

Biology of Marine Life

Ninth Edition

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Chapter 5

Microbial Heterotrophs and Invertebrates

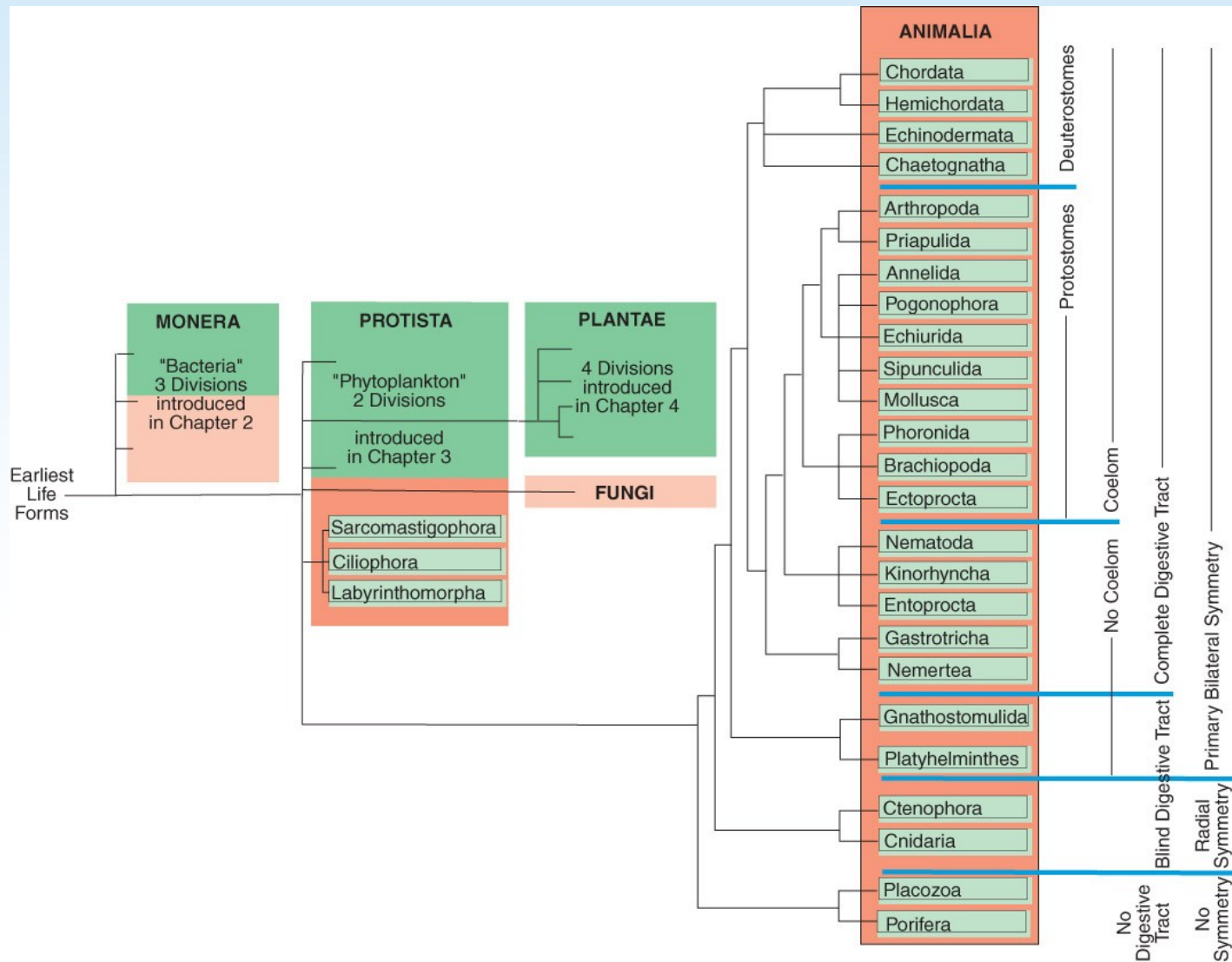


Fig. 5.1 the 3 phyla from the kingdom Protista and 25 phyla from the kingdom Animalia described in this chapter. Yikes!!!

For Pete's

A Partial (and Brief) Taxonomy of the Marine Animal and Nonphotosynthetic Protist Groups Included in Figure 5.1^a

Table 5.1

Kingdom:	Protista
Phylum:	Sarcomastigophora (8700, all habitats)—unicellular animals; locomotion with flagella or pseudopodia
Phylum:	Ciliophora (9000, all habitats)—unicellular animals; locomotion with numerous cilia
Phylum:	Labyrinthomorpha—(40, all habitats) small colonies of cellular slime molds
Kingdom:	Fungi (56,000; 1500 are marine)
Kingdom:	Animalia
Phylum:	Porifera (10,000, mostly marine)—simple multicellular animals found attached to solid substrates in benthic habitats; reproduction is both asexual and sexual and results in free-swimming larval stages
Phylum:	Placozoa (1, marine)—small asymmetrical plate of cells
Phylum:	Cnidaria (10,000, mostly marine)—radically symmetrical animals with mouth, tentacles, cnidocytes, and simple sensory organs and nervous system; common in both benthic and pelagic habitats; reproduction is both sexual and asexual (by budding or fission)
Class:	Hydrozoa—solitary or colonial, with both polypoid and medusoid forms
Class:	Scyphozoa—free-swimming medusoid forms (most jellyfishes)
Class:	Anthozoa—attached benthic polypoid forms (corals and anemones)
Phylum:	Ctenophora (100, marine)—biradially symmetrical pelagic swimming animals with eight rows of cilia (ctenes)
Phylum:	Platyhelminthes (18,500, all habitats)—free-living and parasitic flatworms
Class:	Turbellaria—small free-living flatworms with incomplete digestive tracts and ciliated undersides; found in benthic habitats
Phylum:	Nemertea (900, mostly marine)—most are small, inconspicuous, wormlike benthic animals with complete digestive tracts
Phylum:	Gastrotricha (400, 50% are marine)—microscopic, with elongated bodies; in benthic habitats
Phylum:	Kinorhyncha (150, marine)—elongated, less than 1 mm in length; in benthic habitats
Phylum:	Gnathostomulida (80, marine)—small benthic worms
Phylum:	Priapulida (15, marine)—small, benthic worms
Phylum:	Nematoda (25,000, all habitats)—parasitic and free-living roundworms a few millimeters in length; mostly benthic
Phylum:	Entoprocta (150, mostly marine)—nearly microscopic benthic animals that form colonial encrustations on hard substrates
Phylum:	Ectoprocta (4500, mostly marine)—benthic, with the exception of one pelagic Antarctic species
Phylum:	Phoronida (20, marine)—tube-dwelling benthic worms
Phylum:	Brachiopoda (350, marine)—benthic animals; bodies covered with hinged shell
Phylum:	Mollusca (94,000, mostly marine)—unsegmented body usually covered with external shell of one, two, or eight pieces
Class:	Aplacophora—rare benthic mollusks without shells
Class:	Monoplacophora—rare, benthic
Class:	Amphineura—shallow-water benthic animals known as chitons; eight-piece shell
Class:	Gastropoda—mostly benthic; shell usually absent or of one piece; includes slugs, snails, and limpets
Class:	Scaphopoda—benthic; shell of one piece and elongated; known as tusk shells
Class:	Bivalvia—benthic; shell of two pieces; clams, oysters, and other bivalves
Class:	Cephalopoda—benthic and pelagic; shell usually absent, foot modified as tentacles with suckers; octopuses and squids
Phylum:	Sipuncula (250, marine)—benthic worms a few centimeters long; known as peanut worms
Phylum:	Echiurida (140, marine)—benthic; cylindrical worms
Phylum:	Pogonophora (120, marine)—deep-water benthic tube-dwelling worms; to 2 m in length
Phylum:	Hemichordata (90, marine)—elongated benthic worms; acorn worms
Phylum:	Chaetognatha (120, marine)—pelagic, active predators; to 15 cm long; known as arrow worms
Phylum:	Annelida (16,500, marine, freshwater, and terrestrial)—segmented worms, mostly small, but to 3 m in length
Class:	Polychaeta—mostly benthic, free living
Class:	Hirudinea—leeches, some parasitic
Phylum:	Arthropoda (1,100,000, all habitats)—segmented animals with bodies covered by exoskeleton of chitin; most a few centimeters or less in length; several classes not found in marine habitats
Class:	Merostomata—horseshoe crabs; benthic near-shore animals
Class:	Pycnogonida—sea spiders; benthic animals with four pairs of elongated legs
Class:	Crustacea—mostly marine; with two pairs of antennae; numerous pelagic and benthic species
Subclass:	Branchiopoda—brine shrimp
Subclass:	Ostracoda—seed shrimps; pelagic animals usually less than 1 cm
Subclass:	Copepoda—abundant animals in pelagic and benthic habitats; microscopic to about 1 cm
Subclass:	Cirripedia—barnacles; larger benthic, attached animals
Subclass:	Malacostraca

(continued on next page)

Sake!!!

A Partial (and Brief) Taxonomy of the Marine Animal and Nonphotosynthetic Protist Groups Included in Figure 5.1^a—Continued

Table 5.1

Order:	Mysidacea—mysids; benthic and pelagic; size to a few centimeters
Order:	Cumacea—burrow in mud and sand; size to a few centimeters
Order:	Isopoda—benthic; body flattened dorsoventrally; size usually a few centimeters, but one reaches 45 cm
Order:	Amphipoda—benthic and pelagic; body laterally flattened; size to a few centimeters
Order:	Stomatopoda—mantis shrimps; benthic; size to 30 cm
Order:	Euphausiacea—krill; pelagic; size to several centimeters
Order:	Decapoda—crabs, shrimps, and lobsters; mostly benthic; several centimeters to 1 m in size
Phylum:	Echinodermata (7000, marine)—five-sided radial symmetry; most benthic
Class:	Echinoidea—sea urchins, sand dollars
Class:	Asteroidea—sea stars
Class:	Ophiuroidea—brittle stars
Class:	Crinoidea—feather stars, sea lillies
Class:	Holothuroidea—sea cucumbers
Class:	Concentricycloidea—sea daisies
Phylum:	Chordata (55,000, all habitats)
Subphylum:	Urochordata
Class:	Ascidiacea—sea squirts; benthic; solitary or colonial
Class:	Larvacea—pelagic; less than 1 cm
Class:	Thaliacea—salps; pelagic; gelatinous
Subphylum:	Cephalochordata—slender, laterally compressed; benthic
Subphylum:	Vertebrata—fishes and tetrapods
Class:	Agnatha—lampreys and hagfishes
Class:	Chondrichthyes—sharks, skates, and rays
Class:	Osteichthyes—bony fishes; includes about 30 orders with marine species
Class:	Amphibia—frogs, toads, and salamanders
Class:	Reptilia—marine turtles, iguanas, crocodiles, and sea snakes
Order:	Testudinata—turtles
Order:	Squamata—iguanas and snakes
Order:	Crocodylia—caymens and crocodiles
Class:	Aves—marine birds
Order:	Sphenisciformes—penguins
Order:	Procellariiformes—albatrosses, petrels, fulmars, shearwaters
Order:	Pelecaniformes—pelicans, cormorants, gannets, boobies
Order:	Charadriiformes—gulls, sandpipers, puffins
Class:	Mammalia
Order:	Carnivora—sea lions, seals, walruses, sea otters
Order:	Cetacea—whales
Order:	Sirenia—manatees and dugongs

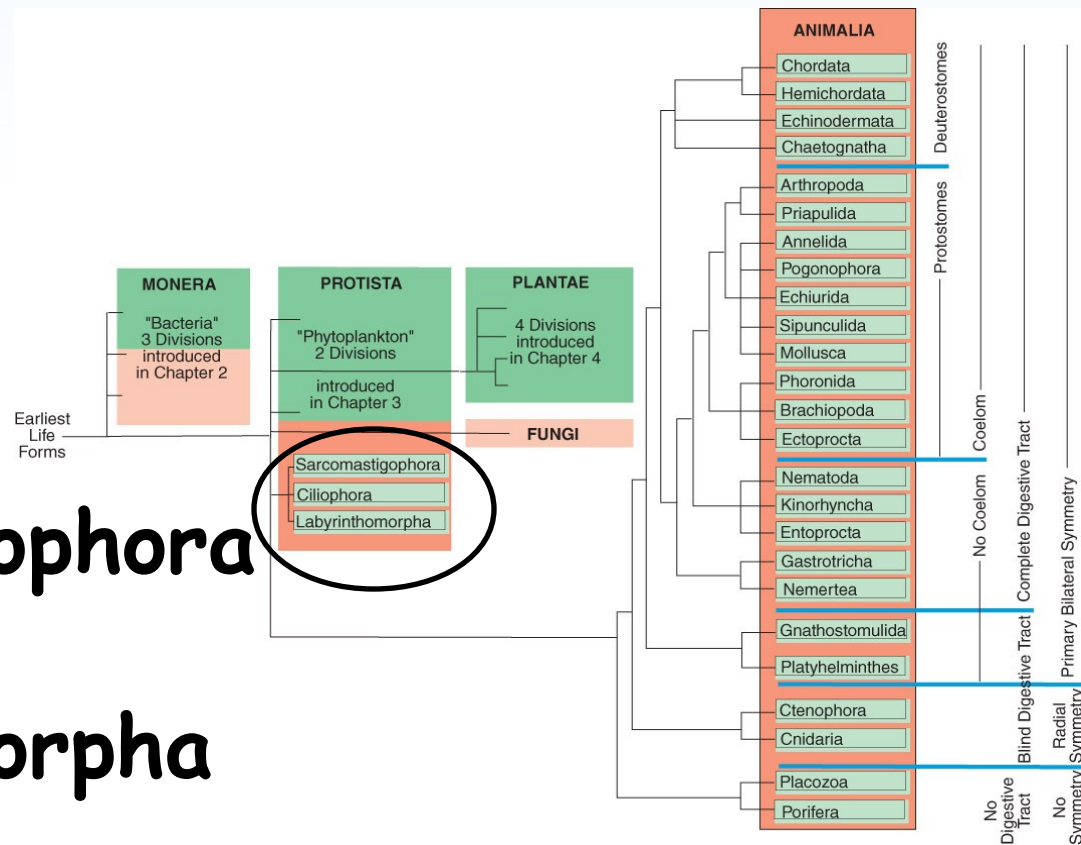
^aThe numbers in parentheses refer to the approximate numbers of described species in that group.


Animal Beginnings: The Protozoans

Protists are eukaryotic organisms that are not fungi, plants, or animals

No single trait is unique to protists – the “catch-all” kingdom!

Kingdom Protista
Phylum Sarcomastigophora
Phylum Ciliophora
Phylum Labyrinthomorpha



A microscopic image of a cell, likely a protozoan, with a magnifying glass highlighting a specific organelle. The cell is roughly oval-shaped and contains various internal structures. The magnifying glass is positioned over a large, circular, granular structure, possibly a nucleus or a large organelle. The background is a textured, brownish surface.

**Phylum
Sarcomastigophora –
flagella or psuedopodia**

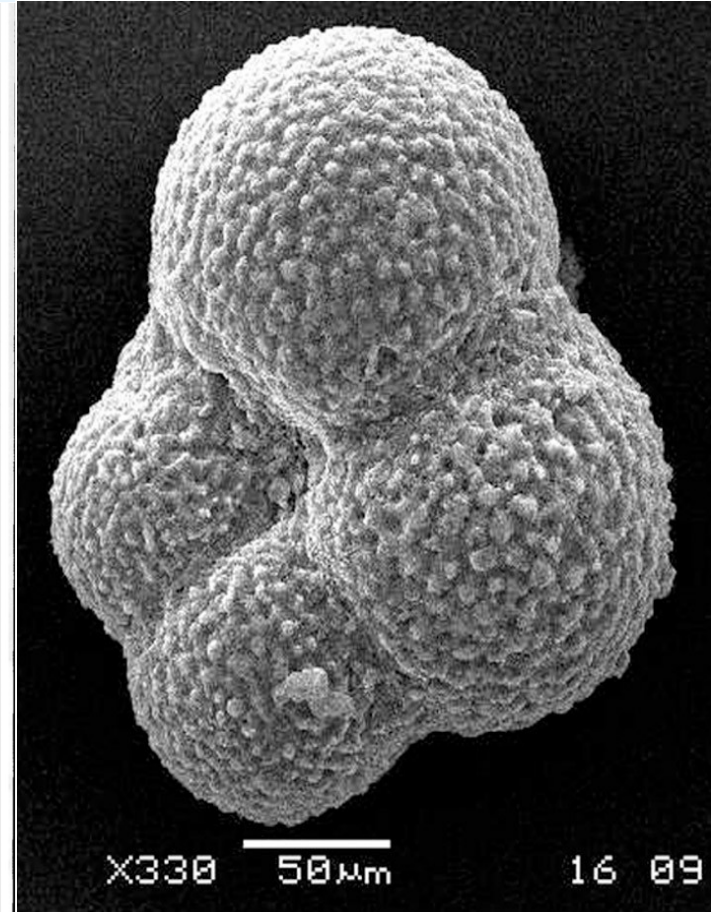
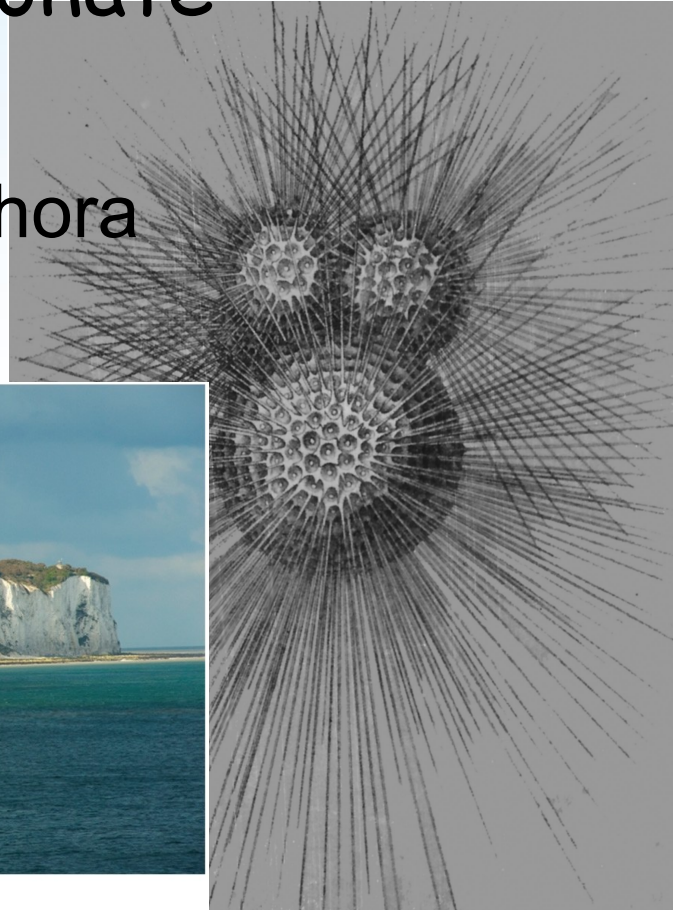
Animal Beginnings: The Protozoans

Foraminiferans

Calcium carbonate

Phylum

Sarcomastigophora



(b)

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b

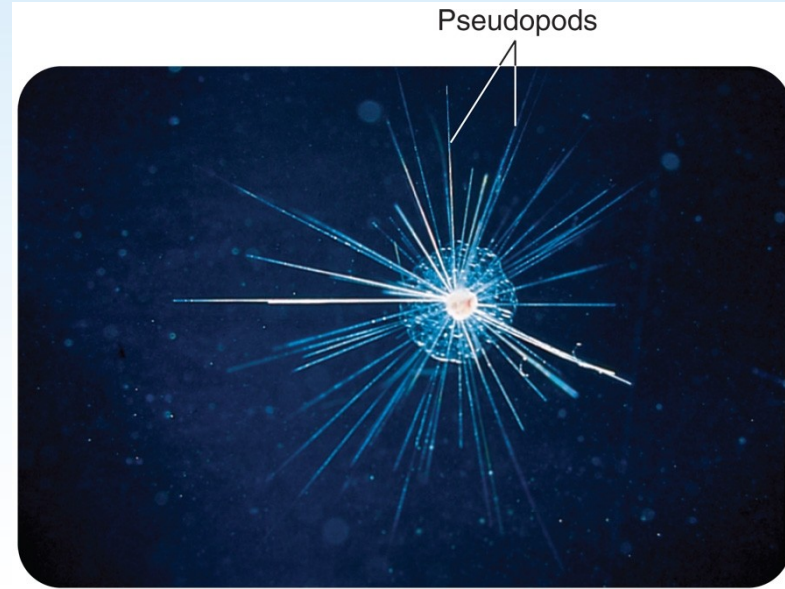
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Coccolithophores & forams!

Animal Beginnings: The Protozoans

Radiolarians Silica!

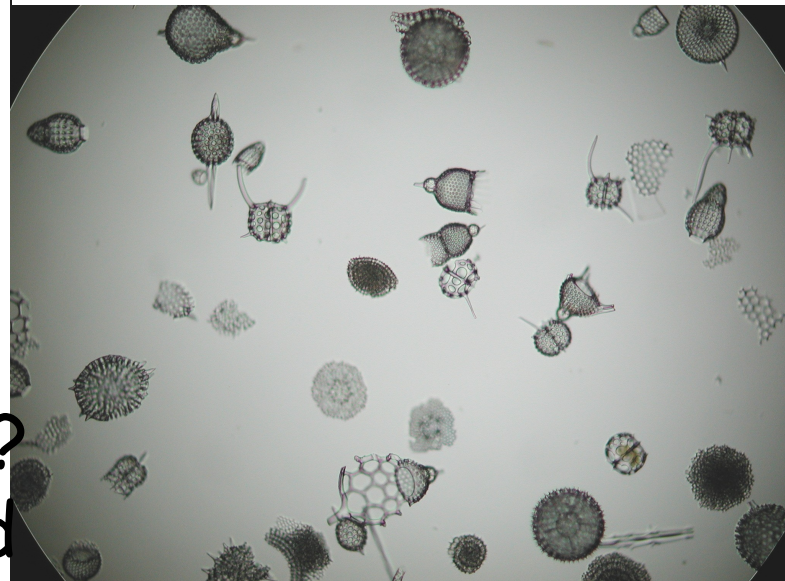
Phylum
Sarcomastigophora



Pseudopods

(a)

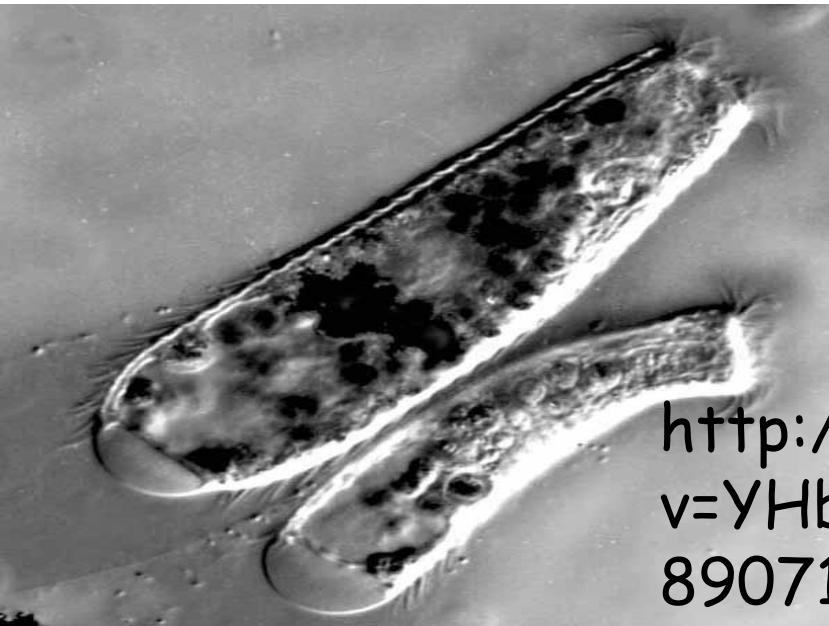
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<https://www.youtube.com/watch?v=75b1Cq1VlOk&feature=related>

Animal Beginnings: The Protozoans

Phylum
Ciliophora –
cilia!!!

