The Musculature of the Head and the Mouth Parts of the Larva of *Oryctes nasicornis.*

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For several years the interpretation and nomenclature of the sclerites and the muscles in the insect head have been much discussed. Every author has introduced a new terminology, and Snodgrass (1935) was the first to give some head lights in his great comparative work on the morphology of insects. Full agreement as to the principle points of the insect morphology has not yet been obtained, and misinterpretations and misunderstandings still occur.

The present paper is meant to be an attempt to contribute to the discussion of these problems and especially the muscles and their significance to the interpretation of the different sclerites, by means of their origin and insertions.

Also the question of hypognathism and prognathism, and which of the two typical conditions is the more primitive, has been much discussed.

Walker (1932) holds that the prognathous type must be the more primitive, since many of the earliest insects are prognathous.

However, the prognathism (Snodgrass 1930) is characterized by the presence of a gula, a sclerite placed between the foramen magnum and the labium due to the changed position of the head in relation to the longitud-

inal axis of the body. If it is assumed that the insects descend from Arthropods with the hypognathous type of head as the Crustacea, the gula must be considered a secondary feature developed as an adaptation to the changed conditions of life, especially the food biology, and thus it seems most logic to regard hypognathism as the more primitive; the adaptation to the prognathous type of the head, however, occurred at an early stage in the evolution.

It is a question, however, whether it is reasonable to look at the problem: hypognathism (orthognathism) contra prognathism from a phylogenetic standpoint. Both types occur coordinately through several insect orders, and both features are thus subject to great biological variation. In the Trichoptera, for instance, hypognathism is the more primitive, whereas prognathism is the more original in the Coleoptera. In the Isoptera there are no gula, and still the head is typically prognathous.

Here the musculature of the head and the mouth parts of a coleopterous larva, the larva of *Oryctes nasicornis*, will be considered. This larva is secondarily hypognathous, i. e. the position of the head is typically hypognathous, due to the arrangement and position of the mouth parts. A gula exists, however, but the gular area is small, thin and almost membranaceous and does not function as a gula. The function of a gula would be a protection of the ventral surface of the head capsule, as the prognathous head during evolution is turned forwards and upwards, but in the Oryctes larva this protection is effected by the big skin of the first thoracic segment which like a collar is folded over the gular, postgenal and occipital areas of the head.

The presence of a gula indicates that the Oryctes larva must have descended from prognathous ancestors. In the evolution a sclerite will always be hard at first and then sclerotize due to the necessity of protecting

the thin-skinned area on the surface of the body. Gradually as this protection is effected by other elements, the sclerotization diminishes. In this way the gula in the Oryctes larva has developed.

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Material and Technique.

Altogether 11 larvae have been dissected. The larvae were killed by being put into boiling water and fixed in 70 % alcohol. Even a long stay in 70 % alcohol did not cause any perceptible shrinking of the musculature, as is often the case, if boiling water is not used.

The Head Capsule.

(Figs. 1, 2, 3, 13.)

The different typical sutures of the head are well developed in the Oryctes larva. In dorsal view the head capsule is semi-circular, and both the coronal suture (cs) and the frontal suture (frs) are very distinct. The strong epistomal suture borders distally the frons (fr) against the clypeus (cl); the subgenal suture (sgs) surrounds the subgenal areas (sg), its anterior branch not reaching the ventral rim of the head capsule, and its posterior branch reaching the ventral rim just in front of the posterior articulations of the mandible (mda). Between the antennal part of the subgenal area and the posterior articulation of the mandible the ventral rim is strongly

thickened, so it looks as if the subgenal suture ends here, but actually it runs on the under side of the thickening for a small distance and finally reaches the ventral rim just in front of the articulation of the mandible. Thus the subgenal area looks as if it is bipartite.

A postgenal suture (pgs) is present too, but does not reach the coronal suture dorsally, nor does it reach the subgenal suture ventrally. Almost on a level with the posterior articulation of the mandible a hypostomal suture (hys) joins the postgenal suture and demarcates a hypostoma (hy) carrying the point of articulation of the mandible (mda), and medially of this the point of articulation of the maxilla (ca). A postoccipital suture is not present, but internally represented by a postoccipital ridge (poock).

Thus the frons (fr) and the two genae (g) form the greater part of the head capsule. The rest of the sclerites are relatively weakly developed proportionally. The occiput (occ) is not separated from the gena by any suture, the postgena (pg) is very weakly sclerotized, because the anterior part of the big thoracic skin, like a collar, is folded over the postgenae and fastens on the postgenal suture. The postgena is therefore only so much sclerotized as is necessary for the insertions of the big thoracic muscles and the muscles moving the head. The postgena and the occiput abut the foramen magnum (fm).

Both the subgenal suture, the postgenal suture and the hypostomal suture form ridges on the inner side of the capsule, the subgenal ridge (sgk), the postgenal ridge (pgk) and the hypostomal ridge (hyk) respectively. Only the postgenal ridge forms origins of muscles, viz. partly a portion of the cranial flexor laciniae (14) and partly the promotor muscle of the cardo (11), together with the posterior part of the abductor muscle of the mandible (9). Finally on the internal side of the capsule

the coronal suture is represented by a coronal apodeme (fig. 11, cap), on which the lateral muscles of the labrum issue.

