RECONSIDERATION OF SOME POINTS IN THE MORPHOLOGY OF THE HEAD OF HOMOPTERA.

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A great deal has been written about the morphology of the head of Hemiptera, and the Cicada has been the type chiefly used. That there are points upon which there are very divergent opinions is shown by Snodgrass' very valuable criticism*, where some of the difficulties that confront the investigators are well set forth. This constructive criticism is a type of work far too scarce in American entomological literature and our science would be the better for more of it.

Comstock, in his "Introduction to Entomology," has presented an interpretation which is accepted by a number of workers, but which the writer considers is not well sustained by facts, especially that dealing with the mandibular sclerite.

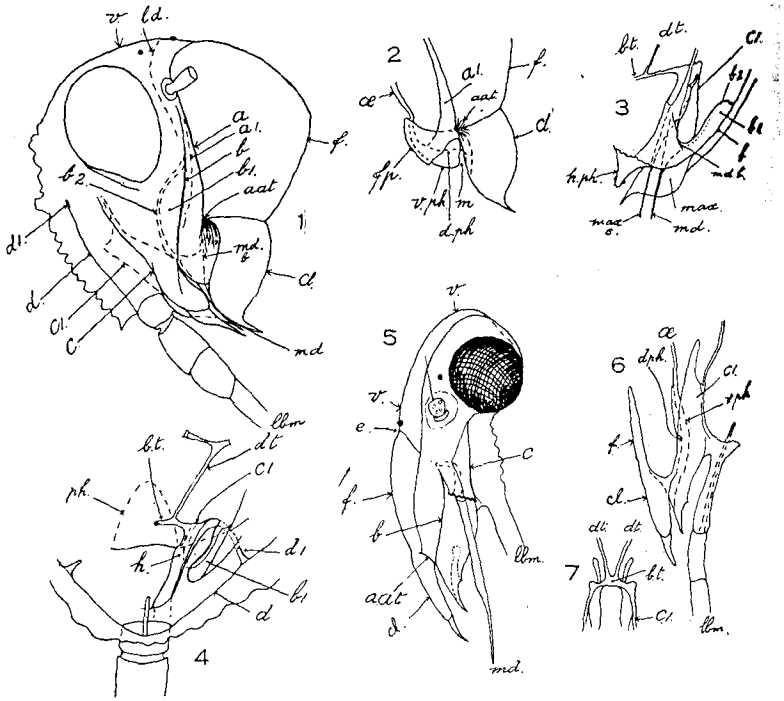
In 1911 and 1912 the writer in collaboration with J. C. Kershaw† published on this subject, but they unfortunately went astray in identifying the arms of the tentorium. The recognition of this fact has caused the writer to reconsider the matter, and the new interpretation arrived at appears to throw fresh light upon the subject and removes certain objections raised by Snodgrass.

The present work was mainly done on the head of *Melampsalta* sp. in its last nymphal stage. The specimens were kindly supplied to me by Dr. J. G. Myers of New Zealand, as there are no Cicadidæ in Hawaii.

In the head of this nymph the labium is carried projecting forward at an angle with the clypeus and frons, and not nearly in a line with them as in the adult. Four distinct sutures can be distinguished on each side of the head, (Fig. 1, a, b, c, d).

*Pro. Ent. Soc. Wash. 23 (1) pp. 1–15, Figs. 1–15, (1921).

†F. Muir and J. C. Kershaw, 1911, Psyche XVIII, pp. 1–12, pp. 75–79, 1912, Psyche XIX, p. 77–89.



