BULLETIN

OF THE

Illinois State Laboratory

OF

NATURAL HISTORY,

URBANA, ILLINOIS.

VOLUME IV.

CONTRIBUTIONS TO A KNOWLEDGE OF THE NATURAL HISTORY OF ILLINOIS.

1892-1897.

SPRINGFIELD, ILL.
H. W. ROKKER, PRINTER AND BINDER,
1898.

CONTENTS.

BULLETIN

OF THE

Illinois State Laboratory

OF

NATURAL HISTORY,

CHAMPAIGN, ILLINOIS.

VOLUME IV.

(ARTICLES I—V.)

SPRINGFIELD, ILL.:
H. W. ROKKER, PRINTER AND BINDER,
1895.

State Laboratory of Natural History.

LABORATORY STAFF.

Professor Stephen Alfred Forbes, Ph. D.,
Director of State Laboratory, and State Entomologist.

Frank Smith, A. M.,
Assistant Zoölogist.

Charles Arthur Hart,
Curator of Collections.

Willis Grant Johnson, A. M.,
Assistant Entomologist.

Mary Jane Snyder,
Stenographer.

Henry Clinton Forbes,
Librarian and Business Agent.

Lydia Moore Hart,
Artist.

BULLETIN

OF THE

ILLINOIS STATE LABORATORY

OF

NATURAL HISTORY.

VOLUME IV.

ARTICLE I.—*Bacteria Normal to Digestive Organs of Hemiptera.* BY S. A. FORBES.

In 1833 Léon Dufour described and figured in his "*Recherches sur les Hémiptères,*"* under the non-committal name of "*cordons valvuleux,*" some curious appendages of the alimentary canal in Scutelleridæ, Pentatomidæ, and certain Coreidæ, misinterpreting their structure, however, and expressing no opinion as to their function, which, in fact, he called a mystery.† These organs had been previously distinguished by Ramdohr (1811), and they have since been several times referred to by entomologists as glands or follicles secreting a digestive fluid, presumably pancreatic. My own entomological studies did not make me particularly acquainted with structures of this class until 1888, in the autumn of which year, while studying the contagious diseases of the chinch bug (*Blissus leucopterus*) I made some dissections of that insect, isolating the alimentary canal and searching different parts of it for the source of a bacterial infection discovered in the fluids of chinch bugs when crushed under the microscope. This bacterial development I thus traced to certain cœcal appendages of the small intestines so unlike the "*cordons valvuleux*" of Dufour's descriptions, that it did not for a time occur to me to connect the two; but in the course of some general dissections of

* Pp. 149–151, etc., and figs. 1, 2, 6, 13, 19, 21.

† Pp. 150, 171.

Hemiptera made at my office this summer by my assistant, Mr. John Marten, and myself, it became evident that these dissimilar organs could be connected by intermediate gradations, that they had substantially the same anatomical relations and histological structure, and that all were alike, wherever they occurred, in the highly remarkable fact that they were invariably loaded with myriads of bacteria, differing in genus and species in the different insects, but always confined to these organs.* We further observed that in Coreidæ and Lygæidæ these cœcal structures might be present in one genus and absent in another of the same family, only the higher Hemiptera (Pentatomidæ, Scutelleridæ, Corimelænidæ, etc.) invariably possessing them, and the lower Hemiptera invariably wanting them. In case they were absent, their bacterial relationship was never assumed, in whole or in part, by any other organ. The occurrence of "masses of motile vibrio-like objects" in these glands in a Pentatoma was noticed by Leydig in 1857, but I have found no other mention of the matter than that on page 337 of his *Lehrbuch der Histologie.*

There are certain cœcal appendages of the alimentary canal of other orders of insects, which have a general resemblance to these in Hemiptera, but can be considered homologous with them only in a very loose sense of the word, since they are certainly not homogenous. These gastric pouches in grasshoppers, cockroaches, and carabid beetles do not commonly contain bacteria so far as we have been able to determine. In fact, the only other insect structures in which we have found bacteria normally present with any constancy, were the fatty bodies of various species of cockroaches. It is not absolutely certain that these objects from cockroaches are bacteria, as they have not yet been cultivated, our own recent efforts having failed, as did Blochmann's.†

* No hibernating specimens have as yet been examined, and it is possible that this phenomenon will be found to disappear with the functional quiescence of these glands.

† Biologisches Centralblatt, Vol. VII., p. 606.

Balbiani's observations, however, (reported in *Comptes Rendus*, Vol. 103, p. 952) to the effect that bacterial forms introduced in the blood of insects are taken up by the cells of the pericardial tissue and destroyed therein, give a certain probability to the hypothesis that these seeming bacteria of cockroaches are really such. It is true that Balbiani's statements are limited to the pericardial tissue in the vicinity of the heart; but as Kowalevsky has shown* that this tissue is intermingled in many insects with the so-called fatty bodies, it is not unlikely that a more general and critical search would have shown the cells in question to have the same functions wherever found.

There can, however, be no doubt as to the nature of the objects found in the cœcal appendages of the Hemiptera above mentioned. They not only present every visible characteristic of micrococci and bacilli, but by their reaction to stains, their resistance to prolonged treatment with solutions of caustic potash, and especially and conclusively by the success of our culture experiments with both fluid and solid media, they answer to all the tests applicable to the recognition of bacteria.

These cœcal structures are probably shown in their simplest form in Pyrrhocoridæ (see Dufour, p. 171, and figures 17 and 21), although in the absence of specimens of this family for microscopic examination I can only repeat Dufour's surmise that the small and variable cœcal pouches of the small intestine in these Hemiptera are homologues of the complicated apparatus of Anasa and Euschistus. The next simplest form of this organ which I have thus far seen, is that of the chinch bug, where it consists of five to eight large cœca radiating from a common point of attachment on the intestine about .2 mm. behind the third stomach. These cœca are about .12 mm. in diameter, and average 1.5 mm. in length. They are straight or slightly contorted, with smoothly rounded ends, and are nearly filled, when in normal condition, with large, pale, loosely-attached, sub-

* Biologisches Centralblatt, Vol. IX., p. 44.

spherical cells, similar to those of the gastric epithelium, and like them usually binucleate, but containing more fatty granules. These cells are variable in size, and individual ones become greatly swollen, and probably break down in secretion. The lumen of the tube is an irregular linear space, not always readily distinguishable in the midst of the cells. That these tubules actually communicate with the intestine at the point of their insertion, I have repeatedly demonstrated under the microscope by carefully readjusted pressure on the cover-glass. By this means granules may be made to pass freely from any one of the cœca into the intestine, and even from the third stomach into the cœca through the slender portion of the intestine connecting them.

The microbe of these cœca (in the chinch bug commonly *Micrococcus insectorum* only) occurs primarily in the intercellular fluids of these structures, and was excessively abundant in every one of a great number of specimens, the cœca of which I examined separately. My specimens were from all parts of the State of Illinois and from Kansas, and were of various ages, from young immediately following the first moult to the adult. A thorough exploration and examination of all the other organs of these chinch bugs failed to discover any trace of this or any other bacterium, with the exception of an occasional infection of that part of the intestine into which the cœca open.

Examples of five other genera of Lygæidæ have thus far been dissected by us, in three of which (*Lygæus turcicus*, *Nysius angustatus*, *and Geocoris uliginosus*) there is no trace of these "pancreatic" organs, while in two others (*Trapezonotus nebulosus*, and *Myodocha serripes*) they are present in a stage of development quite above that of the chinch bug, but far below that characteristic of the higher Hemiptera. In Myodocha, for example, they are made up of numerous cœcal tubes arranged side by side in a single layer, in flat, leaf-like lobes, three in succession, the largest leaf anterior, and the middle one of the series the smallest, the three being bunched together, wrapped around the stomach, and imbedded in fatty tissue in a way to require careful dissection for their display. The tube-like structures of which these leaflets are composed are thickest distally, and are attached by their narrow ends to the alimentary canal, which in the first lobe is indistinguishable from the edge of the sheet itself. This anterior sheet is irregularly palmate, the longest of the finger-like cœca measuring 1.1 mm. and the shortest (those most posterior) about .7 mm. The transverse diameter of a single cœcum at its broadest end is about .07 mm. This lobe is partly folded together, the folds being held in place by branches of a large trachea, which is distributed abundantly to all parts of the structure.

The second or smallest lobe is attached to the intestine by a narrow insertion about .1 mm. behind the preceding. It is .5 mm. long by about .2 wide.

The third lobe, of medium size, is also attached by a narrow insertion to the intestine immediately beyond the preceding. It is quite regularly palmate in form, is supplied by a single much-branched trachea, and measures about .7 mm. long by .5 wide.

Crushing successively and separately all the portions of the alimentary canal upon cover-glasses, and treating by the usual methods for the demonstration of bacteria, I found all the preparations quite free from them, with the exception of those from the above-described leaf-like cœcal structures; and in these, and in every part of them, immense numbers of a minute Micrococcus occurred (not *M. insectorum*), situated, as in the chinch bug, chiefly between the large spherical cells of which these bodies were principally composed. Several repetitions of this experiment with other specimens gave the same result. In Trapezonotus this organ has the same structure and general appearance as in *Myodocha serripes.*

Among the Coreidæ I have seen it in *Anasa tristis*, *Alydus pilosulus*, and *A. eurinus*, but have found nothing resembling it in *Corizus lateralis*. In this family it has a much more considerable extent than in the foregoing, and now takes the form of rows of short, transverse cœcal tubules, standing in general at right angles to the small intestine, but with their inner ends the smaller. They are fused into a continuous layer, and make by their arrangement a broad plaited border on each side of the intestine for its whole length, from the stomach to a bladder-like expansion into which the Malpighian organs open. A large trachea runs along the intestine, and its branches are very liberally distributed, right and left, to all parts of these gland-like bodies*. The tubules are lined with a single-layered epithelium very different from that of the part of the intestine into which they open. They may be easily demonstrated, by pressure under the microscope, to open separately into the alimentary canal running along between the rows, and the same fact is evident in stained sections. In every case, again, the intercellular substance within these tubules is little more than a mass of bacteria,—micrococci or bacilli, as far as determined.

The same may be said of the Pentatomidæ and Corimelænidæ dissected,—Corimelæna, Peribalus, Mormidea, Euschistus, and Hymenarcys,—except that in these families there are always four rows of the short transverse tubules instead of two. In Capsidæ, Nabidæ, Reduviidæ, and Aradidæ—the only other families examined with this matter in mind—we have not found these structures, and Dufour notes their absence in examples of these families, and in Miris, Phymata, Cimex (Acanthia), and the lower Hemiptera generally.

In every case where they have occurred in our dissections, we have made exhaustive search for bacteria in other parts of the alimentary canal also, and in the salivary glands, the fatty bodies, etc., and in all these Hemiptera with only negative results.

* The abundant tracheal supply of these organs and the minute distribution of the tracheal branches—scarcely less abundant than in the fatty bodies, and much more so than in other portions of the alimentary canal—hint at a peculiar function for this so-called pancreatic apparatus.

I have no present desire to speculate concerning the meaning of the bacterial contents of these glands, but limit myself to this preliminary account, and await the completion of the several investigations in which we are now engaged,—upon the distribution of the cœca, their variations, and their relations to the habits of the species possessing them, and upon the kinds and nature of the bacteria constantly harbored by these interesting appendages of the alimentary canal.

Concerning their relations to insect disease, I will only add that in chinch bugs perishing gradually but rapidly, we find them varying considerably in number in the cœcal appendages; and that where they are most abundant, the epithelium of these structures is completely disorganized, only the basement membrane remaining, in the form of cœcal tubes filled with a pure culture of *Micrococcus insectorum* and a little granular debris, the latter apparently the product of the decomposition of the epithelium.

Article II.—*Description of two New Deltoid Moths.* By G. H. French, Carbondale, Ill.

Pseudaglossa forbesii, n. sp.

Similar to *P. lubricalis*, and probably heretofore mistaken for that common species. In size and color more like *P. scobialis*, but smaller. Color dull brownish black, with very little of the lustre of *P. lubricalis*. T. a. line straight in its course, slightly wavy, black, preceded by a pale line; median shade forming a distinct black line, curved outward through the cell; t. p. line black, extending obliquely outward from the costa to subcostal vein, thence nearly straight to posterior margin, slightly dentate, followed by a pale line that is very fine except on costa, where it is quite prominent; a subcostal pale line that is obscure except on the costa, a terminal black line cut with pale between the veins; fringe dusky. The pale part is paler than in *P. lubricalis* and less yellowish. Hind wings blackish, the basal portion pale, the lines of the fore wings, except the t. a., continuous across these but parallel to outer margin, the pale lines white and prominent; discal spots of both wings obsolete. Under side gray, from a mixture of black and white scales, the lines of upper side, except the t. a., repeated. Head and thorax above solid brownish black, the tip of joint 3 of the palpi pale; abdomen concolorous with hind wings, annulate with pale.

Expanse from .70 to .75 inch; length of body .25 inch.

Described from 4 females collected at Savanna, Ill., in 1892, two of which were taken at sugar, and two found upon the flowers of sweet clover (*Melilotus alba*) by day. Three of these are in the collection of the State Laboratory of Natural History, and one is in the author's cabinet.

PALLACHIRA HARTII, n. sp.

Male attennæ pectinate, female simple; fore wings narrow, costa but little falcate, outer margin rounded; in color darker than *P. bivittata*, a dusky yellow, more dusky than *Heliophila phragmitidicola;* a blackish stripe below median vein, and another from middle of cell to outer margin, a series of blackish points, tending to triangular shape, in a slightly incurving line from apex to posterior angle, the spot located midway between the veins and followed by a few pale scales; beyond the pale spot a few dark scales in the intervenular fold to outer margin; terminal row of black dots; fringe dusky; two black points at end of cell, on each side of the blackish stripe. Hind wings smoky. Under side darker than the upper; fore wings immaculate, hind wings with a discal dot and a dusky subterminal line. Body concolorous with wings, palpi dark, with tip of terminal joint pale. Hind tibiæ with two pairs of long spurs, the proximal pair much the longest.

Expanse from .90 to .93 inch; length of body .35 inch.

Described from two males and three females in the collection of the State Laboratory of Natural History, and one female in the author's cabinet. These were all taken at light in Champaign county, Ill., from July 27 to August 20, in the years 1886 and 1892.

Article III.—*The Life History and Distribution of the Prothonotary Warbler in Illinois.* By W. E. Loucks, Peoria, Illinois.

INTRODUCTION.

During the latter part of the year 1892, Dr. A. C. Murchison and the writer issued circulars to some two hundred persons in the State of Illinois who were known to be interested in ornithology, soliciting their coöperation in ascertaining the distribution of certain birds in this State. Though at first the response was very light, it has since proved highly gratifying, far exceeding expectations. The object in view was to obtain by means of coöperative labor the present range of certain species of birds in Illinois, and to issue monthly reports, based on the contributors' notes and such information as could be obtained from lists and catalogues, both state and local. By January 1, 1893, we had the assurance of aid from about forty ornithologists, taxidermists, and collectors residing in Illinois, or in adjacent states, in close proximity to the Illinois line. Through the kindness of Mr. Frank B. Webster, the first paper, by Dr. A. C. Murchison, treating of the long-eared owl, appeared in the February number of the *Ornithologist and Oölogist*, together with a reference map, an incomplete list of the contributors' names, and a few introductory remarks by the writer. Up to January 1, 1894, articles on the distribution of the long-eared owl, Cooper's hawk, bobolink, mockingbird, black-crowned night heron, and yellow-headed blackbird, had appeared in the above magazine.

In preparing the present paper, the seventh in the series, the writer has relied chiefly on the notes of his correspondents, especially in that portion treating of the distribution of the warbler. He therefore has the pleasure of acknowledging his indebtedness to those who have contributed, and thanks each one for assistance received and courtesy shown. He feels under especial obligation to those along the Illinois River, Dr. W. S Strode, W. S. Cobleigh, B. F. Bolt, and R. M. Barnes, Esq., who have so kindly given him their time and willing aid. Nor should the valuable papers of Mr. O. Widmann, of Old Orchard, Mo., be forgotten, nor the kindness of Prof. S. A. Forbes, in the loan of lists and in assistance rendered.

LIFE HISTORY AND DISTRIBUTION.

A most attractive and abundant bird in certain portions of the Mississippi Valley is that beautiful feathered gem, the Prothonotary Warbler. Its biography, prior to the last few years, has been somewhat erroneous and fragmentary, the bird being to many only a dried skin in the cabinet drawer.

The subject of the present sketch is a difficult one to treat; and notwithstanding the copious notes so generously furnished me by my correspondents, and my own careful observation, it is with considerable hesitation that I begin this paper. This warbler is so at home in the prevailing river bottoms of the State, that ample opportunity is offered for a thorough study of its habits; and yet the most versatile pen could never portray the natural elegance, the charming grace, and the exquisite beauty of this fascinating swamp warbler, as it appears in the willow swamps of Illinois. I feel the impossibility of doing my subject justice, and this bit of biographical sketch is presented, not as a complete and final result, but merely as material for future elaboration.

To one unacquainted with *Protonotaria citrea* its distribution might seem peculiar; but a study of the topography of the country in relation to the bird's geographical range, will reveal the cause of the irregularity.

Rivers, lakes, or ponds bordered with willow swamps, are essential to its presence; hence it is not surprising that in great tracts of Illinois the bird is wanting, while in adjoining portions it may be present in great numbers.

Formerly Illinois was a typical prairie state, but the rapid advance of civilization has converted the rolling prairies into cultivated farms, has dotted the land with villages and cities of wondrous growth, and has utterly eliminated the characteristics of the western prairie. The original timber is restricted chiefly to the river courses and to precarious growths along the smaller streams. The river bottoms, lying as they do in many places between high and sheltering bluffs, and well watered by inundations and the numerous tributary streams, prove the richest portions of the State in vegetation. Their elevation varies from one hundred to one thousand feet above the sea, gradually increasing northward, the country also assuming a more rugged character, until, finally, the southern type is lost altogether. As I have stated, these bottoms are exceedingly rich in vegetation, especially in those lowest portions bordering the rivers, where are found vast willow swamps and immense tracts of huge timber, standing through the greater part of the year in black and sluggish backwaters, and in many places extending over a number of miles. These tracts are the home of the prothonotary warbler. Probably in no other locality in the great Mississippi Valley is this warbler found in greater abundance than in the timbered swamps along the Illinois River, and in southern, southeastern, and western Illinois. Although a common and characteristic bird in these localities, in those parts of the State wherein no suitable environment for its nidification exists, the prothonotary, or golden swamp warbler, as it is frequently and appropriately called, is extremely rare. Its northern range has never been exactly stated in any of the standard works. Only by a comparison of local lists can this be authentically ascertained or the distribution of the bird definitely traced.

When migrating, the great Mississippi Valley is the highway up which these transient warblers pass, until, finally reaching the mouth of the Ohio, the hosts separate, immense numbers traveling up the latter stream, and the rest, perhaps the majority, continuing up the Mississippi. Many of those passing up the Ohio Valley find summer homes along its numerous tributaries and around the many sloughs, bayous, and lagoons in southern Illinois; while the rest, pushing on, deviate from their course only at the mouth of the Wabash River. But few, if any, continue up the Ohio, there being comparatively no attractions for them in its valley east of the Wabash. In the lower valley of the latter stream the prothonotary warbler is exceedingly abundant, inhabiting the timbered bayous and lagoons, the cypress swamps, and the willow-environed lakes and ponds. Mr. Wm. Brewster's account of this warbler in Wabash county, undoubtedly the most elaborate biography of this species yet written, gives some idea of its abundance in this attractive locality.* Mr. E. W. Nelson also gives it as a common bird in the same locality in his excellent paper, "Notes upon Birds observed in Southern Illinois between July 17 and September 4, 1875."† As far north as Danville the bird appears to be common, as Mr. G. C. Pearson reports it as well represented in that vicinity. In a recent letter, Mr. J. H. Hitt, of Indianapolis, Ind., informs me that the warbler is quite rare there, only one nest having been found, and that at New Castle. It extends its migration up the Wabash River to certain points in Indiana, although at present it appears to be very sparingly distributed in that State. The bird is considered a "rare summer resident" in Carroll county, Ind., by Mr. B. W. Evermann.

Although great numbers of this species pass up the Ohio, and thus to the Wabash, undoubtedly the majority continue up the Mississippi, some branching off at the Kaskaskia and Missouri, immense numbers

---

*Bull. Nutt. Ornith. Club, Vol. III. (1878), p. 155.
†Bull. Essex Inst., Vol. IX., p. 34.

at the Illinois, and the rest traveling north at least to 41°. In the summer of 1875, Mr. E. W. Nelson found it a common bird at Anna, Union county, Ill., but at Cairo, just south of Anna, he did not find it so, as he says: "Very uncommon, probably owing to the late high water. Only a few were observed about the borders of lagoons in dense bushes."*

Mr. Philo Smith, Jr., writes that he has found this warbler in abundance in certain localities along the Okaw River, and also in St. Clair and Calhoun counties along the Mississippi. From a most interesting letter from Mr. Louis Fuchs, of Belleville, Ill., I extract the following: "In 1849, I commenced collecting here for a French firm. My particular attention was to the golden swamp warbler drawn on account of his peculiar and sedate habits, and no inclination to observe danger ahead. I found him and nests only in the neighborhood of streams. (This was Kaskaskia River, at that time very abundant; more so near Green River, Kentucky.)" In his own locality (Belleville) he considers the warbler a very rare summer resident, having procured only two specimens within five years. Mr. Fuchs, with his forty-four years' experience with this bird, might reveal some interesting facts concerning it, and the writer regrets that the manuscripts are so brief. The bird is undoubtedly abundant along the Kaskaskia for some distance north. In a recent communication, Mr. E. F. Steinhaur, of Vandalia, informs me that the prothonotary is an abundant summer resident along the Kaskaskia in his locality, and that there is a great deal of rich bottom-land and quite a number of small lakes in the vicinity.

The bird is given as an abundant summer sojourner in Madison county, by Mr. J. Hurter,† and is reported by W. L. Jones as an abundant summer resident around St. Louis. In a valuable communication from Mr. O. Widmann, of Old Orchard, Mo., is the following:

---

*Bull. Essex Inst., Vol. IX. p. 52.

†Ornithologist and Oölogist, Vol. IX., p. 86.

"Protonotaria is a denizen of the wooded borders of lakes, and it does not matter whether they are in the midst of the deep forest or only fringed by a few rows of willows, provided that the bird finds a suitable hole for a nest. It is one of the most abundant birds in the swampy lands of S. E. Missouri, where it was apparently in full force and pairs, visiting tree holes as early as April 12. Around St. Louis, in ordinary seasons, it does not become numerous before the last week of that month."

As far north as Muscatine, Iowa, the prothonotary is an abundant summer resident. Mr. E. S. Currier has found it breeding commonly in the vicinity of Keokuk; it is abundant near Warsaw; and Mr. C. P. Fore writes me that the bird breeds around the mouth of the Des Moines River. From Mr. D. L. Savage, of Salem, Iowa, I have the following: "I have found it here about the middle of May, but have never found it nesting in this county, although I have no doubt but that it does in favorite localities, as it nests in the adjoining counties, Lee county especially, which borders the Mississippi River and has many favorite localities for this warbler." A large and valuable series of eggs has been taken near Burlington, Iowa, many of which are now in the possession of J. P. Norris, Esq., and are described by him in the *Ornithologist and Oölogist* (Vol. XV., Dec., 1890, pp. 177–182). An interesting article by Mr. O. C. Poling, of Quincy, Ill. appeared in the same publication* in 1887, in which, of the bird in his locality, Mr. Poling writes: "The Golden Swamp Warbler (*Protonotaria citrea*) is perhaps the most abundant bird in the bottom-lands on either side of the Mississippi for about twenty miles north of Quincy, and in Missouri, it is most plentiful just across the river."

Mr. B. H. Wilson has found this species breeding abundantly in the willow swamps near Muscatine, Iowa, but he considers the bird a rare summer resident at

---

*Vol. XII., p. 160.

Davenport. The comparative absence of the species in the vicinity of Davenport would seem to indicate the scarcity of suitable places for nidification, but, unfortunately, data is meagre from this point, and having never investigated the locality in question, I can give nothing further. From Davenport to the northern part of the State, I have no information whatever, which will necessitate our leaving the Mississippi and tracing its distribution elsewhere.

Retracing our steps to the mouth of the Illinois, we find the golden swamp warbler one of the most abundant birds in the rich bottom-lands of this river. It is reported by R. M. Barnes, Esq., as a very common summer resident as far north as Lacon, but the writer has found it considerably north of this. South of Lacon, the bird is exceedingly plentiful in the prevailing willow swamps, and around the numerous small lakes and lagoons which are found bordering the river. Dr. W. S. Strode writes that they arrive at Thompson's lake about May 1 to 10, and that they have greatly increased in the last four or five years along the Illinois and its tributaries. It is reported from the vicinity of Duck Island and Spring Lake as very abundant, by W. S. Cobleigh; and also from Peoria by B. F. Bolt, who has made some valuable observations on this species. The writer has found the prothonotary warbler very plentiful at all points along this river as far north as Senachwine Lake.

About fifty miles north of Lacon, the prothonotary seems to decrease in numbers somewhat abruptly. From Ottawa, Mr. A. Hamfeldt writes: "The prothonotary warbler is quite unknown hereabouts. I saw only one two years ago in May, and this must have been only a straggler." Evidently the limit to its abundance on the Illinois is reached a little south of this point, the essential bottomlands and willow swamps being here practically exhausted. Although with us the vicinities of Ottawa and Davenport are apparently at the extreme northern limit of its breeding range, the warbler certainly appears much farther north as a summer resident. Mr. George C. Canttwell, in "A List of the Birds of Minnesota," says of this species: "Common along the Mississippi in the south, as at Redwing and La Crescent, breeding at both places."* These points are certainly localities well suited to the bird, as it passes over a great amount of territory in reaching them and yet remains at few, if any, intervening points. A record was made at Shiocton, Outagamie county, Wis., May 4, 1882, a male bird being taken there by F. L. Grundtvig.†

A *rara avis* is the prothonotary warbler in northern Illinois, the few records we possess being only of stragglers. Mr. J. E. Dickinson, of Rockford, writes that he has never met the bird in that part of the State. It is not likely that this warbler will be found in this part of Illinois, as the elevation here, especially in the northwestern corner, including Jo Daviess and Stephenson counties, is the highest in the State, rising some two hundred feet above the surrounding country, or about 1,250 feet above the sea.

The prothonotary warbler is given as a rare summer visitant in Lake and Cook counties by Mr. E. W. Nelson, and he mentions taking two specimens in that region in the summer of 1875.‡ Mr. W. E. Pratt informs me that he has found no suitable locality in either of these counties for the prothonotary warbler. Mr. B. F. Gault, of Glen Ellyn, Du Page county, gives me but one record, May 13, 1893, as does also Mr. L. W. Nichols, of Somonauk: "June 27, one male bird." These two records were the only ones which I procured out of the notes of fifteen correspondents in this portion of the State.§

*Ornithologist and Oölogist, Vol. XV. (1890), p. 136.

†Bull. Nutt. Ornith. Club, Vol. VIII. (1883), p. 68.

‡"Birds of Northeastern Illinois." *Bull. Essex Inst.*, Vol. VIII., p. 98.

§According to a note received June 9, 1892, from Mr. Martin D. Atkins, of Irving Park, a fine male of this species was shot at Fourth Lake, in Lake county, Illinois, about April 27, 1892. The bird was alone in the willows bordering the lake, and no more were found on thorough search. The specimen is now in the collection of the Jefferson High School in Chicago.—S. A. F.

I am informed by Mr. W. E. Pratt, that he found this warbler in great abundance along the Kankakee River, near English Lake, Ind.; and Mr. H. K. Coale found great numbers of this species some sixty miles southeast of Chicago, in Stark county, Indiana, along the Kankakee, which river he regards as the northern limit of its breeding range.* Mr. A. W. Butler, in his "Notes on the Range of the Prothonotary Warbler in Indiana," an interesting article published in the *Ornithologist and Oölogist* (Vol. XIII., March, 1888), propounds the question as to what route is chosen by the birds in reaching the locality in which Mr. Coale found them. He speaks of the warbler in this region as follows:

"For several years, since making the acquaintance of this attractive bird, Mr. Coale has visited the Kankakee swamps in Stark county. Each year the warblers appear to be as common and as ready to be studied as when he first saw them. The northward range of this species, however, does not stop here. Mr. Coale, in his persistent searchings, has traced it to the shores of Lake Michigan, along which he has occasionally taken it both in Indiana and in Illinois." He continues, "Whether these birds pass the narrow and almost imperceptible division between the drainage of the Wabash and the Kankakee, or also extend their semi-annual pilgrimages along the latter stream, remains to be determined. It seems certain, however, that they must pass over the indistinguishable watershed between Kankakee Valley and the Lake Basin, the waters of which, at certain seasons of the year, find common feeders in many swamps and lakes in northwestern Indiana. No barriers of any consequence being present, it seems probable that the Wabash Valley is the route by which this species is distributed over the region considered."

So far, the distribution of the prothonotary warbler has been traced only along the courses of the larger rivers. Were we to follow it up the numerous tributaries of these larger streams, its range would be consid-

*Nat. Hist. Surv. Ill., Vol. I., pp. 199, 120.

erably increased and, in some instances, penetrate far into the interior of the State. Preëminently a bird of the timbered creek and river bottoms, its geographical range is coextensive with them, the records of its occurrence elsewhere being limited to an occasional straggler.

The arrival of these birds in spring is scarcely noted by the casual observer. No heraldic song proclaims that they are here, and were it not for their bright, gleaming color among the trees, they would be entirely unobserved.

In the latter part of April or the first of May, as the locality may chance to be, if we paddle the canoe along the willow-fringed banks of the river, or among the trees in the back-water, we shall be very sure to find a few early-arrived prothonotaries—probably old birds eager for their return to a northern clime, or perhaps hasty and impatient migrants, far in advance of the hosts which are to follow, but shy and silent, seemingly ashamed of being so premature. Their numbers rapidly increase, however, as that wonderful and mysterious instinct which prompts birds to semi-annual migration brings hosts of them northward and drops them here and there among the willows. Timidity wears away as their numbers increase, and they may be seen now clinging and creeping, in creeper-like manner, on moss-covered stumps and trunks of trees, sometimes head downwards, now expanding their steel-blue tails, and greatly contrasting with a background of bright green moss or gray-colored bark. The males, as is customary with most mirgatory birds, arrive first, the females making their appearance shortly afterward.

I have no data of their arrival in the extreme southern end of the State. Mr. O. Widmann writes that by the last week in April they become quite numerous around St. Louis, Mo. It arrives at Mt. Carmel, Wabash county, Ill., about April 23, according to Mr. Robert Ridgway;* and April 19 to 27 is given by Mr. Wm. Brewster, in his charming account of this bird in Wabash county, as the period of spring arrivals.† In central Illinois, the last

*Nat. Hist. Surv. Ill., Vol. I., p. 32.
†Bull. Nutt. Ornith. Club, Vol. III., pp. 154,155.

days in April generally bring a few of these birds, the bulk of them arriving, however, between May 1 and 10. It is reported from Davenport, Iowa, about the 10th of May, and I find a record of May 3 for its arrival in the vicinity of Burlington, Iowa.* Northward, the arrivals are a little later. Mr. H. K. Coale found a few of these birds in Stark county, Ind., on the 11th of May, but they became more abundant on and after the 18th.†

Their departure in the fall is as mysterious and as quiet as their arrival in the spring. There seems to be a gradual falling off in their number after the breeding season, until but few are seen, and when these depart, the vacancy caused by their absence is hardly perceptible. The last and lingering individuals take leave in central Illinois about the first or middle of September, but whether they linger in the southern part of the State or pass directly south, I am unable to say.

Soon after the arrival of the females, mating begins, and at this time they are the most interesting to observe. Many a love match takes place in the willow woods. Should another male intrude upon the scene, a conflict is certain, and should the intruder be victorious, he immediately makes love to the fair one, and indifferent as she is, it is readily accepted. These conflicts are frequent between the male birds, even though no female be at hand, the males seeming to have a fighting propensity whenever they meet. I have often stopped rowing my boat to watch a couple of them battling in mid-air, and not until they had fallen into the dark, murky-colored water below, did they cease, and dart off in opposite directions, apparently much startled by their sudden plunge. At other times, a mischievously inclined little fellow will dart recklessly at some unsuspecting one, who, being startled by the onset, will at once retreat. The pursurer gives chase, and away they go, not far apart, over the tree tops, through the underbrush and thickets, now darting directly along the surface of the

---

*U. S. Dept. Agr., Div. Economic Ornith., Bull. 2, p. 239.
†Nat Hist. Surv. Ill., Vo'. I., p. 119.

water, then among the trees, seemingly to illuminate the dark shadows beneath, until they are lost to view and one wonders at the finale. The courting of the ma'e bird is a pretty sight. Swelling with pride in his bright, golden coat, this little lover in feathers presents his case in the most loving and winning manner, hovering around or perched near the object of his adoration with spread wings and tail extended, fairly outdoing himself in his efforts to make an impression. She, with bewitching indifference, seems to care but little as to the outcome, but finally matters are amicably settled between them and household duties are almost immediately commenced. The birds, especially the males, have a pretty habit of carrying their tails spread, much in the manner of the redstart. When the sexes meet, a tender note, that of salutation or recognition, is barely audible.

The most difficult feature to describe in the biography of a bird is its song. Even the most elaborate treatise fails to bring to the unaccustomed ear a true conception of it, and as I pen these lines, I feel my utter inability to convey to the reader's imagination the notes of the prothonotary warbler. True, they do not vie with the melodious ditties of some other woodland songsters, but they are very striking, even pleasing, and when once heard are not easily forgotten. Six or, sometimes, seven syllables, uttered in rapid succession but with an instantaneous pause after the first note, constitute the regular song. It much resembles, *peet*, *tsweet*, *tsweet*, *tsweet*, *tsweet*, *tsweet*, *tsweet*, uttered in a ringing or penetrating tone and on a tolerably high pitch. At a distance, it much resembles the notes of the solitary sandpiper, and I have frequently found it somewhat difficult when the two species were in the immediate vicinity, to distinguish between them; but upon a closer approach, the resemblance is lost, the penetrating ring in the warbler's notes being then audible. The male is an incessant singer, caring not for the elemental conditions nor for the time of day. He is as likely to be heard in the early morning as at noon or in the evening Frequently he will sit amidst the green foliage, dividing his time between adjusting his plumage and singing sweet little dities to his mate, she, more than likely, being just within the entrance of her domicile on her eggs. Occasionally he remains perfectly motionless on his green perch, probably deep in thought or in a reminiscent mood, but suddenly bursting out with *pee'*, *tsweet*, *tsweet*, *tsweet*, *tsweet*, *tsweet*, he darts away in search of some fat unsuspecting spider for his better half.

The notes of alarm, anger, or distress, are somewhat sharp, being compared to those of the large-billed water thrush by Mr. Wm. Brewster. According to this author, there is another song, which might be termed a love song. He describes it as follows: "In addition to the song above described the male has a different and far sweeter one, which is reserved for select occasions,—an outpouring of the bird's most tender feelings, intended for the ears of his mate alone, like the rare evening warble of the oven-bird (*Siurus auricapillus*). It is apparently uttered only while on the wing. Although so low and feeble as to be inaudible many rods away, it is very sweet, resembling somewhat the song of the canary, given in an undertone, with trills or 'water-notes' interspersed. The flight during its delivery is very different from that at all other times. The bird progresses slowly, with a trembling, fluttering motion, its head raised and tail expanded. This song was heard most frequently after incubation had begun."* I cannot remember ever hearing this song. It certainly must be quite rare, and, as Mr. Brewster says, kept for select occasions. After nesting, the males gradually stop singing, although a few persistent ones may be occasionally heard quite late in the season.

The fast decaying driftwood, tossed among the trees by the surging waters of a spring freshet, and left floating or partly submerged in the stagnant pools or backwater, contains myriads of insects upon which the pro-

*Bull. Nutt. Ornith. Club, Vol. III. (1878), p. 157.

thonotary warbler feeds. Now he may be seen flitting from log to log, pulling some unfortunate spider from a crevice, and scanning every dark-looking cranny in search of the coveted bug; then away he darts to a water-soaked stump, where, in spiral like manner, he winds his way to the top, frequently turning his golden breast to the sun, and glancing downwards as if to catch a glimpse of himself in the mirror-like water beneath.

These birds confine themselves almost exclusively to decayed stumps and driftwood in search of food, but occasionally venture up the trunks of trees and hunt for insects concealed in the bark. I have never observed them feeding among the leaves, as is the habit of many of our warblers. The flight of the bird is swift and decided, slightly undulating when crossing an open or flying for some distance among the trees.

There are two kinds of bottom-land in which the prothonotary breeds: the willow swamp consisting entirely of a heavy growth of large willows, interspersed here and there with rotten stubs; and the bottom-land covered with a forest of elm, oak, cotton-wood, and maple, with an occasional willow and many decaying stumps. While both of these are acceptable to the warbler for nesting purposes, I am inclined to believe the latter situation is the more often chosen. Throughout the greater part of the year, these bottoms are overflowed, making it impossible to visit them without the aid of a skiff or canoe.

As previously stated, soon after mating the birds begin to build their nests, usually, in central Illinois, about the middle of May, although many pairs do not begin until the latter part of this month. I have found nests under construction on the 12th of May, but this is exceptional in this part of the State. Mr. Wm. Brewster says in his account of this bird, that Mr. Robert Ridgway found a nest with four fresh eggs on April 27, near Mt. Carmel, Ill. He considers this an exceptionally early date. The greater portion of the nests Mr. Brewster found in the same locality between May 8 and 12, contained fresh eggs.* I find that the precise time of nest-building along the Illinois River depends upon the water level, the bird being seriously delayed some seasons. The few cavities that are not submerged are quickly taken, and birds not so fortunate are compelled to wait for the receding water, unless, perchance, they steal a site from another pair.

A typical nesting site is in the cavity of an old water-soaked stump, either standing in or projecting over the water. Occasionally stumps containing nests are found on comparatively dry land, but in these instances the nests were probably built at high water, which, upon receding, left the stumps high and dry. The stump selected is generally a short, smooth one, rotten, and so water-soaked that it can easily be torn asunder with the fingers. The heights of the cavities vary from a few inches to twenty-five feet or more, the extremes being exceedingly rare. In fact, nests more than ten feet above the water must be considered exceptional. The only reasonable conjecture I can offer for the high positions, is that they are due to the receding water. A low position is preferred by the birds, but if one is chosen, a sudden inundation often causes the destruction of the nest. I have frequently found submerged or partly submerged nests, with the distressed parent birds flying around. The birds seem indifferent as to the condition, depth, or shape of the cavity. Every conceivable kind of a hole or crevice to be found in stumps, stubs, or snags, from a rent in the side of a stump to a deserted woodpecker's hole, is acceptable. Generally, however, the selection is a cavity once occupied by a chickadee or small woodpecker, but now long forgotten by its previous owner, and open to any tenant chancing along.

In the construction of the nest, the female bird works alone. I have never yet seen a male really aiding in this task. He frequently accompanies his mate on trips after building material, hunting here and there for choice pieces

*Bull. Nutt. Ornith. Club. Vol. III. (1878), p. 158

of moss, or climbing a wild grape-vine with the view of getting a strip of bark, but always failing to bring it home. However, we must not censure him too severely, for he apparently takes great interest in the construction of the nest, watching for the return of his mate and accompanying her to the entrance of their domicile, perhaps following her within—but here we are intruding upon their private affairs. If the cavity be deep, it is filled up to within a few inches of the entrance before the nest proper is begun. The materials used for this purpose are various, probably those most convenient or accessible. In one case, I took from under the nest proper a quart, or more, of moss which had been utilized in filling a cavity nearly a foot deep. The foundation of a typical nest is composed largely of green moss, intermixed with pieces of dead leaves and rubbish. A few nests that I found had a foundation made entirely of large burrs and a little moss. A female was once timed to ascertain the speed she made in gathering material from a moss-covered tree trunk some seventy-five or a hundred feet distant from the cavity in which she was building. She was very active, and evidently desired to get the cavity filled as quickly as possible. No time was wasted in idle loafing or wandering, for she went from tree trunk to stump, carrying huge bunches of green moss, depositing them in the cavity, and returning within a minute. Frequently she made it in less time. On every trip, she would alight on a small limb of an adjacent tree before entering the hole, and utter a *tchip* now and then, even though her bill was full of moss. Almost immediately after her entrance, she would reappear, apparently only dumping the moss on the bottom, as she seldom remained within long enough to arrange it. Very unsuspicious of us, she worked steadily for the half hour we remained. Where her husband was, I am unable to say, for we saw nothing of him during our sojourn.

The materials in the nest proper are various. Bark strips, fibrous roots, pieces of dried grass, small weed stems, bits of decayed wood, a few wisps of straw, in fact almost any bit of vegetable rubbish the builder can find near at hand may enter into the make-up of the nest. The moss is frequently lacking; sometimes found only in small quantities; and at other times in large bunches. The lining is chiefly of rootlets or fine dry grass. The nest is generally very compact, although sometimes so loosely put together that it falls apart on removal from its resting place. The shape and size correspond to that of the interior of the cavity. Some nests, taken from particularly deep holes, are five or six inches deep and from three to four across. The interior of an average nest is well-rounded and cup-shaped, from one to one and a half inches deep, and about two in diameter. A nest taken from a very shallow cavity will prove a very flat affair, frequently not more than a lining. The top of the nest is, in nearly every case, within three or four inches of the entrance, and often the bird can be seen sitting on her eggs. At least a full week is consumed in building the structure, and a few days intervene between its completion and the deposition of the eggs.

Within the last few years I have found and heard of some very curious nests of this warbler, which were peculiar either in their position or construction, or because of the materials used. I have read of its nesting in an outbuilding, and also in a tin can. While this is certainly unusual, it is not to be wondered at, for this species is as apt to deviate from its natural mode of nest-building as are others which have been found so doing. I have never noticed a prothonotary around a house, but they are frequently or continually seen around the ice-breakers of one of the old wagon bridges near Peoria. These may possibly be only wandering males from an adjacent willow swamp, still I should not be surprised to find a nest in one of those old piles. Mr. Otho C. Poling mentions finding a nest in a bridge pier near Quincy, Ill.*

Two curious nests, heretofore described by me,† are certainly worth noting here. One, placed in a cavity of a dry

*Ornithologist and Oölogist, Vol. XII., p. 160.
†Oölogist, Vol. X., p. 20.

stump, was composed partly of cast-off snake skins; and the other—the finest and most beautiful specimen that I have ever seen—was built in a cavity of an old water-soaked stump, the entrance of which was within a few inches of the water. This nest was composed entirely of bright green moss, kept fresh by its damp and low situation. It was slightly lined with grass, and contained five beautiful eggs. A nest was found several years ago about twenty-five feet above the water, in a cavity of a live willow tree. Another was discovered in a bowl-shaped cavity in the top of a small stub, the entrance being at the top. Occasionally nests are found in huge stumps two or three feet in diameter, the bark of which still remains, environing a mass of decayed and crumbling wood. Under this shell-like covering, in pocket-shaped cavities, I have found their nests. In no case, however, should I have discovered the nest, had not the golden-colored head of the owner popped out of the small round orifice in the side of the bark.

As previously stated, a few days elapse between the completion of the nest and the deposition of the eggs. As far as my observations go, an egg is laid daily until the clutch is complete. There has been considerable controversy regarding the number of eggs laid. Four, five, and six are the usual numbers, sets of seven being occasionally found, and sets of eight and nine in extremely rare instances. Many regard the set of seven a rare find, but I do not consider it so, having found it frequently around Peoria. Mr. W. S. Cobleigh informs me that he found a set of ten eggs in the Mackinaw Creek Bottoms. This is the largest clutch that has been reported to me. The first sets of the season are probably the largest, consisting of five, six, or seven eggs; the second laying is of four, and frequently five eggs; and if a third, it is very small. During the month of July, I have found nests with one, two, and three incubated eggs, undoubtedly the third clutch of the year, and probably belonging to birds repeatedly robbed of their previous nests. If unmolested, the warbler generally raises two broods in a season, but if deprived of their first and second sets, a third is deposited. In the series of seventy sets of prothonotary warblers' eggs described by J. Parker Norris, Esq., in the *Ornithologist and Oölogist* (Vol. XV., pp. 177–182), nearly all of which were collected in or near the State of Illinois, there are thirty-two sets containing six eggs each, eighteen containing five, fifteen of seven, three of four, and two of eight.

The coloration of the eggs is a broad subject, and were I to do it justice, the text would be voluminous. I have examined many, and have found a limitless variation in their markings. I find two, three, four, and even more, types of coloration in a large series of eggs, and have selected for description, from a series of my own, seven sets fairly representing these types.

Set. I. Six eggs. Ground a glossy white, blotched at larger ends with chestnut and lilac. Rest of surface more or less spotted, speckled, and seemingly streaked, with light chestnut. Two of the eggs have the larger ends entirely covered with large blotches of rich chestnut, and another has a large blotch of light brown overlapping lilac, producing an intermediate color.

Set. II. Six eggs. These eggs resemble those of a wren in their markings, the whole surface being marked with light chestnut and lilac, not blotched, but so finely speckled that the ground of the larger ends is nearly obscured.

Set III. Four eggs. Ground glossy white, covered with blotches of pale lilac and light chestnut. The former are large, lilac being the predominating color on two of the eggs. The chestnut is streaked and daubed on in very small blotches, one of the specimens, however, having two large chestnut blotches on one side. The colors seem to run into each other, giving the eggs a daubed appearance.

Set IV. Four eggs. These are beautiful eggs. The colors are a rich chestnut and a shade that is nearer lavender than the lilac of other specimens, a purple effect being produced where the two colors combine. The markings extend over the whole surface in small blotches and spots, and at the larger ends are so confused that the ground is partly obscured.

Set V. Six eggs. Ground glossy white, spotted, speckled, and minutely blotched with varying shades of chestnut and lilac. The markings are thickest around the larger ends, but they are defined, and nowhere do they obscure the ground by blending.

Set VI. Four eggs. These specimens are not pretty, but are smeared and blotched with light brown and buff, the ground, where visible, being of a dirty white. Very little, if any, lilac appears.

Set VII. Four eggs. These eggs have comparatively few markings. Each of them has a wreath around the larger end and a blotch on one side. The wreath in two of the eggs is quite distinct, and the blotch quite dark and bold, the latter being dark lilac overlaid with dark chestnut, and the former light chestnut and pale lilac. The third specimen is semi-wreathed, and has a trace of the blotch on one side; while the fourth has a distinct wreath of lilac blotches, and the china-white background sprinkled all over with light chestnut. The ground of the first three is of a pinkish cast, the slight marking being at the larger ends.

I have never found the markings to consist of more than two colors, lilac and chestnut, each varying in tints and shades in the different eggs. The lilac markings are often styled "shell markings" from their appearance of being within the shell, and are frequently so dim that they are barely perceptible. In the majority of specimens having blotches, the chestnut overlaps the lilac, producing a purple effect.

The typical shell is china white, very glossy, and quite thick and strong. Occasionally a calcareous shell is found, but these are always of yellowish cast, and very slightly, if at all, marked with pale lilac. A fresh egg is of a beautiful pinkish color, which is lost upon blowing the specimen. Albinism frequently occurs. I have found numbers of white specimens, and Mr. R. M. Barnes, of Lacon, Ill., reports taking a whole set of white eggs.*

The endless variation in the coloration of the eggs is only equaled by the vast variation in their sizes and shapes. The extreme measurements of an exceedingly large series of these eggs are .62 and .79 in length, by .50 and .62 in width. In the *Ornithologist and Oölogist* (Vol. XIV., p. 38), R. M. Barnes, Esq., writes: "I have in my collection one 'runt' egg of this species that is not larger than a pea. It measures .48 x .40. The other four eggs in this set average .73 x .55. The 'little fellow' is in every way as perfectly marked and formed as any of its larger brothers."

As a rule, the eggs are blunt at the smaller end; and while some are quite elongated and others approach a spherical shape, probably the greater number are ovate. One egg that I found in a set of four was ovate pyriform, the other three being normal.

Incubation is carried on entirely by the female, and extends over a period of ten days or two weeks. During incubation the male spends the most of his time exploring every nook and crevice in the vicinity, often meeting another husband on a similar foraging expedition. He keeps his mate well supplied with food, but should there be any spare time, he indulges in singing. After the young are hatched, both birds are kept continually busy filling the hungry little mouths with insect delicacies. After the nesting season, the birds are usually found in small flocks, consisting of the parents and the young, and so they remain until their departure.

Frequently these birds are found breeding in colonies, and many nests are found in a surprisingly small area. In some localities there are more pairs of birds than there are holes or cavities to nest in. This scarcity of nesting sites is undoubtedly the cause of the large sets of eggs and double nests that have been found. The set of ten eggs, previously mentioned, taken by Mr. W. S.

*Ornithologist and Oölogist, Vol. XIV., p. 38.

Cobleigh, certainly must have been a double set. I can think of no warbler that lays a corresponding number of eggs. Mr. B. F. Bolt, of Peoria, Ill., found a double nest a number of years ago, the lower half containing seven eggs, and the upper five. I am therefore quite positive that two females will lay their eggs in the same cavity, and that one pair of birds will deprive another of their nesting site, and build another nest over that of the original owner, in localities wherein nesting sites are few. I have never noticed but one published account of such a procedure on the part of this bird. Mr. O. C. Poling, who found double nests and sets of the prothonotary warbler near Quincy, Ill., says:*

"It is also characteristic of this warbler to remain close about the nest at all times to avoid being deprived of its home by some neighboring pair, for there are more birds than nesting places in the localities searched.

"On several occasions a hole would contain a nest and fresh eggs, with still another nest built on top of it, also containing eggs, thus showing that some pair had driven off the first occupants. Several of these two-story nests which I brought home with me got somewhat crushed in packing, and the eggs were found broken within them.

"Still another nest was found, in which two females had laid, containing nine eggs which were of two different types and piled up on top of each other. Both females were near and they appeared quarrelsome during the time I watched them."

Another interesting feature connected with the nesting of the prothonotary warbler is the imposition of the cowbird. It is not universally known or believed that this parasite will enter a cavity to deposit her egg or eggs; but it is not unusual to find one or more eggs of the cowbird in a prothonotary's nest. Mr. R. M. Barnes informs me that he has in his possession sets as follows: two eggs of the warbler and three of the cowbird; three of the warbler and two of the cowbird; four of the warbler

---

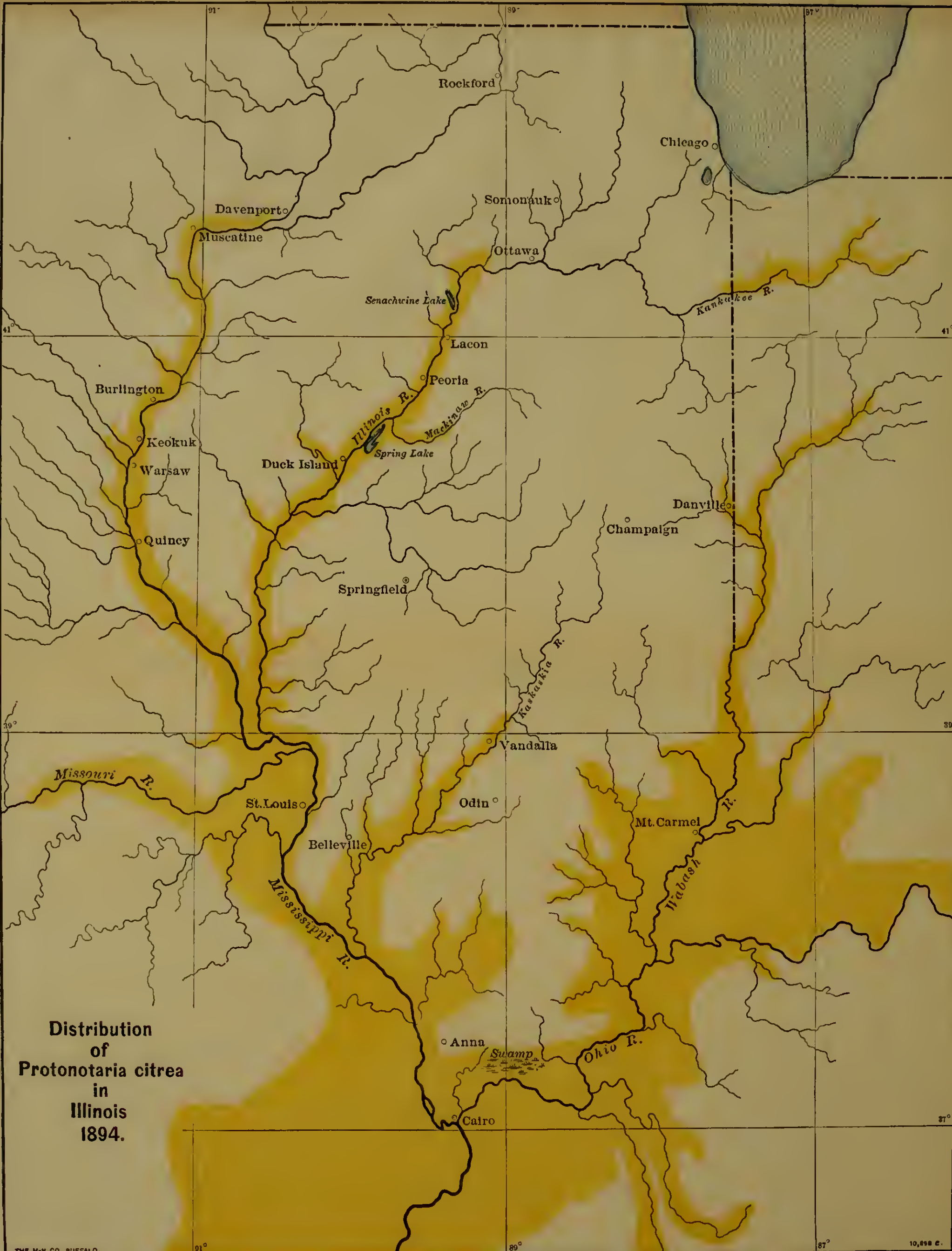
*Ornithologist and Oōlogist, Vol. XV., p. 92.

and two of the cowbird; five of the warbler and one of the cowbird. Some have expressed their belief that the cowbird only deposits her egg when the nest is in a large, natural cavity, and that she never enters an excavated hole for this purpose; but the entrances to many of the nests containing the parasites' eggs are so small and round, that apparently only the owners can slip through. How the large and awkward cowbirds deposit their eggs is a question yet to be solved.

The warblers never wander far from the location of their nest, and the song of the male bird can always be heard in the immediate vicinity. In fact, when looking for a nest, I invariably listen for the song, and with a little searching, I soon have the cavity located. When a nest is molested, unless it contains young, the birds are very indifferent and seldom come near. The female sits very closely, and can easily be caught by clapping the hand over the entrance.

Perhaps the only enemies this bird has to contend with, except the egg collectors, are the snakes. I have had many fine sets destroyed by the intrusion of a water snake before the clutch was completed. The first nest of the prothonotary warbler that I ever found, was discovered by seeing a snake crawl slowly out of a hole in a stump with a beautiful egg in its mouth.

A memorable visit was made, a year or two ago, in the congenial company of my friend, B. F. Bolt, to Spring Lake, a veritable paradise for the golden swamp warbler. This lake is one of the many lying along the Illinois River, and has gained the reputation of being one of the finest fishing and hunting resorts in the State. It is situated between the wooded bluffs on the east, and the river on the west, bounded on all sides by miasmatic swamps, luxurious growths of aquatic vegetation, impenetrable and vast in extent, interspersed with heavy willow growths, miniature forests of dead and lifeless trees, in many of which are visible, for a great distance, the bulky nests of the cormorant. Isolated patches of beautiful and graceful trees, some of them venerable forest


Distribution
of
Protonotaria citrea
in
Illinois
1894.
Rockford
Chicago
Davenport
Muscatine
Somonauk
Ottawa
Senachwine Lake
Kankakee R.
Lacon
Peoria
Mackinaw R.
Illinois R.
Spring Lake
Burlington
Keokuk
Warsaw
Duck Island
Danville
Champaign
Quincy
Springfield
Kaskaskia R.
Vandalia
Missouri R.
St. Louis
Odin
Mt. Carmel
Belleville
Wabash R.
Mississippi R.
Anna
Swamp
Ohio R.
Cairo
91°
89°
87°
41°
39°
37°
THE M-H CO., BUFFALO.
10,898 E.

monarchs, give a pleasant diversity to the monotony of this marsh, and afford summer homes to many woodland species. At a low stage of the water, the lake proper is comparatively small in area, and has no outlet save the canal cut some years ago from the river to the lake. Nowhere is the water very deep, in many places not exceeding a foot. Its surface is bordered by a dark, rich carpet of the leaves and blossoms of the water-lily, among the roots of which brilliantly colored sunfish, palatable bass, and the wary pickerel play.

At the time of our visit, the water being at a high stage, the aspect of the country was far different. As we stood early that morning on the high bluffs overlooking the whole river valley, an immense expanse of water met our view. No small lake was discernible, as that and the river had joined as one, covering everything from bluff to bluff except the timber.

Our arrival at the small inn-like hotel the night previous had quite astonished the natives. The month of May was far too early in the season for fishing and too late for hunting, and what else did we desire. The object of our visit being made known, they were equally astonished to learn that we had come for the sole purpose of seeing a cormorant roost. The landlord's wife being busy in getting our supper, we chatted with the men on bird lore and kindred subjects, and soon had the exact location of the roost. By this time a great number of the surrounding farmers had dropped into the tavern, and invariably each one had a cob pipe fixed between his teeth. While in Rome, do as Romans do, so we procured cobs and did likewise.

In the morning, an early start was made. Paddling northward to avoid the driftwood, we struck across a broad expanse of water some two miles distant, beyond which lay the desired roost. The early start had enabled us to reach our goal in a much shorter time than was anticipated, and investigations to that end being completed, we turned our exclusive attention to the prothonotary warbler, which we found in great abundance.

It was the most attractive inhabitant of these picturesque woods, flying hither and thither, flashing like a golden streak, brightening the whole scene before us, the males making the woods fairly echo with their penetrating notes. All day we idled in our canoe, watching this bird in its native haunts, now and then peeping into a nest to learn of its household affairs, or following one on a foraging expedition. Occasionally one would treat us with a special concert, or two males would exhibit their courage by entering into combat. The females apparently perform all drudgeries in nest building; not once did I observe a male lending the least bit of aid, and yet I have no doubt but that perfect felicity reigned in each household.

Aimless paddling had eventually brought the canoe into a beautiful sylvan retreat, a perfect prothonotarian haunt. Seemingly all avian songsters had centered in this wood, each striving to contribute his mite to the chorus. The monotonous drum of a woodpecker on a sun-bleached limb of a tree, the incessant singing of the warbling vireo, or ditty of the nervous redstart, with now and then the harsh guttural croak of a heron, or the booming of a bittern which had by the inundation been deprived of its abode and was now the occupant of adjacent driftwood, gave a sort of zest to this scene, the home of *Protonotaria citrea.* Above all songsters, the clear, penetrating notes of this interesting warbler were audible, now coming from a point behind and echoed and re-echoed by other individuals throughout the wood. Even at noontide, when otherwise a silent hush prevailed, the oppressive heat seeming to have dampened the spirits of the most ardent singer, the drowsy drone of insects being alone wafted to our ears by an occasional breeze,—even then the persistent prothonotaries still continued the avian concert. We lingered till the waning of the day, long after the golden sun had sunk in the distant west, and not until issuing stars cast dim reflections in the dark waters beneath did we resume our paddling, loath, though now compelled, to depart from this bird's domain. Nature was hushed in slumber, and not a sound broke the enchanting quiet save the splash of the paddle, the weird hoot of an owl, and the notes of a whip-poor-will in the distance.

Article IV.—*List of Altitudes in the State of Illinois.* By C. W. Rolfe.

PREFACE.

Most of the elevations in the following list were collected during the years 1889 and 1890, as the basis of a model of the State. The others were gathered during the progress of a barometric survey of the State, made under the auspices of the Illinois Board of World's Fair Commissioners. The data were derived as follows:

From the Mississippi River Commission were obtained a line of levels from Cairo to Dunleith, a line of levels from Fulton to Chicago along the line of the Chicago, Milwaukee, and St. Paul R. R., a series of charts of the Illinois shore of the Mississippi, and the low water slope of the Mississippi; from the U. S. Lake Survey, a series of geodetic stations between Chicago and Olney; from the Illinois and Michigan Canal, low water levels of the Illinois River; from the U. S. Geological Survey, a series of charts covering a belt of country about fourteen miles wide, between Chicago and Peoria; from the U. S. Coast and Geodetic Survey, a line of levels from Olney to St. Louis, one from Centralia to Cairo, and low water levels of the Ohio and Wabash rivers; from the U. S. Engineers, the preliminary survey of the Hennepin Canal; and from various railway companies, profiles of their lines.

In order to test and correct the railroad profiles, the bench-marks of the lines of levels and the geodetic points were connected with the nearest railroad stations, the results being used to correct the profiles of these roads; the elevations of the various railroad bridges over the Illinois and Mississippi rivers above low water, and hence above sea level, were obtained and the railroad profiles checked by them; and the relations of the railroads at intersecting points were ascertained, and the profiles of the roads checked on each other, using those that had been corrected by U. S. data as master systems.

Barometric profiles were made, with stationary and moving barometers, of such roads as had no profiles, and after the profiles of the other roads had been brought into agreement, these were added and corrected in the same manner.

To the outline thus established, the details of the surface between the roads were added by traverses, with barometer and telescopic hand-level, arranged to intersect railroads as often as possible, and practically to bring the observer within sight of every section of land in his district. Prominent points either of elevation or depression were visited, and observations made upon them. Many cross checks and other means of correction were applied to overcome errors due to changes in atmospheric pressure, instrumental irregularities, and observation.

In regard to the accuracy of the barometric work, it may be said that a county was made the unit of work in these surveys, and that the results obtained in each county in no way depended upon those arrived at in adjoining territory; in fact, the observer was generally uninformed as to what had been done in the surrounding counties. When the results of these independent surveys were brought together, it was found that a difference of more than twenty feet in the elevation of points along county lines but rarely occurred, the average difference being less than ten feet. The cost of the survey was twenty-four cents per square mile.

The figures at the right of the page indicate, in feet, the elevation above the level of the sea. Where the locality name in the left-hand column is followed by the name of a railroad, the locality is a station on that road. Where it is followed by a personal name in the middle column, it is the name of a small town or other rural locality, and the personal name is that of the observer.

By the elevation of railroad stations, the level of the track at the platform is intended. For each town not on the railroad, the location of its post office in the years 1891 and 1892 may be understood, and for sections, the elevation of the highest point in the section is given.

Grateful acknowledgment is here rendered to the officials of the U. S. Government, as above indicated, to officers of the railroad lines of the State, to Dr. J. Lindahl, ex-State Geologist, for many courtesies during the progress of the survey, and to Mr. J. G. Mosier, whose intelligent assistance aided me greatly in the collection of the material.

C. W. Rolfe.

University of Illinois,
April 10, 1894.

NOTE.—A survey of the St. Louis branch of the Chicago, Burlington and Quincy Railroad made since Article IV. was printed, a profile of which was courteously sent me by the Engineer, necessitates the following corrections:

Arenzville, Cass County	483
Hagener, Cass County	469
Astoria, Fulton County	686
Table Grove, Fulton County	711
Baldwin, Greene County	645
Barrow, Greene County	661
Epperson, McDonough County	661
Walnut Grove, McDonough County	700
Medora, Macoupin County	612
Piasa, Macoupin County	609
Woods, Madison County	469
Baders. Schuyler County	614
Alsey, Scott County	636
Merritt. Scott County	604
Riggston, Scott County	602

Insert after page 38.

ADAMS COUNTY.

Bench-marks.

U. S. P. B. M. 12.

Bolt in ninth course masonry from top in west abutment R. R. bridge, West Quincy, Mo. 476.7

Black's	Wabash R. R.	717
Bluff Hall	C., B. & Q. R. R.	477
Camp Point	"	732
Chatton	Wabash R. R.	714
Cliola	C., B. & Q. R. R.	716
Clayton	Wabash R. R.	732
Coatsburgh	C., B. & Q. R. R.	763
Eubanks	"	732
Fall Creek	"	468
Fowler	"	729
Golden	"	719
Homan	"	505
LaPrairie	"	709
Loraine	"	643
Marble Head	"	477
Mendon	"	654
Paloma	"	736
Quincy	"	483
Rock Creek	"	500
Ursa	"	588
Woodville	"	664
Antonius	E. C. Eidmann	630
Adams	"	700
Bauman	"	750
Beverly	"	780
Big Neck	"	660
Burton	"	640
Columbus	"	738
Chestline	"	715
Elm Grove	"	705
Ellington	"	655
Fair Weather	"	820
Hazelwood	"	640
Hazen	"	640
Kellerville	"	720
Lima	"	625
Marcelline	"	560

Payson	E. C. Eidmann	710
Plainview	"	660
Richfield	"	725

ALEXANDER COUNTY.

Bench-marks.

P. B. M. 64.

Bolt in stone post, 1260 M. back from river, 1 M. north from fence, on north side of road leading east from Goose Island P. O., and about 19 mi. above Cairo 331.51

P. B. M. 65.

Stone post in woods 1500 M. from river, and eight and one half miles above Cairo P. O., 26 M. from levee, and two and one fourth miles below Speis's Mills 318.25

P. B. M. 66.

Stone post 61 M. east of a point on I. C. R. R. that is 391 M. north of the three-mile post north from Cairo 311.28

U. S. P. B. M. 1.

Bolt in N. W. side of Custom House, Cairo 317.8

Lowest Gauge Mark, Ohio River 268.58

Cairo	I. C. R. R	321
Beech Ridge	M. & O. R. R	328
Elco	"	379
E. Cape Girardeau	G. T. & C. R. R.	342
Hodge's Park	M. & O. R. R	337
Idlewild	"	341
McClure	G. T. & C. R. R	337
Sandusky	M. & O. R. R	343
Commercial Point	C. B. Klingelhoefer	320
Goose Island	"	325
Olive Branch	"	325
Willard	"	326
Wheatland	"	330
Thebes	"	337
Santa Fé	"	345
Sec. 17, T. 14 S., R. 2 W.	"	631

Sec. 28, T. 14 S., R. 2 W.	C. B. Klingelhoefer	583
" 26, " R. 3 W.	"	560
" 5, T. 15 S., R. 2 W.	"	555

BOND COUNTY.

Durley	J. S. E. R. R	563
Greenville	Vand. Line	555
Hookdale	J. S. E. R. R	503
Maple Grove	"	586
Mulberry Grove	Vand. Line	549
Pierron	"	517
Pocahontas	"	498
Reno	J. S. E. R. R	585
Sorento	"	591
Stubblefield	Vand. Line	510
Smithborough	"	548
Tamalco	J. S. E. R. R	465
Beaver Creek	E. Ellison	490
Baden Baden	"	495
Dudleyville	"	498
Woburn	"	592
Old Ripley	"	540
Pleasant Mound	"	515
Sec. 30, T. 1 N., R. 2 W.	"	650
" 27, " "	"	630

BOONE COUNTY.

Belvidere	C. & N. W. R. R	792
Caledonia	"	933
Capron	"	917
Garden Prairie	"	790
Herbert	"	877
Irene	I. C. R. R	817
Poplar Grove	C. & N. W. R. R	902
Reed's Crossing	"	845
Beaverton	W. M. Hay	980
Blaine	"	1005
Bonus	"	823
Hunter	"	1010
Sec. 26, T. 46 N., R. 4 E.	"	950

Sec. 15, T. 46 N., R. 4 E.	W. M. Hay	1000
" 15, T. 46 N., R. 3 E.	"	990
" 16, T. 44 N., R. 3 E.	"	850
" 15, T. 43 N., R. 3 E.	"	920
" 26, T. 43 N., R. 4 E.	"	890

BROWN COUNTY.

Gilbird's	Wabash R. R.	659
Hersman	"	693
Mounds	"	751
Mt. Sterling	"	716
Perry Springs	"	436
Versailles	"	584
Benville	E. Jerrey	610
Buck Horn	"	721
Cooperstown	"	615
Fargo	"	715
Morrellville	"	575
Ripley	"	525
Scott Mill	"	590
Siloam	"	660
White Oak Springs	"	625
Sec. 6, T. 1 N., R. 4 W.	"	759
" 20, " "	"	769
" 32, " "	"	807
" 24, " "	"	715
" 20, " R. 3 W.	"	777
" 3, " "	"	650
" 31, " "	"	770
" 21, " "	"	610
" 18, T. 1 S., R. 2 W.	"	620
" 2, T. 2 S., "	"	649
" 27, " R. 3 W.	"	720

BUREAU COUNTY.

Arlington	C., B. & Q. R. R.	763
Buda	"	761
C., R. I. & P. Junction	"	645
Grover	"	729
Bureau Junction	C., R. I. & P. R. R.	479
DePue	"	471

Kasbeer	C., B. & Q. R. R.	765
Lamoille	"	805
Loceyville	C., R. I. & P. R. R.	464
Mineral	"	639
Malden	C., B. & Q. R. R.	708
Neponset	"	823
Ohio	"	920
Princeton	"	700
Spring Valley	"	460
Sheffield	C., R. I. & P. R. R.	673
Van Orin	C., B. & Q. R. R.	813
Walnut	"	717
Wyanet	"	661
Ladd	"	656
Tiskilwa	C., R. I. & P. R. R.	519
Dover	W. W. Danley	733
Green Oak	"	715
Hollowayville	"	655
Limerick	"	728
Manlius	"	795
Lone Tree	"	680
Milo	"	885
New Bedford	"	650
Seaton	"	625
Thomas	"	635
Providence	"	975
Yorktown	"	638
Sec. 23, T. 18 N., R. 6 E.	"	680
" 2, " "	"	685
" 16, " R. 7 E.	"	695
" 30, " R. 8 E.	"	832
" 36, " "	"	810
" 24, " R. 9 E.	"	800
" 36, " R. 10 E.	"	805
" 2, " R. 11 E.	"	831
" 22, T. 17 N., "	"	700
" 22, " R. 9 E.	"	710
" 23, " R. 8 E.	"	722
" 20, " "	"	750
" 4, " "	"	855
" 3, " R. 7 E.	"	730
" 30, " "	"	674
" 14, " R. 6 E.	"	670
" 18, " "	"	660
" 6, T. 15 N., "	"	880
" 25, " "	"	861

Sec. 16, T. 15 N., R. 7 E...W. W. Danley	....	869
" 32, " R. 9 E. "	....	691
" 10, T. 14 N., R. 8 E. "	....	910

CALHOUN COUNTY.

Bench-marks.

Calhoun Point at mouth of Illinois River, 60 M. from edge of woods on Illinois River and 150 M. from edge of woods on Mississippi River. Top of stone set in ground.. 420.41

U. S. P. B. M. 29.

Bolt in stone set in ground, 5 M. east of Sny levee, opposite Clarkville, Mo., and about 50 M. east of ferry landing.... 447.63

U. S. P. B. M. 30.

Stone post east of Sny levee, and three and one half miles below U. S. P. B. M. 29. 447.56

U. S. P. B. M. 31.

Stone post at base of levee 175 M. northwest of house occupied by Mr. Cain, and owned by Rock & Baker.................. 424.77

U. S. P. B. M. 32.

Top surface of rock on hillside, 50 M. east of shore of Hamburg Bay, side of wagon road.. 466.71

U. S. P. B. M. 33.

Top surface of natural rock, east side of wagon road, and four miles north of Hamburg Bay.. 513.84

U. S. P. B. M. 34.

North face of natural rock forming south side of first exposure south of Hamburg, 120 M. east of sharp bend in road, one foot below top surface of rock, and four and one half feet above creek........... 444.

U. S. P. B. M. 35.

38 M. east of bank, and 250 M. below island No. 482.. 437.73

U. S. P. B. M. 36.

Stone 8 M. from river bank, 1190 M. above warehouse at Red's Landing......... 436.91

U. S. P. B. M. 37.
Stone 10 M. from small house opposite foot of Sterling Island.............................. 436.58
U. S. P. B. M. 38.
Stone 50 M. east of river bank, 800 M. south from Church's Landing, and 400 M. north of Hoyville Landing...................... 433.81
U. S. P. B. M. 39.
100 M. north of upper landing, warehouse, Turner's landing.............................. 435.64
U. S. P. B. M. 40.
90 M. back from bank, 600 M. south of Foot Island No. 197............................ 433.81
U. S. P. B. M. 41.
74 M. east and below top of hill at West Point.. 444.89
U. S. P. B. M. 42.
Boulder 225 M. below warehouse at Hasting's Landing.................................. 442.
U. S. P. B. M. 43.
Bluff rock, second exposed place north of Martin's Landing 434.69
U. S. P. B. M. 44.
Upper layer of rock, 900 M. south of Martin's Landing...................................... 434.27
U. S. P. B. M. 45.
Bluff rock. Thomas's Landing. Between east end of coke furnace and river.......... 427.77
U. S. P. B. M. 46.
Bluff rock, 1 mi. below Dixon's Landing. 453.
U. S. P. B. M. 47.
Bluff rock, 350 M. north of Pount Landing.. 430.46

Batchtown	J. C. Turner	450
Beechville	"	620
Belleview	"	440
Brussels	"	530
Byerton	"	600
Cliffdale	"	450
Conrad	"	420
Deer Plain	"	450
Gilead	"	430
Golden Eagle	"	430
Hamburg	"	435
Hardin	"	440
Kampsville	"	425

Meppen	J. C. Turner	440
Mozier	"	440
Silver Creek	"	450
Sec. 22, T. 8 S., R. 3 W.	"	750
" 19, T. 9 S., R. 2 W.	"	690
" 8, T. 10 S., R. 2 W.	"	720

CARROLL COUNTY.

Bench-marks.

U. S. P. B. M. 60.	
Thomson, foundation wall east end of Christian Church, 250 M. east of C., M. & St. P. R. R.	604.48
U. S. P. B. M. 61.	
1 mi. south of Savanna, in middle pier of R. R. bridge, No. E, 392	585.74
U. S. P. B. M. 62.	
Savanna, door-sill engine room of elevator, C., M. & St. P. R. R., on bank of river. South end, south door, east side.	590.64
U. S. P. B. M. 64.	
Savanna, 2½ mi. east of Junction House, 50 M. south of C., M. & St. P. R. R., in top of west end of abutment of wagon bridge over Plum River	595.57
U. S. P. B. M. 65.	
300 M. north of 1-mi. post west of Hickory Grove station. In east side stone foundation of barn owned by J. Fish, 5 ft. south of door, 3 ft. from ground.	672.39
U. S. P. B. M. 66.	
Mt. Carroll, 100 M. south and 40 M. east of depot, in stone foundation of barn attached to elevator, south face, 3 ft. above ground	816.10
U. S. P. B. M. 67.	
4 mi. west of Lanark, north end east abutment of R. R. bridge, No. 454, in second course of stone from top	787.36
U. S. P. B. M. 68.	
Lanark, upper door-step of brick building occupied as bank by Walf Bros., cor. Carroll and Main streets, 1½ ft. above ground	881.66

U. S. P. B. M. 69.
2½ mi. east of Lanark, coping north end east abutment R. R. bridge over Carroll Creek.. 839.35

U. S. P. B. M. 70.
3½ mi. east of Lanark Junction. In east end north face stone foundation of barn, owned by M. Crabtree, 140 M. south of track, 2 ft. above ground.......... 946.51

Chadwick	C., B. & N. R. R.	785
Daggett	"	749
Hickory Grove	C., M. & St. P. R. R.	696
Kittredge	"	850
Lanark	"	881
Marcus	C., B. & N. R. R.	604
Milledgeville	"	761
Mt. Carroll	C., M. & St. Paul R. R.	816
Shannon	"	919
Savanna	"	592
Thomson	"	605
Timbuctoo	"	611

Argo	W. M. Hay	660
Elkhorn Grove	"	740
Fair Haven	"	875
Hitt	"	730
Ideal	"	880
Nursery	"	935
Zion	"	915
Sec. 1, T. 25 N., R. 4 E.	"	920
" 23, " "	"	890
" 19, " "	"	860
" 34, " "	"	910
" 3, " R. 5 E.	"	870
" 21, " "	"	930
" 10, " R. 6 E.	"	1005

CASS COUNTY.

Low water, Illinois river, Beardstown.................. 427

Anderson	J. S. E. R. R.	585
Arenzville	C., B. & Q. R. R.	472
Ashland	O. & M. R. R.	634
Beardstown	"	446

Burlingame	O. & M. R. R.	626
Bluff Springs	"	510
Cass	"	600
Chandlerville	J. S. E. R. R.	476
Gurney	O. & M. R. R	637
Hagener	C. B. & Q. R. R.	475
Little Indian	J. S. E. R. R.	615
Philadelphia	O. & M. R. R.	623
Virginia Junction	"	614
Virginia	"	619
Victoria	J. S. E. R. R.	585
Lucas	E. Jerrey	620
Newmansville	"	615
Sylvan	"	615
Sec. 33, T. 19 N., R. 11 W.	"	460
" 11, T. 18 N., R. 11 W.	"	650
" 17, " R. 10 W.	"	620
" 30, T. 19 N., R. 8 W.	"	532
" 8, T. 17 N., R. 8 W.	"	630
" 13, T. 17 N., R. 11 W.	"	574

CHAMPAIGN COUNTY.

Geodetic Stations.

Sec. 35, T. 22 N., R. 10 E. The center of this section lies 274.67 M. S. 79° 22′ E.	819.98
Sec. 7, T. 19 N., R. 10 E. The S. W. corner of this section lies 236.21 M. S. 48° 12′ W.	705.18
Sec. 31, T. 13 N., R. 10 E. The S. W. corner of this section lies 1144.4 M. S. 79° 45′ 32″ W.	771.58

Bondville	I. C. R. R.	718
Broadlands	C. & E. I. R. R	682
Champaign	I. C. R. R.	737
Deers	Wabash R. R.	688
Dewey	I. C. R. R.	731
Dillsburgh	"	744
Dickerson	"	745
Fisher	"	721
Foosland	Wabash R. R.	737
Gifford	I. C. R. R.	810
Homer	Wabash R. R.	661
Howard	I. C. R. R.	741

Ivesdale	Wabash R. R.	679
Leverett	I. C. R. R.	731
Ludlow	"	770
Longview	C. & E. I. R. R.	678
Mayview	C., C., C. & St. L. R. R.	687
Mahomet	"	709
Myra	Wabash R. R.	684
Ogden	C., C., C. & St. L. R. R.	673
Penfield	I. C. R. R.	728
Prospect	"	727
Pesotum	"	715
Philo	Wabash R. R.	727
Rantoul	I. C. R. R.	756
Rising	C., C., C. & St. L. R. R.	731
Sadorus	Wabash R. R.	691
Savoy	I. C. R. R.	737
Seymour	"	700
St. Joseph	C., C., C. & St. L. R. R.	671
Staley	I. C. R. R.	745
Sidney	Wabash R. R.	649
Thomasboro	I. C. R. R.	734
Tolono	"	733
Tomlinson	"	727
Urbana	C., C., C. & St. L. R. R.	718
Flatville	J. C. Turner	710
Parkville	"	660
Royal	"	725
Sellers	"	718
Shiloh Center	"	730
Sec. 17, T. 22 N., R. 10 E.	"	820
" 13, " R. 11 E.	"	750
" 29, T. 21 N., R. 14 W.	"	820
" 3, T. 18 N., R. 8 E.	"	755
" 3, " R. 7 E.	"	690
" 36, " R. 9 E.	"	770
" 8, T. 17 N., R. 14 W.	"	731

CHRISTIAN COUNTY.

