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The external morphology of the termite Reticulitermes flavipes Kollar (order, Isoptera).

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THE EXTERNAL MORPHOLOGY OF THE TERMITE RETICULITERMES FLAVIPES KOLLAR (ORDER, ISOPTERA)

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(ORDER, ISOPTERA)

by

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C O N T E N T S

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INTRODUCTION

The genus Reticulitermes is of importance as a major pest in consuming the parts of non-living organisms that contain cellulose. Of the eight known species native to the United States, six have proven to be of economic importance. An introduced species, native to Europe, has not as yet become a general pest, whereas, in Europe it is the most dangerous member of the order. The rich fauna of this genus is limited entirely to the northern hemisphere.

Isoptera are ancient, primitive, Pterygota of the Orthopteroid type, closely related to the Blattids. Paleontologists have found their fossil remains in the Oligocene of the Tertiary but since these fossils are of a recent genus and their nearest relatives, the Blattids, have been found in the Carboniferous, the actual origin of Isoptera must have occurred millions of years earlier. They are called white ants although all the forms of any species are not white nor do they exhibit general morphological likeness to the true ant.

There is a dearth of literature describing morphological features of various parts among the genera although much has been written of the general appearance of Reticulitermes.

There is no complete account of the external morphology of any representative species in the Nearctic fauna. A paper, each as the present one, should be valuable not only as a comparative study of the species of the genus, but also, since the genus is representative of the order, it describes much of the external morphology of the entire order.

EXTERNAL MORPHOLOGY

Reticulitermes flavipes Kollar was chosen to represent the genus because it is well known, due to its wide distribution in all the States east of the Mississippi River. It was the first of the American termites to be d escribed, having been named by Kollar in 1837.

The alate form was used primarily to illustrate this work since the pigmentation of all the sclerotized regions makes it possible to distinguish the parts even in individuals as small as the present ones. However, for completeness, parts of individuals of other castes are also included in the study.

The Head

The Head Capsule. (Figs. 7, 8, 9, 10)

From the ventral aspect it appears almost as broad as long. It is uniformly rounded at the front and back giving it an ovoid appearance. The cuticle of the dorsal surface is not very rigid and a depression may be made with slight pressure. Many live individuals were observed with the head capsule partially collapsed by some external force. The color ranges from a dark brown to nearly black and is generally darker than the other parts of the body. At the anterior end is the labrum (l), which morphologically is a part of the head capsule although it functions as the "upper lip" of the mouthparts. It forms the roof of the mouth cavity and is dorsally convex with a few setae near the weakly bilobed anterior margin. Behind it is the clypeus (c) which is approximately three times as broad as long and is divided into two parts. The weakly sclerotized anterior portion, which is cream-colored, is the anteclypeus (ac) and the normally sclerotized posterior portion which occupies about one half the length of the clypeus is the postclypeus (pc). The clypeus is bordered posteriorly by the epistomal suture (es) which is a line of demarcation between the clypeus and the frons (fr), the latter being the anterior portion of the dorsal surface of the cranium. The coronal suture, which usually separates the cranium into two lateral areas or parietals (p), is lacking in this species. The highest region of the head is called the vertex (v), not demarked by any definite suture that would separate it from the adjoining regions. The areas that include the two lateral surfaces below and behind the compound eyes are known as the genae (g). Along the ventral edge of the gena extends a slender sclerite termed the subgena (sb) separated from the gena by the subgenal suture (sbs). Posterior to the vertex is the occiput (oc), the two regions being separated by the occipital suture (os). The occiput is continued ventrally along the genae to form the postgenae (pg). The occiput and the postgenae combined form the so-called occipital arch. Similarly, the occipital suture extends ventrally on each side to form the postgenal sutures (pgs) which separate the postgenae anteriorly from the genae. The occipital arch partly surrounds the occipital foramen (of) which is an opening in the head capsule opposed to a similar opening in the prothorax and gives passage to the internal structures which extend from the head to thorax. The lateral surface of the head above the compound eye and bordering the occipital arch is termed the tempora (te).

The Mouthparts. (Figs. 11, 12, 13, 14)

The mouthparts of Isoptera are of the mandibulate type. Characters which closely resemble the more primitive

Orthoptera add to the evidence that the group is Orthopteroid in origin.

Mandibles.

The mechanism of the mandibles (md) is of a unique design. Each mandible is hinged to the head capsule at two points of articulation at the base. One of these points is at the dorsal anterior margin of the head capsule on the lateral margin of the postclypeus. Here a rounded process of the clypeus forms a point of articulation with the ginglymus (gy) or shallow pit on the dorsal or exterior edge of the base of the mandible. At the lateral anterior margin of the postgena is a similar point of articulation. Here the structure is reversed, with the rounded process, called the condyle (cd) located on the mandible, and the saucer-shaped depression or acetabulum, situated at the opposing point on the postgena. Near the other corner of the somewhat triangular base, and near the cutting edge of the mandible, is attached a strong tendon known as the flexor tendon. It is heavily sclerotized near the mandible and extends posteriorly, just ventral to the anterior arm of the tentorium, into the head capsule where it becomes pliable and fan-shaped and affords an attachment for the adductor muscles from the endo-dorsal region of the head. The extensor tendon is much smaller and is attached to the mandible near the condyle. It affords attachment for the abductor muscles. These tendons are often referred to as "apodemes".

The mesal or cutting edge of the mandible may be divided into the distal toothed lobe and the proximal molar lobe (Snodgrass). The hook-like incisor at the apex is called the gnathapex (gn) and is used for tearing loose morsels of wood to be masticated between the file-like ridges of molars (mr) located at the base of the cutting edge.

The labium.

According to Snodgrass, the parts of the labium of R. flavipes may best be divided into the prelabium or movable distal portion, and the postlabium or stationary proximal portion which in this case is fused into one sclerite. The four terminal lobes of the prelabium constitute the ligula. The median pair of these ligular lobes is called the glossae (gl). The lateral lobes are the paraglossae (pa). These lobes are borne on the distal end of the labiostipites (lt) or the body of the prelabium. The labial palpi (lp) are three-segmented and are attached dorsally on the lateral margins of the labiostipites. The proximal margin of the labiostipites lies along the union of the prelabium with the postlabium.

