PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL. XVI, No. 14, pp. 397-499, text-figures 1-287 APRIL 27, 1927

XIV

A STUDY OF THE TERMINAL ABDOMINAL STRUCTURES OF MALE DIPTERA (TWO-WINGED FLIES)

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This paper was written as a part of the requirements for the degree of doctor of philosophy at Stanford University, and I wish to express my thanks to Professors R. W. Doane and G. F. Ferris of the Department of Entomology in that University for their helpful suggestions and aid in many ways during the progress of the investigations. The original manuscript and the drawings were sent to Dr. G. C. Crampton of Massachusetts Agricultural College, and I am greatly indebted to him for reading over the manuscript and suggesting many important changes. In the original manuscript I had followed Berleze and Metcalf in numbering the abdominal segments (allowing for a hypothetical first segment fused with the thorax) but I am now converted to the view held by Dr. Crampton. The genitalia are therefore considered to be on the ninth abdominal segment, any fusion of segments occurring at the apex of the abdomen.

I am indebted to the following entomologists for material loaned: Dr. C. P. Alexander, Massachusetts Agricultural College; Mr. C. W. Johnson, Boston Society of Natural His-

tory; Mr. E. P. Van Duzee, California Academy of Sciences, and Dr. J. M. Aldrich of the U. S. National Museum. Most of the material used was from the Stanford University collection and from the writer's collection.

Manuscript notes and drawing of the hypopygia of the Muscidæ (sens. lat.) were prepared some years ago by R. E. Snodgrass while at Stanford University, and these were of assistance in comparing results of dissections. Any study of this kind has of necessity to borrow more or less from the results of previous workers, and the papers by Lowne, Snodgrass, Wesche, Newstead, Metcalf, Crampton, and others, have paved the way for this contribution to the study of the genitalia of male diptera.

In studying a series of insects ranging from primitive to specialized types it is often very difficult to homologize the parts of the genitalia; it may require in some cases a study of the organs in the early stages of the insect, and there is much work yet to be done in this field. There is danger in drawing conclusions from a small amount of material; a series of generalized and specialized types should be studied where possible, but in a paper such as this space forbids the description of more than a few representative species for each family. The fine work recently done by Crampton in this field demonstrates clearly that the basic plan of the male genitalia of the Diptera can be established, and a generalized type arrived at which can be homologized with the orders of insects that are closely related. Some of the secondary structures may be difficult to homologize.

The systematist in present-day entomology has to deal with very minute differences of structure in the characterization of species. Some of the most remarkable characters are to be found in the structures that go to make up the male genitalia, and as a rule these characters are the most dependable of all. In studying other parts of the body we often find a great deal of individual variation, as in the body color, shape of markings or color of the pile, but the male genitalia are remarkably constant for the species and the student of Diptera will find it well worth while to study these organs in any group with which he is working.

We cannot, of course, have a system of classification based

on the male genitalia alone, or on the female reproductive system alone, because a natural classification will not admit of the adoption of one set of characters to the exclusion of others. The greatest value of genitalic characters will be in the characterization of species, but there may be structures common to genera or even larger groups.

Time did not permit of biological investigations in connection with this study. The paper is intended primarily as an aid to the worker in taxonomy, but there are many interesting problems suggested for the insect morphologist. All of the principal families of Diptera were studied and more than 250 species dissected.

Charles Darwin in a letter to B. D. Walsh in October, 1864, wrote the following: "What can be the meaning or use of the great diversity of the external generative organs in your cases in *Bombus* and the phytophagous coleoptera? What can there be in the act of copulation necessitating such complex and diversified apparatus?" The same could be said of most male Diptera. The meaning or use may not be clear to us, but it probably has an important bearing on the evolution or the stability of the species.

Methods

The writer has had good results with very simple methods in preparing the genitalia for study and very few fresh specimens were used, most material being pinned and dried. Specimens were prepared by breaking off the abdomen, or the genital portion, and boiling in 10 per cent KOH for from ten to thirty minutes, depending upon the degree of chitinization; in a few cases it was necessary to soak the material in KOH for a few hours. After this the material was washed in distilled water and placed in 70 per cent alcohol until studied. Most specimens were of such size that dissecting could be done under a binocular microscope. The writer prefers to draw without the aid of a camera lucida.

The Male Genitalia

The most recent work in this field is that by Metcalf on the male genitalia of the Syrphidæ and Crampton on the male genitalia of Mecoptera and Diptera. Metcalf studied all of

the important syrphid genera in North America and about 200 species, so that his conclusions are of considerable importance in a study of the Diptera as a whole; he made no attempt to homologize the parts of the genitalia with those described in other orders of insects, giving, in large part, such names as were appropriate to the parts and in addition to these terms certain others that were devised for convenience in description. The work of Crampton is much broader in its scope and deals with many of the genitalic structures from the standpoint of phylogeny.

There has been considerable theorizing as to the number of abdominal segments and most authors have given ten as the number in higher insects. The presence and position of the spiracles is of importance in determining the actual segments represented. Most embryologists hold that there are twelve segments in the primitive forms and the Protura in certain cases retain the twelve segments. Crampton finds that the retention of even eleven segments is not common in the lower winged insects. Certain embryologists have apparently established the fact that the cerci are modified limbs of the eleventh segment, and if this is true there are two segments beyond the genitalia proper. I have finally come to the conclusion that *the first visible segment is actually the first* and that there is no fusion of a hypothetical first segment with the thorax, a theory held by Berlese and Metcalf. If any fusion has taken place it is in the tenth and eleventh segments. There are never more than eight pairs of spiracles on the abdomen and usually only seven pairs, so that the apical segments are sometimes hard to distinguish. Berlese calls the first visible segment the actual third, but this is certainly a mistaken view, as is his supposition that the apparent sixth segment is a "large basal expansion of the seventh."

Metcalf uses two convenient terms in dealing with the Syrphidæ, namely, *preabdomen* and *postabdomen*. These terms are useful where the posterior segments of the abdomen are modified, but there are only a few families where the divisions of the abdomen are so distinct as in the Syrphidæ. The preabdomen may be reduced to three segments, or the apical modification of the segments may be confined to the last three, the postabdomen being adapted to the form and function of

the genital appendages. The anus bearing segments are involved in the revolution of the genitalia of Diptera, and in this respect they differ from the male sawflies. The torsion of the terminal abdominal segments is found in certain tipulids and culicids and also in a few mycetophilids. This revolution of the last three segments is quite different from the remarkable twisting of the postabdomen found in the Syrphidæ and Pipunculidæ. These last two families have the basal segments of the abdomen crowded over to the left side of the preabdomen; the rotation is clockwise along the long axis, and in many species of these two families the terminal tergites and sternites have gaped apart.

There is often a depression in the preabdomen caused by the folding of the postabdomen against it; this depression is partly or wholly membraneous owing to the pressure on the hypodermal cells; it is called the *genital pouch* by Metcalf and is greatly developed in the Syrphidæ. Owing to the torsion and pressing together of segments in the genital region there has been considerable misinterpretation of the postabdomen; tergites are apt to be mistaken for sternites and vice versa. The term *hypandrium* for the plate or sternite below the genitalia is a useful term proposed by Crampton; the term *epandrium* is used for the plate above the genitalia. The word *hypopygium* is used to designate the entire male genitalia and is therefore confined in its strict interpretation to the ninth abdominal segment.

The eighth urite in many forms is a single sclerite and as there are no spiracles on this segment there is often some question as to its being a sternite or tergite, but it is probably the latter. The modified appendages and limbs of the ninth abdominal segment make up the male genitalia and none of these parts are a part of the tenth segment. It is probable that there are eleven segments in the abdomen, in which case the anal region, or *proctiger* of Crampton, consists of the fused tenth and eleventh segments.

The ninth urite becomes specialized and greatly developed in many families of the Diptera and carries the *styles*. The shape of the ninth tergite is modified by the shape of the cerci on the distal margin in many species; the ninth sternite in many forms serves as a lever between the styles and the

base of the ædeagus. The genital opening is said to be primitively between the ninth and tenth sternites. The cerci make up most of the proctiger and there are indications of *parapodial plates* at the base of the cerci in some of the families; in fact the organs called the cerci may in reality be parapodial plates in some forms, as has been suggested by Crampton. The plates on either side of the anus will in this paper be considered the cerci; this point could possibly be made clear by embryological investigations. The surface of the cerci is usually hairy, the hairs being probably sensory in many cases. The plate above the anus, or supraanal plate, may be termed the *epiproct;* as used in this paper the term refers to the terminal abdominal tergite. The cerci are the *appendages IV* of Newell and the *forceps superiores* of Wesche. They are usually quite simple and do not vary greatly.

The intromittant organ of the male is centrally located and is easily homologized in the families of the Diptera; the true penis is membranous and largely internal, or with a sheath, and the organ often referred to as the penis is best termed the *ædeagus,* a term used by the students of several orders of insects. Several investigators have found that the true penis is often exserted by blood pressure; the sheath, or ædeagus, guides the penis and is nearly always rigid. There are a few cases in the Diptera where the true penis seems to be without any covering. The ædeagus in some species is armed near the tip with *cornuti,* or more or less complex appendages. In some insects there is a false penis which is used to open the vagina before the true penis is exserted; an arrangement of this kind is probably present in some of the Diptera.

Sharp and Muir termed their work on the Coleoptera as a study of the "male genital tube," and these authors maintained that a complete understanding of the male structures was possible only when the female organs were studied in connection, the two taken together forming the "genital conduit."

The orifice of the genital tube arises from the invagination of the tube itself, so that it is a doubled tube, one end a continuation of the body wall and the other branching to

the two testes; there may be a chitinization of some parts of the wall. The tube is a ventral structure and has no tergal plates, but sternites may enter into the making of it. The ædeagus may be produced into a long flagellum, it being coiled into the apical segments of the abdomen in some of these forms. In some of the Coleoptera and Mecoptera this kind of structure is to be found. In some of the Diptera there are two or even three openings of the ejaculatory duct. In a few primitive orders of insects the penis is represented by structures that are in some cases difficult to homologize; in the Ephemeridæ and in the sawflies this organ is represented by paired valves or "penis valves" as they are termed by Crampton. The ædeagus is generally considered the fused appendages of the ninth segment, arising from the caudo-ventral portion of the segment. The orifice of the ejaculatory duct is often hard to make out and may be on an elevated portion called by Metcalf the *ejaculatory process.*

In describing the appendages of the ædeagus Lowne used several terms which it may be well to retain as they have been used by several writers since his time, these are: the *paraphalli,* two strongly chitinized, lateral rods from the back of the part, and the *hypophallus,* a paired organ arising from the front part of the sheath. One or both of these structures may be present or absent. The "chitinous box," so-called by Metcalf and Berlese, is an expansion near the base of the projecting portion of the ædeagus (Metcalf states that is near the apex of the penis) and rests usually on the apex of the double apodeme. The processes on this structure are given names by Metcalf in his paper on the family Syrphidæ. The "ejaculatory hood", a term used by Metcalf, is a modification of the apex of the ædeagus that is unusually well developed in the Syrphidæ. This structure is absent in many of the families of Diptera.

The structure called the *double apodeme* by Wesche and the *"sustentacular apodeme"* by Metcalf, gives support to the ædeagus, especially to the chitinous box and the muscles which rotate the parts are attached to it. The apodeme is easily seen in many species when cleared; it may be double, partially fused or wholly united, and is often specifically distinct in related forms.

The *ejaculatory sac* is an expansion of the efferent ejaculatory duct near its proximal end and is often flask-shaped. Delicate muscles extend from this sac to the margins of the *ejaculatory apodeme,* which varies in form but is in many cases umbrella-shaped. The theory is that the contraction of the muscles pulls the rod-like base of the apodeme into the sac like a piston and expels the seminal fluid, but there are many cases where this action must be quite different owing to the shape of the apodeme or its small size. The form of the ejaculatory apodeme may be of considerable taxonomic importance.

The ædeagus is often heavily chitinized and is usually more or less cylindrical, being as a rule much longer than broad, but in some groups it is very short; in many groups the ædeagus is greatly specialized, possessing keels, ridges, tubercles, etc. Berlese divides the sheath of the penis into "two canals (epiphallus and hypophallus)", considering them contributions from the eighth and ninth segments; in this he is certainly in error, any apparent division being due to difference in chitinization. There are various lobes on the ædeagus. The projection partly filling the cephalic emargination in certain of the Syrphidæ is called the *lingula* by Metcalf.

I have adopted many of the names used by Lowne and Wesche in considering these structures at the base of the ædeagus, many of which are absent in whole families of the Diptera. The base of the ædeagus in the Diptera is apparently the same as the "tegmen" of the Coleoptera, a name given by Sharp and Muir, and consists of a basal piece or ring and the appendages. Of these appendages there are, as a rule, two in the Coleoptera (lateral lobes), and usually two pairs in the Lepidoptera. These appendages may be known under the general name of "gonopods." The term "harpes" is preferable for the terminal segments of the gonopods of insects in general, but there may be some confusion if it is adopted because of other uses of the name. The terms *basistylus* and *dististylus,* proposed by Crampton for the two segments of the genital styles, will be used in this paper. In the Diptera and other higher insects a pair of styles forms the outer ventral pair of claspers on each side of the ædeagus. The lateral portions of the ninth segment may be prolonged

and form accessory clasping organs, which may be known as *surstyli.* The dististyli and surstyli often have spines or ridges on the surface to aid in holding the females more securely. The genital styles are the "appendages 1" of Newell, the "claws" of Lundbeck, the "forceps inferiores" of Wesche, and correspond to the "valvulæ externæ" of Lowne. They are commonly known as the "claspers" and vary greatly in size and shape; there is often an accessory lobe of the dististylus (occurring also in some Panorpids) and in some the dististyle is divided into an inner and outer lobe.

The *laminæ superiores,* so named by Dziedzicki, are paired processes, often on a separate plate on the anterior edge of the cavity containing the genitalia; they are strongly chitinized in some species and often armed with bristles. They probably aid in holding the female and are absent in most of the Diptera.

The term *interior forceps* may be used for the "forceps interiores" of Wesche. These are small, usually blade-like processes on either side of the ædeagus, generally articulated and more or less chitinized, the surfaces usually smooth. These organs were called the "posterior gonapophyses" by Lowne and later Snodgrass used this term, pointing out at the same time that the name "gonapophyses" was likely a misnomer from the standpoint of homology. The so-called *genital palpi* are small palpiform organs, one on either side of the ædeagus but anterior to the interior forceps; they usually possess sensory hairs or setæ. The term "palpi" was used by Wesche and is not a good one because of the generally accepted use of the term in referring to the palpi of the mouth parts. Wesche, of course, was attempting to show the close correspondence of the mouth parts to the genital structures. These organs were called "anterior gonapophyses" by Lowne. When they are absent there may be compensating sense organs in this region. Metcalf terms the two pairs of organs described above the "internal lobes", referring to them as *cephalic* or *caudal* internal lobes.

The so-called *spinus titillatorius* is a single unpaired organ and is not found in many of the families of Diptera; it arises from the base of the ædeagus without any suture and has a

tendency to being membranous at the tip. Lowne termed the organ the "spine." It is well developed in some species of the genus *Dolichopus*.

ASYMMETRY

There are some remarkable cases of asymmetry in the genitalia of the Diptera, but no examples are known among the more primitive forms; beginning with the family Cyrtidæ we find many instances of distinct asymmetry through the various families. The Syrphidæ and Pipunculidæ nearly always have the postabdomen quite asymmetrically developed, and there are other families in which this is the general rule. The uneven development is usually cephalad of the ninth segment, but there are instances where the appendages of the ninth segment are not the same on the two sides; in these cases it is nearly always the left side or left appendage which is shortened. In the Syrphid genus *Sphegina* all of the parts of the genitalia are asymmetrical. The pressure of some part of the genitalia against the sternites adjacent to them apparently stops chitinization in many species, so that the ventral part of the postabdomen is often largely membranous. A study of the pupal stage should be made in this connection, in order to see where this asymmetry first takes place and just what causes it.

FUNCTIONS

The object of the male genital tube is to introduce the seminal fluid into the uterus of the female, and, as Sharp and Muir point out, the male and female genitalia form functionally a single organ—the genital conduit. It is probable that the sperm is always placed directly in the spermatheca, but there are species so constructed that it is difficult to see just how this is done. In cases where there is a very long female ovipositor there is a correspondingly long ædeagus in the male, as in the Ortalididæ and Trypetidæ. The evagination of the penis is by means of blood pressure, the invagination by means of muscle contraction in certain areas. The spines and hairs on the ædeagus, when present, point basally, thus serving to keep the organ in the uterus of the female. There must be great pressure in order to send the seminal fluid through the

penis when this organ is remarkably long and the duct of small diameter, and a great amount of muscular force is necessary to control the organ. The female undoubtedly plays a more or less active part in copulation in many species.

Certain of the organs are of use in holding the female during copulation; the styles are among the most important of these and they often have spines and hairs on their surfaces which aid in the holding; in some cases there are claw-like appendages. There may be processes, bristles, etc. on the fourth and fifth sternites which aid in holding, or there may be modifications of these segments into claspers, as in some of the Scatophagidæ and Micropezidæ. Various parts of the ædeagus are also modified so as to hold the female.

Metcalf states that the only organs that appear to have a sensory function are the cerci. These organs are almost always exposed and often have on their surfaces sensory pits or hairs. It is quite possible that the genital palpi also have certain sensory functions.

TAXONOMY AND PHYLOGENY

Coleopterists have found the male genitalia to be of great importance in taxonomy, especially in the separation of species, and Sharp and Muir have shown their importance in arranging large groups of species. In the Hemiptera the genitalia may be of generic value and in the Odonata they have been used in the defining of tribes and subfamilies. We find in the Diptera that there are types of genitalia characteristic of whole families, even though there are at the same time great specific differences. In certain groups Nature seems to have "run amuck" in the matter of specialization of the genitalia, just as it has done in the specialization of wing venation in some groups. The Tipuldæ are primitive in most respects and yet the genitalia are remarkably complex in many of the genera. The female genitalia have been given considerable weight in the erection of genera and even families in the Muscoid flies, but it is doubtful if the male genitalia will always show structures that will fit into this classification.

The chitinization of certain areas gives very good characters for the differentiation of species, and the limits of these areas are usually quite constant. Creases and pressure in certain

areas may prevent the development of the hypodermal cells and limit their extension. The genital tube is long in some forms and in such cases there would be a tendency for it to fold and form separate sclerites along its length.

There may be some objection to taxonomic work which requires more or less preparation of the specimen or even dissection, but the mere fact that more work is required is not always a primary consideration. It is a pleasure to be able to determine species with the aid of a low power lens or without the aid of a lens, and fortunately there are many species which will not under ordinary circumstances require closer work, but the day is coming when "new species" in the Diptera will be founded on some structural character, and, when other parts of the body are not sufficiently characteristic of the species to preclude confusion with related forms, the genitalia of the males will in most cases decide the point. Many species described in the past have been separated by differences of color and vesture; in these cases the naming of poorly preserved specimens is an almost hopeless task, yet a study of the male genitalia may reveal remarkable differences, and these organs are seldom injured in preserved specimens. When the male genitalia of certain forms are carefully worked out by one student, then others may profit by this work and in many instances no dissection is necessary, enough of the structures being visible to make the determination certain. In describing the genitalia many structures can be best described by figures; it is often difficult to describe some of the complex parts in words.

PHYLOGENY

The student is referred to recent papers by Crampton for detailed information on this subject. In the lower Diptera, such as the Tipulidæ, the relation of the parts of the genitalia is the same as in the sawflies (Hymenoptera of the family Tenthredinidæ), certain of the structures being developed secondarily so that the general appearance is often quite complex, but the basic plan is the same. Crampton is undoubtedly correct in his conclusion that the Diptera are very closely related to the Mecoptera; this relation is clearly seen in a study

of the male genitalia, and the relation is borne out in a study of the mouth parts and other organs. According to recent studies the Mecoptera are probably the nearest living representatives of types ancestral to the Diptera, and possibly both orders are derived from Neuroptera-like ancestors, although the genitalia of Neuroptera are dissimilar from the parts of other insects in many ways.

Morphology

A study of the anatomy of the male genitalia

Family Tanyderidæ

Dr. C. P. Alexander in studying this family has arrived at the conclusion that its known representatives are the most primitive of the recent crane flies, and judging from my own limited study of this interesting little group this seems to be true. Through the kindness of Dr. Alexander I was able to study two forms, *Tanyderus forcipatus* O. S. from New Zealand, and the rare *Bruchomyia argentina* Alexander from Argentina.

The genitalia of *T. forcipatus* are shown in fig. 1. The ædeagus is divided into three forks at the apex, apparently the middle one being the opening of the ejaculatory duct. Two ridges at the base of the basistyli (so-called side pieces) take the place of the guards of the ædeagus. The cerci are greatly reduced.

From a study of the male genitalia (as well as some other characters) the writer agrees with Alexander in placing *Bruchomyia argentina* with the Tanyderidæ rather than considering it a primitive form in the Psychodidæ, as some authors have suggested. The genitalia do not suggest the Psychodidæ, and for that matter are quite different from the genitalia of *Tanyderus,* as can be seen from figures 2 and 3. The ædeagus is normally almost entirely internal and there are no indications of the interior forceps or genital palpi. Probably a new family will be required for the reception of this unusual species.

Family TIPULIDÆ

The male hypopygium in this family has been used considerably by taxonomists as a source of characters important in the classification of species; the structures can be homologized through the group although there are some unusual specializations. The generalized forms in many genera have a simple hypopygium and there are rarely any modifications of the segments cephalad of the eighth segment; in some species the ninth segment is greatly specilized and the structures quite complex. The genitalia of several genera were worked out by Snodgrass, whose interpretation has been followed by Alexander and others in many taxonomic papers.

In the Tipulinæ the so-called "pleurites" are closely attached to the sternites and have various appendages. Crampton called the writer's attention to the fact that the "pleurites" of Snodgrass are in reality the basistyli. The ninth tergite is variable in shape and may be large or small, with the caudal margin straight or variously modified. In some forms the appendages of the basistyli project through the median notch of the ninth tergite when at rest; in certain species a median lobe may be developed. The ninth sternite is also of various shapes and sizes and in some forms is separated from the basistyli by a distinct suture. As noted by Alexander, the "pleural" suture is often short and may be only a short impression on the ventral side of the basistyle. In some species, as in *Tipula derbyi* Doane, the eighth sternite is large and the ninth sets into it. The eighth sternite is usually notched and in some species is apparently divided by a median line. In the lower genera the basistyli are in their normal position, but in some forms they are pushed to the outer side of the sternite or are absent. The terms proposed by Westhoff for these structures seem unnecessarily cumbersome. There are many modifications of the basistyli, usually with two appendages, the outer one often more or less fleshy, the inner, or secondary appandages, usually heavily chitinized. The latter I interpret as the dististyli. Crampton figures these as the apical and subapical appendages.

The interior forceps and guards of the ædeagus vary a great deal in different species. In the lower genera the ædeagus usually projects backward as a slender rod, in the Tipulidæ being carried up anteriorly and on the dorsal wall of the geni-

tal chamber, then down the anterior wall and posteriorly along the floor of the genital chamber. The ejaculatory sac is usually quite conspicuous as a basal swelling. The true penis is inside the long rod and in some species is half the length of the abdomen when stretched out. In all groups the ædeagus has a guard, usually two long plates, the lower edges being united by a membrane; there are many modifications of this form. In most forms the interior forceps and the genital palpi (gonapophyses) can be made out. The sheath of the penis may have been originally a pair of processes projecting caudally above the penis and another pair below.

In the Limnobiinæ the basistyli are prominent and have appendages of considerable size which act as claspers. In *Geranomyia* and others the apical appendages of the dististyli are soft and fleshy, the subapical appendages in the form of sharp hooks (fig. 12). The genitalia in *Gonomyia* are very complex and hard to homologize (fig. 13). In *Acyphona* and some other genera the hypopygium is asymmetrical and there is more or less torsion, the ninth segment being twisted half way around (as in some of the Culicidæ). In *Chionea, Cladura* and *Pterochionea* there is a single powerful pleural appendage on each side, the basistylus. The penis guards on the venter of the genital chamber are quite prominent in some forms.

The cerci are usually large hairy plates and are quite varied in shape, one on each side of the anal opening. There is usually a double apodeme at the base of the ædeagus; in *Nephrotoma* two pieces represent the atrophying apodemes. According to Alexander, the genus *Macromastix,* with more than 50 species from Australia and New Zealand, shows considerable torsion of the genital segments.

Family Ptychopteridæ

Three species were studied in this family, *Bittacomorpha clavipes* (Fabr.), *Bittacomorphella sackeni* (Röder), and *Ptychoptera lenis* O. S. The basistyli are well developed in all of these forms and have apical appendages. The surstyli are unusually developed.

The abdomen in the first two genera is exceptionally long and slender. The ninth tergite has a tendency to divide and the cerci are not well developed. Below the ædeagus there is

a peculiar structure which resembles the anal segment in some other forms; this structure serves as a guard for the ædeagus. The interior forceps in *Bittacomorpha* are chitinized and peculiar in shape, the gonapophyses rounded and more fleshy (fig. 14). In the genus *Ptychoptera* the guard below the ædeagus is larger and forms a half sheath.

Family RHYPHIDÆ

According to Wesche the cerci (which he calls forceps superiores) are complicated and strongly chitinized in *Rhyphus fenestralis* Scopoli, hairy and smaller than the same structures in *R. punctatus* Fabr. In the latter species the ejaculatory duct at the inner end presents the appearance of a long tangled thread (figs. 16 and 18). A specimen of *R. alternatus* Say was loaned from the National Museum collection. The thread of the ejaculatory duct is much longer than in *R. punctatus,* there being eleven coils at the end when stretched out as shown in fig. 16. The ædeagus and apodemes are heavier than in *punctatus;* the styles are short, heavy and claw-like. The cerci are comparatively large and densely pilose.

A male of *Mycetobia divergens* Walker was loaned by the National Museum. Some of the genital structures were accidentally broken in dissecting and a structure which I take to be the long ejaculatory duct has become separated from the basal attachment; it is not shown in fig. 34. This is an added proof of the correct placing of *Mycetobia* in the Rhyphidæ, as the long, coiled tube is not found in any other group so far dissected.

