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THE EXTERNAL ANATOMY OF
MELANOTUS COMMUNIS, GYLL.

Thesis for the Degree of M. S.
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This is to certify that the
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THE EXTERNAL ANATOMY OF MELANOTUS COMMUNIS, GYLL.

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INTRODUCTION

Considerable effort has been expended on the bionomics of many species of Elateridae that are serious economic pests in our agricultural setup. Most of the work has been done on the larval (wireworm) stage which causes great losses in our crops.

The Elaterid genus, Melanotus, is quite common throughout the eastern United States, and eastern Canada, as a pest of corn. As considerable confusion exists in this group, especially in the Melanotus communis, Gyll. and Melanotus fissilis, Say, species, it was decided to work out the external anatomy of the adult Elaterid, Melanotus communis, Gyll., as a contribution of a type description of an economic species of wireworm.

SYNONOMY

The synonymy of Melanotus communis, Gyll. is as follows:

1. Melanotus cinereus, Weber.
2. Melanotus communis, Gyll.
3. Melanotus simplex, Germ.
4. Melanotus spadix, Er.

J. L. Weber first described this species as Melanotus cinereus in 1801. In 1817, L. Gyllenhal re-described it as Melanotus communis. E. F. Germar, in 1824, named it Melanotus simplex, and W. F. Erichson, in 1842, called it Melanotus spadix. (11).

Dr. H. Dietrich (2) later broke this down into:

1. Melanotus communis, Gyll.
2. Melanotus communis, Var. "A."
3. Melanotus communis, Var. "B."

The basis of Dietrich's work was based on genitalic variation.

LIFE HISTORY OF MELANOTUS COMMUNIS, GYLL.

The life history for this genus is very incomplete due to the long time spent in the larval stage underground, and the attending difficulties of rearing such an insect. It is generally believed to have a life cycle of three or four years.

The duration of the larval period of Melanotus communis, Gyll. is said by Comstock and Slingerland (1891, page 263) (4), to be at least three years. This conclusion is based on the length of time between confinement of larvae in soil cages and emergence of the beetles.

Blatchley (1) says that the larval stage extends over three or four years, and while Hawkins (4) says that under laboratory conditions it is at least three years, he generalizes for the whole Genus Melanotus, and does not commit himself on the species M. communis, Gyll.

Fenton (3) states that M. communis, Gyll. has a life cycle of at least six years, and the following is abstracted from his paper.

The adults emerge from their spheres of hibernation, (usually under loose bark, or in cracks and crevices of rotten logs and stumps) in May or early June, and are quite active in flight. During the adult stage they feed mainly on pollen.

The eggs are laid mainly in June, and possibly as late as July. They are placed in the soil by the female

at a depth of one or two inches. Eggs are laid singly, and are spherical and pearly white.

The eggs hatch in July into small, pale yellowish larvae. The growth is slow and one larval moult takes place, with the larvae passing the first winter in the second instar.

The second, third, fourth and fifth years are spent in the larval stage, with one or two moults each year. During this period they do the most damage, especially to young corn, attacking the kernels after they swell, and eating them completely out. They also attack other young plants after germination, eating away the roots, causing the plants to wither and die.

Pupation takes place in late July or August of the sixth year, after a moult followed by a period of activity, during which time they construct an oval cell in the soil, become torpid, and finally moult into the pupal stage. The pupal stage lasts from seven to 39 days, with a mean of 18.14 days for 42 records.

Emergence, therefore, takes place in late August and early September. The winter is spent hibernating above the ground, under bark, cracks or crevices of logs and stumps, where they are sheltered. They may hibernate singly, in groups of two or three, or occasionally in groups of as many as fifteen.

GEOGRAPHICAL DISTRIBUTION IN NORTH AMERICA

M. communis, Gyll. is quite common in eastern Canada and eastern United States, to Nebraska, and south to Louisiana and Florida (1).

MATERIAL AND METHODS

(a) Collection and preservation of material.

Adults were collected mainly on the campus of Michigan State College in the demonstration woodlot on the south shore of the Red Cedar River, during the fall term of 1946.

They were found singly or in groups of two or three, or up to as many as fifteen in a group. The favoured places for hibernation were under the loose bark of rotten logs and stumps, or in cracks and crevices in the wood itself. There was no indication that the adults actually burrowed into the log, but seemingly forced their way into sheltered spots.

Adults collected after snowfall and freezing weather, became active in a matter of a few minutes while lying on the palm of the hand. Some of the specimens collected were placed in small cages with damp moss, bark and rotten wood, and lived for over three months. They were quite active when in a darkened area, but burrowed under the debris when lights were switched on.

The remainder, and bulk of the specimens were killed in cyanide bottles, and then stored in sixty per cent alcohol. These adults were the most satisfactory for dissection and study, as the tissues did not become dessicated.

(b) Techniques for extrusion of genitalia.

As one of the main features of identification of this species is based on male genital characteristics (2), several methods for extruding the aedeagus and protrusible abdominal segments were tried.

Barber's solution (16) and Dietrich's solution (2) for relaxing and work on genitalia were used in the early stages of this study, and were made up as follows:

Barber's solution

Ethyl alcohol.....265 parts.

Distilled water.....245 parts.

Ethyl acetate..... 95 parts.

Benzol..... 35 parts.

Dietrich's solution

Ethyl alcohol.....280 cc.

Distilled water.....230 cc.

Ethyl acetate..... 95 cc.

Benzol..... 35 cc.

The benzol separated out on top of the solutions, due to its lack of miscibility with the water in the solutions. Agitation was tried with both solutions, but after standing a short time, the benzol separated out again.

To get around this difficulty, samples were made up, and a small amount of sodium laurel sulfate (Dreft) added to each formula. These solutions were agitated, and the resulting emulsion allowed to settle. This produced a milky fluid, which, after standing, "creamed"

somewhat, but still retained its milkiness, indicating some benzol dispersion, and the probability of some action on the tissues immersed, by the benzol in the formula.

Specimens were placed into these solutions and removed forty-four hours later. The genitalia were extruded approximately three-quarters of their length, and became fully extended when pressure was applied to the abdomen. This method was used in the earliest stages for extruding genitalia, but later work produced a method that cut down on the time necessary, and involved less handling.

(c) Preferred technique for extrusion of genitalia.

Whole specimens were gently boiled in ten per cent potassium hydroxide for thirty minutes, rinsed in distilled water, and then placed into three per cent hydrogen peroxide for bleaching. After an interval of about thirty minutes, examination of the material shows that bubbles form in and around the specimens, and that the genitalia are starting to voluntarily extrude. After an hour in the solution, examination will show that in most cases the genitalia, both male and female, are fully extruded, and that bleaching has also been affected. Several slides were made up from this material to supplement those previously made.

Further tests were carried out using the above method, with both dried and preserved material. This method did not work with dried material, but was very

effective with all material that had been freshly killed and preserved. This method should be of considerable aid to systematic entomologists, as the whole procedure of clearing, bleaching and extrusion, as well as less manipulation, can be affected in approximately one and one-half hours.

(d) Technique for clearing and bleaching.

Clearing was done by using ten per cent potassium hydroxide and heating gently for about thirty minutes. The specimens were then rinsed several times in distilled water, and then dissected under water. Due to the heavy sclerotization and dark colour, most of the material for slide preparation had to be bleached, and the dissected material was placed into three per cent hydrogen peroxide until the desired degree of colour was reached, then removed to and washed in water.

Slides of the meso and metathorax, as well as those of the dorsal abdominal area, were not cleared, as clearing removed the underlying fat bodies. The resulting thin membranous areas lost their identity without the background of fats to throw the segmentation and sclerotization into relief.

(e) Technique for slide preparation.

Slides were prepared by running the dissections through the various strengths of alcohol as normally recommended (9). Xylol was used for Balsam mounts, but most

of the slides were mounted directly from absolute alcohol into Diaphane.

(f) Technique used in study and drawing.

A squared grid in the eyepiece of the compound microscope was used in connection with graph paper to draw the various structures and appendages to proportion, and the scale was varied, depending on the size of the appendage or area to be depicted. A 4H pencil was used for all drawings. When completed and checked, the drawings were traced onto Strathmore Board, and inked in with India Ink.

GENERAL DESCRIPTION OF ADULT

The adult of Melanotus communis, Gyll. is dark brown to reddish brown in colour, and clothed with a fine, dense pubescence. The third antennal segment is somewhat shorter than the fourth, and the fourth antennal segment of the male has short erect bristles on its inferior margin. The antennae are serrate and eleven jointed. The clypeus is margined in front.

The pronotum is never wider than the base of the elytra, and is broader than long. The prosternum is lobed in front, the sutures double, concave on the outer side, and the prosternum prolonged into a prosternal spine posteriorly.

The mesothoracic legs have a small trochantin, and the coxal plates of the metathoracic legs are gradually dilated inwards to form a protective plate over the femora when at rest. The tarsal claws have distinct comb-like teeth or pectinations. The elytra have nine striae, which are coarsely and irregularly punctured, with the intervals punctate.

