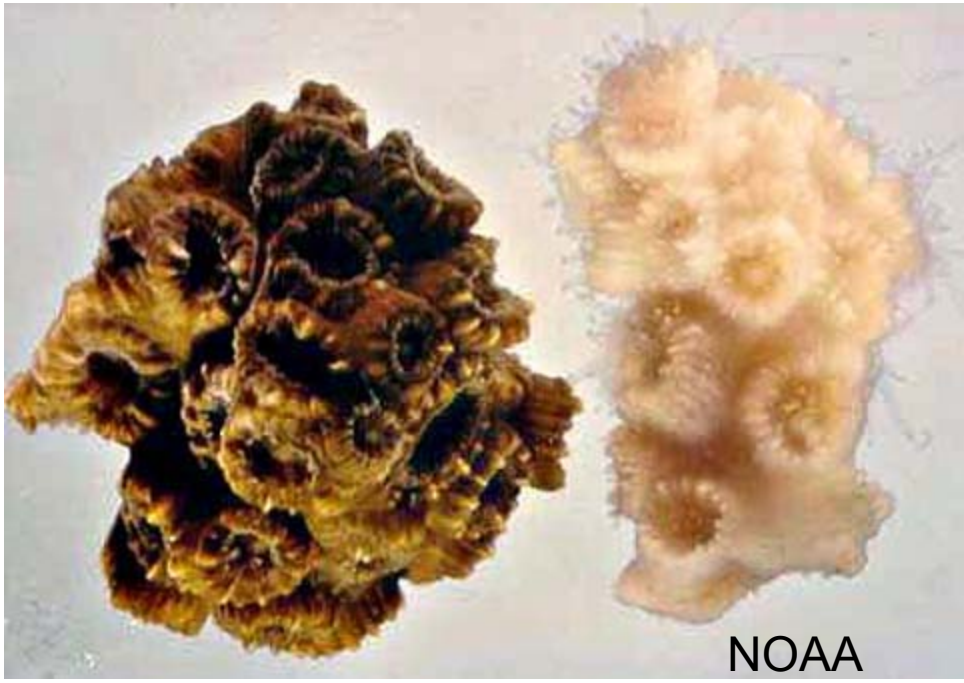
Climate and Coral Bleaching

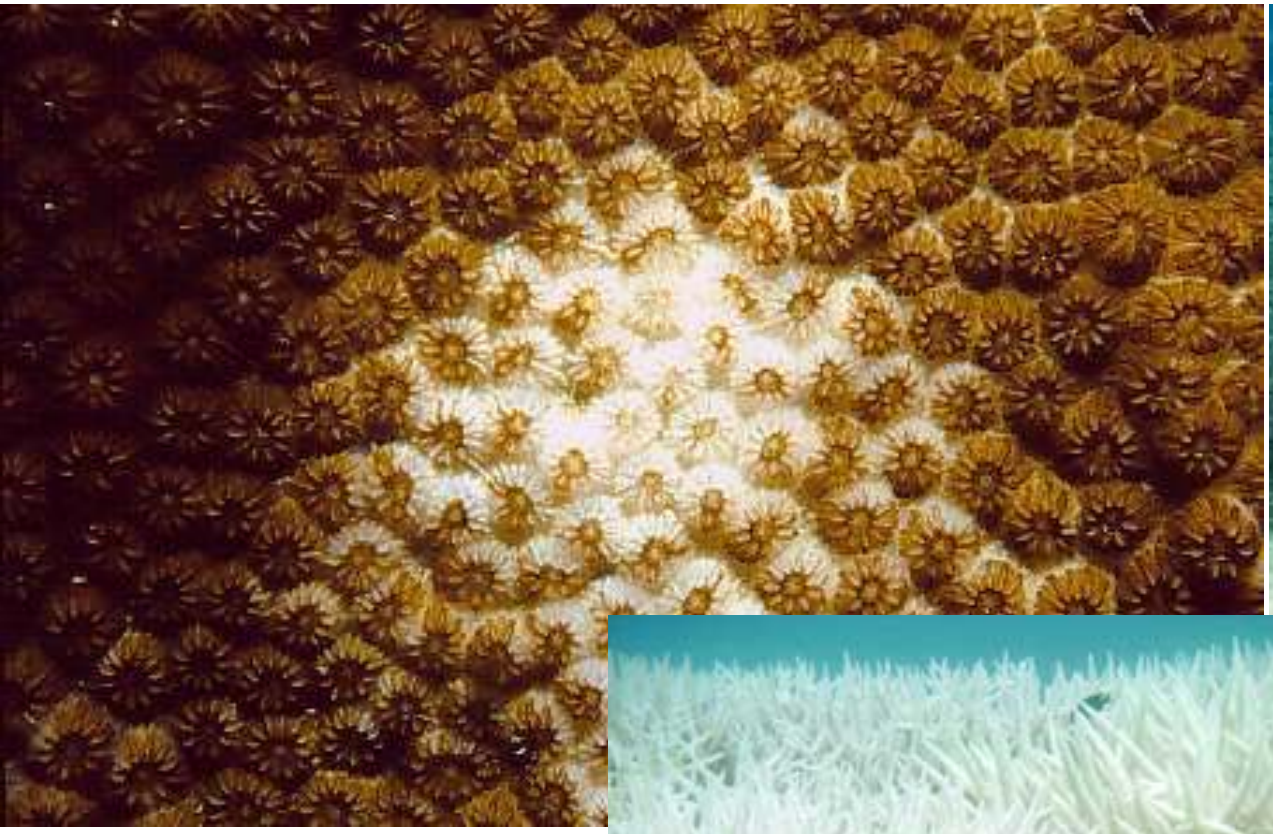
- Coral bleaching first documented in 1980s
- Ocean warming and El Nino-Southern Oscillation (ENSO)
  - ENSO brings unusually warm water to the Pacific and Indian Oceans
  - Bleaching events in 1982-83, 1987-88, 1997-98, 2001-2002 tied to ENSO
  - 1997-98 event lost 16% of global coral reefs

What is Coral Bleaching?

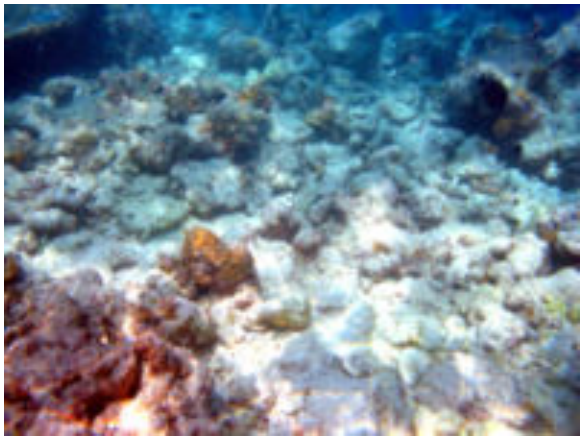
- Any Cnidarian with symbionts can be "bleached"
- Bleaching is the loss of symbiotic algae by the coral or other host
  - Living tissue becomes translucent
- Biological response of corals
  - Cellular mechanisms
    - Degeneration of *Symbiodinium*
    - Host release of algae



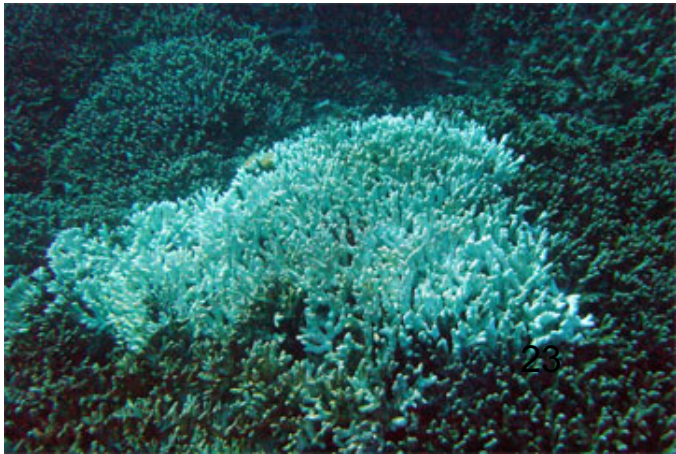
Coral Bleaching Images



Coral Bleaching

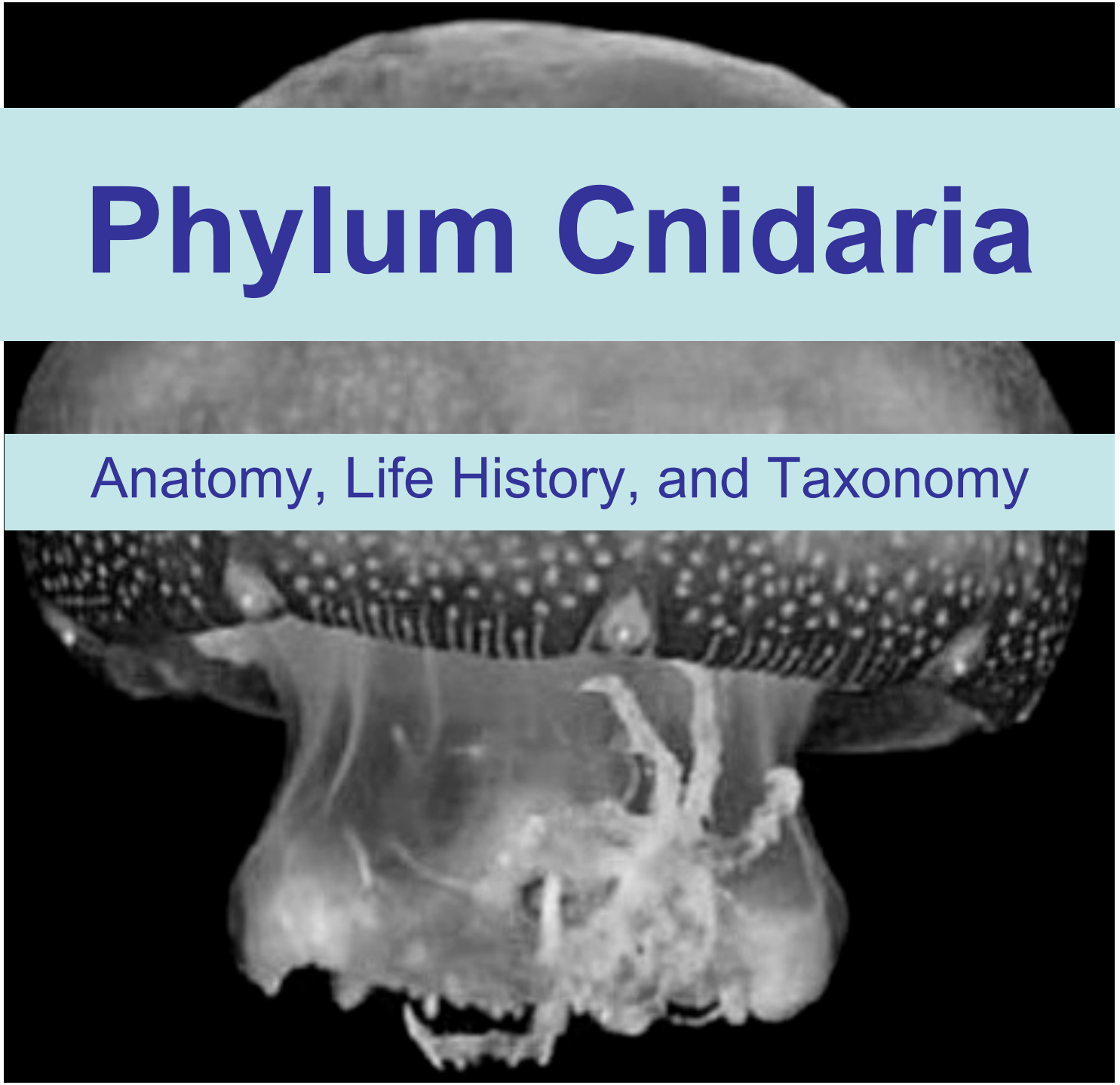


- Attributed to:
  - high light levels
  - increased solar ultraviolet radiation
  - temperature or salinity extremes
  - high turbidity and sedimentation
- Generalized stress response of coral
- Some species more susceptible than others under the same conditions
- Important indicator of disease

