ERRATA.

Page 12, lines 16 and 17, for *one* hundred read *three* hundred and for *one thousand* read *six hundred.*

Page 17, line 2, dele first letter in the line.

Page 168, line 12, page 177, lines 13 and 14, and page 271, line 10, for *Lemna trisulca* read *Spirodela polyrhiza.*

Page 209, line 2 of foot-note, after *but* insert *represents.*

Page 256, line 7, and page 266, line 19: *snowi* n. s. has been shown to be *hieroglyphica*, ♂.

Page 257, insert as line 8 as follows: -ken to the office produced young in ten days. The

Page 272, line 13, for *P. biguttatus* read *Pompilus biguttatus.*

Page 278, Plate V., 16, after *view* insert as follows: *a*, mentum; *b*, labial rudiment; *c*, maxillary palpi; *d*, maxilla; *e*, labrum; *f*, antenna; *g*, eye; *h*, mandible.

Page 286, line 11, drop initial *the* one line.

Page 386, line 1, for *Comstocki* read *Comstock.*

Page 399, line 17, for *specimens* read *specimen.*

Page 411, line 10, for *Michaelson* read *Michaelsen.*

Page 441, line 3 from bottom, for *66* read *68.*

Page 445, line 10 from bottom, for *57* read *58.*

Page 466, line 1 from bottom, for *Cypria* read *Cypris.*

ARTICLE VI.—*On the Entomology of the Illinois River and Adjacent Waters.* FIRST PAPER. BY C. A. HART.

INTRODUCTORY.

This paper gives a part of the results of our observation and study of the insect fauna of the Illinois River and adjoining waters in the neighborhood of the University of Illinois Biological Experiment Station, at Havana, Illinois, during the first year of the Station work, as a preparation for further and more detailed observations in the same field. In order to make the account more complete and useful to Illinois students, and to give a general view of the relations of the species studied to the aquatic fauna of the State as a whole, the data concerning these forms afforded by the note boxes and general collections of the State Laboratory of Natural History are also here included.

Distinctive characters, when known to me, are tabulated in the form of keys. These are necessarily imperfect because of the small number of immature forms now known, the difficulty of determining the true rank of the differences observed, and the frequent impossibility of harmonizing the grouping with the present classification of the imagos. I hope, however, that they may prove useful, and suggestive in further studies. It is evident that a knowledge of all stages is necessary to the formation of the best natural classification.

Special thanks are due to Prof. S. A. Forbes, who originated the Station and has planned and directed its work; and to Messrs. C. H. Fernald, W. H. Ashmead, and W. A. Snow for determinations. I am also under obligations to my fellow-workers at the Station for their kindly coöperation, and to Miss Lydia Moore Hart for the accurate drawings herewith presented.

GROUPS TREATED.

The insects treated in the present paper belong to three groups: the aquatic caterpillars (Lepidoptera), the hymenopterous enemies or parasites of water insects, (Hymenoptera,) and the aquatic flies (Diptera) of several families, those including the larger forms of the Orthorhapha, or "straight-seamed flies;" especially the crane-flies (Tipulidæ, Pl. V–IX) the soldier flies (Stratiomyiidæ, Pl. XIV) and the horse-flies (Tabanidæ, Pl. X–XII), the larvæ of all these families being largely aquatic in habit. The distinguishing characters of these groups are given in the keys which follow.

THE LOCATION.

The Illinois River runs through one of the most remarkable and interesting valleys in this country. Although this valley is from one hundred to two hundred feet below the level of the surrounding country, it often reaches a width of ten or even twenty miles between the uplands on either side, rivaling in extent the great trough of the Upper Mississippi, and containing alluvial deposits of great depth and of enormous extent. In striking contrast with these evidences of vast erosion is the quiet river that lazily winds its way through a network of shallow weedy lakes and intricate sloughs—a paradise of aquatic life. It is evident that some greater stream once occupied this valley, by turns, no doubt, the outlet of Lake Michigan and the drainage channel of the great ice-sheet which is supposed to have thrown up the principal drift ridge of central Illinois.

Away from the low muddy flats along the river, with their lakes and sloughs, this valley is very generally filled in to a considerably higher level with extensive deposits of comparatively pure sand, alternating with sheets of clay. A well at Havana seventy feet deep does not reach the bottom of this formation. The surface of these sandy

areas has partly been blown into undulating mounds and ridges, and occasionally presents expanses of barren sand. They are quite peculiar in their fauna and flora, which are very different from those of the uplands. At Havana the width of the sand deposit between the river and the eastern upland is about fifteen miles.

Just above Havana, Spoon River enters the Illinois from the west, and the sediment brought down by it has raised the bottom-lands below its mouth to a higher level, narrowing the river, and forcing it for a short distance against the margin of the sandy plain.

Above the mouth of Spoon River the bottom lands are lower. Here wide stretches of shallow lake and marsh appear, with bottoms of soft black mud, and comparatively narrow intervening wooded ridges, rarely sandy, except at certain exposed and wave-washed points or along the margins of the sand plain.

THE SUBSTATIONS.

In order to cover a variety of situations, a number of typical points or substations were selected for special study and periodical examination. Each of these was regularly searched from the shore into deep water; but as the forms here treated are essentially shallow-water forms, the characteristics of the marginal surroundings will receive special attention.

Three of these stations were located in Quiver Lake. This is a permanent arm of the river extending northwards along the margin of the sand plain above Havana. The natural drainage of the sand escapes in large quantities along its eastern side, keeping the shore constantly saturated with cool percolating water, to a greater or less width, according to the level of the river. Beyond the head of the lake, this drainage forms a considerable stream, Quiver Creek, which empties into the broad shallow head of the lake through a muddy and weedy flat. Near the place where the clear waters of this stream cease to follow a definite channel, Station

A is located. Not far below this issues the most extensive flow of water from the muddy and sandy shore on the east side of the lake, maintaining there a considerable variety of plants and animals left upon it in spring by the receding waters. This is Station B. The lake itself is moderately shallow, and is filled during low water in summer by a dense mat of Ceratophyllum, Anacharis, Œdogonium and other algæ, with areas of Nelumbo, Nymphæa, Vallisneria, and Potamogeton. Through this mass of vegetation the clear water of the lake slowly moves towards the river, reinforced by the constant inflow.

Station C is located near the outlet of the lake, the shores here being near together and sheltered. The east bank is sandy, with a muddy coating over the part which is exposed at low water, while the west shore is of black mud grown over with willow trees and overflowed in moderately high water. The water on both sides is thickly filled in summer with algæ and other aquatic plants. Here during the first season our cabin-boat was located, giving us a greater opportunity to make observations at this station than at some of the others, to which fact is due a slight preponderance of data from this place.

At the opening of the second season (1895) another point, Station L, was selected in Dogfish Lake, a branch of Quiver Lake on the west, also matted with vegetation but without flow of spring water.

Near Station C, in the river itself, is Station E, a gently sloping muddy shore with but little vegetation; and in a weedier but more exposed position at the side of the broad expansion of the river known as Havana Lake, is Station D.

In the narrower and more rapid part of the river below the city is Station H, with steeper shores, sandy and gravelly on the east and muddy on the west.

Between Havana Lake and the margin of the sand plain at the east is a low bare island, separated from

the sand by a small grassy and weedy slough, sparsely grown with willows, through which the escaping spring water makes its way to the river. This peculiar slough is known as Station I.

The three remaining stations are on the west side of the river, in lakes which have no noticeable inflow of percolating water: Phelps Lake, temporary in nature, now open water, now dry, communicating with the river only at rather high water, gives us Station F; Thompson's Lake, large and permanent, with almost constant river communication, mostly open water, affords us Station G; and Flag Lake, a broad swampy expanse, widely margined with club-rush (Scirpus), and with a line of open ponds, is studied as Station K.

The location of the different stations and their characteristics at ordinary stages of water may be summarized as follows:

A. Junction of Quiver Creek and Quiver Lake; shallow, mud and sand, grass and floating vegetation, variable.

B. Wet springy shore of Quiver Lake; sand and mud, grass and coating of algæ.

C. Near foot of Quiver Lake; shores moderately sloping and sheltered, the eastern sand and mud, the western mud, low, and wooded; water clear, with dense aquatic vegetation, having little or no current in ordinary stages.

L. Dogfish Lake; arm of Quiver Lake, shallow, very gently sloping, mud, much floating vegetation, dead water.

E. River near Station C, somewhat narrow but deep at middle; margin rather shallow, soft mud, little vegetation, current slight, bank wooded.

D. Exposed shore of Havana Lake (a broader part of river); moderately sloping, mud, considerable grass and aquatic vegetation, very little current, not wooded.

H. River below Havana, narrow, east bank steep and sandy, a layer of mud over sand at lower levels, water

quickly deepening, considerable current, a little vegetation, west bank of mud, low and wooded, steeply sloping, water almost without vegetation, decided current.

I. Bed of the "Slough," with grass, rushes, and willows, and a very shallow stream of spring water when river is low.

F. Phelps Lake; very shallow, often entirely dry mud, almost no vegetation, dead water, shores densely wooded.

G. Thompson's Lake; exposed sandy shore, moderately sloping, grass and considerable aquatic vegetation, bottom of lake muddy, dead water.

K. Flag Lake; shallow, muddy, bordered with rushes, thick with floating vegetation.

LIFE AT THE DIFFERENT STATIONS.

It is not too sweeping a statement to say that the full lists for each station of every species observed there during the year do not conspicuously differ. On the other hand, variations in relative abundance of the forms at each station and of the total life at each, with the presence or absence of some prominent species or group of species, impart an individuality to each station. These lists are unusually large, and I have at hand a much greater variety and number of species than a single locality will usually furnish. It will be best therefore to point out merely the leading differences, with special reference to the forms herein reported upon, leaving the full treatment of the subject until the material collected has been more fully studied.

Evidently the main requisites of insect life are food and protection from enemies. An abundant growth of aquatic vegetation, therefore, supports a large number and variety of insects; those which find in it food and shelter, as do many Diptera and the case-flies, and those which prey upon the plant-feeding forms and upon each other while sheltered from vertebrate enemies. The

stations in Quiver, Dogfish, and Thompson's lakes (A, B, C, L, and G), and D, in the broader part of the river, are situations of the above description.

Station A has no definite shore, but because of its shallowness exhibited many features of shore life, and varied greatly as the real mouth of the creek shifted up and down with the changes in the height of the river. Aquatic caterpillars found food here, and horse-fly and crane-fly larvæ lived in the mud; certain case-flies were more common because of the running water; soldier-fly larvæ (Stratiomyiidæ), well protected by their tough skin, found appropriate food; and predaceous bugs and beetle larvæ also abounded. Surface-beetles (Gyrinidæ) were seen only now and then as single examples, and the larger surface-bugs or water-striders (Hydrobatidæ) were never very numerous, though the smaller ones (Veliidæ) were often seen on the floating vegetation in immense numbers. Water-beetles, except the haliplids, were as a rule comparatively few, seeming to prefer grassy margins and sticks and logs. Chironomid larvæ were abundant in the vegetation and the mud of the bottom. Top-minnows were seen gliding about in the little clear spaces; leeches and mollusks were plentiful.

At Station C the life was quite similar to the above, but the muddy west shore, often flooded and washed bare by the river, seemed inhospitable to shore-loving forms, beetles and dipterous larvæ of this class being noticeably few, although small surface-bugs, stratiomyiid larvæ and aquatic caterpillars were common in the abundant vegetable growth. The neuropteroid forms were here unusually abundant.

The shore of Thompson's Lake at Station G, although exposed, was protected during the summer by a belt of algæ and "moss" (Ceratophyllum etc.) and differed from the west side of C in its sandy shore, favorable to the development of dipterous larvæ generally, horse-fly larvæ and Stratiomyiidae often abounding in the rubbish

washed upon the shores at times of higher water. The definite grassy margins also favored water-beetle life, as was the case at Station D, which became very similar to the west shore of C as the river fell and the current nearly disappeared.

Station B and the east shore of Station C, also belonging to this group, located on the east shore of Quiver Lake, introduce a new element—the belt of saturated sandy shore, uniform in temperature, coated with algal growth, and teeming with life, including vast numbers of Asellus and Gammarus and an abundance of dipterous larvæ. Leeches and spring-tails (Podura and Isotoma) were unusually common.

At the upper station, B, the surfaces of bare reeking mud were inhabited by soldier-fly larvæ of the genus Stratiomyia. The little hollows produced here by the tramping of cattle quickly filled with water, and in these hollows, as well as in similar protected depressions along margins everywhere, the mosquito larvæ were noticeably abundant in due season, occurring also less commonly in open pockets in thick floating vegetation. Lack of a suitable food plant prevented the occurrence of aquatic caterpillars.

Station E is like the west shore of C, except that a great reduction in the quantity of vegetable life correspondingly reduces the number of the more delicate shallow-water forms. There is a considerable amount of sticks and rubbish, and the harder-shelled water-beetles and water-bugs are therefore more numerous. Gyrinidae in small schools also appeared.

The most aberrant station of all, Phelps Lake, the bottom of which was almost as bare as a floor, was *apparently* equally destitute of life. Close search, however, revealed abundant Corisidæ in the deeper water; Berosus and other small water-beetles in the shallows hiding under fallen leaves; Notonecta about a fallen branch in the water; and Heteroceridæ swarming over the mud at the margin, in their tiny mole-like burrows.

FOOD RELATIONS OF THE GROUPS TREATED.

The plant-feeding aquatic caterpillars seemed to occur wherever their food plants grew. They are pretty well protected by their habits of concealment in cases or between leaves, the Hydrocampa apparently being kept in check largely by its hymenopterous parasite.

The sand-wasps (Bembecidæ) and the spider-wasps (Pompilidæ) were frequently seen flying about. The former provision their nests with flies; the latter with spiders, which are themselves predaceous and abundant along wet shores. The effect of the sand-wasps on aquatic Diptera is presumably injurious, and that of the spider-wasps beneficial.

The larvæ of soldier-flies (Stratiomyiidæ) herein treated seem to feed on minute plant life, Odontomyia as a rule taking that on aquatic vegetation, and Stratiomyia that on wet muddy surfaces. Their tough skin efficiently protects these species from insect enemies, in both larval and pupal stages, and it is probable that like the Hydrocampa, they also are kept in check largely by their hymenopterous parasites (Smicra). *Megilla maculata*, a coccinellid beetle, has been observed feeding on the eggs. I do not know of their being eaten by fishes.

The larvæ of horse-flies (Tabanidæ), except possibly the little Chrysops larvæ, are active and rapacious. They apparently do not attack operculate univalves, but are known to eat those in which the opening of the shell is not protected by an operculum. I have not noticed, however, that they have any preference for these. They did not attack the blue earthworm (*Sparganophilus eiseni*)—so abundant in their usual habitats—when placed in confinement with them. Breeding-cage experiments lead me to think that their chief food is soft larvæ. They are usually found in the light or sandy substance of wet shores. Although crane-flies (Tipulidæ) oviposit freely in such places, their larvæ

never become excessively abundant, being probably a prominent element in the food of the horse-fly larvæ. The latter, when washed out of their positions in the soft bottom of shallow waters or in the sand of the margins, float exposed upon the water and become an easy prey to fishes. A very efficient check on their increase is the hymenopterous egg parasite, which often destroys a large percentage of the eggs in an egg mass.

The aquatic crane-fly larvæ (Tipulidæ) feed as a rule on minute algæ and the like, but one species observed is in all probability predaceous. Their probable relation to the horse-fly larvæ has just been mentioned. I have not observed any hymenopterous parasites upon them. Predaceous Coleoptera and their larvæ are often associated with them and other small dipterous larvæ on wet shores.

The food of the larvæ treated under the name Leptidæ, I am unable to discuss at present. A careful study of stomach contents is of course necessary before the food relations of the above forms can be definitely and fully described.

METHODS.

Collecting.—Insects in vegetation and on or in the bottom were taken by means of a dip-net—a net of about equal depth and width attached to a strong semicircular ring firmly fixed to a long handle, the straight side of the ring being opposite the point of attachment. (See Plate XV.) For the larger and more active forms, a coarser net of minnow netting was used, and for smaller forms, one made of bobbinet proved most durable and satisfactory. To collect from the mud of the bottom, the water immediately over it was violently stirred and then swept with the net. The surface layer of mud was also scooped up in the fine dip-net and then allowed to wash through, leaving the coarser contents in the net. In a similar way, insects on the bottom in deep water were secured by using a dredge, and washing its contents through

a series of net sieves. The aquatic vegetation, when free from mud, was violently washed in a large pan, many smaller forms being thus dislodged and coming to the surface. Insects occurring in open water were taken in drawing an ordinary towing-net.

A whole world of minute insect life largely passes through these nets, which would clog up badly were they made of finer material, and a set of wire sieves was therefore used, the lowest one of very fine brass wire gauze, through which the mud or sand of the bottom and margins was sifted, the washing in the fine sieve being diluted and examined; or the bottom of the sieve was held slightly below the surface in a large vessel of clear water, and the contents gently stirred and closely examined. These fine washings from mud or thick vegetation are often well worth saving in bulk. The minute life of weedy waters may be well collected by means of a Birge net, which is a small, deep, fine net, the opening guarded by a coarse wire gauze cone, its apex outward, which parts the vegetation as the net is drawn through it. The contents are removed by unscrewing a small cap from a short tube inserted at the narrow bottom of the net.

Preserving.—Methods of preservation have very greatly improved of recent years, but much remains to be done before all kinds of material can be satisfactorily preserved. The best results with most larvæ of any size were obtained by heating them in water, not too rapidly, to about 200° Fahr., and setting aside till cool. A small percentage of acetic acid will prevent the collapsing of very soft larvæ. The principal trouble with this method arises from the expansion of the air within, but a slight inflation, especially in the crane-fly larvæ (Tipulidæ), is desirable, as it fills out the anal prominence and its soft appendages. This method is not suitable for pupæ generally, nor for ephemerid nor perlid larvæ with their flat gills. As a general preservative for material so prepared and for other large insects, we have depended

chiefly upon 80% alcohol and water. Experiments with formaline indicate that it will satisfactorily preserve small and easily penetrated forms.

Breeding.—For merely rearing insects, the best cage proved to be a wide-mouthed glass vessel varying in size according to the insects to be reared. The mouth may be covered when desirable by a piece of "Swiss" or cheese cloth held in place by a rubber band. For most work, cylindrical battery jars five or six inches in diameter and about seven inches deep were very useful. In these, by attending to a few simple rules, one can rear successfully almost any kind of aquatic insects, except such as require running water. Direct sunlight must not fall on the vessels, as it often overheats the water; and hard water should not be used. We reproduce so far as possible the natural surroundings where the insect occurred, using material from the place where it was found. The water need not be changed if no film appears upon its surface and healthy animal and plant life are present; but if a film develops and a foul odor becomes noticeable, actively decaying organic matter is evidently present. This should be immediately removed, the water being frequently changed for a time. A very little water is often better than a large quantity, and too much vegetation may be a disadvantage. A foothold above water for emerging imagos is desirable. Those forms which leave the water for pupation, such as the larvæ of beetles, horse-flies and some Neuroptera, (Sialidæ), are transferred when full grown to clean damp sand, covered with light, fresh rubbish for shelter and moisture. Beetle larvæ will often pupate under chips in such a place; and pupæ in puparia may be placed on damp sand. Pupæ will often be killed by suffocation if collected in a bottle of water. Some isolated individuals should be reared to verify results.

For keeping insects under continual observation and in natural conditions a square box, eight inches each way, was used, two sides and the bottom of wood, the

other two sides of wire gauze. The upper rim is all of wood and supports a close fitting glass cover in a wooden frame, overhanging outwardly, so that the whole interior is visible through the glass. (See Plate XV.) These cages are so placed in the lake or river as to be about half full of water, thus maintaining the quality of water and the temperature natural to life occurring there.

CHARACTERS USED IN THE KEY TO ORDERS.

A typical insect larva or pupa has about a dozen usually well-marked divisions. The first is the head, the next three constitute the thorax, and the remainder the abdomen. In the stratiomyiids the thoracic segments are closely like those of the abdomen, but there is usually a noticeable difference. In most larvæ the thoracic segments are readily distinguished by the pair of jointed feet on each, and in the pupa or older nymph, by a conspicuous backward extension from each side of the second thoracic segment, more or less covering a smaller pair of similar extensions on the third, these being the two pairs of wing-pads. The second pair is rudimentary in the Diptera. The distinction between the larvæ of groups A and B is not applicable to very young individuals, but one will easily learn to know those of the first group, as they closely resemble the older stages, and the inter-resemblances are quite marked in each of its subdivisions, which are not numerous.

The spring-tails are minute wingless insects, many of which frequent wet shores, often hopping on the surface, but rarely discovered beneath it. The next three orders take up air from the water, usually by flat membranous gills upon the thorax, or the sides or the end of the abdomen, or within the end of the alimentary canal. The terminal setæ are long antenna-like tails. The true bugs breathe air directly, those which swim in water coming to the surface for it.

In group B the abdomen often bears beneath fleshy jointless prominences, used as feet and called false feet.

When gills are present they are usually filamentous or thread-like and borne on the sides or back. The spiracles or stigmata are the external openings of the internal air-tubes or tracheæ.

The separation of the pupæ of this group has proven difficult. The dipterous pupa when it develops within the old larval skin usually gets air from spiracles at the posterior end, but the free pupa, with legs and wing-pads visible, receives its principal air supply from the spiracles of the first thoracic segment (prothorax). These are usually well up on the dorsal surface, large or prominent, and very frequently borne upon long antenna-like prolongations. On the other hand, the prothoracic spiracles in the remaining orders are on the sides at the hinder edge of the segment and never very conspicuous. The antennæ of the pupa rest against the surface of the body, but may be known by their origin on the upper surface of the head.

KEY TO THE ORDERS OF IMMATURE AQUATIC INSECTS.

In this key extensive use has been made of the chapter on Insects by Dr. E. Schmidt-Schwedt in "Die Tier- und Pflanzenwelt des Süsswassers." The eggs can best be determined at present by an examination of the various ways in which they are deposited, as illustrated by the figures which will be published in the course of this work.

Nymphs (larvæ and pupæ) similar at all ages; wing-pads present except on very young nymphs, wanting in Thysanura; thoracic legs always present and functional; no abdominal legs....A.

Larvæ without wing-pads; pupæ with wing-pads and with thoracic legs visible but not in use;* pupa sometimes concealed in a hardened footless larval skin.....B.

*The pupæ of Phryganeidæ use their thoracic legs on leaving their cases for emergence. Other exceptions to the characters given in these keys will probably appear as our knowledge increases. They can only approximate the truth at present, but may serve as a stepping-stone to something better in the future. Although they are drawn up for aquatic forms exclusively, it seems to me that the natural relationships of the different orders are here very unmistakably exhibited.

A. *Nymphs.*

With biting mouth parts.

Maxillæ and mandibles retracted, apices only visible; minute semi-aquatic air breathers.

(Spring-tails) *Thysanura.*

Maxillæ and mandibles prominent; water breathers, usually with tracheal gills.

Abdomen with terminal setæ.

Gills on thorax; setæ usually two.

(Stone-flies) *Plecoptera.*

Gills on side of abdomen; setæ usually three.

(May-flies) *Ephemerida.*

Abdomen without terminal setæ, and with terminal flat gill-plates or internal gills.

(Dragon-flies) *Odonata.*

With jointed beak; air breathers.

(True Bugs) *Hemiptera.*

B. *Larvæ.*

With jointed thoracic legs.

False legs wanting (except in a Philhydrus, which has six pairs present); not living in a case.

Filamentous gills wanting—present but not segmented in Berosus and Gyrinidæ, segmented in Cnemidotus, in which the legs have but one claw; abdomen usually with terminal spiracles.

(Beetles) *Coleoptera.*

Body with segmented filamentous gills; no spiracles at apex of abdomen; two claws on legs.

Neuroptera.

A pair of false legs on last segment, each with one or two strong claws; usually in a tubular case.

(Case-flies) *Trichoptera.*

Five pairs of false legs, provided at their apex with numerous hooklets; no spiracles at apex of abdomen. (Caterpillars) *Lepidoptera.*

Without jointed thoracic legs. (Flies) *Diptera.*

B. *Pupæ.*

Prothoracic spiracles small and lateral, or wanting.
Appendages mostly free from each other.
Pupæ formed on land; without gills.
Antennal joints fewer than twelve. *Coleoptera.*
Antennal joints numerous, more than twelve. *Neuroptera.*
Pupæ formed in the water in a case; with filamentous gills. *Trichoptera.*
Appendages, head, and thorax all united. *Lepidoptera.*
Prothoracic spiracles dorsal, prominently developed, often borne at the end of antenna-like appendages; or the pupa is concealed in the hardened last larval skin. *Diptera.*

LEPIDOPTERA.

Two groups of this order may be considered here; those species which feed internally on aquatic plants and breathe by spiracles, probably making no use of the air contained in the water, although it seems that some can swim from one plant to another when occasion requires; and those which feed externally, being provided with means for appropriating oxygen from the air in the water, at least in the earlier stages, and therefore completely aquatic during a part of their life; living in cases or shelters usually covered exteriorly with green plant tissue, and filling these cases with air during the pupal and sometimes also during the later larval period. To the former group belong certain Noctuidæ, such as Arzama and Nonagria, and a pyralid (Pyrausta) herein treated; to the latter group belong the members of the remarkable and interesting pyralid subfamily Hydrocampinæ.