EXPLANATION OF LETTERING.

a.....Frontal suture.
a. a. t..Origin of anterior arm of tentorium.
a. l.....Apodeme of frontal suture.
b.....Genal suture.
b. t.....Body of tentorium.
b. l.....Apodeme of genal suture.
b. 2.....Thickened wall of genal apodeme.
c.....Maxillary suture.
cl.....Clypeus, clypeo—labrum or labrum.
c. l.....Maxillary apodeme.
d.....Labial suture.
d. ph...Dorsal wall of pharynx.
d. t.....Dorsal arm of tentorium.
d. l.....Apodeme of labial suture.
e.....Junction of vertex and frons.
f.....Frons or clypeo-frons.
f. p.....Frontal plate of tentorium.
h.....Crescent shape sclerite.
h. ph...Hypopharynx.
lbm.....Labium.
ld.....Line of dehiscence at ecdysis.
m.....Mouth of pharynx.
max.....Maxillary.
max. s..Maxillary seta.
md.....Mandible.
md. s...Base of Mandible.
œ.....Oesophagus.
ph.....Pharynx.
v.....Vertex.
v. ph...Ventral plate of pharynx.

EXPLANATION OF FIGURES.

Fig. 1. Lateral view of head of *Melampsalta* sp. at last nymphal stage.
Fig. 2. Ditto, pharynx with support formed by frontal plate of tentorium.
Fig. 3. Maxillary apodeme with setæ viewed from dorsal aspect.
Fig. 4. Maxillary apodeme, viewed from ventral aspect.
Fig. 5. Lateral view of head of *Mnemosyne bergi* with free maxillary sclerite cut away.
Fig. 6. Lateral view of maxillary apodeme, cl, lbm. and ph. of *Mnemosyne bergi.*
Fig. 7. Full view of apex of maxillary apodeme, and body of tentorium of *Mnemosyne bergi.*

The Frontal Sutures: (a) These delimit the lateral extent of the frons and they continue beyond the antennæ, curving and meeting together in the middle line. The area so delimited represents the frons, or perhaps the frons and clypeus. On account of this uncertainty it was called by Kershaw and Muir the "clypeal region." Internally the frontal suture forms a flange-like apodeme, narrow near the antenna and widening apically till it reaches the junction of the frons and clypeus, where it invaginates, flattens out and joins the one from the opposite side, (Figs. 1, 2, al) thus forming a plate which appears to be homologous to the frontal plate of the tentorium of some orthoptera, (Fig. 2, f. p.). This frontal plate forms the support of the posterior half of the pharynx. The invagination (Fig. 1, a. a. t.) forming this frontal plate is similar in position to that forming the anterior arms of the tentorium in other orders. The area bounded by the frontal sutures appears, therefore to be the frons (or frons and clypeus) and this idea is supported by the fact that the pharyngial muscles are attached to it, a point made by Snodgrass. Has not Snodgrass fallen into the same error in the honey bee, for his clypeus appears to be morphologically the same as this area and the muscles from the pharynx are attached to it.

The pharynx itself is membraneous with a strengthening rod of chitin, the ventral wall being fastened to the frontal plate. In a nymph just after ecdysis, before the chitin has hardened, the pharynx can be separated from the frontal plate of tentorium (Fig. 2, f. p., v. p. h.). Along the medio-longitudinal line of the dorsal wall of the pharynx arise a number of long, thin apodemes to which the thin, fan-like sheets of muscles are attached, the outer edges of these muscles being attached to the transverse ridges of the frons. It is questionable whether the elasticity of the dorsal wall of the pharynx is responsible for the closing of the pharynx; the median apodemes are long and strong enough to allow of muscular action in both directions.

Clypeus, Labrum: The exact composition of the portion marked cl. (Fig. 1), is left in doubt, for it may be the clypeus, clypeus plus labrum or labrum.

The genal suture: (Fig. 1, b). This is behind the frontal suture to which, posteriorly, it is approximate. The area bounded by the frontal and genal sutures is called the mandibular sclerite, or lora. The author considers it to be homologous with the gena of other orders, or with a part of that area. Interiorly this suture forms a deep flange-like apodeme (b. 1), arcuate along its inner margin where it is considerably thickened (b. 2); anteriorly it joins with the apodeme from the opposite side and forms the anterior support for the ventral wall of the pharynx. Like all such apodemes, it is formed by a double wall which is membraneous except along the bottom, where it forms a thin chitin rod (b. 2). The dorsal arm of the tentorium arises from near this suture where it approaches the antenna; it joins the tentorial body near the middle.

