

# Chapter 16 (p. 460-462) & 18 (p.521) – Coral Reef Environments

## Coral Reef Ecology – Lecture

### 1. The Biological vs. Geological context of Coral Reefs

The “Biological” context of coral reefs generally refers to the **living** parts of the reef:

- The Cnidarian coral animal living at the surface of the reef structure & secreting the Calcium Carbonate ( $\text{CaCO}_3$ ) which forms the structural (geologic) base of the reef
- The microscopic algae (zooxanthellae) living symbiotically within the coral’s tissue
- The other creatures present in the surrounding Coral Reef Ecosystem

The “Geologic” Context of corals generally refers to the structural, non-living aspect of the reef.

- The Calcium Carbonate ( $\text{CaCO}_3$ ) structures
- Types of Reefs (ie. Fringing, Barrier, & Atoll; and Spur & Grove formations), & how they developed as the result of large-scale geologic oceanographic processes (such as: plate tectonics; and wave energy & currents), rather than biologic-based evolution.

### 2. Where are corals in the “Tree of Life”?

- Kingdom : **Animalia**
- Phylum : **Cnidaria**
- Type of Symmetry : **radial**
- Examples of other organisms in this Phylum : **Sea Anemones & Jellyfish**

### 3. Very basic understanding of coral reproduction and growth

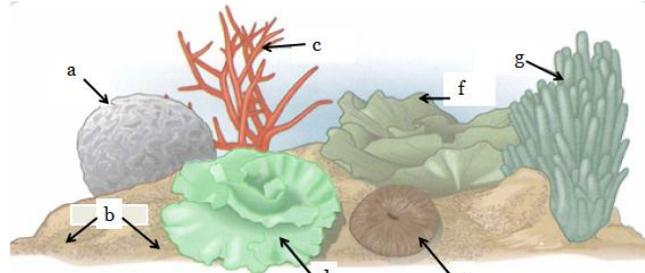
- Know the terms “Polyp” and “Medusa,” & be able to recognize (visually) which is which, & know where they’re located (ie. which is found on top of the  $\text{CaCO}_3$  base, & which is free-swimming in the water column)

The Polyp looks like a Sea Anemone & is the stationary phase of coral reproduction (located on the surface of the structure, secreting the  $\text{CaCO}_3$  that forms the structure). Whereas, the Medusa looks more like a jellyfish & is the free-swimming larval stage of coral reproduction.

- What type of substrate (ocean floor) is required for coral attachment & development  
Corals need a **hard** substrate to attach to
- The direction of coral growth with regard to currents and wave action  
Corals grow in the direction of currents and waves

### 4. Know the 7 most common coral morphologies & be able to recognize them

- Massive
- Encrusting
- Branching
- Foliaceous
- Free-Living
- Platelike
- Columnar



### 5. Have a general understanding of the geographic distribution & diversity of corals

- corals are located in low-latitude, equatorial tropical waters
- coral diversity is much higher in the Indo-Pacific than it is in the Caribbean

### 6. What are the 3 types of reefs, how did they evolve (geologically), & who proposed this theory?

**Charles Darwin** came up with the following theory of geologic reef types & evolution:

- **Fringing** reefs are found around the base of volcanoes.
- **Barrier** Reefs are formed as the volcano subsides (sinks), resulting in a gap (lagoon) between the land & reef.
- **Atolls** represent the final stage of this process, when the volcano has sunk beneath the surface of the water.

7. Spur & Groove Formations are adaptations to & mechanisms for...
  - Spur & Groove formations are adaptations to **wave energy & currents**.
  - Spur & Groove formations serve as mechanisms for **sediment removal during storms**
  
8. Why are corals important?
  - Protection from Wave Erosion
  - Mitigate Hurricane Damage
  - Base of the food chain, providing habitat & protection
  - Economic reasons – Food/Tourism
  - Enhances Quantity & Quality of Life
  - Beauty
  - Etc.
  
9. What “stresses” coral?
  - Competition
  - Predation
  - Bioerosion
  - Eutrophication
  - Sedimentation
  - Water temperatures
  - Salinity
  - Pollution
  - Diseases
  - Over-fishing
  - Destructive fishing (i.e. dynamite & cyanide fishing)
  
10. Coral Bleaching:
  - a. What causes coral bleaching? **Increased water temperatures & general stress**
  - b. What role, if any, does the coral-algal symbiotic relationship play in bleaching?  
**The increased temperature causes the zooxanthellae (zoox.) to perform less optimally. The corals in turn expel the zoox. & go into a hibernative-state until environmental conditions become more favorable. Since the zoox. are what contained the pigment (color) that is associated with the coral, when they are expelled the coral turns white (absence of color).**
  - c. When were the two largest bleaching events & what is expected over the next 100+ years?
    - 1998 & 2005 were the two largest/most severe bleaching events
    - Over the next 100 years ocean temperatures are projected to increase more than 2°C; which would be lethal to most corals
  
