

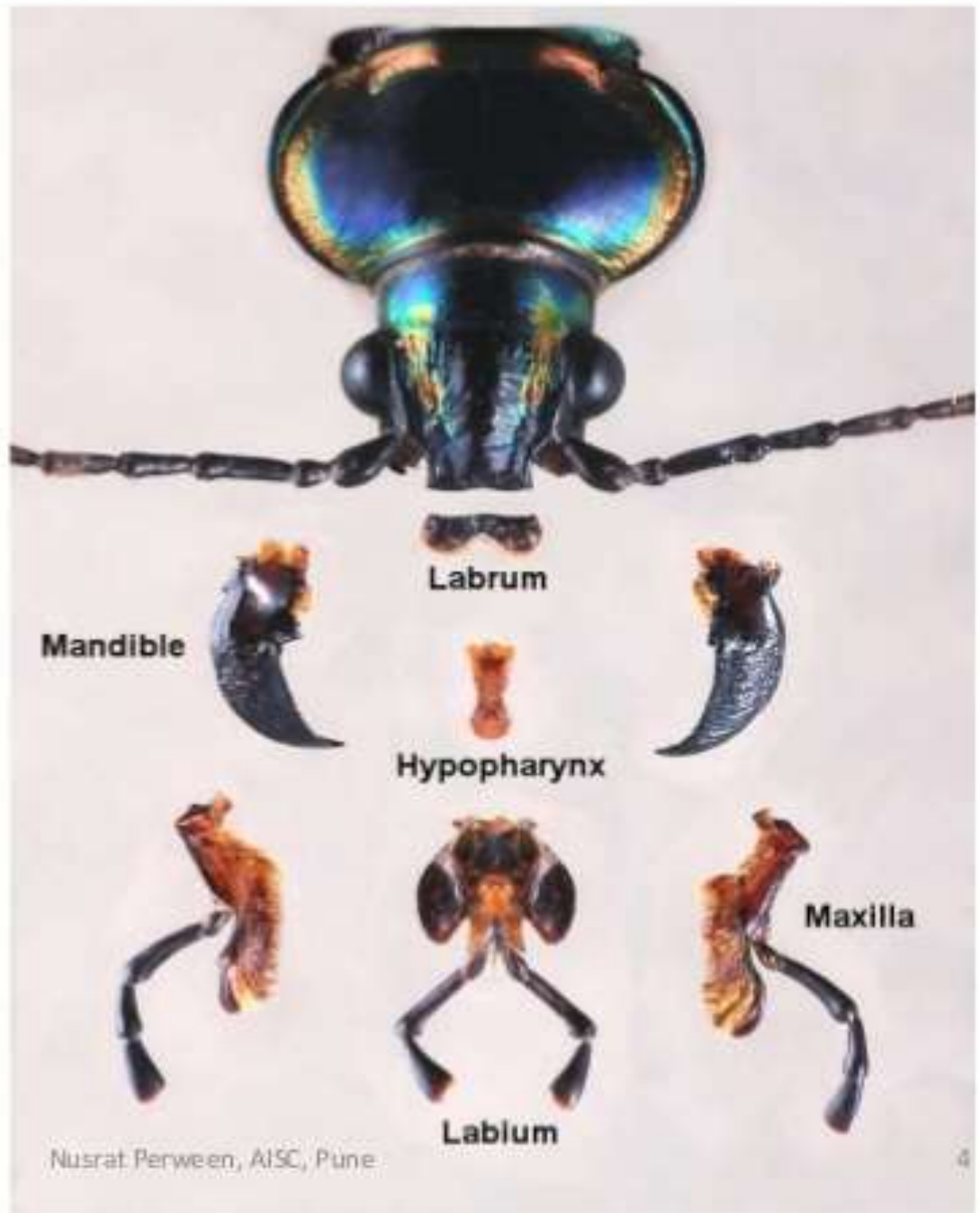
**ADAPTIVE MODIFICATIONS IN
INSECTS MOUTH PARTS**

DR.SHEETAL JAIN

Mandibulate Mouthparts

- In all “primitive” insects, the mouthparts are adapted for grinding, chewing, pinching, or crushing solid food. These are known as “**mandibulate**” mouthparts because they feature prominent chewing mandibles.

five basic
components of
mouthparts:



Labrum

Mandibles

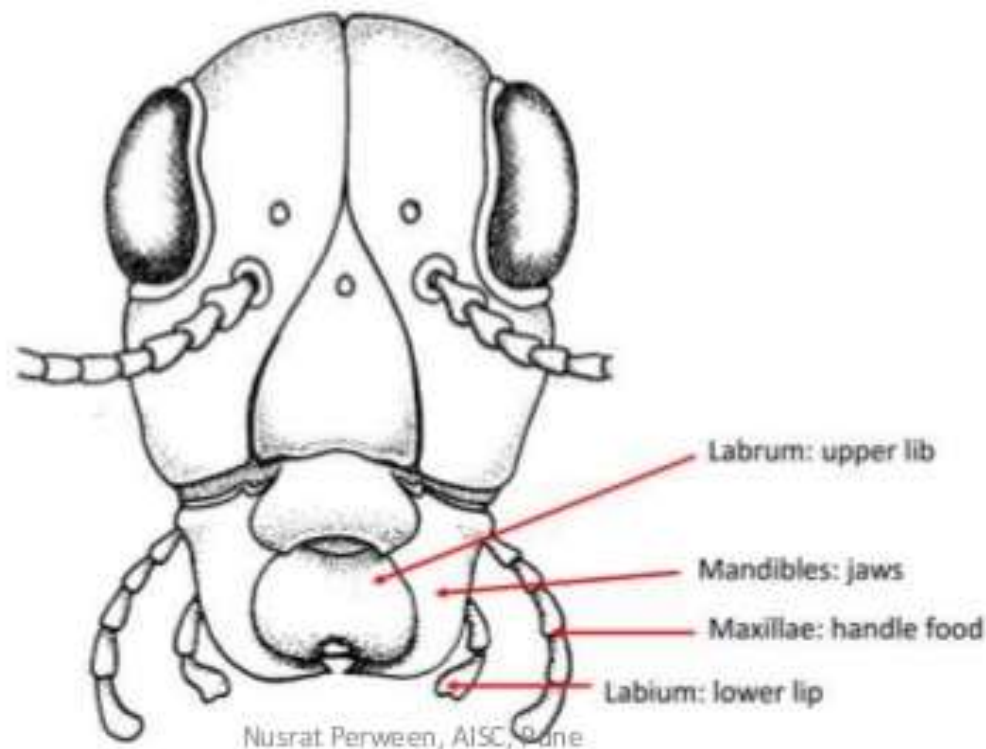
Maxillae

Hypopharynx

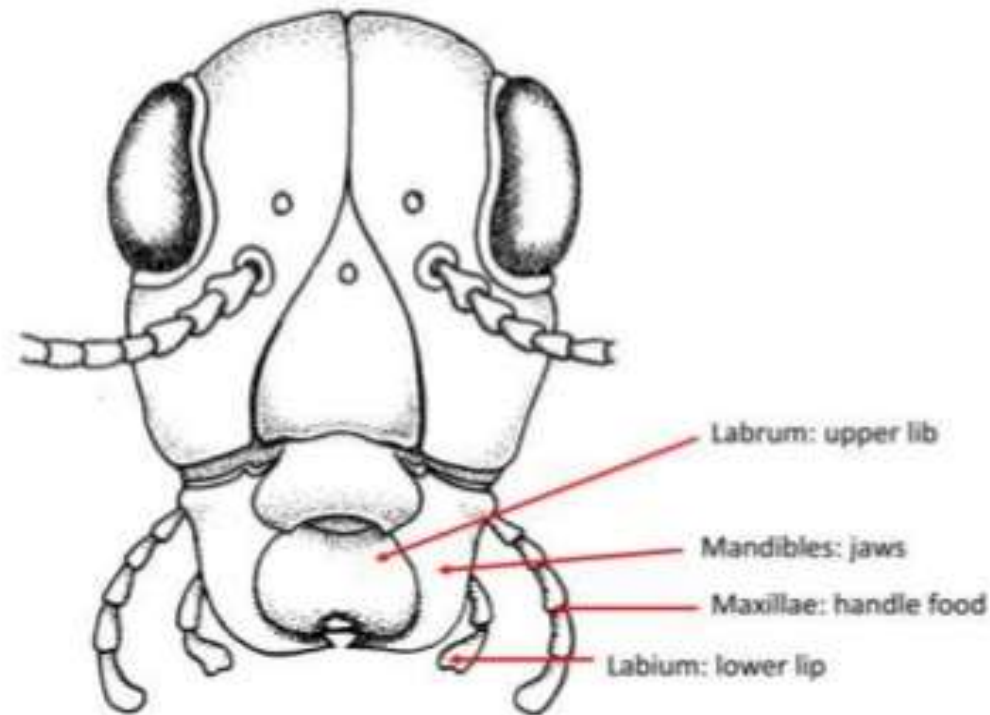
Labium



- **Labrum** (upper Lip)— simple flap ,covers the upper jaw
- **Mandibles** (upper jaw)— a pair of jaws for crushing or grinding the food.



