1 ***Animals of the Benthic Environment***

2 **Chapter summary in haiku form**

Stuck to the bottom
Barnacles, anemones
Waiting for a meal

3 **Chapter Overview**

- Benthic communities include a variety of habitats.
- Corals need specific environmental conditions.
- Hydrothermal vents support diverse communities that rely on chemosynthesis.

4 **Distribution of Benthic Organisms**

- Benthic biomass matches surface chlorophyll distribution.
- Benthic organisms live mainly on continental shelves.
- Their distrubition is affected by surface ocean currents.
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5 **Distribution of Benthic Organisms**

6 **Communities on Rocky Shores**

- Epifauna
  - Attached to substrate (e.g., marine algae)
  - Move over seafloor (e.g., crabs, snails)
- Moderate diversity of species
  - Greatest animal diversity at tropical latitudes
  - Greatest algae diversity at mid-latitudes
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7 **Intertidal Zonation**

- Rocky shore:
- Spray zone – above spring tide zone
- Intertidal zone
  - High tide zone
  - Middle tide zone
  - Low tide zone

8 **Intertidal zonation (rocky shore)**

9 **Spray Zone**

- Supratidal zone
- Organisms
  - Avoid drying out
  - Many animals have shells
  - Few species of marine algae
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10 **Intertidal zonation (rocky shore)**

Spray zone (supratidal)

11 **Intertidal Zone Organisms**

- High tide zone
  - Animals have shells to avoid drying out
  - Marine algae—rock weeds with thick cell walls
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14 **Intertidal Zone Organisms**

- Middle tide zone
  - More types of marine algae
  - Soft-bodied animals

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17 **Intertidal Zone Organisms**

- Low tide zone
  - Abundant algae
  - Many animals hidden by sea weed and sea grass
  - Crabs abundant in all intertidal zones
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21 **Sandy Beach Organisms and Adaptations**

- Burrowing animals
- No stable, fixed surface
- Burrowing provides more stable environment
  - Less risk of temperature extremes and drying out

22 **Sandy Beach Organisms and Adaptations**

- Bivalve mollusks
  - Soft body, hard shell
  - Example: clams and mussels
  - Greatest number in low tide regions
- Annelid worms
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23 **Sandy beaches**

- Animals burrow
- Bivalve mollusks
- Annelid worms
- Crustaceans
- Echinoderms
- Meiofauna

24 **Sandy Beach Organisms and Adaptations**

- Crustaceans
  - Segmented body, hard exoskeleton, paired jointed limbs
  - Example: crabs, lobsters
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25 **Sandy Beach Organisms and Adaptations**

- Echinoderms
  - Spiny skin
  - Five tapered legs
  - Example: starfish and heart urchin
- Meiofauna
  - Small, feed on bacteria

26 **Mud Flats**

- Eelgrass and turtle grass common
- Bivalves and other mollusks
- Fiddler crabs
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29 **Shallow Offshore Ocean Floor Communities**

- Rocky bottoms (subtidal)

- Kelp and kelp forests
  - Attaches to rocky bottoms
  - Can grow up to 0.6 meters (2 feet) per day
  - Productive ecosystems
  - Provides shelter for other organisms

30 **Kelp Distribution**

31 **Rocky Bottom Shallow Offshore Ocean Floor Communities**

- Lobsters
  - Large, spiny antennae
  - Live in water deeper than 20 meters (65 feet)
  - Scavengers
  - Also feed on live animals

32 **Rocky Bottom Shallow Offshore Ocean Floor Communities**

- Oysters
  - Sessile bivalve mollusks
  - Thick shell
  - Start life as plankton

33 **Coral Reefs**

- Reefs – shallow water communities restricted to tropics
- Polyps – individual corals

34 **Coral Reef Distribution**

35 **Conditions for Coral Reef Development**

- Warm (but not hot) seawater
- Sunlight (for symbiotic algae)
- Strong waves or currents
- Clear seawater
- Normal salinity
- Hard substrate
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36 **Symbiosis of Coral and Algae**

