6 Producers and Consumers

In kelp forests or coral reefs near the shore of the ocean it is easy for us to see the various parts of an ecosystem, especially because the near-shore ecosystems tend to be particularly productive and have a high level of biodiversity. The level of biodiversity in an ecosystem, however, is not always obvious. For example, consider the open ocean: huge and deep bodies of waters away from coasts and continental shelves. The open ocean is an ecosystem that supports populations of fish, whales, and other animals. Think about a tuna or a whale in the middle of the ocean, far from any land, reef, or kelp forest. What does it eat? Where does its oxygen come from?

Much of the life in the open ocean consists of free-floating organisms called plankton. **Plankton** are drifting organisms that live for at least part of their life in the open ocean or other body of water. The majority of plankton are minuscule; in fact, one drop of ocean water can contain thousands of plankton. Most plankton inhabit the top 20 m (about 66 feet) of the water. Those are concentrated in this narrow layer of the ocean because that is as deep as sunlight penetrates water fairly easily. This light allows plankton that are capable of photosynthesis—phytoplankton—to survive. Phytoplankton are responsible for nearly half of the oxygen production on Earth! Other plankton, called zooplankton, are consumers that feed on phytoplankton or other zooplankton. Plankton are the sole food source for most larval fish and many open-ocean consumers. The blue whale is the largest living organism in the world. It's a consumer, and its diet consists entirely of plankton, which it strains from the water with the baleen plates in its mouth.

One blue whale (Balaenoptera musculus) *consumes up to 4,100 kg of plankton, consisting of more than 300 different species every day.*

Challenge

How do plankton populations affect the sustainability of a fishery?

MATERIALS

FOR EACH GROUP OF FOUR STUDENTS

- 8 prepared sides of plankton (closterium, copepods, diatoms, euglena, rotifers, oscillatria, stentor, volvox)
- dropper
- 15-mL dropper bottle of methyl cellulose
- graduated cup of water containing live plankton

FOR EACH PAIR OF STUDENTS

- microscope
- microscope slide with a well
- coverslip

FOR EACH STUDENT

- Student Sheet 6.1, "Plankton Dichotomous Key"

Procedure

Part A: Observing Prepared Slides

1. You and your partner will observe eight prepared slides of plankton. Choose one slide, and place it on your microscope stage.

   Hint: Most of the plankton you will see are multicellular creatures similar to the ones shown in the image at the end of Part B. You might also see some single-celled plankton on your slide.

2. Use the information on the next page, "Focusing a Microscope," as guidelines for how to use your microscope.

3. Begin by observing the specimen at the lowest level of magnification, and draw what you see.

4. Observe the specimen at each of the higher levels of magnification, and draw what you see at each level. **Note:** Use only the fine-focus knob for a middle- or high-magnification setting to avoid breaking the slide.

5. In your science notebook, sketch what you observe on the slides, as directed by your teacher. Label your sketch with the slide number. Make notes on any features you see that help you to decide whether it is a phytoplankton or a zooplankton.

6. Repeat Steps 3–5 with each prepared slide.

7. Using Student Sheet 6.1, "Plankton Dichotomous Key," try to identify each of the plankton from your sketches.

Safety

Always carry a microscope properly with both hands—one hand underneath and one holding the microscope arm. Because you are working with live organisms, wash your hands thoroughly after you are finished.

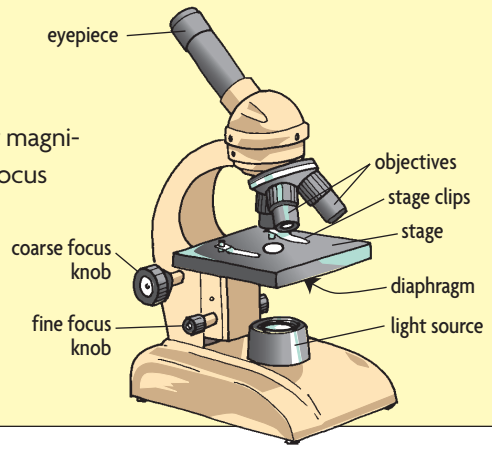
Focusing a Microscope

Be sure that your microscope is set on the lowest power before placing your slide onto the microscope stage. Place the slide on the microscope stage. Center the slide so that the sample is directly over the light opening, and adjust the microscope settings as necessary. If the microscope has stage clips, secure the slide in position so that it does not move.

Observe the sample. Focus first with the coarse-focus knob, and then adjust the fine-focus knob.

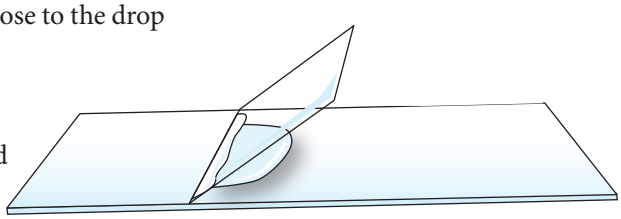
After switching to a higher power magnification, be careful to adjust the focus with the fine-focus knob only.

Return to low power before removing the slide from the microscope stage.

