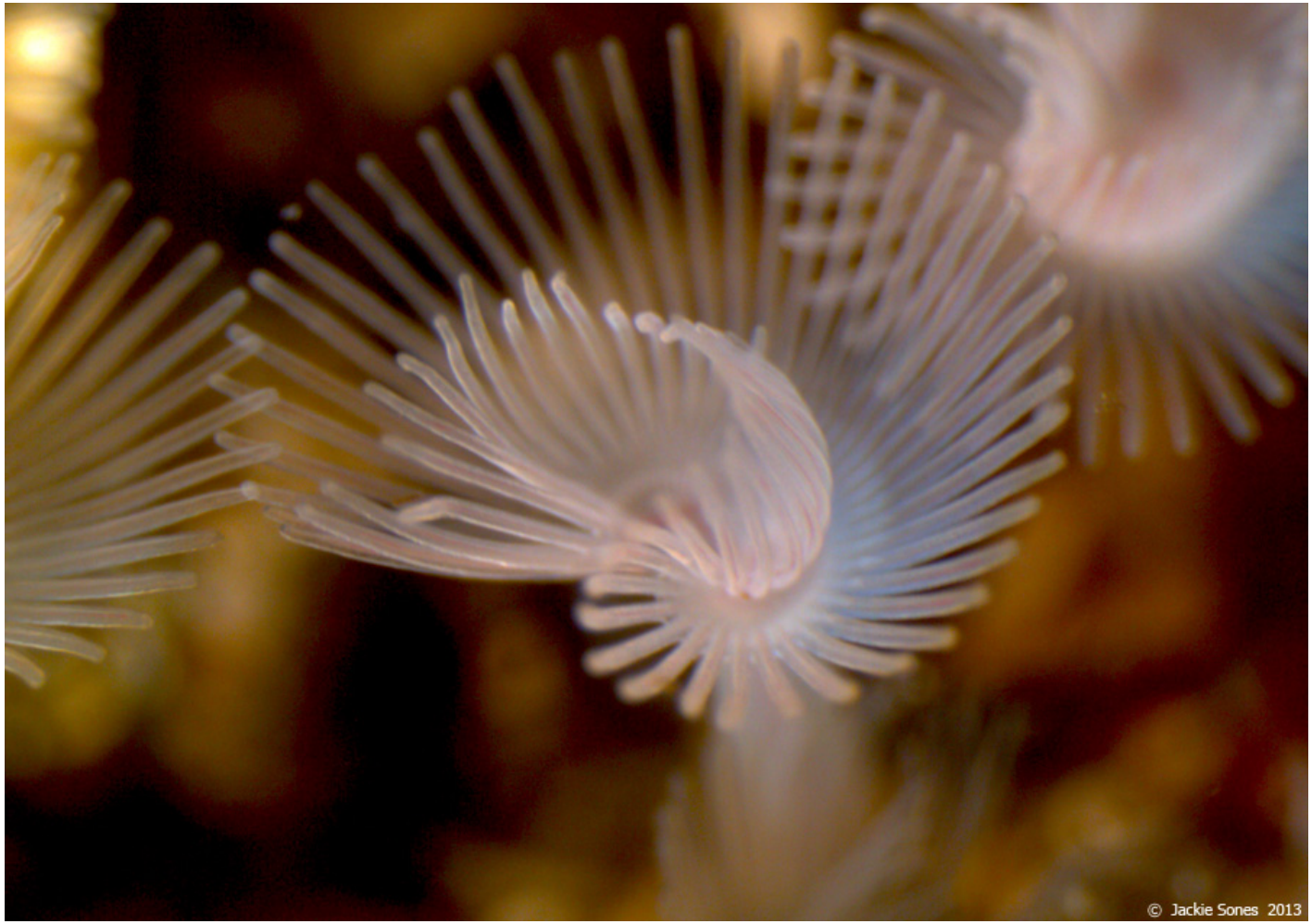
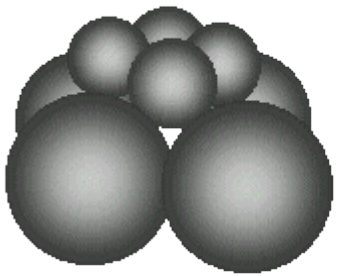
Lecture Lophophorates

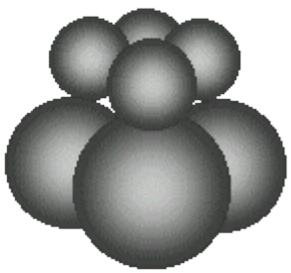


V • T • E	Extant phyla of kingdom Anima				
Domain: Archaea · Bacteria · Eukaryota · (Kingdom: Plant · Hacrobia · Heterokor					
Parazoa	**Porifera** (Calcarea · Demospongiae · Hexactinellida) · Placozoa (*Trichoplax*)				
Mesozoa	Orthonectida · Dicyemida · Monoblastozoa *dubious*				
Eumetazoa	**Radiata**	Ctenophora · **Cnidaria** (Anthozoa · Hydrozoa · Scyphozoa · Cubozoa · Staurozoa · Myxozoa · Polypodiozoa)			
	Bilateria	**Protostomia**	**Ecdysozoa**	**Scalidophora**	Kinorhyncha · Loricifera · Priapulida
				Nematoida	**Nematoda** · Nematomorpha
				Panarthropoda	Onychophora · Tardigrada · **Arthropoda**
			Lophotrochozoa (Spiralia)	**Platyzoa**	**Platyhelminthes** · Gastrotricha
					Gnathifera Rotifera · Gnathostomulida · Micrognathozoa
				Trochozoa	Nemertea · Sipuncula · **Mollusca** · **Annelida** · Phoronida · Brachiopoda
				Polyzoa(?)	**Bryozoa** · Entoprocta · Cycliophora
		Deuterostomia	**Ambulacraria**	**Echinodermata** · Hemichordata	
			Chordata (Craniata (Vertebrata · Myxini) · Cephalochordata · Tunicata)		
		Basal/disputed	Chaetognatha · Acoelomorpha (Acoela · Nemertodermatida) · Xenoturbellida		

Spiralia is applied to those phyla that exhibit canonical spiralian cleavage.



Spiral Cleavage



Radial Cleavage

All recent molecular studies support this version of protostomes

Spiralia: animals with spiral cleavage of their embryos

- **Platyzoa**: flatworms, rotifers
- **Polyzoa**: bryozoans, entoprocts, cycliphorans
- **Trochozoa**: animals with a **trochophore** stage
  - → annelids, molluscs, nemerteans, brachiopods

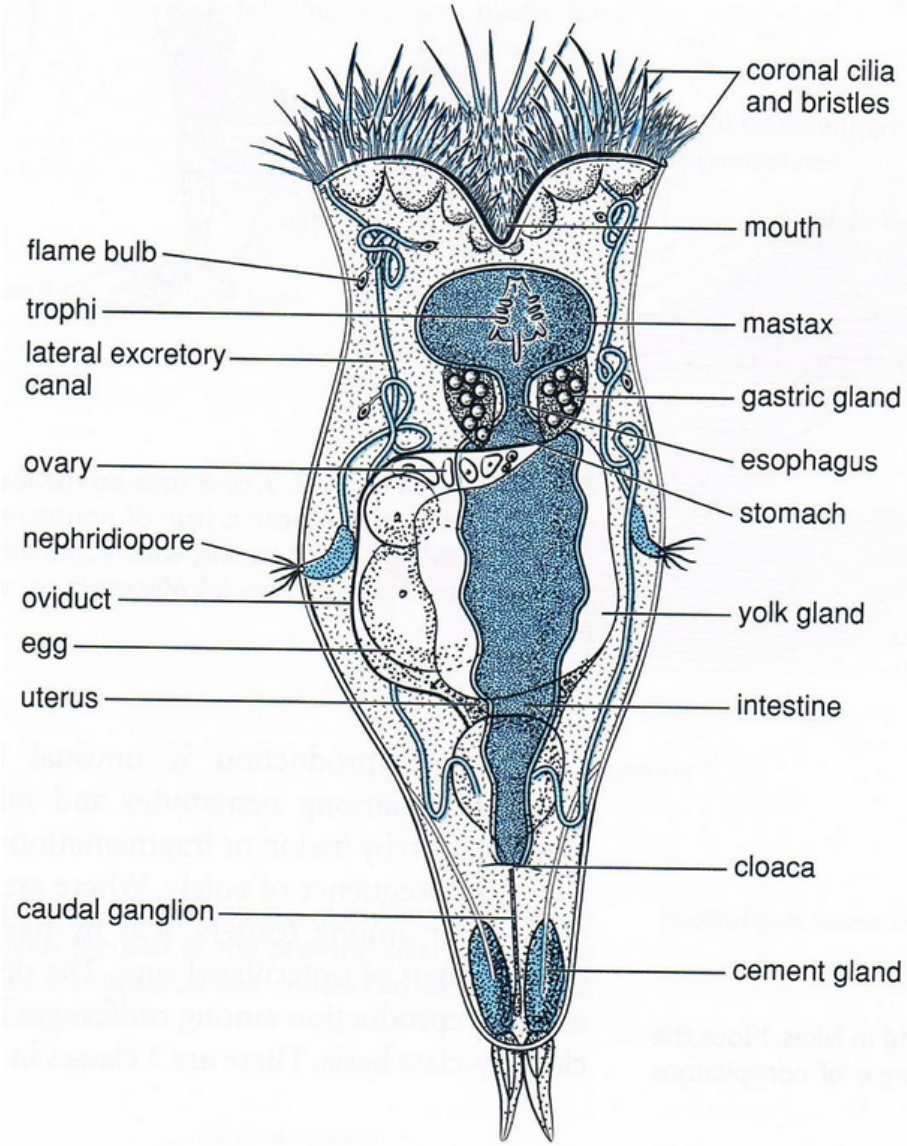
Ecdysozoa: animals with an external cuticle, that **molt** to grow

- → nematodes, arthropods, minor phyla

Phoronids
Chaetognaths
} placement uncertain; phoronids are probably trochozoans

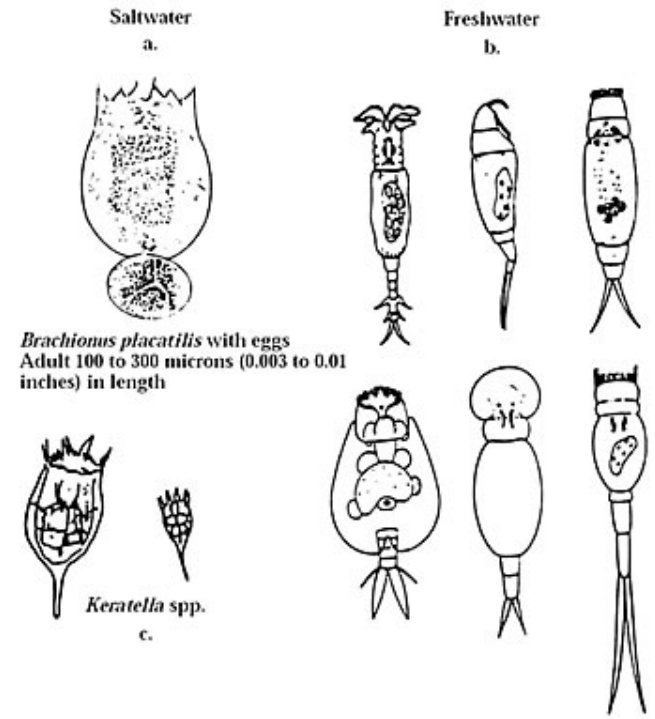
Its name from…

- The name rotifer came from the Latin word rota meaning wheel and ferre meaning ‘to carry’.
- When these animals are swimming or feeding the beating of their hair like fibers give the illusion that the animal carries two small rotating wheels.