A male of *Obliogaster tæniatus* Bellardi was loaned by the National Museum. The genitalia are comparatively large, the cerci especially so (shaped much as in *Mycetobia divergens).* The genitalia are more complex than in other species of the family studied. The basistyli and dististyli are short, heavily chitinized, with an apical long spine curved at the tip; this hook-like spine is on the inner side; a blade-like process projects at right angles to it. There are two pairs of inner appendages, apparently tergal and attached to the base of the cerci, one pair long and blade-like, the other short and blunt, with apical pile. The sternite of the ninth segment has a large median structure which might be mistaken for the ædeagus,

but the true ædeagus is probably at the base of this structure. The ejaculatory duct is not long and coiled at the apex.

The genus *Trichocera* is now placed in this family, partly because of the great similarity of the early stages; the male genitalia are quite different. In the *Trichocera* species figured the interior forceps are slender and spine-like (fig. 15); the ædeagus is short and there is no great development of the ejaculatory duct. In another western species of *Trichocera* dissected the genital styles are simpler, the ædeagus, interior forceps and cerci about the same as in the figured species. The Trichocerinæ are the most generalized of the Rhyphidæ.

Family DIXIDÆ

This is a small family, with one genus, *Dixa*. The genitalia of one undetermined species of *Dixa* were studied and found to be tipulid-like in general form, as can be seen from figures 20 and 21. The basistyli are not developed as in some of the Tipulidæ. A male of *Dixa fusca* Loew was studied and the ædeagus found to be very short, probably extended by blood pressure. The basistyli are heavy, as in the Chironomidæ, with two inner appendages on each, which have bristles on the edges, much like those shown in fig. 26. The cerci cannot be made out with certainty with the binocular microscope; there is a small dorsal structure on each side of the usual location of the cerci. The apodemes are not visible in prepared specimens and are probably delicate and weakly chitinized.

Family PSYCHODIDÆ

The male genitalia of the genus *Phlebotomus* have been worked out in detail by Mr. R. Newstead (Bull. Ent. Research, London, vol. 2, p. 61), and very good specific characters have been found in the study of these structures. In some forms there is no distinct line between the ninth tergite and sternite. The tergal portion is deeply bifid and usually with more or less elaborate appendages, called by Newstead the "superior claspers", which are probably the surstyli; these structures are generally hairy and in some species possess scales. The sternal part is composed largely of processes termed "inferior claspers" by Newstead (probably gonostyli);

between these is a pair of slender appendages, more or less developed. Near the base of the styles are structures which correspond to the interior forceps. The ædeagus in *Phlebotomus* is bifid from the ejaculatory sac to the tip; there are two ducts and the penis is therefore double, its sheath also for some distance.

The genus *Trichomyia* resembles *Phlebotomus* in the genitalia characters (fig. 22). The other two forms studied, *Psychoda* sp. and *Pericoma californica* Kincaid, are much simpler and do not show the double ædeagus and the interior forceps (figs. 23, 24 and 25).

Family ORPHNEPHILIDÆ

In Aldrich's Catalogue this family is placed between the Rhyphidæ and Stratiomyiidæ; it may be related to the former through the genus *Trichocera,* but the Rhyphidæ are now placed near the Tipulidæ. The one species examined, *Orphnephila testacea* (Ruthe), has the general appearance of some of the Chironomidæ and the male genitalia show this relation.

The eighth segment is greatly reduced but symmetrical, the ninth tergite with a small median keel as in some of the Chironomidæ. There is a median structure which resembles a double ædeagus (fig. 33), consisting of two slender rods curved over at the apical third. The true penis is probably membranous and is exserted from between these two structures. The ninth sternite is bifid to the base and with an apical claw-like appendage on each side. The cerci are small, only slightly chitinized and concealed beneath the ninth tergite.

Family CHIRONOMIDÆ

The male genitalia of the Chironomidæ have been studied to some extent and have been figured by Malloch, Johannsen and others in this country. The main clasping organs are on the basistyli. The tergite is often in the form of a keel. The dististyli are the "claspers" and possess good specific characters. The cerci are not well developed.

In *Tanypus venustus* Coquillett the hypopygium is quite simple, being reduced to two large "side-pieces", which I

interpret as the basistyli; the ninth tergite is greatly reduced (fig. 27). In the genus *Chironomus* two species were studied, one illustrated in fig. 26; the genitalia are more complex than in *Tanypus;* the cerci are greatly reduced and not visible from above. The other species of *Chironomus* studied is practically the same as the species illustrated. In *Paraclunio alaskensis* Coquillett the genitalia are very simple.

Family CULICIDÆ

The importance of the male genitalia in this family has long been emphasized by students working on the taxonomy, and as they were among the first workers in Diptera to use these structures a number of names had to be proposed for the purpose of description. Many of these names are not used in other groups of the Diptera, but the names are given here and future work in this field will make clear the homologies. A recent paper on "terminalia" of male mosquitoes by Freeborn (see Bibliography) marks a great advance in this study. There is a great specialization in the genitalia and some of the structures are difficult to homologize. The hypopygium has characters very important in classification and some of the larger groups have structures in common.

The so-called "side-pieces" are undoubtedly the basistyli, the clasping appendages on the apices of these the dististyli; these clasping appendages vary greatly and are quite intricate in some of the Sabethinæ. The eighth sternite is usually represented by a pair of small plates, often termed "basal appendages". In the simplest forms of the family there are three pairs of structures on the ninth segment, usually called by students of the family the *unci, harpagones* and *harpes.* This use of the term harpes is not the best. In the simplest forms the small "basal appendages", the "harpes" and "harpagones" may be absent (as in *Anopheles,*) but the "unci" are always present. The harpagones may be divided, the first division having a supplementary division in *Culex pipiens* (fig. 30). The so-called harpes (different structures here than in other orders of insects) often have a crown of spines and in many forms have finger-like projections. Edwards, in discussing the genus *Culex,* suggests that perhaps after use the parts may assume a different relative position, the unci

folded outwards and the harpagones pushed out so as to be at right angles to the usual position. The above mentioned paper by Freeborn should be consulted for an understanding of the torsion of the terminal segments (including the eighth) through an angle of 180 degrees.

The simplest hypopygium is found in *Anopheles* and the genus *Ædomyia* may be regarded as next in simplicity, only the unci being somewhat complex. The genus *Uranotænia* has no recognizable "harpes", but complex appendages represent the unci. In the genus *Sabethes* the dististyli are developed in a remarkable manner.

The Corethrinæ may be considered as a subfamily of the Culicidæ, although several authors give the group family rank. The male genitalia are simple and show a relation to the *Anopheles* group. Two species were dissected for study; in one, a species of *Corethra,* the basistyli are long and with long apical clasps; the unci are present and are strongly chitinized, with a subapical ridge, the other paired structures are not visible or are represented by projections of the surface. The ædeagus is not visible. In the only specimen of *Eucorethra underwoodi* Underw. available for study the dististyli are broken off, the rest of the hypopygium is shown in fig. 28.

Family MYCETOPHILIDÆ

There is considerable variation in the hypopygia of these flies. Johannsen has made use of the male genitalia in the classification of the North American species and European workers have made use of genitalic characters for some time. The dististyli are often curiously modified; the ædeagus is usually short and not prominent (figs. 36, 39 and 42); the guards of the ædeagus are often spine-like. The cerci are usually well developed.

The ninth tergite is unusually developed in the species of *Symmerus* studied (fig. 36). In a few of the difficult genera, such as *Exechia,* the characters of the male genitalia are the most important in differentiating the species, some of the females being almost indistinguishable. In *Boletophila hybrida* (figs. 38 and 39) the slender interior forceps recall the structures in some of the Rhyphidæ. The cerci in this species

and in *Mycetophila punctata* (fig. 42) are very large; the ædeagus in this species and in *Tetragoneura pimpla* (fig. 40) is very short.

The Sciarinæ are here considered as a subfamily of the Mycetophilidæ and not as a separate family. Wesche figures *Sciara thomæ* (Linn.) in his paper on the male genitalia of the Diptera; the cerci are shown as well developed, hairy and bulb-like. The styles in this species are valvular in appearance and on the ventral side of the abdomen, their true position. The ædeagus is a hyaline lobe, not heavily chitinized; the interior forceps are paired blades.

Family Itonididæ (Cecidomyiidæ)

The species illustrated, *Cecidomyia resinicoloides,* is fairly typical of the family (figs. 44 and 45); the basistyli form the principal part of the genitalia. In the genus *Lobodiplosis* there is a much greater development and modification of the ædeagus. In all the forms studied there is a great reduction of the ninth tergite. The dististyli may be larger than in the species figured, as in *Colpodia longimana* Felt, and the apices may be more or less modified for clasping, as in the genus *Porricondyla.* The hypopygium of *Epimyia carolina* Felt, as figured by Felt (N. Y. State Mus. Bull., 165, p. 218), shows a more complex arrangement, the basistyli having two apical appendages, the ninth tergite quite large and considerably modified.

Family Bibionidæ

In this family there is more specialization in the male genitalia and more development of the ninth tergite. The ædeagus and appendages in two closely related species, *Bibio hirtus* and *B. nervosus,* are quite different, as shown in figures 50 and 51. The clasping appendages of the ninth sternite are simple, the basistyli not entirely separated from the ninth sternite. In *Plecia ruficollis* there is considerable difference in the styles and an appendage in a pit near the base of the styles (fig. 54). In all these forms there is a noticeable development of the internal genitalia and framework.

Wesche states that in *Bibio hortulans* (Linn.) and *B. marci* (Linn.) the ædeagus appears as a plate, with edges bent over and covered by a delicate membrane. The interior forceps are not clearly differentiated in *B. hirtus* and *B. nervosus* but may be part of the ædeagus.

Family SCATOPSIDÆ

The Scatopsidæ are a group separated from the old family Bibionidæ mainly on the characters of wing venation, but a comparative study of the male genitalia would seem to justify the separation. Wesche describes and figures *Scatopse notata* (Linn.) in his previously mentioned paper. If Wesche's drawings are correct there is some difference in this species and the one known by that name in this country. The cerci are large in this species and all parts of the genitalia present except the spinus. The ædeagus externally suggests the Muscidæ, internally the arrangement is more like the Tipulidæ, so the family is almost on the border line between the two groups of the Diptera. The ejaculatory sac and apodeme are well developed (fig. 48).

In *Rhegmoclema atrata* (Say) there is a remarkable specialization of the ædeagus into a long coiled ribbon-like flagellum arising from a broad base (fig. 53); this form of structure is not found again until we come to the Ortalididæ. The ninth sternite is prolonged into an asymmetrical lobe, or a joining of two lobes (fig. 52); the ninth tergite has no styles; the internal forceps are short and pilose.

In *Reichertellia collaris* Melander the ejaculatory sac is large; the apodemes and basal projections are not developed as in *S. notata.* The ninth sternite is smaller than the tergite and has style-like projections (fig. 46), the larger pair the styli, with a very small median one and two rather small outer ones. The cerci are rather large.

Family SIMULIIDÆ

The male genitalia of this family have been described by Lundstrom and by Edwards. In dried material the structures of the hypopygium are hard to make out. Dipterists have not attempted to describe the genitalia of North Ameri-

can species. According to the writer's experience the males are quite rare in collections. Edwards figures the genitalia of several species (Bull. Ent. Research, vol VI, p. 24) and finds that they possess important specific characters.

Apparently the most important characters are on the basistyli, although the ninth tergite is more or less modified and the cerci are often specifically distinct. Edwards notes that owing to the absence of the ninth sternite these organs have taken up a more ventral position than usual in the Nematocera. Between the ninth tergite and the basistyli is the ædeagus (called the adminiculum by Edwards) and its appendages; it is of use in separating closely related species.

In *Prosimulium hirtum* (Fries) the seventh sternite is deeply notched on the posterior margin (fig. 57), the eighth sternite absent, and basistyli make up most of the ninth sternite.

In *Simulium pictipes* the epiproct is small, the cerci are small rounded plates. The dististyli are quite large (fig. 58). The genital framework is quite large and heavily chitinized. The ædeagus is small, flattened, with a flattened, curved, chitinized guard on either side.

Family BLEPHAROCERIDÆ

The genitalia in this group, especially the ædeagus and internal structures, suggest the Tipulidæ. The ædeagus is three-pronged and rests on a guard or half sheath (fig. 60) in *Bibiocephala grandis* O. S. The ninth tergite is small, the hypandrium well developed and with a dististylus or clasper on each side. The seventh and eighth segments are more or less reduced and modified, leaving a large membranous area. The cerci are fairly well developed in *B. grandis* and in *Hapalothrix lugubris,* the other species figured (fig. 61).

Family STRATIOMYIIDÆ

There is quite a departure from the preceding types in this family. The sternites of the abdomen are well developed in all of the species studied, being almost as large as the tergites.

The genital styles are simple and ventral in *Chloromyia formosa* Scop. and *Microchrysa polita* (Linn.), according to Wesche; the cerci are slender and hairy. The superior laminæ are absent. In *Beris vallata* the ædeagus is divided into three prongs at the tip, a central rod and two blade-like guards. In *Beris annulifera* (Big.) the ædeagus is somewhat the same (fig. 62). The guards of the ædeagus are the interior forceps and are found in *Odontomyia hoodiana* Bigot, *O. arcuata* Loew and *Stratiomyia maculosa* Loew (figs. 65, 66, and 67).

In *Sargus viridis* Say the ædeagus is much the same as in Beris. In *Odontomyia hoodiana* there are six visible segments, the true fifth being the last large one, the following segments much smaller, the sixth, seventh, and eighth being normally retracted in the fifth, the ninth projecting. In *Ptecticus trivittatus* Say the first five pairs of spiracles are in the membrane under the anterior corners of the tergites; segments seven and eight are greatly reduced, especially the tergites, as shown in figures 70. The ædeagus is different in shape than in the other genera studied and is not forked; the interior forceps are small.

Family TABANIDÆ

This family is clearly related to the preceding. The spiracles are in the intersegmental area. The cerci are larger than in the Stratiomyiidæ and are hairy, usually broadly rounded. The dististyli are normally bent inward at right angles and the ninth sternite is deeply bifid. The ædeagus is largely covered by the guards, the true penis being probably membranous and exserted by blood pressure. There is a distinct double apodeme and an ejaculatory apodeme attached to the ejaculatory sac (fig. 73).

Chrysops noctifer O. S., *Tabanus striatus* Fabr. and *T. punctifer* O. S. were dissected and studied by the writer, and all were found to have genitalia of much the same type, as can be seen from an examination of figures 69, 71, 72, and 73.

In this family the range of variation in species examined is so slight that it is doubtful if the characters will in all cases prove of value in taxonomic work.

Family PANTOPHTHALMIDÆ

These flies are tropical in their distribution and there are very few specimens in collections in this country; they have been called Acanthomeridæ by many authors in the past. The specimen studied I take to be a male of *Pantophthalmus versicolor* Austen. The genitalia of this species show a relation to the Rhagionidæ (Leptidæ) and other characters show them to be related to the Xylophaginæ and Cœnomyiinæ.

The ædeagus is comparatively large and simple, with no interior forceps or gonapophyses near the base. The double apodeme is well developed and straight sided. The styles are blunt and plain (fig. 77). The cerci are quite conspicuous and protect the ædeagus on the dorsal side; between the basistyli there is a sharp projection which also aids in protecting the ædeagus. The segments of the abdomen are well developed and there is a resemblance to some of the Rhagionidæ.

Family RHAGIONIDÆ (LEPTIDÆ)

The genitalia seem to be in general simpler than in the Stratiomyiidæ. The spiracles are in the intersegmental area between sternites and tergites. The sternites are somewhat reduced in this family but are still well developed. The hypandrium resembles that of the Tabanidæ.

The dististyli are of peculiar shape in *Symphoromyia cruenta* Coquillett; the ædeagus consists of two fused pieces on either side of a central part, the latter attached to the ejaculatory apodeme (fig. 74). In *Leptis incisa* Loew the ædeagus, framework and apodemes are nearly the same as in *S. cruenta.* The genitalia in *Xylomyia pallipes* (Loew) are quite different in general shape from the other forms examined (fig. 75) and this species is aberrant in structures other than genitalic. The styles are short; next to the ædeagus are two long rods, one on each side, probably the interior forceps; below these is another pair of structures which may be the genital palpi; the ædeagus is curved and pointed.

Family NEMESTRINIDÆ

Two species were examined in this family and the two are quite different in general appearance; one species, *Rhyncocephalus volaticus* Williston, is shown in figures 78 and 79; the other species, *Nemestrinus ariasi* Lichtwardt, has the eighth and ninth sternites unusually developed, the ninth fitting up against the ninth tergite and inclosing the genitalia; the ædeagus is slender in this species and with the interior forceps projects up through the notch in the ninth tergite. The cerci are longer than in *R. volaticus* and quite slender.

R. volaticus has comparatively small genitalia which are, however, quite complex. The abdomen is broad and rounded, the tergites distinctly overlapping and hard to pull apart; the spiracles are in the intersegmental area, with a conspicuous ring of membrane around them; the sternites are broad and not heavily chitinized, the membrane not so easily distinguished from the sternites and tergites in the cleared specimen. There is a narrow plate running from the cerci to the base of the ædeagus. The interior forceps are pointed and the genital palpi, which are larger, are serrated at the tips. The ejaculatory apodeme is quite large (fig. 79).

Family CYRTIDÆ

The genus *Eulonchus* has quite simple genitalia, with conspicuous cerci. The ninth tergite curves over the ædeagus and is not split into claspers or surstyli (fig. 84). The two structures at the base of the ædeagus are probably the halves of the hypandrium rather than the interior forceps. The basal apodeme is slender and partly covered by the sheath of the penis.

In *Ogcodes* there is a short rounded abdomen with very wide sternites and very little intersegmental membrane; the spiracles are *all in the margins of the tergites,* which curve over the sides of the abdomen. The seventh and eighth segments are reduced to narrow rings and the ninth is small (fig. 82). The figures of the genitalia show that *Ogcodes costatus* Loew and *O. albicincta* Cole are distinct species (figs. 81, 82 and 90). In this genus the guards of the ædeagus, probably the ninth sternite with fused basistyli, are peculiar in

shape, dish-like, the ædeagus projecting only a short distance beyond them. There is a central apodeme at the base of the ædeagus and a smaller one on either side. The cerci are small.

In *Opsebius diligens* O. S. the arrangement is more like that in *Eulonchus* than in *Ogcodes*. The ninth tergite is large and covers the most of the structures (fig. 83). There is one pair of inner claspers, the interior forceps.

Family Bombyliidæ

In the species examined in this family the apical segments of the abdomen are not greatly modified. There is a suggestion of the Cyrtid genus *Eulonchus* in some of the forms. The ninth sternite has well developed basistyli and dististyli that are variously modified and characteristic of the species. The ninth tergite is usually large, cupping over and protecting the inner genitalia. The cerci are usually well developed. A number of species were studied and figured. The greatest variation and some of the best specific characters are to be found in the ædeagus and the chitinization at the base. The apodemes are not very well developed.

There are many genera in the family and no doubt there is a great variation in genitalia. In some species of the genus *Aphœbantus* the hypopygium is very large, but in most genera the genitalia are comparatively small and the characters difficult to make out unless the specimen is dissected and a considerable magnification used. The species dissected and illustrated are: *Bombylius major* Linne (figs. 85, 91, and 92), *Heterostylum robustum* O. S., *Exoprosopa caliptera* (Say), and *Spogostylum œdipus* (Fabr.), shown in figures 88, 94, and 95. *Villa lateralis* (Say) shows much the same form as the other species (fig. 89); in this species there is a structure resembling the "spinus".

Family Therevidæ

The general form of the hypopygium is often of great value in the determination of species. The genitalia of some of the species of this family are illustrated in this paper.

The tergite of the ninth segment is usually smaller than the sternite, or hypandrium; both are variously modified in

the family and the anterior and posterior gonapophyses are well developed, often with pile or bristles. The ninth sternite is often split to the base. The cerci are usually quite conspicuous and the proctiger often comparatively large. The styles and the ædeagus with its appendages vary considerably. The ejaculatory apodeme is well developed in some species. The ædeagus and apodemes of *Psilocephala hæmorrhoidalis* Macquart are shown in figure 98, greatly magnified. In *Thereva vialis* the interior forceps are well developed (fig. 93) but in *Dialineura crassicornis* they are absent.

Family SCENOPINIDÆ

Wesche did not study any species of this family, but mentions the description given by Dufour of *Scenopinus fenestralis* Linn. ("Recherches anatomiques et physiologiques sur les Dipteres", 1851, Mém. Prés. Ac. Sci. Paris, tome XI, p. 198). Dufour never attempted to name the separate parts of the genitalia.

Scenopinus fenestralis has quite a complex arrangement of structures (fig. 100). The interior forceps and genital palpi are well developed and there are two small projections below these, probably merely outgrowths of the wall of the ninth sternite. The ædeagus is three pronged and the apodemes of good size; the opening of the ejaculatory duct is evidently at the tip of the middle prong of the ædeagus. The seventh and eighth segments are greatly reduced and more or less asymmetrical; the ninth segment is without styles. The cerci are quite large.

In *Pseudatrichia unicolor* Coquillett the tergal portion of the ninth segment is much larger than the sternal part. The ninth tergite is split to the base on the median line above, the upper corners spread, the cerci set between the halves of the tergite. The sternites of the abdomen are almost as large as the tergites. The ædeagus is large at the tip and quite different in shape from that in *Scenopinus fenestralis* (fig. 104).

Family MYDAIDÆ

Mydas abdominalis and *Leptomydas pantherinus* have the same general type of genitalia. In *L. pantherinus* the proctiger is rather large, the cerci small (fig. 101); the ædeagus

is small and protected. There are no appendages on the sternite or tergite of the ninth segment. *L. sponsor* has genitalia closely resembling those of *L. pantherinus,* but the halves of the hypandrium are different in shape. The genitalia show a general resemblance to the Asilidæ.

Family APIOCERIDÆ

In *Rhaphiomydas acton* Coquillett the genitalia are quite simple and no appendages of the ædeagus are visible in a pinned specimen. In *Apiocera haruspex* O. S. the genitalia are quite complex (figs. 106 and 107); the hypopygium is normally closed in a box-like structure (fig. 105), the ninth sternite and tergite both notched but without articulated appendages. The spiracles are in the membrane near the posterior margins of the segments; the sternites and tergites are normally touching or overlapping; on segments 5, 6, and 7 the spiracles are enormous, especially on the sixth segment, where the spiracle is about eight times as wide as on the third segment. The ædeagus is rather complex and the interior forceps have apical appendages. The apodemes are well developed and suggest those of some of the Cyrtidæ.

In *R. acton* the interior forceps have apical appendages; the cerci are long and rather slender and are obscured by the enormous halves of the ninth tergite when viewed from the side, as shown in figure 108.

Family ASILIDÆ

There is a great range of variation in this family, as might be expected in a large group with many distinct genera. Both the ninth sternite and the ninth tergite are large and heavily chitinized. Mr. R. E. Snodgrass published papers on the genitalia of the genera *Dasyllis* and *Laphria* some years ago and noted the inversion of the hypopygium; but it seems that this is not the normal position of the genitalia and that the organs are twisted during copulation, because the neck of the hypopygium is small and weak. In the genera *Dasyllis* and *Laphria* the interior forceps and the genital palpi are both present, each strongly arched dorsally and projecting out of the dorsal notch; the ninth sternite is usually very

large and the floor contains the ædeagus and appendages. The eighth segment is reduced to one small sclerite and the seventh is greatly reduced; the eighth is symmetrical in shape but asymmetrical in position and normally almost hidden within the seventh segment. The ædeagus is usually chitinized and in many species ends in three prongs, the seminal duct evidently dividing. The apodemes of the penis are usually very large. The cerci are well developed.

In *Cyrtopogon præpes* Loew the ædeagus is different than in *Dasyllis* and *Laphria,* not being forked at the tip (fig 109), the apodemes large and the framework strong. In *Promachus vertebratus* Say the ædeagus is very large (fig. 111), also in *Asilus occidentalis* Hine (fig. 118). *Erax barbatus* Fabr. has the tip of the ædeagus hook-like (fig. 121), the ninth tergite large and covering the inner organs. Two species of *Lasiopogon* are illustrated, *arenicola* (O. S.) and an undescribed species; these species show a relation to the genus *Cyrtopogon* in the general character of the genitalia as they do in other ways. As can be seen from figures 120 and 124 the shape of the ædeagus is different in the two forms. In *L. arenicola* the cerci are studded with short, backward projecting spines on the inner side (fig. 119).

Family DOLICHOPODIDÆ

Mr. R. E. Snodgrass published a paper on the genitalia of these flies in the Proceedings of the California Academy of Sciences (Ser. 3, III, p. 273, 1904). Several dipterists have made use of the male genitalia in taxonomic work and many forms have been figured. One distinct character of the hypopygium of the Dolichopodidæ, as has been pointed out by Snodgrass, is the fact that the body cavity opens into the eighth segment not by a foreamen at the anterior end but by an aperture on the anterior part of the left side. In the species studied the spiracles are all in the intersegmental membrane. Wesche studied several forms in his previously mentioned work; he stated that the ædeagus has processes developed on it in some species. The laminæ superiores are not developed; the interior forceps and genital palpi are present. The barbs of the ædeagus in some forms may be homologous with the paraphalli and the hypophalli. The spinus

titillatorius is noted here for the first time in the sequence of the families and Wesche recognizes the genital palpi here for the first time, an interpretation which must be wrong.

The two or three segments of the abdomen preceding the hypopygium may be reduced, distorted or even lacking, segments one to six or seven being the unmodified part. The eighth segment is small and scale-like in some forms, covering the lateral foreamen of the ninth segment; the seventh segment forms the peduncle of the hypopygium, its axis oblique.

The genus *Scellus* is different from the average (figs. 126 and 127); in this species, according to my interprepation, the usual fifth segment is modified into a remarkable structure that may serve as a clasping organ, or it may be merely a sex ornament.

In most forms the sixth segment is small, the tergite much larger than the sternite, the whole largely retracted into the fifth segment. The fifth segment is seldom modified; in some forms it is largely composed of the tergal portion, as in *Liancalus similis* Aldrich (fig. 128).

In *Scellus monstrosus* O. S. there are no true claspers present on the genitalia (the styles not modified for holding), but *the fore tibiæ are modified for holding the female.* In the genus *Dolichopus* the cerci are developed into remarkable structures sometimes known as "fans"; they are usually distinctly different in each species and often possess strong bristles (figs. 131, 132).

