Distribution of Sensilla and Interlocking of Mouthparts in Red Eye Bug, *Leptocoris augur* (Hemiptera: Heteroptera: Rhopalidae)

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ABSTRACT: The mouthparts of soapberry bug, *Leptocoris augur* is piercing and sucking type modified into long tube called as proboscis or rostrum. The rostrum is made up of long thin stylets. These stylets are modified mandibles and maxillae, which fits together to form canals. The stylets are wrapped in the labium tube. The stylets of maxillae are sharply pointed while stylets of mandibles have barbed tip to penetrate the host plant. The labrum (LAB) is on antero- ventral side of the labium (LBI), broader towards the anterior end and tapering towards the posterior end which is inserted into the labial groove (LG). The ventro-lateral position of anterior end of labrum consist of linearly arrange sensilla trichoidea (ST-I, ST-II) and sensilla trichoidea curvata (STC). The outer surface of labium consist of sensilla trichoidea (ST-I, ST-II), sensilla trichodea curvata (STC) and sensilla basiconica (SB). The tip of labium have sensilla trichoidea (ST), sensilla basiconica (SB-I, SB-II), sensory peg (PEG) and maxillary stylets (MS). Transverse section through segments of labium shows interlocking of maxillae and mandibles forming food canals and salivary canals.

KEY WORDS: *Leptocoris augur*, SEM, Labium, Labrum, Mandible, Maxilla, Sensilla

INTRODUCTION:

Leptocoris augur is economically important as it is the major pest of soapberry (Rittha), *Sapindus saponaria*. When bugs are extremely numerous they feeds on vegetable and fruit plants around the common host plant. Bugs damage the host plants by sucking the plant sap as they have piercing and sucking type of mouthparts.

Although nymphal feeding causes less damage as they are terrestial, major damage, however, is caused by the adult bugs. Damage caused by bugs results in early falling of fruits (Rittha) even by single piercing. Different types of sensilla present on the mouthparts of bug may acts as chemo and mechanoreceptor (Gaffal, 1981). Labium modified into tube in which stylets of mandibles and maxillae enclosed. The mandibles penetrate plant tissue along with maxilla as mandibles have conical denticles at its proximal end which helps in piercing and sucking plant sap (Paladini *et al.,* 2008). Mandibles and Maxillary stylets form canal for sucking the plant sap. Some authors (Herzog 1967; Schoonhoven and Henstra, 1972; Khan, 1972) suggested that sensilla, which are placed on the tip of the labium in *Dysdercus sp.* are chemosensilla. The small hairs and the long bristels on entire labial surface, especially preapical bristles of the terminal rostral segment are mechanosensilla (Bernard, 1974)

Ultrastructure of mouthparts sensilla and interlocking structure of mouthparts of *Leptocoris augur* were analysed. The aim of this paper was to investigate different sets, position and shape of sensilla on mouthparts of bugs, specially the labial sensilla as they might be working as chemoreceptor and mechanoreceptor. It also reveals morphological linkage system of mandibles and maxilla.

MATERIAL AND METHODS:

The adult red eye bug *Leptocoris augur* were collected from soapberry plant, *Sapindus saponaria L.* and rearing was carried out in the insectary of Department of Zoology, RTM Nagpur University, Nagpur. The head with the complete mouthparts of adult bug were carefully and gently removed under the dissecting binocular microscope (Zeiss). For SEM study, dehydrated mouthparts were dried at room temperature and mounted on carbon coated metallic stubs as per desired view and proceeded for platinum coating in poloron gold coating automatic unit. Finally scanned under Jeol (JSM 6380A) Scanning Electron Microscop (SEM) at desirable magnification at the SEM centre of Vishveshvaraya National Institute of Technology (VNIT) Nagpur, India. The head of bug fixed in bouin's fixative, dehydrated in graded alcohol, cleared in xylene and embedded in paraffin wax. Sections were taken with the help of microtome and stained with haematoxylene eosin.

