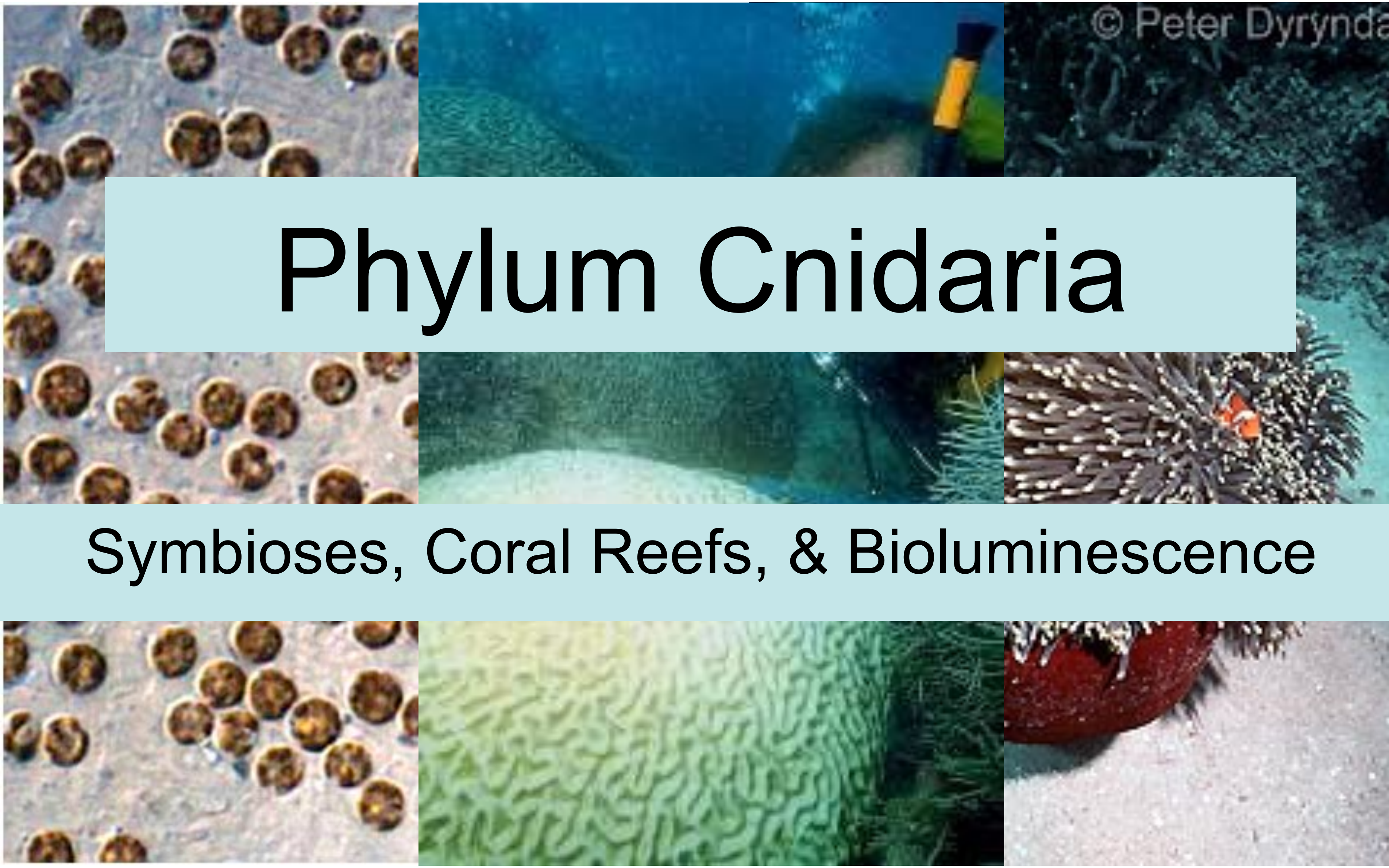
Phylum Cnidaria

Symbioses, Coral Reefs, & Bioluminescence



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				

MINI ASSIGNMENT

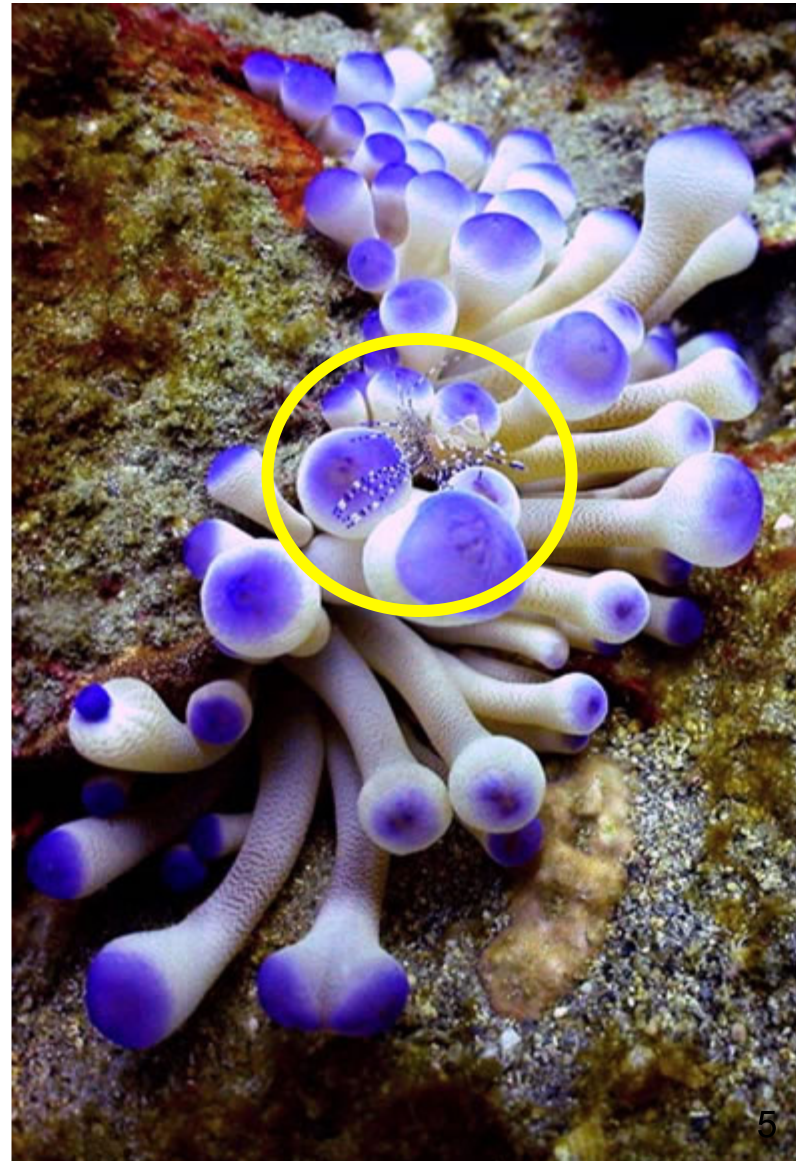
	Anthozoa	Cubozoa	Hydrozoa	Scyphozoa
Medusa stage	N	Y	Y	Y
Polyp stage	Y	Y	Y	Y small, asexual
Location of Gonads	gastro	gastro	gastro	gastro
Skeleton type	hydrostatic & calcium carbonate	hydrostatic	hydrostatic, periderm (chitin) & calcareous	hydrostatic
velum in medusa stage		N	Y	N
Stage w/ sexual reproduction	polyp	medusa	medusa & polyp (*Hydra*)	medusa
cnidae	Y	Y	Y (epidermis only)	Y