- Maxillae (lower Jaw)— sensory in function, taste
- Hypopharynx (tongue) — a tongue-like process that helps mix food and saliva.
- Labium — (lower lip) sensory in function



Types

- Biting and chewing



- lapping



- Piercing and sucking



- Sponging



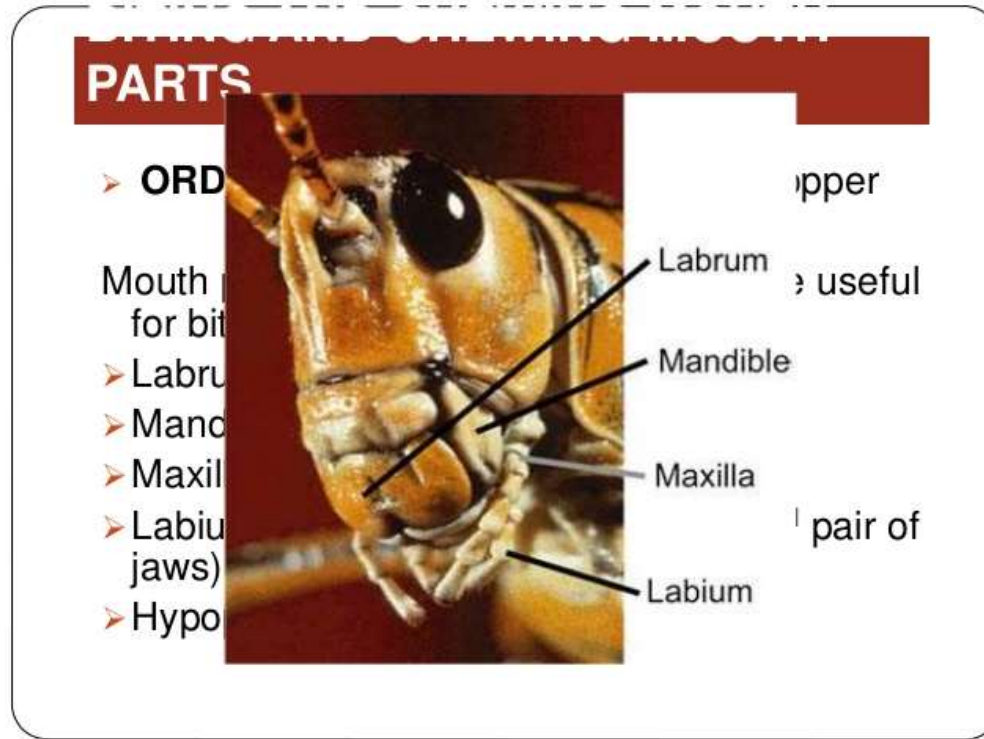
- Siphoning



Biting and chewing

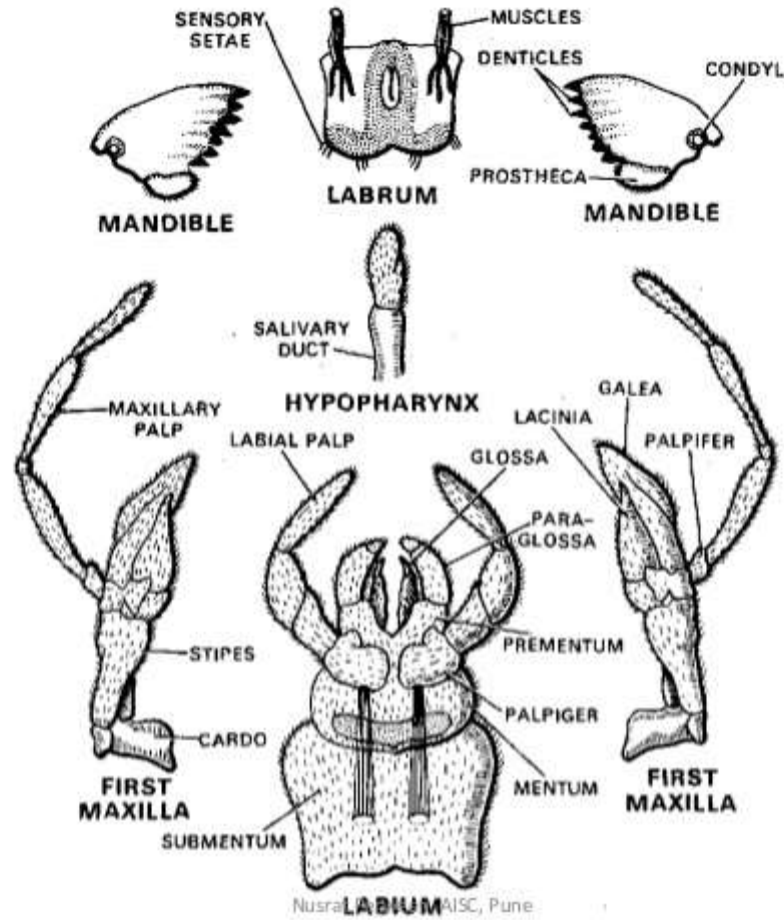
- basic and most primitive type of mouthparts
- grasshopper, cockroach and beetles
- i. **Labrum**
- ii. **Epi-pharynx**
- iii. **Mandibles**
- iv. **Maxillae**
- v. **Labium**
- vii. **Hypopharynx**

MOUTH PARTS



Labrum:

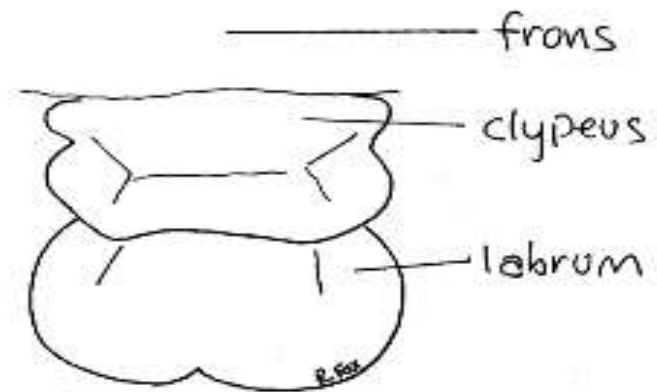
- A simple plate like structure situated below the clypeus on the anterior side of the head and moves up and down.
- The functions of the labrum are to close the front of the mouth cavity, protect the mandibles, guide the food into the mouth.



Mandibles:

- Paired un segmented, heavily sclerotized jaws lying immediately below the labrum.
- Articulate with the headcapsule side wise by means of two joints; ginglymus and condyl.
- Possess two types of teeth; incisors and molars.
- Adopted for cutting and masticating the food material.

- **i. Labrum:**
- flap like bilobed structure attached to the clypeus.
- It helps to guide the food into the mouth and also holds the food in position so that mandibles can act on it.



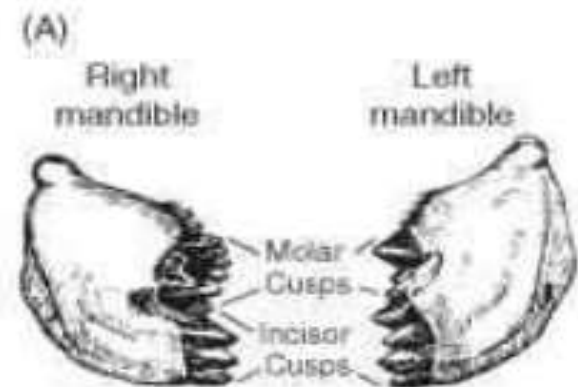
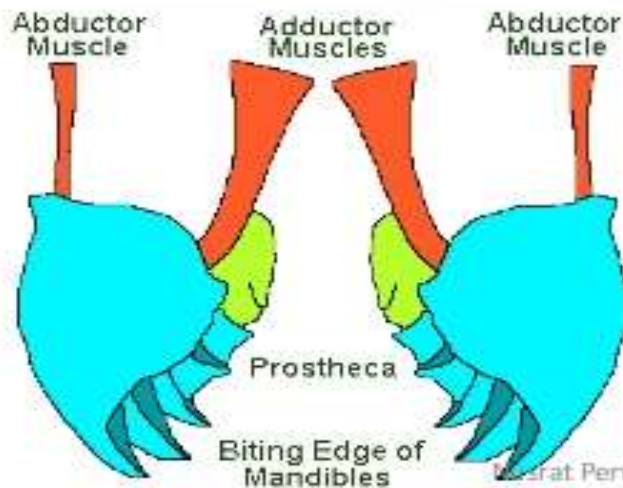
- **iii. Mandibles:**
- They are also called as primary or true jaws
- and concerned with chewing and grinding the food.