RESULT AND DISCUSSION:

The head of adult bug was triangular in shape. A pair of compound eye and a pair of lateral ocelli present on the upper facial region of head. The upper facial region called as frons (F). Genae (GE) represents the lateral areas of head on both side and extended from compound eye upto the clypeus (CL). Clypeus occupies the position between the anterior labrum and posterior frons (F). All the region of head including clypeus, genae, frons bears two types of sensilla i.e. sensilla trichoidea (ST) and sensilla trichoidea curvata (STC) (fig:1) (table:1).

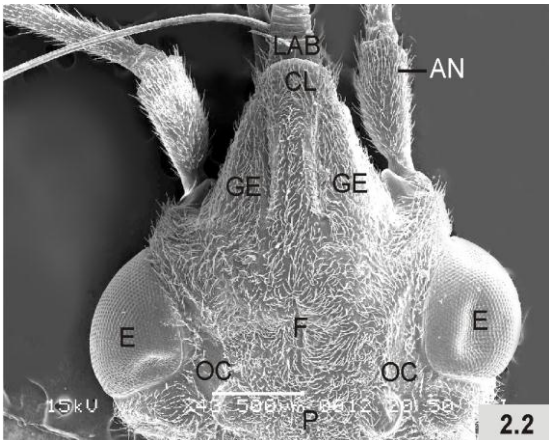

Fig 1: SEM structure of head showing STC on Genae region.

Abb:-AN-Antenna; CL-Clypeus; GE-Genae; OC-Ocelli; F-Fons; E-eye; STC-Sensilla Trichoidea Curvata.

Table 1: Morphological observations of sensillae on head of *Leptocoris augur*

Sr. No.	Adult bug	Type of sensilla	Length (µm)	Width (µm)
1.	Head	Sensilla trichoidea Sensilla trichoidea curvata	57.77 ± 0.11 67.11 ± 0.91	2.1 ± 0.11 1.9 ± 0.03

Mouthparts :

The piercing and sucking type of mouthpart were modified into long tube called proboscis. The mouthparts of *L. augur* consist of mandibles (MAN), maxillae (MAX), labrum (LAB) and labium (LBI) (table:2).

Table 2: Morphological observations of mouthparts of *Leptocoris augur*

Sr. No.	Mouth parts	Length (mm)	Width (µm)
1.	Mandibles	7.12 ± 0.01	17.21 ± 2.2
2.	Maxillae	7.37 ± 0.03	62.77 ± 3.1
3.	Labrum	1.91 ± 0.01	87.11 ± 3.2
4.	Labium	7.22 ± 0.1	170.44 ± 3.5

Labrum :

Labrum are broad towards anterior end and tapering towards the posterior end. At the end of first segment of labium, labial groove (LG) present where labrum was inserted (fig:2). The surface of labrum was rough without sensilla but the antero-ventral end of labrum had two types of sensilla, sensilla trichoidea (ST) and sensilla trichoidea curvata (STC). They are arranged ventro-laterally in linear manner (fig:3).

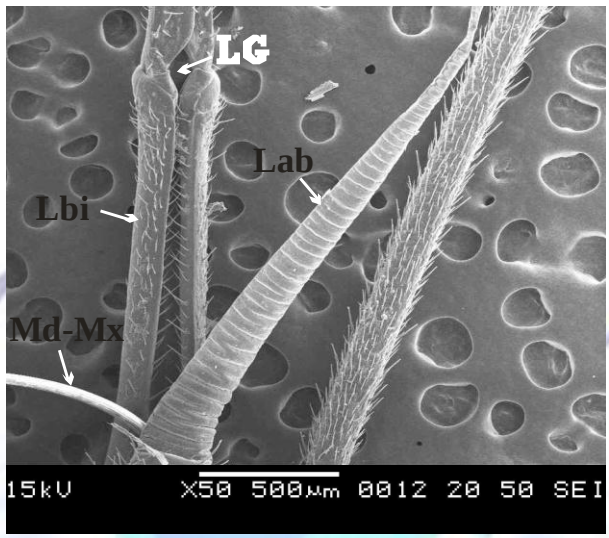

Fig 2: SEM structure of labrum showing ridges.

