

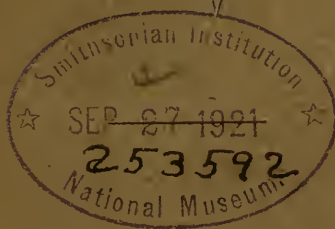
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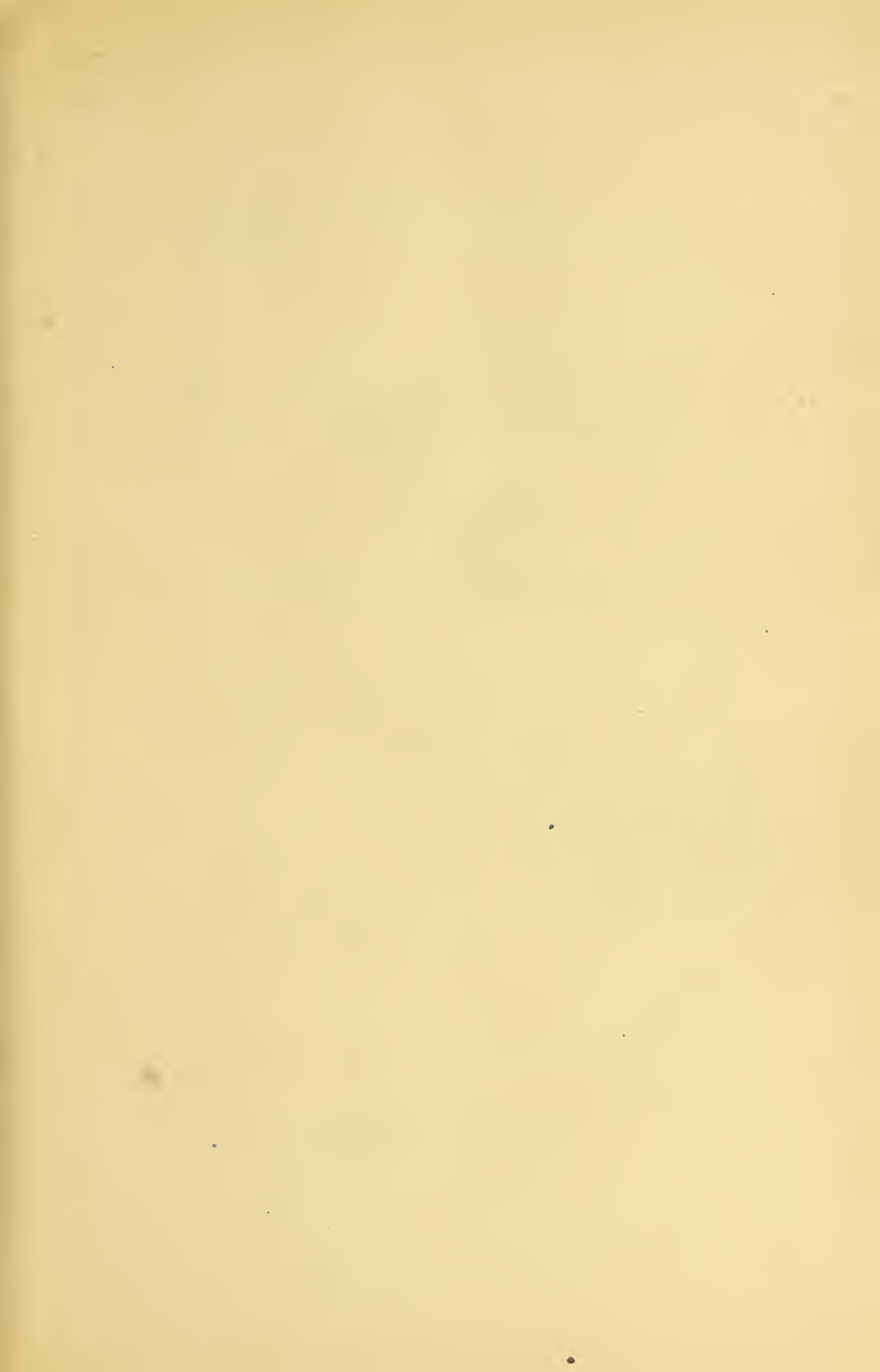
THE CRANE-FLIES OF NEW YORK  
PART II. BIOLOGY AND PHYLOGENY

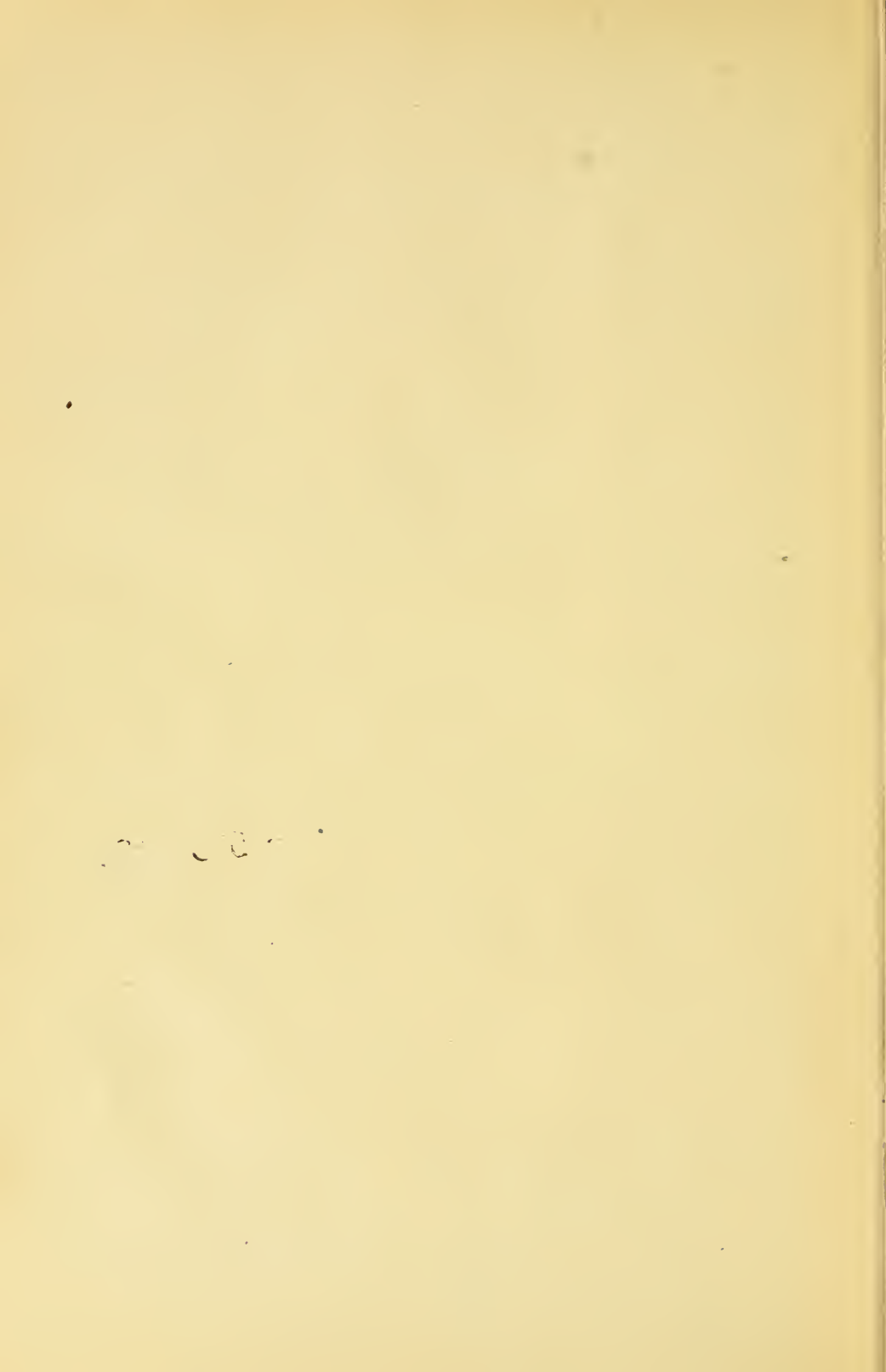
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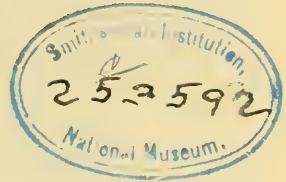


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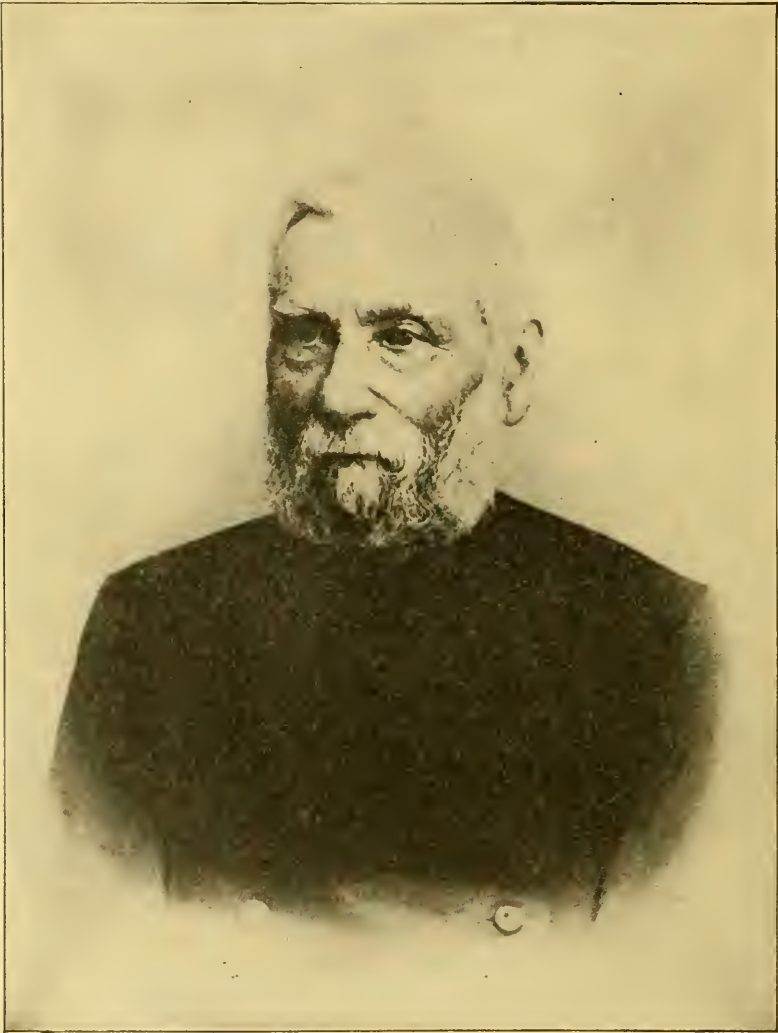
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THEODOR BELING  
(1816-1898)

## KARL WILHELM THEODOR BELING

No sketch of the life of Theodor Beling, the great German student of the immature stages of the Tipuloidea, has ever appeared in English. It was with considerable difficulty that the writer was able to get into communication with relatives and friends of Beling and obtain the data presented herewith.\*

Theodor Beling was born at Steterburg, in the Duchy of Brunswick, Germany, on March 26, 1816. He was a son of the district forester. From 1828 to 1834 he attended school at Wolfenbüttel. At Easter, 1834, he began his chosen career as a forester, having served his prescribed apprenticeship of two years with his father at Danndorf. He attended the Royal Saxon Academy at Tharand from 1836 to 1837, and in the following year visited the University of Göttingen to round out his technical training in various branches relating to forestry. Beling's career as a forester extends from Easter, 1834, to October 1, 1858, when he was officially retired with a pension. In April, 1861, he was made Master of the Forest, a position which he held until his retirement.

After his retirement from active public service, Beling long continued his vigorous researches afield and at home. When far advanced in years, he went alone on long trips to seek new stations for plants and to observe animal life in wood and field. He died on December 17, 1898, at Seesen, where much of his finest work was accomplished.

During his lifetime Beling published one hundred and seven articles. The series of three papers which rank him as a pioneer in the field of crane-fly biology were published in the years 1873, 1879, and 1886, respectively. In these papers the histories of sixty-nine species of crane-flies are discussed in detail, and brief notes on five additional species are included. The other published articles of Beling cover a remarkable range of subjects relating directly or indirectly to the science of forestry. His most important researches on the life histories of insects, in addition to those on the Tipuloidea, are on the coleopterous families Parnidae and Elateridae. His published articles are dated between 1850 and 1888, but practically all of his entomological studies were published in the seventies and eighties.

Beling's excellent collection of dried plants, mounted birds, and sections of various woods, and his cabinet of insects — the last-named including the types of several species described by himself and by others — are preserved in the collection of the Natural History Museum at Brunswick. It is understood that the insects in this collection, including the alcoholic larvae and pupae of the Tipuloidea, are still in excellent condition.

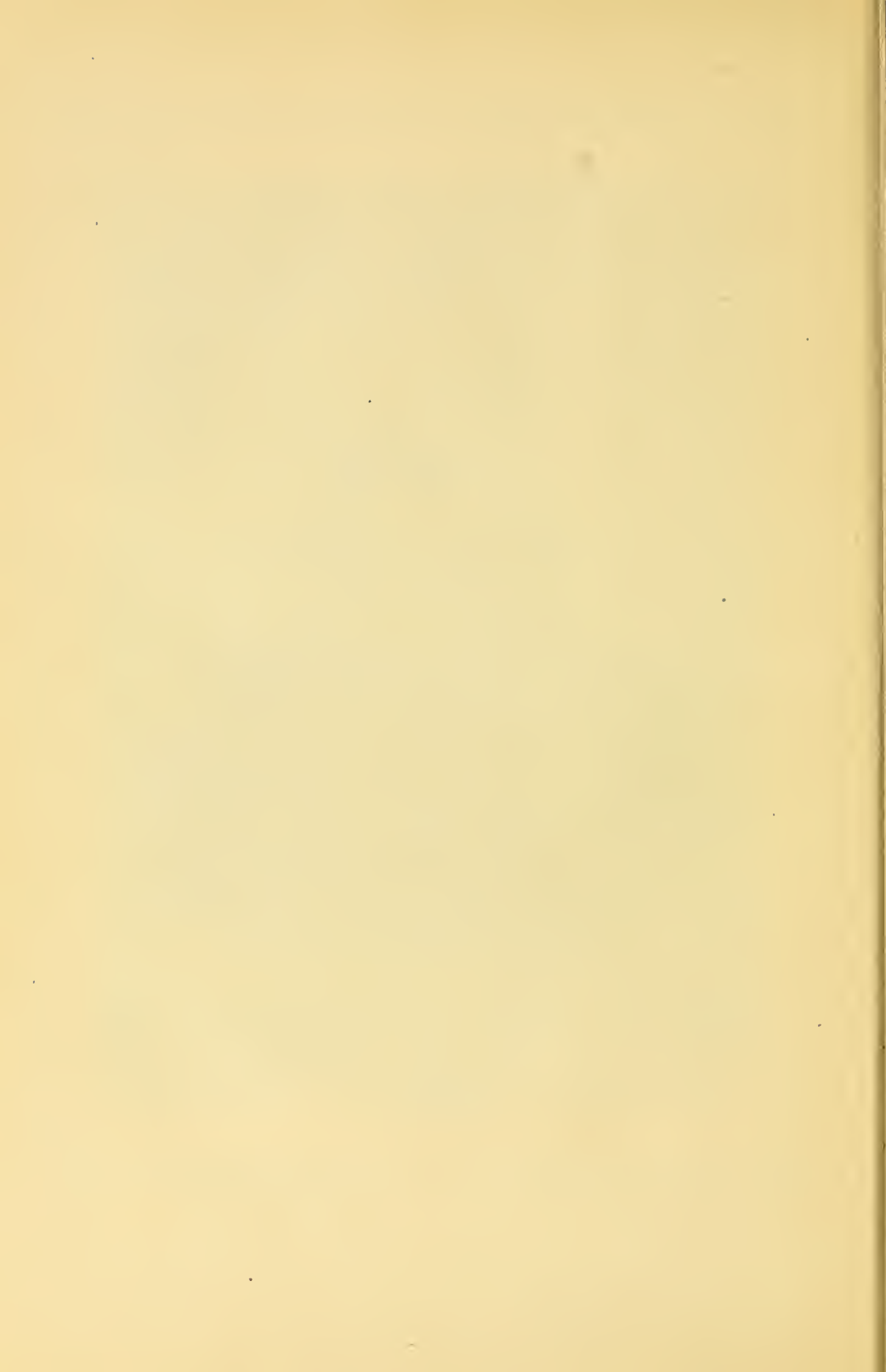
\* Sincere thanks are here extended to the following persons, who have added materially to the value of this biographical notice:

Landesforstmeister K. Block, son-in-law of Beling, who published in April, 1899 (in *Allgemeinen Forst- und Jagd-Zeitung*), a complete obituary notice relating to his father-in-law, and to whom the writer is indebted for several additional unpublished notes and for the loan of the excellent portrait of Beling reproduced herewith.

J. Meerwartz, Director of the Natural History Museum at Brunswick, who has furnished data concerning the present condition of the collection of the immature stages of the Tipuloidea described by Beling, now preserved in the above-mentioned institution.

William Prindle Alexander and Elsa Müller Alexander, who have rendered valuable service in translating the account of Beling's life.





## CONTENTS

	PAGE
General considerations.....	704
Representative crane-fly life histories.....	704
<i>Eriocera longicornis</i> (Walk.).....	704
<i>Cylindrotoma splendens</i> Doane.....	708
Life activities of crane-flies.....	710
The adult.....	710
The egg.....	714
The larva.....	715
The pupa.....	719
Enemies.....	721
Predatory natural enemies.....	721
Vertebrates.....	721
Invertebrates.....	727
Parasitic natural enemies.....	730
External parasites.....	730
Internal parasites.....	733
Historical summary of the immature stages.....	735
Economic importance.....	736
Species affecting herbaceous plants.....	737
Species affecting woody plants.....	739
Methods of experimental procedure.....	740
Collecting.....	740
Killing and preserving.....	740
Study.....	741
Rearing.....	741
Types of the immature stages.....	743
External morphology.....	744
The larva.....	744
General features.....	744
Body form.....	745
Organs of respiration.....	746
The spiracular disk.....	746
Anal gills.....	748
The head.....	748
The pupa.....	752
General features.....	752
The head.....	753
The thorax.....	754
The abdomen.....	756
Internal morphology.....	758
The digestive system.....	758
Herbivorous larvae.....	758
Carnivorous larvae.....	759
Respiration and circulation.....	760
The nervous system.....	762
The reproductive system.....	762
The muscular system.....	763
The fat bodies, or adipose tissue.....	763
The imaginal disks, or histoblasts.....	763

	PAGE
Phylogeny.....	763
The geological record.....	764
Comparative morphology.....	766
Phylogenetic considerations.....	766
Life histories of crane-flies, with keys and descriptions of the species.....	767
Family Tanyderidae.....	769
Family Ptychopteridae.....	772
Subfamily Ptychopterinae.....	773
Subfamily Bittacomorphinae.....	779
Family Rhyphidae.....	787
Subfamily Trichocerinae.....	789
Family Tipulidae.....	791
Subfamily Limnobiinae.....	793
Tribe Limnobiini.....	795
Subtribe Antocharia.....	799
Subtribe Ellipteraria.....	806
Subtribe Limnobaria.....	808
Subtribe Dieranoptycharia.....	828
Subtribe Rhamphidaria.....	830
Tribe Hexatomini.....	835
Subtribe Ularia.....	838
Subtribe Epiphragmaria.....	843
Subtribe Pseudolimnophilaria.....	848
Subtribe Dactylolabaria.....	852
Subtribe Limnophilaria.....	856
Subtribe Hexatomaria.....	876
Subtribe Polymeraria.....	893
Tribe Pediciini.....	894
Subtribe Adelphomyaria.....	895
Subtribe Pedicaria.....	899
Tribe Eriopterini.....	908
Subtribe Eriopteraria.....	911
Subtribe Elephantomyaria.....	952
Tribe Styringomyiini.....	957
Subfamily Cylindrotominae.....	959
Subfamily Tipulinae.....	974
Tribe Tipulini.....	981
Subtribe Dolichopezaria.....	981
Subtribe Ctenophoraria.....	986
Subtribe Tipularia.....	990
Bibliography and references cited.....	1019
Index.....	1129

THE CRANE-FLIES OF NEW YORK  
PART II. BIOLOGY AND PHYLOGENY



## THE CRANE-FLIES OF NEW YORK

### PART II. BIOLOGY AND PHYLOGENY<sup>1</sup>

CHARLES PAUL ALEXANDER

A preliminary classification of the immature stages of the Tipulidae and related families, suggested to the writer by Dr. J. G. Needham in 1911, is presented in this memoir. But few of the sixty-odd families of Diptera, and comparatively few species of the Tipulidae, have as yet been studied from this viewpoint, and therefore the arrangement herein adopted must be considered as tentative. The majority of the specimens used in the study were reared in New York State, the crane-fly fauna of which is typical of a great area throught northeastern North America. In 1913, thru the kindness of Dr. Charles D. Woods and Dr. Edith M. Patch, the writer was enabled to continue his investigations in Maine.

It is the writer's purpose to outline the morphological characters available for the classification of the larvae and the pupae, and to give preliminary keys for the separation of the various groups; such keys will, of necessity, require constant revision or complete remodeling with the accession of new life-history material, but it is at least hoped that they may furnish a basis for future investigation. The most important work on the European fauna, that of Theodor Beling (1873 to 1887),<sup>2</sup> is rendered incomplete by the total lack of illustration, the insufficiency of description of the details of the larval head, and the artificial nature of the keys. That this difficulty in using Beling's figureless descriptions is not confined to the writer is shown by the following criticism by one of his fellow-countrymen (Czizek, 1911:7):

"Leider fehlen uns bis jetzt fast vollständig gute Abbildungen der Larven und Puppen, ein fühlbarer Mangel auch in Beling's Abhandlungen, da die genaueste Beschreibung das Bild nie ganz zu ersetzen vermag."

It is intended to include in this paper the following material:

1. Descriptions of all new life-history material available, with notes on the biology and occurrence of the species.

<sup>1</sup>Part I of *The Crane-Flies of New York*, dealing with distribution and taxonomy of the adult flies, was published in 1919 as Memoir 25 of the Cornell University Agricultural Experiment Station.

<sup>2</sup>Dates in parenthesis refer to *Bibliography and References Cited*, page 1019.

2. Brief summaries of published life histories of genera and important species not available for study as specimens and included here to complete the data.

3. Summaries and tabulations of life-history records, larval habitats, economic importance, and related subjects.

4. Keys to the families, tribes, and lesser groups.

The adult flies are not here considered in any detail, since they have been discussed by the writer in an earlier paper (Alexander, 1919 d).

The life histories remaining to be discovered in the Nearctic fauna are still numerous in species, tho few in genera. There are but four or five genera whose life histories when made known may upset the present ideas on arrangement. Until more is known of these missing groups, they must be classified according to the adult structure.

It will be noted that a number of important changes in nomenclature have been adopted in this paper. The system hitherto in vogue, based entirely on the structure of the imagines, was conceived by Osten Sacken and represented the culmination of research on the structure and affinities of the adult flies. A casual survey of the immature stages is sufficient to show the impossibility of many of the groups hitherto generally accepted. The principal modifications adopted in this paper are as follows:

1. The erection of the family Tanyderidae to receive the genera *Tanyderus* and *Protoplasa*. These had hitherto been placed with the *Ptychopteridae*, a group to which they are not closely allied.

2. The removal of the genus *Trichocera* from the *Tipulidae* to the *Rhyphidae*, and the inclusion of the latter family as one of the four existing families of crane-flies.

3. In the *Tipulidae*, the elimination of four tribes — *Antochini*, *Limnophilini*, *Dolichopezini*, and *Ctenophorini* — as being based on a conglomeration of forms referable to other tribes or else separated on an insufficient basis. The former tribe *Antochini* included members which the writer now refers to the *Limnobiini* (*Antocha*, *Rhamphidia*, *Dicranoptycha*, and other genera) and to the *Eriopterini* (*Teucholabis*, *Elephantomyia*); the *Limnophilini* are too close to the *Hexatomini*; and the tipuline forms constitute a very compact group which cannot well be subdivided into tribes.

4. The erection of nineteen subtribes, or divisions, to include lesser groups of genera within the tribes. In the following pages these are

treated in what seems to be their phylogenetic sequence from the generalized to the specialized.

The arrangement of families, subfamilies, and lesser groups may be summarized as follows:

Families	Subfamilies	Tribes	Subtribes	Representative genera
Eoptychopteridae (fossil)				Eoptycheptera
Architipulidae (fossil)				Architipula
Tanyderidae				Tanyderus
Ptychopteridae	Ptychopterinae			Protoplasa
	Bittacomorphinae			Ptychoptera Bittacomorpha Bittacomorphella
Rhyphidae	Rhyphinae			Rhyphus
	Mycetobiinae			Mycetobia
	Trichocerinae			Trichocera
Tipulidae	Limnobiinae	Limnobiini	Antocharia	Antocharia
			Ellipteraria	Elliptera
			Limnobia	Limnobia
			Dieranomyia	Dieranomyia
			Dieranoptycharia	Dieranoptycha
			Rhamphidaria	Rhamphidia
		Ularia	Ula	
		Epiphragmaria	Epiphragma	
		Pseudolimnophilaria	Pseudolimnophila	
		Dactylolabaria	Dactylolabis	
		Hexatomini	Limnophilaria	Limnophila Ulomorpha
			Hexatomaria	Eriocera
Hexatoma	Hexatoma			
Polymeraria	Polymera			
Adelphomyaria	Adelphomyia			
Pedicaria	Pedicia			
Eriopterini	Erioptera	Erioptera		
	Ormosia	Ormosia		
Styringomyiini	Elephantomyia	Elephantomyia		
	Styringomyia	Styringomyia		
Cylindrotominae			Cylindrotoma Phalacrocera	
Tipulinae	Tipulini	Dolichozeptaria	Dolichozepta Brachypremna	
		Ctenophoraria	Ctenophora	
		Tanyptera	Tanyptera	
		Tipularia	Tipula Nephrotoma	



A permanent series of the immature stages of the species studied has been carefully preserved in the writer's collection, while additional material has been placed in the principal collections of the United States. A series of two hundred and seventy microscope slides showing details of structure of the larvae and the pupae has been prepared, representing some seventy species arranged in forty genera. The typical larvae and pupae (*nepionotypes* and *neanotypes*) have been designated and preserved in alcohol for future reference.

For the most part, the life histories discussed in this paper have not been described hitherto. Besides the reared material, the writer has in his collection a very large number of unknown larvae and pupae, many of them representing interesting and undescribed types. In this paper but three or four of these are considered, and these only because they introduce new features of organization (Eriopterine No. 1, Tipulini No. 1 and No. 2).

A vast amount of work remains to be done on the immature stages of crane-flies. Exact, detailed life histories of individual genera and species are especially needed and the reward for effort will undoubtedly be great. Nothing is known of the tropical and the antipodal faunas, and their life histories will probably be unraveled but slowly, due to the inaccessibility of most of the regions.

The majority of specimens studied in the preparation of this paper were reared by the writer during the past nine years. Many specimens were received from various sources, however, including many of the most desirable life histories, and these are herewith gratefully acknowledged:

Dr. James G. Needham, Ithaca, New York. The extensive collections received from Dr. Needham include the material described in the various Adirondack reports, as well as numerous previously unrecorded specimens. In addition, the writer has accompanied Dr. Needham on many of his field trips in quest of the immature stages of aquatic insects, and has received much encouragement and inspiration from this association.

Charles W. Johnson, Boston, Massachusetts. Immature stages of *Aeshnasoma*, *Elephantomyia*, *Teucholabis*, and other species.

The late Frederick Knab, Washington, D. C. Immature stages of *Rhipidia bryanti*, *Elephantomyia*, *Epiphragma solatrix*, and other species.

J. A. Hyslop, Hagerstown, Maryland. *Longurio* (larvae), *Oropeza*, *Gnophomyia*.

J. R. Malloch, Urbana, Illinois. *Rhipidia bryanti*.

C. T. Greene, Washington, D. C. *Protoplasa* (supposition).

H. L. Viereck, Washington, D. C. *Protoplasa* (supposition).

W. L. McAtee, Washington, D. C. *Protoplasa* (supposition); numerous larvae from the Pribilof Islands.

William Lundbeck, Copenhagen, Denmark. *Helobia* and other species.

Dr. C. Wesenberg-Lund, Hillerød, Denmark. *Phalacropera*, *Ptychoptera paludosa*, *Tipula mazima*, and other species.

- William G. Dietz, Hazleton, Pennsylvania. Notes on larvae of *Dicranomyia macateei* Alex.  
 Oskar A. Johannsen, Ithaca, New York. *Limnobia fallax*, and other species.  
 Carl Ilg, Philadelphia, Pennsylvania. Notes on *Rhipidia fidelis*.  
 O. H. Swezey, Honolulu, Hawaii. Notes on Libnotes and Styringomyia.  
 H. K. Munro, Pretoria, Transvaal. Notes on Trentepohlia and Styringomyia.  
 Charles Bruch, La Plata, Argentina. Notes on Trimicra, Helobia, and Epiphragma.  
 D. B. Young, Albany, New York. Notes on Gnophomyia.  
 J. T. Lloyd, Cincinnati, Ohio. Eriocera.  
 The late C. Gordon Hewitt, Ottawa, Canada. The Canadian-Arctic Tipulidae, including *Tipula arctica*.  
 A. E. Cameron, Ottawa, Canada. *Cylindrotoma splendens*.  
 R. C. Shannon, Ithaca, New York. Elephantomyia, Brachypremna, *Tipula fuliginosa*, and other species.  
 J. Speed Rogers, Grinnell, Iowa. Notes on *Phalacrocera tipulina*.  
 Harold Morrison, Washington, D. C. Holorusia, and *Tipula usitata*.  
 C. Hamilton Kennedy, Columbus, Ohio. Prionocera and Rhamphidia.  
 J. Chester Bradley, Ithaca, New York. Longurio.  
 H. S. Barber, Washington, D. C. Oropeza.  
 Adam Böving, Washington, D. C. Tanyptera; notes on Helobia.

In addition to the preceding, the writer acknowledges specimens or data received from the following:

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 From Cambridge, Massachusetts: Roland Thaxter.  
 From Ithaca, New York: H. H. Knight, L. G. Brown, C. C. Hamilton, V. R. Haber, E. A. Richmond, Chih Ping, Waro Nakahara, M. D. Leonard, W. A. Riley, J. D. Tothill, Mrs. J. D. Tothill, W. P. Alexander, W. A. Clemens, W. C. Woods, P. A. Munz, P. W. Claassen, Axel Olsson.  
 From Washington, D. C.: C. H. Popenoe, E. R. Kalmbach, Alex. Wetmore, A. T. Speare.  
 From Lawrence, Kansas: H. B. Hungerford, P. B. Lawson, H. L. Fackler.  
 From Urbana, Illinois: T. H. Frison, W. P. Flint.

The writer would express his great indebtedness to Dr. Ewald Bergroth, of Jämsä, Finland, for help in determining the derivation of some of the more obscure generic names in the Tipulidae; to Professor T. D. A. Cockerell for notes on the stratigraphy of fossil-bearing beds in many parts of the world; and to Miss Lela G. Gross, assistant editor of the Cornell memoirs, whose critical work on this and the preceding part under this title has been of the greatest value in assuring uniformity and accuracy.

Further acknowledgments of assistance in determining plant and animal associates of crane-flies are made thruout the text. In conclusion, the writer expresses his indebtedness to his wife, Mabel M. Alexander, for her untiring care and assistance in the typing and final preparation of this thesis.

## GENERAL CONSIDERATIONS

## REPRESENTATIVE CRANE-FLY LIFE HISTORIES

The life histories of but few species of crane-flies have been studied in detail. The very nature of the habitat (mud or earth) required by most species of the family renders it a most difficult operation to rear the species from the egg to the adult and note the various stages, their molts, their habits, and other features. The subfamily *Cylindrotominae*, the immature stages of which live on the leaves of various higher plants and curiously resemble the caterpillars of certain *Lepidoptera*, furnishes species whose habits are more readily studied than most others, and as a result the immature stages of this group are better known, perhaps, than those of any other section of the family. Two widely different species have been chosen, and their life histories as they are known at present are here outlined. The first is a species of *Eriocera*, a powerful, semi-aquatic carnivore; the second is a species of *Cylindrotoma*, a terrestrial herbivore. In the text which follows, notes on the life activities of various other species are given, but the gaps in the knowledge of this phase of the subject are very considerable and there still remain innumerable interesting facts to be ascertained.

*Eriocera longicornis* (Walk.)

The common crane-fly *Eriocera longicornis* is widely distributed over the northeastern United States and Canada. Altho the species is local in its distribution, the flies may be found in abundance wherever it does occur. The situations that favor the presence of these flies are large streams or rivers with sand or gravel bottoms and banks. The following notes were taken, partly in Fulton County, New York, along the Sacandaga River, and partly in Tompkins County, along Fall and Cascadilla Creeks. Some of these data have already been published by Alexander and Lloyd (1914:12-18) and by the writer (Alexander, 1915 c:149-152).

On May 27, 1914, the adult flies were exceedingly numerous near the village of Northampton, Fulton County. They were present in untold myriads, and at every step they arose in clouds from under foot or from the leaves of chokecherry on which they rested. They sat on the leaves with the head directed away from the observer, ready to take instant flight, and at the first approach of a possible enemy they darted up into

the air and far overhead. A few were in copulation on the leaves, but from observations made later it seems probable that mating begins in the air and the united pair seek a support later on. Toward twilight the flies may be found in great numbers in company with many kinds of caddice flies and may flies. The swarms vary in numbers from about fifty individuals to those including many thousands. Some of the larger of these swarms cover a vertical height of at least fifty feet, the lower individuals being about fifteen feet above the water. When danger approaches, the swarm either mounts into the air overhead or retreats before the breeze, never advancing nor moving sidewise.

Out over the land in the smaller swarms, copulation was observed several times. The males in the swarm dart swiftly at the females and seize them almost instantly. They then usually leave the swarm and go sailing away, the male above doing the flying, the smaller female hanging limply beneath. The antennae of the male at this time are directed straight ahead and are slightly divergent, the legs hang downward, the wings vibrate rapidly. The female hangs downward with the legs trailing limply beneath, the wings nearly horizontal and motionless. The dead weight of the female continually pulls the male toward the water, and often both fall into the river. As a rule, copulation ends before the male is exhausted. The male opens his forceps and the female drops straight downward for a foot or so, quite like a parachute released from a balloon. If the pair are near the surface at the time of separation, the released female drops into the water. The male darts upward again and back into the swarm. The female slowly flies away, usually upstream but sometimes downstream, presumably to lay her eggs. She does not stop for swarms that she may encounter, and may even make a wide detour in order to avoid them. In a very few cases the female is the active partner and succeeds in pulling the male where she wills altho she is much smaller. No matings were observed during the hours of sunlight, and it was only at twilight or just after sunset that mating took place. Often a second male will seize a female already in copula and the three will come tumbling down into the water together. One such pairing of three individuals came down, and when they were about a foot above a board in the water the male in copulation dropped the other two. These rested for a moment, and then the remaining male attempted to engage the female in copulation. She resisted but finally he managed to seize her

with his forceps. Then he attempted to fly away, but she seized hold of the board with all her feet and he was unable to disengage her. This seems to indicate that the normal place for copulation is in the air.

The motions of the insects in the swarm were very rapid, almost like those of bees, and the sound produced was at a very low pitch, much lower than that made by *Culex*. The movements are on a horizontal plane, each individual flying mostly in the path of a figure 8, sometimes slowly and at other times much more rapidly.

Many specimens were seen dipping down into the water, as tho engaged in laying eggs. All of the few specimens captured proved to be males, but why this sex should go thru these motions is not clear to the writer. This action has been observed several times in various species of crane-flies. It is very probable that the female lays her eggs in the water in this manner.

The eggs are pale white or brown, not heavily chitinized as are those of *Hexatoma* but with the chorion feebly sculptured. They vary in number from 892 to 1034, with an average of 952. They are small, about the same size as those of *Hexatoma*. The ovaries almost completely fill the abdominal cavity, and the eggs are arranged in the ovaries like bananas on a stalk, with numerous pale nurse-cells in between.

The larval life is passed in streams, usually under rocks. The winter is spent in the larval condition, but the larvae do not attain full size until the following spring. At this time they come to the land and live in the sand and gravel along the banks of the streams. By the alternate extension and contraction of the body and the inflation of the penultimate segment of the abdomen at the moment of extension, the larvae are capable of inflating this segment into an enormous globular structure which serves as an aid to progression thru the soil. The food of the larvae consists largely of animal matter, and often large species, such as chironomid larvae, are swallowed whole. The almost total lack of chitinization of the mental region allows for great distension of this part of the body. The powerful mandibles and the retrorsely roughened esophagus serve the function of both holding the prey and preventing its ejection when once swallowed. Considerable gravel and particles of vegetable tissue are also found in the proventricular region.

When ready to transform to the pupal condition, the larva becomes sluggish. After molting the last larval skin, the pupa is disclosed, pale

yellowish white and very callow. The pupa forms burrows in the loose gravel, these being vertical, or, more often, a little oblique. The diameter of the burrow is a little greater than that of the pupa. The length varies, the burrow for a young pupa being a mere chamber inclosing the individual and located from one-half to one inch below the surface. As the pupa becomes older, by a bobbing up-and-down motion it lengthens the burrow upward until finally it penetrates the surface layer and forms a small shot-like opening. Here the pupa rests, often bobbing up and down with a rhythmic motion, but ducking down into the burrow when danger threatens. The length of the burrow is rarely more, but usually less, than twice the length of the pupa. A few of the pupae seem to be inclosed in a very delicate silken tube and the salivary glands seem to be well adapted for the purpose of forming silk; but the great majority of the pupae are entirely naked. The indoor pupal period varies from one hundred and seventy to one hundred and seventy-three hours, or a little more than seven days. The outdoor pupal period, however, is undoubtedly longer, unless the weather is very warm.

The emergence of the adults usually takes place during the late hours of the morning, the greatest number emerging between ten o'clock and noon. When ready to emerge, the pupa pushes part of its body out of the earth, the posterior two-thirds or half remaining attached to the soil. If it projects farther than this, its transformation seems to be a very difficult operation. The pupa bends backward and forward constantly, flexing the body dorso-ventrally. This motion appears to exhaust it, since it frequently rests. The skin splits lengthwise up the mesonotum and the adult emerges. The male has difficulty in extricating its very long antennae from their sheaths. The tips of the fore femora are placed underneath the sharp spines of the flagellum, and by raising the legs the insect pulls the antennae slightly outward. These spines are regularly spaced, and, since both fore legs work in unison, the spines function as cogs and the whole antenna is gradually forced from the pupal sheath. The body is carried very straight and stiff during the operation, and the abdomen is very long and pale. The drawing out of the extreme tips of the antennae is usually accomplished by the insect flexing its whole body backward. When the antennae are freed, the insect walks a few steps from the cast skin, withdrawing its abdomen from the case. (The emergence of *E. spinosa* is shown in Plate XII, 1.) A drop of nearly colorless liquid is excreted

from the body at this time. The teneral adult then waits quietly until it gains more strength and color. This condition of the insect is the most dangerous period of its existence, since it is defenseless against all enemies.

The insects are associated in the gravel with ground beetles of the genera *Omophron*, *Schizogenius*, *Dysehirus*, *Bembidion*, *Tachistodes*; with click beetles of the genus *Cryptohypnus*; and with rove beetles, of which *Paederus*, *Lathrobium*, and *Gastrolobium* are the commonest forms. In addition, numbers of larvae of *Tabanidae*, *Leptidae* (*Atherix*), *Eriocera spinosa*, *E. fulltonensis*, *E. cinerea*, and *Erioptera armata* were found. Natural enemies of the pupae and the teneral imagines are the medium-sized black lycosid spiders, which preyed in numbers on the weak, uncolored adults. Dozens of these spiders were noticed with individuals of the crane-flies in their grasp. When alarmed they would run rapidly away, but only in exceptional cases would they release their victims. A few spiders of other families, notably the *Attidae*, were found with *Eriocera*. Dragon-flies appear to be the most serious enemies of the active adults. *Helocordulia uhleri* (Selys) has been observed capturing the crane-flies by darting back and forth thru the swarms of individuals.

#### *Cylindrotoma splendens* Doane

The life history of the species *Cylindrotoma splendens* has been worked out in considerable detail by Dr. A. E. Cameron, from material obtained near Westholme, Vancouver Island, British Columbia, in late April, 1917. The following account is abstracted from Cameron's detailed paper (1918) on this interesting crane-fly:

The adults first appear on the wing about the middle of May. Without food they do not live longer than five or six days, but in breeding cages, where they were supplied with food in the nature of a sugar solution, they lived as long as from seven to nine days. In nature the adults were found on the wing during a period of about three weeks.

Soon after emergence the adults begin to copulate, and one male may have intercourse with more than one female. Copulation often takes place in a vertical position, the female above, the male below, with the tips of the abdomens interlocked. At times the female was noted hanging to the roof of the breeding cages, with the male suspended head downward, his body at an angle of 90° to that of the female, and his legs unsupported. If disturbed, the female may walk off, dragging her mate after her, or she may take flight, bearing the male with her. In nature the act of copulation is generally undertaken in the deep shade of the large leaves of the insect's food plants, the sexes resting on the under surface of the leaves or on the stems. Copulation may last but a few minutes or may require several hours.

The eggs are of a dull glistening white, elongate-oval in shape. Under natural conditions they are almost invariably found on the under surface of the leaves of the food plant *Trautvetteria grandis* Nuttall (*Ranunculaceae*), inserted beneath the incised epidermis. They

are usually deposited in series along and just within the margin of the serrate, palmately-lobed leaf. They are found in groups of one or more, all arranged parallel to one another and with their long axes perpendicular, or nearly so, to the margin of the leaf. The eggs are only partly hidden beneath the epidermis, being exposed dorsally, the margins of the slit overlapping the egg laterally and, to a lesser degree, both anteriorly and posteriorly. This arrangement of the eggs in series gives to the leaf margin a somewhat beaded appearance. When the eggs are older, the leaf margin turns brown and the presence of the eggs is readily detected. In ovipositing, the female rests on the under side of the leaf, with the tip of the abdomen directed toward the leaf edge. The abdomen is slightly flexed ventrally, and the margin of the leaf is held between the bifurcated valves of the ovipositor, which is applied to the upper surface of the leaf, while the paired cutting valves, with their blades, are applied against the under surface. These blades are then moved to and fro, cutting a slit in the epidermis. The eggs are then deposited. In no case do the eggs actually touch one another on the leaf. In the breeding cages females lay their eggs indiscriminately on both the upper and the lower surface of the leaves. In some cases, when a leaf has been eaten earlier in the season by larvae, the female will deposit her eggs along the ragged edge of this damaged part.

The indoor duration of the egg stage is from fourteen to eighteen days, but in the field as long a period as three weeks may be required. When first deposited the egg is translucent, grayish white, and spindle-shaped, with the chorion unornamented, and measures on an average 0.84 by 0.303 millimeter.

The larva requires about three hours to emerge from the egg. The chorion of the egg splits longitudinally down the mid-dorsal line, the slit extending almost half the length of the egg. In emerging, the almost transparent, grayish white larva utilizes the body tubercles as levers in freeing itself from the eggshell. As soon as it is freed from the shell, the newly hatched larva begins to feed on the leaf tissue of the host plant.

The first-stage larvae are grayish white in color, are translucent, and measure 1.19 by 0.37 millimeter in size. They feed on both the upper and the lower surface of the leaf, burrowing thru the epidermal layer with their mandibles and feeding on the parenchymatous tissue within. The young larvae are very sluggish and are not readily disturbed when feeding, the mandibles being firmly embedded in the leaf tissue. While engaged in feeding they assume various positions on the leaf surface. At the end of nine days the larvae have increased in length to 5.84 millimeters, and show all the characteristic behavior of the full-grown larvae. Growth is very slow, and before the first molt the larvae become covered with particles of their excrement, which adheres readily to the skin. The first larval molt occurs after a period of from eighteen to twenty-one days; in some cases, however, it does not occur until five or six weeks have elapsed.

The second-stage larvae gradually assume a leaf-green color as they continue to feed. Toward the end of July, coincident with the dying-off of their food plant, the larvae, which have now reached a length of from 8.32 to 9 millimeters, become quiescent and cease to feed. Feeding and movement gradually cease completely and the larvae remain clinging motionless to the leaves. As the leaves wither, the larvae drop off, and, in some cases, attach themselves to the stems; under natural conditions, however, they usually fall among the dead leaves on the ground and under these they pass the winter in a dormant condition. Many of these larvae match the brown color of the dead leaves, but some of them retain their leaf-green tint.

The overwintering larvae first show signs of activity in March of the following spring, when *Trautvetteria grandis* sends up its new shoots. Growth then proceeds rapidly until pupation in the middle of May. There seems to be one molt before hibernation and two after, the last being the casting of the larval skin, previous to pupation. The fully grown larvae measure 17 millimeters. They are invariably found on the upper surface of the leaf, and in the spring are actively engaged in feeding. On a fresh leaf the larvae usually begin by skeletonizing it, leaving the lower epidermis intact. Later on, however, large holes may be eaten completely thru the leaf. The fully grown larvae, and to a somewhat lesser degree the younger larvae, progress by a looping motion, which may be aptly compared to that



of the measuring worms (Geometridae), progression being accomplished by the aid of the mandibles and the ventral tubercles, or pseudopodia. In a quiescent condition the thoracic region of the body has a noticeable humped appearance. The fully grown larvae are very sluggish and inactive. When disturbed they relax their hold on the leaf surface and fall to the ground. Altho several hundred adults were reared, not a single parasite was discovered.

Before pupation the larva attaches itself firmly to the surface of the leaf or to the leaf petiole, by means of its anal pseudopodia. The skin splits transversely behind but is only partially sloughed off. The head, the thorax, and the first four abdominal segments of the pupa are exposed, but the apex of the abdomen remains encased in the larval skin, the terminal part of which, collapsed and wrinkled, is attached to the leaf surface. Pupation may take place on either the upper or the lower surface, but it occurs oftener on the former. If pupation takes place on the petiole, it is generally at the axil. In the breeding cages the duration of the pupal period was found to vary from six to ten days.

When the adult first emerges it is of a pale green color, which is gradually replaced by the black and yellow of the fully colored insect. From one and one-half to two hours are required for the adult to emerge. After emergence is completed, the fly rests for a short period until the cuticle hardens and the wings expand. It seems that the adherence of the larval skin to the pupa is necessary for the emergence of the adult, at least in many cases. There appears to be a large disproportion of females over males, this sometimes being as high as five to one. Since a single male may copulate with several females, this disproportion is not so serious as it appears at first sight.

#### LIFE ACTIVITIES OF CRANE-FLIES

##### *The adult*

*Emergence.*—Emergence from the pupal hull may require but a few seconds (as described for *Gnophomyia* by Hyslop *in litt.*, the whole operation requiring but eight seconds), or it may take several hours. The emergence of the strictly aquatic genus *Antocha* has not been observed, but it must be practically instantaneous as in *Blepharocera* and the lotic caddice flies.

*Mating.*—In several widely different species, the females as they emerge from the pupal hulls are at once seized in copulation by the males altho they are still callow and uncolored. Mik (1882b:40, and 1886a) discusses this curious condition in considerable detail. In all the cases that are known to the writer — *Dicranomyia trinotata*, *Discobola caesarea*, and *Cylindrotoma distinctissima* (Mik, 1886a, the last-named also cited by Mik, 1882 b), *Liogma glabrata* (Müggenberg, 1901), *Tipula rufina* (Giard, 1895), and *Tipula ultima* (Caudell, 1913) — the abdomen of the female is elongate, flabby, and nearly colorless. In *Dicranomyia trinotata* the females scarcely have time to remove their legs from the pupal sheaths before they are seized in copulation. In other cases the males emerge before the females and wait beside the pupae for the emergence of their mates, when they at once seize them in copula. In most species of *Tipula* the males, when seeking the females, progress by a fluttering

motion, partly flying and partly walking, over the ground or up the trunks of trees. This habit is discussed under the account of *Tipula taughanock* (p. 1013), and has been observed in other woodland-inhabiting species of this genus — as *T. macrolabis*, *T. fuliginosa*, *T. fragilis*, and others. In *T. fragilis*, when a male comes upon a pair already in copula he passes on without interrupting them. Somewhat similar mating habits are found in some species of *Dicranomyia* (*D. trinotata*, *D. badia*, and *D. simulans*), *Discobola*, *Antocha*, *Chionea*, *Dactylolabis montana*, some *Pediciini* as *Dicranota*, and the *Cylindrotominae*.

Many crane-flies have developed swarming habits for the purpose of mating, these including representatives of most of the tribes of the *Limnobiinae* and a few tipuline forms. *Dicranomyia morioides* was observed by Needham (1908 a:204) swarming in vast numbers near Ithaca, New York, but here the swarms consisted only of males. Likewise, *Erioptera armata* (Needham, 1908 a:206) was found swarming near Lake Forest, Illinois; but, out of several hundred individuals captured, all except three were males. The writer has observed swarming in numerous species of *Ormosia*, *Molophilus*, *Erioptera*, *Gonomyia*, *Rhabdomastix*, *Limnophila*, *Ula*, *Epiphragma*, *Eriocera*, *Dicranota*, *Rhaphidolabis*, *Trichocera*, and other genera, and here, too, the males were always predominant. The specific data may be consulted under these various headings. The males of *Dicranota* swarm in rather large numbers preliminary to searching for the females, which rest quietly on the branches of neighboring shrubbery. *Limnophila ultima*, as noted at Gloversville, New York, on September 7, 1916, was swarming at half past six o'clock in the evening. The swarms here consisted of from fifty to sixty individuals and took place from ten to eighteen feet above the earth. Mating took place frequently in the air, and as soon as a pair were in copula they flew away to some point to rest, many pairs being observed hanging on a clothesline a few feet away. There were three distinct swarms, which showed little tendency to fuse altho their flight area was very close. The vast swarms of *Eriocera longicornis* and of *Trichocera* are mentioned or discussed elsewhere in this paper. When pairs are in copula, they readily take flight, still united, the female usually trailing the male after her; altho in a few groups, in which the male is the larger individual of the two, the situation is the opposite. *Brachypremna*, the familiar "weaver" of the Southern States, has a very remarkable vertical dance of several

feet in shady spots, and has been aptly termed by Johnson (1907-12 [1909]:123) "the king of the dancing tipulids." Doubtless many interesting facts remain to be discovered concerning the dances of the tropical species of *Brachypremna*, *Tanypremna*, and *Megistocera*.

*Dancing*.—The dances of *Thrypticomys saltens* (Dol.) should be mentioned at this point. According to Doleschall (1857), Jacobson (De Meijere, 1911:22-23), and others, this species is common in Java in shady places thruout the year. The insects have the habit of clinging to spider webs by means of the fore feet, or, if a fore foot is lacking, one of the middle legs is used. Often twenty or more of these flies are seen hanging close beside one another on a horizontally spun web, all seesawing rapidly up and down and at the same time swaying to and fro, sometimes rhythmically, sometimes not. This ludicrous tight-rope dance is continued for a long time. Somewhat similar habits have been described for *Trentepohlia pennipes*, *Rhamphidia venustissima* Alex., and other species with white tarsi.

*Bobbing*.—Species of *Dicranomyia* and *Geranomyia*, as well as a few other crane-flies, have the curious habit of bobbing up and down while resting, the long, slender legs acting as springs. The species of the latter genus practice this same oscillating movement while resting on a head of flowers and feeding. H. K. Munro has recorded this bobbing habit in a species of *Trentepohlia* (p. 943).

*Resting habits*.—When at rest crane-flies assume various positions which are often fairly characteristic. Many species (*Erioptera*, *Molophilus*, and some *Dicranomyia*) resemble spiders when flattened against a tree trunk or some other vertical support. *Styringomyia* resembles a bit of cobweb, the fore and middle legs stretched out in front, the hind legs directed backward. In a position of rest the tipuline forms generally hold their wings outspread or divaricate, exceptions being in the genera *Longurio*, *Oropeza*, and others, and in a few species of *Tipula*, as *T. arctica* and the woodland-inhabiting species of the *marmorata* group (*T. fragilis* and *T. ignobilis*). The limnobiine forms usually fold the wings incumbent over the abdomen, but here again exceptions are found in *Pedicia*, *Limnophila toxoneura*, and other species, which normally rest with the wings outspread. *Oropeza* hangs to the roofs of bridges, culverts, and similar places, with only the fore legs attached to the support, the middle legs divergent, the posterior legs hanging loosely behind. The apparently

closely allied *Dolichopeza*, on the contrary, has the four anterior legs on the support, the hind legs dangling, the wings divaricate. Many of these species — as *Oropeza*, *Dolichopeza*, *Dicranomyia badia*, and exotic species of the genera *Thrypticomyia* and *Trentepohlia* — habitually rest on spider webs (page 982; also, Knab, 1912). During heavy rains, crane-flies rest on the lower side of the broad leaves of deciduous trees or hide beneath loose flakes of bark.

*Feeding.*—The adult flies feed but little, the majority of the species whose habits are at all known merely lapping nectar from open flowers. Knuth (1909:579) and Wahlgren (1917) record the plants frequented by a number of European Tipulinae as well as by Ptychoptera. These species are found on Umbelliferae (*Aegopodium*, *Anthriscus*, *Heracleum*, *Carum*, *Anethum*, and other genera), on Rosaceae (*Spiraea*, *Rubus*, and other genera), and on a few other plants. A few of the local Limnobiinae have the rostrum very greatly elongated — an obvious adaptation for sucking the nectar from tubular flowers. The species of *Geranomyia* feed on various composite, umbelliferous, and lauraceous flowers. *Toxorhina* frequents composite, rhamnaceous, apocynaceous, and ericaceous plants. The exact plants frequented are discussed under the descriptions of the respective genera.

*Oviposition.*—The females lay their eggs in the habitat frequented by the larvae. In the case of aquatic forms — as *Antocha*, *Hexatoma*, *Eriocera*, and other genera — the eggs are deposited in dipping down to the water surface, one or more eggs being deposited at each descent. Forms that live in mud or moist earth lay their eggs in these situations. Many species with acute ovipositors insert the eggs carefully into the soil or other substance. The oviposition of *Limnophila (Eutonia) alleni* as noted by the writer may be regarded as typical of this class of species:

Observations made at Gloversville, New York, June 28, 1916. A female was noted ovipositing in low, wet spots along a small woodland stream. She flew about slowly and silently, just skimming the ground, until a place suitable for egg-laying was found. She finally chose a much-decayed log and the eggs were driven home securely by the acicular tergal valves of the ovipositor. Much effort is expended to place the eggs firmly and the rate of oviposition is not more than eight or ten a minute, the female often pausing to rest for several seconds. While thus engaged, the fly is entirely unconcerned with other agencies and may be picked up by hand.

The females of most crane-flies usually live but a short time after egg-laying is completed. Indeed, the entire duration of life of the adult crane-flies is probably but a few weeks at the most.

The specialized methods of oviposition in the *Cylindrotominae* have already been discussed on page 709 under the account of *Cylindrotoma splendens*. The species of *Tipula* and other genera the females of which have blunt valves to the ovipositor (*Styringomyia*, *Macromastix*, and others), all probably scatter their eggs promiscuously or else have a specialized method of egg-laying. Similarly, the species of *Tipula* of the *arctica* group, in which the dorsal valves of the ovipositor are very large, placed horizontally, and with the margin finely serrated, undoubtedly have a peculiar method of oviposition, but this has not yet been observed.

### The egg

The number of eggs laid by crane-flies varies from about forty-five in *Styringomyia* to some two thousand in the larger species of *Eriocera*. The following table indicates the general range in the group:

Species	Number of eggs laid			Reference
	Maximum	Minimum	Average	
<i>Ptychoptera albimana</i> .....	587	520	554	Topsent, 1914-16
<i>Styringomyia didyma</i> .....	45	.....	45	Terry ms.
<i>Eriocera longicornis</i> .....	1,034	872	952	Alexander ms.
<i>spinosa</i> .....	2,061	1,824	1,942	Alexander ms.
<i>Hexatoma megacera</i> .....	372	316	347	Alexander, 1915 c
<i>Phalacrocerca replicata</i> .....	60	.....	60	Miall and Shelford, 1897
<i>Liogma glabrata</i> .....	60	.....	60	Müggenberg, 1901
<i>Ctenophora angustipennis</i> .....	400	200	300	Lovett, 1915
<i>Tipula cunctans</i> .....	.....	.....	300	Hyslop, 1910
<i>bicornis</i> .....	297	282	289	Webster, 1893 b
<i>tephrocephala</i> .....	255	.....	255	Webster, 1893 b
<i>angustipennis</i> .....	602	.....	602	Hyslop, 1910
<i>collaris</i> .....	329	.....	329	Alexander ms.
<i>dejecta</i> .....	366	251	309	Alexander ms.
<i>oleracea</i> .....	600	.....	600	Del Guercio, 1914

The eggs are in most cases elongate with the ends narrowed and rounded, or, in other words, spindle-shaped. The chorion in the species of *Tipula*, *Hexatoma*, and other genera is blackened and in some cases more or less sculptured. In *Ctenophora angustipennis* (Lovett, 1915) the egg is ebony black with deep purple reflection, elongate-oval, uniform, without pits or ridges, and measuring from 1.26 to 1.4 millimeters by 0.375 millimeter.

In *Tipula bicornis* (Webster, 1893 b) the egg is 0.8 millimeter long by 0.3 to 0.4 millimeter in diameter, elongate-ovoid, with one side deeply concave, the surface highly polished. The egg of *Nephrotoma ferruginea* is smaller, with five distinct grooves. The egg of *Tipula glacialis* (Pokorny, 1887:53) is described as being 1.2 millimeters long and only 0.3 millimeter in diameter, cylindrical, the two ends equally rounded, the surface smooth, shiny black, with faint steel-blue or purplish red reflections. In many other genera of Tipulidae, especially the smaller forms, the eggs are soft and whitish or nearly hyaline. In a few species the eggs take on a decided green or greenish tinge. The egg of *Cylindrotoma splendens* is described elsewhere in this paper (page 709). The egg of *Ptychoptera albimana*, as described by Topsent (1914-16), measures 0.825 by 0.264 millimeter, and is pale yellow, slightly arcuated, and with the surface curiously ornamented.

#### *The larva*

As a rule, the larvae live in the haunts where the eggs are laid. The duration of the larval stage varies from about a month in *Styringomyia* (larva and pupa together, thirty-seven days — Terry ms.) to the greater part of a year in most crane-flies. Many of the smaller species of Erioptera, Ormosia, Rhabdrolabis, and other genera are on the wing in the spring and again in the fall, and with little doubt are double-brooded. This would make the larval existence but a few months, but still probably longer than the other stages taken together. This problem of double broods should be worked out carefully. It often appears that there are two broods, when in reality there may be two developing generations, each passing the winter as larvae, but one attaining its growth much more slowly in the spring and summer and not maturing until late summer. Phalacroceras and *Cylindrotoma splendens* spend about eleven months in the larval stage (Bengtsson 1897, and Cameron 1918), while *Tipula paludosa* spends nine months in that stage (Rennie, 1917). It is probable that nearly all crane-flies in the North Temperate Zone winter normally as larvae. The growth during summer, fall, and winter is very slight, but in the spring it is greatly accelerated and in a month the larva may attain its full growth. Larvae of *Tipula ignobilis* taken at Ithaca, New York, on April 23, 1917, measured only 6.5 millimeters in length; on May 19 they had attained their full growth of 18 millimeters and were ready to pupate. *Cylindrotoma splendens* spends the winter as a larva,

9 millimeters in length, but grows rapidly during the spring, attaining its full size (17 millimeters) in two months of growth. *Liogma glabrata* spends the winter as a very small larva, but in the spring its growth is greatly accelerated.

The haunts in which the larvae of crane-flies occur are exceedingly varied. In the case of single large genera, such as *Dicranomyia* and *Tipula*, the species range from those that are almost strictly aquatic to others that are entirely terrestrial, living in decaying wood or even mining in the leaves of plants.

The transition between strictly aquatic and terrestrial forms is very gradual, as was pointed out by Miall (1895:11) some years ago when he wrote:

How did insects ever come to seek the water, seeing that their mode of respiration is primarily adapted to another element? We can see almost all the steps of the adaptation on the shores of our rivers, lakes and seas. We can see dipterous larvae which, like the "leather jacket" (the larva of the daddy-long-legs), burrow in the ground for their vegetable food, and devour the roots of grasses. Other larvae of the same family (*Tipulidae*) prefer moist earth in the neighborhood of streams. Others again live immersed in water, or mud saturated with water, though they come to the surface at times and push their tails, which carry the spiracles, into the air. Some few have become so completely aquatic that they seldom, if ever, come to the surface, and all their supply of oxygen is obtained from the water.

The culmination of this latter condition is reached in forms such as *Antocha* and related genera and species. Crampton (1919:100) has made similar observations on the subject.

The haunts of the larvae of crane-flies are best shown by the following table, in which the various species are arranged according to habitat, from the strictly aquatic to the various terrestrial forms:

Habitat	Species
Strictly aquatic, in silken cases	<i>Antocha</i>
In very rapid water (lotic) on or in submerged mosses (hygropeptic association)	<i>Dicranomyia simulans</i> , <i>Pedicia</i> , <i>Triogma</i> , <i>Tipuline</i> No. 1, and others
Aquatic, on submerged plants	<i>Phalacropera</i> , <i>Triogma</i>
Semi-aquatic (part of life spent in water, but pupation taking place on land)	<i>Dicranomyia simulans</i> , <i>Eriocera</i> , <i>Hexatoma</i> , <i>Aeshnasoma</i> , <i>Longurio</i> , <i>Tipula abdominalis</i> , <i>T. caloptera</i> , <i>T. bella</i> , and others
On cliffs and wooden walls, usually in silken cases covered by water	<i>Dicranomyia simulans</i> , <i>Geranomyia</i> , <i>Elliptera</i> , <i>Dactylolebia</i> , and others
In cold springs	<i>Pedicia</i> , <i>Thaumastoptera</i>

Habitat	Species
In stagnant water in the axils of bromeliaceous and other plants	Trentepohlia, <i>Gnophomyia rufa</i>
Amphibious in decaying wood	Protoplasa (supposition), Epiphragma
In mud or sand:	
a. In open swamps	Bittacomorpha, Ptychoptera, Rhamphidia, <i>Erioptera septemtrionis</i> , <i>E. chlorophylla</i> , <i>E. vespertina</i> , <i>Limnophila adusta</i> , <i>L. macroccra</i> , <i>Pilaria recondita</i> , <i>P. tenuipes</i> , <i>P. quadrata</i> , <i>Tricyphona inconstans</i> , Prionocera, <i>Tipula dejecta</i> , <i>T. sayi</i> , <i>T. tricolor</i> , and others
b. In shaded woods	Bittacomorphella, <i>Ormosia innocens</i> , <i>Erioptera megophthalma</i> , <i>Molophilus hirtipennis</i> , Uloromorpha, Dieranophragma, Penthoptera, <i>Tipula cayuga</i> , and others
c. Along the margins of streams and other bodies of water	<i>Limnobia fallax</i> , <i>Erioptera (Hoplolabis) armata</i> , <i>Trimicra</i> , <i>Gonomyia (Leiponeura) alexanderi</i> , <i>G. kansensis</i> , <i>Eriocera</i> , <i>Hexatoma</i> , and others
In or beneath damp cushions of moss	<i>Dicranomyia badia</i> , <i>D. stulta</i> , <i>Tipula oropezoides</i> , <i>T. collaris</i> , <i>T. nobilis</i> , <i>T. ignobilis</i> , and others
In or beneath dry cushions of moss	Liogma, Dolichopeza, Oropeza, and others
In dry soil	Dicranoptycha, Cladura, <i>Nephrotoma ferruginea</i> , <i>Tipula cunctans</i> , <i>T. angustipennis</i> , and others
In fungi	<i>Limnobia triocellata</i> , <i>L. cinctipes</i> , Ula, and others
In decaying vegetables, plant stems, manure, and like situations	Trichocera, <i>Limnobia indigena</i> , <i>Rhipidia domestica</i> , <i>R. maculata</i> , and others
In wood:	
a. In decaying wood, usually just beneath the bark	<i>Dicranomyia rara</i> , <i>D. macateei</i> , <i>Rhipidia fidelis</i> , <i>R. bryanti</i> , <i>Elephantomyia</i> , <i>Teucholabis</i> , <i>Gnophomyia</i> , <i>Limnophila unica</i> , <i>Brachypremna</i> , <i>Ctenophora</i> , <i>Dictenidia</i> , <i>Tipula trivittata</i> , <i>T. usitata</i> , and others
b. In nearly solid wood	Tanyptera
On leaves of terrestrial plants:	
a. On flowering plants	Cylindrotoma
b. On mosses	Liogma, Triogma (in some instances)
Mining in the leaves of plants	<i>Dicranomyia foliocuniculator</i>

*Feeding.*—The various larvae of crane-flies show a considerable diversity in their habits of feeding. The majority of species, as known, are herbivorous, but a large group are decidedly carnivorous in their habits.

The Tipulinae feed on the living vegetable tissue or plant remains occurring in their habitat, or, when pressed for food, they will eat earth-



worms (Patterson, 1908) and other soft-bodied animals. Dissections of *Tipula abdominalis* show the food of this species to consist principally of small filamentous algae, diatoms (Diatoma, Navicula, and others), and rootlets of small plants. The alimentary tract is often crammed with sand or soil particles. The species of *Tipula* and *Nephrotoma* that are injurious to plants, considered later in this paper under the heading *Economic Importance*, effect their damage by devouring the living tissues of the roots. The *Cylindrotominae* feed on the living tissues of the plants on which they dwell; in the case of *Phalacrocer*, *Triogma*, and *Liogma* these are mosses, in *Cylindrotoma* they are the parenchyma and epidermis of higher plants (spermatophytes). With this habit of feeding on plant tissues the extreme of sluggishness of motion is attained. The wood-boring species of *Tipulinae* (such as the species of *Tanyptera* and *Ctenophora*) feed on the ligneous tissue of the trees in which they occur. Other species of crane-flies injure young seedlings by destroying the bark and the bast tissues.

The hexatomine and pediciine forms represent the opposite extreme, being for the most part carnivorous or even cannibalistic in their habits. In order to capture their prey they are of necessity rapid of movement, and in this group the most graceful and active of all tipulid larvae are found. The motions of the species are, at times, exceedingly agile and snakelike. The food consists of a variety of animal forms. *Dicranota* has been recorded as feeding on worms of the genus *Tubifex*. *Pedicia* usually feeds on the larvae of small insects, especially *Chironomidae*, but the large species of this genus and of *Eriocera* are capable of capturing almost any insect of a size equal to their own. The larvae of *Eriocera spinosa* are able to inflict painful bites on tender parts of the skin of a man. *Pentoptera*, *Eriocera*, *Hexatoma*, and most of the *limnophiline* groups likewise feed largely on midge larvae. From one small larva of *Limnophila* (*Dicranophragma*) *fuscovaria* the writer has dissected out the remains of two large midge larvae, whose heads were nearly half the size of that of the captor. The chitinized mentum in these predacious forms is very weak or is lacking, allowing for a tremendous distension of the gular region. The mandibles are always developed into powerful curved hooks which serve well their purpose of grasping and holding the victims. The esophageal region is often retrorsely roughened to prevent the egress of anything that has once started down the throat. In addition to the

various chitinized jaws, legs, heads, and other insect remains, the distended proventricular regions usually show a considerable amount of sand particles and much plant tissue.

### *The pupa*

When ready to pupate, the larva ceases feeding and becomes much contracted and sluggish. The pupa is formed within the last larval skin, which is then shed completely except in certain *Cylindrotominae* and a few scattered genera in other tribes, in which cases the larval skin adheres to the posterior end of the abdomen. The pupal existence is spent in or near the haunts of the larva.

In the strictly aquatic genus *Antocha* the pupa lives in water in a silken case, respiration being accomplished by means of the many-branched breathing horns. The species of *Elliptera* and certain *Dicranomyia* (*simulans*, for example) approach this aquatic condition. The other species of crane-flies with aquatic larvae known to the writer go to the soil in order to pupate, this category including *Eriocera*, *Hexatoma*, *Tipula caloptera*, *T. abdominalis*, and many others.

The pupae of some, at least, of the *Cylindrotominae* attach themselves to plant stems for the purpose of pupation. The leaf-mining *Dicranomyia foliocuniculator* pupates within the larval passages. The majority of the limnobiine forms spend the pupal existence in silken cases to which pebbles and particles of debris or plant tissues adhere.

The pupae of the *Ptychopteridae* have one of the two breathing horns enormously elongated, the tip of this being projected above the water level into the air for respiration. Certain tipuline crane-flies have a somewhat similar development of the breathing horns, discussed later.

The duration of the pupal existence is remarkably uniform thruout the group, averaging from six to eight days. The following table illustrates this for the more representative genera and species. Records which have not been determined sufficiently close, and which as stated are probably too long, are indicated by an asterisk.

Species	Duration of pupal existence (days)			Reference
	Maximum	Minimum	Average	
<i>Ptychoptera rufocincta</i> .....		4 $\frac{3}{4}$		Alexander ms.
<i>albimana</i> .....	*12	10	11	Topsent, 1914-16
<i>Bittacomorphella</i> .....	*13			Alexander ms.
<i>Dicranomyia badia</i> .....	7		7	Alexander ms.
<i>stulta</i> .....	*8			Alexander ms.
<i>Rhipidia bryanti</i> .....	7		7	Shannon ms.
<i>Limnobia cinctipes</i> .....		5		Alexander ms.
<i>triocellata</i> .....	9	8	8 $\frac{1}{2}$	Alexander ms.
<i>Rhamphidia mainensis</i> .....	6		6	Alexander ms.
<i>Dicranoptycha winnemana</i> .....	*10			Alexander ms.
<i>Ula elegans</i> .....	*10			Alexander, 1915a
<i>Epiphragma</i> .....		6	6	Alexander ms.
<i>Pseudolimnophila</i> .....	9	8	8 $\frac{1}{2}$	Alexander ms.
<i>Limnophila macrocera</i> .....	9	8	8 $\frac{1}{2}$	Alexander ms.
<i>fuscovaria</i> .....	*14	8	10	Alexander ms.
<i>Pilaria</i> .....	7	7	7	Alexander ms.
<i>Ulomorpha</i> .....	*9			Alexander ms.
<i>Eriocera fultonensis</i> .....	7	7	7	Alexander ms.
<i>longicornis</i> .....	7.3		7.3	Alexander ms.
<i>Hexatoma megacera</i> .....	6 $\frac{1}{2}$		6 $\frac{1}{2}$	Alexander ms.
<i>Pedicia rivosa</i> .....	*14	7	10 $\frac{1}{2}$	Beling, 1879:46
<i>Erioptera macrophthalma</i> .....	8	7	7 $\frac{1}{2}$	Alexander ms.
<i>Molophilus hirtipennis</i> .....	*10			Alexander ms.
<i>Gnophomyia tristissima</i> .....	5	4	4 $\frac{1}{2}$	Hyslop ms.
<i>Ormosia nigripila</i> .....	*11			Alexander ms.
<i>Teucholabis complexa</i> .....	9			Johnson ms.
<i>Elephantomyia</i> .....	8	6	7	Shannon ms.
<i>Cylindrotoma splendens</i> .....	10	6	8	Cameron, 1918
<i>Liogma glabrata</i> .....	11	10	10 $\frac{1}{2}$	Müggenberg, 1901
<i>Phalacropera replicata</i> .....	8	7	7 $\frac{1}{2}$	Bengtsson, 1897
<i>Dolichopeza albipes</i> .....	6		6	Beling, 1886 ( <i>assylvicola</i> )
<i>Ctenophora angustipennis</i> .....			10	Lovett, 1915
<i>Dictenidia bimaculata</i> .....	7		7	Beling, 1873b
<i>Tipula maxima</i> .....	*14	*10	*12	Beling, 1886
<i>oleracea</i> .....	8	7	7 $\frac{1}{2}$	Del Guercio, 1914:315
<i>cayuga</i> .....	7.6		7.6	Alexander ms.
<i>ignobilis</i> .....	8	7	7 $\frac{1}{2}$	Alexander ms.
<i>dejecta</i> .....	8		8	Alexander ms.
<i>collaris</i> .....	8	7	7 $\frac{1}{2}$	Alexander ms.
<i>Nephrotoma lineata</i> .....	7		7	Beling, 1879 (as <i>histrion</i> )
<i>lunulicornis</i> .....	7		7	Beling, 1879
<i>analis</i> .....	*12	*8	*10	Beling, 1886

## ENEMIES

Crane-flies have many enemies and but few means of combating them. Every stage of the crane-fly's existence is fraught with danger. The larvae of the majority of species are soft-bodied, herbivorous creatures, which form a choice morsel of food for carnivorous forms of many classes and orders. The period when the adult fly has just emerged from the pupal hull is undoubtedly the one in which the greatest danger is found, for then the insects are teneral and incapable of rapid motion. The adult flies are sometimes drowned in the sea or other large bodies of water and their dead fragments cast up in windrows on the shore. A very unusual instance of this kind is recorded for *Tipula oleracea* by Patterson (1908). At their best, the adult flies are poor, awkward fliers and are easily captured by a wide range of species, as indicated in the following pages.

*Predatory natural enemies**Vertebrates*

*Mammalia*.— Undoubtedly many of the smaller mammals prey on the larvae of various species of *Tipula*. In another paper (Alexander, 1919 d: 776-777) the writer has discussed the value of the larvae of an undetermined species of *Tipula* in the Pribilof Islands as an article of food for the arctic fox. These larvae occur in enormous numbers beneath the lichens of the tundra and the foxes can easily get them at a time when other food is scarce or unobtainable. Mice, shrews, and moles find an important element of their food from this source. White (1914) states that in North Wales the European mole, *Talpa europaea*, eats, on an average, twenty crane-fly larvae a day, these constituting one of the main foods of this mammal.

*Aves*.— Birds are well-known enemies of crane-flies, both in their immature stages and as adult flies. Hyslop (1910:129-130) lists ninety-one species of birds which are known to feed on crane-flies. Baer (1913) describes ravens and starlings as feeding on the larvae of a species of *Tipula*. While working with the United States Biological Survey, the writer was given the opportunity to examine files for records. His thanks for assistance in this work are due to Messrs. Kalmbach, McAttee, and Wetmore. The records of the Survey are based on an examination of the contents of the stomachs of many thousands of individuals, and furnish very valuable and fairly complete data on the North American

birds which prey on various stages of the Tipulidae. These records are here arranged according to the latest check list of the American Ornithologists' Union:<sup>3</sup>

Longipennes:

Laridae:

- Larus delawarensis* Ord. Ring-billed gull  
*L. franklinii* Rich. Franklin's gull  
*Sterna hirundo* Linn. Common tern

Anseres:

Anatidae:

- Mergus americanus* Cass. Merganser  
*Anas platyrhynchos* Linn. Mallard  
*A. rubripes* Brewst. Black duck  
*Mareca americana* (Gmel.). Baldpate  
*Nettion carolinense* (Gmel.). Green-winged teal  
*Dafila acuta* (Linn.). Pintail  
*Aix sponsa* (Linn.). Wood duck

Herodiones:

Ardeidae:

- Egretta candidissima candidissima* (Gmel.). Snowy egret  
*Butorides virescens virescens* (Linn.). Green heron

Limicolae:

Phalaropodidae:

- Phalaropus fulicarius* (Linn.). Red phalarope  
*Lobipes lobatus* (Linn.). Northern phalarope  
*Steganopus tricolor* Vieill. Wilson's phalarope

Recurvirostridae:

- Recurvirostra americana* Gmel. Avocet  
*Himantopus mexicanus* (Müll.). Black-necked stilt

Scolopacidae:

- Philohela minor* (Gmel.). American woodcock  
*Gallinago delicata* (Ord). Wilson's snipe  
*Arquatella maritima maritima* (Brünn.). Purple sandpiper  
*Pisobia aurita* (Lath.). Sharp-tailed sandpiper  
*P. maculata* (Vieill.). Pectoral sandpiper  
*P. bairdii* (Coues). Baird's sandpiper  
*Limosa fedoa* (Linn.). Marbled godwit  
*Totanus flavipes* (Gmel.). Yellow-legs  
*Heteractitis incanus* (Gmel.). Wandering tattler  
*Bartramia longicauda* (Bechst.). Bartramian sandpiper

Charadriidae:

- Charadrius dominicus dominicus* (Müll.). Golden plover  
*Oxyechus vociferus* (Linn.). Killdeer

Aphrízidae:

- Arenaria interpres interpres* (Linn.). Turnstone

Gallinae:

Tetraonidae:

- Bonasa umbellus umbellus* (Linn.). Ruffed grouse

Raptores:

Buteonidae:

- Ictinia mississippiensis* (Wils.). Mississippi kite

<sup>3</sup> Check list of North American birds, 3d ed., p. 1-430, American Ornithologists' Union, 1910.

## Coccyges:

## Cuculidae:

- Coccyzus americanus americanus* (Linn.). Yellow-billed cuckoo  
*C. erythrophthalmus* (Wils.). Black-billed cuckoo  
*Cuculus canorus telephonus* Heine. Kamchatka cuckoo

## Pici:

## Picidae:

- Dryobates pubescens pubescens* (Linn.). Downy woodpecker  
*D. nuttallii* (Gamb.). Nuttall's woodpecker  
*Sphyrapicus varius varius* (Linn.). Yellow-bellied sapsucker  
*S. thyroideus* (Cass.). Williamson's sapsucker  
*Melanerpes erythrocephalus* (Linn.). Red-headed woodpecker  
*Asyndesmus lewisi* Riley. Lewis's woodpecker  
*Colaptes auratus auratus* (Linn.). Flicker

## Macrochires:

## Caprimulgidae:

- Antrostomus carolinensis* (Gmel.). Chuck-will's-widow  
*Chordeiles virginianus virginianus* (Gmel.). Nighthawk  
*C. acutipennis texensis* Lawr. Texas nighthawk

## Cypselidae:

- Chaetura pelagica* (Linn.). Chimney swift  
*C. vauxi* (J. K. Towns.). Vaux's swift  
*Aënonautes melanoleucus* (Baird). White-throated swift

## Trochilidae:

- Calypte anna* (Less.). Anna's hummingbird  
*Selasphorus rufus* (Gmel.). Rufous hummingbird

## Passeres:

## Tyrannidae:

- Tyrannus tyrannus* (Linn.). Kingbird  
*T. verticalis* Say. Arkansas kingbird  
*T. vociferans* Swains. Cassin's kingbird  
*Myiarchus crinitus* (Linn.). Great-crested flycatcher  
*Sayornis phoebe* (Lath.). Phoebe  
*S. sayus* (Bonap.). Say's phoebe  
*S. nigricans* (Swains.). Black phoebe  
*Myiochanes virens* (Linn.). Wood pewee  
*M. richardsonii richardsonii* (Swains.). Western wood pewee  
*Empidonax flaviventris* (W. M. & S. F. Baird). Yellow-bellied flycatcher  
*E. difficilis difficilis* Baird. Western flycatcher  
*E. virescens* (Vieill.). Acadian flycatcher  
*E. traillii traillii* (Aud.). Traill's flycatcher  
*E. minimus* (W. M. & S. F. Baird). Least flycatcher  
*E. wrightii* Baird. Wright's flycatcher  
*E. griseus* Brewst. Gray flycatcher

## Corvidae:

- Pica pica hudsonia* (Sab.). American magpie  
*Cyanocitta cristata cristata* (Linn.). Blue jay  
*C. stelleri stelleri* (Gmel.). Steller's jay  
*Corvus brachyrhynchos brachyrhynchos* Brehm. American crow  
*C. ossifragus* Wils. Fish crow

## Sturnidae:

- Sturnus vulgaris* Linn. Starling

## Icteridae:

- Dolichonyx oryzivorus* (Linn.). Bobolink  
*Molothrus ater ater* (Bodd.). Cowbird

## Passeres (continued):

## Icteridae (continued):

- Xanthocephalus xanthocephalus* (Bonap.). Yellow-headed blackbird  
*Agelaius phoeniceus phoeniceus* (Linn.). Red-winged blackbird  
*A. gubernator californicus* Nels. Bicolored redwing  
*Sturnella magna magna* (Linn.). Meadow lark  
*Icterus spurius* (Linn.). Orchard oriole  
*I. galbula* (Linn.). Baltimore oriole  
*I. bullockii* (Swains.). Bullock's oriole  
*Euphagus cyanocephalus* (Wagl.). Brewer's blackbird  
*Quiscalus quiscula quiscula* (Linn.). Purple grackle

## Fringillidae:

- Leucosticte griseonucha* (Brandt). Aleutian rosy finch  
*Plectrophenax nivalis nivalis* (Linn.). Snow bunting  
*P. hyperboreus* Ridgw. McKay's snow bunting  
*Calcarius lapponicus lapponicus* (Linn.). Lapland longspur  
*Passerculus sandwichensis savanna* (Wils.). Savanna sparrow  
*Zonotrichia leucophrys leucophrys* (J. R. Forst.). White-crowned sparrow  
*Z. albicollis* (Gmel.). White-throated sparrow  
*Junco hyemalis hyemalis* (Linn.). Slate-colored junco  
*Passer domesticus* (Linn.). English sparrow  
*Melospiza melodia melodia* (Wils.). Song sparrow  
*M. lincolni lincolni* (Aud.). Lincoln's sparrow  
*M. georgiana* (Lath.). Swamp sparrow  
*Passerella iliaca iliaca* (Merr.). Fox sparrow  
*Pipilo erythrophthalmus erythrophthalmus* (Linn.). Towhee  
*Passerina amoena* (Say). Lazuli bunting

## Tangaridae:

- Piranga ludoviciana* (Wils.). Western tanager  
*P. erythromelas* (Vieill.). Scarlet tanager  
*P. rubra rubra* (Linn.). Summer tanager

## Hirundinidae:

- Progne subis subis* (Linn.). Purple martin  
*Petrochelidon lunifrons lunifrons* (Say). Cliff swallow  
*Hirundo erythrogastra* Bodd. Barn swallow  
*Iridoprocne bicolor* (Vieill.). Tree swallow  
*Tachycineta thalassina lepida* Mearns. Northern violet-green swallow  
*Riparia riparia* (Linn.). Bank swallow  
*Stelgidopteryx serripennis* (Aud.). Rough-winged swallow

## Bombycillidae:

- Bombycilla cedrorum* Vieill. Cedar waxwing

## Vireonidae:

- Vireosylva olivacea* (Linn.). Red-eyed vireo  
*V. philadelphia* (Cass.). Philadelphia vireo  
*V. gilva gilva* (Vieill.). Warbling vireo  
*Lanius solitarius solitarius* (Wils.). Blue-headed vireo  
*Vireo griseus griseus* (Bodd.). White-eyed vireo  
*V. bellii bellii* Aud. Bell's vireo  
*V. bellii pusillus* Coues. Least vireo

## Mniotiltidae:

- Mniotilta varia* (Linn.). Black-and-white warbler  
*Helmitheros vermivorus* (Gmel.). Worm-eating warbler  
*Dendroica aestiva aestiva* (Gmel.). Yellow warbler  
*D. coronata* (Linn.). Myrtle warbler  
*D. auduboni auduboni* (Townsend). Audubon's warbler

## Passeres (continued):

## Mniotiltidae (continued):

- D. dominica dominica* (Linn.). Yellow-throated warbler  
*Oporornis tolmiei* (J. K. Towns.). Macgillivray's warbler  
*Geothlypis trichas trichas* (Linn.). Maryland yellowthroat  
*Icteria virens virens* (Linn.). Yellow-breasted chat  
*Wilsonia pusilla pusilla* (Wils.). Wilson's warbler  
*Setophaga ruticilla* (Linn.). American redstart

## Motacillidae:

- Anthus rubescens* (Tunst.). Pipit

## Mimidae:

- Mimus polyglottos polyglottos* (Linn.). Mocking bird  
*Dumetella carolinensis* (Linn.). Catbird  
*Toxostoma rufum* (Linn.). Brown thrasher  
*T. redivivum* (Gamb.). Californian thrasher

## Troglodytidae:

- Heleodytes brunneicapillus couesi* (Sharpe). Cactus wren  
*Salpinctes obsoletus obsoletus* (Say). Rock wren  
*Catherpes mexicanus punctulatus* Ridgw. Dotted canon wren  
*Thryothorus ludovicianus ludovicianus* (Lath.). Carolina wren  
*Thryomanes bewickii bewickii* (Aud.). Bewick's wren  
*Nannus hiemalis hiemalis* (Vieill.). Winter wren  
*Telmatoedya palustris palustris* (Wils.). Long-billed marsh wren

## Paridae:

- Baeolophus inornatus inornatus* (Gamb.). Plain titmouse  
*Penthestes atricapillus atricapillus* (Linn.). Chickadee  
*P. carolinensis carolinensis* (Aud.). Carolina chickadee  
*P. gambeli gambeli* (Ridgw.). Mountain chickadee  
*P. hudsonicus hudsonicus* (Forst.). Hudsonian chickadee  
*Psaltriparus minimus minimus* (J. K. Towns.). Bush-tit

## Chamaeidae:

- Chamaea fasciata fasciata* (Gamb.). Wren-tit

## Sylviidae:

- Regulus calendula calendula* (Linn.). Ruby-crowned kinglet

## Turdidae:

- Myadestes townsendi* (Aud.). Townsend's solitaire  
*Hylocichla mustelina* (Gmel.). Wood thrush  
*H. fuscescens fuscescens* (Steph.). Veery  
*H. aliciae aliciae* (Baird). Gray-checked thrush  
*H. ustulata ustulata* (Nutt.). Russet-backed thrush  
*H. ustulata swainsoni* (Tschudi). Olive-backed thrush  
*H. guttata pallasii* (Cab.). Hermit thrush  
*Planesticus migratorius migratorius* (Linn.). American robin

The principal families that feed on the adult flies are the Caprimulgidae, the Cypselidae, the Tyrannidae, the Icteridae, the Hirundinidae, the Mniotiltidae, the Troglodytidae, the Paridae, and the Turdidae.

Many species of birds feed on the larvae of crane-flies, the more notable of these being the water-fowl, Anatidae, the shore birds, Scolopacidae, and the thrushes, Turdidae. Sim (1907) has recorded the chestnut-sided warbler, *Dendroica pensylvanica* (Linn.) as feeding on *Tipula* sp.



In Europe the raven and the starling are important, as already stated. Patterson (1908) records the starling as eating great numbers of *Tipula cleracea* and as boring into the soil in search of the larvae of this species.

It will be noted that in the foregoing list no species of doves or pigeons are recorded in this country as feeding on Tipulidae. The following note on an Australian pigeon shows the importance of the larvae as a food for these birds: <sup>4</sup>

Mr. North exhibited the head, crop, and gizzard of a wonga-wonga pigeon (*Leucosarcia picata* Lath.) shot by Mr. H. J. McCooey in a myrtle scrub at Upper Burragorang on the 21st inst. The crop is absolutely crammed with dipterous larvae (*Habromastix cinerascens* Sk.) and undigested portions of them mixed with seeds, berries, and earth appear also in the gizzard. As the larvae are known to be destructive to grass, the wonga-wonga would appear to be deserving of consideration.

*Amphibia*.—Crane-flies, both larvae and adults, form a considerable element of the food of many Amphibia. The studies by Needham (1905:13) show this to be true in the case of the bullfrog, *Rana catesbeiana* Shaw. Munz (1920) studied the food habits of eight species of Anura and found that five fed on crane-fly larvae or adults. These species were *Rana clamitans* Latr., *R. sylvatica* Lec., *R. palustris* Lec., *R. pipiens* Schreb., and *Hyla crucifer* Wied. The following additional records are given:

*Desmognathus fusca* Raf. Dusky salamander. Wings of a *Limnophila* found in a specimen from Ithaca, New York. (A. A. Noyes.)

*Rana clamitans* Latr. Green frog. Two larvae of a *Tipula*, near *dejecta* Walker, found in stomach. (S. W. Frost.)

*Bufo lentiginosus woodhousei* Girard. Centerville, Utah, April 27, 1912. Twenty-six per cent of the food of this species consisted of a large tipulid. (E. R. Kalmbach.)

*Bufo* sp. Washington, D. C., May 17, 1890. One per cent tipulid larvae. (W. L. McAtee.)

*Pisces*.—The larvae of crane-flies furnish favorite morsels for many carnivorous species of fish, and as a consequence they are in considerable demand with fishermen as bait for bass and other game fish. These include the larvae of the larger species of Eriocera and many large semi-aquatic species of *Tipula*, especially *Tipula caloptera* and *T. abdominalis*. Fragments of the adult flies are often found in the stomach contents of fish, notably species of trout, most of these pieces being of individuals that

<sup>4</sup> Linn. Soc. New South Wales. Proc., ser. 2:9:585. 1894.

had fallen into the water or were captured while newly transformed. Forbes (1888) records *Coregonus* and *Hyodon* as feeding on the eggs, and *Notropis* as feeding on the larvae, of crane-flies. Levander (1909:1) records *Perca fluviatilis* Linn. as feeding on larvae of Tipulidae.

#### *Invertebrates*

*Arachnida*.—Some spiders are notable enemies of crane-flies, which fall easy victims while in a helpless, teneral condition. These spiders represent many families, such as the Thomisidae, the Lycosidae, the Attidae, the Epeiridae, and others (Alexander and Lloyd, 1914:15; also, Alexander, 1915c:144). An account of their preying on the larger crane-flies of the genus *Tipula* is given under the discussion of *T. taughanock* (page 1013). In a recent paper Bilsing (1920) has recorded four species of crane-flies eaten by spiders. These spiders represented thirteen species arranged in four families—the Lycosidae, the Attidae, the Epeiridae, and the Agelenidae. J. R. Malloch found a female *Tipula angustipennis* which was being eaten by a crab spider, determined by Mr. Banks as *Xysticus ferox* Htz. The spider did not release its hold until after it was placed in a jar of cyanide.

*Hexapoda*.—Odonata: The following records of dragon-flies found feeding on adult crane-flies are available: *Gomphus vastus* Walsh and *G. ventricosus* Walsh, found feeding on *Tipula bicornis* at South Bend, Indiana, May 30, 1914 (E. B. Williamson); *Helocordulia uhleri* (Selys), found feeding on *Eriocera longicornis* (Alexander, 1915c:152); *Agrion puella* Linn., found feeding on *Erioptera flavescens* (Campion, 1914:498). C. H. Kennedy has sent the writer a male and a female specimen of a small crane-fly, *Teucholabis pabulatoria* Alex., which he found in the mouth of a damselfly, *Hetaerina tricolor* Burm., collected in Guatemala by Professor Hine. Needham and Hart (1901-03 [1901]:47) record the nymphs of *Anax junius* (Dru.) feeding on the larvae of Tipulidae.

Diptera: The adult flies of at least three families of the order Diptera—the Asilidae, the Empididae, and the Scatophagidae—and the larvae of a fourth, Anthomyiidae, are notable enemies of crane-flies. The records of Kirby (1892), Poulton (1906-07), Bromley (1914), Alexander (1915c), and McAtee and Banks (1920) on the first three of these families may be summarized as follows:

Asilidae (robber flies)  
*Lasiopogon cinctus* (Fabr.)

*Neotamias cyanurus* (L.w.) (in copulation with female, the latter with the crane-fly)

*Proctacanthus philadelphicus* Macq.

*Asilus* sp.

*Asilus flavofemoratus* Hine

*Asilus notatus* Wied.

*Asilus paropus* Walk.

Asilinae

The Empididae, or dance flies, are small, predacious flies which are closely related to the robber flies and largely replace them in moist shaded situations. They unquestionably play a most important part in the economy of the Tipulidae, since both groups are practically confined to the same general situations and, in the temperate regions at least, representatives of the two groups are invariably found together. Macquart (Kirby, 1892:229), discussing *Empis livida* Linn., writes as follows: "Among the thousands of pairs which I have noticed resting on bushes or hedges, nearly all the females were engaged in sucking some insect, sometimes small Phryganidae or Ephemerae, but more often Tipulidae. They busy themselves with feeding and perpetuating their species at the same time." Howlett (1907) records *Empis borealis* Linn. as feeding on Tipulidae. The following records are from Poulton (1906-07:380-382): *Empis tessellata* Fabr. preys on *Tipula lunata* Linn., *T. paludosa* Meig., and other species; *Empis livida* Linn. preys on *Dicranomyia* sp. (It is probable that the long-legged flies, Dolichopodidae, likewise play an important rôle in the lives of the Tipulidae, but no records are available to the writer to confirm this belief.)

The Scatophagidae (Cordyluridae), or dung flies, unquestionably play an important part in the lives of the smaller crane-flies (Limnobiinae). The following records indicate this relationship, the last being supplied by Malloch:

Enemy  
*Scatophaga suilla* (Fabr.)

*Scatophaga* sp. (*stercoraria*?)

*Scatophaga* sp.

*Scatophaga stercoraria* (L.) and *squalida* Meig.

Prey

*Nephrotoma lineata* (Scop.) (Poulton, 1906-07, as *histrion* [Fabr.])

*Tipula scripta* Meig. (Poulton, 1906-07)

*Nephrotoma* sp. (2 records, Bromley, 1914)

*Nephrotoma ferruginea* (Fabr.) (3 records, Alexander, 1915 c)

*Tipula* sp. (McAtee and Banks, 1920:30)

*Nephrotoma ferruginea* (Fabr.) (McAtee and Banks, 1920:31)

*Epiphragma solatrix* (O. S.) (McAtee and Banks, 1920:31)

*Tipula lateralis* Meig. (Poulton, 1906-07)

Prey

*Dicranomyia lutea* (Meig.) (Poulton, 1906-07)

*Erioptera* sp. (Poulton, 1906-07)

*Hexatoma megacera* (O. S.) (Alexander, 1915 c)

*Trichocera* (Malloch, 1911)

Comparatively recently the larvae of Anthomyiidae have been found to play a highly important rôle in the economy of other insects living in the same haunts. The very important paper by Keilin (1917) may be consulted in connection with this point. This student found the following Anthomyiidae associated with Tipulidae: *Graphomyia maculata* Scop., feeding on larvae of *Ptychoptera contaminata* (L.) (Keilin, 1917:354-360); *Allognosta agromyzina* Fall., associated with and possibly feeding on the larvae of *Ula macroptera* Macq. (page 360-362 of reference cited); *Phaonia cincta* Zett., feeding on larvae and pupae of *Mycetobia pallipes* (page 362-375 of reference); *Phaonia goberti* Mik, associated with and possibly feeding on the larvae of *Gnophomyia tripudians* Bergr. (page

375-377 of reference); *Mydaea pertusa* Meig., possibly feeding on larvae of Tipulidae (page 393-396 of reference).

A species of *Phaonia* with presumably parasitic habits is discussed on page 732 of this memoir.

Coleoptera: The adults and the larvae of the following species of ground beetles (Carabidae) have been recorded as important enemies of crane-flies (Hyslop, 1910): *Pocillus lucublandus* Say; *Micromaseus femoralis* (Kirby); *Platynus* sp.; *Harpalus pennsylvanicus* Dej.; *H. caliginosus* Fabr. Most of these were recorded by Webster (1893 a:241) as feeding on the injurious crane-fly *Tipula bicornis*.

The larvae of Elateridae (wireworms) are enemies of crane-flies. The writer has seen several feeding on large larvae of *Tipula trivittata*.

Hymenoptera: Ants (Formicidae) undoubtedly capture and devour many crane-flies, these generally being pupae or teneral adults. Hyslop (1910) cites the record of an *Aphaenogaster fulva* Roger which was observed dragging a living adult tipulid over the ground. Chapman (1918:191) records feeding species of *Myrmica* on adult Tipulidae which were readily eaten by the ants in preference to most other insect food. On August 2, 1917, at Larned, Pawnee County, Kansas, along the bank of the Arkansas River, the writer noted a small ant which was dragging a still living pupa of *Gonomyia kansensis* from its burrow in the sand at the bank of the river: The ant had the pupa about the head and carried it off despite its struggles. Both the *Gonomyia* and the formicid were common and the tragedy as described was not accidental.

The Pemphredonidae (Mimesinae) and the Crabronidae, fossorial wasps in the Hawaiian Islands, bear an important relationship to the smaller Tipulidae dwelling in the same haunts. Writing of the Mimesinae, a subfamily of the Pemphredonidae, Perkins (1913:lxxxv) says:

All the Hawaiian species of both genera are true forest insects and most of them may be seen in large numbers, where they occur, flying around ferns and bushes in sunny places. The males are often much more numerous apparently than the females, but this is due to the more retiring habits of the latter, which, when they have begun to provision their nests, frequent dark, shady and damp places in search of their prey. This consists of the endemic Limnobiidae or daddy longlegs, which live in such places. . . . Although I have often watched females of these wasps returning with prey to their burrows, it was always Tipulidae that they carried to the nest. Their burrows are usually made in the ground and are often drilled down from beneath a stone, this no doubt serving to keep the burrow sufficiently dry.

Referring to Limnobiinae, Perkins says (page clxxxii of the same reference):

The species of *Dicranomyia* are endemic, and to the five described, others and perhaps many more will, no doubt, be added. They are common insects, sometimes attracted by light and sometimes observed at rest in the daytime, or on the wing in the dark cavity of some hollow tree. In the latter case a number are usually seen flying together, rising and falling in their flight in the narrow space of a few feet. We have bred one or more species from decayed wood, overgrown with damp moss. These fragile flies are the favourite prey of the endemic predaceous wasps of the family Mimesidae, and some of the Crabronidae likewise gather them. Consequently one may find the females of these wasps investigating damp, dark places, where the *Dicranomyia* are likely to be found, but which ordinarily would have but little attraction for such sun-loving insects.

Writing of the Crabronidae, Perkins says (page lxxxvi of the reference cited):

*Xenocrabro hawaiiensis* on one occasion was caught carrying off *Lispe* [Anthomyiidae] and on another occasion a species of the limnobiid *Dicranomyia*.

De Meijere (1920:59) records *Crabro (Rhopalum) tibiale* as provisioning its nest principally with *Molophilus armatus* Meij.

#### *Parasitic natural enemies*

##### *External parasites*

Besides the predatory forms just considered, the various stages of the existence of many crane-flies are threatened with parasites which are equally effective altho more insidious in their method of attack. There are unquestionably many parasites of crane-flies concerning which nothing at all is known at this time. It is inconceivable that such species as *Holorusia grandis*, *Tipula abdominalis*, and other large and common forms do not serve as hosts for parasites as yet unknown. It is this field of investigation that now promises some of the most valuable results.

*Hexapoda*.—The only parasitic insects of which the writer knows are the dipterous Tachinidae. Glover (1874) states that in Europe certain Tipulæ are destroyed by a proctotrupid parasite of the genus *Diapria* Latreille. Kieffer, in his monograph of the Diapriidae (1911), does not mention this and the writer has not seen it referred to elsewhere. It is probable that the reference pertains to some of the smaller Tipula-like forms of another family. However, it is very strange that one or more of the many families of parasitic Hymenoptera do not infest some stage of the Tipulidae, and it may be confidently predicted that such parasites will one day be discovered.

Tachinidae: Most of the species of the interesting genus *Siphona* (Bucentes) are parasitic on the caterpillars of various Lepidoptera. Two have been recorded as parasites of the larvae of species of *Tipula*. The better-known of these is *Siphona cristata* (Fabr.), a constant parasite of the larvae of *Tipula maxima* (Beling 1886, Czizek 1913, Riedel 1913, Thompson 1915). The method of attack by the parasite has been described by Roubaud (1906). The large, massive larvae of this species of crane-fly are amphibious or semi-aquatic, living near the margins of streams and other bodies of water. They live in the mud or in the water beneath the surface, at times coming up to breathe the air thru the two large spiracles at the posterior end of the body. It is at this time, when the spiracular disk is projected thru the surface film and the spiracles are open, that the tachinid is supposed to dart down and deposit its eggs in the open stigmata. The young parasite is somewhat elongated, yellowish orange in color, and about a millimeter in length, and is completely inclosed in a firm, membranous cyst. It is connected with one of the two principal tracheal trunks of the host by a sort of chitinized calyx which opens into the trachea. At the time of their pupation the parasites detach their organs of fixation, and with their heads perforate the skin of the host and enter the humid earth. In nature this departure coincides almost exactly with the time of leaving the water by the host for the purpose of pupation in the earth. The pupal duration of the parasite is about three weeks. Rennie (1912) gives *Siphona geniculata* (De Geer) as a parasite of an undetermined species of *Tipula*.

Species of the genus *Admontia* are important parasites of the larvae of crane-flies. In Europe, *Admontia amica* (Meig.) is parasitic on species of *Tipula*, while in America *A. pergandei* Coq. is an important parasite of the smoky crane-fly, *Tipula cinctans* (Hyslop, 1910:128). In the collection of the Illinois Natural History Survey are several specimens of *A. pergandei* bred from larvae of the smoky crane-fly (larvae taken at Urbana, Illinois, parasites emerged October 9 to 25, 1900). Averin (1913) and Lutchnik (1916), in Russia, record the larvae of a *Tipula*, in one case at least — that of the economic species *T. oleracea* — as being very heavily infested by an undetermined tachinid which may have been the *Admontia* species mentioned above.

A third genus of Tachinidae, *Sturnia*, has recently been reported to the writer by J. D. Tothill as being parasitic on the larva of a large crane-

fly, undoubtedly a tipuline form. The larva was found at Chelsea, near Ottawa, on May 27, 1906, by Dr. James Fletcher, the parasite issuing on June 27. The tachinid is to be described as *Sturmia tipulensis* Tothill.

The genus *Trichoparia* is parasitic on *Ctenophora* and its allies.

Altho the Tachinidae are the only dipterous parasites that are definitely known from the Tipulidae, the writer has a record of a species of *Phaonia*, of the family Anthomyiidae, which possibly is a parasite. Among some Diptera sent to Malloch for naming was one specimen of a *Phaonia* bearing the label "Bred from tipulid pupa, acc. no. 14022." The writer is indebted to R. H. VanZwaluwenburg for the following facts concerning this specimen: The material was taken by Harry L. Parker on June 6, 1916, on South Mountain, near Hagerstown, Maryland. Under litter and growth of Virginia creeper on rock a tipulid pupa was found. The pupa had been eaten out inside and there was a hole in the side of its body. About a half inch away from this pupa was found a newly formed pupa of an anthomyiid fly. The adult emerged on June 23, 1916, and was pinned. It is possible, of course, that the *Phaonia* was merely feeding on the tipulid, as recorded for this genus elsewhere in this paper (page 728), and that the species is a predatory enemy rather than a parasite.

*Arachnida*.—Young mites of species of *Trombidium*, *Rhyncholophus*, and other genera of *Arachnida*, are frequently found attached to the body and the wings of adult crane-flies. This attachment is by anal filaments, and it is doubtful whether any real injury results to the host therefrom. These cases are probably instances of phoresy to provide a means of dispersal of the mite. At various times the writer has found in northeastern America a large number of adult crane-flies so infested, and practically every genus and many species are included among the number.

*Fungi*.—Among the enemies of crane-flies, both to the immature and to the adult stages, probably none are more lethal in their action than certain parasitic fungi. The largest groups of insect-fungous parasites are the Entomophthoraceae (Phycomycetes) and the Laboulbeniaceae (Ascomycetes). Dr. Roland Thaxter informs the writer that, altho the latter group infest other Diptera, he has never seen specimens on Tipulidae, and none have been recorded in the literature. The writer is greatly indebted to Dr. Thaxter and to A. T. Speare, Government Mycoentomologist, for data on this subject. Dr. Thaxter sent to the writer for determination a considerable number of specimens of crane-flies with their para-

sites, these including the types of many of his Entomophthoraceae and some new species not yet described. ‡ From these data and the literature the following notes may be given:

Class, Phycomycetes

Family, Entomophthoraceae

1. *Entomophthora (Empusa) pachyrrhinae* Arthur. On the larvae of *Nephrotoma ferruginea*; a manuscript name.
2. *E. (E.) sepulchralis* (Thaxt.). On an adult *Tipula* of the *subunicolor* group.
3. *E. (E.) caroliniana* (Thaxt.) [= *E. arrenoctona* Giard]. On an adult male of *Tipula entomophthorae*.
4. *E. (E.) arrenoctona* Giard. On male adults of *Tipula paludosa* (Giard 1888, Villeneuve 1910, Picard 1913).
5. *E. (E.) tipulae* Fres. On *Tipula maxima* (Lohde, 1872).
6. *E. (E.) conglomcrata* (Sorokin). A species which is probably this one is recorded by Thaxter on larvae and adults of Tipulidae.
7. *E. (E.) sphaerosperma* Fres. Recorded by Thaxter from adult Tipulidae.
8. *E. (E.) grylli* Fres. Recorded on at least two occasions from the adult flies of *Tipula ultima* Alex. [= *T. flavicans* Fabr.].
9. *E. (E.) punctata* Thaxt., ms. On adult females of *Pseudolimnophila noveboracensis*.
10. *E. (E.) dipterigena* (Thaxt.). On the adult flies of several genera of Limnobiinae, as follows: *Molophilus hirtipennis*, *Limnophila aprilina*, *Pseudolimnophila nigripleura*, *Utomorpha pilosella*, *Pentoptera albitarsis*.
11. *Isaria* sp. On adults of *Dicranomyia pubipennis*. Additional undetermined species of this same genus on various tropical Tipulidae.

Class, Hyphomycetes.

Family, Mucediniaceae.

12. *Sporotrichum densum* Link. On *Tipula cunctans* Say [= *T. infuscata* Lw.] (Hyslop, 1910:130).

### Internal parasites

Crane-fly larvae and adults are infested by numerous protozoan and bacterial parasites, the more conspicuous and constant being the Sporozoa (Gregarinidae) and the Bacteria. General references to this subject may be found in Léger (1892), Labbé (1899), and Minchin (1903). More especial references are made to the parasites of Ptychoptera by Léger and Duboscq (1909), to those of Diceranota by Miall (1893: 237), to those of Ctenophora by Anthon (1908:542), and to those of *Tipula* by Mackinnon (1913). In the case of Ctenophora the parasites were frequent between the cells of the alimentary canal, especially in the proventricular caeca. The writer has found a large gregarine very abundant in the alimentary canal of the larva of *Pedicia albivitta*, many of the individuals being very heavily infested. Gamkrelidze (1913 b) records gregarine and nematode parasites in *Gnophomyia* larvae.



The more important recorded protozoan parasites are as follows:

Class, Sporozoa.

Subclass, Telosporidia.

Order, Coccidiomorpha.

Family, Adeleidae.

1. *Adelea tipulae* Léger. In the intestine of species of *Tipula*.

Order, Gregarinida.

Family, Gregarinidae.

2. *Hirmocystis polymorpha* (Léger, 1892:113). In the intestine of the larva of *Limnobia* sp.
3. *H. ventricosa* (Léger, 1892:111). In the alimentary canal of *Tipula oleracea*, *Nephrotoma pratensis*, and other species.
4. *Gregarina longa* (Léger, 1892:117). In the alimentary canal of a species of *Tipula*.

Family, Actinocephalidae.

5. *Actinocephalus tipulae* Léger (1892:141). In the alimentary canal of *Tipula* larvae. Probably the same species has been recorded from the larvae of a species of *Ctenophora*.
6. *Pileocephalus striatus* Léger & Duboscq (1909:887-893). In the mid-intestinal epithelium of the larva of *Ptychoptera contaminata*. The *Pileocephalus* live in the epithelium of the mid-intestine, attaching themselves to the epithelial cells and hypertrophying the adjoining tissues. They obtain their nutriment from the food that penetrates into the cells.

Family, Stylorhynchidae.

7. Near *Stylorhynchus* (Miall, 1893:237). In the stomach of larvae of *Dicranota bimaculata*.

Subclass, Neosporidia.

Order, Cnidosporidia.

Suborder, Microsporidia.

Family, Nosematidae.

8. *Nosema strictum* Monz. (Moniez, 1887). In muscles, conjunctive tissue, and other parts of *Nephrotoma pratensis*.
9. *Gurleya francottei* Léger & Duboscq (1909:894). In the epithelium of the mid-intestine of the larva of *Ptychoptera contaminata*.

Class, Flagellata.

Family, Trypanosomidae (Herpetomonadidae).

10. *Crithidia campanulata* Léger. At the juncture of the mid- and hind-intestines in the larva of *Ptychoptera contaminata* (Léger & Duboscq, 1909:898-900).

The writer is indebted to Dr. R. Kudo for assistance in determining the terminology used above.

Bacteria are frequently found in crane-fly larvae. Léger and Duboscq (1909:900-901) record undetermined spirochaetes in the epithelial cells of the posterior part of the mid-intestine of *Ptychoptera contaminata*. Dr. Hugh Glasgow, of the Geneva Experiment Station, informs the writer that in Illinois a large tipulid larva, probably that of *Tipula abdominalis*, living in the leaf-drift of prairie streams, is heavily infested with bacteria. Most of the specimens observed had an abundance of small coccus and spirochaete forms, with occasional specimens of a gigantic bacillus measuring from forty to eighty microns in length and disporous. These large bacilli infest the hind-gut of the larva.

## HISTORICAL SUMMARY OF THE IMMATURE STAGES

The discovery and description of the immature stages of crane-flies has by no means kept pace with the taxonomic work that has been done on the adult flies. There are a very large number of common species in every country concerning whose early stages nothing at all is known, and the knowledge that exists concerning a comparatively small number results from the labors of a few students. Among these may be mentioned Beling, Mik, Brauer, Hart, Needham, and Malloch. Some other workers have given excellent descriptions of single species, while still others have contributed important treatises on the anatomy, morphology, histology, and related subjects of the different species. The descriptions of the earlier workers are, for the most part, of historical interest only, but in a few cases they are exceptional and are still the main source of information concerning certain species. Many of the foremost workers on the taxonomy of the adult flies have summarized the earlier writings on the immature stages but have themselves contributed little to the subject, among these being Schiner, Loew, Osten Sacken, Skuse, and Brunetti. The following chronological summary gives an indication of the more important work that has been done on this phase of the subject:

1722.....	Frisch.....	<i>Tipula oleracea</i>
1740.....	De Réaumur.....	Ptychoptera, <i>Tipula</i>
1776.....	De Geer.....	Phalacrocera, Ctenophora, <i>Tipula</i>
1803.....	Schellenberg.....	<i>Cylindrotoma</i>
1829.....	Stannius.....	<i>Limnobia xanthoptera</i> [= <i>bifasciata</i> ]
1832 (Posthumous).	Lyonet.....	Ptychoptera
1833.....	Bouché.....	<i>Dictenidia</i> sp., <i>Tipula</i> sp.
1834.....	Von Röser.....	<i>Hexatoma nigra</i>
1838.....	Boie.....	<i>Cylindrotoma</i>
1840.....	Dufour.....	Trichocera
1842.....	Zeller.....	<i>Cylindrotoma</i>
1846.....	Bremi-Wolf.....	Trichocera, <i>Limnobia xanthoptera</i> [= <i>bifasciata</i> ], <i>Nephrotoma</i>
1849.....	Perris.....	Trichocera, <i>Limnophila dispar</i> , <i>Ula</i> , Tanyptera
1854.....	Brauer, Egger, and Frauenfeld.....	<i>Chionea</i>
1867.....	Nowicki.....	<i>Dactylolabis wodzickii</i>
1872.....	Weyenbergh.....	Ctenophora, Dictenidia: anatomy and histology
1873-86.....	Beling.....	The immature stages of 69 species of European Tipulidae, including 20 species of <i>Tipula</i>
1875-76.....	Hammond.....	<i>Tipula oleracea</i> : anatomy
1876.....	Grobben.....	Ptychoptera: anatomy
1876-1902.....	De Rossi.....	<i>Liogma glabrata</i> , <i>Tanyptera atrata</i>
1880.....	Hermann.....	<i>Tanyptera atrata</i>
1882-1900.....	Mik.....	<i>Discobola</i> , <i>Elliptera</i> , <i>Dactylolabis</i> , <i>Tipula rufina</i> , etc.

- 1883..... Brauer..... Important work on the classification of the immature stages
- 1884..... Gereke..... *Rhamphidia longirostris*, *Tanyptera atrata*
- 1890..... Van Gehuchten..... Ptychoptera: histology of alimentary canal
- 1893-97..... Miall..... Dicranota, Phalacroceera
- 1895 [1898]..... Hart..... Pioneer American worker; Bittacomorpha, etc.
- 1897..... Bengtsson..... Phalacroceera: anatomy
- 1900-09..... Johnson..... Teucholabis, Aeshnasoma, etc.
- 1901..... Kellogg..... *Holorusia grandis* (as *rubiginosa*): anatomy
- 1901..... Muggenberg..... *Liogma glabrata*
- 1901-08..... Needham..... *Dicranomyia simulans*, *Pedicia albivitta*, *Rhaphidolabis*, *Tipula ultima* (as *flavicans*)
- 1907-08..... Steinmann..... *Triogma trisulcata*
- 1908..... Holmgren..... Phalacroceera: mouth parts
- 1908..... Anthon..... *Ctenophora angustipennis*: anatomy
- 1908-09..... Pastejrk..... *Limnobia xanthoptera*, *Ctenophora*
- 1908-09..... Müller..... *Triogma trisulcata*
- 1909..... Brocher..... *Tipula lunata*
- 1909..... Greene..... *Tipula trivittata*
- 1909..... Thienemann..... *Dicranomyia trinotata*
- 1910..... Brown..... *Tipula maxima*: anatomy
- 1910..... Hyslop..... *Tipula cunctans* (as *infusata*)
- 1911..... Vimmer..... *Ctenophora*, *Tipula oleracea*: mouth parts
- 1911-16..... De Meijere..... *Trentepohlia pennipes*, *Tipulodina pcdata*, and several European species
- 1912..... Keilin..... Trichocera: morphology
- 1913..... Caudell..... *Tipula ultima* (as *flavicans*)
- 1913..... Gerbig..... Anatomy of the respiratory system of many European species of Tipulidæ
- 1913..... Picado..... *Trentepohlia bromeliadicola*
- 1914..... Del Guercio..... *Tipula oleracea*
- 1914-16..... Topsent..... *Ptychoptera albimana*
- 1914-19..... Alexander..... Dicranoptycha, Ula, Eriocera, Hexatoma, Pentoptera, Liogma, Prionocera, *Tipula arctica*
- 1915..... Swezey..... *Dicranomyia foliocuniculator*
- 1915..... Lovett..... *Ctenophora angustipennis*
- 1915..... Wesenberg-Lund..... Dicranota, Phalacroceera, *Triogma*
- 1915-17..... Malloch..... *Limnobia immatura*, *Gnophomyia*, and, in his uncertain material, *Antocha*, *Elephantomyia*
- 1916-17..... Rennie..... *Tipula paludosa*
- 1918..... Cameron..... *Cylindrotoma splendens*
- 1920..... Hudson..... *Gnophomyia rufa*, *Limnophila sinistra*
- 1920..... Lenz..... Thaumastoptera, *Cylindrotominae*

## ECONOMIC IMPORTANCE

The larvae of some species of crane-flies, almost all belonging to the genera *Tipula* and *Nephrotoma*, often do considerable damage to various crop species, the injury being largely caused by the larvae devouring the roots and thus killing the plants. Certain of these crane-fly species, as *Tipula oleracea*, *T. paludosa*, and *Nephrotoma maculata* in Europe, and *Tipula bicornis* and *Nephrotoma ferruginea* in America, have long been known, but several others have come into prominence only within the

past ten years, notably *Tipula parva* Lw. (supposition) in Japan, and *T. cunctans* and *T. simplex* in North America. The more important outbreaks of this nature which have been recorded are as follows.

*Species affecting herbaceous plants*

*Nephrotoma ferruginea* has been reported by Webster (1891, and 1893 a: 243-245) as injuring young wheat in Indiana, the injury in some cases being estimated at fifty per cent.

*Tipula oleracea* is the best-known European species in this group, infesting a wide range of plants. The more important outbreaks of this species as recorded are as follows: Ewert (1899) reports from Germany an unusually severe attack, in which the larvae of this species and of *Tipula nigra* did a considerable amount of damage to the roots of grasses. They were so abundant that from ten to twenty could be found in the area of one square foot. Grasses in the infested area were completely destroyed. Ormerod (1885, 1886, 1900) records serious injury by *T. oleracea* to pastures and meadows in England, and recommends applications of guano either alone or mixed with salt, kainit, or superphosphate. This species has been recorded also as being a serious pest in Ireland (Anonymous reference, 1904b) in grainfields and meadows, and careful plowing and the use of fertilizers for its control are advised. Schoyen (1903), in Norway, reports serious injury to meadows and pastures, as well as to cereals and young cabbage plants. Del Guercio (1914) records serious injury in the Italian rice fields.

A few additional outbreaks of *Tipula oleracea* may be mentioned. Barthou (1913) records injury to canes (raspberry, strawberry, and others) in France. Désoil (1914) reports injury to meadows in France, and Ritzema Bos (1915) to meadows in Holland.

*Tipula paludosa* is reported by Lind, Rostrup, and Kolpin Ravn (1914 and 1915) as causing serious injury to oats and barley in Denmark, and Rennie (1916 and 1917) reports the same species as injuring corn and pastures in England.

*Tipula flavolineata* is reported by Sopotzko (1916) as injuring clover in Russia. The specific identity, however, is probably erroneous, as this species lives almost entirely in decaying wood (Beling, 1873b: 581-582).

Onuki (1905) records *Tipula parva* Lw. (supposition) as one of the serious rice pests in Japan. In some localities from sixty to ninety per

cent of the seedlings have been destroyed by this species. The larvae apparently cannot exist in water for any long period of time, and so may be killed by flooding the fields for from six to thirty-six hours. Del Guercio (1914) offers the same recommendation for the control of *T. oleracea* in the Italian rice fields.

*Tipula bicornis* has been found in grass and clover lands in Illinois by Forbes (1890), and on clover in Indiana by Webster (1892 a).

*Tipula cunctans*, as recorded by Hyslop (1910:126, as *T. infuscata*), works largely on Japan clover and other leguminous plants. The larvae are often exceedingly numerous, as many as two hundred having been found in an area covering but little more than one square foot of soil. They destroy the plants by devouring the roots and sucking the juices. It is recommended that the infested fields be plowed under before the adult flies emerge (in the autumn), and the following season be planted to corn or potatoes or else left fallow.

*Tipula simplex* has been found on pasture land and alfalfa in California by Doane (1908) and by Carnes and Newcomer (1912). Doane (cited by Hyslop, 1910:120-121) also reports an outbreak of this species on wheat and grass lands and in clover fields in central California in 1907, and states that thousands of acres of these crops were stripped of their verdure.

The following summary gives the various species of plants that are damaged or destroyed by crane-flies in general. Very many of the injuries reported for *Tipula oleracea*, however, are omitted.

Family	Crop	Species	Authority
Gramineae.....	Wheat.....	<i>Nephrotoma ferruginea</i>	Webster (Indiana), 1891, 1893 a
	Wheat.....	<i>Tipula simplex</i> .....	Hyslop (California), 1910
	Wheat.....	Tipulidae.....	Stedman (Missouri), 1902
	Corn.....	<i>Tipula paludosa</i> .....	Rennie (England), 1917
	Corn.....	<i>Tipula</i> sp.....	Kirk (New Zealand), 1895
	Barley.....	<i>Tipula paludosa</i> .....	Lind, Rostrup, and Kolpin Ravn (Denmark), 1915
	Barley.....	<i>Tipula</i> sp.....	Wahl and Müller (Germany), 1914
	Barley.....	<i>Tipula oleracea</i> .....	Goriatchkovsky (Russia), 1915
	Oats.....	<i>Tipula paludosa</i> .....	Lind, Rostrup, and Kolpin Ravn (Denmark), 1914, 1915
	Rice.....	<i>Tipula oleracea</i> .....	Del Guercio (Italy), 1914
	Rice.....	<i>Tipula parva</i> .....	Onuki (Japan), 1905
	Cereals.....	<i>Tipula oleracea</i> .....	Anonymous reference (Ireland), 1904 b
	Cereals.....	<i>Nephrotoma pratensis</i> ..	Hollrung (Germany), 1898

Family	Crop	Species	Authority
Gramineae . . . . .	Meadows and pastures . . . . .	<i>Tipula bicornis</i> . . . . .	Forbes (Illinois), 1890
	Meadows and pastures . . . . .	<i>Tipula simplex</i> . . . . .	Carnes and Newcomer (California), 1912
	Meadows and pastures . . . . .	<i>Tipula oleracea</i> . . . . .	Anonymous reference (Ireland), 1904 b
	Meadows and pastures . . . . .	<i>Tipula oleracea</i> . . . . .	Désoil (France), 1914
	Meadows and pastures . . . . .	<i>Tipula paludosa</i> . . . . .	Rennie (England), 1917
	Meadows and pastures . . . . .	<i>Tipula</i> sp. . . . .	MacDougall (Scotland), 1915
	Meadows and pastures . . . . .	<i>Tipula</i> sp. . . . .	Ritzema Bos (Holland), 1915
	Meadows and pastures . . . . .	<i>Tipula</i> sp. . . . .	Marchal and Prillieux (France), 1916
	Meadows and pastures . . . . .	<i>Tipula oleracea</i> . . . . .	Ormerod (England), 1885, 1883, 1900
	Liliaceae . . . . .	Tulips (bulbs) . . . . .	<i>Nephrotoma maculata</i> . . . . .
Onions and garlic . . . . .		<i>Tipula oleracea</i> . . . . .	Vassiliev (Russia), 1915
Cruciferae . . . . .	Cabbage . . . . .	<i>Tipula oleracea</i> . . . . .	Schoyen (Norway), 1903
	Cabbage . . . . .	<i>Tipula oleracea</i> . . . . .	Averin (Russia), 1913
	Cabbage . . . . .	<i>Tipula oleracea</i> . . . . .	Goriatchkovsky (Russia), 1915
	Cabbage . . . . .	<i>Tipula</i> sp. . . . .	Lutchnik (Russia), 1916
Polygonaceae . . . . .	Buckwheat . . . . .	<i>Nephrotoma</i> sp. . . . .	Lutchnik (Russia), 1916
	Buckwheat . . . . .	<i>Tipula oleracea</i> . . . . .	Goriatchkovsky (Russia), 1915
Rosaceae . . . . .	Roses . . . . .	<i>Nephrotoma lineata</i> . . . . .	Schaufuss (Germany), 1901
	Raspberry and strawberry . . . . .	<i>Tipula oleracea</i> . . . . .	Barthou (France), 1913
Leguminosae . . . . .	Clover . . . . .	<i>Tipula bicornis</i> . . . . .	Webster (Indiana), 1892a
	Clover . . . . .	<i>Tipula bicornis</i> . . . . .	Forbes (Illinois), 1890
	Clover . . . . .	<i>Tipula flavolineata</i> . . . . .	Sopotzko (Russia), 1916
	Clover . . . . .	<i>Tipula oleracea</i> . . . . .	Del Guercio (Italy), 1914
	Japan clover . . . . .	<i>Tipula cunctans</i> . . . . .	Hyslop (Tennessee), 1910
	Alfalfa . . . . .	<i>Tipula simplex</i> . . . . .	Carnes and Newcomer (California), 1912
	Peas . . . . .	<i>Tipula paludosa</i> . . . . .	Lind, Rostrup, and Kolpin Ravn (Denmark), 1914
Umbelliferae . . . . .	Carrots . . . . .	Tipulidae . . . . .	Lesne (France), 1905
Solanaceae . . . . .	Potatoes . . . . .	<i>Tipula oleracea</i> . . . . .	Beling (Germany), 1887
	Potatoes . . . . .	<i>Tipula lateralis</i> . . . . .	Cameron (Scotland), 1917
	Potatoes, stored . . . . .	Trichocera . . . . .	Johannsen (Maine), 1910
	Potatoes, stored . . . . .	Trichocera . . . . .	Carpenter (Ireland), 1912
Compositae . . . . .	Cardoon . . . . .	<i>Tipula</i> sp. . . . .	Lesne (France), 1908

### *Species affecting woody plants*

Species that injure or destroy living trees or shrubs are not common, and the damage that they do is almost entirely of a minor nature.

*Ctenophora angustipennis* is recorded as doing secondary damage to prune trees in Oregon (Lovett, 1915). Fuchs (1900) records four species — *Tipula scripta*, *T. marginata*, *Nephrotoma cornicina* [as *iridicolor*], and *N. quadrifaria* — as injuring young plants of both deciduous and coniferous species. Taschenberg (1880:54) describes *Tipula flavolineata* and *Nephrotoma crocata* as destroying year-old seedlings of fir and larch. Matsumura (1916:466) records the larva of *Nephrotoma makiella* as injurious to the mulberry (*Morus*) in Formosa.

#### METHODS OF EXPERIMENTAL PROCEDURE

##### *Collecting*

The larvae of the larger species of crane-flies, such as those of the genera *Tipula*, *Pedicia*, and *Eriocera*, may be readily discovered in the field, but the immature stages of the smaller Tipulidae are not so easily found. It is necessary to bring into the laboratory large quantities of the material in which the immature stages are supposed to be living, and there to examine it with considerable care. In the case of mud or earth, it is better to wash away the finer silt particles and examine the residue. The writer has found it most convenient to use a Simplex water-net, placing in it a handful of earth and holding it underneath a running faucet. The mesh of this net is of sufficient diameter to retain any crane-fly larvae except the very young stages. When the fine particles have been removed the residue can be examined in water in white enameled or porcelain dishes, and the larvae and pupae may be easily detected in the water. Numerous associated forms of life will be found, and these should be preserved or recorded.

The immature stages of wood-inhabiting species are most easily found in the field by a patient and painstaking examination of the removed bark and the exposed parts of the tree stump or trunk. Moss-inhabiting species, such as those of *Liogma* and many tipuline forms, may be shaken from their haunts onto a piece of white oilcloth, where they are easily observed.

##### *Killing and preserving*

The larvae and pupae to be studied should be dropped into boiling water for a brief instant. The larva, on contact with the water, at once expands to its maximum size, the spiracular disk is spread wide open, and the anal

gills are completely everted. The specimens should be placed in 4-per-cent formalin or, preferably, 70- to 75-per-cent alcohol. Large, fleshy larvae, such as those of the Tipulinae, should be slit at the third or the fourth abdominal segment to allow easy penetration of the preservative. Other notes on preserving material are given by Banks (1909) and by Williamson (1916).

### *Study*

In the study of the gross material, both the binocular and the compound microscope may be used. A special word on the preparation of the head capsule of the larva may be helpful. In removing the head capsule from the body it is generally easiest to slit longitudinally the thoracic segments back of the head and pull the capsule thru this incision. In forms with compact and massive capsules, the thorax and the head may be snipped off and the head everted after the manner of turning the finger of a glove. The capsule should be left in a 5-per-cent solution of caustic potash until all the fleshy parts have been removed. It should be dissected out so that all the mouth parts are isolated and rendered distinct for study. Then follow the usual processes of washing and dehydration, and the final mounting in canada balsam.

Various means are available for examining the spiracular disk. The specimen may be placed in a watch crystal under water and held firmly in place by a piece of glass, as, for example, a broken microscope slide. By holding a heavy piece of glass over the anterior end of the body, the posterior end may be bent at a right angle and bolstered in place by two or three other glass fragments so that the disk is directed straight upward and its details are easily examined. Other methods, such as embedding the anterior end of the larva in paraffin in a deep dish and submerging the body, may be followed. It must be emphasized that in alcoholic gross material the study should be conducted under alcohol or water.

The measurements of the pupa — abbreviated in the text as *d.-s.* (dextro-sinistral) for the width and *d.-v.* (dorso-ventral) for the depth — are taken opposite the wing pad.

### *Rearing*

In order to rear the immature stages of crane-flies successfully the natural haunts should be imitated as closely as possible. In the case of wood-inhabiting species, large pieces of the material in which the larvae



are working may be brought into the laboratory and placed in the breeding cages. This method may be followed with species of Tanyptera, Ctenophora, and other genera.

Fungicolous species, as a rule, also are easily reared. The entire fungus in which the specimen is found should be brought into the laboratory and placed in a jar on a bed of clean sand. The sand takes up the liquids produced by the disintegration of the fungus and provides a place for pupation. Species of *Limnobia*, *Ula*, and other forms are reared in this manner.

The chances for error in rearing are many. One must be certain that there are no other larvae in the breeding jar with the one that is being reared; else one of these other larvae might transform and emerge first, and the results would be altogether misleading. The writer has had this happen in his breeding cages, even after the utmost care had been used to guard against it. Beling, the great German student of the immature stages of crane-flies, made a few mistakes in the same way; as, for example, in the case of his *Trimicra*, the larvae that he describes being pedicellate and probably a species of *Dicranota* or the young larvae of a *Tricyphona*. What happened, presumably, was that Beling found these pedicellate larvae and placed them in rearing; in the same cage, but unknown to the breeder, was a larva of *Trimicra* which emerged, and naturally Beling thought it came from one of the larvae that he had placed in rearing. It is usually easy to check up such errors. Thus, the writer has placed in rearing the larvae of Penthoptera and, to his surprise, had adults of *Limnophila adusta* emerge. Obviously larvae of *L. adusta* got into the cage in spite of precautions, and emerged first. When closely related species are concerned, however, it becomes a hard matter to straighten the tangle. Hence a species cannot be reared too many times, since each rearing checks up the previous results.

The precaution to be taken in the case of mud-inhabiting or sand-inhabiting species is to see that the mud or sand is baked or thoroly desiccated in order to destroy all life in it. Then it may be remoistened, and the larva or larvae chosen to rear may be put into the earth without the chance that some unknown larva may be lurking in the medium and may emerge first, and so bring about confusion.

The writer has found that the most satisfactory way to rear small tipulid larvae found in earth or sand is to place a small amount of baked

earth from their haunts in a 4- or 6-dram shell vial, moisten the earth, and place a thin layer of moss over it. The vial should not be corked, but should be covered with a piece of cheesecloth held in place by rubber bands. In the case of carnivorous species, as the Hexatomini and the Pediciini, individuals should be isolated in vials, but the herbivorous species may be bred in large numbers in single containers. The predatory forms are usually distinguished without difficulty by their extremely active, snakelike motions, the other species being more sluggish in their actions.

Strictly aquatic forms, such as *Antocha*, are reared only with great difficulty. These species can survive only in rapidly flowing, well-aërated water, and it is usually a difficult matter to imitate this condition successfully. The best plan is to place rearing cages in the natural haunts of the larvae. This can be done if a suitable location is sufficiently close at hand and free from disturbance by inquisitive passers-by. The chief source of danger to breeding cages in natural streams is that a sudden rise of water may suffocate the larvae or wash the cages downstream, or else may destroy the contents of the cage by a thick deposition of silt. Lotic species that are discovered in streams far removed from the laboratory can be transported alive for long distances in folds of wet cheesecloth. The writer has found this to be the most satisfactory way to keep advanced pupae alive until they are ready to emerge as adults.

In general, the writer has found species of the tribe Pediciini the most difficult to rear, and the Limnobiini and the Eriopterini perhaps the easiest. Mud-inhabiting species are easily reared, but species from rushing torrents are at the opposite extreme and it is almost an impossibility to bring some of these species thru to the adult condition.

#### TYPES OF THE IMMATURE STAGES

The material on which this study is based was almost entirely reared. It seems desirable that these authentic specimens of the larva and the pupa should be so designated that they will have a value greater than that possessed by ordinary specimens. No terms for the designation of types of the immature stages are known to the writer, and the two that are needed in this paper are here defined as follows:

*Nepionotype*, The type of the larva.

*Neanotype*, The type of the pupa.

The type specimen should, of course, be selected only when there is absolute certainty of the identification, and in most cases this determination can be made only by rearing the species. After the species has been reared (this should be done many times, if possible, in order to check up the identity), a good representative specimen may be chosen as the type of the stage. In the cases in which the species is known only from a single specimen, the neponotype may be the larval skin, the neanotype the pupal skin. The remaining specimens of the original series become paratypes. The types of the immature stages possess fully the value of the type of the adult and should be as carefully preserved. The types herein designated are in the collection of the writer. They are preserved in alcohol, but the larval heads of most species have been removed, treated with caustic potash, and mounted in balsam.

#### EXTERNAL MORPHOLOGY

The larvae and the pupae of crane-flies show considerable diversity in their general form. The fundamental plan of structure remains much the same thruout the group, but the details are widely different and furnish the characters in use for the separation of the various tribes and lesser divisions.

The immature stages of crane-flies have evolved more rapidly than have the adult flies, and in many features they show a greater specialization. The head capsule of the larva seems to be the most constant feature, the same fundamental type of structure recurring in the generalized members of all the various groups, indicating a close phylogenetic relationship. On the other hand, the respiratory organs of both the larvae and the pupae vary greatly in the different species and are obviously molded by habitat. The often-repeated statement that the inside of an organism shows what it is, while the outside shows where it has been, is well illustrated here.

#### *The larva*

##### *General features*

The form of the larval body is, as a rule, moderately elongated and usually terete. The head is eucephalous and non-retractile in the three families Tanyderidae, Ptychopteridae, and Rhyphidae. It is incomplete and more or less retractile in all the species of Tipulidae. The body is shortest in the more generalized forms, becoming greatly elongated

in many Eriopterini and some Linnobiini (*Dicranoptycha*). It is made up of the composite head capsule, three thoracic segments, and nine evident abdominal segments. In some species all the abdominal segments are subdivided, respectively, into a narrow basal and a usually broader posterior ring, or annulus; in other species only the basal segments are so subdivided. The integument is usually covered with a dense appressed pubescence and often bears setae, or pencils of hairs, or, in some *Cylindrotominae*, spinous projections.

Respiration is characteristically metapneustic; in the Rhyphidae it is amphipneustic, in *Antocha* apneustic. The typical metapneustic forms often show vestigial lateral spiracles, but these are not functional in any species known to the writer and the peripneustic type of larva is still unknown in this group of Diptera. The spiracles are placed at the ends of the long breathing tubes in the Tanyderidae and the Ptychopteridae. In the Tanyderidae, the Tipulidae, and the Rhyphidae the disk is surrounded by a varying number of lobes which are rarely indistinct, these ranging in number from two to eight. Anal gills are found in representatives of almost all the major groups of crane-flies, and their loss is a result of habitat and non-usage. In wood-inhabiting species the gills are often modified into blunt lobes, having the evident function of propulsion by shoving.

### *Body form*

As already stated, in the majority of crane-fly larvae the body is terete or approximately so, but in some species it is decidedly depressed with the ventral surface flattened. Such forms are *Dactylolabis*, some *Cylindrotominae*, and some Tipulinae. The integument is produced into elongate spines and blades in almost all species of *Cylindrotominae*, similar conditions being suggested in a few tipulines. A definite arrangement of setae (chaetotaxy) obtains. The basal abdominal ring is provided with a transverse creeping-welt in the Linnobiini and in some Hexatomini and Pediciini, as well as in a few other forms. In some genera, as *Epiphragma*, this welt is practically naked; in others it is covered with a microscopic scurfiness; while in still others (*Dicranota*) it is separated into distinct paired prolegs, which are armed with circlets of chitinized hooks that lessen in size from the tips basally. The welts are both dorsal and ventral in position in many Linnobiini and in some Pediciini (*Rhaphi-*

dolabina), or are ventral only (Rhamphidaria, Ularia, Epiphragmaria, and most Pediciini). In number they range from four (on abdominal segments 4 to 7) in most Pediciini, to five or six (on abdominal segments 2 to 7) in Ularia, Epiphragmaria, and other forms.

