



Phylum Arthropoda and Onychophora

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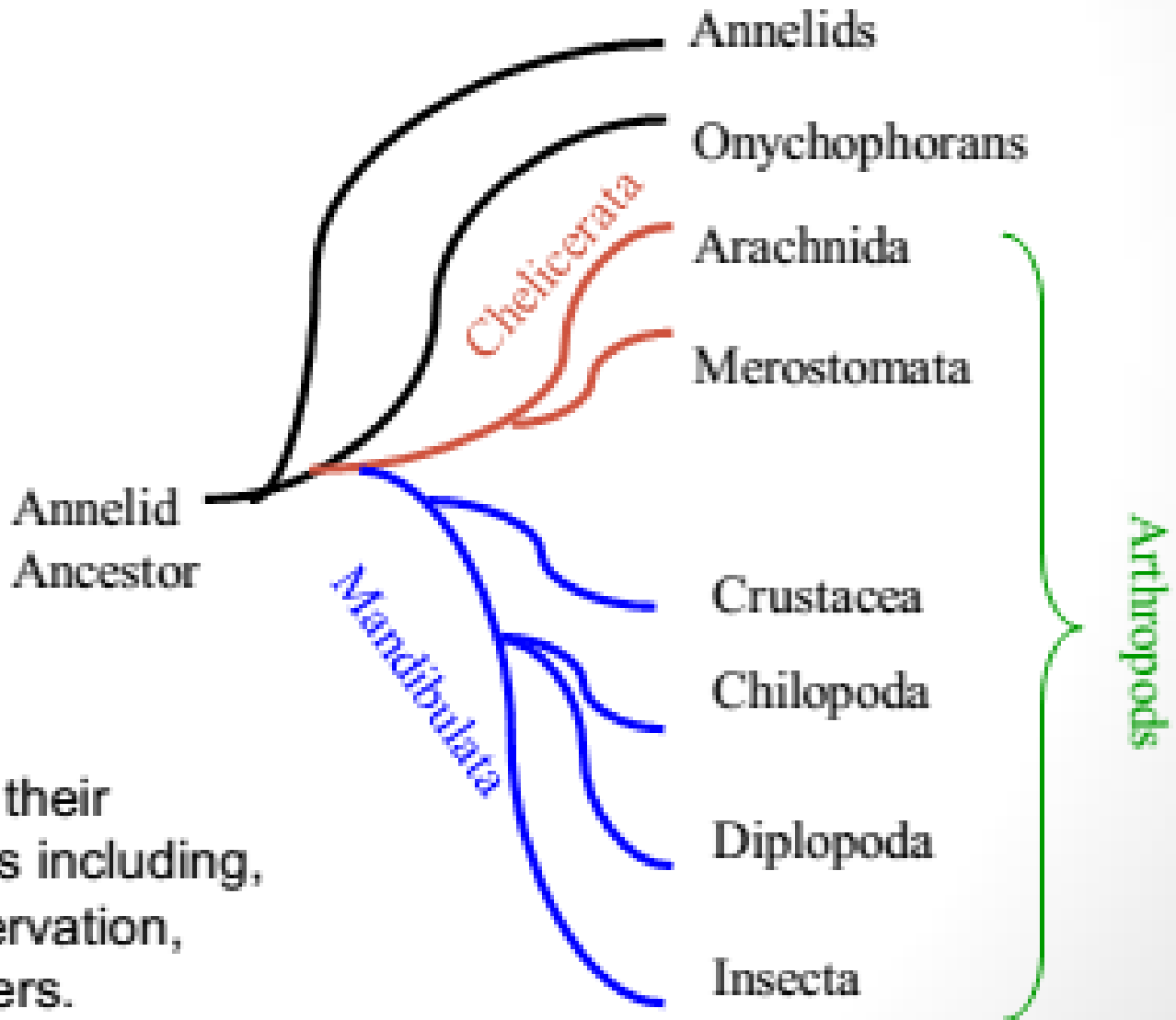
Characteristics of Arthropoda

- Bilaterally symmetrical,
triploblastic with segmented body,
organ system level body organization
coelome is haemocoel
- Body segments usually bear paired jointed appendages,
which variously modified for
feeding,
mastication,
defense,
locomotion,
sensing,
egg carrying and copulation.

- Body is divisible into head, thorax and abdomen, where head and thorax is generally cephalothorax.
- Body is covered with chitin which periodically shed through moulting or ecdysis.
- Digestive system - complete.
- Respiration - through body surface,
gills (aquatic form),
trachea or book lungs (terrestrial form).

- Blood vascular system- open type.
- Nervous system consists of a large bilobed brain (ganglion) and two ventral nerve cords.
- Sense organs include simple eye (Ocellia), compound eye, chemo receptors, tactile receptors (antennae and bristles), auditory organs and statocysts.
- Malpighian tubule and green gland are excretory bodies.

- Sexes are generally separate (sexual dimorphism).
- Gonads and gonoducts are well developed.
- Development indirect- one or many larval forms.
- Parthenogenesis occurs in some crustaceans and insects.



their
is including,
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ers.

Diplopoda

Millipedes - *Julus* , *Glomeris*, *Spirobolus*



- herbivores, nonpoisonous-Poison claws are absent
- known as myriapods (many foot)- "thousand feet"
- Round/ cylindrical or sub- cylindrical body.
- segmented body
- Two pairs of legs arising midventrally per each trunk segment.
- Antennae are short with fewer segments.
- Mandibles are broad and masticating.
- One pair of maxillae is united to form the gnathochilarium.
- Genital opening is situated at the anterior end of the body (progoneata).

Chilopoda

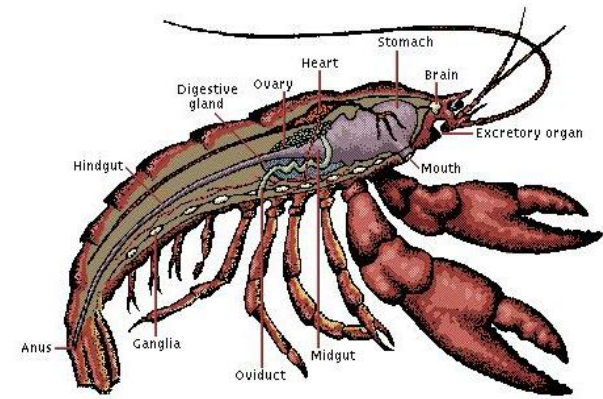
Centipedes- Scolopendra, Lithobius, Scutigera



- carnivorous, poisonous
- myriapods - "hundred feet"
- dorso-ventrally flattened body.
- segmented body
- One pair of leg arising laterally per each trunk segment.
- Antennae are long with many segments.
- Mandibles are toothed and cutting.
- Two pairs of maxillae. Second maxillae are fused to form the labium.
- The first pair of legs called maxillipedes form the poison claws- poisonous.
- Genital opening is situated at the hind end of the body (opisthogoneata).

Crustacea

crabs, lobster, crayfish ,
shrimp, barnacles, water fleas
and pill bugs

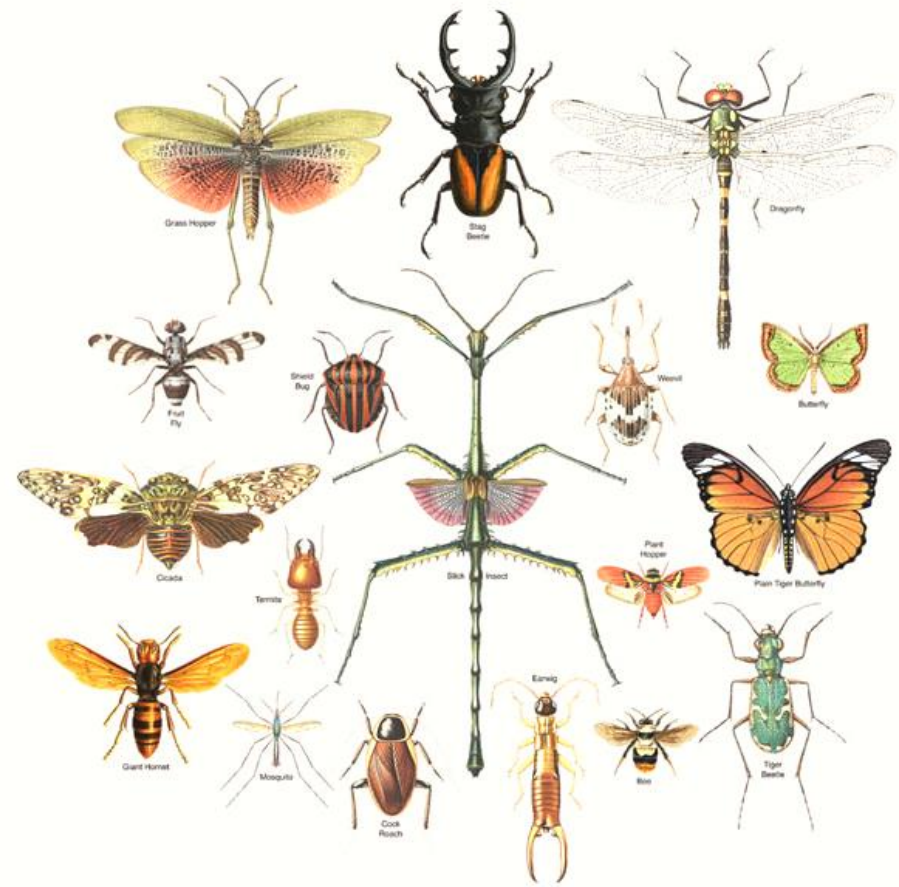


- Essentially aquatic, breath by means of gills but rarely by body surface.
- Hard, flexible exoskeleton of chitin.
- Two body sections abdomen, cephalothorax.
- Larva (Nauplius) with median eye frequently disappears in adult.
- Branched antennae (biramous) except first pair.
protopodite with endopodite + exopodite
- Excretory organ- maxillary glands or antennary (green) glands.

Insecta

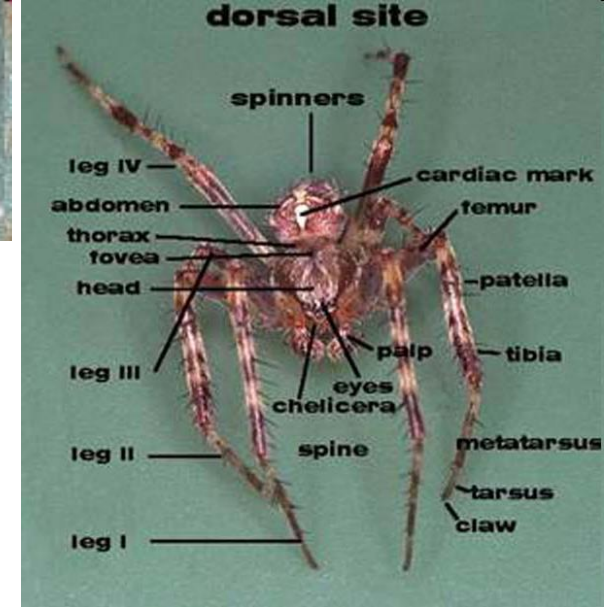
wasps, ladybugs, grasshoppers,
cockroaches, ants

- Mostly terrestrial, air breathing, through a system of branching air tubes or tracheae.
- Three body sections – head, thorax and abdomen.
- Head bears one pair of pre oral antennae, pair of compound eye and mouth parts (one pair of mandibles and two pairs of maxillae).
- Thorax bears - three pairs of legs and two pairs of wings (sometimes only one pair/rarely absent).
- Salivary glands often present.
- Excretory organ- malpighian tubules.