Previously mentioned, the postlabium appears as one sclerite. However, if it is observed closely, there are three distinct regions. The mentum (m) is unpigmented anterior region which overlaps and gives support to the labiostipites. The submentum (sm)is the region which extends from the mentum to a point immediately proximal to the gular pits. This gives support to the subeosophageal ganglion which rests upon the dorsal surface. The posterior part or gula (gu) reaches to the occipital foramen and partially overlies it. In the soldier caste the same relationship of parts persists when the head capsule becomes elongated. The gula becomes greatly elongated to extend over the increased length of the head between the base of the maxillae and the occipital foramen. The subeosophageal ganglion occupies the same general position and the postlabium projects over the prelabium, as in the winged form.

Maxillae.

The maxillae (mx) are located below the mandibles and latero-dorsad of the labium. They form the sides of the buccal cavity and each is composed of the following parts: The cardo is the base or the most proximal sclerite of the maxilla, and acts as a hinge for the maxilla proper. The cardo is divided into two sclerites by the cardinal suture (cs). The basal sclerite thus formed is the basic ardo (bc) and the distal sclerite the disticardo (dc).

Bordering the cardo anteriorly are the sclerites of the stipes which comprise the main portion of the maxilla. The outer sclerite is the eustipes (eu) and the proximal portion is the parastipes (pr). A maxillary plate occurring in this species is formed by the sclerotization of the basimaxillary membrane and is known as the basimaxilla (bm) (Crampton, 1923). This sclerite bounds the inner border of the parastipes. The internal ridge separating the parastipes from the eustipes serves for muscle attachment.

Borne on the distal end of the stipes are two lobes, the lacinia (lc) and the galea (ge). The lacinia bears two claw-like teeth at its distal end and on the inner margin a row of setae which give it the appearance of a brush. The galea extends beyond the lacinia and is composed of two parts. The hooded distal portion is the distigalea (dg) and the basal portion the basigalea (bg).

The maxillary palpus (mp) is an appendage representing the endopod ite of a Crustacean limb (regarded by some to be the telopodite) and contains the usual five segments of Orthopteroid insects.

Far down on each side of the head are located the slightly ovate compound eyes (e) which are their own diameter from the margin of the ventral surface. Immediately mesad of, and on a level with, the front margin of each compound eye is located a small ocellus (oc). This is slightly more than its own diameter from the compound eye. The cuticle encircling the ocelli and the compound eyes is very light in color.

On the dorsal surface, and immediately caudad of the exact middle of a line drawn between the two hind margins of the compound eyes, is situated the fontanelle (f). This has the shape of a small tubercle in the center of which is a small pore, through which the secretions of the internal frontal gland pass to the exterior (Imms, 1929).

Antennae. (Fig. 16)

The antenna (a) is a 16 - 18 segmented appendage located directly in front of the compound eye and near the base of the mandible. In most cases, the soldier form has a total of 17 antennae segments. Except for a few segments at the base, the organ is moniliform or bead-like. It is borne in a membranous depression in the side of the cranium known as the antennal socket (as). Surrounding the antennal socket is a circular sclerite which is the antennal sclerite (asc). On the base of this sclerite is a process projecting dorsally, called the antennifer (af) on which the antenna pivots in any direction. The antennal sclerite is demarked from the rest of the cranium by the antennal suture.

The basal segment of the antenna, or scape (sc), is larger than any other one of the segments. Its base is bulb-like and the entire segment presents a firm foundation for the second segment or pedicel (pd), which is slightly elbowed in shape. The next three segments (3, 4, and 5) are the smallest and have straight sides, but the segments distal to the fifth have symmetrically convex sides. The third and fourth segments are always smaller than the fifth. The fourth segment is usually smaller than the third. All castes of flavipes have the antennae sparsely clothed with setae.

Tentorium. (Fig. 15)

The walls of the lower part of the head capsule are braced internally by an internal skeleton termed the tentorium. It is composed of a pair of anterior arms (am), connected to a pair of posterior arms (pm) by a broad central plate, or corporotentorium (ct), which has the shape of an inverted hood. The anterior arms are flat with the edges firmly sclerotized and the midportion thin and transparent. These ribbon-shaped arms lie in vertical position with a slight twist of the ventral edge outward toward the apex. The outer edge terminates with the head capsule at the anterior base of the antenna, and the dorsal edge terminates with the head capsule near the base of the mandible at the clypeus. Externally there is an invagination of the head capsule known as the frontal pit (fp), which is the origin of the anterior arm. It is readily indicated by a heavier pigmentation at this point. There are no dorsal arms.

Near the center of the corporotentorium is a round aperture or neuroforamen (nf) and extending anterior to this is a median line through the transparent plate. The neuroforamen permits the passage of the nerves connecting the subeosophageal ganglion with the brain proper.

The posterior portion is in the form of an arc, the tentorial bridge (tb), the arms of which extend posteriorly along the lateral edges of the occipital foramen to form the so-called posterior arms.

At the point of union of the posterior arm with head capsule exteriorly is an invagination called the gular pit (gp), which is the origin of the posterior arm. Near the apex of each posterior arm is the point of articulation of the neck sclerite with the head capsule.

Thorax

The Neck. (Figs. 17, 18)

The neck or cervix is anterior to the prothorax. It is believed to have originated from a portion of the labial segment of the head and the anterior region of the prothorax. It is mostly membranous to permit the head to move freely. The sclerites of this region are known as the cervical plates. The laterocervical plates or laterocervicales are the important plates of the neck, while the ventral and dorsal plates are apparently lacking. The laterocervicales are distinctly divided into an anterior portion or eucervicale (ec), and a posterior portion or intercervicale (ic). Anteriorly, the eucervicale articulates with the postgenae bordering the occipital foramen, and serves as a fulcral point for the movement of the head in a dorso-ventral plane. The intercervicales touch each other on the ventro-median line of the body. This is typically characteristic of the Blattids and of the Mantids (Crampton, 1927). This feature lends support to the belief that these families of Orthoptera and of the order Isoptera must have had a common origin. Immediately posterior to the intercervicale, and much in the same relative position, is the postcervicale (pv).