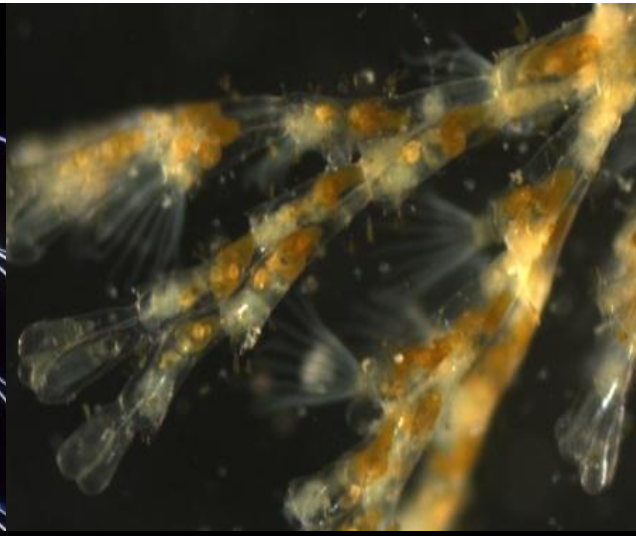


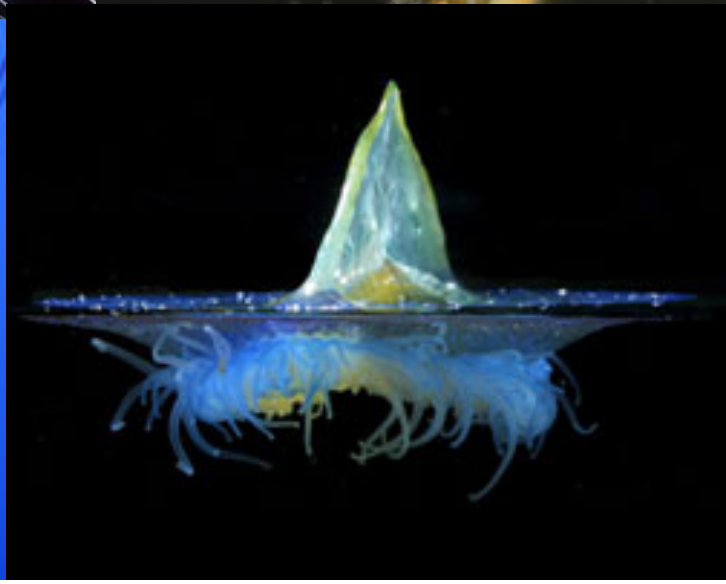
Phylum Cnidaria

Anatomy, Life History, and Taxonomy



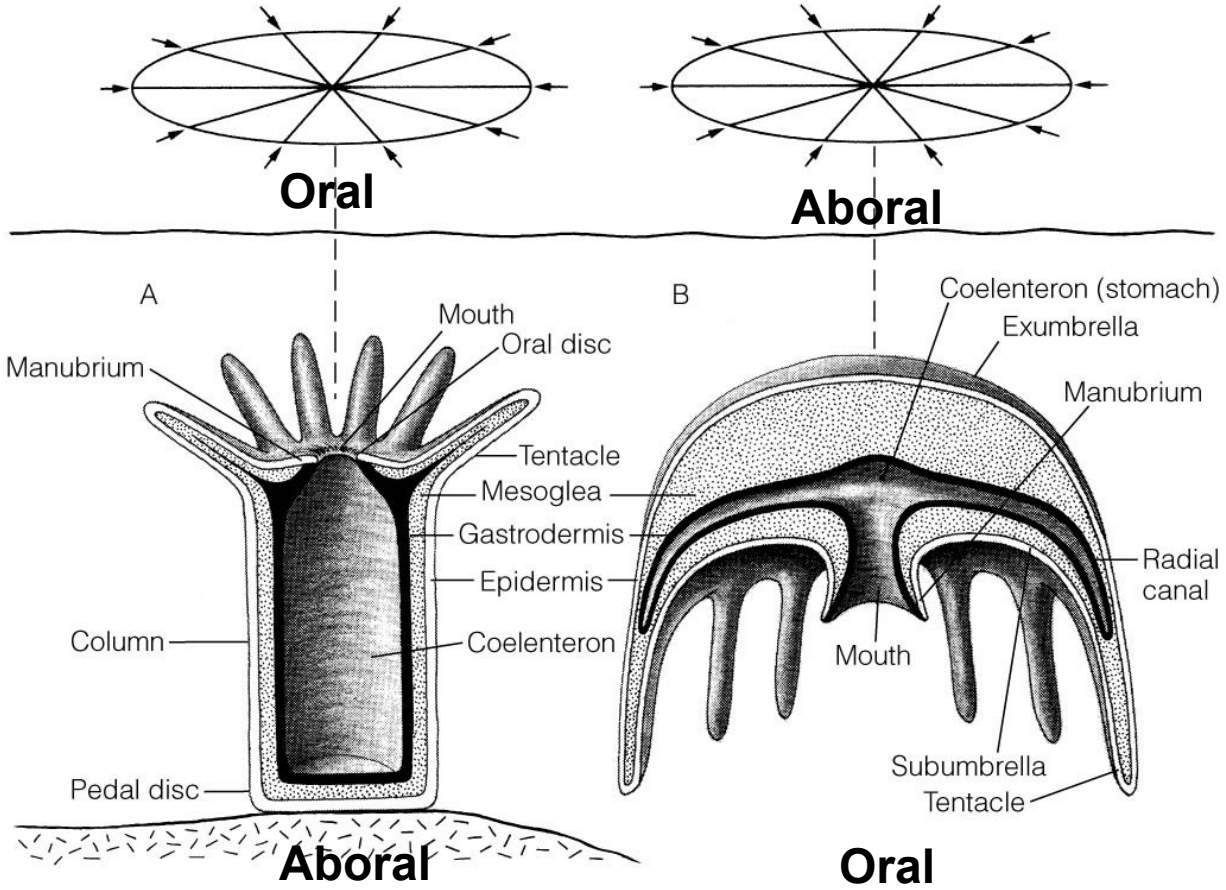
Who are the Cnidarians?





Ecology and Body Plan

- Almost entirely marine
- 10,000 living species have been described



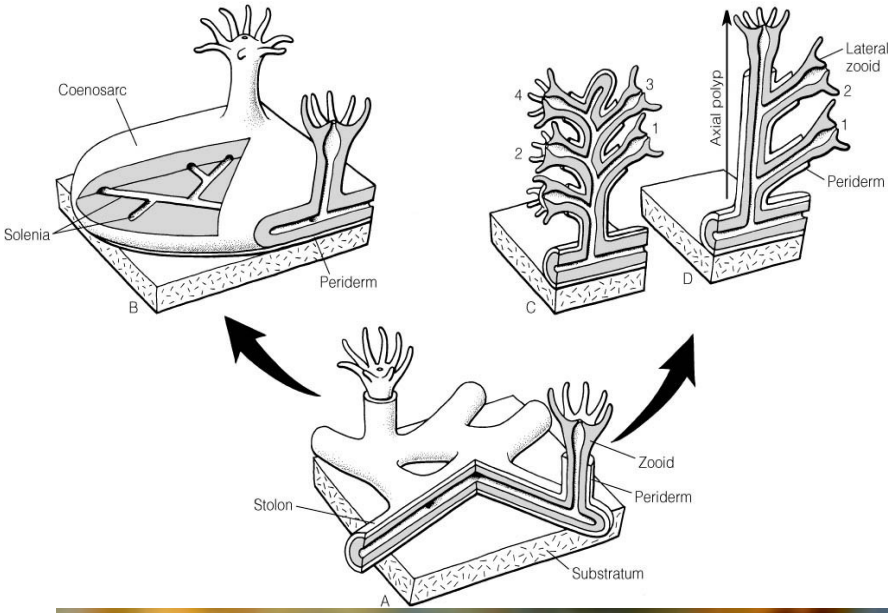
Polyp and Medusa Contrasted

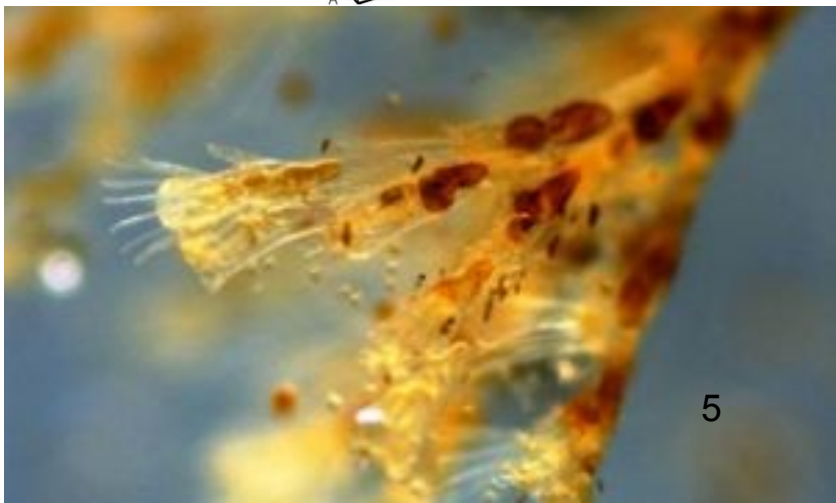
- **Polyp**
  - Attached to substrate
  - Cylindrical shape
  - Thin layer of Mesoglea
  - Often with hard skeleton
  - Reproduce both sexually and asexually
  - Solitary or colonial
- **Medusa**
  - Usually free swimming
  - Saucer or bell shaped
  - Thick layer of Mesoglea
  - Without a hard skeleton
  - Always reproduce sexually; sometimes asexually
  - Usually solitary

Colonies & Polymorphism

Many Cnidarians form colonies

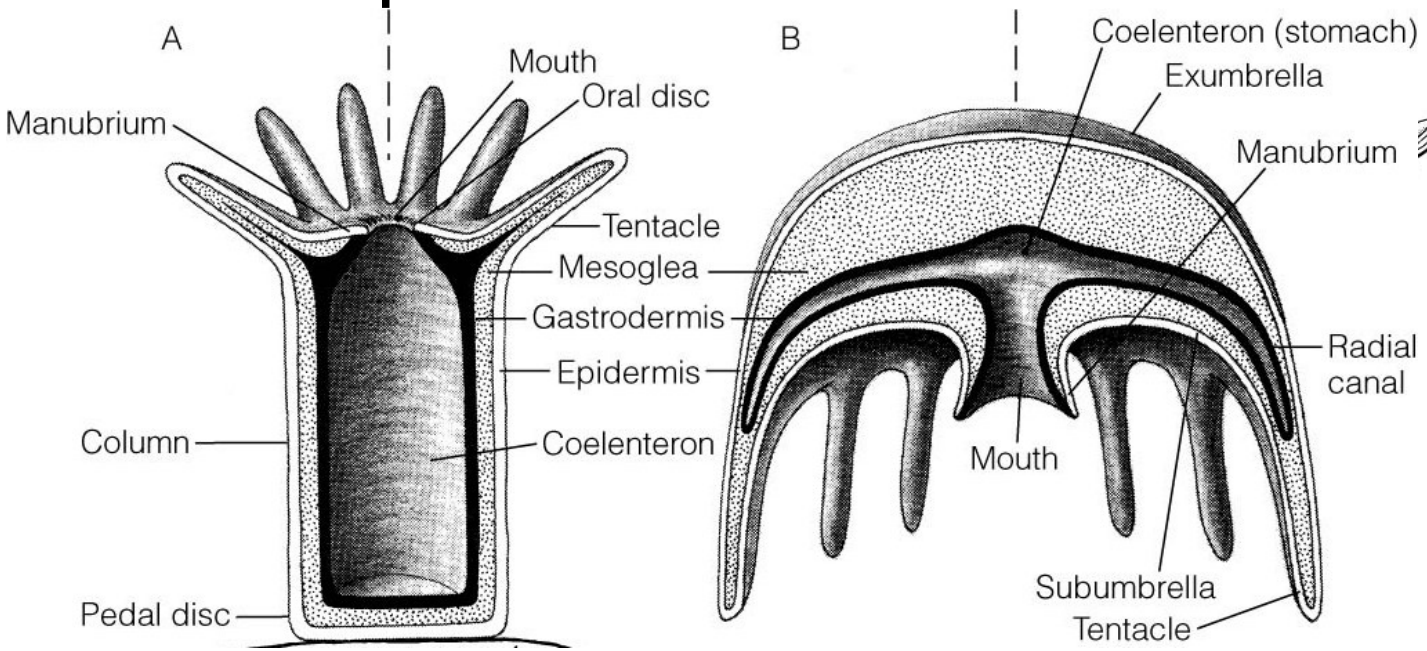
- Share a common gut & nerve network
- Often accompanied by polymorphism; **zooids**