Assumption	I. C. R. R.	636
Clarksdale	Wabash R. R.	621
Dunkel	I. C. R. R.	656
Edinburg	O. & M. R. R.	576
Taylorville	Wabash R. R.	620

Greenwood	O. & M. R. R.	575
Millersville	"	648
Morrisonville	Wabash R. R.	632
Owaneco	O. & M. R. R.	619
O. & M. Crossing	Wabash R. R.	616
Pana	O. & M. R. R.	695
Palmer	Wabash R. R.	622
Radford	I. C. R. R.	622
Rosamond	C., C., C. & St. L. R. R.	706
Sharp's Station	O. & M. R. R.	597
Stonington	Wabash R. R.	580
Velma	O. & M. R. R.	629
Willey	Wabash R. R.	629
Blackburn	E. Ellison	615
Bolivia	"	564
Grove City	"	620
Morgansville	"	580
Mt. Auburn	"	627
County Line, Christian and Sangamon	O. & M. R. R.	584
Sec. 23, T. 14 N., R. 1 E.	E. Ellison	684
" 31, T. 13 N., R. 1 E.	"	630
" 22, T. 12 N., R. 4 W.	"	665
" 15, T. 11 N., R. 4 W.	"	660
" 35, T. 11 N., R. 3 W.	"	651

CLARK COUNTY.

Geodetic Stations.

Sec. 16, T. 10 N., R. 13 W. The center of the section lies 237 M. N. 29° 32′ E. from station 677.48

Sec. 32, T. 9 N. R. 13 W. The corner of sections 4 and 5, on the south line of this section lies 559 M. S. 86° 28′ W. from station 587.28

Auburn	Vand. Line	616
Briscoe	C. & O. R. R	655
Casey	"	656
Darwin Station	C., C, C. & St. L. R. R.	570
Dennison	Vand. Line	574
Farrington	"	579
Griffith's	"	537
Marshall	"	612

McKeen	Vand. Line	585
Martinsville	"	582
Snyder	C., C., C. & St. L. R. R	526
Walnut Prairie	"	474
West Union	"	469
Westfield	C. & O. R. R. R	749
Cohn	J. E. Hallinen	565
Darwin	"	445
Dolson	"	635
Elcone	"	625
Melrose	"	580
Moonshine	"	580
Needmore	"	615
Oak Point	"	615
Orange	"	600
State Line	"	555

CLAY COUNTY.

Bench-marks.

Clay City. East abutment of O. & M. R. R. bridge, 1½ mi. east of city. B. M. 3. 429.78

Flora. Southeast corner school building on front basement window. C_3 B. M. 491.

Clay City	O. & M. R. R	431
Flora	"	495
Iola	"	525
Kenner's	"	502
Louis	"	484
Russell	"	511
Xenia	"	548
Bible Grove	R. M. Hood	500
Ingraham	"	495
Hoosier Prairie	"	490
Oskaloosa	"	550
Sailor Springs	"	460
County Line Clay and Effingham	O. & M. R. R	563
Sec. 34, T. 5 N., R. 6 E	R. M. Hood	550
" 15, T. 3 N., R. 5 E	"	564
" 11, T. 2 N., R. 7 E	"	450

CLINTON COUNTY.

Bench-marks.

Collins (Huey). West abutment of O. & M. R. R. culvert, ¼ mi. east of Collins, B. M. 7	448. 5
Carlyle. Pier of O. & M. R. R. bridge Kaskaskia River, ¼ mile east of Carlyle, B. M. E	470.35
Aviston. West abutment of O. & M. R. R. bridge over Sugar Creek, U. S. B. M. 8.	454.6

Aviston	O. & M. R. R	457
Bartelso	L. E. & St. L. R. R	456
Boulder	J. S. E. R. R	471
Breese	O. & M. R. R	450
Buxton	"	458
Carlyle	"	450
Damiansville Station	L. E. & St. L. R. R	434
Germantown	"	436
Hoffman	"	461
Huey	O. & M. R. R	448
Keyesport	J. S. E. R. R	458
New Baden	L. E. & St. L. R. R	443
New Memphis Station	L & N. R. R	411
Posey	L. E. & St. L. R. R	455
Queen's Lake	L. & N. R. R	409
Shattuc	J. S. E. R. R	469
Trenton	O. & M. R. R	490
Zachary	L. E. & St. L. R. R	430

Damiansville P. O	E. C. Eidmann	440
Frogtown	"	445
Jamestown	"	460
St. Rose	"	480
New Memphis P. O	"	423
Sec. 14, T. 3 N., R. 3 W.	"	478
" 36, " "	"	480
" 22, " R. 2 W.	"	540
" 31, " R. 1 W.	"	507
" 12, " "	"	506
" 35, " "	"	544

COLES COUNTY.

Geodetic Station.
Sec. 25, T. 12 N., R. 10 E. The corner of sections 25, 26, 35, 36 lies 531.7 M. S. 3° 25′ W. 772.48

Ætna	I. C. R. R.	659
Ashmore	C., C., C. & St. L. R. R.	691
Big Four Junction	P., D. & E. R. R.	734
Bushton	T., St. L. & K. Cy. R. R.	668
Charleston	"	665
Doran's Crossing	I. C. R. R.	680
Embarrass Siding	C., C., C. & St. L. R. R.	704
Fair Grange	T., St. L. & K. Cy. R. R.	680
Hites	C. & O. R. R. R.	698
Humboldt	I. C. R. R.	658
Janesville	P., D. & E. R. R.	692
Lerna	T., St. L. & K. Cy. R. R.	751
Loxa	C., C., C. & St. L. R. R.	672
Mattoon	I. C. R. R.	733
Montgomery	P., D. & E. R. R.	750
Oakland	T., St. L. & K. Cy. R. R.	653
Rardin	"	662
Trilla	"	654
Wright	P., D. & E. R. R.	735
Water Tank at Embarrass, T. H. & P. R. R.		652
Campbell	R. M. Hood	700
Cook's Mills	"	630
Diona	"	650
Fuller's Point	"	660
Hutton	"	690
Paradise	"	650
Sec. 29, T. 14 N., R. 9 E.	"	700
" 18, T. 13 N., R. 14 W.	"	720
" 33, T. 11 N., R. 9 E.	"	707
" 36, T. 12 N., R. 7 E.	"	794

COOK COUNTY.

Bench-marks.	
Mean water Lake Michigan. U. S. L. S......	581.28
U. S. P. B. M. 89.	
Bartlett. 150 M. northwest of depot C., M. & St. P. R. R., on east face southeast corner of stone foundation of Congregational church	802.2
U. S. P. B. M. 93.	
Manheim. 250 M. northwest of depot of C., M. & St. P. R. R., in south side of brick chimney, C. H. Bossenbarg's Creamery, 3 feet above ground..........................	649.39
U. S. P. B. M. 94.	
Cragin. N. E. cor. Grand and Armitage avenues, 150 M. north of line of C., M. & St. P. R. R., in east face of Jennings's brick saloon, 4 feet above ground.............	616.52
U. S. P. B. M. 95.	
Chicago. Corner Dixon St. and Bloomingdale road, 20 M. southwest of crossing of C., M. & St. P. and C. & N. W. R. R., in west face of L. Epps's brick malt house, 6 in. from northwest corner, 2½ ft. above ground	590.27
U. S. P. B. M. 99.	
Chicago. I. C. R. R. stone freight depot, foot of Lake St., east face of foundation, 1 foot south of northeast corner, 2½ feet above ground	590
Geodetic Stations.	
Sec. 3, T. 37 N., R. 12 E. In the N. W. ¼ of the section...	728.58
Sec. 13, T. 38 N., R. 12 E. The center of this section lies 37 M. N. 89° 44′ W...	618.88
Sec. 27, T. 38 N., R. 13 E. The N. E. corner of this section lies 580.6 M. N. 38° 41° E...	616.28
Sec. 19, T. 37 N., R. 14 E. The N. W. corner of this section lies 637.8 M. N. 84° 46′ W.	664.98
Sec. 28, T. 36 N., R. 12 E. The S. E. corner of this section lies 285.88 M. S. 89° 57′ E...	767.68

Alpine	Wabash R. R.	700
Arlington Heights	C. & N. W. R. R.	697
Auburn	C., R. I. & P. R. R.	615
Austin	C. & N. W. R. R.	593
Barrington	"	818
Bartlett	C., M. & St. P. R. R.	802
Bellewood	C., St. P. & K. Cy. R. R.	640
Bloom	M. C. R. R.	686
Blue Island	C., R. I. & P. R. R.	606
Bremen	"	699
Brighton Park	C. & A. R. R.	602
Broadview	I. C. R. R.	625
Calvary	C. & N. W. R. R.	616
Canfield	"	661
Chappell	C. & A. R. R.	587
Clark's	E., J. & E. R. R.	829
Clyde	C., B. & Q. R. R.	608
Colehour	L. S. & M. S. R. R.	586
Conley's	Wabash R. R.	636
Corwith	C., St. F. & C. R. R.	603
Cragin	C., M. & St. P. R. R.	614
Crossdale	C., B. & Q. R. R.	618
Des Plaines	Wis. C. R. R.	641
Dolton	C. & E. I. R. R.	605
Dupont	C., R. I. & P. R. R.	648
Elsmere	C., M. & St. P. R. R.	606
Englewood	C., R. I. & P. R. R.	601
Evanston	C. & N. W. R. R.	608
Feehanville	Wis. C. R. R.	646
Forest Glen	C., M. & St. P. R. R.	612
Forest Hill	Wabash R. R.	605
Forest Home	C., St. P. & K. Cy. R. R.	630
Franklin Park	Wis. C. R. R.	635
Gary	C., St. F. & C. R. R.	604
Glenwood	C. & E. I. R. R.	628
Globe	P., C., C. & St. L. R. R.	597
Grand Crossing	I. C. R. R.	590
Greenwood	P., C., C. & St. L. R. R.	605
Hammond	C., M. & St. P. R. R.	746
Harvey	I. C. R. R.	603
Hermosa	C., M. & St. P. R. R.	612
Hillside	I. C. R. R.	665
Homewood	I. C. R. R.	656
Irving Park	C. & N. W. R. R.	608
Kenilworth	C. & N. W. R. R.	618
Kensington	I. C. R. R.	592

La Grange	C., B. & Q. R. R.	642
Lansing	P., C., C. & St. L. R. R.	619
Lavergne	C., B. & Q. R. R.	610
Lemont	C., St. F. & C. R. R.	593
Manheim	C., M. & St. P. R. R.	641
Matteson	E., J. & E. R. R.	707
Maywood	C., St. P. & K. Cy. R. R.	636
Mont Clare	C., M. & St. P. R. R.	653
Montrose	"	613
Morgandale	P., C., C. & St. L. R. R.	620
Morton	C., M. & St. P. R. R.	626
Mount Forest	C. & A. R. R.	585
Normal Park	C., R. I. & P. R. R.	600
Norwood	C. & N. W. R. R.	640
Oak Forest	C., R. I. & P. R. R.	688
Oak Glen	C., M. & St. P. R. R.	631
Oak Lawn	Wabash R. R.	611
Oak Park	C. & N. W. R. R.	628
Orchard Place	Wis. C. R. R.	637
Orland	Wabash R. R.	690
Ovington	C. & N. W. R. R.	635
Palatine	"	748
Park Ridge	"	660
Prospect	"	675
Ravenswood	"	609
Rexford	C., R. I. & P. R. R.	629
Rhodes	Wis. C. R. R.	631
Richton	I. C. R. R.	728
Ridgeland	C. & N. W. R. R.	630
Riverdale	P., C., C. & St. L. R. R.	594
River Forest	Wis. C. R. R.	630
Riverside	C., B. & Q. R. R.	617
Roger's Park	C. & N. W. R. R.	604
Sag Bridge	C. & A. R. R.	591
Schiller's Park	Wis. C. R. R.	635
Shermerville	C., M. & St. P. R. R.	645
Shooting Park	P., C., C. & St. L. R. R.	614
South Chicago	L. S. & M. S. R. R.	586
South Evanston	C. & N. W. R. R.	615
South Lawn	I. C. R. R.	605
South Lynne	P., C., C. & St. L. R. R.	599
Spaulding	C., M. & St. P. R. R.	769
Summit	C. & A. R. R.	585
Thatcher's Park	Wis. C. R. R.	627
Thompson's	P., C., C. & St. L. R. R.	596
Thornton	C. & E. I. R. R.	621
Thornton Junction	"	608

Tremont	P., C., C. & St. L. R. R.	595
Washington Heights	C., R. I. & P. R. R.	621
Wentworth	C., St. F. & C. R. R	608
West Maywood	C., St. P. & K. Cy. R. R.	638
Western Ave	C., M. & St. P. R. R	602
Western Springs	C., B. & Q. R. R	671
Wheeling	Wis. C. R. R	647
Willow Springs	C., St. F. & C. R. R	599
Wilmette	C. & N. W. R. R	618
Winnetka	C. & N. W. R. R	658
Worth	Wabash R. R	630

CRAWFORD COUNTY.

Geodetic Station.
Sec. 32, T. 7 N., R. 13 W. The S. E. corner of this section lies 325.6 M. S. 73° 42′ E. ... 499.68

Baker's Lane	I. & I. S. R. R	465
Duncanville	C., C., C. & St. L. R. R	536
Flat Rock	"	497
Gordon's	I. & I. S. R. R	476
Hutsonville	C., C., C. & St. L. R. R	441
McLane's	I. & I. S. R. R	463
Oblong	"	514
Palestine	"	443
Robinson	"	531
Trimble	C., C., C. & St. L. R. R	486
West York	"	462

Annapolis	J. C. Turner	565
Belle Air	"	545
Eaton	"	490
Handy	"	430
Hardinsville	"	425
Heathville	"	435
Kibbie	"	525
Landers	"	430
Morea	"	510
Villas	"	470

CUMBERLAND COUNTY.

Bench-mark.

Sec. 18, T. 9 N., R. 11 E. The N. E. corner of the section lies 1092.1 M. N. 47° 29′ E. ... 630.18

Bradbury	P. D. & E. R. R.	601
Greenup	"	544
Greenup Hill	"	595
Hazel Dell	C. & O. R. R.	609
Jewett	Vand. Line	584
Neoga	I. C. R. R.	657
Toledo	P., D. & E. R. R.	600
Vevay Park	Vand. Line	631
Winslow	"	595
Woodbury	"	580
Croake	R. M. Hood	600
Johnston	"	640
Neal	"	610
Roslyn	"	615
Union Center	"	645
Walla Walla	"	565

DE KALB COUNTY.

Bench-marks.

U. S. P. B. M. 79.

Fielding. 10 M. north of track of C., M. & St. P. R. R., in south face of stone wall of elevator, 25 ft. west of S. E. corner, and 2½ ft. above ground ... 784.78

U. S. P. B. M. 80.

Kirkland. 175 M. south of depot, in west face of stone foundation of brick building owned by Dean & Rowen, 6 in. from N. W. corner, 5 ft. from ground ... 773.4

U. S. P. B. M. 81.

Kingston. ½ mi. east of the depot, 10 M. north from track, in west face water-table of brick store belonging to Julius Chapman, N. W. corner ... 803.6

U. S. P. B. M. 82.

Genoa. 100 M. south of track, corner Main and Emmet sts., in south end of stone door-sill, on east side of brick store. 837.07

Carlton	C. & N. W. R. R.	896
Charter Grove	I. C. R. R.	871
Clare	C., St. P. & K. Cy. R. R.	878
Colwin Park	I. C. R. R.	849
Cortland	C. & N. W. R. R.	905
De Kalb	"	895
Elva	"	875
Esmond	C., St. P. & K. Cy. R. R.	828
Fielding	C., M. & St. P. R. R.	784
Genoa	"	830
Henrietta	C. & N. W. R. R.	811
Hinckley	C. & I. R. R.	751
Kingston	C., M. & St. P. R. R.	792
Kirkland	"	767
Lee	C. & I. R. R.	955
Malta	C. & N. W. R. R.	925
New Lebanon	C., M. & St. P. R. R.	847
Rolla	C., & N. W. R. R.	763
Sandwich	C., B. & Q. R. R.	655
Shabbona	C. & I. R. R.	911
Shabbona Grove	C. & N. W. R. R.	825
Somonauk	C., B. & Q. R. R.	689
Sycamore	C. & N. W. R. R.	867
Waterman	C. & I. R. R.	832
Franks	W. M. Hay	698
La Clair	"	812
Ney	"	840
Pierceville	"	830
Ross Grove	"	768
South Grove	"	850
Sec. 19, T. 39 N., R. 3 E.	"	955
" 8, T. 37 N., R 5 E.	"	730

DEWITT COUNTY.

Birkbeck	I. C. R. R.	735
Clinton	"	725
Dewitt	"	745
Farmer City	"	730
Fullerton	"	749
Gravel Pit Siding	"	652
Hallville	"	752
Kenney	"	649
Lane's	"	730

Midland City	I. C. R. R.	657
Ospur	"	721
Parnell	"	738
Rowell	T. H. & P. R. R.	755
Salt Creek Siding	I. C. R. R.	735
Tabor	T. H. & P. R. R.	680
Wapella	I. C. R. R.	741
Waynesville	T. H. & P. R. R.	722
Weldon	I. C. R. R.	719
Solomon	H. J. Burt	750
Swisher	"	720
Sec. 12, T. 21 N., R. 1 E.	"	770
" 33, T. 22 N., R. 3 E.	"	770

DOUGLAS COUNTY.

Bench-mark.

Sec. 36, T. 15 N., R. 10 E. The N. W. corner of this section lies 598.6 M. N. 70° 59′ 44″ W. 692.28

Arcola	I. C. R. R.	676
Atwood	I., D. & W. R. R.	672
Bourbon	C. & E. I. R. R.	669
Camargo	I., D. & W. R. R.	642
Chesterville	T. H. & P. R. R.	665
Craigs	C. & E. I. R. R.	679
Dora	T. H. & P. R. R.	670
Fairland	C. & E. I. R. R.	658
Ficklin	I., D. & W. R. R.	660
Filson	T. H. & P. R. R.	666
Galton	I. C. R. R.	651
Garrett's	I., D. & W. R. R.	675
Hayes	I. C. R. R.	692
Hindsboro	T. H. & P. R. R.	660
Kemp	"	668
Murdock	I., D. & W. R.	646
Newman	"	647.6
Tuscola	I. C. R. R.	659
Villa Grove	C. & E. I. R. R.	655
West Ridge	"	691
Brushy Fork	R. M. Hood	655
Hugo	"	680

DU PAGE COUNTY.

Bench-marks.

U. S. P. B. M 90.

Roselle. 80 M. north of track C., M. & St. P. R. R. North face foundation wall of Mathew Secker's brick building, 3 ft. from N. E. cor., 2 ft above ground......... 771.6

U. S. P. B. M. 91.

Itasca. 80 M. north of track, N. E. from depot, in foundation of frame store, 2 ft. from S. E. corner............................... 698.25

U. S. P. B. M. 92.

Bensenville. 40 M. north of depot, in south side of frame store, 2 ft. from S. E. corner.. 679.76

Bensenville	C., M. & St. P. R. R	677
Byrneville	C., St. F. & C. R. R	610
Clarendon Hills	C., B. & Q. R. R	730
Cloverdale	I. C. R. R	755
Downer's Grove	C., B. & Q. R. R	718
East Grove	"	733
Elmhurst	C. & N. W. R. R	688
Eola	C., B. & Q. R. R	715
Frontenac	E., J. & E. R. R	709
Granger	I. C. R. R	766
Gregg's	C., B. & Q. R. R	753
Gretna	C., St. P. & K. Cy. R. R	788
Hinsdale	C., B. & Q. R. R	691
Ingalton	C., St. P. & K. Cy. R. R	781
Itasca	C., M. & St. P. R. R	692
Lisle	C., B. & Q. R. R	684
Lombard	C., St. P. & K. Cy. R. R	727
Naperville	C., B. & Q. R. R	714
North Glen Ellyn	C., St. P. & K. Cy. R. R	748
North Wayne	I. C. R. R	785
Ontarioville	C., M. & St. P. R. R	813
Prospect Park	C. & N. W. R. R	744
Roselle	C., M. & St. P. R. R	770
Salt Creek	"	695
South Addison	I. C. R. R	703
Tedens	C., St. F. & C. R. R	600
Turner	C. & N. W. R. R	766
Warrenhurst	E., J. & E. R. R	727
Wayne	"	760

West Hinsdale	C., B. & Q. R. R.	710
Wheaton	C. & N. W. R. R.	751
Winfield	"	735
Addison	T. Barclay	670
Bloomingdale	"	770
Fullersburg	"	670
Gower	"	665
Meacham	"	735
Warrensville	"	685

EDGAR COUNTY.

Bench-marks.

Sec. 6, T. 16 N., R. 13 W. The N. E. corner of this section lies 1283.6 M. S. 23° 6′ E.	741.68
Sec. 4, T. 12 N., R. 13 W. The S. W. corner of this section lies 510.2 M. S. 58° 55′ W.	838.08

Borton Junction	T. H. & P. R. R.	662
Bowman	T., St. L. & K. Cy. R. R.	690
Brocton	"	661
Cherry Point	I., D. & W. R. R.	625
Chrisman	"	650
Cologne	C., C., C. & St. L. R. R.	714
Dudley	"	713
Edgar	"	642
Ferrell	T. H. & P. R. R.	581
Grover	C., C., C. & St. L. R. R.	640
Hildreth	C. & O. R. R. R.	725
Horace	C., C., C. & St. L. R. R.	648
Hughes	C. & O R. R. R.	658
Hume	I., D. & W. R. R.	653
Isabel	T. H. & P. R. R.	663
Kansas	C. & O. R. R. R.	708
Marley	T. H. & P. R. R.	620
May's	"	684
Melwood	T., St. L. & K. Cy. R. R.	662
Metcalf	"	665
Mortimer	"	702
Neeley	T. H. & P. R. R.	734
Nevins	"	674
Oliver	C., C., C. & St. L. R. R.	642

Paris	C., C., C. & St. L. R. R.	707
Payne	C. & O. R. R. R.	687
Raven	I., D. & W. R. R.	631
Redmon	T. H. & P. R. R.	680
Sanford	C., C., C. & St. L. R. R.	627
Scotland	I., D. & W. R. R.	631
Swango	C., C., C. & St. L. R. R.	636
Vermilion	"	663
Warrington	C. & O. R. R. R.	692
Wetzel	C., C., C. & St. L. R. R.	653
Woodyard	"	673
Clay's Prairie	J. E. Hallinen	575
Flemington	"	667
Garland	"	762
Grand View	"	738
Kidley	"	566
Logan	"	600

EDWARDS COUNTY.

Albion	L., E. & St. L. R. R.	464
Bone Gap	P., D. & E. R. R.	475
Browns	"	404
Ellery	L., E. & St. L R. R.	441
Grayville Junction	P., D. & E. R. R.	398
Siegert	"	431
West Salem	"	515
Maple Grove	J. C. Turner	475
Mill Prairie	"	480
Samsville	"	490
Sec. 34, T. 2 S., R. 10 E.	"	530
Sec, 21, T. 1 S., "	"	540

EFFINGHAM COUNTY.

Altamont	O. & M. R. R.	624
Beecher	"	611
Blue Point	Wabash R. R.	633
Dexter	Vand. Line	593
Dietrich	I. & I. S. R. R.	589
Clio	I. C. R. R.	580
Edgewood	"	577

Effingham	I. C. R. R.	595
Eversman	I. & I. S. R. R.	605
Funkhouser	Vand. Line	586
Gilmore	O. & M. R. R.	581
Moccasin	"	618
Montrose	Vand. Line	599
Shumway	Wabash R. R.	657
Teutopolis	Vand Line	605
Watson	I. C. R. R.	562
Eberle	R. M. Hood	575
Elliottstown	"	588
Winterrowd	"	535

FAYETTE COUNTY.

Avena	Vand. Line	570
Bayle	T., St. L. & K. Cy. R. R.	614
Bingham	"	600
Brownstown	Vand. Line	564
Dresser	T., St. L. & K. Cy. R. R.	626
Farina	I. C. R. R.	584
Hagerstown	Vand. Line.	525
Holliday	O. & M. R. R.	569
La Clede	I. C. R. R.	574
Ramsey	"	611
Shobonier	"	514
St. Elmo	Vand. Line	600
Vandalia	I. C. R. R.	502
Vera	"	552
Hilesberg	R. M. Hood	490
Hissong	"	590
Loogootee	"	565
St. James	"	565
St. Paul	"	560
London City	"	580
Wilberton	"	560
Sec. 32, T. 9 N., R. 1 W.	"	630
" 29, " R. 1 E.	"	650
" 25, " R. 2 E.	"	620
" 14, T. 8 N., R. 2 W.	"	490
River bed, Sec. 12, T. 7 N., R. 1 W.	"	470
Sec. 28, T. 7 N., R. 1 W.	"	540
" 11, T. 5 N., R 1 W.	"	560

FORD COUNTY.

Geodetic Station.
Sec. 14, T. 23 N., R. 10 E. The S. W. corner of this section lies 460.4 M. S. 87° 28′ W. 803.18

Cabery	I. C. R. R.	706
Elliott	L. E. & W. R. R.	776
Garber	Wabash R. R.	810
Gibson City	I. C. R. R.	749
Guthrie	"	803
Harpster	"	746
Henderson	L. E. & W. R. R.	762
Kempton	I. C. R. R.	737
Kirk Station	L. E. & W. R. R.	761
Melvin	I. C. R. R.	808
Paxton	"	790
Piper City	T., P. & W. R. R.	678
Proctor	Wabash R. R.	747
Roberts	I. C. R. R.	781
Sibley	Wabash R. R.	808

Sec. 36, T. 29 N., R. 9 E.	R. M. Hood	730
" 24, T. 28 N., "	"	710
" 5, T. 27 N., "	"	673
" 21, T. 26 N., "	"	750
" 15, T. 24 N., "	"	800

FRANKLIN COUNTY.

Benton	St. L., A. & T. H. R. R.	472
Buckner	"	385
Christopher	"	440
Mulkeytown	"	450
Parrish	"	442
Smothersville	"	483
Thompsonville	"	505
Akin	E. C. Eidmann	485
Brayfield	"	455
Crittenden	"	463
Ewing	"	449
Fitts Hill	"	485
Frankfort	"	507
Gresham	"	430

Locust Grove	E. C. Eidmann	420
Masters	"	450
Osage	"	440
Plumfield	"	380
Portland	"	455
Prosperity	"	458
Taylor Hill	"	475
Snow Flake	"	574
Webb's Hill	"	440

FULTON COUNTY.

Astoria	C., B. & Q. R. R.	660
Avon	"	741
Breed's	T., P. & W. R. R.	494
Bryant	C., B. & Q. R. R.	616
Bybee	F. Co. N. G. R. R.	708
Canton	C., B. & Q. R. R.	661
Civer	T., P. & W. R. R.	678
Cuba	"	677
Dunfermline	J. S. E. R. R.	631
Ellisville	F. Co. N. G. R. R.	543
Fairview	"	757
Farmington	C., B. & Q. R. R.	737
Fiatt	F. Co. N. G. R. R.	694
Ipava	C., B. & Q. R. R.	650
Leaman	T., P. & W. R. R.	511
Lewiston	C., B. & Q. R. R.	584
London Mills	F. Co. N. G. R. R.	560
Maple Mills	J. S. E. R. R.	577
Marietta	T., P. & W R. R.	549
Middle Grove	Ia C. R. R.	726
Norris	C., B. & Q. R. R.	726
Oak Mound	F. Co. N. G. R. R.	538
Phillips	"	516
Rapatee	Ia. C. R. R.	689
Rawalts	T., P. & W. R. R.	633
St. David's	C., B. & Q. R. R.	625
Sepo	F. Co. N. G. R. R.	464
Seville	T., P. & W. R. R.	494
Smithfield	"	648
Table Grove	C., B. & Q. R. R.	744
Vermont	"	664
West Havana	F. Co. N. G. R. R.	448
Low water, Ill. River		427

Babylon	H. J. Burt	500
Banner	"	460
Bernadotte	"	460
Blyton	"	630
Duncan Mills	"	450
Enon	"	450
Fiatt P. O	"	668
Leeseburg	"	635
Manley	"	715
Marietta P. O	"	640
Monterey	"	625
Otto	"	470
Summum	"	625

GALLATIN COUNTY.

Bartley	O. & M. R. R	387
Cypress Junction	"	363
Equality	L. & N. R. R	373
Lawler	"	377
Omaha	O. & M. R. R	371
Ridgeway	"	379
Shawneetown	"	352
Gauge mark, Wabash River		307.1
High water 1884		362.2

Cottonwood	E. C. Eidmann	382
Doherty	"	345
Elba	"	375
Kedron	"	410
Leamington	"	385
New Haven	"	360
Saline Mines	"	371
Sec. 16, T. 8 S., R. 9 E.	"	375
" 10, T. 8 S., R. 10 E.	"	342
" 8, T. 9 S., R. 10 E.	"	410
" 32, T. 8 S., R. 8 E.	"	450
" 4, T. 10 S., R. 9 E.	"	493

GREENE COUNTY.

Baldwin	C., B. & Q. R. R	654
Barrow	"	650
Berdan	C. & A. R. R	507
Carrollton	"	617
Columbiana	J. S. E. R. R	423
Low water, Ill. River	"	404
Daum	"	627
Drake	C. & A. R. R	542
Eldred	J. S. E. R. R	447
Fayette	"	559
Greenfield	C., B. & Q. R. R	586
Happyville	C. & A. R. R.	445
Hurricane	J. S. E. R. R	519
Kane	C. & A. R. R	584
Kaser	J. S. E. R. R	594
Riverdale	C. & A. R. R	487
Rockbridge	C., B. & Q. R. R	539
Roodhouse	C. & A. R. R	651
Whitehall	"	573
Wrightsville	C., B. & Q. R. R	575
Athensville	J. C. Turner	580
Bluffdale	"	475
Bridge Water	"	625
Felter	"	565
Patterson	"	600
Schutz Mills	"	530
Woody	"	555
Walkerville	"	520

GRUNDY COUNTY.

Booth's	K. & S. R. R	572
Braceville	C. & A. R. R	575
Centerville	E., J. & E. R. R	572
Chickering	"	562
Coal City	"	570
Coal Mine Switch	K. & S. R. R	586
Coyne	"	620
Dell Abbey	E., J. & E. R. R	545
Diamond	C. & A. R. R	558
Divine	"	524

Gardner	C. & A. R. R.	586
Kinsman	C., St. F. & C. R.	655
Mazon	"	590
Mazonia	E., J. & E. R. R.	577
Minooka	C., R. I. & P. R. R.	614
Morris	"	522
Verona	C., St. F. & C. R. R.	632
Wauponsee	K. & S. R. R.	611
Nettle Creek	W. A. Dunaway	648

HAMILTON COUNTY.

Broughton	L. & N. R. R.	360
Dahlgren	"	508
Dale	"	376
Delafield	"	427
Hoodville	"	400
McLeansboro	"	483
Thackery	"	505
Belle Prairie	E. C. Eidmann	400
Braden	"	440
Bundy	"	500
Ellis Mound	"	405
Flint	"	531
Hammock	"	430
Logansport	"	475
Lower Hills	"	390
Macedonia	"	515
Martin's Store	"	410
Olga	"	400
Palo Alto	"	470
Piopolis	"	435
Rural Hill	"	530
Walpole	"	380
Sec. 26, T. 6 N., R. 7 E.	"	530
" 13, T. 4 S., "	"	460

HANCOCK COUNTY.

Adrian	C., B. & Q. R. R.	705
Augusta	"	675
Basco	"	650
Bentley	Wabash R. R.	665
Bowen	"	688
Burnside	T., P. & W. R. R.	644
Carthage	Wabash R. R.	678
Colusa	C., B. & Q. R. R.	653
Dallas	"	589
Dallas City	C., S. F. & C. R. R.	530
Denver	Wabash R. R	674
Disco	T., P. & W. R. R.	671
Elvaston	"	669
Ferris	"	684
Ft. Madison, high water	C., St. F. & C. R. R.	519
Mississippi Bridge	"	540
Hamilton	T., P. & W. R. R.	518
La Crosse	"	648
La Harpe	"	694
McCall's	"	697
Niota	C., St. F. & C. R. R.	520
Plymouth	C., B. & Q. R. R.	642
Pontoosuc	C., St. F. & C. R. R.	531
Stillwell	C., B. & Q. R. R.	669
Warsaw	T., P. & W. R. R.	493
West Point	C., B. & Q. R. R.	667
Chili	F. C. Eidmann	670
Durham	"	685
Elderville	"	675
Fountain Creek	"	545
Hickory Ridge	"	650
Joetta	"	525
Mallard	"	500
Middle Creek	"	645
Millikin	"	685
Nauvoo	"	500
Powellton	"	683
Sonora	"	510
Star	"	540
Sutter	"	700
Tioga	"	700
Webster	"	620

HARDIN COUNTY.

High water at Elizabethtown		354
Low water at Elizabethtown		299
Cave-in-Rock	C. B. Klingelhoefer	350
Chambers' Creek	"	375
Grossville	"	575
Hicks	"	650
Karber's Ridge	"	550
Lamb	"	400
Rock Creek	"	465
Rosiclare	"	325
Shetlerville	"	375
Sparks' Hill	"	530
Wolrab Mills	"	600
Sec. 2, T. 11 S., R. 7 E.	"	810
" 4, T. 12 S., R. 9 E.	"	726

HENDERSON COUNTY.

Bench-marks.

U. S. P. B. M. 14.
East abutment of C., B. & Q. R. R. bridge at Burlington, Ia. 541.15

U. S. P. B. M. 15.
East abutment of C., B. & Q. R. R. bridge over Prairie Slough, two miles above Burlington bridge 530.26

U. S. P. B. M. 16.
West abutment of trestle No. 59, 4½ mi. north of Burlington bridge 528.94

U. S. P. B. M. 17.
Oquawka. Stone pillar, S. W. corner Robert Moir's brick building 530.26

U. S. P. B. M. 18.
Oquawka. S. E. corner Third and Schuyler streets. W. side, N. W. corner of brick building, 2½ feet above ground 547.17

Biggsville	C., B. & Q. R. R.	646
Burlington Bridge	"	544.37
Carman	"	537
Carthage Junction	"	534
Decorra	C., St. F. & C. R. R.	682
Gladstone	C., B. & Q. R. R.	546
Iowa Junction	"	552
Lomax	"	549
Media	C., St. F. & C. R. R.	709
Milroy	C., B. & Q. R. R.	570
Oquawka	"	540
Stronghurst	C., St. F. & C. R. R.	671
Hopper's Mills	M. A. Earl	555
Olena	"	600
Rozetta	"	722
South Henderson	"	682
Terre Haute	"	738
Wallbaum	"	660
Sec. 15, T. 12 N., R 4 W.	"	750
" 36, " "	"	734
" 15, T. 8 N., "	"	750

HENRY COUNTY.

Alpha	C., B. & Q. R. R.	802
Annawan	C., R. I. & P. R. R.	629
Atkinson	"	649
Bishop Hill	R. I. & P. R. R.	750
Briar Bluff	C., B. & Q. R. R.	574
Cambridge	R. I. & P. R. R.	805
Colona	C., R. I. & P. R. R.	585
Bridge over Rock R.	"	580
Crampton	R. I. & P. R. R.	738
Galva	"	845
Geneseo	C., R. I. & P. R. R.	643
Green River	"	582
Kewanee	C., B. & Q. R. R.	847
Lynn	"	739
Nekoma	"	813
Opheim	"	704
Orion	"	750
Osco	R. I. & P. R. R.	770
Utah	"	727
Warner	C., B. & Q. R. R.	641
Woodhull	"	820

Andover	J. A. Udden	795
Cleveland	"	580
Edwards	"	705
Hawley	"	765
Hooppole	"	620
Morristown	"	710
Pink Prairie	"	610
Rickel	"	620
Saxon	"	755
Sharon	"	590
Rock River, N. W. corner county	"	575
Sec. 3, T. 17 N., R. 4 E.	"	650
" 12, T. 17 N., R. 5 E.	"	540
" 34, T. 16 N., R. 5 E.	"	770
" 17. T. 16 N., R. 4 E.	"	715
" 15, T. 15 N., R. 4 E.	"	800
" 18, T. 16 N., R. 3 E.	"	770
" 5, T. 14 N., R. 2 E.	"	800
" 6, T. 14 N., R. 3 E.	"	810

IROQUOIS COUNTY.

Geodetic Stations.

Sec. 11, T. 26 N., R. 13 W. The N. E. corner of Sec. 2 lies 2174.4 M. N. 3° 39′ 26″ E.	668.85
Sec. 3, T. 28 N., R. 14 W. The N. E. corner of the Congregational Church lies 251 M. S. 45° 54′ E.	661.08
Sec. 35, T. 25 N., R. 13 W. The N. E. corner of this section lies 1003.8 M. N. 87° 43′ E.	665.78
Sec. 6, T. 25 N., R. 14 W. The middle of the south side of Sec. 31 lies 1588.9 M. N. 26° 00′ 28″ E.	665.48

Ashkum	I. C. R. R.	656
Bellmont	T., P. & W. R. R.	681
Buckley	I. C. R. R.	698
Chebanse	"	663

Cissna Park	C. & E. I. R. R.	674
Cissna Junction	"	695
Claytonville	"	668
Clifton	I. C. R. R.	657
Crescent City	T., P. & W. R. R.	645
Danforth	I. C. R. R.	647
Donovan	C., C., C. & St. L. R. R.	672
Del Rey	I. C. R. R.	665
Effner	T., P. & W. R. R.	683
Gilman	"	650
Goodwine	C. & E. I. R R.	674
Hickman	"	673
Iroquois	C., C., C. & St. L. R. R.	673
Loda	I. C. R. R.	774
La Hogue	T., P. & W. R. R.	668
Martinton	C. & E. I. R. R.	629
Milford	"	666
Wellington	"	700
Onarga	I. C. R. R.	676
Papineau	C. & E. I. R. R.	635
Pittwood	"	645
Ridgeville	I. C. R. R.	671
St. Mary	C., C., C. & St. L. R. R.	667
Sheldon	"	688
Spring Creek	T., P. & W. R. R.	630
State Line	C., C., C. & St. L. R. R.	694
Sugar Creek	T., P. & W. R. R.	625
Thawville	I. C. R. R.	692
Watseka	T., P. & W. R. R.	638
Woodland	C. & E. I. R. R.	639
L'Erable	R. M. Hood	640
Plato	"	635
Schwer	"	655
Stockland	"	700
Woodworth	"	675
Sec. 36, T. 29 N., R. 13 W.	"	660
" 36, T. 29 N., R. 10 E.	"	655
" 26, T. 28 N., R. 10 E.	"	640
" 23, T. 29 N., R. 11 W.	"	650
" 25, T. 28 N., R. 11 W.	"	720
" 27, T. 26 N., R. 11 W.	"	710
" 24, T. 25 N., R. 11 W.	"	720
" 23, T. 24 N., R. 11 W.	"	710

JACKSON COUNTY.

Bench-marks.

B. M. T.

Carbondale. On stone sill under east window of brick store owned by Jacob Beard........ 414.7

B. M. U.

Big Muddy Creek. West end of south abutment of I. C. R. R. bridge........ 384.8

B. M. V.

Drury Creek. S. E. capstone of south abutment of I. C. R. R. bridge No. 87.... 430.5

B. M. 1.

Grand Tower. Stone post, N. E. corner office lot St. Louis Ore & Steel Co........ 363

B. M. 2.

Grand Tower. Foundation stone, depot G. T. & C. R. R........ 363

Ava	M. & O. R. R.	610
Bethel	St. L., A. & T. H. R. R.	400
Bosky Dell	I. C. R. R.	410
Bryden	M. & O. R. R.	412
Campbell's Hill	"	555
Carbondale	I. C. R. R	412
Dean's Mill	M. & O. R. R.	605
DeSoto	I. C. R. R.	402
Elkville	"	404
Fountain Bluff	G. T. & C. R. R.	393
Glenah	St. L., A. & T. H. R. R.	405
Grand Tower	G. T. & C. R. R.	371
Grange Hall	St. L., A. & T. H. R. R.	403
Great Side No. 4	M. & O. R. R.	416
Harrison	St. L., A. & T. H. R. R.	419
Makanda	I. C. R. R.	433
Mount Carbon	G. T. & C. R. R.	372
Mt. Pleasant	G. T. & C. R. R.	425
Muddy Valley	I. C. R. R.	375
Murphysboro	M. & O. R. R.	421
Bridge over Big Muddy	"	376
Oraville	"	400
Perry's	St. L., A. & T. H. R. R.	394
Pomona	M. & O. R. R.	410
Sand Ridge	G. T. & C. R. R.	387

Sato	M. & O. R. R.	475
Sugar Creek	"	399
Vergennes	St. L., A. & T. H. R. R.	399
Degognia	C. B. Klingelhoefer	695
Finney	"	400
Glenn	"	390
Muddy Valley	"	375
Raddleville	"	365
Wagner's Landing	"	350

JASPER COUNTY.

Geodetic Stations.

Sec. 1, T. 5 N., R. 10 E. The S. W. corner of this section lies 966 M. S. 1° 29″ W.	520.88
Sec. 21, T. 5 N., R. 10 R. The N. E. corner of this section lies 727 M. N. 67° 29″ E.	485.98
Sec. 23, T. 5 N., R. 10 E. The N. E. corner of this section lies 712 M. N. 66° 18″ E.	477.98
Sec. 19, T. 5 N., R. 11 E. The N. W. corner of this section lies 105.4 M. N. 77° 12″ N.	485.98
Sec. 7, T. 7 N., R. 14 W. The N. W. corner of this section lies 747 M. N. 67° 05′.	550.58

Advance	C. & O. R. R. R	575
Boos	P., D. & E. R. R	510
Falmouth	"	531
Fort List	I. & I. S. R. R	547
Hidalgo	P., D. & E. R. R	570
Hunt City	C. & O. R. R. R	525
Newton	P., D. & E. R. R	484
Rose Hill	"	551
St. Marie	C. & O. R. R. R	478
Water Tank, at Embarras River	I. & I. S. R. R	464
West Liberty	C. & O. R. R. R	485
Wheeler	I. & I. S. R, R	579
Willow Hill	C. & O. R. R. R	492
Yale	"	553
Bogota	J. G. Mosier	533
Gila	"	580

Latona	J. G. Mosier	440
Palmersburg	"	530
Rafetown	"	435
Silverton	"	525
Sec. 28, T. 8 N., R. 8 W.	"	665

JEFFERSON COUNTY.

Belle Rive	L. & N. R. R.	470
Bluford	L., E. & St. L. R. R.	530
Boyd	J. S. E. R. R.	519
Dix	L., E. & St. L. R. R.	546
Drivers	J. S. E. R. R.	443
Idlewood	L., E. & St. L. R. R.	551
Mannen	W., C. & W. R. R.	474
Marlow	L., E. & St. L. R. R.	522
Mt. Vernon	L. & N. R. R.	506
Opdyke	"	509
Roache's	"	498
Webb's	J. S. E. R. R.	518
Wood Lawn	L. & N. R. R.	496
Little Muddy River	W., C. & W. R. R.	446
Top of Divide between Big and Little Muddy, Sec. 11, T. 4 S., R. 1 E.	"	538
W. Branch Big Muddy	"	431
E. Branch Big Muddy	"	434
Bumpus	E. C. Eidmann	520
Divide	"	545
Dryden	"	490
Elk Prairie	"	460
Fitzgerald	"	470
Hook	"	505
Laur	"	530
Moore's Prairie	"	500
Pigeon	"	545
Range	"	555
Reform	"	540
Rosewood	"	485
Rupe	"	555
Spring Garden	"	435
Sec. 18. T. 3 S., R. 1 E.	"	600
" 35, T. 1 S., R. 1 E.	"	548
" 8, T. 1 S., R. 1 E.	"	595
" 11, T. 1 S., R. 4 E.	"	565

JERSEY COUNTY.

Bench-marks.

U. S. P. B. M. 3.
Top surface of door step of Catholic church, Grafton, Ill 435.76

U. S. P. B. M. 4.
Doorstep of eastern door of Allein's brick building, adjoining Grafton Flouring Mills 445

U. S. P. B. M. 5.
Natural rock, side of bluff above high water mark, 450 M. below flouring mill at Jersey Landing, and four miles below Grafton 443.1

U. S. P. B. M. 6.
Natural flat rock, near surface of ground; also near high water mark. 5600 M. from flouring mill at Jersey Landing, and 9 M. west of small ravine opposite Eagle's Nest 421.84

Low water, mouth of Illinois River 400

Cross	St. L., A. & S. R. R.	595
Delhi	C. & A. R. R.	641
Elsah	St. L. & S. R. R.	418
Fidelity	"	632
Grafton	"	432
Haynes	"	461
Jerseyville	"	662
Kemper	C., B. & Q. R. R.	541
Lock Haven	St. L., A. & S. R. R.	420
McClusky	"	661
Newbern	"	689
Newbern Brickyard	"	669

East Newbern	J. C. Turner	670
Fieldon	"	605
Otterville	"	600
Rosedale	"	470
Spankey	"	420
Sec. 33, T. 8 N., R. 10 W.	"	650
" 36, T. 7 N., R. 10 W.	"	830
" 15, T. 8 N., R. 12 W.	"	620

JO DAVIESS COUNTY.

High water of 1880, East Dubuque		607.27
Zero of Dunleith bridge gauge		584.6
Aiken	C., B. & N. R. R.	610
Apple River	I. C. R. R.	981
Blanding	C., B. & N. R. R.	636
Council Hill	I. C. R. R.	721
Dunleith	"	611
East Dubuque	C., St. P. & K. Cy. R. R.	611
Elizabeth	"	791
Galena	C., B. & N. R. R.	605
Hanover	"	615
Menominee	I. C. R. R.	607
Millbrig	C. & N. W. R. R.	630
Nora	I. C. R. R.	1002
Portage Curve	C., B. & N. R. R.	611
Rodden	C., St. P. & K. Cy. R. R.	685
Scales Mound	I. C. R. R.	943
Stockton	C., St. P. & K. Cy. R. R.	1009
Trousdale	"	644
Tunnel Siding	"	767
Warren	I. C. R. R.	1005
Woodline	C., St. P. & K. Cy. R. R.	876
Avery	W. M. Hay	800
Council Hill	"	900
Derinda	"	1050
Derinda Center	"	850
Greenvale	"	960
Hanover P. O	"	620
Mossbach	"	1000
Pleasant Valley	"	675
Plum River	"	900
Rush	"	1025
Schapville	"	830
Willow	"	975
Winters	"	975
Woodbine P. O	"	850
Yankee Hollow	"	850
Sec. 33, T. 29 N., R. 1 W.	"	840
" 24, T. 29 N., R. 2 W.	"	910

" 36, T. 29 N., R. 3 E.	"	1060
" 16, T. 28 N., R. 4 E.	"	1000
" 10, T. 28 N., R. 3 E.	"	970
" 22, T. 28 N., R. 2 E.	"	1160
" 24, T. 29 N., R. 2 E.	"	(Highest point in the State.) 1257

JOHNSON COUNTY.

Belknap	C., C., C. & St. L. R. R.	363
Bloomfield	"	419
Collinsburg	"	379
Grantsburg	St. L., A. & T. H. R. R.	383
New Burnside	C., C., C. & St. L. R. R.	588
Ozark	St. L., A. & T. H. R. R.	698
Parker City	C., C., C. & St. L. R. R.	536
Reevesville	St. L., A. & T. H. R. R.	366
Sanburn	C., C., C. & St. L. R. R.	625
Simpson	"	412
Tunnel Hill	C., C., C. & St. L. R. R.	661
Vienna	"	389
Buncombe	J. C. Turner	575
Cypress Creek	"	475
Elvira	"	430
Ganntown	"	440
Goreville	"	700
Lincoln Green	"	440
Regent	"	775
Wartrace	"	510
Sec. 10, T. 11 S., R 3 E.	"	700

KANE COUNTY.

Bench-marks.

U. S. P. B. M. 83.

Hampshire. West face, S. W. corner, of Phillip Shultz's brick drug store.............. 898.71

U. S. P. B. M. 84.

Pingree Grove. 100 M. N. E. of depot, in north face of foundation of store owned by J. B. Schedden, 5 ft. from N. W. corner, 1 ft. from ground.............................. 916.38

U. S. P. B. M. 85.
Dumser. In coping stone, east end, north abutment of culvert No. 19, ¾ mi. west of station... 848.91

U. S. P. B. M. 86.
West Elgin. In north face of Waverly House, corner State and Highland Ave., in water table 6 in. from N. E. corner, 4 ft. above ground.................................... 714.9

U. S. P. B. M. 87.
West Elgin. In east end of stone doorstep in north face of Robert Beckwith's brick and stone building on River St...... 714.3

U. S. P. B. M. 88.
In west end of south abutment of C., M. & St. P. R. R. bridge over Fox River. 719.96

U. S. P. B. M. "Newcome."
East Elgin. Center St., in west face of brick foundation of Elgin Scientific Building.. 744.06

Almora	C., M. & St. P. R. R.	835
Aurora	C., B. & Q. R. R.	648
Big Rock	C. & I. R. R.	710
Briar Hill	C., M. & St. P. R. R.	974
Burlington	I. C. R. R.	919
Carpentersville	C. & N. W. R. R.	731
Clintonville	"	740
Coleman	I. C. R. R.	751
Dundee	C. & N. W. R. R.	727
East Plato	I. C. R. R.	864
Elburn	C. & N. W. R. R.	853
Elgin	C., M. & St. P. R. R.	713
Freeman	C. & N. W. R. R.	909
Geneva	"	720
Gilbert's	"	907
Hampshire	C., M. & St. P. R. R.	891
La Fox	C. & N. W. R. R.	807
Lily Lake	C., St. P. & K. Cy. R. R.	925
Maple Park	C. & N. W. R. R.	870
Montgomery	C., B. & Q. R. R.	644
Pingree	C., M. & St. P. R. R.	914
Plato Center	I. C. R. R.	920
Richardson	C., St. P. & K. Cy. R. R.	890
St. Charles	"	734
South Aurora	C., B. & Q. R. R.	644
Sugar Grove	C. & I. R. R.	724

Wasco	C., St. P. & K. Cy. R. R.	832
West Batavia	C., B. & Q. R. R.	718
Youngsdale	I. C. R. R.	808
Bald Mound	T. Barclay	747
Blackberry	"	749
East Burlington	"	896
Grouse	"	730
Kaneville	"	742
North Plato	"	910
Sunset	"	900
Udina	"	820

KANKAKEE COUNTY.

Geodetic Stations.

Sec. 19, T. 32 N., R. 11 W. The N. E. corner of Sec. 20 lies 1,853 M. N. 73,° 17′ E.	715.28
Sec. 22, T. 32 N., R. 12 E. On Chestnut St., between South and First sts., near the R. R. track	690.28
St. Anne. Near the center of the village. The S. W. corner of Sec. 4 lies 961.9 M. S. 82,° 32′ W	675.78
Kankakee. Upper step, west entrance High School building	641.18

Aroma	C., C., C. & St. L. R. R.	616
Bonfield	K. & S. R. R	632
Buckingham	I. C. R. R.	649
Butts	I., I. & I. R. R.	657
Carrow	"	647
Castleton	"	627
Clarke City	I. C. R. R.	585
Dickey	"	647
Eldridge	I., I. & I. R. R.	623
Essex	K. & S. R. R	583
Exline	I., I. & I. R. R.	630
Goodrich	"	634
Grant	C. & E. I. R. R.	693
Greenwich	K. & S. R. R.	646
Gronso	Wabash R. R.	586
Herscher	I. C. R. R.	654
Hopkins	C. & E. I. R. R.	676

Irwin	I. C. R. R	658
Kankakee	"	620
Manteno	"	687
Momence	C. & E. I. R. R	625
Mosiers	K. & S. R. R	593
Otto	I. C. R. R	624
Palmer	C. & E. I. R. R	634
Reddick	I., I. & I. R. R	607
Sacramento	I. C. R. R	618
St. Anne	C. & E. I. R. R	660
Sollitt	"	714
Tracy	I. C. R. R	576
Tucker	"	693
Union Hill	I., I. & I. R. R	616
Summit of Gravel Pit Hill	C., C., C. & St. L. R. R	686
Bourbonnais Grove	M. A. Earl	625
Deselm	"	645
Rockville	"	625
St. George	"	655
Salina	"	635
Sherburnville	"	670

KENDALL COUNTY.

Bristol	C., B. & Q. R. R	648
Fox	"	663
Millbrook	"	621
Millington	"	665
North Oswego	"	658
Oswego	"	615
Plano	"	649
Yorkville	C., B. & Q. R. R	584
Kendall	L. S. Ross	640
Lisbon	"	640
Little Rock	"	710
Newark	"	640
Pavilion	"	730
Plattville	"	600
Sec. 13, T. 37 N., R. 8 E.	"	760
" 24, T. 36 N., R. 8 E.	"	650
" 14, T. 35 N., R. 8 E.	"	660
" 13, T. 35 N., R. 7 E.	"	630
" 5, T. 35 N., R. 7 E.	"	670
" 21, T. 35 N., R. 6 E.	"	740

KNOX COUNTY.

Abington	C., B. & Q. R. R.	747
Altona	"	755
Appleton	C., St. F. & C. R. R.	604
Dahinda	"	595
De Long	F. Co. N. G. R. R.	689
Galesburg	C., St. F. & C. R. R.	755
Gilson	C., B. & Q. R. R.	682
Henderson	"	824
Hermon	Ia. C. R R.	651
Knox	C., St. F. & C. R. R.	672
Knoxville	C., B. & Q. R. R.	769
Livingston	F. Co. N. G. R. R.	770
Maquon	C., B. & Q. R. R.	621
Oneida	"	810
Rio	"	771
St. Augustine	"	741
Saluda	"	764
Wataga	"	829
Williamsfield	C., St. F. & C. R. R.	708
Yates City	C., B. & Q. R. R.	665
Ontario	M. A. Earl	790
Truro	"	700
Victoria	"	835
Sec. 16, T. 13 N., R. 2 E.	"	730
" 15, T. 13 N., R. 4 E.	"	854
" 16, T. 12 N., R. 4 E.	"	834
" 4, T. 12 N., R. 3 E.	"	816
" 34, T. 12 N., R. 3 E.	"	833
" 9, T. 10 N., R. 4 E.	"	733

LAKE COUNTY.

Bench-marks.

N. W. quarter of the N. W. quarter of sec. 7, Benton township	793.88
S. E. quarter of sec. 27, Antioch township	860.38
S. E. quarter of sec. 24, Warren township. The S. E. corner of this quarter-section lies 94.04 M. slightly west of south.	728.66

Antioch	Wis. C. R. R.	763
Aptakisic	"	682
Benton	C. & N. W. R. R.	595
Deerfield	C., M. & St. P. R. R.	681
Diamond Lake	E., J. & E. R. R.	765
Fort Sheridan	C. & N. W. R. R.	690
Grade Siding	"	655
Gray's Lake	Wis. C. R. R.	783
Gurnee	C., M. & St. P. R. R.	676
Highland Park	C. & N. W. R. R.	692
Lake Bluff	"	683
Lake Forest	"	704
Lake Villa	Wis. C. R. R.	792
Lake Zurich	E., J. & E. R. R.	880
Lancaster	C., M. & St. P. R. R.	680
Leithton	E., J. & E. R. R.	721
Libertyville	C., M. & St. P. R. R.	670
Prairie View	Wis. C. R. R.	694
Ravinia	C. & N. W. R. R.	695
Rockefeller	Wis. C. R. R.	753
Rollins	"	815
Rondout	E., J. & E. R. R.	675
Russell	C., M. & St. P. R. R.	673
Spring Bluff	C. & N. W. R. R.	595
State Line	Wis. C. R. R.	802
Wadsworth	C., M. & St. P. R. R.	670
Warrenton	"	707
Waukegan	E., J. & E. R. R.	594
Buffalo Grove	T. Barclay	690
Fort Hill	"	840
Fox Lake	"	775
Fremont Center	"	815
Gilmer	"	820
Grass Lake	"	760
Hainesville	"	805
Half Day	"	660
Hickory	"	725
Ivanhoe	"	793
Long Grove	"	705
Millburn	"	723
Nippersink	"	760
Rosecrans	"	720
Volo	"	890
Wauconda	"	810

LASALLE COUNTY.

Low water, Illinois River, LaSalle		441
Baker	C., B. & Q. R. R.	674
Blake's	"	605
Brickton	C., R. I. & P. R. R.	480
Coal Track	I. C. R. R.	633
Dana	C., St. F. & C. R. R.	670
Dayton	C., B. & Q. R. R.	543
Deer Park	"	490
Dimmick	I. C. R. R.	661
Earlville	C. & N. W. R. R.	702
Garfield	C. & A. R. R.	670
Grand Ridge	C., B. & Q. R. R.	663
Hitt	"	602
Kangley	"	640
Kernan	C., St. F. & C. R. R.	668
LaSalle	C., R. I. & P. R. R.	467
Leland	C., B. & Q. R. R.	701
Leonore	"	620
Lostant	I. C. R. R.	693
Marseilles	C., R. I. & P. R. R.	493
Mendota	I. C. R. R.	747
Meriden	C., B. & Q. R. R.	731
Munster	C. & A. R. R.	635
Oglesby	I. C. R. R.	539
Ottawa	C., B. & Q. R. R.	484
Ottawa Springs	"	499
Peru	C., R. I. & P. R. R.	468
Ransom	C., St. F. & C. R. R.	703
Richards	C., B. & Q. R. R.	644
Rutland	I. C. R. R.	704
Seneca	C., R. I. & P. R. R.	519
Serena	C., B. & Q. R. R.	635
Sheridan	"	591
Sheridan Junction	"	641
Streator	"	622
Ticona	"	651
Tonica	I. C. R. R.	654
Triumph	C. & N. W. R. R.	698
Troy Grove	"	628
Twin Bluffs	C., R. I. & P. R. R.	490
Utica	"	482
Wedron	C., B. & Q. R. R.	529
Wilsman	"	625

Danway	W. A Dunnaway	685
Deer Park P. O	"	610
Farm Ridge	"	680
Freedom	"	652
Galloway	"	612
Northville	"	655
Norway	"	620
Otter	"	660
Prairie Center	"	685
Stavanger	"	675
Sunrise	"	705
Waltham	"	700
Vermilionville	"	620

LAWRENCE COUNTY.

Low water, Wabash River, O. & M. R. R.		399
Low water, mouth of Embarras River		395
Low water, north line of county		408
Low water, St. Francisville		391
Beman	O. & M. R. R.	418
Billett	C., C., C. & St. L. R. R.	440
Bird's	"	428
Bridgeport	O. & M. R. R.	448
Lawrenceville	C., C., C. & St. L. R. R.	454
Lawrence Junction	"	434
Pinkstaff	"	432
St. Francisville	"	460
Sumner	O. & M. R. R.	457
Allison	J. C. Turner	425
Chauncey	"	430
Island Pond	"	445
Pasturefield	"	420
Price	"	415
Ruark	"	450
Russellville	"	420
Westport	"	440
Sec. 32, T. 3 N., R. 12 W.		440

LEE COUNTY.

Amboy	C., B. & Q. R. R.	778
Ashton	C. & N. W. R. R.	832
Brooklyn	C., B. & Q. R. R.	963
Bureau Siding	I. C. R. R.	870
Carnahan	C., B. & Q. R. R.	1017
Compton	"	982
Dixon	C. & N. W. R. R.	745
Eldena	I. C. R. R.	830
Franklin Grove	C. & N. W. R. R.	826
Harmon	C., B. & Q. R.	701
I. C. R. R. Crossing	"	772
Nachusa	C. & N. W. R. R.	809
Nelson	"	676
North Dixon	I. C. R. R.	735
Pawpaw	C., B. & Q. R. R. R.	930
Radley	"	775
Shaw's	"	826
Steward	C. & I. R. R.	858
Stone	C., B. & Q. R. R.	679
Sublette	I. C. R. R.	935
Walton	C., B. & Q. R. R.	751
Early Dawn	W. M. Hay	785
Gap Grove	"	770
Lee Center	"	800
Prairieville	"	720
Sec. 8, T. 21 N., R. 11 E.	"	850
" 23, T. 21 N., R. 1 E.	"	850
" 22, T. 38 N., R. 2 E.	"	940
" 35, T. 19 N., R. 10 E.	"	900
" 15, T. 19 N., R. 9 E.	"	780
" 26, T. 19 N., R. 8 E.	"	740
" 4, T. 19 N., R. 8 E.	"	720

LIVINGSTON COUNTY.

Adams	I., I. & I. R. R.	678
Ancona	C., St. F. & C. R. R.	626
Blackstone	C. & A. R. R.	733
Budd	I., I. & I. R. R.	702
C. & A. Crossing	I., I. & I. R. R.	624
Campus	Wabash R. R.	647
Cayuga	C. & A. R. R.	683

Charlotte	I. C. R. R.	668
Chatsworth	"	735
Coalville Junction	C., St. F. & C. R. R.	615
Cornell	Wabash R. R.	639
Cullom	I. C. R. R.	686
Dwight	I., I. & I. R. R.	630
Emington	Wabash R. R.	696
Eylar	I. C. R. R.	691
Fairbury	T., P. & W. R. R.	692
Flanagan	I. C. R. R.	668
Forrest	T., P. & W. R. R.	689
Graymont	I. C. R. R.	650
Griswold	"	706
Healey	"	716
Kempton Junction	"	693
Lodemia	Wabash R. R.	664
Long Point	C., St. F. & C. R. R.	637
McDowell	Wabash R. R.	657
Manville	"	629
Missal	I., I. & I. R. R.	667
Nevada	C. & A. R. R.	667
Ocoya	"	699
Odell	"	711
Pontiac	I. C. R. R.	639
Reading	C., St. F. & C. R. R.	621
Risk	I. C. R. R.	744
Rook's Creek	"	649
Rosalthe	"	766
Rowe	Wabash R. R.	638
Rugby	I. C. R. R.	682
Saunemin	Wabash R. R.	684
Scovel	I. C. R. R.	692
Smithdale	C. & A. R. R.	623
Strawn	Wabash R. R.	770
Streator Junction	I. C. R. R.	641
Sunbury	I., I. & I. R. R.	662
Swygert	I. C. R. R.	729
Wilson	I., I. & I. R. R.	616
Wing	Wabash R. R.	650

Sec. 34, T. 30 N., R. 7 E.	W. A. Dunaway	678
" 22, T. 29 N., R. 7 E.	"	720
" 35, T. 30 N., R. 5 E.	"	730
" 9, T. 27 N., R. 3 E.	"	710
" 3, T. 27 N., R. 4 E.	"	673
" 27, T. 26 N., R. 6 E.	"	710
" 5, T. 25 N., R. 8 E.	"	831

LOGAN COUNTY.

Atlanta	T. H. & P. R. R	728
Beason	I. C. R. R	645
Bell	P., D. & E. R. R	615
Broadwell	C. & A. R. R	597
Burton View	I. C. R. R	568
Chestervale	P., D. & E. R. R	614
Chestnut	I. C. R. R	619
Cornland	"	595
Elkhart	C. & A. R. R	592
Emden	P., D. & E. R. R	598
Hartsburg	"	600
I. C. R. R. Crossing	"	638
Lake Fork	I. C. R. R	596
Latham	P., D. & E. R. R	611
Lawndale	C. & A. R. R	614
Lincoln	I. C. R. R	591
Mount Joy	T. H. & P. R. R	741
Mt. Pulaski	I. C. R. R	638
New Holland	"	547
Skelton	"	614
Middletown	H. J. Burt	575
Sec. 9, T. 21 N., R. 4 W.	"	675
" 7, T. 21 N., R. 2 W.	"	744
" 10, T. 20 N., R. 1 W.	"	650
" 27, T. 18 N., R. 3 W.	"	664
" 14, T. 19 N., R 4 W.	"	600

McDONOUGH COUNTY.

Adair	C., B. & Q. R. R	645
Bardolph	"	671
Blandinsville	T., P. & W. R. R	730
Bushnell	"	658
Colchester	C., B. & Q. R. R	694
Colmar	"	549
Epperson	"	648
Good Hope	T., P. & W. R. R	714
Macomb	C., B. & Q. R. R	700
New Philadelphia	T., P. & W. R. R	673
Prairie City	C., B. & Q. R. R	659

Sciota	T., P. & W. R. R.	754
Scottsburg	"	669
Tennessee	C., B. & Q. R. R.	686
Walnut Grove	C., B. & Q. R. R.	714
Doddsville	H. J. Burt	698
Fandon	"	668
Industry	"	645
Pennington Point	"	630
Sec. 14, T. 7 N., R. 4 W.	"	751
" 14, T. 7 N., R. 3 W.	"	750
" 11, T. 6 N., R. 3 W.	"	715
" 12, T. 3 N., R. 4 W.	"	726
" 18, T. 3 N., R. 4 W.	"	697
" 14, T. 4 N., R. 3 W.	"	659
" 16, T. 4 N., R. 1 W.	"	637

McHENRY COUNTY.

Alden	C. & N. W. R. R.	964
Algonquin	"	760
Cary	"	809
Chemung	"	877
Coyne	"	885
Crystal Lake	"	922
Hartland	"	924
Harvard	"	935
Hebron	"	931
Huntley	"	897
Lawrence	"	896
McHenry	"	770
Marengo	"	828
Richmond	"	815
Ridgefield	"	928
Ringwood	"	837
Terra Cotta	"	807
Union	"	845
Woodstock	"	916
Barreville	T. Barclay	795
Big Foot Prairie	"	950
Coral	"	875
English Prairie	"	810
Greenwood	"	820
Harmony	"	910
Johnsburg	"	790

Tryon's Grove	"	920
Solon Mills	"	795
Spring Grove	"	770
Stone's Corners	"	890
Sec. 2, T. 45 N., R. 6 E.	"	980
" 12, T. 44 N., R. 5 E.	"	950
" 31, T. 45 N., R. 5 E.	"	890
" 33, T. 43 N., R. 5 E.	"	860

McLEAN COUNTY.

Anchor	I. C. R. R.	772
Arrowsmith	L. E. & W. R. R.	877
Baker	C., C., C. & St. L. R. R.	844
Ballard	C. & A. R. R.	737
Barnes	I. C. R. R.	833
Belleflower	"	784
Bloomington	"	821
Brokaw	L. E. & W. R. R.	855
C. & A. Crossing	C., C., C. & St. L. R. R.	775
Carlock	L. E. & W. R. R.	773
Chenoa	T., P. & W. R. R.	723
Colfax	I. C. R. R.	742
Cooksville	"	763
Cropsey	"	802
C., C., C. & St. L. R. R. Crossing	"	852
Covell	C. & A. R. R.	718
Crumbaugh	I. C. R. R.	777
Danvers	C., C., C. & St. L. R. R.	808
Delana	I C. R. R.	784
Downs	C., C., C. & St. L. R. R.	794
Ellsworth	L. E. & W. R. R	863
Empire	C., C., C. & St. L. R. R.	753
Fletcher	I. C. R. R.	817
Funk's Grove	C. & A. R. R.	705
Gillum	C., C., C. & St. L. Q. R.	820
Gridley	T., P. & W. R. R.	756
Hendrix	I. C. R. R	778
Heyworth	I. C. R. R.	742
Holder	L. E. & W. R. R	834
Hudson	I. C. R. R.	766
Kumler	"	736
Laurette	"	754
Lexington	C. & A. R. R.	750

Leroy	C., C., C. & St. L. R. R.	778
McLean	C. & A. R. R.	733
Meadows	T., P. & W. R. R.	762
Meharry	I. C. R. R.	758
Merna	"	802
Normal	"	778
Osman	Wabash R. R.	747
Padua	L. E. & W. R. R.	846
Randolph	I. C. R. R.	773
Sabina	"	783
Saybrook	L. E. & W. R. R.	786
Shirley	C. & A. R. R.	779
Stanford	"	708
Summers	I. C. R. R.	743
Towanda	C. & A. R. R.	783
Twin Grove	C., C., C. & St. L. R. R.	812
Weedman	I. C. R. R.	722
Weston	T., P. & W. R. R.	708
Yuton	L. E. & W. R. R.	784
Selma	H. J. Burt	754
Sec. 36, T. 26 N., R. 2 E.	"	750
" 9, T. 25 N., R. 5 E.	"	786
" 33, T. 24 N., R. 6 E.	"	840
" 3, T. 21 N., R. 3 E.	"	820
" 19, T. 22 N., R. 1 W.	"	710

MACON COUNTY.

Argenta	I. C. R. R.	673
Bearsdale	P., D. & E. R. R.	684
Blue Mound	Wabash R. R.	601
Boody	"	684
Casner	I., D. & W. R. R.	718
Decatur	I. C. R. R.	666
Elwin	"	708
Emery	"	683
Forsyth	"	674
Harristown	Wabash R. R.	688
Hervey City	P., D. & E. R. R.	692
I. C. R. R. Junction	"	646
Knights	Wabash R. R.	660
Long Creek	I., D. & W. R. R.	677
Macon	I. C. R. R.	715
Maroa	"	715

Mt. Zion	P., D. & E. R. R	681
Niantic	Wabash R. R	599
Oakley	"	685
Oreana	I. C. R. R	684
Prairie Hall	T. H. & P. R. R	706
Sangamon Station	Wabash R. R	653
Suffren	P., D. & E. R. R	665
Turpin	"	670
Walker	I. C. R. R	647
Warrensburg	P., D. & E. R. R	699
Wyckle's	Wabash R. R	673
Allenboro	H. J. Burt	705
Sec. 15, T. 18 N., R. 1 E.	"	650
" 18, T. 17 N., R 4 E.	"	700
" 10, T. 14 N., R. 3 E.	"	725

MACOUPIN COUNTY.

Anderson	C. & A. R. R	665
Atwater	J. S. E. R. R	652
Brighton	C. & A. R. R	661
Bunker Hill	C., C., C. & St. L. R. R	656
Carlinville	J. S. E. R. R	626
Challacombe	St. L., A. & S. R. R	529
Chesterfield	"	594
Clyde	C., C., C. & St. L. R. R	688
Comer	J. S. E. R. R	619
Dorchester	C., C., C. & St. L. R. R	664
Enos	J, S. E. R. R	616
Gillespie	C., C., C. & St. L. R. R	679
Girard	C. & A. R. R	692
Hagaman	St. L., A. & S. R. R	514
Hettick	"	609
Macoupin	C. & A. R. R	528
McVey	J. S. E. R. R	611
Medora	C., B. & Q. R. R	621
Miles	"	667
Modesto	St. L., A. & S. R. R	695.
Mt. Olive	Wabash R. R	686
Nilwood	C. & A. R. R	686
Palmyra.	St L., A. & S. R. R	691
Piasa	C., B. & Q. R. R	619
Plainview	C. & A. R. R	619
Reeders	J. S. E. R. R	586

Shipman	C. & A. R. R.	630
Staunton	Wabash R. R.	621
Virden	C. & A. R. R.	692
Womac	J. S. E. R. R	651
Barr's Store	J. C. Turner	615
Scottville	"	675
Stirrup Grove	"	665
Woodburn	"	655
Sec. 15, T. 9 N., R. 7 W.	"	690

MADISON COUNTY.

Bench-marks.

U. S. P. B. M. 7.

Natural rock on hillside, in woods, 19 M. above high-water mark, and 3,150 M. below mouth of Piasa Creek 450.07

U. S. P. B. M. 8.

Alton. Window of waters-works building 427.74

U. S. P. B. M. 9.

Alton. Door-step in northwest corner of German Catholic Church 485.25

U. S. P. B. M 10.

Top of stone post in woods, 5 mi. below Alton, and 500 M. from river bank, on land of Gringering, and 300 M. east of his house 424.87

U. S. P. B. M. 11.

Stone post in woods, 11 mi. below Alton, and 10 M. north of road 412.49

U. S. P. B. M. 12.

Stone post in grove, 20 M. west of Columbia road, 12.8 mi. above bridge at St. Louis, on Chambers's land, and about opposite lower end of Wilson's Island..... 456.91

Alhambra	T., St. L. & K. Cy. R. R...	571
Alton	C., C., C. & St. L. R. R	440
Alton Summit	C. & A. R. R.	550
Barcoville	J. S. E. R. R	410
Bethalto	C., C., C. & St. L. R. R...	535
Cantine	Vand. Line	485
Carpenter	Wabash R. R.	533
Clifton Terrace	St. L., A. & S. R. R.	430

Collinsville	Vand. Line	465
Comstock	C., C., C. & St. L. R. R.	420
Dorsey	"	604
Edwardsville	T., St. L. & K. Cy. R. R.	560
Formosa	Vand. Line	571
Fruit	T., St. L. & K. Cy. R. R.	542
Glen Carbon	J. S. E. R. R.	476
Godfrey	C. & A. R. R.	626
Highland	Vand. Line	537
Horse Shoe Lake	T., St. L. & K. Cy R. R.	410
Kaufman	"	554
Kinder	Wabash R. R.	423
Madison	J. S. E. R. R.	420
Manix	"	548
Mitchell	C., C., C. & St. L. R. R.	425
Moro	"	563
Nameoki	"	422
New Douglas	T., St. L. & K. Cy. R. R.	612
Newport	Wabash R. R.	412
Peters	T., St. L. & K. Cy. R. R.	456
Poag	Wabash R. R.	433
St. Jacob's	Vand. Line	505
Silver Creek	"	493
Stallings	T., St. L. & K. Cy. R. R.	429
Troy	Vand Line	539
Upper Alton	C., B. & Q. R. R.	448
Venice	C., C., C. & St. L. R. R.	418
Wann	"	448
Wood's	C., B. & Q. R. R.	480
Worden	Wabash R. R.	570
Fosterburg	E. E. Ellison	575
Grant Fork	"	542
Hamel	"	550
Liberty Prairie	"	540
Marine	"	556
Prairie Town	"	567
St. Morgan	"	500
Sebastopol	"	490
Troy P. O.	"	540

MARION COUNTY.

Bench-marks.

Sandoval. West abutment of O. & M. R. R. bridge 2½ mi. west of depot	491
Odin. Capstone east end of O. & M. R. R. culvert near station	526
Odin. S. E. corner of Craig's brick store	527.2
Salem. S. E. corner of Court House	545.8
Iuka. West abutment of O. & M R. R. bridge over Skillet Fork, 2½ mi. east of Iuka	472
Centralia. On stone sill of south window of J. J. Plaff's drug store	493
Centralia. On north abutment of bridge over Crooked Creek, 2 mi. north of Centralia	469.5

Alma	I. C. R. R.	626
Bannister	O. & M. R. R.	526
Central City	I. C. R. R.	493
Centralia	"	493
Fairman	"	515
Greendale	O. & M. R. R.	517
Iuka	"	515
Kinmundy	I. C. R. R.	607
Odin	"	531
Patoka	"	501
Salem	O. & M. R. R.	534
Sandoval	I. C. R. R.	507
Tonti	"	575
Vernon	"	518
Walnut Hill	L., E. & St. L. R. R.	553

Exchange	E. C. Eidmann	480
Foxville	"	530
Hickory Hill	"	475
Lester	"	515
Miletus	"	545
Omega	"	563
Raccoon	"	533
Sedan	"	575
Sec. 31, T. 4 N., R. 2 E.	"	555
" 12, T. 4 N., R. 4 E.	"	650
" 2, T. 1 N., R. 4 E.	"	530

MARSHALL COUNTY.

Caton	C., St. F. & C. R. R.	718
Evans	C. & A. R. R.	702
Henry	I. C. R. R.	485
Lacon	C. & A. R. R.	490
LaRose	C., St. F. & C. R. R.	642
Sparland	I. C. R. R.	450
Toluca	C., St. F. & C. R. R.	701
Varna	C. & A. R. R.	716
Wenona	C. & A. R. R.	691
Wilburn	C., St. F. & C. R.	518
Belle Plain	W. W. Danley	660
Camp Grove	"	825
La Prairie Center	"	790
Lawn Ridge	"	830
Sec. 9, T. 13 N., R. 8 E.	"	820
" 15, T. 13 N., R. 9 E.	"	620
" 8, T. 30 N., R. 1 W.	"	682
" 36, T. 29 N., R. 1 E.	"	720

MASON COUNTY.

Low water, Illinois River, Havana		430
Bath	J. S. E. R. R.	455
Biggs	I. C. R. R.	491
Bishop	J. S. E. R. R.	490
Conover	"	505
Easton	I. C. R. R.	505
Forest City	J. S. E. R. R.	486
Havana	I. C. R. R.	460
Kelsey	J. S. E. R. R.	494
Kilbourne	"	508
Manito	"	503
Matanzas	"	465
Mason City	C. & A. R. R.	575
Matrona	"	578
Poplar City	I. C. R. R.	497
Quiver	J. S. E. R. R.	480
San Jose	C. & A. R. R.	601
Saidora	J. S. E. R. R.	462

Teheran	I. C. R. R.	541
Topeka	J. S. E. R.	480
Union	"	495
Snicarte	E. Jerrey	450
Sec. 7, T. 22 N., R. 7 W.	"	548
" 23, T. 23 N., R. 7 W.	"	530
" 36, T. 22 N., R. 6 W.	"	570
" 6, T. 21 N., R 6 W.	"	553
" 23, T. 20 N., R. 7 W.	"	601

MASSAC COUNTY.

High water, Ohio River, Brooklyn		341.48
High water, Ohio River, Metropolis		339
Low water, Ohio River, Metropolis		285
Low water, Ohio River, west line of county		280
Big Bay	St. L., A. & T. H. R. R.	369
Brooklyn	"	344
Metropolis	"	346
Round Knob	"	374
Boaz	C. B. Klingelhoefer	410
Grinnell	"	350
Hillerman	"	420
Joppa	"	340
Massac Creek P. O.	"	460
New Columbia	"	566
Samoth	"	485
Unionville	"	392
Sec. 4, T. 15 S., R. 5 E.	"	500

MENARD COUNTY.

Athens	J S. E. R. R.	641
Atterbury	"	622
Curtis	C. & A. R. R.	602
Greenview	"	559
Hill Top	J. S. E. R. R.	623
Oakford	"	509
Petersburg	"	517
Tallula	C. & A. R. R.	629
Tice	J. S. E. R. R.	644

Fancy Prairie	E. Jerrey	630
Loyd	"	605
Sweetwater	"	620
Sec. 11, T. 19 N., R. 7 W.	"	580
" 11, T. 19 N., R. 5 W.	"	590
" 35, T. 19 N., R. 5 W.	"	641
" 15, T. 18 N., R. 8 W.	"	640

MERCER COUNTY.

Bench-marks.

U. S. P. B. M. 19. Stone step on south side of brick building on northwest corner of Main and Second streets, Keithsburg	538.87
U. S. P. B. M. 20. Step of Mr. Rife's brick building on N. W. corner of Main and Fifth streets, south side of building	548.84
U. S. P. B. M. 21. On foundation of water tank, 2 mi. east of New Boston, west face	553.59
U. S. P. B. M. 22. In top stone of foundation of north wall, near N. E. corner of Keokuk Northern Line Packet Co.'s Warehouse at New Boston	543.59
U. S. P. B. M. 23. New Boston. Union Hotel, in north wall, near N. E. corner 1.1 M. from ground.	569.87

Aledo	C., B. & Q. R. R	738
Cable	R. I. & P. R. R	688
Gilchrist	C., B. & Q. R. R	744
Joy	"	664
Keithsburg	"	541
Keithsburg Junction	"	561
New Boston	"	567
New Windsor	"	804
North Henderson	"	776
Ogle	Ia. C. R. R.	579
Pre-emption	R. I. & P. R. R.	849
Seaton	Ia. C. R. R	615
Viola	C., B. & Q. R. R	794

Devona	M. A. Earl	615
Eliza	"	670
Hamlet	"	830
Mannon	"	555
Marston	"	750
Millersburg	"	710
Norwood	"	680
Petersville	"	655
Pomeroy	"	680
Suez	"	730
Sunbeam	"	670
Swedona	"	752

MONROE COUNTY.

Burksville	M. & O. R. R.	672
Columbia	"	503
Millstadt Junction	"	444
New Hanover	"	601
Poe	"	576
Waterloo	"	654
Ames	C. B. Klingelhoefer	500
Burksville P. O.	"	695
Chatfin Bridge	"	400
Foster Pond	"	610
Harrisonville	"	400
Hecker	"	475
Ivy Landing	"	380
Madonnaville	"	675
Mayestown	"	600
Merrimac Point	"	385
Mitchie	"	380
Monroe City	"	600
New Hanover P. O.	"	570
Renault	"	675
Sec. 29, T. 4 S., R. 9 W.	"	708
" 1, T. 4 S., R. 9 W.	"	500
" 28, T. 3 S., R. 8 W.	"	440
" 35, T. 2 S., R. 9 W.	"	610

MONTGOMERY COUNTY.