Arachnida

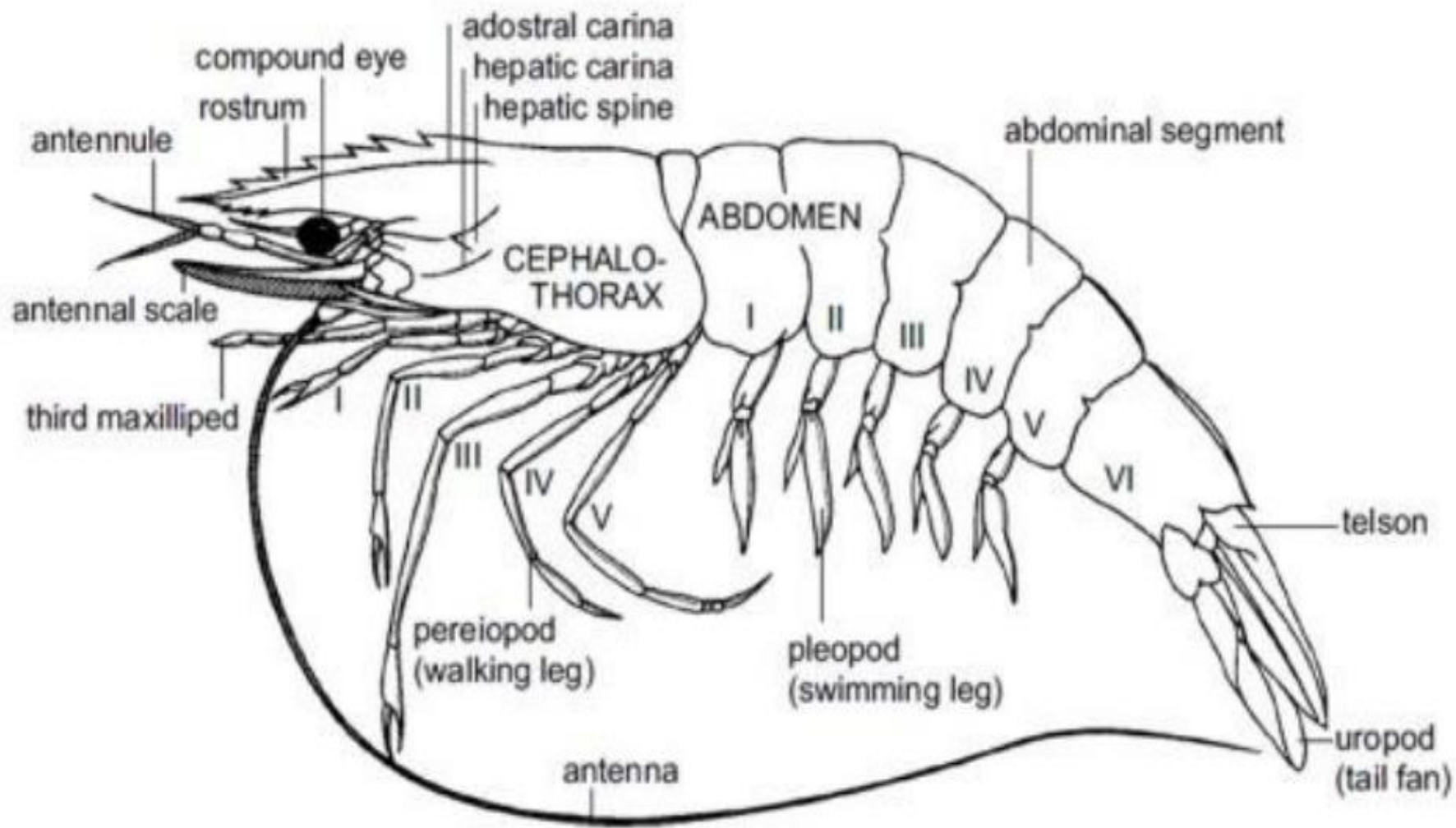
spider, scorpions,
ticks and mites



- Mostly terrestrial, air breathing, tracheae/book lungs/both or by body surface/book gills (aquatic forms)
- Two body sections (somites)- **prosoma** (cephalothorax) and **opisthosoma** (abdomen).
- **Prosoma** bears, four pairs of walking legs, one pair of chelicerae, one pair of pedipalpi and no antennae.
- **Opisthosoma** usually limbless but sometimes ends in a telson.
- Excretory organ- malpighian tubules/ coxal glands/both.
- Pairs of spinnerets.

Penaeus

- Phylum: Arthropoda,
- Subphylum: Mandibulata,
- Class: Crustacea



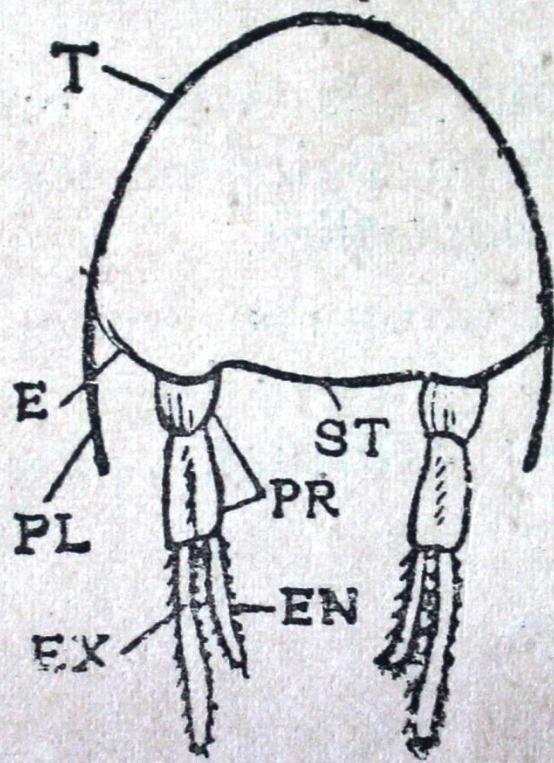


FIG. 322. DIAGRAM TO
SHOW THE PARTS OF
THE EXOSKELETON OF
A SEGMENT

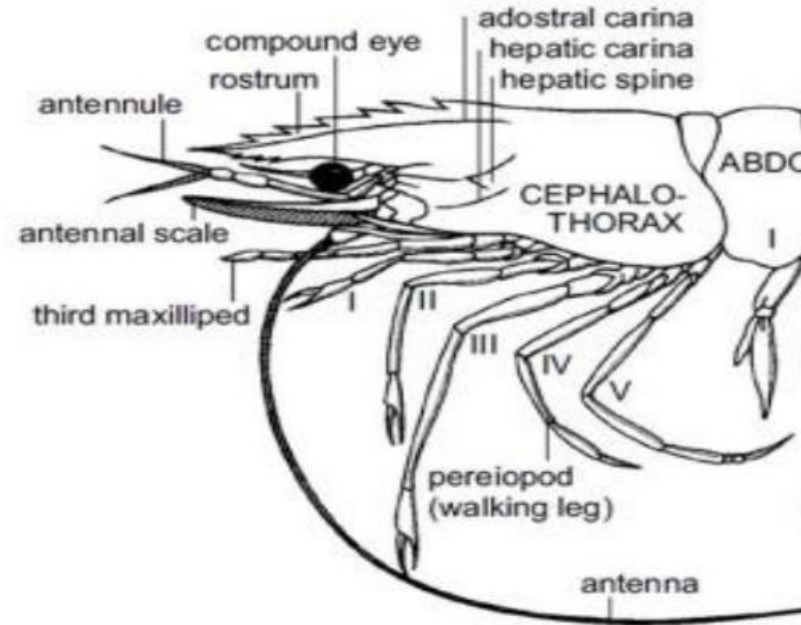
E, epimeron ; EN, endo-
podite ; EX, exopodite ;
PL, pleuron ; PR, proto-
podite ; ST, sternum ;
T, tergum.

External characters

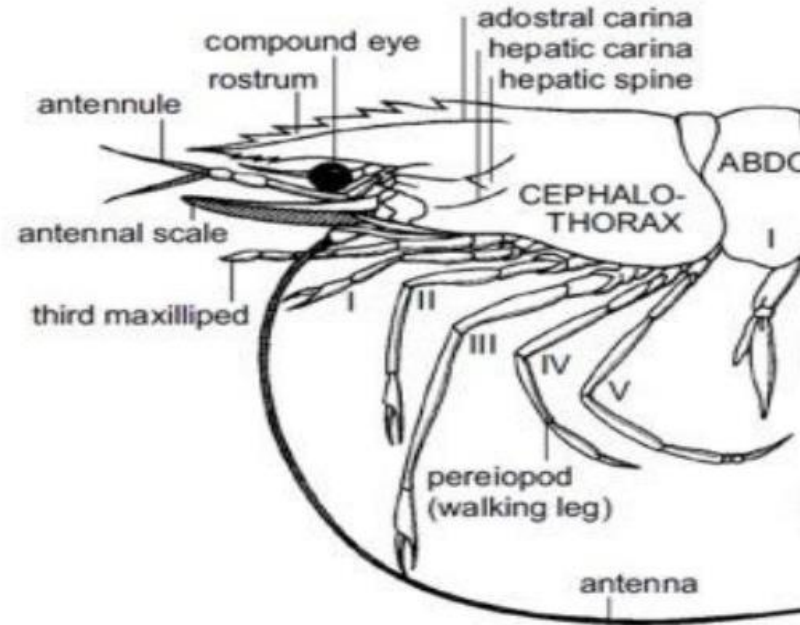
The body = anterior cephalothorax + posterior abdomen

Cephalothorax:

- Cephalothorax = head or cephalon + thorax.
- head – five ; thorax- eight -segments.
- **Carapace** or dorsal shield (single chitinous exoskeleton) - formed by the fusion of terga (five of the head + eight of the thorax).
- A **transverse cervical groove** on dorsum ---seperates-- head from thorax.
- **Rostrum** - a median serrated process.
- **Two compound eyes**- attached to the base of the rostrum by movable stalks.

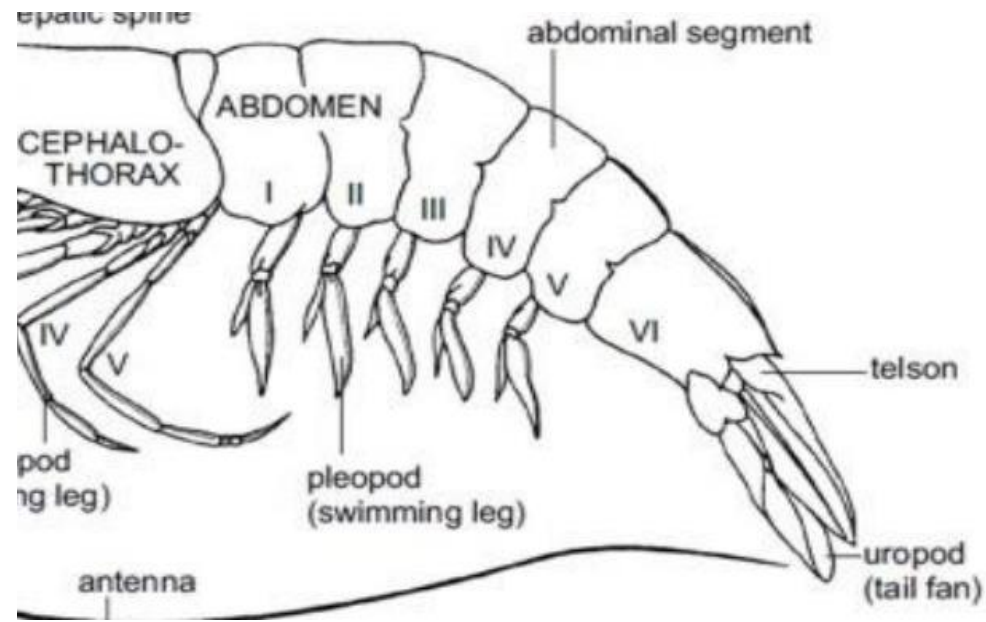


- **Branchiostegite or gill cover** - free ventral flaps on each side of the thorax.
- **Branchial chamber** - The space between the branchiostegite and body wall of each side.
- **Branchiae or gills** - The respiratory organ.
- **Sternal plate** - ventral sterna of the cephalothorax fuse.
- **In female**, the **sternum of the last thoracic segment** forms an outgrowth called **thelycum**, which encloses a cavity. The male deposits its spermatophores into it.
- In female, a pair of **genital openings** lies at the base of the **sixth thoracic legs**.
- In male, a pair of **genital aperture** lies on a **small papillae** at the base of **last pair of thoracic legs**.
- Cephalothorax bears, thirteen pairs of jointed appendages.



Abdomen:

- six segments +terminal piece telson.
- Tergum - The dorsal exoskeleton.
- Pleuron - thin lateral downward prolongation of the tergum.
- Sternum - ventral plate-like exoskeleton.
- Epimeron - The part between the pleuron and ventral abdominal appendage on each side.



- The cuticle between the adjacent segments is thin.
- Each segment bears a pair of jointed ventral appendages (pleopod).
- The last pair of abdominal appendages is called uropods.
- **Petasma**- in male, the first pair of abdominal appendages.
- Telson - The last piece of the abdomen (no appendages).
- Anus lies at the base of the telson ventrally.
- **uropods and the telson** form the. **tail fin**, used for backward movement

Appendages:

- Penaeus bears nineteen pairs of many-jointed appendages.
- They include cephalic, thoracic and abdominal appendages.
- Individual segments – **podomeres**.
- **Biramous** appendages (= two branched).
- Each appendage- **protopodite (two-jointed basal region)**
two distal processes- exopodite and endopodite.

This basic plan is modified in different parts of the body to suit the varying functions

Cephalic Appendages:

Head region bears **five pairs of appendages**.