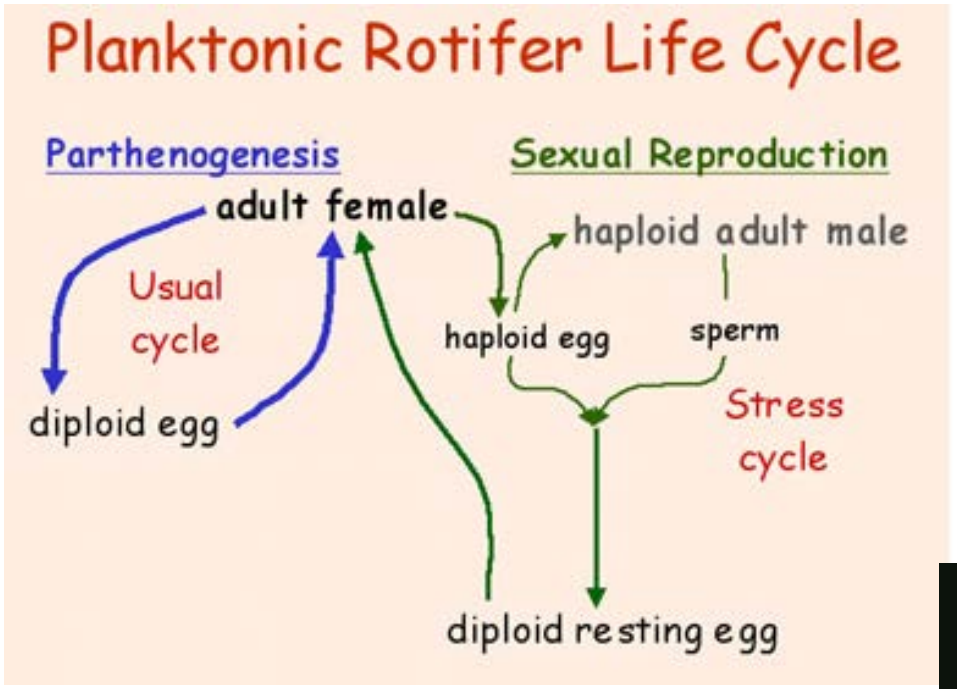


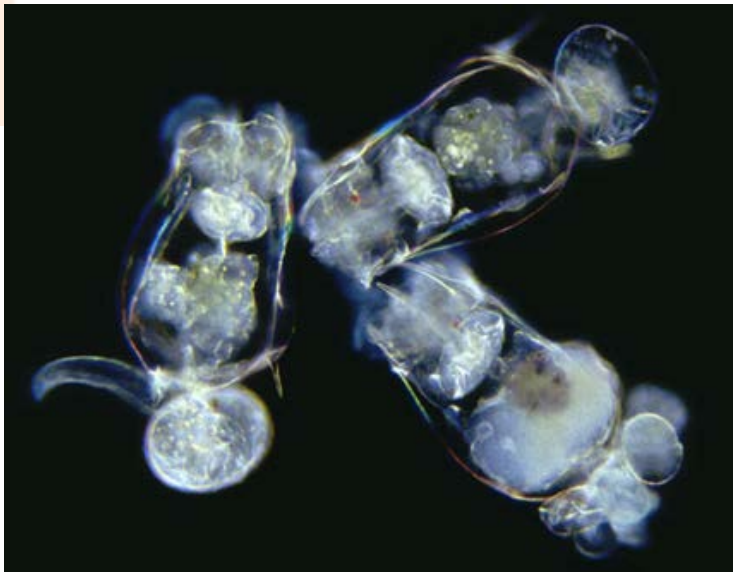
Habitat

- They live in freshwater some of the species live in freshwater
- Some are attached to plant stems while others swim through the water
- They live in moist sands along the shore and in the gravel of aquarium tanks
- They eat algae debris and other protists, bacteria and even other rotifers



Reproduction



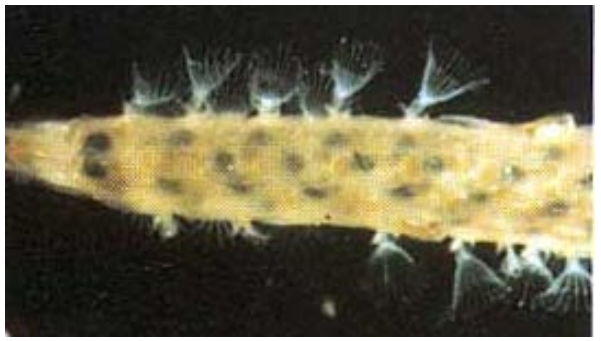


The “Lophophorates”

3 phyla that had an *apparent* synapomorphy (a trait that is shared by two or more taxa) : the lophophore, a horseshoe-shaped ring of ciliated tentacles surrounding mouth, used in filter feeding

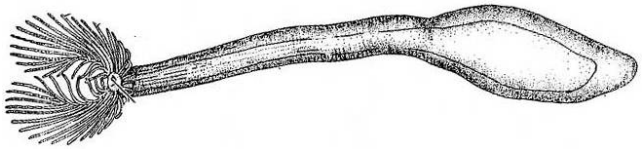
Phylum Bryozoa

- colonies made of microscopic zooids



Phylum Phoronida

- worm-like, tube-dwelling; large



Phylum Brachiopoda

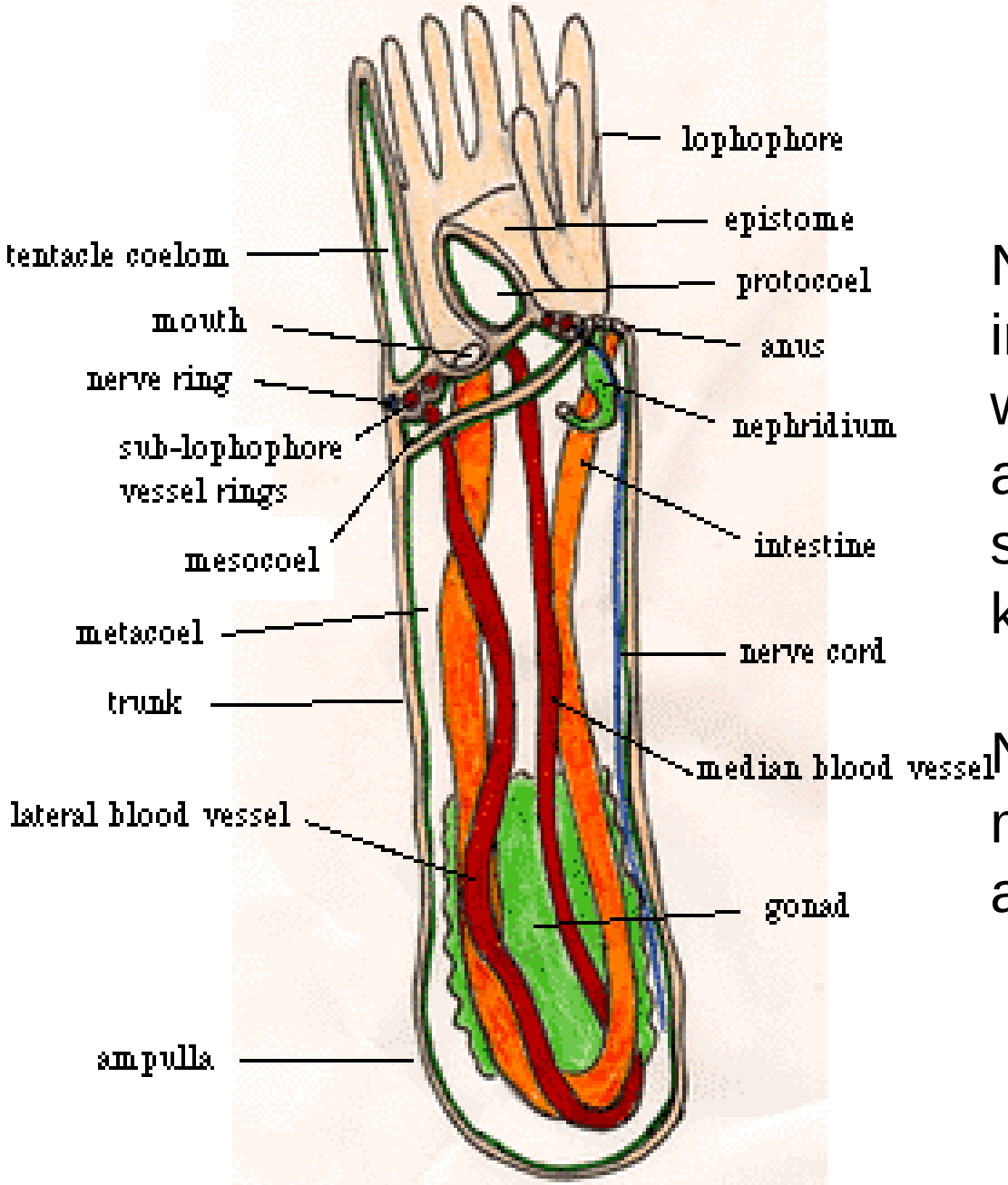
- 2 shell valves; large

Lophophorate characteristics

Body divided in 3 parts, each with its own coelomic space:

	Coelomic space	Body region
Anterior	**Protocoel**	**Prosome**
↕	**Mesocoel**	**Mesosome**
Posterior	**Metacoel**	**Metasome**

This 3-part body/coelom structure is typical of deuterostomes like us... probably an **ancestral feature** kept by deuterostomes and lophophorates, which changed in the **Spiralians**



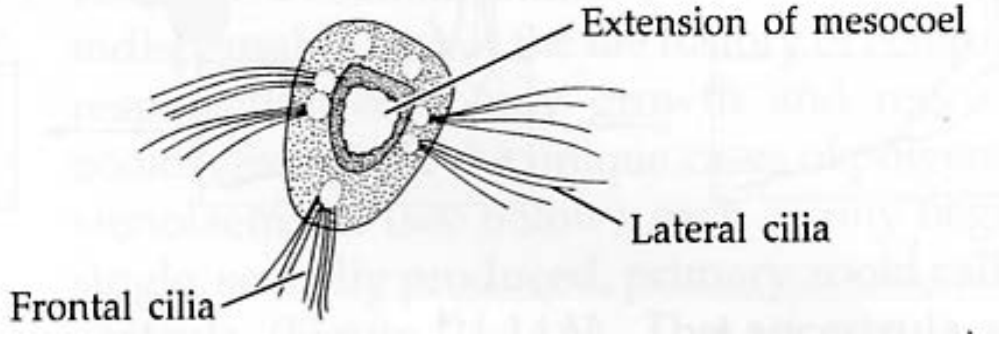
Nephridium is an invertebrate organ which occurs in pairs and performs a function similar to the vertebrate kidney.

Nephridia remove metabolic wastes from an animal's body.

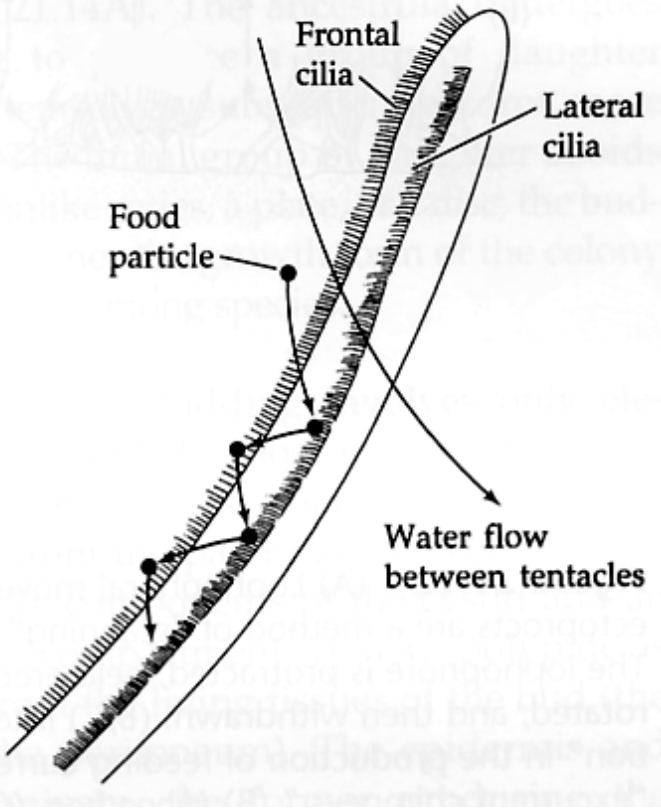
Lophophore Function

Cilia on lophophore tentacles generate a feeding current

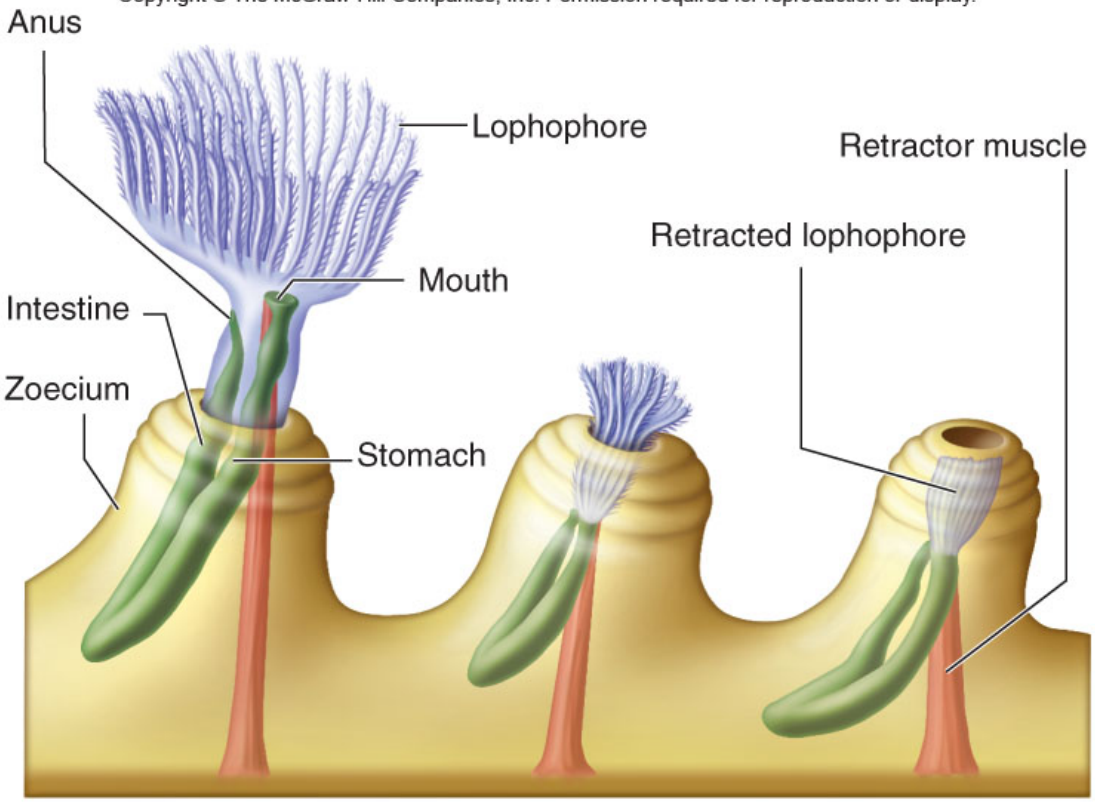
- cilia catch particles, bounce them back and forth to mouth



- each tentacle has 1 row of **frontal cilia** and 2 rows of **lateral cilia**



Phylum Bryozoa



a.

b.

Lophophorate phyla

- **Phoronida** (tube-dwelling marine worms) -unitary organism, tube dwelling with lophorate at upper end of body, only marine
- **Brachiopoda** (marine bivalves, mainly Paleozoic but some modern) –modular (colonial), zooids, polypide, marine and freshwater (statoblast)
- **Bryozoa** (=**Ectoprocta,** marine and freshwater, colonial)-unitary organisms, bivalved-shell is chitin and calcium phosphate, dorsal/ventral-most prominent in the Paleozoic--inarticulate, articulate

Phylum Bryozoa

Bryozoans are small and live in colonies

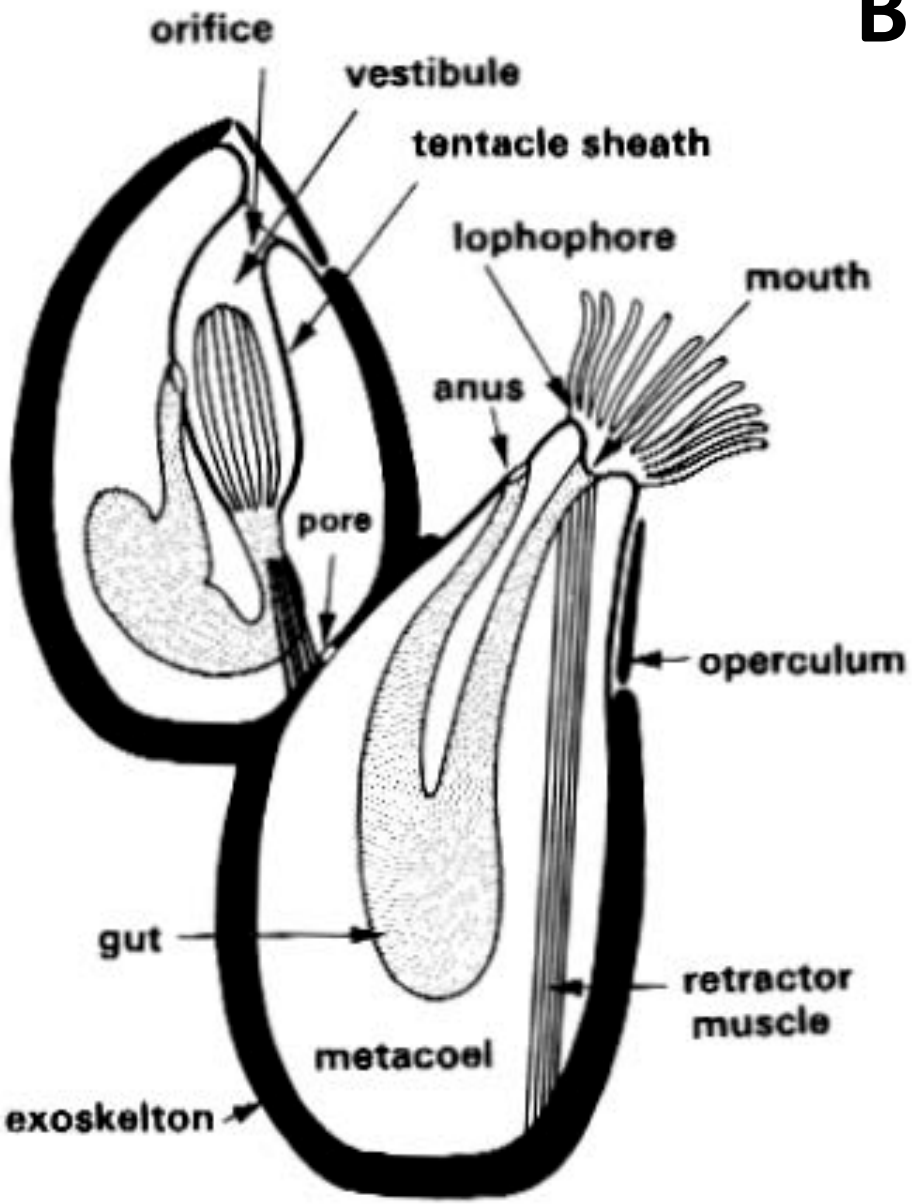
-Their anus opens near their mouth

-Phylum also called Ectoprocta (anus outside of mouth)

