *Enallagma civile*, male, anal appendages.
Fig. 104. *Ischnura verticalis*, female, caudal abdominal segments.
Fig. 105. *Enallagma civile*, male, penis.
Fig. 106. *Chromagrion conditum*, male anal appendages.
Fig. 107. *Enallagma ebrium*, male, penis.
Fig. 108. *Enallagma calverti*, male, penis.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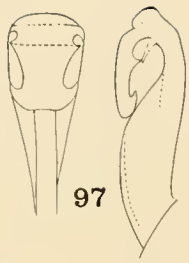
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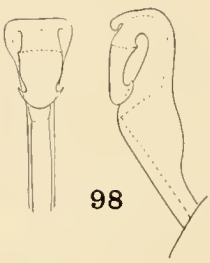
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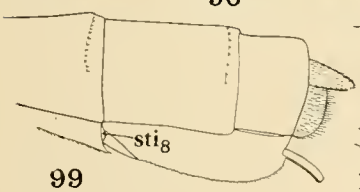
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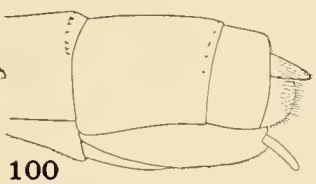
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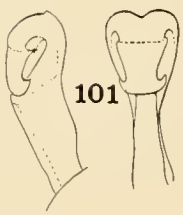
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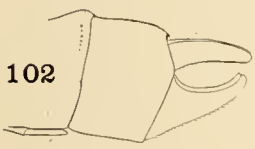
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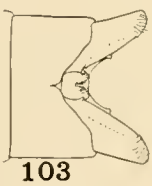
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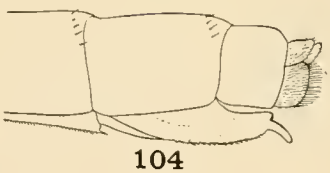
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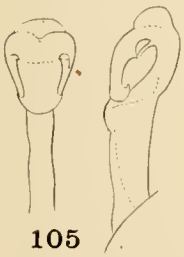
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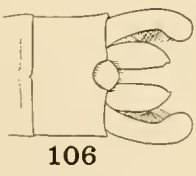
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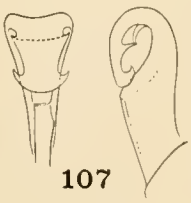
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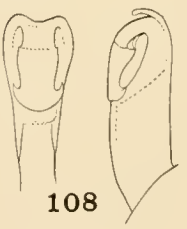
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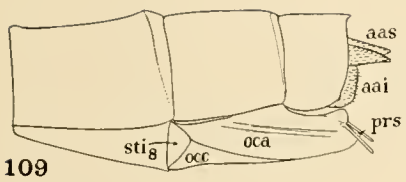
Plate LXVII

Abdominal Structures of Adults

Fig. 109. *Agrion maculatum*, female, caudal end of abdomen.
Fig. 110. *Agrion aequabile*, female, caudal end of abdomen.
Fig. 111. *Hetaerina titia*, female, caudal end of abdomen.
Fig. 112. *Hetaerina americana*, female, caudal end of abdomen.
Fig. 113. *Lestes uncatus*, female, caudal end of abdomen.
Fig. 114. *Lestes forcipatus*, female, caudal end of abdomen.
Fig. 115. *Lestes rectangularis*, female, caudal end of abdomen.
Fig. 116. *Argia moesta putrida*, female, caudal end of abdomen.
Fig. 117. *Agrion aequabile*, male, anal appendages.
Fig. 118. The same, male, sternum of the ninth segment.
Fig. 119. *Hetaerina titia*, male, anal appendages.
Fig. 120. *Lestes disjunctus*, male, second abdominal segment, from side.
Fig. 121. *Hetaerina americana*, male, sternum of the ninth segment.
Fig. 122. *Lestes forcipatus*, male, second abdominal segment, lateral view.

