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TABLE OF CONTENTS

LANDACRE—Muscular and Skeletal Elements of <i>Passalus Cornutus</i>	299
BURR—Ohio Plants with Dissected Leaves.....	314
RIDDLE—Algae from Sandusky Bay.....	317
SCHAFFNER—The Maximum Height of Plants.....	319
LANDACRE—On a Visual Area in <i>Lampsida Ventricosus</i>	320
JENNINGS—Meeting of Biological Club.....	322

MUSCULAR AND SKELETAL ELEMENTS OF *PASSALUS CORNUTUS*.

F. L. LANDACRE.

The present paper on the muscular and skeletal elements of *Passalus cornutus* was begun with a view to determining what changes had arisen in the muscular system in connection with the burrowing habits of the animal. It was found in the course of the study that there was an almost complete atrophy of the muscles concerned in flight and a marked hypertrophy of the muscles of the legs; and that with these changes had arisen certain modifications in the hard parts to which these muscles are attached.

These changes in the hard parts were not so numerous or so radical as to justify the rather extended description of the skeleton, which had been given, if it were not for the fact that the two systems are so intimately related and the changes in the one so dependent upon those in the other that constant reference would have to be made to the skeleton. This would be confusing to a reader not entirely familiar with the hard parts.

The study of these two systems led to an investigation of the habits of the insect, especially those concerned in distribution and reproduction.

Passalus is a large black beetle of common occurrence in decaying logs and stumps which it assists materially in destroying. It can easily be identified by its large size, great strength, sluggish movements and longitudinally striated wing covers. It has a peculiar habit of stridulating when disturbed.

It can be secured in great abundance at all times of the year and is easily kept in the laboratory for observation if it is supplied with an abundance of decaying wood. Specimens for dissection

should be hardened in five per cent. formalin. It is an excellent type for class work so far as its hard parts are concerned, but its muscular system is too highly modified to serve as a type for the group.

It is the only representative of its genus in America, and is quite widely distributed. Its larva is characterized by having its third pair of legs rudimentary and is supposed to have a very long larval stage.

THE EXTERNAL SKELETAL SYSTEM.

The body, as in all insects, is divided into a head, thorax, and abdomen. The head contains seven segments and bears a curved spine on its median dorsal surface, and is articulated posteriorly with the prothorax. This segment bears the first pair of legs and presents a smooth expanded surface dorsally. It is articulated posteriorly with the meso-meta-thorax by a narrow area. This constricted area is part of the meso-thorax, which bears ventrally the second pair of legs. On its dorsal surface are borne the elytra or wing covers. Fused with the meso-thorax is the meta-thorax, which bears dorsally the true wings covered by the elytra and ventrally the third pair of legs. The last region of the body is the abdomen, composed of eight segments, six of which are visible ventrally, but bear no appendages.

FIXED PARTS OF THE HEAD.

These are first the epicranium. This term is applied in a general way to the dorsal and lateral regions of the head. The portion of the epicranium lying posterior to the spine is the vertex (1) and the region lying anterior to and including the spine and extending down to a transverse depression near the anterior end of the head is the frons (2). On either side of the spine on the lateral margins of the head lie the frontal ridges (3) which mark the lateral boundaries of the frons. Below the frontal ridges on the sides of the head lie the eyes (4). The epicranium extends posterior to the eye and ventral to it as the gena (5). Running back and in from the posterior ventral border of the eye is a slight elevation forming the outer wall of a groove into which the antenna fits when retracted under the head. This is called the antennal groove (6). The inner border of this antennal groove is the genal ridge (7). It is a well marked elevation with its pointed anterior extremities free and it forms the outer wall of the deep genal emargination (4') into which the maxilla can be retracted. This sclerite (a small chitinized area) surrounding the foramen at the posterior surface of the head is called the occiput, but is not separated by a definite suture from the remainder of the epicranium. The clypeus (8) or epistoma lies on the dorsal surface

