

Studies on the External Morphology of *Bruchus affinis* Frol. (Coleoptera, Phytophaga, Bruchidae)

Part—1, Head Capsule and Mouth Parts

By

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Introduction

General account of the head capsule and mouth parts of Coleoptera has been dealt by Stickney (1923) and Williams (1938) respectively. They have discussed these structures from the standpoint of phylogeny. Their studies being extensive do not naturally include the family Bruchidae. Work on Bruchidae is by Zacher (1930), Mukerji and Bhuya (1937), Mukerji (1949), Mukerji and Chatterji (1951) and Srivastava (1953) who have described the male and female genitalia of a few bruchids. Besides this there is little work on the morphology of Indian bruchids. Hence, an attempt to study the morphology of the head capsule and mouth parts of *Bruchus affinis* Frol. has been made by the present authors.

Material and Technique

Bruchus affinis, found infesting the common peas (*Pisum* sp.), were collected from local grain merchants during the months of August and September. They were killed in benzene and preserved in 70 % alcohol. Specimens were made transparent by boiling in concentrated potassium hydroxide solution. All the dissections were made under the stereoscopic binocular microscope. Different sclerites were stained in 1 % acid fuchsin solution and permanent mounts were made as usual. The diagrams were drawn with the help of camera lucida.

Head Capsule

The head capsule is a highly chitinised, punctate and deeply pigmented oblong structure with horseshoe-shaped eyes, one on either side, bulging out laterally. The head lies straight in line with the thorax. The prognathous mouth parts are directed cephalad in active state. The head is closely applied, when at rest, to the pro and mesosternum, the mouth parts being then directed backward. The posterior end of the head capsule is distinctly convex. (Fig. 1.)

