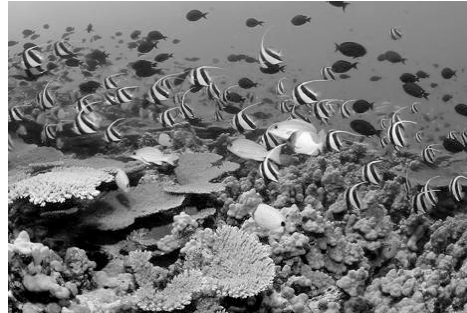


11. Habitats: Coral Reefs

- What are corals and coral reefs
- Geologic history of corals
- Taxonomy
 - Reproduction
- Coral Reefs
 - Coral morphology
 - Reef morphology
- Symbiosis
- Biogeography

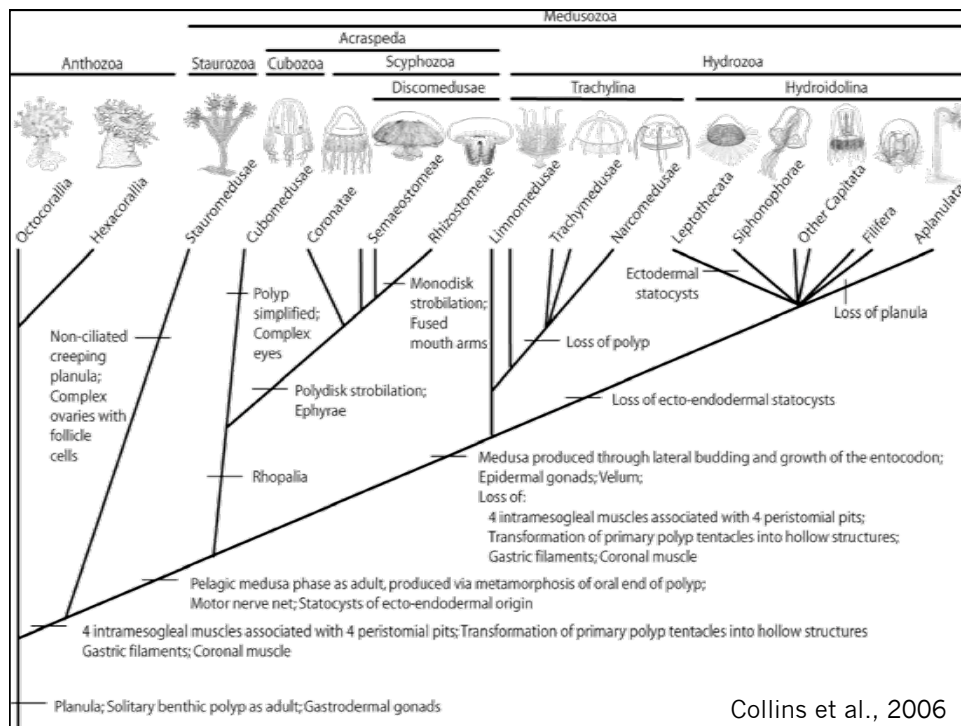


Dr Rhian G. Waller
30th April 2010
Reading: Knowlton & Jackson, 2001

What are corals?

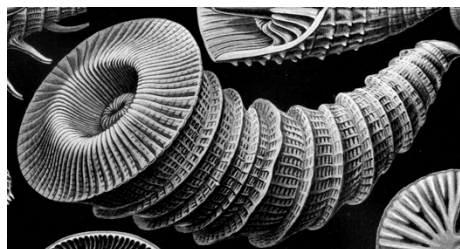
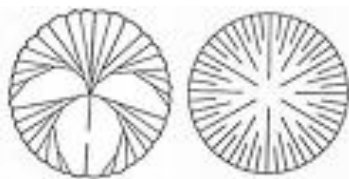
- Phylum Cnidaria
 - “to sting”
 - Diploblastic
- Exclusively marine
 - Found in all oceans at all depths
- Zooxanthellate or Azooxanthellate
 - Hermatypic or Ahermatypic
- Produce calcium carbonate
- Not all are “habitat forming”
 - Easy to think corals are only in reefs!
 - Many different forms