11. Coral Diseases:
  - a. Review the history of coral disease incidences
    - Coral diseases were first discovered in the 1960s
    - Since then the number of diseases, their incidence, severity, & distribution have increased exponentially
  - b. How are coral diseases diagnosed & named?
    - Coral diseases are diagnosed based on the visual “signs” of the disease
    - Most names are based on the color and shape of the disease (ex. White band disease)
  - c. How have diseases affected Caribbean *Acropora*?  
**White band disease (WBD) & White pox disease (WPD) have devastated Caribbean *Acropora* populations. *Acropora* are now listed as Threatened under the Endangered Species Act**
  - d. What causes Aspergillosis & how is it spread?  
**Aspergillosis is caused by a terrestrial fungus (*Aspergillus synowii*) which is carried from Africa to the Caribbean from the by the trade winds in the form of air-borne dust.**
  
12. What can we do to help corals?
  - Marine Reserves- preserve breeding stocks!
  - No Anchoring
  - Reduce stressors – pollution, sediment, cruise ships!
  - Ban humans after bleaching events
  - Seed reefs with fast growing *Acropora* spp.
  - Re-introduce *Diadema* urchins
  - Clean algae off dead corals to increase recruitment
  - Create Artificial hard substrate for coral recruitment

### Window in the Waves: The Flower Garden Banks (Documentary) – Video

1. Where are the Flower Garden Banks located? **In the Gulf of Mexico, 110 miles SE of Louisiana**
2. Describe the condition/health of the Flower Garden Banks: **healthiest corals in the Caribbean**

## Chapter 18 (p. 523-530) – Global Climate Change

### Global Warming: The Signs & the Science (NOVA 2005 Documentary) – Handout

1. For the last 150 years Earth's temperature has been rising faster than any time in the last 10,000 years.
2. List the signs of Climate change :
  - **Droughts** in the American Southwest & Africa's Sahel
  - **Rising sea level** in Louisiana & Bangladesh
  - **Tropical Diseases Spreading North**
  - **Weather Extremes** from Florida to France
  - **Damaged Agricultural Production**
  - **wild species threatened with extinction**
3. Over the last 100 years the average temperature of Earth has increased 1°F
4. During the last 50 years, the average temperature in the Eastern Arctic & Alaska has increased 4 - 7°F.
5. In January 2002, the Larsen B ice-shelf in the Antarctic broke up into small pieces, with an area about the size of Rhode Island melting in less than 1 month.
6. In the Swiss Alps, glaciers are retreating at a rate of 30 - 40 meters /year, which is two times the average rate of glacial retreat over the last 150 years.
7. Explain the following:
  - a) How does the "Greenhouse effect" work?
    - **Solar radiation penetrates Earth's atmosphere**
    - **As the land & the oceans warm they radiate some of their heat back out into the atmosphere**
    - **Some of this re-radiated heat is then trapped by naturally occurring gases like water vapor, methane, & carbon dioxide**
  - b) What is the historical importance of the greenhouse effect?
    - **For millions of years the greenhouse effect has kept Earth's climate livable**
  - c) Why is the greenhouse starting to get too warm?
    - **The sun, which warms the greenhouse, also fuels a process that cycles carbon from the atmosphere & stores it underground.**
8. What does "current and ancient sunlight" refer to?
  - "**Current** sunlight" is the solar radiation that hits Earth, stimulating plant growth. The plants then trap the heat energy from the sunlight through photosynthesis, resulting in the formation of carbohydrates. These carbohydrates are then consumed (directly or indirectly).
  - "**Ancient** sunlight" is the sunlight (in the form of atmospheric carbon) which has been trapped by plants and then stored in the Earth for hundreds of thousands to millions of years, eventually forming fossil fuels.
  - Over the last 1000 years humans have begun to use these fossil fuels as an energy source, which means we are releasing this ancient carbon back into the air, and we are doing it at such a fast rate that we are rapidly returning the atmosphere back into its pre-Jurassic (or Dinosaur) conditions.
9. Sources of carbon in the atmosphere
  - Transportation = 33%
  - Electric power generation in the US = 33 %
  - Heating homes, manufacturing, making cement, agriculture, & deforestation = 33%