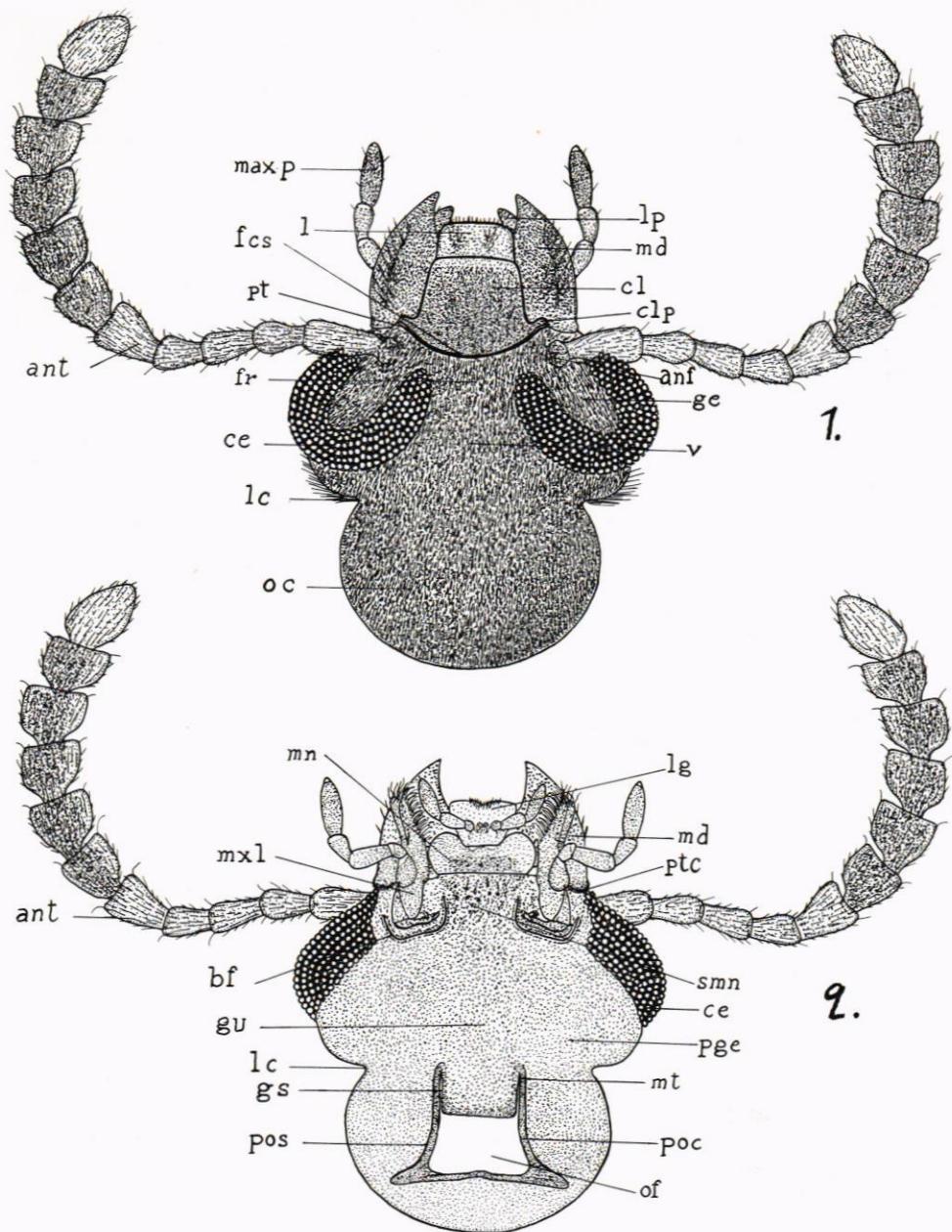


Fig. 1. Dorsal view of the head (male). Fig. 2. Ventral view of the head (male). — Abbreviations p. 230.

There is no trace of the epicranial suture. Hence the frons, an unpaired region of the head, is not demarked posteriorly from the vertex. However, an imaginary line can be drawn across the top of one antennal fossa to the other. At either end of this line another line drawn at an angle of 45 degrees represents the frontal suture of the side. The frons in bruchids, in general, is well marked anteriorly by the frontoclypeal suture (Bridwell, 1932). Contrary to this, Stickney (1923) denies the presence of frontoclypeal suture in coleopterous beetles studied by him. However, he did not include the study of bruchids. Nevertheless, a distinct frontoclypeal suture is present in *Bruchus affinis*. The area of frons is much reduced due to the caudad curving of the frontoclypeal suture. The frontoclypeal suture terminates laterally into the corresponding anterior tentorial pits near the anterior articulations of the mandibles and forms a corresponding internal frontoclypeal inflection (Du Porte, 1946). The anterior tentorial pits, the preten-torinae, lead into respective anterior tentorial arms.

The dorsal surface of the head caudad to the frons and upto the occiput is the vertex. The occiput is not separated from the vertex by any suture, the occipital suture is absent. Bridwell (1932) describes a few characters of the family Bruchidae in which he writes . . . the head is with a transverse furrow extending across the ventral surface and on either side behind to the summit of the eyes, setting off the occiput as a neck. According to him the ventral fissure corresponds to the occipital suture. But the present authors have not observed any ventral fissure in *Bruchus affinis*. However, the semi-circular occiput is cut off by lateral constrictions. An imaginary line drawn across the two lateral constrictions represents the occipital suture. The head is telescoped into the prothorax at the lateral constrictions. The dorsal part of the occiput is not clearly visible when the head is extended.

On each side of the vertex is a deeply emarginate compound eye. There is no trace of any ocellus in *Bruchus affinis* as is the case in other coleopteran beetles (Stickney, 1923). The anterolateral areas to the frons represent the genae. The gena extends posteriorly and takes a peculiar position by filling the gap of horseshoe-shaped eye. Each gena bears an antenna at its cephalic end, close to the emargination of the eye. The flabellate antenna is eleven jointed, compressed, hairy, and expanded structure except the basal four segments which are cylindrical (Fig. 3). The basal five segments and the terminal segment are ochraceous whereas the remaining five are castaneous. Each segment is a cup-like structure the basal stalk of which fits into a depression in the preceding segment. In the female, the basal stalk of each segment is slightly more elongate. The basal segment of antenna, the scape, is the longest whereas the second segment, the pedicel, is the shortest while the rest nine segments form the flagellum or clavola. The antennal sclerite or antennarium is represented by a small pivot-like process, the antennifer, on the cephalic margin of the antafossa or antacava. There is a slit on the bulbous base of scape into which the antennifer fits. To the base of each antenna are attached two short tendons, the antatendons, for the insertion of antennal muscles.