Prothorax

Pronotum. (Figs. 17, 18, 19)

The occipital region of the head, the cervix, the pleura of the prothorax, and the dorsal anterior region of the mesothorax are shielded dorsally by the pronotum (pn). The pronotum, from a dorsal aspect, is heart-shaped, slightly broader than long, and bilobed at both ends. The anterior half of the dorso-median line is without pigment.

The propleuron.

The episternum (er) dorsally joins the pronotum, and at the base is fused to the precoxale (pe). The precoxale or precoxal bridge is a sclerite which extends along the intercervicale from the base of the episternum, and has its termination just anterior to the basisternum (bs). The epimeron (em) is an elongated sclerite which extends parallel to the episternum and is separated from it by an infolding into the integument called the pleural suture (pls). Internally this infolding forms a ridge or endopleuron which serves as an attachment for the muscles.

The trochantin (tr) is a very narrow sclerite extending from the base of the coxa (cx) anteriorly and curving laterally to join with the epimeron. It is divided into two parts: The proximal portion or distitrochantin (dtn), and the distal portion or basitrochantin (btn) near the epimeron.

The prosternum.

The sclerites of the prosternum are greatly reduced. The entire basisternum is triangular and divided at the ventro-median line of the body into two lateral portions. Posterior to the basisternum is a small triangular plate or furcasternum (fs), which is separated from the basisternum by a membranous area.

At each lateral edge of the furcasternum is a furcal pit which is an invagination of the integument to form the internal furca. Both the basisternum and the furcasternum vary in shape and often the furcasternum is so lightly sclerotized that it is not distinguishable. Just posterior to and adjoining the furcasternum is a very small sclerite or spinasternum. A spinal pit is located posterior to this.

Pterothorax

Due to the general similarity of shapes and relative positions of the meso-and metathorax (Figs. 17, 18, 19) one description is adequate for both. A few minor differences will be given special attention.

Meso-and metanotum.

The larg e anterior lobe, which is partly covered anteriorly by the segment before it, is the prescutum (psc). The anterior margin is bordered by a narrow sclerite called the pretergite (prt). At each end of the pretergite is a small triangular sclerite known as the prealare (pra). The lateral edge of the prescutum has a projection known as a suralare (su) serving as an anterior notal wing process. The tegular incision (ti) lies between the prealare and the suralare and contains the tegula (tg), a small, unpigmented, convex sclerite covering the anterior wing base.

Of the notal sclerites, the largest, which is shield-shaped and termed the scutum (st), lies behind and slightly overlaps the prescutum. The anterior corners of the scutum are each modified into a posterior notal wing process or adanale (ad). Between the adanale and the suralare is a deep incision known as the notal incision (ni), which divides the scutum from the prescutum. On the lateral margin of the scutum is borne the tough, pliable axillary cord (ao) which forms the posterior margin of the basal membrane of the wing.

The Axillary Sclerites. (Fig. 19)

Since it is commonly accepted that the wings are formed by the outgrowths of the notum it is fitting that the sclerites of the wing base be treated here. These sclerites are so minute that it is almost impossible to determine their comparative positions from an alcoholic specimen. When a recently killed specimen is observed, before rigor mortis takes place, the sclerites of this membranous area between the axillary cord and the tegula are readily discernible.

The first axillary sclerite or notale (n) has four projecting arms. The two mesad arms are hinged to the prescutum. The second axillary sclerite or mediale (ml) is partly surrounded by the two lateral arms. The third axillary sclerite or basanale (bl) is located immediately posterior to the notale and mediale. Between the basanale and the tip of the adanale is situated a much smaller sclerite which is generally considered to be a fourth axillary sclerite formed from a portion of the adanale. Two median plates or ossicles are joined laterally to the first three axillary sclerites. An anterior plate at the base of the anterior margin of the wing is known as the humeral plate (hp) or parategula.

Meso-and metapleuron.

The two largest and most conspicuous plates of the pleuron are the episternum (er) and the epimeron (em). They are separated by the pleural suture (pls) which extends from the dorsal margin posteriorly on a diagonal to the ventral margin where it forms a coxifer or an articulation point for the coxa. The pleural suture is an infolding of the integument, forming the pleural ridge internally and serving as a process for muscle attachment. On the dorsal margin of the episternum is the pleural wing-bearing process or alifer (al).

In the membranous area at the mouth of the episternal incision anterior to the alifer is a very small sclerite or basalare (x).

In the membrane directly behind the posterior wing-bearing process and near the dorsal margin of the epimeron is located a cresent-shaped sclerite called the subalare (sa). Both the subalare and the basalare are associated with the movements of the wing. The mesothoracic and the metathoracic spiracles (sp) are both located in the membrane of the pleuron directly anterior to the episternum.

Immediately ventral to the base of the episternum are two triangular plates, the laterosternum (ls) and the trochantin (tr). The dorsal edge of the anterior plate or laterosternum is continuous to the episternum and ventrally it reaches the basisternum (bs) or principal sclerite of the sternum. Its dorsal posterior corner is in contact with the anterior corner of the trochantin. The trochantin is slightly curved and the dorsal posterior corner meets with the coxifer of the episternum while the ventral corner forms a point of articulation with the basal rim of the coxa.

Meso-and metasternum.

The sternum is the only region which shows a distinct variation in the shape of the parts in the two segments. The basisternum of these segments is many times larger than that of the prothorax. The anterior third of the mesobasisternum lies just dorsal to the coxa of the prothorax and its posterior end tapers to a small process and extends to the base of the mesocoxae. A membranous incision at the anterior end of the basisternum differs in size among individuals and the shape of the basisternum varies accordingly from a weakly to a strongly bilobed type.