Barnett	J. S. E. R. R.	672
Butler	C., C., C. & St. L. R. R.	649
Chapman	T., St. L. & K. Cy. R. R.	640
Coffeen	"	636
Donnellson	"	623
Farmersville	J. S. E. R. R.	657
Fillmore	T., St. L. & K. Cy. R. R.	630
Harvel	Wabash R. R.	646
Hillsboro	C., C., C. & St. L. R. R.	598
Honey Bend	Wabash R. R.	656
Irving	C., C., C. & St. L. R. R.	667
Litchfield	"	681
Lynn	J. S. E. R. R.	675
McWilliams	"	595
Nokomis	C., C., C. & St. L. R. R.	679
Ohlman	"	638
Pocock	"	675
Raymond	Wabash R. R.	651
Shop Creek	J. S. E. R. R.	663
Thomasville	"	687
Waggoner	"	668
Walshville	"	605
Witt	C., C., C. & St. L. R. R.	672
Zanesville	J. S. E. R. R.	672
Hurricane	E. C. Eidmann	605
White Oak	"	620
Sec. 14, T. 10 N., R. 4 W.	"	716
" 15, T. 10 N., R. 3 W.	"	705
" 35, T. 10 N., R. 3 W.	"	680
" 2, T. 7 N., R. 3 W.	"	639
" 34, T. 8 N., R. 2 W.	"	742
" 32, T. 10 N., R. 1 W.	"	640

MORGAN COUNTY.

Alexander	Wabash R. R.	657
Arnold	"	640
Chapin	"	625
Concord	C., B. & Q. R. R.	599
Franklin	J. S. E. R. R.	696
Jacksonville	Wabash R. R.	602

Literberry	J. S. E. R. R	616
Markham	Wabash R. R	590
Meredosia	"	444
Morgan	"	649
Murrayville	C. & A. R. R	688
Neelyville	"	554
Orleans	Wabash R. R	654
Pisgah	J. S. E. R. R	687
Prentice	C. & A. R. R	630
Rohrer	St. L., A. & R. R	702
Sinclair	C. & A. R. R. R	616
Waverly	J. S. E. R. R	691
Woodson	C. & A. R. R	686
Arcadia	E. Jerrey	608
Bethel	"	645
Jordansville	"	610
Lynnville	"	600
Sec. 19, T. 13 N., R. 3 W.	"	734
" 17, T. 13 N., R. 9 W.	"	710
" 15, T. 14 N., R. 8 W.	"	740
" 7, T. 15 N., R. 8 W.	"	650
" 33, T. 14 N., R. 11 W.	"	610
" 14, T. 16 N., R. 12 W.	"	662

MOULTRIE COUNTY.

Allenville	P., D. & E. R. R	649
Arthur	T. H. & P. R. R	666
Bethany	P., D. & E. R. R	652
Bruce	Wabash R. R	641
Cadwell	C. & E. I. R. R	674
Chipps	"	664
Coles	P., D. & E. R. R	650
Cushman	Wabash R. R	650
Dalton City	P., D. & E. R. R	650
Fairbanks	T. H. & P. R. R	686
Gay's	C., C., C. & St. L. R. R	752
Hampton	P., D. & E. R. R	652
Lake City	T. H. & P. R. R	697
Lovington	Wabash R. R	684
Sullivan	"	687
Ulrich	T. H. & P. R. R	677
Williamsburg	"	697

OGLE COUNTY.

Bench-marks.

U. S. P. B. M. 71.	
Forreston Junction. In lower step of west wing of south abutment of viaduct under I. C. R. R., fourth course of stone from bottom	876 05
U. S. P. B. M. 72.	
Adeline. In S. E. corner of east face of stone foundation of C., M. & St. P. R. R. elevator	749.69
U. S. P. B. M. 73.	
Leaf River. In east end of south face of stone foundation of D. Sprecker's elevator, 70 M. east of depot	707.35
U. S. P. B. M. 74.	
Byron. 560 M. south of track on Walnut St., in northeast corner of north wall of J. F. Spaulding's hardware store, 11 in. from corner, 4 ft. above ground	728.06
U. S. P. B. M. 75.	
1¼ mi. east of Byron. In south side of west abutment of R. R. bridge over Rock River	692 25
U. S. P. B. M. 76.	
Stillman Valley. 50 M. east of depot, 20 M. south of track, in west front of foundation of White's elevator, 11 in. from N. W. corner	705.38
U. S. P. B. M. 77.	
2600 M. west of Davis's Junction. In coping stone of north end of west abutment of small bridge of C., M. & St. P. R. R	807.42
U. S. P. B. M. 78.	
Monroe. 24 M. west of depot in south face of stone foundation of elevator, 1½ ft. north of S. E. corner, 3½ ft. above ground.	841.74

Adeline	C., M. & St. P. R. R	748
Baileyville	I. C. R. R	890
Byron	C., M. & St. P. R. R	727
Chana	C. & I. R. R	800
Creston	C. & N. W. R. R	914

Davis Junction	C., M. & St. P. R. R.	789
Egan City	C., St. P. & K. Cy. R. R.	810
Flagg	C. & N. W. R. R.	796
Forreston	I. C. R. R	927
Haldane	"	906
Harper	C., M. & St. P. R. R.	937
Hazelhurst	C., B. & N. R. R	880
Holcomb	C., St. P. & K. Cy. R. R.	837
Honey Creek	C. & I. R. R.	705
Kings	"	870
Kyte	"	843
Leaf River	C., M. & St. P. R. R	705
Lindenwood	C., St. P. & K. Cy. R. R	779
Maryland	C. & I. R. R.	880
Monroe	C., M. & St. P. R. R.	840
Mt. Morris	C. & I. R. R.	910
Myrtle	C., St. P. & K Cy. R. R	775
Oregon	C., B. & N. R. R.	703
Polo	"	841
Rochelle	C. & N. W. R. R.	815
Stillman Valley	C., M. & St. P. R. R.	706
Stratford	C., B. & N. R. R	820
Tucker Siding	C., M. & St. P. R. R	837
Woosung	I. C. R. R.	827

Brookville	W. M. Hay	790
Eagle Point	"	780
Fountain Dale	"	810
Grand Detour	"	690
Light House	"	825
Paine's Point	"	920
Pine Creek	"	795
Taylor	"	805
White Rock	"	830
Sec. 16, T. 24 N., R. 10 E.	"	900
" 18, T. 24 N., R. 11 E.	"	900
" 27, T. 41 N., R. 2 E.	"	820
" 10, T. 25 N., R. 11 E.	"	830

PEORIA COUNTY.

Bridge over Kickapoo River		470
Alta	R. I. & P. R. R.	763
Bartlett	Ia. C. R. R.	461
Brimfield	C., B. & Q. R. R.	721

Chase	C., St. F. & C. R. R.	730
Chillicothe	"	515
Colliers	T. P. & W. R. R.	485
Cramer's	Ia. C. R. R.	752
Dunlap	R. I. & P. R. R.	727
Edelstein	C., St. F. & C. R. R.	778
Eden	Ia. C. R. R.	727
Edwards	C., B. & Q. R. R.	508
Elmwood	"	619
Glasford	T., P. & W. R. R.	618
Hall's Creek	Ia. C. R. R.	647
Hanna	"	714
Hollis	T., P. & W. R. R.	454
Keller	R. I. & P. R. R.	817
Kramm	C., B. & Q. R. R.	540
Laura	C., St. F. & C. R. R.	730
Mapleton	T., P. & W. R. R.	471
Maxwell	Ia. C. R. R.	660
Monica	C., St. F. & C. R. R.	772
Mossville	C., R. I. & P. R. R.	485
Oak Hill	C., B. & Q. R. R.	557
Orchard Mines	T., P. & W. R. R.	457
Peoria	"	465
Pottstown	C., B. & Q. R. R.	476
Princeville	C., St. F. & C. R. R.	743
Rome	C., R. I. & P. R. R.	485
Sholl's	T., P. & W. R. R.	468
Trivoli	Ia. C. R. R.	731
Wolcott	T., P. & W. R. R.	471
Akron	T. J. Burt	775
Elmore	"	672
French Grove	"	680
Jubilee	"	719
Hallock	"	700
Harker's Corners	"	640
Kickapoo	"	650
Northampton	"	525
Orange Prairie	"	720
Smithville	"	730
West Hallock	"	760

PERRY COUNTY.

Bench-mark.

"R." DuQuoin. On corner of door-sill of main door of DuQuoin Bank, opposite I. C. R. R. depot...... 461.3

Barwell	W., C. & W. R. R.	447
Conant	"	483
Cowen	"	526
Craig's	St. L., A. & T. H. R. R.	569
Cutler	W., C. & W. R. R	510
Dawes	"	485
Denny	St. L., A. & T. H. R. R.	435
DuQuoin	I. C. R. R	455
Galum	W., C. & W. R R	460
Pinckneyville	St. L., & T. H. R. R	444
Pyatt	"	402
St. John's	I. C. R. R	463
Swanwick	St. L., A. & T. H R. R.	574
Tamaroa	I. C. R. R	505
Denmark	C. B. Klingelhoefer	435
Sunfield	"	455
Sec. 1, T. 4 S., R. 3 W.	"	516
" 22, T. 6 S., R. 2 W.	"	450
" 10, T. 4 S., R. 2 W.	"	512
" 10, T. 5 S., R. 4 W.	"	495
" 19, T. 5 S., R. 1 W.	"	456

PIATT COUNTY.

Allerton	I. C. R. R	678
Bement	Wabash R. R	685
Blue Ridge	"	785
Burrowsville	I., D. & W. R. R	675
Cerro-Gordo	Wabash R. R	740
Cisco	I. C. R. R	682
Deland	"	705
Galesville	Wabash R. R	721
Hammond	"	675
Harris	C., C., C. & St. L. R. R	721
LaPlace	I., D. & W. R. R	706
Lintner	"	685

Lodge	Wabash R. R.	699
Mansfield	C., C ,C. & St. L. R. R.	727
Milmine	Wabash R. R.	708
Monticello	"	655
Pierson Station	I., D. & W. R. R.	680
Voorhies	Wabash R. R.	680
White Heath	"	697
Centerville	M. A. Earl	660
Sec. 15, T. 20 N., R. 5 E.	"	720
" 20, T. 19 N., R. 5 E.	"	717
" 22, T. 18 N., R. 6 E.	"	730
" 36, T. 17 N., R. 6 E.	"	700
" 18, T. 16 N., R. 5 E.	"	720
" 8, T. 17 N., R. 5 E.	"	785

PIKE COUNTY.

Bench-mark.

Hannibal, Mo. Bolt in face of natural rock at east entrance of tunnel. In rock facing east on south side of tunnel, 7 ft. south of entrance ... 488.59

Low water at Bedford ... 413

Arden	Wabash R. R.	790
Barry	"	666
Baylis	"	864
Brewster	C., B. & Q. R. R.	466
Griggsville	Wabash R. R.	681
Hadley	"	747
Hannibal Bridge	C., B. & Q. R. R.	481.7
Horton's	"	468
Hull	"	467
Kinderhook	"	464
Louisiana Bridge	"	466.5
Nebo	C. & A. R. R	484
New Canton	C., B. & Q. R. R.	468
New Salem	Wabash R. R.	774
Pearl	"	451
Pike	C., B. & Q. R. R.	455
Pittsfield	Wabash R. R.	760
Pleasant Hill	C. & A. R. R.	459
Rockport	C., B. & Q. R. R.	471
Seehorn	"	479

Shinn	C., B. & Q. R. R.	465
Straut	C. & A. R. R.	655
Valley City	Wabash R. R.	435
Bedford	L. S. Ross	470
Bee Creek	"	470
Chambersburg	"	510
Detroit	"	700
El Dara	"	730
Fish Hook	"	795
Florence	"	440
Martinsburg	"	665
Milton	"	695
Montezuma	"	450
New Hartford	"	735
Perry	"	610
Perry Springs	"	520
Summer Hill	"	710
Time	"	670

POPE COUNTY.

Allen Springs	C. B. Klingelhoefer	505
Colorado	"	675
Eddyville	"	660
Glendale	"	460
Golconda	"	340
Hamletsburg	"	340
Hartsville	"	540
Herod Springs	"	450
Lusk	"	555
New Liberty	"	340
Oak	"	600
Poco	"	440
Raum	"	575
Rock	"	655
Rose Bud	"	525
Tansill	"	475
Temple Hill	"	540
Sec. 15, T. 11 S., R. 5 E.	"	810
" 7, T. 11 S., R. 7 E.	" (Highest point Ozark Range.)	1046

PULASKI COUNTY.

Bench-marks.

"X." N. E. corner of north abutment of bridge No. 15, over Cache River, on I. C. R. R., 250 M. south of Ullin.................... 337

139. East end of middle pier of small bridge No. 12, on I. C. R. R., 523 M. south 17-mile post.. 335.5

"Y." In root of large birch tree, nearly opposite 12-mile post, and north of Stoddard House, Villa Ridge.......................... 380

"Y." In chimney of Stoddard House, Villa Ridge... 385.5

"XII." Near center of south abutment of bridge No. 8, on I. C. R. R., south of 14-mile post... 343

"II." Abutment of I. C. R. R. bridge over Cache Creek...................................... 327

"I." Stone post in yard of section house at Mound City Junction................ 322

America..........................	C., C., C. & St. L. R. R..	358
Grand Chain..................	" ..	424
Mound City...................	" .	329
Mound Junction...........	I. C. R. R.......................	322
Oaktown	C., C., C. & St. L. R. R..	356
Olmstead.......................	" ..	364
Pulaski...........................	I. C. R. R.......................	340
Ullin	"	339
Villa Ridge.....................	"	404
Wetaug...........................	"	355
Yates Landing..............	C. B. Klingelhoefer.........	330

PUTNAM COUNTY.

Putnam..........................	C., R. I. & P. R. R.........	540
Clear Creek.....................	W. W. Danley................	650
Cottage Hill..................	"	690
Florid..............................	"	680
Granville........................	"	670
Hennepin........................	"	450
Magnolia........................	"	645
Mt. Palatine..................	"	733
Ox Bow..........................	"	655

RANDOLPH COUNTY.

Bench-marks.

U. S. P. B. M. 38.

Chester. Bolt in water-table, N. E. corner of Schuchert's block........................... 379.04

U. S. P. B. M. 39.

1240 M. below Chester. Bolt in front face of Cole Bro.s' elevator, 1.3 M. east of S. E. corner..................................... 379.59

Low water Mississippi River, Chester.............. 340.04

Baldwin	M. & O. R. R.	469
Chester	W., C. & W. R. R.	403
Clore's	"	423
Coulterville	St. L., A. & T. H. R. R.	545
Eden Mine	M. & O. R. R.	497
Houston	"	445
Kampenville	W., C. & W. R. R.	534
Percy	"	478
Poland	"	422
Red Bud	M. & O. R. R.	452
Robinson's	C. & C. R. R.	525
Rosborough	M. & O. R. R.	441
Sparta	"	546
Steeleville	W., C. & W. R. R.	449
Tilden	St. L., A. & T. H. R. R.	527
Welga	W., C. & W. R. R.	421
Wheaton	M. & O. R. R.	430
Wilson's	C. & C. R. R.	520
Blair	C. B. Klingelhoefer	560
Bremen	"	515
Ellis Grove	"	548
Evansville	"	450
Kaskaskia	"	365
Leanderville	"	600
Menard	"	650
Modoc	"	395
Palestine	"	610
Prairie du Rocher	"	370
Preston	"	500
Pujol	"	358
Rockwood	"	350
Ruma	"	482
Shiloh Hill	"	565
Wine Hill	"	595

RICHLAND COUNTY.

Geodetic Stations.	
Sec. 2, T. 4 N., R. 9 E. The N. E. corner of this section lies 502. 7 M. N. 62° 25′ E.	567.88
Sec. 29, T. 4 N., R. 14 W. The N. W. corner of this section lies 847 M. N. 60° 03′ W.	605.58
Sec. 21, T. 5 N., R. 10 E. The N. E. corner of this section lies 727 M. N. 67° 19′ E.	495.38
Sec. 19, T. 5 N., R. 11 E. The N. W. corner of this section lies 1054 M. N. 77° 12′ W.	485.98
Sec. 23, T. 5 N., R. 10 E. The N. E. corner of this section lies 712 M. N. 66° 18′ E.	477.98
Sec. 6, T. 4 N., R. 11 E. The S. E. corner of the German Reformed Church lies 20.1 M. N., 53° 10′ W.	521.18
Sec. 21, T. 4 N., R. 9 E. The N. E. corner of this section lies 628.32 M. N. 58° 51′ 58″ E.	543.68
Sec. 30, T. 2 N., R. 11 E. The N. W. corner of this section lies 848.5 M. N. 55° 39′ 56″ W.	567.68
Olney. S. E. corner school yard U. C. and G. S.	481
Olney. North face Court House U. C. and G. S.	487.5

Calhoun	P., D. & E. R. R.	535
Claremont	O. & M. R. R.	507
Dundas	C. & O. R. R. R.	490
Hadley	O. & M. R. R.	480
Higgins	"	451
Hutson's	C. & O. R. R. R.	480
Noble	O. M. & R. R.	476
Olney	"	475
Parkersburg	P., D. & E. R. R.	487

Amity	J. C. Turner	445
Berryville	"	440
Bowyer	"	450
Gallagher	"	415
Passport	"	480
Stringtown	"	490
Wakefield	"	495
Wynoose	"	465

ROCK ISLAND COUNTY.

Bench-marks.

U. S. P. B. M. 40.
Lower end of Arsenal Island, East side of stone tower of U. S. Arsenal, N. E. corner, 4 ft. from ground 576.1

U. S. P. B. M. 41.
Rock Island. N. E. corner of foundation of Atlantic Brewery 579.72

U. S. P. B. M. 42.
South abutment of wagon bridge from Moline to head of Rock Island 567.61

U. S. P. B. M. 43.
Watertown. Near N. W. corner of basement of H. Smith's dwelling 574.12

U. S. P. B. M. 45.
Hampton. N. W. corner of foundation of Baker & Haward's brick store 568.96

U. S. P. B. M. 46.
Rapid City. N. W. corner of foundation of Gilchrist's brick store 575.5

U. S. P. B. M. 47.
On west end of north abutment of C., M. & St. P. R. R. bridge over Barber's Creek 578.86

U. S. P. B. M. 48.
Port Byron. On S. W. corner of foundation of N. Dorrence's brick store 580.05

U. S. P. B. M. 49.
Port Byron. In iron doorstep of A. H. Wandt's brick store 586.4

Low water, Miss. River at Rock Island 541.83
Bridge between Rock Island and Davenport 589

Barstow	C., B. & Q. R. R.	585
Carbon Cliff	R. I. & P. R. R	576
Coal Valley	"	634
Cordova	C., M. & St. P. R. R	596
Hampton	"	583
Hillsdale	C., B. & Q. R. R	580
Joslyn	"	583
Milan	R. I. & P. R. R	566
Moline	C., R. I. & P. R. R	572
Osborne	C., B. & Q. R. R	585
Port Byron	C., M. & St. P. R. R	578
Rapids City	"	589
Reynolds	R. I. & P. R. R	839
Rock Island	C., R. I. & P. R. R	569
Taylor Ridge	R. I. & P. R. R	796
Watertown	C., M. & St. P. R. R	571
Andalusia	J. A. Udden	640
Buffalo Prairie	"	740
Edgington	"	790
Illinois City	"	715
Loding	"	665
Rural	"	715

ST. CLAIR COUNTY.

Bench-marks.

Lebanon. Basement window on east face of school building	459.5
Caseyville. East abutment of O. & M. R. R. bridge, ¼ mi. east	451.98
E. St. Louis. East pier of St. Louis bridge	416

Alma	O. & M. R. R	549
Belleville	L. & N. R. R	535
Birkner	"	507
Cahokia	M. & O. R. R	424
Caseyville	O. & M. R. R	460
Centerville	St. L., A. & T. H. R. R.	425
Coal Shaft	M. & O. R. R	586
Darmstadt	"	679
Dyke	"	428
East Carondelet	"	421
East St. Louis	O. & M. R. R	426

Freeburg	St. L., A. & T. H. R. R.	520
French Village	L. & N. R. R	449
Furman's	O. & M. R. R	575
Gartside	L., E. & St. L. R. R	510
Grassland	"	435
Griswold Place	Vand. Line	429
Hanover	O. & M. R. R	424
Imbs	St. L., A. & T. H. R. R.	470
Lake	L., E. & St. L. R. R	441
Lebanon	O. & M. R. R	441
Lementon	St. L., A. & T. H. R. R.	461
Lenzburg	"	449
Marissa	St. L., A. & T. H. R. R.	455
Mascoutah	L. & N. R. R	433
Millstadt	M. & O. R. R	626
New Athens	St. L , A. & T. H. R. R.	410
O'Fallon	O. & M. R. R	546
Ogles	St. L., A. & T. H. R. R.	600
Pittsburg	L., E. & St. L. R. R	450
Raib's	St. L.. A. & T. H. R. R.	540
Rankin	L. & N. R. R	425
Rentchler's	"	475
Schureman	L., E. & St. L. R. R	545
Sellinger	St. L., A. & T. H. R. R	508
Shiloh Station	L., E. & St. L. R. R	454
South Junction	M. & O. R. R	423
Stookey	St. L., A. & T. H. R. R	510
Summerfield	O. & M. R. R	480
Summerson	St. L., A. & T. H. R. R	490
Summit	L. & N. R. R	540
Tillman	St. L., A. & T. H. R. R	430
Vulcan	M. & O. R. R	420
Ward's	L., E. & St. L. R. R	545
White Oak	St. L., A. & T. H. R. R	472
Wilderman	"	520
Yoch	L., E. & St. L. R. R	550
Fayetteville	E. C. Eidmann	390
Floraville	"	500
Lebanon City	"	475
Paderborn	"	490
Risdon	"	430
Shiloh	"	660
Smithton	"	480
St. Libory	"	430

SALINE COUNTY.

Brooklyn	L. & N. R. R.	402
Carrier's Mills	C., C., C. & St. L. R. R.	410
Eldorado	L. & N. R. R.	384
Galatia	St. L. & T. H R. R.	402
Harrisburg	C., C., C. & St. L. R. R.	371
Ledford	"	417
New Castle	"	442
Raleigh	St. L., A. & T. H. R.R.	407
Rileyville	"	400
Stone Fort	C., C., C. & St. L. R. R.	439
Texas City	"	378
West End	St. L., A. & T. H. R. R.	426
Hartford	E. C. Eidmann	415
Long Branch	"	480
Mitchellsville	"	400
Somerset	"	465
South America	"	510
Sec. 9, T. 9 S., R. 7 E.	"	455
" 3, T. 10 S., R. 7 E.	"	864
" 21, T. 10 S., R. 7 E.	"	860
" 31, T. 10 S., R. 7 E.	"	859

SANGAMON COUNTY.

Auburn	C. & A. R. R.	662
Barclay	I. C. R. R.	564
Bates	Wabash R. R.	637
Beechley	Pawnee R. R.	641
Berry's	O. & M. R. R.	585
Bond	"	594
Bradford	"	602
Breck Station	"	584
Buffalo	Wabash R. R	603
Buffalo Hart	I. C. R. R.	622
Cantrall	J. S. E. R. R.	615
Chatham	C. & A. R. R.	640
Coal Shaft	O. & M. R. R.	537
Cora	J. S. E. R. R.	603
Cotton Hill	"	578

Curran	Wabash R. R.	620
Dawson	"	594
Divernon	J. S. E. R. R.	608
Dyson	Pawnee R. R.	628
Farmingdale	O. & M. R. R	588
Gatton	J. S. E. R. R.	584
German Prairie	I. C. R. R.	576
Glenarm	J. S. E. R. R.	606
Illiopolis	Wabash R. R.	600
Island Grove	"	655
Lanesville	"	589
Loami	St. L., A. & S. R. R.	624
Lowder	J. S. E. R. R.	712
Maxwell	St. L., A. & T. H. R. R.	634
New Berlin	Wabash R. R.	649
Pawnee	Pawnee R. R.	604
Pleasant Plains	O. & M. R. R.	610
Prospect	J. S. E. R. R.	708
Richland	O. & M. R. R.	612
Ridgely	J. S. E. R. R.	597
Riverton	Wabash R. R.	543
Rochester	O. & M. R. R	570
Sangamon	"	562
Sanger	Wabash R. R.	604
Sherman	C. & A. R. R.	581
Spaulding	I. C. R. R.	540
Springfield	O. & M. R. R.	596
Starne	I. C. R. R.	586
Tansey	O. & M. R. R.	586
Trutter	J. S. E. R. R.	580
Williamsville	C. & A. R. R.	604
Woodside	"	625

Berlin	E. Jerrey	648
Cascade	"	550
Cross Plains	"	545
Mechanicsburg	"	570
New City	"	612
Pasfield	"	580
Salisbury	"	580
Zenobia	"	625

SCHUYLER COUNTY.

Bader's	C., B. & Q. R. R.	580
Browning	"	447
Frederick	"	447
Ray	"	508
Rushville	"	677
Ashville	E. Jerrey	490
Birmingham	"	500
Bluff City	"	470
Brooklyn	"	610
Camden	"	670
Center	"	505
Erwin	"	560
Huntsville	"	688
Littleton	"	640
Pleasant View	"	665
Wayland	"	680

SCOTT COUNTY.

Alsey	C., B. & Q. R. R.	621
Bluffs	Wabash R. R.	454
Illinois River Bridge	"	441
Manchester	C. & A. R. R.	696
Merritt	C., B. & Q. R. R.	592
Naples	Wabash R. R.	435
Riggston	C., B. & Q. R. R.	589
Winchester	"	531
Exeter	E. Jerrey	440
Glasgow	"	550
Oxville	"	550
Sec. 15, T. 14 N., R. 13 W.	"	650
" 5, T. 13 N., R. 11 W.	"	580

SHELBY COUNTY.

Cowden	T., St. L. & K. Cy. R. R.	598
Duvall	C. & E. I. R. R.	678
Fancher	T., St. L. & K. Cy. R. R.	611
Findlay	C. & E. I. R. R.	677
Hanson	I. C. R. R.	646

Herborn	Wabash R. R.	634
Herrick	T., St. L. & K. Cy. R. R.	598
Kingman	"	631
Lakewood	O. & M. R. R.	622
Middlesworth	C., C., C. & St. L. R. R.	698
Mode	T., St. L. & K. Cy. R. R.	624
Moulton	C., C., C. & St. L. R. R.	611
Moweaqua	I. C. R. R.	624
Oconee	"	676
Shelbyville	C., C., C. & St. L. R. R.	603
Sigel	I. C. R. R.	634
Stewardson	T., St. L. & K. Cy. R. R.	644
Strasburg	Wabash R. R.	617
Tower Hill	O. & M. R. R.	653
Trowbridge	"	656
Windsor	C., C., C. & S. L. R. R.	708
Brunswick	R. M. Hood	640
Henton	"	635
Obed	"	715
Pleak's Corner	"	650
Prairie Home	"	695
Quigley	"	655
Sexson	"	650
Skates	"	602
Todd's Point	"	658
Yantisville	"	705
Sec. 33, T. 13 N., R. 2 E.	"	724
" 4, T. 11 N., R. 2 E.	"	765

STARK COUNTY.

Bradford	C., B. & Q. R. R.	798
Castleton	"	790
Duncan	"	661
La Fayette	R. I. & P. R. R.	795
Lombardville	C., B. & Q. R. R.	751
Stark	R. I. & P. R. R.	679
Toulon	"	756
Wady Petra	"	683
Wyoming	"	721
Elmira	W. W. Danley	812
Modena	"	689
Osceola	"	818
West Jersey	"	765

STEPHENSON COUNTY.

Bolton	C., St. P. & K. Cy. R. R.	828
Buena Vista	I. C. R. R.	779
Dakota	C., M. & St. P. R. R.	928
Davis	"	901
Eleroy	I. C. R. R.	901
Evarts	"	836
Florence	C., M. & St. P. R. R.	847
Freeport	"	758
German Valley	C., St. P. & K. Cy. R. R.	816
Kent	"	903
Lena	I. C. R. R.	957
McConnell	"	768
Orangeville	"	792
Red Oak	"	769
Ridott	C. & N. W. R. R.	754
Rock City	C., M. & St. P. R. R.	899
Sciota Mills	I. C. R. R.	760
South Freeport	C., St. P. & K. Cy. R. R.	859
Waddam's Grove	I. C. R. R.	1018
Winslow	"	770
Yellow Creek	C., St. P. & K. Cy. R. R.	832
Afolkey	W. M. Hay	990
Cedarville	"	880
Damascus	"	800
Fountain Creek	"	900
Loran	"	800
Oneco	"	860
Rock Grove	"	940
Valley Creek P. O	"	800

TAZEWELL COUNTY.

Allentown	T. H. & P. R. R	684
Armington	"	656
Bradley	"	680
Center	"	658
Cooper	C., St. F. & C. R. R.	818
Crandall	L., E. & W. R. R.	747
Deer Creek	L., E. & W. R. R.	757
Delavan	C. & A. R. R.	607
East Peoria	T., P. & W. R. R.	479
Farmdale	"	542

Fremont	C., C., C. & St. L. R. R.	662
Green Valley	P., D. & E. R. R.	538
Groveland	C., St. F. & C. R. R.	785
Hawley's	P., D. & E. R. R.	499
Haynesville	J. S. E. R. R.	481
Hopedale	C. & A. R. R.	668
Hope Mines	C., C., C. & St. L. R. R.	556
Leslie	"	723
Lilly	"	804
Mackinaw	"	647
Mackinaw Falls	P., D. & E. R. R.	490
Menert	C., C., C. & St. L. R. R.	596
Minier	C. & A. R. R.	660
Morton	T. H. & P. R. R.	712
Pekin	C., St. F. & C. R. R.	476
Sand Prairie	P., D. & E. R. R.	492
Stoehr's	J. S. E. R. R.	500
Tremont	C., C., C. & St. L. R. R.	652
Washington	T., P. & W. R. R.	745
Wesley City	P. & P. U. R.	478
Dillon	H. J. Burt	615

UNION COUNTY.

Bench-mark.

B. M. "W." On stone window-sill of S.W. front of drug store, owned by Mr. Otrich, at Anna 629

Aldridge	G. T. & C. R. R.	346
Alto Pass	M. & O. R. R.	752
Anna	I. C. R. R.	628
Balcom	"	470
Cobden	"	594
Costigan	M. & O. R. R.	439
Dongola	I. C. R. R.	395
Jonesboro	M. & O. R. R.	528
Kaolin	"	478
Mill Creek	"	380
Mountain Glen	"	455
Reynolds	G. T. & C. R. R.	337
Springville	M. & O. R. R.	403
Tunnel Hill	"	535
Vineland	G. T. & C. R. R.	338
Ware	"	340
Weaver Hill	"	497
Wolf Lake	"	347

Bald Knob (highest point in county.)	J. C. Turner	985
Moscow	"	440
Mount Pleasant	"	500
Oakville	"	725
Progress	"	775
Western Saratoga	"	560
Low water Miss. River, south line county	"	296
Low water Miss. River, north line county	"	318
Sec. 33, T. 11 S., R. 2 W.	"	680
" 8, T. 13 S., R. 1 E.	"	550
" 19, T. 12 S., R. 1 E.	"	600
" 29, T. 11 S., R. 1 E.	"	870
" 22, T. 11 S., R. 1 W.	"	775

VERMILION COUNTY.

Bench-marks.

Sec. 35, T. 23 N., R. 13 W. The S. E. corner of this section lies 433. 15 M. S. 25° 04′ 56″ E.	786.58
Sec. 16, T. 20 N., R. 13 W. The N. W. corner of this section lies 774.3 M. N. 82° 03′ 30″ W	778.78
Sec. 8, T. 18 N., R. 13 W. The S. E. corner of this section lies 278. 5 M. S., 86° 50′ E.	703.78

Allerton	C. & E. I. R. R.	701
Alvin	"	662
Archie	C. & O. R. R. R.	665
Armstrong	I. C. R. R.	708
Bismarck	C. & E. I. R. R.	667
Brewer	"	647
Catlin	Wabash R. R.	668
Cheneyville	L., E. & W. R. R.	722
Comfort	C. & E. I. R. R.	692
Danville	"	597
Danville Junction	"	611
Diamond Mines	C., C., C. & St. L. R. R.	640
East Lynn	L., E. & W. R. R.	693
Fairmount	Wabash R. R.	655
Fisher's	C. & E. I. R. R.	670
Fithian	C., C., C. & St. L. R. R.	663
Georgetown	"	672

Grape Creek	C. & E. I. R. R	538
Henning	I. C. R. R	695
Hillery	C., C., C. & St. L. R. R	631
Hoopeston	C. & E. I. R. R	716
Humrick	T., St. L. & K. Cy. R. R	645
Indianola	C. & E. I. R. R	674
Lockett's	"	688
Mission Mines	C., C., C. & St. L. R. R	635
Muncie	"	642
Oakwood	"	646
Potomac	I. C. R. R	682
Rankin	L., E. & W. R. R	716
Rayville	I. C. R. R	689
Ridge Farm	C., C., C. & St. L. R. R	685
Rossville	C. & E. I. R. R	702
Sandusky	"	721
Sidell	"	680
Thomas	I. C. R. R	707
Tilton	C., C., C. & St. L. R. R	649
Vermilion Grove	"	661
West Newell	C. & E. I. R. R	687
Westville	"	669
Bixby	I. J. Stoddard	730
Blount	"	675
Blue Grass	"	703
Charity	"	760
Glenburn	"	600
Henrietta	"	690
Higginsville	"	630
Hope	"	740
Mission Fields	"	607
Pilot	"	730
Snider	"	680
Vernal	"	670
Sec. 32, T. 23 N., R. 13 W.	"	770
" 32, T. 23 N., R. 12 W.	"	750
" 25, T. 23 N., R. 11 W.	"	670
" 33, T. 18 N., R. 13 W.	"	680
" 34, T. 18 N., R. 14 W.	"	690
" 13, T. 18 N., R. 11 W.	"	650

WABASH COUNTY.

Allendale	C., C., C. & St. L. R. R.	464
Bellmont	L., E. & St. L. R. R.	428
Cowling	C., C., C. & St. L. R. R.	396
Keensburg	"	439
Maud	L., E. & St. L. R. R.	439
Mt. Carmel	"	405
Patton	C., C., C. & St. L. R. R.	417
Friend's Grove	J. C. Turner	430
Friendsville	"	445
Gard's Point	"	435
Lancaster	"	485
Linn	"	440

WARREN COUNTY.

Alexis	C., B. & Q. R. R.	685
Berwick	Ia. C. R. R.	704
Cameron	C., B. & Q. R. R.	774
Eleanor	Ia. C. R. R.	683
Gerlaw	C., B. & Q. R. R.	727
Kirkwood	"	746
Larchland	"	732
Little York	Ia. C. R. R.	603
Monmouth	C., B. & Q. R. R.	774
Nemo	Ia. C. R. R.	774
Ormonde	C., St. F. & C. R. R.	775
Phelps	Ia. C. R. R.	775
Ponemah	C., St. F. & C. R. R.	726
Rena	Ia. C. R. R.	621
Roseville	C., B. & Q. R. R.	732
Smithshire	C., St. F. & C. R. R.	737
Surrey	"	760
Swan Creek	C., B. & Q. R. R.	763
Youngstown	"	746
Cold Brook	M. A. Earl	760
Ellison	"	709
Greenbush	"	725
Utah	"	732
Sec. 18, T. 12 N., R. 2 W.	"	708
" 11, T. 12 N., R. 1 W.	"	742

Sec. 12, T. 11 N., R. 2 W.M.	A. Earl	750
" 7, T. 11 N., R. 3 W.	"	700
" 20, T. 8 N., R. 3 W.	"	800
" 21, T. 8 N., R. 1 W.	"	736
" 22, T. 9 N., R. 1 W.	"	670
" 14, T. 10 N., R. 1 W.	"	753

WASHINGTON COUNTY.

Bench-marks.

B. M. "P." S. E. corner of capstone of culvert on S. E. side of I. C. R. R. track, 409 M. south of the 103 mi.-post 1 mi. north of Richview Station 542.7

B. M. "Q." S. E. corner of culvert 212, 230 M. north of Ashley 551.2

B. M. "S." N. E. corner of north abutment of bridge over Little Muddy Creek, 2 mi. south of Radom 498.4

Addieville	L. & N. R. R	475
Ashley	I. C. R. R	554
Beaucoup	L. & N. R. R	541
Dubois	I. C. R. R	523
Hoyleton	C. & C. R. R	560
Irvington	I. C. R. R	534
Nashville	L. & N. R. R	511
Oakdale	C. & C. R. R	495
Okawville	L. & N. R. R	458
Radom	I. C. R. R	530
Richview	"	541
Venedy	L. & N. R. R	420
Caspar's	E. C. Eidmann	500
Covington	"	450
Elkhorn	"	500
Johannisburg	"	460
Lively Grove	"	505
New Minden	"	430
Plum Hill	"	490
Skowville	"	430
Three Mile Prairie	"	485
Venedy P. O	"	502

WAYNE COUNTY

Arrington	L., E. & St. L. R. R.	431
Barn Hill	O. & M. R. R.	383
Boyleston	L., E. & St. L. R.	446
Cisne	O. & M. R. R.	458
Fairfield	"	452
Geff	"	457
Golden Gate	L., E. & St. L. R. R.	425
Hubbard's	O. & M. R. R.	410
Keene's	L., E. & St. L. R. R.	495
Merriam	"	427
Rinard	O. & M. R. R.	465
Wayne City	L., E. & St. L. R. R.	451
Clarkson	J. C. Turner	450
Elm Branch	"	490
Enterprise	"	435
Home	"	475
Johnsonville	"	470
Keenville	"	475
Long Prairie	"	475
Mayberry	"	425
Mount Erie	"	525
Orchardville	"	470
Pin Oak	"	440
Six Mile	"	445
Wabash	"	470
Zif	"	445
Sec. 28, T. 2 N., R. 5 E.	"	520
" 20, T. 2 N., R. 6 E.	"	510
" 23, T. 2 N., R. 9 E.	"	470
" 14, T. 1 N., R. 8 E.	"	440
" 12, T. 3 S., R. 8 E.	"	490
" 29, T. 2 S., R. 7 E.	"	460

WHITE COUNTY.

Brownsville	C., C., C. & St. L. R. R.	417
Calvin	"	462
Carmi	L. & N. R. R.	401
Crossville	C., C., C. & St. L. R. R.	379
Enfield	O. & M. R. R.	435
Gossett	C., C., C. & St. L. R. R.	460
Grayville	"	393

Hawthorne	L. & N. R. R	395
Maunie	"	370
Mill Shoals	O. & M. R. R	381
Norris City	"	424
Roland	"	386
Sacramento	"	409
Skillett Fork (bridge)	"	363
Springer	"	381
Stokes	C., C., C. & St. L. R. R	427
Trumbull	L. & N. R. R	460
White's	O. & M. R. R	379
Ball	I. J. Stoddard	378
Burnt Prairie	"	490
Emma	"	380
Fraser's	"	400
Herald	"	445
Iron	"	450
Phillipstown	"	460
Roland	"	440
School	"	525
Sumpter	"	375

WHITESIDE COUNTY.

Bench-marks.

U. S. P. B. M. 52.

Albany. Near S. W. corner of foundation of Harper & Son's brick store.......... 595

U. S. P. B. M. 53.

Albany. On base of a large shoulder of rock projecting from bluff, 1¼ mi. north of town.......... 597.71

U. S. P. B. M. 54.

Albany. West side of south abutment of C., M. & St. P. R. R. bridge, 2½ mi. north of town.......... 576.69

U. S. P. B. M 55.

Fulton. On south abutment of C., M. & St. P. R. R. bridge, 2 mi. south of town. 579.69

U. S. P. B. M. 56.

On north abutment of same bridge...... 580.97

U. S. P. B. M. 57.

Fulton. South face of foundation of Northern Illinois College, 3½ ft. above ground, 14 in. from southwest corner..... 596.4

U. S. P. B. M. 58. Southeast abutment of R. R. bridge, north of Fulton Junction, 970 M. north of junction with C. & N. W. R. R.	581.22
U. S. P. B. M. 59. 3 mi. north of Fulton Junction, in west end of north abutment of R. R. bridge...	588.32

Albany	C., M. & St. P. R. R.	585
Cedar	C., B. & Q. R. R.	730
Deer Grove	"	656
Denrock	"	611
East Clinton	"	596
Fenton	"	609
Fulton	"	594
Galt	C. & N. W. R. R.	660
Garden Plain	C., B. & Q. R. R.	707
Morrison	C. & N. W. R. R.	685
Prophetstown	C., B. & Q. R. R.	627
Rock Falls	"	672
Round Grove	C. & N. W. R. R.	703
Sterling	C., B. & Q. R. R.	667
Tampico	"	647
Union Grove	C. & N. W. R. R.	690
Coleta	W. M. Hay	798
Como	"	628
Erie	"	610
Leon	"	645
Malvern	"	735
New Genessee	"	785
Penrose	"	740
Spring Hill	"	630
Ustick	"	830
White Pigeon	"	700

WILL COUNTY.

Bench-marks.

Crete. Sec. 20, T. 34 N., R, 11 W.	791
Garden. Sec. 15, T. 34 N., R. 13 W.	800

Beecher	C. & E. I. R. R.	720
Bird's Bridge	C., R. I. & P. R. R.	545
Blodgett	C., St. F. & C. R. R.	523
Braidwood	C. & A. R. R.	588

Bridge Junction	E., J. & E. R. R.	573
Brisbane	"	686
Caton Farm	"	622
Cherry Hills	C., R. I. & P. R. R.	600
Coyne's	E., J. & E. R. R.	645
Crete	C. & E. I. R. R.	720
Custer Park	Wabash R. R.	554
Drummond	C., St. F. & C. R. R.	538
East Joliet	E., J. & E. R. R.	557
Elwood	C. & A. R. R.	635
Frankfort	E., J. & E. R. R.	759
Gauger's	C., R. I. & P. R. R.	610
Gillett's	"	660
Goodenow	I. C. R. R.	739
Hampton	C. & A. R. R.	630
Horse Creek	Wabash R. R.	552
Joliet	C., St. F. & C. R. R.	537
Lockport	"	569
Lorenzo	"	535
Manhattan	Wabash R. R.	665
Marley	"	649
Millsdale	C., St. F. & C. R. R.	524
Mokena	C., R. I. & P. R. R.	719
Monee	I. C. R. R.	804
New Lenox	C., R. I. & P. R. R.	629
Normantown	E., J. & E. R. R.	669
Patterson	C., St. F. & C. R. R.	515
Peotone	I. C. R. R.	717
Plainfield	E., J. & E. R. R.	609
Prison	C. & A. R. R.	539
Ritchie	Wabash R. R.	570
Romeo	C., St. F. & C. R. R.	589
Spencer	M. C. R. R.	711
Steele	Wabash R. R.	655
Summit	C., R. I. & P. R. R.	720
Symerton	Wabash R. R.	642
Walker	E., J. & E. R. R.	612
Wilmington	C. & A. R. R.	540
Wolf's	E., J. & E. R. R.	707
Channahon	T. Barclay	510
DuPage	"	640
Eagle Lake	"	695
East Wheatland	"	630
Endor	"	685
Gooding's Grove	"	730
Goeselville	"	685

Green Garden	T. Barclay	780
Mt. Forest	"	670
Wallingford	"	645
Wilton Center	"	642

WILLIAMSON COUNTY

Bainbridge	St. L., A. & T. H. R. R.	454
Caneyville	"	464
Carterville	"	474
Crainville	"	494
Creal Springs	"	533
Fredonia	"	442
Marion	"	458
New Dennison	"	
Attila	E. C. Eidmann	563
Blairsville	"	380
Chamness	"	480
Corinth	"	480
Cottage Home	"	460
Crab Orchard	"	499
Grant	"	520
Herrin's Prairie	"	445
Lake Creek	"	430
Mead	"	485
Pulley's Mill	"	560
Wolf Creek	"	650

WINNEBAGO COUNTY.

Alworth	I. C. R. R.	896
Argyle	C. & N. W. R. R.	878
Cherry Valley	"	746
Durand	C., M. & St. P. R. R.	773
Genet	"	730
Harlem	C. & N. W. R. R.	775
Jonesville	C., M. & St. P. R. R.	712
Latham	"	724
New Milford	"	714
Pecatonica	C. & N. W. R. R.	759
Perry's	St. L., A. & T. H. R. R.	759
Rockford	C. & N. W. R. R.	728

Rockton	C., M. & St. P. R. R.	744
Roscoe Crossing	"	742
Seward	I. C. R. R.	864
Shirland	C., M. & St. P. R. R.	732
Winnebago	C. & N. W. R. R.	868
Elida	W. M. Hay	870
Harrison	"	725
Kishwaukee	"	715
Wempleton	"	860
Sec. 28, T. 29 N., R. 10 E.	"	970
" 12, T. 46 N., R. 2 E.	"	975
" 3, T. 27 N., R. 10 E.	"	895
" 30, T. 27 N., R. 11 E.	"	860
" 7, T. 45 N., R. 1 E.	"	860
" 14, T. 44 N., R. 2 E.	"	890
" 27, T. 43 N., R. 2 E.	"	840

WOODFORD COUNTY.

Benson	C., St. F. & C. R. R.	764
Cazenovia	C. & A. R. R.	803
Congerville	L. E. & W. R. R.	742
Cruger	T., P. & W. R. R.	760
El Paso	"	750
Eureka	"	735
Goodfield	L. E. & W. R. R.	745
Kankakee Junction	I. C. R. R.	732
Kappa	"	729
Low Point	C. & A. R. R.	750
Mackinaw Dells	L. E. & W. R. R.	667
Metamora	C. & A. R. R.	820
Minonk	I. C. R. R.	749
Panola	"	732
Roanoke	C., St. F. & C. R. R.	720
Secor	T., P. & W. R. R.	744
Streator Junction	C., St. F. & C. R. R.	738
Washburn	C. & A. R. R.	700
Woodford	I. C. R. R.	729
Lourds	W. W. Danley	720
Spring Bay	"	470
Sec. 24, T. 28 N., R. 3 W.	"	700
" 27, T. 28 N., R. 1 W.	"	779
" 32, T. 26 N., R. 1 E.	"	750

RIVER SLOPES.

Big Muddy River.

Mouth	318
M. & O. R. R. Crossing	351
North of Benton	390
East of Mannen	430
West of Boyd	500

Big Vermilion River.

East line Vermilion county	480
Junction of Middle Fork	530
West of Higginsville	600
West line of County	650
East of Henderson	750

Crooked Creek.

Mouth	427
South line McDonough county	500
Mouth of Prairie Creek	550
West of La Crosse	600
South of Disco	650

Desplaines River.

Mouth	490
One mile southwest of Patterson's	500
Lockport	550
Lemont	580
West of Thatcher's Park	600
West of Gurnee	650

Edwards River.

Mouth	523
Near Pomeroy	550
Near Aledo	600
Near Andover	700

Embarras River.

Mouth	395
South line of Jasper county	410
Near Newton	460
North line of Jasper county	510
Opposite Greenup	530
North line of Cumberland county	575
South line of Douglas county	620
Near Villa Grove	635
Opposite Savoy	700

Fox River.

Mouth	453
Near Wedron	500
West line of Kendall county	550
Two miles North of Yorkville	600
Batavia	650
One mile north of Clintonville	700
Near McHenry	750

Green River.

Mouth	563
West line of Bureau county	600
Three and a half miles west of Walnut	650
Near Amboy	750

Illinois River.

Mouth	400
At Columbiana	404
At Bedford	415
At Beardstown	427
At Havana	429
At Peoria	436
At Henry	441
At Ottawa	453
At Marseilles	460
At Seneca	465
At Morris	480
Junction of Kankakee and Desplaines rivers	490

Iroquois River.

Mouth	595
Near Milford	645

Kankakee River.

Mouth	490
Near southeast corner of Will county	550
Waldron	600
East line Kankakee county	620

Kaskaskia River.

Mouth	342
M. & O. R. R. Crossing	375
Near Carlyle	417
North of Shobonier	450
North line of Fayette county	490
O. & M. R. R. Crossing	500
Near Shelbyville	525
South line of Moultrie county	560
East line of Moultrie county	615
North line of Douglas county	650

Kishwaukee River.

Mouth	685
North branch:	
West line of Boone county	720
One and a half miles west of Belvidere	750
North of Marengo	800
Two and a half miles south of Alden	900
South branch:	
Southeast corner of Winnebago county	725
Near Kirkland	750
Near Genoa	800
Two miles southeast of DeKalb	850

Little Wabash River.

Mouth	323
East line of Wayne county	368
West line of Wayne county	396
East of Russell	450
North line of Clay county	478

Mackinaw River.

Mouth	436
West of Stoehr's	460
Three miles east of Mackinaw Falls	500
Mouth of Prairie Creek	550
Near Mackinaw Dells	620
Near Money Creek P. O	700
North of Colfax	750

Macoupin Creek.

Mouth	404
Near Riverdale	450
West line of Macoupin county	500
East of Plainview	550

Mississippi River.

Low water levels:

Cairo	268
North line of Union county	318
Chester	340
St. Louis	380
Grafton	400
Louisiana, Mo	437
East Hannibal	450
Quincy	458
Hamilton	477
Niota	502
Burlington, Ia	511
New Boston	523
Rock Island	542
East Clinton	566
Savanna	572
East Dubuque	585

Ohio River.

Cairo	268
Yates Landing	280
Metropolis City	285
Golconda	293
Elizabethtown	299
Shawneetown	307
Mouth of Wabash	311

Pecatonica River.

Mouth	715
West line of Winnebago county	735
North line of Stephenson county	764

Rock River.

Mouth	541
West line of Whiteside county	575
At Lyndon	600
At Dixon	650
At Rockford	700
North line of Winnebago county	728

Saline River.

Mouth	304
North of Leamington	350
East of Newcastle	400
East of Caneyville	450

Sangamon River.

Mouth	430
Northwest corner of Menard county	445
South line of Menard county	512
Southeast corner of Sangamon county	550
East line of Macon county	600
East line of Piatt county	665

Shoal Creek.

Mouth	381
North line of Clinton county	445
East of Old Ripley	490
Near Hillsboro	550
North line of Montgomery county	650

Spoon River.

Mouth	429
Duncan's Mills	450
Near Babylon	500
South of Maquon	550
West line of Peoria county	600
Two and a half miles south of Wyoming	650
One mile west of Modena	700

Vermilion River.

Mouth	441
Two miles south of mouth	500
North of Kangley	550
East of Reading	600
East line of Livingston county	650

Wabash River.

Mouth	311
Mouth of Little Wabash	323
Grayville	365
Mt. Carmel	376
St. Francisville	391
Opposite Vincennes	397
Opposite Palestine	419
North line of Crawford county	426

ARTICLE V.—*A Preliminary Account of two New Oligochæta from Illinois.* BY FRANK SMITH.

Several species of Oligochæta were collected by the writer during the past summer at the Biological Station upon the Illinois River, at Havana, founded early in the present year by the University of Illinois, with Prof. S. A. Forbes as Director. Since it will be several months before a full report on the Oligochæta can be prepared, it seems best to publish this preliminary account of the larger forms collected.

In the vicinity of the Station, the Illinois River flows for the greater part of its course between low banks, which are overflowed during the higher stages of water that usually occur in the spring or early summer months. They are covered with the usual bottom-land forests and other vegetation of the region. In those portions of the banks that are above water during the greater part of the year, were found many earthworms of a species closely allied to *Diplocardia communis* Garman, which was described from Illinois in 1888* and is abundant in the soil of the prairies of the State. Reproductive activity was greatest throughout the month of May, when cocoons were abundant in their burrows.

Diplocardia riparia nov. sp.

This earthworm is quite similar to *D. communis* in general form, in relative length of somites in different parts of the body, and in the plication and encircling lines of the somites. The number of somites is similar, the average of ten specimens being 150, the minimum and maximum numbers respectively 136 and 157.

The ordinary length of well-extended specimens is 22 to 25 cm., with a diameter of about .3 cm.

*"On the Anatomy and Histology of a New Earthworm (*Diplocardia communis*, gen. et sp. nov.)." (Bull. Ill. State Lab. Nat. Hist., Vol. III., Art. IV., p. 47.)

The color is somewhat darker than that of *D. communis*, which is flesh-colored. The difference is very pronounced on the dorsal surface of the region anterior to the clitellum, where the surface becomes dark brown, this color being usually retained in alcoholic specimens. Posterior to the clitellum the brown dorsal vessel and its lateral branches are very conspicuous through the body wall of the living animal.

The clitellum is of a dull copper-color, and extends over somites XIII to XVIII, inclusive. As in *D. communis*, it is absent or but slightly developed upon a narrow median ventral area of those somites. The setæ have the same arrangement and distribution as in *D. communis*. The first dorsal pore is near the groove between X and XI. The number and position of the gizzards, in somites V and VI, the character of the typhlosole, and other main features of the alimentary tract, are the same in the two species. The nephridiopores are in the vicinity of the outermost setæ.

The generative systems of the two species are alike in main characters, but present specific differences. Two pairs of ciliated rosettes are present in each of the species, occupying the usual position in somites X and XI.

An anomalous position for the testes was ascribed by Garman to *D. communis*. After having sectioned specimens of that species, I find that some of the reproductive organs were misinterpreted by him. Two pairs of digitate testes are present in each of the species. These have the usual position, being attached to the anterior septum of each of somites X and XI.

In number and position of sperm-sacs the two species agree. There is a pair of pre-septal lobulated sperm-sacs in somite IX, and a pair of post-septal lobulated sperm-sacs in somite XII. The latter, in *D. communis*, were described by Garman as testes.

Somites X and XI are filled with developing spermatozoa during the reproductive season, though no definite sacs have been observed. The situation of the sperm-duct in *D. riparia* is like that in *D. communis*. The male pore is also upon somite XIX, in a longitudinal groove, but is near the anterior margin of that somite.

Two pairs of prostate glands are present in each species, having their external openings on somites XVIII and XX. The species also agree in having two ventral crescentic longitudinal grooves (their convexities inward), which extend from the middle of somite XVIII to the middle of somite XX, and have modified setæ and the external opening of a prostate gland at each of their extremities. In each species somite XIX is without ventral setæ.

On the ventral side of alcoholic specimens of *D. riparia*, an area extending from the middle of somite XVII to the anterior portion of somite XXI and bounded upon the sides by the two longitudinal grooves, is depressed to a depth of about one fifth the diameter of the worm. In alcoholic specimens of *D. communis* no such depression is noticeable.

Two pairs of spermathecæ are present in *D. riparia*, one pair in each of somites VIII and IX, with the external openings at the anterior margins of those somites and in line with the inner rows of setæ. *D. communis* has in addition one pair in somite VII. Although Garman makes the possession of three pairs of spermathecæ a character of the genus, I feel justified in including the new species in the same genus, especially as other genera of earthworms include species which differ in the number of spermathecæ.

The ovaries and female pores are in the usual position, the former in somite XIII, and the latter upon somite XIV.

The vascular system of *D. riparia* is much like that of *D. communis*, except that in no case has any trace been seen of the double dorsal vessel, which is so constant in the latter species. The presence of a double dorsal vessel is included by Garman among the generic characters of Diplocardia, but I think without sufficient reason, since in other instances species differing in this respect are assigned to one genus.

The new species, then, possesses all the characters of *D. communis* which are regarded by Garman as generic except two; viz., three pairs of spermathecæ and a double dorsal vessel. Not regarding these characters as of generic importance, for the reasons given above, I include the new species in the genus Diplocardia.

The more obvious external characters by which this species may be distinguished from *D. communis* are smaller size, darker color,—especially of the anterior portion,— the presence of but two pairs of spermathecal pores, and the single dorsal vessel, which in the living animal is plainly visible through the body wall.

For convenience of comparison the following table has been prepared:

	Diplocardia communis.	*Diplocardia riparia.*
Setæ	Four couples. All ventral.	Four couples. All ventral.
Prostomium	Partially dovetailed into peristomium.	Partially dovetailed into peristomium.
Male pore	XIX.	Anterior part of XIX.
Testes and funnels	X and XI.	X and XI.
Sperm-sacs	Sacculated in IX and XII. X and XI filled with spermatozoa without special sac.	Sacculated in IX and XII. X and XI filled with spermatozoa without special sac.
Prostates	Two pairs, with external openings in XVIII and XX.	Two pairs, with external openings in XVIII and XX.
Copulatory fossæ or longitudinal grooves.	One pair, extending from middle of XVIII to middle of XX, with copulatory setæ and prostate pore at the extremities of each groove.	One pair, extending from middle of XVIII to middle of XX, with copulatory setæ and prostate pore at the extremities of each groove.
Ovaries	One pair in XIII.	One pair in XIII.
Female pore	XIV.	XIV.
Gizzards	Two; in V and VI.	Two; in V and VI.
Typhlosole	Slight dorsal fold.	Slight dorsal fold.
Subneural vessel	Absent.	Absent.
Nephridia	Meganephric.	Meganephric.
Nephridiopore in line with	Fourth seta.	Fourth seta.
Clitellum	XIII–XVIII. Incomplete.	XIII–XVIII. Incomplete, or but slightly developed upon narrow median ventral area.

	Diplocardia communis.	*Diplocardia riparia.*
First dorsal pore......	Between X and XI.	Between X and XI.
Spermathecæ..........	Three pairs; in VII, VIII, IX.	Two pairs; in VIII and IX.
Dorsal vessel..........	Double.	Single.
Length, well extended.	30 cm.	22—25 cm.
Color anterior region.	Flesh-color.	Brown.
Color clitellum.........	Dull yellow or flesh-color.	Dull copper.

Geodrilus singularis Ude, described from Illinois in 1893,* has several characters in which it resembles Diplocardia, but the position of the prostates and of the male pore is different, and no mention of the longitudinal grooves is made nor is there any indication of them in the figures. Unfortunately Ude was unable to describe the generative organs fully because of the condition of his specimens.

Sparganophilus eiseni nov. sp.

The second species to be described is very abundant in the mud of the Illinois River and of the bottom-land lakes connected with it. Dredging shows it to be distributed over the entire bottom of these bodies of water, although somewhat more abundant near the margins. Specimens have been taken at all times at which collections were made, from April to December inclusive. Their cocoons were most abundant during the month of June, while the clitellum was well developed two weeks earlier.

These worms agree with *Sparganophilus tamesis* Benham† in all the characters given by him as generic, and in a number of others as well. The table at the end of this article will be sufficient reference to many of these resemblances, while others deserve more special mention.

**Beiträge zur Kenntnis ausländischer Regenwürmer.* (Zeit. f. Wiss. Zool., LVII. Bd., p. 69.)

†"A New English Genus of Aquatic Oligochæta (Sparganophilus) belonging to the Family Rhinodrilidæ." (Quart. Jour. Micr. Sci. Vol. XXXIV., p. 155; Plates XIX and XX.)

A few points of difference seem to sharply distinguish the two forms. The worms from Illinois are the larger, and have a length, when moderately extended, of 18 to 20 cm. I have alcoholic specimens fixed after being anæsthetized, which, without being unnaturally extended, are over 20 cm. in length, and average .26 cm. in diameter.

The arrangement of setæ in the two forms differs chiefly in the position of the outer couples, which are in the dorsal half in the new form, instead of in the ventral half as in *S. tamesis*.* Sections have a quadrangular outline, with a couple of setæ at each angle, the arrangement being similar to that in Criodrilus. The distance between the outer or dorsal couples is one and a fourth times that between the inner or ventral couples in the region posterior to the clitellum, and about one and a half times as great in the region anterior to the clitellum. The distance between the outer couple and the inner couple of the same side is slightly greater than that between the two inner couples. The setæ of a couple are quite closely approximated. As in *S. tamesis*, the outer setæ are missing in the region where the clitellum is fully developed. Specimens taken late in the season have setæ in this region.

The spermathecal pores are in line with the setæ of the outer couple, as in *S. tamesis*, but in consequence of the dorsal position of that couple in the new form, the pores are upon the dorsal half of the animal.

The form of the region of the clitellum during reproductive activity is different from that at other seasons and from that figured for *S. tamesis*. At that season the ventral part of the clitellar region, including the ventral setæ and the tubercula pubertatis, is slightly concave downward, and forms two very conspicuous ridges or actual folds where it meets the lateral walls. This concave appearance, though intensified by the action of alcohol in hardening, is not produced by it, but is present in the living worm.

*Benham, loc. cit., Pl. XIX., Fig. 8.

The male pores are situated opposite the anterior part of somite XIX and upon the ventral crests of the ridges, being immediately outside of the tubercula pubertatis, as in *S. tamesis*.

The last point of difference to be mentioned is the most remarkable and unexpected. *S. tamesis* belongs to Benham's family Rhinodrilidæ, in which, according to him, prostate glands are absent.* There is no mention of any such glands in his paper upon Sparganophilus, yet glands that I consider to be homologous with them are present in the form under consideration. These glands require a somewhat detailed description, since their number and position, and even their occurrence, is rather remarkable. Each gland is tubular and of two well-marked divisions; the true glandular part and the duct. The former is more or less convoluted in an irregular manner, and if straightened out would vary from .5 mm. to 1 mm. in length. Its diameter is fairly uniform, and usually about .13 to .15 mm. In a cross section of the gland the lumen is nearly circular and about .015 mm. in diameter. It is surrounded by an epithelial layer .006 to .01 mm. thick, and outside of this is the layer of glandular cells, which is about .05 to .06 mm. thick. Many of the cells of this layer are club-shaped, and extend from the epithelial layer to the exterior, while others extend only part way through the layer. This part of the gland is surrounded by a plexus of blood vessels from which many minute branches penetrate the gland. The duct has a nearly straight course through the body wall, being but little longer than the thickness of that wall, or about .32 mm., with a diameter of about .06 mm. The inner two thirds has a lumen much smaller than that of the gland and often nearly obliterated. It is surrounded by an epithelial layer as in the glandular region, but this is surrounded by a layer of circular muscular tissue about .02 mm. thick, which replaces the glandular layer of that region. The outer

*"An attempt to classify Earthworms." (Quart. Jour. Micr. Sci., Vol. XXXI., 1891, p. 221.)

third of the duct has a lumen somewhat flattened and .004 to .008 mm. in diameter, which is lined with a cuticular layer continuous with the cuticula of the body wall. Its epithelial layer is also continuous with the epithelium of the body wall, the cells becoming longer in the outer portion of the duct, and partaking of the characters of the columnar epithelium of that part of the body surface which is immediately adjacent to the prostate pores. The muscular layer diminishes in thickness and disappears in the outermost portion of the duct.

Usually four pairs of these glands are present in somites XXIII-XXVI, a pair in the posterior part of each of these somites opening just outside of the outer setæ of the ventral couple. The pore and the two setæ are nearly in line, and the distance between the pore and outer seta is about one half as great as that between the two setæ. In one example two glands were found in one side of a somite and none in the other, the opening of the second gland being between the setæ of the ventral couple, but much nearer the outer one. In another example but three pairs were present—in XXIII XXV.

If these are prostate glands,—and I can see no reason to think that they are not,—they are very far removed from the male pore, and are of an unusual number.

Benham has called attention to several features in the structure of *S. tamesis* as being quite remarkable. In these particulars the resemblance of the new form to that species is striking. (1) The sperm duct has the same superficial position and inconspicuous opening, the only difference being that it does not leave its position at the base of the clitellar layer to pass outward until it reaches the septum between XVIII and XIX, where, curving quite abruptly, it opens at the male pore upon the ridge already mentioned and opposite the anterior part of somite XIX. (2) In each species a pair of ovisacs occurs in somite XIV, in which were found ova showing karyokinesis. (3) Longitudinal tegumentary vessels passing forward from somite XIV are present in both, being readily seen through the body wall of living specimens of the Illinois species. The dorsal one is considerably larger than the other. (4) A perienteric sinus occurs in each species.

From the similarity of the characters just mentioned and of others referred to in the appended table, it is evident that the two forms are very closely allied. Were it not for the presence of the prostate glands in the one here described there could be no question about their belonging to the same genus, and, as it is, I do not feel justified in creating a new one, but prefer, for the present at least, to associate the new species with Benham's by naming it *Sparganophilus eiseni.*

The chief characters by which it may be distinguished from *S. tamesis* are, as already mentioned, its greater size, the dorsal position of the outer setæ and spermathecal pores, the latero-ventral ridges of the clitellar region during the reproductive period, and the presence of prostate glands in some or all of somites XXIII–XXVI.

Necessary figures and additional details will appear in the more complete report to be published later.

	Sparganophilus tamesis.	*Sparganophilus eiseni.*
Clitellum	Somites XVI—XXIV, with part of XV and XXV.	XVI—XXV with part of XV. Diminishing on XXIV and XXV.
Prostomium	Not marked off from the peristomium by a groove.	Not marked off from the peristomium.
Male pore	Inconspicuous. Between XVIII and XIX, without accessory organs.	Inconspicuous. Upon anterior part of XIX.
Sperm-sacs	Two pairs; in XI and XII.	Two pairs; in XI and XII.
Spermathecæ	Simple. Three pairs.	Simple. Three pairs.
Gizzard and œsophageal diverticula	Absent.	Absent.
Typhlosole	Absent.	Absent.
Vascular system	Perienteric blood sinus. Two long tegumentary vessels on each side traverse the anterior somites without communicating with the alimentary tract. No subneural vessel; the only commissural vessels situated anteriorly.	Perienteric blood sinus. Two long tegumentary vessels on each side traverse the anterior somites without communicating with the alimentary tract. No subneural vessel; the only commissural vessels situated anteriorly.

	Sparganophilus tamesis.	*Sparganophilus eiseni.*
Clitellum on ventral surface................	Continuous but thinner.	Continuous but thinner.
Lateral setæ............	Absent in fully developed clitellum.	Absent in fully developed clitellum.
Alimentary tract......	Abruptly widens in IX.	Abruptly widens in IX.
Nephridia..............	Large. First in XIII.	Large. First in XIII.
Nephridiopore.........	In front of seta 1.	In front of seta 1.
Testes and funnels....	Two pairs; in X and XI.	Two pairs; in X and XI.
Sperm-duct............	Subepidermic.	Subepidermic.
Ovaries and female pore.	In usual position.	In usual position.
Ovisacs with ova showing karyokinesis.....	XIV.	XIV.
Spermathecal pores...	In line with lateral setæ, which are ventral.	In line with lateral setæ, which are dorsal.
Dorsal vessel...........	Dilated in IX—XI.	Dilated in IX—XII.
Lateral hearts.........	In VII—XI; large and moniliform.	In VII–XI; large and moniliform. Course more tortuous than figured for *S. tamesis.*
Tegumentary vessels..	In XIV and backward, one pair from each of dorsal and ventral vessels.	In XIV and backward, one pair from each of dorsal and ventral vessels.
Cocoons.................	Sausage-shaped, with one end frayed.	Sausage-shaped, with one end frayed.
Length..................	3 to 4 inches (7.5—10 cm.).	18 to 20 cm.
Outer pair of setæ....	In ventral half.	In dorsal half.
Prostates...............	Absent.	Usually four pairs; in XXIII—XXVI.

CHAMPAIGN, Dec. 10, 1894.

Since this paper went to press, Michaelsen's description of new earthworms from Florida and Georgia* has been received. One species, described under the name *Geodrilus eiseni*, is very closely related to *Diplocardia riparia* described above, but differs in several minor

**Die Regenwurm-Fauna von Florida und Georgia* (Zool. Jahrb. Abth. f. System. VII. Bd. 2 Hft. pp. 177—194.)

characters and seems to be a distinct species. Michaelsen states that Garman's paper upon *Diplocardia communis* was not accessible to him. If it had been, I can see no sufficient reason why he should not have included the new species in the genus Diplocardia. If I am right in not regarding the presence of a double dorsal vessel and of a fixed number of spermathecæ as necessarily of generic importance, and hence in including *D. riparia* in the same genus with *D. communis*, then I think the new species ascribed by Michaelsen to the genus Geodrilus really belongs to the genus Diplocardia, since it has all the other characters of that genus, as far as can be determined from his quite full description, and has no characters that in my judgment are to be considered generically different. I think, therefore, that the new form should be known as *Diplocardia eiseni*.

If Michaelsen be correct in his assumption that Ude's description of *Geodrilus singularis* was erroneous in certain particulars, and, further, in placing his species in the same genus with that of Ude, then it would seem that *G. singularis* must also be regarded as a Diplocardia. I do not, however, believe that this point can be actually settled until *G. singularis* can be more fully described.

The following are some of the differences which distinguish *D. riparia* from *D. eiseni*: (1) The spermathecal pores are in the posterior part of the somite in the latter species, while in the former they are near the anterior margin; (2) the ventral setæ of somites VIII and IX are modified in *D. eiseni* and not in *D. riparia;* (3) a glandular thickening of the ventral surface of somites VIII and IX is present in *D. eiseni* and not in *D. riparia;* (4) setæ 2, or "b," are present in somite XIX in *D. eiseni* and not in *D. riparia;* (5) the first pair of nephridia in *D. eiseni* is found in somite III, while in *D. riparia* a pair is present in somite II; and (6) the first dorsal pore seen in *D. eiseni* is in the first clitellar somite, while in *D. riparia* it occurs in the anterior part of somite XI.

CONTENTS.

From Bulletin Illinois State Laboratory of Natural History

(Champaign. Ill.). Volume IV. . Published

Articles VI – IX. . 189

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 habitat—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.

Nymphæella.

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, however, 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.

---

*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 surface, 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.

---

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'va.—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 antennal 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, or 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-

—13

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 projections, 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 stigmatal 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 inward 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, burrowing actively in search of food. This probably con-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 thorax 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 stri ated, 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 surface; 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-

—16

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 dipnet 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 middle. 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 became 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, 1830, 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 10 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.

ARTICLE VII.—*Descriptions of three New Parasitic Hymenoptera from the Illinois River.* BY WILLIAM H. ASHMEAD.

FAMILY PROCTOTRYPIDÆ.

PHANURUS Thomson.

Phanurus tabanivorus, sp. n. [Fig. 55, 56.]

♀.—Length 1.2 to 1.3 mm. Polished black, impunctate; the head and thorax clothed with a fine sparse pubescence. Head subquadrate, roundly emarginate behind, a little wider than the thorax; eyes oval, faintly pubescent; antennæ 11-jointed, black, if extended backwards not quite reaching to the apex of thorax, and terminating in a long fusiform 5-jointed club, the first joint of which is not quite as wide as the second, ob-trapezoidal, twice as wide as long, the second, third, and fourth joints transverse-quadrate, a little wider than long; the fifth or last joint conical and a little narrower than the preceding joint; the scape is about as long as the funicle with the pedicel, the latter obconical; joints of funicle a little narrower than the apex of the pedicel, the first joint scarcely longer than thick, the second and third small, transverse-moniliform.

Thorax subovoid, not twice as long as wide, the mesonotum scarcely longer than wide, the scutellum lunate, polished, without pubescence; wings hyaline, ciliated, the cilia on the anterior and posterior margins long, much shorter at apical margin; tegulæ black; venation brown, the marginal vein a little shorter than the stigmal, the latter only slightly thickened at tip, the postmarginal vein very long, fully two and a half times as long as the stigmal; legs fuscous, the trochanters, knees, tips of tibiæ and tarsi honey-yellow or testaceous. Abdomen elongate, pointed-fusiform, about twice as long as the head and thorax united, polished, the first segment not longer than wide, with an elevation above at base, the second segment the longest, twice as long as wide at apex, the suture between it and the first striated, the third segment hardly half as long as the second, the fourth about two thirds the length of the third, the three following forming a cone of which the fifth is very short, its apical margin with a median sinus, the sixth twice as long as the fifth, the seventh very short, scarcely discernible; sheaths of ovipositor a little prominent.

♂.—Length 0.8 mm. Black, but with the head, prosternum, and legs testaceous; the antennæ 12-jointed, brown-black, with all the joints of the flagellum, except the pedicel and the last joint, small, moniliform, joints 3 to 5 increasing in size but smaller than pedicel, joints 6 to the penultimate a little wider than long; abdomen not, or only slightly, longer than the head and thorax united, the genitalia long, exserted, curving downwards.

Hab.—Havana, Ill.

Types in collections of the Illinois State Laboratory of Natural History and in my collection.

Described from 11 ♂ and 9 ♀ specimens bred from the eggs of a common horse-fly, *Tabanus atratus* Fabr.

In my recent monograph of the N. A. Proctotrypidæ, pp. 140–141, I characterized four species belonging to this genus, none of which, however, are closely allied to the present species. On the contrary, it appears to resemble more closely three European species described under the genus Telenomus, viz.: *Telenomus othus* Hal., *T. laricis* Hal., and *T. tabani* Mayr.

Dr. Gustav Mayr, in his excellent revision of the European species of Telenomus* did not recognize the validity of Thomson's genus Phanurus.

As defined in my monograph, however, I believe it can be readily separated from Telenomus, although both Haliday and Walker have described Telenomi which

*"Ueber die Schlupfwespengattung Telenomus." Verh. d. k. k. zool. bot. Gesellsch. in Wien, 1877, pp. 697-714.

should now be relegated to Phanurus; while Thomson, in his definition of Telenomus, has included species that really belong to the genus Hadronotus Förster.

These errors probably induced Dr. Mayr to reject the validity of Phanurus in his work cited above.

It is interesting to note here that *Phanurus* (*Telenomus*) *tabani* Mayr, has habits similar to our own, the species having been bred by Dr. Frederick Brauer from a European horse-fly, Tabanus sp.

Our species, although evidently related, is somewhat larger in the female sex, smoother, with the joints of the antennæ and the segments of the abdomen relatively different, while our male is much smaller, differently colored, and with the antennal joints totally dissimilar.

Dr. Mayr's species approaches nearest to *Telenomus laricis* Hal., figured in the Entomological Magazine, Vol. III., Plate XIII., Fig. 2, with which he makes comparison; while our species agrees more nearly with *Telenomus othus*, Hal., represented on the same plate in Fig. 4.

Family BRACONIDÆ.

Clinocentrus Haliday.

Clinocentrus niger, sp. n. [Fig. 14.]

♂.—Length 1.85 to 2 mm. Black, subopaque, shagreened, except the apical third of abdomen, which is smooth and shining; mandibles rufous, palpi whitish; antennæ 25-jointed, longer than the body, black, except a small honey-yellow annulus at base of third joint and the apex of the pedicel or second joint; all coxæ and trochanters brownish yellow, the femora reddish and gradually becoming fuscous toward tips; all tibiæ and tarsi black or blackish fuscous; wings subfuliginous, the stigma and veins dark fuscous, almost black.

The head is transverse, shagreened, with only the occipital orbits smooth and shining; the occiput is acutely margined; the metathorax is rugulose, with a median carina; the first and second abdominal segments are shagreened or granulated and opaque, the second being the longer; the third segment is scarcely half the length of the second, subopaque and only faintly shagreened; while the following segments, in marked contrast to the preceding, are all short, impunctate, and shining.

Hab.—Havana, Ill.

Types in the collections of the Illinois State Laboratory of Natural History and in my collection.

Described from 10 ♂ specimens taken on floating Lemnaceæ in the Illinois River.

Family ICHNEUMONIDÆ.

Cremastus Gravenhorst.

Cremastus hartii, sp. n. [Fig. 13.]

♀.—Length 6.5 mm.; ovipositor about half the length of the abdomen; antennæ 30-jointed, scarcely reaching to the middle of abdomen. Brownish yellow or pale ferruginous; head above, the occiput, the antennæ, a large oblong spot on middle mesothoracic lobe *anteriorly*, the fovea at base of scutellum, axillæ, postscutellar band, base of petiole, basal half of second abdominal segment, a small spot on dorsum of fifth and sixth segments, all tarsi and the hind tibiæ, black or dark fuscous; wings hyaline, the stigma brown, the veins blackish; abdomen twice as long as the head and thorax united, compressed from the third segment, the petiole and base of third segment finely longitudinally aciculated and feebly shagreened; the second segment one half longer than the third, the sixth shorter, the seventh still shorter. (The eighth segment has the basal plates of the ovipositor abnormally exserted, giving the tip of abdomen an unnatural appearance.)

♂.—Length 4.5 mm. Agrees with female except in the usual sexual difference and in color, the sixth and seventh abdominal segments having a black spot above, while the anterior tarsi and the base of the middle tarsi are pale.

Hab.—Havana, Ill.; Washington, D. C.; Lexington, Ky.

Types ♂ ♀ in the collections of the Illinois State Laboratory of Natural History, and in my collection.

EXPLANATION OF FIGURES.

Plate I.

1. *Paraponyx obscuralis*, larva, dorsal view.
2. Larval and pupal case.
3. Posterior false leg of larva.
4. Gill filament of larva.
5. Abdominal segment of larva, showing bases of filaments and setæ of piliferous tubercles.
6. Pupa, side view.

Plate II.

7. *Paraponyx obscuralis*, posterior extremity of pupa, ventral view.
8. *Hydrocampa obliteralis*, eggs on leaf, natural size.
9. A few eggs enlarged.
10. Larva, dorsal view.
11. Larva in case, posterior extremity visible.
12. Posterior false leg of larva.

Plate III.

13. *Cremastus hartii* Ashm., n. s.

Plate IV.

14. *Clinocentrus niger* Ashm., n. s.

Plate V.

15. *Bittacomorpha clavipes*, larva, side view.
16. Head of larva; right side, dorsal view; left side, ventral view.
17. False foot of larva.
18. Thorax of pupa, just before casting larval skin, cut beneath at middle and spread out, showing growth of respiratory tubes.

PLATE VI.

19. *Bittacomorpha clavipes*, pupa, dorsal view.
20. Portion of respiratory tube of pupa, enlarged.
21. Spine such as the pupa is covered with.
22. Last segment of male pupa, dorsal view, showing scar left by larval respiratory tube.
23. *Erioptera?* sp.(*a*), larva, dorsal view.
24. End of last segment of larva.
25. Ventral view of one side of same.

PLATE VII.

26. *Symplecta punctipennis*, larva, dorsal view.
27. End of last segment of larva.
28. Pupa, dorsal view.
29. *Limnophila luteipennis*, larva, dorsal view.

PLATE VIII.

30. *Limnophila luteipennis*, end of last segment of larva.
31. Pupa, dorsal view.
32. *Tipula eluta*, larva, dorsal view.
33. End of last segment of larva.

PLATE IX.

34. *Tipula eluta*, pupa, dorsal view.
35. *Tipula* larva (*b*), dorsal view.
36. End of last segment of larva.
37. *Tipula* sp. (*e*), end of last segment of larva.
38. Last two segments of female pupa, side view.
39. *Pachyrhina ferruginea*, end of last segment of larva.

PLATE X.

40. *Pachyrhina ferruginea*, last two segments of female pupa, side view.
41. *Chrysops vittatus*, larva, dorsal view.
42. *Chrysops æstuans*, egg mass on stem of *Juncus effusus*.
43. *Tabanus lineola*, pupa, dorsal view.
44. Abdominal spiracle of pupa.
45. Left thoracic spiracle of pupa.

Plate XI.

46. *Tabanus lineola*, end of last segment of pupa.
47. *Tabanus stygius*, larva, dorsal view.
48. Last segment of larva, side view, showing projecting spine.
49. *Tabanus* sp. (*b*), larva, dorsal view.
50. *Tabanus atratus*, larva, dorsal view.

Plate XII.

51. *Tabanus atratus*, head of larva, low side view; *a*, eye; *b*, antenna; *c*, labrum; *d*, mentum; *e*, mandible; *f*, maxillary palpus; *g*, maxilla.
52. Abdominal spiracle of pupa.
53. Left thoracic spiracle of pupa.
54. End of last segment of pupa.

Plate XIII.

55. *Tabanus atratus*, egg mass and single egg, latter containing the parasite, both enlarged.
56. *Phanurus tabanivorus* Ashm., n. s., egg parasite of *Tabanus atratus*.

Plate XIV.