Symbiosis

- Greek: *sym* = "with", *biosis* = "living"
- Describes close and often long-term interactions between biologically different species
- Categorized as:
  - **Mutualistic:** both benefit
  - **Parasitic:** one benefits while the other is harmed
  - **Commensal:** one benefits while the other is not harmed or helped
- Symbiotic relationships included:
  - **Ectosymbiosis:** one organisms lives on another
  - **Endosymbiosis:** where one partner lives inside another
- Can be either:
  - **Obligate**: necessary to the survival of at least one of the organisms involved
  - **Facultative**: where the relationship is beneficial but not essential to survival of the organisms

Cnidarian Symbiosis

- Taxa involved:
  - Anthozoa
    - Anemones: crustaceans, fish, and algae
    - Corals (soft and hard): algae
  - Hydrozoa
    - Fire corals: algae
  - Schyphozoa
    - Jellyfish: algae

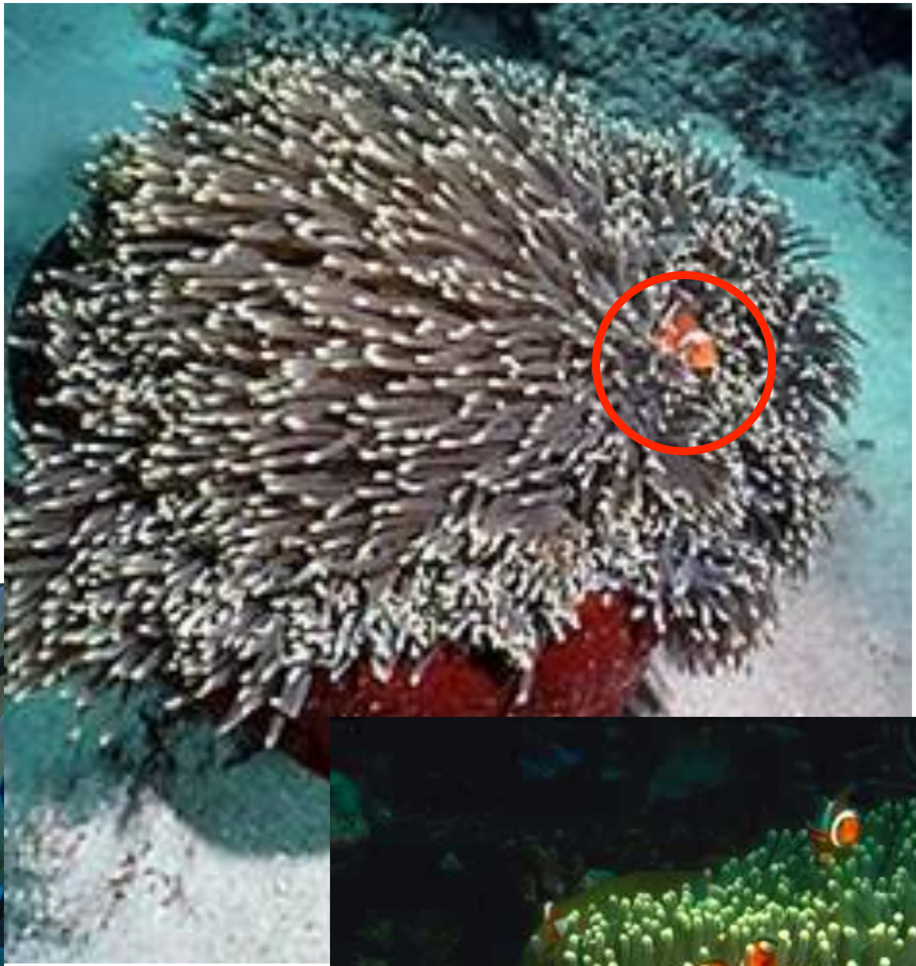


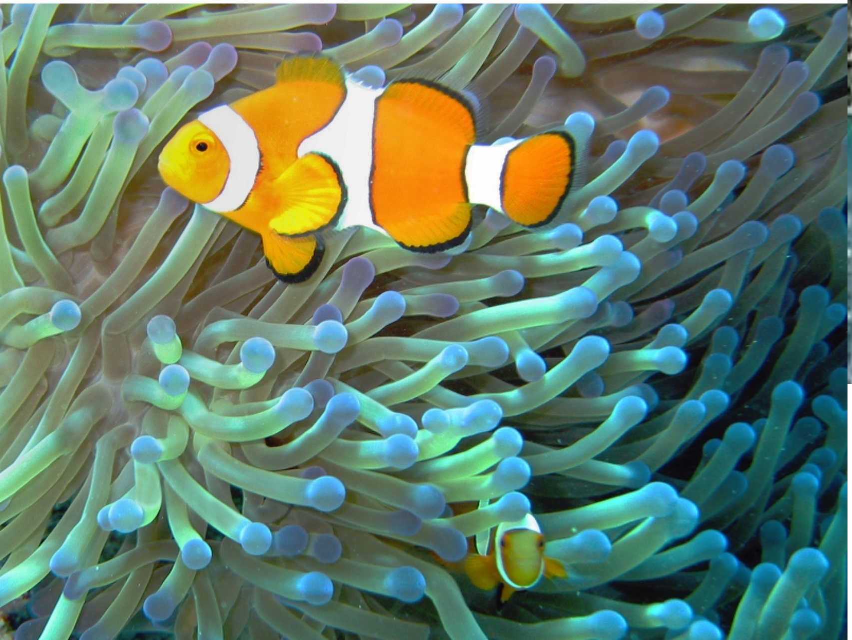
Anemone and Crustacean Symbiosis

- Anemone profits from:
  - Host mobility
- Crab profits from
  - Camouflage
  - Repels predators (octopi)