- Coral reefs made of algae, mollusks, foraminifers as well as corals
- Hermatypic coral – mutualistic relationship with algae
  - Algae provide food
  - Corals provide nutrients
- Mixotrophs – derive part of nutrition from algae
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37 **Coral Reef Zonation**

38 **Importance of Coral Reefs**

- Largest structures created by living organisms
  - Great Barrier Reef, Australia, more than 2000 km (1250 miles) long
- Great diversity of species
- Important tourist locales
- Fisheries
- Reefs protect shorelines
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39 **Humans and Coral Reefs**

- Fishing, tourist collecting, and sediment influx due to shore development harm coral reefs.
- Sewage discharge and agricultural fertilizers increase nutrients in reef waters.
  - Hermatypic corals thrive at low nutrient levels
  - Phytoplankton overwhelm at high nutrient levels

  - Bioerosion of coral reef by algae-eating organisms
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40 **Crown of Thorns Phenomenon**
  - Sea star eats coral polyps
  - Outbreaks (greatly increased numbers) decimate reef

41 **Crown-of-thorns starfish**

42 **Coral Reefs in Decline**
  - 30% healthy today, 41% healthy in 2000
  - One third of corals – high risk of extinction
  - Humans – greatest threat
  - Other threats
    - Hurricanes
    - Global warming
      - Coral bleaching
    - Floods
    - Tsunami

43 **Deep-Ocean Floor Communities**
  - Less known about than shallower water communities
    - Expensive to explore the deep
    - Limited oxygen
    - Robotic technology for exploration

44 **Deep Ocean Physical Environment**
  - Bathal, abyssal, hadal zones
  - Light absent below 1000 meters (3300 feet)
  - Temperature usually between -1.8°C (28.8°F) and 3°C (37°F)
  - High oxygen
  - High pressure
  - Abyssal storms – affect bottom currents

45 **Deep Ocean Food Sources and Species Diversity**
  - No primary productivity
  - Only 1 – 3% of euphotic food present
  - Special adaptations for detecting food
  - Species diversity equivalent to rain forest

46 **Food sources in deep seafloor**
  - Most food from surface waters
  - Low supply

47 **Deep-Sea Hydrothermal Vent Biocommunities**
  - Discovery – *Alvin* in 1977
  - Galapagos Rift in Pacific Ocean
  - Water temperature 8–12°C (46–54°F)
  - Chimney vents, hot acidic water
    - Black smokers

48 **Global hydrothermal vent fields**

49 **Hydrothermal Vent Species**
  - Giant tubeworms
  - Giant clams
  - Giant mussels
  - Crabs
  - Microbial mats
  - Life supported by chemosynthesis

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50 **Chemosynthesis**
- Microscopic archaea – thrive on hydrogen sulfide from vents
  - Manufacture sugar, carbon dioxide, and dissolved oxygen
- Base of hydrothermal vent food chain

51 **Hydrothermal Vent Communities**
- Vents active for years or decades
- Animals species similar at widely separated vents
- Larvae drift from site to site
- "Dead whale hypothesis"
  - Large carcasses may be stepping stone for larvae
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52 **Hydrothermal Vents and the Origins of Life**
- Life on Earth may have originated at hydrothermal vents.
  - Uniform conditions
  - Presence of archaea bacteria
  - Microbes with genes identical to those found in humans
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53 **Low-Temperature Seep Biocommunities**
- Chemosynthetically support life
- Hypersaline seeps
  - High salinity
  - Florida Escarpment – seeping water from limestone fractures

54 **Low-Temperature Seep Biocommunities**
- Hydrocarbon seeps
  - Oil and gas seeps
  - Hydrogen sulfide and/or methane

55 **Low-Temperature Seep Biocommunities**
- Subduction zone seeps
  - Juan de Fuca plate
  - Folded sedimentary rocks
  - Methane

56 **Beneath the Sea Floor**
- A new frontier
- Deep biosphere
- Microbes live in pore fluids
- Might represent much of Earth's total biomass
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57 **End of CHAPTER 15**
Animals of the Benthic Environment