Family Phoridæ

We find considerable asymmetry in the genitalia in this family, but the apical portion of the abdomen is usually not so remarkably modified as in most of the Dolichopodidæ, Pipunculidæ, and Syrphidæ. In *Phora velutina* Meigen the eighth and ninth segments are asymmetrical; the ninth sternite is quite different on the right and left sides (fig. 135); the appendages at the base of the ædeagus are also asymmetrical. In this species the ninth tergite is large and the cerci well developed.

In *Conicera aldrichi* Brues there is a twisting of the hypopygium to one side and against the preabdomen; the seventh

and eighth segments cannot be made out and may be fused with the sixth segment or obliterated. The ninth sternite and tergite are more or less fused, the large styles apparently tergal. The ædeagus is large and shaped much as in the preceding species. The ejaculatory apodeme is chitinized, quite conspicuous, anchor-shaped. The sternites are much smaller than the tergites, the small spiracles being in the membrane between.

An undetermined species of *Apiochæta* from Apia, Samoa, has the peculiar proctiger noted in some other species of the genus; it is a single organ (called the "anal tube" by Lundbeck) with two apical appendages which are seen to be pubescent bristles under the high power microscope (fig. 133). The separate sclerites representing the cerci cannot be made out. There is some torsion of the hypopygium from right to left, the dorsal side turned almost ventral. The genitalia are very small and difficult to make out.

In *Apiochæta rufipes* Meigen the proctiger is nearly like that in the preceding species, but the appendages are not at the exact tip and are bare of microscopic pile; the large bristles of the abdomen are all microscopically pubescent. The ninth tergite is much larger than the sternite, as in the preceding species; the internal genitalia (ædeagus and gonapophyses) are very small and twisted from right to left within the ninth sternite, as shown in figure 134.

Family BRAULIDÆ

A specimen of the rare fly *Braula cœca* Nitsch was loaned by Dr. Aldrich from the United States National Museum collection. A separate family has been erected for this grotesque little species and in the past it has been placed at the end of the series of Diptera. Recent studies have shown the fly to be closely related to some of the wingless, parasitic Phoridæ and it has been placed in that family by some dipterists. Without entering into a discussion of the general characters, I would place the species in a separate family following the Phoridæ.

This small parasite was studied by Wesche, who stated that he could trace the genitalia and that they appeared to be more muscoid than of a type related to *Melophagus*. The

genitalia are quite different from those of any of the Phoridæ studied.

The hypopygium is comparatively large, with a large membranous portion. The first sternal plate is very large, the three following plates quite small, narrow; the tergites are very wide and curve under the abdomen for some distance so that although the spiracles are on the tergites they are ventral in position. The sides of the tergites are separated from the main dorsal portion so that they give the appearance of pleural plates. There are five tergites as viewed from above, but from the side one can clearly see six plates. As seen from above the actual first tergite is hidden by the second. I can find only six pairs of spiracles. The segments beyond the sixth are included in the hypopygium, which is largely membranous. The cerci are quite apparent and there is a central structure which I take to be the ædeagus (see fig. 136); on either side of the ædeagus there is a slender guard, possibly the interior forceps. The apodemes are quite long and show through the membrane when the specimen is cleared.

Family Lonchopteridæ

Aldrich notes the rarity of males of *Lonchoptera* (Psyche, vol. XXV, p. 33), having only two in his collection; in one season he collected 2,652 specimens and got no males. Evidently our common species reproduces parthenogenetically. Lundbeck (in Diptera Danica, pt. V, p. 1-18, 1916) recognizes three species in Denmark; the females of *L. furcata* were common but no males were found and only six males of the species were known in collections. Lundbeck describes the general form of the hypopygium in detail and in the species he studied there was a close relation shown to the Dolichopodidæ, the hypopygium being large and bent in under the venter, with a complicated median organ, the penis and its sheath; to each side of this organ were attached two pairs of variously shaped inner lamellæ or gonapophyses.

I was able to study a male of an undetermined species of *Lonchoptera* from Alaska, loaned by Dr. Aldrich from the National Museum collection. The sternites beyond the fifth are not chitinized and the median portion of the fifth is partly

membranous, the hypopygium folding under the abdomen against this segment. The sixth tergite is large and folds under on the sides, protecting the membranous part of the hypopygium. The seventh tergite is very small, forming the neck of the hypopygium, the eighth tergite is lost or fused with the ninth. The ninth segment is comparatively large and is symmetrical, the tergal portion larger than the sternal. The guards of the ædeagus, which may be the dististyli, but which have the position of interior forceps, are quite large and project beyond the rest of the genitalia (see fig. 144). The structure which is evidently the ædeagus in this species is not complicated and pointing somewhat backward, as in the species described by Lundbeck, but is rather short and membranous (unless the specimen I have figured is broken).

Family PLATYPEZIDÆ

In *Platypeza velutina* Loew the seventh and eighth segments are greatly reduced, the seventh sternite being lost, the eighth consisting of a narrow ring. The proctiger and cerci are well developed. The eighth tergite is asymmetrical, being larger and differently shaped on one side than on the other. Figure 143 shows the floor of the hypandrium from above, the ninth tergite removed. The styles and cerci in *P. velutina* are smaller than in *P. agarici* Willard (fig. 145) and the ædeagus is much shorter and curved distad; two long style-like prolongations on the ninth sternite (dististyles?) serve as guards to the ædeagus.

Family EMPIDIDÆ

The styles are present in most of the species of this family but according to Wesche are absent in *Empis stercorea* L. The cerci are usually not well developed. The spiracles are in the intersegmental membrane and there are thin spots along the sides of the tergites, as in some of the Dolichopodidæ, giving the appearance of large spiracles.

The ædeagus is usually quite slender and I have seen no species where it was forked; in some species there is a long flagellum, called a "talædeagus" by Crampton. In *Rhamphomyia* the long apical part of the ædeagus is curved for-

ward and rigid. All the species of this immense genus that were studied are readily separated by genitalic characters. In *Hilara cilipes,* figured by Wesche, the ædeagus has thorns or barbs pointing forward; Wesche calls these barbs in *Empis stercorea* the paraphallus and hypophallus; these structures are not present in any of the forms I have studied.

In *Empis aldrichi* Melander the seventh sternite has two clumps of comb-like spines (fig. 140), and the segments beyond are normally retracted within this large seventh segment; the ædeagus in this species is remarkable, half coiled and spring-like as can be seen from the figure; the basistyli and surstyli are about the same size. In *Hybos triplex* there is great asymmetry, the right side of the hypopygium being much more developed than the left; the cerci are very small.

Family PIPUNCULIDÆ

In this family we find distinct asymmetry of the abdominal segments reaching back to the preabdomen, and considerable torsion, as in the Syrphidæ, to which family the relation is evident. The genitalia are covered up by the segments which are turned under and against the venter. In the species studied the eighth segment is grown to the sides of the sixth and seventh in twisting over (fig. 151). The division of the sternites is shown in figure 151.

In all of the forms studied the ædeagus ends in three forks, the central one evidently the continuation of the seminal duct. In *Chalarus spurius* (Fall.) there is a slightly different structure (fig. 150). The ejaculatory apodemes are remarkable in shape in the species dissected and are quite distinct for the species. The ædeagus rests in a half sheath in *Pipunculus* sp. no. 2 (fig. 153); in *Pipunculus* sp. no. 1 there are two oval guards at the base of the ædeagus (fig. 147), probably the modified interior forceps.

Family SYRPHIDÆ

Wesche described the structures in this family in some detail. Dr. C. L. Metcalf has recently written a fine paper on the male genitalia of the Syrphidæ and the student is referred to this work for a detailed discussion. The group is remark-

able for the almost universal asymmetry of the last four segments; the division between the preabdomen and postabdomen is usually quite distinct. In the study of this family I have figured ten species, distributed in eight genera.

The styles are well developed and show considerable variation; the cerci are usually rather small. The laminæ superiores are absent. The ædeagus may be flexible and membranous or it may be more or less chitinized, sometimes in plates; the base of the ædeagus is well developed in some species, protecting or serving to rotate the organ. The paraphalli may be represented by processes, as by two blades seen in *Eristalis tenax* (Linn.) shown in figure 154. The interior forceps in *Lasiophthicus pyrastri* (Linn.) take the form of a band around the base of the ædeagus.

The genitalia in the Syrphidæ fit into a hollow or "genital pouch", which is illustrated in figures 155 and 158, and unless dissected out or pulled away from the cavity in which they fit these remarkable structures are hidden from view. The great range of variation in the structure of the ædeagus is shown in figures of *Mesogramma geminata* (fig. 159), *Eristalis tenax* (154), *Lasiophthicus pyrastri* (160), *Eristalis vinetorum* (164), *Eristalis æneus* (161), *Volucella esuriens* (156), *Caliprobola pulcher* (162), and *Melanostoma obscurum* (165).

Family CONOPIDÆ

In this family there is no asymmetry in the organs making up the male genitalia. The genitalia in most forms are protected by the bending forward of the abdomen against the venter of the preabdomen. The eighth and ninth sternites often have combs of spines on the posterior margins which may aid in clasping the females. The abdomen in many forms is more or less rounded, but in some genera *(Conops, Physocephala,* and *Stylogaster)* it is very slender. The abdomen of *Physocephala affinis* Williston is shown in figure 176; the sternites are poorly developed, there being none on the first three segments, the tergites curving down and protecting the membrane of the venter.

The cerci in all the forms studied are small, as in *Myopa rubida* and *M. seminuda* (figs. 172 and 178). The ædeagus

in all the species examined is quite large, blunt and membranous, with characteristic protuberances and folds, possibly homologous with the paraphalli and hypophalli (fig. 168). In *Occemyia modesta* Williston and *O. abbreviata* Loew (figs. 169 and 170) the interior forceps are well developed; the apodemes are very peculiar in shape, especially the large basal part of the double apodeme, which is fused and unusually developed.

In general the genitalia in the Conopidæ are not nearly so complex as in the Syrphidæ and the specific differences are less marked.

THE MUSCOIDEA

The Muscoidea, both calyptrate and acalyptrate, are greatly specialized and cannot be arranged in any graded series to show a theoretical line of development from a generalized form. In a manuscript paper on the genitalia of the Muscoidea (previously mentioned by the writer) Mr. R. E. Snodgrass noted the fact that the Phycodromidæ seem to approach the generalized condition, but perhaps this is only an apparent generalization of the male hypopygium.

The abdomen is apparently quite short in many of the Muscoids owing to the reduction of segments five to nine. The first and second tergites are sometimes fused but the sternites are distinct; the fifth sternite is often deeply notched, the shape usually of specific value. In the study of the segments beyond the fifth it appears that very few of the muscoids have the sixth sternite well developed. The segment following, usually the seventh, is present in some as small plates, in others absent; in many forms the apparent eighth tergite may be regarded as the seventh and eighth fused. In the Helomyzidæ there is a tendency to a fusion of the sixth and seventh tergites.

The ninth segment usually has a large convex tergum terminating the genital part of the abdomen, a smaller sternum, generally concealed within the eighth sternite. The general structure of the hypopygium varies considerably, but there is no great departure from the form seen in some of the preceding

families. The ædeagus is usually large, often complex in structure and in most all forms with two pairs of gonapophyses at the base, the interior forceps and the genital palpi.

Family ŒSTRIDÆ

This family is clearly related to the other Muscoidea in the general structure of the male genitalia, but is less specialized, the genitalia, as well as many other parts of the body, having a small range of specific variation. The genitalia are comparatively small.

The genitalia of *Gastrophilus intestinalis* (De Geer) are illustrated in figures 171 and 173; the ædeagus is short, thick, membranous, with the interior forceps well developed. In *Hypoderma lineata* De Vill. the abdomen shows only five sternites when the genitalia are not extruded, the last tergite covering the genital part of the abdomen; the sternites are rather small; tergites six and seven are evidently fused and are about the size of the eighth. The cerci are well developed. Most of the ædeagus is chitinized, the apex membranous; the interior forceps and palpi are present (fig. 179).

In *Cuterebra americana* Fabr. the first five spiracles are in the tergites and have a chitinous rim, the seventh spiracle is in the membrane between the sternite and tergite, the sixth is in the sixth tergite (fig. 177). The genital portion of the abdomen suggests the genus *Glossina,* the genital organs being normally folded in against the abdomen and entirely concealed. The last large tergite is apparently the fifth and sixth fused, the seventh forms part of the plate set into the fifth, the eighth is small and crescent-shaped, set into the seventh, the ninth tergite is still smaller, as shown in figure 177. The ædeagus is heavily chitinized and there is a blunt spinus; the interior forceps and genital palpi are present (fig. 174).

Family TACHINIDÆ

The Tachinidæ (as limited by Williston and early dipterists) are much like the Muscidæ in the general structure of the male genitalia and also like the next two families, the Dexiidæ and Sarcophagidæ. The hypopygium is not usually large and is folded in against the abdomen in most forms so

that the structures are not easily discernible. In the preparation of this paper I have dissected eight species belonging to seven genera.

The spiracles are in the tergites, except where these are greatly reduced in the genital region. The ninth tergite is well developed and often quite long and pointed. There are usually two claspers, or gonapophyses, on the ninth sternite. The ædeagus is subject to great variation, as shown in figures 182 to 188; the paraphalli and other appendages are often difficult to trace.

There may be some question as to the correct interpretation of the paraprocts and surstyli as illustrated and discussed in this and the following families of muscoid flies. The structures labelled *pp* (figs. 182, 184, etc.) were at first considered surstyli by the writer, but after some discussion with other workers interested in the morphology of the muscoid genitalia and some subsequent study of specimens it was decided that these parts correspond to the paraprocts. In some species these paraprocts may be fused into a single median structure.

Family Dexiidæ

Thelaira leucozona Panzer and *Myiocera tibialis* Desvoidy were studied and figures 191 and 192 show the more important structures. The paraprocts and surstyli are quite clearly shown. Figure 192 shows the distinct separation of the parapodial plate (*pp*) from the ninth tergite. The paraphalli and spinus are well developed, also the apodemes of the ædeagus, but the ejaculatory apodeme is separated some distance from the base of the ædeagus and is small.

Family Sarcophagidæ

Aldrich, in his paper "Sarcophagidæ and Allies", based his classification of the family very largely on the male genitalia. The specific differences are often remarkable in this group and males are usually easy to place when the genitalia are studied. The hindmost of the genital structures are the large, heavily chitinized organs on the sides of the anus; these two prominent organs were called "forceps" by Aldrich and are here considered the paraprocts.

Wesche mentions certain characters in this family and notes that the laminæ superiores are usually quite marked in *Sarcophaga,* often with long lateral processes. The spinus is absent in some species. The drawing of *Sarcophaga communis* Parker (fig. 199) will illustrate the general arrangement of the ædeagus and appendages as well as any. There is a great specific variation as can be seen from a comparison of figures 189, 190, 193, 197, 198 and 199. Wesche includes this group, with several others, in the old family Muscidæ.

The hypopygium is often strongly contrasting in color with the rest of the abdomen, being red or yellow in many species. The fifth sternite is often deeply notched as in the Muscidæ; the reduction of the right side of the sternites in the genital region is not very noticeable; the spiracles are as in the Tachinidæ and Muscidæ. The genital chamber is usually shallow. The cerci are usually small and embedded.

Family MUSCIDÆ

A number of genera are included here which are now generally grouped together in a separate family, the Calliphoridæ; the following genera here considered are in this category: *Cynomyia, Lucilia, Phormia,* and *Pollenia.*

In this family only five segments are normally visible before the genitalia. The first tergite is fused with the second, the first sternite small but free. The hypopygium is retracted into the fifth segment, the fifth sternite deeply notched in many species; the seventh and eighth segments are greatly reduced, fused, or one of them lacking. The ninth segment is in some, as in *Lucilia,* a semicircular band covering the sides and top of the sclerite representing the sternum; the flat, invaginated cavity in the ninth segment accounts for the unusual position of the sternite. The actual floor of the genital chamber is formed by the invagination of the cavity of the eighth segment.

Mr. Robert Newstead has recently published papers on the male armature of the species of the genus *Glossina.* The armature is hidden when the ninth segment is closed against the eighth, the anal groove and membrane showing, but not the cerci. Newstead uses some new terms in describing the structures of the male genitalia, but few of these are adopted

in the present paper. Wesche made a more or less extensive study of the male genitalia in this family and noted the good specific characters.

In *Glossina,* where the whole last segment is turned in under the abdomen, the gonostyli rest against an arched, horny band which represents the superior laminæ; this is absent in *G. palpalis* Desv. In *G. tachinoides* the extremity of the ædeagus has membranous wings studded with minute plates, capable of inflation and erection.

The paraphallus is usually well developed in the Muscidæ and may be more or less serrated or otherwise modified; in *Glossina* the paraphalli together with part of the sheath form a framework which supports an elaborate sensory apparatus and protects the orifice of the ejaculatory duct. The hypophallus is generally present, as in *Pollenia rudis* (fig. 211), and has the appearance of lateral plates in *Calliphora.* The spinus is generally present, as are the interior forceps; the genital palpi are occasionally absent, but are greatly developed in some forms.

In *Musca domestica* the preabdomen consists of four apparent segments; the first segment is reduced to a small ventral plate; the second segment is largest; the sternal plates are small and median. Immediately following the fifth segment is the postabdomen, largely covered by the fifth tergite. In this species the central margin of the ninth sternite carries the ædeagus, which has a short, lobed, membranous tip. The last segment (proctiger) of *M. domestica* is a membranous area with an anal groove and two small plates representing the cerci. In this species there is no paraphallus or hypophallus.

Various forms of genitalia in this family are shown in the drawings of *Graphomyia maculata* (Scop.), *Cynomyia cadaverina* Desv., *Phormia regina* (Meig.), *Myiospila meditibunda* (Fabr.), *Stomoxys calcitrans* (Linn.), *Musca domestica* Linn., *Pollenia rudis* (Fabr.) which are illustrated in figures 195, 196, and 200-211.

Family ANTHOMYIIDÆ

Wesche described the genitalia of a few species in this family. *Hyetodesia obscurata* Meigen is said to have soft haired, bulbous tubercles representing the superior laminæ.

In *Hydrotea,* where the legs are modified to hold the females, the claspers are poorly developed.

In most species the sternites are small and in many the fifth sternite is modified and characteristic of the species. In *Hylemyia alcathoe* Walker the sixth and seventh segments are asymmetrical and greatly modified; segments 2, 3, 4, and 5 have spiracles in the tergites; the sixth sternite is pushed around on the left side and the seventh sternite is missing; the eighth sternite is a narrow strip on the left side (figs. 212 and 213). The seventh segment is of interest here as it is fused with the anterior margin of the eighth tergite, except the lower end, which is an oval plate with a dark margin all around; the seventh spiracle is present on the left side only. The cerci are rather small.

The paraphalli and the hypophallus are present in some of the species, also the genital "palpi". The "palpi" are absent in *Fucellia fucorum* Fallén, the places marked by single bristles. In *Phorbia fusciceps* (Zett.) the fifth sternite is even more deeply notched than in *Hylemyia alcathoe;* the surstyli are long and slender, also the apodemes (fig. 215). In *Phorbia brassicæ* there is the same plan of construction, the genitalia much as in *P. fusciceps.* In *Ophyra leucostoma* there is a notable difference in the general appearance of the genitalia; the styles are short and blunt and the ædeagus is short and thick; the whole hypopygium is rather small, the sixth, seventh, and eighth segments much reduced.

Family SCATOPHAGIDÆ

The fifth sternite in this family is of specific importance, being variously modified on the posterior margin; there is considerable asymmetry beyond the fifth segment; the sixth and seventh segments are very short and the genitalia normally hidden under the edge of the fifth segment. In the genus *Scatophaga* the structures which I take to be the paraprocts are rather large and heavily chitinized (fig. 216) and the styles, evidently surstyli, are pointed and curved near the tips. *Scatophaga furcata* Say is much like *S. stercoraria* in the form of the genitalia, but with some remarkable differences in the apodemes, the ejaculatory apodeme being comparatively enormous in *furcata* (fig. 218). In this species there are two

long bristles on the "palpi". The general structure in *S. stercoraria* is shown in figure 217.

Scatophaga crinita Coquillett is much like *S. stercoraria* in the form of the genitalia, the apodemes being much the same, but the ædeagus is specifically distinct; the anal area is largely membranous, the chitinized cerçi much smaller than in the preceding species. In *S. islandica* Becker the ædeagus and guards are much the same as in *S. furcata,* the apodemes much smaller. The fifth sternite is shown in figure 214.

Wesche found that the hypophallus is often developed in this family and that the palpi often carry long setæ. In *Norellia spinimana* these palpi take the place of the interior forceps in position as well as in function.

In *S. stercoraria* there are only three apparent segments back of the fifth and the seventh and eighth segments are fused; the sixth tergite is short and present on the right side only; the sternite corresponding to the seventh and eighth tergites is developed on the left side and atrophied on the right; the ninth segment, as in the Tachinidæ, is a complete circle.

In a species of *Cordylura* examined the fifth segment is modified on the sternite into two structures which presumably are of use as claspers and which also serve to guard the hypopygium when it is folded against the venter (fig. 219). The styles are large and complicated and the paraprocts well developed. The ædeagus has an apical slender appendage. *Cœnosia ausoba* Walker has the fifth sternite developed much as in the preceding species, but the structures here are probably not of use as claspers, merely serving to protect the genitalia by holding the tip of the ninth segment in place against the venter.

Family Helomyzidæ

This family clearly shows a relation to the Trypetidæ and Ortalididæ. There is considerable asymmetry and variation in the genital portion of the abdomen.

In *Helomyza limbata* the ædeagus is quite large and modified at the tip (fig. 223); the posterior margin of the sixth and seventh combined sternite is curiously irregular, probably due to the pressure of the ædeagus. The cerci are quite large.

The ædeagus is twisted in *Leria cinerea* Loew and arises as two chitinized strips (fig. 221); the interior forceps are well developed; the proctiger is unusually developed. In *Anorostoma grandis* Darlington the ædeagus is twisted and curiously modified (fig. 226); the proctiger is very large (fig. 225). In *Leria serrata* (Linnæus) the ædeagus is quite long and slender (fig. 222), but not at all enlarged at the tip as in the Trypetidæ. In this species as in *L. crassipes* Loew there is considerable asymmetry of the genital segments (fig. 227).

Family CLUSIODIDÆ

In this family segments one to five form the principal part of the abdomen, judging from *Clusia lateralis* Walker, the only species studied. The sixth segment is slightly asymmetrical, the sixth and eighth segments hollowed out on the venter for the reception of the genitalia when folded against the abdomen; the eighth and ninth segments are symmetrical. The ædeagus is rather long and slender, with a bend near the middle (fig. 220). The seventh segment is present only on the left side, the spiracle placed on it; the other spiracles are in the intersegmental membrane. The cerci are comparatively small.

Family BORBORIDÆ

The hypopygium of *Copromyza equina* Fallén is rather small, symmetrical and simple (figs. 232 and 233). The fifth segment is normal, the sixth represented by an asymmetrical sclerite on the venter; the seventh and eighth segments are apparently lost. The ædeagus is short, more or less membranous; the apodemes are well developed (fig. 230).

Segments 6, 7, and 8 are asymmetrical in *Leptocera limosa,* the sixth sternite largely hidden by the large fifth sternite; the seventh tergite is present on the left side only, the seventh and eighth sternites apparently obliterated. The ninth tergite and sternite are largely fused; the styles are blunt and plain; above the styles on each side are two spine-like projections which may serve as claspers. The proctiger and cerci are small. The interior forceps are well developed, the ædeagus small and membranous. In *L. atra* (Adams) the large fifth

sternite has a wide, square excision on the posterior margin; the sixth, seventh, and eighth segments are much the same as in *L. limosa* (Fallén); the spines of the ninth tergite are very short and the styles thinner. The ædeagus, with its appendages and apodemes, is shown in figure 234.

Family Phycodromidæ

Cœlopa frigida Fallén was the species dissected and studied as a representative of this family. The hypopygium is normally retracted within the fifth segment, but may be extruded as figured (fig. 229). The segments 6, 7, and 8 are asymmetrical, the hypopygium itself twisted forward on the left side; the four plates between the fifth and eighth segments represent two segments, as evidenced by the spiracles; the seventh tergite is reduced to a small elongate plate on the right side (not visible in the figure given). The cerci are small and united below, forming together a horseshoe-shaped band.

In general the genitalia are very complete. The ædeagus arises from above the ninth tergite (see fig. 224 for details). The two pecten-like lobes are probably the hypophallus, the plate at the base possibly the paraphallus, or these may represent the interior forceps. The penis is membranous, twisted, and arises from a sac-like structure.

Family Sciomyzidæ

Melina vitalis Cresson shows a modification of the sixth, seventh, and eighth segments, which are small and asymmetrical, being developed on the left side. The spiracles are in the pleural membrane. The genitalia are quite well developed and have inner and outer appendages functioning as claspers. The ædeagus is short and the cerci small. The interior forceps and the "palpi" are present and the framework for the ædeagus and appendages is characteristic. In *Dictya umbrarum* (Linn.) there is not so much asymmetry in the genital segments; the seventh segment is well developed and the fifth sternite has a dense covering of hair-like spines. The interior appendages are quite heavily chitinized. The ædeagus is short and membranous (fig. 238). The ædeagus and appendages of *Tetanocera vicina* Macquart are shown in figure 236.

Family RHOPALOMERIDÆ

Mr. C. W. Johnson kindly loaned a specimen of *Rhopalomera femorata* Fabricius for study. The family seems to be nearer to the Sciomyzidæ than to any other in the structure of the genitalia, and should certainly not be placed between the Ortalididæ and the Trypetidæ, as has been done by many dipterists in the past. The resemblance to the Ephydridæ is only superficial, being largely confined to the appearance of the face.

The small spiracles are in the intersegmental area along the sides of the abdomen. Segments 6, 7, and 8 are greatly reduced and modified, the left side being more extensively chitinized, as in many other families. The fifth sternite is deeply notched and with strong spines on the posterior margin; the sixth segment is greatly reduced, especially the sternite (fig. 239), and a small sclerite near it is probably the seventh sternite. Normally the ædeagus and appendages are sunk between the styles and in a hollow of the ninth segment, but they are attached to a membranous base and in figure 240 are shown pushed up to give a view of all the structures. The double apodeme differs from that seen in the Ortalididæ and Trypetidæ.