The male genitalia (Plate 7) are the best recognition marks for this species (2). The length of the adult varies from 11.5-14 mm. with the female usually slightly larger than the male.

The adults of this species, in common with all members of the family Elateridae, possess the power of springing into the air when placed on their backs. This

springing motion is possible because of certain structural characteristics. The prothorax and the mesothorax are loosely joined, the base of the prothorax and the base of the elytra slope downward toward each other, and the prosternal spine projects posteriorly to fit into the mesosternal cavity. Preparatory to springing into the air, the prothorax and head are bent back, thus bringing the prosternal spine slightly above the mesosternal cavity, and at the same time raising the base of the elytra slightly above the surface on which the inverted beetle is resting. By suddenly relaxing the muscles, the prosternal spine descends forcefully into the mesosternal cavity, causing the base of the elytra to strike violently against the supporting surface, and by their elasticity the whole body is propelled upward (1).

DETAILED DESCRIPTION OF ADULT

Head and mouthparts: Plate 1, Figs. 1, 2, 3, 4, 5, 6.

Plate 2, Figs. 1, 2, 3, 4. Plate 8, Figs. 3, 4.

The head is oval in outline from above, with the eyes protruding laterally. The superior margin or postoccipital suture (Poc) is regularly curved on its median portion, with the sides oblique and nearly straight to the lateral margins. (Plate 1, Fig. 2). The inferior margin is shallowly concave between the gular sutures ventrally (Plate 2, Fig. 1). A heavy carina (Plate 2, Fig. 1) arises on the anterior end of the gena (Ge) and extends posteriorly and upwards around the margin of the eye (E) and gradually fades out in the line on the occiput (Oc) parallel to the margin of the eye. (Plate 1, Fig. 2). The occiput is finely and closely punctate. Anteriorly the gena (Ge) is narrowed between the base of the maxilla and the eye, to the basal margin of the mandible (Md). The interior margin of the gena is bounded by the gular suture (Gs) and exteriorly by the margin of the eye (Plate 2, Fig. 1).

The head is retracted about halfway into the prothorax, and the fronto-buccal region inclines forward and downward (Plate 1, Fig. 3). Viewed from the front, the frons (Fr) is strongly transverse, bounded laterally by the eyes and anteriorly by the free or frontal margin (Fm) of the frons, which is broadly rounded. The frons (Fr) is feebly convex, almost flat. The fronto-clypeal

region (Clp) is bounded laterally by the eyes, basally by the frontal suture, and distally by the base of the labrum (Lm) and the insertion of the mandibles (Md). This region bears the antennal sclerites (AntS) and the parantennal foveae (Pant), and is transverse. The antennal sclerites are located near the lateral margins of the fronto-clypeal region, above the middle, and bear the insertion of the antennae. Between the antennal sclerites are a pair of parantennal foveae, which are shallowly impressed in a vertical plane, with the area between them quadrilateral in shape. The labrum (Lm) is free, transverse, broadly rounded on its inferior margin and sides, with the superior margin straight. It is heavily sclerotized. On its inner surface is a membranous epipharynx (Ephy) which is partially visible below the inferior margin. The eyes are widely separated, compound, large, nearly hemispherical and emarginate from the lateral extremities of the occiput, posteriorly and downwards to the anterior end of the genae ventrally (Plate 1, Fig. 2, Plate 2, Fig. 1). The mandibles are robust externally, strongly curved, cleft near the apex, rugosely punctate and ciliate at the basal external portion. The left mandibular tip overlies the right mandibular tip, the right mandible being a bit more strongly curved than the left. The prostheca (Prs) is broadly rounded, pubescent along its free margin, and prominent when the mandible is extended. The flexor muscle is strongly developed and attached along the middle of the

basal margin. The retractor muscle is weak and used only for opening the mandible. There are two condyles (anterior and posterior) present for articulation. The mandibles are relatively short, never extending far beyond the labrum (Plate 1, Figs. 1, 4, 5).

Ventrally the gula (Gu) is clypsedral (17) in outline, being strongly constricted behind its middle. Anteriorly it is bounded by the transverse mental suture (MtS), latero-anteriorly by the cardo (Cd) and the genae (Ge). Posteriorly the margin is shallowly concave (Plate 2, Fig. 1).

The labium consists of the sclerites lying anterior to the gula, the first being the submentum (Smt). Its base is transverse and contiguous with the gula, and separated from it by the mental suture (MtS). The lateral margins converge anteriorly, and the anterior margin is sinuate. The submentum bears a pair of long, converging, anteriorly directed hairs, their bases being joined by a concave, shallow fossa (Plate 2, Fig. 1). Closely joined and anterior to the submentum, is the semi-membranous mentum (Mt). Laterally it continues the anteriorly convergent sides of the submentum. The posterior margin of the mentum is contiguous with that of the submentum. The anterior margin of the mentum is truncate, except for a small sinuation rising between the bases of the palpigers (Plg). Lying forward of the mentum is the membranous ligula (Lig), which is broadly triangular, and slit along its median line almost to its base. The

anterior margin of the ligula is fringed with a fine pubescence. Lying ventrally to the ligula and anteriorly to the mentum are the labial palpi (LbPlp). The labial palpus is three jointed, the first joint being broad and short, the second joint about twice as long as the first, narrow at its basal end and expanding apically. The third joint is the largest of the three, securiform and curved at its base. The palpus has its origin in the robust palpiger (Plg) which is about one and one-half times as long as broad (Plate 2, Figs. 1, 3, 4).

The maxillae lie along the latero-ventral sides of the head, are composed of variously segmented basal areas, and carry four jointed maxillary palpi. The cardo (Cd) lies in an anterior depression of the gena (Ge), and has a transverse anterior margin which is continuous and on the same plane as the mental suture. The interior lateral margin of the cardo is straight with a slight sinuation at its posterior end, and the exterior latero-posterior margin is weakly convex. Contiguous with the anterior margin of the cardo is the base of the basis-tipes (Bst), which is straight on its inner lateral margin, convergent anteriorly on its external lateral margin. These two margins are joined by an oblique anterior margin, which bears a small, oblique palpifer (Plf) that acts as the basal point of articulation for the maxillary palpus (MxPlp). The maxillary palpus is four jointed, the first joint small and slightly longer than wide, the second elongate, obconical, slightly longer and heavier

than the third. The third is also obconical and slightly arcuate on the exterior margin. The fourth joint is slightly longer than the second, triangular, with its exterior margin nearly straight and its interior margin slightly arcuate. The stipes (St) lies between the basistipes and the submentum, with a narrow basal end expanding anteriorly. It bears the semi-membranous, blade-like lacinia (Lc) on its interior lateral margin. The external margin of the lacinia is thickly ciliate. Anteriorly the basistipes bears the oval shaped galea (Gal), which is also thickly ciliate on its apical margin (Plate 2, Figs. 1, 2).

The antennae are serrate, eleven jointed, with the terminal joint entire. The basal joint is subcylindrical, arcuate and about two and one-half times as long as the second, which is small and subglobular. The third joint is fully one and one-half times as long as the second, and almost as long as the fourth. The fourth to tenth segments are subtriangular and subequal in length. The eleventh segment is elongate oval with the apex rounded. The fourth to eleventh segments of the male are characterized by a thick, erect pubescence on the inferior margins, which is not present in the females (Plate 8, Figs. 3, 4). The antennae arise near the eyes and under the frontal margin, are widely separated, and inserted in small antennal sclerites (Plate 1, Fig. 1).

Prothorax: Plate 3, Figures 1, 2, 3, 4, 5, 6.

The notum (Nt) of the prothorax (Fig. 2) is roughly quadrilateral, with its anterior margin slightly sinuate, and the anterior angles not produced. The lateral margins are subparallel for their basal half, and then converge gently to the anterior angles. Posteriorly, the margin of the prothoracic notum is nearly truncate, varied by slight sinuations, and deflexed. The punctuation of the notum is variable, but is noticeably finer and sparser on the disc than on the lateral margins. The prothorax is wider than long, and the relative width is greater in the female than in the male, but not wider than the base of the elytra. There is a median slightly impressed line on the basal half of the prothoracic notum. Posterior angles (Pa) are prominent, produced posteriorly, and bear two carinae, the inner of which is less well defined and diverges inwardly. The posterior angles embrace the base of the elytra. Medianly from each posterior angle, at about one-quarter of the width of the notum, are the short sulci (Sul) with their basal notches.