CHARACTERS USED IN TABULATING AQUATIC LEPIDOPTERA.

The characters separating the Noctuidæ and Pyralidæ in the following key are those developed by recent attempts at a more natural classification of the Lepidoptera, and are of wide application in separating higher and lower forms. The distinctive features of Cataclysta are taken from Guenée. A piliferous tubercle is typically a darker and slightly elevated spot, bearing one or more stiff hairs or bristles. In a typical noctuid larva the first and uppermost of these, as seen on one of the middle segments of the abdomen, is on the middle fold of the segment, subdorsal in situation; the second is lower down, and on the posterior fold; the third is beneath the first but above the spiracle; the fourth is posterior again; the fifth beneath the third and below the spiracle. In the pyralids the arrangement of the fourth and fifth is different, as shown in the key.

KEYS TO AQUATIC LEPIDOPTERA.

Larvæ.

Middle abdominal segments with the fourth and fifth piliferous tubercles approximate or united. (Pyralidæ.)

Ocelli five.

Body with long respiratory filaments. [Fig. 1.] *Paraponyx.*

Body without respiratory filaments.

Elongate, moniliform. *Cataclysta.*

Rather thick at middle, slightly flattened, ends tapering. [Fig. 10.] *Hydrocampa.*

Ocelli six. *Pyrausta nelumbialis.*

Middle segments of abdomen with the fourth and fifth piliferous tubercles distant from each other. (Noctuidæ.) *Nonagria, Arzama.*

Pupæ.

Seventh abdominal segment freely movable in male, appendages sub-external, separated from internal cavity by well-developed partitions, and breaking away from it at time of emergence.

Developed spiracles present on segments 2–4 of abdomen; its apex merely pointed.

Spiracles of abdominal segments 2–4 about equal in diameter; ventral sheath surpassing seventh segment. [Fig. 6.] *Paraponyx.*

Spiracles of second abdominal segment much smaller than the next two pairs.

Ventral sheath long, nearly as long as abdomen.

? Hydrocampa icciusalis, ? Cataclysta.

Ventral sheath short, not surpassing seventh abdominal segment. (Hydrocampa, *fide* Guenée.) *Hydrocampa obliteralis.*

Developed spiracles present on segments 2–7 of abdomen, its apex flattened, with mass of recurved chitinous filaments. *Pyrausta nelumbialis.*

Fifth and sixth abdominal segments freely movable, seventh and remaining segments united in both sexes; appendages sub-internal, with only a slight separation from internal cavity, and not breaking away from it at time of emergence.

Nonagria, Arzama.

No Arzama or Nonagria were collected at Havana during the season, and further treatment of the Noctuidæ is omitted at present.

Family PYRALIDÆ.

Nymphælla.

The wings of the moths are rather long and narrow, obtuse at apex, the primaries without transverse lines, and more or less spotted or tessellated, the hind wings

whitish, faintly lined or dotted; ocelli wanting. The larva is unknown to me.

N. maculalis Clem. (*dispar* Grote).

These pretty moths were common about the small lakes in northern Illinois August 4, being taken at Sand and Fourth Lakes. They also occurred at Cedar Lake June 19 and August 11, and at Fox Lake June 22; and were taken in Urbana July 8 and 22 at electric lights.

Paraponyx.

The reasons for using this genus name are discussed under Hydrocampa. The moths are of a different facies from that genus, having narrower wings, and long straight dark lines on the posterior pair. The larvæ differ from all other known forms of the order in being provided with filamentous tracheal gills. Their habits are hence completely aquatic.

It is stated that when the cocoon is formed the air vessels of the leaf to which it is attached are tapped, and the water in the cocoon is driven out and replaced by air.

P. obscuralis Gr. [Fig. 1–7.]

The favorite food of the larva of *P. obscuralis* is the leaf of *Vallisneria spiralis*, and it has also been found upon *Potamogeton nutans*. The Vallisneria grows freely at Station A, trailing in the slow currents at the mouth of Quiver Creek, and here almost all our larvæ were found. They feed at first exposed on the leaf, but later two or even three leaves are loosely webbed together face to face by each larva, between which it remains concealed while feeding. They are therefore hard to discover unless their hiding places are broken up by seining or the like, when the larvæ may be seen swimming about. In these retreats a fine but dense cocoon may be found spun by the larva, in which the pupal stage is passed. Full grown larvæ and pupæ were obtained from these situations in July. In August, how-

ever, large quantities of detached cases [Fig. 2] were found floating at the surface in the same vicinity—rough-looking oblong or triquetral cases about an inch long, formed by severing in a ragged way the connections of the larval retreat at either end. In these were pupæ and good-sized larvæ, and it must be the usual habit of this species to come to the surface in this manner before pupation, and live in a detached case, like other Hydrocampinæ. In single instances, pieces of the leaves of Nelumbo and Potamogeton entered into the construction of these cases, and a side of one case was smoothly built up of *Lemna trisulca*, which was abundant there at that time. These cases were seen also in smaller numbers in September and October, at the same place. The imagos were quite generally distributed and abundant along the lake and river shores in June, July, and the first part of August—an earlier period than that of *Hydrocampa obliteralis*, which was still common in September, while the present species was not noticed after August 24. In the breeding-cages they emerged July 18 and 26 and August 1. They have also been taken in Urbana at electric light August 18 and 19. Young larvæ, doubtless of the new brood, were seen on the Vallisneria July 23 in great abundance, and it is probable that the species hibernates in the larval stage, a medium-sized example having been taken at Station A December 17.

The recorded occurrences of this species at Havana throughout the year may be tabulated as follows:

RECORD OF PARAPONYX OBSCURALIS FOR THE YEAR.*

Dates.	A.	B.	C. E.	C. W.	D.	E.	F.	G.	B.-C. &c.
June 13	.....	.....	I-3	.....	.....	.....	.....	.....	.....
July 9	L-2, P-1	.....	.....	.....	.....	.....	.....	.....	.....
" 18	.....	.....	I-1	L-1	.....	.....	.....	.....	P, I; B.-C.
" 23	L-3, I-3	.....	I-3	.....	.....	.....	.....	.....	.....
" 26	.....	.....	.....	.....	.....	.....	.....	.....	I; B.-C.
" 29	.....	.....	.....	.....	.....	.....	.....	.....	L; B.-C.
Aug. 1	.....	.....	.....	.....	.....	.....	.....	.....	I; B.-C.
" 16	L-3, P-2	I-1	.....	.....	.....	.....	.....	.....	.....
" 20	.....	.....	.....	.....	I-1	.....	.....	.....	.....
" 24	.....	.....	.....	.....	.....	.....	.....	.....	I-1; Matanzas L.
Sept. 14	L-2	.....	.....	.....	.....	.....	.....	.....	.....
Oct. 12	L-2	.....	.....	.....	.....	.....	.....	.....	.....
Dec. 17	L-1	.....	.....	.....	.....	.....	.....	.....	.....

Larva [Fig. 1-5].—Length 15–20 mm., breadth 2–2.5 mm. Whitish, slightly tinted with yellowish testaceous, surface subopaque, covered with minute shining points when seen under the microscope; provided with the usual piliferous tubercles, which bear light brown hairs, and with ten long branching filamentous respiratory appendages on each of the middle segments, transparent white in color, their bases tinted with yellowish. The branches of the anterior supra- and infrastigmals arise from the anterior side of the main stem, while those on the

*In this and succeeding tables, the dates of recorded occurrence of the species are given, each being followed, in the column headed by the letter of the station where found, by the initial of the stage (E, egg; Y, young larva; L, older larva; P, pupa; I, imago) and a number indicating its abundance (1, rare; 2, infrequent; 3, common; 4, abundant; 5, excessively abundant). The last column is for breeding-cage results and miscellaneous locations.

remaining gills arise from the posterior side, the branches leaving the stem at approximately equal distances on its basal portion, each branch being about as long as the portion of the stem beyond their point of union [Fig 4]. There are just one hundred of these filamentous gills. The head, prothorax, and terminal segment are destitute of them, the mesothorax lacks one pair, and the penultimate segment lacks all *but* one pair; the remaining nine segments have the full number of ten to each segment, five on each side, which Müller* designates as follows; an anterior and a posterior one forming the suprastigmal pair, a similar infrastigmal pair, and a pedal gill below these [Fig 5]. The number of branches of the different filaments may be expressed by a definite formula for each stage of larval life, notwithstanding the fact that a slight variation from it is very common, there being often one branch more or less in one or all the filaments of a series. By studying a number of individuals I endeavored to eliminate this variation, and the branches in a full grown larva may be tabulated accordingly as follows, the segments back of the head being numbered consecutively:

Segments.	a. s.†	p. s.	a. i.	p. i.	ped.
2	6	5	3	5	—
3	6	5	3	5	6
4–7	4	6	4	5	6
8–10	4	6	4	5	5
11	4	6	4	5	4
12	—	—	—	3	—

*Zool. Jahrbuch, Ab. Syst., VI., p. 626.

† a., anterior: p., posterior; s., suprastigmal; i., infrastigmal; ped., pedal.

Since the number of branches is proportionally nearly as above in all individuals examined, it will be sufficient in the following comparison of larvæ of different ages, to state the formula for the first four abdominal segments, adding also Müller's figures for *P. stratiotata*, a European species.

Species.	Larva.	a. s.	p. s.	a. i.	p. i.	ped.
obscuralis.	Length. 1.5 mm.	—	1*	—	1*	1
	3-6 mm.	1	2	1	2	2
	7.5 mm.	2	3	2	3	3
	10-12 mm.	3	4	3	4	4
	15 mm.†	3	5	3	4	5
	15-20 mm.	4	6	4	5	6
stratiotata.	Stage. Second from last.	—	1	2	1	2
	Next to last.	2	2	3	2	2
	Last stage.	3	2	4	3	3

The head of the larva is pale, faintly mottled, Y-mark light yellowish brown, setæ long, surrounded by light brown ring at base. Clypeus margined in front with dark brown or blackish; labrum deeply but obtusely emarginate; mandibles toothed, tips blackish; palpal joints darker at apex; mentum transversely corrugated; basal antennal joint truncate-conic, variable in appearance, second joint slender, about four times as long as thick, with an apical seta of about equal length, and minute terminal articles; ocelli five, with black angular pigment spots, four in a vertical row, lower three spots contiguous, the fifth lying behind the upper one of the four.

*Short. †About to moult.

Thoracic segments very finely granulose, darkest at anterior margins. Thoracic suprastigmal gills rather near together, and at the same distance from the median line; posterior infrastigmal directly beneath the posterior suprastigmal, the anterior infrastigmal higher up, and close to the anterior margin of the segment. On the abdominal segments [Fig. 5] the anterior suprastigmal is nearer the median line than its mate, and it will be noted that the latter has the more branches, instead of the former, as on the thorax; the anterior infrastigmal is lower than its mate, and more nearly in line with the anterior suprastigmal as compared with the arrangement upon the thorax; the pedal gill is on the latero-ventral fleshy prominence just above the base of the leg, and is wanting on the mesothorax. The ninth abdominal segment bears only a single pair of gills at the posterior margin, which appear to be the posterior infrastigmals. The first piliferous tubercle is immediately in front of the anterior suprastigmal on the thorax, and just within it on the abdomen; the second and third are in their usual places, the former not far beneath the posterior suprastigmal. A pair of short setæ, one above the other, placed between the infrastigmals, appear to represent the fourth and fifth tubercles, and the sixth or seventh is immediately in front of the pedal gill, replacing it on the mesothorax, and bisetose on the prothorax. Spiracles minute, oval, anterior ones slightly elevated, those at middle of body in a more or less distinct yellow-brown spot, often enclosed by a darker ring.

True legs rather stout; sutures brownish; claws blackish, base paler, a small basal lobe; tibiæ with a subapical verticil of hairs. False legs short, five pairs as usual, first four with an oval entire circlet of hooks, the hooks with longer bases alternating with one or two shorter ones, the whole surrounded by a variably distinct fine blackish ring; circlet of hooks on posterior pair diminishing back of middle on each side and coming to an end at the middle third [Fig. 3].

Pupa [Fig. 6, 7].—Length 9–11 mm., greatest diameter 2.5 mm.; spiracle-bearing segments broadest, slightly swollen dorsally, body with sides gently curving, and tapering gradually towards each end; rather soft-bodied, pale yellowish white, eyes darker; surface smooth, subopaque, and nearly naked. Head small, with two small dehiscent spike-like porrect setæ on the vertex. Spiracles of segments 2–4 of the abdomen large and conspicuous, about equal in size, transverse diameter slightly greater than the longitudinal, borne on rounded tubercles. Ventral sheath reaching a little beyond end of seventh segment. Apex of abdomen subacute; ninth segment beneath with a faint elevated line at middle, and a small elevation each side. Anterior margin of ninth segment conspicuously elevated into a broad transverse ridge, bearing a row of seven sharp brownish or blackish short longitudinal carinæ; ninth segment beneath with a Y-shaped impression [Fig. 7].

P. albalis Rob.

The larva of this species is doubtless very close to that of *obscuralis*, as the difference between the imagos is slight, though constant. One of the moths was captured Sept. 11 at Station C. They have also occurred in our collections from the small lake region of northern Illinois and southern Wisconsin; at Cedar Lake June 19; abundant at Sand and Fourth Lakes Aug. 3 and 9; Aug. 30 and Sept. 3 at Lake Geneva, Wis.; and at Delavan Lake, Wis., Sept. 5 and 6. Aug. 4 it was taken in Urbana at electric light.

P. allionealis Walk. (*plenilinealis* Gr.).

This is closely related to the European *P. stratiotata*, whose larva has long been well known, and which differs from that of *P. obscuralis* in the lesser development of the respiratory filaments, as was shown in treating the latter species. Moths of *allionealis* occurred at electric lights in Urbana May 29, June 7 and 29, and July 6, 7, 23, 27, appearing in numbers on the evening of June 29.

Chrysendeton.

The moths of this genus and of Cataclysta are of similar appearance, having rather narrow wings, the hind wings with a series of small patches of metallic scales surrounded by a black background, near the posterior margin. Ocelli are wanting in Cataclysta, present in Chrysendeton. The immature stages are in all probability much alike, and the larvæ aquatic. Cataclysta has not been taken by us in Illinois.

C. claudialis Walk. (*medicinalis* Gr.).

This graceful moth appeared at the electric light in Champaign June 21. Grote's types were from Illinois.

Hydrocampa.

The moths of the three genera Hydrocampa, Oligostigma, and Paraponyx show but slight structural differences; the latter has however been usually maintained as distinct because of its remarkable larval structure, the larva of Oligostigma being hitherto unknown. In Smith's Check List, on the other hand, Prof. Fernald, doubtless appreciating the undesirability of separating these genera by means of the immature stages, at least so long as our knowledge of them remained so glaringly incomplete, has placed all the North American species of these three genera under Hydrocampa, together with some which had previously been included under Homophysa, among them *H. obliteralis*. Our studies show that two very distinct types of larvæ are thus included: one represented by the species previously assigned to Homophysa and Hydrocampa; the other, by those assigned to Oligostigma and Paraponyx. The general appearance of the adults would seem to confirm this grouping. There seems to be a clear generic distinction present in the immature stages,—not only in the development of respiratory filaments, but also in the structure of the posterior feet of the larva and the spiracles of the pupa,—though perhaps not manifest in the imago.

I have therefore restored Paraponyx, including under it, as did Lederer,* the species of Oligostigma.

Packard has figured† the transformations of what he supposed to be *H. icciusalis*—a typical Hydrocampa. We have bred all stages of *H. obliteralis*, which belongs to the group of Hydrocampas once classed with Homophysa. There is no trace in our larva of the posterior pits figured by him in *icciusalis;* and while the pupæ seem to agree in relative size of spiracles, the ventral sheath in his figure is made very long, as described by Guenée for Cataclysta, this character seeming to be correlated with the length of the wings in the adult. The sketchy nature of the figures makes further comparisons uncertain.

The wings of the Hydrocampa moths are broad or moderately so, the hind wings crossed by a pair of wavy lines near middle.

H. gyralis Hulst.

A single example was taken flying about the cabin-boat July 19. The species had been previously taken by us at electric lights near the University June 17 and Aug. 24, 1886. The three examples thus collected are all males, as were also Mr. Hulst's types. We have in our collection also two undetermined Hydrocampas, both females, which, although differing greatly in general appearance from the preceding, and somewhat larger, are in all probability the other sex of this species, as the pattern is essentially the same, and the hind wings scarcely differ at all. The white lines of the fore wings, however, so sharply distinct in the males, are here obscured by a tawny yellowish suffusion, and the dark shades are indefinitely outlined. These also are from electric light collections made near the University in 1886, on May 28 and Aug. 23 of that year.

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*Wien. Ent. Monatschr., VII., p. 452.

†Am. Nat. 1884, p. 824.

H. ekthlipsis Gr.

Taken by us but once, July 5, at an electric light in Champaign.

H. icciusalis Walk. (*genuinalis* Led., *formosalis* Clem.).

Although the moth of this species is the most common hydrocampid about the University, it was not seen at all at Havana. The probable differences between the immature forms of this and the next species have already been mentioned.

We have found the imago at electric light in Urbana May 19, 31; June 3, 15, 26; July 5, 6, 7, 20, 21, 28; Aug. 2, 17, 24; and at Lake Geneva, Wis., on Sept. 3.

H. obliteralis Walk. (*proprialis* Fern.).

The favorite home of this species is among the floating leaves of *Potamogeton nutans*, which often thickly cover the surface of quiet water in large patches. The amber-colored eggs [Fig. 8, 9] were first noted June 1, and are laid in a long band just within the margin, on the lower surface, of some broad floating leaf, usually that of *P. nutans*. They are closely placed in a single layer, in rows running parallel to the margin, the band being about 3 mm. wide and including usually five or six rows of eggs, the members of each row alternating with those of the adjacent rows honeycomb-fashion. Their long axes point to the margin of the leaf, and each egg slightly overlaps those adjoining it on the inner side, showing that the moth probably rests at the edge of the leaf above and extends her ovipositor beneath it. The band is usually an inch or two long. One leaf of *P. nutans* in our collection, over three inches long, is entirely margined with eggs, except a short interruption at the side and another at the extreme base of the leaf. These egg bands were common in July, and a few were seen in August.

Larvæ were obtained from them in the breeding-cage July 13. The next day they had cut out minute oval disks from the leaf, and webbed these to its lower sur-

face, secreting themselves in the retreat thus formed, and feeding upon the substance of the leaf. When a little older, the larva cuts loose the portion of leaf surface to which it has attached its shelter, and is thereafter found traveling about like a case-worm in a lens-shaped case, formed of two irregularly oval convex pieces of green leaf attached at their sides and open at the ends. In the larger cases made by older larvæ the posterior end is narrowed, giving the case an ovate shape, or is even provided with a projecting median lobe, like the neck of a bottle, in which rests the posterior end of the larva [Fig. 11]. A case found by us in September had one side made of the fronds of *Lemna trisulca*, and another was entirely formed of these little fronds. The pupal case is similar to that of the larva, but is smaller, oval, and more convex, and the edges are apparently strongly webbed together throughout, though the anterior end is easily parted, revealing an oval cavity with closely woven silken walls. When quite young, the larva is submerged and water-breathing, but soon fills its case with air and breathes it directly. In this respect it differs from Paraponyx, which remains submerged throughout its larval life.

The larvæ [Fig. 10] were common in July and mostly reached the pupal stage during the first part of August, those seen towards the last of this month being fewer in number and mostly full grown. They continued to appear, however, and still occurred in the collections made in October. The presence of more young larvæ than usual was noted Sept. 20, and a young example taken in Flag Lake Mar. 23 seems to be of this species. A few imagos were seen at the time the first eggs were collected, and they continued to increase in numbers, becoming most abundant in August and September, when they were quite common on plants over water and often settled abundantly upon the sides of our row-boats. A few were seen in October. They emerged in

the breeding-cage Aug. 8–10, having passed through the pupal stage very quickly. Examples of the moth have also been taken in southern Illinois, at Cobden, June 12, and one appeared at the electric light in Urbana Sept. 4.

RECORD OF HYDROCAMPA OBLITERALIS FOR THE YEAR.*

Dates.	A.	B.	C. E.	C. W.	D.	E.	F.	G.	B.-C. &c.
May 16	.....	.....	L-1	.....	.....	.....	....	....	.....
June 1	.....	.....	.....	.....	.....	.....	....	....	E & I-1; Dogfish Lake
July 9	E-3, L-2, I	.....	.....	.....	.....	.....	....	....	.....
" 10	.....	.....	.....	.....	.....	.....	....	E	.....
" 13	.....	.....	.....	.....	.....	.....	....	....	E & L; B.-C.
" 18	.....	.....	.....	L-3	.....	.....	....	....	.....
" 20	.....	.....	.....	.....	L-1	.....	....	....	.....
" 23	L-1	.....	.....	.....	.....	.....	....	....	.....
Aug. 8	.....	.....	.....	.....	.....	.....	....	....	I; B.-C.
" 9	.....	.....	.....	.....	.....	.....	....	....	I; B.-C.
" 10	.....	.....	.....	L-3, P-1	.....	.....	....	....	P & I; B.-C.
" 14	.....	.....	.....	.....	.....	.....	....	L	.....
" 16	E-1	.....	.....	.....	.....	.....	....	....	.....
" 20	.....	.....	.....	.....	L-2, I-3	.....	....	....	....
" 23	.....	.....	.....	.....	.....	.....	....	....	I-1; Matanzas L.
" 31	.....	.....	.....	L-2, I-1	.....	.....	....	....	.....
Sept. 10	.....	.....	.....	.....	.....	I-2	....	....	.....
" 14	L-2, I-3	I-3	.....	.....	.....	.....	....	....	.....
" 20	.....	.....	.....	Y & L-2	.....	.....	....	....	.....
" 24	.....	.....	I-3	.....	.....	.....	....	....	.....
Oct. 11	.....	.....	I-1	L & I-2	.....	.....	....	....	.....

Parasites. Indications of parasitism were sometimes noted, and a small parasitic hymenopteron, determined as *Cryptus cyaneiventris* Riley MS., by Mr. W. H. Ashmead, was constantly present in August about the spot

* See foot-note p. 169.

where the largest numbers of the Hydrocampa occurred, flitting about in an investigating way over the floating leaves, often disappearing in the water beneath the edge of one and soon reappearing at some other point of its margin and flying to another. This Cryptus has, in fact, been previously bred in Florida, March 26, from a Hydrocampa on water lily, supposed to be *obliteralis*.*

Egg [Fig. 8, 9].—Length 6 mm., width 4 mm. Oval, amber-colored, flattened, one surface broadly gummed to the leaf, the other finely longitudinally wrinkled, a longitudinal elevated ridge at middle. Described from examples laid in a band on the under side of a floating leaf of *Potamogeton nutans*, near and parallel to its margin.

Larva, first stage.—This does not differ markedly in surface, structures, or color, from the mature larva; the setæ are more conspicuous, especially posteriorly, and the ocelli are closely approximate, the lower three in a solid oblong black dash, with the other two just above.

Larva, mature [Fig. 10–12].—Length 13–14 mm., width 2 mm. Fusiform subcylindrical, slightly depressed, broadest at middle, uniform dirty whitish. Surface subopaque, microscopically granulate or scabrous, more noticeably so on the anterior part of the thorax.

Head rather small, light brownish yellow; Y-mark narrowly darker, bordered each side with whitish; a lateral brown stripe from base of head nearly to ocelli; labrum deeply and rather acutely emarginate at middle; mandibles sharply toothed; sutures beneath more or less darker; first antennal joint truncate-conic, whitish, second slender, very pale yellowish, tipped with a seta and three minute articles, the middle one of which is deeply cleft; ocelli five, four in a slight curve just back of base of antenna, the middle ones contiguous, their pigment spots large and confluent, the upper one smaller and more isolated, behind it and similar to it, the fifth one.

* "Bred Parasitic Hymenoptera in the Collection of the U. S. National Museumm." *Insect Life*, Vol. III., p. 154.

Cervical shield semicircular, anterior margin straight and distinct, median lines usually narrowly but sharply whitish. Piliferous tubercles of thorax indicated by dark ring about base of hair; those of abdomen very indistinct. Spiracles of anterior abdominal segments more distinct, remaining ones minute and inconspicuous. Ninth abdominal segment with hind margin above broadly retuse, tenth feebly impressed above at middle.

True legs stout and very broad, claws small, with blackish tip and basal lobe; posterior pair rather distant, three or four times as far apart as the middle pair. False feet very short, with the hook-bearing area very narrow and inconspicuous, with two rows of light colored hooks; last pair with merely a straight band of hooks [Fig. 12].

Pupa.—Length 6–8 mm., breadth about 2 mm., rather rapidly narrowed behind; smooth, pale yellowish, wings and head darkening. Head with two small dehiscent black spike-like porrect setæ on the vertex. Spiracles of segments 2–4, round, elevated, reddish brown, with a pale center, and surrounded by a blackish ring; very large, the anterior pair much smaller. Ventral sheath reaching the seventh abdominal segment; ninth with a sharp tooth each side above lateral margin; last two segments grooved and impressed below.