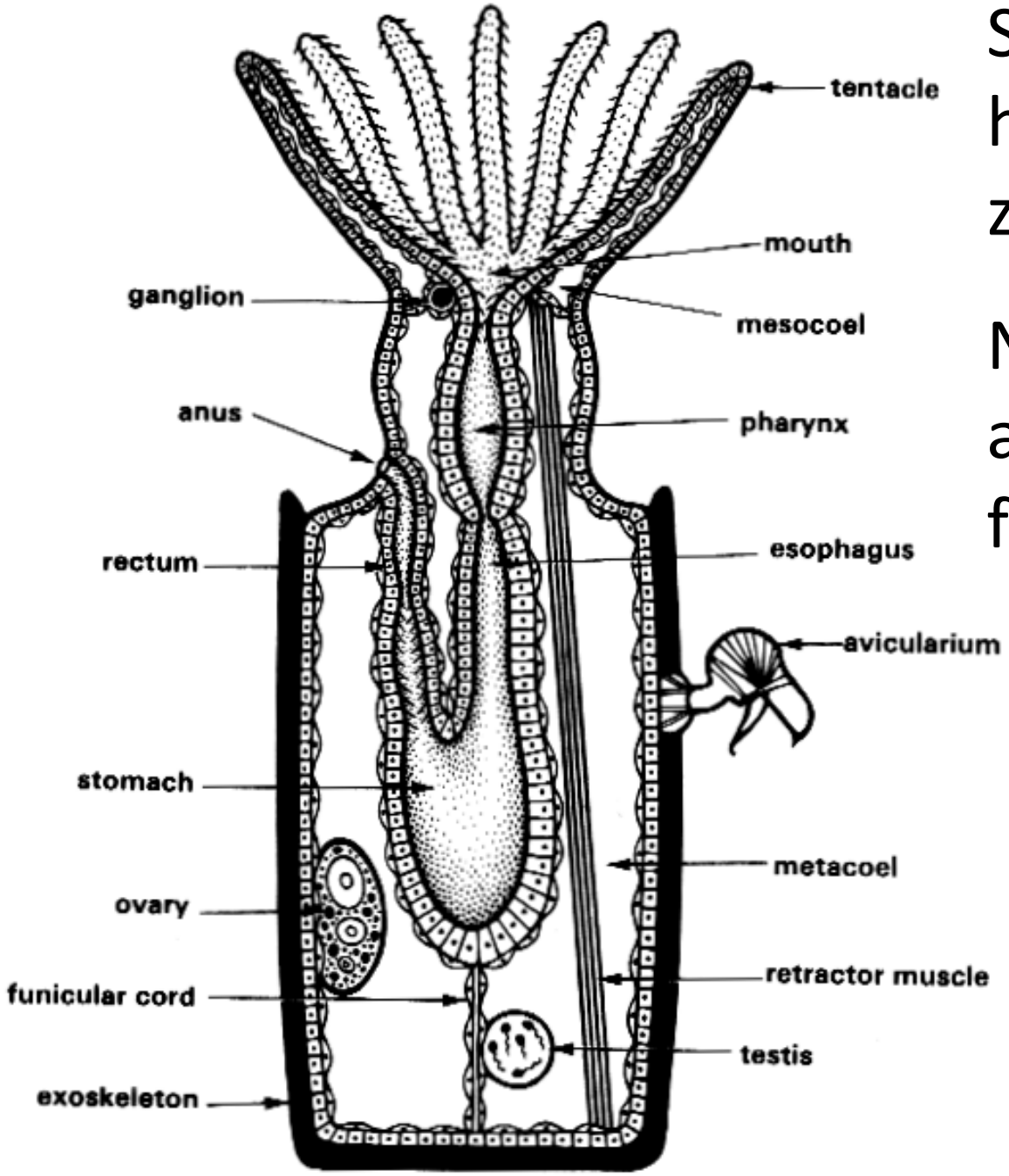
-Individuals secrete a tiny chitinous chamber called a zoecium \zō-ˈē-shē-əm\ used for attachment

-Asexual reproduction occurs frequently by budding

Bryozoan body plan

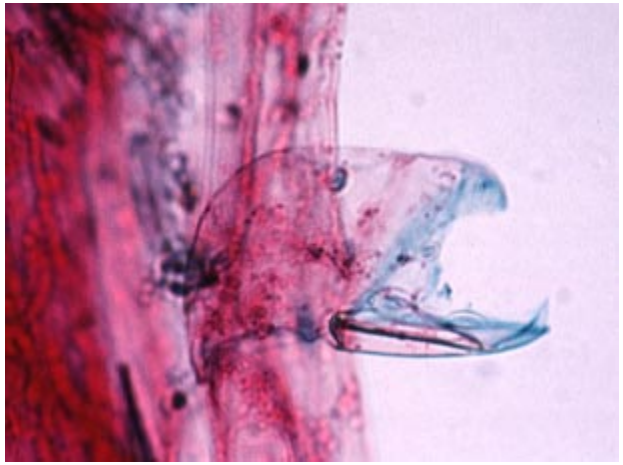


- Reproduction by budding yields colony of connected individuals (zooids)
- Anus outside the lophophore ("ectoproct")
- Calcified exoskeleton in many taxa
- Each zooid has its own compartment & operculum



Some Bryozoa have polymorphic zooids

Note the defensive avicularium (non-feeding zooid?)



Avicularia – giant claws used to defend colony

- polypide reduced to a few large muscles
  (polypide : The internal contents of a bryozoan; includes the digestive and muscular systems)
- claw is **modified operculum**
- prevents fouling by larvae + spores of other organisms

Bryozoan taxa

- **Phylactolaemata ("guarded throat"):** Freshwater, no zooid polymorphism, no calcification; form statoblasts (resting buds).
- **Stenolaemata ("narrow throat"):** Marine bryozoans with tubular zooids with calcified walls. Mostly extinct
- **Gymnolaemata ("naked throat"):** Mostly marine with cylindrical or flattened zooids in calcified exoskeletons. Includes most living bryozoans.

Phylactolaemata

Freshwater bryozoan *Lophopus*

Phylactolaemata *Pectinatella magnifica*

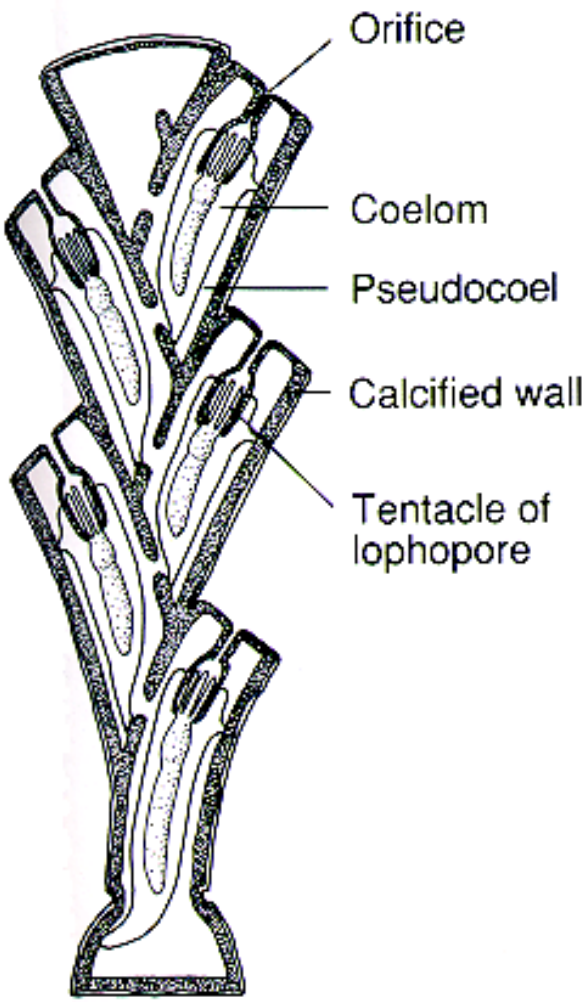
A single scoop ice-con, Yummy!

