Marine Plankton

Objectives

- To identify basic types and characteristics of common inshore marine phyto- and zooplankton
- To estimate the effect of nutrients and sunlight on the growth rate of phytoplankton

Introduction

Plankton live in the pelagic zone and cannot swim effectively against a current. They do, however, migrate vertically in the water column on a diurnal cycle.

Plankton may be classified by:

1. how they obtain nutrition. *Phytoplankton* photosynthesize, *zooplankton* ingest other organisms,
2. color (phyla are based on the dominant photosynthetic pigment)
3. whether they spend all or part of their lives as plankton (holoplankton versus meroplankton), or
4. size.

Phytoplankton are classified, in part, by the color of their photosynthetic pigments. (Table 1).

Table 1. Phytoplankton

Kingdom	Phylum	Common Name
Monera	Cyanobacteria	blue-green algae
Protoctista	Chlorophyta	green algae
	Rhodophyta	red algae
	Dinoflagellata	dinoflagellates
	Phaeophyta	brown algae
	Chrysophyta	golden algae
	Bacillariophyta	diatoms

Zooplankton are heterotrophic. Some are simple single-cell protists such as the radiolaria and foraminifera. However, many zooplankton are larval stages of larger free-swimming animals. Thus, we can distinguish between animals that spend their entire lives as plankton (***holoplankton***) and animals that spend only a part of their lives as plankton (***meroplankton***) (**Table 2**).

Table 2. Zooplankton

Kingdom	**Phylum/larva name**	**Common Name**
Animal (meroplankton)	Chordata	Fish
	Nauplius	Barnacle
	Veliger	Snail
	Zoea	Crab
	Trochophore	Worm/snail/bivalve
	Planula	Jelly
Protoctista (holoplankton)	Protozoa	Dinoflagellates
		Foraminifera
		Radiolarians

Plankton are collected using a fine mesh net towed through the water. A typical mesh size is 70 µm. Using this net we capture organisms larger than 70 µm. **Figure 1** shows a typical plankton net.

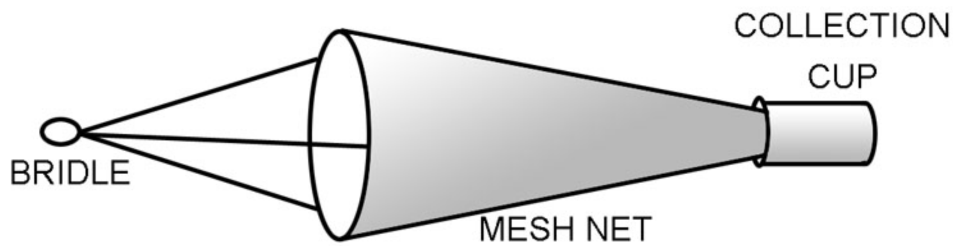

Figure 1. Plankton Net

It is possible to classify plankton based upon size. We use different prefixes to distinguish the sizes pf plankton:

mega plankton	larger than 2mm
macro plankton	0.5 mm to 2 mm
meso plankton	0.2 mm to 0.5 mm
micro plankton	0.06 to 0.2 mm
nanno plankton	0.005 to 0.06 mm
ultra plankton	less than 0.005 mm

When observing plankton, we will usually use a microscope. Table 3 shows the ranges of size for different types of plankton. It should be clear that a 70 µm net will not trap organisms smaller than 0.070 mm.