#### *Organs of respiration*

*The spiracular disk.*—The posterior end of the body is usually truncated, bearing the two spiracles and surrounded by a number of fleshy lobes. These lobes vary much in their shape and armature, and range in number from two in the Pedicaria and the Antocharia to six or eight in the Tipulinae. The inner faces of the lobes are often lined with brown or black horny plates, which serve as points of attachment for the longitudinal muscles. Their arrangement and distribution are of great service in specific classification.

The Linnobaria usually have the lobes surrounding the spiracular disk indistinct; the Antocharia have two long ventral lobes; the Rhamphidaria five lobes; the Ellipteraria and the Dicranoptycharia four lobes.

In the Eriopterini, the Elephantomyaria and some Eriopteraria have four lobes; the majority of species of the latter division have five. In these last-named species the disk is almost squarely truncated, and the five lobes are subequal and stellate in appearance.

The Hexatomini usually have four lobes, with the ventral pair longer than the lateral pair. In a few cases only (Ularia, Dicranophragma, Poecilostola), a reduced mid-dorsal lobe is present. In the more specialized forms the lateral lobes also tend to reduce, simultaneously with the elongation of the ventral lobes. In this tribe the disk is fringed with long hairs, which are sometimes excessively elongate, especially on the ventral lobes where they appear as long fringes of delicate hairs that spread out on the surface film of the water as broad fans. Such fringes are found in a large number of Hexatomini and also in the Adelphomyaria (supposition). Near the tips of the ventral lobes, but inside this fringe of hairs, are often inserted one or more stiff sensory bristles.

In the Pediciini, the Pedicaria have two lobes and the Adelphomyaria (supposition) have four. In the former division the lobes are ventral in position and are almost naked.

The Cylindrotominae have six rather indistinct lobes in Cylindrotoma, and four in the other genera.

The Tipulinae show six lobes in practically all genera, the only exceptions being that there are eight in a few rare cases of *Tipula* and five in *Dolichopeza*, and that lobes are indistinct or lacking in Tanyptera.

In the Rhyphidae (Trichocerinae) the spiracular disk is very similar to that in many Tipulidae, and is surrounded by four lobes. In the Ptychopteridae the very reduced disk is borne at the tip of a slender, retractile breathing tube. In the Tanyderidae the condition is somewhat similar, but here the disk is larger and is surrounded by five lobes at the tip of a long, stout, non-retractile breathing tube.

The spiracles vary greatly in size from very large to small and vestigial, or they may even be lacking in some species of *Antocha*. They consist of an apparently uniform middle piece surrounded by a radially folded margin, or ring, of various widths, called the *stigmatal ring*. Many authors (De Meijere, Mik, Muggenberg, Brown, Keilin, and others) hold that the middle piece is an imperforate chitinized plate and that respiration takes place thru the stigmatal ring. Gerbig (1913), however, shows that the middle piece is split across the disk, the cleft being closed by two overlapping membranes. Directly behind the spiracles the tracheae enlarge into the felt chamber, whose walls are provided with long, branched, tree-like structures, the branches apparently anastomosing. Surrounding the felt chamber in many larvae are dense masses of air tubes, which make up the tracheal lungs. These tubes are arranged in bundles, which arise in special cavities of the felt chamber; thus, in *Tipula paludosa*, there are about fifty bundles, each of about twenty tubules, making a total of one thousand of these air canals (Gerbig).

The early stages of the larva are quite different from the later developmental stages, as Gerbig (1913:137-140), working on *Tipula paludosa*, has well shown. The prominent six-lobed spiracular disk of the more matured larva is represented in the first developmental stage by four heavily chitinized projections, which bear but few bristles on their outer margin. The dorsal lobes are not evident, but are replaced by eight branched bristles, about equidistant from one another. The spiracles are oval, not circular as in the grown larva, and project a little beyond the level of the disk. The writer has noted several first-stage larvae with an appearance almost as described but showing several points of difference. The immature larvae of *Phalacroceras* are described elsewhere in this work (page 963).

*Anal gills.*—In the Ptychopteridae and in the Tanyderidae there is but a single pair of anal tracheal gills. In the former these are very small and are cylindrical, in the latter they are large, branched, fanlike structures. In the Tipulidae the anal gills number from four in most Limnobiinae to six or eight in the Tipulinae. The increase in number is brought about by a division of the original gill of each side. In generalized forms, as Antocha, Pedicia, and others, the anal gills are constricted into segments, the apical ones being more or less telescopic into the preceding ones. As a rule the anal gills are entirely or almost entirely retractile within the body.

In the Tipulinae the gills vary with the genera, being blunt and constructed for propulsion in the wood-inhabiting species, such as those of Ctenophora, Tanyptera, Tipula, and other genera. In the semi-aquatic species of Tipula the number of gills varies from four to eight. In the latter case each of the four principal gills is deeply bifid and the gills are arranged transversely, as in *T. ignobilis*; in species with six gills the posterior branches of the posterior gills are atrophied as a rule; in other species, which have but four gills, the four anterior branches are preserved, the posterior pair being usually atrophied. In Longurio and Aeshnasoma the four anal gills are pinnately branched, each with about six lateral branches. A similar condition is found in the Tanyderidae.

#### *The head*

The primitive crane-fly head was undoubtedly of the eucephalous, non-retractile type, as found in the Ptychopteridae, the Rhyphidae, and other families. The retracted head capsule of the Tipulidae is a derived condition.

The massive, compact capsule is found in all of the lower groups of the three subfamilies of the Tipulidae. Such a head is easily derivable from the condition in the Rhyphidae or in the Tanyderidae, for instance. The dorsal median sclerite, the *prefrons*, is almost as large and conspicuous in Ula as in the eucephalous families. The lateral plates that constitute the capsule are shaped like a mussel in the generalized groups, with the posterior incisions shallow. In the more specialized forms, with the capsule greatly dissected, the two plates of either side are entirely separated—the innermost, next to the prefrons, being the *internal-lateral* of De Meijere, and the outermost being his *external-lateral*. The prefrons

is found in all forms with the capsule compact and massive, and is even preserved in many species with the dissected capsule. In many cases, however, it is firmly fused with the internal-lateral plates; or, in some cases, all the plates of the capsule are firmly united and their individual limits are ill-defined. In the generalized forms the clypeus and the labrum are entirely distinct from each other, while in other forms the two lose their individuality by fusion.

The sclerites of the generalized primitive head bear bristles, or setae, of various types and arrangement. In the Tanyderidae the punctures are multisetose; in most Ptychopteridae the setae are branched or somewhat plumose.

The literature on the head capsule and the mouth parts is as follows:

- Ptychoptera. De Meijere, 1916:188-191, figs. 14-20.  
 Bittacomorpha. Hart, 1898 [1895]:192, pl. 5.  
 Trichocera. De Meijere, 1916:191-194, figs. 21-23.  
 Limnobia. De Meijere, 1916:198-201.  
 Dicranomyia. De Meijere, 1916:197-198, figs. 32-35.  
 Dicranoptycha. Alexander, 1919 b:71, figs. 2, 3.  
 Elliptera. Mik, 1886 b:339, pl. 6.  
 Ula. Alexander, 1915 a:5-6, pl. 1.  
 Dactylolabis. Mik, 1894:261-266, pl. 2; Nowicki, 1867:341 (as Rhicnoptila).  
 Limnophila. De Meijere, 1916:204-206, figs. 49-51.  
 Eriocera. Alexander and Lloyd, 1914:21-22, pl. 1.  
 Hexatoma. Alexander, 1915 c:146, pl. 1.  
 Pentoptera. Alexander, 1915 c:155, pl. 1.  
 Tricyphona. De Meijere, 1916:195-196, figs. 29-31.  
 Pedicia. Needham, 1903:286, fig. 19.  
 Dicranota. Miall, 1893:237-238, pl. 10.  
 Ormosia. De Meijere, 1916:201-204, figs. 37-47.  
 Gnophomyia. Malloch, 1915-17 b:230-231, pl. 34, fig. 10.  
 Chionea. Brauer, Egger, and Frauenfeld, 1854:614, pl. 11.  
 Phalacrocer. Miall and Shelford, 1897:344-345; Bengtsson, 1897.  
 Cylindrotoma. Cameron, 1918.  
 Liogma. Muggenberg, 1901; Alexander, 1914:111, pl. 1.  
 Ctenophora. Anthon, 1908:544.  
 Prionocera. Malloch, 1915-17 b:199, pl. 32, figs. 1-3.  
 Holorusia. Comstock and Kellogg, 1904:55, 61-62.  
 Tipula. Vimmer, 1906, and 1911:1-6.

In addition to the preceding, the genera *Helobia* (Beling, Hart, Malloch), *Rhaphidolabis* (Needham), and *Tanyptera* have been discussed less fully.

All of the above-named genera are considered in this paper, and the head capsule and mouth parts of the following genera are described also: *Protoplasa* (supposition), *Bittacomorphella*, *Rhipidia*, *Rhamphidia*, *Antocha*, *Epiphragma*, *Pseudolimnophila*, *Pilaria*, *Ulomorpha*, *Elephantomyia*, *Teucholabis*, *Gonomyia*, *Erioptera*, *Molophilus*, *Adelphomyia*



(supposition), Rhaphidolabina, Oropeza, Longurio, Aeshnasoma. The descriptions for the genera are either entirely new or else the characters have heretofore been insufficiently described and figured. The details of structure of the head capsules of nearly fifty genera of crane-flies are now known.

*The labrum and the epipharynx.*—The labrum is preserved in all crane-fly larvae. It is usually broadly transverse or oval. The dorsal surface is clothed with short hairs, these being longer on the anterior margin, which is often provided also with a limited number of sensory bristles, or papillae. The lateral regions on the ventral, or epipharyngeal, side often bear long tufts of hairs. The epipharynx proper is variously armed in the different groups of crane-flies.

*The labium.*—The labial region of the capsule is of vast importance in classification, and the location of the constituent parts should be early appreciated. The confusion in terminology of the dipterous larval labium has been partly outlined by De Meijere (1916:253). The principal synonyms are as follows:

*Submentum.*

*Mentum* — The pharyngeal plate, or lower lip (Meinert); submentum (Miall); ectolabium (Bengtsson); labial plate.

*Prementum* — Mentum (Miall); ectolabium (Keilin); endolabium (Holmgren, Vimmer, Bengtsson).

*Hypopharynx* — Labium (Meinert); mentum (Miall, in Diceranota); endolabium (Keilin).

The submentum is represented by a narrow transverse strip in the eucephalous groups of crane-flies, being well shown in Ptychoptera. The mentum is the usually chitinized anterior-ventral plate of the capsule. In Ptychoptera it is margined anteriorly with about twenty comblike teeth. In Bittacomorpha it is more or less distinctly bilobed, but is untoothed. In the generalized Tipulidae it is indistinctly divided into an outer plate and, immediately dorsad of this and closely applied to or fused with it, an inner plate. The outer plate furnishes the apical median tooth of the mentum and in some cases an additional tooth on either side. The inner plate adds a varying number of teeth to the mental plate, from two in Epiphragma to as many as ten or twelve in some species of Limnobia. The chitinized plate is completely divided medially in some Eriopterini (Molophilus and some Erioptera), in the Pedicini, and in some Hexatomini (Pseudolimnophila). In this case, each half is

directly continuous with the ventral bars of the head capsule. In the *Limnophilaria* the mentum is represented by a narrow, transverse, chitinized bar, which is delicately grooved with parallel lines. The mentum is lacking in chitinized parts, or apparently so, in many Eriopterini and in the higher Hexatomini.

Directly behind the mentum is the prementum, rarely prominent and bearing the two small palpi when they are preserved, as in the Ptychopteridae. The hypopharynx lies immediately dorsad of the prementum. In the Ptychopteridae this is an enlarged, two-horned, fleshy lobe which is difficult to study. In the Tipulidae the generalized condition, such as occurs in the Limnobiini and the lower Hexatomini, consists of two collar-like chitinized plates whose anterior margins bear from ten to fifteen or more teeth. In the Tipulini this plate is narrow, with the anterior margin few-toothed, there usually being five or in some cases six teeth. In the Pediciini the hypopharynx is labriform; in many Eriopterini it is cushion-shaped and covered with numerous blunt setae.

*The antennae.*—The antennae are borne on the anterior lateral margin of the capsule, laterad of the labrum. They are one- or two-segmented, and in most cases have one or more apical papillae. De Meijere and others hold that the principal apical papilla constitutes an additional antennal segment. In some cases, however, as in *Ula* for example, two or even more papillae are found which are very similar to one another except for slight degrees of size. It is difficult in such cases to hold any one of these papillae as a true segment. The writer prefers to consider them as apical sensory papillae, and they are so treated in this paper.

The primitive antennae are not greatly elongated, and are usually short-cylindrical or subglobular (*Ula*). An auditory plate, circular in outline and lying on the face of the basal segment, is almost always present. The apical papilla in the *Limnophilaria* and the Eriopterini is egg-shaped, or oval, and is delicately sculptured by a network of apparently impressed lines. In many species, as for example those of the higher Hexatomini, the apical papillae are very long, tapering to the tips. In many Limnobiini, as for example *Limnobia*, and in many species of *Tipula* and related forms, the apical papilla is button-shaped, or disklike, and is often very reduced.

*The mandible.*—In the primitive type, such as occurs in the eucephalous groups and in the generalized Tipulidae, the mandible is rather com-

plicated, usually having a considerable number of teeth on the cutting edge and a distinct sub-basal arm (prostheca) or prosthecal tuft of hairs. At the same time there are usually one or more setae on the outside of the mandible, near the "heel," or base, of the scrobal region. In the generalized tipulid type there are two apical teeth and two rows of cutting teeth. In other cases, as in the Linnobiini, there are but a single dorsal tooth, a single apical tooth, and a varying number of cutting teeth on the ventral face; in some species of Linnobia the number of teeth in the ventral cutting row is six or seven. In the Tipulini the mandible is often reduced in size (as in Tanyptera), there being but a single dorsal and a single ventral tooth in addition to the apical point; the prostheca, however, is usually well developed. In the Eriopterini but one row of teeth, the ventral, is strongly developed. In the Pediciini and the higher Hexatomini, the mandible is elongate and sickle-shaped, with the few teeth on the cutting edge at about midlength. In Ulomorpha the mandible is hinged at about midlength, the basal part being hollowed out on the inner face to receive the blade in a position of rest.

*The maxillae.*—The maxillae are usually of simple form. In the generalized types, such as the eucephalous families and the lower groups of the subfamilies of Tipulidae, they consist of a large and distinct transversely triangular cardo, a conspicuous stipes, and distinct inner and outer apical lobes. In the Pediciini the lobes are separate in the supposed Adelphomyia larva but are fused together in the highest types (Diceranota). In the Hexatomini the lobes are reduced to a single long, flattened blade. The outer and inner lobes are usually densely hairy, especially at the tip and on the inner face of the latter. The palpus is uni-articulate and antenniform in the generalized forms, is short-cylindrical with a varying number of tiny sense pegs at the apex, and bears on its face a circular auditory plate similar to that of the antenna. The armature of the inner lobes is varied, in some species being provided with stiff, comblike setae, or projections.

#### *The pupa*

##### *General features*

The pupa of the crane-fly is of the so-called "free," or "mummy," type. In only a few cases does the larval skin adhere to the end of the abdomen (Dactylolabis, Cyldrotoma, and some other forms.) The head is usually small, and is ventral in position. Immediately behind the

head on the pronotum are the two breathing horns, which are variously developed in the different tribes and genera and furnish invaluable bases for classification. The leg sheaths usually far exceed the short or but moderately elongate wing sheaths. The abdominal segments are often provided with a subterminal armature of stiff setae, or spines. At the posterior end of the body, the last two segments (cauda) are variously modified to inclose the sexual organs of the adult flies.

### *The head*

The head is usually small and flattened, occupying the anterior ventral part of the body. The eyes differ in size in the various groups, in some (Erioptera, Elephantomyia) being larger in the male than in the female; in the male sex they are approximated on the median line above or beneath.

The front between the eyes is usually narrowed behind, delimited by the inner margin of the compound eye, narrowed at the posterior end, and bluntly rounded or pointed at the apex. This part is described herein as the *labrum*, or *labral sheath*. It contains the fronto-clypeus and the labrum of the imago. At its tip it bears two more or less divergent lobes, these being in some cases closely approximated so as to appear as a single lobe; these are herein termed the *labial lobes* or *sheaths*, and they contain the so-called paraglossae of the adult fly.

On either side of the labral sheath, and usually divergent and lying along the posterior margin of its face, are the sheaths of the maxillary palpi, which in most cases extend beyond the knee joint of the fore legs. In almost all the Linnobiinae these are short and stout and almost straight, but in the majority of the tipuline forms they are curved at their tips, which in most species are actually recurved and offer an easy means of distinguishing members of this subfamily. In many of the Linnobiini the margins of the cheeks project as flattened ledges overlying the joint of the fore legs.

The antennae arise from above or between the eyes and bend laterad and thence caudad around the eyes, in some forms, such as Elephantomyia and the males of other species, lying across the face of the eyes. The antennae usually end just beyond the roots of the wings, but in the males of some species (Eriocera) they extend beyond the tips of the wings. The basal segments (scape) of the antennal sheath are often armed with

spines or tubercles, and very often the organ is angulated at the end of each segment of the adult antenna inside.

At its vertex, between or just dorsad of the antennal bases, the head may bear a crest which is usually bilobed and setiferous. In some species this cephalic crest is quadrituberculate, there being a smaller secondary crest behind or before the primary one. In the Tipulini the crest is very inconspicuous and but weakly setiferous. In most of the Limnobiini it is lacking or nearly so.

The head may be variously armed with spines, tubercles, or setae; in *Eriocera spinosa*, for example, there are spines or strong tubercles on the antennal scape, on the clypeal region, and even on the face of the eye. In some cases there are setae on the front between the eyes, on the clypeus, and on the cheek.

#### *The thorax*

The pronotum of the thorax is small. The ventral part is closely applied to the head and often has small setiferous tubercles close to the breathing horns. The pronotal breathing horns are variously developed in the different tribes and genera, and are discussed here in general terms only.

Many species are propneustic, the pronotal horns alone being functional. Other species (in Hexatomini and Eriopterini) are peripneustic, the second to the seventh abdominal segments being provided with functional lateral spiracles in addition to the breathing horns; other pupae have lateral abdominal spiracles, but in most cases they are merely vestigial. Some pupae are amphipneustic, there being in addition to the breathing horns a conspicuous pair of spiracles on the dorsum of the eighth abdominal segment (*Rhamphidia*, *Ula*, *Epiphragma*; in the typical species of *Limnobia* these are present but they are small and are probably nonfunctional).

In the Ptychopteridae the breathing horns are very unequally developed, one being enormously elongated and filiform while the other is abortive. In some Tipulini (*Longurio*, *Prionocera*, *Tipulodina*) the horns are likewise greatly elongated, but in these cases they are shorter than the body and are approximately subequal in size, or at least are not so disproportionately unequal.

In the Limnobiini the breathing horns are usually stout and broad, in the typical *Limnobia* (*Limnobia*, *Dicranomyia*) being subquadrate,

subcircular, or even broader than long. In Elliptera they are earlike and very large. In *Antocha* a unique condition is found, in that the apparatus is divided into eight stout filaments. In the Eriopterini and the Hexatomini the horns are usually long and cylindrical or slightly flattened, and straight or but slightly curved. There are numerous deviations from type, however. In *Gnophomyia* and some species of *Gonomyia* (*alexanderi* and *kansensis*, for example), the horns are trumpet-shaped; in *Gonomyia sulphurella* they are compressed and flattened into fanlike structures. In several widely separated paludicolous genera, such as *Ulomorpha*, *Pseudolimnophila*, and *Prionocera*, the breathing horns are split at their tips into two conspicuous flaps with fimbriate margins, an obvious adaptation to an existence in mud. Often the breathing horns are very small (as in *Elephantomyia*, *Teucholabis*, and *Trichocera*) or even microscopic (*Dicranoptycha*). *Limnophila hyalipennis* (Zett.) is described by Beling (1886:198-199) as lacking the breathing horns, but this is presumably an error of observation which may be due to a defect in the material studied, or possibly the horns are sessile or reduced as in *Dicranoptycha*. In some species (Erioptera, Eriocera) the horns are stout at the base but taper rapidly to the acute points. In many Pediciini the tips of the horns are expanded and usually obliquely truncated, with a row of breathing pores around the margin. The tipuline breathing horns are remarkably uniform in general structure, being usually elongated cylindrical in shape, of moderate length, and with the tips slightly expanded. The most conspicuous deviations from type are the short, flattened, and somewhat clavate horns of Tanyptera.

The thoracic mesonotum is very convex, or gibbous in many species (*Limnobiini* and some Hexatomini). In other species it is declivitous, with a high transverse crest (Eriopterini). This crest may be armed with numerous small spines (*Helobia*); from two to four powerful hooks (*Molophilus*, some species of *Ormosia*, some species of Erioptera, *Teucholabis*); from six to eight tubercles set with stiff bristles (*Gonomyia*); or abundant small setiferous tubercles on either side of the median line, these being less conspicuous along the shoulder (most species of *Ormosia* and of Erioptera). In *Eriocera longicornis* there is a median spine or tubercle on the scutellum. In some *Cylindrotominae* the metanotum bears spines. The extreme lateral or ventral margin is produced into a blunt or somewhat pointed angle just above the wing

root; this is usually armed with from one to three setae. Various other setae usually occur on the mesonotum.

The leg sheaths lie along the ventral side of the pupa. There is, in the various groups, a considerable difference in the length of the sheaths, their position, and the relative arrangement of the ends of the tarsal segments. In the Bittacomorphinae, the fore legs overlie the middle legs. In the Rhyphidae the fore legs overlie the middle pair, which, in turn, overlie the hind legs. In the Ptychopterinae and in the Tipulidae, all three pairs of sheaths lie parallel along the midventral area, those of the hind legs being outermost along the wing sheaths, and those of the fore legs being on the inside and contiguous. In *Gnophomyia* the leg sheaths are very short, extending but little beyond the wing tips and reaching only the end of the second abdominal segment. In other crane-flies they are longer, in some species reaching the end of the fifth abdominal segment. Very often the tips of the tarsi are on a level. In the *Limnobiini* the hind tarsi are usually a little shorter, and the fore tarsi are a little longer, so that the ends of the sheaths form a blunt V. In the *Eriopterini* the middle legs are usually (except in *Gnophomyia*) much shorter than the other legs; in *Helobia*, moreover, the hind legs are conspicuously longer than the fore legs, so that all three sets end at different levels. A somewhat similar and parallel development is found in the tipuline forms.

The wing sheaths are moderately broad, usually ending opposite or a little beyond the apex of the second abdominal segment. The venation of the various species often shows clearly and with little distortion on the wing pad, and in such cases it is of very great help in locating certain genera. Species with a heavy pattern in the adult wings, such as those of the genera *Discobola* and *Epiphragma*, show this pattern on the wing pad in the older pupae, and this helps to confirm their identity.

### *The abdomen*

The abdomen consists of apparently nine segments, the last two being closely approximated or fused to form the cauda. The segments are usually plainly divided into a broad dorsal (tergal) and ventral (sternal) region, and a much narrower and more restricted lateral (pleural) area. The segments beyond the first are variously subdivided into rings, or annuli, by false constrictions, there being usually one, but in some cases

two or more, basal rings and a much broader posterior ring. The segments are variously armed with setae, or spines. In the Limnobiini and some Hexatomini these occur on the basal annulus, and consist of a transverse welt which is margined (as in *Antocha* and *Elliptera*) or covered with abundant microscopic chitinized points. In some Pediciini the setae occupy both the basal and the posterior rings of the intermediate abdominal segments. In the Eriopterini and most Hexatomini, as well as in the tipuline forms, the setae occur on the posterior ring, just before the caudal margin, and consist of a single transverse row of small spines. In the *Cylindrotominae* the segments are often armed with prominent elongate body projections (*Liogma*, *Triogma*). In *Phalacrocera* elongate lobes are confined to the posterior segments of the abdomen. In the *Ptychopteridae* the segments are densely covered with transverse rows of long tubercles which are replaced by chitinized plates near the posterior margin of the segments. In *Bittacomorpha* these tubercles are stellate at their tips.

The dorsum of the cauda in most crane-flies is armed with four, five, or six conspicuous lobes which are often spinous at or near their tips. These represent the lobes that surround the spiracular disk of the larva, and their number generally corresponds to the larval condition. Thus, in the *Ptychopteridae* there is a single lobe, in the Pediciini there are two, and in the Hexatomini and the Eriopterini there are four or five. In the *Tipulinae* there are often but four evident lobes, the dorsal pair of the larva not being represented. In some generalized groups, as the *Limnobia*, the *Rhamphidaria*, and others as indicated elsewhere in this paper, the larval spiracles persist in a more or less functional condition.

*Abdominal spiracles.*— In the Eriopterini and the Hexatomini there is a distinct and apparently functional spiracle on each pleurite of the second to the seventh abdominal segments, located near the base of the posterior ring. In the Eriopterini these spiracles are small and, in the cast pupal skin, appear tubular or elongate. Smaller vestigial spiracles are evident in most genera of the *Tipulidae*.

As has been mentioned earlier in this paper, in certain primitive genera of *Tipulidae* — such as *Rhamphidia*, *Ula*, *Epiphragma*, and to a lesser extent those of *Limnobia* — there is a pair of rather large spiracles on the dorsum of the eighth segment. In *Dactylolabis cubitalis* the lateral



abdominal spiracles are protuberant, notably the pair on the second segment.

*The genitalia.*—The genital sheaths conceal the adult organs within. In the male the valves are usually subequal or the sternal valves are a little the longer. In the female the sheaths, or acidothecae, of the ovipositor usually have the dorsal valves considerably longer than the sternal valves and distinctly upturned at their tips. In the few groups with fleshy ovipositors, the female cauda is very difficult to distinguish from the cauda of the male. The valves are variously armed with spines or lobes, at or before the tips.

#### INTERNAL MORPHOLOGY

The internal morphology and anatomy of the crane-fly larva are here considered in general terms only. The two genera that have been studied in greatest detail by the writer are *Eriocera* and *Antocha*. The most important literature on the various systems of the body is cited in order to make reference to it more easily available.

#### *The digestive system*

The most important literature on the digestive system is as follows:

- Ptychoptera. Grobben, 1876; Van Gehuchten, 1890.  
 Chionea. Brauer, Egger, and Frauenfeld, 1854:613-614, pl. 11, fig. 4.  
 Dicranota. Miall, 1893:242-245.  
 Phalacrocera. Miall and Shelford, 1897:347-351; Bengtsson, 1897.  
 Ctenophora. Anthon, 1908:546-551, figs. 12-35.  
 Holorusia. Kellogg, 1901 a; Comstock and Kellogg, 1904:56-57.

#### *Herbivorous larvae (Tipula, Holorusia, Ctenophora, Phalacrocera)*

In the larva of herbivorous species the alimentary canal extends the length of the body as an almost straight tube inclosed by the coiled, perforated sheets of adipose tissue. The esophagus is slender, opening into the hypopharynx. The proventriculus has a large esophageal invagination at its anterior end. The ventriculus has at its anterior end four elongated ventricular caeca, these being of two distinct lengths in pairs (didynamous) in *Ctenophora*, and all four alike in *Holorusia*. In *Ctenophora* there are four small, pocket-like gastric caeca near the posterior end of the ventriculus, which are not mentioned as occurring in *Holorusia*. At the juncture of the ventriculus and the small intestine are the four

coiled malpighian tubules. Behind the<sup>7</sup> ventriculus lies the small intestine, with a caliber much smaller than that of the ventriculus. At the union of the large and the small intestine is a prominent diverticulum of very large size (in *Ctenophora* three times as large as in *Holorusia*). The large intestine gradually dilates behind to form the rectum.

*Phalacrocera* has the ventriculus without caeca and the hind intestine without a diverticulum, altho it is decidedly a herbivorous genus. The condition in *Chionea* is almost the same. In *Phalacrocera*, and probably in most other larvae, a peritrophic membrane (a secretion of the epithelium which incases the food and keeps it from direct contact with the epithelium) is present.

There are four malpighian tubules in all the *Tipulidae* that have been thoroly studied (*Chionea*, *Eriocera*, *Dicranota*, *Phalacrocera*, *Ctenophora*, *Holorusia*, *Tipula*, and a few others). In the *Rhyphidae*, likewise, there are four tubules in both the larval and adult stages. In the *Ptychopteridae*, however, there are five tubules, as in the *Culicidae*, the *Psychodidae*, and related families. This might indicate some basis for placing the *Ptychopteridae* in close proximity to the *Culicidae*, as has been done by Lamcere (1906).

The salivary glands consist of two large coiled tubules which pass into a collecting duct and unite to form the common collecting duct that opens at the base of the hypopharynx.

#### *Carnivorous larvae (Dicranota, Eriocera)*

The alimentary canal in the carnivorous type of crane-flies is a short, straight tube, with a minimum of appendages such as caeca and diverticula. In *Eriocera* the esophagus is very long, and the ventriculus is short and without caeca. The malpighian tubules are yellow at their origin, soon passing into an orange-brown color. The intestine is short and straight, without a diverticulum.

The salivary glands in the newly killed larva of *Eriocera spinosa* are very conspicuous by their opalescent color, which persists for a day or more after death. These glands consist of two elongate-oval or cylindrical glands, of the opalescent color just mentioned. From the anterior end of each of these glands passes the long, slender, salivary collecting duct, which unites with its fellow to form a common duct opening at the mouth cavity. From the caudal end of each gland is a flattened, almost hyaline,

elongate lobe which is indistinctly pseudo-segmented, in its posterior part being in intimate connection with the abundant fat tissue.

### *Respiration and circulation*

The most important literature on the respiratory and circulatory organs is as follows:

- Ptychoptera. Grobben, 1876.  
 Dicranota. Miall, 1893:245-248.  
 Phalacrocera. Miall and Shelford, 1897:351-356.  
 Liogma. Müggenberg, 1901.  
 Ctenophora. Anthon, 1908:551-554.  
 Holorusia. Kellogg, 1901 a; Comstock and Kellogg, 1904:57-58, 60.  
*Tipula maxima*. Brown, 1910.  
 Tipulinae, Hexatomini (especially *Tipula paludosa* and *Limnophila punctata*). Gerbig, 1913.  
 General articles. De Meijere, 1895; Viallanes, 1880.

The most important works on the structure of the tracheal system with special reference to the mechanics of the spiracles, are those by Müggenberg (1901), De Meijere (1895, 1902, 1916), Brown (1910), and Gerbig (1913). Miall and Shelford (1897:351-356) discuss in much detail the structure of the heart in Phalacrocera.

In *Eriocera spinosa*, which may be considered as typical for this group of crane-flies, there are two principal tracheal trunks which lie in a dorsal position and run almost the length of the body. They are connected across by a very delicate, unbranched, simple, tracheal commissure, and send off branches laterally to supply the various organs of the body. Near the posterior end of the body they are approximated, and just in front of the spiracles they expand into the tracheal chamber. Directly cephalad of this chamber the first lateral branch passes off, numbering from the posterior end forward. Branches 2 to 8 are large and much forked. Just after leaving the main tracheal trunks, each of these sends off a ventral branch which supplies the alimentary canal and the fat tissue. Branch 3 supplies the region of the malpighian tubules; branch 4, the posterior part of the stomach; branch 5, the anterior part of the stomach; branches 6 to 8, the esophageal region — branch 6 supplying the proventriculus, branch 7 and part of branch 8 the esophagus, and the remainder of branch 8 the pharyngeal region.

The main part of each lateral branch continues laterad, at its first (anterior) fork sending a branch forward to the next branch, so as to

form a complete but much-branched lateral trachea. The branches are very diffuse and abundant and the skin is well supplied. As already stated, the cross-commissures are very delicate and are unbranched or nearly so, the dorsal regions of the body being supplied by branches from the lateral supply.

The condition of the tracheae in *Antocha*, the only apneustic crane-fly larva among the species here considered, may be outlined as follows:

The usual two principal trunks are present, joined across on each segment by delicate cross-commissures which send off two approximated branches except on the eighth segment. Laterad and ventrad of the principal trunks are the delicate lateral tracheae. These are joined to the main trunks by fine branches inserted about midway between the dorsal commissures, toward the posterior end of the body lying nearer the posterior commissure than the anterior one.

At the ninth segment each trunk sends off a branch from its proximal side, these branches being connected by a long commissure and supplying the posterior pair of gills. The commissure is about as long as that part of the branch between it and the trunk. Immediately caudad of, or just at, the fork, but on the ventral side, a subequal branch passes into the anterior gills; at the same point the delicate lateral tracheal trunk finally ends in the main trunk. Caudad of this triple forking the main trunk gradually widens out into a cylindrical structure which is truncated apically, at the tip passing out into two small elongate branches, near the base with about three delicate branches, two being dorsal in position and one more lateral. All of these tracheae, to the gills and to the caudal lobes, send off many branched capillaries at frequent intervals, and the caudal lobes unquestionably function as tracheal gills.

A comparison of *Antocha* with *Dicranota* as described and figured by Miall (1893:245-248) shows, in the latter, distinct spiracles and the gills similar but much smaller. The tracheal arrangement differs in that a single branch on either side supplies both gills of that side, while the caudal lobes are tracheated by a branch that leaves the main trunk close to the spiracles. (Plate XII, 2 and 3.)

The arrangement of the tracheae at the base of the wing pad is described and figured for *Bittacomorpha* by Dr. Chapman in Comstock's *The Wings of Insects* (1918:36-37).

*The nervous system*

The most important literature on the nervous system is as follows:

- Ptychoptera. Grobбен, 1876.
- Dicranota. Miall, 1893:241.
- Phalacrocera. Miall and Shelford, 1897:356; Bengtsson, 1897.
- Ctenophora. Anthon, 1908:556-557.
- Holorusia. Comstock and Kellogg, 1904:58-59.

In Holorusia the brain, or supra-esophageal ganglion, is composed of two principal lobes united posteriorly and lying above the esophagus. Beneath the brain and on the under side of the esophagus lies the sub-esophageal ganglion, which is connected with the anterior end of the brain lobe by the circum-esophageal commissures. The above-named organs form a complete ring, or collar, around the alimentary canal. The ventral nervous system leads backward from the subesophageal ganglion on the ventral surface of the body wall. In the thorax there are four closely approximated ganglia representing the thoracic and the first abdominal segments. Beyond these and located in the abdomen are six abdominal ganglia. The ganglia send off four large nerve trunks.

The condition is similar in Ctenophora and in Tipula, there being seven abdominal ganglia, of which the first is located in the thorax and the last six in the abdomen. In Phalacrocera there are eight abdominal ganglia, the first being usually found in the first abdominal segment and the eighth in segment 10. The head ganglia are all independent of one another, not fused into a complex. The longitudinal commissures between the first five ventral ganglia are double, and those between the eight abdominal ganglia are simple (Bengtsson). In Dicranota there are likewise eight abdominal ganglia, the first being located in the first abdominal segment and the others in segments 5 to 10, there being two close together in the tenth segment.

*The reproductive system*

The most important literature on the reproductive system is as follows:

- Ptychoptera. Grobбен, 1876.
- Dicranota. Miall, 1893:248.
- Phalacrocera. Miall and Shelford, 1897:356-357.
- Holorusia. Comstock and Kellogg, 1904:58.

The reproductive organs appear early in the larval development. In Dicranota the testes lie in the ninth segment and form elongate capsules,

when sufficiently advanced giving off the vasa deferentia from the inner side of the hinder end. Even in larvae not fully matured, Miall found ripe spermatazoa mixed with spermatoblasts. No division of the testes into follicles is apparent. In Phalacrocera, also, ripe spermatazoa may be found in the older larvae.

In Phalacrocera the ovaries form a pair of cylindrical bodies tapering to each end, lying on either side of the beginning of the intestine. The ovaries are very peculiar in structure, seeming to be adapted to the almost simultaneous discharge of all the eggs.

#### *The muscular system*

The most important literature on the muscular system is as follows:

##### *Body musculation*

- Ptychoptera. Grobben, 1876.
- Diceranota. Miall, 1893:241.
- Ctenophora. Anthon, 1908:545.
- Holorusia. Comstock and Kellogg, 1904:59-60.

##### *Musculation of the mouth parts*

- Phalacrocera. Bengtsson, 1897.

#### *The fat bodies, or adipose tissue*

The most important literature on the adipose tissue is as follows:

- Diceranota. Miall, 1893:241-242.
- Ctenophora. Anthon, 1908:554.
- Holorusia. Comstock and Kellogg, 1904:56.

#### *The imaginal disks, or histoblasts*

The most important literature on the imaginal disks is as follows:

- Phalacrocera. Miall and Shelford, 1897:357-358.
- Ctenophora. Anthon, 1908:555.
- Holorusia. Kellogg, 1901 b; Comstock and Kellogg, 1904:61.

### PHYLOGENY

The origin and phylogenetic development of the various groups of crane-flies is still largely problematical. The evidence supplied by the adult flies of the most generalized living groups points to an ancestor which in many respects resembled the recent Mecoptera, or scorpion

flies. That this resemblance is presumably not fundamental is suggested by the immature stages of these same generalized forms, which show but few features that can be reconciled with those of a panorpid-like ancestor. Unfortunately the fossil record helps but little. At the beginning of the Tertiaries, crane-flies were already numerous both in species and in individuals, but in most cases they are clearly referable to existing genera. It is evident, then, that the investigator must go still further back for his evidence, and the fossil crane-flies of the Upper Mesozoic are, unfortunately, still largely unavailable. The phylogenetic development of the group may be considered from two standpoints, the geological record and comparative morphology.

#### THE GEOLOGICAL RECORD

The most important works on fossil crane-flies are those of Loew (1850), Seudder (1894), Handlirsch (1906-08, and 1910, a and b), Menner (1906), and Cockerell (1910, 1913, 1916, and 1917, a and b). The writer is indebted to Professor Cockerell for assistance in determining the age of many of the fossil-bearing beds. Excellent accounts of the various deposits may be found in Cockerell (1913) and in Tillyard (1917).

The Tipuloidea, representing the superfamily of crane-flies, is herein considered as being constituted of six families, of which two, the Eoptychopteridae and the Architipulidae, did not survive the Mesozoic period. The Eoptychopteridae are known only from the Mecklenburg Lias (lowest Jurassic), and include but three monotypic genera. The Architipulidae are known from the same formation and include eight species arranged in three genera. The other four families contain recent forms and are included in this paper.

The North American Eocene and Miocene, as represented by the White River and Green River beds and the Florissant shales, respectively, give evidence of having had a northern fauna, especially in the Eocene. This is well shown by the great development of the *Cylindrotominae*, which in the White River basin almost dominated the crane-fly fauna during the Eocene. It seems probable, moreover, that the group was forced into colder regions of the globe during the Oligocene, when the tropical element reached far to the north. No group of crane-flies that can be considered as being tropical has yet been found in the Florissant. On the other hand, the European Oligocene, as shown by the Gurnet Bay beds

and the lower Oligocene Baltic amber, has a considerable tropical element apparent — as, for instance, *Styringomyia*, found in both formations, and *Trentepohlia*, *Polymera*, and *Brachypremna*, the last two being amber records. In connection with these two last-named genera, as fossils known only from the Baltic amber, it should be noted that each is found living to-day only in America, where they are confined to the austral and tropical regions.

The Tanyderidae are represented by the Oligocene *Macrochile* (amber) and *Etoptychoptera*. At present this is still a very small group, including but two genera and nine species.

The Ptychopteridae include a *Ptychoptera* from the Bohemian Krotensee (probably upper Oligocene) and a *Bittacomorpha* from the Florissant.

The Rhyphidae (*Trichocerinae*) are represented by two species from the Baltic amber and one or two additional species from the Miocene.

The Tipulidae may be considered in general terms only. But one tipulid is listed by Handlirsch as being known from the Mesozoic. In the earliest Tertiaries, however, a variety of species is found in this family which almost parallels their recent development.

The Limnobiini first appeared in the Eocene (*Dicranomyia*, *Geranomyia*). In the lower Oligocene, numerous species of *Dicranomyia* and *Rhipidia* occurred. In the Miocene, *Dicranomyia* was common, though probably not so rich in species as at present. *Rhamphidia* is found in amber, and *Antocha* has been described from the Florissant Miocene by Scudder; the latter record, however, seems very doubtful to the writer, judging from Scudder's figure and description.

The Hexatomini are represented by *Ula*, *Linnophila*, *Eriocera*, and *Polymera* in amber, and by *Linnophila* in the Florissant shales.

There is no record of the Pediciini being preserved as fossils.

The Eriopterini are well represented in the Baltic amber by *Erioptera*, *Gnophomyia*, *Gonomyia*, and related genera, and also in the Miocene by *Gonomyia*, *Cladura*, and others. *Toxorhina*, an apparent relative of *Elephantomyia*, occurs in the Baltic amber.

The *Styringomyiini* are represented by the only living genus, *Styringomyia*, a fly of uncertain affinities, in the Gurnet Bay Oligocene (Cockerell, 1917c and 1919) and in amber, reappearing in the Pleistocene African copal.



The dominance of the *Cylindrotominae* (genus *Cyttaromyia*) in the Eocene and Miocene of the North American fauna has already been mentioned. No records of this group from the European Oligocene are available. The recent species of the subfamily are practically all forms belonging to cold, temperate regions, the few Oriental species of *Stibadocera* coming from mountains at considerable altitudes.

The *Tipulinae* have been found as far back as the Mesozoic, but the records are not entirely satisfactory. In the lowermost Tertiaries, however, undoubted tipuline forms occur. Species occur in the Green River shales of Colorado (Eocene). The group was well represented in the Oligocene (Baltic amber, Tulameen beds of British Columbia, Krottensee, and Gurnet Bay), and was very common in the Miocene (Radoboj, and especially in the Florissant of Colorado, where some twenty-five species of *Tipula* and closely allied genera or subgenera have been described by Scudder and Cockerell).

*Tipulidae* of the Pleistocene are not numerous, only a few having been made known from the refuse of lake dwellings in England (*Dicaera*, apparently related to *Ctenophora*), and in the African copal, including such genera as *Styringomyia*, *Elephantomyia*, and *Toxorhina*.

#### COMPARATIVE MORPHOLOGY

The morphology of the various stages of crane-flies has been detailed elsewhere in this paper and need not be repeated here.

#### PHYLOGENETIC CONSIDERATIONS

The eucephalous families of crane-flies are undoubtedly lower, phylogenetically, than the *Tipulidae*, and the latter have been derived from the former. The generalized type recurs in all three subfamilies of the *Tipulidae*, and it is uncertain which of these three should be placed lowermost. Presumably all three groups arose from an immediate common ancestor, or the *Tipulinae* and the *Limnobiinae* arose from one point of the tree, the *Cylindrotominae* developing from the *limnobiine* stem at a somewhat later period. The accompanying phylogenetic tree (Plate XII, 4) graphically illustrates this apparent evolution of the group. The *Limnobiini* show but little deviation from the fundamental type. From the level of the lowermost *Hexatomini* (*Ula* and *Epiphragma*), in close proximity to the *Limnobiini*, the remaining groups of crane-flies can be

derived — the Pediciini and the Eriopterini on the one hand, the hexatome divisions on the other. The highest levels of development of their respective types are apparently *Diotrepha* (Limnobiini), *Dicranota* (Pediciini), *Gonomyia* (Eriopterini), and *Hexatoma* (Hexatomini).

The immature stages of the Tipulidae of the antipodal regions (Australia and Chile) are entirely unknown, and their discovery may bring to light striking novelties that may well upset the present ideas of classification. The largest remaining gaps in the present knowledge of the Nearctic fauna relate to the genera *Atarba*, *Toxorhina*, *Cryptolabis*, *Phyllolabis*, and *Megistocera*, but it is not expected that any major groups will have to be created for their reception.

#### LIFE HISTORIES OF CRANE-FLIES, WITH KEYS AND DESCRIPTIONS OF THE SPECIES

Various classifications and arrangements of Diptera have been proposed in the past, and the principal evolutionary changes in the entomologist's conception of classification are herein indicated.

The groupings in the superfamily Tipuloidea have been very diverse. Brauer (1883) separated the eucephalous families from the Tipulidae (Polyneura). Osten Sacken (1893) placed the Tipulidae in the *Nemocera vera*, the Rhyphidae in the *Nemocera anomala*. Coquillett (in Howard, 1912:85-86) included the Tipulidae in his superfamily Tipuloidea, but separated the Rhyphidae, placing the latter in Bibionoidea. Lameere (1906) gave a classification that had little basis in fact, the Rhyphidae being considered by him as Brachycera and the Ptychopteridae being placed with the Culicidae. Knab (1915), working on the respiratory systems of the larvae, demonstrated the hitherto unnatural groupings of the families of the Nemocera, and arranged the crane-fly families, along with a few others, in the group Polyneura, a group coordinate in rank with the previous conception of the Nematocera. The latest grouping, that of Malloch (1915-17 b), was based on a broad knowledge of both the adult flies and the immature stages; and here, for the first time, one gets the true conception of the superfamily limits — the inclusion of the Ptychopteridae, the Tipulidae, and the Rhyphidae in a single major group. Malloch's arrangement is herein adopted, with the following exceptions: (1) the Limnobiidae are not held as constituting a separate family, but are united with the Tipulidae; (2) the family Tanyderidae has been

erected, to include the generalized Tanyderina which have hitherto been placed with the Ptychopteridae.

The immature stages of the four families of the Tipuloidea are readily separable. The larvae of the Tipulidae can be confused only with those of certain low brachycerous forms, as, for example, the Leptidae. In the Brachycera the mandibles work vertically and parallel to each other; in the Nematoceera, including the Tipuloidea, they operate transversely or obliquely against the teeth of the mentum and the hypopharynx. The presence of fleshy lobes surrounding the spiracular disk is a character possessed by almost all Tipulidae. The larvae of a few groups of brachycerous Diptera, such as certain Leptidae, Sciomyzidae, and other families, possess entirely similar caudal lobes but are readily recognized by the small and very reduced head capsule.

The eucephalous families of the Tipuloidea may be distinguished by means of the characters indicated in the following keys:

#### Larvae

1. Body eucephalous, head non-retractile; amphipneustic or metapneustic.....2  
Head incomplete behind, retractile; not amphipneustic..... TIPULIDAE (p. 791)
2. Caudal end of body prolonged into a slender breathing tube; metapneustic.....3  
Caudal end of body not prolonged into a breathing tube; amphipneustic.  
RHYPHIDAE (p. 787)
3. Breathing tube stouter, non-retractile; gills large, pinnately branched; punctures of head multisetose; found in wet decaying wood..... TANYDERIDAE, supp. (p. 769)  
Breathing tube slender, completely or partly retractile; gills slender, cylindrical, unbranched; punctures of head with simple or plumose hairs; found in wet earth.  
PTYCHOPTERIDAE (p. 772)

#### Pupae

1. One of the pronotal breathing horns greatly elongated, much longer than the body, the other breathing horn very short, abortive. (Family PTYCHOPTERIDAE, p. 772).....2  
Breathing horns short, or, if elongated (some Tipulinae), not longer than the body and the difference in size not so apparent.....3
2. Tarsal sheaths lying side by side, parallel..... Ptychopterinae (p. 773)  
The fore tarsal sheaths overlying the middle pair, the four middle and hind tarsi the longest, parallel..... Bittacomorphinae (p. 779)
3. Tarsal sheaths overlying one another in pairs..... RHYPHIDAE (p. 787)  
Tarsal sheaths lying side by side..... TIPULIDAE (p. 791)

The pupae of the Tanyderidae are still unknown.

It is possible that Bittacomorphella (page 779) has short breathing horns; in this case this genus would run down to couplet 3 above, but by the arrangement of the tarsal sheaths it runs out as indicated in couplet 2.

## FAMILY Tanyderidae

*Larva* (supposition).—Body eucephalous, metapneustic. Integument smooth, shiny white. Last two segments of abdomen produced into a stout, non-retractile breathing tube, which is distinctly five-lobed at the tip. Tracheal gills two, very large, pinnately branched. Head with scattered punctures, which are multisetose; lateral plates of head united across venter. Mandibles opposed, narrow, tridentate. Maxilla with palpus two-segmented, the outer lobe digitiform, pubescent. Labrum small, semi-circular, with two punctures; clypeus with four punctures.

*Pupa*.—Unknown.

The Tanyderidae comprise a group of primitive crane-flies including but three recent genera, with ten species. Of these the genus herein considered, *Protoplasa*, with three known species, is found in the Northern Hemisphere. All that is known concerning the biology of supposed species of this group pertains to *Protoplasa fitchii* and is discussed below.

Genus *Protoplasa* Osten Sacken (Gr. *first + to form*)

1859 *Protoplasa* O. S. Proc. Acad. Nat. Sci. Phila., p. 252.

1878 *Idioplasta* O. S. Cat. Dipt. N. Amer., p. 222.

The genus *Protoplasa* is confined to temperate North America. There are three known species, of which *P. vipio* O. S. and *P. vanduzeei* Alex. are western in their distribution, while *P. fitchii* O. S. is eastern. The general characters of the supposed larva are given above; the detailed account in connection with the species *P. fitchii* follows.

*Protoplasa fitchii* O. S.

1859 *Protoplasa fitchii* O. S. Proc. Acad. Nat. Sci. Phila., p. 252.

The remarkable insect *Protoplasa fitchii* is one of the rarest of the local crane-flies. There are scarcely a score of specimens extant in the various collections of the country, most of which are from the mountainous section of North Carolina. The fly has not been reared, but the writer has in his possession a larva that he refers with much confidence to this species. It is one of the most remarkable dipterous larvae that have ever come to the writer's notice, and, whether or not it belongs to *Protoplasa*, it should certainly be called to the attention of entomologists in the hope that it may some day be bred and its identity confirmed or ascertained. These peculiar dipterous larvae were discovered by H. S. Barber, C. T. Greene, and

R. C. Shannon, on the Potomac River near the mouth of Dead Run, Fairfax County, Virginia. They were found during the latter part of May, 1916, in a much-decayed maple log, where they were associated with the larvae of the syrphid fly, *Temnostoma bombylans* (Fabr.) (Barber, 1913). Greene attempted to rear the larvae procured at this time, but did not succeed. In May, 1917, he sent the writer one of the preserved larvae for study. Later Dr. Viereck was interested in the matter, and on May 27 he procured one fine, healthy larva, which was sent to the writer at Ithaca, New York. It arrived safely on the 29th, and was at once placed in rearing. Unfortunately this larva died the day after it came into the writer's possession, and this remarkable insect still remains unreared. Associated with this larva in the pieces of decaying maple in which it was shipped, were larvae of *Temnostoma* and a larva and a pupa of the tipulid *Epiphragma solatrix*.

The evidences that this larva is that of *Protoplasa* are numerous. It belongs, without doubt, to the Nematocera, and the immature stages of all the remaining families of that division have been made known. Many features in this larva point strongly to the condition in other families of crane-flies. The eucephalous condition of the head, and the elongate breathing tube, are suggestive of the Ptychopteridae; the five-lobed spiracular disk, the anal tracheal gills, the metapneustic respiratory system, and other features, are very similar to conditions in certain Tipulidae. However, there are conditions obtaining here that are found nowhere else in the Diptera, so far as is known to the writer, such as the combination of a eucephalous head of primitive organization, a stout, non-retractile breathing tube, the large, pinnately branched anal gills, the multisetose punctures on the head, and the details of structure of the mouth parts. The multisetose punctures are suggestive of the branched or plumose hairs of Ptychoptera, and give a possible hint of the origin and ancestry of this condition in the latter group. The writer cannot but regard it as suggestive that the larvae are found in direct association with those of *Epiphragma* in saturated decaying wood. He has mentioned in other papers (Alexander, 1910:254, and 1919 d:883, 915) the remarkable superficial resemblance that exists between the adult flies of *Epiphragma fascipennis* and those of *Protoplasa*, both forms having very handsomely banded wings of a pattern not found in other species in the local fauna.

The only observations on the adult flies that the writer has ever been able to make were in reference to five specimens taken in New York State in 1909 (Alexander, 1910:254). These were swept from rich vegetation along the banks of the Sacandaga River in northeastern New York. The adult flies have never been recorded from the vicinity of Washington, but are regional, since the species ranges thruout the eastern United States as far south as Georgia (in the mountains).

*Larva.*—Total length, 11.8 mm.

Length excluding breathing tube, 5.6–6 mm.

Length of breathing tube alone, 5.8–6.2 mm.

Length of ninth segment of abdomen (chitinized part of breathing tube), 3.4–3.6 mm.

Length of anal gills, 2–2.1 mm.

Diameter of body, 2.3 mm.

Coloration pure white, head and apical two-thirds of breathing tube pale brown, chitinized. In the living larva there is a transparent, subcircular area on the dorsum of segment 7 thru which the beating of the heart can be clearly seen, but in preserved specimens this area is hard to perceive. (Plate XIII, 5)

Body eucephalous, entirely smooth, shiny, dorsum of segments 2 to 9 each with a transverse group of tiny points. Thorax with the first segment longer than the succeeding two segments taken together, narrowed anteriorly, broader behind; mesothoracic segment about half as long as the first and about twice as long as the very narrow metathorax. Abdominal segments gradually increasing in length to the seventh; segments 8 and 9 abruptly narrowed into a stout, elongate breathing tube which is about equal in length to remainder of body; basal, or proximal, part of tube (segment 8) shorter than terminal part (segment 9) and not chitinized; segment 9 elongate, chitinized, with a deep transverse constriction a short distance before tip; this apical part, and the region just before the constriction, smooth, the remainder of the last segment with numerous delicate transverse wrinkles. Spiracular disk (Plate XIII, 6) surrounded by five lobes, one dorsal, two lateral, and two ventral in position; dorsal lobe the smallest, lateral lobes the broadest; lobes tipped with sharp, chitinized spines, which are continued for a short distance down the outer face of each lobe; fringes of long hairs along margins of lobes; disk with a brownish tinge around spiracles and an elongate-oval median mark between, and slightly below, the spiracular level; inner face of ventral lobes with indistinct, tiny, brown punctures. Spiracles large, separated by a distance about equal to diameter of one. Anal tracheal gills two, one on either side of the base of segment 8, very large and pinnately branched, there being about fifteen branches to each gill; each of these branches constricted into four or five lobules; lobes at their tips broadly obtuse (Plate XIII, 9).

Head short and broad, epicranium chitinized. Across ventral face, the sclerite firmly united by a narrow transverse band; median part densely punctulate, this area delimited laterally and posteriorly by an indistinct curved line. On dorsum, the prefronts conspicuous and the clypeus distinct from the labrum. Head and mouth parts provided with numerous setiferous punctures, each of which is multisetose (from five to eight setae to each puncture). Chaetotaxy of epicranium (Plate XIII, 7) with three lateral groups of long bristles, the

posterior group being the longest and most dorsal in position; on ventral face, four punctures on either side (Plate XIII, 8); prefrontal sclerite apparently lacking setae, but on the epicranium proper, along margin of prefrons, a longitudinal group of six punctures on either side, the anterior pair the longest. Labrum semicircular in outline, outer margin fringed with long, stiff hairs; dorsal surface with two transverse punctures. Clypeus narrowly transverse, with four setiferous punctures in a transverse row. Dorsal median part of epicranium forming a subquadrate lobe whose lateral angles bear brushes of hairs; laterad of these angles a rounded hollow overlapped by a flat, bilobed operculum (this may be some modification of the antennae which should occupy about this position on the head). Mandible elongate, strongly chitinized, tridentate, the apical tooth the longest and more acute than the others, the middle tooth bluntly obtuse; inner posterior angle of mandible produced proximad beneath outer lobe of maxilla into a bluntly rounded lobe; mandible with a group of curved setae on scrobe near base, and a group of longer bristles lying distad and mesad of these setae on dorsal face of mandible. Maxilla with base, in a position of rest, concealed beneath head-chitin; palpus stout, antenniform, two-segmented, the basal segment short and stout, the apical segment much shorter and narrower, with a small, lateral, sensory papilla; outer lobe of maxilla produced cephalad as a stout, digitiform lobe which is densely hairy.

#### FAMILY Ptychopteridae

*Larva*.—Body eucephalous, metapneustic, long and slender, the caudal end prolonged into a more or less completely retractile breathing tube bearing the spiracles at the tip. Lobes surrounding spiracular disk indistinct. Anal gills two, elongate-cylindrical, unbranched. Integument with tiny hairs (Ptychoptera), or with slight warty protuberances (Bittacomorpha), or with conspicuous elongate tubercles (Bittacomorphella). Pseudopods on abdominal segments 1 to 3 each bearing a curved claw. Head complete; eyespots distinct. Mandibles opposed. Mentum many-toothed (Ptychopterinae) or merely bilobed (Bittacomorphinae).

*Pupa*.—Usually with one of the two pronotal breathing horns greatly elongated, much longer than the body (this may not be true in Bittacomorphella); in Ptychoptera and Bittacomorpha it is the right horn that is elongated, the left being degenerated; in Bittacomorphella the right horn is degenerated. Tarsal sheaths all parallel in the Ptychopterinae, the fore pair overlying the middle pair in the Bittacomorphinae. Abdomen covered with setiferous tubercles arranged in transverse rows on tergites and sternites, and more or less in longitudinal rows on pleurites. Cauda with a powerful dorsal median lobe near base of segment 8.

The family Ptychopteridae includes three genera falling in two tribes: the Ptychopterinae including the single genus Ptychoptera, and the Bittacomorphinae including the "phantom crane-flies," Bittacomorpha and Bittacomorphella. The habits of these species are discussed below in connection with the various genera. The following keys separate the subfamilies of the Ptychopteridae:

## Larvae

- Mentum with outer margin finely serrated; mandibles with three large outer teeth; pseudopods small; coloration yellow or brown . . . . . **Ptychopterinae** (p. 773)  
 Mentum bilobed, not toothed; mandibles with a single large outer tooth; pseudopods prominent, each with a conspicuous curved claw; coloration rusty red or black. . . . . **Bittacomorphinae** (p. 779)

## Pupae

- All tarsi lying parallel; wing pads with *M* branched . . . . . **Ptychopterinae** (p. 773)  
 Fore tarsi lying above middle tarsi; wing pads with *M* unbranched. . . . . **Bittacomorphinae** (p. 779)

The immature stages of this group of flies have long been known, having been investigated by Réaumur (1740), Lyonet (1832), and other early workers. The immature stages of the common American species *Ptychoptera rufoincta* are herein recorded for the first time. The unknown *Ptychoptera* described by Malloch (1915-17b:240-241) is evidently *P. lenis* O. S. and is here considered as that species.

The most important literature on the Ptychopteridae is as follows:

- Ptychoptera paludosa* . . . . . Larva, pupa, general. Réaumur, 1740, pl. 6.  
*Ptychoptera paludosa* . . . . . General. . . . . Wesenberg-Lund, 1915:348-351.  
*Ptychoptera lacustris* . . . . . Larva. . . . . Beling, 1886:171-172.  
*Ptychoptera contaminata* . . . . . Larva, general. . . . . Van Gehuchten, 1890. (Histology of the alimentary canal.)  
*Ptychoptera albimana* . . . . . General. . . . . Cameron, 1917:65.  
*Ptychoptera albimana* . . . . . Larva, pupa, general. . . . . Topsent, 1914-16.  
*Ptychoptera* sp. (*lenis* supp.) . . . . . Larva. . . . . Malloch, 1915-17b:240-241.  
*Ptychoptera* sp. . . . . General. . . . . Léger and Duboseq, 1909. (Protozoan parasites.)  
*Ptychoptera* sp. . . . . Larva, general. . . . . Grobben, 1876. (Morphology.)  
*Ptychoptera* sp. . . . . Larva, general. . . . . De Meijere, 1916:188-191, figs. 14-20. (External morphology.)  
*Ptychoptera* sp. . . . . General. . . . . Lyonet, 1832.  
*Bittacomorpha clavipes* . . . . . Larva, pupa, general. . . . . Hart, 1898 [1895]:189-195.  
*Bittacomorpha clavipes* . . . . . General. . . . . Needham and Betten, 1901:574.  
*Bittacomorpha clavipes* . . . . . General. . . . . Howard, 1912:95-96.  
*Bittacomorpha clavipes* . . . . . Larva, pupa. . . . . Malloch, 1915-17b:239-240.  
*Bittacomorpha clavipes* . . . . . General. . . . . Weston and Turner, 1917:53.

Van der Wulp (1857), Miall (1895), Grünberg (1910), and Brunetti (1912) also give general accounts of the immature stages of *Ptychoptera*, for the most part taken from the earlier works cited above.

SUBFAMILY **Ptychopterinae**Genus **Ptychoptera** Meigen (*Gr. fold + wing*)

- 1800 *Liriope* Meig. Nouv. Class. Mouch., p. 14 (*nomen nudum*).  
 1803 *Ptychoptera* Meig. Illiger's Mag., vol. 2, p. 262.  
 1856 *Çtenoceria* Rond. Dipt. Ital. Prodr., vol. 1, p. 187.



*Larva*.—Head oval to subpyriform, broadest behind, narrowed in front, not heavily patterned above; setae of head branched or plumose. Submentum large, usually but a little narrowed posteriorly, the anterior lateral angles slightly produced; mentum broader than long, outer margin with numerous teeth (18–22). Prementum with palpi rather small, lying parallel, densely hairy on outer, or ventral, face. Mandible with three powerful outer teeth and about six smaller inner teeth. Maxilla with the cardines elongate-triangular, with three setiferous punctures; maxillary palpi antenniform, cylindrical. Labrum broad, transverse, with dense tufts of hair beneath. Integument almost smooth, without prominent warty elevations. Pseudopods low, with small claws.

*Pupa*.—Head small, with a reduced cephalic crest. Sheaths of maxillary palpi elongate, the tips projecting around knee joints of fore legs. Leg sheaths with all the tarsi parallel, not overlapping one another. Wing sheaths with media branched. Pronotal breathing horns very unequal, one (usually the right) exceedingly elongate, longer than remainder of body, the other tiny, degenerate. Abdomen set with transverse and longitudinal rows of small setiferous tubercles on the segments.

Ptychoptera is a small genus including sixteen described species, almost all occurring in the Holarctic region, with a few species in India and Formosa. Two species are found in tropical Africa, and another, an undescribed form, in southern South America; hence the genus is probably found thruout the world in countries in the temperate zones, with the probable exception of Australia.

The literature on the immature stages of this genus is summarized under the family account.

Topsent (1914–16) has furnished the best account of any species of the genus Ptychoptera. His observations refer to *Ptychoptera albimana*. The following notes are extracted from Topsent's paper:

The eggs range in number from 520 to 587, averaging 554. They are pale yellow, slightly arcuated, the surface curiously ornamented, the dimensions being 0.825 by 0.264 millimeters. The duration of the egg stage is seven days. The newly hatched larva measures 3.85 millimeters, the respiratory tube 0.99 millimeters. The adult larva measures 77 millimeters, of which the respiratory tube is 20 millimeters. The growth of the larva is rapid. When fifteen days old it measures, when extended, 25 millimeters. When sixty-seven days old, it measures 45 millimeters. The pupal stage is from ten to twelve days, averaging eleven days. There are normally two generations a year.

De Meijere (1916:188–191) gives a critical account of the structure of the larva of a European Ptychoptera. It agrees well with the description of *P. rufocincta* given below, the most conspicuous differences shown by De Meijere's species being as follows: labium with the submentum having the sides straighter; mentum with the anterior margin evenly, but gently, convex, with only eighteen evident teeth. The details of the maxilla,

especially of the setae on the eardrums, are not the same. However, the generic characters given above include all the species to which the writer has been able to refer.

Malloch (1915-17b:240-241) describes and figures an American *Ptychoptera* which is presumably *P. lenis* O. S. It agrees closely with the other forms in most respects. The author indicates the mentum as having three distinct parts, the median part being projected beyond the level of the lateral parts and having more teeth (eight instead of six). Malloch's specimens were taken in the Yellowstone Park, Wyoming, in August, 1890. From the locality data it is almost certain that the larvae belong to the common *Ptychoptera lenis* of the western United States.

Tonnoir (1919) describes a curious sexual dimorphism in the genus *Ptychoptera*.

*Ptychoptera rufocincta* O. S.

1859 *Ptychoptera rufocincta* O. S. Proc. Acad. Nat. Sci. Phila., p. 252.

The species *Ptychoptera rufocincta* is common around wet swales and among open shrubbery. The adult flies are on the wing from May to early July, and again in late August and early September; they may be double-brooded. In appearance they are conspicuously unlike their relatives of the Bittacomorphinae, rather resembling certain large fungus gnats (Mycetophilidae).

The larvae live in situations similar to those frequented by Bittacomorpha, and often occur in the same associations—with larvae of *Limmophila* (*Lasiomastix*) *macrocera*, *Pilaria tenuipes*, *P. recondita*, and *Erioptera chlorophylla*, as well as with many Chironomidae, leeches, nematode worms, and mollusks. In appearance they are strikingly different from the larvae of Bittacomorpha, being pale, white or yellowish white, with the body almost smooth, not covered with the dense transverse rows of setiferous tubercles found in Bittacomorpha, and with the pseudopods on the basal abdominal segments poorly developed. The larvae of this species are smaller than those of Bittacomorpha, with the head proportionately much smaller. In structural details, however, they are rather similar to the larvae of Bittacomorpha. The larvae of *Ptychoptera rufocincta* feed on the decaying vegetable matter in their haunts. When fully grown, the pupa forms within the last larval skin, and the elongate pupal spiracle is coiled about the mesothorax, as described

for *Bittacomorpha clavipes* (Hart, 1898 [1895]:191). Careful breedings of this species in 1913 at Orono, Maine, placed the indoor pupal life at four days and eighteen hours, and that in nature at probably five days — an unusually short pupal duration.

*Larva*.— Length, when fully grown, 30–32 mm.; when fully extended, about 35 mm.  
Diameter, 2–2.2 mm.

Head light reddish brown, not marked with darker spots as in *Bittacomorpha*; body whitish or pale yellow; tomentum short, pale; seventh and eighth segments of abdomen, and breathing tube, light brown.

Body almost smooth, sparsely clothed with short, appressed hairs arranged in indistinct transverse rows, on intermediate segments of body there being about twenty of these rows; body not at all tuberculate, as in *Bittacomorpha*. Prothoracic segment short, not so long as mesothorax; metathorax nearly as long as preceding two segments combined. (In older larvae that are about to pupate, the right pupal breathing horn may be seen coiled underneath the skin of the mesothorax.) First five abdominal segments swollen posteriorly into a ring that completely surrounds the segments; first three abdominal segments with low, indistinct pseudopods on either side of the median line, each with a small, recurved claw; pseudopods after first pair more widely separated than, and not so well developed as, in the *Bittacomorphinae*. Abdominal segments 4 and 5 more elongate, swollen posteriorly but not bearing pseudopods; segment 6 narrowed behind, with a few scattered, outspreading hairs; segment 7 narrower than preceding and telescopic within itself, at about two-fifths the length there being a transverse row of long hairs marking the limit of telescoping; when fully extended, segment 7 a little longer than segment 8; segment 8 a little narrower, and telescopic basally into segment 7. (The parts of segments 7 and 8 which are exposed in the retracted condition are brown and subchitinized, and bear scattered, outspread hairs which are most numerous near the caudal end of the exposed part and here form transverse rows; similar rows of sparse, setiferous punctures are on the dorsum of the swellings on the first five abdominal segments.) Breathing tube (segment 9) retractile into segment 8 for about one-fourth its length; when retracted, completely concealing gills. Tracheal gills two, elongate-cylindrical, situated near base of segment 9; in normal position of rest, gills usually projecting about one-half their length beyond end of segment 8. Apex of breathing tube truncated but without well-defined lobes.

Head small, proportionately much smaller than in *Bittacomorpha*; oval to somewhat pear-shaped; narrow anteriorly, broadened behind, near posterior margin abruptly narrowed. Prefrons broad, conspicuous. (As noted by most earlier writers on the genus *Ptychoptera*, the head bears numerous punctures with setae which are plumose or have a branched appearance [Plate XV, 20]. The writer has examined numerous specimens under high magnification and is inclined to believe rather that in some cases several bristles arise from a single puncture and are closely approximated basally, altho free distally, and that the plumose appearance is here merely apparent. In other cases, however, actual basal fusion has taken place. The number of free tips from a puncture varies from three to six, five and six being common numbers.) Labrum broad, transverse, on disk two large setiferous punctures bearing branched setae; on either side beneath, conspicuous tufts of long hairs, these tufts continued

obliquely proximad to near median line, where there is a median lobe densely covered with long hairs. Epipharynx small, subquadrate, margin almost transverse, with about seven blunt teeth; sides of organ with long hairs which are directed backward. Labium (Plate XIV, 12) with submentum much narrowed on basal half, sides subparallel, thence expanded so that cephalic end is about twice as wide as caudal end; anterior lateral margins produced into blunt projections; mentum (Plate XV, 17) broadly subquadrate, anterior margin nearly transverse and with from twenty to twenty-two teeth forming an irregular comb. (There is considerable variation in the shape of this comb and in the form of the individual teeth comprising it; usually the median third of the mentum is produced outward beyond the lateral parts, but this condition is not always well-marked; the individual teeth may be blunt or acute. In the specimen shown the normal condition is illustrated; the central lobe includes six teeth, and each lateral part about seven teeth, the lateral teeth being usually a little the larger; in some specimens the median lobe has the teeth very indistinct, while in others there is a conspicuous tendency for the median pair to unite into a single broad tooth.) Prementum pale basally, indistinctly covered with pale papillae; palpi lying close together, subparallel, the lateral parts with short, dense hairs, the ventral face with shorter papillae; each lobe bearing at tip a small, blunt, cylindrical knob which is slightly chitinized. Antenna (Plate XV, 18) short, almost cylindrical but slightly narrowed basally, bearing on truncate apex about five sensory papillae of various diameters, one being much the largest, two others being long and very slender; one of the papillae is bisegmented, the apical part being more slender than the basal part. (De Meijere [1916, fig. 14] shows his European Ptychoptera as having the antennae two-segmented and with the sensory papillae very different from the condition found in *P. rufocincta*.) Mandible (Plate XV, 19) strong and powerful; cutting edge subtriangular, with three large outer teeth and about six or seven small inner ones; of the larger teeth the outermost is the slenderest, the third is the largest and stoutest; small inner teeth subequal in length, the outermost stout, inwardly the teeth becoming more slender; mandible on ventral face near margin with two powerful setae, the posterior one often recurved, the anterior one directed forward. Maxilla (Plate XV, 19) with cardines roughly elongate-triangular, proximal angle acute, ventral face with three large setiferous punctures bearing several bristles of unequal length (the writer has not been able to locate setae on the middle puncture); outer edge of sclerite with a fringe of long hairs, longest at narrow inner end of segment; stipites roughly triangular, with a group of short spines at apex; palpi antenniform, stout, cylindrical, with sensory papillae at tip (one large papilla, about three of medium size, and three or four small ones); outer lobe of maxilla with a small, egg-shaped or subcylindrical, knob at its outer angle, below which the rounded lobe is densely clothed with long, pale hairs; caudad of these, along margin, a row of from six to eight powerful spines and a few long hairs.

*Pupa*.— Total length, 34.3–40 mm.

Length excluding breathing tube, 14.5–15.8 mm.

Length of breathing tube alone, 19.8–26 mm.

Width of body, d.-s., 1.6–1.7 mm.

Depth, d.-v., 1.7–1.8 mm.

Pronotal breathing horns reddish brown, dark brown at extreme base; thorax, wing sheaths, and leg sheaths dark brown; abdomen whitish, with small tubercles and broad

chitinized apices to segments dark brown. Pupa most readily distinguished from pupa of *Bittacomorpha* by the venation, the position of the tarsal sheaths, and the short, non-stellate abdominal tubercles. (Plate XIV, 13.)

Anterior cephalic crest small, deeply bilobed by a broad V-shaped notch, the rounded lobules roughened and each terminated by a single long hair. Dorsad of these, two smaller and slenderer, very widely separated, tubercles, each lying just inside antennal sheaths. Antennal bases located on ventral side of head, between eyes; antennae bent dorsad and thence caudad around knee joints of fore legs, the tips lying just outside middle tibiae; apical antennal segments showing distinctly thru sheaths. Sheaths of maxillary palpi elongate, tips curved over knee joints of fore legs. Clypeus smaller and narrower than the conspicuous labium, transversely wrinkled. Labium rectangular, each half with tips obliquely truncated. (Plate XIV, 14.)

Pronotum with lateral ventral angles almost square, each with about two small setae. Breathing horns very unequal in length; the right one greatly elongated, much longer than remainder of body, enlarged at extreme base, the outer part with numerous papillae which are more numerous and more approximated toward end of organ, these papillae lying in a single straight line which makes a long spiral around organ; left breathing horn very small and degenerate, only a little longer than sheath of maxillary palpi, curved, with about a dozen papillae which are closely crowded toward apex of organ. Mesonotum finely and transversely wrinkled, prescutum with a very acute V-shaped dorso-median mark, its apex directed backward; scutal lobes projecting, each with a few tiny hairs. Postnotum with two small tubercles at about two-thirds its length, one on either side of a pale median line. Metanotum short, sheath of halteres extending just beyond base of second abdominal segment. Wing sheaths clearly showing venation, the branched *media* being characteristic of the genus; wing sheaths extending almost to end of second abdominal segment. Leg sheaths with tips of fore and middle tibiae enlarged, and with inner apical angle of each produced into long points for the long tibial spurs of adult flies. Leg sheaths extending to just before end of third abdominal segment; all six legs lying side by side, not overlapping as in *Bittacomorpha* (Plate XV, 21).

First abdominal segment chitinized above, apical half with a few weak tubercles. Dorsum of segments 2 to 6 with posterior margins each having a chitinized band set with about twenty-five to thirty setiferous tubercles, the outermost ones being the largest; remainder of dorsum of each segment with irregular transverse rows of scattered tubercles, on narrow, interrupted, chitinized bands; usually one of the bands, at about midlength of segment, broader and more strongly chitinized than the others; these bands obliterated on posterior segments, but caudal band here very wide; about fifteen of these rows on segments 2 and 6, and from twenty to twenty-five rows on segments 3 to 5; these bands not regularly transverse, but anastomosing rather freely, not occupying more than half of abdominal surface; segment 7 with the broad caudal band only; tubercles rather short, with three or four short, irregular spines at tip, these not presenting a stellate appearance as in *Bittacomorpha*. Abdominal sternites similar to dorsum, tubercles lacking where leg sheaths rest against segments 2 and 3; segments 4 to 6 with transverse rows similar to those of dorsum but weaker; caudal bands on segments 4 to 7 very broad, the caudal margin with tubercles, there being about twenty tubercles on segment 4, the number gradually decreasing to seg-

ment 7, on which there are about fifteen. Abdominal pleurites with tubercles arranged in longitudinal rows, there being about six rows on each of segments 2 to 6, the rows being almost continuous for the whole length of abdomen; tubercles at caudal margin of each segment enlarged and powerful; on segment 6 the rows converging behind into a single powerful tubercle on caudal margin of segment; a similar enlarged tubercle on caudal margin of seventh segment; segment 7 and cauda narrowed. Male cauda (Plate XV, 22) with a prominent dorso-median lobe projecting directly away from the body; dorsal sheaths short, indistinctly bilobed; ventral sheaths very elongate, divergent (Plate XV, 23). Female cauda (Plate XV, 24) with the same prominent dorso-median lobe; acidotheca of ovipositor long, straight, beyond its midlength a blunt, conical tubercle directed laterad and slightly caudad; sternum (Plate XIV, 15) with ventral lobe only about half length of tergal acidothecae, caudal margin with three lobules.

*Nepiontype*.—Orono, Maine, June 24, 1913.

*Neanotype*.—With the larval type.

*Paratypes*.—Both larvae and pupae, June 24 to July 5, 1913.

#### SUBFAMILY *Bittacomorphinae*

The following keys separate the genera of the subfamily *Bittacomorphinae*:

##### *Larvae*

Size small (total length under 20 mm.); coloration black, breathing tube light yellow; breathing tube entirely retractile; body covered with very long projections which are incased in a black, horny substance; mandibles with an inner comb of teeth.

*Bittacomorphella* Alex. (p. 779)

Size larger (total length over 40 mm.); coloration rusty red; body tapering gradually to the long, slender, partly retractile, breathing tube; body covered with transverse rows of shorter, stellate tubercles; mandibles without an inner comb of teeth.

*Bittacomorpha* Westw. (p. 783)

##### *Pupae*

Size small (length, excluding breathing horn, under 12 mm.); right breathing horn small, degenerate; abdominal tubercles weak, tipped with several strong setae.

*Bittacomorphella* Alex. (p. 779)

Size larger (length, excluding breathing horn, over 14 mm.); right breathing horn elongate, filiform, longer than the body; abdominal tubercles strong, elongate, crowned by a circle of four or five spines and tipped with a setiferous papilla. . . *Bittacomorpha* Westw. (p. 783)

Genus *Bittacomorphella* Alexander (Gr. diminutive of *Bittacomorpha*)

1916 *Bittacomorphella* Alex. Proc. Acad. Nat. Sci. Phila., p. 545.

*Larva*.—Body short, covered with very prominent projections which are longest on lateral and caudal parts of body. Pseudopods prominent, with very large, curved claws. Breathing tube short, entirely retractile within body. Head subquadrate, the foramen ventral in position; setae of head unbranched. Mandible with an inner comb of teeth. Mentum bilobed, cephalic margin untoothed. Coloration black; breathing tube light yellow.

*Pupa*.—Right breathing horn very short, degenerate. Fore tarsi overlying middle tarsi. Tubercles on abdomen moderately elongated, not crowned by a circle of spines as in *Bittacomorpha*, but tipped with a long seta.

The genus *Bittacomorphella* contains but two described species, the genotype, *B. jonesi* (Johns.), and the larger *B. sackenii* (Röder) from western America, the immature stages of which are wholly unknown. There is no published literature on the biology of this group of crane-flies.

*Bittacomorphella jonesi* (Johns.)

1905 *Bittacomorpha jonesi* Johns. Psyche, vol. 12, p. 75-76.

*Bittacomorphella jonesi* is a curious little phantom crane-fly, not uncommon in cold Canadian woods thruout the Northern States, where it is usually found near running water or springs and often in small, dark ravines or along shaded runs. The adult flies sometimes lurk beneath low, dark bridges and culverts, where they are often associated with species of *Dolichopeza* and *Oropeza*. An account of the habits of the adults of this species may be found in an earlier paper by the writer (Alexander, 1916b:545-546).

The larval habitat is very different from that of other local species of the family, which, as a rule, prefer open swamps, swales, or wet meadows. The larvae of this species live in rich organic mud in shaded woods. They were first found on the Bool hillside at Ithaca, New York, beneath decaying beech leaves in wet or damp mud which was mixed with old beechnuts, hulls, acorns, butternuts, broken decayed twigs, and similar débris. The Bool area is a very steep hillside with a general northern exposure, heavily shaded with tall forest trees. In former days it extended far to the eastward and was connected with Slim Jim Woods, near the second bridge in Forest Home. The cut area is now a pasture, but patches of skunk cabbage and cat-tails still persist. On the shaded hillside the skunk cabbage occupies pockets or level areas where the soil is largely calcareous. The forest cover consists of beech, hard maple, basswood, yellow birch, red oak, butternut, elm, a few large alders, a few aspens, and on the surrounding hillside a thick stand of hemlock. The shrubs include *Ribes floridum* L'Her., *Cornus alternifolia* Linn. f., and similar species. The herbage at this season is of the dominant skunk cabbage, young seedlings of *Impatiens biflora* Walt., *Geum rivale* Linn., and *Cardamine Douglassii* (Torr.) Britt. In places there are thick mats of mosses, *Brachythecium rutabulum* (Linn.) B. & S., on the limy soil, and *Amblystegium* on decaying prostrate limbs.

The curious larvae of *Bittacomorphella* were here found associated with the following crane-fly larvae and pupae: *Dicranomyia stulta*, *Limnophila adusta*, L. (*Dicranophragma*) *fuscovaria*, *Utomorpha pilosella*, Pentoptera, *Molophilus hirtipennis*, *Erioptera megophthalma*, *Ormosia innocens*, *O. nigripila*, *Tipula collaris*, *T. oropezoides*, *T. cayuga*, and others. In addition numerous other natural associates were found, such as the larvae of a carabid beetle, *Nebria sahlbergi* Fisch., sow bugs, mollusks, and a great variety of other organisms. On July 10, 1914, adults of *Bittacomorphella* were not uncommon in the same association, at which time they were flying with other crane-flies such as *Dicranoptycha germana*, *Molophilus hirtipennis*, *M. pubipennis*, *Erioptera vespertina*, *E. venusta*, and *Gonomyia blanda*.

The first larvae of *Bittacomorphella* were found on May 11, and at that time were almost fully grown. They present a very remarkable appearance, being black or very dark in color and covered with numerous long projections. The breathing tube, which is capable of entire retraction within the body, is very short, and is light yellow, in contrast with the remainder of the body. The larvae are, as a rule, very slow and sluggish in their movements, but when disturbed they become more active. Large and small larvae, of two distinct sizes only, were often found in the same situations at the same time. A fully grown larva was placed in rearing on June 11, 1917, and emerged as an adult male on June 24. This provides for a pupal duration of not more than thirteen days, but the pupal stage is undoubtedly much shorter.

*Larva*.— Total length, 15–17 mm.

Length exclusive of breathing tube, 12.5–14 mm.

Length of breathing tube, 2.4–3 mm.; to base of gills, 1.3–1.8 mm.; beyond gills, 1.1–1.2 mm.

Greatest diameter across body, 1.7–2 mm.

Coloration dark brown to almost black, breathing tube light yellowish; in young individuals and occasional older specimens, coloration more rusty.

Body short, stout, cylindrical but appearing depressed, covered with numerous elongate projections. Breathing tube very short and capable of complete retraction within body (Plate XVI, 25). Body appearing proportionately broader, and tapering more abruptly to breathing tube, than in other species of the family herein discussed, this appearance being due to great length of lateral body projections.

The most notable single feature of larva consisting of the numerous projections from body (Plate XVII, 33), these being incased in a blackened, horny substance which is somewhat brittle. Usual shape of body extensions cylindrical, slender, and generally simple



except for those near end of body, which are asymmetrically once-forked. Basal half of projections heavily chitinized, but distal end almost transparent. Entire surface of projections beset with numerous transverse rows of short hairs, usually about nine to twelve hairs in each row, nine and ten being common, these hairs doubtless serving to hold the blackened, horny covering of the projection. Sensory papillae (Plate XVII, 34) borne at or near apices of projections, each with a long bristle; these papillae narrowed at base, thence enlarged to form a head, on which bristle is inserted; usually one or two bristles to each projection, but occasionally an additional one present, which is much smaller and degenerate. Dorsal body projections occupying transverse rows across segments, those near lateral and caudal parts of body being long and powerful, those on median region being short and degenerate; segments of thorax and abdomen subdivided into false segments, these transverse rows occupying caudal margins of these segments, there being usually from four to six of the weak projections between the powerful lateral ones. In addition to these projections, sparse branched hairs lying in the same transverse rows (Plate XVII, 35). Projections at end of body surrounding base of breathing tube all long and powerful, and, as stated above, some weakly bifurcate. Ventral body projections similar to those of dorsum but relatively smaller.

Abdominal pseudopods feebly chitinized at tips, with very large, slightly curved claws which are but little shorter than the pseudopods themselves (Plate XVII, 32). Breathing tube short and stout, surface before apex transversely wrinkled. Papillae rather numerous, bearing sense hairs scattered over surface of tube, those just back of apex short and spine-like, those farther back long and slender, very like and homologous to the bristles terminating the body projections, as discussed above. Gills two, stout, about one-third length of terminal section of breathing tube. Body projections incrustated with a black, horny substance, as discussed above; on lateral projections, apical setae likewise incased, at least basally, producing a bilobed or even a trilobed appearance; this black corneous incrustation brittle and easily removed, leaving projection and bristles intact.

Head subquadrate, sides nearly parallel, occipital foramen ventral in position (Plate XVI, 26); surface of head covered with numerous small, chitinized points which are longest on posterior angles; anterior ventral angle slightly produced; two setiferous punctures on ventral surface, one on either side just behind anterior angles, the other closer to foramen. Dorsum with setae arranged as shown in Plate XVI, 27; setae simple. Labrum (Plate XVII, 31) with four dorsal setiferous punctures along anterior margin, the median pair closely approximated; another powerful seta occupying each lateral angle on dorsal side; dense brushes of long hairs on either side beneath. Epipharynx (Plate XVII, 31) supported by two powerful chitinized arms connecting across midventral region and then extending laterad and expanding outwardly to form posterior margin of labrum; surface of epipharynx with closely appressed teeth. Labium (Plate XVI, 28) with cephalic margin of mentum almost entire, the broad median part produced cephalad and feebly bilobed; palpi with a dense fringe of long hairs around base and with sensory papillae at tips. Antenna (Plate XVI, 30) short, cylindrical, somewhat globular or barrel-shaped; about four elongate papillae and two or three shorter ones, these papillae terminal in position, the largest one occupying the inner side. Mandible (Plate XVI, 29, 30) with the outer angle a powerful hook bearing smaller teeth on ventral face at about midlength; inner angle flattened, and, besides terminal blade, bearing a comb of about five teeth, the innermost being the longest and

slenderest; a dorsal line of strong setae extending from base of outer hook inward; outer edge of mandible with two strong setae, these protected at their bases by small dorsal ears, or projections, from the mandible; dorsal face of mandible with a powerful hinged prostheca; near base of mandible on dorsal face a curious five-lobed sensory organ. Maxilla (Plate XVI, 29) with the cardo triangular, the ventral or outer face with two closely approximated setiferous punctures; stipes triangular, with three strong setae near palpus; palpus antenniform, cylindrical, rather elongated, and with about six sensory papillae at tip, one being much longer than the others; outer lobe of maxilla with cephalic margin blackened and chitinized, inner angle with a dense brush of long hairs.

*Pupa*.—Length excluding breathing horn, 9.5 mm.  
Width, d.-s., 1.7 mm.  
Depth, d.-v., 1.4 mm.

The following description is taken from the cast pupal skin of the only specimen that was reared:

Antennal bases approximated on front between eyes. Clypeus bluntly rounded at apex, transversely wrinkled. Lobes of labium (Plate XVII, 36) broad, rounded apically; maxillary palpi short and stout, broad at base, gradually narrowed to the short tip, which is not recurved. (The structure of the head and the eyes indicates some peculiar characters not possessed by the pupae of related genera, but the cast pupal skin is insufficient for accurate diagnosis.) Two bristles below eye and just above base of palpus, and a longer and more slender seta farther laterad. Sides of head behind antennae appear to be produced laterad into blunt points. Right breathing horn small, degenerate, much curved. (In the single pupal skin available, it cannot be determined whether the left horn has been broken off or is undeveloped.) Just laterad of each breathing horn a small tubercle bearing a long seta. Scutal lobes with about four stout setae. Tarsal sheaths of fore legs, as in the subfamily, overlying the middle pair but shorter (Plate XVII, 37).

Abdomen with chitinized bands extensive, as in *Bittacomorpha*. Arrangement of tubercles about as in other species of family. Tubercles shorter and weaker than in *Bittacomorpha* and not crowned by a circlet of spines, each being tipped with one or more (four or five) long setae (Plate XVII, 38); the pleural tubercles the longer and many of them multisetose. Cauda of male, in general features, similar to that in *Bittacomorpha*, the dorsal median lobe (Plate XVII, 39) stout, the ventral horns (Plate XVII, 40) short and powerful, directed laterad; horns on dorsal lobes apparently lacking.

*Nepionotype*.—Ithaca, New York, May 30, 1917.  
*Neanotype*.—Cast pupal skin, reared June 23, 1917.  
*Paratypes*.—Topotypic, May 15 to June 10, 1917.

### Genus *Bittacomorpha* Westwood (Gr. *Bittacus* + *shape*)

1835 *Bittacomorpha* Westwood. London and Edinburgh Phil. Mag., vol. 6, p. 281.

*Larva*.—Form elongate, body gradually narrowed behind into the partly retractile breathing tube. Integument with transverse rows of tubercles. Pseudopods on abdominal segments 1 to 3 prominent, with large curved claws. Head subpyriform, dorsum with rows

of prominent black spots converging behind. Mandible stout, with a single powerful outer tooth. Mentum bilobed, anterior margin not comblike. Color of body, rusty red.

*Pupa*.—Right pronotal breathing horn very elongate; the left very small and short, subdegenerate. Fore tarsi overlying middle tarsi. Tubercles on abdomen very long, located on broad transverse bands of chitin, each tubercle with a star of four or five spines surrounding the apex, which bears a long seta.

The genus *Bittacomorpha*, as here restricted, includes but two species — the genotype, *B. clavipes* (Fabr.), and *B. occidentalis* Ald. of western America, concerning the biology of which nothing has been recorded. The literature on the immature stages of *Bittacomorpha clavipes* is summarized under the family account (page 773).

*Bittacomorpha clavipes* (Fabr.)

1781 *Tipula clavipes* Fabr. Spec. Ins., vol. 2, p. 404.

1835 *Bittacomorpha clavipes* Westw. London and Edinburgh Phil. Mag., vol. 6, p. 281.

*Bittacomorpha clavipes*, the "phantom crane-fly," is a common and widely distributed species thruout North America east of the Rockies. It is easily recognized by the black-and-white-banded legs, with their conspicuously enlarged and swollen metatarsi. The species is very characteristic of alder swamps and the wet margins of ponds. While in copulation the insects often fly, the female ahead, the male trailing on behind like the tail of a kite. When they alight on a plant stem, the female is invariably uppermost, the male often hanging free with none of its feet on a support. The swollen metatarsi are almost completely filled by the tracheae, and these serve to buoy the insects as they drift about in the wind. Brues (1900) describes these peculiar tracheal dilations in detail. He says, in part:

When flying, *Bittacomorpha* uses the wings scarcely at all, relying in great measure upon wind currents for transportation. The legs are exceedingly light, as the exoskeleton is thin and delicate, and encloses practically no tissue which can serve to increase their weight.

In a letter from Dr. J. G. Needham, dated September 27, 1917, valuable data on this habit of drifting are furnished, as follows:

Yesterday while crossing the Fall Creek bridge near my home on Cornell Heights, I made an observation on *Bittacomorpha* that interested me greatly. A breeze was blowing up the gorge, and on the breeze a *Bittacomorpha* was drifting rapidly upward in the usual flight attitude, with broadly outspread legs, the swollen metatarsi hanging vertically, all phantom-like in slenderness and in strongly contrasting black and white. It came up from below the level of the rail, swept past within two feet of my face, and passed on upward with the breeze until lost to view, perhaps 100 feet higher than the bridge, and much farther upstream. Since

the creature can fly only very slowly and here was moving several times faster (I could not see whether it was using its wings), it was obviously drifting in the wind. Perhaps this is a normal function of the expanded metatarsi.

The larvae are usually abundant in decaying vegetable matter in rich organic mud about ponds and in swamps. The writer has found them especially numerous in the Basin Swamp at Orono, Maine (in 1913), and near Round Pond at McLean, New York. At Orono they were associated with larvae and pupae of *Ptychoptera rufocincta*, *Limnophila macrocera*, *Pilaria tenuipes*, *P. recondita*, *Erioptera chlorophylla*, a variety of chironomid larvae, numerous larvae of Trichoptera in their cases, nematodes, and leeches. Needham and Betten (1901:574-575) give a summary of the larval habitat of this species as they found it in the northern Adirondacks. Weston and Turner (1917:53) have recorded the larvae as being scavengers and thus serving as important factors in the elimination of sewage in the Coweetset Stream near Brockton, Massachusetts.

The immature stages of this interesting crane-fly have been well considered by Hart (1898 [1895]:189-195), whose account has been briefly summarized by Howard (1912:95-96). The larvae are found in shallow water that is filled with decaying vegetable matter. Here they live in the mat of dead stems of rushes, grasses, and willow leaves, in semi-stagnant or slowly flowing water. The larvae are elongate-cylindrical, with a long, partly retractile breathing tube. They are deep rusty red or brown in color, quite distinct from the pale whitish larvae of *Ptychoptera* or the black larvae of *Bittacomorphella*. They feed on decaying vegetable matter, diatoms, and mud that is filled with organic matter. They rest beneath the surface of the water, with the tip of the extended breathing tube at the surface film or just beneath the surface, in the latter case breathing by means of the small tracheal gills. When about to pupate, the very long, coiled breathing tube of the pupa is wound around the thorax beneath the larval skin. On pupation the tube soon straightens out into a very long, stiff, bristle-like structure. Like the larvae, the pupae rest beneath the surface of the water, with the tip of the breathing tube projecting above the surface film. The pupal duration is apparently about a week.

*Larva*.— Length when fully extended, about 60 mm.  
Length of breathing tube, about 20 mm.  
Diameter of body, about 2.6 to 3 mm.

Body tapering gradually at either end, posterior end prolonged into breathing tube. Usual color pale rusty brown, but the writer has found a few nearly full-grown specimens which were as pale in color as the larvae of Ptychoptera. Body covered with numerous transverse rows of small tubercles, or papillae, which bear short setae. Head broadly ovate, convex above, where it is conspicuously marked with rows of black spots, these interrupted lines converging behind. Mouth parts in general similar to those in Bittacomorphella, the main points of difference being as follows: mandible (Plate XVIII, 42) shorter and stouter, ending in a powerful outer tooth, the comb of inner teeth being reduced to about eight small tubercles, the two bristles on outer margin of mandible not overlapped by projecting "ears"; labium (Plate XVIII, 41) shorter and stouter, with a different arrangement of papillae; epipharynx long, narrowed behind, distinctly bilobed, each half with parallel rows of long, comblike teeth projecting proximad; anterior comb of epipharynx with the anterior teeth the largest, the teeth gradually reduced in size behind; posterior comb with the rows of teeth widely separated anteriorly, approximated behind so as to be contiguous or nearly so at their ends; space between these rows filled with long hairs; anterior teeth small and feebly chitinized, posterior teeth stronger. First three abdominal segments bearing conspicuous pseudopods, each terminated by a sharp, slender claw which fits into a groove on the face of the pseudopod.

*Pupa*.— Total length, 40–60 mm.

Length excluding breathing tube, 15.5–25 mm.

Length of breathing tube, 25–35 mm.

Degenerate breathing tube, length 2 mm., diameter 0.2 mm.

Width, d.-s., 1.8 mm.

Depth, d.-v., 2.6 mm.

Breathing tube light brown; wing sheaths brown; leg sheaths light brownish yellow and dark brownish black, alternated, corresponding to the leg markings of the adult fly. Abdomen pale yellow, rather uniformly covered with abundant brownish tubercles and transverse, chitinized plates, these brown areas scarcer on pleura and not especially abundant on apical margins of segments.

Pupa somewhat similar in general structure to pupa of Ptychoptera. Anterior cephalic crest small, lobules rounded, each tipped with a long, stout seta; immediately behind anterior crest, a similar blunt, bilobed projection of front; laterad of crest, a slender, elongate tubercle on either side, immediately behind antennal sheaths, each with a long seta; two other setiferous tubercles on head behind antennae and maxillary palpi. Antennal bases approximated between eyes. Sides of head, laterad of eyes, with a small setiferous tubercle. Maxillary palpi not recurved at tip, as in Ptychoptera, ending opposite knee joint. Clypeus elongate, gradually narrowed toward apex, transversely wrinkled; two hairs toward base near inner margin of eye. Each half of labium broad, roughly subquadrate, tips broadened and obliquely truncated (Plate XVIII, 43).

Breathing horns almost as in Ptychoptera. (Nearly always it is the right horn that is elongated, but in about ten per cent of the specimens the left horn is elongated while the right is degenerated; Hart records one specimen in which both horns were developed, but unequally, the right measuring 23 mm. and the left 13 mm.; some of the specimens recorded by Hart are larger than any that the writer has ever seen.) Wing sheaths ending almost opposite tips of fore tarsi; media unbranched. Leg sheaths (Plate XVIII, 47) with fore tarsi much shorter

than the others and lying directly over middle tarsi; tarsi of hind and middle legs parallel and extending beyond tips of fore tarsi. Scutal lobes each with about four setiferous tubercles. Thorax and first abdominal segment transversely crenulated.

Abdomen with transverse bands of chitin much broader than in Ptychoptera, so that they cover almost the entire abdominal surface; these bands with about twelve tubercles on segments 3 and 4, about ten on segment 5, and from six to eight on the posterior segments; tubercles of various sizes, small and somewhat degenerate ones being interspersed with larger ones; tubercles long and slender, each crowned by a circle or star of from three to six (usually four or five) stout spines (Plate XVIII, 44-46), a setiferous papilla arising from the center of this circle of spines; spines on pleura longer than those on remainder of abdomen, but not arranged in distinct longitudinal rows as in Ptychoptera, being usually more irregular, in some cases showing three or four more or less distinct rows; these pleural chitinized areas usually bearing from two to four tubercles, which are closely approximated basally so as to present a somewhat branched appearance. Male cauda (Plate XVIII, 48) as in Ptychoptera, but dorsal median lobe very short and stout; tubercles on segment immediately before cauda long and slender, similar to those on remainder of abdomen.

*Nepionotype*.—Ithaca, New York, May 15, 1917.

*Neanotype*.—Orono, Maine, June 24, 1913.

*Paratypes*.—With the type pupa.

Malloch's figure of the pupa (1915-17 b:pl. 35, fig. 6) is diagrammatic. It was probably made from a female individual, the antennal sheaths being shorter in this sex than in the male.

### FAMILY Rhyphidae

*Larva*.—Body eucephalous, amphipneustic. Mandibles opposed. Eyespots distinct. Spiracles on sides of prothorax. Thoracic and abdominal segments divided by false constrictions. Spiracular disk surrounded by two or five lobes (Rhyphinae) or by four lobes (Trichocerinae), or unprovided with lobes (Mycetobiinae).

*Pupa*.—Head with a bilobed setiferous cephalic crest. Palpi stout, straight. Pronotal breathing horns short, not prominent. Tarsal sheaths lying in pairs, one above another, the fore legs lying on the middle legs, and these latter on the hind legs. Lateral abdominal spiracles small but distinct.

The family Rhyphidae includes an apparently heterogeneous group of genera which are in reality very closely related. The adults are of diverse appearance, but the immature stages are exceedingly similar to one another and undoubtedly all three of the groups included in the family are closely allied.

The immature stages of the Rhyphinae (Rhyphus) have been discussed by many entomologists, among others by Johannsen (1910:35-36,

*Rhyphus punctatus*) and by Malloch (1915-17b:243, *R. punctatus*). The larvae are often handsomely banded and mottled with brown or purplish. Johannsen and other authors describe the cauda as ending in two short lobes, but Malloch mentions five such lobes. The general structural characters are those described above for the family. The larvae occur in decaying vegetable matter, in manure (especially horse and cow dung), in sewage, and in similar material.

The Mycetobiinae are represented by *Mycetobia*, a curious fly which superficially resembles a mycetophilid rather than a crane-fly. Long ago Lyonet, Dufour, Guérin-Méneville and others described and figured the larva of *Mycetobia* and noted the eucephalous condition of the head and the amphipneustic spiracles. Osten Sacken (1863) first suspected the affinities of this genus with *Rhyphus*. More recently, work by Johannsen (1910:31-32), Malloch (1915-17 a, and 1915-17b:244-245), Edwards (1916), Knab (1916), and others has definitely settled the relationship of this insect with the Rhyphidae. The larvae and the pupae agree closely with the general family characters discussed above. The larvae occur in decaying wood and about fermenting sap in wounds of trees. The genera *Ditomyia* Winn. and *Symmerus* Walk. are now placed in a separate family from *Mycetobia*, the *Ditomyiidae* (Keilin, 1919).

Until recently, the *Trichocerinae* have been considered as being members of the family *Tipulidae*. They include only the genus *Trichocera*, with about twenty-five nominal species, and, presumably, *Ischnothrix* Bigot, represented by a single species from Cape Horn. From the general appearance of the adult, these flies have usually been referred to the tribe *Limnophilini*, in a position near the genus *Limnophila*. Brunetti (1912) referred them to the *Pediciini*, and most other recent workers have accorded them tribal or subfamily rank in the *Tipulidae*. Bezzi (1914:214), influenced by the work of Keilin (1912), referred *Trichocera* to the *Rhyphidae*, but later (1918a:20) placed it back in the *Tipulidae* (as *Limnobiidae*). Malloch (1915-17b:234) likewise places *Trichocera* with the *Tipulidae*, but mentions the close resemblance of the larva to that of *Rhyphus*. The best discussions of the morphology of the larva and the pupa are those by Keilin (1912) and De Meijere (1916:191-194), both of whom were strongly impressed by the striking resemblance of the larva to that of *Rhyphus*. In the present paper, the *Trichocerinae* is the only group considered in detail.

SUBFAMILY *Trichocerinae*Genus *Trichocera* Meigen (Gr. *hair* + *horn*)1800 *Petaurista* Meig. Nouv. Class. Mouch., p. 15 (*nomen nudum*).1803 *Trichocera* Meig. Illiger's Mag., vol. 2, p. 262.1911 *Paracladura* Brun. Rec. Indian Mus., vol. 6, p. 286.

*Larva*.—Body eucephalous, amphipneustic. Thoracic segments divided into two annuli. Spiracles on lateral margin of posterior ring of prothorax. Abdominal segments divided into three annuli. Cauda ending in four lobes, ventral lobes the longer and more slender; lobes bearing numerous stout hairs near tips on outer face. Eyespots distinct. Lateral plates of head widely separated on midventral line. Mandible with prostheca distinct.

*Pupa*.—Cephalic crest small, lobes with stout setae. Clypeus short; labrum dumb-bell-shaped; palpal sheaths stout. Antenna elongate. Leg sheaths lying in pairs above one another, gradually lengthening, fore pair the shortest, posterior pair the longest. Pronotal breathing horns short. Abdominal spiracles small, but distinct and functional.

The small winter gnats of the genus *Trichocera* are rather familiar, since they are not rare during the winter months in cellars or even in the open on warm days, occurring in sunlit places in small, dancing swarms. They are abundant during fall and spring. They occur also in cool, shady places in summer, but are less in evidence at this season.

*Trichocera* is found somewhat commonly and regularly in mines, often at very considerable depths. Boheman (1850) records specimens of *T. regelationis* in mines 600 feet below the surface, and Lampa (1890) also records the species as being found at considerable depths. Dr. H. B. Hungerford found numerous adults of a species of *Trichocera* in the Amethyst silver mine near Creede, Colorado, in 1914. Specimens that he obtained were taken at the sixth level, but the miners said the insects were to be seen in all parts of the mine; along the laterals at the sixth level they were noted 7000 feet from the entrance. It is supposed that these individuals breed in the animal waste which naturally accumulates in such places. *Trichocera* is also a characteristic inhabitant of caverns and grottoes, all stages being found in such situations (Schmitz, 1909:80; Bezzi, 1911-12:46-47, 49, and 1914:214).

The swarming and mating of these flies is well known. It has been ably described by Ainslie (1907), and is here discussed only in general terms. The insects swarm commonly in the autumn. Sometimes the swarms include but comparatively few individuals, but at other times many thousands participate. They swarm usually from five to twenty-five feet above the ground, all facing in the same direction, that is,



toward the wind or breeze. Mating takes place in the air, and united pairs then fly away or drop to the ground beneath. The swarms are often very dense, and individuals come in frequent contact with one another. When the breeze shifts, the swarm immediately readjusts its position and direction.

The immature stages of *Trichocera* are spent in decaying vegetable matter, beneath dead or decaying leaves, in débris, in fungi, and in similar situations. Sometimes the larvae and pupae are rather numerous in stored roots and tubers, especially potatoes, in which cases they may assume an economic importance (Johannsen, 1910:34-35; Carpenter, 1912). The specimens used by the writer for study are part of Johannsen's material, determined as *T. regelationis* from Patten, Maine. The taxonomic condition of the group is such that no specific identification of the adult flies can be attempted at this time. The immature stages of the generalized subgenus of *Trichocera*, *Diazosma* Bergroth, are unknown.

The most important literature on the genus *Trichocera* is as follows:

<i>Trichocera regelationis</i> .....	General.....	Dufour, 1840:161.
<i>Trichocera regelationis</i> .....	Larva, general.....	Schmitz, 1909:80, pl. 8, fig. 3.
<i>Trichocera regelationis</i> .....	Larva, pupa.....	Johannsen, 1910:34-35, figs. 51-57.
<i>Trichocera regelationis</i> .....	Pupa.....	De Meijere, 1916:194.
<i>Trichocera himmalis</i> .....	Larva, general.....	Curtis, 1846b.
<i>Trichocera himmalis</i> .....	General.....	Cameron, 1917:63.
<i>Trichocera fuscata</i> .....	General.....	Carpenter, 1912. (Damage.)
<i>Trichocera</i> sp.....	Larva.....	Bremi-Wolf, 1846:175.
<i>Trichocera</i> sp.....	Larva.....	Perris, 1847:37, pl. 1, fig. 3.
<i>Trichocera</i> sp.....	General.....	Bezzi, 1911-12:46-47, 49.
<i>Trichocera</i> sp.....	Larva.....	De Meijere, 1916:191-194, figs. 21-23.
<i>Trichocera</i> sp.....	Larva, pupa.....	Keilin, 1912. (Morphology.)
<i>Trichocera</i> sp.....	Larva.....	Malloch, 1915-17b:234-235, pl. 26, fig. 1; 306.

#### *Trichocera regelationis*, supposition.

*Larva*.—Length, 8-9.5 mm.  
Diameter, 1 mm.

Coloration pale brown in preserved material, whitish in fresh specimens.

Body rather short, cylindrical to slightly depressed (Plate XIX, 49). Pseudopods lacking. Head complete, non-retractile, strongly chitinized; lateral plates of head widely separated on midventral line, connected only by a narrow bridge posteriorly; chaetotaxy as shown (Plate XIX, 52 and 53). Mandibles opposed, of three parts, principal segments bearing on inner side near base an apparently movable appendage (prostheca) which has, besides the large apical tooth, three smaller teeth. Labrum bluntly rounded, with long hairs. Epipharynx with lateral combs of about six blunt teeth. Antenna two-segmented; basal segment

very short, disk-shaped, inserted on a large brown-margined plate which is part of the head chitin; second segment much narrower, egg-shaped; in addition to this segment there are several small sensory papillae on the end of the first segment.

Segments of body divided into secondary annuli, thoracic segments with two such rings, abdominal segments with three; annuli bearing transverse rows of short setae. Anterior spiracles on posterior ring of prothorax near lateral margin conspicuous, smaller than posterior spiracles but constructed on same general principle. Spiracular disk surrounded by four lobes; ventral lobes longer and more slender than dorsal pair, inner face narrowly chitinized, outer face densely clothed with abundant short yellow hairs (Plate XIX, 50 and 51); dorsal lobes shorter and blunter, with short hairs on apices of outer face. Spiracles large, at base of dorsal lobes.

*Pupa*.— Length, 7.5–7.8 mm.  
Width, d.-s., 1.4 mm.  
Depth, d.-v., 1.4 mm.

Coloration whitish; head, thorax, and sheaths of appendages brown.

Anterior cephalic crest small, lobes widely separated, each tipped with a long, stout seta directed ventrad; a tiny seta just behind each anterior lobe. Antennal bases above and slightly between the eyes, bent dorsad and thence caudad, passing behind joints of legs, in the female attaining to about one-third length of wing. Frontal region between eyes slightly tumid, somewhat shiny. Clypeus short, the sides parallel, the apex U-shaped; labrum broad, dumb-bell-shaped, the caudal margin concave. Maxillary palpi very short and stout, ending before knee joints of fore legs (Plate XIX, 55). A small tubercle just laterad of base of antenna. Each cheek produced into a long, blunt, wrinkled tubercle.

Mesonotum (Plate XIX, 54) strongly gibbous, pale medially, narrowed in front, anterior margin truncated and sending a sharp median carina cephalad; sides of mesonotum opposite wing root with four small setae, in two slightly separated groups. Anterior angles of pronotum with a short bristle. Breathing horns small, short and almost straight, broad basally, apical half narrow, inner face fused or closely approximated with pronotum, apex cleft. Wing sheaths attaining level of tips of fore tarsi; venation rather distinct. Leg sheaths with fore legs stout; fore tarsi overlying middle tarsi (Plate XIX, 55); middle tarsi overlying hind tarsi; terminal segments of tarsi swollen. Abdominal segments divided into about three false annuli; caudal margin of each segment fringed with short hairs. Tiny abdominal spiracles on pleural segments. Female ovipositor (Plate XIX, 56) with the dorsal valves short, widely separated, acutely pointed; ventral acidotheca elongate, approximated, bent slightly ventrad.

*Larvae and pupae*.— Patten, Aroostook County, Maine, May 3 and 23, 1907.

### FAMILY Tipulidae

The family Tipulidae is the largest group of crane-flies, and possibly the only one to which the name is justly applicable. It includes a vast number of species (nearly three thousand), arranged in about one hundred

and forty genera. The species are found in most parts of the world, being restricted only by intense heat and cold. Crane-flies require moisture in order to complete their development, and, as a consequence, are almost always found in the neighborhood of flowing or stagnant water. No species known to the writer are inhabitants of desert conditions, the nearest approach probably being some Eriopterini, such as *Helobia*, *Trimiera*, and other genera.

The immature stages frequent very wide ranges of habitat, which are indicated elsewhere (page 716). They are readily separable from other related species by the characters outlined on pages 744 to 758. The subfamilies of Tipulidae may be separated by the following keys:

*Larvae*

1. Body provided with elongate spines or leaflike projections.
 

	<i>Cylindrotominae, pars</i> (p. 959)
Body without distinct spines.....	2
2. Form depressed, with more or less distinct lateral tubercles; terrestrial on spermatophytic plants..... *Cylindrotominae, pars* (p. 959)
 

Form terete; if depressed, without tubercles.....	3
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3. Spiracular disk surrounded by six or eight lobes..... *Tipulinae* (p. 974)
 

Spiracular disk not as above.....	4
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4. Spiracular disk surrounded by two, four, or five lobes..... 5
 

Spiracular disk with three lobes or without distinct lobes.....	7
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5. Head capsule massive, the hypopharynx a flattened plate with few teeth; size large (aberrant *Tipulinae*)..... 6
 

Head capsule massive or dissected, if the former the hypopharynx not as above; size usually small.....	<i>Limnobiinae, pars</i> (p. 793)
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6. Spiracular disk with five lobes; lives in moss..... Genus *Dolichopeza* Curt. (p. 981)
 

Spiracular disk with four slender, hornlike lobes; lives in earth.....	<i>Tipula selene</i> Meig. (p. 1016)
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7. Size large (30 mm. or over); form very stout, terete; head capsule of the tipuline type; lives in wood..... Genus *Tanyptera* Latr. (p. 988)
 

Size small (20 mm. or under); form slender, terete; head capsule of the limnobiine type.....	<i>Limnobiinae, pars.</i> (p. 793)
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*Pupae*

1. Basal abdominal segments unarmed with teeth or spinous projections before posterior margin..... 2
 

Basal abdominal segments armed with a transverse row of usually small teeth or chitinous projections before posterior margin.....	3
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2. Last larval skin adhering to posterior end, attaching pupa to a plant stem or a leaf; coloration bright green..... *Cylindrotominae, pars* (p. 959)
 

Not as above.....	<i>Limnobiinae, pars</i> (p. 793)
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3. Maxillary palpi curved or recurved at tips; size large, usually 12 mm. or over.
 

Maxillary palpi not recurved at tips.....	<i>Tipulinae, pars</i> (p. 974)
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4. Maxillary palpi long, slightly or decidedly curved at tips; size large, length usually 12 mm. or over..... 5
 

Maxillary palpi short, straight; size small, usually 10 mm. or under.....	<i>Limnobiinae, pars</i> (p. 793)
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4. Head capsule massive, compact, the posterior incisions usually shallow..... 5  
 Head capsule of four or six slender rods, the posterior incisions profound..... 15
5. Mentum completely divided, a toothed plate on either side; abdominal segments without distinct creeping-welts..... 6  
 Mentum, if present and chitinized, not completely divided; abdominal segments with basal creeping-welts..... 8
6. Spiracular disk squarely truncated, surrounded by five lobes..... *Eriopterini* (p. 908)  
 Spiracular disk with four lobes..... 7
7. Each mental plate four-toothed; hypopharynx labriform.  
*Pediciini*, subtribe *Adelphomyaria* (p. 895)  
 Each mental plate with seven or eight teeth; hypopharynx a comblike ring.  
*Hexatomini*, subtribe *Pseudolimnophilaria* (p. 848)
8. Spiracular disk with five lobes..... 9  
 Spiracular disk with four lobes..... 12
9. Antennae almost globular, with two conical apical papillae; lives in fungi.  
*Hexatomini*, subtribe *Ularia* (p. 838)  
 Antennae elongate-cylindrical..... 10
10. Abdomen with dorsal and ventral creeping-welts; mentum with more than five teeth.  
*Limnobiini* (p. 795)  
 Abdomen with six ventral welts only; mentum with five or fewer teeth..... 11
11. Mentum five-toothed; lives in earth..... *Limnobiini*, subtribe *Rhamphidaria* (p. 830)  
 Mentum three-toothed; lives in wood..... *Hexatomini*, subtribe *Epiphragmaria* (p. 843)
12. Antennae almost globular, with two conical apical papillae; lives in fungi.  
*Hexatomini*, subtribe *Ularia* (p. 838)  
 Antennae elongate-cylindrical..... 13
13. Abdomen with dorsal and ventral creeping-welts, the latter naked; mentum not three-toothed; forms aquatic..... *Limnobiini*, subtribe *Ellipteraria* (p. 806)  
 Abdomen with ventral creeping-welts only; mentum with only three primary teeth; species not aquatic..... 14
14. Form long, slender; skin naked, shiny, transparent; apical segment of antennae elongate, as long as, or longer than, basal segment; mentum with a smaller tooth on either side; lives in earth..... *Limnobiini*, subtribe *Dicranoptycharia* (p. 828)  
 Form short, stout; skin white, opaque; apical segment of antennae short, hemispherical; mentum without small lateral teeth; lives under bark.
15. Blades of maxillae not produced; form long and slender..... 16  
 Blades of maxillae produced into flattened elongate appendages, the tips of which protrude from the thoracic orifice when the head is completely retracted; form short and stout..... 17
16. Spiracular disk squarely truncated, surrounded by five lobes which are fringed with numerous, usually short, hairs; esophageal region not conspicuously grooved.  
*Eriopterini*, subtribe *Eriopteraria* (p. 911)  
 Spiracular disk surrounded by four lobes, each ventral lobe with a single elongate bristle; esophageal region elongate, grooved; lives under bark.  
*Eriopterini*, subtribe *Elephantomyaria* (p. 952)
17. Mental region a narrow, transverse, chitinized bar.  
*Hexatomini*, group *Limnophilae* (p. 858)  
 Mental region not chitinized..... 18
18. Mandibles hinged; maxillae and labrum densely hairy; dorsal plates of head capsule united into a spatula..... *Hexatomini*, group *Ulomorphae* (p. 869)  
 Mandibles not hinged; maxillae and labrum not densely hairy; dorsal plates of head capsule separated..... *Hexatomini*, subtribe *Hexatomaria* (p. 876)
19. Head capsule massive, compact..... 20  
 Head capsule of six slender rods; lives under bark.  
*Eriopterini*, subtribe *Eriopteraria* (p. 911)

20. Mental plates not completely divided; abdominal segments with basal creeping-welts on both ventral and dorsal surface; spiracular disk indistinctly four- or five-lobed. *Limnobiini* (p. 795)  
 Mental plates completely divided; abdominal segments without welts; spiracular disk obliquely truncated. . . . . *Eriopterini* (p. 908)

### Pupae

1. Pronotal breathing horns eight-branched; forms entirely aquatic. *Limnobiini*, subtribe *Antocharia* (p. 799)  
 Pronotal breathing horns simple, unbranched. . . . . 2  
 2. Rostral sheath elongated; lives in wood. *Eriopterini*, subtribe *Elephantomyaria* (p. 952)  
 Rostral sheath not elongated. . . . . 3  
 3. Pronotal breathing horns very minute, conical, visible only with a lens.<sup>5</sup> *Limnobiini*, subtribe *Dicranoptycharia* (p. 828)  
 Pronotal breathing horns larger, not microscopic. . . . . 4  
 4. Dorsal spiracles on eighth abdominal segment large and functional. . . . . 5  
 Dorsal spiracles on eighth abdominal segment small or lacking. . . . . 7  
 5. A large circular spinous area on abdominal pleurites; cephalic crest chitinized, acutely pointed; pronotal breathing horns directed ventrad; lives in decaying wood. *Hexatomini*, subtribe *Epiphragmaria* (p. 843)  
 Not as above. . . . . 6  
 6. Pronotal breathing horns large, flattened, the tips yellow; abdominal tergites with shagreened crossbands. . . . . *Hexatomini*, subtribe *Ularia* (p. 838)  
 Pronotal breathing horns slender, cylindrical; abdominal tergites with transverse rows of small spines. . . . . *Limnobiini*, subtribe *Rhamphidaria* (p. 830)  
 7. Abdominal pleurites with circular areas set with numerous microscopic spicules; pronotal breathing horns short, usually truncated at tips, which are margined with the breathing pores. . . . . *Pediciini* (p. 894)  
 Abdominal pleurites not as above, if with spines these large and few in number; pronotal breathing horns long, cylindrical. . . . . 8  
 8. Abdominal segments with broad transverse bands or welts on basal rings of third to seventh tergites. . . . . *Limnobiini* (p. 795)  
 Abdominal segments with basal ring unarmed as above, posterior ring before margin with a transverse row of spines or stiff setae. . . . . 9  
 9. A distinct crest on mesonotal prescutum armed with tubercles, spines, or setae; size small (usually under 9 mm.). . . . . *Eriopterini* (p. 908)  
 No distinct crest on mesonotal prescutum (scutellum armed in some Eriocera); size large (usually over 10 mm.). . . . . 10  
 10. Leg sheaths very short, barely exceeding wings; lives under bark. *Eriopterini*, genus *Gnophomyia* (p. 934)  
 Leg sheaths longer, extending one or more segments beyond tips of wings. . . . . 11  
 11. Size small (under 6 mm.); abdominal armature weak, lacking on segment 7. *Pediciini*, subtribe *Adelphomyaria* (p. 895)  
 Size larger; abdominal armature stronger, spinous; if small in size (*Dicranophragma*), basal annuli of abdominal segments armed with naked tubercles. *Hexatomini* (p. 835)

### Tribe Limnobiini

A large group of crane-flies, arranged in a few often extensive genera, comprise the tribe Limnobiini. At first sight the tribe appears to be a

<sup>5</sup>In the genus *Cladura* (*Eriopterini*), reared while this paper was going thru the press, the breathing pores are likewise microscopic, being entirely sessile (page 949).

heterogeneous assemblage, but in reality it constitutes a natural group. The tribe as herein arranged includes the old group *Limnobiini*, with the addition of several genera that were formerly distributed in the *Antochini*. The divisions of the tribe as now constituted are as follows:

1. *Limnobaria* — including the old tribe *Limnobiini*.
2. *Ellipteraria* — including the genus *Elliptera*. This is close to the preceding subtribe and may be a group belonging to it.
3. *Antocharia* — including *Antocha* and presumably allied genera, as *Orimargula*, *Orimarga*, *Diotrepha*, and possibly others.
4. *Rhamphidaria* — including *Rhamphidia* and its allies.
5. *Dieranoptycharia* — including *Dieranoptycha* only.

These groups are not far removed, phylogenetically, from the lowermost divisions of the *Hexatomini*, such as the *Ularia* and the *Epiphragmaria*, and the two tribes are unquestionably closer together than their arrangement on paper would indicate. The separation of the two major groups was made largely on the characters of the imagines.

The larvae have the body terete, moderately elongate or very long and slender (*Dieranoptycha*). The abdominal segments are subdivided into a basal and a posterior ring, the former with transverse welts of microscopic chitinized points or hooks. In the *Limnobaria* and the *Antocharia* these welts occur on both the dorsal and ventral surfaces in the form of microscopic hooks; in the *Ellipteraria* they are on segments 3 to 9 on the dorsal surface only, being indicated on the ventral surface but naked; in the *Rhamphidaria* the welts are ventral in position on segments 2 to 7; in the *Dieranoptycharia* they are similar, on segments 2 to 8. The body in *Dieranoptycha* is entirely glabrous.

The head capsule is of moderate to large size and is massive and compact, consisting of a narrow dorsal plate which is usually indented behind, and two broad mussel-shaped lateral plates which are connected anteriorly across the venter to form the mental plate. The mental plate consists of an outer plate which usually terminates in a single median point, and behind this an inner plate which contributes additional teeth to the mentum. In *Dieranoptycha* there is but one subequal tooth on either side, with an additional much-reduced tooth; in *Rhamphidia* there are two teeth, and in the other groups there are usually four or five. The hypopharynx is usually a double plate united at the ends to form a collar, with the anterior margins finely toothed. The maxillae are

large and simple in structure; the cardo and stipes are large; the palpus is flattened. The antennae have the apical segment or papilla ranging from elongate, in *Dicranoptycha*, to very flattened and disklike, in *Limnobia* and its allies. The mandibles are usually of simple structure, with one or two dorsal teeth and from three to seven teeth in the ventral cutting row.

The spiracles are lacking in some species, at least, of *Antocha*. The spiracular disk is surrounded in *Rhamphidia* by five subequal lobes, in *Dicranoptycha* by four slender, naked lobes; in many *Limnobia* the lobes are lacking or indistinct.

The larvae of many of the species are able to spin silken cocoons or tubes in which they live. These tubes are open at both ends, and are usually covered exteriorly with particles of extraneous matter gathered in the larval haunts.

The pupae usually lack a distinct setiferous cephalic crest, altho one is present in *Rhamphidia* and in *Dicranoptycha*. The pronotal breathing horns are usually large, and are either subcircular, or wider than long (most *Limnobia*), rarely elongate (*Rhamphidaria*), very large, earlike, and contiguous or practically so on the median line (*Ellipteraria*), or branched into eight long filaments (*Antocharia*); in the *Dicranoptycharia*, however, they are microscopic. The abdominal segments on the basal ring often show a transverse welt of small hairs or a double convergent row of chitinized hooks; in *Discobola*, *Rhamphidia*, and *Dicranoptycha*, however, this is apparently not the case, the abdominal armature being more eriopterine or hexatomine in appearance. The eighth abdominal segment often bears a pair of dorsal spiracles; these are apparently lacking in some species (*Antocha saxicola*) and are small in most *Limnobia*, but are large and functional in *Rhamphidia*.

The following keys separate the subtribes of the tribe *Limnobiini*:

*Larvae*

1. Body ending in two long ventral lobes; spiracles lacking or very reduced; forms strictly aquatic. . . . . *Antocharia* (p. 799)
- Body not as above; spiracles large. . . . . 2
2. Body with ventral and dorsal welts on abdominal segments. . . . . 3
- Body with ventral welts only. . . . . 4
3. Spiracular disk surrounded by four lobes which are provided with long fringes of hair; dorsal welts microscopically spiculose; ventral welts naked; species aquatic. . . . . *Ellipteraria* (p. 806)
- Spiracular disk not as above; dorsal and ventral welts alike. . . . . *Limnobia* (p. 808)



4. Body moderately elongated, covered with a long, dark pubescence; abdomen squarely truncate at end, surrounded by five lobes, presenting an eriopterine appearance; mentum conspicuously five-toothed..... *Rhamphidaria* (p. 830)  
 Body very long and slender, glabrous; abdomen surrounded by four narrow, glabrous lobes; mentum indistinctly five-toothed..... *Dicranoptycharia* (p. 828)

*Pupae*

1. Pronotal breathing horns branched; forms entirely aquatic..... *Antocharia* (p. 799)  
 Pronotal breathing horns simple..... 2  
 2. Pronotal breathing horns very tiny, microscopic, conical..... *Dicranoptycharia* (p. 828)  
 Pronotal breathing horns large, conspicuous..... 3  
 3. Pronotal breathing horns large, earlike, contiguous basally; forms aquatic, in silken cocoons..... *Ellipectera* (p. 806)  
 Pronotal breathing horns not contiguous basally..... 4  
 4. Cephalic crest small or lacking; pronotal breathing horns short and broad, rarely elongated; a pair of small spiracles on dorsum of eighth abdominal segment... *Limnobia* (p. 808)  
 Cephalic crest large, setiferous; pronotal breathing horns long and slender, cylindrical; a pair of large spiracles on dorsum of eighth abdominal segment.  
*Rhamphidaria* (p. 830)

The most important literature on the tribe Limnobiini is as follows:

- Antocha saxicola*..... General..... Needham, 1908a: 205.  
*Antocha* sp..... Larva..... Malloch, 1915-17 b: 236-237.  
*Ellipectera omissa*..... Larva, pupa, general... Mik, 1886 b.  
*Ellipectera omissa*..... Larva, pupa..... Grünberg, 1910: 31-32. (Copy.)  
*Ellipectera omissa*..... Larva, pupa..... Malloch, 1915-17 b: 226-227.  
*Thaumastoptera calceat*..... Larva, pupa, general... Lenz, 1920a.  
*Limnobia quadrimaculata*..... General..... Von Röser, 1834 (as *annulus*).  
*Limnobia quadrimaculata*..... Larva, pupa..... Beling, 1873 b: 590-591 (as *annulus*).  
*Limnobia bifasciata*..... Larva, pupa, general... Bremi-Wolf, 1846 (as *xanthoptera*).  
*Limnobia bifasciata*..... Larva, pupa, general... Pastejrk, 1909 (as *xanthoptera*).  
*Limnobia bifasciata*..... Larva, pupa..... De Meijere, 1916: 198-201.  
*Limnobia decemmaculata*..... General..... Loew, 1873: 41.  
*Limnobia decemmaculata*..... General..... Verrall, 1912.  
*Limnobia flavipes*..... Larva..... Beling, 1886: 202.  
*Limnobia inusta*..... General..... Beling, 1886: 202 (as *macrostigma*).  
*Limnobia sczrpunctata*..... Larva..... Beling, 1879: 54-55 (as *nigropunctata*).  
*Limnobia nubeculosa*..... General..... Beling, 1879: 56.  
*Limnobia obscuricornis*..... Larva, pupa..... Beling, 1879: 55-56.  
*Limnobia tripunctata*..... Larva, pupa..... Beling, 1873 b: 591-592.  
*Limnobia triocellata*..... Larva, pupa, general... Johnson, 1906: 2.  
*Limnobia triocellata*..... Larva, pupa..... Malloch, 1915-17 b: 215-216.  
*Limnobia immatura*..... Pupa..... Malloch, 1915-17 b: 216.  
*Limnobia perkinsi*..... General..... Perkins, 1913: clxxxii (as *Limnobia*).  
*Discobola caesarea*..... Pupa..... Mik, 1884.  
*Dicranomyia trinotata*..... Larva, pupa..... Thienemann, 1909.  
*Dicranomyia trinotata*..... Larva, pupa..... Grünberg, 1910: 29. (Copy.)  
*Dicranomyia dumetorum*..... General..... Winnertz, 1853.

<i>Dicranomyia dumetorum</i> .....	General.....	Beling, 1873 b:592.
<i>Dicranomyia dumetorum</i> .....	General.....	Beling, 1879:56.
<i>Dicranomyia dumetorum</i> .....	Larva.....	Beling, 1886:201-202.
<i>Dicranomyia</i> sp.....	General.....	Schubart, 1854.
<i>Dicranomyia foliocuniculator</i> .....	General.....	Swezey, 1913.
<i>Dicranomyia foliocuniculator</i> .....	Larva, pupa.....	Swezey, 1915:87.
<i>Dicranomyia umbrata</i> .....	Larva.....	De Meijere, 1916:197-198.
<i>Dicranomyia simulans</i> .....	Larva, pupa, general..	Needham, 1908 a:214-217.
<i>Dicranomyia simulans</i> .....	Larva, pupa.....	Malloch, 1915-17 b:213-214.
<i>Rhipidia maculata</i> .....	Pupa.....	Beling, 1873 b:592.
<i>Rhipidia maculata</i> .....	Larva, general.....	Beling, 1879:52-53.
<i>Rhipidia uniscripta</i> .....	Larva, general.....	Beling, 1879:53-54.
<i>Rhipidia domestica</i> .....	General.....	Johnson, 1910:704.
<i>Dicranoptycha winnemana</i> .....	Larva, pupa.....	Alexander, 1919 b.
<i>Rhamphidia longirostris</i> .....	General.....	Gercke, 1884.
<i>Rhamphidia longirostris</i> .....	General.....	Grünberg, 1910:30. (Copy.)
<i>Rhamphidia flavipes</i> .....	Larva.....	Hart, 1898 [1895]:197-199.
<i>Rhamphidia flavipes</i> .....	Larva.....	Malloch, 1915-17 b:231-232.

### Subtribe Antocharia

The subtribe Antocharia includes the genus *Antocha* and probably three or four related genera, such as *Diotrepha*, *Orimarga*, and *Orimargula*. The group is well-defined in all stages, so far as these are known, the larvae presenting a curious superficial resemblance to those of *Pedicaria*, while the pupae introduce a novelty of structure of the breathing horns, which is discussed in detail elsewhere (page 805). It is probable, however, that these peculiarities of larval and pupal structure are largely the result of habit and habitat, and a critical survey of the structure shows a close relationship with the other subtribes herein recognized.

#### Genus *Antocha* Osten Sacken (Gr. *close approximation*)

1859 *Antocha* O. S. Proc. Acad. Nat. Sci. Phila., p. 219.

*Larva*.—Body slender, tapering behind, ending caudally in two elongate ventral lobes which bear a few hairs at their tips and at intervals along their length. Abdominal segments 2 to 7 each with a swollen area on basal ring densely covered with microscopic hairs. Tracheal gills four in number, large, constricted into three or four lobes. Spiracles lacking or rudimentary. Head capsule moderate in size. Mentum with nine or ten teeth, deeply split behind. Maxilla conspicuous, consisting of two subequal lobes which are provided with dense brushes of hairs. Hypopharynx with chitinized teeth.

*Pupa*.—Anterior end of body large, tapering behind. Head with a small median lobe in front, on either side of which is a small tubercle; genae gibbous. Pronotal breathing horns large, flattened, the margin branching into eight long filaments. Abdominal segments on basal ring with a double transverse row of small hooks which converge at the ends to inclose an oval depressed area; last segment of body terminating in two strong, recurved, chitinized hooks.

*Antocha* is a small genus of crane-flies (about seven species) whose specific limits are still not well understood. The species are well distributed throught the Northern Hemisphere. The adult flies are of primitive organization, but the larvae and the pupae are highly specialized in many respects.

The only previous record of the immature stages of any member of this group is the unknown Limnobiine No. 2 (Malloch, 1915-17b:236-237), which surely refers to an *Antocha*, possibly *A. monticola* Alex. The main point of difference between the species described by Malloch and the species described in detail hereinafter is the small spiracles mentioned in the description of the former species. *A. saxicola* lacks spiracles, since it has no use for them, being confined to submerged cases often many feet below the surface of the water.

Altho nothing is known concerning the immature stages of the genera *Orimargula*, *Orimarga*, and *Diotrepha*, the writer believes that these genera will be found to have larvae of this same general type, since from the structure of the adults they are obviously derived from the *Antocha* stem. The larvae are curiously suggestive of the *Pediciini* (as compared with *Dicranota*), but the structure of the mouth parts, the smooth pseudopods, and the cauda, are quite different and indicate that the similarities are analogous only. The pupae are unlike those of any crane-fly as yet made known, in the very remarkable breathing horns; but this is possibly a condition brought about by the habitat rather than a fundamental feature. The apparently very different pupae of *Elliptera* are closely related to *Antocha*.

*Antocha saxicola*. O. S.

1950 *Antocha saxicola* O. S. Proc. Acad. Nat. Sci. Phila., p. 219.

*Antocha saxicola* has one of the most interesting life histories of any of the crane-flies yet discovered, not only because of the larval and pupal habitat, but also because of the peculiar structures that appear in the larva and in the pupa and have been found nowhere else in the immature stages of the family, so far as is known. The larvae simulate strikingly the same stage in the *Pedicularia*, but are apneustic, entirely lacking functional spiracles and depending wholly on tracheal gills for their respiration. The pupae have the pronotal breathing horns split into eight long filaments, so that they bear a curious superficial resemblance to the pupae

of the black fly (Simuliidae). Both larvae and pupae spend their entire lives in cases on stones in water — usually in running, well-aërated water, and often in the most rushing torrents.

The larvae, as already stated, lack spiracles, the entire respiration being carried on thru tracheal gills, four in number, and the rich tracheal development in the elongate caudal lobes. Thus the tracheal system is truly closed, and represents the maximum of specialization in the reduction in size and final loss of the spiracles. In air-breathing, terrestrial forms, the spiracles are large and situated comparatively close together, gradually becoming smaller and more removed from one another as the creature becomes more and more dependent on blood gills or tracheal gills for respiration. This is the only truly closed tracheal system known to the writer to occur in the Tipulidae. It should be noted that the loss of the spiracles is accompanied by great enlargement of the gills and the taking on of the gill function by the two caudal lobes. The haunt of the larvae is in silken cases on rocks, often in the swiftest part of the stream, where it is impossible to breathe thru spiracles and where the associated forms of life (Ephemera, Plecoptera, Trichoptera, and Diptera) all, or practically all, depend entirely on gills for respiration.

As a rule, the larval cases are made on rubble or rounded stones, a crevice or a groove caused by inequalities of the rock surface covered over being the simplest and commonest place chosen. The inequalities in the rock are bridged over by a silken, mud- or silt-covered case, which is very delicate and laterally fimbriated with the young larva but becomes much firmer, thicker, and more compact with the older larva and pupa. The larval case is open at both ends and the larva passes backward and forward freely, showing considerable agility when disturbed. When the larva is still small, the case is correspondingly small and insignificant; but the case of the matured larva is conspicuous, measuring from 4 to 5 centimeters in length and about 1.2 centimeters across the lateral "wings," or fimbriations. The insect moves freely along the tube but is very loath to leave it unless actually ejected. As stated above, the late larval and pupal covering is very different from the flimsy, silt-covered tube of the young larva, being smooth, compact, hard, and often covered with pebbles. The pupa has two powerful hooks at its caudal end, enabling it to fasten to the case. In most cases the pupa hangs with the current, head downstream, like the pupa of *Blepharocera*

and unlike the somewhat similar-appearing pupa of the Simuliidae, which rests with the head upstream, against the current, the pupal case being open at the cephalic end only.

These curious larvae were first noted at Ithaca, New York, in mid-April, in Cascadilla Creek. They were common in situations such as described above. Larvae were found thruout most of April, May, and June; they would probably be seen in somewhat fewer numbers thru most of the summer season, since the adult flies have a long seasonal appearance. The first pupa was found on May 15, 1917, but the season that year was very backward and undoubtedly the species pupates earlier in more nearly normal seasons.

