Membracidae

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A THESIS

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by

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1. Morphology and Ecology of *Entylia sinuata* Fab.
2. Taxonomy of Kansas Forms.

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In the first place I wish to thank Prof. S. J. Hunter, University of Kansas, at whose suggestion the study of this family was undertaken, for his assistance and encouragement in the work. To Messrs H. B. Hungerford and F. X. Williams, and Miss Ruby Hosford, of University of Kansas, I am indebted for a careful examination of material and criticism on classifications of the same.

Dr. Edward P. Van Duzee has rendered me valuable assistance by means of his paper on "North American Membracidae." The greater portion of the classifications contained in this paper on Kansas forms are based primarily on the characters used by Van Duzee. In several cases I have copied directly. Dr. Van Duzee also gave me information concerning the number of described species of Membracidae.

MEMBRACIDAE

Order - - Hemiptera - - Sub-order - - Homoptera.

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Introductory

In taking up the study of the Membracidae it may be well to consider the relation which this family bears to the insect world, both in its numerical and economic sense.

Insect forms comprise more than seventy-five per cent of the animal life of the globe, there being more than three hundred thousand (300,000) species described at this time, with vast multitudes yet untouched. Of this number of the class Insecta, 18,000 are claimed by the order Hemiptera. The **Family Membracidae** includes but a small portion of this order as not more than 1500 species are now described. Buckton in his Monograph describes 650 species; Van Duzee describes 191 species, many of which are, of course, contained in the number recorded by Buckton. Kansas

has recorded nineteen species as collected within her boundaries and it is with these species that this paper will consider in the Systematic work.

Owing to the oddity of its appearance in shape, the family has received considerable attention and recognition in systematic study; but on account of its inobtrusive action along economic lines, its small size and the fact that it never appears in sufficient numbers to do any appreciable damage, the family has not received much attention from a morphological point of view.

As far as general economic reports give us information, and judging from observation while collecting, the Membracidae seem to be comparatively harmless, although Riley reports Ceresa bubalus as injuring the potatoe and apple. The injury which the female makes, by slitting the bark and laying her eggs therein, would be harmful if there were a great number of the insects at work, but they have never appeared in sufficient prolificacy to cause any alarm. What little injury is done is confined, for the most part, to the less valuable foliage in nature. Some few forest shrubs as low osage

orange, and the ground shoots of Pin Oak are sometimes attacked but the principal food plants belong to the families of weeds and volunteer grasses. The family is distinctly - phytophagous, but as it confines its limited destruction to weeds and grasses with which nature could dispense it has not as yet reached any marked economic importance.

On the other hand it would not be well to ignore completely this side of the question as the check in nature which holds this family in subservient relation may be overbalanced. The little insect is capable of producing great injury should their number increase; It would be advisable for the Entomologist to keep the family in mind during his field observations.

GEOGRAPHICAL DISTRIBUTION: Frogatt states that the Membracidae is a group confined to the tropical regions and well represented in Australia, but better in South America where the forms are large and more profuse. Notwithstanding this statement this family is found all over the United States and Canada, Great Britain, Australia, New Zealand, Philippine Islands and New Guinea, Sumatra and Ceylon; in Brazil, Amazons and Ecuador, on temperate slopes of the Himalaya Mountains and on high ground in Central Africa. The distribution seems to follow the isothermal lines of temperature rather than the boundaries of the zones. However, a peculiar instance is noted in that Europe, excluding the British Isles, is void of the family with the exception of three species of Centrotida.

On account of its jumping habits, it is difficult to collect and there are many localities, no doubt, where the form remains unobserved. Those forms in the tropics are more prolific than those in the temperate zones; are larger and of more brilliant colorings than the more northern species.

In the United States the following States have reported collections: Alabama, Arizona, Colorado, North

Carolina, California, Florida, Georgia, Vermont, Missouri, Oregon, Virginia, New York, Texas, New Jersey, Wyoming, Illinois and Kansas.

In Kansas the following Counties have yielded specimens: Neosho, Reno, Douglas, Finney, Rawlins, Gove, Cheyenne, Cowley, Sedgwick, Woodson, Wilson, Allen, Seward and Sheridan.

HISTORY of the STUDY of the Family: In this, the writer has relied on Buckton as an authority, as the means at my disposal for ascertaining this information first hand are limited.

"The older writers on the Membracidae may be noted this in sequence: Linnaeus, Fabricus, Caspar Stoll (1788) Latreille and a little later Germar, Burmeister and Amyot and Serville." All these workers published descriptions of species of the family and a few used illustrations to assist in identification but it was not until the year 1845-1846, when Dr. Leon Fairmaire published his "Revue de la Tribu des Membracides" in the Ann. Society Entom. de France, that the literature of the family took definite shape. In 1864 Carlos Stal published his "African Membracidae" in Vol. IV of "Hemiptera Africanus." Since 1864 we have had numerous works by Goding and Walker, and recently the memoir by Canon W. W. Fowler in Godman and Salvin's "Biologia Centrali Americana". It is deplorable that this work is available to so few but as it is published in the series, only, its general use is impossible. In 1892 Goding published a Synoptical Table of the Genera of the Family Membracidae (Transactions of Amer. Ento.

Society, Vol. XIX) and in 1903 a pamphlet on Australian Membracidae.

"Other authorities are Dr. Handlirsch, Dr. Aurivillius, Dr. Ganglbauer and M. Severin." The latest comprehensive work was published in 1908 by Dr. Edward P. Van Duzee in bulletin of Buffalo Society of Natural Science, "Membracidae of North America."

Ball has just published a short description of a few new species of the genus Telamona, in which he endeavors to break up many species already described. However, sure he may feel he cannot be positive of these differentiations until he has bred out the forms or has numerous specimens upon which to base his differentiations. Variation within a species is often revealed through life history studies: and frequently classifications based solely on museum specimens are found to be at fault as in case of Entylia sinuata and Entylia bactriana in collection of the University of Kansas, (see page 81)

As the bulk of the literature, obtainable at this time, deals with this family only from a systematic point of view, the writer will endeavor to present this interesting and grotesquely appearing family not only in its

systematic relation to Kansas but also from a morphological and ecological standpoint in regard to Entomology in general.

DESCRIPTION OF THE FAMILY: The family Membracidae, commonly called Tree-hoppers, belongs to the sub-order Homoptera of the Order Hemiptera, and is placed by Buckton between Cicadidae and cercopidae. The classification as given by Comstock in "Introduction to Entomology" is as follows: "Beak evidently arising from the mentum; tarsi three jointed; antennae minute, setiform; ocelli only two in number or wanting; males without musical organs; prothroax prolonged into a horn or point above the abdomen----- Membracidae.

The head is usually perpendicular and, when viewed from the front, appears somewhat triangular with large globular eyes protruding on either side. On the face or cephalic aspect of the head and between the compound eyes are situated the two, small, but bright ocelli.

In all genera the prothorax is abnormal, being produced upward and backward or forward into numerous shapes. In the Kansas forms, at least, it extends well back over the abdomen concealing the meso- and meta-thorax and frequently continuing as far back as the tips of the tegmina. It rises from the head in a perpendicular line and is as wide as the head extending back of the compound eyes and under the mesothorax for a short distance, by

means of small lateral arms. (See Fig. 34). Frequently the prothoracic legs are removed with the Prothorax as they are connected to the lateral arms by a delicate membrane. Back of the compound eyes, the prothoracic lateral margin rises and turns caudad suddenly under the supra-humerals, thus forming the lateral angles or humeri. Fastened into this angle is a tiny sclerite which seems to help in the protection of the tegmina. (See Fig. 5)

In the prothorax there are four main divisions, the metopidium, procephalon, dorsum and posterior process, although there are no definite sutures to mark the divisions.

METOPIDIUM is the sloping portion of the front of the prothorax extending from the head to the front of the dorsum., and bearing the suprahumeral processes (Fig. 5,a). It may extend in a horn over the head as in Campylenchia curvata, Fig. II, or it may be void of any protuberance on the top. The suprahumeral processes are the lateral protuberances seen at the sides over the compound eyes and humeri, (Fig. 5,e- Fig. 7,x.) These suprahumerals are variable in shape and are sometimes so obscure as to appear absent until the hand lens is used. The procephalon is the portion above the metopidium. In the exotic forms

it may extend backward as a horn and be branched into several spines, but among the Kansas species this form is not found. The procephalon is not present except in the two genera, Enchenopa and Campylenchia, Fig. II, 12. The dorsum is the ridge from between the suprahumerals to the tail. It is convex in the Kansas forms and without any processes: Usually surmounted by a prominent longitudinal mediam carina.

Posterior process is the sharply constricted portion at the caudal extremity of the prothorax, it continues frequently to the tips of the tegmina and usually ends in a sharp black point.

The prothorax is almost always pitted and is sometimes pilose. It is highly developed and may take on various shapes and forms in fact the family has been likened to Brownies on account of the queer facial expression the grotesque appearance of the prothorax. There are some forms with two "humps," one caudad or back of the other as in Entylia sinuata, Fig. 61, while other forms bear only one spine or "hump" as in Enchenopa binotata, Fig. 13, and Campylenchia curvata, Fig. 11.

In some cases this single protuberance may be over the head and be a formation of the metopidium, called

the pocephalon, as in the two foregoing species; or it may be a crest on the dorsum over the abdomen as in Telamona, Fig. 31 & 73. Frequently the pronotum rises high in front and by sloping backward from the metopidium forms a high tectiform hood over the abdomen, sloping down posteriorly to the posterior process, as in Archasia, Figs. 22 & 23, and Stictocephala, Fig. 17 & 29.

In all the above mentioned forms, the suprahumerals are obtuse and minute but in Ceresa the prothorax bears a prominent lateral horn on either side just back of the head. Figs. 5, 6, 9 and 10. In a few cases the pronotum may not present any protuberance except obscure suprahumerals and the metopidium may rise only sufficiently high to cover the thorax. It thus seems to form a close protection for the thorax and abdomen, as in Micrutalis and Acutalis, Figs. 18, 19, 20 and 21, and Vanduzea, Figs. 14 and 15. Among the genera, other than those found in Kansas, the pronotum may not cover the abdomen and in some cases does not conceal the meso and metathorax, but ends in elevated and protruded spines or balls of odd shapes.

TEGMINA- The tegmina are elongate or lanceolate, membranous throughout, transparent in the main but sometimes coriaceous and smoky in regions. The tegmina are unequally divided into corium or embolium and clavus, (See Fig. 75,) which are separated by a fold, indicated in the drawing by a dotted line. The CORIUM is the anterior portion of the tegmen and, according to Goding, has a costal and three longitudinal veins proceeding from the base. In no case in the Kansas forms does this hold good, there being no more than two longitudinal and the costa, and frequently only one longitudinal and the costa proceeding from the base of the corium. Goding names the veins as costa, radia and two ulnar. In case of Cyrtolobus vau and Campylenchia curvata, this is consistent if the two ulnars are fused at the base, but in the majority of forms there is but one vein other than the costa proceeding from the base of the corium.

In the study of the nymphal pad some of this fusing and the disappearance of several veins is cleared up. In the nymphal pad there are two veins in the costal region, the costa and sub-costa; these fuse in the adult and are usually referred to as the Costa. (See Fig. 75) Frequently as in Ceresa bubalus the one longitudinal

vein, other than the costa, is branched soon after leaving the base and forms the radial and one ulnar vein. In the nymph pad is found one other vein-"media"- which is fused with the radia in the adult.

The CLAVUS has usually two anal veins, one of which frequently forms the posterior margin of the tegmen for some distance; the other anal vein usually joins the marginal vein at about its middle point. Much more discussion of the veins in tegmina of different species could be given, but observations on the drawings of the tegmina will give a conception as to the variation in the veination.

The TEGMEN (and in this instance I take Ceresa bubalus as a typical illustration as it appears to be nearly constant) has four basal cells, the third of which is frequently referred to as the sutural area as it contains the sutural fold between the clavus and corium. (See Fig. 75) The costal cell in all forms is long and slender, proceeding to the first apical cell without the intervention of a discoidal cell.

The cells between the apical cells and the basal cells are known as Discoidal cells and usually number three.

The apical cells are typically five in number, al-

though some genera may have only four as in Micrutalis. These cells are marginal and are surrounded by nervules, no nerves or nervules extending to the outer edge of the tegmen in this region; but are surrounded by an unveined membrane, the limbus. (See Fig. 75.) The third apical cell is characteristic in genera and often forms the basis for classification. The tegmina are not covered laterally by the pronotum but are free, united to the thorax below the humeri of the pronotum. When at rest, the tegmina lie with the costal region downward as in the Aphididae.

The WINGS are more or less spatulate and broad; smaller than the tegmina, the anterior margin being about equal to the posterior margin of the tegmina. When at rest the wings are folded once and lie between the tegmina and abdomen, the costal region downward.

The wing is uniformally transparent and clearly veined. Here is again found the division into the corium and clavus, the corium usually having the costa and two other longitudinal veins (radia and ulnar) proceeding from its base. Here the costa does not always form the anterior margin as in the tegmina, almost the entire nerve area being bounded by the narrow limbus.

In the clavus are two anal veins the second of

which frequently lies in the posterior margin. There are three and sometimes four basal cells, in the third of which is the sutural fold. There are no discoidal cells and frequently only three apical cells, although there may be more in some genera.

The hind LEGS are fitted for jumping, as this is a favorite means of locomotion for this insect. The femora are cylindrical and curved, and the tibiae quadrangular, prismatic or spatulate. In the metathoracic leg the tibia is densely spined with the points of the spines downward toward the end of the claws. The tarsi are composed of three segments, the first one longer than the other two, the last segment of the tarsus ends in a pair of sharp black claws. (Fig. 2)

COLOR: Buckton figures some of the species in brilliant reds, yellows and vivid greens but the Kansas forms are decidedly modest in their colorings. Some few are pale green when alive as Ceresa bubalus and Ceresa taurina and Stictocephala but these turn tawny when dried. A great number are mottled brown and tan with touches of black or white sometimes both, (See Entylia sinuata, Fig. 61 and 62, Ceresa diceros Fig. 6, Vanduzea Fig. 15, and Telamona Fig. 73.) The only bright colors met with in

the Kansas species occur in the ocelli which, in life are usually a cherry red and frequently remain so when dried. Enchenopa binotata Fig. 13, has two yellow spots near the region of the mediam carina. Some species are polished black, and may be outlined with palish yellow as Micrutalis calva while others are a dull black with a rough surface. A few forms Micrutalis occidentalis, for instance, are frequently orange with more or less dark marking toward the head. Publilia modesta is diamorphic and during a season may produce forms almost white with a downy surface.

MIMICRY: We may ask the reason for this peculiarity of color and also the grotesque development of the prothorax which is even more pronounced in the exotic forms than in those found in Kansas.

Comstock suggests that "Nature must have been in a joking mood when Membracidae were developed" and assuredly the family is odd. To many observers it resembles the pictures of the fabled Brownies.

Kellogg remarks that "The peculiar development of the prothorax may be a protective device, since it causes them to resemble seeds, thorns, crumpled bits of leaves and other plant structures." There is a great resemblance in many cases, to thorns and leaves and frequently seeds. In the former two the writer can see a reason but in regard to the seeds it would seem to be an unwise resemblance, since in mimicing seeds to escape carnivorous forms, they would only fall prey to herbivorous animals such as birds, squirrels and rabbits.

Dr. Poulton in the article, published in Buckton's Monograph, to which is given the title, "Suggestions as to the Meanings of the Shapes and Colors of Membracidae in the Struggle for Existence," considers that the develeopement has been the outcome of the struggle and environ-

ment and that the forms have been developed to promote the longevity of the species. In a few cases he thinks the forms resemble obnoxious coleoptera but in most cases he considers the mimicry to be cryptic in that by such a resemblance the carnivorous insects will pass them by. Poulton goes into detail taking many species and suggesting the possible causes for mimicry but he makes no definite statements, arguing that more studies in life histories and behavior must be investigated before any knowledge can be ascertained. It is noticeable, however, that these prothoracic developments are not solid, but are filled with air so as not to interfere in the activities of the insect. They do not help the form in procuring its food or in rearing its young, therefore, it must be for some aesthetic or protective purpose that this device has been developed. We cannot hope to receive any definite results along this line until more extensive study has been made upon this family in its "Home-life".

The family is attended by ants of numerous species which are attracted by the honey dew or sweet exudation secreted by the forms. These ants assist the forms in hatching and mouting, and may be observed in the act of stroking or caressing the bodies of the Membracids.

The family lives in communities on the under sides of twigs and leaves. Goding gives one sub-family, Tragopinae, which lives in the ground, in nests of ants, but the Kansas forms or at least all those known to the writer, live above ground.

SIZE: According to Buckton the forms may be as large as two English inches (about 50 mm.) in wing expanse: But 20 mm. will include our largest species. Ceresa bubalus and Telamona ampelopsides, which are 9 to 10 mm. from tip of tegmina to front of head. Our smallest species, Micrutalis occidentalis, is not more than 3 mm. in length. The sizes vary greatly within the species and the male is almost invariably smaller than the female.

The word Membracidae is derived from the Greek Membrak which means a "kind of Cicada." If the prothorax of the membracid be removed this resemblance will be more clearly observed, (See Fig. 1 and 3.) The homologies of the parts of the body are comparable although they do not agree exactly. The mouth parts are comparable although varying in a slight degree.

As has been stated in a foregoing paragraph, it is the intention of the writer to present this family from an ecological as well as a morphological and systematic point

of view. With this object in view, it will be well to look into the ecological phase at this point.

Entylia sinuata Say. is abundant around Lawrence, Douglas county, Kansas, and on account of the availability, this species has been chosen as the one upon which to make the Life-history observations.

Life History of Entylia sinuata:

As far as the writer has observed or can ascertain from reports, the genera of the Kansas forms of Membracidae live on the leaves and twigs of shrubs, bushes and weeds. No form has been found living in ants nests as the members of the sub-family Tragopidae do, but numerous species of ants are found on the vegitation with the membracidae, supposedly attending to their wants and being repaid in honey dew exuded from the anus. At least three species of formicidae have been collected with membracidae, namely Formica fusca, and another of the same genus, but the species is not determined. The third is Prenolepis imparis.

In Douglas county the most numerous species are Enchenopa binotata and Entylia sinuata, a specimen or more being taken up in every sweeping where their food plant is contained. Frequently a settlement or colony was observed and the stability with which individuals remained upon a certain leaf suggested the idea of studying the life history in its normal "out-of-door" environment.

As the colonies of Entylia sinuata were most easily accessible this species was chosen as the one upon which to make further investigation.

In order to avoid accidents from winds and weed cutters, a tent-like arrangement was constructed around a certain clump of weeds where Entylia sinuata was numerous. This enclosure was three sided, open at the top and bottom and pegged down to the ground.

Entylia sinuata are found in great numbers upon the under sides of the leaves of Cnicus altissimus, Willd.

Notes: Food plant, Cnicus altissimus. In a shady grove on the east slope of a hill. Temperature records were kept on a self recording thermometer and during the observations from June 29th to July 23rd, the minimum was 72 F.; the maximum 91.9 F.

Owing to the lateness of the season at which these observations were commenced, the first of the broods cannot be recorded. Adult forms and some half-grown nymphs were discovered early in June, but as a heavy rain washed all the insects off it was necessary to wait until the colonies were firmly settled before work of observation could be definitely started.

On June 29th, 1909, a pair was noted. In the morning (June 30th) the male was missing, but the female sat quietly on the midrib on the underside of the leaf with her head pointed toward the apex of the leaf. In the even-

ing of the same day the female was missing and two dark longitudinal, parallel lines, about 10 mm. in length were discernible on the midrib. With a hand lens (12X), the eggs could be made out. There were imbedded in the midrib, but the ends of the eggs were visible appearing clearly and of a white color. (See Fig. 56.)

There was no preceptible change until four days later (July 4th) when the slits were found burst open and the sides of the eggs were exposed to view. (Fig. 56 at B).

On the ninth day, or July 9th, the slit was spread further and hatching was in progress. The egg is 7/8 mm. in length and has a small protuberance at the "Hatching end," which is the last end to leave the ovipositors and is that portion visible in the midrib after the egg has been deposited.

When first hatched the nymph is pale yellow or nearly colorless but after a period of thirty minutes the color and markings begin to appear. The head, first thoracic segment and tip of abdomen become dark brown while dark markings are noticeable on the second, third, fourth and fifth rings of the abdomen. The other portion of the dorsal aspect of the body is pale gree n, the ventral portion of the thorax and abdomen are white, with legs

of a pale, transparent yellow. Each of the abdominal segments except the first, bear two dorsal and two lateral spines or tubercles, one on each side, tipped with black hairs. The second and third segments of the thorax, (The undeveloped meso and meta thorax) bears hairs in place of spines. The mesothorax, though light in color, bears a dark spot on the front edge. The first segment or prothorax has a hair on each side. On the cephalic or front edge of the head are four hairs and there is a hair cephalad and one caudad of each compound eye. The nymph when one hour old, measures 1 and 1/8 mm. and is extremely active.

The antennae are pale and transparent, delicately haired and are very nearly equal to the length of the antennae on the adult forms, being about one-half the length of the nymph, (See Fig. 58.)

The prothoracic segment, which is dark brown, is a third wider than the mesothoracic segment and as wide as the head. This prothoracic enlargement, is no doubt, the beginning of the overdevelopment of the prothorax to be seen in the maturing and adult forms. In this first instar it is interesting to note that there is an articulation between this segment and the head. The

head which is dark and shiny is extremely large in proportion to the body, in fact it is larger in a line from back to front in dorsal aspect than in the adult forms. (Fig. 58.)

The MOUTHPARTS are enlarged out of all normal proportion, the distal end of the beak reaching to the end of the sixth abdominal ring (See Fig. 57.) The ocelli are found in about the normal position.

On the twelfth day (counting from the date of oviposition and on the third day of the life of the nymph,) July 12th, occurred the first moult. In this second instar the enlargement of the prothorax takes on a shape similar to that in the adult form except that it does not extend back over the abdomen, but it does extend far enough to cover the mesothorax. The prothorax bears the shovel-like horn and the notch which forms the dorsal hump. The head is reduced in size in this instar. The second, third, fourth, fifth, sixth, seventh and ninth abdominal segments bear two dorsal hirsute spines, the lateral ones having disappeared. The third, fourth and fifth segments are marked with dark dorsally and about half way down the lateral face. The nymph, in the second instar, measures 2 and 1/2 mm. in length.

A curious fact noticed is that in the nymphal stages the forms do not exhibit any jumping power, but run so rapidly that they might be said to scoot. When four days old the measurement was 3 mm. but they had not moulted.

On the fifth day after hatching, (July 14th), the second moult occurred. In this instar a differentiation of color is observed. A number of the forms are dark with black hoods while others are light with tan hoods. Upon further observations, this color difference seemed to be the indication of the sex to be formed in the adult stage; the dark ones emerging as males and the light ones as females. In this instar also the wing pads appear. See Fig. 59. When nine days old (July 18th), the third moult occurred. In this fourth instar we have the stage which is comparable to the pupa stage in forms having complete metamorphosis. In Figure 60 is seen the "pupa" with the prothoracic enlargement split open ready for the emergence of the adult. This emergence occurred when the nymph was fourteen days old, (July 23d). The imago is transparent, of a pale greenish gray tinge void of markings. It is active and will jump immediately upon emerging. Some were observed as kicking off the old shell or

jumping away from it. Within twenty minutes or half an hour the color markings begin to appear and in less than an hour the imago is not discernible from the individuals many days older.

SUMMARY:

Egg stage ---------- 9 days

First Instar ------- 3 days

Larva stage-Second Instar ----- 2 days

Third Instar----------4 days

Pupa or Fourth Instar----------5 days

Total days----------23 days.

Twenty three days are necessarily consumed from time of the oviposition of the egg until the form reaches the adult stage, As nine days are used in the development of the embryo, we have two weeks as the time from hatching until the form emerges as an imago. Mrs. Rice in her report on the Life History of Entylia sinuata, states two weeks as the time from hatching to adult stage if ants are present and one week if undisturbed by ants. In my experiments the first time accords, but in the experiments indoors without the presence of ants, the forms seemed unable to moult successfully and died before reaching maturity. This fact leads me to believe that the ants are necessary factors in the life of an individual membracid.

From three to four days after emergence the female commences to lay eggs. It has not been absolutely as-

certained, but has been more or less satisfactorily observed that one female lays more than one egg mass during her life, each mass averaging about thirty-five eggs.

The number of eggs is equally indefinite but as forms have been observed late in May and nymphs found as late as the first of November and as it takes approximately four weeks from the time an egg mass is laid until a female from that generation begins to deposit her eggs, the writer feels justified in estimating six or seven broods in a season.

As to the winter state, it is conjectured that it is spent either in the egg stage or as adult, protection being obtained from the fallen leaves. On October 24th, adult forms, a few nymphs in the pupa stage and newly emerged adults were observed, notwithstanding the occurrence of two heavy frosts. On November 1st, several nymphs and adults were found on a food-plant stalk which had been taken to the laboratory for search of egg masses. No evidence of the theory that the form passes the winter in the egg stage has been ascertainable up to this date.

MORPHOLOGY

External anatomy of the Head.

Having studied the relation of the Membracidae in its Life History, the next point to be taken up will be the morphology. Very naturally the external anatomy will interest the observer first.

External Anatomy

HEAD. The head of a membracid is arranged in two planes; one vertical and parallel with the transverse planes of the body of the insect, the other set at an angle of about 95 degrees, or little more than a right angle, to the vertical plane. (Fig. 38 A)

This vertical plane, (which is continued by the caphalic form of the metopidium), when viewed in cephalic aspect, appears as an isosceles triangle. The suture between the head and the metopidium of the prothorax forms the base, and the globular eyes form the equal angles. The ventral edge of the face, which is formed by the clypeus, is the vertex of the triangle; the sides of the lorae extend from clypeus to compound eye and form the sides of the triangle. (See Fig. 62)

Before the head can be viewed in its entirety, the prothorax must be removed as the top of the head is con-

cealed by prae-scutum. The suture, although in an approximately straight line, slopes slightly downward toward the sides, thus giving the base of the metopidium a curved appearance. (See Fig. 62). This suture is not articulate in the adult forms and although easily opened care must be taken in removing the prothorax as there are tiny arms produced from the front of the lateral angles of prothorax, which surround the head back of the compound eyes. Frequently, if these arms are not first broken away, the head will pull off with the prothorax. These arms extend almost around the union of the head with the thorax and reach to the coxae of the prothoracic legs to which the arms are attached by a delicate membrane. (Fig. 34) The prothorax removed, the head or cephalic aspect thereof, can be viewed. This ventral plane is flat when viewed laterally, but is really curved slightly backward on the sides, the middle of the curve being the central line dividing the face into bilateral halves. In this aspect three divisions of the head can be seen, namely Epicranium, clypeus and lorae. (Fig. 35)

The EPICRANIUM, in the generalized insect, is the dorsal part of the head lying back of an inverted Y shaped suture. (Comstock and Kochi) In this family the suture is clearly marked, the main suture branching at the top of the clypeus and the arms of the suture formed by the lateral edges of the clypeus. The top of the epicranium is almost flat although there is a slight indentation at the suture and the line curves down slightly to meet the compound eyes. In dorsal view (Fig. 1) the epicranium narrows from front to back rolling gently backward and then dropping suddenly to the occiput. (Fig. 40). The vertex of the epicranium is just back of the suture between the head and the prothorax. The COMPOUND EYES are considered the outgrowth of the epicranium and are situated at the extreme lateral edges of the sclerite. They are large and globular and composed of thousands of hexagonal facets. As the ventral surface of the eye contains approximately as many facets and is as large in area as the cephalic surface, it would seem that the downward vision of the insect would equal its forward vision. (Fig. 35 at a and 37A at c).

OCELLI: Situated in the front of the head on epicranium and nearer the clypeus than the vertex, lying either side of the epicranial suture are the brilliant little ocelli, which are probably of the same use to the membracid as to all insects, that of looking at close objects.

LORAE. Separated by no apparent suture, but nevertheless a division of the epicranium are the lorae. Their lateral edges extend from the base of the compound eyes to the ventral point of the lateral edge of the clypeus. The division line is about midway of the lateral edge of the clypeus in an oblique line upward to the base of the compound eye. There is thus formed a small triangle with two long and one short side, the short side being next to the clypeus. (Fig. 35 at b).

CLYPEUS. This sclerite has been discussed and pointed out by the foregoing descriptions until it needs very little explanation. In this cephalic aspect it is triangular and with a curved base, the apex of the triangle at the epicranial suture. The ventral edge is densely hirsute. The whole cephalic face is deeply pitted or punctuate and frequently mottled with dark patches.(Fig.35 at y).

The plane at an angle of 95 degrees to this cephalic

face is also a triangle, the base being the ventral edge of the cephalic face and the apex the distal end of the epipharynx. (See Fig 37 A)

In this plane are found the mouth-parts proper and here are situated all the typical sclerites of a suctorial mouth, namely Clypeus, labrum, epipharynx, mandibular and maxillary sclerites, with their respective setae, and the labium or beak. Situated also in this plane are the genae or cheeks and the antennal sockets with the delicate antennae. The compound eyes are also visible in this plane.

When at rest the beak lies between the coxae legs of the insect and close to the sternum, but when in use it is lowered onto the food plant by special muscles. The GENAE. (Fig. 37 A at g) are irregular quadrangular plates surrounded by the compound eyes, the mandibular and maxillary sclerites and the overhanging lorae. These genae with the maxillary sclerites form the lateral edges of this plane of the head.

ANTENNAL SOCKET. (Sig. 35 at x) Situated on the inner edge of the genoe and lying against the ventral face of the clypeus and under the overhanging edge of the lorae is the circular socket or antennal sclerite, its edge to the genae being the quadrant of a circle.

ANTENNAE(Fig. 36 and 37 A) The antennae are pale in color and extremely minute and bristle like: so minute and delicate are they that they are scareely discernible with a pocket lens. In fact they are frequently a absent in mounted specimens as they are easily broken off. Surely the sense to the use of which these organs are put must be very sensitive or else it is dormant. Although extremely minute and measuring 45 mm. in length the antenna is composed of three segments, two stout basal segments (m and n Fig. 36), the second and heavier of which bears sensoria: the third segment is spur-like having a thickened base and gradually becoming slender until the distal end is hair-like.

This spur although unsegmented has more than fifty small divisions, the last one much longer than the others (Fig. 36 x). The antennae are very deeply set into the socket, there being found upon dissection an interior spine nearly as long as the two basal segments.

In caudal aspect the head presents a concave surface smooth and unhaired or punctured. Only small margins of the compound eyes can be seen. (Fig. 40). Branching out from the occipital plates which surround the cavity are seen the tentoria (t in Fig. 40.) from

these, is a narrow chitinized bar with three pairs of branches, one pair inward to support the pharynx, the second pair toward the thorax to help join the head to the thorax, and the third pair join to meet the bar which supports the labium.

The portions of the head and face thus discussed, the attention is now turned to the Mouth-parts themselves.

MOUTH-PARTS.

In this ventral aspect (Fig. 37 A), the clypeus appears as a fleshy, swollen cushion, very large in proportion to the other sclerites and rising in a dome. It is haired and its lateral edges fit down tightly upon the other sclerites. (See Fig. 37 A at y).

LABRUM. Lying against the distal edge of the clypeus is the labrum. Light in color and also fleshy and slightly elevated but smooth and unhaired. It is elongated, with lateral edges curving inward distal. (See 1b Fig. 37 A). In its under side the edges are seen to curve inward to support the epipharynx. The distal edge is pilose.

EPIPHARYNX. Arising beneath and extending beyond the labrum is the external portion of the epipharynx. It is pointed and grooved on its inner surface, fitting closely

over the opening in the first segment of the beak and making, with the labium, an almost perfect tube (Fig. 38 B) for the setae which come together and enter the beak at this point. It extends exteriorly to the joint between the first and second segments (Fig. 37 A.) On its inner or under side the epipharynx is grooved and extends in a slender thin plate to the hypopharynx which will be discussed later. (Fig. 39)

MANDIBULAR SCLERITES. (Fig. 37 A at m) Lying lateral of the clypeus is a slender curved plate immovably sutured with the clypeus. Muir and Kershaw seem to consider this sclerite as a lateral projection of the clypeus. They figure a mandibular suture but no sclerite. I find this suture between the clypeus and the projected plate of Muir and Kershaw, easily opened and the two sclerites separated. In Figure 42 can be seen this sclerite with the labrum removed. It has a delicate distal process which is covered and protected by the labrum. The cross on Figure 42 shows where the seta is joined to the sclerite on its inner surface. This sclerite is also sparsely covered with hairs. It cannot be seen in caudal aspect until the maxillary sclerite has been removed. (Fig. 41.)

MAXILLARY SCLERITES. (Fig. 37 A at n) Situated laterad and below the mandibular sclerites are the maxillary sclerites. They too are curved, but on the front face, are much narrower than mandibular sclerites. They form the lateral surface of the plane, however, and in caudal aspect are wide. (Fig. 40 at x) Each sclerite bears two processes, one above the other and both grooved on their outer edges to assist the setae better on their way into the head. The processes are also concealed under the labrum. Figure 39 shows the inner surface of the clypeus, mandibular sclerites, labrum and epipharynx. Situated on the distal edge of the clypeus and at the base of the epipharynx is the heart-shaped HYPO-PHARYNX. Its function seems to be to cover the setae as they merge together and continue the tubular structure of the Pharynx and enter the grooved trough of the epipharynx.