anterior to the frons, and is separated from it by a transverse depression which does not extend completely across the head. The clypeus is called epistoma when reduced in size. The gula (9) occupies the posterior half of the median ventral portion of the head and is largely taken up with a rounded elevation which articulates with the prosternum. Anterior to this elevation there is a median depression with lateral elevations. The suture which separates the gula from the sclerite lying in front of it is situated on the anterior portion of this median depression and extends laterally over the elevations on its sides. It is a well marked suture and is called the gular suture (10). The submentum (11) lies in front of the gula and is separated from it by the gular suture. It is usually called the mentum, but since it is in contact with the gula it is probably the submentum. It is deeply emarginated on its anterior border and free on its lateral borders. The posterior portion of this free lateral border forms the inner boundary of the genal emargination into which the maxilla can be retracted. The anterior emargination is occupied by the labrum (8'9'). The compound eyes (4) lie on the sides of the head under the frontal ridges and are divided into two nearly equal portions on their anterior border by a posterior projection of the frontal ridge.

THE MOVABLE PARTS OF THE HEAD.

The antenna (2') lies just in front of the eyes under the anterior border of the frontal ridge. It has ten segments of which the first is large and concealed by the frontal ridge. The following six are almost equal in size, number 2, 3 and 4 being somewhat smaller and all are slightly elongated anteriorly. The last three are much larger and prolonged anteriorly, forming a pectinate club. These three are not in contact with each other. The labrum (1') lies anteriorly to the clypeus between the mandibles. It is bilobed and covered with stiff short bristles. It can be easily removed for study. The mandible (3') should be removed for examination. It is flattened laterally and examined from the under surface will be seen to bear a number of cutting spines. One of these on the ventral border near the proximal end is articulated. The maxilla (4'-7') can be removed easily for study by inserting a pin into the posterior border of the genal emargination into which the maxilla is retracted and pushing it out forward. It should be examined from the dorsal surface. It consists of a long, slender basal piece, the cardo (4'); following this is a large median piece divided longitudinally into an inner and an outer portion. The outer piece is spindle shaped and is called the stipes (5'). It bears on its anterior end a four-jointed palp (10'). On the inner border of the stipes and extending beyond its anterior end is the lacinia (6'). It bears many bristles on its free inner border and

two prominent curved spines on its anterior end. On the tip of the stipes and between the palp and the lacinia is the galea (7') covered with bristles and ending in an incurved spine. It is somewhat shorter than the palp and longer than the lacinia. The labium (8'-9') lies on the median ventral surface and is attached posteriorly to the anterior margin of the submentum, and lies between the lateral projections of the submentum and under the labrum. The parts which are separate in other beetles seem to be fused in this. The labium seems to be composed of mentum (8') ligula (9') and paraglossa fused. The palp is as in other forms. The proximal portion (8') probably corresponds to the mentum, the median anterior spine to the ligula (9') and the rounded lateral elevations lying on either side of the spine to the paraglossa; the palp is three-jointed.

THE PRO-THORAX.

The following definitions should be kept in mind: A typical body segment of an insect is composed of four main pieces or sclerites. The dorsal portion is called the tergum. The side pieces are called pleura and bear spiracles when present. The pleuron is divided into two smaller sclerites, the anterior or episternum and posterior or epimeron: owing to the flattening of the body dorso-ventrally in beetles the sclerites of the pleura lie on the ventral surface. The ventral portion of the segment is called the sternum and is usually modified according to the size and method of articulation of the limb. The dorsal portion or tergum is also similarly modified by the attachment of the wing.

The pro-notum (4-7) or pro-thoracic tergum, is a smooth rectangular sclerite covering the dorsal surface of the pro-thorax. It is divided into right and left halves by a longitudinal suture. Anteriorly it ends in a sharp border, but laterally and posteriorly it is inflexed to unite with the sclerite forming the ventral wall of the body.

The prosternum (1) occupies the median ventral portion of the pro-thorax. It is compressed in the middle region between the pro-thoracic coxae and expands posteriorly into a small diamond-shaped piece. Anteriorly it expands almost to the lateral border of the coxal cavities. The suture limiting the lateral area of the anterior end of the pro-sternum is V-shaped, the apex of the V pointing toward the median line. The transverse depression on the median anterior portion is not a suture but is the remnant of the fold where the articular portion of the pro-sternum was doubled under in the pupa.