57. *Stratiomyia norma*, larva, dorsal view; and last three segments, ventral view.
58. *Odontomyia cincta*, egg mass, with all except bottom layer removed from the lower portion, also single egg, both enlarged.
59. Larva, dorsal view, and last three segments, ventral view.
60. *Odontomyia vertebrata*, larva, dorsal view, and last three segments, ventral view.

Plate XV.

Examples of breeding-cage and semicircular dip-net in use at the Station.

INDEX.

ARTICLE VIII.—*Notes on Species of North American Oligochæta.* BY FRANK SMITH.

A number of species of Oligochæta have been collected during the present year (1895) at Havana, Ill., in connection with the work of the University of Illinois Biological Experiment Station. It seems best to give a preliminary account of some of them at this time, although a more complete description, with plates, is in preparation. In this account is included some recently obtained information upon *Enchytræus* (*Halodrilus*) *littoralis* Verrill.

Diplocardia (*Geodrilus*) *singularis* Ude.

In the months of April and May there were found at Havana, Ill., many sexually mature earthworms which are probably identical with *Geodrilus singularis*, described by Ude (**14**, p. 69)* from specimens collected at Danville, Ill. Michaelsen (**8**, p. **190**) has recently shown that a close scrutiny of Ude's description makes it likely that the pores of the prostate glands are upon somites XVIII and XX instead of upon XVII and XIX, and that the male pore is upon XIX, and a letter recently received from Ude confirms the correctness of Michaelsen's assumption. The Havana specimens correspond to the description of *G. singularis* as thus amended, except in minor characters to be mentioned later.

The poor state of preservation of Ude's specimens made a satisfactory account of the reproductive organs impossible. In having three pairs of spermathecæ in VII, VIII, and IX, *Diplocardia singularis* agrees with *D. communis* Garman, and differs from the three remaining

*Here and throughout this paper the full-face parenthetical figures refer to the bibliographical list which follows it.

species of the genus thus far described, while it agrees with all but *D. verrucosa* Ude, (**15**) in the presence of prostate glands opening upon XVIII and XX. The prostate-gland pores are connected on each side by a longitudinal groove. The male pores are upon the anterior part of XIX. The clitellum is nearly as thick upon the ventral part of the somites as upon the dorsal, except upon XVII and XVIII. A pair of genital papillæ is situated upon the posterior part of XVII or the anterior part of XVIII, and a second pair occurs upon XX or XXI, the position of both pairs being variable.

The testes and ovaries and the funnels of the sperm ducts are present in the usual number and situation, and the sperm sacs agree in number and arrangement with those of the other species of the genus. The dorsal vessel is single. The nephridia of the first pair are very small and open upon II. The position of the first dorsal pore is not uniform, being in some specimens in the anterior part of IX and in others in the anterior part of X. In the other species of the genus I have found it in the anterior part of XI, where it is stated by Ude to occur in *D. singularis.* The penial setæ of the specimens studied by me are long and slender, but have a slight double curve instead of the form figured by Ude (**14**, Fig. 18). The ventral setæ are absent upon XIX, as the in some of the other species. The anterior end of worm is dark-colored upon the dorsal surface, as in *D. eiseni* Mich. and in *D. riparia.*

Diplocardia riparia Smith.

Since writing a previous paper (**12**) in which I described the above species and compared it in some particulars with *Diplocardia* (*Geodrilus*) *eiseni* Michaelsen (**8**, p. 184), I have received, through the kindness of a friend in Florida, forty-one living specimens of *D. eiseni* which were collected last June from the banks of Lake Eola in that state. A comparative study of these worms and of the *D. riparia* from Havana shows clearly that they belong to distinct species; but it is necessary to revise somewhat the list of differences as given on p. 148 of my earlier paper (12).

The two species agree in the presence of a pair of very small nephridia opening upon II, and also in the position of the first dorsal pore, which is in the anterior part of XI.

The principal characters which distinguish the species are as follows: (1) The spermathecal pores are posterior to the setæ in *D. eiseni*, while they are anterior to the setæ in *D. riparia;* (2) the ventral setæ of VIII and IX in *D. eisini* are modified and accompanied by glandular structures, while in *D. riparia* they are not; (3) the ventral setæ of XIX are one or both present on each side of the somite in *D. eiseni*, but both are lacking in *D. riparia;* (4) the quadrangular glandular area upon the ventral part of XVIII—XX described by Michaelsen in *D. eiseni* is quite conspicuous in that species, but is not noticeable in *D. riparia;* and (5) the two species are very different as regards size. On this latter point I may say that the specimens of *D. eiseni* received by me were quite uniform in size, and that none of them had a length of more than 150 mm. when alive and fully extended, the diameter of the anterior part being only 2 mm. and that of the other regions still smaller. Michaelsen, on the other hand, gives 160 mm. as the length of one of his specimens and 3–3.5 mm. as the diameter, but this seems to have been exceptional, since he states that "andere Stücke sind beträchtlich kleiner." Ordinary specimens of *D. riparia* are 220–250 mm. in length when fully extended, and 3 mm. in diameter. By comparing average specimens of each species I find the ratio between the weights of individuals of *D. riparia* and of those of *D. eiseni* to be more than 5:1.

Fridericia agilis n. sp.

Numerous specimens of an enchytræid worm belonging to the genus Fridericia were found at Havana, Ill., associated with the different species of Diplocardia. They were sexually mature in April and May.

The length of well-extended living specimens is 25–30 mm. and the number of somites is 57–66 in the specimens examined, the average number being 62.

The setæ are straight, with the exception of a slight curvature of the proximal end, the usual number in each bundle being two, although sometimes one or even two additional may be present in a few of the bundles. Occasional specimens are found in which between the ordinary setæ of a pair a second pair of very slender ones is present, the diameter of the latter being one half that of the former, or even less. In such specimens this arrangement of setæ prevails posterior to the clitellum as well as anterior to it. A head pore is present between the prostomium and peristomium, and the first dorsal pore is in VII. The clitellum is on XII and XIII.

The posterior margin of the brain is quite convex, while its anterior margin is slightly concave. Its length is one and a half times its greatest width, and the posterior part is a little wider than the anterior. The salivary glands are large and very much branched, and open into the alimentary tract between its lateral and ventral walls in somite III. Septal glands occur in IV, V, and VI. The anteseptal part of each of the nephridia equals the postseptal part in size. The duct of the former is convoluted, and the terminal duct arises from the posterior end of the postseptal part and opens in front of the ventral setæ. The dorsal vessel arises in XIX. The spermathecæ communicate with the alimentary tract, each of them having about nine well-developed diverticula, which are hollow and somewhat unequal. The duct, which is about three times the length of the pouch, is slender, cylindrical, and without glands, except a few scattering cells at the external opening. The length of the funnel of the sperm duct is about twice its diameter, and the duct itself is very slender, much coiled, and confined to XII.

F. agilis is distinguished from the other species of the genus, except *F. bisetosa* and the two species recently described by Nusbaum (**10**), by the number of setæ in each bundle, and it is distinguished from these by the form of the brain and by other characters. The spermathecæ are more nearly like those of *F. oligosetosa*, but the dissimilarity in the number of somites and of septal glands, together with the differences in the nephridia, in the duct of the spermathecæ, and in the brain, clearly distinguish the two species.*

Enchytræus (*Halodrilus*) *littoralis* Verrill.

Verrill's description of this species (**20**, p. 623) contains no account of the reproductive organs, and consequently its relation to other Oligochæta has been quite uncertain. Vejdovsky (**18**, p. 45) placed it with the Tubificidæ, while Vaillant (**16**, p. 292), Michaelsen (**7**, p. 50), and Beddard (**1**, p. 312) have considered it as an enchytræid. As a number of specimens, many of which were sexually mature, were obtained by me at Wood's Holl, Mass., in August of the present year (1895), I am able to extend the description somewhat. I think there is no doubt that these specimens belong to Verrill's species, since they correspond very closely to his description and were extremely abundant in precisely the same sort of situation in which he found his, namely, in dead seaweed and under stones near high-water mark, those under

*Since the above description was written, an account of four new species of Fridericia from the vicinity of Philadelphia has been received from Mr. J. Percy Moore (Proc. Acad. Nat. Sci. Phil., 1895, p. 341). Of these *F. longa* is quite similar to *F. agilis* in several characters. The arrangement of the setæ is somewhat different in the two species, and the number of diverticula of the spermathecæ is somewhat greater in *F. agilis* than in *F. longa*, but the most obvious difference is in the character of the salivary glands. Other differences may appear when more is known of the nephridia, the dorsal vessel, and the reproductive organs of the latter species.

stones and in the sand being, as a general rule, much smaller than those in the seaweed.

The living animals are sufficiently transparent to enable one to determine many facts concerning their structure, and such observations have been supplemented by dissections and by the study of both longitudinal and transverse serial sections, which show the general anatomy to be that characteristic of the Enchytræidæ. The length of the larger specimens is approximately 25 mm. and the diameter .5 mm. to 1 mm. The average number of somites in several specimens taken at random is 59, the minimum and maximum numbers noticed being respectively 53 and 69. The setæ are somewhat hooked at the proximal end, but are otherwise straight or sometimes slightly curved. The most frequent number of setæ in a bundle is three. There are often four present in the bundles of the anterior region, and sometimes even six, but in the latter case they are in two sets of three each, as though a second set had been formed before the first one had been lost. In the bundles of the posterior region there are frequently but two setæ present. The clitellum is on XII and XIII. I found no dorsal pores.

The length of the brain is one and a half to one and three-fourths times its width, the ratio varying with the state of contraction. Its sides are nearly parallel, the anterior margin being slightly concave, and the posterior slightly convex or straight. A careful examination of this organ in several living specimens shows that the posterior margin is not concave, and that its convex or straight appearance is not due to the peritoneal cells, as suggested by Michaelsen (**7**, p. 36) in the case of *E. vejdovskyi*. Two long tubular unbranched salivary glands open into the alimentary tract upon its dorsal surface, behind the pharynx, and extend into IV, having a somewhat contorted course. Three pairs of septal glands occur in IV–VI, but those of V and VI are one-or both so constricted and contorted that there appear to be two pairs in each somite. I think that there is not the slightest doubt that these glands, together with the spermathecæ, are the structures mentioned by Verrill as the cæcal lobes of the alimentary tract, situated just behind the pharynx. There are certainly no extensive diverticula like those of some species of Henlea. The septal glands nearly surround the œsophagus, and this fact, together with the actual communication of the spermathecæ with the œsophagus, would make it quite natural to assume that they were all thus connected if one should study living specimens only. The gland cells surrounding the œsophagus in VII and VIII are higher than those of the next following somites, and this fact probably explains Verrill's statement that the so-called cæcal lobes "are followed by a large two-lobed portion, beyond which the intestine is constricted."

The dorsal vessel arises behind the clitellum, in XVII. The arrangement of the blood vessels in the anterior somites is the same as that described and figured by Michaelsen (6, p. 26; Taf. II., Fig. 2) for "*Enchytræus Möbii.*" The blood is colorless. The anteseptal part of each nephridium is small and forms the funnel only. The terminal duct arises from the posterior end of the postseptal part, and opens in front of the ventral setæ. The spermathecæ are without diverticula. The duct is of about the same length as the pouch, and is closely beset with glands throughout its length. The length of the funnel of the sperm duct is several times its diameter. The duct itself usually extends to XVII or XVIII in a tolerably straight course, and then, making a short, abrupt turn, retraces its course, the second part lying close beside the first, and communicating with a small prostate gland in XII. As one traces the duct from the funnel, the diameter is nearly uniform until just after the turn, where it is nearly doubled, the size being again uniform until a point is reached about one third of the distance from the prostate gland to the turn. From this point the diameter gradually diminishes, and before reaching the prostate, becomes smaller than in any other part of the duct. The diameter of the widest part of the duct is one fifth that of the entire worm in that region, and three times the diameter of its own lumen.

In specimens that have passed the period of sexual activity the sperm duct becomes reduced in size, more convoluted, and extends backward a shorter distance.

Enchytræus littoralis is evidently very closely related to *E. vejdovskyi* Eisen (**3**, p. 25) and *E. humicultor* Vejdovsky (**17**, p. 57). The chief difference would seem to be in the sperm duct, which in *E. littoralis* extends back as far as XVIII, but which at the height of sexual activity is entirely free from the numerous flexures described by Eisen (**3**, Fig. 19h), Michaelsen (**6**, p. 39; and **7**, p. 37), and Ude (**13**, p. 86) as existing in *E. vejdovskyi* and *E. humicultor*. Specimens of *E. littoralis* are frequently found in which the sperm duct passes from one side of the body to the other once or sometimes twice, but it is without sharp turns except at the point farthest back, where its course is reversed. The somewhat abrupt increase in the diameter, already described, is also very characteristic. The brain is similar in form to that of *E. vejdovskyi* as figured by Eisen (**3**, Fig. 19f), though less concave in front and less convex behind. In view of the above facts it seems reasonable to question the advisability of regarding the differences between the European and American forms as more than varietal. Verrill's name has priority, of course, in the event of its being necessary to unite the species from the two continents under one name.

Thinodrilus inconstans, n. g. et n. sp.

At various times since April 1894 specimens of a species belonging to the Lumbriculidæ have been collected from the east shore of Quiver Lake, at Havana. They are sometimes found in the algæ, sometimes in the mud at the bottom of the lake, and sometimes on the shore above the level of the water, under rubbish which is kept moist by the springs constantly flowing from the bank. Among specimens collected last February from a situation like that last described, one individual was found that was sexually active, with others that had been in that condition recently enough to be of use in gaining a knowledge of the sexual organs.

The worms are 30–60 mm. in length and .6–.8 mm. in diameter. The number of somites is usually 150–200, and sometimes even greater. The setæ are in four rows of bundles with two setæ in each. They are .15–.2 mm. in length, with bifid extremities, and have the same form as those of *Lumbriculus variegatus* Grube as figured by Vejdovsky (**18**, Taf. XII, Fig. 27). The length of the prostomium in alcoholic specimens is about equal to that of the first three somites taken together, and its width is almost as great as the diameter of the first somite. The width is nearly uniform for the greater part of the length, and the extremity is bluntly rounded. The brain is quite similar to that of *L. variegatus* Grube as figured by Ratzel (**11**, Pl. XLII., Fig. 10), if I understand his figure, but not if Beddard's interpretation (**1**, p. 212) be correct. A comparison of Ratzel's figure 10 with figures 12 and 13 of the same plate makes it quite evident that the supraœsophageal ganglia are represented by Ratzel in a position the reverse of the normal one, so that what is described by Beddard as the anterior part is really the posterior part, and *vice versa*. In the brain of *Thinodrilus inconstans* the masses of cells are upon the posterior part, and are not united by a narrow layer of cells as represented in *Lumbriculus variegatus*, although such a layer is present upon the outer surface of the brain, and if no sections were made might be supposed to connect the two masses. The median part of the brain, which connects the two lateral divisions, is composed entirely of fibers with the exception of a few cells in the dorsal part. Groups of cells are situated respectively in front of and behind the point of union of the commissures with the ventral chain. The pharynx extends through II—V and is followed by the œsophagus in VI and VII, and in VIII by the intestine, which, as indicated by the chloragogue cells, commences in that somite. The septal glands are large in IV—VI, and slightly developed in III.

Beginning with the eleventh somite, paired appendages of the dorsal vessel with several cæcal branches are present. Nephridia are contained in the same somites with the gonads at the time of maturity of the latter. No especial modification of the epidermis to form a clitellum has been noticed. Albumen glands are wanting. Two pairs of testes are present in IX and X and two pairs of ovaries in XI and XII. The male pores were determined with certainty in but three specimens, in two of which the pores were upon X and in the other upon XI. The atria are similar in form and in the structure of the walls to those of *L. variegatus* as described by Hesse (**4**, p. 358) and by Vejdovsky (**19**, p. 81). Whether or not a definite penis is developed I am unable to state. The funnels of the sperm ducts are borne upon the posterior walls of IX and X. The sperm ducts have not yet been followed throughout their entire course. A pair of elongated sperm sacs communicate with X and extend backward for a varying number of somites, in some cases as far as XX. Well-developed spermathecæ were found in but one specimen, and in that did not contain spermatozoa. There are five pairs in XI—XV, with their pores dorsad to the ventral setæ and situated similarly to those of *L. variegatus*. In another example vestiges of these organs were present in XI—XV, while the specimen having male pores upon XI had traces of spermathecæ in XII—XVI. The oviducts are short and open at the posterior margin of their somites XI, XII. In all the specimens examined gonads were present in IX—XII.

No attempt will be made at present to distinguish fully between generic and specific characters. The characters of the setæ and of the branches of the dorsal vessel distinguish *Thinodrilus inconstans* from other Lumbriculidæ except Lumbriculus, while the number and position of the various reproductive organs distinguish it from that genus. Its relation to *Lumbriculus limosus* Leidy (**5**, p. 49) cannot be determined until more is known of that species. It seems probable enough that they may belong to the same genus, though I do not think that they are identical if the setæ of *L. limosus* are correctly figured by Leidy (**5**, Pl. 2, Fig. 16), since the distal portion is much more curved in his figure, and the point of abrupt change in diameter is considerably nearer the distal end than in the setæ of *Thinodrilus inconstans*. Also, the number of cæcal appendages of the dorsal vessel is greater than I have noticed in the latter species. In spite of these differences, however, there is a possibility that the forms may prove to be identical.

The genus Diplocardia apparently contains five distinct species, and is distributed over an area extending from Florida at least half way across the continent. Sparganophilus has several species and at least as wide a distribution. Benham (**2**, p. 175) suggests that the occurrence of *S. tamesis* in England is due to its importation, presumably from America, which seems highly probable, especially as Moore (**9**, p. 473) reports the occurrence of that species near Philadelphia. Bimastos is very distinct from the European Lumbricidæ. In view of the above facts, the distinctness of the Palæarctic and Nearctic regions as shown by the earthworm fauna would seem greater than has previously been supposed.

I take this opportunity to express my gratitude to Prof. E. L. Mark, of Harvard University, through whose kindness I have been permitted to work during the past summer in the laboratory and library of the Museum of Comparative Zoölogy, and especially to Prof. S. A. Forbes, of the University of Illinois, whose continued encouragement and assistance have enabled me to carry on my study of this interesting group of animals.

Champaign, Dec. 12, 1895.

LIST OF PAPERS CITED.

1. Beddard, F. E.—A Monograph of the Order Oligochæta. 1895. 769 pp., 5 plates.
2. Benham, W. B.—A New English Genus of Aquatic Oligochæta (Sparganophilus), belonging to the Family Rhinodrilidæ. 1893. Quart. Journ. Micr. Soc., Vol. XXXIV., pp. 155–179, Pl. XIX. and XX.
3. Eisen, G.—On the Oligochæta collected during the Swedish Expeditions to the Arctic Regions in the years 1870, 1875, and 1876. Kongl. Sv. Vet.-Akad. Handl., Bd. 15, No. 7. 1879.
4. Hesse, R.—Die Geschlechtsorgane von Lumbriculus variegatus Grube. 1894. Zeit. f. wiss. Zool., Bd. LVIII., pp. 355–363, Taf. XXII.
5. Leidy, J.—Descriptions of some American Annelida abranchia. 1850. Journ. Acad. Nat. Sci. Phil., Vol. II., 2d ser., pp. 43–50, Pl. II.
6. Michaelsen, W.—Untersuchungen über Enchytraeus Möbii Mich. und andere Enchytraeiden. Kiel, 1886. 50 pp., 3 Tafeln.
7. ——— Synopsis der Enchytraeiden. 1889. Abhandl. d. Naturw. Ver. Hamb., Bd. XI., Heft I., 60 pp., 1 plate.
8. ——— Die Regenwurm-Fauna von Florida und Georgia. 1894. Zool. Jahrb., Abth. f. Syst. Bd. VIII., 2 Heft, pp. 177–194.

9. Moore, H. F.—On the Structure of Bimastos palustris, a New Oligochæte. 1895. Journ. Morph. Vol. X., No. 2, pp. 473-496, Pl. XXVI. and XXVII.
10. Nusbaum, J.—Zur Anatomie und Systematik der Enchytraeiden. 1895. Biol. Centr., Bd. XV., No. I., pp. 25-31.
11. Ratzel, F.—Beiträge zur anatomischen und systematischen Kenntniss der Oligochaeten. 1868. Zeit. f. wiss. Zool., Bd. XVIII., pp. 563-591, Taf. XLII.
12. Smith, F.—A Preliminary Account of two New Oligochæta from Illinois. 1895. Bull. Ill. State Lab. Nat. Hist., Vol. IV., Art. V., pp. 138-148.
13. Ude, H.—Würmer der Provinz Hannover. I. 1892. Jahresb. Nat. Ges. Hann., pp. 63-98, 1 plate.
14. ——— Beiträge zur Kenntnis ausländischer Regenwürmer. 1893. Zeit. f. wiss. Zool., Bd. LVII., pp. 57-75, Taf. IV.
15. ——— Über zwei neue Lumbriciden-Arten aus Nordamerika. 1895. Zool. Anz. Jahrg. XVIII., No. 483, p. 339.
16. Vaillant, L.—Histoire naturelle des Annelés marins et d'eau douce. Tome III., Prem. Part.
17. Vejdovsky, F.—Beiträge zur vergleichenden Morphologie der Anneliden. I. Monographie der Enchytraeiden. 1879. 61 pp. 14 plates.
18. ——— System und Morphologie der Oligochæten. 1884. 166 pp., 16 plates.
19. ——— Zur Kenntnis des Geschlechtsapparates von Lumbriculus variegatus. 1895. Zeit. f. wiss. Zool. Bd. LIX., pp. 80-82.
20. Verrill, A. E.—Report upon the Invertebrate Animals of Vineyard Sound and the Adjacent Waters. 1873. Rep. U. S. Fish Comm. 1871-72, pp. 295-778, 38 plates.

Article IX.—*Some Notes on the Brain and Pineal Structures of Polyodon folium.* By H. Garman, Lexington, Ky.

Some time about 1888 the writer of these notes made several dissections of the brain of this interesting fish and drawings of them were made by Magnus Westergren, at that time Artist of the Illinois State Laboratory of Natural History. Other duties have until recently prevented further prosecution of the study, but I have now to present some of the results of a reëxamination of these dissections, kindly placed in my hands by Professor Forbes, together with some facts gained by a study of fresh material obtained by me from the Ohio River. For purposes of comparison I have dissected out the brain of our common sturgeon (*Acipenser rubicundus*).

As in other sturgeons, the brain of *Polyodon folium* is enclosed by a thick cartilaginous cranium. It rests on the floor of a cavity which it only partly fills, the space above being partly occupied by fatty tissue, but that part dorsal to the mid-brain being almost entirely empty. As if to make up for the deficiency of padding about the brain, the fore- and mid-brains are enclosed in a tough whitish fatty tissue of considerable thickness, which can only be removed by the exercise of great care, so closely and tenaciously does it adhere. A peculiar feature of the brain when first exposed is a dense black fat which encloses the hind-brain and fills a large space surrounding the base of the spinal cord where it leaves the medulla. I have seen nothing just like it in other fresh-water fishes.

The olfactory nerves are very large, indicating that the sense of smell is an important one to the shovel-fish. Each nerve is separated, from its origin on the walls of the olfactory lobe, into two divisions, with some slight intermingling of fibers at the base. The divisions lie parallel at first, but separate completely at about the middle of their course, and before reaching the nasal sac each divides into a number (seven were counted) of small diverging branches passing into the walls of the sac. One can see in the olfactory nerve of *Acipenser rubicundus* an indication of doubleness, but in Polyodon it is carried much further, the divisions being independent except for the slender fibers which cross from one to the other at the base. The nerves have a very slight upward turn as they pass out to the sac.

The olfactory lobe is well developed in both Polyodon and *A. rubicundus*, but is not a conspicuous part of the brain in either fish. To ordinary inspection it looks like a slight enlargement of the base of the olfactory nerve. It contains a ventricle of large relative size which communicates with the ventricle of the fore-brain.

The fore-brain presents no outward trace of doubleness. When viewed from above it is oval in general shape, widest at about the middle, and is obtusely angulate medially in front. Viewed from the side it is seen to rise above the level of the olfactory lobes. It appears not to be so well developed in Polyodon as in Acipenser. The division commonly termed the thalamencephalon can hardly be said to exist, though the constriction of the brain at this region and the positions of the epiphysis and hypophysis definitely locate it. The ventral wall of the fore-brain bears two large, lobed, white, basal ganglia which encroach a good deal upon the ventricle. The front extremity of each lies opposite the opening into the ventricle of the olfactory lobe. A membranous dorsal sac is present which communicates freely posteriorly with the cavity of the fore-brain. It is not as conspicuous in Polyodon as in our sturgeon, and is not perceptible from without except as its outline is roughly indicated in alcoholic specimens by collapse of its dorsal wall, which usually gives rise to a depressed area on the posterior dorsal surface of the fore-brain. In front of the dorsal sac the dorsal wall of the fore-brain, viewed from within, presents a slight median ridge, while anteriorly, between the olfactory lobes, is a slight membranous fold, these being the only indication of separation of the cavity of the fore-brain into two ventricles. The fore-brain of *A. rubicundus* shows a similar but, I think, somewhat larger trace of a septum between the halves of this division of the brain. The lateral wall of the fore-brain of Polyodon is provided within with thin vertical plicæ, resembling those on the inside of the dorsal membrane of the fourth ventricle.

Arising from the dorsal wall of the brain at the junction of the fore- with the mid-brain is a slender white filament having the appearance, to ordinary inspection, of a nerve. At first it is concealed by the dorsal wall of the dorsal sac. By reflecting this wall it appears running along the ventral side of the wall as a whitish line. It emerges to the exterior near the anterior extremity of the dorsal sac and extends thence obliquely upward and forward to the cartilaginous cranium, where it passes into a special channel, along the middle of which it extends in a direct course nearly to the surface. In a fish which must have been about 3½ feet long, the end organ to which this filament passes lies about 1.66 mm. from the outer surface. The stalk expands as it enters the end organ. It is enclosed throughout its course in a membranous sheath, which gives it an appearance of being larger than it really is. It is accompanied by small blood vessels which supply the walls of the passage and eventually give small capillary vessels to the end organ.

The end organ is also enclosed in a sheath continuous with that surrounding the stalk. From the surface of the sheath radiate numerous small slender fibers (muscular?) which pass to the walls of the cavity in which the organ lies, and thus serve to keep it in place. Some of the fibers arise from the dorsal face of the sheath of the end organ. The essential part of the organ, within the sheath, looks, on ordinary examination with a low-power objective, like a small whitish nervous ganglion. It is somewhat slipper-shaped viewed from the side, but a dorsal view shows it to be a little depressed, with the dorsal side slightly convex. The outline is roughly oval in shape, viewed from above. In the specimen studied most carefully there was a slight rounded anterior projection. From my recollection of some sections prepared by me at the Illinois Laboratory, and of a drawing of one of them made by Mr. Westergren, I can say that the organ contains a cavity, but presents nothing which could be regarded as a lens. The stalk and end organ are sometimes accompanied by pigment, but may show only a slight trace of it, as indicated in my outline figure (Fig. 9) of these structures. In one example studied pigment was much more abundant than in the rest, and was accumulated beneath the end organ somewhat as it is back of the eyes of Vermes and Crustacea.

The channel in which the stalk and end organ lie is in one of the shovel-fish* examined 18.5 mm. in length, and has an average diameter of about two millimeters. Distally it enlarges somewhat, and is rounded at its extremity. A system of smaller passages ramifying in the cartilage of the cranium is in communication with it.

In one of my specimens the cavity about the end organ is more enlarged than in the others and a small passage leads through the cartilage above to the exterior. The passage was plugged with connective tissue similar to that constituting the skin which overlies the cartilage above the end organ. In another example studied I found no trace of an opening to the exterior. Unfortunately I neglected to examine thoroughly, with reference

* This fish was not less than three feet long.

to this point, two other examples dissected, but I am disposed to think such passage could not have been present in them, else it would have caught my attention.

From the outside the position of the end organ can be made out at once in Polyodon by the presence of an elliptical foramen* in the bony exoskeleton which covers the cartilage of the head. It shows as a depressed area when undisturbed, and is occupied by skin in which one can see with a magnifier uniformly distributed pigment specks. In one of my specimens the foramen measures 7 mm. in diameter and 19 mm. in length. It extends lengthwise with the cranium, and lies between the eyes. I can see no change in the character of the skin immediately over the end organ, which lies beneath or a trifle posterior to the center of the foramen. When the skin occupying the foramen is removed the cartilage under it is seen to be gently convex; and when the surrounding bony exoskeleton is also taken away the region is still perceptible, owing to this convexity and to the different color and greater translucency of its cartilage, through which, by close looking, one can see the end organ. The adjoining cartilage is of a more opaque whitish cast. The thickness of the cartilage and skin together just above the end organ measures in one of my examples 1.75 mm., of which each tissue constitutes about one half. The end organ in this specimen lies 0.50 mm. beneath the cartilage, and measures about one millimeter in diameter, excluding the enclosing sheath.

In *Acipenser rubicundus* the pineal structures are in general much like those of Polyodon. In this fish the stalk is concealed at first beneath the wall of the dorsal sac and reaches the roof of the brain proper at the same point as in Polyodon. It is accompanied into the channel in

*The foramen is completely surrounded by the "frontal" bones of Collinge (Quar. Jour. Micr. Science, Vol. 36, 1894, pp. 499–537). These bones are not separate at the middle line, as represented by this author, but meet both in front and behind the foramen, so that the median bone, the "dermo-ethmoid," is excluded from the foramen in front. Collinge may have described the bones of an immature example; otherwise the difference between his account and my own indicates considerable variation.

the cartilage by an extension of the dorsal sac, which can be followed rather more than half the distance to the end organ. The stalk is, however, throughout its course an entirely independent structure, and is made conspicuous by the blood vessels accompanying it, the blood supply here being apparently greater than in Polyodon. The end organ lies close under the cartilage, but not quite so near the surface as in Polyodon. The cartilage over it, in one example studied, is 1.50 mm. thick. I found no opening through the cartilage, and the bony exoskeleton of the head, which is here about 2 mm. thick, is without a foramen.

The end organ in *A. rubicundus* is somewhat different from that of Polyodon. The stalk in its sheath expands gradually at its distal extremity and forms an elongate-obovate or club-shaped organ which is not firmly suspended like that of Polyodon by elastic bands. It measures 2 mm. in length and has a diameter of 0.66 mm. near its extremity. A system of minute blood vessels ramifies over the surface of its sheath in such profusion that one cannot help thinking that the organ must be functional. No pigment is apparent about it.

Whether these end organs are to be considered eyes or not they certainly are entirely independent not only of the lateral line system, but of all other nervous structures. In both of these fishes the slender stalk has a very direct and evident course from its origin on the roof of the brain to its end organ, and without receiving or giving off branches expands in the substance of this terminal enlargement. If its present condition is taken into account one must conclude that the structure is, or has recently been, an important sense organ to the sturgeons.

The infundibulum is very large in both Polyodon and *A. rubicundus*. It opens freely above into the posterior part of the fore-brain. The cavity extends well down into the organ, but the hypophysis itself, though somewhat hollowed out within, is a compact, solid, whitish body. The *saccus vasculosus*, also of large size, is noticeable from its dark color. It is completely hollow, and its cavity communicates with that of the infundibulum. In *A. rubicundus* there is on each side of the infundibulum a conspicuous oval swelling, which dissection shows to be a thin-walled sac or pouch opening widely into the cavity of the infundibulum. In Polyodon this swelling is scarcely evident.

The optic nerves are small in Polyodon, as would be expected from the small size of the eyes. They are of larger relative size in our sturgeon.

The mid-brain is a compact rounded mass of small size, whitish in color when the pigmented connective tissue is all removed, and without any decided outward trace of separation into two lobes. There is a very slight median impression in front, but beyond this the mid-brain shows little appearance of doubleness, either inside or out. In *A. rubicundus* this division of the brain is more extensively and deeply impressed along the dorsal middle line, but even in this fish the mid-brain is a single structure with one undivided cavity. Its ventricle is occupied in part by an extension of the cerebellum, called by Goronowitsch the *valvula cerebelli*.

The oculo-motor nerve arises on the ventral side of the mid-brain close to its junction with the hind-brain.

The trochlear nerves are exceedingly small and slender, and their origin is so concealed by the adjacent structures and so covered up by connective tissue that one must follow them up with care in order to find where they leave the roof of the brain. Both nerves, in both Polyodon and *A. rubicundus*, seem to arise at the dorsal middle line, and originate so close together that they look like a single nerve passing over the roof of the brain and joined to the latter at the middle line. In the sturgeon there is a small whitish lunate swelling just in front of the point where they leave the brain.

The hind-brain is the largest division of the brain in Polyodon. It is large also in *Acipenser rubicundus*, but the disproportion is not so great in the latter. In the shovel-fish it is, in front, more than twice the width of the mid-brain. The extensive fourth ventricle is completely covered dorsally by a thick, tough, black epithelial membrane, with strongly plicate inner surface. When this membrane is removed the ventricle is seen to be widely open and bounded largely by the conspicuous restiform tract. The lobe of the cerebellum, already mentioned as the *valvula cerebelli*, can be seen extending into the ventricle from the front, its forward extension, already noted, occupying the posterior part of the ventricle of the mid-brain.

The trigeminal group of nerves, arising from the lateral wall of the medulla, is made up of three well-defined parts in Polyodon. The most anterior division is a slender nerve* about as large as the oculo-motor, which extends obliquely outward and forward, crossing over the oculomotor and passing out towards the snout. It seems to be throughout entirely independent of the other divisions of the fifth nerve. The second division is much larger and, arising just behind the first, extends outward and forward, parallel with the first, until it joins the third division. The latter is the largest division of the three, and arises from the restiform tract, some distance behind the second division and well up on the side wall of the medulla. At first it extends downward and forward, then outward over the large second division.

The seventh nerve (facial) looks in Polyodon like a posteriorly directed branch of the trigeminal. It arises from the side of the medulla beneath the third division of the fifth, with which it is at first very closely bound up, extends forward and outward, and then turns abruptly backward, leaving the fifth at once.

*Ramus opthalmicus superficialis, according to Collinge.

The auditory (eighth) is a strong nerve which arises just behind the facial and on a level with it, but is completely independent. It divides into two branches at once, and these subdivide before being distributed to the ear.

A considerable space separates the ninth nerve (glosso-pharyngeal) from the eighth. It is slender in Polyodon, and extends backward parallel with the spinal cord at first, lying beneath the tenth nerve (vagus), so that it is not visible from above. A short distance posterior to the medulla it turns outward and then becomes distinguishable.

A slender nerve arises above the ninth and extends back over it to the side of the tenth with which it joins and merges, though not entirely losing its identity as far as followed. I take this to be the lateral line nerve. Near its origin it exchanges fibers with the ninth.

One of the largest cranial nerves in Polyodon is the vagus, although it is not as large as in *A. rubicundus*. It arises well back on the side of the medulla, on a level with the nerves just mentioned. Its fibers separate into bundles where it joins the medulla, of which I count eleven, the two hindmost being smallest and turning abruptly out of the general course to join the medulla.

The sixth nerve (abducens) I have not studied in Polyodon. In *A. rubicundus* it is very small, and arises by two roots near the ventral middle line, about midway between the eighth and ninth nerves.

Further explanation may be left to the figures accompanying these notes.

Looking at the brain of Polyodon as a whole, and as compared with that of the sturgeon and other fishes, it may be said that it impresses one as that of a fish of inferior rank, although the peculiar snout and other features of the anatomy speak of a somewhat special development. The large relative size of the medulla oblongata and the undivided and poorly developed fore- and mid-brains justify this impression, as do the condition of the pineal structures and their relation to the exterior.

The brain of *A. rubicundus* is certainly that of a more active and intelligent fish. The corresponding nerves are larger in the sturgeon; its fore-brain is larger relatively; the mid-brain is larger and with an evident suggestion of doubleness; the medulla is smaller relatively; and, finally, the pineal end organ is less evidently placed and surrounded to receive impressions from without.

EXPLANATION OF FIGURES.

Plate I.

Fig. 1. Side view of brain and pineal structures of Polyodon as they appear when the cartilage is cut away from one side. Natural size. *Magnus Westergren del.*

Plate II.

Fig. 2. Dorsal view of brain of Polyodon, with the connective tissue and fat removed from the fore- and mid-brains and the cerebellum, but with membrane roof of 4th ventricle left in place. A, nasal sac; B, olfactory lobe; C, pineal stalk; D, fore-brain; I, mid-brain; J, cerebellum; M, medulla oblongata; O, spinal cord; 1, olfactory nerve; 3, oculo-motor nerve; 10, vagus nerve. From a photograph.

Plate III.

Fig. 3. Dorsal view of brain of Polyodon. B, olfactory lobe; C, pineal stalk; D, fore-brain; I, mid-brain; J, cerebellum; K, valvula cerebelli; L, restiform tract; O, spinal cord; P, part of membrane roof of medulla oblongata, turned aside; 1, olfactory nerve; 2, optic nerve; 3, oculo-motor nerve; 4, trochlear nerve; 5, 5, trigeminal nerves: 7, facial nerve; 8, auditory nerve; 9, glosso-pharyngeal nerve; 10, vagus nerve. *H. Garman del.*

Fig. 4. The glosso-pharyngeal and vagus nerves, completely uncovered and drawn apart so as to show the lateral line nerve at R. *H. Garman del.*

Fig. 5. Side view of brain of Polyodon turned so as to show the infundibulum. F, hypophysis cerebri; G, saccus vasculosus. Other letters and figures as in Fig. 3. *H. Garman del.*

Plate IV.

Fig. 6. Side view of brain of *Acipenser rubicundus*. B, olfactory lobe; C, C, pineal stalk terminating distally in the pineal end organ; D, fore-brain; E, infundibulum; F, hypophysis cerebri; G, saccus vasculosus; H, swelling on side of infundibulum; I, mid-brain; J, cerebellum; M, medulla oblongata; O, spinal cord: 1, olfactory nerve; 2, optic nerve; 3, oculo-motor nerve; 4, 4, trochlear nerves; 5, 5, origin of trigeminal nerve; 7, origin of facial nerve; 8, origin of auditory nerve; 9, origin of glosso-pharyngeal nerve; 10, origin of vagus nerve. The small enclosed area connected with 10 by an arrow, marks the origin of the lateral line nerve, a part of 10. *H. Garman del.*

Plate V.

Fig. 7. The exposed channel in which the pineal end organ and its stalk lie in Polyodon. A, aperture to the exterior. (The skin covering the cartilage has been removed.) B, end organ; C, cut end of stalk. *H. Garman del.*

Fig. 8. Pineal end organ and a part of its stalk in Polyodon, removed from the channel in cartilage, and the end organ turned so as to show the surface presented to the exterior. A, end organ enclosed in sheath and with part of the elastic bands remaining attached; B, cut end of stalk. *H. Garman del.*

Fig. 9. Pineal end organ and stalk of Polyodon shown in place. A, end organ; B, cut end of stalk; C, sheath

enclosing stalk; D, line representing boundary of channel. *H. Garman del.*

Fig. 10. Pineal end organ and stalk of *Acipenser rubicundus.* Letters as in Fig. 9. *H. Garman del.*

PLATE XXI.

Fig. 11. Part of the bony exoskeleton of head of Polyodon, with the elliptical foramen under which the pineal end organ lies. Natural size. From a photograph.

ARTICLE X.—*Descriptions of New Species of Rotifera and Protozoa from the Illinois River and Adjacent Waters.* BY ADOLPH HEMPEL.

In April, 1894, the Biological Experiment Station of the University of Illinois was established on the Illinois River at Havana, Illinois. Collections were made from various substations, located upon the river and adjacent lakes, at stated periods, the intervals varying from one week to one month. Nearly all of the towings made were examined by me, and the list of animals includes ninety species of Rotifera and eighty species of Protozoa. Among the Rotifera there are three presumably hitherto undescribed species of the genus *Brachionus*. This genus is well represented by ten species and two varieties, and affords an interesting field for study.

ROTIFERA.

Brachionus variabilis n. sp.

(Plate XXII., Fig. 1 and 2.)

This species is remarkable because its posterior spines disappear with age.

The lorica is smooth and oval in outline. There are six occipital spines, of which the middle pair are longest and are curved outward. The second and third pair are of about equal length, and half as long as the middle pair. There are usually two lateral posterior spines present, which have a slight outward curve. A square plate projects from the dorsal posterior edge just over the foot orifice, and is a constant feature.

The outer pair of occipital spines are strengthened by a sharp spine-like reinforcement at their bases. The pectoral edge is very irregular. There is a sinus in the middle, at each side of which is a papillæ-like process. Between these processes and the lateral spines, there is a deep sinus on each side. The surface of the lorica is marked by short ridges running back from the spines and median processes.

The posterior spines are about one fifth the length of the lorica. In many specimens, especially old ones, these spines are quite short, and in some instances they are entirely wanting. So far as observed, the newly hatched young and embryos in the eggs all possess the posterior spines, this indicating that the spines are characteristic of the species and are shed or absorbed only in old age. The quadrate plate over the foot orifice may serve as an easy means of identification, since I know of no other member of this genus that has a similar structure. The eggs are carried about fastened to the posterior part of the lorica.

The internal structure of this rotifer is normal. There is a large subquadrate dark-ruby eye just in front of the mastax. The foot and two toes are small for such a large species. Length of lorica, including spines, .342 mm. to .418 mm.; width .209 mm. to .257 mm.

This species was found in tows from the Illinois River, Quiver Lake, Thompson's Lake, and Phelps Lake. It is very restless and active, and occurs only in open water, free from vegetation.

Brachionus punctatus n. sp.

(Plate XXIII., Fig. 3–5.)

Lorica, as seen dorsally, subquadrate, sides slightly convex. A cross section would be nearly circular. Four occipital spines of about equal length, curving slightly downward and outward. In the lumbar region there is a slight invagination of the lorica on each side, thus causing blunt angles on the surface of the lorica, and making it irregular. The entire surface and spines are covered with minute spinules. The surface of the lorica is also marked off into areas by several curved lines. There are no posterior spines.

The posterior part is slightly excavated on the dorsal and ventral surfaces around the foot, the ventral excavation being more pronounced than the dorsal. The pectoral edge is slightly indented in the center, the edges sloping uniformly from the lateral edges to the middle. A small red eye is situated just in front of the large mastax. A dorsal antenna is prominent in the sinus between the antlers. The foot is long and wholly retractile. The eggs are carried about fastened to the posterior part of the lorica.

The characteristic features of this rotifer are the shape of the lorica, the latero-posterior inangulations, the shape of the occipital spines, and the small spines covering the surface of the lorica. Its nearest ally is *B. budapestinensis* Daday (Plate XXIII., Fig. 6), from which it differs in the form of the lorica, in the size and shape of the occipital spines, and in the shape of the foot orifice.

This is a lively little species, and is found only in clear water, away from vegetation. Length of lorica, including spines, .151 mm. to .172 mm.; width .092 mm. to .096 mm.

Brachionus mollis n. sp.

(Plate XXIV., Fig. 7 and 8.)

Lorica thin, smooth, oval in outline; the dorsal surface highly arched; ventral surface but slightly convex. The anterior margin straight and truncated. No occipital or posterior spines. A very prominent dorsal antenna near the anterior margin.

This species is peculiar in having a very thin, soft lorica and no spines. When the animal contracts, it frequently invaginates those parts of the lorica that serve as attachments for the muscles. The foot orifice is guarded by a collar. The foot is very large and long, is wholly retractile, and ends in two small toes. The toes are very characteristic for this species. Viewed either dorsally or laterally, they taper to very fine points. Their inner edges are convex and separated from each other, while the outer edges are concave, consequently when viewed dorsally, the toes are seen to be separated and to curve away from each other. A ruby eye is situated in front of the large mastax. The ovary is large and spherical. The stomach, viewed dorsally, is pear-shaped, with large end towards the anterior part. The eggs are carried about fastened to the posterior part of the lorica. When the animal withdraws into the lorica, the anterior edge is thrown into a number of longitudinal plications.

This species was found during July and August in tows from the Illinois River and Phelps Lake.

Length of lorica .228 mm.; width .150 mm.

PROTOZOA.

Of the eighty species of Protozoa observed, four appear to be new to science. Two of these, *Difflugia tuberculosa* and *Ceratium brevicorne*, were first found in Matanzas Lake.

Difflugia tuberculosa n. sp.

(Plate XXV., Fig. 9 and 10.)

Shell compressed, irregularly ovoid in shape, slightly constricted around the mouth, and prolonged into a short neck. Fundus rounded, and ending in one or more blunt processes, like *D. pyriformis* var. *nodosa* Leidy. On each of the compressed sides there are three small prominences or tubercles.

This is a medium-sized species, about one and a fourth times as long as wide. The shell is composed of large and small rounded sand grains. No diatoms and but very few grains of sand with sharp corners are found in the shells. This species is characterized by having three small tubercles on each of the two compressed sides. These tubercles are arranged on each side of the shell so as to form the angles of a triangle.

One is near the edge of the fundus, and the other two are placed one at each side of the shell a little above the neck. Although the shell itself varies greatly in outline and is asymmetrical, these tubercles are constant and afford an easy means of recognizing the species. The pseudopodia are simple and few in number. Length .143 mm.; width .111 mm.

This species was found in towings taken in Matanzas Lake during August. It was not common, and we have seen it but once since.

Ceratium brevicorne n. sp.

(Plate XXV., Fig. 11 and 12; Plate XXVI., Fig. 13.)

Body small, compressed, triangular; three spines, one anterior and two posterior, the left posterior one quite small. The surface is slightly roughened by the small plates, but there are no small spines. The long anterior spine smooth.

This is a compact robust little species, about two and a half times as long as wide. The shell is curved so as to be convex on the dorsal surface and concave on the ventral. The three horn-like processes or spines are straight prolongations of the shell; no specimen was found in which they were bent or curved. Length, including spines, .115 mm.; width .046 mm.

This is a rather rare form. It was found during August in towings from Matanzas Lake, in company with *Peridinium tabulatum* Ehrbg., and has been observed only at rare intervals since. It can be distinguished very readily by its compact triangular body and short straight spines.

Tintinnopsis illinoisensis n. sp.

(Plate XXVI., Fig. 14 and 16.)

Animal small, ovate, inhabiting a narrow cylindrical or thimble-shaped chitinous shell, covered for the most part with small sharp angled grains of sand. Fundus obtusely conical or rounded. Shell either of the same diameter throughout, or slightly dilated at oral opening. Sides straight, more than twice as long as wide.

This species agrees very closely with *T. beroidea* Stein, and I place it here provisionally until its minute structure can be more closely studied. The shape of the lorica is characteristic: long, narrow, with straight sides, often slightly dilated at the mouth, and frequently with a bluntly conical fundus, giving it the shape of a rather long thimble. It is smaller than *T. beroidea*; its average length being .059 mm. and the average width .029 mm.

It was found in April and May, in company with *Codonella cratera* Leidy, in tows from the Illinois River, Thompson's Lake, and Quiver Lake.

Opercularia irritabilis n sp.

(Plate XXVI., Fig. 17 and 18.)

Body ovate, elongate, truncated posteriorly, two and a half times as long as wide. Greatest diameter in front of the middle, from whence the sides slope gradually from the posterior end. Peristome border everted, thickened, forming a conspicuous ridge or ring; constricted below the border.

Ciliary disc slightly dome-shaped, not highly elevated; two rows of cilia present. The cuticular surface is smooth. Endoplasm granular, yellowish. Contractile vacuole large, circular, placed in the anterior part, near the peristome. Nucleus band-like, curved, placed transversely in the anterior part of the body.

The zoöids are very sensitive, and when contracted they have an oval shape; the anterior part is projected into a snout-like prominence and thrown into numerous longitudinal folds; while the posterior part is contracted around the base of the pedicle, and thrown into transverse plications. The membranous collar is not very conspicuous. The pharynx is large, extends half the length of the body, and is lined with cilia. The endoplasm in the posterior part of the body is clear, and numerous fine longitudinal striations can be differentiated. These unite and form the core of the stalk, which has also fine longitudinal striations. The stalk is variously branched. Some of the zoöids have long pedicles, while others are nearly sessile. The colonies are large, consisting of several hundred individuals. Multiplication by longitudinal division was noticed. Length, .178 mm. to .20 mm.; width .078 mm.

This species is similar to *Opercularia articulata* Ehrbg., but differs from it in the shape of the body, the character of the peristome border and pharynx, and the elevation of the ciliary disc.

It was found during the summer months at many of the stations, always attached to some animal, and seemed to prefer the young musk turtle, *Aromochelys odoratus*. It also occurred on the backs of the snapping turtle, *Chelydra serpentina*, and the crayfishes *Cambarus diogenes*, and *C. blandingii* var. *acuta*.

Tokophrya quadripartita C. & L. was found common in company with this species, as was also a small *Opercularia* which may turn out to be a variety. The zoöids are small—length .08 mm.; width .042 mm.—but otherwise they seem to agree with the larger species. A part of the food of this species consists of diatoms and *Euglena*.

Collections are still being made at the various stations, and further study will no doubt add other forms to this list.

Havana, May 12, 1896.

EXPLANATION OF PLATES.

Plate XXII.

Fig. 1. *Brachionus variabilis* n. sp.
Fig. 2. " *variabilis* n. sp. Form without posterior spines.

Plate XXIII.

Fig. 3. *Brachionus punctatus* n. sp. Lateral view.
Fig. 4. " *punctatus* n. sp. Dorsal view.
Fig. 5. " *punctatus* n. sp. Anterior and posterior ends of lorica.
Fig. 6. *Brachionus budapestinensis* Daday.

Plate XXIV.

Fig. 7. *Brachionus mollis* n. sp. Dorsal view.
Fig. 8. " *mollis* n. sp. Lateral view.

Plate XXV.

Fig. 9. *Difflugia tuberculosa* n. sp.
Fig. 10. " *tuberculosa* n. sp. Another form.
Fig. 11. *Ceratium brevicorne* n. sp. Ventral view.
Fig. 12. " *brevicorne* n. sp. Dorsal view.

Plate XXVI.

Fig. 13. *Ceratium brevicorne* n. sp. Lateral view.
Fig. 14. *Tintinnopsis illinoisensis* n. sp.
Fig. 15. " *illinoisensis* n. sp. Another form.
Fig. 16. " *illinoisensis* n. sp. Another form, not so much magnified.
Fig. 17. *Opercularia irritabilis* n. sp. Expanded zoöid.
Fig. 18. " *irritabilis* n. sp. Contracted zoöid.

ARTICLE XI.—*A Check-List of the Coccidæ.* BY T. D. A. COCKERELL, *New Mexico Agricultural Experiment Station.*

Anyone who will take the trouble to peruse the "Zoological Record" will see that the present is a time of unusual activity among coccidologists. In the last volume to hand, that for 1893, nearly four pages are occupied by the abstract of the literature on this family, as against three pages for the rest of the Homoptera! Before many years have passed, the *Catalogue général des Hémiptères* of M. Severin will have reached the Coccidæ, and we may then expect to be presented with an elaborate bibliographical index to the group. In the meanwhile the works of Signoret, Comstock, Maskell, and the forthcoming list of American Homoptera by Ashmead, will greatly assist us in reviewing the subject; but I have thought that a check-list, complete to date, would be a noteworthy convenience at the present time.

In preparing this list I have consulted almost all the recent works, but for many of the older ones have been obliged to rely on the information given by Signoret. A list of the one hundred and twenty-four persons who have named genera, species, or varieties of Coccidæ is appended, with the dates on or between which their writings pertinent in this connection were published. For the older works, the dates may not in all cases be perfectly correct, as those given by Signoret and Hagen do not always agree. The numbers in parentheses after the authors' names indicate the number of valid species described by each.

Specific names may be placed in three categories according to the manner of publication:

(1.) *Nomina nuda.* Names published wholly without description. These are entirely ignored in the present list.

(2.) *Nomina seminuda.* Names published with descriptive matter insufficient for the determination of the species. These are included, but numbered separately from the rest. The length of a description is not a proper test in this connection, as a very short account may be ample to identify a well-marked species, while some quite long descriptions are inadequate.

(3.) *Nomina valida.* Names published with descriptions sufficient for the recognition of the species. These are numbered consecutively.

S. means synonym, v., variety or mutation.

Many names proposed by Green, W. G. Johnson, Olliff, and the present writer have been included, though unpublished at the time of writing; but in every case the description is understood to have been prepared, and to be awaiting very early publication. For the reference of *Ortonia natalensis* to *Icerya* I am indebted to Mr. L. O. Howard, who has examined specimens. The use of the name *vitis* for *Margarodes vitium* seems to be demanded by strict priority, though it is only adopted with extreme reluctance. *Tetrura* is referred to *Oudablis*, as it seems to be practically identical with it. *Asterolecanium oncidii* is restored, as I have received from Trinidad (Hart) a different species, which I believe to be the real *A. aureum*. In *Lecanium* I have separated the section *Eulecanium*; but among the tropical forms I have not even distinguished *Bernardia* or *Saissetia* (*L. oleæ*, &c.), because the very large number of new species lately discovered necessitates a thorough revision of the groups, with more prolonged study than is possible for me at the present. I am not familiar with *Aspidiotus sabalis*, Comst., but have no option but to propose a generic name (*Comstockiella*) for it, as Comstock's excellent description and figures show that it is not an *Aspidiotus*. Some of its characters might almost be called Psylliform.

The Japanese species are placed with the palæarctic, but it must be admitted that many of them have oriental or Indian affinities.

The species added since the list was made up are numbered consecutively from the end of the list.

LIST OF AUTHORITIES.

Anderson, J., 1787–95. (1.)
Ashmead, W. H., 1879–91. (1.)
Atkinson, E. T., 1886–89. (1.)
Baerensprung, F. von, 1849. (4.)
Beccari, 1877. (1.)
Bernard. (1.)
Bergen, C. A. von, 1739–48.
Boisduval, J. A., 1867–68. (10.)
Bosc d'Antic, L. A. G., 1784.
Bouché, P. F., 1833–51. (17.)
Brandt, J. F., 1834–36. (1.)
Bréme, F. de. (1.)
Bremi-Wolf, J. J., 1847.
Buckton, G. B., 1894.
Burmeister, H. C. C., 1839–49. (1.)
Butler, A. G., 1876.
Chavannes, M. A., 1848. (2.)
Cockerell, T. D. A., 1892–95. (104.)
Cockerell and Bennett, 1895. (1.)
Cockerell and Townsend, 1894.
Colveé, P., 1880. (5.)
Comstock, J. H., 1881–83. (32.)
Cook, A. J., 1878–79. (1.)
Coquillett, D. W., 1889–90. (5.)
Costa, O. G., 1850–57. (3.)
Craw, Alex., 1893–94. (2.)
Crawford, F. S., (see Maskell).
Curtis, John, 1838–43. (1.)
Dalman, J. W., 1826.
De Geer, Carl, 1752–60. (1.)
Del Guercio, G., 1894. (2.)
Douglas, J. W., 1881–93. (23.)
Dufour, L., 1833–64. (1.)
Dugès, A., 1888.
Fabricius, J. C., 1775–1803. (3.)
Fitch, Asa, 1855–59. (9.)
Fonscolombe, Boyer de, 1831. (4.)
Forbes, S. A., 1884–94. (2.)
Forster, A., 1851.
Frauenfeld, G. R. von, 1868. (1.)
Froggatt, W. W., 1893–94. (22.)
Germar, E. F., 1856. (3.)
Gennadius, P., 1881–83. (2.)
Geoffroy, E. F., 1767. (2.)
Giard, A., 1893–95. (1.)
Gmelin, J. F., 1788–93. (3.)
Goethe, R., 1884. (1.)
Goureau, Col., 1867. (1.)
Gray, J. E., 1828. (1.)
Green, E. E., 1886–95. (44.)
Guérin-Méneville, F. E., 1841–69. (1.)

Guilding, L., 1833. (1.)
Hardwicke, Gen. T., 1822. (1.)
Hardy, J., 1860.
Hartig, Theo., 1839. (1.)
Haworth. A. H., 1812. (1.)
Icery, E., 1864. (1.)
Illiger, J. C. W., (see Burm., 1835).
Inzenga (see Del Guercio).
Johnson, W. G., ined. (4.)
Kaltenbach, J. H., 1846-75.
Karsch (see Mik, 1882).
Kawall, H., 1867.
Kennicott, R., 1854.
Kerner, J. S., 1778. (1.)
Kerr, James, 1781. (1.)
Kirby, W. F., 1891.
Klug, J. C. F., 1830. (1.)
Kollar, V., 1848-51. (1.)
Künckel d' Herculais, J., 1877-78. (1.)
Lamarck, de, 1801. (1.)
Leach, W. E., 1814-18.
Ledermueller, M. F., 1761-76.
Lichtenstein, J., 1873-86. (3.)
Linné, C. von, 1735-72. (17.)
Llave, de la, 1832. (1.)
Loew, F., 1862-84. (4.)
Lucas, H., 1853-55. (2.)
Maskell, W. M., 1879-95. (192.)
Mayer.
Menge, A., 1856. (1.)
Modeer, Adolph, 1778-92. (3.)
Montrouzier, P., 1864. (1.)
Morgan, A. C. F., 1888-93. (5.)
Morgan and Cockerell, 1892-93. (1.)
Newport, Geo., 1852.
Newstead, R., 1891-95. (20.)
Niedielski. (1.)
Nietner, John, 1861. (1.)
Olliff, A. S., 1891. (3.)
Packard, A. S., 1869-70. (2.)
Pallas, P. S., 1767-1801.
Panzer, G. W. F., 1793-1806.
Penzig, O., 1887. (1.)
Philippi, F., 1884. (1.)
Planchon, Prof., 1864. (3.)
Putnam, J. D., 1880. (1.)
Rathvon, Dr., 1854. (1.)
Ratzeburg, J. T. C., 1843-44.
Réaumur, R. A. F. de, 1734-42.
Reed, E. C., 1895.
Riley, C. V., 1873-81. (1.)
Riley and Howard, 1890. (3.)
Rossi, P., 1790-94.
Rübsaamen, E. H., 1894. (5.)
Sasaki, C., 1894. (1.)
Schrader, H. L., 1863. (7.)
Schrank, F. von. P., 1798-1804. (7.)
Scudder, S. H., 1890. (1.)
Shaw, Geo., 1806. (1.)
Signoret, Dr. V., 1867-86. (91.)
Snellen, van Vollenhoven, S. C., 1852. (1.)
Sulc, Karel, 1894-95. (2.)
Targioni-Tozzetti, A., 1866-94. (22.)
Tepper, J. G. O., 1893. (5.)
Thiebaut, de Berneaud. 1824.
Thomas, C., (see Forbes, 1894).
Townsend, C. H. T., 1892. (1.)
Tryon, Hy., 1889. (1.)
Vallot, Dr. J. N., 1830-39. (2.)
Walker, Francis, 1852-58: (3.)
Walsh, B. D., 1860-68. (1.)
Westwood, J. O., 1839-71. (8.)
White, A., 1846.
White, B., 1880.
Zetterstedt, J. W., 1828-40.

COCCIDÆ.

Monophlebinæ.

Monophlebus Leach.

Oriental. ♂ only known.

1. dubius, *Fabr.*
   s. fabricii, *Westw.*
2. atripennis, *Klug.*
3. leachi, *Westw.*
4. saundersi, *Westw.*

Ceylon, ♀ known.

5. zeylanicus, *Green.*

Patria incerta.

6. burmeisteri, *Westw.*

Africa, ♂ only known.

7. raddoni, *Westw.*

Australia.

8. illigeri, *Westw.*
9. crawfordi, *Mask.*
   v. levis, *Mask.*
   v. pilosior, *Mask.*
10. fuscus, *Mask.*

Guerinia, Sign. ex Targ.

11. serratulæ, *Fabr.*

Drosicha, Walk.

12. contrahens, *Walk. MS.*, *Sign.*

Llaveia, Sign.

13. axinus, *Llave.*
    v. dorsalis, *Dugès.*

Tessarobelus, Montr.

14. guerinii, *Montr.*

Callipappus, Guér.

15. westwoodii, *Guér.*

Walkeriana, Sign.

16. floriger, *Walk.*
17. compacta, *Green.*
18. euphorbiæ, *Green.*
19. poleii, *Green.*
20. senex, *Green.*

Cœlostoma, Mask.

New Zealand.

21. assimile, *Mask.*
22. wairoense, *Mask.*
23. zealandicum, *Mask.*
24. compressum, *Mask.*
25. pilosum, *Mask.*

Australia.

26. australe, *Mask.*
27. immane, *Mask.*
28. rubiginosum, *Mask.*

Palæococcus, Ckll.

(Leachia, *Sign.*, preocc.)

Palæarctic.

29. fuscipennis, *Burm.*
30. hellenicus, *Genn.*

New Zealand.

31. zealandicus, *Mask.*

Neotropical.

32. braziliensis, *Walk.*

Fossil. ♂ only known.

33. simplex, *Scudd.*
34. irregularis, *Germ.*
35. pinnatus, *Germ.*
36. trivenosus, *Germ.*

Ortonia Sign.

Neotropical.

37. bouvari, *Sign.*
38. uhleri, *Sign.*

Icerya Sign.

Australia.

39. purchasi, *Mask.*
40. koebelei, *Mask.*

Ethiopian.

41. natalensis, *Dougl.*

Oriental.

42. seychellarum, *Westw.*
 s. sacchari, *Guér.*
43. ægyptiacum, *Dougl.*
44. tangalla, *Green.*
45. crocea, *Green.*
46. pilosa, *Green.*

Neotropical.

47. montserratensis, *R. & H.*
48. palmeri, *R. & H.*

s. g. *Crypticerya*, Ckll.

49. rosæ, *R. & H.*
50. australis, *Mask.*

s. g. *Proticerya*, Ckll.

51. rileyi, *Ckll.*

Porphyrophorinæ.

Porphyrophora, Brandt.

Palæarctic.

52. gallica, *Sign.*
53. hameli, *Brandt.*
 s. armeniaca, *Burm.*
54. perrisi, *Sign.*
55. polonica, *L.*
56. radicum-graminis, *Baer.*
 ? fragariæ, *Gm.*
 ? poterii, *Auctt.*
 ? potentillæ, *Mayer.*
 ? alchimillæ, *Bergen.*

Margarodes, Guild.

Neotropical.

57. formicarium, *Guild.*

s. g. *Sphæraspis*, Giard.

58. vitis, *F. Phil.*
 s. vitium, *Giard.*
 s. trilobitum, *Reed.*

Coccinæ.

Coccus, L.

59. cacti, *L.*
 ? v. bassi, *Targ.*
 v. ceylonicus, *Green.*
60. tomentosus, *Lam.*
61. confusus, *Ckll.*

Capulinia, Sign.

62. sallei, *Sign.*

Gymnococcus, Dougl.

63. agavium, *Dougl.*

Conchaspis, Ckll.
(Pseudinglisia, *Newst.*)

64. angræci, *Ckll.*
 s. rodrigueziæ, *Newst.*
 v. hibisci, *Ckll.*

Eriococcus, Targ.

Palæarctic.

65. aceris, *Sign.*
66. buxi, *Sign.*
67. ericæ, *Sign.*
68. insignis, *Newst.*
69. thymi, *Schr.*
70. rorismarinus, *Fonsc.*

American.

71. azaleæ, *Comst.*
72. quercus, *Comst.*
73. neglectus, *Ckll.*
74. coccineus, *Ckll.*
 v. lutescens, *Ckll.*
75. dubius, *Ckll.*

New Zealand.

76. araucariæ, *Mask.*
77. multispinus, *Mask.*
78. hoheriæ, *Mask.*
79. pallidus, *Mask.*
80. raithbyi, *Mask.*
81. phyllocladi, *Mask.*
82. fagicorticis, *Mask.*
83. danthoniæ, *Mask.*

Australia.

76a. araucariæ v. minor, *Mask.*
66a. buxi v. australis, *Mask.*
77a. multispinus v. lævigatus, *Mask.*
84. paradoxus, *Mask.*
85. tepperi, *Mask.*
86. confusus, *Mask.*

87. eucalypti, *Crawf. MS., Mask.*
88. leptospermi, *Mask.*
89. turgipes, *Mask.*
90. coriaceus, *Mask.*
91. conspersus, *Mask.*

Rhizococcus, Sign.

Palæarctic.

92. gnidii, *Sign.*

New Zealand.

93. celmisiæ, *Mask.*
94. fossor, *Mask.*
95. totaræ, *Mask.*
96. pulchellus, *Mask.*
97. maculatus, *Mask.*
98. intermedius, *Mask.*

Australia.

99. grandis, *Mask.*
v. spinosior, *Mask.*
100. casuarinæ, *Mask.*
101. pustulatus, *Mask.*

Gossyparia, Sign.

Palæarctic.

102. mannifera, *Hardw.*
s. manniparus, *Sign.*
103. ulmi, *Geoff.*
s. alni, *Mod.*
s. spurius, *Mod.*
? s. farinosus, *DeG.*
s. lanigera, *Gmel.*

New Zealand.

104. cavellii, *Mask.*

Australia.

105. casuarinæ, *Mask.*
106. confluens, *Mask.*

Nidularia, Targ.

107. pulvinata, *Planch.*

Antonina, Sign.

108. purpurea, *Sign.*
109. brachypodii, *Licht.*

Xylococcus, Lw.

110. filiferus, *Lw.*

Cerococcus, Comst.

111. quercus, *Comst.*
112. ehrhorni, *Ckll.*

Solenophora, Mask.

113. fagi, *Mask.*
114. corokiæ, *Mask.*

Rhizœcus, Künck.

115. falcifer, *Künck.*

Puto, Sign.

116. antennata, *Sign.*

Cryptococcus, Dougl.

117. fagi, *Baer.*

Ripersia, Sign.

Palæarctic.

118. corynephori, *Sign.*
119. pulveraria, *Newst.*
120. tomlinii, *Newst.*
121. fraxini, *Newst.*
122. subterranea, *Newst.*
774. terrestris, *Newst.*

Nearctic.

123. maritima, *Ckll.*

Australia.

124. leptospermi, *Mask.*

New Zealand.

125. formicicola, *Mask.*
126. rumicis, *Mask.*
127. fagi, *Mask.*

Phenacoccus, Ckll.

(Pseudococcus, *Sign.*, ex err.)

Palæarctic.

128. aceris, *Sign.*
129. æsculi, *Sign.*
130. brunnitarsis, *Sign.*
131. hederæ, *Sign.*
132. mespili, *Geoff.*
? s. pruni, *Burm.*
133. platani, *Sign.*
134. quercus, *Dougl.*

135. ulicis, *Dougl.*
136. ulmi, *Dougl.*
137. socius, *Newst.*
138. pergandei, *Ckll.*

Nearctic.

139. yuccæ, *Coq.*
   s. mexicanus, *Ckll.*
140. helianthi, *Ckll.*

Neotropical.

139a. yuccæ v. barberi, *Ckll.*

Oriental.

141. mangiferæ, *Green.*

Australia.

142. casuarinæ, *Mask.*
143. nivalis, *Mask.*

New Zealand.

144. asteliæ, *Mask.*

Oudablis, Sign.
   (Tetrura, *Licht.*)
145. quadricaudata, *Sign.*
146. rubi, *Licht.*
147. lauri, *Boisd.*
148. piceæ, *Lw.*

Dactylopius, Costa.

Palæarctic.

149. alaterni, *Sign.*
150. caricus, *Genn.*
151. ceratoniæ, *Sign.*
152. citri, *Boisd.*
   s. destructor, *Comst.*
   ? s. farinosus, *DeG.*
   s. phyllococcus, *Ashm.*
   s. brevispinus, *Targ*, p.p.
153. ficus, *Sign.*
154. indicus, *Sign.*
155. lavandulæ, *Sign.*
156. robiniæ, *Sign.*
157. viburni, *Sign.*
158. vitis, *Nied.*
159. walkeri, *Newst.*
775. hibernicus, *Newst.*
776. radicum, *Newst.**

Patria incerta.

160. adonidum, *L.*
   s. longispinus, *Targ.*
   ? s. coffeæ, *Lederm.*
   s. longifilis, *Comst.*
161. bromeliæ, *Bouché.*
162. cyperi, *Sign.*
163. hoyæ, *Sign.*
164. liliacearum, *Bouché.*
165. mamillariæ, *Bouché.*
166. perrisii, *Sign.*
167. pteridis, *Sign.*
168. tuliparum, *Bouché.*
169. theobromæ, *Dougl.*
170. zamiæ, *Lucas.*

American.

171. crawii, *Coq.*
172. ryani, *Coq.*
173. ephedræ, *Coq.*
174. trifolii, *Forbes.*
175. sorghiellus, *Forbes.*
176. aphyllonis, *Ckll.*
1. ? poæ, *Thos.*
177. virgatus, *Ckll.*
   v. farinosus, *Ckll.*
   v. humilis, *Ckll.*
178. segregatus, *Ckll.*
179. simplex, *Ckll.*
180. brevipes, *Ckll.*
181. nipæ, *Mask*
182. filamentosus, *Ckll.*
183. solani, *Ckll.*
   v. atriplicis, *Ckll.*
184. townsendi, *Ckll.*
   v. steelii, *Ckll. and Twns.*
185. sacchari, *Ckll.*

---

* I believe that the form described by Newstead as the second stage of *D. radicum* is a distinct species, and a true Ripersia. It cannot well be doubted that it is, in fact, the long-lost *Coccus halophilus*, Hardy, which must be called *Ripersia halophila*.

186. olivaceus, *Ckll.*

Sandwich Is.

187. vastator, *Mask.*

Marquesas Is.

188. pandani, *Ckll.*

Oriental.

189. viridis, *Newst.*
190. ceriferus, *Newst.*
191. cocotis, *Mask.*
192. talini, *Green.*
193. scrobicularum, *Green.*

Ethiopian.

194. graminis, *Mask.*

Australian.

195. affinis, *Mask.*
196. lobulatus, *Mask.*
197. herbicola, *Mask.*
198. ericicola, *Mask.*
199. acaciæ, *Mask.*
200. albizziæ, *Mask.*
201. hibbertiæ, *Mask.*
202. globosus, *Mask.*
203. eucalypti, *Mask.*

New Zealand.

204. alpinus, *Mask.*
205. calceolariæ, *Mask.*
206. glaucus, *Mask.*
207. poæ, *Mask.*
208. arecæ, *Mask.*
209. aurilanatus, *Mask.*
210. obtectus, *Mask.*
211. iceryoides, *Mask.*

Subfam. incert.

Ochyrocoris, Menge.
(Fossil in amber.)

212. electrina, *Menge.*

Polyclona, Menge.
(Fossil in amber, no species named; probably not a coccid.)

Aspisarcus, Newpt.

2. eucalypti, *Newpt.*

Genus incertus.

Palæarctic.

3. aterrimus, *Costa.*
4. asari, *Schr.*
5. cratægi, *Kalt.*
6. crispus, *Fonsc.*
7. cryptus, *Kawall.*
8. elioides, *Costa.*
9. fagi, *Walk.*
10. frauenfeldi, *Karsch.*
11. fraxini, *Chav.*
12. halophilus, *Hardy.*
13. hordeolum, *Dalm.*
14. hypericonis, *Gmel. ex Pall.*
15. hystrix, *Baer.*
16. laricis, *Bouché.*
17. myrtilli, *Kalt.*
18. pilosellæ, *L.*
19. purpuratus, *Dalm.*
20. strobi, *Baer.*
21. uva, *Mod.*
22. uvæ-ursi, *L.*
    s. arbuti, *Fabr.*
23. xylostei, *Schr.*

Ethiopian.

24. capensis, *L.*
25. diosmatis, *Mod.*
26. ceratiformis, *Butler.*

Oriental.

27. laniger, *W. F. Kirb.*
28. chlœoon, *And.*
29. diacopeis, *And.*
30. erion, *And.*
31. koleos, *And.*
32. microogenes, *And.*
33. oogenes, *And.*
34. sinensis, *Walk.*
35. trichodes, *And.*

Australia.

36. blanchardii, *Targ.*

America.

37. caudatus, *Walk.* ♂.
38. edwardsii, *Ashm.* ♂.
39. tuberculatus, *Bouché.*

Fossil in Amber.

40. avitus, *Menge* ♂.
41. termitinus, *Menge* ♂.

Hemicoccinæ.

Kermes, Auctt.

Palæarctic.

213. ballotæ, *Sign.*
214. bauhinii, *Planch.*
215. ilicis, *Linn.*
 s. vermilio, *Planch.*
216. fuscus, *Sign.*
217. gibbosus, *Sign.*
218. pallidus, *Sign. ex Réaum.*
219. reniformis, *Sign. ex Réaum.*
220. variegatus *Gm.*

Ethiopian.

221. quercus, *Newst.*

Nearctic.

222. galliformis, *Riley.*
223. gillettei, *Ckll.*

Australian.

224. acaciæ, *Mask.*

Ortheziinæ.

Orthezia, Bosc.

Palæarctic.

225. cataphracta, *Shaw.*
 s. chiton, *Zett.*
 s. signoreti, *B. White.*
226. urticæ, *Linn.*
 s. characias, *Bosc.*
 s. dubius, *Panz.*
 ? s dispar, *Kalt.*
 ? s. glechomane, *Fab.*
 ? s. delavauxi, *Thib.*
 ? s. uva, *Mod.*
227. floccosa, *DeG.*
 s. normani, *Dougl.*
228. mænariensis, *Dougl.*

Nearctic.

42. americana, *Walk.*
229. occidentalis, *Dougl.*
230. annæ, *Ckll.*
231. nigrocincta. *Ckll.*
232. sonorensis, *Ckll.*

Neotropical.

233. insignis, *Dougl.*
 s. nacrea, *Buckt.*
234. prælonga, *Dougl.*

Ortheziola, Sulc.

235. vejdovskyi, *Sulc.*

Asterolecaniinæ.

Lecaniodiaspis, Targ.

236. sardoa, *Targ.*
 s. g. *Prosopophora*, Dougl.

Nearctic.

237. yuccæ, *Riley MS.*, *Twns.*
 v. rufescens, *Ckll.*
238. prosopidis, *Mask.*
777. celtidis, *Ckll.*

Neotropical.

239. dendrobii, *Dougl.*

Japanese.

240. quercus, *Ckll.*

Australian.

241. eucalypti, *Mask.*
242. acaciæ, *Mask.*

Asterolecanium, Targ.

Series i.

Palæarctic.

243. quercicola, *Bouché.*
244. ilicicola, *Targ.*
245. hederæ, *Licht.*
 s. massalongianum, *Targ.*
 s. valloti, *Licht.*
246. arabidis, *Licht. MS.*, *Sign.*
247. fimbriatum, *Fonsc.*

Tropical.

248. aureum, *Boisd.*
249. oncidii, *Ckll.*
 s. aureum, *Targ. ex err.*
 ? s. of epidendri, *Bouché.*
250. pustulans, *Ckll.*

Australia.

251. stypheliæ, *Mask.*
252. ventruosum, *Mask.*

New Zealand.

253. epacridis, *Mask.*

Series ii.

254. bryoides, *Mask.*

Series iii.

Tropical.

255. bambusæ, *Boisd.*
256. miliaris, *Boisd.*
    v. longum, *Green.*
257. delicatum, *Green.*
258. solenopheroides, *Green.*
259. palmæ, *Ckll.*
260. urichi, *Ckll.*

s. g. *Pollinia*, Targ.

261. pollini, *Costa.*
    s. costæ, *Targ.*
262. thesii, *Dougl.*
263. grande, *Newst.*

Brachyscelinæ.

Tachardia, Sign.
(Carteria, *Sign.*, preocc.)

American.

264. mexicana, *Comst.*
265. gemmifera, *Ckll.*
266. pustulata, *Ckll.*
267. fulgens, *Ckll.*
268. cornuta, *Ckll.*
269. larreæ, *Comst.*

Oriental.

270. lacca, *Kerr.*
    s. ficus, *Fabr.*

Australian.

271. melaleucæ, *Mask.*
272. acaciæ, *Mask.*
273. decorella, *Mask.*

Gascardia, Targ.

274. madagascariensis, *Targ.*

Apiomorpha, Rübs.
(Brachyscelis, *Schrad.*, preocc.)

275. munita, *Schrad.*
    v. foliosa, *Tepp.*
    v. reducta, *Tepp.*
276. pileata, *Schrad.*
    ? *v.* ovicoloides, *Tepp.*
277. pharetrata, *Schrad.*
278. ovicola, *Schrad.*
    v. glabra, *Tepp.*
279. duplex, *Schrad.*
280. tricornis, *Frog.*
281. minor, *Frog.*
282. variabilis, *Frog.*
283. conica, *Frog.*
    v. subconica, *Tepp.*
284. pomiformis, *Frog.*
285. baeuerleni, *Frog.*
286. dipsaciformis, *Frog.*
287. sessilis, *Frog.*
288. rosiformis, *Frog.*
289. fletcheri, *Olliff.*
290. nux, *Olliff.*
291. umbellata, *Frog.*
292. thorntoni, *Frog.*
293. regularis, *Tepp.*
294. urnalis, *Tepp.*
295. calycina, *Tepp.*
    ? *v.* neumanni, *Tepp.*
296. rugosa, *Frog.*
297. strombylosa, *Tepp.*
298. cornifex, *Rübs.*
299. similis, *Rübs.*
300. karschi, *Rübs.*
301. beyeriæ, *Tepp.*
    ? alii generis.

Ascelis, Schrad.

302. præmollis, *Schrad.*
303. schraderi, *Frog.*
304. attenuata, *Frog.*

Opisthoscelis, Schrad.

305. subrotunda, *Schrad.*
    v. gracilis, *Schrad.*
306. verrucula, *Frog.*
307. maskelli, *Frog.*
308. spinosa, *Frog.*
309. pisiformis, *Frog.*

310. mammularis, *Frog.*
311. fibularis, *Frog.*
312. maculata, *Frog.*
313. serrata, *Frog.*
314. globosa, *Rübs.*

Frenchia, Mask.

316. casuarinæ, *Mask.*
317. semiocculta, *Mask.*

Idiococcinæ.

Sphærococcus, Mask.

Sandwich Is.

318. bambusæ, *Mask.*

Australia.

319. acaciæ, *Mask.*
320. casuarinæ, *Mask.*
321. elevans, *Mask.*
322. froggatti, *Mask.*
323. inflatipes, *Mask.*
324. leptospermi, *Mask.*
325. melaleucæ, *Mask.*
326. pirogallis, *Mask.*
327. styphеliæ, *Mask.*

s. g. *Pseudolecanium*, Ckll.

Japan.

328. tokionis, *Ckll.*

Cylindrococcus, Mask.

Australia.

329. casuarinæ, *Mask.*
330. spiniferus, *Mask.*
331. amplior, *Mask.*

Crocidocysta, Rübs.

315. froggatti, *Rübs.*

Lecaniinæ.

Signoretia, Targ.

332. luzulæ, *L. Duf.*
v. australis, *Mask.*

Eriochiton, Mask.

333. hispidus, *Mask.*
334. spinosus, *Mask.*
335. cajani, *Mask.*

Filippia, Targ.

336. oleæ, *Costa.*
s. follicularis, *Targ.*

Eriopeltis, Sign.

337. festucæ, *Fonsc.*
338. lichtensteinii, *Sign.*
43. brachypodii, *Giard.*

Lichtensia, Sign.

Palæarctic.

339. viburni, *Sign.*
778. eatoni, *Newst.*

Nearctic.

340. lycii, *Ckll.*

Neotropical.

341. lutea, *Ckll.*

Pulvinaria, Targ.

Palæarctic.

342. artemisiæ, *Sign.*
343. betulæ, *Linn.*
v. alni, *Dougl.*
344. camellicola, *Sign.*
345. ericæ, *Lw.*
346. fraxini, *Sign.*
347. linearis, *Targ.*
348. mesembryanthemi, *Vall.*
349. oxyacanthæ, *Linn.*
350. persicæ, *Newst.*
351. populi, *Sign.*
352. ribesiæ, *Sign.*
353. tremulæ, *Sign.*
354. vitis, *Linn.*
355. carpini, *Linn.*
356. euonymi, *Gour.*
44. fagi, *Hardy.*
357. lanata, *Gm.*
s. marginata, *Targ.*
358. aurantii, *Ckll.*

Nearctic.