Family SAPROMYZIDÆ

In the *Sapromyza* species studied the principal part of the abdomen consists of six visible pregenital segments (1-6), which are unmodified. The tergites are large, the sternites small, with a large membranous area between; there are only five pregenital sternites; segments 7 and 8 are normally concealed in the sixth segment and are combined into a narrow ring. The ninth sternal plate is at the base of the ædeagus. Snodgrass, in a manuscript paper, figured a long membranous ædeagus in *Sapromyza flaveola,* but in the species studied by the writer the ædeagus is quite different, being very short (fig. 241). In this family the spiracles are in the membrane below the tergites.

In *Caliope gracilipes* Loew the genitalia are very different, suggesting the genus *Lonchæa,* described further on, and also some of the Agromyzidæ; the ædeagus and appendages are heavily chitinized.

Family LONCHÆIDÆ

This family has only recently been separated from the Sapromyzidæ by some authors. Wesche uses *Toxoneura muliebris* as an example of the family and gives an illustration which shows a close relation of this species to *Palloptera terminalis* Loew, a form which has a remarkable ædeagus (fig. 244). Wesche states that *Palloptera ustulata* has an unusual ædeagus. In *T. muliebris* there is a spinus titillatorius at the base of the long flagellum; in *Palloptera ustulata* and *terminalis* there is a structure on the enlarged apical part of the ædeagus which Wesche believed to have the same function; it can hardly be the same structure morphologically. The interior forceps and "palpi" appear to be in an atrophying state.

Family ORTALIDIDÆ

The ædeagus in this family is very long and complicated, but it is usually hidden under a fold of membrane in the fifth segment, being normally coiled and very difficult to straighten for the purpose of examination. In *Tetanops aldrichi* Hendel the genitalia are very nearly the same as in *Anacampta pyrrhocephala* Loew, as can be seen from figures 248 and 250. In *Euxesta thomæ* the general plan of structure is about the same as in the two preceding species, but the ædeagus is shorter and the fringe very fine; the reduction of the sixth and seventh tergites is about the same.

In *Chrysomyza demandata* (Fabricius) the genitalia are of the usual form; the ædeagus is very long and the apical third is much enlarged and modified at the tip (fig. 245). In *Seoptera vibrans* the genitalia are typical; the basal half of the ædeagus is slender and smooth, the apical half enlarged and with a dense fringe of rather long pile; the cerci are large. In *Rivellia viridulans* Desvoidy the ædeagus is more like that usually found in the Trypetidæ, there being no fringe of pile (fig. 252). In *Rivellia 4-fasciata* the structures are essentially the same as in *R. viridulans,* but the bifid portion of the ædeagus begins very near the bulbous portion, and there are other slight specific differences. *Enicoptera proditrix* has the main claspers or styles much as in *Anastrepha ludens* (Loew), but not so pointed; the ædeagus is slender and smooth until near

the tip, where it is suddenly enlarged and modified as in the family Trypetidæ, and it is not in a tight coil as in most of the Ortalididæ examined; the apodemes are quite slender. The genitalia of *Richardia podagricia* (Fabr.) suggest those of *Enicoptera proditrix* in general appearance, but the cerci are smaller and the apex of the ædeagus different; here the appendage inside the ditistylus is distinctly separate, more slender, toothed at the tip and forming a guard to the ædeagus. In *Melieria occidentalis* Coquillett the ædeagus has tooth-like structures at the base of the flagellum and long blade-like spines near the tip (fig. 247).

Family TRYPETIDÆ

The figure of *Epochra canadensis* Loew will give an idea of the general appearance of the abdomen in this family and the relation of the parts of the genitalia (fig. 255). There are apparently only four visible tergites, but the first large sclerite is composed of the first fused with the second; the fifth sternite is large and variously notched on the posterior margin in different species of the family, the sixth segment normally retracted within the fifth. The ædeagus is long and slender in *E. canadensis* as in all other species of the family examined, the tip enlarged and more or less chitinized. There is an asymmetrical depression on the right side of the abdomen. The ædeagus of *Euaresta æqualis* Loew is shown directed posteriorly in figure 253; it is usually curved and bent up over the ninth tergite.

The anal area is usually large, membranous and protruding in this family. There are no apparent cerci in *E. æqualis,* but cerci are present in *E. canadensis* and *Eutreta sparsa* Wiedemann and there are very thin chitinous strips on the sides of the anal opening in *A. ludens.* The ejaculatory apodeme is usually very large.

The genitalia of *A. ludens* are much like those of *Eutreta sparsa* Wiedemann in general shape; the ædeagus is proportionately about twice as long and the membranous anal area even larger than in *E. sparsa;* the ædeagus in this species is actually longer than the abdomen. The ejaculatory apodeme is not fan-shaped but rather slender. *Dacus cucurbitæ* has genitalia like those in the preceding species; the ædeagus has

an enlarged tip and is considerably modified. *Ptilona brevicornis* has appendages on the inner side of the styles; the basal half of the ædeagus is slender and on the median portion there is a brush of hairs extending only a short distance; the tip of the ædeagus is enlarged and considerably chitinized and the extreme apex slender and hyaline. *Eurosta comma* has genitalia more or less typical of the family; the small appendages inside the genital styles are separate and free moving; the ædeagus is nearly the same as in *Eutreta sparsa.* In *Anastrepha fratercula* the ædeagus is specifically distinct in structure and proportionately shorter than in *A. ludens.*

Family MICROPEZIDÆ

The normal appearance of the dried abdomen in a specimen of *Calobata alesia* Walker is shown in figure 258, the appearance after boiling the pinned specimen in KOH and stretching to its full length is illustrated in figure 259. The spiracles are plainly in the membrane between the tergites and sternites. There are six main segments in the preabdomen (1-6), and back of this there is more or less modification. In *C. alesia* and *C. univitta* Walker there are remarkable claspers present on the fourth sternite and it is significant that we find no clasping organs on the ninth segment. The ædeagus is variously modified in the species studied and in *C. alesia* and *C. univitta* it is branched at the tip (figs. 259 and 261); the appendages probably represent the hypophallus and paraphalli. The cerci are small and inconspicuous in the three species studied. *C. antennipes* has a somewhat different structure of the abdomen, the ventral clasping organs being on the fifth sternite and rather slender; the ædeagus is not branched at the tip (fig. 260). The eighth segment is well developed in all of these species, but the seventh tergite is developed on one side only.

Cresson's figure of *Micropeza ambigua* (1908, Trans. Amer. Ent. Soc., XXXIV, 13, pl. 1) shows the claspers to be on the fourth sternite in that species. Cresson also figures claspers of the males of several species of *Calobata* in the paper mentioned, the structures being specifically quite distinct.

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Family SEPSIDÆ

In *Sepsis similis* Meigen there are only six visible segments; the first apparent segment is long and represents two actual segments, the fused first and second. The apparent fourth segment is actually the fifth; the seventh and eighth segments have disappeared. The spiracles are in the membrane just under the tergites. *Sepsis violacea* Meigen is very close to the preceding species in the form of the genitalia. Wesche states that the superior laminæ may be well developed in this family; he figures a species of *Nemopoda* which has a very complicated ædeagus, the paraphalli being quite well developed. The paraphalli are present in *S. violacea,* the hypophalli very small (fig. 263); the double apodeme is distinctly double at the base and more or less fused with the ninth sternite; the ejaculatory apodeme is large. The ninth sternite is small and the clasping structures are apparently the surstyli.

Family PIOPHILIDÆ

This family has commonly been placed with the Sepsidæ, but Dipterists have recently shown that the two groups can be separated into two homogeneous groups. There are three genera in North America, of which *Piophila* is the best represented. Melander states that in *Piophila* the ædeagus is sometimes long and curled; in *Piophila nigricoxa* Melander the ædeagus is not fringed, but in *P. nigriceps* it is thick and is provided with four longitudinal fringes of long yellow hair. This is evidence of a relation to the family Ortalididæ.

In *Piophila casei* the first five segments form the principal part of the abdomen. The sternites are quite large and the spiracles in the intersegmental membrane. The apical segments are asymmetrical, the sixth, seventh and eighth fused and pulled to the venter where they join to the ninth tergite. The genitalia are twisted sideways, the ninth segment large and the ædeagus long and fringed on the basal portion (fig. 264).

Family PSILIDÆ

In *Chyliza leguminicola* Melander the first segment is small, then there are five large segments making up most of the ab-

domen; there are six spiracles marking segments one to six; the sixth sternite is split to the base. In the membranous area between the sixth and ninth segments there is a narrow chitinous strip on each side which may be considered the seventh segment. One spiracle is in the margin of the sixth tergite, the others are in the membrane. The eighth segment is represented by a small rectangular piece, a tergite, attached to the ninth tergite (fig. 269) and by two narrow strips, probably the sternite. The ædeagus is membranous and very short.

Chyliza robusta Coquillett is very near the preceding species. The eighth tergite is reduced to a narrower strip and the ninth segment is different in shape; the apodemes and framework are much the same. The ædeagus with its appendages is different, as shown in figure 270.

Wesche mentions that the males of *Loxocera albiseta* (Schrank) have small genitalia of an indefinite character, and he gives no further information on the family.

Family Diopsidæ

In *Diopsis subnotata* Westwood the genitalia are difficult to homologize. The ædeagus is comparatively small and the genital framework unusual in shape (fig. 267, one side cut away in the drawing); the double apodeme is large and fused; the styles are simple and rather small. The membranous anal area is large.

In *Sphyracephala brevicornis* Say, the only North American species, the first three abdominal segments are long, the first and second segments being fused and almost as long as the rest of the abdomen. The sixth, seventh, and eighth segments are greatly reduced but there is no asymmetry. The surstyli and the cerci are well developed. The double apodeme is very long, the ædeagus and interior forceps are quite small (fig. 268).

Family Ephydridæ

In *Ephydra millbræ* Jones there is a curious modification of the abdomen beyond the fifth segment and the cerci are apparently at the base of the ninth tergite, which is developed

horizontally. The sternites are much reduced. The intersegmental membrane is very tough and thicker than usual and the minute spiracles are in the edges of the tergites (possibly an adaption to hydrophytic conditions); around these spiracles are many small thin spots which are more or less transparent. The general appearance of the abdomen of *Ephydra millbræ* is shown in figure 274.

In *Ephydra gracilis* the plan of construction is the same, but there are specific differences. In *Parydra bituberculata* Loew the genitalia are relatively smaller and simpler; the sternites are larger; the ædeagus and appendages are shown in figure 271. In *Ochthera mantis* (De Geer) the sternites are larger than in the preceding species, the hypopygium moderate in size and folded up against the venter, reaching to the base of the fourth segment. In this species there are some spiracles distinctly in the intersegmental membrane, each with a faint chitinous ring. The styles are peculiar in shape (fig. 273). The ædeagus and adjacent appendages are more complicated than in the other species studied.

In *Gymnopa tibialis* Cresson the abdomen is as usual heavily chitinized; segments one to six make up most of the abdomen; the ninth segment is rather small, the seventh and eighth greatly reduced. There are no distinct cerci. The ædeagus here, as in the Oscinidæ studied, may be the true penis, as it is a membranous tube continuing the ejaculatory duct; the guards, probably the interior forceps, have one long spine on the inner side, as shown in figure 276.

Family OSCINIDÆ

The species studied by Wesche were said by him to have apodemes of the Muscoid type. *Meromyza flavipalpis* Malloch is almost hyaline when cleared in KOH, but the strong interior forceps, apodemes and framework of the ædeagus are more distinct. There is a great reduction of the sixth segment and the seventh and eighth have disappeared. It is necessary to use the compound microscope to make out the membranous ædeagus, which is elongate and slender and may be the true penis (fig. 277). In *Chloropisca glabra* the genital segments before the ninth are merged into a peculiar striated mem-

branous structure which does not show definite sclerites. The styles are quite short and the genital framework rather narrow; the ædeagus is comparatively large, more chitinized than in the preceding species and the double apodeme is quite slender.

Family DROSOPHILIDÆ

In general there are five visible abdominal segments in the male, the first apparent segment being morphologically the first and second combined. The dorsal and lateral surfaces of the abdomen have dorso-lateral plates; the sternites become narrower posteriorly. There are two spiracles under the edge of the fused first and second segment and the next three segments have the spiracles just under the edges of the tergites in the membrane. The sixth and seventh segments are small and fused, the eighth represented by a small plate which is difficult to make out, and behind this is the genital framework or arch. On the ninth segment there are usually claspers; these may be articulated to the ninth segment or more or less free, as in *Drosophila busckii;* they are probably genital styles.

There are cerci on each side of the anal opening and these are always hairy, or with characteristic bristles; in some species studied by Sturtevant these cerci are connected to the ninth segment by a chitinous bridge, and according to this writer the plates of the ninth segment have the same general relation in the species of *Curtonotum, Zygothrica, Pseudophortica, Scaptomyza* and *Drosophila.* In *Curtonotum helvum* Loew there is an extra clasper, as in *Sinophthalmus,* probably the interior forceps. The ædeagus is a chitinized tube, differing greatly in the species studied, and it can be extruded through the genital arch; the structure shows a relation to the Muscidæ. In *Curtonotum* the ædeagus is long and curved as in the Trypetidæ.

In *Scaptomyza terminalis* Loew the abdomen is more slender than in the genus *Drosophila;* segments 2-6 are about equal in length, the seventh and eighth greatly reduced and modified. The sternites are small and narrow and the intersegmental membrane in the pleural region of considerable extent; the spiracles are in the membrane opposite and near the middle of the tergites. The ædeagus is comparatively long

and the guards near the base furnished with tufts of spines (fig. 279).

In *Sinophthalmus pictus* the genitalia are like those in the preceding species in general character. There is a considerable reduction in the chitinization of the basal part of the abdomen and a remarkable reduction of the ninth segment. The eighth segment is apparently lost or fused and the seventh fused with the sixth, the line of division being visible in cleared specimens. The apodemes are well developed. The genitalia are shown in figure 278.

Family GEOMYZIDÆ

In *Geomyza lurida* Loew the first apparent segment is the fused first and second, there being four other large tergites in the preabdomen, and the ninth segment is large; the seventh and eighth segments are fused with other segments or are lost. The ædeagus is most unusual, parts of it being chitinized in a complex, yet symmetrical manner (fig. 280), the rest hyaline when cleared; judging from the form the ædeagus can evidently be telescoped. The interior forceps and "palpi" are not developed; the double apodeme is small and slender. The cerci are large and rather pointed.

In *Cerodontha dorsalis* Loew the sternites are very small, the number and arrangement of the segments being about as in the preceding species. In *Tethina coronata* Loew the ædeagus is very unusual; it is rather large, with a slender geniculate basal portion which is chitinized, and an apical part which is membranous, greatly enlarged, and bulbous in form; the basal portion has a dense covering of erect hairs longer than its own diameter. The cerci are rather small and membranous.

Family AGROMYZIDÆ

In *Agromyza æneiventris* Fallén the abdomen is about the same as in the Geomyzidæ, being composed largely of segments one to six, with the genital portion rather small. There is only one segment between the sixth and ninth, probably the eighth. The ædeagus and apodemes are well developed (fig. 282), the ædeagus being quite complex on the apical portion.

There are no separate styles on the ninth segment. The cerci are well developed.

In *Phytomyza obscurella* Fallén segments one and two are fused and segments 3-6 make up most of the rest of the abdomen. The seventh segment is apparently lost. The ædeagus in this species is one of the most complex seen in the study of the dipterous genitalia (fig. 284), and there is an immense double apodeme for the attachment of the muscles which control this organ. In *Agromyza scutellaris puella* Meigen the ædeagus is quite simple; the apodeme is rather long and slender and relatively smaller than in *P. obscurella.*

Mr. J. R. Malloch has recently figured the hypopygia of several species of *Leucopis* in a paper on the subfamily Ochthiphilinæ (Bull. Ill. Nat. Hist. Survey, vol. 13, art. 14, 1921). The genitalia possess good specific characters. The cerci are small but distinct. The ædeagus is apparently quite variable; it is very long, chitinized and curved in *L. piniperda* Malloch, much shorter in the other species. The ninth tergite is well developed but the surstyli are small or rudimentary. *L. griseola* Fallén has the interior forceps and "palpi" well developed; the ejaculatory apodeme in this species is large and broad, not slender as in the species of *Agromyza* (fig. 283). In *L. bella* Loew the apodeme is much smaller, the ædeagus relatively larger and shorter, with an apical slender portion differentiated from the rest; the interior forceps and "palpi" are nearly the same as in *L. griseola.* In a large undescribed species from Arizona the interior forceps, "palpi" and ædeagus all project about the same length from the floor of the ninth segment and all are protected by the slender arms of the ninth tergite; the apodeme in this species of *Leucopis* is of the same general shape as in *L. griseola.*

Family Milichiidæ

In this family (included by some as a subfamily in the Agromyzidæ) there is not the great development and specialization of the ædeagus seen in the Geomyzidæ and Agromyzidæ, if one can judge from the three species examined. *Madiza halteralis* Coquillett is heavily chitinized and the segments one to six make up most of the abdomen; the genital portion of the abdomen is extremely small, the seventh and eighth segments

greatly reduced or lost and difficult to make out in the forms studied. The whole genital portion of the abdomen is normally drawn into the sixth segment or under the sixth tergite. The outer claspers are tergal and therefore are surstyli; they are relatively large, simple, and close over the internal parts. In *M. halteralis* the ends of the styles are broad and toothed on the margin; in this same species the double apodeme is small, slender, and can be made out only under high magnification; the ædeagus is minute and there is probably an extensile membranous portion.

In *Milichia leucogaster* Loew the sternites are reduced to very narrow strips, the sixth sternal segment largest and hollowed out posteriorly; the pleural membranous area is large. The seventh and eighth segments have disappeared and the hypopygium is relatively very small. There are two long styles on the ninth tergite, the surstyli (fig. 281). On the anal segment there are two long spines, one on each of the rudimentary cerci. The double apodeme is fused with the genital arch.

Milichiella nitida Hendel has much the same plan of construction as *M. leucogaster*. The sixth tergite is very large in comparison with the rest of the abdomen and the sternites are relatively larger than in the preceding species. The proctiger is different from *M. leucogaster* and lacks the two long spines. The surstyli are longer, more slender and not enlarged at the tips; the double apodeme is smaller. There are small spines near the base of the ædeagus, probably representing the interior forceps and the palpi.

Family HIPPOBOSCIDÆ

In *Olfersia americana* Leach the abdomen is largely membranous and the segments can be located by the presence of spiracles, of which there are seven pairs; one pair of spiracles is at the extreme base of the abdomen, the second pair in the chitinous base of the abdomen (the second segment), three pairs in the membranous area along the sides of the abdomen, but in a tergal position, the last two pairs in the anal region; the sixth spiracle is actually posterior to the seventh, which is moved up on the dorsum not far from the anal opening. The ædeagus, at least the intrommitant organ,

which may not contain the true penis is long and sharp. The genital styles, according to my interpretation, are represented by bristly knobs and are located on each posterior corner of the genital opening. In this case the interior forceps are the long, slender, style-like appendages which point back and have a heavy framework at the base. The double apodeme is large and easily seen in cleared specimens. The anal area has a flap, bristly on the margin, and the opening of the genital organs at the tip of the abdomen is also the anal opening (cloaca).

Lipoptena subulata Coquillett has genitalia of the same general character as in the preceding species. The abdomen is membranous except for a poorly chitinized anal plate. In *L. mazamæ* (Rondani) the ædeagus is short, scarcely projecting beyond the genital opening, the interior forceps a little longer. The framework at the base of the interior forceps reaches to the basal third of the abdomen. The styles are represented by very small chitinous areas over the interior forceps, with two long spines and two shorter ones; the interior forceps are blunt. In *L. traguli* Ferris and Cole the last five spiracles are all near the apex of the abdomen, the third pair about opposite the base of the interior forceps.

In *Melophagus ovinus* the genitalia are much the same as in *Olfersia americana.* The ædeagus is slightly longer than the interior forceps and is blunt. The spiracles are of great size, the first and second pair near the base of the abdomen, the sixth and seventh near the apex of the abdomen, below the anal opening; they are pulled around to the ventral side of the abdomen but are really tergal in location.

Family Streblidæ

There is less evident segmentation of the abdomen here than in the Hippoboscidæ. In *Paradyschiria fusca* Speiser the outer styles are reduced to small strips on the sides of the genital opening. The inner claspers (probably interior forceps) are long and point backwards. The ædeagus is long, slender, thick at the base and quite distinctive in shape; the apodemes are well developed. Most of the structures are internal and the specimens must be cleared to see the construction. The ejaculatory apodeme is almost as large as the double apodeme.

Family NYCTERIBIIDÆ

Wesche, in his study of the male genitalia of the Diptera, had only loan material in this family and could not dissect the specimens. In *Penicillidia dufourii* Westwood there is a large pair of ventral forceps, heavily chitinized and articulated at the base, probably representing the interior forceps. The ædeagus is small. There is no actual plate in the region of the laminæ superiores; laterally there are two bulbous processes which are thickly spined, probably the genital styles. Wesche states that the apodemes cannot be differentiated, but a strong double apodeme is visible in cleared specimens. *P. antrozoi* has genitalia of the same type as the preceding species.

In *Cyclopodia hopei* the male has a pointed abdomen; on the ventral side there is a pair of forceps which meet at the tips, and between these are two small chitinous knobs. The segment opposite the forceps has a short row of blunt spines on the margin which may represent the laminæ superiores. *Nycteribia westwoodii* has a like row of spines which may represent the laminæ. The ædeagus is apparent in cleared specimens and the apodemes strong.

In *N. biarticulata* Herm. the styles and interior forceps are plainly visible, as can be seen in figure 286. The ædeagus is pointed and curved at the tip. The double apodemes are fused, the ejaculatory apodeme short and slender. In *N. schmiedlii* Schiner the double apodeme is long, reaching almost to the base of the abdomen. There are seven pairs of spiracles, representing as many segments; the last (and largest) segment with spiracles is the seventh; that being the case, the seventh, eighth and ninth segments are merged in one or the seventh and eighth lost.

In *Eucamprisipoda sp.* the outer forceps are slender and studded with short, black tubercles. In *Cyclopodia ferrarii* the first three spiracles are apparently in the tergites, the fourth and fifth in the membrane, the sixth and seventh in the tergites.

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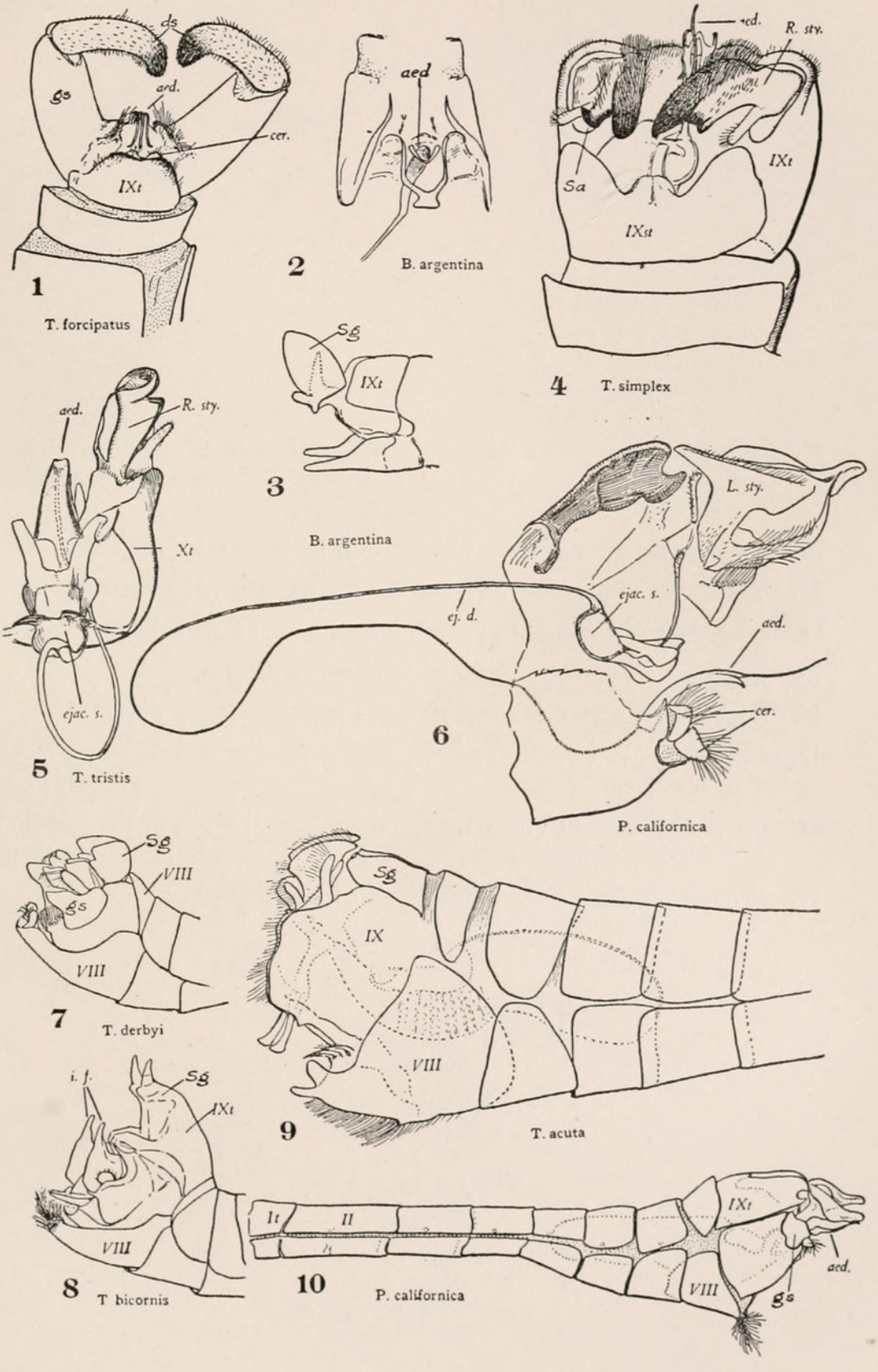
Explanation of Plates

Abbreviations.

aed.....Ædeagus or intrommitant organ.
cer.....Cerci (parapodial plates in some cases).
d. apod.....Double apodeme (or sustentacular apodeme).
ds.....Dististylus (also called harpes, harpagones, etc.).
ejac. s.....Ejaculatory sac.
ej. d.....Ejaculatory duct.
ej. apod.....Ejaculatory apodeme.
gs.....Gonostipes or basal segment of genital style.
hyp.....Hypophallus.
i. f.....Interior forceps (posterior gonapophyses).
L. sty.....Left genital style.
pa.....Palpi or anterior gonapophyses.
par.....Paraphallus.
pp.....Paraprocts, or parapodial plates.
R. sty.....Right genital style.
s. or st.....Sternite.
Sa.....Subapical appendix of claspers.
Sg.....Surstyli, or surgonopods.
sh.....Sheath of ædeagus.
s. l.....Superior laminæ.
sp.....Spinus titillatorius.
t.....Tergite.