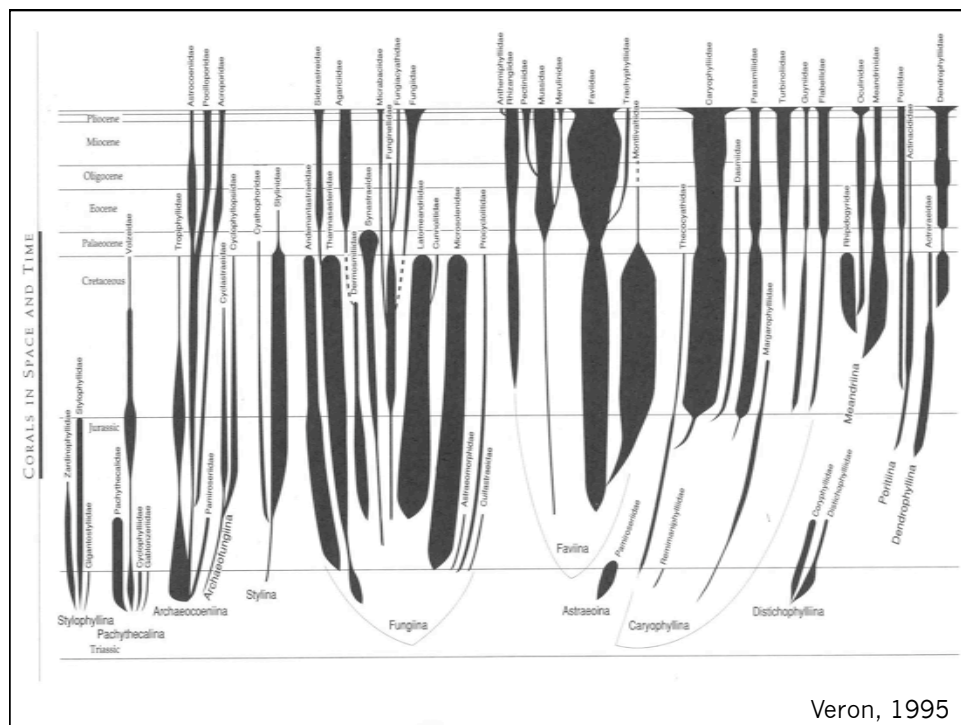
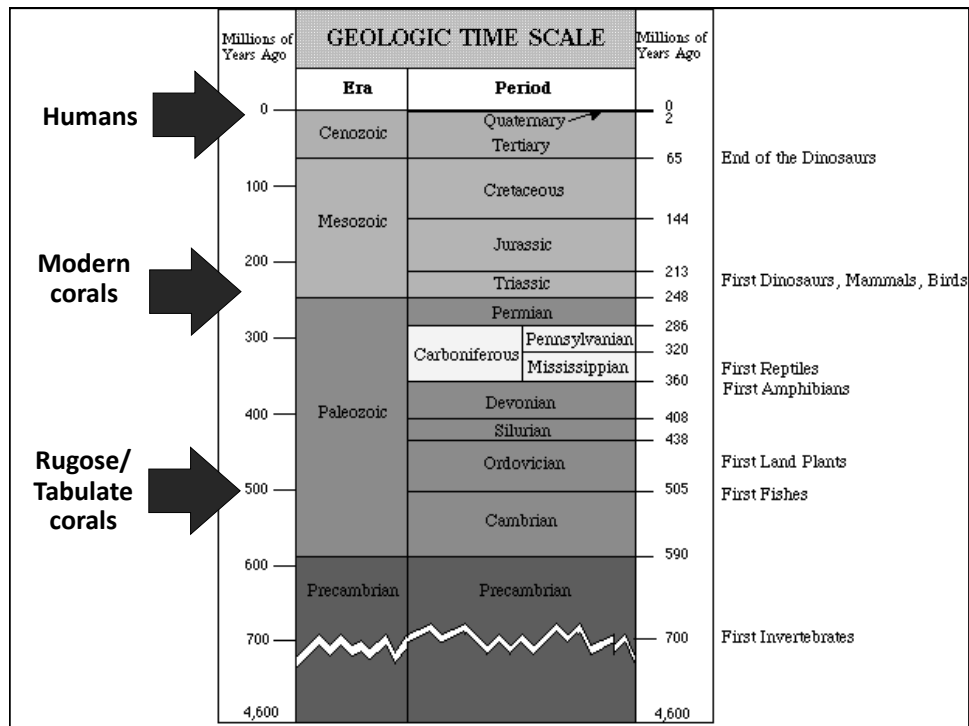




Where did corals come from?

- Reef building corals evolved at the beginning of the Mesozoic ~240 Ma
- Preceded by Tabulate and Rugose Corals
 - Non-reef building, Tetra-corals, azooxanthellate
 - Calcite – not aragonite
 - Extinct at the end of the Paleozoic





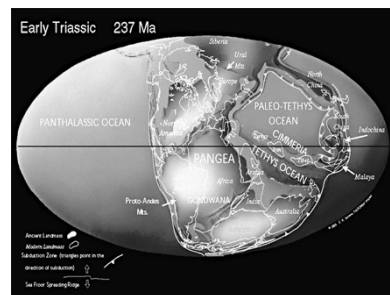
Evolution

- **Large environmental changes in past 240 Ma**

- Tectonic drift
- Oceanic basins & circulation patterns
- Climate/temperature changes
- Sea level rise/fall and rates of change
- Episodic natural disasters

- **Geologically robust**

- Not as fragile as regarded?