PLATE LXVII



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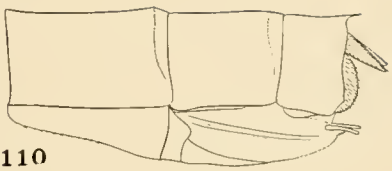
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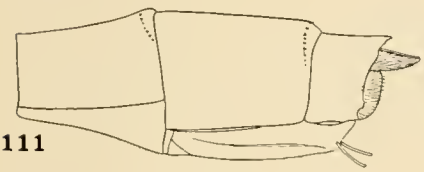
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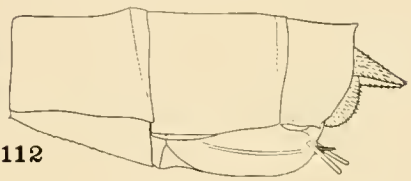
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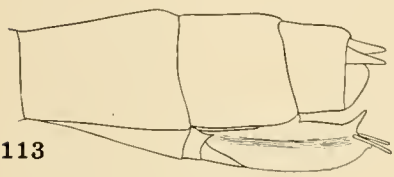
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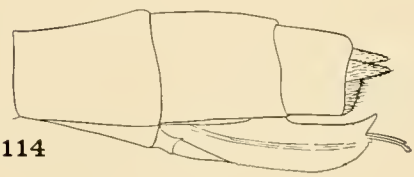
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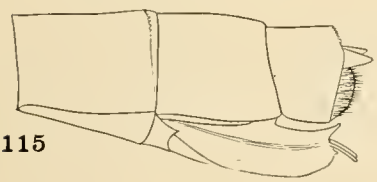
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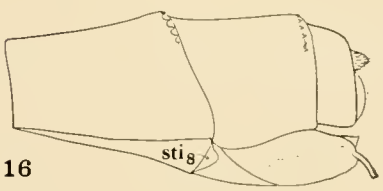

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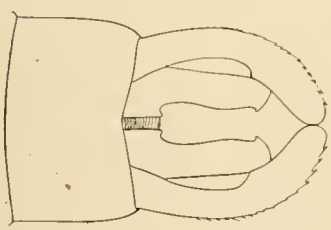
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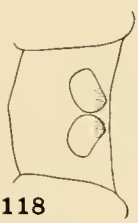
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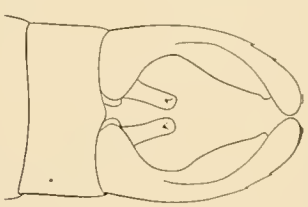
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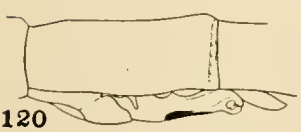
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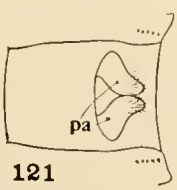

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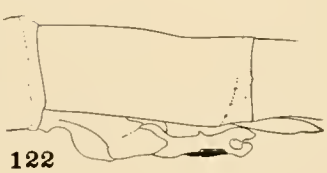
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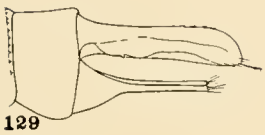
Plate LXVIII

Anal Appendages of Adults

Fig. 123. *Lestes congener.*
Fig. 124. *Lestes congener.*
Fig. 125. *Lestes unguiculatus.*
Fig. 126. *Lestes unguiculatus.*
Fig. 127. *Lestes rectangularis.*
Fig. 128. *Lestes rectangularis.*
Fig. 129. *Lestes vigilax.*
Fig. 130. *Lestes vigilax.*
Fig. 131. *Lestes inaequalis.*
Fig. 132. *Lestes inaequalis.*
Fig. 133. *Lestes disjunctus.*
Fig. 134. *Agrion aequabile.*
Fig. 135. *Lestes uncatus.*
Fig. 136. *Lestes uncatus.*
Fig. 137. *Lestes forcipatus.*
Fig. 138. *Lestes forcipatus.*
Fig. 139. *Agrion maculatum.*
Fig. 139a. *Agrion maculatum.*