Calliactis parasitica (sea anemone)

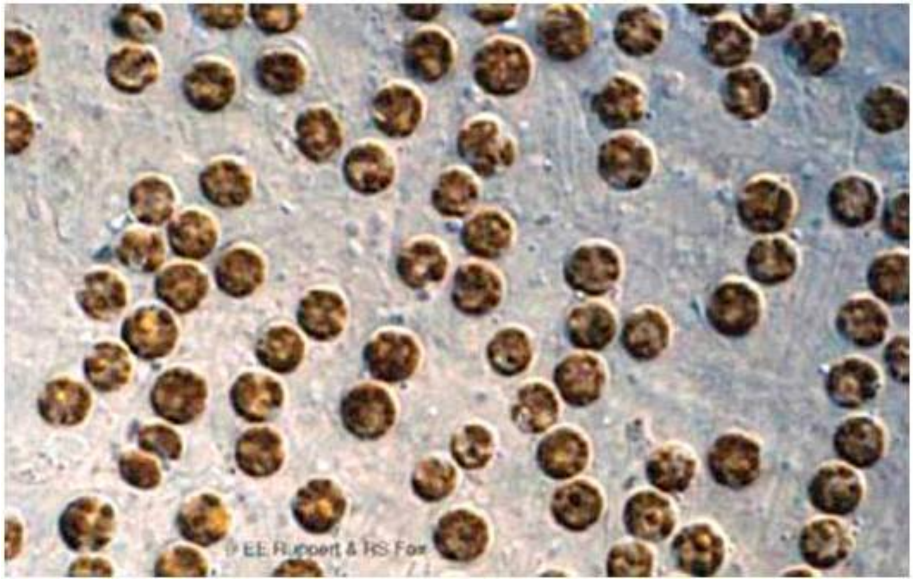
Anemone & Fish Symbiosis



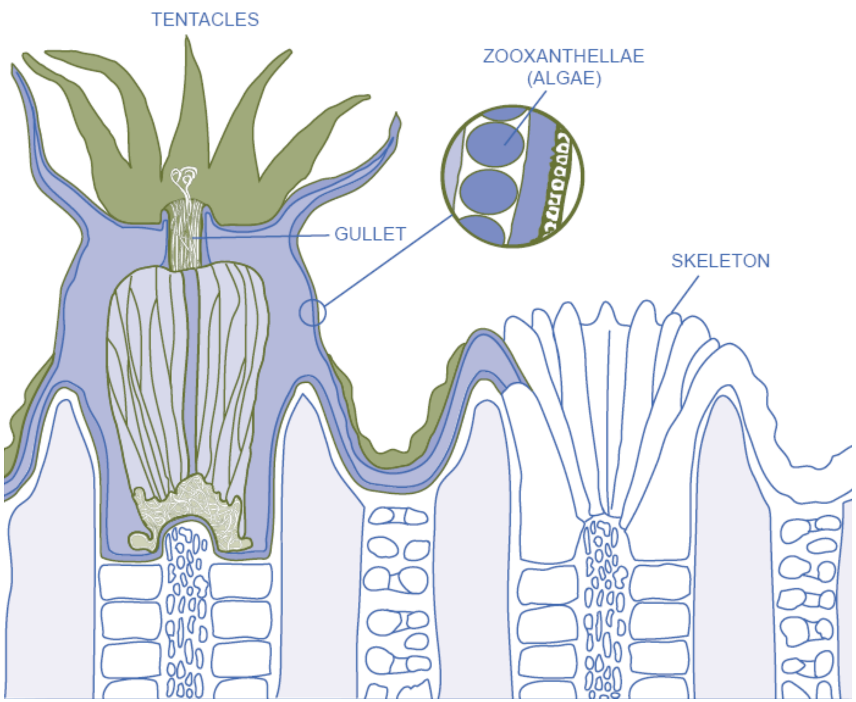


Cnidarians and Algae Symbiosis

- Cnidarian symbiosis with photosynthetic algae was discovered in the 19th century
- Endosymbionts typically referred to as **Zooxanthellae**
  - Dinoflagellates of the genus *Symbiodinium*
- Acquired by direct ingestion or transmitted by eggs/ planula larvae



Cnidarian and *Symbiodinium* symbiosis



- Cnidarian benefits:
  - Nutritional
    - Provided with Carbon
  - Waste disposal
    - CO_2 & nitrogenous waste recycled
- *Symbiodinium* benefits:
  - Location for photosynthesis/ protection
  - Constant supply of CO_2 & nitrogenous waste

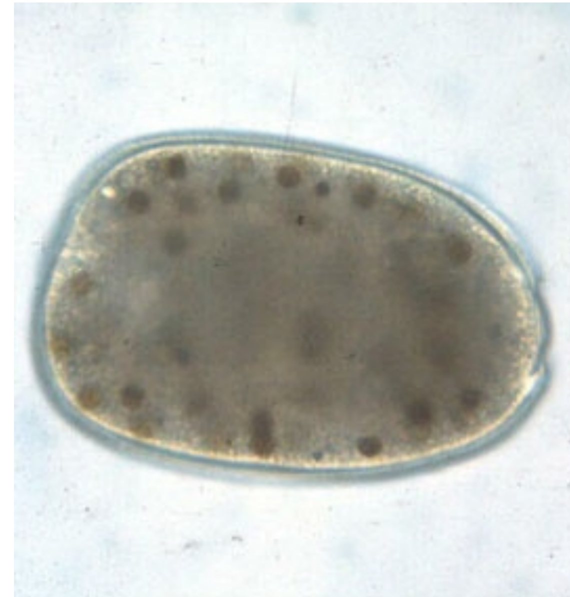
Anthozoans with *Symbiodinium*

- Local example: *A. elegantissima & A. zanthogrammica*

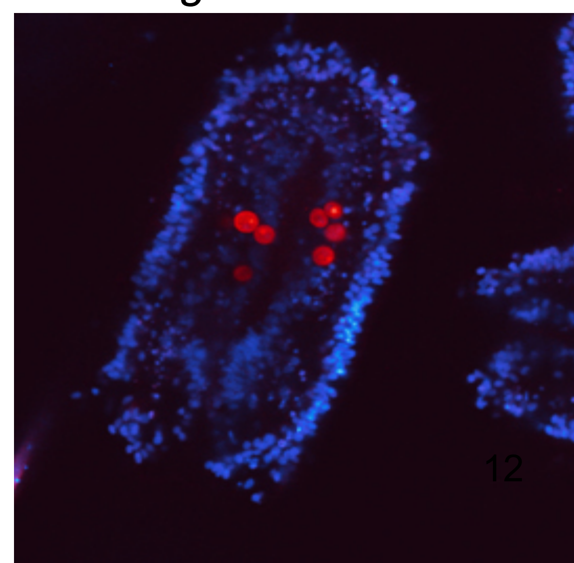
Anemone cover itself with rocks/shells or bury itself in the sand to avoid too much exposure to the light