LABIUM. (Fig. 37 A, Fig. 38 B) This is the beak in which lie the setae. It is composed of three segments the second of which, in cephalic view, appears longest but in lateral aspect seems to be joined to the distal segment by a sort of socket joint, the dorsal edges of which are formed by this second segment and the distal segment set into this socket thus formed. (Fig. 38 A)

The first segment of the beak as it passes under the labrum, clypeus and maxillary sclerites broadens until it seems to form the base of the caudal cavity of the head. This segment forms the floor of the mouth and, although chitinized, it is flexible. It is supported down the middle by a chitinized rod, (Fig. 40 at r) coming from the bar and joining the tentorial sclerites. This rod extends the entire length of the beak, ending in the third segment. On the dorsal side, the labium is closed and flat but on the ventral side its edges curve inward to form a groove or trough for the setae. The first two segments of the beak are slightly hirsute but the distal one is furnished with heavy spines or sensorial hairs. The end of the beak is rounded and heavily chitinized, probably thus protected as this portion rests upon the food-plant during feeding.

SETAE. The setae are four in number. One pair assigned to the mandibular processes and the other pair to the maxillary. The inner pair of MAXILLARY SETAE, are separated with difficulty as they appear to be tightly grooved, forming a tube. The distal end of this pair extends beyond the other pair and projects out of the distal end of the beak. (Fig. 38 B) The distal ends of the maxillary setae are smooth and hair-like but curved slight-

ly at the extreme tip. They lie between the other pair until the first segment of the head is reached when they become caudad in position and separate from each other on either side of the pharynx, disappearing into the head cavity. The inner end of each seta is thickened and is joined to the inner surface of the top of the head by heavy muscles. From this muscle decends a muscle to the inner face of the maxillary sclerite. (Fig. 41)

MANDIBULAR SETAE. These are heavier than the maxillary setae although not as long. The distal end is blunt and its outer edge or surface bears eight black teeth. (Fig. 37 B) The setae lie laterad of and surround the maxillary setae in their passage into the head but on entering the head, they lie cephalad. These mandibular setae are thickened in the head and connected to the sclerites by a well articulating joint. (Fig. 41 at v) From this joint extends a heavy muscle which branches into two as it nears the top of the head.

For further investigation, observations must be based on sections both transverse and longitudinal.

In making observations on sections to ascertain the structures of mouthparts, it seems to be advisable to begin at the distal end of the beak and carry our observations into the head piece by piece.

In general shape of the beak or labium transversely is elliptical the outline varying, somewhat in the different segments. The back or dorsal side of the labium (the side which lies against the sternum) is protected and strengthened by a chitinized rod. (Fig. 40). The labial wall, on the ventral side comes almost together and then curves inward forming a groove in which the setae lie.

In a section near the tip of the beak (Fig. 46), the groove is shallow and opens in front allowing the setae free and unhampered movement. In this section the maxillary setae are found as they are longer than the mandibullar setae, which do not always extend to the end of the beak. In fact the maxillary setae are frequently a full mm. longer than the beak. In this third segment the shape near the tip is circular. The supporting rod is not visible in the figure but the dorsal wall is indentated slightly in the middle, and the rod probably plays in this indentation. The maxillary setae here appear as one, but upon closer observation this structure appears to be made up of two sections tightly grooved on their inner surfaces. One seta is situated above the other throughout the entire line of the beak.

A section near the middle of the third segment is shown at Figure 45. Here the shape is elongated dorso-ventrad, (Fig. 38 A). In this section we notice the presence of the mandibular setae; they are crescent shaped, folding around the maxillary setae. As the sections proceed toward the head the labium becomes more circular in shape until near the upper end of the second segment it seems to be almost a perfect circle. (Fig. 44) A clearer conception of the various parts may be seen in Figure 43. The shape is elliptical laterad and the strengthening rod is very clearly present. The epipharynx completely closes the tube and protects the setae. The mandibular setae show an opening which has been noticable in the other sections. The shape of the setae is circular on its outer edge but on the inner edge it is triangular, (See e, Fig. 43). The ventral curve folds around the maxillary setae. The maxillary setae show the grooved structure on their inner edges.

By making observations on Figure 38 A. the reader will ascertain that a cut made transversely on the back will also cut transversely, or nearly so across the mandibular and maxillary sclerites. Such a section is shown at Figure 47. The setae have become much larger than they

were in the beak. The maxillary setae have separated from each other (x and D-Figure 47). The clypeus shows its various braces and pharyngeal muscles.

In a longitudinal section, that is across the vertical plane, the cut will be parallel to the longitudinal line of the maxillary and mandibular sclerites. Such a section is shown at Figure 48.

MAXILLARY SETAE. As the setae enter the head, they separate going either side of the pharynx and extending to the top of the epicranium. The setae widen as they approach this extremity. Each seta is fastened to the epicranial wall by a heavy muscle (a, Fig. 48) from which arises another muscle which is attached to the upper side of the seta and forms the refractory muscle. Attached to the lower edge of the widened extremity of the seta is a pair of muscles, one of which is branched. This pair of muscles proceed along the line of the seta and are attached to the inner surface of the maxillary sclerite at its distal end, thus forming the protractory muscles.

MANDIBULAR SETAE. The mandibular setae, in the head, lie laterad of the maxillary setae. They do not extend as far into the head as they are joined to the mandibular sclerite by an articulating joint. The seta is connected

to the epicranial wall, however, by a very strong muscle, the retractor, (m, Fig. 48). The protractor is shown at n, this muscle is branched at the end attached to the sclerite. This attachment is not visible in the figure. In this same section is shown a longi-section of the salivary ejaculator or pump of the suctorial apparatus. (See c, Fig. 48,) Connected to this pump are the ducts which supposedly lead to the salivary glands, although the glands have not been satisfactorily located by the writer.

PHARYNX may be seen in both the transverse and longitudinal sections as it enters the head in such a manner that a cross section of it is obtained near the back of the head in a transverse section (Fig 47) and turns downward passing over the oesophagal ganglion and is found again in longi section.

GANGLIA. In longi section and through the compound eyes near the top of the head (See Fig. 49), the sub and superoesophagal ganglion are shown with the maxillary setae on either side of the sub-ganglion over which the pharynx passes. The super-ganglion or upper brain is extremely large in proportion to the head and lies forward toward the front surface of the face or epicranium. Branching out on either side of this

ganglion is a large optic nerve which leads to the compound eye. (See o, Fig. 49)

An endeavor has been made to locate the nerves governing the mouth parts, but as yet without success.

CLYPEUS. In sections shown at Figs. 47 and 48, the heavy muscular tissues on the interior of the clypeus are seen. There are transverse and longitudinal muscles which presumably regulate the muscular contraction and retraction of the upper part of the pharynx and for this reason are called the PHARANGEAL MUSCLES.

SUMMARY. In a median lateral longitudinal section of the entire head and beak, a final and more comprehensive conception of the entire structure is presented. A careful study of this section combined with the others just referred to, give the following results. (Fig. 50)

THE PHARYNX enters the head in a plane at an angle of about 60 degrees with the vertical or cephalic face of the head. It passes over the sub-oesophagal ganglion and turning suddenly downward passes under the super-oesophagal ganglion (See b). The pharynx proceeds toward the ventral face of the head until near the base of the distal end of the clypeus (z). When it turns sharply downward in a line parallel to the ventral face of the clypeus. At this turn the upper wall of the

pharynx is formed by the hypopharynx (h) which joins itself to the epipharynx (g) lying beneath the labrum (l). The upper wall of the pharynx is expanded and compressed by the heavy muscles in the clypeus and labrum (t-u-n). The maxillary setae (x) lie either side of the pharynx gradually approaching each other until they meet, one lying over the other forming a complete tube to continue the alimentary canal to the end of the maxillary setae.

Pump (p). Situated below the pharynx is a fleshy bundle of muscles with an opening into a short duct which appears closed at the forward end. From this duct are two smaller ducts, (k and o, Fig. 50), one leading into the pharynx and the other, presumably leading from the salivary glands.

BEAK or labium. The floor of the mouth is formed by the extension of the first segment of the beak, (f, Fig. 50) and is supplied with muscles near the curve of the first segment. These muscles are presumably used in lowering and raising the beak. Each segment has three pair of lateral muscles and there are numerous muscles running longitudinally, which are not shown at Fig. 50, but may be seen in cross sections Figs. 46 and 45 at mm.

Running along the exterior surface of the floor and down the dorsal side of the beak is the chitinous rod used as a brace.

THORAX: The head is fastened to the prothorax by two muscles (m-m Fig. 40). It is fastened to the meso-thorax by a pair of lateral muscles. The union with the meso-thorax is completely covered by the prothorax with its lateral arms, back of the compound eyes.
SHAPE. The prothorax may be seen in Fig. 61. It is compressed and the metopidium rises into a compressed and greatly elevated procephalon, which in lateral view is "spade shaped." The dorsum is deeply sinuated at about one third the way toward the posterior end. This sinuation forms the back of the procephalon and also the front edge of the dorsal hump. The color of the prothorax is dull tan and brown, varying in the sex. The color markings differ in some respects, but this is fully discussed under the head of Eutylia sinuata in the Systematic paper at the close of this treatise. The meso- and meta thorax is shown in dorsal aspect at Fig. 1. Here the bullae or lobes are to be seen; also the articulation of the tegmina and wings with the body. In each section (Meso or meta) the scutum or bulae are elevated and polished; much enlarged in comparison with the other segments as they contain muscles used in flying.

The prae-scutum, scutum, scutellum and post-scutellum are marked and indicated on Fig. 1.

TEGMINA: The tegmina of Entylia sinuata, like all of the genera of the Tribe Polyglytini, are punctuate and darkly coriacious in the costal, radial and first basal cells. In Entylia sinuata the punctating is dense and heavy as is shown in Fig. 1 and Fig. 76.

The veins in the tegmen seem to be pushed anteriorly leaving a wide, unveined area below the first ulnar vein. The second ulnar vein disappears soon after leaving the base but reappears near the posterior margin where it appears in a hooked shaped line curving into the anal vein of the clavus. (Fig. 64).

The discoidal cells are small and only two in number, unless the vacant unveined portion be considered a discoidal. The first three apical cells are small, the third one petiolate while the third and fourth are abnormally large. There is one and possibly two anals proceeding out of the base of the clavus. The tegmen is 3.8 mm. from base and 1.2 mm. wide, in broadest portion.

The WING is typical of the family , having the three longitudinal veins, costa, radia, and ulnar in corium, and two in clavus. It is difficult at times to see the

second anal vein. The limbus surrounds the veined portion except at the base and along the costal area. Wing measures 2.2 mm. from base to tip.

LEGS. The pro, meso, and meta-thoracic legs, in all genera, differ greatly. The meta differs from the pro and meso more than the pro and meso do from each other. The prothoracic leg has a heavy coxa which is joined to the arm of the prothorax by a heavy membrane. The prothoracic leg is almost as large as the mesothoracic. The tibia, however, appears heavier in prothoracic, presumably, because the pro thoracic leg is more developed through the aid it gives during feeding time. The femur of the prothoracic leg as well as that of the meso-thoracic is much curved, especially the outer margin. The tibiae are slender and quadrangular, and spineless and haired. The claws are longer than those in the meta-thoracic leg; are sharp, bearing a soft spongy cushion between them. This cushion is perhaps used as a suction in clinging to the plant, as the insect shows strong clinging abilities and is not easily shaken off its plant. In the prothoracic leg the tibia is scarcely longer than the femur but in mesothoracic it is one third longer. The Meta-thoracic leg or "Jumping leg" is the member with

which the insect does its rapid work in locomotion. The femur is cylindrical but is not as curved on the outer edge as the femur in the prothoracic or mesothoracic leg. It is narrower in the middle than on either end, having a more forceful lever power than in the other shape. The tibia is at least twice the length of the femur. It is quadrangular with numerous black shining spines on the four angular edges and also on the planes between. There are also dark spines around the distal end of the tibia and on the first joint of the tarsus. (See Fig. 2.)

The tibia and tarsi are densely haired and the tibia is larger at its distal end than in any other portion of its length.

The ABDOMEN: The abdomen is composed of the typical ten segments, (eight, and the two forming the genitalia.) It is compressed and has a ridge on its medial dorsal area. Each of the eight segments bears a pair of dark markings either side of the ridge. The first segment is narrower than the meta-thorax, thus giving the insect a marked constriction just back of the wings. The body line curves outward, the fourth segment being some little wider than the first or eighth. Viewed laterally the spiracles can be seen. (See Fig. 54.)

The GENITALIA form a part of the abdomen and must here be discussed.

The MALE genital organs, viewed laterally, present all the typical sclerites, (Fig. 62.)
The supra-anal plate (g, Fig. 52) is joined to the eighth abdominal segment by a heavy membrane. Proceeding from the ventral side of the lateral face of the supra-anal plate is a sclerite which extends caudad beyond this plate. Its ventral edge curves upward forming an apex with the dorsal edge on the caudal extremity of the sclerite. It is densely haired and flexible. This sclerite is a cercus and has a mate on the opposite side of the insect, (Fig. 52, p) These are used as claspers.
CLASPER. The most ventral plate in lateral aspectis a clasper. It is narrowed posteriorly; hirsute and also has a mate. (See r at Figs. 52 and 51). Proceeding from the inner side of the claspers are four polished, claw-like appendages, two on a side. The posterior pair are larger than the other pair, which on the other hand are darker than the posterior paid. (x, Fig. 52).
In ventral aspect the SUB-GENITAL plate (See g, Fig. 51) is seen. It is a fleshy sclerite, dentate twide on its ventral edge. The two pairs of claw-like organs are

attached to the cerci beneath this plate.

The anal plate, in lateral aspect is boot shaped, pale and hirsute. It is joined to the supra-anal plate by a membrane. (See y, Fig. 52).

The COPULATORY ORGAN is little seen in lateral aspect, as it is situated on the ventral side of the anal plate, and is closely attached thereto. In ventral aspect, this organ is seen lying against the anal plate, (K, Fig. 51). It is highly chitinized and dark; bearing a set of conspicuous, polished elevations.

The FEMALE genital organs. OVIPOSITORS. The last ventral segment is triangular on its caudal edge, the sides sloping obliquely from the middle. Proceeding from under this sclerite, is a pair of long slender highly chitinized plates, (o, Fig. 53). Near the ventral plate of the abdomen these plates enlarge or broaden and surround the vaginal opening. These slender sclerites are pointed at the caudal extremity situated close together forming a groove for the placing of the eggs. These are the ovipositors. Either side of the ovipositors is another long slender sclerite. This with its mate form the EGG GUIDES (r, Fig. 53).

In lateral aspect, (Fig. 54) are seen the supra-anal plate, (g), the sub-genital at (gs), the cerci or clas-

pers at (r), and the egg guides at (e). The ventral plate is shown at (v). In the female the sub-genital plate lies beneath the anterior edge of the ovipositors. On its posterior edge it is double curved. (g, Fig. 53.)

TECHNIQUE: In the work of morphology, the process of killing and fixing bears an important part. Specimens killed in Potassium Cyanide fumes can be used for museum specimens but they are of little value in morphology as the parts dry and become distorted by the falling away of the less chitinized structures.

Three processes of killing were used by the writer, first the hot water method. Boiling water was poured over the specimens and allowed to stand without further heating, for five minutes. At the end of this time, dehydration was commenced using increasing grades of alcohol from 30% to 70% and left in 70% for keeping. The second method: Gilson's solution, "Acetic alcohol with Sublimate," (See Lee's Vade Mecum,) was poured over specimens and allowed to stand for fifteen to thirty minutes. The solution was washed out with Claret solution of Iodine in 85% alcohol. This washing must be repeated several times for an hour or two until no trace of the odor of acetic acid can be detected. If this acetic acid remains in the specimen it will cause

the insect to swell and there is danger of the abdomen bursting. The Claret solution is replaced by 70% alcohol for keeping. The third method was to kill in Picro aceto sublimate, (See Vade Mecum). The last two methods were found most efficient in external and coarse dissection as the sutures are more distinct and the muscles less brittle than in the water killing.

Before much work could be done in external anatomy of the head, it was necessary to clear the heads by boiling for fifteen minutes in one part saturate solution Potassium Hydrate and ten parts water. This boiling destroys the muscle tissue but leaves the chitinized portions clear and easily dissected.

For sectioning, any one of the three fixative methods seemed equally good. On account of the difficulty of cutting through the chitin, the material had to be softened. Sodium Hypo-chlorite solution : (Saturate solution 1 part to 10 parts water) was found satisfactory. The writer left the specimens over night (about 14 hours) in this solution, and then dehydrated up to 85% alcohol from which the specimens were put into cedar oil for 24 hours or longer.

For infiltration, watch glasses were partially filled with melted paraffin. The specimens before being placed

in the paraffin were drained on Hotting paper. This process makes the change of paraffin unnecessary. The infiltration is continued for 96 hours.

The imbedding was done in paper boxes and the sectioning done with a dry knife on microtome with a stationary knife. The sections were made microns think and floated out onto the slide by means of Mayer's albumen water. The slides were placed on the top shelf of the electric oven until all water had evaporated and the slides were perfectly dry. The slides were next placed just low enough in the oven for the paraffin to be kept warm but not melted. As long as 24 hours will not do any harm as long as the paraffin is not melting.

After removing from the oven and allowing the slides to cool, the process for staining was commenced.

The slides were placed in xylol to remove the paraffin and then into absolute alcohol; taken through decreasing grades of alcohol baths; 95%, 90%, 85%, 70%, 50%, 25%, and distilled water. From the water the slides were placed in Mayer's Carmulum Stain for 3 to 4 hours. After staining, examine under low power to ascertain if stain is heavy enough. The color should be a trifle darker than desired as the dehydration bleaches slightly.

The slides were passed through the increasing grades of alcohol and into xylol. Here they can remain for several days if the student finds it necessary to leave the work. The slides were finally mounted in Canada Balsam and hardened in the oven.

TAXONOMY.

The following Synoptical table of the Sub-families of the Membracidae is copies from Van Duzee (41) who uses that given by Canon Fowler, who founded his work formally on that of Stal.

Scutellum wanting or entirely concealed by pronotum--1
Scutellum distinct and more or less uncovered, with its apex nearly always excavated or broadly sinuated and furnished on each side with acute angles, CENTROTINAE, Stal.

1, Tarsi of equal length or posterior pair longest
--Posterior tarsi much shorter than the anterior and in-
--termediate----------HOPLOPHORINAE Stal.
2, Tibiae, at least the anterior and intermediate, dilated or foliaceous-------II MEMBRACINAE Stal.
--Tibiae simple or very slightly dilated, never foliaceous ----------3
3, Third apical or terminal areole of the corium periolate, the adjacent areoles contiguous before it-4
4, Elytra externally broadly coriaceous portion scarcely distinguishable and the free margin broad--
TRAGOPINAE Stal.
-- Elytra entirely membranous with the veins distinct

or coriaceous and punctured at the base only--1-

SMILIINAE Stal.

1 SUB-FAMILY SMILIINAE,* Stal.

The Smiliida are more northern in their distribution and form by far the greater portion of our North American fauna in this family.

Elytra free, with the clavus uncovered, its interior margin touching the external margin of the pronotum,

1, CERASINI, Godg.

Clavus and frequently a part of the corium covered by the pronotum----------1

1, Wings with the terminal areole sessile, its base truncated---------- 2 TELAMONINI Godg.

---Wings, with the terminal areole triangular, stylate-2

2, Base of the corium with two closely contiguous veins---------- 3 POLYGLYPTINI Godg.

---Base of the Corium with three veins, usually contiguous---------- 4 SMILIINI Godg.

*

1, Tribe Cerasini.

Corium with two veins contiguous at base, sometimes united in one----------1

* To accord with the general custom of term endings, in sub-family names, I have changed the ending from ida to inae.

Corium with two distinct veins at base, contiguous at most but for a short space at base where they are sub-obsolete----------2

1, Pronotum armed with supra-humeral horns, sometimes reduced to mere tubercular angles-----1, CERESA-A & S.

---Pronotum without supra-humeral horns, the sides of the metopidium, at most, obtusely angled---2, STICTOCEPHALA, Stal.

2, Elytra with five apical areoles, veins distinct, 3,ACUTALIS, Fairm.

---Elytra with four apical areoles, veins indistinct, 4, MICRUTALIS, Fowler.

1. Ceresa,Genus A & S.

The members of this genus are of large size, ranging from 7 to 10 mm. in length. In North America we find fifteen species, of which only three have been recorded from Kansas. The type character of the genus is the lateral horns or suprahumerals, the shape and differentiations of which are variable and merge one species into the other until there is often difficulty in drawing a hard and fast line between the species. I give below a small key based somewhat on that given by Van Duzee (4)

Genus, Ceresa. A & S

A- Supra-Humerals broad, stout and triangular.

B- Elytra infuscated, metopidium pale, Prothorax brown, transversely banded with pale near middle and a narrower pale marking near posterior process.....2, Diceros, Say.

AA- Supra-humerals acute, distinctly produced as horns, triangular, sometimes short. Elytra, very transparent. Species green, when alive, turning to tawny or green mottled with tawny when dried. Prothorax covered with small white dots.

B- Metopidium slightly curved cephalad between the supra-humerals; produced at times into an obtuse angle; sometimes flat but never concave.

C- Clypeus short at apex, continuing contour of cheeks. ----------1 bubalus Fabr.

BB- Metopidium concave between the supra-humerals, sometimes flat or a trifle convex in the very middle. Supra-humerals (viewed from above) subterete, sloping upward and curving slightly backward.

C- Clypeus produced at apex forming an angle in contour of cheeks ----------3 taurina, Fitch.

1- Ceresa bubalus, Fabr. Figs. 5-8-10-87.

Green when alive, turning to a tawny or an ochreous hue when dried. Finely punctured with obscure whitish dots. Pronotum bearing, laterally, two large horns called supra-humerals, in front of the lateral angles. These suprahumeral processes point outward but never upward; are dark brown at the tips and along the upper margin as far as the union with the prothorax.

The metopidium rises perpendicularly from the head but slopes gently toward the sides leaving an apparent carina down the middle of the face of the metopidium. The metopidium slopes backward as well as slightly upward and, with the dorsal margins of the supra-humerals, forms an equilateral triangle, the apex of which is at the dorsal carina. Laterally, the supra-humerals slope inward and backward forming the lateral edges of the prothorax. The prothorax is produced into a sharply constricted point at the posterior process. The prothorax extends nearly to the tip of the tegmina but does not cover them laterally. The sides of the pronotum slope inward and upward meeting the dorsal carina and forming a high, tectiform hood. From the apex of the plane of the metopidium, the dorsum slopes downward and backward

until it meets the sharp black point of the posterior process. The pronotum, caudad of the metopidium, possesses a strong median longitudinal precurrent carina, slightly piceous in spots. The lateral edges of the prothorax are strongly carinated. The clypeus is not produced beyond the face but the lateral edges continue the contour. Tegmina tawny but tegmina tawny but transparent. The base of the clavus slightly coriaceous. Tibiae quadrangular.

Length, 8 to 10 mm. Described from thirty specimens.

FOOD PLANTS. The writer has taken the species upon the following food plants:

Osage orange-- Maclura aurantiacae

Gama Grass---- Tripsacum dactyloides

Sunflower----- Helianthus annuus

Alfalfa------- Medicago sativa

Horse Radish-- Nasturtium armoracia

Reported on Apple and Potato (Riley)

HABITAT. Brownville, Texas; Buffalo, Colo.; Kansas City, Mo.; Manchester, Vermont; Douglas, Sedgwick, Finney, Graham, and Rawlins Counties, Kansas; Eastern United States, Southern Canada and extending west to California.

2- Ceresa diceros, Say- Figs. 6-88

Prothorax brown, finely punctured and mottled or banded with light tawny spots, usually two on each side, one pair about the middle of the dorsum and the other pair near the posterior process. This process is black and polished. The general shape of this species agrees with that of Ceresa bubalus but the suprahumerals are broader and thicker. The front margin of the metopidium is not produced into an obtuse angle but the cephalic margin of the suprahumerals curves gently outward and backward until near the middle of the front margin when the line abruptly protrudes forward producing a slight bump. The metopidium is pilose and is tawny in color. Tips of suprahumerals, black.

Length 8 to 10 mm. Described from seventeen specimens.

FOOD PLANTS: This species has not been collected by the writer but Van Duzee records it as feeding upon the Elder Berry bushes.

Amyot and Serville described this species as C. post fasciata.

HABITAT: Colorado Springs, Colo.; Pennsylvania; New York; Nova Scotia; Kansas City, Mo.; Douglas County, Kansas.

3- Ceresa taurina, Fitch. Figs. 8-9.

Green when alive turning tawny when dry. Agreeing in many particulars with Ceresa bubalus but the species is more slender and smaller. Supra-humerals more acute, curving upward and a little forward making the front margin of the metopidium present a concave line. Clypeus usually produced below the face causing a break in the contour of the ventral line.

Length, 7 to 8 mm. Described from twelve specimens.

FOOD PLANTS: The writer has collected the species on the following.

Sunflower---------Helianthus annuus.

Osage Orange------Maclura aurantiacae

Apple-------------Pyrus Augustifolia

Horse Radish------Nasturtium armoraciae

Choke Cherry,-----Pyrus arbutifolia

HABITAT: Oak Creek Canon, Arizona; Lush, Wyoming; Columbia and Kansas City, Mo.; Welland County, Ontario; Colorado; North Carolina; Douglas, Sedgwick and Rawlins Counties, Kansas.

2- Genus, Stictocephala- Stal.

This genus comprises a large number of species. Van Duzee gives eleven species for North America and three of these occur in Kansas. The members of this genus, like Ceresa, are green when alive, turning to a yellow or orange hue, frequently mottled when dry and covered over with small white dots. Its characteristic differentiation from Ceresa is the absence of the produced horn-like suprahumerals.

A- Carinate sides of the metopidium meeting before the middle of the body.

B- Metopidium viewed from before, obviously widened upward to the rounded supra-humeral angles. Length of insect 7.5 to 8 mm.

C- Lorae continuing the rounded contour of the cheeks, the clypeus scarcely longer than the cheeks. Last ventral segment of the female broadly and subangularly excavated behind. Inhabits region East of the Continental divide-

1- Inermis, Fabr.

AA- Carinate sides of the metopidium with no distinct meeting before the middle of the body.

B- Metopidium viewed from before, widened upward to the obtuse suprahumeral angles.

C- Dorsum, viewed laterally, distinctly arcuated; metopidium high, its sides angulate; distinctly carinate, uniting somewhat behind the middle of the dorsum. Face evenly and regularly punctate, carinae frequently rufous---------- 3- festina, Say.

BB- Metopidium regularly narrowing above the suprahumerals.

C- Carinate sides of the metopidium meeting at or near the middle. Dorsum elevated, Face smoothly corrugated, evenly and closely punctate. Clypeus and lorae little produced. Length of insect 6 to 6.5 mm.

D- Pectus and outer face of femora black; clypeus briefly but obviously produced beyond the lines of the cheeks. ----------2- lutea, Walk.

1- Stictocephala inermis, Fabr. Figs. 16 and 17, and 89.

This is the largest species of the genus. In cephalic aspect the metopidium shows slight, obtuse suprahumerals but these are in no case produced as in Ceresa. The metopidium rises from the head in a perpendicular plane which almost immediately inclines slightly forward, causing the front of the metopidium, when viewed laterally, to present a curved surface. The metopidium, above the line of the suprahumerals, curves gently backward. Cephalad of the middle of the pronotum, the plane of the metopidium is terminated by the union of the dorsal carinae of the suprahumerals, thus forming an isosceles triangular plate as in Ceresa. From this point the dorsum slopes gently downward and backward to meet the posterior process which is usually dark and always acute. The dorsum bears a longitudinal median carina which is sometimes rufous or dotted with light brown. The sides of the pronotum are concave or inwardly arcuated and the ventral line, which is carinated slopes rapidly to meet the constricted posterior process. The tegmina are slightly colored with dark coriaceous spots at the base. The pectus and outer face of the femora black but frequently light and concolorous.

Length 7 to 9 mm. Described from 25 specimens.

FOOD PLANTS: The writer has collected the species on, Gama Grass-----Tripsacum dactyloides.

HABITAT: Oak Creek Canon, Arizona; Trenton Falls, N. Y. Kansas City, Mo.; Oregon (Canada Mountains); Douglas and Cowley counties, Kansas.

2- Stictocephala lutea, Walk. Figs. 28 and 29, 90.

This species although commonly found and reported from Kansas has not been collected by the writer. Therefore this description is based on Museum material only. It is some smaller than S. inermis, but as the two species intergrade to a considerable degree it is difficult to draw a fast and positive line between them. The specific differentiation of lutea from inermis lies in the convex metopidium (with its slightly and delicately carinated edges) which in S. lutea has its apex caudad of the middle of the pronotum. The dorsum is high and the sides well arcuated. The pectus and outer face of the femora are black. Length 7 to 7.5 mm. Described from 12 specimens.

HABITAT: Alabama; Mississippi; Arizona; Hayti; Ssdgwick and Douglas counties, Kansas.

3- Stictocephala festina, Say.

The material at my disposal was accidentally in-

jured so that no detailed description can be given at this time.

3- Genus Acutalis, Fairmaire.

This genus is distinguished from Micrutalis, which it much resembles, by the fact that the Acutalis tegmina have five apical cells while Micrutalis has but four. (See Figs. 80-81-82.) There has been some question among investigators concerning the advisability of separating these two into different genera, the tegminal characters however, would seem to be of generic value.

Van Duzee gives three species common to North America but up to this time only one has been collected in Kansas. Acutalis Tartarea - Say, (Figs. 18, 19 and 80.)

Pronotum black and shiny. Metopidium rising perpendicularly for a short distance and then curving gently back over the abdomen. Small inconspicuous suprahumerals light in color. Lateral edges of pronotum light, extending to the posterior process, which is compressed into a point, Posterior process pale. Face black and shiny, compound eyes and ocelli light. Tegmina black with a purplish irridescence as far as the apical region where the tegmina become transparent; nervules heavy. Metathoracic legs are heavily spined and of a greenish hue; other legs pale yellow, hirsute and with a dark spot on

the distal end of the tibiae.

Length 4 to 5.5 mm.

FOOD PLANTS. The writer has taken specimens on:

"Horse Rag Weed"- (Ambrosia trifida.)

HABITAT: Virginia; and Douglas county, Kansas.

Van Duzee gives the species as common throughout the Middle Atlantic States, and northward through New York to Canada. Described from 15 specimens.

4- Genus Micrutalis, Fowler.

This genus has only four apical cells in the tegmina. Frequently, as in M. dorsalis, (a species according to Van Duzee not reported from Kansas) there is a fifth terminal aerole, but this is not formed in the regular way but by the crowding of this nervure against that forming the apex of the costal areole. In the Francis Huntington Snow Collection at the University of Kansas, this genus seems not to be represented. It is there, however, but included in Acutalis on account of the older manner of classification.

The specimens labelled Acutalis calva and Acutalis occidentalis the writer classifies Micrutalis on account of the four apical cells.

Van Duzee records six species from North America. In

the smaller and more typical species of this genus the terminal aerole may be small or even wanting.

Genus Micrutalis- Fowler.

A- Size small, less than 4 mm. but more than 2.5 mm.

B- Pacific coast species, pronotum, when viewed dorsally, slightly rounded, at least not acute, on edges before posterior process.

C- Color pale, the dorsum sometimes marked with a brown median line which may be expanded between the supra-humerals and before the apex. ------1- Occidentalis, Godg.

BB- Eastern species, with pronotum, viewed dorsally, with edges continuing the lime directly with that of the posterior process. Pronotum relatively more acute than in the former.

C- Black marking much extended, the pronotum usually entirely black except at tip. In pale specimens the color of the dorsum is gathered anteriorly and does not form a dorsal line widening before the apex. --

2-- calva, Say.

1- Micrutalis occidentalis. Goding, (Fig. 81)

Although this species seems to be accredited to

the Pacific Coast, the F. H. S. Collection records it from Brownsville, Texas. This fall (1911) the writer found one specimen in sweepings at Lawrence, Kansas. It is a small pale species, in some cases almost void of color markings. In cases of this kind there is a slight collection of light brown color near the cephalic end of the pronotum. In other specimens this color may be dark and extend about midway to the tip of the pronotum.

Length, 2.8 to 3.2 mm.

HABITAT. Brownsville, Texas; Riverside, California; Lawrence, Kansas. Described from seven specimens.

2- Micrutalis calva, Say. (Figs. 20 and 21 and 82.)

Prothorax smooth, black and shiny. Posterior process face and compound eyes pale. There are small, obscure, obtuse suprahumerals outlined with a pale yellow carina. Femora black, tibiae bear dark spots near femora. Tegmina clear with pale but distinct neuration.

Length 3 to 3.5 mm. Described from ten specimens.

Redescribed as Smilia flavipinnis by Germar.

HABITAT: (Van Duzee) of wide distribution from southern New York to Florida and west to the Rocky Mountains.

F. H. S. Collection records specimens collected in Texas, Missouri and Kansas.

2- Tribe Telamonini, Godg.

A- Pronotum unarmed,

B- Dorsum strongly compressed, foliaceous,

1- Archasia, Stal.

AA- Pronotum armed with a horn or dorsal crest more or less developed.

B- Dorsum armed with a compressed horn which is erect or nearly so, with a dorsal crest more or less elevated.

C- Dorsal crest arising from behind the supra-humerals. If distinctly elevated, wider than high. Corium coriaceous and if at all punctured only for a short space at the base.

D- Dorsal crest rounded; Obtusely pointed, truncate or sinuate at apex, sometimes scarcely elevated.

2- Telamona. Fitch.

1- Genus, Archasia, Stal.