Table 3. Size ranges for plankton by taxon

sizes (mm)	phyto-plankton		zooplankton					size range for 70 µm net
	diatoms	dinoflagellates	invert larvae	copepods	arrow worms	fish larvae	jellies	
							■	■
100					■	■	■	■
					■	■	■	■
					■	■	■	■
					■	■	■	■
					■	■	■	■
10				■	■			■
			■	■	■			■
			■	■	■			■
			■	■	■			■
1	■	■	■	■				■
	■	■	■	■				■
	■	■	■	■				■
	■	■	■	■				■
	■	■	■	■				■
	■	■	■	■				■
0.1	■	■	■					■
	■	■						■
	■	■						
	■	■						
	■	■						
0.01	■							
	■							
	■							
0.001								

Phytoplankton Observations

Diatoms

Diatoms occur in two basic shapes: centric (circular) and pennate (elongated or triangular). Diatoms tests are unique to each species and diatoms may occur individually or in long connected chains.
In this lab you will

1. observe prepared microscope slides of "recent marine diatoms."
2. identify the types of diatoms you see using **Smith, D.L and Johnson, K.B., 1996, and**
3. draw at least three different types of diatom.

Dinoflagellates

Dinoflagellates have two flagella. One flagellum is wrapped around the cell in a groove, called the belt or girdle. The second flagellum is used for locomotion, and thus extends away from the organism. These organisms lack a shell; cellulose plates often form a kind of body armor. In this lab you will:

1. observe prepared microscope slides of *Noctiluca*, *Ceratium*, and *Procentrum*.
2. identify the types of dinoflagellates you see using **Smith, D.L and Johnson, K.B., 1996,** and
3. **d**raw each of these organisms.

Zooplankton Observations

Larval Transformations

Many zooplankton undergo one or more larval metamorphosis. **Figure 2** shows the larval transformations for several zooplankton. You will observe prepared slides of several of these larvae and sketch them.

Cnidarians (Anemones, corals and jellies)

- *Aurelia* planula larvae
- *Aurelia* ephyra stage

Echinoderms (Seastars, sand dollars and sea cucumbers)

- *Asterias* or starfish bipinnaria larvae
- *Asterias* or starfish brachiolaria larvae

Crustaceans (crabs, shrimp, and lobster)