As mentioned above the gula (gu) is only slightly sclerotized, being almost membranaceous. Laterally it is delimited by the hypostomal sutures, distally by the submentum and proximally by the foramen magnum. Internally it is supported by two ridges converging distally against the tentorium from the postoccipital ridge (though without joining it). Obviously the ridges only serve to support the gula, as no muscles take their issue from them.

The tentorium (fig. 13, t) is very much reduced and consists only of a thickened unpigmented chitinous bar, lying across the border between the gula and the labium, and joining the inner side of the head capsule just behind the posterior articulations of the mandibles. In most insects this area is distinctly developed as a pair of pits, the posterior tentorial pits, but in the Oryctes larva the pits are very faint and undistinct.

In the middle of the tentorium there are two small tenons (ta), directed forwards, probably rudiments of the anterior tentorial arms (Anderson 1937); here they serve as origins partly of the ventral (17) and dorsal (18) premental muscles, and partly of the adductors of the cardo (12) and the stipes (13).

The different mouth parts are linked to the head at the ventral rim. The anterior mandibular articulation consists of a condyle and a pit on the mandible which fits into a pit and a condyle on the capsule rim, just under the corner of the clypeus. The posterior mandibular articulation consists of a condyle on the mandible fitting into an acetabulum on the rim of the hypostoma, just laterally of the tentorial pits. The ventral rim is here much thickened, because of the big mandibles. The maxillar articulation consists of a very weak con-

dyle (fig. 6, ca) at the end of the proxicardo, fitting into a pit which is just as weak, in the rim of the hypostoma. So the greater part of the movements and support of the maxilla is effected by the soft skin between the maxilla and the head capsule.

The Antennae.
(figs. 1, 2, a).

The antennae are 4-jointed and nearly all the joints are equally long and faintly club-shaped. The last joint is obliquely jointed in the last but one, so that it is directed obliquely forwards and outwards.

The Muscles of the Antenna:

(1) A depressor muscle, originating on the inner side of the frontal suture, inserting on the ventro-medial rim of the first joint.
(2) A levator muscle, a little thinner, originating on the inner side of the frontal suture, just above the origin of (1), inserting on the dorso-lateral rim of the first joint.

There are no muscles attached to the component joints, the antenna only being moved by these two muscles.

The Labrum.
(figs. 1, 3, 10, 11, lbr.)

The labrum is fairly big and a little asymmetrical, broader than long; the anterior rim faintly convex. The ventral side is not sclerotized as much as the dorsal one, except the tormae, which are placed quite asymmetrically on a proximally directed extension of the ventral side, projecting under the clypeus (cl). The whole faintly sclerotized ventral side is densely filled with bristles. Near the distal rim of the ventral side there is a scle-

rotized area, like a crushing tooth, resembling the molar part of the hypopharynx, but a little smaller.

The Muscles of the Labrum:

(3) The lateral adductors of the labrum, two fanlike muscles, with joint origin, partly on the coronal apodeme (cap), partly on the frons, thence diverging towards the insertions on the tormae.

The Clypeus.

(figs. 1, 3, 11, 12, cl.)

The clypeus is well defined from the frons by the strong epistomal suture (es). It is a trapezoid sclerite, reaching and just covering the anterior mandibular articulations at the base. It is distinctly divided into a strongly sclerotized and pigmented postclypeus (cl), and a more faintly sclerotized and unpigmented anteclypeus (acl), situated distally of the postclypeus.

The epistomal suture is strongly thickened internally and carries a backwards and upwards directed ridge with a thickened rim (ek).

No muscles are attached to the clypeus.

The Hypopharynx.

(figs. 9, 11, hyp.)

Carpenter and Mac Dowell (1912) found that the hypopharynx in Geotrupes and Phyllopertha is separated from the labium by a weak suture just above the insertions of the dorsal muscles of the prementum. Such a suture has completely disappeared in the Oryctes larva, and the labium and the hypopharynx are coalesced. The border between the hypopharynx and the labium is identifiable by means of the dorsal muscles of the prementum (18), inserting on the dorsal rim of the labium. Thus the hypopharynx cannot really be regarded as an independent organ, especially as no muscles are attached to it. It is moved exclusively by the muscles of the labium.

On the dorsal side, i. e. on the cibarial side, the hypopharynx carries a very strongly sclerotized crushing tooth (hypm), asymmetrically placed on the surface of the organ.

Of the suspensoriae only a few fragments are left, viz. a laterally situated sclerite, the suspensoria lateralis (susp. l.) and a smaller rectangular sclerite, suspensoria dorsalis (susp. d), a remnant of the dorsal suspensorial branch, serving as insertion for the retractor muscle of the mouth corner, the retractor angulorum oris (4).

The salivary duct (sd) opens just behind the molar part of the hypopharynx on the floor of the entrance to the oesophagus. No muscles are attached to the salivary opening or the salivary duct.

