Activity 2: The Great Plankton Race (Grade 5)

Overview

Dip a clear jar into the sea and examine your sample. At first glance, the contents may seem devoid of life; but, under a microscope, an incredible world teeming with life is revealed. These tiny plants and animals are critically important to the health of the ocean, for they form the base of the food chain. Called *plankton* (from the Greek word for wandering), they drift at the mercy of the currents. Although most plankton are tiny, any organism which can't swim against a current qualifies as plankton; some, like the jelly fish can be quite large. Whatever their size, all plankton must avoid sinking. Phytoplankton or (plant plankton) need sunlight for photosynthesis, so they must stay near the surface in the sunlit or photic zone. Zooplankton or (animal plankton) depend on phytoplankton and other zooplankton for food, so they must avoid sinking as well. Plankton avoid that sinking feeling by using an incredible array of unique adaptations.

In Session 1, students discover "So What is Plankton?" as they observe and sketch a diversity of plankton from video footage. Using transparency cutouts of plankton, students categorize plankton (e.g. as zoo- or phyto-), and focus on the plankton adaptations to slow down how fast they sink. In Session 2, students construct plankton models from materials of various shapes and densities to simulate adaptations which slow sinking. They then "race" their models (slowest wins), and calculate and graph sinking rates. The students then make increasingly detailed observations of live plankton (brine shrimp) and relate what they have learned about plankton adaptations to the living organism. Students discover that plankton have adaptations which help them avoid sinking below the sunlit photic zone.

What You Need

Session 1

For the class:

• large pictures, slides and/or video of various plankton species
Note: Monterey Bay Aquarium's Video Collection has an excellent 6 minute plankton section (See Resources)

• colored markers (various colors)

• tape
• 2 sheets of chart paper to make the following posters, or to make into transparencies (See Getting Ready):
    • About Plankton Poster
    • Plankton Anticipatory Guide
• Diversity of Plankton transparency
• "Baby" to Adult Picture Album transparency
• overhead projector

For pairs of students:
• 2 sheets of 8 1/2" x 11" blank paper
• 2 pencils
• 1 copy of the "Baby" to Adult Picture Album student sheet

For each small group of 4:
• 1 sheet chart paper
• 4 pencils
• 1 sheet of 8 1/2" x 11" blank paper

For Session 2
For the class:
• large aquarium or clear plastic storage box (20 gallons or more, and at least 25 cm deep, if possible)
• water to fill aquarium
• two stopwatches
• a knife for cutting corks
• Award Ribbons (See Getting Ready)
• 1 sheet each of red, blue and white paper
• 28 sheets yellow paper (or another color not red, blue or white)

For each small group:
• one to several gallon jars or clear plastic shoeboxes (e.g.. plastic mayonnaise)
• water to fill the gallon jars or plastic shoeboxes
• a container or plastic bag filled with the following found materials:
recycled Styrofoam packing "peanuts," corks (whole and half), toothpicks, paper clips, metal washers, colored yarn, split-shot fishing sinkers, 1" - 2" square pieces of sponge
• 2 pairs of scissors
• sponge to mop up drips

For Session 3
For the class:
• 3 sheets of chart or butcher paper to make the following posters, or to make into transparencies (See Getting Ready):

- Brine Shrimp Poster
- "Questions We Have About Plankton" Poster
- "What We Know About Plankton" Poster
- colored markers (various colors)
- live brine shrimp (1 ounce) (See Getting Ready)
- turkey baster
- tape

For each small group of 5 students:
- 5 magnifiers (see Getting Ready)
- microscope (Optional: but highly desirable)
- 2 - 3 droppers
- 2 - 3 solo cups (6 ounce)
- 5 small petri dishes
- 5 sheets of 8 1/2" x 11" blank paper
- 5 sheets of 8 1/2" x 11" lined paper
- 5 pencils
- 5 Brine Shrimp student sheets
- 5 sentence strips
- colored markers (3 - 5)
- Optional: jar of green pond water or plankton ordered from a scientific supply house (See Resources)

Getting Ready

1. Make the following two posters on chart paper or make into transparencies: About Plankton, and The Brine Shrimp.

ABOUT PLANKTON

"Similarities"	"Differences"

2. Make a transparency of the Diversity of Plankton illustration. Cut apart the transparency into individual organisms and place into an envelope.

