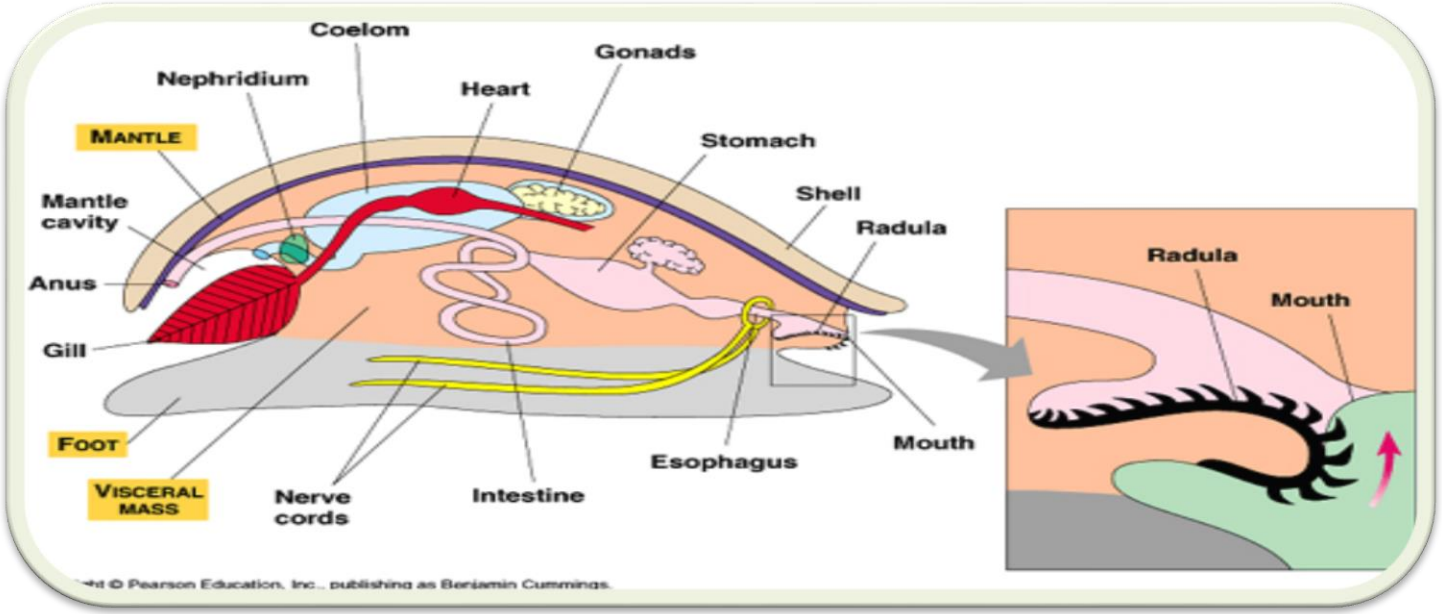
FOOT
AND ITS MODIFICATIONS
IN MOLLUSCA



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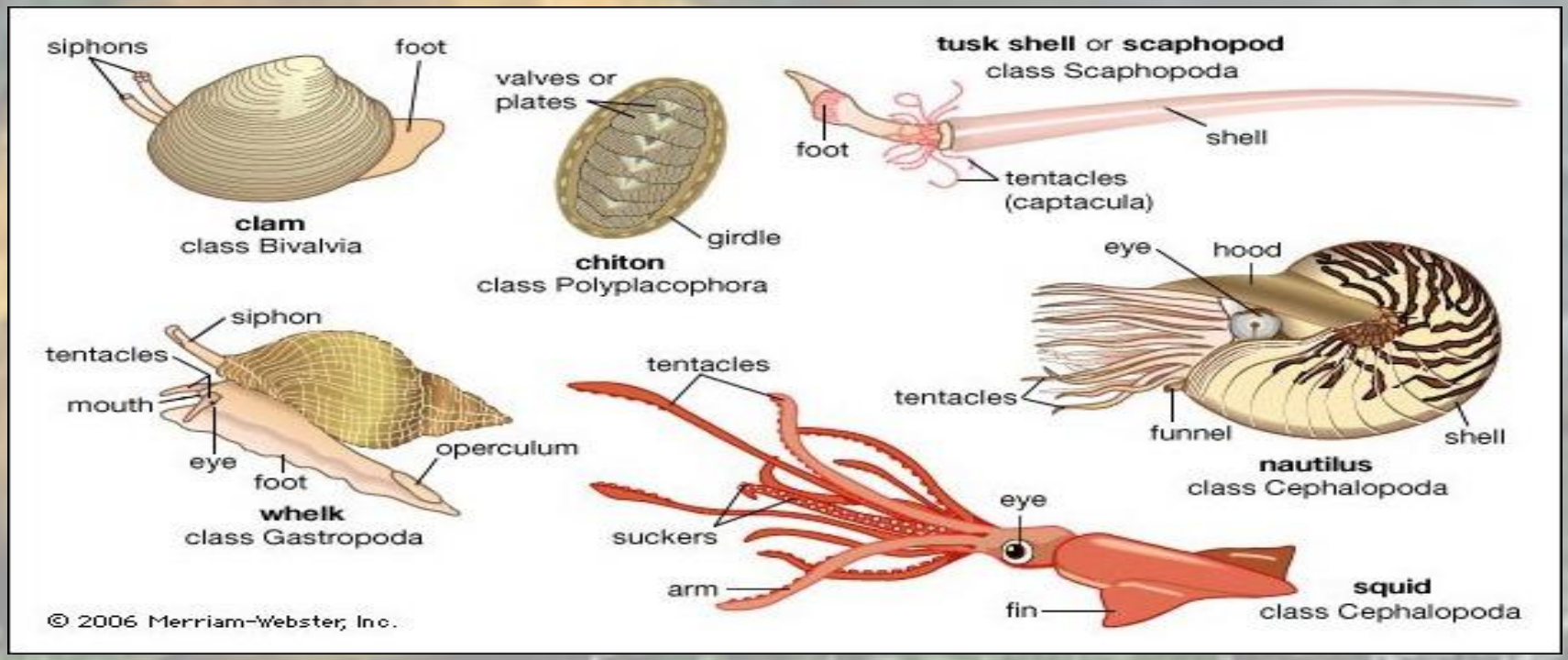
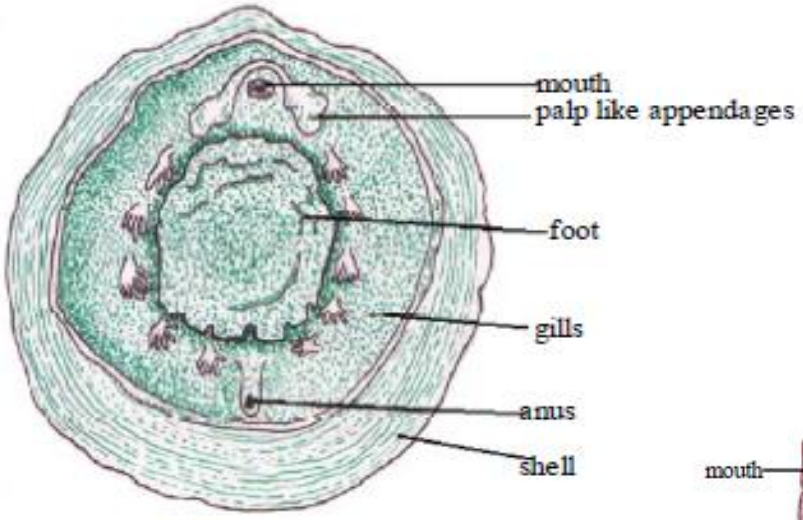
FOOT AND ITS MODIFICATIONS

- Foot is a characteristic feature of the phylum Mollusca adapted for **locomotion**, but can take over the function of **reproduction, defence and capturing of the prey**.



- It is regarded as the remnant of the **dermo-muscular tube of the ancestral form** whose dorsal side becomes degenerated and the ventral side becomes greatly modified for creeping.
- Foot is innervated by the **nerves of the pedal ganglion**.

- Molluscs occupy different niches and thus the foot becomes greatly modified in shape, form and function.
- The simplest and primitive form of foot in molluscs is considered to be a **broad, ventral flat foot adapted for creeping movement**.
- However, foot is **absent** in some of the molluscs e.g. ***Ostrea*** *(class Bivalvia). It is very much reduced in* ***Teredo****.*
- **True molluscan foot is also absent in aplacophorans**. In **Neomenia** (class Aplacophora), a ventral groove with ciliated ridge serves as a locomotory organ.
- **Reduction or complete loss of foot** is also seen in **parasitic gastropods**. In sedentary and sessile gastropods e.g. **Bathysciadium, Vermetus** etc. foot is reduced and the **ventral sole becomes an effective sucker for attachment to the substratum**.