The pleuron is usually composed of two sclerites, the anteriorly located episternum, the posteriorly located epimeron, and sometimes a third dorsally located epipleuron. In *Passalus* they

are completely fused in the pro-thorax. This fused sclerite begins at the V-shaped suture mentioned as forming the lateral boundary of the anterior portion of the prosternum and extends around the coxal cavity and forms a suture with the posterior portion of the sternum. The region in front of the coxal cavity probably corresponds to episternum (2); that behind the coxal cavity to the epimeron (3), and that lateral to the coxal cavity and fused with the pro-notum to the epipleuron. Its anterior and posterior boundaries are free; its lateral fused with the pro-notum and its median forms the lateral and posterior wall of the coxal cavity and unites by a suture with the anterior and posterior portions of the sternum. The fused condition of these parts is probably related to the burrowing habit of the beetle, the solid piece giving greater strength both in forming an attachment for muscles and articulations for the fore-legs.

The pro-thoracic leg consists of the usual number of segments. They are named as follows, beginning at the body or proximal end: coxa, trochanter, femur, tibia, and tarsus. The coxa (8) is the very large sclerite placed transversely in the coxal cavity and reaching three-fourths of the distance from the median line to the lateral border of the pro-thorax. It can be rotated forward and backward on its long axis. It is articulated on the median extremity with the large femur (10) and the small trochanter (9) lying on its anterior proximal surface. The coxa sends a small projection between these parts on the ventral surface resembling a ball-and-socket joint, and on the dorsal surface sends forward a broad flat piece. Between these ventral and dorsal pieces the femur and its fused trochanter articulate.

The trochanter (9) is a small segment lying on the anterior surface of the proximal end of the femur. It is about one-fourth the length of the femur.

The femur (10) is the largest segment of the leg and is flattened dorso-ventrally. On the anterior border of the distal portion there is a cavity into which the tibial spur fits when the tibia is flexed. The dorsal surface of the dorsal wall of this depression bears a bundle of bristles in a slight depression just back of the distal extremity. This distal wall of the depression serves as a brace against which the tibial spine works. The tibia (11) is nearly as long as the femur and is flattened also dorso-ventrally. On its posterior border it bears eight blunt spines, and on its anterior border a single articulated spine near the distal end called the tibial spine. There is a cirlet of bristles around the base of the spine.

The tarsus (12) consists of five segments of which the first and third are the longest; the remaining three small and similar in shape; the fifth bears a pair of claws, two short bristles are

borne between the claws, and also a prolongation of the last segment called the pulvillus. The tibial joint opens forward in the first pair of legs and backward in the second and third pairs. The trochanter lies on the anterior surface of the first pair, but on the posterior surface of the last two pairs. By comparing this leg with the last two it will be seen to be rotated forward, that is, structures on the posterior surface of the first leg are on the anterior surface of the last two pairs.

The trochantin is situated on the outer end of the coxa. It is convex and presents three faces, an outer or lateral, which is smooth; an inner or dorsal, which furnishes attachment for the dorsal muscles, and a ventral face, which furnishes attachment for the ventral muscles. It is articulated by its posterior border with the coxa and lies in a depression of the anterior arm of the coxa below and in front of the point of articulation of the coxa with the body wall.

The jugular sclerites (13) are small pieces lying between the posterior ventral portions of the head and the anterior portion of the pro-thorax. The anterior surface is concave and smooth. It articulates with the head and is attached to it on its ventral inner border by a strong ligament. The ventral portion of the posterior surface is smooth and protrudes from under the pro-thoracic sternum. The dorsal two-thirds of the posterior surface is rough and bears a posteriorly directed process which gives off a ventral keel and a lateral one which runs to near the inner border.