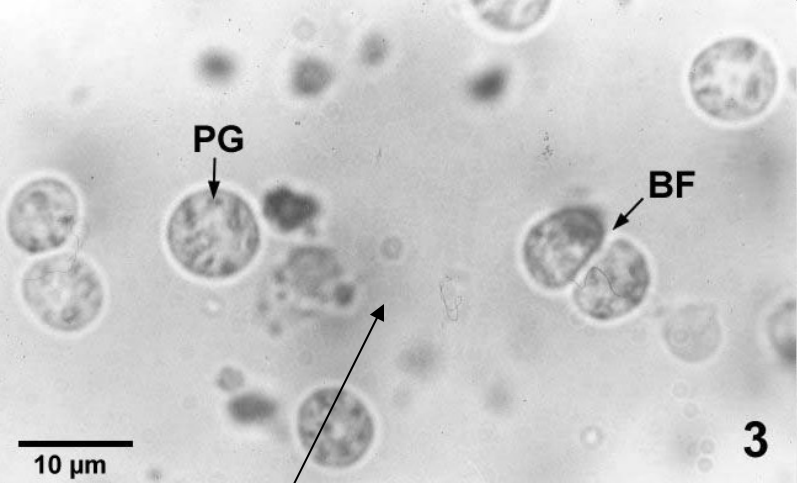


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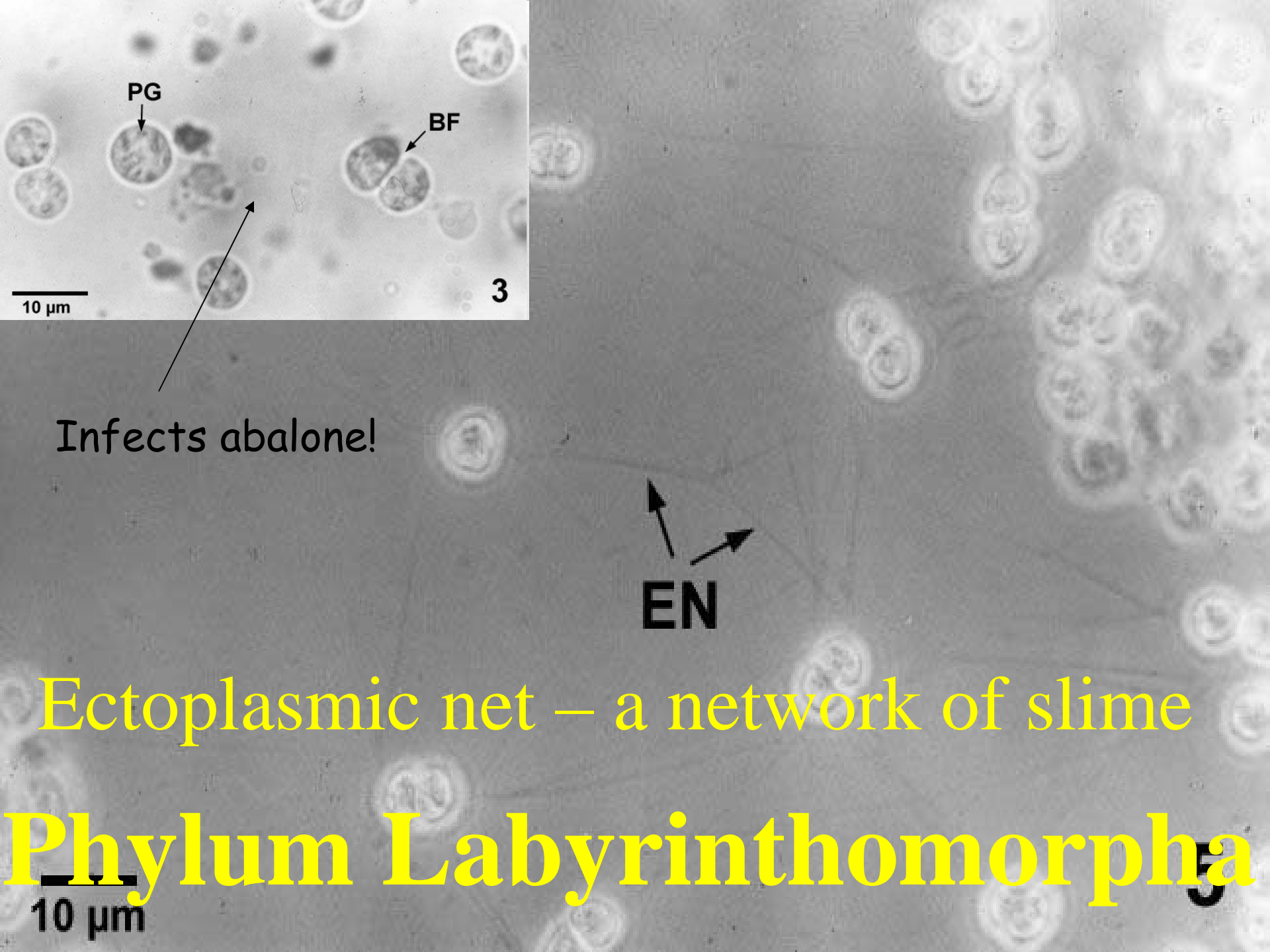


tintinnid

<http://www.youtube.com/watch?v=YHb2JaujIPo&feature=&p=1B3924924890715C&index=0&playnext=1>



Infects abalone!



EN

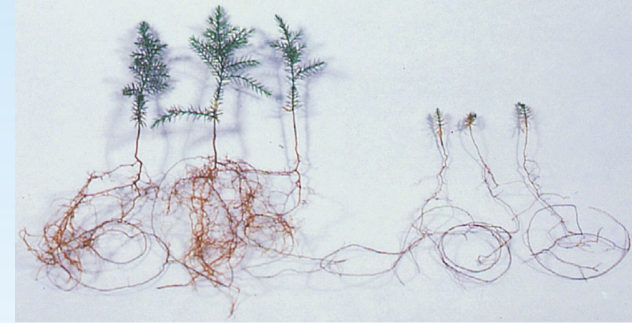
Ectoplasmic net – a network of slime

Phylum Labyrinthomorpha

10 μm

Marine Fungi

Kingdom Fungi



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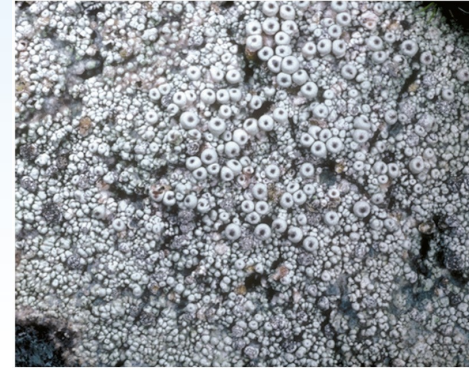
➤ heterotrophic organisms

➤ digest externally (extracellular digestion) through hyphae (mycelium)

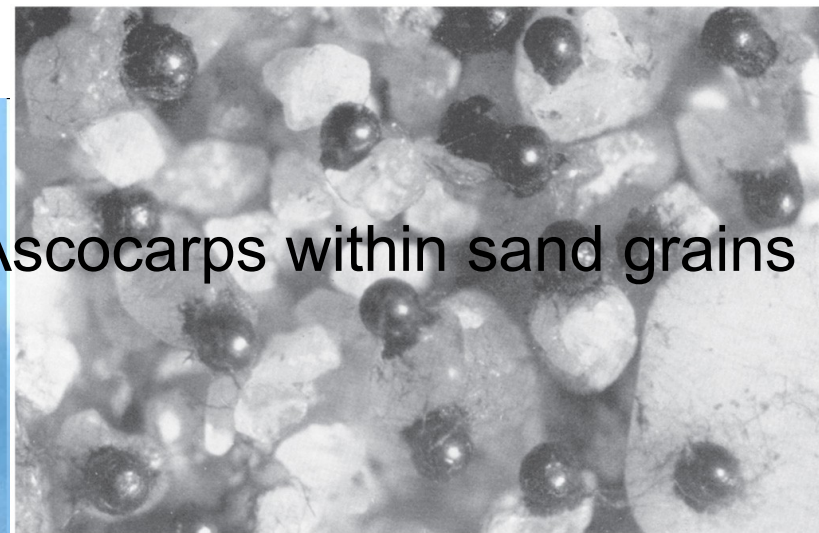
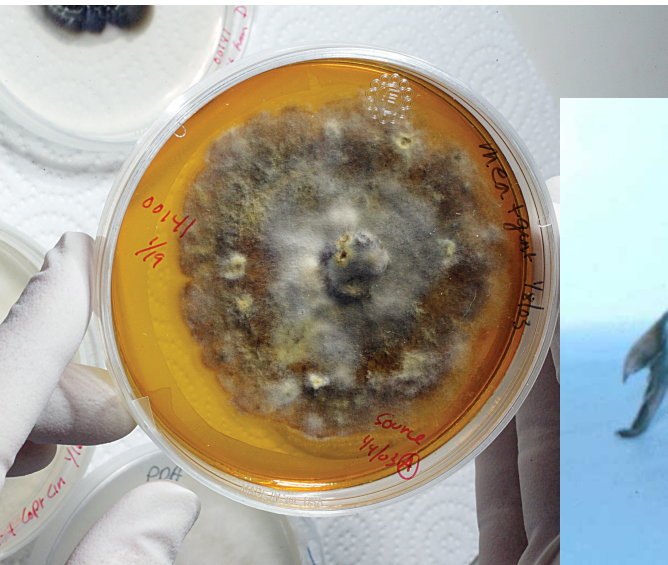
➤ cell wall of chitin

➤ Mostly saprobes (decomposers)

➤ Lichens, mycorrhizas, mycophycobioses



(b)
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Ascocarps within sand grains

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What Are Animals (Kingdom Animalia)?

Animals:

1. are multicellular (unlike most Protists)
2. have eukaryotic cells without cell walls
 - distinguishes them from bacteria, fungi, algae and plants
1. Are heterotrophic
2. can actively move at some point in their lives



Kingdom Animalia: Phylum Porifera

The Sponges

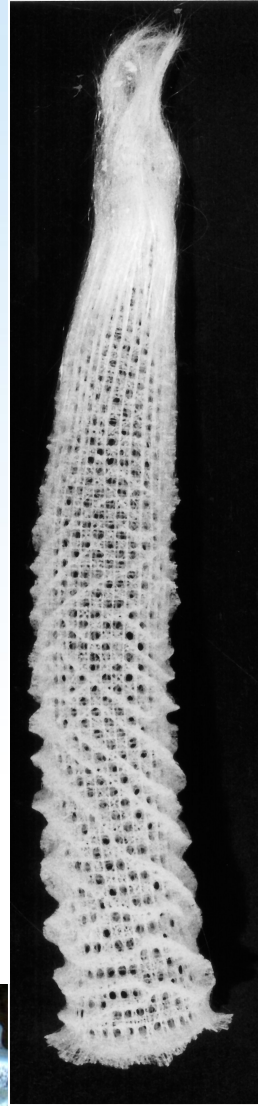
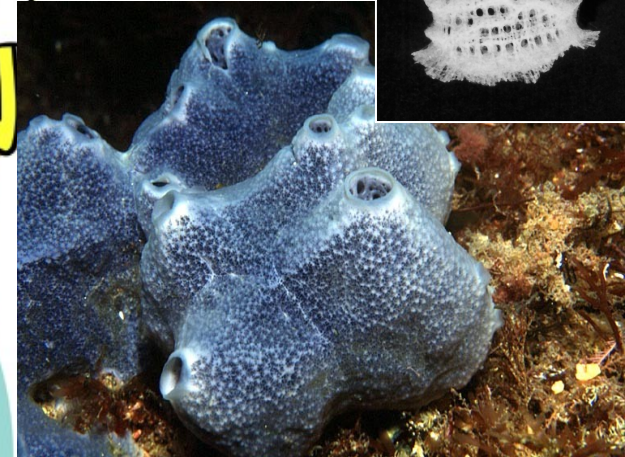
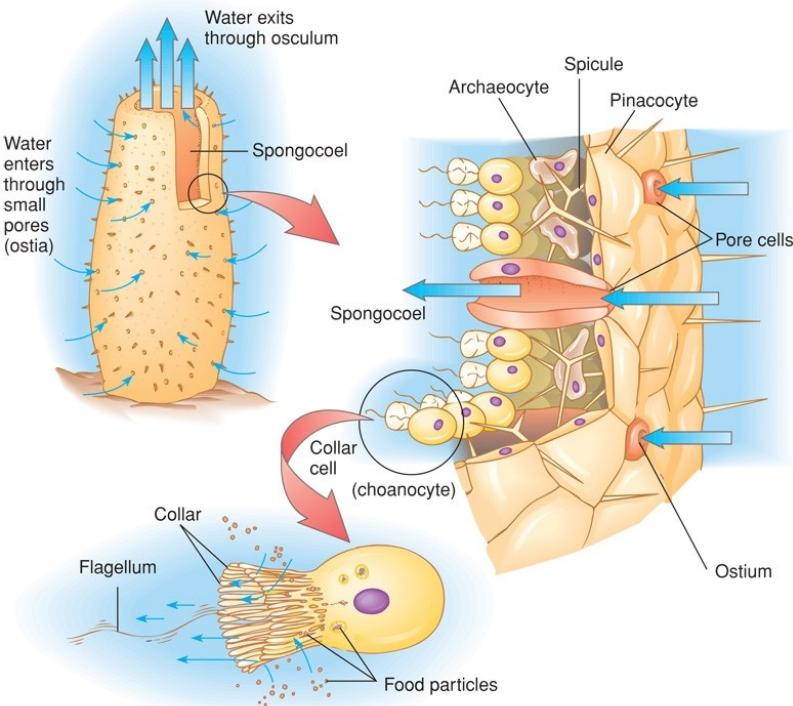
Simple

Asymmetric

Sessile

Choanocytes (collar cells), ostium, oscula

<http://www.youtube.com/watch?v=KOFFzXNYJGO>





(a)



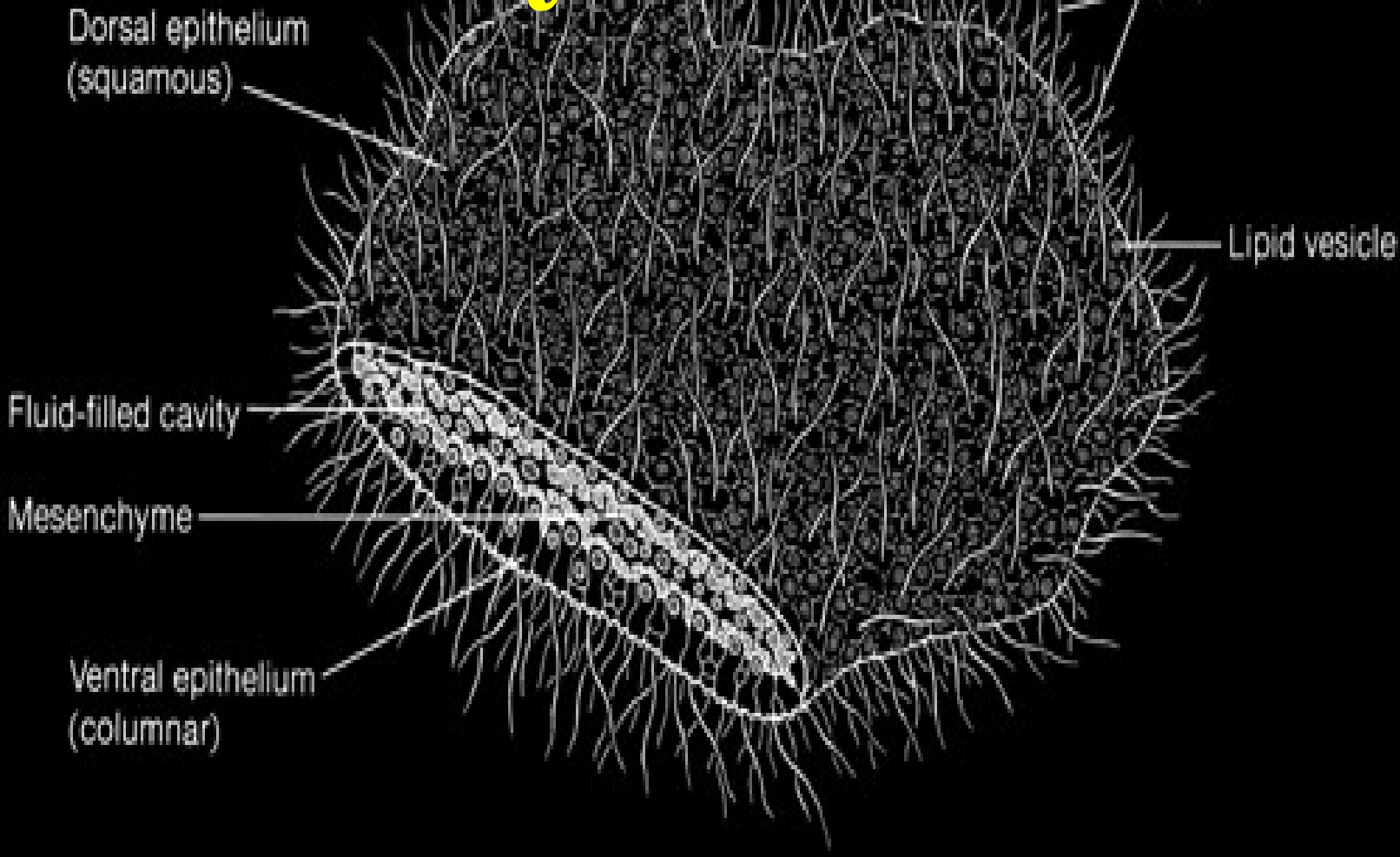
(b)



(d)



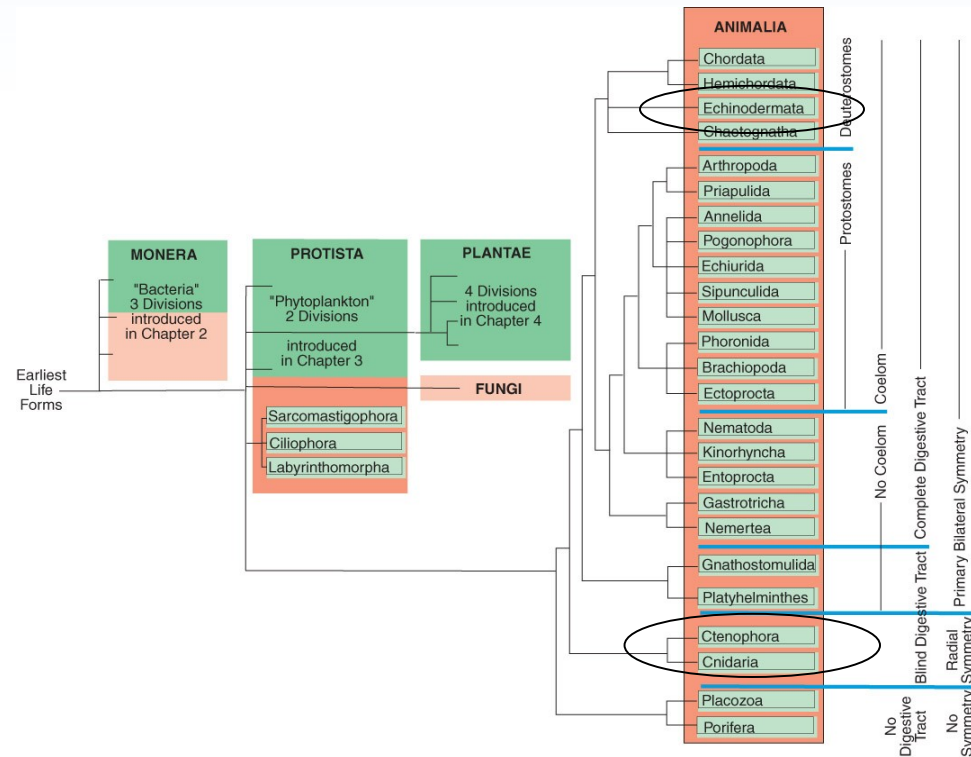
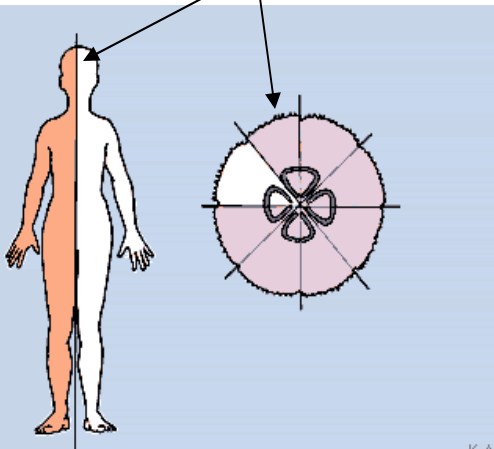
Phylum Placozoa



Let's talk about Symmetry

Some organisms have no symmetry, some have radial, some have bilateral

- Cnidarians, Ctenophores, Echinoderms (adult) have radial
- Sponges & Placozoans have no symmetry
- Everything else – bilateral symmetry



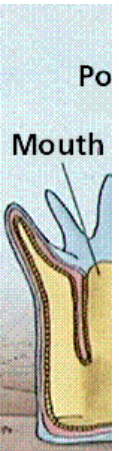
Phylum Cnidaria – stinging cells



Include:

http://www.youtube.com/watch?v=6zJiBc_N

- Jellyfishes
- Sea anemones



Class Anthozoa



Anemones
Corals – all
polyp!