Taxonomy

- **Class Hydrozoa**

- Stylasteridea (Lace Corals)

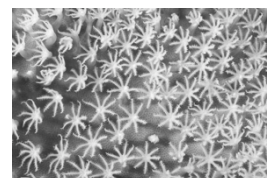
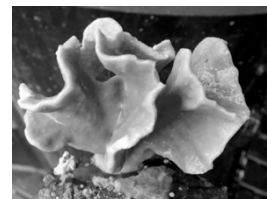
- **Class Anthozoa**

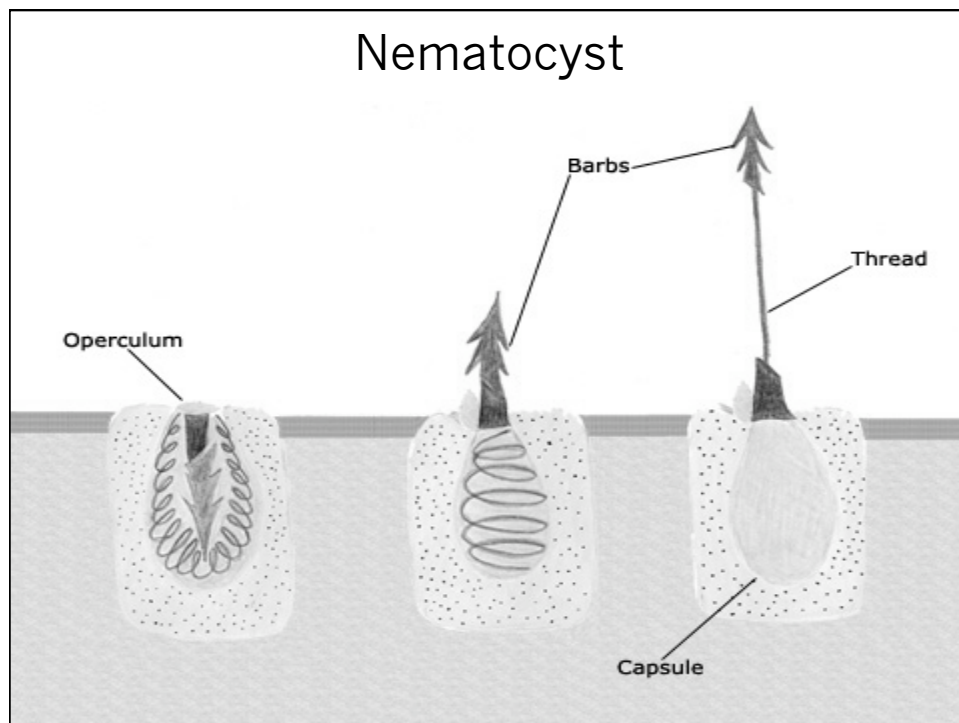
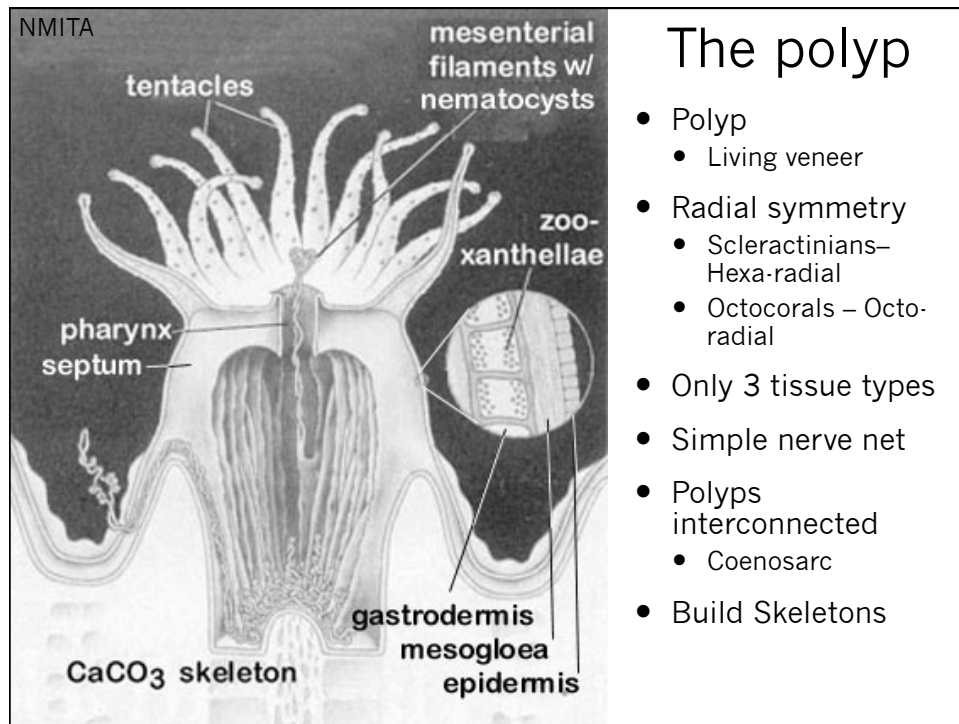
- **Subclass Hexacorallia**