Symbiodinium in Corals

- *Symbiodinium* in corals may be supplied by
  - Maternal transfer (adult to offspring)
  - Water column
- Symbiont diversity greatest early after settlement
  - Revert to maternal
  - May help juveniles proliferate new areas



Fungia scutaria



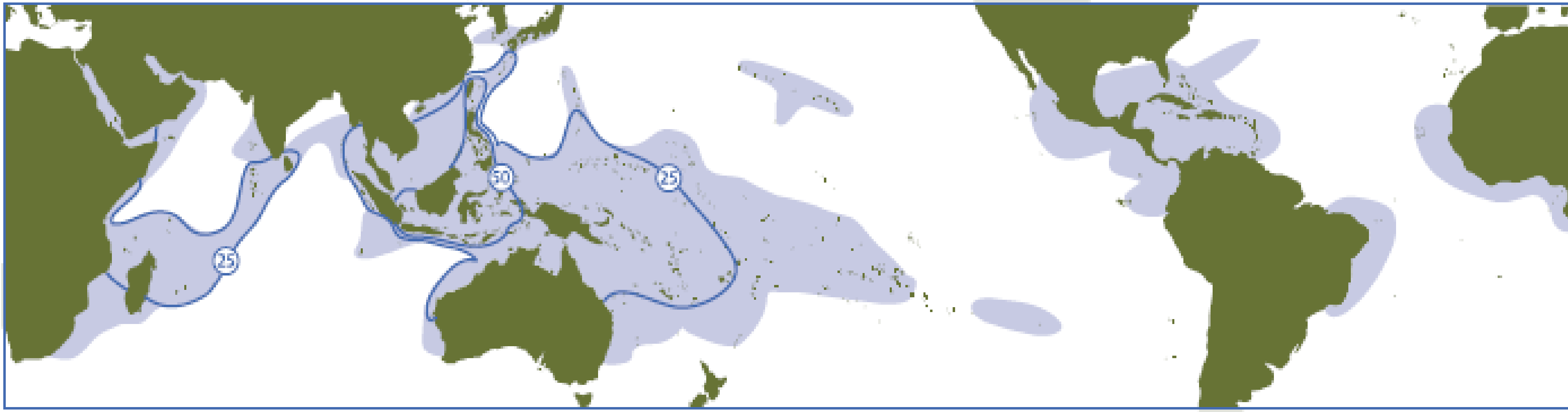
Corals and *Symbiodinium*

- Flexibility and specificity
  - Scleractinians most flexible hosts
    - Contain many types of symbionts
  - Some corals associate with many clades and/or species of *Symbiodinium*
  - Other are restricted to a single clade or subset of clades
  - Limits of *Symbiodinium* in corals:
    - light
    - depth (strong association with light)
    - temperature

Coral Reef Builders

- Cnidarians are “reef builders”
  - Scleractinians (Anthozoans) are principal constituent of most coral reefs
  - Also Hydrozoan order Milleporina (fire corals)
- All reef builders have *Symbiodinium* in their gastrodermal cells