Abb: Lbi-Labium; Lab-Labrum; LG-Labial Groove.

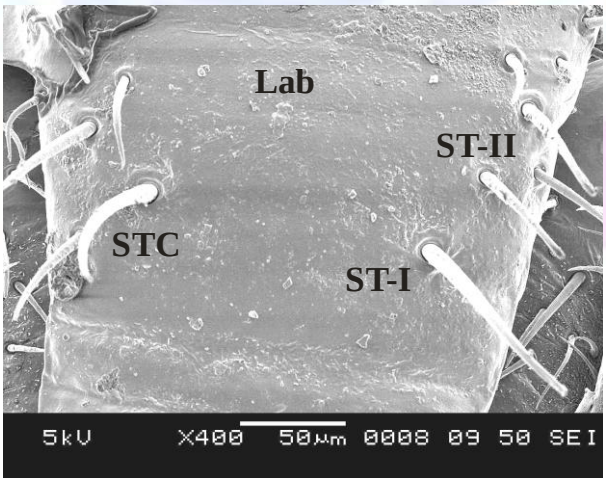

Fig 3: SEM of ventro-anterior region of Labrum showing ST-I, ST-II and STC.

Abb:- ST-Sensilla Trichoidea; STC- Sensilla Trichoidea Curvata.

Mandibles :

A pair of mandible were modified into long thin stylets and wrapped into the labium tube. Mandibles were long, unsegmented and strongly sclerotized from anterior to posterior end, the surface of mandible consist of ridges. There were seven conical structures from D_1- D_7 at the posterior end. These backwardly directed mandible teeth helps during penetration (fig:4) (table:3).

Maxillae :

A maxillae were modified into the long stylets and wrapped into the labium tube with a pair of mandibles. The stylets of maxillae has smooth surface and pointed towards the apex. The maxillae penetrate deeply and suck plant sap with the help of mandibular stylets (fig:5).

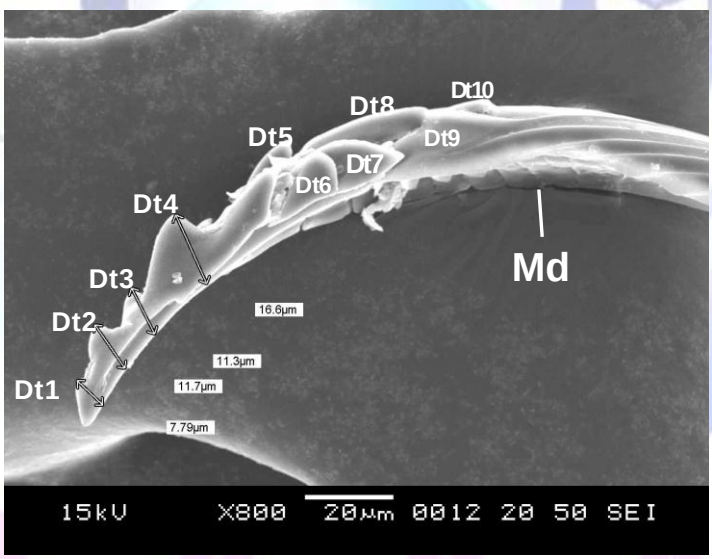

Fig 4: SEM structure of stylets of mandibles tip showing denticles and ridges (*).

Abb: Md-Mandibles; Dt1-Dt7- Denticles.