H. peremptalis Gr.

Examples of the imago have been taken by us at Savanna, Ill., in the immediate vicinity of the Mississippi River, at lights and sugar, July 20–27.

PYRAUSTA.

P. nelumbialis Smith.*

* Additional information concerning this species has been recently secured, and I take advantage of an opportunity to include it here.

In the latter part of August, the larvæ were common upon Nelumbo near Station G. The younger larvæ were feeding upon the upper surface of the leaves, especially near their margins, beneath a slight web. The older larvæ were mostly hidden in a short burrow just large enough to contain them, excavated within the upper end of the leaf stem; the opening of the burrow, in the center of the upper side of the leaf, being

A larva about an inch long, with dark piliferous spots, was found Aug. 11 in Quiver Lake, boring in the large receptacles of *Nelumbo lutea*, the burrow ending at the side of the receptacle in a circular opening 3 or 4 mm. in diameter, about which some frass was adhering. Aug. 29 the larva was found to have deserted its burrow and spun a white cocoon in one of the upper corners of its breeding-cage. The imago emerged Sept. 8, and is identical with those described by Prof. J. B. Smith,* under the name *nelumbialis*, having been reared from the Egyptian lotus, at Bordentown, N. J. The descriptions here given were prepared before I was aware of Prof. Smith's article, which contains biological details and descriptions of larva and imago, with figures of each.

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surrounded by excrementitious matter. Others had burrowed into the receptacle, often hollowing out the interior of the nut-like fruit imbedded in it. One burrow was noted in a young bud.

The cocoon was sometimes formed in the receptacle, firmly webbed to the walls of the burrow, but more usually in the short burrow in the leaf stem, the opening closed by a thick ivory-white lid. Several pupæ were found. The terminal chitinous tuft above mentioned is easily broken off in removing them from the cocoon.

One imago appeared August 18, and another on the 26th, both clearly of the above species.

The small white cocoons of a braconid parasite were frequently noted within the webs of the younger larvæ, from which an imago parasite was secured on August 20; and on the 22d a secondary parasite, one of the Chalcididæ, came out through a small round hole in the side of one of the braconid cocoons. One of the cocoons of the Pyrausta was found packed with small parasitic cocoons.

La rva.—Length 25 mm.; diameter 3 mm. Subcylindrical, thickest near middle, tapering gently towards each end; above grayish, paler in the sutures, beneath white. Head pale testaceous, marked with chestnut-brown; labrum and second antennal joint brownish, clypeus and first anteunal joint whitish; middle triangle brownish anteriorly, paler posteriorly; lateral plates margined with brownish adjoining middle triangle, and mottled with dark brown; ocelli bordered with blackish, a mottled band extending back from them, beneath it a blackish basal spot; near the middle line above, a broader pale stripe each side, the two converging anteriorly, and ending near the posterior angle of the middle triangle; a broad pale space each side in front, separated from the end of the pale stripe by a dark spot. Cervical shield pale brownish gray, nearly semicircular, hind margin dark, sharply interrupted at middle; a more or less double dark spot, and a row of three irregular clusters each side of the pale median stripe. Piliferous tubercles pale to dark brownish gray, margined with whitish, the thoracic darkest; the posterior pair on each abdominal segment quite small; setæ brownish. Anal plate darker medially. False feet with a black apical dot and a circular ring of small black-tipped teeth, the ring broader inwardly, narrower and interrupted outwardly; last pair with a lunate band of teeth, and a scabrous surface between their bases.

*Ent. Amer. V., 6, p. 83.

The other imagos in our collection were taken at electric lights in Urbana May 19 to Aug. 6, with the exception of a single well-marked example, bred July 21 from a larva which was found near the University July 9, boring in the stems of *Polygonum incarnatum*. There is no Nelumbo near Urbana. The moths taken at lights were all more or less worn when captured.

Larva.—The cast skin shows that the larva had six ocelli on a side, three in a vertical row behind the antenna, the adjoining surface slightly darker, one above these but a little further back, one directly behind it, and one directly behind the lowermost, all equidistant; apex of mandibles nearly truncate, with five nearly equal blunt teeth; skin minutely granulate; spiracles surrounded by prominent brownish rings; claws lobed at base.

Cocoon.—This is grayish white, densely woven and papery, thickly covered without with small woody particles firmly attached to it, probably gnawed from the side of the breeding-cage.

Pupa (described from cast skin of female).—Length 12 mm., greatest diameter nearly 3 mm. Subcylindrical, tapering posteriorly from fourth abdominal segment; entire surface very minutely scabrous and subopaque, finely transversely wrinkled except on the wing-pads and apical part of abdomen. Head rounded in front, wing-pads extending about to apex of fourth segment, hind wings narrowly visible on dorsum from their bases to the third abdominal segment. Segments 2–4 of the abdomen are one half longer than segments 1 and 5–7, and segments 8 to 10 somewhat shorter than the latter; segments 5 and 6 are free. A row of four dark minute shining piliferous spots, each with a fine yellowish hair, extends across each segment anteriorly, the outer ones just above the spiracles. Spiracles of second and third abdominal segments large and transversely oval, surrounded by a sharp raised margin; those on

segments 4–7 similar but smaller; that on segment 8 closed up, forming a rounded tubercle. Last segment darker and rougher, flattened, about as broad as long, shield-shaped, with a broad truncate apex; base more convex above; sides with a sharp margin, rather narrowly deflexed; beneath, it is longitudinally sulcate each side; at its apex is a bundle of thick chitinous filaments, whose tips are curled up outwardly and which enable the pupa to attach itself firmly to the silk of the cocoon.

Imago.—Ochre-brown to ochre-buff, abdomen and hind wings paler. Ocelli present; maxillary palpi porrect; eye bordered above with white scales. Fore wings moderately narrow and slightly rounded at tip, not pointed; lines obscure, but not obliterated as in *penitalis*. Anterior transverse line waved, crossing wing at basal third; a dark point in the cell; exterior to this a small pale spot bordered outwardly by a distinct short transverse dash; a brown shade across the end of the cell; posterior transverse line nearly parallel to outer margin, angulated on the veins, very deeply but narrowly indented on vein VII_2*, and about half as much on vein IX; bordered with paler ochre within at middle; the space between this line and the outer edge also somewhat paler, through the middle of which runs the obscure zigzag subterminal line, more or less broken up into chevron-shaped marks. Terminal line nearly or quite wanting. Hind wings pale whitish or yellowish ochre, a brown discal dot, often indistinct, and at the distal third a short transverse fuscous arc, present in all the specimens; a fine wavy marginal line often present. Beneath whitish with ochrey tint, the dorsal markings vaguely repeated in light brownish, except on posterior part of fore wings. Body beneath, and middle and hind legs white. Unusually variable in size; expanse 22–35 mm., body 10–15 mm.

* Comstock's nomenclature. ("Manual for the Study of Insects.")

DIPTERA.

From an aquatic point of view, the immature Diptera divide according to their habits into three great groups. The first is the perfectly aquatic Orthorhapha—the *Micro*-orthorhapha, we may say. This group is represented by such typical families as Culicidæ, Chironomidæ, Simuliidæ, and Blepharoceridæ. It contains genera rich in species and individuals and constitutes one of the most prominent features of the aquatic fauna. The larvæ are provided with a well-developed head, are usually fully aquatic, and subsist, as a rule, on minute organic objects. The second group includes the remaining Orthorhapha, such as the nematocerous families Tipulidæ and Psychodidæ and the brachycerous Stratiomyiidæ and Tabanidæ. A large part of the larvæ of this group are semiaquatic, crawlers rather than swimmers, most at home in or upon wet shores of mud or sand, amongst marginal vegetation, or burrowing in the mud of the bottom, finding in these situations a varied diet. When in open water they float at the surface and are apparently out of their element. The head is chitinous, usually incomplete, not including the brain, and more or less immersed in the prothorax. The third and last group is the great army of cyclorhaphous Diptera, of which a very considerable number of scattered forms are more or less perfectly at home in the water or in wet places. Their food is usually decaying animal or vegetable matter. The head is incomplete, and membranous above. The families here treated are those which contain the larger forms of the second group.

In the following keys I have freely used the valuable generalizations of Dr. Brauer,* modified by the studies of the wing of the imago recently published by Professor J. H. Comstock.†

KEYS TO AQUATIC FAMILIES OF DIPTERA.

Characters used.—Orthorhaphous larvæ show a great diversity of external appearance and structure, (due to their environment,) which masks their true affinities; and therefore a key based, as the present one is, on the more evident characters, must be more or less artificial.

The true legs of the dipterous larva having disappeared, they are replaced as occasion requires by variously developed false feet on the prothorax or on the anterior or posterior abdominal segments. The head may be perfectly developed as in other orders [Fig. 16], or it may be imperfect in structure [Fig. 51], not including the brain ganglia, and strongly retracted into the thorax, as in all the families herein reported on except the Ptychopteridæ. Respiration may take place by tracheal gills, usually filamentous or branching; or through the skin; or the insect may take in air at the surface through posterior terminal [Fig. 15] or anterior thoracic [Fig.19] spiracles. These are often elevated or variously fringed in order that connection with the air may be readily secured and maintained, and are usually chitinous and finely sculptured.

The pupa may be soft and enclosed in the last larval skin, which becomes hard and usually barrel-shaped; or it may be exposed and hard-shelled, with the appendages visible, resembling a lepidopterous pupa, but distinguished by the development of the thoracic spiracles. The feet are folded beneath, the tarsi pointing backwards and in contact along the middle line beneath; the anterior and middle pairs each individually in con-

*"Die Zweiflügler des Kaiserl. Museums zu Wien."
†"Manual for the Study of Insects," pp. 413-489.

tact, or one or both of these separated by the hind tarsi, making a group of four to six tarsi in contact side by side.

Head chitinous, either imperfectly or fully developed. Pupa exposed, or concealed in the last larval skin. The latter opens for the emergence of the pupa or imago by a longitudinal dorsal split, enlarged by transverse splitting so as to form a T or I-shaped opening..... *Orthorhapha.*

Head feebly differentiated, membranous above; body generally twelve-jointed, with only posterior or with anterior and posterior stigmata. Pupa concealed in the indurated subcylindrical last larval skin, which opens for the escape of the imago at the anterior end, either by a horizontal split over the mouth extending back to the fifth segment, or by a vertical entire or partial encircling split also, so that the anterior end, or only its upper half, comes off like a cap.. *Cyclorhapha.*

Orthorhapha—Larvæ.

Mandibles opposed, with biting horizontal movement. [Fig. 16.] (*Nematocera.*)

Body ending in a chitinous respiratory tube; no false feet on prothorax. (Moth Flies.)..... *Psychodidæ.*

Posterior respiratory tube, when present, not chitinous.

Head incomplete, small, retractile, not containing nerve ganglia; body segments twelve, abdominals in part often divided by a pseudo-suture into two divisions; posterior stigmata usually protected by fleshy teeth. [Fig. 24.] (Crane-flies.)..... *Tipulidæ.*

Head fully developed, not retractile, containing the first ganglia. [Fig. 16.]

Last segments drawn out into a very long membranous respiratory tube; false feet on some of the anterior abdominals..... *Ptychopteridæ.*

Respiratory tube wanting or rather short.

A row of ventral suckers and of lateral tracheal gills; body onisciform (sow-bug-shaped) and hard-shelled; living in running water..*Blepharoceridæ.*

No such rows of suckers and gills, body elongate, soft.

Larva moderately slender, with false feet on some of the anterior abdominals; swimming in a U-shape. (Dixa Midges.)..*Dixidæ.*

No false feet on anterior abdominals.

Body without false feet.

Body not very elongate and worm-like; thorax thickened, its segments more or less connate; last segment with a longitudinal fan of swimming hairs beneath, and often a short respiratory tube above. (Mosquitoes.).....*Culicidæ.*

Body very slender and cylindrical.

Last segment with two fleshy points. (False Crane-flies.).....*Rhyphidæ.*

Last segment tapering, entire, with sometimes a circular fringe of hair around posterior tip.

Chironomidæ (*Ceratopogon*).

Body with false feet.

False feet on prothorax and on last segment; body subcylindrical. (Midges or Gnats.).....*Chironomidæ.*

A single median false foot on prothorax; abdomen much broader posteriorly, footless, with a terminal sucking disk; head with a pair of fan-like organs. (Buffalo Gnats or Black Flies.).....*Simuliidæ.*

Mandibles parallel, their motion vertical or obliquely inwards. [Fig. 51.] (*Brachycera.*)

Posterior stigmata very approximate, placed within a terminal stigmatal cleft.

Stigmatal cleft vertical, head retractile. [Fig. 50.] (Horse-flies.).....*Tabanidæ.*

Stigmatal cleft transverse, head not retractile. [Fig. 58.] (Soldier-flies.).....*Stratiomyiidæ.*

Posterior stigmatal tubes or plates separated. (This includes all the remaining orthorhaphous families, of which but one genus belonging to the following family has been reported as aquatic.)

Head long, pear-shaped, retractile, ventral profile straight; 11-12 body segments; posterior stigmata on last segment. (Snipe-flies.).....*Leptidæ.*

Orthorapha—Pupæ.

Prothoracic spiracles borne upon appendages. (*Nematocera.*)·

Not in a cocoon, sometimes in the old larval tube.

Prothoracic respiratory appendages simple, slender, antenna-like.

Body subcylindrical.

First abdominal segment about as long as those following it; each pair of tarsi separately in contact, overlapping the pair next behind it. *Psychodidæ.*

First abdominal about one half as long as those following it.

Prothoracic appendages symmetrically developed [Fig. 31]; tarsi all in one group, side by side and not overlapping.....*Tipulidæ.*

Prothoracic appendages very unequal in length [Fig. 19]; anterior tarsi in contact, overlapping middle pair.....*Ptychopteridæ.*

Body convex, oval, hard-shelled above. *Blepharoceridæ.*

Prothoracic appendages simple but not filiform, sometimes compound.

These appendages more or less clavate.

Last segment large, ending merely in two pointed prolongations; prothoracic appendages short. *Dixidæ.*

Last segment various, not as in preceding family.
Prothoracic appendages short, simple, situated on the dorsal aspect of the thorax; pupa free-swimming..... *Culicidæ.*
Prothoracic appendages many-branched (Chironomus) or simple; situated on the anterior aspect of the thorax; pupa in the larval tube, or resting just beneath the surface, or floating (Ceratopogon) ..... *Chironomidæ.*
These appendages short and pointed..... *Rhyphidæ.*
Pupa in a membranous cocoon, which is tapering behind, open in the front, attached by ventral surface; prothoracic appendage few-branched. *Simuliidæ.*
Thoracic spiracles sessile. (*Brachycera.*)
Pupa enclosed in last larval skin..... *Stratiomyiidæ.*
Pupa free, not active. [Fig. 43.]..... *Tabanidæ*, *Leptidæ.*

Family PTYCHOPTERIDÆ.

The immature stages of the genus Ptychoptera have long been known to science; and I have now to add some observations on the life history of the remarkable and interesting *Bittacomorpha clavipes.* Baron Osten-Sacken's statement that the relationship of these genera is "very great and evident, all the differences of the outward appearance notwithstanding," is abundantly confirmed by their immature stages, which are very much alike in structure and appearance.

The larvæ [Fig. 15] live in shallow waters filled with dead vegetable matter, leaves, or rushes. They are not predaceous, and probably live on the minute growths which would form in such situations. The head is well developed, the body elongate-cylindrical, some of the anterior abdominal segments bearing well-developed false feet, and the posterior segments drawn out into a very long partly retractile respiratory tube. In the pupa [Fig. 19], on the contrary, one of the usual prothoracic

respiratory appendages is developed into an extremely long and slender breathing tube, while the other remains more or less rudimentary—an interesting modification.

The structure of the larval head [Fig. 16] separates this family at once from the Tipulidæ, among which it is usually included. The larvæ and pupæ, however, as well as the imago, have a tipulid *habitus* and mode of life, and the two families should not be widely separated.

The larva of our American Ptychoptera is unknown. The European species of the genus, according to Dr. Brauer, have false feet on the 2d, 3d, and 4th abdominal segments, while in Bittacomorpha they are borne on the 1st, 2d, and 3d.

Bittacomorpha.

Bittacomorpha clavipes Fabr. [Fig. 15-22.]

Station I has previously been described—a shallow swampy slough, bearing a considerable growth of willows, and full of rushes, Sagittaria, and swamp grasses. In the exceptional spring of 1895, the river was not high enough to enter this passage, and in March and April it remained choked with a mat of dead stems, grass, and willow leaves, through which a broad stream of spring water from the bank, a few inches deep, slowly worked its way towards the river.

In this mat of dead stems the Bittacomorpha larvæ [Fig. 15] were abundant March 17. Their cylindrical form, rusty-brown color, and the absence of sutural constrictions made them look much like a decaying piece of grass stem; but they usually revealed themselves, when a mass of material was being searched, by their habit of coiling up when disturbed. The larvæ were still abundant March 28, and stomachs examined were found to be filled with a solid brownish mass, largely diatoms, the remainder mud and dead vegetable tissue, they having evidently fed on the brownish diatomaceous growth which coated the decaying stems. April 9 and

15 larvæ were still present, though in diminishd numbers, but careful search failed to reveal a single pupa or imago. In the breeding-cages the larvæ spent much of their time in the deeper water, their tubes extended but not reaching the surface, and at other times were hidden near the surface, the tubes extended, their tips making a minute hollow in the surface film, but instantly withdrawn if the cage or its contents were disturbed.

Towards the end of March, the larger larvæ in the breeding cage began to show a swelling and lighter color of the thoracic segments, and on March 29 an examination of the cage was made which revealed four pupæ. The loose skin of a larva about to pupate was removed, revealing the soft white pupa. [See Fig. 18.] The left respiratory tube was rudimentary and crooked. The other was coiled between the larval and pupal skins, forming first a double spiral on the right side, then passing around beneath to the left side, where it formed a similar spiral, then crossing the dorsum to the right side again, and making a turn or two there, among the first coils, finally ending at the middle of the under side, having extended one and a half times around the segment. In making this extensive growth it seems to have crowded out and dwarfed its fellow of the left side. The tube rapidly straightens out after pupation, and soon becomes quite straight and bristle-like. The pupæ [Fig. 19] are able to move a little by efforts at crawling and by side-to-side strokes of the posterior extremity. One was isolated and rested quietly in a vertical position, the end of the tube just above the surface of the water. April 6 this produced a fine female imago, and another emerged a few hours later in the stock cage, each leaving its empty skin floating at the surface. Next day a male appeared in the cage, and a number of pupæ were found to be present. One of the examples which emerged had had the greater part of its breathing tube accidentally broken off several days before. Pupæ

were still being formed April 16 among the few larvæ which remained in the cage.

The imago is said by Osten-Sacken to occur early in spring, and also, but more seldom, in autumn. September 3, I saw a number in flight over a shallow reedy flat, bordering Geneva Lake, Wis. Their singular and ghostly appearance as they floated slowly by with their black and white legs radially extended will never be forgotten.

Larva [Fig. 15–17].—Full length 50–60 mm., diameter 2.6–3 mm., an elongate, rough-skinned larva, with a smooth retractile respiratory tube about 20 mm. long when extended; tapering gradually anteriorly to the short broad head; pale rusty brown, surface coarsely granulate, granules blackish when in liquid; covered with regular rows of small setiferous tubercles.

Head [Fig. 16] fully developed, broad-ovate, convex above, constricted at base; light yellowish brown, lateral plates with four more or less curved oblique bands of confluent black dots at base above, apex of middle triangle filled with black mottlings, in front of this a median double row of dots, and a spot each side; eyes at about middle of side, inconspicuous; antennæ in the angle over base of mandible, short, first joint about twice as long as thick, with a terminal seta, second joint very minute; labrum transverse, with two blackish spots; mandibles very short and thick, exterior outline strongly rounded, apex pointed, a prominent tooth within, with an exterior fringe of ciliæ, and an oblique cutting edge at its apex; maxillary palpi small; mentum bidentate.

Thoracic segments short, each but little longer than the head, roughly tuberculate; first six abdominals with very inconspicuous sutures and covered with small setiferous tubercles, arranged on the dorsum and venter in regular transverse rows, slightly interrupted on the median line, limited each side above and below by a longitudinal smooth line; on each side between these

smooth lines three longitudinal rows, with two intervening rows less plainly indicated; behind the middle of each segment the middle row rises, and in the greater space between it and the lower row, the intervening row becomes fully developed. The first four abdominals gradually increase in length, the first one being about as long as the thorax; the first three bear near their posterior margin beneath, a pair of prominent false feet [Fig 17], each with a sharp slender claw or hook at apex; the fourth and fifth are about equal in length; the sixth is about two thirds as long and conically narrowed towards apex; the seventh is much narrower and shorter, scarcely half as long as the fifth, at base about half the diameter of the main body, and narrowed to apex, reddish brown, granulate and sparsely pilose, the setiferous tubercles almost wanting; the remaining two segments form a long and very slender partly retractile respiratory tube with the stigmatal opening at the tip. dirty whitish, smooth, and semi-transparent, the eighth segment short, about as long as the seventh, the ninth extremely long and attenuated, as long when extended as the distance between its base and the third pair of false feet, bearing at its anterior third, beneath, a pair of slender tracheated filaments about one half the length of the basal part of the segment.

Pupa [Fig. 18-22].—Length 20-25 mm., exclusive of the long respiratory tube, which measures about 35 mm.; diameter of abdomen 2.5 to 3 mm. Cylindrical, thorax slightly thicker; abdomen dirty whitish, with numerous spots and transverse bars of brownish fuscous, which bear minute cylindrical setiferous projections; thorax light to dark fuscous brown.

Head quadrituberculate in front. Respiratory tubes arising close to anterior margin of prothorax, unequal, one of them greatly elongated and bristle-like, about .2 mm. in diameter, slightly tapering, finely annulated, ending in an oblong yellowish brown knob, with a flat-

tened button-like apex having radial slits, apparently closed by a delicate membrane; a longitudinal row of minute brown thickened rings (one ring to every ten to twenty annuli) extending from near base to apex. From each of these rings protrudes a delicate membranous papilla, and a short membranous tube unites it within to the trachea, which extends the entire length of the respiratory tube [Fig. 20]. The other tube is usually only about 2 mm. long, slender and twisted, but of similar structure, tracheated, and with numerous lateral papillæ. The right tube was developed in 23 pupæ, and the left in 3; in one, both were developed, but still unequally, the right 21 mm., the left 13 mm. long, their combined length thus about equal to that of the singly developed tube. Thorax and base of abdomen above transversely wrinkled; tips of middle and hind legs closely applied and ending equally at apex of second abdominal, anterior legs overlaying the middle pair and shorter.

Abdomen similar in vestiture to that of larva; dirty whitish, with brownish fuscous closely-set transverse plates above and below, confluent towards its base, each bearing a row of cylindrical tubercles with a stellate circle of acute diverging teeth at apex, and a central seta [Fig. 21]; lateral areas with longitudinal rows of fuscous dots, bearing similar setiferous tubercles; position of larval false feet feebly indicated; sutures marked by a broader whitish line; segments increasing in length to the fifth abdominal, which is nearly twice as long as thick; sixth and seventh indistinctly separated, together shorter than fifth; seventh with the dorsal and ventral transverse bars broken up, and a semicircular fuscous apical area above and below; eighth and ninth very short but distinct, yellowish fuscous, pallid near the sutures, eighth with a few setiferous tubercles and a spinous hook beneath, ninth with a fleshy projection above, and a pair of small spinous teeth beneath, ending in the female with a pair of conical contiguous projec-

tions, each with a small tooth at outer side of apex; in the male [Fig. 22] with a thicker rounded apex, bearing small lateral teeth and another pair behind the dorsal fleshy projection.

Family TIPULIDÆ.

This family is largely aquatic, especially among the Limnobiinæ, no less than fourteen genera being more or less definitely known to live as larvæ in water or burrowing in saturated earth in its vicinity. Even a considerable number of species in the genus Tipula have this habit. The diet of most species is probably vegetarian, although Miall has described* a carnivorous species of Dicranota which burrows in muddy shores, preying upon *Tubifex rivulorum*, a small aquatic worm.

The larvæ are usually pubescent, with a few small bristles which assist in locomotion. The last segment generally ends in fleshy projections of various forms, often as prominent fleshy teeth protecting the stigmatal openings. In both larva and pupa each abdominal segment, except the first and the last, is frequently more or less divided by a pseudo-suture into an anterior and posterior portion, the anterior division differing from the posterior.

A very remarkable piece of work has been carried on by Th. Beling,† who has reared and described in three successive articles immature forms of seventy-eight European Tipulidæ, including twenty-nine species of Tipula. He has arranged a key to the genera and species described, but this being somewhat artificial and based largely on the characters of the last segment, does not work very satisfactorily for the American genera. The primary subdivision of the family into two parts, which seem to be of subfamily rank, is taken from Brauer.

*Trans. Ent. Soc. London, 1893, p. 235.

†Verh. d. k. k. zool.-bot. Gesellsch. in Wien, 1873, p. 575; 1878, p. 21; and 1886, p. 171.