The Muscles of the Pharynx:
(figs. 1, 11).

Unlike most insects the Oryctes larva has few muscles attached to the pharynx.

(4) Retractores angulorum oris, two strong fan-like muscles with triangular origin on the frons, inserting on the suspensoriae dorsales (susp. d.). As these muscles assist in the function of the pharynx during feeding, they are here (according to Snodgrass 1935) considered to be attached to the pharynx, although, after their insertions, they are attached to the hypopharynx.

(5) 1' dilatores pharyngis frontales, two thin muscles originating on the frons, just above the epistomal ridge, and inserting on the pharynx just behind (4).

(6) 2' dilatores pharyngis frontales. Two thin muscles originating on the frons lateral of the base of (4)'s origin, and inserting on the pharynx just behind (5).

(7) Dilatores pharyngis postfrontales. Two thin muscles originating laterally of the top of (4)'s origin, just

beneath the frontal suture, and inserting on the pharynx just in front of the supraoesophageal ganglion.

(8) Dilatores postpharyngis postoccipitales. Two rather strong muscles, originating on the postoccipital ridge, and inserting on the sides of the pharynx just behind the circumoesophageal connectives.

The Mandibles.

(figs. 1, 2, 3, 4, 5, 11, 12, md).

The mandibles are large and strongly sclerotized. They are divided into a distal, incisive part and a proximal, molar part; the right mandible is different from the left, being as follows: just within the tip there is a blunt tooth, and almost in the middle of the incisive part another tooth, but this tooth is absent on the right mandible. The molar part consists of a big crushing tooth, the rugged surface being individually developed.

On the ventral surface of the mandible a stridulation area (str) is situated consisting of sclerotized cross fillets, distally narrower and more densely placed than in the proximal end. To this corresponds, on the dorsal surface of the stipes, a small, short, strongly sclerotized fillet (fig. 7, str), parallel to the fillets of the stridulation area. When this fillet is moved backwards and forwards a sound is produced, reminding of the sound it gives when running over the teeth of a comb with a nail.

On account of the enormous development of the mandibular muscles two big apodemes have been developed, serving as insertions for the muscle fibres. A small, lateral apodeme for the small abductor muscle (a 9) and a very big apodeme for the big adductor muscle (a 10). The latter is split up almost to the base, so it looks as if there were really two. The median part is formed like a fan and is parallel to the longitudinal axis of the head. Anteriorly the other part, the lateral one, is paral-

lel to the first part, but almost in the median line of this it bends at right angles and runs laterally, but still parallel to the longitudinal axis of the head. At the base this big apodeme is supported by a triangular apodemal sclerite (ap).

The Muscles of the Mandible:

(9) A small abductor muscle, originating on the lateral part of the gena and inserting on the lateral mandibular apodeme.

(10) A very big adductor muscle, originating on the major part of the internal surface of the head capsule, viz. the superior part of the frons and the gena, together with a part of the postgena. It inserts on the big apodeme, so that this divides the muscle into four portions: a lateral, a medial, a ventral and a dorsal part.

The Maxillae.

(figs. 2, 6, 7, 13, mx).

In the Oryctes larva all parts of the typical insect maxilla can be found. The mutual position of the cardo and the stipes is as in hypognathous insects, forming an angle to each other.

However, the cardo shows a small peculiarity, it being divided into 3 parts, which is unusual. Besides a proxicardo (prc) and a disticardo (dc) there is, on the ventral side, a rather big area which may be termed ventrocardo (vc). Probably, this extra division is a means of increasing the number of muscle insertions since more internal ridges develop, each with a corresponding suture on the outside.

At the proximal end of the cardo a very weak condyle (co) is situated, corresponding to a pit just as weak on the ventral rim of the hypostoma, forming the articulation of the maxilla with the head capsule. Just inside

the condyle an even smaller process, the cardoprocess (cp), is placed, serving as insertion for the promotor muscle of the cardo (11).

A secondary sclerite has also developed on the ventral side of the stipes, the ventrostipes (vst), clearly belonging to the stipes, as a smaller part of the big stipital adductor inserts here. On the dorsal side of the stipes a sharp edge runs diagonally, and this serves, on the inner side, as insertion for another part of the stipital adductor. Displaced, a little distally of the end of this edge, a small, ovally, well defined area is situated. The longitudinal axis of the fillet is transverse to the longitudinal axis of the stipes. This is the second part of the larval stridulation organ (str), the function of which was mentioned under the mandibles.

On the dorsal side the galea (ga) is completely united with the stipes, but the presence of an obliquely suture (gasts), running backwards on the ventral surface, clearly shows the division. At the end the galea carries a very strongly sclerotized spine.

The lacinia (la) is a distinctly independent part of the maxilla, though it is unmovably attached to the galea. At the end it carries a set of spines, strongly sclerotized, situated in a row along the median edge of the lacinia, the middle one being the smallest. At the proximal end of the lacinia is a small sclerite, secondarily split from the lacinia. It is so weakly sclerotized that it is very difficult to see it at all, but it is conspicuous by the long flexor laciniae (14), inserting here.