Roman numerals are used to indicate the number of the urite, whether tergite or sternite.

1. *Tanyderus forcipatus* O.S., dorsal view of genitalia.
2. *Bruchomyia argentina* Alex., ædeagus and genital framework.
3. *Bruchomyia argentina* Alex., lateral view of external genitalia.
4. *Tipula simplex* Doane, ventral view of terminal structures.
5. *Tipula tristis* Doane, internal genitalia, part of left side cut away.
6. *Nephrotoma californica* Doane, terminal structures as they appear with body wall cut away on right side.
7. *Tipula derbyi* Doane, lateral view of terminal structures.
8. *Tipula bicornis* Loew, lateral view of terminal structures.
9. *Tipula acuta* Doane, lateral view of terminal portion of abdomen.
10. *Nephrotoma californica* (Doane), lateral view of entire abdomen.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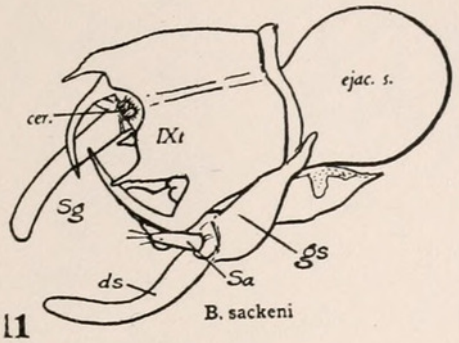
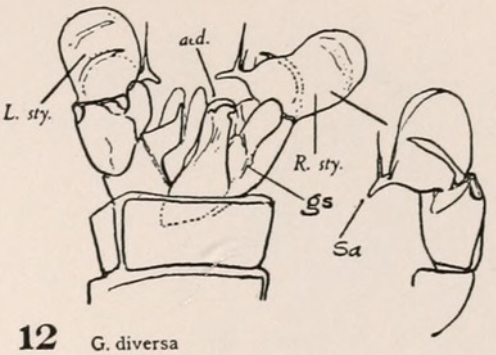
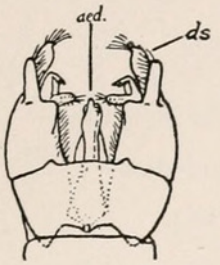
11. *Bittacomorphella sackeni* (Röder), dorsal view of terminal structures, segments in front of ninth cut away to show the large ejaculatory sac.
12. *Geranomyia diversa* O.S., ventral view of terminal structures.
13. *Goniomyia virgata* Doane, ventral view of terminal structures.
14. *Bittacomorpha clavipes* (Fabr.), lateral view of genitalia.
15. *Trichocera* sp., ventral view of terminal structures.
16. *Rhyphus punctatus* (Fabr.), ædeagus and ejaculatory duct.
17. *Bittacomorpha clavipes* (Fabr.), lateral view of terminal structures of abdomen.
18. *Rhyphus punctatus* (Fabr.), ventral and dorsal views of the terminal abdominal structures.
19. *Ptychoptera lenis* O.S., lateral view of terminal structures.



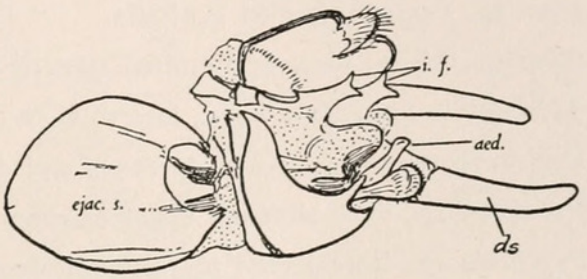
11 B. sackeni



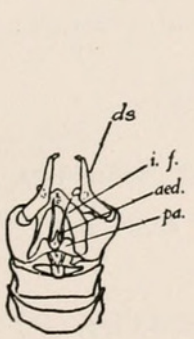
12 G. diversa



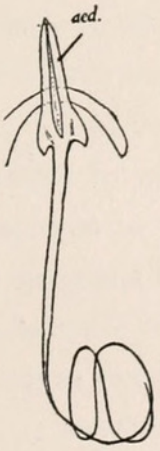
13 G. virgata



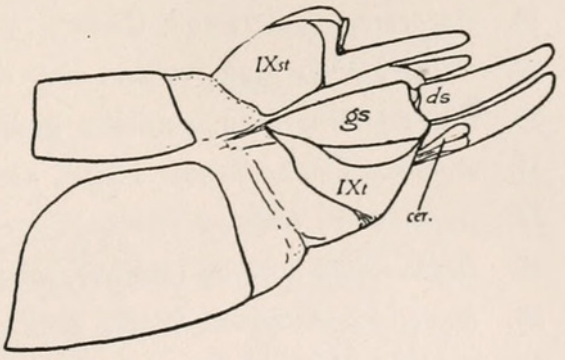
14 B. clavipes



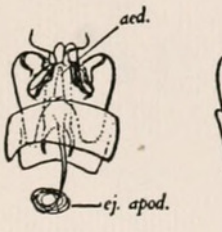
15 Trichocera sp.

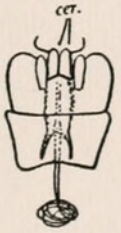


16 R. punctatus

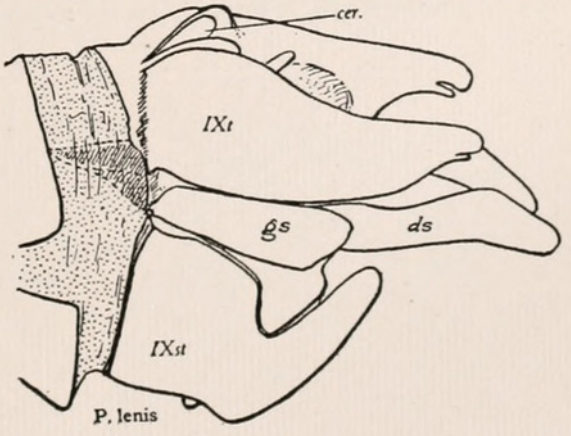


17 B. clavipes





18 R. punctatus

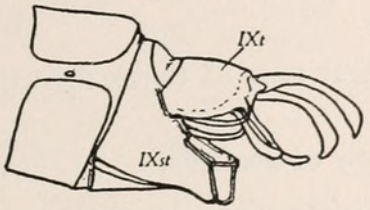


19 P. lenis

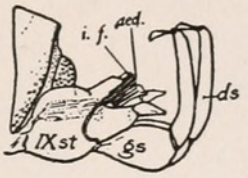
April 27, 1927

20. *Dixa* sp., ventral view of genitalia.
21. *Dixa* sp., lateral view of terminal structures.
22. *Trichomyia lanceolata* Kinc., lateral view of terminal structures.
23. *Pericoma californica* Kinc., ædeagus and double apodeme.
24. *Psychoda sp.,* view showing upper claspers of genitalia.
25. *Psychoda sp.,* lateral view of terminal claspers.
26. *Chironomus sp.,* dorsal view of terminal structures.
27. *Tanypus venustus* Coq., ventral view of terminal structures.
28. *Eucorethra underwoodi* Underw., ventral view of terminal structures.
29. *Culex pipiens* Linn., ventral view of terminal structures.
30. *Culex pipiens* Linn., genitalia, greatly magnified.
31. *Anopheles punctipennis* (Say), ventral view of terminal structures.
32. *Orphnephila testacea* (Ruthe), dorsal view of terminal structures.
33. *Orphnephila testacea* (Ruthe), ædeagus and appendages.
34. *Mycetobia divergens* Walk., ventral view of terminal structures.
35. *Sciophila calceata* Coq., lateral view of terminal structures.
36. *Symmerus sp.,* lateral view of terminal structures.
37. *Symmerus sp.,* ventral view of ninth sternite.

20 Dixa sp.



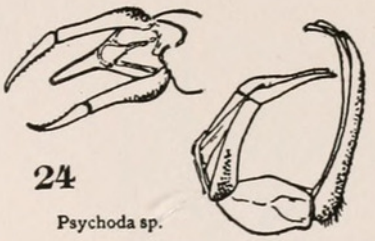
21 Dixa sp.



T. lanceolata

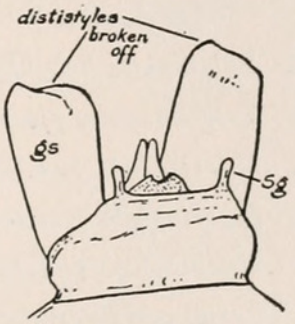
22

23 P. californica

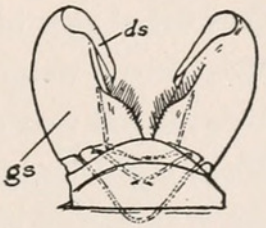


24 Psychoda sp.

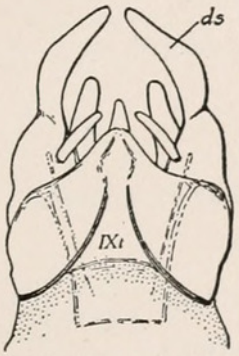
25 Psychoda sp.



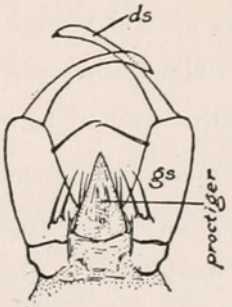
28 C. underwoodi



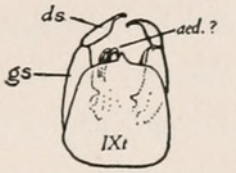
27 T.venustus



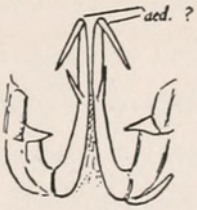
26 Chironomus sp.



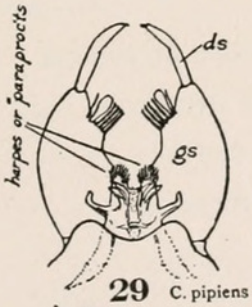
31 A. punctipennis



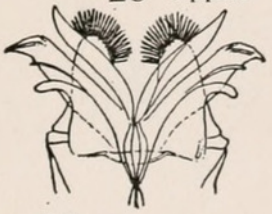
32 O. testacea



33 O. testacea



29 C. pipiens



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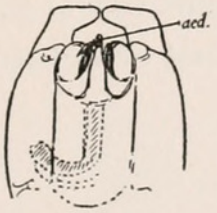
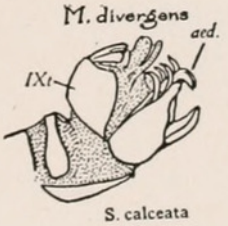
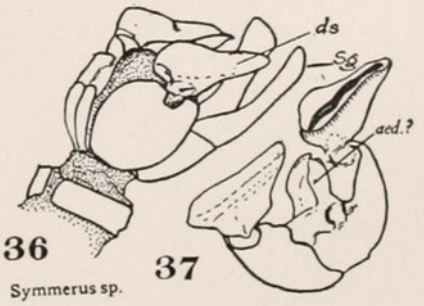


34

M. divergens



35 S. calceata

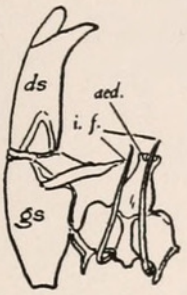


36 Symmerus sp.

37

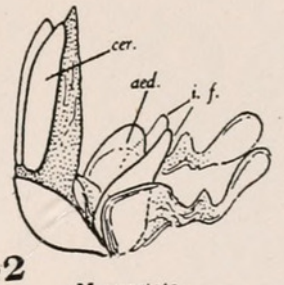
38. *Boletophila hybrida* (Meig.), dorso-lateral view of terminal portion of abdomen.
39. *Boletophila hybrida* (Meig.), ventral view of genitalia.
40. *Tetragoneura pimpla* Coq., dorsal view of terminal structures.
41. *Mycetophila punctata* Meig., lateral view of terminal structures.
42. *Mycetophila punctata* Meig., lateral view of genitalia.
43. *Mycetophila punctata* Meig., dististylus, greatly enlarged.
44. *Cecidomyia resinicoloides* Will., Dorsal view.
45. *Cecidomyia resinicoloides* Will., ventral view.
46. *Reichertellia collaris* Mel., ventral view of terminal structures.
47. *Scatopse notata* (Linn.), ventral view of genitalia.
48. *Scatopse notata* (Linn.), ejaculatory sac and appendages.
49. *Bibio hirtus* Loew., ventral view of terminal structures.
50. *Bibio hirtus* Loew., ædeagus and appendages.
51. *Bibio nervosus* Loew., ædeagus and appendages.
52. *Rhegmoclema atrata* (Say), ventral view of terminal structures.
53. *Rhegmoclema atrata* (Say), ædeagus and adjacent structures.
54. *Plecia ruficollis* Fabr., ventral view of terminal structures.
55. *Plecia ruficollis* Fabr., dorsal view of terminal structures.

38

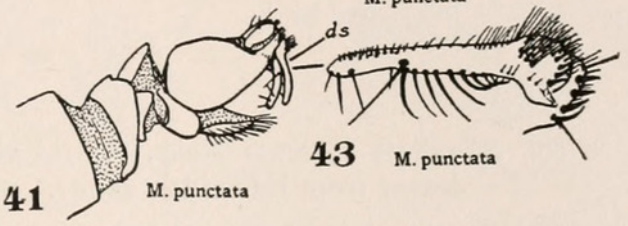


39 B. hybrida

40 T. pimpla



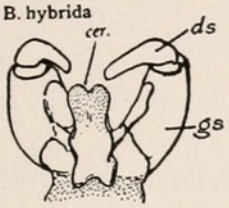
42 M. punctata



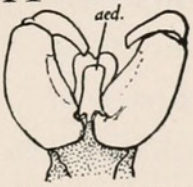
41 M. punctata

43 M. punctata

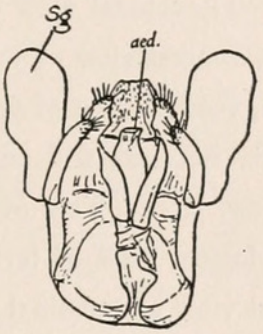
B. hybrida



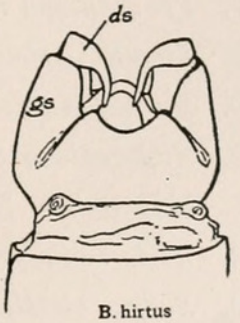
44 C. resinicoloides



45 C. resinicoloides



47 S. notata



B. hirtus

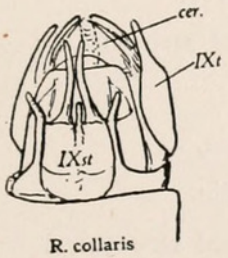
49

B. hirtus

50

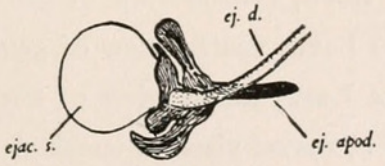
B. nervosus

51

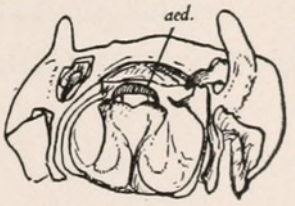


R. collaris

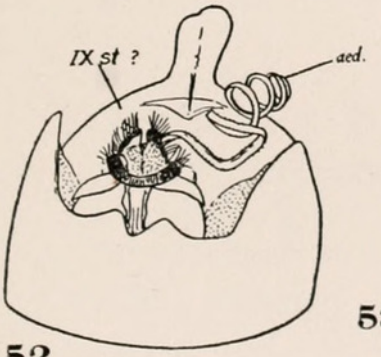
46



48 S. notata



54 P. ruficollis

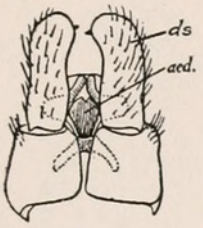


52 R. atrata

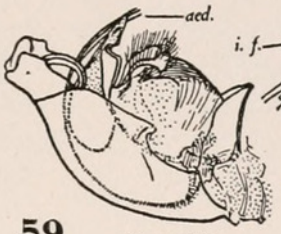
53 R. atrata

55 P. ruficollis

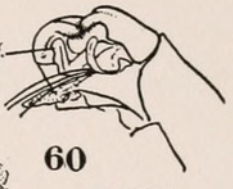
56. *Simulium ornatum* Meig., ventral view of terminal structures (redrawn from Edwards' figure).
57. *Prosimulium hirtum* (Fries), ventral view of terminal structures.
58. *Simulium pictipes* Hagen, ventral view of terminal structures.
59. *Simulium pictipes* Hagen, ventral view of terminal structures.
60. *Bibiocephala grandis* O.S., ædeagus and adjacent structures.
61. *Hapalothrix lugubris* Loew, lateral view of terminal structures.
62. *Beris annulifera* (Big.), lateral view of terminal structures.
63. *Sargus viridis* Say, dorsal view of terminal structures.
64. *Odontomyia hoodiana* Big., dorsal view of terminal structures.
65. *Odontomyia hoodiana* Big., ventral view.
66. *Odontomyia arcuata* Loew, ventral view of genitalia.
67. *Stratiomyia maculosa* Loew, ventral view of genitalia.
68. *Stratiomyia maculosa* Loew, dorsal view of terminal structures.
69. *Tabanus striatus* Fabr., dorsal view of terminal structures.
70. *Ptecticus trivittatus* Say, lateral view of abdomen.



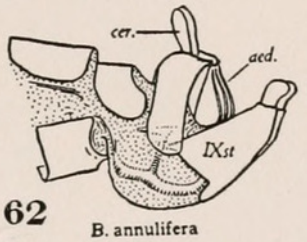
56 S. ornatum



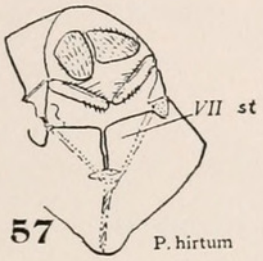
59 B. grandis



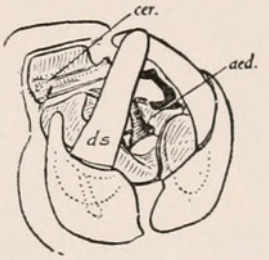
60 B. grandis



62 B. annulifera

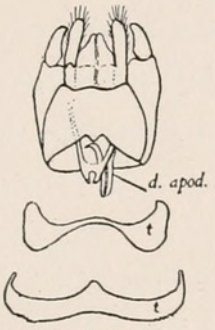


57 P. hirtum

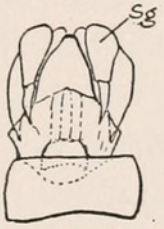


58 S. pictipes

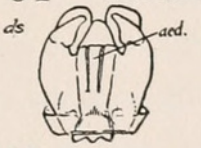
61 H. fugubris



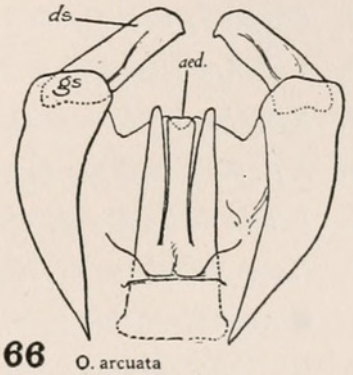
63 S. viridis



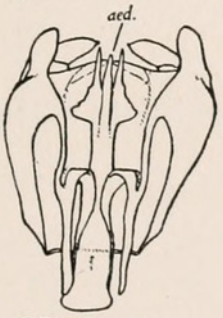
64 O. hoodiana



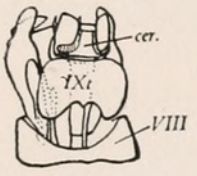
65 O. hoodiana



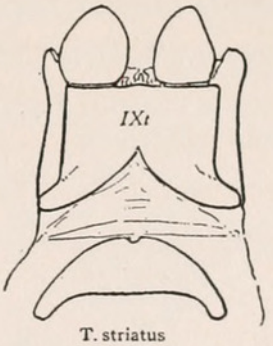
66 O. arcuata



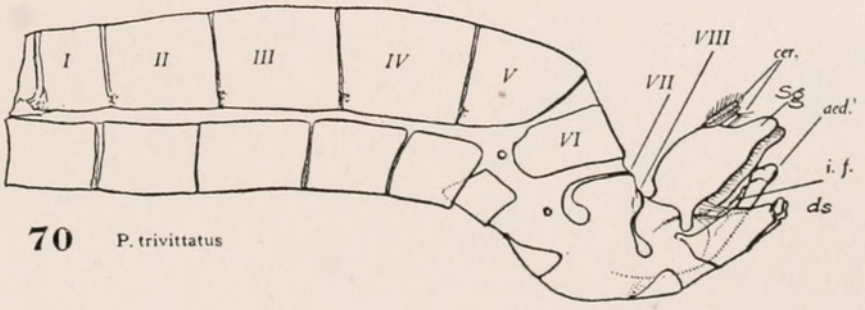
67 S. maculosa



68 S. maculosa

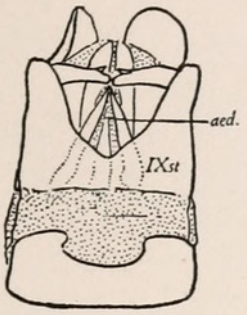


69 T. striatus



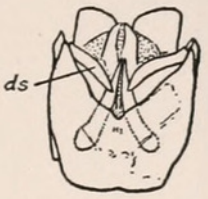
70 P. trivittatus

71. *Tabanus striatus* Fabr., ventral view of terminal structures.
72. *Chrysops noctifer* O.S., ventral view of terminal structures.
73. *Tabanus punctifer* O.S., ventral view of terminal structures.
74. *Symphoromyia cruenta* Coq., ventral view of terminal structures.
75. *Xylomyia pallipes* (Loew), lateral view of terminal structures.
76. *Leptis incisa* Loew, ventral of terminal structures.
77. *Pantophthalmus versicolor* Aust., ventral view.
78. *Rhynchocephalus volaticus* Will., lateral view of hypopygium.
79. *Rhynchocephalus volaticus* Will., genitalia dissected out.
80. *Ogcodes costatus* Loew, ventral view of abdomen.
81. *Ogcodes albicincta* Cole, genitalia dissected out.
82. *Ogcodes costatus* Loew, genitalia dissected out, showing the ædeagus and apodemes.

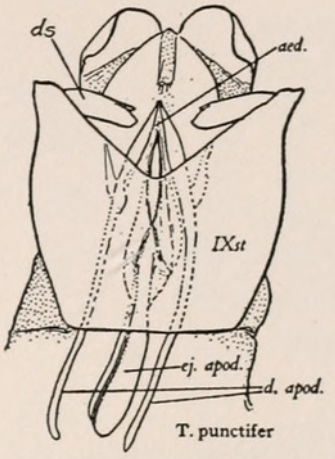


T. striatus

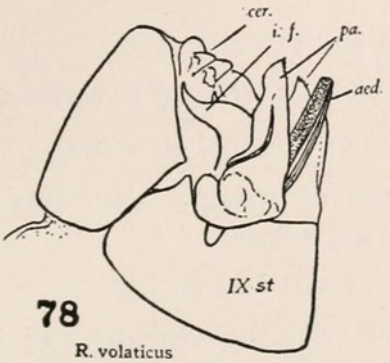
71



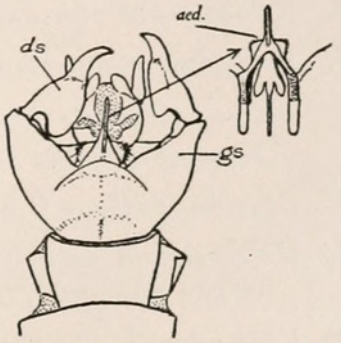
72 C. noctifer



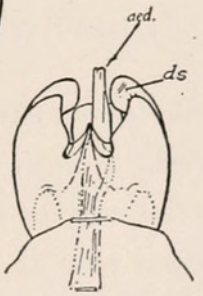
73 T. punctifer



78 R. volaticus

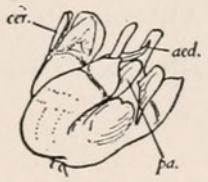


74 S. cruenta

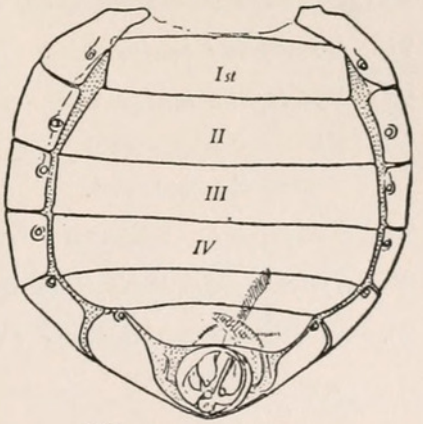


77 P. versicolor

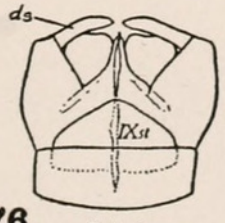
79 R. volaticus



X. pallipes

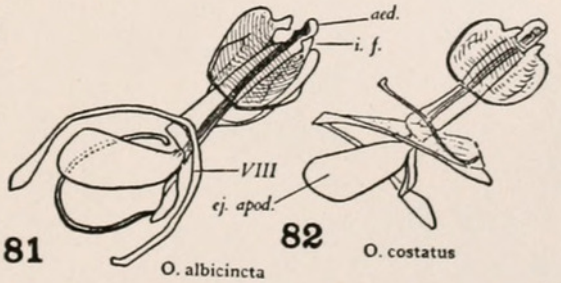


80 O. costatus



76 L. incisa

75



81 O. albicincta

82 O. costatus

83. *Opsebius diligens* O.S., genitalia and ninth tergite.