*Anatomy and physiology of the Honeybee (1925), Fig. 18, p. 58.

The mandibles: The base of the mandible (Figs. 1 and 3, md. b.) lies between the anterior end of the genal apodeme and the origin of the anterior arm of the tentorium, the distal end of the gena covering the base of the mandible. The outer corner of the base of the mandible is attached to the rod-like thickening at the bottom of the genal apodeme, (b. 2) and it is to this thickened portion that the protractor muscles of the mandible are attached, the opposite end being attached to the inner surface of the gena and to the apodeme supporting the pharynx. The retractor muscles of the mandible are attached to the head capsule beyond the origin of the dorsal arm of the tentorium.

The genæ: The sclerite between the frontal and genal sutures is the most controverted sclerites of the head of Hemiptera. J. B. Smith in 1892 stated that it was a portion of the mandible similar to the maxillary sclerite. This idea has been accepted by several workers, including Comstock. If we inquire into the evidence for this interpretation we can find none. The mandibles in Hemiptera arise in the embryo as a simple bud, as they do in all mandibular insects; we can follow them from the earliest beginning up to the adult stage and at no time do they show any signs of a division. The probabilities of a mandible dividing into two portions and one portion (evidently the basal) amalgamating with the head while the distal portion takes up a new position with new articulations, apodemes and muscles, is so very improbable that morphologists should not accept it unless very convincing evidence can be produced. There are several valid reasons for regarding this sclerite as the gena, or part of the gena. The position on each side of the frons and clypeus naturally suggests it; the position of the opening of the anterior arms of the tentorium; the position of the frontal sutures, the support given to the pharynx; the position of the mandibles; the attachment of the protruder muscles of the mandibles. After a reconsideration of the question, the writer comes to the same conclusion as he did when working with Kershaw, viz., that this sclerite is not composed of a part of the mandible; now he further concludes that it is the gena or portion thereof of normal mandibulate insects.

The maxillary suture: (c) Except anteriorly this suture is very indistinct and it is only recognizable as a crease. The region between the genal and maxillary suture is the maxillary plate and that portion of the head capsule to which it is fused. The division of the maxillary into the maxillary plate and seta has been demonstrated by embryological studies. The anterior portion of the maxillary plate projects as a free appendage, meeting the labrum beyond the gena and closing the gap there due to the reduction of the mandible and its internal position; the pointed apex meets that of the opposite maxillary plate below the hypopharynx and, together with the pointed labrum (or epipharynx), form a small opening through which the setæ pass. At the base of the free, apical portion of the maxillary plate on the under side, is the opening of the deep invagination which forms the large maxillary apodeme (cl.). It is the most complex and conspicuous structure in the head of the Cicada. The genal suture joins it and they form a pouch in which the mandible and the maxillary setæ lie. The base of the maxillary seta is carried further back than the base of the mandible. The apices of the maxillary apodemes are joined by a thin bridge (body of tentorium, bt.) and it is to this that the dorsal arms of the tentorium are joined (Figs. 3, 4, bt.). The "crescent-shaped sclerite"* is a thickening of the wall of this apodeme, (Fig. 4, *h*).

The labial suture: (d) This is very ill defined and forms only a crease, but its position is defined by the invagination (Figs. 1, 2, dl.) which in the nymph is joined to the apex of the maxillary apodeme by cellular structure, but which, in the adult, is joined by a chitinous connection. It is possible that this is the posterior arm of the tentorium of other insects.

This may not quite agree with the accepted arrangement of the tentorium but that question must be postponed till another occasion. The tentorium is regarded by some morphologists as representing ancient tracheæ. The writer would suggest that they represent the segmental apodemes and that they arise at the edge of the segments composing the head. In this case there are four pairs of invaginations.

The above interpretation does away with various of the "morphological absurdities" justly complained of by Snodgrass, and it shows that the departure from the normal mandibular head is not very great.

The chief of these departures are:

The flattening of the head so that the maxillaries are visible at the sides in frontal view.

The reduction of the width of the mandible and its withdrawal into the head capsule with the closure of the gap between the maxillary and clypeus (or labrum).