Neopilina

Fig.49 Foot in Monoplacophora

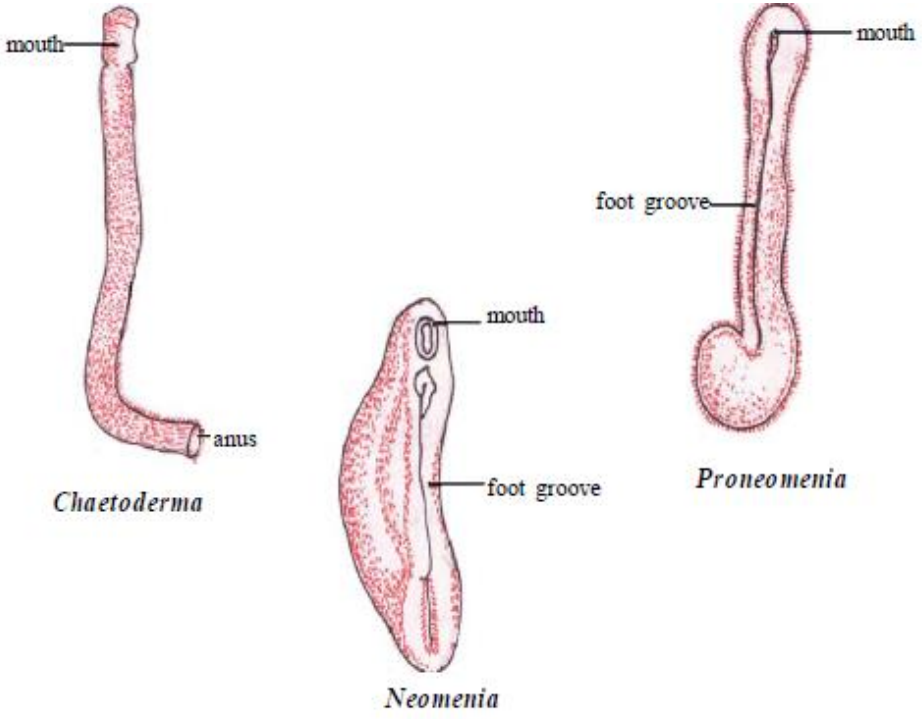


Fig.50 Foot in Polyplacophora

FOOT AS A CREEPING OR CRAWLING ORGAN:

- **In Monoplacophorans :*Neopilina*** is one of the very few living members of the class Monoplacophora that possess a **disc-like foot with a flat creeping sole** that occupies the entire ventral side.
- **In Polyplcophorans: Polyplacophorans like *Chiton*** too have a **broad, muscular flat foot on the ventral side** that helps the animal to adhere to the substratum and creep.
- **In Gastropoda:** The **foot in Gastropoda usually has an elongated, flat, ventral sole for creeping**.
- Very fine bundles of muscles called as the **tarsos muscle** are present on the sole of the foot and are responsible **not only for locomotion but also for capturing the prey.**
- In higher gastropods, the **foot is differentiated into three parts by transverse grooves**: a small anterior **propodium**, large, middle **mesopodium** and small posterior **metapodium**.
- **The mesopodium is the locomotory region.**
- **Metapodium bears the operculum.**
- **However, the propodium is either reduced or absent in most prosobranchs.**
- The foot is variously modified in different gastropods e.g. **anterior margin of the foot may form a small tactile process which helps in creeping as is seen in *Trochus* or the foot may project as a small fleshy process e.g. *Turbonilla*.**
- ***Triton* has a contractile foot**.