PLATE LXVIII

123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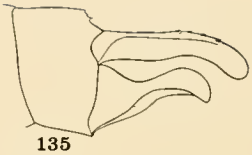
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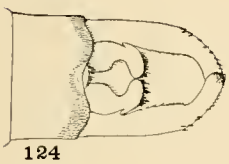
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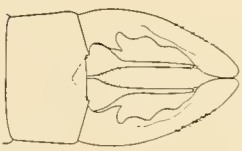
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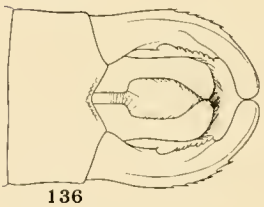
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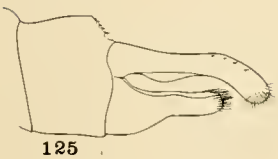
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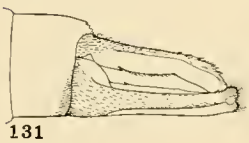
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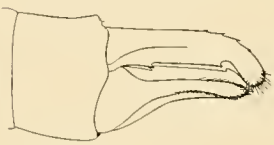
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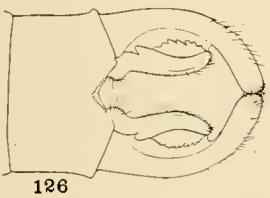
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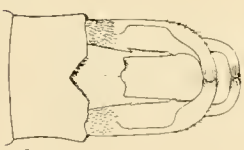
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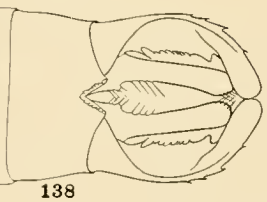
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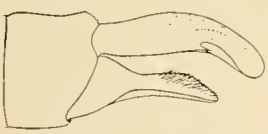
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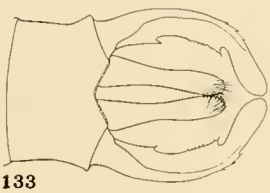
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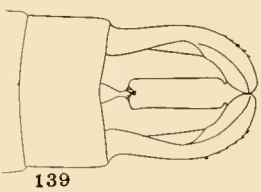
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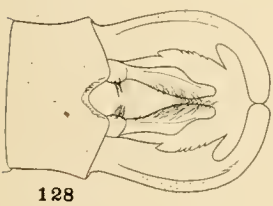
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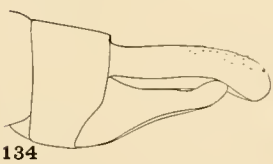
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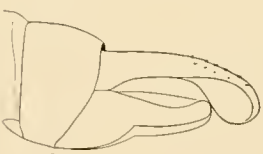
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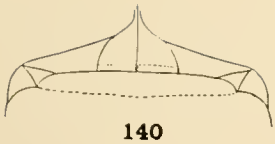
Plate LXIX

Thoracic and Abdominal Structures of Adults

Fig. 140. *Argia tibialis*, female, mesostigmal plates.
Fig. 141. *Argia sedula*, female, mesostigmal plates.
Fig. 142. *Argia violacea*, female, mesostigmal plates.
Fig. 143. *Argia fumipennis*, male, anal appendages.
Fig. 144. The same, male, anal appendages.
Fig. 145. *Argia violacea*, male, anal appendages.
Fig. 146. The same, male, anal appendages.
Fig. 147. *Argia apicalis*, male, ninth sternum.
Fig. 148. *Argia fumipennis*, female, mesostigmal plates.
Fig. 149. *Argia sedula*, male, anal appendages.
Fig. 150. The same, male, anal appendages.
Fig. 151. *Argia apicalis*, male, anal appendages.
Fig. 152. The same, male, anal appendages.
Fig. 153. The same, female, mesostigmal plates.
Fig. 154. *Argia moesta putrida*, female, mesostigmal plates.
Fig. 155. *Argia tibialis*, male, anal appendages.
Fig. 156. The same, male, anal appendages.
Fig. 157. *Argia moesta putrida*, male, anal appendages.
Fig. 158. The same, male, anal appendages.