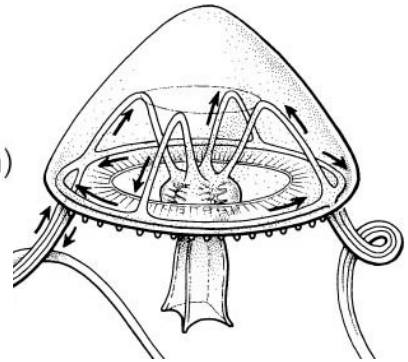


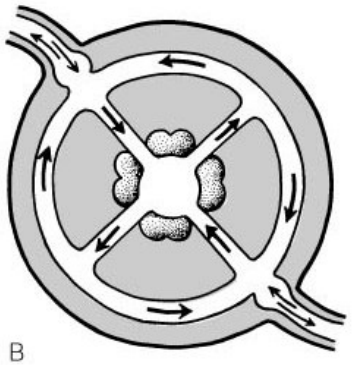


Gastrovascular Cavity

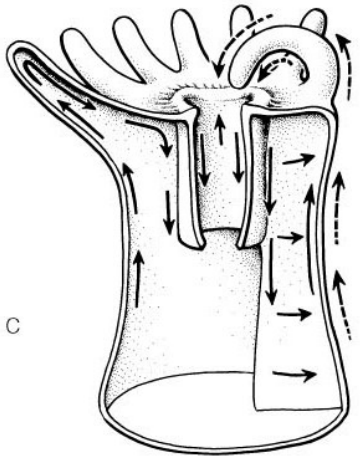
- GVC responsible for circulation





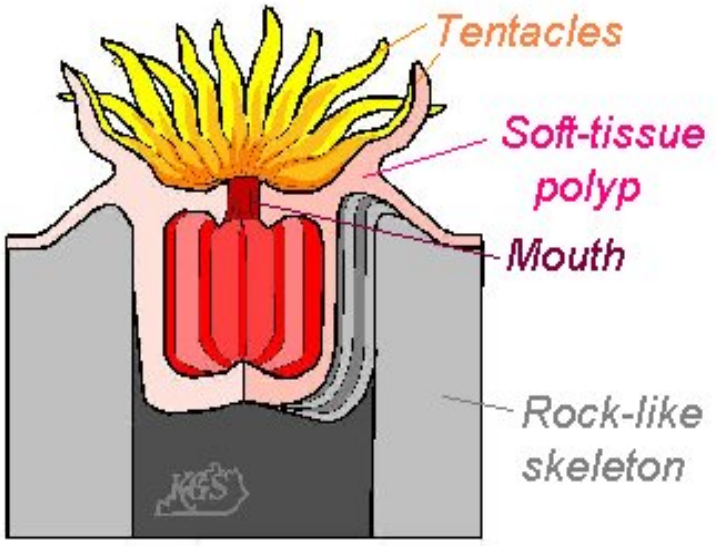


- Respiration occurs by diffusion
- Waste management by diffusion or out of mouth

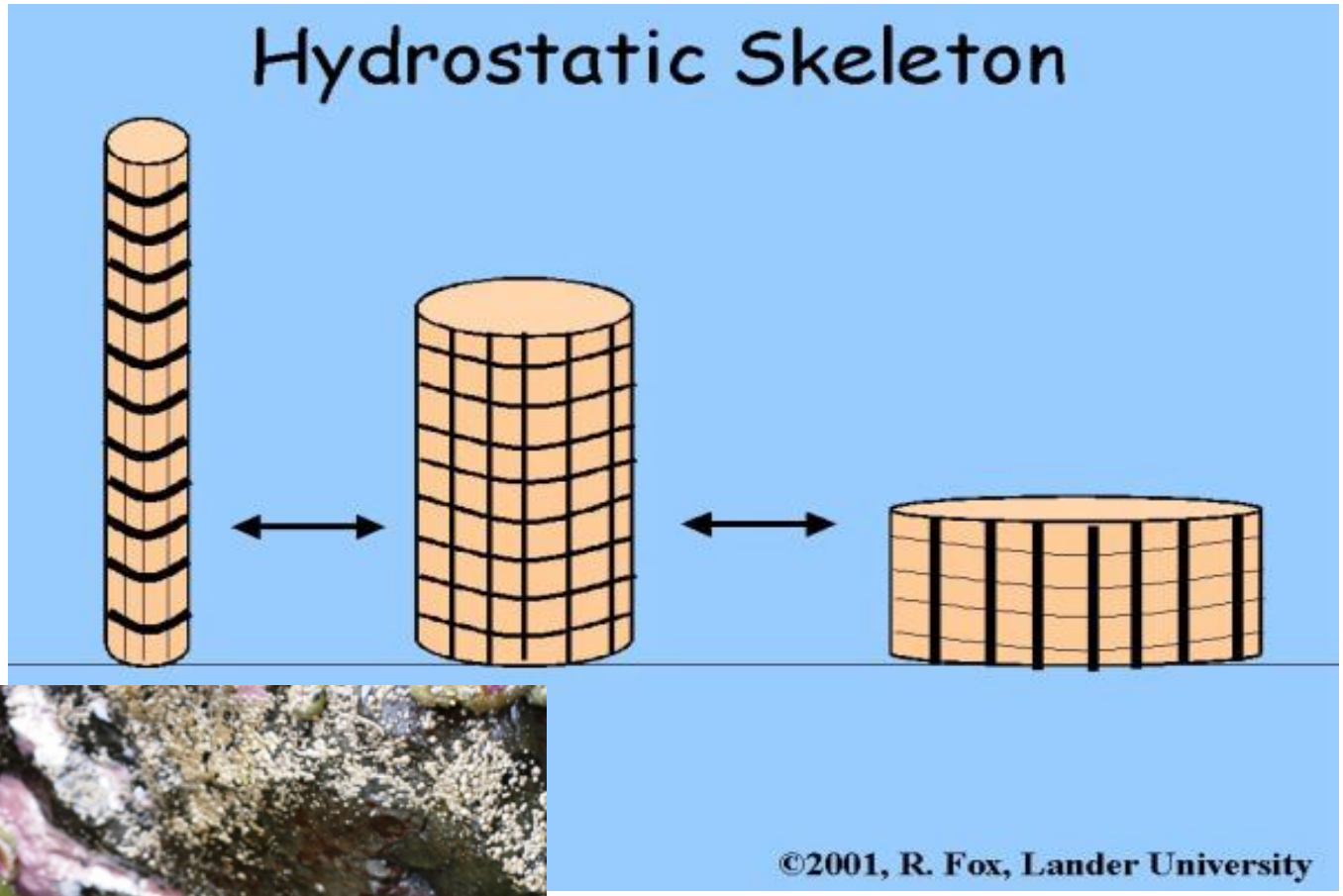


Cnidarian Skeletons

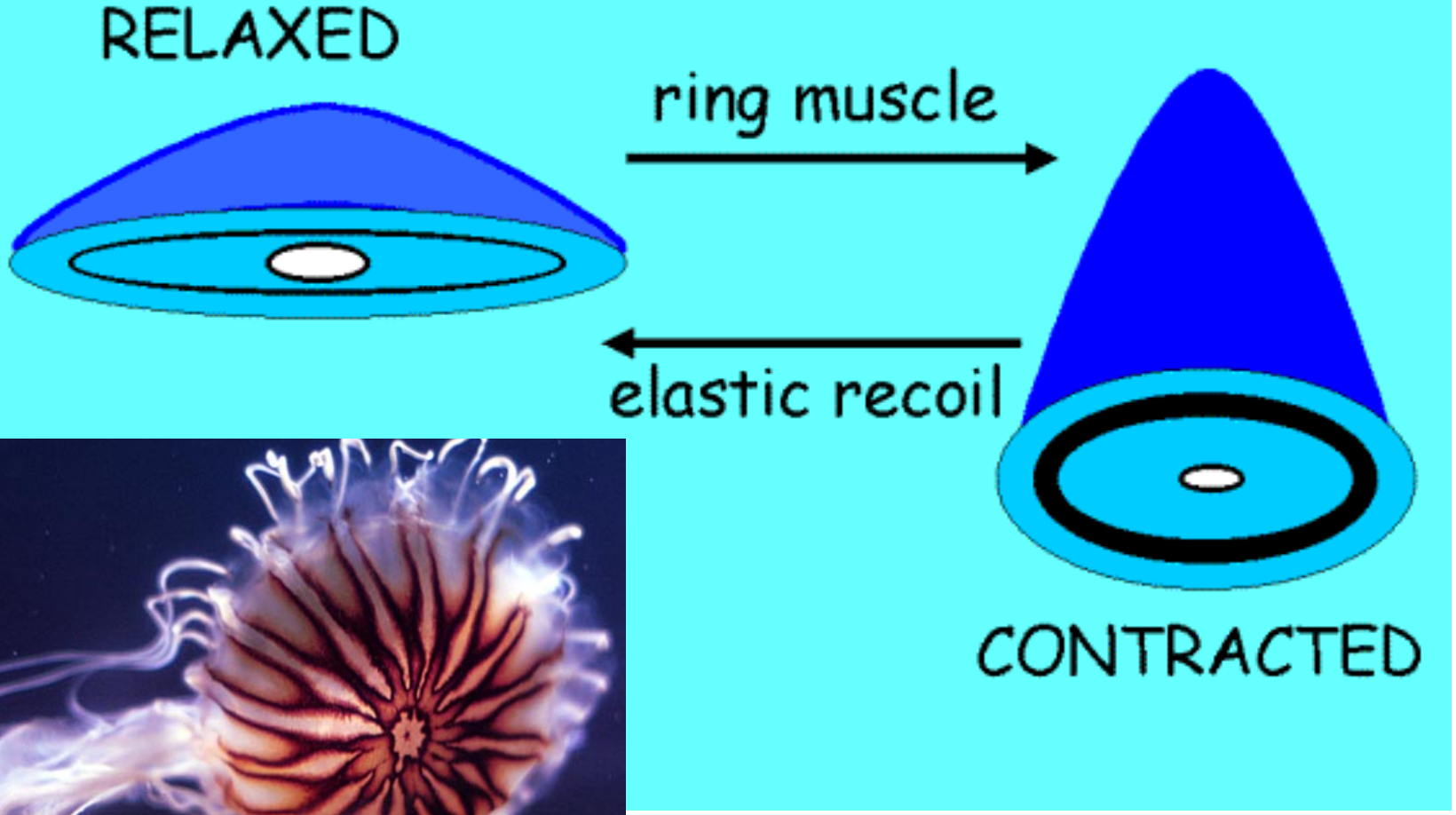
- Internal rods or spicules, external calcium carbonate or proteinaceous skeletons



- Hydrostatic skeleton
  - Muscles surrounding fluid-filled mass
  - Can control size and shape

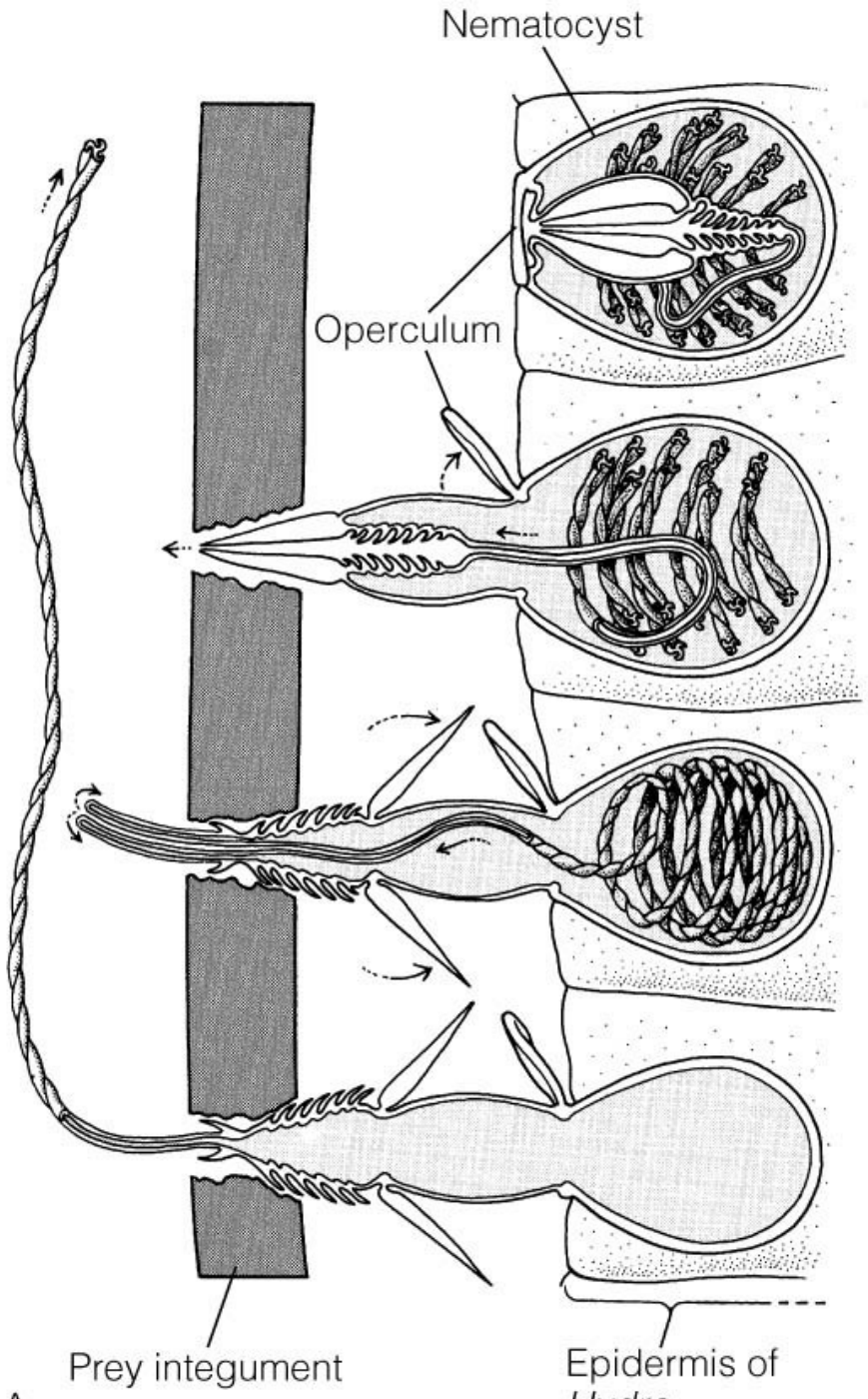

Hydrostatic Skeleton
©2001, R. Fox, Lander University

Medusa Locomotion



Cnidae (nettle/stinging thread)