- ***Patella,*** the true limpet (prosobranch) is a sluggish animal which creeps slowly when required. It remains firmly attached to the rocks and other objects on the sea shore with the help of the foot. Thus, *Patella* has a **well developed ventral foot with a broad, flat creeping sole** to move over the rocks. The foot is surrounded by **horse-shoe shaped muscle band known as the pallial muscles** for attachment.
- ***Acteon and Cypraea* possess a foot with very large, broad creeping sole**. They move by producing waves of contraction on the foot.
- *Limax*, the grey slug is a terrestrial gastropod and **bears a long foot on the ventral side with a creeping sole and a pair of longitudinal grooves**. The pedal gland just behind the head secretes slime or mucus on which the animal creeps.
- Like the ***Limax, Helix***, the land snail, too, is a terrestrial gastropod found in moist shady places like the gardens. It creeps very slowly on a self secreted tract of mucus.
- ***Haliotis*** is a herbivorous gastropod that lives attached to rocks and moves very fast, 5m. in a minute. They **possess a very large foot that dorsally bears a fold of the skin**, the **epipodium.** The epipodium is an appendage of the foot that **gives off numerous sensory epipodal tentacles**. ***Monodonta***, and ***Trochus*** are also examples of gastropod possessing epipodia as appendages of the foot and beset with tactile papillae that assist them in creeping.
- In some Gastropods, the foot shows partial regional modification e.g. in ***Pirulus*** only the **left part of the foot acts as the creeping organ**. In ***Atlanta***, the **posterior part of the foot is altered into a sucker**. In ***Bullia***, the foot is very peculiar as it **encircles whole of the body**. In ***Natica***, the **propodium forms a semicircular flap** and is demarcated from rest of the foot by deep transverse grooves. The **metapodium is provided with lateral parapodia in *Natica***. The **highly glandular foot** of ***Conus* with a long backwardly bent siphon** acts as an efficient creeping organ. ***Caecum*** is a peculiar gastropod that creeps entirely **by the action of the cilia present on the sole of the foot**.