KEY TO GENERA OF AQUATIC TIPULID LARVÆ.

I have carefully translated here Brauer's statements of the characters of his two subfamilies, but have been unable to verify them satisfactorily from my material.

The last segment is subtruncate above the anal prominence, and at the center of the truncation is usually a pair of brownish stigmatal plates, often protected by a ring of fleshy points or teeth. In the Limnobiinæ [Fig. 24] this ring may consist of five teeth, the odd one at the middle above, changing to four teeth by the disappearance of this middle tooth; or in some there are merely two large teeth below the stigmata; or the teeth are very blunt or wanting. In the Tipulinæ [Fig. 33] six teeth about the stigmatal field are almost always present.

Mandibles hook-like, slender, usually not toothed, maxillary palpi long; antennæ small; last segment often with single or double stigmatal tubes, sometimes a pair of stigmatal plates; apex never distinctly stellate; often with false feet on prothorax or abdomen. (*Limnobiinæ.*)

Body with dorsal respiratory filaments....*Phalacrocera.*

Without dorsal respiratory filaments.

Last segment ending in a pair of long tail-like appendages, with the stigmata at their base, above. (*Amalopini* and *Gnophomyia.*)

Abdomen with false feet.

Pedicia, *Dicranota*, *Gnophomyia.*

Abdomen without false feet.....*Amalopis.*

Last segment [Fig. 24, 27] with five teeth about the stigmata, the median above being about equal to the others in size; dirty yellowish or brownish, usually roughened or pubescent.

Teeth all striped or blackish on inner face.

Erioptera.

Three upper teeth brownish on inner face; lower pair brown-margined.....*Symplecta.*

Last segment with tubercles or four short thick teeth about the stigmata; smooth, often shining, transparent white or yellowish. (*Limnobiini.*)
Rhipidia, ?Geranomyia ?Dicranomyia.

Last segment [Fig. 30] with a lower and upper pair of fleshy teeth about the stigmata, the median one above wanting or much smaller than those of the upper pair; or the segment rounded off and entirely without teeth; teeth often bearing long hair: dirty yellowish or brownish, usually roughened or pubescent....*Limnophila, Gonomyia.*

Mandibles thick, toothed, maxillary palpi short, antennæ longer and distinct; last segment [Fig. 33, 36, 37, 39] stellate, with radiating teeth, usually six or more, about the two round stigmatal plates; prothorax without false feet. (*Tipulinæ.*).....*Tipula.*

Subfamily Limnobiinæ.

Erioptera.

E. graphica O.-S.

This pretty little tipulid was taken twice upon the cabin-boat at Station C, flying about a lantern, and the larva is very likely similar in habits to Symplecta. The dates were May 3 and 5, and we have found the imagos also in Champaign county May 28, July 2, Aug. 5–17, and Sept. 14. According to Beling, the Erioptera larvæ live mostly in wet or moist earth.

Erioptera? sp. (*a*). [Fig. 23–25.]

An interesting larva was found this spring (1895) in Flag Lake, where floating rushes had collected by drifting against standing stems. On pressing down and submerging the floating mass, these larvæ were seen struggling in the water, conspicuous by their very dark colors. Their structure evidently locates them near this genus. They were found April 11 and 13. They are very active swimmers, and as restless as a tabanid larva. Their development in the direction of abdominal prolegs, jointed anal appendages, and double prothorax shows a

relationship with the predaceous genus Dicranota, and suggests the possibility of a like habit of life.

Larva [Fig. 23–25].—Length 12–13 mm., diameter about 1 mm. Cylindrical, elongate, body tapering slightly near each end, densely covered with fine silky dark brown or nearly black pubescence, not transversely arranged, with only a few erect setæ, surface of body fusco-testaceous.

Head oblong, retractile, depressed, prolongations converging behind, surface mostly dark brown or blackish; antennæ short, first joint oblong, pale brownish, second very small and slender; mandibles dark brown, three large blunt teeth near apex, and a few on lower edge; remaining mouth parts testaceous or whitish, labrum whitish on disk; mentum blackish, trilobed; gular membrane rather long and narrow, a pair of curved points invading it anteriorly.

First four segments about as long as wide, first longest and divided into two parts by a well-marked suture; next six about twice as long, divided by pseudo-sutures into two divisions; eighth abdominal narrower, broader than long, last a little shorter. Body each side with an indistinct lateral line above and below the lateral area, consisting of whitish dots. Dorsal and ventral surfaces of first four segments and posterior division of next six with a small central bare spot, from which arises a dark seta or bristle; thoracic segments laterally with a dark seta, first abdominal and remaining posterior divisions with two lateral setæ. Anterior divisions with a short transverse pale line each side above. Divided segments (second to seventh abdominals) with a prominent large transverse elevation beneath on anterior divisions, lighter colored and bordered by a pale line, covered with minute scabrous points in close and regular transverse rows; lateral areas with a few large wart-like paler tubercles near each suture.

Last segment [Fig. 24] with posterior face whitish, surrounded by five subtriangular fleshy teeth, somewhat

longer than broad at base, a continuous close fringe of soft hair about as long as the basal breadth of a tooth extending along the margins of the teeth, over their apices, and across the intervening spaces. Teeth sooty brown within, with a median pale streak; upper tooth slightly smaller, with two minute dark rings on inner face, lower pair with a seta at tip. Stigmatal plates broad-oval, with dark brown centers encircled by two yellowish rings, the outer paler, anal prominence elevated, membranous, transparent, with a pair of transparent, tapering appendages each side, distinctly two-jointed, tips visible from above [Fig. 25].

SYMPLECTA.

S. punctipennis Meig. [Fig 26–28.]

The pale cylindrical larva [Fig. 26] of this common little tipulid seems quite at home in the shore of Quiver Lake at Station C, examples being found at the same time with *Tabanus atratus* larvæ by passing the sand through a sieve. It was perhaps this that the tabanids were feeding on. The larvæ were noted as especially abundant on May 17. A single example was taken near the margin of Matanzas Lake, Aug. 24. Larvæ taken May 17 gave imagos within a month. Dec. 13 an imago was taken at Station D, another was seen Mar. 26, and at Station G, Apr. 10, a female was noted flying about on the shore, patting the tip of her abdomen against the moist sand, presumably ovipositing. Oviposition was still going on freely Apr. 25. Our general collections show that adults are very abundant in April and May, nearly all our specimens being taken in these months. Again, July 23, one appeared at Station C; and our collections contain two taken in August, and two in October. They occurred mostly in grassy places, in meadows, and in fields of grain, but one example was taken at an electric light. As regards distribution in the State, they were

from McLean, Champaign, Wabash, and Clark counties. The later broods, if any occur, must generally be limited by the lessened extent of suitable places for the larvæ.

Both larva and pupa [Fig. 26–28] have been carefully described by Beling.* The brownish inner surface of the fleshy teeth is quite pale in my specimens. The anal prominence is prolonged each side into a long tapering filament. The pupa has distant respiratory tubes and feet ending unequally, the second pair being shortest and the third longest.

Geranomyia.

Two species of the genus were taken at Station C, and an observation made on one individual indicates semiaquatic habits, although nothing is known of the larvæ at present.

G. rostrata Say.

The only example we have is a male taken July 23.

G. canadensis Westw.

The imago was seen flying with a short and rapid up-and-down oscillation over the wet sandy shore, at each descending movement tapping the moist surface with the tip of its abdomen. This possibly corresponds to the dipping flight of Chironomus previous to oviposition, but it seems more likely that the female was laying her eggs at the time. This was on July 16, and collections made July 23 show that adults were abundant at that time. We had previously obtained the species April 30 and May 18 in Champaign county.

Limnophila.

L. luteipennis O.-S. [Fig. 29–31.]

This is another form which seems to find very favorable surroundings in the swampy slough already referred to, among the Bittacomorpha and small tabanid larvæ, very possibly now and then affording a meal for the

*Verh d. k. k. zool-bot. Gesellsch. in Wien, v. 28, p. 50.

latter. The larvæ were first noticed there on March 17, 1895, their dirty brown color rendering them difficult of detection. They were then about half to two thirds grown. More were taken on the 28th, from which a pupa [Fig. 31] was obtained April 13. Two days later an examination of the original situation revealed an abundance of mature larvæ and several pupæ, which were placed in breeding-cages. April 20 was warmer than usual, and the majority of the larvæ then pupated, while the pupæ all transformed into males of the above species, agreeing in every detail with Osten-Sacken's description and figure in his monograph of the Brevipalpi. The first pupa mentioned had already transformed on the 18th. During the next few days most of the pupæ allowed to remain reached the final stage. A single pupa had been previously found in 1894, Aug. 16, at Station B. The imagos are said by Osten-Sacken to be common from early spring through the greater part of the summer.

It was ascertained by dissection that the larval food was very similar to that of the Bittacomorpha, the intestine being packed with a cylindrical mass consisting largely of fragments of dead vegetation, with a great profusion and variety of diatoms and a quantity of peculiar tapering filaments which seem to be minute algæ.

An interesting feature of the species is the high development of delicate fringes about the respiratory openings [Fig. 30]. As seen in the water, the larva apparently has a tail-like appendage on the last segment; but the moment this is brought to the surface, it opens and expands, forming a broad fringe about the spiracular disks. It can then be seen that the latter are protected by four narrow black lamellate appendages, a shorter one on each side and a pair of long ones just below, their edges closely fringed with long fine hair, very long toward their tips, the fringe being continued across the intervening spaces, so as to completely enclose the stig-

matal field. This fringe takes so strong a hold on the surface film that the larva cannot release itself by swimming; it does so by looping the head and anterior portion around the posterior extremity, and withdrawing the latter through the loop, repeating this action rapidly until it has sunk beyond reach of the film.

The anterior respiratory tubes of the pupa are dilated and membranous at tip, and provided with a terminal pair of membranous flaps which spread out on the surface film, thus maintaining communication with the air while the body is concealed in floating trash. Many pupæ crawled up on the sides of the breeding-jar when about to transform; others remained floating. One pupa cast its larval skin by simply working itself out below through the anterior dorsal split, as the skin hung suspended by the posterior stigmatal fringe. As the larval skin is delicate and elastic, the contraction of a few segments sometimes causes a surprising dilatation of one or two adjoining.

Larva [Fig. 29, 30].—Length 15–18 mm., diameter 1.5 mm.; tapering gently forward from the anterior third, and slightly narrowed at the posterior end. Light yellowish fuscous, or olivaceous, posterior end and appendages more or less thickly mottled with a sooty-black incrustation, extending forward a short distance upon the dorsum; surface with rather long silky brown pubescence, attached in transverse series, and sparser long erect hair, grouped in five transverse rows on each segment above and below, indistinct except near the posterior end, where these hairs are blacker and more conspicuous.

Head depressed, oblong, middle internal posterior prolongations broad; black, antennæ and mouth parts testaceous, except mandibles, which are black; antennæ slender, first joint with an apical seta on each side; second joint cylindrical, very slender, a little shorter than the first; mandibles with two narrow apical teeth, lower edge serrate. Thoracic segments each about equal

in length to width of the prothorax at base; fourth segment a little shorter; remaining segments except last two equal and distinct, about twice as long as the thoracic. A dorsal small bare spot, at base of a long erect brown seta, on middle of first four segments, and the posterior division of remaining ones, except last.

Last segment [Fig. 30] whiter on posterior surface, which bears four narrow elongate lamelliform appendages, black and transversely striate within, with narrow pale margins, their exterior surfaces whitish fuscous, their margins densely fringed with long fine brown hair, that from near the outer ends very long; fringe continued across intervening spaces, so as to enclose completely the stigmatal field. The lower pair of appendages are below the stigmata, their bases connected by two dark brown streaks angulated forwards at middle; they are about as long as the apical diameter of the segment and the apical part of their fringe is two or three times as long; above these on each side are the other two, about one third as long, their bases partly surrounding posteriorly the large pale testaceous stigmata, with large dark brown centers. Exteriorly, the lower pair bear several black setæ, and the upper pair a single seta near tip. Below these appendages are two short setiferous fleshy tubercles. Surrounding the anal opening beneath are four long tentaculiform appendages, about as long as the last two segments, the two anterior directed laterally; the posterior, backwards and outwards.

Pupa [Fig. 31].—Length 10–13 mm., diameter about 1.5 mm. Subcylindrical, slightly depressed, subopaque; thorax slightly thicker at middle, reddish brown to black; abdomen dirty whitish, surface with light fuscous-brown transverse bars above and below. Prothorax with a pair of dark brown or black respiratory tubes, near anterior margin, not distant, about as long as the distance from their bases to the apex of the first abdominal, finely annulate, curving downward and in-

ward till side by side, then parallel to their tips, which are membranous and dilated, with a pair of membranous terminal flaps; prothorax strongly carinate on median line; mesothorax nearly smooth, a pair of small tubercles over bases of wing-pads, latter ending at apex of second segment; legs blackish apically, tarsi side by side, their sutures and tips quite evenly in line, latter near apex of third segment. Third to seventh abdominals with transverse chitinous darker bars, studded with small pale conical spines with sharp blackish points, each tipped with a hair; anterior divisions of these segments with four ventral and three dorsal narrow bars, each with a row of spines; posterior divisions with a single broader bar, bearing a row of spines near its anterior, and another near its posterior margin; first abdominal, and posterior bar of remaining segments except last two with a pair of black dots each side of middle, exterior to which is a short longitudinal slightly oblique line; a similar marking beneath; lateral margin irregularly spined, posterior angles of each segment rather prominent.

Eighth abdominal whitish, a few spines above, a narrow and sharply prominent spinous ridge at apex on each side beneath; last segment with a pair of small dark finger-like appendages at base above, apex ending in ♀ in a pair of long, slender, tapering, connate, recurved reddish brown projections, each with a minute spinous tooth at outer side of apex; beneath these and applied to their under sides is a similar but shorter bifid projection. In the ♂, the upper pair are diverging, and beneath them is a smaller and more obtuse pair, contiguous throughout, resting against the bases of the pair above.

Limnophila? sp. (*a*).

A single ♀ pupa was found Aug. 24 in White Oak Run, at the head of Matanzas Lake, which seems to be of this genus, and I therefore describe it here.

Pupa.—Length 13 mm., exclusive of respiratory tube, diameter of abdomen 1.6 mm., thorax scarcely broader; abdomen depressed, with prominent margins. Dark chestnut-brown, wings and thorax blackish, sides of abdomen paler, covered with an opaque ochraceous crust when dry, shining above and on appendages where denuded.

Head with a row of four minute setiferous tubercles above antennæ. Prothorax anteriorly with a pair of porrect cylindrical respiratory tubes, finely annulated, about 2.5 mm. long, sinuate, and darker and a little thicker at base, outer portions parallel and contiguous in fact, about as in *luteipennis;* median line above them strongly carinate. Mesothorax nearly smooth; wing-pads ending at apex of second abdominal; tarsi side by side, with joints and tips evenly in line, latter at apex of third segment.

Abdomen not barred, anterior divisions of the second to the seventh abdominals with two dorsal folds, each with a pair of small sharp teeth; posterior divisions with a similar pair of teeth on the anterior and posterior margins, the latter pair included in a close-set row of minute teeth. Beneath, except under the wing-pads, these segments show the same structure, except that the anterior division has three folds, the teeth of the middle fold nearest together. The lateral margins are rather sharp, and bear four sharp teeth, one opposite each set of discal teeth.

Penultimate segment very short, armed with two pairs of dorsal teeth and a prominent lateral tooth, beneath smooth; last segment with three elongate conical recurved projections nearly as long as the preceding segment, an upper pair and a shorter cleft one below, all closely contiguous.

The abdominal sculpture is quite distinct from that of the pupa of *luteipennis.*

Subfamily Tipulinæ.

The larvæ of this subfamily seem to be for the most part terrestrial, living in damp situations and feeding on living and dead vegetation, especially dead leaves and roots. A number of species of Tipula, however, are more or less aquatic, some being quite at home in shallow waters and on wet shores. Pachyrhina is scarcely distinguishable from Tipula in the larval stage. It is not yet known to contain aquatic species and so does not appear in the key, but some species occur in the bottom-lands of the river, and both genera are therefore treated in full. There are a large number of species of Tipulinæ, and the differences are often very slight. Some have soft fleshy tentacular appendages about the anal opening [Fig. 33] which assist in progression, and very likely act as tracheal gills—as do similar appendages in Bittacomorpha and Chironomus. Many of the preceding subfamily (Limnobiinæ) also possess them.

COMMON CHARACTERS.

To avoid repetition and as a general description, the characters common to all immature Tipulinæ studied are given here.

Larvæ.—These are about an inch long (20–30 mm.), rather thick, cylindrical, tapering rapidly in front to the head, and suddenly truncate behind; dusky gray, often tinted with brownish or yellowish, covered with microscopic short dark pubescence, sides paler.

The exposed part of the small head is proportionally broad, flat above, dark brown marked with a whitish + mark. The transverse bar is at the base of the labrum, between the antennæ; the labrum is conspicuously divided into three portions; the narrower middle portion is pale forming the anterior arm of the +; the broader lateral portions are dark brown and bear stiff hairs or spines and often a small tubercle. The antennæ have a broad

conical whitish fleshy base bearing a reddish brown cylindrical joint about four times as long as thick, and slightly curved. At its tip is a small hemispherical whitish joint, and beside this a pair of minute points. The mandibles are broad and usually bluntly toothed on the margins. The maxillæ are also broad and thick, their palpi resembling the antennæ, having a pale conical base and a chitinous short joint bearing a minute terminal joint. The membranous area of the throat (gular area) is Λ-shaped, and the mentum has a slender trifid or many-toothed apex curved up into the mouth and often concealed.

First four body segments about equal in length, gradually thicker, next six about twice as long, divided by a pseudo-suture near middle into two divisions. The anterior divisions are divided above and below by transverse impressed lines into three or four folds; the posterior divisions are less distinctly divided into three folds, the middle one of which is usually larger and with a darker transverse ridge, bearing above and below minute black stiff hairs or setæ, usually four equidistant ones in a straight line above, and four below, the middle pair further forward than the outer pair. Often a close-set pair of setæ appear in place of each seta beneath.

The last two segments are not double and are about half as long as those preceding. On these segments and on the thorax the pubescence is thicker, and the same setæ are present, but more numerous on the thorax. At the apex of the last segment [Fig. 33,36,37,39] beneath is the soft fleshy anal prominence encircled by a fine dark line, variously shaped according to the species, often with long appendages, and used in crawling. Above this the posterior side of the last segment is abruptly truncate, bordered by fleshy or horny points, enclosing the stigmatal field, in the center of which is a pair of large brown or black round stigmatal plates.

Pupæ [Fig. 34].—Color dark brown or black, cylindrical, slightly tapering behind, the surface more or less finely transversely wrinkled. The base of each antenna bears a small tooth or angulation, and a pair of small teeth lie between them. The prothoracic respiratory tubes are rather distant at base, divergent, and not more than twice as long as the distance separating them. They are finely ringed and are knobbed at tip, with an apical vertical slit, apparently closed by a membrane. Between the tubes the prothorax at middle is carinate. The mesothorax bears a small tubercle behind each respiratory tube, and a more acute pair at middle of disk above. The wing-pads attain the apex of the second abdominal segment. All six tarsi lie side by side on the breast, nearly or quite exactly in line, and attaining apex of third abdominal.

The abdominal segments are proportioned about as in the larvæ, segments 2–7 being double. Each bears near its posterior margin a row of short thick spines. The lateral margin is narrow and prominent, and also spined. The last two segments are closely united, the last one bearing four spiny teeth above, and a prominent large pair behind these. The end in the female is conical and pointed, being apparently composed of three united slender tapering prolongations, two above and a broader deeply bifid one below. In the male the end is thick and more or less truncate, each side bearing three small tubercles or teeth

KEY TO LARVÆ OF TIPULINÆ.

Anal prominence bearing six finger-like appendages. Stigmatal teeth six, broad, rather short, about equal. [Fig. 33.]

One or two irregular stripes of brown pubescence each side of back. Aquatic.....*Tipula eluta.*

Back not striped with pubescence. Terrestrial. *Tipula bicornis.**

*Sixteenth Rep. State Ent. Ill., p. 78.

Anal prominence broadly tuberculate or with a short horn each side. Lower stigmatal teeth small, distant from the four above. Setæ of posterior divisions about equidistant. [Fig. 36, 37, 39.]

A pair of acute fleshy teeth anterior to the outer pair of stigmatal teeth; anal prominence quadrituberculate.....Larva (*a*).

No teeth anterior to the stigmatal ones.

Upper four teeth very long and acuminate, the ends overhanging stigmatal field; anal prominence with a large thick acute horn each side. Aquatic. [Fig. 36.].....Larva (*b*).

Upper four teeth straight or recurved; anal prominence broadly tuberculate. Terrestrial.

Inner pair of teeth above not longer than outer pair, pale on anterior face.

No black on four upper teeth except sometimes at their bases.

Teeth all pale except a black dot at tips of lower pair; outer twice the length of inner pair.....Larva (*c*).*

A black stripe at base of inner teeth and often a black line on base of outer teeth; upper face of lower teeth broadly black. Larva (*d*).†

*This larva, taken from amongst the roots of wheat near Urbana May 4, is shrunken by alcohol, but quite a distinct species.

Length about 15 mm. Dark fuscous, pubescence scarcely visible, indicated by short microscopic transverse lines; folds distinct, three impressed lines on anterior divisions; usual setæ present. Upper stigmatal teeth whitish posteriorly, their tips rather slender and pointed, the outer pair about twice as long as the inner pair; lower teeth distinct, whitish, a minute black ring at tip, and a pair of brown dots at their bases; some dots between the stigmatal plates, the latter not distant. Anal prominence with two broad tubercles below the anal opening, and a pair of lateral tubercles.

†This was also collected near Urbana, under the bark of old logs in woods, and seems to be quite common there. The specimens examined were collected April 6 and 12.

Length 25–30 mm., diameter 3.5 mm. Transverse pale line of head rather broad. Yellowish dusky, pubescence distinct, transverse arrangement well marked; folds of segment evident; middle one of posterior divisions bearing above and below a narrow low transverse darker ridge upon which are the usual four setæ. Upper teeth of last segment nearly equal in length, the outer pair distinctly thicker and less acute, inner pair with a lunate-triangular black spot at base of each; apex of lower teeth white, remaining upper surface broadly black or dark brown in subquadrate form. Stigmata large, black, not distant. Anal prominence with a lateral and inferior pair of broad tubercles.

Inner pair of upper teeth black posteriorly, lower teeth blackish at base and apex above. [Fig. 37, 39.]

Black line of outer teeth nearly reaching apex; lower teeth not blackish margined. [Fig. 37].....*Tipula* sp. (*e*).

Black line of outer teeth not extending beyond middle; lower teeth blackish margined. [Fig. 39].....*Pachyrhina ferruginea.*

Inner pair of teeth longer than outer pair, entirely black, smooth, slender and hook-like, with sharp recurved points; stigmata distant; lower teeth with a short black line. Larva (*f*).

PUPÆ OF TIPULINÆ.

The pupa of *Tipula eluta* [Fig. 34] has a pair of spinous teeth beneath in front of the usual row. In *Tipula* sp. *e* the ventral row on the fourth abdominal is complete at middle, as on the segments which follow, but in another species and in *Pachyrhina ferruginea* this row is interrupted at middle behind the tips of the tarsi.

Tipula eluta Loew. [Fig. 32–34.]

On the clean sandy shore at Station C, we noted March 10 an occasional tiny ridge near the margin, like a miniature mole-hill. Such raised lines are due to the burrowing of various aquatic species, but in this instance each was traced to a plump grayish larva [Fig. 32] looking much like the Tipula larvæ found in grass lands. These larvæ were again seen April 14 and 18, being moderately common on shore under high water drift, in rubbish near the margin, and among the floating vegetation along shore. They were pupating at the latter date, and imagos were obtained May 4. Young larvæ were abundant late in May and the older larvæ

were found in diminished numbers in late July and August, while pupæ occurred in August and September. The imagos became common early in May and continued so for several weeks. None were seen later until copulating imagos were noted at Matanzas Lake Aug. 24. Others were occasionally observed afterward, specimens being taken Aug. 30 and Sept. 15. The same interval occurs in our general collections, the imago having been taken five times between May 1 and 23, five times between July 18 and August 16, once on Sept. 19, but not at any other time in Illinois. We have examples from New Orleans, La., collected April 23. Our other material is all from Peoria, McLean, and Champaign counties. The above data would indicate that the species is two-brooded, hibernating as a larva and emerging early in May, the second brood maturing in late summer and early fall.

That the larva is by no means limited to a riparian range was shown by the occasional finding of a larva or pupa in the extensive areas of shallow water at the head of Quiver Lake, one being taken with a dip-net from the bottom where the water was entirely free from standing or floating vegetation. The long fleshy anal appendages are doubtless analogous to the posterior filaments of many Chironomus larvæ, assisting in the aëration of the blood. The movement of the body-contents of the larva in crawling alternately relaxes and dilates these appendages and as they project obliquely backward they help in locomotion. The imago flies by night, and is one of the species attracted to lights, where much of our material has been obtained.