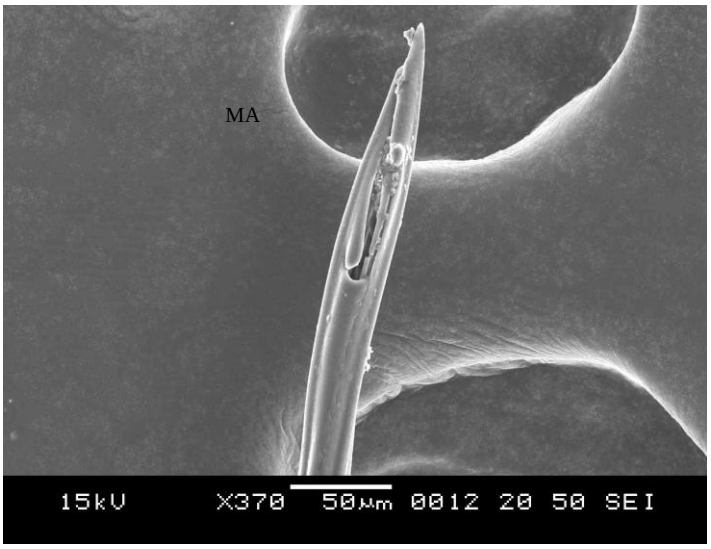

Fig 5: SEM structure of maxillae (MAX) showing pointed tip.

Table 3: Size of denticles present on the mandible

Sr. No.	Denticle	Length (µm)	Width (µm)
1.	D-1	7.79 ± 1.2	8.87 ± 1.5
2.	D-2	11.7 ± 1.9	8.99 ± 3.2
3.	D-3	11.3 ± 1.0	8.87 ± 1.5
4.	D-4	16.6 ± 1.1	15.90 ± 2.5
5.	D-5	17.9 ± 1.3	16.0 ± 3.2
6.	D-6	18.8 ± 1.2	17.99 ± 3.5
7.	D-7	18.7 ± 1.3	17.0 ± 3.1

Labium :

Labium was long, four segments (fig:6) modified into tube, where stylets of mandibles and maxillae wrapped to form a proboscis. At the end of first segment, there was labial groove, where the posterior end of labrum inserted. First to fourth segment of labium bears three type of sensilla, sensilla trichoidea (ST), sensilla trichoidea curvata (STC) and sensilla basiconia (SB) (fig:7). The inner surface of labium bears rows of sensory organ i.e. microtrichia as microtrichtra-I, II and III (fig:8). The tip of labium bears three types of sensilla. They were sensilla trichoidea (ST), sensilla basiconica (SB) and sensory peg. (PEG) (fig:9) (table:4).

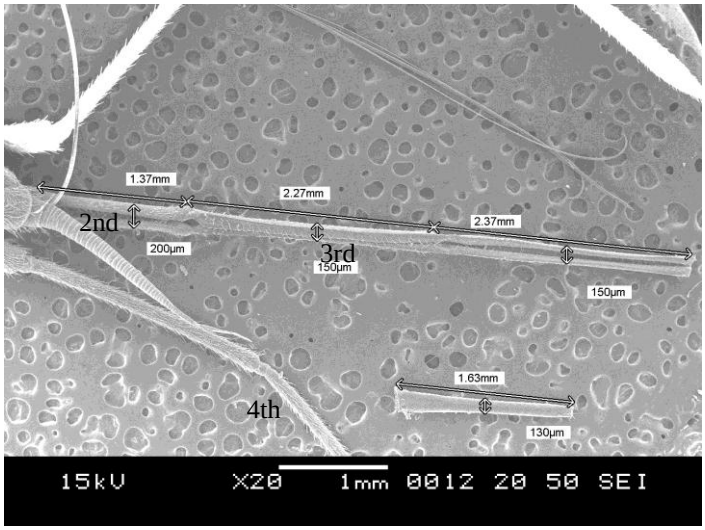

Fig 6: SEM structure 1st to 4th segment of Labium.

Table 4: Morphological observations of sensillae on labium .