- Order Scleractinia (Stony Corals)
- Order Antipatharia (Black Corals, Wire Corals)
- Order Zoanthidea (Zooanthids)

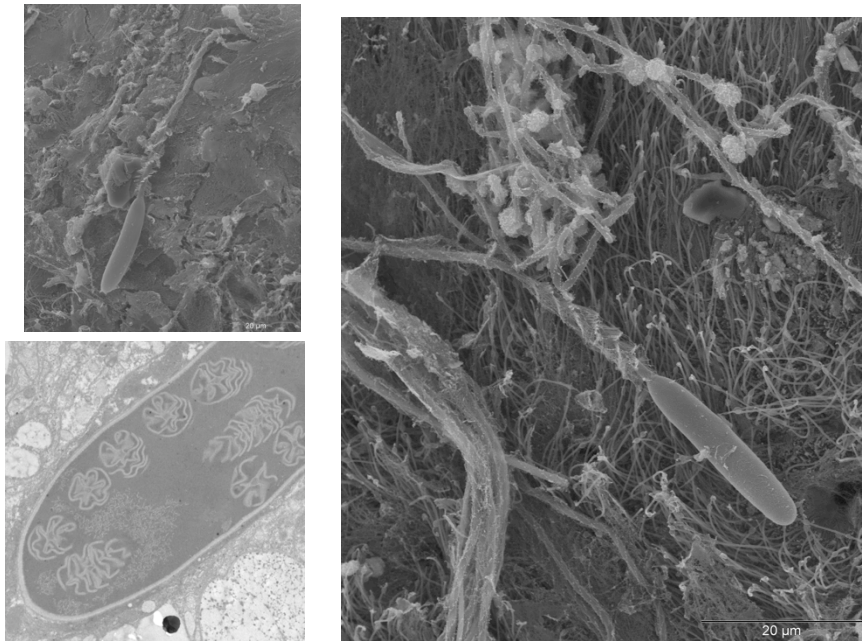
- **Subclass Octocorallia**

- Order Alcyonacea (Soft Corals)
- Order Stolonifera (Organ Pipe Corals)
- Order Gorgonacea (Sea Fans and Sea Whips)
- Order Helioporacea (Blue Coral)