The sternum (St 1) of the prothorax (Fig. 1, 4, 5, 6) is convex and longitudinal, with the sides subparallel as far as the coxal cavities (Cc). Anteriorly it is broadly rounded, slightly deflexed to form a prosternal lobe (Ptl) with a finely raised free margin. On either side, the sternum is bounded by externally concave, double, sterno-pleural sutures, which are slightly widened and excavate anteriorly. Posteriorly these sutures curve

outwards, and the inner one ends in a small pit near the anterior end of the coxal cavity. The outer suture continues posteriorly, passing around the coxal cavity and finally disappearing in the general direction of the posterior angle as a vague sinuate line. Posteriorly the sternum of the prothorax is sharply narrowed by the coxal cavities to form the prosternal process or spine (Pss). The prosternal spine is slightly concave between the coxal cavities, with its lateral margins somewhat rolled. Along the posterior third of the coxal cavities, the prosternal spine becomes gently declivious, at the same time narrowing more sharply on its ventral face than on its dorsal face. The tip is slightly declivious, forming a blunt apical point which slopes gently towards the mesothorax.

Between the sterno-pleural sutures and the lateral margin of the notum lies the episternum (Epsl), which is made up of the fused inflexed portions of the tergum and pleurum. Anteriorly, the outline of the episternum is subovigal and for a short distance along the middle its sides are nearly parallel. Its posterior margin is oblique and widely sinuate. The episterstum is nearly flat, except for a shallow excavation near the posterior angle. The coxal cavities are fairly large, circular in outline anteriorly, and open behind. The sternum is irregularly punctate, heavily chitinated and sparsely pubescent. The prothorax is loosely joined to the mesothorax. Ventrally, the prothorax bears the prothoracic legs.

Mesothorax: Plate 4, Figures 1, 3.

The only part of the notum of the mesothorax visible externally is the elevated, suboval scutellum (Sc1), which rises medianly between the bases of the elytra. The mesothorax is loosely connected with the prothorax, and bears the elytra dorsally and the mesothoracic legs ventrally. When the elytra are removed they expose the prescutum (Psc) which is roughly yoke shaped, transverse, has a medianly reentrant anterior margin, and a strongly depressed central area. Posteriorly it bears the anterior notal wing processes (ANP). The scutellum (Sc1) is suboval and prominent, heavily chitinated, punctate and pubescent. It subdivides the scutum (Sct), which is small and closely fused to the scutellum (Fig. 3). The scutum bears the posterior notal wing processes (PNP).

The sternum (St 2) is roughly pelecoidal (17), and except for the mesosternal cavity (MsC) and the posterior intercoxal piece, is not very prominent. Anteriorly, the margin is double and interrupted by a prominent median bifid knob, which marks the anterior end of the mesosternal cavity (Fig. 1). The lateral margins slope away to meet the coxal cavities (Cc). The posterior margin is defined by the coxal cavities, which are separated by a tongue-like area that extends to the narrowest point between the coxal cavities, where it forms the transverse meso-metasternal suture. The mesosternal cavity occupies about one-third of the entire area of the sclerite, and is roughly flask-shaped with its

posterior end pyramidal. It is narrow at its anterior end, widens gently to about two-thirds of its length, and then becomes posteriorly pyramidal. It is separated from the coxal cavities by a narrow band of the mesosternum.

The episternum (Eps 2) is irregular in outline, with its external angle bluntly rounded. Its interior lateral margin is sinuate and oblique, and lies along the lateral margin of the mesosternum, extending posteriorly about two-thirds of the length of the latter. The exterior margin is roughly convex, and has an oblique marginal cleft below the exterior angle, into which the inflexed margin of the elytron (El) fits when at rest. It is a small sclerite.

The epimeron (Epm 2) is a small sclerite lying beside the posterior lateral margin of the mesosternum and beside the coxal cavity (Cc). The interior margin is concave on its anterior half, with the posterior half straight and extending to partially close the coxal cavity with the trochantins (Tro). The posterior margin is concave and contiguous with the sternum and episternum of the metathorax. The exterior margin is sinuate and sulcate to receive the margin of the elytron.

Associated only with the mesothorax are the trochantins (Tro) which are small, roughly quadrate sclerites, lying at the union of the posterior lateral margin of the mesosternum, the posterior internal angle of the meso-epimeron, bounded on its interior margin by the coxal

cavity and posteriorly by the angular exterior projection of the coxal cavity. The coxal cavities are subspherical and rather large, with an outer angle along the horizontal median plane. The sternal sclerites are heavily chitinized and punctate.

Elytra: Plate 5, Figure 1.

The elytra are strongly chitinized, clothed with a fine pubescence, the disc feebly convex anteriorly and distinctly convex posteriorly. They are borne on the dorsal surface of the mesothorax, and meet in a straight line on the meson when at rest. The anterior margin is deeply emarginate on its interior margin to receive the mesothoracic scutellum, and is transversely rounded and sinuate. The base of the elytra are embraced by the produced hind angles of the prothorax, and as the bases of the prothorax and elytra are strongly deflexed towards each other, there is a slight separation between them, which is sufficient to permit the freedom of movement necessary for the characteristic clicking and jumping.

The elytra are somewhat expanded in the humeral region, and the humeral angle is strongly carinate. The exterior lateral margins are subparallel for about two-thirds of their length, and then gradually converge to a rounded apex. Each elytron bears nine stria (Es), which are coarsely and irregularly punctured, with the intervals punctate. They are widely separated at the

basal end (before the humeral angle), and gradually converge at the apical end of the elytron.

Metathorax: Plate 4, Figures 1, 3.

Dorsally the metathorax is covered by the elytra. The scutellum (Sc1) divides the roughly quadrate scutum (Sct) by a narrow median tongue that extends anteriorly from an expanded, transverse basal scutellar area. The median scutellar tongue expands laterally as it reaches anteriorly. Each lateral division of the scutum is partially divided by a transversely oblique suture, into anterior and posterior areas. The anterior scutal area bears the anterior notal wing process (ANP), and the posterior scutal area bears the posterior notal wing process (PNP). The postnotum (PN) is strongly transverse, straight on its anterior median margin, convex on its posterior median margin, partially divided by a broken transverse suture, and gradually fades laterally into the area of wing articulation and sclerotization (Fig. 3). The posterior margin of the postnotum is closely connected and contiguous with the anterior margin of the first abdominal tergite (T 1). Anteriorly the notum is closely connected to the mesothorax. The entire notum of the metathorax is semi-membranous.

The sternum (St 3) is convex and subquadrate, heavily sclerotized, coarsely and irregularly punctate (Fig. 1). Its anterior margin is roundly emarginated by the coxal cavities (Cc), the lateral margins straight and

slightly divergent posteriorly. The posterior margin is sinuate and forms an antcoxal piece along its median line, partially subdividing the anterior-interior margins of the metathoracic coxal plates (Cx). The metathoracic coxae (Cx) are contiguous with the sternum along the entire length of its posterior margin, except for the separation made by the antcoxal piece. The sternum bears a median longitudinally impressed line known as the metasternal suture (MsS), which extends anteriorly about two-thirds the length of the sternite.

The episternum (Eps 3) is elongate, slightly wider at its anterior end, and divided into two parts. The visible part is elongate, narrow, heavily sclerotized and punctate, while the area enclosed by the elytron is membranous, elongate, and wider at its anterior end. The epimeron (Epm 3) lies in a lateral and dorsal plane along the latero-dorsal margin of the episternum, and is not visible ventrally. The dorsal plane is semi-membranous and sub-triangular in shape. It narrows anteriorly and extends towards the axillary wing process (A 2) (Fig. 3), and posteriorly to the anterior margin of the first abdominal tergite. It is widest opposite the posterior postnotal suture. The lateral area is membranous, narrow and elongate. The metathorax bears the membranous wings dorsally and the metathoracic legs ventrally.

Wings: Plate 5, Figure 2.

The functional wings are of the Cantharoidean type as characterized by Gahan (17). When at rest, with the elytra covering them, they are infolded at the apex and along the inferior margin. The apical infolding is marked by areas of slightly thickened membrane (see Figure 2), but there is no structural evidence of folding along the inferior margin.

The second anal vein (A 2) crosses and interrupts the first anal vein (A 1). The anterior branch of the media (M 1) and the posterior branch of the radius (R 2) are hooked, giving them the appearance of being recurrent branches of their respective veins. A short radial spur (Rs) is attached to the second radial vein (R 2).

Legs: Plate 6, Figures 1, 2, 3, 4, 5, 6.

The prothoracic legs are attached to the prothoracic coxal cavities (Cc) by prominent, subglobular coxae (Cx), into which the small triangular trochanters (Tr) are articulated. The trochanters are connected to the femora (Fm), which are short, stout, straight on the inferior margin, convex on the superior margin, and hollowed slightly on the inferior face to receive the tibia when at rest. The tibia (Tb) are slender, elongate-cylindrical, slightly elbowed at the anterior articulation with the femora, slightly greater in diameter posteriorly, and bearing a pair of tibial spurs (Ts) at

their posterior end. The tarsi (Tar) are five in number; all are slender, being progressively reduced in length from the first to fourth tarsal joint. The fifth tarsal joint (Tar 5) is slender and equal in length to the first tarsal joint. (Fig. 3). The fifth tarsal joint bears a pair of chitinous divergent claws (Tc) which are pectinate (Pt). Considerable variation exists in the number and character of the pectinations (Fig. 4, 5), not only in the species or individual, but even in the two claws of the same tarsus (17).