Worldwide Distribution of Coral Reefs

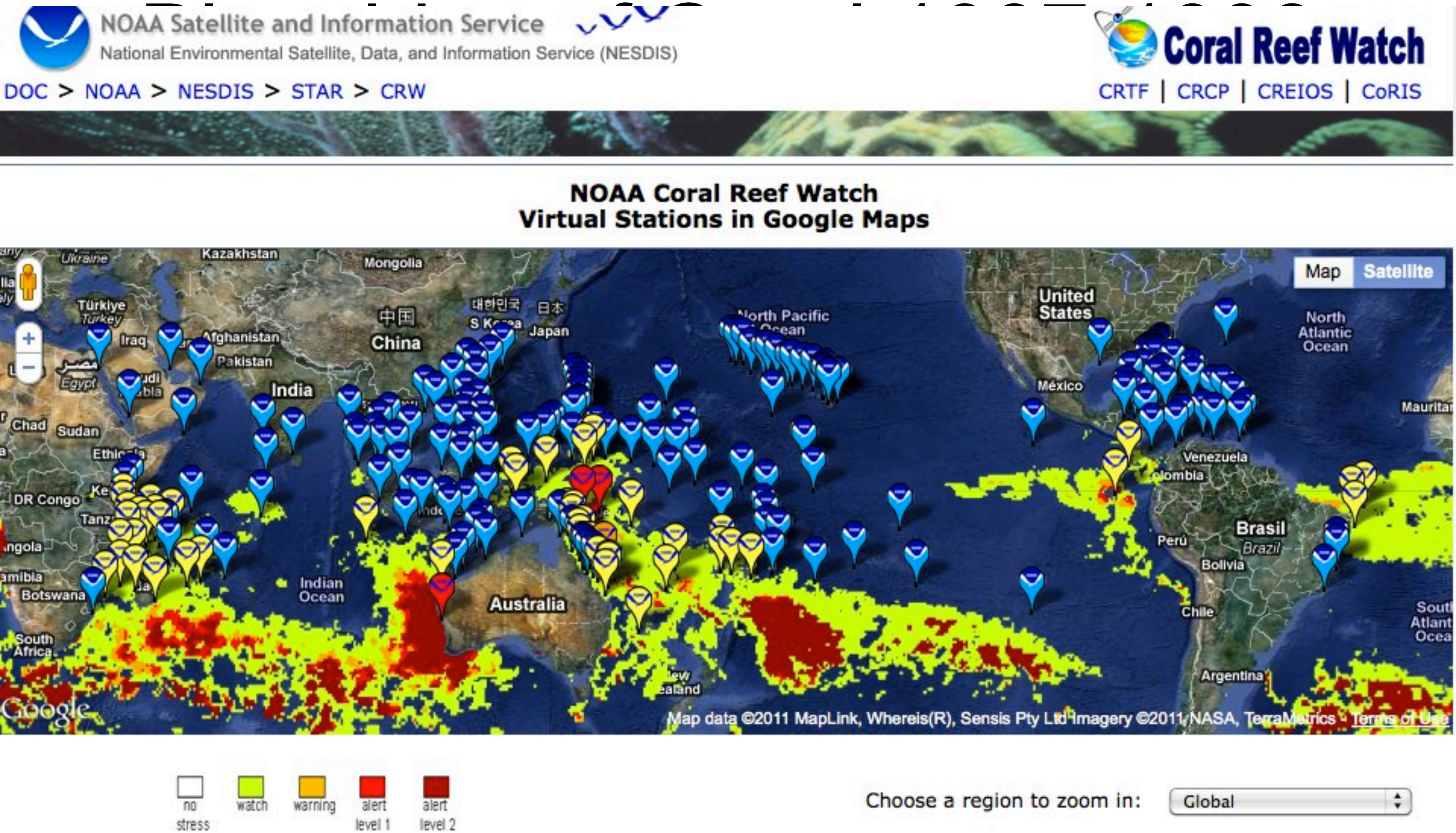


General worldwide distribution of coral reefs, with contours indicating the number of genera (clans of related species). The area inside the 50 genera contour is essentially the high diversity "coral triangle"—the Southeast Asian center of coral diversity. The blue area outside of the contour lines represents regions with at least 10 but fewer than 25 genera. Source: based on Veron (1995).

Importance: support fisheries; natural breakwaters for protection; human use - food, building materials, pharmaceuticals and aquarium trade; ecosystem services – recycling nutrients, providing food, shelter, and nursery habitat for other orgs

Potential Climatic Changes

- Increased Temperature
  - May cause changes in distribution
  - Coral bleaching
- Reduced Calcification Potential (Ocean Acidification)
  - Increases in carbon Dioxide leads to decrease in Calcium Carbonate
    - Leads to slower growing corals
- Changes in Sea Level
  - Corals are often limited by sea level
- Ocean Circulation Patterns
  - Changes could impose different temperature regimes
- Precipitation and Storm Patterns
  - Rainfall likely to increase
    - Leads to lowered salinity and increased sedimentation



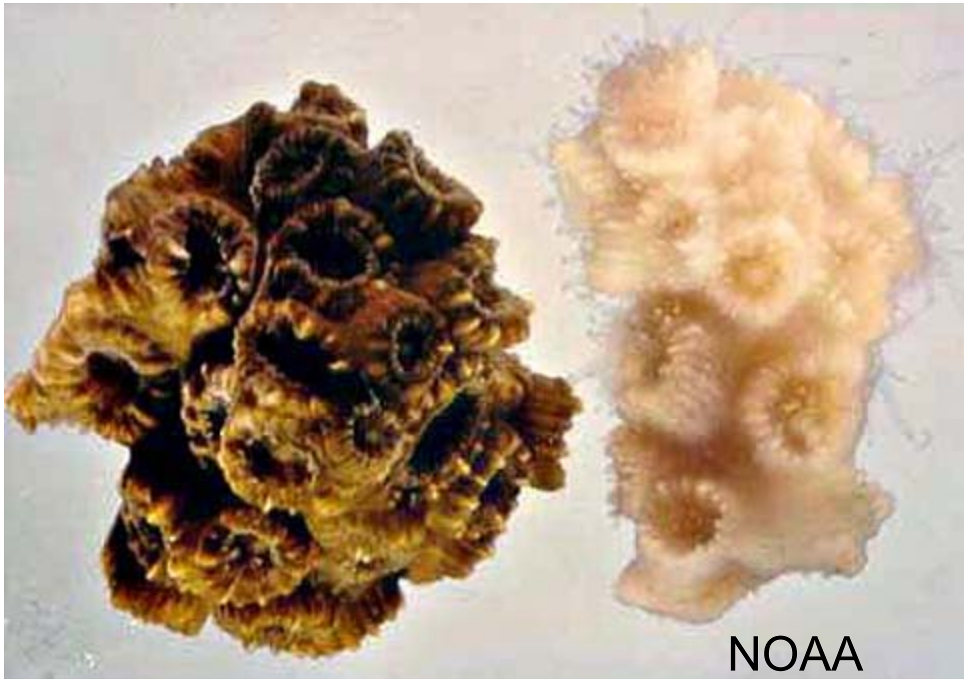
http://coralreefwatch.noaa.gov/satellite/index.html

Climate and Coral Bleaching

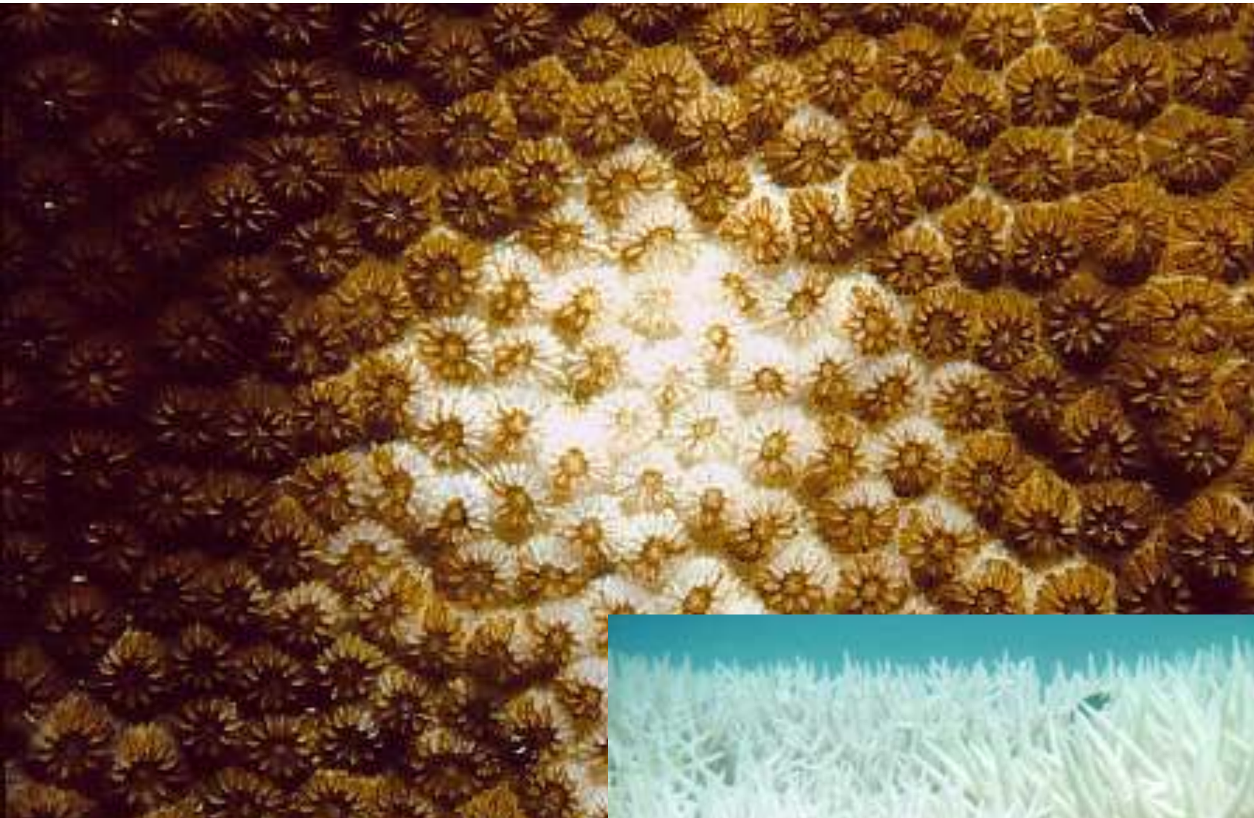
- Coral bleaching first documented in 1980s
- Ocean warming and El Nino-Southern Oscillation (ENSO)
  - ENSO brings unusually warm water to the Pacific and Indian Oceans
  - Bleaching events in 1982-83, 1987-88, 1997-98, 2001-2002 tied to ENSO
  - 1997-98 event lost 16% of global coral reefs