A genus whose species are green when alive, turning ochreous or tawny in museum specimens. Prothorax punctuate and finely although obscurely dotted with white specks. Longitudinal median carina peceous in spots. Prothorax very highly elevated and compressed into a sharp helmet above the head.

Archasia galeata, Fabricus. (Fig. 22-23.) This is the only species of this genus reported from Kansas.There are two species classified by Van Duzee but F. H. S. Collection yields but one specimen of each of the two species and A. Belfragi is not reported from Kansas. On account of the scanty material very little study could be made.

DESCRIPTION: Contour of the prothorax entire, not having elevations or sinuations. Metopidium bears short obtuse suprahumerals.

HABITAT: Van Duzee reports the species from Colorado and Georgia, stating that it is less abundant than A. Belfragi, Stal, in the Northern States, but is a prevailing form in the South. The specimen in F. H. S. Collection is from Douglas county, Kansas. Length 9.5 mm.

2- Telamona, Fitch.

This genus is abundant in Kansas as well as other states in the Union. It contains the largest form found in Kansas, it measuring sometimes 11 mm. in length. The male is much smaller than the female and also darker in color.

A- Crest (viewed laterally) lyramidal, rather slender and narrowed upward.

B- Crest narrowing above to a rounded point, posterior angle scarcely if at all indicated, its front sloping from the metopidium without a sinus at the anterior base--------1-pyramidata, Uhl.

AA- Crest (viewed laterally) rectangular, broad but little narrowed above.

B- Crest nearly vertical before or sometimes overhanging. Gray or brownish species more or less distinctly banded or dotted with dark brown, sometimes almost black.

C- Crest truncated above, the angles nearly or quite right angles. -- 2-ampelopsides, Harris.

1- Telamona pyramidata Uhler, (Figs. 30 - 31 - 84.)

Color varying from a pale tawny concolorous specimen through greenish ochre to brown with darker markings. In

cephalic aspect the form is very broad and somewhat flat, the metopidium curves backward after rising perpendicularly, for a short distance, and gently upward forming a dorsal elevation back of the suprahumerals. This elevation or protuberance slopes abruptly downward and then proceeds in an almost horizontal line to the posterior process. The dorsal carina is prominent and piceous as far as the elevation but caudad it becomes concolorous and obscure. There is frequently a dark color marking extending from back of the elevation to lateral edge of the prothorax, slanting slightly caudad. End of prothorax suffused with dark. Tegmina transparent except for the dark tip and slight coriation of base. Cephalic portion of the prothorax pale. Suprahumerals sometimes dark at the tips.

HABITAT: Colorado Springs, Colo.; Cheyenne, Douglas and Gove counties, Kansas; Missouri.

Length, 10.2 to 8.5 mm.

Described from 25 specimens.

2- Telamona ampelopsides, Harris. (Figs. 73-74).

Redescribed as Thelia cyrtops by Fairmaire. Color dark dusty brown, some specimens having a greenish cast in the lighter portions. Metopidium rising similar

to that in T. Pyramidata but instead of sloping gently backward, it rises abruptly to form the high rectangular dorsal elevation. The dorsal contour of this protuberance runs backward in an almost horizontal, yet slightly descending, plane until past the middle of the prothorax when it slopes suddenly downward and then extends caudad forming a lanceolate posterior process.

Color marking dark brown, the cephalic face of the suprahumerals bearing a splotch which extends toward but does not attain the median carina. This median carina is piceous. The cephalic edge of the elevation has color markings which extend downward and backward to meet the splotch at the caudal edge of the elevation on the side of the prothorax. This color may or may not extend as far as the posterior process, which is dark. Median carina is dark and prominent for its entire length. Femora dark on dorsal side. Tegmina smoky and darker at tip, clear in costal region.

The males in this species are much darker than the females being at times almost black, but with the markings visible.

HABITAT: Menand, N. Y.; Kansas City, Mo.; Manchester, Vt. Douglas county, Kansas.

FOOD PLANT: Virginia Creeper.

Length; 11 mm. to 8.8 mm. Described from 40 specimens.

3- Tribe- Polyglyptini, Goding.

A- Pronotum usually not produced anteriorly, if at all, only very slightly.

B- Dorsum regularly rounded transversely, punctate. Prothorax not elevated in rugae. The furcation forming the base of the terminal areole, is a straight line or nearly so. --------1-Van Duzee Goding.

BB-Dorsum more or less elevated. The surface with longitudinal rugae which may become more or less reticulated. The furcation forming the base of the terminal aerole forming an angle.

C- Dorsum strongly elevated, compressed, with a deep sinus whose base is rounded. 2- Entylia, Germ.

CC-Dorsum but slightly elevated, A little sinuated before the middle, the base of the sinuation being flat or angled, not regularly rounded. ----3-Publilia,Stal.

1- Genus, Vanduzea, Goding.

This genus may be distinguished by the absence of wrinkles or rugae on the prothorax and by the peculiar shape of the terminal aerole or third apical cell, which has a straight view for a base instead of the usual angle toward the base of the tegmen. The metopidium is not produced any higher than is absolutely necessary to cover the meso and meta thorax.

In the species common to Kansas the dorsum is transversely rounded and punctate. Van Duzee states that some species of this genus have the dorsum carinated and sinuated.

The color of the species of the genus Vanduzea is mottled with dark, either dark brown or black with whitish or light oblique vittae. The prothorax is pilose, the legs dark brown to black with light hairs. The tegmina except in the costal region is transparent, the nervules with black or brown dotted lines. The tip of the limbus is infuscated.

Vanduzea arquata, Goding, Figs. 14-15-68-69-78.

Color reddish brown verging to black, there are white or light yellow markings or vittae, an oblique spot joining the lateral margin, and a line just before the posterior process. Sometimes there is a small white

spot on the dorsum almost concurrent with the spots on the sides. The pronotum bears no procephalon or crest and is smoothly rounded transversely. The metopidium rises slightly from the head and then curves gently backward to the dorsum which is slightly arcuated to the posterior process. The metopidium (in cephalic view) is broad with short obtuse suprahumerals. Head and body and legs dark and pilose. Length 5.1 to 4.5 mm. HABITAT: Galveston, and Brownsville, Texas; Douglas and Congress Junction, Arizona; Kansas City, Mo.; Kansas City, Kansas; Morton, Clark, Douglas, Stevens, Seward and Haskell counties, Kansas.

According to the determination in F. H. S. collection there are two species common to Kansas, V. arquata and V. vestita. Van Duzee separates these species by the costal region of the tegmina. V. Arquata has the costal cel coriaceous and punctured for nearly its whole length, V. vestita has the costal areole or cell concolorous, sparsely punctate near the base. If this classification be true, and I have every reason to consider it such, then there is but one species in the F. H. S. Collection as all the specimens agree with V. arquata.

In Van Duzee's description of V. vestita, he

states that the suprahumerals are more prominent than in V. arquata. With this description as a basis, the specimens here cannot be V. vestita as there is no ascertainable difference in the prominence of the supra-humerals.

Genus Entylia, Germ.

This genus has received a considerable list of synonyms, which I append at the close of the description of species. It is widely distributed east of the Rocky Mountains and some species occur in considerable numbers, the writer having found extensive colonies in Kansas and Vermont.

The metopidium of the prothorax rises in a high elevation to form a distinct procephalon almost perpendicular or sloping slightly forward on its cephalic edge. This procephalon is greatly compressed and extends rectiliniarly caudad for a short distance, descending suddenly and abruptly into a deep sinus smoothly curved at the base. This sinus forms also the front of a second elevation or the dorsal hump which does not rise as high as the procephalon but is equally compressed, slopes down rapidly making the dorsal hump, in lateral aspect, appear somewhat rectangular. After dropping

for a distance about equal to the depth of the curved sinus the dorsal line proceeds gently backward and downward to meet the blunt posterior process.

Entylia sinuata, Fabr. Figs. 61, 62, and 83.

In looking over the individuals of this genus, in the F. H. S. Collection, I find two species or rather one species and a variety, Entylia sinuata and Entylia sinuata, var. bactriana. Upon closer examination the writer finds that those determined as E. bactriana are all males and those determined as E. sinuata are all females. In the life history observations (recorded in this paper) the writer found the males agreeing with bactriana and the females agreeing with sinuata. J. C. Crawford, Assoc. Curator, Division of Insects, United States National Museum, states that there are both males and females of both species and variety, in the collection there. From this information and the study of Life History it may be inferred that there has been an error in the determination of the material in the F. H. S. Collection. Whether that is correct statement or not the fact remains the same that the writer has not found any E. sinuata, var. bactriana in Kansas.

DESCRIPTION: It is not necessary to redescribe the procephalon and dorsum of this species as it agrees with

that given in the generic characters. The sides of the prothorax bear three lateral carinae, the central one being branched at its base in such a manner as to frequently appear as two. The lower one forms the edge of the prothorax while the upper branches into the posterior elevations. These carinae frequently appear while, especially in the males. There is a prominent dorsal carina which extends from the base of the metopidium, follows the elevations in their sinuations and finally fades out on the posterior process. The prothorax extends beyond and covers the tips of the tegmina.

The tegmina are transparent except in the basal region of the three longitudinal veins in the corium, this region is dark and heavily coriaceous. The discoidal cells are small and pushed costad and distad leaving the lower part of the corium unveined. The tips of the tegmina are infuscated.

The supra-humerals are distinct, obtuse and not formed by any marked invaginations in the outline of the prothorax.

The male is dark, almost black with the procephalon slightly less elevated than in the female. The face heavily punctate. As a rule the male is smaller than that of the female.

The female is light brown or tan mottled with dark anteriorly. The front of the head and procephalon is densely spotted with irregular dark markings and there is an arcuate dark mark on the sides of the prothorax behind the middle with the posterior end infuscated. The body usually accords in shade to the main color of the prothorax, the legs pale. There are variations in this color marking as the front of the face and prothorax including the cephalic elevation or procephalon may be pale as usual, but the sides of the prothorax including the dorsal hump may be very dark, the caudal third of the prothorax being light, infuscated at the extreme tip. Legs pale; body dark. Sometimes the color markings do not take definite shape but appear in mottled splotches. Again the procephalon may be light in color, continuing on to the sides of the prothorax and forming a cephalo-caudal band meeting the light caudal third, thus leaving only the tip of the cephalic elevation and the sides of the dorsal elevation dark.

Length: Males, 3.3 to 5.1 mm.

Females, 5.2 to 6.1 mm.

The writer has collected the species on the following FOOD PLANTS.

Sweet clover--------Melilotus alba

Thistle-------------Cnicus altissimus

Cat-tail Grass------Phleum alpinum

Sunflower-----------Helianthus annuus.

Alfalfa-------------Medicago sativa

Mrs. Rice reports it on Spikenard -- Ambrosia sp.

HABITAT: Manchester, Vermont; Maine; Kansas City, Mo.; Brownsville, Galveston Texas; Douglas, Sedgwick, Reno, Neosho, counties, Kansas; New York.

Described from 63 specimens.

Synonyms.

1798-Membracis sinuata Fabr. Ent. Syst. Suppl.

1798-Membracis emarginata

1803 " " Fabr. Syst. Phyng.

1851-Entylia concisa, Walk. List. Hom. B: M.

" " decisa, " " "

" " accisa " " "

" Entylia torva, var. Fitch, Cat. Hom, N.Y.

" " " , Walk. List. Hom. B. M.

1876-Entylia carinata, Glover, Rep. U.S. Dept. Agri.#29.

At the close of the Synonimical Catalogue occurs the following habitat. N. Y.; Mo.; Tex.; N. H.; Va.; D. C.; S. C.; N. C.; Penn.; Mich,; Iowa.; Md.; Fla.; Ill.

3- Genus, Publilia, Stal.

This genus has been formed by Stal for the reception of those species formally classed as Entylia, where the elevations are not high enough to put the form strictly into genus Entylia, but in which the dorsum is similarly sinuated. Kansas contributes two species to this genus.

A- Dorsum straight or feebly bowed, scarcely if at all sinuated, form slender, prothorax punctate, not wrinkled.----------2-Modesta Uhler.

AA-Dorsum elevated, obviously sinuated.

B- Sides of the prothorax with longitudinal wrinkles which form a net work along the dorsum--1, Concava, Say.

Publilia concava, Say, Figs. 26-27-65.

A small dark form with a very roughly punctated and coarsely reticulated pronotum which almost covers the tegmina, laterally. The metopidium is slightly elevated being strongly compressed and in cephalic aspect appears as a heavy carina or minute procephalon above the cephalic face of the metopidium. The sinus on the dorsum is obvious although not as marked as in Entylia sinuata, the base is flat or angulated not a regular curve. The dorsal crest is not abrupt caudad but curves gently to the posterior process. Along the sides of the prothorax are distinct carinae which become forked anteriorly and

dorsad forming a net work of veins.

This species is dark, mottled slightly with pale, and there is a light vitta on the side below the sinus and a large spot on the lateral edge behind the middle extending upward toward the dorsal crest but not extending to it. At the back of the dorsal crest is a narrow transverse line of a pale color or there may be reticulation.

Length, 6 to 5 mm.

Described from ten specimens.

FOOD PLANTS. The writer has collected the species on:

Pine Oak--------Querus palastris

Sycamore--------Platanus occidentalis.

HABITAT: Maine; Kansas City, Mo.; N. Y.; Kansas Douglas county.

2- Publilia modesta, Uhler, Figs. 32- 33.

A comparatively pale species with prothorax entirely covering the abdomen and tips of tegmina, leaving only the costal region exposed. The dorsal sinus is very slight, sometimes almost entirely absent. The metopidium is not elevated into a procephalon of any degree but is transversely rounded, the dorsal crest not apparent. Dorsum only slightly arcuated. Body dark with femora black and shiny, frequently body light and legs pale.

Pronotum with lateral carinae indistinct and very slight if any reticulation, closely punctate.

Color variable: There are some individuals whichare pale green with only the front of head and metopidium mottled with dark or the form may be brownish with face still darker. The sides of the prothorax with two pale spots, one large one near the front and an oblique line near the posterior process, concurrent across the dorsum. Frequently these pale spots are a light yellow.

There is a white or grey variation with head and front of metopidium dark grey, and posterior process and an oblique band on the prothorax also grey. A few forms are almost pure white being only inconspicuously mottled and this on the dorsal carina. In these very pale specimens the costal region of the tegmina is the same shade as the ground color of the pronotum and is coriaceous.

The nymphs have sharp spiny dorsal tubercles on the abdomen. The enlargements of the head and prothorax are hirsute. P. bicinctura, Godg. as determined in F.H.S. Collection appears to agree with the grey variation of P. modesta.

Length, 4.5 to 5.1 mm.

HABIBAT: Albuquerque, N. M.; Colorado Springs Colo.; Gove and Rawlins counties, Kansas.

FOOD PLANT: Berlandiera texana.

Described from 17 specimens.

4- Tribe, Smiliini, Goding.

In this tribe we find four genera. Smilia, Germ. Ophiderma, Fairm.; Antianthe, Fowler; and Cyrtolobus, Goding. Of these, only Cyrtolobus, is reported from Kansas. The last three genera are separated from the first, Smilia, by the presence of a transverse nervule between the two inner longitudinal veins, which is absent in Smilia. Cyrtolobus and Antianthe are separated from Ophiderma by the strongly compressed pronotum, as Ophiderma is not at all compressed and the dorsum is rounded transversely.

Again, Cyrtolobus is differentiated from Antianthe by the absence of the strongly produced suprahumerals so evident in Antianthe. In Cyrtolobus there are small suprahumerals and the dorsum is highest at about the middle. Students in this subject have seen fit to divide the genus Cyrtolobus into the subgenera, Xantholobus, V.D., Evashmeadea, Godg., Atymna, Stal, and Cyrtolobus, Godg.

Xantholobus, is separated from the others by its posteriorly inflated pronotum. Atymna and Cyrtolobus

differ from Evashmeadae, Godg., by the lack of sinuation on the dorsal crest. Atymna and Cyrtolobus are differentiated by the position of the highest portion of the crest. In Atymna the highest portion of the crest is anterior to the dorsum, rising above the humeral angles, while in Cyrtolobus the highest portion of the crest is near the middle of the dorsum.

Of this subgenus, Kansas has recorded but one species Cyrtolobus vau, Say. Figs. 24 and 25, 79.

This species is pale brown or tan; frequently banded with both darker and lighter shades than the ground color. The crest is evenly arcuated. and in some cases very little elevated. The metopidium is transversely rounded, the crest beginning to rise back of the humeral angles. The dorsum is rounded from its ventr al edges and the crest is formed by a sharp compression. At times this crest is made manifest only by a distinct and prominent median dorsal carina. The pronotum does not extend to the tips of the tegmina, but covers the abdomen. The carina is usually darker than the rest of the pronotum. The color marking when present consists of three dark spots along the lateral side of the dorsum, cut into by two streaks of light on the crest or carina but joined together on the lower edge of the side of the dorsum.

Posterior process is light if the color marking are present, otherwise it is light and concolorous with the pronotum.

The face is usually void of color markings and is short. With a broad clypeus rounded at the apex, and black shiny compound eyes.

Legs pale and slender; pectus pale.

Tegmina distinctly veined and transparent except near the tip where it commences to become smoky and continues so to the very tip. Length 6.5 to 5 mm.

HABITAT: Colorado Springs, Colo.; Kansas City, Mo.; Colombia, Mo.; Penn.; Douglas County, Kansas.

II Subfamily Membracinae, Stal.

This subfamily is differentiated from the others by the dilated or foliaceous tibiae. In this subfamily are placed the two genera, Enchenopa and Campylenchia, which together are separated from the other members of the subfamily by the pronotum being distinctly compressed and elevated toward the front into a prominent, usually oblique, process. This process is further characterized by the lateral carinae attaining the middle of the posterior process.

The two genera are separated from each other by the position of the lateral carinae.

A- Lateral carinae of the anterior process simple, placed about equally distant from the upper and lower margins. Carinae foliaceous. Pronotum without pubescence---

1-Enchenopa, A. & S.

AA-Lateral carinae of the anterior process with several branches. Carinae placed a little closer the dorsal margin, the inferior carina not foliaceous. Pronotum with appressed pubescence----------2- Campylenchia, Stal.

1- Genus Enchenopa , A. & S. Figs. 12 and 13, 71.

In this genus Kansas has recorded but one species, this one, however, is very common and of wide distribution. Enchenopa binotata, Say, may be distinguished from the other species of this genus by its dorsal carina being very prominent posteriorly. The insect is of a reddish brown while its near relative permutata is pale yellow. The dorsal carina is extremely elevated and continuous prominent to the tip of the posterior process.

The metopidium bears a procephalon or anterior horn which is usually larger at its anterior extremity than where it joins the pronotum. This horn seems to rise obliquely forward from the pronotum for some distance and then turn suddenly forward in a line parallel with

the dorsal carina thus forming a "bump" at the end of the horn. The procephalon is distinctly compressed and the dorsal carina extends into the procephalon, and follows the median line even into the cephalic face.

On the sides of the prothorax but so close to the dorsal carina that they extend over and meet the spots on the opposite side, are two long slender spots, extending for some distance laterally. This is the character which probably gives the species its name. The posterior process is dark and very acute. The tegmina are entirely dark, reddish brown with a smoky translucency. The wings are transparent. The body and pectus dark reddish brown. The tibiae of the pro- and meso-thoracic legs are dilated, the metathoracic grooved on its outer side and spined along the two outer edges.

HABITAT: Missouri; Penn.; Texas; Manchester, Vermont, Canada; Douglas and Sedgwick counties, Kansas.

FOOD PLANTS: Golden Rod--------Solidago Canadensis

Pin Oak----------Quercus palustris

Bitter Sweet.

Described by Buckton as Enchenopa prorecta, and by Walker as Enchenopa brevis.

Length, 5.5 to 7.4 mm.

2- Campylenchia curvata, Fabr., Figs. 70 and 11, 86.

This species is a dusky reddish brown with a pro-

cephalon or horn protruding obliquely over the face for a a distance about equal to the pronotum measuring for the suprahumerals posteriorly. The dorsal carina is not greatly elevated but the lateral carinae are distinct and extend from the tip of the procephalon into the posterior process, which is acute. The pronotum is concolorous, the tibiae as in Enchenopa binotata are dilated. The tegmina smoky, coriaceous in the costal region and on the basal cells. Pectus dark and eyes light.

HABITAT: Colorado; Missouri; Canada; Douglas county, Kansas.

FOOD PLANTS: Golden Rod.

Sensitive Rose.

Length, 8 to 9 mm.

INDEX TO SPECIES.

FOOD PLANTS

Ceresa bubalus.

Osage orange---------Maclura aurantiaca Nutt.

Horse Radish---------Nasturtium armoracia, Fries.

Gama Grass-----------Tripsacum dactyloides L.

Sunflower------------Helianthus annuus L.

Alfalfa--------------Medicago sativa, L.

Acutalis tartarea

Horse Rag Weed-------Ambrosia trifida L.

Ceresa taurina

Horse Radish---------Nasturtium armoracia Fries.

Choke Cherry---------Prunus arbutifolia L.

Campylenchia curvata

Golden Rod-----------Solidago canadensis L.

Sensitive Rose-------Cassia nicitans L.

Enchenopa binotata

Golden Rod-----------Solidago canadensis L.

Pin Oak--------------Quercus palustris, Du Roi.

Bitter Sweet,--------Solanum dulcamara, L.

Entylia sinuata,

Sweet Clover---------Meloitus alba, Lam.

Thistle--------------Cnicus altissimus, Wdlld.

Cat-tail grass-------Phleum alpinum L.

Sunflower------------Helianthus annuus, L.

Alfalfa----------Medicago sativa L.

Publilia concava

Pin Oak----------Quercus palustris, Du Roi

Sycamore----------Platanus occidentalis L.

Publilia modesta

----------Berlandiera texana

Stictocephala inermis

Gama Grass---------Tripsacum dactyloides, L.

Telamona ampelopsides.

Woodbine or Virginia Creeper- Ampelopsis quinquefolia, Michx.

Alfalfa----------Medicago sativa

Ceresa bubalus

Entylia sinuata.

Berlandiera texana

Publilia modesta

Bitter Sweet--------Solanum delcamara

Enchenopa binotata

Cat-tail Grass------Phleum alpinum

Entylia sinuata

Choke Cherry--------Prunus Arbutifolia

Ceresa taurina

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Ceresa bubalus

Stictocephala inermis

Golden Rod----------Solidago canadensis

Campylenchia curvata

Enchenopa binotata

Horse Radish--------Nasturtium armoracia Fries.

Ceresa bubalus

Ceresa taurina

Osage Orange--------Maclura aurantiaca

Ceresa bubalus

Pin Oak----------Quercus palustris,

Enchenopa binotata

Publilia concava.

Sweet clover----------Melilotus alba

Entylia sinuata

Sensitive Rose----------Cassia nictans

Campylenchia curvata

Sycamore----------Platanus occidentalis

Publilia concava

Sunflower----------Helianthus annuus

Ceresa bubalus

Entylia sinuata

Thistle----------Cnicus altissimus

Entylia sinuata

Virginia creeper----------Ampelopsis quinquefolia

Telamona ampelopsidis

Wood-bine, See Virginia Creeper.

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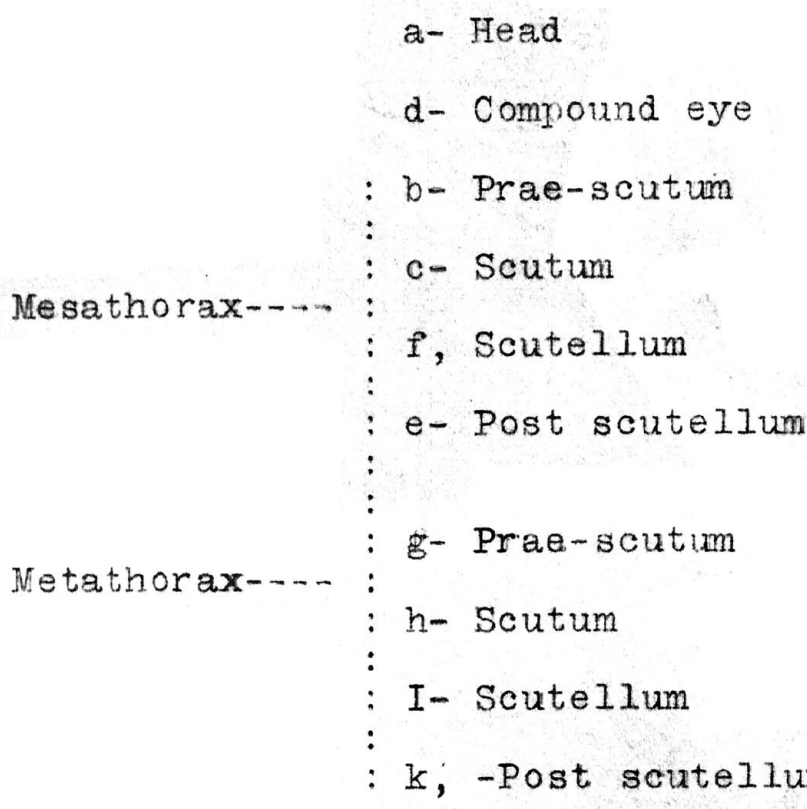
Illustrations for

MEMBRACIDAE

Hazel Elisabeth Branch.

Figure-I-

Dorsal Aspect of Entylia Sinuata,
Prothorax removed.



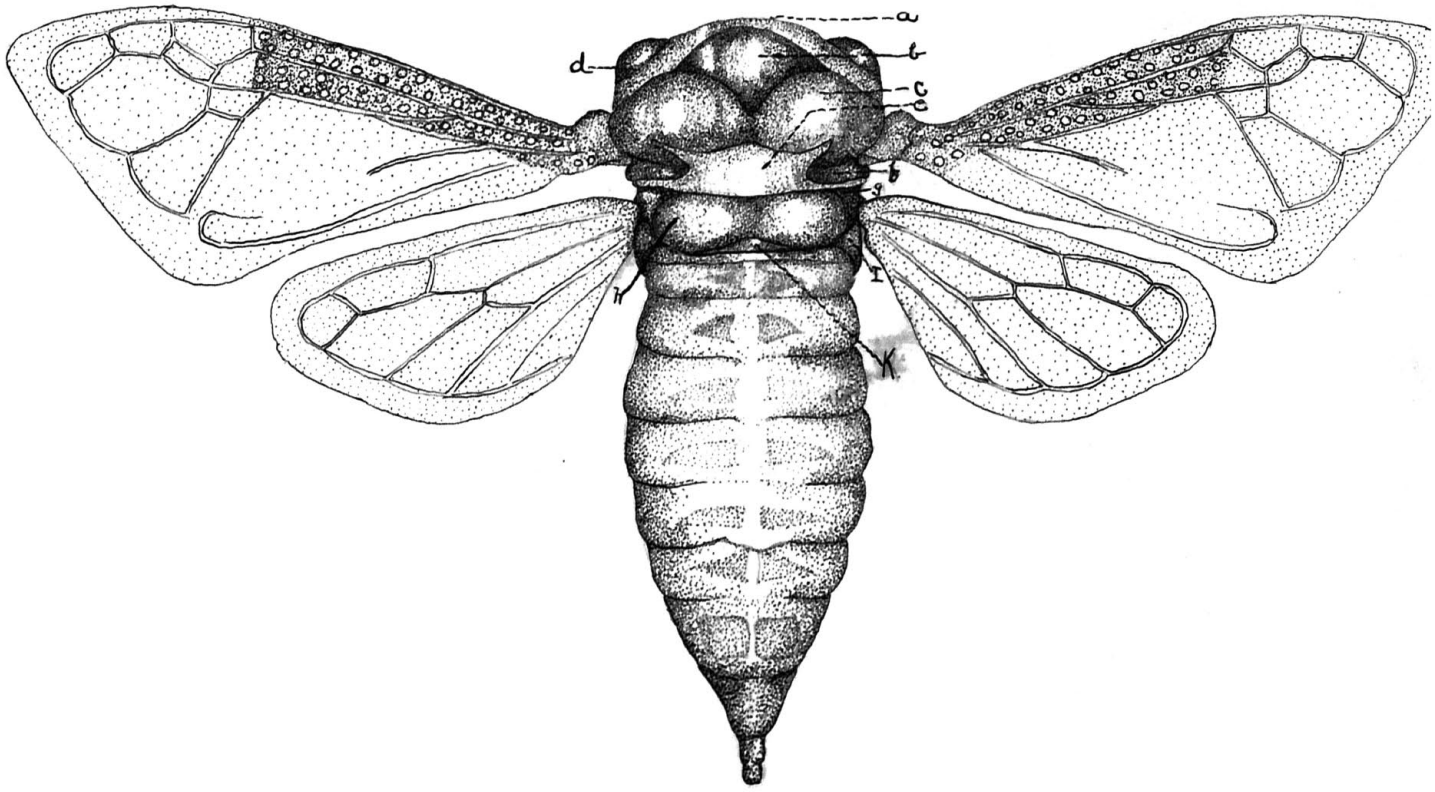


Fig.-I

Figure -2-

Metathoracic Leg of Entylia Sinuata.

a- Coxa

b- Trochanter

c- Femur

d- Tibia

e- Tarsi

f- Claws

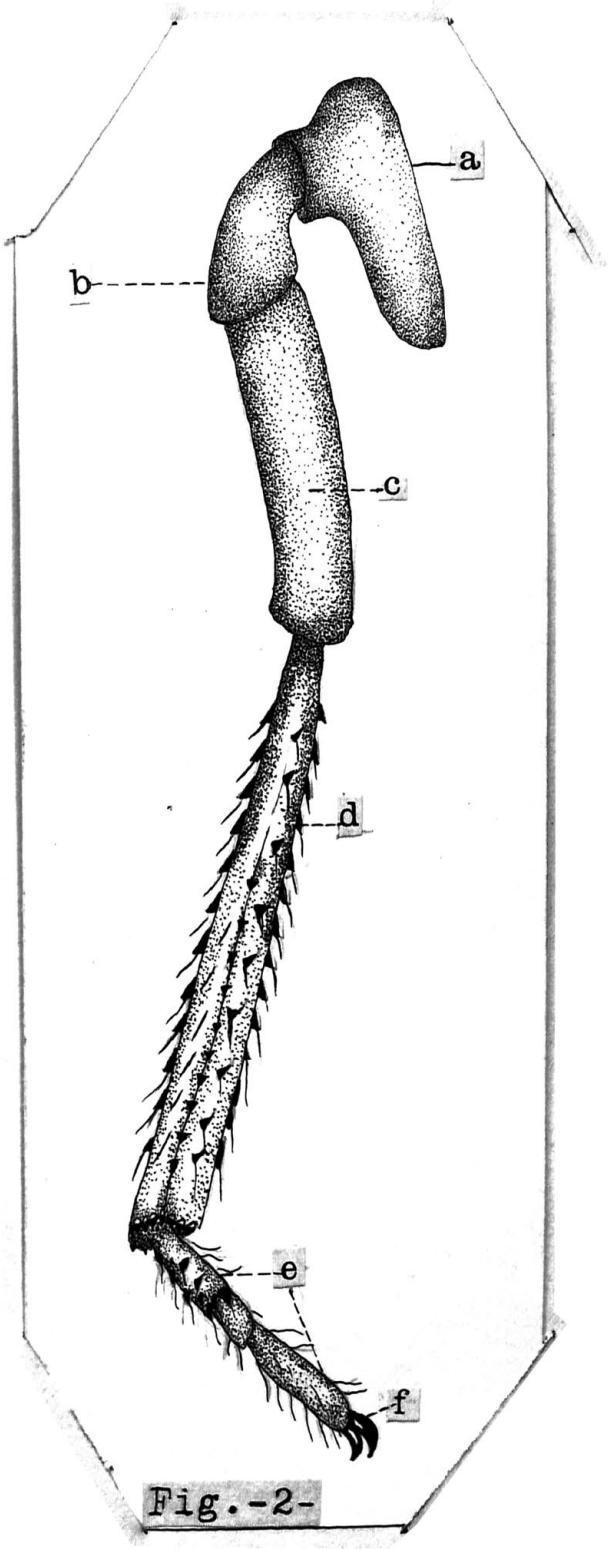


Fig.-2-

Figure-3-

Dorsal Aspect of a cercopidae

to show relation to Membracidae.

Figure-4-

Doreal Aspect of Cicadidae

to show relation to Membracidae.