These include

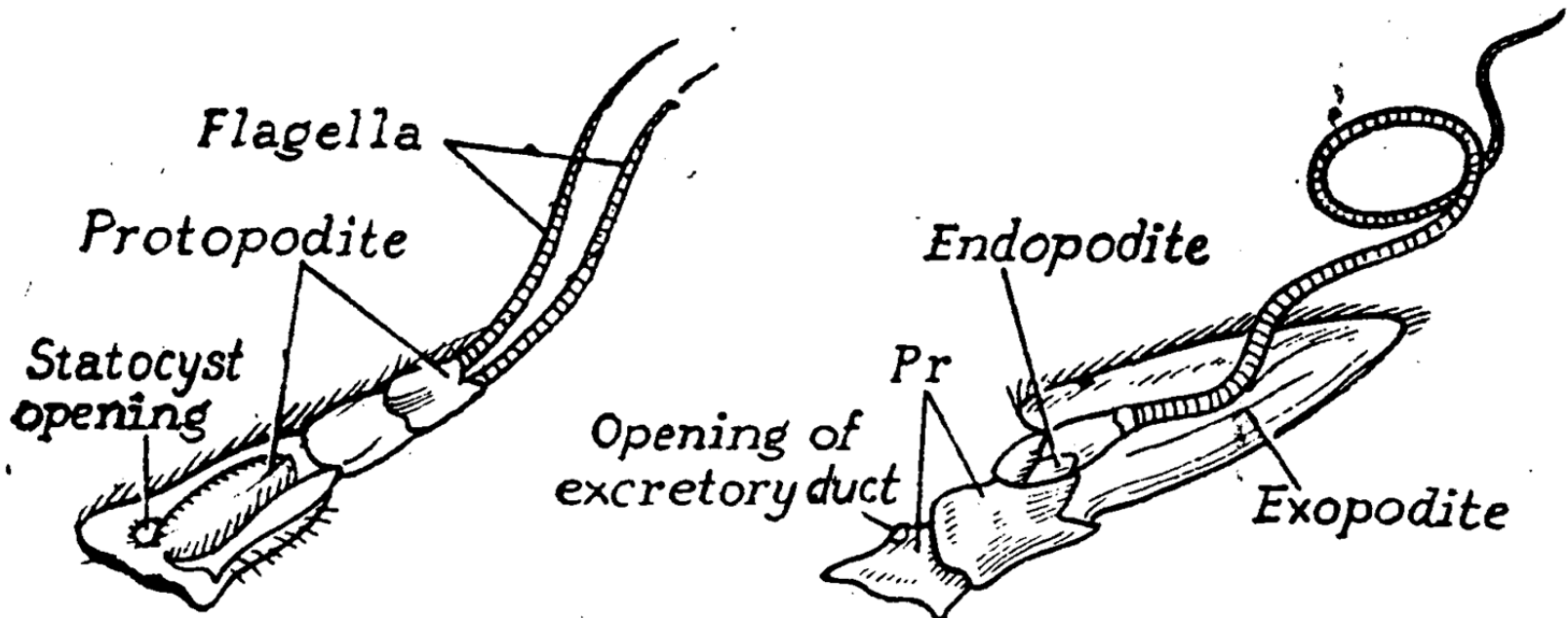
a pair of antennules,

a pair of antennae,

a pair of mandibles,

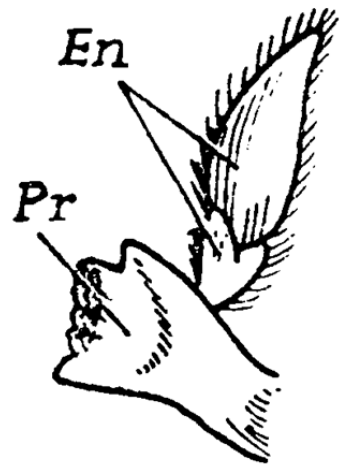
first pair maxillae and

second pair maxillae.

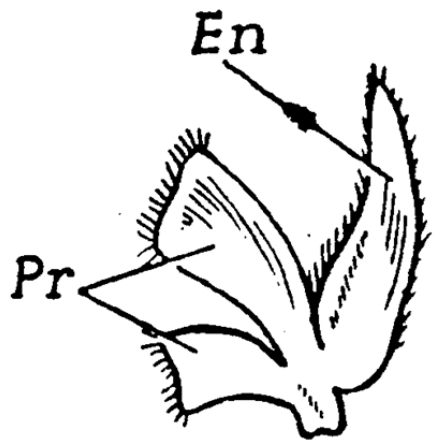


ANTENNULE

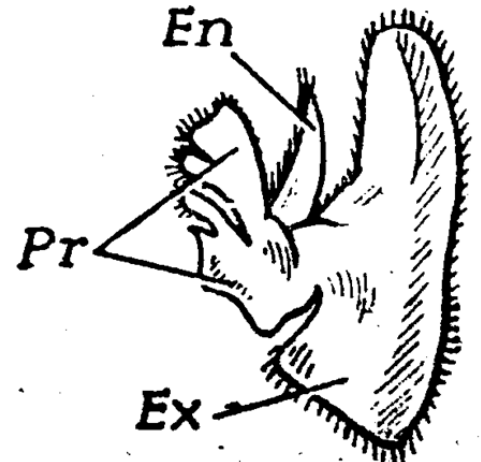
ANTENNA



MANDIBLE



FIRST MAXILLA



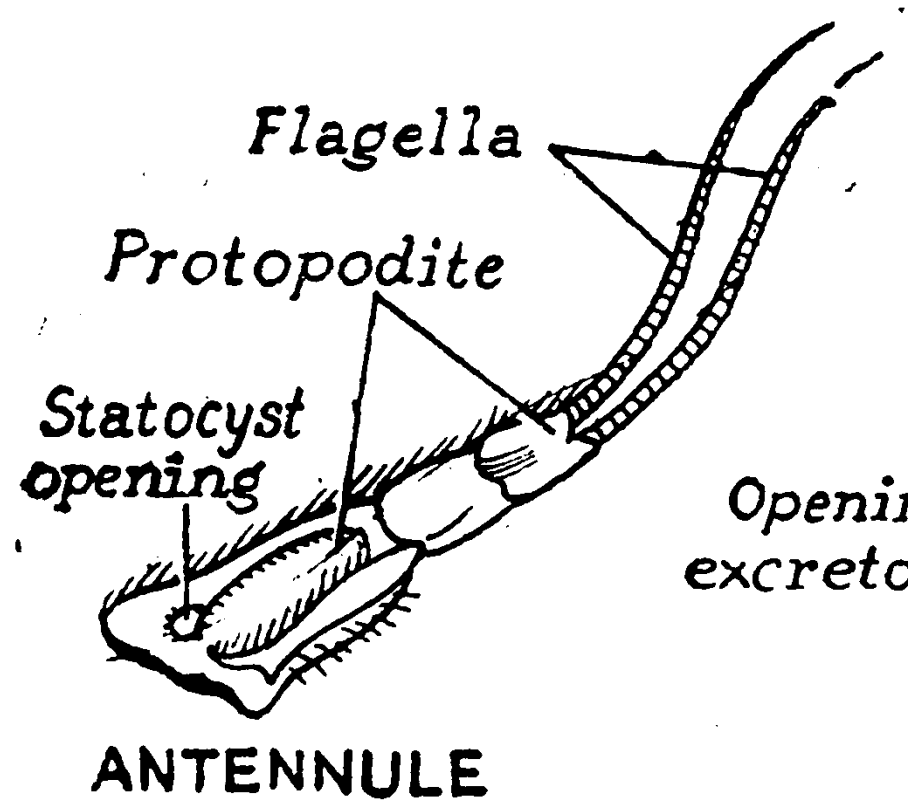
SECOND MAXILLA

FIG. 323. PENAEUS : CEPHALIC APPENDAGES.

Antennules: first antennae

- situated below the level of the eyestalks.
- Each antennule has
 - a **protopodite**,
 - an **exopodite** and
 - an **endopodite**.

Protopodite has **three podomeres**, the proximal **precoxa**, middle **coxa** and the distal **basis**.



Antennae: second antennae.

- consists of **protopodite**, **exopodite** and **endopodite**.

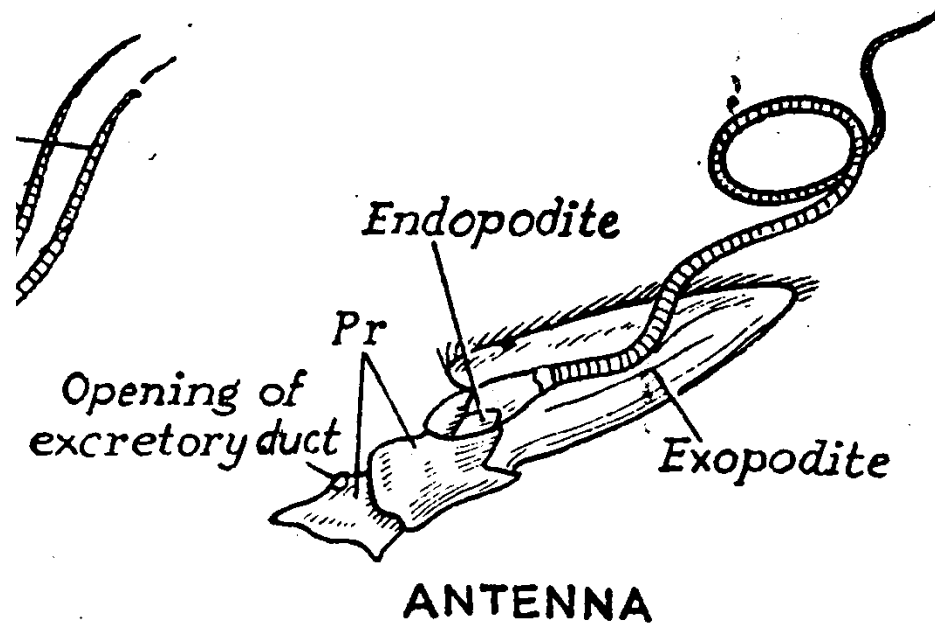
- **Protopodite** = coxa and basis.

- excretory duct.

Exopodite and **endopodite** are situated on the basis.

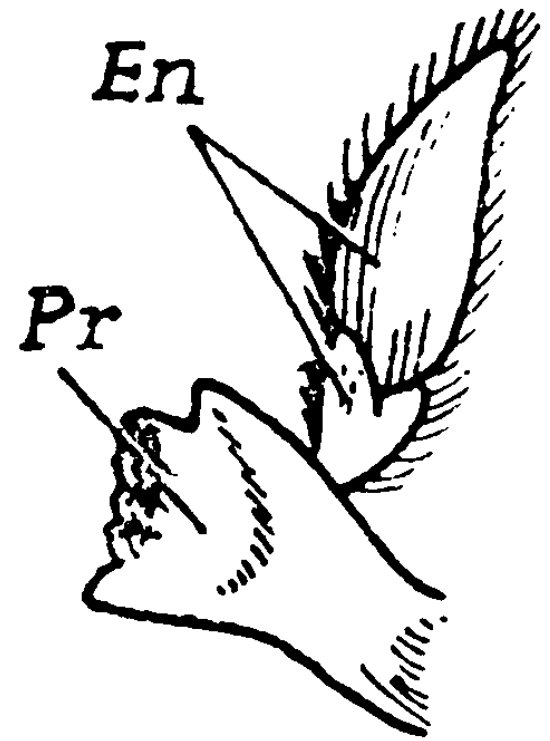
Endopodite - three basal podomeres and a long narrow many-jointed filament (as **tactile sense organ**).

Exopodite (squame)- is a flat broad plate-like structure- **balancing organ**.



Mandibles:

- lie on either side of the mouth.
- **protopodite and an endopodite.**



Exopodite is absent.

Protopodite - a single stout calcified structure with toothed inner edge (for grinding food).

Endopodite- segmented
- known as **sensory palp.**

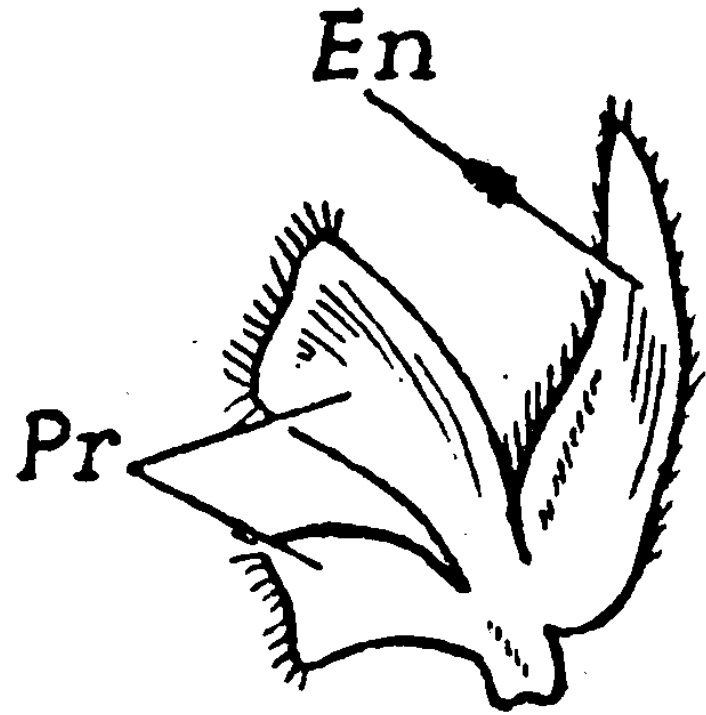
First pair maxillae (Maxillulae):

- smallest appendages.
- **protopodite** and **endopodite**.

Exopodite is absent.

Protopodite - two flattened leaf-like lobes (**coxa** and **basis**) - protect inwards as **jaws**.

Endopodite - unjointed and leaf-like.



FIRST MAXILLA

Second Pair maxillae:

- behind the first Pair of maxillae.
- a **protopodite**, an **exopodite** and an **endopodite**.