S. N.	Labium	Length (mm)	Width (µm)	Type of sensilla	Length (µm)	Width (µm)
1.	1st seg	2.37 ± 0.01	200 ± 1.0	Sensilla trichoidea-I	67.66 ± 1.2	1.2 ± 0.01
				Sensilla trichoidea-II	48.39 ± 0.9	0.9 ± 0.001
				Sensilla trichoidea curvata	51.11 ± 0.8	0.8 ± 0.002
				Sensilla basiconica	1.1 ± 0.01	1.1 ± 0.01
2.	2nd seg	2.27 ± 0.04	150 ± 1.2	Sensilla trichoidea	66.11 ± 1.2	1.2 ± 0.01
				Sensilla basiconica-I	10.2 ± 0.02	1.1 ± 0.01
				Sensilla basiconica-II	0.2 ± 0.0001	0.1 ±0.0001
3.	3rd seg	2.37 ± 0.01	150 ± 1.3	Sensilla trichoidea-I	76.11 ± 1.2	1.2 ± 0.01
				Sensilla	47.37 ±	0.9 ±

				trichoidea-II	1.1	0.002
4.	4th seg	1.63 ± 0.04	130 ± 0.9	Sensilla trichoidea	57.11 ± 1.10	0.9 ± 0.01
5.	Tip	-	-	Sensilla trichoidea Sensilla basiconica	97.37 ± 1.2 1.1 ± 0.01	1.2 ± 0.01 1.1 ± 0.01
6.	Inner surface	-	-	Microtrichia-I Microtrichia -II Microtrichia -III	2.00 ± 0.1 1.3 ± 0.06 0.2 ± 0.001	0.3 ± 0.001 3 ± 0.001 0.1 ± 0.001

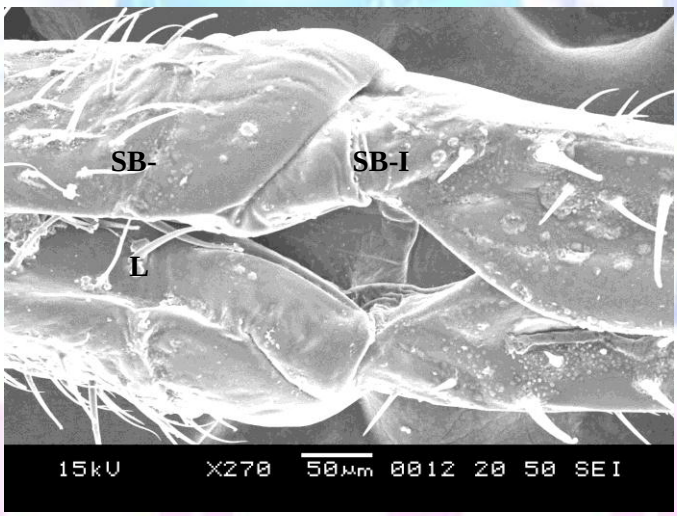

Fig 7: SEM structure of end of 1st segment showing Labial groove (LG) and sensilla basiconica (SBI), (SBII) and sensilla trichoidea (ST).

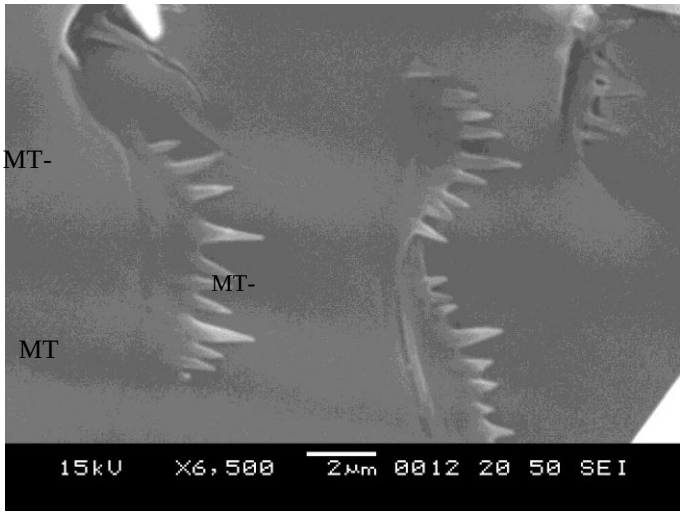

Fig 8: SEM structure of inner surface of labium showing MT-I, MT-II, MT-III.