Figure-5-

Doraal Aspect of Ceresa bubalus

a- Metopidium

b- Dorsum

c- Posterior process

d- Tegmina

e- Suprahumeral

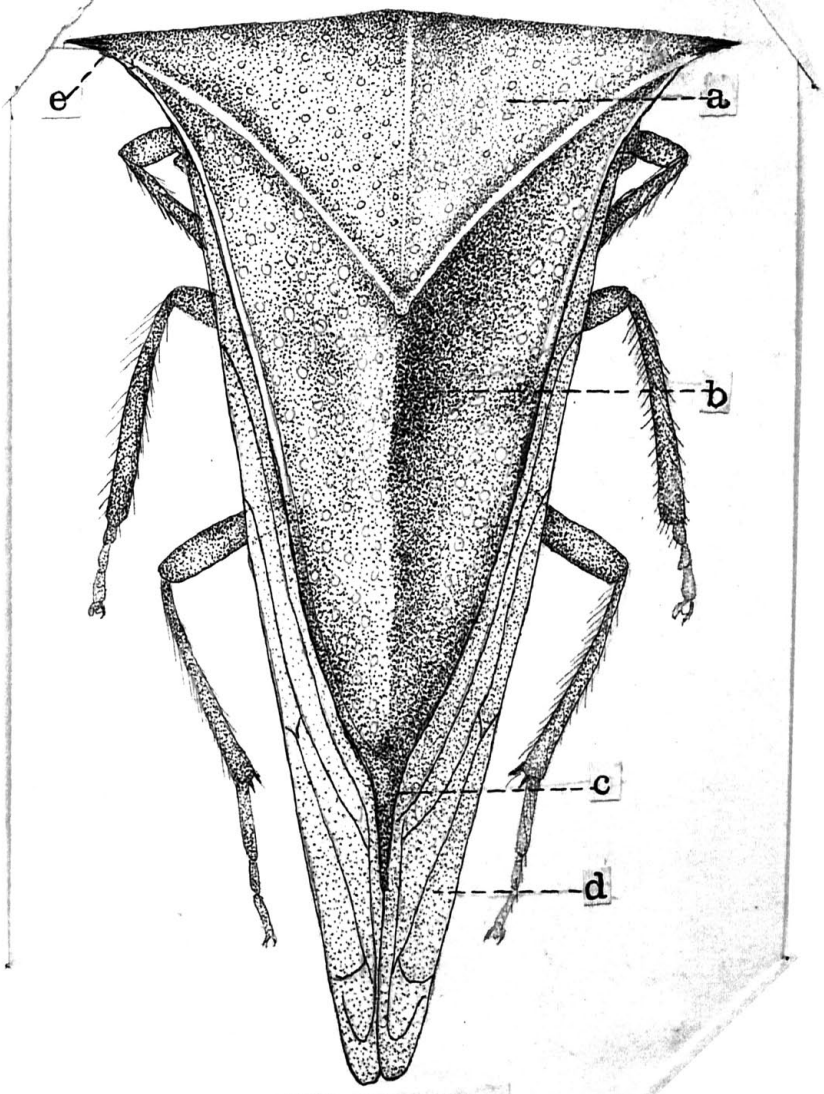


Fig. 5.

Fig.-5-

Figure -6-

Prothorax of Ceresa diceros

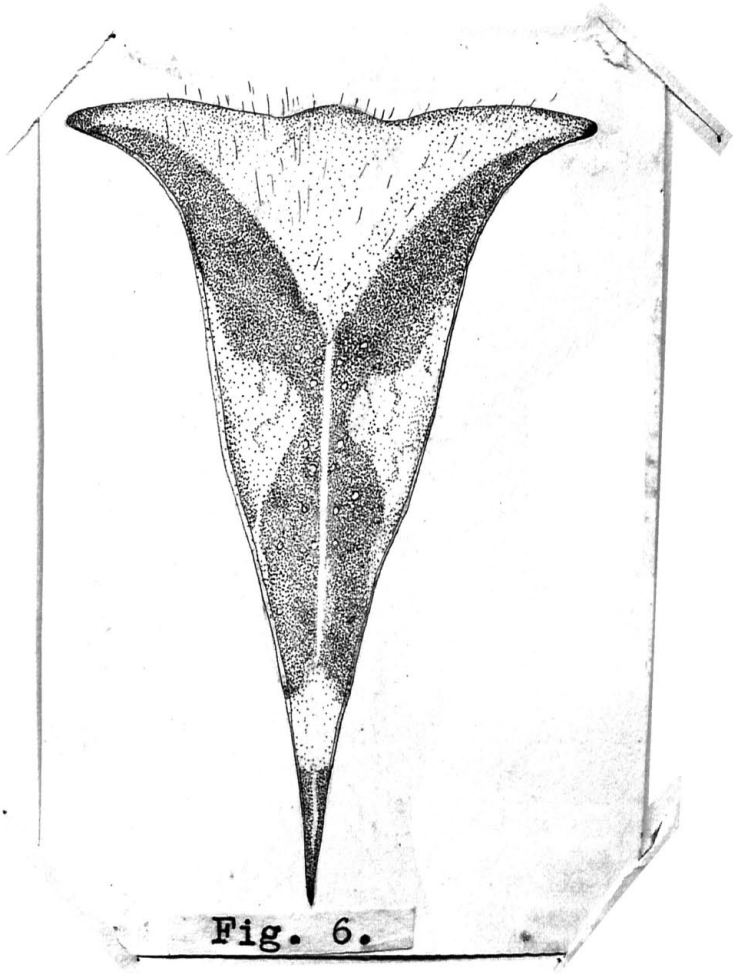


Fig. 6.

Fig.-6-

Figure-7-

Lateral aspect of Ceresa bubalus

x- humeral angle.

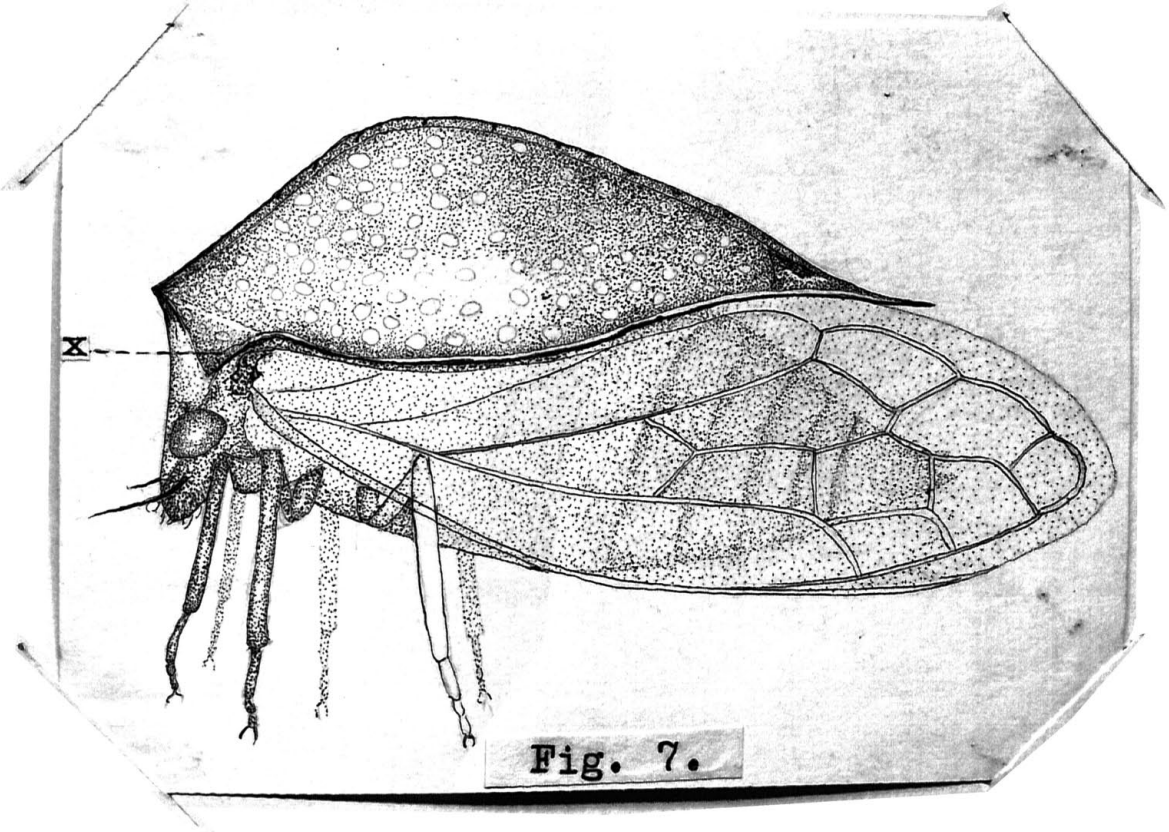


Fig. 7.

Fig.-7-

Figure -8-

Prothorax of Ceresa Taurina

Figure -9-

Front aspect of head of Ceresa taurina

Figure -IO-

Front aspect of head of Ceresa bubalus

a- metopidium crest

b- front of metopidium

c- compound eye

d- ocelli

e- antennae

f- Clypeus

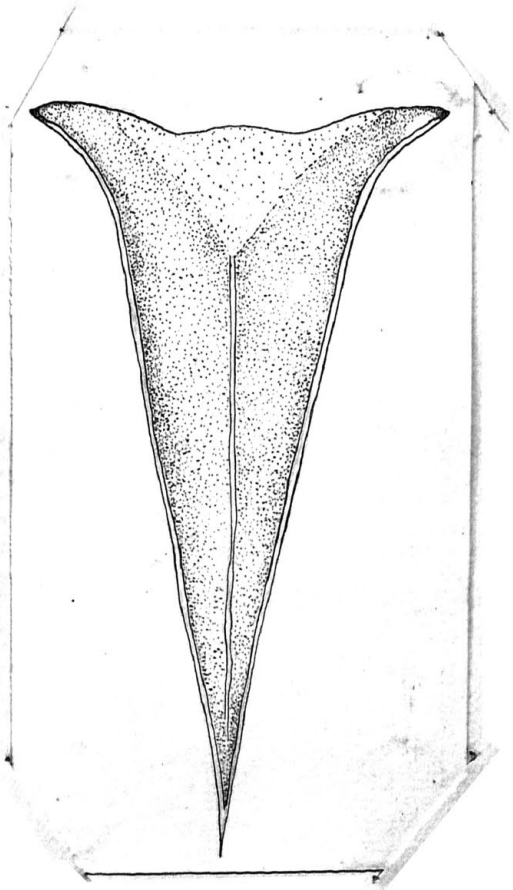
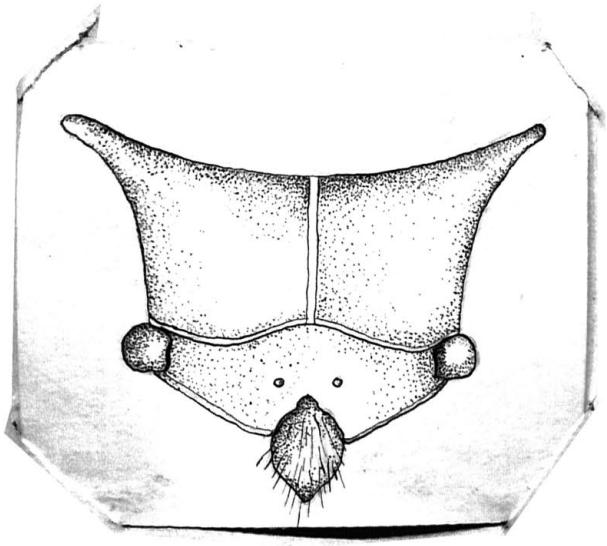


Fig.-8-



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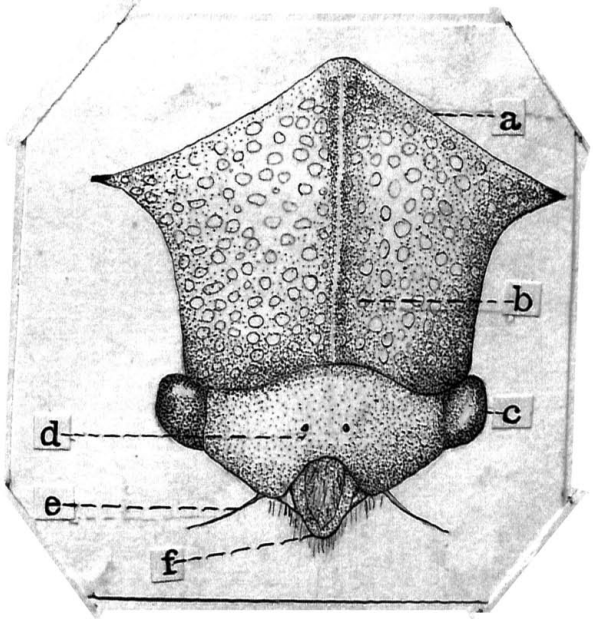


Fig.-IO-

Figure II-

Lateral Aspect of Campylenchia Curvata

a- Procephalon

b- Metopidium

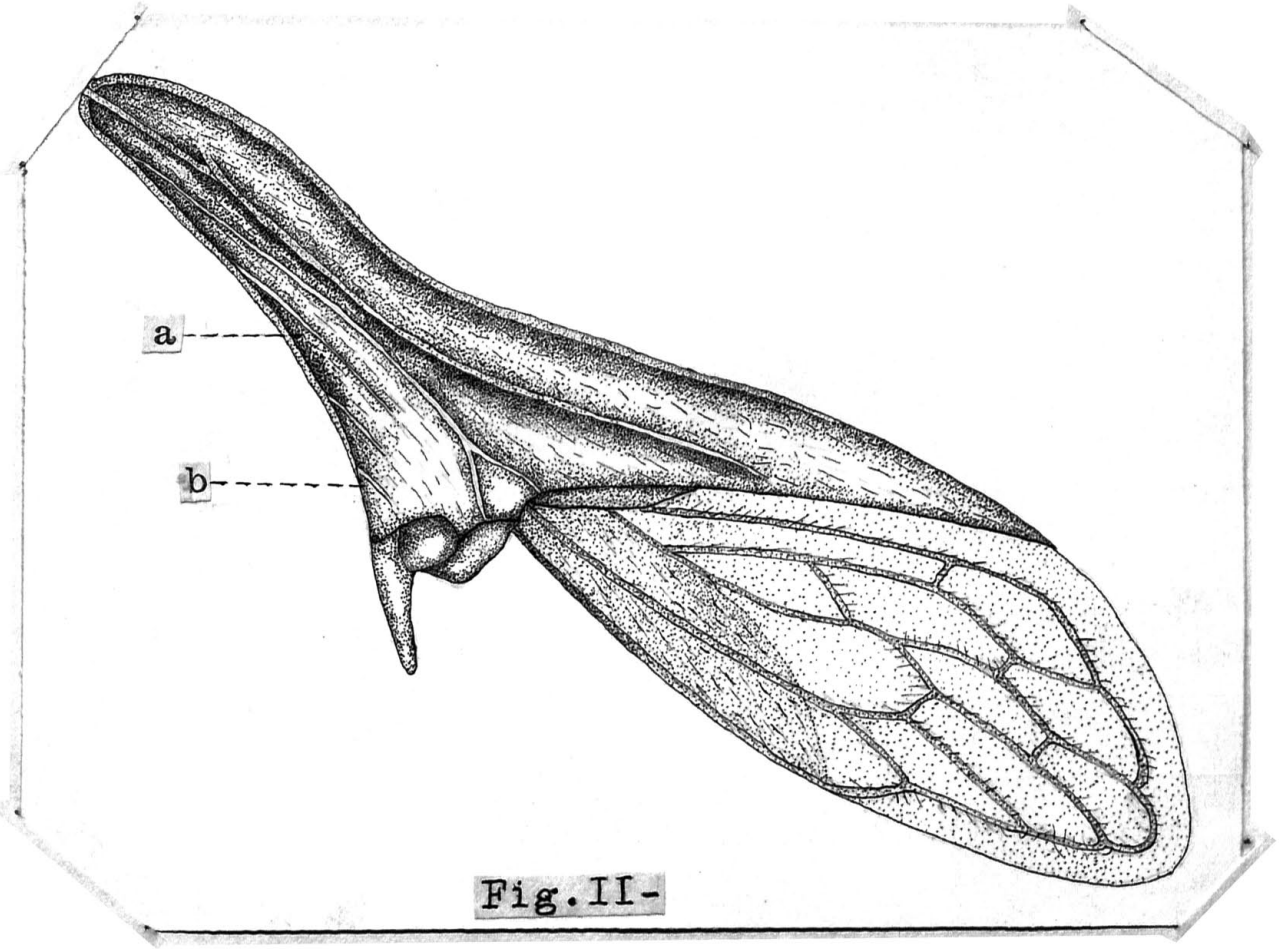


Fig.II-

Figure -I2-

Cephalic Aspect of Enchenopa binotata

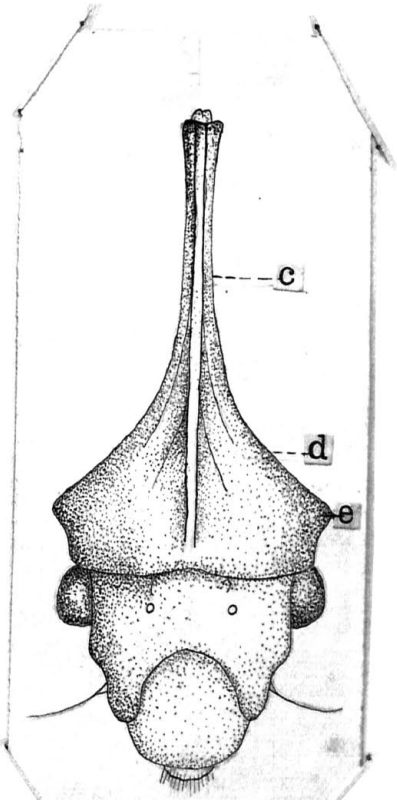
c- Procephalon

d- Metopidium

e- Suprahumeral

Figure -I3-

Lateral Aspect of Enchenopa binotata



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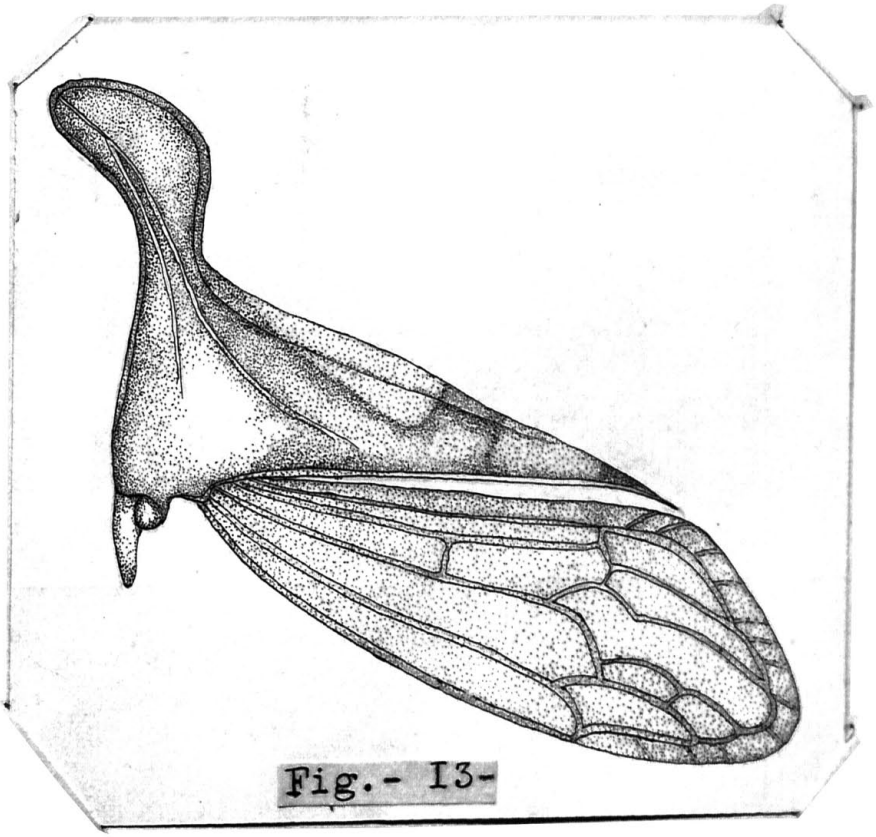


Fig.- I3-

Figure -I4-

Cephalic aspect of head of Vanduzea arquata

Figure -I5-

Lateral aspect of Vanduzea Arquata

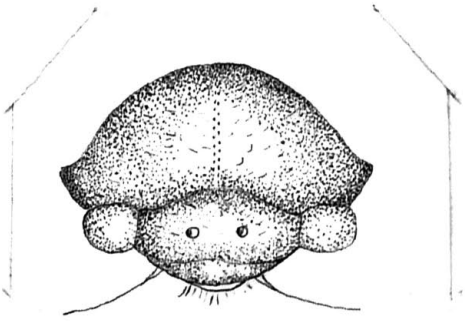


Fig.-I4-

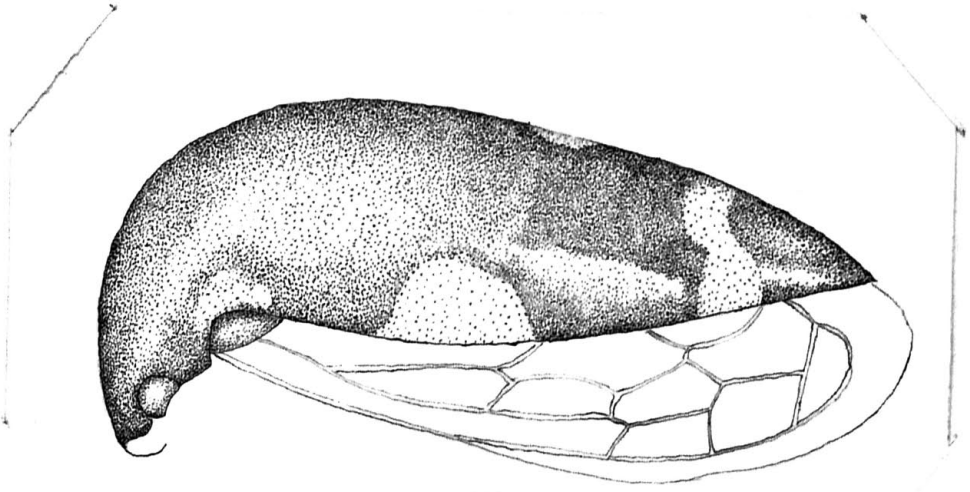


Fig.-I5-

Figure-I6-

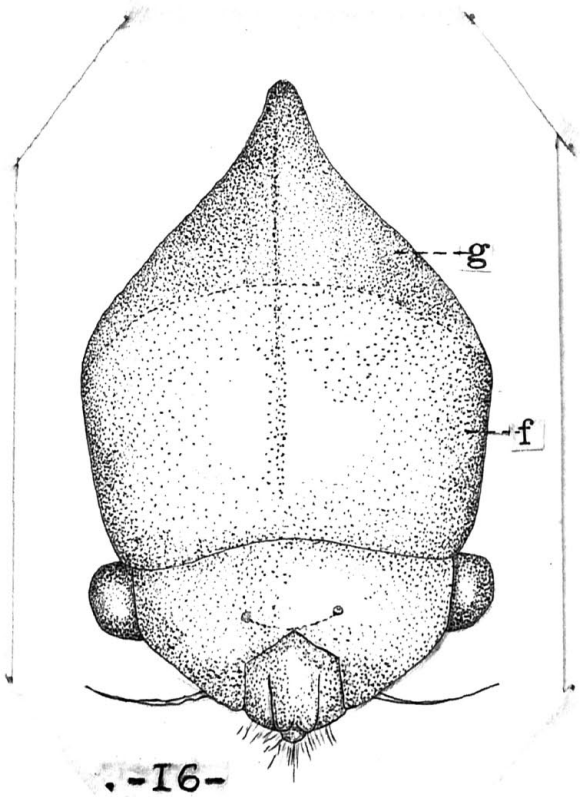
Cephalic aspect of head of Stictocephala inermis

g- Metopidium sloping backward

f- front of metopidium

Figure -I7-

Lateral aspect of Stictocephala inermis



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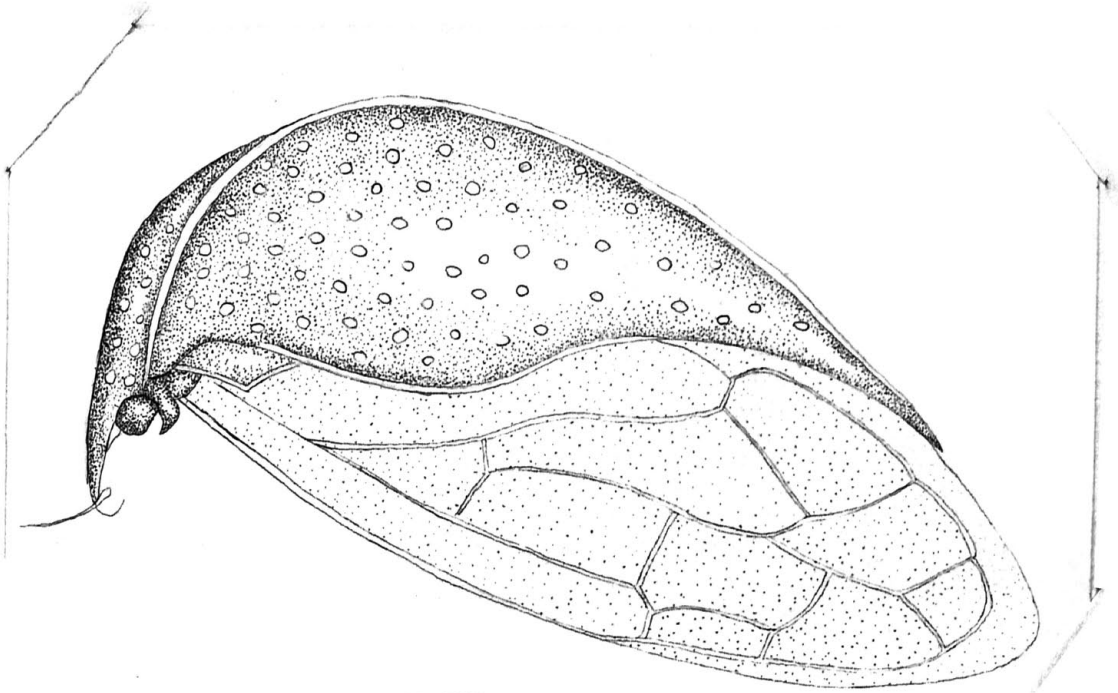