Finally, as a protection of the non-sclerotized area between the maxilla and the labium, a secondary, rather big, weakly sclerotized sclerite has developed, the basimaxillary sclerite (bmx).

We cannot speak of a real palpifer here, but the 4-jointed palpus (mxp) is situated on the high, unsclerotized elevation of the skin at the end of the stipes.

The first joint of the palpus is small, the second and the fourth joints are almost equally long, and the third joint is a little shorter than the second one, but a little longer than the first.

The Muscles of the Maxilla:

(11) A promotor cardinis, originating on the internal ridge between the gena and the postgena, ventrally of the cranial flexor laciniae (14) inserting on the cardoprocess (cp), a weak extension on the proximal end of the proxicardo.

(12) An adductor cardinis, originating in the corner between the tentorial bar and the small remnants of the tentorial arms, immediately dorsally of (13), inserting on the internal ridges between the proxi-, disti- and ventrocardo.

(13) An adductor stipitis, originating in the same place as (12) and immediately ventrally of this one, inserting with 3 portions on the stipes, one on the ridge between the stipes and the ventrostipes, one on the inner lateral surface of the stipes, and one on the inner side of the diagonal longitudinal edge.

(14) A cranial flexor laciniae, a fan-shaped muscle, originating on the postgena and the postgenal ridge, immediately dorsally of (11), and inserting on the almost invisible small sclerite at the base of the lacinia.

(15) and (16). The muscles of the palpus, partly consisting of a depressor muscle, inserting on the medial rim of the first joint of the palpus, partly of 2 levator muscles, inserting on the lateral rim of the first palpal joint; all of them originate on the stipes just beneath the stridulation organ on the inner side of the diagonal longitudinal edge.

The Labium.
(figs. 8, 11, 13, lb).

The common tripartition of the labium of insects in the prementum (pmt), mentum (mt) and submentum (smt) also exists in the Oryctes larva. The united glossae and paraglossae have here — like in many non-orthopterous insects — become a ligula (li), regularly convex in front. The prementum is very weakly sclerotized, with the exception of a w-shaped sclerite, each of its legs surrounding the small, unmovable palpi (lp) and the two, very small sclerites in the suture between the prementum and the mentum, serving as insertions for the ventral muscles of the prementum (17). The tip of the ligula is filled with strong bristles. In front the ligula is united with the hypopharynx without any suture. The limit between the ligula and the hypopharynx is identified by means of the insertion of the dorsal premental muscles (18).

The distal part of the mentum is also very weakly sclerotized, and only the proximal part is fairly strongly sclerotized, serving as insertions for the small and weak submento-mental muscles (19). The submentum is a big sclerite, widest at the base, the sides gradually converging distally. The distal part is weakly sclerotized, whereas the proximal part which is by far the biggest is strongly sclerotized and borders the short, unsclerotized gular area (ga) between the labium and the foramen magnum (fm).

The labial palpi (lp) are small and completely unmovable, 2-jointed, without any muscles attached to them.

The Muscles of the Labium:
(fig. 13).

(17) The ventral muscles of the prementum, two paired muscles, originating on the under side of the two rudimentary tentorial arms, immediately ventrally

of (18), and inserting on the two small sclerites, situated in the proximal limit of the prementum.

(18) The dorsal muscles of the prementum, originating in the same place, but immediately dorsally of (17), converging down to the insertion point on the dorsal rim of the prementum, thus identifying the limit between the prementum and the hypopharynx.

(19) The submento-mental muscles, originating on the posterior region of the submentum, and inserting on the proximal limit of the mentum.

As we have seen, the Oryctes larva does not differ very much from the typical insect head. Some differences should however be pointed out.

The antennae of the Oryctes larva have only two muscles attached to them, a depressor and a levator muscle. In most insects there are in addition muscles attached to the two first joints of the antenna, moving the joints in proportion to each other.

In free-living insects it is necessary that the movability of the antennae is as great as possible, the food being spread over a bigger area, so that the movability and the radius of action of the antennae must be greater. The antennae of the Oryctes larva are continuously in touch with the food, and the muscles have thus been reduced.

The two typical clypeal muscles, the dilator cibarii from the clypeus to the ceiling of the oral cavity (the cibarium), and the dilator buccalis, from the clypeus to the anterior part of the dorso-lateral surface of the pharynx, are not present in the Oryctes larva. These muscles are present in most free-living insects, partaking in the first treatment of the food in the oral cavity, the cibarium, before it is brought into the pharynx. The food of the Oryctes larva is of such a consistency that a first

treatment of that kind is practically unnecessary and at any rate can easily be made by the molar part of the mandibles in connection with the crushing tooth of the hypopharynx.