The basisternum of the metathorax is broader and about one-half the length of that of the mesothorax and its posterior end tapers abruptly to a point between the metathoracic coxae. The coxae of the mesothorax do not extend over the basisternum ventrally.

The furcasternum and the spinasternum, which lie posterior to the basisternum, are not distinct. However, the region is easily located externally by the two furcal pits which lie laterally anterior to the spinal pit located on the ventro-median line of the body.

The Legs

With the exception of a difference in the coxa of the foreleg, the legs are in general alike. (Fig. 20)

Coxa. (Figs. 17, 18, 20)

The simple, cylindrical coxa of the prothorax has its proximal margin oblique to the two lateral margins. At the anterior end it articulates with the coxifer of the pleuron. Another point of articulation is with the distitrochantin near the basisternum.

On the meso-and metathorax the coxa is divided into a eucoxa (ecx) and a meron (me) by a deep suture called the meral suture (ms). Dorsally the coxa articulates with the coxifer which is a process formed by the posterior ends of the episternum and the epimeron of the pleuron.

Trochanter.

The trochanters (tn) are alike in all the legs. Although the trochanter hinges freely with the coxa, distally it is fused with the femur.

Femur.

The femur (fe) is a long, flattened, segment which joins with the trochanter at its proximal end. Distally it forms a hinged joint with the tibia. It is as heavily pigmented as the sclerites of the pleuron.

Tibia.

The tibia (ta) is as long as the femur, but more slender. It is distinctly lacking in pigment as contrasted with the femur. The surface of the segment is clothed with setae and ventrally, on the distal end, it bears a pair of spines. The tibia of the prothoracic leg differs by bearing an extra spine on the distal end on the outer margin of the dorsal surface.

Tarsus.

There are four distinct tarsal segments or tarsameres (tm). The first three segments are small and each bears distally on the ventral surface a small protuberance or tarsal pad (tp). The basal segment is termed the basitarsus (bt). The fourth segment is as long as the combined lengths of the first three and bears on the distal end a pretarsus. The tarsus is of the same color as the tibia.

The pretarsus.

The pretarsus bears a pair of ungues (un) or claws. A small ventral plate or unguitracter plate is concealed dorsally by the ungues. The empodium and the pulvillus are lacking in this species.

Wings

The wings of about fifty individuals were used in this study. These were collected in Amherst, Massachusetts, May 1936. To observe clearly all the major veins, the wings were mounted upon micro-slides and the wing projected with a micro-projector up on a plain white surface. When the wings were embedded in mounting medium such as gum damar or balsam, it was practically impossible to distinguish any of the median or cubitus veins since these are colorless as compared to the heavily pigmented veins of the anterior portion of the wing.

The procedure for mounting the wing dry upon the micro-slide is not elaborate. The wing is simply removed from the alcohol preservative and placed immediately upon the slide. If it happens to be folded it may easily be manipulated into position. The wings are then encircled with a thin layer of gold size and a cover glass is firmly pressed into place while the wings are still moist. In this way the wings are not subjected to twisting on becoming dry. This results in a fairly permanent mount and all the veins remain visible.

The wing venation of Reticulitermes flavipes Kol. is a remarkable variation found among insects because it consistently appears in all individuals. It is not only impossible to find two specimens whose wing venations are identical, but it is also rare to find an individual with the wings of both sides showing the same pattern in the longitudinal veins. The best example of stability observed in the individual is represented by Plate one, Fig. 1 where cubitus has nine and ten branches and media is two-branched with the exception of the left hind wing (d) where it remains unbranched. In rather sharp contrast to this example is Fig. 2 in which the right fore wing (a) has the entire media wanting but has a well developed cubitus to fill the space left vacant when media drops out. The media of the three remaining wings have the same branching condition as prevails in Fig. 1. However, the cubitus is exceptionally plastic in Fig. 2 and represents dichotomus branching near the apex (a, c, and d). This instance of dichotomus branching of the cubitus is not so obvious in the more pectinate branching of the cubitus found in Fig. 1. Another remarkable fact which I observed in only one specimen (Fig. 2) is the greatly reduced convex veins between the two strongly sclerotized marginal veins of the hind wings band. This is indicative of the remnant of the R 2 + 3 vein which is common to the more primitive species of Isoptera, Zootermopsis angusticolis Hagen.

In the right hind wing (Fig. 3b) the media coalesces with R 4 + 5 about one-half the distance from the point where it arises from R 4 + 5 to the apex and also in the left fore wing (c) the media fades out into reticulations and is gradually picked up by the strong R 4 + 5 and then leaves R 4 + 5 near the apex as a single vein. An excellent example of asymmetry is notable in Fig. 4 where media is so reduced in the right wings (a, b) that a small portion shows only in the hind wing while in the wings of the left side (c, d) a media in the unbranched condition is common to both wings.

The limitations of this continuous variation among individuals is illustrated in Figs. 5 and 6. In the fore wings (Fig. 5) the variation is from an example with four-branched media to an example with the media wanting. Not more than four branches were noted on the media in any fore wing. When the cubitus becomes greatly developed in order to fill the space left vacant by the reduced media it is normally dichotomously branched (g and h), however, it may in rarer cases remain uniformly pectinate as in e.

The hind wing (Fig. 6) present a slight increase in the scope of variation from that of the fore wing and also a remarkably freakish behavior of the Cu_1 vein. The exceptional 8-branched media with the corresponding reduced cubitus (d) affords the widest divergence of characters from that which is more usually encountered. The definite union of Cu_1 with media, halfway between the base and the apex, presents a situation in wing venation which is most uncommon among the Insecta. The variation of media and cubitus in the opposite of that shown by d is evident in the greatly reduced media and a well developed cubitus in c and Plate I, Fig. 4b. However the media of the hind wing is never completely eliminated as in the fore wing.

Regardless of all these variations, there are, never-the-less, a few characters which are always constant. The parallel veins on the margin are typically unbranched, always thickened, heavily pigmented and in the same position. The humeral suture near the base of the wing is always at a right angle to the marginal vein in the fore wing. In the hind wing, this angle is usually about 50° with the body but never a right angle or more. The joining of the media with the R 4 + 5 near the base in the hind wing is a character which is constant not only in this genus but also in Termopsis, Mastotermes, etc. This evidence is indicative that this may be an ordinal character.