What is Coral Bleaching?

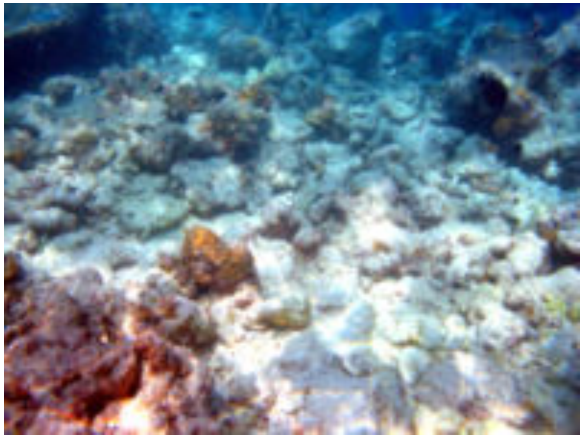
- Any Cnidarian with symbionts can be "bleached"
- Bleaching is the loss of symbiotic algae by the coral or other host
  - Living tissue becomes translucent
- Biological response of corals
  - Cellular mechanisms
    - Degeneration of *Symbiodinium*
    - Host release of algae



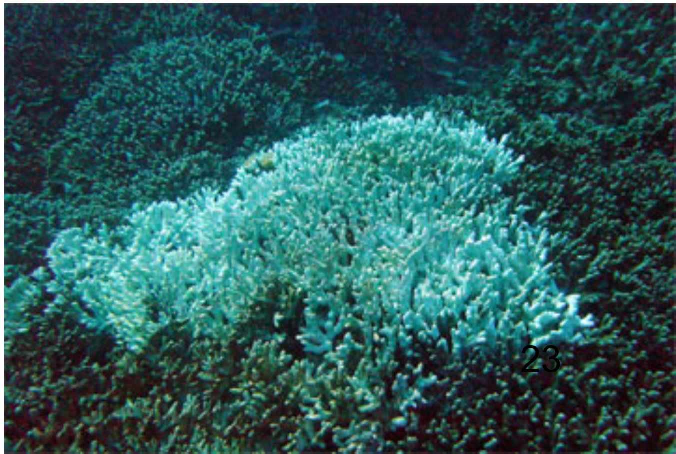
Coral Bleaching Images



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



Coral Diseases

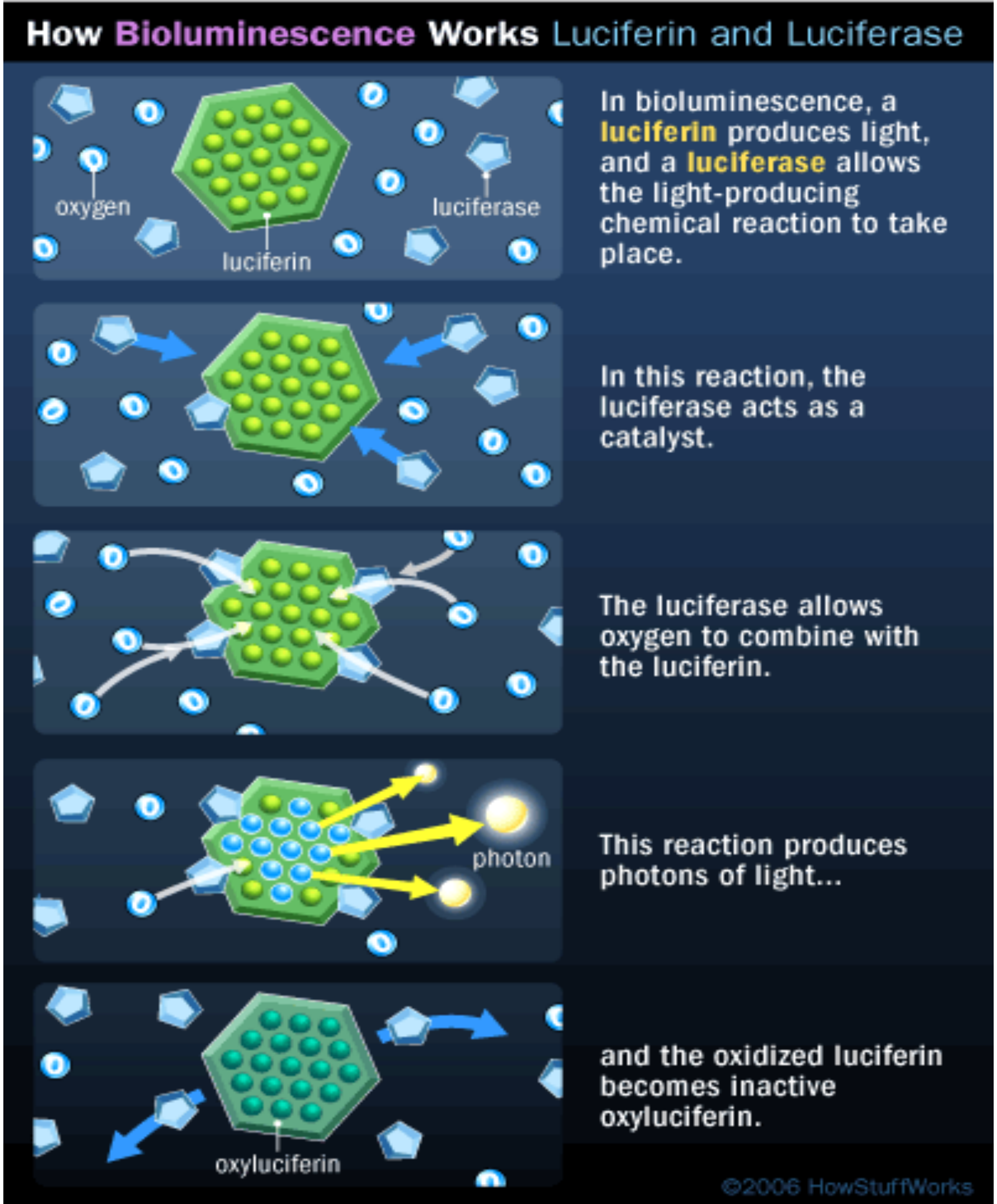
Black Band Disease

Yellow Band Disease

White Band Disease

Cnidarian Bioluminescence

- **Bioluminescence** is the production and emission of light by a living organism as the result of a chemical reaction during which chemical energy is converted to light energy
- Greek: *bios* for "living" and Latin: *lumen* for "light"
- Bioluminescence can be generated by symbiotic organisms (ie: dinoflagellates, bacteria)