Fig.-I7-

Figure-I8-

Cephalic aspect of head of Acutalis tartarea

Figure-I9-

Lateral aspect of Acutalis tartarea

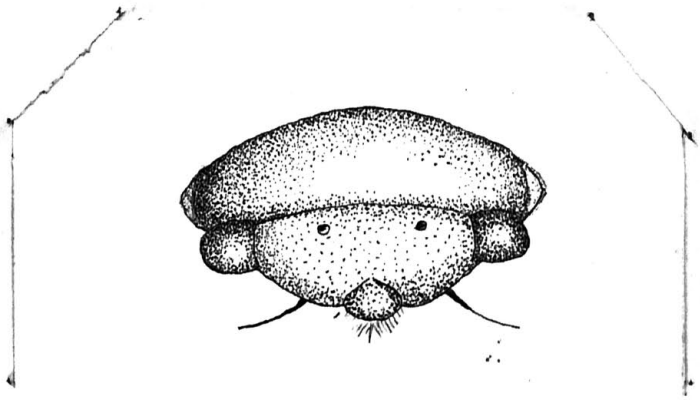


Fig. -I8-

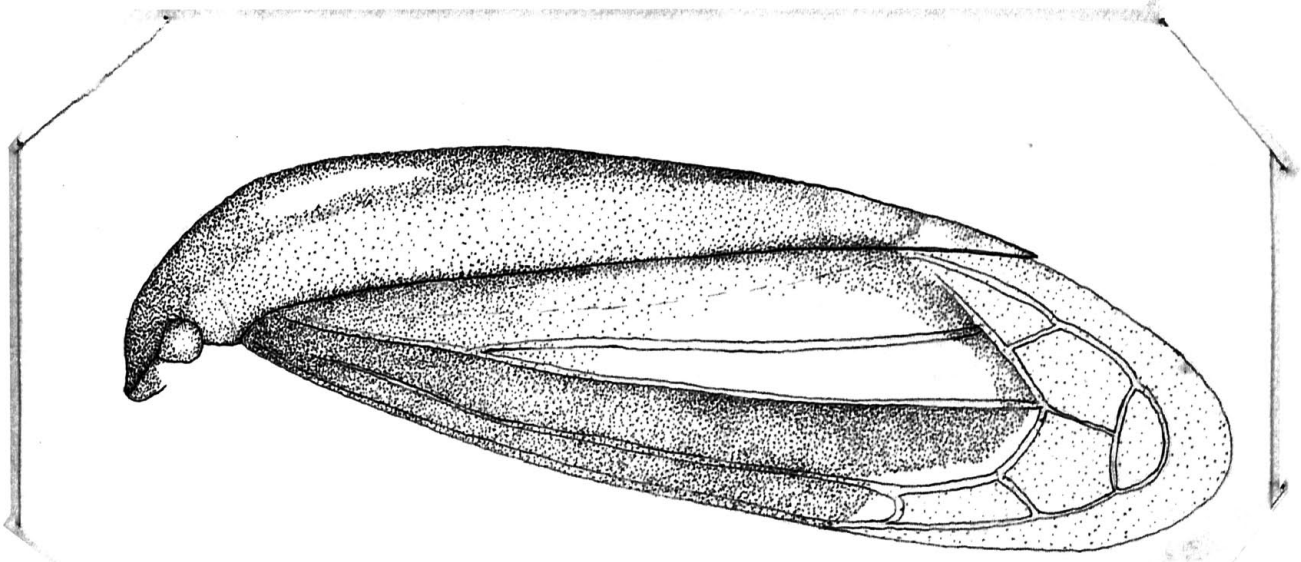


Fig.-I9-

Fifure -20-

Cephalic aspect of Micrutalis calva

Figure -2I-

Lateral aspect of Micrutalis calva

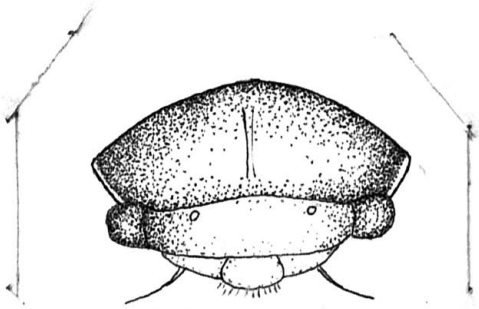


Fig. -20-

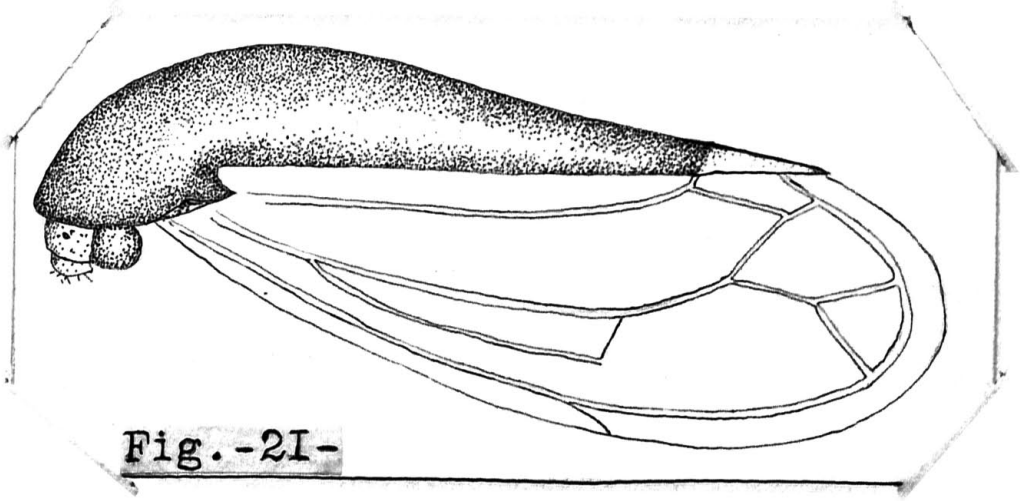


Fig.-2I-

Figure-22-

Cephalic aspect of Archasia galeata

Figure-23-

Lateral aspect of Archasia galeata

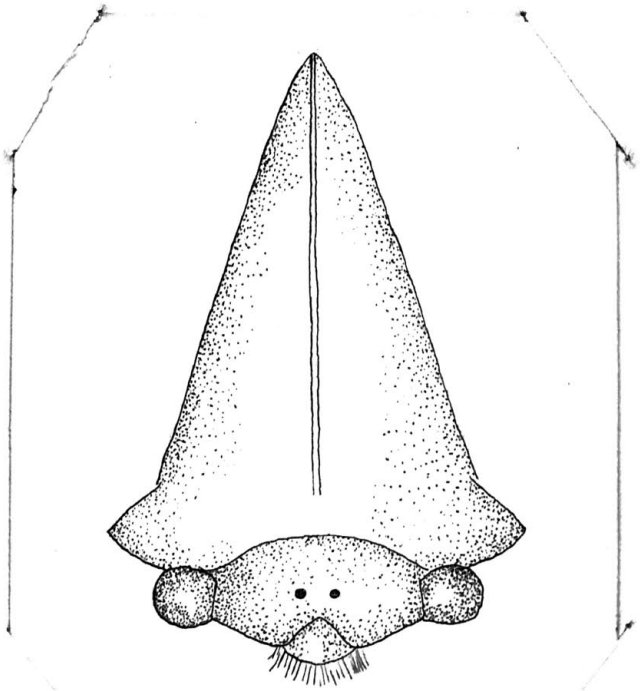


Fig.-22-

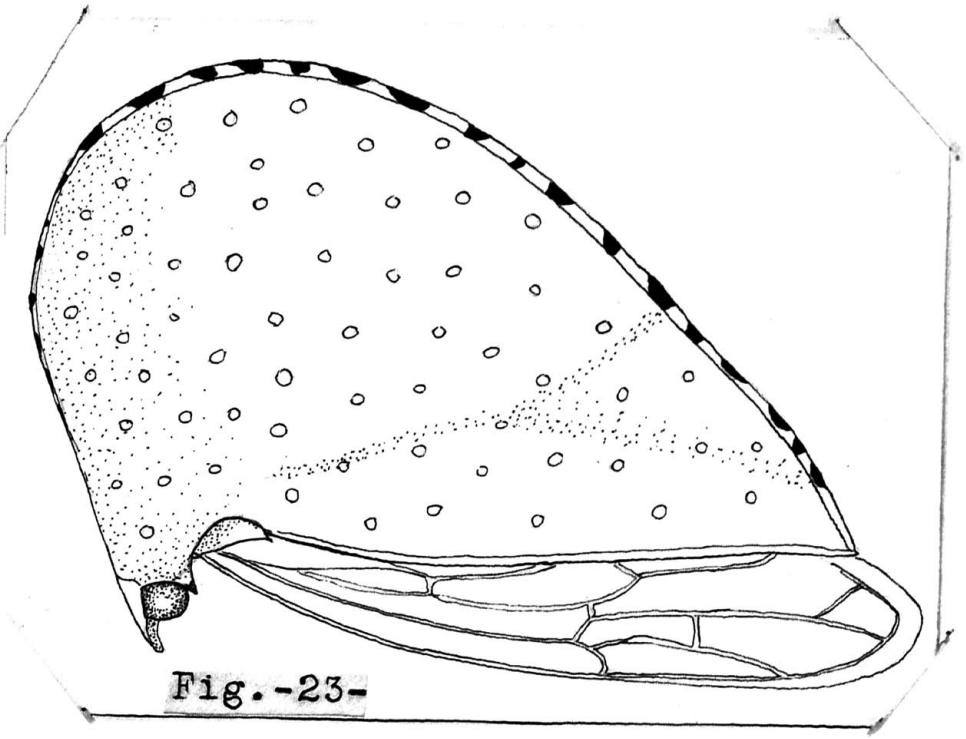


Fig.-23-

Figure-24-

Cephalic aspect of Cyrtolobus vau

Figure -25-

Lateral aspect of cyrtolobus vau

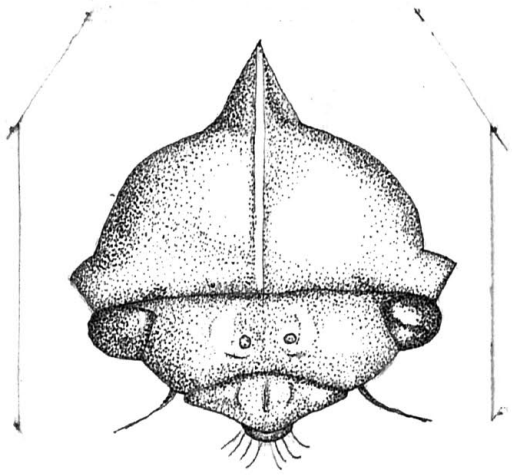


Fig.-24-

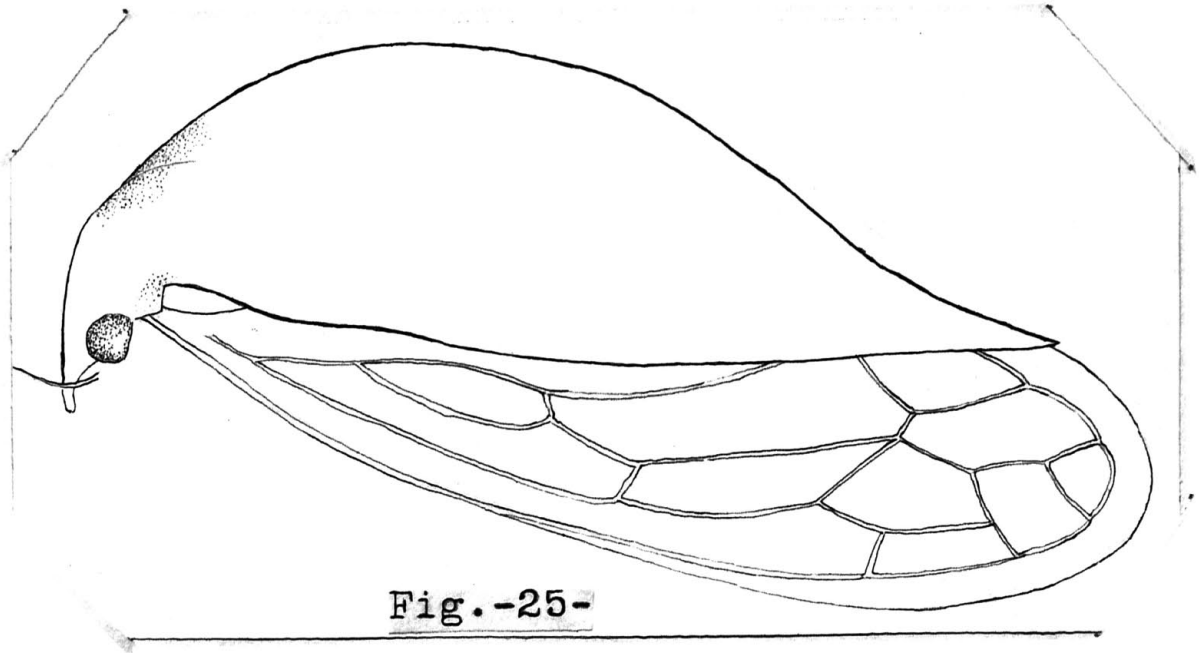


Fig.-25-

Figure-26-

Cephalic aspect of Publilia concava

Figure-27-

Lateral aspect of Publilia concava

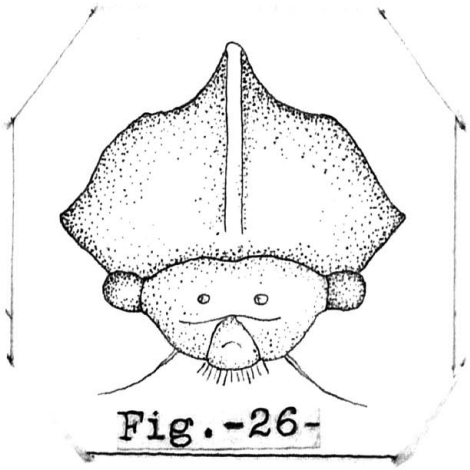


Fig.-26-

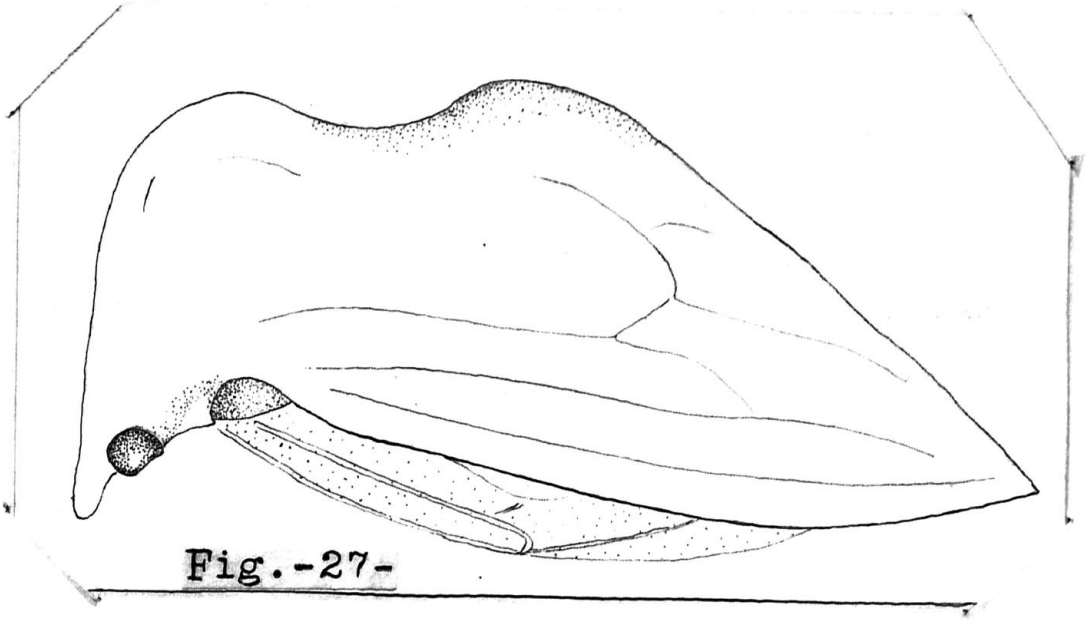


Fig.-27-

Figure-28-

Cephalic aspect of head of Stictocephala lutea

Figure-29-

Lateral aspect of prothorax of Stictocephala

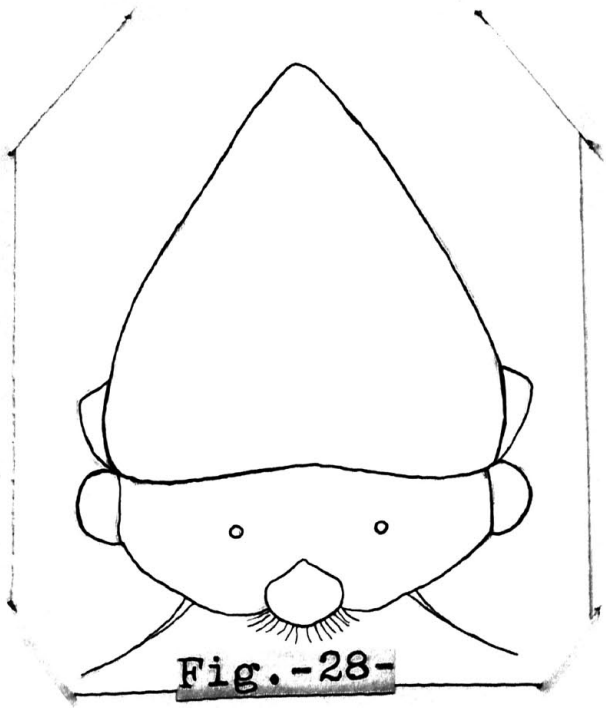


Fig.-28-

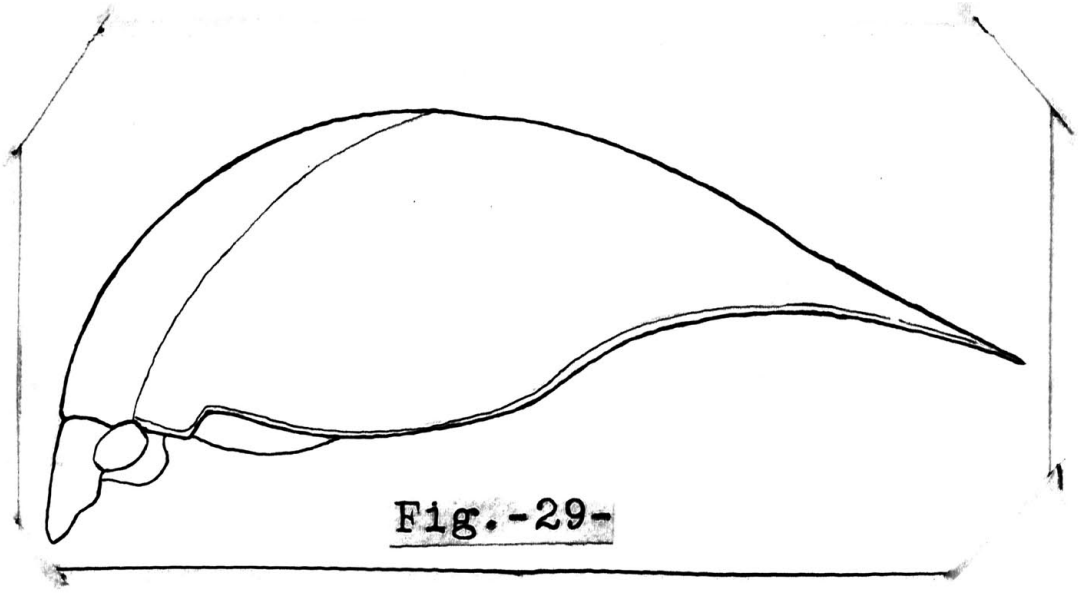


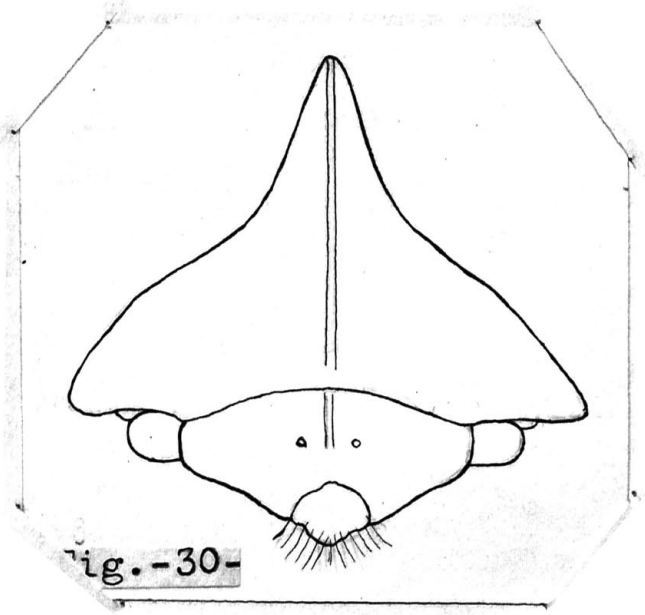
Fig.-29-

Figure-30-

Telemona pyramidata, Cephlalic aspect of the

Figure -3I-

Lateral aspect of prothorax of Telamona pyrami



ig.-30-

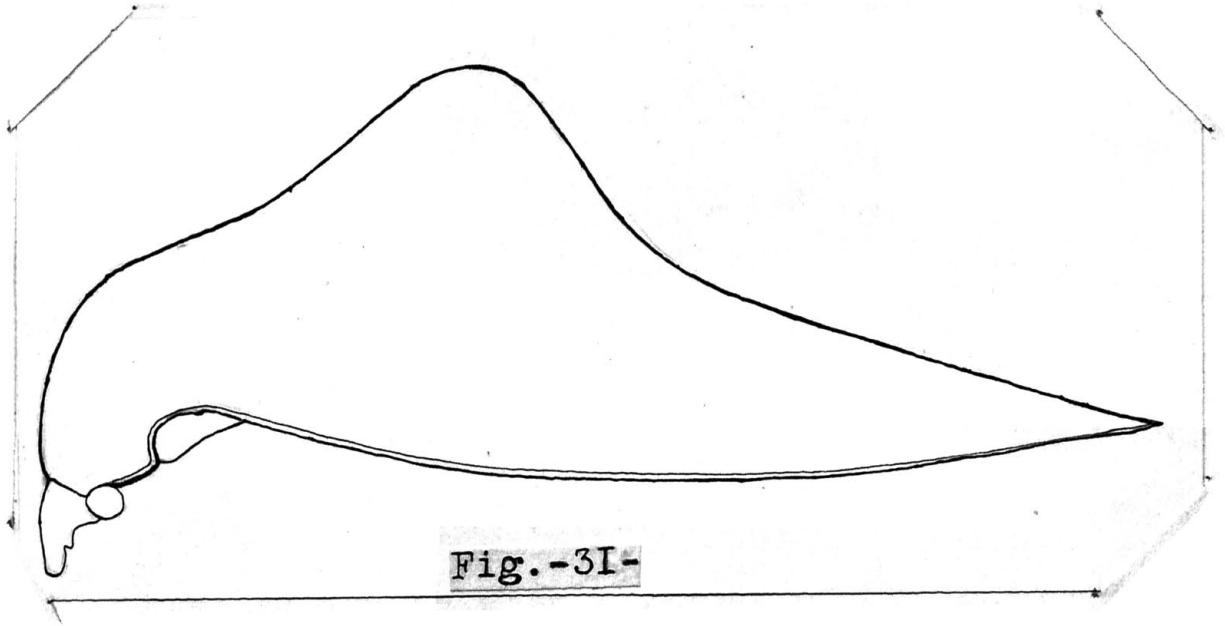


Fig.-3I-

Figure-32-

Cephalic aspect of the head of Publilia modesta

Figure-33-

Lateral aspect of Publilia modesta

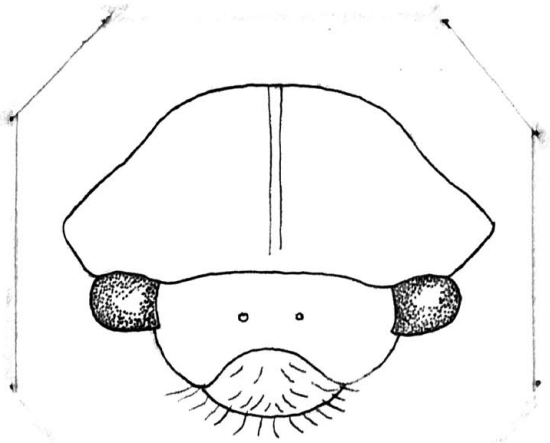


Fig.-32-

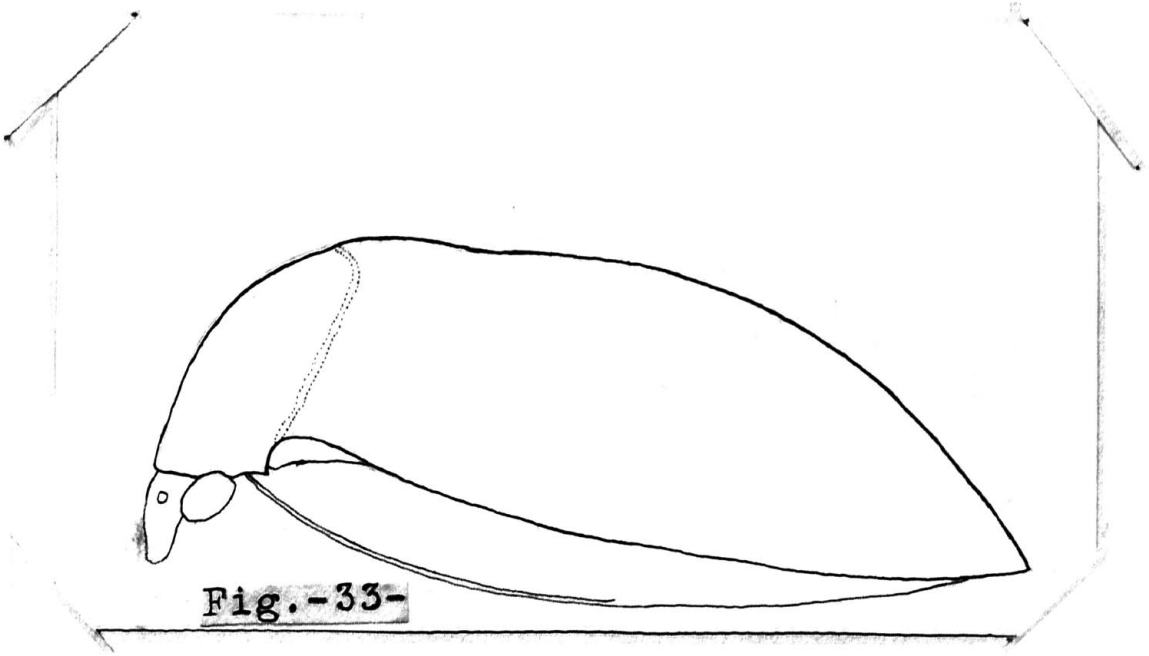


Fig.-33-

Figure-34-

Lateral aspect of prothoracic arm showing pedicel and connection to coxa of prothoracic leg.

b- Cavity for head

c-Coxa of leg.

d-Under sclerite of prothoracic arm.

e- Prothoracic arm

f- indentation where compound eye fits

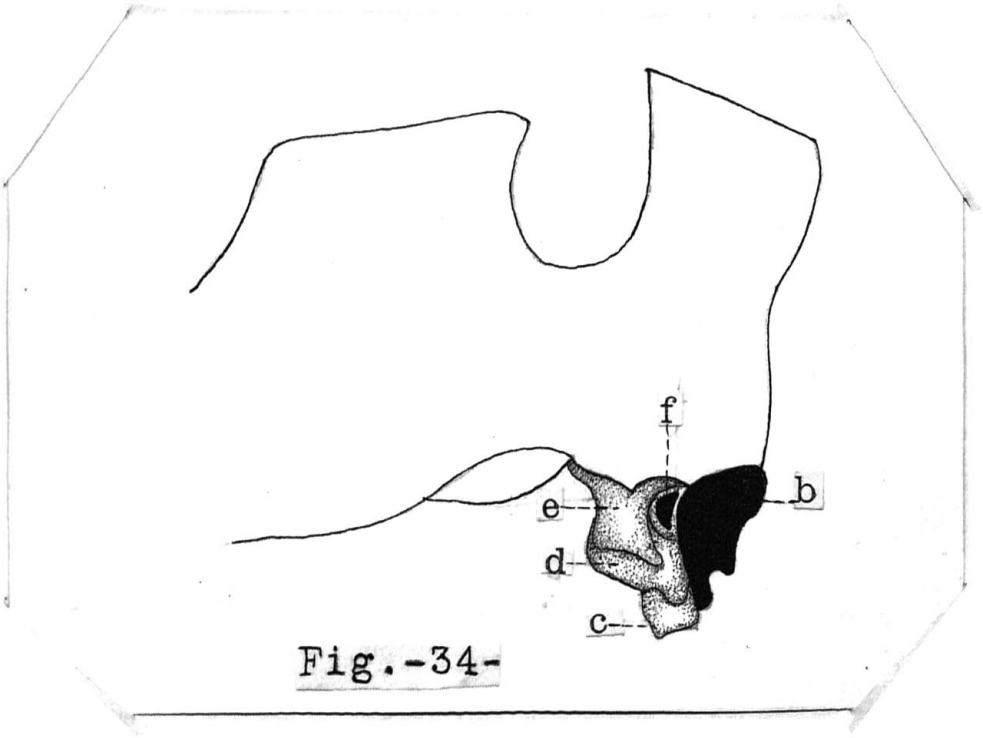


Fig.-34-

Fig.-35-

Cephalic aspect of Head of Entylia sinuata.

e- Epicranium

s- Epicranial suture

o- Ocelli

c- Compound eye

l- Lorae

y- clypeus(Cephalic face)

a- Antennae

Fig. 36-

Antenna of Entylia sinuata

s- Socket

m- Basal segment

n- Second segment bearing sensoria

t- Third segment

x- hair-like termination of third segment.

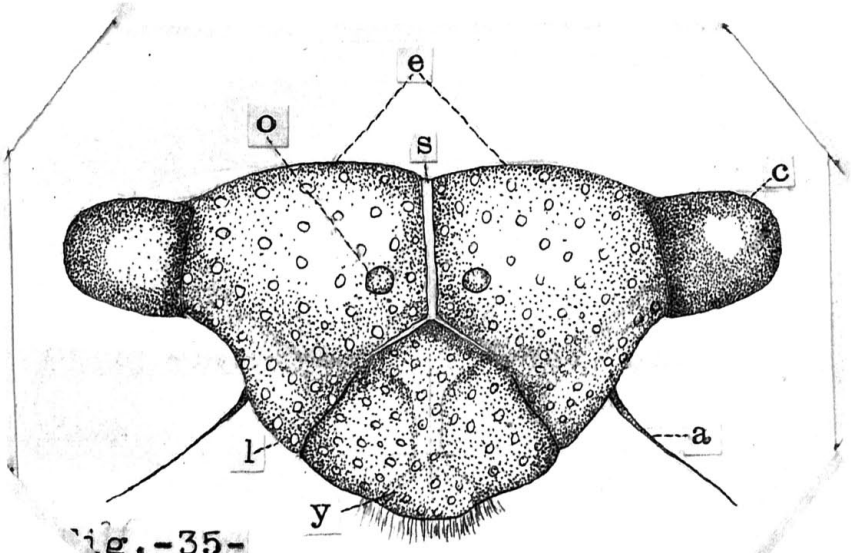


Fig.-35-

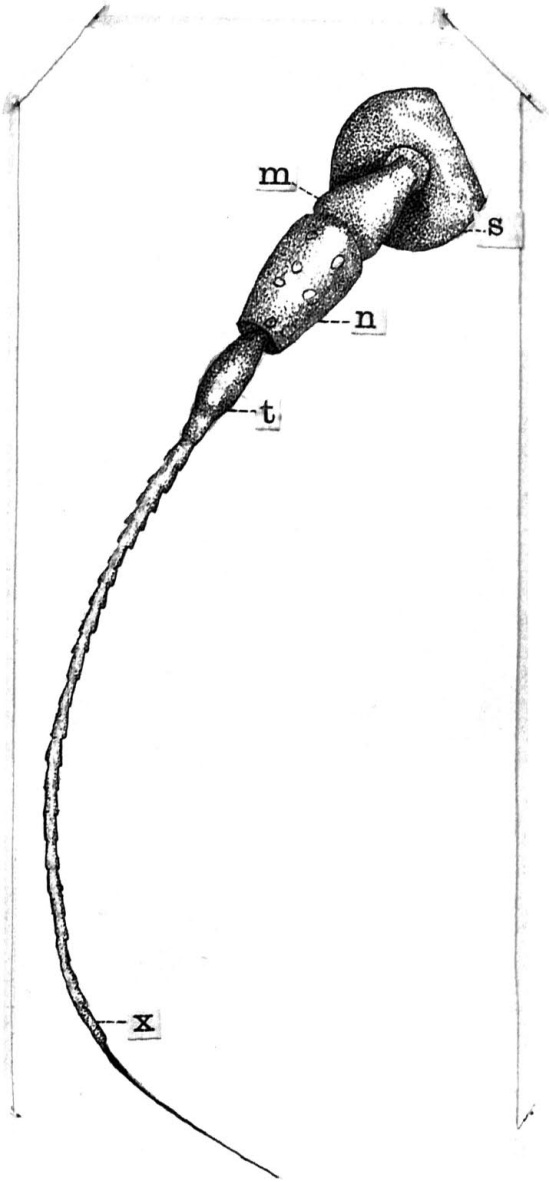


Fig. 37A-

Ventral aspect of Head of Entylia sinuata

x- Epicranium

o- Ocelli

c- Compound eye

a- Antenna

g- Gena

f- Cephalic face of clypeus

y- Ventral face of Clypeus

m- Mandibular sclerite

n- Maxillary sclerite

lb- Labrum

p- Epipharynx

l- the three joints of the beak called the labium

s- Maxillary setae.

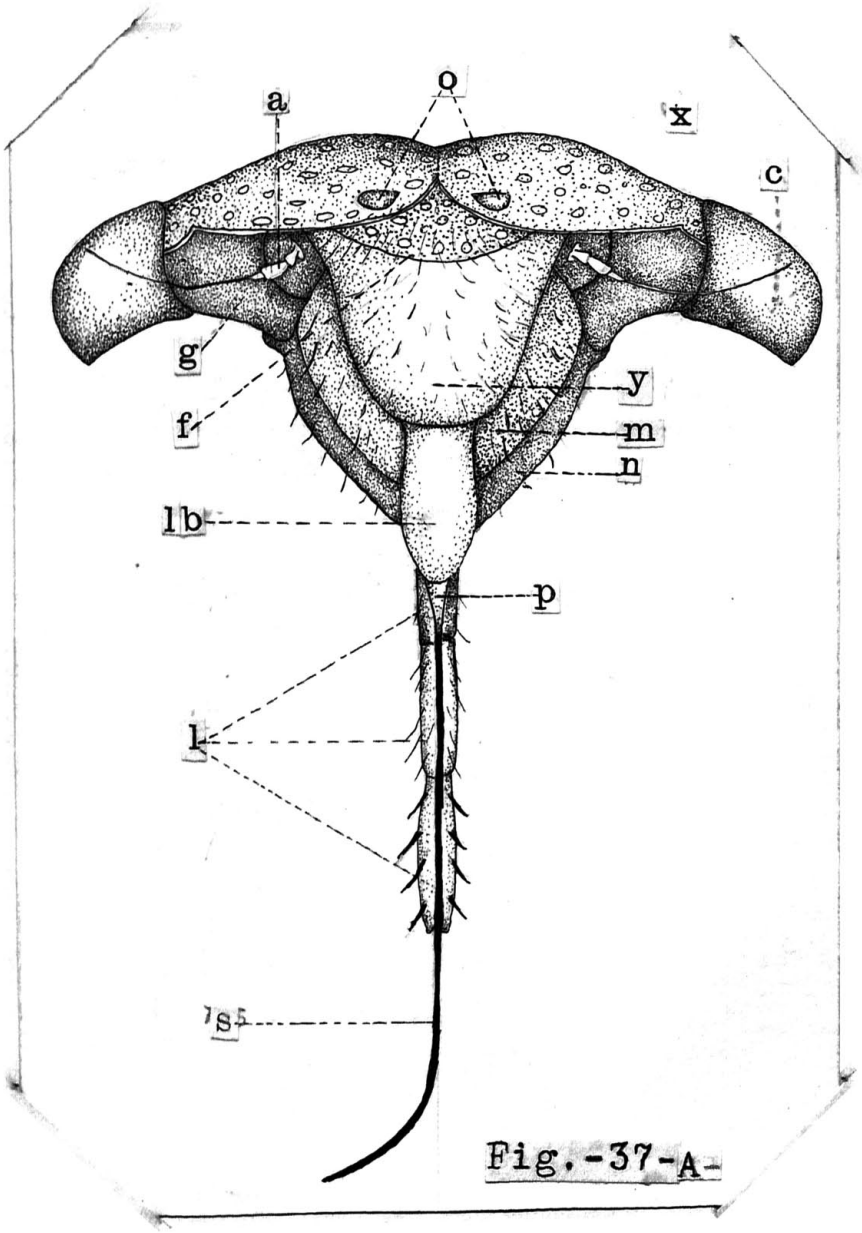


Fig.-37-A-

Fig. 37-B-

m- Tip of mandibular seta

n- Tip of Maxillary seta

Fig 38-B-

Beak of Entylia sinuata, enlarged

b- Tip of labrum

p- epipharynx

l-labium

n- seta of Maxillae

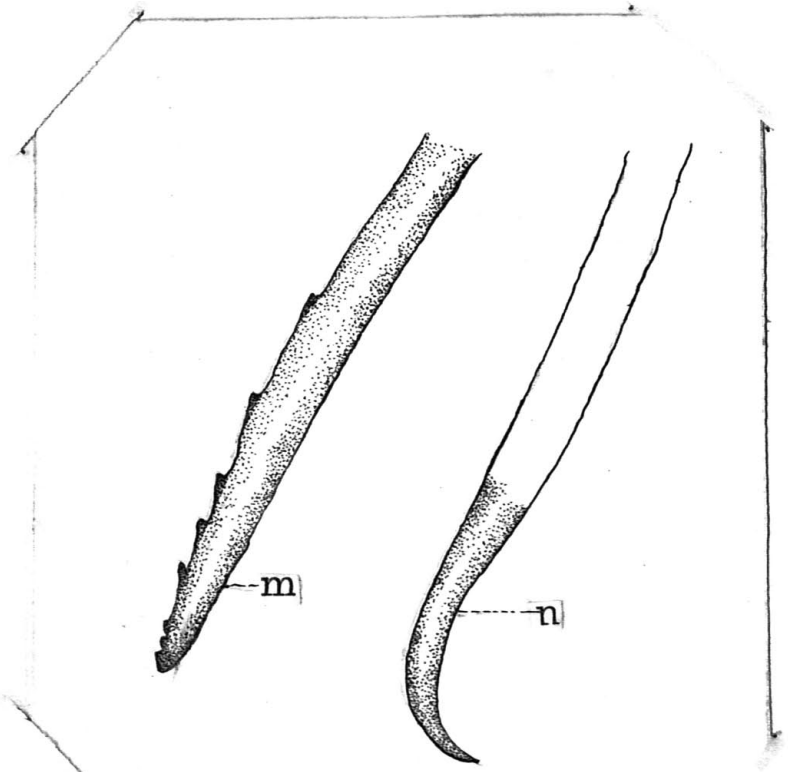


Fig.-37-B-

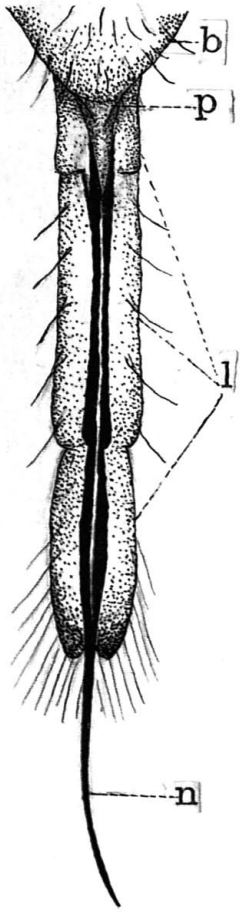


Fig.-38-B-

Fig. 37A-

Ventral aspect of Head of Entylia sinuata

x- Epicranium

o- Ocelli

c- Compound eye

a- Antenna

g- Gena

f- Cephalic face of clypeus

y- Ventral face of Clypeus

m- Mandibular sclerite

n- Maxillary sclerite

lb- Labrum

p- Epipharynx

l- the three joints of the beak called the labium

s- Maxillary setae.