Protopodite

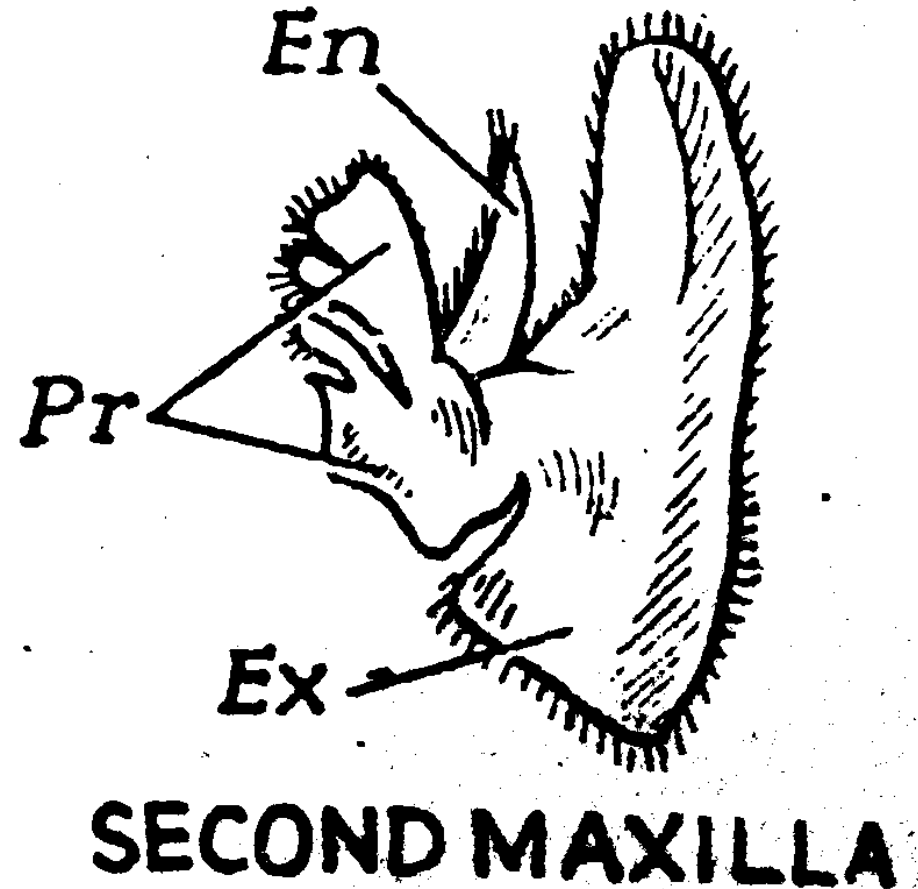
- **flat** and **four lobed**.
- edges are flattened and with hair-like processes (aid in **mastication**).

Endopodite

- small, **unsegmented** and leaf-like.
- situated between the protopodite and the exopodite.

Exopodite

- large, expanded, flat and boat-shaped.
- Its movement produces water currents in the gill chamber .



SECOND MAXILLA

Thoracic Appendages:

- **eight pairs** of appendages.

- **maxillipeds** (foot jaws)-1st three pairs; **directed forwards** and run parallel to the middle line of the body
- **peraeopodes** or walking legs.

- **Protopodite** - two podomeres
- **Endopodite** - five podomeres
- **Exopodite** - unsegmented

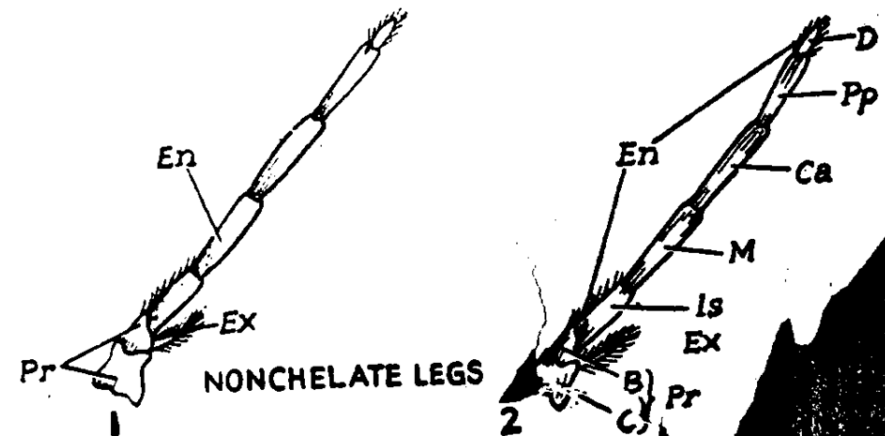
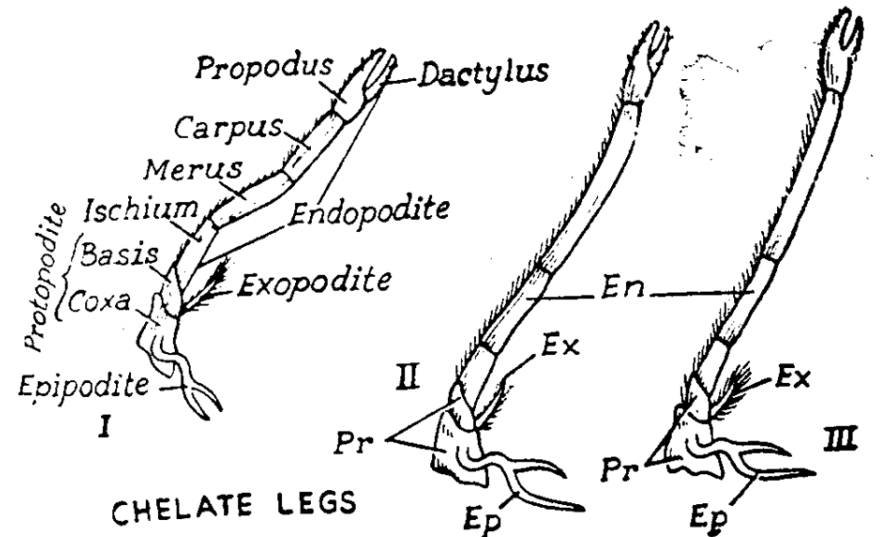
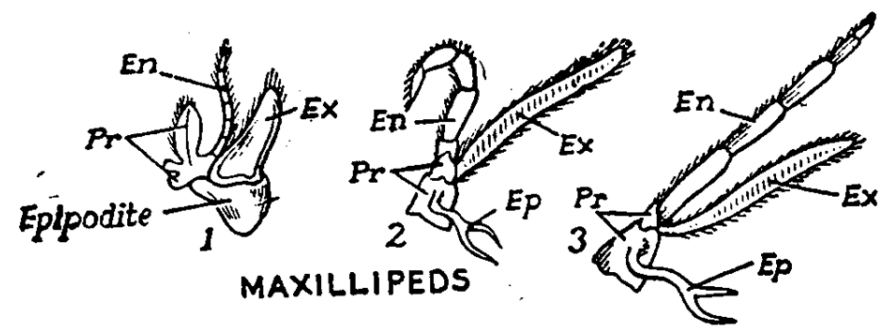


FIG. 324. PENAEUS : THORACIC AP

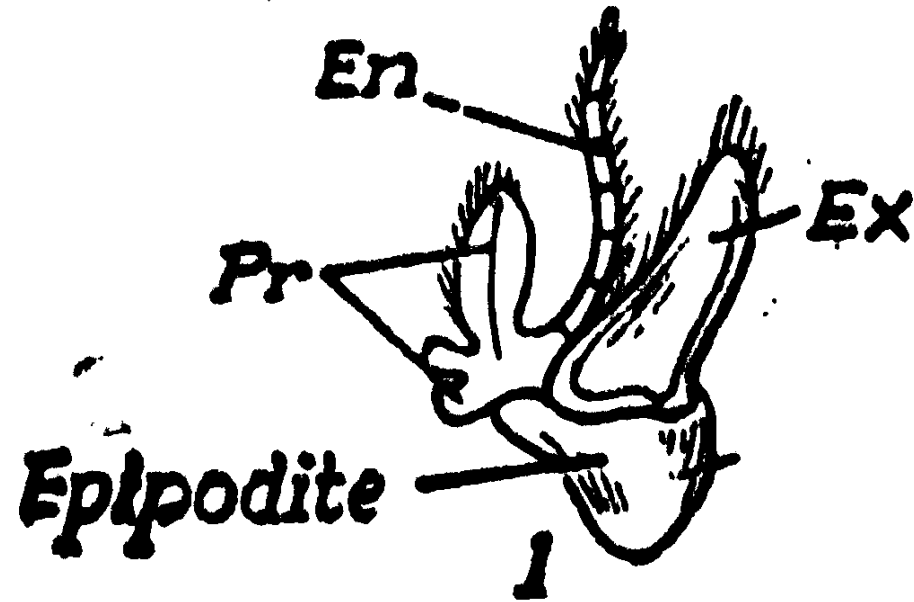
First maxillipeds:

- has a **foliaceous appearance**. - **protopodite**, **exopodite** and **endopodite**.

Protopodite - flat and incompletely divided into two small **proximal lobes** and a **large distal lobe** with setose processes on their edges.

Exopodite - flattened and leaf-like with a broad base.

Epipodite - a proximal, triangular, flat structure **attached to the protopodite and exopodite** (respiratory in function).



Second maxillipeds:

Protopodite- coxa and basis.

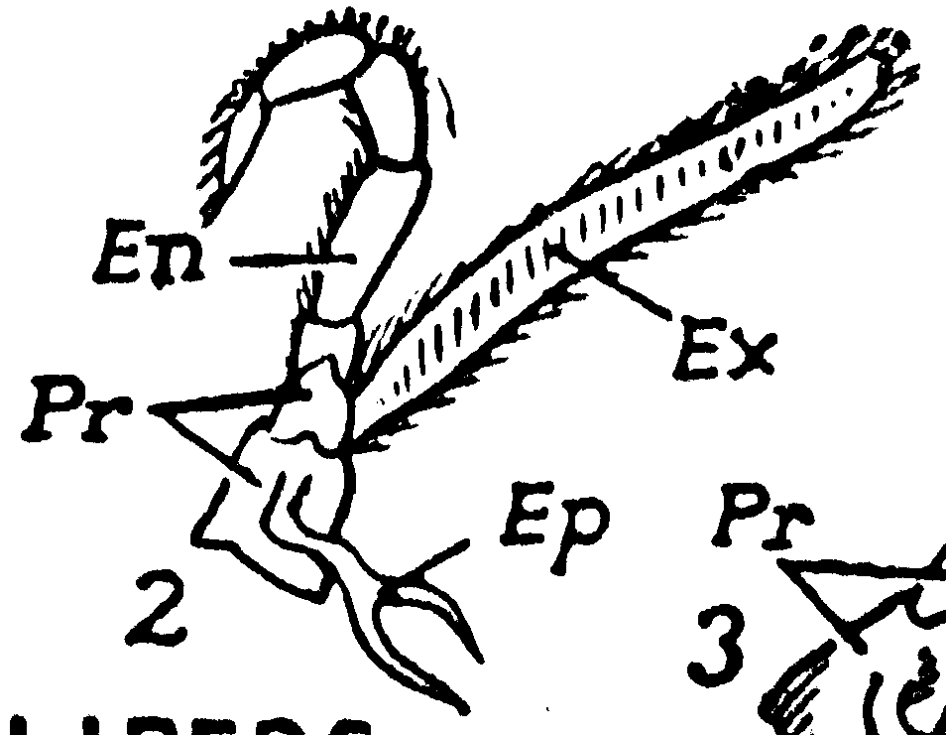
Exopodite and **endopodite** are attached to the basis.

Endopodite- five segments.

Endopodite curves distally and gives the **shape of an interrogation mark**.

Exopodite - flattened with striations and feathery edges.

Epipodite - Y-shaped



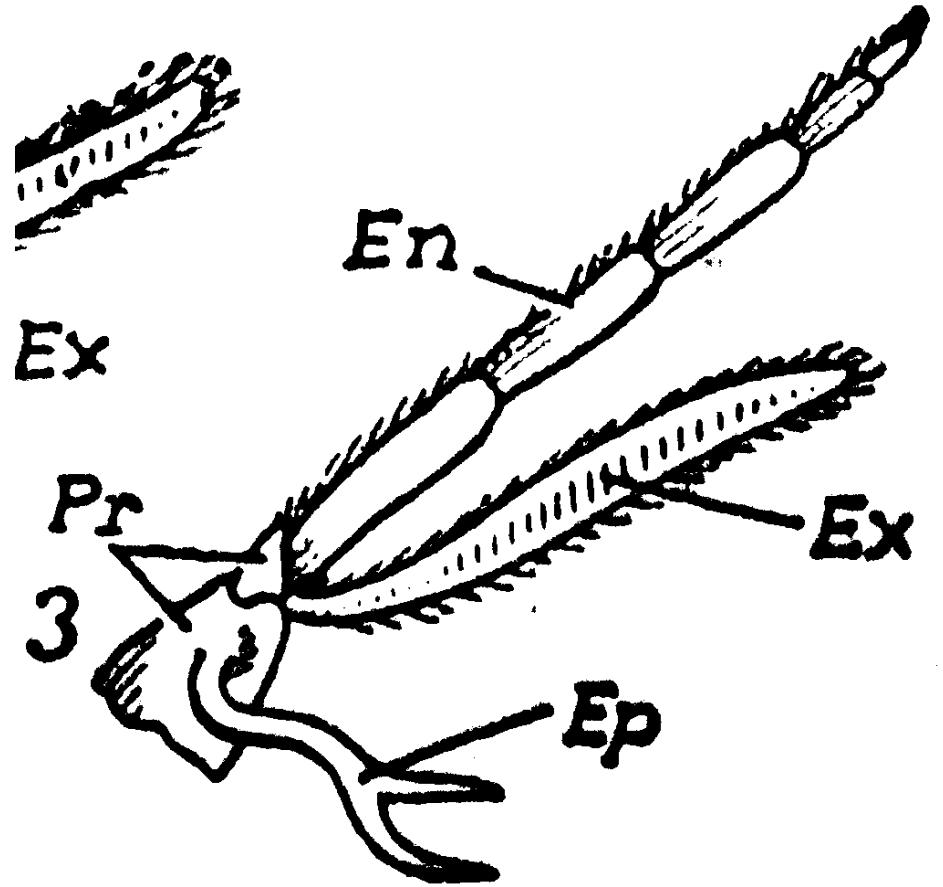
Third maxillipeds:

similar to 2nd maxilliped

Endopodite- is straight.