3. Make a transparency of the "Baby" to Adult Picture Album illustration. Cut apart the transparency into individual organisms and place into an envelope.

4. Duplicate the "Baby" to Adult Picture Album student sheet for pairs of students.

5. Write the words **"Questions We Have About Plankton"** across the top of one sheet of chart paper using colored markers and large bold, letters. Write the words **"What We Know About Plankton"** across the top of a second sheet.

6. Make the Plankton Anticipatory Guide by writing the words **What are all the ways plankton could slow down how fast they sink?** across the top of a sheet of chart paper using colored markers and large, bold letters.

7. Obtain live brine shrimp from an aquarium or pet store. The aquarium trade feeds brine shrimp to many kinds of fish. Call the aquarium store to find out which day their brine shrimp are delivered. Purchase about an ounce (which will cost about $1.00). The store will put the brine shrimp in a plastic bag, but as soon as you get home, put them in a plastic container (Tupperware works great) with the lid off. Place them in your refrigerator until you are ready to use them. Transport them with the lid on! If you are unable to find live brine shrimp, you might try one of the following suggestions:

- purchase brine shrimp eggs (sometimes called sea monkeys) and grow them out yourself
- purchase Triops and grow them out (Often available in nature or museum stores)
- collect pond water from a neighborhood pond or horse trough or place a jar of water to which you have added hay and other greens on a sunny window sill and watch it turn green over the next few weeks. You won't see brine shrimp here, but you will be able to see fresh water, microscopic plankton which are really cool!
- order plankton (live or preserved, fresh or saltwater) from a biological supply house (See Resources)

8. Collect "found" materials to make the plankton models. Place multiples of each of the objects into a plastic bag for each small cooperative group to share. Be sure to have a wide range of objects of varying densities.

9. Duplicate the trophies and ribbons for the award ceremony. Duplicate one copy of the First Place trophy on blue paper, one copy of the Second Place trophy on red paper, one copy of the Third Place trophy on white paper and enough copies of the participant ribbons on yellow (or other) color so that every other student participating receives one.

10. Duplicate the Brine Shrimp Student Sheet, one per student

11. Set up the large aquarium or 20 gallon clear plastic storage box at the front of the classroom and fill it with water. Fill each of the gallon jars or other containers with water and place off to the side of the room.

12. Obtain plankton visuals.

13. Write the Key Concept in large bold letters with colored markers.

Plankton have adaptations which help them avoid sinking below the sunlit photic zone.

Session 1: So What is Plankton?

(Into The Activity)

Plankton Video

1. Have students pair-up to watch a plankton videotape such as the Monterey Bay Aquarium "Treasury of Ten Aquarium Videos" (Alternatively, show photos, pictures or posters to illustrate the diversity of plankton.) Distribute one sheet of blank paper and two pencils to each pair of students.

Sidebar: This is a very cool video clip of plankton – no voice over, just a very fun and catchy musical soundtrack. Students and teachers find it intriguing and very interesting to watch.

2. While watching the videotape, have students quietly discuss with their partner what they observe. Suggest that they look at the colors, shapes, spines, and kind of motion (if video available).

3. Have each pair work together to sketch at least two different plankton species as the video is playing.

4. After the video clip, have them label in their own words, some of the interesting features they noticed on the plankton they sketched. Remind them to again think about the colors, shapes, spines, and kind of motion.

5. Now have them share their drawings with another pair of students. Tell them they can add to or modify their drawings based on any new information the additional pair introduces.

6. Distribute a sheet of chart paper to each group. Have them make detailed drawings of at least four different plankton –BIG– so they can be seen from the back of the room. Display them around the room.

7. Have the foursome designate a recorder. Show them the class chart "About Plankton" and then distribute one sheet of blank paper to each group. Ask the recorder to duplicate the chart on their paper and then record the group's ideas about similarities and differences between the plankton shown on the student charts displayed around the room.