How Bioluminescence Works Luciferin and Luciferase
oxygen
luciferin
luciferase
In bioluminescence, a luciferin produces light, and a luciferase allows the light-producing chemical reaction to take place.
In this reaction, the luciferase acts as a catalyst.
The luciferase allows oxygen to combine with the luciferin.
photon
This reaction produces photons of light...
oxyluciferin
and the oxidized luciferin becomes inactive oxyluciferin.
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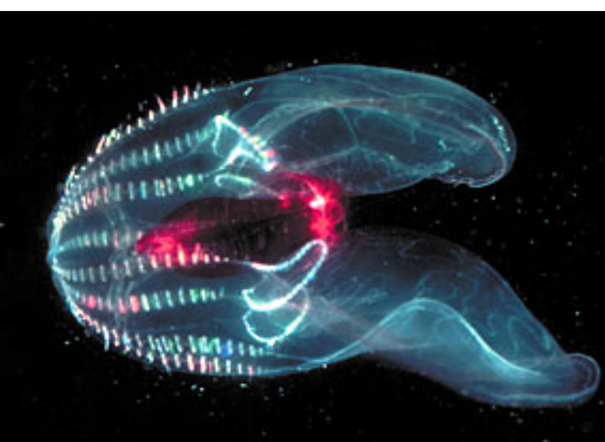
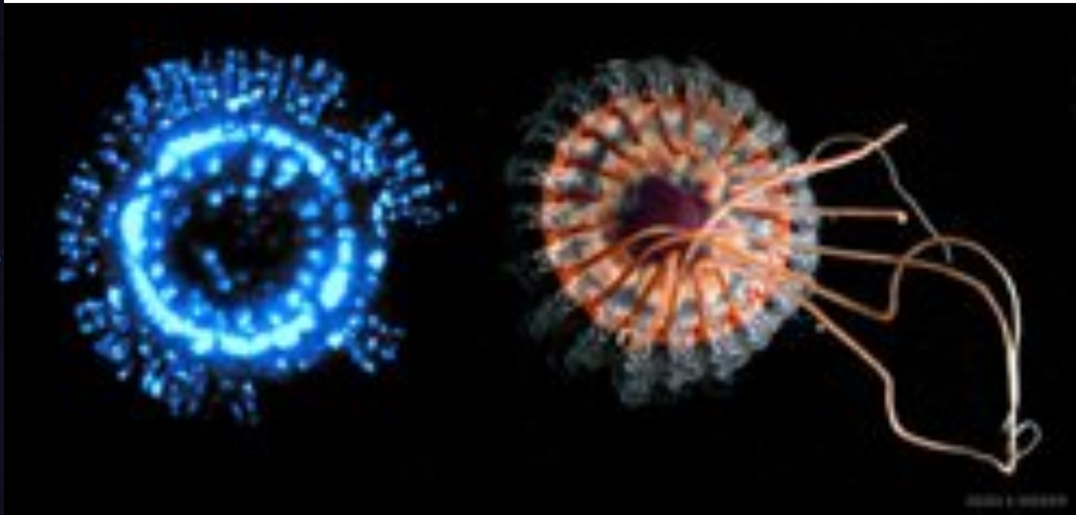
Cnidarian Bioluminescence

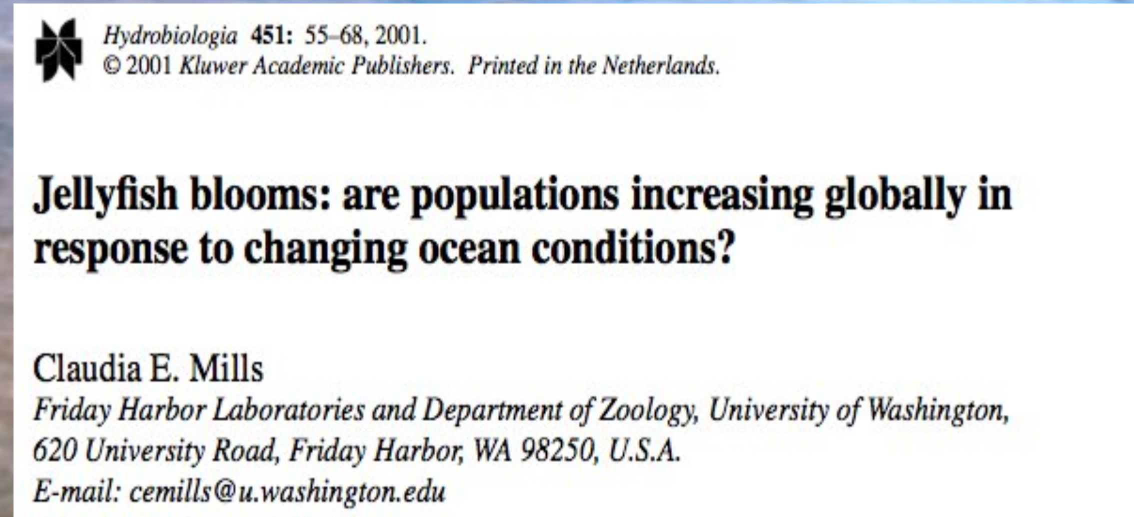
- 50% of cnidarians are bioluminescent
- Siphonophores, medusae, sea pens, soft corals, and ctenophores (comb jellies – Phylum Ctenophora)



Deep Sea Jellies

- *Atolla wyvillei*
- Range from 500m to over 4,500m!




Hydrobiologia **451:** 55–68, 2001.

Jellyfish blooms: are populations increasing globally in response to changing ocean conditions?