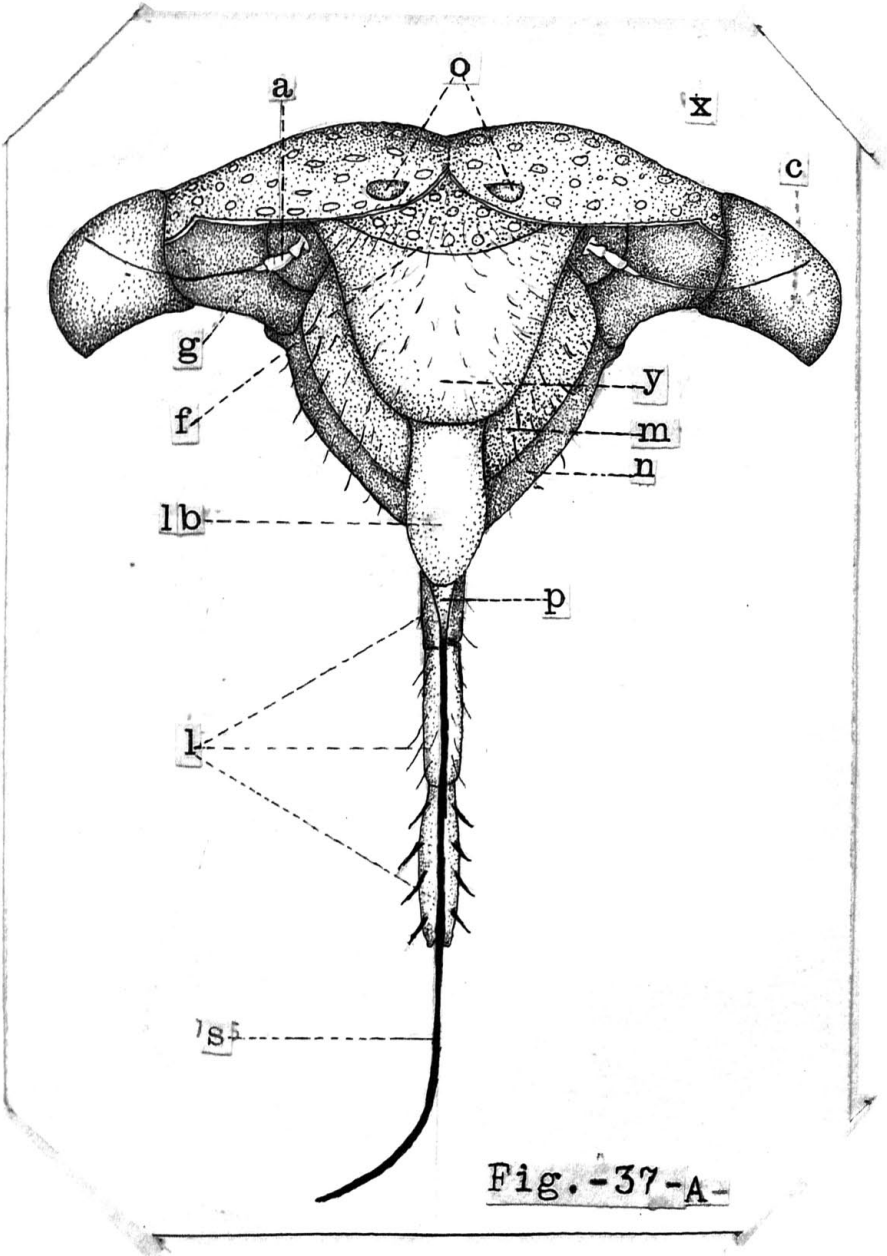


Fig.-37-A-

Fig. 37-B-

m- Tip of mandibular seta

n- Tip of Maxillary seta

Fig 38-B-

Beak of Entylia sinuata, enlarged

b- Tip of labrum

p- epipharynx

l-labium

n- seta of Maxillae

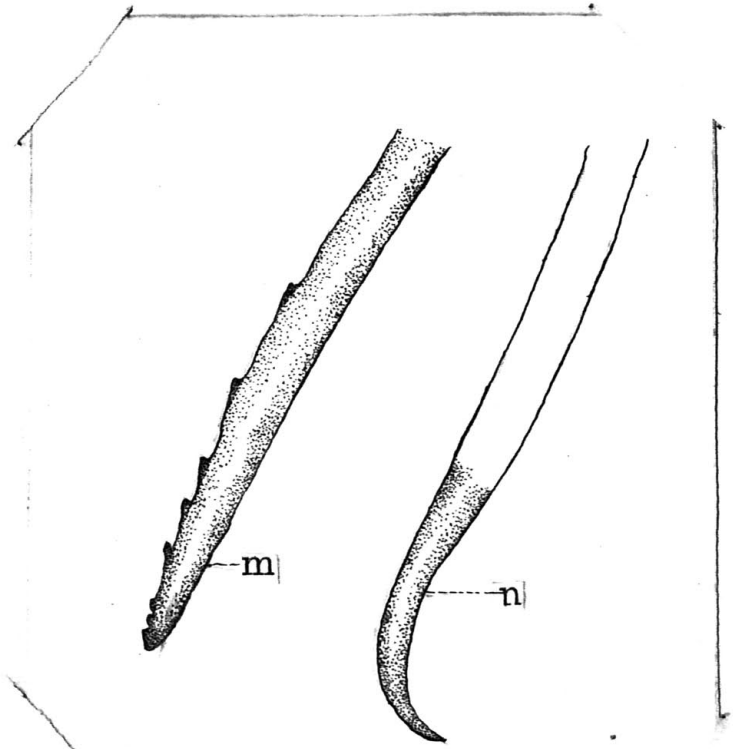


Fig.-37-B-

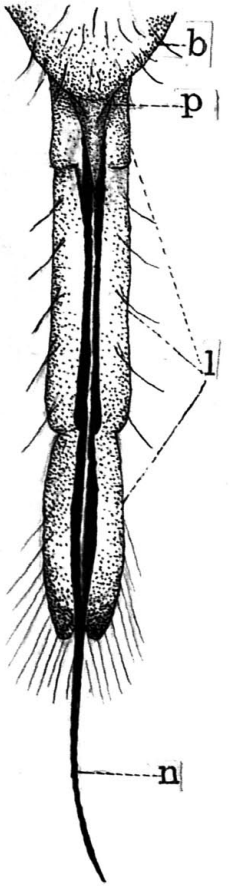


Fig.-38-B-

Fig/-38-A-

Lateral aspect of the Head of Entylia sinuata

c- Compound eye

d-Cephalic face of Clypeus

y- Ventral face of Clypeus

l- Labrum

e- Epipharynx

g- Gena

m- Mandibular sclerite

x- Maxillary sclerite

n- Floor of the mouth

k- the three joints of the labium

Fig. 39-

Interior view of front of mouth

y- Clypeus

x- Mandibular sclerite

n- distal tip of mandibular sclerite

h- Hypo pharynx

e- Grooved inner surface of epipharynx

z- Tip of epipharynx, the portion beyond the

l- edge of labrum curving inward to help hold

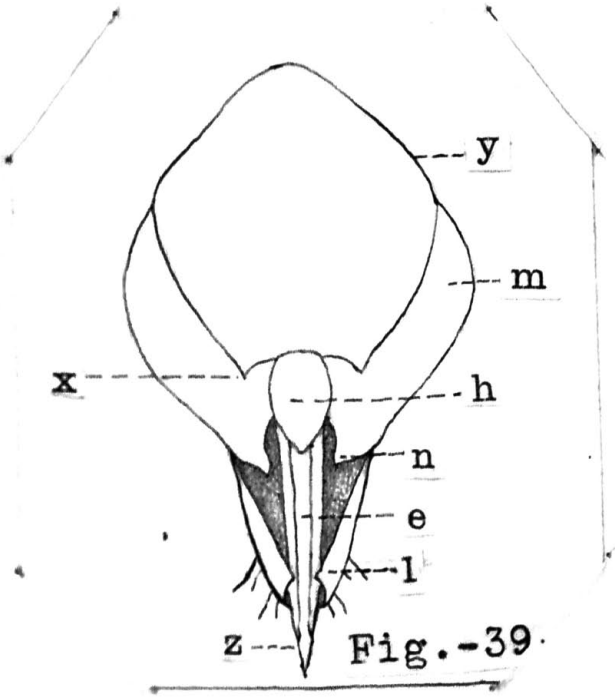


Fig.-39

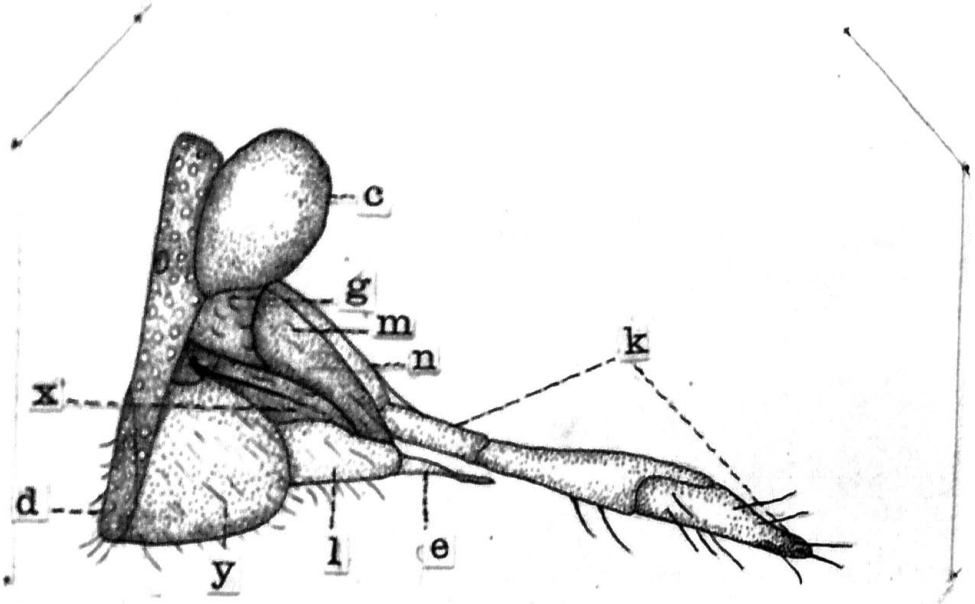


Fig.-38-A-

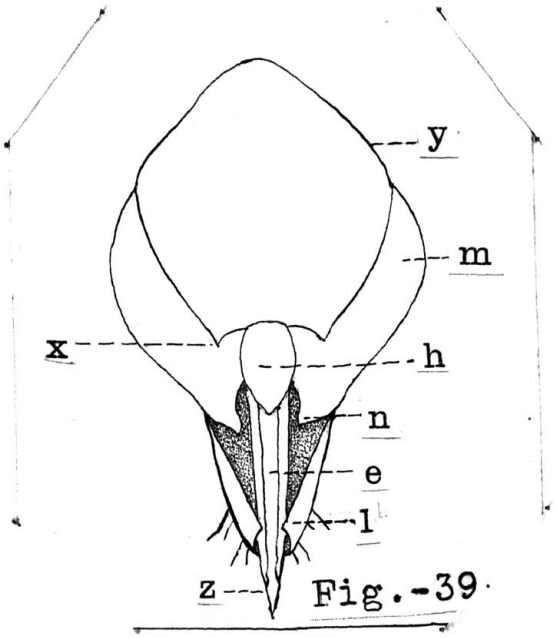


Fig.-39

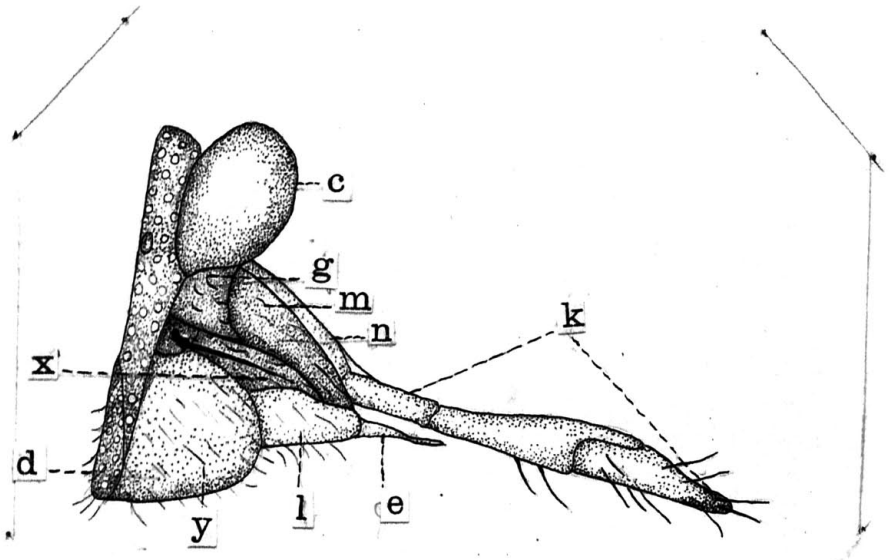


Fig.-38-A-

Fig.40-

View of the head on the side resting against

y- Cavity into head.

m- muscle holding head to thorax

e- Epicranial suture

o- Occiput

c- Compound eye

t- Tentorium with its branches which lead into the and Thorax

r- Rod which supports the labium

n- Floor of mouth

x- Maxillary sclerites

l- Three joints of the Labium

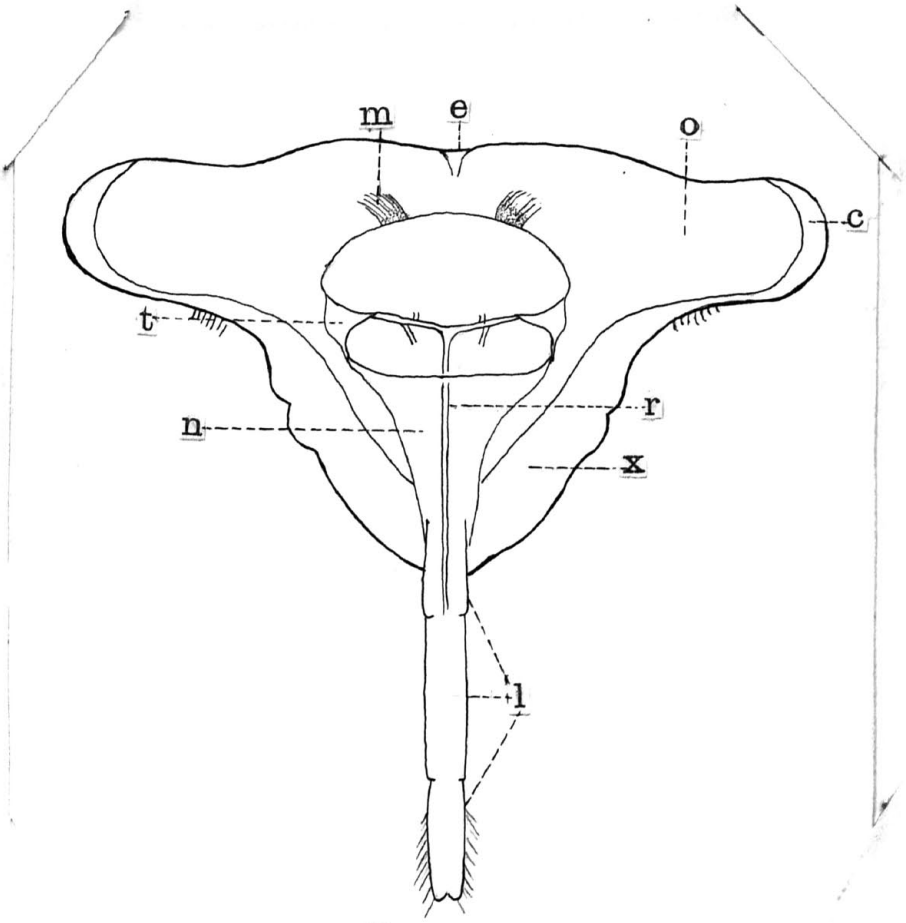


Fig.40-

Fig. 4I-

Back of head with one maxillary sclerite removed to the mandibular sclerite which lies in front of it.

o- Occiput

x- Maxillary sclerite

p- Maxillary process which guides the setae

s- Maxillary seta

y- Muscle connecting the maxillary seta to the

m- Mandibular sclarite

b- Mandibular seta

y- shows the articulating joint which connects the seta to the sclerite

n- Muscle which hold the mandibular seta to th

Fig. 42-

Cephalic aspect of the head with the mandibular and sclerites pulled apart.

e- Epicranium

c- Front face of the clypeus

y- Ventral face of the clypeus

d- Mandibular sclerite

x- Maxillary sclerite

The cross indicated where the seta is joined sclerite.

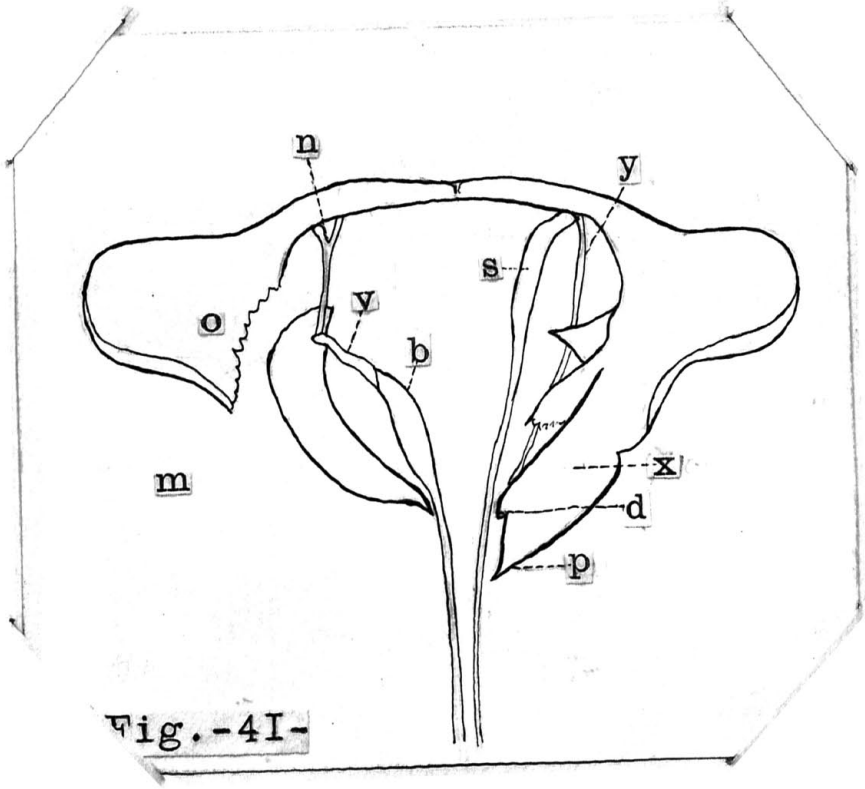


Fig.-41-

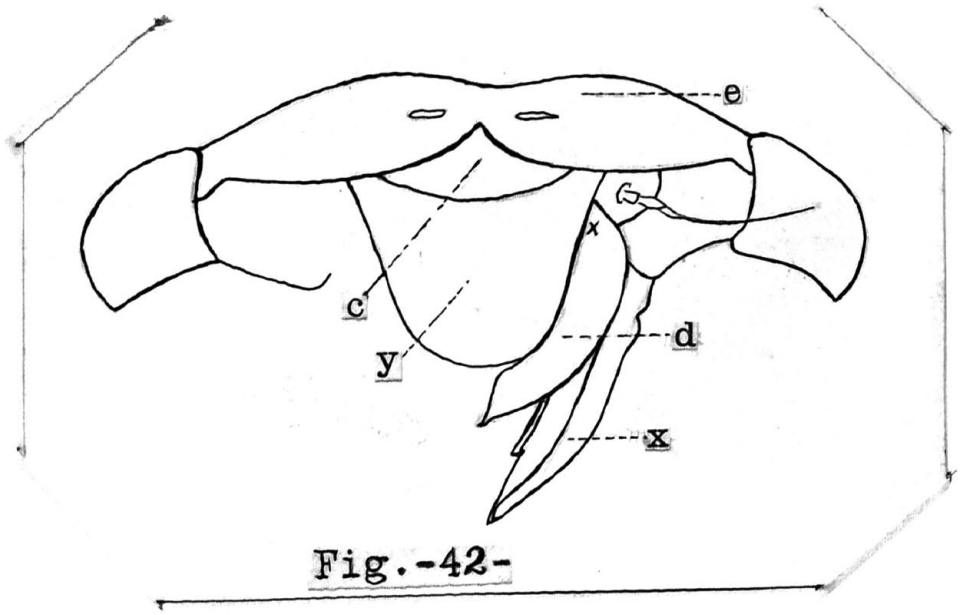


Fig.-42-

Fig. 43

Section through the First segment of the beak.

a- Support rod

b-Inner edge of beak

c- outer edge pf beak

d- edge of labrum

e- Mandibular setae showing opening to form a tube

f- Maxillary setae showing the manner in which the are grooved together to form a tube.

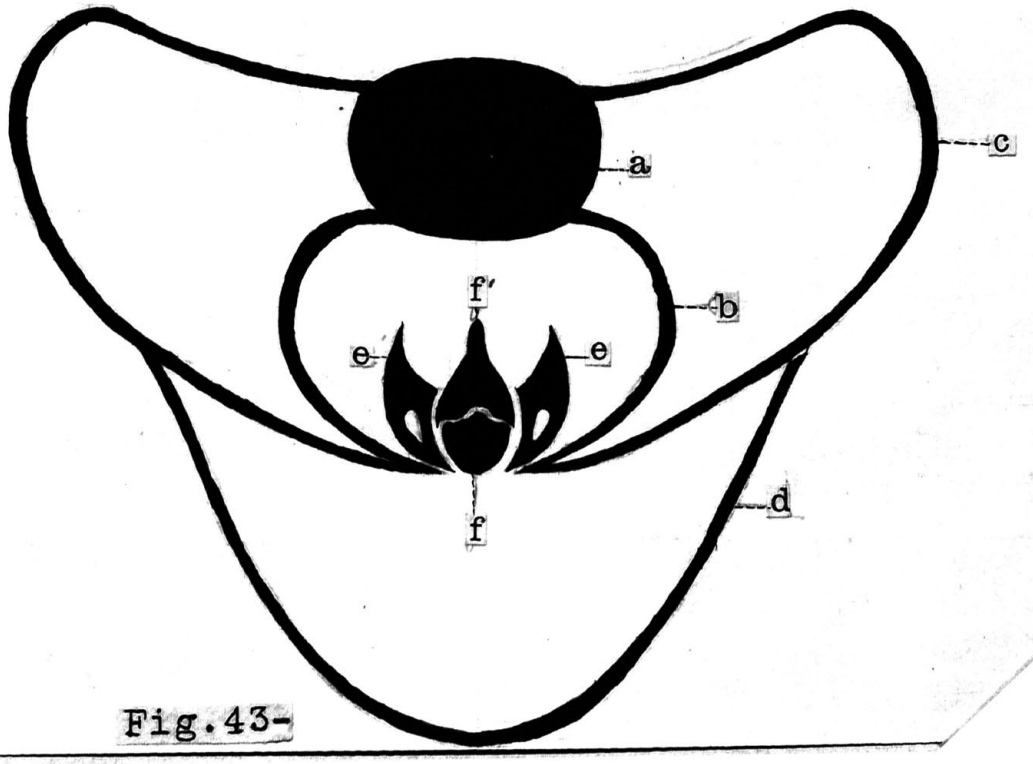


Fig.43-

Figure.44.

Section through the second segment of the beak.

a- indentation for support rod.

b- outter edge of the beak

g- inner edge of the beak

d- epipharynx

e- Mandibular setae

f- Maxillary setae

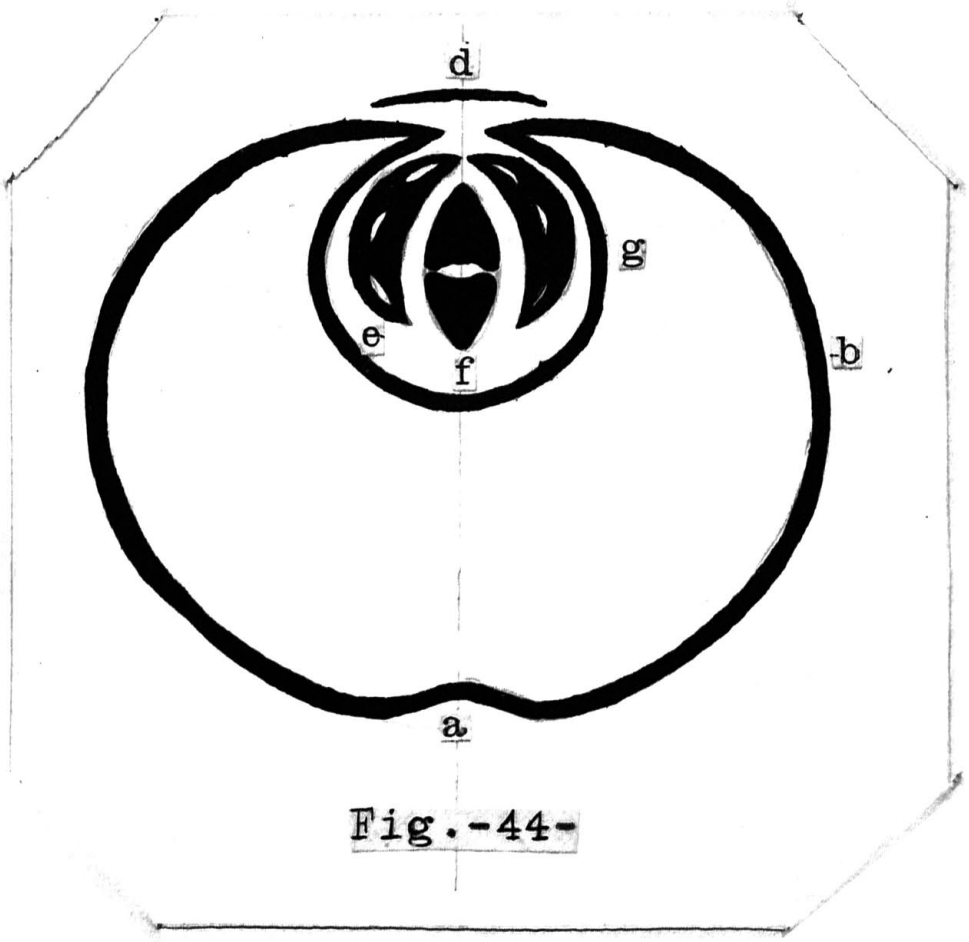


Fig.-44-

Figure 45-

Section through the middle of the third or last segm of the beak.

a- indentation for support rod

b- inner wall of beak

c- outter wall of beak.

f- maxillary setae

e- Mandibular setae

m- muscles

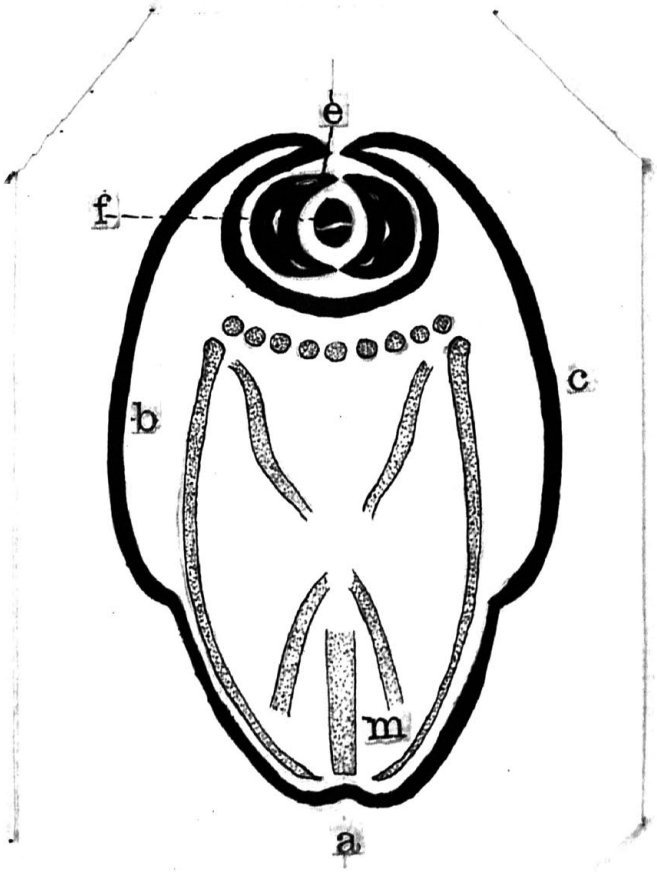


Fig.-45-

Figure-46-

Section through the tip of the beak

a- indentation for support rod

c-b- outter wall

x- Maxillary setae

m- muscles

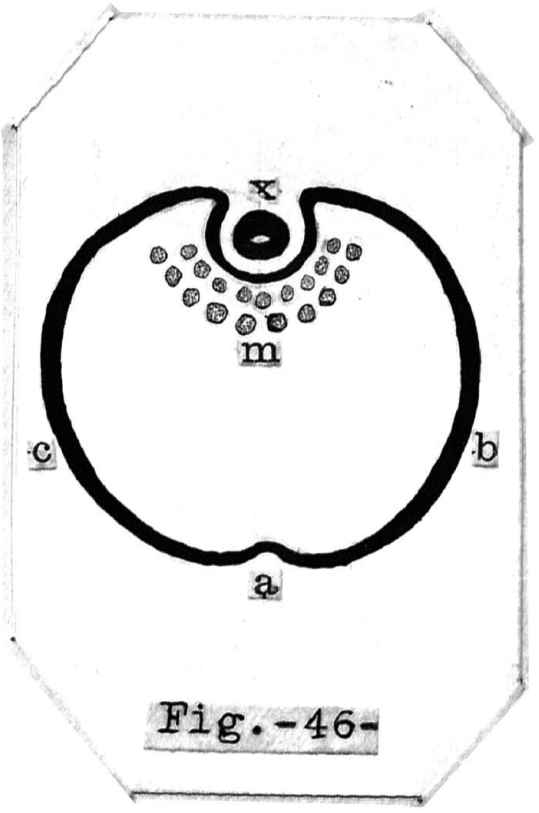


Fig.-46-

Fig. 47-

Cross section of the Head the plane being parallel with the cephalic face.

p- Ring of the Pharynx

x- Maxillary setae

d- Mandibular setae

y- Clypeus

m- Muscles supporting the clypeus

xs- Maxillary sclerite

ds- Mandibular sclerite

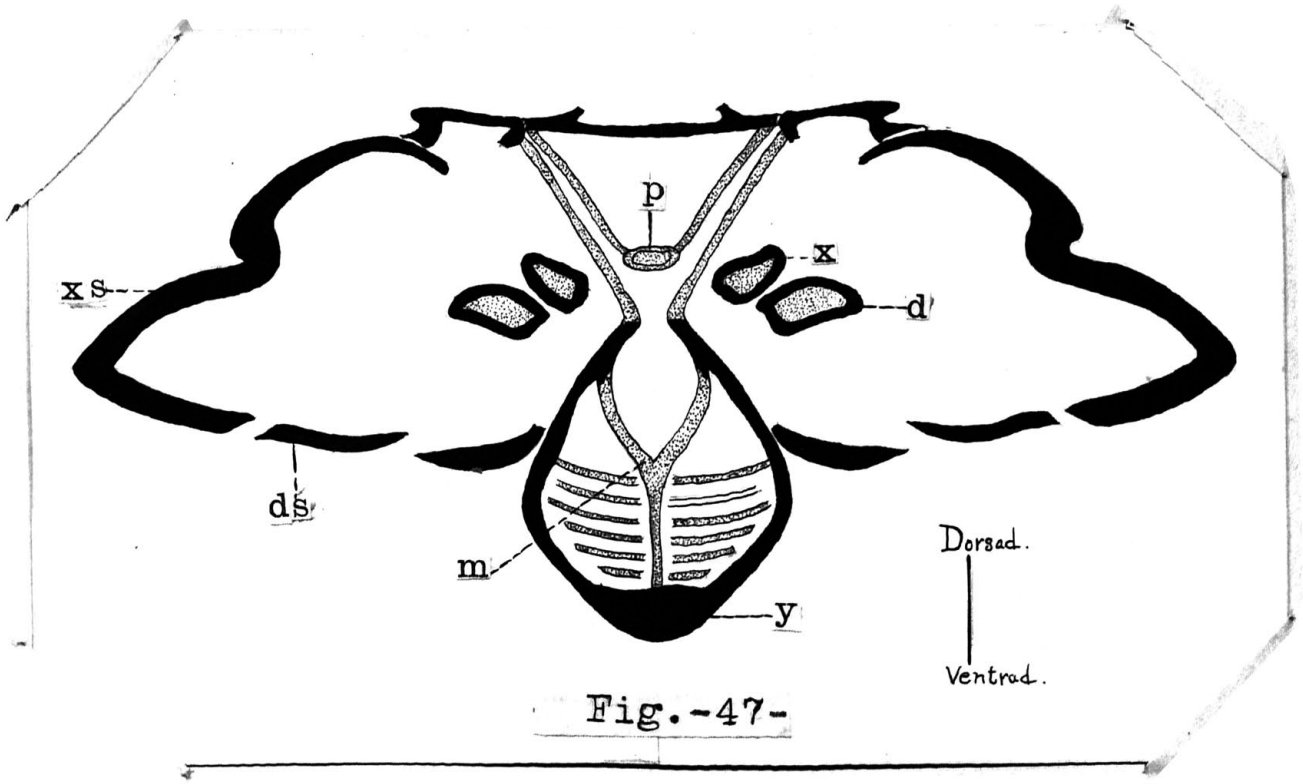


Fig.-47-

Fig.-48-

Cross section parallel with the beak and Maxillary scle

e- Compound eye

o- Optic nerve

h- Ring of the pharynx

x- Maxillary seta

a- Muscle holding the seta to the cranium

r- Retractor

p- Pr-tractor muscles

d- Mandib ular seta

t- Retractor

n- Protractor

c- pumping muscle

m- Muscles which operate the pharynx near the epiph

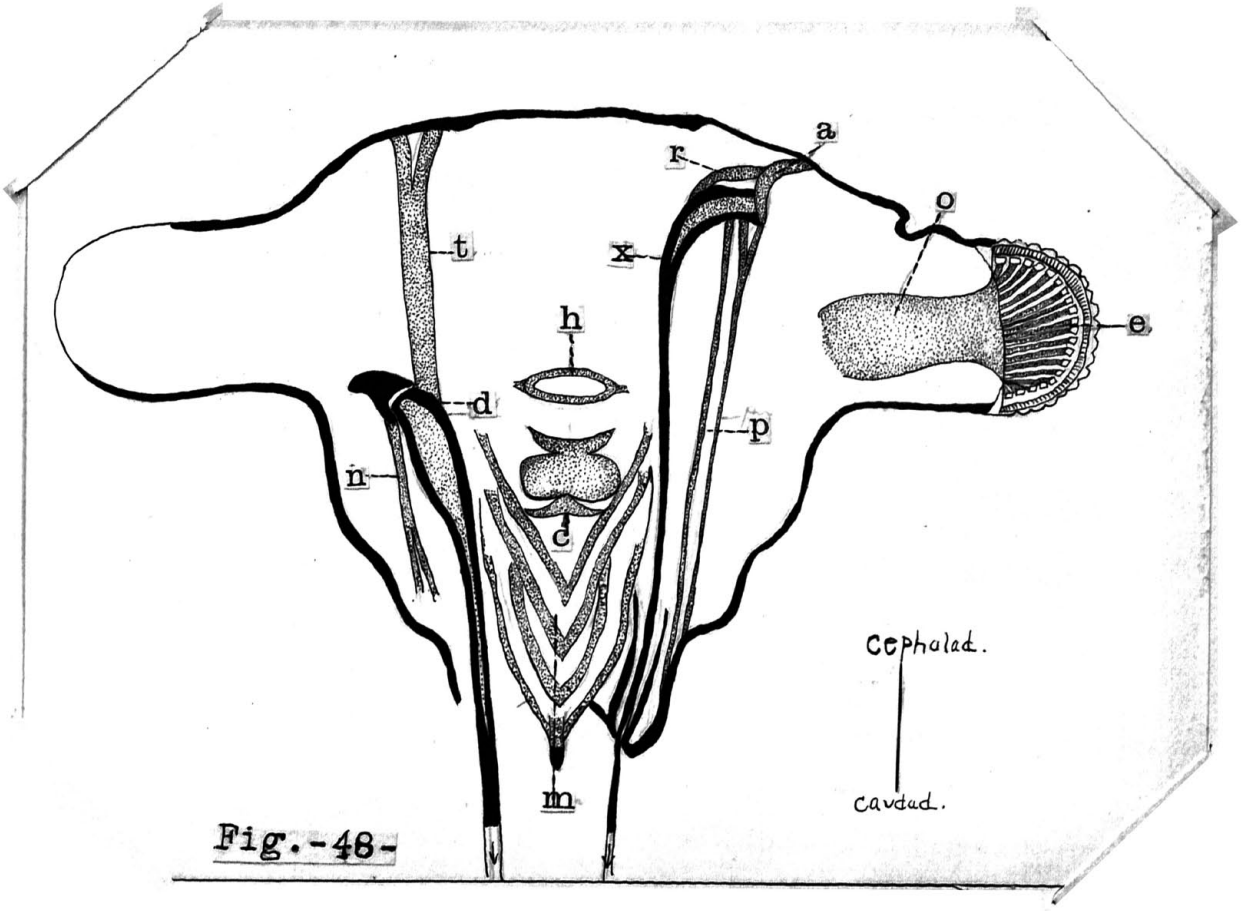


Fig.-48-

Fig. 49-

Cross section near the back of the head

Parallel with the Cephalic face.