Abb:- MT-Microtrichia

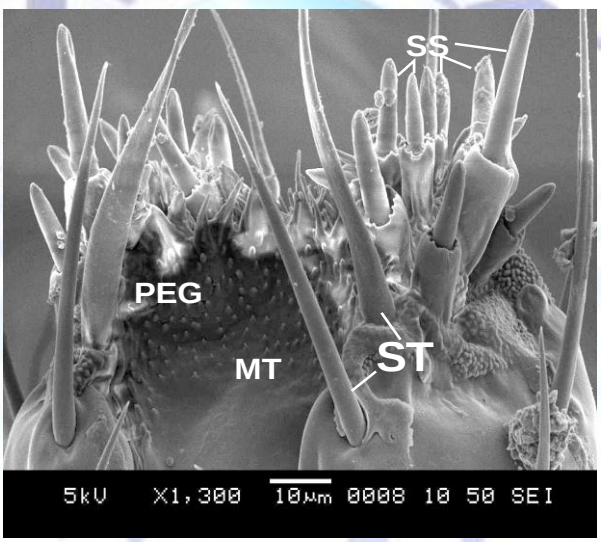

Fig 9: SEM structure of ventral tip of labium showing ST, SS and PEG.

Abb: ST-sensilla trachoidea; SS- sensilla basiconica; MT- microtrichia; PEG-sensory peg.

Interlocking of Mouth Parts

The mouth parts of *Leptocoris augur* consist of pair of mandible (Md), interlocked pair of maxilla (Mx), labrum (Lab) and labium (Lbi) (fig.10). The cross section through the segments of labium reveals the grouping and interlocking of maxillae and mandibles. Transverse section passing through the first segment of labium showing the presence of inverted half circle of

the labrum enclosing maxillae and mandibles. The complex of labrum, maxillae and mandibles are not completely attached with the groove of labium (fig.11).

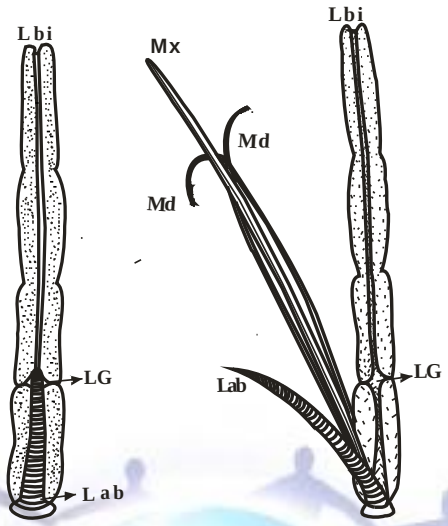

Fig 10. Diagrammatic representation of proboscis with all the stylets.

Abb : Lbi: labium; Lab: labrum; LG: labial groove; Md: mandible; Mx:maxilla; FC: food canal; SC: salivary canal.