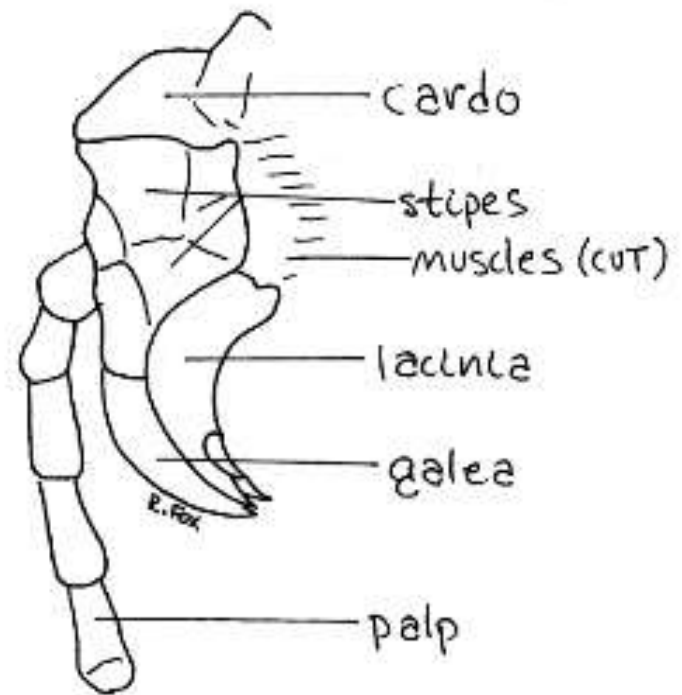
Muzral Perween, MSc, Pune

- movement produced by abductor (outer) and adductor (inner) muscles.
- heavily sclerotized
- Distal teeth are sharply pointed and area called incisors or cutting teeth.
- The proximal teeth are called molar or grinding teeth.

The Insect Mandibles

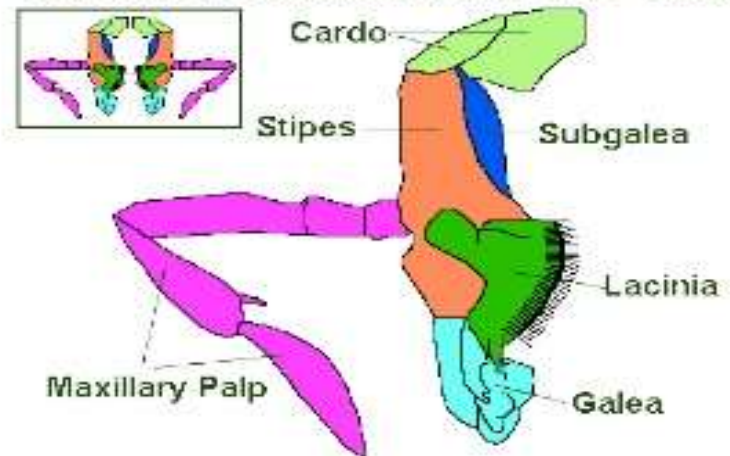


- **iv. Maxillae:**
- They are called as secondary jaws or accessory jaws.
- May be employed for grasping/cutting/chewing food.
- The basal segment, known as the cardo, joins the maxilla to the head.
- This is joined to the central body of maxilla, the stipes.
- On the outer side of the stipes is a more or less distance sclerite known as the palpifer to which the palpus is attached.



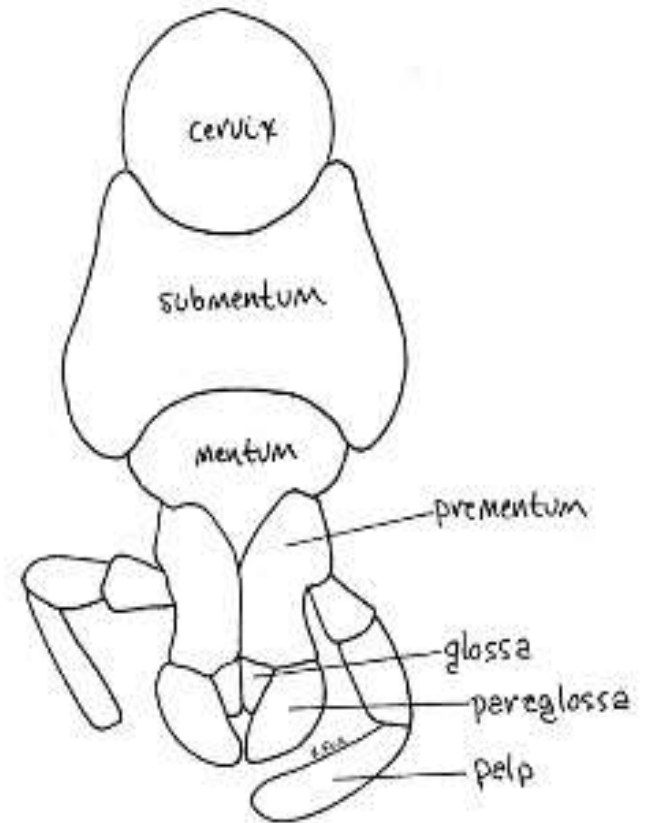
- Antennae like five segmented Palpi, bears tactile hairs and also probably organs of smell or taste.
- On the distal end of the stipes there are two lobes.
- The outer lobe is called galea and the inner lobe lacinia which is toothed.

The Insect Maxillae (one side only)

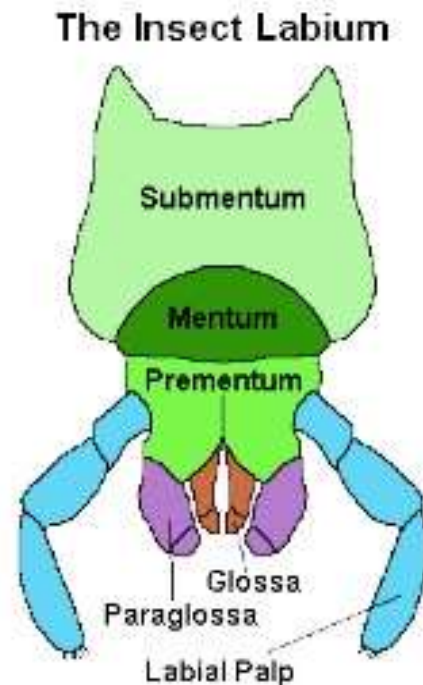


v. Labium:

- It closes the mouth cavity from below or behind.
- It consists of three median sclerites viz. submentum, mentum and prementum
- On the lateral side of the prementum, there are two small lateral sclerites called palpiger bearing 7 segmented labial Palpi.



- Distally prementum bears two pairs of lobes.
- The outer pair is called paraglossae and inner pair glossae.

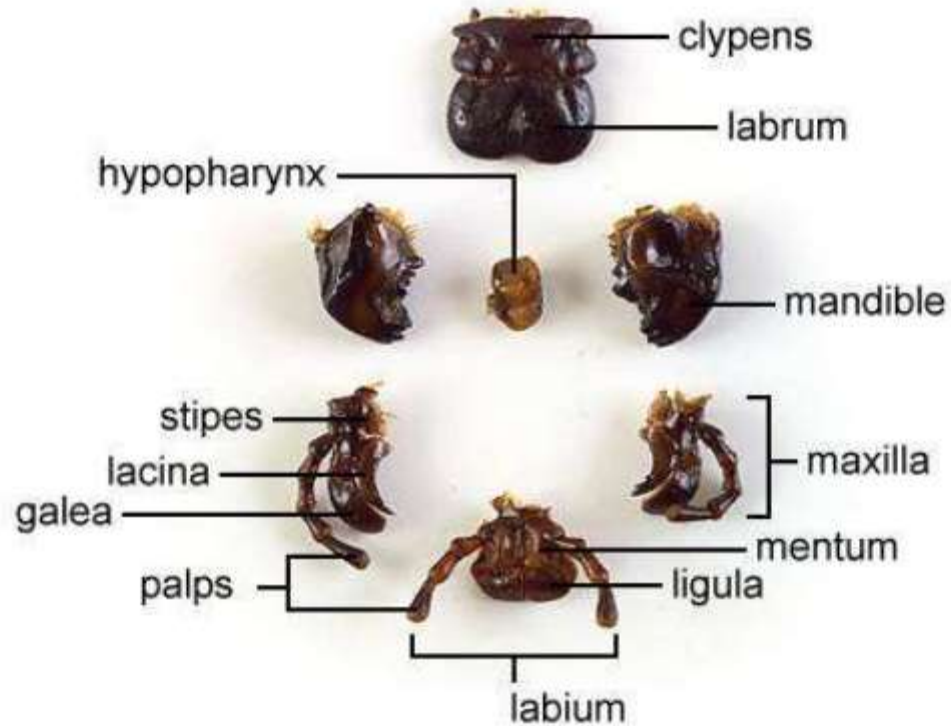


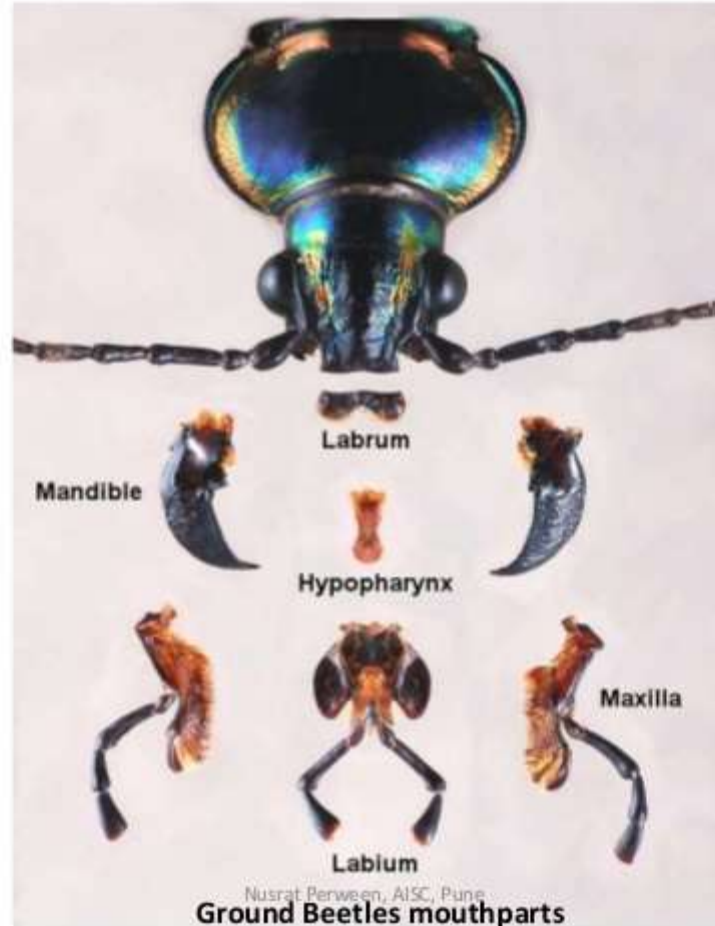
vi. **Hypopharynx** is located medially to the mandibles and the maxillae.