359. innumerabilis, *Rathv.*
s. acericola, *W. & R.*
360. macluræ, *Kenn. MS., Fitch.*
361. bigeloviæ, *Ckll.*

Neotropical.

362. urbicola, *Ckll.*
363. dendrophthoræ, *Ckll.*
364. cupaniæ, *Ckll.*
365. simulans, *Ckll.*
779. broadwayi, *Ckll.*

Oriental.

366. obscura, *Newst.*
367. gasteralpha, *Icery.*
    s. iceryi, *Guér.*
368. psidii, *Mask.*
369. tessellata, *Green.*
370. tomentosa, *Green.*

Australian.

371. flavicans, *Mask.*
372. maskelli, *Olliff.*
    s. atriplicis, *Mask.*
    v. spinosior, *Mask.*
373. dodoneæ, *Mask.*
374. tecta, *Mask.*

Sandwich Is.

375. mammeæ, *Mask.*

Patria incerta.

45. cestri, *Bouché.*
376. brassiæ, *Ckll.*
    s. g. *Takahashia*, Ckll.
377. japonica, *Ckll.*
    s. g. *Protopulvinaria*, Ckll.
378. pyriformis, *Ckll.*

Pseudopulvinaria, Atk.

379. sikkimensis, *Atk.*

Ceronema, Mask.

380. banksiæ, *Mask.*

Ctenochiton, Mask.

New Zealand.

381. depressus, *Mask.*
    v. minor, *Mask.*
382. elæocarpi, *Mask.*
383. elongatus, *Mask.*
384. flavus, *Mask.*
385. fuscus, *Mask.*
386. hymenantheræ, *Mask.*
387. perforatus, *Mask.*
388. piperis, *Mask.*
389. viridis, *Mask.*
390. dacrydii, *Mask.*

Australia.

391. eucalypti, *Mask.*
392. rhizophoræ, *Mask.*

Lecanochiton, Mask.

393. metrosideri, *Mask.*
394. minor, *Mask.*

Inglisia, Mask.

New Zealand.

395. leptospermi, *Mask.*
396. ornata, *Mask.*
397. patella, *Mask.*
398. inconspicua, *Mask.*
399. fagi, *Mask.*

Australia.

400. foraminifer, *Mask.*

Neotropical.

401. vitrea, *Ckll.*

Fairmairia, Sign.

402. bipartita, *Sign.*

Ceroplastodes, Ckll.

403. niveus, *Ckll.*
404. acaciæ, *Ckll.*
405. daleæ, *Ckll.*

Vinsonia, Sign.

406. stellifera, *Westw.*
    s. pulchella, *Sign.*

Ceroplastes, Gray.

Palæarctic.

407. rusci, *Linn.*
    s. hydatis, *Costa.*
    s. testudiniformis, *Targ.*
    s. artemisiæ, *Rossi.*
408. mimosæ, *Sign.*

Nearctic.

409. irregularis, *Ckll.*

Neotropical.

410. cassiæ, *Chav.*
411. fairmairii, *Targ.*

412. iheringi, *Ckll.*
413. psidii, *Chav.*
414. cistudiformis, *Twns. MS.*, *Ckll.*
46. chilensis, *Gray.*
47. jamaicensis, *A. White.*
415. cirripediformis, *Comst.*
416. plumbaginis, *Ckll.*
417. depressus, *Ckll.*
418. denudatus, *Ckll.*
419. floridensis, *Comst.*
420. janeirensis, *Gray.*
421. albolineatus, *Ckll.*
422. utilis, *Ckll.*
780. euphorbiæ, *Ckll.*
781. mexicanus, *Ckll.*

Oriental.

423. ceriferus, *Anders.*
  s. dugesii, *Licht. MS.*, *Twns.*
424. vinsoni, *Sign.*
425. actiniformis, *Green.*

Ethiopian.

48. myricæ, *Linn.*

Australian.

426. rubens, *Mask.*
49. australasiæ, *Walk.*

Ericerus, Guér.

427. pé-la, *Westw.*

Physokermes, Targ.

428. abietis, *Mod.*
  s. hemicryphus, *Dalm.*
  s. racemosum, *Ratz.*
429. coloradensis, *Ckll.*
430. insignicola, *Craw*, *emend.*

Lecanium, Illig.

Palæarctic.

431. angustatum, *Sign.*
432. maculatum, *Sign.*
433. elongatum, *Sign.*
434. genistæ, *Sign.*
435. clypeatum, *Dougl.*
436. emerici, *Planch.*

Patria incerta.

437. acuminatum, *Sign.*
438. alienum, *Dougl.*
439. anthurii, *Boisd.*
440. assimile, *Newst.*
  v. amaryllidis, *Ckll.*
441. beaumontiæ, *Dougl.*
442. palmæ, *Haw.*
  s. cycadis, *Boisd.*
443. depressum, *Targ.*
  ? v. of nigrum, *Nietn.*
444. filicum, *Boisd.*
  ? v. of hemisphæricum, *Targ.*
445. hemisphæricum, *Targ.*
  v. hibernaculonem, *Boisd.*
  ? v. coffeæ, *Walk.*
446. hesperidum, *Linn.*
  v. lauri, *Boisd.*
447. minimum, *Newst.*
448. oleæ, *Bern.*
  v. testudo, *Curt.*
  ? v. citri, *Inzenga.*
449. tessellatum, *Sign.*
450. perforatum, *Newst.*
451. pseudhesperidum, *Ckll.*
50. vaccinii-macrocarpum, *Goethe.*
452. wistariæ, *Sign.*

Nearctic.

51. platycerii, *Pack.*
453. phoradendri, *Ckll.*

Neotropical.

454. terminaliæ, *Ckll.*
455. longulum, *Dougl.*
  v. chirimoliæ, *Mask.*
456. rubellum, *Ckll.*
457. schini, *Licht. MS.*, *Ckll.*
458. batatæ, *Ckll.*
459. punctatum, *Ckll.*
460. imbricatum, *Ckll.*
461. baccharidis, *Ckll.*
462. urichi, *Ckll.*
463. reticulatum, *Ckll.*

464. sallei, *Sign.*
465. monile, *Ckll.*
466. verrucosum, *Sign.*
467. pseudosemen, *Ckll.*
468. begoniæ. *Dougl.*
 ? *v.* of nigrum, *Nietn.*
782. nanum, *Ckll.*

Oriental and Ind. Ocean.

469. viride, *Green.*
470. guerinii, *Sign.*
471. nigrum, *Nietn.*
 ? *v.* depressum, *Targ.*
 ? *v.* begoniæ, *Dougl.*
472. coffeæ, *Walk.*
 ? *v.* of hemisphæricum, *Targ.*
473. mangiferæ, *Green.*
474. planum, *Green.*
 v. maritimum, *Green.*
475. ophiorrhizæ, *Green.*
476. geometricum, *Green.*
477. marginatum, *Green.*
478. expansum, *Green.*
479. antidesmæ, *Green.*
480. caudatum, *Green.*
481. acutissimum, *Green.*
482. piperis, *Green.*
483. formicarium, *Green.*

Australian.

484. patersoniæ, *Mask.*
485. pingue, *Mask.*
486. scrobiculatum, *Mask.*
487. baccatum, *Crawf. MS., Mask.*
488. frenchii, *Mask.*

New Zealand.

489. cassiniæ, *Mask.*

s. g. *Toumeyella*, Ckll.

490. mirabile, *Ckll.*
491. quadrifasciatum, *Ckll.*

s. g. *Pseudokermes*, Ckll.

492. nitens, *Ckll.*

s. g. *Eulecanium*, Ckll.

Palæarctic.

493. aceris, *Schr.*
494. æsculi, *Koll.*
495. tiliæ, *Linn.*
496. ulmi, *Linn.*
 v. fasciatum, *Costa.*
497. alni, *Mod.*
498. berberidis, *Schr.*
499. capreæ, *Linn.*
 s. cypræola, *Dalm.*
 s. gibber, *Dalm.*
 s. salicis, *Bouché.*
500. cerasi, *Goethe.*
501. ciliatum, *Dougl.*
502. corni, *Bouché.*
503. coryli, *Linn.*
504. distinguendum, *Dougl.*
505. fuscum, *Gmel.*
506. quercus, *Linn.*
507. genevense, *Targ.*
508. bituberculatum, *Targ. MS., Sign.*
509. juglandis, *Bouché.*
 ? *s.* juglandifex, *Fitch.*
 ? *s.* variegatum, *Goethe.*
510. mori, *Sign.*
511. persicæ, *Fabr.*
512. prunastri, *Fonsc.**
513. pyri, *Schr.*
514. rosarum, *Snell.*
515. rotundum, *Sign. ex Réaum.*
516. rugosum, *Sign.*
517. sarothamni, *Dougl.*
518. douglasi, *Sulc.*
519. rubi, *Schr.*

Nearctic.

520. antennatum, *Sign.*
521. caryæ, *Fitch.*
 v. canadense, *Ckll.*
52. cerasifex, *Fitch.*
522. fletcheri, *Ckll.*

* According to Mr. R. Newstead (*in litt.*), *L. prunastri* and *L. rotundum* are forms of one species.

523. armeniacum, *Craw.*
? *v.* of pruinosum.
524. pruinosum, *Comst. MS., Coq.*
525. corylifex, *Fitch.*
? *s.* of coryli, *L.*
526. cynosbati, *Fitch.*
527. fitchi, *Sign.*
528. quercitronis, *Fitch.*
529. robiniarum, *Dougl.*
s. robiniæ, *Riley MS., Twns.*
530. quercifex, *Fitch.*
531. ribis, *Fitch.*
532. tarsale, *Sign.*
533. tulipiferæ, *Cook.*
534. lintneri, *Ckll. & Benn.*

Myxolecanium, Beccari.

535. kibaræ, *Beccari.*

Genus incert.

53. angræci, *Boisd.*
54. australe, *Walk.*
55. cambii, *Ratz.*
56. capense, *Walk.*
57. epidendri, *Bouché.*
? *s.* Asterolecanium oncidii.
58. gigas, *Bremi.*
? *s.* of Kermes sp.
59. vagabundum, *Kalt. ex Först.*
60. vulgare, *Först.*

Lecanopsis, Targ.

Palæarctic.

536. rhizophila, *Targ.*
537. formicarum, *Newst.*
783. brevicornis, *Newst.*

Mexican.

61. dugesii, *Licht. MS., Sign.*

Australia.

784. filicum, *Mask.*

Spermococcus, Giard.

538. fallax, *Giard.*

Exæretopus, Newst.

539. formiceticola, *Newst.*

Aclerda, Sign.

540. subterranea, *Sign.*

Diaspinæ.

Aspidiotus, Bouché.

Palæarctic.

541. abietis, *Schr.*
s. pini, *Comst.*
s. abietis, *Comst.*
542. affinis, *Targ.*
543. betulæ, *Baer.*
544. caldesii, *Targ.*
545. ceratoniæ, *Sign.*
62. ericæ, *Boisd.*
546. denticulatus, *Targ.*
547. duplex, *Ckll.*
63. genistæ, *Westw.*
s. ulicis, *Sign.*
64. gnidii, *Sign.*
548. hederæ, *Vall.*
? *v.* nerii, *Bouché.*
549. hippocastani, *Sign.*
550. ilicis, *Sign.*
551. juglandis, *Colv.*
? *s.* juglans-regiæ, *Comst.*
552. lentisci, *Sign.*
553. niger, *Sign.*
554. oleæ, *Colv.*
555. oleastri, *Colv.*
556. ostreæformis, *Curt.*
s. pyri, *Licht.*
557 oxyacanthæ, *Sign.*
558. zonatus, *Frauenf.*
s. quercus, *Sign.*
559. spurcatus, *Sign.*
560. secretus, *Ckll.*
561. signoreti, *Comst.*
s. Targionia nigra, *Sign.*
562. tiliæ, *Sign.*
563. villosus, *Targ.*
564. vitis, *Sign.*
565. piricola, *Del Guercio.*
? *s.* of Diaspis pyri, *Colv.* ♀,
785. albopunctatus, *Ckll.*

786. minimus, *Leon.*
787. patavinus, *Berl.*

Patria incerta.

566. aloes, *Boisd.*
567. budleiæ, *Sign.*
568. rapax, *Comst.*
s. camelliæ, *Sign.*, *nec Bdv.*
? s. convexus, *Comst.*
569. chamæropsis, *Sign.*
570. aurantii, *Mask.*
s. coccineus, *Genn.*
s. citri, *Comst.*
v. citrinus, *Coquill.*
571. cyanophylli, *Sign.*
572. cycadicola, *Boisd.*
573. destructor, *Sign.*
v. fallax, *Ckll.*
s. cocotis, *Newst.*
574. epidendri, *Bouché.*
65. kennedyæ, *Boisd.*
575. lataniæ, *Sign.*
576. myrsinæ, *Sign.*
577. nerii, *Bouché.*
? v. of hederæ, *Vall.*
v. limonii, *Sign.*
66. palmarum, *Bouché.*
578. pandani, *Sign.*
579. perniciosus, *Comst.*
580. phormii, *de Brème.*
581. sphærioides, *Ckll.*
582. vriesciæ, *Sign.*
583. spinosus, *Comst.*
788. degeneratus, *Leon.*
789. minor, *Berl.*

Nearctic.

584. ancylus, *Putn.*
585. howardi, *Ckll.*
586. forbesi, *W. G. Johns.*
587. æsculi, *W. G. Johns.*
588. cydoniæ, *Comst.*
589. juglans-regiæ, *Comst.*
? s. of juglandis, *Colv.*
v. pruni, *Ckll.*
v. albus, *Ckll.*
590. obscurus, *Comst.*
591. perseæ, *Comst.*
592. smilacis, *Comst.*
593. tenebricosus, *Comst.*
594. comstocki, *W. G. Johns.*
595. uvæ, *Comst.*
v. coloratus, *Ckll.*
596. townsendi, *Ckll.*

Neotropical.

597. nigropunctatus, *Ckll.*
598. yuccæ, *Ckll.*
599. bowreyi, *Ckll.*
600. latastei, *Ckll.*
601. ficus, *Ashm.*
602. scutiformis, *Ckll.*
603. articulatus, *Morg.*
604. personatus, *Comst.*
605. biformis, *Ckll.*
v. cattleyæ, *Ckll.*
v. odontoglossi, *Ckll.*
606. dictyospermi, *Morg.*
v. arecæ, *Newst.*
v. jamaicensis, *Ckll.*
607. mangiferæ, *Ckll.*
608. punicæ, *Ckll.*
609. diffinis, *Newst.*
s. affinis, *Newst. preocc.*
v. lateralis, *Ckll.*
610. palmæ, *Morg. & Ckll.*
611. mimosæ, *Comst.*
612. sacchari, *Ckll.*
613. hartii, *Ckll.*
v. luntii, *Ckll.*
614. longispina, *Morg.*

Fiji Islands.

615. vitiensis, *Mask.*

Oriental.

616. theæ, *Mask. nec Green.*
67. transparens, *Green.*
? s. of nerii, *Bouché.*
617. orientalis, *Newst.*
618. osbeckiæ, *Green.*
619. occultus, *Green.*
620. trilobitiformis, *Green.*

Australian.

621. ceratus, *Mask.*

622. unilobis, *Mask.*
623. extensus, *Mask.*
624. acaciæ, *Morg.*
 v. propinquus, *Mask.*
625. casuarinæ, *Mask.*
626. eucalypti, *Mask.*
627. subrubescens, *Mask.*
628. fimbriatus, *Mask.*
629. fodiens, *Mask.*
630. bossieæ, *Mask.*
631. cladii, *Mask.*
632. rossi, *Crawf. MS.*, *Mask.*

New Zealand.

633. corokiæ, *Mask.*
634. dysoxyli, *Mask.*
635. atherospermæ, *Mask.*
636. carpodeti, *Mask.*
637. sophoræ, *Mask.*

Comstockiella, Ckll.

638. sabalis, *Comst.*

Diaspis, Costa.

Palæarctic.

639. blankenhorni, *Targ.*
640. colvei, *Penzig.*
641. carueli, *Targ.*
642. juniperi, *Bouché.*
643. minima, *Targ.*
644. leperii, *Sign.*
645. pentagona, *Targ.*
646. pyri, *Colveé.*
 ? *s.* of circularis, *Fitch.*
 ? *v.* pyri, *Boisd. ex err.*
 ? *v.* ostreæformis, *Sign. ex err.*
 ? *v.* piricola, *Del Guercio.*
647. visci, *Schr.*
648. patelliformis, *Sasaki.*

Patria incerta.

649. calyptroides, *Costa.*
650. zamiæ, *Morg.*
651. amygdali, *Tryon.*
 v. lanatus, *Morg. & Ckll.*
652. pinnulifera, *Mask.*

Nearctic.

653. cacti, *Comst.*
 ? *v.* of calyptroides, *Costa*
654. toumeyi, *Ckll.*

Neotropical.

653a. cacti *v.* opuntiæ, *Ckll.*
 v. opunticola, *Newst.*
655. chilensis, *Ckll.*

New Zealand.

656. santali, *Mask.*

Oriental.

657. flavescens, *Green.*

Aulacaspis, Ckll.

Palæarctic.

658. rosæ, *Bouché.*

Patria incerta.

659. boisduvalii, *Sign.*
 ? *v.* tentaculatus, *Morg.*
660. bromeliæ, *Kerner.*
68. cymbidii, *Bouché.*

Nearctic.

790. texensis, *Ckll.*

Pseudoparlatoria, Ckll.

661. parlatorioides, *Comst.*
662. ostreata, *Ckll.*

Parlatoria, Sign.

Palæarctic.

663. victrix, *Ckll.*
664. zizyphus, *Lucas.*
665. targionii, *Del Guercio.*
666. theæ, *Ckll.*
 v. viridis, *Ckll.*
791. calianthina, *Berlese.*

Patria incerta.

667. pergandei, *Comst.*
 v. camelliæ, *Comst.*
 v. crotonis, *Ckll.*
668. proteus, *Curt.*

Australia.

669. pittospori, *Mask.*
670. myrtus, *Mask.*

Syngenaspis, Sulc.

792. parlatoriæ, *S lc.*

Mytilaspis, Sign.

Palæarctic.

69. abietis, *Sign. nec Schr.*
? *v.* of linearis, *Mod.*
70. anguinus, *Bosd.*
? alii generis.
671. ficus, *Sign.*
672. flava, *Targ.*
? *v.* of linearis, *Mod.*
674. linearis, *Mod.*
s. arborum, *Schr.*
s. conchiformis, *Gm.*
s. falciformis, *Baer.*
793. newsteadi, *Sulc.*
675. pomorum, *Bouché.*
? *v.* of linearis, *Mod.*
s. pyrus-malus, *Kenn.*
s. juglandis, *Fitch.*
s. pomicorticis, *Riley.*
? *v.* juglandis, *Sign.*
? *v.* vitis, *Goethe.*
? *v.* ulicis, *Dougl.*
? *v.* flava, *Targ.*
71. saliceti, *Bouché.*
? *s.* of Chionaspis salicis, *L.*
676. crawii, *Ckll.*

Patria incerta.

677. pinnæformis, *Bouché.*
? *v.* citricola, *Pack.*
678. citricola, *Pack.*
s. flavescens, *Targ.*
s. fulva, *Targ.*
? *v.* of pinnæformis, *Bouché.*
679. gloverii, *Pack.*
680. longirostris, *Sign.*
? *s.* Ischnaspis filiformis, *Dgl.*

Neotropical.

681. philococcus, *Ckll.*
682. crotonis, *Ckll.*
683. alba, *Ckll.*
794. carinata, *Ckll.*

Nearctic.

683*a*. alba v. concolor, *Ckll.*

Sandwich Is.

672*a*. flava v. hawaiiensis, *Mask.*

Oriental.

684. elongata, *Green.*
685. pallida, *Green.*

Australia.

686. striata, *Mask.*
687. nivea, *Mask.*
688. grisea, *Mask.*
689. pallens, *Mask.*
690. casuarinæ, *Mask.*
691. formosa, *Mask.*
692. spinifera, *Mask.*
693. convexa, *Mask.*
694. grandilobis, *Mask.*

New Zealand.

695. intermedia, *Mask.*
696. lactea, *Mask.*
697. pyriformis, *Mask.*
698. phymatodidis, *Mask.*
699. metrosideri, *Mask.*
700. leptospermi, *Mask.*
701. cordylinidis, *Mask.*
702. drimydis, *Mask.*
703. epiphytidis, *Mask.*

Pinnaspis, Ckll.

704. buxi, *Bouché.*
? *v.* pandani, *Comst.*
705. pandani, *Comst.*
? *v.* of buxi, *Bouché.*
706. bambusæ, *Ckll.*

Chionaspis, Sign.

Palæarctic.

707. aceris, *Sign.*
708. alni, *Sign.*
709. myrthi, *Bouché.*
710. planchonii, *Sign.*
711. populi, *Baer.*
72. rosæ, *Goethe.*
712. salicis, *L.*
? *s.* saliceti, *Bouché.*
? *v.* fraxini, *Sign.*
s. maquarti, *Targ.*
713. fraxini, *Sign.*

? *v.* of salicis, *L.*
714. vaccinii, *Bouché.*
s. myrtilli, *Kalt.*
715. sorbi, *Dougl.*
716. latus, *Ckll.*
717. bambusæ, *Ckll.*
795. difficilis, *Ckll.*
796. nerii, *Newst.*
797. bilobis, *Newst.*

Patria incerta.

718. aspidistræ, *Sign.*
719. biclavis, *Comst.*
v. detecta, *Mask.*
720. braziliensis, *Sign.*
721. citri, *Comst.*
722. minor, *Mask.*

Nearctic.

723. americana, *W. G. Johns.*
724. euonymi, *Comst.*
725. furfurus, *Fitch.*
s. harrisii, *Walsh.*
s. cerasi, *Fitch.*
726. salicis-nigræ, *Walsh.*
? *v.* of salicis, *L.*
727. ortholobis, *Comst.*
728. pinifoliæ, *Fitch.*
729. nyssæ, *Comst.*
730. spartinæ, *Comst.*
731. lintneri, *Comst.*

Neotropical.

732. major, *Ckll.*

Sandwich Is.

733. prunicola, *Mask.*

Oriental.

734. theæ, *Mask.*
73. gossypii, *Fitch.*
718*a*. aspidistræ v. mussændæ, *Green.*
743*a*. eugeniæ v. varicosa, *Green.*
v. litzeæ, *Green.*
735. vitis, *Green.*
736. graminis, *Green.*
737. minuta, *Green.*
738. acuminata, *Green.*
739. elæagni, *Green.*
740. exercitata, *Green.*

Australian.

741. assimilis, *Mask.*
742. nitida, *Mask.*
743. eugeniæ, *Mask.*
744. xerotidis, *Mask.*

New Zealand.

745. dubia, *Mask.*
746. dysoxyli, *Mask.*

Leucaspis, Sign.

Palæarctic.

74. epidaurica, *Genn.*
747. loewi, *Colv.*
748. pusilla, *Lw.*
749. pini, *Hartig.*
s. candida, *Targ.*
750. signoreti, *Targ.*

Australian.

751. cordylinidis, *Mask.*

Ischnaspis, Dougl.

752. filiformis, *Dougl.*
? *s.* of longirostris, *Sign.*

Fiorinia, Targ.

Palæarctic.

753. sulcii, *Newst.**

Patria incerta.

754. fioriniæ, *Targ.*
s. arecæ, *Boisd.*
s. pellucida, *Targ.*
v. camelliæ, *Comst.*

Australia.

755. acaciæ, *Mask.*
756. expansa, *Mask.*
757. rubra, *Mask.*
758. syncarpiæ, *Mask.*

New Zealand.

759. grossulariæ, *Mask.*
760. minima, *Mask.*
761. stricta, *Mask.*

---

*Mr. Sulc regards this as a Leucaspis.

762. gigas, *Mask.*
s. asteliæ, *Mask.*

Oriental.

763. saprosmæ, *Green.*
764. secreta, *Green.*
765. scrobicularum, *Green.*
766. palmæ. *Green.*

Poliaspis, Mask.

Patria incerta.

767. cycadis, *Comst.*

Australia.

768. exocarpi, *Mask.*

New Zealand.

769. media, *Mask.*

Aonidia, Sign.

Palæarctic.

770. lauri, *Bouche.*
771. blanchardi, *Targ.*

Oriental.

772. corniger, *Green.*

Australia.

773. fusca, *Mask.*

ADDENDA TO JULY 21.

Since the above list was put into the printer's hands, several publications have appeared to which brief reference must be made. Berlese and Leonardi have proposed some new genera of Diaspinæ,—*Howardia* (with *H. elegans*, Leon.), *Aonidiella*, and *Aspidites;* besides giving *Chrysomphalus* generic rank and proposing a new subgenus *Diaspidiotus*. It appears to me, however, that the characters used to distinguish these genera are not always of generic value, while *Howardia* is made to include forms which are really not congeneric.

Newstead has published, as new, *Icerya ewarti* and *Aspidiotus maculatus* from Lagos, and *Parlatoria distinctissima* (which seems to be an *Aonidia*) from Baluchistan.

Mr. Claude Fuller, since the lamentable death of Mr. Olliff, has published the following, to which MS names had been given by Olliff: *Brachyscelis pedunculata*, *B. crispa*, *B. nux*, *B. shraderi*, *B. fletcheri*.

Mr. Green (Ind. Mus. Notes) has given a preliminary account of seventy-two Coccids found in Ceylon. To these may be added the following, kindly communicated from Mr. Green's MSS, bringing the Ceylon list to eighty-seven:

Aspidiotus ficus, Ashm.
" *rossi*, Mask.
" *cyanophylli*, Sign.
" *excisus*, Green.
" *putearius*, Green.
" *cydoniæ*, Comst.
" *secretus*, Ckll.
" *inusitatus*, Green.

Aonidia bullata, Green.
" *loranthi*, Green.
" *obscura*, Green.

Mytilaspis cocculi, Green.
" *gloverii*, Pack.

Diaspis fagrææ, Green.

Conchaspis socialis, Green.

Mr. Green informs me that his *Diaspis circulata* is *Aspidiotus camelliæ*, and that *Dactylopius talini* is *D. ceriferus*.

Miss M. W. Tyrrell has published *Lecanium pruinosum* v. *kermoides* from California. I doubt if it belongs to *pruinosum*. T. D. A. C.

ARTICLE XII.—*On a Bacterial Disease of the Squash-bug* (*Anasa tristis* DeG.). BY B. M. DUGGAR.

INTRODUCTORY.

During July, 1895, while occupied as an Assistant in the Illinois State Laboratory of Natural History, in studying some fungous diseases of the chinch-bug I used many squash-bugs (*Anasa tristis* DeG.) for experimental purposes, their larger size making them convenient for use in certain investigations for which the chinch-bug is poorly adapted. These squash-bugs were kept in a laboratory breeding-cage, and daily supplied with fresh food and a suitable amount of moisture. They were soon observed to be dying in considerable numbers, although I could detect nothing unhealthful in their surroundings.

A fresh lot of the insects was thereupon brought from the field July 23, put into a large breeding-cage, and kept as far as possible under normal conditions. A few of the bugs recently dead in the first outbreak were broken in pieces and scattered about the earth of this new habitation, or touched to the bodies of some of the healthy individuals. A much larger number of this fresh supply of insects was reserved for another small cage, which, with conditions otherwise similar, was left uncontaminated by the bodies of any of the dead or diseased insects. In three days one half of the insects in the infected cage were dead, while in the untreated cage, with so many more individuals, there were only two or three dead. The dead bugs in the infected cage presenting common characters, and a careful microscopic examination showing a well-defined bacillus uniformly abundant, this preliminary test encouraged further experimentation with this disease from a strictly bacteriological standpoint, with a view to an elucidation of both its practical and scientific features.

PRIMARY INFECTION EXPERIMENTS.

In order to refer all cultures and subsequent results to a definite and unmistakable source. a few preliminary infection experiments were begun, the results of which were recorded in detail. It seems well, therefore, to preface particulars concerning the culture and infection work reported in this paper with the following fundamental infection records:

Experiment 1.—A box breeding-cage was stocked with about two hundred squash-bugs, both nymphs and adults, squash leaves being daily supplied as food, and kept fresh by inserting the stems through the cork of a small jar containing water. From the preliminary disease-cage several dead bugs were taken August 1, the bodies torn apart, and the pieces scattered about the earth and food leaves in the new breeding-cage. In two days ten bugs were dead, and in five days a total of sixty dead was reached. At this date a few of the dead insects were again broken in pieces and scattered about the cage, while the remainder were piled in a corner. On the eighth day the mortality reached ninety, and the following day added ten more. The death rate was now much lessened, and from August 12 to August 15 only three deaths occurred. A few insects had been removed for various purposes, and on the last-named date the number of living bugs remaining was between sixty and seventy-five, while about one hundred and fifteen deaths had occurred.

Experiment 2.—As a check on the preceding, about fifty squash-bugs of the same lot were put into a much smaller breeding-cage on the same date, August 1, and kept subject to similar conditions, but without inoculation. The first death was noted August 7, but the body of the dead insect was normal. This cage was observed until August 17, with a record of but one additional death, and this not attributable to the disease.

From the record of these two experiments it will be seen that evidence of the contagious nature of the disease was clear, and after August 17 the cage used in Experiment 1 served as a general source of infection material. The observations show that the greatest mortality was probably from three to six days after the introduction of the disease, and no dead insects were in any case found at the expiration of the first day. The proportion of deaths was undoubtedly greatest among the younger nymphs, but many adults also succumbed. Subsequent experiments likewise confirmed this conclusion, although the difference was not always very great.

Characters of the disease.—The effect on the insect and the *post-mortem* appearances were carefully noted in Experiment 1. A few hours before death the insect may be found in a sluggish condition, resting low on its ventral surface, and often apparently incapable of raising itself erect, or of crawling without a marked drag. If placed on its back, it has no power to return to the normal position. As the disease progresses the insect loses nearly all muscular activity, and a slight waving of limbs and antennæ may be the only indication of life. Squash-bugs cannot attach themselves strongly to the leaves by their limbs; and as they usually frequent the under surface of the leaf, diseased bugs are commonly found on the earth of the cage.

A few hours before death there is no marked discoloration of the body; but the insect becomes slightly darker as death approaches, owing probably to changes in the body fluids. After death the changes are rapid. The nymphs soon assume a deep purplish black hue, the body does not shrink at all, but appears tense and slightly swollen, and in the course of twenty-four hours or more it becomes a mere sack of gruel-like fluids. In this condition the walls readily collapse, and the insect may not bear lifting without breaking. In the adults the body is observed to have a rather moist appearance at the time of death, especially in the cephalic region of the ventral surface of the abdomen. Later, the wet appearpearance is more evident throughout; but the hard chitinous crust does not shrink or collapse, and unless broken, the offensive fluids within are unnoticed. In all cases, the odor—more pronounced and putrefactive than the normal squash-bug odor--is especially characteristic. A short time after death the appendages are very readily separable at the articulations, and it is almost impossible to lift an insect by means of them.

A long series of infection experiments will be described later, and in this connection it is only necessary to note further the *post-mortem* appearances of insects free from this disease. It has been established that bacteria are normally found in the cœcal appendages of many Hemiptera,* among which are the squash-bugs. It consequently seemed of interest to ascertain if these bacteria might become truly pathogenic, or, at least, cause the peculiar *post-mortem* appearances under abnormal conditions—as of lessened food supply. Such investigation was quite superfluous in view of the check experiment above recorded, but, nevertheless, a few healthy individuals were allowed to die from gradual starvation. Under these conditions the body cavity gradually dried out, and when death finally resulted the shell was greatly contracted in the abdominal region, and slightly drawn together ventrally. This was especially true of the nymphs, and later observations were to the same effect. Lessened vitality may encourage the disease, but it has nothing to do with a "spontaneous" occurrence. Moreover, the microscopic characters and the cultivation experiments enumerated later show conclusively that the disease form is entirely distinct from the normal form.

Other nymphs were killed by immersion in the toxic bacterial infusion from a pure culture of the disease organism,—which toxic infusion will be subsequently de-

* "Bacteria Normal to Digestive Organs of Hemiptera." By S. A. Forbes. (Bull. Ill. State Lab. Nat. Hist., Vol. IV., pp. 1—7.)

scribed,—but the usual shrinking of natural death occurred. It is probable that dead bugs placed on a wet surface might absorb moisture and show an appearance somewhat similar to the disease effect, but this is only a surmise.

ISOLATION CULTURE AND GROWTH ON AGAR-AGAR.

A number of dilution cultures were made during the progress of these preliminary experiments, but the results were so uniform that only one such culture will be reported in detail. For some of the earliest dilution cultures dead insects were necessarily employed, and the body fluids were thus greatly mixed. Even with these, however, cultures were obtained which gave one form of colony in great preponderance, while a few other forms were confined to scattered colonies in the original dish. Here, also, the abundant form was identified as a bacillus. Preliminary experiments demonstrated that this form was an effective pathogenic agent for squash-bugs; and as soon as sick insects were available, every precaution was taken to secure a culture with the least practicable admixture of foreign forms.

All the necessary apparatus having been properly sterilized, a sick nymph was thoroughly washed with corrosive sublimate solution, and a fold in the soft body wall of the abdomen was caught in the forceps, and slit with the scissors in such a manner as not to disturb the alimentary organs. A small amount of the exuded body fluid was then transferred with a platinum needle, in the usual manner, to a tube containing peptonized nutrient agar-agar at the prescribed temperature. After shaking well, several transfers were made from this first tube to a second, and finally to a third; and the contents of each were poured into a Petri dish. To the nutrient agar used in these tubes was added a small quantity of squash-leaf decoction, and as this was found to be of advantage, it was continued in all subsequent agar cultures.

In four days the dish from the original tube gave abundant colony formation, and in the next dish about ten colonies appeared. The surface colonies were circular, slightly yellowish white or dirty white, but with a distinct opalescence. The submerged colonies were elliptical or slightly pyriform in vertical projection, growing, toward the surface, more and more laterally compressed. This peculiar growth of submerged facultative anaërobic bacteria has been well explained by Professor H. Marshall Ward,* who has studied in detail under high powers the formation of micro-colonies in certain cell cultures. The horizontal long diameter of such elliptical colonies is in the plane of fission of the rodlets. The form of growth is due to the fact that as the elongating rods are broken up into daughter cells, these cells slip by each other (one over the other) under the pressure of the contracting gelatine or agar; and if in agar, evidently this form will be retained in the macro-colony. To return to the circular colonies, those that had room for the fullest development showed in a few days marked lobulations, and sometimes beautiful fan-like radiations. Furthermore, those submerged colonies that had reached the surface took on the circular form and very soon developed some of the characteristic radiations, although the growth is thinner than when they develop superficially. All stages of these developments are evident in Plate XXVIII., Fig. 1. Submerged colonies appear deeper colored than the surface ones, but this is only an apparent coloration. It will also be seen that there is a film-like growth on the lower surface of the agar beneath deeply submerged colonies. This, also, is the same form which has spread out between the contracted agar surface and the glass.

The lobulated growth appearance is not always present, even in cultures direct from the insect, and like all such radiating bacterial growths, is probably greatly

* "The Formation of Bacterial Colonies" (Annals of Botany, Vol. IX., No. XXXVI., Dec., 1895.)

affected by the amount of moisture, by the temperature, and by all conditions affecting the vitality of the organism. These radiations are apparently more abundant where the amount of moisture is considerable and the temperature about the *optimum*, but with too much moisture the bacillus spreads over the surface as a continuous sheet-like growth. Where the colonies are very abundant they remain small and circular, or become variously united in a complete network. At low temperatures the lobulations seldom occur. I have also made Petri-dish cultures from tubes kept for some time in the laboratory, and on agar containing varied quantities of water, but these marked growth characters were then entirely absent. This may be due to a lessened motility of the bacillus, or to other causes not wholly understood.

After being grown in the laboratory in several successive tube cultures, this organism seems to lose the power of producing the slight yellowish-white color, and the growth becomes a purer opal white.

It should be noted that in subsequent isolation cultures, it was found that the pathogenic form could often be secured pure, even in the first dish, by using sick insects, observing proper sterilization precautions in clipping off a leg in the region of the femur, and transferring to the tube with a platinum needle a little of the exuded fluid. The fluids of the diseased bug are almost pure cultures of the pathogenic organism, and unless the alimentary tract is badly broken down, I have seldom found many foreign germs.

From the above notes it will be seen that with this bacillus there is apparently no tendency towards spontaneous variation in the colonies growing side by side in a culture direct from the insect. I have also carefully observed the growth in cultures from various sources, and the more marked opalescence after continued growth on agar is the only variation noted.

GROWTH CHARACTERS WITH VARIOUS NUTRIENT MEDIA.

Solid media.—On nutrient gelatine this organism makes a rapid growth. Several stab cultures were made on Sept. 30, and the tubes were kept at a cool, living-room temperature. In two days the central needle-path showed a growth throughout its whole extent, and on the third day liquefaction had begun. The appearance is at first that of a short cylindrical or rotund air cavity, from the lower surface of which projects the tapering liquefied portion for about one third of the inoculation line, showing a considerable precipitate in the lower part. On the third day the liquefied portion was considerably extended, occupying an area shaped like an inverted lamp chimney, along the middle line of which extended the undulating precipitate-like bacterial formation. In the course of one week, three fourths of the gelatine was liquefied, and the bacterial growth was scattered through the lower portion in a flocculent manner. The remainder of the gelatine was soon liquefied, the flocculent material settled to the bottom, and with the exception of a slight turbidity the color of the liquefied portion remained unchanged. After standing for about one month, and before any great amount of evaporation had taken place, the light amber-color was changed to a deep reddish amber, and the color became more pronounced as evaporation advanced.

On slices of sterile potato kept in a moist chamber, this organism makes a profuse growth in two days. About this growth there is nothing especially typical; but the dirty-white color is well marked, and the thick film of growth shows a strong tendency to become lobulated on the margins.

Liquid media.—Fluid cultures were made to determine the nature of the growth, and also to ascertain how the organism might be propagated in considerable quantity for infection experiments, if the latter should prove desirable. In bouillon a considerable turbidity is produced in the course of two days; and with further growth a slight film is developed on the surface, and a precipitate begins to accumulate at the bottom. This precipitation increases with the maturity of the culture, the superficial film disappears, and the liquid is left slightly clouded and very little darker than the uninoculated fluid. After the cessation of growth, there is no further change of color in the bouillon. Other cultures were made on decoctions of green corn, of squash leaves, and also on a mixture of bouillon with each of these. The growth differed little from that on bouillon, except in a thicker, scum-like surface film.

Sterile skimmed milk inoculated from a pure culture of the squash-bug bacillus shows considerable curdling in twenty-four hours, and subsequently a rapid production of whey. In one week the curd is about half dissolved, and it soon assumes a somewhat rusty color, as also does the turbid whey. A few days after inoculation the odor from these milk growths is extremely disagreeable, and it becomes vile and penetrating. It resembles the odor of sulphureted hydrogen, and, while not so strong, it is more nauseating. An infusion of the bacillus from a growth on agar was sterilized at a low temperature, and then added to a small quantity of sterile skimmed milk. No change was produced in the milk, and a subsequent inoculation with the active bacillus gave a growth characterized as above.

From the experiments recorded under the head of "Toxic Properties" it is noted that an infusion* of this organism from an agar culture contains some substance fatal to insects, and various media were employed in order to get this substance in a form suitable for chemical analysis. Buckmaster† has mentioned some nutrient media used by Uschinsky for the cultivation of certain

---

* It is well to note here that in this paper I have used the word infusion only to denote the fluid in which bacteria have been diffused for inoculation or other such purposes, and no idea of heat is thereby implied.

† *Ursprung und Beschaffenheit gewisser Bakteriengifte.* (Biol. Centr. Bd. XV., Nr. 3, Feb., 1895.

pathogenic organisms, by means of which a toxic excretion of bacteria may be secured in a way convenient for chemical study. The mixture which I have tried is formulated as follows:

Water	1,000
Glycerine	40-50
Sodium Chloride	5-7
Ammonium Lactate	10
Calcium Chloride	0.1
Magnesium Sulphate	0.2
Potassium Biphosphate	1

To the above formula Uschinsky added a little sugar for some organisms, and urea or uric acid for others. With the bacillus of this squash-bug disease an addition of 5% sugar gave an abundant growth, but the development was very slow. Three weeks after the inoculation a thick yellowish white film had formed on the upper surface, and the bottom of the flask was likewise thickly covered with a sedimentary deposit. During the first two weeks' of growth the liquid had a slight pinkish coloration. An addition of 10% sugar gave much less growth than the above, but the pink coloration was more marked. Urea to the amount of one half per cent. with the formula mentioned, also urea one half per cent. and sugar 5% in each of two other flasks, differed very little from the culture first described, although the pink color was more lasting, and possibly the growth of less extent. The value of these media for securing the toxic principle for analytical purposes cannot yet be determined, as the chemical work has not been completed.

A culture consisting of fermentation broth in bent tubes gave no gas production. The ingredients of the broth used were as follows:

Water	1,000 c.c.
Glucose	20 grms.
Peptone	10 grms.
Sodium Chloride	5 grms.

In a nitrate solution the organism grows well, but there is no reduction of the nitrates, as shown by negative results (absence of red color) from the usual test—

the addition of a few drops of naphthylamine chloride and a small quantity of sodium sulphanilate. The formula for the nitrate solution used is as follows:

Water	1,000 c.c.
Peptone..	1 grm.
Potassium Nitrate	0.2 grm.

INFECTION EXPERIMENTS WITH THE SQUASH-BUG.

Laboratory Experiments.

In addition to the introductory experiments it is necessary to describe in some detail the numerous infections made in the laboratory under various conditions. It was my practice to accompany every experiment, or series of experiments, with a check subjected to similiar conditions, but without inoculation. Moreover, with all the cages and contents of cages, sterilization by means of heat and corrosive sublimate was employed as far as was compatible with the size and nature of the materials employed. Whenever possible, the bugs used for experimental purposes were first kept in the laboratory for two or three days, in order to watch for any "spontaneous" outbreak of the disease.

Experiment 3.—In a breeding-cage which had served as a check on some previous work, there were twenty-eight adult squash-bugs and twelve large nymphs. These insects had remained perfectly healthy throughout, and on August 12 each of the individuals was inoculated by touching to its body the mixed fluids from a diseased bug out of Experiment 1. In four days eighteen bugs were dead, ten adults and eight nymphs; on the fifth day twenty-four were dead, fourteen being adults and ten nymphs; and during the next four days there were only six deaths, one nymph and nine adults remaining. A second inoculation was then made in the same manner as before, and five days thereafter one half of the remaining ten were dead. Four adults survived both inoculations. In this experiment it was noticeable that the nymphs died rapidly during the first few days.

Experiment 4.—One of the most successful experiments with the organism of this disease was the result of testing the bacillus found so abundantly and almost pure in one of the early isolation cultures. A young colony direct from a Petri dish was diffused in a small quantity of water, and each of five squash-bugs was thoroughly wet with the infusion. Three of the insects were dead on the morning of the second day, and at the end of two and one half days all were dead. A check lot of bugs used in conjunction with this experiment remained healthy.

Experiment 5.—About forty squash-bugs were inoculated from diseased insects, the cage being without moisture except that furnished by the food leaves. The results indicate that the disease took rapid effect, as fifteen bugs were dead at the end of five days. From this time the death rate diminished, but the bugs dropped off gradually until only two or three apparently resistant ones remained.

In order to compare the effect of pure cultures of various ages with infusions direct from diseased insects as sources of infection, a series of experiments were made in each of which six bugs were used. When pure cultures were employed, some of the bacterial growth was diffused in distilled water, and in this the insects were momentarily immersed. With the diseased or dead bugs an infusion was likewise prepared by tearing the bodies apart in water. Healthy bugs from two different fields furnished the subjects, and a separate check was used for each lot. All dead insects were removed as soon as observed, in order that the results might follow only from the first infection.

TABLE I.

Experiment No.	No. Insects	SOURCE OF INFECTION.	NUMBER OF DEATHS.					Number of bugs remaining.
			2 days.	3 days.	6 days.	10 days.	Total.	
6	6	Insects from Experiment 1..	3	(1	escap	ed)	3	2
7	6	Isolation culture one month old......................	......	1	......	......	1	5
8	6	Bacillus from pure culture three weeks old..........	1*	......	2	......	3	3
9	6	Bacillus from pure culture one week old.............	......	......	2	1	3	3
10	6	Bacillus from pure culture one day old..............	2	2	(1 esc	aped)	4	1
11	6	Dead chinch-bugs from previous experiment.........	1	(1	escap	ed)	1	4
12	5	Dead grasshopper previously exposed to disease.....	......	......	......	......	......	5
13	6	Uninoculated: Check on Nos. 6, 9, 10, 11, and 12.........	......	(2	escap	ed)	......	4
14	6	Uninoculated: Check on Nos. 7 and 8..................	......	......	......	......	......	6

These experiments further demonstrate the effectiveness of the isolated bacillus, and they also indicate that fresh cultures are more active than old ones. The tube used in Experiment 10 was inoculated the previous day from the tube subsequently used in Experiment 9. This series would also indicate that fresh cultures are as effective for infection as infusions direct from diseased insects. From general observations, however, I should judge that the most effective infection material is from insects recently dead. Experiment 12 is difficult to explain, since a culture from this same grasshopper seemed

* This insect was probably a spent individual of the first brood, and not diseased, as the *post-mortem* characters were not at all indicative of disease.

to yield the disease organism; and, moreover, one of the bugs immersed for a very short time in the infusion from this grasshopper was killed. This grasshopper had been dead for about two days, however, and this may have injuriously affected the disease organism.

Field Experiments.

Experiment 15.—A careful examination of a squash patch on the Agricultural Experiment Station grounds on Sept. 17 resulted in a find of two dead squash-bugs; but microscopic examination showed that the bacteria in the bodies of these insects were different from the disease bacillus. It was doubtful if the disease existed in the field at all at this time, and a field infection test was greatly to be desired. For this purpose several dead bugs from Experiment 1 were teased out in about 40 cc. of water, and this infusion was sprayed upon a squash-vine containing about two hundred bugs. This vine was somewhat isolated from the remainder of the plat. No attempt was made to get the infusion on all of the bugs; but the spray was simply directed to those leaves containing the largest number of insects. The result of the first infection alone was desired, so the dead bugs were removed as soon as found. Three dead insects and three distinctly sick, all nymphs, were removed on the second day, the true disease bacillus being found in all of their bodies. On the third day eight dead insects were removed, and the number of bugs on the vine was much reduced, owing to migration for fresher food supply. One week after infection the total number of diseased insects amounted to eighteen; but before this time nearly all of the bugs had migrated, and the experiment was discontinued.

Experiment 16.—Although the season was far advanced, and the weather probably too cool for the best results, I was encouraged to repeat Experiment 15, with precautions against migration. An infusion of ten dead bugs out of previous experimental lots was employed in the same manner as above, in this case one gill of water being used. This was sprayed upon two hundred or more half-grown nymphs and adults infesting a squash-vine, and the vine then securely covered with mosquito netting. The weather continued quite cool, and on the fourth day after infection fourteen dead bugs were found, all but two of which showed the disease characteristics. On the seventh day there was a total of thirty-two dead bugs. A frost the previous day killed the food leaves, but the stems were still in good condition. This cold so chilled the bugs that they moved very little during the early part of the day; yet an examination of the field, as a check, gave no dead insects which might not have died from injuries by persons passing about. On the tenth day thirteen recent deaths had resulted; and in spite of the precautions taken, many of the bugs had escaped, the wind having frequently displaced the netting. After the twelfth day, October 9, the netting was removed and only one additional count made, the small number of bugs remaining not justifying further observations. A summary of the results is as follows:

September 27, about two hundred squash-bugs were sprayed with infusion of diseased bugs. October 1, fourteen dead insects were counted, and later, additional ones, as follows: October 4, eighteen; October 7, thirteen; October 9, seven; and October 15, three—a total of fifty-five.

Experiment 17.—Parallel with the above and on the same date (September 27), an experiment was made to test in the field the efficiency of old pure cultures of this organism. The growth from two tubes one month old was diffused in a gill of water, and sprayed upon the insects as before. There were, however, more than two hundred bugs present under the netting in this experiment. Four were dead October 1, and subsequent counts of additional dead were as follows: Oct. 4, two; Oct. 7, thirteen; Oct. 9, four; and Oct. 15, one—making a total of twenty-four.

As the weather was unfavorable for the spread of the disease when once established, these experiments must be judged wholly in the light of results accruing from the original infection alone. Evidently the old cultures were not as effective as the infusions from dead bugs, and the difference is even greater than is apparent from the summaries, for there were more insects in Experiment 17 than in No. 16, and fewer bugs escaped towards the later periods of observation. There is every reason to believe that this disease may be spread among squash-bugs in the field.

INFECTION EXPERIMENTS WITH THE CHINCH-BUG (*Blissus leucopterus Say*).

The first infection experiments with chinch-bugs, made in the early part of August, were wholly unsatisfactory, owing to the spent condition of the bugs of the first brood, and the results are not included in this paper. When the second brood began to make its appearance, late in August, all previous experiments were repeated and new ones were begun.

The majority of bugs involved in the series of experiments tabulated below were in the first stage—a few in the second. In each case a large tumbler about one third filled with moist sand and covered with a muslin cloth was the cage extemporized as best adapted for this purpose. The vessels and the sand were previously sterilized, and stalks of Indian corn cut into suitable pieces were regularly supplied as fresh food. A small pill-box of the bugs, approximately five hundred, were then momentarily immersed in the infusions used, or immediately put into the cage with the infection material. The number of dead bugs in each cage was ascertained by actual count, and is given below.

TABLE II.

Experiment No.	SOURCE OF INFECTION.	NUMBER OF DEATHS. 3 days.	5 days.	7 days.	10 days.	Total.	Number of bugs remaining.
18	Pure culture from first isolation—10 days old	76	23	16	5	120	Many.
19	Pure culture from second isolation—5 days old	210	57	64	29	360	About 50.
20	Check-bugs momentarily immersed in distilled water	24	1	2	4	31	Very many
21	Pieces of diseased squash-bugs from Experiment 1	71	152	155	106	484	About 100.
22	Infusion of diseased squash-bugs from Experiment 1	163	89	59	25	336	About 25.
23	Check, untreated	20	3	1	9	33	Very many
24	Additional check, untreated	15	3	4	6	28	Very many

A few dead bugs were left in the cage each time in order to insure continuous infection if the disease were established, and the forceps used in removing the insects were sterilized before passing from one cage to another. In considering the figures in the above table, however, the number of bugs remaining in each experiment at the close must enter into our estimates, for it was imposible to do more than roughly measure the insects when introduced. The results indicate that under the conditions prevailing this disease may be readily communicated to young chinch-bugs, whether the organism is used direct from diseased insects or from pure cultures. Microscopic examination also showed that the usual disease bacteria were present in the bodies of dead insects. In the case of chinch-bugs, the *post-mortem* appearances are not so characteristic as those cited for squash-bugs. The bodies are often slightly swollen, and they do not dry out as rapidly as those dying naturally. Moreover, the color is apparently somewhat dulled.

The success of the experiments in Table II. led to the institution of a series of tests dealing with the effectiveness of chinch-bugs dead from the disease as a source of infection. The number of bugs, style of cage, and other conditions were similar to those in the preceding series. Many of the bugs had now passed the second molt. The following table summarizes the results.

TABLE III.

Experiment No.	Source of Infection.	Number of Deaths.					Number of bugs remaining.
		3 days.	5 days.	7 days.	10 days.	Total.	
25	Dead bugs from Experiments 21 and 22	35	76	24	25	160	Few.
26	Infusion of dead bugs from Experiments 21 and 22	206	79	26	28	339	Few.
27	Dead bugs from check Experiment No. 20	10	8	3	3	24	Many.
28	Check—untreated	8	6	1	3	18	Many.
29	Check-bugs momentarily immersed in water	12	7	2	7	28	Many.

Experiment No. 26 showed a greater number of deaths than No. 25, but the number of bugs remaining at the close was about equal in each, the former having contained at the beginning more bugs than the latter. The series is almost as conclusive as Table II. in showing how effectively the disease may act upon young chinch-bugs; and it further supplements the results of the latter series in showing that the dead bugs from those infected cages were capable of producing the disease anew, while dead bugs from the check had no such power.

The results with young chinch-bugs were so encouraging that a preliminary infection-box experiment was immediately begun. Squash-bugs recently killed by the disease were broken in pieces and thrown about in the box, and numbers of young chinch-bugs were introduced. In a few days some dead insects were found, but after a time the disease seemed to die out. Most of the insects were reaching the pupa state, and experiments were discontinued until the bugs reached the adult condition.

When the adult bugs became abundant, Mr. W. G. Johnson, an Entomological Assistant in the Laboratory, conducted several infection-box experiments with various diseases, and in one of these the bacillus of the squash-bug disease was used. Every effort was made to get the bugs infected, and they were thoroughly wet with the spray of infusions rich with the bacillus direct from fresh pure cultures. Very few bugs died in this box; indeed, no more than died in other boxes with other diseases,, and apparently no more than in the check box. The failure of these experiments with adult chinch-bugs, and on a scale so much larger than the tumbler experiments which I had previously concluded, somewhat chilled the prospect of pushing field experiments.

It was now necessary to test the organism on adult chinch-bugs under the conditions prevailing in the experiments given in Tables II. and III., in order to compare by actual count the death rate of the old bugs with that of the young. In this instance two tumblers were employed for each experiment. The sand in both jars was very slightly moist at the beginning; but in one it was allowed to dry out gradually, while in the other it was kept moist. As before, about five hundred bugs were used in each tumbler. The bugs were brought from the field in quantity, and as some appeared to be stifled, all dead bugs were removed from each of the cages after twenty-four hours, in order to avoid any error from outside sources. When infusions are mentioned, temporary immersion of the insects to secure infection must be understood. The following table gives all essential data.

TABLE IV.

Experiment No.	SOURCE OF INFECTION.	Condition.	NUMBER OF DEATHS. 4 days.	10 days.	Total.
30 *a*	Dead squash-bugs from Experiment 1............	Dry.	30	100	130
30 *b*		Moist.	42	144	186
31 *a*	Infusion from isolation culture three weeks old..	Dry.	18	22	40
31 *b*		Moist.	11	19	30
32 *a*	Infusion from pure culture two weeks old........	Dry.	15	20	35
32 *b*		Moist.	12	27	39
33 *a*	Infusion from pure culture one day old...........	Dry.	19	46	65
33 *b*		Moist.	19	38	57
34 *a*	Dead chinch-bugs supposed to be diseased	Dry.	22	39	61
34 *b*		Moist	18	30	48
35 *a*	Check—untreated................................	Dry.	5	24	29
35 *b*		Moist.	10	19	29

With the differing conditions and the various sources of infection employed, it would seem that there is no chance for misinterpreting the above results. The effect upon young chinch-bugs, as seen in Tables II. and III., was rapid and marked, while all experiments upon adults were slight in effect, and apparently less effective in proportion as the bugs were unconfined and more nearly free to exercise the liberty of the field. A field test was also attempted, but no beneficial results could be noted, and final experimentation along this line was necessarily deferred.

INFECTION EXPERIMENTS WITH THE BOX-ELDER BUG (*Leptocoris trivittatus* Say).

During a cold season in the early part of October, many box-elder bugs were found under a tree near the laboratory, the cold weather having caused them to fall to the ground. Their food supply was then very scant, as the leaves were drying rapidly; nevertheless, the bugs were used for experimental purposes, as it was desirable to test the squash-bug disease on as many Hemiptera as possible. Small box breeding-cages were used, but it soon became impossible to find suitable food. *Post-mortem* appearances and microscopic examination guided my opinions as to the presence of the disease, and the series was early abandoned on account of the condition of the bugs. The appended table is not, however, without interest.

TABLE V.

Experiment No.	No. bugs.	SOURCE OF INFECTION.	SECOND DAY.		SIXTH DAY.		TOTAL.	
			Dead.	Diseased.	Dead.	Diseased.	Dead.	Diseased.
36	12	Infusion from diseased squash-bugs	2	2	3	2	5	4
37	12	Infusion of the bacillus from isolation culture	1	1	Esc	aped.	......	....
38	12	Infusion of the bacillus from old pure culture.	......	....	5	5	5	5
39	12	Infusion of the bacillus from fresh pure culture	1	1	5	3	6	4
40	12	Check—untreated	1	....	2	....	3	....

INFECTION EXPERIMENTS WITH GRASSHOPPERS.

During the progress of this work with the squash-bug bacillus, grasshoppers dead with a supposed contagious disease were received from Prof. C. P. Gillette, Entomologist of the Colorado Agricultural Experiment Station. For a time the two diseases were not clearly distinguished, and some parallel experiments were conducted. It is only necessary here to mention some attempts to inoculate grasshoppers with the squash-bug bacillus. In one cage four grasshoppers were brushed externally with the body fluid from diseased squash-bugs, and in another cage the infection material was from a pure culture of the bacillus ten days old. In the course of ten days two hoppers were dead in each cage, as also in the check lot. With the hoppers from the inoculated cages, isolation cultures, growth on gelatine, and microscopic characters indicated that the bacillus was that of the squash-bug disease; but the only attempt made to inoculate squash-bugs from these dead grasshoppers gave very slight result.

INFECTION EXPERIMENTS WITH GRUBS AND CATERPILLARS.

No true bacterial disease of Hemiptera has previously been reported, and, with few exceptions, these diseases have been confined, as far as known, to lepidopterous and coleopterous insects. In this connection it is to be remembered that *Bacillus insectorum* (*Micrococcus insectorum* Burrill) of the chinch-bug was finally located as a "normal" form,—one of various normal forms common in the cœcal appendages of the higher Hemiptera,—and it consequently cannot be termed pathogenic with our present knowledge of the subject. These facts make experiments with the squash-bug bacillus on grubs of beetles and on caterpillars greatly to be desired.

White grubs, probably larvæ of *Lachnosterna fusca*, were inoculated externally both with fluids from diseased insects and with fresh pure cultures; but in no case was there any successful infection. Four grubs were used in each experiment, and they were kept under observation for about three weeks.

Fall web-worms were also exposed to this disease by touching to their bodies the fluids of diseased squash-bugs, smearing the material over the food leaves, and scattering bits of the diseased bugs about the cage; but the disease took no effect. A few other preliminary experiments were attempted, which are briefly summarized below.

A tomato-worm (Protoparce) nearly full grown was smeared along the line of spiracles with the diseased fluids. Suitable food could not be obtained, but the larva lived ten days, and gradually shrank in size and partly pupated. At this time a microscopic examination was made, but no bacteria could be found in the tissues or in the fluids.

Following the above, a larva of the white-lined morning sphinx, *Deilephila lineata* Fab., was inoculated by clipping off its horn and injecting into the body a small quantity of an infusion from a pure culture. The larva died in two days, filled with bacteria of several kinds, and four squash-bugs were then inoculated from this larva. At the end of two days one of these bugs was dead, but the others remained healthy.

The evidence certainly indicates that this bacillus is not very effective on any insect yet experimented on outside the order Hemiptera, and that the disease it causes is not likely to be confused with any disease previously described. The growth characters alone, indeed, would serve to distinguish the organism specifically.

TOXIC PROPERTIES.

From one of the early isolation cultures I removed several colonies of the disease bacteria from the surface of the agar, and diffused these in a small quantity of distilled water to serve some inoculation purposes. On immersing young squash-bugs in this infusion, death followed almost immediately. With nymphs somewhat older the effect was not so rapid, but the bugs soon succumbed. Young chinch-bugs, flies, and other insects stiffened as if dead on being immersed from one to several minutes. Many of the hard-shelled insects, if removed immediately on becoming rigid, recover in a few minutes sufficiently to crawl away; but even these die if immersed in the infusion for some time.

The rapid action of these infusions suggested that some poisonous principle was excreted by the bacteria, for it seemed impossible that an effect so marked could result from any circumstances concomitant to the mere presence of the bacteria in the water. Nevertheless, similar experiments were made with other active aërobic bacteria; but in these infusions no such marked or permanent effects could be induced.

In general, soft-skinned insects were much more readily affected; and the yellow-necked apple-tree caterpillar, *Datana ministra*, proved to be an excellent subject for experimentation. I give in detail a record of the effect on one of these larvæ, as made by Professor Forbes: The larva was dipped for ten seconds in a strong infusion of the bacteria, and then removed to a piece of filter paper for observation. On removal it was quite rigid, but in two minutes there were slight signs of life, and in three minutes it was wriggling and tossing, continuing these incoherent movements until after the fifth minute, when it lay quietly upon its back. Six minutes after removal from the infusion, the larva ceased entirely to respond to touch, and was apparently dead. It was kept for twenty-four hours more, but gave no evidence of recovery. Such insects as squash-bugs, flies, etc., often make characteristic movements when about to succumb to this poison; and in the stiffness that finally ensues, the legs are often closely drawn together. As mentioned before, many insects will recover from the effect if removed as soon as they become stiff. I shall have further occasion to refer to this stiffness produced in insects previous to death, and as it is doubtless analagous to certain effects of heat, cold, etc., we may conveniently employ for it the term toxic rigor.

In order to avoid any possibility of confounding with these toxic phenomena those incident to drowning, a number of water-beetles (*Dineutes discolor*) were secured for experimentation. It was first ascertained that a water-beetle easily lives in pure bouillon many hours—thirty in the case recorded; and after such a length of time decomposition would have advanced considerably. In dilute squash-leaf decoction this beetle also survives an immersion of many hours; and it is therefore evident that the ingredients which might be dissolved from agar cultures in making the infusions would play no part in the result. In all subsequent cases the infusions were obtained from agar cultures in slanting tubes, or from the Petri dishes, by adding a small quantity of distilled water, and then with the needle diffusing in this some of the bacterial growth. This infusion was then transferred to a deep Petri dish.

It is probably well to give in detail the results of a few experiments with this water-beetle.

(*a*) Three minutes after immersion in an infusion from an isolation culture the beetle became somewhat sluggish, although it made a few rapid dives when touched, and in ten minutes no movement could be induced. After remaining thus immersed five minutes longer, the beetle was transferred to filter paper. Ten minutes later there was slight sign of revival; but this was only temporary. The insect in this case was immersed in an infusion from pure cultures.

(*b*) In seven minutes rapid diving about the vessel had ceased; in nine minutes there was only a slight movement of the limbs; and in fifteen minutes the beetle was apparently dead. It was kept in the infusion for fifteen minutes after the toxic rigor was produced, and was then removed to filter paper; but there was no recovery.

(*c*) A tube culture was sterilized by exposing it to a temperature of 125° F. for one hour on two successive days. An inoculation from this tube showed that it was perfectly sterile, and an infusion was then prepared, in which a beetle was placed. Sluggishness was manifest in seven minutes, and in fifteen minutes there was no sign of life. Fifteen minutes thereafter the insect was removed to filter paper; but the only sign of recovery was a temporary twitching of the limbs.

The above results and a few others are briefly indicated in the table below.

TABLE VI.

No. of experiment.	Source of the infusion.	No. miuutes required to produce toxic rigor.	Total period of immersion.	After effect.
a	Isolation culture.........	10	15	Slight temporary movement.
a[1]		12	20	No recovery.
b	Pure culture from *a*	15	30	No recovery.
b[1]		36	50	Temporary movement of limbs.
c	Sterile culture.............	15	30	Temporary movement of limbs.

Parallel with the above, I also tested a bacillus isolated from the tissues of a diseased grasshopper out of the lot from Colorado. Two beetles were used. One of these remained healthy for several hours, and no further observations were made. The other was kept in the infusion for a much longer period, and at the end of seventeen hours it was still living, though quite sluggish. In a few hours more death ensued.

A comparison of these two groups of tests gives abundant evidence that the squash-bug bacillus produces by its growth some toxic compound which acts with considerable rapidity even on hard-shelled insects. It is well known that many bacteria produce by their growth organic compounds of one kind or another, and it is well to mention in this connection that while a water-beetle will live for more than a day in fresh bouillon, death occurs in a few hours if the bouillon has "gone bad," although it may be subsequently sterilized. The products of such decomposition are thus to a slight degree deleterious to the water-beetle.

In the above table the record of experiments seems to indicate that the isolation culture was slightly more effective than pure cultures made from it. To determine if the organism was thus attenuated by continuous growth in the laboratory, ten successive cultures were made, the first proceeding immediately from an isolation culture, and the growth in each tube being permitted to mature before the succeeding one was inoculated from it. The first series was kept for one month, and the second series was prepared from this just two days before the experiment was to be made. At this time water-beetles were not procurable, and adult squash-bugs were necessarily used. The latter are rather difficult to operate upon, and recover more readily than water-beetles; but the relative activity of these solutions could be tested by a comparison of the time required to produce the toxic rigor. The results are indicated by the following table.

Table VII.

Number removes.	Number of Minutes Required to produce Toxic Rigor.				
	Cultures one month old.	Culture two days old. Successive trials with the same infusion.			Average.
		First.	Second.	Third.	
2	5½	6¼	6½	8½	6.7
3	2½	2½	14½	5½	6.3
4	14½	22½	7¼	5¼	12.3
5	26	9½	4	4¼	10.9
6	4	6¾	8½	6½	6.4
7	7	5½	13½	7¼	8.3
8	7½	6	7½	6¼	6.8
9	4	4½	9½	5¼	5.8
10	7¼	8	7½	4¼	6.8

This record seems to indicate that there is no deterioration in the properties of this organism when grown successively on agar cultures. The individual variations in the above table are probably due entirely to a difference in the resistance of the bugs themselves.

Chemical analyses of the pathogenic principle produced by this bacillus have been kindly undertaken by Professors A. W. Palmer and H. S. Grindley, of the University of Illinois.

MICROSCOPIC CHARACTERS.

Slides of this organism direct from the insect, if properly stained, show a short bacillus, single or in pairs, usually $1.2–1.8\mu \times 0.6–0.8\mu$. The young bacilli are usually homogeneously stained, but the adult and dividing cells often stain more densely at the poles, frequently leaving the middle part entirely clear (see Plate XXVII., Fig 1). Every gradation from one to the other occurs abundantly in a single preparation. This so-called belted appearance of many bacteria has been written about at length and speculated upon by Billings* and others. In this bacillus the appearance is often less truly belted than the figures of Billings would indicate for the germ of hog cholera, and the line of demarcation between the stained and the unstained portion is less marked. With a magnification of about five hundred diameters, this unstained portion has much the appearance of highly refractive spores; but higher magnifications easily demonstrate the true nature of these conditions. As far as I have observed, the belted appearance does not appear in preparations made from cultures; and in the latter the rods are uniformly shorter. The organism as obtained from agar cultures stains well in acid fuchsin and in Hoffmann's violet. Slides direct from the insect give excellent results with a glycerine solution of violet aniline†, the only difficulty with the latter being that the preparations fade with age.

*"Swine Plague, its Causes, Nature, and Prevention." (Bull. Neb. Agr. Exper. Station, Vol. 2, Pt. I., p. 104, etc.)

†For this stain, and for various technical suggestions, I am indebted to Professor T. J. Burrill.

Some of the squash-bug nymphs sick with this disease, or recently dead, were fixed in hot water, hardened, dehydrated, and imbedded in paraffin by the usual process. Sections were then made, generally 6⅔ μ in thickness, with the idea of ascertaining as well as possible the general distribution of the bacteria within the tissues. It is difficult to find stains that will differentiate an organism under such circumstances. On finding that anilines, hæmatoxylins, and combinations of these worked to little advantage, Löffler's alkaline methylene blue was tried with fairly good results. This was used alone, or after previous staining with eosin.

A few hours after the death of an insect, the tissues are so badly broken down that little of interest is to be gained from a study of such specimens. In sections of an individual fixed just at the time of death, the bacteria will be found in great abundance in all parts of the perivisceral cavity and well differentiated from the blood coagulum. (See Plate XXVII., Fig. 2.) The blood, indeed, appears to have been like a pure culture of the disease organism. At this stage, moreover, the adipose tissue and the hypodermis are considerably broken down, and thoroughly penetrated by the parasite. The cells of the cardiac tissue also show the presence of the bacteria; but the structure of these cells and the form of their nuclei have suffered very slight disturbance at this stage. There are very few structures unattacked besides the muscles and the stout walls of the alimentary organs; and surrounding both of these the bacteria are often found in great abundance.

Sections of a very sick nymph, killed probably not more than an hour before death would have occurred from the disease, show little that is different from the preceding, except that the tissues are somewhat more nearly normal. (See PlateXXVII., Fig. 3.) Another nymph of the lot thus prepared was fixed while in a very early stage of the disease, the only sign of indisposition on the part of the insect being a slight sluggishness, a touch causing it to respond actively. An examination of sections made from this individual showed the bacteria in the blood to some extent (see Plate XXVII, Fig 4) but they were apparently quite as abundant in the hypodermis. In the adipose tissue there was occasionally found a small colony of the bacteria; but here there was at the time no general and uniform distribution. From these results it was quite impossible to decide whether the blood became infected by the entrance of germs through the spiracles, or whether there was direct penetration of the hypodermis. The former would seem to be most natural, and I am inclined to suppose that the fluid of the perivisceral cavity is the seat of first action. On this ground, however, the more marked effect on nymphs, both of squash-bugs and of chinch-bugs would necessarily be explained on a truly physiological basis, rather than on the ground of the more penetrable character of the chitinous outer coat.

TEMPERATURE EXPERIMENTS.

For a further knowledge concerning the conditions of growth of this bacillus and for a guide to any field applications of the organism, a series of temperature tests was planned, by means of which it was hoped to ascertain (1) the period of exposure to various temperatures necessary to kill this organism when mature, and (2) the range of *optimum* temperature relative to its growth and development. In order to secure a mature growth, fresh slanting agar tubes were inoculated, and by means of the water of evaporation the bacteria were distributed as much as possible. The tubes were kept at about 80° F. for two days, when the growth was abundant over the whole surface, and then the exposures were made as indicated in the table. On last removal from the incubator, other slanting tubes of fresh agar were in a similar way inoculated from these, and the new tubes placed under observation for growth developments.

TABLE VIII.

Tube No.	Temperature ° F.	Exposed. No. hours.	Exposed. No. successive days.	Result from fresh inoculation.
1	125°	½	1	Good growth............................
2	125°	½	2	Good growth............................
3	125°	1	1	Good growth............................
4	125°	1	2	No growth................................
5	125°	2	1	No growth................................
6	125°	6	1	No growth................................
7	115°	1	1	Good growth............................
8	115°	1	2	Good growth............................
9	115°	1	4	Slight growth..........................
10	115°	3	1	No growth................................
11	115°	3	2	No growth................................
12	115°	3	4	No growth................................
13	115°	6	1	No growth................................
14	115°	6	2	No growth................................
15	115°	6	4	No growth................................
16	105°	3	2	Good growth............................
17	105°	3	4	Good growth............................
18	105°	6	1	Good growth............................
19	105°	6	2	Good growth............................
20	105°	6	4	Fair growth..............................
21	105°	24	4	Slight growth..........................
22	95°	24	4	Good growth............................

Summarizing, then, it appears that this organism will not survive at 125° F. a continuous exposure of two hours, nor an exposure of one hour on more than one day. At a temperature of 115° F. it will withstand an exposure of one hour for several successive days, but no continuous exposure of three hours or more. It survives in great part an exposure of six hours at 105° F. on four successive days, but with a continuous exposure of four days at this temperature the organism is usually killed.

I have not yet had an opportunity to experiment with this disease while keeping the bugs at different temperatures; but such a line of work would be interesting to supplement the above temperature tests, and to advance our knowledge as to the relationship of conditions required by host and parasite. Neither have I yet determined precisely the range of *optimum* temperature for this organism; but such results as are recorded seem to indicate that it is between 83° and 90° F.

SPECIFIC CHARACTERS.

I have carefully compared the biological characters of this squash-bug organism with those enumerated for the various entomogenous bacteria already described; but there is no form with which it agrees in detail. Its action on the insect and its characteristic pathogenic properties seem to be quite distinct; hence I have given to it the name *Bacillus entomotoxicon*, n. sp.

This disease bacillus has also been carefully compared with the organism "normal" to the cœcal appendages of the squash-bug. There is considerable structural difference, and the normal form is cultivated on nutrient media with difficulty. I have secured cultures of the latter on media strongly alkaline; but further details of such work are not included in this paper, as the cœcal form is hardly to be confused with the disease organism.

Bacillus entomotoxicon Duggar.

Occurrence.—In the blood and tissues of diseased squash-bugs.

Morphology.—Short bacilli 1.2–1.8 $\mu \times 0.6$–$0.8\ \mu$, single or in pairs, motile, not producing spores.

Preparations stain well in most of the anilines, the bacilli often staining much more deeply at the poles, consequently showing a banded or belted appearance.

Growth and pathogenic characters.—An aërobic and facultative anaërobic organism, producing on nutrient agar-agar a dirty white colony often characterized by prominent fan-like radiations. Stab cultures on nutrient gelatine give liquefaction on the second or third day, soon assuming the shape of an inverted lamp chimney, and after standing one month the gelatine is colored wine-red. Milk is rapidly coagulated and the coagulum in great part dissolved, the odor attending this growth on milk being exceedingly vile. Nitrates are not reduced. It grows well at living-room temperature, but is easily killed by exposures to high temperatures.

The infected insect becomes sluggish a few hours before death, and at death it is slightly darker and softer. After death the insect is slightly swollen, darkens rapidly, and soon contains only a mass of gruel-like fluids.

Sterile or active infusions from the growth on agar contain a principle toxic for many species of insects, as shown by temporary immersion.

SUMMARY.

Under the specific description are summarized the leading facts relative to the structure of this organism and to its growth on the usual culture media. It is necessary to add a few brief statements embodying some of the results of general œcological interest.

Bacillus entomotoxicon is the cause of a characteristic disease of the squash-bug, first observed as an epidemic among bugs in a laboratory breeding-cage.

Both laboratory and field experiments show that the disease is readily communicated to healthy squash-bugs by contact with the fluids of infected insects, nymphs being more easily affected than adults.

Fresh agar cultures of the bacillus are effective as sources of infection.

The disease may be communicated to young chinch-bugs either from diseased insects or from cultures; but adult chinch-bugs are strongly resistant.

With the grubs and other larvæ hitherto experimented upon, external applications of infection material have given no successful results.

Infusions from the growth on agar contain an active principle which kills many insects after a very short period of immersion.

Sections of diseased squash-bugs show that the bacillus is present in the blood at all stages of the disease. The hypodermis, adipose tissue, and cardiac tissue are also early affected. When death ensues the body fluids are like pure cultures of the disease organism; and accompanying saprophytic germs are seldom found.

ACKNOWLEDGMENTS.

To the Director of the State Laboratory of Natural History, Professor S. A. Forbes, I owe many thanks for the opportunity of working upon the disease herein discussed, as it is to him that the Department of Insect Disease Work owes its origin. I would also express my thanks to Mr. W. G. Johnson for valuable assistance with various entomological details.

BIBLIOGRAPHICAL.

The list appended deals only with bacterial or so-called bacterial diseases of insects, and in it are included all works and articles to which I have had access, together with the majority of references definitely given in these articles. Some papers are listed which really embody no original work, nor even a critical analysis of previous work; but such papers are often valuable to students who have not access to the original sources of publication.

Altum.—Ueber den Erfolg der Künstlichen Verbreitung der Flacheriebacillen gegen die Nonne in den Herzoglich Ratibor'schen Bestanden. Zeitschrift für Forst-und Jagdwesen, Januar, 1893, p. 21.

Balbiani.—Recherches sur les Corpuscules de la pébrine. Journ. d' Anat. de M. Robin, 1866, p. 599, et 1867, pp. 263 et 329.

——— Études bactériologiques sur les Arthropodes. Comptes Rendus de l' Acad. de Sci., CIII., 1886, p. 953.

Benton, F.—The Honey Bee. Bull. No. 1, New Series, Div. Ent., U. S. Dept. Agr., pp. 112-113, 1895.

Bollinger.—Ueber Pilzkrankheiten niederer und hörerer Thiere, 1880. (Chapter II. of "Zur Aetiologie der Infectionskrankheiten." München, 1881.)

Charrel.—Acetrophie ou Gatine des vers à soie, 1857.

Cheshire, F. R., and Cheyne, W. W.—The Pathogenic History and History under Cultivation of a New Bacillus (*B. alvei*), the Cause of a Disease of the Hive Bee hitherto known as Foul Brood. Journ. Roy. Micr. Soc., Vol. V., Aug., 1885, pp. 581-601.

Ciesielski.—"Foul Brood" of Bees. 1884. (In Polish. See Botanisches Centralblatt, XXVII., 1886, p. 346.)

Cook, A. J.—Foul Brood. Bull. No. 61, Mich. Agr. Exper. Station, April, 1890.

Cushman, S.—Foul Brood. Bull. No. 9, R. I. Agr. Exper. Station, June, 1891.

Dorrer.—Das ende der Nonnencalamität in Württemberg. Forstwiss. Centralblatt, XV., 1893, pp. 73-89.

Eckstein.—Das auftreten der Flacherie in der Gegend von Eberswalde. Zeitschr. f. Forst- und Jagdwesen, XXV., 1893; und Allg. Holzverkaufsanzeiger, XVIII., 1893, Nr. 22, p. 60.

——— Untersuchungen über die in Raupen vorkommenden Bakterien. Zeitschr. f. Forst- und Jagdwesen, XXVI., 1894, pp. 3, 228, 285, 413.

Ferry, C. de.—Contribution à l' étude de la flacherie, causes et traitement. Actes et Mémoires du 4me Congrès Séricicole, Oct., 1874.

——— Recherches experimentales sur les causes de la flacherie du ver à soie. Comptes Rendus Stenographiques, Congrès International Séricicole, No. 23, p. 113, Paris, Sept., 1878.

Forbes, S. A.—Studies on the Contagious Diseases of Insects. Bull. Ill. State Lab. Nat. Hist., Vol. II., Art. IV., 1886.

——— A Contagious Disease of the European Cabbage Worm, *Pieris rapæ,* and its Economic Application. Thirteenth Rep. Board of Trustees, Univ. Ill., 1886, p. 294.

——— Reports of State Entomologist of Illinois: 12th, 1882; 16th, 1887-88; 17th, 1889-90.

Gagnot.—De la Maladie des vers à soie dite Gatine. Le Commerce Séricicole, 1858.

Garman, H.—[Diseases of *Pieris rapæ* believed to be non-transferable to other species.] Insect Life, Vol. III., Nos. 7 and 8, Apr., 1891, p. 333.

Gehren, von.—Bekämpfung der Nonne durch Impfung mit dem Hofman 'schen Bacillus. Zeitschrift fur Forst- und Jagdwesen, XXIV., 1892, p. 501.

——— Bekämpfung der Nonnenraupen durch Infection mit Bacillen. Forstwiss. Centralblatt, XV., 1893, pp. 343–347.

GOLDBERG.—Zur Bekämpfung der Nonnenraupe. Leipzig Tageblatt und Allg. Holzverkaufsanzeiger, XVIII., Nr. 27, p. 300, Juli, 1893.

HABERLANDT, F.—Die seuchenartige Krankheit der Seidenraupen. Wien, 1866.

HOFMANN.—Insektentödtende Pilze mit Besonderer Berucksichtigung der "Nonne." Sondbd. aus dem Wochenblatt für Forstwirtschaft "Aus dem Walde." Dez., 1890.

——— Die Schlaffsucht (*Flacherie*) der Nonne (*Liparis monacha*) nebst einem Anhang: Vortrag über Insektentödtende Pilze. Frankfurt, 1891.

JAGER.—Bakteriologische Untersuchungen von Nonneneiern. Aus dem Walde, 1893, Nr. 18, p. 69.

JEANJEAN.—La Maladie des vers à soie: Conseils aux éducateurs. Montpellier, 1862.

JOLY.—Sur les maladies des vers à soie, et sur la coloration des cocons par l' alimentation du chica. Mém. de l' Acad. des Sci., 30 aout, 1858.

KLAMANN.—Ueber die Faulbrut der Bienen. Bienenwirtschaft. Centralblatt, Hannover, 1888, Nr. 18, u. 19.

——— Der gelbe Faulbrutbacillus (*Bacillus flavidus alvei*). Bienenwirtschaft Centralblatt, Hannover, 1890, No. 2.