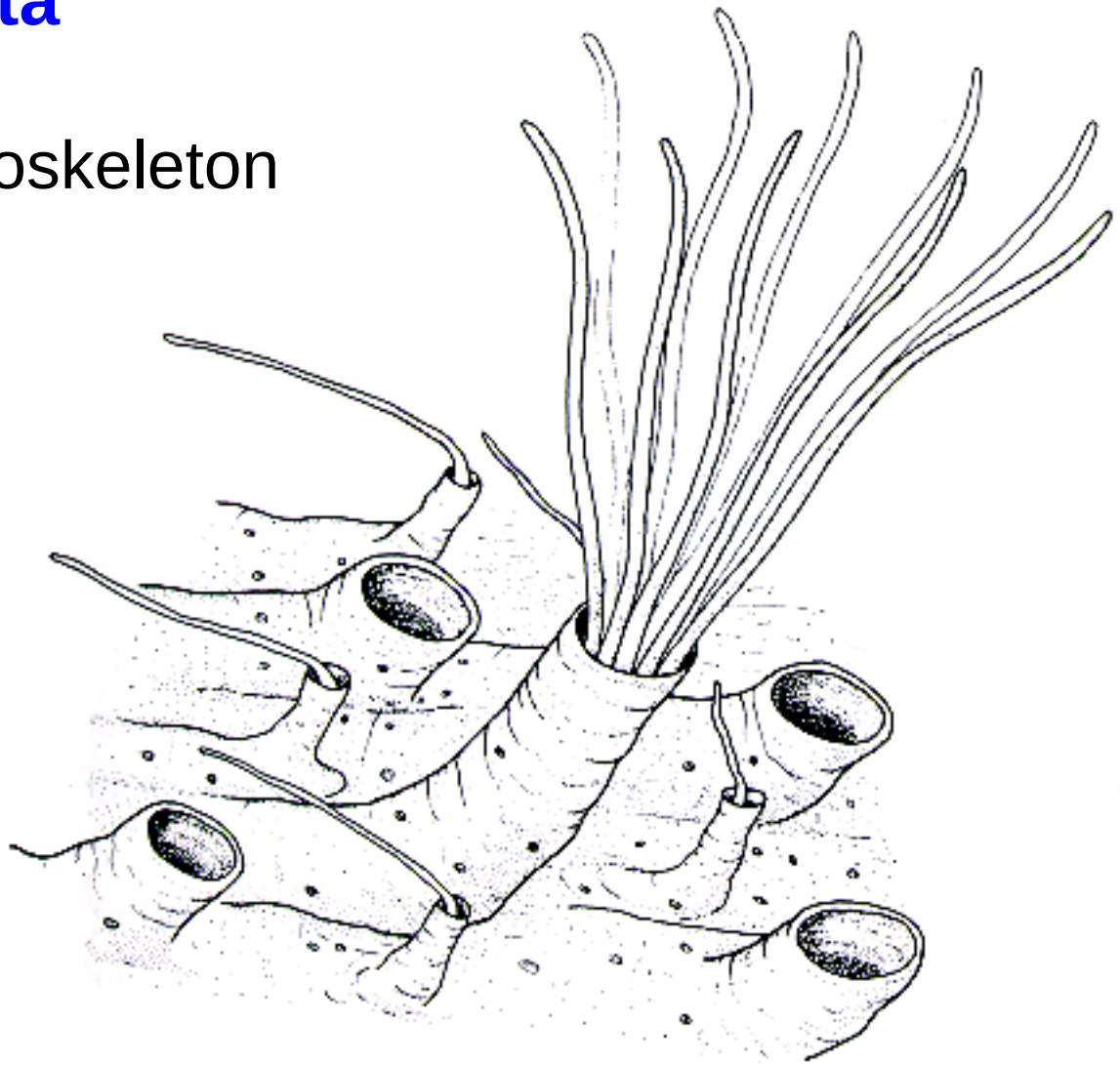
Everlasting air fern…the wonder plant

- Dried, painted marine bryozoan sold as a plant
- NO care needed- no soil, no water!

Class Stenolaemata

- most extinct
- tubular, calcified exoskeleton





Bryozoan Groups

Class Gymnolaemata

- zooids connected by **funiculus** (a coelomic link)

Order Cheilostomata

- openings covered by **opercula**
- embryos usually brooded in **ovicells**
- **avicularia**: claws function in defense

Order Ctenostomata

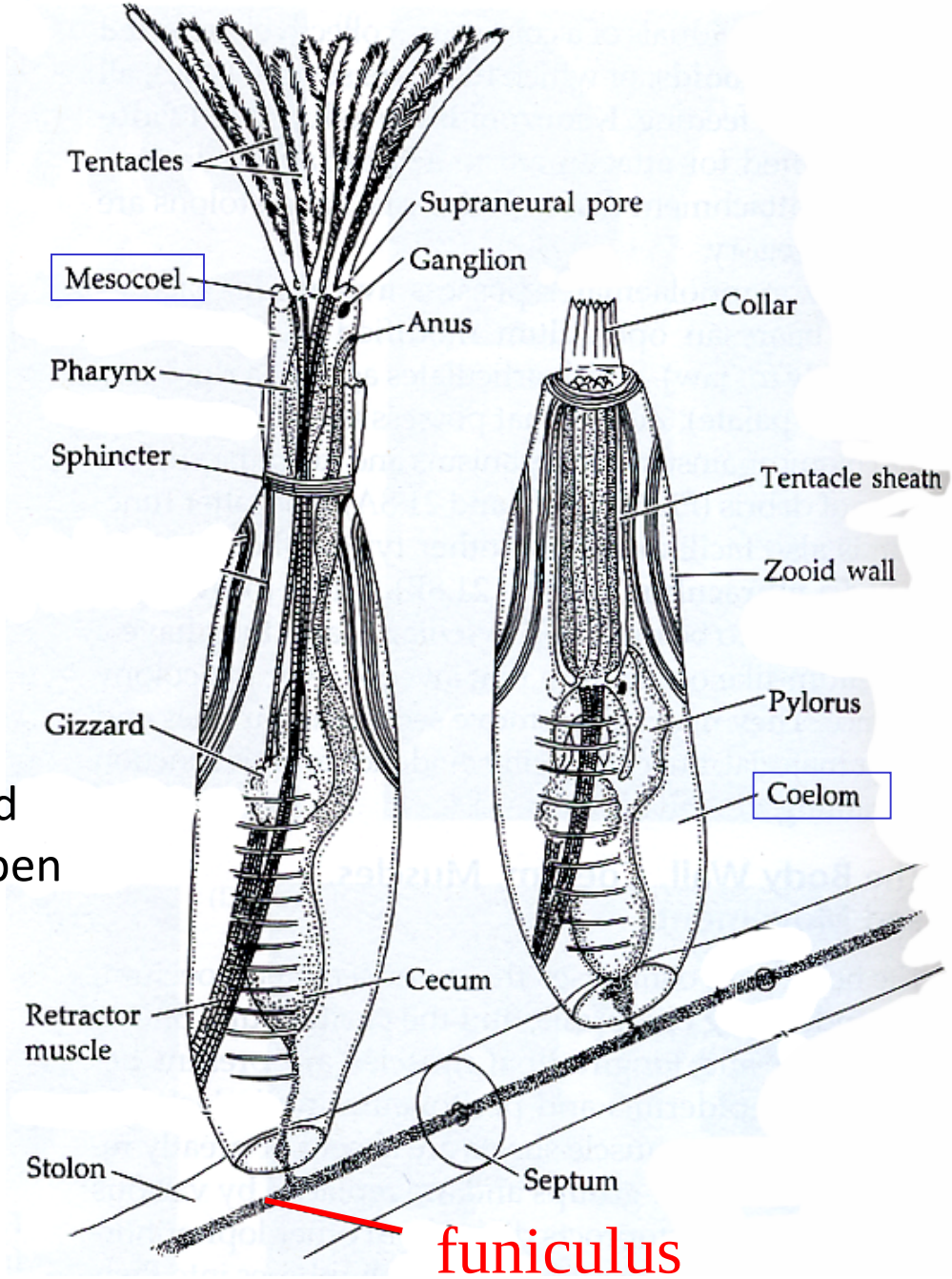
- cylindrical zooids, attached by stolon
- no operculum, ovicells or avicularia

Class Gymnolaemata

Order Ctenostomata

- cylindrical zooids
- flexible, chitinous exoskeleton
- zooids sprout from a horizontal runner called the stolon
- Gizzard : modified region of the stomach cardia incorporating chitinized teeth or plates surrounded by circular muscle, good ability to open frustules of some diatoms

Funiculus = coelomic connection between zooids (may even link stomachs)



Bryozoans are sister to a clade composed of **2 phyla** that were never even grouped as “lophophorates”

Platyhelminthes

Platyzoa

Rotifera

Polyzoa

Bryozoa

Cycliophora

Entoprocta

- based on molecular analysis of protein sequences

Phylum Entoprocta

150 species

- solitary or colonial filter feeders

- feed with anterior ring of ciliated tentacles, but anus opens **inside** the ring (ento = *within*, procta = *anus*)

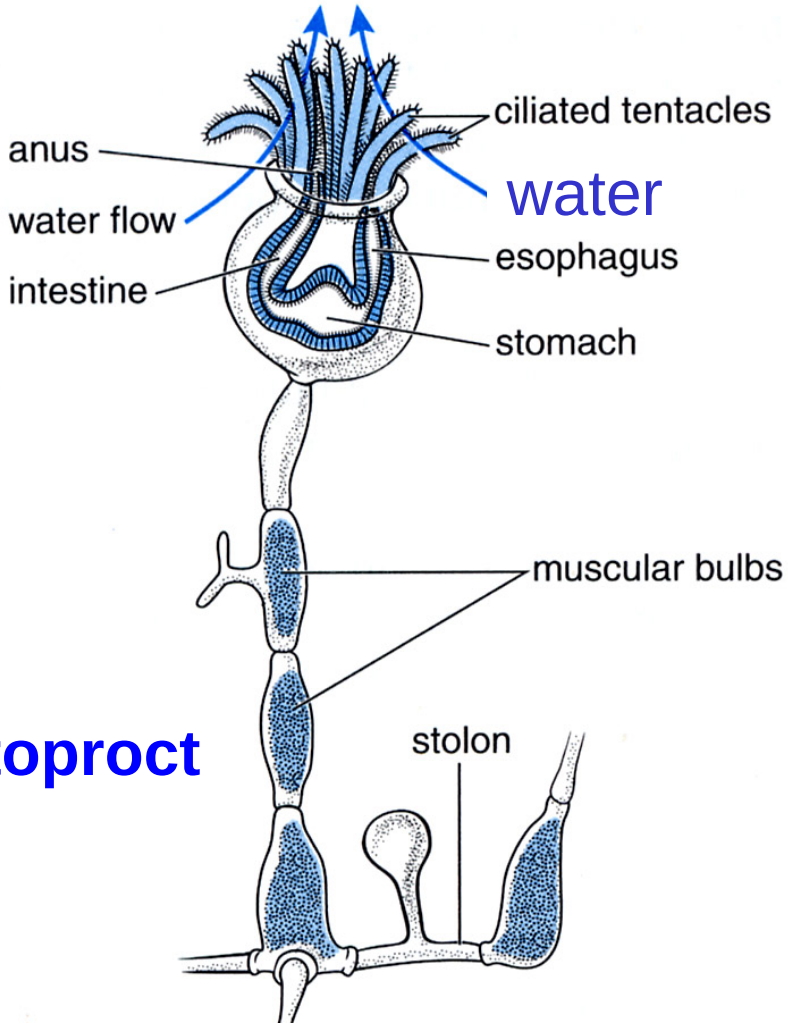
- no blood vessels, U-shaped gut

- **spiral, determinate embryonic cleavage** (typical protostome kind)