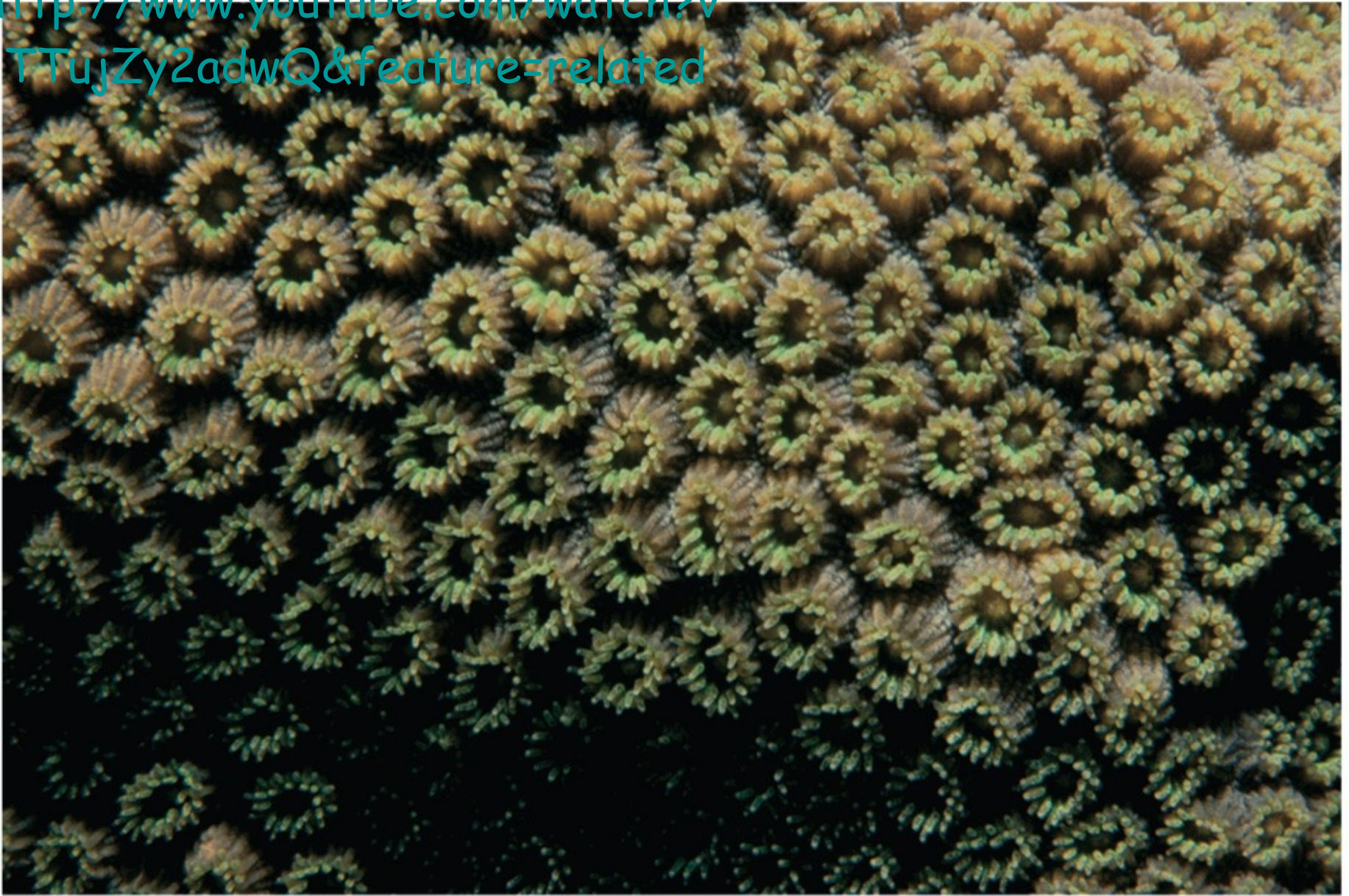


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Look at the cuteness!!! Young anemones on the mommy!!!

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<http://www.youtube.com/watch?v=TTujZy2adwQ&feature=related>



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Coral polyps with extended tentacles for feeding

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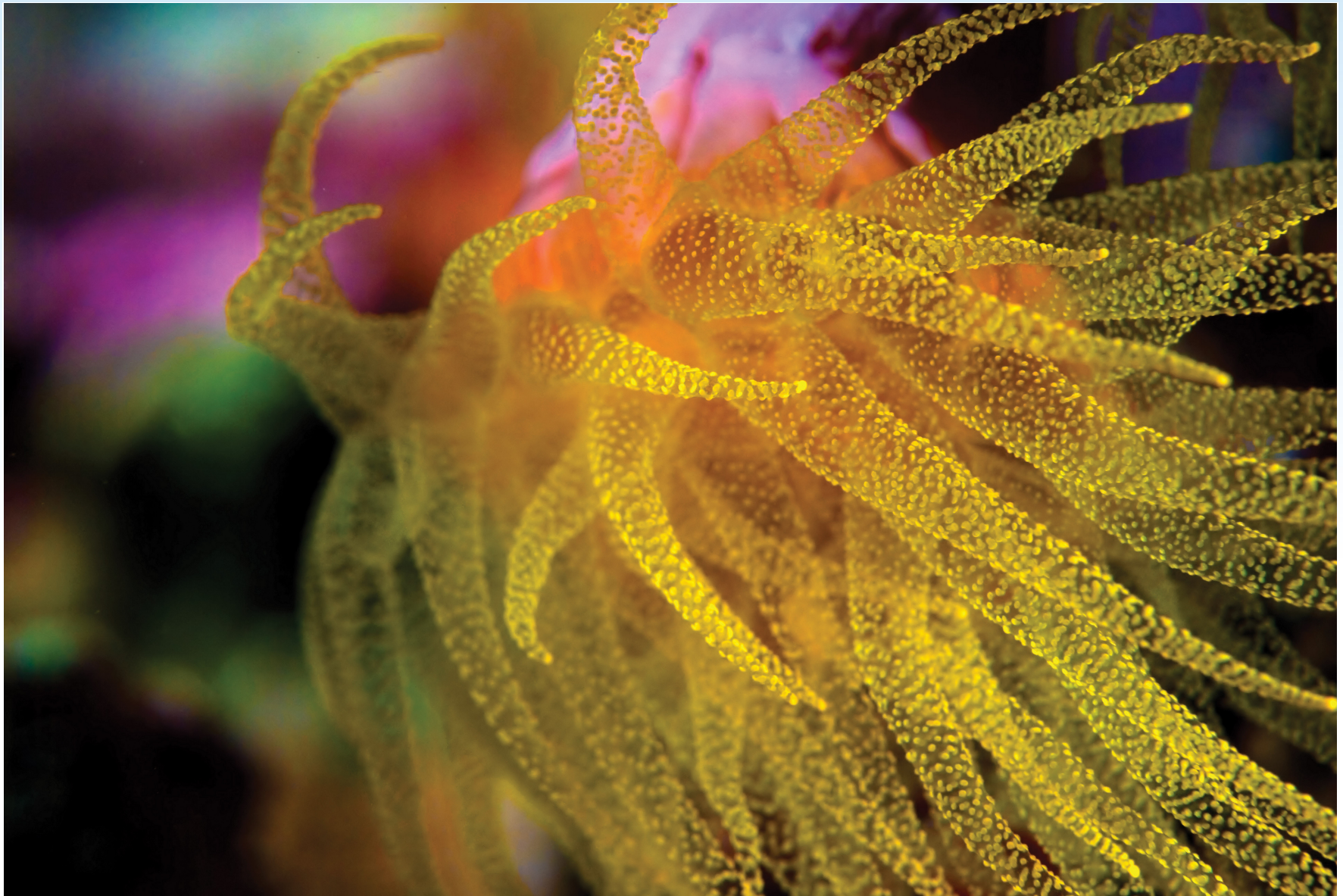
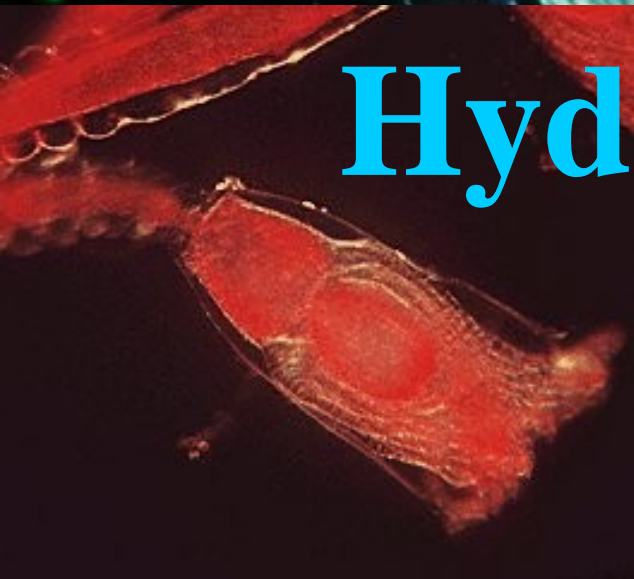


Fig. 5.13 Cnidarian polyp, with batteries of cnidocytes visible as beadlike structures on tentacles.

<http://www.youtube.com/watch?v=yqXkaZwiu6s&feature=related>

Class



Hydrozoa

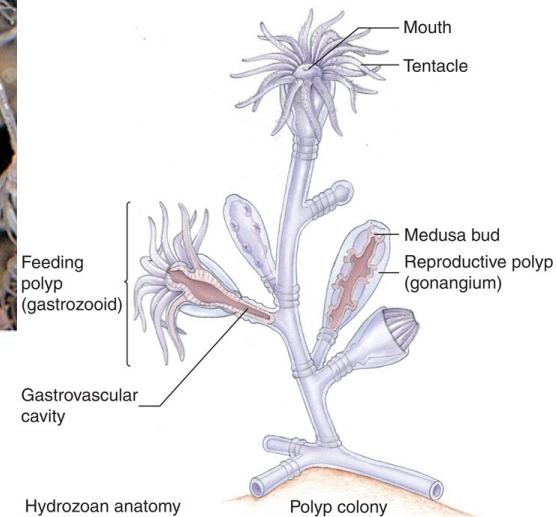
A mix of
polyp and
medusa!!!
Mostly
colonial





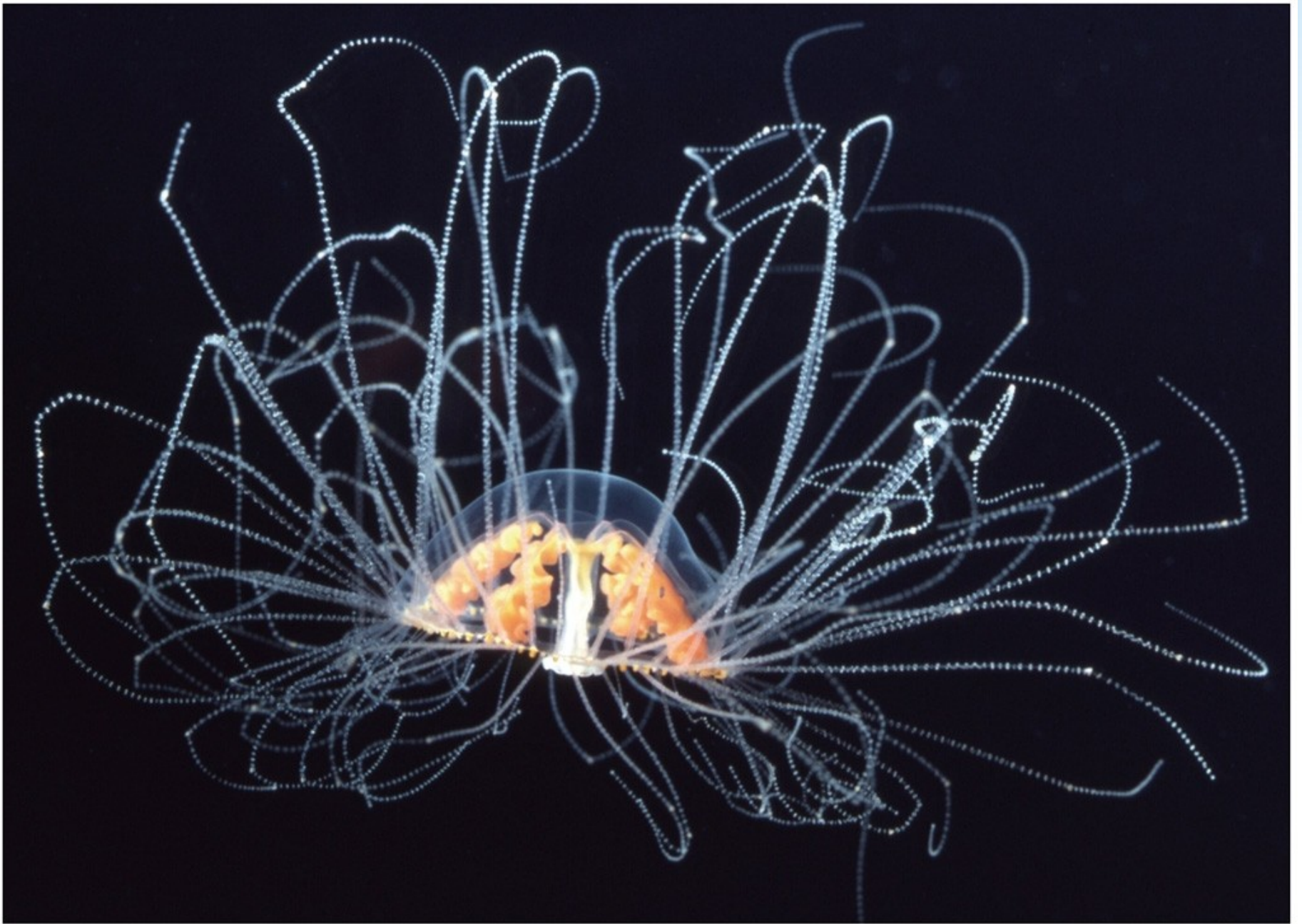
(a)

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Tubularia, a colonial hydrozoan – different zooids have different fxns!



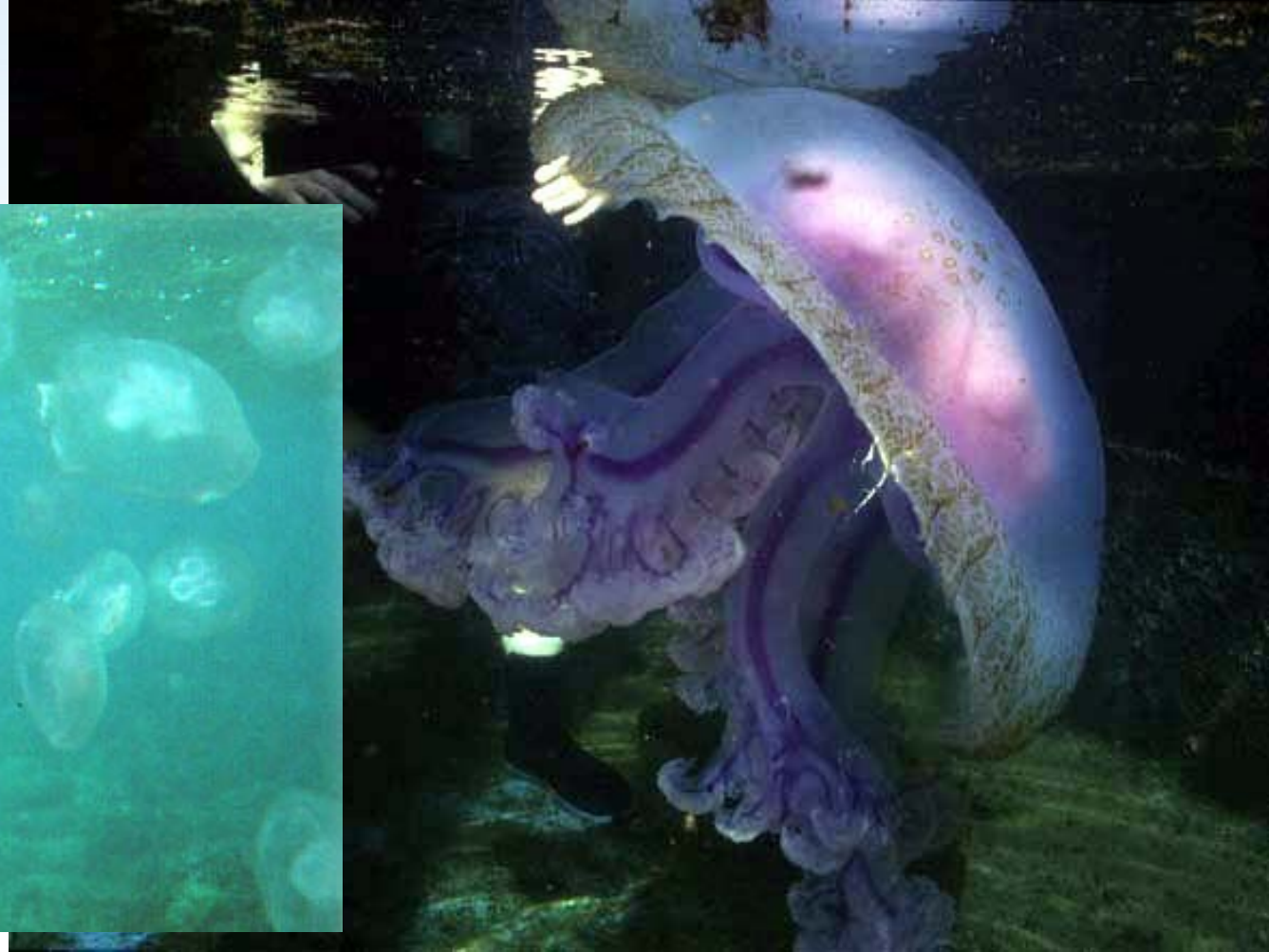


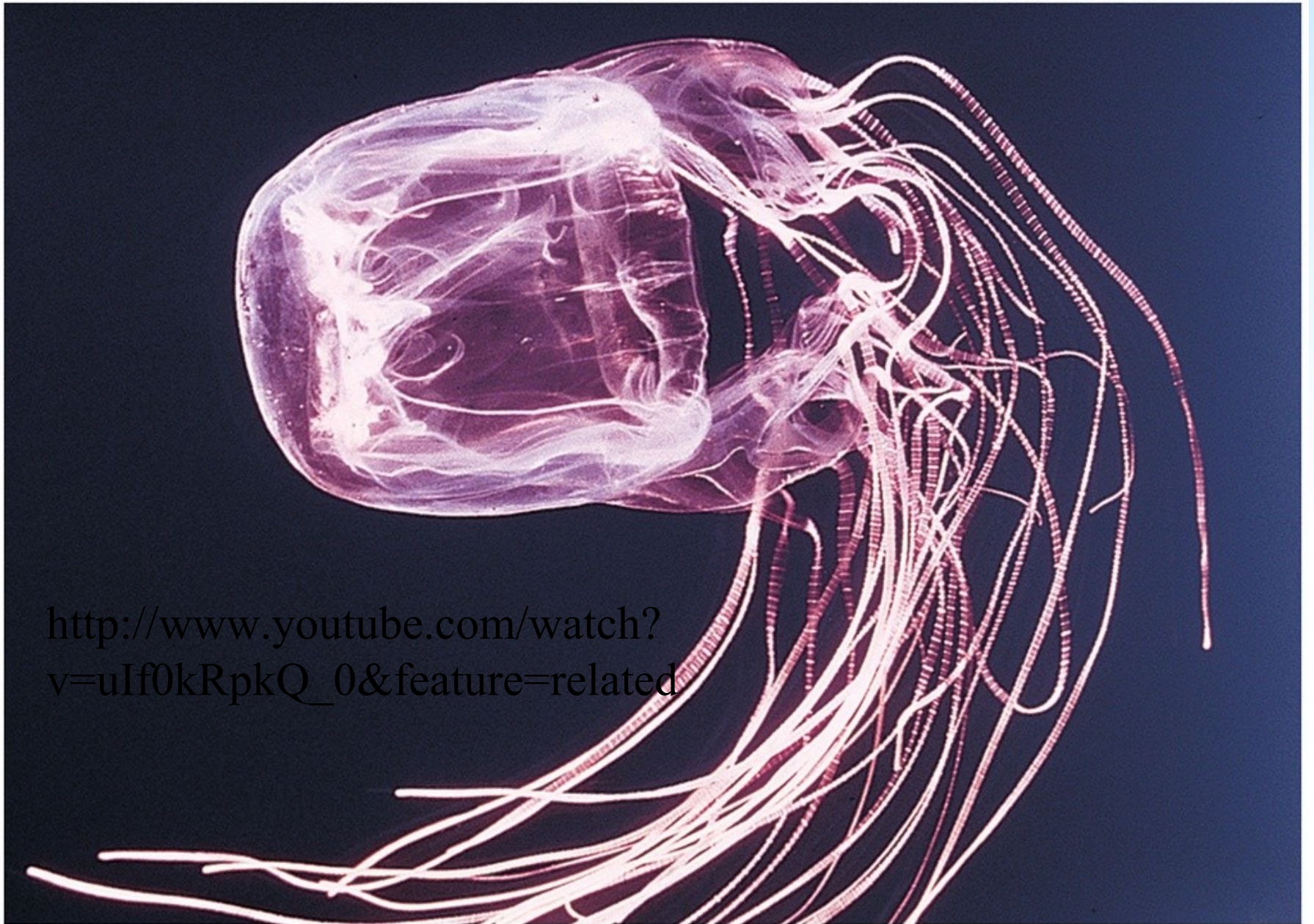
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Milleporina – the fire coral, not really a coral, but a hydrozoan w/a calcareous skeleton

Class Scyphozoa

The jellyfish!
Medusa dominant!!!
Planktonic!





http://www.youtube.com/watch?v=uIf0kRpkQ_0&feature=related



Fig. 5.12 Southern California's purple-striped jellyfish, *Chrysaora colorata*, reaches one meter in diameter.