KRASILSHTSHIK, I.—La Graphitose et la Septicémie chez les insects, deux maladies des larves des Lamellicornes causées par des Bactéries. Mem. de la Soc. Zool. de France, VI., 1893, 3e pt. pp. 244-285.

LEBERT.—Ueber die gegenwärtig herrschende Krankheit des Insekts der Seide. 1858.

——— De la maladie de l' insects de la soie. Berlin, 1858.

LEVERT.—De la maladie des vers à soie dans l' Ardèche. 1858.

LORTET.—La Bactérie loquese; traitement de la loque par le naphthol. Revue internationale d'agriculture, fevrier, 1890.

MACCHIATI, L.—Lo *Streptococcus bombycis* e la flaccidezza del baco da seta. Le Stazioni speriment. Agrarie italiane, Vol. XXIII, Asti, 1892.

MAILLOT, E.—Leçons sur le vers à soie du Mûrier. Paris, 1885.

MALLY, F. W.—Bacteriological Experiments with Insect Diseases. Bull. No. 29, Div. Ent., U. S. Dept. Agr., 1893.

MÉRITAU.—De la Gatine, son origin, les causes qui l'ont produite, et son invasion épidémique. 1858.

METSCHNIKOV.—Les Maladies des larves du Hanneton du Blé (la muscardine vert et le *Bacillus salutarius*). Odessa, 1879. (En Russe.)

METZGER, A., UND MÜLLER, N. J. C.—Die Nonnenraupe und ihre Bakterien. Mündener forstliche Hefte, I Beiheft. Berlin, 1895.

OSIMO.—Recherches sur la maladie actuelle des vers à soie. Padoue, 1859.

PASTEUR.—Études sur la Maladie des vers à Soie. Tomes I. et II. Paris, 1870.

PAULYS.—Die Nonne in den Bayrischen Waldungen, 1890.

QUATREFAGES, DE.—Études sur les maladies actuelles du ver à soie. Mém. de l' Acad. des Sci. de l' Institut Impérial de France, Tome XXX., 1860.

——— Nouvelles Recherches faites en 1859 sur les maladies des vers à soie. Rev. et. Mag. Zool., 1860, T. XII., pp. 412-415.

REUTER, O. M.—Patogena Bakterier i Landtbrukets Tjänst. Öfvertryck ur Finska. Vet.-Soc. Öfversigt., H. XXXVI., 1894.

RILEY, C. V.—The Mulberry Silkworm. Bull. No. 9, Div. Ent., U. S. Dept. Agr., 1888, pp. 32-40.

Robin, Ch.—L' histoire naturelle des végétaux parasites. Paris, 1853.

Schmidt, A.—Die Nonne (*Liparis monacha*). Darstellung der Lebensweise und Bekämpfung der Nonne nach den neuesten Erfahrungen, u. s. f. Ratibor, 1893.

——— Die Bekämpfung der Nonne. Zeitschr. f. Forst- und Jagdwesen, XXV., 1893, pp. 218-222.

Simon.—Reisebericht an die Regierung in Potsdam von Juli, 1892, p. 48.

——— Bekämpfung der Nonne durch Impfung mit dem Hofmann 'schen Bacillus. Zeitschrift für Forst- und Jagdwesen, 1892, p. 499.

Snow, F. H.—Contagious Diseases of the Chinch-bug. First Ann. Rep. Director Kan. Agr. Exper. Station. Lawrence, 1892.

Tangl, F.—Bakteriologischer Beitrag zur Nonnenraupenfrage. Forstwiss. Centralblatt, XV., pp. 209-230, 1893.

Tubeuf, C. von.—Die Krankheiten der Nonne (*Liparis monacha*). Beobachtungen und Untersuchungen beim Auftreten der Nonne in den oberbayerischen Waldungen, 1890-1891.

——— Die Krankheiten der Nonne (*Liparis monacha*). Forstlich-Naturwiss. Zeitschr., Januar, 1892, Heft I., pp. 34-47.

——— Weitere Beobachtungen über die Krankheiten der Nonne. Forstlich-Naturwiss. Zeitschr., 1892, Heft I., p. 277.

——— Ueber die Erfolglosigkeit der Nonnenvernichtung durch künstliche Bakterien-Infektionen. Forstlich-Naturwiss. Zeitschr., 1893, Heft 3, pp. 113-126.

Verson, E.—Études sur la flacherie des vers à soie. Journal Séricicole du Dr. Haberlandt, 15 aout, 1869.

Wachtl und Kornauth.—Beiträge zur Kentniss der Morphologie, Biologie, und Pathologie der Nonne

(*Psilura monacha* L.) und Versuchsergebnisse über den Gebrauchswerth einiger Mittel zur Vertilgung der Raupe. Mitth. aus dem forstlichen Versuchswesen Oesterreichs. Der ganzen Folge, Heft XVI. Wien, 1893.

WALKER, PHILIP.—Grasserie of the Silkworm. Insect Life, Vol. 3, Nos. 11 and 12, Aug., 1891, p. 445.

EXPLANATION OF PLATES.

PLATE XXVII.

Fig. 1. *Bacillus entomotoxicon* from the blood of a diseased squash-bug. Zeiss $^1/_{12}$ hom. imm., oc. 4, tube length 205 mm.

Fig. 2. Distribution of bacteria in the hypodermis and fatty bodies of a squash-bug at the time of death: *c*, cuticle; *h*, hypodermis; *m*, basal membrane; *a*, adipose tissue much degenerated. Zeiss E, oc. 2, tube length 155 mm.

Fig. 3. Distribution of bacteria in the blood and tissues of a squash-bug an hour or more before death: *h*, hypodermis; *m*, basal membrane; *p. c.*, extension of perivisceral cavity; *a*, adipose tissue. Zeiss E. oc. 2, tube length 155 mm.

Fig. 4. Longitudinal section of the dorsal vessel, or heart, of a squash-bug slightly sick, showing distribution of bacteria in the blood.

PLATE XXVIII.

Fig. 1. Growth of the *Bacillus entomotoxicon* on nutrient agar containing a small amount of squash-leaf decoction.

---

* All figures were drawn with the aid of a Zeiss camera lucida.

Article XIII.—*Descriptions of five New Species of Scale Insects, with Notes.* By Willis Grant Johnson, A. M.

ASPIDIOTUS Bouché.

Aspidiotus forbesi sp. n. (Plate XXIX., Fig. 1-5.)

Scale of female.—The general shape of the scale of the female is nearly circular (see Plate XXIX., Fig. 1, *b*), but it varies according to the position of attachment, as scales under a fold in the bark or on some uneven surface are very irregular in outline. The color is dirty grayish in fresh specimens, but darker when dried. The exuviæ are usually slightly to one side of the center, and covered with excretion; the nipple-like prominence in rubbed specimens is reddish or yellowish brown, surrounded by a band a little darker than the margin. Scale rather convex, delicate, and easily torn when removed from fresh material. It varies considerably in size, the average diameter being about 2 mm.

Scale of male.—The scale of the male is elongate-oval (Plate XXIX., Fig. 1, *c*), and is darker and not so delicate as the scale of the female. Nipple-like prominence situated between the center and the anterior margin, usually covered with excretion, and when rubbed or broken of about the same color as that of the female scale. Margins thin and delicate, and lighter than the rest of the scale. Length about 1 mm., width about 5 mm.

Eggs.—The eggs are pale yellow, elongate oval, and about .22 mm. long by .12 mm. wide.

Young.—The young larva (Plate XXIX., Fig. 5), when first hatched, is pale yellow and of the general outline shown in the figure. Antennæ apparently five-jointed and lighter colored than body; last joint as long or longer than the combined length of the other four. Eyes prominent, brownish or purplish black. Legs stout and lighter than body. Segments distinct. Median lobes conspicuous, with two long anal filaments projecting from between them.

Mature male.—The mature male (Plate XXIX., Fig. 2) varies considerably in color even in the same brood, some individuals being reddish brown, while others are yellowish. Legs, antennæ, and style lighter than the body. Eyes dark purplish. Antennæ nine-jointed and about .35 mm. in length. Wing expanse usually about 1 mm.; wing about .44 mm. in length and half as wide. Thoracic band and margins of shield a little darker than body. Poisers prominent, with terminal hooks. Length of body, .48 mm.; style, .26 mm.; total length, .74 mm.

Mature female.—The body of the mature female (Plate XXIX., Fig. 3) is yellowish, rather robust, and of the general outline shown in the illustration. The last segment (Plate XXIX., Fig. 4) is darker than the rest of the body and presents the following characters:

There are five groups of spinnerets: the anterior group includes from 1 to 3, usually 1 or 2; the anterior laterals, from 3 to 7, and the posterior laterals, from 3 to 5. The number of spinnerets is variable, and in many instances they are very scattering. There are two pairs of lobes: the median pair prominent, about as wide as long, and usually notched on the lateral margin; the second pair about half the size of the first, rounded or more or less pointed. Plates inconspicuous or absent, spines prominent, situated as shown in the illustration, the second about as far from the first as the third is from the second, the fourth about twice as far from the third as the third is from the second. Rather deep incision between first and second lobes. Club-shaped organs, about which the spinnerets are grouped, arranged as shown in the illustration. Anal opening about as far from the incision as the spines are long.

This species occurs on wild and cultivated cherry, apple, pear, plum, quince, currant, and possibly on honey locust and mountain ash. Common in Illinois; collected by the author.

Types in collections of the Illinois State Laboratory of Natural History and of the United States National Museum, and in the author's collection.

I first discovered this species on English morello cherry-trees in Champaign, Illinois, December, 1894. It is very generally distributed over Illinois, and from what I have seen of its attack I consider it the most dangerous scale insect of the orchard now established in the State. Cherry seems to be its favorite food plant, and I have found it on wild cherry at Champaign, Decatur, Edgewood, and Eldorado. I therefore propose for it the popular name, "cherry scale." Its specific name is in honor of Professor S. A. Forbes, State Entomologist of Illinois. It attacks the trunk and branches of the cherry and is found occasionally upon the leaves and fruit. In June, 1896, I found a few partially matured scales of this species on cherries; July 6, 1895, I collected several currants on which they were found; and August 14, 1895, I gathered several apples which contained scales of fully developed females of the cherry scale.

I have bred the following seven species of hymenopterous parasites* from this scale insect: *Prospalta murtfeldti* (How.), *Prospalta aurantii* (How.), *Perissopterus pulchellus* (How.), *Signiphora nigrita* (Howard MS.), *Arrhenophagus chionaspidis* (Aur.), *Ablerus clisiocampæ* (Ashm.), and an undetermined species belonging to the Encyrtinæ. Aside from these parasites, I have very often seen small whitish mites under the scales, especially under male scales containing pupæ, and in many cases the pupæ were dead. The twice-stabbed ladybug, *Chilocorus bivulnerus*, and its larva, also feed voraciously on this scale.

*All the hymenopterous parasites mentioned in this paper have been examined and determined by Mr. L. O. Howard, United States Entomologist, of Washington, D. C. I am also under obligations to Mr. Howard, to his Assistant Mr. Theo. Pergande, and to Prof. T. D. A. Cockerell, for various favors rendered in the examination of coccid material.

This species hibernates as a partially matured insect, and is double brooded in the latitude of Springfield, Illinois. The mature males begin to emerge about the middle of April, and the first brood begins to appear early in May; but young and eggs of the same brood are often found as late as June 20. The mature males for the second brood begin to appear about July 10 and continue to emerge until about August 1. The young of the second brood first appear about the first week in August, and may be found until late in September. It is quite possible that there are three broods in the southern part of this State.

The species is related to *Aspidiotus ancylus* Putnam, but may be readily distinguished from that species by its size, its coloration, and by the presence of the second pair of lobes and the spinnerets on the last segment. The mature male is larger and has a greater wing expanse than *ancylus*.

Aspidiotus comstocki sp. n. (Plate XXX.; and Plate XXXI., Fig. 1 and 2.)

Scale of female.—The general shape of the scale of the female depends almost entirely upon its position on the leaf. It is generally attached close to the midrib, veins, or veinlets on the under side of the leaf, and conforms, to a certain extent, to the angle formed by the veins. The commonest form is that shown at *c*, Fig 6, Plate XXX. The side next the vein is slightly curved, sometimes nearly straight, and the scale varies in length from 1.5 to 2 mm., and in width from 0.5 to 1 mm. The exuviæ are near the center of the margin next the vein. The large, well-developed, rather flat scales are cream-buff, excepting that part which covers the exuviæ, which varies from yellowish to reddish brown and is often concolorous.

Scale of male.—The mature male is cream-buff or grayish white, more or less elongate-oval, and about 1 mm. long by 0.5 mm. wide. The larval scale is at the anterior extremity and usually laterad of the meson. The scale is extremely delicate, and semitransparent after the male has emerged. The outline of the male pupa can be plainly seen through the scale. The general form of the male scale is shown at *b*, Fig. 1, Plate XXX.

Eggs.—The eggs are pale yellow.

Young.—The young larvæ are long-oval, pale yellow, the mouth parts prominent and doubled on themselves. Antennæ prominent, little lighter in color than the body; apparently five-jointed, the last two joints much longer than the rest; the last joint with a long transparent hair at its apex. The median pair of lobes conspicuous, with two long delicate hairs projecting from their bases.

Mature male.—The mature male (Plate XXX., Fig. 2, *a*) is light yellow; eyes dark purple, almost black; antennæ yellowish and of the form shown at *b*, Fig. 2; legs and style light yellow; thoracic shield prominent, with its margins and the band brownish; wings prominent, somewhat iridescent. Length about .62 mm.; style, .22 mm.

Mature female.—The body of the mature female (Plate XXXI., Fig. 1,) is rather flat, pale yellow, and of the general shape shown in the illustration. The last segment is a little deeper yellow than the rest of the body and presents the following characters:

There are four groups of spinnerets; the anterior lateral groups usually composed of six; the posterior lateral, of four. There are two pairs of well-developed lobes, the second pair usually rounded, often as long and as broad as the median pair; the median pair commonly notched on the lateral margins near the tip. Plates conspicuous and generally of the form shown in Fig. 2, Plate XXXI. Between the first and second lobes they are more or less toothed and project nearly to the end of the first lobe; laterad of the second lobe there is a broad, circular fringe; still further laterad and between the third and fourth spines there are three large compound plates, the one next the fourth spine with two forks, the others with three, as shown in the illustration. Spines prominent; the first pair near the lateral margin of the base of the median lobes; the second on the lateral margin of the base of the second lobes; the third and fourth on the body margin between the plates as described above. There is a deep incision between the lobes and also laterad of the second lobe. Anal opening conspicuous, and about as far from the base of the median lobes as the lobes are long.

This species was found on leaves of sugar maple, *Acer saccharinum*, received from Dr. Jacob Schneck, of Mt. Carmel, Illinois, and from Mr. R. H. Pettit, of Ithaca, New York, and I have found it on sugar maple at Champaign and Decatur, Illinois.

Types in collections of the Illinois State Laboratory of Natural History and of the United States National Museum, and in the author's collection.

This insect has been very abundant on sugar maple for the past two years at Mt. Carmel, Illinois. It attacks the leaves, living in great numbers on the under side (see Plate XXX., Fig. 1, *a*), and causing yellowish spots on the upper surface. The spots become more conspicuous as the insects mature, and the leaves fall prematurely. It hibernates in the partially mature state under the leaf buds. I have not found this insect on any other tree than the sugar maple, and as it attacks the leaves and is rarely found on the branches, I have proposed for it the popular name, "maple leaf scale." The specific name proposed is in honor of Prof. J. H. Comstock, of Cornell University, who first gave me instruction concerning this interesting group of insects.

A. comstocki is related to *Aspidiotus uvæ* Comstock, but its occurrence on maple and the concolorous exuviæ should facilitate its recognition. It is also near *A. townsendi* Ckll., a species recently described from Mexico. We now have four closely allied forms, which Prof. Cockerell has called the *uvæ* group, and has arranged as follows:

1. *uvæ* Comstocki,	on grape....................	Eastern States.
2. *coloratus* Ckll.,	on Chilopsis..................	New Mexico.
3. *townsendi* Ckll.,	————..................	Northern Mexico.
4. *comstocki* Johnson,	on sugar maple...	Illinois and New York.

The scale of *coloratus* is pale orange-brown, the exuviæ concolorous; that of *comstocki* cream-buff, the exuviæ variable; that of *uvæ* light brownish, the exuviæ yellow; and that of *townsendi* grayish white, the exuviæ pale orange. In the lobes and plates, as also in the spinnerets, these forms are variable; but *comstocki* is noticeable for the comparatively large size of the second lobes.

Aspidiotus æsculi sp. n. (Plate XXXI., Fig. 3; and Plate XXXII., Fig. 1-3.)

Scale of female.—The scale of the female is circular (Plate XXXI., Fig. 3, *c*), rather convex, and varies in diameter from 1.5 to 3 mm., averaging about 2.5 mm. The general color of the scale is dirty gray, conforming usually to the color of the bark to which it is attached. The exuviæ are usually a little one side of the center, and covered with excretion. In rubbed specimens the protuberance indicating the position of the exuviæ is orange-red and surrounded by a band a little darker in color than the rest of the scale. The ventral scale is delicate, white, and adheres to the bark, leaving a whitish scar when the scale is removed.

Scale of male.—The scale of the male is elongate-oval (see Plate XXXI., Fig. 3, *b*), from 1 to 2 mm. in length, and half as wide. It is considerably darker than the scale of the female. The position of the larval scale is marked by a nipple-like prominence situated between the center and the anterior margin of the scale. This prominence is usually covered with a slight excretion. When rubbed it is orange-red. The ventral scale is white and slightly thicker than that of the female.

Eggs.—The eggs are pale yellow.

Young.—The young larva when first hatched is pale yellow, and in outline elongate-oval. Antennæ distinct and apparently five-jointed, the last joint as long or longer than the other four combined. Eyes large. Mesal lobes prominent, notched on their lateral margin, and with two long hairs projecting from between them.

Mature male.—The mature male (Plate XXXII., Fig. 1) is yellowish. Eyes prominent. Antennæ prominent, and of the form shown in the illustration. Body stout. Legs long, and a little lighter yellow than the body. Wings large, with well-developed pocket for the reception of the poiser. Thoracic shield with band distinct, and with margins indistinct in some specimens. Length about .60 mm.; style .39 mm.

Mature female.—The body of the mature female (Plate XXXII., Fig. 2) is ovate, rather plump, and yellow. The last segment is a little darker yellow than the rest of the body, and presents the following characters (see Plate XXXII., Fig. 3):

There are four groups of spinnerets, the number in each group being extremely variable. The anterior laterals vary from five to seventeen, the average being about ten; while the posterior laterals vary from four to eleven, the average being about seven. The number is variable on opposite sides of the same individual. There is only one pair of lobes. They are nearly as broad as long and notched on their lateral margin near the tip. Plates, simple and inconspicuous; one usually just laterad of the lobe, and two between the second and third spine. Spines prominent, arranged as shown in the illustration, and usually one pair on each segment. A rather deep incision just laterad of the lobe. Anal opening about twice as distant from the base of the lobes as the lobes are long. Curious club-shaped organs, as shown in figure, about which the spinnerets are grouped.

Found by the writer on buckeye, *Æsculus californica*, at Stanford University, California.

Types in collections of the Illinois State Laboratory of Natural History and of the United States National Museum, and in the author's collection.

I found this insect very abundant on buckeye in Santa Clara county, California, in 1892. It attacks the trunk, branches, and smaller twigs, but so far as I have observed is not found upon the leaves. It colonizes most abundantly on the under side of the branches, and often accumulates in masses two or three scales deep. This is accounted for by the fact that many scales adhere so closely to the branches that the young larvæ are unable to get out, and therefore attach themselves to the bark underneath the scale. It is not an uncommon thing to find a dozen or more young larvæ attached in this manner underneath the scale of the parent insect, and as the scale is formed and the insect matures the old scales are naturally pushed outward. The color of the scale conforms so closely to that of the tree that it is very difficult to detect the scale, except where it is quite abundant.

I have frequently bred a hymenopterons parasite, *Prospalta murtfeldti* Howard, from scales of this insect.

Aspidiotus ulmi sp. n. (Plate XXXII., Fig. 4 and 5.)

Scale of female.—The scale of the female is circular or nearly so, quite convex, with exuviæ central or slightly laterad of the center. Exuviæ in fresh specimens bright orange-yellow; but dirty whitish in old material. The color of the scale is either dirty whitish or tan-colored, the latter color being due to the covering of the cork-like bark. There is a well-developed, snowy white ventral scale, which usually adheres to the bark when the scale is removed. The ventral scale often adheres to the dorsal scale, especially when the insects are massed together, completely enveloping the insect. The interior of the dorsal scale is also snowy white. Diameter usually about 1.5 mm.

Scale of male.—The scale of the male is more or less circular, sometimes elongate-oval, of the same general color as the female scale. Ventral scale well developed and snowy white, usually about .70 mm. long.

Eggs.—The eggs are pale yellow and ovate.

Young.—The newly hatched larva is pale yellow and elongate-oval in outline. Antennæ apparently five-jointed, last joint longest. Legs lighter than body.

Mature male.—The mature male is bright or lemon-yellow in general color. The thorax is dark or brownish on the dorsum; head about the same color; neck lighter. Antennæ rather brownish, with thick clusters of hairs. Front and median tibiæ brownish. Tarsi of hind legs dark, about the same color as fore tibiæ. Hind tibiæ with a dark band at base. Length about .65 mm.; style about .42 mm.

Mature female.—The body of the female is ovate, sometimes nearly circular (Plate XXXII., Fig. 4), lemon-yellow in color, with the last segment (Plate XXXII., Fig. 5) brownish or amber, and presenting the following characters:

There are no groups of spinnerets, so far as I have been able to determine from a large series of balsam mounts. There is a curious, pretty constant group of club-shaped organs, as shown in the illustration. There is only one pair of lobes. They are very prominent, about as wide as long, notched on each side, and more or less rounded. The body wall is thickened for a considerable distance laterad of the lobes, usually to the last plate. Plates distinct, about as long as the lobes; two laterad of the lobes, between the first and second spines, the one next to the second spine usually forked; four, as a rule, between the second and third spines, the one next the third spine usually forked and longest, and three, all simple, laterad of the third spine. Spines distinct; first pair on the lateral margin of the base of the lobes; the second and third just laterad of the incisions. Anal opening a little more than twice as distant from the base of the lobes as the lobes are long.

Found by the author on the trunk of a white elm, *Ulmus americana*, on the University campus, at Urbana, Illinois. Not common.

Types in collections of the Illinois State Laboratory of Natural History and of the United States National Museum, and in the author's collection.

I have found this species on one tree only, and in very limited numbers. So far as I have observed it does not attack the branches, twigs, or leaves, but lives exclusively upon the new bark of the trunk, clustering between the cracks in the old bark. It often gathers in great numbers, and the masses of scales resemble small shells. I have not worked out its life history as to the number of broods, since it is of little consequence from the economical standpoint.

I have bred from this insect two species of hymenopterous parasites, *Prospalta murtfeldti* How., and *Coccophagus fraternus* How.

CHIONASPIS SIGNORET.

Chionaspis americana sp. n. (Plates XXXIII. and XXXIV.

Scale of female.—The scale of the female is fawn-color at first, but becomes more or less bleached during the fall and winter months, presenting a dirty whitish appearance in the spring. The first larval skin is yellowish, the second is claret-brown, approaching a maroon, and is covered with slight secretion. The interior lining of the scale is snowy white, and when removed from the twig it leaves a whitish scar, the margins of which are very distinct. In general outline the scale resembles that of *Chionaspis furfurus*, but is more convex. It widens near the posterior end of the second larval skin, some scales bending abruptly to the right or left, and others being straight. Length 2–3 mm.; width 1.5–2 mm.

Scale of male.—The scale of the male is snowy white, straight, tricarinate, about .73 mm. long, and .30 mm. wide; the sides rough and nearly parallel; larval skin yellowish

Eggs.—The eggs are purplish, elongate-oval in outline, about .22 mm. long and .15 mm. wide.

Young.—The newly hatched larva (Plate XXXIV., Fig. 3) is .22 mm. long by .13 mm. wide, purplish, and of the form shown in the illustration. Antennæ prominent; eyes blackish. The anal filaments are inconspicuous except at base, and a little longer (.15 mm.) than the body is wide. Segments more or less distinct, with a row of dark spots along the lateral margin.

Mature male.—There are two forms of males: a perfect male with fully developed wings (Plate XXXIV., Fig. 1) and a pseudimago with rudimentary wings (Plate XXXIV., Fig. 2). In the former the wings are long, extending, when folded over the back, a little beyond the tip of the style, and the poisers are well developed (see Fig. 1); in the latter the wings are represented by mere stubs, as shown in Fig. 2, and the poisers are short and stout, lacking the terminal hook. Length of body varies from .25 mm. to .35 mm. In other respects the two forms present few characters that differ, and are in agreement as follows: the color is reddish brown; thoracic shield and band not distinct, conforming in general color to that of the rest of the body; the legs are stout and lighter in color than the body; tarsi sparsely hairy (Fig. 1, *c*). Eyes prominent, nearly black; antennæ yellowish, sometimes pinkish, ten-jointed, covered with stout transparent hairs (Fig. 1. *b*). Style about .20 mm. long, and of nearly the same color as the legs. Segments of abdomen distinct.

Mature female.—The body of the female is rough, deeply lobed (Plate XXXIV., Fig. 4), reddish brown, with the central portion somewhat purplish because of the eggs within. The last segment is yellowish and presents the following characters (Plate XXXIV., Fig. 5):

There are five groups of spinnerets. The anterior group contains 20 to 27; the anterior laterals, 18 to 28; and the posterior laterals, 20 to 25. There are three pairs of well-developed and conspicuous lobes. The median pair are rounded, and unusually notched on the lateral margin near the tip; the second and third pairs are rather flat and broad, more or less notched on their margins. There are two plates between the second and third lobes, one of which is conspicuous and usually forked at the tip, while the other is short, simple, and sometimes inconspicuous. There is also a third plate, usually forked, just laterad of the third lobe. The spines are prominent and about as long as the plates. The first pair are situated near the lateral margin of the base of the first lobes; the second, about the middle of the base of the second lobes; the third, just laterad of the base of the third lobe.

Found on white elm, *Ulmus americana*, throughout Illinois, by the writer, and in Minnesota, on the same species, by Mr. R. H. Pettit.

Types in collections of the Illinois State Laboratory of Natural History and of the United States National Museum, and in the author's collection.

This species is very common throughout the State, and has caused considerable damage to elms planted for shade in some of our larger cities. I have also found it abundant upon virgin timber, but only upon the elm. I believe it to be a native American insect, and propose for it the above-mentioned scientific name, and popularly term it the "American elm scale." From the character and nature of its attack it is clearly a dangerous species. It is two-brooded in central Illinois, the first brood appearing about May 1, and the second about July 1. It hibernates in the egg state. The average number of eggs under each scale is about one hundred and five. The female attacks the trunk and the branches; but the male is most abundant upon the trunk and leaves, although often found upon the branches. According to one season's observations, the peculiar pseudimaginal form of the male is very much more abundant than the true imago. The wingless form is very active, and runs with considerable freedom. I have repeatedly seen it copulating. The winged form is also very active, but is rarely seen. *Gossyparia ulmi* Geof., another coccid injurious to elm, is also peculiar in having two forms of males.*

I have bred two species of hymenopterous parasites, *Perissopterus pulchellus* (Howard) and *Physcus varicornis* (Howard), from this "American elm scale." I have also reared specimens of a parasite, presumably different from the above, but they were so badly damaged by accident that it was found impossible to determine them. Under some scales I have seen a very small mite among the eggs, and I have seen both the larva and adult of the twice-stabbed ladybug, *Chilocorus bivulnerus*, feeding upon this scale. So far as my observations go, the parasitic and predaceous enemies of this insect are to be considered as very trivial agencies in keeping the species in check.

*Insect Life, Vol. II., p. 37.

EXPLANATION OF PLATES.*

PLATE XXIX.

Fig. 1. *Aspidiotus forbesi* n. s.: *a*, infested cherry twig; *b*, scale of female; *c*, scale of male.

Fig. 2. Adult male of same.

Fig. 3. Adult female of same, showing eggs within body.

Fig. 4. Last segment of adult female.

Fig. 5. Young larva of same species.

PLATE XXX.

Fig. 1. *Aspidiotus comstocki* n. s.: *a*, infested maple leaf; *b*, scale of male; *c*, scale of female.

Fig. 2. *a*, adult male of same; *b*, antenna; *c*, poiser; *d*, tarsus.

PLATE XXXI.

Fig. 1. Adult female of *Aspidiotus comstocki.*

Fig. 2. Last segment of same.

Fig. 3. *Aspidiotus æsculi* n. s.: *a*, infested buckeye twig; *b*, scale of male; *c*, scale of female.

PLATE XXXII.

Fig. 1. Adult male of *Aspidiotus æsculi.*

Fig. 2. Adult female of same.

Fig. 3. Last segment of female.

Fig. 4. *Aspidiotus ulmi* n. s., adult female.

Fig. 5. Last segment of same.

---

*All the drawings for this paper were made, under the author's direction, by Miss Lydia M. Hart, Artist of the Laboratory.

Plate XXXIII.

Fig. 1. *Chionaspis americana* n. s., on elm leaf and twig, showing both male and female scales.

Plate XXXIV.

Fig. 1. *Chionaspis americana* n. s.: *a*, adult male, perfect form; *b*, antenna; *c*, tarsus.

Fig. 2. Adult male of same, stub-winged form.

Fig. 3. Young larva of same species.

Fig. 4. Adult female of same species.

Fig. 5. Last segment of same.

Article XIV.—*Notes on Species of North American Oligochæta.* II. By Frank Smith.

Illinois Species.

The collections of Oligochæta made in connection with the work of the Biological Experiment Station upon the Illinois River, at Havana, contain about thirty species, of which the greater number have been previously described. Two species, one of which must be regarded as belonging to a new genus, are described in this paper.

Pristina leidyi n. sp. (Pl. XXXV.)

One of the most abundant species of Naidomorpha occurring in the Illinois River at Havana is a member of the genus Pristina, closely allied to *P. longiseta* Ehrenb., but differing from it in certain characters of sufficient importance to make it necessary to regard it as distinct. In this view I am supported by Prof. Vejdovsky, who has very kindly replied to queries upon the subject. I think it may be the species described and figured by Leidy ('50, p. 44, Fig. 3), and considered by him as identical with the European species *P. longiseta.*

Budding specimens are 4–8 mm. in length when well extended, and sexually mature specimens about 4 mm. The length given by Leidy for specimens measured by him, viz., 1 line, may, I think, reasonably be supposed to apply only to the part anterior to the budding zone, since he states that the "body" is composed of sixteen elongated "articulations," and his figure shows about that number anterior to the budding zone. If this view be correct, the whole length of his specimens would be nearly 4 mm. *P. leidyi* attains a length of 8 mm. only when there is a chain with three or more budding zones. The diameter is .1 to .15 mm. The proboscis is much like that figured by Leidy, and from its tip to the mouth of the worm measures .3–.4 mm. It is about .03 mm. in diameter at the base and tapers slightly toward the tip. The number of somites in sexually mature specimens is about 30, being subject to variation. The number in specimens with budding zone in an early stage is 24–30, plus an indefinite number of indistinguishable ones at the posterior end.

The dorsal setæ agree in number and length with those of Leidy's species. There are three in each bundle, the first ones occurring on II. Those of III are about .7 mm. in length, while those of other somites are .3–.35 mm. In young specimens each of the bundles usually shows the dorsal setæ of different lengths, only one having attained the normal length, a second being one half or two thirds as long, and a third quite short. In older and sexually mature specimens they are approximately equal. The dorsal bundles contain only capillary setæ, but these differ from the ones ordinarily found in naidiform worms in being slightly curved, and in having minute slender teeth upon the convex side, which give a serrated appearance to the setæ (Pl. XXXV., Fig. 6). The proximal teeth are about .006 mm. apart, and the serrated condition is most conspicuous near the distal end, the proximal half of the fully developed seta being without teeth. These serrations seem to be a constant character and are perfectly distinct when examined with high powers, yet they might easily be overlooked, and perhaps escaped Leidy's attention. The ventral setæ (Pl. XXXV., Fig. 5) are in bundles of 5–9, though the more usual number is 6–8. They are about .05 mm. in length. Sexually mature specimens have one pair of genital setæ on each side of VI in place of the ordinary ventral setæ. These genital setæ are bifid at the outer extremity and shaped much like ordinary setæ, but are somewhat straighter and about one half longer.

The brain is slightly longer than wide, and is deeply cleft both anteriorly and posteriorly as in *P. longiseta* ('84, Vejdovsky, Taf. II., Fig. 13).

The alimentary tract agrees with that of *P. longiseta* and of Leidy's species. The glandular ventricle is in the anterior part of VIII, and is followed by a narrow part of the intestine which is convoluted in IX and opens into the wider region of the intestine in the posterior part of that somite. In older specimens these regions are very distinct, but in those recently formed by budding the differentiation is much less obvious. As in *P. longiseta*, septal glands are present in III–V, of which those in IV and V are large.

A pair of contractile vascular trunks connects the dorsal and ventral vessels in each of somites III–VII, being situated just in front of the posterior septum in each. While they are all conspicuous, yet those of VI and VII are a little larger than the others, though not so much dilated as those of *P. longiseta* as figured and described by Vejdovsky. A pair of non-contractile vessels branch off from the dorsal vessel just posterior to the brain.

The first pair of nephridia is in IX. An examination of more than thirty specimens with reference to their location has shown no variation in the position of the first pair, but in five instances the ninth somite contained but one nephridium. The next following somites usually contain but a single nephridium, although in eight per cent. of the cases two nephridia were present, and in nine per cent. the nephridia were entirely wanting. In at least ninety per cent. of the instances observed, when but one nephridium was present it belonged to the left side of the somite. In *P. longiseta* the first nephridia are stated to occur in somite X, and, to my knowledge, there is no record of such variability in the number of nephridia in each somite as characterizes *P. leidyi*. The nephridiopores are a little anterior to the ventral setæ and slightly mesad of the same.

The perivisceral corpuscles are very conspicuous, a fact which is due to the presence of several spherical bodies that nearly fill the cell. The corpuscles are spherical and collected chiefly about the inner ends of the setæ.

In the latter part of July of the present year, 1896, among a large number of specimens without clitellum and sexually immature, I found one individual which had organs in VII and VIII, presumably gonads. I have as yet found no sexually mature specimens of *P. leidyi* in their natural environment, but in the latter part of May of the present year I found a few of them among the progeny of an individual of this species which had been isolated in December of last year and kept with its descendants in confinement at the temperature of an ordinary living room. These worms exhibit uniformity in their reproductive organs, and as they also agree with the specimens above referred to in the presence of organs in VII and VIII, I have no reason for thinking that their reproductive organs are not normal. My sections, and my observations upon the living specimens enable me to establish several important points concerning them. The most noticeable difference between the reproductive organs of Pristina and those of other Naidomorpha in which these structures have been studied, is the fact that they are located two somites further back in Pristina than in other members of this family.

In *P. leidyi* the clitellum extends from the setæ of VII to those of IX, and is quite thick upon the dorsal portion of VIII and the anterior part of IX. In place of the ordinary ventral setæ in each side of VI a pair of genital setæ appears, as previously stated. Ventral setæ of the usual type are present upon each of the neighboring somites. A pair of large multicellular glands without definite lumen is situated in the posterior part of VI. Each of these glands is connected with the ventral wall of the cœlom and surrounds a pair of genital setæ (Pl. XXXV., Fig. 1 and 4). A pair of testes is present in VII, attached to the ventral wall, just posterior to the spermathecæ (Plate XXXV., Fig. 4). The ciliated funnels of the sperm-duct are in the posterior part of the same somite, and are quite large, simple, and funnel-shaped, and have their opening directed dorsad (Pl. XXXV., Fig. 3 and 4). The sperm-duct is short and wide. After entering VIII its course is dorsad, but making a rather short turn it passes ventrad, opening upon the same somite. The walls of the first half of the duct are glandular (Pl. XXXV., Fig. 3), and those of the last half are muscular. The ventral wall of VIII is much thickened in the vicinity of the male pore. The opacity due to the clitellum renders the study of the duct impossible in the living specimen, and I have had to depend upon sections for my knowledge of it. In the specimens sectioned there is no especial enlargement of the lumen to form an atrial chamber. The cavity of VII contains loose spermatozoa, and a single sperm-sac opens from it and extends through VIII into IX, lying dorsad to the alimentary tract. Ova are contained in IX. A pair of ovaries is situated in VIII, and there seem to be oviducal pores at VIII | IX. In the most anterior part of VII is a pair of spermathecæ, the pores of which are at the anterior margin of that somite. (Pl. XXXV., Fig. 1, 2, and 4.)

The asexual reproduction or budding of *P. leidyi* is in some respects quite different from that observed by Bourne in the species studied by him ('91, p. 354). Unfortunately, I have not been able to obtain any data concerning this phenomenon in *P. longiseta*. *P. leidyi* agrees with other naidiform worms in the general features of the budding process, new somites being developed at the budding zone, an indefinite number of which form the posterior part of the anterior daughter worm, and a definite number (z′ of Bourne, '91, p. 339) the anterior part of the posterior daughter worm; but instead of there being a constant, or nearly constant, number of somites anterior to the budding zone (n of Bourne), it is the normal thing in this species for n to vary. The budding zones successively formed in the same worm do not occur at the same place, but a second zone normally occurs one somite nearer the anterior end than the first zone, and the third zone one somite anterior to the second zone, and so on. Of course, a limit is soon reached, anterior to which new zones are not formed. This is usually at XII|XIII or XIII|XIV. When this limit is attained, the next new zone is formed at some point posterior to the position of the last zone. The following data, taken from the records of a large number of worms which were isolated and reared in confinement, will serve as an illustration of the usual order of appearance of budding zones. A specimen isolated December 2, 1895, had a chief budding zone at XIV|XV, and a younger one at XIII|XIV. December 5, the beginning of a still younger zone at XII|XIII was visible, while the posterior division of the worm had a budding zone well started at XVI|XVII, and a younger one at XV|XVI. December 7, the posterior division had been freed, and the chief budding zone of the anterior division was at XIII|XIV. December 11, another worm had been freed, and the only budding zone of the anterior division was at XII|XIII. December 19, another worm had been freed, and a new budding zone started at XIII|XIV, in the regenerated portion of the anterior division. Of the six individuals represented in the chain as observed December 5, all but one had become free by December 19. Not only is n variable normally, but the position of the first budding zone in the newly formed worms is variable. I have found that in the case of individuals kept in confinement, and so under abnormal conditions, there was a tendency for the first budding zone of new individuals to appear further back than in those living in larger bodies of water. Of one hundred specimens observed under normal conditions, or after but brief captivity, fourteen had the first budding zone at XV|XVI, sixty-nine at XVI|XVII, sixteen at XVII|XVIII, and one at XVIII|XIX. In no instance have I found Bourne's z′ to be other than seven. I may state here that after numerous observations upon several species of naidiform worms I have found that *n* is extremely variable in individuals of the same species, and, also, in a less number of species, that the number of somites in the sexually mature worm is not constant for a species.

Mesoporodrilus asymmetricus n. g. et n. sp. (Pl. XXXVI., and Pl. XXXVII., Fig. 11 and 12.)

The following description is based upon two specimens of a lumbriculid species which were found in July of the present year in the sand of the east shore of Quiver Lake, near its foot, and in a situation where small springs of water kept the sand wet and cold. The specimens were received at a time when a study of the living worms could not be made, and they were immediately fixed and preserved. One of the specimens was not in a very good condition, and was chiefly valuable in confirming the observations upon some of the more important characters of the other.

The worms are without pigment, and quite delicate in appearance. They are 30 mm. in length and .5 mm. in diameter, the number of somites in one apparently complete specimen being 65. They are provided with a proboscis that in length equals the diameter of the first somite. There are four pairs of pointed setæ on each somite (Pl. XXXVI., Fig. 9). The clitellum extends from the middle of IX to the middle of XIII, and is conspicuous.

The pharynx extends through III and IV (Pl. XXXVII., Fig. 11). The epithelium of the dorsal half of its wall is thick and ciliated (Fig. 12), although thinner along the median line of the fourth somite than elsewhere.

The ventral half of the wall is very thin and without cilia. In somite V the walls of the alimentary tract become nearly uniform in thickness and ciliated throughout. The lumen in this somite is quite narrow. In the following somites the intestine is sacculated. Beginning with the seventh somite it is invested by a nearly continuous sheath of blood, outside of which is the layer of chloragogue cells. The muscles connecting the pharynx with the body wall are very weak and few in number (Fig. 11). There is no glandular tissue forming pharyngeal and septal glands. There is a similar absence of such glands in *Eclipidrilus frigidus* Eisen ('95, Eisen, p. 86). A few deeply-staining cells are situated on some of the blood vessels of the region, but none upon the pharyngeal muscles.

My knowledge of the circulatory system of this species is very imperfect, owing chiefly to lack of opportunity for studying the worms in the living state. The ventral vessel is forked near the septum V | VI. None of the vascular trunks connecting the dorsal and ventral vessels are especially enlarged. In the anterior part of each of a few of the anterior somites a pair of vessels invested by gland cells connects the ventral vessel with the dorsal part of the intestinal sinus; while in the posterior part of the somite a pair of slender vessels without investing gland cells and having a somewhat tortuous course connects the dorsal and ventral vessels. ' pair of these connecting vessels from somite X extends backward through several somites, being closely associated with the reproductive organs contained therein. In the posterior part of the worm there are two pairs of lateral vessels in each somite; one situated anteriorly, the other, posteriorly. Both pairs branch off from the dorsal vessel, from which they extend laterad, each vessel closely following the body wall. They are similarly invested by gland cells, and have short cœcal diverticula, but the vessels of the posterior pair, unlike the anterior, unite with the ventral vessel.

The first pair of nephridia is in VII, and the nephridiopores are situated in front of the ventral setæ. Albumen glands are wanting.

The reproductive organs of this species are in some respects quite remarkable. One of the specimens had these organs well developed; the other had passed the stage of sexual activity, but still had most of the organs present, though reduced in size. One pair of testes is present in X. The male efferent apparatus is developed upon only one side. The male pore is upon the midventral line in the posterior part of X (Pl. XXXVI., Fig. 7). As this condition exists in each of the specimens, it cannot be ascribed to individual abnormality. The funnel of the sperm-duct is in the posterior part of X. I have been unable to trace the part of the spermduct connected with the funnel, but the distal part has peculiarities of structure closely allying it to the similar organ in *E. frigidus.* An enlarged reservoir extends through XII–XIV (*res.*, Fig. 7). It has a thick wall consisting of a thin epithelial layer and a thick layer of longitudinal muscular tissue. Outside of the muscular layer is a layer of small deeply-staining cells, which in some places are scattered. This layer is nowhere more than one cell in thickness. The reservoir is not constricted by the septa of the somites through which it passes. Surrounding the reservoir, and connected with it, is a thick layer of tissue of a reticulate character, which is constricted by the septa. The posterior end of this reservoir ends blindly, while the anterior end is continuous with a smaller tube which extends forward and inward as far as the middle of XI, and then, making an abrupt turn outward, passes posteriorly half way to septum XI|XII, where, with another abrupt turn, it extends anteriorly and is continuous with a larger portion of the duct corresponding to the "prostate and atrium" of *E. frigidus.* The part of this enlarged portion which is situated in XI (*pr.*, Pl. XXXVI., Fig. 7), and which because of its relations to the other parts of the sperm-duct corresponds to the "prostate" of *E. frigidus*, has thick walls with layers corresponding to those of the reservoir and the connecting duct, the chief difference between the walls being that in the former the ephithelial layer is much thicker than in the two latter. There is no layer of elongated glandular cells like that of the prostate of *E. frigidus*. At a point just anterior to the septum X|XI is an enlargement of the duct and an expansion of the lumen to form a small chamber (*at.*, Fig. 7), in which is a marked change in the lining epithelium, this layer becoming much thinner and the cells more scattered. The terminal portion of the duct extends from the chamber above referred to, ventrad to the male pore. The structure of this portion of the duct leads me to believe that this worm has an eversible penis. A mass of glandular cells (*gl. cl.*, Fig. 7) is closely associated with the sperm-duct at its external opening. It consists of an aggregation of elongated unicellular glands opening to the exterior upon the surface of the body at the male pore. They are much like glands similarly situated in some of the Lumbricidæ. The nerve cord is slightly displaced in the region of the male pore, where it leaves the middle of the ventral floor and lies on one side of the sperm-duct. There is but one sperm-sac, and this extends as far back as XXI, lying partly beneath and partly to one side of the alimentary tract. The reservoir of the sperm-duct with its external sheath of tissue is partially surrounded by the cavity of the sperm-sac. In somites X–XVII the alimentary tract is upon one side of the body, being displaced by the large mass consisting of sperm-sac and sperm-duct. There is one pair of ovaries, in XI. They are large, irregularly bent, and project part way into XII. The oviducts are two in number, short, and open to the exterior at XI|XII (Pl. XXXVI., Fig. 8). Two spermathecæ are situated in IX, but instead of being paired they are both upon the same side of the somite, and their external pores are in the mid-ventral line (Pl. XXXVI., Fig. 10), one behind the other. This unusual state of things exists in both specimens.

M. asymmetricus has several important features allying it closely to *E. frigidus*, and, in my opinion, should be included with it in the subfamily of Lumbriculidæ proposed by Eisen ('95, p. 84) for the latter species. The points of resemblance are the character of the alimentary tract and the absence of pharyngeal and septal glands, some features of the circulatory system, the structure and extent of the sperm-duct, the extent of the sperm-sac, and, finally, the position of testes, male pore, and ovaries. The median position of the pores of the spermathecæ and sperm-duct and the numerical asymmetry of these organs are unique and difficult to account for.

FLORIDA SPECIES.

Through the kindness of Mr. Adolph Hempel, of the Biological Station staff, I received in March of the present year a large number of living Oligochæta from Florida. Among them were sexually active specimens of four different species; viz., *Diplocardia eiseni* Michaelsen, ('94, Michaelsen, p. 184), *Allolobophora giesleri* Ude, ('95, Ude, p. 127), *Sparganophilus eiseni* Smith, ('95, Smith, p. 142), and a species of Microscolex, apparently undescribed. Among the specimens of *Diplocardia eiseni* are a few quite young individuals not so heavily pigmented upon the anterior end as are the adults, and in these the double character of the dorsal vessel in the first fifteen somites, first noticed by Ude ('95, p. 136), is quite obvious. It is not visible in the mature living worms. The specimens of Sparganophilus are much smaller than those found in Illinois, being but half as long and very slender. I have not as yet been able to discover any anatomical characters that distinguish them from *S. eiseni*.

Microscolex hempeli n. sp. (Pl. XXXVII., Fig. 13, and Pl. XXXVIII.)

This species was represented by eleven specimens, mostly mature. They were found near Quincy, Florida, under a manure heap.

They are not pigmented, but, like Eisen's Deltania species, are pale and rather delicate. Alcoholic specimens killed well extended are 35–55 mm. in length and 1–1.5 mm. in diameter. The number of somites in seven specimens averaged 73, with extremes of 63 and 78. The prostomium extends over about half the first somite. The clitellum is upon XIII–XVII, but extends a shorter distance upon the ventral surface of XVII than elsewhere, the outline forming a sinus as in *M. nova zelandiæ* ('93, Beddard, Fig. 1). It is complete and nearly as thick upon the ventral as upon the dorsal surface (Pl. XXXVIII., Fig. 14). Small genital papillæ are present but difficult to see upon the entire worms, and I have studied them only upon sectioned specimens. Their situation is quite variable. In one specimen there is a pair of papillæ on X and a single one on XI; a second specimen has them similarly placed on X and XI, and also has a pair on XVIII; while a third specimen has none on X or XI, but has a pair on the anterior part of XVII.

The setæ are paired, and those of the inner couples converge toward the male pore, as in the species included by Eisen in his genus Deltania ('94, p. 22). In the somites posterior to XIX (See Fig. 13, Pl. XXXVII.) the distance between the setæ of a ventral couple is almost exactly equal to that between the setæ of a dorsal couple, and is about two thirds of that between those couples, and nearly as great as that between the ventral couples. Thus, calling the distance between the inner setæ (1—1) 12, then the distance between the setæ of a ventral couple is 10, that between the ventral and dorsal couples is 15, that between the setæ of a dorsal couple is 10, and that between a dorsal couple and the mid-dorsal line is 22–24. In the anterior somites the setæ of a ventral couple are a little nearer together than those of a dorsal couple. The dorsal setæ are in the dorsal half of the worm. Setæ of the usual shape and size occur in the clitellar region as elsewhere (Pl. XXXVII., Fig. 13). The ordinary setæ are about .16 mm. in length. The penial setæ are nearly four times as long, very slender, and slightly curved outward. They are upon XVII, and are only one sixth as far apart as those of the ordinary ventral couples. There are no dorsal pores.

The buccal cavity is everted in alcoholic specimens. The pharynx is thick only upon the dorsal side (Pl. XXXVIII., Fig. 17). In somite V, as shown by septa, but pushed back to VI, as indicated by external division, is a slightly developed gizzard (*giz.*, Fig. 17). This has a layer of circular muscle fibers slightly thicker than that of the body wall of the same somite, but not nearly as powerful as in some Acanthodrilidæ. The œsophagus continues to XVI, where it joins the greatly enlarged intestine. Septal glands are present in V–VIII, those of VII and VIII being small, and those of V and VI larger. Figure 17 was drawn from median sections, and consequently shows only small parts of the septal glands.

The first nephridia are in II, and those of II–IV each have a nephridiopore anterior to seta 4. Those of V and the following somites each open anterior to and a little ventrad to seta 3, the nephridiopores being almost exactly at the ends of the transverse diameter of a cross section of the body. They all possess a bladder or vesicle next to the wall.

The "hearts" are large and in X–XII.

The testes have the usual situation in X and XI. The small and slightly lobulated sperm-sacs are in XI and XII, and are attached to the anterior septum of their respective somites a little below the œsophagus. The ciliated funnels of the sperm-ducts have the usual situation in X and XI. The sperm-ducts are slender and without convolutions. They meet in XII and extend to XVII, those of either side lying close to each other and passing through each somite just laterad of seta 2 (*sp. d.*, Pl. XXXVIII., Fig. 14). During their course they lie upon the muscle layer of the body wall, without entering it, until they are in the neighborhood of the male pore. When they have reached the vicinity of the penial setæ they enter the muscular wall and unite, and the common duct passes around the posterior side of the duct of the prostate gland and the outer penial seta and opens to the exterior between, and slightly posterior to, the penial setæ (Pl. XXXVIII., Fig. 15 and 16). One pair of prostate glands is present in XVII. The glandular part is tubular and slightly smaller in diameter in the distal region, where it is bent, but not helix-like. More frequently the distal portion projects into XVIII. The wall is composed of long glandular cells, of which many are somewhat bent and irregular. Although I have studied thin sections carefully, I can distinguish no differentiation into two layers. If there is any inner epithelial layer at all, it is very slightly developed and not continuous. I have found the same condition in sections of each of several individuals. The muscular duct is slightly longer than the setal sac near it, and opens to the exterior just outside the outer penial seta. The penial setæ and the pore of the duct of the prostate are very nearly in a straight line, with the male pore between the setæ and the prostate-duct pore just outside the outer penial seta (Fig. 15 and 16). One pair of spermathecæ is present in IX. In some specimens one spermatheca projects into VIII, but the pores are upon IX in each instance. These pores are at the anterior margin of the somite and in line with seta 1. The spermathecæ extend from one third to one half the way across the somite, each having a somewhat elongated sac, and a distinct duct about one half as long as the sac. Two diverticula communicate with the duct about midway of its length. They are approximately equal and one half as long as the spermatheca. Each has a narrow duct and an elongated sac. The ovaries have the usual situation in XIII. There are no ovisacs. The oviducal pore of each side is anterior to seta 1 and in line with it.

In *M. hempeli*, characters are combined which seem to bring the genera Rhododrilus and Deltania very near together and to emphasize the necessity of combining them with Microscolex as Beddard has done ('95, p. 228). Dr. Eisen has expressed his opinion in favor of the same course in a letter recently received, as has also Dr. Benham.

The presence of Microscolex, Sparganophilus, and Diplocardia in Florida serves to bring the earthworm fauna of that region into close relationship with that of the more western parts of this country and South America.

CHAMPAIGN, November 6, 1896.

LIST OF PAPERS CITED.

'93. BEDDARD, F. E.—Some New or Little-known Oligochæta. Proc. Roy. Phys. Soc. Edinb., XII., pp. 30–45.

'95. ————————Preliminary Account of New Species of Earthworms belonging to the Hamburg Museum. Proc. Zool. Soc. London, Pt. II., pp. 210–239.

'91. BOURNE, A. G.—Notes on the Naidiform Oligochæta; containing a Description of New Species of the Genera Pristina and Pterostylarides, and Remarks upon Cephalization and Gemmation as Generic and Specific Characters in the Group. Quart. Journ. Micr. Sci. (n. s.), Vol. XXXII., pp. 335, 356. Pl. XXVI. and XXVII.

'94. EISEN, G.—On California Eudrilidæ. Mem. Calif. Acad. Sci., Vol. II., No. 3, pp. 21-62. Pl. XII.-XXIX.

'95. ———————Pacific Coast Oligochæta, I. Mem. Calif. Acad. Sci., Vol. II., No. 4, pp. 63-90. Pl. XXX.-XLV.

'50. LEIDY, J.—Descriptions of some American Annelida abranchia. Journ. Acad. Nat. Sci. Phil., Vol. II., 2d ser., pp. 43-50. Pl. II.

'94. MICHAELSON, W.—Die Regenwurm-Fauna von Florida und Georgia. Zool. Jahrb., Abth. f. Syst., Bd. VIII., 2 Heft, pp. 177-194.

'95. SMITH, F.—A Preliminary Account of two New Oligochæta from Illinois. Bull. Ill. State Lab. Nat. Hist., Vol. IV., Art. V., pp. 138-148.

'95. UDE, H.—Beiträge zur Kenntnis der Enchytræiden und Lumbriciden. Zeit. f. wiss. Zool. Bd. LXI., 1 Heft, pp. 111-141. Taf. VI.

'84. VEJDOVSKY, F.—System und Morphologie der Oligochæten. 166 pp. 16 Taf.

EXPLANATION OF PLATES.

Abbreviations.

at.	Enlargement of sperm-duct near ♂ pore.	*ph.*	Pharynx.
br.	Brain.	*pr. po.*	Prostate gland pore.
c. d.	Duct connecting reservoir and terminal portion of sperm-duct.	*res.*	Sperm reservoir.
		s. sa.	Inner end of seta.
		sal. gl.	Salivary gland.
		sep.	Septum.
clit.	Clitellum.	*sep. gl.*	Septal gland.
coel.	Cœlom.	*sp. d.*	Sperm-duct.
d. s.	Dorsal seta.	*sp. f.*	Spermiducal funnel.
d. ves.	Dorsal vessel.	*sp. th.*	Spermatheca.
g. s.	Genital seta.	*sp. th. d.*	Duct of spermatheca.
g. s. gl.	Gland of genital seta.	*sp. th. po.*	Spermathecal pore.
giz.	Gizzard.	*t.*	Testis.
gl. c'l.	Gland cells at ♂ pore.	*v. g.*	Subœsophageal ganglion.
int.	Intestine.		
int. sin.	Intestinal sinus.	*v. s.*	Ventral seta.
n. c.	Nerve cord.	*v. ves.*	Subintestinal vessel.
neph. po.	Nephridiopore.	♂ *po.*	Pore of sperm-duct.
oes.	Œsophagus.	♀ *po.*	Oviducal pore.
ov. f.	Oviducal funnel.		

Plate XXXV.

Pristina leidyi.

Fig. 1. A slightly oblique transverse section passing through the glands of the genital setæ in the posterior part of VI, and through the duct of one spermatheca in the anterior part of VII. The septum is not shown. × 335.

Fig. 2. Transverse section near the middle of VII, passing through the spermathecæ. × 335.

Fig. 3. A slightly oblique transverse section passing through the spermiducal funnel in the posterior part of VII and the glandular part of the sperm-duct in the anterior part of VIII. × 335.

Fig. 4. Diagram showing the arrangement of part of the reproductive organs. Setæ are relatively too small.

Fig. 5. A ventral seta. × 550.

Fig. 6. Distal portion of a dorsal seta. × 1000.

Plate XXXVI.

Mesoporodrilus asymmetricus.

Fig. 7. A median longitudinal section reconstructed from several sections. × 80.

Fig. 8. Oviducal funnel and pore. × 210.

Fig. 9. A seta. × 210.

Fig. 10. Ventral portion of a transverse section through IX, showing the position of the pore of one of the spermathecæ. × 190.

Plate XXXVII.

Mesoporodrilus asymmetricus.

Fig. 11. Median longitudinal section of anterior end, from several sections. The proboscis of this specimen had been lost, but its position, as shown by the injury to the wall of the prostomium, is indicated by dotted lines. × 80.

Fig. 12. A cross section of the pharynx. × 120.

Microscolex hempeli.

Fig. 13. Diagram showing the arrangement of the ventral setæ in the anterior part.

Plate XXXVIII.

Microscolex hempeli.

Fig. 14. Cross section from the region of the clitellum. × 33.

Fig. 15. From a superficial frontal section showing the relations of the genital setæ and pores of one side. × 350.

Fig. 16. Portion of a transverse section through the male pore of one side. × 200.

Fig. 17. Median longitudinal section of a specimen with lips everted. × 30.

Article XV.—*Contribution to a Knowledge of the North American Fresh-water Ostracoda included in the Families Cytheridæ and Cyprididæ.* By Richard W. Sharpe, B. S.

INTRODUCTION.

The present paper has been prepared in the course of work at the University of Illinois for the degree of master of science in zoölogy. In addition to extensive collections of Entomostraca made at the Biological Station of the University of Illinois, situated at Havana, on the Illinois River, I have been able, through the kindness of Dr. S. A. Forbes, to examine all the accumulations in this group made by the Illinois State Laboratory of Natural History during the last twenty years, and covering a territory little less than continental. The greater part of the material studied is from the rivers, ponds, and lakes of Illinois and immediately adjacent states, but at least a cursory examination has also been made of collections from the Yellowstone National Park and from the lakes of northwestern Montana.

Although the Ostracoda of Europe have now been extensively studied, but little work has been done upon this order in America. Prof. C. H. Turner, of Clark University, Atlanta, Ga., has, however, paved the way for American students in this field (**35**, **62**, **63**, and **64**), and scattered descriptions occur in the writings of some others. The earlier practice of distinguishing species by characters derived from the shell alone has had the effect to surround the study of this group with extraordinary difficulties and greatly to complicate the synonymy. More recently much use has been made of the structure of the soft parts of these Crustacea, with the result to add several new genera, mostly described by Prof. G. O. Sars. For the convenience of students who follow me I have thought it best to embody synopses of all these genera in the text.

Of the twenty-two species herein mentioned fourteen are new to America, and twelve I believe to be undescribed. Two of these species belong to the genus Limnicythere and to the family Cytheridæ, itself new to America.

It is a pleasure to me to say that whatever value this work may have is due in great part to the kind encouragement I have received from Dr. Forbes, and to his generosity in providing both material and literature for my use.

LIFE HISTORY AND HABITS.*

Unlike the other groups of Entomostraca, most of which, independent of shores or bottom, swim easily and continuously throughout the waters they inhabit, the Ostracoda commonly occupy a more restricted range in small and shallow waters, or along the bottoms and margins of large lakes and streams. With them, the act of swimming is more laborious because of the structure of the animal and the weight of the shell. In collections of the limnetic plankton, therefore, they are either wanting, or present only in relatively insignificant numbers. In consequence of the temporary nature of the small bodies of water in which they are usually found, they are much more frequently observed during the spring months. At this time, in a little short-lived wayside pool or ditch vast numbers may make their appearance, soon to disappear with the drying up of the water. They may also be seen in such situations in the fall. They thrive in both clear and turbid waters, either in the midst of aquatic vegetation or on a bare mud bottom. Most of

* The text and tables under this head were prepared by Mr. C. A. Hart.

them are scavengers, though some species feed upon minute aquatic vegetation, such as diatoms and filamentous Algæ.

Ten of the species and both of the families herein treated were represented in collections of the Biological Station from the region covered by its operations in the vicinity of Havana. The collections examined were partly surface, bottom, and oblique tows taken with a fine towing net in the deeper and more open waters, and partly catches with the towing net or Birge net from among the vegetation along the gently-sloping shores.

In the first table following, the distribution of each species is shown with regard to the various collecting substations, which are grouped according to their general character. Full descriptions of these localities may be found in a previous article of this volume.* The total number of collections examined from each substation is given immediately beneath the letter designating the substation. The lower, larger number of each pair in the table indicates the relative abundance of the species, on the scale of 5, 1 meaning rare, and 5, excessively abundant. The smaller numbers above these show the number of collections in which the species appeared.

It will be seen that in the off-shore collections the first three genera (Limnicythere, Cyprinotus, and Candona) do not appear at all, while the last two (Cypria and Cypridopsis) appear a number of times. This indicates a difference in habits, and does in fact correspond to a decided difference in structure. The members of the second group possess well-developed swimming hairs or natatory setæ, and appear not only in the bottom tows but in the surface tows also, even in the river channel at station E.

---

* Article VI., p. 151.

TABLE OF LOCAL DISTRIBUTION.

The upper figure of each pair shows the number of times the species was found, and the lower figure its relative abundance: 1, rare; 2, infrequent; 3, common; 4, abundant; 5, excessively abundant.

	Off-shore Collections.													Shore Collections.											
	Surface Tows.							Bottom Tows.						Sandy	Muddy.								Miscellaneous.	Totals.	Grand totals.
	River...	Lakes.				Mill-pond...	Totals.	River...	Lakes.			Mill-pond...	Totals...	Lake	Lake.					River.					
															Springy	Not springy.									
Substations	E.	C.	G.	L.	K.			E.	C.	G.	L.			G.	B.	C.e.	A.	C.w.	F.	D.	E.w.	E.e.			
Collections examined	52	5	8	8	1	1	75	45	7	8	9	1	70	12	7	32	6	10	5	14	12	1	6	105	250
Limnicythere illinoisensis														1 1										1	1
Cyprinotus pellucida																							2 1 Roadside pool.	2	2
Candona simpsoni														1 2		4 3				3 2	1 3			9	9
Candona sigmoides														1 2			1 2			1 1				3	3
Candona reflexa																4 1								4	4
Cypria pustulosa						1 1	1	2 2	1 1				3		1 2	6 2				1 1	1 1			9	13
Cypria obesa														1 2										1	1
Cypria exsculpta								1 1					1	1 1		5 2					1 1		1 2 Johnson's L...	9	10
Cypria ophthalmica	7 3		1 1		1 1		9	2 2		1 2			3	1 3	1 2	4 3			1 1		1 1	1 3		9	21
Cypridopsis vidua	1 2		1 1	1 2	1 1		4		2 2	2 3	5 2		9	7 2	2 2	15 2	3 2	3 2		4 2	2 2		1 3 "Slough"......	37	50

TABLE OF SEASONAL DISTRIBUTION.

(For explanation see preceding table.)

		Feb.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Collections examined.	Off-shore Collections	1	0	0	3	29	33	41	20	8	10	145
	Shore Collections	2	3	28	6	12	23	14	5	6	6	105
	Total examined	3	3	28	9	41	56	55	25	14	16	250
Relative abundance; and number of times each species was collected.	Limnicythere illinoisensis			1 **1**								1
	Cyprinotus pellucida							2 **4**				2
	Candona... simpsoni		1 **4**	5 **3**					2 **1**	1 **1**		9
	Candona... sigmoides			2 **2**					1 **1**			3
	Candona... reflexa		1 **1**	2 **1**						1 **1**		4
	Cypria..... pustulosa			6 **2**		3 **1**	3 **1**	1 **2**				13
	Cypria..... obesa			1 **3**								1
	Cypria..... exsculpta		1 **1**	6 **3**		1 **2**			2 **1**			10
	Cypria..... ophthalmica	1 **1**	1 **1**	5 **3**	1 **2**	1 **1**	2 **3**	9 **2**	1 **1**			21
	Cypridopsis vidua	1 **2**	1 **2**	8 **3**	1 **2**	4 **2**	12 **3**	9 **3**	8 **3**	3 **2**	3 **3**	50
	Totals	2	5	36	2	9	17	21	14	5	3	

In the second table, the same data are grouped with regard to the time of year, the figures having the same meaning as in the preceding table. The rise in abundance in spring is quite evident, and probably would be more so if the earlier months were better represented. The first three genera (Limnicythere, Cyprinotus, and Candona) are absent during the summer months, reappearing in fall in lesser numbers. The remaining species (Cypria and Cypridopsis) are more uniformly distributed through the year. As they seem more at home in larger bodies of water, while those of the preceding group are accustomed to live in small ponds and streams which often dry up in midsummer, this difference would naturally be expected.

A full list of the species treated in the following pages, accompanied by biological data, is next given for comparison. Unless otherwise specified, the data given are from the records and collections of the State Laboratory. The relative abundance is indicated by a figure, as in the preceding tables.

The entire absence of species of Cypris from the Biological Station list is doubtless due to their occurrence in small ponds in preference to larger bodies of water, such as the lakes and streams of the Havana region.

Family Cytheridæ.

Limnicythere reticulata n. sp. Pond, Urbana, April, (2).

illinoisensis n. sp. Lake shore, Havana, May, (1). These species are evidently crawlers or burrowers rather than swimmers.

Family Cyprididæ.

Cyclocypris forbesi n. sp. Pond, Bloomington, April.

Cyprinotus pellucida n. sp. In water from creek, Urbana, April; roadside pool, Havana, Sept., (4); creek near Quincy.

burlingtonensis Turner. Jan. and March (Turner); Normal, May.

incongruens Ramd. Abundant in pools in spring (Vávra); Pt. Pinellas, Fla., May.

Cypris reticulata Zadd. Ponds, Normal, Feb., (2), and April, (5); Cypress swamp, Ky., Sept., (1).

fuscata Jurine. Pond, Urbana, April.

testudinaria n. sp. Pond in woods, Bloomington, April.

Candona acuminata Fischer. Pond, Clifton, May, (2).

recticauda n. sp. Pond, Clifton, Feb.

simpsoni n. sp. Lake and river shores, Havana, April, (4), May, (3), Oct., (1), and Nov., (1); pond, Urbana, April, (3).

fabæformis Fischer. Abundant in March and April in small pools (Vávra); pools, Normal, March; August (Turner).

sigmoides, n. sp. Lake and river shores, Havana, May, (2), and Oct., (1).

reflexa n. sp. Lake shore, Havana, April, May, and Nov., (1).

Cypria pustulosa n. sp. Bottom tows in river channel, surface and bottom tows in lakes, and lake and river shores, Havana, May, (2), July, (1), Aug., (1), and Sept., (2).

obesa n. sp. Lake shore, Havana, May, (3).

dentifera n. sp. Zoölogical Gardens, Cincinnati, O., Aug.

exsculpta Fischer. Common in most running streams. Bottom tow in river channel, lake and river shores, Havana, April, (1), May, (3), July, (2), and Oct., (1); ponds, Clifton, Feb. and May, (3); Normal, May; shore of L. Minnetonka, July, (1); Fourth Lake, Aug., (1).

ophthalmica Jurine. Surface and bottom tows in river channel, (2), surface and bottom tows in lakes, and lake and river shores, Havana, Feb., (1), Apr., (1), May, (3), June, (2), July, (1), Aug., (3), Sept., (2), and Oct., (1). A scavenger and active swimmer (Vávra). Common in ponds and ditches where there is little or no vegetation (Brady). Pools, Normal, March, (4); shore of L. Minnetonka, July, (1).

Cypridopsis vidua O. F. Müller. This cosmopolite seems to occur quite uniformly in all kinds of waters and at all seasons.

smaragdina Vávra. Ditch entering Calumet R., Aug., (2); found in July and August (Vávra).

SYNOPSIS OF FAMILIES TREATED IN THIS PAPER.*

1 (4). Second antennæ simple, subpediform, geniculate, clawed at the apex, not very unlike the upper antennæ; both pairs of antennæ bearing long setæ and adapted for swimming, or shortly setose and not used for swimming. Mandibles distinct, mostly strongly toothed at the lower extremity; palp of moderate size, bearing a more or less developed branchial appendage. First pair of maxillæ bearing a large branchial plate. Mostly fresh-water forms. *Tribe* PODOCOPA.

2 (3). Three nearly similar pairs of feet, all directed downwards and used for locomotion. Caudal rami obsolete, forming two rounded setiferous lobes. Antennæ very little adapted for swimming. CYTHERIDÆ.

3 (2). Two dissimilar pairs of feet; the anterior pair ambulatory, the posterior pair not used for locomotion, bent backwards within the valves. Caudal rami commonly well developed, mobile, and bearing two terminal claws. Antennæ commonly with natatory setæ. CYPRIDIDÆ.

4 (1). Second antennæ two-branched; one branch rudimentary, immobile, the other elongate, flexible, with long natatory setæ (Myodocopa); or both branches well developed, movable, and natatory (Cladocopa); or both branches flattened, similar to the feet of the Copepoda (Platycopa). *Marine tribes.*

* Modification of a key prepared by Brady (6).

FAMILY CYTHERIDÆ.

"Shell mostly hard, calcareous, usually with an uneven surface either sparingly clothed with hairs or altogether bare; hinge generally toothed. Eyes more or less separated, sometimes wanting. Antennules subpediform, geniculate at the base; five- to seven-segmented; beset with short setæ which are partly spine like. Antennæ strong, pediform, curved, four- or five-segmented, with two terminal claws; basal segment bearing a long setiform biarticulate flagellum, which conveys a duct from a poison gland; second segment destitute of a setose brush.

"Mandibles usually strong, enlarged and toothed at the apex; palp well developed, directed forward, and bearing on the posterior margin strong curved setæ and a poorly developed branchial appendage. First pair of postoral appendages more or less maxilliform; the three following alike, pediform, directed downwards, adapted for walking. One pair of branchial laminæ attached to the maxillæ. Caudal rami obsolete, forming two rounded setiferous lobes. Copulatory organs of the male large and complex; in addition to which there is a curious bifurcate appendage between the feet of the first pair: ovaria and testes not produced between the valves; no mucous gland. Animal incapable of swimming."—G. O. SARS.

I am not aware that representatives of this family have heretofore been reported for America. Of the dozen or more genera belonging to this family, but one (Limnicythere) seems to be purely a fresh-water genus.

I. LIMNICYTHERE BRADY.

1850. *Cythere*, Baird (**2**, p. 163).
1868. *Limnicythere*, Brady (**6**, p. 419).
1878. *Acanthopus*, Vernet (**72**, p. 516).
1888. *Limnocythere*, Dahl (**20**, p. 615).
1889. *Limnicythere*, Brady & Norman (**9**, p. 170).
1891. *Limnicythere*, Vávra (**68**, p. 107).

Shell strong, irregularly tuberculate or spinous, rather thin and horny in texture; extremities yellowish or hyaline.

The first pair of antennæ five-segmented, provided with short bristles on their outer edge; second pair four-segmented, the "spinning claw" being either two-segmented or unsegmented. The branchial plate of the mandible strongly developed (commonly rudimentary in other genera of this group). Caudal rami rudimentary, commonly but two short bristles.

Males are rare. Previous to Vávra's monograph (**68**) but five species were known: *L. sancti-patricii* B. & R.; *L. monstrifica* Norman, from England; *L. inopinata* Baird, from England and Sweden; *L. relicta* Lillj., from Sweden; and *L. incisa* Dahl, from Germany. Vávra (**68**) adds *L. stationis* as new, and Zschokke (**76**) has recently described *L. neocomensis* from Switzerland. I have found two species which presumably are not yet described.

Limnicythere reticulata n. sp. (Pl. XXXIX., Fig. 1–7.)

A small form, .66 to .73 mm. in length, .35 mm. high, and .25 mm. broad; grayish white. Shell sparsely hairy at the anterior and posterior ends; conspicuously marked with a honeycomb-like network of polygonal reticulations (Fig. 1 and 2), which are somewhat similar to those of *L. sancti-patricii and L. illinoisensis*, but with lateral furrows which serve at once to distinguish it from these species. The upper anterior part, in the neighborhood of the eye, is nearly free from reticulations, marking the position of a lateral depression which is deepest near the middle of the shell, becoming shallower anteriorly.

Seen from the side (Fig. 2), the shell is evenly and gradually rounded at both ends; dorsal margin straight, the ventral sinuate, the deepest part slightly anterior to the middle; posterior part somewhat broader than the anterior.

Seen from above, the shell is sharply and narrowly pointed anteriorly, broadening quickly and then suddenly contracting to broaden again slightly, so that it is widest back of the middle, from which it slopes gradually to the somewhat bluntly pointed posterior part.

Seen ventrally (Fig. 1), the lateral depressions show to greater advantage, appearing as two constrictions; one just posterior to the middle, the other considerably anterior to it.

Muscle impressions (Fig. 2) four, elongate-oval, situated at the bottom of a circular lateral depression, their longest axes parallel to that of the shell and to one another.

As with *L. neocomensis* and *L. stationis*, the first antennæ (Fig. 5) have a long, narrow terminal segment about seven times as long as wide, armed apically with three equal setæ, one of which is cleft apically for about a third of its length, having the appearance of a "sense seta," the inner branch being about half the length of the outer. In other respects the antennæ are the same as in other described species.

The second antennæ seem armed in no especial way. The three terminal spines are strong, plain, and much curved, the two longer being equal in length and four times the length of the apical segment; the other, seta-like, and about an eighth shorter. "Urticating setæ" two-segmented, reaching to the middle of the terminal spines. All of the inner setæ blunt and spine-like.

The palp of the mandible is short and plump. Maxillæ not especially armed in any way; outer edge of the base smooth.

The first of the three pairs of feet is the shortest, the others increasing in length in regular order backwards. All are armed similarly, with a few slight exceptions. The terminal claw of the first foot is slightly longer than the last two segments taken together; the spine-like seta on the inner apical edge of the second segment is two fifths longer than the third segment; third and fourth segments of equal length. Terminal claw of third pair as long as the united lengths of the last three and a half segments (Fig. 6); antepenultimate segment as long as the last two segments, the spine-like seta on its inner distal edge of the same length; width of basal segment one fourth its total length; two spine-like setæ on its lower inner edge, the distal seta twice the length of the other.

Rudimentary caudal rami (Fig. 3) cylindrical, thick, blunt, about three times as long as wide, with a small seta near base, not over two thirds as long as the width of the ramus, and a stouter one near the tip of the ramus, twice as long as the preceding one.

The posterior dorsal part of the carapace (Fig. 7) tapers to a spine-like point, and upon the dorsal aspect there are several rows of tooth-like notches.

Described from several specimens taken from a small pond (Hedges' Pond) south of Urbana, Ill., April 10, 1896. A number were raised from mud taken from the bed of the pond.

Limnicythere illinoisensis n. sp. (Pl.XXXIX., Fig. 8–13; and Pl. XL.)

A medium-sized species, .88 mm. long, .40 mm. high, and .29 mm. wide; dark grayish white. A few scattering hairs on the surface of the shell, which is rather inconspicuously marked on its entire surface with polygonal areas, which are, however, very faint compared with those of *L. reticulata*. With a high power these areas are found to be filled with small elongate-oval to quadrangular granules (Pl. XXXIX., Fig. 9).

Seen from the side (Pl. XXXIX., Fig. 8), the shell is evenly and gradually rounded at both ends, the dorsal margin straight, the ventral deeply sinuate, the deepest part at the anterior third, just below the muscle impressions. (In *L. reticulata* the deepest part is just posterior to a vertical line passing through the muscle impressions.) The posterior part is considerably broader than the anterior.

Seen from above, the shell is sharply and concavely pointed anteriorly, then quickly broadens and remains of the same width nearly to the posterior end, which is convexly and bluntly pointed. There is a constriction or sinus (Pl. XXXIX., Fig. 13) just in front of the middle, which, in the position indicated in Fig. 1, Pl. XL., is seen to be double. The deeper sinus is just anterior to the middle and above the muscle impressions. Anterior to this is a small conical elevation separating it from another smaller sinus or constriction from which the surface slopes quite quickly to the anterior part.

The radiating hairs of the anterior and posterior parts are more abundant than in *L. reticulata*, and resemble those of *L. neocomensis*. The anterior hyaline flange is three times as wide as the posterior one. (Pl. XXXIX., Fig. 8.)

Muscle impressions four, elongate-oval, situated at the bottom of a circular depression just anterior to the middle of the shell and just above the deepest part of the ventral sinus, their long axes parallel to that of the shell. There are two or three similar depressions in the same vicinity.

Terminal segment of the first antennæ (Pl. XL., Fig. 6) four times (in female) or five times (in male) as long as wide, armed apically with three setæ, the terminal one of which is divided apically as a "sense seta" and is once and two thirds the length of the segment; the other two equal, and one fourth longer than the segment. The penultimate segment is a fourth longer than the last one, while the antepenultimate is but half as long as the penultimate. The one preceding this, and also the basal segment, are ciliated along their inner edges (Pl. XL., Fig. 6).

The second antenna of the male differs from that of the female in that the terminal claw is armed with three or four strong teeth at tip (Pl. XL., Fig. 5). The basal part of the penultimate segment has two circles of hairs, as has also the antepenultimate segment, which is two sevenths the length of the penultimate. "Urticating seta" two-segmented, reaching to the middle of the terminal spine; all the inner setæ blunt and spine-like, as in *L. reticulata.*

Maxillæ and mandibles not especially different from those of other members of the genus.

Feet of first pair (Pl. XXXIX., Fig. 11) shortest, armed like those of the second.

Basal segment of second pair faintly ciliated exteriorly near the base; penultimate segment slightly longer than the last, both together equaling the antepenultimate; terminal claw nearly equal to three preceding segments, and in male with two or three accessory teeth near the tip (Pl. XL., Fig. 3).

Feet of third pair (Pl. XL., Fig. 4) in the male with an unusually long terminal seta,—as long as the united segments of the foot,—faintly cross-striated on its distal half, its place of attachment surrounded by a circle of cilia, as is also the joint between the last and penultimate segments; the last two segments together equal to the antepenultimate, which has on its inner distal edge a plumose seta as long as the segment; basal segment somewhat triangular in shape, three times as long as wide.

Rudimentary caudal rami (Pl. XXXIX., Fig. 12) cylindrical, six to seven times as long as wide, gradually tapering to a seta-like extremity which is five sevenths as long as the main part of the ramus. Two dorsal setæ: one situated about the width of ramus from base and as long as the width of the ramus; the other just anterior to the seta-like termination, and about the same length as the first. The male sexual grasping organs are unusually well developed and as shown in Pl. XL., Fig. 2.

Described from specimens found at the Biological Station in a shore collection made at Thompson's Lake (Station G), Havana, Ill., May 26, 1895.

Family CYPRIDIDÆ.

"Shell generally thin and horny; valves equal or but slightly unequal in size, surface usually smooth or simply punctated; ventral margins more or less sinuated; hinge margins edentulous. Eyes simple, usually confluent, sometimes wanting. Antennules (first antennæ) slender, usually seven-jointed, very flexile, usually provided with a number of long hairs forming a dense brush. Antennæ (second antennæ) pediform, geniculated, four- or five-jointed, clawed at the apex, second joint mostly bearing an apical brush of hairs.

"Mandibles strong, apex strongly toothed, palp four-jointed, with a setiferous branchial plate at the base. Two pairs of maxillæ, the first pair four-digitate, its external branch distinctly two-jointed, bearing a large setiferous branchial plate; second pair small, composed of a single prehensile lobe and a palp which in the female is generally simple, rarely pediform, and in the male prehensile. Two pairs of feet dissimilar in structure, the anterior pair strong, ambulatory, directed downwards and having a long curved apical claw; posterior pair bent backwards within the shell, and not used for motion. Caudal rami usually well developed, elongated, very mobile, and bearing two or three apical claws. Intestine forming two dilatations, of which the anterior is provided with cœcal appendages. Generative organs large, and of complex structure, and partly extended within the valves; in the male frequently a complex whorled sac connected with the testis; copulatory organs symmetrical, and of moderate size."—Brady and Norman.