PLATE LXIX



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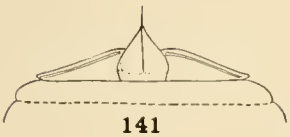

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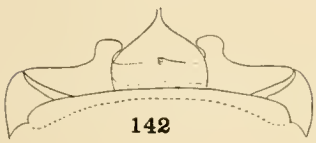

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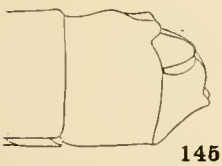

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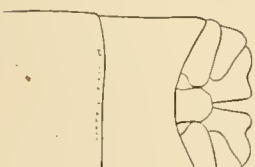

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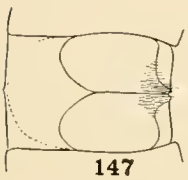

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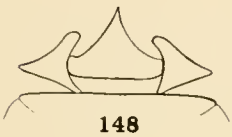

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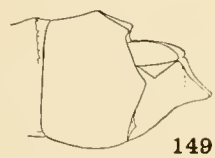

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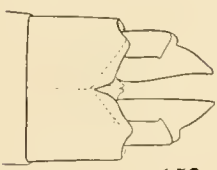

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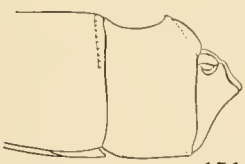

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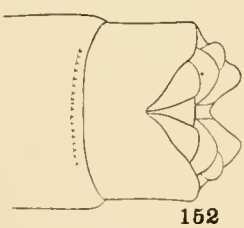

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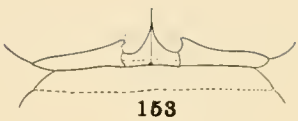

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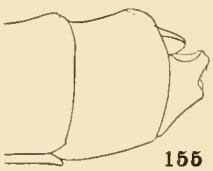

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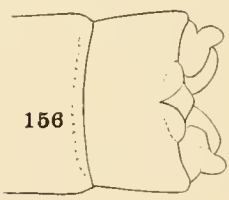

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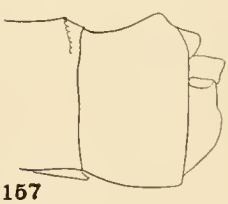

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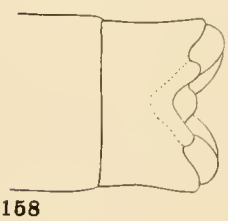

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Plate LXX

Thoracic and Abdominal Structures of Adults

Fig. 159. *Nehalennia irene*, male, anal appendages.
Fig. 160. The same, male, anal appendages.
Fig. 161. *Enallagma hageni*, male, anal appendages.
Fig. 162. The same, male, anal appendages.
Fig. 163. *Ischnura posita*, female, mesostigmal plates.
Fig. 164. *Anomalagrion hastatum*, female, mesostigmal plates.
Fig. 165. *Enallagma aspersum*, male, ninth sternum.
Fig. 166. *Anomalagrion hastatum*, male, anal appendages.
Fig. 167. The same, male, anal appendages.
Fig. 168. *Ischnura verticalis* male, anal appendages.
Fig. 169. *Enallagma doubledayi*, male, right superior appendage seen from the left and above.
Fig. 170. *Chromagrion conditum*, female, mesostigmal plates and dorsum of prothorax.
Fig. 171. *Ischnura posita*, male, ninth sternum.
Fig. 172. *Anomalagrion hastatum*, male, ninth sternum.
Fig. 173. *Ischnura posita*, male, anal appendages.
Fig. 174. *Amphiagrion saucium*, male, anal appendages.
Fig. 175. *Enallagma doubledayi*, male, anal appendages.
Fig. 176. *Enallagma carunculatum*, male, right superior appendage seen from the left and above.
Fig. 177. *Ischnura posita*, male, anal appendages.
Fig. 178. *Amphiagrion saucium*, male, anal appendages.
Fig. 179. *Enallagma civile*, male, right superior appendage seen from the left and above.
Fig. 180. *Ischnura verticalis*, female, mesostigmal plates.
Fig. 181. *Amphiagrion saucium*, female, mesostigmal plates.
Fig. 182. *Nehalennia irene*, female, mesostigmal plates.
Fig. 183. The same, male, ninth abdominal sternum.