Exopodite- flat with striations and feathery edges.

Epipodite Y- shaped.



Peraeopods (walking legs):

There are **five pairs of peraeopods**.

The **first three pairs** of peraeopods are known as **chelate legs or chelipeds** and

the **last two pairs** of peraeopods are known as **non-chelate legs**.

In all peraeopods, the **exopodite is small** and **fringed with many hair-like structures**.

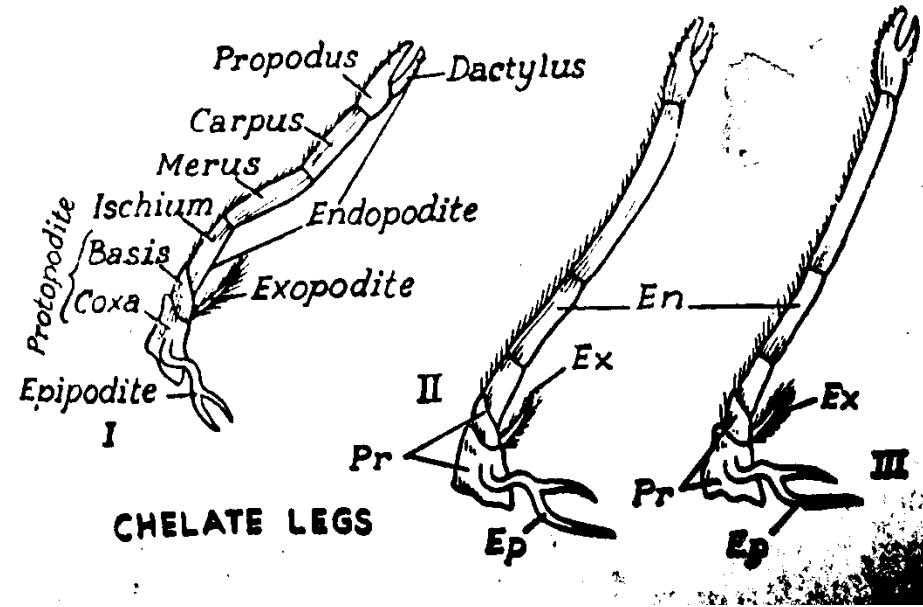
Chelate legs (Chelipeds):

All chelate legs are identical in structure. But they differ slightly in size, the third one being the longest.

The **five jointed endopodite** shows chelate articulation of the terminal two podomeres, the propodus and the dactylus.

By the hinged articulation of the dactylus to the side of the propodus, a **pincer** like apparatus is formed. This helps in grasping the food and passing it on to the mouth.

The chelate legs are also used for walking

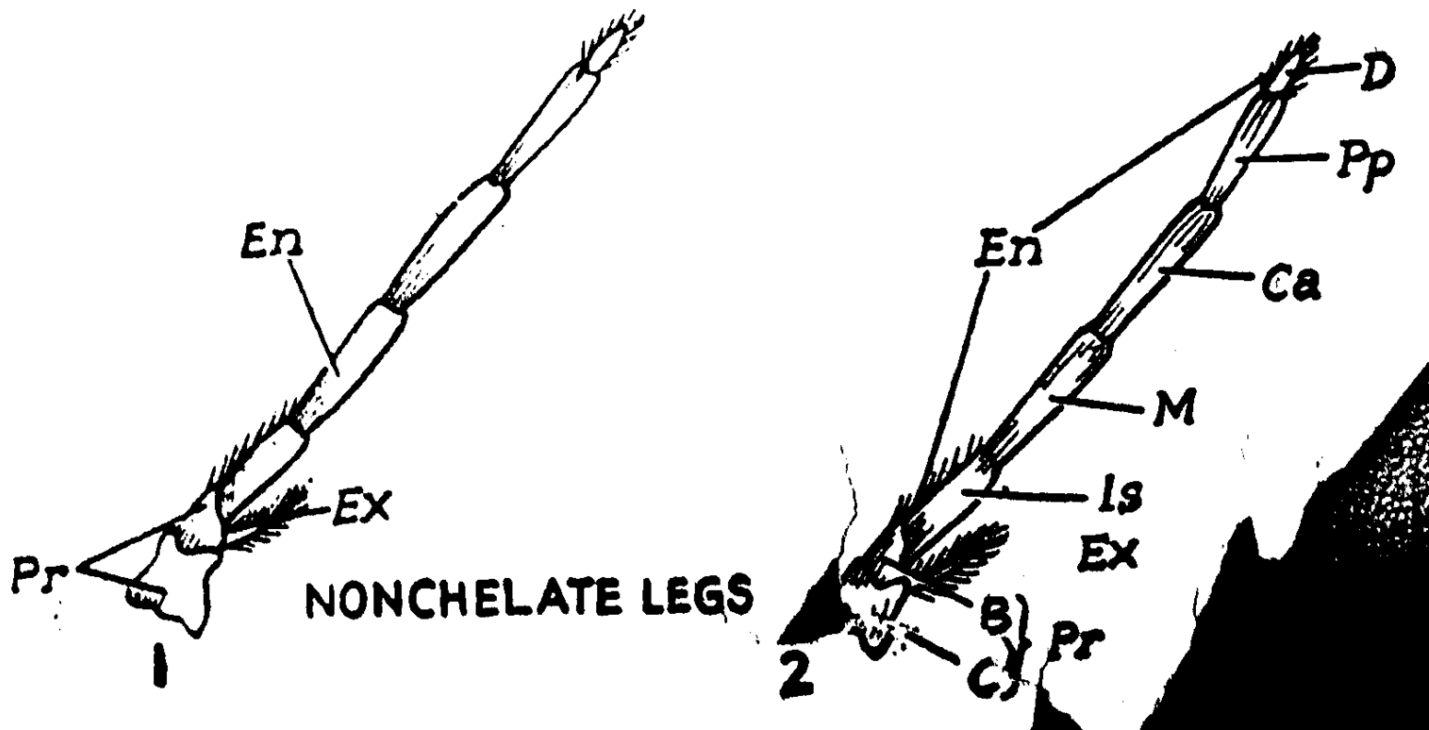


Non-chelate legs

In non-chelate legs, **dactylus and propodus do not form chelate articulation** .

Epipodites are absent.

Non-chelate legs are used for walking.



Abdominal appendages:

There are **six pairs** of abdominal appendages. They are also known as **pleopods** or **swimmerets**.

Each abdominal appendage consists of **protopodite** and **unjointed exopodite** and **endopodite**.

Protopodite is two segmented and the **exopodite** is flattened and fringed with setose processes.

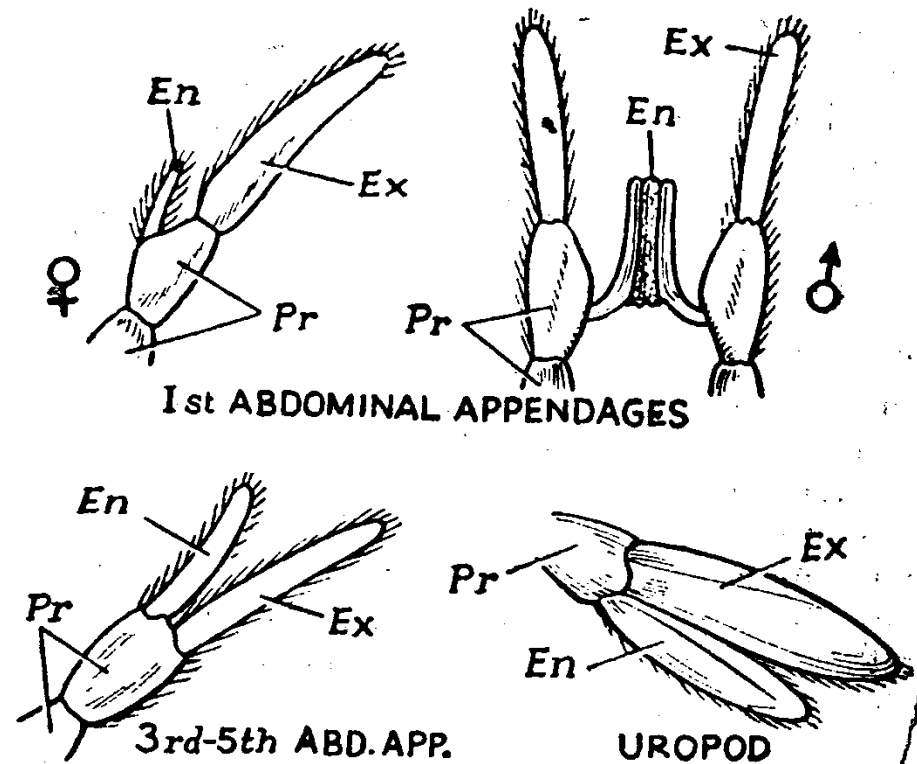
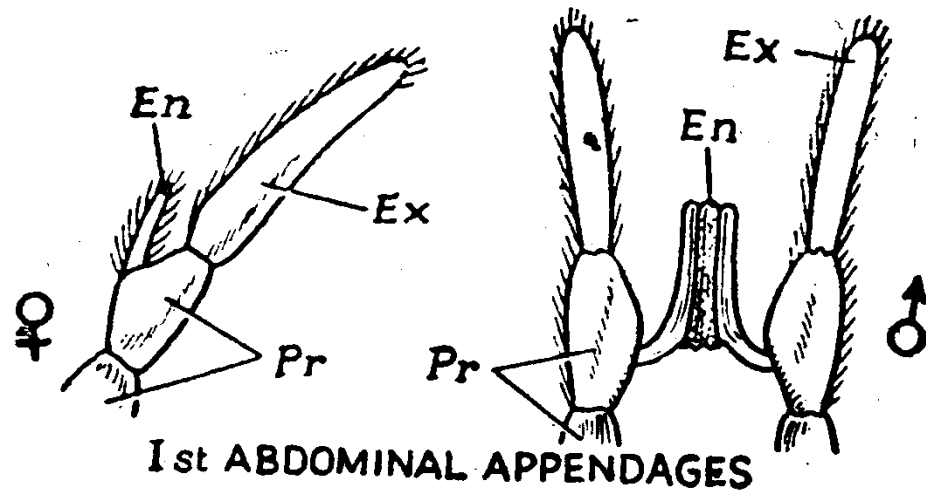


FIG. 325. PENAEUS : ABDOMINAL APPENDAGES.

First pleopods:

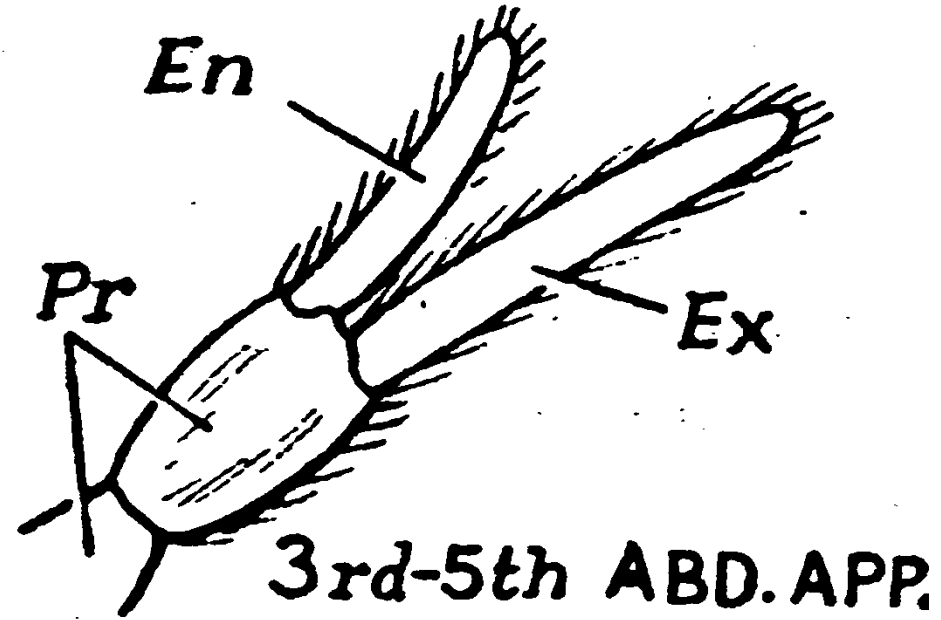
In female, exopodite is flattened, thick and fringed with setose processes. **Endopodite** is absent or may be present as a very small bud-like process.