For the same reason most of the pharyngeal muscles have disappeared. However, as a substitute for the dilator buccalis, the dilator pharyngis frontalis has been split into two muscles, of which the anterior part, the first dilator pharyngis frontalis has moved to the place of the dilator buccalis. A muscle at this place therefore could not be absent. That this muscle is really a dilator pharyngis frontalis is seen from the origin on the frons, whereas the dilator buccalis always originates on the clypeus. Of the ventral and lateral pharyngeal muscles only the dilator postpharyngis postoccipitalis is left which, due to the reduction of the tentorium, has moved its origin from the posterior tentorial arms to the postoccipital ridge.

The hypopharynx is, as mentioned above, completely fused with the labium. Thus independent muscles are not necessary in this organ which can be moved by the muscles of the labium. So also the muscles of the hypopharynx have been reduced.

A single point is not quite clear, viz. the total absence of musles attached to the salivary opening. The literature does not mention a similar condition in other insects but, on the other hand, repeated dissections have not revealed any trace of the salivary muscles. A plausible reason would be that the salivary gland was reduced, but, on the contrary, it is here well developed. The right explanation may be that the salivary opening, at the fusion of the hypopharynx and the labium, has been moved to the dorsal surface of the hypopharynx and is situated on the bottom of the oesophageal opening. By the feeding mechanism the hypopharynx is moved by means of the labial muscles beneath the salivary

duct, and by means of the retractores angulorum oris. Thus these muscles possibly replace the reduced salivary muscles.

On account of the progressive fusion of the different parts of the maxilla a few reductions have also taken place here. Thus a flexor galeo-stipitalis and a flexor lacinio-stipitalis are missing.

In the labium the muscles of the palpi have disappeared, as well as the lateral premental muscles.

The powerful development of the mandibular and the maxillar adductor and abductor muscles has caused various modifications in the elaboration of the sclerites, and in a single case a new sclerite has been formed.

In insects the cardo is generally divided into two areas by a suture, a proxicardo and a disticardo. This suture cannot be regarded as a suture in the proper sense of the word, since it is not formed between two different sclerites joining each other. The strong adductor muscle moving the cardo must have strong insertion points, and thus an internal ridge is formed in the cardo. The development of an internal ridge causes an infolding of the external surface which has the appearance of a suture. In the Oryctes larva this muscle has become still stronger, a new internal ridge has been necessary, and the cardo thus has become tripartite, as this new ridge corresponds to a new suture on the external surface.

The development of a new accessorial sclerite in the stipes, the ventrostipes, has similar causes.

The great development of the mandibular adductor muscle and the resulting increase of the mandibular apodeme has caused the formation of an apodemal sclerite (ap) in the basal part of the apodeme for support and protection of the apodeme which is here situated close to the lateral wall of the oral cavity.

As mentioned under the exordium the different au-

thors disagree in the interpretation of the different parts of the labium. All agree that the labium represents the second maxillae of the Crustacea, being formed by two united maxillae. The primitive insect labium shows this very clearly. The glossae and the paraglossae correspond to the lacinia and the galea respectively, the prementum corresponds to the fused stipites, and the postmentum (mentum + submentum) to the coalesced cardines and the sternal sclerite of the labial segment. Looking at the muscles we can homologize at any rate two of them: The dorsal premental muscles correspond to the flexor laciniae and the ventral premental muscles correspond to the adductor stipitis.

The question is now, how to interpret the different parts of the labium in coleopterous larvae. Here Snodgrass (1935) and Anderson (1937) hold that only two sections can be distinguished, the prementum and the postmentum (submentum), whereas the mentum has disappeared, or exists as an integral part of the submentum. Accordingly, the submentum should represent the fused stipites plus the sternal segment. The most difficult point is the homologizing of the submento-mental muscles (the median muscles (Snodgrass 1935)), as they have no homologues in the maxilla. So they are suggested to be sterno-stipital muscles. In this way the prementum is divided into two parts, the proximal sclerite (mt) being considered to be a part of the prementum, whereas the mentum has disappeared (or is present in the submentum) and the submentum (smt) is thus considered to be the whole postmentum.

Das (1937) gives a more reasonable explanation of the problem stating that the submento-mental muscles (19) are homologous to the adductores cardines in the maxilla. Thus the mentum (mt) alone must be regarded as the fused cardines, whereas the whole submentum

represents the sternal segment, and thus we have here also in the Oryctes larva the typical tripartition of the labium.

Das' interpretation has been followed, as it seems the most reasonable one. The two homologues also function in the same way, both being adductors of the section on which they insert. The homologues then must be as follows:

The dorsal premental muscles = the flexor laciniae.
The ventral „ „ = the adductor stipitis.
The submento-mental „ = the adductor cardinis.

On the basis of the origins of the labral and pharyngeal muscles Cook (1944) has tried to make new definitions of the concepts of the frons, the clypeus and the anteclypeus. Cook regards the anteclypeus as a sclerite situated between the labrum and the epistomal suture, characterized by the absence of muscle origins or insertions. Thus the clypeus becomes the sclerite proximal of this (i. e. the frons), defined by the origin of the pharyngeal and the labral muscles.