I have thought it well to insert all the genera of good workers in the following key, knowing that further usage will best determine their validity

ANALYTICAL KEY TO THE GENERA OF CYPRIDIDÆ.*

1 (13). Second pair of feet ending in a cylindrical segment with two backwardly directed setæ.

2 (3). Second pair of feet in both male and female six-segmented. Second pair of maxillæ without a branchial plate. I. NOTODROMAS.

3 (2). Second pair of feet in female five-segmented, in male six-segmented.

4 (7, 8) Branchial plate of second pair of maxillæ rudimentary, in the form of two feathered setæ.

5 (6). Eye present. VIII. CANDONA.

6 (5). Eye absent. IX. TYPHLOCYPRIS.

7 (4, 8). Branchial plate of second pair of maxillæ developed, in the form of three feathered setæ. X. CANDONOPSIS.

8 (4, 7). Branchial plate of second maxillæ with six feathered setæ.

9 (10). Palp of second maxillæ rudimentary. XI. ILYOCYPRIS.

10 (9). Palp of second maxillæ normally developed.

11 (12). Terminal segment of second pair of feet one fourth as long as fourth segment. XII. CYPRIA.

12 (11). Terminal segment of second pair of feet two thirds as long as fourth segment. II. CYCLOCYPRIS.

13 (1). Second pair of feet ending in a beak-shaped segment with one backwardly directed claw.

14 (15, 16). Caudal rami rudimentary, flagellum-like. XIII. CYPRIDOPSIS.

15 (14, 16). Caudal rami somewhat rudimentary, small, lamellar, terminating in a long seta, and having a much shorter one, placed dorsally at some distance from the tip. XIV. POTAMOCYPRIS.

16 (14, 15). Caudal rami cylindrical, ending in two claws.

---

*A modification of Vávra's Key (**68**, p. 31).

17 (18). Natatory setæ of the second antennæ well developed, plumose, reaching considerably beyond the terminal claws. Anterior and posterior ventral margins of right valve generally armed with a row of tuberculiform teeth. III. CYPRINOTUS.

18 (17). Natatory setæ of the second antennæ not well developed, commonly simple, and not reaching beyond terminal claws. Margins of right valve not armed with a row of tuberculiform teeth.

19 (20). Natatory setæ small or rudimentary, not adapted for swimming. VI. ERPETOCYPRIS.

20 (19). Natatory setæ reaching to, or barely beyond, the tips of the terminal claws.

21 (22). Dorsal setæ of caudal ramus rudimentary or absent. Claws denticulate. VII. STENOCYPRIS.

22 (21). Dorsal setæ of caudal ramus developed as usual, and near claws.

23 (24). Caudal rami exceedingly large and elongate. V. CYPRICERCUS.

24 (23). Caudal rami, as usual, not disproportionately developed. IV. CYPRIS.

Descriptions of each of the above genera are inserted throughout the text for the convenience of workers, although but eight of the fourteen have been found in America.

The keys inserted are intended to be little more than an analysis of the species mentioned in this paper.

I. NOTODROMAS LILLJEBORG.

1792. *Cypris*, O. F. Müller (**49**, p. 48).
1853. *Notodromas*, Lilljeborg (**39**, p. 94).
1854. *Cyprois*, Zenker (**75**, p. 80).

The second pair of antennæ are six-segmented in both male and female. The second maxilla lacks a branchial plate. The palp of the female is two-segmented, the terminal segment ending in two short setæ. In the male this terminal segment is modified into a hook-shaped appendage. The second foot is five-segmented, terminating in three setæ, of which two are directed backward. The two eyes are separate. The abdominal rami are long and slender.

Males are common. This genus numbers but one species, which has been reported from Minnesota by Herrick (1885). I have never examined specimens.

II. Cyclocypris Brady & Norman.

1787–1854. *Cypris.* Auctorum.
1820. *Monoculus*, Jurine (**36**, p. 179).
1854. *Cypria*, Zenker (**75**, p. 79).
1889. *Cypria*, Brady & Norman (**9**, p. 68).
1889. *Cyclocypris*, Brady & Norman (**9**, p. 70).

I give below the description of this genus, partially as amended by Vávra (**68**).

The second pair of antennæ are five-segmented in the female, six-segmented in the male, the fourth segment having no sense organ. Natatory setæ very long, reaching far beyond the tips of the terminal claws. The palp of the mandible and of the first maxilla are but normally developed. The second maxilla bears a branchial plate and palp. In the male the right and left palps are dissimilar, terminating as hooked prehensile organs.

The last segment of the second foot is unusually long, being two thirds the length of the fourth segment. The caudal rami are strong, terminating in unusually strong claws and a delicate seta. The dorsal seta is situated at some distance from the subterminal claw.

Males are numerous. The copulatory organ is quadrangular.

This genus differs from Cypria in the much more plump shell, in the character of the second feet, in the different form of the copulatory organs, and in the absence of the two special sense organs on the second pair of antennæ of the male.

There are five species in this genus: *C. globosa* Sars, *C. lævis* O. F. M., *C. modesta* Herrick, *C. pusilla* Sars, and *C. forbesi* n. sp., of this paper. Of these *C. lævis*, *C. modesta*, and *C. forbesi* are known to occur in America.

COMPARISON OF SPECIES.

1 (2). Caudal ramus twice as long as its terminal claw (measured on front edge). C. LÆVIS O. F. M.

2 (1). Caudal ramus clearly more than twice the length of its terminal claw (measured on front edge).

3 (4). Ramus nearly two and a half times the length of its terminal claw; claws strong, much bent, nearly smooth. C. FORBESI n. sp.

4 (3). Ramus three times the length of its terminal claw; claws strong, nearly straight, weakly bent near end, finely toothed; ramus toothed on hind edge, also with comb of teeth on its side. C. GLOBOSA Sars.

Cyclocypris forbesi n. sp. (Pl. XLI., Figs. 1–7.)

A very small form, scarcely larger than *Cyclocypris lævis*, .55 mm. long, .39 mm. high, and .36 mm. wide. The shell is plump, with equal valves, translucent, of a muddy sepia-brown color in alcohol, sparsely covered both anteriorly and posteriorly with conspicuous hairs, none evident on sides.

Seen from the side (Fig. 1), the shape of the shell approaches a subelliptical form, three fourths as high as long, the dorsal margin a trifle straighter than the ventral, which is very evenly and gently convex.

Seen from above (Fig. 2), the shape is a moderate oval, thickest behind the middle, rather bluntly pointed anteriorly and more so posteriorly.

Second antennæ of male, six-segmented; of the female, 5-segmented. In the female the terminal segment (Fig. 3) is as long as broad, the penultimate four times as long as this, while the antepenultimate is twice as long as the penultimate, two and a half times as long as broad, bearing an unusually long sense organ near its base, reaching beyond the end of the segment. Terminal claws nearly straight, curved at tip, faintly toothed. Natatory setæ four times as long as the terminal claws.

Palps (Fig. 4 and 5) of second maxillæ in the male hook-like, the right one larger than the left.

Terminal claw of first foot rather stout, toothed, much bent at tip, and as long as the last three segments.

Terminal segment of second foot (Fig. 6) three fifths as long as the preceding segment. The longer of the backwardly directed setæ is longer than the combined lengths of the last three segments, the shorter one being one fourth as long, or the length of the last segment; terminal claw half as long as the last segment. Penultimate segment three and a half times as long as broad and armed on the inner edge with but one seta, which is on the middle of the segment, and half its length. In *C. globosa* and *C. lævis* there are two such setæ.

Caudal rami (Fig. 7) rather short, stout, somewhat bent, the terminal claw half as long as the anterior edge, the subterminal claw four fifths as long as the terminal claw, both stout, lightly toothed, and strongly bent at tip. Terminal seta about as long as width of ramus; dorsal seta delicate, two and a half times width of ramus from subterminal claw, and two thirds as long as ramus is wide.

The "organ of Zenker" is about twice as long as wide, resembling that of *C. globosa*.

Described from several male and female specimens in the collection of the Illinois State Laboratory of Natural History, from a pond in the woods near Bloomington, Ill., April 5, 1879.

Named for Prof. S. A. Forbes.

III. Cyprinotus Brady.

1792. *Cypris*, O. F. Müller (**49**, p. 48).
1820. *Monoculus*, Jurine (**36**, p. 170).
1885. *Cyprinotus*, Brady (**8**, p. 301).

Natatory setæ of antennæ reaching considerably beyond the tips of the terminal claws; plumose. Seta of dorsal edge of caudal ramus close to subterminal claw; claws smooth. Margins of right valve of shell generally armed with tuberculiform teeth. Propagation sexual.

In other respects this genus does not differ materially from the genus Cypris.

The species thus far known in America are *C. incongruens* Ramd., *C. crena* Turner, *C. burlingtonensis* Turner, *C. grandis* (Chambers), and *C. pellucida* n. sp.

COMPARISON OF SPECIES.

1 (4). Dorsal seta of caudal ramus more than half as long as subterminal claw.

2 (3). Dorsal seta width of ramus from subterminal claw. C. PELLUCIDA n. sp.

3 (2). Dorsal seta two and a half times width of ramus from subterminal claw. C. INCONGRUENS Ramd.

4 (1). Dorsal seta of caudal ramus less than half as long as subterminal claw, and width of ramus from it; setæ of ramus about equal in length, the dorsal seta reaching beyond tip of ramus by half its own length; ramus faintly serrate. C. BURLINGTONENSIS Turner.

Cyprinotus pellucida n. sp. (Pl. XLII., Fig. 1-6.)

A moderately large species, from 1.10 to 1.40 mm. long, .80 mm. high, and .51 mm. wide, color varying from transparent to brownish yellow, commonly showing the outline of the animal within, the contents of the stomach and intestines being unusually apparent. Shell sparsely covered with small papillar elevations from which short hairs arise, these being longest at each extremity; also commonly well marked with a regular arrangement of dotted lines (Fig. 3).

Seen from the side (Fig. 1), the shell is nearly elliptical, regularly arched dorsally, nearly straight ventrally, anterior and posterior ends convex.

Seen from above (Fig. 2), the shell resembles a pointed ellipse, bluntly pointed posteriorly and rather acutely so anteriorly.

The two longer of the natatory setæ of the second antennæ reach but slightly beyond the terminal claws. The penultimate segment in the female is armed with three claws distally, the outer of which is but a third as long as the other two and a half longer than the last segment. Claws four times as long as the distal segment, which is half as wide as long.

The two-segmented spines on the first pair of maxillæ are toothed.

Terminal claw of first pair of feet (Fig. 4) strong, finely cross-toothed near the extremity, and slightly longer than the last three segments, of which the penultimate and antepenultimate are of the same length, both together just equaling the one preceding. This segment has five patches of fine hairs (Fig. 4) on the inner edge, and a moderately long seta at the inner distal angle. Outer edge slightly crenulate.

Terminal claw of second pair of feet (Fig. 5) nearly straight, finely cross-striated and finely toothed, scarcely longer than terminal segment of foot.

Caudal rami (Fig. 6) slightly bent, about twice as long as the terminal claw. Claws finely toothed, strong, slightly bent, the shorter three fourths the length of the longer. Dorsal seta of ramus width of ramus from subterminal claw, bent, somewhat coarsely plumose, and as long as the subterminal claw, which is situated at width of ramus from terminal claw; terminal seta three fifths the length of dorsal one.

Shaded roadside pool near Havana, Ill. (abundant); Cedar Creek, near Quincy, Ill. (Coll. Ill. State Lab. Nat. Hist.); April, 1896, in an aquarium started from a small creek flowing through the University arboretum at Urbana, Ill.

Cyprinotus burlingtonensis TURNER. (Pl. XLII., Fig. 7.)

1894. *Cypris burlingtonensis*, Turner (**64**, p. 17, Pl. VII., Fig. 14–23).

1895. *Cyprinotus burlingtonensis*, Turner (**35**, p. 333, Pl. LXX., Fig. 14–23).

Length 1.40–1.65 mm., height .66–.90 mm., and width .70–.80 mm.

The shell is thin, covered with long hairs, and yellowish brown except some bluish black stripes on the dorsum and sides. The dorsal band begins just back of the eye-spot, from which place two bands extend directly downward, spreading laterally and covering quite an extended area near the center of the shell. After extending posteriorly a short distance, the dorsal band sends downward two more bands which curve forward near the ventral edge of the shell, and finally merge with the central patch.

Seen from the side, the shell is suboval, somewhat narrower posteriorly, highest just anterior to the middle. Ventral margin quite straight.

Seen from above, the shell is subelliptical, somewhat more pointed anteriorly than posteriorly, while the sides are nearly parallel at the middle for a short distance.

Seen from the end, the sides are very convex.

Second antennæ stout; terminal claws toothed near tip, and of approximately the same length; natatory setæ extending beyond the tips of the terminal claws from one third to one half the length of the claws.

The two-segmented spines on the first process of the first maxilla are toothed.

First foot five-segmented, third segment slightly shorter than the fourth, which is three times as long as the terminal segment.

Second foot slender; terminal claw twice as long as the terminal segment and slightly bent.

Caudal rami long, straight, and narrow, more than twenty times as long as wide, the dorsal edge finely pectinate to within a short distance of base (Fig. 7). Terminal claw slender, straight, finely pectinate, half as long as the ramus; subterminal claw five sevenths as long as terminal one. Terminal seta a fourth longer than the dorsal one, which is a third as long as the subterminal claw and situated less than the width of the ramus from it.

This species greatly resembles *Cypris fuscata* Jurine in many respects, but is easily distinguished from it by the greater length of the natatory setæ, the markings on the shell, the character of the caudal ramus, and by other minor details.

Normal, Ill., May 20, 1881 (Coll. Ill. State Lab. Nat. Hist.); Burlington, Ohio, March, 1893 (Turner); Atlanta, Ga., January, 1894 (Turner); Kent county, Del., March 3, 1894 (Turner).

Cyprinotus incongruens RAMDOHR. (Pl. XLIII., Fig. 1, 2.)

1808. *Cypris incongruens*, Ramdohr (**54**, p. 86, Taf. III., Fig. 1-12, 15, 16, 18-20).
1820. *Monoculus conchaceus*, Jurine (**36**, p. 171, Pl. XVII., Fig. 7, 8).
1820. *Monoculus ruber*, Jurine (**36**, p. 172. Pl. XVIII., Fig. 3, 4).
1820. *Monoculus aurantius*, Jurine (**36**, p. 173, Pl. XVIII., Fig. 5-12).
1821. *Cypris fusca*, Straus (**61**, p. 59, Tab. I., Fig. 1-16).
1844. *Cypris aurantia*, Zaddach (**74**, p. 37).
1850. *Cypris aurantia*, Baird (**2**, p. 159. Tab. XIX., Fig. 13).
1853. *Cypris incongruens*, Lilljeborg (**39**, p. 119, Tab. IX., Fig. 6, 7; XI., Fig. 1-4; XII., Fig. 6).
1855. *Cypris aurantia*, S. Fischer (**24**, p. 650, Taf. I., Fig. 29-31, 60, 61.
1868. *Cypris incongruens*, Brady (**6**, p. 362, Pl. XXIII., Fig. 16-22).
1868. *Cypris fusca*, Fric & Nekut (**27**, p. 47, Fig. 28).
1872. *Cypris fusca*, Fric (**26**, p. 227, Fig. 6).
1889. *Cypris incongruens*, Brady & Norman (**9**, p. 73, Pl. XII., Fig. 8, 9).
1891. *Cypris incongruens*, Vávra (**68**, p. 95, Fig. 32^1 -32^6).
1893. *Cypris incongruens*, Turner (**63**, p. 8, Pl. I., Fig. 9-16; II., Fig. 17-21).
1895. *Cyprinotus incongruens*, Turner (**35**, p. 330, Pl. LXVIII., Fig. 9-16).

Length 1.30 mm., height .75 mm., width .60 mm.

The shell is orange to ochreous yellow, which is somewhat intensified in spots to an almost purple tint especially noticeable at the highest dorsal part just in front of the eye-spot. Its surface is covered with numerous papillar elevations and scattered hairs. It is also finely pitted over its entire surface (Fig. 2), these pits showing to better advantage should the specimen partially project from its medium and be examined with reflected light.

Seen from the side, the dorsal margin is arched, highest at its posterior third. Ventral margin very slightly sinuate.

Seen from above, the shell is broadly ovate, narrowed in front, the right valve being somewhat overlapped by the left. The anterior and posterior margins of the right valve are armed with a row of small tubercles (Fig. 2), which give it a serrated appearance.

Setæ of the mandibular palps plumose. Natatory setæ strongly plumose, extending as far beyond the terminal claws as the length of these claws. The spines on the first process of the first pair of maxillæ are strongly toothed.

Second foot moderately stout, the terminal claw much bent and but little longer than the terminal segment.

Caudal rami (Fig. 1) rather stout for members of this genus, about thirteen times as long as wide, broadened at the base. Terminal claw slender, curved, finely toothed near its tip, and four sevenths as long as the ramus; subterminal claw not quite three fifths as long as the terminal one. Terminal seta four fifths as long as subterminal claw; dorsal seta slightly longer than the terminal one and twice the width of the ramus from the subterminal claw.

Pt. Pinellas, Fla., May 12, 1885 (Coll. Ill. State Lab. Nat. Hist.); Cincinnati, O., 1893 (Turner).

IV. CYPRIS O. F. MÜLLER.

1792. *Cypris*, O. F. M. (**49**, p. 48).
1820. *Monoculus*, Jurine (**36**, p. 170).
1868. *Cypris*, Brady (**6**. p. 360).

Second pair of antennæ five-segmented; natatory setæ reaching to or barely beyond the tips of the terminal claws. Mandibular palp not extending beyond tips of mandibular teeth; first mandibular process armed with two biarticulate spines, which are commonly toothed. Branchial plate of first maxilla large, bearing stiff plumose setæ.

The second foot ends in a bill-shaped segment (as in Cypridopsis) and a strong chitinous claw.

Caudal rami stout, ending in two long slender claws and a terminal seta. Dorsal seta always near the subterminal claw.

The males are as yet unknown. At least eight species occur in America, of which two are herein added to the list for the first time: *C. reticulata* Zaddach, not previously reported from this country, and *C. testudinaria*, described as new.

KEY TO SPECIES OF CYPRIS. *

1 (6). Both spines on the first process of the first pair of maxillæ smooth.

2 (5). Terminal claw of the second foot as long as the last segment. Shell noticeably less than three times as long as high. Terminal seta of caudal ramus a third as long as the terminal claw and of same length as the dorsal one.

3 (4). Caudal ramus straight; subterminal claw two thirds the length of the terminal one. Shell four ninths as high as long. C. CLAVATA Baird.

4 (3). Caudal ramus bent, weakly S-shaped; subterminal claw half the length of the terminal one. Shell two thirds as high as long. C. VIRENS Jurine.

5 (2). Terminal claw of second foot twice as long as the terminal segment. Shell fully three times as long high. Subterminal claw of caudal ramus half as long as the terminal one; terminal seta three times as long as the dorsal one, which is set closely against

* Partly a modification of Vávra's key (**68**, p. 83).

the subterminal claw; ramus straight, stout, and from ten to twelve times as long as wide.

C. FASCIATA O. F. Müller.

6 (1). Both spines on the first maxillary process of the first pair of maxillæ toothed.

7 (14). Third and fourth segments of the first pair of feet not grown together.

8 (13). Shell not reticulated as in Fig. 3, Pl. XLIII.

9 (12). Dorsal seta of caudal ramus not reaching beyond tip of ramus, one and a half times width of ramus from subterminal claw; ramus more than twenty times as long as wide; terminal claw half the length of the ramus; subterminal claw two thirds the length of the terminal one. C. FUSCATA (Jurine).

10 (11). Shell less than twice as long as high (as 5 to 3). Terminal claw half as long as the ramus; subterminal claw three fourths as long as the terminal one. C. TESTUDINARIA n. sp.

11 (10). Shell more than twice as long as high (as 13 to 6). Terminal claw a third as long as the ramus; subterminal claw two thirds the length of the terminal one. C. FISCHERI Lilljeborg.

12 (9). Dorsal seta of caudal ramus reaching beyond tip of ramus, and width of ramus from subterminal claw; ramus less than twenty times as long as wide.

13 (8). Shell of most individuals reticulated as in Fig. 3, Pl. XLIII. (Reticulation occasionally almost obsolete in old adults.) Terminal claw nearly three fifths as long as ramus, straight; terminal seta not more than a fourth as long as the terminal claw; dorsal seta as long as the terminal one, reaching beyond tip of ramus, and width of ramus from subterminal claw; ramus twelve to fifteen times as long as wide. C. RETICULATA Zaddach.

14 (7). Third and fourth segments of the first pair of feet grown together. C. PUBERA O. F. Müller.

Cypris reticulata Zaddach. (Pl. XLIII., Fig. 3 and 4.)

1844. *Cypris reticulata*, Zaddach (**74**, p. 34).
1851. *Cypris affinis*, S. Fischer (**23**, p. 32, Taf. X., Fig. 9–11).
1853. *Cypris affinis*, Lilljeborg (**39**, p. 116, Taf. XI., Fig. 8–14).
1868. *Cypris tessellata*, Brady (**6**, p. 366, Pl. XXIII., Fig. 39–45).
1883. *Cypris affinis*, Lilljeborg (**41**, p. 146).
1889 *Cypris reticulata*, Brady & Norman (**9**, p. 76, Pl. VIII., Fig. 1–2; XII., Fig. 5–7).
1891. *Cypris reticulata*, Vávra (**68**, p. 99, Fig. 34^1–34^2).
1893. *Cypris reticulata*, Daday (**19**, p. 296).

Length 1.25 mm., height .72 mm., width .62 mm.

Shell translucent to clear yellowish, with a dark blue patch dorsally and just posterior to the eye-spot. The strikingly sculptured form of the shell (Fig. 3) is especially noticeable in the young stages. This sculpturing resembles striations at the center of the shell, changing to radially arranged patterns resembling filagree work. Occasionally, in old specimens, this characteristic surface-marking may be almost absent, but a collection could hardly be made which did not contain some specimens showing it clearly.

Seen from the side, the shell is much the broadest in front, highest at the anterior third, where there is a small gibbous elevation, below which is the eye-spot. The dorsal margin slopes rapidly back to the quite narrow posterior extremity; ventral margin nearly straight, slightly sinuate just posterior to the middle.

Seen from above, the shell is tumid, oval, widest in the middle, and tapering somewhat more rapidly anteriorly. The dark dorsal coloration appears in the form of a rough cross.

The longest of the natatory setæ reach but slightly beyond the terminal claws.

The first pair of maxillæ are slender, weakly developed the spines on its first process toothed in my specimens, which differ in this particular from Vávra's, in which these spines are described (66, p. 100) as smooth.

Second foot long, slender, the terminal claw covered, slender, and twice as long as the terminal segment.

Caudal rami (Fig. 4) straight, weakly bent near the end, from ten to twelve times as long as wide, and very faintly toothed on the dorsal margin. Terminal claw slender, straight, finely toothed at its extremity, and nearly three fifths as long as the ramus; subterminal claw five sevenths as long as the terminal claw, straight. Terminal seta slender, short, of the same length as the dorsal one, which is one third the length of the subterminal claw and distant from it the width of the ramus.

This species occurred in April, 1884, in great numbers in a small grassy pool on the grounds of the Normal University at Normal, Ill. (Collection Illinois State Laboratory of Natural History). According to Brady it seems to make its home only in such pools, and is yet to be found in lakes or large bodies of water. The species is also known to occur in Great Britain, Sweden, Germany, and Russia.

Cypris fuscata Jurine. (Pl. XLIII., Fig. 5)

1820. *Monoculus fuscatus*, Jurine (**36**, p. 174, Pl. XIX., Fig. 1, 2).
1837. *Cypris adusta*, Koch (**38**, Heft. XI., p. 3, Fig. 3).
1838. *Cypris galbinia*, Koch (**38**, Heft. XXI., p. 19, Fig. 19).
1844. *Cypris fuscata*, Zaddach (**74**, p. 32).
1850. *Cypris fusca*, Baird (**2**, p. 154, Tab. XIX., Fig. 7).
1850. *Candona hispida*, Baird (**2**, p. 161, Tab. XIX., Fig. 4).
1853. *Cypris fuscata*, Lilljeborg (**39**, p. 114, Tab. X., Fig. 6–9; XII., Fig. 5).
1854. *Cypris fuscata*, Zenker (**75**, p. 73).
1868. *Cypris fusca*, Brady (**6**, p. 362, Pl. XXIII., Fig. 10–15).
1887. *Cypris dugesi*, Herrick (**34**, p. 26, Pl. IV., Fig. 7).
1888. *Cypris fusca*, Sostaric (**60**, p. 47).
1889. *Cypris fuscata*, Brady & Norman (**9**, p. 73, Pl. XII., Fig. 3, 4).
1891. *Cypris fuscata*, Vávra (**68**, p. 98, Fig. 33^1–33^3).
1893. *Cypris fuscata*, Daday (**19**, p. 292).
1894. *Cypris fuscata*, Turner (**64**, p. 16, Pl. VIII., Fig. 41–46.
1895. *Cypris fuscata*, Turner (**35**, p. 320, Pl. LXXI., Fig. 41–46; LXXII., Fig. 7, 7p: LXXVI., Fig. 9).

Length 1.46 mm., height .82 mm., width .76 mm.

Color yellowish brown with a bluish black patch on either side near the middle and just posterior to a vertical line passing through the eye-spot. The anterior part also is tipped with a dark patch. The form and intensity of coloration of these patches seem to be variable, but in general they are as described above. The surface of the shell is quite rough, as though covered with a loose scaly epithelium, and rather thickly set with short hairs.

Seen from the side, the shell is oblong-ovate, highest at its anterior third, sloping rather quickly to the posterior extremity, which is somewhat narrower than the anterior.

Seen from above, the shell is elongate-oval, the anterior end somewhat more acutely pointed than the posterior; widest at the middle.

Maxilla stout, the spines on its first process toothed.

Terminal segment of second foot one thirteenth as long as the penultimate segment, which is seven ninths as long as the preceding one. Terminal claw much bent and twice as long as the terminal segment.

Caudal rami (Fig. 5) long, slender, straight, more than twenty times as long as wide, the dorsal edge finely toothed. Terminal claw slightly bent, slender, finely toothed, and one half as long as the ramus; subterminal claw two thirds the length of the terminal one, straight, finely toothed near the tip. Terminal seta slender, about half as long as terminal claw, and twice as long as the dorsal seta, which is one and a half times width of ramus from the subterminal claw.

The specimens studied by me were obtained from a pond south of Urbana, Ill., April 16, 1892, and are now in the collection of the Illinois State Laboratory of Natural History.

The species occurs in Great Britain, Germany, and Sweden; and, in America, in Mexico and New Mexico (Herrick), at Cincinnati, Ohio (Turner), and at Urbana, Ill. (Coll. Ill. State Lab. Nat. Hist.).

Cypris testudinaria n. sp. (Pl. XLIV., Fig. 1-4.)

This species is 1.15 mm. long, .74 mm. high, and .65 mm. wide. Shell very thin, dirty brown to ochreous, and in all the specimens seen of a leathery flexible consistency, as if composed mostly of animal matter. Indeed, the shell might be rolled like parchment—a peculiarity not known to me as belonging to any other species of Ostracoda. It is rather thickly covered with short hairs, and there is also a thick marginal row.

Seen from the side, the shell is rather narrower anteriorly than posteriorly, elongate-elliptical in outline, the ventral margin somewhat straighter than the dorsal.

Natatory setæ of the second antennæ (Fig. 4) short, simple, just reaching the tips of the terminal claws. The terminal claws are straight, moderately stout, hooked at tips, finely toothed, and as long as the last three segments. Terminal segment twice as long as wide, one fifth as long as the penultimate, which is seven eighths as long as the antepenultimate; antepenultimate segment a little more than three and a half times as long as wide, the sense club short, nearly straight, situated just below the middle of the segment. There is a crown of cilia at the base of the natatory setæ, extending to the inner apical edge of the segment. The spines of the first process of the second maxillæ are toothed.

Claw of first foot (Fig. 2) bent, rather stout, lightly toothed, and one sixth longer than the last three segments combined. The last segment is as wide as long, the outer of the two terminal setæ being twice as long as the segment. The fourth segment from the last commonly has a crown of setæ near its base, besides scattered marginal ones.

Terminal claw of second foot about a third the length of the terminal segment, which is one seventh as long as the penultimate segment. The reflexed seta of the terminal segment is half the length of the penultimate segment.

Caudal rami (Fig. 1) slender, slightly bent, the dorsal edge serrate for two thirds its length, sixteen to eighteen times as long as wide. Terminal claw nearly straight, lightly toothed, half as long as the ramus. Terminal seta half as long as the terminal claw, which is one and a third times as long as the subterminal one; dorsal seta two thirds the length of terminal one, and width of ramus from subterminal claw.

The "organ of Zenker" presents an unusually spiny appearance (Fig. 3), since the spines are thickly set over the entire surface of the cylinder instead of being in wreaths, as is commonly the case; organ fully five times as long as wide.

Described from a number of specimens in the collection of the Illinois State Laboratory of Natural History, which were taken from a pond in the woods near Bloomington, Ill., April 22, 1879.

V. CYPRICERCUS SARS.

1895. *Cypricercus*, Sars (**58** p. 37).

Natatory setæ of both pairs of antennæ well developed; palp and masticatory lobe of the first maxillæ narrow. Feet as in the genus Cypris.

Caudal rami excessively developed and elongate, affording a ready means of recognition. Cœcal appendage of intestine unusually short; ovarial tubes much elongated.

This genus has but recently been established by Sars (**57**) to receive a South African form with excessively developed caudal rami. No species have been reported as yet from America.

VI. ERPETOCYPRIS BRADY & NORMAN.

1792. *Cypris*, O. F. Müller (**49**, p. 48).
1820. *Monoculus*, Jurine (**36**, p. 170).
1889. *Erpetocypris*, Brady & Norman (**9**. p. 84).

Second pair of antennæ five-segmented. Natatory setæ of the third segment very short, not nearly reaching the tips of the terminal claws and not plumose. Having no power of swimming, the animal creeps along the bottom—a very different habit from that of Cypris.

Twelve species are known, two of which were described from America. An analytical table of the species occurring or likely to occur in this country is inserted here for the convenience of workers. I have examined none but *E. barbatus* (Forbes).

KEY TO SPECIES OF ERPETOCYPRIS.

1 (7). Caudal rami with two terminal claws and a terminal and dorsal seta.

2 (3, 6). Claw on last segment of second foot as long as segment. Shell about twice as long as high. Caudal rami about ten times as long as wide, dorsal margin finely toothed; dorsal seta not more than once width of ramus from subterminal claw.
E. STRIGATA (O. F. Müller).

3 (2, 6). Claw on last segment of second foot three times as long as last segment.

4 (5). Dorsal seta of caudal ramus delicate, undeveloped, close to subterminal claw; dorsal edge of ramus armed with five combs of teeth; terminal seta fully as long as subterminal claw. Shell somewhat longer than twice its height, the upper and lower edges nearly parallel. E. REPTANS (Baird).

5 (4). Dorsal seta of caudal ramus transformed into a short spine or claw, close beside the subterminal claw; dorsal edge of ramus armed with an unbroken row of fine teeth; terminal seta three fourths as long as the subterminal claw. Shell seven thirteenths as high as long, the upper edge evenly convex, the under edge very weakly concave.
E. OLIVACEA Brady & Norman.

6 (2, 3). Claw on last segment of second foot seven eighths as long as last segment. Dorsal seta serrate and claw-like, close to subterminal claw; dorsal edge of ramus finely toothed; ramus twenty times as long as wide; terminal seta about a third as long

as subterminal claw. Shell twice as long as high, the upper and lower margins nearly parallel. (The largest known fresh-water ostracode.)

E. BARBATUS (Forbes).

7 (1). Caudal rami with only the terminal claws developed, lacking the terminal and dorsal seta. Shell two and a half to three times as long as high. Second foot slender, ending in a small hook and a single weak seta. E. MINNESOTENSIS (Herrick).

VII. STENOCYPRIS SARS.

1859. *Cypris*, Baird (**3**, p. 233).
1889. *Stenocypris*, Sars (**57**, p. 27).

Natatory setæ of the second antennæ not reaching beyond the tips of the terminal claws. Palp of the first maxillæ very narrow, cylindrical, the last segment small, masticatory lobes long and narrow.

Caudal rami rather large, more or less lamelliform, dorsal edges sometimes pectinate; claws very unequal, both coarsely denticulate; seta of dorsal edge absent or very small, apical seta rather elongate. Propagation exclusively parthenogenetic.

Shell very narrow and elongate, height not nearly attaining half the length. This peculiarity is indicated in the generic name.

But one member of this genus has thus far been described, and it has not been reported from America.

VIII. CANDONA BAIRD.

1792. *Cypris*, O. F. Müller (**49**, p. 48).
1850. *Candona*, Baird (**2**, p. 159).

The following general description of this genus is essentially that given by Vávra (**68**, p. 39).

Second antennæ of female five-segmented, becoming six-segmented in the male through division of the fourth segment. Male provided at this dividing place with two special and characteristic sense organs. Natatory setæ, so commonly present in Ostracoda, lacking in this genus. Second pair of maxillæ provided with a rudimentary branchial plate, formed of two unequal pectinate setæ attached directly to the basal portion of the maxilla; palp two-segmented in the female, terminating with three unequal pectinate bristles; palps of the male unsegmented, different from those of the female and from each other.

Second pair of feet commonly five-segmented, becoming six-segmented occasionally through division of the fourth segment; terminal segment provided with two backwardly directed unequal setæ and one long forwardly directed seta.

Caudal rami strong, each ending in two strong claws and a short seta, dorsal seta of ramus commonly remote from these.

The males are commonly more abundant than the females. The shell of the male is ordinarily larger and of another form than that of the female. The members of this genus are not swimmers, being destitute of natatory setæ. They commonly crawl on the bottom or may burrow in the sand and mud.

This genus numbers twenty-five species, of which nine are known to occur in America.

KEY TO SPECIES OF CANDONA.

1 (7). Fourth segment of second foot divided (second foot therefore six-segmented).

2 (3, 6). Shorter seta on last segment as long as last segment. C. ROSTRATA Brady & Norman.

3 (2, 6). Shorter seta on last segment of second foot two to three times as long as last segment.

4 (5). Caudal rami approximately straight (Pl. XLVI., Fig. 11); dorsal seta two and a half times width of ramus from subterminal claw; claws evenly curved, weakly pectinate, the terminal one half the length of the ramus; the subterminal one nine elevenths the length of the terminal one. C. RECTICAUDA n. sp.

5 (4). Caudal rami curved (Pl. XLV., Fig. 1); dorsal seta about twice width of ramus from subterminal claw; claws approximately straight or curved, with a hook-like extremity; terminal claw one third length of ramus; both claws of nearly the same length, rather stout, moderately toothed.

C. FABÆFORMIS (S. Fischer).

6 (2, 3). Shorter seta on last segment of second foot three to four times as long as last segment. Dorsal seta of ramus situated at two thirds length of seta, or two and a half times width of ramus, from subterminal claw; ramus much broadened at base, a fourth as broad as long; terminal seta half as long as dorsal one. C. ACUMINATA (S. Fischer).

7 (1). Fourth segment of second foot undivided (second foot therefore five-segmented).

8 (11). One or both claws of ramus more or less S-shaped.

9 (10). Both claws slightly S-shaped; ramus more than twice as long as terminal claw; dorsal seta of ramus four times width of ramus from subterminal claw. C. SIGMOIDES n. sp.

10 (9). Only the subterminal claw S-shaped; terminal claw more than half as long as ramus, scimitar-shaped; dorsal seta two thirds as long as subterminal claw. C. SIMPSONI n. sp.

11 (8). Both claws of ramus as usual (with one backward curve); ramus stout, curved; terminal claw half as long as ramus, and five fourths as long as subterminal claw; dorsal seta one and a half times width of ramus from subterminal claw.

C. REFLEXA n. sp.

Candona acuminata S. FISCHER. (Pl. XLIV., Fig. 5–7.)

1851. *Cypris acuminata*, S. Fischer (**23**, p. 148, Pl. IV., Fig. 12–16).
1854. *Cypris acuminata*, Zenker (**75**, p. 74, Pl. II., Fig. D).
1889. *Candona acuminata*, Brady & Norman (**9**, p. 104, Pl. IX., Fig. 9, 10; X., Fig. 5, 6).

1894. *Candona acuminata*, Turner (**64**, p. 19, Pl. VIII., Fig. 34).
1895. *Candona acuminata*, Turner (**35**, p. 299, Pl. LXXI., Fig. 34).

Length 1.00 mm., height .44 mm., width .36 mm.

Alcoholic specimens in the collection of the State Laboratory of Natural History have the shell of a dirty brownish color, thus differing from the specimens found by Turner in Texas which were white (**35**, p. 300).

Seen from the side, the shell is elongate, pointed both posteriorly and anteriorly, the middle dorsal part much arched, sloping abruptly posteriorly so that it is concave for a short distance, then rising slightly to slope again and form the narrow rounded posterior part. The slope anteriorly is much more gradual, with a slight concave depression. Ventral margin concave, the greatest depression being at the center.

Seen from above, the shell is subelliptical, both extremities being bluntly pointed, widest at middle, and narrowing gradually to both ends.

Second antennæ stout, terminal claws not pectinate; terminal segment twice as long as wide. Spines of the first maxillary process smooth.

Feet of the first pair (Fig. 5) made up of long narrow segments, the terminal one conical and twice as long as wide, the preceding one twice as long, the antepenultimate of the same length, and the one preceding this as long as the last three combined; terminal claw not as long as the last three segments together, faintly serrate near tip.

Fourth segment of second foot (Fig. 6) divided, thus making the foot six-segmented; terminal segment as wide as long, the shorter backwardly directed seta three and a half to four times as long as the terminal segment, the longer seta being just twice as long as the shorter one.

Caudal rami (Fig. 7) much broadened at base, where the internal contents seem to be coagulated—a peculiar appearance I have noticed in no other species of the

Ostracoda. Terminal claw a fourth longer than the subterminal one, and nearly half the length of ramus; both faintly toothed, the subterminal one more prominently so along the middle. Dorsal seta plainly plumose, about as long as the shorter claw, situated at two thirds the length of seta, or two and a half times the width of ramus, from subterminal claw; terminal seta half the length of the dorsal one.

This species occurs in the San Antonio River, Texas (Turner), and the specimens belonging to the Illinois State Laboratory of Natural History, mentioned above, were collected from ponds at Clifton, Ill., May 12, 1882.

Candona recticauda n. sp. (Pl. XLVI., Fig. 7-11.)

Shell of male 1.18 mm. long and .70 mm. high, stout, covered with scattered papillar elevations, the spermatozoa, as is usual, showing through as four bands.

Second antennæ of male (Fig. 8) stout, six-segmented, terminal segment two thirds as wide as long, the preceding segment as wide as long. The longer of the two male "sense organs" on the antepenultimate segment reaches beyond the tip of the terminal segment by the length of the hyaline tip, the shorter one reaching to the tip of the segment. Terminal claws as long as the antepenultimate segment and faintly toothed near the middle.

Palp of left second maxilla of male (Fig. 10) elongate, round, bent at tip, ending in a sharp hyaline point; two rather long blunt setæ at point of curvature, reaching three fifths the distance to the end of the palp. Right palp of male (Fig. 9) round, thick, slightly bent, ending in a sharp hyaline point, with two short blunt setæ on its concave side reaching two thirds the distance to the tip of the palp.

Terminal claw of first foot one and a half times as long as the last three segments; terminal segment conical, the penultimate three fifths as wide as long, the antepenultimate two thirds as long as the penultimate, and all three combined scarcely as long as the one preceding them.

Feet of the second pair (Fig. 7) six-segmented, the fourth segment being divided; terminal segment as long as wide. the shorter backwardly directed seta two and a half times as long as the segment, the longer one three and a half times as long as the shorter one.

Caudal rami (Fig. 11) well developed, long, straight. Terminal claw half as long as the ramus, evenly and gently curved, toothed at middle; subterminal claw similar but a tenth shorter. Dorsal seta three fifths the length of the subterminal claw and at two thirds its length from the claw; terminal seta a third the length of the dorsal one. The base of the ramus is broad. A short distance below the base is a small sinus or indentation (Fig. 11) which seems peculiar to the species.

Described from a few specimens in the collections of the Illinois State Laboratory of Natural History, obtained from ponds at Clifton, Ill., Feb. 16, 1882.

Candona simpsoni n. sp. (Pl. XLVI., Fig. 1-6.)

A small elongate species .73 mm. long, .30 mm. high, and .29 mm. wide.

Left valve slightly overlapping the right (Fig. 4); surface of shell covered with a few conical papillar elevations. Color grayish to yellowish white or cinereous.

Seen laterally (Fig. 3), the shell is elongate-elliptical, two and a half times as long as high, evenly rounded anteriorly, somewhat more pointed posteriorly, where the dorsal margin slopes more rapidly than the ventral margin. The dorsal edge is very slightly sloping, nearly straight, the ventral edge being slightly sinuate in the middle.

Seen dorsally, its greatest thickness equals its greatest height; outline subelliptical, the anterior part somewhat more acutely pointed than the posterior, which is bluntly pointed or arched; side contours almost parallel for half the length of the animal.

Second pair of antennæ of female (Fig. 1) shorter and thicker than usual, the second segment being as wide as long, the antepenultimate but slightly longer than broad, and the penultimate four fifths as wide as long and about three times as long as the terminal segment. Terminal claws smooth, about as long as the last two segments taken together.

First pair of feet (Fig. 5) five-segmented; terminal segment conical, approximately as long as the penultimate, which is about as wide as long; antepenultimate segment like the penultimate,—the three combined being but an eighth longer than the second segment. Terminal claw as long as the last three segments.

Second pair of feet (Fig. 2) five-segmented, the fourth segment being undivided as in the great majority of the species of Candona. Foot small; second, third, and fourth segments of the same size; constricted at the joints, and not especially armed in any way except for the presence of several minute spines on each segment (Fig. 2). Terminal segment as long as broad, the shorter terminal seta two and a half times as long as the terminal segment, while the similarly directed seta is two and two thirds times as long as the shorter one.

Caudal rami (Fig. 6) rather short, stout, bent; terminal claw little more than half as long, stout, finely toothed, scimitar-like. The subterminal claw is strongly S-shaped and prominently toothed on the upper curve, and as the caudal rami commonly project from the shell, this structure affords a ready means of distinguishing the species at a glance. Dorsal seta of ramus twice the width of the ramus from the subterminal claw, bent upward at tip, and two thirds the length of the subterminal claw; terminal seta very small, scarcely half as long as the subterminal claw.

This species may be readily distinguished from *C. sigmoides* by the character of the caudal claws and the relative lengths of the terminal setæ of the second feet; also by the difference in the relative lengths of the terminal and penultimate segments of the first foot, which in *C. sigmoides* are as two to three (Pl. XLI., Fig. 11), while in the present species they are approximately equal in length.

Described from a number of specimens collected at the Biological Station of the University of Illinois at Havana, Ill., and from specimens collected by myself at Hedges' Pond, near Urbana, Ill., April 10, 1896.

Named for Chas. T. Simpson, of the United States National Museum.

Candona fabæformis S. Fischer. (Pl. XLV., Fig. 1–3.)

1851. *Cypris fabœformis*, S. Fischer (**23**, p. 146, Pl. III., Fig. 6–16).
1853. *Candona fabœformis*, Lilljeborg (**39**, p. 207).
1870. *Candona diaphana*, Brady & Robertson (**11**, p. 18, Pl. V., Fig. 1–3).
1889. *Candona fabœformis*, Brady & Norman (**9**, p. 103, Pl. IX., Fig. 1–4).
1891. *Candona fabœformis*, Vávra (**68**, p. 45, Fig. 6^2, 12^1–12^9).
1895. *Candona fabfœormis*, Turner (**35**, p. 299, Pl. LXXV., Fig. 10, 11; LXXVI., Fig. 6–8).

Length 1.00 mm., height .47 mm., width .49 mm.

Shell yellowish transparent, a few minute papillar elevations on its surface and a few short scattered hairs.

Seen from the side, it is slightly widest back of the middle, the upper and lower edges nearly parallel, both ends fully rounded, the ventral edge quite deeply sinuate near the middle.

Seen from above, the shell is long, ovate, the two ends suddenly and equally pointed, the two sides nearly parallel at the middle.

Second antennæ quite stout; terminal segment slightly longer than wide; terminal claws smooth, slender, and in the female scarcely longer than the last two segments.

Second foot (Fig. 3) short, slender. the fourth segment divided, making the foot six-segmented. Terminal segment as long as broad, one half as long as the penultimate segment, which is twice as long as broad. Shorter terminal seta twice as long as the terminal segment and a third as long as the longer similarly directed seta; reflexed seta but slightly longer than the longer terminal one.

Caudal rami (Fig. 1) short, stout, curved, much broadened at the base, and fully seven times as long as wide. Terminal claw faintly toothed, nearly straight, but hooked at its extremity, and a third as long as the ramus; subterminal claw nine tenths as long as the terminal one and similar to it. Terminal seta as long as ramus is wide; dorsal seta four fifths as long as the subterminal claw, and distant twice the width of ramus from it. Dorsal margin slightly indented at its proximal third.

Atlanta, Ga., 1895 (Turner); Pools, Normal, Ill., March 27, 1881 (Coll. Ill. State Lab. Nat. Hist). The species occurs also in Russia, Sweden, England, and France.

Candona sigmoides n. sp. (Pl. XLV., Fig. 4–11.)

A large elongate form, the male being 1.25 mm. long and .63 mm. high.

Surface of shell without any special markings; anterior and posterior extremities finely hairy. The testes show through the shell in the form of four curved bands which coalesce posteriorly. (Fig. 4.)

Seen from the side (Fig. 4), the shell of the male is much higher posteriorly, the greatest height being about half the length; anterior extremity evenly rounded, narrow; posterior sloping ventrally. Dorsal margin rather evenly rounded; ventral, deeply sinuate anterior to the middle of the shell.

Second foot (Fig. 7) five-segmented, its longer terminal seta one and three fifths times as long as the last three segments combined; shorter seta as long as the two segments preceding the last, or five times the length of the last segment.

Male antennæ (Fig. 5) six-segmented, the last two segments of the same length, together just equaling the antepenultimate segment; "sense organs" on the distal edge of the antepenultimate segment (Fig. 5), reaching beyond the last segment, the transparent tips funnel-shaped (Fig. 8). Palps of maxillæ as in Fig. 9 and 10.

Caudal rami (Fig. 6) long, straight, more than twice as long as the terminal claw. Subterminal claw three fourths the length of the terminal one, both being somewhat S-shaped, the shorter one quite noticeably so. Terminal seta small, one fifth the length of the terminal claw; dorsal seta reaching one half the distance to the subterminal claw, and situated four times the width of the ramus from it.

This species is somewhat closely related to *C. candida* (O. F. Müller), although easily distinguished by the form of the "sense organs" on the male antennæ; by the great length of the terminal setæ of the second feet (which more than equal the preceding three segments, while in *C. candida* they only equal the two preceding the last); by the relative lengths of the terminal and penultimate segments of the second feet, which in *C. sigmoides* are as 1 to 2 and in *C. candida* as 1 to 4; and by the comparative lengths of the terminal seta and terminal claw of the caudal ramus—in *C. sigmoides* as 1 to 5, in *C. candida* as less than 1 to 2.

It is also somewhat closely allied to *C. simpsoni*, especially in the form of the second feet and the caudal claws, but is easily distinguished from that species by the form of the shell, by the much greater length of the terminal setæ of the second feet, and by the fact that both caudal claws are slightly S-shaped in *C. sigmoides*, while in *C. simpsoni* only the subterminal one is S-shaped, and that very noticeably so.

Described from a few male specimens collected at Havana, Ill., May, 1895.

Candona reflexa n. sp. (Pl. XLVII., Fig. 1-3.)

Shell twice as long as high, thin, minutely granular or pitted, fragile, cinereous, somewhat thickly ciliated on both extremities, which are evenly rounded, the anterior more pointed than posterior. (Further notes on shell impossible from lack of specimens.)

Terminal segment of first foot as long as the penultimate segment is wide; sides of all the segments armed with clusters of small setæ (Fig. 1).

Second foot (Fig. 2) five-segmented, the fourth segment being undivided; terminal segment as wide as long and about a third as long as the penultimate segment. The shorter terminal seta, instead of pointing backward as usual, is somewhat reflexed; for about a third of its length it lies in the same line as the inner edge of the terminal segment; then it is flexed at an angle of about 60° and lies in nearly the same straight line as the penultimate segment. The longer of the two backwardly directed setæ is as long as the last two segments.

Caudal rami (Fig. 3) slightly curved, stout, eight times as long as wide. Terminal claw evenly curved, lightly toothed, strong, half as long as the ramus; subterminal claw three fourths as long as the terminal one and slightly bent near its base. Dorsal seta as long as the subterminal claw, and distant one and a half times the width of the ramus from it; terminal seta somewhat shorter than the width of the ramus, blunt, rather stout.

This is the only Candona I have thus far met with having the peculiar partly reflexed seta of the second foot. Whether this is a characteristic of a young stage or not, I am not prepared to say. The species is somewhat closely related to *C. candida*, but easily distinguished by the characters of the second feet, and the proportions of the segments of the first feet.

Collected at Havana, Ill., May, 1895.

IX. Typhlocypris Vejdovsky.

1880. *Cypris*, Vejdovsky (**70**, p. XLIX).
1882. *Cypris* (*Typhlocypris*), Vejdovsky (**71**, p. 64).
1891. *Typhlocypris*, Vávra (**68**, p. 51).

Second antennæ five-segmented in the female, and six-segmented in the male through the division of the fourth segment. Natatory setæ absent, eyes lacking. The second maxilla carries a rudimentary branchial plate formed of two unequal plumose setæ.

Second pair of feet five-segmented, terminal segment short, bearing two unequal backwardly directed setæ, and one long forwardly directed seta.

This genus differs from the genus Candona principally in the absence of eyes. On account of its haunting dark places the eyes have become rudimentary and, as a partial substitute, the "sense organs" have been excessively developed.

This genus contains but one species, which as yet has not been found in America.

X. Candonopsis Vávra.

1870. *Candona*, Brady & Robertson (**11**, Pl. IX., Fig. 9–12).
1891. *Candonopsis*, Vávra (**68**, p. 54).

Second antennæ similar to those of Candona. Mandible provided with an extraordinarily long palp. Second maxilla bearing a branchial plate formed of three plumose bristles. Caudal rami slender, without the usual dorsal seta.

The female is as yet unknown. No members of this genus have been found in America.

XI. Ilyocypris Brady & Norman.

1820. *Monoculus*, Jurine (**36**, p. 177).
1838–1868. *Cypris*, Koch (**38**); Zaddach (**74**); S. Fischer (**23**); Lilljeborg (**39**); Brady (**6**).
1889. *Ilyocypris*, Brady & Norman (**9**, p. 106).

Shell very strong, irregular, and spiny, somewhat resembling that of Limnicythere.

Second pair of antennæ five-segmented, natatory setæ reaching beyond the terminal claws (except in one variety). Second pair of maxillæ very characteristic; palp rudimentary, two-segmented; branchial plate formed of six plumose setæ.

Second foot five-segmented, terminal segment short, provided with two long, unequal, backwardly directed setæ and a rather short forwardly directed seta.

Caudal rami stout; dorsal seta distant from the subterminal claw.

This genus contains but one known species, which as yet has not been found in America.

XII. Cypria Zenker.

1785–1854. *Cypris, auctorum.*
1820. *Monoculus*, Jurine (**36**, p. 178).
1854. *Cypria*, Zenker ((**75**, p. 77).
1889. *Cypria*, Brady & Norman (**9**, p. 68).
1891. *Cypria*, Vávra (**68**, p. 62).

I give the following general description of the genus from Vávra's emendation (**68**).

Second pair of antennæ five-segmented in the female and six-segmented in the male; distal extremity of the fourth segment in the male provided with two special sense organs; natatory setæ, on the end of the third segment, extraordinarily long, reaching far beyond the tips of the terminal claws.

Mandibular palp, also that of the first maxilla, unusually well developed. Second maxilla with a well-developed branchial plate; palp unsegmented in the female, ending in three bristles; right and left palps of male different in shape, each forming a hooked prehensile organ.

Terminal segment of second foot small, about a third as long as the fourth segment, bearing two nearly equal backwardly directed setæ, which are comparatively short, and a long forwardly directed seta.

Caudal rami stout, ending in two strong claws and a seta; dorsal seta commonly situated about the middle of the dorsal margin. Copulative organ triangular.

The members of this genus are all small and rather compressed. There are eleven species, of which seven are found in America.

KEY TO SPECIES OF CYPRIA.

1 (8). Terminal setæ of second feet approximately equal.

2 (3). Terminal setæ of second feet twice as long as the terminal segment. Left valve with a dorsal flange; right valve with a row of tubercles anteriorly and ventrally. C. PUSTULOSA n. sp.

3 (2). Terminal setæ of second feet approximately as long as the terminal segment.

4 (5). Terminal claw of caudal ramus half the length of the ramus. C. OPHTHALMICA (Jurine).

5 (4). Terminal claw of caudal ramus three fifths the length of the ramus.

6 (7). Dorsal seta of caudal ramus rudimentary, shorter than width of ramus, situated at four times the width of the ramus from the subterminal claw, and above the center; subterminal claw with a comb of very long teeth beyond the center of the claw. C. DENTIFERA n. sp.

7 (6). Dorsal seta slender, two and a half times as long as ramus is wide, and two and a half times width of ramus from subterminal claw, which is almost smooth. Shell marked with closely set parallel and anastomosing lines. C. EXSCULPTA (S. Fischer).

8 (1). Terminal setæ of second feet plainly unequal, the shorter terminal seta being scarcely longer than the segment and but half the length of the other similarly directed seta. Dorsal seta of ramus three times width of ramus from subterminal claw. C. OBESA n. sp.

Cypria pustulosa n. sp. (Pl. XLVIII., Fig. 6–10.)

This species is .51 mm. long, .39 mm. high at the highest part, and .22 mm. wide; clear brownish in color, with a dark patch anteriorly, another just above and posterior to the eye-spot, and still another on the posterior part. Both extremities are hairy, the disc moderately so. Lucid spots (Fig. 6) six, four large and two small, the smaller ones situated ventrally. All are elongate and situated near the center of the shell.

Seen from the side (Fig. 7), the whole specimen seems to be highly arched, owing to the presence of a dorsal flange on the left valve, which is otherwise of the form of the right. Right valve (Fig. 6) regularly arched dorsally; both extremities fully rounded, the anterior sloping, however, somewhat more rapidly; ventral margin nearly straight, except a small sinuation at the middle. Anterior margin of right valve (Fig. 6) with a row of thirteen to sixteen small tubercles, and just posterior to the ventral sinuation are three or four others, which are not so conical but seemingly flattened out and pointed posteriorly.

The sense club on the third segment of the second antennæ reaches but to the upper quarter of the segment, the terminal part being bent outwardly; natatory setæ three times as long as the distance between their place of insertion and the tip of the claws; terminal segment twice as long as broad.

Palp of first maxilla very prominently developed, the first segment twice as long as broad, the terminal segment nearly circular, with two well-developed setæ and three or four shorter ones.

Terminal claw of first pair of feet (Fig. 8) smooth and as long as the two segments preceding the last; the segment preceding these two hairy.

Terminal segment of second foot (Fig. 10) small, carrying two equal, simple, distally directed setæ and a reflexed one, which is as long as the last three segments; penultimate segment provided with a row of cilia at its distal end and several irregularly scattered plumose cilia on its inner edge, also with a stiff seta on its inner edge situated slightly below the middle and reaching to the distal end of the segment; antepenultimate segment as long as the penultimate, covered with scattered plumose cilia and bearing a seta at its inner distal angle which is slightly longer than the seta on the penultimate segment.

Caudal rami rather long and narrow (Fig. 9), nearly straight, two and two fifths times as long as the terminal claw, which is weakly bent and smooth; subterminal claw four fifths as long as the terminal one, provided with a comb of long teeth near the tip. Terminal seta two fifths as long as the terminal claw; dorsal seta situated at the middle of the ramus, scarcely as long as the ramus is wide.

This Cypria occurs quite abundantly in the collections of the Biological Station, made near Havana, Illinois.

Cypria obesa n. sp. (Pl. XLVIII., Fig. 1–5.)

Length .78 mm., height .48 mm., width .33 mm.

Shell plump, clear to brownish yellow, with a few scattered elevations on its surface, but not especially marked in any way. Muscle impressions quite small. Seen from the side, the shell is of a regular suboval form with a straight ventral edge, three fifths as high as long.

Second antennæ of male six-segmented; terminal segment twice as long as wide; inner terminal claw half the length of the outer; apical part of fourth segment with two "sense setæ" reaching to the tip of the terminal segment; sense club on the inner edge of the third segment rather short, extending slightly beyond the upper quarter of the segment; natatory setæ only twice as long as the distance between their place of insertion and tips of terminal claws.

Palp of right maxilla of male (Fig. 5) larger than that of the left maxilla (Fig. 4), and formed as shown in the figure.

Claw of last segment of first pair of feet (Fig. 1) smooth and slightly longer than the united lengths of the last three segments; terminal segment conical, about as long as wide; two segments preceding just equaling one another; seta at inner distal angle of antepenultimate segment as long as the penultimate segment.

Last segment of second foot (Fig. 3) seven tenths as wide as long and a fourth as long as the preceding segment; shorter backwardly directed seta half as long as the longer one, or just equal to the last segment in length; antepenultimate segment slightly shorter than the penultimate, the seta at its inner distal angle as long as that on the penultimate segment. The anterior distal part of the penultimate segment has a crown of cilia surrounding a short seta, and there are also several clusters of coarse cilia on this and the antepenultimate segments.

Caudal rami (Fig. 2) bent, somewhat stout, and nine times as long as wide, finely toothed along the inner margin. Claws evenly bent, finely toothed, but more coarsely so at middle; terminal claw three fifths as long as the ramus; subterminal one half as long as ramus. Terminal seta of ramus three sevenths as long as the subterminal claw; dorsal seta two thirds as long as the terminal one and situated three times the width of the ramus from the subterminal claw, or slightly beyond middle of ramus.

Described from a number of male and female specimens taken at Havana, Ill., August, 1895.

Cypria dentifera, n. sp. (Pl. XLVII., Fig. 6–11.)

Shell .69 mm. long, .38 mm. high, and .26 mm. wide. Entire surface smooth; sparsely hairy except at each end; brownish yellow, with dark brown markings as follows: an anterior, a ventral, and a dorso-ventral patch, and a vertical stripe dorsally just posterior to the eye-spot. Muscle impressions in the form of a rosette, closely clustered, six or seven in number (Fig. 6).

Seen from the side (Fig. 6), the shell is highest just posterior to the middle, quickly sloping posteriorly, more gradually anteriorly. The anterior margin of the right valve projects as a hyaline flange, receiving as in a pocket the anterior margin of the left valve, which is armed with a row of eighteen to twenty tuberculiform teeth. Ventral margin slightly sinuate at middle, the anterior and posterior parts sparsely hairy.

Seen from above (Fig. 7), the shell is widest back of the middle, blunt and evenly rounded, sides nearly parallel, then quickly narrowing anteriorly to a rather pointed end.

Natatory setæ of second antennæ long, slightly plumose, three of them reaching the entire length of the antennæ beyond the terminal claws. Terminal and penultimate segments in female three times as long as wide.

Mandibles and maxillæ not especially marked; palp of left second maxilla of male as in Fig. 8.

First pair of feet (Fig. 9) rather stout; terminal claw smooth, much bent, and as long as the last three segments; terminal segment subconical, a third as long as the penultimate, which is of the same length as the antepenultimate; latter with a few scattered setæ dorsally, and a short, slender seta at the inner apical angle, two thirds as long as the segment.

Two terminal setæ of the second feet (Fig. 10) approximately equal, as long as the last segment, faintly toothed; terminal segment sinuate on its inner edge, two thirds as wide as long; penultimate segment three and three fourths times as long as the terminal one, four times as long as wide, the dorso-basal edge somewhat crenulate, the inner finely ciliate, a plumose seta at its middle point and a comb of cilia at its inner apical angle; antepenultimate segment as long as the penultimate, finely setose on its inner margin and with a rather stout plumose seta at its inner apical angle, as long as the seta on the penultimate segment. The long seta of the terminal segment is as long as the last three segments.

Caudal rami (Fig. 11) rather stout, about ten times as long as wide. Terminal claw stout, nearly smooth, curved beyond the middle, and three fifths as long as the ramus; subterminal claw two thirds as long as the terminal one, with a comb of remarkably long teeth near the tip. These teeth are longest distally, decreasing in length towards the base of the claw. Terminal caudal seta half as long as the subterminal claw; dorsal seta very slender, nearly four times width of ramus from subterminal claw, upwardly curved, not longer than ramus is wide, situated slightly above center of ramus.

This Cypria would attract attention from the manner in which the right valve overlaps the left, and it might be taken for *C. inequivalva* Turner (**63**, p. 6) except for differences in the second feet, in the markings of the shell, in the caudal rami, and some others.

Described from a number of specimens in the collection of the Illinois State Laboratory of Natural History, taken in the Zoölogical Gardens at Cincinnati, Ohio, Aug. 30, 1881. Not as yet known from any other locality.

Cypria exsculpta S. Fischer. (Pl. XLVII., Fig. 4).

1853. *Cypris elegantula*, Lilljeborg (**39**, p. 206).
1855. *Cypris exsculpta*, S. Fischer (**24**, p. 652. Pl. XIX., Fig. 36–38).
1864. *Cypris striolata*, Brady (**4**, p. 60, Pl. III., Fig. 12–17).
1868. *Cypris striolata*, Brady (**6**, p. 372, Pl. XXIV., Fig. 6–10).
1880. *Cypris granulata*, Robertson (**55**, p. 18).
1887. *Cypris striolata*, Herrick (**34**, p. 29, Pl. IV., Fig. 3).
1889. *Cypria exsculpta*, Brady & Norman (**9**, p. 68, Pl. XI., Fig. 1–4).
1894. *Cypria exsculpta*, Turner (**64**, p. 13, Pl. VII., Fig. 2–8).
1895. *Cypria exsculpta*, Turner (**35**, p. 305, Pl. LXX., Fig., 1–8; LXXII., Fig. 3).

Length .58 mm., height .37 mm., width .25 mm.

Shell thin; clear yellow to transparent.

Seen from the side, the shell is broadly subovate, highest in the middle, but of about the same width for two thirds its length; dorsal margin strongly arched, the eye-spot anterior to the highest point.

Seen from above, the shell is a narrow, much compressed ellipse.

Terminal segment of second foot a fourth as long as the preceding segment. The two short terminal setæ are of the same length as the segment, the longer one as long as the last three segments.

Caudal rami short, stout, and much curved. Terminal claw smooth, curved, and about half the length of ramus; subterminal claw five sixths the length of the terminal one, smooth, curved, twice the length of the terminal seta; dorsal seta somewhat longer than the terminal seta and situated slightly beyond the middle of the ramus.

This species may at once be recognized by the meshwork of anastomosing parallel longitudinal lines over the entire surface of the shell (Fig. 4). These may commonly be quite readily seen, thus settling its identity at once, as I am not aware of any other ostracode with shell markings of this character.

This species is quite common in most running streams, and was one of the commonest forms seen in my examination of the collections of the Illinois State Laboratory of Natural History from various localities, and of the Illinois Biological Station at Havana, Ill.

Cypria ophthalmica Jurine. (Pl. XLVII., Fig. 5.)

1820. *Monoculus ophthalmicus*, Jurine (**36**, p. 178, Pl. XIX., Fig. 16, 17).

1835. *Cypris compressa*, Baird (**1**, p. 100, Pl. III., Fig. 16).

1837. *Cypris tenera*, Koch (**38**, H. XII., p. 3, Fig. 3).

1838. *Cypris punctata*, Koch (**38**, H. XXI., p. 23, Fig. 23).

1850. *Cypris compressa*, Baird (**2**, p. 154, Taf. XIX., Fig. 14, 14*a*–*c*).

1851. *Cypris elegantula*, S. Fischer (**23**, p. 161, Pl. X., Fig. 12–14).

1853. *Cypris compressa*, Lilljeborg (**39**, p. 112, Tab. X., Fig. 16–18).

1854. *Cypria punctata*, Zenker (**75**, p. 77, Taf. III., Fig. A).

1868. *Cypris compressa*, Brady (**6**, p. 372, Pl. XXIV., Fig. 1–5; XXXVI., Fig. 6).
1868. *Cypris ovum*, Fric & Nekut (**27**, p. 48, Fig. 30).
1872. *Cypris ovum*, Fric. (**26**, p. 228, Fig. 28).
1874. *Cypris compressa*, Brady, Crosskey, & Robertson (**14**, p. 123; Pl. I., Fig. 5, 6).
1885. *Cypris punctata*, Nordqvist (**50**, p. 150).
1888. *Cypris punctata*, Schwarz (**59** p. 18).
1888. *Cypris compressa*, Sostaric (**60**, p. 47).
1889. *Cypria ophthalmica*, Brady & Norman (**9**, p. 69, Pl. XI., Fig. 5–9).
1891. *Cypria ophthalmica*, Vávra (**68**, p. 63, Fig. 19^1–19^6, 20^1–20^4).

Length .56 mm., height .37 mm., width .32 mm. The American representative seems to be smaller than the European form, if one may judge from the descriptions of Vávra (**68**, p. 63) and of Brady (**6**, p. 372).

Shell much compressed, reniform, clear brown, except at the anterior and posterior ends and just back of the eye-spot where there are dark brown bands or patches, these three bands being perhaps a ready means of distinguishing the species.

Seen from the side, the dorsal margin is much arched, but hardly as much as in Vávra's specimens.

Seen from above, the shell is widest at the posterior third, narrow, somewhat acutely pointed anteriorly and rounded posteriorly.

Natatory setæ very long, reaching beyond the tips of the terminal claws by more than the total length of the antennæ, or three times as long as the distance between their point of insertion and the tips of the terminal claws.

Terminal segment of second foot somewhat longer than broad, a third as long as the preceding segment, and sinuate at its inner margin. The two terminal short setæ are about the same length and as long as the terminal segment.

Caudal rami (Fig. 5) short, rather stout, bent, and fully eight times as long as wide. Terminal claw simple, curved. half as long as the ramus, subterminal claw two thirds as long as the terminal one, with a patch of teeth near its tip. Terminal seta half as long as subterminal claw; dorsal seta slender, as long as width of ramus, situated at middle of ramus. The inner edge of the ramus was smooth in the specimens examined, thus differing from Vávra's description (**68**, p. 63).

Minn., 1883 (Herrick); Baxley, Ga., 1895 (Turner); Havana, Ill. (Coll. Ill. State Lab. Nat. Hist.).

XIII. CYPRIDOPSIS BRADY.

—— *Cypris, auctorum.*
1820. *Monoculus*, Jurine (**36**).
1868. *Cypridopsis*, Brady (**6**, p. 375).

Second pair of antennæ five-segmented. Natatory setæ at end of third segment long and plumose. The branchia of the second maxilla consists of a plate bearing five plumose setæ or else of two setæ which are inserted directly on the blade.

Second foot five-segmented, with a strong chitinous claw at its extremity.

Caudal rami rudimentary, flagelliform, base turgid, a short cilium on the dorsal edge.

The males of this genus are unknown. There are eleven species, of which three are known to occur in America.

KEY TO SPECIES OF CYPRIDOPSIS.

1 (2). Branchia of second maxilla with five setæ. Three dark bands on dorsal and lateral aspect of shell; very plump. Common.
C. VIDUA (O. F. Müller).

2 (1). Branchia of second maxilla formed of two setæ.

3 (4). Caudal rami cylindrical, turgid at base, suddenly narrowing to a bristle which is little longer than the basal part.
C. NEWTONI Brady & Robertson.

4 (3). Caudal rami broad, gradually narrowing to a bristle. Shell much compressed.

5 (6). Natatory setæ of second antennæ reaching to the end of the terminal claws. Shell pale green.

C. villosa (Jurine).

6 (5). Natatory setæ of second antennæ reaching beyond the end of the terminal claws. Shell grass-green, at least dorsally.

C. smaragdina Vávra.

Cypridopsis vidua (O. F. Müller).

1792. *Cypris vidua*, O. F. Müller, (**49**, p. 55, Tab. IV., Fig. 7–9).
1820. *Monoculus vidua*. Jurine (**36**. p. 175, Pl. XIX., Fig. 5, 6).
1837. *Cypris maculata*, Koch (**38**, H. X., p. 2, Fig. 2).
1841. *Cypris strigata*, Koch (**38**, H. XXXVI., p. 19, Fig. 19).
1844. *Cypris vidua*, Zaddach (**74**, p. 35).
1850. *Cypris vidua*. Baird (**2**, p. 152, Pl. XIX.. Fig. 10, 11).
1850. *Cypris sella*, Baird (**2**, p. 158. Pl. XIX., Fig. 5, 5*a*).
1851. *Cypris vidua*, S. Fischer (**23**, p. 162, Pl. XI., Fig. 1–2).
1853. *Cypris vidua*. Lilljeborg (**39**, p. 111, Tab. X., Fig. 10–12).
1854. *Cypris vidua*, Zenker (**75**, p. 79).
1868. *Cypridopsis vidua*, Brady (**6**. p. 375, Pl. XXIV., Fig. 27–30, 46).
1868. *Cypris vidua*, Claus (**17**, Pl. I., Fig. 6–8).
1868. *Cypris vidua*, Fric & Nekut (**27**, p. 48, Fig. 29).
1869. *Cypridopsis obesa*, Brady & Robertson (**10**, p. 364, Pl. XVIII.. Fig. 5–7).
1870. *Cypridopsis obesa*, Brady & Robertson (**11**, p. 15).
1871. *Cypris vidua*, Heller (**31**, p. 90).
1872. *Cypris vidua*, Fric (**26**, p. 227, Fig. 27).
1874. *Cypridopsis obesa*, Brady, Crosskey & Robertson (**14**, p. 128, Pl. I., Fig. 1–4).
1879. *Cypris vidua*, Herrick (**32**, p. 112, Pl. XVII., Fig. 1).
1880. *Cypridopsis vidua*, Robertson (**55**, p. 20).
1887. *Cypridopsis vidua*, Herrick **34**, p. 31, Pl. IV., Fig. 1).
1888. *Cypris vidua*, Sostaric (**60**, p. 46).
1889. *Cypridopsis vidua*, Brady & Norman (**9**, p. 89).
1891. *Cypridopsis vidua*, Vávra (**68**, p. 75, Fig 23^1–23^4).
1892. *Cypridopsis vidua*, Turner (**62**, p. 73).
1893. *Cypridopsis vidua*, Daday (**19**, p. 300).
1894. *Cypridopsis vidua*, Turner (**64**, p. 19).
1895. *Cypridopsis vidua*, Turner (**35**, p. 312, Pl. LXXII., Fig. 1–1*g*; LXXV., Fig, 5, 6, 8, 9; LXXVI., Fig. 4, 7).

This well known species needs no extended notice in this paper.

Length, .60–.70 mm., height, .35 mm., width, .38–.45 mm.

Seen from above, the shell is broadly ovate, widest back of the middle. Three characteristic darker bands varying from dark brown to green extend down each side from a longitudinal dorsal band. These bands together with its oblong spheroidal form and plump appearance can hardly fail to identify the species.

The caudal rami are rudimentary, the terminal part being produced into a long slender stylet which is somewhat longer than the ramus.

This species is ubiquitous, and I have yet to know of a pond or stream which it has not made its home. It is seemingly always present in aquaria, and appears to play the rôle of scavenger, thriving in situations to which other Ostracoda seem to be totally unadapted. Viewed with a low power these creatures present a very pretty appearance as they rapidly swim about, the banded shell at once attracting attention.

It would seem that its great adaptability to adverse situations and its scavenging habits might account in part for its almost universal distribution throughout the temperate zones.

Cypridopsis smaragdina VÁVRA. (Pl. XLVIII., Fig. 11–12.)

1891. *Cypridopsis smaragdina*, Vávra (**68**, p. 80, Fig. 26^1–26^3).

Length .65 mm., height .45 mm., and breadth .34 mm.

This striking and interesting form appears at first glance, when seen from the side (Fig. 11), to be in the shape of a half-moon, except that the under edge is nearly straight. The shell is light to grass-green, especially on its dorsal aspect; alcoholic specimens, however, commonly show but a trace of this coloration. Surface thickly covered with long hairs, which are all parallel to one another, backwardly directed, and closely appressed to the shell (Fig. 11).

The eye-spot, instead of being at the highest point of the shell, as in the typical forms described by Vávra, is slightly below and anterior to this location. The natatory setæ of the second antennæ are long, reaching beyond the tips of the terminal claws by the length of the claws, thus differing from *C. villosa* (Jurine), its near relative, the natatory setæ of which reach but to the terminal claws.

The caudal rami (Fig. 12) are rudimentary, the basal part cylindrical, more than three times as long as wide, then suddenly narrowing into a long flagellum, fully twice as long as the basal part. The ramus also has a dorsal seta at the termination of the basal part, slightly longer than the ramus is wide.

South Chicago, August 24, 1881, from a ditch opening into the Calumet River (Coll. Ill. State Lab. Nat. Hist.).

XIV. POTAMOCYPRIS BRADY.

1868. *Bairdia*, Brady (**6**, p. 474).
1870. *Potamocypris*, Brady (**7**, p. 366).

Second antennæ four-segmented, third and fourth segments bearing numerous setæ, which are short, not reaching beyond the middle of the terminal claws; last segment with two strong terminal claws and two or three short, slender setæ. Mandible stout, palp three-segmented and bearing a single branchial seta near the base. Feet as in Cypris, caudal rami rudimentary, consisting of a long seta with a lamellar base, bearing a short dorsal one commonly at base of the lamellar part.

Shell compressed, outline when seen from the side similar to that of Cypridopsis.

I know of but two species of this genus,—*P. fulva* (Brady) and *P. gregaria* Sars,—neither of which is known to occur in America.

BIBLIOGRAPHY.

1. BAIRD, W., 1835.—Trans. Berw. Nat. Club, Vol. I., p. 100.
2. ——— 1850.—Natural History of the British Entomostraca. Printed for Ray Society. 36 plates.
3. ——— 1859.—Proc. Zoöl. Soc. London. Plate.
4. BRADY, G. S., 1864.—Species of Ostracoda New to Britain. Ann. and Mag. Nat. Hist., Ser. III., Vol. XIII., p. 59.
5. ——— 1868.—On the Crustacean Fauna of the Salt Marshes of Northumberland and Durham. Nat. Hist. Trans. Northumberland and Durham, Vol. III., p. 1.
6. ——— 1868.—A Monograph of the Recent British Ostracoda. Trans. Linn. Soc., Vol. XXVI., Pt. II., p. 353.
7. ——— 1870.—Notes on Entomostraca taken chiefly in the Northumberland and Durham District. Nat. Hist. Trans. Northumberland and Durham, Vol. III., p. 361.
8. ——— 1885.—Notes on Entomostraca collected by Mr. A. Haly in Ceylon. Journ. Linn. Soc., Vol. XIX., p. 293. 4 Plates.
9. BRADY, G. S., AND NORMAN, A. M., 1889.—A Monograph of the Marine and Fresh-water Ostracoda of the N. Atlantic and of N. W. Europe. Sec. I., Podocopa. Trans. Royal Dublin Society. 16 Plates.
10. BRADY, G. S., AND ROBERTSON, D., 1869.—Notes on a Week's Dredging in the West of Ireland. Ann. and Mag. Nat. Hist., Ser. IV., Vol. III., p. 353. 5 Plates.
11. ——— 1870.—The Ostracoda and Foraminifera of Tidal Rivers. Ann. and Mag. Nat. Hist., Ser. IV., Vol. VI., p. 1. Plates.
12. ——— 1872.—On the Distribution of British Ostracoda. Ann. and Mag. Nat. Hist., Ser. IV., Vol. IX., p. 48. 2 Plates.

13. ——— 1874.—On Ostracoda taken among the Scilly Islands, and on the Anatomy of *Darwinella stevensonii.* Ann. and Mag. Nat. Hist., Ser. IV., Vol. XIII., p. 114. 2 Plates.

14. Brady, G. S., Crosskey, W. H., and Robertson, D., 1874.—Monograph of the Post-tertiary Entomostraca of Scotland and parts of England and Ireland. Palæontographical Society. 16 Plates.

15. Chambers, V. T., 1877.—New Entomostraca from Colorado. Bull. U. S. Geol. and Geogr. Surv., Vol. III., p. 151. Figures.

16. Chyzer, C., 1858.—Über die Crustaceen-Fauna Ungarns. Verhandl. der k.-k. zool.-bot. Gesellschaft in Wien., Bd. VIII., p. 505.

17. Claus, C., 1868.—Beiträge zur Kenntniss der Ostracoden. I. Entwicklungsgeschichte von Cypris. Published separately in 1868, and in Schrift. der Gesellsch. zu Beförd. d. gesammt. Naturwiss. zu Marburg, Bd. IX., 1872, p. 151. 2 Taf.

18. ——— 1892.—Beiträge zur Kenntniss der Süsswasser-Ostracoden. Arbeiten aus dem zoolog. Institut zu Wien, Tome X., Heft 2. 12 Taf.

19. Daday, E. v., 1893.—Über die Ostracoden der Umgebung von Budapest. Természetrajzi Füzetek, Vol. XV., Part 4, 1892, p. 286.

20. Dahl, F., 1888.—Die Cytheriden der westlichen Ostsee. Zool. Jahrbücher, Bd. III., Abth. f. Systematik, p. 597. 4 Plates.

21. De Kay, J. E., 1844.—Zoölogy of New York. Part VI., Crustacea. 13 Plates.

22. Fischer, S., 1847.—Über die in der Umgebung von St. Petersburg vorkommenden Crustaceen aus der Ordnung der Branchiopoden und Entomostraceen. Mém. des Sav. Étrangers, T. VI. Figure.

23. ——— 1851.—Abhandlung über das Genus Cypris und dessen bei Petersburg und Reval vorkommende Arten. 11 Plates.

24. ——— 1855.—Beitrag zur Kenntniss der Ostracoden. Abhandl. d. mathemat.-physik. Classe der königl.-Bayerischen Akad. der Wiss., VII. Band, III. Abth., p. 635. 2 Taf.

25. FORBES, S. A., 1893.—A Preliminary Report on the Aquatic Invertebrate Fauna of the Yellowstone National Park, Wyoming, and of the Flathead Region of Montana. Bull. U. S. Fish Comm., 1891, pp. 207–258. 6 Plates.

26. FRIC, A., 1872.—Die Krustenthiere Böhmens. Archiv der naturw. Landesdurchforschung von Böhmen, Bd. II., Abth. IV., p. 206.

27. FRIC, A., AND NEKUT, F., 1868.—Korysi země Ceské. Prag. Zeits. Ziva, v. J., 1867.

28. GUERNE, J. DE, 1887.—Note sur la faune des Açores. 7 pp. Naturaliste, Paris.

29. ——— 1893.—Un Ostracode nouveau pour la faune française. Revue Biol. Nord France, 4 Anneé, pp. 518–519.

30. HALDEMAN, C., 1843.—[Descriptions of new Cyprids.] Proceedings Phil. Acad. Sciences, 1841–43, pp. 53, 166, 184.

31. HELLER, C., 1871.—Untersuchungen über die Crustaceen Tirols. Berichten des medizinisch.-naturwiss. Vereines in Innsbruck. 2 Taf.

32. HERRICK, C. L., 1879.—Microscopic Entomostraca. Seventh Ann. Rep. Geol. and Nat. Hist. Surv. Minn., 1878, pp. 81–123. 21 Plates.

34. ——— 1887.—Contribution to the Fauna of the Gulf of Mexico and the South. Memoirs of Denison Scientific Ass'n, Vol. I., No. I. 8 Plates.

35. HERRICK, C. L., AND TURNER, C. H., 1895.—Synopsis of the Entomostraca of Minnesota: Copepoda, Cladocera, and Ostracoda. Second Report of the State Zoölogist of Minnesota.