The importance of this remarkable wing venation rests entirely in its significance. The paleontologist, may easily misconstrue a fossilized wing, as abnormal in its venation as Fig. 13 or 14 for a new species unless he is aware of the wide limits to the variation of the already described species. To the taxonomist, the wing venation is practically useless for separating the species.

From an evolutionary point of view, these variations have remained because there has been no chance for natural selection due to the very short duration of the nuptial flight. The termite using his wing only during this period discards it long before it has begun to show any signs of its weaknesses there by leaving all these mutations to remain with the generations to come. This is substantiated in the fact the Mastotermes and Termopsis, which are much more primitive, have comparatively very slight variation in wing venation.

The Abdomen

The abdomen (Figs. 21, 22, 23) of R. flavipes contains ten segments. The dorsal plate of each segment or tergite (t_1 - t_{10}), each of which slightly overlies the succeeding plate. The tergites show no differences in the sexes.

The first tergite (t_1) is more curved on its anterior margin and is shorter than the tergites succeeding it. Between the tergites and the ventral plates or sternites (s_2 - s_{10}) is an unsclerotized region that expands with an increase in the turgidity of the abdomen. Under each postero-lateral margin of the first eight tergites there is located in the membrane a spiracle (sp).

The first sternite (s_1) is reduced to unsclerotized cuticle under the metacoxae and extends over the metathorax, covering the spinasternal and the furcasternal regions.

The sternal plates exhibit sexual differences in the alate caste. In the female, sternites 2 to 6, inclusive, are simple transverse plates with rounded lateral edges. The seventh sternite (s_7) is elongated to form a sub-genital plate which completely overlies ventrally the 8th and 9th sternites, which are modified into mechanical structures of reproduction. The seventh, eighth, and ninth sternites of the male are similar to the preceding ones except that they are slightly shorter and the ninth bears a pair of styli (sy) on the ventro-median line of the posterior margin. In both sexes between the base of each parapodial plate or <u>paraproct</u> (pp) of the tenth sternite and the lateral edges of the tenth tergite, a small one or two segmented cercus (ce) is located which appears to be morphologically an appendage of the tenth segment although embryologically the cerci are modified limbs of the eleventh segment.

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ABBREVIATIONS

a	antenna
ac	anteclypeus
ad	adanale
af	antennifer
al	alifer
am	anterior arm
ao	axillary cord
as	antennal socket
asc	antennal sclerite
bc	basicardo
bg	basigalea
bl	basanale
bm	basimaxilla
bs	basisternum
bt	basitarsus
btn	basitrochantin
c	clypeus
cd	condyle
ce	cercus
cs	cardinal suture
ct	corporotentorium
Cu	cubitus
cx	coxa
dc	disticardo
dg	distigalea
dtn	distitrochantin
e	compound eye
ec	eucervicale
ecx	eucoxa
ei	episternal incision
em	epimeron
er	episternum
es	epistomal suture
eu	eustipes
f	fontanelle
fe	femur
fp	frontal pit
fr	frons
fs	furcasternum

g - gena
ge - galea
gl - glossa
gn - gnathapex
gp - gular pit
gu - gula
gy - ginglymus

hp - humeral plate

ic - intercervicale

l - labrum
lc - lacinia
lp - labiopalpus
ls - laterosternum
lt - labiostipes

M - media
m - mentum
md - mandible
ml - mediale
mp - maxillary palpus
mr - molar
ms - meral suture
mx - maxilla

n - notale
nf - neuroforamen
ni - notal incision

oc - ocellus
occ - occiput
of - occiputal foramen
ol - ossicle
os - occipital suture

p - parietal
pa - paraglossa
pb - postlabium
pc - postclypeus
pd - pedicel
pe - precoxale
pg - postgena
pgs - postgenal suture
pl - prelabium
pls - pleural suture

pm - posterior arm
pn - pronotum
pr - parastipes
pra - prealare
prt - pretergite
psc - prescutum
pv - postcervicale

R - radius

s - sternite
sa - subalare
sb - subgena
sbs - subgenal suture
sc - scape
sm - submentum
sp - spiracle
st - scutum
su - sualare

t - tergite
ta - tibia
tb - tentorial bridge
tg - tegula
ti - tegular incision
tm - tarsomere
tn - trochanter
tp - tarsal pad
tr - trochantin

un - unguis

v - vertex

x - basalare

EXPLANATION OF PLATES

PLATE I

Figs. 1, 2, 3, 4, represent fore and hind wings from one individual. (a - right fore wing, b - right hind wing, c - left fore wing, and d - left hind wing.)

PLATE II

Fig. 5
Right and left fore wings from various individuals.

Fig. 6
Right and left hind wings from various individuals.

(With the exception of Fig. 9 all Figs. in PLATES III and IV are of an alate form.)

PLATE III

Fig. 7 Dorsal view of head.
Fig. 8 Ventral view of head.
Fig. 9 Ventral view of head of a soldier.
Fig. 10 Lateral view of head.
Fig. 11 Ventral view of mandibles.
Fig. 12 Dorsal view of mandibles.
Fig. 13 Ventral view of labium.
Fig. 14 Ventral view of maxilla.
Fig. 15 Ventral view of tentorium.
Fig. 16 Antenna

PLATE IV

Fig. 17 Lateral view of thorax and neck region.
Fig. 18 Ventral view of thorax and neck region.
Fig. 19 Dorsal view of thorax.
Fig. 20 Lateral view of right mesothoracic leg.
Fig. 21 Ventral view of male terminal structure of abdomen.
Fig. 22 Ventral view of female terminal structure of abdomen.
Fig. 23 Lateral view of abdomen.