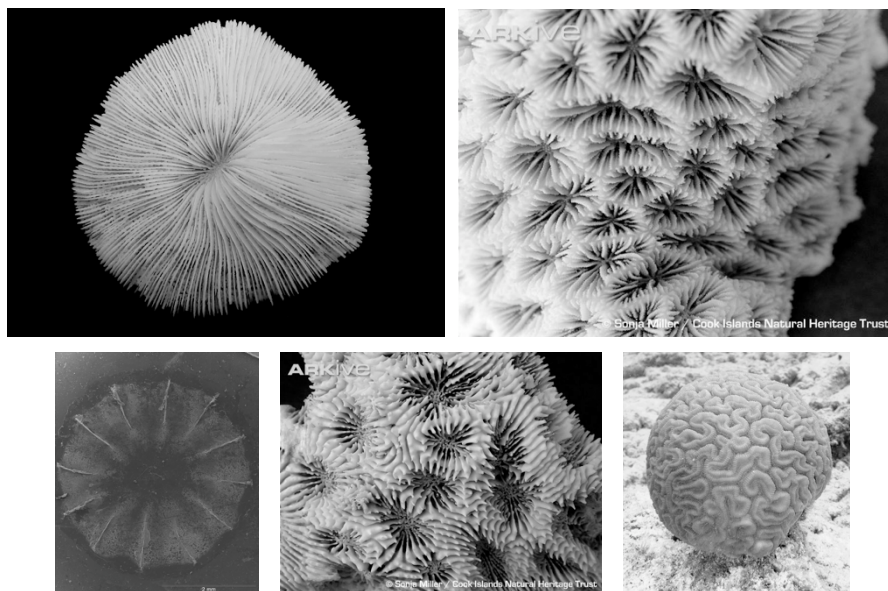




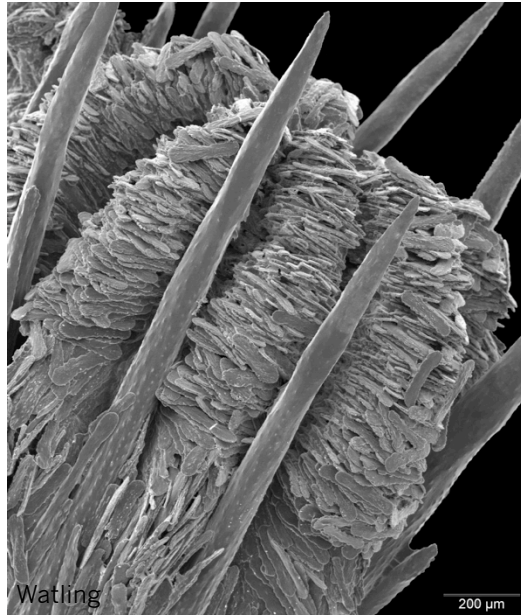
Nematocyst



Skeleton – Hard Corals



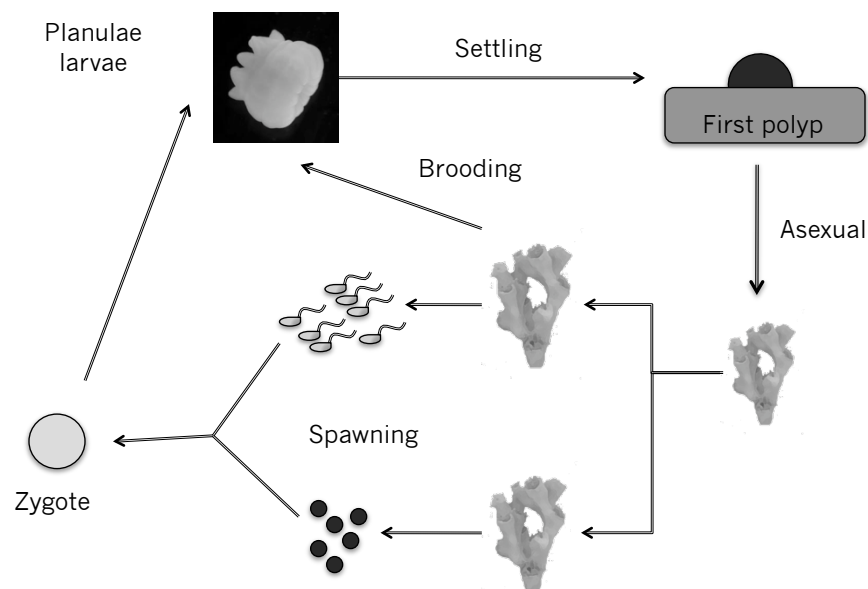
Skeleton – Soft Corals



- “Gorgonin” and calcite skeletons
 - Horny protein
- Sclerites
 - Calcium carbonate

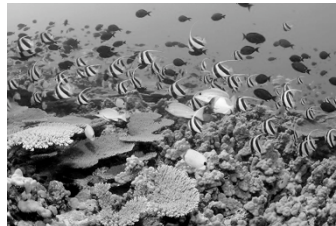


Colonial Coral Life Cycle



What is a coral reef?

- **“Reef”**
 - Feature lying beneath the surface of the water with which a boat could get stuck on
- Typically diverse assemblage of habitat forming scleractinians
- Mainly Shallow
 - But.....not always.....
- Important engineers
 - Biodiversity
 - “Rain forests of the ocean”
 - Cover less than 1/10% of ocean floor
 - Habitat for 25% of all marine species