RECORD OF TIPULA ELUTA FOR THE YEAR.*

Dates.	A.	B.	C. E.	C. W.	D.	E.	F.	G.	B.-C. &c.
Feb. 26	.....	.....	L-2	.....	.....	.....	.....	.....	.....
Mar. 10	.....	.....	L-3	.....	.....	.....	.....	.....	.....
" 17	.....	.....	.....	.....	.....	.....	.....	.....	L-1; Slough.
" 18	.....	.....	L-1	.....	.....	.....	.....	.....	.....
" 22	L-1	.....	.....	.....	.....	.....	.....	.....	.....
" 22	.....	L-1	.....	.....	.....	.....	.....	.....	.....
Apr. 14	.....	.....	L-3	.....	.....	.....	.....	.....	.....
" 18	.....	.....	L-3	.....	.....	.....	.....	.....	.....
May 3	.....	.....	♀-2	.....	.....	.....	.....	.....	.....
" 4	.....	.....	.....	.....	.....	.....	....	.....	♂, ♀, P; B.-C.
" 5	L-1	.....	.....	.....	.....	.....	.....	.....	.....
July 21	.....	.....	L-1	.....	.....	.....	.....	.....	.....
" 23	.....	.....	♂-1	.....	.....	.....	.....	.....	.....
Aug. 11	.....	.....	L-2	.....	.....	.....	.....	.....	.....
" 13	.....	.....	P-1	.....	.....	.....	.....	.....	.....
" 24	.....	.....	.....	.....	.....	.....	.....	.....	♂ ♀; Matanzas L.
" 30	♂ & ♀-2	... ..	.....	.....	.....	.....	.....	.....	.....
Sept. 14	P-1	.....	.....	.....	.....	.....	.....	.....	.....
" 15	.....	.....	.....	.....	.....	.....	I-1	.....	.....

Larva [Fig. 32, 33].—Length about 30 mm., diameter 3–3.5 mm. Head blackish, transverse pale line not broader at middle, second antennal joint minute, mandibles with four or five blunt teeth.

Body whitish gray, more or less brownish, especially on the thorax. Surface covered with fine short brown pubescence arranged in minute short transverse rows, which is aggregated on the dorsum into two wavy longitudinal brown stripes, interrupted at the sutures, beginning near together on the mesothorax, bounded externally on this segment and the next by denser

* See foot-note ,p. 169.

brown pubescence, especially behind the middle of the segments; diverging till they reach the fifth segment, converging inwardly just back of each false suture; traces of an outer pair of lines present, which at these points curve outwardly and become stronger. These stripes are not evident in young larvæ. On the posterior portion of each double segment are six black setæ on each side, in small bare spots surrounded by heavier pubescence, the bases of the larger ones in a distinct brown or blackish dot. Between the posterior ends of the curves above mentioned is a transverse elongate area containing three of the above setæ, the two uppermost close together; some distance in front of the lower one is a little tuft of pubescence, beneath which is the fourth seta; and on the ventral surface, in line with the transverse area mentioned, is a conspicuous dense dark brown tuft of longer pubescence, half surrounding a bare spot containing a long seta, behind which, and one half nearer the ventral median line, is the shorter sixth seta. Anterior divisions with four folds.

Last segment [Fig. 33] with whitish stigmatal area surrounded by six nearly equal broad fleshy teeth about as long as their basal breadth; a marginal fringe of minute ciliæ encircles the area, carried over the margins and apex of each tooth; upper four teeth pale fuscous within, paler along the middle of each; lower teeth within pale, with a brown longitudinal streak, and an apical seta; three dark dots at base of each; spiracles large, fuscous brown with elliptical blackish centers; often a pair of brown dots between them; exteriorly on lower teeth several setæ, backs of upper four nearly bare, with a subterminal and two basal setæ. Anal prominence bears six long, whitish, fleshy appendages, a pair each side, about as long as the diameter of the segment, directed outwards and backwards when in action, and a shorter pair on their bases beneath, directed backwards.

Pupa [Fig. 34].—Length, ♀ 20-22 mm., ♂ 18 mm.; diameter of abdomen, ♀ 3 mm., ♂ 2 mm. Reddish

brown, varied with blackish. Respiratory tubes with a blackish sulcus dorsally. Mesonotum with rounded discal tubercles, and more pointed humeral ones behind each respiratory tube; transverse suture deeply impressed between the humeral tubercles and the tubes; wing-pads dark, paler medially, reaching apex of second segment; legs blackish, usually attaining apex of third segment; middle tarsi a little shorter than the others.

Each abdominal segment or half segment with three blackish dots on each side above and below, in a row directed obliquely inward and toward the nearest true suture, variably distinct, lateral margin bearing a small tooth on each anterior, and a minute one on each posterior, division, posterior divisions above and below with a transverse row of eight or ten short spinous teeth; beneath, a pair also in front of these, indistinct anteriorly.

Last two segments closely connate, bearing anteriorly larger spinous teeth, four ventral in a transverse row, two lateral, sometimes blunt, and six dorsal, arranged like the fleshy teeth of the larva, anterior pair approximate and smaller, terminal cone of female scarcely longer than the pair of teeth just above it; male with corresponding area strongly protuberant, median line impressed, a pair of sharp lateral teeth, and a pair of obtuse tubercles above and below these.

Larva (*a*).

One example was taken May 18 in bottom-land earth on the bank of Spoon River. It is probably young.

Larva.—Length 16 mm., diameter 1.5 mm.; grayish, covered with microscopic short dark brown pubescence denser on thorax and last segments, in transverse arrangement; folds very distinct, each slightly transversely carinate and crested with darker pubescence, four folds on anterior divisions; each segment with the usual four setæ, prothorax with several setæ. Last segment with lower stigmatal teeth very small, triangularly black on upper surface; upper teeth slender, pointed, whitish,

outer pair nearly twice as long as inner pair; a similar tooth anterior to each of the outer two, near the anterior margin of the segment; a blackish spot at the base of each upper tooth, and one below each stigmatal plate; anal prominence with four blunt tubercles about the anal opening.

Larva (*b*). [Fig. 35, 36.]

One example was found May 16, in the wet sand of the shore at Station C, during the interval between the larval broods of *Tipula eluta*. The last segment is extremely different from that of *eluta*.

Larva [Fig. 35, 36].—Length 30 mm., diameter 3.5 mm. Head with larger pale areas, transverse line very broad, otherwise about as in *eluta*.

Body pale dirty yellowish, surface scarcely pubescent, evenly covered with minute brown points or very short hairs grouped by twos and threes in transverse arrangement, confused on sides of body. Last two segments very indistinctly separated, noticeably pubescent and darker above. Transversed impressed lines of anterior divisions well marked, three in number; posterior divisions slightly swollen, with two distant indistinct lines; first four segments and posterior divisions bearing four brown setæ with thicker blackish bases in a straight transverse row above, inner setæ less distinct, and a curved row of close-set pairs of long setæ below; on each double segment two lateral setæ, one on each division, thoracic segments with two lateral setæ one above the other, or only one. Prothorax with an anterior elevation, bearing a short transverse darker ridge each side in a chitinous area.

Last segment [Fig. 36] with concave transverse stigmatal field, and overhanging it above four very long, slender, tapering, nearly equal teeth in almost a straight line; below it two short rather distant teeth, each with an apical seta; all similar to outer surface in color and vestiture. Stigmatal plates nearly black, three deep-set

black dots below each, one above, and four in a square between them. Anal prominence very large, bearing on each side a very thick, subconical, pointed, recurved fleshy horn.

Tipula sp. (*e*). [Fig. 37, 38.]

A lot of larvæ from which the present species was bred, were collected from some leafy hollows in the black soil of the higher bottom-land on the west side of the river, below station H, on several dates between April 13 and 23. There were two sizes of these larvæ, so closely similar in all respects that they were supposed to belong to a single species. The pupæ from these forms, however, maintaining the difference in size, differed distinctly in certain structures, although for the most part apparently identical; and they were accordingly bred separately, and each pupal skin was removed with its imago, as they emerged. The remarkable fact now became apparent that while the larger pupæ gave the above species, those from the smaller form were not only of a different species, but of another genus, being *Pachyrhina ferruginea.*

Both larvæ were probably feeding on the wet decaying matted leaves at the bottom of the little hollows in which they occurred.

None had pupated when examined April 26, some were pupæ May 1, and all of the present species had reached this stage by May 3, from which the imago was obtained May 7, thus making the pupal period about a week. The same larva has also been taken by us at Urbana, April 27.

Aside from the fact that the size of this species is about twice that of the Pachyrhina, the two larvæ are almost identical. In the Tipula, the transverse pale line on the head above is broader, the darker transverse bars of the body are more distinct, and the lower pair of stigmatal teeth are larger, with a more extensive and darker

border within [Fig. 37]. As to the pupæ, I can only compare the females, as I have not the male of this species. The row of teeth next behind the tarsi—that of the fourth abdominal—consists in the Tipula of about eight small teeth, the middle ones distinct, and directly back of the tarsi. In the Pachyrhina, those directly behind the tarsi are wanting, leaving only a small pair on each side, as on the preceding segment in both species. The conical mass at the apex of the female abdomen [Fig. 38] is prolonged in the Tipula, greatly exceeding the posterior pair of dorsal teeth, while in the Pachyrhina it is short, not extending beyond the tips of those teeth [Fig. 40].

Larva [Fig. 37].—Head with the pale transverse line rather broad at middle; last antennal joint larger, brownish, mandibles with the blunt teeth larger and longer than in *eluta*.

Body blackish fuscous with a brownish tint, covered with very fine brown pubescence. Anterior divisions with only two distinct transverse impressed lines above and below, forming three folds between the true and false sutures; first abdominal and posterior divisions elevated into a low transverse ridge of darker color, bearing the usual four black setæ above and four pairs of setæ below, each pair appearing like one seta; anterior divisions with one lateral seta, posterior divisions and first abdominal with two, thoracic segments with three or four, vertically arranged.

Last segment [Fig, 37] with stigmatal field and anal prominence whitish; above the former, four narrow erect fleshy teeth; the inner pair sharper and slightly recurved, posterior faces black, narrowly pale margined; outer pair more slender, diverging, with a black streak on posterior faces. Stigmatal plates black; below them the other pair of teeth, short and inconspicuous, not setiferous, tips blackish, sometimes slightly margined with fuscous on inner face; in front of them a black dot;

anal prominence large, with a lateral and inferior pair of broad tubercles.

Pupa [Fig. 38].—Length 27-29 mm., diameter 5.5 mm. Dark reddish brown, more or less blackish. Respiratory tubes slightly longer than in *eluta*, longer than the distance between them; prothorax with middle of anterior portion depressed and blackened. Mesonotum with a pair of acute teeth at center and a similar tooth behind each respiratory tube, the transverse suture deeply and sharply impressed and blackish, in front of each of the latter teeth. Wing-pads and legs black or dark brown, middle tarsi often shorter than the others.

Lateral margins of abdomen bearing a sharp tooth on each division, and numerous black dots above and below; posterior divisions above and below with a transverse row of sharp spinous conical teeth, small anteriorly, more numerous upon middle segments, larger and fewer posteriorly, middle teeth of ventral row wanting on third abdominal, fifth to seventh abdominals with six to eight teeth in ventral rows, those of dorsal rows more variable, and unequal in size; no other teeth outside of these rows.

Last two segments [Fig. 38] bearing anteriorly large spinous teeth, four ventral in a transverse row, two lateral, and six dorsal, anterior inner pair very small and blackish, lying between and in line with the outer pair; remaining four about equal in size. Terminal cone of female long, projecting beyond the posterior dorsal teeth as far as their distance from the base of the eleventh segment.

Pachyrhina ferruginea Fabr. [Fig. 39, 40.]

As stated under the preceding species, larvæ of this species were taken April 13 to 23; the first pupæ were formed after April 26, and most of the others by May 1, when the first example, a female, emerged, another imago appearing May 3. The larva had been previously found at Urbana May 7 in a corn field. The imago is common,

and we have collected it four times in May, once in June, once in August (on the 6th), and three times in September, in central Illinois. It would therefore seem at least two-brooded. One imago came to a light at night.

The situation where they were found at Havana, habits, differences, etc., have already been fully discussed under the preceding species, which it closely resembles in the immature stages.

Larva [Fig. 39].—Length 20–25 mm., diameter 3.5–4 mm. Transverse line of head above rather narrow, each fold of body with more distinctly darker transverse bar; anal prominence rather small, pair of teeth below stigmata rather prominent and not very short, above fuscous and margined with black, more strongly on outer margin. Otherwise almost exactly like the preceding species.

Pupa [Fig. 40].—Length 19–21 mm., diameter 3.5–4 mm. Yellowish brown, varied with blackish, wing-pads and legs yellowish brown, former with narrow dark margin, each abdominal posterior division with two or three blackish dots on each side of disk above and below; row of spinous teeth of fourth abdominal wanting at middle behind the tarsi, two small teeth remaining on each side, as on the third abdominal. Last segment [Fig. 40] with smaller lateral teeth, four larger dorsal ones about equal in size, terminal cone of female short, scarcely or not at all projecting behind the tips of the posterior pair of dorsal teeth; male with corresponding area protuberant, median line strongly impressed, terminal surface broader below, with a sharp recurved spine at the outer inferior angles. Otherwise exactly as in the preceding species.

Larva (*f*).

A very common species in the light sandy soil of the sand plain at Havana, under the deep layers of dead leaves which accumulate in the woods. Larvæ were collected May 26 and June 1.

Larva.—Length 25–30 mm., diameter about 4 mm. This looks very much like the two preceding species, and is of the same color. The pubescence is distinct and dark brown; the anterior divisions show but two impressed transverse lines; the middle fold of each posterior division bears a darker low transverse ridge with four setæ above and four pairs of setæ below, each pair very approximate; posterior divisions with two principal lateral setæ, anterior with one, thoracic segments with three or four.

Last segment quite distinct, the upper teeth rather long, strongly diverging and recurved, outer pair distinctly shorter than inner pair, latter entirely black, forming a pair of slender tapering sharp-pointed recurved hooks; outer pair with a posterior longitudinal black stripe along nearly the entire length of each. Stigmata large, black, distant, separated above by the black bases of the inner teeth; lower teeth small, with a distinct black Λ-mark on their sides and apex; anal prominence tuberculate as usual.

Family TABANIDÆ.

The horse-fly larvæ [Fig. 41, 47, 49, and 50] are very uniform in structure and appearance, and are easily known by their glassy, whitish cylindrical bodies with similarly tapering ends, a retractile chitinous head in front, and a retractile short breathing tube at the tip of the last segment above, seemingly an additional segment. The smaller species and the young of larger kinds are only faintly marked, but the larger larvæ are distinctly ringed and laterally striped with dusky or blackish. They are predaceous, restless, and active, and the larger examples use their mandibles freely as a means of defence, readily puncturing the skin and producing a momentary sharp pain.

Some are terrestrial, but most of the species live in the wet sand, mud, or matted and drifted vegetation of shores, where they are sometimes quite abundant, bur-

rowing actively in search of food. This probably consists largely of soft larvæ, and they have also been known to devour water-snails not protected by an operculum. In open water they project themselves forward by horizontal strokes of the posterior end of the body, and are often found floating, making efforts at progression, but acting as if out of place. According to Garman,* they are eaten in quantities by the channel catfish and occasionally by bull-pout.

The eggs [Fig. 42, 55] are deposited in summer in masses on rushes and other smooth surfaces over water or wet ground; the larvæ hibernate nearly full grown and transform in May and June.

The pupæ [Fig. 43] are also very similar to each other and are formed on shore, concealed in damp rubbish They resemble lepidopterous pupæ, but may be known at once by the large somewhat ear-shaped spiracles [Fig. 45, 53] on the back of the thorax.

COMMON CHARACTERS.

All the larvæ and pupæ of Tabanidæ studied, agree in the following general characters.

Larvæ.—Body cylindrical, 11-jointed, not counting the head, tapering at both ends, which are somewhat pointed; skin shining and glassy, more or less striated, whitish, with opaque markings of a microscopic felted pubescence, variably present in the form of rings upon the sutures and false feet, and lateral stripes accompanying the four punctate lines of each side; areas between these lines longitudinally striated, remaining surface often striated, at least in the young.

Labrum and epistoma [Fig. 51, c] forming a median partition anteriorly, upper edge grooved, lower applied to the bifid tip of the mentum [d]; a pair of long claw-like black mandibles [e] each side of it, each with a short subapical groove; exterior to these the pale maxillæ

*Bull. Ill. State Lab. Nat. Hist., Vol. III., p. 156.

[g], brownish near the acute apex, and bearing anteriorly the palpi [f], which have thick short joints; antennæ [b] slender, directed outwardly, attached to the anterior angles of the head above the palpi, three-jointed, basal joint quite short; a bunch of stiff diverging recurved hairs between each antenna and the median line above.

Prothorax grooved below; dorsal and ventral areas of each body segment (limited by the upper and lower pairs of lateral lines) alike, longitudinally striated or nearly smooth, the striation greatest in young larvæ; those of thorax with discal punctures, abdomen with a Y-shaped group of punctures on each side of the dorsal areas, and a short oblique row, similarly placed, on the ventral areas; lateral areas always regularly longitudinally striate between the lines of punctures. The upper and lower of these lines are distinct, with numerous punctures; the two intermediate ones have fewer punctures, are often indistinct, especially upon the abdomen, and are wanting upon the prothorax. Abdominal segments except the last with a circle of fleshy tubercles or false feet near their anterior margins, consisting of two transverse dorsal, one lateral each side, and four rounded ventral ones. Last segment with a bilobed rounded anal prominence beneath, and a subconical retractile short prolongation at apex above, with a terminal vertical stigmatal slit, from which a sharp compressed spine often projects [Fig. 48].

Pupæ [Fig. 43].—Subcylindrical, rather abrupt in front, tapering rapidly behind; ferruginous-brown, often tinted with fuscous; finely wrinkled and subopaque, each abdominal segment with a fringe of slender spines posteriorly.

On each side of the head anteriorly are the short, thick, appressed, antennal sheaths; between them, a little above, a pair of prominent setiferous tubercles; a little below, a pair of transverse elevations, crested with a sharp transverse ridge, separated by a narrow deep cleft at

middle, each divided by a notch into two lobes. Beneath, the head bears on each side a pair of setiferous tubercles, and between these a pair of short closely appressed palpal sheaths. The three small tubercles supposed to represent the ocellar triangle lie at the point of separation of the head and the two halves of the thorax, one on each, and are indistinct in smaller pupæ. The upper margin of the head is angulate at middle and over each antenna.

Thorax obsoletely wrinkled; pro- and mesothorax separating and splitting on the well-marked middle line above at time of emergence. Prothorax about as long as the anterior surface of the head with a setiferous tubercle each side near the ocellar triangle and another at each hind angle; an impressed curve originates above each antenna. Mesothorax one half longer than prothorax; its anterior margin extended angularly forward on each side, bearing at this point a large darker spiracular prominence [Fig. 45, 53] with an arcuate rima or air slit, closed by a thin membrane; inwardly from each prominence is a deep closed notch in the margin; disk with two small setæ each side; wing-pads attaining second abdominal. Metathorax very short at middle, sides a little longer and with two angles in front; a seta each side.

Abdominal segments about equal in length, the first obsoletely transversely wrinkled, one seta, or more, each side on an obsolete ridge near hind margin. Next six segments distinctly transversely wrinkled, encircled by a continuous fringe of slender spines, borne upon a slight ridge near the hind margin. Lateral areas of first seven segments limited by sharply impressed lines, and slightly elevated, each bearing a rounded spiracular tubercle [Figs. 44, 52]. Last segment short with a truncate tip [Figs. 46, 54] margined by six acute teeth; anal tubercle beneath large in the male, with a fringe of spines in front of it; small in the female, the fringe broadly interrupted at middle; a few lateral spines on this segment.

CHARACTERS USED IN TABULATING GENERA OF TABANIDÆ.

Larvæ.

The larvæ and pupæ of Chrysops, as well as the imago, are distinguishable from those of Tabanus by the antennal structure, as stated in the keys. Otherwise the Chrysops larvæ closely resemble in structure small or young Tabanus larvæ. The dull pubescent annuli are partly present in Chrysops, but the longitudinal lateral lines, except on the prothorax, are shining and almost entirely without pubescence. There is very little pubescence here, however, in some young Tabanus larvæ. The species herein described [Fig. 41] is easily recognized by the dark patch on the last segment.

The Tabanus larvæ and pupæ studied form two groups, which may be called the *lineola* and the *atratus* groups. The larvæ show the most distinctive characters in the sculpture of the surface, especially that of the prothorax, which has lateral, dorsal, and ventral shining areas, limited in front by an opaque pubescent annulus. Comparing the anterior extension of these shining areas, we find them all of about the same length in Chrysops and the *lineola* group of Tabanus, although this length varies in the Chrysops. The lateral prothoracic areas are extensively invaded by the anterior annulus in the *atratus* group of larvæ, the striated shining space becoming basal, being not more than half as long as the dorsal area. The upper lateral space of the mesothorax is not very closely striate, and quite shining. In all except some of the *atratus* group the remaining lateral striation, including that of the prothorax, is not much finer, and is also shining, but in the others (as in *atratus*) the prothoracic and abdominal lateral striation becomes microscopically fine and even subopaque. A smooth spot near the lower hind angle of the prothoracic lateral area also gives good characters. The dorsal and ventral striation varies in extent according to age, but the tho-

rax is striated above in Chrysops, and smooth or nearly so in Tabanus. The three types of coloration observed are well shown by the three Tabanus larvæ figured.

Pupæ.

The little Chrysops pupæ have longer antennæ, and the thoracic spiracular prominence is more nearly in a vertical plane than in Tabanus, its inner edge being more strongly elevated. Its lower free edge is crossed by sharp folds, making it serrated. In Chrysops, the abdominal spiracles are subcylindrical near the apex; the spinose fringes consist of long teeth only; and the terminal teeth are long and rather narrow at the base.

The great difference between the abdominal spiracles and terminal teeth of the *lineola* group [Fig. 44, 46] and those of the *atratus* group [Fig. 52, 54] is evident from the figures. In both, the thoracic spiracles are in a plane nearly parallel to the adjacent surface and the spinose fringes contain long and short spines. The preanal fringe in the *lineola* group shows more or lesss of a chitinous web uniting the bases of the spines.

A pair of short appressed palpal sheaths on the lower surface of the head, resembling the antennal sheaths, differ slightly in position in related species of the *atratus* group.

Pangonia is unknown to me in the immature stages; it would probably group here with Chrysops.

KEYS TO GENERA OF TABANIDÆ.

Eggs.

In one flat tier, forming an oval or diamond-shaped area, pointed at one or both ends. [Fig. 42.]..... *Chrysops.*

In an elevated, thick, subconical mass of several tiers, [Fig. 55.]..... *Tabanus.*

Larvæ.

Last antennal joint much longer than the one preceding, dorsal areas of thorax striated like those of abdomen ..... *Chrysops.*

Last antennal joint not longer, usually much shorter, than the one preceding; dorsal areas smooth or striated, but those of thorax nearly or quite free from striæ ..... *Tabanus.*

Pupæ.

Antennæ surpassing adjacent margin of head; fringes of abdomen of long spines only; inner margin of thoracic spiracular prominences sharply elevated, lower margin serrate-edged; abdominal spiracles slender, subcylindrical near apex; size small.. *Chrysops.*

Antennæ not attaining margin of head; fringes of abdomen of long and short spines; inner edge of thoracic spiracular prominence not, or but slightly, more prominent than outer edge; abdominal spiracles subconical or rounded; size medium or large. [Fig. 43.].. *Tabanus.*

PANGONIA.

P. rasa Loew.

Illinois (*Le Baron**).

CHRYSOPS.

C. excitans Walk.

One example, margin of Grass Lake, Lake Co., June 22.

C. mitis O.-S.

A specimen with all the characters of this species, but nearer *C. fugax* in size, was taken June 15 near Sand Lake, Lake county. Dr. Williston also mentions the smaller size of a specimen in his collection (Trans. Kans. Acad. Sci. Vol. X., p. 132).

*Osten-Sacken, "Prodrome of a Monograph of the Tabanidæ of the United States," Part I., p. 366.

C. niger Macq.

Taken along shore at Station C on May 16, 17, and 18. It appears in our collections from McLean and Champaign counties (central Illinois) and from Union county, in southern Illinois, on seven dates between May 16 and June 15, being apparently earlier in its appearance than *callidus*.

C. æstuans v. d. Wulp.

This northern species is common about the small lakes of northern Illinois. They were noted Aug. 3–10 flying among the marginal rushes of Fourth Lake, Sand Lake, and Slough Lake, in Lake county, and ovipositing on the stems of the rushes. The flies have also occurred about Urbana June 8, 16, and 17.

Egg [Fig. 42].—Length 1.6 mm., diameter 25 mm., Cylindrical with rounded ends, straight or slightly curved, smooth, slightly opaque, cream color when laid, becoming dark fuscous brown, placed in a single flat layer, obliquely stacked as in Tabanus, about one fourth of the length of each egg being visible at the surface, the remaining three fourths being covered by those stacked against it. The mass is about 10 mm. long and 3 or 4 mm. wide, its outline variable, usually diamond-shaped, both ends pointed, or one end short or truncate, making it more or less triangular.