The meso-thoracic spiracle lies on the hinder border of the coxa in the membrane connecting the coxa to the posterior border of the pro-sternum and epimeron. It is not visible from the exterior but can be seen by removing the coxa. It is very large, being about four millimeters in length.

THE MESO THORAX.

This segment articulates anteriorly with the pro-thorax and is fused posteriorly with the meta-thorax. It is much narrower than either of these segments and bears on its dorsal surface a strongly chitinized elytra or wing cover, and on its ventral surface the second pair of walking legs. The meso-thoracic tergum of some beetles contains four sclerites, the prescutum, scutum, scutellum, and postscutellum. The prescutum and postscutellum are frequently wanting.

The scutellum (6) lies on the mid-dorsal line of the meso-thorax. It is triangular with the base of the triangle directed forward. It is free in front, and laterally is continued under the triangular base of the elytra in a less chitinized area which finally is continuous with the articular membrane of the elytron. Posteriorly it is fused with the postscutellum. The postscutellum (7)

is a long rod-like sclerite and is fused with the posterior border of the scutellum by which it is partly concealed. From the posterior apex of the scutellum it extends laterally and anteriorly. Its total length is about equal to the scutellum. Its lateral extremity articulates with the metathoracic prescutum.

The scutum is not well defined in *Passalus* and seems to be divided into two portions, which are located on the anterior and lateral extremities of the scutellum. These small pieces are elongated and inflexed anteriorly, and laterally, come into contact with the episternum. Posteriorly they pass into the articular membrane of the elytra.

The elytra (15) are articulated to the body by a triangular base which fits between the scutellum and episternum. In studying the elytron it should be extended at right angles to the body as in flight. When thus extended there can be seen in the articular membrane which connects the inner surface of the basal triangle with the body a small sclerite called the paraptara (14). The elytron bears ten longitudinal grooves and is inflexed slightly on the lateral margin to form the epipleuron. The inner margins are bevelled so that the edges fit closely when the wing covers are at rest. There is in addition to this a clasp which fits in between the lateral margins of the scutellum and the postscutellum. This clasp lies on the inner border of the triangular base of the elytron and can be demonstrated by slowly separating the wing covers and observing the manner in which the clasp slips from under the edge of the scutellum.

The mesothoracic sternum (1) lies on the median ventral portion of the mesothorax anterior to the mesothoracic leg and is kite-shaped. It is truncated at the anterior end and on its anterior lateral border is in contact with the episternum (2). Its lateral tip touches the epimeron and its hinder border is in contact with the meta thoracic epimeron and the coxal cavities. It ends posteriorly in a narrow neck between the coxal cavities. Just in front of the outer half of the coxal cavity is a crescent-shaped area separated from the sternum by a slight depression.

The episternum (2) forms the side wall of the constricted region of the meso-thorax. It is triangular in shape, its base being anterior and free. On its ventral surface it is in contact with the sternum. On its dorsal surface it is in contact in front with the articular region of the elytron and posteriorly with the small epimeron (3) throughout about half of its length.

The epimeron (3) is a small sclerite lying at the posterior angle of the episternum and is visible at the anterior ventral border of the wing cover when it is closed. It is roughly triangular with the apex directed up and forward. It is in contact anteriorly throughout its whole length with the episternum, ventrally with

the sternum, posteriorly with the metathoracic sternum and episternum and dorsally with the metathoracic scutum.

The coxa (8) of the mesothoracic leg appears globular on its surface, but is really as long as the prothoracic coxa, as will be seen by examining its internal surface. The coxal cavity is much smaller, however, and not circular. The coxa is dovetailed between the trochanter and femur on the ventral surface and articulates over them on the dorsal surface.

The trochanter (9) is fused to the posterior surface of the femur at its proximal end. The femur (10) is flattened dorso-ventrally and hollowed on its posterior surface from the distal end of the trochanter to the tibial joint. The mesothoracic tibia (11) bears no spine at its proximal end. The articulation should be examined from the inner surface. On its dorsal surface it bears a dense row of bristles and at its articulation with the tarsus, four spines, two ventral and two lateral. The tarsus (12) resembles the prothoracic tarsus closely, having first and last segments long and the intermediate ones short.