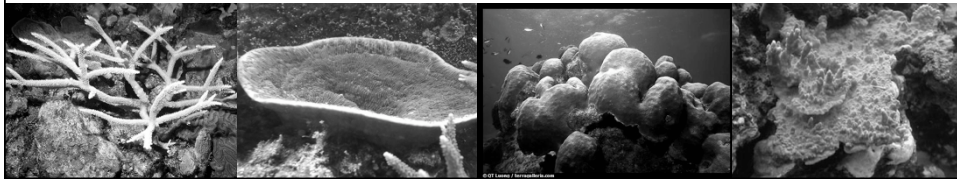


Coral Reefs of the World

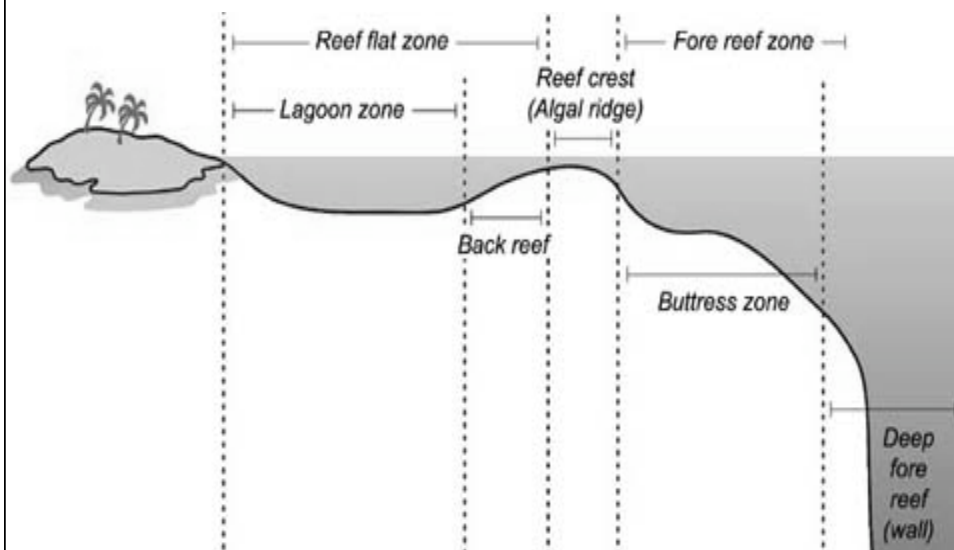
- **Great Barrier Reef, Australia**
 - Largest coral reef in the world, 2600km
- **Belize Barrier Reef**
 - Second largest in the world
- **New Caledonia Barrier Reef**
 - Second longest double barrier reef – 1500km
- **Andros Barrier Reef**
 - 3rd largest barrier reef, 167km long and 64km wide
- **Red Sea Coral Reef**
 - Egypt & Saudi Arabia
- **Pulley Ridge**
 - Florida, Deepest photosynthetic coral reef, 60m deep

Scleractinian morphology

- **Branching**
 - Often fast growing
- **Plate-like**
 - Often found in deeper environments
- **Massive/lobed**
 - Generally slower growing, k-selected
- **Encrusting**
 - Sometimes parasitic



Reef Zones



Types of Reef

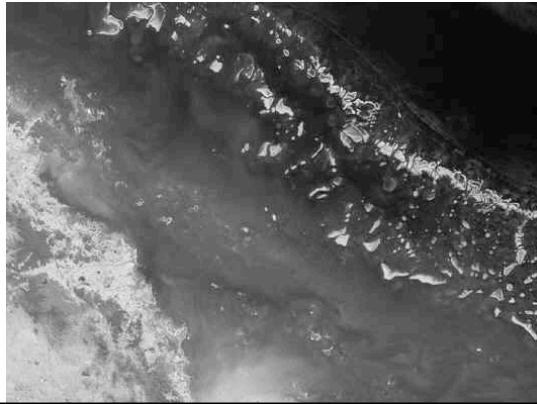
- 4 Main types of reef
 - Fringing, Barrier, Patch and Atoll
 - Also – Apron, Bank, Ribbon & Table
- Fringing reef
 - a reef that is directly attached to a shore or borders it with an intervening shallow channel or lagoon
 - Bora Bora, French Polynesia



Types of Reef

- **Barrier Reef**

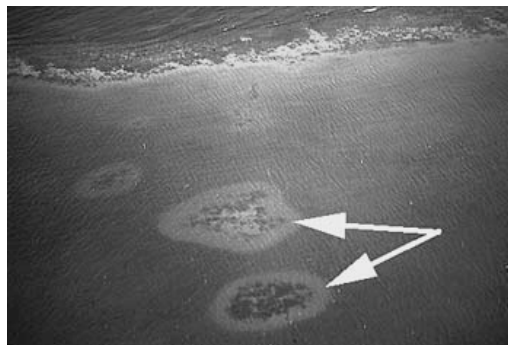
- a reef separated from a mainland or island shore by a deep lagoon
- Great Barrier Reef - Australia



Types of Reef

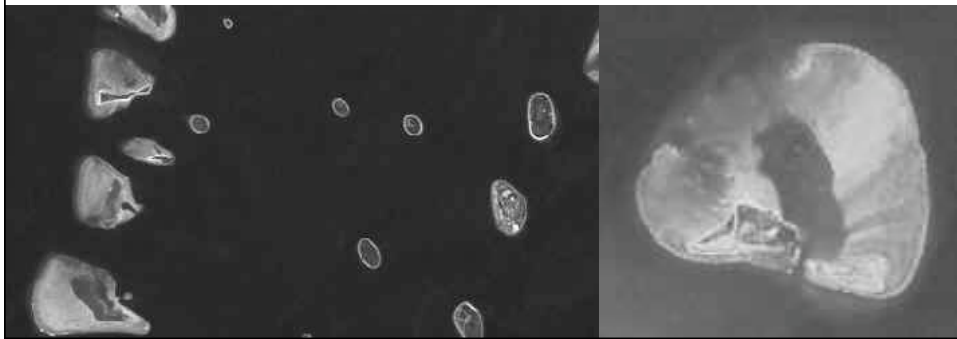
- **Patch Reef**

- an isolated, often circular reef, usually within a lagoon or embayment
- halo of sand
 - Fish foraging
- Florida