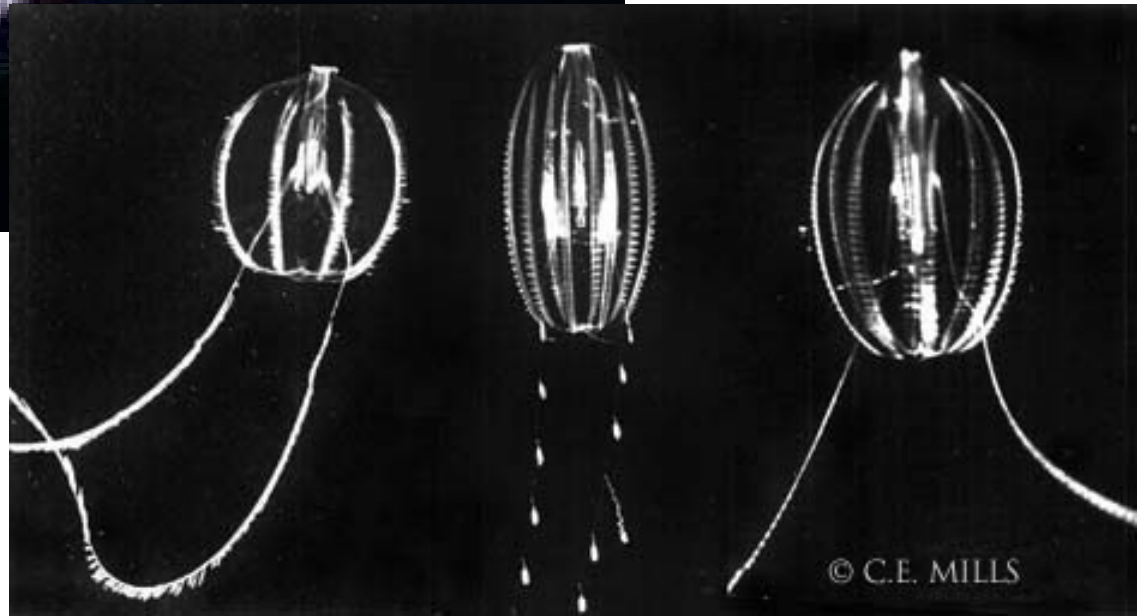
UPSIDE-DOWN JELLYFISH. The upside-down jellyfish (*Cassiopeia*)





- Have:
- Radial symmetry
 - Ctenes - motion
 - Sticky cells (colloblasts), not stinging
- <http://www.youtube.com/watch?v=1S0GVMt4>

Phylum Ctenophora



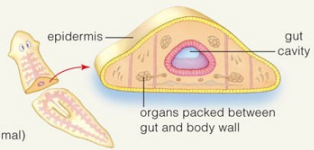
Bilateral Symmetry!!!

Marine Acoelomates and Pseudocoelomates

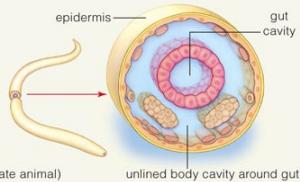
Bilateral EXCEPT Echinoderms

Acoelomates lack an internal body cavity

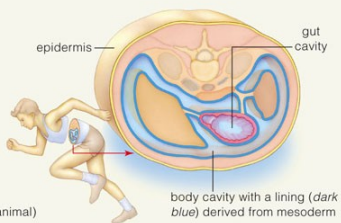
Pseudocoelomates have a poorly developed one!



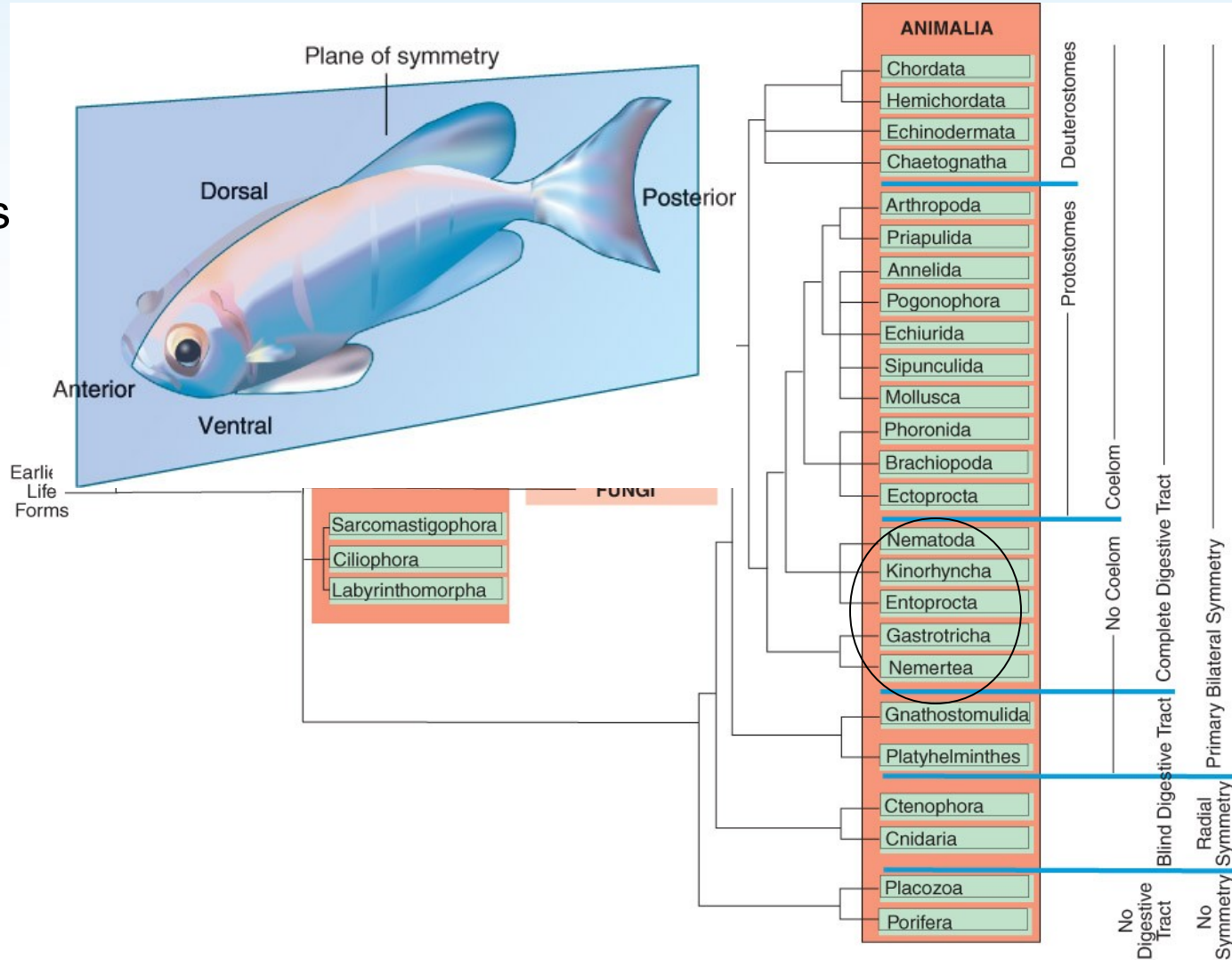
A No coelom (acoelomate animal)



B Pseudocoel (pseudocoelomate animal)



C Coelom (coelomate animal)



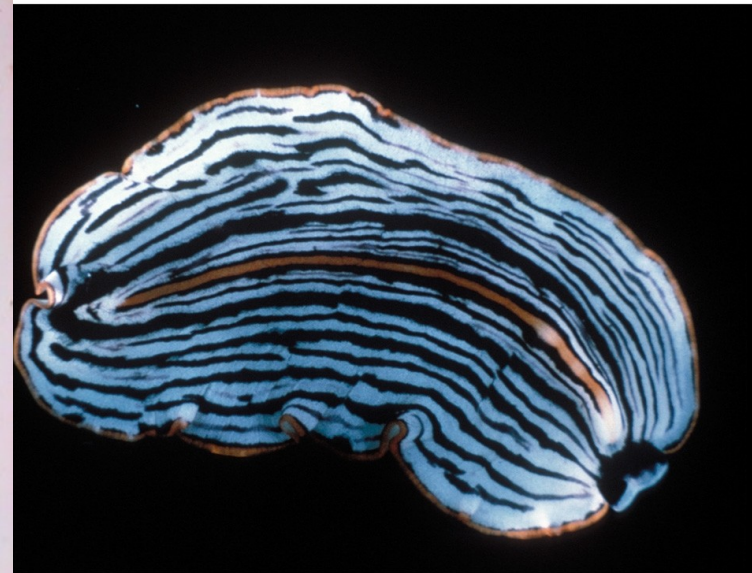
Marine Acoelomates and Pseudocoelomates

Phylum Platyhelminthes
Phylum Gnathostomulida
Phylum Nemertea
Phylum Gastrotricha
Phylum Kinorhyncha
Phylum Nematoda
Phylum Entoprocta

Small, found in sand and mud

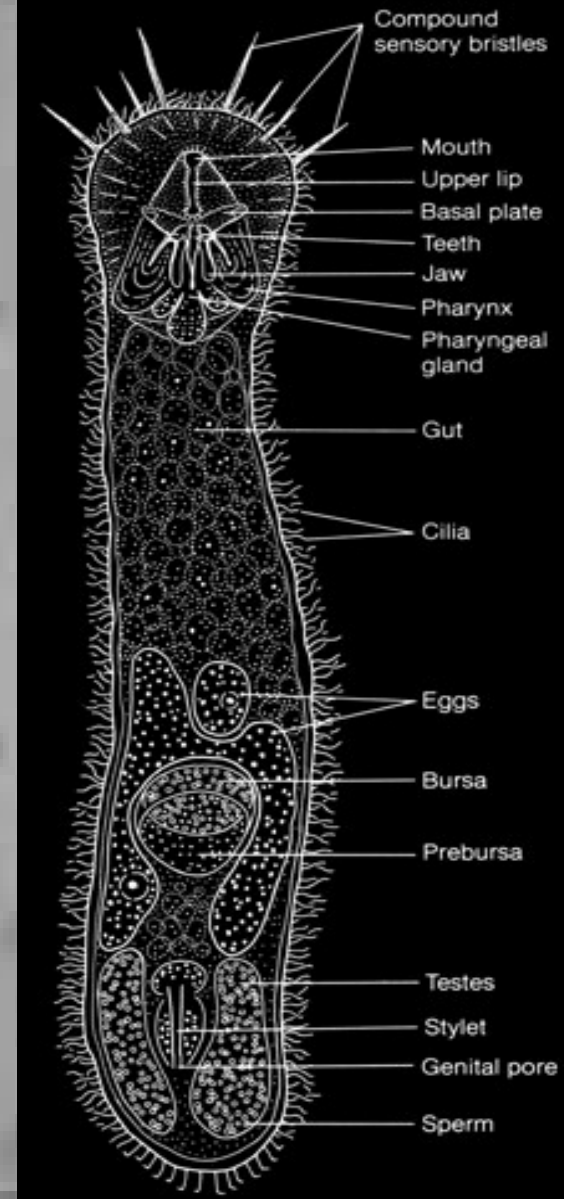
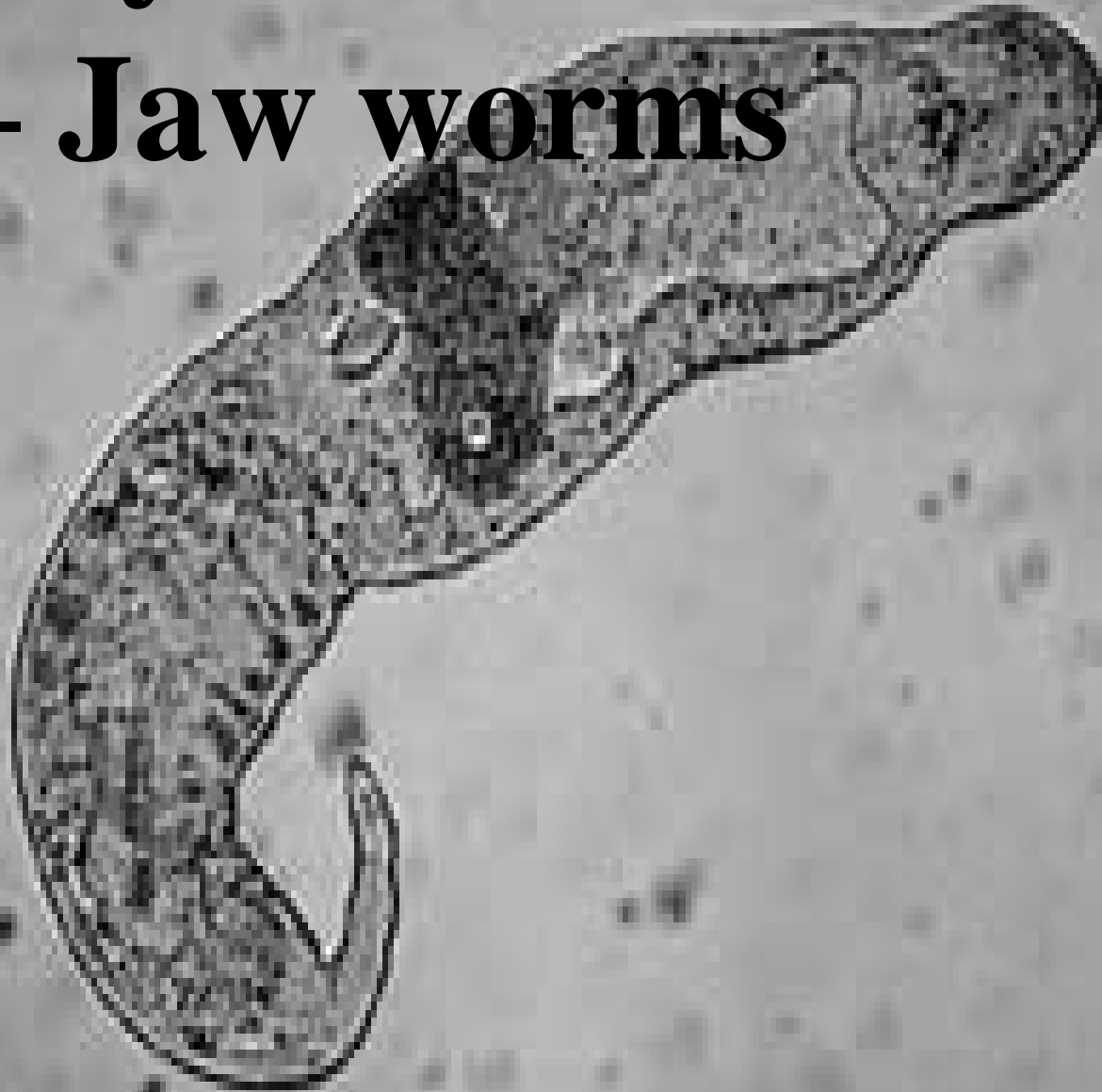
<http://www.youtube.com/watch?v=ET1v9-65Jwk>

Phylum Platyhelminthes - flatworms



Phylum Gnathostomulida

– Jaw worms

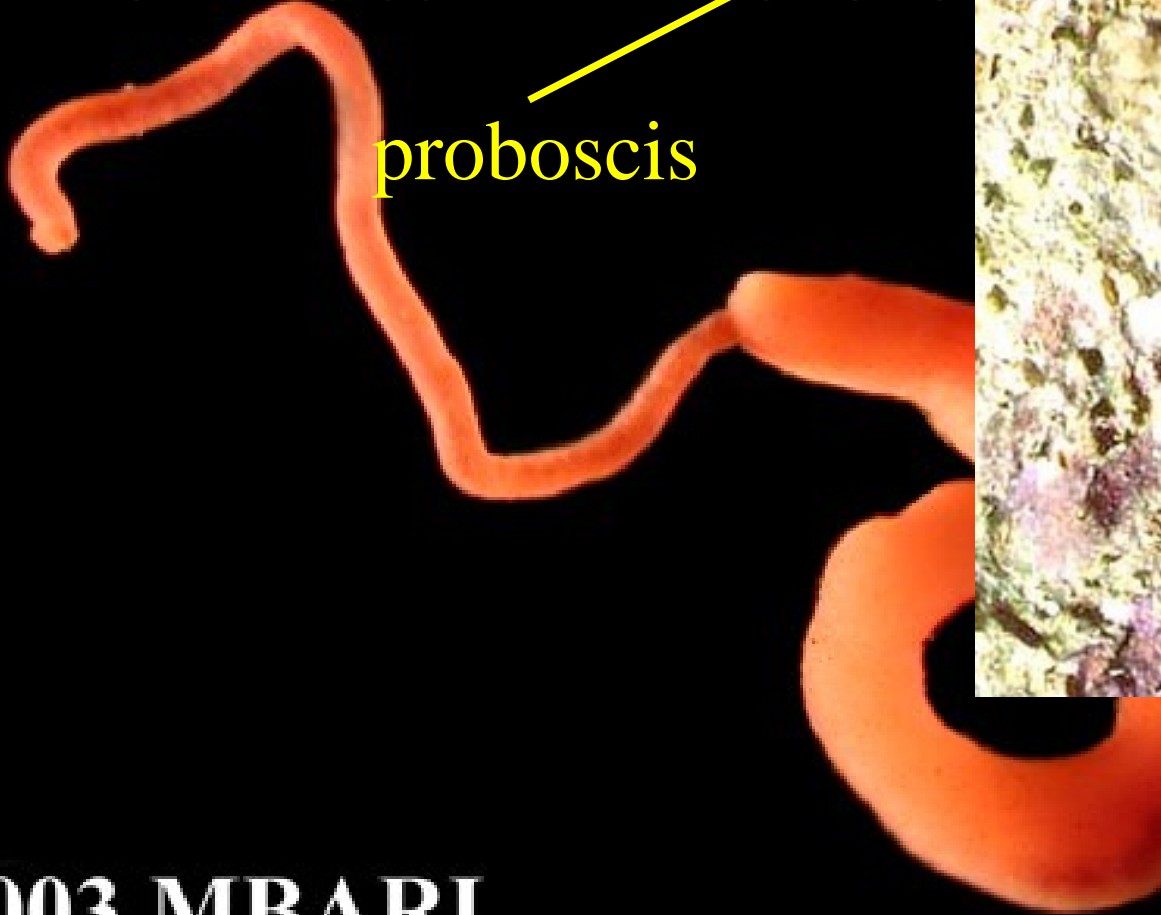


Phylum

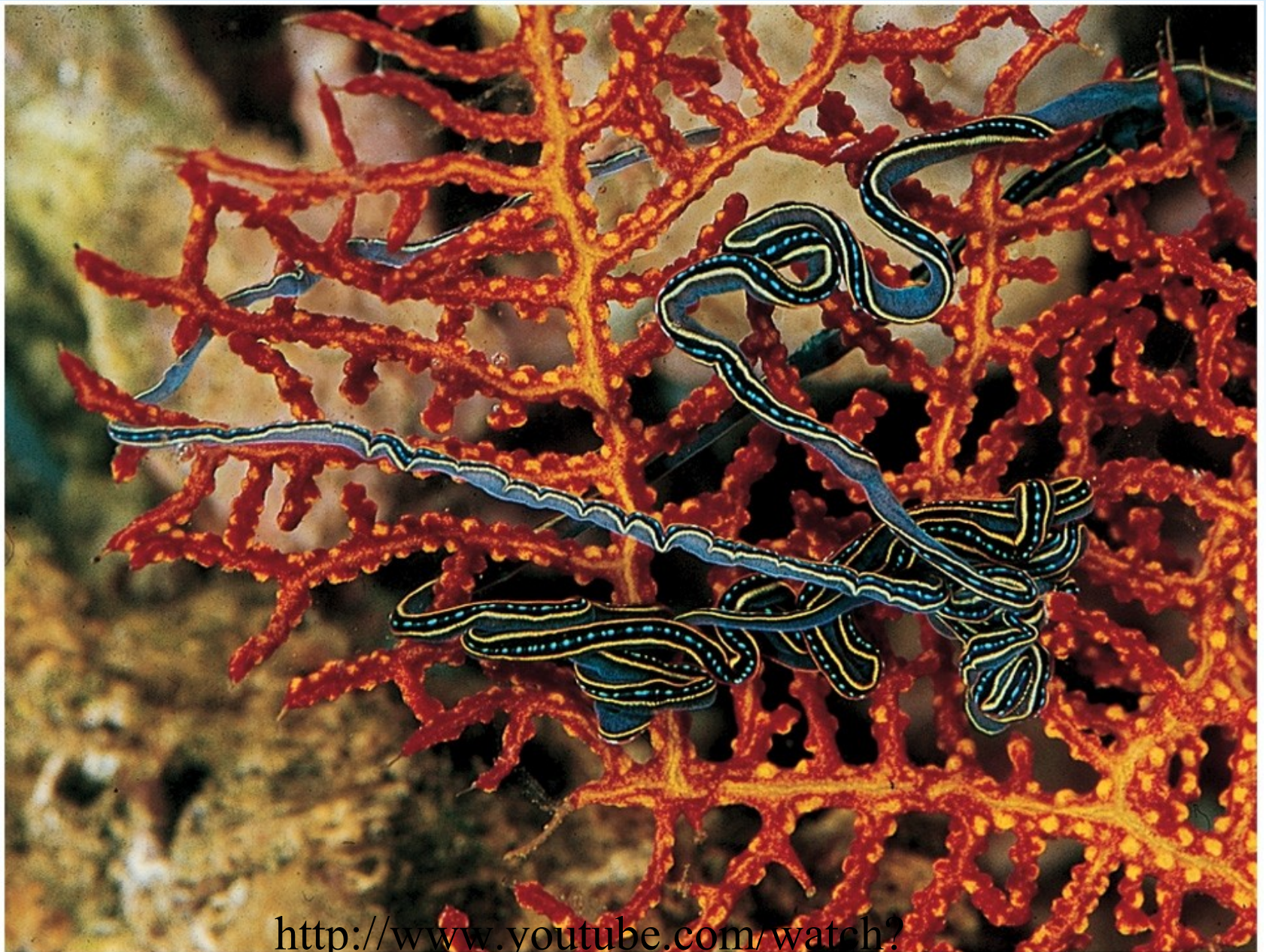
Nemertea – ribbon worms

2.0 mm

proboscis

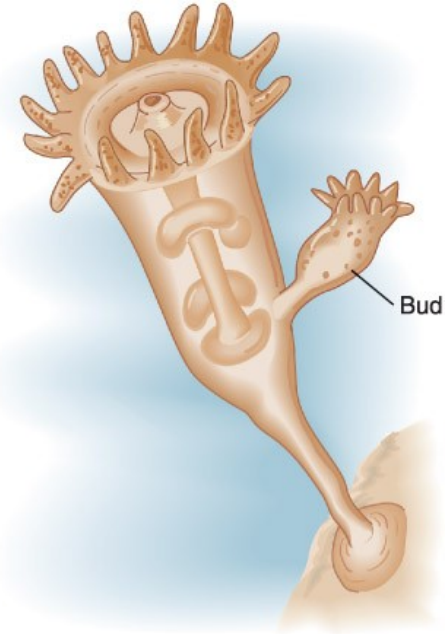


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<http://www.youtube.com/watch?v=SnkHY1CvfEA>

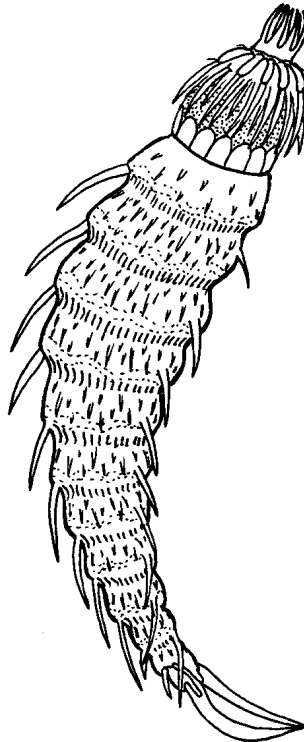
Phylum Entoprocta (inner anus)



Phylum Gastrotricha



Phylum Kinorhyncha



94/96

Phylum Nematoda

Round Worms

- Cylindrical Body Tapered at Both Ends
- Unsegmented
- Pseudocoelomate



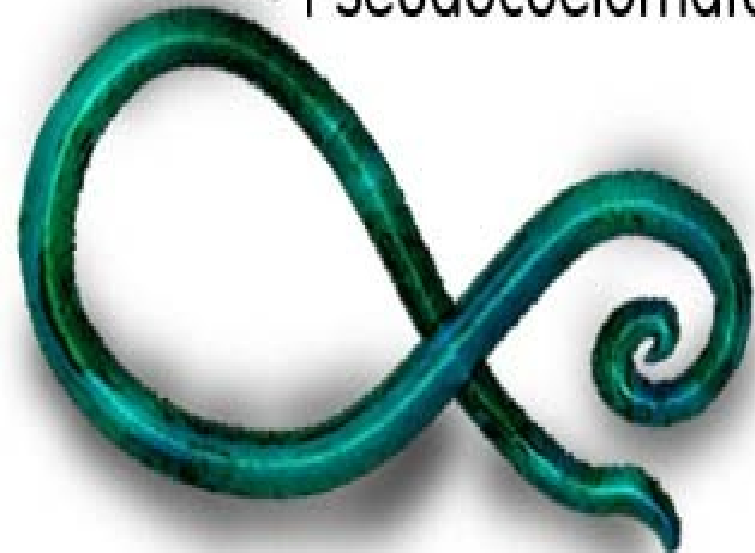
Most numerous animals on earth!