In male, endopodite is short and provided with hooks. The hooks of the endopodites of the two sides interlock and form a rod-like structure called the **petasma** which is used for transferring sperms into the thelycum of female.



Second to fifth pleopods:

The second, third, fourth and fifth pairs of pleopods have a **typical biramous structure**, with a **two-jointed protopodite**, and **unjointed exopodite and endopodite** .



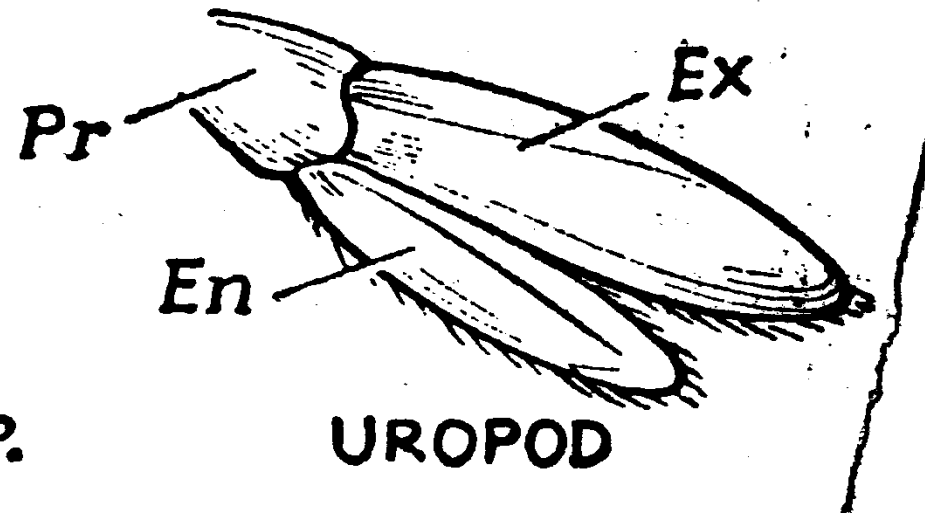
Sixth pleopods (Uropods):

The sixth abdominal appendages are known as **uropods**.

Each uropod has a **protopodite**, an **exopodite** and an **endopodite**.

Protopodite - coxa and basis fuse to form one segment.

The two uropods and the **telson** form the **tail-fin** or **tail-fan** which acts as a **balancing organ**. Its sudden **flexion** causes backward leap.



Metamorphosis in Insect

Metamorphosis can be defined as the change in growth and development of an insect undergoes during its life cycle from birth to maturity.

Or

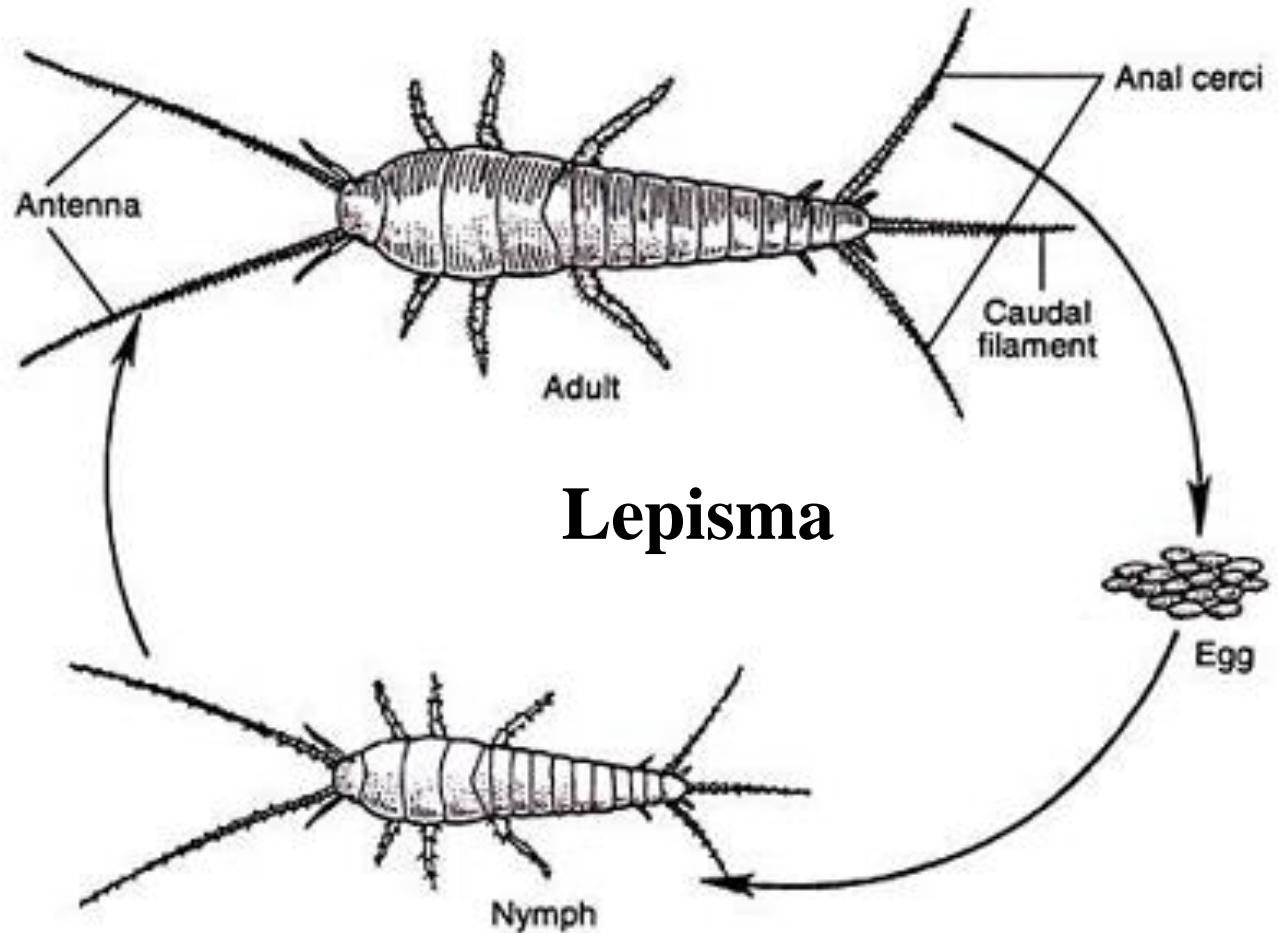
“a process of profound postembryonic reorganization of tissues which usually prepares an animal for the rest of its life in a different habitat”

Or

“a rapid and complete transformation from an immature larval life to a sexually adult form involving morphology, function and habitat changes”.

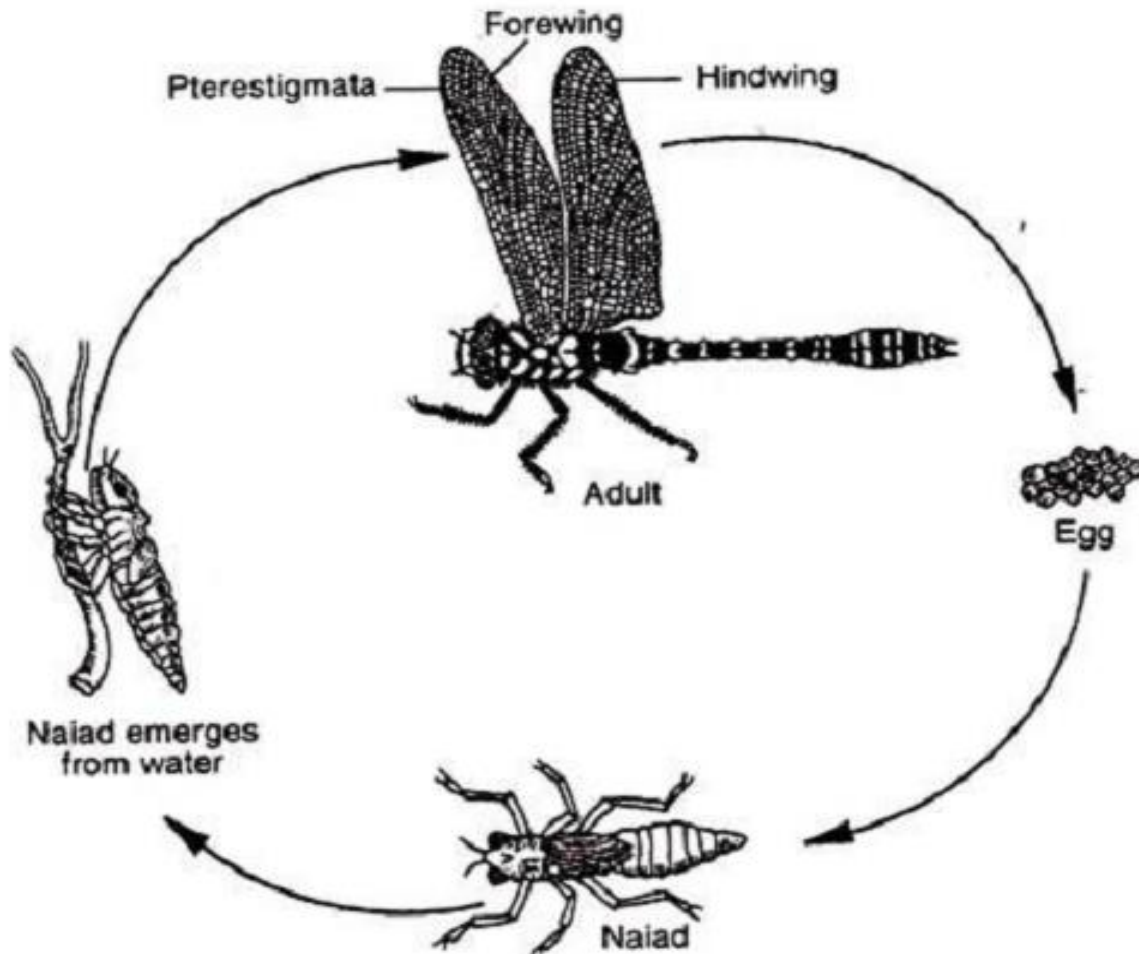
Types of Insect Metamorphosis

Ametabola or Direct development



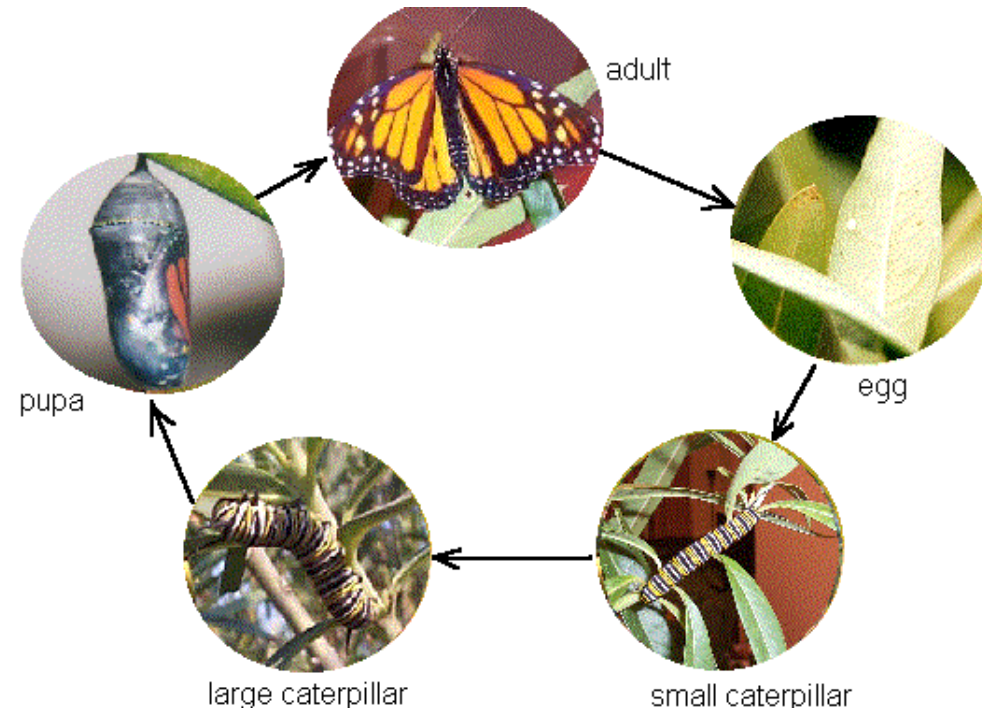
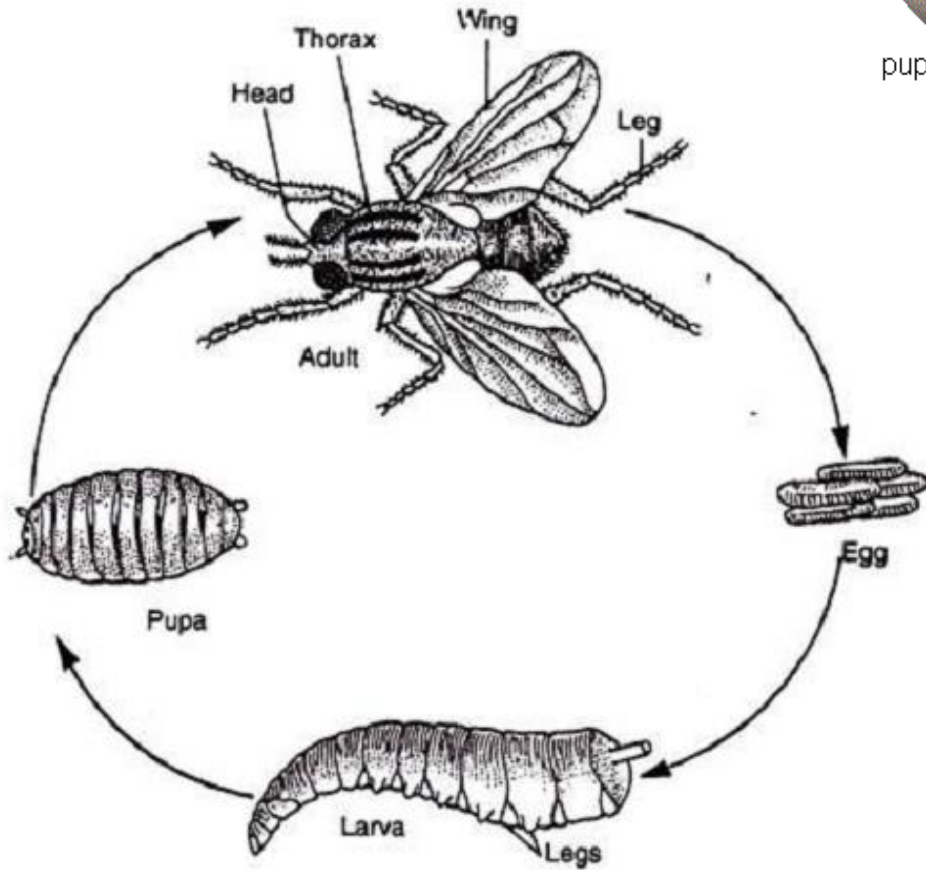
Lepisma, Collembola (spring tails)...