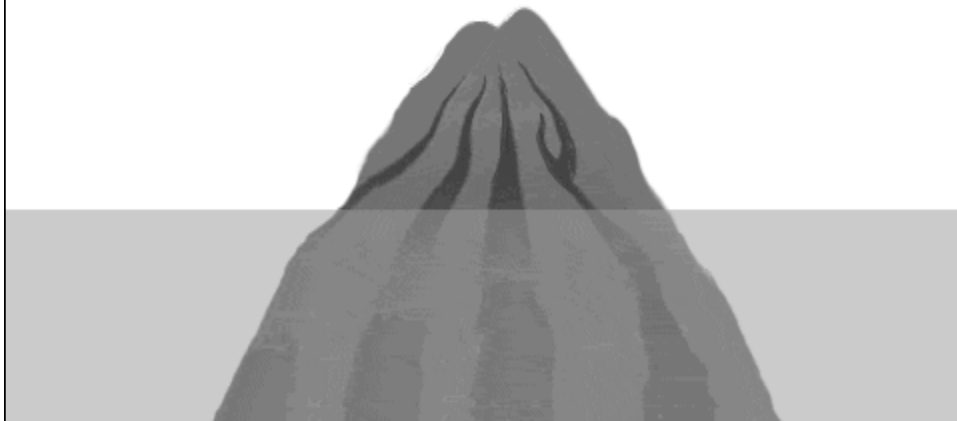
Types of Reef

- **Atoll Reef**
 - a more or less circular or continuous barrier reef extending all the way around a lagoon without a central island
 - Midway, Hawaiian Islands



Atoll Formation

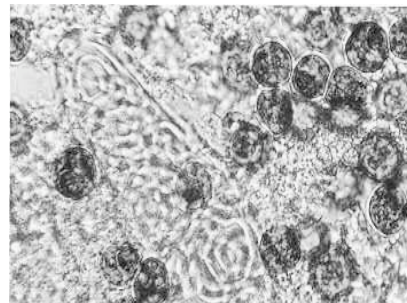
- **Island erosion**
- **Island sinking**
- **Reef accretion**





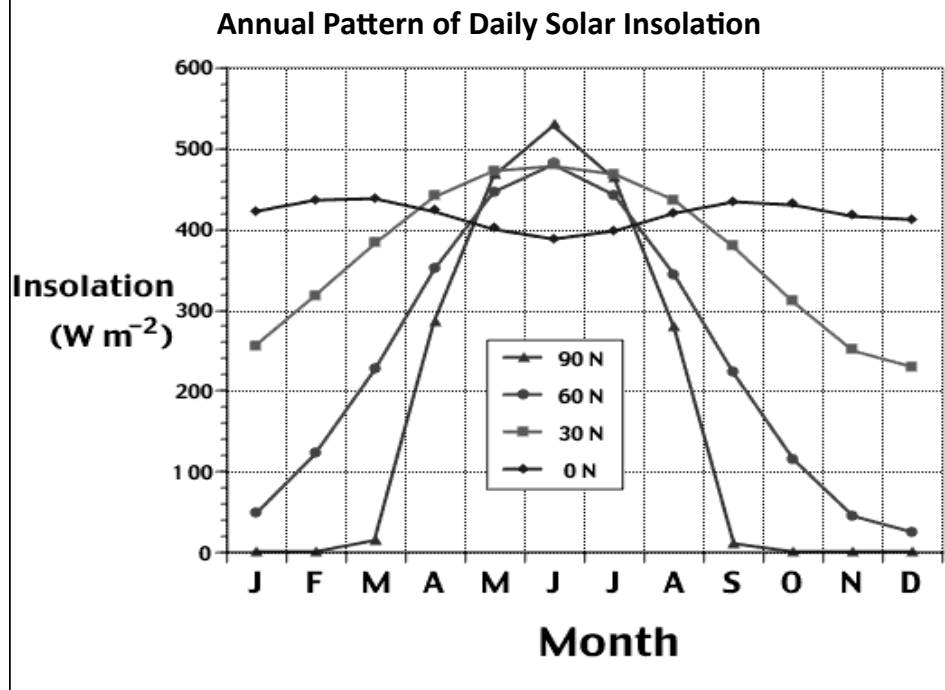
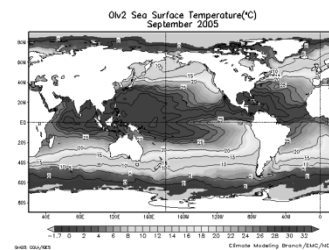
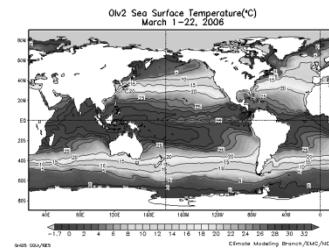
Symbiosis