However, according to Snodgrass (1935) the clypeus is defined by the origins of two muscles, partly the dilator muscle of the oral cavity (the cibarium), inserting on the ceiling of the oral cavity, partly the dilator buccalis, inserting on the dorsal side of the pharynx between the two retractores angulorum oris. The absence of these muscles in the clypeus in many non-orthopterous insects does not prove that they have never been there, and the term anteclypeus for clypeus thus cannot be preserved, but should still be used to designate the unpigmented and unsclerotized distal part of the clypeus in many insects (among which the Oryctes larva). Therefore the frons is defined (Das 1937) as the sclerite forming the origins of the labral muscles, and this definition can be extended to include the dorsal pharyn-

geal muscles. Cook's new definitions thus cannot be accepted, since they only contribute to increase the confusion already existing in the interpretation of the different parts of the insect head.

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The Muscles:

(1) The depressor muscle of the antenna.
(2) The levator muscle of the antenna.
(3) The lateral adductor of the labrum.
(4) The retractor angulorum oris.
(5) The 1' dilatores pharyngis frontales.
(6) The 2' dilatores pharyngis frontales.
(7) The dilatores pharyngis postfrontales.
(8) The dilatores postpharyngis postoccipitales.
(9) The mandibular abductor muscle.
(10) The mandibular adductor muscle.
(11) The promotor cardinis.
(12) The adductor cardinis.
(13) The adductor stipitis.
(14) The flexor cranio-laciniae.
(15) and (16) the depressor and levator muscle of the maxillary palpus.
(17) The ventral premental muscles.
(18) The dorsal premental muscles.
(19) The submento-mental muscles.

Abbrevations in the Figures.

a	= antenna	frs	= frontal suture
acl	= anteclypeus	g	= gena
ap	= apodemal sclerite	ga	= galea
a9	= apodeme for the mandibular abductor muscle	gasts	= galeo-stipital suture
		gu	= gula
		gul	= supporting fillets of the gula
a10	= apodeme for the mandibular adductor muscle	hj	= supraoesophageal ganglion
bmx	= basimaxillary sclerite	hy	= hypostoma
ca	= articulation of the cardo	hyk	= hypostomal ridge
		hyp	= hypopharynx
cap	= coronal apodeme	hyp. m	= molar part of the hypopharynx
cl	— clypeus (postclypeus)		
coe	= circum-oesophageal connective	hys	= hypostomal suture
		la	= lacinia
cp	= cardo process	lb	= labium
cs	= coronal suture	lbr	= labrum
dc	= disticardo	li	= ligula
ek	= epistomal ridge	lp	= labial palpus
es	= epistomal suture	md	= mandible
fm	= foramen magnum	mda	= the posterior articulation of the mandible
fr	= frons		

mo	= molar part of the mandible	sg	= subgena
mt	= mentum	sgk	= subgenal ridge
mx	= maxilla	sgs	= subgenal suture
mxp	= maxillary palpus	smt	= submentum
occ	= occiput	st	= stipes
pg	= postgena	str	= stridulation organ
pgk	= postgenal ridge	susp. d.	= suspensoria dorsales
pgs	= postgenal suture	susp. l.	= suspensoria laterales
phx	= pharynx	t	= tentorium
pmt	= prementum	ta	= tentorial arms
pocck	= postoccipital ridge	to	= tormae
prc	= proxicardo	vc	= ventrocardo
sd	= salivary opening	vst	= ventrostipes

Explanation of the Figures.

Fig. 1. Dorsal view of the head. The dotted areas show muscle origins.

„ 2. Ventral view of the head.

„ 3. Lateral view of the head. The dotted areas show muscle origins.

„ 4. Ventral view of the left mandible, showing the mandibular part of the stridulation organ (*str*), a part of the big apodeme for the adductor muscle (*a 10*), together with the small apodeme for the abductor muscle (*a 9*).

„ 5. Medial view of the left mandible, showing the big crushing tooth (*mo*), the basal part of the big apodeme for the adductor muscle (*a 10*) and the apodemal sclerite (*ap*).

„ 6. Ventral view of the left maxilla, showing the suture between the galea and the stipes (*gasts*), the tripartite cardo, and the narrow, secondary sclerite in stipes, the ventrostipes (*vst*).