- Secreted within cells called **cnidoblasts**; most complex intracellular secretion products known
- 3 major categories of cnidae:
  - **Spirocysts** – anthozoans (corals/sea anemones)
  - **Ptychocysts** – tube anemones
  - **Nematocysts** – most common and well studied (over 30 types; many types in a single species)


Nematocyst
Operculum
Prey integument
Epidermis of
Hydra

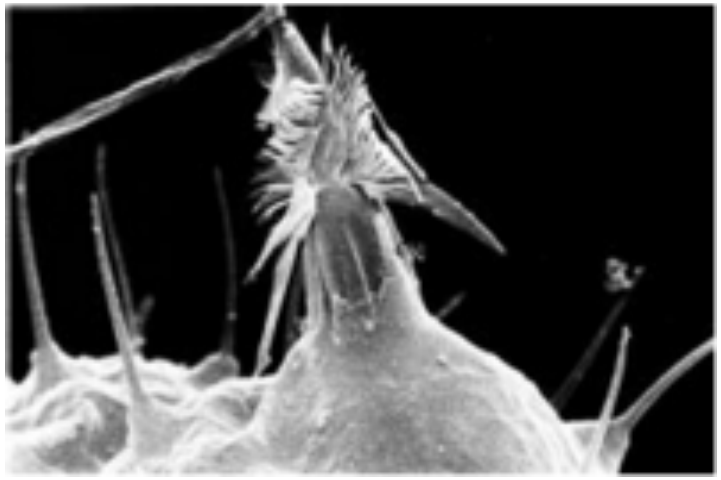
A


dt
sr
I III II I
3 2 1 3 2 1

B

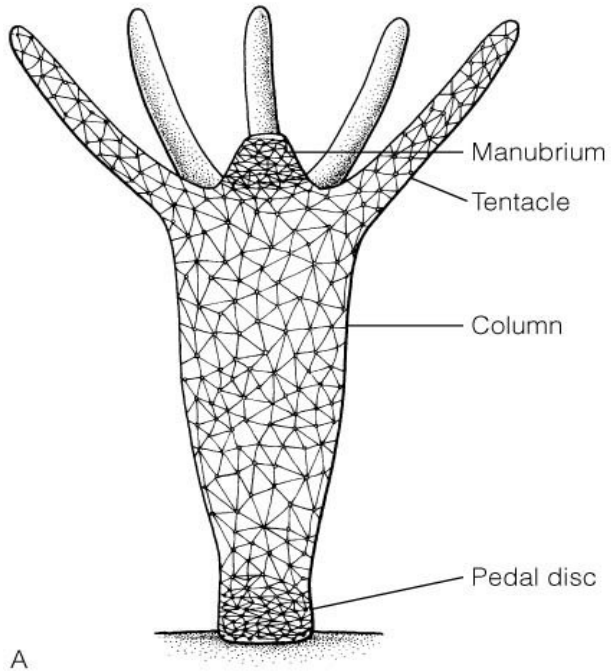
Cnidae con't.

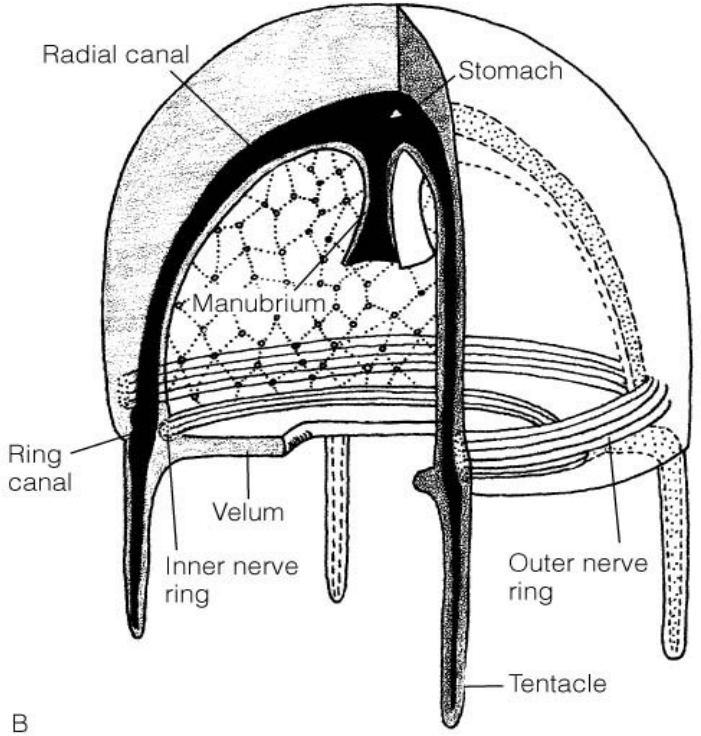
- Stimulation is independent of the nervous system and is generally
  - Chemical (produced by prey or predator)
  - Tactile (contact with the nematocyst)
- **FUNCTION**: food collection, defense, and locomotion
- Generally, nematocysts are species specific; important in species identification



The Cnidarian Nervous System

- No ganglia – not a true CNS
- Nervous system is a “nerve net”
- At each cross the two neurons communicate
  - Stimulation radiates away from source of contact



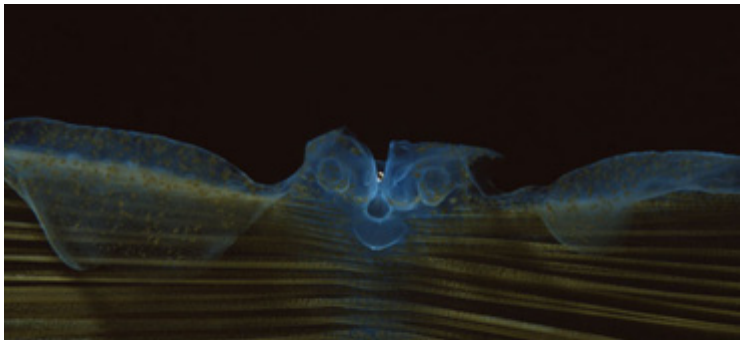


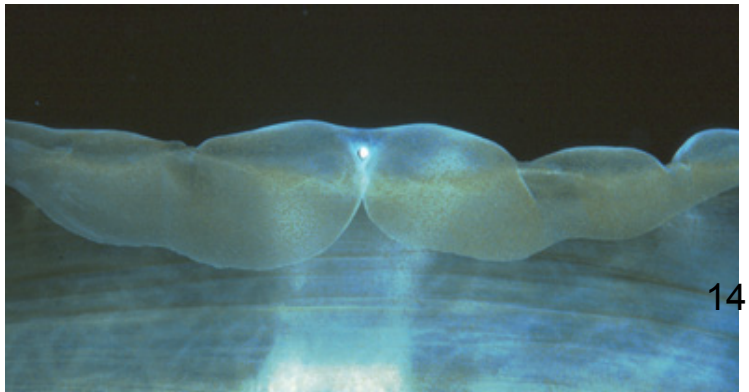
Cnidarian Sensory Organs

- Sensory organs in the Cnidarians include:
  - Statocysts – balance organ
  - Ocelli – light receptor
  - Sensory lappets – touch receptor

- Statocysts and ocelli are contained within club-shaped structures called **rhopalia**

* Characteristic of Scyphozoans





Cnidarian Reproduction

- Gametes originate from undifferentiated epithelial cells
- No specialized ducts for carrying out gametes
  - Gametes shed into the gut leave by the mouth or pores in the tentacles
- Most Cnidarians are dioecious
  - Separate sexes
- Others are hermaphroditic
- Reproduction and life cycles in Cnidarians vary greatly