Hookworms

Ascaris

Enterobius

Trichinella





(a)

[http://www.youtube.com/watch?](http://www.youtube.com/watch?v=ALqshhGLdE4)

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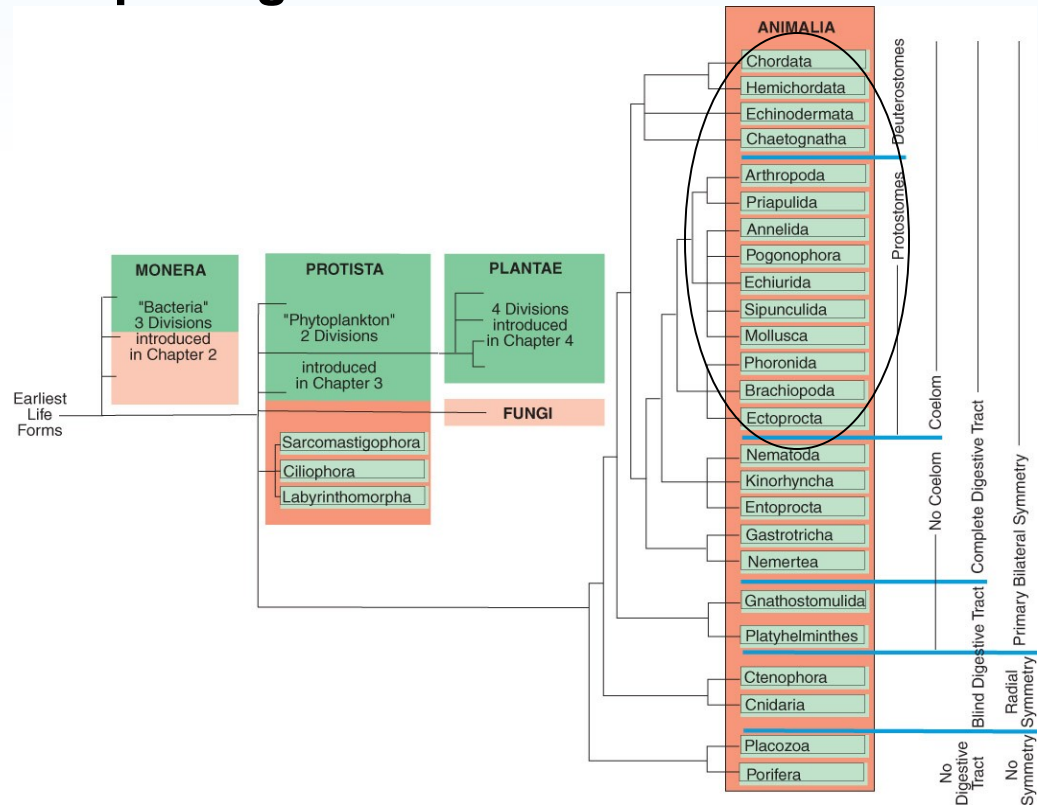
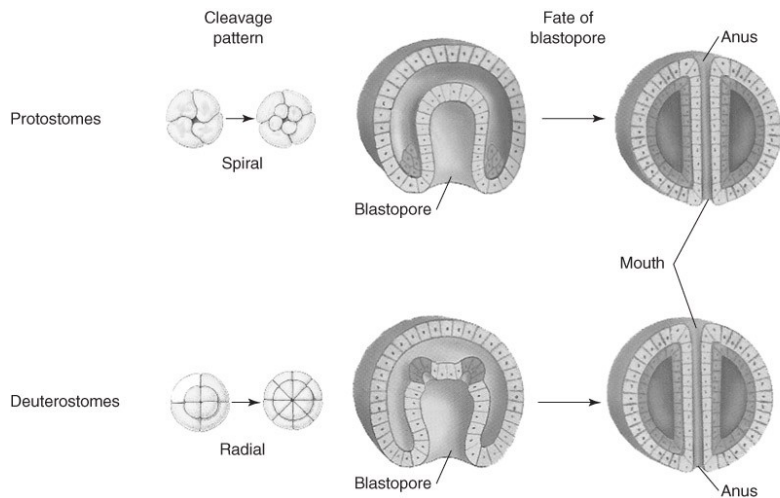
[v=ALqshhGLdE4](http://www.youtube.com/watch?v=ALqshhGLdE4)

www.jbpub.com
Fig. 9-29, p. 239

Marine Coelomates

Higher animals possess:

- a true coelom
- are separated into two fundamentally different lineages:
 - the protostomes: first opening is mouth
 - the deuterostomes: first opening is anus



The Lophophorate phyla

➤ Ectoprocta (Bryozoa)

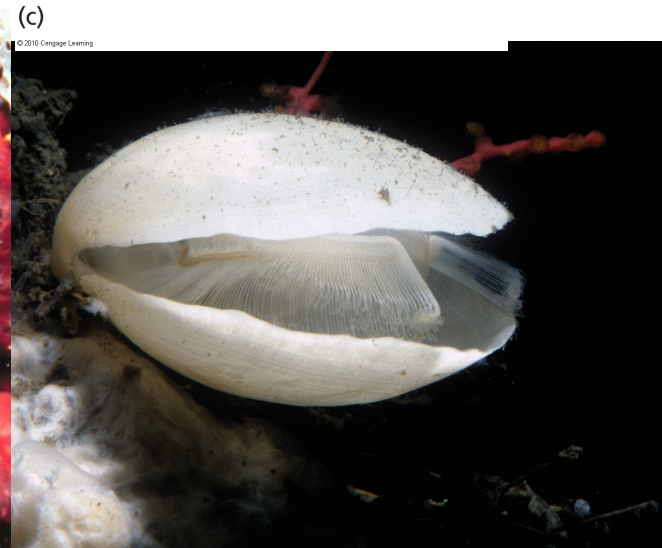
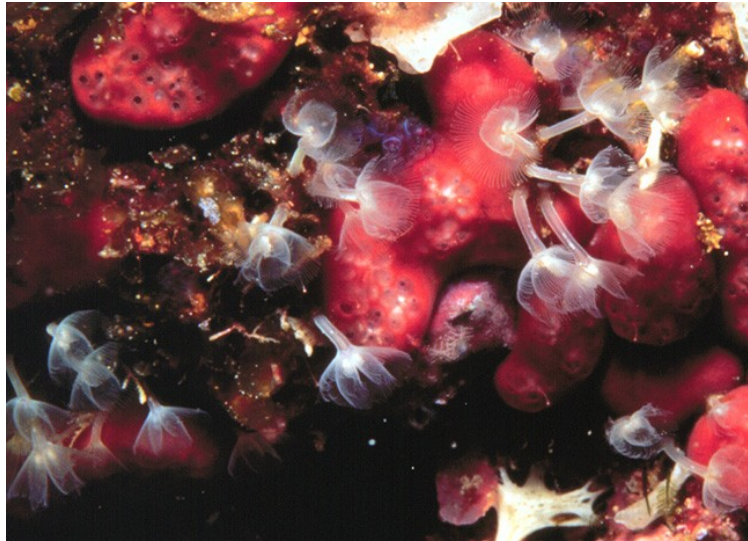
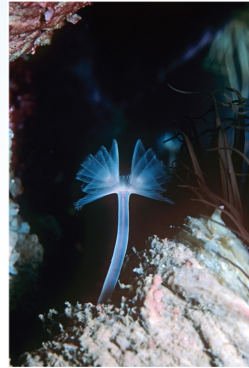
➤ Phoronida

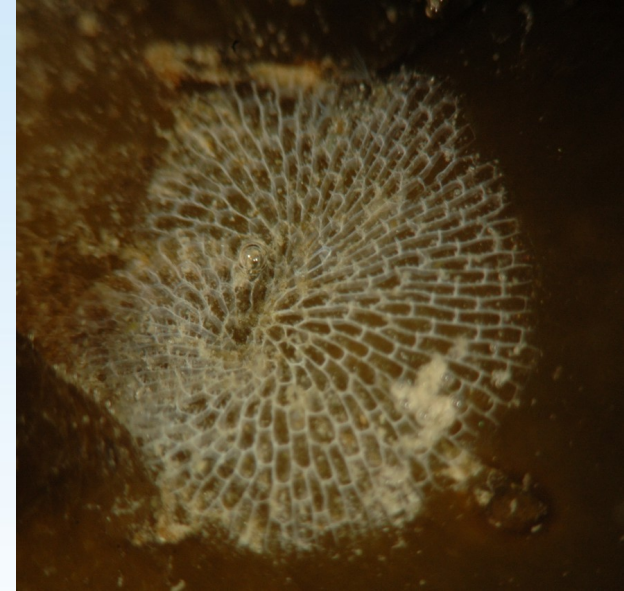
➤ Brachiopoda,

- all possess a crown of ciliated feeding tentacles (lophophore).



http://www.youtube.com/watch?v=P_gxxYWvhFw





Membranipora

Bugula



<http://www.youtube.com/watch?v=4MI8kBLcRco>

Entoprocts (bryozoans)

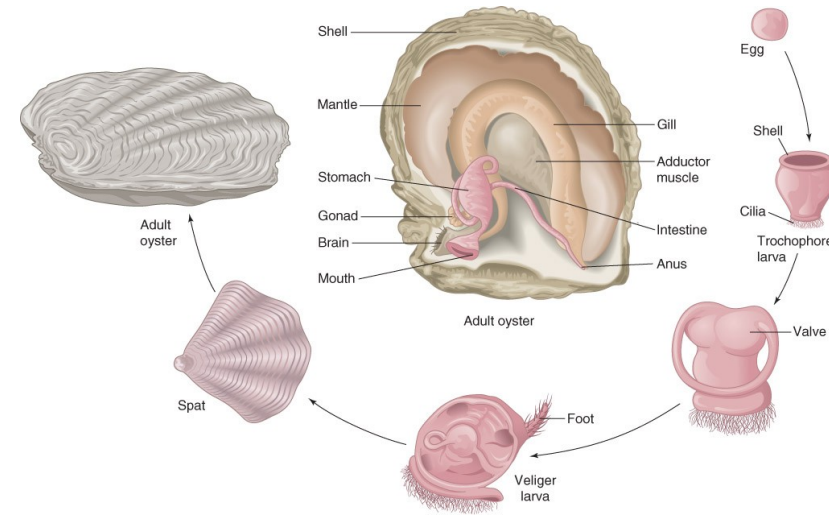
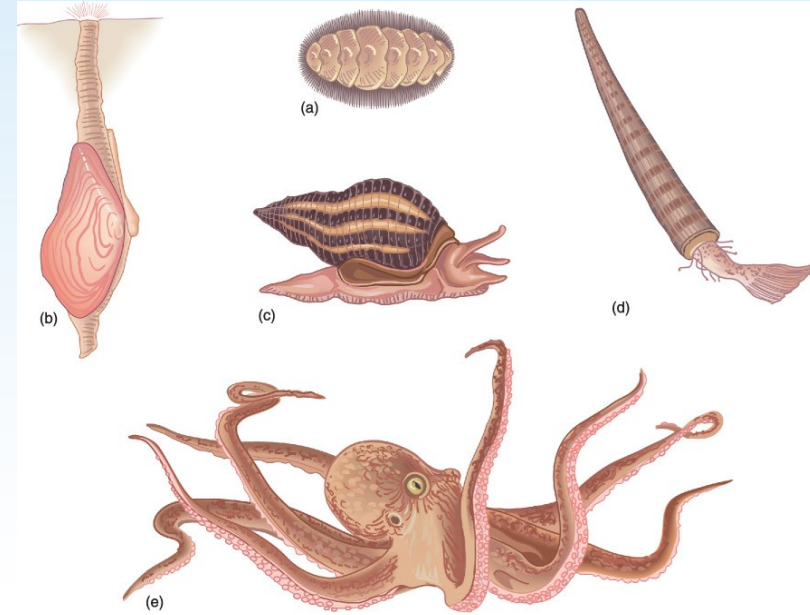
Phylum Mollusca

Include:

- Snails
- Clams, mussels, oysters, scallops
- Octopus, squid
- Chitons
- Scaphopods

Have (mostly):

- Shells
- Foot
- Larvae – as do most of these animals (what are larva?)
- Mantle
- Radula



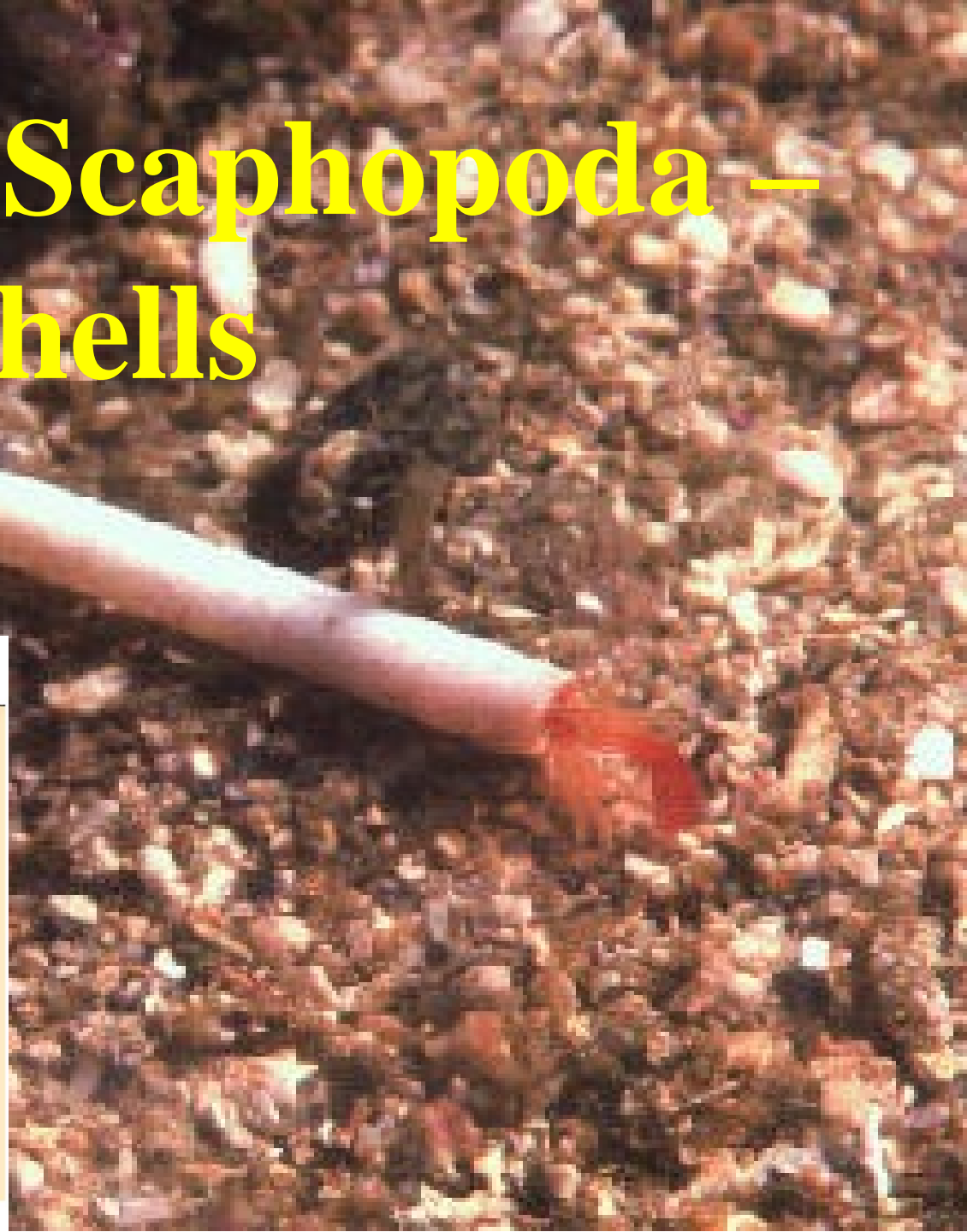
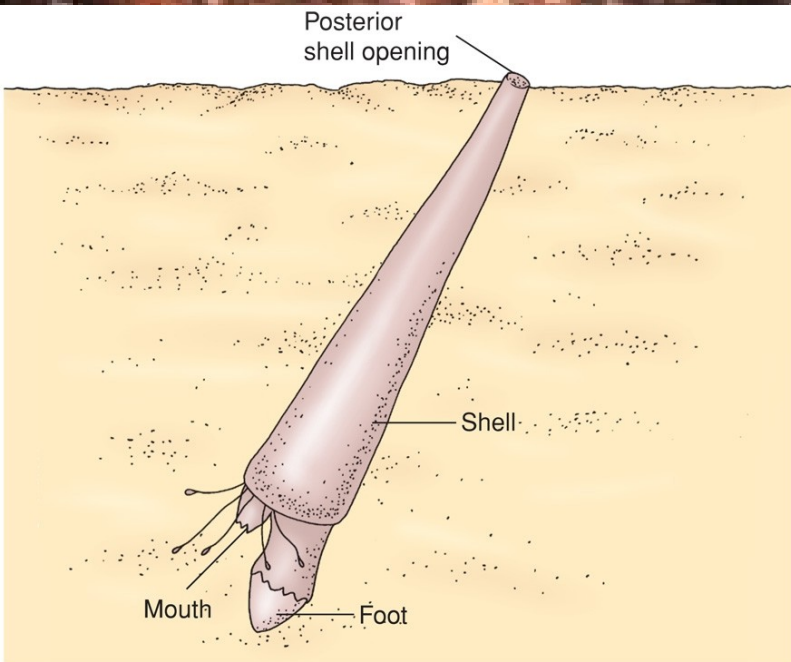
<http://www.youtube.com/watch?v=Tskd6mvzomc&feature=related>



Class Amphineura Chitons 8 plates

<http://www.youtube.com/watch?v=okq5Tt6d5Zg&feature=related>

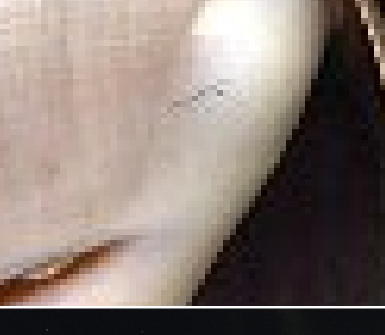
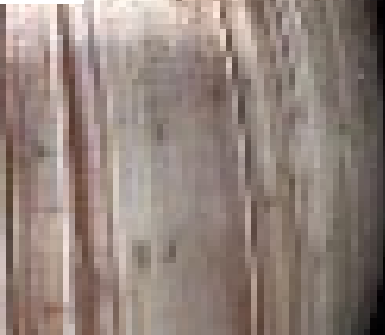
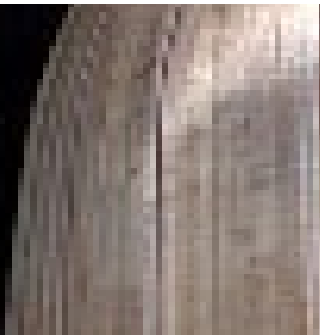
Class Scaphopoda – tusk shells



Class Gastropoda – snails & slugs



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The one below can kill a person! 6 species of cone snails can kill humans!



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<http://www.youtube.com/watch?v=nHV0V0MVwSc&feature=fvw>

<http://www.youtube.com/watch?v=iSsciYySSK8&feature=related>

<http://www.youtube.com/watch?v=tWwebIIAQR4&feature=PlayList&p>

[=FAC85375EC5A997F&playnext=1](http://www.youtube.com/watch?v=FAC85375EC5A997F&playnext=1)

<http://www.youtube.com/watch?v=HyFBwmmnc4Q>



(a) Many gastropods lay their eggs in protective cases such as this one of the whelk (*Busycon contrarium*).



<http://www.youtube.com/watch?v=YKtJNZGkVkE>

(c)

Veliger larva!



Class
Bivalvia
2 halves
(valves)
of shell

- Clams
- Oysters
- Mussels
- Scallops

Filter feeders!!!