The mesothoracic legs are attached by rounded, subspherical, but not prominently protruding coxae, which are hollowed slightly externally, to accommodate the trochanters and part of the femora when at rest. The trochanters are relatively small, triangular, and closely united with the femora. The femora, tibia and tarsi follow the same general description as that of the prothoracic legs (Fig. 2), but they are generally larger in proportion.

The metathoracic legs are closely attached to the metasternum along the entire length of its posterior margin, except for a separation along its median line, by the hind coxae. These coxae are flat, strongly transverse, gradually narrowed, and separated along their inner margins by the antcoxal pieces of the metasternum and the first abdominal sternite. The posterior margin of the coxa is gradually dilated inward, and sulcate or strongly excavate for the reception of the femora in

repose. The small, roughly rhomboidal trochanters lie between the coxae and the femora, being loosely articulate with both. The femora are subparallel on their superior and inferior margins. Tibia and tarsi follow the same general description as that used for the prothoracic legs, except that they are relatively larger (Fig. 1). All three pairs of legs are heavily sclerotized and punctate.

Abdomen: Plate 4, Figures 2, 4.

The abdomen is elongate triangular, with sides gently arcuate, especially on the apical third. It is composed dorsally of seven tergites (T), and ventrally of five sternites (S).

The tergites (T) are visible when the elytra are removed or raised. The first six are membranous and closely connected with the tergopleural membrane.

The median length of the first tergite (T 1) is slightly less than that of the second tergite (T 2), and both are shorter than each of the remaining five.

The seventh tergite (T 7) is similar in both sexes. It is narrower, longer, moderately sclerotized and flexible as compared to the preceding segments. The outline is roughly subtriangular, fimbriate posteriorly, and broadly rounded medianly. It is emarginate on either side before the apex, with a longitudinal impression beginning at the emargination and continuing more or less parallel with the lateral margin nearly to the base.

The tergum is paralleled on either side by a lateral ridge (Lr) extending from the second to the seventh tergite, and is formed by the pleurite. A narrow channel into which the elytron fits when at rest, separates it from the sternites.

Borne on the tergo-pleural membrane, and visible dorsally, are seven pairs of spiracles (Sp), one pair to each tergite. The first spiracle (Sp 1) is wide, suboblong, soft-lipped and deeply set in the membrane. It extends obliquely along the length of the lateral margin of the first tergite, and is arcuate on its anterior edge. The second spiracle (Sp 2) is circular in shape, with a chitinized stoma, and is located in a fold in the pleural membrane very close to the lateral margin of the second tergite (T 2). The third to seventh spiracles are slightly smaller and rounder than the second, and are located close to the lateral ridge.

Ventrally, the five visible sternites (S) are heavily sclerotized, strongly convex, coarsely and irregularly punctate, and sparsely clothed with a fine pubescence.

The first ventral sternite (S 3) is morphologically the third or fused second and third sternites. The anterior margin of the third sternite is sinuate and contiguous with the posterior margin of the metasternal coxal plates, except for a spear shaped anteriorly projected process fitting medianly between the coxal plates. The posterior margin of the third sternite is shallowly

arcuate. The anterior margins of the fourth, fifth and sixth sternites are shallowly arcuate, lateral margins are subparallel, converging posteriorly, and the posterior angles are somewhat produced, the prolongation becoming somewhat more pronounced proceeding posteriorly. The seventh sternite (S 7) is subtriangular, its sides arcuate, and its apex slightly rounded. It is flexible and slightly longer than the other sternites.

Remaining segments, both dorsal and ventral, are visible only when extended, and act as a carrier for the external genitalia. They are dealt with in a later section.

Protrusible segments and genitalia of male: Plate 7, Figures 1, 2, 3, 4.

When fully extended, the dorsal view of the protrusible abdominal segments (Fig. 3) shows that the eighth tergite (T 8) is nearly as long as the seventh (T 7) and slightly narrower. It is longer than broad, with sides subparallel, broadly rounded on its apical half, nearly flat, and quite heavily chitimized. The ninth tergite (T 9) is short and subquadrate, with the posterior margin deeply emarginate, and the anterior margin obliquely sinuate. The tenth tergite (T 10) is narrower than the ninth at its base, elongate triangular in outline and slightly longer than the ninth tergite. The two latter tergites (T9-10) are less heavily chitimized, and more flexible than the eighth. The anus (An) lies

just below the tip of the tenth tergite on the dorsal plane as shown in Figure 2.

The pleural areas are membranous in nature, and very obvious when the protrusible abdominal segments are fully extended (Fig. 2).

The eighth sternite (S 8), as shown in Figure 4, is subquadrate, sides subparallel to the apical fourth, and then broadly rounded on its posterior margin. It is nearly flat and moderately sclerotized. The ninth sternite (S 9) is elongate, slender, sides narrowly rounded, triangular for its apical third, and about three times as long as its greatest width. The base is membranous, but quite heavily chitinized at its apical end to act as support for the tenth sternite (S 10) and aedeagus. The tenth sternite (S 10) is ovate and flat, slightly narrower at its base than the ninth sternite, about one-third as long, and weakly chitinized.

The aedeagus of the male consists of a basal segment (Bs), median lobe (ML), and two lateral lobes (LL). The basal segment is chitinous ventrally, membranous dorsally, and shallowly rounded on its anterior margin. The posterior margin is open, triangularly depressed, and encloses the bases of the median lobe and the two lateral lobes (Figure 1).

The median lobe is expanded at its basal third, elongate slender, and with sides subparallel and pointed at its apex. Dorsally, the median lobe is chitinized for support, ventrally it is membranous.

The paired lateral lobes (LL) of the aedeagus are one of the main characteristics in the identification of this species (2) (Figure 1). The exterior margin of the lateral lobe is strongly angulated near its apex, giving it a half spearhead shape. The interior margin lies obliquely over the median lobe to meet the interior margin of its opposing lobe about halfway down the aedeagus, continuing down the median line to the base of the structure. The exterior margin starts anteriorly at the outer posterior margin of the basal segment, and narrows posteriorly to the angle of the apex. The apical angles are sparsely pubescent.

Protrusible segments and genitalia of female: Plate 8, Figures 1, 2.

The eighth tergite (T 8) is subovigal in outline, with the sides almost parallel on the basal half, shorter than the seventh tergite (T 7), membranous at its base, but well chitinized apically. Its sides are flexed downward to partially enclose the pleurites, and just below the flexed edge is the small eighth spiracle, which is borne on the membranous pleural tissue.

The eighth sternite (S 8) is as long as the seventh sternite (S 7), longer than wide, sides subparallel and rounded to the apex. It is moderately chitinized.

There is no differentiation as to tergal, pleural or sternal regions for the ninth segment (OvSh), which

acts as an everted, membranous, cylindrical sheath for the ovipositor when it is extruded (Figure 1).

The ovipositor of the female is a long, slender, transparent, cylindrical tube of a membranous nature (Ov), having its base contained in the ovipositor sheath (OvSh). Within the cylindrical tube of the ovipositor, are two elongate, slender, flexible, chitinous rods (Rd) which serve to strengthen the structure. Near the apical end, the ovipositor is enlarged to a bulbous structure, bearing paired genital valves (Gv), which in turn bear small terminal styli (Sty). The genital valves are slender, elongate, and about three times as long as the cylindrical terminal styli. The genital valves and styli are sparsely and finely haired. (Figure 1 and 2).

LITERATURE CITED

1. Blatchley, W. S., 1910. Coleoptera of Indiana, Part 2, pp. 713-722.
2. Dietrich, Henry, 1945. The Elateridae of New York State, Cornell University Agr. Expt. Station, Memoir #269.
3. Fenton, F. A., 1926. Observations on the biology of Melanotus communis and Melanotus pilosus. Journal of Economic Entomology, Vol. 19, No. 3, pp. 502-504.
4. Hawkins, J. H., 1936. The bionomics and control of wireworms in Maine, Maine Agr. Expt. Stn. Bulletin #381, pp. 51-55.
5. Henshaw, Samuel, 1885. List of the Coleoptera of America, north of Mexico.
6. Henshaw, Samuel, 1885. List of the Coleoptera of North America, with third supplement.
7. Imms, A. D., 1924. A General Textbook of Entomology.
8. Junk, W., and Schenkling, 1925-27. Elateridae in Catalogus Coleopterorum. 1925, part 80, pp. 263. 1927, part 88, pp. 373.
9. Kingsbury, B. F., and Johannsen, O. A., 1927. Histological Technique.
10. Leconte and Horn, 1883. Coleoptera of North America, pp. 186.
11. Leng, C. W., 1920. Catalogue of the Coleoptera of North America, North of Mexico, pp. 174, 384, 389, 391, 440.