84. *Eulonchus sapphirinus* O.S., lateral view of terminal structures.

85. *Bombylius major* Linn., ventral view of terminal structures.

86. *Eulonchus tristis* Loew, lateral view of terminal structures with separate drawing of ædeagus and appendages.

87. *Opsebius diligens* O.S., lateral view of terminal structures.

88. *Heterostylum robustum* O.S., lateral view of genitalia, the tenth tergite removed.

89. *Villa lateralis* (Say), lateral view of terminal structures.

90. *Ogcodes albicincta* Cole, ventral view of terminal structures.

91. *Bombylius major* Linn., lateral view of terminal structures.

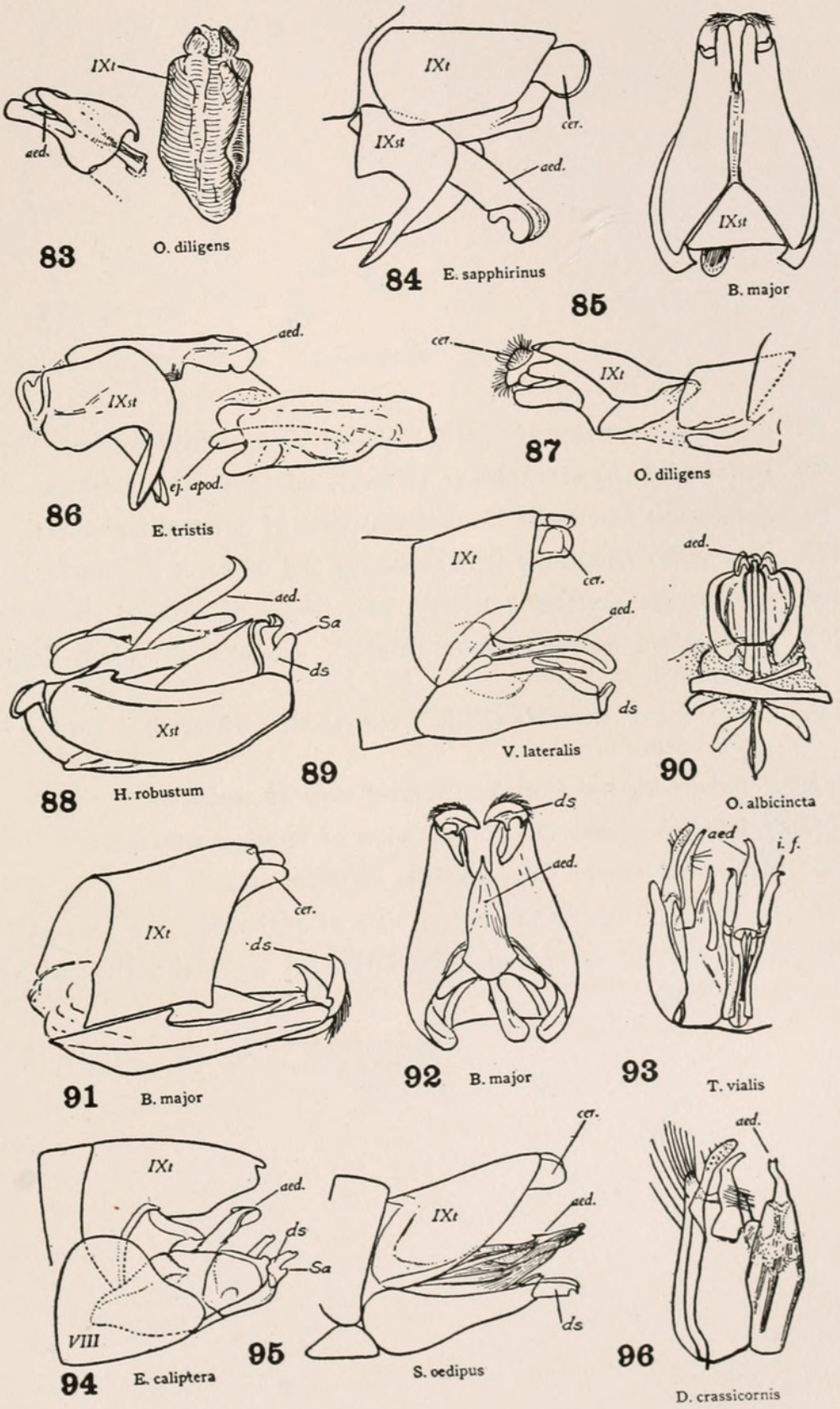
92. *Bombylius major* Linn., ventral view of terminal structures.

93. *Thereva vialis* O.S., genitalia, the ninth tergite and right side of sternite removed.

94. *Exoprosopa caliptera* (Say), lateral view of terminal structures.

95. *Spogostylum œdipus* (Fabr.), lateral view of terminal structures.

96. *Dialineura crassicornis* (Will.), ædeagus and claspers of left side.


IXt
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83
O. diligens
IXt
IXst
cer.
aed.
84
E. sapphirinus
IXt
IXst
85
B. major
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86
E. tristis
cer.
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87
O. diligens
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V. lateralis
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Xst
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H. robustum
89
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O. albicincta
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E. caliptera
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IXt
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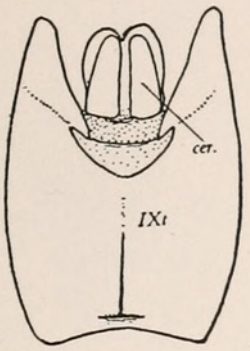
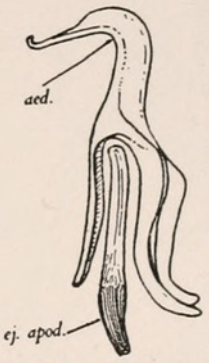
95
S. oedipus
aed.
96
D. crassicornis

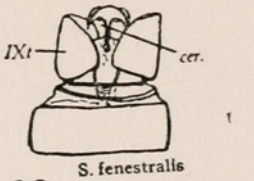
97. *Dialineura crassicornis* (Will.), dorsal view of hypopygium.
98. *Psilocephala hæmorrhoidalis* (Macq.), ædeagus and apodemes.
99. *Scenopinus fenestralis* Linn., dorsal view of terminal structures.
100. *Scenopinus fenestralis* Linn., ædeagus and adjacent structures.
101. *Leptomydas pantherinus* Gerst., lateral view of terminal structures.
102. *Psilocephala hæmorrhoidalis* (Macq.), genitalia, the ninth tergite removed.
103. *Dialineura crassicornis* (Will.), ventral view of terminal portion of abdomen.
104. *Pseudatrichia unicolor* Coq., ventral view of genitalia.
105. *Apiocera haruspex* O.S., lateral view of terminal structures.
106. *Apiocera haruspex* O.S., genitalia dissected out.
107. *Apiocera haruspex* O.S., lateral view of genitalia.
108. *Rhaphiomydas acton* Coq., lateral view of terminal portion of abdomen.



97 D. crassicornis

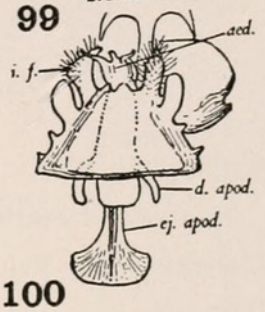


98 P. haemorrhoidalis

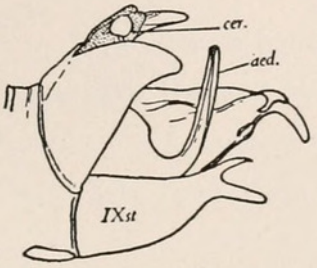


S. fenestralis

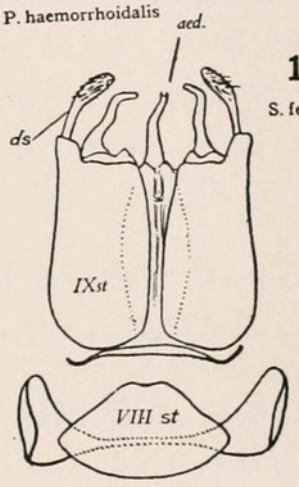
99



100 S. fenestralis



101 L. pantherinus



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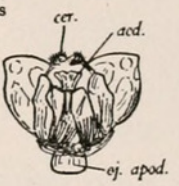
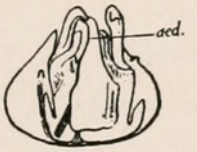


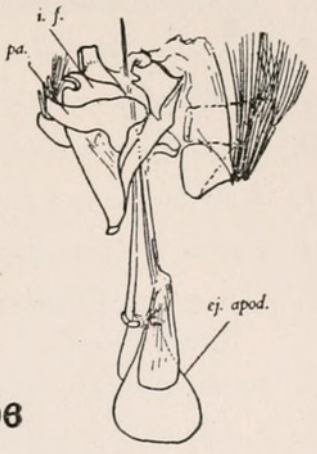
P. unicolor



P. haemorrhoidalis

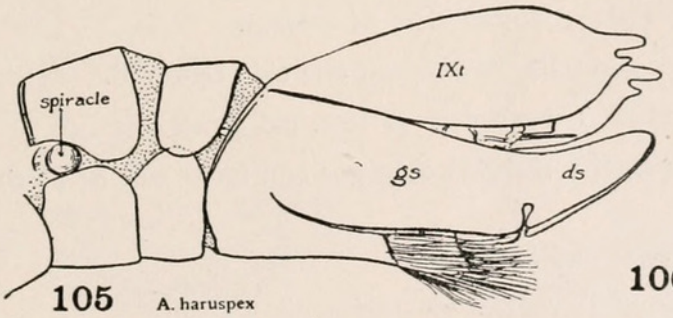
102

103 D. crassicornis

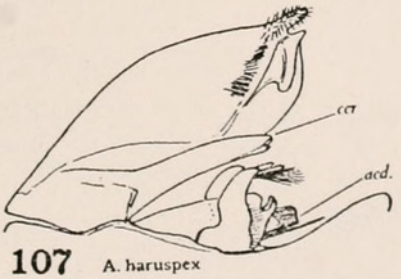


106

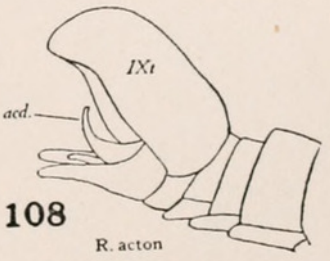
A. haruspex



105 A. haruspex



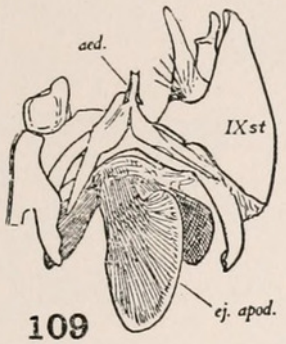
107 A. haruspex



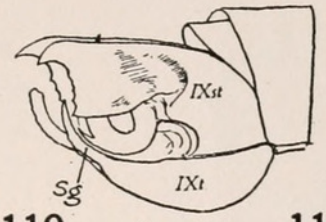
108

R. acton

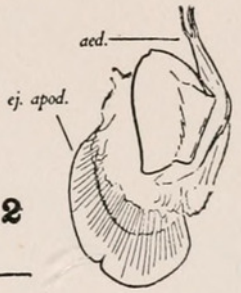
109. *Cyrtopogon præpes* Loew, ædeagus and adjacent structures, a part of one side of ninth segment removed.
110. *Dasyllis grossa* Fabr., lateral view of terminal structures.
111. *Promachus vertebratus* Say, lateral view of terminal structures.
112. *Dasyllis californicus* Banks, ædeagus and apodemes.
113. *Dasyllis californicus* Banks, showing structures guarding the ædeagus.
114. *Dasyllis californicus* Banks, dististylus and appendages.
115. *Dasyllis californicus* Banks, dorsal view of terminal portion of abdomen.
116. *Dasyllis californicus* Banks, lateral view of hypopygium.
117. *Lasiopogon arenicola* O.S., dorsal view of terminal structures.
118. *Asilus occidentalis* Hine, ædeagus and claspers.
119. *Lasiopogon arenicola* O.S., under side of cerci.
120. *Lasiopogon arenicola* O.S., lateral view of ædeagus.
121. *Erax barbatus* Fabr., genitalia, tergite and one side removed.
122. *Asilus occidentalis* Hine, lateral view of terminal structures.
123. *Dasyllis californicus* Banks, showing ædeagus and inner side of ninth tergite.
124. *Lasiopogon sp.*, ædeagus and apodemes.
125. *Lasiopogon arenicola* O.S., ventral view of genitalia.



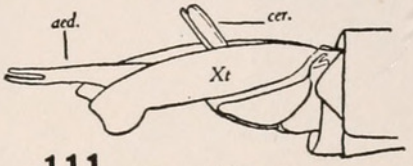
109 C. praepes



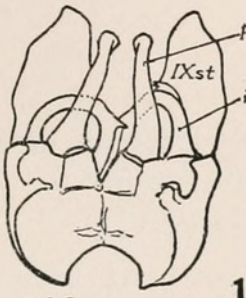
110 D. grossa



112 D. californicus



111 P. vertebratus

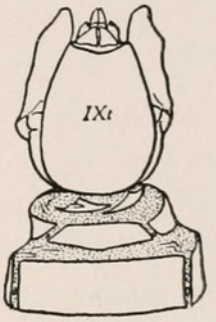


113 D. californicus

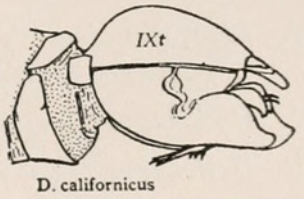
114 D. californicus

A. occidentalis

118



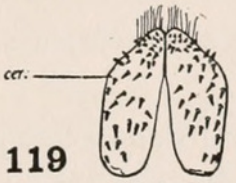
115 D. californicus



D. californicus

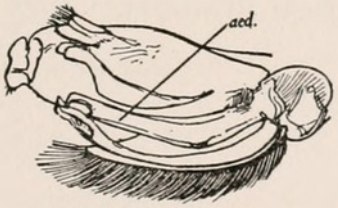
116

117 L. arenicola



119 L. arenicola

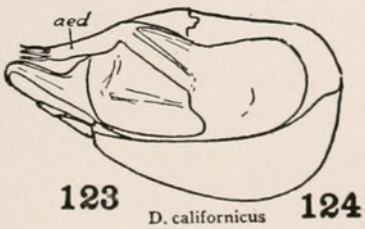
120 L. arenicola



E. barbatus

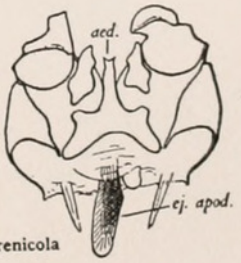
121

122 A. occidentalis



123 D. californicus

124 Lasiopogon sp.



125 L. arenicola

126. *Scellus monstrosus* O.S., lateral view of terminal portion of abdomen, showing remarkable modification of fifth segment.

127. *Scellus monstrosus* O.S., ventral view of segments IV-VII.

128. *Liancalus similis* Aldr., lateral view of terminal portion of abdomen.

129. *Liancalus similis* Aldr., lateral view, showing right side of terminal segments (smaller magnification).

130. *Dolichopus plumosus* Aldr., lateral view of terminal structures.

131. *Dolichopus plumosus* Aldr., under side of cerci.

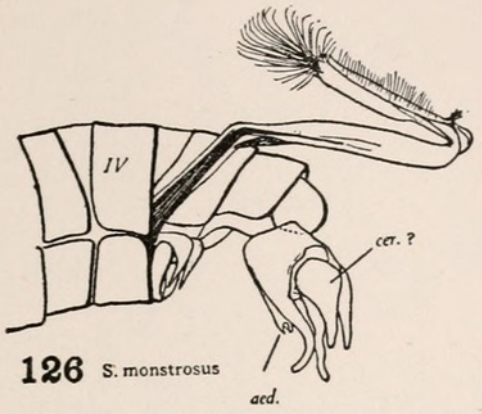
132. *Dolichopus plumosus* Aldr., Genitalia, right side removed.

133. *Apiochæta sp.*, lateral view of hypopygium.

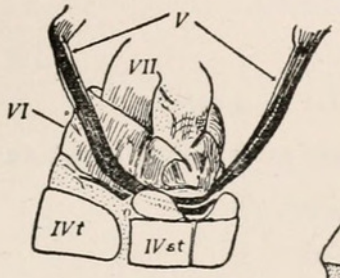
134. *Apiochæta rufipes* Meig.

135. *Phora velutina* Meig., lateral view of hypopygium.

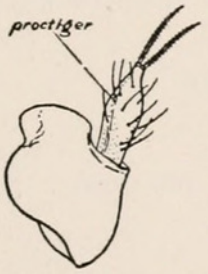
136. *Braula coeca* Nitsch., lateral view of terminal structures.



126 S. monstrosus

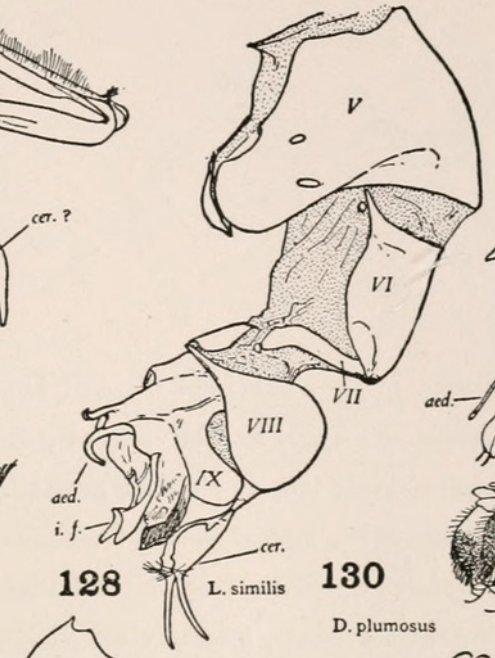


127 S. monstrosus

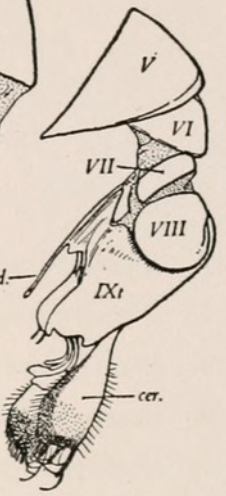


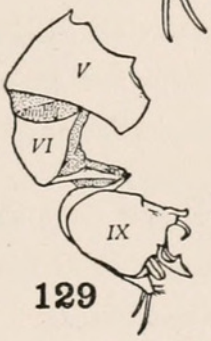
133

Apiochaeta sp.

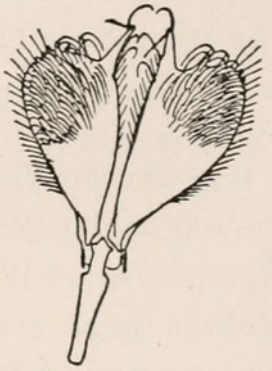


128 L. similis **130** D. plumosus

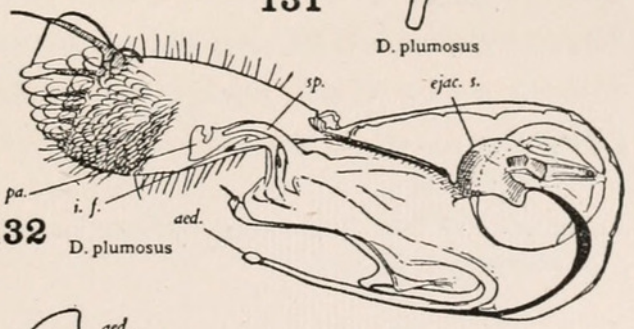




129 L. similis



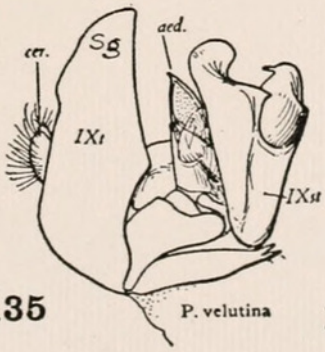
131 D. plumosus



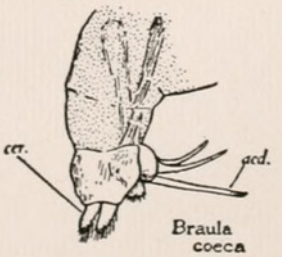
132 D. plumosus

A. rufipes

134



135 P. velutina



136 Braula coeca

137. *Rhamphomyia sp.,* no. 2, lateral view of hypopygium.

138. *Rhamphomyia sp.,* no. 1, lateral view of genitalia.

139. *Empis aldrichi* Mel., lateral view of genitalia.

140. *Empis aldrichi* Mel., lateral view of terminal structures.

141. *Rhamphomyia sudigeronis* Coq., lateral view of terminal structures.

142. *Platypeza velutina* Loew, lateral view of hypoygium.

143. *Platypeza velutina* Loew, ædeagus and guards.

144. *Lonchoptera sp.,* lateral view, apical segments of abdomen.

145. *Platypeza agarici* Williard, lateral view of hypopygium, with separate figure showing proctiger from above.

146. *Chalarus spurius* (Fall), ventral view of genitalia.

147. *Pipunculus* sp., no 1, ædeagus and guards.

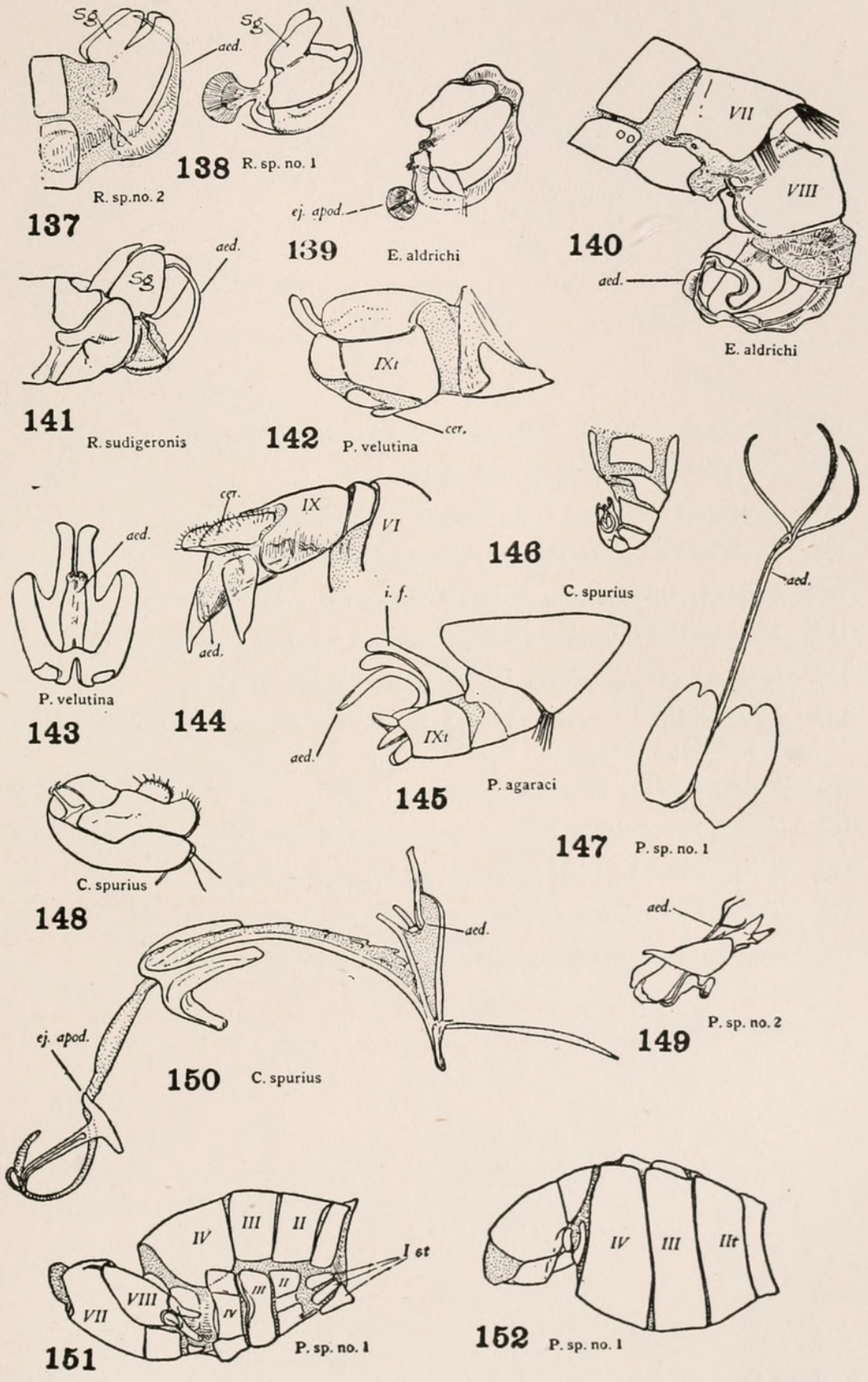
148. *Chalarus spurius* (Fall), genitalia, ninth tergite removed.

149. *Pipunculus* sp., no. 1, ædeagus and attachments.