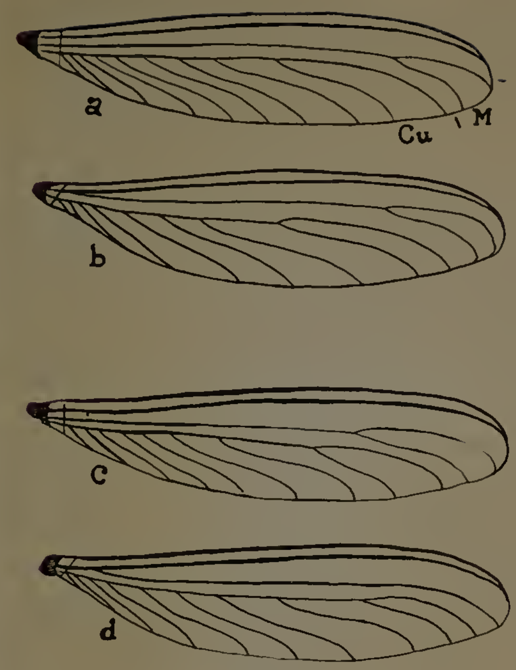


Fig. 1

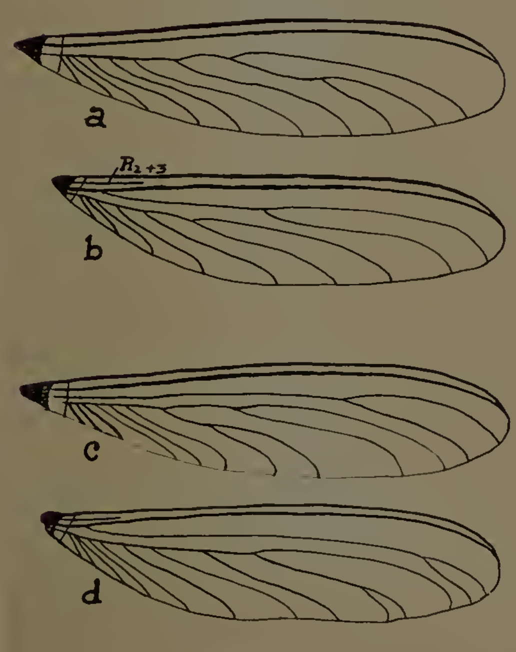
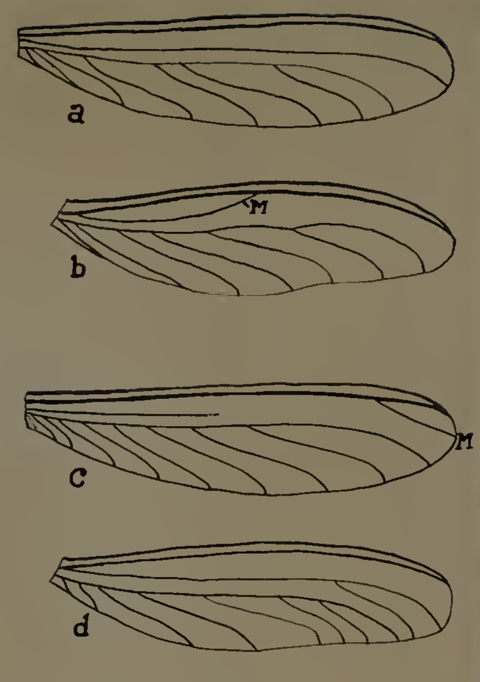


Fig. 2



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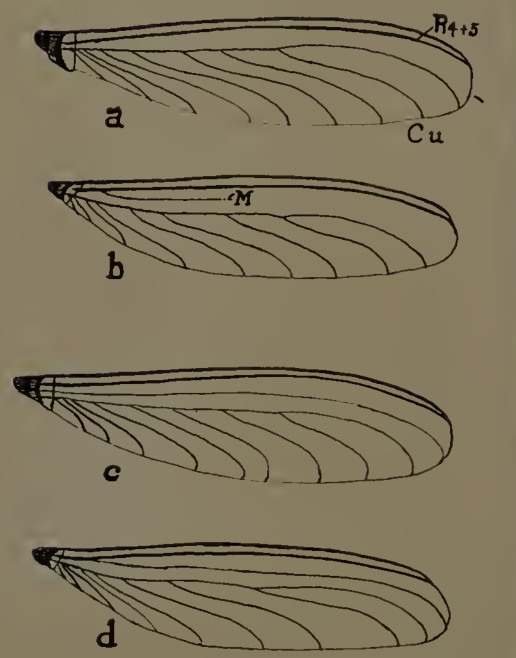