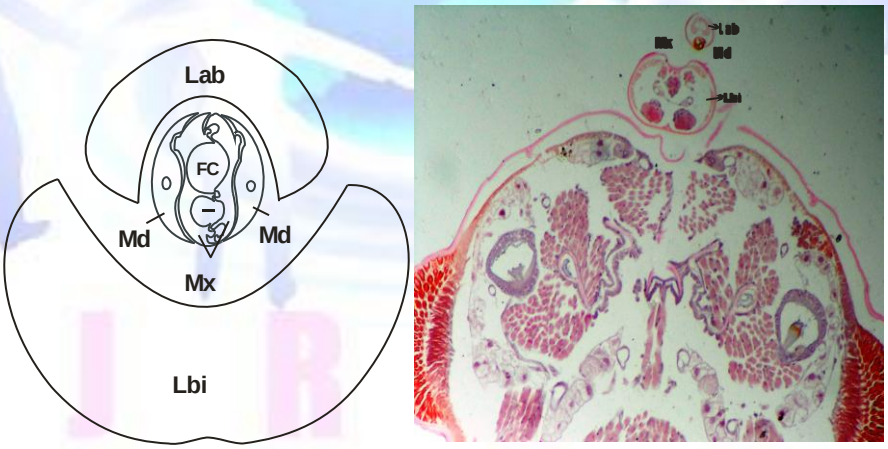

Fig.11: Diagrammatic representation and cross section through first segment of labium.

Abb : Lbi: labium; Lab: labrum; LG: labial groove; Md: mandible; Mx:maxilla; FC: food canal; SC: salivary canal.

The section passing through the second, third and fourth segment of labium showing completely merging of maxillary and mandibular stylets within

labium. The arrangement of maxillae and mandibles forming two canals, anterior food canal and posterior salivary canal (fig.12).

In the *L. augur* the linkage between maxillae and mandibles is appeared in the form of lock and key system. The cross section passing through all segments of labium show presence of lock and key system called as system of linkage. For the linkage both right and left maxillae have internally formed two types of appendages. These are categorized as unciform (u) i.e. curved appendages and straight (s) appendages. In the linkage system there are three locks are formed as dorsal, middle and ventral.

The dorsal lock is formed by the four appendages i.e. two unciform and two straight. Among these three appendages i.e. one unciform and two straight are present on the left maxilla while one unciform is present on the right maxilla. The unciform appendages form strong linkage.

The middle lock consists of two appendages on each side. On the left maxilla one straight and one unciform and on the right maxilla one straight and one unciform are observed. The ventral lock has four appendages i.e. two straight and two unciform. Out of these, on the left maxilla two straight and one unciform while on the right maxilla one unciform appendage has been observed interlocking with unciform appendage of left maxilla. In between dorsal and middle lock the food canal is form representating the digestive track similarly in between middle and ventral the salivary gland represents in the form of salivary canal. Both the canals are closed by appendages of interlocking system (fig.13).

Fig.12: Diagrammatic representation and cross section through labium

Abb : Lbi: labium; Lab: labrum; LG: labial groove; Md: mandible; Mx:maxilla; FC: food canal; SC: salivary canal.

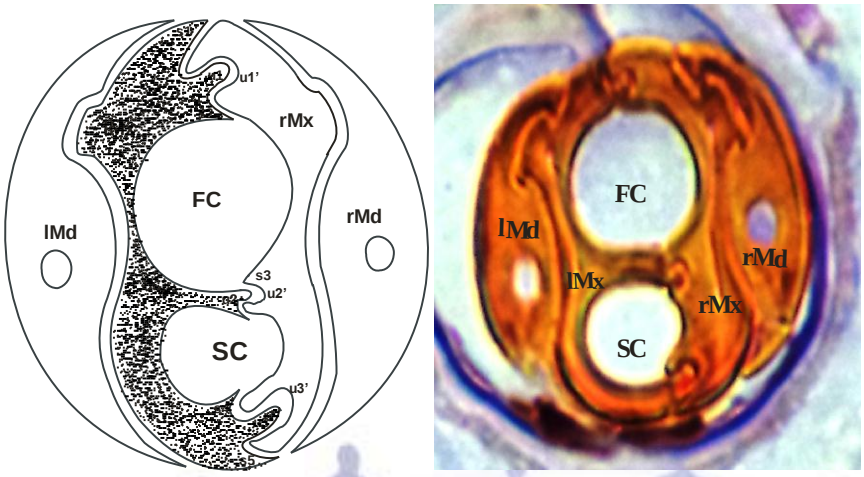

Fig.13: Diagrammatic representation and cross section showing interlocking of maxillary and mandibular stylets. Abb : Lbi: labium; Lab: labrum; LG: labial groove; Md: mandible; Mx:maxilla; FC: food canal; SC: salivary canal.