The sutures with their large apodemes, either flange-like or long and complex.

The fusion of part of the maxillary with the head capsule and the withdrawal of the setæ into the maxillary pouch.

The bringing together of the setæ so as to form a continuous tube with the pharynx.

Considerable changes take place at the last ecdysis so that it is not easy to understand the origin of some of the structures without watching the ontogeny.

The following are some of the chief changes.

The great increase of the size of the maxillary apodeme and the amalgamation of its apex with the labial apodeme, together

*Comstock. Introduction to Entomology (1924), p. 399, fig. 465 ca; marked *H* in Snodgrass' figures.

with the filling up of the space between, except for two holes through which muscles pass into the neck. The greater portion of the ventral surface of this apodeme serves for the attachment of the muscles which work the salivary pump which has two large, flat apodemes to which the muscles are attached. The great enlargement of the apodemes of the frontal and genal sutures; in the latter the chitinization increases and the membraneous portion breaks down, or is difficult to recognize, leaving a wide apodeme from the base of the mandible to the head capsule near the opening of the dorsal arm of tentorium. Unless the origin of this structure is recognized it is impossible to understand the arrangement of the head capsule and the mouth parts, and the failure to recognize it has led to the idea that the mandibles arise far back in the head capsule. Such a head as Meek figures and Comstock* reproduces gives a totally wrong impression.

The heads of all the families of Cicadoidea are very similar in build. The Membracidæ appear to have one characteristic different from all the others, and that is the frons overlaps the base of, and often entirely hides, the clypeus (or labrum). This character is not found in *Aethalion*† which, along with the absence of an intestinal filter, separates it from that family and places it near *Eurymelus*.

If we take the head of cixiid (i. e., *Mnemosyne bergi* Muir) as a representative fulgorid we can see that the head has been straightened or flattened out, the vertex enlarged and brought to the front, forming the "frons" of most systematists, with the median ocellus near its apex. By this development the antennæ are brought below the eyes and the lateral ocelli between them. The elongation of the frons causes the anterior portion of the head to be lengthened, the maxillary sclerites following in this line of development; the frontal suture is confined to the opening of the anterior arm of the tentorium which forms the support for the pharynx. The maxillary apodeme is long and joined together by the bridge to which the dorsal arms are attached. The labial suture and apodeme do not appear to be present (Figs. 5, 6, 7).

If we bend such a fulgorid head backward at the point of junction of the vertex and frons (Fig. 5, e) we can at once see

*Comstock. Introduction to Entomology, p. 398, f. 465.

the relationship with the Cicada. The Fulgoroidea are much more specialized than the Cicadoidea.

While there are a number of important points still unexplained, yet the foregoing notes appear to add to our knowledge of the morphology of the head of Hemiptera, and to eliminate some of the "morphological absurdities" that have rightly appeared so illogical to Snodgrass.

SOME "BITING" LEAFHOPPERS.

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The members of the family Cicadellidæ are commonly regarded as herbivorous since they are thought to depend entirely on plant juices for their food. It has been known for some time, however, that they will bite man. Riley and Johannsen, for example, mention *Platymetopius acutus* (Say) and *Empoasca mali* (LeB.) in this connection. The writer has frequently been told of such attacks and has himself been bitten a considerable number of times by these insects. At present most of us would probably ascribe this biting to causes other than the desire to get blood for food, and the question as to whether or not blood is actually ingested in such cases will require further observation. The persistence with which these insects sometimes bite, however, makes one wonder whether any other motive can satisfactorily explain their action.

The species most commonly reported as biting people is undoubtedly *Empoasca fabæ* (Harris), until recently called *Empoasca mali* (LeB.). The writer has often felt a bite on his hand when collecting under lights or when reading at night, and in most cases this has been the species involved. Others report being bitten by "a little light green bug" which is probably the above-mentioned species in most cases.

Professor Raymond H. Beamer recently reported being bitten by a leafhopper while working under a light. This specimen, which proved to be *Erythroneura basilaris* (Say), after biting in one place a while, moved a short distance and inserted