PLATE LXX

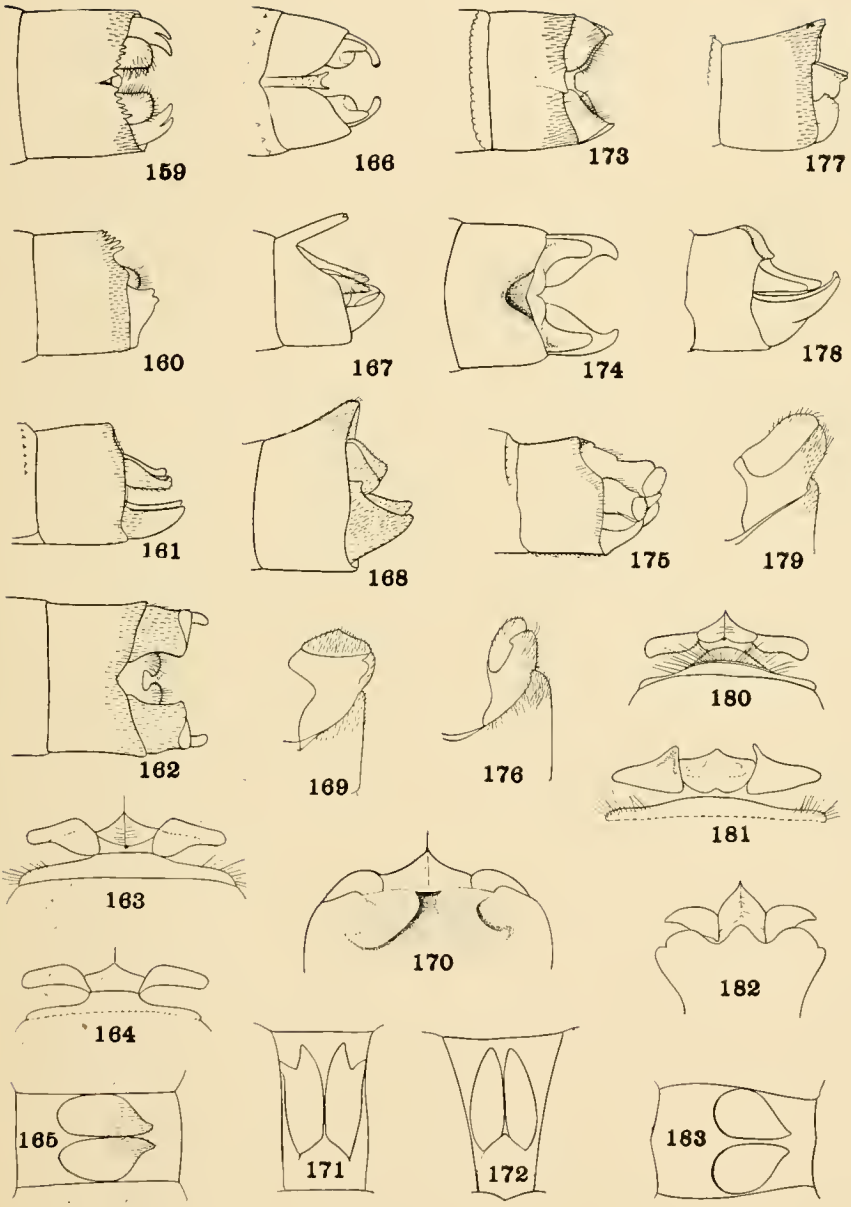
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Plate LXXI