Cnidaria Development & Primitive Lifecycle

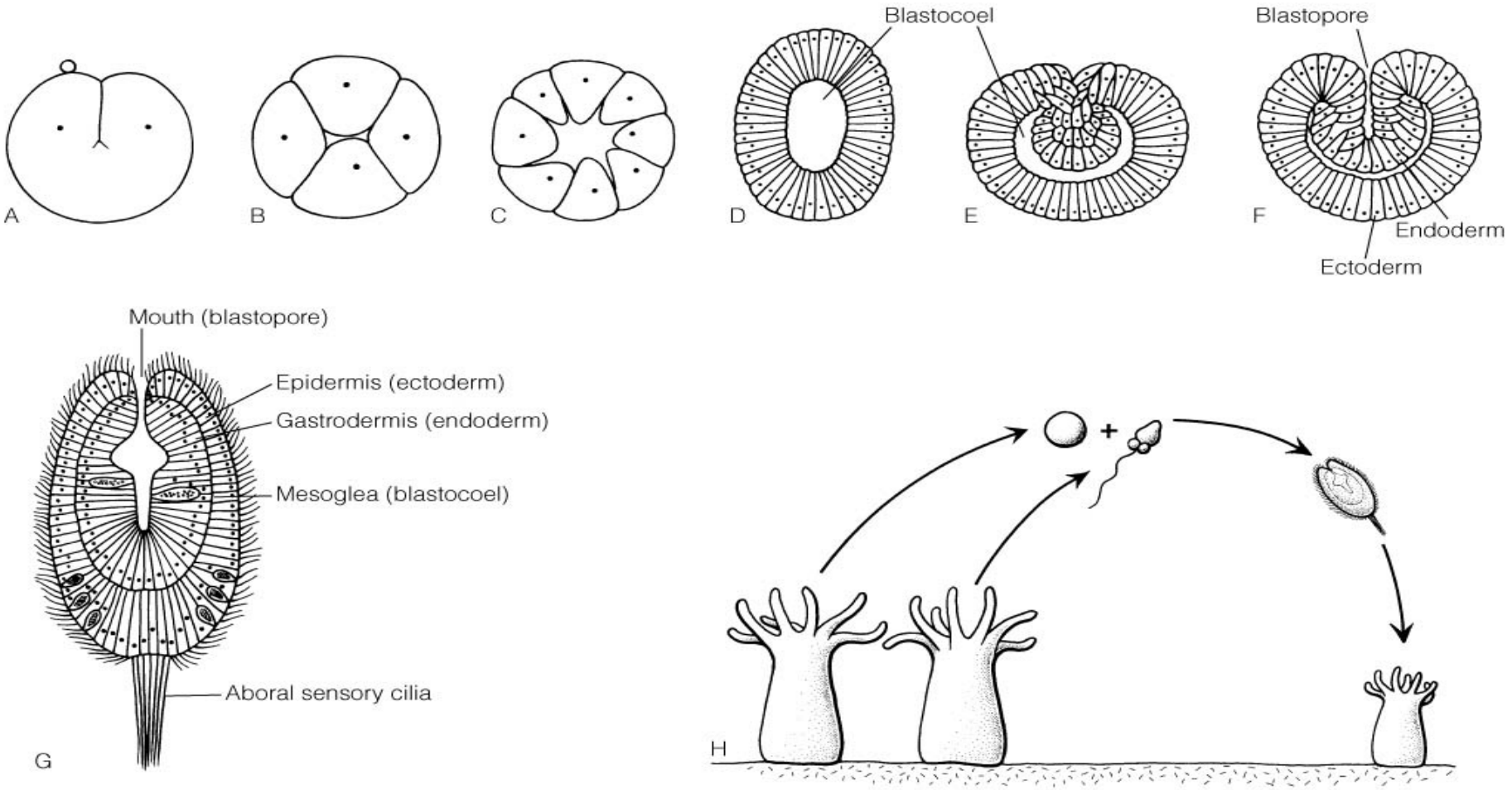
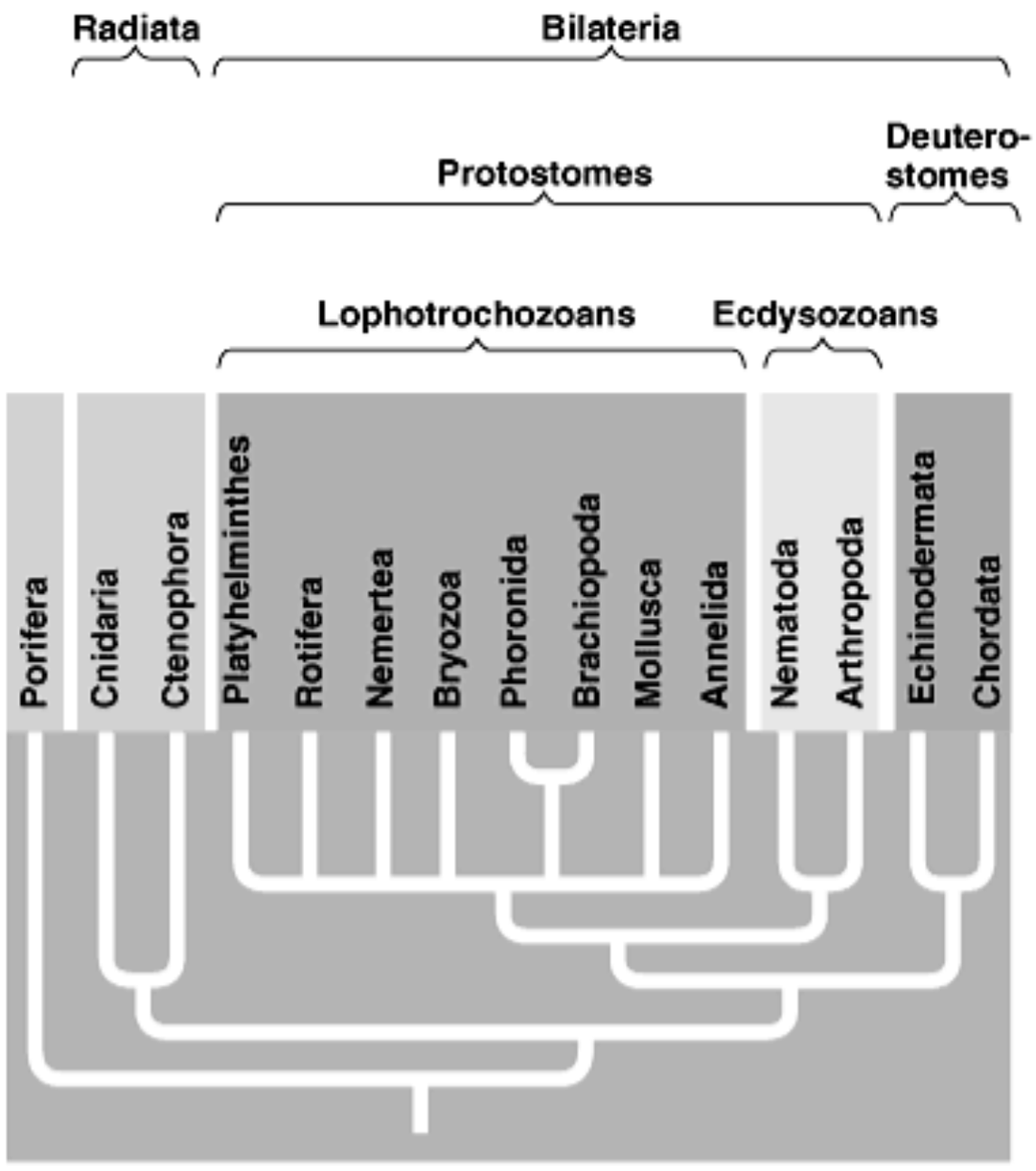
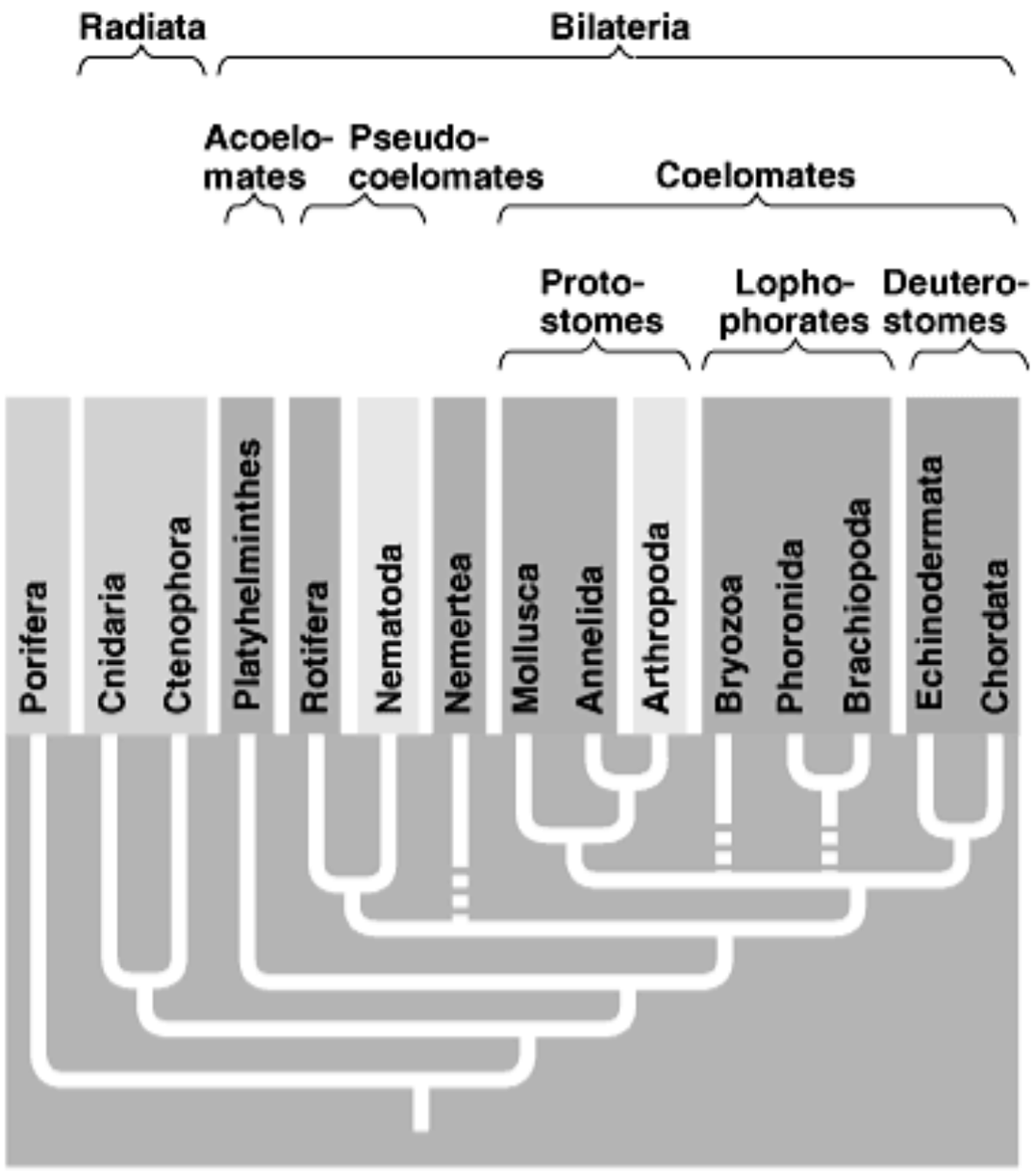


FIGURE 7-14, page 124: Cnidaria: development, larva, and life cycle. A-F, Embryonic development. G, Longitudinal section of an anthozoan planula. H, The presumed primitive life cycle.



(a) Tree based on molecular comparisons



(b) Tree based on body-plan grades

Cnidarian Asexual Reproduction

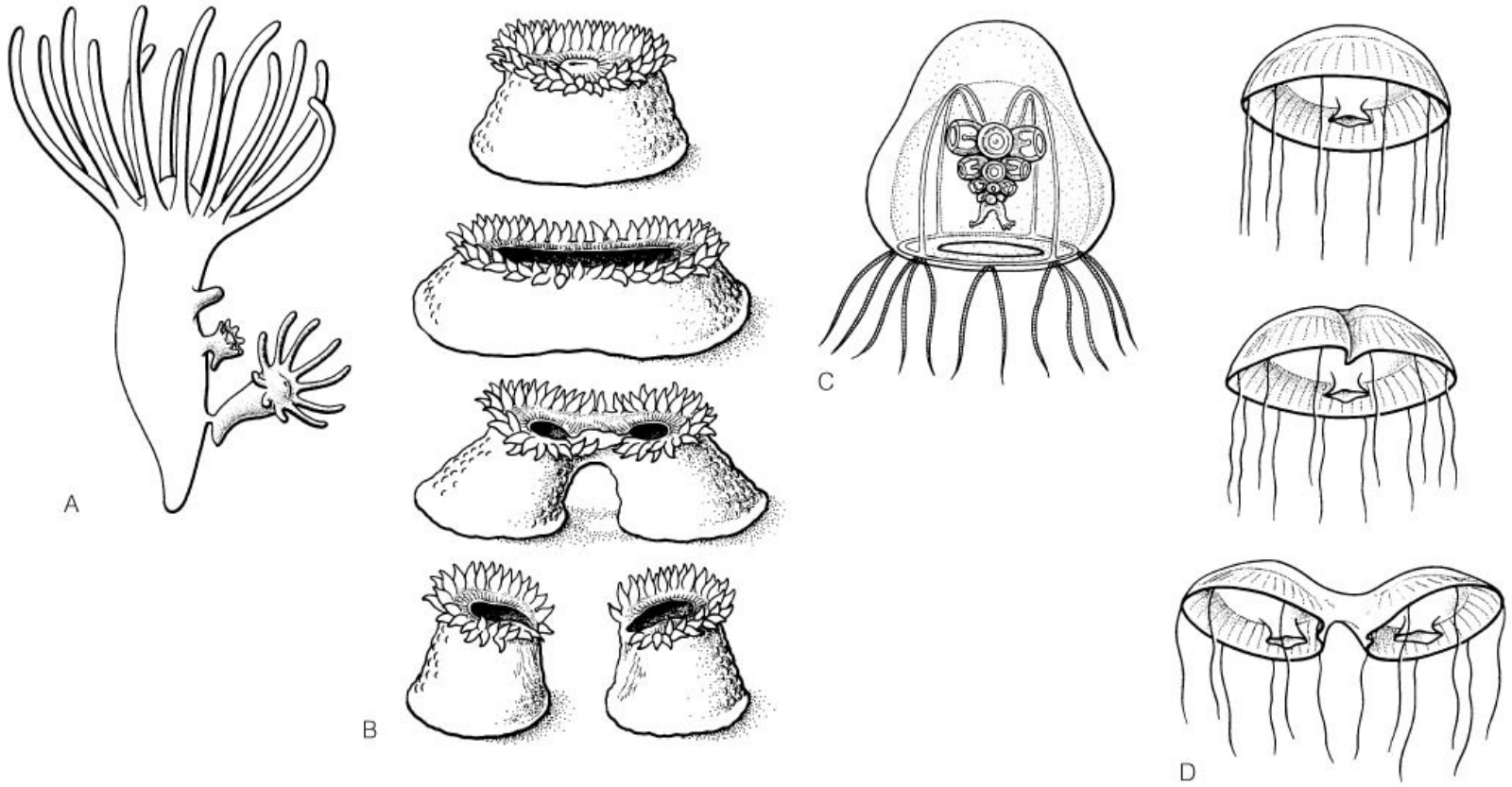


FIGURE 7-13, page 123: Cnidaria: clonal (asexual) reproduction. A, Budding (polyp). B, Longitudinal fission (polyp). C, Budding (medusa). D, Longitudinal fission (medusa).