The paired sclerites of head posterior to the frontal sutures sometimes including frons also, are termed as epicranium. These paired sclerites are not demarked from each other in *Bruchus affinis* as the epicranial suture is absent.

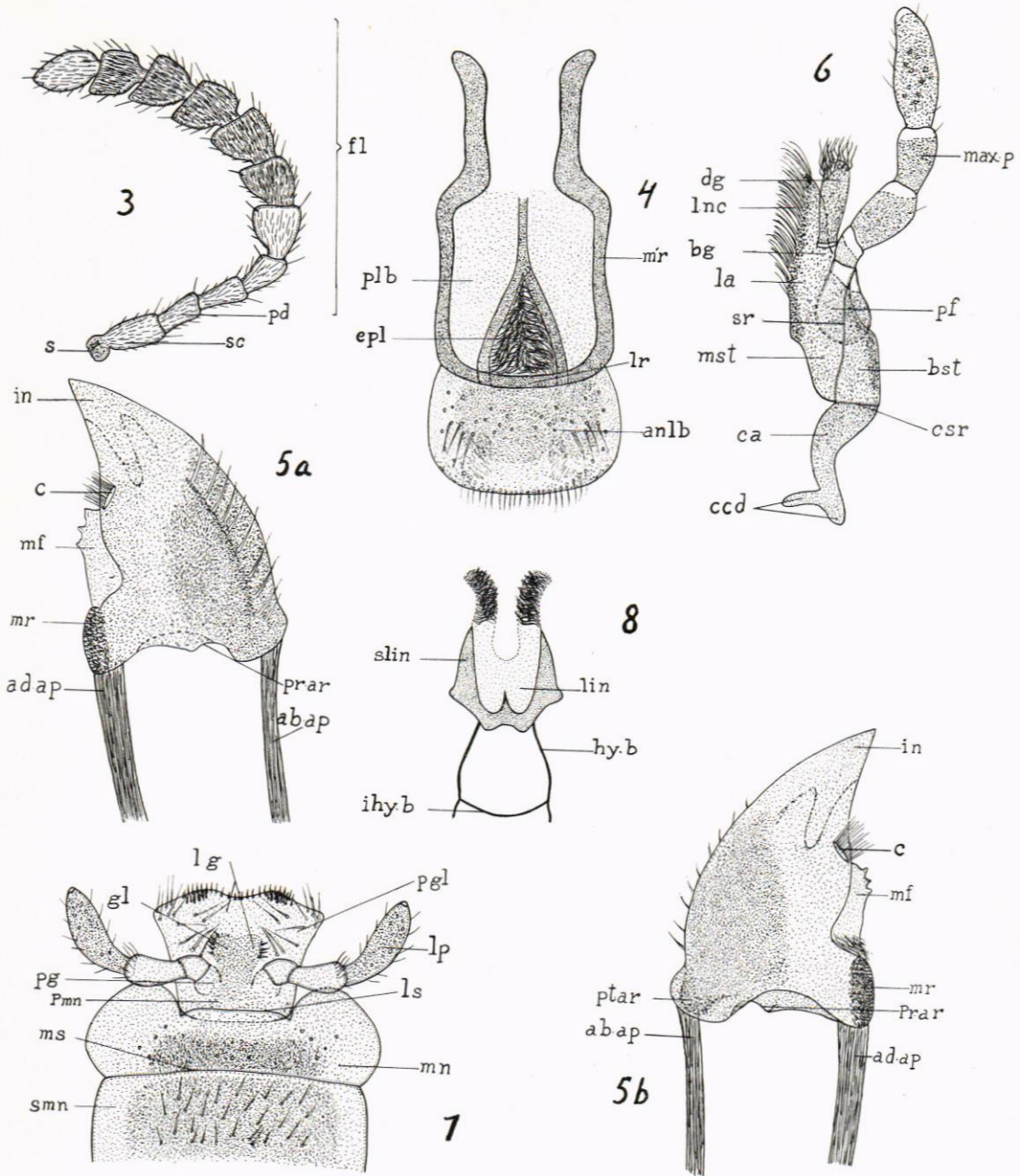


Fig. 3. The female antenna. Fig. 4. Dorsal view of the labrum. Fig. 5 a. Dorsal view of the right mandible. Fig. 5 b. Ventral view of the right mandible. Fig. 6. Dorsal view of the right maxilla. Fig. 7. Ventral view of the labium without the hypopharynx. Fig. 8. Dorsal view of the hypopharynx. — Abbreviations p. 230.