By comparing the mesothoracic legs with the prothoracic these latter will be seen to be rotated through 90 degrees on their coxae so that posterior, anterior, dorsal and ventral are reversed.

The metathoracic spiracle is situated on the hinder and upper border of the epimeron in the membrane connecting this sclerite with the wing articulations. It is usually tucked under the border of the epimeron.

THE META-THORAX.

The metathoracic sternum (1) forms the floor of this segment between the second and third pairs of legs. Anteriorly it begins on the median line by a narrow neck extending between the meso-coxae. The anterior boundary then curves around in front of the coxal cavity and comes into contact with the meso-sternum and ends antero-laterally in contact with the meso-thoracic epimeron. Beginning with the hinder border of the coxal cavity and extending to the epimeron is a shallow groove marking off a narrow strip from the anterior border to this sclerite. This is usually described as the mesothoracic epimeron, but is attached to the meta-sternum and cannot be separated from it. The lateral boundaries of the meta-thoracic sternum are straight and begin at the mesothoracic epimeron and end at the metathoracic coxal cavities. The lateral border bears a shallow groove and the outer elevated wall of this groove is in contact with the metathoracic episternum (2) throughout its whole length. Posteriorly the metasternum forms the anterior boundary of the metathoracic coxal cavity.

The metathoracic episternum (2) is a long, narrow sclerite lying on the lateral border of the sternum from which it is sepa-

rated by a sharply defined groove except at the posterior end. At this point it is fused with both the sternum and epimeron to form the lateral articulation for the metathoracic coxa. Anteriorly it gives off a dorsal process which forms part of the wing articulation and lies between similar processes on the scutum (5) and epimeron (3). On its dorsal surface it is in contact throughout its whole length with the epimeron. The suture separating the episternum from the epimeron is best seen on the dorsal process and on the anterior half of the dorsal surface. Its boundaries are ventrally the sternum, anteriorly the scutum, and dorsally the epimeron.

The epimeron (3) is a somewhat ill-defined sclerite lying dorsally to the episternum with which it is in contact throughout its whole ventral border. It consists of a strong narrow, chitinized bar with an anterior dorsal process which with similar processes from the episternum and the scutum form the ventral articulation for the wing. This sclerite can be easily separated from the episternum on its anterior half. Its posterior half is fused with the episternum. The dorsal boundaries of this sclerite are less definite. The anterior half bears a large, slightly chitinized triangular area, the posterior end of which articulates with a lateral process from the postscutellum. Excepting this triangular area the dorsal boundaries of this sclerite seem to be membranous.

The first abdominal spiracle (25) lies above the posterior border of the epimeron in a membranous area and is over two millimeters in length. It is placed in a slightly more oblique position than the mesothoracic spiracle, and its hinder border lies directly under the second abdominal spiracle.

The metanotum (4-7) forms the dorsal wall of the metathorax extending from between the wings as far back as the first segment of the abdomen. It is variously marked with chitinized bars and membranous areas so that the boundaries of its separate sclerites are hard to locate. In attempting to determine these dry specimens should be used to determine the sutures and moist ones to determine the articulations. The prescutum (4) lies just back of the meso-scutellum, its median rod-like portion being concealed by the meso-scutellum. It is dumb-bell-shaped and its enlarged ends form part of the anterior squarish end of the metanotum. It extends on either side of the median line to points even with the lateral edges of the meso-scutellum. It is bounded posteriorly by the chitinized bar extending across the body between the articulation of the wings. The scutum (5) is a small sclerite lying directly beneath and in front of the articulation of the wings. Its ventral border rests on the meso-epimeron (3). Its posterior border rests on the anterior bar of the met-episternum (2): dorsally it assists in forming an articulation for the wing, and on the median border

is connected with an articular cartilage. On its anterior face it bears a circular depression limited internally by a drum-like membrane. In the body this drum-like membrane is borne on the small end of a funnel-shaped piece whose large end extends freely into the body cavity. This cone furnishes attachment for muscles. Between this sclerite and the end of the prescutum lies a circular chitinized area. The scutellum (6) is a large sclerite forming the greater part of the dorsal surface of the metathorax. It is limited in front by a chitinized bar extending between the articulation of the wings and forming the squarish front to the metanotum. Laterally it is bounded by a membrane lying below and behind the articulation of the wing with the dorsal surface of the epimeron. The postscutellum (7) is not well separated from the scutellum except at its lateral margins. Posteriorly the scutellum is fused with the postscutellum.