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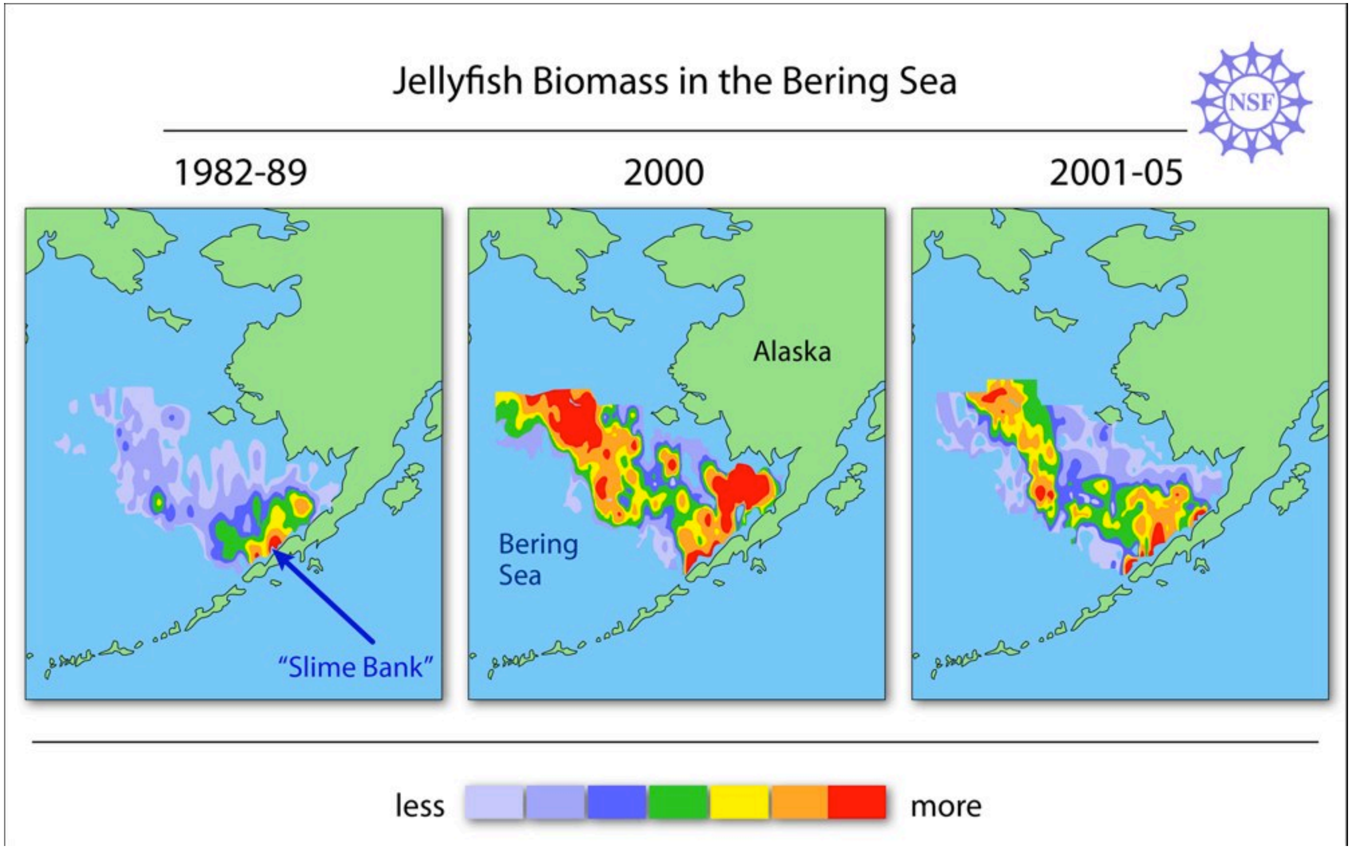
Jellyfish Blooms

- Negative effects
  - Tourism: sting swimmers
  - Fishing: clog nets, predators & competitors
  - Aquaculture: kill net-pen fish
  - Power plants: clog cold water intake
- Anthropogenic causes
  - Warming caused by climate change & thermal effluent
  - Eutrophication: increase zooplankton, turbidity and hypoxia
  - Overfishing: removes predators & competitors
  - Dams: influence hydrology & salinity
  - Aquaculture
  - Accidental introductions

- Although recent articles state that jellyfish populations are increasing, most available evidence shows that jellyfish abundances fluctuate with climatic cycles



- Reports remain local in scope
- Lack of a baseline – fragmentation of data sources
- Need analyses across marine ecosystems

As human effects on coastal environments increase, jellyfish blooms **may** increase as a consequence.

Lake Palau Jellies

Jellyfish fishery!?

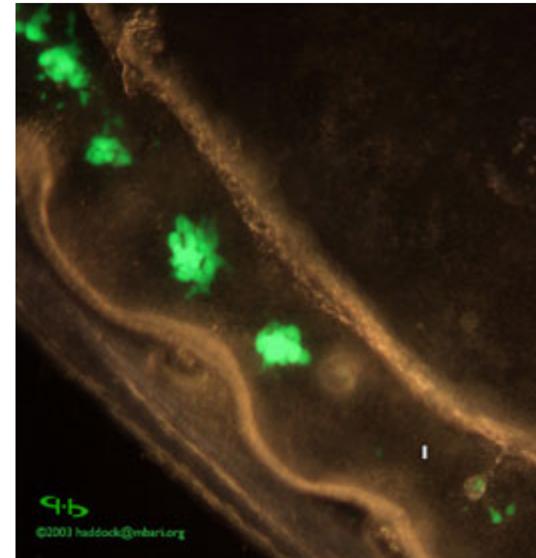
Culinary uses

- Jellyfish are an important source of food in many Asian countries
- Only jellyfish belonging to the order Rhizostomeae (Scyphozoan) are harvested for food

Rhopilema esculentum
Chinese name: 海蜇 *hǎizhē*

Biotechnology

- 1961 green fluorescent protein (GFP) was discovered in the jellyfish *Aequorea victoria*



- Uses: cell biology – fluorescent microscopy, protein expression, *in vitro* & *in vivo* optical cell detection

Biotechnology

- Harvested for their collagen (mesoglea)
- Used for a variety of scientific applications including the treatment of rheumatoid arthritis

This concludes material on the Phylum Cnidaria

- FYI: If you or someone you know gets stung by a jellyfish…do not, I repeat **DO NOT pee on it!** This will worsen the pain and is just plain GROSS!
- Apply vinegar to the sting. This will inactivate undischarged cnidae and potential toxins. If no vinegar, rinse the area with **salt water** and definitely do not rub the area!
- If the person appears ill (vomiting) call 911