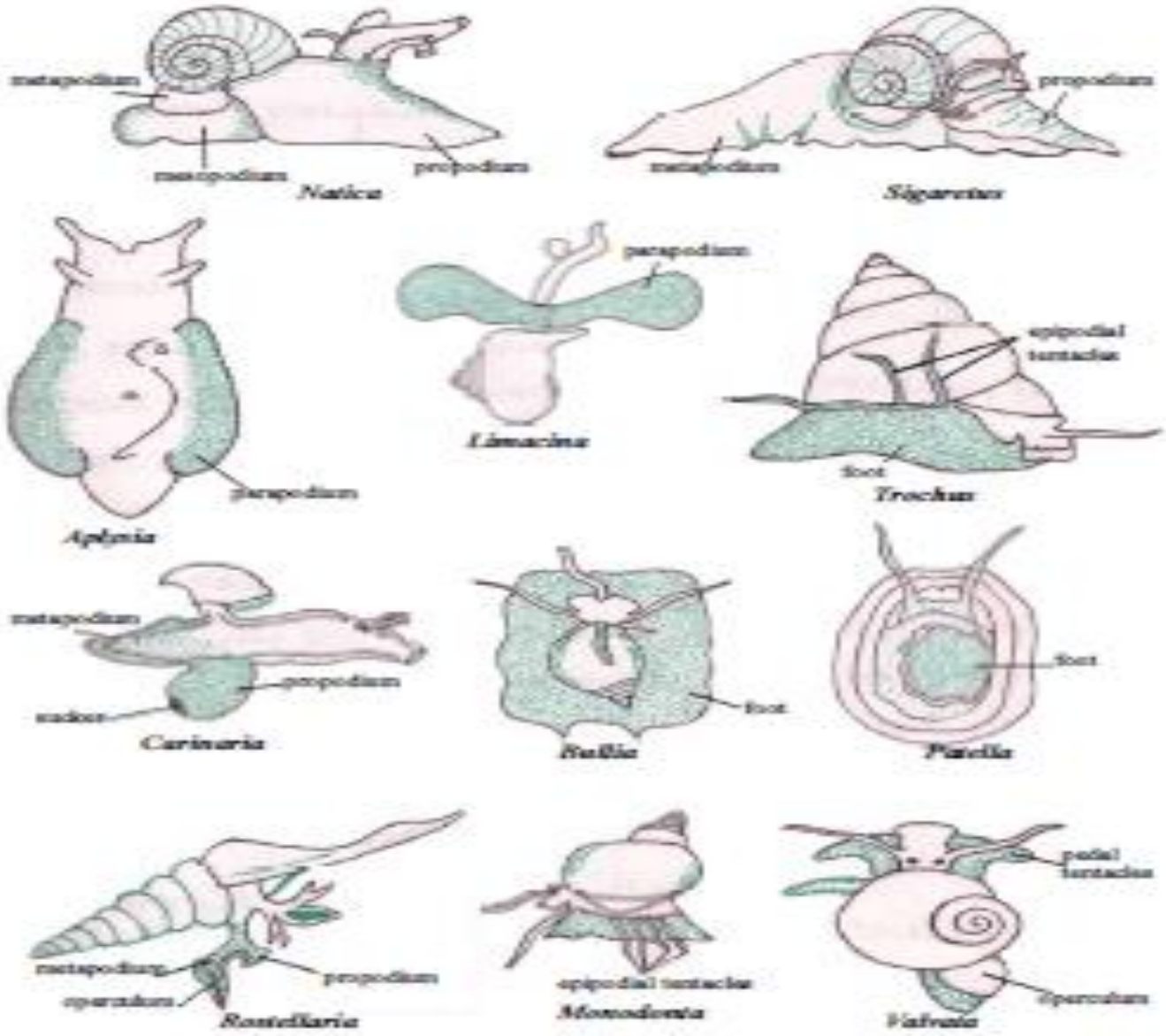


Fig.51 Foot in gastropods

CREEPING MOVEMENT:

- Creeping commonly occurs by **waves of muscular contraction that sweeps over the foot.**
- The sole of the foot is firmly attached to the substratum by the **mucus** which is sticky and gelatinous. In most of the gastropods, mucus is secreted by the **gland cells present in abundance on the sole of the foot**.
- However, in pulmonates, mucus is secreted by the **pedal gland** situated on the ventral foot.
- As the muscular wave of contraction is passed forward, the gelatinous mucus **liquefies in this region thus allowing the foot to move forward.**
- The muscular contractions may be **direct, i.e. passing forwards along the foot from behind or may be retrograde, i.e. passing backwards (anterior to posterior)** as is seen in most gastropods, particularly in prosobranchs **(refer *Pila*).**
- **The direct waves involve the contraction of the longitudinal and the dorsoventral muscles (from the posterior to the anterior end), while the retrograde waves involve contraction of the transverse muscles followed by the contraction of the longitudinal muscles (from the anterior to the posterior end).**
- The waves may be **monotaxic, i.e. a single series of waves traversing the foot, or ditaxic, i.e. distinct coordinated waves on the right and left halves of the foot i**s responsible for the snails movement. The amplitude of the waves however, is **small.**

- Bivalves like ***Anodonta and Unio*** have a laterally compressed **triangular and ploughshare like or hatchet shaped muscular foot for crawling and ploughing through mud**.
- Foot is actually the extension of the visceral mass. It is antero-ventral in position and ends ventrally in a keel.
- During locomotion, Unio **protrudes out its foot between the two valves of the shell and burrows like a plough-share through the mud or sand by the contraction of the pedal protractor muscles**. This results in the **flow of blood into the foot which swells up and becomes turgid and anchors the foot in sand or mud**.
- The blood is prevented from returning to the body by **sphincter muscle**.
- Now the **retractor muscles contract** and the body of Unio moves forward.
- During this action, the **blood is forced out of the foot and it becomes narrow**.
- Thus, by **alternate contraction and extension of the foot**, the animal slowly creeps or burrows.
- In Bivalves like ***Nucula,*** the foot shows a **primitive form,** possessing a flat ventral sole which is not for creeping. The foot is **laterally compressed and directed downward. The two sides of the foot can be folded together producing blade-like edge which is thrust into the sand or mud. The ventral sole then opens to serve as an anchor and the body is drawn down into the substratum.** In ***lepton*** and some other Bivalves, the foot **secondarily acquires a large free extremity with a creeping surface**.