In Cascadilla and Fall Creeks, at Ithaca, the immature stages of *Antocha* are usually associated with a fauna of rapid-water (lotic) forms, the following being the more notable and constant:

Planarians.	<i>Planaria</i> sp.
Ephemeroidea.	Nymphs of <i>Baetis</i> , <i>Leptophlebia</i> , <i>Ephemerella</i> , <i>Ecdyurus</i> , <i>Epeorus</i> , <i>Iron</i> , <i>Heptagenia</i> , <i>Chirotenetes</i> , and others.
Perlidae.	Nymphs of <i>Pteronarcys</i> , <i>Perla immarginata</i> Say, <i>Acro-neuria</i> , <i>Neoperla</i> , and others.
Trichoptera.	Larvae and pupae of <i>Helicopsyche</i> (abundant), <i>Hydropsyche</i> , <i>Hydropsychodes</i> , <i>Ithytrichia</i> , <i>Rhyacophila</i> , <i>Lep-tocerus</i> , <i>Polycentropus</i> , and others.
Lepidoptera.	Larvae and pupae of <i>Elophila</i> .
Coleoptera.	Larvae of <i>Psephenus</i> .
Diptera.	Larvae and pupae of <i>Blepharocera</i> , <i>Simulium</i> , <i>Ortho-cladius</i> , <i>Tanytarsus</i> , and others.

Early in spring the rocks are plastered with dense coatings of Diatomaceae (*Navicula*, *Synedra*, *Meridion*, and other genera), which later in the season become much rarer or disappear entirely. It is often impossible to tell the case of *Antocha* from that of some very similar caddis-worm cases, especially some of the glossosomatine *Rhyacophilidae*. Dr. Noyes found larvae of *Antocha* in a small, rapid-flowing stream near Ringwood Hollow, and here the cases were covered with tiny pebbles and it was quite impossible to distinguish them superficially from associated caddis-worm cases. In Cascadilla Creek the little cases of *Helicopsyche* often plaster the upper surfaces of submerged rocks, and the writer has found tubes of *Antocha* that were almost buried beneath these cases.

*Antocha* is by no means confined to rapidly flowing streams, altho the insects are very often found in such situations. The writer has found adults in his tent traps set over the Sacandaga River, in Fulton County, New York, where the water was very quiet and at least ten feet deep. Needham (1908a:169-170, 205), similarly, found adults in numbers in his tent traps set over Beaver Meadow Brook at Old Forge, New York, in August, 1905, but did not locate the larvae. In rapid-flowing streams the insects sometimes occur just at the surface in a few millimeters of water, or at greater depths. The immature stages seem adapted to live under almost any conditions of current, from moderate pressure to situations where the water rushes by in torrents and where but few of the usual lotic organisms, such as *Blepharocera*, *Simulium*, *Psephenus*, and others, can exist. From Clemens' studies (1917:14-23) it is evident that the current is much more rapid just beneath the surface than at various lower depths, so that at a depth of one foot the current velocity is only about two-thirds of that at the surface. Thus these aquatic organisms are not constantly and entirely subjected to such tremendous pressures as on first sight they appear to be. Many of the larvae and pupae perish from desiccation, due to the lowering of the stream level and the consequent exposure of the rocks on which their homes are made.

Copulation between the adult flies takes place on the exposed rocks in and along the margins of the streams where the larvae live (Osten Sacken, 1869:127). The eggs are deposited in the water, and the entire life, until the emergence of the adult fly, is spent beneath the water. The whole life cycle may require a year, altho the species is possibly double-brooded. At a single time, and even on a single rock, larvae of various sizes, from very small ones to those almost fully grown, may be found, and this probably explains the long flight-period of the adult. That the species is double-brooded remains to be proved.

The food of the larva consists of microscopic plant organisms in the water, the curious maxillae, with their dense brushes of long hairs, undoubtedly being an adaptation for this type of food.

*Larva*.— Total length, 9.5-10.5 mm.

Length of caudal lobes alone, 1.1-1.2 mm.

Diameter of body, 1-1.1 mm.

Coloration of living larva, light greenish brown above, clearer greenish ventrally; contents of alimentary canal showing clearly thru the thin skin; on segments 7 and 8, two paired, bright

orange bodies which are very conspicuous, these possibly being fatty in nature; welts on the abdomen dark brown; in preserved specimens general coloration fading to a dull yellow.

Form elongate (Plate XX, 57), tapering behind. Surface with a dense, appressed pubescence and scattered erect hairs. Prothorax long, narrowed in front, anterior orifice margined with dense, fine pubescence; sides of prothorax with numerous long, erect, pale hairs. Mesothorax and metathorax indistinctly divided into two approximately equal annuli; anterior annulus with a few lateral setae. First abdominal segment short, the setae arranged as follows: dorsal, two small grouped setae near posterior margin, laterad of each of these, but in alignment, a solitary stout seta, proximad of each of these a stout seta, and cephalad of each of these another strong seta, the principal setae of each side thus forming a rough triangle; a long, delicate pleural seta on each side; ventral, two small groups of setae, with an arrangement similar to that of the grouped setae of dorsum. Abdominal segments 2 to 7 each indistinctly divided into two annuli by a transverse constriction, the anterior ring about half the length of the posterior ring and bearing medially a transverse elongate-oval (dorsal) to short-oval (ventral) welt, covered with microscopic points; ventral welts very convex and swollen; pleura with a long seta; posterior ring with setae arranged as described above for first abdominal segment; setae of posterior segments of body longer, but occupying same relative position; small solitary inner seta of dorsal posterior line becoming large and prominent on seventh segment; segment 8 with six powerful setae in alignment on ventral surface, situated at base of gills, two being pleural and four ventral in position; dorsum of segment 8 with a rounded median lobe. Gills four, long, delicate, divided into lobes by constrictions (the two caudal lobes, as well as the gills, have taken on a respiratory function). Caudal ventral lobes two (Plate XXI, 68) very long, parallel, with scattered setae arranged as follows: at tips, six or seven; at about two-thirds length, three; at about one-third length, a tuft of from fifteen to twenty long and short setae on lateral and dorsal faces; a small solitary seta, dorsal in position, at base of lobe; a similar bristle on ventral face at about midlength of lobe. Like remainder of body, cauda covered with an abundance of delicate appressed pubescence; on dorsal side, at base of each lobe, a rounded spot, and just inside this a narrow, longitudinal line which is destitute of pubescence. Only dorsal lobe the median one of eighth segment, mentioned above. Spiracles lacking.

Head capsule (Plate XX, 58) moderate in size. Lateral plates thin, double, inner one the longest, outer one forming mental plate. Dorsal plate broad in front, narrowed behind, posterior margin bluntly notched; in front of this plate, two broad plates, rather widely separated medially, presumably belonging to clypeus. Labrum broad, cephalic margin and ventral face with transverse rows of short hairs. Mentum (Plate XX, 59) conspicuous, deeply split behind but not entirely divided as in the *Pediciini*; an outer flattened, circular median lobe whose outer face is covered with small, scalelike roughenings; behind (dorsad of) this outer lobe the mentum proper, roughly triangular in outline, conspicuous, margin with a broad, blunt, median tooth which is sometimes (Plate XXI, 66) bilobed to form two subequal apical teeth; besides this median tooth, four lateral teeth, the outermost one broad with its lateral angle rounded. Hypopharynx (Plate XXI, 64) forming a ring into which ducts of salivary glands open; anterior part, somewhat resembling mentum in shape, a narrow blade with anterior margin having about eight teeth; posterior part a transverse, arcuated band with anterior margin having about twenty teeth. (In the figure, the two parts of the hypo-

pharynx are shown diagrammatically and separated; in some specimens the lateral teeth are more acute, in others they are more rounded.) Antenna (Plate XXI, 65) elongate, cylindrical, chitinized, apex pale, with two long, sensory setae and a few papillae. Mandible (Plate XXI, 63 and 67) strong, flattened, with two powerful bristles on back, or scrobal region, near base; inner face concave, tip ending in a long tooth, dorsad of apex a single smaller tooth, ventral cutting edge with four gradually smaller teeth, beyond the last of which the margin is crenulated into four or five indistinct carunculations; viewed from inside, lateral teeth appearing blunt. Maxilla (Plate XXI, 63) large, consisting of two elongate-oval lobes, the inner one densely hairy; palpus, borne at tip of outer lobe on ventral face, shaped like one-half of a cylinder split lengthwise, several tiny hyaline sense pegs at apex; laterad of palpus and nearer base of outer lobe, a small elongate sensory tubercle with hairs at apex; inner lobe of maxilla subequal in size and length to outer lobe, but more densely hairy; on its ventral face, four or five long sensory tubercles which are expanded at their ends into setiferous heads; at base of maxilla, a long, slender arm with three setiferous punctures at apex and another puncture at about two-thirds length; setae of this arm very long and delicate. (A dorsal view of the larva is shown in Plate XX, 57.)

*Pupa*.—Length to tip of cephalic crest, 6.2–6.8 mm.

Width, d.-s., 1.4–1.5 mm.

Depth, d.-v., 1.1–1.2 mm.

Head, thorax, and sheaths of appendages dark brown in fully colored individuals; abdomen pale yellowish white; terminal hooks of abdomen heavily chitinized.

Head on margin above eyes with a blunt median lobe and on either side a small but prominent tubercle; gena gibbous. Compound eyes large, semicircular in outline. Front between eyes with margins almost parallel. Labrum with apex truncated or indistinctly bilobed. Labial lobes broad, appearing subtriangular. Sheaths of maxillary palpi not greatly elongated, slender, cylindrical.

Pronotal breathing horns (Plate XX, 61) flattened at base, each arcuated basally behind, bending laterad to form a concave hollow in front; base dark brown, chitinized, branched into eight long, pale filaments which are grouped more or less in pairs; the two ventral and the four dorsal filaments arising from a short common base, the other two being separate for their entire length; these filaments as long as, or longer than, antennal sheaths, varying in length from rather short to a longer type. Thoracic dorsum broad, ample, feebly wrinkled transversely. Leg sheaths (Plate XX, 60) with all the tarsi very long and slender, reaching almost to end of fifth abdominal segment. Wing sheaths comparatively narrow, reaching base of third abdominal segment; anal angle sharp; venation fairly distinct.

Abdomen pale. Intermediate abdominal segments divided into two annuli, the posterior ring much the larger; dorsa of segments 3 to 6 (Plate XXII, 71), and sternum of segment 6, each with basal annulus tumid and with two transverse rows of small hooks converging at the ends to inclose a linear depressed area; these areas capable of contraction, so that the hooks of each row are united or approximated with those of the opposite row; from thirty to thirty-five hooks in each row, anterior row with hooks directed backward, posterior row with hooks directed forward; on seventh segment, only the anterior row of hooks present, very slightly arcuated, the lateral hooks smaller than those near middle of row; caudad of this



row on segment 7, a darkened, transversely rectangular area bearing setiferous punctures in two broken rows, the posterior row the more complete; posterior rings of other segments of dorsum bearing setae in somewhat the same arrangement. Pleural area pale, segments 2 to 8 with a long, delicate seta on each annulus. Dorsum of segment 8 (Plate XXII, 70) with a large setiferous tubercle on either side, this tubercle densely covered with hairs that are longest behind and shorter in front; caudad of these large, blunt knobs, a slender, setiferous tubercle. Last segment with tergal valves chitinized, elongate, extreme posterior margin rounded medially and feebly bilobed, lateral angles produced caudad and dorsad into powerful curved, heavily chitinized hooks; a few setae at about midlength of these hooks (Plate XX, 62). Sternal valves shorter, slightly bilobed medially.

*Nepionotype*.— Ithaca, New York, June 4, 1917.

*Neanotype*.— With the nepionotype.

*Paratypes*.— Topotypic, May 1 to June 10, 1917.

### Subtribe Ellipteraria

The present knowledge of the immature stages of the genus *Elliptera* is due entirely to the work of Mik (1886 b). From his rather detailed description and figures, it certainly appears that the group should receive coordinate rank with *Antocharia*, *Limnobarria*, and other divisions herein created. The genus *Elliptera* shows peculiarities of structure in all stages, but many features of its organization remind one forcibly of species of *Dicranomyia* (such as *D. simulans* and *D. trinotata*) on the one hand, and of *Antocha* on the other; and it may be that the genus *Elliptera* stands in closer relationship to *Dicranomyia* than is now believed.

#### Genus *Elliptera* Schiner (Gr. *I omit*, or *ellipse* + *wing*)

1863 *Elliptera* Schin. Wien. Ent. Monatschr., vol. 7, p. 222.

1913 *Elliptoptera* Bergr. Ann. Mag. Nat. Hist., 8th ser., vol. 11, p. 576 (correct spelling).

*Elliptera* is a small genus, including but five species which have a discontinuous range, two being found in Europe and three in western North America. The commonest of the North American species, *E. clausa* O. S., was found on wet moss in the spray of Vernal Falls, Yosemite Valley, California (Osten Sacken, 1877:198). The only information available on the immature stages of a member of this genus is that furnished by Mik (1886 b) on the European species *E. omissa* Egg. (quoted subsequently by Grünberg, 1910:31-32, and by Malloch, 1915-17 b: 226-227). The description and account as given below are based entirely on Mik's paper.

*Elliptera omissa* Egg.

1863 *Elliptera omissa* Egg. Verh. Zool.-Bot. Ges. Wien, vol. 13, p. 1108.

Specimens of *Elliptera omissa* were found by Mik (1886 b) along water-courses and near falls in mountainous regions. The adult flies were noted as late as September 10, swarming about the waterfalls.

Larvae and pupae were found on July 30 and August 17 near Salzburg, upper Austria, living in elongate and somewhat depressed cocoons about 10 millimeters long and 4 millimeters broad which were arranged in longitudinal rows with short spaces between. These cocoons, which were placed with the current, occurred on the wet walls of wooden chutes or runways and also on dripping chalk cliffs. The immature stages spend their existence in these small cocoons of mud and silk. When ready to emerge as an adult, the pupa makes its way thru the end of the cocoon away from the current, leaving the cast skin attached to the opening. The margins of the large pronotal breathing horns of the pupa are finely serrated and are presumably used in making this opening thru the cocoon. The young larva probably creeps about on the floor of the runway, feeding on algae growing in the same situation. When nearly full-grown, the larva crawls to a less exposed place and spins its cocoon. Many larvae and pupae are killed by the drying-out of their haunts when the water supply becomes insufficient to cover them.

*Larva*.— Length, 7 mm.

Diameter, 1.5 mm.

Body clearly depressed (Plate XXIII, 72), greenish white, scarcely shiny, with delicate appressed grayish hairs which are thicker at the two ends of the body, especially on last segment, where they become almost villous. Integument very transparent, so that intestine and contents show thru, the intestine narrowing on segment 6 and thru to segment 8, where it broadens out and almost entirely fills the ninth and tenth segments. On sides of prothorax a delicate, long, pale hair; on remaining segments two such hairs. On each of abdominal segments 3 to 9, on dorsum near anterior margin, a low transverse ridge which is thickly set with short, blackened points; on sternum of each of same segments, a similar welt which is destitute of points. In male larvae, clawlike appendages of genitalia of adults showing thru skin on ventral side.

Head capsule (Plate XXIII, 73 and 74) massive, slightly longer than broad, black, somewhat shiny, all the sclerites compact and closely united; anterior projecting part of capsule with margins transparent, rust-brown; median part with two small knobs, laterad of which are two larger projections which are crowned with short points; capsule weakly keeled behind on dorsum (Plate XXIII, 74), anterior to which are two swollen elevations; on hinder margin of clypeus a styliform, bristly lobe, easily broken off, which is presumably the antenna.

Labium strongly chitinized, triangular, split longitudinally. Mandible (Plate XXIII, 75) clawlike in appearance, a little smaller than either half of labium, on inner face with a chitinized projection which is serrated. Maxilla indistinct, the palpi coroniform. Spiracular disk (Plate XXIII, 77) with four lobes whose inner faces are narrowly lined with black chitin; lobes provided with lashes of long gray hairs; dorsal lobes the shorter and broader, and bearing on their inner face two elongated stigmata which are margined with pale rust-yellow.

*Pupa*.—Length, 6.5 mm.

Pronotal breathing horns (Plate XXIII, 76) large, ear-shaped; bright yellowish white in color, in contrast to dirty yellowish brown skin of head, thorax, and appendages; each horn consisting of two parts: the dorsal side, appearing smooth and homogeneous; and the ventral side, with two longitudinal furrows converging toward apices, and with abundant elongate tubercles, under low magnification this part appearing pitted because of the spaces between these tubercles. Margin of breathing horn chitinized and very finely notched. On outer basal part of each ear a parchment-like lobe, which joins ear to side of prothorax; in addition to this, each ear at base is drawn out into an almost rectangular lobe which is closely approximated to pronotum. Leg sheaths extending about to base of fifth abdominal segment. Abdomen distinctly depressed, greenish white in color; segments 3 to 7 on both dorsum and sternum near base with a double cross-row of spicules which present a comblike appearance (Plate XXIII, 78), those on dorsal segments being somewhat stronger. Female pupa with acidothecae grown together on inner face, at outer angle of each a chitinized hook which is curved upward. Male pupa with ventral side of last segment produced into two chitinized points which are bent toward each other and almost touch, these inclosing clasping organs of adult male and hooks of male larva as described above.

### Subtribe *Limnobaria*

The subtribe *Limnobaria* includes about ten genera, which are very closely related to one another and whose limits are as yet not clearly defined. Many of the generic distinctions are based on male characters of wing form, venation, or antennal structure. The genera are often very large and it is difficult to give satisfactory characters to separate their immature stages. The keys to the genera, given below, will unquestionably need much revising when a larger number of forms are studied.

#### *Larvae*

1. Form stout; teeth of mandibles and of mentum usually more numerous; mentum more pointed anteriorly.....*Limnobia* Meig. (p. 809)  
Form usually more slender; teeth of mandibles and of mentum usually fewer; mentum transverse or subtransverse.....2
2. Mandibles very broad, flattened, with three ventral cutting teeth; mentum about transverse, with nine or eleven teeth.....*Rhipidia* Meig. (p. 825)  
Mandibles more slender, with usually four or five cutting teeth; mentum usually a little pointed anteriorly, with about eleven teeth.....*Dicranomyia* Steph. (p. 819)

*Pupae*

1. The five basal abdominal segments on both dorsum and venter with a comb of small, blunt teeth; wing sheaths showing an ocellate pattern; pupae living beneath bark of coniferous trees..... *Discobola* O. S. (p. 815)  
Abdominal segments provided with basal transverse welts of microscopic points on segments 3 to 7; wing pattern not ocellate..... 2
2. Pronotal breathing horns long and narrow, about three times as long as broad. *Rhipidia* Meig. (p. 825)  
Pronotal breathing horns short and broad, length and breadth not greatly different.... 3
3. Size large (usually over 10 mm.); breathing horns often broader than long. *Limnobia* Meig. (p. 809)  
Size smaller (usually under 10 mm.); breathing horns usually as long as broad. *Dicranomyia* Steph. (p. 819)

Genus *Limnobia* Meigen (Gr. *swamp* + *I live*)

- 1800 *Amphinome* Meig. Nouv. Class. Mouch., p. 15 (*nomen nudum*, preoccupied in Annelida).  
 1803 *Limnobia* Meig. Illiger's Mag., vol. 2, p. 262.  
 1818 *Limnobia* Meig. Syst. Besch. Zweifl. Ins., vol. 1, p. 116.  
 1818 *Unomyia* Meig. Syst. Besch. Zweifl. Ins., vol. 1, p. 116.  
 1856 *Limnomyza* Rond. Dipt. Ital. Prodr., vol. 1, p. 185.

*Larva*.—Form stout, terete. Abdominal segments with dorsal and ventral transverse welts covered with chitinized points on basal rings. Spiracular disk surrounded by indistinct lobes, the spiracles large. Head capsule large, massive, the dorsal plate narrowed behind and more or less bifid at its tip. Labrum transversely oval, with sensory bristles near margin. Mandible blunt, with from four to seven cutting teeth. Maxilla simple, cardo and stipes large. Antenna with apical papilla button-like. Mentum broad, margin with from eleven to thirteen teeth. Hypopharynx a circle of two chitinized plates, each with from twelve to fifteen teeth.

*Pupa*.—No cephalic crest. Pronotal breathing horns flattened, earlike, as broad as, or broader than, long. Mesonotum unarmed. Abdomen with transverse welts of fine hooks on basal annuli of tergites 3 to 7 and sternites 5 to 7. Two tiny spiracles on dorsum of eighth abdominal segment.

*Limnobia* is a rather small genus (comprising about forty-five species) of usually large and handsome flies. The species are most numerous thruout the Holarctic and Ethiopian regions. The immature stages have a wide range of habitat.

Of the European species, *Limnobia bifasciata* Schr. [= *L. xanthoptera* Meig.] is characteristically fungicolous, the larvae occurring in various species of *Agaricus* and related genera as stated by Stannius, Pastejrik, De Meijere, and other investigators. *L. decemmaculata* Lw. occurs in fungi (*Daedalea* and similar species), as recorded by Loew (1873) and by Verrall (1912). *L. quadrimaculata* (Linn.) [= *L. annulus* Meig.] often occurs in tree fungi but is not confined to this habitat. This species,

*L. macrostigma* Schum., and *L. obscuricornis* Bel. are often found in decaying, principally deciduous, wood. *L. tripunctata* Fabr., *L. sexpunctata* Fabr. [= *L. nigropunctata* Schum.], *L. flavipes* Fabr., and *L. nubeculosa* Meig. are found in humous earth and beneath leaves in woods. The pupal duration of *L. quadrimaculata* is from eight to twelve days, and this species, as well as others of the genus, pupates in the ground, inclosed in delicate silken cases which are covered with particles of earth and other matter.

In America, *L. triocellata* O. S. is characteristically fungicolous. *L. cinctipes* Say, and presumably *L. immatura* O. S., are found both in fungi and in decaying wood. *L. indigena* O. S. has been found in living tulip roots from Greenville, South Carolina (Greene, ms.). *L. fallax* Johns., and presumably *L. solitaria* O. S., live in organic mud near water. *L. parietina* O. S. probably has a similar habitat, since it was found in tent traps set over Beaver Meadow Brook in the Adirondacks (Needham, 1908a:171).

#### *Limnobia cinctipes* Say

1823 *Limnobia cinctipes* Say. Journ. Acad. Nat. Sci. Phila., vol. 3, p. 21, no. 4.

*Limnobia cinctipes* is one of the largest and commonest American species of the genus *Limnobia*. It has been reared many times, some of the records being as follows:

On July 23, 1883, Pergande collected larvae in an old fungus growing on rotten wood. On July 20, 1886, the same species of larvae was found constructing silken cases thru the fungus, and later in the ground for pupation. The pupae were active, and were able to draw back and forth in their tubes. Adults began to issue on July 28, showing the pupal stage in this case to be not more than eight days.

On April 25, 1912, a number of specimens of this species were received from W. H. Shideler, of Miami University, Ohio. The specimens were taken at Oxford, Ohio, on April 20, when several hundred larvae and pupae were found in an old dry log. The young pupae in the wood are not covered with particles of débris, but the older pupae are inclosed in a case which is covered with wood fragments, only the top of the head and the tip of the abdomen projecting beyond the case. When the pupae are about to transform, the insect emerges to about half its length and the

skin splits down the dorsum, the pupal skin remaining in place after the adults have emerged.

On September 15, 1912, many full-grown larvae were found in a fleshy species of Fomes near Gloversville, New York, where they were associated with a much larger number of larvae of *Ula elegans* and a much lesser number of *Limnobia triocellata*. When about to pupate, the larva becomes pale green in color and incases itself completely in a silken sheath which is covered with particles of sand and other débris. As the pupa grows older, the case becomes harder and more rigid. Numerous little mites are to be found running up and down over these pupae, more especially at the head end, and possibly seeking ingress into the insect. One young pupa had a piece of cloth adhering to the side of its case. The pupal stage lasts about five days.

*Larva*.—Length, 18-22 mm.  
Diameter, 2.5-3.2 mm.

Coloration light yellow to greenish, the setiferous transverse welts at base of abdominal segments brownish.

Body terete, abdominal segments subdivided into two narrow basal rings and a broad posterior ring. Abdominal segments 1 to 7 with a broad basal welt on tergites and sternites, that of the first segment much smaller; these welts densely covered with microscopic hooks; on the last two thoracic segments, welts indicated by very narrow lines. Cauda blunt, obliquely truncated. Spiracular disk (Plate XXIV, 83, and Plate XXV, 93) surrounded by indistinct lobes, the ventral margin projecting far caudad and indistinctly divided into two short lobes; lateral lobes very blunt; dorsal lobes short and blunt, often divided into two smaller lobes. Spiracles oblong or elliptical, placed obliquely. Gills four, blunt and rounded, formed for propulsion rather than for respiration.

Head capsule (Plate XXIV, 79) very much as in *Antocha*, the dorsal plate narrowed behind and somewhat bifid at apex; lateral plates shaped like a mussel shell, curved around to form mentum. Labrum (Plate XXV, 86) distinct, oval, the anterior margin fringed with delicate hairs, the hairs at the lateral margins longer and coarser; on either side near anterior margin, a blunt tubercle with three sensory bristles; just laterad of this a stout seta; along anterior margin, four sensory setae which are subequally spaced. Epipharynx densely hairy. Clypeus broader than labrum, with a seta at each outer anterior angle and two more on either side near posterior margin. Mentum (Plate XXIV, 81) elongate-triangular, not completely divided into halves but deeply split behind, with an outer plate running cephalad into a long, broad point; behind this another plate with the margins toothed, there being about five or six long, acute teeth on either side. Hypopharynx (Plate XXIV, 80) with two rows of teeth forming a circle, into which duct of salivary gland opens; anterior row having about nine large, blunt teeth, with about six smaller teeth on either side, these latter sharper-pointed and more crowded; posterior row having long, pointed teeth, about twelve in number. Antenna (Plate XXIV, 82) two-segmented, the basal segment chitinized, elongate-

cylindrical, the second segment flattened, shaped somewhat like a door knob; a few sensory projections. Mandible (Plate XXV, 87 and 88) powerful, produced into a strong apical point, with about four or five blunt or irregular inner teeth and a strong dorsal tooth on outer margin before tip. Maxilla (Plate XXV, 87) large, the outer margin thickened, subchitinated; palpi at apex small, shaped like half a pill box, with a few sensory papillae at tip.

*Pupa*.—Length, 18–20 mm.  
Width, d.-s., 2.8–3 mm.  
Depth, d.-v., 3.1–3.3 mm.

Entire head and thorax, including leg and wing sheaths, light brown, the thoracic dorsum somewhat darker-colored, the wings more yellowish brown; abdomen pale light green, the segments with the submedian brown band interrupted on pleural region; tip of abdomen brownish, chitinated.

Form stout (Plate XXV, 89); body destitute of noticeable setae.

Head flattened (Plate XXIV, 84). Cephalic crest lacking; forehead with a shallow V-shaped notch between antennal bases. Eyes of male large, the front narrowed, with points of tentorium close to inner margin of eye; eyes of female more widely separated. Antenna rather short, ending just beyond wing root. Labrum short, obtuse. Labial lobes contiguous, divergent, blunt at their tips, posterior margin a little convex medially. Lobes of maxillary palpi large, subquadrate. Cheek with a large, flattened ledge overlying joint of fore legs.

Thorax very gibbous. A distinct anterior median carina between breathing horns. Pronotal breathing horns (Plate XXV, 90) flattened, earlike, broader than long, directed slightly proximad, margin with a row of breathing tubercles, outer face wrinkled. Wing sheaths reaching base of third abdominal segment. Leg sheaths reaching base of fourth abdominal segment or a little longer; tarsi ending about on a level, or sloping gradually from short hind tarsi to long fore tarsi.

Abdominal segments indistinctly subdivided into three rings; on tergites 3 to 7, and sternites 5 to 7, basal ring with a transverse welt which is densely covered with short hairs or hooks, these welts tapering gradually to ends; sternites of segments 3 and 4 having incomplete welts on either side of leg sheaths; band on tergum of segment 7 not broken medially, but a little constricted in some specimens; in older pupae the other annuli, especially the posterior one, variously darkened on dorsum and venter. Female cauda (Plate XXIV, 85) with the acidothecae short, the sternal valves the shortest, the tergal valves a little longer; prominent lateral lobes at base of tergal valves, and a slightly smaller but very broad one on each side of tergal valves at about midlength. Male cauda (Plate XXV, 91) similar to that of female, but the dorsal lobes (Plate XXV, 92) much shorter, not longer than the ventral lobes, and separated by a U-shaped notch; ventral lobes approximated, each ending in a small, blunt tubercle. Two small circular spiracles on dorsum of segment 8, these a little more widely separated in male than in female.

*Nepionotype*.—Gloversville, New York, October 26, 1912.

*Neanotype*.—Female pupa with type larva.

*Paratypes*.—Several larvae and pupae with types and from Oxford, Ohio, April 20, 1912.

*Limnobia fallax* Johns.

1909 *Limnobia fallax* Johns. Proc. Boston Soc. Nat. Hist., vol. 34, p. 125.

*Limnobia fallax* belongs to the *solitaria* group and is apparently more Austral in its distribution than the other members of this group (*L. solitaria* O. S., *L. hudsonica* O. S.).

Larvae and pupae were found by Dr. Johannsen near Ithaca, New York, July 20–26, 1905. They were wrapped in silken cases covered with earthy matter, and were removed from the soil near a brook.

*Larva*.—Length, contracted, 8–8.2 mm.  
Diameter, 1.2–1.3 mm.

Coloration white.

Form stout and short, body terete. Transverse welts with chitinized points on abdominal segments 2 to 7, those on dorsal surface broad, those on ventral surface narrower. Spiracular disk blunt, surrounded by four indistinct lobes, the lateral pair the largest and capable of close approximation, closing the large yellow spiracles. Anal gills indistinct.

Head capsule of usual *Limnobia* type. Labrum (Plate XXVI, 95) broadly oval, lateral angles and disk of epipharynx with tufts of long hairs; anterior margin fringed with short setae; about eight sensory bristles and papillae along anterior margin. Mentum (Plate XXVI, 96) large, triangular, running out into a long median apical point; lateral margins with about six or seven flattened subacute teeth on each side. Hypopharynx as in this group; a collar formed of two chitinized, comblike plates; the first plate rectangular, its face covered with flattened scales, anterior margin with about fourteen acute pointed teeth, the two outermost much the smaller, acicular; the second plate a narrow band of chitin similarly toothed, the teeth at each end large, flattened, the next tooth very narrow, acicular, the remaining teeth, ten in number, flattened, acute, the middle teeth a little shorter and broader. Antenna (Plate XXVI, 97) with basal segment elongate, cylindrical, and apical papilla or segment very tiny, disklike. Mandible (Plate XXVI, 98) large, moderately broad, with apical tooth prominent, two large dorsal teeth, and a row of about five or six comblike teeth along ventral cutting edge, the most basal being short and blunt. Maxilla (Plate XXVI, 99) about as in this tribe, cardines and stipites large and simple; palpus large.

*Pupa*.—Length of cast pupal skin, 10–13 mm.

Labrum (Plate XXVI, 100) triangular, apex obtuse. Labial lobes prominent, subquadrate. Posterior margin convex medially. Pronotal breathing horns (Plate XXVI, 101) flattened, subcircular in outline, with an outer marginal row of breathing tubercles. Leg sheaths ending just before apex of fourth abdominal segment; tips of tarsi about on a level, or those of fore legs a little the longer. Band of spicules on seventh tergite, slightly constricted medially. Female cauda (Plate XXVI, 102 and 103) with tergal valves a little longer than sternal valves, and more acute at their tips; a small tubercle on outer margin of outer lobes before tips.

*Nepionotype*.—Ithaca, New York, July 21, 1905.

*Neanotype*.—Cast pupal skin with type larva.

*Paratypes*.—One larva and three pupal skins.



*Limnobia triocellata* O. S.

1859 *Limnobia triocellata* O. S. Proc. Acad. Nat. Sci. Phila., p. 216.

*Limnobia triocellata* is a common crane-fly in eastern North America. It is closely allied to the European *L. bifasciata* Schr., the immature stages of which have long been known.

Johnson (1906:2) found larvae of this species in a fungus at Riverside, Massachusetts, on August 21, 1904, which pupated on the 22d and emerged on the 30th and 31st, thus giving a pupal duration of about nine days. Malloch (1915-17 b:215-216) found larvae and cast pupal skins in an *Agaricus* at Urbana, Illinois, in September of 1915. The writer found larvae of *Limnobia triocellata* in a species of *Fomes*, associated with the larvae of *L. cinctipes* and *Ula elegans*, at Gloversville, New York, on September 15, 1912. C. H. Popenoe found larvae at Great Falls, Virginia, on September 8, 1912, in the fungi *Hypomyces Lactifluorum* (Schw.) Tul. and *Armillaria* sp., the adult flies emerging on October 7, 1912. Other specimens from the same place found on October 9, 1913, in a species of *Clitocybe*, produced adults on October 20. Scores of specimens were taken in *Boletus felleus* at Bradley Hill, Maryland, the flies emerging on July 16, 1914.

*Larva*.—Length, 10-18 mm.  
Diameter, 1.2-1.4 mm.

Coloration a little more yellowish than that of *Limnobia fallax*. Species very close to *fallax* in all details. Ventral welt on abdominal segment 1 well developed, but dorsal welt lacking or very reduced. Spiracular disk (Plate XXVI, 94) rather large, exposed; circular spiracles large, separated by a distance less than the diameter of one; lobes surrounding disk small and indistinct.

*Pupa*.—Length, 12-15 mm. Not very different from other species of genus described herein.

*Nepiontype*.—Great Falls, Virginia, September 28, 1913.

*Paratypes*.—With the type.

Genus *Libnotes* Westwood (derivation obscure)

♀ 1876 *Libnotes* Westw. Trans. Ent. Soc. Lond., p. 505.

*Libnotes* is a small genus (about thirty-five species) of rather large crane-flies, which are chiefly Oriental in their distribution altho three species occur in South and Central Africa. The species *Libnotes perkinsi* (Grimsh.) has been considered as being a *Limnobia*, but it seems

to the writer that the present generic reference is more nearly correct, altho the distinctions between *Limnobia* and some species of *Libnotes* are very poorly marked. *L. perkinsi* was bred from larvae in damp moss (Perkins, 1913:clxxxii, as *Limnobia*), and in a letter to the writer Mr. O. H. Swezey states that he has reared this species from larvae in decaying vegetation and in the accumulation of débris behind old leaf-sheaths on banana plants (*Musa*, Scitamineae) in the Hawaiian Islands.

Genus *Discobola* Osten Sacken (Gr. *discus* + *I throw*)

1865 *Discobola* O. S. Proc. Ent. Soc. Phila., p. 226.

1869 *Trochobola* O. S. Mon. Dipt. N. Amer., part 4, p. 98.

*Discobola* is a well-marked genus including about eight described species, which are most numerous in the Australasian region, two species only being found in Europe and two others in America. The adults of the commoner American species, *D. argus* (Say), are not rare. They are most numerous in late summer, and are often found resting on the stumps and trunks of coniferous trees, especially white pine (*Pinus Strobus* Linn.).

The immature stages of *D. caesarea* (O. S.) were found by Mik (1884) in Austria, living in decaying pine stumps from which the bark had been removed. The following account is taken entirely from Mik's paper:

*Male pupa*.—Body cylindrical, slender (9.2 mm. long, 1.5 mm. in diameter). Head, prothorax, mesothorax, leg sheaths, and wing sheaths chitinized, dark brown, shiny, the last-named somewhat brighter than the others, the leg sheaths somewhat darker at their tips. Eyes kidney-shaped, strongly shiny, blackish, between them a small, triangular, blackish brown spot. Prothoracic breathing horns dull-colored, dark rust-brown at base, becoming a brighter rust-brown more distally, compressed laterally, tuberculate, with margin indented. Prothorax carinate, rust-yellow, margined on both sides by dull reddish brown tubercles. In fully colored specimens, forehead and leg sheaths blackish brown, wing pattern indicated on sheaths as somewhat diffused rings. Leg sheaths reaching end of abdominal segment 3, wing sheaths reaching end of abdominal segment 1. Metathorax and abdomen thin-skinned, the former verdigris-colored, the latter white or somewhat yellowish green; metathorax resembling an abdominal segment, but its posterior margin is unarmed, while the first to the fifth abdominal segments on both dorsum and venter bear a comb of very small, short, blunt teeth, which are closely approximated; these teeth chitinized and rusty brown at their tips, giving to abdomen the appearance of having brown incisions; these transverse rows of teeth interrupted at pleura. Sixth abdominal segment pale thruout and lacking the comb. Seventh segment shorter and narrowed on dorsum, pale, bearing on sternum a rust-yellow chitinized plate which is narrowed anteriorly, leaving an uncolored triangular area on either side at base of segment. Eighth segment swollen to include genitalia, the

two basal parts ellipsoidal, strongly shiny, rust-yellow, somewhat darker at tips, the apical parts small and knotlike, bluntly rounded; segment bearing on dorsum a weak triangular piece at its base; between apical parts of genitalia are inserted two small chitinized shields; on venter, between basal parts, sheath of penis is inserted.

*Female pupa*.—Body resembling that of male, but longer and somewhat stouter (length 10.5 mm., diameter 1.8 mm). Leg sheaths extending to just beyond midlength of abdominal segment 2. Seventh abdominal segment shortened and somewhat narrowed, on dorsum largely pale, with a narrow chitinized margin only on lateral parts, so that the unchitinized part forms a triangle with the apex directed backward; on sternum this segment almost completely chitinized, rust-yellow, only a small triangular area at base on either side remaining uncolored; chitinized plate separated from plate of next segment only by an incomplete segmentation, swollen, and bearing two longitudinal impressions. Eighth segment bearing on its dorsal surface the dorsal valves of ovipositor, fused at their base, chitinized thruout, rust-yellow in color; segment bearing on its ventral surface a depressed conical chitinized plate of a rust-yellow color, and with transverse impressed wrinkles; on either side a small, dark, chitinized, lower valve of ovipositor. Other characters as in male. (When the pupae are placed in alcohol, the green of the metathorax and the abdomen disappears and is replaced by a yellowish white color.)

Pupae were collected in large numbers in a pine wood near Hammern in Freistadt (upper Austria) in the latter days of August, 1882. The pupae live in pine stumps, near the ground, where the bark has been removed, more especially in situations where the wood is somewhat sappy and not yet completely decayed. Those found were not deep in the wood. Their presence was discovered by finding the teneral adults on and near a stump, and many cast skins of the pupae projecting horizontally, the caudal end of the body, up to the leg sheaths, adhering to the wood. No emergence holes were found on the cut surface of the stump. The adults at first have a very long, pale abdomen, which is of a verdigris color, most intensive at the base and paler toward the tip. The pupae that were found transformed as adults in from one to three days.

#### Genus *Geranomyia* Haliday (Gr. *crane* + *fly*)

- 1833 *Geranomyia* Hal. Ent. Mag., vol. 1, p. 154.  
 1835 *Limnobiorkhynchus* Westw. Ann. Soc. Ent. France, vol. 4, p. 683 (spurious name).  
 1838 *Aporosa* Macq. Dipt. Exot., vol. 1, part 1, p. 62.  
 1865 *Plettusa* Phil. Verh. Zool.-Bot. Ges. Wien, vol. 15, p. 597.

*Geranomyia* is a rather extensive genus including about eighty species, which are most abundant in the tropics of America, Asia, and Australia. On the African continent the genus is apparently less common. The adult flies have an elongate rostrum which is used for sucking nectar

from tubular flowers. The various species of the genus have been recorded as feeding on a wide range of plant species, which have been indicated by Knab (1910) and by Alexander (1916 b:486-493) and may be summarized as follows:

Species	Plants frequented
<i>Geranomyia canadensis</i>	Compositae — Eupatorium, Solidago, Aster, Silphium, Rudbeckia, Verbesina, Cacalia, and similar species
<i>Geranomyia diversa</i>	Compositae — Solidago, Erigeron Umbelliferae — Daucus
<i>Geranomyia virescens</i>	Lauraceae — Persea
<i>Geranomyia rostrata</i>	Compositae — Eupatorium, Solidago, Helianthus

For many years nothing was known concerning the immature stages of any species of *Geranomyia*. In 1917, J. R. Malloch found larvae and pupae of *G. canadensis* at Urbana, Illinois. Mr. Malloch and the writer have in press a detailed paper on the immature stages of this species, and the following brief account is abstracted from this paper and included herewith in order to complete the data.

Mr. Malloch found the larvae on the grounds of the Floriculture Department of the University of Illinois. There is a small bubbling fountain here, the waste water from which flows along an open gutter. In this gutter the immature stages of *G. canadensis* lived among the vegetable growth and diatomaceous ooze in the bottom of the trough. Mr. Malloch and the writer found this same species in Union County, southern Illinois, in 1919. Here larvae and pupae occurred on the face of rocks where the surface was continually damp with percolating water. A railroad bank had been formed by piling up slabs of limestone to a height of about four feet. In the irregularities and crevices of these pieces of limestone, the larvae of *Geranomyia* were living in delicate silken tubes covered with a deposit of silt and diatoms. They emerged from their cases to feed on the exposed surface of the wet rocks during twilight, and even during the hours of sunlight, but upon being disturbed or alarmed they retreated with great agility into their tubes. The pupae are found in short, nearly vertical burrows in the same situations as the larvae; here they rest with only the long, conspicuous breathing horns projecting from the entrance to the burrow. When transformation takes place, the pupal skin projects from the mouth of the burrow nearly to the ends

of the wing sheaths. The number of larvae vastly exceeds the number of pupae, and this would seem to indicate that the pupal existence is of very short duration, else this stage would be found oftener.

*Larva*.— Length, 12–12.5 mm.  
Diameter, 0.8–0.9 mm.

Coloration grayish subhyaline; a large orange area on posterior lateral parts of prothorax; abdominal welts dark brown.

Form moderately long and slender; thoracic segments gradually decreasing in length from prothorax to mesothorax; abdominal segments gradually elongated to the fifth, thence shortened to end of abdomen. Ventral surface of meso- and metathorax and of first eight abdominal segments provided with a basal transverse welt which is densely set with microscopic points; on dorsal surface these bands smaller, occurring on metathorax and on abdominal segments 2 to 8, not connected with sternal bands except on metathorax and on eighth abdominal segment. Spiracular disk similar to that in *Dicranomyia*; the usual ventral lobes represented only by two small, dusky, setiferous areas. Spiracles large, elongate-oval, placed obliquely on the sides of a deep split and so capable of close approximation. Anal gills four, each short, tapering gradually to the blunt tip.

Head capsule compact, massive, as in tribe. Labrum transversely oval, margin with short yellowish hairs and a larger tuft on either side. Antenna two-segmented, second segment rather stout, cylindrical, slightly arcuate; apical papilla small but high. Mandible broad and flattened, with a small dorsal tooth and a row of five ventral teeth. Maxilla generalized in structure, as in tribe. Hypopharynx as in *Limnobia*, consisting of a roughly circular chitinized collar provided with a crown of stout teeth. Mentum broad, undivided, anterior margin with eleven teeth.

*Pupa*.— Length (including breathing horns), 8–9 mm.  
Length of breathing horns, 1.2–1.3 mm.  
Width of body, d.-s., 0.85–0.9 mm.  
Depth, d.-s., 1–1.05 mm.

Pronotal breathing horns grayish subhyaline; head and thorax with sheaths dark brown; abdomen whitish, hooks and spines brown.

Cephalic crest small, indistinctly bilobed, not setiferous; front long and parallel; rostral sheath very long and narrow, subtended on either side by sheaths of paraglossae, the latter projecting beyond tip of rostrum and ending almost opposite end of wing sheath; margin of cheeks flattened as in *Limnobia*. Antennal sheaths short, ending slightly beyond base of wing pad. Pronotal breathing horns very large and prominent, not contiguous basally; about a dozen breathing pores along dorsal margin. Mesonotum unarmed; wing sheaths ending opposite base of third abdominal segment; leg sheaths ending opposite or slightly beyond midlength of fourth abdominal segment; tarsal sheaths ending about on a level. Abdominal segments 3 to 7 near base with two bands of chitinized hooks arranged in curved transverse rows inclosing an oval transverse area. Cauda chitinized, tergal region produced into two parallel curved hooks bending strongly dorsad.

Found at Alto Pass, Union County, Illinois, June 6, 1919.

Genus *Dicranomyia* Stephens (Gr. *fork + fly*)

- 1818 *Furcomyia* Meig. Syst. Besch. Zweifl. Ins., vol. 1, p. 106 (*nomen nudum*).  
 1829 *Dicranomyia* Steph. Cat. Brit. Ins., vol. 2, p. 243.  
 1830 *Siagona* Meig. Syst. Besch. Zweifl. Ins., vol. 6, pl. 65, figs. 5-7.  
 1830 *Glochina* Meig. Syst. Besch. Zweifl. Ins., vol. 6, p. 280.  
 1854 *Numantia* Bigot. Ann. Soc. Ent. France, ser. 3, vol. 2, p. 470.

*Larva*.—Form slender. Body nearly glabrous, abdominal and thoracic segments with dorsal and ventral transverse welts on basal annuli. Spiracular disk small, the five lobes indistinct but indicated, spiracles large. Anal gills four, slender. Head capsule massive, of the *Limnobia* type. Mouth parts almost as in *Limnobia*; ventral cutting edge of mandible with fewer teeth; mentum with anterior margin more transverse and with fewer teeth.

*Pupa*.—Cephalic crest lacking. Pronotal breathing horns broad, in *D. simulans* with a basal recurved hook on dorsal side, in other known species unarmed. Basal abdominal annuli with transverse welts. Dorsum of eighth abdominal segment with vestigial spiracles.

*Dicranomyia* is a very extensive genus including more than two hundred described species of usually small flies which are found in most parts of the world. The immature stages, which are found in a variety of habitats practically as extensive as is covered by the entire family of crane-flies, range from forms that are almost strictly aquatic, thru species living beneath the bark of trees, to still other species which are leaf miners.

In Europe, *Dicranomyia trinotata* (Meig.) is a characteristic member of the hygropetric association, the insects living on rocks in streams, where they are covered with a thin sheet of water and are usually associated with such insect forms as *Beraea*, *Tinodes*, *Stactobia* (Trichoptera), *Orphnephila testacea* (Ruthe), *Pericoma nubila* (Meig.), *Dixa maculata* Meig., *Oxyccera pulchella* Meig., and other Diptera. The larva is cylindrical, measuring from 10 to 11 millimeters in length and from 1.5 to 2 millimeters in diameter. The dorsal surface is greenish mottled with darker, the ventral surface brighter. The larvae live in loosely spun silken cases in which they pupate. The pupae are about 10 millimeters long, and live in cocoons which are almost horizontal in position. The mature pupa breaks thru the cocoon by means of its sharp-edged breathing horns, the adult then creeping forth and leaving the cast pupal hull behind. (Thienemann, 1909:64-65, and Grünberg, 1910:29.)

*Dicranomyia dumetorum* Meig. lives in decaying, principally deciduous, wood. Winnertz (1853) found it in large numbers in a decaying beech tree, associated with *Bremia ciliipes* (Winn.).

A species of crane-fly doubtfully referred to *Dicranomyia pilipennis* Egg. (Schubart, 1854) has been found in ditch water in Holland.

*Dicranomyia umbrata* de Meij., a Javan species, lives in the slimy green algae floating in stagnant, as well as flowing, water. The pupae live in cocoons in the algal sheath, with the cephalic end projecting. The larvae are from 10 to 12 millimeters in length, cylindrical, about 0.6 millimeter in diameter, and of a yellowish color. The head is almost entirely retractile. The body is almost smooth, having only an inconspicuous transverse welt on the second abdominal segment near the posterior margin. The caudal end is somewhat enlarged and is truncated behind. De Meijere (1916:197-198) supplies a good description of the structure of the larval head capsule.

*Dicranomyia foliocuniculator* Swez., of the Hawaiian Islands, is the only recorded leaf-mining crane-fly. It was found by Swezey mining in the leaves of a species of *Cyrtandra* (Gesneriaceae) in the island of Oahu. Pupation of the species takes place within the mines (Swezey, 1913 and 1915).

In North America a number of species are known. *Dicranomyia simulans* has been ably discussed by Needham (1908a:214-217) and later by Malloch (1915-17b [1917]). This species is, for the most part, a member of the hygropetric fauna, dwelling in usually lotic water where it is associated with a characteristic rapid-stream fauna. Other conditions under which the species is found are discussed later. *D. badia* and *D. stulta* live in and under saturated moss cushions. *D. macateei* Alex. has been bred from larvae in decaying wood (Dr. W. G. Dietz). *D. rara* O. S. has been bred from larvae in a rotten willow, the larvae being taken on Plummers Island, Maryland, by H. S. Barber on October 12, 1913, and emerging as adults on November 14.

*Dicranomyia simulans* (Walk.)

1848 *Limnobia simulans* Walk. List Dipt. Brit. Mus., vol. 1, p. 45.

The best account of the life history of the common and widespread *Dicranomyia simulans* is that by Needham (1908a:214-216), quoted below:

It is abundant on the piers along the west shore of Lake Michigan. . . . This pier [at Lake Forest, Illinois] was built on heavy driven piling, covered outside with heavy plank. About three feet of surface was exposed above the water at its normal stage. The planks were old, and sheltered a scanty growth of short, stemmed mosses in the cracks, and bore

a heavy fringe of *Cladophora* and other algae just below the water line, with a film of "skin algae" extending a little higher.

All over the sides of the plank, in either sun or shade, the adult *simulans* could be seen throughout the summer months, sometimes in considerable numbers. I was first attracted to notice them by their habit of running rapidly sidewise along the pier, and their resemblance to harvestmen (Phalangidae). They run habitually sidewise, apparently rarely moving forward except to escape an obstruction, and very rarely appearing on the top of the pier. They rest in an inverted position on the under surface of the overhanging plank on the top of the pier. They stick to the surface so persistently that it is difficult to make one take flight; they may be driven all about on the surface, or poked with a stick; they can fly well enough when they will, but when induced to fly they settle again almost at once, and within a few feet of their starting place.

They are associated upon the piers with *Geranomyia canadensis* and with numerous midges and micro-caddis flies (Hydroptilidae) and a few larger caddis flies of the genus *Hypopsyche*.

Males are more in evidence, but probably not more abundant in fact. The females come out from their resting places only to lay their eggs, and are only to be seen when busily engaged in the performance of this task. They stand on tiptoe, with the long ovipositor held in vertical position at the tip of the deflexed abdomen, and they swing the body up and down in rapid shuttlelike vibration, freely rising and falling on the long and widely outspread legs. Thus the point of the ovipositor is driven against the wet surface of the plank, thrusting almost as rapidly as the needlebar of a sewing machine; it is moved about over the surface, as if searching for soft spots in the wood, and occasionally it makes a deeper thrust when a suitable place is found, and an egg is deposited.

The egg-laying process is often interrupted and is continuously interfered with by the too importunate males. When a male in running about on the plank comes upon a female ovipositing, he stands directly above her at the full upward stretch of his legs, while she goes right along with her work; but the instant she ceases her vibrating and lifts her ovipositor, he is ready with his forceps, upturned and outspread at the tip of his decurved abdomen, to seize her. Usually she does not want to be interrupted and moves away, while he tries to run parallel and maintain all the while his position of vantage above her. Often other males are encountered, and then the males engage in a rough and tumble fight. They push and shove each other in a most ludicrous manner, reminding one of pigs fighting, and often an encounter of this sort enables the female to escape and go on quietly with her work.

The males have well developed eyes, but their sight must be very poor; for, while always searching for females, they seem quite unable to find them by sight, often passing females at work within a distance of a few centimeters. But their tactile sense seems more acute. When a male in running to and fro had passed several times within six centimeters of a female without noticing her, was deflected from his course toward her by an obstruction I purposely placed in his way, he instantly sprang toward her upon the slightest contact, even of tips of tarsi, but was quite unheeding until this contact occurred. If it did not occur he would pass on, even by the narrowest margin.

All stages are found together on the piers. The eggs are laid in the soft spots in the old wood, where the surface of the pier is kept wet, but not continually covered by water, in the zone of the "skin algae." The larvae live exposed or thinly algae covered, and crawl about slowly over the wet surface. They are greenish in color and very inconspicuous. In a cavity among the stems of the dwarf mosses (*Bryum binum* Schoeb. var. *varium* Lindb. and *Amblystegium orthocladon* Lesq. and James) in a crevice at the upper limit of the wet area the larva spins about itself a sheet of tissue and fastens bits of moss stems and leaves to its outside, and transforms inside the tube thus formed into a pupa. The tube is longer than its body, and the pupa moves in or out at will, doubtless by the aid of the hooks at the ends of its body.



The following descriptions of the immature stages are adapted from those of Needham and Malloch:

*Larva*.— Length, 10–15 mm.  
Diameter, 1.5–2 mm.

Coloration green, with distinct brown marks on dorsum and with an interrupted mid-dorsal row of alternating paler dots and crossmarks; dark area made up of closely placed spinous hairs, clear areas for the most part devoid of hairs.

Body cylindrical, abruptly tapering behind on last abdominal segment. Legs lacking, but a scurfy, pubescent creeping-fold on under surface of meso- and metathorax, a similar one on first abdominal segment, and much larger, transversely placed, fusiform creeping-ridges on ventral surface of abdominal segments 2 to 7, on anterior ring of each segment. Incisions between dorsal segments of abdomen margined with blackish spinules, which are slightly stronger than other hairs of dorsum. Spiracular disk vertically cleft, with sloping sides, folded together when under water, border of aperture fringed with short hairs and destitute of fleshy lobes. Spiracles oval. Anal gills four, fleshy.

Head large, similar in general appearance to that of *Limnobia*, entirely retractile within enlarged prothorax; head showing a broad, pale yellow, median band, sides black from base of antennae backward. Labrum transversely oval, with a margin of close-set, scurfy hairs; clypeus one-fourth broader than labrum, yellow, with parallel sides but emarginate on front for reception of labrum; three recurved, stout setae on lateral margin of clypeus on each side, one on each angle and two on disk. Mentum slightly convex in outline, median tooth much longer and stouter than first lateral, second and third laterals as large as median tooth. Antenna long, the shaft about three times as long as its greatest diameter. Maxillary palpi short and inconspicuous.

*Pupa*.— Length, 8–9 mm.  
Diameter, 1.5 mm.

Body smooth and shiny, ends brownish. Front of thorax upcurved dorsally. Pronotal breathing horns broad, laterally flattened, obtuse at apex, each with a basal recurved, sharp hook on its dorsal side; breathing tubercles arranged in a semicircular row along obtuse tip of horns. Dorsum of thorax with a faint fretwork of raised lines on surface. Abdomen smooth, with transverse lines of scurfy pubescence, terminating in a pair of stout, sharply recurved hooks.

Malloch (1915–17 b, pl. 33, fig. 5) has figured the peculiar pronotal breathing horn of this species.

*Dicranomyia stulta* O. S.

1859 *Dicranomyia stulta* O. S. Proc. Acad. Nat. Sci. Phila., p. 210.

Adults of *Dicranomyia stulta* are often exceedingly abundant, flying about, or resting in close proximity to, rocky ledges or cliffs near streams. They are found commonly in June, associated with such crane-fly species

as *Geranomyia canadensis*, *Dactylolabis montana*, *Tipula ignobilis*, *T. apicalis*, and similar forms. The larvae live in and beneath the saturated cushions of moss (*Amblystegium*) that grow on the shale near the water's edge. The only associated crane-fly larvae found near Cascadilla Creek, Ithaca, New York, where this species is common, were *Tipula ignobilis*, the larvae of both species being exceedingly abundant.

*Larva*.—Length, 10–12.2 mm.  
Diameter, 0.6–0.7 mm.

Color pale whitish with a green cast; transverse abdominal welts dark brown.

Form rather long and slender. In addition to dorsal and ventral welts on abdominal segments 2 to 8, a complete band at base of metathorax and ventral bands on mesothorax and first abdominal segment; ventral abdominal bands larger and more conspicuous than narrow dorsal welts. A few erect setae on body. Spiracular disk (Plate XXVII, 105) rather small, with a deep vertical split, the large ovate spiracles capable of close approximation; ventral lobes blunt, with a black spot on face, fringed with short black hairs and with two sensory setae; each blunt lateral lobe narrowly lined with a black crescent; dorsal lobes very small, dusky; spiracular disk fringed with short, dark hairs. Anal gills four, large and pale.

Head capsule as in tribe. Labrum (Plate XXVII, 106) subtriangular; anterior margin broad, nearly straight across, with a dense fringe of hairs which are coarser at ends of lobe; near anterior margin of labrum two oval, hyaline areas, each with three short papillae; a few sensory setae along anterior margin. Mentum (Plate XXVII, 107) broad, anterior outline triangular, running out into a rather long apical point, each side with about five teeth. Hypopharynx (Plate XXVII, 108) as in this group of genera, consisting of a collar of two chitinized combs, each with about ten sharp teeth. Antenna (Plate XXVII, 109) short, cylindrical, the apical papilla very small, reduced to a tiny disk. Mandible (Plate XXVII, 110) broad, flattened, with a blunt apical point which is only a little longer than the teeth on either side of it; ventral cutting edge with about five blunt teeth, which are gradually smaller from the outermost toward the base; inner face of mandible with a blunt prosthecal tooth and an oblique fringe of coarse setae. Maxilla (Plate XXVII, 111) with the cardines large, with about three setiferous punctures; stipites short, cylindrical; outer lobe fringed with long hairs and bearing the short, flattened, disklike palpus, which has five or six hyaline pegs; inner lobe smaller, with dense, short hairs and a few sensory organs.

*Pupa*.—Length, about 6 mm.

Labrum very obtusely rounded at apex, not bilobed. Labial lobes straight across or very slightly convex across posterior margin. Maxillary palpi narrowed toward tips (Plate XXVIII, 112). Pronotal breathing horns (Plate XXVIII, 113 and 114) elongate-oval, earlike, the ventral margin more bulging, the apex a little narrowed but obtuse; a row of breathing pores along outer margin, beginning on lateral face near dorsal margin, these few in number and widely separated, becoming more numerous toward apex of organ. Leg sheaths as usual in this group of genera, those of fore legs the longest, those of hind legs the shortest. Male cauda (Plate XXVIII, 115) with ventral lobes (Plate XXVIII, 116) large, bluntly rounded at tips; two small, brown, approximated tubercles at base of split on

ventral side; two blunt tubercles on dorsal surface near base and close to median line (Plate XXVIII, 117). Tergal lobes at outer angles of a flattened plate, very short, triangular, each with two small hairs on caudal face before tip.

*Nepionotype*.— Cascadilla Creek, Ithaca, New York, May 22, 1917.

*Neanotype*.— Type locality, June 6, 1917.

*Paratypes*.— Abundant larvae and pupae with types, May 22 to June 6, 1917.

*Dicranomyia badia* (Walk.)

1848 *Limnobia badia* Walk. List Dipt. Brit. Mus., vol. 1, p. 46.

1859 *Dicranomyia humidicola* O. S. Proc. Acad. Nat. Sci. Phila., p. 210.

*Dicranomyia badia* is a very common species thruout eastern North America, occurring in gorges and ravines and along streams. The adult flies may be found resting on perpendicular cliffs near these haunts. In a position of rest they have all six feet on the support, a very different resting position from that of the often-associated genera *Oropeza* and *Dolichopeza*.

The larvae, as is frequent in this genus, live in and beneath moss, especially saturated cushions of moss growing in or near the margins of streams. They are of a clear light pea-green color, and simulate the moss to an astonishing degree. The writer found these larvae in Needham's Glen, Ithaca, New York, on April 16, 1917, beneath wet cushions of *Amblystegium irriguum* (Hook. & Wils.) B. & S., a moss that covers all the rocks and stones near water. In these moss cushions the larvae were associated with tiny larvae of *Tipula ignobilis* and pupae of *T. collaris*. When ready to pupate, the larva spins a small, silken, silt-covered case, which is further protected by a covering of small pieces of moss stems adhering to its outside, this case being hung up in the moss cushion, with the cephalic end of the pupa projecting. The pupal duration is about seven days (April 21 to 28 in the cases observed). The dark-colored pupa, with its contrasting yellow breathing horns, is very handsome.

*Larva*.— Length, 10.5 mm.

Diameter, 0.6-0.65 mm.

Coloration light pea-green, abdominal welts brown; after death general color fading to very pale greenish white.

Form slender; body terete, dorsal and ventral transverse welts at base of abdominal segments conspicuous. Spiracular disk (Plate XXVII, 104) with lobes indistinct, suffused with dusky, lateral lobes very blunt; disk surrounded by a fringe of short, dark-colored hairs. Spiracles very large, ovate, dorsal ends close together. Anal gills long and slender, pale.

Head capsule and mouth parts similar to those of *D. stulta*, already described, judging from the scanty material of *D. badia* available for study.

*Pupa*.— Length, 8–8.5 mm.  
Width, d.-s., 1.1 mm.  
Depth, d.-v., 1.2 mm.

Head, thorax, and appendages dark brown; pronotal breathing horns light yellow; abdomen greenish, the cauda chitinized, light brown.

Labrum very broad, indistinctly bilobed at tip. Labial lobes large, broadly transverse, posterior margin almost straight across. Maxillary palpi broad, tips truncated (Plate XXIX, 119). Lateral margins of cheeks flattened into ledges.

Pronotal breathing horns large, flattened, in lateral outline (Plate XXIX, 118) subcircular or nearly so, with a row of rather widely separated breathing tubercles along margin; as viewed from above, horns directed proximad, so as to be contiguous at tips. A high median crest on mesonotum behind breathing horns. Wing sheaths ending before apex of abdominal segment 2. Leg sheaths ending far before apex of abdominal segment 4; as usual in this division, the hind legs a little the shortest, the fore legs a little the longest. Abdominal segments with a distinct basal welt which is thickly margined with microscopic curved hooks. Lateral spiracles distinct, but small and probably nonfunctional. Female cauda with sternal valves shorter than long tergal valves, the latter (Plate XXIX, 120) almost straight, each with a powerful, acute spine on lateral margin at about midlength, this directed dorsad. Near the margin of segment 8, on dorsum, a pair of rudimentary spiracles.

*Nepionotype*.— Needham's Glen, Ithaca, New York, April 16, 1917. (No. 5-1917.)

*Neanotype*.— Type locality, May 7, 1917.

### Genus *Rhipidia* Meigen (Gr. *a fan*)

1818 *Rhipidia* Meig. Syst. Besch. Zweifl. Ins., vol. 1, p. 153.

1911 *Ceratostephanus* Brun. Rec. Indian Mus., vol. 6, p. 271.

*Larva*.— Form rather stout, body terete. Abdominal sternites 1 to 7 and tergites 2 to 7 with narrow transverse basal welts of chitinized points. Spiracular disk with indistinct lobes. Head capsule massive, not unlike that of *Dicranomyia*. Labrum broadly transverse. Mandible very broad, flattened, with only three ventral cutting teeth. Maxilla of simple structure. Antenna with apical papilla or segment very flattened, disklike. Hypopharynx of two chitinized plates, each with about twelve comblike teeth. Mentum almost transverse across anterior margin, with from nine to eleven teeth, the outermost fused.

*Pupa*.— Pronotal breathing horns elongate for this subtribe, about three times as long as broad. Abdomen with transverse bands of spicules on tergites 3 to 7 and sternites 5 to 7, and on extreme lateral parts of sternites 3 and 4.

*Rhipidia* is a small to medium-sized genus (about thirty-five species) having its center of distribution in the American tropics, with some species occurring thruout temperate Europe and America and a less number in Africa and the Oriental region. The genus is based on a sexual char-

acter, the pectinate antennae of the male, and several of the species run inconveniently close to *Diceromyia*.

The immature stages are spent beneath the bark of decaying trees or in decaying vegetable or animal matter. In Europe the genotype, *Rhipidia maculata* Meig., has been recorded as living in old cow-manure. Beling found the insects in such a situation, associated with the larvae of *Rhyphus punctatus* (Fabr.) (Beling, 1879:52-53) and a staphylinid beetle, *Platystethus morsitans* Payk. (Beling, 1873b:592). *R. uniseriata* Schin. was found by Beling (1879:53-54) living in decaying beech wood, in company with larvae of *Xylota lenta* Meig. and *X. segnis* (Linn.) (Syrphidae) as well as with larvae of a tipuline crane-fly, *Ctenophora*. The larvae of this species, like those of *R. maculata*, live in thin silken cases, open at both ends and covered with particles of wood and other débris.

In America, besides *Rhipidia bryanti* (which is discussed in some detail) the following records of the immature stages are available: *Rhipidia maculata*, recorded in Europe as living in decaying organic matter, was found by Needham (1908a:170, 204) in tent traps set over the bed of Beaver Meadow Brook in the Adirondacks, the insects presumably having emerged from the stream bed or from the thin layers of moss covering the exposed stones. *R. fidelis* O. S. was reared from larvae in decaying wood near Ithaca, New York, by Carl Ilg. This species belongs to the same subgenus (*Monorhipidia* Alex.) as the European *R. uniseriata*, which has similar larval habits. *R. domestica* O. S. has been bred from larvae obtained in fermented sap of the sour gum (*Nyssa sylvatica* Marsh., Cornaceae) at Clementon, New Jersey (Johnson, 1910:704). Males and females of this species were bred by Popenoe at Washington, D. C., from larvae on more or less decaying roots of taro (*Colocasia antiquorum* Schott, Araceae) taken at Gough, South Carolina, on February 1, 1911. Specimens of *R. domestica* emerged on August 21, 1906, at Juneau, Alaska, in radishes infested with *Hylemyia brassicae* (Bouché).

*Rhipidia (Rhipidia) bryanti* Johns.

1909 *Rhipidia bryanti* Johns. Proc. Boston Soc. Nat. Hist., vol. 34, p. 123-124, pl. 16, fig. 20.

*Rhipidia bryanti* is one of the largest and handsomest species of the genus, and is widely distributed thruout the eastern United States from Maine to Texas. The immature stages are spent beneath the decaying

bark of trees. The material studied was collected by J. R. Malloch in Potomac Park, Washington, D. C., on May 11, 1913, and was reared by R. C. Shannon (No. 35-1913), whose notes on the subject are as follows:

A small colony (about seven) of tipulids were found in a hollow of a tree behind the bark. The larvae were covered with slime, which gathered débris as they moved about and so formed a case. The next morning one had pupated. Two larvae were boiled and preserved in alcohol, while two others were preserved in formal. As they move about they leave a path of slime behind them. On May 14, the one that had pupated on the 12th emerged. On May 18 another imago issued.

There is an obvious error in the duration of the pupal stage as given — only two days. It is possible that a pupa was included in the material and was overlooked in its case of débris. The date of emergence of the second adult would show a pupal duration of six days, which is probably nearly correct.

*Larva*.— Length, 13.2-14 mm.  
Diameter, 1 mm.

Coloration white.

Form terete, rather stout. Sternites 1 to 7 and tergites 2 to 7 with narrow transverse welts on basal rings; welts yellow, provided with long, transverse rows of microscopic roughened points, those along margins of welts coarser, those in centers very tiny; these rows interrupted along pleura. Caudal end blunt, with lobes of spiracular disk indistinct. Spiracles large, capable of close approximation.

Head capsule massive, of the *Limnobia* type. Labrum (Plate XXX, 121) broadly transverse, anterior margin almost straight across, near margin two oval areas which are provided with small sensory papillae. Epipharyngeal region with abundant hairs. Mentum (Plate XXX, 122) chitinized, the anterior margin almost transverse, with a large median tooth and about three lateral teeth on either side, the outermost of these an evident fusion of about three lesser teeth. Hypopharynx (Plate XXX, 123 and 124) as usual in this subtribe, a collar-like structure composed of two parallel combs united at the ends; the larger plate broadly elongate, surface with abundant scalelike plates, anterior margin with twelve teeth, the lateral ones narrow, the teeth gradually enlarging toward the middle, the middle pair a little shorter; second plate of hypopharynx broadly transverse, narrow, likewise with about twelve teeth, the two outer most on each side long, subacute, the middle tooth shorter and more flattened; between the two middle teeth a small triangular or conical point. Antenna (Plate XXX, 125) short cylindrical, the apical papilla a very flattened disk or button which is much broader than long. Mandible (Plate XXX, 126) very broad, flattened, with the apical tooth rather long and slender; two smaller teeth dorsad and three others ventrad, the dorsal teeth blunt, the ventral teeth truncated, the most basal tooth very broad. Maxilla (Plate XXX, 127) of the simple generalized structure of this tribe; cardines large, with two setiferous punctures; stipites weakly chitinized basally; outer lobe of maxilla with the large flattened palpus at its tip; palpus surrounded by numerous long setae and having several hyaline sense pegs at its apex; inner lobe of maxilla smaller, with numerous long hairs, especially a slitlike brush near margin.

*Pupa*.—Length, about 12 mm. (cast skin).

Labrum broad, rounded at apex. Labial lobes broadly transverse, caudal margin indistinctly trilobed. Maxillary palpi large, flattened, apex bluntly pointed; a rather angular tooth on margin near base (Plate XXXI, 128). Cheeks produced into flattened ledges. Antennae short and stout.

Pronotal breathing horns (Plate XXXI, 129) elongate for this subtribe, about three times as long as the greatest diameter, flattened, apical half slightly expanded, margin with tiny tubercles. Wing sheaths attaining base of abdominal segment 3. Leg sheaths attaining base of abdominal segment 5; tarsi ending about on a level, or hind tarsi a little the shorter and fore tarsi a little the longer. Abdomen with basal bands of setae on tergites 3 to 7 and sternites 5 to 7, and on the extreme lateral parts of sternites 3 and 4; these bands thickly margined with tiny, golden-yellow hairs or points, the median part of each band naked or nearly so. Male cauda (Plate XXXI, 130) with dorsal lobes (Plate XXXI, 131) very small, more or less flattened, divergent, rather blunt at tips; ventral lobes elongate, contiguous along inner face.

*Nepionotype*.—Potomac Park, D. C., May 11, 1913.

*Neanotype*.—Cast pupal skin, with type larva, May 14, 1913.

*Paratype*.—One larva with type.

### Subtribe *Dicranoptycharia*

The subtribe *Dicranoptycharia*, so far as known, includes only the genus *Dicranoptycha*. The division is close to the *Rhamphidaria* but is easily separated from it in all stages.

### Genus *Dicranoptycha* Osten Sacken (Gr. *fork* + *fold*)

1818 *Marginomyia* Meig. Syst. Besch. Zweifl. Ins., vol. 1, p. 147 (*nomen nudum*).

1859 *Dicranoptycha* O. S. Proc. Acad. Nat. Sci. Phila., p. 217.

*Larva*.—Form very elongate, terete. Integument smooth, glassy, transparent. Abdominal segments 2 to 8 each with a basal transverse band or area of microscopic chitinized points on ventral surface; segment 8 with a similar band on dorsum. Spiracular disk surrounded by four lobes, the lateral pair more slender than the blunt ventral pair; dorsal lobe very low or lacking; a triangular brown mark on disk between spiracles. Spiracles small, widely separated. Anal gills a fleshy protuberant ring surrounding anus.

Head capsule compact, massive, the prefrons large with a few marginal punctures; external plates very broad. Labrum large, flattened, pale. Antenna two-segmented; apical segment almost as long as basal segment, gradually narrowed to the blunt tip. Mandible with a blunt dorsal and two blunt ventral teeth. Maxilla generalized in structure. Hypopharynx a rounded cushion. Mentum deeply split behind but not completely divided, with three principal teeth and a small reduced lateral tooth on either side.

*Pupa*.—Cephalic crest low, depressed, setiferous. Labrum tumid. Labial lobes oval, contiguous. Antennal sheaths ending opposite base of wing pad. Pronotal breathing horns microscopic, represented only by tiny triangular tubercles. Mesonotum unarmed.

Wing sheaths ending opposite middle of third abdominal segment. Leg sheaths ending opposite base of fifth abdominal segment, the tarsi terminating on a level or nearly so. Abdominal tergites and sternites each with four transverse rows of microscopic setae; lateral spiracles on segments 2 to 7; no apparent spiracles on dorsum of segment 8.

*Dicranoptycha* is a principally Holarctic genus including twelve known species, six of which occur in the United States. The flies are of medium size and of a dull, inconspicuous appearance, and are rather difficult of taxonomic separation. The life histories of members of this genus have only recently been ascertained. The following notes are taken from more detailed accounts in earlier papers by the writer (Alexander, 1919, a and b).

The habits of the immature stages of *Dicranoptycha* may be briefly summarized as follows: The larvae and the pupae live in rich humous soil overlain with a cover of leaf mold and other vegetable débris. They frequent open woods where there is more or less shubbery and tall herbage. Running streams or rills are not necessary for the development of the immature stages. The larvae live in the uppermost zone of the soil, where they are associated with a rather characteristic group of animal forms, such as dipterous larvae (*Sciara*), beetle larvae, and centipedes. They are characterized by the exceedingly long, slender body and the shiny glabrous skin, and may be confused with no other dipterous larva yet made known. The glassy appearance of the body suggests the shiny shell of a small univalve snail, the dead fragments of which occurred in some numbers in the same situations. The larvae of *Dicranoptycha winnemana* Alex., an Austral species, attain a length of from 20 to 22 millimeters, with an average diameter of only 1 millimeter. The larvae of the genus are herbivores. When ready to pupate they incase themselves in compact earthen cells, which are 10 x 3.5 millimeters in size, firm in texture, and rather thick-walled but apparently without silk. There is a small opening at either end. The pupal period is about ten days or possibly a little less. Pupation takes place in the relatively dry soil that forms the larval haunt.

The pupa of *Dicranoptycha winnemana* measures from 9.1 to 12.8 millimeters in total length. The width at the wing pad is about 1.7 millimeters. The diagnostic features are given above at some length for the genus and need not be repeated here. For other notes the reader is referred to the papers already cited.



The adult flies of the various species of *Dicranoptycha* are usually abundant where they occur. They may be found resting on the upper surface of leaves of shrubbery and tall herbage in open woods, often far from water, which is not so necessary for development as with most species of *Tipulidae*.

### Subtribe *Rhamphidaria*

The division *Rhamphidaria* includes the genus *Rhamphidia*, with the possible addition of a few exotic genera. *Rhamphidia* is one of the constituent genera of the former group *Antochini*, but differs considerably from all others whose life histories have been made known. The closest relatives of *Rhamphidia* seem to be the *Dicranoptycharia*, on the one hand, and the lowermost divisions of the *Hexatomini*, on the other. The larvae and the pupae of *Rhamphidia* present a curious eriopterine appearance, but their structure indicates only a distant relationship with the *Eriopterini*.

### Genus *Rhamphidia* Meigen (Gr. *rostrum*)

- 1825 *Megarhina* St. Farg. et Serv. Encyclop. Method., Ins., vol. 10, part 2, p. 585.  
 1825 *Helius* St. Farg. et Serv. Encyclop. Method., Index, p. 831.  
 1829 *Leptorhina* Steph. Cat. Brit. Ins., vol. 2, p. 243.  
 1830 *Rhamphidia* Meig. Syst. Besch. Zweifl. Ins., vol. 6, p. 281.

*Larva*.—Body terete. A transverse welt, covered with microscopic scabrous points, on ventral surface of basal annuli of abdominal segments 2 to 7. Spiracular disk surrounded by five short lobes which are fringed with abundant, rather long, hairs. Head capsule massive, generalized in structure. Mandible short and stout, ending in two subequal blunt teeth. Maxilla consisting of two rather short, densely hairy lobes. Antenna short. Hypopharynx chitinized, outer margin with about a dozen teeth. Mentum not completely divided, with five teeth. Coloration of body dark brown, produced by the dense appressed pubescence covering it.

*Pupa*.—Cephalic crest double, the anterior part low, the posterior part the larger; lobes setiferous, divergent. Two setae on front between eyes. Pronotal breathing horns long and slender, slightly curved. Mesonotum convex. Wing sheaths reaching end of second abdominal segment. Leg sheaths ending just before posterior margin of fourth abdominal segment; all the tarsi about equal in length, or those of fore legs a little longer. Abdominal segments with two narrow basal rings and a broader posterior ring having four narrow transverse bands of spicules and comparatively few setae. Spiracles rather large on pleurites 2 to 7, and a large conspicuous pair on dorsum of segment 8.

*Rhamphidia* is a small genus of crane-flies (about thirty-five species), widely distributed thruout the temperate and tropical regions of the world. The larvae of the European *R. longirostris* Meig. were found by Gericke

(1884) in submerged stems of the water doek, *Rumex aquaticus* Linn. The eggs are described as being rather long, white, and granulate. It is suggested that the developmental stages may be associated with water. The two local species have been reared and are discussed herewith.

*Rhamphidia mainensis* Alex.

1916 *Rhamphidia mainensis* Alex. Proc. Acad. Nat. Sci. Phila., p. 498-499, fig. 14.

*Rhamphidia mainensis* appears to be a rather uncommon form, much rarer than *R. flavipes*, the other local species. Adult flies were not uncommon in the Basin Swamp, Orono, Maine, on June 12, 1913. This swamp is a low, sunken area surrounded on most sides by hills, opening into the "Basin," an affluent of the Penobscot River. Cold springs of water percolate down from these hillsides, and the soil is very wet, boggy, and richly filled with organic matter. The chief floral constituents are a few elms and white birches and an abundance of alders, *Spiraea latifolia* Borkh., and *S. tomentosa* Linn. The herbage consists of ferns such as *Onoclea* and *Osmunda*, patches of *Iris*, *Impatiens biflora* Walt., and many rushes and sedges. Crane-flies associated with *R. mainensis* on the date mentioned included the following: *Dicranomyia haeretica*, *Epiphragma fascipennis*, *Pseudolimmophila luteipennis*, *P. inornata*, *Limmophila fasciolata*, *L. macrocera*, *Pilaria recondita*, *Ulomorpha pilosella*, *Tricyphona inconstans*, *Erioptera vespertina*, and *Tipula sulphurea*, also an abundance of *Ptychoptera rufocincta* and *Bittacomorpha clavipes*.

Larvae were first found on April 20, 1917, in the dark, cold swamp known as Larch Meadows, south of Ithaca, New York. Here they occurred in the thick, black, saturated organic matter comprising the soil of the swamp. The vegetation consists of the dominant alder (*Alnus incana* [Linn.] Moench.), the poison sumac (*Rhus Vernix* Linn.), and the marsh marigold (*Caltha palustris* Linn.), as well as an abundance of other plant species in lesser numbers. The earthy material in which the crane-fly larvae were found was full of the organic remains of plants, such as ferns, leaves, alder catkins, and the like. Associated with these larvae at this time were numerous small hydrophilid beetles, and a great abundance of larvae of a dascillid beetle of the subfamily Helodinae, of various sizes and ages. Numerous tabanid and stratiomyiid larvae, and the larvae of the crane-fly species *Bittacomorpha clavipes*, *Pseudolimmophila luteipennis*, and *Tipula dejecta*, also occurred.

The larvae were conspicuous by their dark coloration and, when placed in water, by their active, snakelike movements, in this regard being very different from somewhat similar larvae of certain Eriopterini which they resemble superficially because of the five subequal lobes surrounding the spiracular disk. The indoor pupal period is six days (May 8 to 14, 1917).

*Larva*.—Length, 9–11.2 mm.  
Diameter, 0.75–0.9 mm.

Coloration dark brown, sutures pale; pale spots on dorsum and on sides of body; spiracular disk pale, lobes marked with darker.

Form rather stout, terete (Plate XXXI, 132). Body densely covered with a long, appressed, dark pubescence. Prothoracic segment narrowed in front, long, divided into two rings by a faint constriction; mesothoracic and metathoracic segments gradually longer. First abdominal segment shorter than last thoracic segment; abdominal segments 2 to 7 long, each divided into two narrow annuli by a deep constriction which is destitute of hairs but has just before it a sharp, transverse ridge of stiff hairs; short, incomplete ridges of these stiff hairs on dorsum of anterior ring; anterior ring about half as long as posterior ring; on ventral side of each of segments 2 to 7 on anterior ring, a transverse swelling, these swellings becoming more convex and prominent on posterior segments; swellings appearing almost smooth, being covered only with microscopic, roughened points; posterior ring with a sharp ridge of hairs at about two-thirds its length. Chaetotaxy as follows: dorsal segments with short setae at about midlength of posterior ring; a single rather stout, black bristle on pleura of anterior ring, immediately above transverse swellings; a similar seta on posterior ring; two groups of very long, delicate setae on ventral face of posterior ring, one on each side of the ridge of erect hairs; thoracic segments approximately similar to abdominal segments, but sternal setae at about midlength even more prominent. Last segment of body elongated, the spiracular disk (Plate XXXI, 136) surrounded by five lobes; dorsal lobe the smallest, rather blunt, inner face with a brownish, triangular-oval mark; lateral lobes of medium length, inner face suffused with brown, which is darkest, almost black, on lower edge of lobe; ventral lobes the longest, inner face of each with two broad, parallel, blackish lines, separated by a somewhat narrower pale line; entire disk fringed around with long, dark-colored hairs, which are longest near tips of lobes, where they are strongly recurved, almost pencil-like; fringe continuous between dorsal and lateral lobes, but between ventral and lateral lobes, and between the two ventral lobes, hairs toward base of each lobe very short to lacking; ventral lobes just before tips with a single long sensory bristle. Spiracles large, subcircular, situated at base of lateral lobes, dark-colored, narrowly margined with pale. Anal gills consisting of two pairs of pale, stout, cylindrical lobes, tapering toward tips, before which there is a slight constriction.

Head capsule massive and compact, of the normal generalized limnobiine type. Labrum large, conspicuous, transverse, densely fringed with long hairs; on epipharyngeal region, a large, dense tuft of moderately elongate hairs on either side of median line. Mentum (Plate XXXI, 133) not completely divided, but with a very deep split behind, a large median tooth, and two smaller teeth on either side; behind (dorsad of) elongate median tooth, a slightly wider flattened lobe whose margins extend beyond those of outer tooth. Hypo-

pharynx a broad semicircular band of chitin whose anterior margin is provided with about a dozen teeth, the intermediate ones more blunt and rounded, the lateral teeth longer and more slender. (The antennae of this species were not distinguishable in the specimens available, but are undoubtedly similar to those of *R. flavipes* described hereinafter.) Mandible (Plate XXXI, 135) of the generalized limnobiine type, short and stout, terminating in two blunt teeth; ventral cutting edge with about three teeth which are gradually smaller toward base of mandible; a dorsal row of two teeth, of which the basal one is the smaller; base of mandible on outer face (heel) prolonged into an acute flattened blade; a conspicuous tuft of hairs at prosthecal region. Maxilla consisting of two rather short, stout lobes which are shorter than the mandible, densely provided with short hairs; palpi large, shaped like a half of a short cylinder split lengthwise.

*Pupa*.—Very similar to that of *R. flavipes*, as described on the following pages. (The writer has only the cast pupal skin of *R. mainensis*, and it seems to agree very closely with the pupa of *R. flavipes* except that the lobes of the labial sheaths are longer and more pointed, and the labrum is a little longer to provide for the longer rostrum of the former species.)

*Neopionotype*.—Ithaca, New York, April 20, 1917.

*Neanotype*.—Cast pupal skin, May 14, 1917.

### *Rhamphidia flavipes* Macq.

1855 *Rhamphidia flavipes* Macq. Dipt. Exot., 5th supp., p. 17.

1856 *Rhamphidia prominens* Walk. Ins. Saunders, vol. 1, Dipt., p. 435.

1859 *Rhamphidia brevisrostris* O. S. Proc. Acad. Nat. Sci. Phila., p. 222.

*Rhamphidia flavipes* is a common and widely distributed fly thruout the eastern United States and Canada. The species is characteristic of cat-tail swamps and similar situations. It has been reared from leaves of bur reed, Sparganium, brought in by C. H. Kennedy from Ringwood Hollow, near Etna, New York, in September. These larvae were associated with larvae of *Prionocera fuscipennis*, likewise a characteristic inhabitant of open swamps. The specimens here described were taken in a small cat-tail swamp near Bool's hillside, Ithaca, New York, in June, 1917. Here they were associated with a number of larvae of characteristic swamp-inhabiting crane-flies, such as *Ptychoptera rufocincta*, *Pseudolimnophila luteipennis*, *Limnophila macrocera*, *Pilaria recondita*, *Liogma nodicornis* (in moss), *Prionocera fuscipennis*, and *Tipula tricolor*.

This is unquestionably the larva that was found by Hart and doubtfully referred by him to the genus Erioptera (Hart, 1898 [1895]:197-199, also Malloch, 1915-17b:237). Later, Mik (1898:62) doubted that this belonged to Erioptera because of the long lashes of hairs surrounding the caudal lobes, a character not shown by typical eriopterine larvae. The larvae that Hart found were living among rushes and other vegetation floating

on the surface of the water in the Illinois River. When submerged these larvae were very active, quite as noted in the account of *R. mainensis*.

*Larva*.— In all general features like larva of *R. mainensis* (with the material available the writer is unable to point out differences). Present species a little larger than *R. mainensis*, measuring from 12 to 13 mm. in length and 1 mm. in diameter. Mouth parts and head capsule almost exactly like those of *R. mainensis*, already described. Antenna (Plate XXXI, 134) with first segment elongate, a little enlarged toward tip, and with an elongate, thimble-shaped papilla at tip whose surface is delicately sculptured; surrounding this papilla at tip of basal segment, a few microscopic tubercles and pegs; on face of basal segment on proximal half, a circular porous plate.

*Pupa*.— Length, 7.8–8.8 mm.

Width, d.-s., 1 mm.

Depth, d.-v., 1.1–1.2 mm.

Coloration light brown; abdomen paler, trivittate with dark brown; a broad, dorso-median line, and narrower, somewhat interrupted, pleural stripes; breathing horns yellow, darker at extreme bases.

Cephalic crest (Plate XXXII, 137) low, the lobes divergent, their lateral angles with a stout seta which is directed cephalad. Just behind the anterior crest a much larger, low, appressed lobe, which is transversely wrinkled, bearing on its side a seta directed dorsad. Eyes rather large, widely separated by front; two setae on front between eyes. Labrum triangular, pointed at apex. Front a little elongated to provide for short rostrum of adult. Sheaths of maxillary palpi long, stout, almost straight. Labial palpi contiguous, lying side by side at tip of labrum. Antennae rather widely separated at their bases, ending just beyond wing root; in males lying across face of eye, due to the large size of eyes in this sex.

Mesonotum prominent, carinate medially (Plate XXXIII, 142). Breathing horns long and slender, slightly curved, transversely crenulated, a little enlarged toward tips; proximo-cephalad of base of each horn a small rounded tubercle bearing two setae. Lateral angles of thorax with about three short setae. Mesonotum convex, transversely wrinkled, with a few very short setae. Wing sheaths ending about opposite posterior margin of second abdominal segment. Leg sheaths parallel, about subequal in length or those of fore legs a little longer, ending just before posterior margin of fourth abdominal segment. Dorsal abdominal segments (Plate XXXIII, 143) each with two narrow basal rings and a much broader posterior ring; ventral segments (Plate XXXIII, 144) with the two basal rings confluent; dorsal segments with each narrow basal ring having a narrow, slightly arcuated band of spicules, and posterior ring having a narrow basal band of spicules which is more or less arcuated, and a straight caudal band, immediately in front of which are four groups of two setae each, or, in some specimens, with the intermediate groups reduced to a single seta; ventral segments with posterior ring having a broad transverse band of spicules, with three setae in alinement at each end of this band; closer to base of segment, two strong setae on either side; anterior ring darkened. Pleura with large but apparently nonfunctional spiracles on segments 2 to 7, a strong ante-spiracular seta, and three post-spiracular setae, as illustrated (Plate XXXIII, 144). Male cauda (Plate XXXII, 139 and 140) terminating in two acute tips which are directed dorsad; at base of these lobes on

dorsal face, two blunt, approximated, parallel lobes directed cephalad; at the base of long apical lobes, a shorter, pointed, setiferous lobe, directed laterad and dorsad, bearing on its side and near the apex a few setae. Dorsum of segment 8 with four prominent lobes surrounding a hollow, these lobes ending in acute tips, the posterior pair directed more dorsad, the anterior pair directed more laterad, at the base of the latter a pair of spiracles. Female cauda similar but with acidothecae prolonged, bearing on the side prominent lateral lobes (Plate XXXII, 141), corresponding to the setiferous lobe of male as described above; quadrangle of tubercles on dorsum of segment 8 (Plate XXXII, 138) about as in male, all the tubercles ending in chitinized points.

*Nepionotype*.—Ithaca, New York, May 11, 1917.

*Neanotype*.—Ithaca, New York, June 3, 1917.

*Paratypes*.—Pupae with neanotype.

### Tribe Hexatomini

The tribe Hexatomini, as here understood, comprises a very extensive group of medium-sized crane-flies, made up of the members of the former groups Limnophilini and Hexatomini. The more generalized members of the group are herbivorous, but the two highest subtribes, Limnophilaria and Hexatomaria, are carnivorous in their feeding habits.

The larvae of the lower divisions have the head capsule massive and compact, the mentum chitinized and with the anterior margin toothed, and the hypopharynx usually well preserved. The mandibles are not formed into long, curved hooks, and the maxillae are of a generalized organization. The higher subtribes, Limnophilaria and Hexatomaria, have the head capsule long and slender and very much dissected, with the constituent plates very narrow and separate. The mentum is very reduced or lacking, in some of the Limnophilaria consisting of an articulated transverse bar which is grooved with parallel fine striae. In the group Ulomorphae and in the Hexatomaria the chitinized mental region is nearly, if not quite, lacking, allowing for great distention of this region of the head. The mandibles are powerful, curved hooks, bearing a few teeth at about midlength. In the group Ulomorphae the mandibles are hinged at about midlength, the basal part being deeply grooved on the inner face to receive the blade in a position of rest. The maxillae have the outer lobe prolonged into an elongate flattened blade which extends out of the thoracic orifice when the head is retracted.

The pupae of the Ularia and the Epiphragmaria have a pair of large spiracles on the dorsum of the eighth abdominal segment, indicating a close phylogenetic relationship with the Limnobiini. Daetylolabis has

the lateral abdominal spiracles protuberant, with those of the second segment very large and conspicuous. *Pseudolimnophila*, the *Ulomorphae*, and *Pilaria* have the pronotal breathing horns very long and slender, with the tips split into divergent flaps. In the *Hexatomaria* the lateral abdominal spiracles are large and functional.

The immature stages of the *Polymeraria*, including the single tropical American genus *Polymera* Wiedemann, are unknown. Their discovery might result in the inclusion of this subtribe with the *Pediciini* rather than with the *Hexatomini*.

The following keys separate the subtribes of the tribe *Hexatomini*:

*Larvae*

1. Mentum completely divided, each half with seven teeth on anterior margin; hypopharynx a semicircular chitinized ring with numerous teeth around anterior margin. *Pseudolimnophilaria* (p. 848)  
Mentum when present not divided; hypopharynx not shaped as above..... 2
2. Abdominal segments 2 to 7 with a basal transverse creeping-welt..... 3  
Abdominal segments 2 to 7 without such a welt..... 4
3. Mentum three-toothed; antenna elongate, the apical segment hemispherical. *Epiphragmaria* (p. 843)  
Mentum nine-toothed; antenna short, subglobular, the apex with two short papillae. *Ularia* (p. 838)
4. Body depressed; head capsule massive, compact; mentum heavily chitinized, seven-toothed; maxilla not projecting..... *Dactylolabaria* (p. 852)  
Body terete; head capsule of slender bars, not compact; mentum feeble, at most a narrow, transverse bar which is delicately striate; maxilla projecting from thoracic orifice..... 5
5. Mental bar present..... *Limnophilaria* (group *Limnophilae*) (p. 858)  
Mental bar lacking..... 6
6. Dorsal plates of head capsule firmly united; epipharynx and maxilla densely hairy; mandible hinged..... *Limnophilaria* (group *Ulomorphae*) (p. 869)  
Dorsal plates of head capsule widely separated, at most merely contiguous behind; epipharynx and maxilla not hairy; mandible not hinged..... *Hexatomaria* (p. 876)

*Pupae*

1. Two large spiracles on dorsum of eighth abdominal segment..... 2  
No large spiracles as above..... 3
2. Pronotal breathing horns subchitinized, directed strongly ventrad; abdominal segments without shagreened transverse bands; pupates in wood..... *Epiphragmaria* (p. 843)  
Pronotal breathing horns flattened, directed laterad; shagreened transverse bands on abdominal segments; pupates in earth..... *Ularia* (p. 838)
3. Abdominal segments with large protuberant spiracles, those on second segment very large..... *Dactylolabaria* (p. 852)  
Abdominal segments without conspicuous protuberant spiracles..... 4
4. Pronotal breathing horns elongate, split into two flaps at tip..... 5  
Pronotal breathing horns not split into two such flaps..... 6
5. Abdominal segments with five or six rows of setiferous tubercles. *Pseudolimnophilaria* (p. 848)  
Abdominal segments without such rows of tubercles. *Limnophilaria* (group *Ulomorphae*) (p. 869)

6. Head and thorax without spines or tubercles; lateral abdominal spiracles small.

*Limnophilaria* (group *Limnophilae*) (p. 858)

Head and thorax often with tubercles on antennal scape, labrum, or mesonotal scutellum; lateral abdominal spiracles large, functional.....*Hexatomaria* (p. 876)

The most important literature on the tribe Hexatomini is as follows:

<i>Ula macroptera</i> .....	Larva.....	Stannius, 1829:205.
<i>Ula macroptera</i> .....	Larva, pupa, general..	Perris, 1849:337-341.
<i>Ula macroptera</i> .....	General.....	Alexander, 1915 a:2.
<i>Ula macroptera</i> .....	General.....	Pierre, 1919-20:76.
<i>Ula bolitophila</i> .....	General.....	Loew, 1869:4-5.
<i>Ula elegans</i> .....	Larva, pupa, general..	Alexander, 1915 a.
<i>Ula elegans</i> .....	Larva, pupa.....	Malloch, 1915-17 b:226. (Copy.)
<i>Epiphragma picta</i> .....	Larva.....	Bremi-Wolf, 1846.
<i>Epiphragma picta</i> .....	Larva, pupa.....	Beling, 1873 b:589-590.
<i>Epiphragma fuscipennis</i> .....	Larva, pupa, general..	Needham, 1903:281-285.
<i>Epiphragma fuscipennis</i> .....	Larva, pupa.....	Malloch, 1915-17 b:224-225. (Copy.)
<i>Pseudolimnophila luteipennis</i> .....	Larva, pupa, general..	Hart, 1898 [1895]:202-204.
<i>Pseudolimnophila luteipennis</i> .....	Larva, pupa, general..	Malloch, 1915-17 b:222-223.
<i>Dactylobis wodzikii</i> .....	Larva, pupa, general..	Nowicki, 1867:340-343.
<i>Dactylobis denticulata</i> .....	Larva, pupa, general..	Mik, 1894.
<i>Limnophila ferruginea</i> .....	Larva, pupa, general..	De Meijere, 1916:204-206.
<i>Limnophila hyalipennis</i> .....	Larva, pupa.....	Beling, 1886:198-199.
<i>Limnophila lineola</i> .....	Pupa.....	Beling, 1879:54.
<i>Limnophila lineola</i> .....	Larva.....	Beling, 1886:199-200.
<i>Limnophila nemoralis</i> .....	Larva, pupa.....	Beling, 1886:200-201.
<i>Limnophila ochracea</i> .....	General.....	Beling, 1886:262.
<i>Limnophila pallida</i> .....	Larva, pupa.....	Beling, 1873 a:556-558.
<i>Limnophila dispar</i> .....	Larva, general.....	Perris, 1849:331.
<i>Limnophila pictipennis</i> .....	Larva, pupa, general..	Beling, 1879:51-52.
<i>Limnophila pictipennis</i> .....	Larva.....	Brauer, 1883:55.
<i>Limnophila punctata</i> .....	Larva.....	Scheffer, in Rossi, 1848:10.
<i>Limnophila punctata</i> .....	Larva.....	Osten Sacken, 1869:201.
<i>Limnophila punctata</i> .....	Larva, pupa, general..	Beling, 1886:195-197.
<i>Limnophila punctata</i> .....	Larva.....	Gerbig, 1913:158-161.
<i>Limnophila punctata</i> .....	General.....	Cameron, 1917:63.
<i>Limnophila bryobia</i> .....	General.....	Mik, 1881:205-206.
<i>Limnophila sinistra</i> .....	Larva, pupa.....	Hudson, 1920:33-34.
<i>Pilaria fuscipennis</i> .....	Larva, pupa.....	Beling, 1886:197-198.
<i>Pilaria fuscipennis</i> .....	Larva.....	Gerbig, 1913:164-166.
<i>Pilaria fuscipennis</i> .....	General.....	Cameron, 1917:63.
<i>Pilaria discicollis</i> .....	Larva.....	Gerbig, 1913:163-164.
<i>Pilaria discicollis</i> .....	General.....	Cameron, 1917:63.
<i>Pilaria tenuipes</i> .....	Pupa.....	Hart, 1898 [1895]:204-205.
<i>Pilaria tenuipes</i> .....	Pupa.....	Malloch, 1915-17 b:223-224.
<i>Eriocera spinosa</i> .....	Larva, pupa, general..	Alexander and Lloyd, 1914:27-30.
<i>Eriocera spinosa</i> .....	General.....	Alexander, 1915 c:149.
<i>Eriocera cinerea</i> .....	Larva.....	Alexander and Lloyd, 1914:21-23 (as <i>longicornis</i> ).
<i>Eriocera longicornis</i> .....	Pupa, general.....	Alexander and Lloyd, 1914:23-27.



<i>Eriocera longicornis</i> .....	General.....	Alexander, 1915c: 149-152.
<i>Eriocera fultonensis</i> .....	Larva, pupa, general..	Alexander and Lloyd, 1914: 30-33.
<i>Hexatoma nigra</i> .....	General.....	Von Röser, 1834.
<i>Hexatoma megarera</i> .....	Larva, pupa, general..	Alexander, 1915c: 141-148.
<i>Pentoptera albilarisis</i> .....	Larva, pupa, general..	Alexander, 1915c: 152-157.

### Subtribe *Ularia*

The division *Ularia* includes only the genus *Ula*. It represents a very primitive group of crane-flies, presumably the most generalized of the entire tribe. The head capsule of the larva is oval and very massive, with the prefrons large and distinct. The head capsule and its arrangement of setae is not conspicuously unlike that of the eucephalous families of crane-flies, and this group of Tipulidae is presumably not very different from the early tipulid ancestors. The mentum is heavily chitinized, not completely divided behind, consisting of two plates, one behind the other. The outermost plate terminates in three teeth, while the second plate furnishes three additional teeth on each side. The hypopharynx is not chitinized. The antennae are very small; the basal segment is nearly globular, bearing at its tip two blunt, conical papillae. The mandibles are slender; the ventral cutting edge has about five narrow teeth; there is a distinct brush of hairs at the prosthecal region. The maxillae are of a generalized type, with the palpus large, flattened, and disklike. The abdomen is provided with six creeping-welts on the ventral surface of the segments. The spiracular disk is moderate in size, squarely truncated, surrounded by five subequal lobes which are heavily marked with black on their inner faces.

The pupa has the cephalic crest small and provided only with very small setae. The pronotal breathing horns are very long, tapering to the subacute tips. The abdominal segments have a basal transverse band of a shagreened appearance. The dorsal spiracles on the eighth abdominal segment are large and distinct.

The closest relative of the division is apparently the genus *Epiphragma* in the subtribe *Epiphragmaria*. But this entire group of genera (those included in the subtribes *Ularia*, *Epiphragmaria*, and *Pseudolimnophilaria*) is not far removed from the tribe *Limnobiini*.

Genus *Ula* Haliday (Gr. *soft*)1833 *Ula* Hal. Ent. Mag., vol. 1, p. 153.1864 *Macroptera* Lioy. Atti dell' Institut Veneto, ser. 3, vol. 9, p. 224.

*Larva*.—Body covered with a short pubescence. Basal annuli of abdominal segments 2 to 7 with a transverse creeping-welt on ventral surface. Spiracular disk squarely truncated, surrounded by five subequal lobes which are fringed with very short hairs. Head capsule massive, prefrontal sclerite very large, tapering to a point behind. Labrum large, conspicuous, with tufts of hairs. Mandible slender; ventral cutting edge with five teeth; a tuft of hairs on prosthecal region. Maxilla simple; palpus large. Antenna very small; basal segment subglobular, with two apical sensory papillae. Mentum not deeply divided behind; outer plate with three apical teeth; inner plate adding three additional teeth to each side. Hypopharynx not chitinized.

*Pupa*.—Cephalic crest small, setae tiny. Pronotal breathing horns long, tapering to subacute, flattened apices. Wing sheaths ending opposite base of third abdominal segment. Leg sheaths ending at about midlength of sixth abdominal segment. Abdominal segments on tergites and on apical sternites with transverse bands of microscopic points, producing a shagreened appearance; dorsal spiracles on segment 8 conspicuous.

The genus *Ula* includes only six described species, of which three are European, two are North American, and one is Javanese.

The adult flies of the American species are commonest in spring and late summer. They frequent cool, shaded gorges and ravines, or dark woods in mountainous regions, and may be swept from beds of low vegetation, such as ferns, yew, and other species.

The larvae of all the known species live in various species of fungi, but go to earth for pupation.

In Europe the common genotype, *Ula macroptera* (Macq.), has been discussed rather frequently in the literature. Stannius (1829:205) found the larvae in a species of *Agaricus*. Perris (1849:337-341) furnishes a brief account of the species, from which the following notes are taken: The fungus in which the larvae were found was *Hydnum erinaceum* Bull., growing on the trunks of living oak trees. The larvae are gregarious and frequent galleries in the fungus, along which they progress by means of their mandibles, by their ambulatory feet, and by the short hairs that cover the body. They were found in the month of November. A month later they went into the earth, where they transformed as pupae. The pupae bear a strong resemblance to those of *Limnophila*, but differ in the shape of the pronotal breathing horns. In February and March the pupae come to the surface of the earth and the adults emerge. The

caudal end of the larva is described as having but four lobes; no mention is made of the median dorsal lobe found in the American species, and it is presumably lacking or very reduced in size. Pierre (1919-20:76) has reared this species from larvae living in *Russula nigricans* Fries.

Another European species, *U. bolitophila* Loew, was bred from larvae living in fungi on beech trees in Austria (Loew, 1869:4-5).

In America, the immature stages of *Ula elegans* have been discussed by the writer (Alexander, 1915a), the notes given below being in part supplementary to his earlier account.

### *Ula elegans* O. S.

1869 *Ula elegans* O. S. Mon. Dipt. N. Amer., part 4, p. 276-277.

*Ula elegans* is a rather common species in mountainous regions thruout the northeastern United States. The adult flies swarm in early spring and again in the fall. At Ithaca, New York, on May 14, 1912, the writer found them swarming at half past four in the afternoon. There were about fifteen to twenty individuals in a swarm within a foot or two of the ground. In some cases the swarms were reduced to two or three individuals, or in a few instances to a single specimen. In copulation the flies rest on the upper surface of near-by plants (*Symplocarpus*, in the instance cited), with all the legs on the support. Copulation is rather firm, and the insects fly for short distances still united. The only crane-fly associated with *Ula* at that time was *Limnophila ultima* O. S.

On September 15, 1912, the writer found a fleshy species of fungus (*Fomes*) growing on a much-decayed stump close to the ground. This fungus contained a number of crane-fly larvae, including about thirty-five larvae of *Limnobia cinctipes*, a lesser number of *L. triocellata*, and many larvae of *Ula elegans*. The larvae of these species frequented the upper layers of the mushroom and had reduced the surface to a semi-liquid state. At the end of a week the whole fungus was reduced to a very decayed condition. The fungus, which was taken at Gloversville, New York, was then transferred to Ithaca, and was placed in large glass jars, with sand in the bottom to take up the liquids produced by decay and to provide a place for pupation. The first adults emerged on October 14. Emergence continued until the 27th, when the remaining pupae were killed and placed in alcohol. At that time they were very dark-

colored and evidently nearly ready to emerge to the adult state. At times the larval movements are very active and eel-like, but at other times they are very slow and sluggish. At each movement forward, the terminal segment partly telescopes into the subterminal and is thrown violently backward. After transforming to the adult condition, the pupal skin is left adhering to the sand, with the posterior half, or a smaller portion, attached, often standing quite perpendicular to the surface and very conspicuous.

*Larva*.— Length, 8.5–11.9 mm.  
Diameter, 1.4–1.8 mm.

Color dull white; head capsule very dark brownish black.

Form moderately slender (Plate XXXIV, 145), but the body not greatly elongated as in the Eriopterini and some Limnobiini. Integument covered with a fine, short pubescence. Abdominal segments 2 to 7 each divided by a constriction into a narrow basal annulus and a broad posterior annulus; basal ring at about midlength and at the end with narrow transverse rows of tiny setae; abdominal segments 2 to 7 on ventral surface of basal ring with conspicuous raised transverse creeping-welts which are covered with microscopic points; eighth abdominal segment suddenly constricted before spiracular disk. Region around anus protuberant, this evidently being an aid to propulsion. Spiracular disk (Plate XXXIV, 153) surrounded by five blunt lobes, of which the dorsal one is median in position and blunter than the others; inner face of each lobe with a conspicuous brownish black mark; a fringe of delicate blackish hairs surrounding disk, these hairs a little longer and more prominent at ends of lobes. Spiracles almost circular, widely separated, the distance between them being about three times diameter of one spiracle. Disk between spiracles with an indistinct arcuated line.

Head capsule (Plate XXXIV, 146) massive and compact, rather narrow, posterior incisions not extending deeply into capsule. Prefrons very large, tapering gradually to a sharp point behind; numerous setae on prefrons and on other sclerites of capsule. Labrum (Plate XXXIV, 147) large, conspicuous; epipharynx and lateral margins strengthened by narrow bands of chitin; lateral and anterior margins of labrum with a dense fringe of long hairs; an irregular tubercle on dorsal surface on either side of labrum; epipharynx with a narrow transverse band of setae; juncture of clypeus and labrum with four setiferous punctures, two on either side, the posterior pair a little the closer together; clypeal region with a dark transverse basal and terminal band; base of clypeus with three setiferous punctures on either side. Mentum (Plate XXXIV, 148) almost completely undivided, the usual median split obliterated except behind; outermost mental plate terminating in three apical teeth, the median one of which is a little shorter and broader than the other two; behind (dorsad of) outer plate, another similar plate which adds three more teeth to each side of mentum. Hypopharynx not chitinized. Antenna (Plate XXXIV, 149) very small, short, cylindrical or subglobular, about as broad as long; at the tip two hyaline papillae shaped like immature mushrooms, the outer one about twice the size of the inner one. Mandible (Plate XXXIV, 150 and 151) slender, ending in a blunt, slightly curved, apical point; on ventral cutting edge a row of about five flattened

teeth; the more apical ones larger, the basal one very broad and truncated; two or three dorsal teeth, gradually lessening in size from tip of mandible toward base; two conspicuous tufts of long setae at prosthecal region; base of mandible on dorsal side with a large, somewhat curved, plate overlying head sclerites. Maxilla (Plate XXXIV, 152) with cardo long and narrow, transverse, with three conspicuous setiferous punctures bearing long setae; outer lobe short and stout, a little narrowed to tip; palpus rather large, flattened, disklike, the truncated apex with several tiny hyaline pegs; inner lobe with a sensory bristle and an inner fringe of rather short hairs.

*Pupa*.—Length, 6.4–7 mm.

Width, d.-s., 1.2–1.3 mm.

Depth, d.-v., 1.2–1.6 mm.

Mouth parts, wing sheaths, and leg sheaths rather dark brown; thoracic dorsum and abdomen light yellowish brown; pronotal breathing horns dark brown, passing into light yellow on apical third or quarter; mesonotal prescutum retaining its light color even in old pupae and those preserved in alcohol.

Cephalic crest (Plate XXXV, 155) represented only by a small bilobed protuberance behind and between antennal bases, each lobe tipped with a very tiny seta. Labrum short, bluntly rounded at tip. Labial lobes appearing as a large, roughly quadrate plate, a little narrowed behind and with all angles rounded. Sheaths of maxillary palpi very long and slender, rather stout at base, tapering to blunt tip. Antennae not conspicuous, rather widely separated at bases, ending just before or opposite origin of wing pad.

Pronotal breathing horns (Plate XXXV, 154 and 155) long and conspicuous, cylindrical, gradually tapering to subacute and flattened apices; horns directed laterad and cephalad, widely divergent. Thoracic dorsum without lobes or spines. Wing sheaths extending to just beyond end of second abdominal segment. Leg sheaths extending to about midlength of sixth abdominal segment; tarsal sheaths ending almost on a common level, the fore legs being a very little the longest, the middle legs a little shorter. Abdominal tergites with transverse rows of scattered punctures; on tergites 2 to 6 a transverse band of subchitinized points, producing a shagreened appearance; these bands located on basal rings of segments excepting the last two, which are on extreme ends of segments 5 and 6; on sternites the bands appearing only on segments 7 and 8, the other sternites being largely concealed by the unusually long leg sheaths; band on segment 8 very broad, but narrowly interrupted medially. Male cauda with ventral lobes bluntly rounded and inclosing pleural appendages of adult (in fully colored pupae these show thru the pupal skin as from twelve to fifteen strong, chitinized points on the inner posterior face); dorsal lobes (Plate XXXV, 157) very short and blunt, and closely approximated medially; on eighth tergite a broad rectangle of five lobes, including an anterior and a posterior lobe on either side and a much broader anterior median lobe; just proximad of anterior lateral lobes a large and distinct spiracle, in the cast skin with the large tracheal trunks still attached. Female cauda (Plate XXXV, 156) stout, tergal valves a little longer than sternal valves and a little upcurved.

*Nepionotype*.—Ithaca, New York, October 14, 1912.

*Neanotype*.—With type larva.

*Paratypes*.—Type locality, October 12 to 19, 1912.

Subtribe **Epiphragmaria**

So far as is known to the writer, the division *Epiphragmaria* includes only the genus *Epiphragma*. The immature stages are of a very primitive organization. The larvae have the head capsule broad and massive, with the posterior incisions very shallow. The labrum is broad, with lateral tufts of hair. The mentum is heavily chitinized, entire, with only a single lateral tooth on either side of the median tooth. The hypopharynx is not chitinized but the entire surface is provided with rows of tiny spinous points, somewhat as in the *Dicranoptycharia*. The antennae have the terminal papillae hemispherical. The mandibles are not greatly elongated; each has an apical tooth and two rows of lateral teeth. The maxillae are very simple in structure. The abdomen is provided with six ventral creeping-welts. The spiracular disk is large and simple, with the lobes short and obtuse.

The pupa has the breathing horns heavily chitinized, tapering to acute, slender points. The spiracles on the dorsum of the eighth abdominal segment are large and conspicuous.

The relationships of this group are obviously with the *Rhamphidaria* of the *Limnobiini* and the *Ularia* of the *Hexatomiini*, the three groups probably being closer together phylogenetically than their arrangement in tribes would indicate. From a study of the adults alone, there seems to be little connection between the genera *Rhamphidia*, *Epiphragma*, and *Ula*, which were placed in three widely separated tribes by Osten Sacken. A study of the immature stages, the structure of the larval head, the abdominal creeping-welts, and the dorsal spiracles of the eighth abdominal segment of the pupa, indicate a relationship that cannot be denied.

Genus **Epiphragma** Osten Sacken (*Gr. upon + partition*)

1859 *Epiphragma* O. S. Proc. Acad. Nat. Sci. Phila., p. 238.

*Larva*.—Body nearly smooth; basal annuli of abdominal segments 2 to 7 with a naked transverse creeping-welt on ventral surface. Spiracular disk large, with four or five lobes, the dorso-median lobe often reduced. Spiracles large, circular. Anal gills four, retractile. Head capsule massive. Labrum broad, with lateral tufts of hairs and with two setae on anterior margin. Mandible with a blunt apical tooth and two rows of two lateral teeth. Maxilla small, simple; palpus large; inner lobe with a dense tuft of stiff hairs. Antenna two-segmented; basal segment elongate, apical papilla hemispherical. Hypopharynx not chitinized. Mentum entire, with only three teeth — a slender median tooth, and a broad, fat tooth on either side.

*Pupa*.—Cephalic crest erect, rectangular, the outer lateral angles produced into strong, chitinized spines. Pronotal breathing horns large at base, the elongate tips nearly chitinized, tapering into subacute points. Wing sheaths ending opposite base of third abdominal segment. Leg sheaths terminating just before end of fifth abdominal segment. Abdominal tergites with a transverse band of spicules at caudal margin; pleurites with a transverse oval area of similar spines; terminal sternites with a similar transverse band of spicules, most powerfully developed on segment 8; dorsal spiracles on segment 8 conspicuous.

*Epiphragma* is a rather small genus (twenty-five species) of usually large and handsome crane-flies, finding its center of distribution in the tropical regions of the New World. The adult flies of the local species are usually common. *Epiphragma fascipennis*, the best known of these species, is often found swarming in shady places, the swarms usually consisting of from twelve to fifteen individuals.

The immature stages of all the species thus far known are spent in decaying wood. In Europe, Beling (1873 b:589-590) records finding larvae and pupae of *E. picta* (Fabr.) in decaying ash (*Fraxinus*) and beech (*Fagus*) in the spring. He gives the pupal duration of this species as about two weeks. Needham (1903:281-285) gives an excellent account of *E. fascipennis*, which he found in partly decayed stems of willow and button-bush. The same species has been found living in the stems of black ash and elm. *E. solatrix* has been found in various deciduous trees in a dead or decaying condition. Bruch (*in litt.*) records an Argentinian *Epiphragma* from decaying wood.

*Epiphragma solatrix* (O. S.)

1859 *Linnophila* (*Epiphragma*) *solatrix* O. S. Proc. Acad. Nat. Sci. Phila., p. 238.

*Epiphragma solatrix* is a beautiful crane-fly, a little more Austral in its distribution than the more widely distributed *E. fascipennis*. H. S. Barber found larvae and young pupae very numerous in a drift log of sycamore (*Platanus*) at Plummers Island, Maryland, on May 19, 1913, and it is the study of this material that is included in this paper. Shannon found larvae in rotten wood at Rosslyn, Virginia, on November 23 and 25, 1912, and a pupa on January 3, 1913. Later he reared both *E. solatrix* and *E. fascipennis* from larvae taken from the same log on the same day. The species was again found in a decaying maple log on the Potomac River opposite Plummers Island, Maryland, where it was associ-

ated with the larvae of the syrphid fly, *Temnostoma bombylans* (Fabr.) and the supposed larva of *Protoplasa* (p. 770).

*Larva*.— Length, 18 mm.  
Diameter, 1.6 mm.

Coloration pale whitish; anterior segments of body brighter-colored, more reddish.

Form stout and plump, not narrowed at ends of body. Pronotum longer than other thoracic segments. Integument covered with a short appressed pubescence. Abdominal segments 2 to 7 with conspicuous white creeping-welts on ventral surface of basal ring; these welts not interrupted medially, and entirely naked. Spiracular disk (Plate XXXVI, 163) large, unmarked, surrounded by five short lobes, the ventral pair very widely separated; dorsal lobe broad and obtuse; entire disk fringed with very short, delicate hairs which are interrupted only between paired lobes; inner face of lobes suffused with pale brown at tips. Spiracles large, circular, reddish with a very broad yellow margin, separated by a distance nearly equal to two times the diameter of one spiracle. Anal gills four, retractile.

Head capsule (Plate XXXVI, 158) broad and massive, the constituent plates firmly united except on ventral parts. Labrum broadly transverse; a median epipharyngeal part whose surface is finely pitted, bearing on ventral side near margin two stout setae; lateral angles of labrum directed proximad and densely tufted with hairs; extreme lateral margins of labrum with a curved hyaline seta; juncture of labrum and clypeus with two large setiferous punctures on either side; a few setiferous punctures on head capsule. Mentum (Plate XXXVI, 159) heavily chitinized, the outer face terminating in a single median tooth, behind which is a tridentate plate with three flattened teeth, the lateral ones very broad. Prementum (Plate XXXVI, 160) lying just behind mentum, a moderately broad transverse plate whose anterior margin is deeply and almost squarely notched, the lateral lobes thus formed being rounded or feebly indented at their tips. Hypopharynx (Plate XXXVI, 161) lying above and connected with prementum, consisting of a large flattened lobe, whose outer margin is evenly rounded, the surface densely set with longitudinal rows of small, subacute papillae. Antenna short, two-segmented; basal segment cylindrical, with auditory plate almost basal in position; apical segment small, subglobular or hemispherical. Mandible moderate in size, broad at base with a blunt apical tooth and a few blunt lateral teeth, two on dorsal cutting edge and two on ventral cutting edge, the more basal of these latter tending to be evanescent; two stiff setae at heel of mandible; a triangular lobe on dorsal face which projects onto lateral parts of labrum. Maxilla (Plate XXXVI, 162) primitive in structure; cardo elongate, transverse, with four setiferous punctures bearing powerful setae; outer lobe glabrous, with palpus at its tip; palpus slightly elongate, the auditory plate just before midlength; a seta on outer lobe below palpus; inner lobe of maxilla with a dense terminal brush of stiff yellow hairs and a few sensory papillae.

*Pupa*.— Length, 12–12.5 mm.  
Width, d.-s., 2–2.1 mm.  
Depth, d.-v., 2–2.1 mm.

Head, thorax, and appendages brown, becoming darker with age; pronotal breathing horns light red; abdomen whitish, the terminal rows of spicules on the segments chitinized.



(In older specimens the wing pattern shows on the sheath and is not distinctly fasciate as in *E. fascipennis*.)

Cephalic crest (Plate XXXVII, 166) erect, rectangular, the outer lateral angles directed ventrad and laterad as powerful chitinized spines, which in most cases curve outward; a stout seta beneath each spine. Labrum subtruncated or indistinctly bilobed at apex. Labial lobes triangular, projecting caudad as two cones. Maxillary palpi bent backward, lying along margin of cheek, stout, tapering suddenly to blunt tips. Checks projecting as flattened ledges. Antennae moderate in length, on scapal segment with a flattened tubercle on either side of cephalic crest; antennae extending rather far beyond wing root.

Pronotal breathing horns (Plate XXXVII, 164) with base enlarged, the elongate, subchitinized tips gradually narrowed, and the extreme apices subacute; breathing horns at tips directed ventrad and proximad; a truncated setiferous tubercle before each breathing horn. Mesonotum very deep. A short, but high, median crest behind breathing horns. Lateral angles of thorax produced into a slender lobe bearing a stout seta at tip. Wing sheaths ending opposite base of third abdominal segment. Leg sheaths terminating just before end of fifth abdominal segment; middle tarsal sheaths usually a little shorter than the others; in some specimens, especially females, fore legs the shortest, hind legs the longest. Abdominal segments (Plate XXXVII, 167) with two narrow basal rings and a broader posterior ring. Tergites on segments 2 to 7 near caudal margin of posterior ring with a narrow transverse crossband densely beset with acute spicules; on posterior segments these bands becoming gradually weaker, on segment 7 being very weak; two setae near lateral margin of posterior ring at about midlength. Pleurites with a transverse oval area with about twenty sharp spines near caudal margins of segments; a stout seta lying cephalad of this area. Spiracles distinct, oval, lying on ventral cephalic part of pleural posterior ring; a seta near dorsal margin of second basal ring. Sternites with a transverse band of spicules on segments 5 to 8, these being weakest on segment 5 at ends of tarsal sheaths and very strong and powerful on segment 8, where the band is interrupted medially; band often rather narrow but sometimes much broader. A seta near midlength of posterior ring on either side. Male cauda (Plate XXXVIII, 170) with dorsal lobes very stout, globose at base but soon narrowed into slender cylindrical appendages, each bearing three setae at tip; viewed from above, these lobes are seen to be separated by a wide U-shaped notch; ventral lobes blunt and with a flattened depressed disk at base of incision; eighth segment with a wide rectangle of lobes, two posterior lobes that are weakly setiferous and two smaller anterior lobes with a large spiracle proximad of each. Female cauda (Plate XXXVIII, 171) with tergal valves a little longer than sternal valves, upcurved, and with a stout seta before tip.

*Nepionotype*.—Plummers Island, Maryland, May 19, 1913.

*Neanotype*.—With type.

*Paratypes*.—Larvae and pupae with type.

### *Epiphragma fascipennis* (Say)

1823 *Limnobia fascipennis* Say. Journ. Acad. Nat. Sci. Phila., vol. 3, p. 19.

1859 *Limnophila* (*Epiphragma*) *pavonina* O. S. Proc. Acad. Nat. Sci. Phila., p. 239.

1869 *Epiphragma fascipennis* O. S. Mon. Dipt. N. Amer., part 4, p. 194.

*Epiphragma fascipennis* is a very common crane-fly thruout eastern North America. As already stated, the immature stages are spent in decaying or partly sound wood, a wide variety of deciduous trees and shrubs being chosen, such as willow, elm, ash, buttonbush, and others. Needham gives the pupal duration as about twelve days, larvae and pupae found on May 18 emerging as adults on the 30th. A fully grown larva that the writer found in a decayed log beneath moss at Ithaca, New York, on May 8, 1917, pupated early in the morning of the 10th. The specimen died on the 18th, when about to emerge, and this would give a much shorter pupal period than is generally recorded for the genus. It was noted at the same time that the larva superficially resembles the larva of the lepid fly *Chrysopila thoracica* (Fabr.), with which it was associated but from which it is easily distinguished by its massive head capsule.

Needham found abundant pupae in a decaying log of black ash (*Fraxinus*) near Freeville, New York, on May 6, 1915. The pupae occurred in burrows in the semi-decayed wood. Adults emerged on the 11th. Additional material was found at Mud Creek, near Freeville, on May 15, 1915, in elm (*Ulmus*).

The account of the habits of the larvae as observed in Illinois by Needham (1903:281-285) is here quoted in part:

The larvae bore in the dead and fallen stems of buttonbush and willow, where these lie on the mud at the borders of shallow ponds. I found them always in stems that were still partially sound, tunneling beneath the bark or even into the deeper parts and into the sounder wood. These stems are frequently submerged in spring and autumn, and even in summer, when the pond has gone dry, they are always saturated with moisture. . . .

The most interesting thing about the larva, aside from its wood-boring habits, is its singular adaptation to amphibian life. It must needs live part of the time wholly submerged beneath the waters of the pond, and part of the time out on land; it has, therefore, both open spiracles and tracheal gills; and, moreover, its tracheal gills are so placed that they may be withdrawn into the body in a dry time, where they escape the ills of too rapid evaporation.

In his description of the immature stages, Needham points out a probable error of Beling in describing a sexual dimorphism in the larvae of a species of this genus — Beling stating that the larvae producing females have three caudal lobes while those producing males have five. Malloch (1915-17 b:224-225) cites Needham's descriptions of this species.

*Larva*.—(No larvae are available to the writer for a comparison with this stage of *Epiphragma solatrix*, but from Needham's characterization, and manuscript notes on specimens taken at Ithaca, New York, by the writer, the following differences seem to hold):

Spiracular disk surrounded by but four lobes, the dorso-median lobe being very reduced; inner faces of these lobes, as well as disk itself, entirely unmarked with darker.

*Pupa*.—Similar to pupa of *Epiphragma solatrix*, but differing as follows:

Cephalic crest (Plate XXXVII, 165) low, the lateral horns shorter, not elevated, and directed ventrad or slightly downward; setae on lateral face of spines often projecting above (cephalad of) it. Pronotal breathing horns shorter and stouter than in *solatrix*. Spines on eighth abdominal sternite widely separated or interrupted on median line. Male cauda (Plate XXXVIII, 169) with dorsal lobes much stouter than in *solatrix*.

*Neotype*.—Bool's hillside, Ithaca, New York, May 8, 1917.

*Paratype*.—Pupa, Mud Creek, Freeville, New York, May 15, 1915.

The type pupa has one of the pronotal breathing horns deformed and bent caudad so as to be appressed against the body. Needham, who has a very much larger series available for study, notes this same peculiarity when he states that "a crumpled horn on one side is of rather common occurrence" (Needham, 1903:284).

### Subtribe *Pseudolimnophilaria*

As at present constituted, the division *Pseudolimnophilaria* includes the single genus *Pseudolimnophila*, but other groups may be added to it when the immature stages of other species of the old genus *Limnophila* are made known. The larva is of a distinctly primitive type, the head capsule being compact and massive, the mentum chitinized and completely divided, each half provided with seven or eight teeth. The hypopharynx is a heavily chitinized semicircle with numerous teeth around the anterior margin. The antennae bear two elongate apical papillae. The mandibles each have two blunt apical teeth and two rows of lateral teeth.

The pupa is similar to that of the *Limnophilaria*, but the abdominal segments have transverse rows of setiferous tubercles.

The larva shows many points of resemblance to the tribe *Limnobiini*, and the two groups are probably derivable from an immediate common ancestor.

### Genus *Pseudolimnophila* Alexander (Gr. *false* + *Limnophila*)

1919 *Pseudolimnophila* Alex. Cornell Univ. Agr. Exp. Sta., Mem. 25, p. 917.

*Larva*.—Body covered with delicate appressed hairs and numerous erect setae. Spiracular disk surrounded by four lobes, the ventral pair very long and narrow, with long fringes of hair. Gills four, long and slender. Head capsule massive, the sclerites large, fused.

Mandible short and blunt, of the generalized limnobiine type, the two apical teeth blunt. Maxilla not greatly projecting. Antenna slender, with two elongate apical papillae. Hypopharynx a chitinized band, with numerous teeth along anterior margin. Mentum completely divided, each half with about seven teeth.

*Pupa*.—Cephalic crest tipped with long setae. Pronotal breathing horns elongate, tips deeply split into divergent flaps. Abdominal segments with transverse rows of setiferous tubercles, there being five such rows on the tergites and six on the sternites. Lateral spiracles protuberant.

The name *Pseudolimnophila* was proposed for a certain group of the old genus *Limnophila*, including *L. luteipennis* and its allies. The adult flies closely resemble species of *Limnophila*, but the immature stages are very different and of a distinctly more generalized type.

The larvae are herbivores, with the mentum heavily chitinized, completely divided into two halves, the margin conspicuously toothed, the hypopharynx heavily chitinized and with numerous teeth, and the mandibles short and blunt and with many obtuse teeth. The points of resemblance to the *Limnobia* type are numerous, and the head capsule shows few features in common with *Limnophila*, in the restricted sense. The pupae have the abdomen with numerous transverse rows of setiferous tubercles bearing long setae. The genotype is *Limnophila luteipennis* O. S., of eastern North America. Other species referable to this genus are *L. inornata*, *L. contempta*, *L. nigripleura*, and *L. noveboracensis*, of the Nearctic fauna; *L. lucorum* (Meig.), of Europe; and *L. frugi* Bergr., *L. claduroneura* Speis., *L. natalensis* Alex., *L. spectabilis* Alex., and several other species, of the Ethiopian fauna.

Hart (1898 [1895]:202-204) describes the habits of *P. luteipennis* in some detail. Larvae about half grown were found on March 17, 1895, these attaining their growth and pupating on April 13. Hart ascertained by dissection that the species is a herbivore, feeding on fragments of dead vegetation, numerous diatoms of many species, and minute algae.

As in many species of the *Limnophilaria* and a few other groups of crane-flies, the spiracular lobes are fringed with long, delicate hairs which spread out on the surface film of the water into broad fans. The larva is unable to release itself from the hold of the water except by looping the head and the anterior end of the body around the posterior end, and drawing the latter thru this loop, repeating this action until the hairs have gone below the level of the film.

It is probable that other groups of species of the old genus *Limnophila* will be found to deviate from the characters of this group as now restricted. Species such as *L. hyalipennis* (Zett.), *L. nemoralis* (Meig.), and others in Europe, and *L. brevifurca*, *L. emmelina*, *L. mundoides*, *L. toxoneura*, *L. ultima*, and similar anomalous forms in America, should be investigated critically when opportunity offers.

*Pseudolimnophila luteipennis* (O. S.)

1859 *Limnophila luteipennis* O. S. Proc. Acad. Nat. Sci. Phila., p. 236.

*Pseudolimnophila luteipennis* is one of the most abundant species of the tribe, and is very widely distributed thruout eastern North America. The adult flies are common in swamps and along the marshy edges of streams and ponds. The immature stages are characteristic swamp inhabitants. They have been described in detail by Hart (1898 [1895]: 202-204). Malloch (1915-17 b: 222-223) adds several supplementary notes and figures of Hart's material.

*Larva*.—Length, 15-18 mm.  
Diameter, 1.5-1.7 mm.

Coloration light brownish yellow, slightly darker toward posterior end of body.

Body covered with a delicate appressed brownish pubescence and abundant stiff bristles and erect hairs on each segment, arranged in about five transverse rows; these bristles more numerous, coarser, and blacker, on posterior segments, forming a large tuft on sides of penultimate segment of body. Spiracular disk (Plate XXXIX, 176) surrounded by four lobes, the posterior pair very long and slender, finger-like, the lateral pair much shorter but slender; the inner face of these lobes with brownish black or dark brown transverse lines which cover almost the entire face; an arcuate line extending from ends of ventral marks across disk between spiracles; two small triangular marks located between ventral lobes; lobes fringed with long, delicate hairs, those at ends very elongate, those toward base of lobes shortened but continuous around disk. Anal gills four, very long and slender, exceeding ventral lobes of spiracular disk.

Head capsule short and stout, exhibiting a very generalized condition. Prefrons very broad, only slightly narrowed behind and but slightly exceeding lateral plates. Labrum broadly transverse, with a large tuft of hairs on either side. Mentum (Plate XXXIX, 172) completely divided, each half with seven (or rarely eight) teeth along anterior margin, of which the third (or fourth) from the inside is the largest; a flattened lobe just laterad of each half of mentum; mental plates continuous behind with strong lateral plates of capsule; in a normal position the two halves of mentum overlying each other to a greater or less degree. Hypopharynx (Plate XXXIX, 173) with anterior margin broadly rounded, with numerous (from ten to fifteen) bluntly rounded teeth. Antenna slender, with two long apical papillae. Mandible (Plate XXXIX, 175) short and broad, of the generalized limnobiine

type; tips blunt, ending in two large approximated teeth, with a row of smaller lateral teeth extending basad of each; ventral cutting edge with about four such lateral teeth, dorsal edge with one or two much larger teeth; two strong setae near base of scrobe, and two others near tip of mandible; a large brush of hairs at prosthecal region. Maxilla not projecting, with dense brushes of short, stiff hairs and with two short sensory tubercles which are tipped with very elongate setae; palpi stout and chitinized at base, the apex narrowed and pale.

*Pupa*.— Length, 10–13 mm.

Width, d.-s., about 1.5 mm.

Thorax reddish brown to black in color, depending on age of specimen; abdomen dirty whitish with narrow transverse brownish lines, both above and below; pronotal breathing horns dark brown or blackish.

Form subcylindrical, abdomen slightly depressed. Cephalic crest of two slender tubercles behind, tipped with long setae; another pair of setae between antennal bases. Pronotal breathing horns elongate, transversely ringed, the tips widely and deeply split into two divergent flaps. Prothorax with a prominent median carina. A tubercle in front of each breathing horn, each with about four stout setae. Mesonotum above wing axil with a tubercle bearing three setae. Wings reaching end of second abdominal segment. Legs reaching end of third abdominal segment, the tarsi ending about on a level or those of fore legs a little longer than those of other two pairs.

Abdominal segments divided into two annuli, the basal one still further subdivided into annulets; on tergum three annulets, each bearing a transverse row of setiferous tubercles, the setae very long and conspicuous, in some cases the tubercles multisetose, third annulet with two widely separated, slender, elongate tubercles. Posterior annulus with a basal and a terminal transverse row of setiferous tubercles. On sternum, four transverse rows of setiferous tubercles on basal ring and two on posterior ring. On pleura, protuberant spiracles. Lateral angles of segment 8 jutting out into stout lobes which are densely studded with setiferous tubercles, on ventral face continued toward median line as a nearly straight row of about eight setiferous tubercles, on dorsum a finger-like lobe on either side. Male cauda (Plate XL, 178) with sternal valves shorter than dorsal lobes, blunt at tips; tergal valves acutely pointed, directed dorsad. Female cauda (Plate XL, 179 and 180) with tergal valves considerably longer than the more slender sternal valves, broad medially, tapering to the broad, blunt tips which terminate in blackened points; two setae on outer margin.

*Nepionotype*.— Larch Meadows, Ithaca, New York, April 20, 1917.

*Neanotype*.— Female pupa, with type. No. 19–1917.

*Paratypes*.— Larvae with type. Pupae of both sexes from Boob's hillside, Ithaca, New York, June 6, 1917. A female pupa, Orono, Maine, taken as a larva June 13, 1913, emerged June 22. Female pupa, July 15, 1913, No. 75–1913.

### *Pseudolimmophila inornata* (O. S.)

1869 *Limmophila inornata* O. S. Mon. Dipt. N. Amer., part 4, p. 219, 220.

*Pseudolimmophila inornata* is not so common as *P. luteipennis* but is found in similar situations. The immature stages are spent in rich organic mud. The only specimens that the writer has reared were taken in

Larch Meadows, near Ithaca, New York, on May 15, 1917, where they were associated with larvae of *Rhamphidia mainensis*, *Pseudolimnophila luteipennis*, *Tipula dejecta*, and other swamp-inhabiting species.

*Larva*.—Very similar to that of *P. luteipennis*, but body is darker and is conspicuously blotched with whitish, especially on posterior parts of ventral segments. Mouth parts nearly the same in the two species. Antenna (Plate XXXIX, 174) with two very long and slender terminal papillae, one blunt at tip, the other much longer and tapering gradually to tip.

*Pupa*.—Very similar to that of *P. luteipennis*, but somewhat smaller and darker-colored. Pronotal breathing horns (Plate XL, 177) darker brown, the divergent terminal flaps proportionately a little more elongate, equal to almost one-quarter length of entire horn. Dorsal lobes at base of ovipositor more attenuated.

*Nepionotype*.—Larch Meadows, Ithaca, New York, May 15, 1917. No. 53-1917.

*Neanotype*.—Larch Meadows, Ithaca, New York, May 25, 1917. No. 53-1917, cast pupal skin.

### Subtribe Dactylolabaria

The division Dactylolabaria is proposed for the genus Dactylolabis, a small group of curious crane-flies which are still not well understood. The adult flies bear a striking resemblance to species of the genus Limnophila, but the larvae and the pupae show characters that are not found in the more specialized divisions of the Hexatomini. The type of the genus is *Limnophila montana* O. S. of the eastern United States. Other Nearctic species included are *L. damula* O. S. (western United States), *L. rhicnoptiloides* Alex. (northwestern Canada), *L. cubitalis* O. S. (eastern United States), *L. nitidithorax* Alex. (western United States), and *L. hortensia* Alex. (western Canada).

The immature stages of two European species — *D. wodzickii* (Now.) and *D. denticulata* Bergr.— have been made known by Nowicki (1867: 340-343) and by Mik (1894), respectively. Their descriptions of the details of the larval head and the lateral spiracles of the abdomen of the pupa are incomplete, however. The larvae of none of the American species have as yet been made known, but the pupae of *D. cubitalis* O. S. were found by Needham and are described hereinafter.

### Genus Dactylolabis Osten Sacken (Gr. *finger forceps*)

1859 *Dactylolabis* O. S. Proc. Acad. Nat. Sci. Phila., p. 240.

*Larva*.—Body very depressed, the ventral surface, especially, being greatly flattened. Head capsule compact; mentum not completely divided, its anterior margin with seven teeth. Mandible with but few lateral teeth.

*Pupa*.—Somewhat similar to pupae of *Limnophilaria*. Pronotal breathing horns short and cylindrical. In some species, at least, second abdominal segment with a very large and prominent lateral spiracle.

*Dactylolabis* is a small genus including about thirteen known species which are about equally well distributed in Europe and North America.

*Dactylolabis denticulata* (Bergr.)