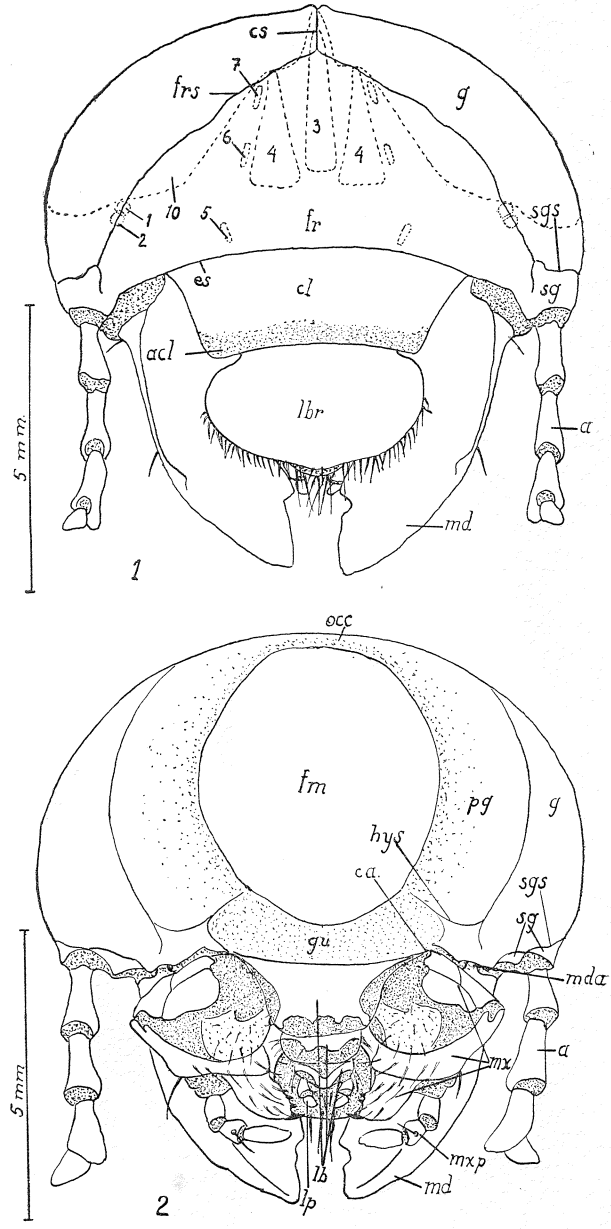
„ 7. Dorsal view of the maxilla, showing the galea and the stipes here united, the diagonal, longitudinal edge, and the stridulation organ (*str*).

„ 8. Ventral view of the labium.

„ 9. Dorsal view of the hypopharynx and the oesophageal opening, with the salivary opening (*sd*).

„ 10. Ventral view of the labrum and the clypeus, showing the insertion of the lateral labral muscles on the tormae (*to*).