The boundaries of the postscutellum (7) are very difficult to make out. In the median line it is a very narrow bar lying between the posterior ends of the median rectangular area of the scutellum. This narrow bar fades out as it passes to the side of the body, but again becomes chitinized and enlarging forms an articulation with the median dorsally projecting bar of the episternum. Its boundaries are posteriorly the thin membrane of the first abdominal segment, laterally the meta-sternum, and anteriorly it is fused with the scutellum.

On the posterior border is a thin membrane stretching from the second abdominal spiracle of one side to that of the other. It is about as broad as an abdominal tergum and probably belongs to the first abdominal segment. It appears to be simply a broadened articular membrane, but may include a portion of the postscutellum.

THE WING.

The articular membranes at the base of the wings bear several small sclerites which can be located more easily after the wing veins have been described. In identifying the wing veins the wings should be extended at right angles to the body. The margin which lies anteriorly when the wing is extended is called the anterior margin and the hinder border the posterior or anal margin. The homology of the wing veins is somewhat doubtful and the transverse folding of the hinder third of the wing in beetles to enable the wing to be withdrawn under the elytron renders the identification of the small veins in that region still more difficult.

The costa (13) is a short vein lying on the anterior proximal border of the wing and is nowhere completely separate from the vein lying next to it except for a short distance at about one-fourth the distance from the proximal end of the wing to the tip. Here

there is a spindle-shaped area where the veins are separate. The proximal portion of this vein is connected by a transverse chitinized bar with the next vein, and from this point is continued as a strongly chitinized bar to the end of which the articular membrane lying in front of the wing is attached.

The subcosta (14) lies just posterior to the costa and is closely fused to it except at the point mentioned above and also at the proximal end where after fusing with the transverse bar connecting it with the costa it projects toward the median line and articulates with a large movable sclerite. The fused costa and subcosta can be traced as far as a transverse articulation of the outer third of the wing.

The radius (15) is a large vein lying posterior to the subcosta and extending from the base of the wing to the transverse articulation. At its proximal end it is interrupted by an oval membranous area over which it extends as a narrow bar, and beyond this enlarges and fuses with the enlarged end of the subcosta. It also sends posteriorly a small process which articulates with one of the free sclerites. Distally beyond the transverse articulation of the wing these veins are continued as a broad slightly chitinized area. Just posterior to this broad area which forms the anterior margin of the outer third of the wing is a short vein extending from the articulation of the wing. It is the posterior division of the radius.

The next three veins arise together from an irregular plate formed by the fused and enlarged ends of the veins. The plate articulates with the movable sclerite by a well defined process extending between two non-chitinized areas. The media (16) is the most anterior and the largest of the three. At its base it is in contact on its anterior border with the radius. Distally it separates from the radius and at the transverse articulation turns posteriorly and reaches the margin of the wing. There is a second short vein lying anterior to the distal end of the medius and reaching from the transverse articulation to the tip of the wing. This is media No. 1, the main vein beyond the articulation being media No. 2. Posterior to the main branch of the media and within the transverse articulation is a small vein which is probably media No. 3. It does not come quite into contact with the media but arises near it.

The cubitus (17) is the second of this group and arises posterior to the medius and is in contact with it for some distance after which it turns by a gentle curve to the anal margin of the wing. It forms a large triangle in which the third division of the media lies.