- It is behind the preoral cavity and in front of the labium.
- The hypopharynx is mostly membranous and closely associated with the salivary glands and/or salivary ducts.
- The hypopharynx functions as a tongue, moving food around in the preoral cavity..

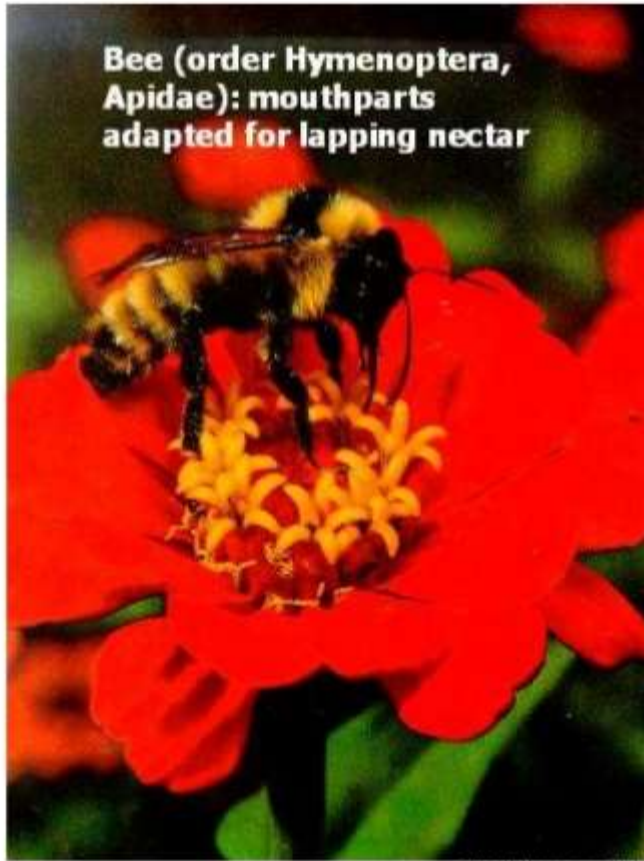


Grasshopper - Mouthparts

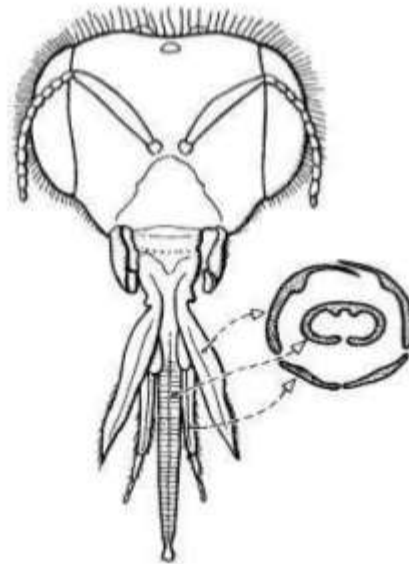




**Bee (order Hymenoptera,
Apidae): mouthparts
adapted for lapping nectar**



***lapping
mouthparts***



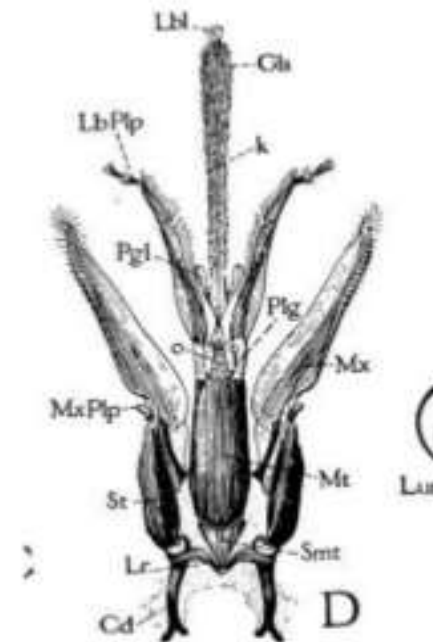
- **Chewing and Lapping Type**
- **e.g. Honey bee**
- Labrum & Mandibles remain more or less similar as that of the Generalized type,
- Maxillae & Labium are greatly modified



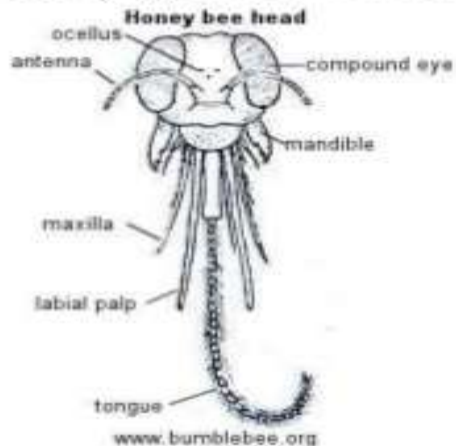
- **Labrum.** It is narrow and quite simple.
- **Mandibles:** They are blunt dumbbell shaped and are not toothed.
- They are not used for feeding but are useful for moulding wax into cells for comb (next) building.



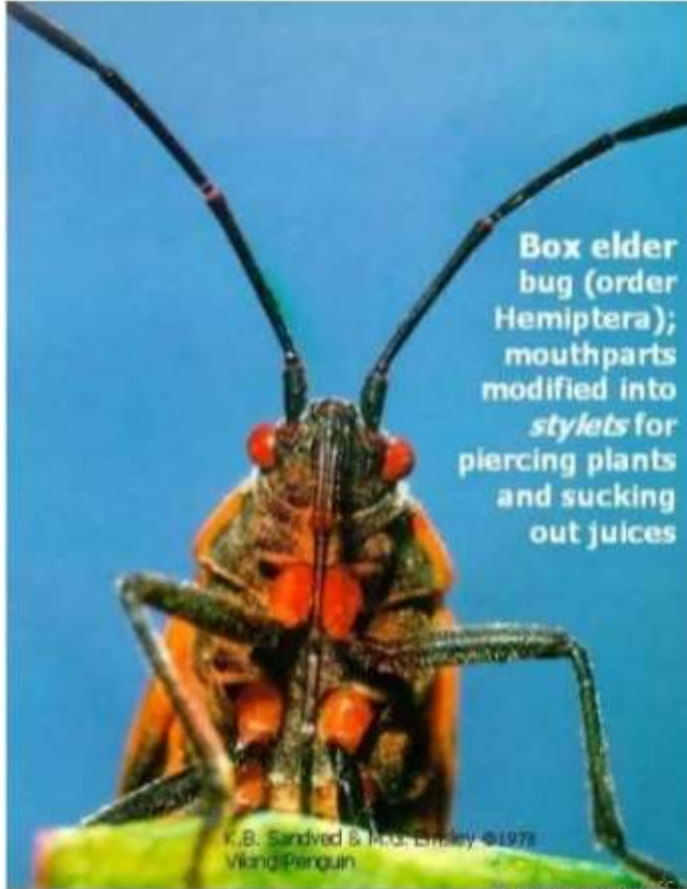
- **Labium:** The glossae are greatly elongated to form a hairy, flexible tongue.
- The glossa terminates into a small circular spoon shaped lobe called labellum, which is useful to lick the nectar.



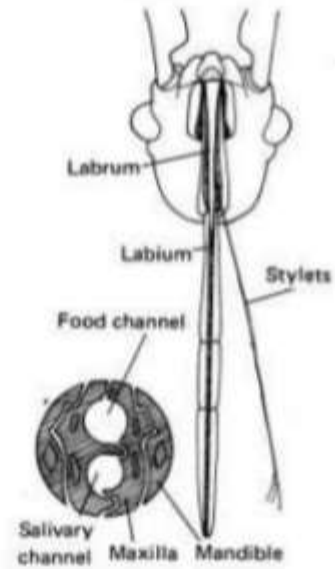
- **Maxillolabial Structures:**
- Maxillolabial Structures are modified to form the lapping tongue.
- The tongue unit consists of the two galeae of maxillae, two labial Palpi and elongated flexible hairy glossa of labium.