12. Leonard, M. D., 1926. A list of the insects of New York, Cornell University Agr. Expt. Stn. Memoir #101, pp. 351.
13. Schwarz, Otto, 1906. Genera Insectorum, 46B Fascicule, pp. 186-191.
14. Snodgrass, R. E., 1935. Principles of Insect Morphology.
15. Thomas, C. A., 1940. The Biology and Control of Wireworms (A review of the literature), Penn. State College, Bulletin #392.
16. Valentine, J. Manson, 1942. On preparation and preservation of insects, with particular reference to Coleoptera, Publication 3696, Smithsonian misc. collections, V. 103, No. 6.
17. Van Zwaluenberg, R. H., 1922. External anatomy of the Elaterid genus Melanotus (Coleop) with remarks on the taxonomic value of certain characteristics, Ent. Soc. of Washington, Proc. 24, pp. 12-29.

KEY TO PLATE 1.

1. Habit sketch of frontal view of head.

Ant.....Antenna
AntS.....Antennal sclerite
Clp.....Clypeus
E.....Compound eye
Ephy.....Epipharynx
Fr.....Frons
Fs.....Frontal suture
Gal.....Galea
LbPlp.....Labial palpi
Lig.....Ligula
Lm.....Labrum
Md.....Mandible
MxPlp.....Maxillary palpi
PAnt.....Parantennal fovea
Plf.....Palpifer

2. Dorsal view of head.

Cvx.....Cervix
E.....Compound eye
Fr.....Frons
Fs.....Frontal suture
Oc.....Occiput
Poc.....Postoccipital suture

3. Lateral view of head and part of prothorax.

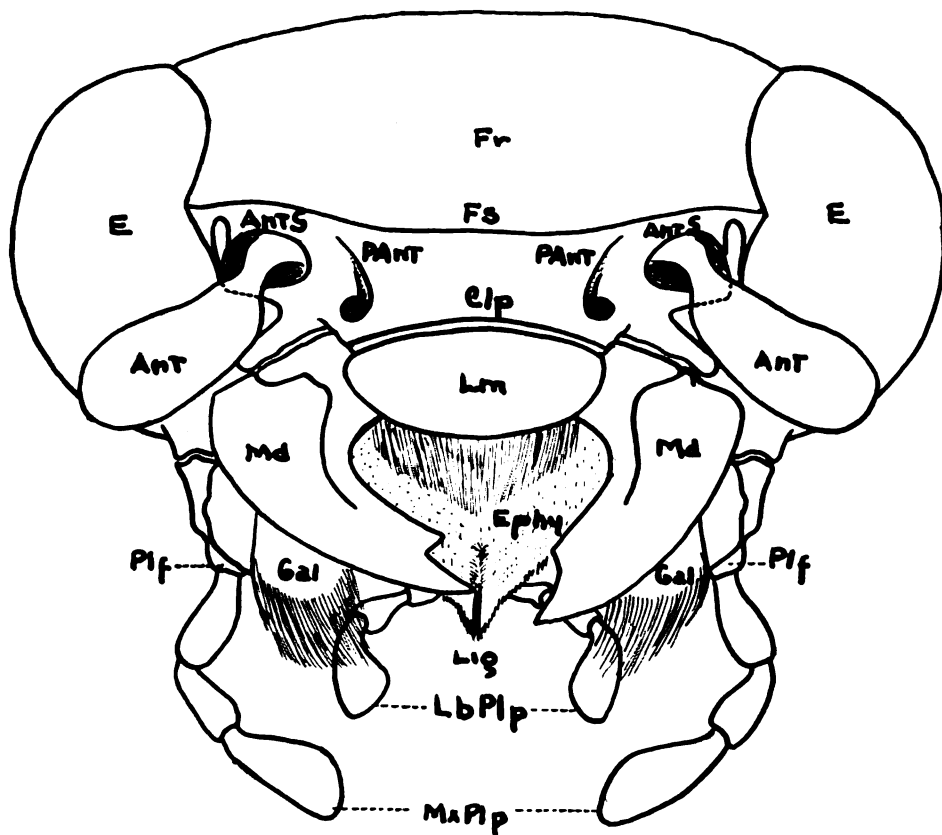
AntS.....Antennal sclerite
Clp.....Clypeus
E.....Compound eye
Eps 1.....1st episternum
Fr.....Frons
Fs.....Frontal suture
Lm.....Labrum
Md.....Mandible
MxPlp.....Maxillary palpi
Nt.....Notum
PAnt.....Parantennal fovea
Ptl.....Prosternal lobe
St 1.....1st sternum

4. and 5. Mandibles.

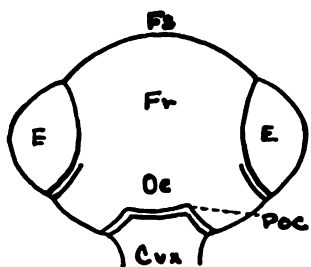
Ac.....Anterior condyle
D.....Dentes
Prs.....Prostheda

6. Dorsal view of labrum.

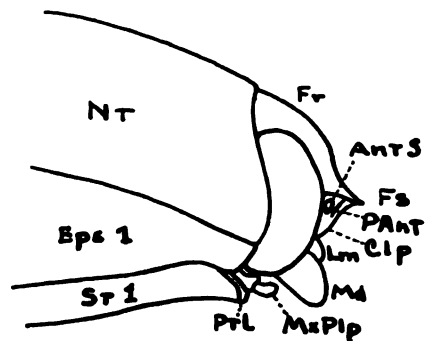
Lm.....Labrum



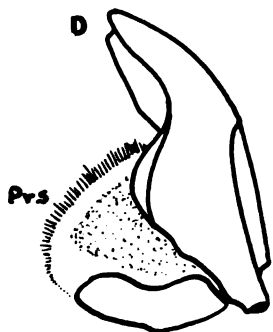
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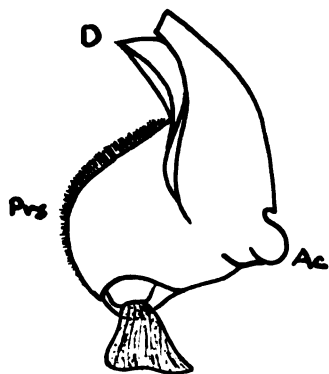
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PLATE 1

KEY TO PLATE 2.

1. Ventral view of head and mouthparts.

Bst.....Basistipes
Cd.....Cardo
E.....Compound eye
Gal.....Galea
Ge.....Genae
Gs.....Gular suture
Gu.....Gula
LbPlp.....Labial palpi
Lc.....Lacinia
Lig.....Ligula
Md.....Mandible
Mt.....Mentum
MtS.....Mental suture
MxPlp.....Maxillary palpi
Plf.....Palpifer
Plg.....Palpiger
Smt.....Submentum
St.....Stipes

2. Ventral view of maxilla.

Bst.....Basistipes
Cd.....Cardo
Gal.....Galea
Lc.....Lacinia
MxPlp.....Maxillary palpi
Plf.....Palpifer
St.....Stipes

3. Dorsal view of labium.

LbPlp.....Labial palpi
Lig.....Ligula

4. Ventral view of labium.

LbPlp.....Labial palpi
Lig.....Ligula
Mt.....Mentum
MtS.....Mental suture
Plg.....Palpiger
Smt.....Submentum

KEY TO PLATE 3.

1. Ventral view of prothorax.

Cc.....Coxal cavity
Eps 1.....1st episternum
Pa.....Posterior angle
Pss.....Prosternal spine
PtL.....Prosternal lobe
St 1.....1st sternite

2. Dorsal view of prothorax.

Lc.....Lateral carina
Nt.....Notum
Pa.....Posterior angle
Pss.....Prosternal spine
Sul.....Sulca

3. Posterior view of prothorax.

Cc.....Coxal cavity
Eps 1.....1st episternum
Lc.....Lateral carina
Nt.....Notum
Pa.....Posterior angle
Pss.....Prosternal spine
Sul.....Sulca

4. Ventral view of 1st sternite.

5. Interior dorsal view of 1st sternite.

6. Lateral view of 1st sternite.

Cc.....Coxal cavity
Pss.....Prosternal spine
PtL.....Prosternal lobe
St 1.....1st sternite

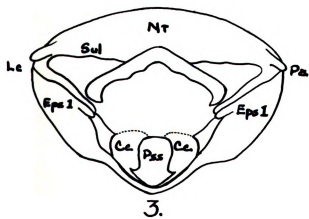
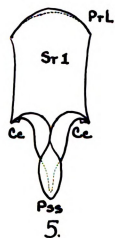
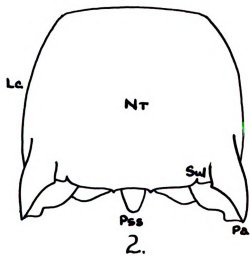
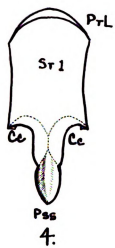
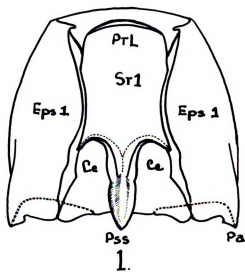


PLATE 3

KEY TO PLATE 4.