In most of the sap sucking Hemiptera, the mouthparts are adapted for the piercing and sucking type (Backus, 1988; Bourgoin *et al.*,1997). During the present study in the *L. augur* the mouthparts are found to be piercing and sucking type forming proboscis. The proboscis comprises with a pair of mandibles, a maxilla modified into long stylets enclosed into the four segmented labium tube. The anterior end of labrum inserted into the labial groove when not in use. The mandibular stylets bears backwardly directed teeth help in penetration. Similarly mandibular stylets of *Notozulia entreriana* (Hemiptera) have conical denticle like structure at the proximal end. (Paladini *et al.*, 2008). The mandible of carpenter ant, *Componotus compressus* have teeth like structure and also bears sensilla trichoidea and sensilla basiconica (Kadu, 2010). The stylets of mandibles and maxillae form canal for sucking plant sap. Similar structure and function of piercing and sucking mouth parts were described in other sap feeding insect by earlier workers (Saxena and Chadha 1951; Parish, 1967; Backus and Mclean,

1982). In chinch bug, *Blissus leucopterus* similar type of mouth parts has been noticed by Anderson *et al.,* (2006).

In the present study, it has been noticed that on the ventral side of proximal end of labrum, two types of sensilla, sensilla trichoidea (ST) and sensilla trichoidea curvate (STC) arranged in linear manner. Both the stylets of mandibles are free having conical denticles at the posterior end. While both the stylets of maxillae are fused having pointed end with smooth surface without sensilla. The four segmented labium consist of sensilla trichoidea (ST), sensilla trichoidea curvata (STC), sensilla basiconica (SB), microtrichia (MT) and sensory peg (PEG). Earlier, several researchers Backus and Mclean, 1982, 1985; Walker and Gorth, 1989 were identified the apical labial sensilla of bugs as chemo and mechanoreceptors in host plant selection and feeding mechanism. The labium of *Dysdercus intermedins* bears sensilla basiconica and sensilla chaetica (Gaffal, 1981). The labium of different water bugs, *Notonecta glauca*, *Lethocerus deyrollei*, *D. zealandiae* bears sensilla basiconica as chemoreceptor and *L. deyrollei* bears sensilla trichoidea as mechanoreceptor (Jolanta Brozek, 2008). The mouthparts of *Lape phacopa* (Tricoptera) shows sensilla trichoidea, sensilla basiconica, sensilla styloconica. (Spanhoff *et al.*, 2008).

In the rostrum, internally a system of linkage of two maxillary stylets is noticed in *L. augur* during present study. There are three such locks dorsal, middle and ventral which holds the maxillae together with the help of appendages. The two stylets of maxillae are held so firmly because of straight and unciform appendages. Due to the arrangement of appendages two canals, salivary canal (SC) and food canal (FC) are formed in between the right and left maxilla. The right and left mandibles are crescent shaped placed lateral toward the maxilla. Similar types of arrangement of maxilla and other mouthparts were noticed in *Xenophyes cascus*, showing locking of maxillae with straight and unciform appendages, while mandibles placed lateral towards the maxilla (Brozek, 2008) and in Homoptera, *Homalodisca coagulate* (Leopold *et al.,* 2003).

CONCLUSION :

The various type of sensilla present on the mouthparts of *L. augur* are acts as chemo and mechanoreceptor. They play important role in food searching and communication. Interlocking of maxillary and mandibular stylets form food canal and salivary canal. This information provides basic morphological structure and may help in further behavioural study and feeding mechanism of bug.

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