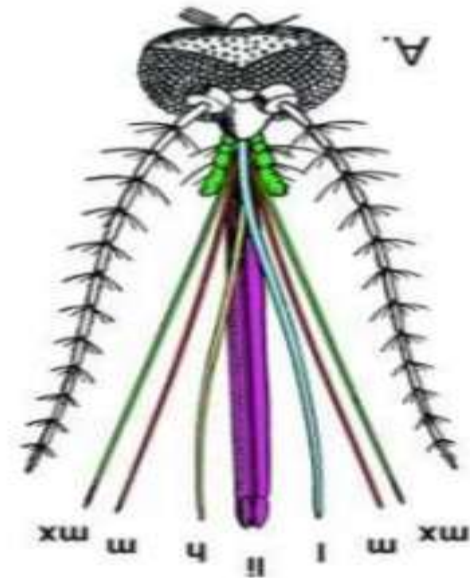




piercing- sucking mouthparts



- In mosquito, mouth parts are **piercing & sucking** type i.e. they are adapted for piercing the tissues of animal or plants to suck blood or plant juice.
- The mouth parts consist of labium, labrum-epipharynx, hypopharynx, mandibles & maxillae
- Mouth parts:-
 - Labium:-
- _The labium is modified to form a long, straight, fleshy tube called proboscis.
- It has a deep labial groove on its upper side.



- At the distal end of labium is a pair of small tactile **labella** which are reduced labial palps.
- **Function:-**
- The labial groove lodges all other mouthparts.
- During piercing, labella guides the mandibles & maxillae.
- The whole labium bends back to allow needle like mouthparts to go in the flesh.



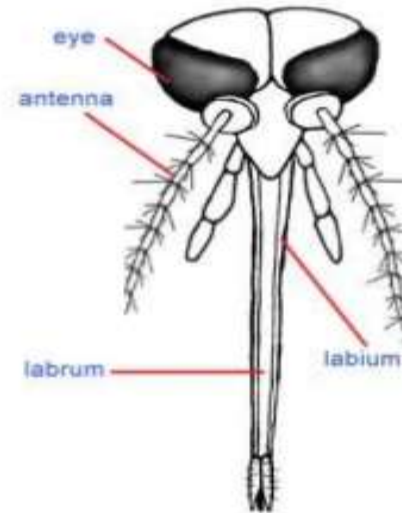
BIODIDAC © Houseman

Courtesy of the BIODIDAC Project, University of Ottawa, Canada



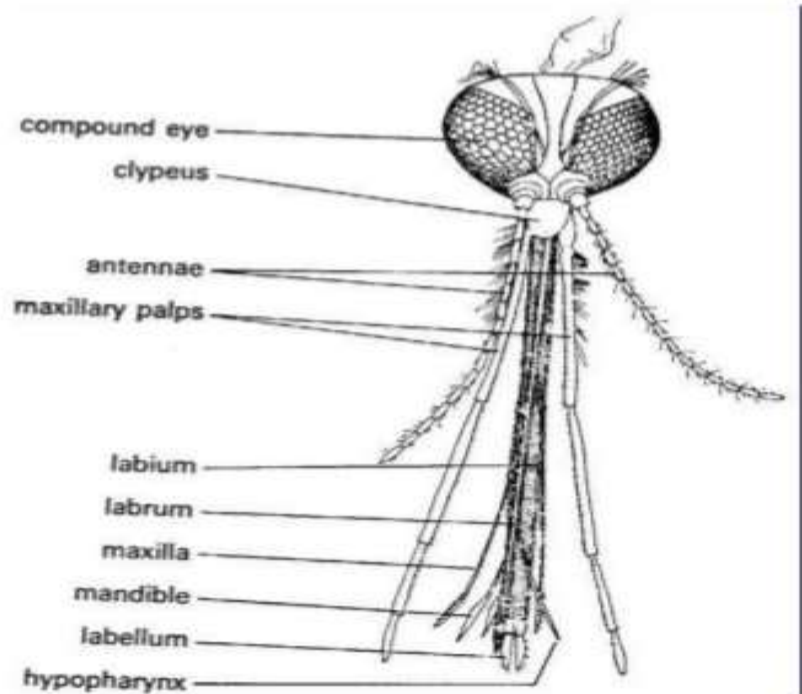
- **Labrum**
- The labrum is long & needle like with ventral groove.
- **Function: -**
- This structure appears C - shaped in transverse section having a groove called food channel.

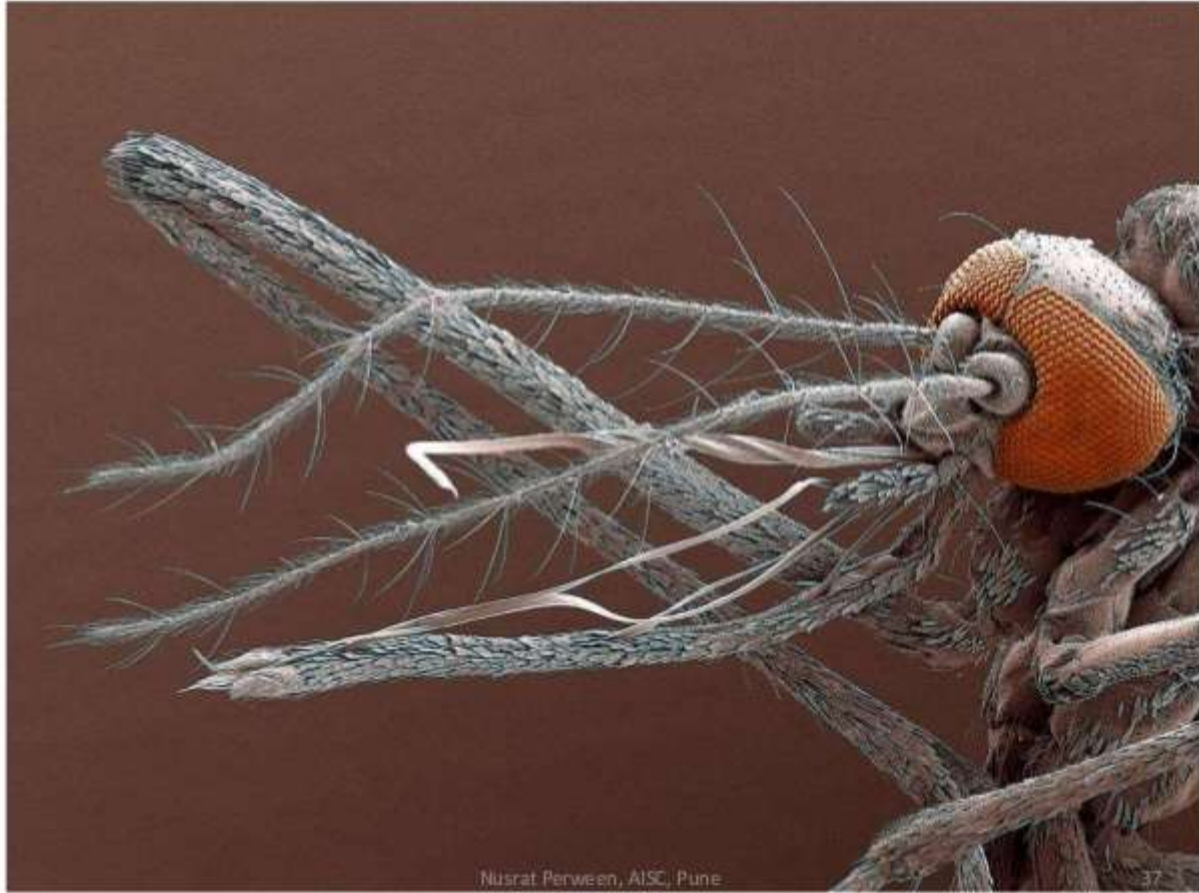
- **Hypopharynx:-**
- Food channel is closed below by a long, pointed & flattened plate, like a double edged sword, called hypopharynx. It possesses a salivary duct, opening at its tip.
- **Function: -**
- Through this duct saliva is poured to prevent coagulation of blood during sucking.



Mandibles & maxillae:-

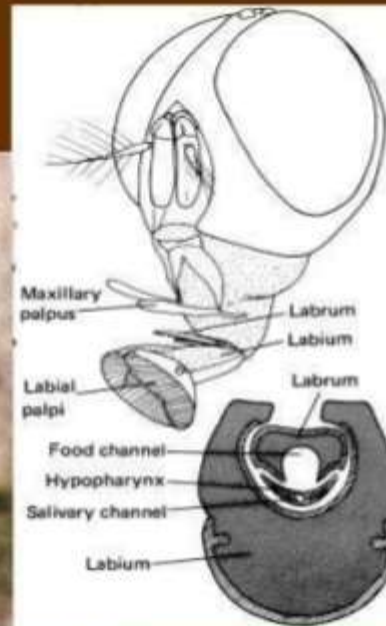
- long, needle shaped mandibles & maxillae.
- Mandibles end in sharp tiny blades, while maxillae into saw like blades bearing teeth.
- Function:-
- Mandibles & maxillae act as piercing organs.
- In male mandibles & maxillae are very short & functionless