1891 *Limnophila denticulata* Bergr. Mittheil. Naturf. Ges. Bern, p. 132.

The present knowledge of the life history of *Dactylolabis denticulata* is due to the work of Mik (1894), whose paper is cited by other workers, among them Grünberg (1910:54-55).

Larvae and pupae were found on the dark brownish gray chalk cliffs near Steiermark on August 3, 1891. In certain places on the cliffs were broad or narrow bands of black. The larvae and the pupae were found along these dark bands and showed a decided resemblance to their surroundings. The surface of the rock was wet with dripping water, which supported a flora of lowly plant organisms on which the larvae presumably fed. The adherence of the pupa to the last larval skin is of interest since it presumably aids in the emergence of the adult. A similar condition is found in *Cylindrotoma*.

*Larva*.—Length, 7 mm.  
Width, 2 mm.

Form very depressed (Plate XLI, 183), the ventral surface flattened, almost leechlike. Both dorsal and ventral surface provided with hairs, with longer and more numerous hairs on sides of body. Body covered with small, black, structureless particles of earth or excrement, more numerous near margins of dorsal surface, these particles lacking a definite arrangement and being very firmly attached to the body hairs; when particles are removed, larva is of a greenish gray color, subhyaline. Abdominal segments divided into two rings bearing long hairs which are more conspicuous on sides of body. Head capsule (Plate XLI, 182) small but compact, completely retractile within prothoracic segment. Labrum relatively large and semitransparent, the margins with long hairs; on dorsum on either side a long delicate seta. Mentum chitinized; anterior margin with seven teeth, behind median tooth a brush of hairs. Antenna two-segmented; basal segment cylindrical; second segment button-like, with apex pointed. Mandible three-toothed; a tuft of hairs at prosthecal region. Spiracular disk surrounded by two fleshy welts which are deeply incised medially to appear as four blunt lobes. Spiracles difficult to distinguish in a position of rest, elliptical, margined with blackish brown.

*Pupa*.—Length, 8 mm.  
Width, 1.75 mm.



Coloration blackish; abdomen dark greenish gray.

Pupa (Plate XLI, 181) attached to old larval skin, which in turn remains attached to rock surface. (Just before pupating, the larva sticks itself to the surface by means of its saliva.) Pronotal breathing horns cylindrical, a little swollen at ends. Sheaths of appendages dull and black in color. Leg sheaths attaining end of fourth abdominal segment.

*Dactylolabis wodzickii* (Now.)

1867 *Rhinoptila wodzickii* Now. Verh. Zool.-Bot. Ges. Wien, vol. 17, p. 337-354.

The species *Dactylolabis wodzickii* was first found in the high Alpine region of the Hungarian Tatra, at an altitude of from 6000 to 8000 feet, in a region frequented by the wall creeper (*Tichodroma*). Here the adults and the immature stages were found together on the granite cliffs where water dripped continuously, supporting a considerable algal flora. Associated with the species were other flies, *Liancalus virens* (Scop.) and *Clinocera fontinalis* Hal., as well as *Tricyphona schineri* (Kol.). The degenerate wings of the insects prevent their flying, and they probably live and die close to the place where the eggs are deposited. One fly was observed laying her eggs in the masses of algae in this situation. The larvae live in these masses and pupate in them.

*Larva*.—Length, 12.5 mm.

Width, 2.4 mm.

Dorsum of body dark greenish brown, with dark longitudinal brown stripes producing a curious pattern of straight and convergent lines; ventral surface almost white, unmarked.

Body depressed, flattened, abdominal segments divided into a narrow basal and a much broader posterior annulus. Head capsule (Plate XLI, 185) compact, massive. Mandible showing but a single inner tooth. Posterior abdominal annuli with two long setae on lateral margins. Spiracular disk (Plate XLI, 186) surrounded by four lobes, the ventral pair longer than the others; these lobes margined with darker chitinized lines and provided with fringes of moderately long hairs. Spiracles not described, and undoubtedly overlooked by the describer.

*Pupa*.—Length, 12.5-13.5 mm.

Width, 2.6 mm.

Color brown. Pronotal breathing horns short, cylindrical. Wing sheaths ending opposite middle of second abdominal segment. Leg sheaths ending beyond middle of third segment. Abdomen armed with rows of spines (Plate XLI, 184).

*Dactylolabis cubitalis* (O. S.)

1869 *Limnophila cubitalis* O. S. Mon. Dipt. N. Amer., part 4, p. 229.

*Dactylolabis cubitalis* is a local species, often occurring in great numbers. In the gorge of Fall Creek near the Cornell University campus this species

can be found in myriads by sweeping the rank herbage in May. The writer has never located the immature stages, but the species was reared by Dr. J. G. Needham at Ithaca, New York, on May 20, 1898. There is no record as to where these larvae occurred, but they are presumably mud-inhabiting forms, or possibly they frequent habitats similar to those described for the two preceding species.

*Pupa*.—Length of cast skin, about 12 mm.

Pronotal breathing horns (Plate XLI, 187) short, cylindrical, the tips scarcely enlarged. Mesonotum behind with a prominent rounded tubercle on either side of median line, which is set with two spines, a larger outer spine and a small inner spine. Wing sheaths ending opposite apex of second abdominal segment. Leg sheaths ending opposite apex of third abdominal segment, the tarsal sheaths terminating on a common level.

Abdominal segments divided into two rings. Tergites with posterior ring having a transverse row of elongate tubercles, there being about eight on segment 2, about six on intermediate segments (3 to 5), and about four on segments 6 and 7; these tubercles fleshy, but sparsely armed with chitinized spines. Basal ring unarmed. Pleura with a strong tubercle on each ring; a blunt but prominent spiracle at extreme base of posterior ring; this spiracle very prominent on segment 2 (Plate XLI, 188), much exceeding lateral tubercles and being about two-fifths length of pronotal breathing horns. Sternites with about six tubercles on posterior ring. Male cauda (Plate XLI, 189) with tergal lobes slender, running out into acute chitinized points, which are directed caudad, slightly divergent; dorsum of segment 8 with posterior lobes powerful, about equal in size to, or a little larger than, tergal lobes of cauda just described; anterior lobes small, directed caudad and laterad; two large lateral lobes and two smaller ventral lobes. Female cauda with tergal valves moderately elongate, stout, broad at base, narrowed toward tip, where they run out into long, chitinized points directed caudad and slightly dorsad.

*Neanotype*.—Cast pupal skin, Ithaca, New York, May 20, 1898.

*Paratype*.—Pupae, cast skins, with type.

### *Dactylolabis montana* (O. S.)

1859 *Linnophila montana* O. S. Proc. Acad. Nat. Sci. Phila., p. 240.

The species *Dactylolabis montana* is common and widely distributed throuth the northern United States. It is a characteristic inhabitant of rocky cliffs, where it rests in crevices on the almost vertical walls. The immature stages have long remained unknown, but during the spring of 1920 W. L. McAtee found a pupal skin and the teneral adult near Washington, D. C. Mr. McAtee writes that the pupa was found in the moss that covers the almost vertical north face of a cliff on Plummers Island; this moss is mostly shaded, and grows on a thin layer of black soil which, at that time of the year at least, is saturated with water. The

pupal skin was not in condition for study, but now that the larval habitat is known it is hoped that more material of the immature stages will become available.

### Subtribe *Limnophilaria*

The division *Limnophilaria* comprises a large and heterogeneous group of species which in their larval and pupal characters grade rather insensibly into the next subtribe, the *Hexatomaria*, altho the adults of the two subtribes are very distinct.

The larvae of the various species in the group *Limnophilae* are rather similar to one another. The head capsule is long and narrow, with the lateral plates very slender. The labrum is ample, with several sensory papillae and setae. The antennae (which are two-segmented in the subgenera *Phylidorea* and *Lasiomastix*, and probably also in *Dicranophragma* and others) bear at their tips, in addition to the usual elongate setae, an oval or elongate-oval papilla which is delicately sculptured. The mental region is feebly chitinized, and consists of two short longitudinal bars articulated at their cephalic ends with a transverse bar which functions as the mental plate; this bar, or plate, is usually delicately grooved with parallel striae, a type of articulation that allows for great distention of the gular region in feeding. The mandibles are powerful chitinized hooks bearing two or more acute or flattened teeth at about midlength. The outer lobes of the maxillae project far cephalad as pale flattened blades.

The spiracular disk, in the primitive condition, is squarely truncated and is surrounded by five subequal lobes which are fringed with rather short hairs. The dorso-median lobe is lost in most species, but the two pairs of lobes are more or less preserved in the other species known to the writer, altho the lateral pair is sometimes reduced to a mere fringe or tuft of hairs. The terminal fringes of the ventral lobes are often greatly elongated, and fanlike. The anal gills are four in number, retractile, and rarely conspicuous. As is usual in many mud- or sand-inhabiting species of *Tipulidae*, the larvae are capable of greatly distending the subterminal abdominal segment. This segment is often provided with numerous transverse rows of fine points, and its inflation assists in the larva's progression thru the soil.

The larvae of the group are carnivorous, and almost without exception are exceedingly agile and snakelike in their motions.

The pupae of the group *Limnophilae* have the pronotal breathing horns usually small, or at least not greatly elongated. The abdomen is often greatly depressed, with the lateral margins flattened and carinate and the segments incised. In the species of the subgenus *Phylidorea* the segments of the abdomen are armed with rows of long, slender spines.

The group *Ulmorphae* seems to be closely related to the other members of the division, but the immature stages present some curious conditions which it is difficult to correlate with the same structures in the group *Limnophilae*. The writer has removed a group of species from the old genus *Limnophila*, and has placed these in the genus *Pilaria* Sintonis.

In the larvae of the group *Ulmorphae*, the epipharynx and the maxillae are densely hairy. The maxillary lobes are slender. The mandibles are hinged at about midlength, the basal segment being concave on its inner face to receive the mandibular blade when in a position of rest. The mandibular blade has one, or sometimes two, elongate acute teeth at the base. The mental region is not chitinized. The spiracular disk is surrounded by four lobes, of which the lateral pair are often very reduced; the inner faces of the lateral lobes are capable of close approximation, so that when they are closely applied the spiracles are contiguous. The pupae have the pronotal breathing horns very elongate, with their tips split into two flattened divergent lobes, as in *Pseudolimnophila* and a few tipuline forms.

The following keys separate the genera and the subgenera of the subtribe *Limnophilaria*:

*Larvae*

1. Mental region not chitinized; maxillae and epipharynx fringed with conspicuous, long, golden-yellow hairs; mandibles hinged; head capsule with dorsal plate spatulate at its tip. (Group *Ulmorphae*, p. 869).....2
- Mental region a narrow, transverse, chitinized bar, finely striate; maxillae and epipharynx without conspicuous hairs; mandibles not hinged; head capsule not as described above. (Group *Limnophilae*, p. 858).....3
2. Length under 12 mm.; basal tooth of mandibular blade nearly half the length of blade.
 

*Ulmorpha* O. S. (p. 869)

 Length over 14 mm.; basal tooth of mandibular blade about one-third or less the length of blade.....*Pilaria* Sint. (p. 872)
3. Spiracular disk almost squarely truncated, surrounded by five subequal lobes producing an eriopterine appearance.....*Dicranophragma* O. S. (p. 861)
- Spiracular disk obliquely truncated, surrounded by two pairs of lobes of which the lateral pair are the shorter.....4
4. Mandibles with two or three acute teeth at about midlength; epipharynx with a circular area bearing two biarticulate papillae.....*Phylidorea* Bigot (p. 866)
- Mandibles with three or four flattened and truncated teeth along blade; epipharynx without papillae as above.....*Lasiomastix* O. S. (p. 863)

## Pupae

1. Pronotal breathing horns very long, cylindrical, the tips split into divergent flaps. (Group *Utomorphae*, p. 869).....2  
 Pronotal breathing horns not elongate-cylindrical. (Group *Linnophilae*, p. 858).....3
2. Abdominal segments with tubercles or spines only near posterior margins of segments. *Utomorpha* O. S. (p. 869)  
 Abdominal segments with three or four pairs of blunt, naked tubercles. *Pilaria* Sint. (p. 872)
3. Abdominal segments depressed, lateral margins flattened, carinate, segments deeply incised.....4  
 Abdominal segments not depressed nor incised; pronotal breathing horns bicolored. *Dieranophragma* O. S. (p. 861)
4. Abdominal segments with rows of acute slender spines; pronotal breathing horns very short, semicircular in outline, bluntly rounded at their tips. *Phylidorea* Bigot (p. 866)  
 Abdominal segments without such slender spines; pronotal breathing horns short, broad, slightly compressed, tips a little pointed.....*Lasiomastix* O. S. (p. 863)

Group *Linnophilae*Genus *Linnophila* Macquart (Gr. *swamp* + *friend*)

- 1834 *Linnophila* Macq. Suit. à Buff., vol. 1, Hist. Nat. Ins., Dipt., p. 95.  
 1854 *Phylidorea* Bigot. Ann. Soc. Ent. France, p. 456.  
 1861 *Linnomyia* Rond. Dipt. Ital. Prodr., vol. 4, p. 11.

*Larva*.—Form slender. Spiracular disk surrounded by five, or more commonly four, lobes, the ventral pair the longer and fringed with long, delicate hairs. Anal gills four, not conspicuous. Head capsule flattened, very dissected, with plates narrow. Mandible not hinged, curved, chitinized, on cutting edge with a few acute or flattened teeth. Maxilla with outer lobe produced into a flattened projecting blade. Antenna two-segmented, at its tip with a short or elongate-oval papilla which is delicately sculptured. Mentum a transverse chitinized crossbar which is finely grooved.

*Pupa*.—Cephalic crest setiferous. Pronotal breathing horns usually small, flattened, tips not split. Mesonotum convex or flattened above. Abdominal segments in some cases armed with tubercles or spines.

The genus *Linnophila* comprises a very extensive group of crane-flies (more than one hundred and fifty species), which are found in most parts of the world but are apparently more numerous in the temperate regions. The adult flies seem to be closely related, but the immature stages are so varied in structure as to make it appear that the group must be a heterogeneous one and the similarity of the adults a result of convergent evolution.

The adult flies may be found resting on rank vegetation. Several of the species (*Linnophila ultima*, for example) swarm in small groups of from fifty to sixty individuals, copulation taking place in the air, as is discussed more fully on page 711.

The immature stages of several species have been made known, but there are still very considerable gaps in the present knowledge. The larvae are among the most carnivorous of all crane-fly larvae. The feeble chitinization of the mental region allows for great distention, and oftentimes the prey of these larvae consists of forms that are nearly as large as the captors themselves.

The data regarding extra-American species may be summarized as follows:

*Limnophila bryobia* Mik (1881:205-206) was reared from moss, taken in the Auckland Islands, near New Zealand, in the summer (December to February) of 1874-75. The moss was dried and then placed in a temperature of from 12° to 15° Réaumur. In March of 1879 an adult fly appeared. This long interval of more than four years was supposed by Mik to have been passed by the insect as a larva, the dry moss furnishing the food. Possibly the eggs were carried over for a long period before hatching.

*Limnophila sinistra* Hutton, of New Zealand, has been discussed in some detail by Hudson (1920:33-34), who states that this species is common in most dense forests thruout the country. The larva inhabits fallen tree-trunks in an advanced state of decay, forming burrows between the soft, decayed part and the harder part of the wood. It is about 25 millimeters in length, cylindrical, tapering toward the head, which is very small, and furnished with two minute jaws and a pair of very short antennae. There are eleven visible body segments. The extremity of the last segment is truncate and deeply excavated, the concavity being protected by five converging spines, which can be spread out or drawn inward at the will of the insect. Pedal warts occur on the undersides of all the segments except the three immediately following the head and the terminal segment. The pupa is about 12 millimeters in length, and rather stout. The breathing horns are about one-third the length of the wing sheaths, and are moderately stout and strongly recurved. There are two dorsal rows of hooks on each exposed abdominal segment and one ventral row near the terminal extremity. The valves of the ovipositor are strongly recurved and very stout. The head and the thorax are dark brownish black, highly polished; the abdomen is grayish ochereous, darker in the middle; the ovipositor and the terminal segments of the posterior tarsi are reddish. The pupa rests in a burrow made by the larva near the surface of the log.

Edwards has decided that this insect and a few related species should be placed in a new genus. The affinities of the fly, to judge from the details supplied by Hudson, are with the *Epiphragmaria* rather than with the *Limnophilaria*, but until more details are forthcoming it cannot be definitely referred to that division.

*Limnophila (Phylidorea) ferruginea* (Meig.), of Europe, is closely allied to *L. adusta* (page 867), and is of especial interest as being the type of the subgenus *Phylidorea*. It was reared by De Meijere (1916:204-206) from larvae found living between saturated decaying leaves along the banks of watercourses. Further mention of the species is made under the discussion of the subgenus *Phylidorea* (page 866).

*Limnophila hyalipennis* (Zett.), of Europe, was found by Beling (1886:198-199) in piny woods, where the larvae live in old ant hills or in piles of earth thrown up by wagon wheels. The apparent lack of pupal breathing horns in this species is discussed on page 755. The European species *L. lineola* (Meig.) (Beling, 1879:54 and 1886:199-200), *L. nemoralis* (Meig.) (Beling, 1886:200-201), and *L. ochracea* (Meig.) (Beling, 1886:202) are all found in damp earth along the margins of woodland streams or in damp spots in the woods. Larvae of *L. dispar* (Meig.) were found by Perris (1849:331) living in the hard, withered stalks of an umbellifer, *Angelica sylvestris* Linn., where they hollowed out long passages in the pith. (This reference is cited by Mik, 1881:204, and by Osten Sacken, 1869:201-202.) *Limnophila pallida* Bel. was reared by Beling (1873a:557) from larvae living in a decaying ash trunk.

The reference to *Limnophila platyptera* Macq. given by Heeger (1854) is considered by Osten Sacken (1869:4, 202) to refer to a mycetophilid, probably *Bolitophila*.

The American species that are now known are considered in the following pages. In addition, *Limnophila unica* O. S. has been bred from larvae found in decaying wood.

It is very probable that some of the species listed above, as well as many of the limnophiline forms that are still unknown as regards their immature stages, will be found to belong to some one or other of the remaining divisions of the tribe, rather than to the *Limnophilaria* as here restricted. This group requires more careful study than does any other division of crane-flies.

(Subgenus *Dicranophragma* Osten Sacken)

1859 *Dicranophragma* O. S. Proc. Acad. Nat. Sci. Phila., p. 240.

*Larva*.—Form short and stout. Spiracular disk surrounded by five short lobes, the ventral pair the longest, the dorsal lobe very blunt; disk surrounded by a fringe of delicate hairs which are longest at tips of lobes. Head capsule of the hexatomine type. Mandible powerful, prolonged into a strong hook with a large acute tooth just beyond midlength. Maxilla very long and slender. Mentum chitinized, consisting of a narrow transverse bar which is ribbed with fine parallel grooves.

*Pupa*.—Cephalic crest prominent, each half with three setae. Pronotal breathing horns short, cylindrical, or slightly narrowed to a blunt tip. Mesonotum convex, unarmed. Wing sheaths short, broad, ending before tip of second abdominal segment. Leg sheaths moderate in length, ending just beyond base of fourth abdominal segment, hind tarsi a little longer than the others. Abdominal segments divided into two rings; posterior ring with a subterminal transverse armature, on dorsum consisting of numerous setiferous tubercles, on pleura consisting of two or three groups of setiferous tubercles; basal ring with about eight slender tubercles on dorsal surface. Spiracles present, but evidently nonfunctional. Dorsum of segment 8 with four slender tubercles.

*Dicranophragma* is a well-defined group of the genus *Limnophila*, with about six known species whose center of distribution seems to be in the Oriental region. The type of the subgenus, *Limnophila* (*Dicranophragma*) *fuscovaria*, discussed in detail below, is the only described New World form. The immature stages are spent in rich organic mud in cool, shaded woods.

*Limnophila* (*Dicranophragma*) *fuscovaria* O. S.

1859 *Limnophila* (*Dicranophragma*) *fuscovaria* O. S. Proc. Acad. Nat. Sci. Phila., p. 240.

The adult flies of *Limnophila fuscovaria* may be easily distinguished by their broad, heavily spotted wings and the strong supernumerary crossvein in cell  $R_2$ . They may be swept from rank vegetation in cool, shaded woods. The larva has the body stouter and less elongate than is usual in this group of species, but it possesses the same snakelike movements as its near relatives. The pupal duration is not longer than eight days (June 8 to 16, in 1917).

*Larva*.—Length, 6.8-7.2 mm.  
Diameter, 0.7-0.8 mm

Coloration light golden-yellow; maxillary lobes yellow; spiracular disk lined with dark brown.

Body rather short and stout, not of the exceedingly elongate type of the Eriopterini, gradually narrowed to anterior end (Plate XLII, 190); prothoracic segment truncated anteriorly;



when head is retracted, tips of maxillae projecting from prothoracic orifice. Seventh abdominal segment with a transverse fringe of stiff hairs on the sides, these directed laterad and slightly caudad. Body noticeably constricted just before last segment. Spiracular disk (Plate XLII, 195) surrounded by five lobes, and in superficial appearance decidedly eriopterine rather than hexatomine; ventral lobes the longest but still much shorter than is usual in this tribe, slightly divergent, inner face with a double, V-shaped, dark brown mark, inner arm of V narrow, outer arm more expanded, especially at proximal ends, one large inner and two smaller outer sensory bristles at apex of V; lateral lobes narrow, with a V-shaped mark similar to that of ventral lobes but narrower and darker; dorsal lobe broad, the inner face indistinctly lined with parallel, dusky, longitudinal stripes; all five lobes surrounded by a fringe of long, delicate hairs lying just outside brown marks, these hairs longest at tips of lobes and continuous around disk. Spiracles circular, rather widely separated; ring broad, light yellow, narrowly margined outwardly with black. Anal gills four, short and stout.

Head capsule (Plate XLII, 191) very dissected, consisting of six elongate slender plates, three on either side, articulating at a point laterad of mental plate. Labrum (Plate XLII, 192) large; anterior margin indistinctly trilobed, the median lobe hairy; on the ventral, or epipharyngeal, surface, on either side, a slender cylindrical papilla, subhyaline, directed cephalad; sides of epipharynx with a tuft of long setae. Mentum chitinized, consisting of two lateral rods and an anterior transverse bar which is finely ribbed with parallel lines. Immediately dorsad of mentum two roughened papillae (prementum) directed cephalad; esophagus retrorsely roughened. Antenna (Plate XLII, 193) stout, in caustic-potash preparations almost hyaline, tipped with an elongate cylindrical lobe distad of which is a small setiferous tubercle with two long, delicate setae exceeding antennae in length. Mandible (Plate XLII, 194) powerful, very deep at base, produced into an acute, strongly curved tip; just beyond midlength a very large, acute tooth which is about one-third length of apical point, in its angle a small, hyaline, flattened, leaflike blade with a truncated apex; basad of large tooth two or three gradually smaller teeth. Maxilla with outer lobes stout, broad at base, gradually narrowed to tip, which is cut off by a constriction into a semi-oval structure; palpi on inner dorsal face of maxillary lobe at about midlength, short, semi-globular, with abundant sensory papillae; when head is completely retracted, the long, pale, slightly divergent tips of maxillary lobes projecting from orifice.

*Pupa*.—Length of cast skin, about 6 mm.

General coloration dark brown; pronotal breathing horns almost black, with apical fourth conspicuously light yellow; abdominal incisions pale.

Cephalic crest large and prominent, with three long setae on outer face. Labrum blunt at apex. Labial lobes with a blunt point on either side, these directed proximad and caudad. Maxillary palpi broad at base, suddenly narrowed to the long, cylindrical tip, which is darkened. Antennae rather short. Pronotal breathing horns (Plate XLIII, 196) stout, short, almost straight, broad basally, tapering gradually to the blunt tips. Wing sheaths very short and broad, ending before tip of second abdominal segment. Leg sheaths short, extending to just beyond base of fourth abdominal segment; all the tarsi ending about on a level, or outer sheaths a little the longer.]

Abdominal segments (Plate XLIII, 198) each divided into two rings by a false constriction, basal ring about two-thirds length of posterior ring. Basal ring on dorsum with a transverse row of about eight slender, blunt tubercles before caudal margin; on pleura a similar but larger tubercle opposite basal ring, this tipped with a long, delicate seta. Sternum unarmed. Posterior ring on dorsum with a subterminal row of blunt tubercles, simple or bifid, often approximated or crowded, bearing one or two long setae; near base of tergum, opposite spiracle, a setiferous tubercle; on pleura, opposite base of posterior ring and nearer dorsum than sternum, a vestigial spiracle with a double setiferous tubercle ventrad of it; near caudal margin of pleura two or three compound multisetose tubercles (Plate XLIII, 197) or aggregations of simple tubercles, which are largest on seventh segment. On sternum, two slender tubercles on either side, near base of posterior ring. Female cauda (Plate XLIII, 201) elongate, with the tergal valves a little longer than the sternal valves; each of tergal valves with a small tubercle at base. Male cauda (Plate XLIII, 199 and 200) with the ventral lobes blunt, the dorsal lobes a little longer and ending in an acute point; a tiny tubercle on either side at base of dorsal lobes. Dorsum of segment 8 with a trapezoid of four conspicuous lobes ending in truncated tubercles; anterior pair of lobes smaller and a little more widely separated than posterior pair.

*Nepionotype*.— Ithaca, New York.

*Neanotype*.— Ithaca, New York, May 31, 1917. No. 57-1917.

*Paratypes*.— Pupal skins, June 11, 1917 (No. 99-1917), June 16, 1917 (No. 132-1917).

Abundant larvae, with nepionotype.

#### (Subgenus *Lasiomastix* Osten Sacken)

1859 *Lasiomastix* O. S. Proc. Acad. Nat. Sci. Phila., p. 233.

*Larva*.— Body slender, with pencils of stiff setae on lateral margins of thorax. Spiracular disk with four lobes, the ventral pair a little the longer and bearing a fringe of long, delicate hairs, these about twice length of lobes. Anal gills short and stout. Head capsule of hexatomine type. Mandible powerful, cutting edge with a single row of three or four flattened, bladelike teeth. Maxilla very long and slender. Antenna elongate, at tip with a small elongate-oval papilla whose surface is delicately sculptured. Mentum chitinized, a strong transverse bar which is ribbed with fine parallel grooves.

*Pupa*.— Cephalic crest very small, inconspicuous, bilobed. Pronotal breathing horns short, broad, somewhat compressed, a little pointed at apex. Mesonotum unarmed. Abdominal segments depressed, armed with numerous tubercles or small spines, these being most abundant on posterior annuli of segments.

The subgenus *Lasiomastix* includes but six known species, three of which are from eastern North America. *Limnophila* (*Lasiomastix*) *macrocera* is common and widely distributed thruout the Eastern States. *L. (L.) tenuicornis* O. S. and *L. (L.) subtenuicornis* (Alex.) are found only in the Northeastern States and are more local in their distribution. The immature stages of *L. (L.) macrocera* are spent in rich organic mud. They are very similar to those of the subgenus *Phylidorea*.

*Limnophila (Lasiomastix) macrocera* (Say)

1823 *Limnobia macrocera* Say. Journ. Acad. Nat. Sci. Phila., vol. 3, p. 20.

*Limnophila macrocera* is a common swamp-inhabiting crane-fly, the larvae living in organic mud. At Orono, Maine, the writer found larvae of this species associated with larvae of *Bittacomorpha clavipes*, *Pilaria tenuipes*, *P. recondita*, *Erioptera chlorophylla*, and other crane-flies, as well as with leeches, snails, worms of many kinds, and other forms of life. The larva is similar to that of other related species. When placed in water it is very active and has the habit of darting the anterior quarter of its body from one side to the other, suggesting the striking of a reptile. The pupal duration is not more than eight days (June 24 to July 2, June 28 to July 6).

*Larva*.— Length, 14.5–15 mm.

Diameter, 1.4 mm.

Coloration, pale yellowish white.

Body terete, narrowed toward both ends but more noticeably toward anterior end. Integument covered with a dense appressed pubescence. Chaetotaxy as follows: two stout setae on both dorsal and ventral margins of prothoracic orifice; thorax with pencils of stiff setae near anterior margins of segments, two large lateral tufts and a smaller ventral pair; abdominal segments with a pencil of similar bristles on ventro-lateral margins, one on anterior half, the other midlength, of each ring; a seta at posterior lateral angles of sternites; four setae in a transverse row near posterior margin of tergites, the lateral pair the larger; lateral margins of cauda near base of lateral lobes and above gills with pencils of blackish setae; basal part of segments on both sternum and tergum with transverse parallel rows of fine scabrous points, this area very narrow on second abdominal segment, consisting only of three or four rows, the areas gradually becoming broader and the rows more numerous, there being on sixth and seventh segments about 28 to 30 rows which occupy nearly the basal third of segments.

Spiracular disk (Plate XLIV, 208) surrounded by four lobes; ventral pair the longest, lateral pair a little shorter; ventral lobes near tips with a brush of delicate, exceedingly long hairs which curl into loops at tips, the longest of these hairs about twice length of lobes bearing them; this fringe of hairs continuous around disk, longest at ends of lobes, gradually shortened toward their bases but not interrupted; lateral lobes with terminal hairs a little shorter but still longer than lobes themselves; inner faces of lobes delicately margined with dark brown, those of ventral lobes having the outer lateral margins the broadest. Spiracles rather small, located at base of lateral lobes. Anal gills four, very stout and plump.

Head capsule with a framework of long, slender plates, as is usual in this group. Labrum (Plate XLIV, 205) broadly transverse; anterior margin irregularly rounded; anterior median area truncated, with the lateral angles slightly projecting, cut off squarely, each with a small, hyaline, sensory papilla; laterad and caudad of each, two sensory papillae, the innermost elongate-cylindrical, more than twice length of short, oval, outer one. Epipharyngeal

region roughened by tiny groups of parallel ridges. Mental region consisting of a heavily chitinized transverse bar which is delicately grooved, enlarged at ends, and articulating with a small ventral bar. Antenna (Plate XLIV, 206) long and slender; basal segment short and broad; second segment elongate-cylindrical, bearing at its tip a small, hyaline, sensory papilla which appears delicately crosshatched by fine impressed lines, this papilla elongate-oval with the apex broadly rounded; a long hair near base of this papilla and about twice its length. Mandible (Plate XLIV, 207) long and powerful, the tip produced into a slender point, the cutting edge at about midlength with a single row of three or four flattened, bladelike teeth which are truncated at their tips, these teeth varying considerably in their shape and relative proportions. Maxilla with outer lobe elongate, the base strongly chitinized, this chitinized part continuing up margin of lobe almost to tip, the apical part nearly hyaline; at about midlength, the small palpus and a long seta. Esophagus enlarged, the walls thickened and roughened.

(A slide of a larva that was supposed to belong to this species differs considerably from the material described above. The antenna is much shorter, with the apical tubercle much larger and elongate-cylindrical; the mandible has the teeth fewer and more acute, quite as shown by De Meijere for *Linnophila* [*Phylidorea*] *ferruginea*. It is probable that this species likewise is a *Phylidorea*.)

*Pupa*.—Length, 14–16 mm.  
Width, d.-s., 1.8–2 mm.  
Depth, d.-v., 1.9–2.2 mm.

Breathing horns pale whitish brown, a little darker at base; remainder of body dark brownish black, abdomen a little lighter-colored; incisures of segments, and pleural line, pale.

Cephalic crest very small, inconspicuous, bilobed, each principal lobe subdivided into two smaller lobes terminating in a small seta; another seta on anterior face. Labrum rather blunt and truncated at apex. Labial lobes terminating in sharp points projecting proximad. Maxillary palpi short and stout, tapering to blunt tips (Plate XLV, 210). Antenna of male elongate, reaching to beyond midlength of wing sheath; antenna of female short, ending at about one-fourth length of wing sheath. Segments of antenna cylindrical, unarmed.

Pronotal breathing horns (Plate XLV, 209) short, broad, somewhat compressed, a little pointed at tip. Thorax broad and deep, the pronotum flattened, carinate medially. Mesonotum high, convex, transversely wrinkled. Wing sheaths ending some distance before tip of second abdominal segment. Leg sheaths short, ending before tip of third abdominal segment, the hind legs a little longer than the other legs, which end about on a common level.

Abdomen depressed, lateral margin carinate. Abdominal segments distinct, incised, each segment divided into two annuli, basal one about half length of posterior one. Basal ring on dorsum with a transverse single, or somewhat double, row of small subacute spines, which are more numerous and larger on mid-dorsal area. Pleura unarmed. Sternum with an oblique flattened lobe or wing on each side, directed caudad and proximad; between these lobes a more or less broken transverse row of from six to twelve slender tubercles. Posterior ring on dorsum with numerous small scattered tubercles. Pleura with a small circular spiracle near base and close to dorsal margin; a slender seta near spiracle and ventrad of it;

two other setae caudad of spiracle; at caudal margin a solitary seta close to ventral margin. Sternum with scattered slender tubercles, on segment 3 these appearing as a longitudinal row of about ten alongside the hind legs; between this lateral longitudinal row and the scattered discal tubercles, a bare space, at anterior end of which is a large, stout, setiferous tubercle; a subterminal transverse row of about fifteen acute black spines; on terminal segments the lateral longitudinal rows interrupted, or, on the seventh segment, lacking, on seventh segment the subterminal armature of both dorsum and sternum more powerful, especially the intermediate spines of sternum, which are very large; numerous setae scattered along rows. Segments 3 to 8 on ventral surface of posterior ring with a circular disklike area, median in position and at about two-thirds length of ring. (In some specimens, especially females, the discal tubercles on the posterior ring are much smaller and lie in longitudinal rows.) Male cauda (Plate XLV, 211) with tergal valves slender, elongate, slightly divergent, tapering to the acute tips, which bear a small subterminal seta; sternal valves short, blunt, with a flattened oval lobe between valves of sternum; eighth segment on dorsum with a trapezoid of four very long, slender, pointed lobes, which are provided with delicate hairs, the posterior pair of lobes longer, stouter, and lying closer together; just above anterior pair of lobes a blunt setiferous tubercle; pleural region of segment 8 with two spines; a small seta cephalad of these spines; sternal region of segment 8 with two widely separated setiferous tubercles. Female cauda (Plate XLV, 212) with tergal valves elongate, narrowed at tips, and armed with sharp, black spines; a few small setae before tips; sternal valves short, blunt, narrowed at tips.

*Nepionotype*.—Orono, Maine, July 19, 1913.

*Neonotype*.—With type larva, July 17, 1913.

*Paratypes*.—Larvae, with type larva, June 13 to July 27, 1913. Pupae, June 9 to July 22, 1913.

#### (Subgenus *Phylidorea* Bigot)

1854 *Phylidorea* Bigot. Ann. Soc. Ent. France, p. 456.

The immature stages of the type species of *Phylidorea*, *Limnophila* (*Phylidorea*) *ferruginea* (Meig.), were described by De Meijere (1916: 204–206). In Holland, larvae were found in April on the banks of a ditch, where they were living between decaying leaves. The larvae are cylindrical, and are from brownish yellow to brown in color. The antennae are described as three-segmented, the apical papilla being considered as a segment. The labrum bears on the epipharyngeal surface a median projection provided with two conspicuous biarticulate lobes. The outer lobes of the maxillae project as flattened blades. The mandibles are powerful and strongly curved, and have a group of small lateral teeth at about midlength.

The pupa is about 10 millimeters long and is blackish brown in color. The pronotal breathing horns are almost semicircular and are yellowish

brown in color. The abdomen is depressed, with sharp lateral margins. The abdominal armature is described as consisting of small hairs instead of slender spines as in the American species of this subgenus.

In the Nearctic fauna, the subgenus *Phylidorea* includes *Limnophila adusta*, *L. similis* Alex., *L. novae-angliae* Alex., *L. lutea* Doane, *L. terrae-novae* Alex., *L. costata* Coq., *L. fulvocostalis* Coq., *L. insularis* Johns., and probably other western species. It seems quite possible, moreover, that the species allied to *Limnophila lenta* O. S. also belong here.

*Limnophila (Phylidorea) adusta* O. S. (supposition)

1859 *Limnophila adusta* O. S. Proc. Acad. Nat. Sci. Phila., p. 235.

A larva of a crane-fly that is almost certainly a member of this genus was taken at Ithaca, New York, on May 30, 1917, in company with a *Ulomorpha* (No. 88-1917). An unknown pupa was taken in the sedge association on the Bool hillside, Ithaca, on June 4, 1917. It was not reared and its identity can only be surmised, but there can be little doubt of its relationship with *Phylidorea*.

*Larva*.—Length, 8.6-9 mm.  
Diameter, 0.8 mm.

Coloration a deep saturated orange-yellow, the body with silky iridescent reflections.

Body a little narrowed at both ends. Integument with a long, appressed, golden pubescence. Numerous long setae and pencils of hairs on body, usually at about midlength of, or on posterior half of, the segments; posterior margin of each segment elevated into a prominent transverse ridge of hairs. Spiracular disk surrounded by four lobes, ventral pair about twice length of lateral pair; ventral lobes with a rather narrow, dark brown line on inner face; outer margin fringed with very long dark hairs which are somewhat paler at their bases, this fringe of hairs longest at tips of lobes, where it reaches a length of about eight or ten times length of lobe; hairs shorter toward base of lobe; a stiff sensory bristle on outer face of lobe, rather far back from tip; lateral lobes similar, with the fringe of hairs yellow and about twice length of lobes. Spiracles of medium size, directed toward each other. Anal gills four, fleshy, pale in color, posterior pair longer than anterior pair.

Head capsule of hexatomine type, the dorsal plates narrowly interrupted on mid-dorsal line behind clypeal-labral sclerite. Labrum very large, anterior margin provided with eight or ten papillae and setae. Epipharyngeal region having a large, median, circular area which is slightly elevated and bears two bisegmented cylindrical papillae. Mental region as usual in the genus, consisting of three hinged bars forming three sides of a rectangle, the anterior transverse bar delicately grooved. Antenna two-segmented, second segment narrower than first and bearing at its tip an elongate sculptured papilla and a long seta. Mandible of hexatomine type, a powerful curved hook, at about midlength of which is an

acute tooth; in axil of latter a small flattened blade which is slightly widened outwardly and has the tip truncated. Maxillary lobe broad at base, tapering to narrow tip.

*Pupa*.— Length, 12 mm.

Depth, d.-v., 1.6 mm.

Similar to *Limnophila macrocera* in general shape and color, differing as follows:

Labrum broadly obtuse at tip. Pronotal breathing horns (Plate XLIII, 203) very short, stout but flattened, constricted beyond midlength, and with a row of breathing pores around apex; pronotum and mesonotum carinate medially in front; wing pad showing venation rather clearly, cell  $M_1$  deep, basal deflection of  $Cu_1$  beyond midlength of cell 1st  $M_2$ . Abdominal segments with lateral margins very deeply incised, the carinate lateral margins very accentuated, appearing as thin, flattened wings (Plate XLIII, 204). Armature of abdomen consisting of abundant elongate, acicular spines, some of which are sinuously twisted; on basal ring these spines appearing as a subterminal transverse row on both dorsum and sternum; on posterior ring, besides the subterminal transverse row, spines are scattered over surface in more or less distinct longitudinal rows; at lateral carina a group of about a dozen long spines at caudal margin, as well as a powerful spine below level of spiracle on extreme margin of carina; ventrad and caudad of this, three long setae, two close beneath spine and the third underneath spiracle. Female cauda (Plate XLIII, 202) about as in *Limnophila macrocera*, but sternal valves divergent at their tips; eighth segment with a trapezoid of dorsal lobes about as in *L. macrocera*, but sternum with four stout spines bearing setae on their sides; a blunt median lobe near base of eighth sternite.

(Described from a female pupa taken on Bool's hillside, Ithaca, New York, on June 4, 1917, where it was associated with a characteristic swamp-inhabiting crane-fly fauna—*Bittacomorpha clavipes*, *Pseudolimnophila luteipennis*, *Limnophila macrocera*, *Pilaria recondita*, and *Prionocera fuscipennis*.)

#### (Subgenus *Limnophila* Macquart)

1834 *Limnophila* Macq. Suit. à Buff., vol. 1, Hist. Nat. Ins., Dipt., p. 95.

1863 *Poecilostola* Schin. Dipt. Austriaca, vol. 2, p. 551.

*Limnophila* is the typical subgenus of the group, the type having been designated as *Limnophila pictipennis* by Westwood in 1840. No species of this subgenus have yet been described from North America.

The larva of *L. punctata* (Meig.) was described by Beling (1886:195–197) and by Gerbig (1913:158–161) as living in wet earth, by Scheffer (1848:10) and by Cameron (1917:63) as living in decaying wood. Gerbig found larvae in sandy soil near both standing and flowing water. The larvae are very active, are rust-brown in color, and attain a length of 15 millimeters with a diameter of from 1.5 to 2 millimeters. The body is provided with several setae and setiferous projections. The spiracular disk (Plate XLVI, 214) is surrounded by four subequal lobes and an additional reduced dorso-median lobe; all of these lobes are fringed with long

hairs, and each of the four paired lobes has a sensory bristle near the tip. The four anal gills are not very prominent.

The head capsule is of the hexatomine type. The mandibles are sickle-shaped, with two small, broad, blunt, sawlike teeth just beyond midlength.

Brauer (1883:55) found the larvae of another species — *L. pictipennis* (Meig.), the type of the genus — between wet decaying leaves in bogs. His figure of the head capsule (1883, pl. 1, fig. 10) shows a typical hexatomine head (Plate XLVI, 213). Beling (1879:51–52) found this species in the sand of a small, dried-out brook bed.

### Group Ulomorphae

#### Genus *Ulomorpha* Osten Sacken (Gr. *Ula* + *shape*)

1869 *Ulomorpha* O. S. Mon. Dipt. N. Amer., part 4, p. 232.

*Larva*.—Form slender. Body covered with a rich golden-yellow pubescence. Spiracular disk surrounded by four unequal lobes, the ventral pair the longest, lying subparallel, fringed with exceedingly elongate hairs. Spiracles small. Head capsule narrow, the dorsal plate narrow, at tip expanded into a spatula. Mandible hinged, blade very long and slender, with a single very long lateral tooth at its base. Maxilla densely golden hairy, outer lobe projecting, bladelike. Antenna with a very long, tapering, apical papilla. Mentum not chitinized.

*Pupa*.—Cephalic crest prominent, each lobe with three setae. Pronotal breathing horns very long and slender, sinuous, cylindrical, at apex split into two flattened divergent lobes. Mesonotum short, very convex, unarmed. Wing sheaths attaining end of second abdominal segment. Leg sheaths short, ending before tip of third abdominal segment; hind tarsi a little longer than the others. Abdominal segments divided into two rings, posterior ring with a subterminal transverse armature of stout black spines and a few long setae; sternal armature stronger than that of dorsum. Pleura armed with a few similar spines. Acidothecae of ovipositor very long and slender. Dorsum of segment 8 with a trapezoid of four lobes.

The genus *Ulomorpha* includes five known species, the genotype, *Ulomorpha pilosella*, of the eastern United States, and four western North American species. The immature stages of the genotype are spent in rich organic mud in shaded situations.

#### *Ulomorpha pilosella* (O. S.)

1859 *Limnophila pilosella* O. S. Proc. Acad. Nat. Sci. Phila., p. 242.

*Ulomorpha pilosella* is not uncommon in cool Canadian woods thruout northeastern North America, and the adult flies may be swept from



rank vegetation in such haunts. The flies bear a marked resemblance to the species of the subgenus *Lasiomastix* of the genus *Limnophila*, but the pupae, especially in the structure of the pronotal breathing horns, are quite distinct. The larvae are different from the related and somewhat similar larvae of the subgenus *Dieranophragma* of the genus *Limnophila*, of Pentoptera, and of similar hexatomine genera, in their pale whitish yellow coloration instead of the deep saturated yellows and oranges of the genera mentioned. All, however, have the quick, restless movements so characteristic of this group of crane-flies. Larvae found on Bool's hillside, Ithaca, New York, on May 14 and 23, 1917, transformed to adults on June 9.

*Larva*.— Length, 8.5–9 mm.  
Diameter, 0.5–0.6 mm.

Coloration pale whitish yellow, the eighth abdominal segment suddenly whitish.

Form slender. Body covered with a dense golden-yellow pubescence. A transverse fringe of stiff, erect, short hairs at posterior margin of prothorax. A number of pencils of setae or solitary bristles on sides of segments, one on each annulus, longest near posterior margins of segments. Behind these setae, tufts of small hairs. Spiracular disk (Plate XLVI, 219) surrounded by four lobes; ventral pair the longest, lying subparallel to each other, outer margin fringed with long, delicate hairs, those near tip coarse and easily broken, some of the hairs at tips exceedingly elongate; inner face of ventral lobes heavily suffused with dark brown, this color more intense proximally; lateral lobes short, with an apical fringe of coarse yellowish setae. Spiracles very small, widely separated, located at base of lateral lobes. Anal gills four, very slender, pale in color, the posterior pair a little the longer. On sternum of eighth abdominal segment, before gills, a transverse row of four long, coarse setae.

Head capsule (Plate XLVI, 215) very long and narrow, the dorsal plate slender, at end expanded into a spatula; lateral plates a little shorter than dorsal plate. Labrum (Plate XLVI, 216) and epipharynx broadly transverse, projecting, the anterior margin narrower, truncated, on either side near base with a brush of long hairs; disk of epipharyngeal region with four setae, posterior pair a little the closer together; a few tiny papillae on ventral surface; clypeal region emarginate, with two large setae near anterior margin and another immediately behind base of antenna. Mental region not readily distinguishable in the material available, but at the most with little or no chitization. Antenna (Plate XLVI, 217) with basal segment cylindrical, a little narrowed medially, the truncated apex with about two or three long setae and a very long, hyaline, sensory papilla which tapers gradually to apex, this papilla about three times length of segment bearing it. Mandible (Plate XLVI, 218) hinged, the base slender but powerful, with the inner face deeply concave to receive mandible in a position of rest; blade of mandible produced into a very slender hook which is almost straight, a little curved at extreme tip, at its base a very large, acute, flattened blade which is more than half length of mandible itself; in its angle this blade has a second, microscopic, tooth; protheca with about five long, stout, comblike teeth exceeding the mandible in length, and an additional shorter, flattened blade marked with parallel grooved

lines. Maxilla with dense tufts of long yellow hairs; outer lobe produced cephalad as a hyaline, flattened blade which projects from prothoracic orifice when head is retracted.

*Pupa*.— Length, 8.5-9 mm.

Length of pronotal breathing horns, nearly 2 mm.

Width, d.-s., 1 mm.

Depth, d.-v., 1 mm.

) Head, thorax, and appendages dark brown; pronotal breathing horns similar, but terminal half gradually paler, the tip almost yellow; abdomen pale brown.

Cephalic crest consisting of two prominent lobes, each with three strong setae, the most ventral directed outward; just before primary crest and lying between antennal bases, a very low, slightly bilobed crest which is not setiferous. Labrum elongate, obtusely rounded at apex and separating labial lobes, the latter produced caudally into subacute points. Maxillary palpi stout at base, narrowed to tip (Plate XLVII, 221). Antenna short (in female sex, at least), extending but a short distance beyond knee joints of fore legs. Pronotum (Plate XLVII, 220) high, feebly carinate medially. Breathing horns separated basally, very long and slender, sinuous, transversely wrinkled, at tip split into two flattened divergent lobes (Plate XLVII, 222 and 223). Mesonotum very short and convex, with numerous black dots which are most abundant anteriorly. Two small setae on either side behind wing axilla. Lateral angles of mesonotum blunt, but tip produced into a slender setiferous tubercle. Wing sheaths ending opposite tip of second abdominal segment. Leg sheaths short, ending just before tip of third abdominal segment, hind legs a little longer than others.

Abdomen with a narrow basal ring and a much broader posterior ring, the latter armed before posterior margin with a transverse row of small black spines, strongest on pleura, weakest on dorsum; on dorsum (Plate XLVII, 224) the spines reduced in number, there being from one to five (or in some cases none), and occurring only at or near ends of row; ends of row with two setae; on either side of median line a group of three closely approximated setae; usually segments 2 and 3 have the spines weak or lacking; segments 4 to 6 with two spines, and segment 7 with one spine, but in some specimens the number is slightly increased. Sternites (Plate XLVII, 225) with the intermediate segments (4 to 6) having about twenty spines in an almost continuous row which as a rule is uninterrupted; at each end of row about two strong setae; near base of posterior ring a narrow transverse area with two setae at each end. Pleura with a few powerful spines, small or lacking on basal segments, larger and more numerous on posterior segments, there being usually two on segment 4, three on segments 5 and 6, and four on segment 7; on pleura at about mid-length of posterior ring and nearer dorsal side, three black setae in transverse alinement, these somewhat longer on basal segments; opposite basal ring a stout seta. Female cauda (Plate XLVII, 225) elongate; tergal valves slender, slightly upcurved, near apex with a sharp black spine which is directed dorsad, laterad, and caudad; two weak setae on either side before apex. Dorsum of segment 8 with four lobes; posterior pair elongate, slender, curved, and divergent; anterior pair blunt, small, and more approximated; just ventrad of these lobes a stout seta; pleural region with two powerful spines, above the more dorsal of which is a stout seta; a seta near ventral margin.

*Nepionotype*.— Ithaca, New York, May 30, 1917. No. 88-1917.

*Neanotype*.— With type larva, reared June 9, 1917.

*Paratypes*.— Larvae, May 30, 1917. Pupa, June 13, 1917.

Genus *Pilaria* Sintenis (Lat., derived from *the long antennal verticils*)1888 *Pilaria* Sintenis. Sitzber. Nat.-Ges. Dorpat., vol. 8, p. 398.1919 *Eulimnophila* Alex. Cornell Univ. Agr. Exp. Sta., Mem. 25, p. 917.

*Larva*.—Form moderately slender. Spiracular disk surrounded by four unequal lobes, lateral pair in some cases very reduced, elongate ventral lobes fringed with long hairs. Head capsule of Ulomorpha type. Mandible linged, blade with one or two acute teeth at base. Maxilla densely hairy. Mentum not chitinized.

*Pupa*.—Pronotal breathing horns elongate-cylindrical, tips split into flattened lobes. Abdominal segments with three or four pairs of naked tubercles.

The genus *Pilaria* includes a group of species of the old genus *Limnophila*, comprising *Limnophila tenuipes* and *L. pilicornis* and their allies. Its relationships are plainly with *Ulomorpha* rather than with *Limnophila*. The genotype is *Limnophila pilicornis* (Zett.), of northern Europe. Other included species are *L. tenuipes*, *L. recondita*, *L. imbecilla* O. S., *L. edwardi* Alex., *L. quadrata*, *L. stanwoodae* Alex., and *L. osborni* Alex., of North America, and *L. discicollis* (Meig.), *L. fuscipennis* (Meig.), *L. subtineta* (Zett.), and probably other species, of Europe.

The immature stages are spent in mud or moist earth. In Europe, *Pilaria discicollis* (Plate XLVIII, 232) has been found by Gerbig (1913: 163–164) and by Cameron (1917:63). *P. fuscipennis* is described by Beling (1886:197–198) as living in mud near a ditch. Gerbig (1913:164–166) found the larvae (Plate XLVIII, 231) in a similar situation. Brauer (1883:54) describes them as living between decaying leaves in swamps. Cameron (1917:63) states that the larvae are found in decaying wood, this record possibly being an error. According to Beling, the pupal duration is not more than ten days. In America, *P. tenuipes* has been discussed by Hart (1898 [1895]:204–205) and by Malloch (1915–17b:223–224), as stated under the discussion of the species.

The species of the genus *Pilaria* may be separated by the following keys:

*Larvae*

- Ventral lobes of spiracular disk elongate, heavily marked with brownish black; coloration pale yellow..... *P. tenuipes* (Say) (p. 873)  
 Ventral lobes of spiracular disk short, pale; coloration deep yellow. *P. recondita* (O. S.) (p. 874)

*Pupae*

1. Pronotal breathing horns short, black; lobules of cephalic crest blunt and rounded. *P. quadrata* (O. S.) (p. 875)  
 Pronotal breathing horns elongate, pale, brownish yellow or yellow; lobules of cephalic crest elongate, finger-like..... 2

2. Antennal sheaths of male elongate; pronotal breathing horns longer, pale yellow.

*P. tenuipes* (Say) (p. 873)

Antennal sheaths of male short; pronotal breathing horns shorter, yellowish brown.

*P. recondita* (O. S.) (p. 874)

### *Pilaria tenuipes* (Say)

1823 *Limnobia tenuipes* Say. Journ. Acad. Nat. Sci. Phila., vol. 3, p. 21.

1869 *Limnophila tenuipes* O. S. Mon. Dipt. N. Amer., part 4, p. 210-211.

*Pilaria tenuipes* is a widely distributed crane-fly thruout eastern North America. The immature stages are commonly found in the mud of swamps, or near streams and other bodies of water. This is the unknown *Limnophila* described by Hart (1898 [1895]:204-205), and also considered in much detail by Malloch (1915-17b:223-224), who found the pupae along the banks of the Sangamon River in Illinois.

*Larva*.— Length, 16 mm.

Diameter, 1.4-1.5 mm.

Coloration of living larva, pale brownish yellow. Body covered with a long, dark-colored, appressed pubescence, more conspicuous on posterior segments. Lateral pencils of setae near base and apex of segments. Antepenultimate segment of body capable of globular distention, covered with numerous transverse rows of microscopic roughened points. Spiracular disk (Plate XLVIII, 230) moderately large, surrounded by four lobes; ventral lobes long and slender, inner face with closely approximated, transverse, brownish black lines which cause entire face to appear dark; near tips of lobes these black marks tapering out into a long point; basal parts of dark marks subcontiguously hollowed out interiorly to form a large pale area below spiracles; ventral lobes fringed with long, pale hairs, some of them exceedingly elongate. Lateral lobes very small, blunt, tending to be reduced, bearing short fringes of dark hairs. Anal gills slender, pale in color.

Head capsule of Ulomorpha type and not very different from that of the type genus; dorsal plate broad basally, narrowed gradually behind to near tip where it expands into a very large spatula. Epipharyngeal region of labrum and maxillae fringed with dense tufts and brushes of long yellow hairs. Maxillary lobe relatively small but elongate, hyaline, tapering to flattened apex. Antenna (Plate XLVIII, 229) with basal segment elongate, bearing at its tip an elongate apical papilla which is a little longer than the segment, bluntly rounded at its tip, and delicately sculptured. Mandible (Plate XLVIII, 228) very long, hinged, at its base an acute tooth equal in length to about one-third length of mandible; in the type larva, the left mandible a little longer than the right mandible. Mental region not chitinized.

*Pupa*.— Length, 10-15 mm.

Width, d.-s., 1.5-1.6 mm.

Depth, d.-v., 1.6-1.8 mm.

Coloration dark brown; pronotal breathing horns light yellow, extreme bases brownish.

Cephalic crest small, composed of three slender, finger-like lobes which are tipped with strong setae; on front, before crest, two setiferous lobes. Labrum small, bluntly rounded

at apex. Labial lobes oval. Maxillary palpi slender. Antenna of female moderately elongated, reaching to just beyond wing root. Pronotal breathing horns (Plate XLIX, 233) elongate, cylindrical, sinuous, transversely wrinkled, apex scarcely enlarged but deeply split on inner margin; a setiferous tubercle ventrad and laterad of breathing horns. Thorax with a very high anterior median crest. A slender, setiferous tubercle above wing axil, and two others on either side of median line. Sheaths of halteres long and slender. Leg sheaths ending about on a level, or those of hind legs the shortest and those of fore legs a little longer.

Abdominal segments divided into two annuli. Tergites (Plate XLIX, 235) on posterior ring with a caudal row of blunt, naked tubercles; at end of row two setae; on either side of median area and just in front of row, a large setiferous tubercle; at base of ring two naked tubercles, one on either side of median line; two slender setiferous tubercles near margin of ring. Basal ring with four naked tubercles. (The third pair of tubercles found in the pupa of *Pilaria quadrata* is vestigial.) Pleura with four tubercles, two on each ring, the basal one of each ring setiferous, the posterior one naked. Sternites with six naked tubercles on basal ring, arranged in three transverse pairs; on posterior ring at base two setiferous tubercles, each with two bristles, directly behind last naked tubercle of basal ring; at caudal margin two or three large tubercles near end of row and about four or five small naked tubercles between. Female cauda (Plate XLIX, 234 and 236) very elongate, tergal valves slightly upcurved, terminating in a sharp spine and with two setae on outer face. Eighth tergite with four elongate lobes; posterior pair blunt, directed laterad; anterior pair elongate, slender, with two setae laterad of each. A blunt lobe on pleural region. Pleura with three or four powerful tubercles, with a seta located between the more dorsal pair. Sternal region with four small setae, two on either side of broad median area.

*Nepionotype*.—Orono, Maine, July 1, 1913. No. 50-1913.

*Neanotype*.—With type larva.

### *Pilaria recondita* (O. S.)

1869 *Limnophila recondita* O. S. Mon. Dipt. N. Amer., part 4, p. 212-213.

*Pilaria recondita* is a common crane-fly thruout the northeastern United States. The immature stages are swamp inhabitants, and are very frequently found in exactly the same situations as are those of *P. tenuipes*. *P. recondita* belongs to the same group as *P. tenuipes*, and the pupae of the two species are very difficult to distinguish.

*Larva*.—Length, 15 mm.

Diameter, 1.2 mm.

Color a uniform light yellow.

Body covered with a long, appressed, yellow pubescence and with a few long setae. Spiracular disk very small, in a position of rest almost closed, surrounded by four lobes; ventral lobes moderately elongated, fringed with long, golden-yellow hairs which are longest at tips of lobes; if bent backward these elongate hairs extending to beyond gills; inner face of lobes almost unmarked, with only a delicate brown line extending from tip toward base

for a distance equal to about one-half length of lobes; lateral lobes small, subdorsal in position, separated by a narrow notch, their inner faces opposed to each other, margin fringed with short, golden-yellow hairs. Anal gills four, moderately elongated.

Head capsule as in *P. tenuipes*. Antenna with sculptured apical papilla tapering to blunt tip; besides this papilla, an even longer, hyaline, flattened blade. Mandible with apical bladelike part shorter and stouter, with two subequal stout triangular teeth at base (Plate XLVIII, 227).

*Pupa*.—Very similar to pupa of *P. tenuipes*, but smaller. Antennal sheaths of male short. Breathing horns a little shorter than in *P. tenuipes* but still much longer than in *P. quadrata*, of a pale yellowish brown color. On abdominal tergites, along caudal margin of posterior ring, from four to seven naked tubercles between the setiferous tubercles (in *P. tenuipes*, four or five). Male cauda (Plate L, 237) with dorsal lobes stout, cylindrical, narrowed at tips, divergent, directed caudad and ventrad; on outer face before tip a slender seta; ventral lobes blunt, with a flattened ventral tubercle at base of notch. Segment 8 on dorsum with posterior lobes blunt, straight, directed caudad and slightly laterad, but not so strongly as in *P. tenuipes*.

*Nepionotype*.—Orono, Maine, July 3, 1913.

*Neanotype*.—Ithaca, New York, emerged June 11, 1917. No. 112-1917.

*Paratypes*.—Pupa, Orono, Maine, placed in rearing as a fully grown larva, June 26, 1913; emerged as an adult male, July 3, 1913, showing a pupal duration of seven days. Larva, Orono, Maine, July 5, 1913 (No. 74-913).

### *Pilaria quadrata* (O. S.)

1859 *Limnophila quadrata* O. S. Proc. Acad. Nat. Sci. Phila., p. 241.

*Pilaria quadrata* is a widely distributed spring and early summer species. The immature stages are very similar to those of *P. tenuipes* and *P. recondita*. A pupa was found by Dr. Needham in the Indian Spring, Ithaca, New York, where it was found floating among the water cress. From this pupa an adult female fly was reared. On June 3, 1917, the writer found two fully matured male pupae in Chickaree Woods near Ithaca. There had been a very heavy rainstorm on the preceding day, and the low spots in the woods had been converted into small ponds, many of the insects that normally live in the mud or beneath the decaying leaves being forced to the surface. The pupae of *P. quadrata*, as well as an abundance of *Tipula* larvae, were found clinging to small islands of debris floating on these temporary woodland pools. The adult flies emerged on June 3.

*Pupa*.—Length of cast pupal skin, 9-12 mm.

Coloration almost black, including pronotal breathing horns; abdomen more dusky gray.

Cephalic crest small, black, trilobed, each lobe with a seta at apex. Labrum narrow, blunt at tip. Labial lobes rounded. Sheaths of maxillary palpi elongate, tapering to the

slender points. Antenna short in both sexes. Pronotal breathing horns (Plate L, 238) moderately elongate, cylindrical, transversely wrinkled, at tips smooth, flattened, and slightly enlarged. A tubercle with two long setae above wing axil. Two setiferous punctures on dorsum on either side of median line. Wing sheaths ending before tip of second abdominal segment. Leg sheaths ending before tip of third abdominal segment, the tarsal sheaths ending about on a level or the hind legs shorter.

Abdominal segments with tergites (Plate L, 239) 2 to 6 provided with eight naked, discal tubercles, arranged in four transverse pairs, the third pair more approximated; laterad of third pair of naked tubercles, two small setiferous tubercles; on seventh segment one of the four pairs of tubercles lacking; near caudal margin of segments a transverse row of weak, setiferous tubercles; on either side of median line, in alinement with discal tubercles and just anterior to the transverse setiferous row, a large tubercle provided with three setae. Pleural region carinate, each segment armed with four slightly curved tubercles: anterior one solitary, setiferous; second one solitary, naked; third one with two or three setae; posterior one bifid, naked. Sternites (Plate L, 240) with six naked, discal tubercles corresponding to those of tergites but reduced in number. Subterminal armature weak, ends of rows tuberculate; an isolated setiferous tubercle ventrad and laterad of ends of rows. Male cauda (Plate L, 242) elongate; dorsal lobes elongate-cylindrical, directed caudad and slightly dorsal, tapering to acute tips; three weak setae on outer ventral face; ventral lobes blunt, much shorter than dorsal lobes, with a blunt median lobule between them at their base; eighth segment on tergum provided with a large, blunt, median tubercle, with two large posterior lobes which are directed caudad and with two tiny lobes on either side in front; sternum with a transverse row of four separated setiferous tubercles; caudal margin with a transverse row of about eight or nine pale tubercles on either side, the outermost the largest; a small seta above second tubercle at ends of row. Female cauda (Plate L, 241) very long and slender, subacicular, sternal valves a little shorter than tergal valves; tergal valves terminating in blunt cylindrical points.

*Neanotype*.—Male pupal skin, Ithaca, New York, June 3, 1917.

*Paratypes*.—Pupa, a male skin with type pupa; a female skin, Ithaca.

### Subtribe Hexatomaria

The subtribe Hexatomaria comprises a well-defined division with but four known genera, three of which are North American and are considered in this paper. The only other group of crane-flies with which the species may be confused are certain of the Limnophilaria, especially the Ulomorpha group of genera.

The larvae have the labral sclerite of the head capsule large, separated from the remainder of the capsule by a distinct suture. The epipharyngeal region is restricted to the anterior median part of the sclerite, and is provided with two large tubercles on either side, which are tipped with two or three hyaline, cylindrical papillae. Between these papillae is a brush

of hairs surrounding two pairs of setiferous tubercles. The mental region is not chitinized. The dorsal plates of the head capsule are widely separated from each other by a median split.

The pupae are often armed with spines or tubercles on or about the head and the thorax. The lateral abdominal spiracles are large and functional.

The genera of the subtribe Hexatomaria may be separated by the following keys:

*Larvae*

- 1. Coloration of body a deep saturated orange-yellow; spiracular disk with ventral lobes unlined with darker, bearing at tips a few very long hairs. . . *Pentoptera* Schin. (p. 891)  
 Coloration of body pale yellow, whitish, or greenish; spiracular disk with lobes lined with dark brown or black . . . . . 2
- 2. Size small, form slender (length 14–15 mm., diameter 1–1.3 mm.) . . *Hexatoma* Latr. (p. 877)  
 Size larger, form stouter (length over 15 mm., diameter over 1.6 mm.)  
*Eriocera* Macq. (p. 881)

*Pupae*

- 1. Pronotal breathing horns short and stout, red at base and apex, the remaining part dark-colored, transversely wrinkled; horns bent strongly toward each other at tips.  
*Pentoptera* Schin. (p. 891)  
 Pronotal breathing horns not as above. . . . . 2
- 2. Size small (length under 10 mm.) . . . . . *Hexatoma* Latr. (p. 877)  
 Size larger (length over 12 mm.) . . . . . *Eriocera* Macq. (p. 881)

Genus *Hexatoma* Latreille (Gr. *six* + *I cut*)

- 1809 *Hexatoma* Latr. Gen. Crust. et Ins., vol. 4, p. 260.
- 1818 *Nematocera* Meig. Syst. Besch. Zweifl. Ins., vol. 1, p. 209.
- 1818 *Anisomera* Meig. Syst. Besch. Zweifl. Ins., vol. 1, p. 210.

*Larva*.—Size small (length of *Hexatoma megacera* about 14 mm.). Spiracular disk surrounded by two pairs of lobes, ventral pair the longer, inner face marked with a narrow brown line which is expanded at its inner end. Head capsule with lateral angles of labrum elongate and densely clothed with hairs.

*Pupa*.—Size small (length under 10 mm.). A large spinous tubercle on scape of antenna. No median projection on mesonotal scutellum. Pronotal breathing horns short and straight. Wing pads with cell *R*<sub>2</sub> very small and *M* with but a single branch reaching wing margin.

The genus *Hexatoma* includes a small number of forms with a chiefly Holarctic distribution, there being about eleven Palearctic, two Ethiopian, and one North American species so far described. The adult flies of the North American species, *Hexatoma megacera*, are common on vegetation along the banks of rather large streams. They are discussed herein in detail under the account of this species. The adult flies of some of the larger European species have habits quite like those of the genus *Eriocera*,



as discussed elsewhere in this paper (page 705). Riedel (1909:29) describes in some detail the habits and swarming of *H. bicolor* (Meig.), the males of which are very active in the forenoon during the hours of brightest sunlight, the females resting on the willow branches near by. Similar habits are recorded by Riedel (1910:30) for *H. saxonum* (Lw.). The immature stages of the European species are practically unknown, the only original reference being that of Von Röser (1834), who states that the larvae of *H. nigra* Latr. live in the sand along the banks of streams.

### *Hexatoma megacera* (O. S.)

1859 *Anisomera megacera* O. S. Proc. Acad. Nat. Sci. Phila., p. 242.

The adult flies of *Hexatoma megacera* are on the wing during the months of May and June and may be swept from the rank vegetation along the streams from which their larvae emerged. The following notes on copulation, resting positions, egg laying in nature and in captivity, and other details, are quoted from published field observations (Alexander, 1915 c: 143-145):

May 14, 1911 — This usually rare insect was common on a grassy plot of land along Cascadilla Creek [Ithaca, New York]. The flies sit on the blades of grass, the long antennae of the male directed straight ahead. The males are very poor fliers and prefer to drop to the ground when disturbed and clumsily work their way off along the ground. When approached from the side they are much more easily alarmed and fly away. When approached from above, they do not move until the stick, finger, or whatnot, is within a couple of inches, when they remove the fore feet from the support and, on nearer approach, fall to the ground. When in copulation, the female tries to disengage by rapidly vibrating the wings in attempted flight, repeating this often, from every one to five seconds until disengaged or exhausted. The male can disconnect himself at will. In copulation the female is always uppermost unless exhausted, when both sexes lie flat on a grass-blade. The female has the head up, the male the head downward; copulation always takes place on a vertical support, usually a blade of grass, sometimes a plant stem. The sexes remain in copulation for quite a long time and are perfectly motionless. All of the legs of both sexes are on the support unless in a position where this is physically impossible, in which case as many as possible are used; the hind legs of both sexes are held at right angles to the support, the forelegs in front. After copulation the female generally drops to the ground, the male, after a few moments' rest, flies away. Specimens in copulation were found in abundance from 2 to 4.30 p.m. when no more could be discovered. From 4.30 to 7 p.m. solitary males were common, but no females could be found on the grass-blades. At 4.30 p.m., a few females were found clinging to the trunks of the willow trees about two feet from the ground. At 5.30 p.m., females were noted in small groups over the water, evidently engaged in oviposition, as they frequently dipped down to the surface. These latter were in company with a large swarm of dancing empidid flies (*Rhamphomyia*). Of the great numbers that were picked from grasses in the afternoon a considerable proportion were females and toward 5 p.m. they commenced egg-laying on the sides of the containing vessel, large shell vials. By 7 p.m. the sides of the vials were black in places with the large, dark-colored eggs. This data would seem to place the time for oviposition at about sunset. The females are very good fliers and often travel for long

distances before alighting as is shown toward sunset when they fly for long stretches upstream. The males are rather poor fliers, due in part, possibly, to the weight of the long antennae and, as stated before, this sex prefers to skulk rather than fly. When the males fly, they do so heavily and seize the first support that they collide with and hang on, occasionally flying on immediately to another support. When the male comes in contact with a stem, he very often ascends to the top by means of a part-flying, part-climbing motion and, on reaching the summit, flies off to another place. As a rule the flies, especially the females, alight on a single grassblade, but very often the males are observed on two blades, the legs of one side on one blade and those of the opposite side on the other; when the body thus hangs between the stalks, the tarsi diverge from one another, whereas on a single support, the legs converge.

Hexatoma was preyed upon by large numbers of a scatophagid fly that occurred in great abundance in this vicinity and seemed to be subsisting almost entirely on these flies. At least twenty of these predaceous flies were noted with Hexatomae and this species seemed to constitute the principle insect enemy of the crane-fly. They would lurk on the grass blades and sally forth after their prey, carrying it back to some point to feed upon it. It is probable that the blood is taken since the body of the Hexatoma appeared almost uninjured when examined. On an old beam where males had a habit of walking up the vertical face, a small spider's web was found, in which eleven specimens were entangled, two being still alive; eight of these were males, the remaining three, females.

The males especially can walk up smooth surfaces, as glass, moving the legs alternately and awkwardly. The first pair taken were in copulation but in placing them in the vial they became disengaged and ran about in the container. After a short time they began to copulate in the tube.

May 15, 1911 — A pair were taken in copulation at 10 a.m.; at 8 p.m. they were still in coitu, but this is exceptional as most of the pairs disengage very readily. In the morning the species is very active and although the males do not fly far, they fly readily and it is difficult to pick them up by hand. The females are excellent fliers especially in the morning.

Several pairs were taken in copulation and each pair was isolated in a separate vial in order to ascertain the number of eggs per female. The clutch was determined by dissection. When the captive insects began to oviposit, the eggs shot out from the body, at first slowly, then more rapidly, one per second, later much slower again, the eggs being extruded one at a time. The total period of oviposition required seven minutes; at the end of sixty seconds, in the space between sixty and seventy seconds, eighteen eggs were laid, or 1.8 per second. Toward the end of egg-laying, the eggs appeared much more slowly, one in two seconds. The eggs are quite sticky or viscid and adhere to the glass. When the female is in danger of death, as when she falls into the water, she begins, at once, to deposit the egg-complement. In nature it seems probable that one egg is laid at each descent to the water. As soon as the female touches the water, although she has not deposited an egg all day, she immediately starts to deposit the oblong black eggs. After the last egg is expelled the muscles of the ovipositor still go through the motions of expulsion. One specimen was placed in the water and as usual began to deposit her eggs. She was decapitated, laid eleven eggs and tried to lay still more but failed. The number of eggs laid varied from 316 to 372 with an average of 347; the time required for oviposition varied from seven minutes to seven minutes and forty seconds. In most cases the number of the egg-complement is probably between 300 and 400.

The greater part of the larval existence is probably spent in the water, and it is only when the larvae are fully grown and ready to pupate that they come to land. On April 26, 1914, gravel from the bank of Cascadilla Creek was carefully examined, but no signs of larvae or pupae were to be discovered. On May 6, however, the same bank was examined and about ten larvae and seventy-five pupae were found. Sometimes the immature stages are very abundant. On May 12, 1917, near the place

just described, the writer found larvae and newly transformed pupae in great numbers, the former pupating in the dry sand rather distant from the water's edge. In one dry patch of sand on a rocky ledge, sixty specimens were found in six square inches of soil. The insects are often found in gravel or coarse sand that is thickly penetrated by grass roots and rhizomes, rarely in pure gravel. They are most commonly found in soil that has been recently deposited after freshets. The immature stages of *Hexatoma* are associated with larvae of *Eriocera spinosa*, *E. cinerea*, *Tipula bella*, and *Atherix* probably *variegata* Walk., with pupae of *Chrysops excitans* Walk., and with many beetles such as *Paederus littorarius* Grav., *Gastrobium bicolor* (Grav.), *Bledius* sp., *Omophron* sp., *Dyschirius sphaericollis* Say, *Tachistodes partarius* (Say), *Anadaptus discoideus* (Dej.), *Laccobius agilis* Rand, and other species characteristic of the sandy margins of large streams. The pupal duration of *Hexatoma* is six and one-half days.

*Larva*.— Length, 14–15 mm.  
Diameter, 1–1.3 mm.

Color of body, pale brownish yellow.

Body covered with rather abundant appressed hairs, the subterminal distended part of abdomen with transverse rows of very short spines or setae, there being from thirty-five to forty such rows. Spiracular disk (Plate LI, 246) surrounded by four lobes; ventral lobes the longer, with a fringe of a few long hairs at apex; on inner face a long, narrow, brown mark, extending from the tip inward, the proximal end expanded; lateral lobes with numerous long hairs which are gradually shorter toward base of lobes. Spiracles circular, situated at base of lateral lobes; a dusky mark extending from spiracles dorsad.

Head capsule of usual hexatomine type, as described for *Eriocera longicornis* (page 888). Entire general features and details of mouth parts very similar to those of *Eriocera longicornis*. Labrum (Plate LI, 243) transversely oval, with frame strong and chitinized, anterior median part produced into a small lobe (Plate LII, 250) bearing two lateral papillae and two setiferous tubercles surrounded by short hairs; lateral margins of labrum produced into prominent lobes directed proximad and cephalad, densely hairy and entirely protecting anterior margin of labrum. Antenna (Plate LI, 244) with apical papillae shorter than segment, the largest papilla transversely sculptured (Plate LII, 251). Mandible (Plate LI, 245) long and slender, the lateral teeth more accentuated than in *Eriocera*; largest tooth with a flattened truncated blade in its axil, this in some cases broken up into two or three small blades; basad of largest lateral tooth a flattened lobe which is barely indicated in the species of *Eriocera* studied. Maxilla with outer flattened blade conspicuous; palpus near its base on inner side, similar to the condition obtaining in *Eriocera*; just laterad of palpus a powerful seta.

*Pupa*.— Length, 9.2–9.6 mm.  
Width, d.-s., 1.2 mm.  
Depth, d.-v., 1.4 mm. }

Pupa (Plate LI, 247) very similar to that of *Eriocera longicornis*, differing only in its small size, greater development of scapal spine, lack of projection on mesonotal prescutum, and a few lesser characters. Cephalic crest (Plate LI, 248 and 249) as viewed from beneath, very different in shape. Fore pair of legs much shorter than the others, ending just beyond posterior margin of second abdominal segment; hind pair of legs extending far beyond the others, ending beyond midlength of third abdominal segment; in some specimens the tarsal segments much closer to posterior margin of third abdominal segment, but usually a marked difference in tips of tarsi of the various legs. Cephalic crest as viewed from side, triangular, ending in an acute point directed strongly forward. Viewed from beneath, lobes conspicuously triangular, pointed, lying parallel or slightly divergent and separated by a deep median split. Spine on scape of antennae very large, conspicuous. Tubercle on labrum strongly developed. Antennal sheaths of male very long, those of female much shorter. Pronotal breathing horns short, straight. Mesonotum strongly wrinkled along median line; scutellar lobes not developed. Wing pads dark, venation not showing clearly but, if made out, the very short cell  $R_2$  and the reduced  $M$  characteristic of *Hexatoma* alone. Posterior leg sheaths extending beyond level of middle legs, these, in turn, being longer than sheaths of fore legs.

Abdomen (Plate LII, 252) with about thirty-four spicules on sternite 4, about thirty in a straight, uninterrupted row on tergites 3 and 4, and about twenty on tergite 5. Chaetotaxy about as in *Eriocera longicornis*, but the seta lying ventrad of spiracle on pleurites much farther ventrad and very weak. Male cauda with sternal lobes strongly rounded, enlarged, and bent suddenly dorsad. Female cauda as that of male; ovipositor viewed from side with an obtuse notch; from beneath, sternite obtusely pointed and with a deep median split; from above, tergite almost flat across caudal margin, the lateral angles rounded, with a deep median split.

*Nepionotype*.— Ithaca, New York, May 6, 1914.

*Neanotype*.— Type locality, May 2, 1913.

*Paratypes*.— Several hundred larvae and pupae from type locality.

### Genus *Eriocera* Macquart (Gr. *wool* + *horn*)

- 1830 *Caloptera* Guér. Voyage de la Coquille, Zool., Ins., pl. 20, fig. 2.  
 1838 *Eriocera* Macq. Dipt. Exot., vol. 1, p. 74.  
 1838 *Evanioptera* Guér. Voyage de la Coquille, Zool., vol. 2, part 2, p. 287.  
 1848 *Pterocosmus* Walk. List Dipt. Brit. Mus., vol. 1, p. 78.  
 1850 *Allarithmia* Loew. Bernstein und Bernsteinauna, p. 38.  
 1857 *Oligomera* Dolesch. Natuurk. Tijdschr. Nederl. Indie, vol. 14, p. 387.  
 1859 *Arrhenica* O. S. Proc. Acad. Nat. Sci. Phila., p. 242.  
 1859 *Physecerania* Bigot. Ann. Soc. Ent. France, ser. 3, vol. 7, p. 123, pl. 3, fig. 1.  
 1912 *Androclosma* Enderlein. Zool. Jahrb., vol. 32, part 1, p. 34.  
 1916 *Globericera* Matsumura. Thous. Ins. Japan, add. 2, p. 471.

*Larva*.— Spiracular disk surrounded by four lobes which are rarely (as in *Eriocera cinerea*, subobsolete, inner face lined with brown or black, tips with fringes of moderately long hairs. Head capsule long, narrow, the constituent plates very slender; dorsal plate completely divided tho contiguous or approximated behind. Labral sclerite large and conspicuous, sensory tubercles and papillae crowded on median cephalic region. Mandible long, acute

at tip, with two teeth at about midlength. Maxilla with outer lobe greatly prolonged into a flattened blade. Antenna cylindrical or clavate, with three or four long papillae at tip. Mentum not chitinized, in *E. cinerea* with a flattened rectangular plate on either side, this armed with numerous hooks and spines.

*Pupa*.—Cephalic crest of various shapes and sizes, very reduced in *Eriocera spinosa*. Antennal sheaths of males of several species (*E. spinosa*, *E. longicornis*, *E. cinerea*) very long, extending beyond end of wing pad. Pronotal breathing horns of various shapes, acutely pointed in *E. spinosa*, short and blunt in several species. Head and thorax often with spines or tubercles on scape of antenna, on labrum, or (in *E. spinosa*) on face of eye; a tubercle on scutellum (in *E. longicornis*), one on dorsum of second abdominal segment (in *E. spinosa*). Abdominal segments with a conspicuous transverse armature of spines near posterior margin. Lateral spiracles large, distinct.

*Eriocera* is an extensive genus (including approximately 150 species) of medium-sized to large flies, most of which are tropical. The genus has not been found in Europe, but elsewhere it is represented by a host of species. The habits of the adult flies have already been noted (page 704). The immature stages are spent in sand or gravel near running water, more especially along large streams. A more complete account of the genus is given by Alexander and Lloyd (1914) and by Alexander (1915 c: 148–152).

The occurrence of the flies is somewhat local. During an entire summer of collecting in Maine in 1913, the writer did not find a single specimen of any species; and Dr. Dietz has stated that the only living individual which he has found was a single male of *Eriocera spinosa* taken in the Pocono Mountains in Pennsylvania. On the other hand, the flies are often found in countless numbers, and several species may be found associated together. Thus, at Ithaca, New York, in the sandy gravel along Cascadilla Creek, the immature stages of four species of *Eriocera* and one of the closely related *Hexatoma* occur together in unlimited numbers.

The species of *Eriocera* may be separated by the following keys:

*Larvæ*

1. Lobes surrounding spiracular disk obsolete or nearly so; a flat, chitinized plate with serrate margins on either side of mental region. . . . . *E. cinerea* Alex. (p. 886)  
Spiracular disk surrounded by four slender lobes; no plate as described above on mental region. . . . . 2
2. Very large (length 40–45 mm., diameter 4–5 mm.); spiracular disk with ventral lobes narrowly lined with black, inner ends of each forked, Y-shaped; lateral lobes narrowly lined with black, inner ends of marks expanded. . . . . *E. spinosa* (O. S.) (p. 883)  
Smaller (length under 30 mm., diameter under 2.5 mm.); spiracular disk not marked as above. . . . . 3

3. Ventral lobes of spiracular disk bearing one or two very long, dark setae in addition to the shorter yellowish fringe; inner face of each lobe with a capillary black line which is suddenly expanded at its inner end into a triangular brown mark, the two marks inclosing an oval pale area between their proximal ends; lateral lobes with a capillary black line. . . . . *E. fultonensis* Alex. (p. 880)
- Ventral lobes of spiracular disk with apical fringe consisting of numerous long, pale setae; inner face of each lobe lined with pale brown, at about midlength gradually expanded into an elongate-triangular mark, the two marks inclosing a linear pale area between their proximal ends; lateral lobes with a brown line. . . . . *E. longicornis* (Walk.) (p. 888)

*Pupae*

1. Size large (length 25 mm. or over); pronotal breathing horns tapering to acute tips; cephalic crest small, reduced to four small tubercles; cell  $M_1$  on wing pad present; a strong spinous tubercle on either side of median line at base of second abdominal tergite; a tubercle on eye. . . . . *E. spinosa* (O. S.) (p. 883)
- Size smaller (length under 18 mm.); pronotal breathing horns blunt at tips; cephalic crest prominent; cell  $M_1$  on wing pad lacking; no tubercles on second abdominal tergite or on eye. . . . . 2
2. A tubercle on mesonotal scutellum. . . . . *E. longicornis* (Walk.) (p. 888)
- No tubercle on mesonotal scutellum. . . . . 3
3. Pleurites of abdominal segments with a transverse row of three setae ventrad and slightly caudad of spiracle; antennae of male elongated. . . . . *E. cinerea* Alex. (p. 886)
- Pleurites of abdominal segments with two stout setae dorsad and caudad of spiracle<sup>1</sup>; antennae short in both sexes. . . . . *E. fultonensis* Alex. (p. 890)

*Eriocera spinosa* (O. S.)

1859 *Arrhenica spinosa* O. S. Proc. Acad. Nat. Sci. Phila., p. 244.  
 1869 *Eriocera spinosa* O. S. Mon. Dipt. N. Amer., part 4, p. 252-253.

*Eriocera spinosa* is the commonest of the large species of the genus in eastern North America. The larvae occur in great numbers beneath rocks in rapid water in the autumn, when they form a considerable proportion of the insect life in the streams. When about to pupate they go to the neighboring banks and live for some time in the sand or gravel. The habits of the larvae have been discussed by Alexander and Lloyd (1914:16-17) and by Alexander (1915c:149).

The larvae were found on May 1, 1913, along the banks of Fall Creek, Ithaca, New York, in considerable numbers. They were associated with young and mature pupae of *E. longicornis*, which were emerging in great numbers at the time. On May 27, both larvae and pupae of *E. spinosa* were found to be very abundant, the larvae being more numerous in the wetter places, the pupae in the drier spots. They occurred at various distances from the water's edge, from within a foot of the margin to as far back as eight or ten feet. The pupae are found in short, more or less vertical, burrows, from one to three inches below the surface. Not often

were larvae and pupae found in close proximity to each other. Pupae of *E. spinosa*, as well as of all other species of the tribe as known, are very active when removed from their burrows, wriggling rapidly to and fro, and are exceedingly tenacious of life: Larvae, as found on May 27, were mostly contracted; a few, however, were expanded and had the subterminal segment of the abdomen swollen. In this regard it may be mentioned that almost all of the larvae of crane-flies that live in the sand or mud along the banks of streams have this ability to inflate the end of the abdomen. Larvae of Eriopterini, of Pediciini, and of Hexatomini have been observed with this conspicuous enlargement. It is undoubtedly used to propel the larva thru the soil by alternate expansion and contraction of the segment.

Larvae of *E. spinosa* were placed in breeding jars on May 13 and adult flies emerged on the 28th. It is probable that the pupal stage is not longer than from ten to twelve days, at the most. On May 30 a large number of larvae and pupae were brought into the laboratory in a bucket of gravel. Some of the fully matured pupae transformed in the pail while being brought to the laboratory.

The larvae are carnivorous. Their powerful, sickle-shaped mandibles are capable of inflicting a painful bite on tender parts of the hand. S. G. Rich placed larvae in dishes together with the nymphs of various dragon flies. The smaller of the nymphs were eaten by the Eriocera larvae, thus confirming previous observations on the carnivorous habits of the species.

*Larva*.— Length when fully extended, 40–45 mm.  
Diameter, 4–5 mm.

Color varying from very pale whitish to rather dark brown; in life, the skin showing conspicuous bronzy reflections.

Spiracular disk (Plate LIV, 262) surrounded by four slender elongate lobes, one pair being lateral, the other ventral, in position; inner face of lateral lobes with a capillary black line, this beginning as an enlarged black spot just ventrad of spiracle, reaching tip of lobe; dorsal outer edge of lobe with a dense fringe of long, conspicuous, reddish hairs, inner edge of row beginning just laterad of spiracle where the hairs are very short, gradually becoming longer to tip, where they are as long as the lobe itself; ventral lobe with a capillary black line on proximal edge, this dividing at base of lobe, the lower branch running along ventral margin of stigmal field and approaching its fellow of the opposite side on median line of body; a dense fringe of conspicuous reddish hairs at tip of lobe and continued on outer dorsal side for a short distance toward base; a few dusky brown spots on stigmal field between spiracles; two small hairs between spiracles. Spiracles rather small, widely separated. Underneath caudal lobes and behind penultimate swollen segment, four anal gills, short, stout, cylindrical,

the lateral pair directed outward, the inner pair directed caudad. Head capsule (Plate LIV, 267) broad in proportion to its length, measuring 3.5–3.8 mm. by 1.8–2 mm. (across dorsal plates). Papillae at tip of antenna short, not more than one third length of segment. Mandible (Plate LIV, 271) lacking a prominent conical tooth at midlength, such as is found in *E. cinerea* and other species.

*Pupa*.— Length: male, 26.5–27 mm.; female, 25–28.5 mm.  
 Width, d.-s.: male, 3.4–3.9 mm.; female, 3.4–4 mm.  
 Depth, d.-v.: male, 4–4.2 mm.; female, 3.5–4 mm.

In life, pupae varying in color from very pale yellowish to dark brown or almost black, the deepest color being that of head and thorax of old pupae; body often showing bronzy reflections.

Cephalic crest very reduced, scarcely projecting beyond level of antennae; viewed from beneath, somewhat quadrate, the anterior lateral angles produced into small pointed lobes bearing a small seta at apex; viewed from side a second pair of lobes is seen, these being subequal to anterior lobes in size, and likewise setiferous. Spine of antennal scape very large, somewhat curved, directed ventrad. Inner caudal surface of eye with a conspicuous tubercle. Tentorial region produced into a small median tubercle. Tubercles at base of labrum very large, close together, their tips strongly chitinized; a small seta above each of these labral tubercles and another small seta on each cheek. Pronotal breathing horns long, slender, broad at base, flattened and rather pointed at tips, the organ arcuated so that apex is bent strongly ventrad. Mesonotal scutellar lobe (Plate LV, 280) prominent, rather strongly projecting. Wing pad light brown, venation showing very clearly, the presence of cell  $M_1$  in connection with elongate antennae in male sex being found in this species alone in eastern North America. Leg sheaths with tarsal sheaths ending on a level, about opposite end of third abdominal segment.

Second abdominal tergite with a conspicuous basal tubercle on either side of median line. Abdominal segments (Plate LVI, 283) with subterminal rows of spines, there being about twenty to twenty-two on tergites 2 to 5; tergites 6 and 7 destitute of spines but with four subapical setiferous tubercles; tergites 2 to 7 with a conspicuous setiferous tubercle on ventrocephalic angle of each posterior ring; eighth tergite concave on posterior margin, bearing a pair of strong apical tubercles on either side of median line. Pleural region of abdomen rather restricted, longitudinally wrinkled. Spiracles large, elliptical, transverse, placed about opposite midlength of segments. Three small setiferous tubercles ventrad and caudad of spiracle, and another similar tubercle on dorso-cephalic angle of each pleuron. Sternites on segment 3 with two spines on each outer angle; segments 4 to 6 with from sixteen to twenty spines; segment 7 with about ten spines; an isolated setiferous tubercle caudad and dorsad of ends of row; segments 4 to 7 with a setiferous tubercle about midlength of posterior ring; segment 8 lacking soft pleural region, bearing an apical row of strong spines which are interrupted only on dorsum and for a small space on median line of venter, there being about twenty of these spines in the circle. Male cauda (Plate LV, 281 and 282) with ninth sternite rounded, swollen, with a deep median furrow bearing a small lobe on ventral side at end of split; ninth tergite produced caudad into two strong conical points separated by a V-shaped notch, these points directed caudad and slightly dorsad, each one a little split near tip on outer face and with a prominent lateral tooth at about midlength. Female cauda (Plate



LVI, 284) with ninth sternite elongated, cylindrical, its tip rounded, feebly split beneath; ninth tergite very long, pointed, with a deep median split.

*Nepionotype*.— Ithaca, New York, May 1, 1913.

*Neanotype*.— With type larva.

*Paratypes*.— Numerous larvae and pupae with types, May 1–15, 1913.

*Eriocera cinerea* Alex.

1912 *Eriocera cinerea* Alex. *Psyche*, vol. 19, p. 169–170, pl. 13, fig. 9.

*Eriocera cinerea* is locally common, flying in May. The larvae were found on May 16, 1917, in sand along the banks of Cascadilla Creek, Ithaca, New York. They have been found at various dates during the past few years, but always in scanty numbers. Larvae found on April 28 were associated with larvae of *Hexatoma megacera*, *Eriocera spinosa*, *Atherix*, and other insects. The larvae are stouter than those of *E. longicornis* and are pale whitish yellow, quite devoid of the greenish tints of the latter species. A larva found on April 28 transformed to an adult female on May 16. Additional larvae and pupae were found on May 24, and a few pupae on May 30, 1917.

The supposed larva of *E. longicornis* described by Alexander and Lloyd (1914:21–23) pertains to this species; the true *longicornis* is discussed later in this paper.

*Larva*.— Length, 15–16 mm.  
Diameter, 2–2.2 mm.

Color light yellow.

Form almost terete, abdominal segments subdivided into two annuli. Subterminal abdominal segment greatly enlarged, capable of great distention. Spiracular disk (Plate LIV, 263 and 264) very reduced, the usual four lobes exceedingly small; ventral lobes practically obsolete, not projecting, each fringed with from twenty to thirty long, golden-yellow hairs; lateral lobes very short, triangular, fringed with from twelve to fifteen long hairs; a faint dusky mark from dorsal margin of each spiracle to edge of field; a faint vertical stripe between spiracles; ventral lobes marked with brownish black, the mark of each side three-pointed at its inner end, the innermost of these points connected with its fellow of the opposite side; lateral lobes with the marks elongate, triangular, the points directed outward. Spiracles small, oval, separated by a distance a little less than the diameter of one. Anal gills four, very short and inconspicuous.

Head capsule long and narrow, measuring about 1.5 by 0.275 mm.; dorsal plates of capsule with proximal anterior angles produced inward. Labral sclerite (Plate LII, 253) having labrum itself subquadrate. Mental region entirely lacking strongly chitinized points as in this group of genera. Present species showing a structure which is probably a part of labium, either mentum or hypopharynx, and which has not been found in any other species of the

genus (Plate LII, 254); this structure located on either side of capsule on ventral face, a flattened, subrectangular plate whose surface, except at base, is densely set with small spines and large pits; inner margin provided with large, acute spines, beginning at about one-third length of sclerite, gradually enlarged toward tip, at inner angle acute; these teeth interrupted before outer posterior angle, which terminates in a blunt, flattened lobe. Antenna cylindrical, apex obliquely truncated, terminating in a slender apical papilla which is longer than the segment that bears it, broad at base, tapering gradually to tip; two or three long apical setae; small auditory plates at about one-third length of segment. Mandible (Plate LII, 255) a powerful, slender, curved hook, at about midlength with a strong pointed tooth bearing in its axil a smaller tooth; as is usual in the genus, an egg-shaped chitinized piece isolated in one of the ventral tendons of mandible. Maxilla arising just ventrad of mandible, outer lobe persisting as a very elongate, bladeliike organ.

*Pupa*.— Length, 13–15 mm.  
Width, d.-s., 1.6 mm.  
Depth, d.-v., 1.7 mm.

Head and appendages dark brown, thoracic dorsum a little paler; abdomen with posterior rings of tergum and sternum dark brown, producing a banded appearance.

Cephalic crest (Plate LIII, 257) very large and conspicuous, consisting of two rounded lobes behind, each tipped with a strong seta; anterior part of crest directed ventrad and consisting of two lobes, the larger bearing a strong seta on outer face; viewed from front, these anterior lobes separated by a very narrow, U-shaped, median notch; crest of female a little smaller. Two blunt tubercles on scapal segments of each antenna. Junction of clypeus and labrum with two tubercles, above and slightly laterad of each a strong seta. A strong seta on cheek below eye. Labrum broad, very obtusely rounded at tip. Labial lobes rectangular, widely separated. Maxillary palpi blunt at tips (Plate LIII, 258). Antenna of male elongate, exceeding wing and ending opposite base of last tarsal segment of hind leg. Pronotal breathing horns short, slender, cylindrical, scarcely longer than cephalic crest. Two long curved setae and a smaller straight seta laterad and ventrad of base of each breathing horn. Lateral angle of thorax with two setae; two long setae above wing axil (Plate LIII, 256). A strong seta on either side of mesonotum and a group of two small setae in front of each of these. Wing sheaths extending to base of third abdominal segment. Leg sheaths extending to base of fourth abdominal segment; tarsal sheaths ending about on a level, or those of fore legs considerably shorter.

Abdominal segments (Plate LIII, 259) divided into two subequal rings. Chaetotaxy as follows: pleura with a seta on dorsal margin of basal ring; a transverse row of three setae on posterior ring, lying ventrad and slightly caudad of spiracle (as in *E. spinosa*); tergum with basal ring unarmed, posterior ring with a subterminal row of sharp black spines; two long setae at each end of row and a few small setae at intervals along row; a solitary seta on basal lateral part of posterior ring; armature weaker on posterior segments, on segment 7 being reduced to four separated groups of setae, the outer groups with a single spine; sternum with basal ring unarmed, posterior ring with a subterminal transverse row of stout black spines with two long setae at each end of row and an isolated seta laterad and caudad of end of row; at base of ring on either side a group of two setae, the lateral one the smaller. Male cauda (Plate LIII, 260) with the sharp dorsal lobes directed dorsad, rather acute at tips, two

setae on outer face before tips; viewed from above, these setae seen to be separated by a deep U-shaped notch; eighth segment with a dorsal pentagon of five closely approximated lobes; just laterad of these a group of three setae, the posterior one long and slender, the anterior one short and stout; pleural region produced into a long lobe tipped with a slender seta; on sternum two small setae on either side. Female cauda (Plate LIII, 261) elongate, tergal valves very long and slender, two delicate setae on either side before tip and a stouter one at tip.

*Nepionotype*.— Ithaca, New York, April 28, 1917.

*Neanotype*.— Fall Creek, Ithaca, May 18, 1917

*Paratypes*.— Larvae and pupae with types.

### *Eriocera longicornis* (Walk.)

1848 *Anisomera longicornis* Walk. List Dipt. Brit. Mus., vol. 1, p. 82.

1869 *Eriocera longicornis* O. S. Mon. Dipt. N. Amer., part 4, p. 253-254.

*Eriocera longicornis* is probably the commonest species of the genus in the eastern United States. The adult flies are sometimes very abundant, occurring in swarms in late afternoon and early evening in May, some of the swarms numbering thousands of individuals. At other times of the day, the flies may be found resting quietly on bushes. The larvae live in the sand near the water's edge. The pupal duration is seven days. The detailed life history of this species is given on pages 704 to 708.

*Larva*.— Length, 17-19 mm.

Diameter, 2-2.3 mm.

Color, greenish brown.

Body covered with a long, appressed, dark pubescence. Penultimate segment of abdomen capable of great distention and destitute of pubescence; last segment of body conspicuously narrowed. Spiracular disk (Plate LIV, 265) surrounded by four slender lobes, the ventral pair the longer, bearing at tip elongate hairs, some of which exceed the lobes in length; on lateral face at about midlength a small pencil of hairs; on ventral face one or two long setae; inner face of ventral lobes lined with pale brown, beginning as a narrow brown mark at tip, at about midlength gradually expanded into an elongate triangular mark, the two lines inclosing between their inner ends a pale linear mark; lateral lobes similar to ventral lobes, fringed with long yellow hairs which are longer than the lobes; inner face of lateral lobes lined with pale brown. Spiracles rather large, separated by a distance equal to about one and one-half diameter of one. Anal gills pale. A few setae in transverse alinement on last segment behind lateral lobes. Two pairs of short black setae behind gills.

Head capsule and mouth parts very similar to those of *Hexatoma*, dorsal plates of capsule separate from each other, not fused as in the *Ulomorphae*; inner margins of dorsal plates straight and parallel. Labral sclerite broadly transverse, narrowed at ends, lateral margins produced into long lobes which are densely tufted with short, golden-yellow hairs. Median lobe of epipharyngeal region projecting, provided with two large sensory papillae, one on either side, and a few other setiferous papillae near tip, surrounded by numerous hairs.

Antenna elongate, a little narrower at base, at tip with three or four hyaline, seta-like papillae which are of various diameters and shorter than the segment, the largest of these papillae delicately sculptured with transverse lines. Mandible acute, curved, at about midlength with a blunt, flattened tooth, this with a smaller similar tooth in its axil. Maxillary blade very long and slender, about half length of capsule.

*Pupa*.—Length: male, 13.2–15.2 mm.; female, 14–15.4 mm.

Width, d.-s.: male, 2.1–2.2 mm.; female, 1.8–1.9 mm.

Depth, d.-v.: male, 2.1–2.3 mm.; female, 2.2 mm.

Young pupae very pale; soft abdomen almost white; chitinized anterior part of body very pale brown. Older pupae much darker, the chitinized part becoming black with a bronzy reflection; abdomen very dark brownish gray; breathing horns dark brown on apical half.

Cephalic crest (Plate LV, 275) very prominent, elongate, tapering to the subacute tips; lobes with blunt tubercles behind, as well as four long setae on each lobe, three on dorsal margin and a longer one on lateral face at about midlength; viewed from in front, lobes separated by a broad, square or U-shaped notch; ventral part of crest produced forward between antennal bases as a depressed lobe bearing a stout seta on either side. Tubercle on antennal scape very prominent. A slightly smaller tubercle on either side of clypeus, with a small rounded knob cephalad of each. Labrum truncated. Labial lobes roughly diamond-shaped. Maxillary palpi very broad, rectangular, tips truncated. Antennal sheaths of male greatly elongated, enlarged at base; viewed from beneath, the swollen bases nearly contiguous on median line, just above and proximad of inner margin of eye, with scapal tubercle described above. Antenna of male exceeding wing pads, those of female ending just beyond wing base. Pronotal breathing horns short and stout, straight, transversely wrinkled, directed cephalad, dorsad, and laterad; when viewed from beneath, completely concealed by large cephalic crest. Thoracic notum convex; mesonotum transversely wrinkled (Plate LV, 277); median lobe of mesonotal scutellum projecting dorsad and caudad as a blunt point (Plate LV, 272). Two or three setae above wing axil. Lateral angles of thorax subacute, with a weak seta. Wing sheaths attaining end of second abdominal segment. Leg sheaths ending before caudal margin of third abdominal segment; tarsi of hind legs the longest, the two inner pairs ending about on a level (Plate LV, 273).

Abdominal segments (Plate LVI, 285) divided into a basal and a posterior ring; tergites on posterior ring with a subterminal transverse row of spines, these varying from about thirty-two on segment 3 to about fourteen on segment 7; these rows of spines interrupted on dorso-median line; at each end of row, three long setae, and two additional groups of setae interspersed along row; two setae on either side at anterior-lateral angle of ring; tergites on basal ring unarmed; sternites on posterior ring with a subterminal transverse row of from twenty-four to thirty-two spines, with two setae at each end of row; an isolated seta on caudolateral margin, close to pleura; a group of two approximated setae near base of posterior ring, on either side, about at level of spiracles. Sternites on basal ring unarmed; pleurites on basal ring with a solitary seta at about midlength, but slightly nearer dorsal margin; posterior ring with two setae dorso-caudad of spiracle, and a third seta ventrad of it. Malp. cauda (Plate LVI, 286) very blunt, much narrower than remainder of abdomen; ventral lobes very blunt; dorsal lobes short, stout, ending in sharp points directed dorsad, on outer face a long and a short seta; segment 8 with a dorsal trapezoid of four lobes, the posterior

pair the longer, each with two setae; anterior pair of lobes a little more widely separated; laterad of latter pair of lobes, a tubercle bearing three setae; a long, powerful seta on pleura; two setae on either side of median line of sternum. Female cauda (Plate LV, 274) similar, but ventral lobes more pointed, slightly exceeding level of dorsal lobes.

*Nepionotype*.— Ithaca, New York, April 18, 1917.

*Neanotype*.— Fall Creek, Ithaca, May 2, 1913.

*Paratypes*.— Several hundred larvae and pupae with types.

### *Eriocera fultonensis* Alex.

1912 *Eriocera fultonensis* Alex. *Psyche*, vol. 19, p. 163-169, pl. 13, fig. 7.

*Eriocera fultonensis* is a rather common but usually local species thruout the northeastern United States. The larvae are found in the same situations as are described for the other species of the genus, in sand or gravel near the margins of usually large streams. On May 30, 1913, larvae were found in considerable numbers along the banks of Fall Creek, Ithaca, New York, where they occurred in company with numerous larvae and pupae of *E. spinosa*, a few large tabanid larvae, a small tabanid pupa, and the following beetle associates: Bembidion, Schizogenius, Tachys, Gastrolobium, and a few others. The pupal duration is seven days (from May 31 to June 6, 1913).

*Larva*.— Length, 18-26 mm.

Diameter, 2-2.3 mm.

Color, pale flesh yellow; anterior segments of body a little darker.

Body long and slender. Spiracular disk (Plate LIV, 266) with ventral lobes long and slender, lateral lobes shorter; ventral lobes at their tips with one or two very elongate blackish hairs which are from two to three times length of lobes; in addition to these the usual apical fringe of yellowish hairs not exceeding lobes; near base on outer side a small pencil of hairs; each ventral lobe with a very delicate capillary black line which expands abruptly at its inner end into a brown area, these two areas inclosing between their proximal ends a more or less oval pale area (in some specimens the inner ends completely encircling this pale area, while in others the brown lines are not continuous over the disk); lateral lobes shorter, similarly fringed with yellow hairs which are longer than lobes; inner face of lobes with a capillary black line. Spiracles rounded oval, widely separated.

Head capsule and mouth parts almost as in *Hexatoma megacera* and *Eriocera longicornis*, as already described; epipharyngeal region (Plate LIV, 268) produced into a hemispherical rounded lobe which is densely covered with fine hairs; two large papillae on either side near tip, between them a terminal tuft of long yellow hairs surrounding two long, slender, setiferous papillae. Antenna with sensory papillae at tip short, about one-third length of segment.

*Pupa*.— Length, 14-16 mm.

Width, d.-s., 1.8-2 mm.

Depth, d.-v., 2.5-2.7 mm.

Fully colored pupae dark brown; cephalic crest paler; pronotal breathing horns pale yellow, darkening into brown at tips; wing pads light yellow, with dark venation showing clearly; pleurites of abdomen of a darker brown than sternites or tergites.

Body somewhat similar to that of *E. longicornis*, but general form much stouter. Cephalic crest (Plate LVI, 287) prominent, tuberculate, consisting of four lobes, the posterior lobes somewhat the larger, on posterior and lateral faces with two stout setae; a stout seta on ventral face of anterior lobes. Scapal spine lacking. Clypeal tubercles large, blunt, with a small setiferous tubercle above each. Labrum bluntly rounded at apex. Labial lobes elongate, diamond-shaped, tips rather acute. Pronotal breathing horns rather long and slender, transversely wrinkled, longer than cephalic crest. Mesonotum (Plate LV, 279) more convex than in *E. longicornis*. Wing pads usually showing venation clearly on pale background; vein *r* connecting  $R_1$  with  $R_{2+3}$  distinctive of this species, lack of cell  $M_1$  separating this pupa from that of *E. spinosa* and *E. brachycera*. Legs sheaths ending about on a level, the hind tarsi a little longer than the two inner pairs.

Arrangement of setae on abdomen (Plate LVI, 288) about as in *E. longicornis*. Pleura with two stout setae dorsad and caudad of each spiracle, and a weak seta ventrad of spiracle and close to it; basal ring with a single pleural seta; spicules on caudal margin of posterior ring small and numerous, on intermediate segments about forty in number; seventh sternite with about four to six spines at each end of row, the broad median area devoid of spines. Female cauda (Plate LV, 276) with tergal valves exceeding the long sternal valves, scarcely directed dorsad (this condition may be compared with that in *E. longicornis*). Male cauda with abdomen bluntly rounded at tip.

*Nepionotype*.— Ithaca, New York, May 30, 1913.

*Ne notype*.— With type larva, June 6, 1913.

*Paratypes*.— Larvae and pupae with types.

### Genus *Penthoptera* Schiner (Gr. *sorrow* + *wing*)

1863 *Penthoptera* Schin. Wien. Ent. Monatschr., vol. 7, p. 220.

*Larva*.— Spiracular disk surrounded by four blunt lobes, the ventral pair a little the longer, inner face not marked with darker, at tip with one or more long setae. Head capsule about as in *Eriocera*. Coloration a deep saturated yellow.

*Pupa*.— Cephalic crest with lobes rounded, setiferous. No distinct tubercles or spines on head or thorax. Pronotal breathing horns short, stout, cylindrical, apex expanded into a flattened head, stem coarsely wrinkled, base enlarged. Abdominal armature weak. Spiracles not well developed.

*Penthoptera* is a small genus which includes four European and three American species, two of the latter occurring in tropical America. The eastern North American *Penthoptera albitarsis*, discussed below, has been considered in some detail by the author in another paper (Alexander, 1915c:152-157).

*Penthoptera albitarsis* O. S.

1869 *Penthoptera albitarsis* O. S. Mon. Dipt. N. Amer., part 4, p. 257-258.

The larvae of *Penthoptera albitarsis* are usually not uncommon in rich organic mud in shaded places thruout the range of the species. Larvae of many sizes, some very small, others apparently almost fully grown, may be found at a single time. This would probably indicate that the species emerges at intervals thruout the summer, rather than that it is double-brooded.

Larva.— Length, 10-12 mm.  
Diameter, 1-1.2 mm.

Color bright chestnut-yellow, anterior half of body richer- and deeper-colored; thoracic segments suffused with brown; skin with a silky, iridescent reflection.

Body provided with numerous long, appressed hairs. A few setae on body, the following being the most conspicuous: one on lateral dorsal margin of last segment, near base of lateral lobes; a series of four groups of one or two in each row across dorsal surface of the three thoracic segments at about midlength; a group of two or three long setae on sides near caudal margin of segments. Subterminal enlargement of abdomen with about twenty-five transverse rows of fine points.

Spiracular disk (Plate LVII, 292 and 293) with four blunt lobes; ventral lobes densely fringed with long, pale hairs, those toward ends of lobes longer; one or more elongate setae near tip of each ventral lobe, these being longer than lobes themselves; lateral lobes with a similar fringe of rather short, yellow hairs; spiracular disk almost free from dark markings, a pale brown line extending dorsad from each spiracle and an indistinct brownish line along ventral margin of lateral lobes. Spiracles circular. Anal gills four, pale. Head capsule rather broad, dorsal plate with inner anterior angles rounded. Labrum (Plate LVII, 289) almost as in *Eriocera spinosa*, the extreme cephalic epipharyngeal parts with the usual papillae and setiferous tubercles; lateral papillae bearing at their tips three or four slender pegs; between these papillae two pairs of setiferous tubercles, a basal larger pair and a more apical smaller pair. Mandible (Plate LVII, 291) a little more curved than is usual in this subtribe, inner margin with a double tooth at about midlength.

Pupa.— Length, 10-10.5 mm.  
Width, d.-s., 1.4-1.5 mm.  
Depth, d.-v., 1.5-1.6 mm.

Thorax dark brown, wing and leg sheaths paler; pronotal breathing horns dark brown, swollen bases and tips much paler, light orange; abdomen brownish yellow.

Cephalic crest consisting of two widely separated rounded lobes behind, each bearing two setae; anteriorly the crest appearing as a large depressed lobe between antennal bases, with a very large, stiff seta on either side. A powerful seta on each side of region of clypeus. A seta on genal region between eye and sheath of maxillary palpus. Labrum evenly rounded or a little truncated at apex. Labial lobes widely separated, roughly rounded or indistinctly pentagonal in outline. Maxillary palpi broad, ending bluntly beneath or just before antennal sheaths. Antennae ending just beyond wing root in female, considerably longer in male.

Pronotal breathing horns (Plate LVII, 294) short, stout, cylindrical, apex expanded into a flattened circular head, stem coarsely and transversely wrinkled, base enlarged; breathing horns widely separated at their bases, but bent proximad so as to be almost contiguous at their tips; two strong setae laterad of base of breathing horn and an additional one in front of it. Mesonotum transversely wrinkled, with a distinct carina anteriorly (Plate LVIII, 296). Two groups of two setae on either side of median line, with an additional solitary seta; two longer setae above wing axil. Wing sheaths ending before tip of second abdominal segment. Leg sheaths ending at from two-thirds length to opposite end of third abdominal segment; tarsal sheaths ending about on a level, or, in some specimens, the hind tarsi a little longer than the others (Plate LVIII, 297).

Abdomen indistinctly divided into a narrow basal ring and a broader posterior ring; basal ring further very indistinctly subdivided into two subequal annuli. Abdominal armature weak; on sternites a subterminal transverse row of delicate spines with two setiferous tubercles at each end of row; on posterior ring two setae on either side at about midlength; tergites with four groups of two or three setae near posterior margin and an additional group of two setae on lateral margin of posterior ring near base; pleural region with a stiff seta on extreme anterior part of basal ring. Spiracles distinct; a group of two setae caudad and slightly ventrad of each spiracle, with an additional solitary seta caudo-ventrad of these. Female cauda (Plate LVIII, 298) with tergal valves of ovipositor only a little longer than sternal valves, at tip ending in a short, rather blunt point directed dorsad; on outer face before tip a short, stiff seta; segment 8 on dorsum with a close trapezoid of four irregular lobes; two setiferous tubercles on dorsal and lateral part of eighth segment, the more dorsal of these with two setae, the lateral one with a single seta; sternum with four stout setae, of which two are lateral and two are median in position. Male cauda (Plate LVII, 295, and Plate LVIII, 299) with sternal valves short and blunt; tergal valves slender, ending in an acute point directed dorsad; a few short setae on outer face before tip.

*Nepionotype*.—Ithaca, New York, May 25, 1917.

*Neanotype*.—Bool's hillside, Ithaca, June 5, 1917.

*Paratypes*.—Abundant larvae and a few pupae with types.

### Subtribe *Polymeraria*

Genus *Polymera* Wiedemann (Gr. *many* + *part*)

1821 *Polymera* Wied. Dipt. Exot., vol. 1, p. 40.

*Polymera* is a tropical American genus including fifteen described species, one of which, *Polymera georgiae* Alex., occurs in the southeastern United States. A single additional species, *P. magnifica* Meunier (1906: 385), has been described from the Baltic amber (Lower Oligocene). The only species concerning the ecology of which we have any record is *P. geniculata* Alex., which has been found living in crabholes beneath rocks in Porto Rico. In this connection the long-horned democeritine mosquitoes



which live in similar habitats should be considered. Howard, Dyar, and Knab (1915:213) say, in describing these mosquitoes:

These crab-hole inhabiting species possess peculiarly developed antennae in order, as we suppose, to enable them to detect the approach of their crustacean host and fly out of the holes before being overwhelmed in the water in the bottom by the incursion of the crab, whose body must completely fill the entrance to the hole.

It is curious and suggestive that the males of *Polymera* should likewise possess elongated and very complicated antennae.

### Tribe *Pediciini*

The *Pediciini* constitutes a small tribe which seems to be divisible into two well-marked subtribes, the more generalized *Adelphomyaria* indicating a relationship with the *Hexatomini*.

The larvae of the *Pediciini* have the labrum broad and the epipharynx usually feebly armed. The mentum is completely divided into two parts, each half with not more than four, usually three, teeth. The hypopharynx is labriform. The maxilla consists of two lobes, distinct and separate in the *Adelphomyaria*, more or less approximated or fused in the *Pedicaria*. The mandible is powerful, ending in a strong apical point; the cutting edge has about four teeth; there is a simple tuft of setae on the prosthecal region in the *Dicranotae* and in *Pedicia*. The head capsule is very elongate, massive, and compact, with the posterior incisions very shallow. In the *Adelphomyaria* the cauda is surrounded by four lobes which are fringed with exceedingly elongate hairs; in the *Pedicaria* there are two ventral caudal lobes, each tipped with a very few setae. The anal gills are four in number and are segmented, the terminal segment being more or less retractile. In the *Pedicaria* prolegs are developed on the abdominal segments of some of the genera.

All of the species of the tribe, so far as is known to the writer, are carnivorous in their larval state, which is spent in mud or earth close to water.

The two subtribes of the *Pediciini* may be separated as follows:

#### *Larvae*

Spiracular lobes four in number, fringed with very long, delicate hairs.

*Adelphomyaria* (p. 895)

Spiracular lobes two in number, ventral in position, each tipped with from six to eight setae.

*Pedicaria* (p. 899)

The most important literature on the tribe *Pediciini* is as follows:

<i>Pedicia rivosa</i> .....	General.....	Scheffer, in Rossi, 1848:9.
<i>Pedicia rivosa</i> .....	Larva, pupa, general..	Beling, 1879:45-46.
<i>Pedicia rivosa</i> .....	General.....	Reuter, 1893.
<i>Pedicia rivosa</i> .....	General.....	Wesenberg-Lund, 1915:335.
<i>Pedicia albivitta</i> .....	Larva.....	Needham, 1903:285-286; 1905:8.
<i>Tricyphona immaculata</i> .....	Larva, general.....	Beling, 1879:47.
<i>Tricyphona immaculata</i> .....	Larva, pupa, general..	De Meijere, 1916:195-196.
<i>Tricyphona schineri</i> .....	Larva, pupa, general..	Beling, 1879:47.
<i>Dicranota bimaculata</i> .....	Larva, pupa, general..	Mjall, 1893.
<i>Dicranota bimaculata</i> .....	Larva, pupa.....	Grünberg, 1910:66-67. (Copy.)
<i>Dicranota bimaculata</i> .....	General.....	Wesenberg-Lund, 1915:342-343.
<i>Dicranota bimaculata</i> .....	Larva.....	Malloch, 1915-17 b:219-220.
		(Copy.)
<i>Rhaphidolabis tenuipes</i> .....	Larva, general.....	Needham, 1908 a:212-214.

### Subtribe *Adelphomyaria*

The division *Adelphomyaria*, as known, includes but the single genus *Adelphomyia* Bergroth, a curious genus of small crane-flies which, in the general appearance of the adults, strongly suggest the hexatomine subtribe *Limnophilaria*. The immature stages have not been associated with the adult flies by rearing, and there is, of course, the possibility of a mistaken reference. The immature stages of the insect herein described are easily recognized, however, and, no matter to what group it belongs, it deserves subtribal rank under the *Pediciini*.

### Genus *Adelphomyia* Bergroth (Gr. *brother* + *fly*)

1891 *Adelphomyia* Bergr. Mittheil. Naturf. Ges. Bern, 1890, p. 134.

*Larva* (supposition).—Body with pencils of stiff setae, producing a spiny appearance. Spiracular disk surrounded by four short lobes which are fringed with exceedingly elongate hairs. Spiracles large, separated by a distance less than the diameter of one. Head capsule long and massive, all the plates firmly united except behind. Mandible acutely pointed. Maxilla of two elongate separated lobes. Antenna two-segmented, the terminal segment with three small papillae. Hypopharynx labriform. Mentum completely divided, each half with four teeth, the middle pair on each side the largest (*minuta*, supposition) or the second from the inside the largest (*americana*, supposition).

*Pupa* (supposition).—Cephalic crest small, each lobe with three setiferous tubercles. Pronotal breathing horns moderate in length, broadly tipped with light yellow. Mesonotum unarmed. Wing sheaths extending beyond base of third abdominal segment. Leg sheaths extending to beyond base of fifth abdominal segment. Abdominal armature weak, especially on posterior segments.

*Adelphomyia* is a small genus of crane-flies, including but four European and three North American species, and a doubtful species from Africa. The

insects resemble tiny species of the genus *Limnophila*. The adult flies are not uncommon on rank herbage, especially ferns, in woods and usually near running water. As already stated, the immature stages have not been reared, but larvae found by the writer in Maine are referred with considerable confidence to *Adelphomyia americana* and *A. cayuga*, while larvae and pupae of another species taken at Ithaca, New York, seem to be those of *A. minuta*. The larvae show a curious combination of tribal characters. The general appearance and the structure of the spiracular disk are altogether those of one of the Hexatomini; but the head capsule and the details of the mouth parts indicate a relationship with the Peditiini that cannot be denied.

*Adelphomyia minuta* Alex. (supposition)

1911 *Adelphomyia minuta* Alex. Can. Ent., vol. 43, p. 287-288.

*Adelphomyia minuta* is a characteristic late spring species, common in boggy woods and on vegetation along rapid streams. Larvae and pupae which are referred to this species were sifted from organic mud taken on Bool's hillside, Ithaca, New York, thruout May and early June, 1917. The pupae referred to this species strongly resemble those of *Dicranophragma* but in reality are very different. The species is discussed herewith in the hope that it may be definitely recognized in the future.

*Larva*.— Length, 4.5-5 mm.; caudal fringe, 2 mm. additional.  
Diameter, 0.4 mm.

Coloration, saturated yellow with a faint orange-brown tinge.

Form narrow, body tapering gradually to both ends, spiracular disk narrowed. Body clothed with a delicate appressed pubescence and numerous tufts of conspicuous stiff hairs which produce a spiny or bristly appearance; the more conspicuous of these tufts located on pleural region, there being three such rows on abdominal segments — one on basal ring, the second and largest at base of posterior ring, and the third just before posterior margin of segment and more ventral in position; only the large intermediate tuft present on thoracic segments, the small brush on anterior annulus of abdominal segments lacking. Spiracular disk (Plate LIX, 305) with four lobes; ventral pair not more than three times length of lateral pair; inner face of lobes margined with brown; at tip of ventral lobes a fringe of exceedingly elongate hairs, which are from one-third to nearly one-half length of entire body and about fifteen times length of lobes bearing them; a stiff sensory bristle located in black margin at tip of lobe; lateral lobes with fringe of hairs relatively much shorter, tho still long. Spiracles large, close together, separated by a distance less than diameter of one, the middle piece black, the ring pale yellow. Anal gills four, slender, hyaline, each subdivided by constrictions into four lobes which are gradually narrowed from the base outward, the last being cylindrical.

Head capsule very compact, lateral plates united with broad dorsal plate except for a short distance behind. Labrum (Plate LIX, 300) broadly transverse; cephalic margin truncate or very slightly concave; epipharyngeal region with about five transverse interrupted rows of setae. Mentum (Plate LIX, 302) of two entirely separated plates, each half with four teeth, those at the ends the smallest, the outermost tooth tending to be reduced, the two middle teeth of each side notably larger than the others; outside of mentum a thin plate, its inner proximal margins nearly contiguous at median line of body. Hypopharynx labriform, projecting beyond level of both labrum and mentum; outer lateral angles densely hairy, median posterior area with about eight small, hyaline spines. Antenna (Plate LIX, 301), in caustic-potash mounts, hyaline; basal segment elongate-cylindrical, bearing at its tip about two papillae as follows: a long, slightly curved, cylindrical papilla which is finely sculptured, and immediately proximad of this a slightly smaller second segment of the antenna, bearing near its tip three tiny papillae, an inner flattened subspatulate blade, and two longer cylindrical papillae; near base of this second antennal segment a long seta. Mandible (Plate LIX, 303) rather long and slender, apical point narrow; about four small lateral teeth near ventral cutting edge, the most basad of these acute; a large dorsal tooth on cutting edge and two very small acute teeth near base; on dorsal face of mandible two long setae, and two somewhat shorter setae near heel of mandible; about five or six stout setae at prosthecal region. Maxilla (Plate LIX, 304) consisting of two elongated lobes which are separate from each other, the outermost the longer, the pale rounded palpus terminal in position; inner lobe shorter, with three elongate setae, of which one is apical and the longest is sub-basal in position.

*Pupa*.—Length, 4.5–4.7 mm.

Depth, d.-v., 0.8 mm.

Color light yellowish brown, the thoracic dorsum paler; pronotal breathing horns dark brown, apical quarter abruptly light yellow; abdomen brown, lateral and posterior parts of each segment darker.

Cephalic crest small, each lobe with three small setiferous punctures on anterior face; ventrad of crest between antennal bases a prominent median lobe. Labrum broad; apex truncated, indistinctly bifid. Labial lobes large, with a deep U-shaped median notch behind. Maxillary palpi rather short and stout, ending before joint of fore legs (Plate LX, 307). Pronotal breathing horns moderately elongate, curved slightly laterad, strongly divergent, cylindrical, of uniform diameter thruout their length. Mesonotum not very gibbous (Plate LX, 306). Thorax with a high anterior median carina. Wing sheaths extending beyond base of third abdominal segment, the venation indistinct. Leg sheaths rather long, ending at about one-third length of fifth abdominal segment; hind legs much longer than the others, middle legs a very little longer than fore legs.

Abdominal segments indistinctly subdivided into two rings, a narrow anterior ring and a much broader posterior ring; abdominal armature very weak, lacking on segment 7; basal annulus on tergites and sternites with a number of small pits on sides, these sometimes sparse or lacking; posterior ring with a transverse row of numerous long, stout setae or delicate spines before margin. Spiracles weak, at base of posterior ring. Male cauda (Plate LX, 309 and 310) with sternal lobes elongate, contiguous except at extreme tips; tergal lobes terminating in very slender and acute curved points, directed caudad and dorsad; tergite

8 swollen, with four blunt lobes, the posterior pair large, with their posterior faces setiferous. Female cauda (Plate LX, 308) with sternal valves much shorter than tergal valves and rather blunt at tips; tergal valves broad at base, narrowed at tips, which terminate in acute black spines, situated on lateral margin before apex, the spines directed dorsad, laterad, and caudad.

The larvae were common near Ithaca, New York, from May 10 to June 5, 1917. The pupae are described from one male and two females washed from mud from Bool's hillside, at Ithaca, on June 11, 1917. A little later in June adult flies of this species were common at this location.

*Adelphomyia americana* Alex. (supposition)

1912 *Adelphomyia americana* Alex. Pomona Journ. Ent., vol. 4, p. 829-831.

Larvae that were rather common in the rich organic mud from the Standpipe Woods, Orono, Maine, from July 1 to 14, 1913, are referred with some doubt to *Adelphomyia americana*. They are unquestionably congeneric with the species last described (*A. minuta*, supposition) and with the form discussed in the following pages as *A. cayuga*. A short time after the larvae of these three species were obtained, the adult flies appeared in considerable numbers in the same situations and there seems to be but little doubt as to the reference. Associated with the larvae of this species in the organic mud were a few larvae of Pentoptera, Rhabdrolabis, and other species of crane-flies.

The larva of the present species averages larger than that of *A. minuta*, when fully grown measuring 5.5 millimeters in length. In coloration it is light yellow. The ventral lobes of the spiracular disk have the dark markings on their inner face much more extensive, the apical half being suffused with brown. The mouth parts are similar to those of *A. minuta* as described, but the outermost of the two large teeth of each half of the mentum is reduced in size so that only a single tooth is of conspicuous size.

(Described from larvae taken at Orono, Maine. No. 66-1913.)

*Adelphomyia cayuga* Alex. (supposition)

1912 *Adelphomyia cayuga* Alex. Pomona Journ. Ent., vol. 4, p. 831.

The supposed larva of *Adelphomyia cayuga* occurred with specimens of the preceding (*A. americana*, supposition) at Orono, Maine, from July 1 to 13, 1913. This is a smaller species than the preceding, measuring but 4 millimeters in length, and is much paler, the color being almost

white. The condition of the mental teeth is almost as in *A. americana*, but the outermost of the two large intermediate teeth is a little larger. The larvae were rather frequent in the mud beneath saturated moss.

(Described from larvae taken at Orono, Maine. Nos. 57- and 67-1913.)

### Subtribe *Pedicaria*

The *Pedicaria* comprise a well-defined division of the tribe *Pediciini*, including two groups of genera — the more generalized *Pediciae*, with the genera *Pedicia*, *Tricyphona*, *Ornithodes*, and *Rhaphidolabina*, and the specialized *Dicranotae*, with the genera *Dicranota*, *Rhaphidolabis*, and probably *Polyangaeus*.

The genera of the *Pedicaria* may be divided in the main as follows:

#### *Larvae*

1. Abdomen without prolegs, but with raised welts on segments 4 to 7, these covered with a microscopic scurfiness. (Group *Pediciæ*)..... 2  
 Abdomen with conspicuous cylindrical prolegs on segments 3 to 7, these with circlets of conspicuous chitinized hooklets around their ends..... Group *Dicranotæ* (p. 906)
2. Abdominal segments 4 to 7 with raised welts on both dorsal and ventral surfaces; sides of hypopharynx not parallel, narrowed toward base..... *Rhaphidolabina* Alex. (p. 901)  
 Abdominal segments 4 to 7 with welts on ventral surface only; sides of hypopharynx subparallel..... 3
3. Size very large, when fully grown 40 mm. in length; mental plates without a small lateral tooth..... *Pedicia* Latr. (p. 899)  
 Size smaller, when fully grown under 30 mm. in length; mental plates with a small lateral tooth..... *Tricyphona* Zett. (p. 903)

The writer is unable to separate the genera of the group *Dicranotæ* with the material available, and is inclined to suspect the congenerousness of *Rhaphidolabis* with *Dicranota*. The characters given by Malloch (1915-17b:217) to separate the two genera do not hold at all in a series.

It is impossible also to key the pupae with the present knowledge of the group.

### Group *Pediciae*

#### Genus *Pedicia* Latreille (Gr. *a field*)

1809 *Pedicia* Latr. Hist. Nat. Crust. et Ins., vol. 4, p. 255.

1916 *Daimiotipula* Matsumura. Thous. Ins. Japan, add. 2, p. 463.

*Pedicia* is a small genus including but six described species, one occurring in Europe, one in Japan, and four in North America. Of the last-named,

two are eastern and two are western in their distribution. They include the largest and most beautiful species of the Limnobiinae.

The European *Pedicia rivosa* (Linn.) was found by Beling (1879:45-46) living in brooks and springs, or in wet spots among saturated leaves and other débris, sometimes associated with the larvae of *Tipula lutescens* Fabr. The pupae live in cylindrical vertical burrows, clothed in the last larval skin, and are able to move up and down in these passages. Pupation lasts from one to two weeks.

Needham (1903:285-286, and 1905:8) was the first to describe and figure the larva of the commonest eastern species, *Pedicia albivitta* Walk.

### *Pedicia albivitta* Walk.

1848 *Pedicia albivitta* Walk. List Dipt. Brit. Mus., vol. 1, p. 37.

*Pedicia albivitta* is a beautiful fly, common and widely distributed thruout the northeastern United States and Canada. The adults are on the wing in midsummer, and a few individuals may usually be found in June. The much rarer and more local *P. contermina* Walk. is a vernal species, on the wing in May and early June.

The larvae of *P. albivitta* live in cold springs and beneath saturated moss at the edge of streams. The writer has never succeeded in rearing this species to the adult condition.

*Larva*.—Length, 40-44 mm.

Diameter, 5-5.5 mm.

Color dark grayish brown above, paler at sutures and on posterior half of body; paler beneath, more grayish.

Body covered with a short, appressed, dusky pubescence. Thoracic segments with a pencil of small setae on pleural region. Abdominal segments with a few delicate lateral setae on posterior ring, at about midlength of segments. Ventral creeping-welts on abdominal segments 4 to 7 completely divided on median line, the welts covered with a microscopic scurfiness. Spiracles (Plate LXI, 311) circular, separated by a distance about equal to diameter of one, situated on a slightly protuberant elevation. Spiracular lobes two, ventral in position, short, slender, each with about six setae at tip. Anal gills (Plate LXI, 315) short, stout at base, before tip a constriction cutting off the elongate conical terminal segment, which is partly telescopic within the next basal segment.

Head capsule (Plate LXI, 312) massive, elongate, as in this division. Labrum broadly transverse, lateral parts a little enlarged and projecting anteriorly into blunt lobes, with a long seta near inner margin; median region of labrum with two widely separated setae, just laterad of each of which is a small papilla. Epipharynx roughened into a narrow transverse band of small spines. Mentum completely divided, each half continuous with ventral plate

of same side; anterior margin of each half with three slender, flattened teeth, the middle one of which is slightly the shortest. Hypopharynx conspicuous, labriform; anterior margin with a deep notch to form distinct lobes at lateral angles, and with several rows of small chitinized tubercies. Antenna (Plate LXI, 313) small; basal segment elongated, slightly curved, a circular auditory plate near base, at tip with numerous papillae, two of which are very long, nearly as long as segment itself; in addition to these, three or four tiny cylindrical papillae. Mandible powerful; ventral cutting edge with a row of about four teeth which are successively enlarged from tip to base; basal tooth very broad and fat, with outer margin truncate or slightly concave; teeth on dorsal cutting edge indistinct; a pencil of moderately delicate setae on scrobal region of mandible, and another at prosthecal region. Maxilla elongate; outer lobe larger than inner lobe, chitinized, apex with a very flat circular palpus (Plate LXI, 314) which is provided with a few disklike papillae around margin and a few scattered sensory papillae over pale apex; inner lobe with a long, powerful seta on ventral face and smaller setae near tip.

*Nepionotype*.—Ithaca, New York, June 1, 1917.

*Paratypes*.—Larvae from type locality.

### Genus *Rhaphidolabina* Alexander (Gr. diminutive of *Rhaphidolabis*)

1916 *Rhaphidolabina* Alex. Proc. Acad. Nat. Sci. Phila., p. 540-541.

*Larva*.—Body covered with an abundant, appressed pubescence and tufts of erect hairs which are more numerous on anterior end of body. Creeping-welts on dorsal and ventral surfaces of abdominal segments 4 to 7. Spiracular lobes two, moderately elongated, each with about six hairs at tip. Spiracles large. Anal gills four, long and diaphanous. Head capsule long and massive. Mandible powerful. Antenna short, with two elongate papillae. Hypopharynx labriform, anterior margin concave. Mentum completely divided, each half with three large teeth and a much smaller lateral tooth.

*Pupa*.—Labrum truncate. Pronotal breathing horns short-cylindrical or slightly flattened. Abdominal segments with circular areas of spicules on pleurites. Intermediate tergites with a broad transverse band of tiny spines.

The genus *Rhaphidolabina* includes only *R. flaveola*, a curious pallid fly of the northeastern United States, serving as a connecting link between *Tricyphona* on the one hand and the *Dicranotae* on the other. The adult flies are common on rank vegetation in cold woods. The immature stages are spent in rich organic earth in the same situations as are frequented by the adult flies.

### *Rhaphidolabina flaveola* (O. S.)

1869 *Rhaphidolabis flaveola* O. S. Mon. Dipt. N. Amer., part 4, p. 288.

The writer has found the larvae of *Rhaphidolabina flaveola* in Maine and in New York. At Orono, Maine, larvae were numerous in the rich



organic mud of the Standpipe Woods. One large larva was placed in a watch crystal with a fully grown larva of *Adelphomyia cayuga* (supposition). It at once seized the latter in its mandibles at about the third abdominal segment, and carried it helplessly all around the dish, occasionally shaking it, quite as a terrier does a rat.

*Larva*.—Length, 9.8 mm.  
Diameter, 0.8 mm.

Color, brown to orange-yellow on anterior segments of body, becoming darker on abdominal segments due to the increase of pubescence.

Body covered with an abundant, appressed pubescence. Form terete; body moderately elongated, gradually narrowed toward both ends. Abdominal segments 2 to 8 divided into a narrow basal ring and a much broader posterior ring; segments 4 to 7 with conspicuous dorsal and ventral welts, which are larger and more conspicuous on posterior segments; these welts occupying basal ring of segments, and bisected by a deep longitudinal median impression, their surface covered with microscopic points. Thoracic segments before mid-length with a transverse row of stiff, dark brown hairs grouped in tufts or pencils; these hairs occurring on abdominal segments also, but less prominent here and occupying posterior region of segments; pencils more numerous on ventral and pleural regions, much scantier on dorsal surface except on pronotum. On sides of last abdominal segment, between spiracles and spiracular lobes, several long setae arranged in a transverse row, lacking on mid-dorsal and ventral regions. Spiracular disk (Plate LXII, 321) reduced to two ventral lobes, as in this division, these lobes slightly united basally, not very elongate, blunt at their tips, which bear about six dark setae. The two spiracles large and conspicuous, entirely exposed on dorsum of last segment, separated by a distance a little less than diameter of one; middle piece of spiracles large, black; ring brownish yellow. Anal gills four, long and slender, nearly hyaline, divided into lobes by slight constrictions; posterior pair of lobes a little longer than anterior pair.

Head capsule elongate, flattened, massive, as in this tribe. Labrum conspicuous, exceeding mentum and hypopharynx, the anterior margin fringed with long hairs. Mentum (Plate LXII, 316) completely divided, each half with three subequal prominent teeth and an additional much smaller lateral tooth; middle tooth of each side a little broader. Hypopharynx (Plate LXII, 317) labriform, anterior margin deeply concave, roughened. Antenna (Plate LXII, 318) short, the segment short-cylindrical, a little enlarged toward truncated apex; at tip several papillae, of which two are exceedingly elongate, very slender, about twice length of basal segment. Mandible (Plate LXII, 319) powerful, ending in an acute point; ventral cutting edge with about four teeth, the basal one of which is the largest, subtruncate, the next outer tooth a large, flattened, acute blade, two or three smaller flattened teeth just before tip; dorsal cutting edge with about two small teeth. Maxilla (Plate LXII, 320) short and very stout, the outer lobe much longer than the slightly smaller inner lobe.

*Pupa*.—(The following notes are taken from the cast pupal skins of the bred specimens.)

Labrum truncate. Labial lobes ovate. Maxillary palpi short and stout, broadest just beyond base, tips blunt (Plate LXII, 322). Antenna moderate in length, tapering gradually to tip. Pronotal breathing horn (Plate LXII, 323 and 324) short, cylindrical or

slightly flattened, with a row of circular breathing pores along margin of distal end, which is slightly enlarged. Wing sheaths short. Leg sheaths much longer.