- Crab zoea larvae
- Crab megalops larvae

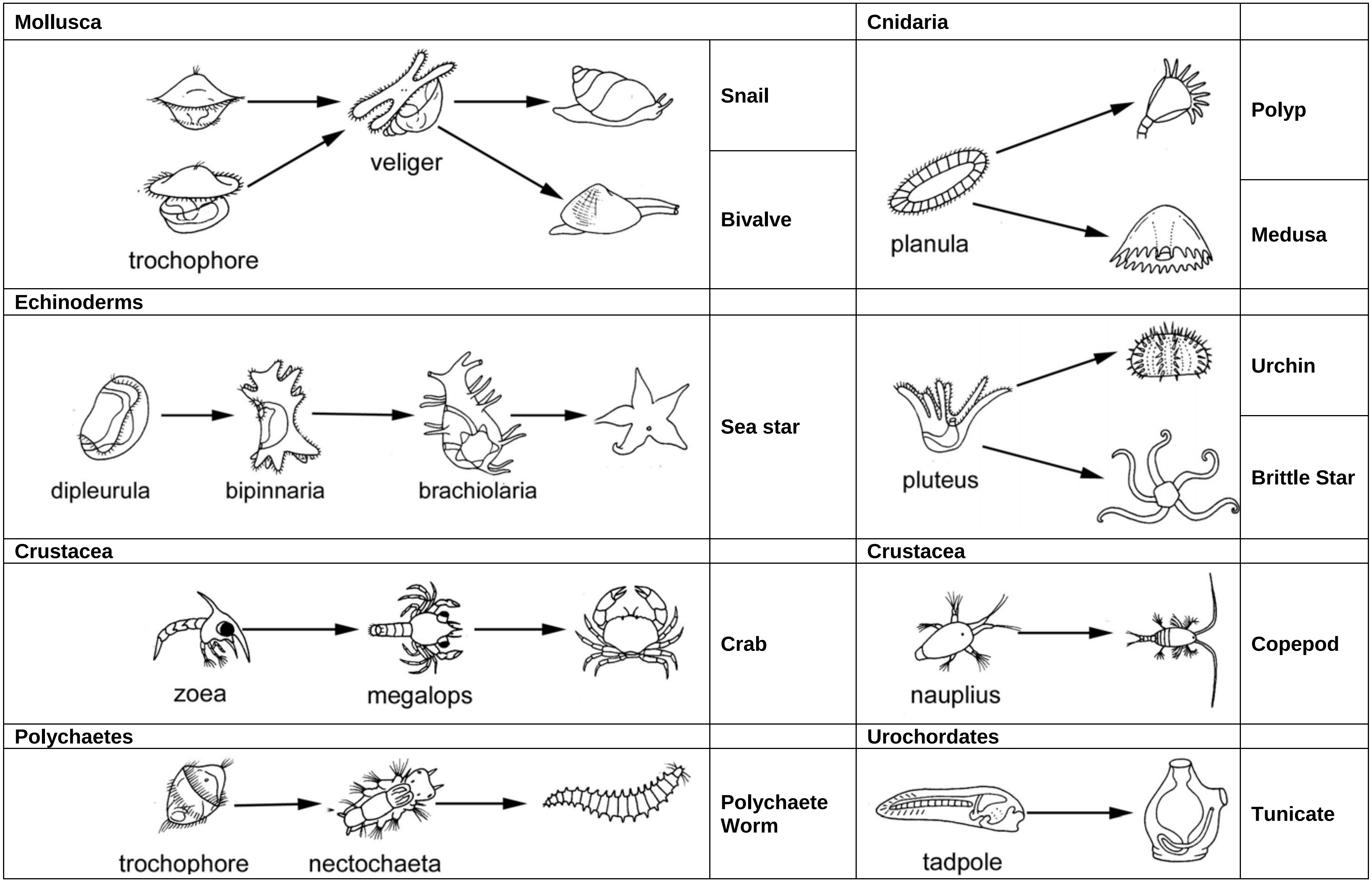

Figure 2. Some planktonic larval stages of selected organisms

Chordates (fish, amphibians, reptiles, birds, and mammals)
You will observe the larval form of a sea squirt, or tunicate. How does this larval form differ from the adult? How does it resemble a small fish?

Adult Zooplankton

The Radiolaria and Foraminifera are two of the most abundant holoplanktonic animals.

Using your microscope, observe prepared slides and sketch examples of the following:

- Radiolaria (Radiolarian strew) These single-celled animals have skeletal elements made of silica.
- Foraminifera (Foraminifera strew) or *Globigerina* (Globigerina strew) *Globigerina* is a very common "foram." These animals have shells made from calcium carbonate. Each of the shell segments is connected to the rest of the animal by a foramen (hole).

Modeling Phytoplankton Growth

The two most important factors affecting the abundance of phytoplankton in marine system are the

1. availability of nutrients and
2. intensity of sunlight.

The most common nutrients, nitrogen and phosphorous, are provided in coastal ecosystems by upwelling. During upwelling an increase in available nutrients stimulates a rapid increase in the number of phytoplankton (“bloom”).

When nutrients are used up and no further upwelling occurs a rapid die off commonly follows.

Seasonal changes in sunlight intensity and day length also affect phytoplankton abundance.

How fast do phytoplankton grow? The rate of increase of phytoplankton cells is really relatively easy to understand. One cell divides into two cells and each of those divide into two more. So the population numbers follow a predictable sequence: 1, 2, 4, 8, 16 and so on. This is called geometric growth and the formula to predict the population size at any time is

$$N_t = N_o 2^t$$

where t is the time (in units of the doubling time),
N_t is the total population size at time t, and
N_o is the starting population size.

Let's say we have a beaker with 50 cells per liter. Assume the doubling time is 24 hours, or 1 day. How many cells will be present after 4 days?

$$t = 4$$
$$N_o = 50$$
$$N_t = 50 \times 2^4$$
$$N_t = 50 \times 16 = 800 \text{ cells/L}$$

In the real world predation by zooplankton would decrease the total population size.