Anal Appendages of Adults

Fig. 184. *Ischnura kellicotti.*
Fig. 185. *Enallagma signatum.*
Fig. 186. *Enallagma pollutum.*
Fig. 187. *Enallagma caruncula-tum.*
Fig. 188. *Enallagma aspersum.*
Fig. 189. *Enallagma ebrium.*
Fig. 190. *Enallagma divagans.*
Fig. 191. *Ischnura kellicotti.*
Fig. 192. *Enallagma signatum.*
Fig. 193. *Enallagma pollutum.*
Fig. 194. *Enallagma caruncula-tum.*
Fig. 195. *Enallagma aspersum.*
Fig. 196. *Enallagma ebrium.*
Fig. 197. *Enallagma divagans.*
Fig. 198. *Enallagma civile.*
Fig. 199. *Enallagma traviatum.*
Fig. 200. *Enallagma calverti.*
Fig. 201. *Enallagma cyathigerum.*
Fig. 202. *Enallagma antennatum.*
Fig. 203. *Enallagma exsulans.*
Fig. 204. *Enallagma geminatum.*
Fig. 205. *Enallagma caruncula-tum.*
Fig. 206. *Enallagma traviatum.*
Fig. 207. *Enallagma calverti.*
Fig. 208. *Enallagma cyathigerum.*
Fig. 209. *Enallagma antennatum.*
Fig. 210. *Enallagma exsulans.*
Fig. 211. *Enallagma geminatum.*

Plate LXXI

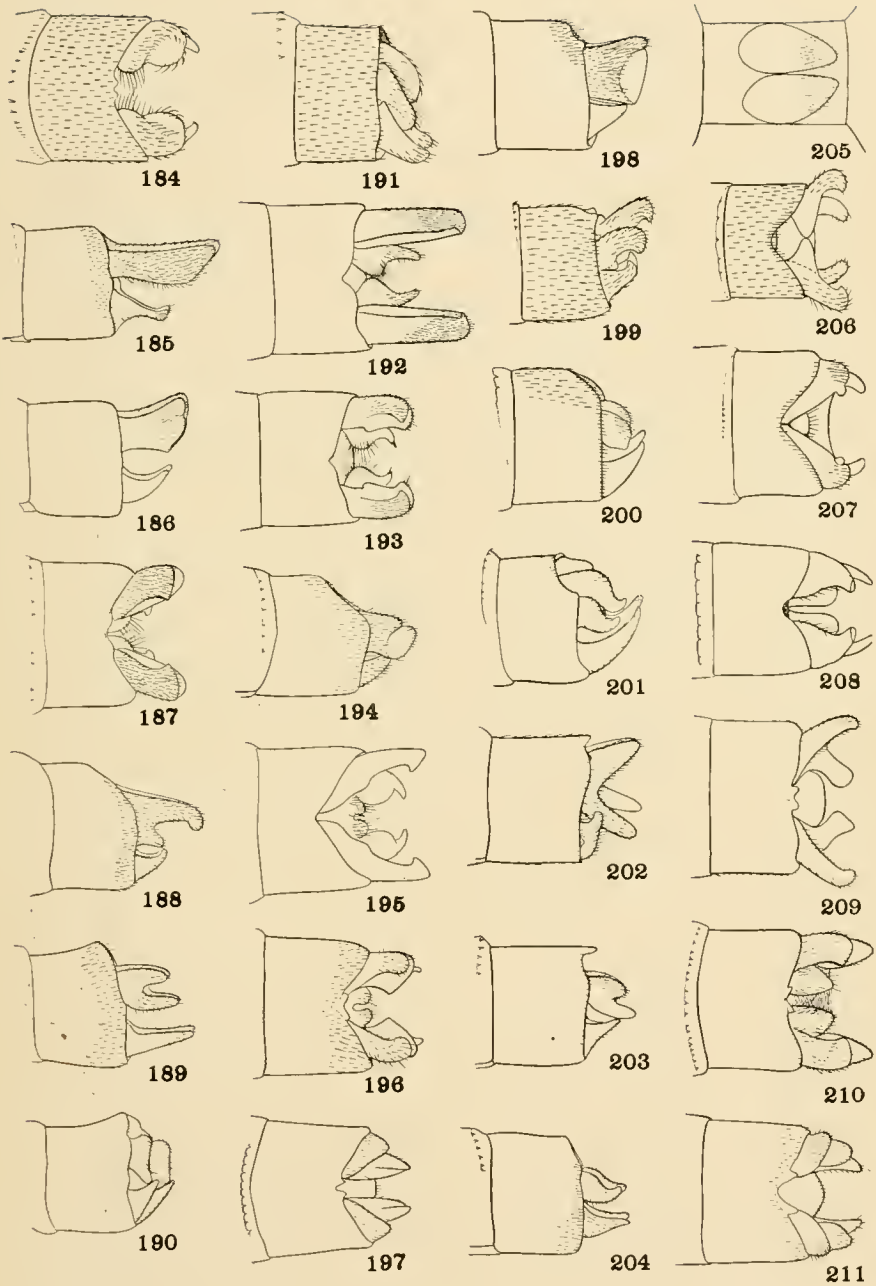
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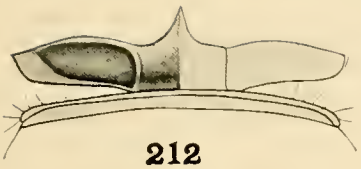
Plate LXXII