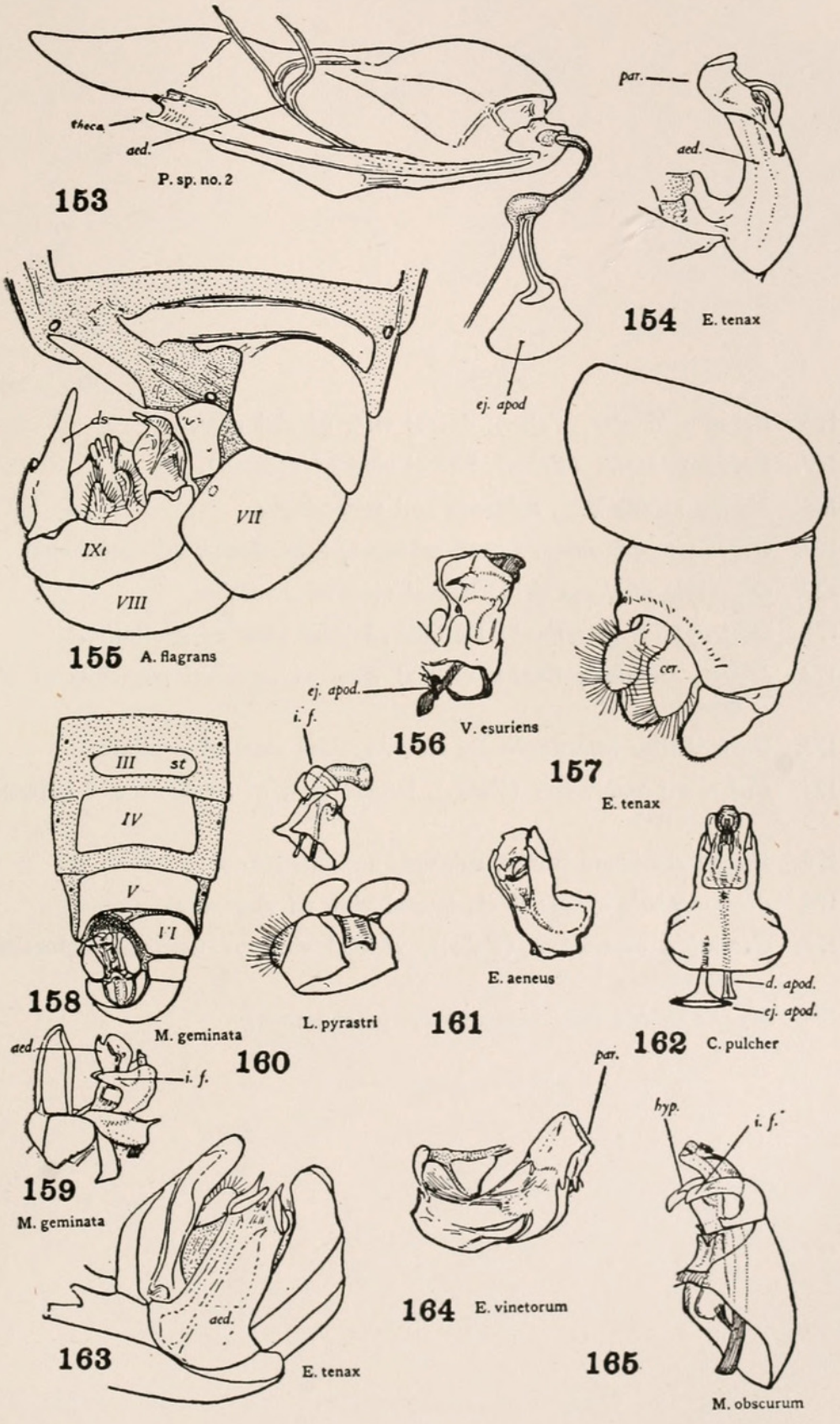
150. *Chalarus spurius* (Fall), ædeagus and apodemes, greatly enlarged.

151. *Pipunculus* sp. no. 1, showing right side of abdomen and portion of venter.

152. *Pipunculus* sp. no. 1, showing dorsum and part of left side of the abdomen.


Sg
aed.
R. sp.no. 2
137
Sg
aed.
138 R. sp. no. 1
ej. apod.
139 E. aldrichi
VII
VIII
140
aed.
E. aldrichi
Sg
aed.
141 R. sudigeronis
IXt
cer.
142 P. velutina
aed.
P. velutina
143
cer.
IX
VI
aed.
144
146
C. spurius
i. f.
IXt
aed.
145 P. agaraci
aed.
147 P. sp. no. 1
C. spurius
148
aed.
ej. apod.
150 C. spurius
aed.
P. sp. no. 2
149
IV
III
II
I st
VIII
VII
151 P. sp. no. 1
IV
III
IIt
152 P. sp. no. 1

153. *Pipunculus* sp. no. 2, ædeagus and apodemes, greatly enlarged.
154. *Eristalis tenax* (Linn.), ædeagus.
155. *Arctophila flagrans* O.S., ventral view of hypopygium.
156. *Volucella esuriens* (Fabr.), ædeagus and apodemes.
157. *Eristalis tenax* (Linn.), dorsal view of hypopygium.
158. *Mesogramma geminata* (Say), ventral view of abdomen.
159. *Mesogramma geminata* (Say), genitalia, lateral view.
160. *Lasiophthicus pyrastri* (Linn.), ædeagus and apodemes; ninth tergite and cerci.
161. *Eristalis æneus* (Scop.), ædeagus.
162. *Caliprobola pulcher* (Will.), ædeagus and appendages.
163. *Eristalis tenax* (Linn.), ventral view of genitalia.
164. *Eristalis vinetorum* (Fabr.), ædeagus and appendages.
165. *Melanostoma obscurum* (Say), lateral view of genitalia.


theca
aed.
P. sp. no. 2
153
par.
aed.
154 E. tenax
ej. apod
ds
VII
IXt
VIII
155 A. flagrans
ej. apod.
156 V. esuriens
cer.
157 E. tenax
III st
IV
V
VI
158 M. geminata
i. f.
L. pyrastri
161
E. aeneus
d. apod.
ej. apod.
162 C. pulcher
aed.
i. f.
160
159 M. geminata
par.
hyp.
i. f.
164 E. vinetorum
aed.
163 E. tenax
165
M. obscurum

166. *Paragus bicolor* (Fabr.), dorsal view of abdomen.

167. *Paragus bicolor* (Fabr.), lateral view of genitalia.

168. *Myopa rubida* Big., ædeagus and appendages.

169. *Occemyia abbreviata* Loew, ædeagus, appendages, and apodemes.

170. *Occemyia modesta* Will., lateral view of genitalia.

171. *Gastrophilus intestinalis* De Geer, lateral view of genitalia.

172. *Myopa seminuda* Banks, ventral view of terminal segments of abdomen.

173. *Gastrophilus intestinalis* De Geer, ventral view of genitalia.

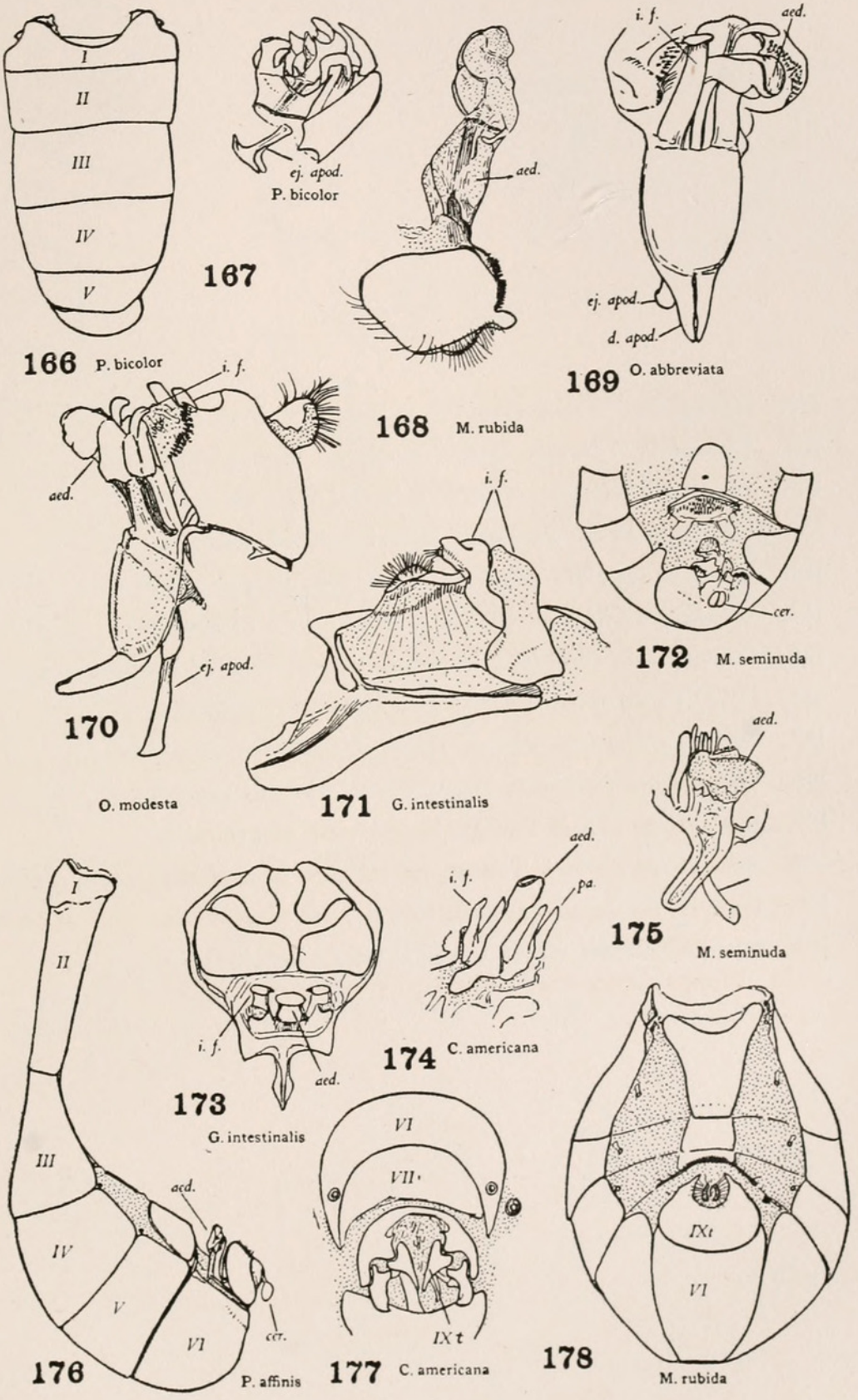
174. *Cuterebra americana* (Fabr.), lateral view of ædeagus and adjacent structures.

175. *Myopa seminuda* Banks, ædeagus and apodemes.

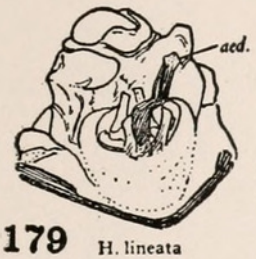
176. *Physocephala affinis* Will., lateral view of abdomen.

177. *Cuterebra americana* (Fabr.), ventral view of terminal abdominal segments.

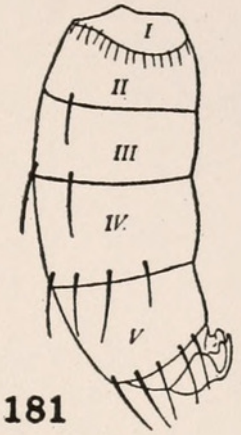
178. *Myopa rubida* Big., ventral view of abdomen.


I
II
III
IV
V
166 P. bicolor
ej. apod.
P. bicolor
167
aed.
168 M. rubida
i. f.
aed.
ej. apod.
d. apod.
169 O. abbreviata
i. f.
aed.
ej. apod.
170
O. modesta
i. f.
171 G. intestinalis
cer.
172 M. seminuda
aed.
175 M. seminuda
aed.
pa.
i. f.
174 C. americana
i. f.
aed.
173
G. intestinalis
I
II
III
IV
V
VI
aed.
cer.
176 P. affinis
VI
VII
IXt
177 C. americana
IXt
VI
178
M. rubida

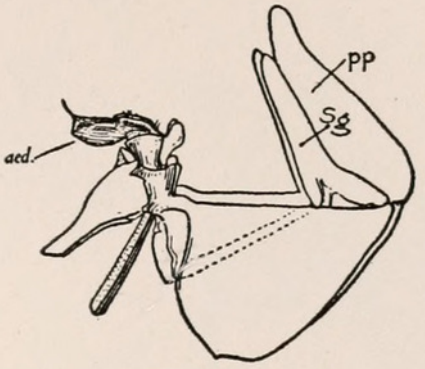
179. *Hypoderma lineata* (De Vill.), ventral view of genitalia.
180. *Senotainia trilineata* (v.d.W.), ventral view of abdomen.
181. *Senotainia trilineata* (v.d.W.), lateral view of abdomen.
182. *Blepharipeza adusta* Loew, lateral view of genitalia.
183. *Peleteria tesselata* (Fabr.), lateral view of genitalia.
184. *Senotainia trilineata* (v.d.W.), lateral view of genitalia.
185. *Paradejeania rutiloides* (Jeann.), ventral view of hypopygium.
186. *Ocyptera argentea* Towns., ventral view of genitalia.
187. *Ocyptera argentea* Towns., ædeagus and structures at base.
188. *Gymnosoma fuliginosa* Desv., ventral view of genitalia.
189. *Sarcophaga helicis* Towns., lateral view of genitalia.
190. *Sarcophaga cimbicis* Towns., lateral view of genitalia.
191. *Thelaira leucozona* (Panz.), lateral view of genitalia.
192. *Myiocera tibialis* (Desv.), lateral view of genitalia.



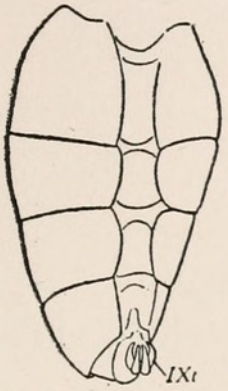
179 H. lineata



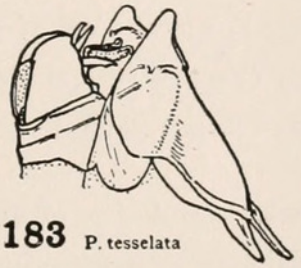
181 S. trilineata



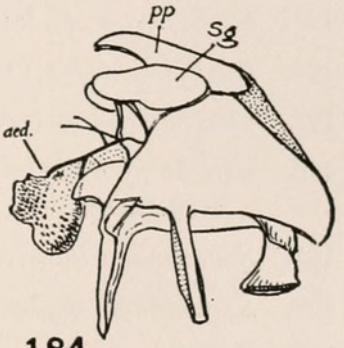
182 B. adusta



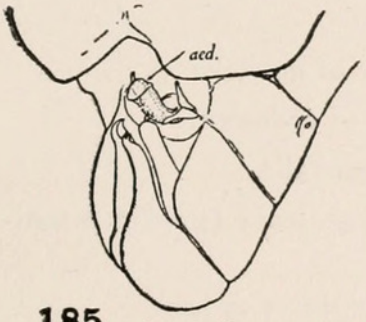
180 S. trilineata



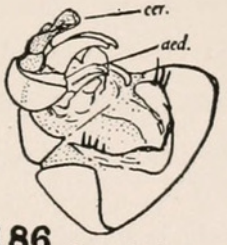
183 P. tesselata



184 S. trilineata



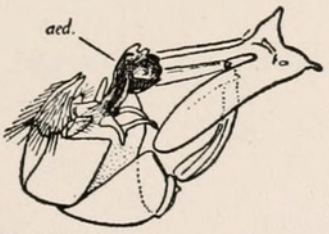
185 P. rutiloides



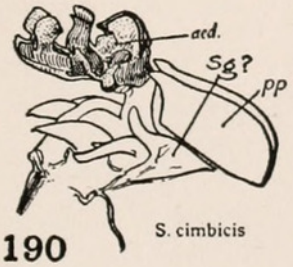
186 O. argentea

187 O. argentea

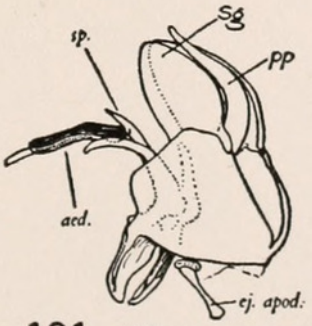
188 G. fuliginosa



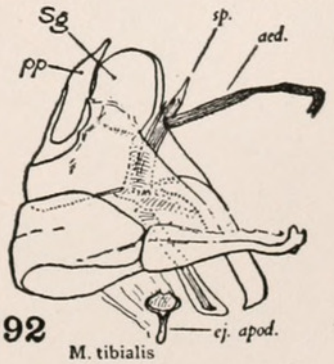
189 S. helicis



190 S. cimbicis



191 T. leucozona



192 M. tibialis

193. *Sarcophaga sp.*, lateral view of genitalia.

194. *Lucilia sericata* (Meig.), lateral view of genitalia.

195. *Graphomyia maculata* (Scop.), ventral view of genitalia.

196. *Graphomyia maculata* (Scop.), lateral view of ædeagus and adjacent structures.

197. *Sarcophaga inoa* Walk., lateral view of genitalia.

198. *Sarcophaga sp.*, lateral view of hypopygium.

199. *Sarcophaga communis* Parker, lateral view of genitalia.

200. *Cynomyia cadaverina* Desv., ventral view of abdomen.

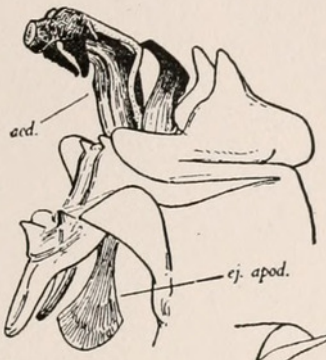
201. *Phormia regina* (Meig.), lateral view of genitalia.

202. *Phormia regina* (Meig.), ventral view of genitalia (smaller magnification than fig. 201).

203. *Phormia regina* (Meig.), ædeagus and structures at base.

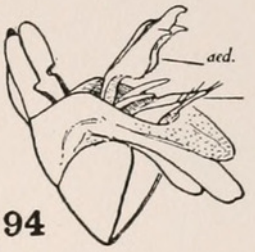
204. *Myiospila meditabunda* (Fabr.), lateral view of terminal segments of abdomen.

205. *Cynomyia cadaverina* Desv., genitalia viewed from below and on left side.



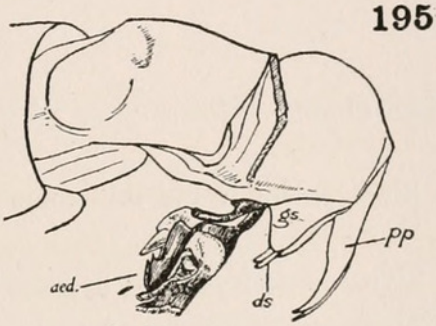
Sarcophaga sp.

193



194 L. sericata

195 G. maculata



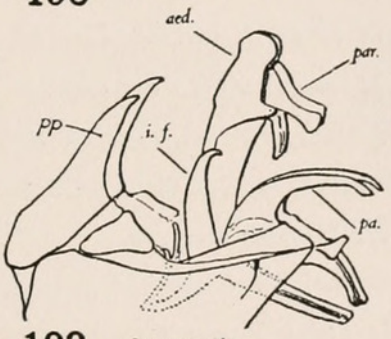
S. sp.

198

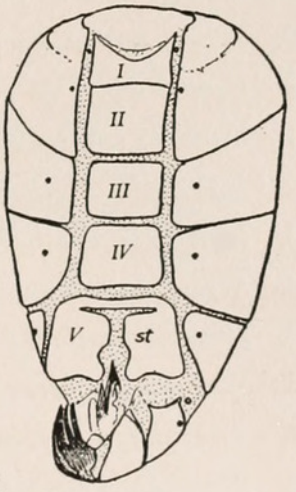
196 G. maculata

S. inoa

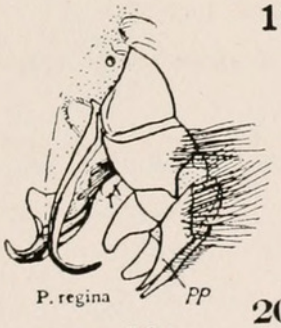
197



199 S. communis



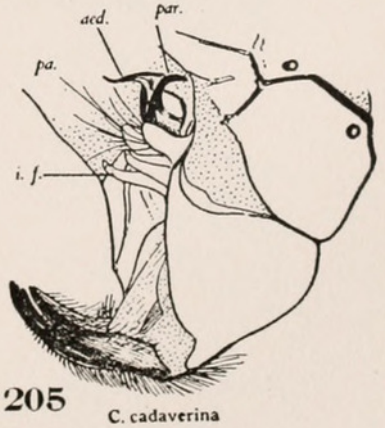
200 C. cadaverina



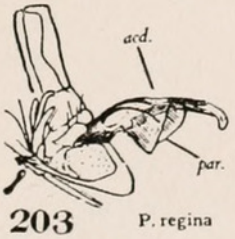
P. regina

201

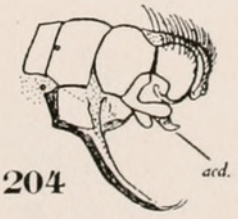
202 P. regina



205 C. cadaverina



203 P. regina



204 M. meditibunda

206. *Stomoxys calcitrans* (Linn.), ventral view of genitalia, greatly enlarged.

207. *Musca domestica* Linn., ædeagus and structures at base, greatly enlarged.

208. *Musca domestica* Linn., ventral view of hypopygium, showing membranous anal portion.

209. *Musca domestica* Linn., lateral view of genitalia.

210. *Cochliomyia macellaria* (Fabr.), lateral view of genitalia.

211. *Pollenia rudis* (Fabr.), lateral view of genitalia.

212. *Hylemyia alcathoe* (Walk.), ventral view of abdomen.

213. *Hylemyia alcathoe* (Walk.), lateral view of hypopygium.

214. *Scatophaga islandica* Beck., fifth sternite.

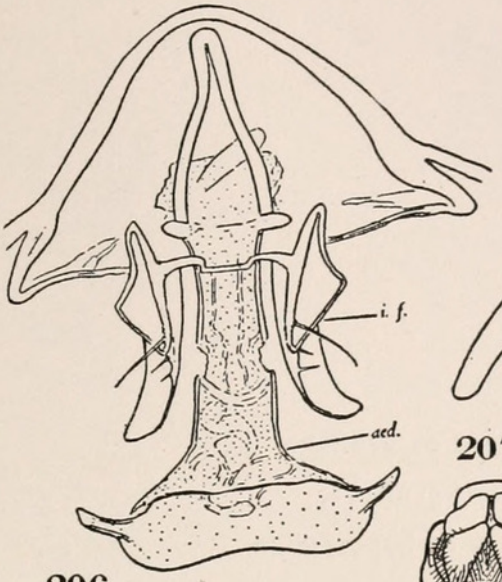
215. *Phorbia fusciceps* (Zett.), lateral view of genitalia.

216. *Scatophaga stercoraria* (Linn.), ninth tergite and cerci.

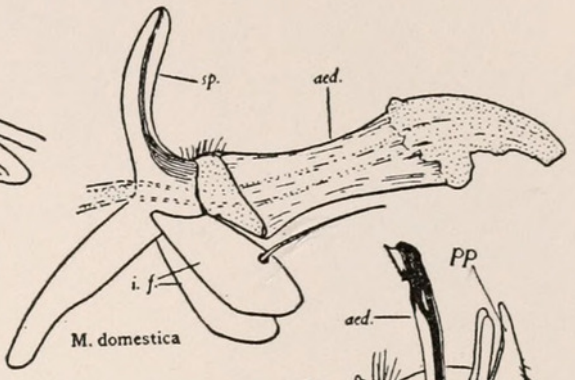
217. *Scatophaga stercoraria* (Linn.), ædeagus and adjacent structures.

218. *Scatophaga furcata* (Say), ædeagus, apodemes, etc.

219. *Cordylura* sp., lateral view of terminal segments of abdomen, showing unusual claspers on fifth sternite.



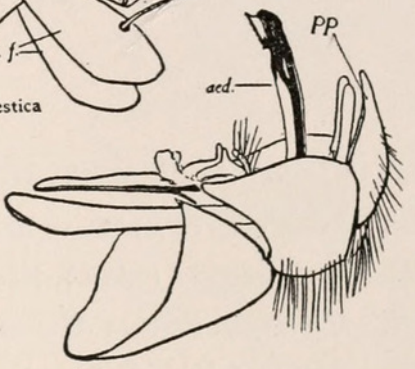
206 S. calcitrans



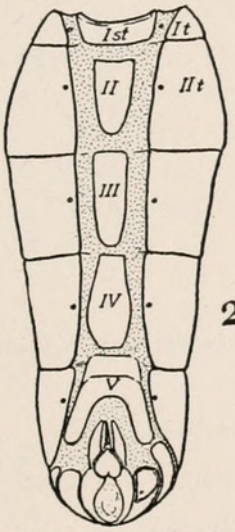
M. domestica

207

208 M. domestica

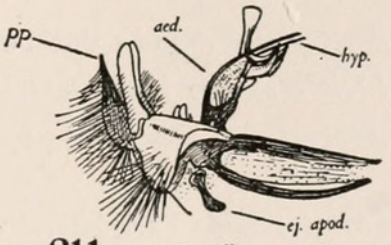


210 C. macellaria

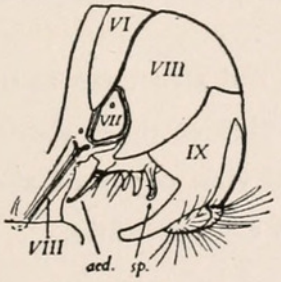


209

M. domestica

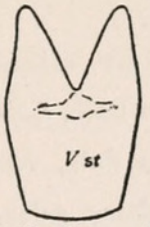


211 P. rudis



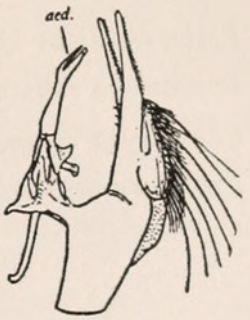
212 H. alcathoe

213 H. alcathoe

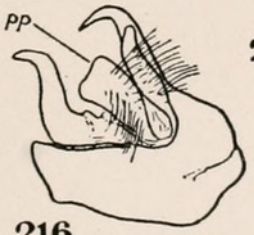


S. islandica

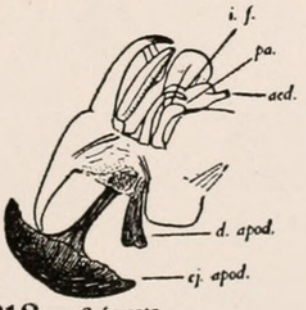
214



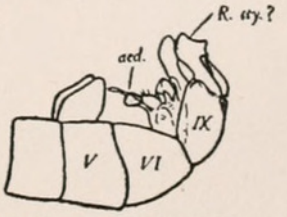
215 P. fusciceps



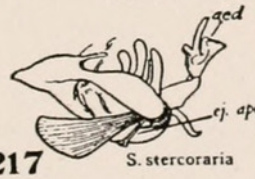
216 S. stercoraria



218 S. furcata



219 Cordylura sp.



217 S. stercoraria

220. *Clusia lateralis* Walk., ventral view of genitalia.