The third (18) and most posterior vein arising from this plate is the first division of the anal vein. It is not in contact with the

cubitus after leaving the plate, but bending forward comes almost into contact and then turns sharply to the anal margin of the wing. The second (18) and third (18) divisions of the anal veins are separated from the first by the articulation by which the anal margin of the wing is doubled under when the wing is at rest. There are two of these, the anterior being a well defined vein, while the posterior is simply a broad chitinized area. The bases of these veins articulate with one of the movable sclerites at the base of the wing.

THE DETACHED SCLERITES AT THE BASE OF THE WING.

The most prominent of these detached sclerites is a strongly chitinized V-shaped (19) piece which is directed in and forward. The base of the V articulates with the antero-lateral edge of the scutellum. The anterior arm of the vein articulates at its extremity with the end of the subcostal vein. The posterior arm articulates by its anterior border and its extremity with a large irregular slightly chitinized sclerite to be described next. This V-shaped sclerite consists of a narrow piece projecting from the lateral chitinized border of the scutum and scutellum. In moving the wing the V rolls forward and over the spine; so that, if the spine is depressed and the V is pulled as described, the wing is elevated.

The second large sclerite (20) lies between the posterior arm of the first and the end of the wing veins. The anterior half which articulates with the posterior arm of the first is depressed below the level of the posterior half which articulates with the anal vein. The anterior depressed portion articulates with the projection from the plate which serves as the origin for the media and cubitus.

A third small sclerite (21) lies in the membrane just posterior to the posterior arm of the V-shaped sclerite. It is well chitinized and triangular in shape.

There is a fourth sclerite (22) lying ventral to the base of the wing in the membrane which connects the base of the wing with the dorsal surface of the epimeron. It is oval and slightly chitinized.

A fifth sclerite (23) similar in shape to the fourth, lies just anterior to the base of the wing in the triangular membrane lying under the outer border of the metathoracic scutellum.

THE ABDOMEN.

There are seven sterna (1-7) in the abdomen, six of which are visible. The first (2) can be seen at the outer angle of the metathoracic coxal cavity as a small triangle; but if the coxa be removed it will be seen to extend across the body as a narrow

bar and to unite in the middle line in a slight elevation between the inner ends of the coxa. It is separated on the median line from the second sternum by a decided notch. The second sternum is indented by the coxa and presents a median elevation between the coxae which is visible on the surface. The median elevation on the first segment cannot be seen from the surface. The second and third sterna articulate; the remainder are imovably fused. The third, fourth, fifth and sixth sterna are fused and, like the first and second, are inflexed at the sides of the body and end in a well-defined suture just beyond the point of inflexion except the surface. The seventh sternum is not visible on the ventral surface of the body, but can be seen on the posterior end of the body forming the ventral wall of the anal opening. It is crescent-shaped and bears a number of short hairs. It cannot be divided into sternum and tergum.

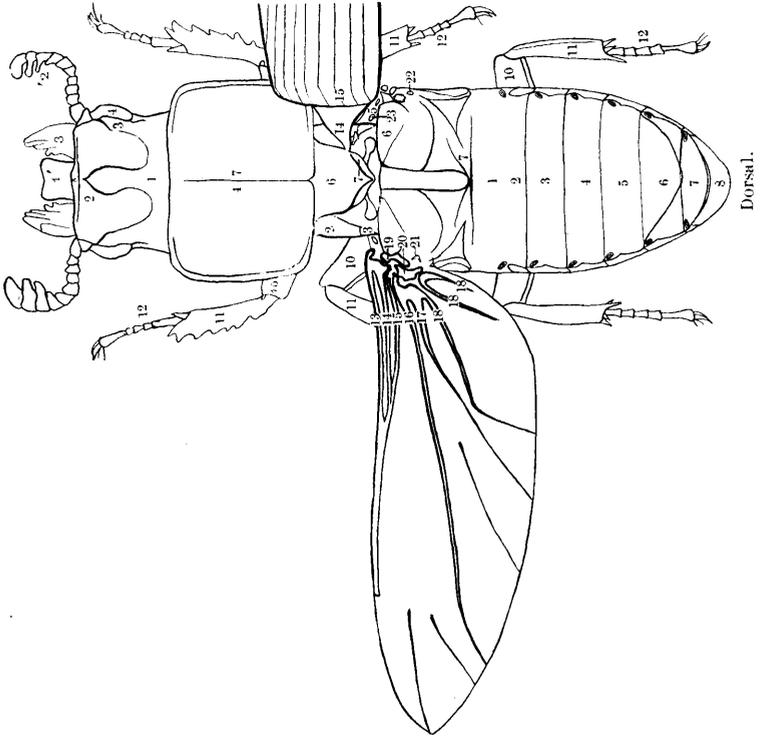
There are seven pleura corresponding to the seven sterna. The first six are distinctly separated from the sterna by a well defined longitudinal suture. The seventh is fused with its sternum to form the ventral wall of the anal opening. Each sternum is fused to its corresponding tergum.