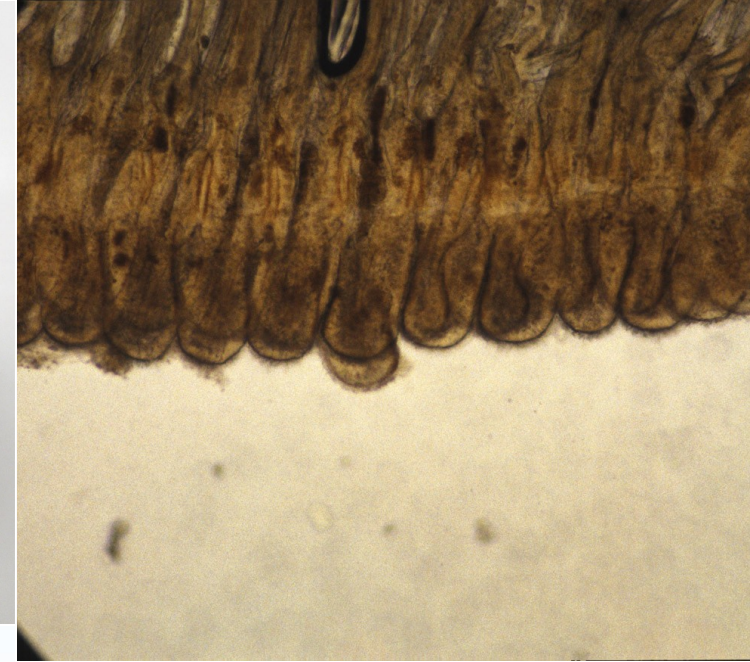


Fig. 5.25 Lateral view (left) of the intact gill of a ribbed mussel, *Geukensia demissa*, and a micrograph of the gill edge with cilia (right).

http://www.youtube.com/watch?v=_2iXHBuSIJY



(b)



(b)

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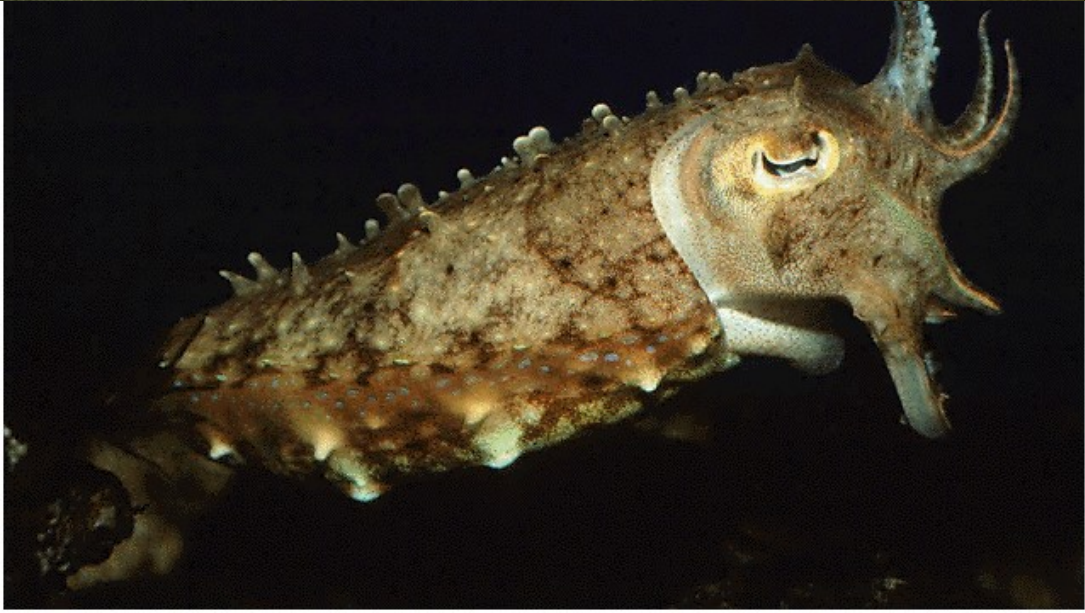


(a)

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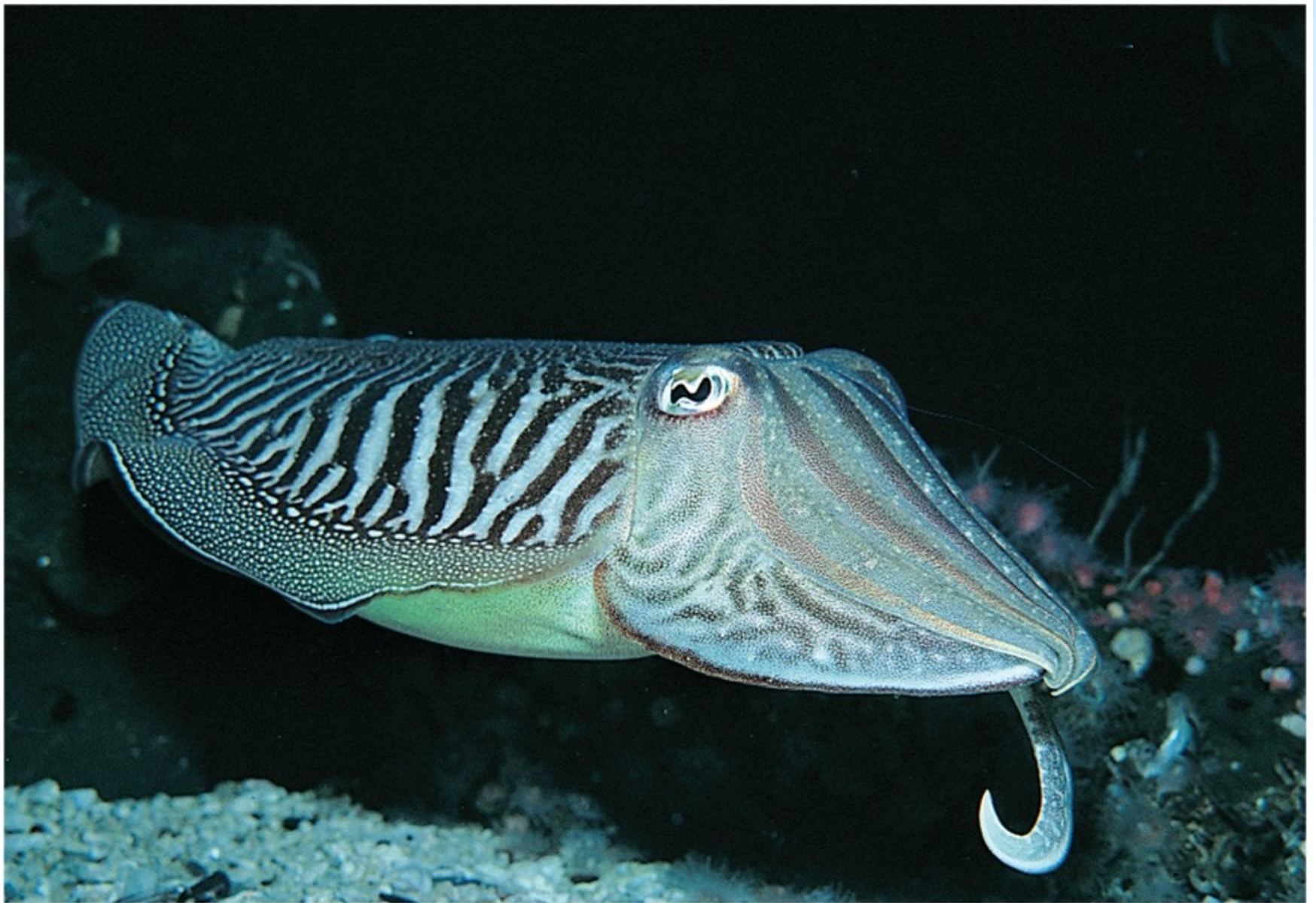
<http://www.youtube.com/watch?v=QMFqV4SJLWg>

Class Cephalopoda



shown at Funny-games.biz

w.jpup.com)



(a)
The cuttlefish resembles a squid
and has a small internal shell

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The blue-ring octopus, *Hapalochlaena maculosa*, from Australia, uses color to advertise its toxicity. By changing its background color from dark to light, the bright blue rings on its body become more evident.

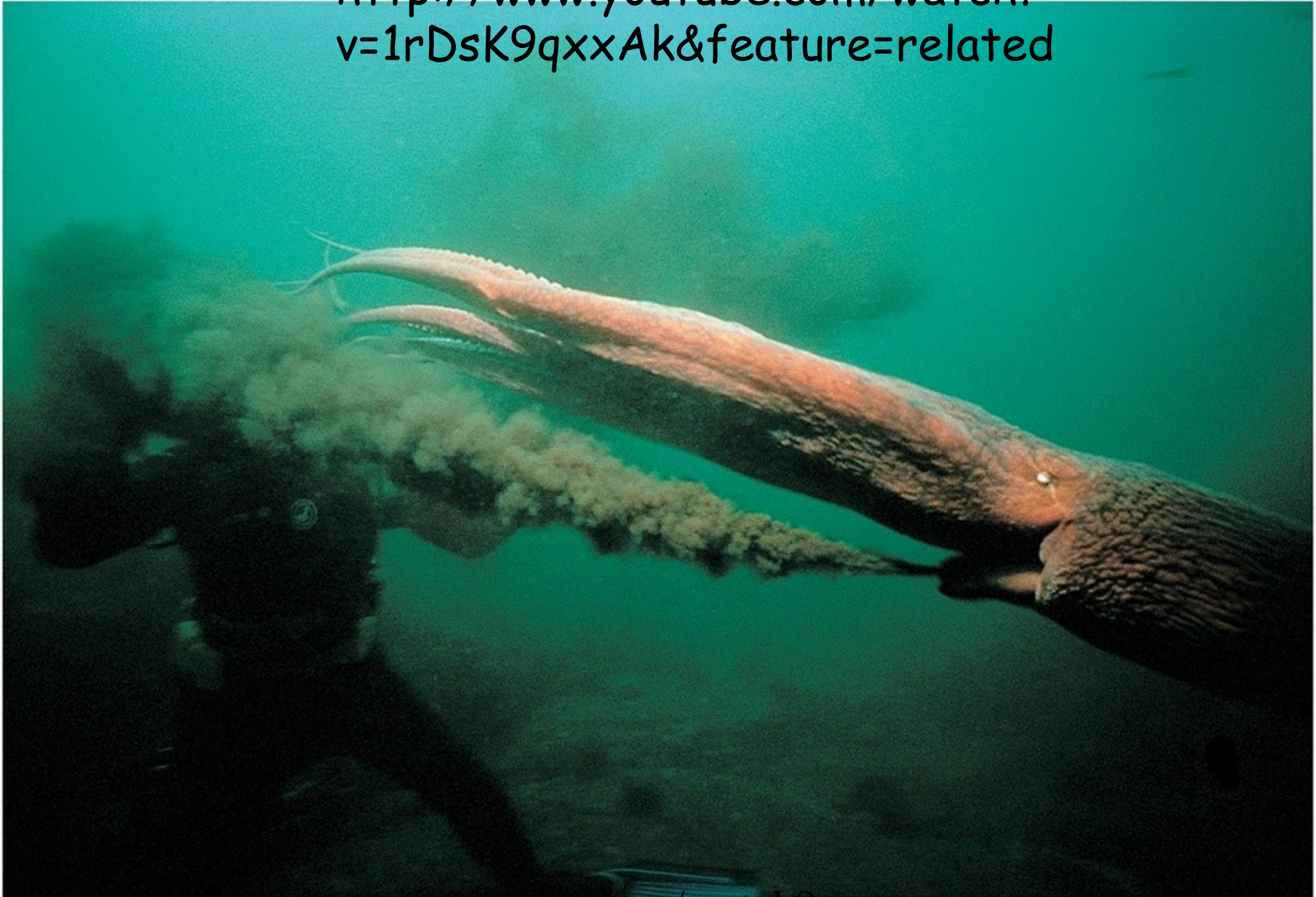
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(b) The octopus *Thaumoctopus mimicus* protects itself and sneaks up on prey by changing its body shape to resemble other animals. Notice how the arms of this specimen mimic venomous sea snakes.

<http://www.youtube.com/watch?v=1rDsK9qxxAk&feature=related>

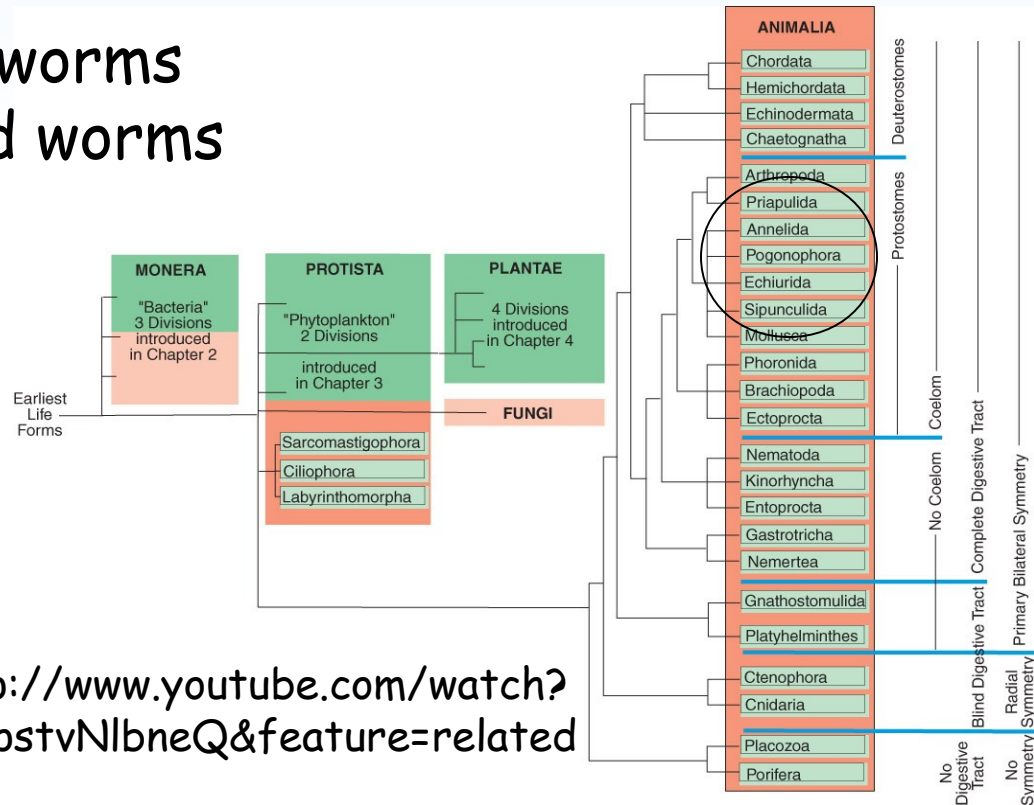


<http://www.youtube.com/watch?v=1QYn7WwESAc>

Wormlike Protostomes



- Phylum Priapulida
- Phylum Pogonophora
- Phylum Echiurida
- Phylum Sipunculida - peanut worms
- Phylum Annelida - segmented worms



<http://www.youtube.com/watch?v=TpstvNlbneQ&feature=related>

Wormlike Protostomes

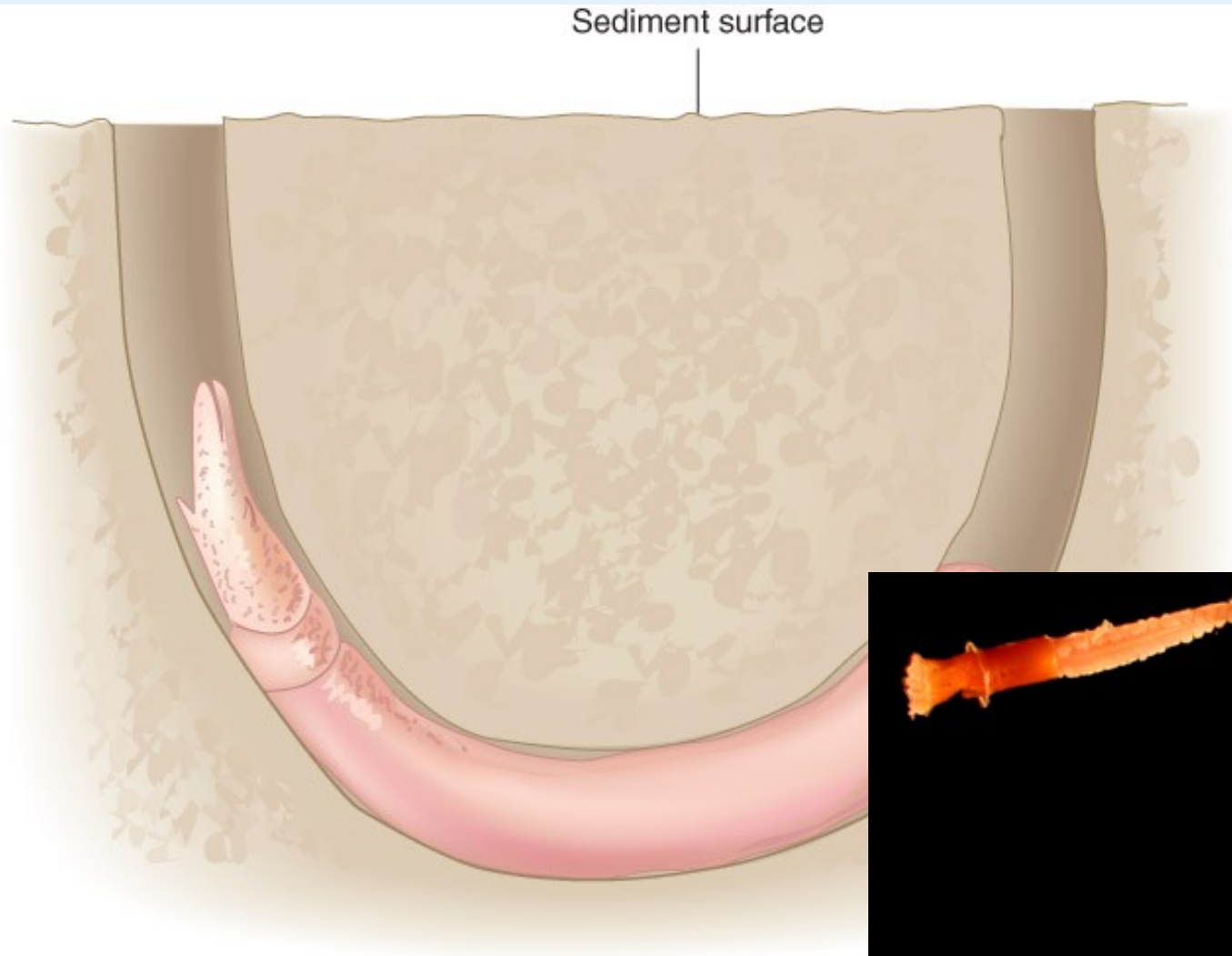


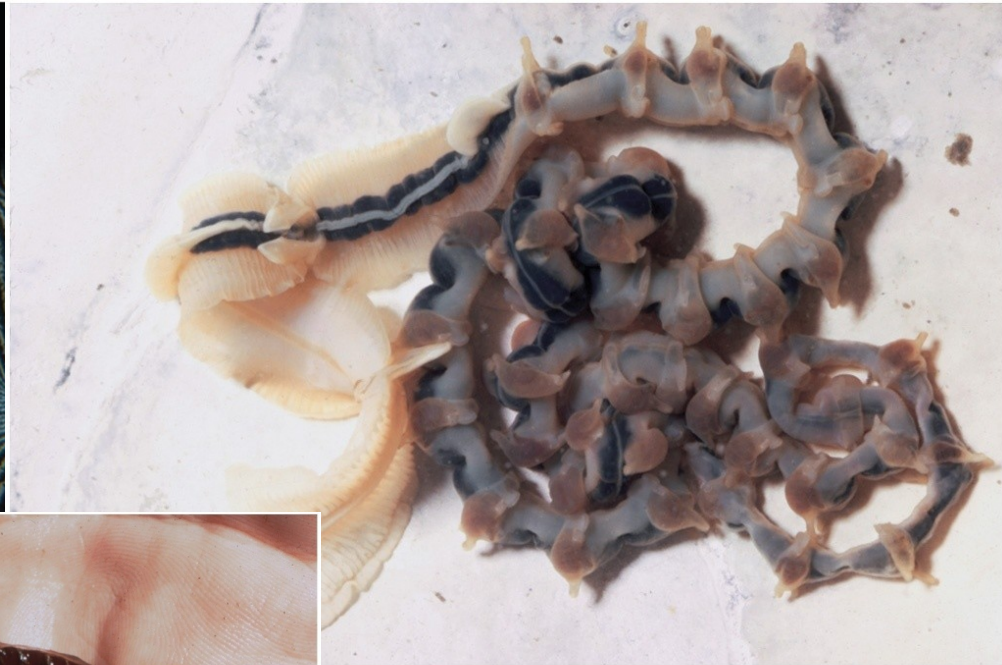
Fig. 5.28 The fat keeper, *Urechis*, in its burrow.

Pogonophora

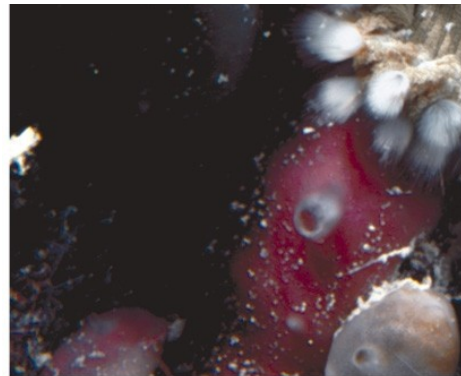


Phylum Annelida – Segmented Worms





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Phylum Arthropoda – jointed appendages

➤ Include:

- Horseshoe crabs
- Sea spiders
- Crabs, lobsters, shrimp, copepods, krill, beach hoppers
barnacles



➤ Have (mostly):

- Chitinous exoskeleton
- molting
- Jointed appendages
- Segmented body



➤ Phylum Arthropoda = 75% of identified species

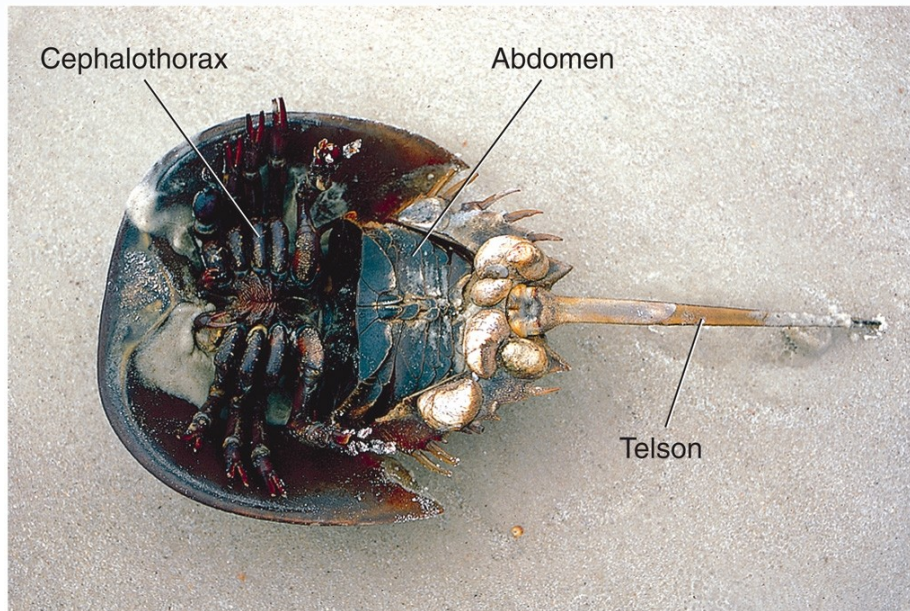
➤ Large part of the zooplankton



Phylum Arthropoda

Class Merostomata – horseshoe crabs

<http://www.youtube.com/watch?v=MrrYtOc6Y0c&feature=related>



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Fig. 5.31 Two horseshoe crabs, *Limulus*, emerge from the sea to mate on the sand.

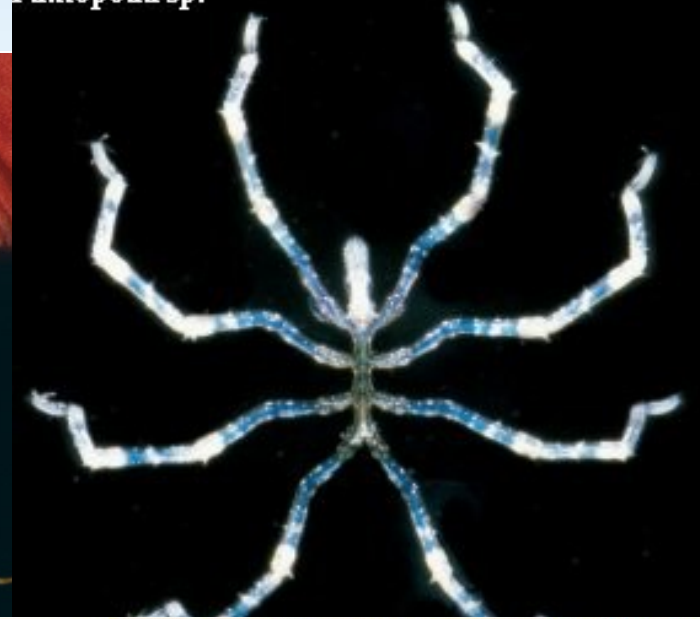
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Phylum Arthropoda

Class Pycnogonida – sea spiders



Pantopoda sp.