Fig. 4

PLATE I

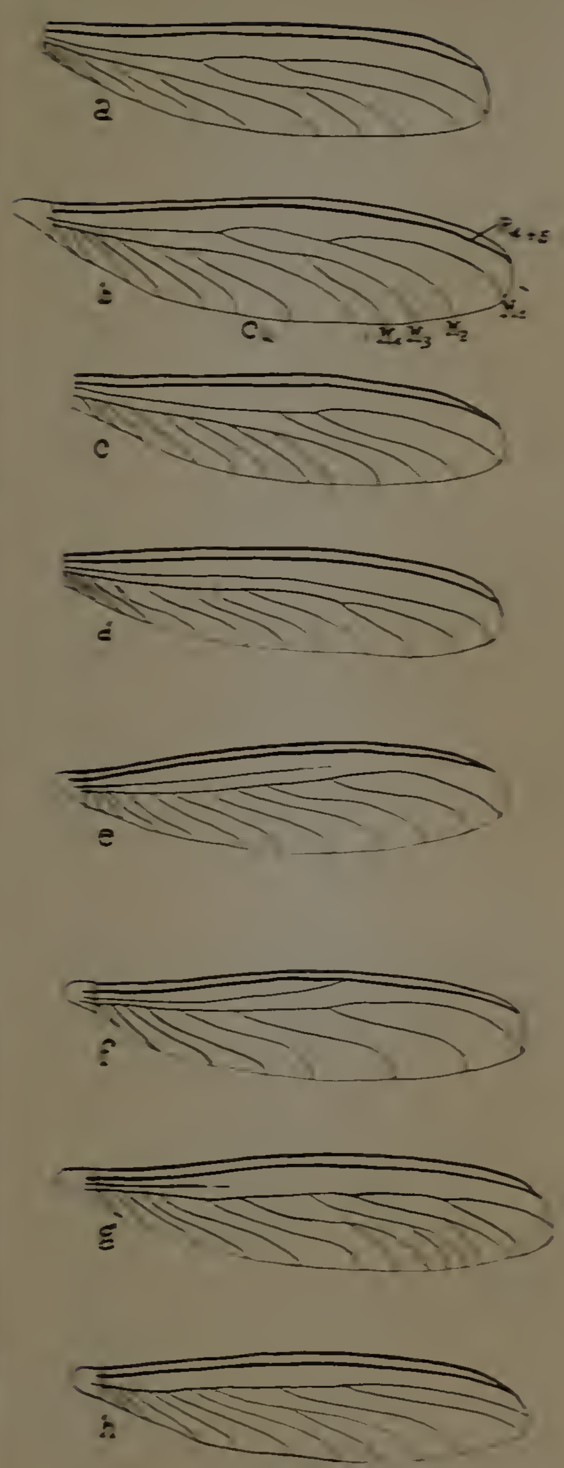

Fig. 5

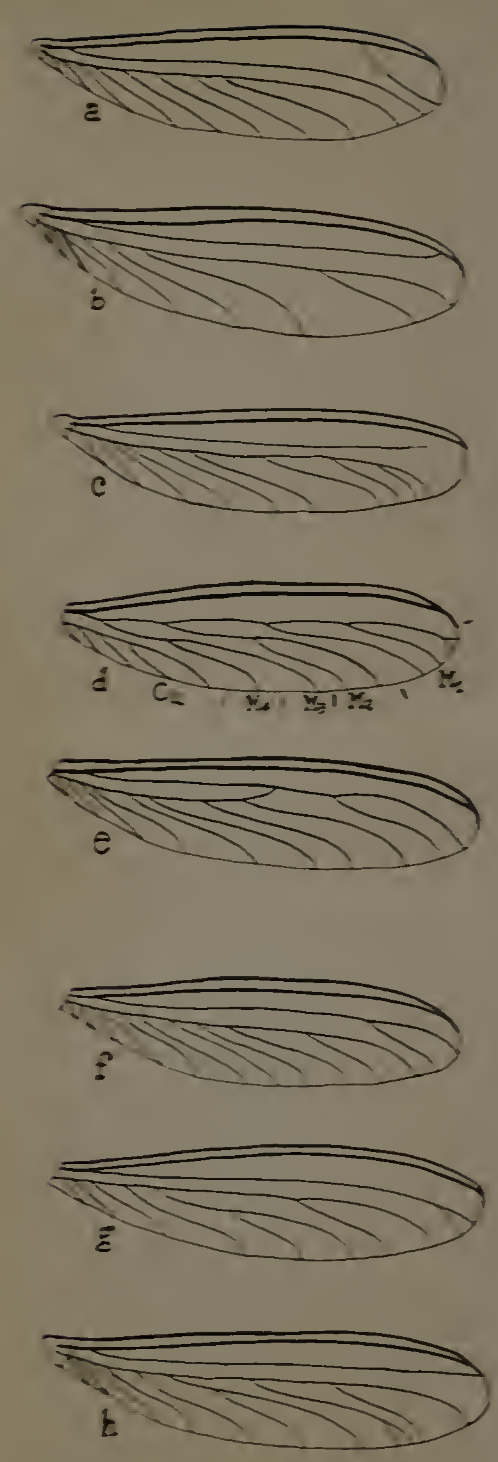

Fig. 6

PLATE II

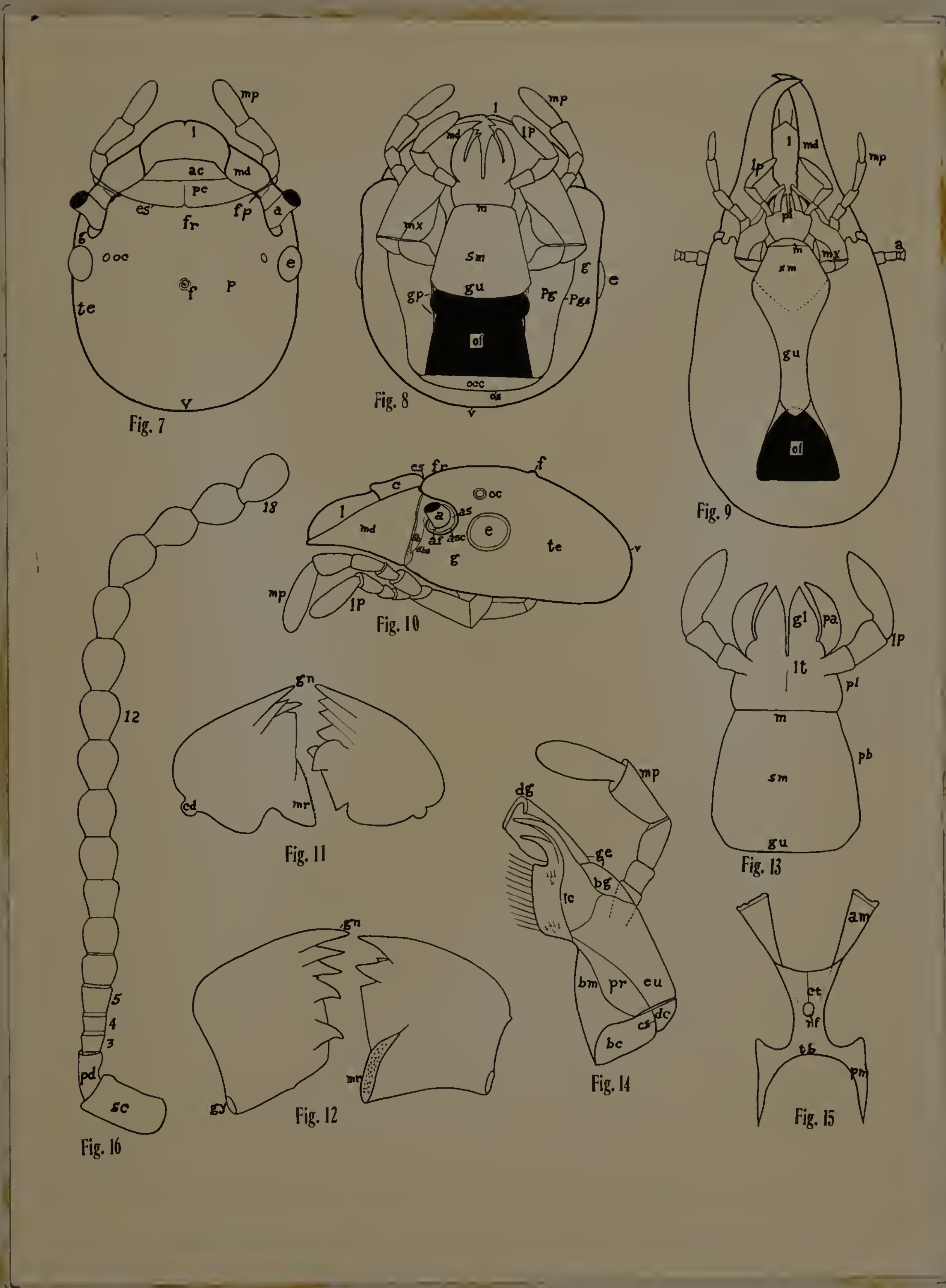

PLATE III

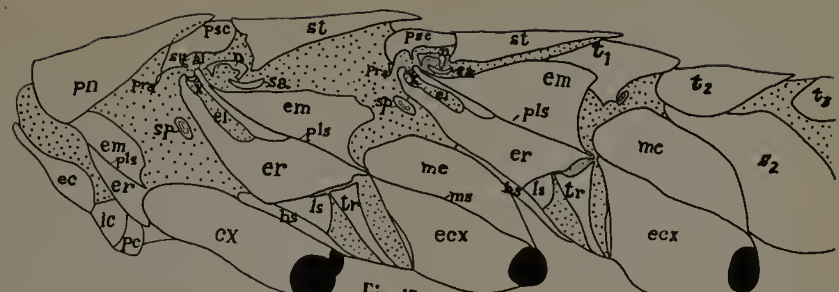

Fig. 17

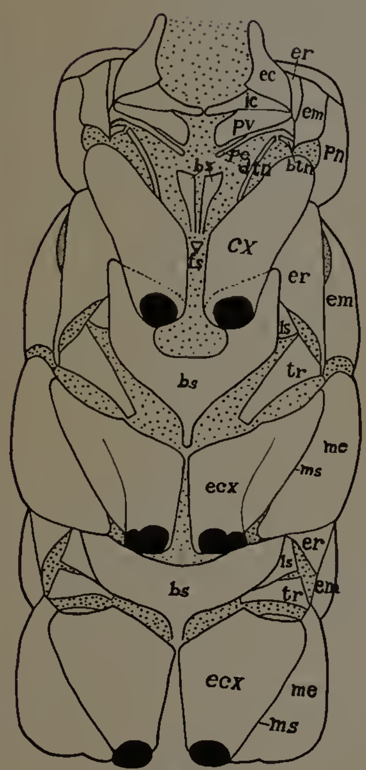

Fig. 18

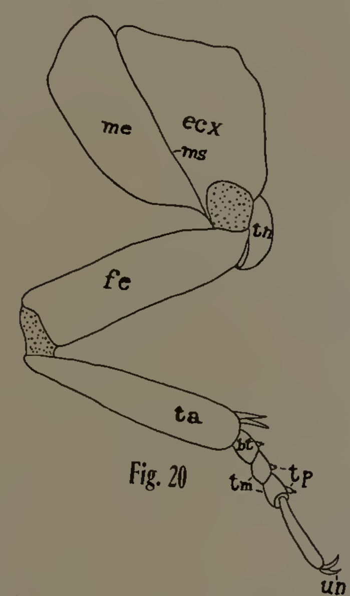