The abdominal spiracles are situated on the dorsal anterior borders of their respective pleura, excepting the second, which lies anterior to its pleuron and directly over the end of the large first abdominal spiracle. The first abdominal spiracle is the large one described in connection with the meta-thorax. The seventh spiracle is much reduced in size and difficult to see from the surface.

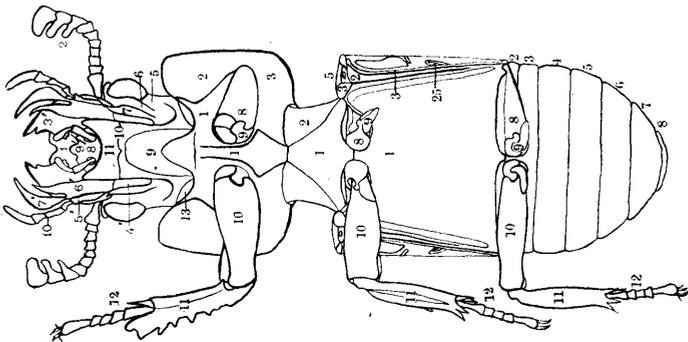
There are seven abdominal terga (2'-7') corresponding to the seven pleura, but there are eight in all. The first is the broad membrane lying in contact with the metathoracic postscutellum. The second, third, fourth and fifth are similar and membranous. The sixth, seventh and eighth are chitinized more or less, and the seventh is called the propygidium, and the eighth the pygidium. The eighth forms the dorsal wall of the anal opening.

OHIO NATURALIST.

Plate 1.



Dorsal.



Ventral.

LANDACRE ON PASSALUS.

EXPLANATION OF PLATES.

<i>The Head</i>	<i>The Mesothorax</i>
1 Vertex	1 Mesosternum
2 Frons	2 Episternum
3 Frontal ridges	3 Epimeron
4 Eyes	4-5 Apparently absent
5 Gena	6 Scutellum
6 Antennal groove	7 Postscutellum
7 Genal ridge	8 Coxa
(4') Genal emargination containing cardo	9 Trochanter
(8) Clypeus	10 Femur
9 Gula	11 Tibia
10 Gular suture	12 Tarsus
11 Sub-mentum	13 Not represented
	14 Paraptera
	15 Elytra
	<i>The Metathorax</i>
1' Labrum	1 Sternum
2' Antenna	2 Episternum
3' Mandible	3 Epimeron
4' Cardo	4-7 Metanotum
5' Stipes	4 Prescutum
6' Lacinia	5 Scutum
7' Galea	6 Scutellum
8' Mentum	7 Postscutellum
9' Ligula	8-12 Metathoracic Leg
10' Palp	13 Costa
	14 Subcosta
	15 Radius
	16 Media
	17 Cubitus
	18 Anal
	19-23 Detached sclerites
	25 First Abdominal Spiracle
	<i>The Abdomen</i>
	1-7 Abdominal Sterna
	1'-8' Abdominal terga
<i>The Prothorax</i>	
1 Prosternum	
2 Episternum	
3 Epimeron	
4-7 Pronotum	
8 Coxa	
9 Trochanter	
10 Femur	
11 Tibia	
12 Tarsus	
13 Jugular sclerites	