- Can provide up to 90% of corals energy
- Genus Symbiodinium
 - Different species live in different corals
 - Controversial
- Ingested by corals
 - But not digested
- Reproduce by budding
- 3 Life Stages
 - Vegetative
 - Cyst
 - Motile

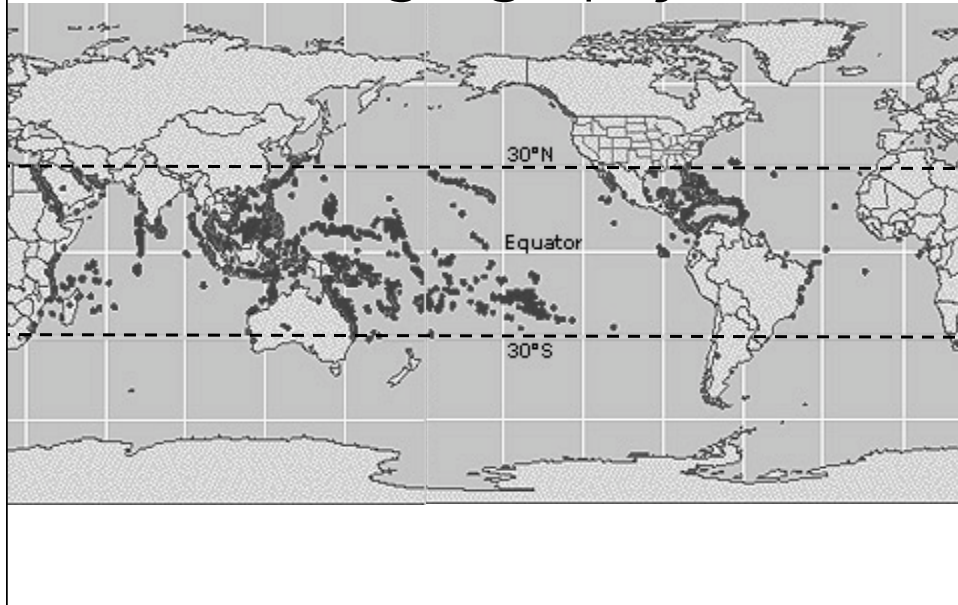


Shallow water coral biogeography

- Warm tropical climates
 - Low latitudes (30°N to 30°S)
 - High solar insolation
 - Warm water currents
- Clear shallow waters
 - good light penetration
 - ~30m
- low sedimentation and turbidity
 - Oligotrophic waters
 - Not exclusively
- Hard substrata



Biogeography



Biogeography

- Distinct fauna between Atlantic and Indo-Pacific
- Lower diversity in the Atlantic
 - Younger, smaller ocean basin with less thermal capacity
 - More extinction events
 - But older coral genera ~60 mya

Taxonomic Group	Indo-West Pacific	Eastern Pacific	Western Atlantic & Caribbean	Hawaii
Scleractinian corals				
genera	80	n/a	28	16
species	719	34	62	52
Alcyonarian corals	690+	0	6	4
Sponges	244		117	
Bivalves	2,000	564	378	
Echinoderms	1,200	208	148	
Fish	4,000	650	1,400	
Seagrasses	34	7	9	
Mangroves	59	13	11	

Modified from Spalding, M. et al. 2001

Biogeography

- Higher diversity in the Indo-Pacific
 - Older ocean basin with more stability through geological time
 - Larger body of water with more thermal capacity
 - East-west mountain ranges limited glacial advances during ice ages
 - But younger coral genera ~30 mya
- Center of diversity in the Indo-Australian Archipelago (IAA)
 - Diversity gradient as radial distance from center increases

Why Study Corals?

- **Biodiversity and complexity**
 - Coral reef ecosystems rival tropical rain forests
 - Large array of biological and ecological processes
 - Diversity of life history strategies
- **Ecosystem engineers**
 - Corals create habitat for many organisms
 - Hermatypic corals (via photosynthetic symbionts) form the base of the food chain
- **Economically Important**
 - Tourism
 - Fisheries
 - Subsistence for local populations
 - Source for natural products chemistry

Conclusions

- Cnidarians
 - Have been around for 240 million years
 - Have stinging cells (nematocysts)
- Four major morphologies
 - Branching, Plate, Massive, Encrusting
 - Suitable for different environments
- Four major morphologies of reef
- Symbiosis
 - Photosynthesis by dinoflagellates
- Biogeography
 - More species in the indo-pacific – center of diversity