Phylum Arthropoda

Class Crustacea

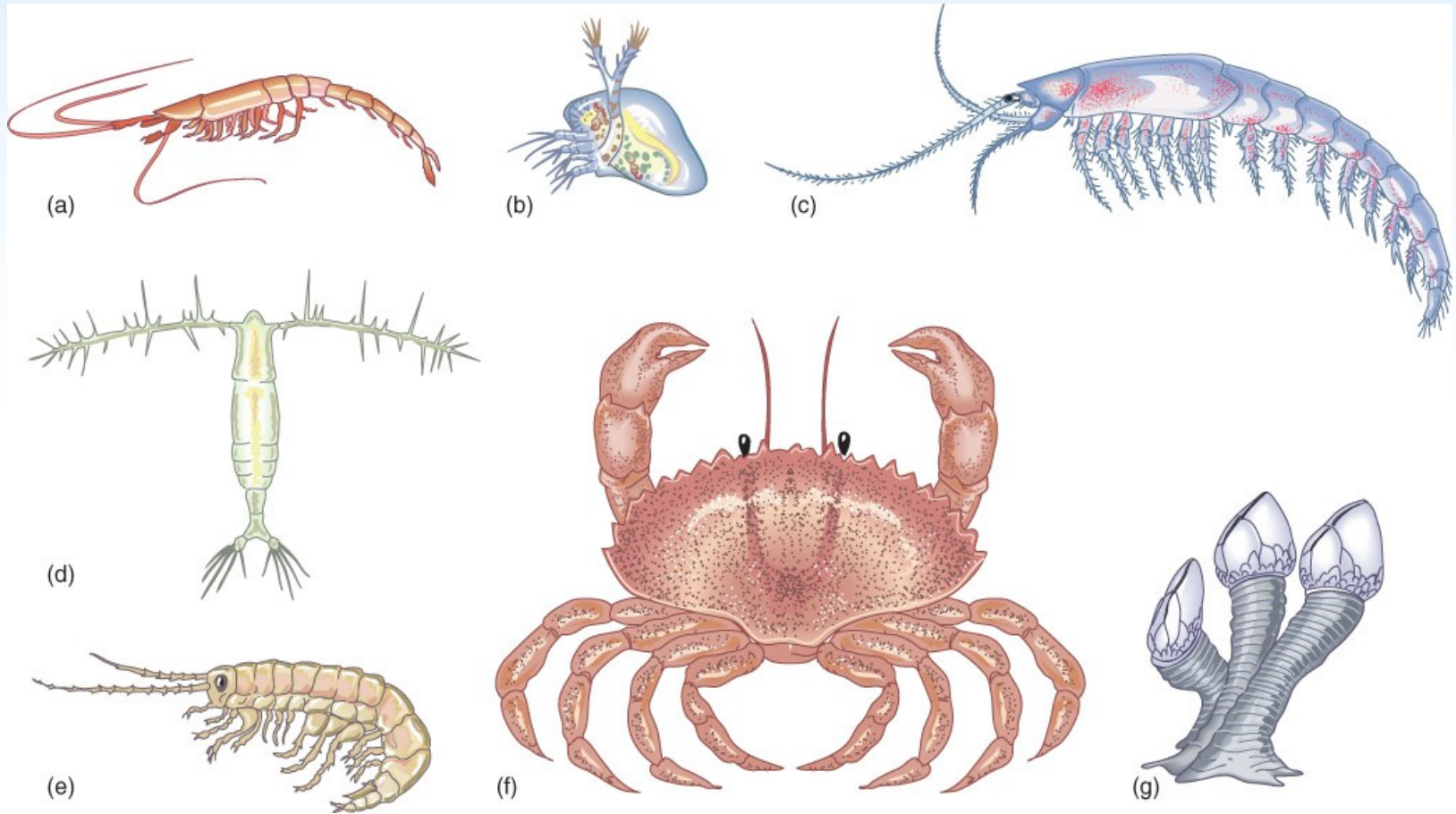


Fig. 5.33 A variety of marine crustaceans: (a) mysid, (b) cladoceran, (c) euphausiid, (d) copepod, (e) amphipod, (f) crab, and (g) barnacle.



T] (c)

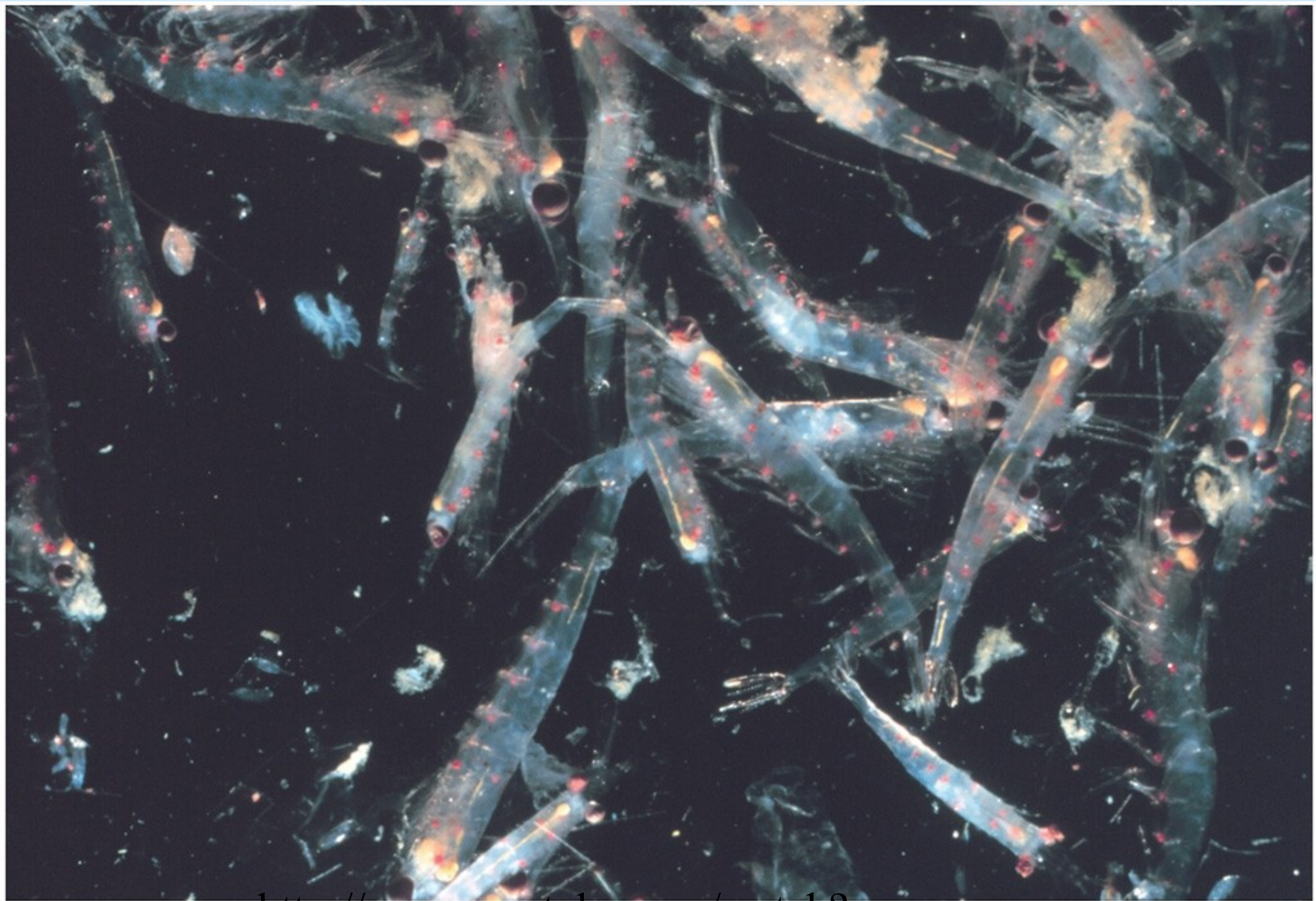
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Pacific, is the largest living arthropod



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http://www.youtube.com/watch?v=Hkv_30niM_A

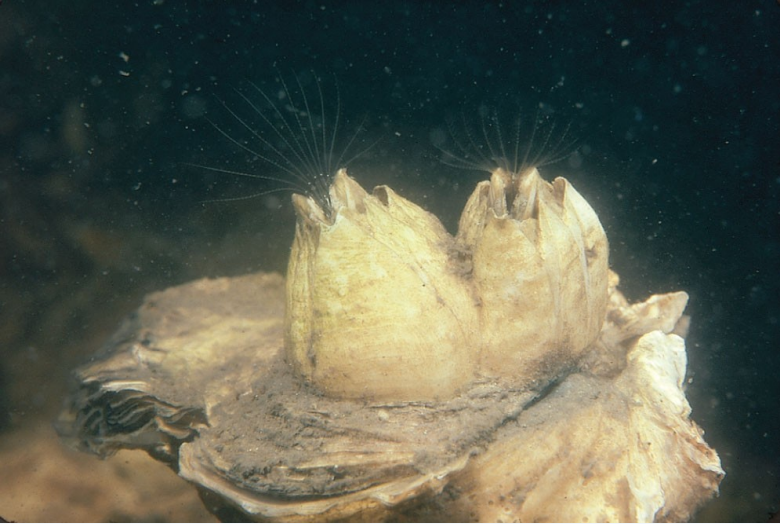
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Fig. 9-36, p. 244



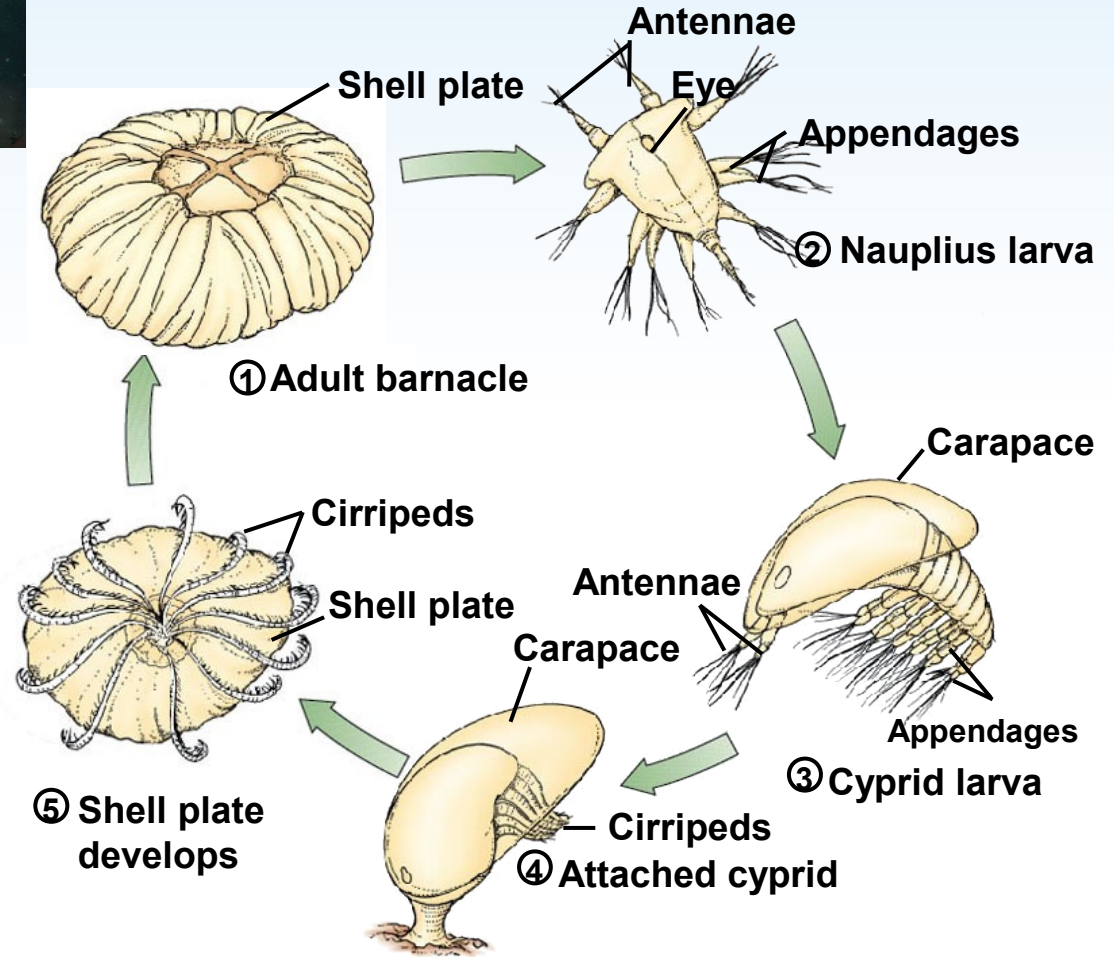
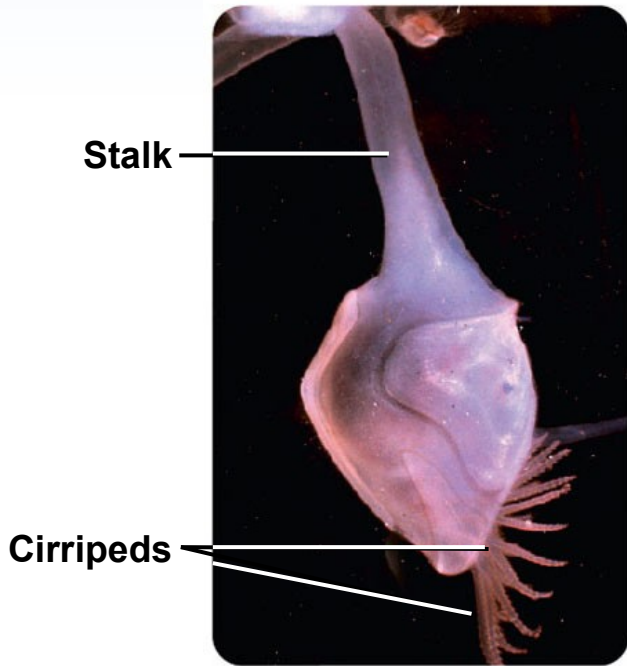
[http://www.youtube.com/watch?](http://www.youtube.com/watch?v=WjX4L7Lxlv&feature=related)

[v=WjX4L7Lxlv&feature=related](http://www.youtube.com/watch?v=WjX4L7Lxlv&feature=related)



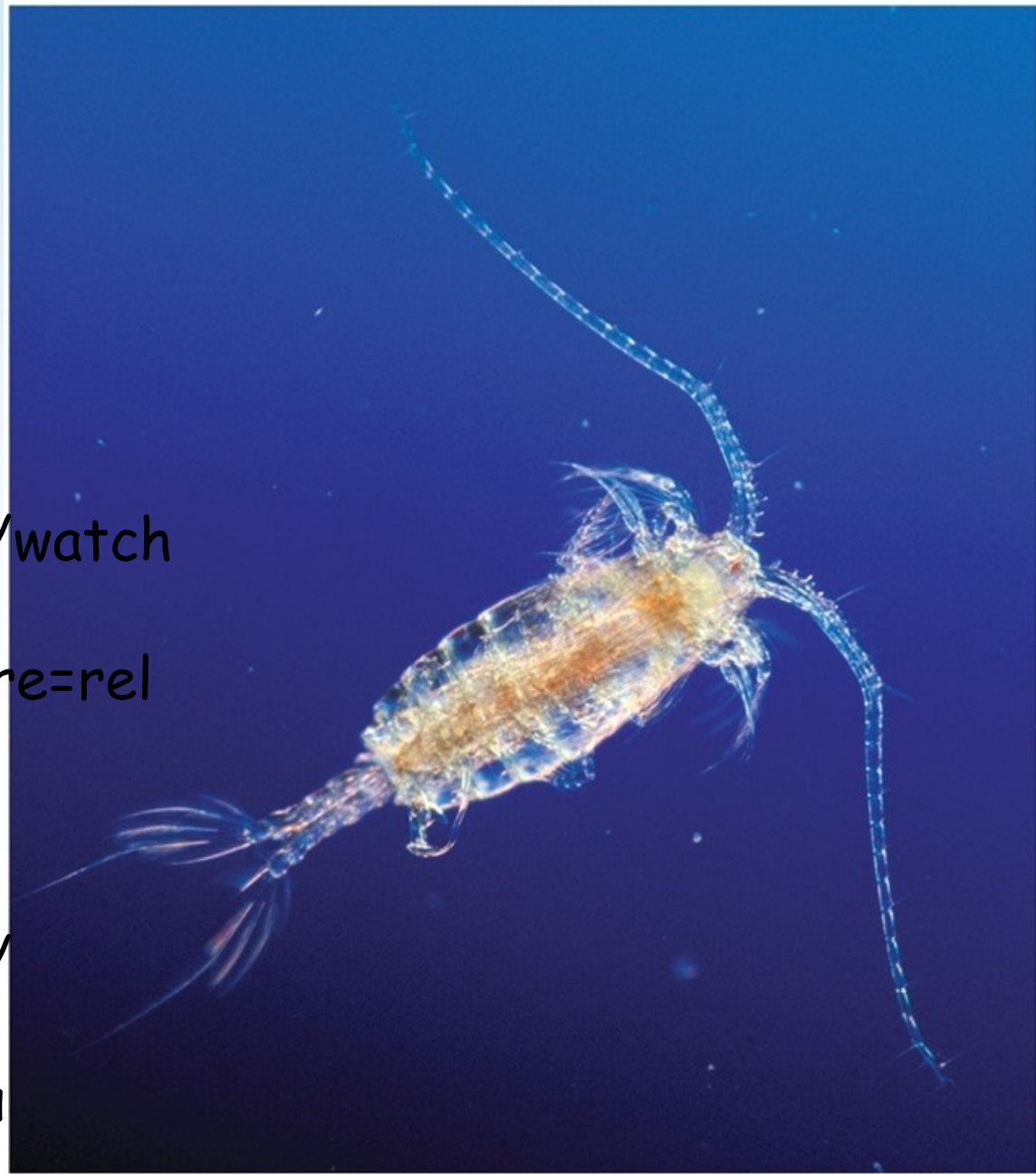


<http://www.youtube.com/watch?v=25F7xMVNt-w>



<http://www.youtube.com/watch?v=Ggk2O7p4vWQ&feature=related>

<http://www.youtube.com/watch?v=ZTcWGGTKKNE&feature=related>
Crab larvae!

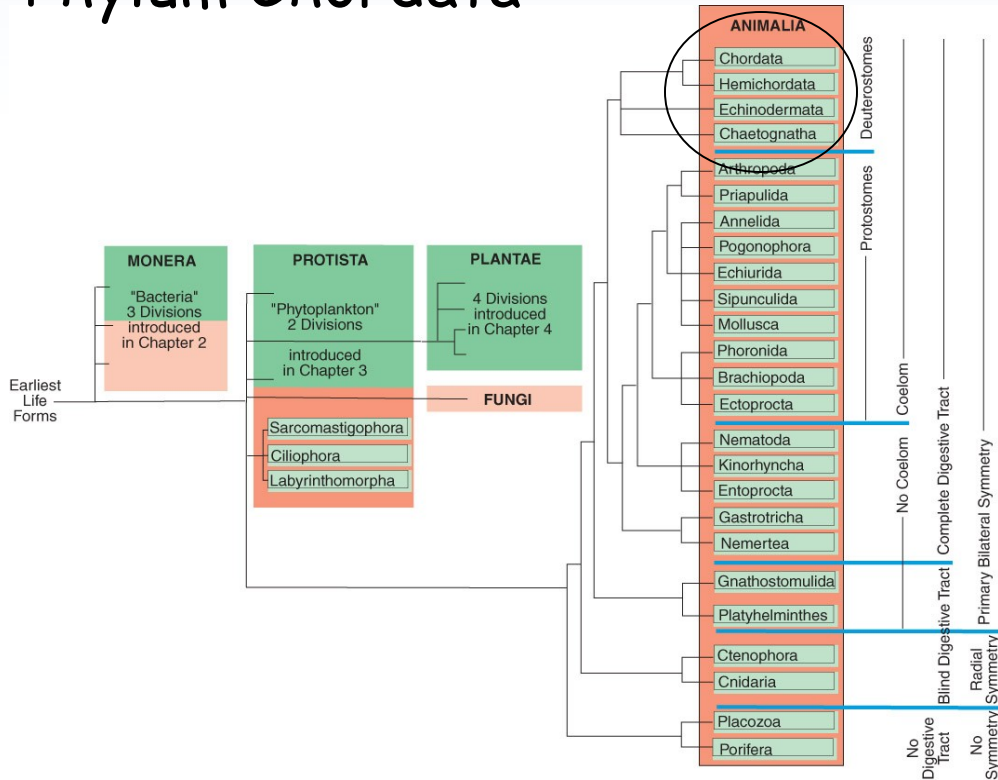


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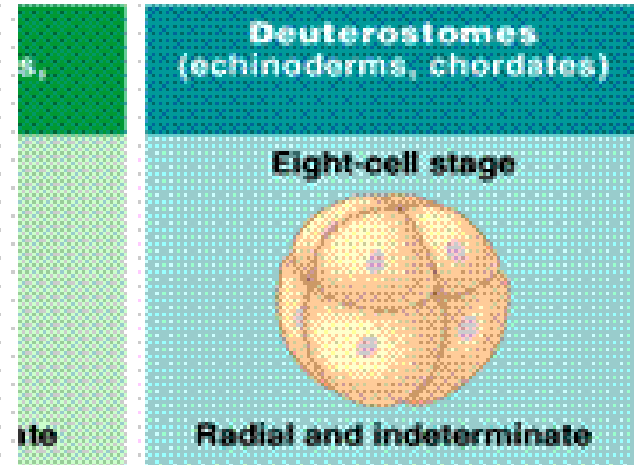
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Fig. 9-39, p. 245

Deuterostomes

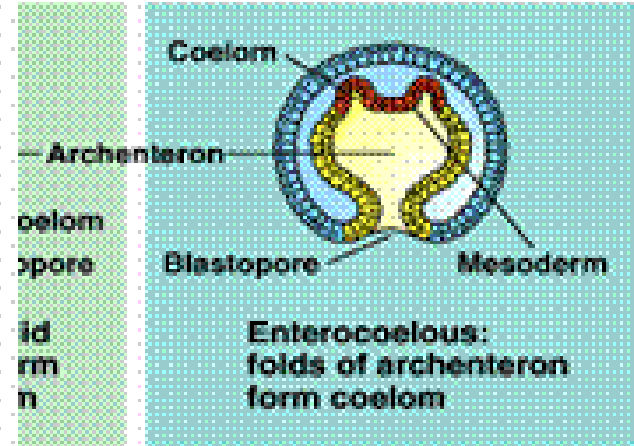
- Phylum Chaetognatha
- Phylum Echinodermata
- Phylum Hemichordata
- Phylum Chordata



