PLANKTON

Concept 4. Plankton organisms are tiny, but are important to coastal zone ecology.

a. Background Reading

Plankton are small organisms that inhabit aquatic environments. Their small size keeps them from being obvious to casual visitors to the sea coast, but once seen, their strange shapes and adaptations are facinating and their role in the productivity and population dynamics of coastal zone ecosystems is so important that some mention of them is essential to any effort in marine education.

Plankton are drifters, plants and animals that move passively or very feebly with currents in the sea. Derived from the Greek word, "plantos", meaning wanderer, plankton vary in size, but are generally small. Plant plankton (phytoplankton) is often dominated by diatoms less than five microns in diameter (a micron is one millionth of a meter). Two common characteristics of plankton are their inability to control their movements against currents, and their habitat, typically in the upper regions of the water column. Plankton are divided into phytoplankton (plants) and zooplankton (animals). Further divisions are the holoplankton (permanent members of the plankton community) and meroplankton (temporary members such as larval stages of benthic invertebrates and fish).

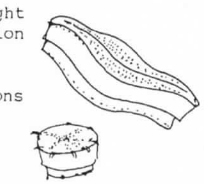
All of these organisms share certain general features: they are all small; they have flotation devices; most are transparent; and many have long body wall extensions that increase the surface to volume ratios of their bodies. These features hold true for both marine and freshwater plankton and can thus be demonstrated without access to ocean collections.

The importance of plankton in marine ecology involves both quantitative and qualitative features. Quantitatively, plankton are one increasingly important part of marine food chains as one moves offshore from the seacoast. Most food chains begin with plant photosynthesis in which sunlight and inorganic nutrients are converted into the organic matter of plant tissues. In the open sea, only the floating phytoplankton occur in the sunlit zone, thus phytoplankton are the major unit of primary production for the oceanic food chain. In shallow waters, however, sunlight reaches all the way to the sea floor so attached algae and rooted higher plants (eel grass and salt marsh species) become important contributors to food chain primary production. Qualitatively, plankton is important because of its nutritional role in marine food chains and its role in the reproduction distribution of marine organisms. There is evidence that phytoplankton are more easily digested, and thus more nutritious per unit weight, than is higher plant material produced by salt marsh species. For example, a common estuarine zooplankton crustacean (the copepod Eurytemora affinis) produces more eggs when grown on a diet of phytoplankton than when grown on a diet of salt marsh plant material. The qualitative significance of phytoplankton to egg production and other life cycle processes may ultimately show that phytoplankton are more important to nearshore food chains than currently conceived.

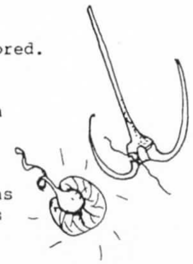
Plankton are also quantitatively important to nearshore ecology because a large fraction of the nearshore zooplankton community consists of larval stages of important nekton and benthic organisms. Thus survival and repopulation of many commercially important marine animals such as fish, shrimp, crabs, and oysters depend upon the success of the planktonic larval stage of their life cycle (meroplankton). Approximately 80% of all the sport and commercial catch on the east coast of the United States is of animals who spend some portion of their life cycle in nearshore and estuarine areas. The vast majority of these spend much of their nearshore life as meroplankton. These meroplanktonic stages are dramatically different from adults of the same species, both in their morphology and in their requirements for survival. The existence of commercial populations of marine species depends on maintaining conditions suitable for survival of both the adults and the meroplanktonic stages that lead up to the adult stage. At the moment scientists know far more about survival requirements of adults than of their meroplankton, i.e. young. From what is known, it appears that larvae can tolerate less pollution, less food scarcity, and, in general, less exposure to abnormal or unstable environments than can adults. This unsurprising fact lends increasing practical importance to studies of larvae in the light of potential pollution due to human development of the coastal zone.