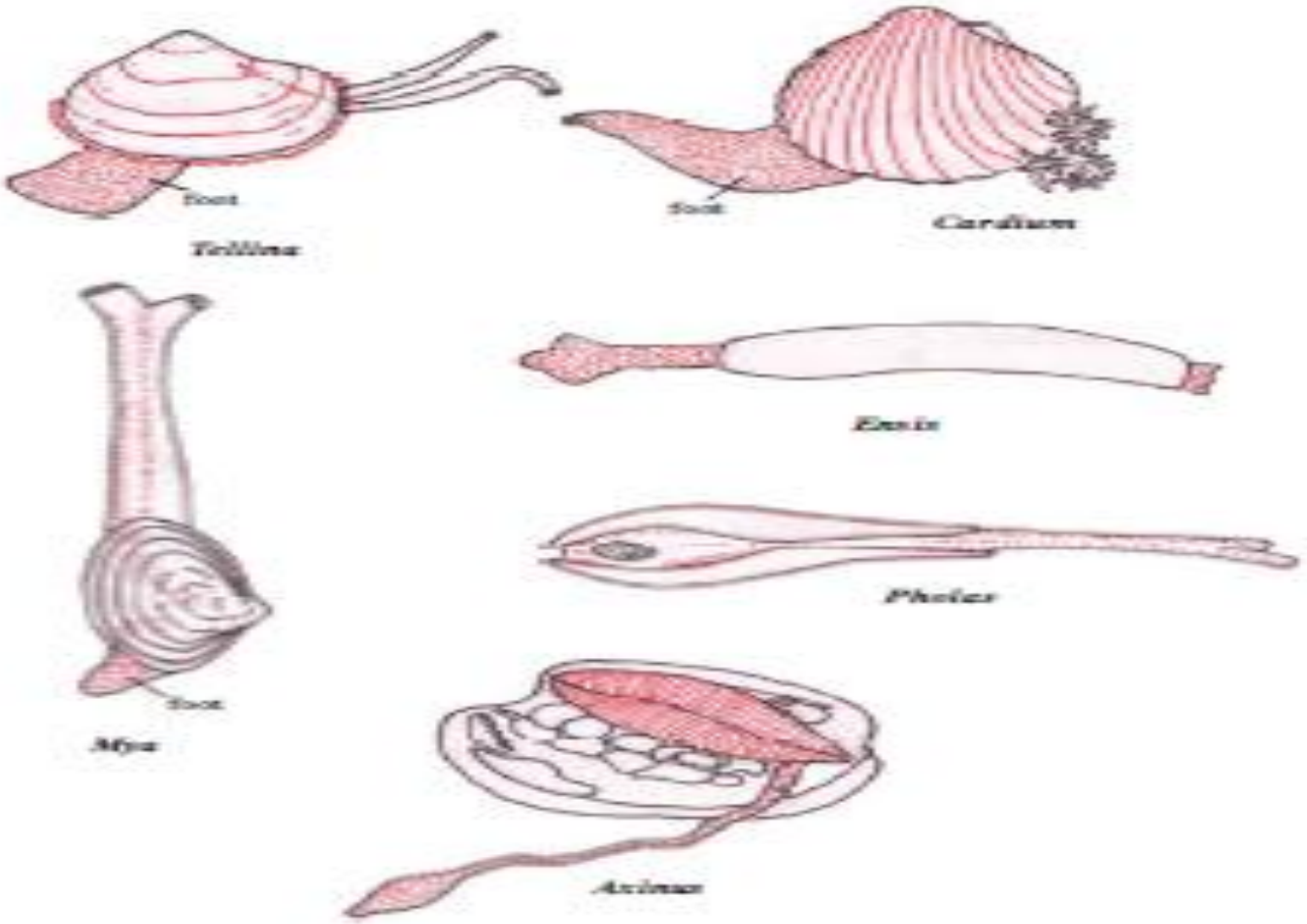
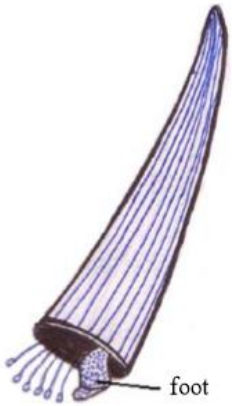


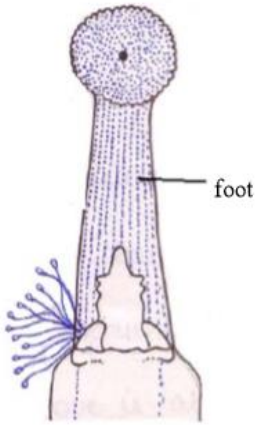
Fig.52 Foot in Bivalves

FOOT AS A BURROWING ORGAN:

- ***Dentalium*** (class Scaphopoda) has a **small conical, highly extensible foot adapted for digging and burrowing**. The foot in *Dentalium* and other scaphopods is **equipped with pedal haemocoel which acts as a hydrostatic skeleton for extending the foot into the sand**.
- In ***Siphonodentalium***, the foot terminates in a **retractile disc having papillae on the margins** and is well adapted for digging like *Dentalium.*
- The foot In ***Pholas*** (class Bivalvia) **assumes a short and blunt form, adapted for its burrowing habit**. The mantle is closed except for a **small pedal aperture** through which the small foot can be protruded out to grip the end of the burrow.
- The foot in ***Anodonta and Unio*** can perform the **function of burrowing in addition to creeping**.