Fig. 20

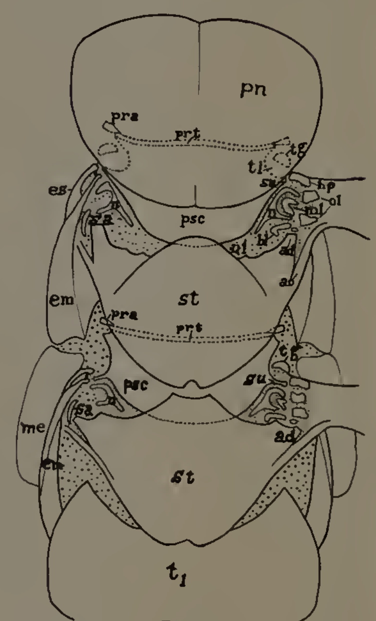

Fig. 19

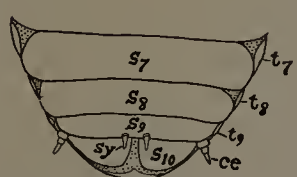

Fig. 21

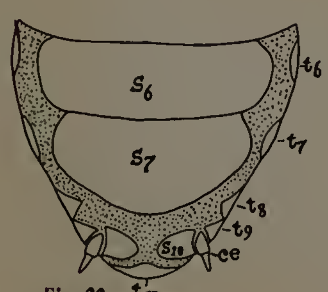

Fig. 22

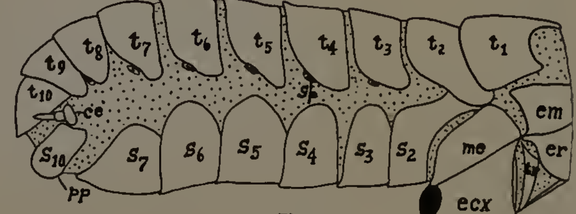

Fig. 23

PLATE IV

Approved by

G. C. Crampton

Lucius H. Jones

Robert P. Holdsworth

Date June 4, 1938