- some species have trochophore-like larvae

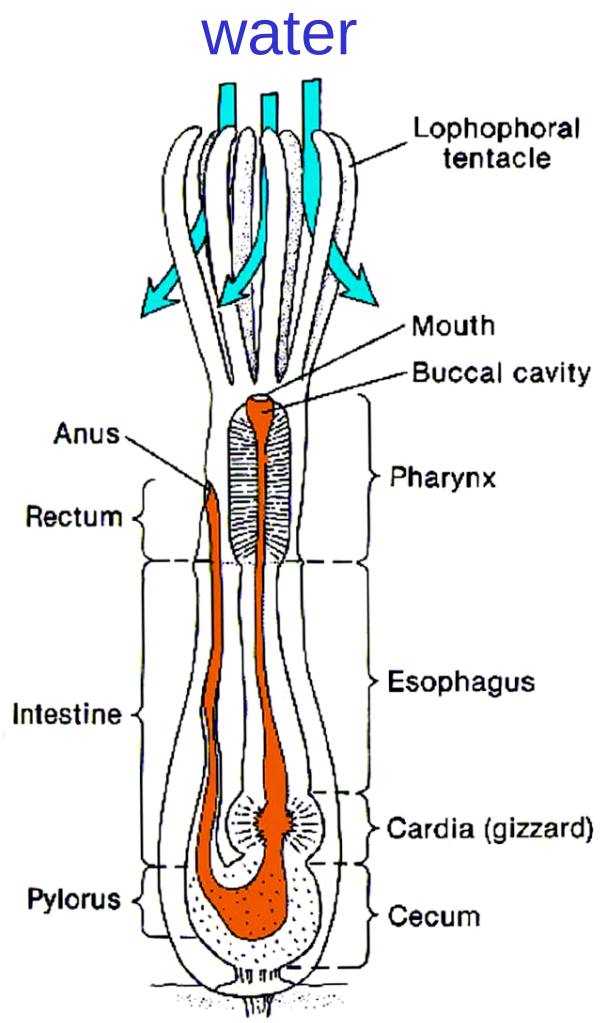
→embryos + larvae are like other protostomes, adults are like bryozoans.. close relatives that develop quite differently

water moves through the ring of ciliated tentacles in the opposite direction of lophophore flow



Entoproct

Lophophorate



Phylum Entoprocta

family Pedicellinidae

Barentsia benedeni

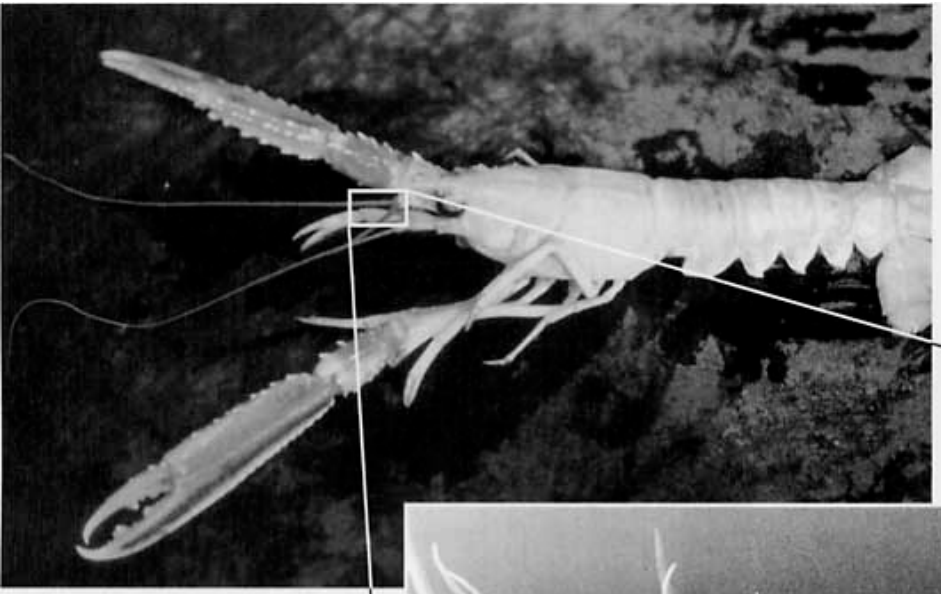
developing larvae may be found attached to inside of calyx

calyx, with fringe of tentacles

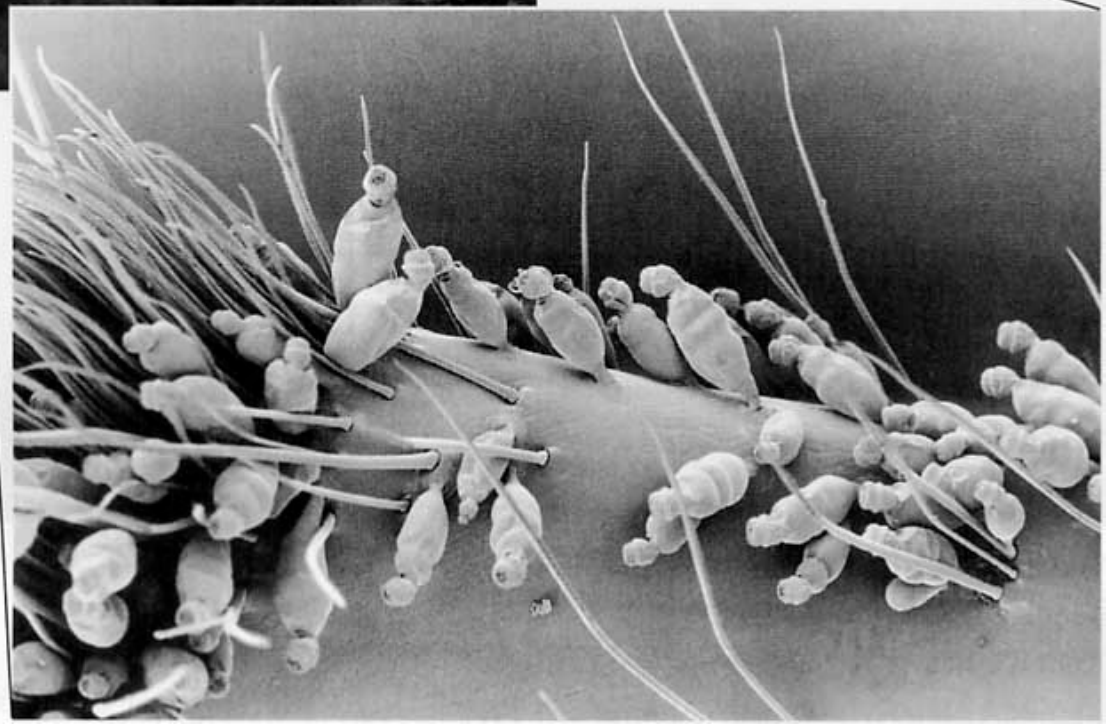
stalk may have up to 12 **joints** on older individuals