C. callidus O.-S.

One example was found flying along shore at Station C July 16. We have collected this species at Urbana, in the vicinity of a small creek, June 8 and 16 and July 20; and at Savanna, on the Mississippi, in Carroll county, August 1.

C. pudicus O.-S.

Illinois (*Kennicott**).

C. montanus O.-S.

Ogle Co. (*Osten-Sacken*).

C. flavidus Wied.

* Osten-Sacken, "Prodrome."

Taken July 1 and 15 at Urbana, also near New Orleans April 23.

C. univittatus Macq.

This species is very common about Urbana in woods and orchards, and appeared in twenty-two collections between June 3 and July 28—most abundantly about June 21—from Champaign and McLean counties.

C. vittatus Wied. [Fig. 41.]

The larvæ were found in connection with those of Bittacomorpha, Limnophila, and Sialis in the weedy swampy little stream at Station I. They were quite common here, occurring in the mud and the mats of dead stems, rarely floating at the surface. The first were seen March 28, but they continued to occur up to April 15, increasing slightly in size. In the breeding-cage they burrowed in the mud and through the vegetation. In the latter part of May the water was allowed to dry away and on the 28th all that remained was poured off. June 1–3, three pupæ were formed in the damp mass of dead vegetable matter resting on the mud in the cage. Two imagos emerged June 9, both males, the third failing to transform. The coloration of the larva readily distinguishes it.

Larva [Fig. 41].—Length 10–15 mm., diameter 1.6 mm. Head light colored, mouth parts pale, tips of maxillary palpi in line with end of labrum; body whitish, a mottled appearance within at middle of body.

Dorsal and ventral areas striate, striæ entire, distinct, and not very fine; lateral striation a little finer, that of prothorax very fine, with a small smooth spot adjoining the smoother surface of its ventral area; latter shorter than dorsal, not including anterior pair of setæ, median sulcus scarcely dull-pubescent. Meso- and metathorax with lateral impressed lines, and dull-pubescent pale annuli, but the lateral lines almost without pubescence. Fleshy false feet of abdominals rather prominent, dorsal pair united into one, there being no narrowing near the

median line; annuli very pale except on the last two or three segments; last segment white basally, remainder covered with dull blackish microscopic pubescence reaching forwards to the anal prominence, a triangular extension each side of middle above often a small spot accompanying each; respiratory tube whitish, spine sometimes projecting.

Tracheal trunks sinuate posteriorly, crossing and recrossing in front of middle.

Pupa.—Length 9–10 mm., diameter 2 mm. Light brownish ferruginous, obsoletely transversely wrinkled, head and thorax shining, abdomen duller.

Antennal sheaths not very thick at base, surpassing the marginal angulation above them; carinated tubercles not prominent, lateral notches broad and shallow, palpal sheaths indefinite, rather distant; setiferous tubercles scarcely darker; ocellar tubercles replaced by pale dots. Rima of thoracic spiracles strongly elevated from inner side, so that the flat top of the prominence is nearly vertical, the upper edge of the rimal border forming a sharp carina and its anterior extremity ending at the tip of the marginal extension in an acute angle; the free lower edge is crossed by sharp ridges, giving it a serrate profile; rima less curved at middle, more strongly at each end, scarcely hooked; inner notch with radiating striations.

The abdominal fringes consist of a single row of pale spines on each segment, rather long except dorsally on the second, where they are shorter and thicker. The abdominal spiracular tubercles arise from a slight elevation, tapering from a comparatively small base as far as middle, thence nearly cylindrical to apex, which bears a subcircular rima; on anterior slope a small transverse groove, not longer than the rima; tubercle about as high as its basal diameter. Last segment with six nearly equal terminal teeth, their points marking the angles of a hexagon; slender, even constricted at base, twice as

long as their diameter near base. Lateral spines almost wanting; ventral fringe in front of anal tubercle in male; a tuft of about five spines on each side in place of this fringe in the female.

C. striatus O.-S.

Illinois (*Le Baron**).

C. obsoletus Wied.

One example from Urbana, Aug. 3; two from the Mississippi bottoms in Union county, Aug. 11.

Tabanus.

On account of the general similarity of habit and structure among tabanid larvæ and pupæ, the discussion under the family heading covers all points to be mentioned regarding this genus. There are many species, and the separation of their immature forms will be at best very difficult. Those known to me represent two quite distinct groups. The species preceding *T. lineola* perhaps compose a third group, their immature stages being unknown to me.

The larvæ differ from those of Chrysops in the greater variety of striation. That of the upper mesothoracic lateral area is more noticeably coarse than that in the other lateral areas; in the dorsal and ventral areas it is usually wanting or sparser on the disk, at least on the dorsum of the thorax, and more or less restricted to the margin of each area, except in young larvæ, in which the striæ may all be entire, as they are in Chrysops. The dark ring encircling the membrane at the base of the respiratory tube is not wide and is usually parallel-sided, not reaching forwards to the anal prominence, as in Chrysops, but often joined to it by a lateral isthmus.

KEYS TO SPECIES OF TABANUS.

Larvæ.

Lateral shining striated area of prothorax nearly or quite as long as dorsal area; lateral striation not

* Osten-Sacken, "Prodrome."

very fine; dorsal and ventral areas of abdomen strongly but rather unevenly striate. (*lineola* group.)

Upper and lower thirds of prothoracic lateral area striated, middle third smooth, without striæ; only noticeable marking a fleck of light brown in front of the outer end of each dorsal false foot...species (*a*).

Middle third of prothoracic lateral area striated like the rest.

Upper thoracic lateral lines, at least of mesothorax, accompanied by pale brown opaque stripes of pubescence, which are slender, not dilated posteriorly, lateral edges of thoracic dorsal areas diverging [as in Fig. 47].....*lineola.*

Lateral lines of thorax without color or pubescence. *costalis.*

Lateral shining striated areas of prothorax short, not more than half as long as dorsal area, thoracic lateral darker stripes present. (*atratus* group.)

Lateral stripes of meso- and metathorax slender, pale brown, scarcely dilated at posterior ends, lateral edges of their dorsal areas diverging. [Fig. 47.]

Lateral striation of prothorax scarcely finer than that of mesothorax.....*nigrescens*, *stygius.*

Lateral striation of prothorax microscopically fine and opaque; that of mesothorax much coarser, distinct and shining.....species (*b*).

Lateral stripes of meso- and metathorax dark brown in adult, dilated posteriorly on each segment, so that the lateral edges of the dorsal areas become parallel behind middle of segment; lateral striations minute and subopaque except in upper spaces on meso- and metathorax; markings distinct at all ages, annuli well developed. [Fig. 50.] *atratus.*

Pupæ.

Abdominal spiracular tubercles subtriangular, narrower behind, obliquely subconical, much shorter than basal diameter, bearing a short arcuate or subcircular small rima [Fig. 44]; middle upper pair of terminal teeth much smaller than the lateral pair [Fig. 46]. (*Lineola* group.)

Tips of four upper terminal teeth in line [Fig. 46]. *lineola.*

Tips of middle upper pair of teeth well above a line connecting tips of outer pair.....*costalis.*

Abdominal spiracular tubercles rounded, broad behind, low subhemispherical, bearing a long rima with curved ends [Fig. 52]; terminal teeth marking the angles of a broad hexagon [Fig. 54]. (*Atratus* group.)

Spines of fringes pale or blackish tipped, short spines very unequal.....*nigrescens, stygius.*

Spines of fringes distinctly annulated and tipped with black.....*atratus.*

Subgenus *Therioplectes.*

T. trispilus Wied.

Illinois (Le Baron Collection.)

T. lasiophthalmus Macq.

Two from southern Illinois, in May; two taken near Urbana, also in May.

T. epistates O.-S.

Credited by Osten-Sacken to Illinois ["Prodrome," p. 467], although this locality is not mentioned for it in his Catalogue [p. 56].

Subgenus *Atylotus.*

T. bicolor Wied.

Four specimens, all taken about a piece of wet ground in Champaign county July 24 to Aug. 29.

T. reinwardtii Wied.

One example, Urbana, July.

T. cerastes O.-S.

A single specimen in our collection; Illinois.

Subgenus *Tabanus.*

T. cymatophorus O.-S.

From near the Mississippi at the southern border of Jackson county in southern Illinois, Aug. 8 and 26; moderately common. See also remarks under *T. abdominalis.*

T. venustus O.-S.

Not rare about Urbana; taken in June and up to July 20; also Aug. 16, on flowers.

T. turbidus Wied.

A specimen from Illinois doubtfully referred to this species [Osten-Sacken, "Prodrome"].

T. abdominalis Fabr.

While in Grand Tower, on the Mississippi, near the southern boundary of Jackson county, I secured August 26 a quantity of Tabani in really good condition from the boys who were tending cattle. Every specimen brought in was a female. The list is as follows:

T. cymatophorus,	5	examples.
T. abdominalis,	56	"
T. exul,	3	"
T. giganteus,	29	"

The fifty-six examples of the present species varied extensively in quality of abdominal color, but all had a narrow front and a closed first posterior cell. Females have also been collected by us at Grand Tower Aug. 8.

T. exul O.-S.

In addition to the three examples mentioned in the preceding list, we have three females and a male (the latter as described by Osten-Sacken) from Urbana and the Mississippi bottoms of Union county, Aug. 3–Sept. 6.

T. sulcifrons Macq.

Two males, one from the Union county bottoms, the other from Urbana, not in the same day's collection with any female Tabani, Aug. 1 and 11, are clearly of this species according to Osten-Sacken's description. They have a slightly different aspect from the two preceding species, but show close resemblances. Possibly some females of this species are included among those of *T. exul.* The characters given by Osten-Sacken for their separation do not seem to me very satisfactory.

This and the two preceding species seem to appear quite late in the season.

T. trimaculatus Pal. Beauv.

One female was collected about May 23 at Station C. We have taken this species also at Pekin (Tazewell Co.) and Urbana July 19 and Aug. 15.

Tabanus sp. (*a*).

My two examples of this peculiar species are from very diverse situations. One was taken under bark in woods near Urbana April 6; the other, from a prairie ditch in Kane county which was swollen by a heavy rain.

Larva.—Length 19 mm., diameter 2.5 mm. Last antennal joint short and very slender, epistoma not sulcate anteriorly, but with an elongate puncture. Whitish, lateral pubescent stripes wanting, annuli much reduced and pale except upon false feet. Prothorax shining, with anterior opaque annulus; lateral areas as long as the dorsal, their upper and lower thirds rather coarsely striate, middle third smooth, with several punctures; ventral area smooth, middle groove with three striæ, dorsal area nearly smooth. Striæ of upper lateral spaces of meso- and metathorax and of dorsal and ventral areas of abdomen moderately coarse; those of lateral areas of abdomen somewhat finer; dorsal and ventral areas of mesothorax with a few striæ; of metathorax rather sparsely striate. All areas more or less shining. On the anterior side of each dorsal false foot, at its outer end, an opaque

light brown elongate fleck. False feet shining and rather finely striated on each side. No projecting spine posteriorly; only a narrow pale annulus on last segment, at base of breathing tube.

T. lineola Fabr. [Fig. 43–46.]

The larva of this species closely resembles the young of *nigrescens*, and was not separated from it at first. Examples were taken at stations C, I, and H on April 14, 15, and 30; and in Flag Lake April 27—as shown by specimens preserved. We have also taken the larva April 8 and June 15 and 24 in Sand Lake, Lake county, and in ponds in Kane and Champaign counties. Three pupæ have been obtained on May 18 of different years. Imagos were obtained from these May 27, 29, and June 6. The tabanid pupæ develop much more rapidly in hot weather than in cold, and to this fact is probably due the difference in time of emergence. Another pupa was found at Matanzas Lake Aug. 24.

Imagos were also collected in the vicinity of the cabin boat at Station C May 17, June 13, July 14, and Sept. 9. In our general collections they have been taken April 23 at New Orleans, and in Illinois on fourteen occasions from June 2 to July 28, also Aug. 3 and 13 and Sept. 27. Whether there are one or two broods remains to be determined. These imagos were from Lake, Champaign, and Union counties, being obtained once at sugar, once at an electric light, and several times found visiting flowers. The species is a common one in central Illinois.

Larva.—Length 20 mm., diameter 2.7 mm. Prothorax with lateral shining areas about as long as the dorsal area, striation about the same as that of the upper mesothoracic area, no noticeable central smooth spot, a small one on lower margin posteriorly; remaining lateral areas a little more finely and closely striate; dorsal and ventral areas of thorax nearly smooth on disk, with basal striæ; those of abdomen with moderately close striæ, more or less interrupted on disk; all areas more or less shining.

Surface whitish, dull pubescent markings very light brown but distinct, annuli narrow, crests of false feet also dull pubescent, their sides striate; lateral stripes of thorax distinct, slender, not dilated posteriorly, lateral edges of dorsal areas of thorax diverging. An opaque dark ring about base of respiratory tube, and another encircling anal prominence, above it usually three light brown spots.

Main internal tracheæ rather thick and noticeable, subparallel, not strongly sinuate, at least back of the middle. Terminal stigmatal spine often protruded.

Pupa [Fig. 43–46].—Length 19 mm., diameter 3 mm. Light ferruginous brown, shining, abdomen roughly wrinkled and subopaque. Palpal sheaths indistinct, not distant; tubercles not dark; ocellar tubercles indistinct or wanting; thoracic spiracular tubercles [Fig. 45] slightly but nearly equally elevated, free margin rounded at tip, rima not vertical, evenly arcuate, slightly hooked in front.

Abdominal spiracular tubercles subtriangular, narrower behind, obliquely subconical, much shorter than basal diameter, bearing a small subcircular or short and strongly arcuate rima [Fig 44]; on anterior slope a transverse groove, usually longer than the rima; fringes formed of unequal pale spines, only one or two long spines above on seventh segment; outer terminal teeth much longer than the others, directed laterally and upwards, the tips of the four upper teeth about in line [Fig. 46]. Fringe anterior to anal prominence showing a chitinous webbing between the bases of the spines, so that the separated tufts of the female look like a pair of broad low teeth with several spiny points; lateral tufts low down, near ends of ventral fringe, formed of short spines.

T. costalis Wied.

This seems to be normally a terrestrial larva. We have taken it two or three times in the earth of corn

fields in Champaign county. The dates given are May 31 and June 4. Examples were placed in a breeding-cage, and an imago of *costalis* was secured from them.

The imago, known as the "green-head," is very generally common, and is quite a pest in some bottom-land prairies. A few examples were noted along shore at Station D Aug. 20. The examples in our collection were taken on twenty-two occasions, all between July 15 and Aug. 13 except three dates, July 8 and Aug. 18 and 31, which would make it probable that it is single brooded. The localities are Carroll, Lake, Cook, and Ford counties at the north, and Fulton, McLean, and Champaign counties in central Illinois. The specimens were from a variety of situations, usually in low herbage, often taken visiting flowers.

Larva.—Length 20 mm., diameter 2.7 mm. Prothorax with lateral shining areas about as long as the dorsal, coarsely striate, a smooth spot near center of disk; dorsal and ventral areas of thorax smooth, a few striæ on those of metathorax, especially posteriorly; remaining areas moderately striate, lateral areas of abdomen a little more finely striate than the others; all more or less shining.

Dark annuli pale, narrow, longitudinal stripes scarcely present; false feet with dull pubescent crests, their sides rather finely striate; a narrow dark annulus at base of respiratory tube, another around base of last segment, enclosing anal prominence and giving off a pair of lateral stripes, the lower one longer; no projecting spine seen.

Pupa (from defective cast skin of male).—Length 20 mm., diameter 3 mm. Light fuscous brown, shining; abdomen smoothly wrinkled, slightly opaque; prothoracic spiracular tubercles slightly but nearly equally elevated, free margin rounded at tip, rima not vertical, evenly arcuate, slightly hooked in front.

Abdominal spiracular tubercles small, subtriangular, narrower behind, obliquely subconical, much shorter

than basal diameter, bearing a very small subcircular rima; fringes formed of unequal pale spines, the longer ones sparse on seventh segment above; outer terminal teeth twice as large as lower pair, directed laterally and slightly backwards; upper pair smallest, directed upwards; ventral fringe of last segment not noticeably webbed; lateral tufts rather high, not near ends of ventral fringe.

My material of this species is not in the best condition for accurate comparisons.

T. fulvulus Wied.

One example from the banks of the Mississippi, in Carroll county (northern Illinois), July 30.

T. sagax O.-S.

Illinois (*Osten-Sacken**).

T. nigrescens Pal. Beauv.

An undersized larva supposed to belong with those of the next species pupated May 18, and on June 1 produced an imago of *T. nigrescens*, which is a closely related species. Most of the larvæ treated above as *stygius* were very uniform in size and characters, and although I cannot now separate these species in the larval stage, I believe the bulk of my material, at least, was *stygius*. We had previously taken the imago of *nigrescens* near the Mississippi, in Jackson county, in southern Illinois, August 10.

Pupa, ♂.—Length 25 mm., diameter 5.5 mm. Palpal sheaths narrowly separated, about one fourth as far apart as the setæ borne by the large frontal tubercles, a smooth depressed space between them, without tubercles. Lobes of carinate transverse ridges of head more rounded and separated by a deeper notch than usual. Abdomen a little more shining and more smoothly wrinkled. Otherwise not different from the pupa of *stygius* (female) next described.

* "Prodrome."

T. stygius Say. [Fig. 47, 48.]

The present species was the most abundant tabanid larva in the vicinity of Havana last spring (1895). It first appeared in our collections Sept. 14, when a number were noted swimming amidst vegetation near the margin at Station B. In the spring they were found at nearly all of the stations, but more particularly in connection with tipulid, muscid, and Eristalis larvæ in matted accumulations of dead stems and leaves over mud. They were especially abundant March 30 in Flag Lake, where large plump larvæ appeared at every turn. It was a surprise to find a few of them upon the bottom in open shallow water, far from shore, in the middle of Quiver Lake at Station A. Young larvæ have been common in connection with larvæ of Bittacomorpha and Limnophila at Station I since March 17. At Stations B and G, they have been common in moist drifts of fine rubbish washed up by waves. Pupæ were formed in the breeding-cages May 10 and 23. One emerged May 27, and another tried to emerge June 2, but died and was removed from its case.

The larvæ resemble those of the *lineola* group in their striation and coloration, but differ in their short lateral prothoracic areas and larger size. They are like *atratus* in size, but may be readily separated from it by their coarser lateral striation, straw-yellow tint, slender lateral vittæ, and usually projecting terminal stigmatal spine.

Larva [Fig. 47, 48].—Length 45–55 mm., diameter 6–7 mm. Bright straw-yellow, varying in some young larvæ to nearly clear white; marked with light fuscous brown microscopic pubescence, usually paler at each stage than *atratus*.

Lateral prothoracic striated areas not more than half as long as the dorsal, striation not finer than that of the middle and lower lateral areas of the mesothorax, striated portion shining; a small smooth spot adjoining the impressed line below; remaining upper lateral thoracic areas a little less closely striated, but not strongly different from that of the prothorax; abdominal lateral

areas a little more finely striate; dorsal and ventral areas with margins striated, disks nearly smooth in adult larvæ, last segment more strongly striate, especially beneath.

Dark annuli distinct, broad, including false feet, a distinct transverse dorsal and ventral pale spot in front of the false feet; abdominal annuli often with a small triangular backward prolongation on median line above. Prothoracic lateral space occupied by a pale brownish fuscous quadrate spot in front of the striated space. Meso- and metathoracic lateral stripes usually distinct, but slender, scarcely dilated posteriorly, lateral edges of dorsal areas diverging; lateral stripes of abdomen almost wanting, except on last two or three segments. In these stripes the punctures of the upper and lower rows are indicated by rounded pale dots, and those of the inner rows by elongate dots. Last segment with bases of respiratory tube and anal prominence encircled with dark rings, joined by a lateral connection, its dorsum with at most a short basal line or pair of dots on each side. Coarser pubescence of false feet tipped with pale brownish.

Main internal tracheæ thick and noticeable, especially in young larvæ, lustrous, subparallel, not strongly sinuate, nearly straight posteriorly; terminal stigmatal spine dark reddish brown, smooth, usually protruded. [Fig. 48.]

Pupa, ♀.—Length about 30 mm., diameter about 6 mm. Light brownish fuscous, thorax paler, shining, abdomen roughly transversely wrinkled, and subopaque. Palpal sheaths distinct, as far apart as are the setæ borne by the larger tubercles at the center of the anterior surface of the head; surface between them rounded, bearing a small wrinkled tubercle at middle; antennæ and tubercles darker than surrounding surface; ocellar tubercles distinct; prothoracic spiracular tubercles slightly but evenly elevated in a plane parallel to that of the surrounding sur-

face; rima nearly straight in its outer half, inwardly curving strongly forward, and ending in a conspicuous hook; free margin of tubercle rounded at tip. [See Fig. 53.]

First abdominal with two distinct setæ each side above the spiracles; abdominal spiracular tubercles rounded, broad behind, low-subhemispherical, rima long, following posterior border of tubercle, slightly curved at middle, more strongly curved forwards at each end; on anterior surface a transverse groove extending across the tubercle, but not as long as the rima. [See Fig. 52.] Fringes of unequal spines, often tipped with blackish, all but two of the long spines wanting in a broad space above on seventh segment. Terminal teeth nearly equal, tipped with blackish, their points marking the angles of a hexagon, slightly wider than high. [See Fig. 54.] Ventral fringe of last segment not webbed together; lateral tufts high—on a level with upper lateral line.

Tabanus sp. (*b*). [Fig. 49.]

In collecting the larvæ of Limnophila and Bittacomorpha in the swampy slough of Station I, many small tabanid larvæ were found in the mud and dead trash, and among them occurred, on April 15, two examples of a distinct very white form with faint markings like those of the preceding species, but laterally striate more like *atratus*, and with a conspicuous isolated smooth spot in the lateral striated area of the prothorax.

Larva [Fig. 49].—Length 22—23 mm., width 2.5 mm. Very pale whitish, markings like those of *stygius*, but pale yellowish fuscous and inconspicuous. Head pale brownish.

Lateral prothoracic areas not more than half as long as the dorsal, striation scarcely visible, microscopically fine and opaque, much finer than that of the middle and lower lateral areas of the mesothorax, which are somewhat shining; a rather large smooth spot included in the striated lateral area of the prothorax, not far from the shining ventral area but entirely isolated from it; re-

maining upper lateral thoracic areas distinctly more coarsely striated than the areas below them, and quite shining; abdominal lateral areas more finely striate, feebly shining, microscopically striate on the posterior portion of each area. Dorsal and ventral areas shining, with sparse marginal striæ interrupted on the disks, those of thorax especially smooth.

Dull annuli broad, including the false feet, a distinct transverse dorsal and ventral pale spot in front of the false feet. Lateral prothoracic area occupied by a very pale fuscous opaque quadrate spot in front of the striated area. Meso- and metathoracic lateral stripes usually visible, but slender, not dilated, lateral edges of dorsal areas diverging; lateral stripes of abdomen almost wanting, except on last two or three segments. Last segment with bases of respiratory tube and anal prominence ringed with opaque fuscous, that around anal prominence sending up an indistinct stripe, with posterior extensions. Pubescence of false feet whitish or pale fuscous. Respiratory tube slender, no spine protruding.

T. atratus Fabr. [Fig. 50–56.]

The larva of this abundant species has been carefully described by Walsh,* and Riley has described and figured the different stages.† The larvæ were taken in every month of the season except June, at which time they had mostly reached the pupa or imago stage They seemed to prefer the sandy shores, and were taken abundantly May 17 at Station C, by running through a coarse sieve the surface layers of sand of the shore near the wave-washed margin. The same process was repeated June 25, and not a single larva was found. Individuals placed in breeding-cages failed to transform, but a pupa was collected June 30, from which the imago appeared July 17. A cast pupal skin was also picked up July 18. One imago was seen about May 23, and in June they were taken on the 12th and 22d.

*Proc. Bost. Soc. Nat. Hist., Vol. IX., p. 304.
†Second Missouri Report, p. 128.

In July and August oviposition was noticed, and egg masses became frequent. Our last date for the imago is August 15. On the 11th of August, a female was observed ovipositing on the side of a wooden frame standing over the water. The egg mass was placed in a breeding-cage, and one week later, on the 18th, many larvæ hatched from it. Another egg mass of the same form and appearance, placed on the dry bark of a stick projecting from the water, was brought in July 27, from which hatched on August 4 larvæ apparently of this species. The larvæ were at this time more commonly found in water among the vegetation, less commonly in the sand of the shore, and young individuals became frequent.

During the winter, good-sized larvæ sometimes occurred in dip-net collections, and March 18 they were again found to be common at Station C, in loose drift, partly frozen, left by an early spring rise. The previous year they were common in April far from the margin, amongst sticks, logs, and other drift, marking the higher stage reached by the water on March 19 of that year. These situations remained moist for a long time, harboring a large variety of aquatic forms, some of which completed their transformations successfully while others apparently failed, the river remaining low and the weather dry.

The imagos in our general collections were taken at frequent intervals and on twenty-two occasions between June 30 and September 2, also on September 19 and 29, and once in October, the counties represented being Rock Island, Grundy, Tazewell, Mason, McLean, Champaign, and Jackson.