Pleural region of abdominal segments with circular areas which are armed with abundant, short, straight or slightly arcuated, rows of spicules, there being from five to seven spicules in each row; under high magnification these appearing as flattened, scalelike tubercles, fringed with the spicules described above; dorsum of intermediate abdominal segments with a broad transverse band which is rather densely set with tiny, sharply curved spines; on posterior segments these rows lacking or much weaker; dorsal bands lying posterior to level of lateral areas. Male cauda (Plate LXII, 325) with dorsal plate rather small, each half indistinctly bilobed at tip; outer lobe minutely tuberculate and with a small seta; ventral lobes large, blunt at tips; eighth tergite on either side with a small tubercle bearing two setae.

*Nepionotype*.— Ithaca, New York, May 14, 1917.

*Neanotype*.— Ithaca, May 26, 1917. Cast pupal skin; larva placed in rearing May 14, 1917, emerged May 26, male.

*Paratypes*.— Larvae, with type larva. Pupae, taken as larvae May 27, 1917, placed in rearing, emerged June 7, 1917. No. 79-1917.

### Genus *Tricyphona* Zetterstedt (Gr. *three* + *bend*)

1837 *Tricyphona* Zett. Isis von Oken, p. 65.

1856 *Amalopsis* Hal. Ins. Brit., Dipt., vol. 3, p. 15.

1856 *Bophrosia* Rond. Dipt. Ital. Prodr., vol. 1, p. 183.

1860 *Crunobia* Kol. Wien. Ent. Monatschr., vol. 4, p. 391.

1881 *Nasiterna* Wall. Ent. Tidskr., vol. 2, p. 179, 191.

*Larva*.— Body moderately elongate, with ventral transverse creeping-welts on basal annuli of abdominal segments 4 to 7. Spiracular lobes two, moderately elongate. Anal gills four, divided into two to four lobes by from one to three constrictions. Head capsule massive, elongate. Eyespots distinct. Mandible powerful, ending in an acute point and with about four lateral teeth. Maxilla stout, consisting of two distinct lobes, the slender inner lobe closely approximated to the larger outer lobe. Antenna small; basal segment cylindrical at tip, with two exceedingly long, hyaline papillae (possibly lacking in *T. immaculata*). Hypopharynx labriform, anterior margin concave, roughened. Mentum completely divided, anterior margin of each half with three large teeth.

*Pupa*.— Pronotal breathing horns short and stout, blunt, angles rounded. Abdominal segments with transverse bands of spicules on tergites and sternites, and circular areas on pleurites.

*Tricyphona* is the largest genus of the *Pediciini*, including more than fifty described species. Almost all of these species are found in the Holarctic region, but two or three are Antipodal. In the eastern United States, *Tricyphona inconstans* is the most widely distributed and apparently the commonest species. This species and certain others (as *T. paludicola* Alex.) are characteristic swamp inhabitants, but other species

occur along running streams (*T. vernalis* [O. S.]) or near cliffs (*T. auripennis* [O. S.]).

The immature stages of the known species are usually spent in moist earth. In Europe, *T. immaculata* (Meig.) was reared by Beling (1879:47) from larvae taken beneath decaying vegetable mold in the bed of a dried-up woodland stream. Other specimens were found in old horse manure in beech woods. De Meijere (1916:195-196) found the same species in decaying leaves and other vegetable matter in wet spots near the banks of streams. *T. schineri* (Kol.) was found on August 19 in a wet spot in beech woods, where the larvae were associated with pupae of *Pedicia rivosa* in damp earth beneath 'débris,' adults emerging on September 6 and 12 (Beling, 1879:47). The only American species whose immature stages have been found is *T. inconstans*, described herein.

*Tricyphona immaculata* (Meig.), the genotype, as described by De Meijere in the paper cited above, differs from *T. inconstans* as herein described in the following points: The antenna bears a very short terminal papilla instead of the two very long ones in the local species. The small lateral tooth on the mentum is not mentioned nor figured as appearing in *T. immaculata*. The anal gills are short and with but a single constriction. The pupa has the pronotal breathing horns small, kidney-shaped, the outer margin rounded. The fore legs are a little shorter than the middle legs, and these in turn are somewhat shorter than the posterior legs. The skin of the abdomen is very delicate, with crossrows of very small spicules, arranged in numerous irregular transverse rows, at the posterior margins of the segments, about seven such crossrows being present.

*Tricyphona inconstans* (O. S.)

1859 *Amalopis inconstans* O. S. Proc. Acad. Nat. Sci. Phila., p. 247.

*Tricyphona inconstans* is an abundant species thruout eastern North America. It has been recorded also from Europe, but the latter records are almost certainly erroneous. The writer found larvae of this species in rich mud at Larch Meadows, near Ithaca, New York, on May 15, 1917, in association with larvae of *Rhamphidia mainensis*, *Pseudolimnophila luteipennis*, and *P. inornata*. Adults emerged on May 27, 1917 (No. 52-1917). An account of the association in which these larvae occurred

is given in connection with the discussion of *Rhamphidia mainensis* (page 831).

*Larva*.— Length, 17–17.5 mm.  
Diameter, 1.3 mm.

Color pale yellowish white; anterior parts of body sometimes a more saturated yellow. Form moderately stout, body a little narrowed toward ends; surface of body almost glabrous, the vestiture being a microscopic pale pubescence and scanty scattered hairs. Ventral surface of abdominal segments 4 to 7 with a prominent transverse welt, which is hollowed out medially so as to appear as paired prolegs, these being unarmed with hooks or points. Spiracular lobes short, divergent, tapering gradually to the blunt tips, which are provided with seven or eight setae. Spiracles (Plate LXIII, 330) on a transverse oval elevation, small, rounded, separated by a distance greater than diameter of one; middle piece of spiracles large, black, rings narrow. Anal gills four, very long and slender, constricted into about four lobes which are successively narrowed from the base outward, the terminal division very slender.

Head capsule of the usual elongate, massive type of this tribe. Labrum large, projecting beyond hypopharynx, anterior margin with long hairs. Mentum (Plate LXIII, 326) large, completely divided, each half with three subequal narrow teeth and an additional reduced lateral tooth; on proximal margin of each half of mentum, near base of innermost tooth, a few tiny notches dovetailing into those of opposite half. Hypopharynx (Plate LXIII, 327) projecting far beyond mentum, labriform; anterior margin deeply concave and provided with small rounded papillae; lateral angles smooth, rounded, subchitinized. Antenna (Plate LXIII, 328) small; basal segment cylindrical, bearing at its tip two elongate papillae which are about one-half longer than basal segment alone; besides these an oval papilla. Mandible (Plate LXIII, 329) of the usual pedicellate type, powerful, the apex running out in a long, curved point; ventral cutting edge very flat, cut into about five teeth, the two basal of which are very large; the most basal of these teeth squarely truncated, the left mandible with an additional small tooth on lower inner angle of this blade; the next outer tooth rather acute; outermost teeth small and flattened; dorsal cutting edge, as usual with this division, with two very small teeth located far out on apical point; a tuft of a few long setae on back of mandible near heel. Maxilla (Plate LXIII, 329) powerful, as in this group of genera, but not exerted from the prothoracic orifice when head is retracted; outer lobe very stout, feebly chitinized basally, hyaline at apex, which bears the flattened, disklike palpus; inner lobe slenderer, shorter, with a few setae and small papillae.

*Pupa*.— (The following notes are taken from the cast skins of the reared specimens.)

Labrum with apex broadly triangular. Labial lobes large, ovate, tips narrowed and bluntly rounded (Plate LXIII, 331). Pronotal breathing horns (Plate LXIII, 332 and 333) very short, stout, roughly cylindrical, the apices truncated; in lateral outline, pentagonal, with a row of breathing pores around margin of truncate apex. Thoracic dorsum transversely roughened by short, irregular grooves.

Abdominal sternites with broad transverse bands of spicules on segments 5 to 7, the last of these three bands the weakest; similar bands on tergites 4 and 5, these bands subequal in size; pleural region with a large, roughly circular area of short rows of microscopic spicules,

these areas near base of segments. Female cauda (Plate LXIII, 334) with tergal valves elongate, tapering gradually to the rather blunt tips; sternal valves very small, blunt at tips; at base, on dorsal side of eighth segment, two setiferous tubercles.

*Nepionotype*.—Larch Meadows, Ithaca, New York, May 15, 1917. No. 52-1917.

*Neanotype*.—Ithaca, May 27, 1917, a cast pupal skin.

### Group *Dicranotae*

#### Genus *Dicranota* Zetterstedt (Gr. *a fork*)

1838 *Dicranota* Zett. Ins. Lapponica, Dipt., p. 851, no. 164.

*Dicranota* is a small genus of crane-flies (about fifteen described species) occurring throuth the Holarctic region. Four species are found in eastern North America. None of the American species have been reared. In Europe, the life history and morphology of *Dicranota bimaculata* (Schum.) has been discussed in detail by Miall (1893) and by Wesenberg-Lund (1915:342-343). Larvae were found by Miall in numbers in the muddy banks of small streams and ponds, where they bury themselves in the mud and gravel. They creep about with ease and rapidity between the sand and gravel, and are able to swim well by a looping movement. Their food consists largely of small worms, *Tubifex rivulorum* Lam., which abound in these haunts. The pupal stage is passed in damp earth. The larva is stated to be about 18 millimeters in length, but this seems to be a maximum figure. The body is dirty white in color and is covered with fine, appressed hairs. Abdominal segments 3 to 7 bear paired retractile pseudopods, which are circled with three rows of chitinized hooks gradually decreasing in size from the tips inward. The anal gills, four in number, are distinctly segmented. The head capsule is elongate and massive, as in the tribe. The mentum is completely divided, its anterior margin having the usual six teeth. The mandible is of the usual pedicine type, with acute teeth on the ventral cutting edge and a brush of hairs near the prosthecal region. (Plate LXIV.)

The pupa is small, only about 10 millimeters in length, and has the pronotal breathing horns expanded and flattened at the tips. The dorsal surface of the abdomen is provided with roughened plates armed with rather strong and dense spines, there being one such plate on the third segment, two on the fourth to sixth segments, and one on the seventh segment.

Genus *Rhaphidolabis* Osten Sacken (Gr. *needle* + *forceps*)1869 *Rhaphidolabis* O. S. Mon. Dipt. N. Amer., part 4, p. 284-27.1911 *Claduroides* Brun. Rec. Indian Mus., vol. 6, p. 288.

*Rhaphidolabis* is a small genus, including about fifteen described species ranging thruout the North Temperate Zone. The larvae strongly resemble those of *Dicranota*, and the two genera are undoubtedly very closely related.

*Rhaphidolabis tenuipes* O. S.1869 *Rhaphidolabis tenuipes* O. S. Mon. Dipt. N. Amer., part 4, p. 287.

Needham (1908a:212-214) found adult flies of the species *Rhaphidolabis tenuipes* in great numbers in tent traps set over Beaver Meadow Brook in the Adirondaeks in July and August, 1907. Larvae that almost certainly belong here were found among the rounded stones in the creek bottom.

*Larva*.— Length excluding caudal lobes, 8-9 mm.  
Length of caudal lobes, 1 mm.

Abdominal segments 3 to 7 with prominent fleshy prolongations on ventral surface, these being retractile, unpaired, and widely separated on mid-ventral line, and bearing at tip a circle of outcurved hooklets, with series of smaller hooklets beyond. Spiracular disk with the two ventral lobes long and obtuse at tips. (Further details are given by Needham.)

*Rhaphidolabis cayuga* Alex. (supposition)1916 *Rhaphidolabis cayuga* Alex. Proc. Acad. Nat. Sci. Phila., p. 543-544.

Larvae which the writer refers to this species were found in Needham's Glen, Ithaca, New York, on March 30, 1916. Later in the season, in April and May, adult flies of the species are very numerous in this glen, and these account for the specific reference.

*Larva*.— Agreeing very closely with descriptions of both *Dicranota* and *Rhaphidolabis tenuipes*. Spiracles large, lying in a distinct longitudinal groove, by the closing of which they are capable of being entirely hidden. Antenna long and slender, tapering to apex, which bears numerous short papillae. Mandible with third lateral tooth of ventral cutting row very long and acute, much exceeding second tooth; basal tooth shaped like a pruning knife, with the cutting edge sinuate; at prosthecal region of mandible, a small tuft of about seven or eight long setae. Maxilla having the two lobes firmly united except on apical quarter.

*Tribe Eriopterini*

The tribe Eriopterini comprises a vast assemblage of usually small crane-flies whose geographical range is coextensive with that of the family.

The larvae, so far as known, are herbivorous. They show a remarkable uniformity in the structure of the head capsule. In the generalized members such as *Molophilus* and some Erioptera, the ventral bars of the head capsule are toothed at their anterior ends and form mental plates which are apparently homologous with those of the Pediciini. In *Chionea* an apparently similar condition exists, to judge from Brauer's figures. In the majority of species, however, the ventral bars of the capsule are not enlarged nor toothed anteriorly and do not function as the mental plates. The hypopharynx is preserved as a hemispherical cushion which is densely provided with setae. The mandibles are small and are blunt at their tips; the teeth of the cutting edge are usually three in number and blunt, but in some species (*Ormosia*, *Gonomyia*) they are longer and more prominent. A distinct prosthecal lobe or hook is usually developed, and near the base of the mandible is a slitlike opening bearing a fringe of long, yellow setae. The maxillae are rather large, hairy lobes. The labrum and epipharynx is long and narrow, and densely hairy. The antennae are remarkably uniform thruout the group, consisting of a stout cylindrical basal segment with a slightly smaller apical papilla of an elongate-oval shape. In the *Elephantomyia* the condition is somewhat similar, the mandibles being very small, and the esophageal region being conspicuously grooved with parallel lines and ridges. The spiracular disk is obliquely truncated and indistinctly lobed in *Chionea* and *Teucholabis*; surrounded by four lobes in *Elephantomyia*; squarely truncated and surrounded by four (in *Rhabdomastix*) or usually five lobes. In the undetermined Eriopterine No. 1, the five lobes are spatulate flattened blades with the margins hooked. Anal gills are usually present and variously developed in the different genera. The pupa is rather slender, in the *Elephantomyia* with the rostral sheath very long and the palpi strongly recurved. The head usually bears a small setiferous crest which is rarely lacking. The pronotal breathing horns vary considerably in form and relative size, being flattened into fans in some *Gonomyia*, small and trumpet-shaped in other *Gonomyia* and in *Gnophomyia*, elongate in most species. The mesonotum is usually armed at the crest with spines, hooks, or setiferous tubercles. The leg sheaths are very short in Gno-

phomyia but are longer in other genera, and the middle tarsi are usually shorter than the other legs. The abdominal segments are subdivided into two rings, the posterior ring with a transverse row of spines and setae before the margin. The lateral spiracles are small, protuberant, and, in some cases at least, apparently functional. The dorsum of the eighth abdominal segment is provided with four or five lobes, which are in some cases (as in some *Ormosia*) spinous at the tips.

The writer has subdivided the tribe Eriopterini into two divisions: the Elephantomyaria, with *Elephantomyia* and presumably *Toxorhina* and *Ceratocheilus*, and the Erioptera, including the other Nearctic genera as known. It is probable that *Cladura* and its relatives will require a division when their immature stages are better known.

The genera of the tribe Eriopterini may be separated by the following keys:

*Larvae*

1. Spiracular disk surrounded by four lobes.....2  
Spiracular disk not as above.....3
2. Ventral lobes with a single powerful seta; coloration a saturated golden yellow; lives under bark.....*Elephantomyia* O. S. (p. 952)  
Ventral lobes fringed with short setae; coloration pale yellow; lives in earth. *Rhabdomastix* Sk. (p. 942)
3. Spiracular disk obliquely truncated, appearing indistinctly trilobed or without lobes... 4  
Spiracular disk squarely truncated, surrounded by five lobes.....5
4. Mandibles with eight teeth; mental plates with seven teeth; lives in earth. *Chionea* Dalman (p. 950)  
Mandibles with less than eight teeth; mental plates not toothed; lives under bark. *Teucholabis* O. S. (p. 945)
5. Spiracular disk ending in five flattened black plates which are finely toothed along their margins.....*Genus incertus*, Erioptera No. 1 (p. 956)  
Spiracular disk not as above.....6
6. Ventral plates of head capsule expanded and toothed at anterior ends.....7  
Ventral plates not toothed as above.....8
7. Ventral plates with four teeth; coloration yellow; spiracular disk large, very heavily marked with black.....*Molophilus* Curt. (p. 911)  
Ventral plates with five to eight teeth; coloration green; spiracular disk very reduced, almost unmarked.....*Erioptera (chlorophylla)* O. S. (p. 918)
8. Marks of all the lobes solidly black.....*Trimicra* O. S. (p. 932)  
Some of the marks more or less split by a pale line.....9
9. The three dorsal lobes solidly dark, the ventral pair split by a pale line.....10  
All paired lobes split by a pale line.....11
10. Coloration saturated yellow; anal gills bluntly rounded; lives under bark. *Gnophomyia* O. S. (p. 934)  
Coloration pale yellow; anal gills elongate; lives in earth. *Helobia* St. Farg. et Serv. (p. 928)
11. Lobes surrounding disk very stout, blunt; marks of lateral lobes surrounding spiracles and often suffusing disk.....*Gonomyia* Meig., subgenus *Leiponeura* Skuse (p. 939)  
Lobes surrounding disk longer; marks of lobes not so extensive.....12



12. All the lobes with two lines..... 13  
 Dorsal lobe solidly dark..... Some *Ormosia* Rond. (p. 922)
13. No dark marks on disk between spiracles..... Some *Ormosia* Rond. (p. 922)  
 Dark marks between spiracles..... 14
14. Spiracular disk very small; two spots on disk..... *Erioptera (megophthalma)* Alex. (p. 915)  
 Spiracular disk large; four or six spots on disk..... *Helobia* St. Farg. et Serv. (p. 928)

## Pupae

1. Rostral sheath very elongated; antennal sheaths lying across face of eye.  
*Elephantomyia* O. S. (p. 952)  
 Rostral sheath not elongated; antennal sheaths lying behind eyes..... 2
2. Leg sheaths very short, barely exceeding wings; crest of mesonotum smooth or nearly so.  
*Gnophomyia* O. S. (p. 934)  
 Leg sheaths longer, ending about one segment beyond end of wings; crest of mesonotum with spines or tubercles..... 3
3. Mesonotum at crest with numerous sharp spines; hind tarsi the longest, middle tarsi the shortest, fore tarsi intermediate in length..... *Helobia* St. Farg. et Serv. (p. 928)  
 Mesonotum and tarsal arrangement not as above..... 4
4. Mesonotum at crest with six to eight tubercles provided with numerous setae; breathing horns fanlike or trumpet-like..... *Gonomyia* Meig. (p. 938)  
 Mesonotum and breathing horns not as above..... 5
5. Mesonotum at crest with four sharp spines or two plates produced into spines..... 6
6. Mesonotum at crest without distinct prominent spines..... 8
6. Mesonotum at crest with four spines..... 7  
 Mesonotum at crest with a plate on either side split at tip into three or four teeth.  
*Ormosia (nubila)* [O. S.] (p. 923)
7. Crest of mesonotum with two large spines; pronotal breathing horns small, closely applied to thorax; lives under bark..... *Teucholabis* O. S. (p. 945)  
 Crest of mesonotum with four large spines; pronotal breathing horns long, slender, curved; lives in earth..... *Molophilus* Curt. (p. 911)
8. Abdominal pleurites with a transverse subterminal row of from eight to twelve spines or stout setae; dorsum of segment 8 with a pentagon of five lobes.  
*Ormosia* Rond. (p. 922)  
 Abdominal pleurites without such a row of spines or setae; dorsum of segment 8 with four or fewer lobes..... *Erioptera* Meig. (p. 914)

The most important literature on the tribe Eriopterini is as follows:

<i>Molophilus biflatus</i> .....	Larva, general.....	Keilin, 1913:4. (Hypodermal glands.)
<i>Molophilus obscurus</i> .....	General.....	Beling, 1879:56.
<i>Molophilus ochraceus</i> .....	Larva, pupa.....	Beling, 1886:193-194.
<i>Erioptera maculata</i> .....	Pupa.....	Beling, 1879:49.
<i>Erioptera flavescens</i> .....	Larva.....	Beling, 1879:50.
<i>Erioptera lutea</i> .....	Larva, pupa.....	Beling, 1886:192-193.
<i>Erioptera sordida</i> .....	General.....	Beling, 1879:56.
<i>Cheilotrichia imbuta</i> .....	General.....	De Meijere, 1920:76.
<i>Lipsothrix icterica</i> .....	Larva, pupa.....	Beling, 1886:192.
<i>Ormosia haemorrhoidalis</i> .....	Pupa.....	Beling, 1879:48-49.
<i>Ormosia haemorrhoidalis</i> .....	Larva, pupa.....	Beling, 1886:191-192.
<i>Ormosia lineata</i> .....	General.....	Beling, 1886:202.
<i>Ormosia nodulosa</i> .....	General.....	Beling, 1886:202.
<i>Ormosia nodulosa</i> .....	General.....	Cameron, 1917:65.
<i>Ormosia varia</i> .....	Larva, pupa.....	De Meijere, 1916:201-204.

<i>Helobia hybrida</i> .....	Larva, pupa.....	Beling, 1879:50-51.
<i>Helobia hybrida</i> .....	Larva.....	Hart, 1898 [1895]:199-200.
<i>Helobia hybrida</i> .....	Larva, pupa.....	Malloch, 1915-17 b:229-230.
<i>Trimicra pilipes</i> .....	Larva, general.....	Gerbig, 1913:161-163.
<i>Gnophomyia rufa</i> .....	Larva, pupa.....	Hudson, 1920:32-33.
<i>Gnophomyia tripudians</i> .....	General.....	Gamkrelidze, 1913, a and b.
<i>Gnophomyia tripudians</i> .....	General.....	Keilin, 1913:3. (Hypodermal glands.)
<i>Gnophomyia tripudians</i> .....	Larva.....	Keilin, 1913:4. (Hypodermal glands.)
<i>Gnophomyia tripudians</i> .....	General.....	Edwards, 1919 b.
<i>Gnophomyia tristissima</i> .....	Larva, pupa, general...	Malloch, 1915-17 b:230-231.
<i>Gonomyia tenella</i> .....	General.....	Beling, 1879:56.
<i>Rhabdomastix schistacea</i> .....	Larva, pupa.....	Beling, 1886:195.
<i>Trentepohlia bromeliadicola</i> .....	Larva, pupa, general...	Picado, 1913:356-357.
<i>Trentepohlia leucorena</i> .....	General.....	Alexander, 1915 b.
<i>Trentepohlia pennipes</i> .....	Larva, pupa, general...	De Meijere, 1911:50-51.
<i>Teucholabis complexa</i> .....	General.....	Johnson, 1900.
<i>Chionea araneoides</i> .....	Larva, general.....	Brauer, Egger, and Frauenfeld, 1854.

### Subtribe Eriopteraria

#### Genus *Molophilus* Curtis (derivation obscure)

1833 *Molophilus* Curt. Brit. Ent., p. 444.

*Larva*.— Form long and slender. Spiracular disk squarely truncated and surrounded by five subequal lobes; paired lobes of disk heavily lined with black; a black mark running proximad from spiracles; dorsal lobe with an oval black area. Head capsule long and narrow; ventral rods flattened; anterior ends expanded, four-toothed, to form mental plates. Labrum narrow, densely hairy. Mandible blunt at apex; ventral cutting edge with about four teeth; a single subapical dorsal tooth. Maxilla large and blunt. Antenna large; apical papilla elongate-oval, sculptured.

*Pupa*.— Cephalic crest setiferous. Pronotal breathing horns long and slender, sinuously curved. Mesonotum declivitous, at crest with four powerful teeth. Wing sheaths ending at about midlength of second abdominal segment. Leg sheaths ending at about midlength of fourth abdominal segment; tarsi of middle legs the shortest. Abdomen with spiracles on segments 2 to 7; dorsum of segment 8 with four blunt lobes.

*Molophilus* is a well-defined genus (including more than fifty species) of small and usually dull-colored flies, which are found practically thruout the world.

The adult flies frequent shaded situations and may be swept from rank vegetation in such places. The swarming habits of this group are discussed later under the specific accounts.

The immature stages of the various species are spent in wet earth. In Europe, *Molophilus obscurus* (Meig.) (Beling, 1879:56) and *M. ochraceus* (Meig.) (Beling, 1886:193-194) have been found in wet earth near running

water in shaded woods. The pupal duration of the latter species is not more than ten days. Keilin (1913:4) notes the presence of hypodermal glands in larvae of *M. bifilatus* Verr., but does not mention the larval habitat. Of the American species, *M. hirtipennis* has been reared from similar situations.

*Molophilus hirtipennis* (O. S.)

1859 *Erioptera hirtipennis* O. S. Proc. Acad. Nat. Sci. Phila., p. 228.

The little dark-colored crane-flies of the species *Molophilus hirtipennis* are common on vegetation in shaded woods in spring and early summer, or they may be found in small dancing swarms in similar situations.

The larvae are exceedingly abundant in wet organic mud or in cool, rich woods in the neighborhood of streams or springs. The writer has reared the species very frequently from specimens found in Needham's Glen and on Bool's hillside, Ithaca, New York, in April and May, 1914 to 1917. The pupal period is probably about a week, but in all the rearings of the writer this could not be ascertained closer than ten days.

*Larva*.—Length, 9–10 mm.  
Diameter, 0.4–0.5 mm.

Coloration light yellow.

Form long and narrow; body terete, noticeably constricted before spiracular disk (Plate XLV, 344). Integument covered with a delicate appressed pubescence and a few transverse rows of very short, erect setae. Spiracular disk (Plate LXV, 351) squarely truncated, surrounded by five subequal lobes; ventral lobes on inner face with two heavy black parallel lines, separated by a capillary yellow line; lateral lobes with a similar double line running inward far beyond spiracle; these double lines not connected at distal end; dorsal lobe with a single oval black mark which is less intense outwardly; a black mark beginning at spiracle running proximad toward center of disk; lobes with a few short hairs at tips. (There is a little variation in the degree of intensity, but the general pattern is as described above.) Anal gills four, short and blunt.

Head capsule (Plate LXV, 345) long, narrow, consisting of six chitinized rods, the ventral rods broad and flat, at the anterior end expanded to form the mental plates (Plate LXV, 346), each rod contributing four teeth, of which the outermost is bluntly rounded, the middle pair the largest and subequal. Dorsal bars two on either side, one slender, at their anterior ends articulating with a transverse chitinized rod; the various bars connected by a thin membranous tissue. Labrum and epipharynx elongate, narrow, occupying the space between mandible and antenna on either side, the ventral face with abundant long hairs, on sides margined with numerous long, incurved, flattened setae. Mental plates as described above; behind them the hypopharynx (Plate LXV, 347), consisting of a semicircular cushion provided with dense, short setae. Antennae (Plate LXV, 348) rather closely approximated on dorsum, prominent, each 1-segmented but bearing a long apical papilla; basal segment moderately elongated, cylindrical, the apex obliquely truncated, the papilla hyaline, gradually narrowed

toward tip, shaped somewhat like an ear of corn, the surface delicately sculptured; besides this papilla, two or three much smaller cylindrical ones. Mandible (Plate LXV, 349) slender, ending in a blunt rounded lobe; ventral cutting edge with four blunt teeth, the second from the base very tiny and connected with the third from the base (in some specimens the teeth are very blunt and rounded, so that the cutting edge appears crenulated or wavy); a single tooth on dorsal cutting edge, immediately behind apex; prosthecal region of mandible with a longitudinal slitlike opening filled with a dense row of long setae. Maxilla (Plate LXV, 350) large and blunt, the outer lobe pale, roughly triangular, covered with numerous short hairs, and with a few small sensory papillae near apex, surrounding palpus; inner lobe a little shorter, densely clothed and fringed with abundant long yellow hairs.

*Pupa*.— Length, 6.2-7.3 mm.

Width, d.-s., 0.7-0.8 mm.

Depth, d.-v., 0.8-1 mm.

Head, thorax, and appendages brown, when fully matured almost black; breathing horns yellowish; abdomen pale yellowish white.

Cephalic crest of moderate size, consisting of two conical lobes directed forward and bearing a stout seta on anterior face; immediately in front of these, a smaller transverse crest lying between antennal bases. Front rather broad. Labrum triangular; lobes of labium triangular, divergent; maxillary palpi elongate, moderately stout, narrowed at tips and extending beyond joints of fore legs. Thorax prominent, carinate medially before declivity. Breathing horns long and slender, sinuously curved, apices directed forward. Declivity of mesonotum (Plate LXVI, 352) precipitous, at the crest armed with four powerful teeth, median pair the largest, somewhat divergent, separated by median line; a few tiny setae on mesonotum, including four in a transverse row at about the level of wing root. Wing sheaths ending opposite apex of second abdominal segment. (In fully matured pupae the characteristic venation of this genus shows on the wing pads.) Leg sheaths rather short, ending about opposite mid-length of fourth abdominal segment; hind legs slightly the longest, fore legs a little shorter, middle legs conspicuously shorter, ending about opposite apex of fourth tarsal segment of fore legs.

Abdominal segments with two very narrow basal rings and a much broader posterior ring. Abdominal spiracles distinct on segments 2 to 7. Setae as follows: on pleura, one immediately caudad of spiracle, a second caudad and somewhat dorsad of spiracle opposite posterior ring, another opposite anterior ring. Tergum with two setae on sides of posterior ring. Segment 8 with four blunt lobes on dorsum. Male cauda (Plate LXVI, 353 and 354) with ventral lobe large, bluntly rounded at tips; dorsal lobes ending in two acute, chitinized points which are widely separated and directed dorsad and slightly caudad, on outer face with a small seta; near base of cauda on dorsum, surface tumid and bearing a small seta on either side. Female cauda (Plate LXVI, 355 and 356) with sternal acidothecae much shorter than the very long tergal valves, these latter, just before apex, with an acute spine which is directed dorsad and with a seta on side. (When the pupa is nearly ready to transform to the adult, the long, coarse bristles covering the body of the adult, and the chitinized genitalia, show thru the pupal integument.)

*Nepionotype*.— Ithaca, New York, May 11, 1917. No. 33-1917.

*Neonotype*.— Ithaca, June 1, 1917.

*Paratypes*.— About one hundred larvae and pupae from type locality.

*Molophilus ursinus* (O. S.)

1859 *Erioptera ursina* O. S. Proc. Acad. Nat. Sci. Phila., p. 228.

*Molophilus ursinus* is probably the smallest crane-fly in North America. The following notes on the swarming were made along Power House Creek, Gloversville, New York, on June 27, 1915:

This species occurred in small dancing swarms over the little lateral streamlets that poured down the steep slope, some of the swarms including scores of individuals. When not swarming, they rested flat on the upper surfaces of leaves, their wings folded over the abdomen. Crane-flies associated with this species today included the following: *Bittacomorphella jonesi*, *Limnophila toxoneura*, *L. areolata*, *L. (Lasiomastix) tenuicornis*, *Liogma uodicornis*, *Dolichocheza americana*, *Tipula collaris*, *T. nobilis*, *T. iroquois*, *T. hermannia*, *T. macrolabis*, *T. submaculata*, *T. fuliginosa*, *Nephrotoma macrocera*, *N. tenuis*, *Longurio testaceus*, and others.

Genus *Erioptera* Meigen (Gr. *wool* + *wing*)

- 1800 *Polymeda* Meig. Nouv. Class. Mouch., p. 14 (*nomen nudum*).  
 1803 *Erioptera* Meig. Illiger's Mag., vol. 2, p. 262.  
 1818 *Polygraphia* Meig. Syst. Besch. Zweifl. Ins., vol. 1, p. 88.  
 1854 *Octavia* Bigot. Ann. Soc. Ent. France, p. 474.  
 1856 *Chemalida* Rond. Dipt. Ital. Prodr., vol. 1, p. 180.  
 1856 *Limnaea* Rond. Dipt. Ital. Prodr., vol. 1, p. 181.  
 1856 *Ilisia* Rond. Dipt. Ital. Prodr., vol. 1, p. 182.  
 1861 *Limnoica* Rond. Dipt. Ital. Prodr., Corrigenda, vol. 4, p. 11.  
 1863 *Trichosticha* Schin. Wien. Ent. Monatschr., vol. 7, p. 221.  
 1864 *Platytoma* Lioy. Atti dell' Institut Veneto, ser. 3, vol. 10, p. 42.

*Larva*.—Form elongate, in some cases very slender, terete. Spiracular disk tending to be reduced, in some species (as *E. chlorophylla*) very small. Anal gills blunt. Head capsule slender, consisting of six bars, four dorsal and two ventral; ventral bars in some species (as *E. chlorophylla*), at least, with five to eight teeth at their expanded anterior end, forming the mental plates. Labrum narrow, densely hairy. Mandible small, bluntly toothed. Maxilla blunt, hairy. Hypopharynx cushion-like.

*Pupa*.—Cephalic crest consisting of blunt or acute (in *E. chlorophylla* and *E. vespertina*) lobes. Pronotal breathing horns elongate, the length many times the diameter, usually straight and slightly divergent (*E. megophthalma*, *E. septemtrionis*), or acutely pointed and directed forward (*E. chlorophylla*). Mesonotal declivity along crest with very numerous setiferous tubercles or (in the European *E. lutea*) with four prominent teeth. Leg sheaths moderately long, reaching fourth abdominal segment; middle tarsi conspicuously shorter than the others. Subapical armature of abdominal segments strong on sternites and tergites but lacking on pleurites. Spiracles distinct, tubular. Lobes on dorsum of eighth abdominal segment not forming a distinct pentagon.

*Erioptera* is a large genus of small flies, including more than one hundred described species, chiefly from the temperate regions. In the case of all species of which the immature stages are known, these stages are spent in wet earth. In Europe, *Erioptera (Acyphona) maculata* (Beling, 1879:

49) was found under leaves in damp earth in woods. Pupae taken on June 8, 1874, emerged as adults on the 13th. The species was found also in the sandy mud of a small brook bed. *E. (E.) flavescens* (Beling, 1879:50) was found in sandy, damp earth, *E. (E.) sordida* (Beling, 1879:56, mention only) in wet, sandy earth along brooks, and *E. (E.) lutea* (Beling, 1886:192-193) in woods, in damp hollows, and along the margins of brooks, usually under leaf mold. Edwards (1919 a) has recorded a species of Erioptera as being associated with the larvae of the mosquito *Taeniorhynchus* at the roots of water grass (*Glyceria fluitans*) in England.

In America, *E. chlorophylla*, *E. vespertina*, *E. caloptera*, and other species inhabit wet mud in open swamps; *E. septentrionis* and *E. megophthalma*, rich organic mud in cool, shady woods; *E. armata*, *E. near knabi*, and other species, the soil along the sandy banks of streams. *E. (Acyphona) graphica* was considered by Hart (1898 [1895]:197) to be semiaquatic.

The writer has before him the larvae of only two species of the genus, *E. chlorophylla* and *E. megophthalma*. These are readily separated by their color, *E. chlorophylla* being pale green, *E. megophthalma* pale yellow and more elongate. The pupae of the Nearctic species of the genus may be separated by the following key:

1. Breathing horns and cephalic crest strongly pointed and curved forward at their tips; coloration light green. . . . . *E. chlorophylla* O. S. (p. 918)
2. Breathing horns and cephalic crest not as above; coloration not green. . . . . 2
3. Breathing horns elongate-cylindrical to slightly flattened, almost straight but slightly divergent, diameter subequal for entire length. . . . . 3
4. Breathing horns not as above, more or less curved, or else blunt at their tips. . . . . 4
5. Cephalic crest sharply pointed; eyes large. . . . . *E. megophthalma* Alex. (p. 915)
6. Cephalic crest not sharply pointed; eyes small. . . . . *E. septentrionis* O. S. (p. 920)
7. Breathing horns almost straight, enlarged distally, tips blunt. . . . . *E. sp. (near knabi* Alex.) (p. 922)
8. Breathing horns curved, narrowed toward tips. . . . . 5
9. Breathing horns widely separated at base, bent strongly proximad, contiguous medially; lobes of cephalic crest acute, vertical; eyes large. . . . . *E. vespertina* O. S. (p. 919)
10. Breathing horns curved gently forward; cephalic crest with lobes directed laterad, divergent; eyes of moderate size. . . . . *E. armata* O. S. (p. 921)

#### *Erioptera megophthalma* Alex.

1918 *Erioptera megophthalma* Alex. Can. Ent., vol. 50, p. 60-61.

The adult flies of *Erioptera megophthalma* are not uncommon in cool, shaded, and boggy woods during the months of early spring.

They may be swept from rich vegetation in company with such characteristic species as *Limnophila brevifurca*, *L. fuscovaria*, *L. subtenuicornis*, *Adelphomyia minuta*, *Rhaphidolabina flaveola*, *Molophilus hirtipennis*, *Erioptera venusta*, *E. stigmatica*, *Gonomyia florens*, *G. subcinerea*, and *Tipula orepzoides*.

The elongate larvae of this fly were very common in rich organic mud taken from Bool's hillside, Ithaca, New York (as discussed under the account of *Bittacomorphella jonesi*, page 780), where they were associated with a crane-fly fauna characteristic of such situations. The larvae, in life, are pale yellowish, with the food contents, of a chalky white color, showing thru the integument. The head capsule and the spiracular disk are very small; the inner face of each lobe of the latter is very narrowly lined with black. The species was reared many times during late May and early June, 1917, the length of the pupal existence indoors being seven or eight days.

*Larva*.—Length, 10.4–11.6 mm.  
Diameter, 0.7–0.75 mm.

Coloration very pale yellow; contents of alimentary canal chalky white.

Form terete, elongated, body tapering gradually to the posterior end, just beyond gills (Plate LXVII, 35S) suddenly constricted; last segment elongate-cylindrical, tapering gradually to the very small spiracular disk. Body covered with a short, appressed pubescence, on last segment this pubescence coarser and more erect, with a few elongate hairs interspersed; lateral parts of body at caudal margins of segments with short transverse lines of small, erect setae; a few other similar rows at about midlength of certain of the segments. Spiracular disk (Plate LXVII, 357) very small, tending to be eliminated by reduction; lobes short and blunt, dorso-median lobe the smallest; ventral lobes with two short brown lines, not connected distally, the proximal line a little longer than the lateral line of each lobe; the pale space between these lines a little less than diameter of one; lateral lobes with two similar divergent lines, the dorsal one attaining inner level of spiracles; dorsal lobe with two small, indistinct, brown lines; on disk between spiracles two small round spots which do not touch spiracles; lobes fringed with short hairs near tip, and capable of close approximation so that disk is often entirely closed. Spiracles large, nearly circular.

Head capsule small, very long and slender, greatly dissected, the three bars of either side long and delicate; dorsal bars at their articulation joined with a short longitudinal bar near whose anterior end the antennae are inserted; ventral bars of capsule not conspicuously expanded at their anterior end, and apparently not toothed as in other species of this genus and in *Molophilus*. Labrum and epipharynx long and narrow, lying between antennal bases; epipharyngeal region densely clothed with short setae at tip and with two parallel brushes on ventral face. Mentum apparently not formed as in *E. chlorophylla*, a slightly

arched transverse chitinized bar. Hypopharynx about as in *Molophilus*. Antennae rather closely approximated, directed cephalad; basal segment moderately elongated, cylindrical; apical papilla relatively small, elongate-oval. Mandible very small, with blunt teeth; apical point short, blunt; ventral row of teeth about three in number, often very blunt. Maxilla as in *Molophilus*, but outer lobe with the vestiture of hairs rather longer.

*Pupa*.—Length, 7.2–8.2 mm.

Width, d.-s., 0.8–0.9 mm.

Depth, d.-v., 1–1.1 mm.

Head light brown; thorax anterior to declivity conspicuously darker brown; remainder of body light yellowish brown; breathing horns light yellow. (In fully colored individuals the head and the thorax with their appendages become much darker, almost black, but the breathing horns retain their conspicuous yellow color.)

Head short, face tumid. Eyes of male very large, widely separated by front; eyes of female smaller. Cephalic crest consisting of two prominent lobes; viewed from side, these lobes sharply pointed and directed slightly forward, with a seta on outer ventral face before tips; viewed from front, lobes rounded, ending in acute tips, separated by a deep, rather narrow, V-shaped notch. Front between eyes narrowed toward labrum, which is rather sharply pointed. Labial sheaths small, the lobes contiguous with their apices truncated, the lateral angles obtuse or produced into a tiny lobe. Sheaths of maxillary palpi short and stout, tapering gradually to tips. Antennal sheaths moderately elongated, angulated at segments, ending just beyond base of wing. Pronotal breathing horns stout, expanded at base, almost straight and only slightly divergent, somewhat compressed, transversely wrinkled basally; a small setiferous tubercle in front of base of breathing horn. Mesonotum precipitous, at crest (Plate LXVII, 359) on either side of median line with abundant tiny setiferous tubercles bearing long, pale hairs, these tubercles continued back along shoulder. Lateral margin of thorax with two small setae. Wing sheaths ending before tip of second abdominal segment. Leg sheaths (Plate LXVII, 360) short, attaining base of fourth abdominal segment; tarsi of hind legs the longest, those of middle pair the shortest; fore legs with femora and tibiae very short.

Abdominal segments (Plate LXVII, 361) divided into two annuli by a constriction near midlength, the anterior ring very indistinctly subdivided further into two lesser annulets; on segments 4 to 7, before caudal margin of posterior ring on both dorsum and sternum, a transverse row of small, conspicuous, blackened, setiferous tubercles, which are more distant from one another near ends of rows; on basal abdominal segments these tubercles less evident but still present. Pleura with small but probably non-functional spiracles, which are very indistinct in young pupae but are more evident in fully colored individuals; these spiracles located near base of posterior ring. Setae on abdomen as follows: on sternal segments, one seta just caudad of end of row of spicules, a second at lateral end of this row, intermixed with spicules, two on posterior ring on a level with spicules; on tergal segments, a strong seta on a line with spiracles, another seta below end of row of spicules; on pleura, one seta just ventrad of spiracles, and two post-spiracular and one ante-spiracular setae. Male cauda (Plate LXVII, 362 and 363) with ventral lobes obliquely truncated, blunt at tips, projecting beyond level of subacute dorsal lobes; dorsal lobes slender, slightly divergent apically, blackened before tips and with two setae at tips on outer face; at base of cauda,



on dorsal face of eighth segment, a close quadrangle of four rounded tubercles, placed on a slight elevation. Female cauda with tergal acidothecae elongate, subacute at tips; sternal valves short, blunt; quadrangle of tubercles on dorsum of eighth segment more distinct than in the male.

*Nepionotype*.— Ithaca, New York, May 14, 1917.

*Neanotype*.— Ithaca, June 5, 1917.

*Paratypes*.— Larvae and pupae in large numbers from type locality, May 14 to June 5, 1917.

### *Erioptera chlorophylla* O. S.

1859 *Erioptera chlorophylla* O. S. Proc. Acad. Nat. Sci. Phila., p. 226.

*Erioptera chlorophylla* is conspicuous by its pale green color in the larval, pupal, and adult stages. It is a common and widely distributed species thruout eastern North America. Several larvae were found in organic mud at Orono, Maine, on June 13, 1913, one of which pupated on the 21st. When the insect is dropped into boiling water, the green color immediately disappears. The associates of this species are discussed under the account of *Ptychoptera rufocincta* (page 775).

*Larva*.— Length, 9-10 mm.

Diameter, 0.7-0.75 mm.

Color uniformly pale green, fading to a pale yellow after death.

Form moderately elongated, last segment of body elongate, gradually narrowed to bluntly rounded apex. Body clothed with numerous appressed hairs. Spiracular disk somewhat as in *E. megophthalma* but even more reduced, disk usually entirely closed, lateral lobes on either side capable of close approximation, tracheae before the opening into spiracles very large.

Head capsule (Plate LXVIII, 364) of the *Molophilus* type, but longer and slenderer; the two dorsal bars of each side very delicate, the ventral bars broader and flattened. Mental plates (Plate LXVIII, 365 and 366) slender; anterior end of each ventral bar widely expanded and provided with several teeth; these teeth varying in number, in some specimens there being only five, in others eight, teeth to each plate; in the latter case the third from either side is larger, with two smaller teeth between. Hypopharynx about as in *Molophilus*. Antenna (Plate LXVIII, 367) large, basal segment stout, cylindrical; apical papilla elongate-oval, with apex bluntly rounded and surface weakly sculptured; laterad of this papilla a tiny cylindrical hyaline peg. Mandible (Plate LXVIII, 368) rather large; cutting edge with about four slender teeth, the second from base the smallest; dorsal face of mandible with a blunt subapical tooth and an oblique comb of about six stout setae or chitinized teeth. Maxilla similar to that of *Molophilus*, but the hairy vestiture longer and coarser.

*Pupa*.— Length, 8.8-9 mm.

Width, d.-s., 1.2 mm.

Depth, d.-v., 1.2 mm.

Breathing horns reddish brown; thoracic dorsum green, with a brownish tinge; abdomen uniformly pale green, posterior half of each dorsal segment a little darker.

Cephalic crest small and compact, consisting of two prominent but closely approximated lobes which are separated by a deep U-shaped notch, the tips acute and directed forward; on outer face before apex a short seta. Labrum broadly obtuse at tip. Labial lobes roughly triangular, divergent. Maxillary palpi short and stout, narrowed toward tip. Antennal sheaths with a slender tubercle at base above eye.

Pronotal breathing horns broad at base, narrowed to the acute tip which is directed almost ventrad; viewed from above, horns very broad basally and with a dorsal carina; ventral side at base transversely wrinkled; a small setiferous lobe just in front of breathing horns, directed laterad. Mesonotum behind breathing horns with a high compressed carina, on either side of this produced into a lobe directed cephalad and laterad; mesonotum moderately declivitous (Plate LXIX, 369), at crest with numerous setiferous tubercles which are fewer in number and more widely separated along shoulder. Leg sheaths reaching to about middle of fourth abdominal segment; hind legs a little longer than fore legs; middle legs very short, ending opposite base of last segment of fore legs.

Abdominal segments divided into two narrow basal rings and a broad posterior ring; on pleura a distinct spiracle, opposite posterior annulus and nearer dorsal margin; posterior annulus, before caudal margin, with a dorsal and a ventral row of long, stout setae. Setae on abdomen as follows: on pleura, a seta opposite second basal ring, a second ventrad of spiracle, and two setae caudad of spiracle, the posterior one a little more dorsal in position; on tergites, two stout setae lying transversely on the margin opposite spiracle, a third seta at end of terminal rows of bristles; on sternites, a group of two transverse setae on posterior ring, slightly below level of spiracle and rather widely separated by the broad midventral area. Female cauda (Plate LXIX, 370) with dorsal acidothecae short, distinctly upturned, and ending in a small, subacute tip; before apex with two very short setae; a short blunt tubercle near base of valves; ventral lobes short, their tips very blunt; dorsum of segment 8 with two blunt median tubercles, one immediately behind the other.

(Described from larvae taken in the Basin Swamp, Orono, Maine, June 13, 1913; one pupa with the larva, July 5, 1913.)

### *Erioptera vespertina* O. S.

1859 *Erioptera vespertina* O. S. Proc. Acad. Nat. Sci. Phila., p. 226.

*Erioptera vespertina* is a characteristic inhabitant of open swamps and wet meadows. It has not been reared, but a pupa found in organic mud in the Basin Swamp, Orono, Maine, on June 24, 1913, undoubtedly belongs to this species. The associates are discussed under the account of *Bittacomorpha clavipes* (page 785).

*Pupa*.—Length, 8.5 mm.

Depth, d.-v., 1.1 mm.

Breathing horns reddish brown; thoracic dorsum reddish brown, with an interrupted whitish line running down posterior half of mesonotum; sheaths of wings and legs pale

brown; abdomen whitish yellow, posterior half of each sternite and tergite dark brown, basal half with two narrow transverse lines of same color.

Lobes of cephalic crest widely separated, subtriangular, acutely pointed at tips. Pronotal breathing horns cylindrical, transversely wrinkled, tapering gradually to tips. (In the only specimen at hand, the horns are widely separated at the base but soon bend proximad and thence outward and ventrad, so that the two horns are closely approximated or almost contiguous on their distal parts.) Behind breathing horns, mesonotum with conspicuous divergent lobes such as are described for *E. chlorophylla*; mesonotum at crest with abundant black setiferous tubercles, which are fewer in number, smaller, and more scattered along shoulder, interrupted at mid-dorsal line. Hind legs a little longer than fore legs, which, in turn, are a little longer than middle legs.

Abdominal segments with subterminal armature of posterior ring more spinous than in *E. chlorophylla*. Distribution of setae about as in *E. chlorophylla*.

(Described from a pupa taken at Orono, Maine, June 24, 1913.)

### *Erioptera septemtrionis* O. S.

1859 *Erioptera septemtrionis* O. S. Proc. Acad. Nat. Sci. Phila., p. 226.

*Erioptera septemtrionis* is a widely distributed species thruout the northeastern United States and Canada. The larvae are not uncommon in rich organic mud in cool, shaded woods. The writer found them commonly in the Standpipe Woods, Orono, Maine, in July and August, 1913. A larva placed in rearing on July 3 transformed to an adult female on the 16th. Other larvae placed in rearing on July 15 transformed to adult males on the 25th. This limits the pupal duration to not more than ten days, but it is probably much less, presumably about one week.

*Pupa*.—Length of cast skin, 7 mm.

Cephalic crest low and flat. Antennal sheaths moderately elongated, individual segments showing clearly thru sheaths. Pronotal breathing horns elongate, cylindrical, almost straight but slightly diverging, transversely wrinkled, paler at tips, with a row of small breathing pores along apical margin; a few small setiferous tubercles before base of breathing horns. Declivity of mesonotum rather steep, at crest with numerous small tubercles and abundant pale yellow hairs which are less numerous along shoulder. Leg sheaths with middle pair conspicuously the shortest, as in the genus.

Abdominal segments with subterminal armature of posterior ring consisting of stout, pale setae; arrangement of these setae about as in *E. chlorophylla*. Lateral spiracles distinct. Male cauda (Plate LXIX, 371 and 372) with the ventral lobes blunt at tips, obliquely truncated, separated by an acute V-shaped notch; dorsal lobes separated by a U-shaped notch, each lobe terminating in a small tip, with two tiny setae on lateral face before apex; dorsum of eighth segment with four prominent, pale, fleshy lobes which are closely approximated, the anterior pair directed laterad and a little more distant from each other than the posterior pair, which are directed more dorsad.

*Neanotype*.—Orono, Maine, July 25, 1913. No. 105-1913.

(Subgenus *Hoplolabis* Osten Sacken)1869 *Hoplolabis* O. S. Mon. Dipt. N. Amer., part 4, p. 160.

The subgenus *Hoplolabis* includes but three known species — the type of the group, *Erioptera* (*Hoplolabis*) *armata*, discussed below; *E. (H.) bipartita* O. S., of western North America; and *E. (H.) asiatica* Alex., of Japan.

*Erioptera* (*Hoplolabis*) *armata* O. S.1859 *Erioptera armata* O. S. Proc. Acad. Nat. Sci. Phila., p. 227.

*Erioptera armata* is a rather common fly thruout the northeastern United States. A larva was found in the sand along the banks of Fall Creek, Ithaca, New York, on May 16, 1917. This larva was of the typical eriopterine form, being elongate, terete, and with the spiracular disk surrounded by five subequal lobes. It was placed in rearing and transformed to an adult female on May 31. This larva was found associated with numerous hexatomine larvae, such as *Eriocera spinosa*, *E. longicornis*, and *E. cinerea*.

The following description is from the cast pupal skin.

Length, about 7 mm.

Cephalic crest consisting of two moderately large, slightly divergent lobes which are acutely pointed at tips; lobes directed strongly outward and bearing a seta on outer face. Labrum acutely pointed. Labial lobes large, divergent, almost straight across caudal margin. Sheaths of maxillary palpi stout, rather pointed at tips. Pronotal breathing horns broad at base, tapering to slender apices, bases conspicuously wrinkled; a small setiferous tubercle before base of each breathing horn. Mesonotum at crest (Plate LXIX, 373) with numerous short, chitinized points. Lateral angle of thorax with two setae; a strong seta above wing axil. Leg sheaths with middle tarsi ending conspicuously before tarsi of other legs.

Each abdominal segment before posterior margin with a transverse row of slender black spicules or short bristles on tergum and sternum, and smaller areas on pleura. Lateral abdominal spiracles distinct. Setae on pleura just ventrad of spiracle, and on tergum just above transverse row of spicules. Female cauda with tergal valves elongated, gently upcurved, unarmed; sternal valves shorter, blunt; at base of cauda, on dorsum of eighth segment, four small darkened tubercles which are produced into slender tips.

*Neanotype*.— Cast pupal skin, Ithaca, New York, May 31, 1917.

(Subgenus *Mesocyphona* Osten Sacken)1869 *Mesocyphona* O. S. Mon. Dipt. N. Amer., part 4, p. 161.

*Mesocyphona* is one of the larger subgenera of *Erioptera*, reaching its maximum of specific development in the Tropics of the New World.

The immature stages of *Erioptera (Mesocyphona) caloptera* (Say) and *E. (M.) parva* O. S. are spent in wet mud along the banks of streams and other bodies of water. The species discussed below as *Erioptera (Mesocyphona)* species (near *knabi*), was reared from the sandy margins of a small prairie stream in Kansas.

*Erioptera (Mesocyphona)* species (near *knabi* Alex.)

Adult flies of a small species of *Mesocyphona* which is close to *E. (M.) knabi* Alex., of Mexico, were not uncommon along Buckner Creek, a small prairie stream flowing thru Jetmore, Kansas. These adults, especially the females, were photophilous, appearing in considerable numbers around lanterns which were hung in tents pitched along the banks of this stream. A single pupa found in the muddy sand along the bank of the creek on July 20, 1917, emerged as an adult on the 22d. The following general characters of the species may be noted:

*Pupa*.—Labrum small, apex rather sharp. Labial lobes squarely truncated, with lateral angles subacute. Sheaths of maxillary palpi slender. Pronotal breathing horns moderately long, cylindrical, curved slightly forward, enlarged outwardly, blunt at tips. Mesonotum at crest rather tumid and with a few long hairs inserted on stout black tubercles. Leg sheaths with middle tarsi the shortest, hind tarsi the longest.

*Neanotype*.—Jetmore, Hodgeman County, Kansas, July 22, 1917.

### Genus *Ormosia* Rondani (Gr. *chain*)

1856 *Ormosia* Rond. Dipt. Ital. Prodr., vol. 1, p. 180.

1860 *Rhypholophus* Kol. Wien. Ent. Monatschr., vol. 4, p. 393.

1863 *Dasyptera* Schin. Wien. Ent. Monatschr., vol. 7, p. 221.

*Larva*.—Form terete, moderately elongated. Spiracular disk squarely truncated, surrounded by five subequal lobes which are lined with double marks of brown. Anal gills blunt. Head capsule slender, very dissected, of six narrow bars, four dorsal and two ventral, the ventral bars broader. Labrum narrow, epipharynx hairy. Mandible with teeth moderately elongated. Antenna of the *Molophilus* type. Mentum without chitinized teeth.

*Pupa*.—Cephalic crest setiferous. Pronotal breathing horns rather short and stout, more or less flattened and with a row of tubercles along posterior margin. Mesonotum declivitous, at crest with a flattened, toothed, chitinized plate on either side (in *O. nubila*) or with abundant setiferous tubercles. Wing sheaths ending opposite or just beyond tip of second abdominal segment. Leg sheaths varying in length with the different species, middle tarsi the shortest. Abdominal segments with a subterminal transverse row of spines or setae, these occurring on pleura (as small groups of eight to twelve) as well as on tergites and sternites. Lateral spiracles distinct, on segments 2 to 7; dorsum of segment 8 with

a pentagon of five lobes, these being unarmed (*O. innocens*, *O. meigenii*) or spinous-tipped (*O. nubila*, *O. nigripila*).

*Ormosia* is a large and rather difficult genus (including more than seventy-five species) of small crane-flies which are characteristic of sub-arctic and temperate regions and apparently rare or lacking in the Tropics.

The adult flies occur in small dancing swarms, usually in cool, shaded situations in or near woods or along brooks. They are most numerous in early spring and in late summer or early autumn, many of the species being apparently double-brooded.

The immature stages are spent in moist organic mud near water. In Europe, Beling records *Ormosia haemorrhoidalis* (Zett.) (Beling, 1879: 48-49, and 1886:191-192), *O. lineata* (Meig.) (Beling, 1886:202), and *O. nodulosa* (Macq.) (Beling, 1886:202), as being found in wet earth in woods, usually beneath leaf mold. Cameron (1917:65) likewise records the last-named species as living in mud. *O. varia* (Meig.) was found by De Meijere (1916:201-204) among decaying leaves in a wet spot near a ditch.

Of the American species, the writer has bred *Ormosia innocens*, *O. nubila*, *O. meigenii*, and *O. nigripila* from larvae or pupae in entirely similar situations to those given above for the European species.

The larvae of only two of these species, *O. nubila* and *O. meigenii*, are available to the writer at this time. *O. nubila* is a large brown species; *O. meigenii* is much slenderer, and is light yellow in color.

The pupae of the known Nearctic species may be distinguished as follows:

1. Dorsum of eighth abdominal segment with a pentagon of five lobes which are spinous at their tips. . . . . 2  
    Dorsum of eighth abdominal segment with a pentagon of five fleshy lobes. . . . . 3
2. Crest of mesonotum with a flattened chitinized plate on either side of median line. . . . .  
    *O. nubila* (O. S.) (p. 923)  
    Crest of mesonotum tumid, with abundant coarse, yellowish setae on either side of median line. . . . . *O. nigripila* (O. S.) (p. 927)
3. Abdomen with large, rectangular, dusky areas on posterior annuli of segments 2 to 8, giving abdomen a banded appearance; pleural setae rather numerous. . . . .  
    *O. innocens* (O. S.) (p. 925)  
    Abdomen without such dusky areas; pleural setae few in number. . . . .  
    *O. meigenii* (O. S.) (p. 928)

### *Ormosia nubila* (O. S.)

1859 *Erioptera nubila* O. S. Proc. Acad. Nat. Sci. Phila., p. 227.

*Ormosia nubila* is probably double-brooded, since the flies are on the wing in the spring and again in the fall. The immature stages live in

organic mud that is usually covered over with a layer of leaf mold. On March 27, 1914, the writer found four large brown cripopterine larvae in rich earth from Needham's Glen, Ithaca, New York. An adult female of the present species emerged on April 9. This makes the maximum pupal existence less than two weeks, but it is undoubtedly very much less than this.

*Larva*.—Length, 11.5–11.8 mm.  
Diameter, 1.1–1.2 mm.

Color a deep reddish or cinnamon brown; incisures of segments paler.

Form rather stout, body terete. Skin covered with a short, appressed pubescence. Spiracular disk (Plate LXX, 375) squarely truncated, surrounded by five subequal lobes; ventral lobes with two parallel dark brown lines which are narrowly united distally, the pale stripe between rather broad, distinct, especially near center of disk; lateral lobes with two parallel dark brown stripes which are indistinctly connected distally, the space between dusky with numerous brown spots; dorsal lobe with an elongate-oval mark inclosing a linear yellow center; lobes fringed with long hairs which are longest at tips, shorter toward base, and narrowly interrupted between lobes; disk between spiracles unmarked. Spiracles large; middle piece and extreme outer margins of ring blackish; spiracles separated by a distance about equal to one and one-half times diameter of one.

Head capsule about as in *Molophilus*, but ventral bars of capsule not toothed to form the characteristic mental plate of that genus. Labrum and epipharynx about as in *Molophilus*. Hypopharynx broad, flattened, provided with numerous transverse rows of short setae. Antenna short; basal segment stout, cylindrical; apical papilla rather small, elongate-oval. Mandible (Plate LXX, 374) ending in a rather long apical point, with about four long, flattened teeth along ventral cutting edge, the second from base very small; a short, recurved hook at prosthecal region and a dense tuft of long yellow hairs in prosthecal slit; a dorsal appendage at heel of mandible. Maxilla about as in *Molophilus*.

*Pupa*.—Length, 7.5 mm.  
Width, d.-s., 1.2 mm.  
Depth, d.-v., 1.4 mm.

Head, thorax, and appendages pale yellow; breathing horns yellow; chitinized plates on mesonotum dark brown; abdomen brown. (In mature pupae, the sheaths of the appendages are probably darker.)

Cephalic crest (Plate LXXI, 381) low; lateral angles produced into conical, erect, spinous tubercles, each bearing a stout seta on outer ventral face. Antennal sheaths very angulated, almost serrate. Opposite each segment of antenna on basal half of organ, a conspicuous blackened tubercle, those at base larger and more conspicuous, the lateral one directed outward, above it a second tubercle directed cephalad and simulating a crest. Antenna extending to just beyond base of wings. Front broad; a blackish area on either side near inner margin of eye, probably indicating point of attachment of tentorium. Labrum triangular, apex subacute. Labial lobes triangular, tips blunt. Sheaths of maxillary palpi rather long, narrowed to the slender tip. Pronotal breathing horns short and slender, some-

what flattened, pale yellow; a stout seta just before base of each breathing horn. Mesonotum precipitous; at crest (Plate LXXI, 380) on either side of median line, a heavily chitinized flattened plate projecting dorsad; this plate, at its tip, forking into two lesser teeth, the lateral one of these still further subdivided into two still smaller teeth (in one specimen the left plate is divided dichotomously into four teeth, the inner primary tooth being further subdivided); on shoulder laterad of these plates a slightly swollen plate which is parallelly grooved; two spines on lateral angle of thorax above base of wing; mesonotum with a few setae behind crest, as follows: an anterior solitary seta on either side of median line and close to it, a solitary stout seta above wing axil, two groups of paired setae, one just dorsad of base of wing and the other midway between this group and the anterior seta first described. Wing sheaths rather short, ending opposite base of third abdominal segment. Leg sheaths rather long for this genus, ending opposite midlength of fifth abdominal segment; fore tarsi a little shorter than hind tarsi, middle tarsi very short, ending opposite or just beyond end of third tarsal segment of fore legs.

Abdominal segments near posterior margin with transverse rows of short black spineg which are much smaller and more widely separated near ends of row; at intervals along a row a few elongate setae; on pleura a similar area of eight to eleven spines with a single seta in row; tubular lateral spiracles on segments 2 to 7. Chaetotaxy as follows: on pleura, just above dorsal end of row, one seta, another solitary seta cephalad of spiracle on anterior ring; on tergites, a solitary seta on posterior ring about opposite spiracle; on sternites, two small setae on either side of median line of posterior ring. Female cauda (Plate LXXI, 382) with tergal valves long and slender, almost straight but slightly upcurved near tips; on dorsal lateral margin, just before tip, a prominent tooth directed laterad and slightly caudad; about midlength of valves a somewhat similar blunt tubercle on either side near dorsal margin; at base of eighth tergite a pentagon of five chitinized lobes, the anterior one rudimentary, the four developed lobes ending in acute chitinized points and each bearing a subapical seta; anterior pair of lobes more widely separated and bearing on lower side near base a small, slender lobule.

*Nepionotype*.— Ithaca, New York, March 27, 1914.

*Neanotype*.— Ithaca, with type larva, April 9, 1914. No. 2-1914.

*Paratypes*.— With types.

### *Ormosia innocens* (O. S.)

1869 *Rhyphotophus innocens* O. S. Mon. Dipt. N. Amer., part 4, p. 142.

*Ormosia innocens* is a characteristic early spring species, the adult flies being found in late April and during May. On May 12, 1917, a few pupae in an advanced stage of development were sifted from organic mud from Bool's hillside, Ithaca, New York. One of these emerged as an adult on the following day. The associated crane-fly larvae that occurred with this species on the date named were as follows: *Bittacormorphella jonesi*, *Dicranomyia stulta*, *Limnophila adusta*, *L. fuscovaria*, *Utomorpha pilosella*, *Penthoptera albitarsis*, *Rhaphidolabina flavcola*,



*Molophilus hirtipennis*, *Erioptera megophthalma*, *Ormosia nigripila*, *Tipula oropezoides*, *T. collaris*, *T. cayuga*.

*Pupa*.— Length, 7.5–10.5 mm.  
Width, d.-s., 0.8–1 mm.  
Depth, d.-v., 1–1.2 mm.

(The smaller measurements are those of males, the larger those of females.)

Head and thorax brown; mesonotum before declivity darker brown; abdomen pale yellowish white, the sternal and tergal sclerites with broad, rectangular, darker areas, producing a banded appearance; breathing horns pale yellow. (In older pupae, the coloration of the head and the thorax is much darker.)

Cephalic crest of moderate size, bilobed; viewed from side, lobes blunt, with two lateral setae; viewed from front, lobes separated by a very broad, V-shaped notch. Between antennal bases, forehead longitudinally grooved, these lines converging between eyes. Labrum triangular, subacute, separating the small labial lobes. Maxillary palpi of moderate length, tapering to blunt apices. Antenna of moderate length, reaching to just beyond wing base. Pronotal breathing horns rather short and stout, almost straight and only slightly diverging, subcylindrical, compressed, and slightly constricted just beyond base. Mesonotum precipitous, carinate medially; at crest (Plate LXX, 376) with numerous pale hairs, these narrowly interrupted on median line; lateral angle of thorax with two tiny setae; a strong seta slightly dorsad and cephalad of wing root; about four small setae in alinement across mesonotum. Wing sheaths moderately broad, ending at or just before tip of second abdominal segment. Leg sheaths short, tips of all the tarsi ending about on a level, or those of fore legs a little longer, terminating just before end of third abdominal segment.

Abdominal segments divided into two distinct annuli by a constriction at about mid-length of segment; sternum and tergum of posterior ring of segments 2 to 8 near caudal margin with large, rectangular, dusky areas which appear subchitinized; caudal margin of this area with a fringe of long, black hairs, there being about seventy-five of these on intermediate segments; on pleural membrane a very small, similar area bearing from twenty-five to thirty-nine hairs, and near its dorsal margin a distinct black tubular spiracle on segments 2 to 7; the following additional setae on segments: on dorsal segments, rectangular darkened areas with sparse scattered elongate hairs over surface, and two setae on each anterior ventral angle, their arrangement oblique; sternal segments similar, but the two setae on rectangular area arranged transversely; just caudad of ends of fringe of hairs, one or two isolated hairs; pleural membrane opposite basal annulus with a single seta; another seta opposite posterior annulus near ventral margin; a third seta on ventro-cephalic angle of pleural setiferous area just above level of spiracle; segment 8 on dorsum with five pale, gill-like lobes arranged in a quadrangle or a pentagon, the anterior lateral pair the longest, the median one rather the smallest; at base of anterior pair, two setae on cephalic face; at base of posterior pair, a single seta on lateral face. Male cauda (Plate LXX, 377 and 378) terminating in two very blunt ventral lobes and two separated, slender, dorsal lobes projecting caudad and dorsad. Female cauda similar to male cauda, but tergal acidothecae very elongate, much longer than sternal valves.

*Neotype*.— Ithaca, New York, May 12, 1917.

*Paratypes*.— Seven pupae, with type.

*Ormosia nigripila* (O. S.)

1869 *Rhypholophus nigripilus* O. S. Mon. Dipt. N. Amer., part 4, p. 142.

The larvae of *Ormosia nigripila* are common in rich organic mud in shady places. Larvae found in Needham's Glen, Ithaca, New York, on March 27, 1914, emerged on April 18. Other larvae from Coy Glen, found on April 17, emerged on May 1. At Orono, Maine, large larvae were found on July 14, 1913, and were placed in rearing, emerging on the 26th as adult males. This limits the pupal duration to not more than two weeks, but it is undoubtedly much less, probably not more than a few days or a week.

*Pupa*.— Length, 5.2 mm.  
Width, d.-s., 0.9 mm.  
Depth, d.-v., 1 mm.

Head, thorax, and appendages light brown, becoming darker in maturity; breathing horns and abdomen pale whitish.

Cephalic crest with lobes small, low, and rounded, with a powerful seta at tip, directed forward. Labrum blunt at apex. Labial lobes large, subtriangular, lateral angles obtusely pointed. Sheaths of maxillary palpi stout, rather elongate. Pronotal breathing horns (Plate LXXII, 384) rather short and flat, compressed, slightly expanded beyond base; outer, or posterior, margin with about five small tubercles, at least one of which is setiferous. Mesonotum very steep and precipitous, as in this group of species; crest (Plate LXXII, 383) tumid, extensive, on either side with abundant coarse yellow bristles; caudad of these, four stout setae in a quadrangle, two on either side of median line; lateral angles of thorax with two stout setae; a strong seta just above wing base. Wing sheaths reaching base of third abdominal segment. Leg sheaths moderately long, extending almost to midlength of fourth abdominal segment; tarsi of middle legs much shorter than the others, hind legs a very little longer than fore legs.

Abdomen with segments (Plate LXXII, 385) before their caudal margin bearing transverse rows of slender spines; pleura with a small area lying a little cephalad of tergal and sternal rows and margined behind with eight to ten spines. Spiracles distinct, tubular. Setae as follows: on pleura, a seta on anterior annulus, a stout seta just ventrad of spiracles, and a third lying a little ventrad and cephalad of spiracle; on sternites, two stout setae near base of posterior annulus; on tergites, two setae on posterior annulus, lying transversely at level of spiracle, and a third seta just cephalad of end of row of spines. Male cauda (Plate LXXII, 386) with ventral lobes rather slender, narrowed outwardly, and somewhat pointed at apex; dorsal lobes curved strongly backward, terminating in acute, chitinized points with a strong seta on outer face before tip and a second seta nearer base; dorsum of segment 8 with five brown, chitinized lobes which are crowned at their apices with a cirlet of spines; posterior pair the longest and stoutest, broad at base, more slender outwardly, with a large lateral spine and about three smaller inner spines; anterior pair more slender; median lobe slender, crowned with a cirlet of about six small, subequal spines. Female cauda (Plate

LXXII, 387) with dorsal cerebra elongate, almost straight or very slightly upturned; eighth segment with dorsal pentagon of spino-tipped lobes quite as in male.

*Ormosia meigenii* (O. S.)

1859 *Erioptera meigenii* O. S. Proc. Acad. Nat. Sci. Phila., p. 226.

*Ormosia meigenii* is one of the commonest species of the genus, occurring in small dancing swarms in early spring. Larvae of this species were taken on April 10, 1914, in organic mud from Needham's Glen, Ithaca, New York. An adult female emerged on May 4.

*Larva*.—Length, 6.5 mm.

Diameter, 0.5–0.6 mm.

Color, light yellow.

Form elongate, terete. Spiracular disk (Plate LXX, 379) about as in *O. nubila*, dorso-medial lobe the smallest, ventral lobes with brown lines rather close together, the distal line the broadest; lateral lobes with lines rather short, not contiguous at their distal ends and not extending past midlength of spiracles; dorso-medial lobe with marks oval, solidly dark brown. Lobes fringed with moderately long, yellowish setae, which are almost lacking at extreme tips; disk between spiracles unmarked. Spiracles large, transversely oval, separated by a distance a little greater than the long diameter of one.

Head capsule and mouth parts almost as in *O. nubila*; mandible with the long, slender teeth of that species.

*Pupa*.—(Described from a cast skin.)

Cephalic crest consisting of low, rounded lobes, each with a seta on anterior lateral face. Pronotal breathing horns of moderate length, flattened, a little narrowed toward tip, outer margin with fine tubercles. Mesonotum not so declivitous as usual in the genus, with tiny roughenings at crest; the usual two setae at lateral angle of thorax present, another above each wing, and four more in a transverse row at level of axilla of wing; a seta on mesonotum, close to median line, just below crest. Middle legs much shorter than fore and hind legs.

Subterminal rows of setae on abdominal segments consisting of slender, acute spines, with a few setae interspersed; on pleura the spines few in number. Spiracles elongate, tubular. Female cauda with tergal sheaths very long, sternal sheaths short, their tips blunt; on dorsum of eighth abdominal segment five small unarmed tubercles, which are blunt or nearly so, anterior pair more widely separated than posterior pair. (In the shape of the cephalic crest, the breathing horns, and the declivity of the mesonotum, this species resembles *O. nigripila*; but the arrangement of setae on the abdomen, and the great reduction and unarmed condition of the lobes on the eighth abdominal tergite, are distinctive.)

*Nepimotype*.—Ithaca, New York, April 10, 1914.

*Neanotype*.—Cast pupal skin, Ithaca, May 4, 1914.

Genus *Helobia* St. Farg. et Serv. (Gr. *marsh* + *I live*)

1825 *Helobia* St. Farg. et Serv. Encyclop. Method. Ins., vol. 10, p. 585.

1830 *Symplecta* Meig. Syst. Besch., vol. 6, p. 282.

1865 *Idioneura* Phil. Verh. Zool.-Bot. Ges. Wien, vol. 15, p. 615.

1886 *Symplectomorpha* Mik. Wien. Ent. Zeitung, vol. 5, p. 318.

*Larva*.—Form moderately elongated, body terete. Spiracular disk surrounded by five subequal lobes which are marked with V-shaped brown lines, in some specimens the inner faces of the three most dorsal lobes being entirely brownish black. Anal gills moderately elongate. Head capsule as in the Eriopterini. Antenna with the apical papilla very short, subpyriform.

*Pupa*.—Cephalic crest setiferous. Pronotal breathing horns elongate-cylindrical, directed ventrad and cephalad, with rows of breathing pores along dorsal face. Mesonotum declivitous, at broad crest armed with numerous chitinized spines; an arcuated longitudinal row of six small pits extending from wing axil toward crest of thorax. Wing sheaths ending before tip of second abdominal segment. Leg sheaths ending about opposite tip of third abdominal segment; tarsi of hind legs the longest, those of middle legs the shortest, fore legs intermediate in length. Abdominal segments with a strong subterminal armature on ventral segments, much weaker to lacking on dorsal segments; lateral spiracles distinct on segments 2 to 7; dorsum of segment 8 with five blunt lobes.

*Helobia* is a small genus (five species) of common and sometimes very widely distributed crane-flies. The only North American species, *Helobia hybrida*, is apparently the most widespread tipulid known, ranging over practically the entire Holarctic region, southward in the mountains to India, and, in the New World, to Central America. The immature stages of the known species are spent in moist earth near water. Bruch (*in litt.*) mentions the rearing of *H. macroptera* (Phil.) in Argentina.

*Helobia hybrida* (Meig.)

1804 *Limonia hybrida* Meig. Klass., vol. 1, p. 57.

1818 *Limnobia punctipennis* Meig. Syst. Besch. Zweifl. Ins., vol. 1, p. 147.

1830 *Symplecta punctipennis* Meig. Syst. Besch. Zweifl. Ins., vol. 6, p. 283.

1848 *Limnobia cana* Walk. List Dipt. Brit. Mus., vol. 1, p. 48.

*Helobia hybrida* is undoubtedly the most widely distributed North American crane-fly. Beling (1879:50-51) found larvae and pupae at the end of July, 1876, in wet, sandy earth along the margins of small brooks in deciduous woods. Adults emerged in his breeding cages on July 27 and August 6. Hart (1898 [1895]:199-200) found the larvae in similar sandy situations along the Illinois River, associated with the larvae of *Tabanus atratus* Fabr. He suggests that it may serve as food for this horse-fly larva. Larvae of *Helobia* were especially abundant on May 17, and these transformed to adults within a month. Females were observed ovipositing along the shore, patting the valves of the ovipositor against the moist sand. Malloch (1915-17b:229-230) has given additional notes on the structural details of Hart's material.

Dr. Adam Böving found this species in Iceland and made careful notes on the burrows made by the larvae. Thru the kindness of Dr. Böving, the writer is able to include a translation of his manuscript. The writer is indebted also to Dr. Lundbeck, director of the museum at Copenhagen, for the loan of this material for study. These are the specimens discussed later in this paper. Böving's notes were made at Fell Station, southeast Iceland, in 1908. The translation follows:

Inside the moraine of 1877, in the low land where ice was standing in 1886, quantities of dipterous larvae were found in the moist sand on the bottom of flat hollows which at times are flooded by water and at times are partly drained, as was the case on the day when the following observations were taken.

The whole dark, moist surface of the bottom was covered by an irregular system of slightly elevated, long, tubular galleries, some of which were rather straight, some formed broken lines, some peculiar arabesques, and some plain spirals. The width of the galleries was about the size of an ordinary pinhead, some a trifle larger, some a little smaller. In the anterior part of each gallery was found either a cylindrical white tipulid larva (*Helobia*) about one centimeter long, or another dipterous larva of the same general size and appearance. The larvae were found just below the surface. It was not always easy to capture them, for when I pushed my knife under the mouth of the gallery they moved quickly backward, and then, digging deeper into the soil, made a new gallery that branched off from the main one. It was not possible to distinguish the galleries of the crane-fly larvae from those of the other dipterous associate. Very often, from the mouth of the spiral galleries, one-third of a broken pupal skin stuck out; but larvae were found also in many of these galleries.

The imagines of the two Diptera were present in large numbers, some flying close to the ground, others resting on it. Both forms were long-legged and capable of running over the water film. I secured a pair of both in copulation. The eggs were found on the moist surface, singly or in small masses of two or three together.

The larvae feed, of course, on organic particles in the sand. The imagines were not observed to take any nourishment at all; they copulated as soon as they had left the pupal skins, and I did not find them in any other place than on the bare, moist soil where the larvae lived; not, for instance, on flowers growing near by.

A small carabid (probably *Bembidion grapti* Gyll.) was present in the locality in comparatively large numbers, evidently preying on the larvae of the Diptera. A single carabid larva also was found; from its size and habitus it may very well be the larva of the *Bembidion*.

A small black spider was probably feeding on the imagines of the Diptera. It did not make a regular web, but spun a number of single threads, each about two feet long, attaching them to a piece of gravel and proceeding from this as a common center, spreading the threads close to the ground like radii, and finally fastening the ends to small grains of sand.

The adult flies of *Helobia hybrida* are very common. They are the first tipulids to appear on the wing in spring, some appearing in early March or, in open winters, even in late February. They remain until late in the fall. The writer has noted the females running about on the wet sand along the banks of the Kaw River at Lawrence, Kansas, and ovipositing quite as described by Hart (1898 [1895]:199-200).

*Larva*.—Length, 7.8-10 mm.  
Diameter, 0.6-0.7 mm.

Coloration, pale brownish yellow.

Form moderately elongated. Body covered with a sparse appressed pubescence. Spiracular disk (Plate LXXIII, 388) surrounded by five lobes, the dorsal one notably smaller than the paired lobes; inner face of lobes with two subparallel brown lines, connected at their outer ends to form narrow V's; disk marked with about six spots between spiracles, the largest at base of ventral lobes; disk fringed with short hairs, which are interrupted for a short distance between lobes. Anal gills moderately elongated, pale. (Beling describes the three dorsal lobes of the disk as having the entire inner face shiny blackish brown, and the ventral lobes merely margined with brownish; there would thus seem to be some variation in the character and degree of markings in this species.)

Head capsule as in the tribe. Antenna with the basal segment stout, cylindrical, the apical papilla very short, subpyriform. Mandible flattened; teeth large but very bluntly rounded; apical tooth the largest, with a slightly smaller denticle on either side.

*Pupa*.—Length, 7-9 mm.

Cephalic crest small; lobes pointed, directed ventrad, each bearing a short, stout seta. Labrum narrow. Labial lobes large, divergent, caudal margin almost straight across. Sheaths of maxillary palpi slender, narrowed at tip (Plate LXXIII, 390). Antenna moderately angulated, ending just beyond base of wing. Pronotal breathing horns elongate-cylindrical, directed ventrad and cephalad, with rows of breathing pores along dorsal face; ventral face transversely wrinkled. Mesonotum moderately declivitous, at broad crest (Plate LXXIII, 389) armed with numerous black chitinized spines directed backward; these spines most numerous proximally, interrupted by a median space, less numerous along shoulder; four setae in a transverse row across mesonotum, two on either side of median line; lateral angle of thorax broad and blunt, with two small setae, the outermost one the larger, the inner one about half its size; an arcuated longitudinal row of about six pits extending from above axil of wing toward crest of mesonotum. Wing sheaths short, ending before tip of second abdominal segment. Leg sheaths ending opposite or slightly beyond tip of third abdominal segment; hind legs much the longest, middle legs much the shortest, fore legs intermediate (Plate LXXIII, 391).

Abdomen with a rather strong armature of stout black spines on sternal segments, on segment 3 this appearing as a small area of about ten spines, on either side of tips of hind tarsi; tergal armature much weaker or lacking; lateral spiracles very distinct, tubular, in cast pupal skin the principal tracheal trunks being very conspicuous. Female cauda (Plate LXXIII, 393) with tergal valves the longest, terminating in sharp cylindrical points; sternal valves much shorter, blunt at tips; dorsum of segment 8 with five blunt lobes. Male cauda (Plate LXXIII, 392 and 394) with dorsal valves the longest, each terminating in a long, subacute, chitinized spine directed dorsad and laterad and bearing before its tip two stout setae; ventral lobes stout and blunt, longer than dorsal lobes.

*Nepionotype*.—Fell, between Öraefi and Heineberg, southeastern Iceland.

*Nemotype*.—Cast pupal skin, with type.

*Paratypes*.—Numerous cast pupal skins, with types (in the collection of the Copenhagen Museum).

Genus *Trimicra* Osten Sacken (Gr. *three* + *small*)1861 *Trimicra* O. S. Proc. Acad. Nat. Sci. Phila., p. 290.

*Trimicra* is a small genus of crane-flies, including about fifteen described species found in most parts of the world, almost all being forms of moderate size and obscure coloration. These various species bear a close resemblance to one another and are hard to distinguish specifically.

Bergroth and other European writers consider the genus *Trimicra* as being the same as *Psiloconopa* Zetterstedt, but at this time the writer is not entirely willing to accept this view.

Beling (1879:48) described what he took to be the larva of one of these flies, and in his key to the larvae of crane-flies (1886:206) he included it in close proximity to the *Pediciini*. As mentioned elsewhere in this paper, it is highly probable that Beling described a *pediciine* larva, but by an accident had larvae of *Trimicra* in his breeding jars, the latter larvae emerging first and confusing the author.

Gerbig (1913:161-163) describes the real larva of *Trimicra pilipes* (Fabr.), the best-known species of the genus. It is found along the margins of flowing streams with muddy banks. It is a dark-colored larva, about 15 millimeters in length and about 2 millimeters in diameter. The skin of the body is similar to that of the larvae in the typical subgenus of the genus *Limnophila*, being covered with chitinous, hairlike projections, which in *Trimicra* are longest on the dorsal surface of the body. On each segment, there are solitary elongate bristles, above and below each of which is a gland. The spiracular disk (Plate LXXIII, 395) is surrounded by five nearly equal lobes, which have the inner faces marked with equal blackened, chitinized areas. On the lateral margins of each lobe, but occupying only the distal part of the lobe and not continuous around the disk, is a fringe of moderately long hairs. At the tip of each ventral lobe are two bristles, and at the tip of each lateral lobe is a single bristle, these being inserted outside the line of hairs and surrounded by a bright circular area. The ventral sensory bristles found in some crane-fly larvae (as *Tipula variipennis*) are lacking. At the base of the lateral lobes are the spiracles, which are generally similar to those in the subgenus *Limnophila*. Gerbig discusses in detail the structure of the spiracles, the felt chamber, and the musculation of this region of the body.

Bruch (*in litt.*) mentions the rearing of *Trimicra reciproca* (Walk.) in Argentina from larvae very similar to that described above, occurring in the same type of habitat.

Genus **Empedomorpha** Alexander (Gr. *Empeda* + *shape*)

1916 *Empedomorpha* Alex. Proc. Acad. Nat. Sci. Phila., p. 507-508.

*Empedomorpha* is a monotypic genus of flies, evidently related to *Trimicra*. It is very curious in its marked sexual dimorphism, the male having an extremely large, hairy stigma, which encroaches upon the adjoining veins and often distorts them. The fly is still very insufficiently known. It is a prairie-inhabiting species, occurring from South Dakota to Texas and New Mexico. Nothing is known concerning the immature stages, and the following observations on the habits and occurrence of the adult flies are all that are available.

*Empedomorpha empedoides* (Alex.)

1916 (?) *Trimicra empedoides* Alex. Can. Ent., vol. 48, p. 44-45.

*Empedomorpha empedoides*, as stated under the generic account above, is a prairie-inhabiting species. Adult flies were found running about on the sand flats of the Arkansas River, near Cimarron, Kansas, from July 13 to 15, 1917, by H. L. Fackler and the writer. The vegetation of the sand bars here is very sparse to almost lacking, a few psammophytic grasses being the main element. Associated with these flies on the sandy surface were a characteristic group of sand-loving insects, of which the following were the most constant: larvae and adults of tiger beetles, representing at least three species of *Cicindela*; ground beetles, Carabidae, including such genera as *Omophron*, *Dyschirius*, *Bembidion*, *Tachys*, and a few others; rove beetles, Staphylinidae, such as *Stenus*; Heteroceridae, Psammocharidae, Asilidae, Saldidae, and similar groups. In the cool of early evening, numerous small spiders that lurk in hollows and in deserted insect burrows during the day emerge from hiding and become active.

The crane-flies were observed during the hours of bright sunlight, when the temperature registered over 100° F. in the sun. They run rapidly over the moist sand, their course being very shifting and zigzag, quite like that of tiger beetles. They fly readily but only for short distances, and prefer to alight on the sand rather than on the vegetation. They walk awkwardly over the sand, but are able to crawl up grass blades or



similar objects. The habits of the adult flies are strikingly like those of *Helobia* (page 930). The writer is sure that the larvae are to be found in the sand in these same haunts.

Genus **Gnophomyia** Osten Sacken (Gr. *darkness* + *fly*)

- 1859 *Gnophomyia* O. S. Proc. Acad. Nat. Sci. Phila., p. 223.  
 1867 *Furina* Jaenn. Abhandl. Senkenb. Ges., vol. 6, p. 318.  
 1911 *Dasymallomyia* Brun. Rec. Indian Mus., vol. 6, p. 304.

*Larva*.—Body slender, tapering toward ends, with transverse welts on intermediate abdominal segments. Spiracular disk surrounded by five subequal lobes. Anal gills consisting of four blunt, rounded lobes, constructed for propulsion rather than for a respiratory function. Head capsule moderately elongated, rather compact for the Eriopterini. Antenna rather small, apical papilla elongate-oval. Mandible slender, with a long apical point and three teeth along ventral cutting edge.

*Pupa*.—Cephalic crest a low, blunt tubercle on either side of median line, each tipped with a long seta. Pronotal breathing horns small, narrowly trumpet-shaped. Mesonotum moderately declivitous, at crest practically unarmed; a strong seta at lateral angle of thorax and another on either side of mesonotum behind crest. Wing sheaths short, ending before tip of second abdominal segment. Leg sheaths very short, reaching just beyond wings, attaining end of second abdominal segment; all the tarsi ending about on a level. Abdomen provided with long setae; spiracles on abdominal segments 2 to 7.

*Gnophomyia* is a small genus including about forty described species which are most abundant in the Tropics of the New World. The European *Gnophomyia tripudians* Bergr. has recently been reared by Gamkrelidze (1913, a and b) and by Keilin (Edwards, 1919b). The former found larvae in large numbers in the viscous, semi-decomposed mass of tissue beneath the bark of a fallen carolina poplar, associated with *Miastor metraloas* Meinert. These larvae were found near Paris, France, in March, 1911. Gamkrelidze records a gregarine parasite in the intestine and a nematode worm in the body cavity. The species was later reared in England from dead oak by Keilin, who has discussed and figured glands in the larvae (1913:3). The only American species that has been reared is the common *Gnophomyia tristissima*, discussed later.

*Gnophomyia rufa* Hudson, of New Zealand, has recently been discussed in some detail by Hudson (1920:32-33). It is occasionally found in dense forests in the vicinity of Wellington. The larva lives in and feeds on the semi-liquid vegetable detritus which accumulates in large quantities at the bases of the leaves of *Astelia Solandri*, a common and very conspicuous epiphytic plant in most of the primitive native forests. The length of

the fully grown larva is slightly over 30 millimeters. It is subcylindrical, considerably flattened. Oval warts armed with minute teeth are situated on both surfaces of abdominal segments 2 to 7. The larva is very dark slaty gray in color, darker toward the extremities. The spiracular disk as shown by Hudson's colored figure is very small. Apparently only one larva inhabits the space between the two sheathing leaves of the *Astelia*, and only those leaves which are full of a thick, brown, coffee-like liquid are frequented. The pupa is inclosed in a rather tough, extremely elongate, silken tube situated between the sheathing leaves. It rests in an upright position in the midst of the semi-liquid mass. The pupa measures about 38 millimeters in length, being very elongate with the head and the thorax unusually small. The two pronotal breathing horns are shaped somewhat like a bivalve shell. Abdominal segments 3 to 6 at the base on the dorsal side have finely-toothed warts; the ventral surface has plain ridges. It is probable that the present species is not a true *Gnophomyia*, but until more is known of this species and its relatives it should be referred to this genus.

The *Gnophomyia pilipes* referred to by Beling (1879:42) and by Gerbig (1913:161-163) pertains to *Trimicra* (page 932).

*G. tristissima* has been recorded by Malloch (1915-17b:230-231) as living in wet mud, but this is an error. The writer has material from exactly the same source as Malloch's, received from James A. Hyslop, and this shows that the haunt of the larvae is beneath the decaying bark of trees — an unusual habitat for one of the Eriopterini, which for the most part live in damp sand or earth near water. The rearing of this species in New York (by Young), Massachusetts (by Johnson), Maryland (by Hyslop), Virginia (by Shannon), Kansas (by Alexander), Illinois (by Malloch and Alexander), and Texas (by Mitchell), leaves no question that the immature stages are to be found beneath the decaying bark of the larger hardwood trees, the tulip tree, *Liriodendron Tulipifera* Linn., being often preferred.

### *Gnophomyia tristissima* O. S.

1859 *Gnophomyia tristissima* O. S. Proc. Acad. Nat. Sci. Phila., p. 224.

*Gnophomyia tristissima* is an interesting black fly with conspicuous yellow halteres. It is common and widely distributed thruout the eastern

United States and Canada. As stated above, the species has been reared on at least seven different occasions in as many States, the most complete account being that by Hyslop, whose specimens and manuscript notes were kindly placed at the writer's disposal. His data on this species are as follows:

May 14, 1914. Wolfsville, Maryland. Under the bark of a rotten stump of a tulip poplar (*Liriodendron*) on the roadside near Warrenfeltz schoolhouse, field on the left going to town. I found a great number of amber-yellow dipterous larvae (three in alcohol), and also three pupae slightly shortened and with the thorax and legs ferruginous and the abdomen pale amber. They were in a very moist nidus of rotted inner bark; placed in rearing in a tin box.

May 16. One adult emerged today (pinned); pupal case in alcohol.

May 18. Three adults emerged today (pinned); pupal cases in alcohol. Observed emergence of one adult. The swaying motion observed in *Tipula infuscata* was not observed, but the adult simply glided straight out of the pupal case by a wavelike contraction of the abdomen. The whole emergence took only about eight seconds. A larva pupated.

May 23. Adult emerged. Pupal stage five days. Placed the remainder of the pupae (all had transformed from larvae to pupae) in alcohol. The pupae are quite active and move under a shelter if exposed. Just before emerging, the pupa takes on a black color on the thorax and smoky yellow on the abdomen.

Shannon's material was reared from pupae taken under the bark of a dead tulip tree at Dead Run, Fairfax County, Virginia, on May 5, 1913. A larva that is undoubtedly this same species was found beneath the same tree on April 17, 1913. Johnson bred this species from larvae found beneath bark at Riverside, Massachusetts, on April 24, 1905. The Texas specimens were found by Mitchell beneath the bark of cottonwood (*Populus*) at Victoria, on June 30.

At Lawrence, Kansas, in 1919, the writer found a few larvae under the bark of a box elder, associated with the following dipterous larvae: *Pterocalla strigula* Loew, *Lonchaea laticornis* Meig., *Phaonia harti* Mall. These associated species were kindly determined by Mr. Malloch. In 1920 the flies were bred from under the bark of several deciduous trees at Urbana, Illinois, by Mr. Malloch and the writer.

Well-preserved specimens of the larvae are not available to the writer, and the following description is taken direct from Malloch (1915-17 b: 230-231):

*Larva*.—Length, 9-11 mm. Slender, slightly tapering toward both extremities, more decidedly towards the cephalic. Body yellowish testaceous, covered with dense decumbent pile.

Head [Plate LXXIV, 396] more compact than that of *Helobia*, the lateral rods stouter; antennae very small; maxillae large, produced beyond the apex of the narrow labrum, the palpi stout; labium not chitinized; mandibles slender, with a long sharp apical tooth and about three poorly defined teeth along the lower lateral margin. Locomotor organs consisting of rather

broad fusiform areas on anterior portion of abdominal segments except basal and apical; hairs along margins of segmental incisions more distinct than elsewhere because of their being slightly curved upward; apical segment with five processes, their structure and markings as in figure [Plate LXXIV, 397]; anal ventral blood-gills in the form of four short rounded protuberances.

The pupa is described from four cast skins, kindly presented by Mr. Hyslop:

*Pupa*.—Length, 8–10 mm.

Cephalic crest a low, blunt tubercle on either side of median line, each tipped with a long, stout seta. Labrum broad, elongate, obtuse at tip, completely separating triangular labial lobes. Sheaths of maxillary palpi moderately slender, tapering gradually to tip. Antennal sheaths moderately elongated, extending to about opposite wing root; basal segments angulate. Pronotal breathing horns (Plate LXXIV, 399 and 400) small, trumpet-shaped, very flattened, median area lacking and hence the margins contiguous; just proximad of breathing horns a large, roughly triangular lobe on either side, immediately behind which are two small setae. Mesonotum moderately declivitous, at crest rather tumid, but unarmed, with a few parallel grooves on either side of median line; lateral angle of thorax very sharp, before tip with two setae, one very powerful, the more dorsal one abortive; a strong seta on either side of mesonotum behind crest. Wing sheaths short, ending just before tip of second abdominal segment. Leg sheaths (Plate LXXIV, 398) very short, ending just opposite tip of second abdominal segment and thus projecting but slightly beyond wing tips; hind legs a little the shortest, but no striking difference in length of various sheaths.

Abdominal segments subdivided into a narrow basal ring and a much broader posterior ring; abdominal segments on dorsum with four transverse rows of tiny but stout setae, two on basal ring and two on posterior ring, one being subbasal, the other subterminal, in position; sternum with only the subterminal row of setae present, but this well marked, the other rows merely vestigial; on either side of dorsum, just cephalad of ends of subterminal row of setae, a powerful bristle; in alinement with these and subequally spaced, two smaller setae; a strong pleural seta on a raised papilla opposite basal ring and three opposite posterior ring, the two anterior being larger, the posterior one very small; sternum with a strong seta on extreme lateral margin of posterior ring; lateral spiracles distinct, on segments 2 to 7. Male cauda (Plate LXXIV, 401) with ventral lobes small, blunt, rather widely separated basally but converging apically; dorsal lobes powerful, divergent, and rather acute at tips; at base of each near lateral margin a short bifid knob sending one arm dorsad, the other laterad; at base on cephalic angle a short, stout seta; two long, powerful, lateral setae on either side, and a single powerful seta on either side of dorsum, immediately behind which is a blunt tubercle. Female cauda with sternal valves elongate, powerful, at their tips terminating in slender, divergent points; dorsal valves small, blunt, divergent, located at base of sternal valves, at their tips with a short, slender spine directed backward; base of segment about as in male.

*Neanotype*.—Wolfsville, Maryland, May 16, 1913. No. 234.

*Paratypes*.—Two male and one female pupae from type locality, May 18, 1913.

Genus *Gonomyia* Meigen (Gr. *angle* + *fly*)1818 *Gonomyia* Meig. Syst. Besch. Zweifl. Ins., vol. 1, p. 146.1856 *Taphrosia* Rond. Dipt. Ital. Prodr., vol. 1, p. 182.1869 *Gonomyia* O. S. Mon. Dipt. N. Amer., part 4, p. 176.

*Larva*.—Form elongate, terete. Spiracular disk surrounded by five blunt lobes which are heavily marked with brown, in some species (*G. alexanderi*) the brown suffusing the disk between the spiracles. Head capsule of eriopterine type. Mandible with lateral teeth slender, flattened. Antenna with apical papilla elongate-oval. Mentum not chitinized.

*Pupa*.—Cephalic crest blunt, the surface with minute roughenings. Pronotal breathing horns flattened, fanlike (*G. sulphurella*), or short, trumpet-shaped. Mesonotum declivitous, at crest with an interrupted transverse row of six to eight tubercles which are densely beset with sharp black spicules. Wing sheaths attaining base of third abdominal segment. Leg sheaths moderately elongated, reaching base of fourth abdominal segment; tips of middle tarsi ending a short distance before apices of other tarsi. Armature of abdominal segments weak. Lateral spiracles distinct, tubular. Five blunt, fleshy lobes on dorsum of eighth abdominal segment.

*Gonomyia* is a large and diverse genus of small crane-flies (including more than one hundred known species) described from all parts of the world. They are divided into four recent subgenera, of which three — *Gonomyia* Meig., *Progonomyia* (new name for *Gonomyella* Alex., pre-occupied), and *Leiponeura* Skuse — occur in the Nearctic fauna.

The immature stages of the known species are spent in moist sand or earth, usually near water. In Europe, *G. tenella* Meig. (Beling, 1879:56, mention only) was found in August in damp, sandy earth along the margin of a dried-up brook.

The writer has found the immature stages of *Gonomyia* (*Leiponeura*) *alexanderi* and *G. (G.) kansensis* in wet sand near rivers. *G. sulphurella* and *G. subcinerea* O. S. occur in muddier and more stagnant conditions near ponds and small streams.

Not enough larvae are available for study to require a key at this time. The pupae of the known Nearctic species may be distinguished by the following key:

1. Pronotal breathing horns narrow at base, expanded distally into a very flattened, fan-like blade with delicate and anastomosing nervures. . . . . *G. sulphurella* O. S. (p. 940)
2. Pronotal breathing horns not as above, more earlike or trumpet-shaped. . . . . 2
2. Pronotal breathing horns massive, trumpet-shaped; lateral margin of thorax before wing root produced into an angle; male cauda small, elongate, dorsal lobes a little shorter than ventral lobes, with two stout lobes on dorsal side far removed from their base. . . . . *G. alexanderi* (Johns.) (p. 939)
- Pronotal breathing horns flattened, earlike or narrowly trumpet-shaped; lateral margins of thorax above wing root broad and blunt; male cauda short, stout, dorsal and ventral lobes subequal in length, the latter closely approximated along median line, the former widely separated, at their base with two acute points. . . . . *G. kansensis* Alex. (p. 941)

(Subgenus *Leiponeura* Skuse)

- 1889 *Leiponeura* Skuse. Proc. Linn. Soc. N. S. Wales, ser. 2, vol. 4, p. 795.  
 1915 *Lipophleps* Bergr. Psyche, vol. 22, p. 55.

*Gonomyia (Leiponeura) alexanderi* (Johns.)

- 1912 *Elliptera alexanderi* Johns. Psyche, vol. 19, p. 3.

The beautiful crane-fly *Gonomyia alexanderi* is locally common in the eastern United States. The adult flies may be swept from rank vegetation in the neighborhood of streams. When resting, the adults have a characteristic position, the fore legs standing straight ahead and almost parallel, the middle legs extended laterally and slightly forward, the hind legs directed backward but widely divergent, and the wings folded over the back. This is the characteristic resting position for the genus. The larvae were found in some numbers in rather coarse sand, around small pools of water near the Sacandaga River, Fulton County, New York, on June 5, 1914. The adults emerged on June 16, giving a pupal period of not more than eleven days and presumably much less. The description and figures of the pupa are made from the cast pupal skin of the male.

*Larva*.—Length, 8.3 mm.

Diameter, 0.4–0.5 mm.

Coloration very pale yellow or yellowish white.

Form terete, elongated, slender. Body with a sparse, pale pubescence, at posterior margins of segments with a transverse erect ridge of stiff hairs. Spiracular disk (Plate LXXV, 403) large, flattened, almost pentagonal in outline, surrounded by five lobes; dorso-medial lobe small, slender; paired lobes very short and blunt; margin between lobes almost straight or but feebly concave; when disk is partly closed, lobes appearing a little more prominent; ventral lobes a little larger than lateral lobes; lobes heavily suffused with brown; on ventral lobes a lateral dark brown line running dorsad to near spiracles, at its dorsal end connected across disk by a paler brown suffusion; proximal stripes of ventral lobes shorter and paler, above their inner ends with a small brown spot; lateral lobes almost entirely suffused with brown, this entirely surrounding spiracles and in some specimens entirely suffusing disk between spiracles, this mark bifid at its distal end; dorsal lobe indistinctly marked with very pale brown; disk margined with short, pale hairs which are not interrupted and are only a little longer at tips of lobes. Spiracles widely separated, the distance between them being three or four times diameter of one; spiracles yellow, centers pale brown.

Head capsule as in the tribe, the ventral bars broader than the slender dorsal bars, their inner ends not expanded or toothed to form the mental plate. Labrum-epipharynx moderately elongate, densely hairy. Mentum not chitinized; hypopharyngeal region a cushion, covered with delicate, short setae. Antenna as in this tribe, basal segment moderately elongate, densely hairy, apical papilla rather small, elongate-oval. Mandible (Plate LXXV, 402)

moderately large; apical point elongated, slender; ventral cutting edge with three flattened teeth, gradually smaller from outermost toward base; outermost tooth flattened, a little enlarged distally, about as long as apical point; basal tooth small, acute; a prosthecal appendage with a brush of hairs beneath it.

*Pupa*.—Length of cast pupal skin, about 5.5 mm.

Cephalic crest of two prominent lobes, blunt at tips, their surface granulated. Labial lobes blunt at tips. Sheaths of maxillary palpi moderately stout, tapering suddenly to sharp apices. Antenna with basal segment very angulated. Pronotal breathing horns (Plate LXXVI, 408 and 409) massive, short, trumpet-shaped, flattened laterally, and here margined with an elevated ridge, along which are scattered the rows of breathing pores; mouth of this trumpet wide. On thorax between breathing horns, large, rounded lobes which are minutely granulated. Declivity of mesonotum (Plate LXXVI, 407) somewhat precipitous, at the rather narrow crest with about six small tubercles which are densely beset with spicules; along shoulder a similar, but more elongate, transverse welt; lateral margin of thorax before wing root projecting out as a sharp angle with a seta at its base. Wing sheaths reaching end of second abdominal segment. Leg sheaths moderately long, attaining base of fourth abdominal segment; fore legs a very little longer than hind legs; middle legs much shorter, ending just beyond base of last tarsal segment of fore legs.

Abdominal segments divided into two narrow basal rings and a much broader posterior annulus. Armature of abdomen very weak. Male cauda (Plate LXXVI, 410 and 411) small, elongate; ventral lobes a little longer than the short, blunt dorsal lobes; on dorsal face near end of eighth segment, two stout lobes pointed at the tips which are directed dorsad and slightly caudad; eighth segment with a close pentagon of pale, slender lobes, the posterior pair larger and closer together than the anterior pair, the median lobe the smallest.

*Neopionotype*.—Scaandaga River, Fulton County, New York, June 5, 1914.

*Neotype*.—With type larva.

*Paratypes*.—Two larvae with type.

(Subgenus **Gonomyia** Meigen)

*Gonomyia (Gonomyia) sulphurella* O. S.

1859 *Gonomyia sulphurella* O. S. Proc. Acad. Nat. Sci. Phila., p. 230.

1869 *Gonomyia sulphurella* O. S. Mon. Dipt. N. Amer., part 4, p. 180-181.

*Gonomyia sulphurella* is a handsome little crane-fly which is very common and widely distributed thruout the eastern and central United States. Larvae are not infrequent in mud along the banks of streams. The writer has bred this species from larvae sifted from sandy mud from the banks of Cascadilla Pond, Ithaca, New York, where they occur associated with numerous larvae and pupae of a tabanid (*Chrysops indus* O. S.), a stratiomyiid (*Odontomyia* sp.), and other forms. Larvae collected on May 14, 1913, emerged as adults on June 1. Adults have been reared as late as October 19 by E. A. Richmond.

*Pupa*.—Length of cast pupal skin, about 6.5-7 mm.

Cephalic crest small, blunt. Labrum triangular, apex obtusely rounded. Labial lobes subcircular, outer margin rounded. Sheaths of maxillary palpi short and stout, at apex suddenly narrowed (Plate LXXVII, 414). Antennal sheaths angulated at segments, the organ extending to beyond base of wing. Pronotal breathing horns (Plate LXXVII, 413) with extreme base expanded, the neck short, constricted, soon passing into a greatly expanded and very compressed disk, the whole suggesting a fan or certain polypores; margin of this disk entire or gently crenulated, and sloping from ventral side outward; surface finely nerved and reticulated. Mesonotum somewhat precipitous, crest (Plate LXXVII, 412) tumid, with rounded knobs arranged transversely along it, there being about eight isolated knobs and a more elongate one along shoulders, these knobs covered with minute blackened spicules. Lateral margin of thorax above wing root forming almost a right angle. Wing sheaths ending opposite base of second abdominal segment. Leg sheaths comparatively short, ending opposite base of fourth abdominal segment; fore legs a little the longest, middle legs conspicuously shorter than the others.

Abdominal segments divided into two narrow basal rings and a broad posterior annulus. Armature of abdominal segments weak, posterior ring with a narrow row of small black spines before caudal margin; on basal ring a broad band of microscopic scabrous points arranged in interrupted transverse rows, there being about seven or eight of these rows to a band. Spiracles small but distinct. Female cauda with tergal valves short, but little longer than sternal valves, slightly upturned, ending in short, cylindrical tips; near base with a small, blunt tubercle on either side; dorsum of segment 8 with five rather long, pale lobes, the anterior pair more slender and more widely separated than the posterior pair, which are sometimes closely approximated.

*Neanotype*.—Cast pupal skin, Ithaca, New York, October 19, 1915.

*Paratypes*.—Three pupae with type.

### *Gonomyia (Gonomyia) kansensis* Alex.

1918 *Gonomyia kansensis* Alex. Can. Ent., vol. 50, p. 158-160.

*Gonomyia kansensis* is a prairie species of the *cognatella* group and appears to be common along the Arkansas and Kaw Rivers in Kansas. Living pupae were found at Larned on August 1, 1917, in sand along the banks of the Arkansas River, where they were associated with the typical sand-loving fauna, including Gelastocoridae, Saldidae, and Carabidae (Omophron, Dyschirius, Bembidion, and Tachys). The observation of a small ant preying on a living pupa of this fly is discussed on page 729.

*Pupa*.—Length of cast pupal skin, 6 mm.

Similar to *G. alexanderi* in most essentials but showing the following differences: antennal sheaths strongly angulate at segments; a tubercle on ventral face of antenna at base, and another at inner cephalic margin of eye.



Pronotal breathing horns (Plate LXXVII, 415 and 416) flattened, earlike or very narrowly trumpet-shaped, with a thick marginal ridge, the disk restricted. Lateral angle of thorax above wing root very broad and blunt, setiferous. Leg sheaths of fore and hind legs almost on a level, those of middle legs shorter, ending a little beyond midlength of last tarsal segment of fore legs. Male cauda (Plate LXXVII, 417 and 418) with dorsal and ventral lobes very short and blunt, subequal in length; ventral lobes closely approximated on median line; dorsal lobes widely separated at their base, with two small acute points directed stro. gly dorsad, divergent at their tips, each with two small setae on outer face near base; dorsum of segment 8 with five lobes, the anterior pair a little more widely separated than the posterior pair, the median lobe slender.

*Neanotype*.—Larned, Kansas, August 1, 1917.

### Genus *Rhabdomastix* Skuse (Gr. *rod* + *whip*)

1889 *Rhabdomastix* Skuse. Proc. Linn. Soc. N. S. Wales, ser. 2, vol. 4, p. 828-829.

The genus *Rhabdomastix* includes nearly a dozen species, some of which have been previously described as *Gonomyia*.

The immature stages of *Rhabdomastix schistacea* (Schum.) were found by Beling (1886:195) in wet earth beside a stream in beech woods on May 6. The larva measures 6 millimeters in length; the greatest diameter is 0.8 millimeter. The body is strongly dilated in the anterior part and gradually narrowed behind. The integument is deep brownish yellow. The spiracular disk is short and blunt, and has four very small, tuberculate teeth, the lateral pair lying somewhat more cephalad than the more powerful ventral pair; spiracles small, circular, yellowish brown, separated by a distance about equal to four times the diameter of one. The pupa has the mesonotal declivity provided with an interrupted crossrow of small, unequal, chitinized teeth.

### (Subgenus *Sacandaga* Alexander)

1911 *Sacandaga* Alex. Ent. News, vol. 22, p. 349-352.

### *Rhabdomastix* (*Sacandaga*) *flava* (Alex.)

1911 *Sacandaga flava* Alex. Ent. News, vol. 22, p. 351-352.

*Rhabdomastix flava* is a curious fly which is apparently related to *Gonomyia* but represents a quite different offshoot of the Eriopterini. The writer believes that the larvae might be found in moist earth along streams, but at present they are quite unknown. The following notes

on the swarming habits of this species have been published (Alexander, 1912 a: 72-73):

On June 13, 1909, I found the species swarming [on Sport Island, in the Sacandaga River, New York] and made the following observations: The species came out at about 7.45 p.m. and at 7.51 p.m. began its flight in under an elm tree at the northeast end of the island. The flight was generally forward, but continually from side to side for a few inches. The flight was quite irregular, always toward the slight north breeze. The whole swarm would often move away and return, a little later, to the first place. It swarmed within four feet of the ground, generally much lower, averaging, perhaps, two feet. . . . The number of individuals participating in the swarm was about twenty. Other species swarming nearby at the same time were *Chironomus hyperboreus*, var. *meridionalis*, Joh., and the may-flies, *Ephemera excrucians* Walsh, and *Siphonisca aerodromia* Ndm.

### Genus *Trentepohlia* Bigot (named after J. J. Trentepohl)

- 1854 *Trentepohlia* Bigot. Ann. Soc. Ent. France, p. 474.  
 1911 *Mongomioides* Brun. Rec. Indian Mus., vol. 6, p. 296.  
 1912 *Mongomella* Enderl. Zool. Jahrb., vol. 32, part 1, p. 61.

*Trentepohlia* is a tropicopolitan genus including about fifty-five described species arranged in six subgenera — *Trentepohlia* Bigot, *Anchimongoma* Brun., *Mongoma* Westw., *Plesiomongoma* Brun., *Paramongoma* Brun., and *Neomongoma* Alex. Of these species, fifteen are American and the remainder are Old World forms. They are almost all species of delicate, ethereal structure, with long, slender legs. It is an interesting fact that *Trentepohlia* (*Mongoma*) *pennipes* has been observed by Jacobson (De Meijere, 1911: 50, and Edwards; 1912-13: 211) to form chains on horizontal spider webs, as is noted herein for *Thrypticomyia* (page 712) and somewhat similarly for *Oropeza* (page 982). H. K. Munro has supplied (*in litt.*) the following interesting notes on the habits of *Trentepohlia* (*Trentepohlia*) *humeralis* Alex. as observed in eastern Transvaal at the end of April, 1920:

Very inconspicuous when flying and resting. When flying resembles very much a small piece of thistle-down. Invariably settles on under side of twigs, leaves, and similar objects. Usually found among bushy undergrowth, but also in grass. When at rest the wings are folded along back; very often on settling the insect moves itself up and down in the manner of the long-legged harvest spiders (Phalangiidae). Slow flier.

A fossil *Trentepohlia*, *T. eruciferella* (Ckll.), has been described from the Gurnet Bay Oligocene (Cockerell, 1917b: 373-374). Observations on the immature stages of three species are available.

(Subgenus *Mongoma* Westwood)*Trentepohlia* (*Mongoma*) *pennipes* (O. S.)

1887 *Mongoma pennipes* O. S. Berl. Ent. Zeit., vol. 31, part 2, p. 204.

The immature stages of *Trentepohlia pennipes* have been described by De Meijere (1911:50-51) as follows: Jacobson found the larvae at Semarang, Java, in January, 1903, in decaying plant stems. The only larva sent was 9 millimeters long and almost 1 millimeter in diameter, of cylindrical form, only slightly narrowed behind and brownish in color. The head capsule was entirely retracted. The entire body was thickly beset with fine, short, appressed hairs; in addition to these, on the ventral side of each of the six intermediate segments were transverse swellings where the hairs were shorter and even more numerous. Surrounding the anus were four long, cylindrical, anal gills, each constricted in three or four places; if bent forward, the anterior pair would reach the middle of the penultimate segment of the body, the posterior pair being somewhat shorter. The last segment of the body was truncated, the lower angles being somewhat produced and provided with a few somewhat longer hairs; the spiracles, situated in the upper part of the spiracular field, were relatively small and somewhat elongated.

The pupa (Plate LXXVIII, 419) was about 9 millimeters long, elongate, of a yellowish brown color, the abdomen for the most part brighter. The thorax was almost smooth, with only a few short, brownish yellow bristles. The abdomen, except on the anterior segments, was thickly set with numerous tubercles. The apex of the abdomen had two short, thorn-like projections, curved outwardly; beneath these were two shorter tubercles, and four short tubercles formed a quadrangle on the dorsum of the last segment. The pronotal breathing horns consisted of flattened, leaflike lobes, the upper surface of which was scaly.

(Subgenus *Paramongoma* Brunetti)*Trentepohlia* (*Paramongoma*) *bromeliadicola* (Alex.)

1912 *Mongoma bromeliadicola* Alex. Ent. News, vol. 23, p. 415-417.

*Trentepohlia bromeliadicola* and *T. leucoxena* have a larval habitat which has not been found elsewhere in the family. They live in the water that gathers in the leaf axils of tropical bromeliaceous plants,

spending their immature stages in this habitat, where they are associated with a remarkable fauna of other organisms. The adult females have the valves of the ovipositor greatly elongated, and the writer has suggested elsewhere that this may be an adaptation for laying the eggs in this habitat. *T. bromeliadicola* was reared in Costa Rica by Picado, whose important paper (Picado, 1913) on the bromeliaceous epiphytes contains colored figures of the larva, the pupa, and the adult. From this paper it is seen that the larva (page 356, figure A, and plate 13, figure 4, of reference cited) is not unlike that of *T. pennipes*, described above, the four prominent anal gills of *T. bromeliadicola* (Plate LXXVIII, 420, of this paper) being a notable feature in common, altho here the constrictions are very numerous, there being twenty-five or thirty shown in the figure. The pupa (Picado, 1913:357, fig. 51, and pl. 13, fig. 2) has the pronotal breathing horns (Plate LXXVIII, 421, of this paper) approximated on the median line, and the sheaths of the ovipositor (Plate LXXVIII, 423) greatly elongated to contain the elongated terebra of the adult within. According to Keilin (1913), the tegumentary glands of this larva are a provision against drought, which is the great source of danger to organisms living in this habitat.

*Trentepohlia* (*Paramongoma*) *leucoxena* (Alex.)

1915 *Mongoma leucoxena* Alex. Ent. News, vol. 26, p. 29-30.

*Trentepohlia leucoxena* was reared by Knab in Mexico, from larvae found living in bromeliaceous plants quite as in the preceding species.

Genus *Teucholabis* Osten Sacken (Gr. *weapons* + *forceps*)

1859 *Teucholabis* O. S. Proc. Acad. Nat. Sci. Phila., p. 222.

*Larva*.—Form elongate, slender, terete. Body practically destitute of pubescence and setae. Spiracular disk surrounded by three very broad lobes, a flattened ventral lobe and two shorter lateral lobes at the base of which are the small black spiracles. Gills four, bluntly rounded and developed for propulsion. Head capsule of four elongate, slender rods or plates, interno-lateral pair forked at about midlength. Mandible rather small, with about three blunt lateral teeth. Antenna elongate, two-segmented.

*Pupa*.—Cephalic crest setiferous. Pronotal breathing horns short, blunt, closely applied to thorax. Mesonotum precipitous, at crest with two powerful hooks and smaller serrated plates near shoulder. Wing sheaths reaching end of second abdominal segment. Leg sheaths reaching end of fourth abdominal segment, middle tarsi the shortest. Abdomen with a transverse row of setae before ends of segments.

*Teucholabis* is a rather extensive genus of small crane-flies (including more than fifty described species) which find their center of distribution in the Tropics of the New World. A few species occur in Africa and the Oriental region. The genotype, *Teucholabis complexa*, is the only species that has been reared (Johnson, 1900). Johnson's material was kindly sent to the writer for study, and furnishes the basis for the following descriptions.

*Teucholabis complexa* O. S.

1859 *Teucholabis complexa* O. S. Proc. Acad. Nat. Sci. Phila., p. 223.

Larvae of *Teucholabis complexa* were found by Johnson in considerable numbers beneath the bark of a decayed oak below Avalon, New Jersey, on June 8, 1899. They commenced pupating about the 13th, the imagines continuing to emerge from the 22d to the 27th. This gives a pupal duration of not more than nine days.

*Larva*.—Length, 9 mm.  
Diameter, 0.55–0.6 mm.

Coloration pale yellowish white, spiracles conspicuously darker.

Form long and slender, body terete, tapering abruptly to the small prothoracic segment (Plate LXXIX, 424). Sutures between segments indistinct. Body practically destitute of pubescence and setae. Spiracular disk (Plate LXXIX, 427) with a broad, flattened, ventral lobe, which is very bluntly rounded to subtruncate at apex, and two very short, blunt, lateral lobes, at the base of which are the spiracles; spiracular disk without distinct markings. Spiracles small; middle piece black, ring pale horn-color; spiracles rather widely separated, the distance between them about equal to the long diameter of one. Anal gills (Plate LXXIX, 428) represented by four blunt, rounded lobes, which are apparently developed for propulsion rather than for a respiratory function.

Head not easily distinguishable in material available for study. Head capsule consisting of four long, slender, rodlike plates, the internal lateral pair forked at about midlength, so that capsule ends in six rods. Epipharynx with numerous small spines. Antenna (Plate LXXIX, 426) two-segmented, basal segment elongate-cylindrical, apical segment small, ovate. Mandible (Plate LXXIX, 425) rather small, apical point inconspicuous, with about three similar lateral teeth below it. Lobes of the maxilla blunt, stout, hairy, not extending far beyond tip of mandible.

*Pupa*.—Length, 6.5–6.6 mm.  
Width, d.-s., 1–1.1 mm.  
Depth, d.-v., 1.2 mm.

Coloration pale; head, thorax, and sheaths of appendages darker; eyes black.

Form slender, narrowed behind. Between antennal bases a prominent, two-parted crest, each lobe somewhat truncated behind and bearing a single stout seta. Front above eyes

slightly raised, two narrow lines on front, meeting below at a very acute angle. Eyes large in male, smaller in female, the front correspondingly narrowed or broadened. Labrum short, subtriangular. Sheaths of labial lobes small, suboval, separated by tip of labrum. Sheaths of maxillary palpi short, stout, straight. Antennal sheaths moderately long, extending to just beyond wing base; basal segments prominent, indicated on sheath as prominent elevations. Pronotal breathing horns short, blunt, anterior face closely applied to pronotum, outer face free; at base a small rounded knob. Thorax very deep, precipitous, at crest (Plate LXXIX, 429) armed with two strong curved hooks, one on either side of median line; on shoulder laterad of these hooks, two prominent flattened plates whose margins are minutely serrated, the dorsal, or outer, plate being the larger and terminating in a large curved hook. Wing sheaths moderately broad, ending just before tip of second abdominal segment. Leg sheaths (Plate LXXIX, 430) long and slender, outer pair much the longest, ending about opposite tip of fourth abdominal segment, middle pair the shortest. Mesonotum with two strong setae.

Abdominal segments divided into two annuli by an indistinct suture, anterior ring narrow; anterior ring with a strong seta on pleural region; posterior ring with strong setae on dorsum and sternum near caudal margin; three other setae on pleural region, two at about midlength of segment, the third near base and more dorsal in position. Male cauda (Plate LXXIX, 431) suddenly narrowed, terminating in two blunt ventral lobes and two acutely pointed dorsal lobes bent strongly dorsad at their tips and bearing a short seta in notch on inner face before apex; near base of cauda, on dorsum, a broad transverse swelling terminating in two widely separated, slender tubercles, immediately cephalad and laterad of which is a long seta; three strong setae on either side near base of cauda; posterior margin of segment 7 with two powerful, decussate setae on dorsum, and between them two small setae; another powerful seta near pleural region, and just inside still another smaller seta.

*Neponotype*.— Avalon, New Jersey, June 8, 1899.

*Neanotype*.— With type, June 14, 1899.

*Paratypes*.— One larva and one pupa.

### Genus *Cladura* Osten Sacken (Gr. *branch* + *tail*)

1859 *Cladura* O. S. Proc. Acad. Nat. Sci. Phila., p. 229.

The genus *Cladura* includes six known species — two from eastern North America, one from western North America, and three from Japan. The small *Cladura delicatula* Alex., of the mountainous regions of the north-eastern United States, differs from the genotype, *C. flavoferruginea* O. S., in several important respects and it is necessary to erect a new group to receive it. This group may, for the present at least, be considered as a subgenus of *Cladura*, and the name *Neocladura* (Gr. *new* + *Cladura*) is proposed. Moreover, the genera *Crypteria* Bergr. and *Pterochionea* Alex. are closely related to *Cladura*, and the entire group are almost certainly the direct forbears of the subapterous genus *Chionea* Dalman. *Neocladura*

curiously combines the structural characters of *Cladura*, *Pterochionea*, and *Crypteria*. In the long basal fusion-segment of the antennal flagellum and in the wing venation, it agrees with *Pterochionea* and, to a somewhat lesser degree, with *Cladura*. In the structure of the male hypopygium, which has two slender pleural appendages, it departs widely from the type of typical *Cladura*, *Chionea*, and *Pterochionea*, and agrees better with *Crypteria*, as well as with *Conosia* v. d. W. and *Lecteria* O. S. Because of this combination of characters, *Neocladura* must be separated in some manner from *Cladura* in the strict sense. It must be borne in mind, however, that the conspicuous difference in the structure of the male hypopygium probably has a phylogenetic significance, and the two flies may not be so closely united as this arrangement would indicate.

The habits of the adult flies of *Cladura* and *Neocladura* are generally similar. Both species fly in late summer and in the autumn. They often occur on dry, wooded hillsides remote from streams and other bodies of water. The habits of the adult flies of *Cladura flavoferruginea* have been discussed by the writer in an earlier paper (Alexander, 1910:250, as *C. indivisa*). His observations, made near Gloversville, New York, on September 22, 1909, are as follows:

I went to Simmon's Woods, southeast of Gloversville, New York, this afternoon, and was very agreeably surprised at the occurrence, in large numbers, of this usually uncommon insect. Near the entrance of the woods, where Simmon's Brook emerges, the insects were found in numbers. At each step they flew out of the bushes to others farther away. They are wary insects, and when sitting on the upper side of a leaf, slip over the edge and hang inverted from the lower side when alarmed by an observer. They present a very characteristic attitude, sitting on the leaf of a tree, with their wings folded flat over the abdomen, and the six long legs stretched out over the leaf. A few were taken in copulation; these were all hanging on the under side of a leaf. Their habit of clinging to the under surface of a leaf is quite remarkable and I found several by looking for them there.

There were hundreds of specimens in the low bushes of the woods, usually on the broad leaves of deciduous trees at a height of two or three feet. Sometimes they would alight on hemlock, and, occasionally, in ferns near the ground. It was the only tipulid observed here to-day.

The eggs of *C. delicatula* have been taken from gravid females. They are comparatively few in number, but because of their unusual size they almost fill the entire abdominal cavity of the fly. These large eggs are elongate-ovate in shape.

#### *Cladura flavoferruginea* O. S.

- 1859 *Cladura flavoferruginea* O. S. Proc. Acad. Nat. Sci. Phila., pl. 4, fig. 34.  
 1861 *Cladura indivisa* O. S. Proc. Acad. Nat. Sci. Phila., p. 291.

The immature stages of *Cladura flavoferruginea* were discovered while this paper was in press. A brief account of the larvae and pupae are given here in order to complete the data.

The larvae were found in Augurville Woods near Urbana, Illinois. They occurred in soil which was baked hard and dry and which supported scarcely any other insect life. Associated with the larvae when first discovered were larvae of a scarabaeid, *Xyloryctes satyrus*; a tenebrionid, *Meracantha contracta*; a few dipterous larvae of the genera *Sciara* and *Psilcephala*; millepedes of the genus *Spirobolus*; and a few less common forms of animal life. A layer of dead leaves and other decaying vegetable matter covered the surface, but this had not prevented an almost complete drying out of the soil to a depth varying from six inches to more than a foot. The only other tipulid larvae characteristic of such dry soil are species of *Dicranoptycha* (page 828).

The most conspicuous features of the pupa are its exceedingly small size as compared with the adult fly that emerges from it, and the entire lack of protuberant pronotal breathing horns.

*Larva*.— Length, 10–10.5 mm.  
Diameter, 1.2 mm.

Coloration light yellow thruout.

Form comparatively short and stout. Integument provided with a delicate appressed pubescence; no distinct setae. Basal annulus of abdominal segments 2 to 7 with a transverse area of microscopic points arranged in long transverse rows; last ventral segment with a flattened lobe covered with short setae, evidently an organ for shoving. Spiracular disk entirely without lobes, the spiracles being located on the exposed dorso-caudal surface of the last abdominal segment. Head capsule relatively compact; frontal plate broad, only slightly narrowed behind. Labrum quadrate, with conspicuous oval lateral arms. Antenna two-segmented, terminal segment elongate-oval. Mandibles of a herbivorous type, with an apical point and two incomplete rows of teeth on inner, or cutting, face. Mental bars widely separated, each bar provided with two acute teeth at its proximal end.

*Pupa*.— Length, 6.7 mm.  
Width, 1.4 mm.  
Depth, 1.4 mm.

Coloration pale yellow; head, thorax, and appendages darkening in age.

Cephalic crest gibbous, entire or feebly bifid, armed on either side with a single powerful bristle; two bristles on vertex and two on front; labrum with a pair of small bristles at each cephalic lateral angle. Labial lobes subquadrate, weakly separated by apex of labral sheath. Palpal sheaths short and stout, straight. Lateral margin of eye produced laterad into a digitiform lobe. Antennal sheaths extending to opposite one-third length of wing sheaths. Pronotal breathing pores entirely sessile. Pronotum and mesonotum armed with



conspicuous bristles. Wing sheaths ending opposite base of third abdominal segment. Leg sheaths unusually long, ending opposite base of sixth abdominal segment; hind legs the longest, middle legs the shortest. Abdominal tergites with ten strong bristles, eight being arranged in a single transverse row along posterior margin; abdominal pleurites with four strong bristles, one on each anterior ring, two near caudal margin of posterior ring, one ventrad of spiracle, the last-named rudimentary, located on segments 2 to 7; sternites unarmed with bristles.

### Genus *Chionea* Dalman (Gr. *snow*)

1816 *Chionea* Dalm. K. Vet. Akad. Handl., vol. 1, p. 102.

1912 *Sphaconophilus* Beck. Ann. Soc. Ent. Belgique, vol. 56, p. 142.

*Chionea* is a small genus of nearly apterous crane-flies, found thruout the North Temperate Zone. All of the known species (about eight) have the wings reduced to mere vestiges, this being the only genus of considerable size in which all the species show this condition. The South African genus *Platylimnobia* Alex., which shows a somewhat similar condition of wing atrophy, is probably not very closely allied to *Chionea*.

The adult flies of *Chionea* are most often found walking awkwardly over the snow in the late fall or early spring or during warm days in winter. A few instances, however, have been recorded in which specimens were found with the temperature below freezing. At other seasons of the year they may be found among fallen leaves, under moss and stones, in the nests of small mammals as *Arvicola* (Schmitz, 1914), or in deserted subterranean wasps' nests (Schmitz, 1916, and Becker, 1912). Interesting accounts of the habits of the adult flies of the commonest local species, *Chionea valga* Harris, are supplied by Ainslie (1906), Johnson (1907), Washburn (1907), and others. Luger (1896) gives the following interesting account of the habits of the same species:

As a general rule the wingless flies are found only early in the morning, though in one case a female was discovered crawling over the snow in the evening. . . . A few winters ago the writer discovered a female moving slowly over the snow and by searching he soon detected a male. Putting both together under an inverted glass the snow-flies immediately mated, notwithstanding it was several degrees below the freezing point. Soon afterward the female found a crack in the glassy surface of the frozen snow, and forcing herself into it slowly disappeared from view. Penetrating for some depth into the snow she deposited a number of elongated eggs, which, however, did not hatch. Most females found seemed to have the eggs already fully matured and only lacked to be fertilized.

Frauenfeld (Brauer, Egger, and Frauenfeld, 1854:616) believed that the eggs are deposited in snow, since they are often laid in January or February. He thought the slimy substance secreted by the small lateral

vesicles of the *receptaculum seminis* of the female acts as a covering to protect the eggs from wet and cold. It seems probable, however, that the flies enter some crevice in the snow around the base of trees or shrubs and reach solid earth, at least in some cases. Many authors have held the flies to be nocturnal in their habits. Recently, Marchand (1917) has furnished some interesting notes on an alpine *Chionea*, presumably *C. alpina* Bezzi. His observations and experiments showed him that *Chionea* was perfectly adapted to life on the snow, being attracted to this medium by its bright light and white color, the contact of the cold surface on the feet resulting in a direct stimulus thru the claws. The insects drink water by pressing their proboscides against the snow. Marchand considers the principal reason for these activities' being held on the snow to be for the purpose of mating, since the insects can cover considerable distances over the level surfaces and are much more visible to one another at this time. The copulation of this crane-fly has been fully described by Mik (Osten Sacken, 1887:196) as follows:

The upper valves of the ovipositor prevent the male from getting on the back of the female; it lies on its own back, in the direction of the longitudinal axis of the body of the female; when the latter is walking it drags the male, who raises himself on his hind legs to an almost perpendicular position; this serves to explain the unusual incrassation of these legs.

The genotype, *C. araneoides* Dalm., is the only species whose immature stages have been described.

#### *Chionea araneoides* Dalm.

1816 *Chionea araneoides* Dalm. K. Vet. Akad. Handl., vol. 1, p. 104.

The present knowledge of the life history of *Chionea araneoides* is due almost entirely to the work of Brauer, Egger, and Frauenfeld (1854). In February these investigators brought living adults, taken in copula, into an unheated room and placed them with their natural surroundings, such as rich, damp, humous earth, rotten grape leaves, and similar substances, in glass containers. After a time a great number of small, elongated eggs of a hyaline appearance were noted, laid at random, some being deposited on the walls of the container, where they adhered but soon shrunk and appeared dried out. Unfortunately the duration of the egg stage was not ascertained. Some weeks later the young larvae were found in the soil. They were of a cylindrical form, very pale yellow in color and not especially active. They were associated with numerous

larvae of *Sciara longipes* Meig. Toward the end of May only a few larvae were left, and these appeared fully grown but were not carried over into the pupal condition, which is still unknown.

*Larva*.—Length when fully grown, 7.4 mm.

Color light reddish yellow, contents of alimentary tract showing thru body. Body terete (Plate LXXXII, 443), consisting of twelve segments, there being, besides the head, three thoracic and nine abdominal segments; last segment wedge-shaped (Plate LXXXII, 446 and 447), obliquely truncated so that the surface slopes from behind upward. Two spiracles on this oblique surface, with a paler brown, pincer-shaped mark between. Mouth parts powerfully constructed. Mandible (Plate LXXXII, 444), produced into a long apical point; near midlength on inner edge of mandible a deep incision, distad of this about five teeth, basad of it three teeth. Labrum quadrangular, with two lateral points on anterior part. Mentum projecting outward as a cuticular rounded lobe. (Brauer shows two other appendages which are toothed on the outer face [Plate LXXXII, 445, of this paper]; these probably represent part of the mentum, but from Brauer's figures they would appear to lie above the labrum.)

### Subtribe Elephantomyaria

Genus *Elephantomyia* Osten Sacken (Gr. *elephant* + *fly*)

1859 *Elephantomyia* O. S. Proc. Acad. Nat. Sci. Phila., p. 220.

*Larva*.—Form terete. Segments of body just before sutures with transverse rows of stiff hairs; abdominal segments 5 to 8 on ventral surface with a mouthlike depression surrounded by long, stiff hairs. Spiracular disk surrounded by four lobes, ventral pair the longest, each of the latter bearing at its tip a single very long bristle. Spiracles moderately large, located at base of lateral lobes. Head capsule very long and narrow, the four plates very elongated. Mandible very small. Maxillary palpi short. Esophageal region surrounded by chitinized plates which are conspicuously obliquely ridged. Body of larva covered with numerous long, appressed hairs, producing a satiny appearance. Coloration saturated golden yellow.

*Pupa*.—Form slender. A small crest on vertex above eyes. Eyes very large, globular, narrowly separated on frontal and vertical regions. Rostral sheath very elongated; palpi recurved against it. Antennal sheaths lying across eye. Head and thorax with setiferous tubercles. Abdomen with rudimentary lateral spiracles.

*Elephantomyia* is a small genus of crane-flies including about a dozen described living species. These are found in widely separated regions of the world, there being about four in the East Indies, five in Africa, and two in North America, one of which has been recorded also from Europe. The genus is found fossil in the Baltic amber. The adult flies are remarkable for their very elongated rostra, and undoubtedly they feed on the nectar of tubular flowers as in the related genus *Toxor-*

hina. No records are available, however, to indicate what species of plants are thus frequented. The larvae live in decaying wood. The only species whose immature stages are known is the genotype, *Elephantomyia westwoodi*. The literature on the immature stages of this group of flies is very limited, the only record being the unknown Limnobiine No. 1 of Malloch (1915-17 b:235-236), who gives a good description of the larva. The pupa is here described and figured for the first time.

*Elephantomyia westwoodi* O. S.

1869 *Elephantomyia westwoodi* O. S. Mon. Dipt. N. Amer., part 4, p. 109.

*Elephantomyia westwoodi* is a rather common fly in eastern North America. The adults are usually found in cool, shaded woods and may be swept from vegetation in these localities. The larva lives in decaying wood, as is shown by the three records available to the writer.

The larvae were found by Shannon in a very wet, rotten, willow log lying near the tidal flat above the brewery at Rosslyn, Virginia, on May 21, 1913. About eight larvae were found, well scattered thru the log. They were very active in their movements and were very beautiful, in life being of a deep golden yellow color. These larvae were placed in rearing, and adults issued on May 27 and 29 and June 5 and 7, indicating a pupal duration of a week or slightly less. Larvae were found in this log also on November 23, 1912, and at that time they were almost grown, being about one-half inch in length. This shows that the species spends the winter as almost fully grown larvae.

Johnson found these larvae near Edge Hill, Pennsylvania, on June 25, 1899, and on May 25, 1905, in a log, just beneath the bark. Larvae and pupae obtained by him were in the material studied in the preparation of this paper.

Malloch found a single larva of this species in a much decayed log at White Heath, Illinois, on April 30, 1916 (Malloch, 1915-17 b:236).

*Larva*.— Length, 10-13.4 mm.  
Diameter, 1.2-1.3 mm.

Coloration of body, a deep saturated golden yellow throat.