Phylum Cycliophora

~5 species

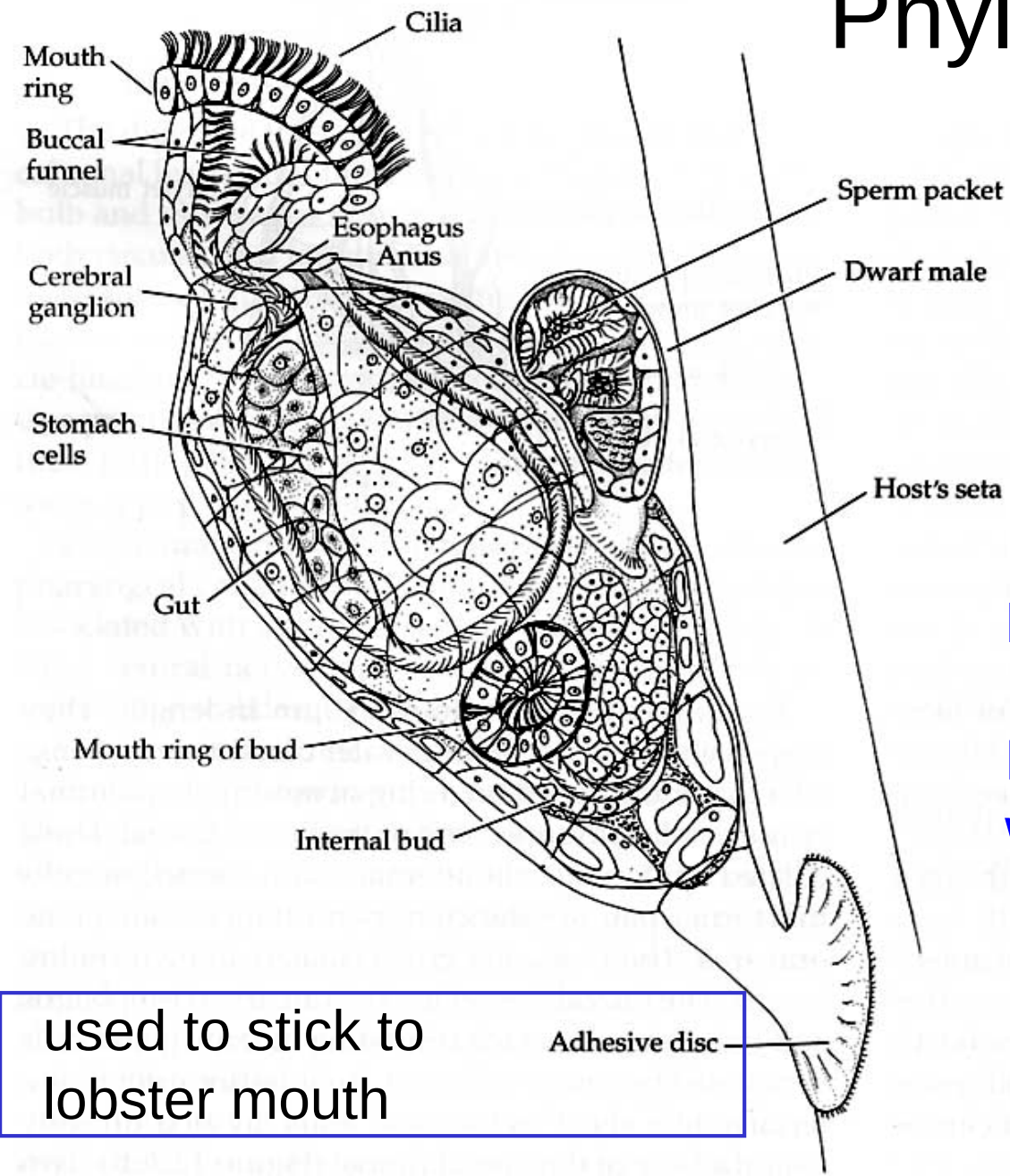


Close-up of mouthparts of Norwegian lobster, showing…



Symbion pandora

Phylum Cycliophora



First reported in 1995

Entire phyla are still waiting to be discovered

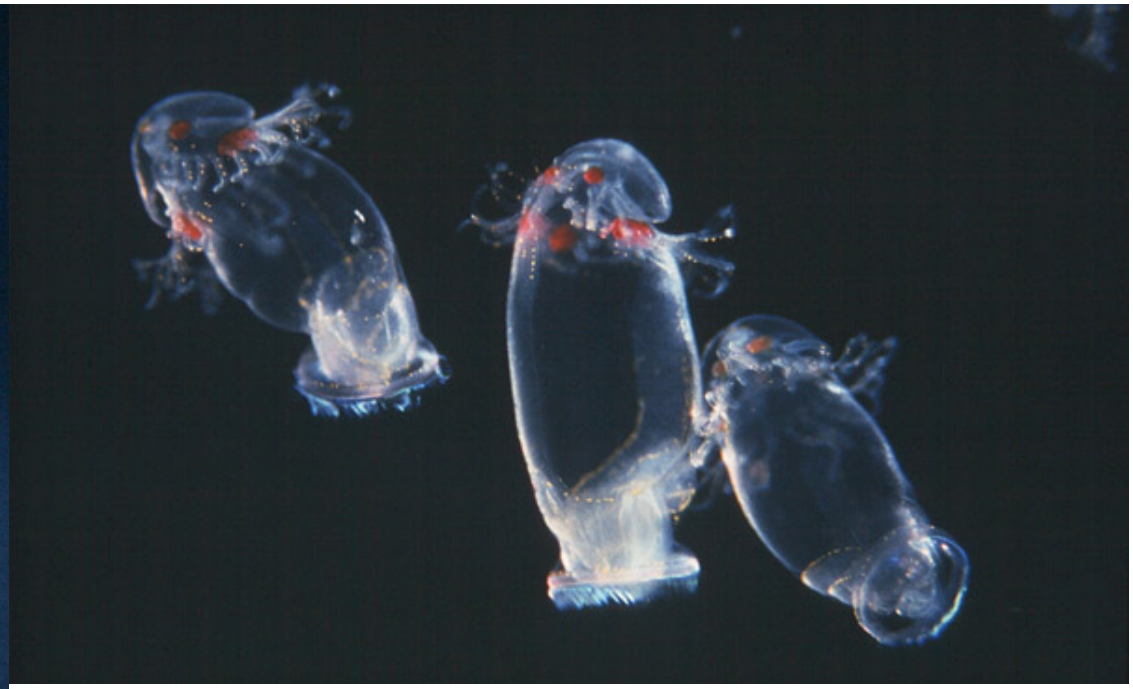
used to stick to lobster mouth

Phylum Phoronida

2 genera
14 species

- worm-like body inside a **chitin** tube
- body has a flappy (loose) **prosome**, **mesosome** w/ lophophore, and an elongated trunk (**metasome**)
- U-shaped gut; mouth and anus very close together
- 1 pair of metanephridia, **closed** circulatory system
- gonads simple, temporary; separate sexes or hermaphrodites
- **blastopore becomes mouth** (protostome character)
- unique **actinotroch** larvae

Actinotroch larvae



- distinctive flattened head, body ringed with fat tentacles

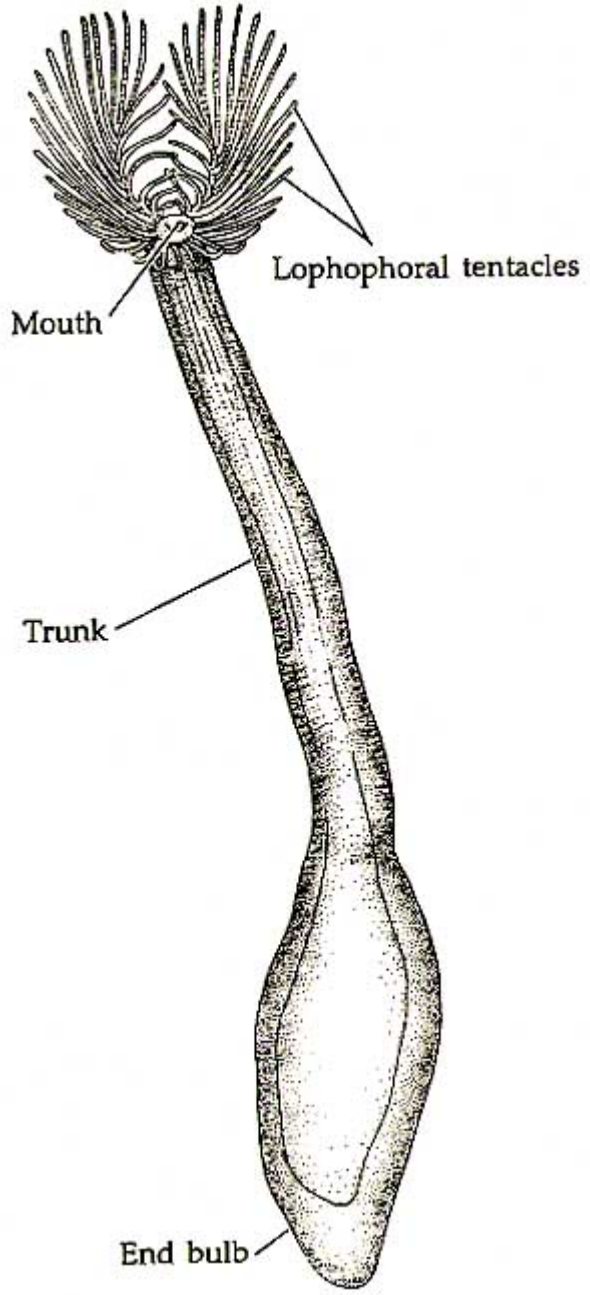
- ring of cilia at base of body

Phylum Phoronida

- Called “horseshoe worm”
- lophophore is a double row of tentacles
- each tentacle contains blood vessel for gas exchange, extension of coelom

- food particles brought into ring by current; then trapped in mucus lining food groove

- gametes proliferate in **metacoel** of trunk, released through nephridia (excretory gland, kind of kidney), or ruptured out of tentacle ends



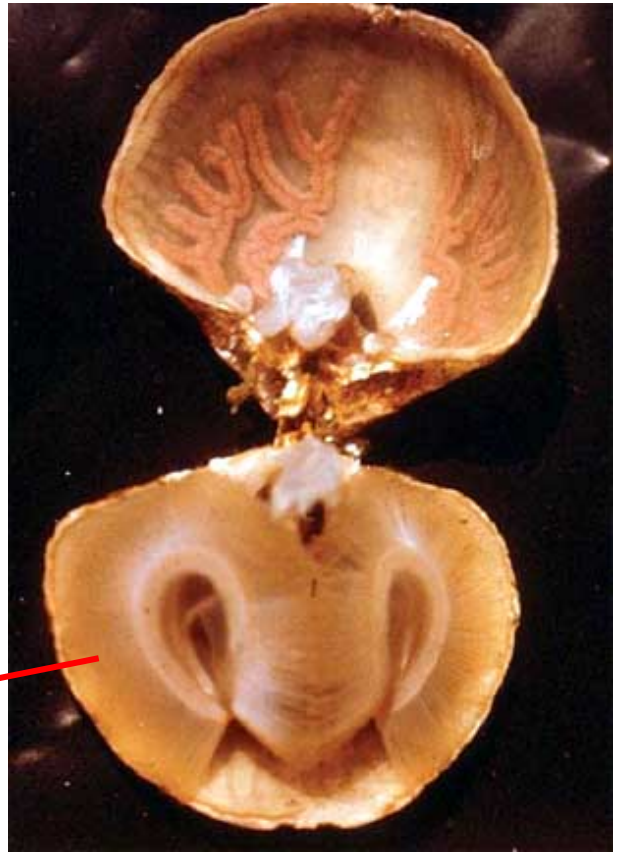
Phoronis vancouverensis

Few species = not evolutionarily successful

Can be very **ecologically** important, however; tubes can form dense aggregations on local mudflats, creating habitat

Phylum Brachiopoda

"brachiopod" is formed from the Ancient Greek words βραχίων ("arm") and πούς ("foot"). They are often known as "lamp shells"



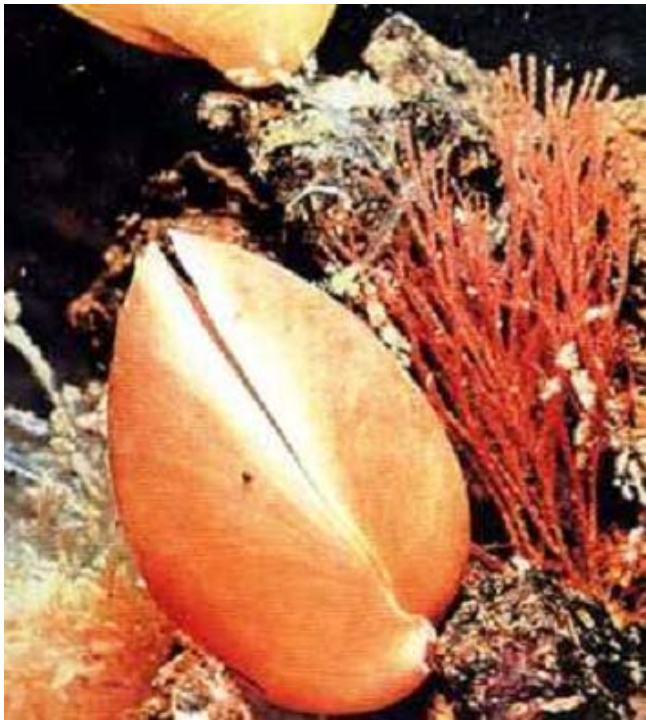
valves house lophophore inside mantle cavity

