11. Habitats: Coral Reefs and Deep Water Corals

- What are corals and coral reefs?
- Taxonomy and Reproduction
- Types of Reef
- Symbiosis
- What is a deep water coral?
- Where are they?
- Feeding and Ecosystems
- Human Impacts

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Reading: Knowlton & Jackson, 2001 and Roberts et al., 2006
What are corals?

- Phylum Cnidaria
  - “to sting”
- 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
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)
The polyp

- Polyp
- Radial symmetry
  - Scleractinians—Hexa-radial
  - Octocorals—Octo-radial
- Only 3 tissue types
- Simple nerve net
- Polyps interconnected
  - Coenosarc
- Build Skeletons
Skeleton – Soft Corals

- “Gorgonin” and calcite skeletons
  - Horny protein
- Sclerites
  - Calcium carbonate
Colonial Coral Life Cycle

- Zygote
  - Spawning
    - Asexual
      - First polyp
        - Settling
          - Brooding
            - Planulae larvae
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 species

- Mainly Shallow
  - But......not always......

- Important engineers
  - Biodiversity
    - “Rain forests of the ocean”
    - Cover < 1/10% of ocean floor
    - Habitat for 25% of all marine species
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
Bora Bora
Types of Reef

- **Barrier Reef**
  - a reef separated from a mainland or island shore by a deep channel or 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

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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
Coral Reef Biogeography

- Majority of corals in Indo-Pacific region
- 30° N and 30° S zone
- Tropical corals restricted to <50m
- Optimum temperature 26-27 °C
- Rare along American and African west coasts
  - Owed to upwelling and strong coastal currents which cause cooler waters
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

- **Many threats**
Conclusions: Coral Reefs

- Cnidarians
  - Have stinging cells (nematocysts)

- Diverse assemblages
  - Branching, Plate, Massive, Encrusting
    - Suitable for different environments

- Four major morphologies of reef
  - Fringe, Barrier, Patch, Atoll

- Symbiosis
  - Photosynthesis by dinoflagellates
    - Mutualistic relationship
What is a Deep-Water Coral?

- No zooxanthellae
- Where are they found?
  - All oceans
  - Temperatures from -1.5°C - ~12°C
  - From 3m - >6000m
- Known since early 18th century
  - Taxonomy
  - Ecological research started ~2000
- “Oasis in the Deep”
  - Over 1000 associated species
  - Poster child for deep water research
Taxonomy

- **Lace Corals**
  - Stylasterids
- **Stony Corals**
  - Scleractinians
- **Black Corals**
  - Antipatharians
- **Zooanthids**
- **Soft Corals**
  - Alycyonacea
- **Sea Fans**
  - Gorgonians
Solitary vs Colonial

- **Solitary**
  - Genetically distinct
  - Produced sexually
  - Only scleractinian solitary coral species
  - Common deeper & colder

- **Colonial**
  - Polyps are clones
  - Colonies produced sexually
  - All types of coral have colonial form
  - Scleractinian – only to 2000m
    - Other types - deeper
Deep-Water Corals

Alex Sirotek, USGS
Deep Water Coral Distribution

- Not limited but sunlight or by temperature
- Found in all the worlds oceans
- But there are patterns
  - Reef building scleractinians – Continental Shelf
  - Octocorals & Antipatharians – Bathyl
  - Solitary scleractinians - Abyssal
- Why?
Deep Water Coral Distribution

- No definite reason as yet..
- Carbonate saturation
  - Aragonite
  - Scleractinians
  - Calcite
  - Octocorals
- Patterns of ASH and CSH may control biogeography
- Not getting energy from photosynthesis

$\text{Ca}^{2+} + 2\text{HCO}_3^- \leftrightarrow \text{CaCO}_3 + \text{CO}_2 + \text{H}_2\text{O}$

Feely et al., 2004
Deep Water Coral Feeding

- No zooxanthellae – feed entirely on food fall
- Suspension feeders
  - Zooplankton, phytoplankton, resuspended & detritus
  - May be strategies
    - Kiriakoulakis et al., 2005
    - Two species side by side feeding on different matter
- Seamounts & Ridges
  - Accelerated currents
  - Internal waves
  - Retention of food particles
Deep Water Coral Ecosystems

- “Reefs of the Deep”
- Røst Reef
  - 400m depth
  - NW coast of Norway
    - Loften islands
  - 40Km long, 3km wide
    - 100km²
  - Largest known deep-water coral reef
  - *Lophelia pertusa*
  - Over 750 associate species
Anthropogenic Impacts

- “Out of sight, out of mind”

- Main causes of anthropogenic damage
  - Oil/Mineral Exploration
  - Coral Harvesting
  - Deep Water Bottom Trawling
  - Climate Change
Conclusions: Deep water corals

- Deep water corals are similar to their shallow water counterparts, but do not have zooxanthellae
- Wider distribution and different limits of tolerance
  - Aragonite saturation (?)
- Cold-water corals are important
  - Nursery and feeding habitat
- Cold-water corals are being impacted too
  - Deep water fishing
  - Ocean acidification
References