1. Ventral view of meso and metathorax.

Cc.....Coxal cavity
Cx.....Coxa
El.....Elytron
Epm 2.....2nd epimeron
Eps 2.....2nd episternum
Eps 3.....3rd episternum
MsC.....Mesosternal cavity
MsS.....Mesosternal suture
St 2.....2nd sternite
St 3.....3rd sternite
Tro.....Trochantin

2. Ventral view of abdominal segments.

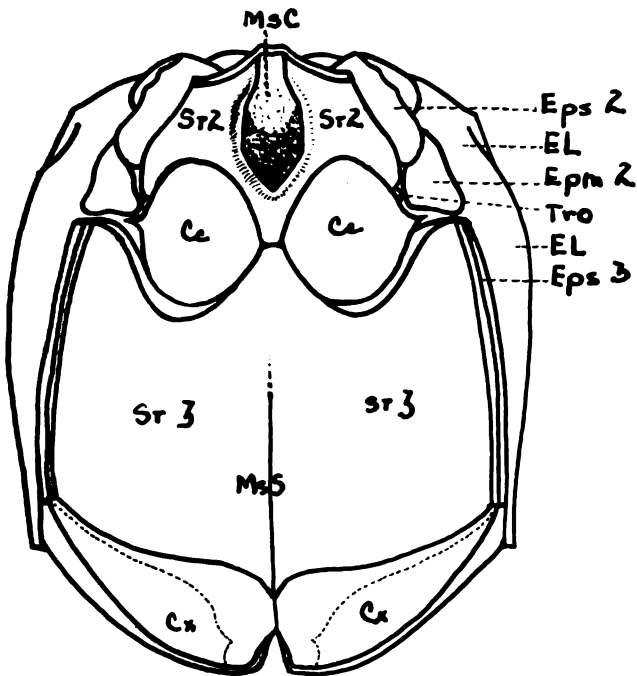
S 3.....3rd sternite
S 4.....4th sternite
S 5.....5th sternite
S 6.....6th sternite
S 7.....7th sternite

3. Dorsal view of meso and metathorax (Elytra and wings removed).

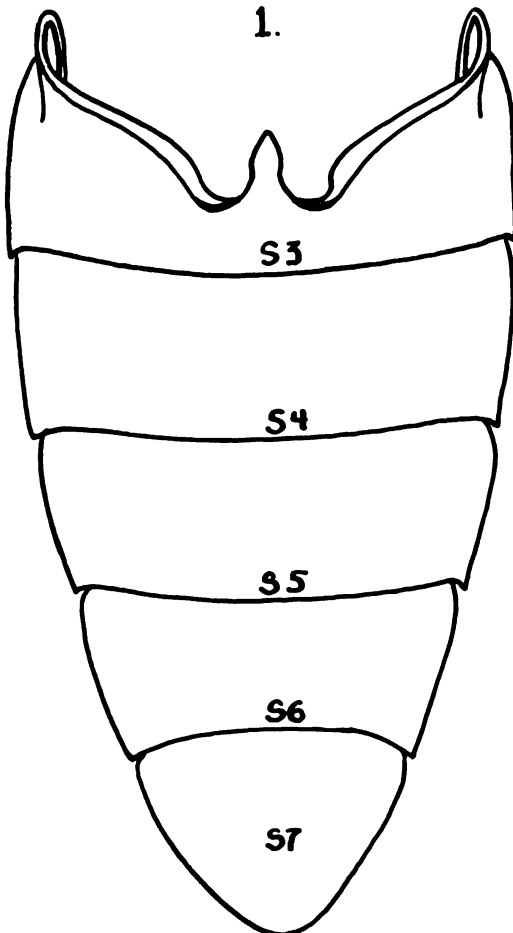
A 1.....1st axillary wing process
A 2.....2nd axillary wing process
ANP.....Anterior notal wing process
Epm 3.....3rd epimeron
PN.....Postnotum
PNP.....Posterior notal wing process
Psc.....Prescutum
Scl.....Scutellum
Sct.....Scutum
Sp 1.....1st spiracle
T 1.....1st tergite

4. Dorsal view of abdominal segments (Elytra and wings removed).

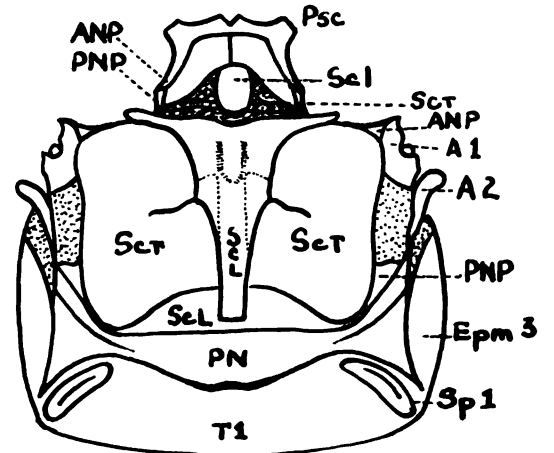
Lr.....Lateral ridge
Sp.....Spiracles
T.....Tergites



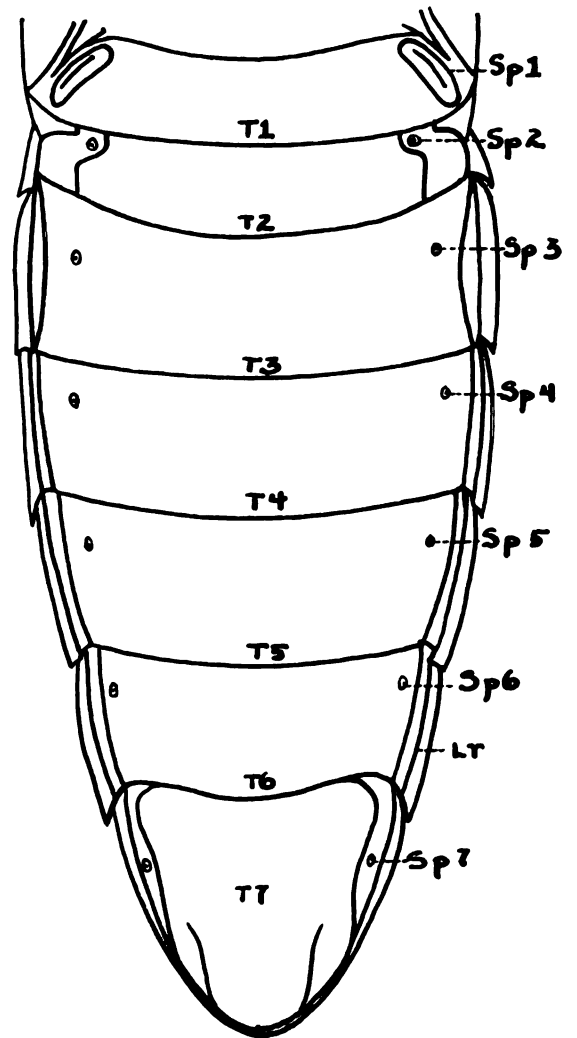
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KEY TO PLATE 5.

1. Elytron.

ES(9).....Elytral stria (nine in number)

2. Wing.

A 1.....1st anal vein
A 2.....2nd anal vein
A 3.....3rd anal vein
A 4.....4th anal vein
C.....Costal vein
Cu 1.....1st cubital vein
Cu 2.....2nd cubital vein
M 1.....1st medial vein
M 2.....2nd medial vein
R 1.....1st radial vein
R 2.....2nd radial vein
Rs.....Radial spur
Sc.....Subcostal vein