Plankton play a dual role in considerations of marine pollution. Not only are meroplankton generally more susceptible to pollution than are adults, but also plankton can absorb non degradable pollutants like metals and particles which can become concentrated through the food chain. Phytoplankton form the link in the marine food chain that change inorganic nutrients to organic material. Zooplankton and other filter-feeding animals feed on phytoplankton and in turn are eaten by larger animals. Unfortunately, toxic slowly degradable substances such as pesticides, mercury, cadmium, and polychlorinated byphenyls (PCB's) can also be incorporated into the plant cell and thus be carried up the food chain where sufficient accumulation results in death of large animals. The classic example involves DDT, a pesticide running off from farms to water, being absorbed by phytoplankton, filter-feeders, fish, and finally fish-feeding pelicans. In California, pelicans nearly were eliminated from the state as DDT in their bodies upset their reproductive success.

The exotic morphology of plankton makes them interesting to examine. Nearshore phytoplankton caught by normal plankton nets (cone-shaped nets of fine nylon cloth or stockings) are numerically dominated by diatoms and dinoflagellates. Diatoms are single-celled organisms with glass (silicon dioxide) sheletons made up of two valves. Some marine species are centric (circular, like a button) and some are elongated (pennate). Diatoms are one of the most nutritious food sources for animals. Diatoms occur singly or in chains and can multiply up to three times a day under optimal conditions. Dinoflagellates are single-celled organisms that possess two whip-like flagella causing them to constantly spin as they move.



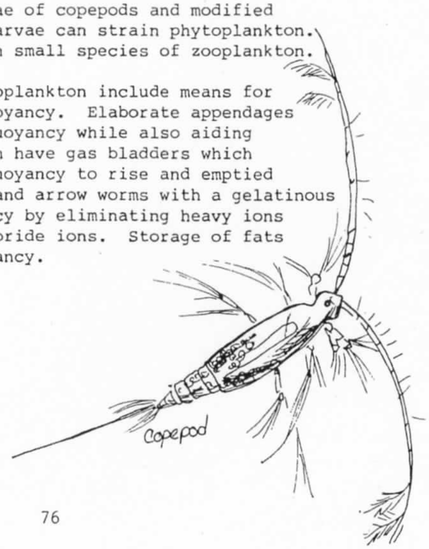
Dinoflagellates may be armored with plates or unarmored. Some species are luminescent while others are the causative organism of the Red Tide, an abnormal concentration of cells and their excretions that can kill fish. (Figure 6)



Phytoplankton must stay in the photic zone to survive, and even though they have little or no means of locomotion, they have evolved several adaptations to increase their buoyancy. Diatoms store oil in their cells and their specific gravity is thereby decreased. Many species have spines and cell wall extensions that increase surface area, and others link into spiral chains that increase their ability to remain within a specific mass of water.

Nearshore zooplankton caught by normal nets are usually dominated by holoplanktonic copepod crustacea although, in spring and summer, any of several types of meroplankton may dominate the catch. Other common holoplanktonic forms include the arrow worms, several types of jelly-fish-like animals and some protozoans. Meroplankton are very common in nearshore zooplankton samples and include larvae of many species of benthic invertebrates such as crabs, starfish, sea urchins, and mollusks plus eggs and larval stages of many fish. The abundance of zooplankton is related to their food supply, and since most are small, they feed either on small phytoplankton, higher plant fragments or on each other. Consequently, most zooplankton employ some mechanism for straining small particles from the water. The feathery antennae of copepods and modified mouth parts of crustacean larvae can strain phytoplankton. Arrow worms actively prey on small species of zooplankton.

Adaptations for the zooplankton include means for feeding, locomotion, and buoyancy. Elaborate appendages increase surface area and buoyancy while also aiding in feeding. Some jelly-fish have gas bladders which can be filled to increase buoyancy to rise and emptied to sink. Other jelly-fish and arrow worms with a gelatinous watery body increase buoyancy by eliminating heavy ions and replacing them with chloride ions. Storage of fats and oils also increase buoyancy.



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Plankton

Article questions

1. What is plankton?
2. What is the difference between phytoplankton and zooplankton?
3. What are some general features all plankton exhibit?
4. What is the importance of plankton?
5. How does pollution affect plankton?
6. What are the most common types of phytoplankton?
7. What are the most common types of zooplankton?
8. How is buoyancy controlled in plankton?