b- Lower brain over which the oesophagus passes

s- Upper brain

h- Oesophagus

m- Muscle which supports the oesophagus

x- Maxillary seta

e- Compound eye

o- Optic nerve

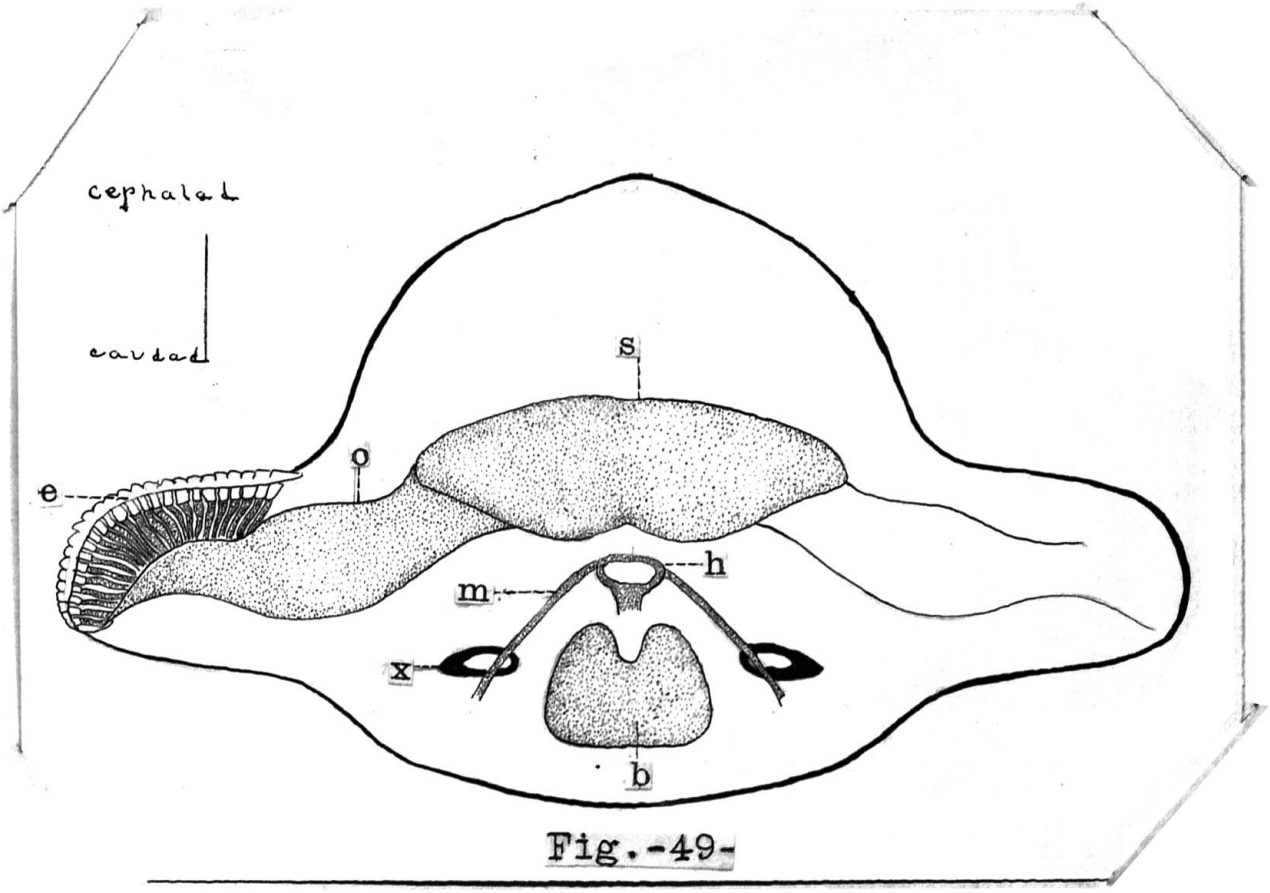


Fig.-49-

Figure-50-

Longitudinal section of the head.

a- Back of beak lying against the sternum

b- Supraoesophagal ganglion or upper brain

e- sub-oesophagal ganglion or lower brain

r- support rod

p- pumping muscles or salivary ejaculator

k- duct leading from salivary glands

o-duct from salivary ejaculator(p) to oesophagu

f-floor of mouth

v- muscles

j-muscles

x- maxillary seta

g-epipharynx

l- labrum

n-muscles governing pharynx

u- muscles governing pharynx

z- Clypeus(Ventral face)

y- Clypeus(Cephalic face)

t-m- muscles supporting clypeus

h- hypo-pharynx.

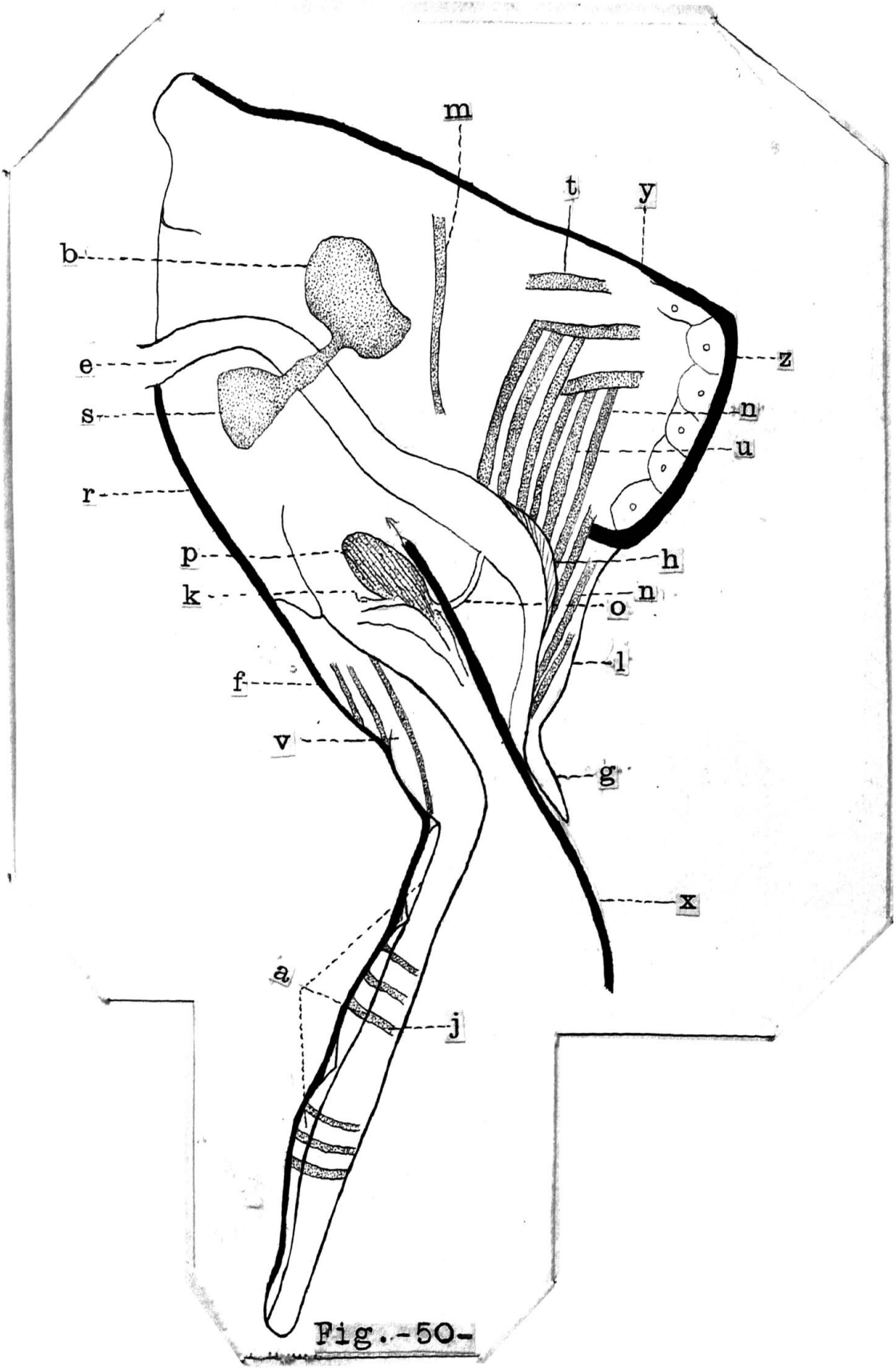


Fig.-50-

Fig. -5Is

Ventral aspect of the reproductory organs of the male

a -last abdominal segment.

s - Sub-genital plate

r- claspers

x-z-claspers

k- copulatory organ

y- anal plates

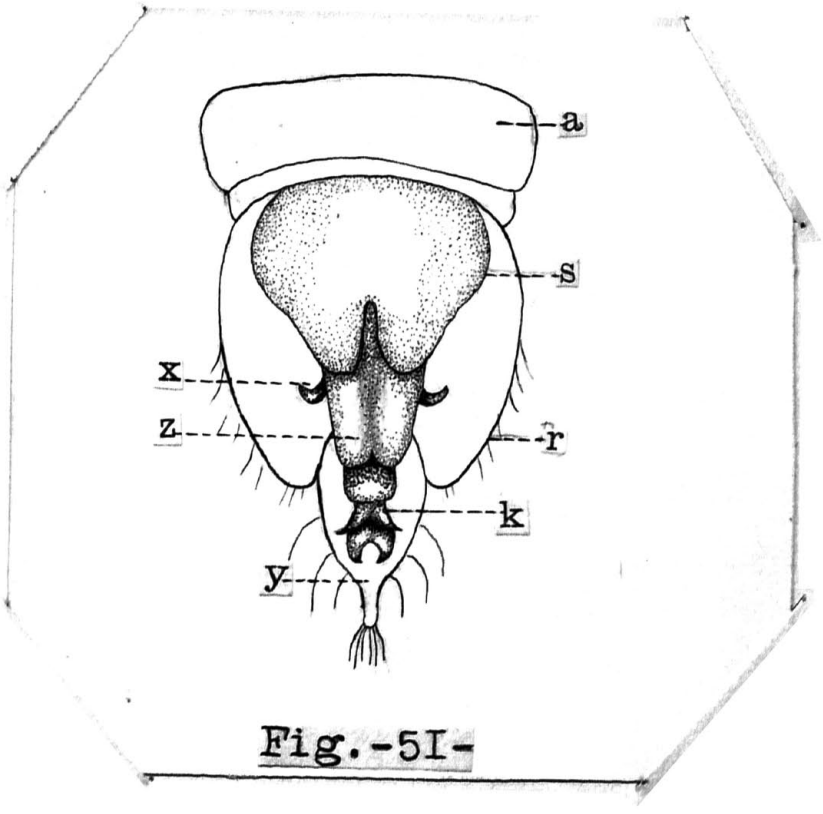


Fig.-5I-

Figure-52-

Lateral aspect of the tip of the abdomen of the male.

g- Supra-anal plate

p- cercus

r- claspers

x-z claspers

y- anal plate bearing the copulatory organ on its vent al side(See Fig. 51)

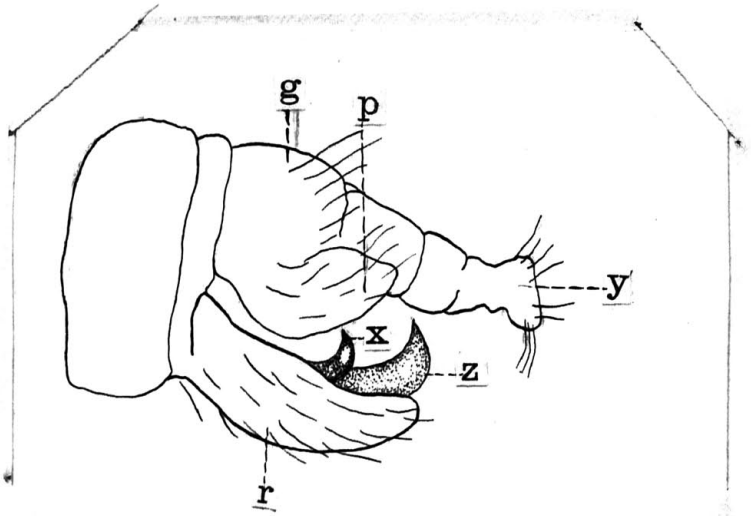


Fig. 52-

Figure 53-

Ventral aspect of the Female Abdomen tip.

v- Ventral plate

g- supra anal plate

r- egg guides

e- claspers

o- oviducts

y- anal plates

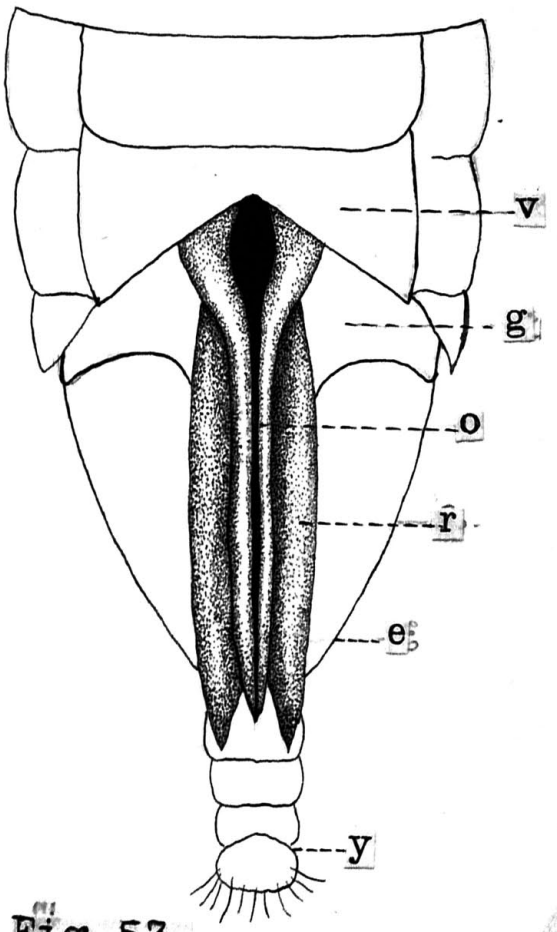


Fig. 53-

Figure-54-

Lateral aspect of the tip of the abdomen of the female

g- Supra-anal plates

y- anal plates

gs- sub-genital plate

r-claspers

e-egg guides

v- last ventral segment of the abdomen

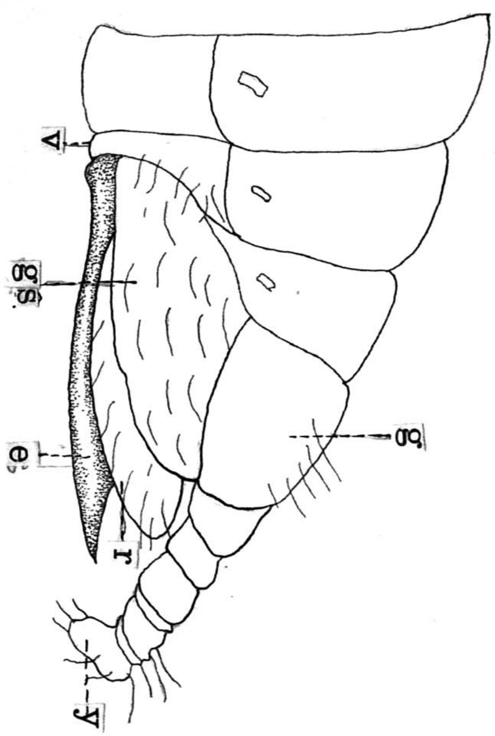


Fig.-54-

Figure-55-

Leaf of Cnicus altissimus showing at A, the egg masslaid by Entylia sinuata

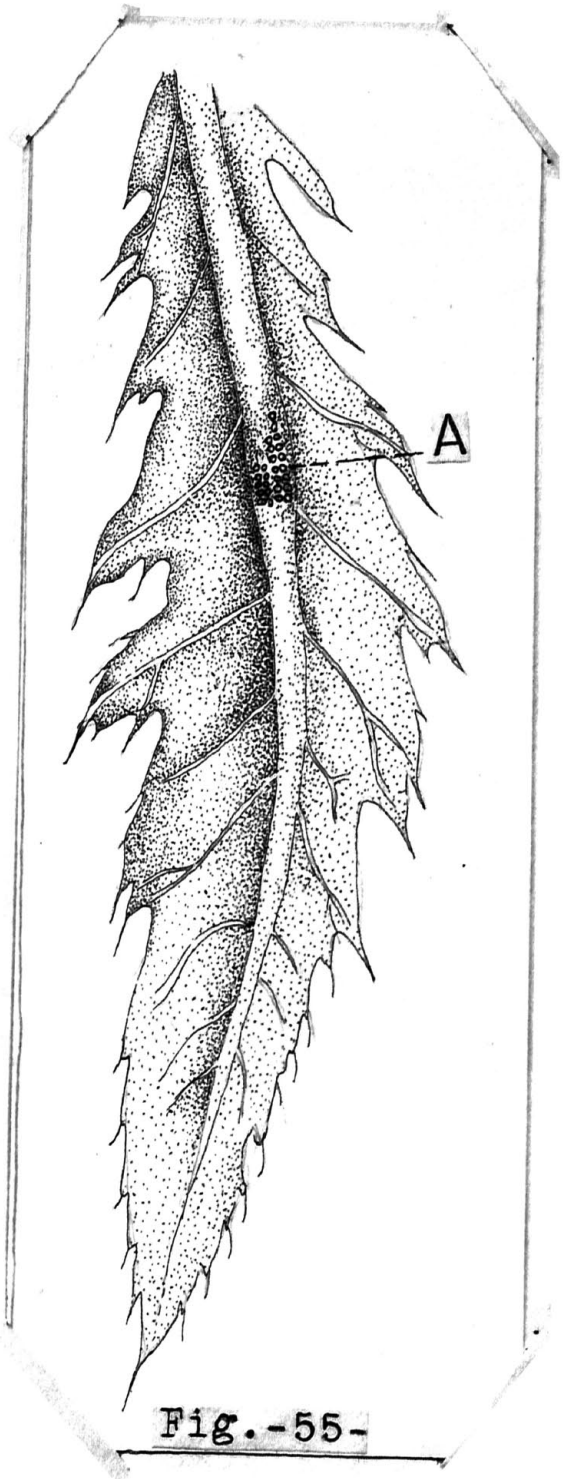


Fig.-55-

Figure-56-

B- Enlarged drawing of vein of leaf containing egg

The vein is burst open exposing eggs to view

C- an egg enlarged 3I times
x- Micropyle

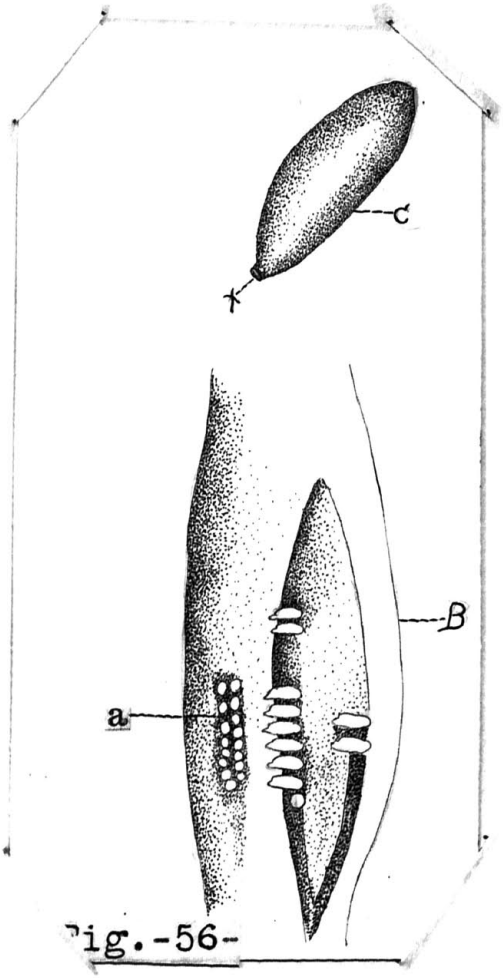


Fig.-56-

Figure-57-

Ventral aspect of newly hatched nymph of Entylia Sinuata

Figure-58-

Dorsal aspect of nymph of Entylia sinuata after first moult.

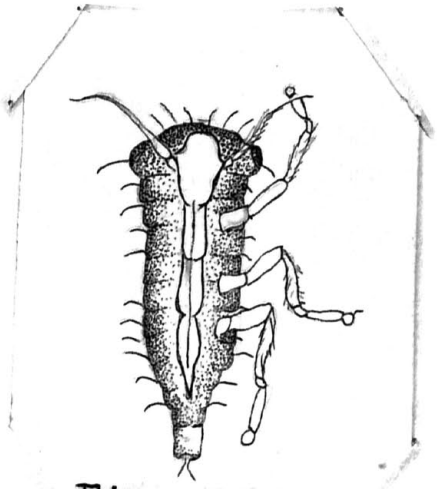


Fig. 57-

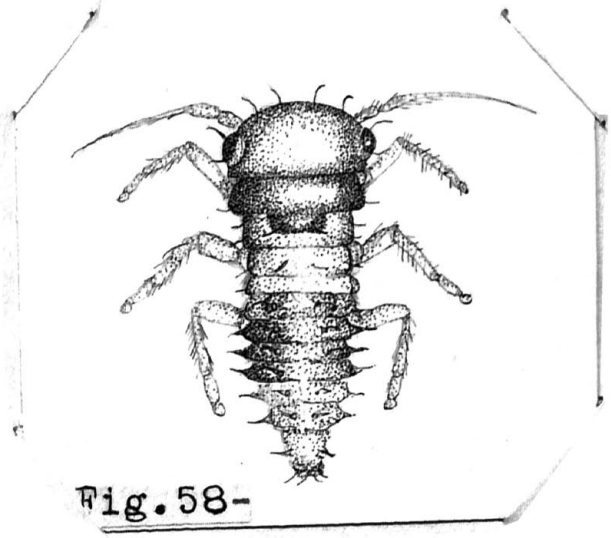


Fig.58-

Figure-59-

Lateral aspect of nymph of Entylia sinuata after second moult/

Figure-60-

Lateral aspect of nymph of entylia sinuata after third moult and just preceeding the moult i adult stage.This period represents the pupa stat

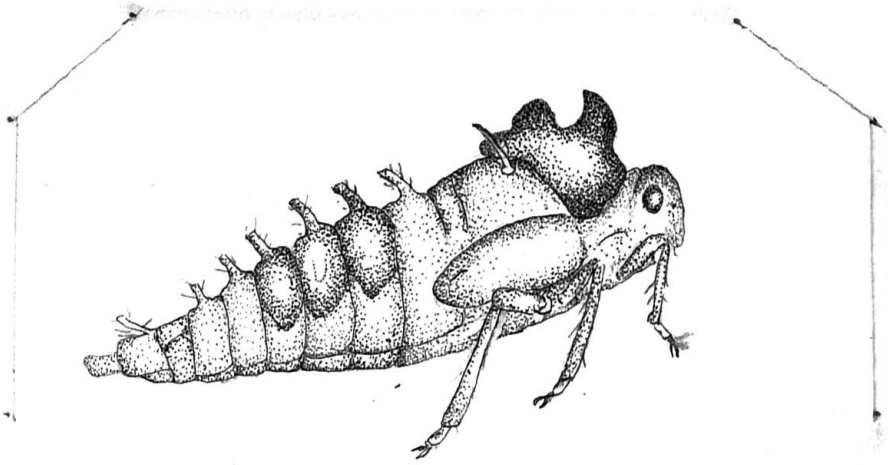


Fig.-59-

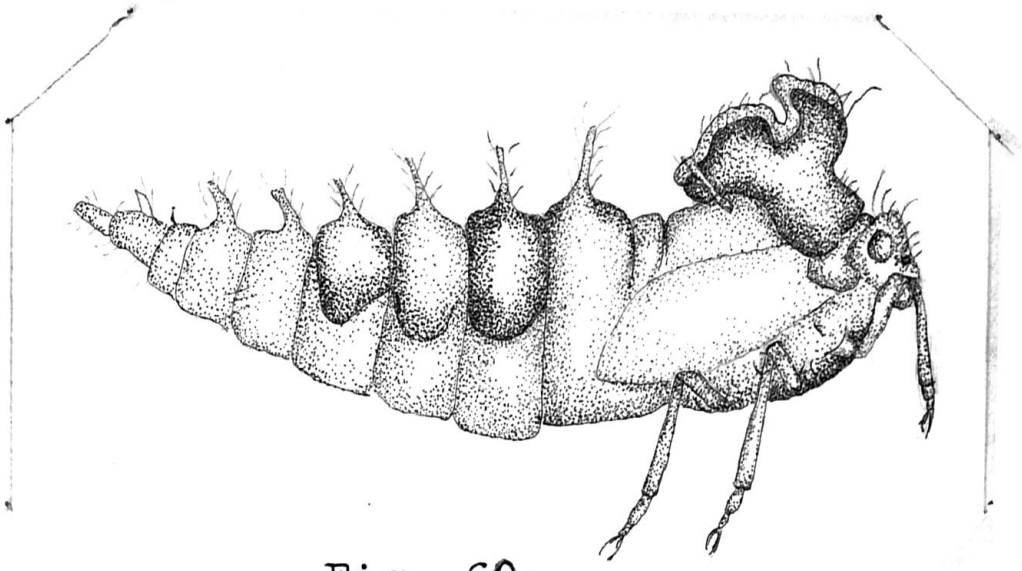


Fig. 60-

Figure-61-

Lateral aspect of Entylia sinuata

Figure-62-

Cephalic aspect of the head of Entylia sinuata

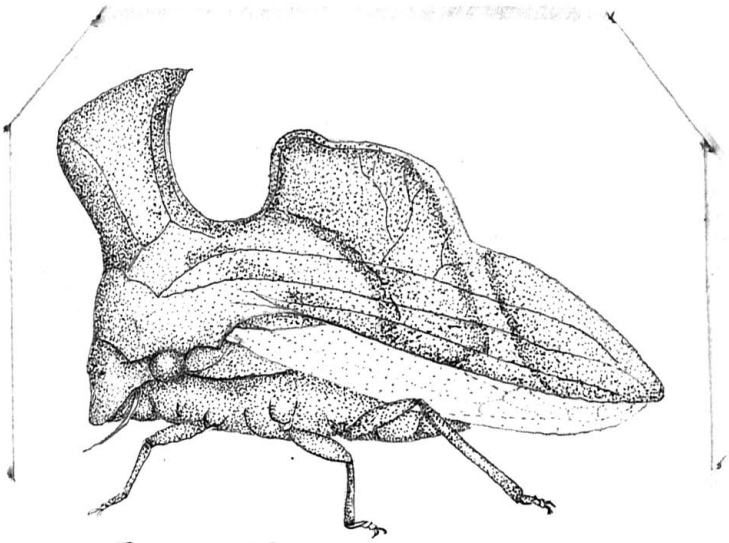


Fig.-6I-

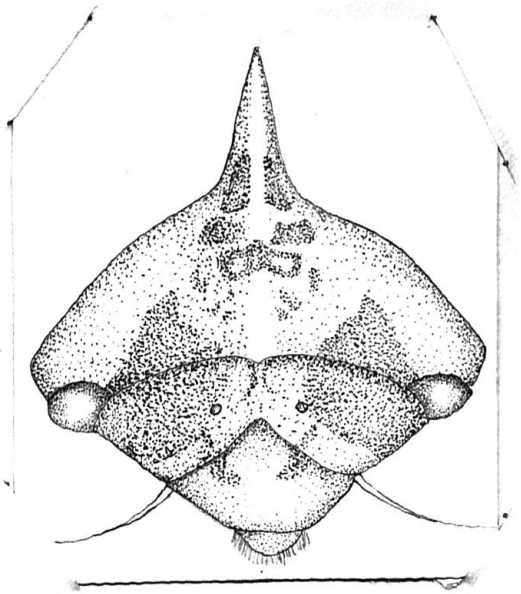


Figure-63- Tegmina and Wing of Micrutalis calva

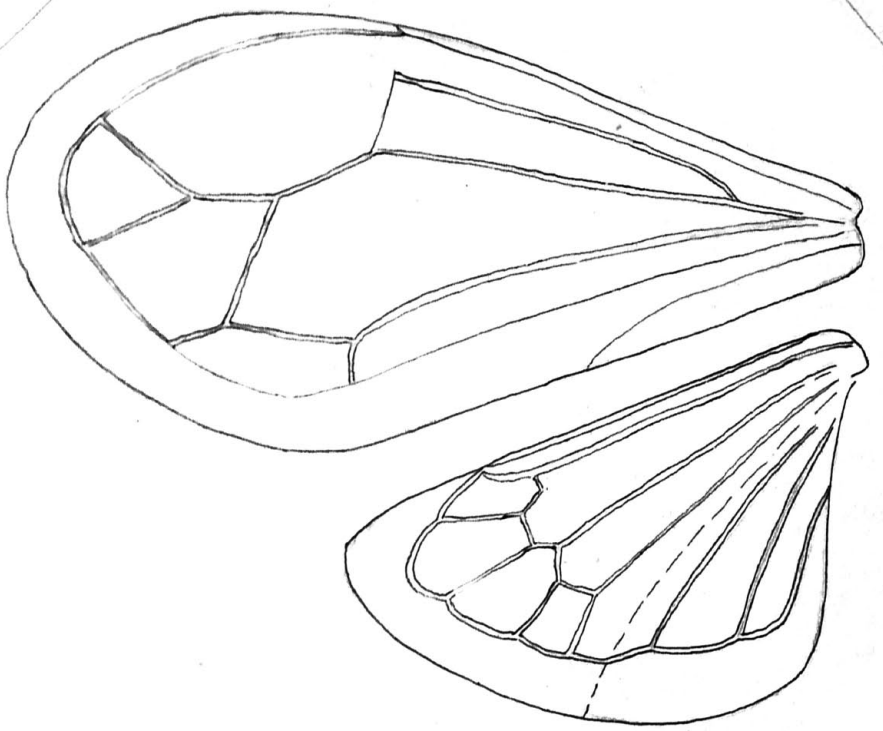
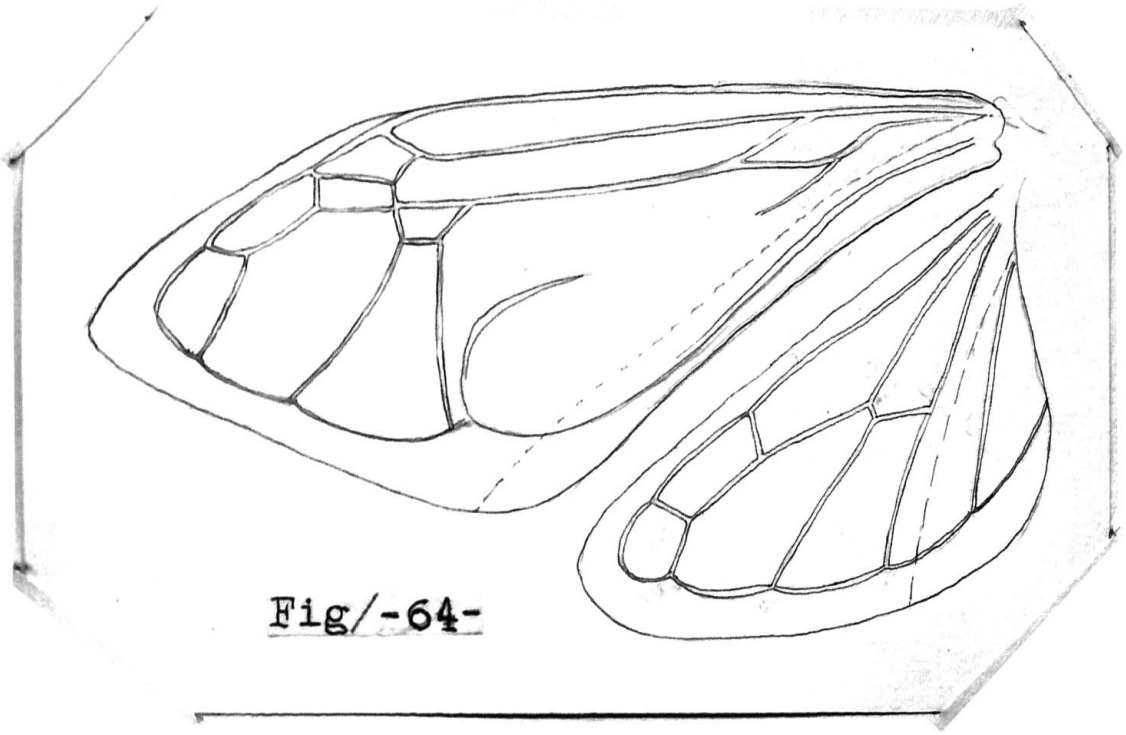