Cephalad to frons and separated from it by a distinct frontoclypeal suture is the clypeus. The clypeus is not divided into an ante and a postclypeus. The caudolateral ends of clypeus are produced into small processes which represent the clypealia. No suture separates the clypealia from the clypeus. There is a ridge on the lateral margins of the clypeus running ventrally from the middle to its caudolateral ends where it thickens and forms the precoila of respective side to which the preartis of the mandible articulates. (Fig. 2.)

The occipital foramen lies at the caudal end of the head capsule on the ventral side. It is surrounded by a narrow rim, the postocciput, separated from the occiput by the postoccipital suture. The neck membrane or cervix as usual, is attached to the postocciput.

The median region of the ventral epicranium is formed by the gula. The gula is not demarked from the epicranium cephalad to the imaginary occipital suture as the gular sutures are distinct only posteriorly. Anteriorly, the gular sutures end into the posterior tentorial pits, the metatentorinae. The gula continues forward to receive the labium on its entire anterior margin. There is no gulomental suture, the gula is indistinguishably fused with the distally placed submentum. The area of epicranium on either side of the gula and cephalad to occiput is the postgena. On the anteromesal region of each postgena is a U-shaped fissure, the buccal fissure (Bridwell, 1932). It is in the form of a pocket, the anterodorsal margin of which forms the paracoila, to which the articular processes of cardo of the respective side articulate. The postgena bears a cavity, the postcoila, at its laterocephalic end into which articulates the postartis of the mandible of its side.

Mouth Parts

(a) *Labrum*. (Fig. 4.) — The labrum or upper lip is a movable sclerite forming the roof of the preoral cavity. According to Comstock and Kochi (1902) the labrum is last of the series of unpaired sclerites between the epicranial suture and the mouth. The labrum in *Bruchus affinis* is about two and a half times longer than broad. The clypeolabral suture is absent as the labrum lies ventral to the clypeus. A thick transverse ridge, the labral ridge, divides the labrum into two parts, the anterior sclerotised antelabrum and the posterior membranous postlabrum. The postlabrum is completely covered by the clypeus while the antelabrum projects in front of the clypeus and appears to be in continuation with it. The labral ridge continues backward, on either side as the marginal ridge which bends slightly inward in the middle of its course and guards the side of the postlabrum. The ventral wall of postlabrum forms the epipharyngeal wall of the preoral cavity. From the middle of the caudal end of antelabrum arises ventrally a Y-shaped epipharyngeal lobe provided with hair. The epipharyngeal lobe represents the epipharynx.

The dorsal surface of antelabrum is punctured and bears hairs and setae. The distal margin of the antelabrum is fringed with strong setae.

(b) *Mandibles*. (Fig. 5 a and 5 b.) — The mandibles are thick, and highly cuticularised appendages having transverse movements of abduction and adduction. They are situated, one on either side of the clypeus and dorsal

to the maxillae. Each mandible is a roughly triangular structure with the broad base and a pointed apex directed forward. The outer margin is entire while the cutting mesal surface is differentiated into a distal toothed incisor lobe and a proximal molar lobe provided with irregular, dentate, and thickly chitinised masticatory surface. The distal lobe forms the cutting organ while the proximal lobe forms the grinder. The arrangement and number of the incisors and molars are same in the left and right mandibles.

There is a thin membranous flap with irregular margin on the mesal side between the cutting apex and the basal molar mass (Bridwell, 1932). At the inner margin, in front of the membranous flap, is a comb-like structure provided with hairs directed mesally.

Each mandible has two articulatory processes, the anterior and posterior, on its proximal end. The former process, the preartis, fits into the precoila. The latter, the postartis, is a well developed condyle which articulates with the postcoila by a ball and socket arrangement to facilitate the movement.

Two long apodemes are attached to the inner and outer angles of the mandibular base. The inner broader adductor apodeme and the outer comparatively narrow abductor apodeme for the insertion of adductor and abductor muscles respectively.