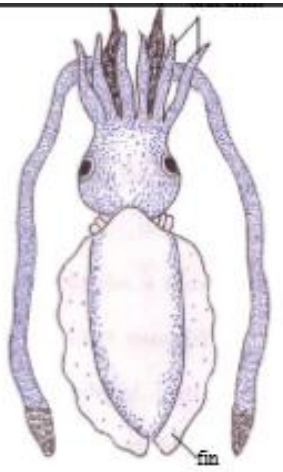


Dentalium



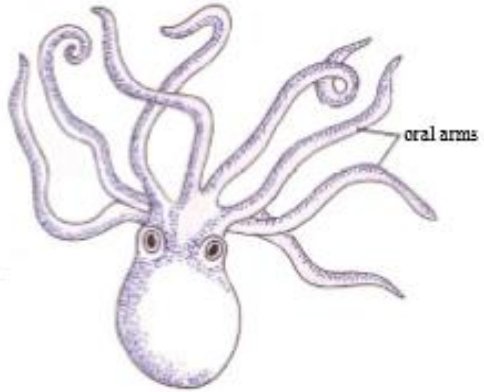
Siphonodentalium

Fig.53 Foot in Scaphopoda



Sepia

Loligo



Octopus

Fig.54 Foot modified into arms in Cephalopoda

- ***Solen and Ensis*** (class Bivalvia) have a **large, cylindrical and powerful foot that protrudes out from the anterior end of the shell and is used as a burrowing organ**. The *Solen* burrows like *Unio*, but very quickly. They can dig about 30cm. in sand in a few seconds. They can also **swim forward in jerks** by suddenly withdrawing the foot and squirting out water through the siphons.
- In fast burrowers like ***Tellina***, the **foot is large and can be stretched out into a wide sheet of muscle as thin as a blade of a knife** as it burrows in the sand.
- In ***Mya*** (soft-shell clam) the foot is **feebly developed and is used as a weak burrowing organ**.
- ***Sigaretus*** (class Gastropoda) is a burrower and the **propodium is well developed** and sharply marked off from the mesopodium to **act as a digging organ**. A dorsal flap-like fold of foot covers the head as a protective, fleshy shield.
- ***Tenebridae***, a burrowing gastropod extends the anterior extremity of the foot with flow of blood, thus **forming an anchor as is seen in bivalves and scaphopoda**.
- In gastropods which crawl about in wet sand e.g. ***Oliva***, the propodium is **circular or disc-like modified for burrowing**.

FOOT AS THE LEAPING ORGAN:

- In ***Trigonia and Cardium*** (class Bivalvia) the foot is bent upon itself and **when the foot suddenly straightens it violently lifts the animal off the ground in a powerful leap**.
- In ***Trigona*** the foot is **compressed antero-posteriorly as an elongated keel.**
- ***Mytilus*** (class Bivalvia) has a cylindrical foot that acts as a **spring tail.** ***Mytilus*** remains attached to the substratum by a **bunch of byssus thread.**
- In gastropods like ***Rostellaria*****, the foot is reduced**, and the **operculum becomes sharp like a dagger**. The metapodium is not sharply marked off from the rest of the foot.
- As the animal **digs into the sand, the reduced hook-like foot becomes flexed pulling the animal forward in short sharp leaps**.

FOOT AS A LOOPING ORGAN:

- In ***Pedipus***, the **propodium is sharply marked off** from the rest of the foot by a groove that helps in the looping movement.

FOOT AS A SWIMMING ORGAN:

- In many Molluscs, the foot becomes modified as a swimming organ.
- The foot of the swimming gastropods show several adaptive modifications. The common adaptation for swimming is the **development of parapodia as lateral lobes of the foot which acts as fins**, for example, in ***Oxygyus and Atlanta*** (class gastropoda), the **propodium is fin like, the mesopodium bears a sucker and the metapodium is produced into a laterally flattened swimming lobe**. The shell is laterally compressed and produced into a sharp keel.