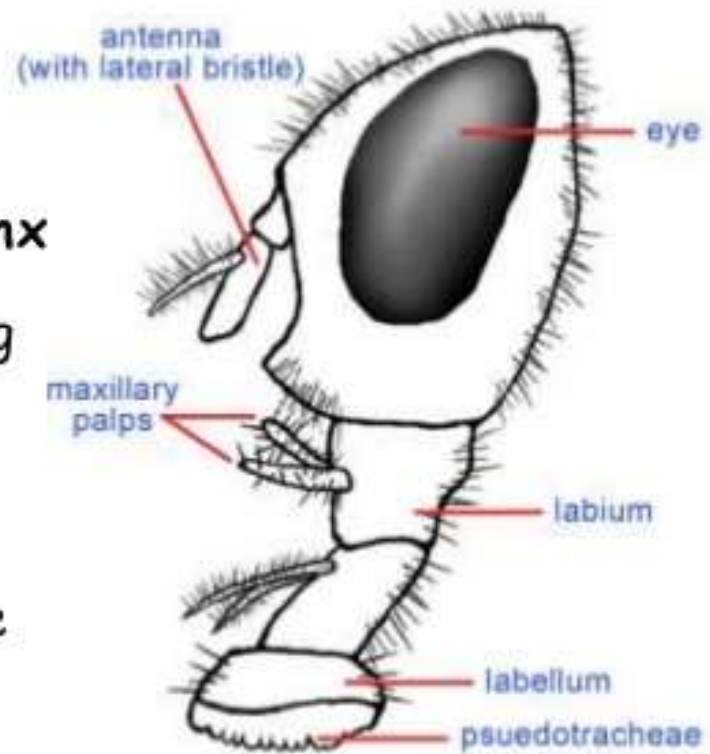


Nusrat Perween, AISC, Pune

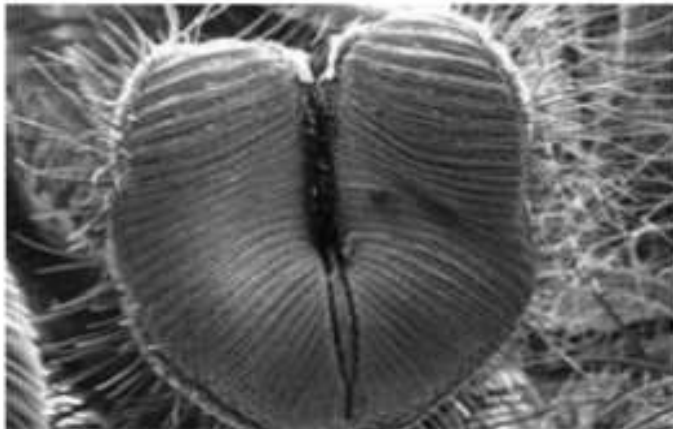
sponging mouthparts



- **Sponging Type of Mouth Parts** (e.g. Housefly)
- The prominent fleshy and retractile proboscis consists mainly of the labium
- The proboscis is grooved on its anterior surface, within this groove lie the **labrum-epipharynx** (enclosing the food canal) and slender **hypopharynx** (containing the salivary canal).
- **Mandibles** are absent.
- The **maxillae** have evidently become fused with the fleshy elbow of proboscis, and only the prominent single segmented maxillary palpi remains.



- The end of the proboscis is enlarged, sponge like and two-lobed which acts as suction pads.
- They are called labella.
- collect the liquid food and convey it to the food canal.
- These insects often spit enzyme-containing saliva onto solid foods to liquefy them and then sponge up the mixture.

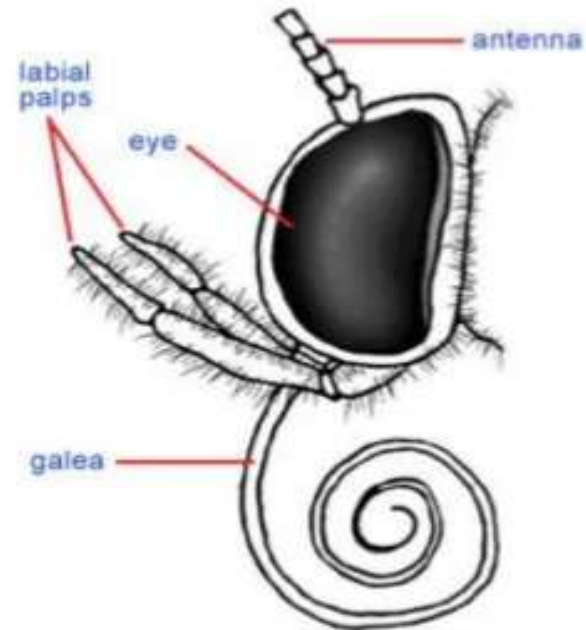


- **SIPHONING TYPE OF MOUTH PARTS:**

- Mouth parts of butterfly and moths
- They are modified for sucking the juices from flowers or nectar from flowers
- The proboscis which helps in sucking the food is formed by apposition of two galea of 1st maxillae.



- **Maxillary** palps and labial palps are present in reduced condition.
- **Labium** or upper lip is reduced.
- **Mandibles** are absent
- **Hypopharynx** is absent.
- **Labium** is reduced to a triangular plate represented by a pair of labial palps.



- During the resting phase proboscis is highly coiled and is situated beneath the head, it is also called watch spring like proboscis.
- While ingesting the food material proboscis is uncoiled and inserted into the interior part of flower to suck the nectar due to flow of haemolymph into it under high pressure.

Maxillae:

- Paired segmented structures lying below the mandibles.
- Each maxilla bears a feeler-like organ, the palpus (which discharges a gustatory or tasting function).
- Have two segments, the basal cardo and apical stipes.
- Palpus arise on a lobe of the stipes called the palpifer.
- Stipes bears two lobe like structures at its apex (outer simple galea and inner jaw like structure lacinia)
- Functionally maxillae are of accessory jaws, their lacinia aiding mandibles in holding the food.

Hypopharynx:

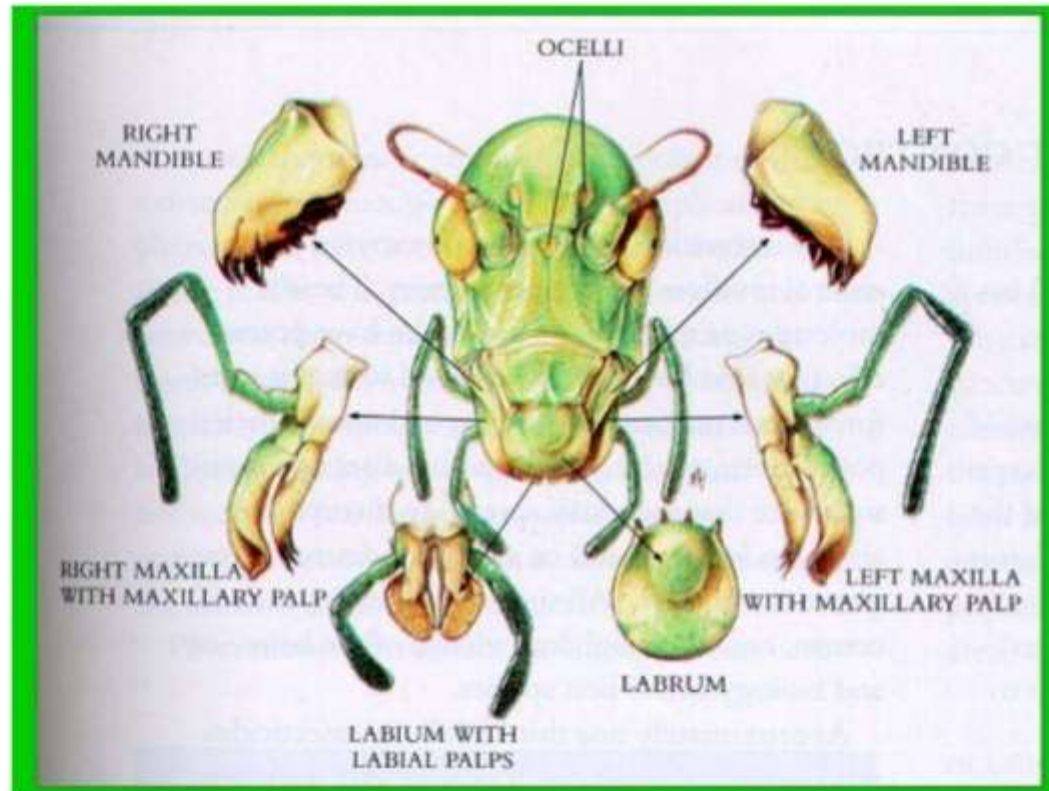
- A short tongue like structure located above the labium and between the maxillae.
- The ducts from salivary glands open on or near the base of hypopharynx.