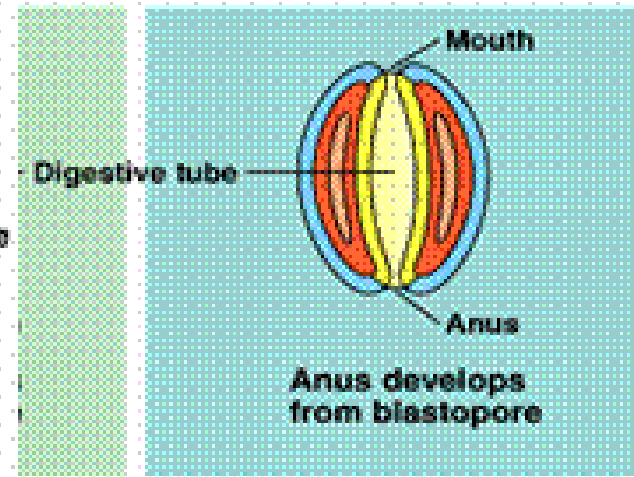
(a) Cleavage



(b) Coelom formation

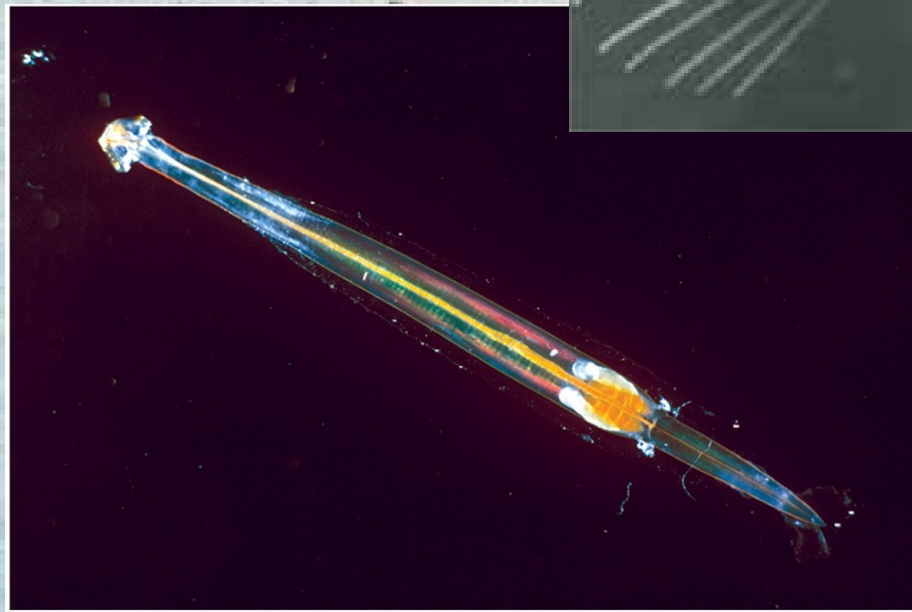
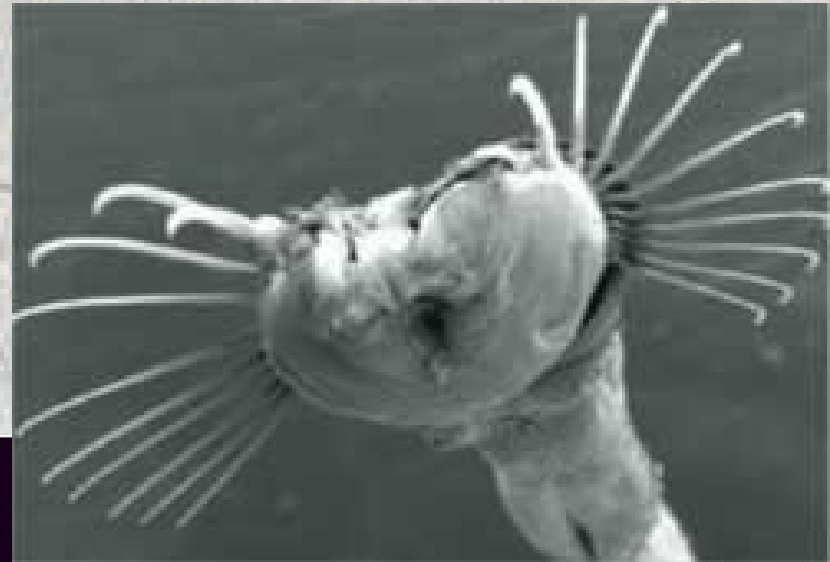


(c) Fate of blastopore



Phylum Chaetognatha

Arrow Worms



0.5 mm



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Phylum Hemichordata

Acorn worms

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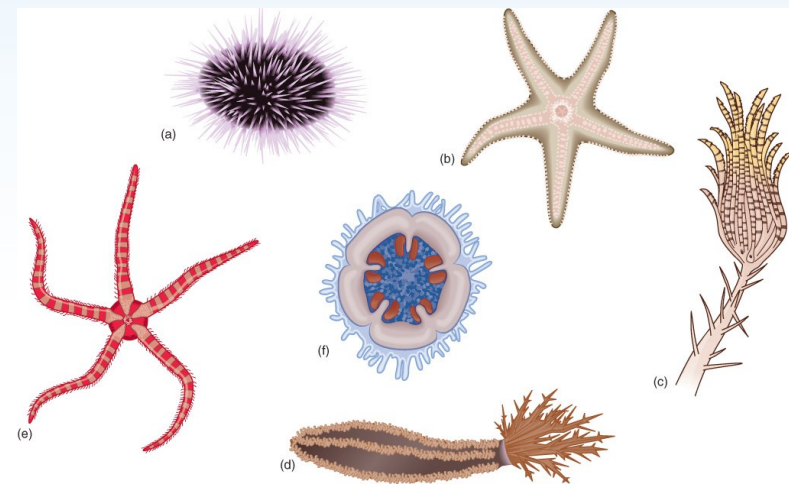
Phylum Echinodermata – back to radial symmetry???

➤ Include:

- Sea stars
- Sea urchins, sand dollars
- Sea cucumbers
- Brittle stars, basket stars
- Feather stars, sea lilies
- Sea daisies

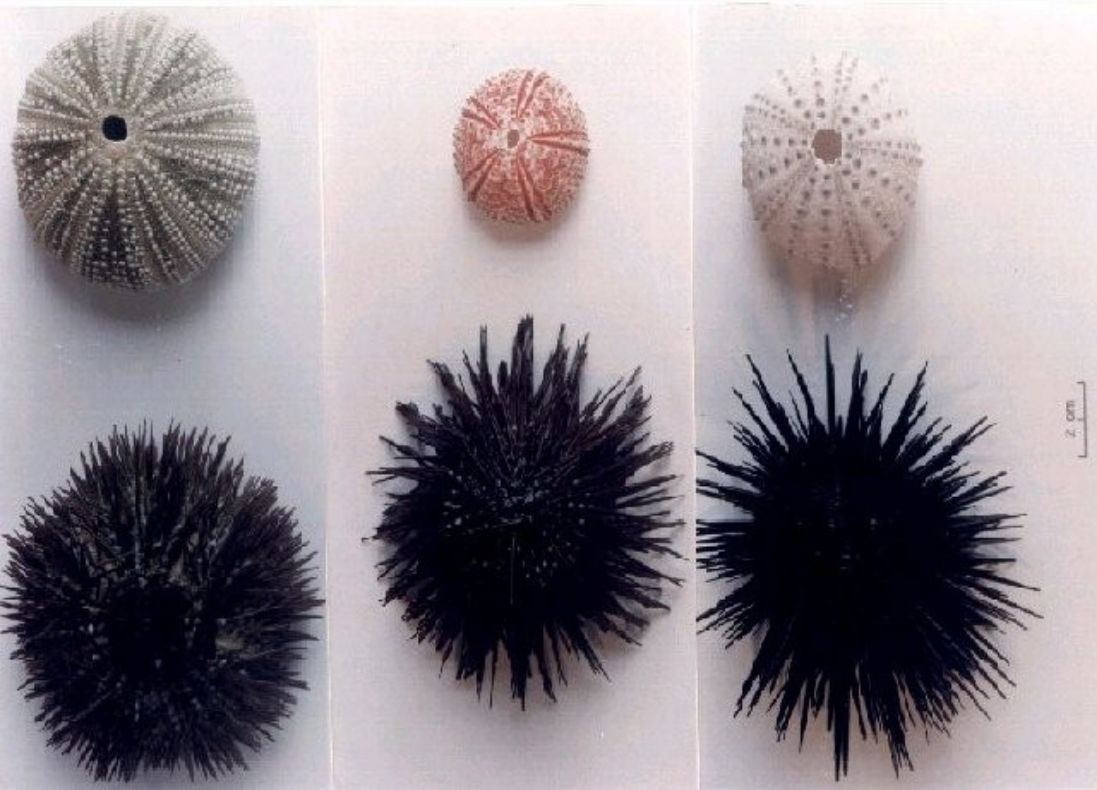
➤ Have (mostly):

- Bilateral larvae/radial adults
- Endoskeleton with spines (spiny skin!)
- Water-vascular system
- Tube feet
- Regeneration



Phylum Echinodermata

Class Echinoidea





[http://www.youtube.com/watch?](http://www.youtube.com/watch?v=PakhDt8W4I4&feature=related)

[v=PakhDt8W4I4&feature=related](http://www.youtube.com/watch?v=PakhDt8W4I4&feature=related)

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Sand dollar video – 25
minutes of footage

[http://www.youtube.com/watch?
v=gLK71-vsi2E&feature=related](http://www.youtube.com/watch?v=gLK71-vsi2E&feature=related)

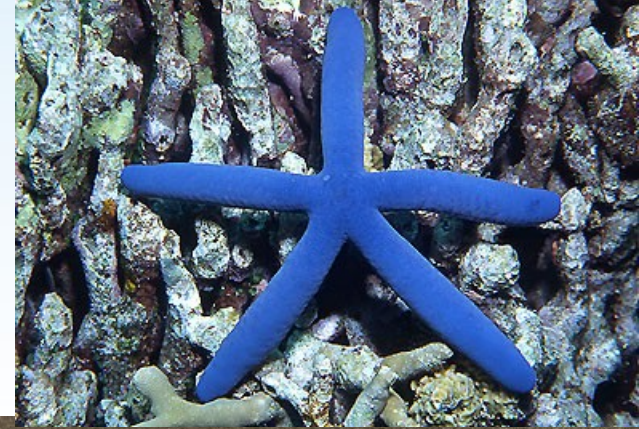


heart urchins are adapted to

(b) burrowing and have much smaller
spines than sea urchins.

Phylum Echinodermata

Class Asteroidea





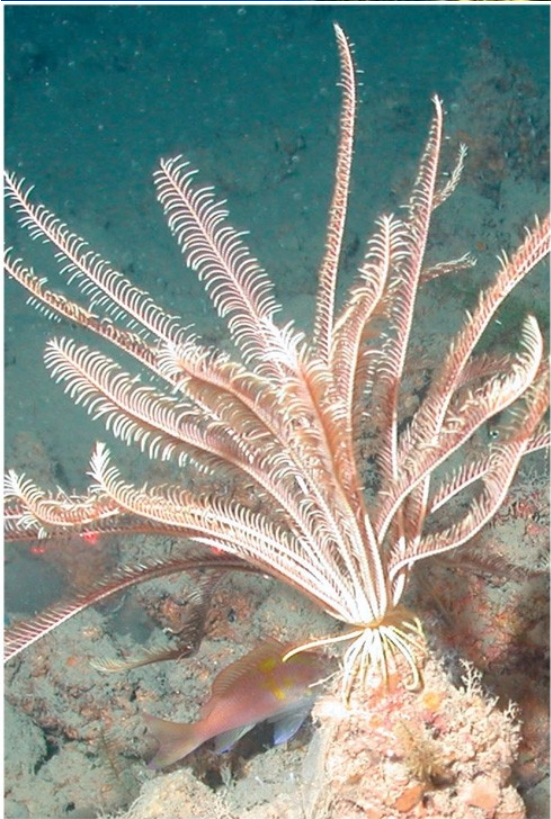
<http://www.youtube.com/watch?v=0NHdT7dg2dM>

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Phylum Echinodermata

Class Crinoidea



<http://www.youtube.com/watch?v=vzV/E6sTGQ&feature=related>

Phylum Echinodermata

Class Holothuroidea

<http://www.youtube.com/watch?v=aCxKFc3XtJs>

DR. LANE CAMERON ELICITING SPONTANEOUS EVISCERATION IN *P. californicus*

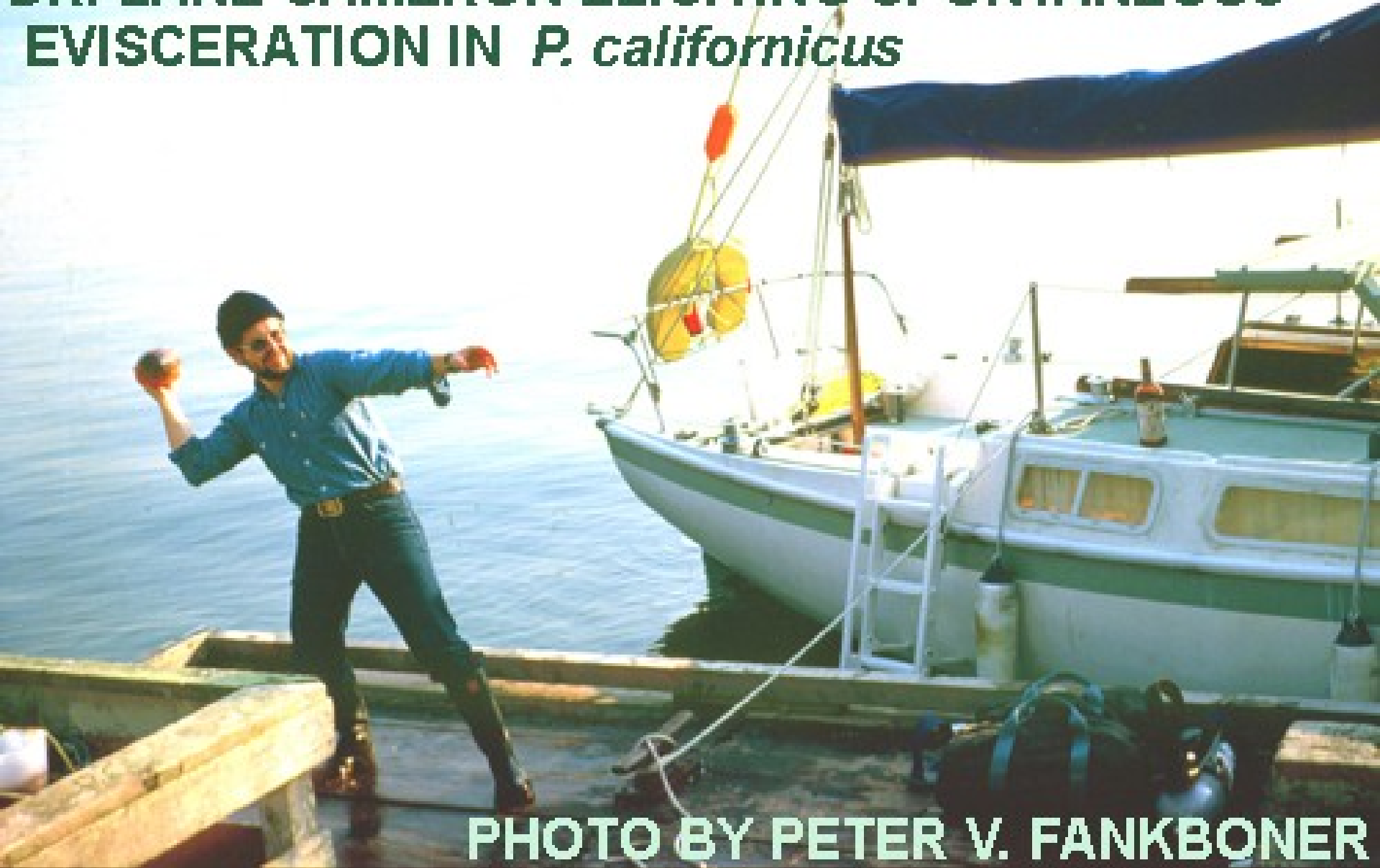
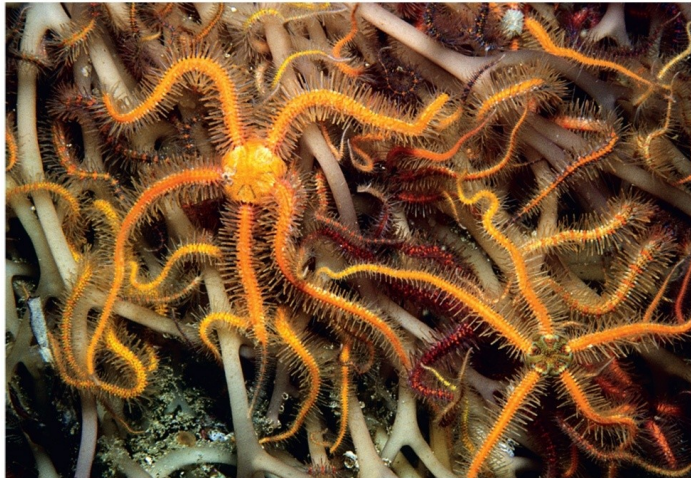


PHOTO BY PETER V. FANKBONER

Phylum Echinodermata

Class Ophiuroidea



(a)



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A basket star *Gorgonocephalus arcticus* from Friday Harbor, Washington. Basket stars use their highly branched rays to capture plankton.

Phylum Echinodermata

Class Concentricycloidea

Xyloplax tumerae - male



PHOTO BY DANIEL JANIES

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Phylum Chordata

- All chordates possess (at some point in their life):
 - a dorsal hollow nerve cord
 - a cartilaginous notochord
 - pharyngeal gill slits
 - a postanal tail
- Invertebrate chordates – 2 subphyla
 - Urochordata – the tunicates
 - **Sea squirts, salps, larvaceans**
 - Cephalochordata – the lancelets
 - Subphylum Vertebrata – coming next chapter!!!

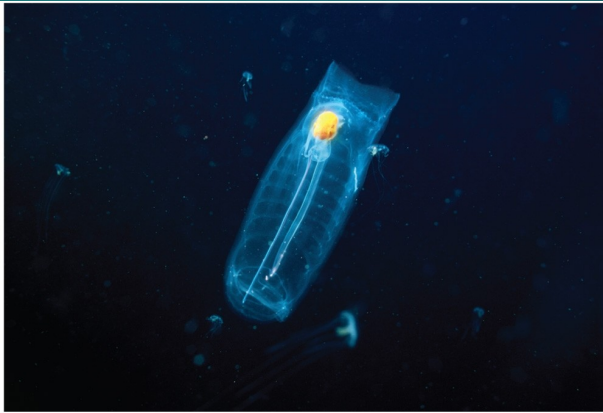
Phylum Chordata

Subphylum Urochordata

tunicates or sea squirts



Salps



(c)

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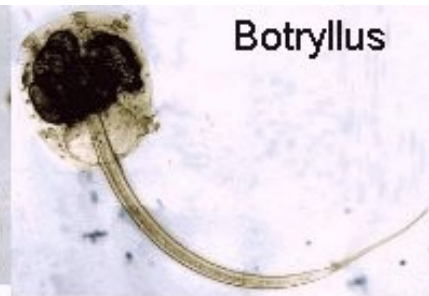
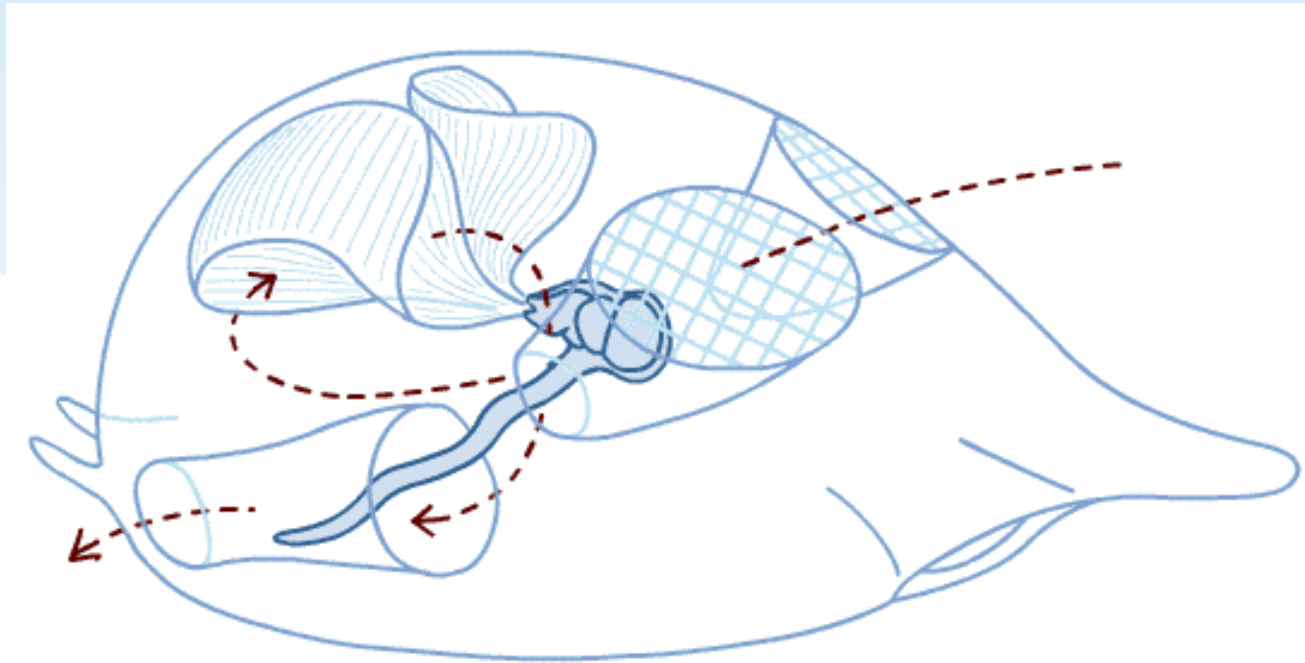
<http://video.google.com/videoplay?docid=-6131803023048807387#docid=1593646019025193466>

Larvaceans

<http://www.youtube.com/watch?v=-Jooz4gz264>



Oikopleura (0.1 mm)



TUNICATE LARVAE GALLERY

Phylum Chordata
Subphylum Cephalochordata
Only chordate to keep all
chordate characteristics
throughout life!!!



Subphylum Vertebrata