Fig.63-

Figure-64-

Tegmina and Wing of Entylia Sinuata



Fig/-64-

Figure-65-

Tegmina and Wing of Publilia concava

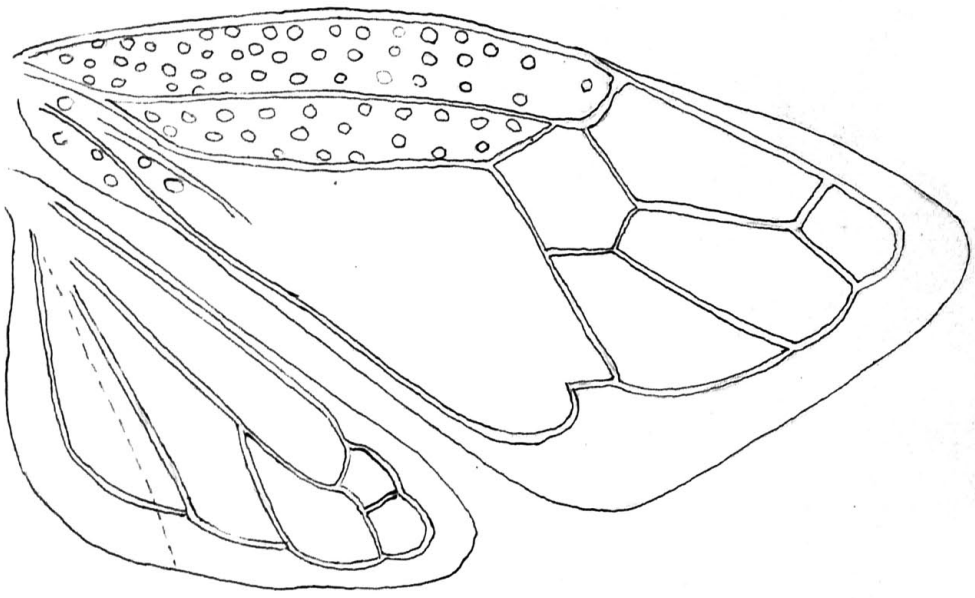


Fig.-65-

Figure-66-

Tegmina and Wing of Stictocephala inermis

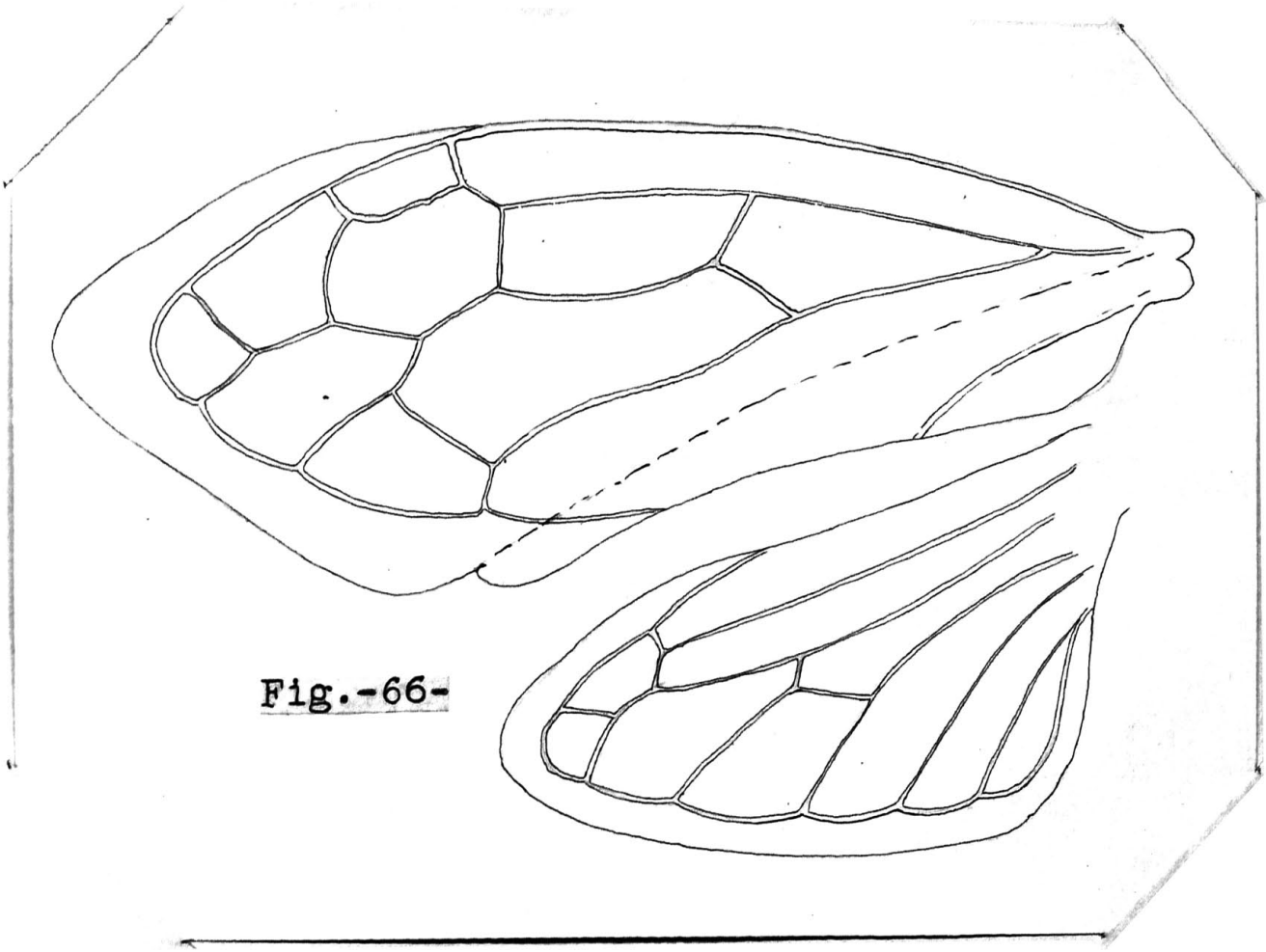


Fig.-66-

Figure-67-

Tegmina and Wing of Cyrtolobus vau

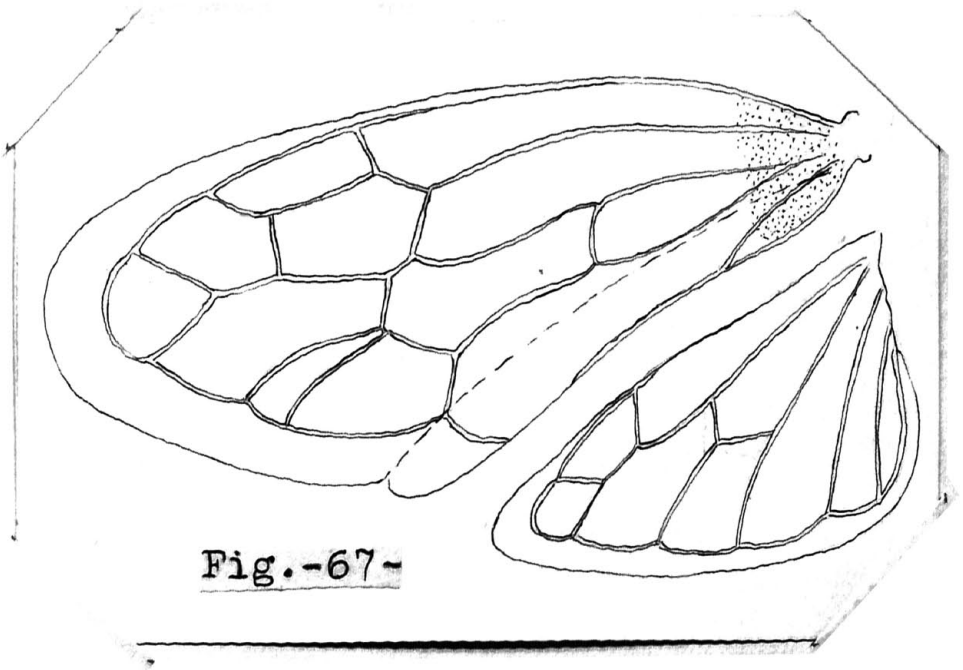


Fig.-67-

Figure-68-

Tegmen of species determined in K.U.Collection as Vanduzea vestita

Figure-69-

Tegmen of Vanduzea arquata.

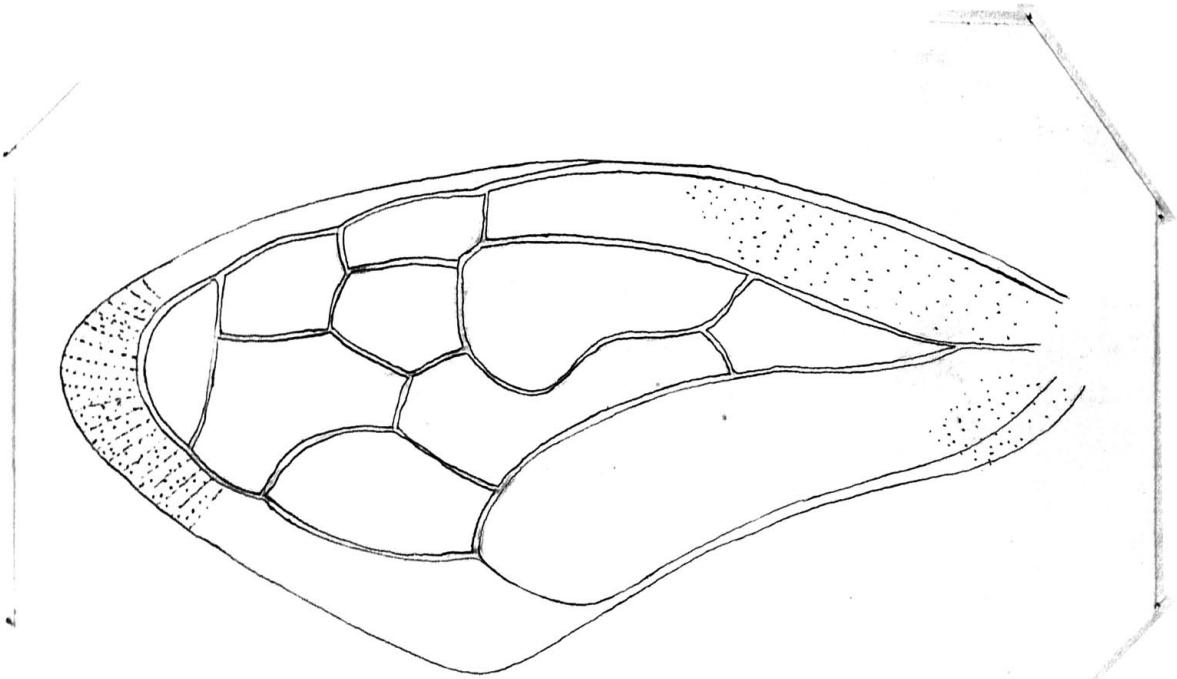


Fig.68-

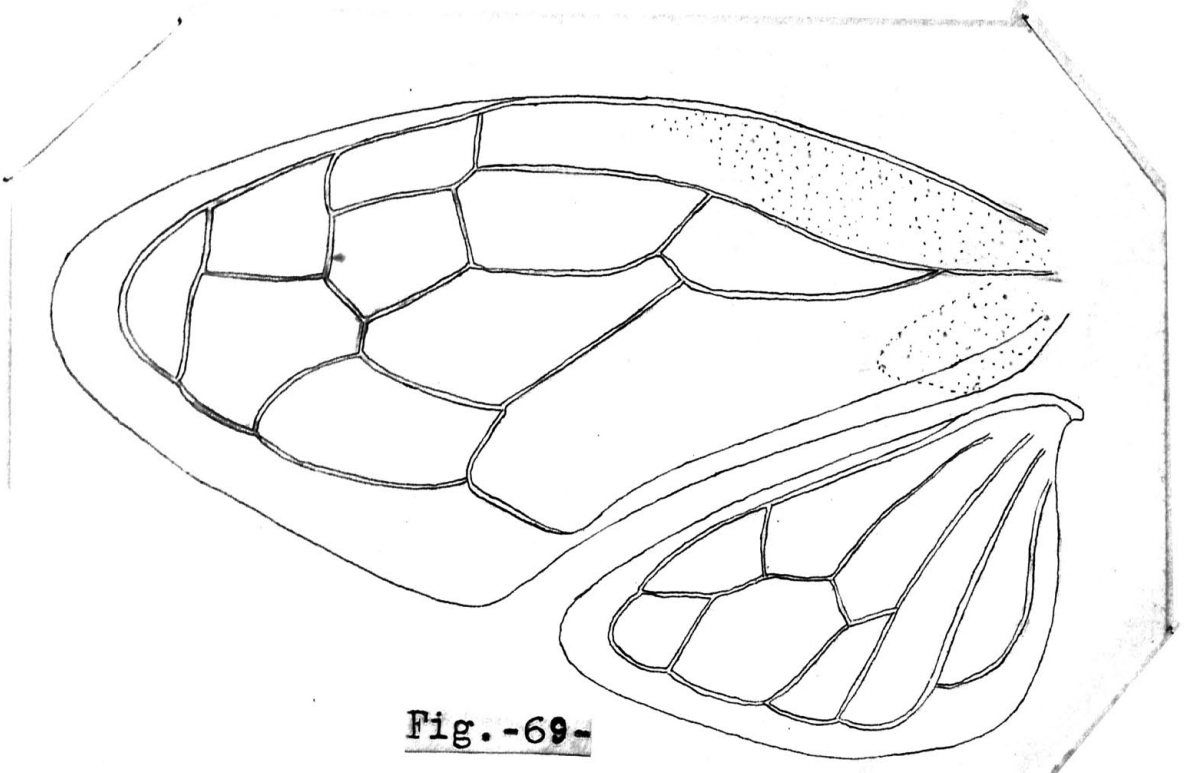


Fig.-69-

Figure-70-

Tegmina and wing of Campylenchia curvata

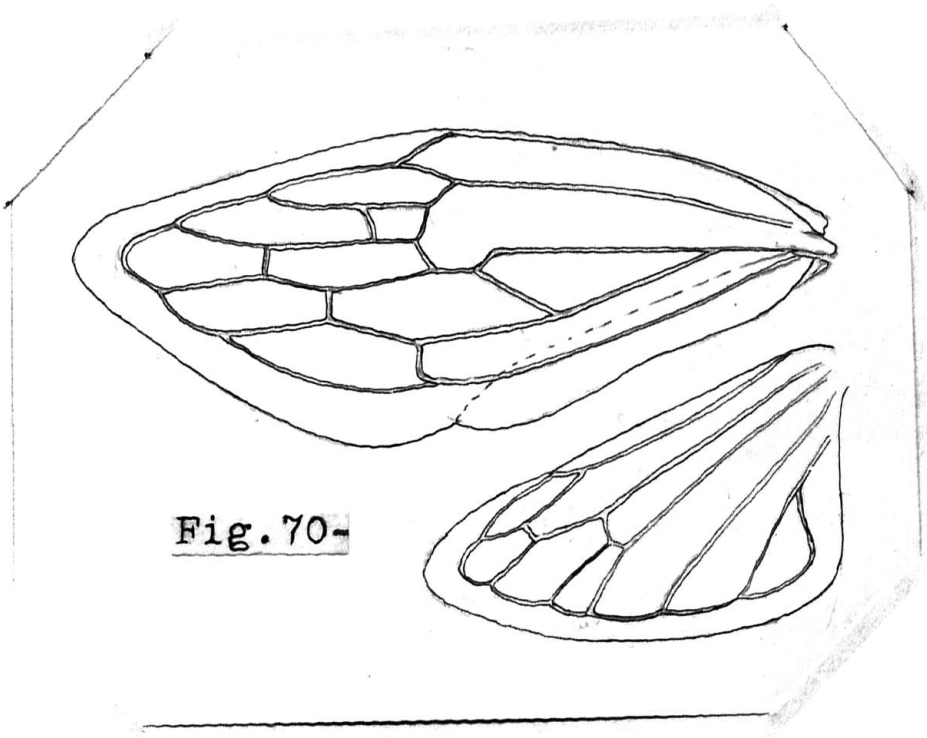


Fig. 70-

Figure-7I-

Tegmina and wing of Enchenopa binotata

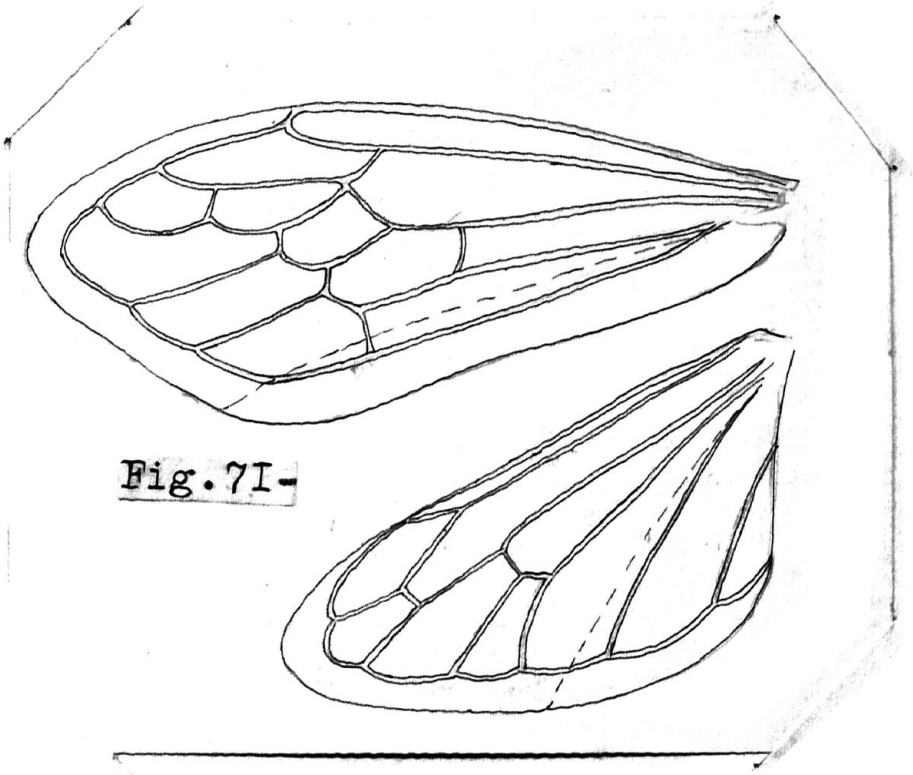


Fig. 7I-

Figure-72-

Tegmina and wing of Cereas bubalus

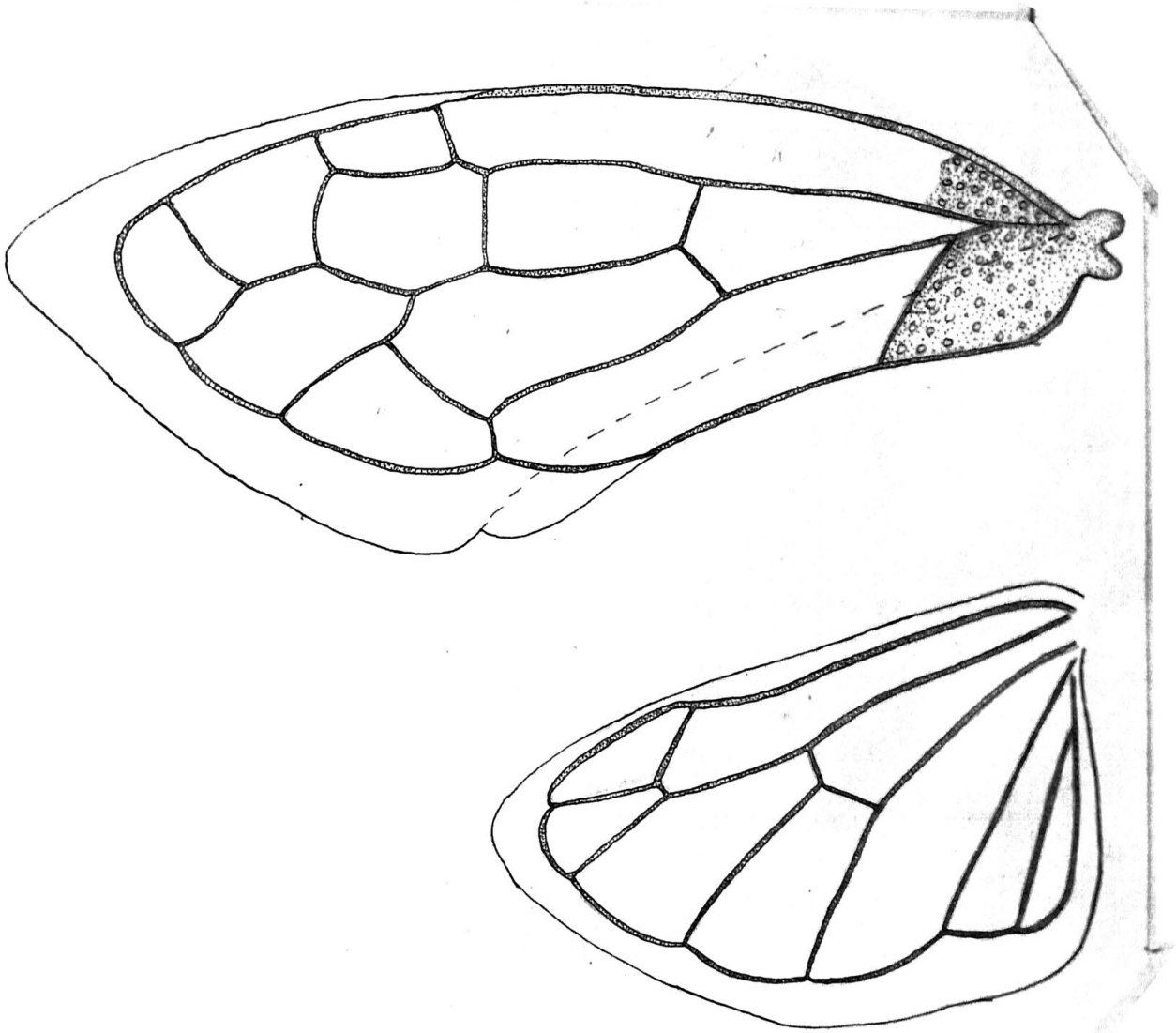


Fig.-72-

Figure-73-

Lateral aspect of Telemona ampelopsidis

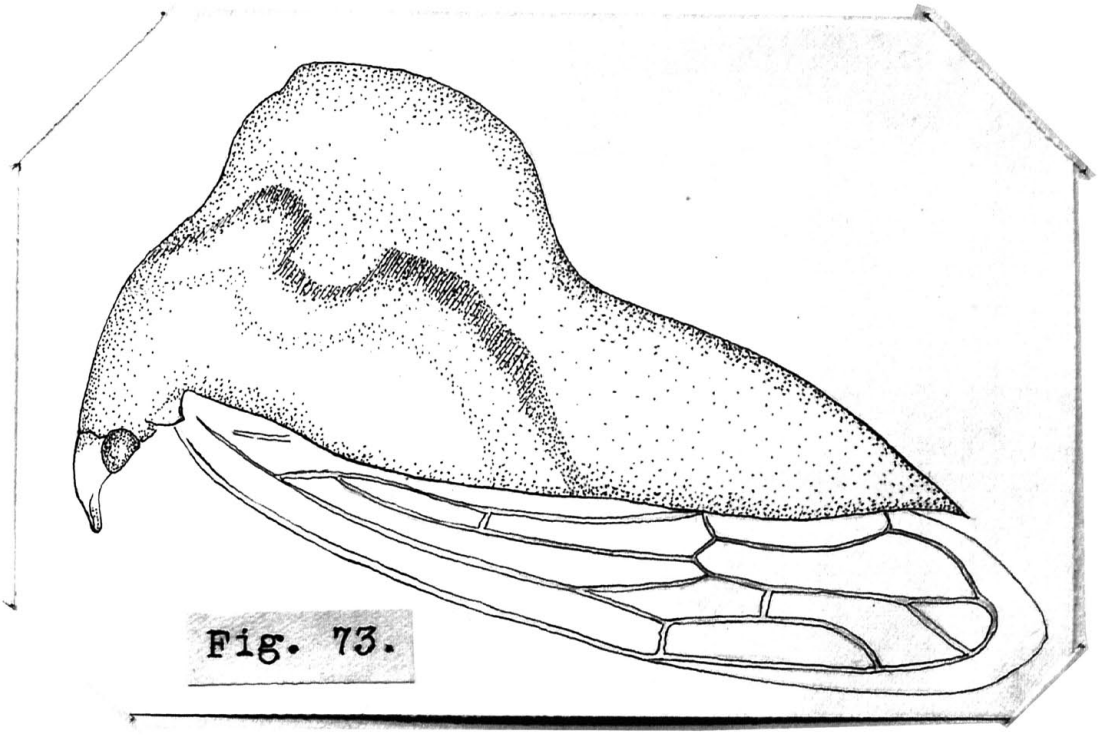


Fig. 73.

Figure-74-

Cephalic aspect of head of

Telamona ampelopsidis

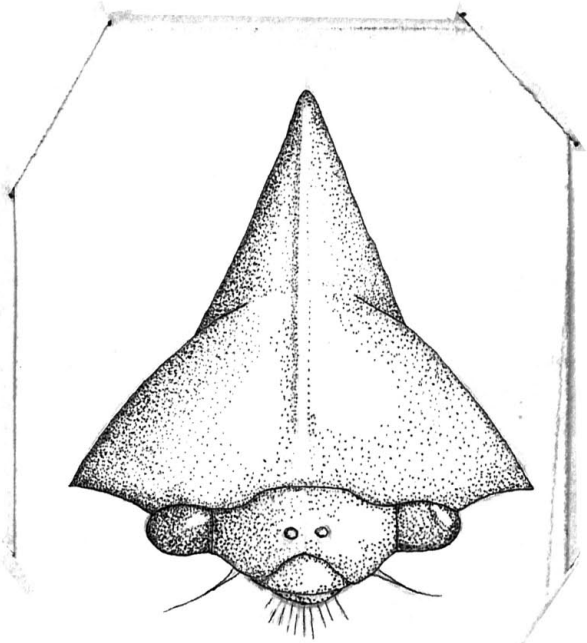


Fig. 74.

Fig/-74-

Figure-75-

Tegmen and wing of Cereas bubalus,with veins and areas named.

L-limbus or menbrane

c- corium or embolium

a-costa

b- radia

u-ulnar

x-z-anals

1,2,3- basal cells

3-also sutural area

f-sutural fold

9,10,11- discoidal cells

4,5,6,7,8,apical cells

6- terminal apical cell

y- clavus.

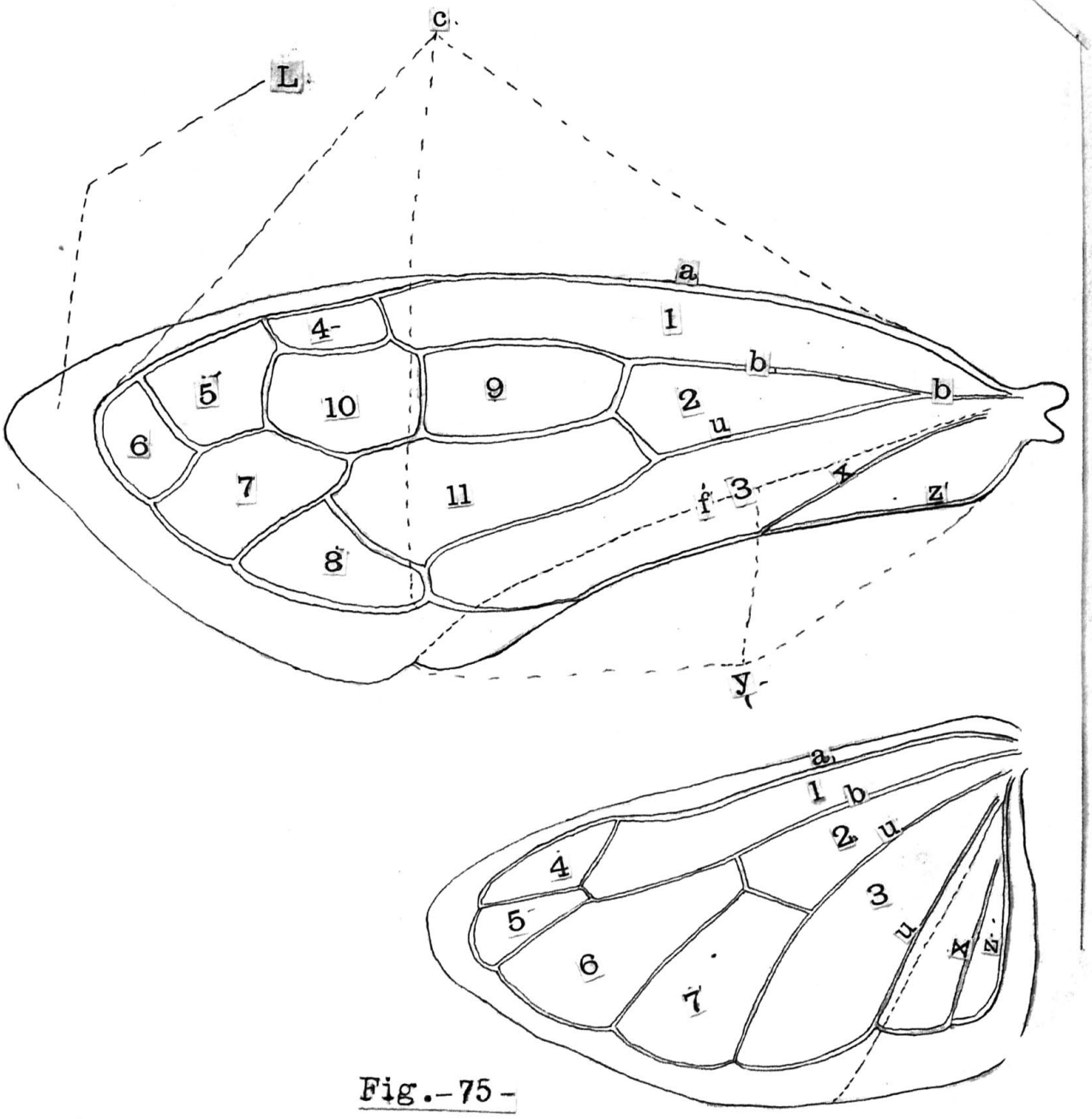


Fig.-75-

Pl. 75-

Figure 76-

Legs of Entylia sinuata

a-Prothoracic leg

b- mesothoracic leg.

c- Metathoracic leg.

Figure-77-

Legs of Campylenchia

a- Prothoracic leg, the coxa and femur are broken apart.

b- Mesotthoracic leg.

c- Metathoracic leg.

Figure -78-

Tegmen of Vanduzea arguata

Figure-79-

Tegmen of Cyrtolobus vau.

Figure-80-

Tegmen and wing of Acutalis tartarea.

Figure 81-

Tegmen of Micrutalis occidentalis

Figure-82-

Tegmen of Micrutalis clava.

Figure-83-

Tegmen and wing of Entylia sinuata

Figure-84-

Tegmen of Telamona pyramidata

Figure-85-

Tegmen of Enchenopa binotata

Figure-86-

Tegmen of Campylenvhia curvata

Figure-87-

Tegmen of Ceresa bubalus

Figure-88-

Tegmen and wing of Ceresa diceros

Figure-89-

Tegmen of Stictocephala inermis

Figure-90-

Tegmen of Stictocephala lutea.