Labium:

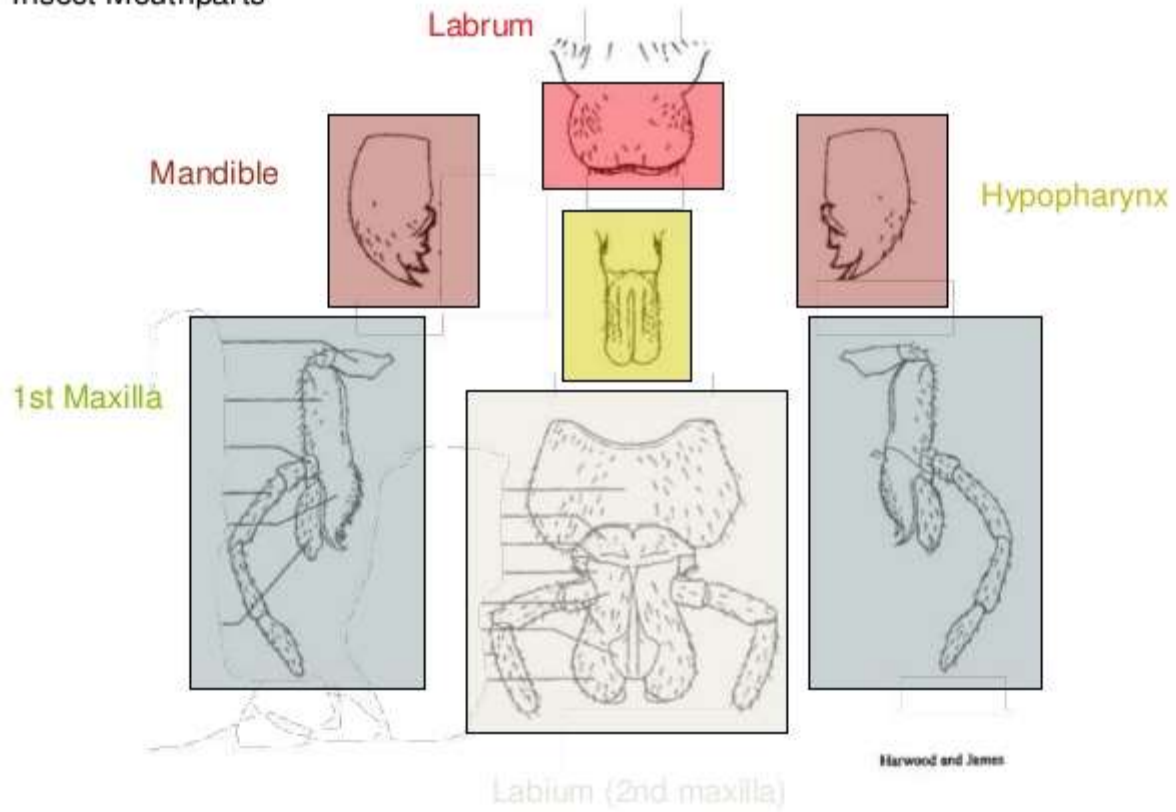
- Lies behind the maxillae
- Derived by the fusion of the second pair of maxillae, hence also referred as the second maxillae.

- Divided by transverse suture (labial suture) into two portions, basal postmentum and distal prementum
- Postmentum is usually divided into basal submentum and distal mentum.
- Prementum bears a pair of palpi called labial palpi and a group of apical lobes which constitute the ligula.
- Labial palpi arise on lateral lobes of the prementum called palpigers.
- Ligula consists of a pair of small lobes in the middle, inner glossae and outer paraglossae.
- Labial palpi act as sense organs comparable to the gustatory function of maxillary palpi.

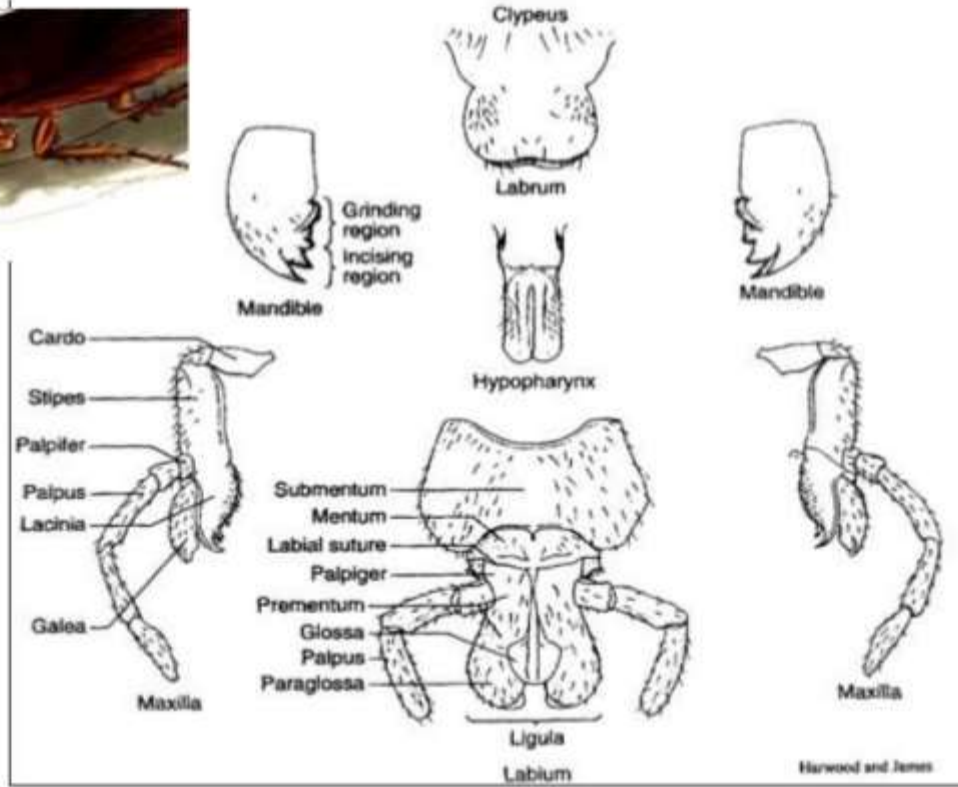
Biting and chewing mouth parts



Insect Mouthparts



mouthparts



Feeding mechanism :

- The labrum or upper lip helps the insect to pull the food into the mouth.
- Mandibles masticate the food. They cut off the food material. Small teeth present in each mandible work against those of the opposite for effective grinding.
- The maxillae aid in holding the food in mouth while it chewed by mandibles. They also aid in breaking up the food.
- Both maxillae and mandibles move side ways.
- Labial palpi works similar to that of maxillary palpi.
- The maxillae and labium helps in passing the food into oesophagus

SIPHONING OR SIMPLE SUCKING TYPE

- **Order: Lepidoptera**, e.g.: butterflies and moths
- Mandibles totally absent. Majority of Lepidoptera mandibles are wanting and maxillae to form a suctorial proboscis
- Maxillae is composed of elongated galea. Each galea of maxillia elongated, semi-circular towards inner side. Galea of both the sides meet together forming into a tubular structure, proboscis.
- Observe the coiled proboscis beneath the head.
- Liquid food is imbibed through groove formed by galea

- All other mouth parts highly reduced.
- When fully developed mouth parts, maxillary palpi are 5 or 6 segmented.
- Labium reduced to small ventral plate.
- Hypopharynx is present on floor of mouth.

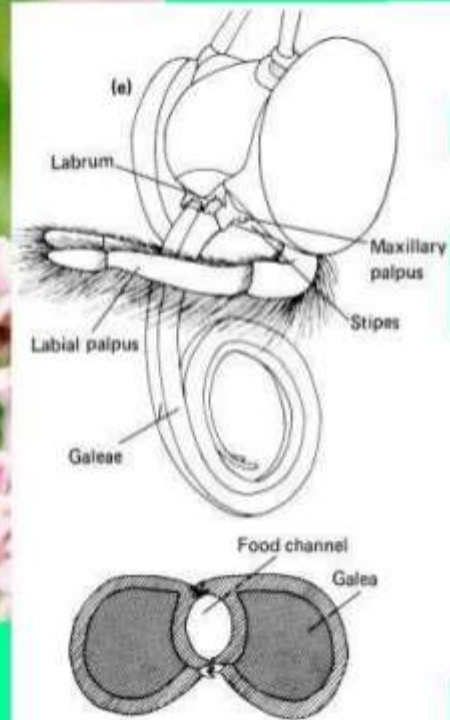
Feeding mechanism:

- When not in use, proboscis is spirally coiled and beneath the thorax.
- It presents an extraordinary variation in length. Eg. Sphingidae, Danaus.
- According to Breitenback they are often developed into denticulate spines.
- Proboscis extended by blood pressure. Eastham and Eassa (1955).

**Gulf fritillary butterfly
(order Lepidoptera,
Nymphalidae):
coiled mouthparts,
adapted for
siphoning
nectar**



Siphoning mouthparts



PIERCING AND SUCKING TYPE

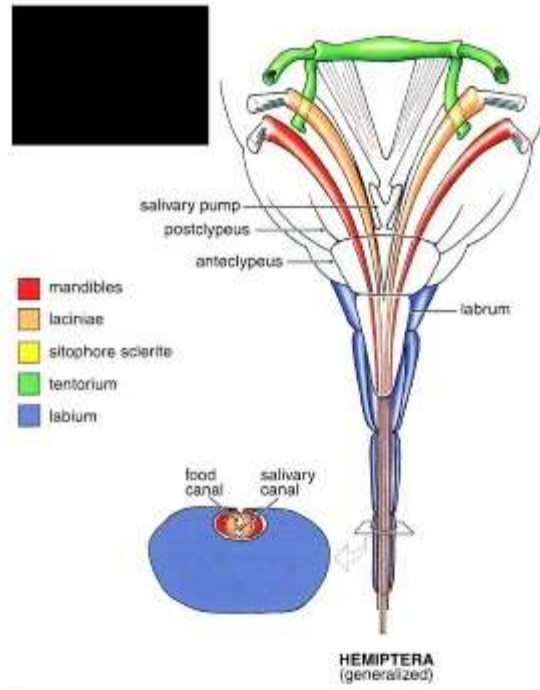
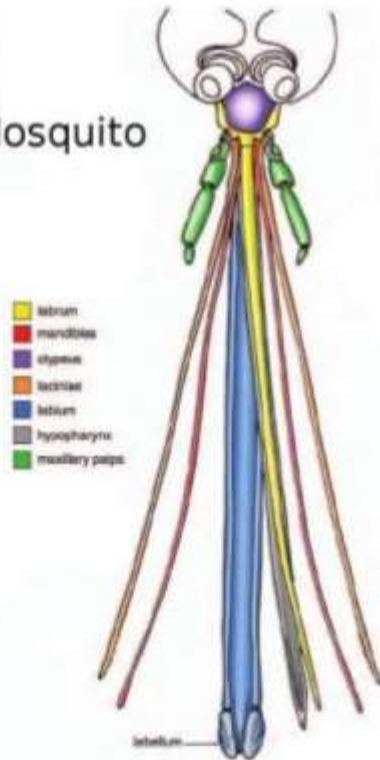
- **Order : Hemiptera**
- Mandibles and maxillae being modified to form slender bristle like stylet which rest in grooved labium.
- Both pairs of stylets are hollow seta-like structures.
- These stylets back into prothorax (Cranston and Sprague, 1961).
- Stylets withdrawn into a pocket connected with the channel of the labium.
- Mandibular stylets form anterior (outer) pair and posterior pair of stylets (inner) constitute part of maxilla.
- Dorsal stylet as a suction canal.