221. *Leria cinerea* Loew, ventral view of genitalia.

222. *Leria serrata* (Linn.), lateral view of hypopygium.

223. *Helomyza limbata* Thoms., ventral view of apical half of abdomen.

224. *Cœlopa frigida* Fall., ædeagus and structures adjoining.

225. *Anorostoma grandis* Darl., ventral view of right side of 10th tergite.

226. *Anorostoma grandis* Darl., ædeagus, apodemes, etc.

227. *Leria crassipes* Loew, lateral view of hypopygium.

228. *Anorostoma grandis* Darl., lateral view of apical portion of abdomen.

229. *Cœlopa frigida* Fall., lateral view of abdomen.

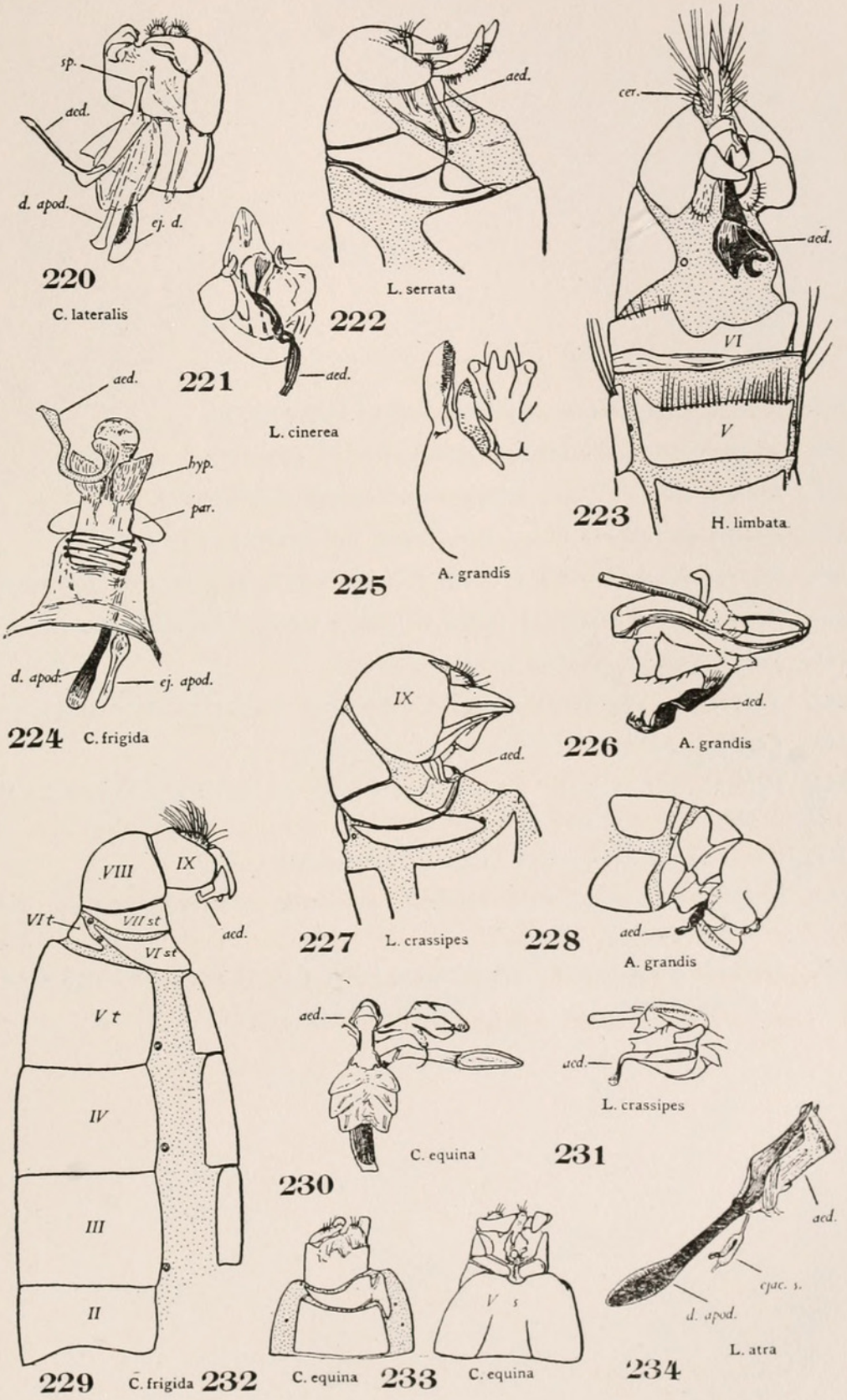
230. *Copromyza equina* Fall., ventral view of ædeagus and structures on right side.

231. *Leria crassipes* Loew, ædeagus and structures at its base.

232. *Copromyza equina* Fall., dorsal view of tip of abdomen.

233. *Copromyza equina* Fall., ventral view of tip of abdomen.

234. *Leptocera atra* Adams, ædeagus and apodemes.


sp.
aed.
d. apod.
ej. d.
220
C. lateralis
aed.
L. serrata
222
aed.
221
aed.
L. cinerea
cer.
aed.
VI
V
223
H. limbata
aed.
hyp.
par.
d. apod.
ej. apod.
224
C. frigida
225
A. grandis
IX
aed.
227
L. crassipes
aed.
226
A. grandis
VIII
IX
VI t
VII st
aed.
VI st
V t
IV
III
II
229
C. frigida
aed.
228
aed.
A. grandis
aed.
C. equina
230
aed.
L. crassipes
231
V s
C. equina
232
C. equina
233
aed.
ejac. s.
d. apod.
L. atra
234

235. *Melina vitalis* Cress., ventral view of hypopygium.

236. *Tetanocera vicina* Macq., lateral view of genitalia.

237. *Melina vitalis* Cress., ædeagus and adjacent structures.

238. *Dictya umbrarum* (Linn.), ædeagus and adjacent structures.

239. *Rhopalomera femorata* (Fabr.), fifth, sixth, and seventh sternites.

240. *Rhopalomera femorata* (Fabr.), lateral view of hypopygium.

241. *Sapromyza* sp., ventral view of genitalia.

242. *Sapromyza* sp., dorsal view of structures connected with ædeagus.

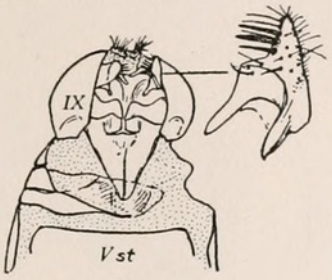
243. *Lonchæa polita* Say, ædeagus, apodemes, etc.

244. *Palloptera terminalis* Loew, lateral view of genitalia, showing remarkable ædeagus and apodemes.

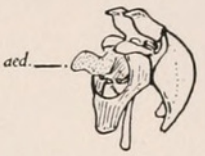
245. *Chrysomyza demandata* (Fabr.), ædeagus.

246. *Chrysomyza demandata* (Fabr.), genitalia, showing base of the ædeagus.

247. *Melieria occidentalis* Coq., showing inner side of style, base and apex of ædeagus.

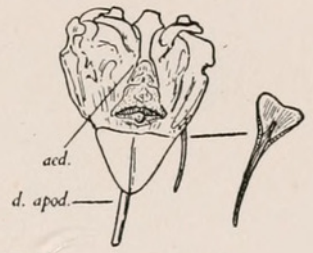


235 M. vitalis



T. vicina

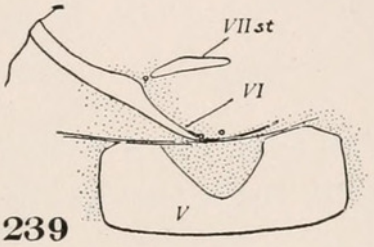
236



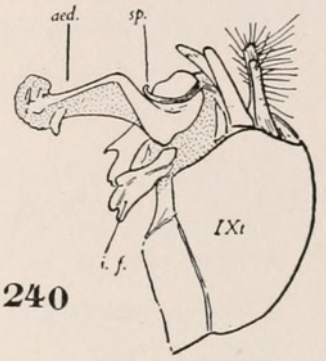
237 M. vitalis

D. umbrarum

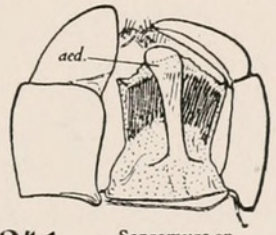
238



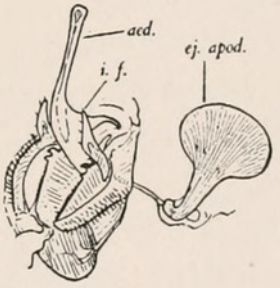
239 R. femorata



240 R. femorata

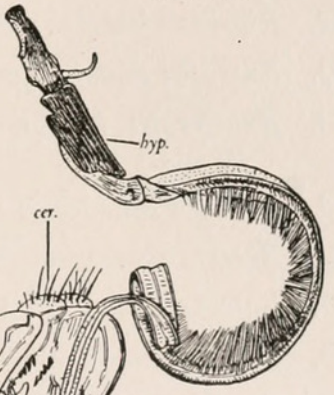


241 Sapromyza sp.

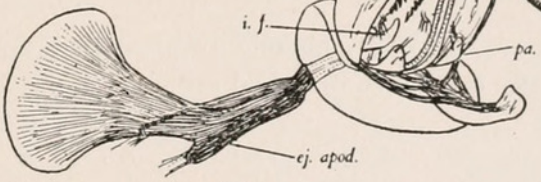


L. polita

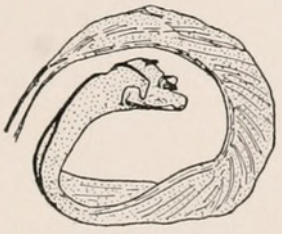
243



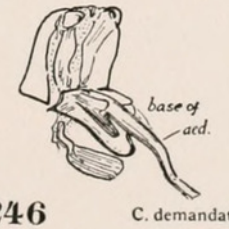
242 Sapromyza sp.



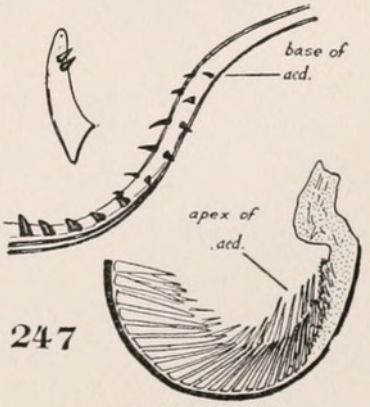
244 P. terminalis



245 C. demandata



246 C. demandata



247 M. occidentalis

April 27, 1927

248. *Anacampta pyrrhocephala* Loew, ventral view of genitalia.

249. *Tetanops aldrichi* Hendal, lateral view of genitalia, showing only base of ædeagus.

250. *Tetanops aldrichi* Hendel, ventral view of tip of abdomen.

251. *Richardia podagrica* (Fabr.), lateral view of hypopygium.

252. *Rivellia viridulans* Desv., ædeagus.

253. *Euaresta æqualis* Loew, ventral view of genitalia.

254. *Anastrepha ludens* (Loew), lateral view of proctiger and ninth tergite.

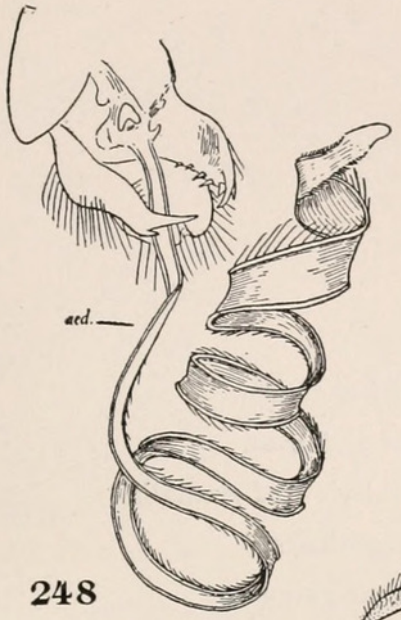
255. *Epochra canadensis* Loew, latero-ventral view of abdomen.

256. *Eutreta sparsa* Wied., left side of genitalia.

257. *Eutreta sparsa* Wied., right side of genitalia.

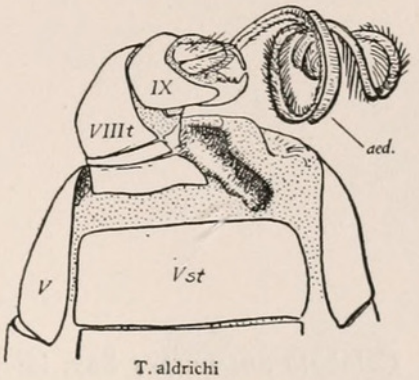
258. *Calobata alesia* Walk., abdomen of normal dried specimen.

259. *Calobata alesia* Walk., abdomen boiled in KOH, with the genitalia and body segments stretched out.



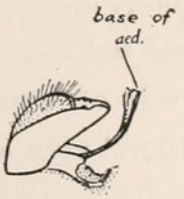
248

A. pyrrhocephala



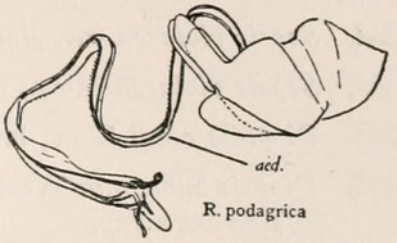
T. aldrichi

250



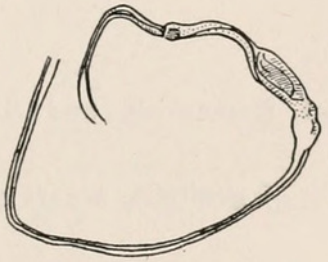
T. aldrichi

249



R. podagrica

251



R. viridulans

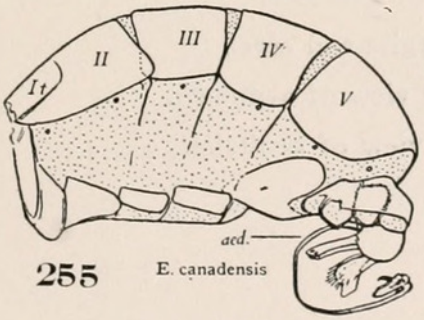
252

E. aequalis

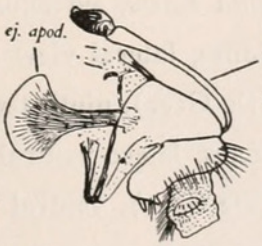
253

A. ludens

254

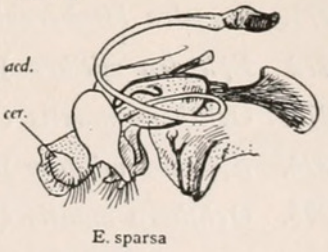


255 E. canadensis



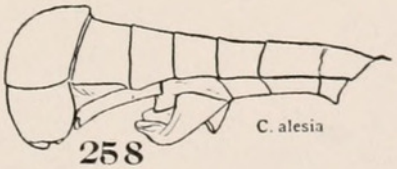
E. sparsa

256



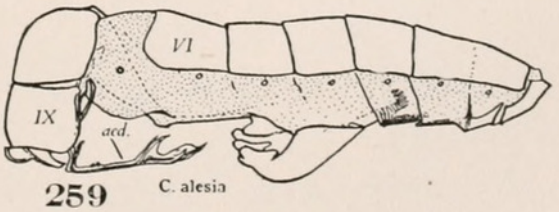
E. sparsa

257



C. alesia

258



C. alesia

259

260. *Calobata antennipes* Say, lateral view of abdomen.

261. *Calobata univitta* Walk., lateral view of abdomen.

262. *Sepsis violacea* var. *similis* Macq., lateral view of genitalia.

263. *Sepsis violacea* Meig., ædeagus and appendages.

264. *Piophila casei* Linn., lateral view of hypopygium.

265. *Diopsis subnotata* Westw., ventral view of genitalia, portion of left side cut away.

266. *Diopsis subnotata* Westw., ninth tergite.

267. *Diopsis subnotata* Westw., ædeagus, basal framework, and the apodemes (right side cut away).

268. *Sphyracephala brevicornis* Say, ventral view of genitalia, a part of left side cut away.

269. *Chyliza leguminicola* Mel., ventral view of genitalia.

270. *Chyliza robusta* Coq., ventral view of genitalia (ædeagus and adjacent structures.

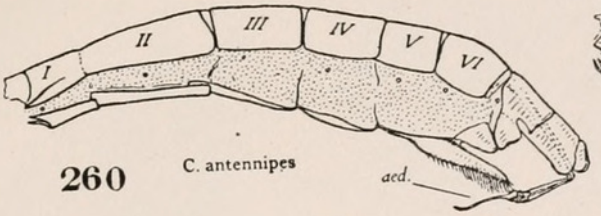
271. *Parydra bituberculata* Loew, ædeagus and appendages of one side.

272. *Ephydra millbræ* Jones, lateral view of genitalia.

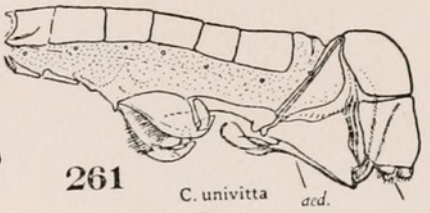
273. *Ochthera mantis* (De Geer), ninth tergite and cerci.

274. *Ephydra millbræ* Jones, latero-ventral view of abdomen.

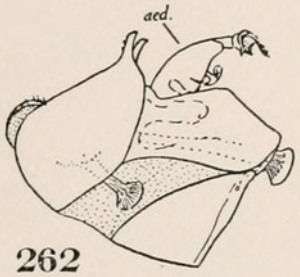
275. *Ochthera mantis* (De Geer), ventral view of genitalia.



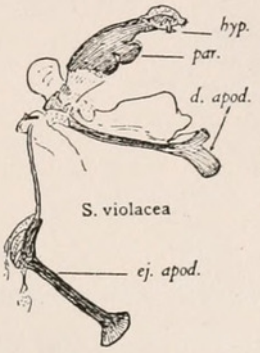
260 C. antennipes



261 C. univitta

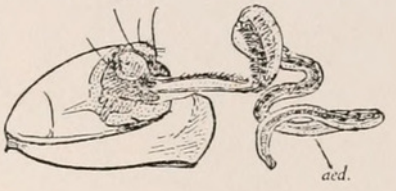


262 S. similis



S. violacea

263

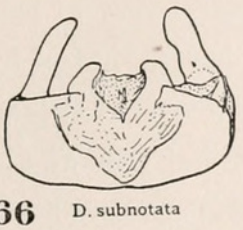


Piophila casei

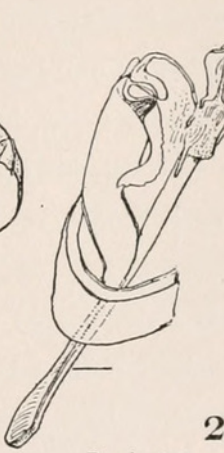
264

D. subnotata

265

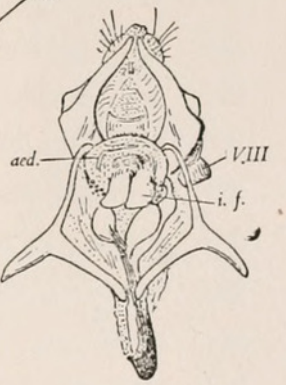


266 D. subnotata

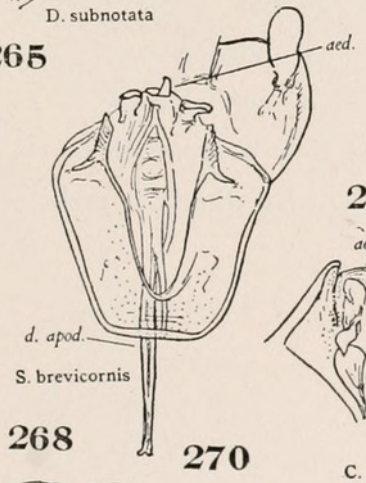


D. subnotata

269



C. leguminicola

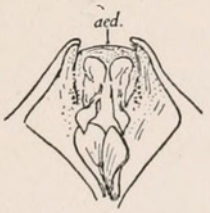


S. brevicornis

268

270

267



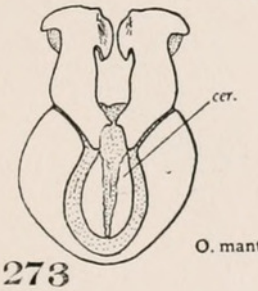
C. robusta

271

P. bituberculata

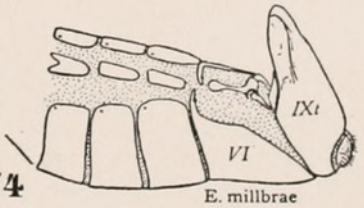
E. millbrae

272

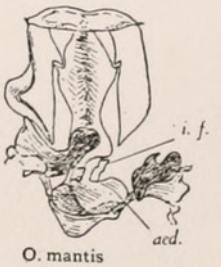


O. mantis

273

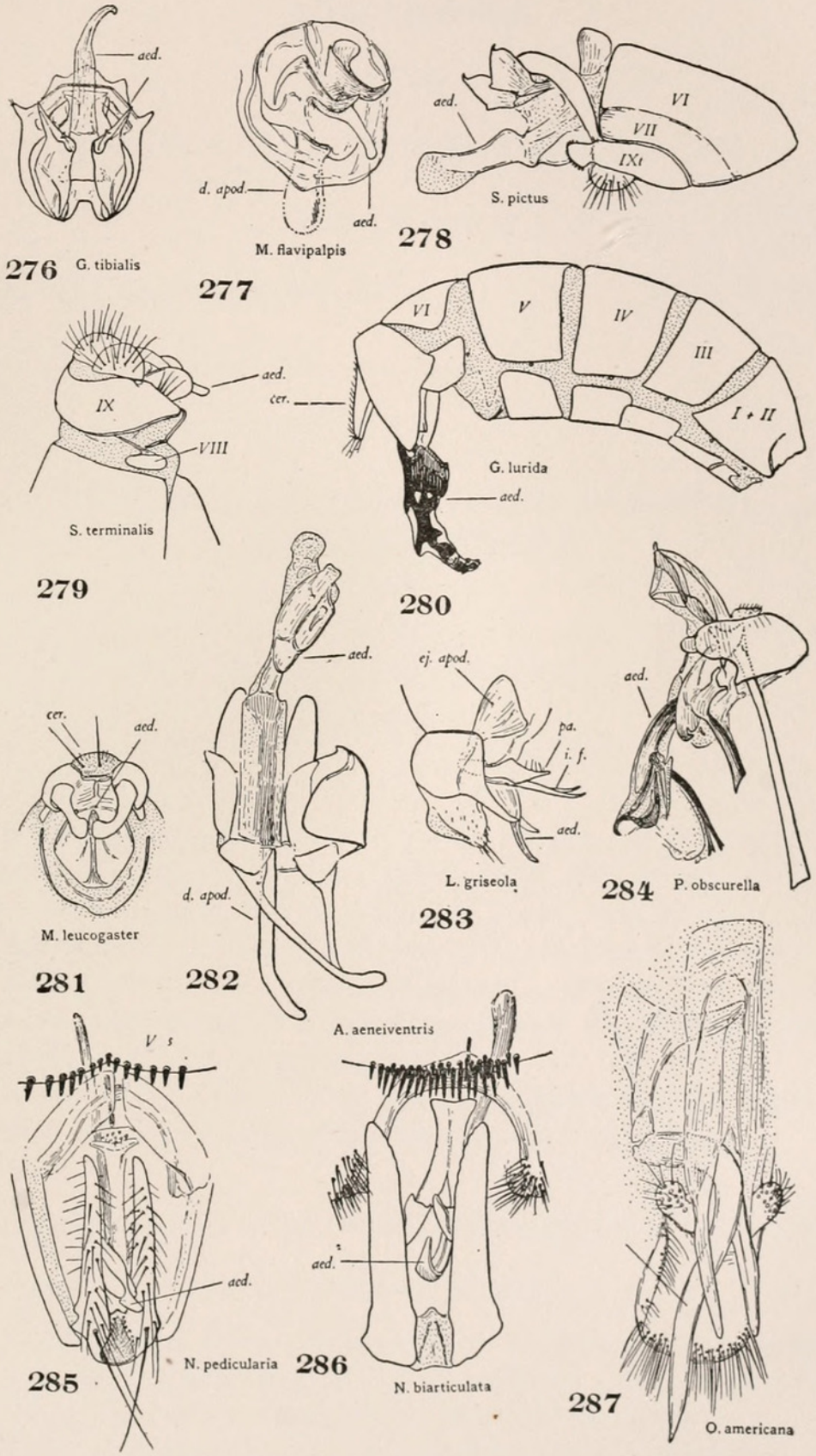


274 E. millbrae



275 O. mantis

276. *Gymnopa tibialis* Cress., ventral view of genitalia.
277. *Meromyza flavipalpis* Mall., ædeagus and adjacent structures.
278. *Sinophthalmus pictus* Coq., lateral view of hypopygium.
279. *Scaptomyza terminalis* Loew, lateral view of hypopygium.
280. *Geomyza lurida* (Loew), lateral view of abdomen.
281. *Milichia leucogaster* Loew, ventral view of genitalia.
282. *Agromyza æneiventris* Fall., ædeagus and appendages.
283. *Leucopis griseola* Fall., lateral view of genitalia.
284. *Phytomyza obscurella* Fall., ædeagus and appendages.
285. *Nycteribia pedicularia* Latr., ventral view of genitalia.
286. *Nycteribia biarticulata* (Herm.), ventral view of genitalia.
287. *Olfersia americana* (Leach), ventral view of genitalia.


aed.
276 G. tibialis
d. apod.
aed.
M. flavipalpis
277
aed.
VI
VII
IXt
S. pictus
278
IX
VIII
aed.
cer.
S. terminalis
279
VI
V
IV
III
I + II
G. lurida
aed.
280
cer.
aed.
M. leucogaster
281
aed.
d. apod.
282
A. aeneiventris
ej. apod.
pa.
i. f.
aed.
L. griseola
283
aed.
P. obscurella
284
V s
aed.
N. pedicularia
285
aed.
N. biarticulata
286
O. americana
287