Cnidarian Asexual Reproduction

- Local example: *Anthopleura elegantissima*
  - Aggregate sea anemone
  - Undergoes binary fission
    - Split apart into two anemones
    - Clones of each other

Starting to divide in the laboratory

2 hours later

3 days later

Pictures found at: http://www.rosario.wwc.edu/inverts/Cnidaria/Class-Anthozoa/Subclass_Zoantharia/Order_Actiniaria/Anthopleura_elegantissima.html

Taxonomy of Phylum Cnidaria

- Four Main Classes
  - Anthozoa
    - Subclass Hexacorallia (= Zoantharia)
    - Subclass Octocorallia (= Alcyonaria)
  - Hydrozoa
  - Scyphozoa (Staurozoa?)
  - Cubozoa

  - *Myxozoa & Polypodiozoa: microscopic parasites - intermediate between cnidarians and bilaterian animals

Class Anthozoa

- Members of this class include:
  - Sea anemones, soft corals, hard corals, and sea pens

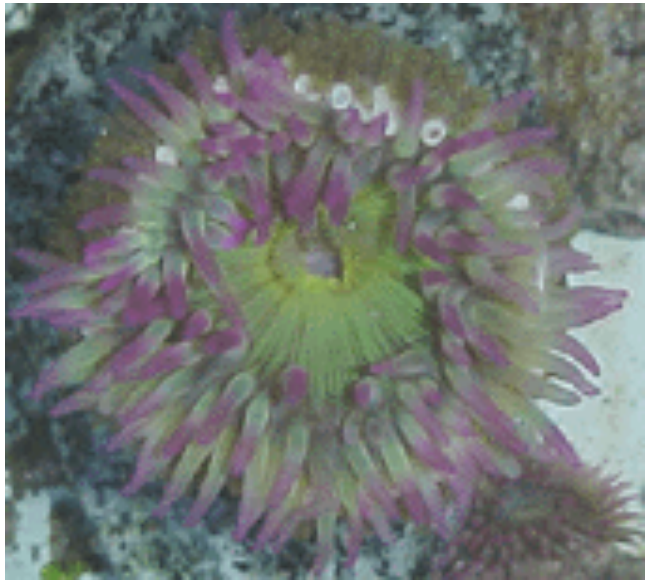
Anthozoan Characteristics

- **No** medusa
- Reproduce sexually or asexually
  - Gonads derived from the gastrodermis
  - Hermaphroditic or dioecious
  - Asexual reproduction highly developed
    - Fission
    - Pedal laceration

Anthozoan Characteristics

- Solitary or colonial
- Most carnivores, some suspension feeders (cilia/mucus)
- Some have symbionts

Filter feeding *Metridium*



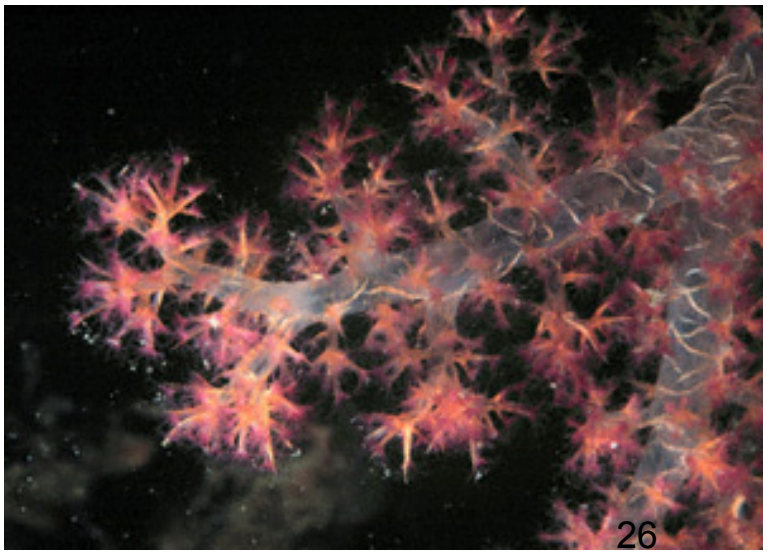
Aggregating anemone, *Anthopleura elegantissima* have algal symbionts

Subclasses of Anthozoa

- Subclass Hexacorallia (=Zoantharia)
  - Sea anemones, stony (true) corals
  - Can be solitary or colonial but never polymorphic
  - Almost all carnivores
  - Tentacles and septa usually in multiples of 6 (hexa)
  - Skeleton when present usually external

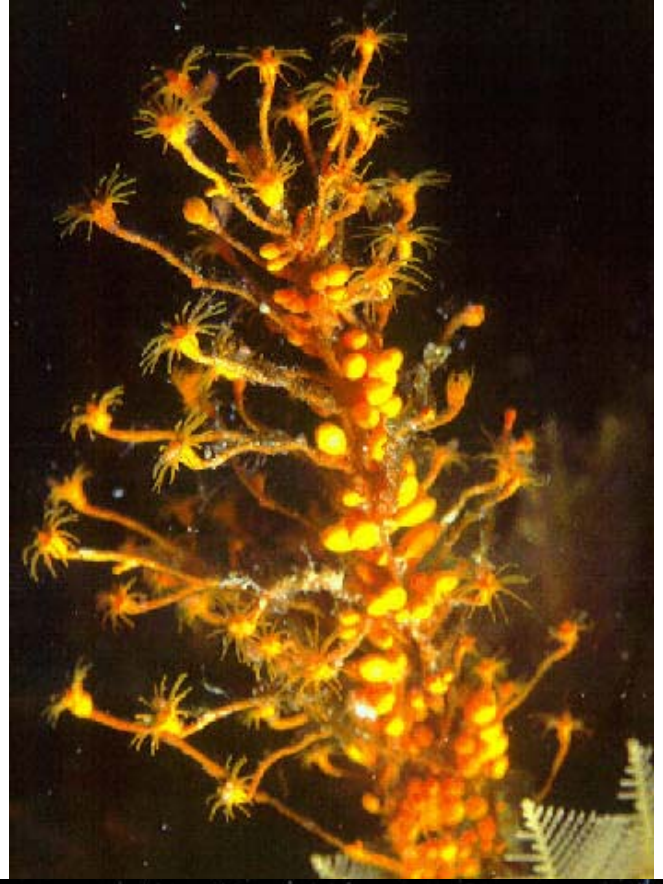
Subclasses of Anthozoa

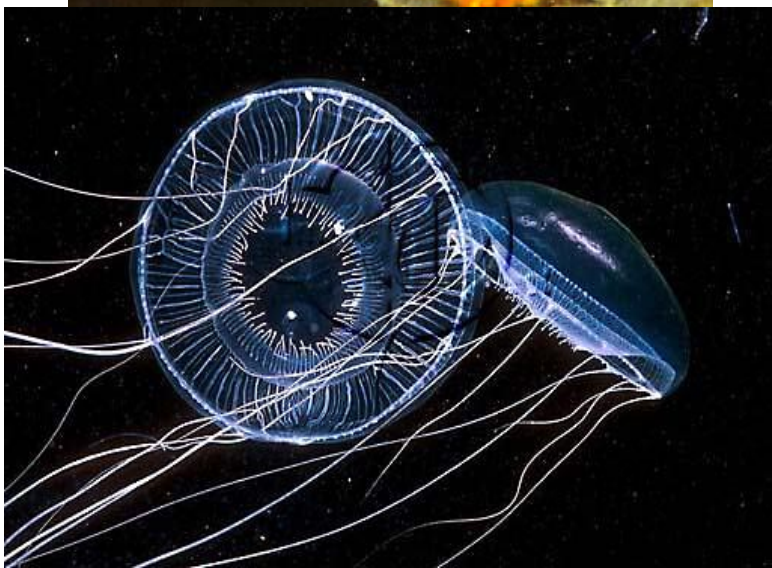
- Subclass Octocorallaria (=Alcyonaria)
  - Soft corals and relatives
  - 8 branched feather-like tentacle per polyp
    - Pinnate – lateral outfoldings called pinnules
  - Only 8 septa
  - All colonial & polymorphic
  - Skeleton when present is <u>internal</u>
    - Spicules, tubes, or rods in the mesoglea



Class Hydrozoa

- Members of this class include:
  - Hydroids, Siphonophores, & Hydrocorals
  - 3,000 living species
- Have both polyp and medusa stage
  - Multiple stages at once
  - Some only one stage
- Gastrodermal tissue **lacks** cnidae (only epidermis)
- No cells found within mesoglea