✓ ***Carinaria*** too is a pelagic, marine gastropod where the **foot is modified into a fin like swimming organ**, its sole forming an adhesive sucker. The shell and metapodium are reduced in *Carinaria*.

✓ In ***Pterotrachea***, the **metapodium loses the operculum and becomes reduced to a short, filament like tail for swimming**.

✓ ***Creseis*** , the sea butterfly is a small marine gastropod adapted for pelagic life. The foot develops a **pair of large lateral parapodia that functions as fins for swimming**.

✓ ***Spiratella*** is a pelagic gastropod that **swims by flapping the parapodia**. The foot develops anteriorly into **highly muscular wing like projections called the parapodia** while the posterior part of the foot is greatly reduced.

✓ ***Aplysia*** possesses a broad, muscular and ventral foot that bears a **pair of lateral fleshy fan-like outgrowths, the parapodia which help in swimming**. The posterior part of the foot is usually adhesive and gives rise to a very short and distinct tail. Swimming in *Aplysia* is achieved in **short bursts by the rhythmic waves which pass along the parapodia**.

- ✓ In **shelled pteropods** or sea-butterflies, broad **wing like or oar-like parapodia** confined to the anterior part of the body, form the largest part of the foot. For example, ***Limacina*** swims spirally upwards using the parapodia as oars and drops down by holding them motionless over the head. **Naked pteropods** are the fastest swimmers among gastropods and rapid sculling motion is brought about by the parapodia which are present on the ventral side.
- ▪ The foot is greatly reduced in ***Pecten,*** a marine bivalve. It swims by **clapping of the shell-valves**.
- ▪ In **Cephalopods** foot is partly modified into a funnel lying below the head and partly into sucker bearing arms or into tentacle bearing lobes surrounding the mouth.
- ✓ They are eight in *Octopus,* ten in *Loligo* and *Sepia.* The fifth pair of arms in *Loligo* and *Sepia* are long, slender and prehensile and are called tentacles bearing suckers only at their expanded ends .
- ✓ Loligo is very active and can swim both forward and backward with the help of fins and funnel.
- ✓ Octopus, the devil-fish inhabits all the seas and closely resembles squids and cuttlefish. They possess eight arms which are alike and slightly webbed at the bases. Each arm bears two rows of sessile suckers. Fins are absent in them.
- ✓ Both *Sepia* and *Octopus* dart quickly by forcing out jets of water through the funnel. Sepia also swims about gently by undulating movements of the fins.
- ✓ ***Amphitretus*** is an inhabitant of deep sea and the arms are united by a web-like fold, the **interbrachial membrane**.
- ✓ **Female of *Argonauta***, the paper nautilus usually keeps her trunk in the shell, and when disturbed completely withdraws into it. She **sails in the shell, propelling it with her arms**. She has one of her arms flattened and expanded at the ends for the secretion and support of the shell. The **male Argonauta** is a **coinhabitant** of the females shell.

FOOT AS AN ORGAN HELPING REPRODUCTION:

- ✓ **In some cephalopods**, during the breeding season, **one of the arms in males is modified into an intromittent organ for the transference of sperm** and is known as the **hectocotylised arm**. In **male *Octopus***, the third right arm is modified into a spoon-shaped **hectocotylized arm**.

ACCESSORY ORGANS ASSOCIATED WITH THE FOOT:

- ✓ The foot in Molluscs is also a **highly glandular organ**.
- ✓ Some glands are present on the foot that help in locomotion. The **secretions of the glands lubricate the passage during movement** e.g. the pedal glands and the mucus secreting glands of the gastropods.
- ✓ In some bivalves, the adult or even the larva possesses a **byssus apparatus** which helps the animal **in adhesion to the substratum**. The foot in these animals is much reduced.
- ✓ The byssus gland may be considered **homologous to the pedal mucus secreting glands** of the gastropods.
- ✓ ***Mytilus*** is a common bivalve which remains attached to the rocks by byssus threads. These **byssus threads are secreted by the byssus glands** in the posterior groove of the much reduced foot.
- ✓ As the secretion of the gland passes out through the aperture, it hardens on contact with the water forming **tough, bundle of silky threads which anchors the animal firmly to the substratum**.
- ✓ The '**Organ of Valenciennes' in some cephalopod females and 'Van der Hoeven' in Nautilus males are some of the accessory organs** associated with the foot.

Thank you