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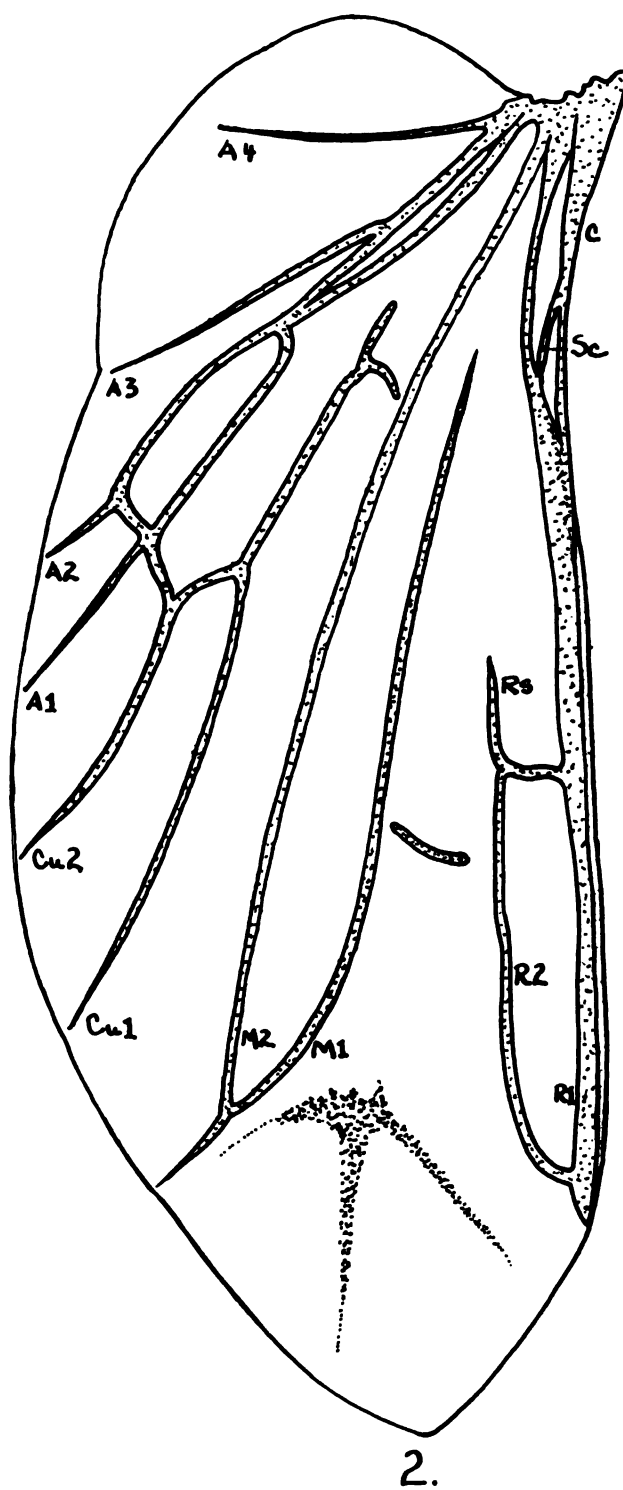
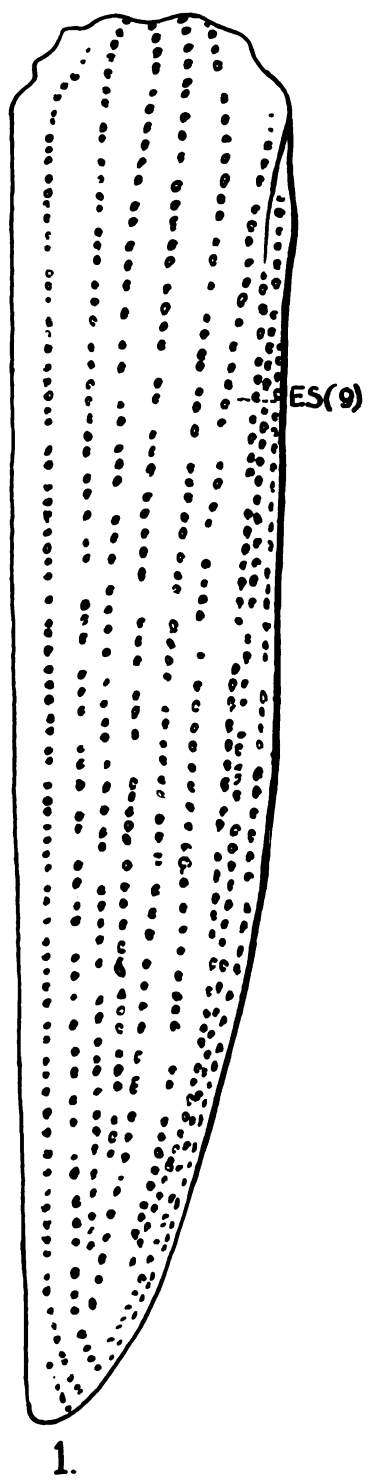


PLATE 5

KEY TO PLATE 6.

1. Metathoracic leg.

Cx.....Coxa
Fm.....Femur
Tar 1.....1st tarsus
Tar 2.....2nd tarsus
Tar 3.....3rd tarsus
Tar 4.....4th tarsus
Tar 5.....5th tarsus
Tb.....Tibia
Tc.....Tarsal claws
Ts.....Tarsal spurs

2. Mesothoracic leg.

Cx.....Coxa
Fm.....Femur
Tar 1.....1st tarsus
Tar 2.....2nd tarsus
Tar 3.....3rd tarsus
Tar 4.....4th tarsus
Tar 5.....5th tarsus
Tb.....Tibia
Tc.....Tarsal claws
Ts.....Tarsal spurs

3. Prothoracic leg.

Cx.....Coxa
Fm.....Femur
Tar 1.....1st tarsus
Tar 2.....2nd tarsus
Tar 3.....3rd tarsus
Tar 4.....4th tarsus
Tar 5.....5th tarsus
Tb.....Tibia
Tc.....Tarsal claws
Ts.....Tarsal spurs

4. and 5. Tarsal claws with pectinate teeth.

PT.....Pectinate teeth
Tar 5.....5th tarsus
Tc.....Tarsal claws

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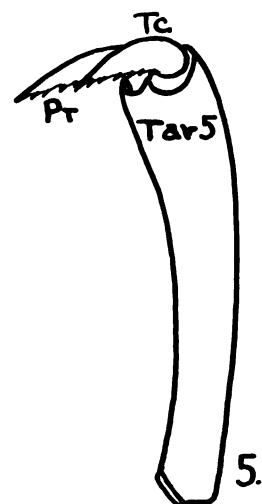
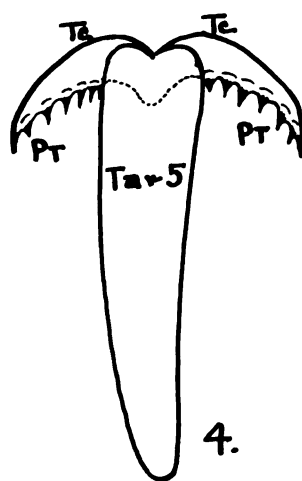
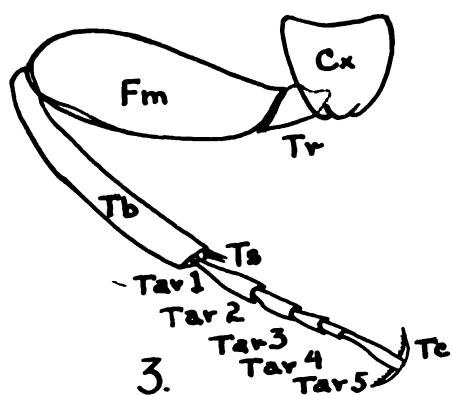
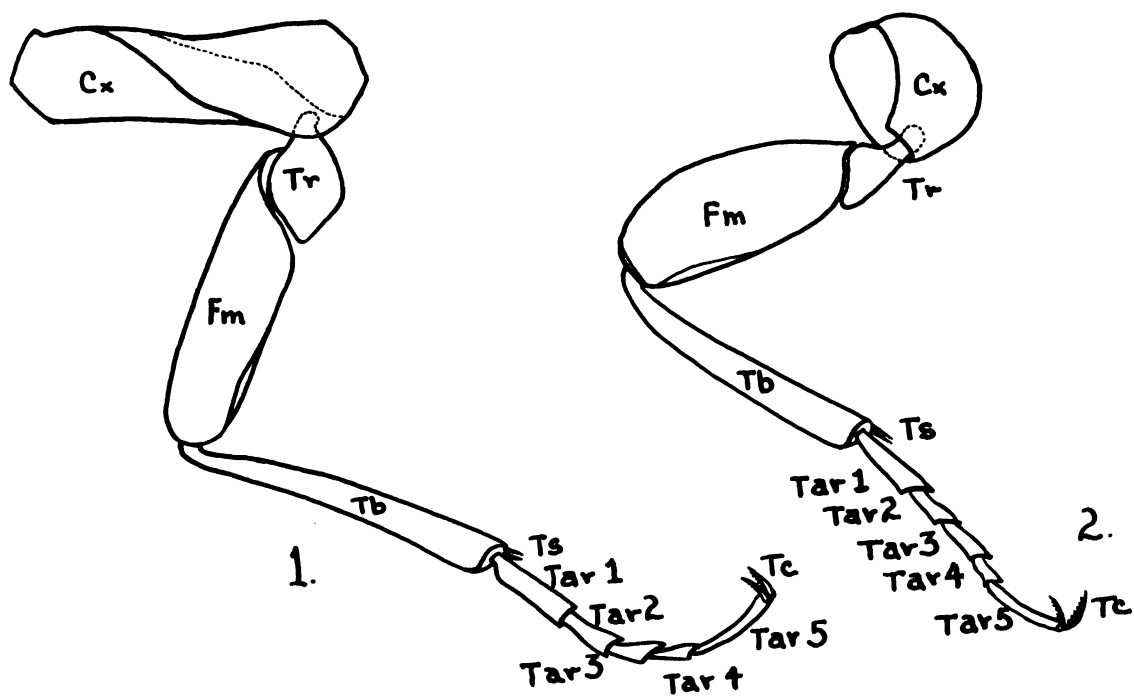


PLATE 6

KEY TO PLATE 7.