These dates, taken in connection with the observations here recorded, go to show that the species is single-brooded, hibernating in the larval stage and mostly emerging in July after a brief pupal period, the eggs being laid without delay and producing larvæ a week later.

RECORD OF TABANUS ATRATUS FOR THE YEAR.*

Dates.	A.	B.	C. E.	C. W.	D.	E.	F.	G.	B.-C. &c.
Apr. 14	.....	.....	L-2	.....	.....	.....	.....	.....	.....
" 18	.....	.....	L-1	L-1	.....	.....	.....	.....	.....
" 19	.....	.....	L-1	.....	.....	.....	.....	.....	.....
May 17	.....	.....	L-4	.....	.....	.....	.....	.....	.....
" 23	.....	.....	♀-1	.....	.....	.....	.....	.....	.....
June 12	.....	.....	♀&♂-3	.....	.....	.....	.....	.....	.....
" 25	.....	.....	L-0	.....	.....	.....	.....	.....	.....
" 30	.....	.....	P-1	.....	.....	.....	.....	.....	.....
July 6	.....	.....	Y-2	.....	.....	.....	.....	.....	.....
" 9	.....	.....	L-1	.....	.....	.....	.....	.....	.....
" 12	.....	L-2	.....	.....	.....	.....	.....	.....	.....
" 17	.....	.....	.....	.....	.....	.....	.....	.....	♂; B.-C.
" 18	.....	.....	I-2	.....	.....	.....	.....	.....	.....
" 28	.....	.....	♀-1	.....	.....	.....	.....	.....	.....
Aug. 11	.....	.....	L&♀-1, E-2	.....	.....	.....	.....	.....	.....
" 15	.....	.....	♀-1	.....	.....	.....	.....	.....	.....
" 16	.....	L-1	.....	.....	.....	.....	.....	.....	.....
" 23	.....	.....	.....	.....	.....	.....	.....	.....	L-3; Matanzas L.
" 24	.....	.....	.....	.....	.....	.....	.....	.....	L-2 "
Sept. 14	.....	Y-2	.....	.....	.....	.....	.....	.....	.....
Dec. 16	.....	.....	.....	.....	.....	.....	.....	.....	L-1; Slough.
Mar. 18	.....	.....	L-3	.....	.....	.....	.....	.....	.....
" 26	.....	L-2	.....	.....	.....	.....	.....	.....	.....
Apr. 1	.....	.....	L-2	.....	.....	.....	.....	.....	.....
" 11	.....	.....	.....	.....	.....	.....	.....	.....	L-3; Matanzas L.
" 13	.....	.....	.....	.....	.....	.....	.....	.....	L-1; Deep Slough.

*See foot-note, p. 169.

Parasites.—A half-grown larva taken April 18 had a curious dull surface, and the surface of the last segment was covered with oval white scales of various sizes irregularly placed, apparently some kind of a parasite.

After the two egg masses mentioned above had produced larvæ, they were placed in a dry vial, and a little later it became evident that both masses had been parasitized by Hymenoptera, minute black imagos emerging freely in the vial. An examination of one of the masses showed that about one half of the eggs had been infested. [Fig. 55, 56.] Examples of the imago were sent to Mr. W. H. Ashmead, who found the speceis to be a new one; and it is described by him as *Phanurus tabanivorus* on p. 274.

Egg mass [Fig. 55].—Blackish-brown, subconic, with oval base, 10–15 mm. long and 8–10 mm. wide, height 5–7 mm.; sides convex or concave, apex correspondingly rounded or pointed; eggs pointing obliquely upward and towards one end, both sides meeting upon that end in a more or less prominent longitudinal crest. The eggs are stacked in four or five tiers, one above another, and gummed together into a firm mass.

Egg.—Length 2.5–2.7 mm., diameter .4 mm. Dark brown, subcylindrical, ends more or less tapering and curved, surface minutely rugose and subopaque.

Larva, newly hatched.—In this stage the lateral areas are sculptured similarly to those of the adult, but the dorsal and ventral areas, though shining, are rather sparsely striated. Traces of the dark markings are visible, especially on the posterior segments.

Larva, mature [Fig. 50, 51].—Length 45–55 mm., diameter 6–7 mm. Transparent whitish with a greenish tint, marked with conspicuous dark brownish or greenish fuscous, paler in younger specimens.

Lateral prothoracic striated areas less than half as long as the dorsal, striation microscopically fine and opaque or scarcely shining, a small smooth spot on the

anterior margin of the striated area, resting on the lower lateral line; remaining upper lateral areas of thorax much more coarsely and sparsely striate and shining; middle and lower thoracic areas—often much reduced, or even entirely covered, by the lateral stripes—with distinctly finer and closer striation, but still shining; abdominal lateral areas with still finer striation, nearly as fine as that of the prothorax and feebly shining; dorsal and ventral areas all smooth and shining, rarely a few broken striæ about their margins, at the base of the prothorax or on the anal segment.

Dark annuli distinct, broad, including false feet, transverse pale spot immediately in front of dorsal tubercles narrow or closed up in the mature larva; on the abdomen above, each annulus usually extends back on the median line in a triangular prolongation, often nearly attaining the next annulus, less developed in younger larvæ. Prothoracic lateral space occupied in front of the striated area by a dark opaque quadrate spot, extending from the anterior annulus. Lateral stripes of meso- and metathorax broad, at least the upper ones widened posteriorly, the lateral edges of the dorsal areas therefore parallel behind the middle of the segment, as seen from above; lateral stripes of abdomen, especially the intermediate ones, more or less abbreviated and broken up posteriorly except on the segment next the last. In these stripes the punctures of the upper and lower rows are indicated by rounded pale dots, and those of the inner rows by elongate dots. Last segment with broad dark annuli about base of respiratory tube and around anal prominence, with lateral connections; also more or less invaded above by the basal annulus, often leaving there only a pair of pale spots posteriorly. Often a dark spot in the anterior angles of the ventral space on the seventh abdominal, and one behind the anal dark ring.

False feet moderately elevated, with coarse whitish pubescence more or less tipped with fuscous or with

brownish in younger larvæ, dorsal pair narrowly connected over median line. Main internal tracheæ usually subparallel, sinuated, not very conspicuous, although easily traceable. Stigmatal spine rarely visible.

Pupa, ♂ [Fig. 52–54].—Length 30–35 mm., diameter 7.5 mm. Yellowish fuscous with a brownish tint, thorax not paler. Palpal sheaths distinct, short, very narrowly separated by a depressed space. Abdomen roughly wrinkled and subopaque. Spiny fringes tipped and annulated with black. Otherwise as in the pupa (female) of *T. stygius*.

A few larvæ have come to my hands which are like *atratus* except in one particular—the surface of the body, especially of the anterior abdominal segments, shows a fine undulate wrinkling resembling the sculpture of the pupa, but smoother. As the specimens showing this appearance are shrunken and in bad condition, I surmise that it is an effect of letting the alcohol get too weak and then changing to strong alcohol.

T. americanus Forst.

Illinois [Le Baron Collection].

T. giganteus De G.

Occurs late in the season. Taken from Aug. 26 to Sept. 6, in Woodford, Champaign, Washington, Jackson, and Union counties. Dr. Williston found it extraordinarily abundant and very annoying to stock in woodlands of Fayette county, near Vandalia, in September.*

Family STRATIOMYIIDÆ.

The elongate-lanceolate flattened larvæ of Stratiomyia and Odontomyia [Fig. 57, 59, 60] were common features of the shore life wherever aquatic vegetation flourished. They are rather large, opaque, greenish, brown, or gray, obscurely striped, and are found either in the water upon vegetation near the surface or floating about, or crawling over the bare mud and among the matted algal growths on wet shores. Odontomyia seems

*Trans. Kans. Acad. Sci., Vol. X., p. 139.

to prefer the water and Stratiomyia the shore. The pupa is formed within the larval skin, which changes very little, usually becoming slightly inflated. Only the anterior part is occupied, the remaining space being filled with air, causing the pupa to float at the surface, where its thick larval casing protects the tender morsel within. As the pupa matures the larval skin becomes prepared to split transversely across the disk of the second segment just over the face of the pupa, transversely on the fourth segment, and on the median line between these two, so as to form an I-shaped opening. Through this opening, when formed, the fly emerges while its case is floating on the water or resting on the shore. The hibernating larvæ and pupæ may often be found in large numbers under loose drift on shore, even at a considerable distance back from the margin, emerging here in early summer. The adults are often common about flowers, especially on low ground. They are prettily marked with greenish or yellowish and black or brown; and have a broad short abdomen, quite flat above.

The life histories of the three species studied at Havana are quite similar. The early summer brood of flies, derived from hibernating larvæ, gives rise to a summer brood of larvæ, which probably produces a second brood of flies in fall, as the abundance of very young larvæ in early spring is quite marked.

KEY TO THE GENERA OF STRATIOMYIIDÆ.

Three genera of this family are known to be aquatic in habit. They may be distinguished by the following characters:

Last segment with a circle of plumose hairs surrounding the stigmatal cleft; head oblong-conic, eyes at anterior third. (*Stratiomyiinæ.*)

Body acuminately narrowed posteriorly, last segment very elongate. [Fig. 57.].....*Stratiomyia.*

Body but little narrower posteriorly, last segment not more than twice as long as its greatest width. [Fig. 59, 60.].....*Odontomyia.*

Last segment with four long bristles; head slender, eyes prominent, at middle of side.....*Nemotelus.*

STRATIOMYIA.

S. obesa Loew.

S. quaternaria Loew.

The types of these species were collected in Illinois by LeBaron.

S. apicula Loew.

The most abundant imago in our general collections, but not yet taken at Havana. We have it from Champaign and McLean counties in central Illinois, and from Cook, Lake, Kendall, and LaSalle counties in northern Illinois. It occurred abundantly not far from the University June 21, near a shallow pond, and less abundantly May 22 and 25; and it has been taken on various dates from May 17 to August 2.

S. discalis Loew.

Described by Loew from Illinois examples received from LeBaron. In our collection from Provo, Utah.

S. marginalis Loew.

Imagos taken June 23 to Aug. 18, in Bureau, Rock Island, McLean, and Champaign counties.

S. norma Wied. [Fig. 57.]

April 16, at Havana, the hibernated pupæ were found under drift some distance from water. In May larvæ were taken in vegetation along shore. In June, close examination of bare mud on the wet shore at station B revealed numerous larvæ trailing over the surface, scarcely distinguishable from it. July 9, a pupa from this place contained a fully developed and perfectly colored imago. August 6 the imago appeared in the breeding-cage. Meanwhile the larva occasionally occurred in dip-net collections along shore. At Matanzas Lake, August 23, about fifty examples were found in a mass of cow-dung lying half submerged near the margin. November 10 undersized larvæ were frequent on the shore at

Station B, and in March and April single examples occurred. The imago has been taken by us also several times between July 6 and 22, in Carroll, Bureau, and Kankakee counties, upon various flowers.

The larvæ taken July 9 were placed in a dish of water with Ceratophyllum, which they immediately began to work upon, crawling through and over it, seeming to browse upon the minute life which it bore.

A pupa in a breeding-cage in company with pupæ of *Odontomyia cincta* was noted July 6 to have a round hole in one side of the eleventh segment, and an example of *Smicra rufofemorata* was in the cage. As some of the Odontomyia pupæ showed the same kind of holes, I could not be sure which species it came from. In Europe also, these larvæ are parasitized by Smicra.

The larva of this species is easily distinguished from the Odontomyia larvæ by its shape, by its dark ashy color, and by the entire absence of the ventral hooks on the two segments preceding the last.

RECORD OF STRATIOMYIA NORMA FOR THE YEAR.*

Dates.	A.	B.,	C. E.	C. W.	D.	E.	F.	G.	B.-C. &c.
Apr. 16	.....	.....	L-1	.....	.....	.....	.....	.....	.....
May 4	.....	.....	L-1	.....	.....	.....	.....	.....	.....
June 10	.....	.....	L-1	.....	.....	.....	.....	.....	.....
" 21	.....	L-3	.....	.....	.....	.....	.....	.....	.....
July 9	.....	L & P-3	.....	.....	.....	.....	.....	.....	.....
" 12	.....	.....	.....	L-1	L-1	.....	.....	.....	.....
Aug. 6	.....	.....	.....	.....	.....	.....	.....	.....	♀; B.-C.
" 11	.....	.....	L-1	.....	.....	.....	.....	.....	.....
" 16	.....	L & P-0	.....	.....	.....	.....	.....	.....	.....
" 23	.....	.....	.....	.....	.....	.....	.....	.....	L-3; Matanzas L. (a)
" 24	.....	.....	.....	.....	.....	.....	.....	.....	L-3 " (b)
" 24	.....	.....	.....	.....	.....	.....	.....	.....	L-2 " (d)
" 24	.....	.....	.....	.....	.....	.....	.....	.....	L-1; White Oak Run.

* See foot-note, p. 169.

Dates.	A.	B.,	C. E.	C. W.	D.	E.	F.	G.	B.-C. &c.
Sept. 14	.....	L-3	.....	.....	.....	.....	.....	.....	.....
" 24	.....	.....	L-2	.....	.....	.....	.....	.....	.....
Nov. 10	.....	L-2	.....	.....	.....	.....	.....	.....	.....
Feb. 26	.....	L & P-0	.....	.....	.....	.....	.....	.....	.....
Mar. 26	.....	Y-1	.....	.....	.....	.....	.....	.....	.....
Apr. 9	.....	L-1	.....	.....	.....	.....	.....	.....	.....
" 27	.....	.....	.....	.....	.....	.....	.....	.....	L-1; Slough.

Larva [Fig. 57].—Length 30–40 mm., greatest width (6th segment) 5.6 mm.; tenth segment 25.3 mm. wide, last, near base, 1.5 mm., apical half 1 mm.; length of last, segment from preanal fold about 6.5–7.5 mm., or about four times length of anal slit, shorter than this in the young larva.

Elongate-lanceolate, depressed, rapidly narrowed in front, acuminately narrowed behind; dark fuscous to blackish, clean specimens showing a cinereous bloom when dry, lateral edge and six narrow dorsal vittæ more or less distinctly pale cinereous; a dark dot surrounding the spiracles; on the overlapping margins of the segments the vittæ are much lighter and in strong contrast with the intervening spaces, which are here nearly black. The middle pair of light vittæ are more distinct than the others, and the dark median dorsal line is usually well marked. The other lines are nearly or quite obliterated on the disks of the segments. The dark ground color above and below is more or less mottled with the lighter color—a dot at the base of each hair. Previous to the later moults the larvæ become nearly unicolorous blackish. Above and below, in each transverse suture, usually concealed by the overlapping of the segments, is a double row of enlarged impressed granules, or minute shallow pits, and two short rows of

similar points, marked by paler or darker dots, lie near the side margin of each segment, the ends of the rows converging; these are irregular on the anterior part of the body, and the outer row on the last segment is prolonged indistinctly to its apex. Surface covered with minute hexagonal granulations, shining or opaque in varying lights, sparsely hairy above and below on the disks of the segments, lateral margin prominent, bearing dorsally minute round spiracles on segments 1 and 3–10.

Head small, pale dusky brownish, bisulcate above, a dark longitudinal streak passing through eye, which is surrounded by a fine light circle; the inner side of the lateral fold beneath often shows a clear-cut pale streak edged each side with darker, running from the hind angles of the mouth to those of the head; clypeus notched, maxillæ with plumose hairs, antennæ very small, consisting of a single joint with two minute joints on its truncate apex; eyes small, dark, not prominent.

On segments 9 and 10, beneath, a delicate opaque median line, sometimes pale, often nearly obsolete, extends from the base to beyond the middle of each segment. Last segment broader at anal slit, beyond this parallel-sided, beneath sulcate, a pale piliferous spot each side near middle, another pair less than half way from these to the tip, and an approximate pair at the posterior end of the anal slit; above, an approximate pair at the posterior third, and two pairs on each side close to the lateral margin, one pair in front of the middle, the other near the tip. Apical fringe short, plumose.

Puparium.—This differs very little from the active larva. It is usually more inflated at middle, often somewhat collapsed behind, the color markings more or less obliterated.

Odontomyia.

Two species of this genus (*cincta* and *vertebrata*) were studied at Havana, quite unlike in structure and easy to distinguish. No other imagos of this genus were found on shore during the season's work.

The females were seen ovipositing in large numbers on stakes projecting above the water, always upon the overhanging side, which was thickly covered with overlapping clusters. Dead branches in the water, reeds, and stems of various plants, also served the same purpose. The method of oviposition seemed to be the same in both species. The females all stood head downward except one. The long and narrow eggs were placed parallel to the longitudinal axis of the mass in an irregular oval or mytiloid low-convex mass, to the number of several hundred, closely laid, their tapering ends inserted between the ends of those adjacent to them. The fly having selected with its ovipositor a suitable place for an egg, and having placed its tip where the end of this egg is to be inserted or attached, the ovipositor is suddenly withdrawn, leaving about two thirds of the length of the egg protruded in its place. Then, after a momentary pause, the ovipositor is more slowly withdrawn from the remaining portion of the egg. The flies were quite imperturbable during the operation.

As mentioned under *Stratiomyia norma* the nymphs of that species and of Odontomyia are parasitized by large chalcids of the genus Smicra. In a cage containing larvæ and pupæ of *cincta* and a single pupa of *Stratiomyia norma*, some of these chalcids emerged July 6, all escaping but one, which was determined by Mr. W. H. Ashmead as *Smicra rufofemorata*. The small rounded holes made in the larval skin by the escaping chalcids were present in the Stratiomyia pupa and several of the *cincta*. A well-formed example of a closely related species, *S. microgaster*, was extracted from a pupa of *O. vertebrata*, also on July 6. The latter chalcid was again found July

10 upon a reed stem, mutilating an Odontomyia egg mass. The lower part of the mass was gone, and in its place stood the chalcid with its jaws apparently working at the lower edge of the remaining portion, where many of the eggs were evidently roughly displaced. July 15 I found an example of *S. microgaster* resting on a Sagittaria leaf at Station A, and another appeared in my dip-net August 20 at D. *Megilla maculata*, a coccinellid beetle, has been found by us eating Odontomyia eggs.

These two Odontomyia larvæ may readily be distinguished from the Stratiomyia, not only by their shape, but also by their green or brown colors when not blackened by exposure, and by the presence of one or more pairs of ventral hooks on the posterior margins of segments nine and ten. They differ from each other as follows:

KEY TO LARVÆ OF ODONTOMYIA.

Surface covered with minute peltate scales; ventral lines of segments 9 and 10 distinct, basal (Fig. 59); dorsal pale lines parallel posteriorly, continued upon last segment.....*cincta.*

Surface naked, with a few bristles; ventral lines of segments 9 and 10 discal (Fig. 60); dorsal pale lines converging behind and vanishing, on last segment obliterated, the dark stripes there confluent into one broad dorsal stripe [Fig. 60].....*vertebrata.*

Mr. Day's key to the imagos* is a purely artificial one based on color characters, and the close relationship of *cincta* (*extremis*) and *vertebrata* (*willistoni*) there indicated is misleading. Their true groupings in the genus may be seen by the following tabulation of our Illinois species, based primarily on structural characters.

*Proc. Acad. Nat. Sci. Phil., 1882, p. 74.

KEY TO IMAGOS OF ODONTOMYIA.

Third vein from outer side of discal cell very imperfect or wanting, therefore not more than four posterior cells; small cross-vein distinctly present, though short.

Basal two joints of antennæ black, first twice as long as second.

Front of ♀ piceo-ferruginous at middle, abdomen in both sexes with narrow lateral yellow marks at incisures.....*intermedia.*

Front of ♀ black, abdomen of ♂ with triangular lateral yellow spots.....*pubescens.*

Basal two joints of antennæ ferruginous, about equal in length.

Scutellum distinctly and rather densely punctate, it and face black, or nearly so.

Face in profile broadly rounded.....*plebeja.*

Face in profile strongly protuberant beneath antennæ.....*pilimana.*

Scutellum smooth and shining, finely and very sparsely punctulate, it and face light green. (*extremis* Day.).....*cincta.*

Third vein from outer side of discal cell fully developed like those on either side of it, therefore five posterior cells; small cross-vein wanting and third and fourth longitudinal confluent at that point, or the cross vein extremely short.

Scutellum light greenish, with distinct spines.

Thorax with two spots; large species.

Face of ♂ black.....*binotata.*

Face light greenish, with blackish fasciæ in ♀. *megacephala.*

Thorax unspotted; a small species, face of male piceo-testaceous, paler at middle, sides of male abdomen broadly pale; spines small, distant about half the length of the scutellum. (♀ *willistoni* Day.).....*vertebrata.*

Scutellum black, at least at base, its spines rudimentary, very minute and scarcely visible, or entirely wanting, face strongly protuberant.

Thorax, face, and scutellum, except sometimes narrow apical margin of latter, black; scutellar spines minute; antennæ dark rufous, base and apex black. ♂. *snowi* n.s.*

Four angles of thorax, scutellum except at base, and sides of thorax beneath broadly light greenish; scutellar spines entirely wanting; antennæ black. *hieroglyphica.*

O. intermedia Wied.

The adult was taken in Champaign and Lake counties May 23 to June 19 in low ground or near water.

O. pubescens Day.

Adult, Lake county, near Sand Lake, June 15.

O. plebeja Loew.

The imago is very common in Illinois, usually in low grounds, upon flowers. We have it from near the Mississippi River in Carroll county, also from Lake and Bureau counties, both northern; from McLean and Champaign counties; and from Wabash county in southeastern Illinois. It has been taken at frequent intervals from May 28 to August 2, at which latter date several were found.

O. pilimana Loew.

Also common as an adult, apparently somewhat later than *plebeja*. The earliest date is July 15, after which it frequently occurred and was still abundant at the last date recorded for the species—August 2. From Carroll, Bureau, LaSalle, De Kalb, and Champaign counties.

O. cincta Oliv. (*extremis* Day). [Fig. 58, 59.]

This species was in all its stages the most abundant aquatic stratiomyiid at Havana, though the imago has rarely occurred in our general collections.

*Named after Mr. W. A. Snow. The characters given will suffice without further description.

The place and manner of oviposition have already been described. Females were first seen ovipositing June 1, though they had doubtless begun to do so some time before, judging from the period of emergence. From this time on they were constantly seen ovipositing in ken to the cabin-boat produced young in ten days. The favorable weather until late in July. Freshly-laid eggs ta- very young larvæ became conspicuously abundant early in July, being especially noted on the 10th at Station G. The older larvæ were common from early in May till late in September, and a few were seen during the winter in open water, although they seem to hibernate mostly among drifted material left by the waves upon the shore. Collections made December 18 and February 26, and also in March and April, show that a large part of those which pass the winter are quite young. November 11 they were especially common on the shore at Station G.

Pupæ were also often seen in the water, but occurred in the largest number in April and May in the line of drift left by the water at the highest point reached by it earlier in the spring, some of the specimens being still in the larval state. They were then some distance from the water, and often quite dry externally. One was found July 18, still alive, fully 100 feet back on a sloping shore. May 17, on examining some fine drift where the pupæ were especially numerous, I noted a few empty skins, and found two imagos just emerged. May 19, imagos were seen on herbage on the west shore of Station C. They began to emerge during my absence, between May 21 and 26, from pupæ collected May 17, and the last from this lot of pupæ appeared June 27. July 6 parasitic chalcids were seen in the cage, and skins of this species from which the parasites had emerged—as already mentioned. The imagos collected on the shores were all taken in May, males and females in about equal numbers. They have also been collected

by us in Tazewell county, and in Carroll and Lake counties in northern Illinois.

The contents of one larval stomach seemed to be mostly mud, with a little vegetable matter, and here and there a diatom frustule. The others examined were empty.

RECORD OF ODONTOMYIA CINCTA FOR THE YEAR.*

Dates.	A.	B.	C. E.	C. W.	D.	E.	F.	G.	B.-C. &c.
Apr. 14	.....	.....	L-3,P-1	.....	.....	.....	.....	.....	.....
" 17	.....	.....	L & P-3	.....	.....	.....	.....	.....	.....
" 18	.....	.....	L & P-3	.....	.....	.....	.....	.....	.....
" 24	.....	.....	L-1	.....	.....	.....	.....	.....	.....
May 4	.....	.....	L, P	.....	.....	.....	.....	.....	.....
" 8	.....	.....	.....	L-3	.....	.....	.....	.....	.....
" 14	.....	.....	.....	.....	.....	.....	.....	L-2	.....
" 15	.....	.....	.....	.....	L-2	.....	.....	.....	.....
" 17	.....	.....	L-2	.....	P-4,♂ & ♀-2	.....	.....	.....	.....
" 19	.....	.....	.....	L-3,♂ & ♀-3	.....	.....	.....	.....	.....
" 21	.....	.....	.....	.....	.....	.....	.....	.....	
" 24	♀-1	.....	.....	L-2	.....	.....	.....	.....	
" 31	.....	.....	.....	.....	P-1	.....	.....	.....	
June 1	.....	.....	.....	E & I-2	.....	.....	.....	.....	♂ & ♀; B.-C.
" 11	L-1	.....	.....	.....	.....	.....	.....	.....	
" 13	E & I-3	.....	.....	.....	.....	.....	.....	.....	
" 15	L-1	.....	.....	.....	.....	.....	.....	.....	
" 27	.....	.....	.....	.....	.....	.....	.....	.....	
" 29	.....	.....	Y	.....	.....	.....	.....	.....	.....
July 2	.....	.....	Y	.....	.....	.....	.....	.....	.....
" 3	Y-2	.....	.....	.....	.....	.....	.....	.....	.....
" 7	Y-2	.....	.....	.....	.....	.....	.....	.....	.....
" 9	L-2	.....	.....	.....	.....	.....	.....	.....	.....
" 10	.....	.....	.....	.....	.....	.....	.....	E&Y-4	.....
" 11	.....	.....	Y	.....	.....	.....	.....	.....	.....
" 12	.....	.....	.....	L-1	L-3	.....	.....	.....	.....
" 18	.....	.....	E, L&I-2	.....	.....	.....	.....	.....	.....