- Ventral stylet as a salivary canal.
- Labium no part in perforating the tissue of host plant.
- Hypopharynx is highly specialized in Hemiptera.
- Salivarium is modified into a powerful salivary pump.

Feeding mechanism:

- At rest rostrum is flexed beneath the body.
- In most Hemiptera stylets are only slightly longer than the rostrum. Eg. Aphididae, Lygus.
- In Coccoidea stylets are forced deeper and deeper into the plant.
- Mandibles are first pushed then followed by maxillae.

Mosquito

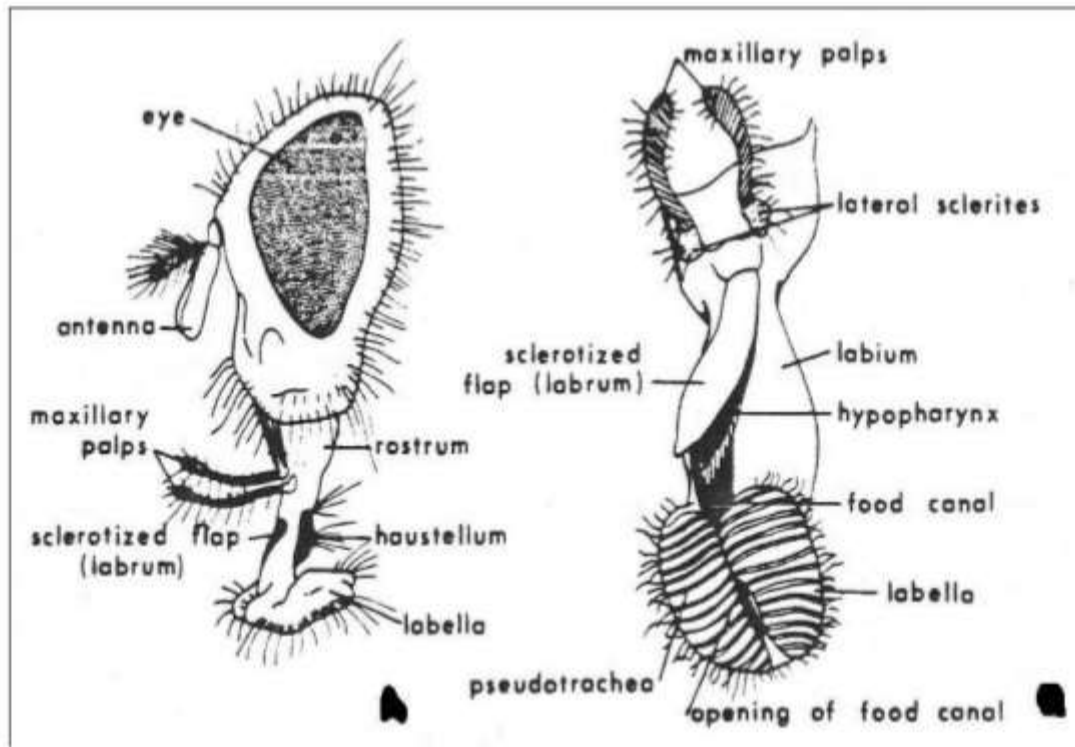


SPONGING TYPE

- Eg: HOUSEFLY.
- Mandibles are absent.
- Maxillae are represented by a pair of maxillary palp.
- Labium is divided into basal rostrum, middle haustellum and distal labellar lobes. Labella are tranversed by small channels known as pseudotrachia which converge at one point and open into the food channel.
- Epipharynx and hypopharynx together form the food channel which leads to Oesophagous

sponging mouthparts





- **Mode of feeding:** It is used for food which is either liquid or readily soluble in saliva. While feeding after dissolving the food by saliva, the labella is thrust into the liquid food as a result the pseudotracheae get filled with the liquid by capillary action. The food is then passed through the food channel to the Oesophagus
Eg. Houseflies

CHEWING AND LAPPING TYPE

Eg: HONEYBEES

- Mandibles and labrum are of chewing type and help in holding the food.
- Maxillae and labrum are elongated and united. They are suspended from the cranium and articulate to it through the base of the maxillae.

Maxillae :

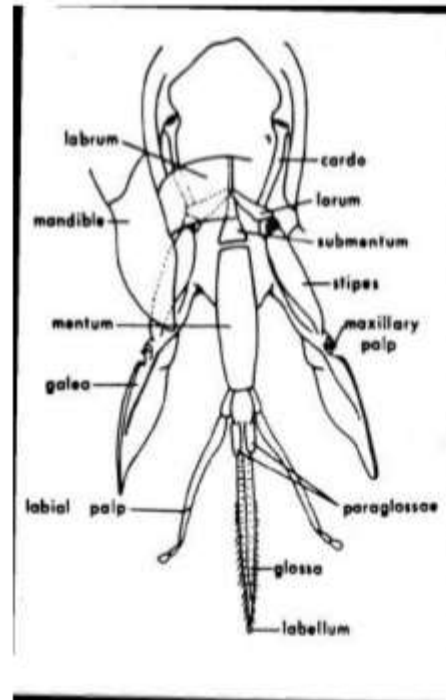
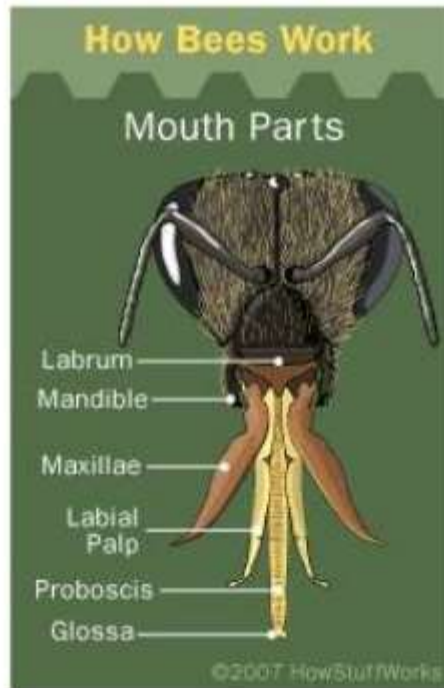
- Palps are very small
- Galea with its concave inner surface forms a roof over the glossa and fits lengthwise against labial palps. In this way a food channel is formed.

Labium:

- Palps are long and form food channel with galea
- Glossae are fused to form a channeled organ termed as **alaglossa** which can reach deep into nectar of blossoms.
- **Mode of feeding:** The mandibles and labrum help in holding food / prey. In honey bees the labrum is used for molding wax into cells. Regarding intake of nectar king, Imm's and Snodgrass gave their own view.

King's Views: After sucking the nectar with the tip of glossa, it is retracted into labial palp and galea, where the latter squeezes off the nectar which is deposited at the base of the glossa in a small cavity formed by the paraglossa. Finally as a result of bending of the labium upward, the base of the glossa comes near the mouth cavity and the accumulated nectar is sucked into the Oesophagous by the action of the pharyngeal pump.

CHEWING AND LAPPING TYPE



Chewing and Lapping Type

- (e.g. Honey bee)
- This type of mouthparts are possessed by Honey bee wherein, the Labrum & Mandibles remain more or less similar as that of the Generalized type, whereas the other components viz. (Maxillae & Labium) are greatly modified.
- **Labrum**; It is narrow and quite simple.
Mandibles: They are blunt dumble shaped and are not toothed.
- They are not used for feeding but are useful for moulding wax into cells for comb (next) building.

- **Libium:** The glossae are greatly elongated to form a hairy, flexible tongue. The glossa terminates into a small circular spoon shaped lobe called flabellum, which is useful to lick the nectar. Labial palps are elongate and four segmented.
- **Maxillolabial Structures:** Maxilloblial Structures are modified to form the lapping tongue. The tongue unit consists of the two galeae of maxillae, two labial Palpi and elongated flexible hairy glossa of labium.

- **Feeding Mechanism:** The galeae fit tightly lengthwise, against the elongated labial palps and they in turn roof over the elongated glossae (tongue) to form a temporary food channel through which saliva is discharged. The tongue (glossae) is thrust into flower, which gets smeared with nectar. It is then retracted between labial palps & galeae. Nectar is then squeezed by galeae and is deposited in the cavity formed by the paraglossae. Accumulated nectar is then drawn into oesophagus by the pharyngeal pump.

THANKS