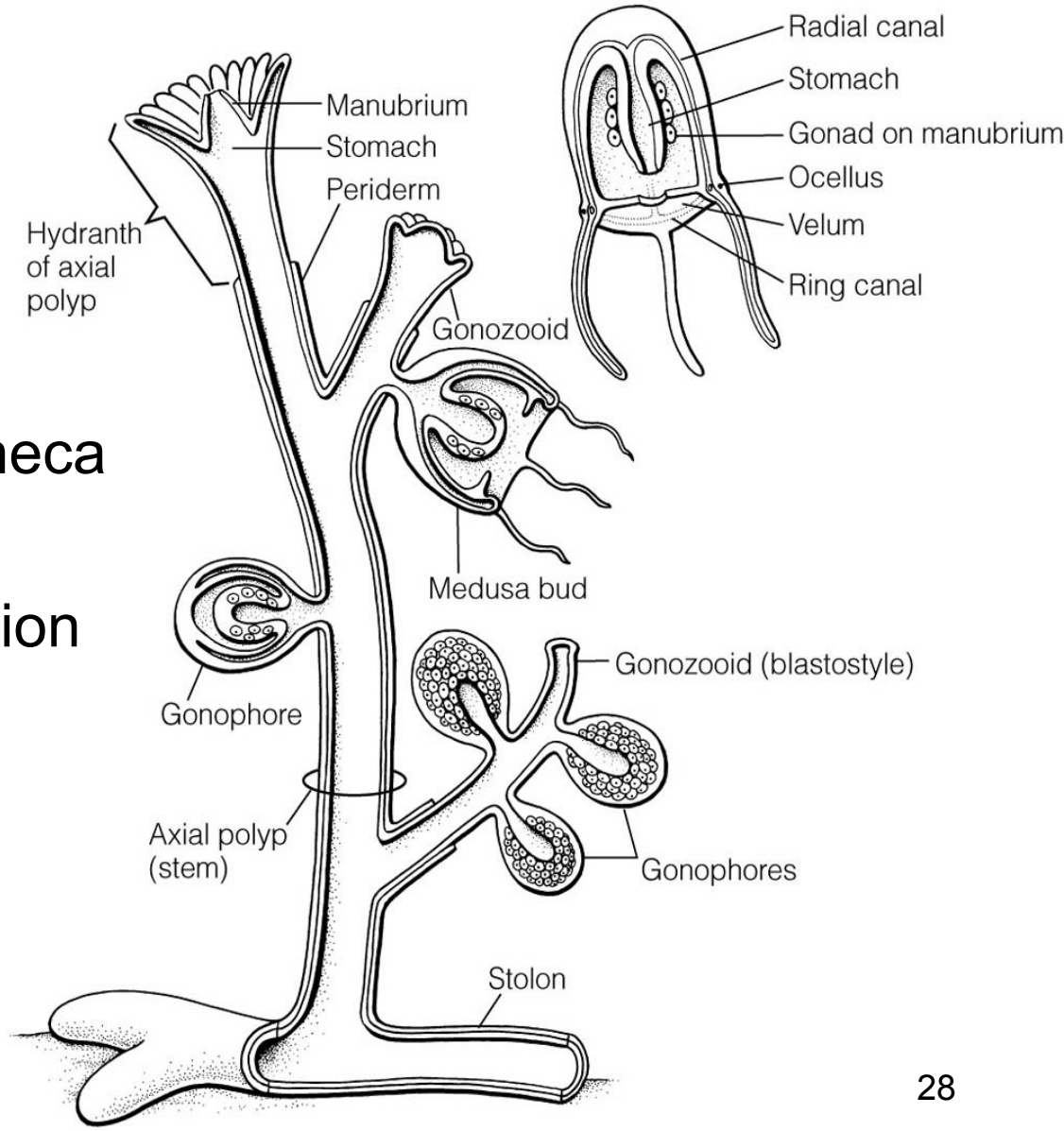




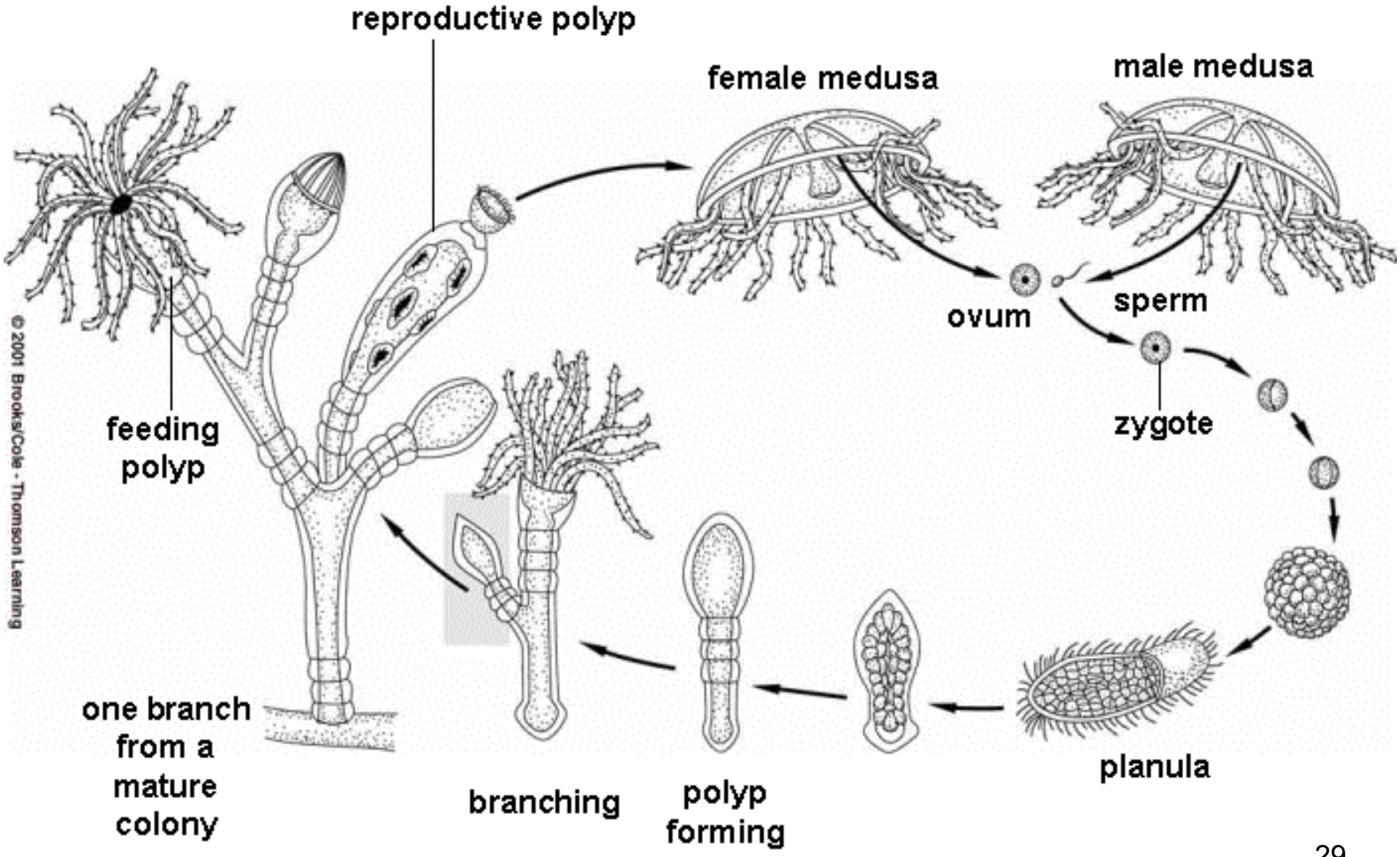
Hydrozoan Morphology

- **Polyp** parts to note:
  - Stolon
  - Gastrozooid -feeding
    - Hydranth
    - cup surrounding hydranth – Hydrotheca
    - Thecate/Athecate
  - Gonozooid -reproduction
    - Medusoids
  - Dactylzooid –defense

- **Medusa** parts to note:
  - Velum

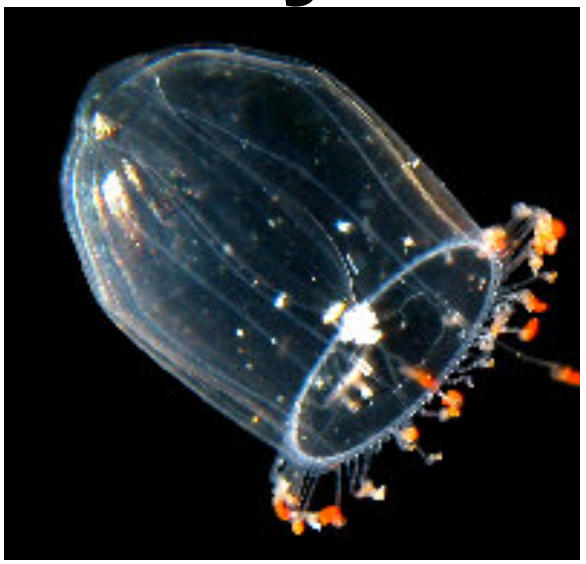


Obelia Life Cycle (Hydrozoan)



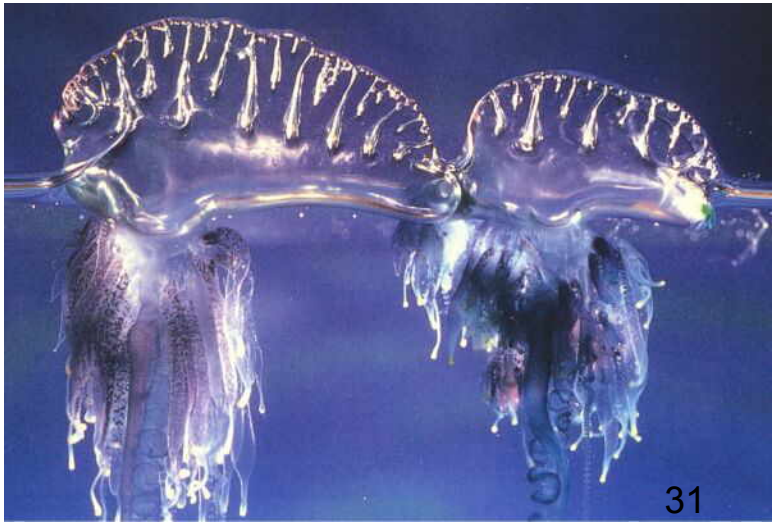
Hydrozoan Taxonomy

- Order Hydrodia – hydroids & hydromedusae
- Order Siphonophora – Portuguese man-of-war, Siphonophores
- Order Hydrocorallina – fire coral



Aglantha digitale

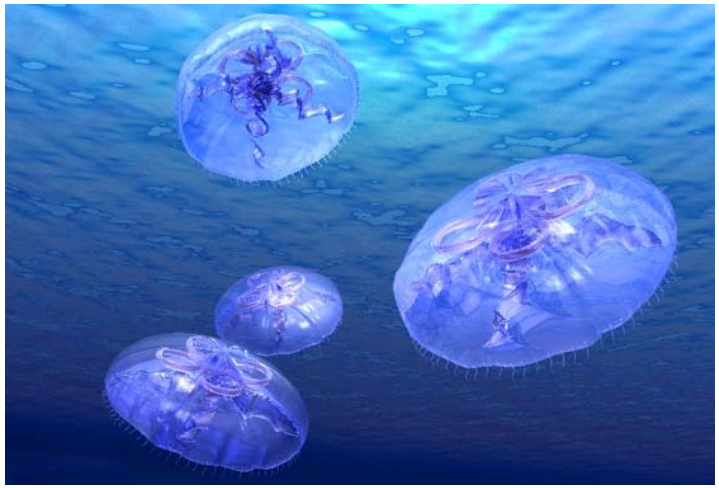
Millepora platyphylla



Physalia physalis

Class Scyphozoa

- Members of this class include:
  - True jellyfish
  - 200 species

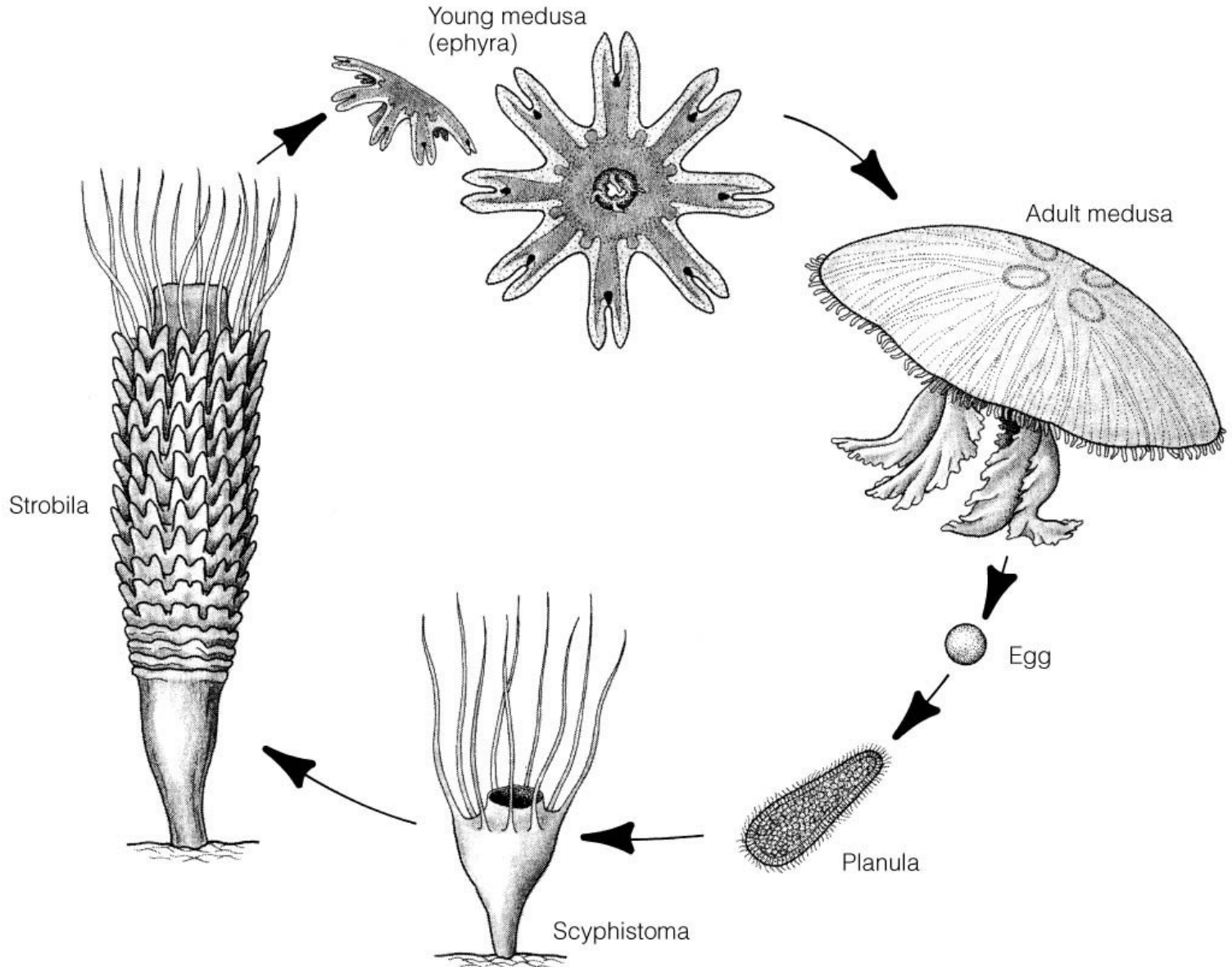


- Mostly medusae
  - Small polyp-like asexual stage seen in some groups

Class Scyphozoa

- Characteristics of the Schyphozoan medusae:
  - **Medusoid** morphology
  - No velum
  - Edges of mouth drawn out into long muscular cylinder - **manubrium**
  - Gonads are gastrodermal in the GVC
  - Feed using cnidae on tentacles, few use cilia and mucus
  - **Rhopalia** on margins of swimming bell
  - Asexual replication by **strobilation**