10. Concentrations of CO<sub>2</sub> remain in the atmosphere for how long? **100 years**
11. CO<sub>2</sub> concentrations have increased from 280 parts per million (ppm) during the Industrial Revolution to **370** ppm today, & may climb to 500 within our lifetime.
12. Why is Carbon dioxide important?
  - **It's a greenhouse gas (GHG)**
  - **It drives photosynthesis**
  - **Controls our blood chemistry**
13. Which country has the biggest economy, consumes the most energy, & emits the most greenhouse gases in the world? **The United States**
14. What are the largest polluters (hint: types of industries)? **Coal-fired factories & power plants**
15. Hotter summers & prolonged heat waves cause mass mortalities in large cities. Without accounting for global warming, big cities are about **3 - 5**°F hotter than rural areas. When global warming is factored in, "unhealthy air days" could increase by **60**%.
16. Rising temperatures are expanding the range of **infectious diseases** (like Ebola & vibrio cholera)
17. Excess CO<sub>2</sub> is fertilizing the micro-organisms which trigger allergies like hay fever & asthma. With regard to ragweed, doubling the amount of ambient CO<sub>2</sub> causes a **9-10**% increase in plant growth, and a **61**% increase in the amount of pollen produced.
18. Changes in precipitation patterns & draughts caused outbreaks of **hantavirus** & **West Nile Virus**.
19. El Nino Southern Oscillation:
  - a. What happens during an "El Nino" ?  
**The trade winds weaken causing the warm water to drift back towards South America, bringing with it severe weather systems.**
  - b. How does global warming impact El Ninos?  
**Global warming increases temperatures which in turn might not only increase the frequency of El Ninos, but also the severity of the storms caused by El Ninos**
20. The top of New Orleans levees are about **17 feet** above lake/sea level.
21. The Mississippi delta loses the equivalent of **one football field** of dry land every **15 minutes**.
22. Global warming will cause dry, arid & semi-arid areas to become **drier**, because... **the increased temperatures will decrease water availability**.
  - a. In England a **1**°F increase in temperature causes water availability to decrease by **10**%
  - b. A **1**°F increase in temperature would also cause a **10** % decrease in rice yields, which provides **30** % of Earth's food supply.
23. What can humans do to help?
  - **Recognize that we are a part of the environment, and that while we don't control it, what we do that harms the environment will also harm us.**
  - **We can start adapting to the conditions that will result from warming environments**
  - **We can slow down the rate of global warming by reducing our impact on the atmosphere**
    - ↳ **by using less energy and increasing our efficiency**
    - ↳ **reducing human population size**
    - ↳ **reducing carbon emissions**
    - ↳ **etc.**

## Global Climate Change: An Introduction to the IPCC & the 2007 IPCC Synthesis Report – Lecture

1. What does “IPCC” stand for? **The Intergovernmental Panel on Climate Change**

2. When was the IPCC established and by who?

**The IPCC was established in 1988 by two branches of the United Nations**

3. What is the purpose of the IPCC?

**The purpose of the IPCC is to evaluate anthropogenic (human-induced) climate change, including its ramifications, and possible adaptations or solutions.**

4. Who makes up the IPCC?

**The Panel is made up of 30 representatives appointed by governments & organizations from around the world. The Contributors include 2500 scientific expert reviewers & more than 800 & 450 contributing & lead authors, respectively, from more than 130 countries. Anyone who participates in the IPCC process (either as a Panel or Contributing member) MUST do so WITHOUT any type of compensation (monetary or otherwise).**

5. What are some of the Pro’s & Con’s of the IPCC?

**Pro’s: - IPCC reports are the most reliable information on climate change because they represent a consensus of the global scientific community**

- The “Boy who Cried Wolf” syndrome is prevented by the conservative nature of the IPCC reports. The IPCC was designed intentionally to be very conservative so as to NOT overstate or exaggerate any of the risks of Climate Change.

**Con’s: - IPCC reports are too conservative. By only reporting the “lowest common denominator” findings, they’re under-estimating the dangers & risks of climate change**

- **Objectivity** of the 30 Panel members. There’s concern that governments will only the people they have a strong influence over.
- Reports are **Out of Date** by the time they are published. All the literature must be extensively peer-reviewed in order to become eligible for review by the IPCC. The most recent data included in each IPCC report is at least 2 years old.
- The “No compensation” requirement weeds out good Scientists

6. Why are IPCC reports important?

**IPCC reports are the most reliable information on climate change. They synthesize global scientific knowledge on the subject, essentially describing the current condition of Earth & what can be definitively attributed to Climate Change (ie. the facts). Then, based on this information, they give multiple possible scenarios of what could potentially happen in the future. Last they make recommendations to the reader for how to steer towards the most favorable scenarios.**