Thoracic Structures of Adults

Fig. 212. *Enallagma civile*, mesostigmal plates.
Fig. 213. *Enallagma cyathigerum*, mesostigmal plates.
Fig. 214. *Enallagma signatum*, mesostigmal plates.
Fig. 215. *Enallagma carunculatum*, mesostigmal plates.
Fig. 216. *Enallagma geminatum*, mesostigmal plates.
Fig. 217. *Ischnura verticalis*, nymph. (See Plate LXXIII.)
Fig. 218. *Enallagma traviatum*, mesostigmal plates.
Fig. 219. *Enallagma antennatum*, mesostigmal plates.
Fig. 220. *Enallagma exsulans*, mesostigmal plates.
Fig. 221. *Enallagma hageni*, mesostigmal plates.
Fig. 222. *Agrion maculatum*, nymph. (See Plate LXXIII.)
Fig. 223. *Enallagma calverti*, mesostigmal plates.
Fig. 224. *Enallagma divagans*, mesostigmal plates.
Fig. 225. *Enallagma pollutum*, mesostigmal plates.
Fig. 226. *Enallagma doubledayi*, mesostigmal plates.
Fig. 227. *Enallagma ebrium*, mesostigmal plates.
Fig. 228. *Lestes forcipatus*, nymph. (See Plate LXXIII.)



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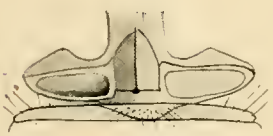

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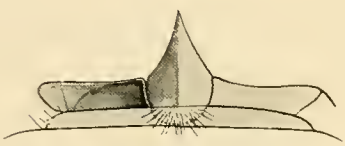

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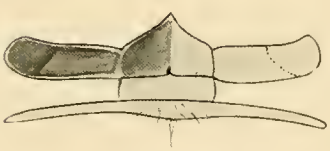

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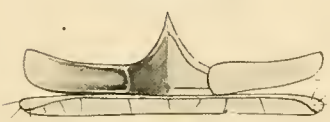

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PLATE LXXIII

Nymphs

Fig. 217. *Ischnura verticalis.*
Fig. 222. *Agrion maculatum.*
Fig. 228. *Lestes forcipatus.*

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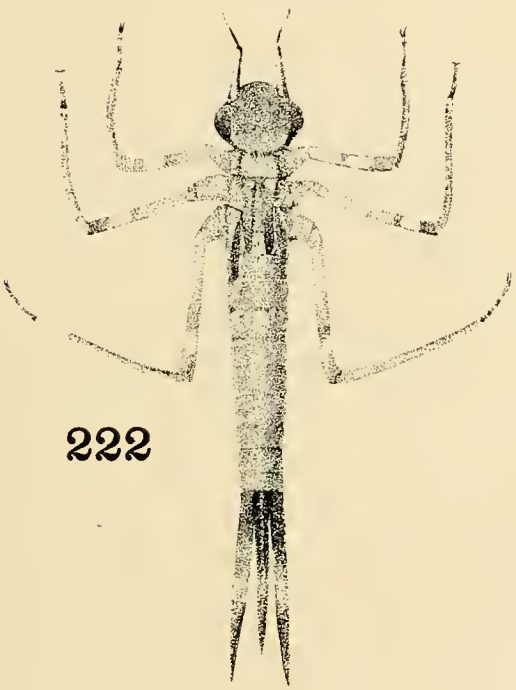

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