Body moderately elongated, terete, relatively slender, tapering gradually toward either end but more noticeably and abruptly toward anterior end (Plate LXXX, 432); the three thoracic segments gradually increasing in size from the prothoracic backward. Abdominal segments 1 and 2 short, the third to the fifth the longest, remaining segments gradually shorter. Sur-

face of body densely covered with long, satiny, appressed hairs; thoracic and abdominal segments with a dorsal and a ventral transverse ridge of short, stiff hairs just before caudal margins of segments, these being longest on lateral parts of ridge; dorsal segments 6 and 7 with incomplete transverse rows at about midlength; on ventral surface of abdominal segments 1 to 3, near base, two transverse rows of tiny spines with a depressed area between; segment 4 without this distinct double ridge; segments 5 to 7 with a very conspicuous mouthlike depression at base of each, with a liplike margin on either side, the anterior margin narrow with stiff hairs, the posterior margin swollen and densely set with tiny spines; on segment 8 the transverse mouth lying near end of segment, its anterior lip with a dense fringe of long hairs directed backward. Spiracular disk (Plate LXXX, 434) surrounded by four lobes; lateral lobes the shortest, blunt at tips, inner face of each lobe slightly expanded at tip, a few short silky hairs on outer face of lobe, inner face slightly chitinized; ventral lobes longer, broad, tapering gradually to obtuse tips, notch between lobes deep, V-shaped, a narrow fringe of short, dense, golden, recurved hairs along outer face; at tip of each ventral lobe a single long, powerful bristle. Spiracular disk unmarked. Spiracles large, very widely separated, situated at base of lateral lobes.

Head capsule (Plate LXXX, 433) very small and narrow, the plates, four in number, being greatly elongated. (The exact details are difficult to see in the material available for study.) Labrum broad, anterior margin evenly rounded, with a few long hairs. Epipharyngeal region provided with long setae directed backward. Mandible very small, base narrowed, tip produced into an acute point with smaller teeth at about midlength. Mental region feebly chitinized. Hypopharynx semicircular, rounded, anterior margin delicately grooved. Esophageal region elongated, inclosed by chitinized plates provided with parallel ridges running outward on one side and inward on opposite face, upon focusing producing a latticed appearance. Maxilla densely hairy. Antenna two-segmented, conspicuous; basal segment short, apical segment larger, suboval. Sides of capsule on swelling behind the maxilla with a brush of very long hairs. Plates of capsule elongated, expanded and chitinized at tips and along margins; ventral plate near esophageal region with setae.

*Pupa*.— Length, 8.4 mm.  
 Width, d.-s., 1.1 mm.  
 Depth, d.-v., 1.3 mm.

Coloration light yellowish brown; abdomen darker; thoracic dorsum, sheaths of legs, and ovipositor more yellowish. (In younger pupae the coloration is more uniformly pale.)

Form slender, body narrow. Eyes very large, rounded (Plate LXXXI, 441). Antennal sheaths lying directly across face of eye. Vertex with a small but prominent crest lying transversely above eyes; cephalad of this crest and just proximad of the antennal bases, a setiferous tubercle. Front between eyes moderately broad, produced caudad into the very elongate rostral sheath, which is transversely wrinkled. Sheaths of maxillary palpi recurved, lying alongside rostrum. Sheaths of labium tiny, bilobed, lying at tip of rostrum. Two long setae on front between eyes. Eyes very large, narrowly separated on dorsum of head, the hinder part sunken under pronotum. Two conspicuous black tubercles behind antennal bases, each bearing a long, stout seta. Pronotal breathing horns (Plate LXXX, 435) small,

short, clavate, yellow, constricted at bases, which are blackened; a prominent seta just above each breathing horn; two setae on each side of pronotum beneath eye. Mesonotal prescutum strongly convex, with six strong setae on each side, one just cephalad of base of wing, another at joint of wing, and two semitransverse groups in front of and behind level of wing base. Wing sheaths short, ending some distance beyond tips of hind tibiae and just beyond base of third abdominal segment. Leg sheaths (Plate LXXXI, 442) with fore femora strongly swollen, lying alongside rostral sheath; tips of middle tibiae ending just beyond tips of fore tibiae; legs very long, ending just before tip of fifth abdominal segment.

Abdominal segments densely and microscopically punctulate. Segments 2 to 7 with two narrow basal rings and a broad posterior ring. Setae of dorsal abdominal segments (Plate LXXX, 437) on the posterior ring consisting of a caudal series of two strong outer setae and two smaller inner ones, the outer one of the inner series close to the proximal one of the outer series; lateral series of setae powerful; basal series in alinement with anterior lateral seta, consisting of two powerful outer setae and a delicate inner one; pleural segments with a rudimentary spiracle on segments 2 to 7, each spiracle with a stout seta above it; setae of ventral segments (Plate LXXX, 436) with two strong bristles on each side near posterior lateral margin, the outermost with a tiny seta above it; a single basal seta located on a level with vestigial spiracles. Female cauda (Plate LXXX, 439) with sternum of eighth segment having two sharp, curved, widely separated spines, and just laterad of these a stout seta; pleural region with another seta on same level; sternal valves of ovipositor only a little shorter than tergal valves; dorsum of segment 8 with two long teeth, above which are two slender, divergent tubercles; tergal valves broad basally, narrowed suddenly at tip, on either side with a small, subapical seta. Male cauda (Plate LXXX, 438 and 440) with eighth sternite having a strong median tubercle that is two-toothed; laterad of this a strong chitinized tooth bearing a powerful seta on outer face; a similar strong lateral seta; eighth tergite with four strong tubercles arranged to form a square; ninth sternite blunt, each lobe ending in two small tubercles; ninth tergite ending in two divergent lobes bearing at tip a large and a small seta and on dorsal face at about midlength another strong seta.

*Nepionotype*.— Rosslyn, Virginia, May 21, 1913.

*Neanotype*.— Edge Hill, Pennsylvania, May 25, 1905.

*Paratypes*.— Larvae with type larva (two) and with type pupa (two).

### Genus *Toxorhina* Loew (Gr. *bow* + *nose*)

1835 *Limnobiaorhynchus* Westw. Ann. Soc. Ent. France, p. 683 (spurious name).

1851 *Toxorhina* Loew. Linnaea Entomol., vol. 5, p. 400.

1869 *Toxorhina* O. S. Mon. Dipt. N. Amer., part 4, p. 109-114.

1910 *Neoceratocheilus* Wesché. Journ. Linn. Soc., Zool., vol. 30, p. 358.

*Toxorhina* is a small genus including about nine described species, almost all of which are from the New World. Two species occur in Africa and one in India. *Toxorhina madagascariensis* Meun. is described from African copal (Pleistocene). Nothing has been published concerning the immature stages of any member of this genus.

*Toxorhina muliebris* (O. S.)

1865 *Tozorhina muliebris* O. S. Proc. Ent. Soc. Phila., p. 233.

*Toxorhina muliebris* is the commonest species of the genus in the United States, with a rather wide range thruout the Northeastern States. The adult flies suck nectar from various flowers, such as the following: Rhamnaceae, *Ceanothus americanus* Linn. (Banks); Ericaceae, *Clethra alnifolia* Linn. (McAtce); Apocynaceae, *Apocynum medium* Greene (McAtce); Compositae, *Solidago canadensis* Linn. (Knab).

The immature stages are unknown, but from Mrs. Tothill's tent-trap observations they are presumably spent in mud, since adult flies were found in her traps set over wet, sedgy spots near Ithaca, New York. It may be, however, that the insects live in fragments of decaying wood which might be buried in this mud, since such a habitat conforms more closely to that of *Elephantomyia*, which is apparently closely related to *Toxorhina*.

## Eriopterine No. 1

A very curious larva, which has not been reared, has been found in various places near Ithaca during the past few years. It is a small, pale larva, very delicate and almost diaphanous in appearance, at the posterior end with five flattened black plates with serrated margins, and with its thoracic segments capable of considerable lateral extension. The larva is undoubtedly an eriopterine, but it introduces a type of spiracular disk that has not been found elsewhere in the tribe. The writer finds it difficult to believe that this curious larva can belong to any of the eriopterine genera discussed in this paper, and yet there are very few possibilities remaining; and one of these (*Cryptolabis*) does not occur in the habitat frequented by this larva. The genus *Atarba*, whose immature stages are still wholly unknown, is a possibility. *Empeda*, which the writer considers to be a subgenus of *Erioptera*, has not been reared and must also be considered as a possibility. If this is the larva of *Empeda*, the group at once assumes full generic rank as given it by Osten Sacken, but occupying an isolated position and no closer to *Gonomyia* than to *Erioptera*. The larvae of this species were found commonly on Bool's hillside, at Ithaca, where they occurred in association with numerous other crane-fly larvae discussed elsewhere (page 781). The

larva is described here in the hope that it will be reared and its identity ascertained.

*Larva.*— Length, 7–8.2 mm.  
Diameter, 0.4–0.5 mm.

Coloration pale yellowish white; skin very delicate, almost diaphanous.

Body moderately elongated, terete; meso- and metathoracic segments (Plate LXXV, 404) and eighth abdominal segment capable of considerable expansion laterally, and, in death, usually greatly swollen; last segment of body narrowed, cylindrical, with a number of long setae, including a group of five near base of lateral lobes. A few scattered setae along abdominal segments. Spiracular disk (Plate LXXV, 405) surrounded by five equal elongate spatulate blades, these blades flattened, jet-black in color, margins finely toothed; paired lobes near base with a subhyaline median spot; margins of lobes (Plate LXXV, 406) with twenty-five to thirty hooks, recurved ones alternating with others laterally directed; when blades are closed, these margins hooking closely together; at ends of blades and sparsely scattered along margin, long, delicate setae; at apex of blades, two bristles; no spiracles found at base of lobes. Anal gills four, lateral pair elongated, telescopic, inner pair shorter.

Head capsule much as in other eriopterine genera, especially *Ormosia* and *Gonomyia*, dorsal plates slender, ventral bars a little longer. Labrum as in the tribe; epipharyngeal region with a large apical setiferous pad and two smaller pads nearer base. Mentum not formed of ventral bars of capsule as in *Molophilus*. Hypopharynx a semicircular cushion covered with long, dense setae, their tips a little recurved. Antenna with apical papilla very long for this tribe, about equal in length to basal segment, cylindrical, with tip rounded. Mandible moderately large, apical tooth not prominent, lateral teeth rather conspicuous, basal ones smaller but not so excessively reduced as in other members of the tribe; prostheca large.

(Described from larvae, Ithaca, New York, May 11, 1917. No. 29-1917.)

### Tribe *Styngomyiini*

The *Styngomyiini* comprise a small group of very peculiar crane-flies with a tropicopolitan distribution. There is only the single genus, *Styngomyia*, with about twenty-five described species. Most of the species are from tropical Africa and Asia, tho a few range into Australia and the Hawaiian Islands, and one, *Styngomyia americana* Alex., is found in tropical South America.

### Genus *Styngomyia* Loew (Gr. a kind of tree-gum + fly)

- 1845 *Styngomyia* Loew. Dipt. Beitr., vol. 1, p. 6. (Correctly *Syngomyia* — Bergroth in litt.)  
1903 *Idiophlebia* Grünb. Zool. Anzeig., vol. 26, p. 524–528.  
1912 *Pycnocrepis* Enderl. Zool. Jahrb., vol. 32, part 1, p. 65.  
1917 *Mesyngytes* Kkll. Proc. U. S. Nat. Mus., vol. 52, p. 377.



The history of the genus *Styringomyia* is remarkable. It was erected by Loew in 1845, being based on the fossil species *Styringomyia venusta* Loew, from African copal. Many years later it was found to be still living in the Tropics of both hemispheres. The earliest fossil records pertain to the Oligocene of northern Europe (page 765).

The adult flies have such a curious structure that it seems best to remove them from the former tribe Antochini, where they have long been placed. Concerning the first living species to be described, the Hawaiian *S. didyma* Grimsh., Perkins (1913:clxxxii) says:

It sometimes swarms at night around the electric lights, sitting quietly on the walls and ceilings, with the body pressed closely to the surface, and the front and middle legs extended straight forward in front of the head in a characteristic manner.

Annandale has made similar observations on the resting positions of *S. ceylonica* Edw., taken in India. He says (cited by Edwards, 1914-15:207): "This species rests on walls with the two anterior pairs of legs stretched out straight in front and the posterior pair behind, resembling a stray piece of cobweb." Jacobson has recorded much the same for *S. jacobsoni* Edw. (De Meijere, 1911:41-42, as *S. didyma*) in Java. The flies are attracted to lamps and are almost always to be found in copulation, the head of one directed away from the other; while thus engaged, sometimes one, sometimes the other, will run forward for a short distance, producing a peculiar appearance. Munro (*in litt.*) reports that the habits of *S. vittata* Edw. as observed in eastern Transvaal in late April, 1920, are very similar. He writes: "Two specimens taken 'in cop.' Settled on under side of a twig, heads in opposite directions, front legs of each stretched out in front along twig, wings laid flat along abdomen."

#### *Styringomyia didyma* Grimsh.

1901 *Styringomyia didyma* Grimsh. Fauna Hawaiiensis, p. 10.

In *Fauna Hawaiiensis*, Perkins (1913:clxxxii) mentions the breeding of *Styringomyia didyma* by F. W. Terry. Before the reference could be investigated by the writer, Mr. Terry died. The following letters from O. H. Swezey in regard to the matter were then received.

In response to a letter sent on February 21, 1915, Mr. Swezey replied on March 26 that "no information on the rearing of the species is available in Mr. Terry's notes."

In a letter dated April 10 of the same year, however, the following notes were enclosed:

About forty-five eggs deposited in tube December 5, 1910. Chorion jet black, shining and thick, resisting dryness, 0.3 mm. by 0.15 mm., very finely parallel-striate.

One hatched December 10. The batch was placed with rotten apples and cow manure, hatching December 15. Larva long, head small, mandibles distinct and well chitinized. An adult male emerged about January 21, 1911.

Mr. Swezey, thru whose kindness the above notes are available, adds: "You see from the notes of Terry's that he did not breed *Styringomyia didyma* in its natural habitat. That is yet unknown, I guess."

The striking feature of this life history is its brevity, the entire egg, larval, and pupal stages being passed in about a month and a half. The writer knows of no other crane-flies in which this is equaled, its nearest approach presumably being in the smaller Eriopterini.

#### SUBFAMILY *Cylindrotominae*

The subfamily *Cylindrotominae* constitutes a small, isolated group of crane-flies, with twenty described species arranged in seven recent genera. All the species are Holarctic in their distribution with the exception of five species of the Oriental genera *Stibadocera* Enderl., *Stibadocerella* Brun., and *Agastomyia* de Meij. The group is a decadent one, having been much better developed in the early and middle Tertiaries than at present (page 764).

The adult flies are sluggish in their habits, occurring on vegetation in cool, shaded spots. The species of *Cylindrotoma* are brightly colored, yellow and black, but the other forms are somber in appearance and black or dark in color, the body being in some cases highly polished or metallic. The immature stages of the *Cylindrotominae* differ from those of all other Tipulidae, so far as is known to the writer, in being spent on various bryophytic and spermatophytic plants, on the leaves of which the larvae feed. The larvae are usually bright green in color and suggest a caterpillar in their general form. Most of them simulate their host plants to an astonishing degree. The immature stages of *Cylindrotoma* and *Liogma* are terrestrial, while those of *Triogma* and *Phalacrocera* are aquatic or nearly so.

The genera of the subfamily *Cylindrotominae* may be separated as follows:

## Larvae

1. Body appendages very long and filiform; aquatic . . . . . *Phalacrocera* Schin. (p. 961)  
Body appendages short, leaflike or tuberculate . . . . . 2
2. Dorsal appendages all simple, on the terminal abdominal segments in a single row; terrestrial on spermatophytic plants . . . . . *Cylindrotoma* Macq. (p. 966)  
Dorsal appendages with teeth on anterior convex side . . . . . 3
3. Some of the dorsal appendages with three or four teeth on anterior face; aquatic on mosses . . . . . *Triogma* Schin. (p. 973)  
Dorsal appendages with one (*L. nodicornis*) or two (*L. glabrata*) teeth. *Liogma* O. S. (p. 969)

## Pupae

1. Basal abdominal tergites without spines . . . . . 2  
Basal abdominal tergites with acute spines . . . . . 3
2. Mesonotum unarmed; segments 6 and 8 each with two powerful dorsal hooks; segment 7 with a pair of strong ventral spines; pronotal breathing horns elongate, directed backward . . . . . *Phalacrocera* Schin. (p. 961)  
Mesonotum with two flattened erect lobes; segments 6, 7, and 8 naked; pronotal breathing horns small, directed slightly forward . . . . . *Cylindrotoma* Macq. (p. 966)
3. Abdominal spines branched . . . . . *Liogma (glabrata)* (p. 969)  
*Triogma (trisulcata)* (p. 974)  
Abdominal spines not branched . . . . . *Liogma (nodicornis)* (p. 971)

The most important literature on the Cylindrotominae is as follows:

- General account of subfamily. Osten Sacken, 1897; Alexander, 1914:105-106; Malloch, 1915-17 b:210-211; Lenz, 1920 b:113-115.
- Phalacrocera replicata* . . . . . Larva, pupa, general . . . De Geer, 1773; 1776:135-141, [351].
- Phalacrocera replicata* . . . . . Larva . . . . . Grube, 1868.
- Phalacrocera replicata* . . . . . Larva . . . . . Engel, 1884.
- Phalacrocera replicata* . . . . . General . . . . . Giard, 1895 b.
- Phalacrocera replicata* . . . . . Larva, general . . . . . Bengtsson, 1897. (Morphology of larva.)
- Phalacrocera replicata* . . . . . Larva, pupa, general . . Miall and Shelford, 1897. (Morphology of larva and pupa.)
- Phalacrocera replicata* . . . . . Larva . . . . . Bengtsson, 1899. (Morphology of heart.)
- Phalacrocera replicata* . . . . . Larva . . . . . Holmgren, 1903. (Morphology of head.)
- Phalacrocera replicata* . . . . . Larva, pupa . . . . . Grünberg, 1910:32-35.
- Phalacrocera replicata* . . . . . Larva, pupa, general . . . Wesenberg-Lund, 1915:343-347.
- Phalacrocera replicata* . . . . . Larva, pupa, general . . . Lenz, 1920 b:127-129.
- Cylindrotoma distinctissima* . . . . . Larva, general . . . . . Sehellensberg, 1803:22-23.
- Cylindrotoma distinctissima* . . . . . Larva, pupa, general . . . Boie, 1838:234.
- Cylindrotoma distinctissima* . . . . . Larva, pupa, general . . . Zeller, 1842.
- Cylindrotoma distinctissima* . . . . . General . . . . . Schiner, 1864:563.
- Cylindrotoma distinctissima* . . . . . Larva, pupa, general . . . Kaltenbaeh, 1874:7.
- Cylindrotoma distinctissima* . . . . . Larva . . . . . Wesenberg-Lund, 1915:335 (as *Triogma*).
- Cylindrotoma distinctissima* . . . . . Larva, pupa, general . . . Lenz, 1920 b:115-117.
- Cylindrotoma splendens* . . . . . Larva, pupa, general . . . Cameron, 1918.
- Liogma glabrata* . . . . . Larva, general . . . . . De Rossi, 1876.
- Liogma glabrata* . . . . . General . . . . . Osten Sacken, 1878 a.

<i>Liogma glabrata</i> .....	Larva, pupa, general...	Müggenberg, 1901.
<i>Liogma glabrata</i> .....	Larva, general.....	De Rossi, 1902.
<i>Liogma glabrata</i> .....	General.....	Alexander, 1914:106-107.
<i>Liogma glabrata</i> .....	Larva, pupa, general...	Lenz, 1920 b:117-121.
<i>Liogma nodicornis</i> .....	Larva, pupa, general...	Alexander, 1914:107-115.
<i>Triogma trisulcata</i> .....	Larva, general.....	Steinmann, 1907-08.
<i>Triogma trisulcata</i> .....	Larva, pupa, general..	Müller, 1908-09.
<i>Triogma trisulcata</i> .....	Larva, general.....	Wesenberg-Lund, 1915:347-348 (as <i>Liogma glabrata</i> ).
<i>Triogma trisulcata</i> .....	Larva, pupa, general...	Lenz, 1920 b:121-127.

### Genus *Phalacrocera* Schiner (Gr. *bald* + *horn*)

1863 *Phalacrocera* Schin. Wien. Ent. Monatschr., vol. 7, p. 224.

*Larva*.—Body covered with numerous elongate, trachea-bearing filaments, the posterior pair on dorsal segments deeply forked, the others simple. Spiracular disk with dorsal pair of lobes formed by rudimentary posterior branch of branched filaments of eighth abdominal segment. Head capsule compact. Mentum with about fifteen teeth.

*Pupa*.—Cephalic crest low, not setiferous. Pronotal breathing horns long, almost straight. Dorsal abdominal segments with tubercles, those of sixth and eighth segments enlarged into spinous hooks; two pointed tubercles on seventh sternite.

*Phalacrocera* is a small genus (four species) of medium-sized to large, dull-colored flies, of which the genotype, *Phalacrocera replicata*, is European, *P. mikado* Alex. is Japanese, and the two remaining species are North American.

The adult flies of the American species are not common, the best-known, *P. tipulina* O. S., being most frequently found in or near sphagnum bogs in mountainous localities. Needham (1908 a:209) found the wings of an individual of this species in the pitcher plant, *Sarracenia purpurea* Linn., in the Adirondack Mountains, together with the wings of four specimens of *Elephantomyia westwoodi* and numerous other insects. Most of the specimens that have been found by the writer were taken in close proximity to bogs.

The immature stages of *Phalacrocera replicata* have long been known, having been described by De Geer and other early workers on insect biology. More recently the life history, anatomy, and morphology have been discussed in commendable detail by several other writers (page 960). Both the larvae and the pupae are aquatic, living among submerged plants in quiet, but non-stagnant, water.

The immature stages of *P. tipulina* are very much to be desired, as the adult shows some features in its organization not found in the other species of the genus.<sup>6</sup>

<sup>6</sup> The larva of this species was discovered by J. Speed Rogers in 1920.

Bengtsson (1897) erected for this genus the group *Erucaeformia*, which he considered as the primitive form from which the *Nematocera* and the *Brachycera* have been derived. This group, of course, has no standing whatsoever.

*Phalacrocera replicata* (Linn.)

1761 *Tipula replicata* Linn. *Fauna Suecica*, 2d ed., p. 500-502.

1863 *Phalacrocera replicata* Schin. *Wien. Ent. Monatschr.*, vol. 7, p. 224.

The larvae and the pupae of *Phalacrocera replicata* have been discussed in such detail by Miall and Shelford, by Bengtsson, by Holmgren, and by Wesenberg-Lund, that they are considered here only in general terms. The habits of the immature stages have been discussed by many writers since the time of De Geer. They are oftentimes rather numerous among aquatic plants such as *Ranunculus fluitans* Lam., *Fontinalis antipyretica* Linn., *Hypnum elodes* Schp., *H. exannulatum* Guenbel, and other species, feeding on these mosses and probably on other plants. These moss fragments give a green tinge to young larvae when seen thru the nearly transparent body wall. Older larvae are more opaque and are brownish green in color, indistinctly striped with pale and darker. The larva is extremely sluggish, remaining almost motionless for hours. It clings to moss stems by its large anal hooks, and, thus secured, it often sways its body from side to side as if to accelerate respiration. The larvae can go for long periods of time without fresh air. Miall and Shelford kept specimens alive for two weeks in bottles completely filled with water, and for a long time in water that had been boiled. The larvae can live for a long time out of water. Progression thru the mats of submerged vegetation is accomplished by grasping with the mandibles and the anal hooks, alternately. When alarmed the larvae curl into a rounded ball, after the manner of many caterpillars. The skin, and more especially the long body processes, are often covered with ectoparasitic organisms, such as algae and infusoria, on which small fresh-water mollusks, *Planorbis*, have been observed feeding and creeping about over the body of the larva. This coating of organisms, the body outgrowths, and the general coloration of the larva, give it a striking resemblance to the mosses among which it lives. De Geer (1776:355) shows that the larva can endure excessive cold. He placed four larvae in a vessel at the beginning of winter, and examined them in the following May. During the winter

the water in which the larvae lived had frozen into a solid mass, yet, on investigating the jar in the spring, De Geer found two of the larvae still alive and able to feed, and within a month both had pupated.

The larval habitat is in ponds in which a moss vegetation flourishes and in which currents keep the water in constant motion. A female fly was observed by Miall and Shelford (1897:360) depositing her eggs in the leaf axils of a submerged moss. The eggs, about sixty in number, are laid singly and adhere slightly to the moss; they are opaque, dark in color, and spindle-shaped, with the surface of the chorion irregularly pitted, and with a rosette-like micropyle at one end. Bengtsson, Muggenberg, and others believe that *Phalacrocer* has but a single brood in a year, the larval existence occupying about eleven months; Miall and Shelford, however, admit the possibility of a second brood. The egg stage requires from eight to twelve days and the pupal duration is seven or eight days, according to Bengtsson. According to Miall and Shelford, the pupal period is considerably longer.

During the larval development there are numerous moltings, at least eight and possibly ten; the old larval skin is cast by a simple dorsal split extending from the first to the fourth segment. Just after emerging from the egg the larva is from 2 to 2.25 millimeters in length and about 0.5 millimeter in diameter, excluding the body projections. The first larval stage (Bengtsson, 1897) lasts until the second molting. The body is provided with ten pairs of long, delicate, threadlike, lateral projections, which are located on the second to the eleventh body segments and are half as long as the body. The other projections of the older larvae are merely indicated. The attachment apparatus is placed immediately before the anus, and consists of from eight to twelve chitinized hooks, directed forward and arranged in an arcuated crossrow. The color of the body is white, almost transparent. The mouth parts show the mandibles without a prostheca and moving horizontally. The second larval stage lasts from the second until the fourth molting. The body appendages have appeared and are clearly developed, resembling in appearance and relative length those of the definitive stage. The attachment apparatus is post-anal. The body takes on a distinctly striped appearance. The mouth parts have the prostheca well developed on the mandibles, which are vertically placed and therefore have an up-and-down movement. The third larval stage represents the fully grown larva from the fourth

molt up to the time of pupation. Here the dorsum of the body is a dirty brownish green with more or less distinct brighter spots, and the venter is bright green in color. The mouth parts and the attachment apparatus are as in the second stage.

The pupa is comparatively active, moving about by flexion of the abdomen. Its usual position is vertical, with the tips of the breathing horns just reaching the surface of the water. This vertical position the pupa maintains by grasping the vegetation with its caudal abdominal hooks. At times the pupa descends beneath the water by clinging to the vegetation, but a submergence of six hours causes asphyxiation. The pupal existence was determined by Miall and Shelford as eleven days. When the adult emerges, the cast pupal skin is left attached to a moss leaf by the dorsal abdominal projections at the posterior end of the body.

*Larva*.—Length, about 25 mm.

Young larvae distinctly greenish, especially on ventral side, this coloration caused, at least in part, by contents of alimentary canal showing thru body wall; older larvae more opaque, brownish green in color; dorsum with an indistinct striping of brown and whitish; ventral surface whitish.

Head entirely retractile within prothorax and usually so retracted except when larva is feeding; opening transverse. Prothorax, viewed from above, roughly rounded, anterior margin convex; on ventral surface traversed by a weak suture. Meso- and metathorax narrow. Abdominal segment 1 indistinctly divided into two annuli, the more basal one very narrow; abdominal segments 2 to 7 divided into a narrow basal ring and a much broader posterior ring, each of these annuli still further subdivided into two annulets. Body provided with numerous elongate trachea-bearing filaments, both simple and branched, giving larva a very bristly appearance (Plate LXXXIII, 448), these spines arranged as follows: *tergites* with both simple and bifurcated filaments; on posterior part of pronotum two short, simple filaments; on meso- and metanotum, two pairs of simple filaments; on abdominal segment 1, an anterior pair of simple, and a posterior pair of deeply branched, filaments; segments 2 to 7 with basal ring unarmed, posterior ring with an anterior pair of simple, and a caudal pair of deeply branched, filaments; segment 8 with only a branched pair, anterior branch long, slender, posterior branch very small, its outer face heavily chitinized and forming dorsal lobes of spiracular disk; *pleurites* with all the filaments simple; one on posterior part of prothorax, and on anterior part of each of the other two thoracic segments; posterior filament on these latter nearly vestigial; two unequal filaments on first abdominal segment; segments 2 to 7 with one filament on basal ring and two on posterior ring, the anterior one the longest; segment 8 with a single rudimentary filament; *sternites* with all the filaments simple; prosternum without filaments; meso- and metasternum with a strong filament near lateral margins; abdominal segment 1 with two pairs of filaments, posterior pair the longer and more widely separated; segment 2 with three pairs of filaments, anterior pair very short; segments 3 to 7 with four pairs of filaments and an additional median one, arranged as follows:

two pairs of small filaments on basal ring, the anterior pair more widely separated, two pairs of much longer filaments on posterior ring, the last pair more widely separated, longer, and tipped with blackish, between them a tiny median filament. Chaetotaxy as follows: tergites with four solitary setae along anterior margin of prothorax, and two setae just laterad of each dorsal filament of prothorax and posterior filaments of meso- and metathorax; abdominal segments with a seta laterad of each simple and branched filament; pleurites with a stiff seta at base, and out toward apices, of middle lateral filaments; sternites with a group of about four stiff setae on either side of posterior ring of prosternum, and a single stiff seta on either side of median line; meso- and metasternum with a lateral group of setae; a seta laterad, and another at about midlength, of each of the posterior pair of ventral filaments.

Spiracular disk with ventral lobes elongate, slightly recurved, the posterior face intensely blackened, chitinized, each lobe with two acute spines at tip, with two setae near them; a stiff seta on side of base of each ventral lobe; dorsal lobes as already described, the rudimentary posterior branch of last furcate dorsal filament much smaller than in ventral lobes, the posterior face heavily blackened; spiracular disk rhombic in form, white, and having almost the appearance of porcelain. Spiracles situated between bases of dorsal lobes. Skin about spiracles capable of retraction so as to form a deep recess.

Head capsule rather short, almost conical, formed of two large lateral plates and a somewhat smaller and shorter prefrontal plate. Mentum with an outer (ectolabial) part and an inner (endolabial) part; mentum a triangular or somewhat pentagonal plate, strongly chitinized, fore margin with about fifteen teeth; mandibles working against teeth of both endo- and ectolabia. Antenna of a single segment, bearing on its truncated apical end a few sensory papillae. Mandibles small but strong, curved inward at tip and furnished with a fringe of setae, which assist in closing the mouth opening. Maxilla expanded into flattened, shovel-like structures, inserted high on side of head; palpus with a number of sensory papillae at apex, and with a porous plate on outer side which seems to be an organ of hearing.

*Pupa*.—Length, 16–18 mm. (Miall gives length up to 20 mm.)

Width, d.-s., 2.9–3.3 mm.

Depth, d.-v., 2.7–2.9 mm.

Coloration greenish brown, in alcohol a paler yellowish brown, a very broad dorso-median dark brown stripe which is narrowly margined laterally with yellowish; dorsum of abdomen suffused sublaterally with dusky, extreme lateral margins of body yellowish; ventral surface with two broader sublateral stripes and a very narrow ventro-median stripe.

Anterior end of body very deep and thick, as is usual in this group of crane-flies. Abdomen greatly depressed, with lateral margins very thin and flattened. Cephalic crest low, non-setiferous, located between antennal bases. Labrum broad basally, narrowed toward apex, which is broadly rounded; two setae at base of labrum. Labial lobes subcircular in outline. Maxillary palpi elongate, bent strongly backward so as to lie along flattened cheek. Antenna rather elongated, extending far beyond origin of wing pad (Plate LXXXIII, 449). Thorax very deep, flattened above. Pronotal breathing horns, which are broken in the writer's specimens, seen from other descriptions to be rather elongate, almost straight, and slightly divergent; two small setae between bases of breathing horns; two groups of setae on anterior part of pronotum before breathing horns. Mesonotum (Plate LXXXIII, 449) with six



small, setiferous tubercles, one above each wing axil, the other four arranged in a trapezoid on dorsum with the anterior pair closer together; metanotum with six setiferous tubercles, four of which are median in position, the other pair at antero-lateral margin, near base of halteres. Wing sheaths ending about opposite apex of second abdominal segment. Leg sheaths ending before apex of third abdominal segment.

First abdominal segment similar to metanotum; segments 2 to 7 indistinctly subdivided into a narrow basal ring and a much broader posterior ring; basal ring unarmed except for a seta on pleural margin and a trapezoid of tubercles on sternum; posterior annulus armed as follows: tergites with four tubercles arranged in a quadrangle and located in the dark median stripe, posterior tubercles with a stiff seta just laterad of each; a lateral seta on a line with anterior tubercles; two lateral setae on a level with posterior tubercles, the proximal one considerably the larger; these setae located in the yellow sublateral stripe; pleural margin with two setiferous tubercles with an acute subappressed spine between them; a seta immediately ventrad of anterior tubercle; on segments 6 and 7, spine closer to caudal margin of segment, and tubercle beyond it lacking; sternites with a trapezoid of naked tubercles on basal ring, posterior pair the closer together; a trapezoid of larger setiferous tubercles on posterior ring, anterior pair the closer together; posterior punctures each having two setae, with an additional slender seta laterad of these in the lateral dark stripe; dorsum of segment 6 (Plate LXXXIII, 450) with posterior pair of tubercles replaced by two powerful lobes directed caudad and laterad; segment 7 unarmed on dorsum, sternum with two acute spines near caudal margin; segment 8 with lateral angles produced dorsad into slender lobes which are spinous on all the faces; caudal angles directed caudad into slender lobes, acute at tips and with anterior inner face spinous and bearing a few setae. Male cauda with sternal valves very blunt and rounded, on either side of ventro-median line produced caudad into an acute spine. Female cauda with dorsal acidothecae a little longer than the more slender sternal valves, both pairs much exceeded by caudal angles of eighth segment.

*Nepionotype*.— Larva, Denmark.

*Neanotype*.— Pupa, Denmark.

*Paratypes*.— One larva and one pupa.

(The writer is indebted to Dr. C. Wesenberg-Lund for this material, as well as for several other interesting European crane-fly life histories.)

### Genus *Cylindrotoma* Macquart (Gr. *cylinder* + *I cut*)

1834 *Cylindrotoma* Macq. Suit. à Buff., vol. 1, Hist. Nat. Ins., Dipt., p. 107.

*Larva*.— Body covered with simple tubercles, a median dorsal row and a double ventral row. Spiracular disk large, surrounded by small lobes. Head capsule compact. Mentum with about fifteen teeth.

*Pupa*.— Pronotal breathing horns short, cylindrical, directed strongly ventrad. Mesonotum with two flattened lobes directed cephalad. Abdomen unarmed with spines or lobes.

*Cylindrotoma* is a small genus including six species distributed thruout the North Temperate Zone, three of these species occurring in North America.

The adult flies of *Cylindrotoma tarsalis* Johns., the only species that the writer has ever found in nature, are common on rank vegetation in cool, boggy, and swampy woods. The immature stages of the genotype, *C. distinctissima* (Meig.), have long been known, having been discussed by Schellenberg (1803), Boie (1838), Zeller (1842), Kaltbach (1874), and others. The larva shows some resemblance to that of *Phalacrocer*, but is almost entirely terrestrial in its habits, feeding on the leaves of various spermatophytic plants such as *Caltha palustris*, *Anemone nemorosa*, *Ranunculus repens*, *Chrysosplenium*, *Stellaria nemorum*, *Sanicula europaea*, *Viola biflora*, *Valeriana officinalis*, *Allium*, and others. It attains a length of nearly 25 millimeters, and is narrow, depressed, tapering to either end, and of a grass-green color. There is a slight dorsal ridge from which a row of short, fleshy spines projects, these spines being directed backward and one spine on each segment being longer than the others. There is a broad lateral margin bearing very short processes, and there are also eight pairs of ventral ridges without hooks and a pair of longer backward-directed processes near the anus. The pupa affixes itself to stalks or leaves by the caudal end, to which the remains of the last larval skin adhere. The larvae generally remain on the lower surface of the leaves, on which they feed, gnawing holes in them. When about to pupate they generally leave their food plants and fasten themselves on grass blades and leaves near by, usually pupating the following day. From the foregoing observations it would seem that there are in the various localities two generations a year, one in the spring and the other in the autumn.

The life history of *C. splendens* has recently been worked out in considerable detail by Dr. A. E. Cameron, thru whose kindness the writer has received specimens for study.

#### *Cylindrotoma splendens* Doane

1900 *Cylindrotoma splendens* Doane. Journ. N. Y. Ent. Soc., vol. 8, p. 197.

1900 *Cylindrotoma juncta* Coq. Proc. Wash. Acad. Sci., vol. 2, p. 401.

1918 *Cylindrotoma splendens* Cameron. Ann. Ent. Soc. Amer., vol. 11, p. 67-89.

*Cylindrotoma splendens* is an interesting crane-fly occurring from British Columbia northward to Alaska. Dr. Cameron's excellent notes on the life history of this species are abstracted in detail on pages 708 to 710 of this paper. The following descriptions were made from material sent

to the writer by Dr. Cameron, a few details being added from Dr. Cameron's published notes.

*Larva*.— Length, 15–17 mm.  
Width, d.-s., 2.4–2.5 mm.  
Depth, d.-v., 1.5 mm.

Coloration light chlorophyll green, with two narrow, pale brown lines on dorsum, extending from posterior end, above spiracles, anteriorly, becoming more expanded and diffused on fore part of body.

Body very depressed, both dorsal and ventral surfaces being flattened, lateral margins sharp (Plate LXXXIV, 453). Head completely retractile within prothorax. Skin delicately reticulated and roughened. Thorax, viewed from above, semicircular in outline, margined with about four tubercles on either side, anterior pair the largest, separated by a V-shaped notch. Pronotum with an anterior pair of small tubercles and a larger median tubercle behind, directed backward; segments 2 and 3 each with lateral margins two-toothed, the anterior tooth the larger and more pointed; a blunt dorsal tubercle on anterior margin and a larger one behind. Abdominal segments indistinctly divided into four annuli which are poorly delimited; the two basal annuli narrow and corresponding to basal annulus of most crane-fly larvae, the third annulus the largest and bearing a slender lateral tooth; other segments less distinctly divided serrately on lateral margin; dorsum of abdominal segments with a row of blunt median tubercles, there being four on each segment, the first very small to vestigial, the third slender, the last the stoutest; on venter of abdominal segments 1 to 7, near posterior margin, a fleshy conical lobe (pseudopodium) on either side of median line, these being smaller on anterior segments (1 to 4), and much larger and paler on posterior segments (5 to 7). Spiracular disk very large and flattened, obliquely truncated, surrounded by six small lobes, the dorso-lateral pair small, widely separated, the ventro-lateral pair much larger, the ventral pair very small, slender. Spiracles very small, circular, widely separated, the distance between them about equal to six times diameter of one.

Mouth parts with labrum linguliform, terminating in four teeth, external pair smaller than internal pair. Mentum with seven teeth on either side of small median one, the first and the third on either side being the largest. Hypopharynx with two rows of small teeth. Antenna two-segmented; basal segment elongate, pyriform; apical segment thimble-shaped. Mandible (Plate LXXXIV, 454) powerful; cutting edge with about five marginal teeth and two dorsal teeth; a large basal prosthema. Maxilla large; outer lobe fringed with stiff hairs; a few acute sensory bristles situated on elevated papillae, two on cardo, one on outer lobe of maxilla; maxillary palpi short, cylindrical, apex obliquely truncated and provided with numerous sensory knobs, on side near tip a circular porous plate (which as it appears in *Phalacrocera* is suggested by Bengtsson as probably being an organ of hearing).

*Pupa*.— Length, 11.7–14 mm.  
Width, d.-s., 2–2.8 mm.  
Depth, d.-v., 1.4–2 mm.

Color of live pupa, leaf green; preserved specimens much paler, yellowish; pronotal breathing horns grayish white; margins of abdomen nearly translucent.

Labrum narrow, apex evenly rounded. Labial lobes stout, separated by labrum, at tip narrowed and somewhat pointed. Maxillary palpi long and stout, just beyond base bent strongly backward. Antennae rather short, bases not widely separated (Plate LXXXIV, 456). Thorax very deep, much flattened anteriorly (Plate LXXXIV, 455). Pronotal breathing horns short, cylindrical, slightly divergent, apex of each a little expanded. Mesonotum at declivity with two flattened plates, which are blunt and directed cephalad and slightly laterad; above wing axil a smaller tubercle. Wing sheaths ending just before apex of second abdominal segment. Leg sheaths ending just before apex of third abdominal segment; tarsi ending about on a level.

Abdomen strongly depressed, lateral margins carinate; segments distinct, unarmed, subdivided into a narrow basal ring and a much broader posterior ring; segments 2 to 5 a little longer than segments 6 and 7. Male cauda with valves divided into two rounded lobes by a small median notch. Female cauda with dorsal valves straight, a little longer and much stouter than the slender sternal valves.

*Nepionotype*.— Westholme, Vancouver Island, B. C., May 15, 1917.

*Neanotype*.— Female pupa with type larva.

### Genus *Liogma* Osten Sacken (Gr. *smooth* + *furrow*)

1869 *Liogma* O. S. Mon. Dipt. N. Amer., part 4, p. 298.

*Larva*.— Body covered with elongate, leaflike projections, dorsal ones with one or two teeth on anterior convex face. Spiracular disk surrounded by four lobes. Head capsule compact. Mentum with about fourteen teeth.

*Pupa*.— Metanotum and abdominal tergites with elongate spines, branched in *L. glabrata*, simple in *L. nodicornis*.

The genus *Liogma* includes three known species, of which the genotype, *Liogma nodicornis* (O. S.), is American. The adult flies of this species are sluggish, and are found resting on vegetation growing in and about shaded ponds and similar situations.

In Europe the life history of *L. glabrata* (Meig.) has been worked out by De Rossi (1876), by Wesenberg-Lund (1915:347-348), and in considerable detail by Muggenberg (1901). The larvae were found in the woods near Berlin, in wet, grassy spots where the moss *Hypnum squarrosus* Brch. & Schp. occurs. The complete metamorphosis of the insect takes one year, the larval life requiring the greater part of this period. The egg stage lasts from eight to ten days and the pupal stage from eleven to twelve days. The duration of adult life is not known, but it is certainly short, occupying but a few weeks at the most.

Near Berlin the flies emerge during the first half of July. The males appear first, the females later, and the latter are always seized in copulation

by the males just after they have forsaken the pupal skin and while still teneral and undeveloped. Each female lays about sixty eggs, and these are deposited singly on the leaves or branches, or attached lightly to the axils of the leaves, of *Hypnum squarrosum*. Egg deposition begins from one-half to one day after copulation, and may be extended, with many interruptions of greater or less extent, thru a whole day. The eggs are from 1 to 1.2 millimeters long, spindle-shaped, yellowish green in color, the chorion with a reticulate sculpturing. After the accomplishment of oviposition the exhausted female soon dies. The larvae when first hatched are 2 millimeters in length and do not yet possess the beautiful moss-green color of the later stage. With the exception of the chitinized head capsule, they appear ashy gray. The numerous thornlike projections are to be noted already in the same positions as those of the developed larva, but do not show the branching of the later stages. In the autumn the young larva grows very slowly, and during the winter it is still very small and difficult to detect. In the spring the growth is greatly accelerated, and the larva becomes fully grown during the latter half of June. While attaining its growth the larva molts several times, probably at least eight — the number determined for Phalacroceras by Bengtsson. Pupation occurs in the moss where the larva happens to be. In its green color, with brown blotches, the larva remarkably simulates its host plant and the effect of the shadows cast by the plant stems and leaves. The larvae are extremely sluggish in their habits.

The American species *Liogma nodicornis* has been found in various mosses of the genus *Hypnum* (Alexander, 1914). The immature stages of this species are discussed below.

The following keys separate the species of *Liogma*:

*Larvae*

- Prothoracic segment bearing four conspicuous dorsal projections about on a line; meso- and metathorax with two pairs of dorsal appendages, each bearing two lateral teeth in front; second abdominal segment with four dorsal appendages, the last two bearing two teeth in front (Palearctic).....*glabrata* (Meig.) (p. 969)
- Prothoracic segment bearing four inconspicuous dorsal tubercles; meso- and metathorax with two pairs of dorsal appendages, the anterior pair small, both pairs simple; second abdominal segment with four dorsal appendages, the last two bearing a single small tooth in front (Nearctic).....*nodicornis* (O. S.) (p. 971)

*Pupae*

- Pronotal breathing horns directed cephalad and dorsad; mesonotum bearing two pairs of spines, the more anterior being the smaller, situated just behind breathing horns, posterior pair the larger; metanotum with two pairs of spines; abdomen with first tergite bearing two pairs of spines, the first having two lateral branches, the second simple; second tergite bearing two pairs of spines, the first with two lateral branches, the second with one branch; third tergite bearing three pairs of spines, the first very short and simple, the second with two lateral branches, the third with one branch; tergites 4 and 5 with three pairs of branches, the first two similar to those of third segment, the last possessing two lateral branches..... *glabrata* (Meig.) (p. 969)
- Pronotal breathing horns directed cephalad and ventrad; mesonotum spineless; metanotum with one pair of spines; abdominal tergites bearing but a single pair of appendages, which are unbranched and correspond in position to the last or more posterior of those of the European species..... *nodicornis* (O. S.) (p. 971)

*Liogma nodicornis* (O. S.)

- 1865 *Triogma nodicornis* O. S. Proc. Ent. Soc. Phila., vol. 4, p. 239.  
 1869 *Cylindrotoma nodicornis* O. S. Mon. Dipt. N. Amer., part 4, p. 301.  
 1887 *Liogma nodicornis* O. S. Berl. Ent. Ztschr., vol. 31, p. 226.

*Liogma nodicornis*, the only American species of the genus, is widely distributed thruout the Northeastern States. The larvae are found in moss — *Hypnum cupressiforme* Linn. and related species. They are the most sluggish of any crane-flies known to the writer, moving only with great slowness and much of the time appearing to be quite dead. They crawl about among the stems of their host plant and probably never leave it, even to pupate. The pupal duration indoors is not more than six days. Further details of the life history are given by the writer in an earlier paper (Alexander, 1914).

*Larva*.— Length, 14.5–15 mm.  
 Width, 3 mm.  
 Depth, 2.5 mm.

Color of live larva light green, the numerous spines covering the body darker; sides with seven black marks, the first on first abdominal segment, the last on seventh abdominal segment; the marks on ends the smallest and least distinct, the five intermediate marks large and conspicuous; these marks all lying parallel to one another; posterior face of ventral lobes surrounding stigmal field intensely black.

Prothorax in front (Plate LXXXV, 462) sloping from anterior end, on ventral slope provided with liplike lobes, with a transverse slit from which head capsule is exerted; upper lip the higher, not strongly chitinized, provided with a few small, scattered bristles, these more numerous on sides of lobe; lower lip not so high, with small, scattered bristles not arranged in a row as in *L. glabrata*; at angle of slit a small rounded lobe bearing a small bristle. Dorsal body appendages reduced to a pair of lobes in front, separated by a space a little greater than diameter of one, and a pair of smaller lobes behind, very widely separated; lateral body appendages long, conspicuous; ventral body appendages not apparent. Meso- and meta-thorax swollen and arched ventrally like prothorax; dorsal appendages two, a small conical

one in front and a much larger one behind bearing a small tooth in front and with its tip directed backward; lateral appendages, viewed from above, two in number, anterior one the larger, directed sharply backward, the second smaller, conical; ventral appendages, viewed from side, four, anterior pair the larger, posterior pair small, slightly behind the others.

Dorsal appendages of abdominal segments (Plate LXXXV, 457) as follows: first segment with two pairs of appendages; anterior pair the shorter, conical, tips strongly recurved and bearing a tiny tooth on anterior face at about midlength; posterior pair much longer, with tips bent strongly backward, a small tooth on anterior face at about one-third length from base; segments 2 to 7 with four pairs of appendages, the first pair very small, conical, the second exactly similar but larger, the third and fourth pairs similar to appendages of first abdominal segment; the tiny anterior appendage largest on second segment, gradually becoming smaller toward end of body. Lateral abdominal appendages as follows: first segment with three pairs of appendages, the first directed laterad, the posterior two more recurved and directed caudad; segments 2 to 7 with four pairs of appendages, the first very small, conical, at anterolateral angle of segment, the other three subequal and directed caudad. Ventral abdominal appendages as follows: first segment with three pairs of appendages, which are successively larger from the short anterior one to the large posterior one; segments 2 to 7 with five pairs of appendages, the first three small, the fourth intermediate in size between them and the enlarged fifth pair. Eighth segment bearing spiracular disk and its lobes; dorsal side of field with a pair of long, slender lobes bent conspicuously cephalad. Spiracular disk (Plate LXXXV, 461) small, oval, the two rounded-oval spiracles situated side by side and close to each other, inclined toward each other and capable of being closely appressed; ventral lobes of disk directed ventrad, inner faces of lobes with a conspicuous jet-black line, tip of each lobe ending in a sharp recurved hook. (Müggenberg regards these lobes as representing the ninth abdominal segment.) Ventral surface of terminal segments with small protuberances.

Head completely retractile into first thoracic segment. Mentum (Plate LXXXV, 458) with about seven teeth on either side, terminal pair the larger, separated by a V-shaped notch. Antenna (Plate LXXXV, 460) two-segmented, basal segment elongate-cylindrical, tip very short, thimble-shaped, with a diameter less than that of elongate basal segment. Mandible (Plate LXXXV, 459 and 460) many-toothed on inner face, with a prominent basal prostheca; mandibles working vertically against teeth of mentum. Maxilla (Plate LXXXV, 458) with palpi very short, broad, basal segment chitinized, tip narrow, pale.

*Pupa*.—Length: male, 10.4–11.4 mm.; female, 10–13 mm.

Width, d.-s.; male, 2–2.2 mm.; female, 2.2–2.6 mm.

Depth, d.-v; male, 1.9–2.2 mm.; female, 2.1–2.5 mm.

Living pupae with pronotal breathing horns light yellow, the terminal half a little more brownish; a brownish black mark on prescutum; abdomen greenish, more yellow behind; dorsal spines clear light green thruout or with tips in some specimens a little infuscated. (In pupae preserved in alcohol, the greenish colors are lost, the dark brownish black mark of the mesonotal prescutum is irregularly U-shaped, with the arms of the U directed backward, and the dark color is produced caudad and cephalad along the dorso-median line; there is a triangular or rounded black spot on either side of the scutellar lobe; on the metanotum is a large blackish median blotch, which is continued cephalad onto the mesonotal postnotum; the abdomen has an interrupted brownish black longitudinal line along either side of the midline of the dorsum; the posterior margin of each tergite is suffused with

brown.) In old and fully colored pupae, bases of dorsal spines brown, with the tips paler; head and thorax with appendages brown, in some specimens very dark; abdomen yellowish.

Cephalic part of head very flat and broad, without spines but with a small, blunt tubercle behind antennal bases. Labrum transversely wrinkled, narrowed to the bluntly rounded apex. Labial lobes large, divergent, each lobe rectangular with angles rounded. Sheaths of maxillary palpi rather long, curved strongly backward. Antennal sheaths rather enlarged, directed cephalad, bending around anterior margin of eye and thence directed caudad, ending just beyond knee joint of fore legs. (In older pupae, the peculiar nodose antennal segments of the adult show thru the sheath.) Pronotal breathing horns (Plate LXXXV, 464) large, conspicuous, directed dorsad and laterad, the terminal half bent rather suddenly cephalad. Mesonotum transversely wrinkled. Metanotum (Plate LXXXV, 463) with two long, slender spines, arising beyond midlength of segment, directed caudad and slightly dorsad. Wing sheaths broad, reaching posterior margin of second abdominal segment. Leg sheath ending just before posterior margin of third abdominal segment; fore legs the shortest, hind legs the longest.

Abdominal segments with a narrow basal ring and a broader posterior ring; segment 1 about half as long as segment 2; tergites 1 to 7 with a pair of long, slender, spinous projections, shortest on anterior segment, longest on seventh segment, these projections arising from near caudal margin of segment, directed dorsad and caudad, those of anterior segment almost parallel, those of posterior segments more divergent; segments 2 to 7 having lateral margins produced into three sharp spines, one on basal ring and two on posterior ring of each segment, these spines directed laterad and caudad, the terminal spines more sharply caudad than the other two; abdominal sternites armed as follows: segment 3 with a small, subapical spine on either side, these spines very widely separated, segment 4 with similar spines but larger and more prominent, segments 5 to 7 similarly armed but with another pair of small spines about midlength of segment and much nearer midline of body, segments 2 to 7 with a subbasal triangular pit on either side, these pits widely separated; eighth tergite with caudal margin rounded, concave, the lateral angles produced backward, upward, and slightly outward as strong spines; suture on ventral surface incomplete; two small spines on either side of middle line of body; posterior margin of segment produced caudad as two strong spinous projections. Male cauda with sternal valves rather long, tipped with two to four acute spines, in some specimens with two spines on one of the lobes and only one on the other; tergal valves a little rounded at tips, slightly longer than sternal valves. Female cauda (Plate LXXXV, 465 and 466) with sternal valves slender, feebly notched at tips; tergal valves broader, rounded at tips, and with a deep median split.

*Nepionotype*.—Coy Glen, Ithaca, New York, May 8, 1913.

*Neanotype*.—Ithaca, May 30, 1913.

*Paratypes*.—Larvae and pupae with types; others from Orono, Maine, June 17 and 19, 1913.

### Genus *Triogma* Schiner (Gr. *three* + *furrow*)

1863 *Triogma* Schin. Wien. Ent. Monatschr., vol. 7, p. 223.

*Larva*.—Body covered with elongate leaflike projections, some of the dorsal ones with as many as four teeth on anterior convex face. Spiracular disk surrounded by four lobes.

*Pupa*.—Dorsum of abdomen with elongate branched spines.



The genus *Triogma* includes but three known species, the genotype *Triogma trisulcata* (Schum.) of Europe, *T. kuwanai* (Alex.) of Japan, and *T. exculpta* O. S. of the eastern United States. The last-named species is very rare and its habits are entirely unknown.

The first reference to the immature stages of *T. trisulcata* is by Steinmann (1907-08), who discusses the larva as that of an unknown species of Phalacrocera. The true identity of this insect was made known by Müller (1908-09). Steinmann found the larvae at Säckingen at the end of April, fourteen days after the melting of the snow. They were found in mountain streams, attached to and living among the stems of the aquatic moss *Fontinalis antipyretica* Linn., to which they clung firmly by means of two strong chitinized hooks at the caudal end of the body. The larva resembles to a startling degree the moss on which it lives. Along the dorsal surface are two rows of leaflike appendages, each of the abdominal segments having three such appendages, of which the most anterior one is the shortest and the posterior one is the longest. The anterior appendage is untoothed, the others have as many as four teeth on the anterior face. The pleural region likewise bears a row of leaflike structures, while the ventral surface shows a double row of small, knoblike leaflets. Thru the strong accentuation of the dorsal and the two lateral rows, there is produced a copy of the ternate condition of the leaf arrangement in *Fontinalis*.

The larva of *T. trisulcata* (Plate LXXXIII, 452) is of a light green color marked with darker blotches, and measures 19 millimeters in length. The longest body appendage is 1.5 millimeters in length. Müller found larvae and also pupae. The pupa is characterized by the possession of somewhat similar appendages to those of the larva, the dorsal row showing the peculiar branched condition found in the larva.

#### SUBFAMILY Tipulinae

The subfamily Tipulinae comprises a remarkably homogeneous assemblage of usually large species. It is made up of a relatively few but in some cases very extensive genera, which are found thruout the world. Efforts have been made in the past to maintain three tribes—the Dolichopezini, the Ctenophorini, and the Tipulini. It has become increasingly difficult, however, to define these groups on the constant accession of exotic genera and species. A study of the immature stages likewise

fails to substantiate the validity of these groups, and, for the present at least, or until other and better characters may be found, it is better to eliminate the Dolichopezini and the Ctenophorini, founded, as they are, on insufficient or sexual characters.

The species of the Tipulinae include the largest crane-flies known, some exotic species of *Ctenacroscelis* attaining a wing expanse of nearly 10 centimeters. In North America the largest species are representatives of the genera *Longurio* and *Holorusia*. The great majority of the species in this subfamily are well above the average in size, this feature alone being sufficient to eliminate all but a very few of the other groups of Tipulidae. The smallest member of the subfamily Tipulinae known to the writer is *Microtipula amazonica* Alex., of Brazil, in which the wing of the male measures but 7.2 millimeters in length and is very long and narrow. Practically all of the common local species of this group belong to the two genera *Tipula* and *Nephrotoma*.

The immature stages of members of the subfamily Tipulidae are found in a wide range of habitats. Some species of *Tipula* are almost entirely aquatic in the larval state. The majority of the known species live in moist earth near water, or beneath damp cushions of moss. Some, such as *Oropeza*, live in much drier mosses on exposed rocks. A rather considerable number of species (*Brachypremna*, *Ctenophora*, *Diectenidia*, and several species of *Tipula*) live in decaying wood or beneath the bark of prostrate trunks. *Tanyptera* lives in wood which is relatively sound, and this represents the extreme development of this tendency in the family.

The larvae are never very slender, and are usually very plump and terete. In a few cases only is the body decidedly depressed. There is a definite arrangement of setae on the body, there being none on the anterior annulus of the abdominal segments except a single seta on the pleura of either side. The spiracular disk is surrounded by six lobes, a number not found in the Limnobiinae. In *Dolichopeza* the number is described as being five, the normal number in the Eriopterini, but all other features of the genus are essentially tipuline. In a few species the number of lobes is increased to eight. In the genus *Tanyptera* the lobes are exceedingly reduced in size so that the caudal end appears almost naked and exposed. The spiracles are always present and in some cases are very large. The anal gills are almost always present and are variously

developed according to the habitat. The head capsule is remarkably uniform thruout the group, being broad, compact, and massive, with the posterior incisions shallow and the prefrontal sclerite very large and usually distinct. The labrum is usually conspicuous, transverse, with fringes of hairs. The mentum has from seven to nine teeth along the anterior margin, and is deeply split behind but not completely divided. The hypopharynx consists of a narrow, flattened plate, with the basal lateral angles produced into strong arms and the anterior margin having usually five teeth, the teeth being rarely more numerous and in some cases obsolete. The antennae are cylindrical, and are stoutest in the wood-inhabiting species; in many species of *Tipula* and *Prionocera* they are long and slender, the length being about four times the diameter; the apical papilla, in some cases obsolete, is usually very small and is flattened. The mandibles are not large in proportion to the size of the capsule; they have few teeth, in some species only a dorsal and a ventral tooth in addition to the apical point; the prosthecal appendage is variously developed. The maxillae are simple and generalized in structure.

The pupae are fairly uniform in structure thruout the subfamily. The tips of the sheaths of the maxillary palpi are strongly curved, or, in the majority of species, actually recurved. The pronotal breathing horns are variously formed, but in practically all species they are short, cylindrical, and with the tips but little expanded. In some genera (*Longurio*, *Prionocera*, and *Tipulodina*) the breathing horns are greatly elongated, and, in some cases at least, are slightly unequal in length, the longer measuring nearly half the length of the body. In some genera, such as *Prionocera* and *Holorusia*, the horns are split at their tips into two divergent flaps. The only short, clavate horns in the subfamily are those of the genus *Tanyptera*. The mesonotum is often provided with four or six variously developed tubercles. The abdominal segments are almost always armed with transverse posterior rows of spines, these ranging in number from about four to twenty.

The large size of the larvae and the pupae will, as a rule, easily separate this subfamily from almost all members of the *Limnobiinae*. The few large members of the latter group are readily separated by the characters outlined above.

The following keys separate the genera of the subfamily Tipulinae:

*Larvae*

1. Spiracular disk surrounded by five lobes; living in moss. . . . . *Dolichopeza* Curt. (p. 981)
- Spiracular disk surrounded by four or six lobes, or with lobes indistinct. . . . . 2
2. Spiracular disk with lobes indistinct; living in nearly solid or semi-decayed wood. . . . .
- Tanyptera* Latr. (p. 988)
- Spiracular disk with lobes distinct. . . . . 3
3. Spiracular disk with four slender, hornlike lobes. . . . . *Tipula* (*selene* Meig.) (p. 1016)
- Spiracular disk with six lobes. . . . . 4
4. Anal gills pinnately branched. . . . . *Longurio* Loew (p. 990)
- Aeshnasoma* Johns. (p. 993)
- Anal gills not pinnately branched. . . . . 5
5. Antepenultimate segment of abdomen with a strong lateral tubercle. . . . .
- Oropeza* Needm. (p. 982)
- Antepenultimate segment of abdomen without such a tubercle. . . . . 6
6. Dorsum of head behind antenna with a slender, flexible spine; living in wood. . . . .
- Ctenophora* (*apicata* O. S.) (p. 986)
- Dorsum of head without such a spine. . . . . 7
7. Lobes surrounding spiracular disk elongate, digitiform, fringed with long hairs. . . . .
- Prionocera* Loew (p. 995)
- Lobes surrounding spiracular disk less elongate. . . . . 8
8. Size large (over 50 mm.); spiracular disk with the six moderately long lobes fringed with long hairs; mandible small, with a dorsal and a ventral tooth; found in western North America. . . . . *Holorusia* Loew (p. 993)
- Size smaller; if large (*T. abdominalis*), the lobes surrounding disk bifid; mandible with two or three ventral teeth. . . . . *Tipula* Linn. (p. 998)
- Nephrotoma* Meig. (p. 1016)

*Pupae*

1. Pronotal breathing horns very long, slender, the longest one nearly if not quite half length of body. . . . . 2
- Pronotal breathing horns short, cylindrical or flattened, subequal in size. . . . . 3
2. Length 40 mm.; longest breathing horn 18 mm.; maxillary palpi not recurved at tips; venation with petiole of cell  $M_1$  very short. . . . . *Longurio* Loew (p. 990)
- Length 20 mm.; longest breathing horn 9 to 10 mm.; maxillary palpi recurved at tips; venation with petiole of cell  $M_1$  longer. . . . . *Prionocera* Loew (p. 995)
3. Pronotal breathing horns short, compressed, deeply bi-eremulated; living in wood. . . . .
- Tanyptera* Latr. (p. 998)
- Pronotal breathing horns cylindrical. . . . . 4
4. Maxillary palpi not recurved at tips. . . . . 5
- Maxillary palpi recurved at tips. . . . . 6
5. Pronotal breathing horns with apices deeply split; mesonotum with two tubercles; abdominal segments with fourteen to thirty-four spines; found in Western States; living in mud. . . . . *Holorusia* Loew (p. 993)
- Pronotal breathing horns short, slender, apices not split; mesonotum with eight tubercles; abdominal segments with four powerful spines near posterior margin; found in Southern States; living in wood. . . . . *Brachypremna* O. S. (p. 984)
6. Mesonotum with two spines; ventral abdominal spines six to eight; fore and middle tarsi subequal, shorter than hind tarsi; living in wood. . . . . *Ctenophora* Meig. (p. 986)
- Characters not as above. . . . . 7
7. Mesonotum with a large, roughly triangular, reticulated area on either side of median line; dorsum of cauda with four lobes. . . . . *Oropeza* Needm. (p. 982)
- Mesonotum unarmed or with four or six lobes; dorsum of cauda with six, or rarely four, lobes. . . . . *Tipula* Linn. (p. 998)
- Nephrotoma* Meig. (p. 1016)

The most important literature on the Tipulinae is as follows:

<i>Dolichopeza albipes</i> .....	Pupa.....	Beling, 1879:44-45 (as <i>sylvicola</i> ).
<i>Dolichopeza albipes</i> .....	Larva, pupa, general...	Beling, 1886:189-191 (as <i>sylvicola</i> ).
<i>Tanyptera atrata</i> .....	General.....	Perris, 1840:92; 1849:333.
<i>Tanyptera atrata</i> .....	General.....	Nördlinger, 1848.
<i>Tanyptera atrata</i> .....	General.....	De Rossi, 1882.
<i>Tanyptera atrata</i> .....	Larva, pupa, general...	Gereke, 1884, Pl. I, figs. 12-19.
<i>Tanyptera atrata</i> .....	General.....	Hermann, 1880.
<i>Tanyptera atrata ruficornis</i> .....	Larva.....	Gerbig, 1913:156-158 (as <i>Ctenophora flavicornis</i> ).
<i>Tanyptera fumipennis</i> .....	Larva, pupa, general...	Malloch, 1915-17 b:194-195; 1919.
<i>Dictenidia bimaculata</i> .....	Larva.....	Bouché, 1834:32.
<i>Dictenidia bimaculata</i> .....	General.....	Zetterstedt, 1851:4023.
<i>Dictenidia bimaculata</i> .....	Larva, pupa, general...	Weyenberg, 1872.
<i>Dictenidia bimaculata</i> .....	General.....	Beling, 1873 b:575.
<i>Dictenidia bimaculata</i> .....	General.....	Czizek, 1913:102.
<i>Ctenophora flavcolata</i> .....	Larva, pupa, general...	Réaumur, 1740, Pl. I, fig. 9.
<i>Ctenophora flavcolata</i> .....	General.....	Zetterstedt, 1851:4016.
<i>Ctenophora flavcolata</i> .....	Larva, pupa, general...	Weyenberg, 1872.
<i>Ctenophora pectinicornis</i> .....	Larva, pupa.....	Bouché, 1834:29-31.
<i>Ctenophora pectinicornis</i> .....	General.....	Fischer von Waldheim, 1838.
<i>Ctenophora pectinicornis</i> .....	Larva, pupa.....	Weyenberg, 1872.
<i>Ctenophora pectinicornis</i> .....	General.....	Zetterstedt, 1851:4014.
<i>Ctenophora pectinicornis</i> .....	General.....	Kaltenbach, 1874:202.
<i>Ctenophora festiva</i> .....	Larva.....	Kaltenbach, 1874:631.
<i>Ctenophora festiva</i> .....	Larva.....	Czizek, 1911:48.
<i>Ctenophora nigricoxa</i> .....	Pupa.....	Lundström, 1906:7.
<i>Ctenophora apicata</i> .....	Larva, pupa.....	Johannsen, 1910:32-33.
<i>Ctenophora angustipennis</i> .....	Larva, pupa, general...	Anthon, 1908.
<i>Ctenophora angustipennis</i> .....	Egg, larva, pupa, injury.	Lovett, 1915.
<i>Aeshnasoma rivertonensis</i> .....	Larva.....	Johnson, 1906:1-2.
<i>Aeshnasoma rivertonensis</i> .....	General.....	Johnson, 1907-12 [1909]:115-116.
<i>Tipulodina pedata</i> .....	Pupa.....	De Meijere, 1911:64.
<i>Holorusia rubiginosa</i> .....	Larva, pupa, general...	Kellogg, 1901, a and b.
<i>Holorusia rubiginosa</i> .....	Larva.....	Comstock and Kellogg, 1904:54-62.
<i>Prionocera fuscipennis</i> .....	Larva, pupa, general...	Malloch, 1915-17b:199-200.
<i>Prionocera parri</i> , supp. (Palearctic species)	Larva.....	Alexander, 1919 c.
<i>Tipula caesia</i> .....	General.....	Schiner, 1864:516.
<i>Tipula dilatata</i> .....	Larva, pupa.....	Beling, 1886:176.
<i>Tipula dilatata</i> .....	Larva, pupa.....	Czizek, 1913:169.
<i>Tipula flavolineata</i> .....	General.....	Staeger, 1840:23.
<i>Tipula flavolineata</i> .....	Larva, pupa.....	Beling, 1873 b:581-582.
<i>Tipula flavolineata</i> .....	Larva, pupa.....	Czizek, 1913:146.
<i>Tipula fulvipennis</i> .....	Larva, pupa.....	Beling, 1879:22-24 (as <i>lutescens</i> ).
<i>Tipula fulvipennis</i> .....	Larva, pupa.....	Czizek, 1913:74.
<i>Tipula hortensis</i> .....	Larva, pupa.....	Beling, 1873 b:578-579.
<i>Tipula hortensis</i> .....	Larva.....	Gerbig, 1913:154-156.

<i>Tipula hortulana</i> . . . . .	Larva, pupa, general . . .	Beling, 1879:25; 1886:178-179.
<i>Tipula hortulana</i> . . . . .	Larva, pupa, general . . .	Czizek, 1913:96.
<i>Tipula imbecilla</i> . . . . .	General . . . . .	Loew, 1869:9.
<i>Tipula irrorata</i> <sup>7</sup> . . . . .	Larva, pupa . . . . .	Beling, 1873 b:586-587.
<i>Tipula irrorata</i> . . . . .	Larva, pupa . . . . .	Czizek, 1913:98-99.
<i>Tipula lateralis</i> . . . . .	Larva, pupa . . . . .	Beling, 1879:26-28.
<i>Tipula lateralis</i> . . . . .	Larva . . . . .	Gerbig, 1913:153-154.
<i>Tipula lateralis</i> . . . . .	Larva, pupa . . . . .	Czizek, 1913:128.
<i>Tipula lateralis</i> . . . . .	General . . . . .	Cameron, 1917:61.
<i>Tipula lunata</i> . . . . .	Larva, pupa . . . . .	Brocher, 1909.
<i>Tipula luteipennis</i> . . . . .	Larva, pupa . . . . .	Beling, 1886:181-182.
<i>Tipula luteipennis</i> . . . . .	Larva, pupa . . . . .	Czizek, 1913:143.
<i>Tipula marmorata</i> . . . . .	Larva, pupa . . . . .	Beling, 1886:182-183.
<i>Tipula maxima</i> . . . . .	Larva, pupa . . . . .	Beling, 1886:177-178 (as <i>gigantea</i> ).
<i>Tipula maxima</i> . . . . .	Larva . . . . .	Gerbig, 1913:152-153 (as <i>gigantea</i> ).
<i>Tipula maxima</i> . . . . .	Larva, pupa . . . . .	Czizek, 1913:70-71.
<i>Tipula maxima</i> . . . . .	General . . . . .	Wesenberg-Lund, 1915:335 (as <i>gigantea</i> ).
<i>Tipula micans</i> <sup>7</sup> . . . . .	Larva, pupa . . . . .	Beling, 1886:183-184.
<i>Tipula nigra</i> . . . . .	Larva, pupa . . . . .	Beling, 1879:28-29.
<i>Tipula nigra</i> . . . . .	Larva, pupa . . . . .	Czizek, 1913:132.
<i>Tipula nubeculosa</i> . . . . .	Larva, pupa . . . . .	Beling, 1873 b:575-577.
<i>Tipula nubeculosa</i> . . . . .	Larva, pupa . . . . .	Czizek, 1913:113.
<i>Tipula ochracea</i> . . . . .	Larva, pupa . . . . .	Beling, 1873 b:582-583.
<i>Tipula ochracea</i> . . . . .	Larva, pupa . . . . .	Czizek, 1913:157.
<i>Tipula oleracea</i> . . . . .	Larva, pupa . . . . .	Del Guercio, 1914.
<i>Tipula oleracea</i> . . . . .	General . . . . .	Patterson, 1908.
<i>Tipula pabulina</i> . . . . .	Larva, pupa . . . . .	Beling, 1873 b:579-580.
<i>Tipula pabulina</i> . . . . .	Larva, pupa . . . . .	Czizek, 1913:86.
<i>Tipula pagana</i> . . . . .	Larva, pupa . . . . .	Beling, 1879:29-31.
<i>Tipula paludosa</i> . . . . .	Larva, pupa . . . . .	Beling, 1873 b:583-585.
<i>Tipula paludosa</i> . . . . .	Larva . . . . .	Gerbig, 1913:136-151.
<i>Tipula paludosa</i> . . . . .	Larva, pupa . . . . .	Czizek, 1913:136.
<i>Tipula paludosa</i> . . . . .	Larva, pupa . . . . .	Rennie, 1916; 1917.
<i>Tipula parva</i> , sup . . . . .	General . . . . .	Onuki, 1905.
<i>Tipula peliostigma</i> . . . . .	Larva, pupa . . . . .	Beling, 1879:33-34.
<i>Tipula peliostigma</i> . . . . .	Larva, pupa . . . . .	Czizek, 1913:159.
<i>Tipula pruinosa</i> . . . . .	Larva, pupa . . . . .	Beling, 1879:31-32; 1886:184.
<i>Tipula pruinosa</i> . . . . .	Larva, pupa . . . . .	Czizek, 1913:148.
<i>Tipula rufina</i> . . . . .	Larva, pupa . . . . .	Mik, 1882 a.
<i>Tipula scripta</i> . . . . .	Larva, pupa . . . . .	Beling, 1873 b:577-578.
<i>Tipula scripta</i> . . . . .	Larva, pupa . . . . .	Czizek, 1913:110.
<i>Tipula selene</i> . . . . .	Larva, pupa . . . . .	Beling, 1879:34-35.
<i>Tipula selene</i> . . . . .	Larva, pupa . . . . .	Czizek, 1913:160-161.
<i>Tipula signata</i> . . . . .	Larva, pupa . . . . .	Beling, 1879:32-33.
<i>Tipula signata</i> . . . . .	Larva, pupa . . . . .	Czizek, 1913:104.
<i>Tipula simplex</i> . . . . .	General . . . . .	Doane, 1908.
<i>Tipula subnodicornis</i> . . . . .	Larva, pupa . . . . .	Beling, 1886:185-186.
<i>Tipula truncorum</i> . . . . .	Larva, pupa . . . . .	Beling, 1879:24-25.

<sup>7</sup> *Tipula micans* is considered by Kertész and others as a synonym of *T. irrorata*, but Beling's descriptions indicate that he had two distinct species before him.

<i>Tipula truncorum</i> .....	Larva, pupa.....	Czizek, 1913:82.
<i>Tipula unca</i> .....	Larva, pupa, general...	Beling, 1886:179-181 (as <i>longicornis</i> ).
<i>Tipula unca</i> .....	Larva, pupa.....	Czizek, 1913:101-102 (as <i>longicornis</i> ).
<i>Tipula variicornis</i> .....	Larva, pupa.....	Beling, 1886:173-174 (as <i>annulicornis</i> ).
<i>Tipula variicornis</i> .....	Larva, pupa.....	Czizek, 1913:122-123.
<i>Tipula variipennis</i> .....	Pupa.....	Beling, 1873 b:580-581.
<i>Tipula variipennis</i> .....	Larva.....	Beling, 1886:186.
<i>Tipula variipennis</i> .....	General.....	Westhoff, 1879.
<i>Tipula variipennis</i> .....	Larva.....	Gerbig, 1913:131-136.
<i>Tipula variipennis</i> .....	Larva, pupa.....	Czizek, 1913:91-92.
<i>Tipula vernalis</i> .....	Larva, pupa.....	Beling, 1879:25-26.
<i>Tipula vernalis</i> .....	Larva, pupa.....	Czizek, 1913:120.
<i>Tipula vittata</i> .....	Larva, pupa.....	Beling, 1886:186-188.
<i>Tipula vittata</i> .....	Larva, pupa.....	Czizek, 1913:78.
<i>Tipula winnertzii</i> <sup>8</sup> .....	Larva, pupa.....	Beling, 1873 b:585-586; 1886:188-189.
<i>Tipula winnertzii</i> .....	Larva, pupa.....	Czizek, 1913:84-85.
(Nearctic species)		
<i>Tipula abdominalis</i> .....	Larva.....	Malloch, 1915-17 b:200-201 (as <i>Tipula</i> sp. 2).
<i>Tipula arctica</i> .....	Larva, pupa.....	Nielsen, 1910:57-59.
<i>Tipula arctica</i> .....	Larva, pupa.....	Alexander, 1919 c:18c, 19c.
<i>Tipula bicornis</i> .....	Larva, pupa.....	Forbes, 1890.
<i>Tipula caloptera</i> .....	Larva.....	Needham and Betten, 1901:575-576 (as <i>abdominalis</i> ).
<i>Tipula cunctans</i> .....	Larva, pupa, general...	Hyslop, 1910 (as <i>infusata</i> ).
<i>Tipula cunctans</i> .....	Larva, pupa.....	Malloch, 1915-17 b:204.
<i>Tipula eluta</i> .....	Larva, pupa, general...	Hart, 1898 [1895]:212-214.
<i>Tipula eluta</i> .....	Larva, pupa.....	Malloch, 1915-17 b:203.
<i>Tipula sarta</i> (?).....	Pupa.....	Malloch, 1915-17 b:205.
<i>Tipula trivittata</i> .....	Larva, pupa.....	Greene, 1909.
<i>Tipula trivittata</i> .....	Pupa.....	Malloch, 1915-17 b:204-205.
<i>Tipula ultima</i> .....	Pupa, general.....	Needham, 1903:280-281 (as <i>flavicans</i> ).
<i>Tipula ultima</i> .....	General.....	Caudell, 1913 (as <i>flavicans</i> ).
<i>Habromastix cinerascens</i> .....	General.....	Skuse, 1890:95.
<i>Nephrotoma analis</i> .....	Larva, pupa.....	Beling, 1886:172-173.
<i>Nephrotoma analis</i> .....	Larva, pupa.....	Czizek, 1911:70-71.
<i>Nephrotoma coruicina</i> .....	Larva, pupa.....	Beling, 1879:39-40 (as <i>iridicolor</i> ).
<i>Nephrotoma coruicina</i> .....	Larva, pupa.....	Czizek, 1911:76.
<i>Nephrotoma crocata</i> .....	Larva, pupa.....	Beling, 1879:40-41.
<i>Nephrotoma crocata</i> .....	Larva, pupa.....	Czizek, 1911:87.
<i>Nephrotoma lineata</i> .....	Larva, pupa.....	Beling, 1879:42-43 (as <i>histrion</i> ).
<i>Nephrotoma lineata</i> .....	Larva, pupa.....	Czizek, 1911:83-84.
<i>Nephrotoma lunulicornis</i> .....	Larva, pupa.....	Beling, 1879:41-42.
<i>Nephrotoma lunulicornis</i> .....	Larva, pupa.....	Czizek, 1911:61.
<i>Nephrotoma maculata</i> .....	Larva, pupa.....	Beling, 1879:36-37.
<i>Nephrotoma maculata</i> .....	Larva, pupa.....	Czizek, 1911:80-81.
<i>Nephrotoma pratensis</i> .....	Larva, pupa.....	Beling, 1886:175-176.

<sup>8</sup>Riedel (1913:25) considers *Tipula winnertzii* as a synonym of *T. truncorum*, but Beling's descriptions indicate that the larvae he had before him represented two distinct species.

<i>Nephrotoma pratensis</i> .....	Larva, pupa.....	Czizek, 1911:85-86.
<i>Nephrotoma quadrifaria</i> .....	Larva, pupa.....	Beling, 1879:37-39.
<i>Nephrotoma quadrifaria</i> .....	Larva, pupa.....	Czizek, 1911:66.
<i>Nephrotoma ferruginea</i> .....	Larva, pupa.....	Hart, 1898 [1895]:218-219.
<i>Nephrotoma ferruginea</i> .....	Larva, pupa.....	Malloch, 1915-17 b:206.

### Tribe Tipulini

#### Subtribe Dolichopezaria

#### Genus *Dolichopeza* Curtis (Gr. *long* + *feet*)

- 1825 *Dolichopeza* Curt. Brit. Ent., p. 62.  
 1830 *Leptina* Meig. Syst. Besch. Zweifl. Ins., vol. 6, pl. 65, fig. 10.  
 1846 *Apeilesis* Macq. Dipt. Exot., Suppl. 1, p. 8.

The genus *Dolichopeza* is a small group of flies including about a score of species, most numerous in the Oriental and Australian regions. The immature stages of the European *Dolichopeza albipes* Ström, a species that is very close to the American species *D. americana* Needm., have been described by Beling (1879, 1886). He found larvae in and beneath moss cushions covering the piles of waste copper slag in the Harz Mountains. On June 11, 1878, larval and pupal material was taken from a tussock of the Jungermanniales liverwort *Alicularia scalaris* Corda. The pupal period was found to be six days. Females were noted depositing their eggs in these hummocks, and small swarms of males were observed dancing near by. It appears that the larvae feed on the upper side of the moss cushion at night, withdrawing into the interior at other times. A larva was found in earth, which shows that these larvae are not dependent on mosses.

The larva is described by Beling (1886:189-191) as being about 12 millimeters long and 2.3 millimeters in diameter. The body is almost terete. The color is a rather bright green, the dorsum being marked with two zigzag dark brown stripes. The spiracular disk has but five lobes; the three dorsal lobes are long and narrow, the median tooth being formed by the apparent fusion of two teeth; the ventral lobes are very short, are tuberculate, and have a small, dark brown, triangular mark at the inner tip. There is a small dark cross-stripe at the base of each lateral lobe. The spiracles are small, are circular, and are separated by a distance equal to about one and one-half the diameter of one. Beneath each spiracle is a rather large, irregular, blackish brown spot. The anal gills are strongly protuberant. The pupa measures about 14.5 millimeters in length and 2.5 millimeters in diameter. The pronotal breathing horns



are directed straight outward and finally downward. The eighth segment has a circle of four dorsal, four ventral, and two pleural spines, which are finely bifid at their tips. The pupa is green, as is the larva, with similar angular dorsal stripes.

This is the only tipuline larva known to the writer with five lobes surrounding the spiracular disk. This feature is the more remarkable when this larva is compared with that of *Oropeza*, apparently closely related but with a normal tipuline appearance. The immature stages of other species of *Dolichopeza* and related genera will be of interest.

The resting positions of *Dolichopeza* are described on page 713 of this paper, and the striking dissimilarities to *Oropeza* noted. It may be that *Oropeza* is not so close to *Dolichopeza* as has been believed. Osten Sacken (1886:157) describes the mating of a European *Dolichopeza*, presumably *D. albipes*, as follows:

I had occasion to observe the copula (in Heidelberg, July 26); the female was hanging down from some support to which it held on by its front legs; it bore the whole weight of the male, who was fastened to it merely by the forceps, hanging head downwards, with his legs stretched out. I have seen *Bittacomorpha* copulate in the same manner.

#### Genus *Oropeza* Needham (Gr. *mountain* + *feet*)

1908 *Oropeza* Needm. 23d Rept. N. Y. State Ent. (1907), p. 211.

*Larva*.—Form somewhat depressed. A strong tubercle on sides of body before spiracular disk. Spiracular disk surrounded by six lobes, the four dorsal ones slender, the ventral pair blunt. Anal gills blunt. Head capsule of the tipuline type. Mandible blunt, with about seven teeth. Hypopharynx five-toothed. Mentum seven-toothed. Coloration dark green.

*Pupa*.—Pronotal breathing horns elongate-cylindrical, slender. Mesonotum with a slightly elevated triangular area on either side of mid-dorsal line. Leg sheaths ending about on a level, or fore legs a little longer. Abdominal segments with two stout pleural spines; posterior annuli before margin with a transverse row of twelve or fewer spines.

*Oropeza* is a genus of crane-flies including ten described species, all of which occur in eastern North America with the exception of three Japanese forms. The flies are common beneath dark culverts and bridges, in outhouses, in crannies and crevices of rocky cliffs, beneath overhanging boulders along mountain streams, and in similar situations. The resting positions of the adult flies are discussed on page 712. Many species show a notable predilection for resting on spiders' webs. The immature stages of *Oropeza obscura* are spent in dry moss, as discussed below. Other species have been reared in sandy soil and in wet moss.

*Oropeza obscura* Johns.

1909 *Oropeza obscura* Johns. Proc. Boston Soc. Nat. Hist., vol. 34, p. 122.

Mr. Hyslop has sent to the writer, at various times during the past two or three years, larvae of *Oropeza obscura*. Numerous larvae and one pupal skin were found under dry moss (*Hedwigia albicans* [Web.] Lindb.) on rocks in the South Mountains, Maryland, on November 4, 1916, by H. L. Parker. They were associated with the larvae of a dascillid beetle, *Eurypogon niger* (Melsh.). Additional specimens were found in a decaying log, but the preferred habitat seems to be beneath moss. The dark green larvae are very sluggish.

*Larva*.— Length, 11–12 mm.  
Diameter, 1.7–1.8 mm.

Color dark brownish green, ventral surface clearer green.

Form depressed; body short and stout. Dorsum covered with small, blackened points, producing the dark color of this region of the body. Segments much wrinkled, especially on basal ring. On each side of penultimate segment a stout tubercle which simulates dorsal lobes of spiracular disk. Spiracular disk (Plate LXXXVI, 469) moderate in size, surrounded by six fleshy lobes, dorsal pair short and slender, lateral pair long and slender, ventral pair very short and blunt; ventral lobes sparsely fringed with short, black hairs, and with a pale apical area bearing a sensory bristle; inner face broadly suffused with brown; at base of other lobes similar but smaller triangular brown marks; a dusky area ventrad of spiracles. Spiracles large, placed obliquely. Anal gills four, large and blunt, pale yellow.

Head capsule of the massive tipuline type. Labrum broad, with a short, blunt lobe on either side; median epipharyngeal region with dense rows of stout setae and two small papillae on margin; lateral lobes with about four or five sensory bristles or papillae of various sizes. Mentum (Plate LXXXVI, 467) seven-toothed, median point long and slender, a prolongation of outer mental plate. Hypopharynx (Plate LXXXVI, 468) five-toothed, the three intermediate teeth the largest, lateral tooth on either side small. Antenna slender, cylindrical, with apical segment very reduced. Mandible rather slender, with about seven blunt teeth on margin. Maxilla with cardo large, triangular, with two setiferous punctures, the outermost very large and hyaline and with two long, powerful setae; lobes of maxilla fringed with dense hairs; palpus short, disklike, with a large group of tiny hyaline papillae at apex.

*Pupa*.— Length of cast skin, about 12 mm.

Coloration brown; pronotal breathing horns dark blackish brown. (It is possible that the pupae when alive are dark green in color, like the larvae.)

Labrum triangular. Labial lobes large, separated by apex of labrum. Sheaths of maxillary palpi short and stout, apex recurved to beyond midlength. Antennal sheaths moderately elongated. Pronotal breathing horns elongate, slender, cylindrical, tips a little expanded. Mesonotum on either side of median line with a large, roughly triangular, reticulated area which is slightly elevated, with apex of triangle directed toward mid-dorsal line. Mesonotum

transversely wrinkled. Metanotum (Plate LXXXVI, 470) near anterior margin with a transverse row of setiferous punctures, there being four on either side, the intermediate ones with two setae. Wing sheaths reaching base of third abdominal segment. Leg sheaths reaching beyond midlength of fourth abdominal segment, fore legs a little the longest, hind legs a little the shortest.

First abdominal segment on dorsum somewhat similar to metanotum, with a transverse row of four punctures at about midlength, the lateral ones with two setae; remaining abdominal segments (Plate LXXXVI, 471) subdivided into approximately equal basal and posterior rings; on tergites, posterior ring with a transverse row of spines, basal ring unarmed; on sixth tergite, where best developed, spines on posterior ring numbering about twelve, with a seta at each end of the row and two others interspersed; on anterior tergites, spines very small; on seventh tergite spines large, elongated; on eighth tergite four powerful spines in transverse alignment; on pleurites, a strong spine on each ring, that of basal ring deeply bifid and with a strong seta in notch thus formed; posterior ring with a single spine bearing a long seta on its face; on sternites, condition generally similar to that on tergites, the spines a little more prominent but of about the same number, these spines slender at their slightly curved tips and lacking on sternites 2 to 4. Female cauda (Plate LXXXVI, 472 and 473) with acidothecae elongate, contiguous, on either side of tergites at base with a powerful incurved hook; posterior margin of eighth tergite with four spines, lateral pair a little the larger; ventral side at base with a median protuberance bearing two powerful lateral lobes and two smaller chitinized spines which are directed caudad and ventrad; base of segment 8 with a crossrow of eight spines; posterior ring of segment 8 with a powerful spine at lateral end.

*Nepionotype*.—South Mountains, near Myersville, Maryland, March 31, 1916.

*Neanotype*.—Hagerstown, Maryland, May 9, 1916; cast pupal skin in collection of United States National Museum.

*Paratypes*.—Larvae from type locality.

### Genus *Brachypremna* Osten Sacken (Gr. *short* + *trunk*)

1886 *Brachypremna* O. S. Berl. Ent. Ztschr., vol. 30, p. 161.

*Larva*.—Unknown.

*Pupa*.—Antennal segments enlarged at base. Antenna short. Sheaths of maxillary palpi short, not recurved at tips. Pronotal breathing horns short, slender, finely annulated. Mesonotum with eight prominent tubercles. Leg sheaths reaching beyond midlength of fourth abdominal segment, fore tarsi very short, other tarsi subequal in length. Abdominal segments each with four slender spines on posterior ring of both sternites and tergites, just before posterior margin; two pleural spines; eighth segment of male with four prominent, spinous lobes.

*Brachypremna* is a small genus, including but nine recent species found in the Austral and Tropical regions of the New World. *Brachypremna cocenica* Meunier is described from the Baltic amber. The flies of the best-known species, *B. dispellens*, are known in parts of the Southern

States as "weavers." They frequent rather shady places and have a remarkable dance over three or four feet of vertical space, whence the name "king of the dancing tipulids" given them by Johnson. This species is the only one whose immature stages are at all known.

*Brachypremna dispellens* (Walk.)

1860 *Tipula dispellens* Walk. Trans. Ent. Soc. London, n. ser., vol. 5, p. 333-334.  
 1886 *Brachypremna dispellens* O. S. Berl. Ent. Ztschr., vol. 30, p. 162.

*Brachypremna dispellens* is the most widely distributed species of the genus. It ranges from New Jersey southward thru North America, and thru South America as far as Argentina. A larva found by R. C. Shannon in a rotten log by a stream near Washington, D. C., on April 23, 1913, was placed in rearing and emerged in May as an adult male of this species. The badly mutilated pupal skin was preserved and is here described. No part of the larva was preserved.

*Pupa*.—Length of cast pupal skin, about 18 mm.

Coloration brownish yellow; abdomen with a broad brown sublateral stripe on both ventral and dorsal segments; each of pleural spines set in a brown spot.

Head small. Antennal spines very large and crowded at base, soon passing into the short, slender flagellum. Labrum (Plate LXXXVII, 474) blunt. Labial lobes closely approximated, so as to appear as a single large, transversely rectangular lobe at end of labrum. Sheaths of maxillary palpi short, not recurved at tip. Pronotal breathing horn (Plate LXXXVII, 475) small, slender, curved, ringed with fine annuli, tapering gradually to the small apex; margin of apex set with breathing pores. Mesonotum with eight conspicuous, blunt, naked tubercles; the four intermediate tubercles larger, arranged in the form of a trapezoid; anterior median pair high, conical, located rather close to mid-dorsal line. Wing sheaths reaching end of second abdominal segment. Leg sheaths (Plate LXXXVII, 476) extending beyond mid-length of fourth abdominal segment; fore legs very short, ending opposite base of third tarsal segment of other legs.

Abdominal tergite 1 with a pair of long, slender spines before posterior margin; segments 2 to 7 subdivided into a basal and a posterior ring, the latter with a transverse row of four long, slender spines before posterior margin, the seventh tergite with about six such spines; sternites similar, with four spines on posterior ring; pleurites with a slender spine on basal and posterior ring; at base of posterior ring between spines, an indistinct, slightly protuberant spiracle. Male cauda (Plate LXXXVII, 477) narrowed, small, valves blunt; on dorsal side near base four conspicuous lobes, each terminating in a slender, chitinized spine; a small acute spine on sides of ninth segment at base.

*Neotype*.—Cast pupal skin, Washington, D. C., May, 1913 (in collection of United States National Museum).

Subtribe **Ctenophoraria**Genus **Ctenophora** Meigen (Gr. *comb + to bear*)1800 *Flabellifera* Meig. Nouv. Class. Mouch., p. 13 (*nomen nudum*).1803 *Ctenophora* Meig. Illiger's Mag., vol. 2, p. 263.1910 *Phoroctenia* Coq. Proc. U. S. Nat. Mus., vol. 37, p. 589.*Larva*.—Body opaque, integument rather thick. Spiracular disk surrounded by six lobes.*Pupa*.—Sheaths of maxillary palpi recurved. Pronotal breathing horns long and slender. Two spines on mesonotum. Fore and middle tarsi subequal, a little shorter than hind tarsi. Ventral abdominal segments with six to eight spines.

*Ctenophora* is a small genus including about sixteen nominal species found thruout the Holaretic region. The larvae and the pupae occur in decaying wood. The early stages have long been known, having been described by Réaumur and De Geer.

In Europe, *Ctenophora flaveolata* (Fabr.) is described and figured by Réaumur (1740) and by Weyenbergh (1872). *C. pectinicornis* (Linn.) is described or mentioned by Bouché (1834), by Fischer von Waldheim (1838), by Zetterstedt (1851:4014), by Weyenbergh (1872), and by Kaltenbach (1874). *C. festiva* Meig. was reared by Kaltenbach (1874:631) from larvae in decayed beech stems. *C. nigricoxa* Lundst. (*Malpighia vittata* Meig., auct. Frey) was reared by Lundström (1906:7) from pupae in rotten birch stumps. The immature stages of the various European species of *Ctenophora* are described as living in the wood of various trees such as willow (*Salix*), birch (*Betula*), cherry (*Prunus*), and other hardwood species.

In North America, *C. apicata* is described by Johannsen (1910) from elm (*Ulmus*), and *C. angustipennis* Loew by Anthon (1908) in alder (*Alnus*) and in poplar (*Populus*). The latter species is recorded also as injuring prune trees (*Prunus*) in Oregon, by Lovett (1915), who gives an excellent account of all stages and the type of injury done. The female lays from 200 to 400 eggs, which hatch in from nine to seventeen days and the larvae tunnel into the surrounding dead wood. Here they feed and grow, reaching maturity the following spring. Pupation takes place in the burrows, the pupal stage requiring about ten days. Osten Sacken (1877:211) supposed that the larvae live in the stumps of redwood (*Sequoia*), but this has never been confirmed.

*Ctenophora apicata* O. S.1864 *Ctenophora apicata* O. S. Proc. Ent. Soc. Phila., vol. 3, p. 46.

The larvae and the pupae of *Ctenophora apicata* that were described by Johannsen (1910) have been studied by the writer in the collection of the Maine Agricultural Experiment Station. They were collected at Orono, Maine, on June 23, 1909, by Dr. William C. Woods. In 1913 the writer examined the stump from which they were taken, and found a few cast pupal skins.

The notes here given are taken partly from Dr. Johannsen's description and partly from the original material.

*Larva*.— Length, about 30 mm.

Color white. Body stout, cylindrical. Antenna cylindrical, with an apical papilla. On dorsum of head behind antennae, a slender, flexible spine. Spiracular disk surrounded by six lobes, dorsal and lateral pairs slender, finger-like; ventral pair blunt.

*Pupa*.— Length, 25-27 mm.

Length of breathing horns, 3 mm. additional.

Width, d.-s., 5.2 mm.

Depth, d.-v., 5 mm.

Pupa somewhat similar to that of Tanyptera, differing as follows: Form stout; abdomen a little depressed. Sheaths of maxillary palpi strongly recurved at tips. Pronotal breathing horns long and slender. Mesonotum with a prominent tuberculate spine on either side of median line. Legs short, ending before tip of third abdominal segment; tarsal sheaths ending about on a level, or those of hind legs a very little longer. Abdominal segments 5 to 7 with six to eight spines. Female cauda with six powerful ventral spines or tubercles and two dorsal tubercles on either side. Valves of ovipositor short, tergal valves a little longer than sternal valves.

*Nepionotype*.— Orono, Maine, July, 1909.

*Neanotype*.— Orono, Maine, July, 1909.

*Paratypes*.— Numerous pupae in collection of Maine Agricultural Experiment Station.

### Genus *Dietenidia* Brullé (Gr. *double* + *comb*)

1833 *Dietenidia* Brullé. Ann. Soc. Ent. France, vol. 2, p. 401-402.

1856 *Cerocena* Rond. Dipt. Ital. Prodr., vol. 1, p. 186.

1863 *Dicera* Lioy. Atti dell' Institut Veneto, ser. 3, vol. 9, p. 216.

*Dietenidia* is a genus of Palaearctic crane-flies including three species, of which one is European and the others are Japanese. The genotype, *Dietenidia bimaculata* Brullé, is very well known. The immature stages are described or mentioned by Bouché (1834), by Zetterstedt (1851), by Weyenbergh (1872), by Beling (1873 b), by Czizek (1913), and by other investigators. Beling found the larvae in decaying birch (*Betula*). He describes the larvae as being grayish yellow, with four spiracular lobes. The pupal duration is seven days. Osten Saeken (1886:173-175) states that he has often found larvae in the wet detritus underneath the bark

of decaying trees. The larvae are much closer to *Ctenophora* than to *Tanyptera*, the skin being tough and opaque, with a fine pubescence, and the spiracular disk consisting of small but distinct lobes. The pupae likewise are similar to those of *Ctenophora*, having the pronotal breathing horns elongate, five spines on abdominal sternites 3 to 6, and four spines on tergites 2 to 7.

Genus *Tanyptera* Latreille (Gr. *extend* + *wing*)

1805 *Tanyptera* Latr. Hist. Nat. Crust. et Ins., vol. 14, p. 286.

1832 *Xiphwa* Brullé. Ann. Soc. Ent. France, vol. 1, p. 206.

*Larva*.—Integument very thin, with numerous setae, those on dorsum very small. Spiracular disk with lobes practically lacking. Spiracles large, lying exposed on the face of last segment. Anal gills bluntly rounded. Mandible small, with one dorsal and one ventral tooth. Antenna cylindrical, capped with an apical cone. Mentum with seven to nine teeth.

*Pupa*.—Cephalic crest lacking. Sheaths of maxillary palpi not recurved at tips. Pronotal breathing horns large, broadly flattened, margin deeply crenulated. Mesonotum with two blunt tubercles. Abdominal segments with six to ten spines on tergites, three to five spines on sternites.

*Tanyptera* is a small genus including about twelve nominal species whose limits and relationships are still but little understood. The immature stages are spent in the decayed or partly decayed wood of various deciduous trees.

In Europe, *Tanyptera atrata* (Linn.), the genotype, was found by Perris (1840) and by De Rossi (1882) in decaying alder (*Alnus*) stems. Nördlinger (1848) found the same species in linden (*Tilia*) and in poplar (*Populus*). It has also been taken in oak (*Quercus*), beech (*Fagus*), birch (*Betula*), and other hardwood species. Gerbig (1913) discussed the variety *ruficornis* Meig. under the name *Ctenophora flavicornis*.

In America, Malloch (1915-17 b:194-195) describes *T. fumipennis* (O. S.) from a much-decayed chestnut log (*Castanea*), and later (1919) in basswood (*Tilia*), where the species was associated with larvae of *Xylota fraudulosa* Loew and *Chalcomyia aerea* (Loew), of the family Syrphidae. *Tanyptera frontalis*, discussed below, was found in red maple (*Acer*).

*Tanyptera frontalis* (O. S.)

1864 *Ctenophora frontalis* O. S. Proc. Ent. Soc. Phila, vol. 3, p. 48.

The writer found numerous larvae of *Tanyptera frontalis* in a fallen log of red maple (*Acer rubrum* Linn.) near Beebe Lake, Ithaca, New York, on March 22, 1913. Larvae of several sizes were found. They were working in wood which was well preserved, not entirely sound but still so hard that it had to be cut with a hatchet. The larvae pupated in April. A small male emerged on May 1.

Other larvae of *Tanyptera* were found in a hickory log (*Carya* sp.) at Sandy Landing, Virginia (opposite Plummers Island), on September 9, 1913. Detailed drawings of the larval structure made by Dr. Böving are in the collection of the United States National Museum.

*Larva*.— Length, 30–35 mm.  
Diameter, 7–7.2 mm.

Coloration, pale yellowish white.

Form terete, very stout. Integument thin. Numerous long black setae on segments (Plate LXXXVIII, 482), arranged in transverse rows before posterior margin; setae of dorsum (Plate LXXXVIII, 481) very tiny, one on either side of median line; a pair of setae laterad of these and in alinement; setae on pleural region very long and delicate; on thoracic segments, setae at about midlength; on abdominal segments, setae closer to posterior margin; mid-ventral setae very tiny, four in number, on thoracic segments at about midlength, forming a stiff pencil on sides of venter, with two small setae between; laterad of these four intermediate setae, a group of three setae, two long and one very short; ventral setae lying at a level posterior to that of pleural setae. Spiracular disk (Plate LXXXVIII, 483) with lobes practically lacking, the two large, oval spiracles lying exposed on truncated end of last segment; above and laterad of each spiracle, a small, blunt lobe with a blackened mark and three long setae; below spiracles, two narrow black lines representing the two ventral lobes; a small pencil of setae below each of these marks, and each mark having a sensory bristle; three or four long setae on sides of spiracular disk. Spiracles with small middle piece black, ring yellowish brown; spiracles separated by a distance a little greater than diameter of one. Anal gills four, bluntly rounded, very protuberant and evidently formed for propulsion. (In older specimens the anal gills are minutely roughened and are darker in color.)

Head capsule of the massive tipuline type. Labrum rather broad; median epipharyngeal region with a small brush of hairs surrounding two sensory setae; lateral lobes large, on their ventral face densely hairy, surrounding four sensory setae and a flattened hyaline peg. Mentum (Plate LXXXVIII, 478) rather small, broadly rounded, anterior margin with seven or nine teeth, in the latter case the outermost tooth on either side very blunt and reduced, the median tooth long and flattened. Antenna (Plate LXXXVIII, 479) short-cylindrical; apical papilla very small, hyaline, conical, with surface sculptured; in addition to this cone, three or four small hyaline sense pegs; the usual auditory organ located at about midlength of segment. Mandible (Plate LXXXVIII, 480) small, with one dorsal and one ventral tooth in addition to the apical point, ventral tooth flattened and with margin crenulated; a stout seta at heel of mandible; prosthema an elongated cone, situated at base



of mandible. Maxilla rather small, simple; palpus large, antenniform, with apex bluntly rounded; inner lobe densely covered with short, stout setae surrounding a powerful bristle and a small brown sensory organ.

*Pupa*.—Length, 30–33 mm.  
Width, d.-s., 5–6 mm.  
Depth, d.-v., 5.5 mm.

Coloration pale yellow; pronotal breathing horns liver-colored. (In older specimens the thorax and appendages are dark-colored, and the abdomen has broad brown sublateral stripes.)

Head rather small, cephalic crest lacking. Antenna stout, rather elongate, extending far beyond ends of palpi, segments angulated. Clypeus and labrum tumid, transversely wrinkled. Labial lobes slender, divergent. Sheaths of maxillary palpi rather slender, tips curved but not recurved (Plate LXXXVIII, 485). Pronotal breathing horn (Plate LXXXVIII, 486) large, broadly flattened, slightly incurved, broader at apex than at base, deeply furrowed up middle of outer face, the broad margin thus formed deeply wrinkled to crenulate. Mesonotum large, transversely wrinkled, with two blunt tubercles provided with short setae (Plate LXXXVIII, 484). Wing sheaths small, reaching end of second abdominal segment. Leg sheaths ending before tip of third abdominal segment; fore tarsi very short, hind tarsi the longest, those of middle legs intermediate.

First abdominal tergite with two spines; segments 2 to 7 broad, divided into the usual basal and posterior rings; second segment on posterior ring with four spines; segments 3 to 6 with six to ten spines, the intermediate ones usually smaller; segment 7 with four spines; pleurites with a spine on each ring; sternites with similar arrangement to that of tergites, but spines usually fewer in number, segments 3 and 4 with only a single widely separated spine on each side, segments 5 and 6 with four or five spines, segment 7 with three spines; segment 8 has four small spines between the large lateral ones described below. Male cauda blunt, dorsal lobes very divergent, ending in sharp, chitinized points. Female cauda (Plate LXXXVIII, 487) with tergal valves elongate, narrowed to the moderately acute tips; sternal valves similar in shape but smaller; lateral lobes of ninth segment directed caudad and laterad, at tips running out into chitinized points; two small setae before tips; segment 8 with a powerful lateral lobe on either side, each terminating in a chitinized point; posterior lateral angles of segment produced into slender, blunt points.

*Nepionotype*.—Ithaca, New York, March 22, 1913.

*Neanotype*.—May 1, 1913. No. 11–1913.

*Paratypes*.—Four larvae and two pupae with types.

### Subtribe *Tipularia*

Genus *Longurio* Loew (Lat. *a tall man*)

1869 *Longurio* Loew. Berl. Ent. Ztschr., vol. 13, p. 2.

*Larva* (supposition).—Body massive. Integument semi-transparent. Form clearly depressed. Spiracular disk surrounded by six lobes, dorsal pair very small, ventral pair very long; ventral and lateral lobes provided with but few setae at and near tips; spiracular

disk and lobes unmarked. Spiracles small. Anal gills branched. Mandible small, with but a single dorsal and ventral tooth in addition to apical point. Mentum with nine teeth. Hypopharynx five-toothed.

*Pupa*.—Antenna short, ending opposite tips of maxillary palpi. Sheaths of maxillary palpi not recurved at tips. Mesonotum unarmed. Pronotal breathing horns very long and slender, one, at least, about half length of body. Wings showing clearly the characteristic venation of *Longurio*. Abdomen elongate, posterior ring of individual segments with short, stout spines, including a few on pleurites; dorsum of eighth segment with four powerful lobes.

*Longurio* is a small genus including about ten described species, of which two occur in eastern North America. The genotype, *Longurio testaceus*, is the best-known species locally. The immature stages of this species are here discussed for the first time. They are spent in sand or sandy earth. The branched anal gills of the larva, and the excessively elongate breathing horns of the pupa, are notable features.

*Longurio testaceus* Loew

1869 *Longurio testaceus* Loew. Berl. Ent. Ztschr., vol. 13, p. 2.

*Longurio testaceus* is probably the largest crane-fly in North America, the females exceeding the better-known *Holorusia* of the Western States. The adult flies are difficult to capture, being very wary. When the insect is at rest the body generally hangs perpendicularly, with the wings folded incumbent over the abdomen.

On November 9, 1916, Mr. Hyslop sent the writer two living larvae which are referred with little doubt to this species. They were found in wet sand in a bog on the top of South Mountains, near Myersville, Maryland. The larvae were very restless, the head capsule being constantly exerted and withdrawn. Waves of contraction start from the posterior end of the body and pass toward the head. A large pupa taken by Dr. J. C. Bradley at Tallulah Falls, Georgia, on June 17, 1910, undoubtedly belongs to this species, the venation being clearly apparent on the wing pad. An additional cast pupal skin is in the collection of the United States National Museum.

*Larva* (supposition).—Length, 31 mm. contracted, 58 mm. extended.  
Diameter, 11–12.5 mm.

Color whitish, subhyaline; thoracic segments more yellowish; in life the brown food contents showing clearly thru abdomen.

Form very depressed, lateral folds prominent; body very stout and fleshy. Skin very thin and semitransparent, showing internal organs within, practically destitute of pubescence;

a few short setae on body, especially on thoracic segments. Spiracular disk (Plate LXXXIX, 490) large, flattened, surrounded by six lobes; dorsal pair very small, represented by two short, conical protuberances; lateral and ventral lobes slender, the latter a little the longer, each with three or four long, delicate setae at tip and two or three others before tip on outer face; a long seta on margin of disk between dorsal and lateral lobes; spiracular disk and lobes entirely unmarked with darker. Spiracles small, circular, stigmal rings very narrow; spiracles separated by a distance equal to about three times diameter of one. Anal gills four, large, pinnately branched, each gill with six lateral branches.

Head capsule massive, of the tipuline type. Labrum with a distinct, densely hairy lobe on either side. Mentum (Plate LXXXIX, 488) large; anterior margin with nine slender teeth, median one the longest, outermost teeth on either side blunt, flattened, evidently formed by fusion of two teeth. Hypopharynx (Plate LXXXIX, 489) five-toothed; teeth blunt, the three middle ones larger, the lateral tooth on either side a little smaller. Antenna long and slender, cylindrical; apex blunt and without distinct sense pegs or setae. Mandible small, with a large conical dorsal tooth and a single flattened ventral tooth in addition to apical point; prostheca distinct. Maxilla small; palpi large, cylindrical, truncated at apex and with a circular auditory plate near end; inner lobe of maxilla with abundant elongate setae.

*Pupa*.—Length, 42–45 mm.

Length of longest breathing horn, 18–19 mm. additional.

Width, d.-s., 3 mm.

Depth, d.-v., 4.2 mm.

Color dark brown; pronotal breathing horns paler at tips; mesonotum chestnut brown; abdominal segments indistinctly ringed with pale and darker.

Front between antennal bases swollen, finely tuberculate but without distinct setae. Antenna very short, ending opposite tips of maxillary palpi. Labrum large. Sheaths of maxillary palpi not recurved at tips. Mesonotum unarmed, with fine transverse wrinkles. Pronotal breathing horns (Plate LXXXIX, 491) very long and slender, the right one, at least, exceedingly elongate, with tip expanded. (The left breathing horn was broken before the apex in both the pupae studied; it was almost as long as the right horn, and may, of course, have been longer.) Wing pads reaching end of second abdominal segment; characteristic venation of genus showing clearly on sheath. Leg sheaths long, extending to beyond mid-length of fourth abdominal segment; fore legs shorter than the others.

Abdomen elongate. Abdominal segments 2 to 7 near posterior margin with a transverse row of short, stout spines which are interrupted only near pleura; pleural area with four or five spines; ventral and dorsal segments with numerous spines; dorsal row of spines more distant from posterior margin of segment than the other areas; dorsum of eighth segment with four powerful, chitinized lobes directed dorsad and caudad; posterior margin of these lobes with about five or six small teeth; two spines near base of pleural region on segment 8. Male cauda consisting of two blunt sheaths, lying between posterior pair of lobes described above.

*Larva*.—South Mountains, near Myersville, Maryland, November 6, 1916.

*Neanotype*.—Tallulah Falls, Georgia, June 17, 1910.

*Paratype*.—Cabin John Bridge, Maryland, May 31, 1900.

Genus *Aeshnasoma* Johnson (Gr. *a dragon fly* + *body*)

1909 *Aeshnasoma* Johns. Proc. Bost. Soc. Nat. Hist., vol. 34, p. 115-116.

*Aeshnasoma* is a monotypic genus found in northeastern North America. It is unquestionably close to *Longurio* and may be congeneric with it. The type, *Aeshnasoma rivertonensis* Johns., is apparently very local in its distribution.

Johnson (1906:1-2) described an unknown tipuline larva which undoubtedly pertains to this species. The larva was found on June 10, 1900, in a cold spring at Riverton, New Jersey. It was brought into the laboratory but could not be reared, the change from the cold spring (about 60° F.) to warmer waters being fatal. The larva when fully extended measured about 45 millimeters in length. It was yellowish white in color and was translucent, the alimentary canal with its contents being clearly visible thru the thin skin. Johnson describes and figures the peculiar branched anal gills (Plate LXXXIX, 492) of this genus. The larva was doubtfully referred to *Longurio*, the adults of *Aeshnasoma* being undescribed at that time.

In a later paper (1907-12 [1909]:115-116) Johnson mentions the taking of several more larvae in 1902, and, on July 20, the capture of the adult flies on which the genus and species are based.

The only larva that was preserved was kindly sent to the writer for study by Mr. Johnson. It is undoubtedly very close to *Longurio*, both genera showing the same peculiar spiracular disk and the branched anal gills, a condition that is found nowhere else in the Tipulidae so far as is known to the writer.

Genus *Holorusia* Loew (derivation obscure)

1863 *Holorusia* Loew. Berl. Ent. Ztschr., vol. 7, p. 1.

*Larva*.—Spiracular disk surrounded by six moderately elongate lobes fringed with long hairs; inner face of lateral and ventral lobes with capillary black lines; disk between spiracles dusky. Anal gills six. Mandible small, with a single dorsal and ventral tooth in addition to apical point. Antenna with a conical apical papilla. Mentum seven-toothed. Hypopharynx six-toothed.

*Pupa*.—Sheaths of maxillary palpi recurved at tips. Pronotal breathing horns rather short and stout, the long apices flattened. Armature of abdominal segments almost as in *Prionocera*, but the posterior rows of spines more numerous (fourteen to twenty-four); pleurites with three spines, the two on posterior ring situated one behind the other. Cauda with six stout dorsal lobes.

*Holorusia* is a small genus (about ten species) of New World crane-flies, only one of which—the genotype, *Holorusia rubiginosa*—is Nearctic. This species and *Longurio* are the largest Nearctic crane-flies. The anatomy of the “giant crane-fly” has been described in some detail by Kellogg (1901, a and b) and by Comstock and Kellogg (1904). The immature stages are spent in moist earth. The genus is undoubtedly closely related to *Prionocera*, and, presumably, to the Old World genus *Ctenacroscelis* Enderlein.

*Holorusia rubiginosa* Loew

1863 *Holorusia rubiginosa* Loew. Berl. Ent. Ztschr., vol. 7, p. 1.

1888 *Tipula (Holorusia) grandis* Bergr. Ent. Tidskr., vol. 9, p. 140.

*Holorusia rubiginosa* is widely distributed thruout the western United States and Canada. A number of larvae were taken by H. Morrison near Stanford University, California, on February 22, 1915. They were shipped to the writer at Ithaca, New York, where the species was reared. The massive larva is used for purposes of dissection in the entomological courses at some of the western universities.

*Larva*.—Length, 50–60 mm.

Diameter, 6.2–6.4 mm.

Coloration, dark greenish brown.

Form stout, subterete. Integument covered with dense, short, erect, black hairs. A few weak and delicate setae, two on dorsum and on venter of each abdominal segment; two long setae on lateral margins of posterior rings. Spiracular disk (Plate XC, 496) moderately large, surrounded by six stout, elongate lobes which are similar to those of *Prionocera* but are stouter and less digitiform; ventral lobes a little the longest, dorsal lobes a little the shortest; all the lobes capable of close approximation, completely protecting spiracles; lobes fringed with long black hairs which are longest near apices, shorter between lobes; ventral and lateral lobes with a delicate black line down inner face, these lines barely indicated on dorsal lobes; remainder of disk and lobes dusky. Spiracles very large, circular, separated by a distance a little less than diameter of one. Anal gills six, short, slender, the two anterior gills of either side united basally, posterior pair simple.

Head capsule of the usual massive tipuline type, prefrons running caudad as a narrow point, lateral plates broad. Labrum broad, with a densely hairy lobe on either side. Mentum (Plate XC, 493) with a prominent median point; behind it on either side three flattened teeth, the innermost the broadest, the middle tooth more acute, the outermost formed by fusion of two small teeth. Hypopharynx (Plate XC, 494) about six-toothed, the intermediate teeth with a large notch between. Antenna (Plate XC, 495) with basal segment very long and slender; principal apical papilla conical; a number of small hyaline sense pegs. Mandi-

ble slender, with only two teeth, a stout dorsal tooth and a single flattened ventral tooth. Maxilla small, lobes covered with short, dense hairs.

*Pupa*.— Length, 32 mm.  
Width, d.-s., 5 mm.  
Depth, d.-v., 5 mm.

Color brown; flattened lateral margins of abdomen broadly yellowish.

Thorax terete; abdomen depressed, with lateral margins flattened, carinate. Cephalic crest represented by two low, parallel ridges, provided with one or two tiny setae. Labrum large, tumid, transversely wrinkled, the blunt apex completely separating the diamond-shaped labial lobes. Maxillary palpi stout, extreme tip recurved. Antenna moderately elongated, extending some distance beyond maxillary palpi. Pronotal breathing horns rather short and stout, finely ringed, the rather long tips flattened, about equal to one-fifth length of entire organ. Mesonotum convex (Plate XC, 497), with transverse anastomosing wrinkles; on either side of median line behind, a blunt tubercle. Wing sheaths reaching end of second abdominal segment. Leg sheaths extending just beyond base of fourth abdominal segment; fore tarsi short, middle tarsi a little longer than hind tarsi.

Abdominal segments with the usual basal and posterior rings; armature almost as in *Prionocera*; tergites with posterior row of spines numbering between twenty and twenty-four on intermediate segments, near anterior lateral angle two spines, basal ring unarmed; pleurites with one setiferous spine on basal ring and two similar spines on posterior ring, one placed considerably behind the other; sternites armed similarly to tergites, but the posterior row of spines larger and somewhat fewer in number (fourteen to eighteen); posterior ring on either side median line near base with two spines, the innermost very large and powerful. Male cauda with ventral lobes blunt, each armed with a slender black spine near posterior margin; dorsal surface of cauda almost as in *Prionocera*, armed with six stout lobes, which here are shorter and stouter, with tips abruptly narrowed; lateral margin of segment 8 with a stout lobe on either side, each terminating in a cylindrical spine. Female cauda similar to male cauda, dorsum with the same six lobes; acidothecae short, tergal valves slightly exceeding the more blunt sternal valves.

*Nepionotype*.— Stanford University, California, February 27, 1915.

*Neanotype*.— April 5, 1915.

*Paratypes*.— Larvae and pupae with types.

### Genus *Prionocera* Loew (Gr. *saw* + *horn*)

1844 *Prionocera* Loew. Stett. Ent. Zeit., vol. 5, p. 170.

1863 *Stygeroptis* Loew. Berl. Ent. Ztschr., vol. 7, p. 298.

*Larva*.— Spiracular disk surrounded by six long, finger-like lobes fringed with long, delicate hairs; each lobe with a capillary black line down middle of inner face. Spiracles large. Anal gills unbranched. Mentum seven- to nine-toothed. Hypopharynx five-toothed. Mandible with about two dorsal and three ventral teeth.

*Pupa*.— Maxillary palpi recurved at tips. Pronotal breathing horns very elongated, unequal, the longer one about half length of body; horns at tips split into long flaps. Abdominal tergites with a posterior transverse row of fifteen or fewer spines, and two small spines

near anterior lateral margin of posterior ring; pleurites with a spine on basal ring and two transverse spines on posterior ring. Cauda with six strong dorsal lobes.

Prionocera is a small genus (about a dozen species) of usually far northern flies of somber coloration. The only species found in eastern North America is *Prionocera fuscipennis*, discussed below. The immature stages are somewhat similar to those of Holorusia. The apparent similarity of the pupa to that of Longurio is probably not indicative of a very close relationship.

The immature stages have been discussed but little in the literature. The "Tipula sp. No. 1" of Malloch (1915-17 b: 199-200) refers to *P. fuscipennis*. The immature stages of a species supposed to be *P. parri* (Kirby) have been discussed and figured by the writer in his report on the Canadian-Arctic Tipulidae (Alexander, 1919 c: 19c-20c).

The name *Stygeropsis* has been in use for many years under the belief that the earlier name *Prionocera* was preoccupied in the Coleoptera. Dr. Bergroth states that this is not so and that *Prionocera* should be used.

*Prionocera fuscipennis* (Loew)

1865 *Stygeropsis fuscipennis* Loew. Berl. Ent. Ztschr., vol. 9, p. 129.

C. H. Kennedy found two cast pupal skins among Sparganium stems in Ringwood Hollow, Ithaca, New York, on November 20, 1916. Several larvae had been found here in the preceding July, and some others were found on June 4, 1917 (No. 106-1917), in a cat-tail swamp near Bool's hillside, Ithaca, where they were associated with the characteristic helophytic crane-fly fauna (*Bittacomorpha*, *Rhamphidia flavipes*, *Pseudolimnophila luteipennis*, *Pilaria recondita*, *Tipula tricolor*, and other species). Malloch's material was taken in Wisconsin in May. Dr. Needham has reared the species near Lake Forest, Illinois.

*Larva*.—Length, 18-22 mm.  
Diameter, 2-2.2 mm.

Coloration dark brown, in some cases with a pale dorso-median stripe.

Form terete, tapering gradually to anterior end of body. Segments with several scattered elongate setae. Spiracular disk (Plate XCI, 502) surrounded by six long, finger-like lobes which are delicately fringed with long hairs; ventral lobes considerably the longest; lateral lobes a little larger and stouter than dorsal lobes; all the lobes broadly margined with dark brown, these marks expanding at inner ends; on ventrallobes, lateral margin expanded at inner

end and continued across disk, meeting its fellow of the opposite side between spiracles; dorsal margin of lateral lobes touching spiracles; each of the lobes marked with a capillary dark brown line down center of inner face, this beginning near ends of lobes and extending almost to base; lobes fringed with long hairs, these very tiny near base, longer near tips of lobes, but scarcely, if at all, interrupted between lobes. Spiracles large, circular, separated by a distance a little greater than diameter of one. Anal gills six, long, slender, unbranched.

Head capsule of the usual tipuline type. Labrum covered with dense, short hairs, those on lateral lobes longer. Mentum (Plate XCI, 498) usually seven-toothed, in some cases nine-toothed; median tooth slender, lateral teeth flattened, subacute. Hypopharynx (Plate XCI, 499) narrow, five-toothed. Antenna (Plate XCI, 500) long and slender; first segment a little enlarged near base; at apex several tiny sensory papillae; auditory plate near base of segment. Mandible (Plate XCI, 501) moderately large, with two large dorsal and about three ventral teeth; prosthema large. Maxilla small; palpus large, cylindrical, apex truncated.

*Pupa*.—Length, 15–22 mm.  
Width, d.-s., 2.4 mm.  
Depth, d.-v., 2.6 mm.

Coloration dark brown; lateral and posterior margins of abdominal segments paler. (In old specimens the general coloration is very dark brown; in younger specimens the abdomen is more or less distinctly lined with brown.)

Thorax subterete; abdomen depressed, lateral margins flattened. Labrum broad, apical point narrow. Labial lobes broad, slightly separated on median line. Maxillary palpi short, stout, apex recurved. Antenna moderately elongated, extreme tip darkened. Pronotal breathing horns long and slender, unequal in length, the longer about 9 or 10 mm. in length, the other 6 mm., at tips split into divergent flaps (Plate XCI, 504) almost as in the hexatomine genera *Pseudolimnophila* and *Pilaria*, which live in the same muddy situations. Mesonotum (Plate XCI, 503) transversely wrinkled. Leg sheaths reaching posterior margin of third abdominal segment; hind legs the longest; middle legs a little shorter than fore legs.

Abdominal segments divided into a basal and a posterior ring; tergites with basal ring unarmed; posterior ring with a subterminal transverse row of short spines, with a few setae located on lateral face of some of the spines; on second tergite, four to six spines, on tergites 3 to 7, three to fifteen spines; two small spines with setae near anterior lateral angle of posterior ring; pleurites with a small setiferous spine on basal ring, and two such spines on posterior ring located side by side; sternites with the basal ring unarmed, posterior ring armed similarly to that of tergites; in addition to posterior row of spines, a pale oval area on either side of midventral line, each with two transversely placed spines. Male cauda (Plate XCI, 505) with four powerful lobes on dorsum of last segment, directed dorsad and slightly caudad, lobes bearing three or four small spines before tips; between anterior pair of lobes, two additional slender lobes, each ending in two acute spines.

*Nepionotype*.—Ringwood Hollow, Ithaca, New York, July 20, 1916.

*Neantotype*.—Cast pupal skin, type locality, November 20, 1916.

*Paratypes*.—Larvae and pupal skins, type locality.



Genus *Tipula* Linnaeus (Lat. *a water-strider*)

- 1758 *Tipula* Linn. Syst. Natur., ed. 10, p. 585.  
 1842 *Pterelachisus* Rond. Mag. Zool. Ins., pl. 106.  
 1864 *Anomaloptera* Lioy. Atti dell' Institut Veneto, ser. 3, vol. 9, p. 218.  
 1887 *Oreomyza* Pokorny. Wien. Ent. Ztg., vol. 6, p. 50.  
 1894 *Manapsis* Scudder. Proc. Amer. Philos. Soc., vol. 32, p. 222.  
 1894 *Rhadinobrochus* Scudder. Proc. Amer. Philos. Soc., vol. 32, p. 223.  
 1894 *Tipulidca* Scudder. Proc. Amer. Philos. Soc., vol. 32, p. 238-239.  
 1916 *Nippotipula* Mats. Thous. Ins. Japan, add. 2, p. 457-458.  
 1916 *Platytipula* Mats. Thous. Ins. Japan, add. 2, p. 459.  
 1916 *Yamatotipula* Mats. Thous. Ins. Japan, add. 2, p. 461-462.  
 1916 *Togotipula* Mats. Thous. Ins. Japan, add. 2, p. 465.

*Larva*.—Form generally stout, terete or nearly so. Integument with pubescence and almost invariably with a definite chaetotaxy. Spiracular disk surrounded by six or rarely eight lobes, simple, or in certain species (as *T. abdominalis*) more or less split at their tips. Spiracles small and widely separated (in *T. abdominalis*), or in other species large and rather close together. Anal gills almost invariably present, with six or eight branches, these branches simple, not pinnate. Head capsule compact and massive. Labrum broadly transverse. Mandible usually small, with few teeth, ventral cutting edge with usually two or three teeth. Maxilla rather complicated, of the generalized tipuline structure. Antenna usually elongated, basal segment two to four times as long as it is thick, stouter in species living in decaying wood. Mentum with seven to nine teeth. Hypopharynx a flattened plate, anterior margin usually with five teeth.

*Pupa*.—Form generally stout. Cephalic crest lacking or very small, with rudimentary setae. Mouth parts as in the subfamily, sheaths of maxillary palpi strongly recurved at tips. Pronotal breathing horns subequal in length, short, stout, usually straight, tips but little expanded. Mesonotum transversely wrinkled, in some wood-inhabiting species (as *T. trivittata*) with about four conspicuous tubercles. Wing sheaths and leg sheaths moderate in length. Abdominal armature usually strong, each segment with a posterior row of four to twenty spines; in some species a basal ventral row of spines on posterior ring of segments. Cauda with dorsal armature of four powerful lobes; eighth segment adding, as a rule, ten spines, of which six are ventral and lateral in position, and two or four are dorsal; dorso-median pair lying between anterior pair of lobes of cauda, as discussed above, and lacking or very reduced in some wood-inhabiting species (*T. trivittata*). Lateral abdominal spiracles lacking or merely vestigial.

*Tipula* is the largest genus of crane-flies, comprising a vast assemblage of species (between six and seven hundred described forms) which are found on all the continental areas of the world but are few in the Australasian region and apparently lacking on many of the lesser oceanic islands. The genus is one of extreme interest, and its study will require many years of conscientious application. Subapterous species are not rare in this group, of which many are far northern forms, others are coastal species, while a few live inland and under influences that make it difficult to explain their subapterous condition.

The immature stages of the various species are diverse in their habits, ranging from species that are nearly if not quite aquatic, thru the majority of the known forms which live in generally moist earth or mud along the margins of water bodies, to still others that live in the semi-decayed wood of prostrate tree trunks. Mellor (1919:64) has recorded *Tipula* larvae as breeding in manure. So far as is known, the larvae are herbivorous, tho they will eat animal food under stress (as described by Patterson [1908] for *Tipula oleracea*, which feeds in considerable numbers on earthworms).

In Europe, a great number of life histories in this genus have been worked out in commendable detail, mainly thru the efforts of Beling, who discusses no fewer than thirty species. His descriptions give a clear idea of the range in structure and habitat to be expected in the genus. The number of lobes surrounding the spiracular disk varies from four (apparently) in *T. selene* and related forms, to as many as eight in *T. subnodicornis*. Practically all of the known species show the normal tipuline number of lobes, six.

A summary of the larval habitats of the Palaearctic species is as follows:

1. Species living in saturated earth along watercourses or in débris at the water's edge, or species that are aquatic — *Tipula fulvipennis* de Geer, *lateralis* Meig., *lunata* Linn., *maxima* Poda, *varicornis* Schum., *varipennis* Meig., *vittata* Meig.

2. Species living in earth, usually in woods, underneath a mold of leaves or coniferous needles — *Tipula caesia* Schum., *dilatata* Schum., *fulvipennis* de Geer, *hortensis* Meig., *hortulana* Meig., *nigra* Linn., *nubeculosa* Meig., *ochracea* Meig., *pabulina* Meig., *paludosa* Meig., *pruinosa* Wied., *scripta* Meig., *selene* Meig., *truncorum* Meig., *unca* Wied., *varipennis* Meig., *vittata* Meig.

3. Species living in earth in gardens, pastures, or meadows, usually beneath turf — *Tipula irrorata* Macq., *luteipennis* Meig., *nigra* Linn., *ochracea* Meig., *oleracea* Linn., *paludosa* Meig., *pruinosa* Wied., *subnodicornis* Zett., *truncorum* Meig., *vernalis* Meig.

4. Species living in or beneath cushions of moss or in earth overgrown with a mossy covering — *Tipula dilatata* Schum., *hortulana* Meig., *marmorata* Meig., *pagana* Meig., *pelostigma* Schum., *pruinosa* Wied., *rufina* Meig., *signata* Staeg., *truncorum* Meig., *unca* Wied.

5. Species living underneath moss on logs — *Tipula irrorata* Macq.

6. Species living in decaying wood — *Tipula flavolineata* Meig., *irrorata* Macq., *truncorum* Meig.

Bouché describes *T. lunata* and *T. ochracea* as living in decaying willow wood, and Sopotzko records *T. flavolineata* as injuring clover; but these records are presumably based on mistaken identifications.

Comparatively few of the eastern American species have been reared, and it is not considered advisable to attempt a key to the larvae or the pupae at this stage of knowledge of the subject. Such a key would

include but a fraction of the possible species and would be of little value. It will require the careful rearing of species for many years before a workable key to the immature stages of the eastern species of the genus can be produced. The characters that will prove of greatest value in the separation of the larvae and the pupae of the species of *Tipula* are as follows:

#### Larvae

1. *Anal gills*. (These are rarely lacking, and the number and arrangement of the branches, their form, and their function, are of primary importance.)
2. *Spiracular disk*. Number of lobes surrounding disk and whether they are simple or branched; character and nature of fringe of hairs around disk, if such is present; size, shape, and distance apart of spiracles; markings on inner face of disk and lobes.
3. *Chaetotaxy*. Arrangement, length, and number of setae on segments.
4. *Body form*. Terete, subdepressed, or flattened ventrally only; clothing of pubescence, and pattern formed on dorsum.
5. *Head capsule*. (The head is remarkably uniform thruout the group, a condition to be expected in a group so compact as *Tipula*.) Shape of mentum and hypopharynx, and number, size, and shape of teeth along their anterior margins; shape of antenna, and other details of head.

#### Pupae

1. General form, whether terete or depressed.
2. Mouth parts.
3. Pronotal breathing horns, their relative length, size, and form.
4. Armature of mesonotum.
5. Wing sheaths and leg sheaths.
6. Spines on abdominal segments, their size and number; whether lacking or present at base of posterior ring of sternites; arrangement and number of pleural spines.
7. Cauda, shape of genital sheaths, armature of dorsum, and ventral margin of eighth sternite.

Descriptions are given in the following pages of about ten life histories which are entirely new or have been insufficiently considered elsewhere. A few notes on certain other species that have been observed in the past few years may be added here:

*Tipula cayuga* Alex. A conspicuous yellow larva, living in organic earth beneath leaves, in association with *Bittacomorphella jonesi* and other forms which are discussed elsewhere (page 781). The pupal duration is slightly over seven days.

*T. angustipennis* Loew. Found living in rather dry earth beneath leaves in shaded woods (Lawrence, Kansas, Mrs. C. P. Alexander).

*T. umbrosa* Loew. Occurs in garden soil in company with the larvae of *Tipula bicornis* Forbes.

*T. fuliginosa* Say. Reared from larvae living in débris under the nest of a turkey vulture (Jackson Island, Maryland, May 23, 1913, R. C. Shannon).

*T. sayi* Alex. and *T. tricolor* Fabr. In saturated mud in marshy or swampy situations.

*T. tephrocephala* Loew. A large larva, nearly if not quite aquatic in its habits.

The life histories of other Nearctic species are recorded in the summary of literature on page 980. These are as follows: *Tipula arctica* Curt. (Nielsen, Alexander), *T. cluta* Loew (Hart, Malloch), *T. cunctans* Say (Hyslop, Malloch), *T. bicornis* Forbes (Forbes), and *T. ultima* Alex. (Needham, Caudell). *T. arctica*, according to Nielsen (1910:57-59), was found commonly in eastern Greenland. The immature stages were discovered in circular holes from two to three centimeters deep in the ground, especially beneath tufts of *Cassiope tetragona* (L.) D. Don. The pupae were found at the end of June, and empty pupa cases were found as early as the 25th of the same month. According to Nielsen, the larvae require two years to attain their growth.

*Tipula (Trichotipula) oropezoides* Johns.

1909 *Tipula oropezoides* Johns. Proc. Boston Soc. Nat. Hist., vol. 34, p. 131-132.

Larvae of *Tipula oropezoides* were first found on March 30, 1917, living beneath saturated moss in Needham's Glen, Ithaca, New York, where they were associated with larvae of *Dicranomyia badia*, *Pentoptera albitarsis*, *Tipula collaris*, and other species. Numerous additional larvae were found in the same locality on April 18, 1917. Some of these were placed in rearing and emerged on May 6. The larvae are nocturnal in their habits, being very sluggish and retiring during the day but becoming active after sunset.

The adult flies bear a strong resemblance to species of the genus *Oropeza*, with which they are sometimes found associated. They may often be swept from rank herbage in cool Canadian woods.

Larva.— Length, 16.5-17 mm.  
Diameter, 1.8-2 mm.

Coloration above, a deep velvety brown with mottlings of paler; on basal ring of tergites six median transverse pale spots, posterior ring less regularly marked; pleura and venter pale. (The dark markings on the dorsum are produced by patches of dark-colored hairs, which cover the body densely in places.)

Form subterete. Integument with an abundant pubescence, longest on dorsum. Chaetotaxy as follows: dorsum (Plate XCIII, 516) on posterior ring with six stout setae, three on either side, the middle seta a little closer to the inner seta; ventral segments (Plate XCIII, 517) with four setae, two anterior and two posterior, the latter a little more separated. Spiracular disk (Plate XCIII, 518) surrounded by six approximately subequal lobes, their inner faces heavily lined with dark brown; at tip of each lobe a pale rounded spot, largest on ventral lobes and here with a sensory bristle; lateral mark not reaching spiracles; lateral and dorsal lobes slightly paler medially; above and below each spiracle a transverse brown

line; on disk, between spiracles, two indistinct dusky spots; lobes fringed with rather short, pale hairs which are narrowly interrupted between lobes. Spiracles irregular, roughly triangular. Anal gills four, slender, posterior pair the larger (Plate XCII, 506).

Head capsule as in genus. Labrum and maxilla very densely fringed with long golden-yellow hairs. Mentum (Plate XCIII, 513) with two flattened lateral teeth, the median point elongated; mentum very deeply split behind. Hypopharynx (Plate XCIII, 514) with but three evident teeth, the lateral teeth very broad, flattened. (In some specimens these teeth are all very blunt, so that the anterior margin of the hypopharynx appears merely crenulate.) Antenna with apical disk very flattened. Mandible (Plate XCIII, 515) with a dorsal tooth and a powerful ventral tooth.

*Pupa*.—Length: male, 12 mm.; female, 12.5–13 mm.

Width, d.-s.: male, 1.6–1.7 mm.; female, 1.8–1.9 mm.

Depth, d.-v.: male, 1.6 mm.; female, 1.7–1.8 mm.

Coloration dark brown; dorsum of thorax and abdomen, and face, more reddish brown.

General features as in *Tipula collaris*. Form slender. Pronotal breathing horns long and slender, dark-colored, divergent at tips. Antenna elongate. Wing sheaths ending opposite apex of second abdominal segment. Leg sheaths long, extending to beyond mid-length of fourth abdominal segment. Male cauda with dorsal lobes of genitalia short, blunt; ventral lobes produced caudad into slender, blunt lobes which are transversely wrinkled, separated by a U-shaped notch, at base on outside with a prominent spine. Female ovipositor elongate; dorsal valves narrowed to the blunt tip; ventral lobes stout, a little shorter than dorsal valves, tips strongly divergent; the six dorsal lobes of cauda spinous-tipped, sharply pointed.