36. JURINE, L., 1820.—Histoire des Monocles, qui se trouvent aux environs de Genève. 22 Plates.

37. KAUFMANN, A., 1892.—Ueber die Gattung Acanthopus Vernet und eine neue Süsswassercytheride. Zool. Anz., 1892, p. 393.

38. KOCH, C. L., 1837–41.—Deutchlands Crustaceen, Myriapoden und Arachniden. Heft 10, 11, 12, 1837; Heft 21, 1838; Heft 36. 1841.

39. LILLJEBORG, W., 1853.—De Crustaceis ex ordinibus tribus: Cladocera, Ostracoda et Copepoda in Scania occurrentibus. 27 Plates.

40. ——— 1862.—Beskrifning öfver två arter Crustaceer af ordningarna Ostracoda och Copepoda. Öfvers. af k. Vet.-Akad. Förhand., XIX., p. 391.

41. ——— 1883.—Collections of chiefly Fresh-water Crustacea from Sweden. Special Catalogue International Fisheries Exhibition, London, p. 140.

42. MEEKER, J. W., 1871.—Cypris pullipes. A new species of Cypris found in New Jersey. Am. Journ. Microsc., I., pp. 68, 97.

43. MONIEZ, R. 1887.—Liste des Copépodes, Ostracodes, Cladocères et de quelques autres Crustacés recueillis à Lille en 1886. Bull. de la Soc. Zool. de France, T. 12, pp. 508–518.

44. ——— 1888.—Faune des Eaux Souterraines du Departement du Nord et en particulier de la ville de Lille. Ostracoda. Revue Biol. Nord France, 1 Année, pp. 179-180, 241-257.

45. ——— 1889.—Sur la faune du Hable d'Ault. Ostracoda. Revue Biol. Nord France, 1 Année, pp. 277–280.

46. ——— 1889.—Sur quelques Cladocères et sur un Ostracode nouveaux du Lac Titicaca. Revue. Biol. Nord France, 1 Année, pp. 419–429. 13 Figures.

47. ——— 1891.—Entomostracés d'eau douce de Sumatra et de Célèbes. II. Ostracodes. Zool. Ergeb. einer Reise in Niederlandisch Ost-Indien, p. 129. Plates.

48. ——— 1893.—Description d'une nouvelle espèce de Cypris vivant dans les eaux thermales du Hammam-Meskhoutine. Bull. Soc. Zool. France. T. 18, No. 3, pp. 141,142. 7 figures.

49. Müller, O. F., 1792.—Entomostraca seu Insecta testacea, quæ in aquis Daniæ et Norvegiæ reperit, descripsit et iconibus illustravit. Tab. 21.

50. Nordqvist, Osc., 1885.—Beitrag zur Kenntniss der inneren männlichen Geschlechtsorgane der Cypriden.

51. ——— 1887.—Die Pelagische und Tiefsee-Fauna der grösseren finnischen Seen. Zool. Anz., X. Jahrg., pp. 339–345, 358–362.

52. Plateau, F., 1867.—Recherches sur les Crustacés d'eau douce de Belgique. Mem. Cour. et des Sav. Étrangers, T. XXXIV. 1 Plate.

53. Poggenpol, M. J., 1874.—List of the Copepoda, Cladocera, and Ostracoda of the Environs of Moscow.

54. Ramdohr, F. A., 1808.—Über die Gattung Cypris Müll. und drei zu derselben gehörige neue Arten Mag. d. Gesellsch. naturforsch. Freunde zu Berlin, II. Jahrg., pp. 83–93. 1 Tab.

55. Robertson, D., 1880.—Fauna of Scotland with special reference to Clydesdale and the Western Districts; Fresh- and Brackish-Water Ostracoda. Proc. Nat. Hist. Soc. Glasgow, Vol. IV. 35 pp. 1 Plate.

56. Sars, G. O., 1864.—Beretning om en i Sommeren 1863 foretagen zoologisk Reise i Christiania Stift. Nyt. Mag. f. Naturvid. 13 Bd., pp. 225–260.

57. ——— 1889.—On some Fresh-water Ostracoda and Copepoda raised from Dried Australian Mud. Christiania Vid. Selsk. Förh., 1889, No. 8. 79 pp. 8 Taf.

58. ——— 1895.—On some South-African Entomostraca raised from Dried Mud. Vid. Selsk. Skrift. I. Math.-Naturv. Klasse, 1895, No. 8. 8 Plates.

59. Schwarz, C. G., 1888.—Ueber die sogenannte Schleimdrüse der männlichen Cypriden. Berichten der Naturforsch. Gesellsch. Freiburg, Bd. III., p. 133. 2 Plates.

60. Sostaric, D., 1888.—Prilog poznavanju faune slatkovodnih korepnjaka hrvatske. Rad. jugoslav. akad. XCII., IX., 103-214.

61. Straus, H. E., 1821.—Mémoire sur les Cypris de la classe des Crustacés. Mém. du Muséum, Vol. VII., pp. 33-61. Plates.

62. Turner, C. H., 1892.—Notes upon the Cladocera, Copepoda, Ostracoda, and Rotifera of Cincinnati, with Descriptions of New Species. Bull. Sci. Lab. Denison Univ., Vol. VI., Pt. II., pp. 57-74. 2 Plates.

63. ——— 1893.—Additional Notes on the Cladocera and Ostracoda of Cincinnati, Ohio. Bull. Sci. Lab. Denison Univ., Vol. VIII., Pt. I., pp. 1-18. 2 Plates.

64. ——— 1894.—Notes on American Ostracoda, with Descriptions of New Species. Bull. Sci. Lab. Denison Univ., Vol. VIII., Pt. II., pp. 13-25. 2 Plates.

65. ——— Turner, C. H., and Herrick, C. L., 1895. See **35**.

66. Underwood, Lucien M., 1886.—List of the Described Species of Fresh-water Crustacea from America North of Mexico. Bull. Ill. State Lab. Nat. Hist., Vol. II., Art. 5, p. 323.

67. Vávra, V., 1891.—Über das Vorkommen einer Süsswasser-Cytheride in Böhmen. Zool. Anz., XIV. Jahrg., p. 77.

68. ——— 1891.—Monographie der Ostracoden Böhmens. Archiv der naturw. Landesdurchforschung von Böhmen, VIII. Band., Nr. 3. Figures.

69. Vávra, V., and Fric, Ant., 1894.—Untersuchungen über die Fauna der Gewässer Böhmens. IV. Archiv der naturw. Landesdurchforschung von Böhmen, IX. Band., Nr. 2. Figures.

70. VEJDOVSKY, F., 1880.—O puvodu fauny studnicné. Slavnostní prednáska ve vyrocním, sezení král. ceské spol. nauk. v. Praze, dne 3 Cervna.

71. ——— 1882.—Thierische Organismen der Brunnenwässer von Prag. 8 Taf.

72. VERNET, H., 1878.—Acanthopus, un nouveau genre d'Ostracodes. Forel's Matériaux pour servir a l'étude de la Faune profonde du Lac Leman. IV. Série, 1878, p. 506.

73. ZACHARIAS, O., 1888.—Die Tierwelt der Eifel-Maare. Biol. Centr., 8 Bd., p. 574.

74. ZADDACH, E. G., 1844.—Synopseos Crustaceorum Prussicorum Prodromus.

75. ZENKER, W., 1854.—Monographie der Ostracoden. Wieg. Archiv f. Naturg., XX. Jahrg., I. Bd., pp. 1–87. 6 Taf.

76. ZSCHOKKE, F., 1894.—Die Tierwelt der Juraseen. Revue Suisse de Zoologie, T. II., p. 369. 1 Plate.

EXPLANATION OF PLATES.

Plate XXXIX.

Fig. 1. *Limnicythere reticulata* n. sp.: ventral view.
Fig. 2. Inside view of left valve of shell.
Fig. 3. Rudimentary caudal ramus.
Fig. 4. Second foot.
Fig. 5. First antenna.
Fig. 6. Third foot.
Fig. 7. Posterior dorsal part of carapace.
Fig. 8. *Limnicythere illinoisensis* n. sp.: lateral view.
Fig. 9. Markings on shell.
Fig. 10. Part of anterior surface of shell.
Fig. 11. First foot.
Fig. 12. Rudimentary caudal ramus.
Fig. 13. Ventral view.

Plate XL.

Fig. 1. *Limnicythere illinoisensis* n. sp.: view of side from below.
Fig. 2. Male sexual clasping organs.
Fig. 3. Second foot.
Fig. 4. Third foot.
Fig. 5. Second antenna of male.
Fig. 6. First antenna of male.

Plate XLI.

Fig. 1. *Cyclocypris forbesi* n. sp.: lateral view.
Fig. 2. Dorsal view.
Fig. 3. Second antenna of female.
Fig. 4. Palp of left second maxilla of male.

Fig. 5. Palp of right second maxilla of male.

Fig. 6. Second foot.

Fig. 7. Caudal ramus.

Plate XLII.

Fig. 1. *Cyprinotus pellucida* n. sp.: lateral view.

Fig. 2. Dorsal view.

Fig. 3. Markings on shell.

Fig. 4. First foot.

Fig. 5. Second foot.

Fig. 6. Caudal ramus.

Fig. 7. *Cyprinotus burlingtonensis* Turner, caudal ramus.

Plate XLIII.

Fig. 1. *Cyprinotus incongruens* Ramd.: caudal ramus.

Fig. 2. Anterior end of right valve, pittings indicated at *x*.

Fig. 3. *Cypris reticulata* Zadd.: markings on shell.

Fig. 4. Caudal ramus.

Fig. 5. *Cypris fuscata* Jur.: caudal ramus.

Plate XLIV.

Fig. 1. *Cypris testudinaria* n. sp.: caudal ramus.

Fig. 2. First foot.

Fig. 3. End of organ of Zenker.

Fig. 4. Second antenna.

Fig. 5. *Candona acuminata* Fisch.: first foot.

Fig. 6. Second foot.

Fig. 7. Caudal ramus.

Plate XLV.

Fig. 1. *Candona fabaformis* Fisch.: caudal ramus.

Fig. 2. First foot.

Fig. 3. Second foot.

Fig. 4. *Candona sigmoides* n. sp., ♂: lateral outline view.

Fig. 5. Second antenna.

Fig. 6. Caudal ramus.

Fig. 7. Second foot.

Fig. 8. "Sense organ" of second antenna.

Fig. 9. Palp of left second maxilla.

Fig. 10. Palp of right second maxilla.

Fig. 11. First foot.

Plate XLVI.

Fig. 1. *Candona simpsoni* n. sp.: second antenna of female.

Fig. 2. Second foot.

Fig. 3. Lateral view.

Fig. 4. Ventral view.

Fig. 5. First foot.

Fig. 6. Caudal ramus.

Fig. 7. *Candona recticauda* n. sp.: second foot.

Fig. 8. Second antenna of male.

Fig. 9. Palp of right second maxilla of male.

Fig. 10. Palp of left second maxilla of male.

Fig. 11. Caudal ramus.

Plate XLVII.

Fig. 1. *Candona reflexa* n. sp.: first foot.

Fig. 2. Second foot.

Fig. 3. Caudal ramus.

Fig. 4. *Cypria exsculpta* Fisch.: reticulations on shell.

Fig. 5. *Cypria ophthalmica* Jur.: caudal ramus.

Fig. 6. *Cypria dentifera* n. sp.: inside view of left valve of shell.

Fig. 7. Dorsal view of shell.

Fig. 8. Palp of left second maxilla of male.

Fig. 9. First foot.

Fig. 10. Second foot.

Fig. 11. Caudal ramus.

Plate XLVIII.

Fig. 1. *Cypria obesa* n. sp.: first foot.

Fig. 2. Caudal ramus.

Fig. 3. Second foot.

Fig. 4. Palp of left second maxilla of male.

Fig. 5. Palp of right second maxilla of male.

Fig. 6. *Cypria pustulosa* n. sp.: inside view of right valve of shell.

Fig. 7. Lateral view of left valve of shell.

Fig.. 8. First foot.

Fig. 9. Caudal ramus.

Fig. 10. Second foot.

Fig. 11. *Cypridopsis smaragdina* Vávra: lateral view.

Fig. 12. Rudimentary caudal ramus.

INDEX.

(Synonyms in Italics.)

INDEX.

A

C

D

E

J

K

L

P

U

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.*

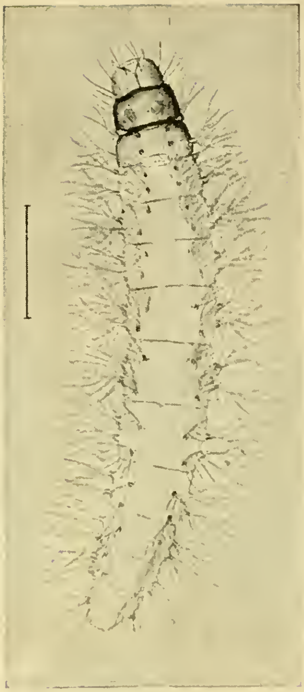
Page 411, line 10, for *Michaelson* read *Michaelsen.*

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

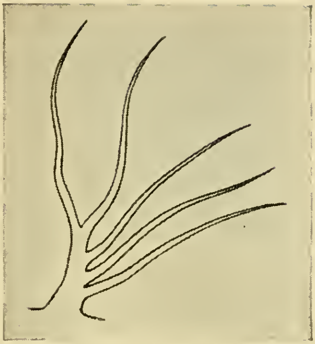
Page 445, line 10 from bottom, for *57* read *58.*

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

Plate I.

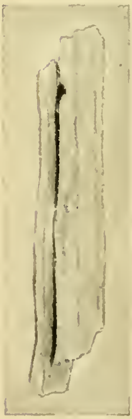


1

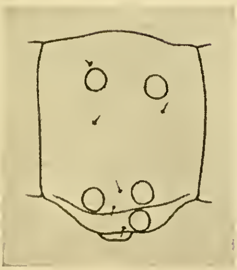


4

3



2



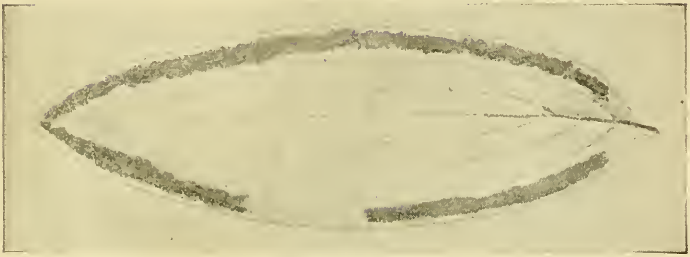
5

6

Plate II.

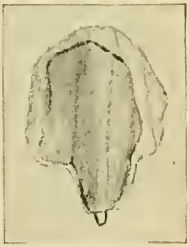
7

9

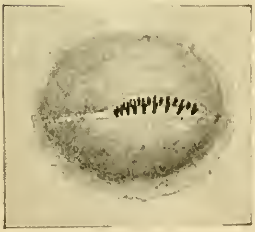


8

10



11



12

PLATE III.

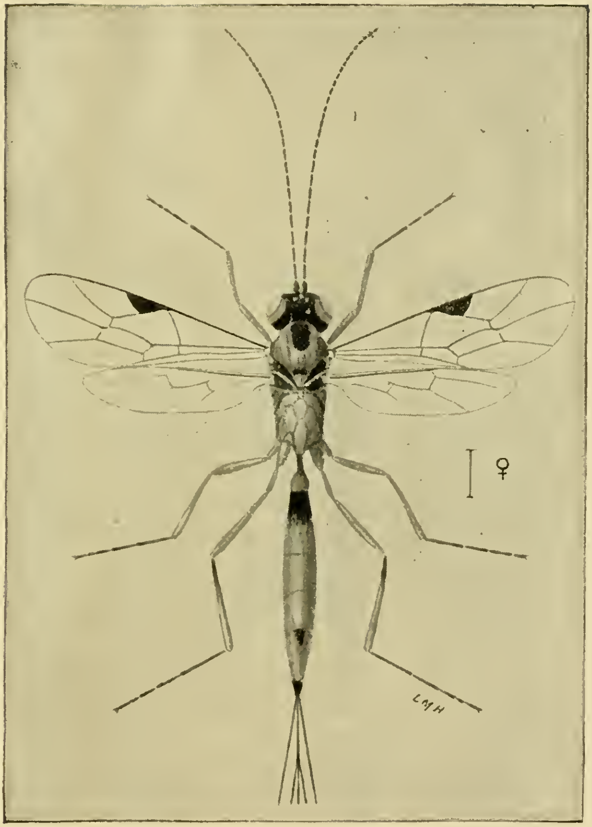
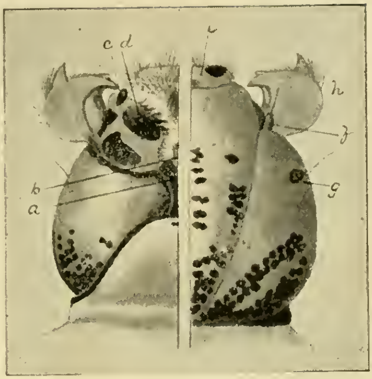


Plate IV.

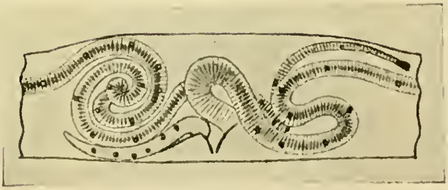
PLATE V.

15



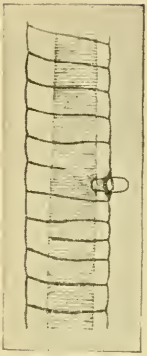
16

17



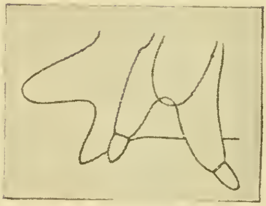
18

PLATE VI.



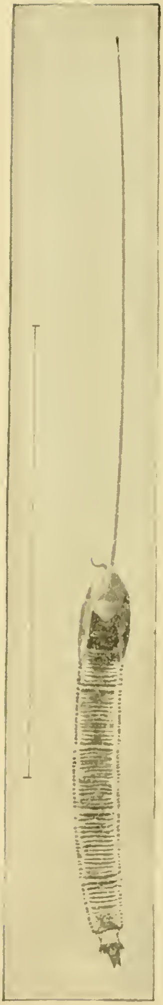
20

21

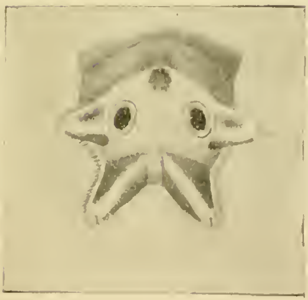


25

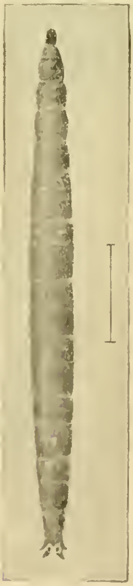
22



19

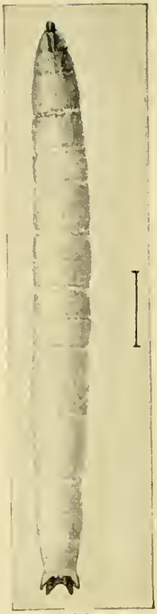


24

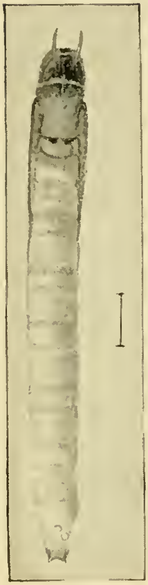


23

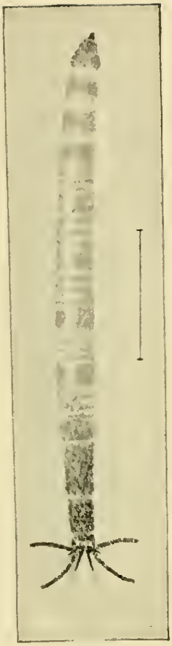
PLATE VII.



26



28

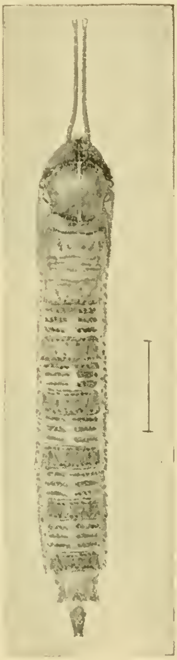


29

27

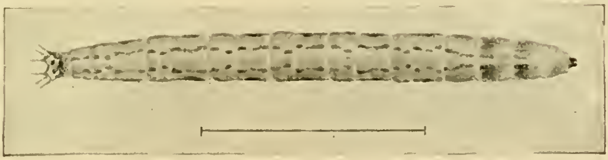
Plate VIII.

30



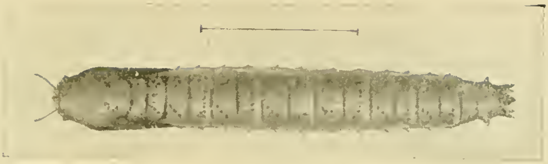
31

33

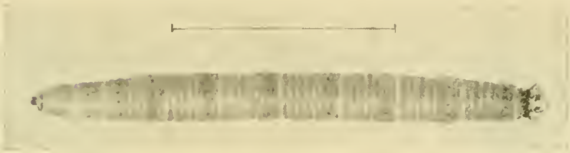


32

Plate IX.

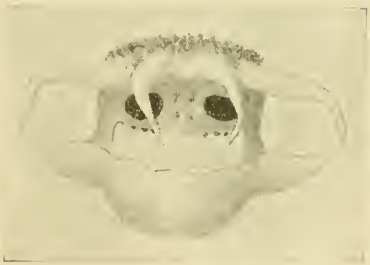


34



35

38



36

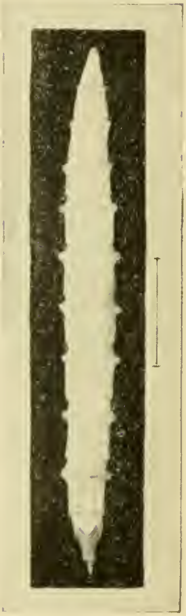
37

39

PLATE X.

40

42



41

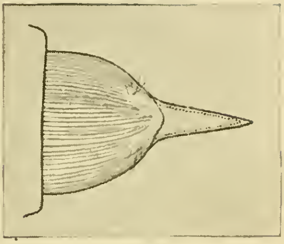
43

45

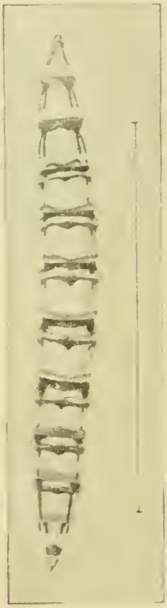
44

PLATE XI.

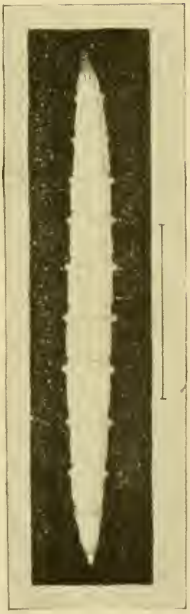
46



48



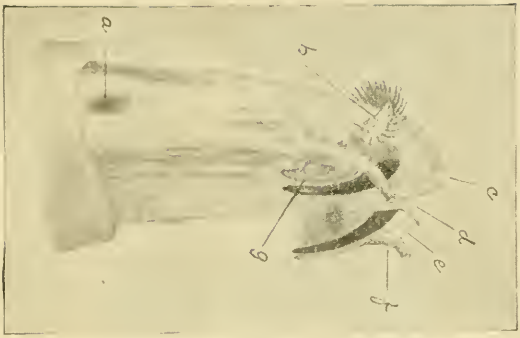
47



49

50

PLATE XII.



51

53

52

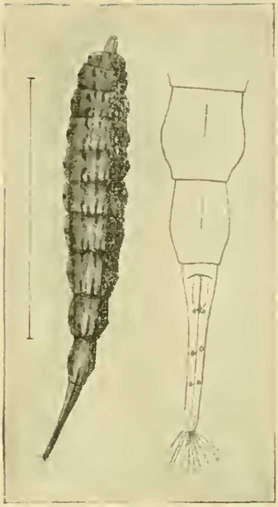
54

PLATE XIII.

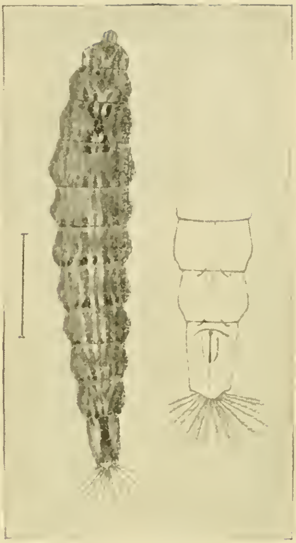
55

56

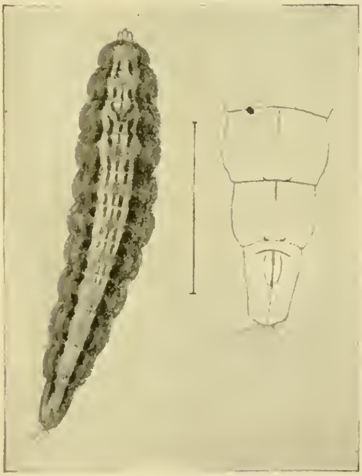
Plate XIV.



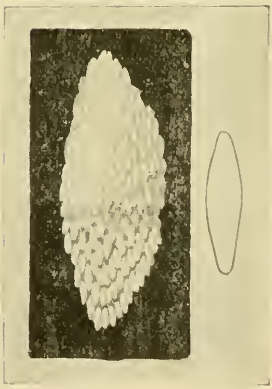
57



60



59



58

Plate XV.

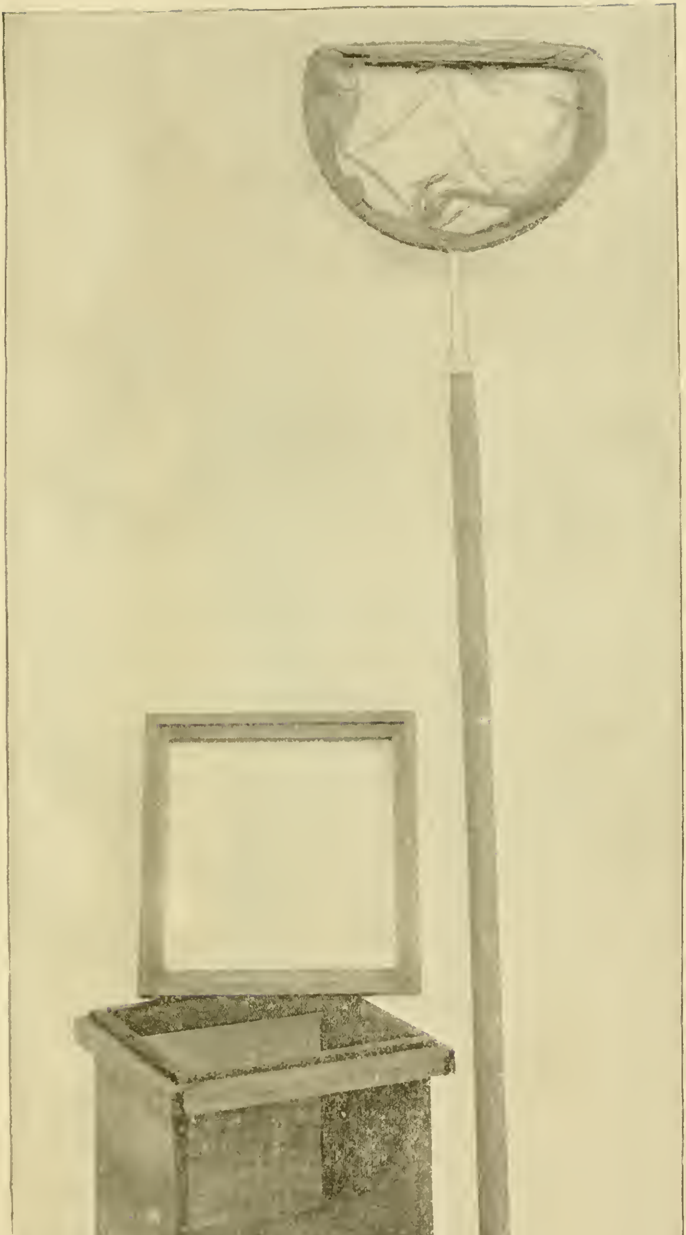


PLATE XVI.

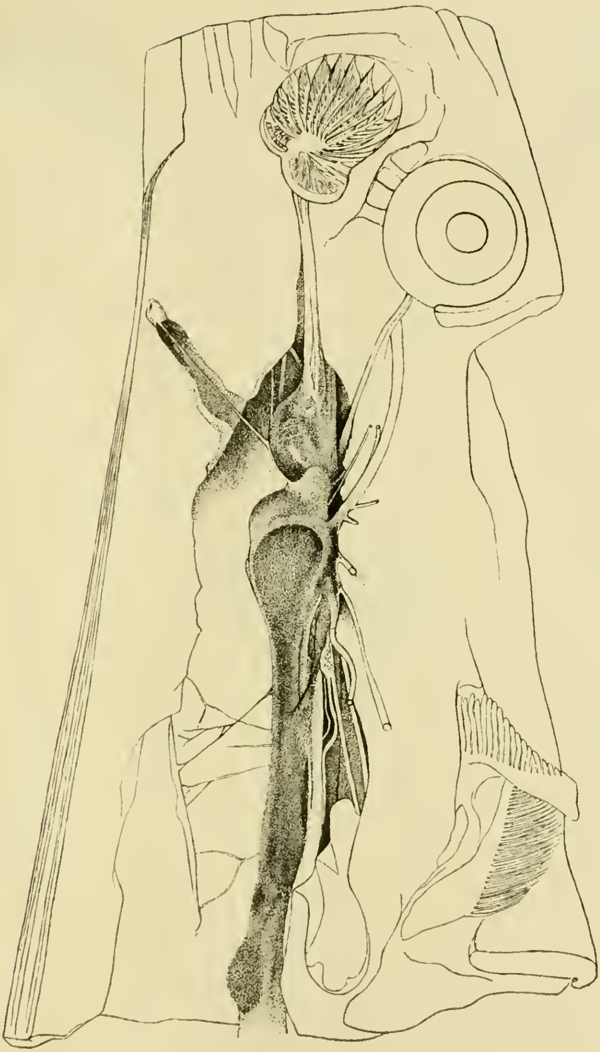


Fig. 1.

PLATE XVII.

Fig. 2.

Plate XVIII.

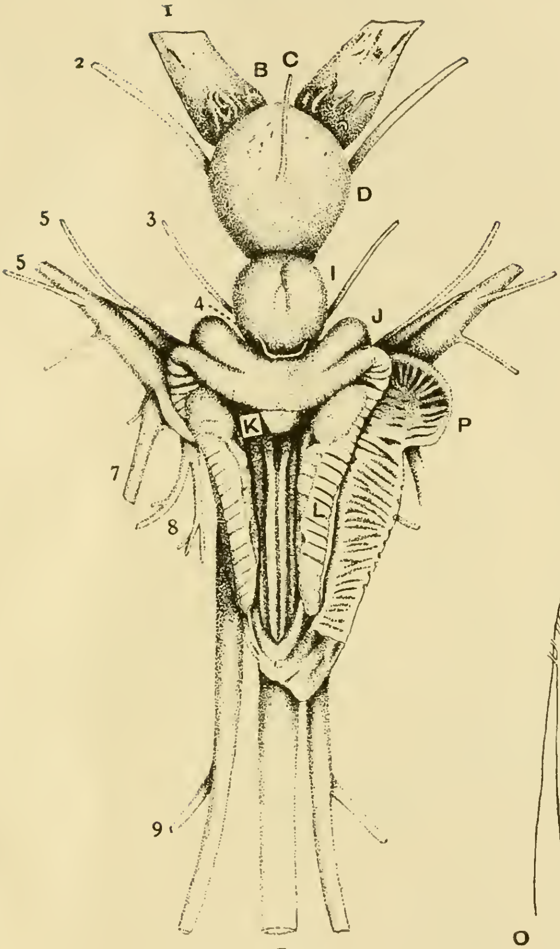


Fig. 3.

Fig. 4.

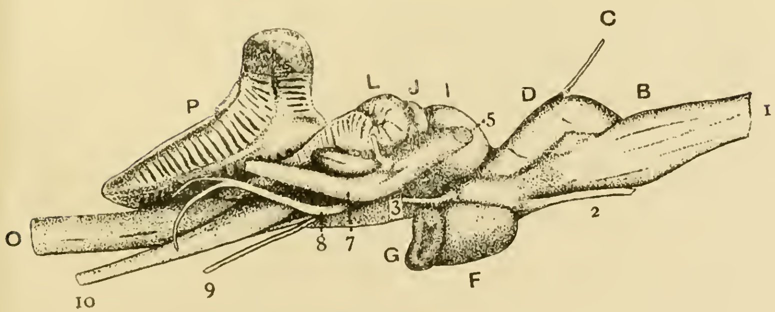


Fig. 5.

PLATE XIX.

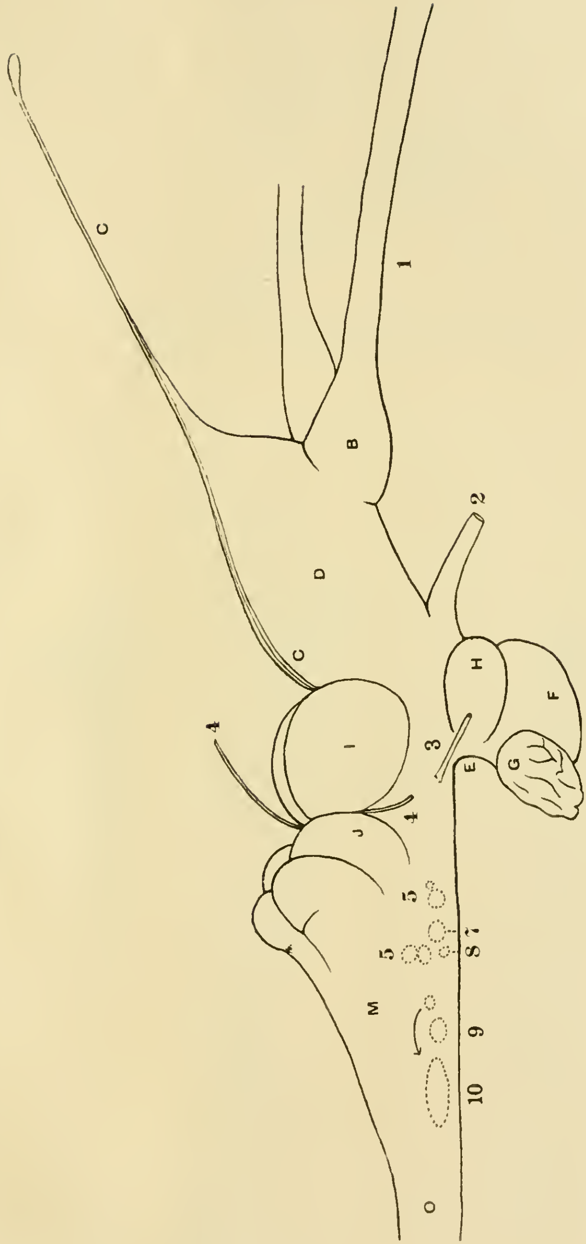


Fig. 6.

Plate XX.

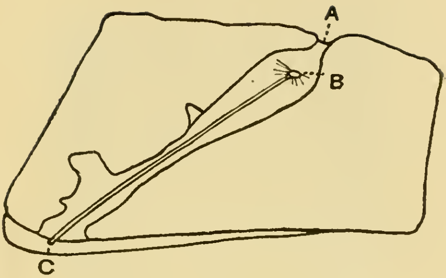


Fig. 7.

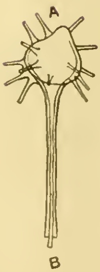


Fig. 8.

Fig. 9.

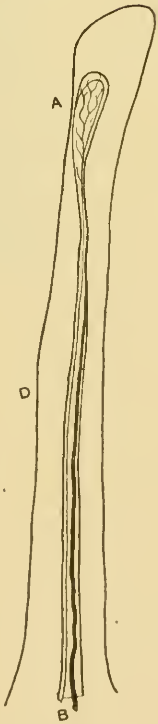


Fig. 10.

PLATE XXI.

Fig. 11.

PLATE XXII.

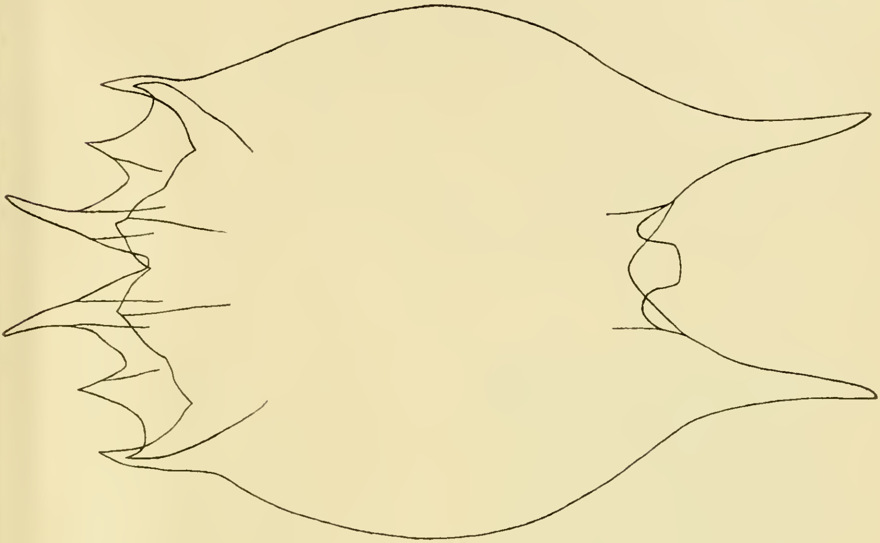


Fig. 1.

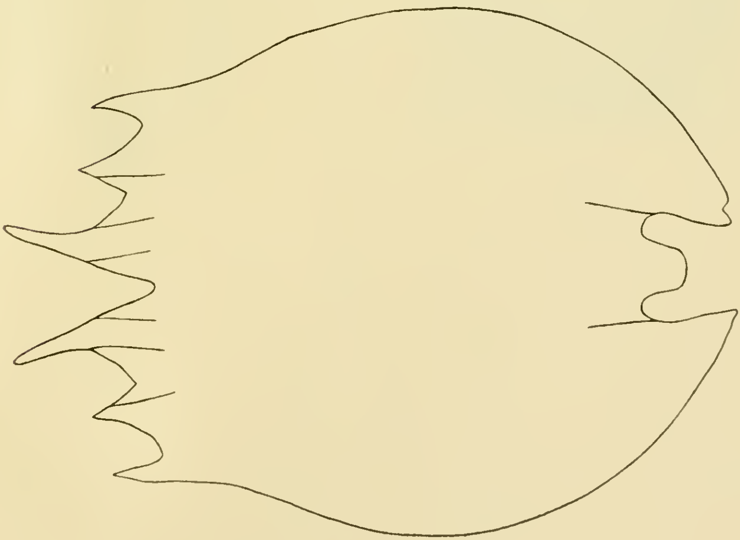


Fig. 2.

Plate XXIII.

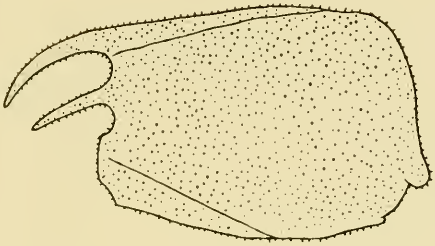


Fig. 3.

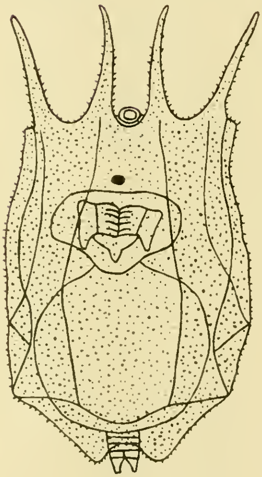


Fig. 4.

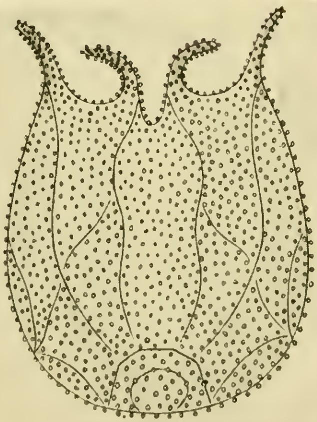


Fig. 6.

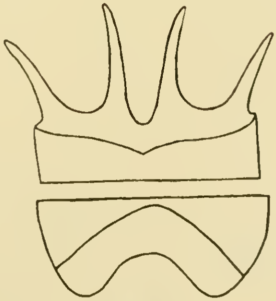


Fig. 5.

PLATE XXIV.

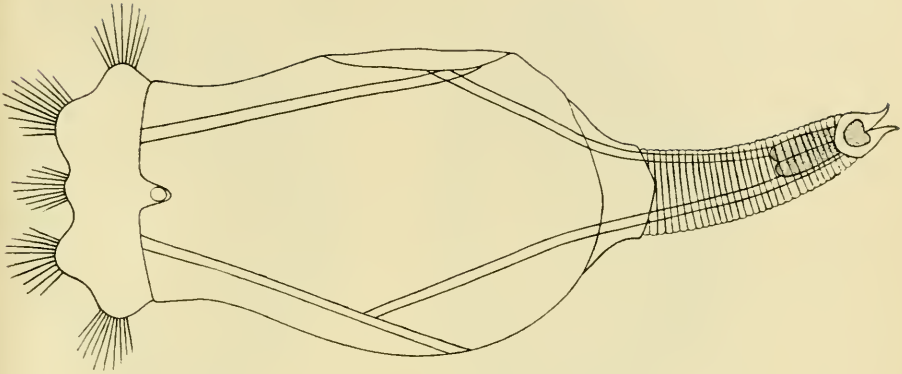


Fig. 7.

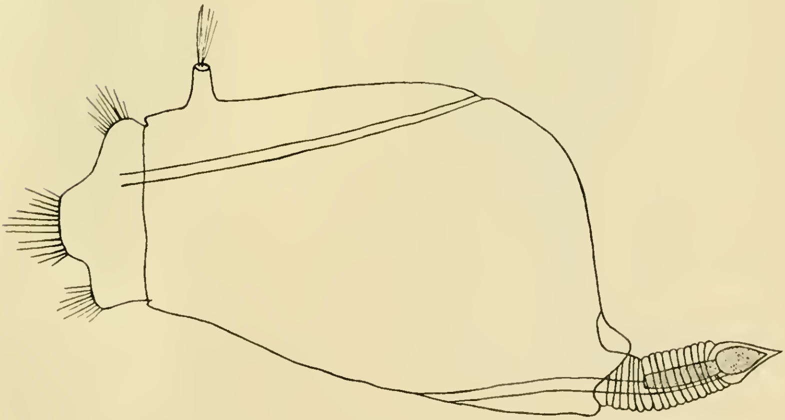


Fig. 8.

Plate XXV.

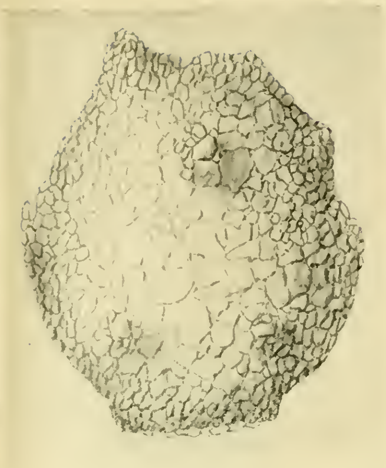


Fig. 9.

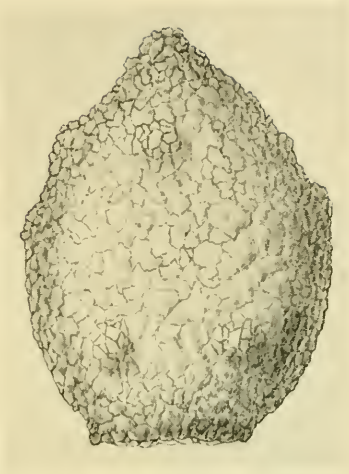


Fig. 10.

Fig. 11.

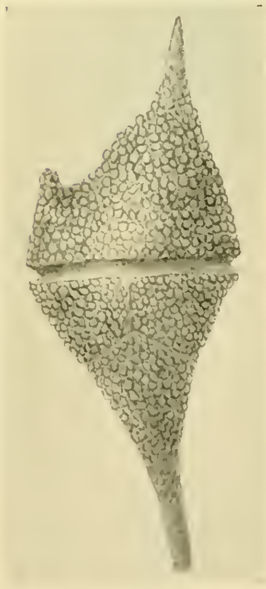


Fig. 12.

Plate XXVI.

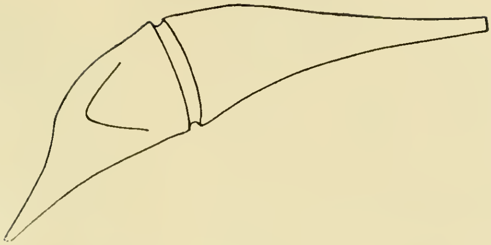


Fig. 13.

Fig. 14.

Fig. 15.

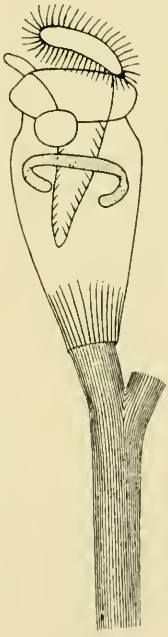


Fig. 17.

Fig. 16.

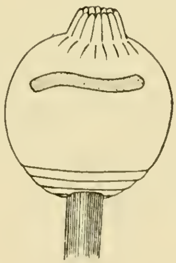


Fig. 18.

Plate XXVII.

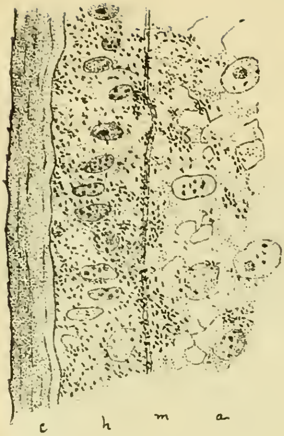


Fig. 2.

Fig. 3.

Fig. 1.

Fig. 4.

PLATE XXVIII.

Fig. 5.

Plate XXIX.

Fig. 1.

Fig. 3.

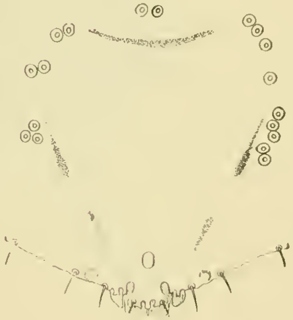


Fig. 4.

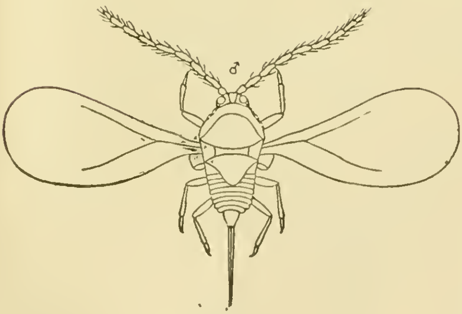


Fig. 2.

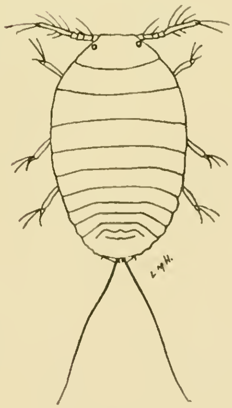


Fig. 5.

PLATE XXX.

Fig. 1.

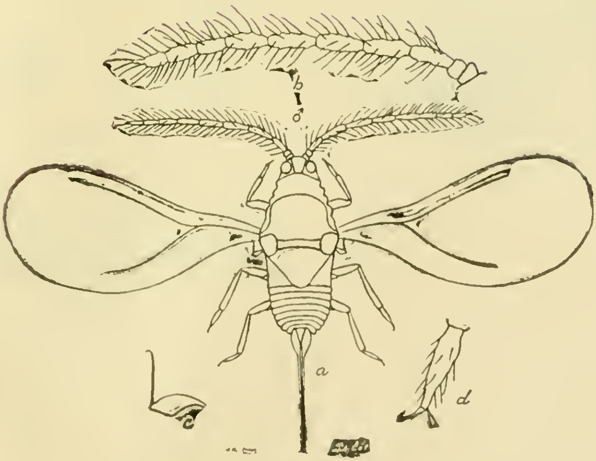


Fig. 2.

Plate XXXI.

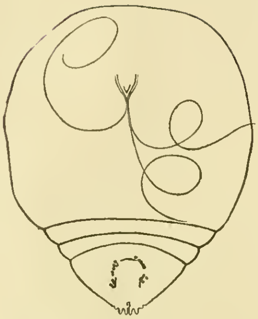


Fig. 1.

Fig. 2.

Fig. 3.

PLATE XXXII

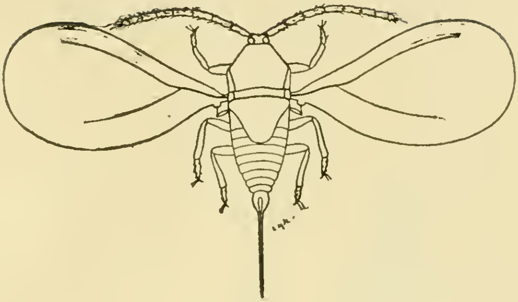


Fig. 1.

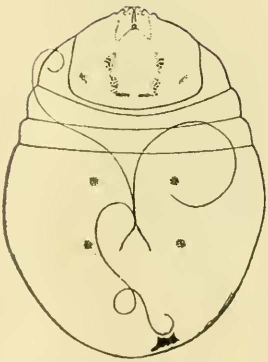


Fig. 2.

Fig. 3.

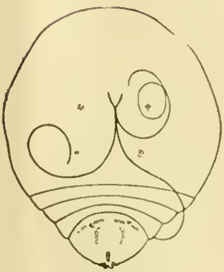


Fig. 4.

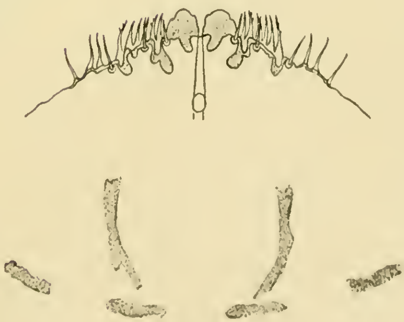


Fig. 5.

Plate XXXIII.

Fig. 1.

Plate XXXIV.

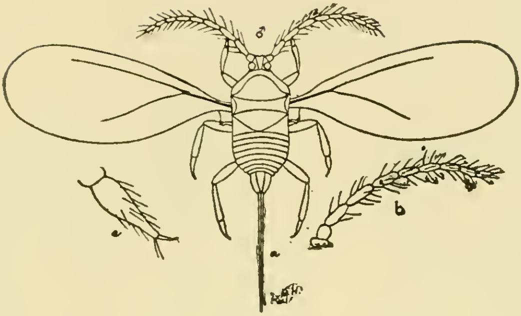


Fig. 1.

Fig. 2.

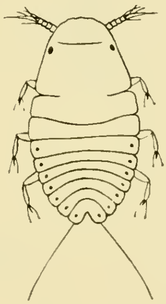


Fig. 3.

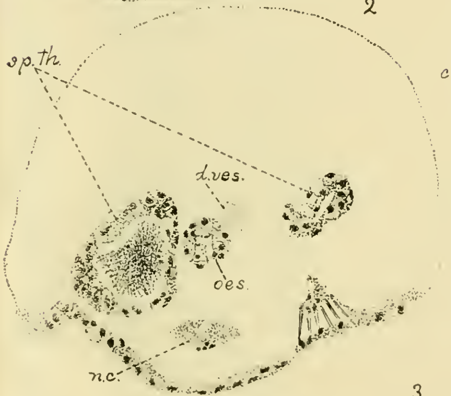
Fig. 4.

Fig. 5.

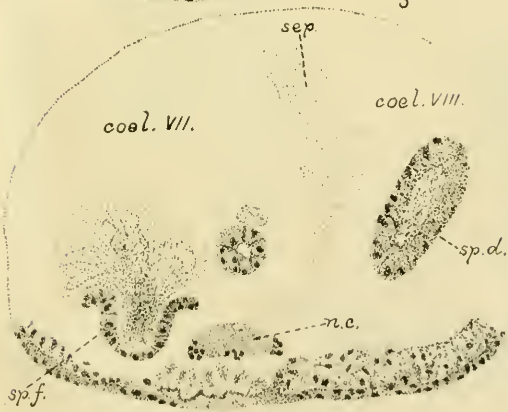
PLATE XXXV.

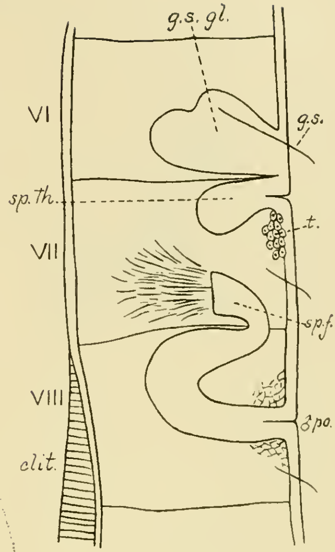
1

2



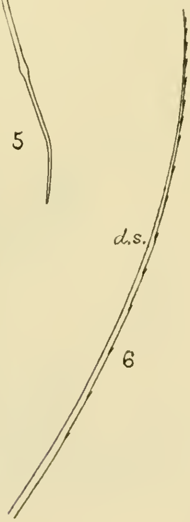
3





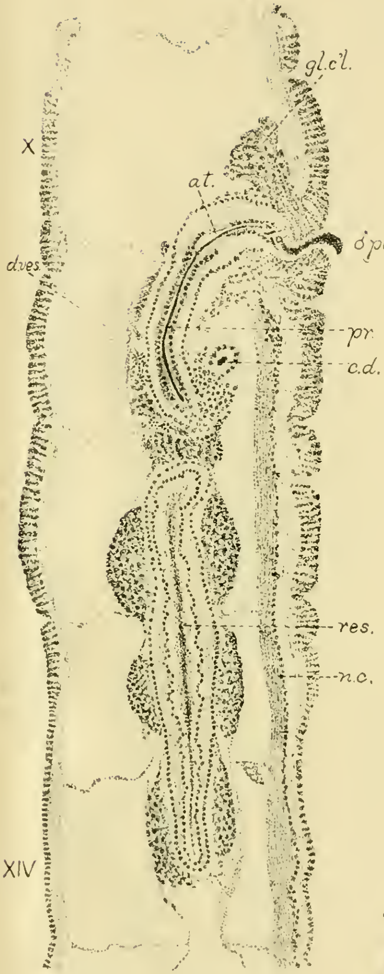
4

5



6

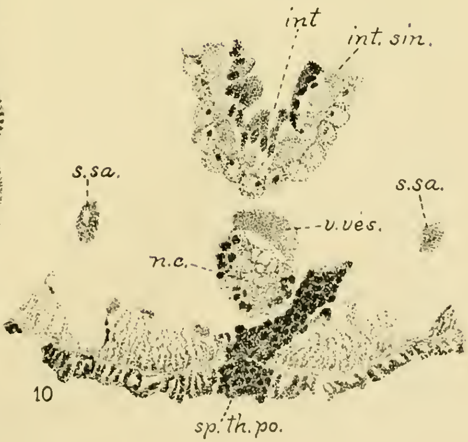
Plate XXXVI.



7

8

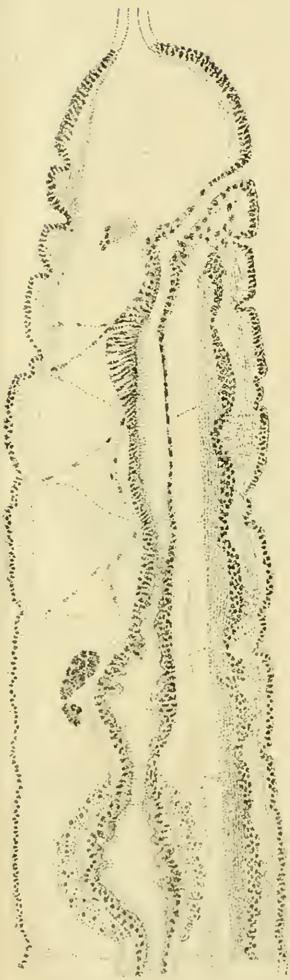
9



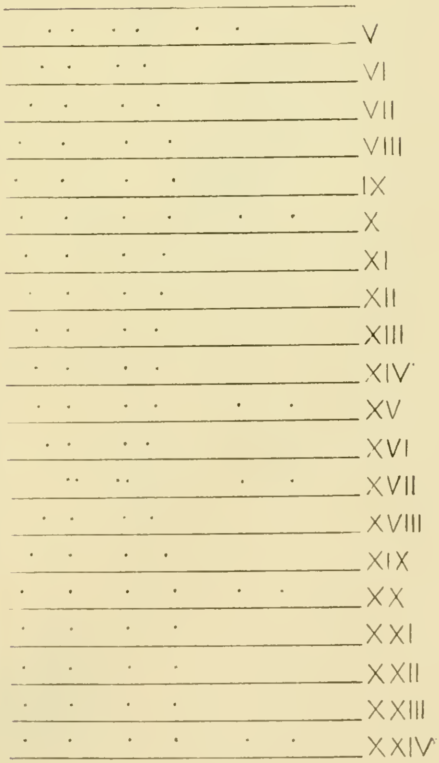
10

Plate XXXVII.

12



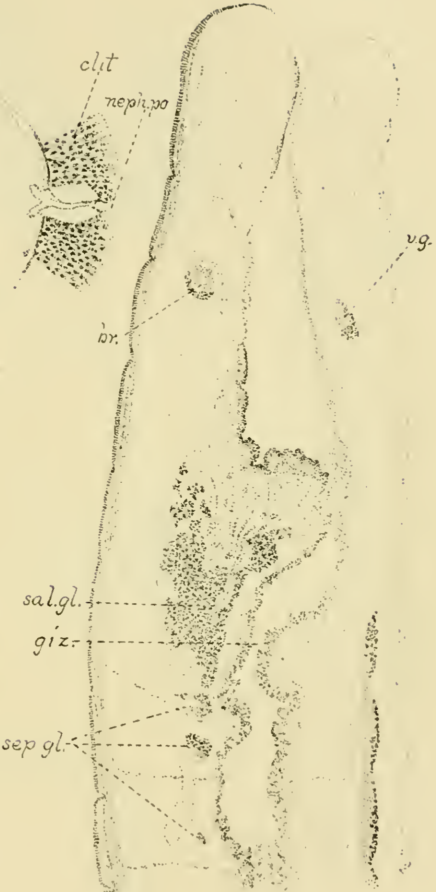
11



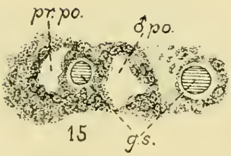
13

Plate XXXVIII.

14



17



15

16

Plate XXXIX.

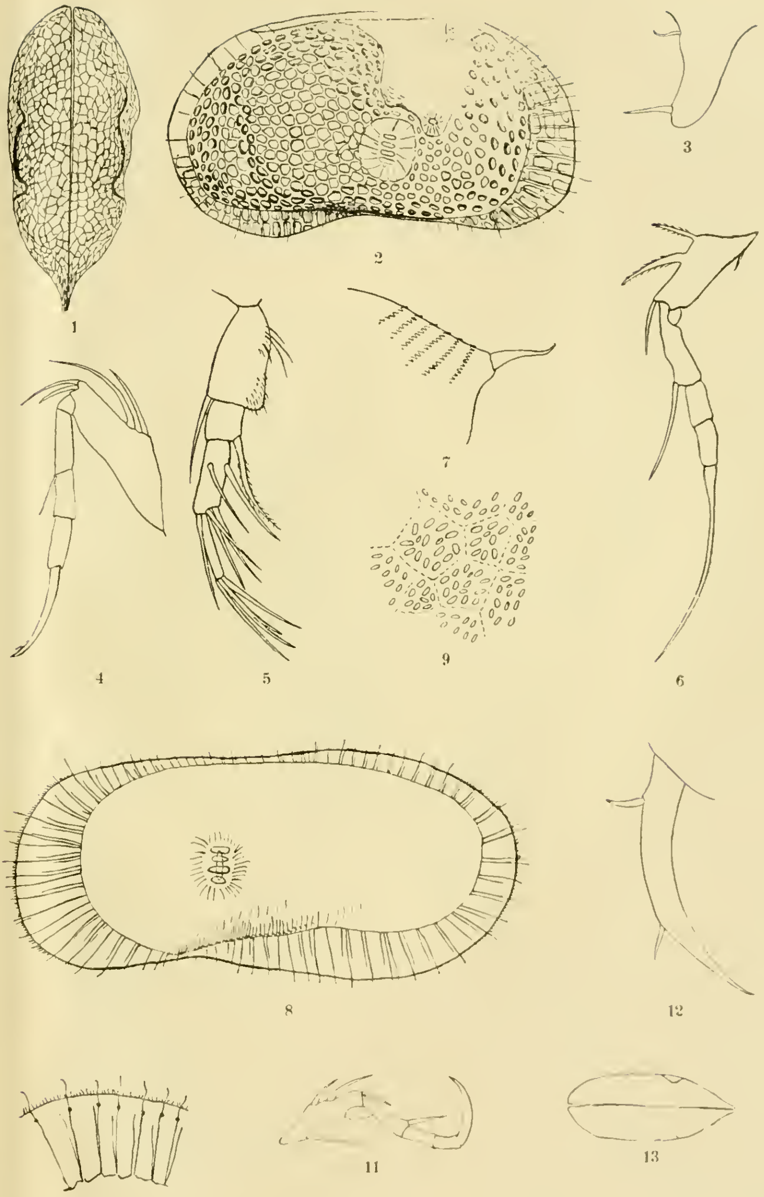
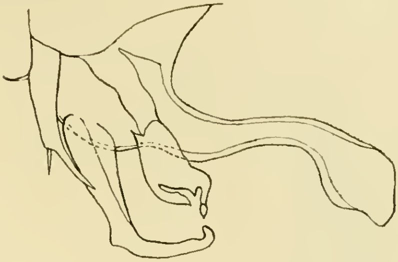


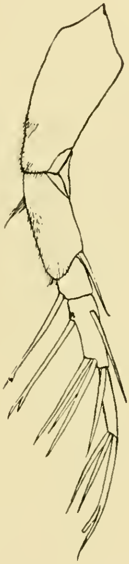
Plate XL.

1

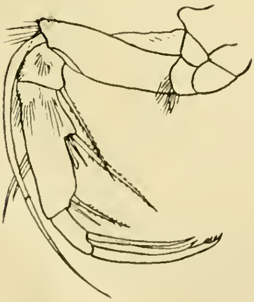


2

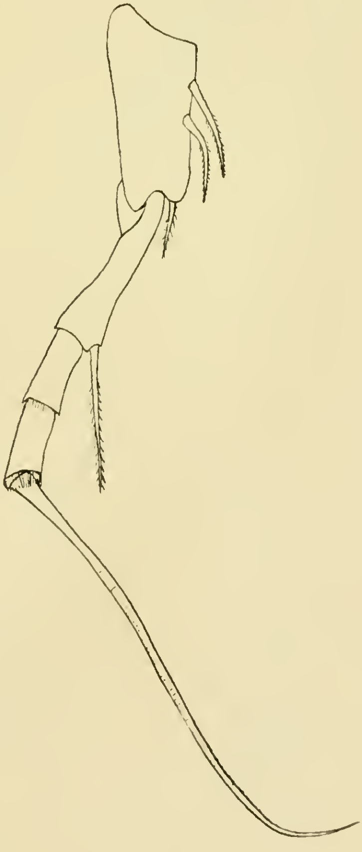
3



6

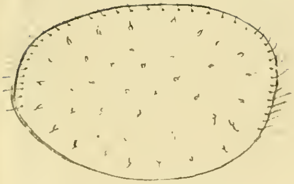


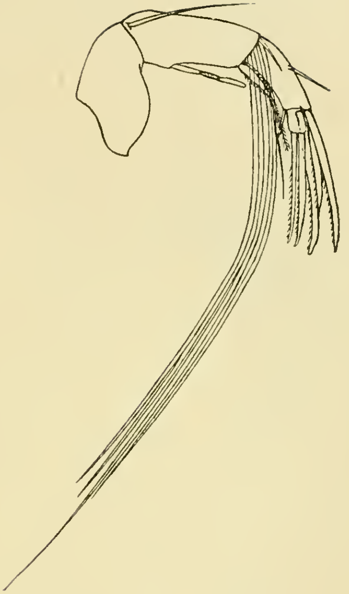
5

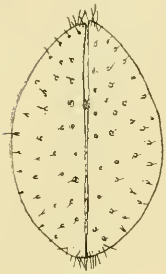


4

Plate XLI.


1


3


2

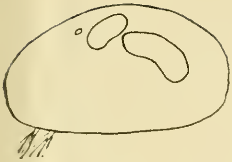

4


6

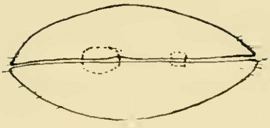

7


5

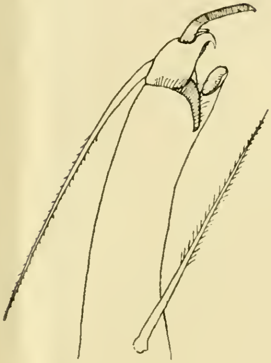
Plate XLII.



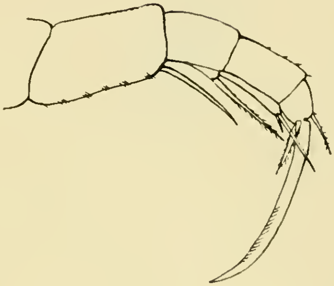
1



2



5

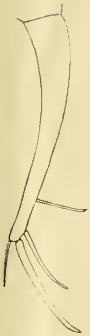


4

6

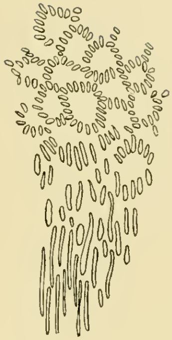
7

Plate XLIII.

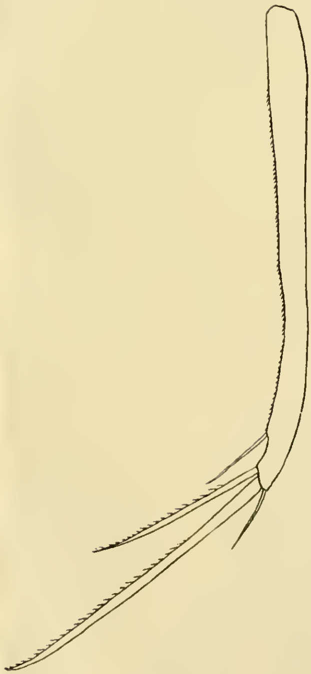


1

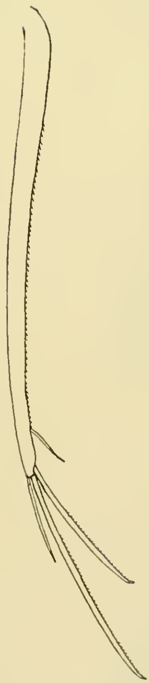
2



3



4



5

Plate XLIV.

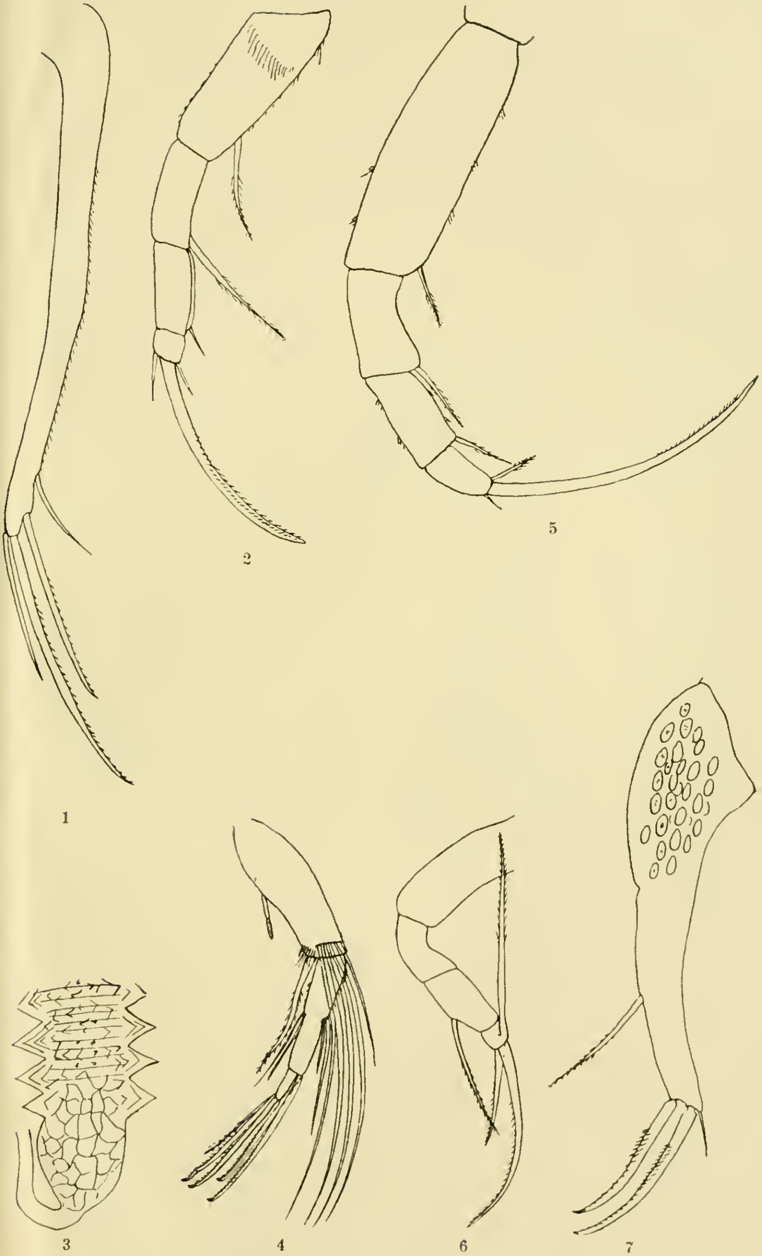


Plate XLV.

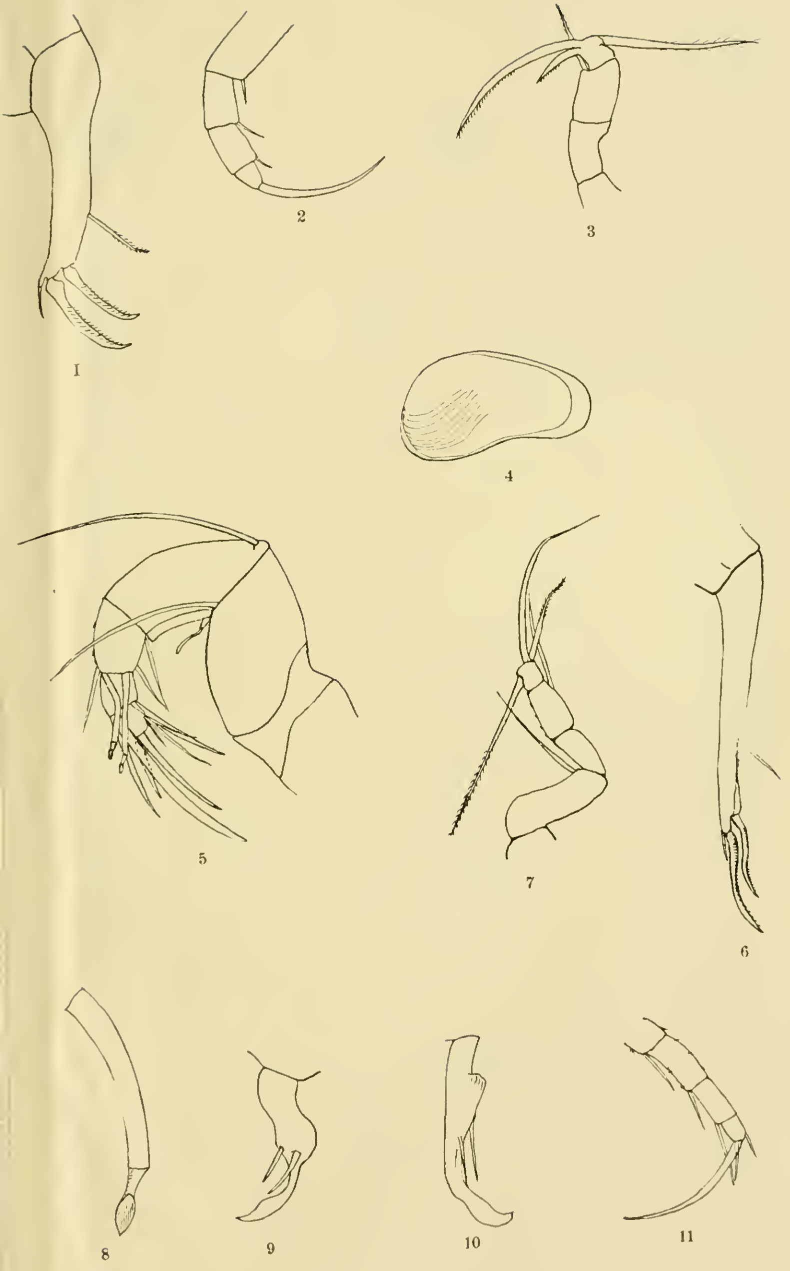


PLATE XLVI.

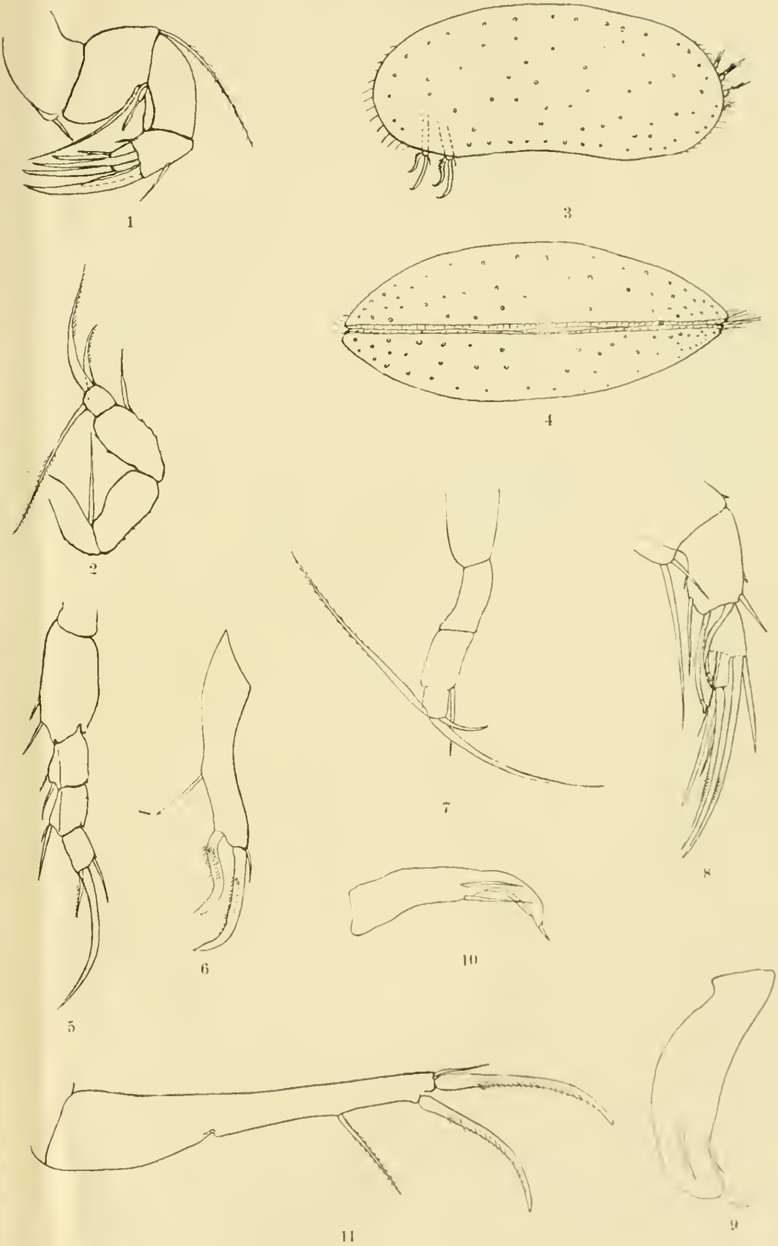


Plate XLVII.

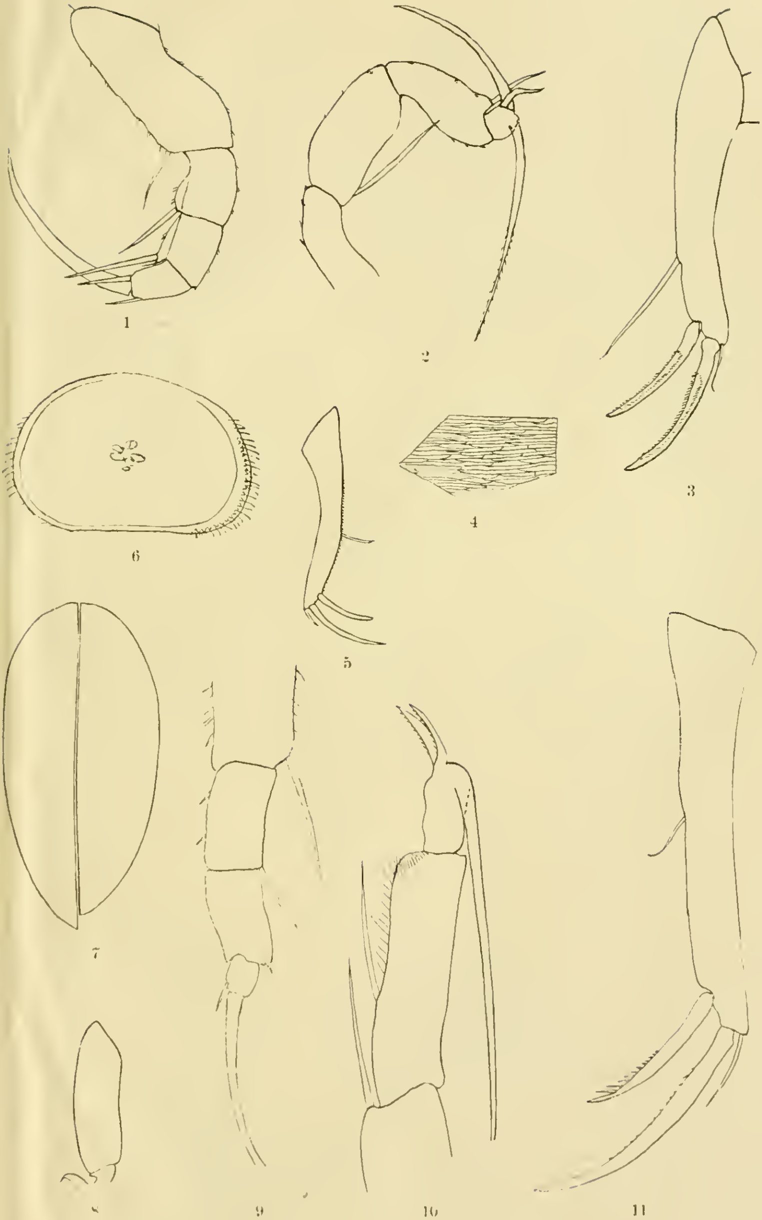


PLATE XLVIII.