„ 11. Sagittal section through the left half of the head capsule, showing the muscles attached to the labium, the pharynx, the hypopharynx and the labrum.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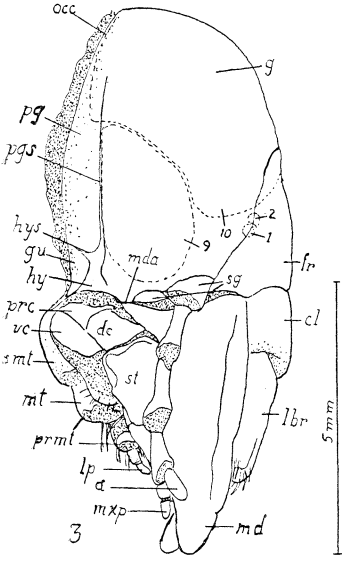
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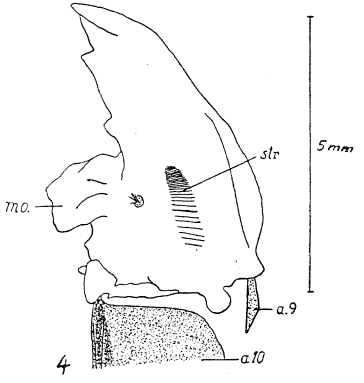
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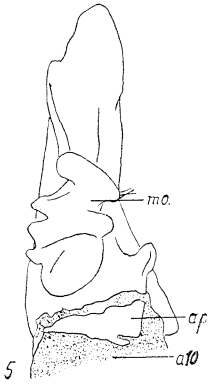
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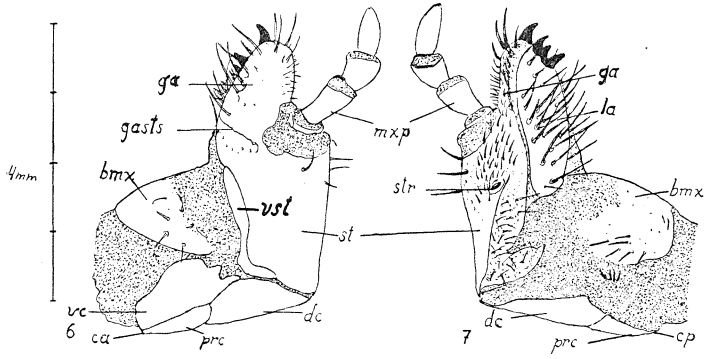
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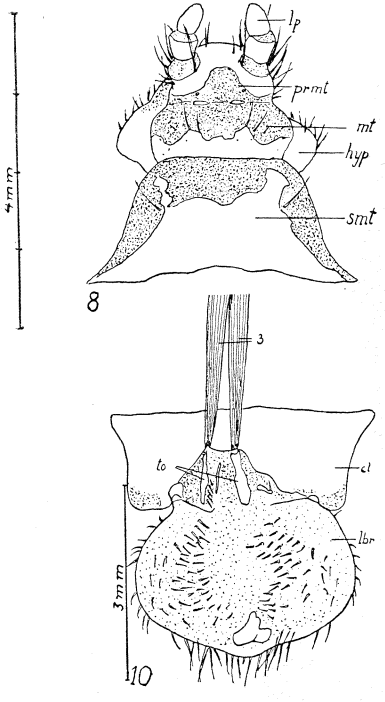
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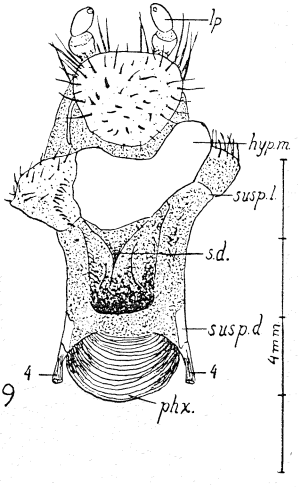
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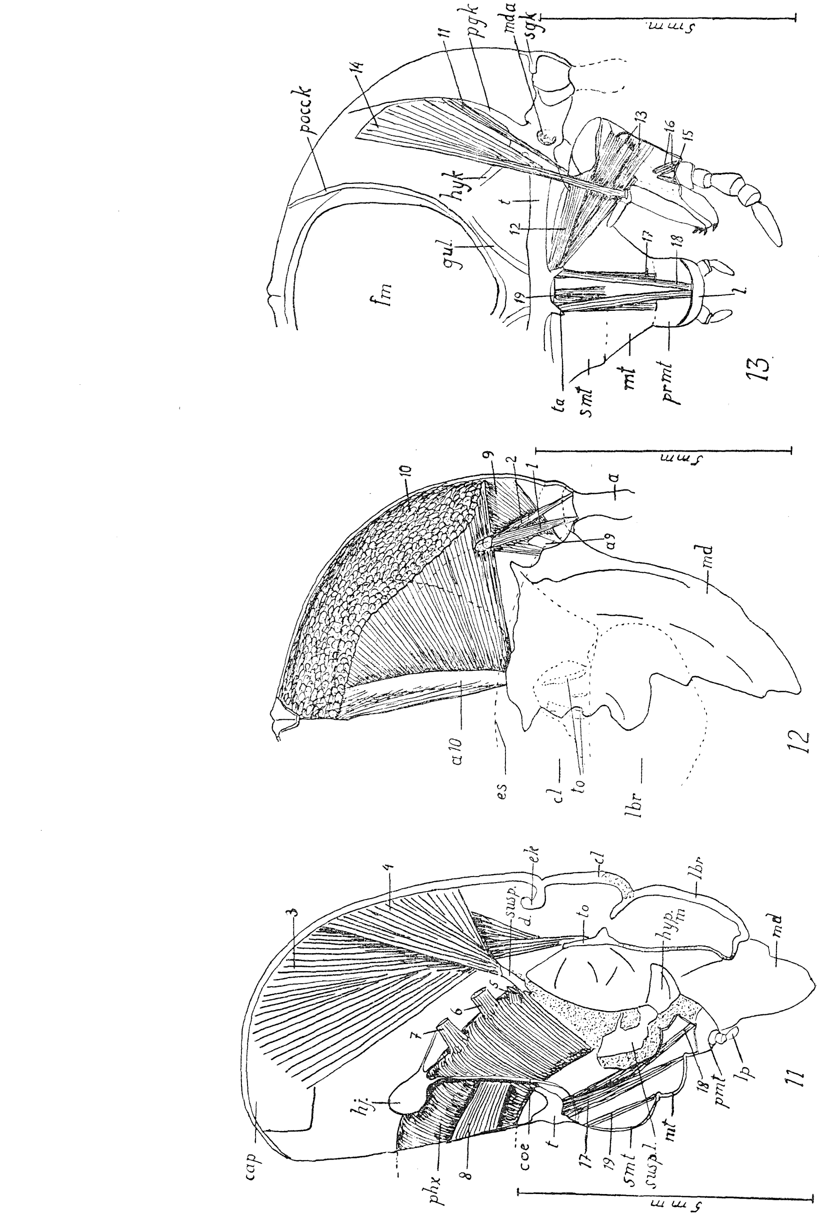
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Fig. 12. Dorsal view of the left half of the head capsule. The dorsal wall of the capsule, the labrum, and the clypeus have been removed to show the muscles of the mandible and the antenna. The dotted lines suggest partly the position of the labrum and the clypeus and partly (in the big muscle) the lateral wing of the big mandibular apodeme (*a 10*).

„ 13. Dorsal view of the left half of the head capsule. The dorsal wall of the capsule, the labrum, clypeus, mandible, hypopharynx together with a part of the stipes have been removed to show the muscles of the maxilla and the labium, and the internal skeleton of the head capsule.

Anmeldelse.

H. Kalmus: **Simple Experiments with Insects.** London (Will. Heinemann) 1948. 131 Sider. Pris: 7 sh 6 d indb.

H. Kalmus: **Einfache Experimente mit Insekten.** Aus dem Englischen übersetzt. Basel (Verl. Birkhäuser) 1950. 197 Sider. Pris: 9.75 Schw.fr. indb.

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S. L. Tuxen.