(c) *Maxillae*. (Fig. 6.) — Each maxilla is situated on the lateral side of the medially placed labium. It is composed of the cardo, stipes, lacinia, galea, palpifer, and maxillary palpus.

The maxilla articulates with the paracoila of cranium by means of basal articular condyles of the cardo which serve for the attachment of three promotor apodemes (Misra, 1945), one to the outer side and two to the inner side, for the insertion of muscles.

The cardo is the proximal segment of maxilla and is not divided into a basi and a disticardo as in most beetles (Williams, 1938). The distal end of the cardo is bulged and deflects at right angles to the stipes while the cylindrical proximal end in turn is deflexed dorsally at right angles to the distal end.

The stipes forms the major portion of maxilla and is separated from the distal end of cardo by a cardostipital ridge. An oblique ridge, the stipital ridge, running from the mesal end of the cardostipital ridge toward the distal end of palpifer divides the stipes into a more or less triangular basistipes and an irregular mediostipes. The dististipes, a small membranous area between the basigalea and basistipes present in many coleopterous forms (Williams, 1938), is absent in *Bruchus affinis*.

The terminal lobes of maxilla, the external cylindrical galea and the internal knife-like lacinia, arise from the distal end of the mediostipes. The lacinia is distinguished from mediostipes by the high degree of cuticularisation at its base. The galea is divided into a basal region, the basigalea, and a distal region, the distigalea by a transverse ridge. The basigalea is not demarcated from mediostipes. The distigalea as in *Silpha* (Williams, 1938) is tipped with a dense tuft of long hair. Dorsally, the galea partially overlaps the lacinia. The mesal margin of lacinia bears numerous long hair, the lacinarasta directed toward the preoral cavity.

On the outer side of stipes, separated from it by a well developed ridge, is a pitcher-shaped distinct sclerite, the palpifer, which bears a four segmented maxillary palpus at its distal end. The first segment of palpus is the

shortest while the terminal segment is the longest of all. The dorsal and ventral surfaces of the palpus are beset with sparsely arranged setae.

(d) *Labium*. (Fig. 7.) — The labium or lower lip forms the floor of the preoral cavity and is medially placed between the maxillae. It consists of the submentum, mentum, prementum, ligula (glossae and paraglossae), palpigers and labial palpi. The main body of the labium is formed by the mentum and prementum. The submentum is the proximal and highly sclerotised sclerite of the labium and is indistinguishably fused with the caudally placed gula, the gulomental suture being absent. However, externally the posterior boundary of submentum can be arbitrarily demarked by drawing an imaginary line from the basal articulation of the cardo of one side across the basal articulation of the cardo of the other side (Crampton, 1928). Snodgrass' (1935) criterion of judging the posterior boundary of submentum by the presence of two metatentorinae is not tenable here as the metatentorinae lie quite posterior to the basal articulations of the cardines. Moreover, the metatentorinae shift in a very irregular fashion whereas the basal articulations of cardines are not subjected to such disconcerting shiftings and on this account the cardines are more satisfactory landmarks for determining the posterior limit of the submental region. According to Crampton (1928), the submentum may be merely a derivative of the gulomental plate of the larvae which becomes differentiated into the gula and submentum in higher forms and in adult stages of larval forms having only a gulomental region.

The submentum bears a bilobed mentum on its distal end. A distinct mental suture separates the mentum from the submentum.

The mentum receives prementum or eulabium of Crampton (1928) on its distal end between two lobes. The prementum is separated from mentum by the labial suture. Distally, the prementum bears labial palpi and ligula. The anteromesal margin of ligula is provided with fine hair and setae. Though the ligula is formed collectively by the paraglossae and glossae, but the median highly sclerotised, bilobed glossae can be demarked from the membranous lateral paraglossae by their difference in consistency. Ventrally, from the sides of prementum, one on either side, arise three segmented labial palpi supported on thin membranous palpigers. The palpigers are not separated from the prementum by any suture. The first segment of the palpus is shortest, the second is longer whereas the third is the longest. Each palpus bears sparsely arranged setae.

