Chapter 11
Between The Tides

CHAPTER SUMMARY

Chapter 11 surveys intertidal communities. They are by far the best known and most accessible of all marine communities, hence the need for a relatively lengthy chapter.

Rocky shore communities are examined by first outlining how the demands of physical factors (type of substrate, exposure to air by tides, and wave action) are met by intertidal organisms. Morphological as well as behavioral adaptations are highlighted. We found this the most appropriate place to briefly discuss refraction and the distribution of wave energy along the coast.

The chapter emphasizes how biological factors influence community structure. It incorporates results of some of the most current approaches in the study of rocky shore communities. We specifically discuss competition for space, grazing, predation, availability of food, feeding interrelationships, how these and other factors influence vertical zonation, and ecological succession. The food web diagrams in figures 11.15 and 11.33 use arrows that are color-coded to allow comparison with other food webs throughout the book.

The chapter concludes with an examination of the particular characteristics of soft-bottom intertidal communities, those established on muddy and sandy bottoms. The types of sediments and their distribution are first examined, followed by a look at how organisms are adapted to the availability of oxygen, and motility, feeding, and zonation patterns in soft bottoms.

CHAPTER OUTLINE

A) The intertidal zone, sometimes called the **littoral zone**, is the narrow fringe along the shoreline that lies between the highest high and lowest low tide.
   1) Most studied and best understood of all marine communities.
   2) Unique because regularly exposed to air. Being out of the water and exposed to air is called **emersion**. (Being submerged is **immersion**.)
   3) The **substrate** or **substratum** is the bottom material on or in which an organism lives. Intertidal communities differ greatly depending on whether they have rocky or soft bottoms.

B) Rocky Shore Communities
   1) Rocky shores usually occur on recently uplifted or geologically young coasts or on coasts where erosion is removing sediments and soft rock.
      a) American west coast is largely rocky because of an active margin.
      b) American east coast north of Cape Cod is rocky because of ice age processes.
   2) Most rocky intertidal organisms, called **epifauna**, live on the substrate. Many are **sessile** and stay attached to the rock. Therefore they are fully exposed to the elements and subjects to great physical stress.
      a) Exposure at Low Tide
         Emersion time, or time spent out of the water, gets longer the higher in the intertidal you go. The highest part of the intertidal is almost never immersed and is kept wet by wave splash.
         (1) Water Loss
            (a) Marine organisms must be able to prevent **desiccation**, drying out, tolerate it, or both when exposed to air.
               (i) Run-and-hide strategy – huddle in moist, shady cavities or crevices in the rocks; hide in **tide pools**, etc.
               (ii) "Clam up" strategy – organisms have protective covering, use mucus for better seal, carve shallow depression in the rock, etc.
               (iii) Dry out strategy – allow themselves to dry out, withstanding up to 75 or 90% water loss, then

quickly recover with the tide comes in.

(2) Temperature and Salinity
   (a) Because tide pools are shallow, they too experience extreme temperatures, though usually not as extreme as air. Strategies include run-and-hide, shells have ridges to lose excess heat, shell color can also help to tolerate temperature, wave spray can help cool, etc.
   (b) Precipitation brings fresh water and evaporation increases salinity. Strategies included clam up locking out fresh water, ability to withstand great salinity ranges, burrow, reduce activity to ride out extreme conditions, etc.

(3) Restriction of Feeding
   (a) Little sediment accumulates so **deposit feeders** are uncommon. Most are **filter feeders**. Some are grazers. Some are predators. Difficult to feed during low tide, most are avoiding harsh conditions.

b) The Power of the Sea
   (1) Ocean waves expend tremendous energy as they crash on the shore.
   (2) The Distribution of Wave Energy Along the Shore
      (a) The impact of the waves varies along the shoreline. Recall what you know about waves: waves travel faster in deeper than shallow water, waves almost never approach the shore straight on and the wave bends or refracts causing it to become nearly parallel, waves focus on headlands, bays generally have less wave energy, submarine canyons may cause wave refraction, waves can break on reefs or sand bars expending their energy, etc.
   (3) Coping with **Wave Shock**
      (a) Some are found in only sheltered locations.
      (b) Exposed organism strategies: anchor themselves (e.g., seaweeds use **holdfasts** or encrust on rocks, barnacles glue themselves, mussels use their **byssal threads**, limpets and chitons use their muscular foot, intertidal fishes tend to lack **swim bladders**), thicker shells, low profile shells, are flexible and "go with the flow," safety in numbers, etc.

c) The Battle for Space
   (1) Rocky intertidal populations are often limited by space, not food or nutrients.
   (2) Ways to compete for space:
      (a) Be the first to get the open spot, thus having effective means of **dispersal**. Most rocky intertidal species disperse via larvae or spores.
      (b) Having taken over the space, the organism must be able to hold onto it or be able to reproduce rapidly.
      (c) Take over space that is already occupied by pushing them out, growing over them, etc.

d) Vertical Zonation (details provided by you)
   (1) The Upper Intertidal
   (2) The Middle Intertidal
   (3) The Lower Intertidal