1. Aedeagus of male (Dorsal view).

Bs.....Basal segment
LL.....Lateral lobe
ML.....Median lobe

2. Lateral view of protrusible abdominal segments and aedeagus of male.

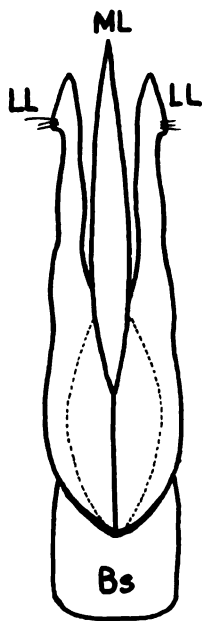
An.....Anus
Bs.....Basal segment
LL.....Lateral lobe
M.....Membrane
ML.....Median lobe
S 7.....7th sternite
S 8.....8th sternite
S 9.....9th sternite
S 10.....10th sternite
T 7.....7th tergite
T 8.....8th tergite
T 9.....9th tergite
T 10.....10th tergite

3. Dorsal view of protrusible abdominal segments of male; aedeagus not fully extended.

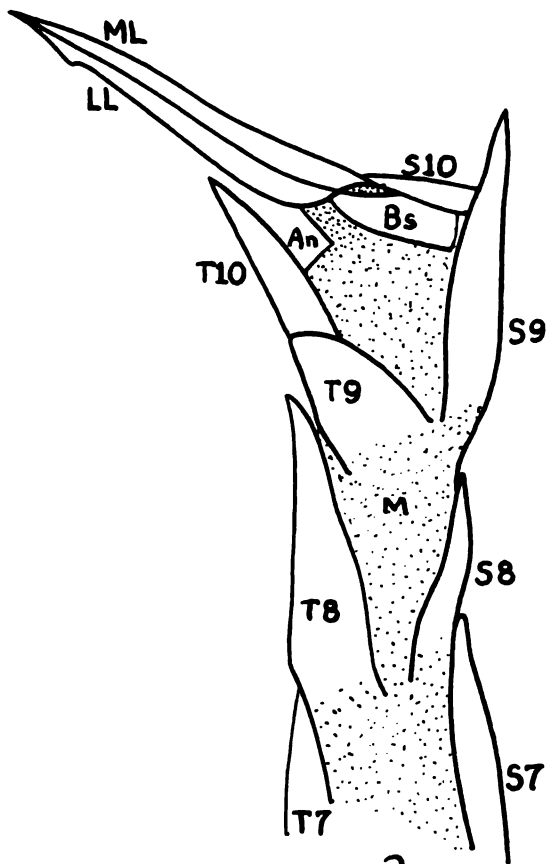
LL.....Lateral lobe
ML.....Median lobe
T 7.....7th tergite
T 8.....8th tergite
T 9.....9th tergite
T 10.....10th tergite

4. Ventral view of protrusible abdominal segments of male; aedeagus not fully extended.

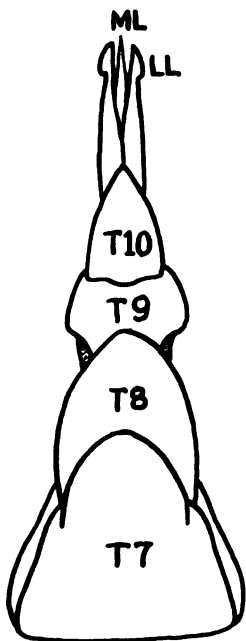
Bs.....Basal segment
LL.....Lateral lobe
ML.....Median lobe
S 7.....7th sternite
S 8.....8th sternite
S 9.....9th sternite
S 10.....10th sternite
T 8.....8th tergite
T 9.....9th tergite



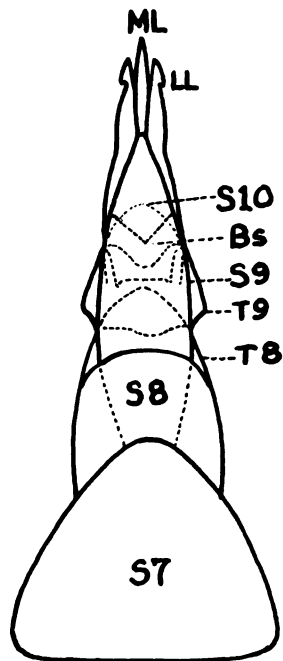
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KEY TO PLATE 8.

1. Dorsal view of protrusible abdominal segments of female, with ovipositor fully extended.

Gv.....Genital valve
Ov.....Ovipositor
OvSh.....Ovipositor sheath
Rd.....Ovipositor rod
Sty.....Stylus of genital valve
T 7.....7th tergite
T 8.....8th tergite

2. Apex of ovipositor.

Gv.....Genital valve
Ov.....Ovipositor
Rd.....Ovipositor rod
Sty.....Stylus of genital valve

3. Male antenna showing erect pubescence on inferior margin of fourth joint.
4. Female antenna showing pubescence on fourth joint.

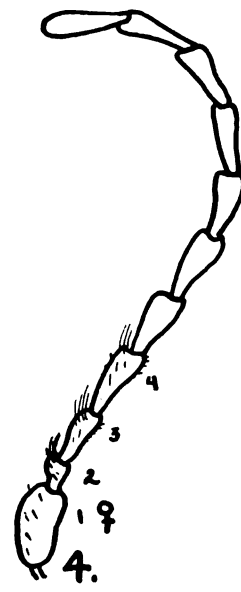
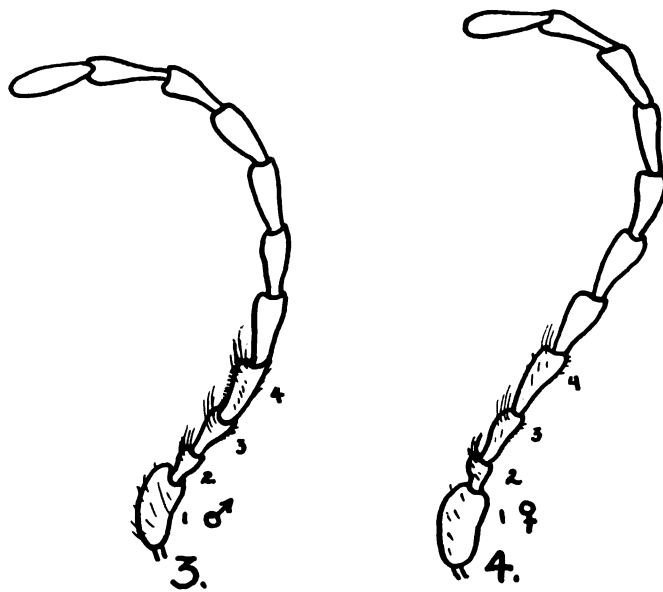
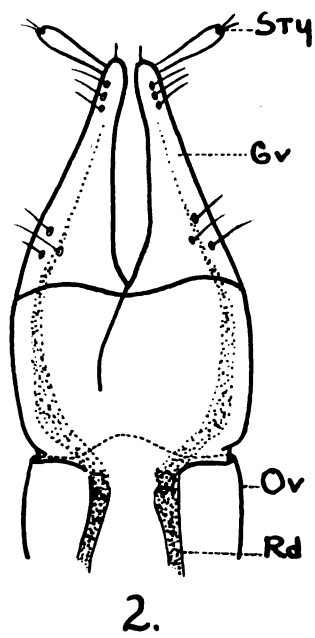
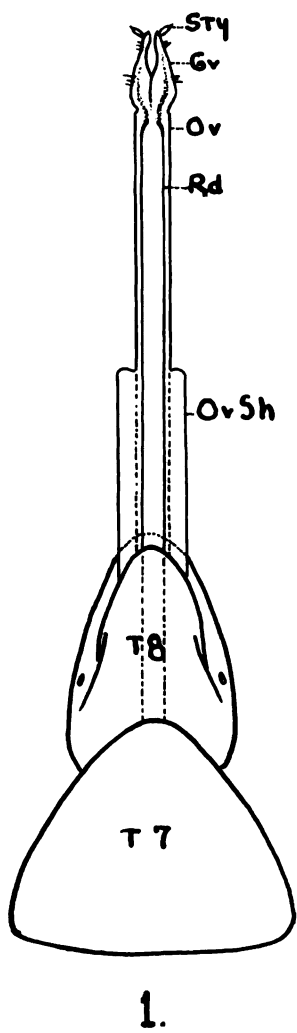


PLATE 8

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