Phylum Brachiopoda

350 living species

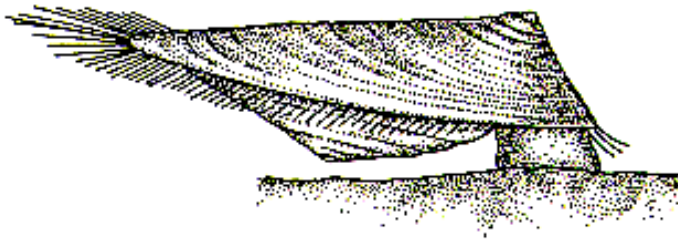
30,000 fossil species

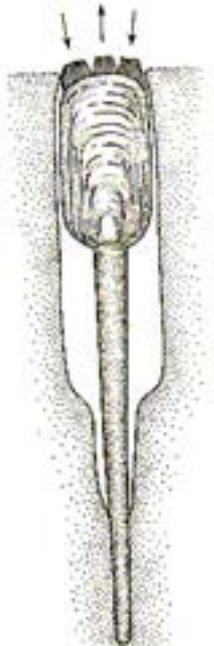
- body enclosed between 2 valves (dorsal + ventral)
- live cemented to bottom, or dig with ventral foot-like **pedicle**
- U-shaped gut, with or without anus
- 1-2 pairs of metanephridia,
- **open** circulatory system
- separate sexes



Class Inarticulata

- shells may be equal, especially in burrowers
- valves **not** hinged; attached by muscles
- lophophore **w/out** skeleton
- anus **present**

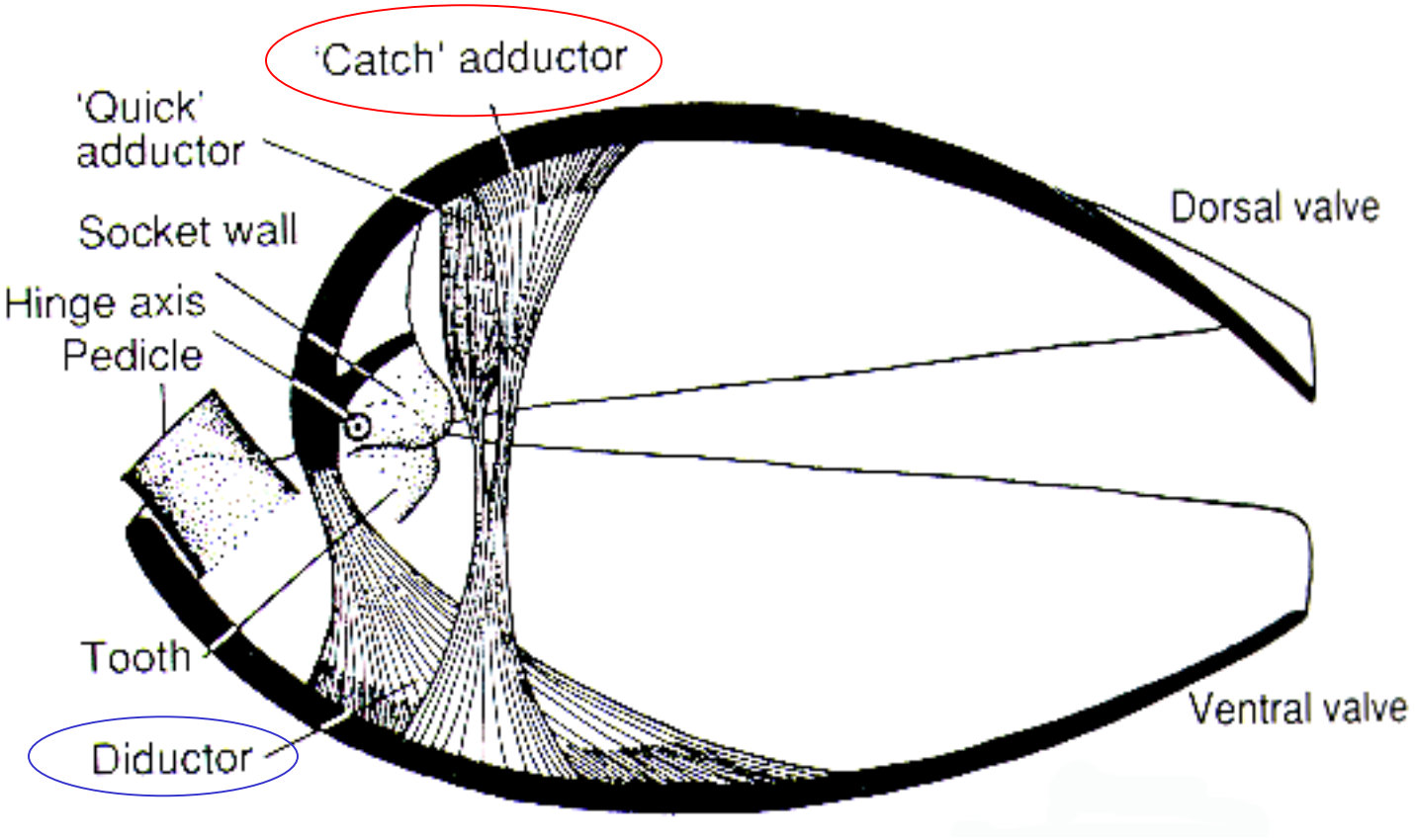




Class Articulata

- shells usually unequal
- valves **hinged**: ventral teeth lock into dorsal socket
- lophophore w/ skeleton
- **no** anus

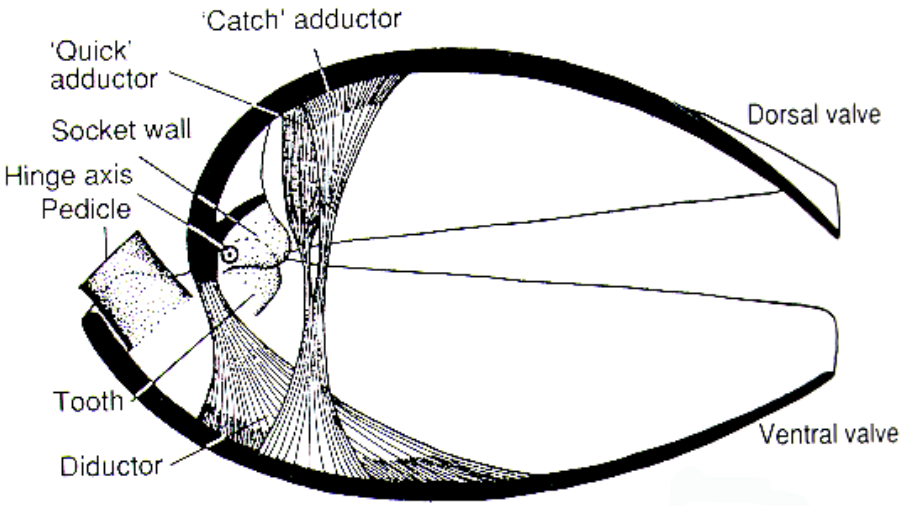
Articulate Brachiopod



- Ventral valve bears teeth that lock into dorsal valve socket
- Adductor muscles close valves; diductors open valves
  - contrast w/ bivalve, where springy ligament forces shell valves open if adductor muscles relax

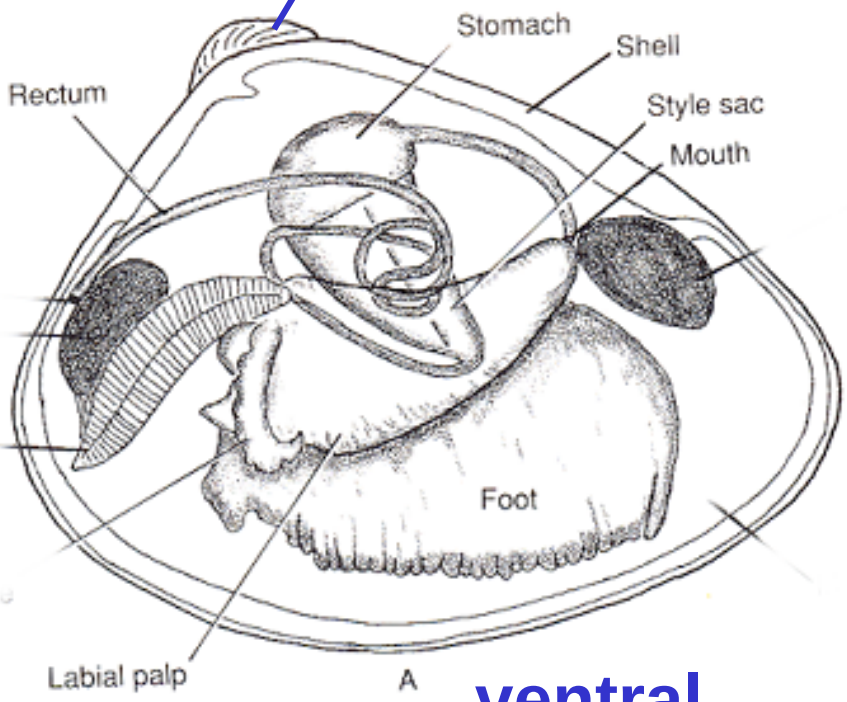
Brachiopod vs. Bivalve

top valve is dorsal



ventral

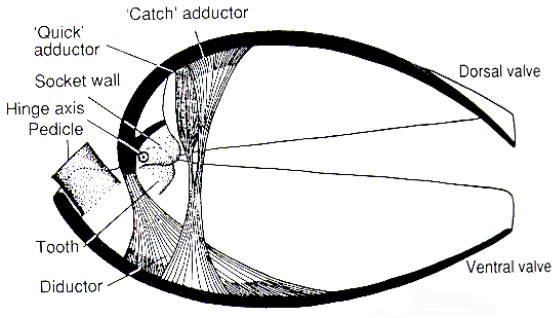
umbo is dorsal

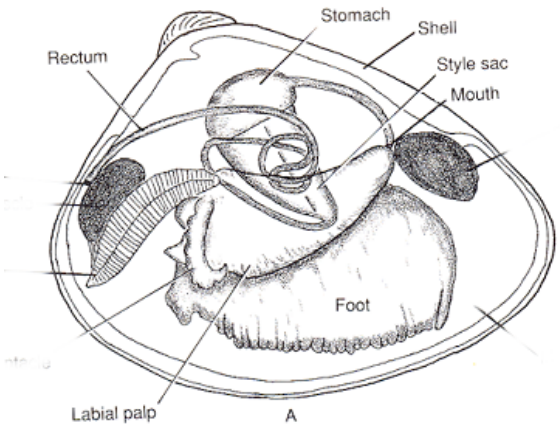


ventral

dorsal ..... **ventral**

Brachiopod vs. Bivalve





evolutionary **loser**
350 living spp.

evolutionary **winner**
7,600 living spp.

Bivalves and brachiopods compete for the same resources; bivalves have been come dominant, while most brachiopods went extinct

Key bivalve innovation may have been the mantle fusing into a **siphon** for drawing water into the shell