*Nepionotype*.—Ithaca, New York, April 18, 1917. No. 6-1917.

*Neonotype*.—With type. No. 7 1917.

*Paratypes*.—Numerous larvae and pupae.

### *Tipula collaris* Say

1823 *Tipula collaris* Say. Journ. Acad. Nat. Sci. Phila., vol. 3, p. 23.

Larvae and pupae of *Tipula collaris*, a common vernal crane-fly, occurred frequently beneath saturated moss (*Amblystegium irriguum* [Wils.] B. & S.) in Needham's Glen, Ithaca, New York, on April 17, 1917. Their associates are noted under the account of *T. oropezoides* (page 1001). In the same moss areas occurred numerous small red-backed salamanders (*Plethodon cinereus*), which probably fed on the insect denizens of the place. Specimens emerged in the writer's breeding jars as late as May 10.

The adults are on the wing during April and May, some persisting into early June in cool northern woods. The life history undoubtedly requires a year for its completion.

*Larva*.—Length, 21.5–25 mm.

Diameter, 2.5–3.5 mm.

Coloration pale dusky, darker above; dorsum behind with two broken lines which are divergent on each annulus, those of anterior annulus made up of three circular spots; pleura with a conspicuous dark brown stripe; venter almost uniformly pale, with indistinct lines; anterior part of thoracic segments darker. (In life the color is rich reddish brown, and the pleural stripe is not evident.)

Form terete. Body covered with a delicate, pale pubescence, in addition to the usual setae. Chaetotaxy as follows: tergites (Plate XCIV, 521) with a transverse row of six setae on posterior ring before margin, the two innermost solitary, each lateral pair closely approximated; a solitary seta on extreme lateral margins of tergite, at margin of dark pleural stripe, and at about midlength of posterior ring; pleura on basal ring with a single seta, posterior ring with a group of about three or four setae, one larger than the others; sternites with four widely separated setae on posterior ring, the lateral pair a little nearer posterior margin than the median pair. Spiracular disk (Plate XCIV, 522) surrounded by six lobes which are moderately slender; ventral pair a little longer, dorsal pair a little shorter; all the lobes broadly margined with pale brown; ventral lobes having in addition a black capillary line extending from tips backward to beyond midlength of lobes, this line broadest at tip, gradually narrowing, and becoming paler toward base of lobes; below each spiracle, two conspicuous black dots; lobes fringed with numerous rather long hairs. Spiracles large, separated by a distance a little greater than diameter of one. Anal gills six, one pair much shorter than the others, consisting of a basal branch of the anterior gill.

Head capsule rather small, of the usual tipuline type. Mentum (Plate XCIV, 519) very broad, anterior margin almost transverse, seven-toothed, median point the longest. Hypopharynx (Plate XCIV, 520) with five teeth, which are very short and blunt giving anterior margin a deeply crenulated appearance; before hypopharynx a rounded lobe which is densely covered with six short, blunt, chitinized points, this being probably the prementum. Antenna elongate-cylindrical; apex with apical disk very small, button-like. Mandible small, with about one dorsal and two ventral teeth. Maxilla slender, densely hairy; palpus subglobular, with several small, hyaline papillae.

*Pupa*.— Length, 17–19 mm.  
Width, d.-s., 2.8–3.2 mm.  
Depth, d.-v., 3–3.3 mm.

Coloration brown; wing sheaths, except in older individuals, pale; pleural region of abdomen light yellow; abdominal incisures often pale.

Head rather small. Cephalic crest low and indistinct, with tiny setae. Labrum broad, apex pointed. Labial lobes oval, contiguous at inner end. Maxillary palpi strongly recurved at tips. Antenna slender, moderately elongated, extending some distance beyond wing root. Pronotal breathing horns equal in length, rather short, the moderately long tips flattened, smooth; two small, approximated setae on either side of median line. Wing sheath (Plate XCIV, 523) extending just beyond end of second abdominal segment; venation distinct. Leg sheaths extending beyond base of fourth abdominal segment; fore tarsi considerably shorter than the others.

Abdominal segments with armature of posterior ring weak, the spines very short and stout, with a few setae; maximum number of spines on the tergites about twenty; lateral anterior angle of posterior ring of tergites with two small spines; pleurites with one basal spine, and

three setiferous spines on posterior ring, arranged transversely; spiracles very rudimentary, opposite base of posterior ring; sternites with spines slightly more numerous and stouter; near base of posterior ring two transverse spines on either side median line, the outermost setiferous. Male cauda on dorsum with six lobes; the four posterior ones stout, with tips spinous or those of ventral pair slightly bifid; the two anterior median lobes shorter and more slender; eighth sternite with four large spines about equally spaced; eighth pleurite with a large, powerful, acutely tipped lobe, and two or three smaller dorso-lateral spines above base of middle pair of dorsal lobes. Female cauda almost the same as male cauda, due to the blunt terebral sheaths of this species.

*Nepionotype*.— Ithaca, New York, March 30, 1917.

*Neanotype*.— With type larva.

*Paratypes*.— Numerous larvae and pupae, March 30 to April 18, 1917.

### *Tipula nobilis* (Loew)

1864 *Pachyrrhina nobilis* Loew. Berl. Ent. Ztschr., vol. 8, p. 62.

Larvae of *Tipula nobilis* were found in wet moss and beneath decaying witch-hazel leaves at Orono, Maine, on June 17, 1913. An adult emerged on July 1. A fully grown pupa found on July 11 attempted to transform, but died after two hours without being able to extricate itself from the pupal case.

The adults, which strikingly resemble some species of *Nephrotoma*, fly somewhat later than does *T. collaris*, but both species may be taken together in early June.

*T. nobilis* is very similar in all respects to *T. collaris*.

*Larva*.— Length, 20 mm.

Diameter, 2.9–3 mm.

Coloration, reddish brown.

Spiracular disk as in *T. collaris*, the brown lateral margin to the lobes a little paler. Anal gills as shown in Plate XCII, 507.

Head capsule almost as in *T. collaris*. Mentum with apical point elongate, with three blunt teeth on either side. Hypopharynx with five moderately acute teeth. Antenna with a blunt conical papilla, larger and more conspicuous than in *T. collaris*. Mandible with teeth very blunt.

*Pupa*.— Length of cast pupal skin, about 18.5 mm.

Pupa very similar to that of *T. collaris*.

*Nepionotype*.— Orono, Maine, June 19, 1913. No. 40-1913.

*Neanotype*.— With type.

### *Tipula bella* Loew

1863 *Tipula bella* Loew. Berl. Ent. Ztschr., vol. 7, p. 291-292.

*Tipula bella* is a common species, flying thruout the summer. Larvae and pupae are not rare in sandy or loamy soil along streams. A larva taken on April 28, 1917, in gravel at Ithaca, New York, where it was associated with larvae of *Hexatoma*, was placed in rearing. It emerged as an adult male on May 15. On May 27, 1913, three fully colored pupae were found along the sandy banks of Fall Creek, Ithaca, in association with *Eriocera spinosa*. They emerged as females on May 29 and 30.

*Larva*.—(The description is from field notes on the larva mentioned above.)

Length, 20–25 mm.

Coloration light grayish brown, with a slight reddish cast most noticeable on venter; dorsum with two narrow, almost continuous, dark brown lines, these lines subparallel at anterior part of each segment, then strongly bellied out, and then parallel but finally divergent.

Spiracular disk surrounded by six rather short lobes; ventral lobes with a linear, rather pale, brown mark, and a few sensory bristles at tips; lateral lobes with ventral margin lined with brown; dorsal lobes with both margins feebly bordered with brown; two small brown dots below each spiracle. Anal gills six, very long and slender.

*Pupa*.—Length of cast pupal skin, about 24 mm.

Pupa similar to pupae of other species of genus. Pronotal breathing horns short, cylindrical, narrowed to tips. Spines on abdominal segments rather large, especially on sternites; spines on base of posterior ring of sternites small but evident. Female cauda with dorsal valves long, pointed; sternal valves shorter. Cauda with the usual six lobes on dorsum, the four posterior stout, divergent, spinous-tipped, the anterior median pair much smaller; venter of segment 8 with three strong spines on either side, gradually smaller from lateral spine toward innermost spine.

*Neanotype*.—Ithaca, New York, reared May 25, 1917.

*Paratypes*.—Pupal skins, type locality, May 5, 1914 (No. 42-1914); August, 1911; May 25, 1917; etc.

### *Tipula caloptera* Loew

1863 *Tipula caloptera* Loew. Berl. Ent. Ztschr., vol. 7, p. 292.

The vigorous larva of *Tipula caloptera* is one of the largest and most striking in the family. The larvae live in rapid- or slow-flowing streams either in the water among débris and under stones, or in the sand, gravel, or mud in very close proximity to the water. Here they are associated with the larvae of various species of *Eriocera*, *Erioptera armata*, *Tabanus*, *Atherix*, and other forms. Oftentimes they are found in deep water in exceedingly lotic situations. A larva placed in rearing on April 19, 1917, emerged as an adult female on May 13.



This is evidently the larva taken by Dr. Needham in the Adirondacks and referred by him with some doubt (Needham and Betten, 1901:575-576) to *T. abdominalis*. This dubious reference has created considerable confusion ever since the species was figured on the cover of *Entomological News* under the facetious name "*Quisnam sexcaulatus?*" Malloch (1915-17b:200-201) mentions the same larva under the name *T. abdominalis*. As stated elsewhere, the larva of *abdominalis* is very different.

*Larva*.—Length, 45-55 mm.  
Diameter, 4.8-6.8 mm.

Coloration above, dark brown or brownish green; segments beautifully marked with small white spots, especially anterior segments; a broad, dark brown, median stripe, and a more or less distinct pale lateral stripe (in preserved specimens the pleura is usually dark brown, more distinct behind, with numerous pale white dots); sternum dark greenish. (In older specimens the color is very dark and the pattern is more or less obliterated.)

Form stout, terete. Body smooth, segments with indistinct posterior tubercles. Chaetotaxy very weak, a few weak pleural setae on posterior ring, sternal and tergal setae minute. Spiracular disk rather small, surrounded by six subequal, moderately narrow, lobes which are fringed with short hairs; margins of disk and lobes somewhat as in *T. bella*, each lobe with a delicate capillary brown line; two brown spots beneath each spiracle. Spiracles small, separated by a distance about equal to twice diameter of one. Anal gills six, very long and slender (Plate XCII, 508).

Head capsule as in genus. Mentum broad; anterior margin nearly transverse, with three subacute teeth on either side, median point not conspicuously elongated.

*Pupa*.—Length of cast skin, about 32-35 mm.

Characters almost as in *T. bella*. Pronotal breathing horns short, cylindrical, tips not expanded. Abdominal spines prominent, projecting, few in number, on intermediate tergites 9 or 10; pleurites with a single strong spine on each ring; sternites with a posterior row of seven or eight strong spines; on segments 5 to 7 two strong spines at base of posterior ring, those of seventh segment the largest. Cauda almost as in *T. bella*.

*Nepionotype*.—Ithaca, New York, April 26, 1917. No. 16-1917.

*Neanotype*.—Cast pupal skin, reared May 13, 1917.

*Paratypes*.—Larvae and cast pupal skins from type locality.

### *Tipula dejecta* Walk.

1856 *Tipula dejecta* Walk. Ins. Saunders, vol. 1, Dipt., p. 442.

1901 *Tipula fumosa* Doane. Journ. N. Y. Ent. Soc., vol. 9, p. 99.

*Tipula dejecta* is a characteristic vernal species flying in April and May. The flies are notable inhabitants of swamps, especially alder swamps.

On April 20, 1917, the writer found larvae of this fly in Larch Meadows, near Ithaca, New York, in association with larvae of *Rhamphidia mainensis*, *Pseudolimnophila luteipennis*, and other swamp inhabitants. The

conditions are discussed more fully under the account of *Rhamphidia* (page 831). The larvae are reddish brown in color, and rather sluggish. One of the larvae found on April 20 pupated on the 22d and emerged as an adult female on the 30th, a pupal duration of eight days. An additional pupa was taken, associated with larva of *Pseudolimnophila luteipennis*, *P. inornata*, *Tricyphona inconstans*, and other species.

*Larva*.—Length, 20 mm.  
Diameter, 1.8 mm.

Coloration brown; dorsum marked with light and dark brown; a narrow, indistinct, dark brown, median line, with a broader zigzag brown line on either side; ventral surface a little paler.

Body covered with a short, dark pubescence at sides of segments, at margins longer and more conspicuous. Chaetotaxy as follows: tergites with six strong setae in transverse alinement, the outermost in pairs; two strong setae on each pleural annulus; posterior ring of sternites with eight strong setae, arranged in four pairs. Spiracular disk (Plate XCV, 526) pale, surrounded by six approximately equal lobes which are heavily marked with brown; dorsal and lateral pairs pointed, ventral pair blunt; ventral lobes with apical half shiny black, on ventral inner margin continued dorsad, almost contiguous on midline; inner face of dorsal and lateral lobes suffused with dark brown, proximal margin of dorsal lobe produced inward so that the marks are almost contiguous on median line; beneath each spiracle a transversely rectangular, dark brown mark. Anal gills with four anterior lobes which are long and slender, and a pair of rudimentary blunt posterior gills (Plate XCII, 509).

Head capsule and mouth parts as in genus. Mentum (Plate XCV, 524) seven-toothed, apical point the longest. Hypopharynx (Plate XCV, 525) bluntly five-toothed.

*Pupa*.—Length, 15.3 mm.  
Width, d.-s., 2.3-2.4 mm.  
Depth, d.-v., 2.1-2.2 mm.

Coloration dark brown; abdominal incisures paler.

Form relatively stout. General features as in genus. Cephalic crest consisting of two blunt lobes with microscopic setae. Maxillary palpi strongly curved at tip, but not entirely recurved. Pronotal breathing horns short, tips a little enlarged.

Abdominal tergites with spines weak, on median area of each row weak or lacking; on intermediate segments about fifteen spines; pleurites with only a single weak spine on basal ring; on posterior ring a rudimentary anterior spine and a somewhat larger posterior spine; sternites similarly armed to tergites, but spines fewer in number and larger, on segment 5 about twelve in number; on base of posterior ring a large spine on either side median line and a small setiferous tubercle laterad of each. Female cauda with tergal valves of ovipositor long and straight, sternal valves a little shorter; cauda with the usual six dorsal lobes, these terminating in slender spines; at end of eighth sternite six large spines; dorsal spines reduced to a single small pair, one near each lateral margin.

*Nepionotype*.—Larch Meadows, Ithaca, New York, April 20, 1917.

*Neanotype*.—With type.

*Paratypes*.—Two pupae with type pupa.

*Tipula usitata* Doane

1901 *Tipula usitata* Doane. Journ. N. Y. Ent. Soc., vol. 9, p. 124.

A large number of fully grown larvae of an unknown species of *Tipula* were found beneath the bark of a fallen tree at Stanford University, California, on March 22, 1915, by Harold Morrison. They were sent to the writer at Ithaca, New York, and emerged as adults on April 15. The immature stages are very distinct, closest perhaps to *T. trivittata*, which also lives beneath the bark of decaying trees. Nothing is known of the habits of the adult flies.

*Larva*.— Length, 25–27 mm.  
Diameter, 3–3.2 mm.

Coloration pale greenish yellow, darker above.

Form terete. Body with a very sparse pubescence. Chaetotaxy as follows: tergites (Plate XCV, 527) with a posterior row of eight setae, the middle pair of each side very closely approximated; a seta near lateral margin at base of posterior ring, on a level with pleural seta; pleurites, one seta on each ring; sternites with eight setae in closely approximated pairs on posterior ring. Spiracular disk (Plate XCV, 528) surrounded by six lobes; dorsal and lateral pairs slender, tips of former acute; ventral lobes blunt; ventral lobes with tips blackened, continued down proximal margin of lobes as a paler brown line; lateral lobes with inner face narrowly blackened, this mark not reaching spiracles; dorsal lobes with entire inner face bulging, intensely black, the marks contiguous at their basal inner angle; an indistinct brown spot underneath each spiracle, in some specimens this mark continuous with that of ventral lobes; lobes not fringed with hairs. Spiracles large, separated by a distance about equal to, or a little greater than, diameter of one. Anal gills short and blunt, strongly protuberant, surrounding anus as four fleshy lobes (Plate XCII, 510).

Head capsule as in genus. Mentum broad, with seven to nine teeth, in the latter case the outermost pair very small. Hypopharynx with three or five very blunt teeth. Antenna much shorter and stouter than in most species of *Tipula*, the length only a little greater than twice the diameter, at apex with a blunt conical papilla and a few small, cylindrical sense pegs. Mandible powerful, with two or three flattened teeth on ventral cutting edge.

*Pupa*.— Length, 15–16.8 mm.  
Width, d.-s., 2 mm.  
Depth, d.-v., 2.3–2.4 mm.

Coloration pale brown; posterior margin of abdominal rings pale; lateral margin of abdomen conspicuously pale yellowish white.

Form slender. Pronotal breathing horns narrow, a little expanded at tips. Leg sheaths ending on a level.

Abdominal spines very strong, but few in number; tergites with four to six spines; pleurites with a single weak spine on each ring; sternal spines very strong, five or six in number, those on segment 7 subequal in size to those on segment 8; no sternal spines on base of posterior ring. Male cauda with posterior dorsal lobe very strong, pale, tips acute; lateral lobes greatly

reduced in size, the median pair represented only by two blunt brown tubercles; eighth segment with the usual six strong ventral and lateral lobes. Female ovipositor with valves small; sternal valves short and broad, much shorter than tergal valves.

*Nepionotype*.—Stanford University, California, April 15, 1915.

*Neanotype*.—With type, bred April 15, 1915.

*Paratypes*.—Numerous larvae and pupae with type.

### *Tipula trivittata* Say

1823 *Tipula trivittata* Say. Journ. Acad. Nat. Sci. Phila., vol. 3, p. 26.

The larvae and the pupae of *Tipula trivittata* live beneath the bark of much-decayed prostrate trunks or under the layers of moss that often cover fallen trees. Abundant larvae were found on March 22, 1913, and were placed in rearing, adults emerging on April 26. On April 16, 1914, larvae of two distinct sizes—some very small and some nearly fully grown—occurred in abundance beneath moss (*Entodon seductrix* [Hedw.] C. Muell., *Brachythecium acuminatum* [Hedw.] Kindb., *Hypnum Haldanianum* Grev., and *Mnium sylvaticum* Lindb.) on prostrate decaying elms, sycamores, and other trees, at Renwick Park, Ithaca, New York.

The adult flies are among the commonest of the eastern species of *Tipula*, and fly during a large part of the season.

*Larva*.—Length, 24–25 mm.

Diameter, 2.7–3 mm.

Coloration pale brownish yellow, a little paler beneath.

Form moderately elongated, terete. Pubescence very short or practically lacking. Setae on anterior segments strong, on posterior segments shorter. Chaetotaxy as follows: tergites with a posterior row of six setae, the two middle punctures each with a single seta, the two lateral punctures each with two setae; pleurites with a single seta on each ring; sternites with two rows of setae, the anterior row consisting of two closely approximated groups of two setae each, the posterior row consisting of a single large seta, laterad of which is a minute bristle. Spiracular disk (Plate XCV, 529) surrounded by six lobes; lateral pair long and slender; dorsal pair a little shorter, slender; ventral lobes blunt; ventral lobes with a jet-black mark on inner face; lateral lobes with dark markings represented only by a very small linear dash; dorsal lobes with a small black area. Spiracles large, separated by a distance a little less than diameter of one. Anal gills indistinctly lobed, four in number, two on either side, very blunt and protuberant.

Head capsule as in genus, the mouth parts almost as in *T. usitata*. Mentum broad, with seven teeth. Hypopharynx with five teeth, the three middle ones the longest, subequal in size. Antenna shorter and stouter than is usual in the genus.

*Pupa*.—Length, 19–20 mm.

Width, d.-s., 2.5–2.6 mm.

Depth, d.-v., 2.8–3 mm.

Coloration dark brown; abdomen yellow, with a broad sublateral brown stripe on both sternites and tergites; abdominal segments beyond posterior row of spines brighter, more yellowish.

Characters of head as in genus. Cephalic crest very small. Labrum broad. Pronotal breathing horns short, slightly curved. Mesonotal prescutum with fine transverse wrinkles; two blunt lateral tubercles, and behind these, on either side of median line, two smaller flattened ledges which are often bifid at their tips. (Similar ledges, but much less prominent, occur in *T. usitata*.)

Abdominal tergites with subapical armature weak, spines varying in number from six to eight, those of posterior segments larger; pleural spines long and slender, one on each ring; sternal spines powerful, four to six in number, no spines on base of posterior ring. Female cauda with sternal valves long and slender, but little shorter than tergal valves; dorsal lobes of cauda four in number, posterior pair very powerful, lateral pair small, anterior median pair lacking.

*Nepionotype*.— Ithaca, New York, March 22, 1913.

*Neanotype*.— With type.

*Paratypes*.— Numerous larvae and pupae with types, April 26, 1917; March 22, 1913; etc.

### *Tipula ignobilis* Loew

1863 *Tipula ignobilis* Loew. Berl. Ent. Ztschr., vol. 7, p. 280.

The adult flies of *Tipula ignobilis* are not common in collections, due in part to their retiring habits. The larvae, however, are common in their preferred habitat, saturated moss cushions.

At Orono, Maine, numerous larvae were taken in wet moss on June 17, 1913, associated with other larvae, such as those of *Rhaphidolabina*, *Tricyphona*, *Pedicia*, and *Tipula nobilis*. At Ithaca, New York, on April 23, 1917, four very small larvae were found in wet cushions of moss (*Amblystegium*). They grew very rapidly, emerging as adults on May 21. On May 22 this moss was carefully examined and about thirty fully grown to rather immature larvae of this species were taken. They were associated with equally numerous larvae of *Dicranomyia stulta* O. S. At Needham's Glen, the species occurred in the same moss that earlier in the season harbored *Tipula collaris* and *T. olopezoides*. On June 14 two teneral adults of *T. ignobilis* were captured, in company with *Dicranomyia stulta*, *Geranomyia canadensis*, *Dactylolabis montana*, and other species. The species is very common at the Indian Ladder, Helderberg Mountains, New York.

*Larva*.— Length, 16.5–18 mm.

Diameter, 2.5–2.6 mm.

Coloration grayish brown, paler gray beneath; thoracic segments conspicuously reddish brown.

Body terete. Dorsum covered with a short, dark pubescence, which gives upper surface its dark color. Chaetotaxy as follows: tergites (Plate XCVI, 530) with a posterior transverse row of two setae near base of posterior ring; sternites (Plate XCVI, 531) with about eight setae, anterior median row consisting of two large setae, each with a tiny seta proximad of it, the posterior pair of large setae more widely separated, laterad of each of these two closely approximated smaller setae. Spiracular disk (Plate XCVI, 532) surrounded by six moderately long lobes fringed with rather short, pale hairs; tips of ventral lobes with a pale circular area provided with a sensory seta; inner face of spiracular disk with the markings pale, ventral lobes with an indistinct capillary brown line; two brown spots beneath each spiracle. Spiracles large. Anal gills eight, consisting of a transverse row of four short, slender, two-branched lobes (Plate XCII, 511).

Mentum of head capsule with median point prominent, the three lateral teeth of either side small, moderately acute. Mandible with about four teeth, in addition to the large basal prosthecal tooth.

*Pupa*.— Length: male, 12 mm.; female, 14–15 mm.

Width, d.-s.: male, 1.7–1.8 mm.; female, 1.8–2 mm.

Depth, d.-v.: male, 1.9–2 mm.; female, 2.1–2.2 mm.

Head and mouth parts as in genus. Pronotal breathing horns rather long and slender, tips a little expanded. Leg sheaths rather short, just exceeding third abdominal segment; hind legs a little the longest, the other tarsi ending about on a level.

Abdominal tergites with armature weak, spines small; pleurites and sternites with spines notably larger and more powerful; sternites with subterminal row consisting of twelve to fifteen spines, those of the sixth and seventh segments larger; no spines at base of posterior ring; pleural spines setiferous, very weak, one on basal ring, two on posterior ring. Male cauda with ventral lobes widely separated, terminating in slender, curved spines directed caudad; dorsal lobes slender, approximated on dorso-median line. Female cauda (Plate XCVI, 533) with tergal valves a little longer than sternal valves, the latter at their tips terminating in slender points directed ventrad and laterad; dorsum of cauda with the usual six lobes, posterior pair the largest, terminating in two distinct points; eighth segment on pleural and sternal region with six very powerful, curved spines.

*Nepionotype*.— Ithaca, New York, June 3, 1917.

*Neanotype*.— With larva, June 3, 1917.

*Paratypes*.— Numerous larvae and pupae, June 1 to 12, 1917.

### *Tipula abdominalis* (Say)

1823 *Ctenophora abdominalis* Say. Journ. Acad. Nat. Sci. Phila., vol. 3, p. 18.

*Tipula abdominalis* is the largest eastern species of the genus, altho some specimens of *T. caloptera* are nearly as large. The adult flies are on the wing in late August and September, and even, in fewer numbers, in June and July.

The large, fleshy larvae occur beneath or among drift at or near the margins of streams. They are usually abundant under saturated decaying leaves or under tussocks of grass at the edge of the water. They are entirely herbivorous, feeding on diatoms, decaying plant tissues, and other vegetable matter. The larvae are readily distinguished from all other species of the genus by the small spiracles and the bifid or split lobes surrounding the spiracular disk. Pupation takes place in the mud or earth at the water's edge. Malloch's *Tipula* sp. 2 (1915-17b:200-201) seems to refer to *T. abdominalis*, but the mouth parts of his specimens do not seem to be normal.

*Larva*.— Length, 55-65 mm.  
Diameter, 7.5-10 mm.

Coloration pale grayish brown; anterior end darker.

Form stout, terete, thin-skinned. Posterior ring of abdominal segment, both above and below, with a naked transverse welt, which bears the setae; this welt very protuberant at its lateral ends, almost like a pair of prolegs. Skin naked, except for a microscopic dotting and the rather short, delicate setae. Chaetotaxy as follows: tergites, on welt at about mid-length, a transverse row of eight setae, the middle pair of each half closely approximated; pleurites with a single seta opposite basal ring, and two opposite posterior ring, arranged one behind the other; sternites with four pairs of setae on welts, anterior middle pair closer together than posterior lateral pair. Spiracular disk (Plate XCVII, 537) moderately large, flattened, truncated, surrounded by six deeply bifid and irregular lobes; ventral lobes elongate, with a blunt basal branch bearing two setae; posterior branch longer, indistinctly bifid at tip and with a few setae and several hairs; lateral lobes deeply bifid, the ventral one armed with lateral setae; dorsal lobes small, simple; inner faces of dorsal and lateral lobes with a narrow dark brown stripe, ventral lobes with two narrow, usually indistinct lines, these markings broadest and darkest on dorsal lobes. Spiracles very small, circular, separated by a distance about equal to four times diameter of one. Anal gills six, long and slender, the middle one on either side a little shorter than the others. Pleural region of penultimate segment of body with a blunt setiferous tubercle.

Head capsule and mouth parts about as in genus. Mentum (Plate XCVII, 536) broadly transverse, anterior margin with seven to nine teeth, in the latter case the outermost teeth very indistinctly separated from the sublateral teeth. Hypopharynx broad, anterior margin with teeth very indistinct.

*Pupa*.— Length of cast pupal skin, about 35 mm.

Pronotal breathing horns short, straight, cylindrical; apex short, and but little if at all expanded. Details of mouth parts as in other species of genus. Wing sheaths ending before apex of second abdominal segment. Leg sheaths extending to about opposite end of third abdominal segment; fore tarsi the shortest, hind tarsi the longest, ends of tarsal sheath thus forming a broad, inverted U-shaped notch.

Abdominal armature generally weak. Tergites (Plate XCVII, 538) with subterminal row broken, consisting of an anterior median pair of large spines, laterad of which are two or

three smaller spines; close to ends of row a bifid setiferous spine; pleurites with spines long, slender, directed strongly caudad, tips narrowly bifid, bearing a seta in notch; basal spine the largest; posterior spines two in number, anterior dorsal one the smaller; sternites (Plate XCVII, 539) with posterior row unbroken, of comparatively few spines, there being about eleven excluding the two larger spines at ends of row; the innermost of the large lateral spines conspicuously bifid, bearing a stout seta in its notch; base of posterior ring on either side of median line with a powerful conical spine which is acutely tipped. Female cauda as in genus, sternal valves conspicuously shorter than the long tergal valves; the six dorsal lobes powerful, chitinized, more or less bifid at tips; dorsal lateral lobes at end of eighth segment split before tips.

*Nepionotype*.—Cascadilla Creek, Ithaca, New York, May 31, 1913.

*Neanotype*.—Cast pupal skin, reared at Ithaca, September, 1911.

*Paratypes*.—Abundant larvae from type locality.

*Tipula taughannock* Alex.

1915 *Tipula taughannock* Alex. Proc. Acad. Nat. Sci. Phila., p. 476-479.

*Tipula taughannock* is of exceptional interest in the striking color dimorphism that it shows, the females being black and yellow, the males light yellowish. The following account of the habits of the adult flies is taken from the writer's field notes:

June 12, 1915. Deciduous forest association of the southern Helderberg Mountains, near the village of New Salem, Albany County, New York. This association is an open deciduous forest, with an undergrowth of *Cystopteris*, *Geranium*, *Caulophyllum*, and *Impatiens*. It is a very open woods, having an eastern exposure and with the talus slopes so old that an extensive vegetation has sprung up. The great boulders scattered about thru the woods have come from the high Silurian and Devonian cliffs above. The woods are of such a nature that much sunlight penetrates to the ground beneath. The forest cover shows a striking lack of coniferous species, but the following deciduous species are common: butternut, hop hornbeam, hard maple, basswood, white ash. The shrubbery consists of mountain maple, bladdernut, and a few dogwoods. The dominant herbage consists of jack-in-the-pulpit, wild ginger, bloodroot, bishop's-cap, false bishop's-cap, blue cohosh, white baneberry, herb robert, touch-me-not, waterleaf, bedstraw, and other characteristic flowering plants in fewer numbers, as well as several ferns, such as the bulbous bladder fern, maidenhair, and, on the rocks, the walking fern. The crane-fly under consideration is very common in these woods. The proportion of males to females is about one hundred to one, but this is due, in large part at least, to the very secretive habits of the latter. The males are untiring, almost always moving along, silently and relentlessly, in quest of their mates. They pass in and out among the dense herbage, usually close to the ground, occasionally fluttering up a tree trunk or over a mossy boulder which is covered with various bryophytes and walking ferns. They are so intent upon their quest that they are readily scooped up by hand. If this is attempted and fails, however, they become instantly alarmed and fly away with great speed, their flight at this time having a strong undulating motion. In a position of rest, the male almost always hangs on the under surface of a leaf, with the body directed straight toward the ground. Several specimens of this species, as well as of *Tipula trivittata* Say and *T. senega* Alex., were found dead in spider's webs. These small webs, made by species of *Epeiridae* and *Linyphiidae*, are very common on and between the leaves of herbaceous plants and are presumably intended for smaller game. The large *Tipulas* are probably taken in by accident.



The females are more active when in flight than are their mates and are capable of moving very rapidly. Their flight is a rapid, fluttering progression along the ground. Copulation takes place on either the upper or the lower surface of leaves, usually near the ground. Sometimes copulation is end to end, with the heads directed away from each other; at other times it is face to face, the bodies being arcuated into a convex loop.

The larva almost certainly lives among or beneath the decaying leaves and débris which cover the talus slope.

### *Tipula macrolabis* Loew

1864 *Tipula macrolabis* Loew. Berl. Ent. Ztschr., vol. 8, p. 58.

*Tipula macrolabis* is distinctly northern in its distribution. It is a characteristic fly of northern deciduous woods in June. The following notes were made near the village of Indian Castle, Herkimer County, New York, on June 13, 1915:

A small woodland stream with a forest cover of trees such as hemlock, beech, slippery elm, and basswood, and a ground cover of false solomon's seal, wood nettle, wild ginger, herb robert, touch-me-not, waterleaf, sarsaparilla, and the two abundant ferns maidenhair and the bulbous bladder fern. The males of *T. macrolabis* were in search of the females, and fluttered up the tree trunks often to a height of ten or fifteen feet, flying close to the ground, around brush heaps, hovering about the leafy ends of branches, and performing similar actions in their untiring quest for their mates. They occurred in company with males of *T. fuliginosa* and *T. valida*, which were similarly engaged in searching for the females.

### Tipuline No. 1 (possibly *Tipula iroquois* Alex.)

1863 *Tipula cincta* Loew. Berl. Ent. Ztschr., vol. 7, p. 288-289, not *T. cincta* Gmel., Syst. Nat., ed. 13, vol. 1, p. 2820 (1792).

1915 *Tipula iroquois* Alex. Insec. Inscit. Menstr., vol. 3, p. 128.

The larva discussed below has never been reared and is mentioned here principally because of its interesting habitat. It is referred to *Tipula iroquois* with considerable doubt.

The larva lives among dense mats of an aquatic moss, a Hypnum (Rhynchostegium) of the *dilatatum* group, in the most rapid-flowing streams. At Coy Glen, Ithaca, New York, these larvae are especially frequent, often living at the brink of falls or rapids in the most rushing waters. A study of the structure of the larva reveals numerous small but prominent tubercles, which doubtless assist the insect in clinging to the moss stems. The gills are large, but no better developed than in many aquatic species of the genus that live in much less lotic conditions. The green color and the transverse rows of tubercles on the body give the larva a strong resemblance to its mossy habitat. The larvae are very sluggish and crawl but slowly, often appearing quite dead for long periods of time.

Associated with these larvae in Coy Glen, the following characteristic forms of insect life occur:

Plecoptera: a small species of Perlidae.

Ephemera: Ephemeridae, such as *Bactis*, *Iron fragilis*, Ephemerella, and others.

Trichoptera: Ryacophilidae, Hydroptilidae, and other forms.

Neuroptera: Chauliodes larvae.

Diptera: Chironomidae, a few; Psychodidae, *Psychoda albitarsis* Banks; Stratiomyiidae; Anthomyiidae, *Linnophora torreyae* Joh.; and other groups.

Coleoptera: Parnidae, larvae of *Psephenus lecontei* (Lec.), and adult beetles of a species of Elmis in large numbers.

Up to the present time it has been found impossible to rear this larva to the adult condition, chiefly because of the constant need of well-aërated water and the difficulty of supplying it. By placing the larvae in the folds of moistened cheesecloth, it was possible on one occasion to carry the species to the pupal state, but no further. It will be of interest to ascertain the identity of this conspicuous larva.

*Larva*.—Length, 24–25 mm.  
Diameter, 2.6–3 mm.

Coloration above, dark green with a brown pattern; beneath, light green with indistinct transverse brown lines; on dorsum a pale longitudinal mark on sides of posterior ring, crossing sutures between segments onto extreme base of anterior ring of following segment, the dark area of each segment thus appearing cruciform, this cross-shaped mark spotted and marbled with darker in transverse rows; base of gills and center of spiracular disk light green in living, healthy larvae.

Form moderately terete, each segment with transverse rows of small, prominent tubercles, some of which are provided with setae. On dorsum of posterior ring a subterminal row of six tubercles, the middle one on each side with two setae, the remaining four tubercles unisetose; two rows of smaller naked tubercles at base and middle of posterior annulus; basal annulus with four transverse rows of small naked tubercles; pleurites with three tubercles, a small seta on basal ring ventrad of basal tubercle, and two setae on posterior ring ventrad and cephalad of posterior tubercle; sternites on posterior ring with six setae, four on anterior row, the two middle ones very tiny. Spiracular disk almost as in *T. collaris*, *T. ignobilis*, and similar species, surrounded by six lobes fringed with moderately long hairs; inner face of lobes somewhat pale; ventral lobes with a narrow, capillary, dark brown line, extending from tip toward base; lobes narrowly and more or less indistinctly margined with brown; two brown spots at base of each ventral lobe, underneath each spiracle; dorsal and lateral lobes jutting backward at tips into fleshy conical points. Spiracles circular, moderately large, separated by a distance about equal to one and one-half diameter of one. Anal gills with eight branches, rather short and stout, with two lateral divergent branches on either side and an inner pair with one ventral and one posterior branch (Plate XCII, 512).

Head capsule and mouth parts of almost normal tipuline appearance. Mentum with outer plate forming the unusually long apical point, inner plate adding three teeth on either side, margins bulging. Antenna with apical papillae somewhat flattened, surrounded by three sense pegs.

(Described from abundant specimens, Coy Glen, Ithaca, New York, April 23, 1914.)

### Tipuline No. 2

The larva discussed below is known only from a single, apparently fully grown, specimen. The writer has no clue as to which species it represents, altho from the larval structure it is obviously allied to *Tipula scelene* Meig. of Europe.

*Larva*.— Length, 23 mm.  
Diameter, 3 mm.

Coloration, a rather uniform pale yellowish or reddish brown.

Body covered with a rather sparse, long pubescence, setae unusually long and powerful. Chaetotaxy as follows: tergites (Plate XCVI, 534) with two strong lateral setae near posterior margin and an additional one at extreme lateral margin of ring; pleural setae, one on basal ring, two, one behind the other, on posterior ring; sternites with a transverse pair of powerful setae near extreme lateral margin, and two anterior pairs of much smaller setae. Spiracular disk (Plate XCVI, 535) with four elongated, cylindrical, chitinized horns which are narrowed to the acute, blackened, slightly curved tips; longer dorsal pair rather closely approximated, lying almost parallel, with tips a little curved dorsad; shorter and more slender lateral horns directed ventrad at tips, at base on inner face with a powerful seta, the large black spiracles lying above base of lateral horns; ventral lobes, if present, very blunt and indistinct. Anal gills not protruded in the only specimen available.

Head capsule and mouth parts rather normal but showing the following points of difference from the usual *Tipula* type: Mentum almost completely split, apical point long and narrow; the three lateral teeth on either side blunt, lateral pair tending to be reduced.

Hypopharynx with five blunt teeth. Antenna short, stout, length only about twice diameter, at tip with a subglobular, feebly chitinized papilla.

(Described from a single larva found beneath a stone in a field near Taughanock Falls, Tompkins County, New York, May 1, 1912.)

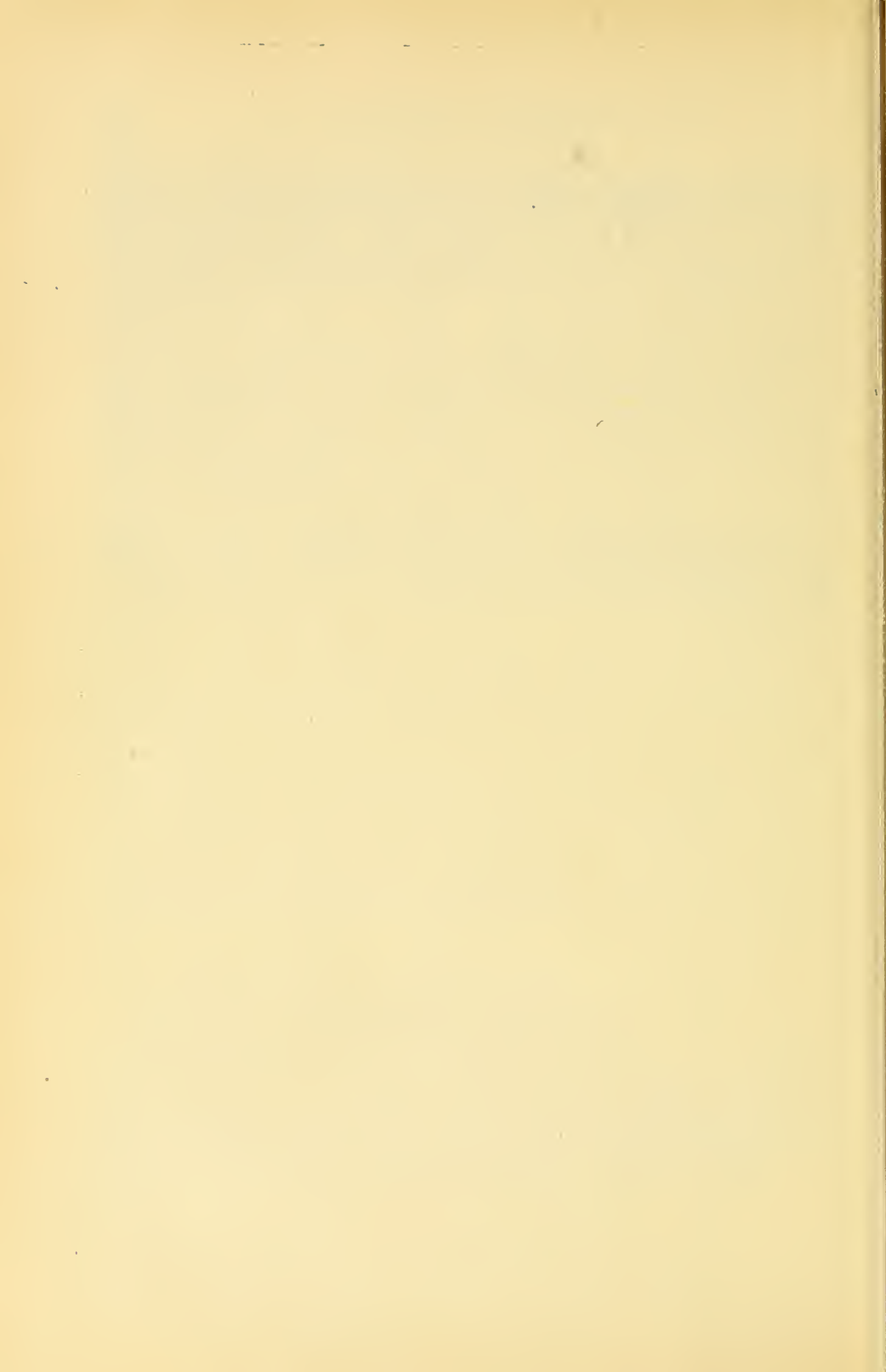
### Genus *Nephrotoma* Meigen (Gr. *kidney* + *I cut*)

- 1800 *Pales* Meig. Nouv. Class. Mouch., p. 14 (*nomen nudum*).  
1803 *Nephrotoma* Meig. Illiger's Mag., p. 262.  
1834 *Pachyrrhina* Macq. Hist. Nat. Ins., Dipt., vol. 1, p. 88.

The large genus *Nephrotoma*, including some one hundred and fifty described species, is very close to *Tipula* in all respects. The writer cannot attempt to separate the immature stages of the genus from those of *Tipula*, on the scanty material that has been available for study.

In Europe, Beling and others have described the life histories of about eight of the commoner species. The following species live in earth, beneath a covering of leaf mold: *analis* (Schum.), *cornicina* (Linn.), *lineata* (Scop.), *maculata* (Meig.), *lunulicornis* (Schum.), *pratensis* (Linn.). The following have been described as living in decaying wood, some of the records apparently being in error: *cornicina* (Linn.), *crocata* (Linn.), *lineata* (Scop.), *quadrifaria* (Meig.). Some of the species are injurious to young seedlings, especially those of coniferous plants.

In North America the commonest species, *N. ferruginea* (Fabr.), has been discussed several times in its economic relations to agriculture. Hart (1898 [1895]:218-219) gives an excellent description of the immature stages, while Malloch (1915-17 b:206) gives supplementary notes and figures of the same species. The immature stages live in sand or earth. *N. virescens* (Loew) was bred from a larva found in moss on Plummers Island, Maryland, on April 5, 1913, by R. C. Shannon. *N. eucera* (Loew) and *N. polymera* (Loew) have been reared from larvae taken under leaf mold in woods by Mabel M. Alexander.



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## EXPLANATION OF ABBREVIATIONS USED ON PLATES

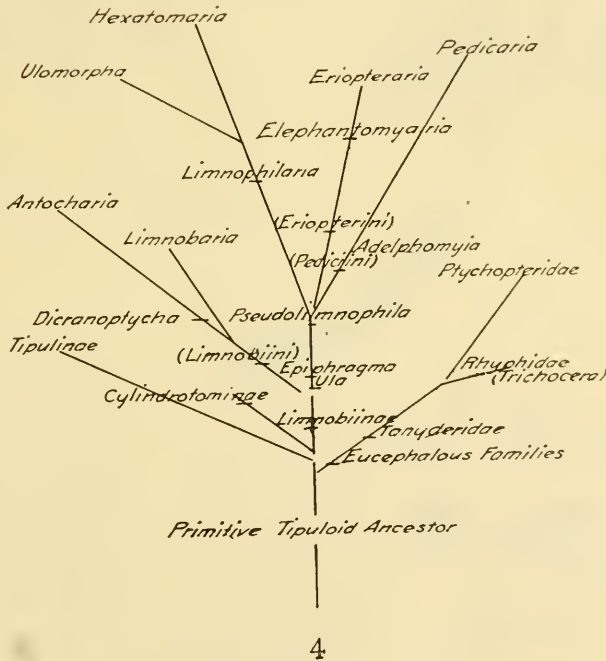
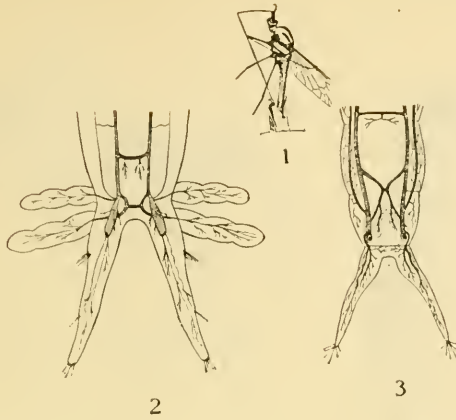
A=antenna	Pl=pleuron
C=cardo	PM=prementum
Lb=labium, or labial lobes	S=stipes
M=mentum	SM=submentum
Md=mandible	Sp=spiracle
Mx=maxilla	St=sternite
P=palpus, or palpal sheath	T=tergite

Memoir 34, *An Economic Study of Farm Layout*, the fourth preceding number in this series of publications, was mailed on January 31, 1921.

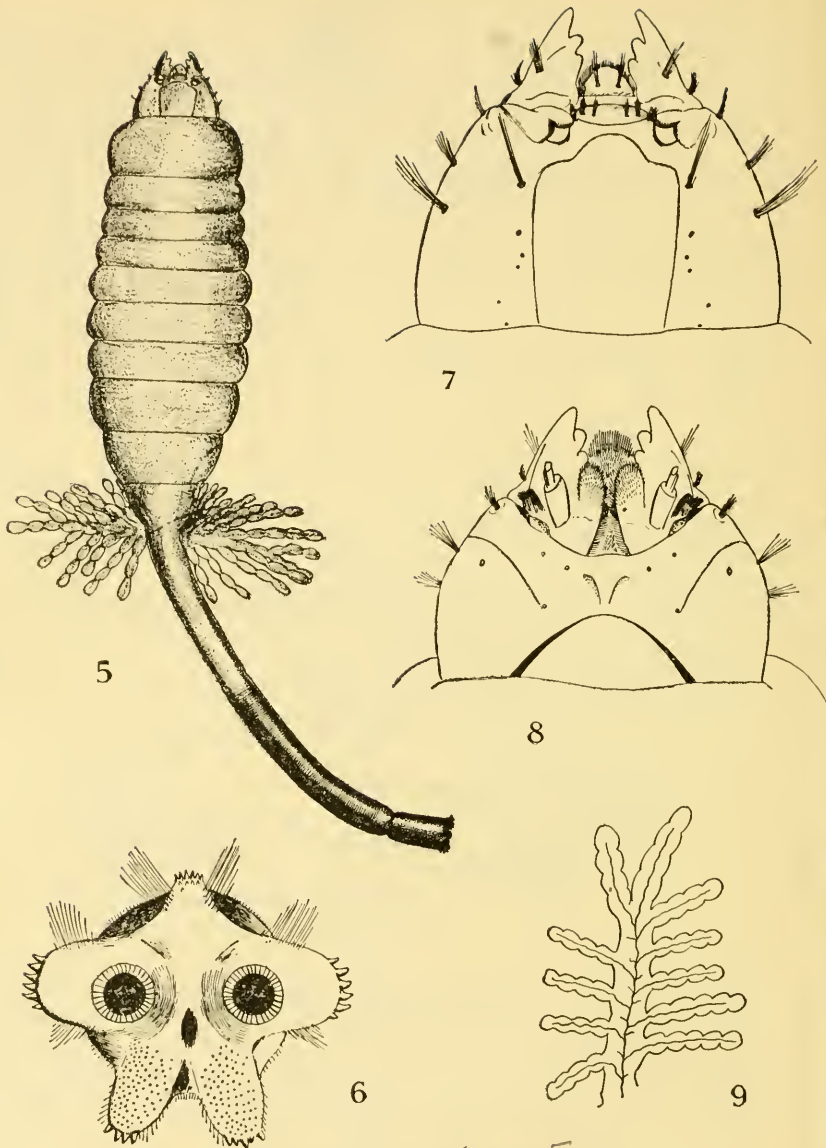
Memoir 35, *Some Effects of Potassium Salts on Soils*, the third preceding number in this series of publications, was mailed on January 29, 1921.

Memoir 36, *Resistance of the Roots of Some Fruit Species to Low Temperature*, the second preceding number in this series of publications, was mailed on January 19, 1921.

Memoir 37, *A Modified Babcock Method for Determining Fat in Butter*, the next preceding number in this series of publications, was mailed on December 10, 1920.



1, *Eriocera spinosa* emerging from pupal hull.  
 2-3, Spiracular disk and tracheation of larvae: 2, *Antocha saxicola* (apneustic); 3, *Dicranota bimaculata* (metapneustic), after Miall  
 4, Phylogenetic tree



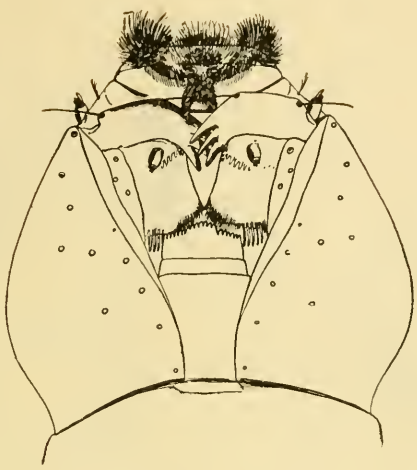
= *Azymia succata*

PROTOPLASA FITCHII, SUPPOSITION

5, Dorsal aspect; 6, spiracular disk; 7, head, dorsal aspect; 8, head, ventral aspect; 9, anal gill



10



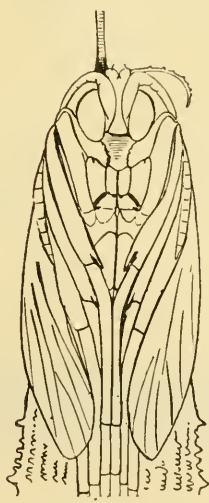
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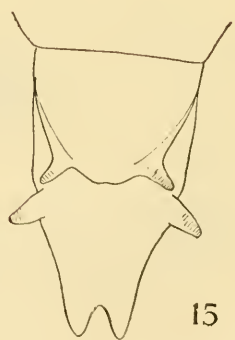
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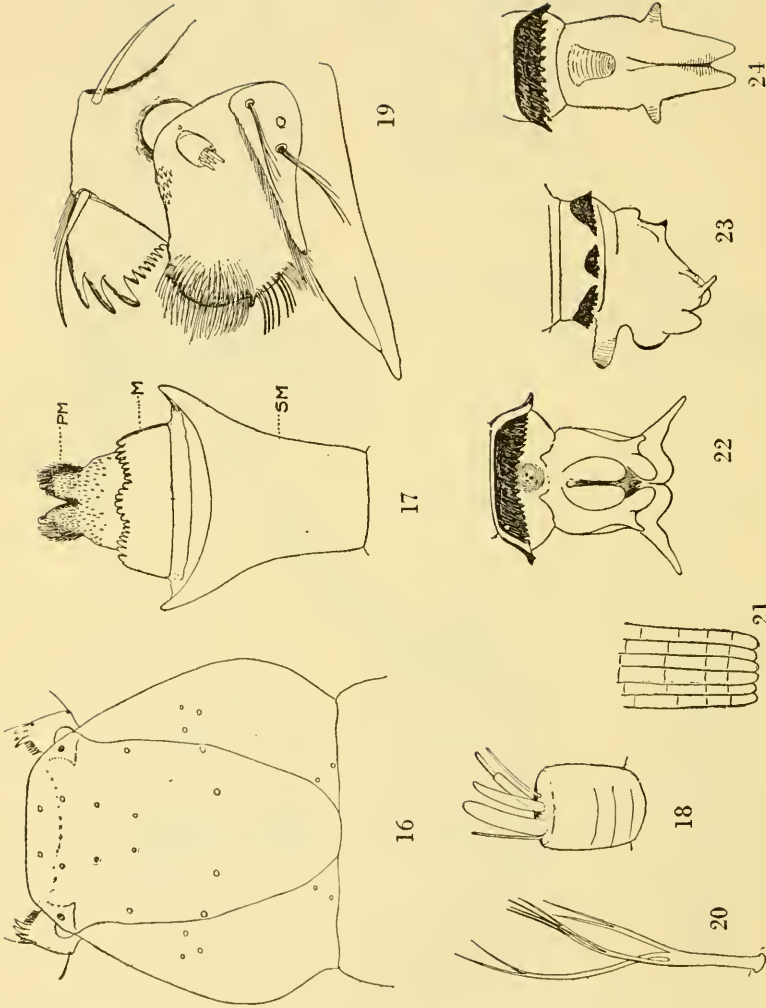


15

PTYCHOPTERA RUFOCINCTA

Larva: 10, dorsal aspect; 11, breathing tube extended; 12, head, ventral aspect  
 Pupa: 13, lateral aspect; 14, ventral aspect; 15, female cauda, ventral aspect



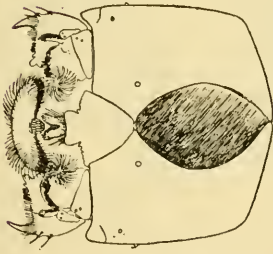


## PTYCHOPTERA RUFOCINCTA

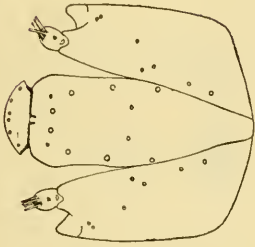
Larva: 16, head, dorsal aspect; 17, labium, ventral aspect; 18, mandible and maxilla.  
 Pupa: 21, arrangement of leg sheaths; 22, male cauda, dorsal aspect; 23, male cauda, lateral aspect;  
 24, female cauda, dorsal aspect.



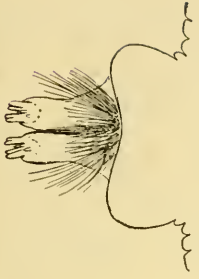
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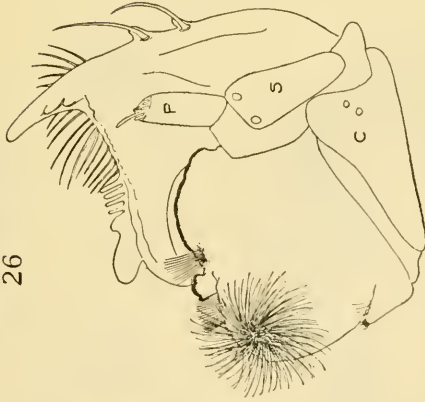
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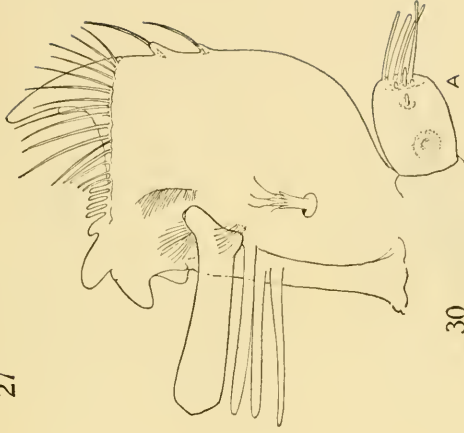
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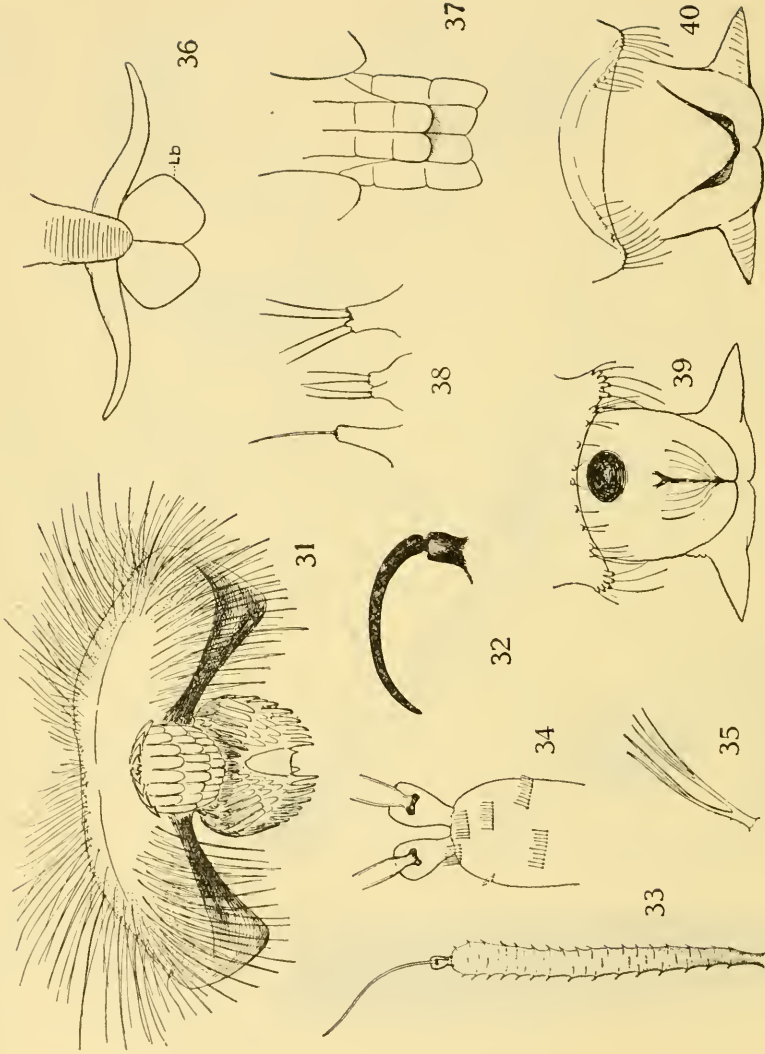
29



30

*BITACOMORPHELLA JONESI, LARVA*

25, Dorsal aspect; 26, head, ventral aspect; 27, head, dorsal aspect; 28, labium, ventral aspect; 29, mandible and maxilla, ventral aspect; 30, antenna, dorsal aspect

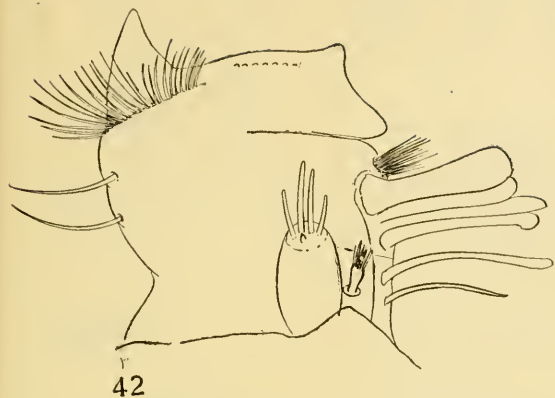


## BITTACOMORPHELLA JONESI

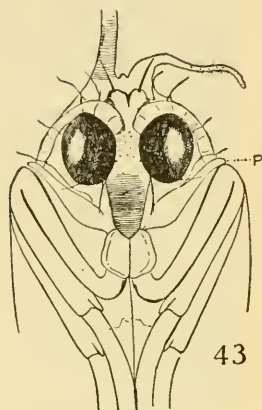
Larva: 31, labrum-epipharynx; 32, apex of pseudopod, and claw; 33, body projection; 34, body projection, enlarged; 35, branched hairs on body

Pupa: 36, mouth parts; 37, arrangement of leg sheaths; 38, types of abdominal tubercles; 39, male cauda,

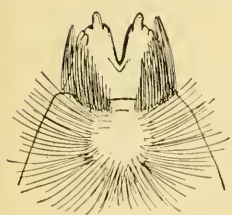
dorsal aspect; 40, male cauda, ventral aspect



42



43



41



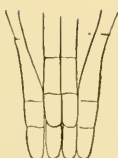
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46



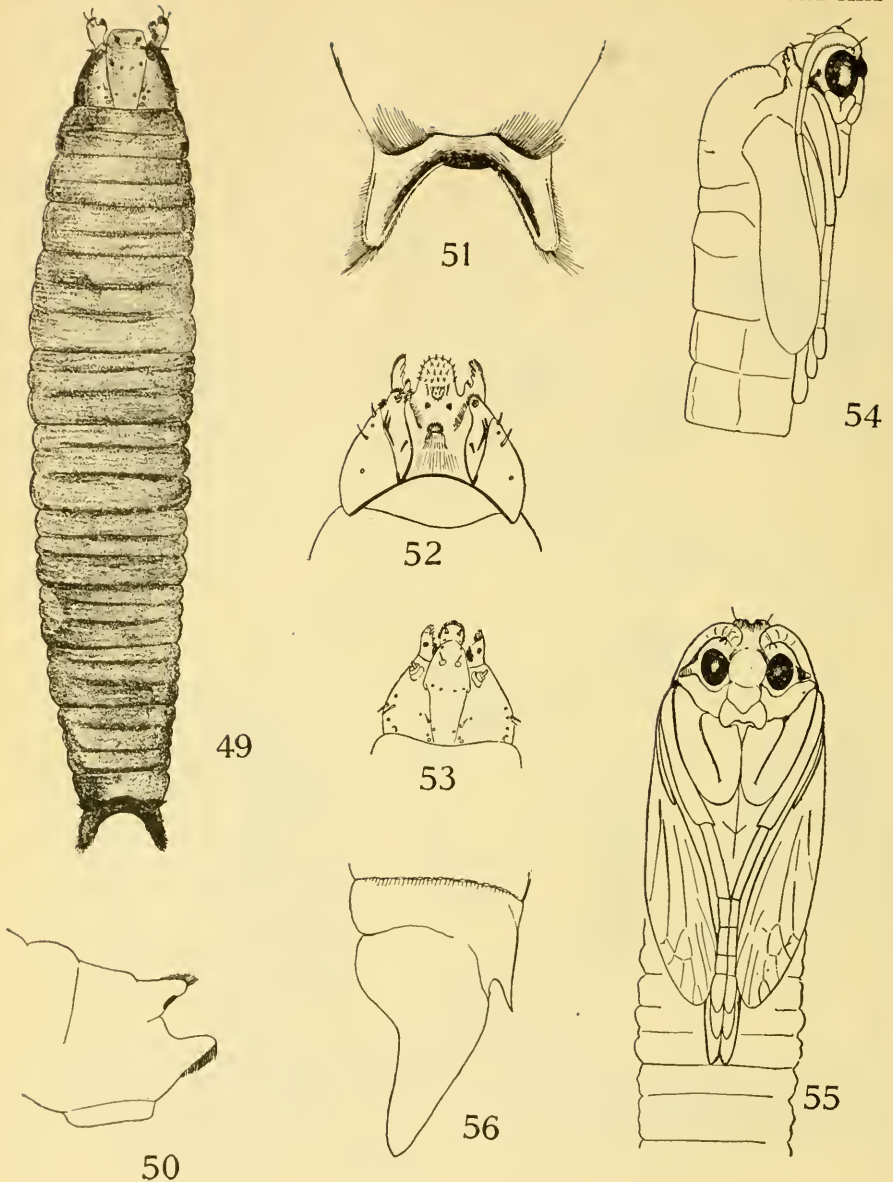
47



48

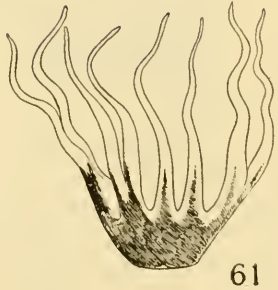
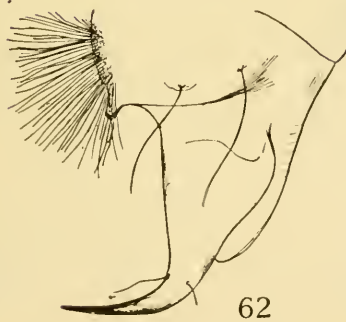
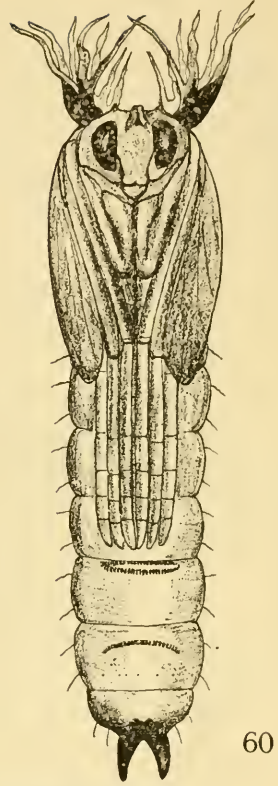
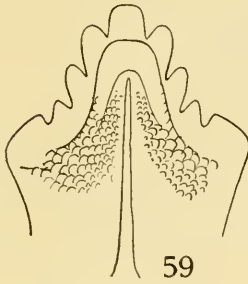
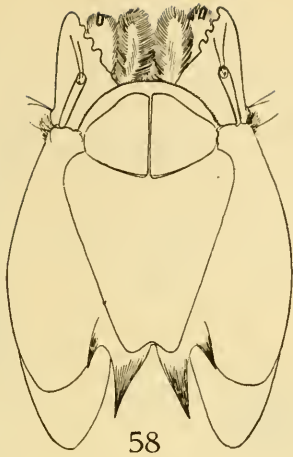
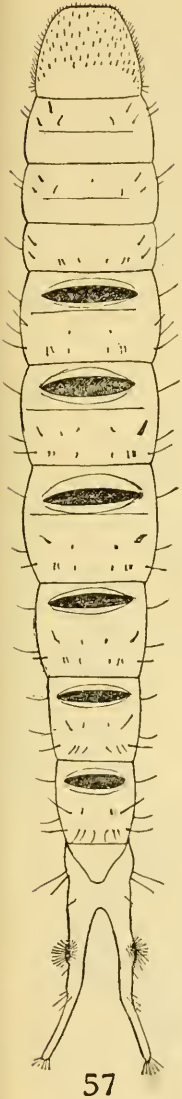
## BITTACOMORPHA CLAVIPES

Larva: 41, labium; 42, mandible and antenna, dorsal aspect  
 Pupa: 43, ventral aspect; 44-46, types of abdominal tubercles; 47, arrangement of leg sheaths; 48, male cauda, dorsal aspect



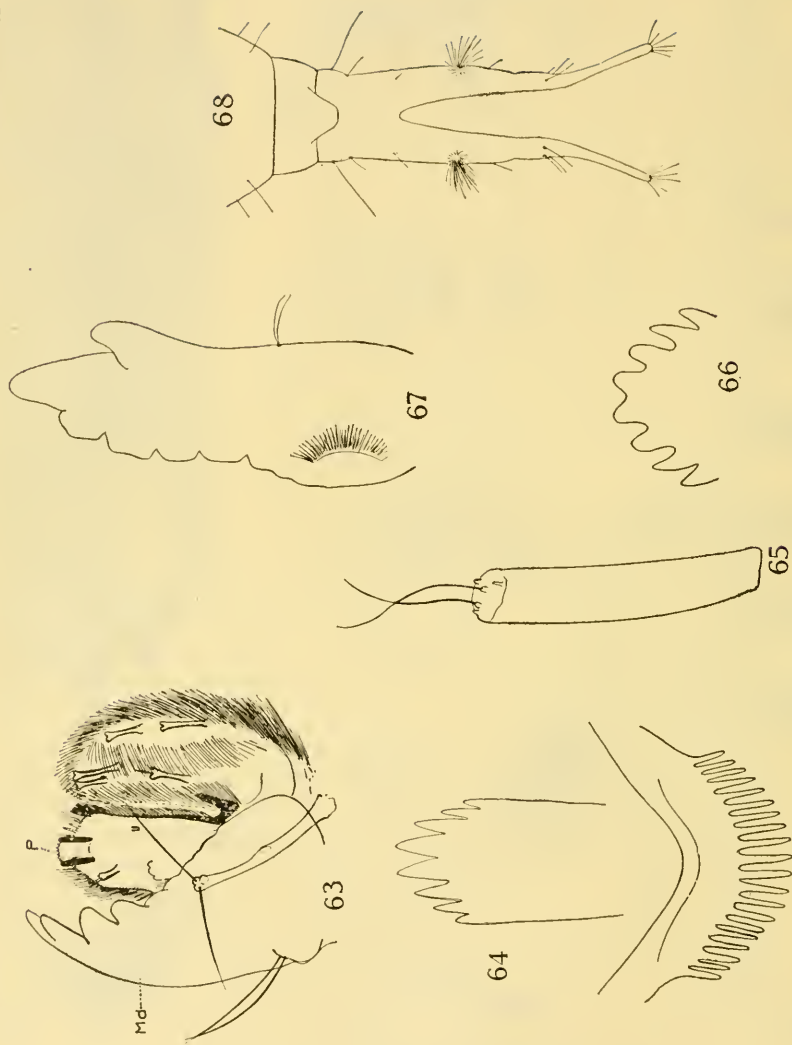
## TRICHOCERA SP. (REGELATIONIS, SUPPOSITIO)

Larva: 49, dorsal aspect; 50, spiracular disk, lateral aspect; 51, spiracular disk, dorsal aspect; 52, head, ventral aspect (after De Meijere); 53, head, dorsal aspect (after De Meijere)  
 Pupa: 54, lateral aspect; 55, female, ventral aspect; 56, female cauda, lateral aspect



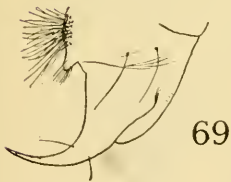
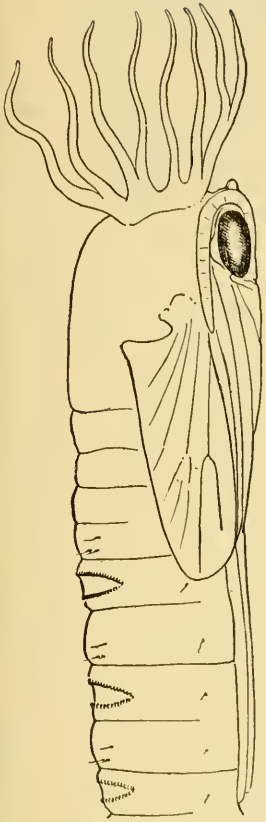
ANTOCHA SAXICOLA

Larva: 57, dorsal aspect; 58, head capsule, dorsal aspect; 59, mentum  
Pupa: 60, ventral aspect; 61, pronotal breathing horn, lateral aspect; 62, female cauda, lateral aspect

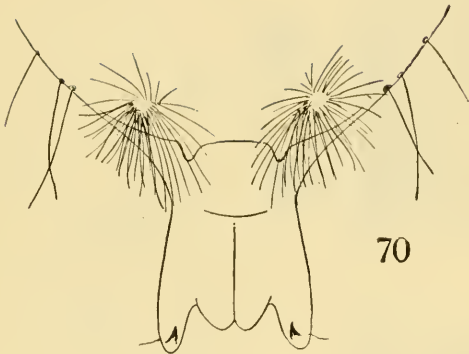


ANTOCHA SAXICOLA, LARVA

63, Mandible and maxilla, ventral aspect; 64, hypopharynx; 65, antenna; 66, mentum, aberration; 67, mandible; 68, spiracular disk, dorsal aspect



69



70

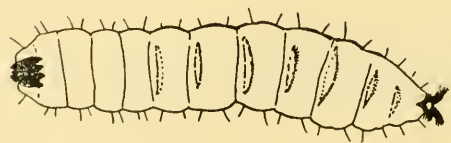


71

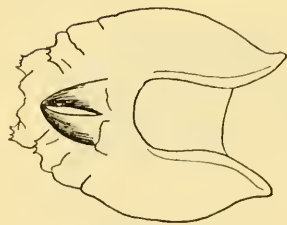
ANTOCHA SAXICOLA, PUPA

69, Lateral aspect; 70, male cauda, dorsal aspect; 71, fifth abdominal segment, dorsal aspect (diagrammatic)

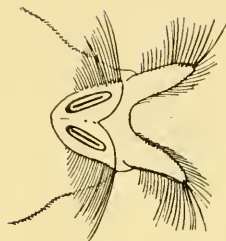




72



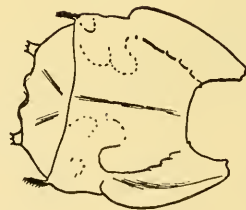
73



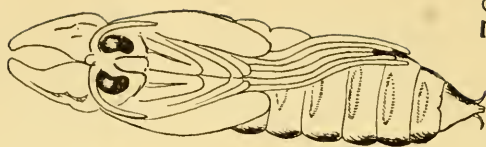
75



74



76



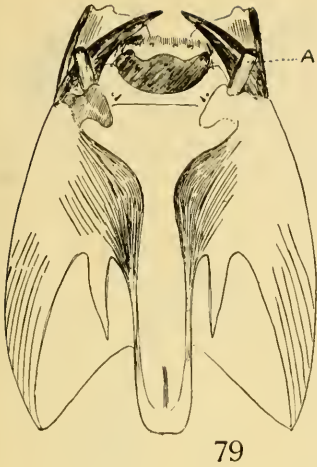
77



78

ELLIPTERA OMISSA (AFTER MILK)

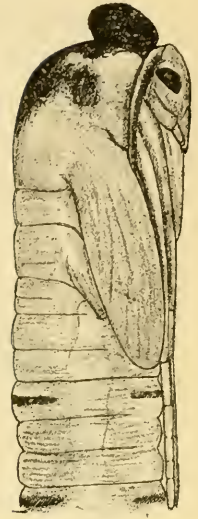
Larva: 72, dorsal aspect; 73, head capsule, ventral aspect; 74, head capsule, dorsal aspect; 75, mandible; 77, spiracular disk  
Pupa: 76, pronotal breathing horn; 78, ventral aspect



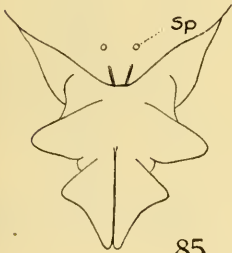
79



81



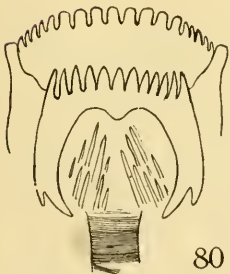
83



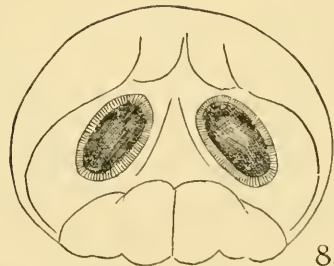
84



85



80

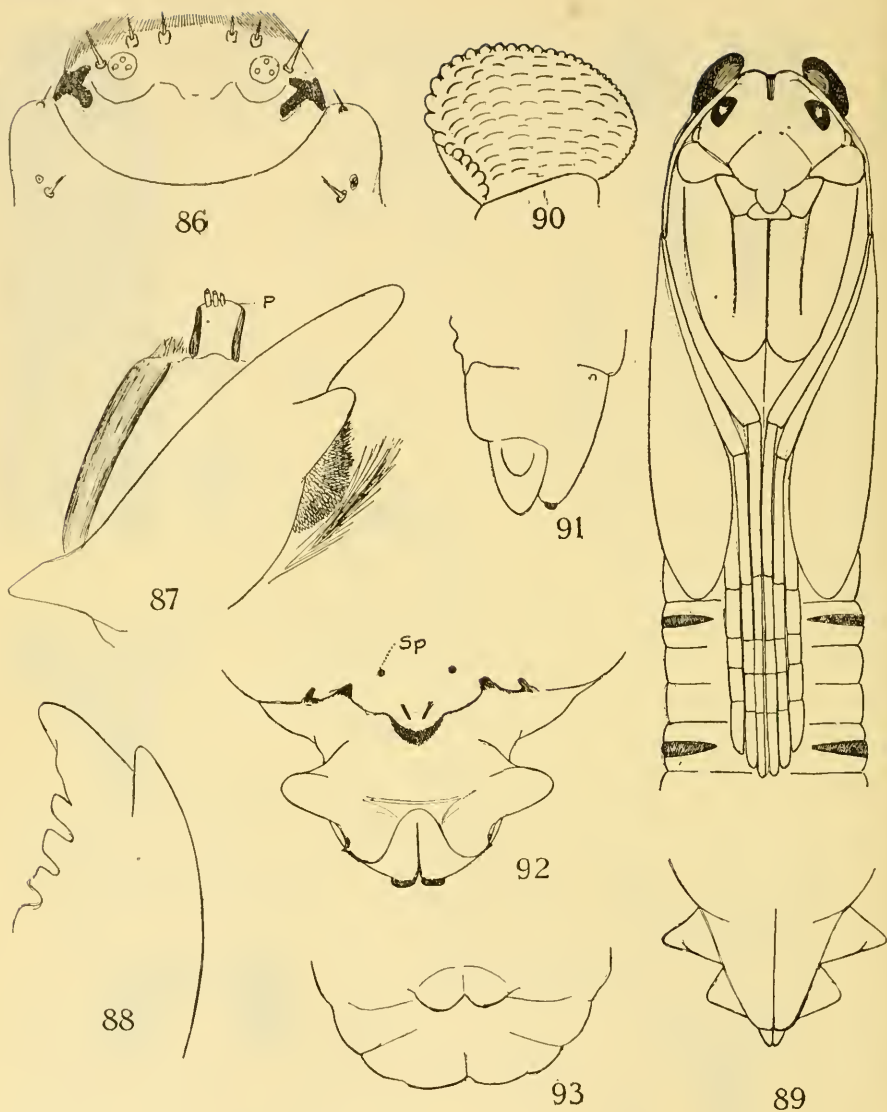


84

LIMNOBIA CINCTIPES

Larva: 79, head capsule, dorsal aspect; 80, hypopharynx; 81, mentum; 82, antenna; 83, spiracular disk

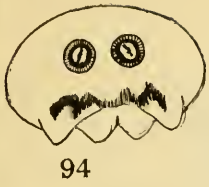
Pupa: 84, female, lateral aspect; 85, female cauda, dorsal aspect



## LIMNOBIA CINCTIPES

Larva: 86, labrum-epipharynx; 87, mandible and maxilla; 88, mandible; 93, spiracular disk, dorsal aspect

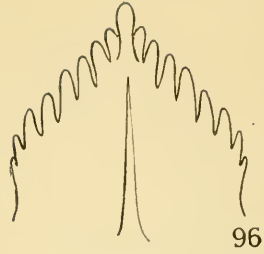
Pupa: 89, female, ventral aspect; 90, pronotal breathing horn, lateral aspect; 91, male cauda, lateral aspect; 92, male cauda, dorsal aspect



94



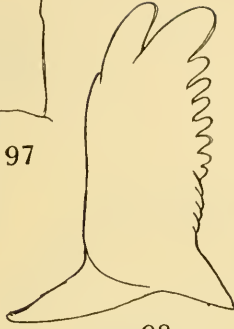
97



96



99



98



95



100



101



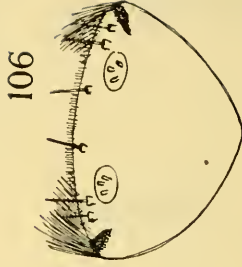
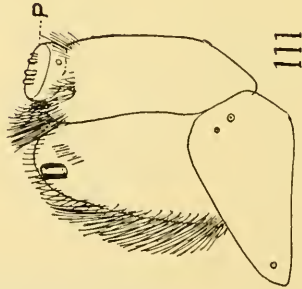
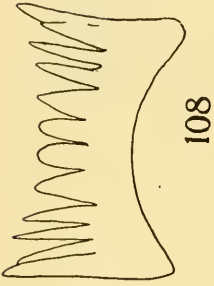
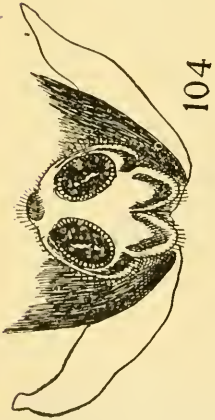
102



103

## LIMNOBIA TRIOCELLATA AND L. FALLAX

- Limnobia triozellata*: 94, spiracular disk  
*Limnobia fallax*, larva: 95, labrum-epipharynx; 96, mentum; 97, antenna; 98, mandible;  
 99, maxilla  
*Limnobia fallax*, pupa: 100, mouth parts; 101, pronotal breathing horn; 102, female  
 cauda, dorsal aspect; 103, female cauda, lateral aspect



DICRANOMYIA BADIA AND D. STULTA

*Dicranomyia badia*: 104, spiracular disk

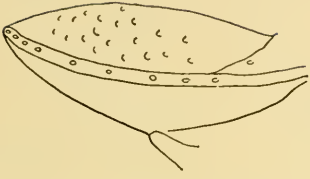
*Dicranomyia stulta*, larva: 105, spiracular disk; 106, labrum; 107, mentum; 108, hypopharynx; 109, antenna; 110, mandible; 111, maxilla



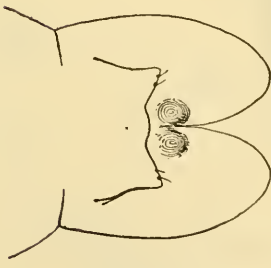
112



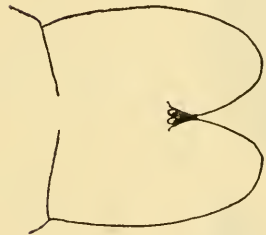
113



114



115



116



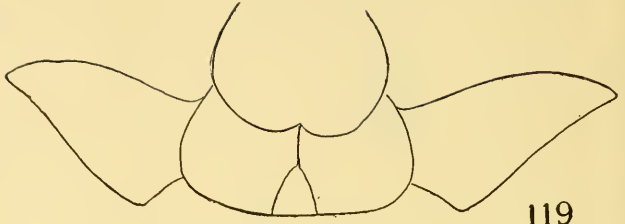
117

DICRANOMYIA STULTA, PUPA

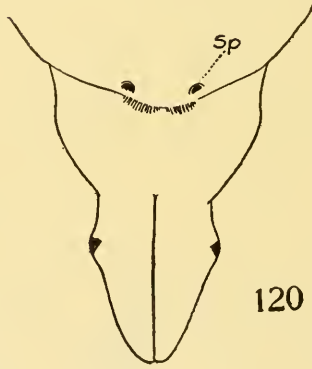
112, Mouth parts; 113, pronotal breathing horn, dorsal aspect; 114, pronotal breathing horn, lateral aspect; 115, male cauda, dorsal aspect; 116, male cauda, ventral aspect; 117, male cauda, lateral aspect



118



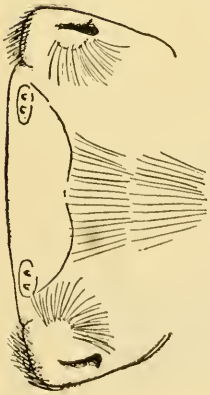
119



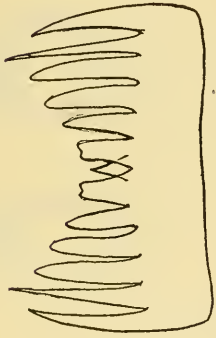
120

DICRANOMYIA BADIA, PUPA

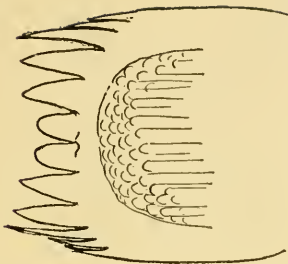
118, Lateral aspect; 119, mouth parts; 120, female cauda, dorsal aspect



121



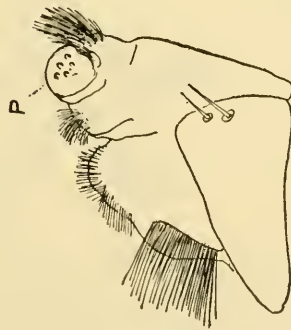
122



123



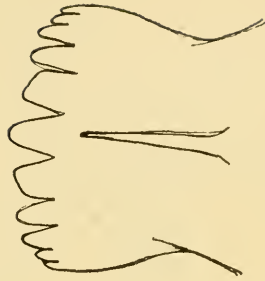
124



125



126

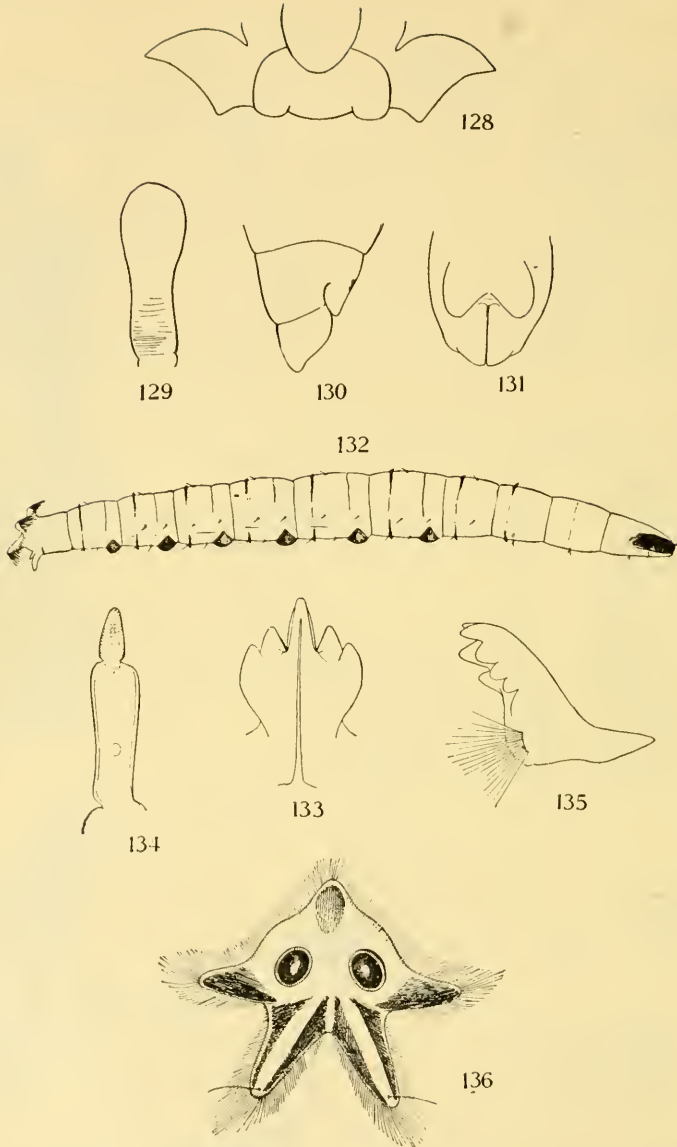


127

RHIPIDIA BRYANTI, LARVA

121, Labrum-epipharynx; 122, mentum; 123 and 124, hypopharynx; 125, antenna; 126, mandible; 127, maxilla



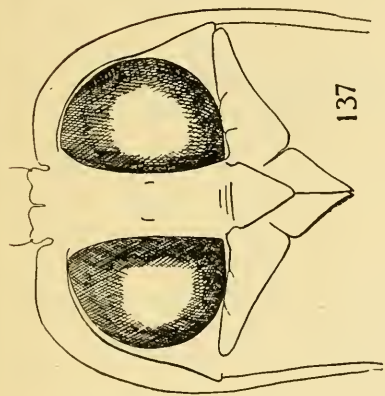


RHIPIDIA BRYANTI, RHAMPHIDIA MAINENSIS, AND RHAMPHIDIA FLAVIPES

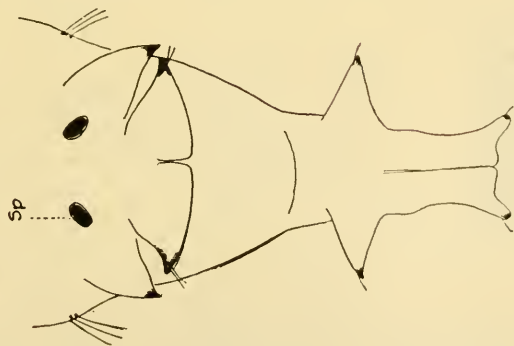
*Rhipidia bryanti*, pupa: 128, mouth parts; 129, pronotal breathing horn; 130, male cauda, lateral aspect; 131, male cauda, dorsal aspect

*Rhamphidia mainensis*, larva: 132, lateral aspect; 133, mentum; 134, mandible; 135, spiracular disk

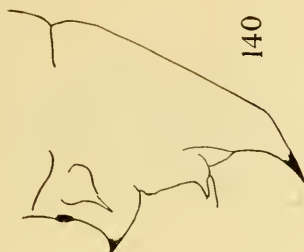
*Rhamphidia flavipes*, larva: 136, antenna



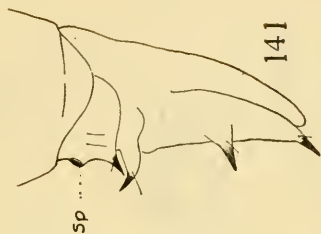
137



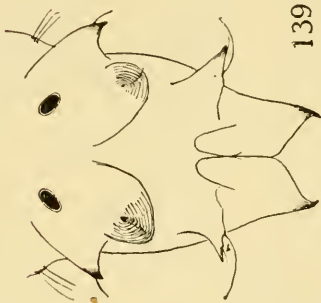
138



140



141



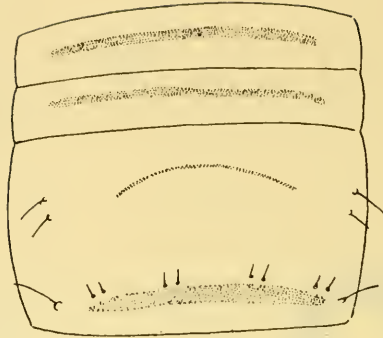
139

RHAMPHIDIA FLAVIPES, PUPA

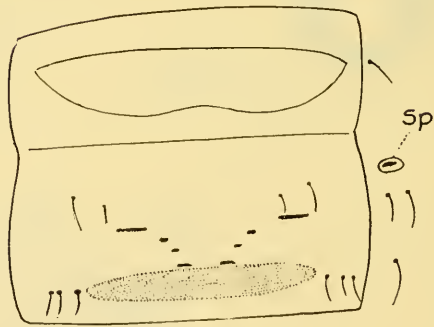
137, Head of male, ventral aspect; 138, female cauda, dorsal aspect; 139, male cauda, dorsal aspect; 140, male cauda, lateral aspect; 141, female cauda, lateral aspect



142



143

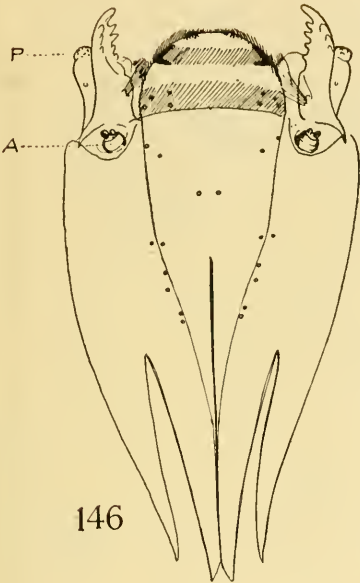
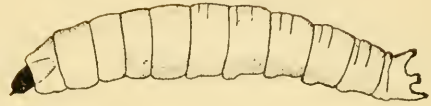


144

RHAMPHIDIA FLAVIPES, PUPA

142, Lateral aspect; 143, fifth abdominal segment, dorsal aspect (diagrammatic); 144, fifth abdominal segment, ventral aspect (diagrammatic)

145



146



150



151



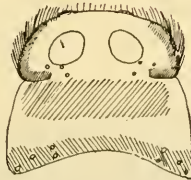
149



152



148



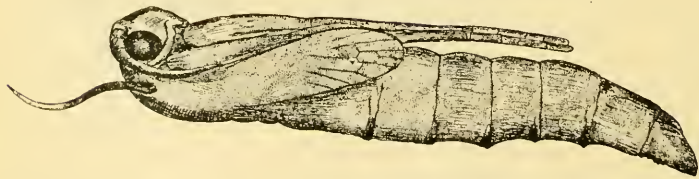
147



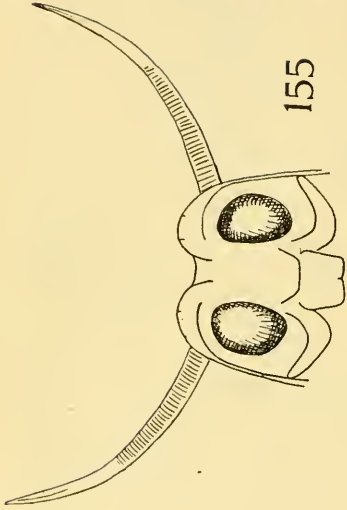
153

ULA ELEGANS, LARVA

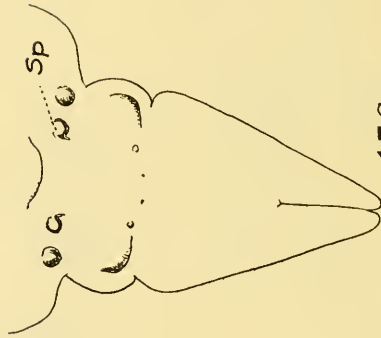
145, Lateral aspect; 146, head capsule, dorsal aspect; 147, labrum-epipharynx; 148, mentum; 149, antenna; 150, mandible, lateral aspect; 151, mandible, from inside; 152, maxilla; 153, spiracular disk



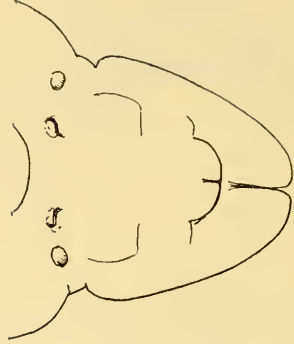
154



155



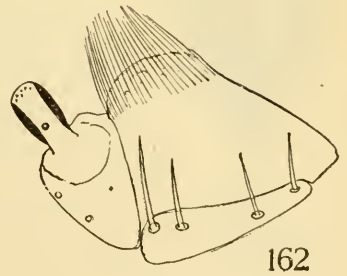
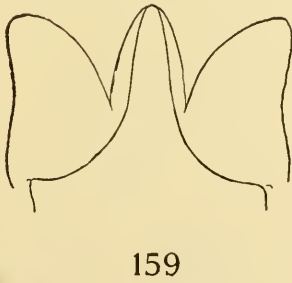
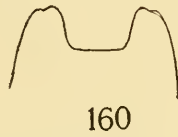
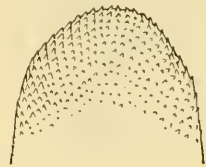
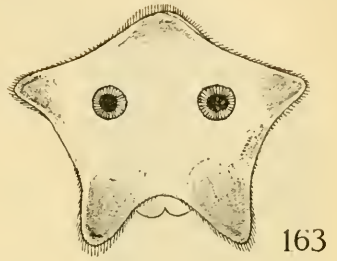
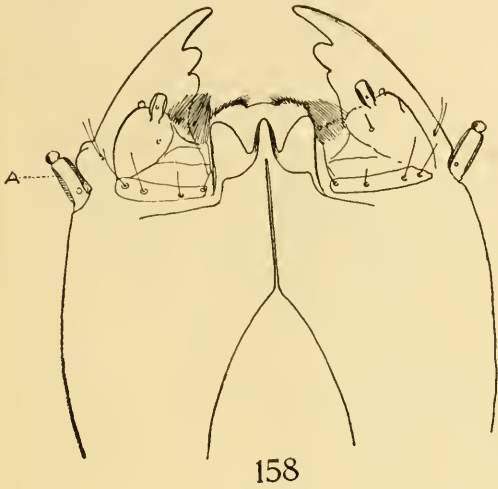
156



157

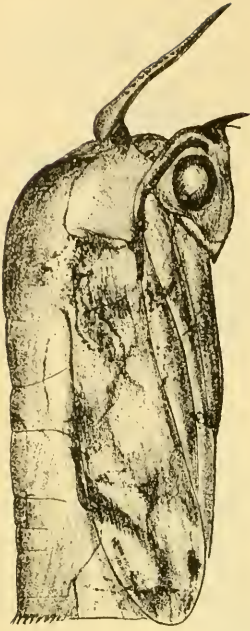
ULA ELEGANS, PUPA

154, Female, lateral aspect; 155, head, ventral aspect; 156, female cauda, dorsal aspect; 157, male cauda, dorsal aspect

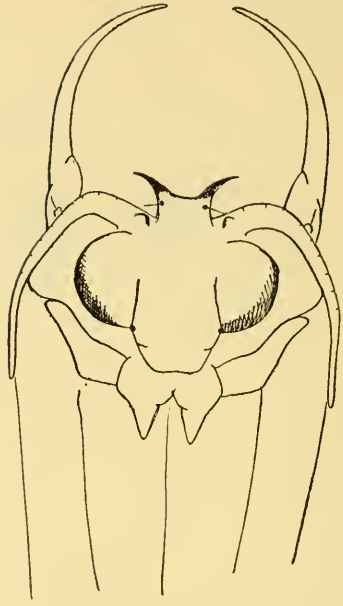


EPIPHRAGMA SOLATRIX, LARVA

158, Head capsule, ventral aspect; 159, mentum; 160, prementum; 161, hypopharynx; 162, maxilla; 163, spiracular disk



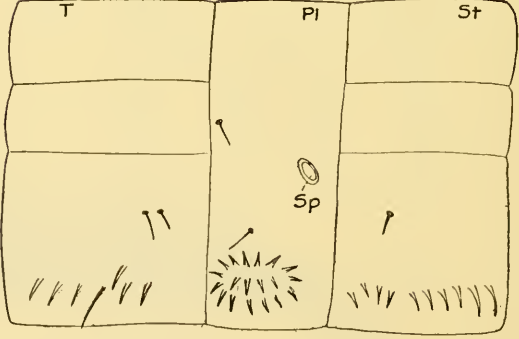
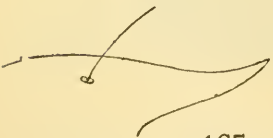
164



166



165

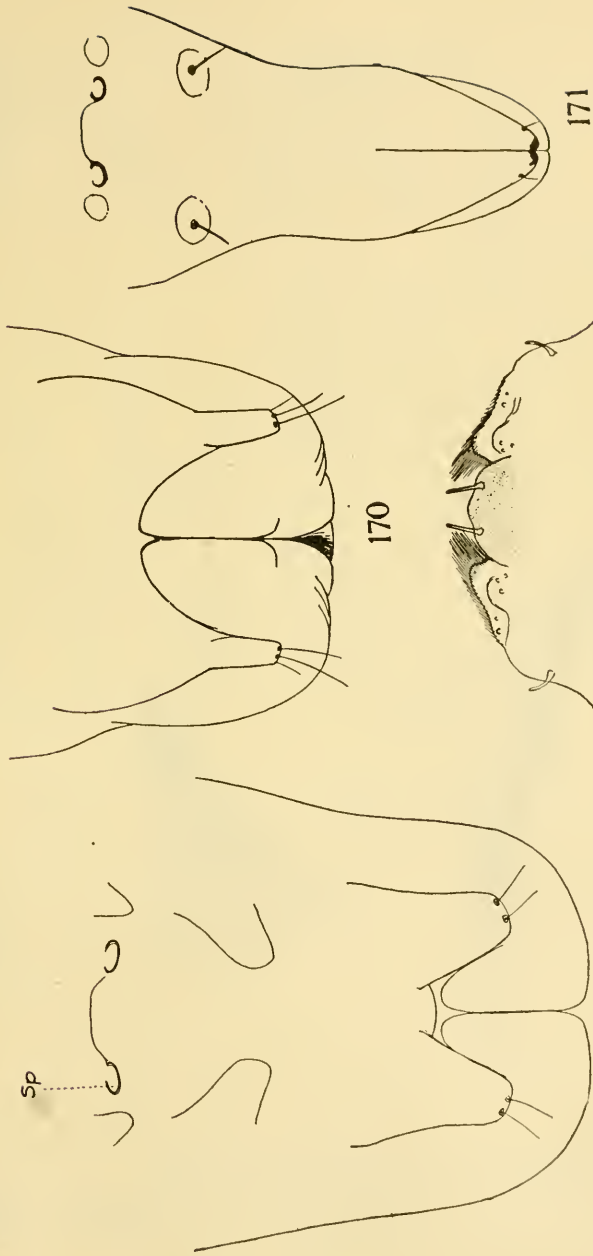


167

EPIPHRAGMA SOLATRIX AND E. FASCIPENNIS

*Epiphragma solatrix*, pupa: 164, lateral aspect; 166, head of male, ventral aspect; 167, fifth abdominal segment (diagrammatic)

*Epiphragma fascipennis*, pupa: 165, cephalic crest, lateral aspect



169

170

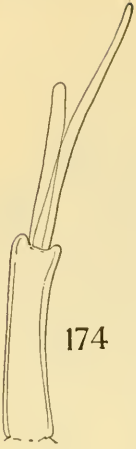
171

168

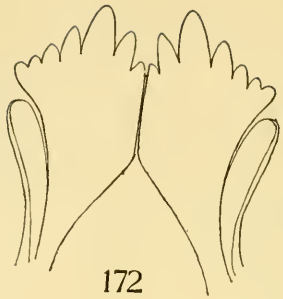
ΕΠΙΦΡΑΓΜΑ FASCIPENNIS AND E. SOLATRIX

*Epiphragma fascipennis*: 168, larva, labrum; 169, pupa, male cauda, dorsal aspect  
*Epiphragma solatrix*, pupa: 170, male cauda, dorsal aspect; 171, female cauda, dorsal aspect

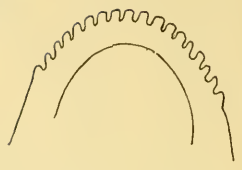




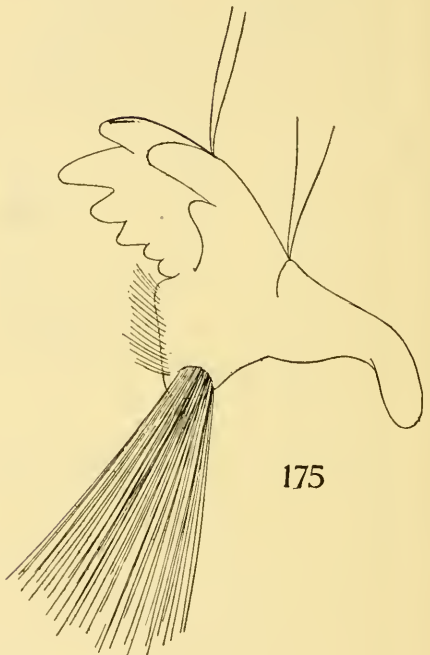
174



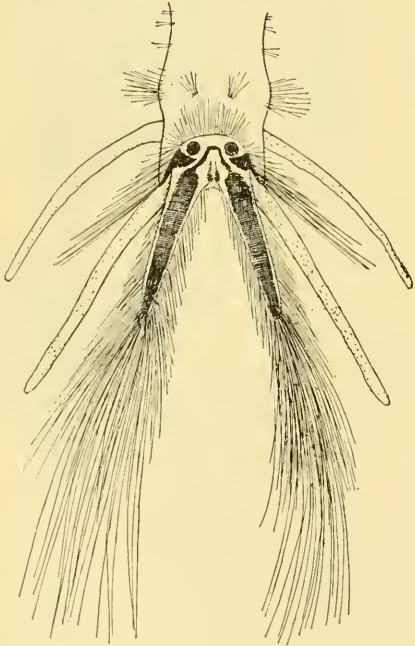
172



173



175

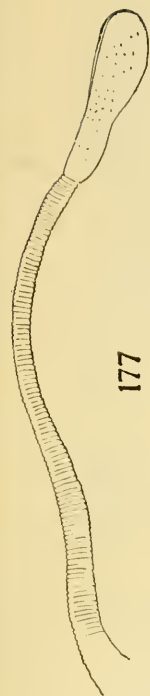


176

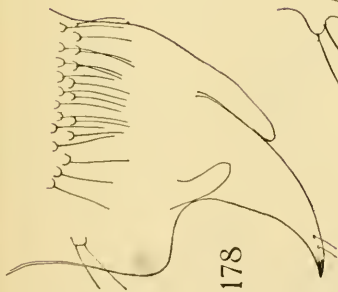
PSEUDOLIMNOPHILA LUTEIPENNIS AND P. INORNATA

*Pseudolimnophila luteipennis*, larva: 172, mentum; 173, hypopharynx; 175, mandible; 176, spiracular disk

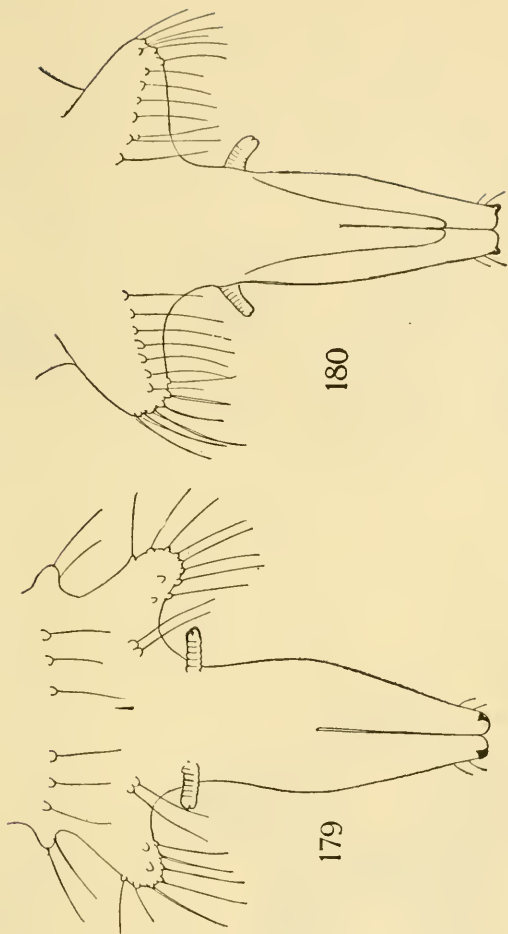
*Pseudolimnophila inornata*, larva: 174, antenna



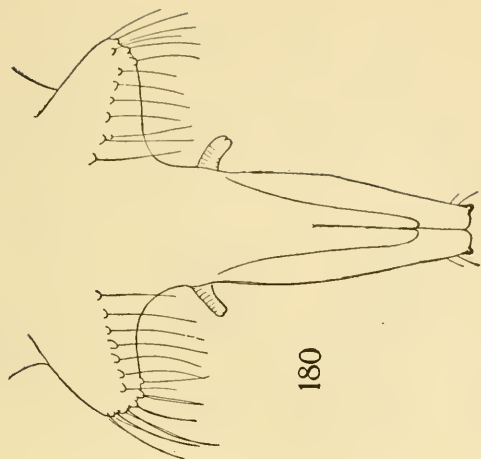
177



178



179



180

## PSEUDOLIMNOPHILA INORNATA AND P. LUTEIPENNIS

*Pseudolimnophila inornata*, pupa: 177, pronotal breathing horn*Pseudolimnophila luteipennis*, pupa: 178, male cauda, lateral aspect; 179, female cauda, dorsal aspect; 180, female cauda, ventral aspect



184



185



186



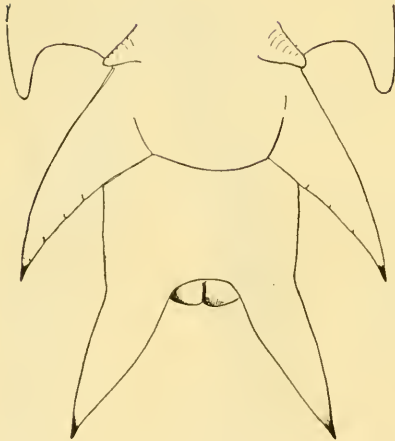
183



182



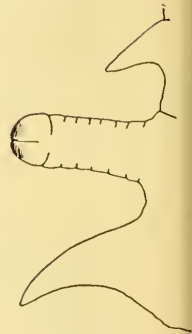
181



189



187



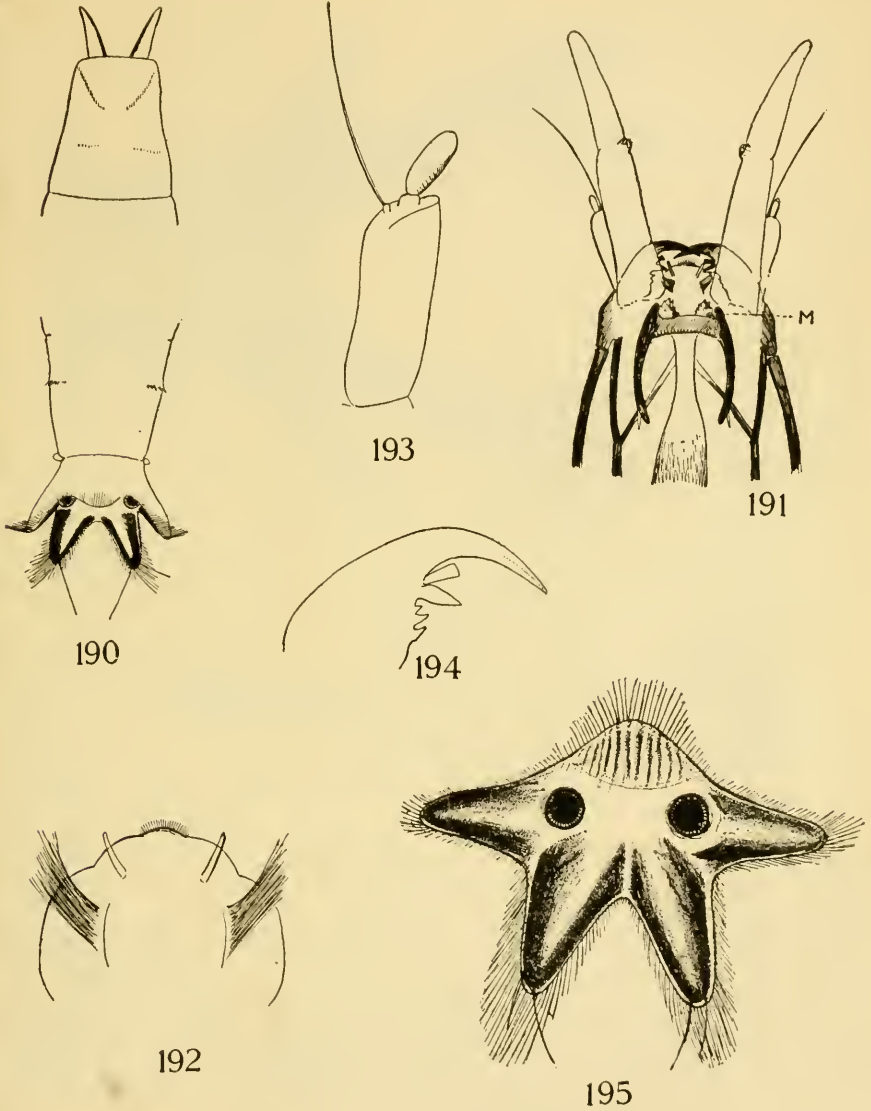
188

DACTYLOLABIS DENTICULATA, D. WODZICKII, AND D. CUBITALIS

*Dactylolabis denticulata* (after Mik): 181, pupa; 182, larva, head capsule, ventral aspect; 183, larva, dorsal aspect

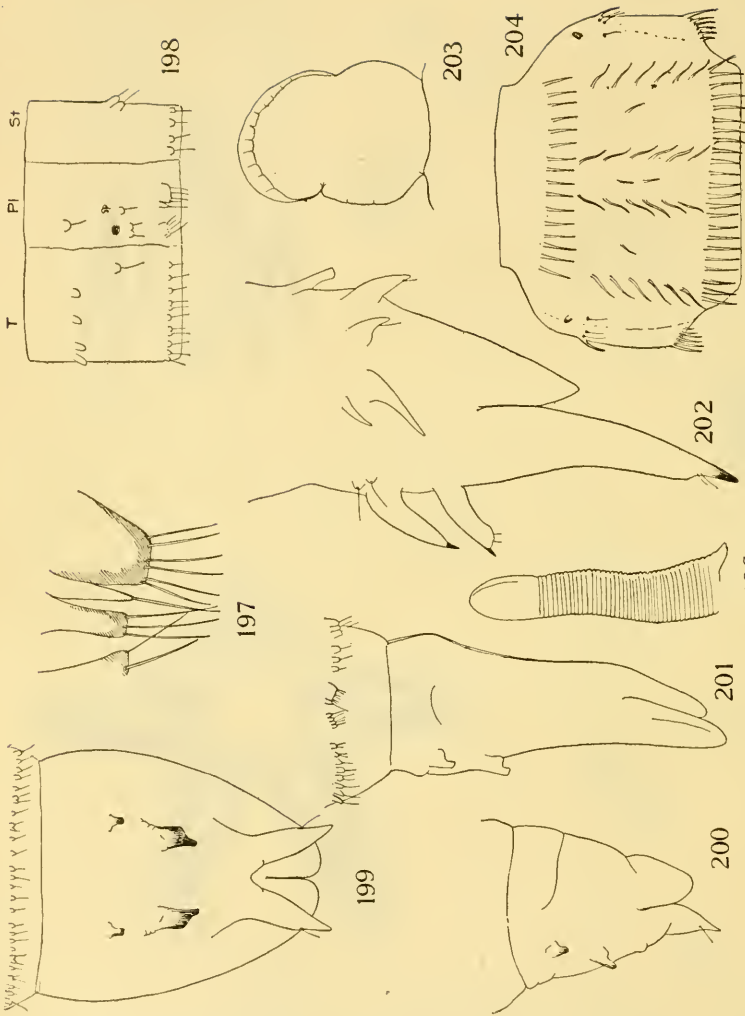
*Dactylolabis wodzickii* (after Nowicki): 184, pupa; 185, larva, head capsule; 186, larva, spiracular disk

*Dactylolabis cubitalis*, pupa: 187, pronotal breathing horn; 188, second abdominal segment, showing spiracle; 189, male cauda, dorsal aspect



LIMNOPHILA (DICRANOPHRAGMA) FUSCOVARIA, LARVA

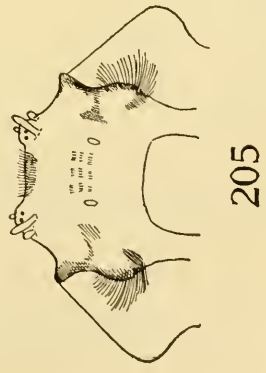
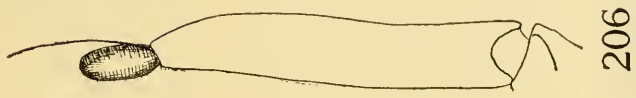
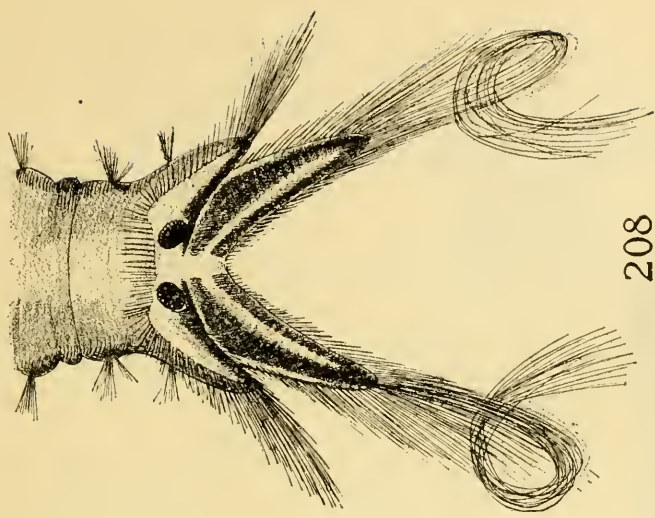
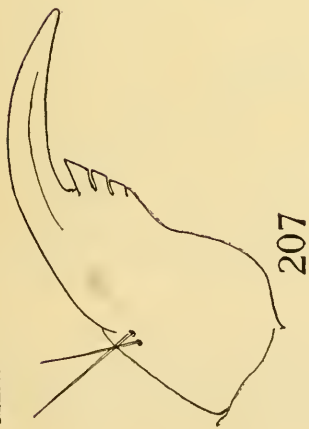
190, Cephalic and caudal ends, dorsal aspect; 191, head capsule, ventral aspect; 192, labrum epipharynx; 193, antenna; 194, mandible; 195, spiracular disk



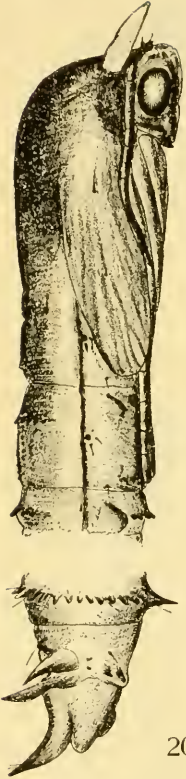
LIMNOPHILA (DICRANOPHRAGMA) FUSCOVARIA AND LIMNOPHILA (PHYLIDOREA) ADUSTA, SUPPOSITION

*Limnophila* (*Dicranophragma*) *fuscovaria*, pupa: 196, pronotal breathing horn; 197, pleural abdominal spines; 198, fifth abdominal segment (diagrammatic); 199, male cauda, dorsal aspect; 200, male cauda, lateral aspect; 201, female cauda, lateral aspect

*Limnophila* (*Phylidorea*) *adusta* (supp.), pupa: 202, female cauda, lateral aspect; 203, pronotal breathing horn; 204, fifth abdominal segment, ventral aspect



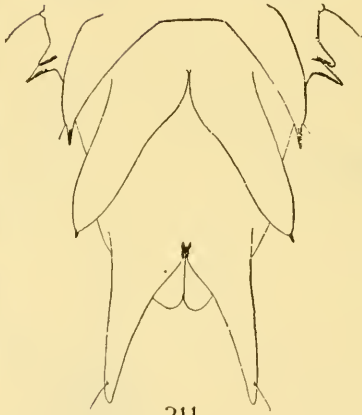
LIMNOPHILA (LASIOMASTIX) MACROCERA, LARVA  
 205, Labrum; 206, mandible; 207, antenna; 208, spiracular disk, dorsal aspect



209



210



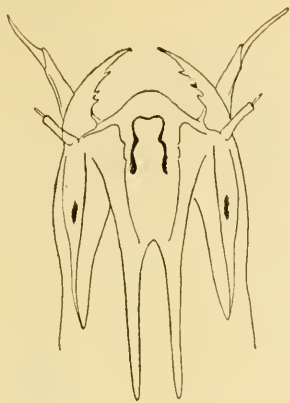
211



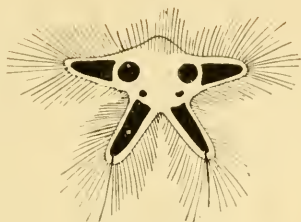
212

LIMNOPHILA (LASIOMASTIX) MACROCERA, PUPA

209, Male, lateral aspect; 210, mouth parts; 211, male cauda, dorsal aspect; 212, female cauda, lateral aspect



213



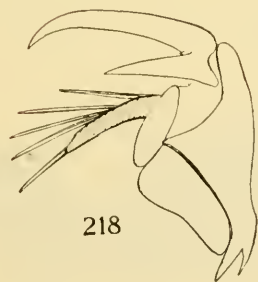
214



.215



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218



217



219

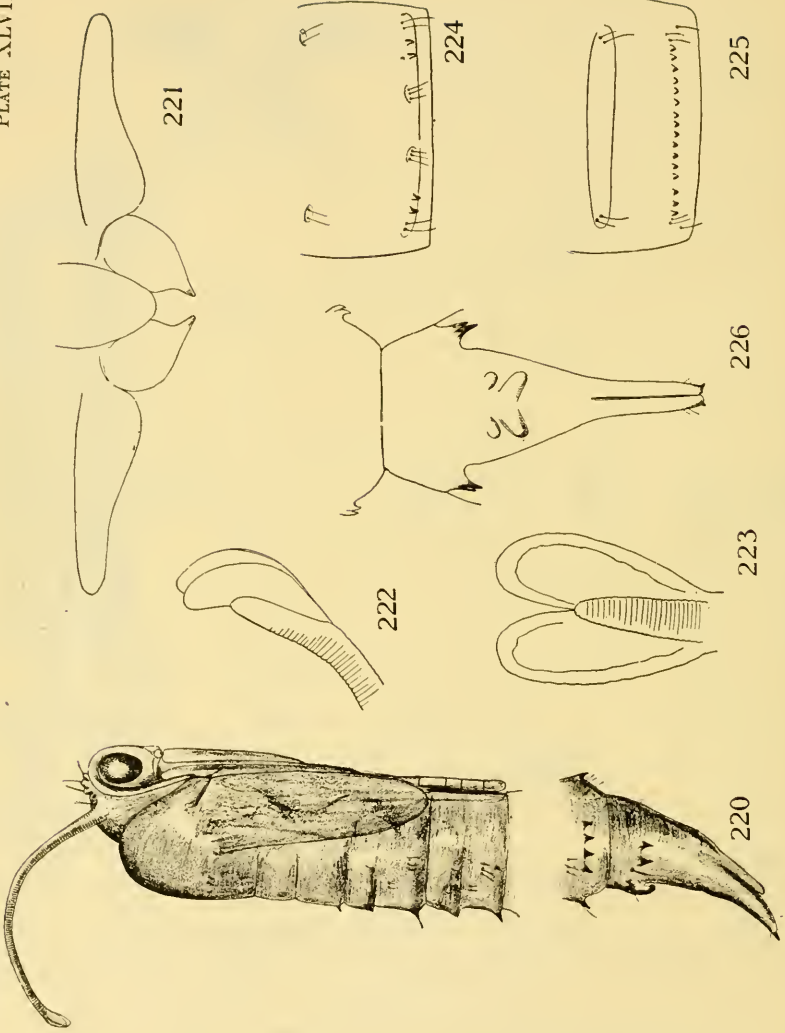
LIMNOPHILA PICTIPENNIS, L. PUNCTATA, AND ULOMORPHA PILOSELLA

*Limnophila pictipennis*: 213, head capsule (after Brauer)

*Limnophila punctata*: 214, spiracular disk (after Gerbig)

*Ulomorpha pilosella*, larva: 215, head capsule, dorsal aspect; 216, labrum; 217, antenna; 218, mandible; 219, spiracular disk, dorsal aspect





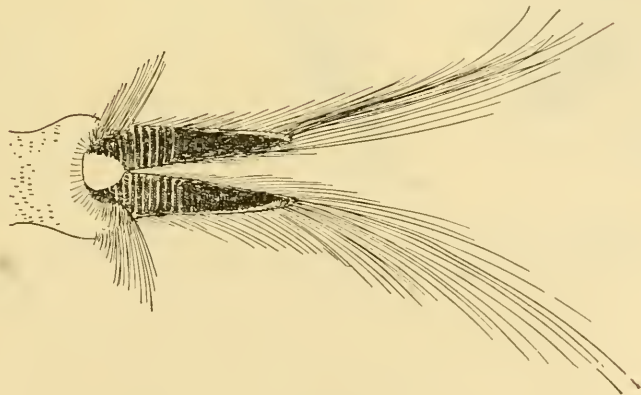
ULOMORPHA PILOSELLA, PUPA

220, Female, lateral aspect; 221, mouth parts; 222, apex of breathing horn, viewed from beneath; 223, fifth abdominal segment, dorsal aspect; 224, fifth abdominal segment, dorsal aspect; 225, fifth abdominal segment, ventral aspect; 226, female cauda, dorsal aspect

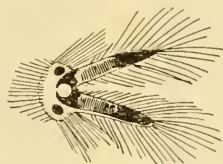
227



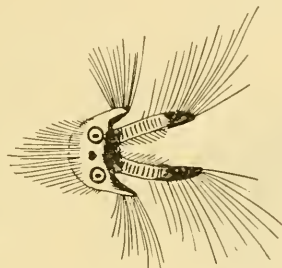
228



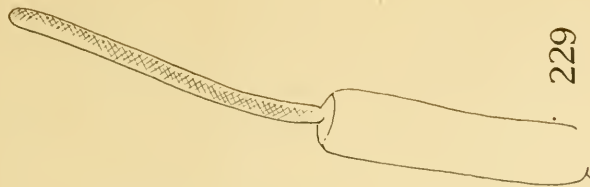
231



232



229



230

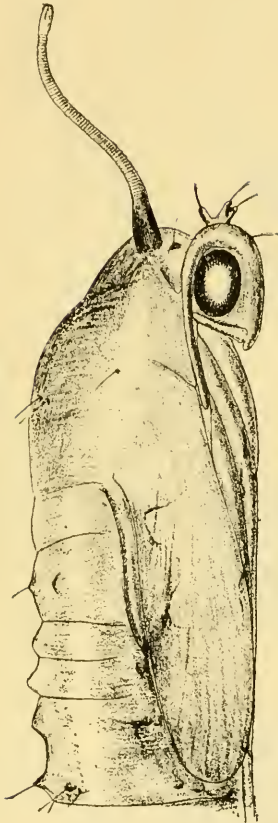
PILARIA RECONDITA, P. TENUIPES, P. FUSCIPENNIS, AND P. DISCICOLLIS

*Pilaria recondita*, larva: 227, tip of mandible

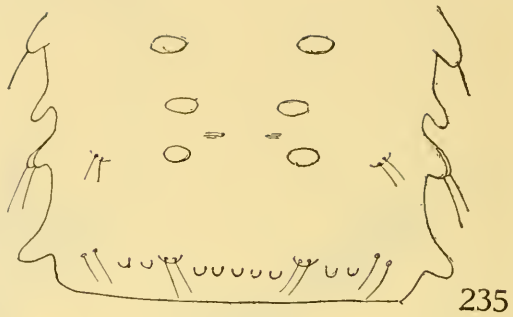
*Pilaria tenuipes*, larva: 228, tip of mandible; 229, antenna; 230, spiracular disk, dorsal aspect

*Pilaria fuscipennis*: 231, spiracular disk (after Gerbig)

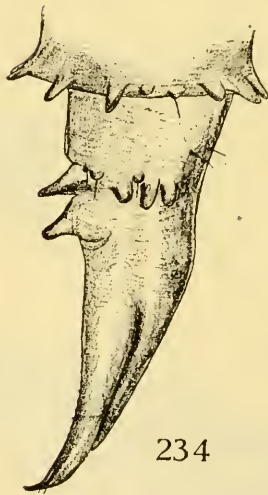
*Pilaria discicollis*: 232, spiracular disk (after Gerbig)



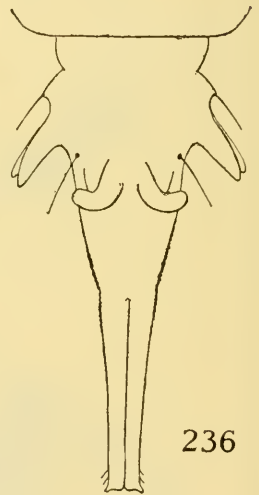
233



235



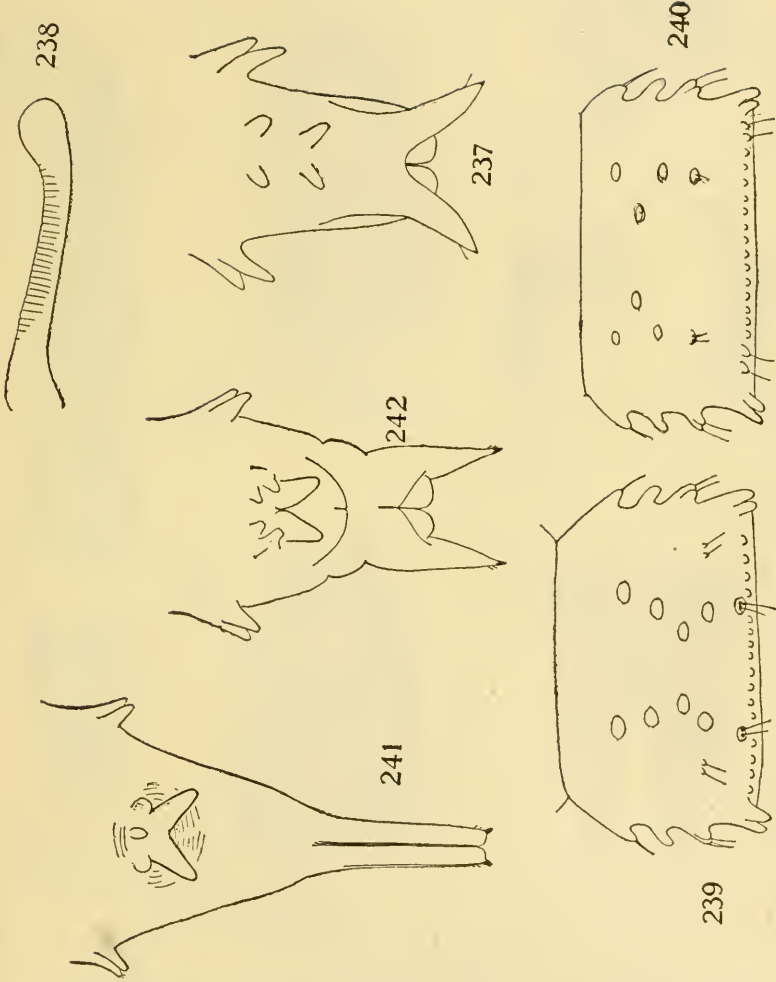
234



236

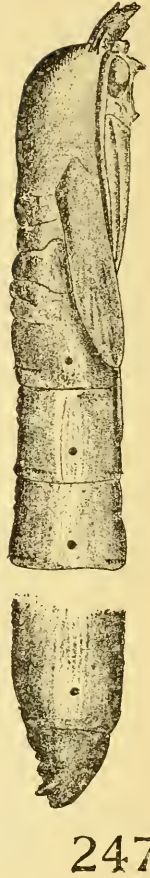
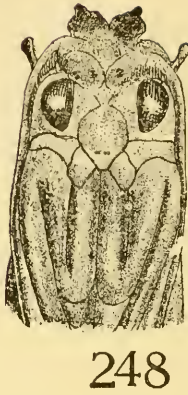
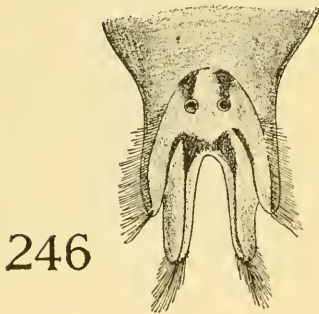
*PILARIA TENUIPES*, PUPA

233, Female, lateral aspect; 234, female cauda, lateral aspect; 235, fifth abdominal segment, dorsal aspect; 236, female cauda, dorsal aspect



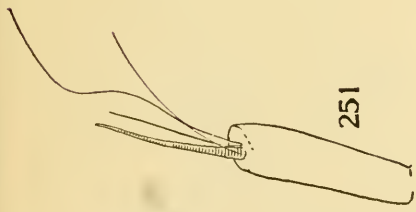
PILARIA RECONDITA AND P. QUADRATA

*Pilaria recondita*, pupa: 237, male cauda, dorsal aspect  
*Pilaria quadrata*, pupa: 238, pronotal breathing horn; 239, fifth abdominal segment, dorsal aspect;  
 240, fifth abdominal segment, dorsal aspect; 241, female cauda, dorsal aspect; 242, male cauda, dorsal aspect.