Hemimetabola or Incomplete Metamorphosis



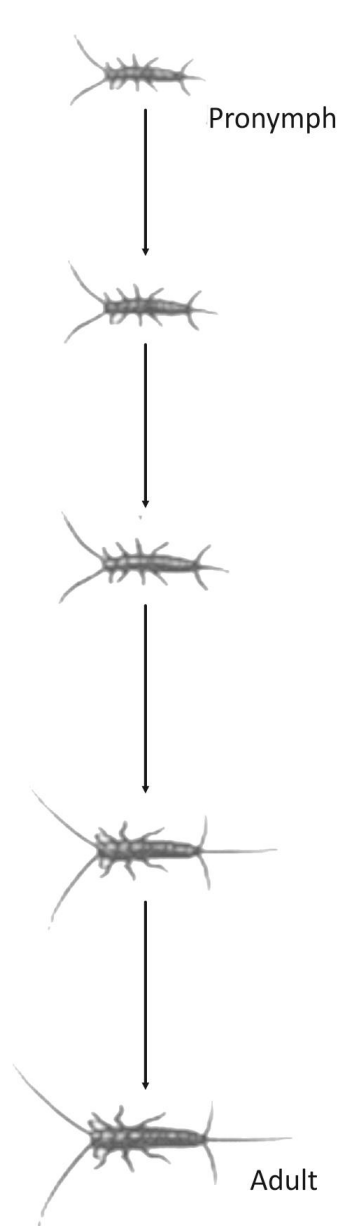
Cockroaches (Orthoptera), Grasshoppers, Rhodinus bugs (Hemiptera), Dragon flies (Odonata), Earwigs (Dermaptera).....

Holometabola

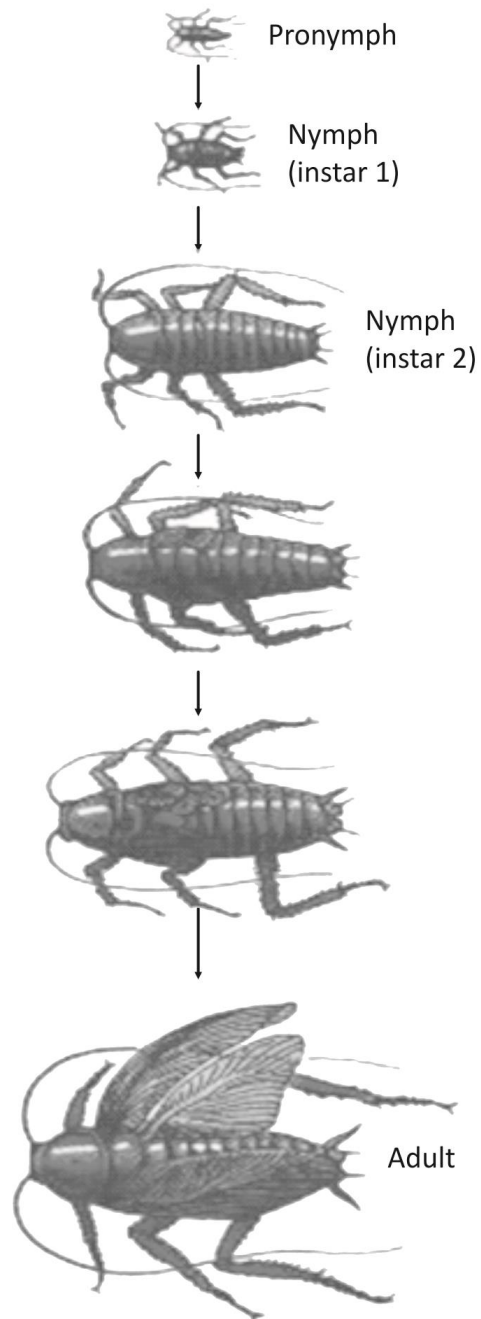


True flies (Diptera); Moths and butterflies (Lepidoptera); Ants, Wasps and Bees (Hymenoptera) and Beetles (Coleoptera).

