Overview

- Coral Reefs extend back over 500 m.y.
- Grow in tropical seas with normal salinity
- Support a great variety of plant and animal life
- Cover less than 0.2% of sea floor
- Contain about 25% of marine life

What are Corals?

- Invertebrate marine organisms - Phylum Cnidaria, Class Anthozoa
- Simple radial body plan with one opening
- Make external and internal skeletons
- Two types: (1) Reef-building (hermatypic or hard) corals; (2) non-reef building (ahermatypic or soft) corals
- Hard corals have zooxanthellae (algal symbionts)
Soft Corals

- Similar to hard corals but without a solid skeleton
- Do not have zooxanthellae and do not depend on sunlight
- Many are branching forms such as sea whips and sea fans

Great Barrier Reef

- Largest structure built by living organisms
- Only living structure visible from space
Biology of Corals

- Body is called a polyp, a hollow sac-like structure smaller than a pencil eraser
- Mouth surrounded by tentacles, which contain stinging structures called nematocysts for paralyzing prey
- Hard corals produce limestone skeleton
- Intricate patterns of hard corals produced by polyp shape and the calcareous skeleton it secretes

Coral Structure
The structure of a hard coral polyp

Tentacles
Mouth
Pharynx
Mesenteries
Stomach cavity
Calcereous base of polyp

How a nematocyst works

Trigger
Hollow thread containing toxin
Barbs
How coral colonies grow

All coral colonies arise from a single polyp. Here we show two classic growth patterns. The mound-forming corals build up in layers, while the branching species develop in a longitudinal fashion to form more fragile twiglike growths.

Mound coral

Living layer of polyps
Original polyp

Branching coral

Living polyps
Polyp divides to form branch
Polyps develop longitudinally
Original polyp
Corals

- Corals can not survive in fresh, brackish water or highly turbid water.
- Corals do best in nutrient poor water because they are easily out-competed by benthonic filter feeders in nutrient-rich water where phytoplankton and seaweed are abundant.

Corals

- Corals share a mutually beneficial relationship with zooxanthallae (algae) which live within the tissue of the polyp and can comprise up to 75% of the polyp’s body weight.
- Corals can be either solitary or colonial.
- Coral reefs flourish in water that is warmer than 20 degrees C; found in tropical and subtropical latitudes.
Corals and Zooxanthellae

- Algal cells live within polyp tissues in a symbiotic relationship
- Algae provide oxygen; corals generally eat zooplankton
- Corals provide CO\(_2\), nutrients and protection
- Algae need sunlight; reefs only grow in photic zone
- Algae give corals their color

Feeding and Reproduction

- All are carnivorous; use nematocysts to paralyze their prey
- Tentacles of hard corals extend to feed only at night; soft corals feed during the day
- Reproduce both sexually and asexually
- Asexual reproduction occurs by budding; a colony develops by addition of new buds
- Grows very slowly, up to 2 cm/year
- Largest coral structures may be 100s of years old
- All colonies arise from a single polyp
Optimum Conditions for Reef Growth

- Thrive in shallow, clear, sunlit saltwater
- Between 16 - 36°C (61 - 97°F), optimum is 23 - 25°C (73 - 77°F)
- Salinity of 35 ppt, but can tolerate slightly wider range
- Clear water is necessary for sunlight (algae need it)
- Corals will suffocate in muddy water
- Must be exposed to currents for food since they cannot move
Locations

- Most found between 20°N and 20°S
- Three regions: Indo-Pacific, Western Atlantic, Red Sea
- Indo-Pacific is richest in coral and fish species
- 60% of reefs are in Indian Ocean/Red Sea; 25% in Pacific; 15% in Western Atl.
What Makes a Reef?

- It is of biological origin
- It is a rigid structure
- It stands topographically above the surrounding floor and, therefore, exerts local control on marine processes
Parts of a Reef

- Algal ridge - occurs on windward side and endures the wave energy
- Buttress zone - reef slope extending seaward of the algal ridge
- Reef face - seaward of the buttress zone; usually devoid of colonial corals because of insufficient light

Fringing Reefs

- Begin to develop in shallow water parallel to coast
- Actively growing part is on seaward face where conditions are more favorable
- Broadens into a platform extending out from the shore
- Trapped corals behind active reef gradually die
Barrier Reefs

- Elongated structures parallel to coast but further out to sea and separated from land by moderately deep water
- Form by rise in sea level or subsidence of land
- Large reefs occur mainly on eastern side of large landmasses due to global current systems
Atolls

- Develop similarly to barrier reefs but based on an island instead of a long shoreline.
- Most abundant in central Indian Ocean and the Pacific.

Evolution of Coral Reefs
Fringing Reef Zones

- Lagoon - sandy with algae or sea grasses; diversity inhibited by high T & S and lack of currents; patch reefs
- Back reef - richer due to exposure to open water breaking over reef
- Reef flat - broad shallow area with strong wave action; encrusting calcareous algae
- Reef crest - highest point of reef on seaward side of reef flat; strong wave action
- Reef front - seaward and deeper than crest; less wave energy
- Upper reef slope - most productive area; gentle slope to sheer drop; great diversity; abundant fish
- Lower slope - beyond depth most shallow water corals can tolerate; platelike corals and soft corals
Barrier Reef Zones

- Leeside face - toward the land; fronts on open ocean conditions rather than a lagoon; prolific coral growth
- Reef flat - much wider
- Reef crest - very exposed; high energy wave action
- Upper reef slope - fairly steep with dense coral growth
- Lower reef slope - may drop steeply
Value of Coral Reefs

- Enrich sea life
- Provide food and shelter to many plants and animals
- Exchange energy and nutrients with adjacent ecosystems
- Break waves (boat anchorages), protect shorelines
- Supply fin fish and shell fish for subsistence, commercial, recreational and ornamental uses
- Seafood consumption exceeds pork or beef
Threats to Coral Reefs

- Highly sensitive to environmental conditions
- Natural threats include: sea level changes, storms, abnormal weather, temp fluctuations, heavy rains, disease, and predation
- Human threats: global warming, harmful fishing practices, mariculture, damage from boats and divers, coral mining, and pollution