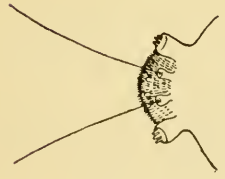


HEXATOMA MEGACERA

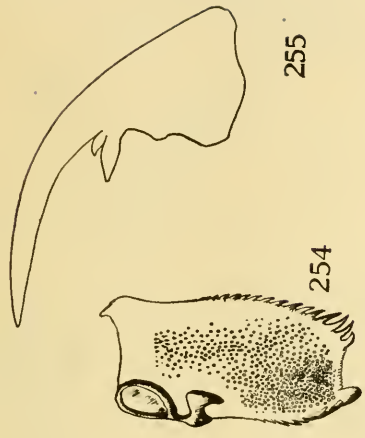
Larva: 243, labrum; 244, antenna; 245, mandible; 246, spiracular disk  
Pupa: 247, lateral aspect; 248, male, ventral aspect; 249, female, ventral aspect



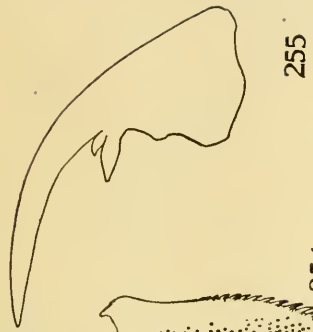
251



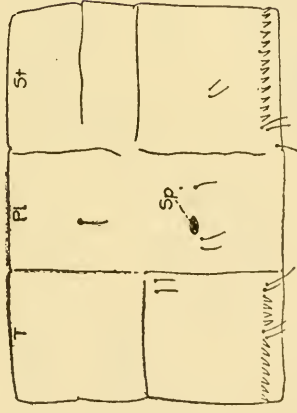
250



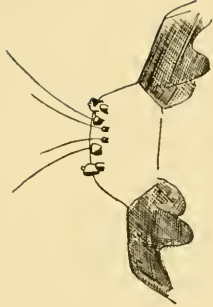
254



255



252

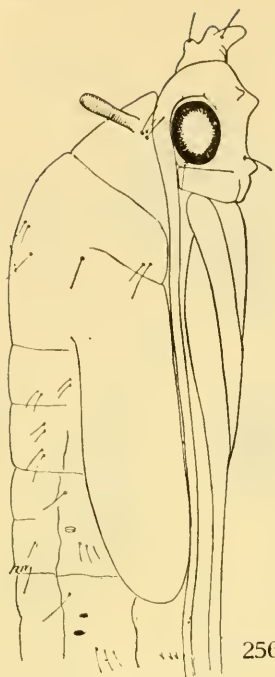


253

HEXATOMA MEGACERA AND ERIOCERA CINEREA

*Hexatoma megacera*: 250, larva, apex of labrum; 251, larva, antenna; 252, pupa, fifth abdominal segment, lateral aspect

*Eriocera cinerea*, larva: 253, labrum; 254, pharyngeal plate; 255, mandible



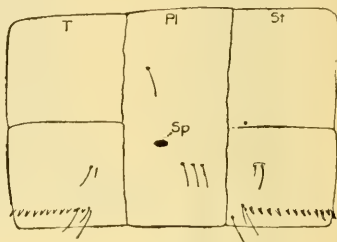
256



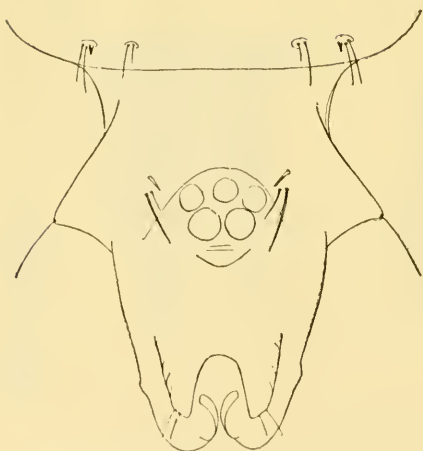
257



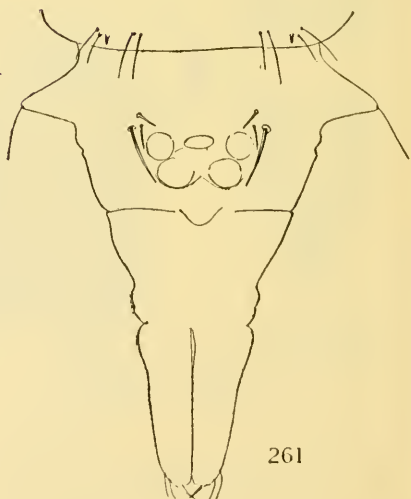
258



259



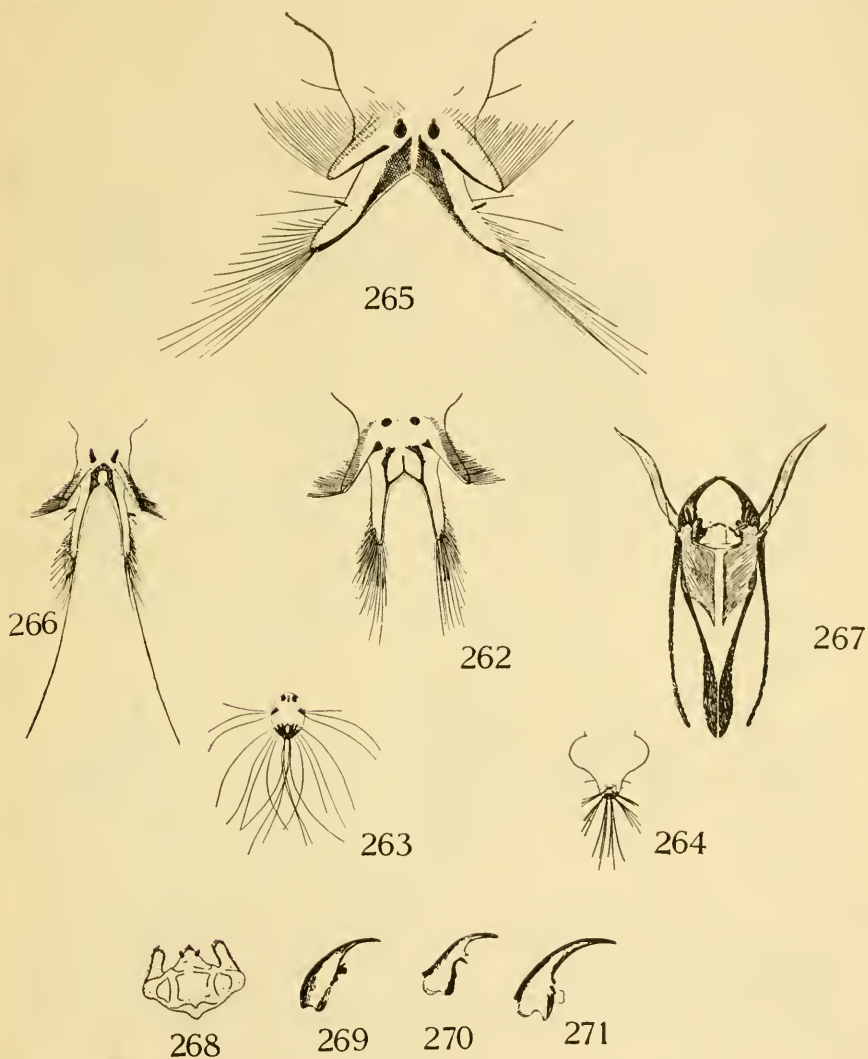
260



261

## ERIOCERA CINEREA, PUPA

256, Male, lateral aspect; 257, cephalic crest of male, ventral aspect; 258, mouth parts; 259, fifth abdominal segment, lateral aspect; 260, male cauda, dorsal aspect; 261, female cauda, dorsal aspect



ERIOCERA SPINOSA, E. CINEREA, E. LONGICORNIS, AND E. FULTONENSIS

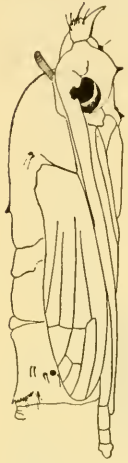
*Eriocera spinosa*, larva: 262, spiracular disk; 267, head capsule, dorsal aspect; 271, mandible

*Eriocera cinerea*, larva: 263 and 264, spiracular disk; 270, mandible

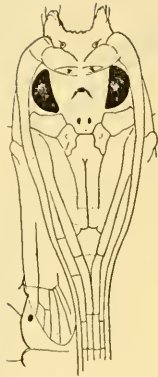
*Eriocera longicornis*, larva: 265, spiracular disk

*Eriocera fultonensis*, larva: 266, spiracular disk; 268, labrum; 269, mandible





272



273



277



278



274



275



276



281



279



282



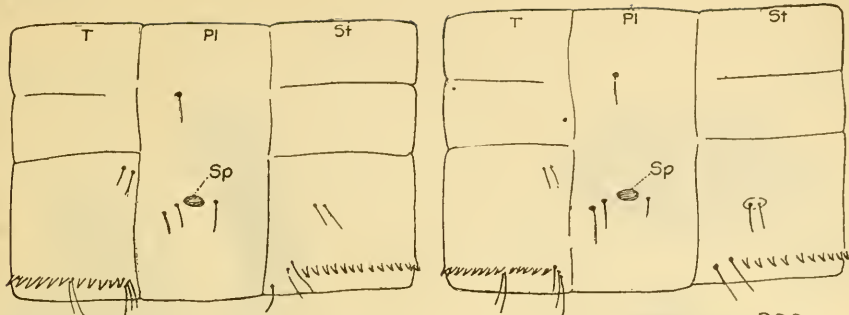
280

## ERIOCERA LONGICORNIS, E. FULTONENSIS, AND E. SPINOSA

*Eriocera longicornis*, pupa: 272, male, lateral aspect; 273, male, ventral aspect; 274, female cauda, lateral aspect; 275, head of male, ventral aspect; 277, thorax of male, dorsal aspect; 278, female, lateral aspect

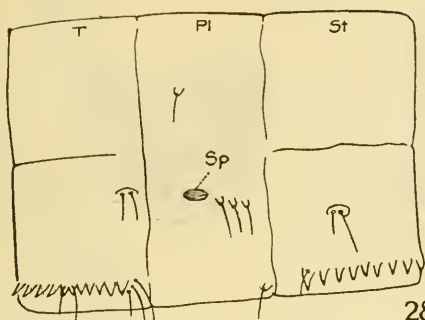
*Eriocera fultonensis*, pupa: 276, female cauda, lateral aspect; 279, female, lateral aspect

*Eriocera spinosa*, pupa: 280, female, lateral aspect; 281, male cauda, dorsal aspect; 282, male cauda, ventral aspect

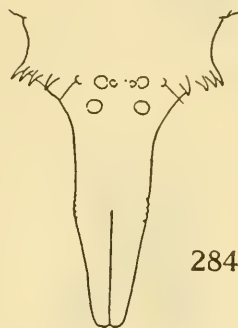


285

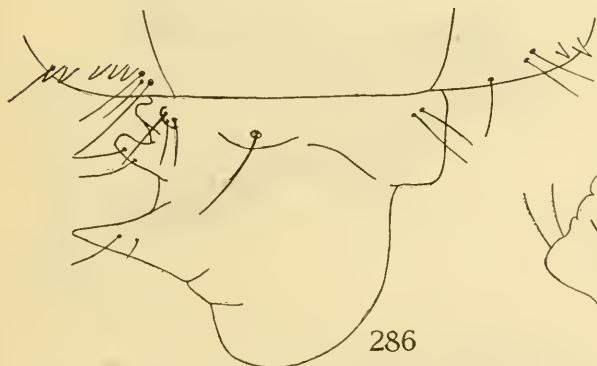
288



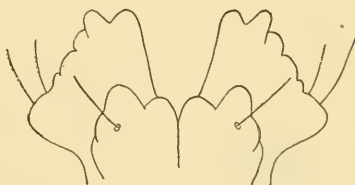
283



284



286



287

## ERICERA SPINOSA, E. LONGICORNIS, AND E. FULTONENSIS

*Eriocera spinosa*, pupa: 283, fifth abdominal segment, lateral aspect (diagrammatic); 284, female cauda, dorsal aspect

*Eriocera longicornis*, pupa: 285, fifth abdominal segment, lateral aspect (diagrammatic); 286, male cauda, lateral aspect

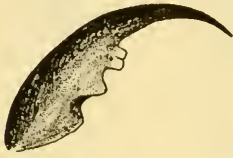
*Eriocera fultonensis*, pupa: 287, cephalic crest of male, ventral aspect; 288, fifth abdominal segment, lateral aspect (diagrammatic)



289



294



291



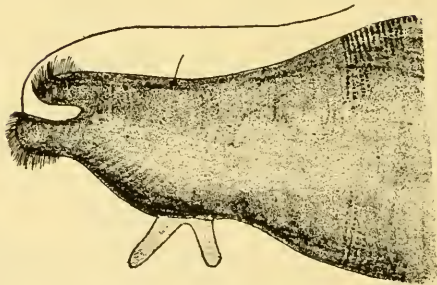
290



295



292

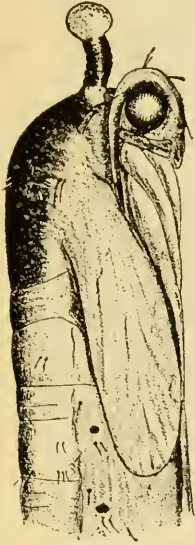


293

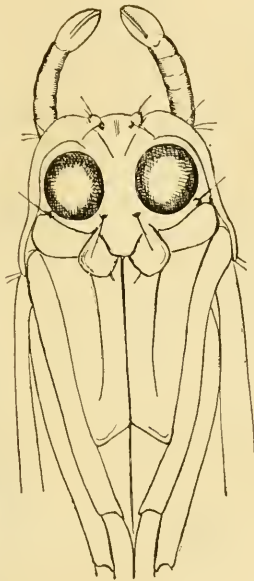
PENTHOPTERA ALBITARSIS

Larva: 289, labrum; 290, antenna; 291, mandible; 292, spiracular disk, dorsal aspect; 293, spiracular disk, lateral aspect

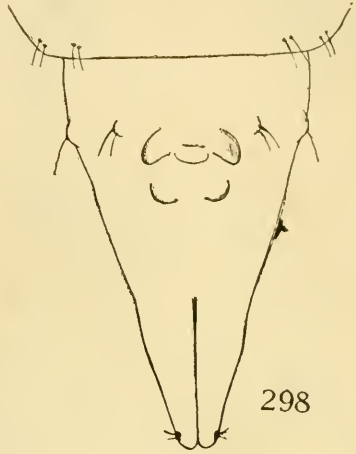
Pupa: 294, pronotal breathing horn; 295, male cauda, lateral aspect



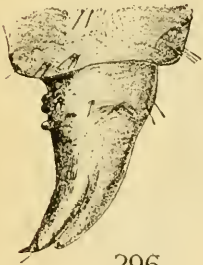
296



297



298



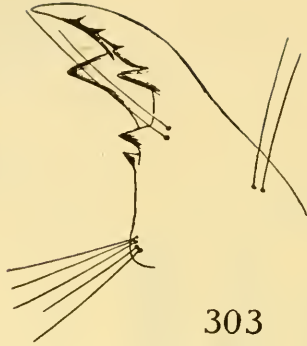
299

PENTOPTERA ALBITARSIS, PUPA

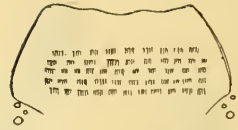
296, Female, lateral aspect; 297, female, ventral aspect; 298, female cauda, dorsal aspect; 299, male cauda, lateral aspect



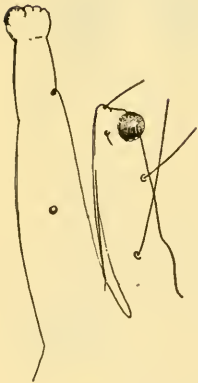
301



303



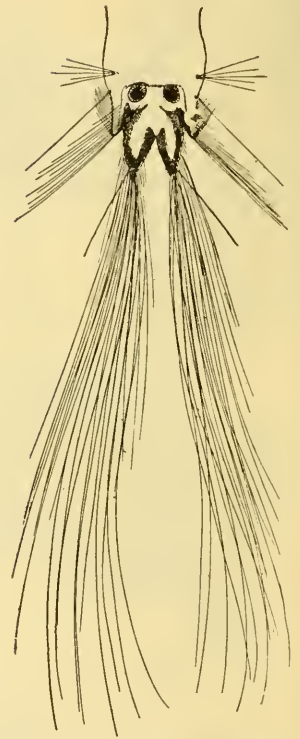
300



304



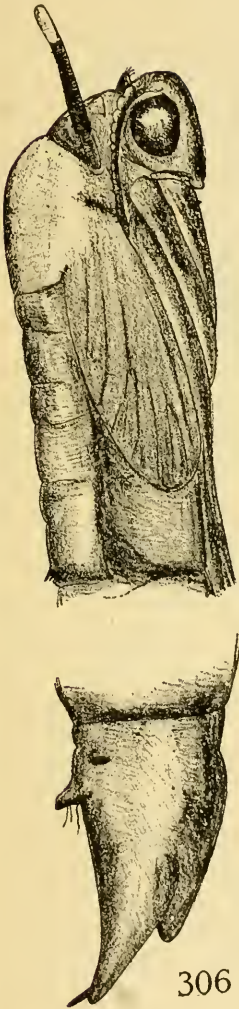
302



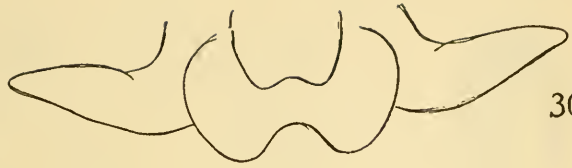
305

ADELPHOMYIA MINUTA (SUPPOSITION), LARVA

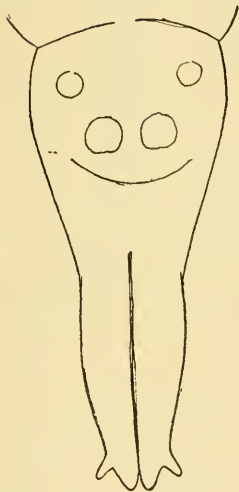
300, Labrum; 301, antenna; 302, mentum; 303, mandible; 304, maxilla; 305, spiracular disk



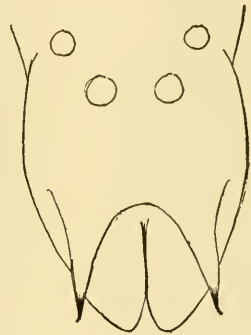
306



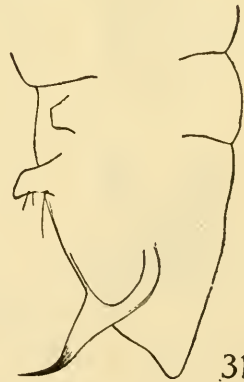
307



308



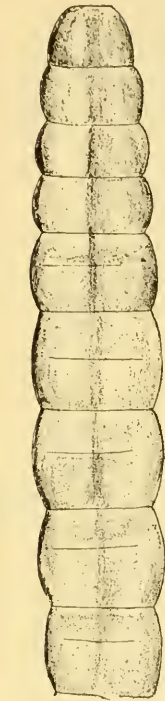
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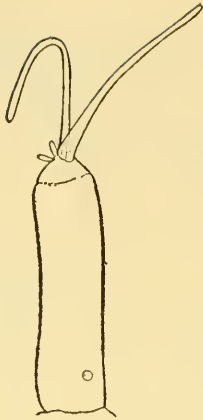
310

ADELPHOMYIA MINUTA (SUPPOSITION), PUPA

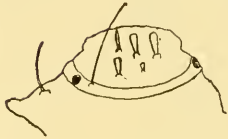
306, Female, lateral aspect; 307, mouth parts; 308, female cauda, dorsal aspect; 309, male cauda, dorsal aspect; 310, male cauda, lateral aspect



311



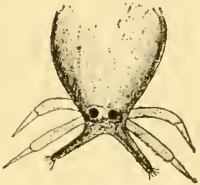
313



314



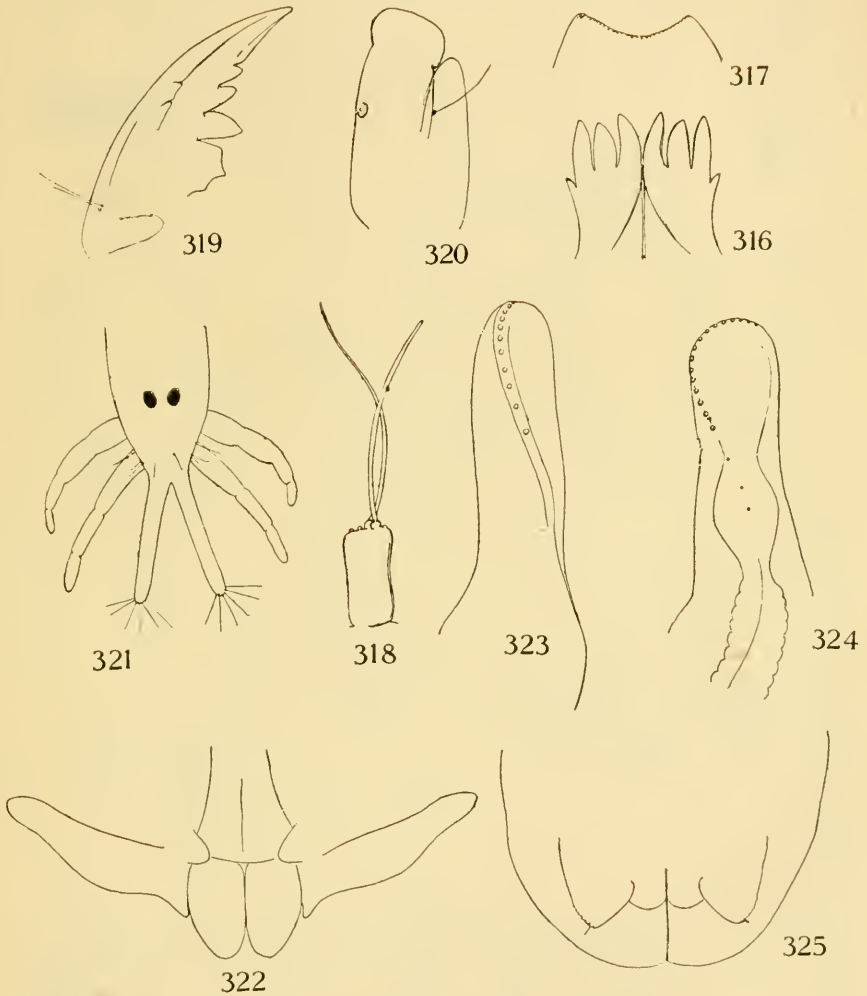
312



315

PEDICIA ALBIVITTA, LARVA

311, Dorsal aspect; 312, head capsule, ventral aspect; 313, antenna; 314, maxillary palpus; 315, anal gills, ventral aspect

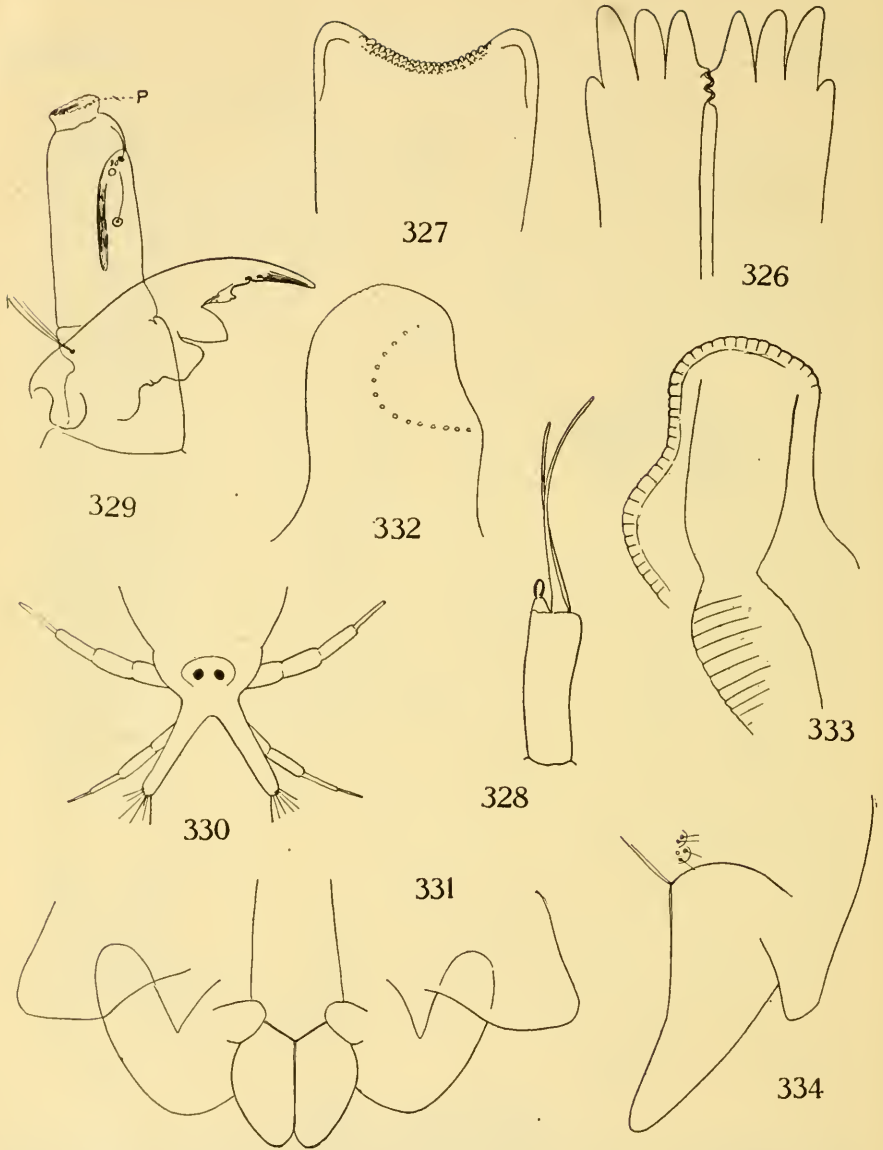


## RHAPHIDOLABINA FLAVEOLA

Larva: 316, mentum; 317, hypopharynx; 318, antenna; 319, mandible; 320, maxilla; 321, spiracular disk

Pupa: 322, mouth parts; 323, pronotal breathing horn, dorsal aspect; 324, pronotal breathing horn, lateral aspect; 325, male cauda, dorsal aspect

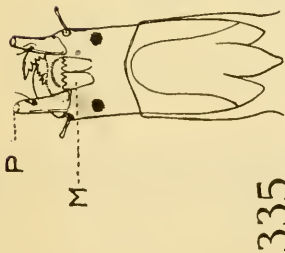




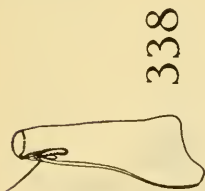
TRICYPHONA INCONSTANS

Larva: 326, mentum; 327, hypopharynx; 328, antenna; 329, mandible and maxilla; 330, spiracular disk

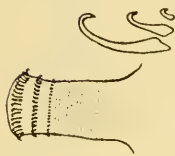
Pupa: 331, mouth parts; 332, pronotal breathing horn, dorsal aspect; 333, pronotal breathing horn, lateral aspect; 334, female cauda, lateral aspect



335



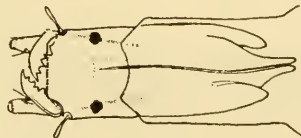
338



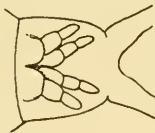
339



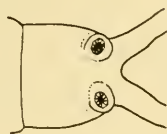
337



336



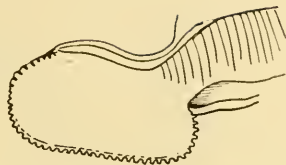
340



341



342

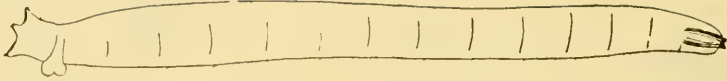


343

## DICRANOTA BIMACULATA (AFTER MIALL)

Larva: 335, head capsule, ventral aspect; 336, head capsule, dorsal aspect; 337, mandible; 338, maxillary palpus; 339, abdominal pseudopods; 340, spiracular disk, dorsal aspect; 341, anal gills

Pupa: 342, female, lateral aspect; 343, pronotal breathing horn



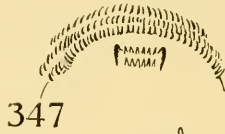
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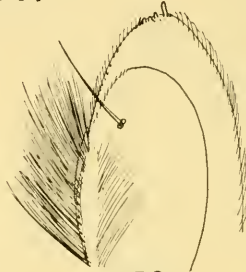
345



348



347



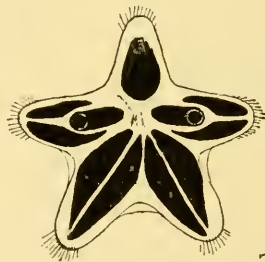
350



349



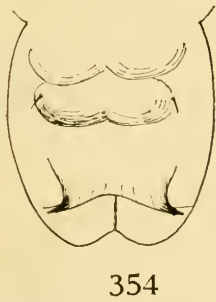
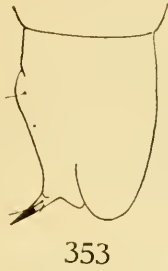
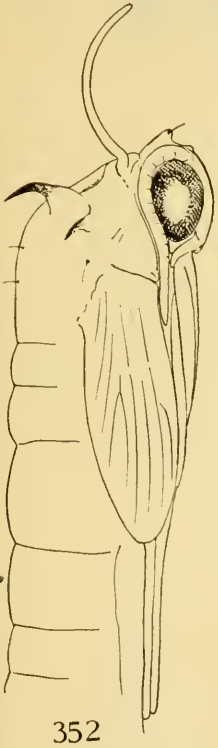
346



351

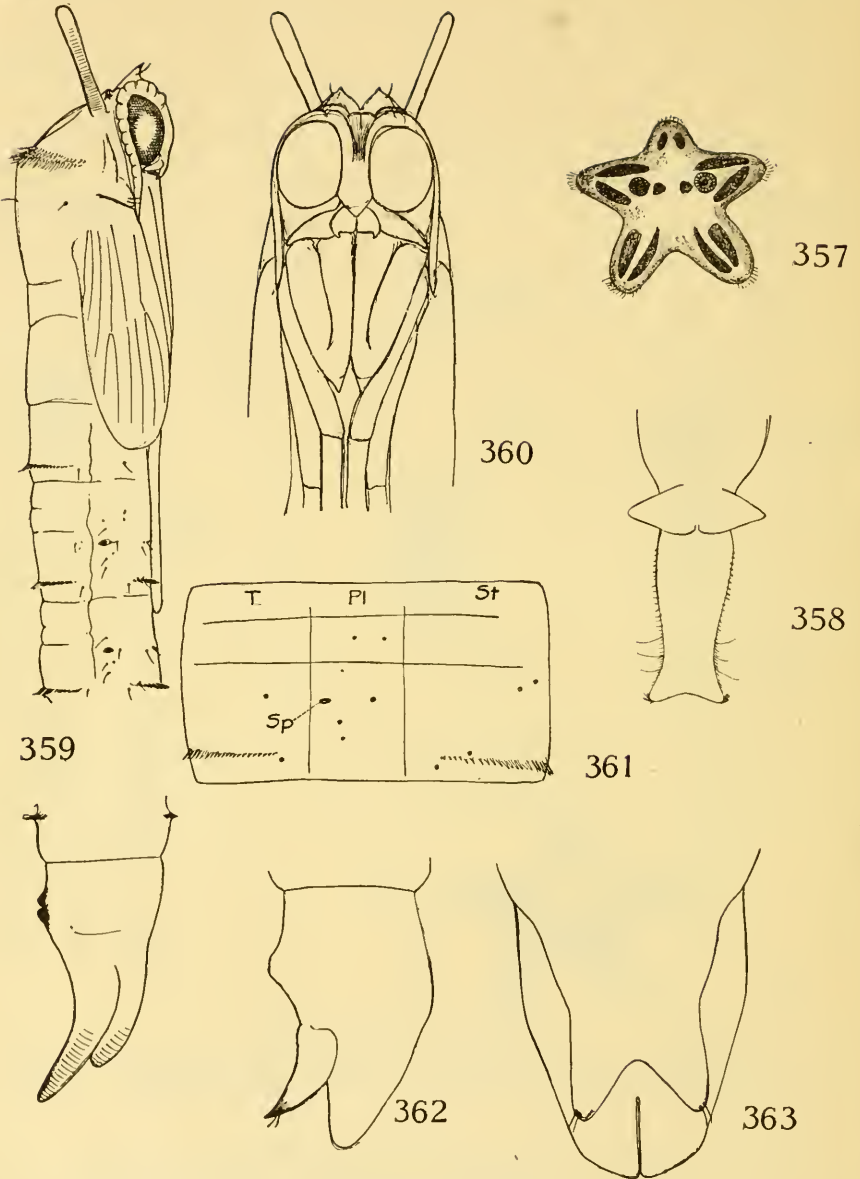
MOLOPHILUS HIRTIPENNIS, LARVA

344, Lateral aspect; 345, head capsule, ventral aspect; 346, mental plate; 347, hypopharynx; 348, antenna; 349, mandible; 350, maxilla; 351, spiracular disk



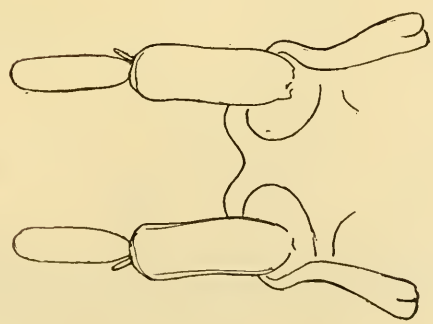
MOLOPHILUS HIRTIPENNIS, PUPA

352, Female, lateral aspect; 353, male cauda, lateral aspect; 354, male cauda, dorsal aspect;  
355, female cauda, lateral aspect; 356, female cauda, dorsal aspect

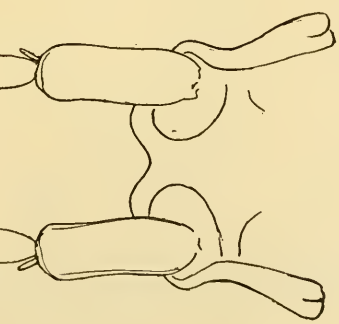


## ERIOPTERA MEGOPHTHALMA

Larva: 357, spiracular disk; 358, anal gills, ventral aspect  
 Pupa: 359, female, lateral aspect; 360, female, ventral aspect; 361, fifth abdominal segment, lateral aspect (diagrammatic); 362, male cauda, lateral aspect; 363, male cauda, dorsal aspect



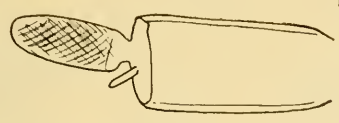
364



365



366



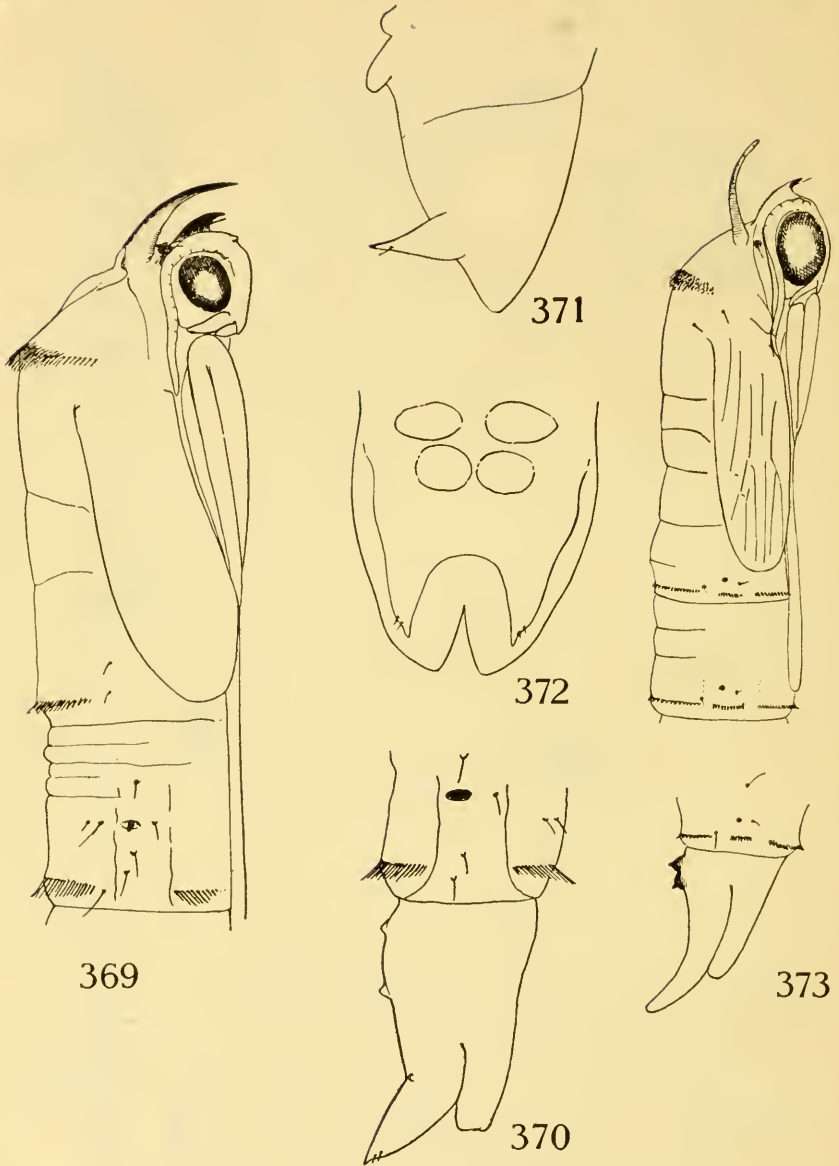
367



368

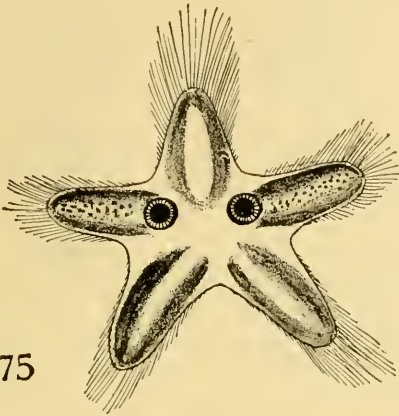
ERIOPTERA CHLOROPHYLLA, LARVA

364, Head capsule, showing bases of antennae; 365, mental bar; 366, aberration of mental bar; 367, antenna; 368, mandible

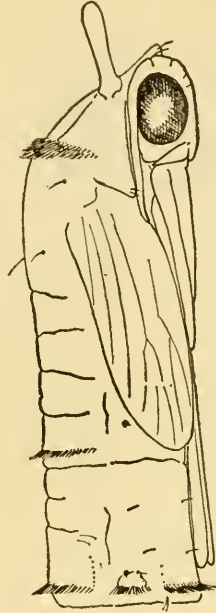


## ERIOPTERA CHLOROPHYLLA, E. SEPTENTRIONIS, AND E. ARMATA

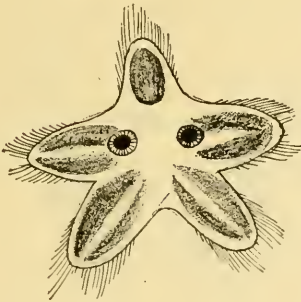
*Erioptera chlorophylla*, pupa: 369, female, lateral aspect; 370, female cauda, lateral aspect  
*Erioptera septentrionis*, pupa: 371, male cauda, lateral aspect; 372, male cauda, dorsal aspect  
*Erioptera armata*, pupa: 373, female, lateral aspect



375



376



379



374



377



378

ORMOSIA NUBILA, O. INNOCENS, AND O. MEIGENII

*Ormosia nubila*, larva: 374, mandible; 375, spiracular disk

*Ormosia innocens*, pupa: 376, female, lateral aspect; 377, male cauda, dorsal aspect; 378, male cauda, lateral aspect

*Ormosia meigenii*, larva: 379, spiracular disk

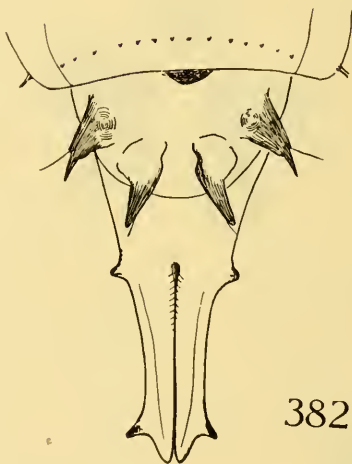




380



381



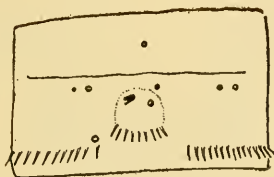
382

## ORMOSIA NUBILA, PUPA

380, Female, lateral aspect; 381, cephalic crest of female, ventral aspect; 382, female cauda, dorsal aspect



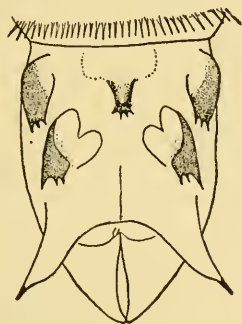
383



385



384



386



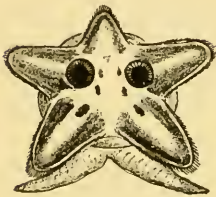
387

## ORMOSIA NIGRIPILA, PUPA

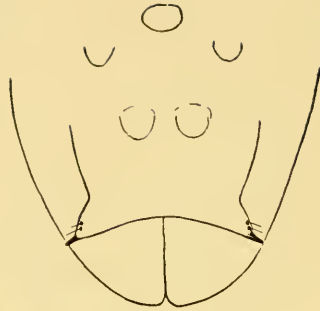
383, Male, lateral aspect; 384, pronotal breathing horn; 385, fifth abdominal segment, lateral aspect (diagrammatic); 386, male cauda, dorsal aspect; 387, female cauda, lateral aspect



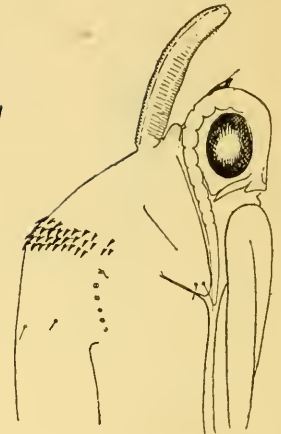
395



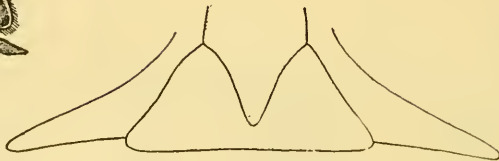
388



392



389



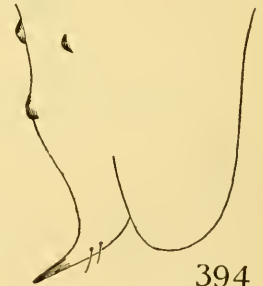
390



391



393



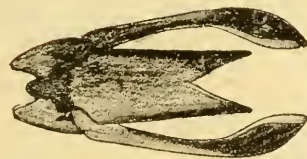
394

HELOBIA HYBRIDA AND TRIMICRA PILIPES

*Helobia hybrida*, larva: 388, spiracular disk

*Helobia hybrida*, pupa: 389, female, lateral aspect; 390, mouth parts; 391, arrangement of leg sheaths; 392, male cauda, dorsal aspect; 393, female cauda, lateral aspect; 394, male cauda, lateral aspect

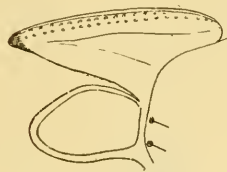
*Trimicra pilipes*, larva: 395, spiracular disk (after Gerbig)



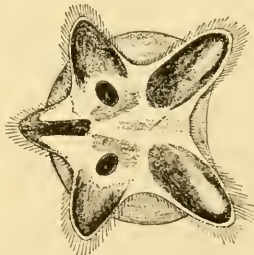
396



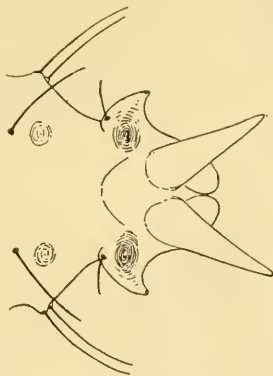
399



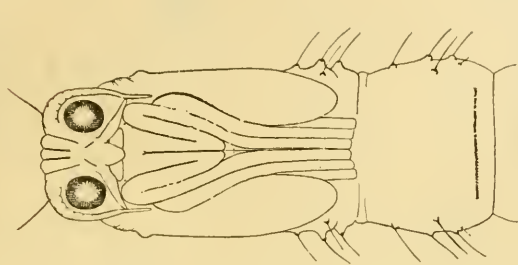
400



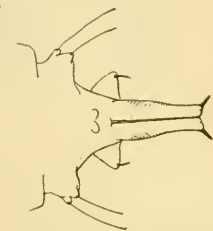
397



401

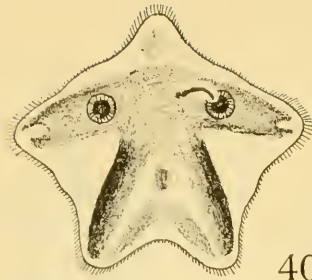


398



GNOPHOMYIA TRISTISSIMA

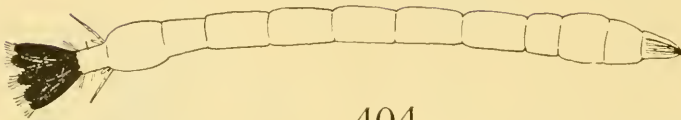
Larva: 396, head capsule (after Malloch); 397, spiracular disk (after Malloch)  
 Pupa: 398, female, ventral aspect; 399, pronotal breathing horn, lateral aspect; 400, pronotal breathing horn and thoracic crest, dorsal aspect; 401, male cauda, dorsal aspect



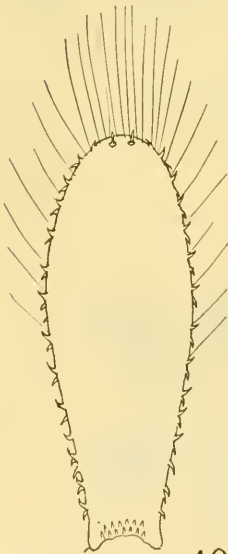
403



402



404



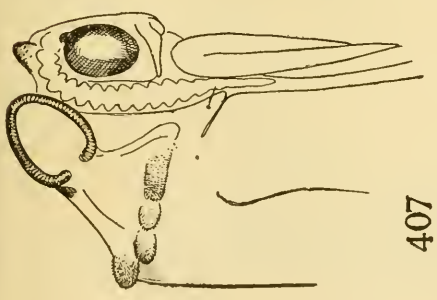
406



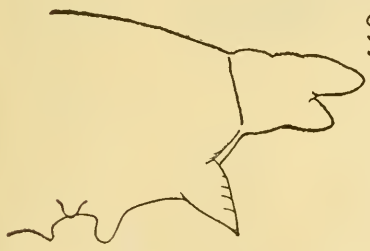
405

GONOMYIA ALEXANDERI AND ERIOPTERINE NO. 1

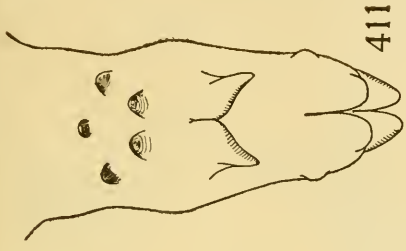
*Gonomyia alexanderi*, larva: 402, mandible; 403, spiracular disk  
 Eriopterine No. 1, larva: 404, lateral aspect; 405, spiracular disk and anal gills;  
 406, lobe of spiracular disk, enlarged



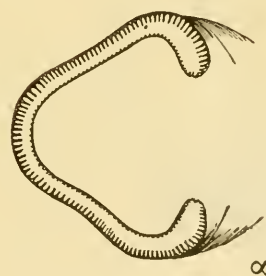
407



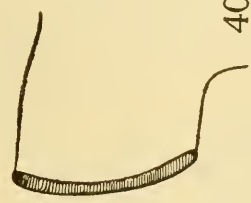
410



411



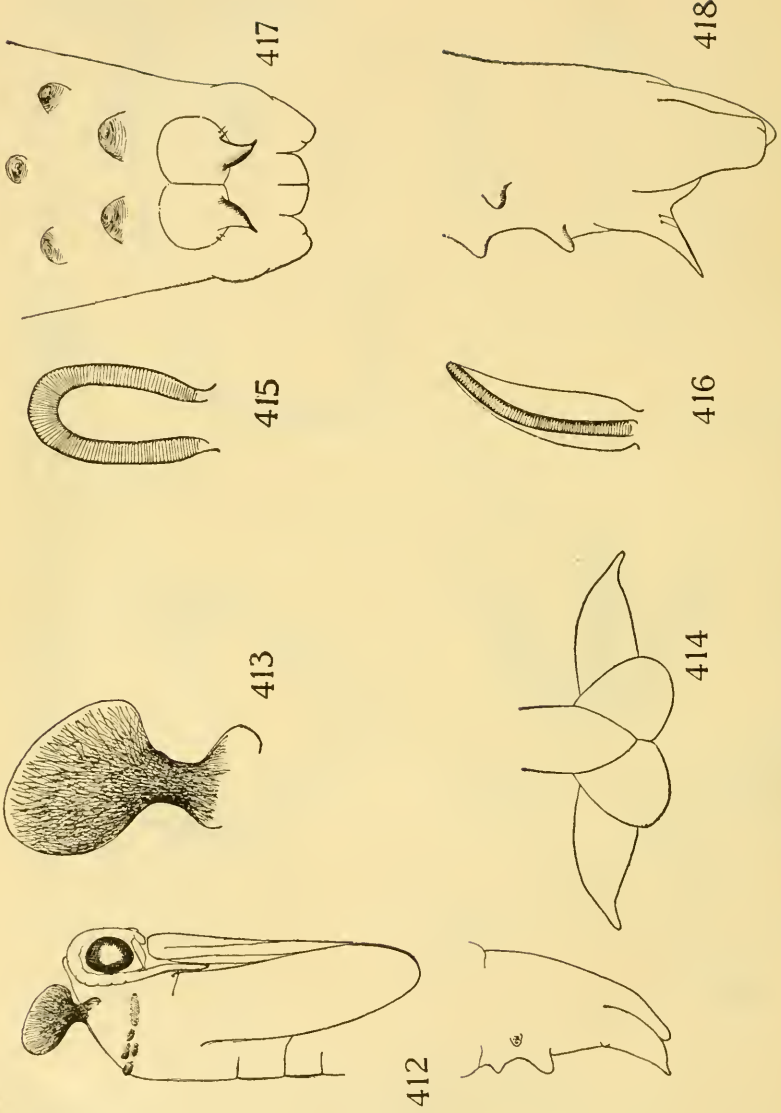
408



409

GONOMYIA ALEXANDERI, PUPA

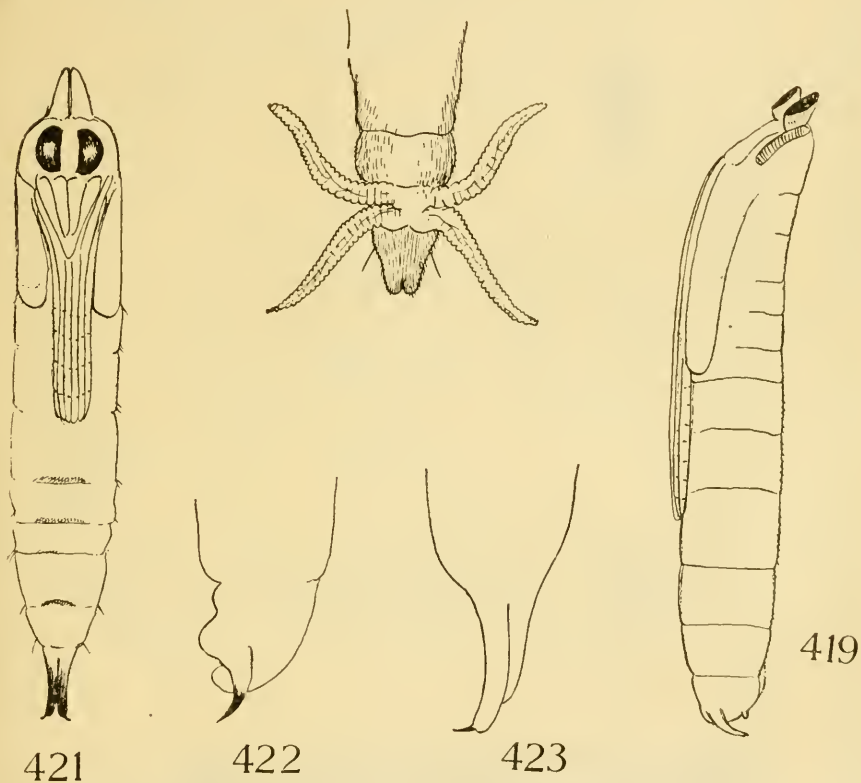
407, Male, lateral aspect; 408, pronotal breathing horn; 409, pronotal breathing horn, lateral aspect;  
 410, male cauda, lateral aspect; 411, male cauda, dorsal aspect



GONOMYIA SULPHURELLA AND G. KANSENSIS

*Gonomyia sulphurella*, pupa: 412, female, lateral aspect; 413, pronotal breathing horn, lateral aspect; 414, mouth parts  
*Gonomyia kansensis*, pupa: 415, pronotal breathing horn, lateral aspect; 416, pronotal breathing horn, ventral aspect;  
 417, male cauda, dorsal aspect; 418, male cauda, lateral aspect

420



419

421

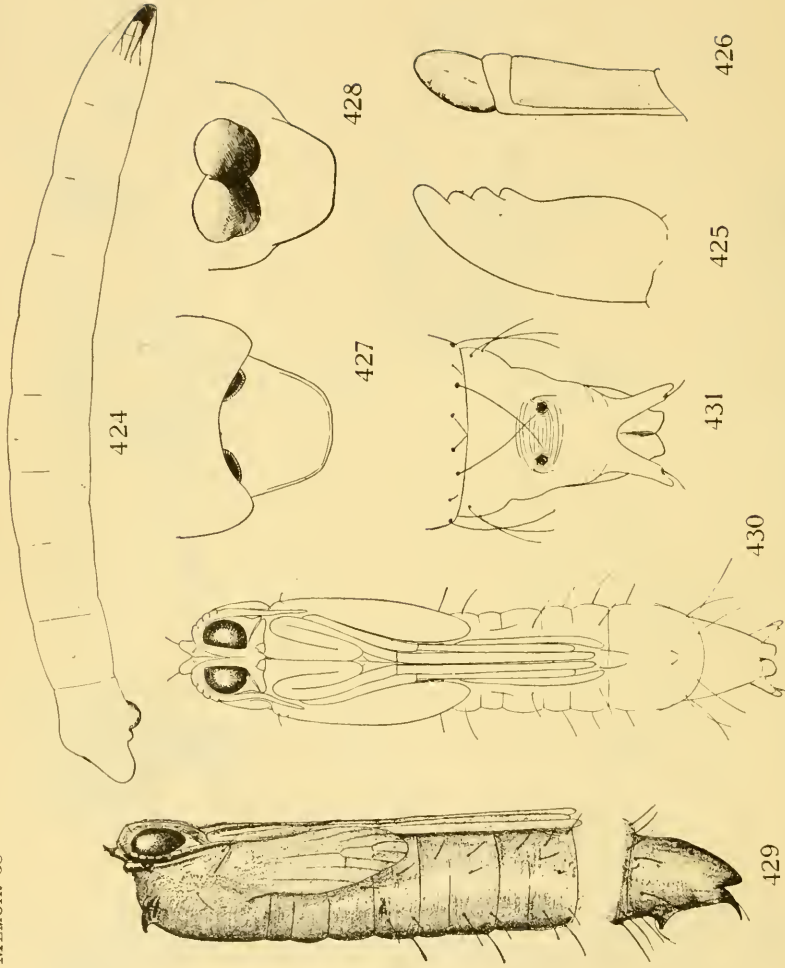
422

423

## TRENTEPOHLIA PENNIPES AND T. BROMELIADICOLA

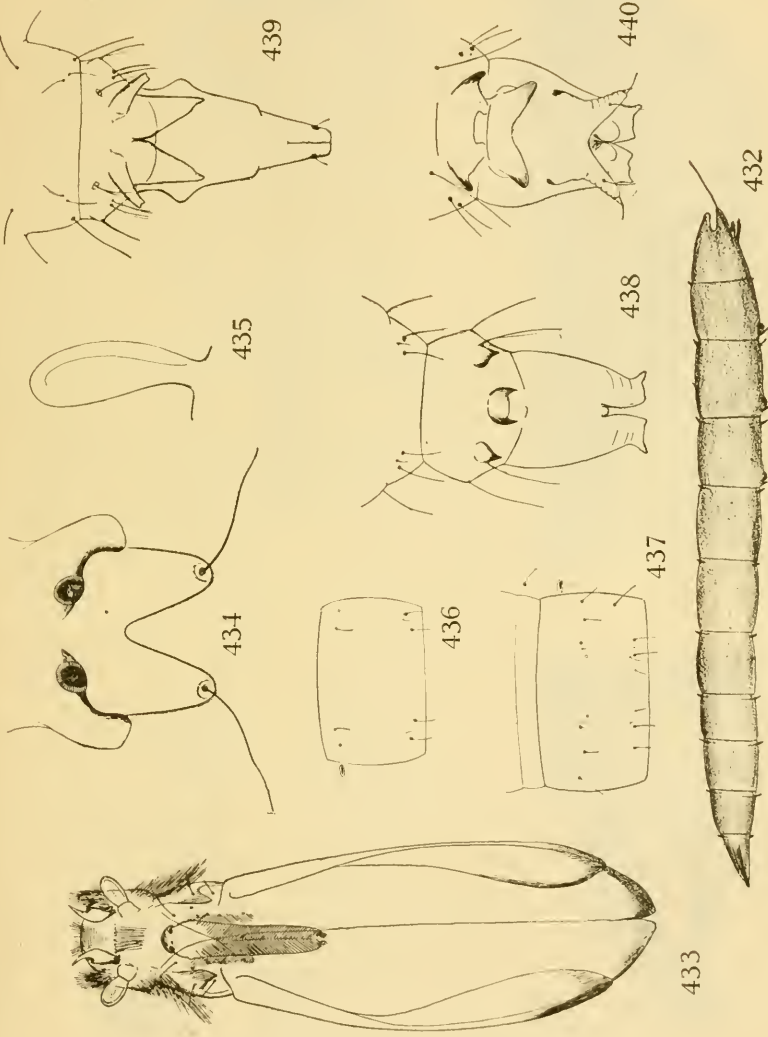
*Trentepohlia pennipes*, pupa: 419, lateral aspect (after De Meijere)*Trentepohlia bromeliadicola*, larva (after Picado): 420, anal gills*Trentepohlia bromeliadicola*, pupa (after Picado): 421, female, ventral aspect; 422, male cauda, lateral aspect; 423, female cauda, lateral aspect





TEUCHOLABIS COMPLEXA

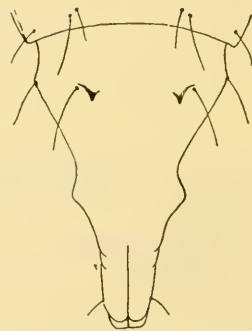
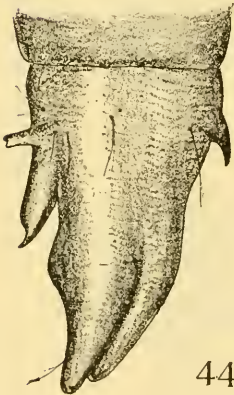
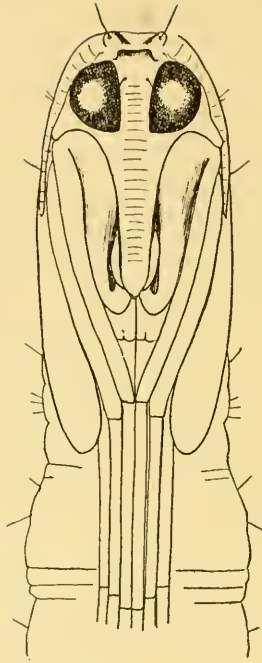
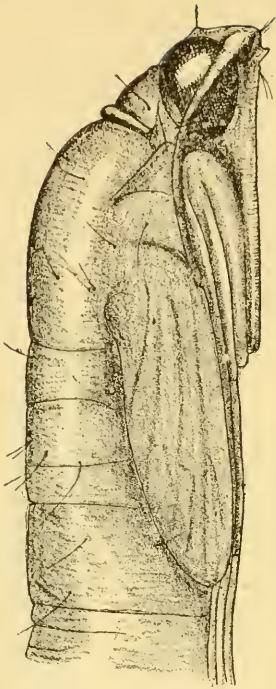
Larva: 424, lateral aspect; 425, mandible; 426, antenna; 427, spiracular disk, dorsal aspect; 428, anal gills  
 Pupa: 429, male, lateral aspect; 430, male, ventral aspect; 431, male cauda, dorsal aspect



## ELEPHANTOMYIA WESTWOODI

Larva: 432, lateral aspect; 433, head capsule, ventral aspect; 434, spiracular disk, dorsal aspect

Pupa: 435, pronotal breathing horn; 436, fifth abdominal segment, dorsal aspect (diagrammatic); 437, fifth abdominal segment, ventral aspect; 438, male cauda, ventral aspect; 439, female cauda, dorsal aspect; 440, male cauda, dorsal aspect

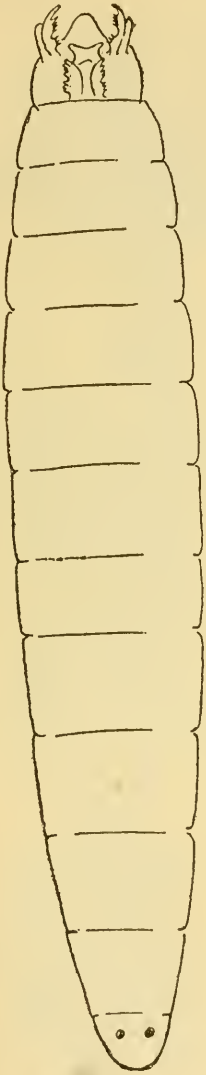


441

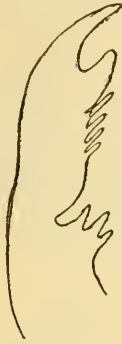
442

*ELEPHANTOMYIA WESTWOODI*, PUPA

441, Female, lateral aspect; 442, female, ventral aspect



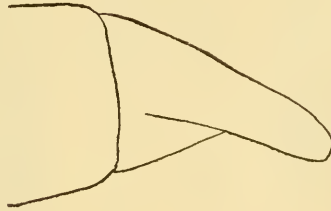
443



444



445



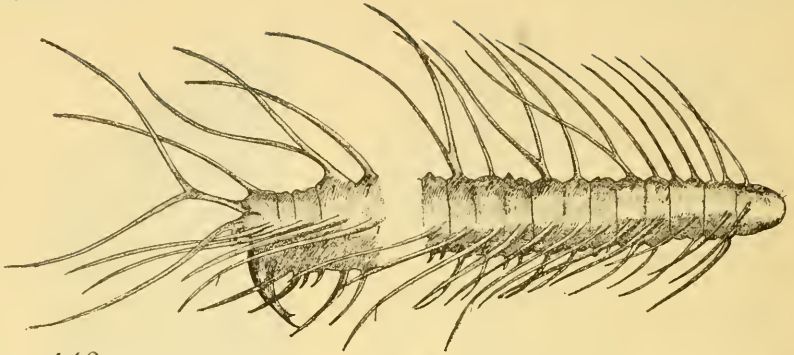
446



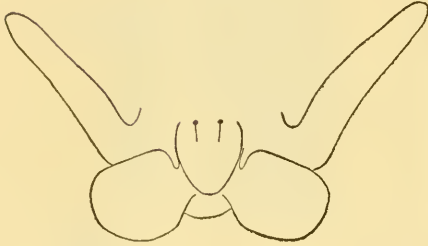
447

CHIONEA ARANEOIDES, LARVA (AFTER BRAUER)

443, Dorsal aspect; 444, mandible; 445, possibly mental plate; 446, spiracular disk, lateral aspect; 447, spiracular disk, dorsal aspect



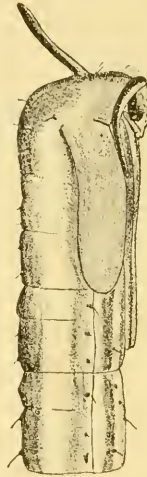
448



451



452



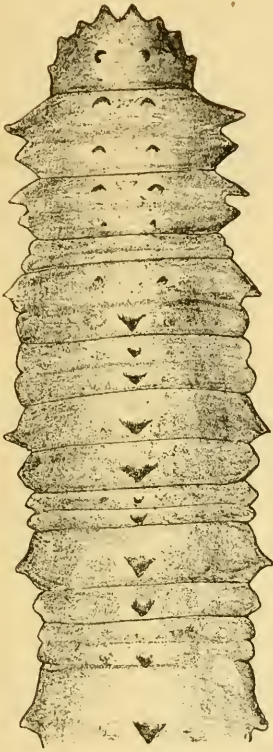
449



450

PHALACROCERA REPLICATA AND TRIOGMA TRISULCATA

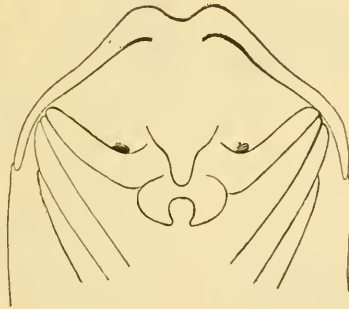
*Phalacrocera replicata*, larva: 448, lateral aspect  
*Phalacrocera replicata*, pupa: 449, male, lateral aspect; 450, male, dorsal aspect; 451, mouth parts  
*Triogma trisulcata*: 452, larva (after Steinmann)



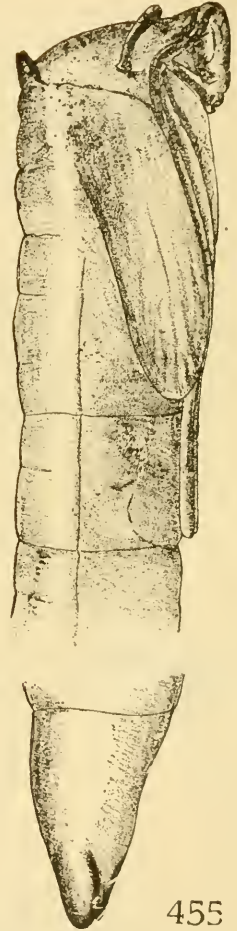
453



454



456

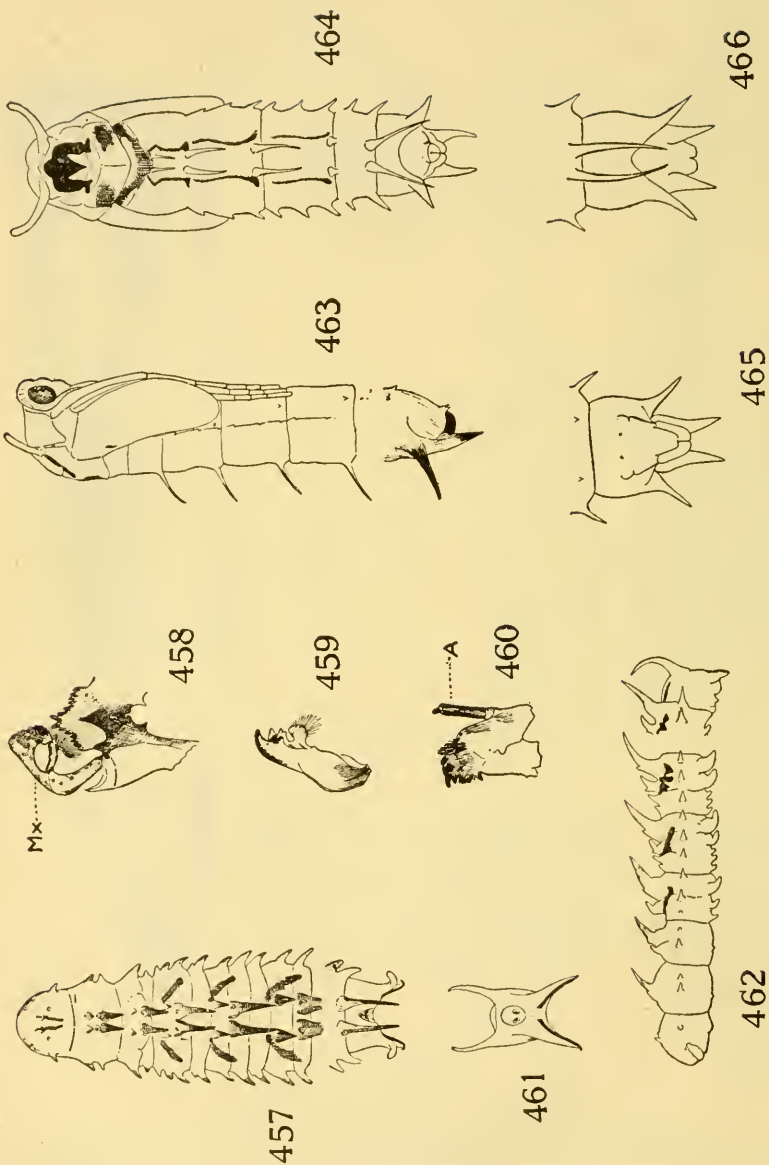


455

CYLINDROTOMA SPLENDENS

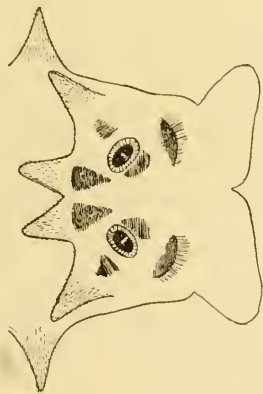
Larva: 453, dorsal aspect; 454, mandible

Pupa: 455, female, lateral aspect; 456, head of female, ventral aspect

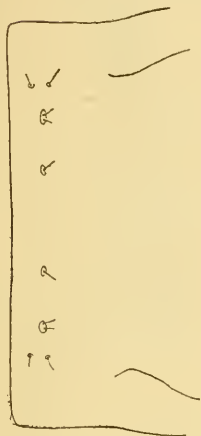


LIOGMA NODICORNIS

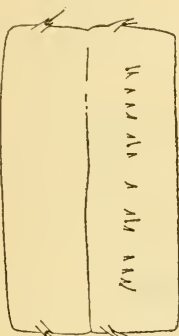
Larva: 457, dorsal aspect; 458, mentum and maxilla; 459, mandible; 460, mandible and antenna; 461, spiracular disk; 462, lateral aspect of larva  
 Pupa: 463, male, lateral aspect; 464, male, dorsal aspect; 465, female cauda, dorsal aspect; 466, female cauda, ventral aspect



469



470



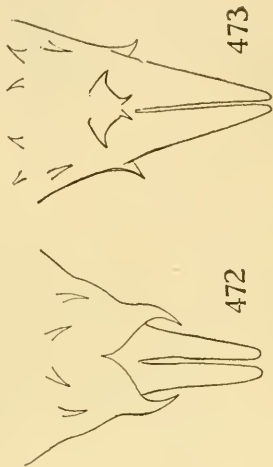
471



467



468



472

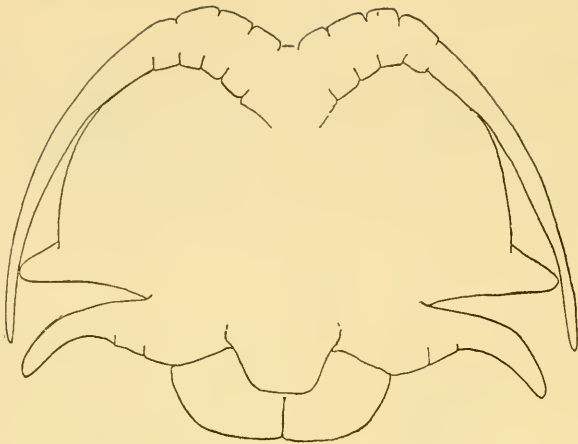


473

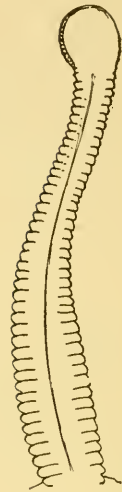
OROPEZA OBSCURA

Larva: 467, mentum; 468, hypopharynx; 469, spiracular disk  
 Pupa: 470, metanotum (diagrammatic); 471, fifth abdominal tergite (diagrammatic); 472, female cauda, dorsal aspect; 473, female cauda, ventral aspect

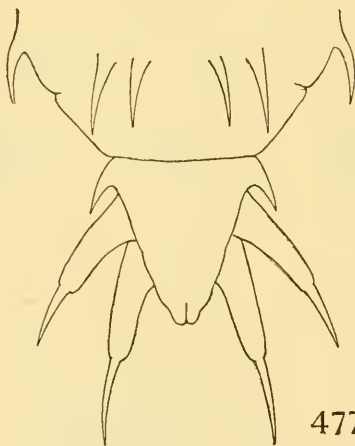




474



475



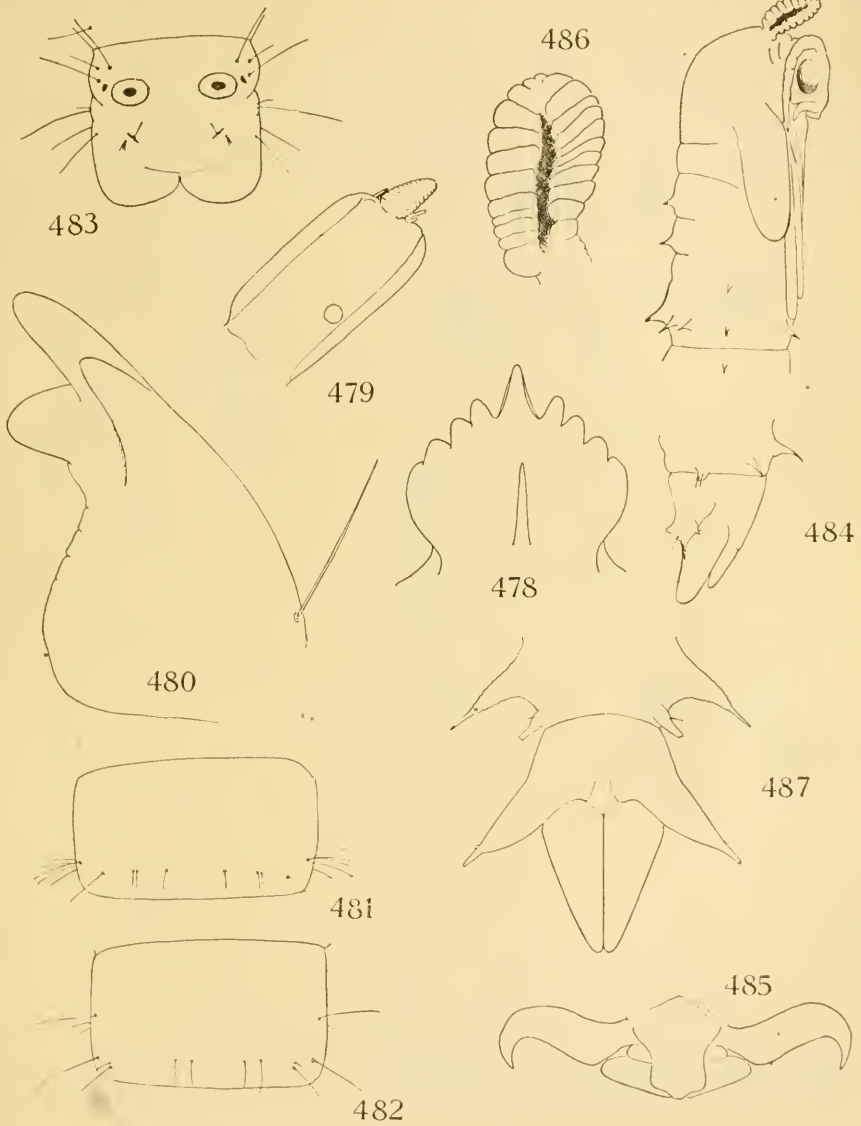
477



476

BRACHYPREMNA DISPELLENS, PUPA

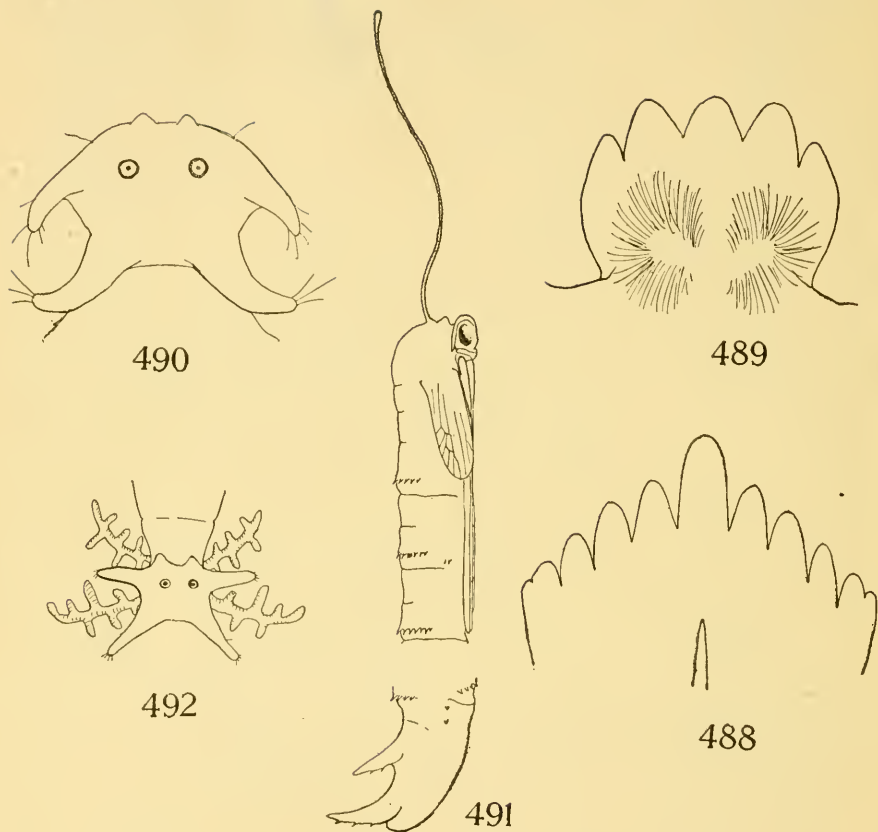
474, Head, ventral aspect; 475, pronotal breathing horn; 476, arrangement of leg sheaths;  
477, male cauda, ventral aspect



## TANYPTERA FRONTALIS

Larva: 478, mentum; 479, antenna, 480, mandible; 481, fifth abdominal segment, dorsal aspect (diagrammatic); 482, fifth abdominal segment, ventral aspect (diagrammatic); 483, spiracular disk

Pupa: 484, female, lateral aspect; 485, mouth parts; 486, pronotal breathing horn; 487, female cauda, dorsal aspect

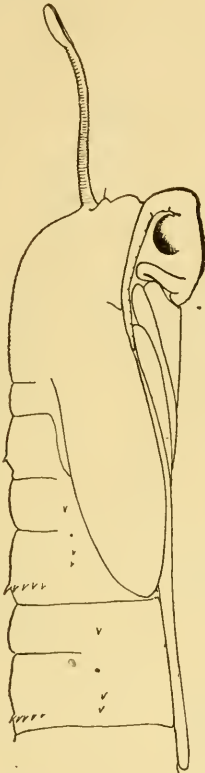


## LONGURIO TESTACEUS AND AESHNASOMA RIVERTONENSIS

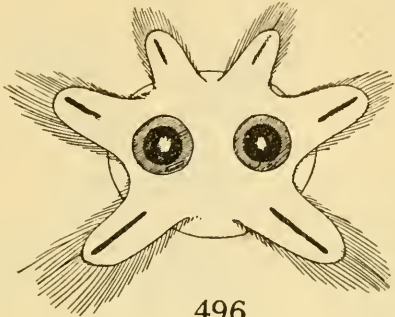
*Longurio testaceus*, larva: 488, mentum; 489, hypopharynx; 490, spiracular disk

*Longurio testaceus*, pupa: 491, male, lateral aspect

*Aeshnasoma rivertonensis*, larva: 492, spiracular disk, showing branched anal gills (after Johnson)



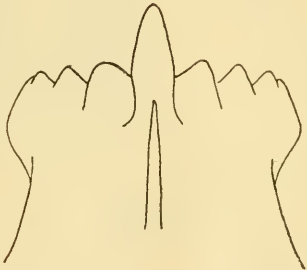
497



496



495



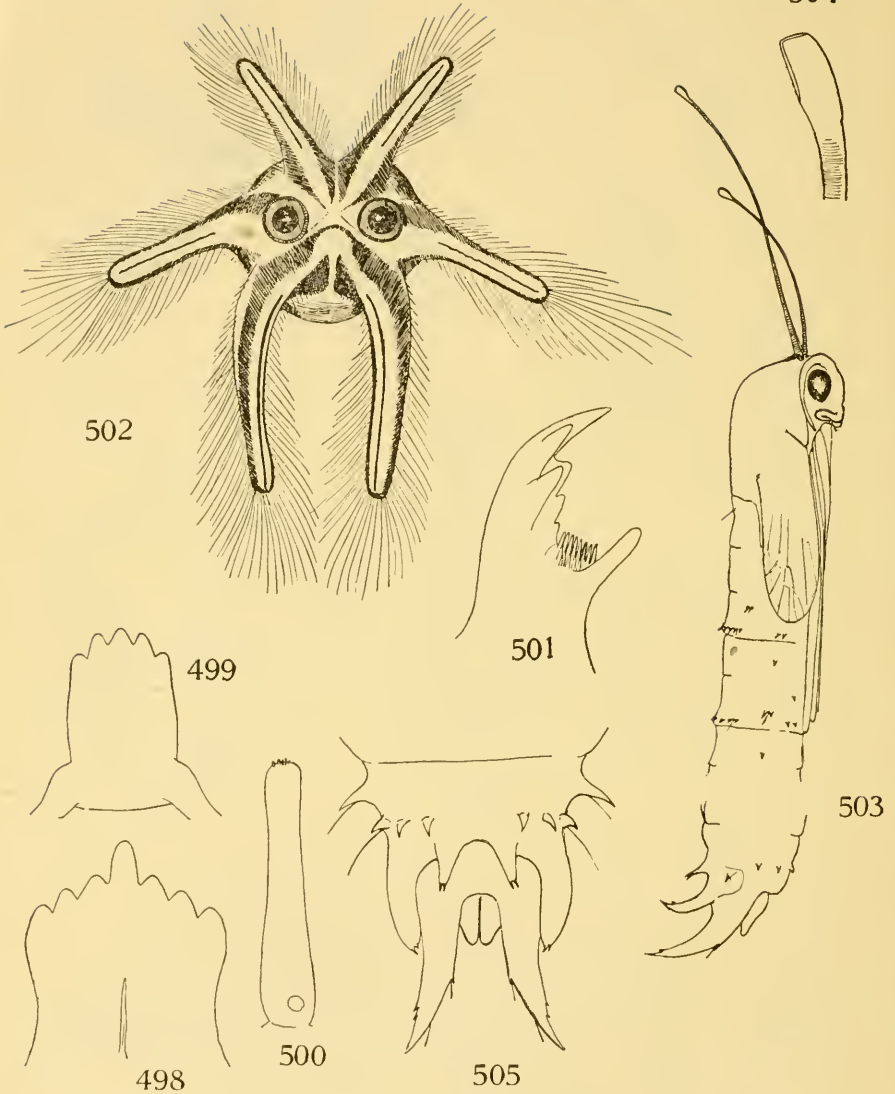
493



494

HOLORUSIA RUBIGINOSA

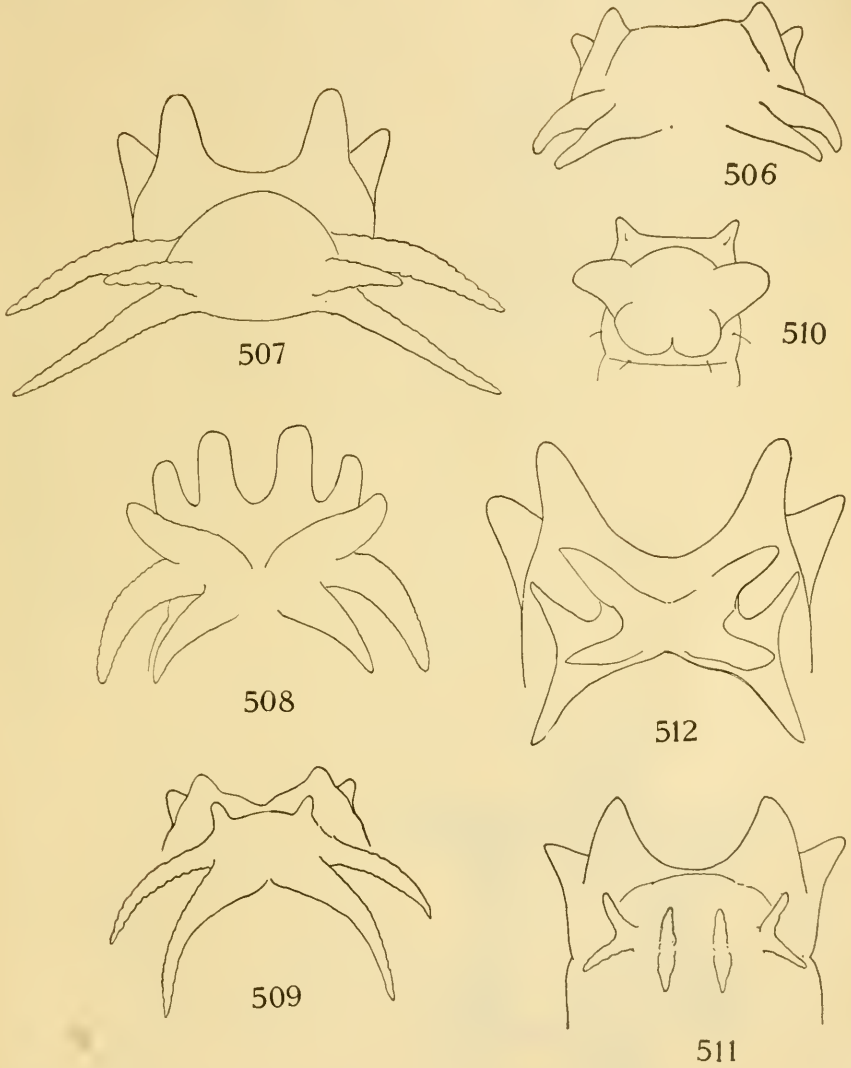
Larva: 493, mentum; 494, hypopharynx; 495, antenna; 496, spiracular disk  
Pupa: 497, male, lateral aspect



PRIONOCERA FUSCIPENNIS

Larva: 498, mentum; 499, hypopharynx; 500, antenna; 501, mandible; 502, spiracular disk

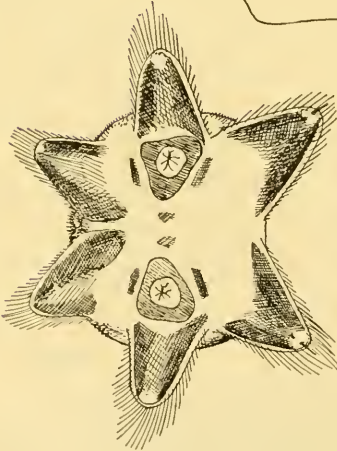
Pupa: 503, lateral aspect; 504, tip of pronotal breathing horn; 505, male cauda, dorsal aspect



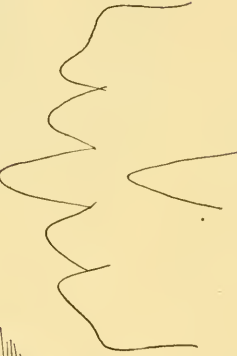
TYPES OF ANAL GILLS IN GENUS TIPULA, VENTRAL ASPECT

506, *Tipula oropezoides*; 507, *T. nobilis*; 508, *T. caloptera*; 509, *T. dejecta*; 510, *T. usitata*;  
511, *T. ignobilis*; 512, *T. iroquois* (supposition)

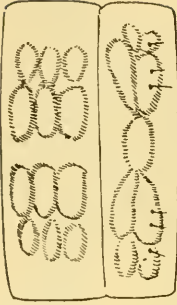
518



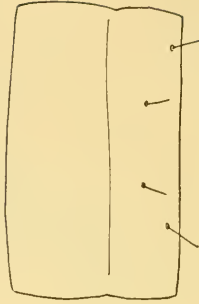
513



516



517



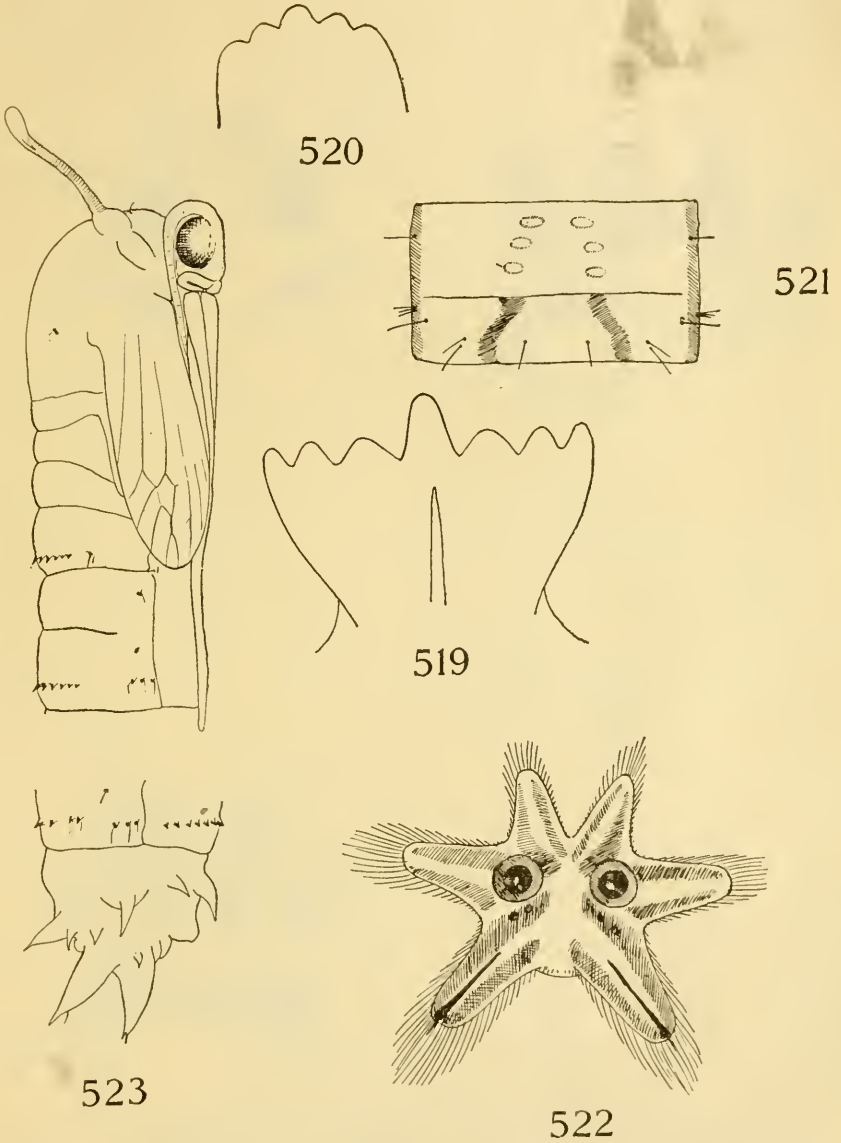
515



514

TIPULA OROPEZOIDES, LARVA

513, Mentum; 514, hypopharynx; 515, mandible; 516, fifth abdominal segment, dorsal aspect; 517, fifth abdominal segment, ventral aspect; 518, spiracular disk



TIPULA COLLARIS

Larva: 519, mentum; 520, hypopharynx; 521, fifth abdominal segment, dorsal aspect;

Pupa: 523, male, lateral aspect

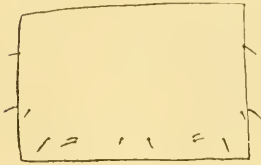




528



529



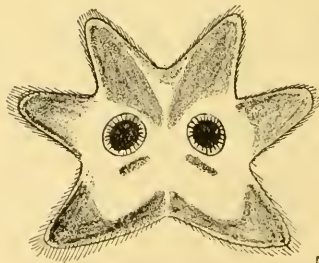
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524



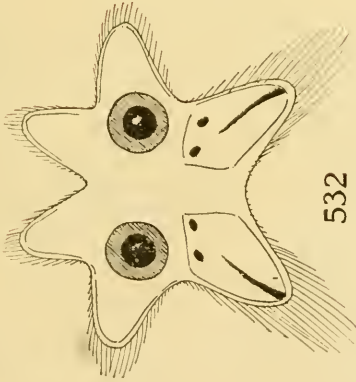
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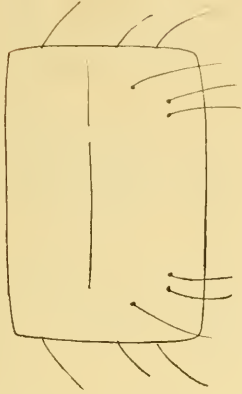
526

TIPULA DEJECTA, T. USITATA, AND T. TRIVITTATA

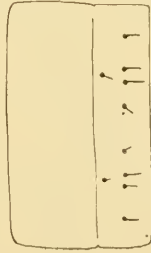
*Tipula dejecta*, larva: 524, mentum; 525, hypopharynx; 526, spiracular disk  
*Tipula usitata*, larva: 527, fifth abdominal segment, dorsal aspect; 528, spiracular disk  
*Tipula trivittata*, larva: 529, spiracular disk



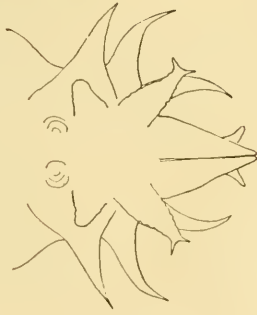
532



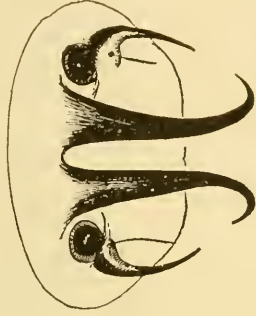
534



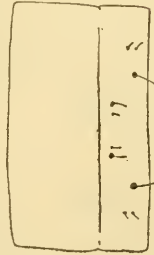
530



533



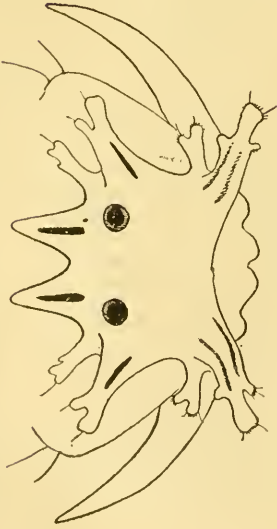
535



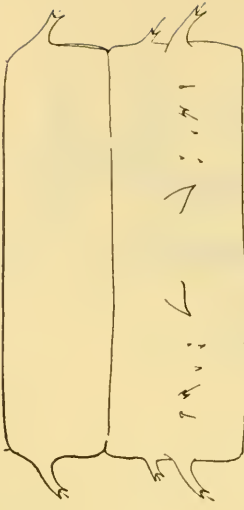
531

TIPULA IGNOBILIS AND TIPULINE NO. 2

*Tipula ignobilis*, larva: 530, fifth abdominal segment, dorsal aspect; 531, fifth abdominal segment, ventral aspect; 532, spiracular disk  
*Tipula ignobilis*, pupa: 533, female cauda, dorsal aspect  
 Tipuline No. 2, larva: 534, fifth abdominal segment, dorsal aspect; 535, spiracular disk



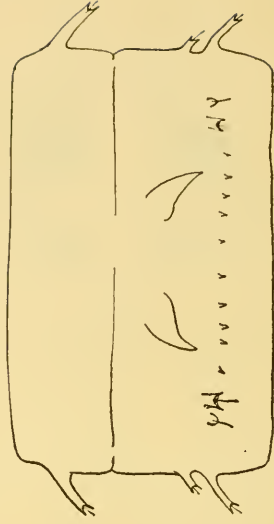
537



538



536



539

TIPULA ABDOMINALIS

Larva: 536, mentum; 537, spiracular disk  
Pupa: 538, fifth abdominal tergite; 539, fifth abdominal sternite

# INDEX

(When more than one page reference is given, the more important references are italicized)

A	PAGE		PAGE
Ab-lomen of pupa . . . . .	756	Cylindrotominae . . . . .	792, 959
Abdominal spiracles . . . . .	757	Cylindrotominae, keys to genera of . . . . .	960
Adelphomyaria . . . . .	895	<b>D</b>	
Adelphomyia . . . . .	895	Dactylolabaria . . . . .	852
<i>americana</i> . . . . .	898	Dactylolabis . . . . .	852
<i>cayuga</i> . . . . .	898	<i>cubitalis</i> . . . . .	854
<i>minuta</i> . . . . .	896	<i>denticulata</i> . . . . .	837, 853
Adipose tissue . . . . .	763	<i>montana</i> . . . . .	855
Aeshnasma . . . . .	993	<i>wodzickii</i> . . . . .	837, 854
<i>rivertonensis</i> . . . . .	978, 993	Dicranomyia . . . . .	819
Amphibia feeding on crane-flies . . . . .	726	<i>badia</i> . . . . .	820, 824
Anal gills of larva . . . . .	748	<i>dumetorum</i> . . . . .	798, 799, 819
Antennae of larva . . . . .	751	<i>foliocuniculator</i> . . . . .	799, 820
Anthomyiidae feeding on crane-flies . . . . .	728, 732	<i>macateei</i> . . . . .	820
Antocha . . . . .	799	<i>pilipennis</i> . . . . .	820
<i>monticola</i> . . . . .	800	<i>rara</i> . . . . .	820
<i>saxicola</i> . . . . .	798, 800	<i>simulans</i> . . . . .	799, 820
Antocharia . . . . .	799	<i>stulta</i> . . . . .	820, 822
Ants feeding on crane-flies . . . . .	729	<i>trinotata</i> . . . . .	798, 819
Arachnida feeding on crane-flies . . . . .	727	<i>umbrata</i> . . . . .	799, 820
Arachnida parasitic on crane-flies . . . . .	732	Dicranophragma . . . . .	861
Arrangement of families and lesser groups . . . . .	701	Dicranoptycha . . . . .	828
Asilidae feeding on crane-flies . . . . .	728	<i>winnemana</i> . . . . .	799, 829
Aves feeding on crane-flies . . . . .	721	Dicranoptycharia . . . . .	828
<b>B</b>		Dicranota . . . . .	899, 906
Bacteria in crane-fly larvae . . . . .	734	<i>bimaculata</i> . . . . .	895, 906
Beling, Theodor, life of . . . . .	693	Dicranota . . . . .	906
Bibliography . . . . .	1019	Dietenidia . . . . .	987
Birds feeding on crane-flies . . . . .	721	<i>bimaculata</i> . . . . .	978, 987
Bittacomorpha . . . . .	783	Digestive system . . . . .	758
<i>clavipes</i> . . . . .	784	Diotrepha . . . . .	800
Bittacomorphella . . . . .	779	Diptera feeding on crane-flies . . . . .	727
<i>jonesi</i> . . . . .	780	Dipterous parasites of crane-flies . . . . .	731
Bittacomorphinae . . . . .	779, 779	Discobola . . . . .	815
Bittacomorphinae, keys to genera of . . . . .	779	<i>argus</i> . . . . .	815
Body form of larva . . . . .	745	<i>caesarea</i> . . . . .	798, 815
Brachypremna . . . . .	984	Ditomyiidae . . . . .	788
<i>dispellens</i> . . . . .	984, 985	Dolichocheza . . . . .	981
<i>eocenica</i> . . . . .	984	<i>albipes</i> . . . . .	978, 981
Breathing horns of pupa . . . . .	754	<i>americana</i> . . . . .	982
<b>C</b>		<i>sylvicola</i> . . . . .	978
Cheilotruchia imbuta . . . . .	910	Dolichochezaria . . . . .	981
Chionea . . . . .	950	Duration of pupal existence . . . . .	720
<i>alpina</i> . . . . .	951	<b>E</b>	
<i>araneoides</i> . . . . .	911, 951	Economic importance . . . . .	736
<i>valga</i> . . . . .	950	Egg . . . . .	714
Circulatory system . . . . .	760	Elephantomyaria . . . . .	909, 952
Cladura . . . . .	947	Elephantomyia . . . . .	952
<i>delicatula</i> . . . . .	947, 948	<i>westwoodi</i> . . . . .	953
<i>flavoferruginea</i> . . . . .	948	Elliptera . . . . .	806
Coleoptera feeding on crane-flies . . . . .	729	<i>omissa</i> . . . . .	798, 806, 807
Collecting . . . . .	740	Ellipteraria . . . . .	806
Comparative morphology . . . . .	766	Emergence of adult . . . . .	710
Ctenophora . . . . .	986	Empedomorpha . . . . .	933
<i>angustipennis</i> . . . . .	978, 986	<i>empedoides</i> . . . . .	933
<i>apicata</i> . . . . .	978, 986	Empididae feeding on crane-flies . . . . .	728
<i>festiva</i> . . . . .	978, 986	Enemies of crane-flies . . . . .	721
<i>flaveolata</i> . . . . .	978, 986	Epipharynx of larva . . . . .	750
<i>nigricoxa</i> . . . . .	978, 986	Epiphragma . . . . .	843
<i>pectinicornis</i> . . . . .	978, 986	<i>fascipennis</i> . . . . .	837, 844, 846
<i>vittata</i> . . . . .	986	<i>pieta</i> . . . . .	837, 844
Ctenophoraria . . . . .	986	<i>solatrix</i> . . . . .	844
Cylindrotoma . . . . .	966	Epiphragmaria . . . . .	843
<i>distinctissima</i> . . . . .	960, 967	Eriocera . . . . .	881
<i>splendens</i> . . . . .	708, 960, 967	<i>cinerea</i> . . . . .	837, 886
<i>tarsalis</i> . . . . .	967	<i>fultonensis</i> . . . . .	838, 890

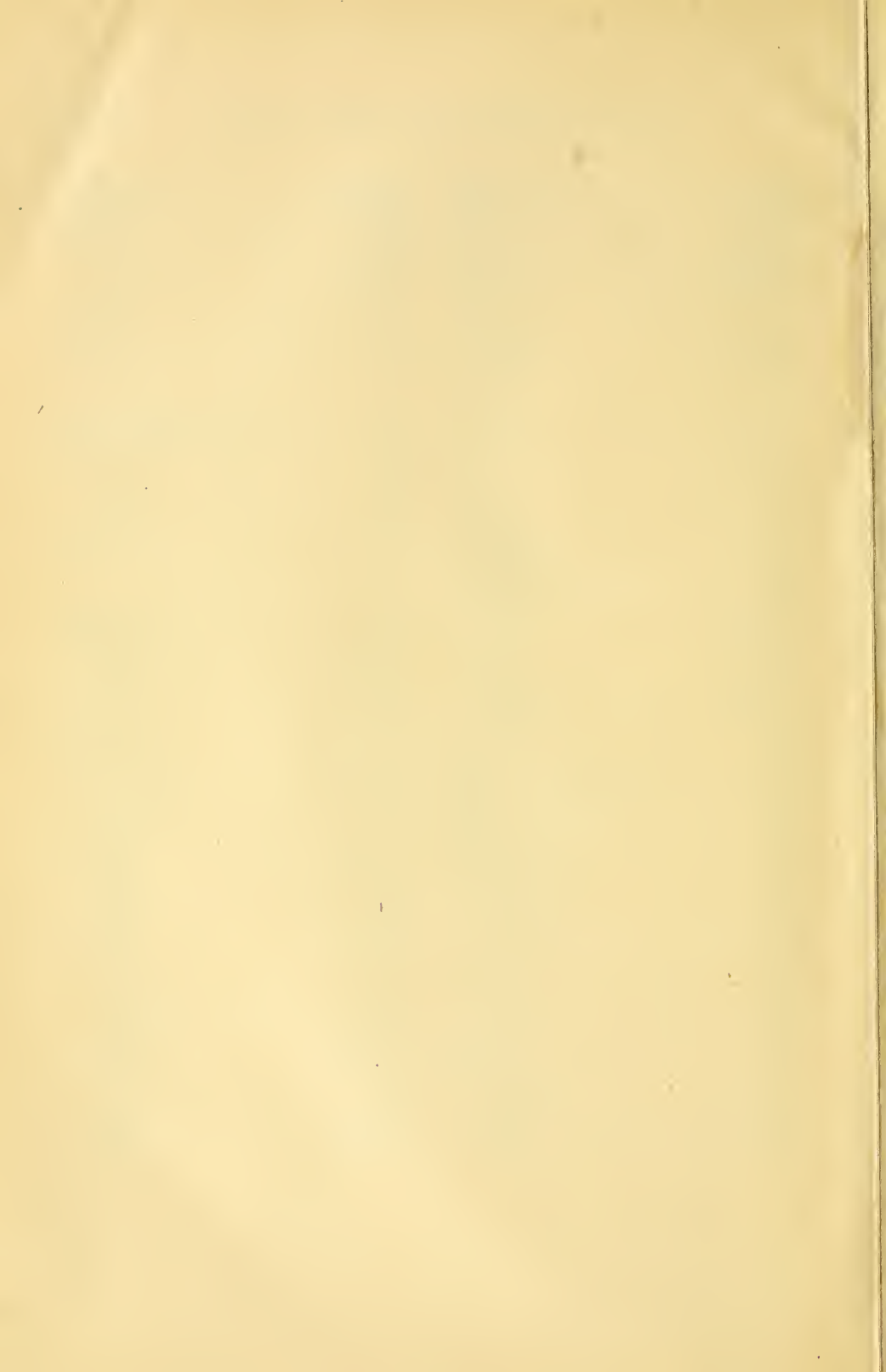
	PAGE		PAGE
<i>Eriocera</i> (continued)		<i>Hexatomaria</i> , keys to genera of . . . . .	877
<i>longicornis</i> . . . . .	704, 837, 888	<i>Hexatomini</i> . . . . .	835
<i>spirosa</i> . . . . .	837, 883	<i>Hexatomini</i> , keys to subtribes of . . . . .	836
<i>Eriocera</i> , keys to species of . . . . .	882	<i>Histoblastus</i> . . . . .	763
<i>Erioptera</i> . . . . .	914	<i>Historical summary of immature stages</i> . . . . .	735
<i>armata</i> . . . . .	915, 921	<i>Holorusia</i> . . . . .	993
<i>caloptera</i> . . . . .	915, 922	<i>rubiginosa</i> . . . . .	978, 994
<i>chlorophylla</i> . . . . .	915, 918	<i>Hoplolabis</i> . . . . .	921
<i>flavescens</i> . . . . .	910, 915	<i>Hymenoptera</i> feeding on crane-flies . . . . .	729
<i>graphica</i> . . . . .	915		
<i>knabi</i> . . . . .	915, 922	I	
<i>lutea</i> . . . . .	910, 915	<i>Imaginal disks</i> . . . . .	763
<i>maculata</i> . . . . .	910, 914	<i>Internal morphology</i> . . . . .	758
<i>megophthalma</i> . . . . .	915	<i>Internal parasites of crane-flies</i> . . . . .	733
<i>parva</i> . . . . .	915, 920		
<i>septemtrionis</i> . . . . .	915, 915	K	
<i>sordida</i> . . . . .	910, 915	<i>Killing and preserving specimens</i> . . . . .	740
<i>vespertina</i> . . . . .	915, 919		
<i>Erioptera</i> , key to pupae of . . . . .	915	L	
<i>Eriopteraria</i> . . . . .	911	<i>Labium of larva</i> . . . . .	750
<i>Eriopterine</i> No. 1 . . . . .	956	<i>Labrum of larva</i> . . . . .	750
<i>Eriopterini</i> . . . . .	908	<i>Larva</i> . . . . .	715
<i>Eriopterini</i> , keys to genera of . . . . .	909	<i>Larval habitat</i> . . . . .	716
<i>Eulimnophila</i> . . . . .	872	<i>Lasiomastix</i> . . . . .	863
<i>External morphology of larva</i> . . . . .	744	<i>Leponera</i> . . . . .	939
<i>External morphology of pupa</i> . . . . .	752	<i>Libnotes</i> . . . . .	814
<i>External parasites</i> . . . . .	730	<i>perkinsi</i> . . . . .	798, 814
		<i>Life activities of crane-flies</i> . . . . .	710
F		<i>Life histories of crane-flies, representative</i> . . . . .	704
<i>Fat bodies, or adipose tissue</i> . . . . .	763	<i>Limnobaria</i> . . . . .	808
<i>Feeding habits of adults</i> . . . . .	713	<i>Limnobaria</i> , keys to genera of . . . . .	808
<i>Feeding habits of larvae</i> . . . . .	717	<i>Limnobia</i> . . . . .	809
<i>Fish feeding on crane-flies</i> . . . . .	726	<i>annulus</i> . . . . .	798, 809
<i>Flagellate parasites of crane-flies</i> . . . . .	734	<i>bifasciata</i> . . . . .	798, 809
<i>Fungus parasites of crane-flies</i> . . . . .	732	<i>cinctipes</i> . . . . .	810
		<i>decemmaculata</i> . . . . .	798, 809
G		<i>fallax</i> . . . . .	810, 813
<i>General features of larva</i> . . . . .	744	<i>flavipes</i> . . . . .	798, 810
<i>General features of pupa</i> . . . . .	752	<i>immatura</i> . . . . .	798, 810
<i>Geological record</i> . . . . .	764	<i>indigena</i> . . . . .	810
<i>Geranomyia</i> . . . . .	816	<i>inusta</i> . . . . .	798
<i>canadensis</i> . . . . .	817	<i>macrostigma</i> . . . . .	798, 810
<i>diversa</i> . . . . .	817	<i>nigropunctata</i> . . . . .	798, 810
<i>rostrata</i> . . . . .	817	<i>nubeculosa</i> . . . . .	798, 810
<i>virescens</i> . . . . .	817	<i>obscuricornis</i> . . . . .	798, 810
<i>Gnophomyia</i> . . . . .	934	<i>parietina</i> . . . . .	810
<i>rufa</i> . . . . .	911, 934	<i>quadrifasciata</i> . . . . .	798, 809
<i>tripudians</i> . . . . .	911, 934	<i>sexpunctata</i> . . . . .	798, 810
<i>tristissima</i> . . . . .	911, 935	<i>solitaria</i> . . . . .	810
<i>Gonomyella</i> . . . . .	938	<i>trilocellata</i> . . . . .	798, 810, 814
<i>Gonomyia</i> . . . . .	938, 940	<i>tripunctata</i> . . . . .	798, 810
<i>alexanderi</i> . . . . .	938, 939	<i>xanthoptera</i> . . . . .	798, 809
<i>kansensis</i> . . . . .	938, 941	<i>Limnobiinae</i> . . . . .	793
<i>subcinerea</i> . . . . .	938	<i>Limnobiinae</i> , keys to tribes and subtribes of . . . . .	793
<i>sulphurella</i> . . . . .	938, 940	<i>Limnobiini</i> . . . . .	795
<i>tenella</i> . . . . .	911, 938	<i>Limnobiini</i> , keys to subtribes of . . . . .	797
<i>Gonomyia</i> , key to pupae of . . . . .	938	<i>Limnophila</i> . . . . .	858, 868
		<i>adusta</i> . . . . .	867
II		<i>bryobia</i> . . . . .	837, 859
<i>Habromastix cinerascens</i> . . . . .	980	<i>dispar</i> . . . . .	837, 860
<i>Head of larva</i> . . . . .	748	<i>feruginea</i> . . . . .	837, 860, 866
<i>Head of pupa</i> . . . . .	753	<i>fuscovaria</i> . . . . .	861
<i>Helobia</i> . . . . .	928	<i>hyalipennis</i> . . . . .	837, 860
<i>hybrida</i> . . . . .	911, 929	<i>lineola</i> . . . . .	837, 860
<i>macroptera</i> . . . . .	929	<i>macrocera</i> . . . . .	864
<i>Hexatoma</i> . . . . .	877	<i>memoralis</i> . . . . .	837, 860
<i>bicolor</i> . . . . .	878	<i>ochracea</i> . . . . .	837, 860
<i>megaecera</i> . . . . .	838, 878	<i>pallida</i> . . . . .	837, 860
<i>nigra</i> . . . . .	838, 878	<i>pictipennis</i> . . . . .	837, 869
<i>saxonum</i> . . . . .	878	<i>punctata</i> . . . . .	837, 868
<i>Hexatomaria</i> . . . . .	876	<i>sinistra</i> . . . . .	837, 859

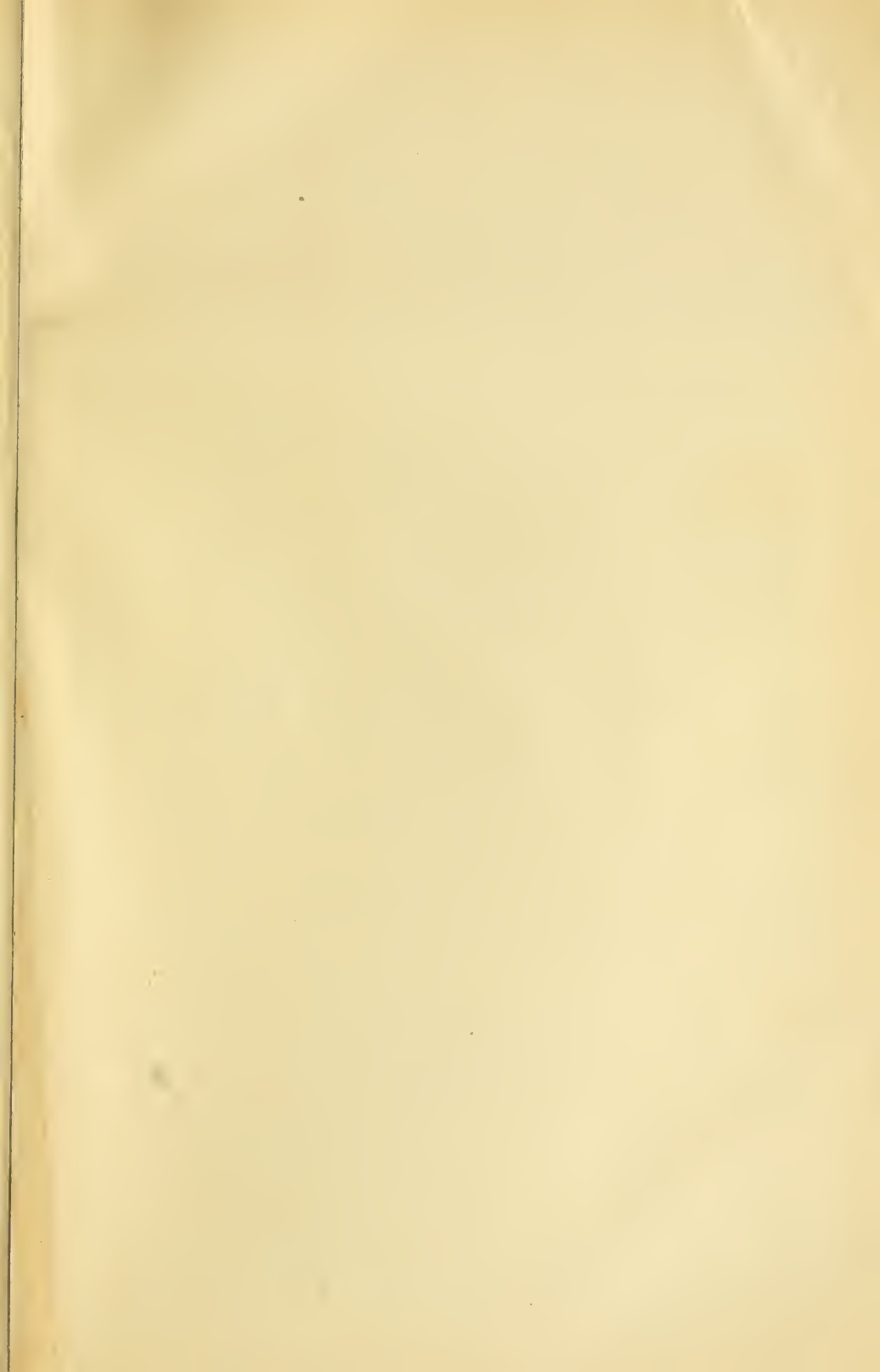
	PAGE	P	PAGE
<i>Limnophila</i> ( <i>continued</i> )			
<i>ultima</i> . . . . .	711	<i>Paramongoma</i> . . . . .	944
<i>unica</i> . . . . .	860	Parasitic natural enemies of crane-flies . . . . .	730
<i>Limnophilac</i> . . . . .	858	<i>Pedicularia</i> . . . . .	899
<i>Limnophilaria</i> . . . . .	856	<i>Pedicularia</i> , key to genera of . . . . .	899
<i>Limnophilaria</i> , keys to genera and subgenera of . . . . .	857	<i>Pedicia</i> . . . . .	899
<i>Liogma</i> . . . . .	960, 969	<i>albivitta</i> . . . . .	895, 900
<i>glabrata</i> . . . . .	960, 969	<i>contermina</i> . . . . .	900
<i>nodicornis</i> . . . . .	961, 971	<i>rivosa</i> . . . . .	895, 900
<i>Liogma</i> , keys to species of . . . . .	970	<i>Pediciae</i> . . . . .	899
<i>Lipsothrix icterica</i> . . . . .	910	<i>Pediciini</i> . . . . .	894
<i>Longurio</i> . . . . .	990	<i>Pediciini</i> , key to subtribes of . . . . .	894
<i>testaceus</i> . . . . .	991	<i>Pentoptera</i> . . . . .	891
		<i>albitarsis</i> . . . . .	838, 892
M		<i>Phalacroceca</i> . . . . .	961
Mammalia feeding on crane-flies . . . . .	721	<i>replicata</i> . . . . .	960, 962
Mandible of larva . . . . .	751	<i>tipulina</i> . . . . .	961
Mating . . . . .	710	<i>Phylidorea</i> . . . . .	866
Maxillae of larva . . . . .	752	Phylogenetic considerations . . . . .	766
Mesocypbona . . . . .	921	Phylogeny . . . . .	763
Methods of rearing . . . . .	741	<i>Pilaria</i> . . . . .	872
Methods of study . . . . .	741	<i>discicollis</i> . . . . .	837, 872
<i>Molophilus</i> . . . . .	911	<i>fuscipennis</i> . . . . .	837, 872
<i>biflatus</i> . . . . .	910, 912	<i>quadrata</i> . . . . .	875
<i>hirtipennis</i> . . . . .	912	<i>recondita</i> . . . . .	874
<i>obscurus</i> . . . . .	910, 911	<i>tenuipes</i> . . . . .	837, 873
<i>ochraceus</i> . . . . .	910, 911	<i>Pilaria</i> , keys to species of . . . . .	872
<i>ursinus</i> . . . . .	914	<i>Pisces</i> feeding on crane-flies . . . . .	726
<i>Mongoma</i> . . . . .	944	<i>Polymera</i> . . . . .	836, 893
Muscular system . . . . .	763	<i>geniculata</i> . . . . .	893
<i>Mycetobia</i> . . . . .	788	<i>georgiae</i> . . . . .	893
<i>Mycetobiinae</i> . . . . .	788	<i>magnifica</i> . . . . .	893
		<i>Polymeraria</i> . . . . .	836, 893
N		Predatory natural enemies of crane-flies . . . . .	721
Neanotype . . . . .	743	<i>Prionocera</i> . . . . .	995
<i>Neocladura</i> . . . . .	947	<i>fuscipennis</i> . . . . .	978, 996
<i>Nephrotoma</i> . . . . .	1016	<i>parri</i> . . . . .	978, 996
<i>analis</i> . . . . .	980, 1017	<i>Progonomyia</i> . . . . .	938
<i>cornicina</i> . . . . .	980, 1017	<i>Protoplasa</i> . . . . .	769
<i>crocata</i> . . . . .	980, 1017	<i>fitchii</i> . . . . .	769
<i>eucera</i> . . . . .	1017	<i>Pseudolimnophila</i> . . . . .	818
<i>ferruginea</i> . . . . .	737, 981, 1017	<i>inornata</i> . . . . .	851
<i>histrion</i> . . . . .	980	<i>luteipennis</i> . . . . .	837, 859
<i>iridicolor</i> . . . . .	980	<i>Pseudolimnophilaria</i> . . . . .	848
<i>lineata</i> . . . . .	980, 1017	<i>Ptychoptera</i> . . . . .	773
<i>lunulicornis</i> . . . . .	980, 1017	<i>albimana</i> . . . . .	773, 774
<i>maculata</i> . . . . .	980, 1017	<i>contaminata</i> . . . . .	773
<i>polymera</i> . . . . .	1017	<i>laeustris</i> . . . . .	773
<i>pratensis</i> . . . . .	980, 1017	<i>lenis</i> . . . . .	773, 775
<i>quadrifaria</i> . . . . .	981, 1017	<i>paludosa</i> . . . . .	773
<i>viroseus</i> . . . . .	1017	<i>rufocincta</i> . . . . .	775
<i>Nepiontype</i> . . . . .	743	<i>Ptychopteridae</i> . . . . .	772
<i>Nervous system</i> . . . . .	762	<i>Ptychopteridae</i> , keys to subfamilies of . . . . .	773
		<i>Ptychopterinae</i> . . . . .	773
O		<i>Pupa</i> . . . . .	719
<i>Odonata</i> feeding on crane-flies . . . . .	727	<i>Pupal duration</i> . . . . .	720
<i>Orimarga</i> . . . . .	799		
<i>Orimargula</i> . . . . .	799	R	
<i>Ormosia</i> . . . . .	922	References cited . . . . .	1019
<i>haemorrhoidalis</i> . . . . .	910, 923	Reproductive system . . . . .	762
<i>innocens</i> . . . . .	923, 925	Respiratory organs . . . . .	760
<i>lineata</i> . . . . .	910, 923	Resting habits . . . . .	712
<i>meigenii</i> . . . . .	923, 928	<i>Rhabdomastix</i> . . . . .	942
<i>nigripila</i> . . . . .	923, 927	<i>flava</i> . . . . .	942
<i>nodulosa</i> . . . . .	910, 923	<i>schistacea</i> . . . . .	911, 942
<i>nubila</i> . . . . .	923	<i>Rhamphidaria</i> . . . . .	830
<i>varia</i> . . . . .	910, 923	<i>Rhamphidia</i> . . . . .	830
<i>Ormosia</i> , key to pupae of . . . . .	923	<i>flavipes</i> . . . . .	799, 833
<i>Orpeza</i> . . . . .	982	<i>longirostris</i> . . . . .	799, 830
<i>obscura</i> . . . . .	983	<i>mainensis</i> . . . . .	831
<i>Oviposition</i> . . . . .	713	<i>Rhaphidolabina</i> . . . . .	901
		<i>flavola</i> . . . . .	901

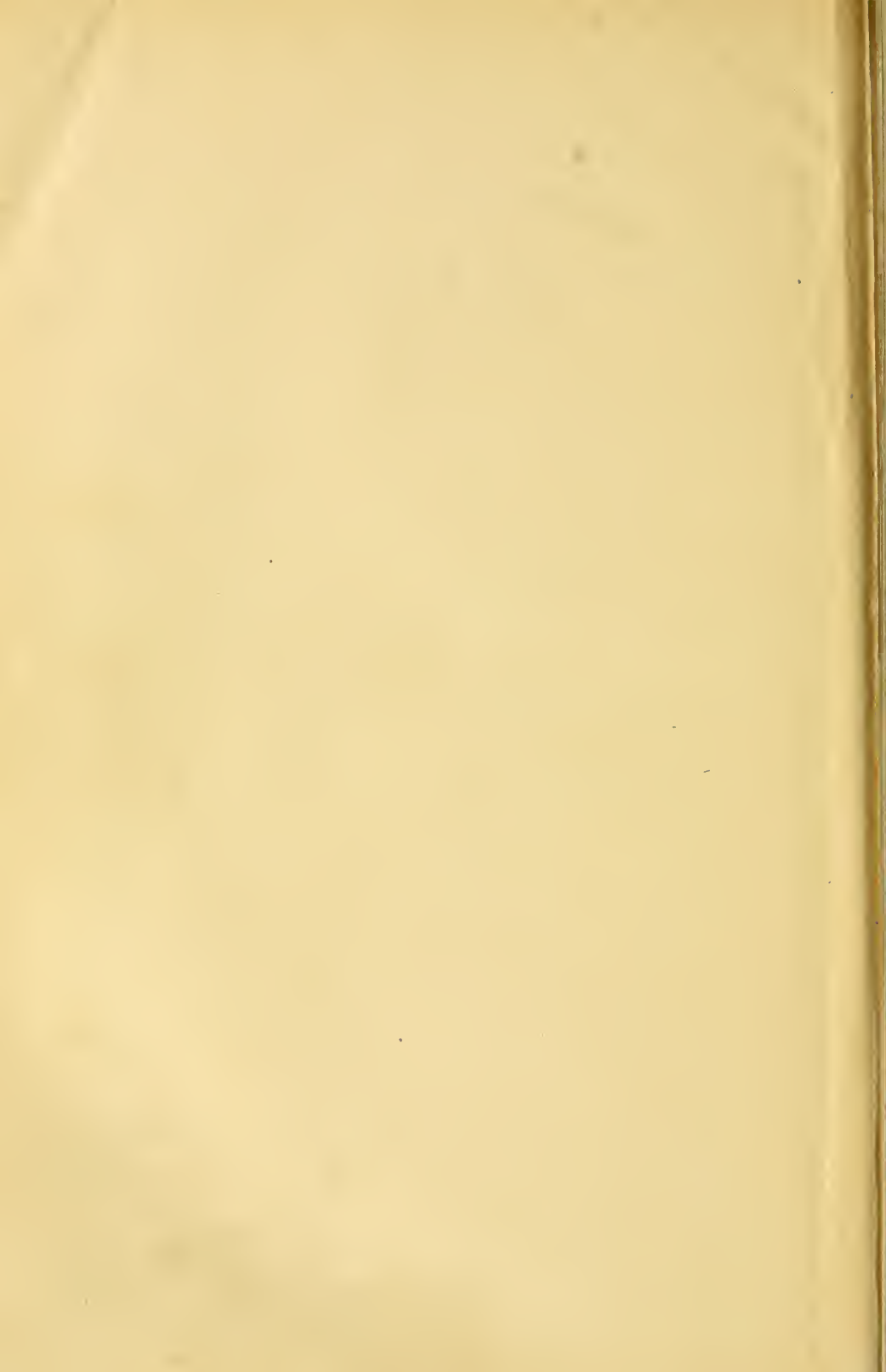
	PAGE		PAGE
Rhabdolabis	937	Tipula ( <i>continued</i> )	
cayuga	937	lunata	979, 999
tenuipes	895, 907	luteipennis	979, 999
Rhipidia	825	lutescens	978
bryanti	826	macrolabis	1014
domestica	799, 826	marmorata	979, 999
fidelis	826	maxima	979, 999
maculata	799, 826	micans	979
uniseriata	799, 826	nigra	737, 979, 999
Rhyphidae	787	nobilis	1004
Rhyphinae	787	nubeculosa	979, 999
Rhyplus	787	ochracea	979, 999
punctatus	788	oleracea	737, 979, 999
		oropeczoides	1001
		pabulina	979, 999
S		pagana	979, 999
Sacandaga	942	paludosa	737, 979, 999
Scatophagidae feeding on crane-flies	728	parva	737, 979
Spiracular disk of larva	746	peliostigma	979, 999
Sporozoon parasites of crane-flies	734	pruinosa	979, 999
Stytingomyia	957	rufina	710, 979, 999
ceylonica	958	sayi	1000
didyma	958	scripta	979, 999
jacobsoni	958	selene	979, 999, 1016
venusta	958	sorta	980
vittata	958	signata	979, 999
Stytingomyiini	957	simplex	738
Swarming	711	subnodicornis	979, 999
		taughanmock	1013
T		tephrocephala	1000
Tachinid parasites of crane-flies	731	tricolor	1000
Tanyderidae	769	trivittata	980, 1009
Tanyptera	988	truncorum	979, 999
atrata	978, 983	ultima	980, 1001
atrata ruficornis	978, 983	umbrosa	1000
flavicornis	978, 983	unca	980, 999
frontalis	988	usitata	1008
fumipennis	978, 983	varicornis	980, 999
Teucholabis	945	varipennis	980, 999
complexa	911, 946	vernalis	980, 999
Thaumastoptera	716, 798	vittata	980, 999
Thorax of pupa	754	winnertzii	980
Tipula	998	Tipularia	990
abdominalis	980, 1011	Tipulidae	791
angustipennis	1000	Tipulidae, keys to subfamilies of	792
annulicornis	980	Tipulinae	792, 974
arctica	980, 1001	Tipulinae, keys to genera of	977
bella	1004	Tipulini	981
bicornis	738, 980, 1001	Tipulodina pedata	978
caesia	978, 999	Tipuloidea, keys to families of	768
caloptera	980, 1005	Toxorhina	955
cayuga	1000	madagascariensis	955
collaris	1002	muliebris	956
cunctans	738, 980, 1001	Trentepohlia	943
dejecta	1006	bromeliadicola	911, 944
dilatata	978, 999	cruciferella	943
cluta	980, 1001	humeralis	943
flavicans	980	leucoxena	911, 945
flavolineata	978, 999	pennipes	911, 944
fuliginosa	1000	Trichocera	789
fulvipennis	978, 999	fuscata	790
gigantea	979	hiemalis	790
hortensis	978, 999	regelationis	790
hortulana	979, 999	Trichocerinae	788, 789
ignobilis	1010	Trichotipula	1001
imbecilla	979	Tricyphona	903
infuscata	980	auripennis	904
iroquois	1014	immaculata	895, 904
irrorata	979, 999	inconstans	904
lateralis	979, 999	paludicola	903
longicornis	980	schineri	895, 904
		vernalis	904

	PAGE		PAGE
Trimiera.....	932	Ula ( <i>continued</i> )	
pilipes.....	911, 932	elegans.....	837, 840
reciproca.....	933	macroptera.....	837, 839
Triogma.....	973	Ularia.....	838
exculpta.....	974	Ulomorpha.....	869
kuwanai.....	974	pilosella.....	869
trisulcata.....	961, 974	Ulomorphae.....	869
Types of the immature stages.....	743		
		W	
Ula.....	839	Wasps feeding on crane-flies.....	729
boltophila.....	837, 840		



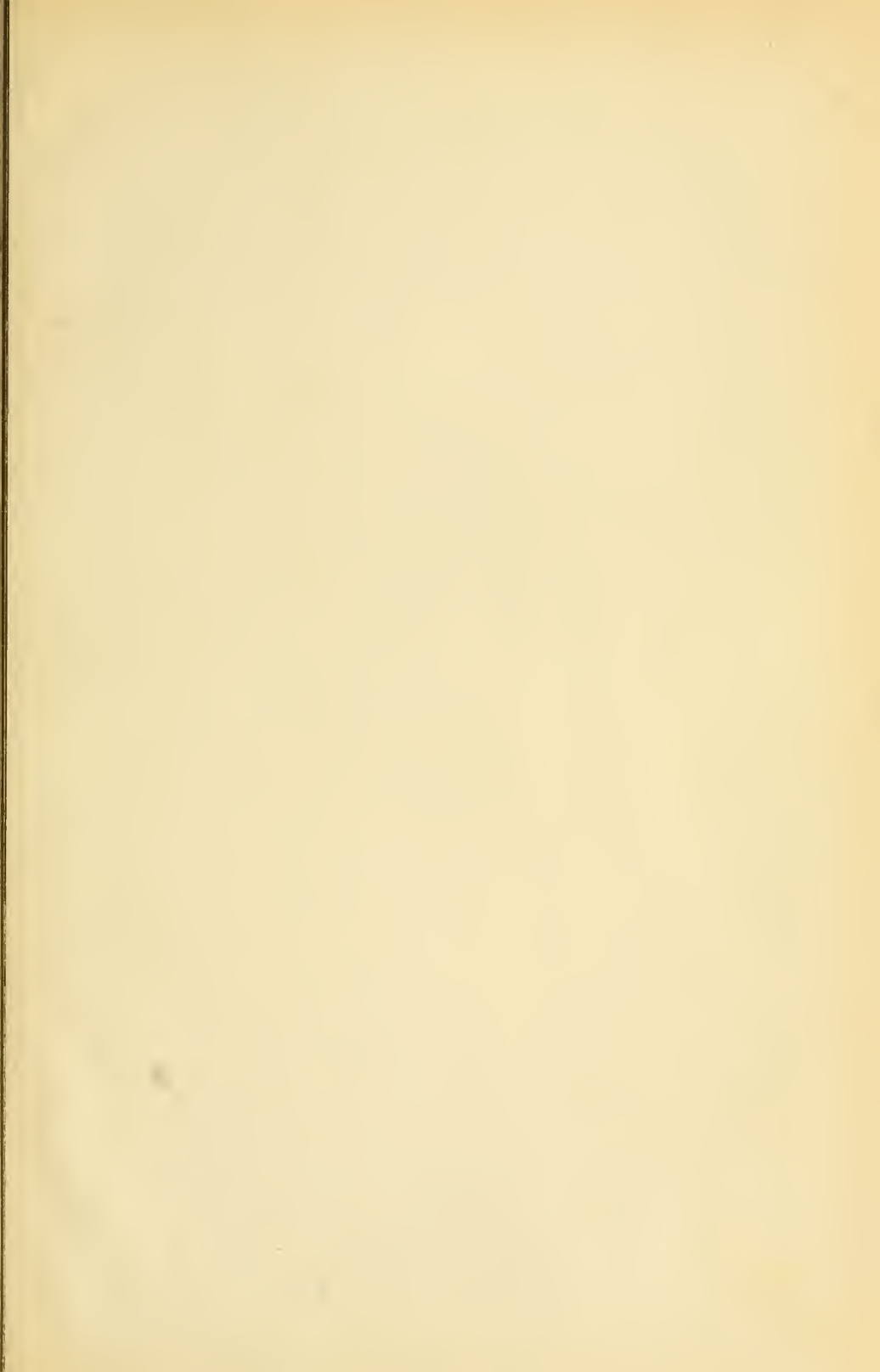














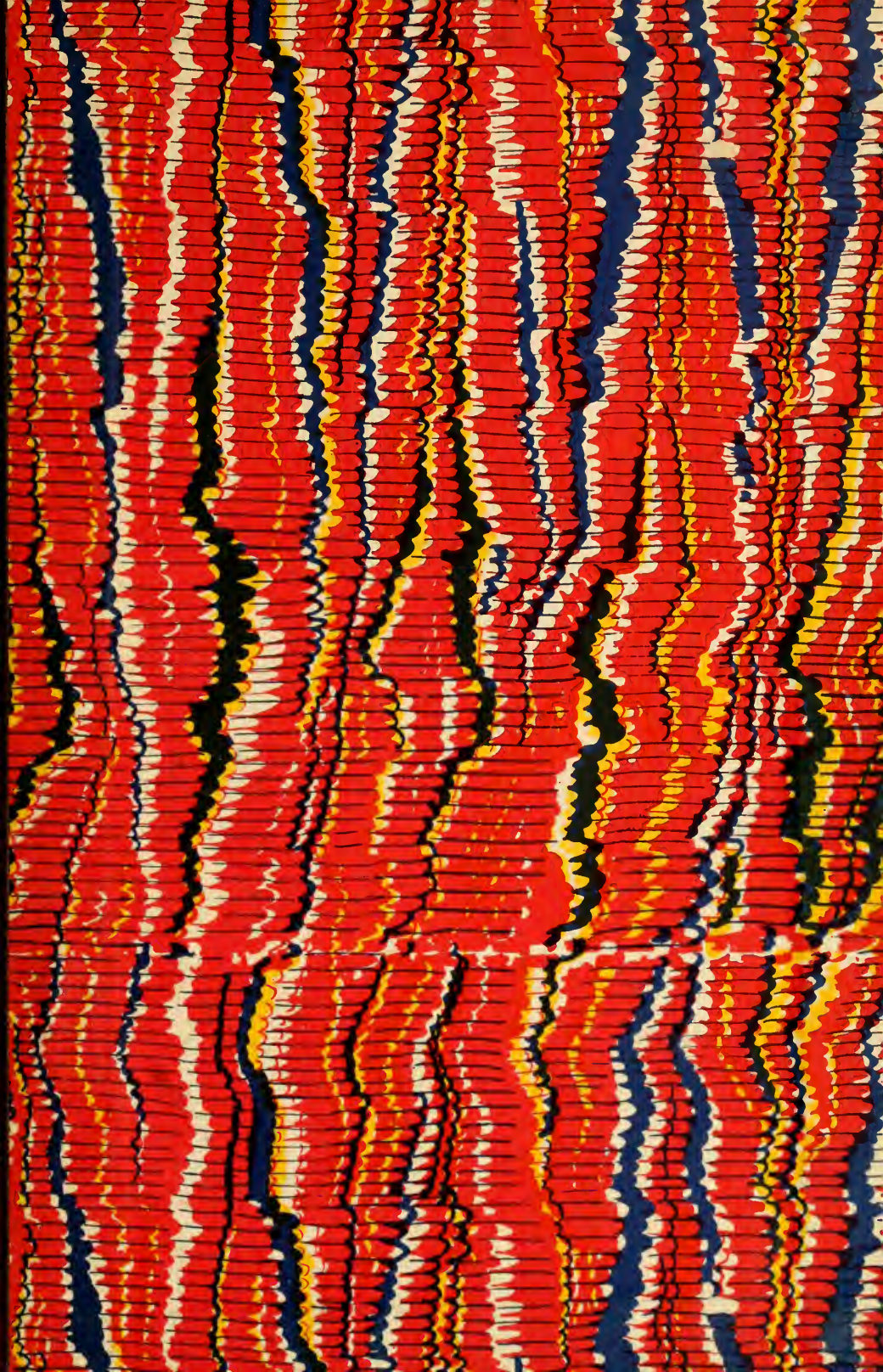




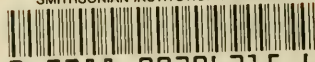








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