Generic Scyphozoan Life Cycle



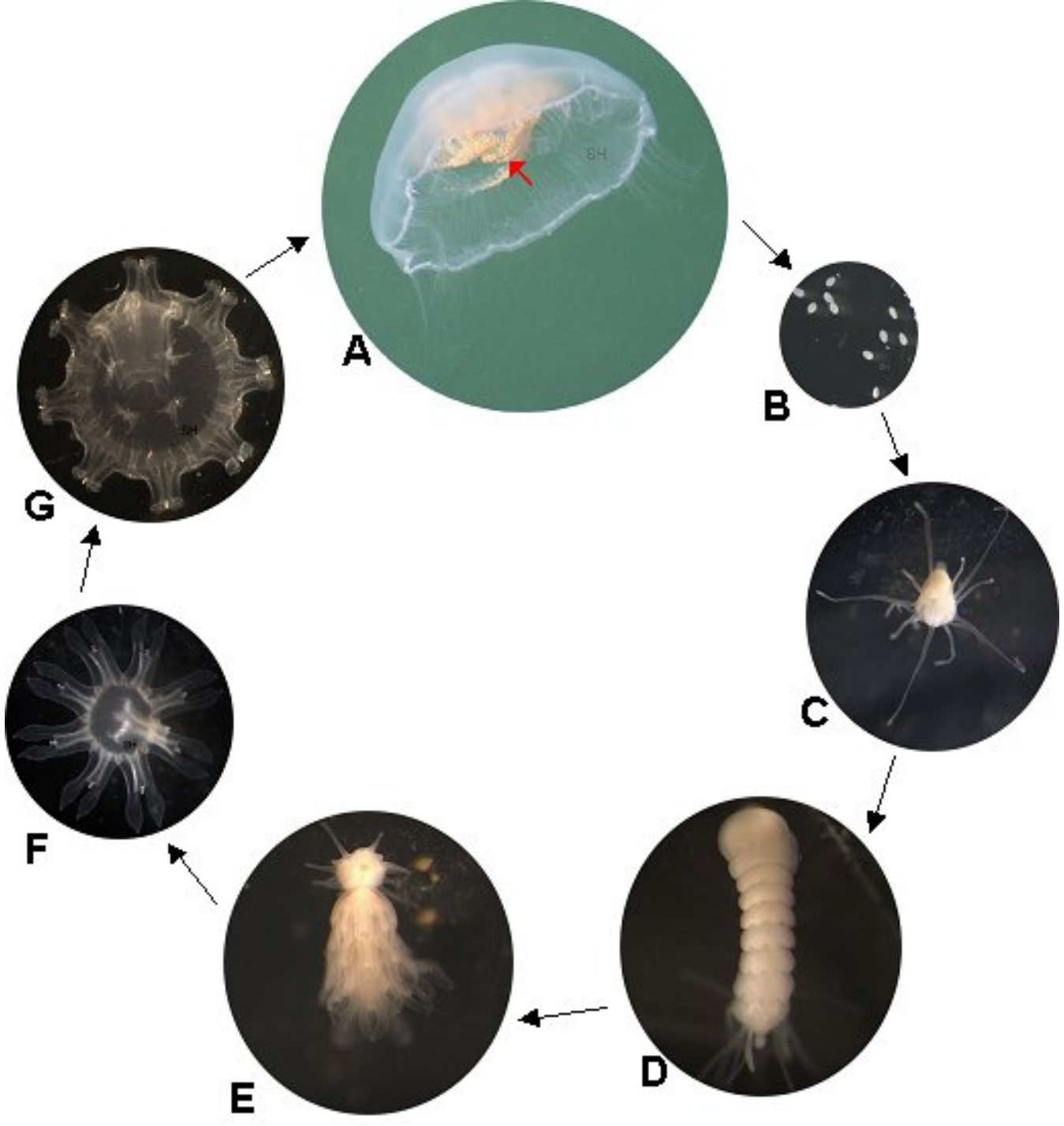
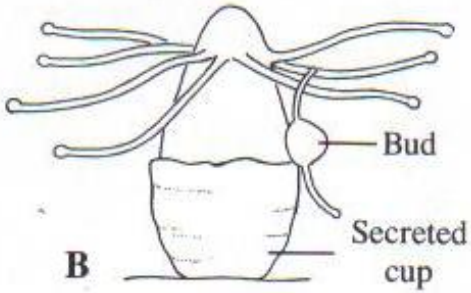


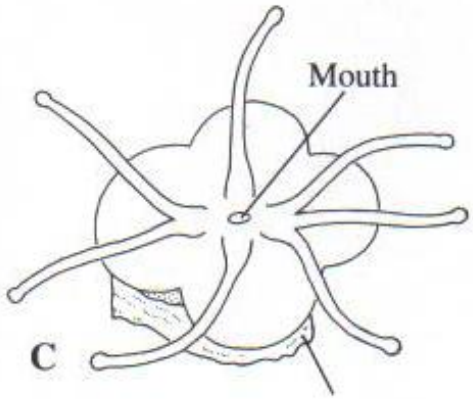
Fig. 1. Life cycle of the moon jellyfish *Aurelia aurita*. **A** Mature female medusa (30 cm in diameter) carrying **planula larvae** (red arrow) in brood pouches in the oral arms. **B** released, free-swimming **planulae** (0.2-0.3 mm). **C** Polyp (1-3mm). **D** Beginning **strobilation**. **E** Advanced **strobilation**. **F** Young **Ephyra** (3-5mm). **G** Ephyra, 4 weeks after release (8-10mm).

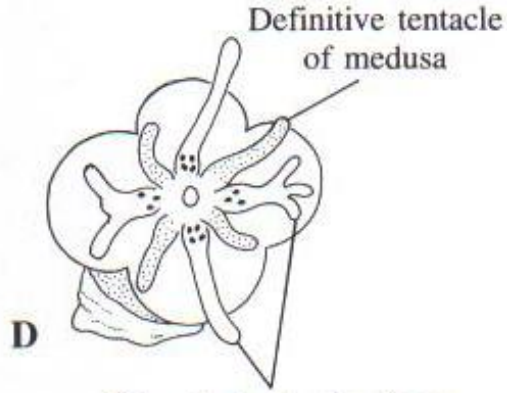
Class Cubozoa

- Members of this class include:
  - Box Jellies
- Characterized by:
  - Tall square bell
  - Solid tentacles
    - w/ either four of them or four groups of them
  - Lots of complex eyes
  - Efficient in orientation
  - Nasty nematocysts with neurotoxins
  - Range from Indian Ocean to Coral Sea

Cubozoan Life Cycle

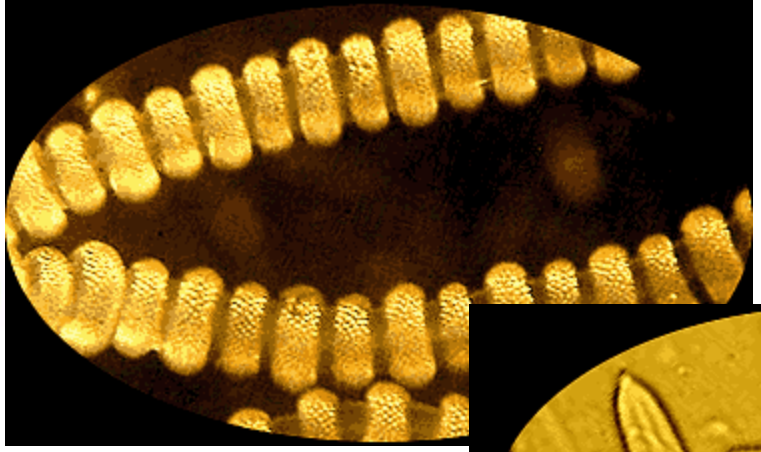


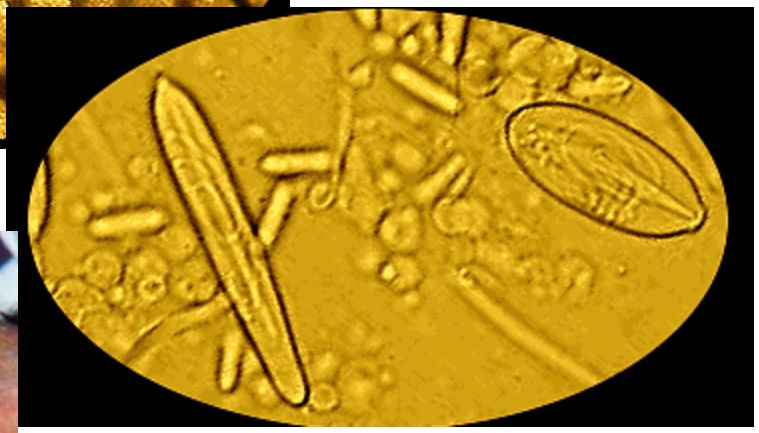




Polyp tentacles (as these regress, their basal portions, which contain masses of dark pigment, develop into rhopalia)

Tripedalia cystophora





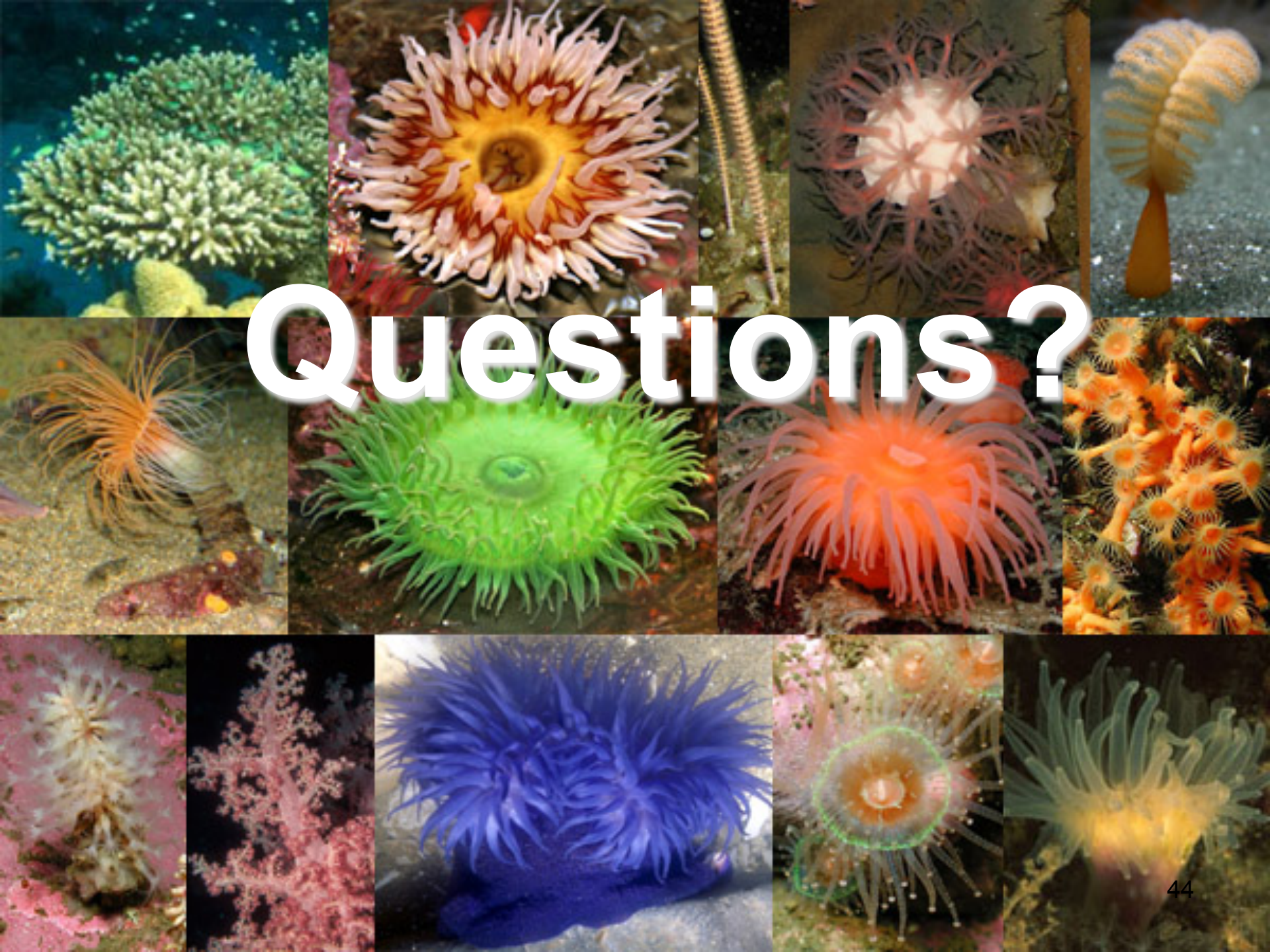

MARINE STINGERS
ARE PRESENT
IN THESE WATERS
DURING THE
SUMMER MONTHS

Review: Defining Characteristics of Cnidarians

- possess complex intracellular organelles called **cnidae**
- **Planula larvae** - free-swimming, flattened, ciliated, bilaterally symmetric larva
- All have basic **radial symmetry**
- **Diploblastic** – possess 2 layers of living tissue (epidermis and gastrodermis) with **mesoglea** inbetween
- All have tentacles around the mouth
- A **single** opening to the digestive system

MINI ASSIGNMENT FOR NEXT LECTURE

	Anthozoa	Cubozoa	Hydrozoa	Scyphozoa
Medusa stage				
Polyp stage				
Location of Gonads				
Skeleton type				
velum in medusa stage				
Stage w/sexual reproduction				
cnidae				


Questions?