(A) Ametabolous Development



(B) Hemimetabolous Development



(C) Holometabolous Development

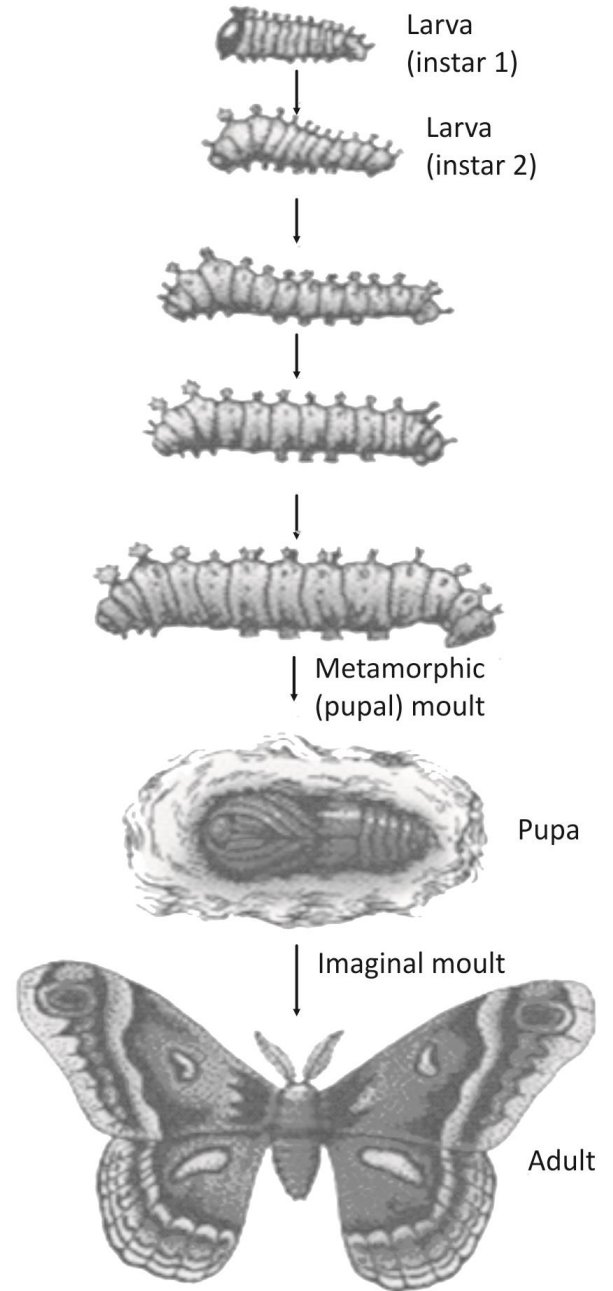


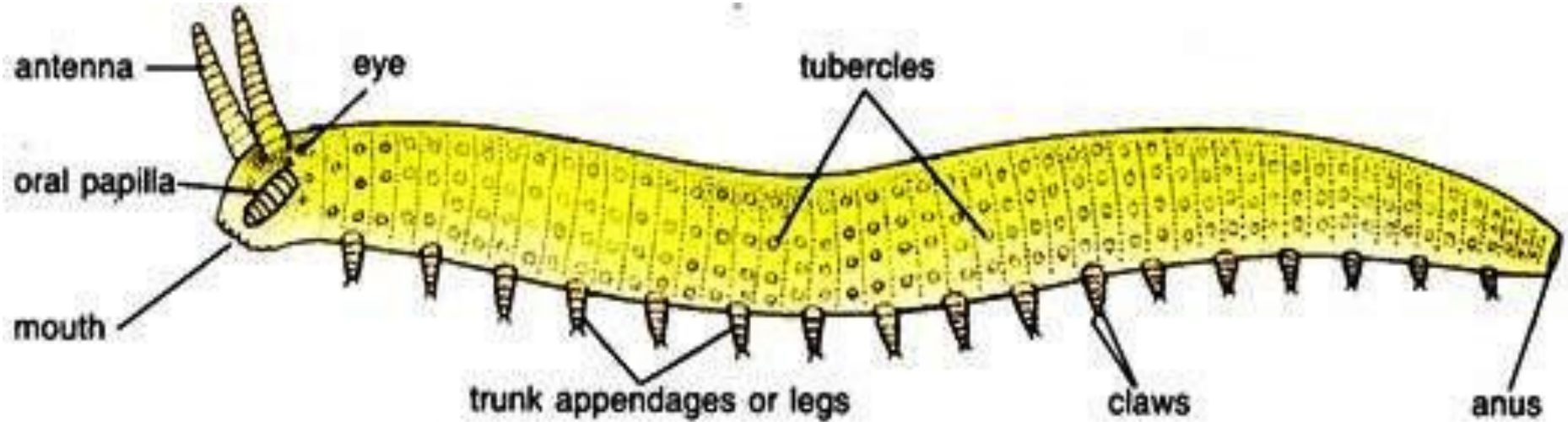
Fig. : Insect metamorphosis

Onychophora

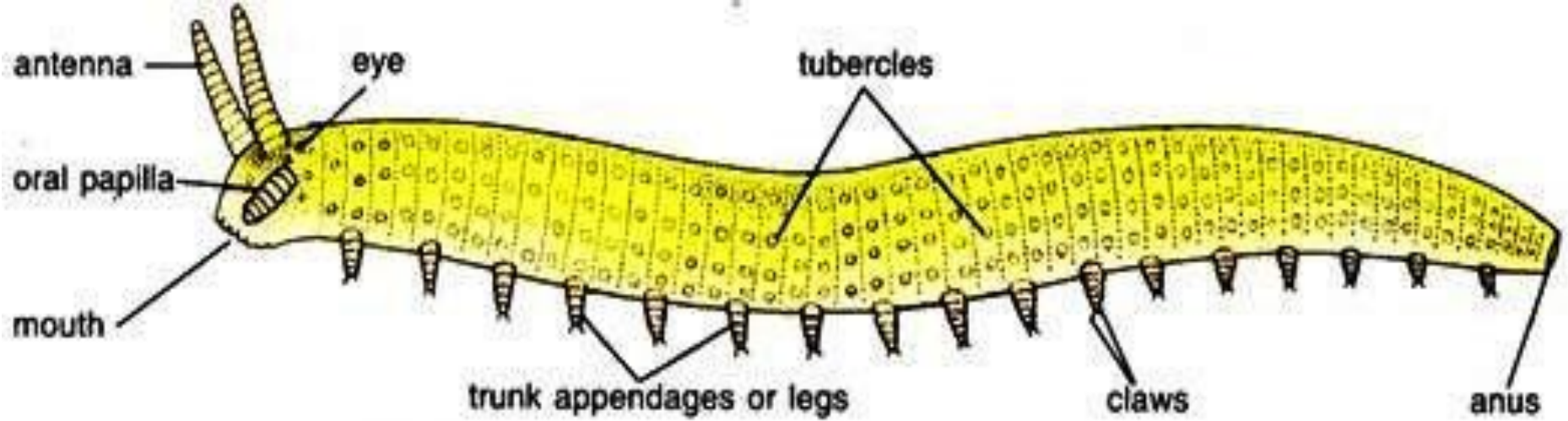
Peripatus

Gk. Peripatos = walking about

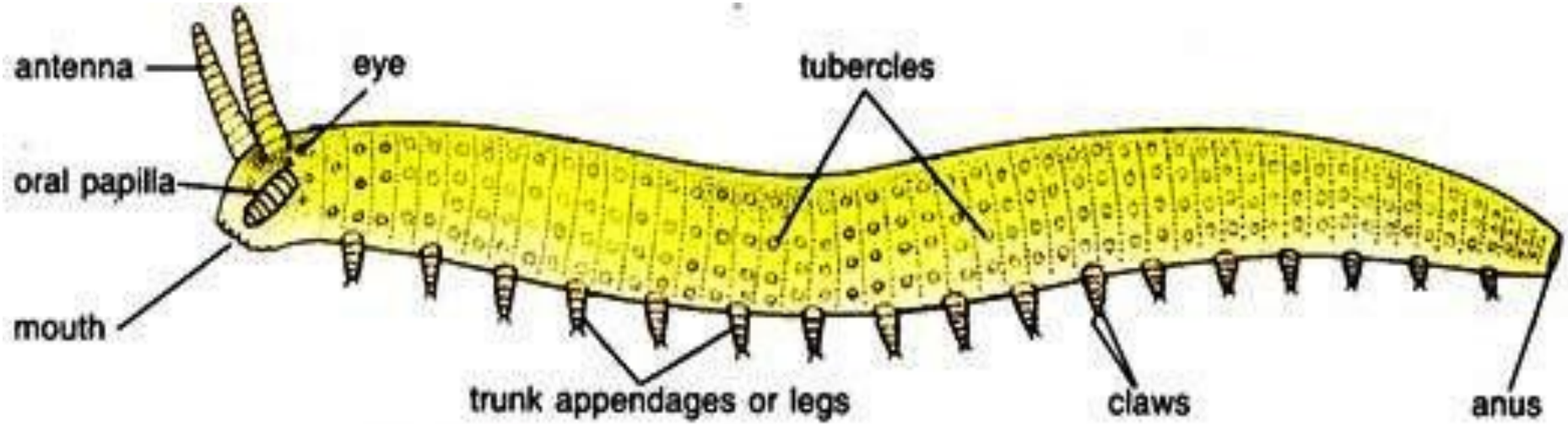
Gk. Peripatein = to walk about, stroller



- velvet worms or walking worms
- terrestrial and found in moist habitats
- Body soft and Caterpillarlike,
5 mm to 15 cm in length
(e.g., *Peripatopsis torquatus*)
- colouration- blue, green, orange or black



- Bilaterally symmetrical
- Metamerically segmented
 - segmentation is denoted only by the presence of short paired (1413pairs) unjointed stumpy walking legs (lobopods).
- Protostomous coelomates
- Circulatory system - Haemocoelomic body cavity



Integument

- thin
- chitinous cuticle with varied ringlike striations
- papillae and scales

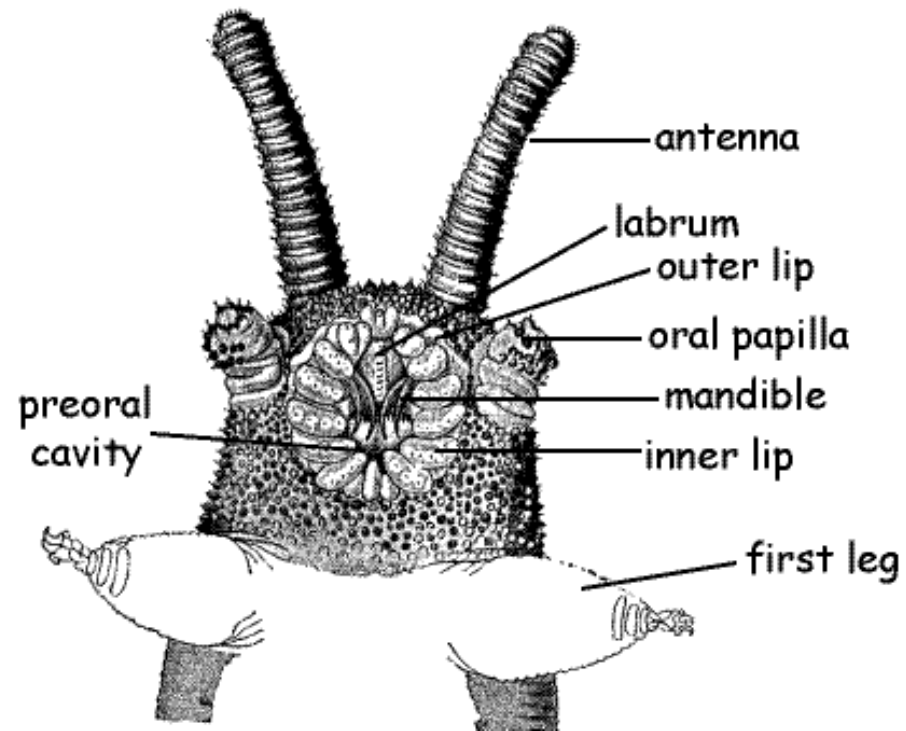
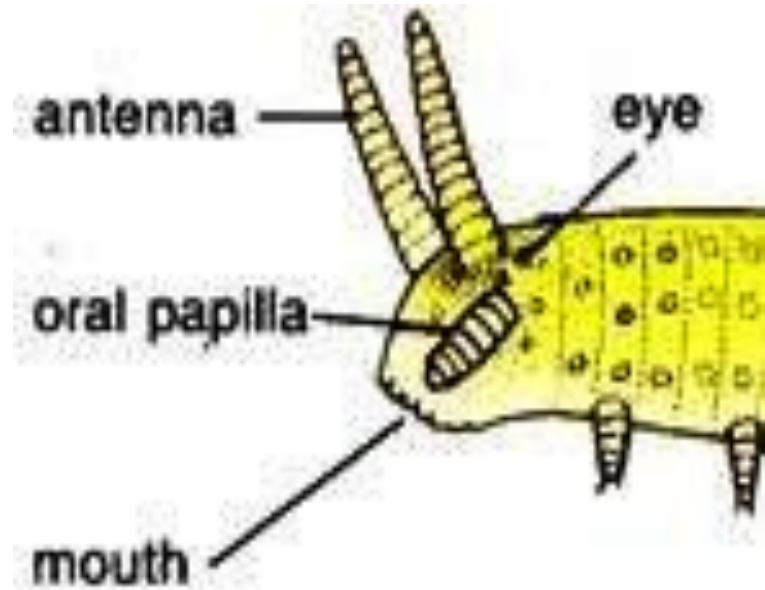
➤ Head is not clearly differentiated. Tagmatization is not well pronounced.

➤ Eyes- ocelli.

➤ Mouth-biting and chewing type

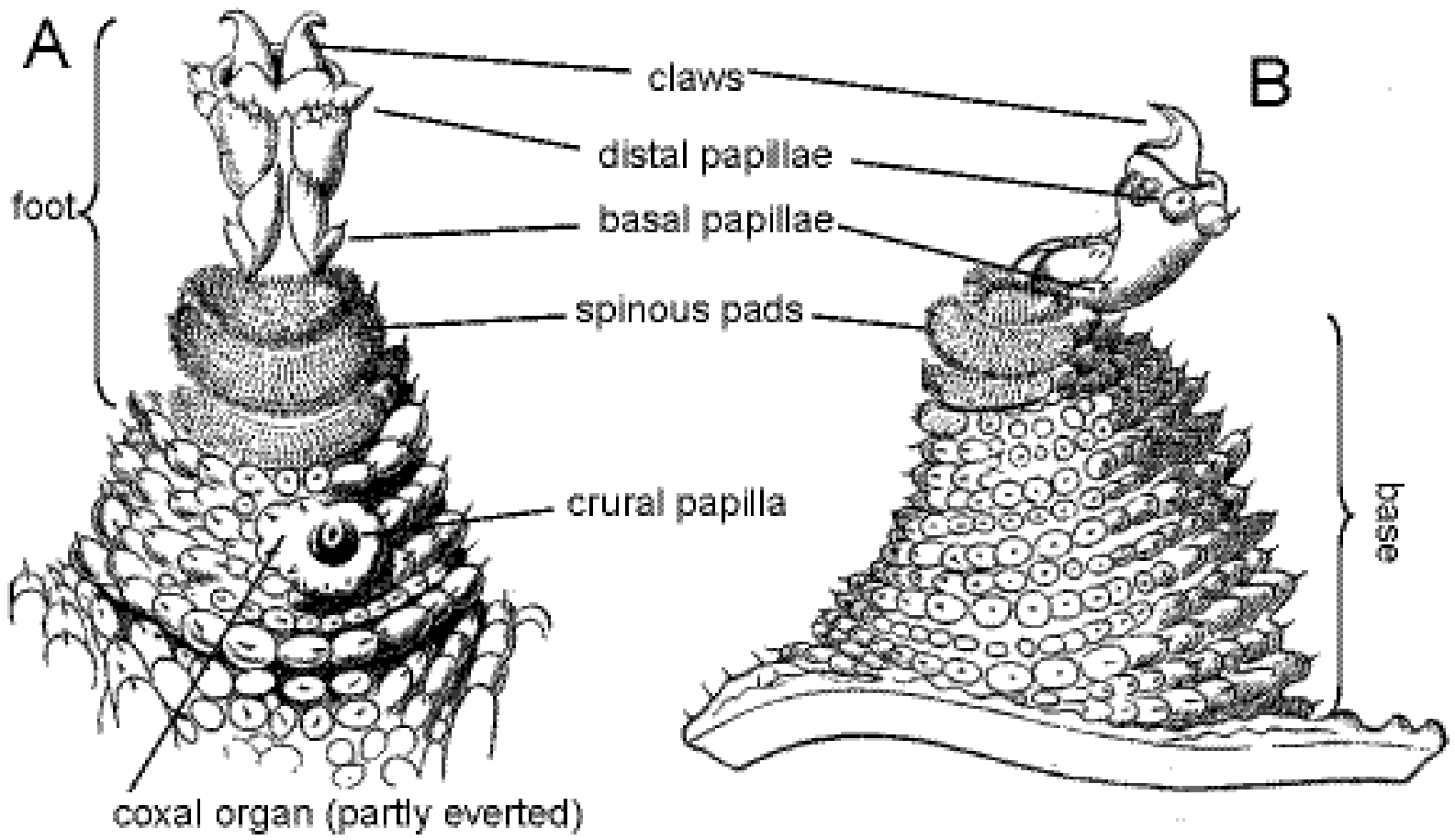
➤ Head appendages

- a pair of fleshy annulated antennae
- a pair of jaws (2nd pair of appendages)
- a pair of short oral papillae (3rd pair of appendages)



- Muscles are unstriated.
- Alimentary canal is straight tube- mouth and anus.
- Respiration- by tracheal tubes open through spiracles laterally.
- Slime glands - oral papillae - for prey capture or defence.
- Nervous system- large bilobed cerebral ganglion on the dorsal side of the pharynx.
- Excretory organs –
 - Nephridia** -segmentally arranged coiled ciliated tubules (one pair on each segment)
 - Coxalglands or crural glands** - leg.
 - Malpighian tubules are absent.
- Sexes separate (gonochoristic).
- Fertilization internal.

- The legs are terminated into curved claws.
- Locomotion- by peristaltic waves from anterior to posterior end of the body .



Arthropod characters of Onychophora

1. Presence of antennae.
2. Body is covered with chitinous cuticle.
3. Appendages are provided with claws.
4. Jaws are modified appendages, provided with striped muscles.
5. Locomotion by definite legs having definite musculature.
6. Presence of haemocoel.
7. Dorsal tubular heart with lateral ostia.
8. Presence of tracheal respiratory system.
9. Coelom reduced to small cavities that surround the excretory & reproductive ducts.
10. Peculiar salivary gland supposed to be modified nephridia.
11. Brain is large & typically arthropodan.
12. General structures of the reproductive organs & development mainly arthropodan.

Annelid characters of Onychophora

1. Vermiform body with truncated extremities.
2. Absence of true head.
3. Outer body covering is cuticle, skin thin & flexible.
4. Muscles separate in identical way.
5. locomotion - slow & by peristalsis as in an earthworm.
6. Simple & straight alimentary canal.
7. Paired, segmentally arranged nephridia.
8. Presence of cilia in excretory & reproductive ducts.
9. Structure of eye same as in polychaetes.
10. Slime & coxal glands correspond with similar glands of chaetopods.

Similarities with Mollusca:

1. Sluglike appearance.
2. Ladderlike nervous system resembling that of chiton and lower prosobranchia.
3. Antennae ---- tentaclelike.

Onychophoran characteristics

The following features are peculiar to Onychophora in which they differ from other phyla:-

1. Body shows no or indistinct segmentation.
2. Texture of skin. A rough cuticle covered with numerous velvety processes not known in other phyla.
3. Antennae not homologous to the antennae of other arthropods.
4. 3 segmented head- a condition mid way between that of Annelida & Arthropoda.
5. Restriction of jaws to a single pair. Movement of jaws is antero-posterior.
6. Presence of non jointed legs with claws.
7. Irregular distribution of spiracles or tracheal openings.
8. 2 ventral nerve cords widely separated & without true ganglia.
9. Structure of eye less complicated.