(e) *Hypopharynx*. (Fig. 8.) — The small U-shaped, chitinised hypopharynx lies closely adnate to the dorsal wall of prementum. It consists mainly of two parts, the outer and the inner. The former is chitinised while the latter is membranous. According to Snodgrass (1935) the hypopharynx in generalised insects includes a pair of lateral lobes known as the superlinguae and the median lingua. The outer chitinised portion is referred to here as superlinguae and the inner membranous as lingua. There is no suture separating the two superlinguae. The cephalic portion of the lingua bears setae. The base of the hypopharynx is supported by a pair of chitinous bars, the hypopharyngeal bars (Dorsey, 1943). A transverse bar, the interhypopharyngeal bar, connects the two hypopharyngeal bars. The latter are attached to the posterior side of the membranous postlabrum.

(f) *Tentorium*. — The tentorium or endoskeleton is a thin, chitinous, π -like structure, inverted when seen from the posterior side. It consists of the anterior tentorial arms and the posterior tentorial arms.

The long, thin and slender anterior arms of the tentorium arise from the ends of the frontoclypeal ridge and their external pits, the pretentorinae lie in the corresponding suture. The posterior tentorial arms are continuous in a transverse bar, the tentorial bridge, through the back of the head with the anterior arms attached to it near its outer ends. The posterior tentorial arms open outside through the metatentorinae which lie at the anterior ends of gular sutures.

Summary

The present paper deals with the morphology of head capsule and mouth parts of *Bruchus affinis* Frol. The following features are noteworthy.

1. The head is an oblong structure with the horseshoe-shaped compound eyes bulging out laterally.
2. The mouth parts are prognathous.
3. There is no epicranial suture.
4. A distinct frontoclypeal suture divides the anterior region of the head into clypeus and frons.
5. The frontoclypeal suture terminates laterally into the pretentorinae.
6. The genae take a peculiar position in filling the gap of the strongly emarginate compound eyes.
7. At the cephalic end of each gena, is a flabellate eleven-jointed antenna.
8. The clypeolabral suture is absent as the labrum lies ventral to the clypeus.
9. A transverse labral ridge divides the labrum into an ante- and a postlabrum. The ventral wall of the postlabrum bears a Y-shaped epipharyngeal lobe representing the epipharynx.
10. The occipital suture is absent, semicircular occiput is constricted by two lateral constrictions.
11. The gula is indistinguishably fused with the submentum, the gulomental suture is absent.
11. There is a membranous flap on the mesal side of each mandible extending between the cutting apex and the basal molar mass.
13. The distal end of cardo deflects at right angles to the stipes and the proximal end in turn is deflexed dorsally at right angles to the distal end.
14. The hypopharynx lies adnate to the prementum.
15. The tentorium is a thin and π -like structure inverted when seen from the posterior side.

Acknowledgments

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Abbreviations

ab.ap=abductor apodeme	lr=labral ridge
ad.ap=adductor apodeme	ls=labial suture
anf=antafossa	max.p=maxillary palpus
anlb=antelabrum	md=mandible
ant=antenna	mf=membranous flap
bf=buccal fissure	mn=mentum
bg=basigalea	mr=molar
bst=basistipes	m'r=marginal ridge
c=comb-like structure	ms=mental suture
ca=cardo	mst=mediostipes
ccd=cardo condyles	mt=metatentorina
ce=compound eye	mxl=maxilla
cl=clypeus	oc=occiput
clp=clypealia	of=occipital foramen
csr=cardostipital ridge	pd=pedicel
dg=distigalea	pf=palpifer
epl=epipharyngeal lobe	pgl=paraglossa
fl=flagellum	pge=postgena
fcs=frontoclypeal suture	pg=palpiger
ga=galea	plb=postlabrum
ge=gena	pmm=prementum
gl=glossa	poc=postocciput
gs=gular suture	pos=postoccipital suture
gu=gula	prar=preartitis
hy.b=hypopharyngeal bar	ptar=postartitis
ihy.b=interhypopharyngeal bar	ptc=postcoila
in=incisor	pt=pretentorina
l=labrum	s=slit
la=lacinia	sc=scape
lc=lateral constriction	slin=superlingua
lg=ligula	smn=submentum
lin=lingua	sr=stipital ridge
lnc=lacinastra	v=vertex
lp=labial palpus	