*See foot-note, p. 169.

Dates.		A.	B.	C. E.	C. W.	D.	E.	F.	G.	B.-C. &c.
July	20	.....	.....	.....	.....	L-3	.....	.....	.....	.....
"	21	.....	.....	L	.....	.....	.....	.....	.....	.....
"	23	Y, L, & P-3	.....	.....	.....	.....	.....	.....	.....	.....
"	27	.....	.....	.....	.....	.....	.....	.....	.....	Y; B.-C.
"	29	.....	.....	L	.....	.....	.....	.....	.....	.....
Aug.	5	.....	.....	L-1	.....	.....	.....	.....	.....	.....
"	10	.....	.....	.....	L-3	.....	.....	.....	.....	.....
"	11	.....	.....	L-2	.....	.....	.....	.....	.....	.....
"	14	.....	.....	.....	.....	.....	.....	.....	L	.....
"	16	L-3	.....	.....	.....	.....	.....	.....	.....	.....
"	23	.....	.....	.....	.....	.....	.....	.....	.....	L-3; Matanzas L.,(a)
"	24	.....	.....	.....	.....	.....	.....	.....	.....	Y & L-2 " (b)
"	24	.....	.....	.....	.....	.....	.....	.....	.....	L-1 " (d)
"	31	.....	.....	.....	L	.....	.....	.....	.....	.....
Sept.	14	.....	L-2	.....	.....	.....	.....	.....	.....	.....
"	15	.....	.....	.....	.....	.....	.....	.....	.....	L-1; at Havana.
"	20	.....	.....	.....	L-1	.....	.....	.....	.....	.....
"	21	.....	.....	.....	.....	.....	.....	.....	L-3	.....
Oct.	12	L-1	.....	.....	.....	.....	.....	.....	.....	.....
Nov.	11	.....	.....	.....	.....	.....	.....	.....	L-3	.....
Dec.	18	.....	.....	.....	Y-2	.....	.....	.....	.....	.....
Feb.	26	.....	.....	Y-2	.....	.....	.....	.....	.....	.....
Mar.	17	.....	.....	.....	.....	.....	.....	.....	.....	Y-2; Slough.
"	18	.....	.....	Y-1	.....	.....	.....	.....	.....	.....
"	21	.....	.....	.....	.....	.....	.....	.....	Y&L-4	.....
"	22	.....	L-2	.....	.....	.....	.....	.....	.....	.....
"	23	.....	.....	.....	.....	.....	.....	.....	.....	L-1; River.
Apr.	9	.....	Y&L-2	.....	.....	.....	.....	.....	.....	.....
"	10	.....	.....	.....	.....	.....	.....	.....	L-3	.....
"	27	.....	.....	.....	.....	.....	.....	.....	.....	L-2; Slough.

Egg [Fig 58].—Length 1.1 mm., greatest diameter .27 mm. Pale yellowish when first laid, becoming blackish before hatching; smooth, fusiform, somewhat attenuated towards each end; laid in irregular oval rounded convex clusters about one third of an inch long, containing on an average about five hundred eggs.

Larva, newly hatched.—Length 1 mm. Broad and much flattened; blackish; last segment nearly as broad as long; plumose hairs as long as the segment, anal slit about half its length; head similar to last segment in shape and nearly as large, remaining segments very much broader than long, each half as long as last segment, and about twice as wide at middle of body, lateral margins serrulate; no distinct coloration.

Larva, mature [Fig. 59].—Length 20–30 mm., usually about 25 mm., greatest width (fourth or fifth segment) 4.5–5 mm.; tenth segment 2.5–3 mm. wide; last, at base, 2 mm., its length 2.5–3 mm., or twice the length of anal slit. Elongate-lanceolate, depressed, tapering slightly from apex of fifth segment; fuscous brown, grayish luteous when dry, becoming blackish previous to later moults, striped above and below with light yellowish or greenish yellow. Upper surface with lateral margins and six vittæ pale. Of the intervening seven dark lines, the middle one on each side is very broad and generally the darkest, its inner edge quite straight and usually distinct, and the body more or less angulate along this edge. The median dark line widens greatly on the disk of each segment, causing the narrow pale vitta on each side to curve outwardly, and is somewhat distinctly V-shaped and confluent anteriorly with the adjoining dark lines on segment 3, less so on 4, but not especially darker at these points. The next pair of pale vittæ, lying just within the angulation, varies greatly—sometimes very indistinct, but generally broad and in sharp contrast with the dark band exterior to each; the space between the angulations often forms a broad conspicuous pale dorsal stripe with three dark lines near mid-

dle. The middle pair of pale vittæ are more conspicuous anteriorly; all the lines are distinct at the sutures, and obscured on the disks of the segments. The pale vittæ are all continued, at their relative distances, to the middle of the last segment, where they fade out more or less completely.

Beneath, with the lateral margin and six parallel nearly equal straight vittæ brownish, these markings narrower and more distinct at the sutures. On both dorsal and ventral surfaces is a double row of blackish points in each suture, usually concealed by the overlapping of the segments, and two or three short rows of similar points, converging at each end, on the disk of each segment near the lateral margin, the outer row on the last segment prolonged nearly to its tip. Surface finely granulate, thickly covered with minute peltate scales, becoming setaceous near dorsal line, with a few scattering hairs. Spiracles on upper side of lateral margins of segments 1 and 4–10; brownish, all but the first minute.

Head small, subopaque but not granulate except basally beneath, more or less longitudinally striped, dark brown at middle beneath; middle lobe rather strongly sulcate above, back of the eyes; clypeus not notched; antennæ very small, basal joint curved, latter brown apically with two minute joints on its truncate apex; eyes small, dark, slightly prominent.

On the median line beneath, on segments 9 and 10, is a short distinct narrow smooth space, extending from near the base one fourth or one third of the length of the segment, minutely elevated and opaque along middle. At the middle of the ventral hind margin of these two segments is an approximate pair of minute dark-brown hooks, their points curving forwards, each often accompanied by one or more accessory hooks, especially on the tenth segment. Last segment with sides almost parallel to near middle, thence tapering slightly to apex. Beneath sulcate beyond anal slit. Piliferous spots somewhat inconspicuous. Apical fringe short, plumose.

Puparium.—Closely resembling larva, more inflated, especially near middle; body bisinuate posteriorly, being bent upward at segment 7, thence arcuate and convex above to the last segment, which is flexed upward; ventral stripes more or less obliterated.

O. binotata Loew.

Types collected in Illinois by Dr. Le Baron.

O. megacephala Loew.

This large and handsome species is not common in Illinois. Our specimens are mostly from the northern portion,—from Carroll, Bureau, and McHenry counties,—although one is from the Illinois River bottoms in Tazewell county.

O. vertebrata Say. [Fig. 60.]

From pupæ as much alike as two prints from the same cut were reared males of this species, and females agreeing with the description of *O. willistoni* Day. There is no other female known for *vertebrata*, nor any male for *willistoni*, and no other unisexual species known to me can possibly belong to either. Their close relationship is evident from the foregoing key, in which both forms are included under the name *vertebrata*, and I feel justified in treating them as sexes of one species under the older name.

The females were seen ovipositing at the same times and places and in the same manner as *O. cincta*, but not in such numbers, *vertebrata* being much the less common about Havana. Young were obtained July 27 from the eggs of this species.

A young larva was taken Apr. 14 under drift on shore among the examples of *O. cincta*, and the older larvæ were taken frequently throughout the season, usually in floating vegetation with *O. cincta*, rarely on the springy shore, the last date of their occurrence being Sept. 14. Pupæ were noted on the water in June, July, and August. The hibernating larvæ must be largely young, as these be-

came quite common, floating on the water, early in the following spring. Larvæ and pupæ were also collected from a small pond near the University, at Urbana, July 12 and 15, from which three examples of *vertebrata* were obtained July 19 and Aug. 2. The imago was first seen at Havana June 12, and one emerged in a breeding-cage June 16. A female was found ovipositing on the 15th, and continued to lay eggs on being placed in a breeding-cage. Miscellaneous collections of the adult were also made from June 14 to July 24 in the neighborhood of the water. In our general collections we have it only from Champaign county, near bodies of water, May 19, and July 15, 20, and 29.

RECORD OF ODONTOMYIA VERTEBRATA FOR THE YEAR.*

Dates.	A.	B.	C. E.	C. W.	D.	E.	F.	G.	B.-C.
Apr. 14	.....	.....	Y-2	.....	.....	.....	.....	.....	.....
May 5	.....	L-1	.....	.....	.....	.....	.....	.....	.....
" 14	.....	.....	.....	.....	.....	.....	.....	L-1	.....
" 17	.....	.....	L-1	.....	.....	.....	.....	.....	.....
" 19	.....	.....	.....	L-3	.....	.....	.....	.....	.....
" 30	.....	.....	.....	L-1	.....	.....	.....	.....	.....
June 1	.....	.....	E & I-2	.....	.....	.....	.....	.....	.....
" 12	.....	.....	.....	.....	.....	♂-1	.....	.....	.....
" 14	.....	.....	♀-1	.....	.....	.....	.....	.....	.....
" 15	.....	.....	♀ & E-3	.....	.....	.....	.....	.....	.....
" 16	L & P-2	.....	.....	.....	.....	.....	.....	.....	♀
" 19	♀-1	.....	.....	.....	.....	.....	.....	.....	.....
" 21	.....	L-2	.....	.....	.....	.....	.....	.....	.....
" 24	.....	.....	♂-1	.....	.....	.....	.....	.....	.....
" 27	.....	.....	.....	.....	.....	.....	.....	.....	E & Y.
July 18	.....	.....	E, L & I-2	.....	.....	.....	.....	.....	.....
" 20	.....	.....	♀-1	.....	L-1	.....	.....	.....	.....
" 23	L & P-3	.....	.....	.....	.....	.....	.....	.....	.....
" 24	.....	.....	♀-2	.....	.....	.....	.....	.....	.....

* See foot-note, p. 169.

Dates.	A.	B.	C. E.	C. W.	D.	E.	F.	G.	B.-C. &c.
Aug. 4	.....	.....	P-1	.....	.....	.....	.....	.....	.....
" 5	.....	.....	P-1	.....	.....	.....	.....	.....	.....
" 10	.....	.....	.....	L-2	.....	.....	.....	.....	.....
" 14	.....	.....	.....	.....	.....	.....	.....	L	.....
" 16	P-1	.....	.....	.....	.....	.....	.....	.....	.....
" 20	.....	.....	.....	.....	L-1	.....	.....	.....	.....
" 31	.....	.....	.....	L-2	.....	.....	.....	.....	.....
Sept. 14	.....	L-1	.....	.....	.....	.....	.....	.....	.....
Mar. 22	.....	L-1	.....	.....	.....	.....	.....	.....	.....
" 23	.....	.....	.....	.....	.....	.....	.....	.....	Y-1; B.-C.
Apr. 13	.....	.....	.....	.....	.....	.....	.....	.....	Y-3; Flag L.
" 27	.....	.....	.....	.....	.....	.....	.....	.....	Y-3; Slough.

Parasites.—On opening a somewhat shrunken pupal skin I found within it, in the place of the pupa, a well-marked and almost fully-developed specimen of *Smicra microgaster*.

Egg.—Length about 1 mm., greatest thickness .2 mm.; otherwise very similar to that of *O. cincta*, and laid in similar masses.

Larva newly hatched.—Length 1 mm. This when hatched is much more slender than that of *cincta*, paler in color, especially beneath, the intermediate segments more elongate. In an older example 6 mm. long, the characteristic coloring of the species is well developed.

Larva, mature [Fig. 60].—Length 12–15 mm., greatest width 2.8–3.6 mm., tenth segment 1.5–2 mm. wide, last segment, near base, 1.25 mm., its length 1.5–1.8 mm., about twice the length of anal slit. Shape as in *O. cincta*, often more depressed and broader, colors about as in *cincta*, but distinctly different in arrangement, and darker when dry. An approximate pair of dorsal pale vittæ, usually separated by a narrow dorsal dark line which is slightly dilated on the

disks of the segments. On the third segment it is especially dilated, always darker in color, and more or less confluent with the adjoining dark lines, which are also darker here, so that a blackish X-shaped spot is formed more or less conspicuously. On the other segments it is often nearly obliterated, so that a narrow dorsal pale stripe is formed between the first pair of dark lines, but never between the second pair as is the case with the dorsal stripe in *O. cincta*. This first pair of dark vittæ are the broadest; exterior to them the pale vittæ are obsoletely indicated, but always visible at the sutures. At the posterior margin of the eleventh segment the middle pair of pale vittæ invariably end, and the three upper dark vittæ unite npon the last segment in a dorsal band, narrowest and blackish at its anterior fourth, and widening greatly to near its apex. The second pair of dark vittæ curve inward from the base of the last segment towards the narrow part of the middle stripe, and beyond this are usually more or less widely interrupted, the second and third pairs of pale vittæ then uniting in a broad pale stripe in sharp contrast with the middle one. Three or four of the segments preceding the last are bordered posteriorly by a fuscous band. Beneath, six nearly equal parallel dark vittæ, sometimes nearly or quite obliterated, more or less broken up on the last segment; lateral margin pale, with a dark point in the middle on each segment. Impressed sutural and lateral blackish points as in *cincta*, the lateral ones ringed with blackish and more conspicuous, especially those beneath and on the last segment above. Surface finely granulated, sparsely short-pilose above and below at the middle of each segment. Spiracles brown, more distinct than in *cincta*, present on segments 1 and 4–10, plainly absent on the meta- and mesothoracic segments.

Head small, light brown, a dark longitudinal stripe through each eye, middle lobe very feebly or not at all sulcate, clypeus not notched; basal joint of antenna

slender, basal portion slightly curved, the usual two minute joints at apex; eyes small, pale, scarcely prominent.

The median ventral line on segments 9 and 10 is minutely elevated from the base to the posterior third of the segment, and the ventral surface of these segments is flattened at middle. At their posterior margins are two sharp light brown diverging hooks, their points directed forwards, longer and further apart than in *cincta*, the margin of the segment somewhat prominent at the points of attachment. No accessory hooks in any of the specimens. Last segment with sides nearly parallel to near middle, thence tapering slightly to apex. Beneath sulcate beyond anal slit. Apical fringe plumose, three fourths the length of the last segment.

Puparium.—More inflated and cylindrical than the larva, not noticeably sinuated, posterior margins of segments 6–9 bordered more or less narrowly with blackish.

O. snowi, n. s.

This well-marked species was collected July 2 in Champaign county.

O. hieroglyphica Oliv.

Taken only in Champaign county July 24.

Nemotelus.

Larvæ of Nemotelus have been reported as aquatic by Haliday,* but the genus was not recognized by us at Havana, although one species at least is common in the State.

N. unicolor Loew.

Taken in low grounds and in meadows, among grass and weeds, May 23 to 28 and July 1 and 2; Wabash, Champaign, McLean, and DeKalb counties.

* Nat. Hist. Review, 1857, No. III., p. 194.

Family LEPTIDÆ.

Several large families, including Asilidæ and Bombyliidæ, follow before the completion of the Orthorhapha; but nearly all of their species seem to be terrestrial or parasitic in larval habit. A few, however, among Leptidae, Empidæ, and Dolichopodidæ are known to breed in wet places.

Cœnomyia.

This wandering genus, originally constituting the Cœnomyiidæ and placed by Loew in the Xylophagidæ, seems most recently to be included by Comstock in the Leptidæ, together with Xylophagus, judging from the characters given by him for that family.*

C. pallida Say.

According to a note in Osten-Sacken's Catalogue of the Diptera of North America, p. 43, this is the same as the European species *C. ferruginea*, the immature stages of which have been described and figured by Beling† and other European writers, having been obtained by them in rotting poplar wood and in earth about old stumps.

At Sand Lake, in Lake county, June 15, one of our assistants found an example of *C. pallida* in the act of emerging from its pupal skin, which was sticking to the stem of an aquatic plant some distance out from shore, and on the following day another imago was taken near the margin of Fourth Lake, in the same county.

The pupa agrees with Beling's somewhat general description. I may add here that it is much like the tabanid pupa in several respects, such as the proportions and splitting of the thorax, ocellar triangle, abdominal fringes, sculpture, etc. The spiracular rima is broad, shining, C-shaped, the ends turned forward on the abdomen, while that on the thorax, which is scarce-

* "Manual for the Study of Insects," pp. 418, 424, 456.

† Verh. d. k. k. zool-bot. Gesellsch. in Wien, 1930, p. 343

ly larger, has the ends turned *backward*. The spinous fringes of the abdomen are very scanty; but there is always a pair of large spines present behind each spiracle. The abdominal sculpture is simply a strongly roughened surface, scarcely transverse. The last segment ends in a square flattened truncate broad tooth, each side of which is a hand-shaped tubercle bearing five thick spines; there are also smaller spines above on this segment.

The three following species of larvæ evidently belong in this connection, according to Brauer's synopses and figures, showing various combinations of the characters figured; and without further speculation on their identity, I will close with a statement of the observations made and the prominent characteristics of these larvæ. They all agree in being quite white, moderately slender, cylindrical, tapering anteriorly and truncate posteriorly, usually with four fleshy teeth at the margin of the truncation; 12 segments, increasing gradually in length up to the penultimate, the anterior margins of the segments thickened and more or less elaborately provided beneath with teeth and hooks for crawling; the head with a median pair of black posterior prolongations, ending anteriorly in a lunate transverse bar, in front of which are the hook-like mandibles; the maxillæ and their palpi at the anterior angles of the head; the labrum narrow; and the antennæ short and pale-colored, borne upon the whitish sides of the head. They are usually sluggish.

Larva (*a*).

This species bores in the decaying and water-soaked floating stems of rushes. The larvæ look much like the white calcareous masses which form in the decaying tissues, and are easily overlooked. They were found April 13 and 15.

The larva is about 9 mm. long, white, posterior prolongations of head not long, abdominal segments, except first and last, with anterior transverse ridge beneath, bearing in front, each side, a row of small double-pointed teeth, with an arc of minute teeth at inner ends of rows; back of each row a series of oblique rows of small teeth, the inner ones converging at median line, and between their tips a larger truncate tooth; last segment with longitudinal anal slit, two rows of minute teeth each side, four scabrous elevations in front, and a U-shaped line of teeth each side, all the teeth clear testaceous. Apex of last segment bluntly rounded off, a small deeply concave area at center containing the light brown stigmata, a low tubercle exterior to each, and an approximate pair of short teeth below.

Larva (*b*).

There seems to be no question as to the aquatic habit of this species, as examples were taken March 27, with dip-net and sieve, from the mud at the bottom of the main river, not far from the channel, in several feet of water, off the south end of the city. One larva was found also March 22 in Quiver Lake, at Station B, lying exposed in a few inches of water.

In general appearance it is like the preceding, 12–13 mm. long, whitish, transparent and glassy, the black posterior prolongations of the head quite long and straight, diverging at tip; the anterior transverse ridges of the abdominal segments crossed by glassy lamellar raised edges, their posterior ends, especially of the inner ones, extended inwardly toward the median line, each elevated near its middle into a triangular saw-tooth, with acute apex and vertical serrulate posterior edge; posterior truncation encircled by seven broad concave membranous teeth with thin transparent edges, two large ones at the lower angles, a pair of small double-pointed truncate lateral ones, two medium-sized ones at the upper angles, separated from those below by a

deep notch from which a sulcus extends forwards, their apices with recurved bristles, and at their base within, the light yellowish stigmata; seventh tooth small, medio dorsal, anal prominence cordate.

Larva (*c*).

From earth in bottom-land, April 17. It is much like the preceding, and probably of the same genus.

Length about 14 mm., not essentially different from larva *b* except on the last segment, which has the truncation surrounded by four acute teeth, an upper and a lower pair, with a broader lateral interval, in which is a very small tooth on each side; the upper teeth bear an apical fascicle of setæ, and the yellowish stigmata are at their base within.

HYMENOPTERA.

None of the members of this order are strictly aquatic.* Some of them, however, concern us in this connection because of their attack upon aquatic forms, either as true parasites or for the purpose of provisioning their nests. The breeding of the parasites of aquatic insects has received very little attention in this country, and much still remains to be done in this direction.

In the Parasitica, Mr. W. H. Ashmead has kindly worked up our Station collections and prepared descriptions of the new species, his article following the present one, and beginning on p. 274.

Family ICHNEUMONIDÆ.

Cryptus cyaneiventris Riley MS.

Common in July on the floating leaves of *Potamogeton nutans*, associated with *Hydrocampa obliteralis*, under

*A parasitic hymenopteron, *Polynema natans*, is able to swim with its wings, and seems to be the nearest approach to an aquatic insect of any in this order.

which species fuller details are given. A hydrocampid parasite, and in all probability parasitic upon the above *Hydrocampa.*

Cremastus hartii Ashm., n. s. [Fig. 13.]

Both sexes were taken upon the surface of Quiver Lake Sept. 14, at Stations A and B. Its host is unknown.

Described by Mr. Ashmead on page 277.

Family BRACONIDÆ.

Clinocentrus niger Ashm., n. s. [Fig. 14.]

In September *Lemna trisulca* and other Lemnaceæ were everywhere abundant, often covering the water in a continuous sheet along the shores. Several forms appeared to find a natural habitat upon the surface, among them the present species, which often occurred in considerable numbers. As this genus is generally parasitic upon larvæ of Lepidoptera, and none of these were observed where the Clinocentrus occurred, I am at a loss to account for its presence there, unless it was in search of food.

Mr. Ashmead's description follows on page 276.

Family CHALCIDIDÆ.

Smicra microgaster Say.

Adult taken July 6 from puparium of *Odontomyia vertebrata.* Collected July 10 and 15 and Aug. 20, in the first instance apparently feeding on Odontomyia eggs. (See treatment under Stratiomyiidæ.)

Smicra rufofemorata Cress.

Bred July 5 from cage containing puparia of *Odontomyia cincta* and *Stratiomyia norma.* (See Stratiomyiidæ.)

Family PROCTOTRYPIDÆ.

Loxotropa ruficornis Ashm.

One male taken Sept. 10 while collecting with dip-net along river margin.

Cosmocoma maculipes Ashm.

Female taken in a similar way Sept. 14, in collecting along shore of Quiver Lake.

Phanurus tabanivorus Ashm., n. s. [Fig. 55, 56.]

Bred from eggs of *Tabanus atratus* Aug. 4 and Sept. 13. The species is described and discussed by Mr. Ashmead on page 274, and the biological details are given under *Tabanus atratus*.

Family POMPILIDÆ.

The low shores about the head of Quiver Lake were frequented by many species of this family, probably in search of the spiders which are so abundant on these wet shores. *P. biguttatus* was taken May 20 and *P. philadelphicus* Aug. 30, together with three other well-marked species which seem to be new to our collection, although it already contains more than seventy-five Illinois species of this family. They are perhaps correlated with the peculiar character of the surrounding region.

Pompilus, n. s. (?)

A cluster of hymenopterous cocoons was found in August on the springy shore of Station B, under an old log. They were placed in a breeding-cage, in which the first imago appeared Sept. 1, the last of the lot coming out on the 8th of this month. The species is apparently new, but those bred were all females, and it seems hardly desirable under the circumstances to offer an isolated description in the present connection.

The cocoon is isabella color (reddish-argillaceous), elongate-elliptical, 12–13 mm. long, and 5 mm. in diameter at the anterior third, opening near this end by a clean circular cut for the escape of the imago, the end separating as a hemispherical cap. At the other end is a darker knob, marked off by a slight constriction. The walls are dense, but thin and papery, shining within,

dull without. The color and texture distinguish it from others I have seen.

The imago is rather small, 9–10 mm. in length, somewhat shining, faintly purplish black, a short inconspicuous blackish pilosity; the wings quite blackish, with violaceous iridescence; the pronotum subangulate behind, the propodeum smoothly rounded and shining; second cubital elongate-quadrate, length on radial and cubital veins about equal, third cubital narrowed about one third towards the marginal cell; last abdominal very opaque, with close-set moderately long black setæ.

Family BEMBECIDÆ.

Bembex spinolæ Lep.

This well-known and common sand-wasp was often noted along the sandy east shore of Quiver Lake, and often several at once were hovering about our boat while we were at work at Station A, in the middle of the shallow but broad expanse of water at the head of this lake. Since it is the habit of sand-wasps to provision their nests with Diptera—including among these some which breed in water—they must considerably affect the numbers of such species.