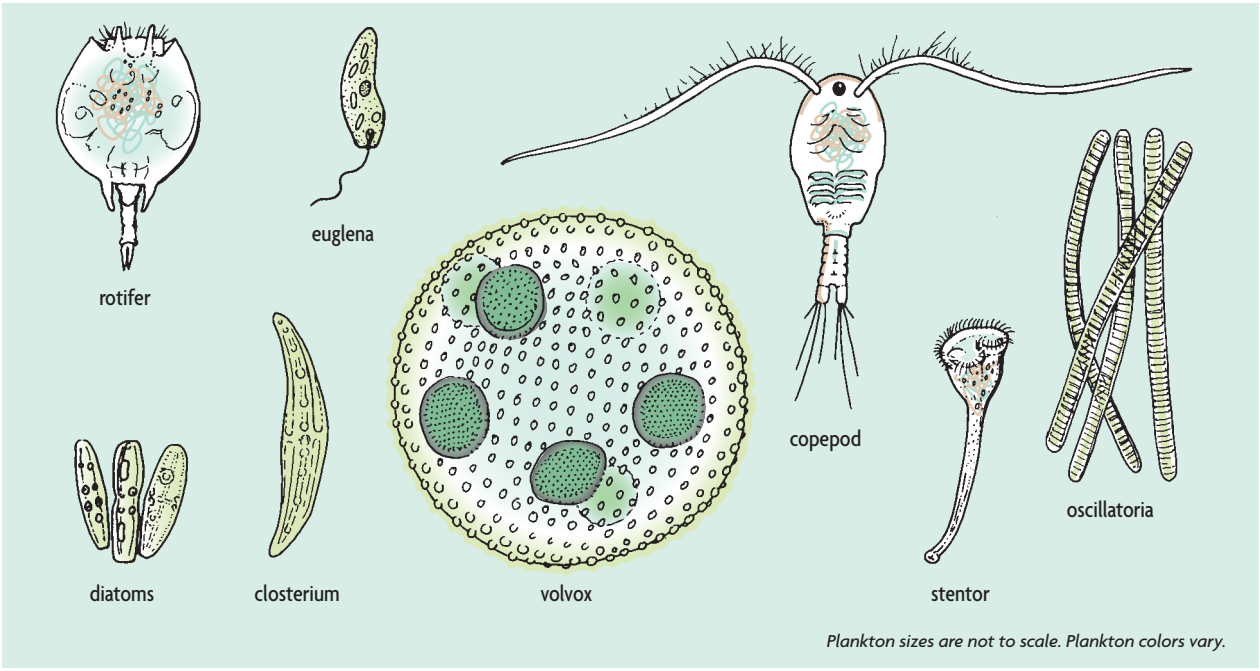


Part B: Searching for Plankton

8. Use the dropper to place a drop of water containing live plankton into the well of a microscope slide.
9. If your teacher directs you to, add one drop of methyl cellulose to the drop on the slide.
10. Carefully touch one edge of the coverslip to the water, at an angle. Slowly allow the coverslip to fall into place. This should prevent trapping of air bubbles under the coverslip.
11. Center the slide so that the well is directly over the light opening, and adjust the microscope settings as necessary.
12. Begin by observing the sample on the lowest objective lens. You may need to search the slide to find specimens, and they may move across your field of view.
13. Draw at least two different organisms that you observe.
14. Check your answers for Student Sheet 6.1, "Plankton Dichotomous Key," using the drawings on the next page.
15. Follow your teacher's directions for using Appendix G at the back of this book to learn more about the characteristics of the organisms you saw through the microscope. Compare the major characteristics of these organisms to those in other kingdoms.



Placing the coverslip.



Some of these microscopic plankton are phytoplankton and are able to perform photosynthesis. Others are zooplankton that consume the phytoplankton.

Part C: Calculating Plankton Biomass

The plankton you have been examining are only a few examples of the thousands of species of plankton found in the oceans and freshwater bodies around the world. The Atlantic herring *(Clupea harengus)* fishery is one of the largest commercial fisheries on the east coast of the United States. A **fishery** is an industry that catches or raises a specific type of fish or shellfish to be processed or sold. To better understand the link between plankton and this fishery, complete the calculations below in your science notebook.

13. It is estimated that the mature Atlantic herring population today has a biomass (total weight of the population) of approximately 2 million metric tonnes (2 billion kg). If an average adult Atlantic herring weighs 0.125 kg, how many adult Atlantic herring are there in the entire population?

Hint: $\dfrac{\text{kg}}{\text{0.125 kg per fish}} = \underline{\qquad\qquad}\ \text{fish}$

14. An adult Atlantic herring consumes, on average, 10 g of plankton per day. How much plankton would the adult Atlantic herring population consume in a day?

15. In some places, human impacts on the marine environment, such as coastal erosion, global warming, and pollution, have caused up to a 70% decrease in the biomass of plankton. If there were a severe reduction of plankton available to the Atlantic herring population, and therefore a 55% decrease in the herring, how many mature Atlantic herring would be supported by the ecosystem? How many kilograms?

Analysis

1. Identify at least two similarities and two differences between phytoplankton and zooplankton.
2. What is the role of phytoplankton in an aquatic ecosystem?
3. Did you observe evidence of the roles of phytoplankton or zooplankton in your sample of live plankton? Explain.
4. How might changes in the amount of plankton in the ocean affect the ocean's ability to provide a sustainable source of food for the world's human population? Explain.
5. Strict fishing limits were set on the Atlantic herring fishery in the 1970s and 1980s because the population had dropped to about 75,000 metric tons. There was alarm that the population was so small that it was not sustainable if unlimited fishing continued. By the early 1990s the population returned to historically normal levels, and the yearly catch limit now ranges from 80,000 to 124,000 metric tons to keep the fishery sustainable.
   a. If the scenario in Procedure Step 15 were to occur, would the Atlantic herring fishery still be sustainable? Explain what indicator(s) you would use to monitor this.

      Hint: The biomass of the Atlantic Herring can be found in Procedure Step 13.

   b. What do you think would happen to the sustainability of the plankton population if this scenario occurred? Explain.
6. Using Appendix G in the back of this book, compare and contrast the characteristics of the following taxonomic groups:
   a. Archaea
   b. Bacteria
   c. Protists
   d. Fungi
   e. Plants
   f. Animals

KEY VOCABULARY

biodiversity	phytoplankton
consumers	**plankton**
fishery	producers
organism	zooplankton