ABOUT PLANKTON

"Similarities"	"Differences"

8. Lead a class discussion as groups share their drawings and observations. Record their ideas on the class About Plankton chart. *[Some of their observations about similarities may include the following: many are transparent; lots of legs or appendages; weird-looking; spiny; weak-swimmers; red coloration; connected in chains, beating cilia (hair-like structures). Differences may include: lots of different shapes; some are stationary; some look like worms; some look like jellyfish; some have long and some short spines].*

(Through The Activity)

Baby to Adult Picture Cut-outs

1. Use the students' drawings and the class About Plankton Poster to introduce the following vocabulary that you feel will be new to your students: pelagic, producer, herbivore, consumer, invertebrate, carnivore, decomposer, photic zone, zooplankton, phytoplankton, meroplankton, holoplankton, density, buoyancy, appendage. Add any new vocabulary to the About Plankton poster using arrows to connect them to the students own words already listed there. You might also label the students' drawings displayed around the room with the new vocabulary words.

Putting vocabulary in context using the students own drawings and observations will help them to understand the new words and concepts and to use them to help design and describe their "plankton."

2. Distribute the "Baby" to Adult Picture Album student sheet to pairs of students and ask them to use lines to match the baby picture with how it will look as an adult. Have them write on the line what characteristics or features of each they used to match them up.

Holoplankton (stay plankton their whole life) examples include the following: jellyfish, krill, brine shrimp, diatoms, dinoflagellates, and copepods. Meroplankton (only plankton part of their life) examples include: fish, crabs, seastars, barnacles, sea anemones, worms, sea urchins, etc.

3. After they have had time to complete and dicuss their matches, show the "Baby" to Adult Picture Album transparency cut-outs and lead a class discussion as student volunteers take turns making matches of baby and adult on the overhead projector. If they didn't discover the actual matches on their own, show and discuss them after they have had a chance to share their ideas.

Diversity of Plankton Cut-outs

1. Show the Diversity of Plankton transparency cut-outs on the overhead projector and have the students help you find similarities and differences between all the various samples shown. Ask the students how we might categorize them. What criteria could they use to place the organisms in categories? What are all the adaptations that they can see in the transparency drawings? Some possible categories include: phytoplankton or zooplankton; meroplankton or holoplankton. Possible adaptations include: those plankton with spines, or connected in chains, or hairy, or many legs and etc.

Sidebar: Adaptations are those features which help an organism to survive and thrive or be successful in its habitat.

2. Have the class brainstorm possible advantages to the adaptations they observe in the drawings (e.g. camouflage, predator avoidance, prey capture, flotation). Group all of transparency drawings together which show adaptations to keep from sinking. Ask the students to discuss why flotation adaptations or at least a slow rate of sinking are so important to plankton. [Phytoplankton need to stay near the surface

sunlight and zooplankton need to stay near their food the phytoplankton.]

Anticipatory Guide

1. Post the Anticipatory Guide question near the video monitor. Tell the students they are going to watch the video again, but this time they will work with a partner to answer the question: **What are all the ways plankton could slow down how fast they sink?** (*Possible answers include: flattened appendages, small bodies, long spines, gas or oil floats, chains, etc.*).

It sometimes helps to relate how lifeguards jump into the water with legs and arms spread wide so that their head remains above water. If they were to jump in straight like an arrow, they would sink quickly to the bottom and lose sight of the drowning victim.

2. Distribute a sheet of paper to each pair and have them write down their ideas about how plankton slow their sinking rate. Also, tell them that they can call out their ideas on whether each of the plankton shown is holoplankton or meroplankton and if the latter, what will it become.

3. After the video, have groups share their ideas as you write them on the board. Ask them how they could confirm their ideas about ways to slow sinking rates, whether an organism is holo- or meroplankton and what it will become. *(Possible answers: library research, field or aquarium observations, modeling, etc.)*

4. Tell the students that in the next session, they will make plankton and race them to determine the winner in the Great Plankton Race. The winning plankton will be the one with the slowest sinking rate.

Session 2: The Great Plankton Race

Designing and Building Plankton

1. Tell students that each of them will design and build a plankton model from materials with different densities. Show the class the materials they can use to make their plankton and the gallon jar of water they will use for their pre-race testing. Remind students that each model should be constructed to sink as **slowly** as possible, but must not float at the surface *(in nature some plankton species do live at or on the surface, but most drift beneath it).*

2. Tell them that they will try out how well their plankton does in their small group aquarium and then once they have made a model that they like, they will have the opportunity to race it against another student's model in the large aquarium at the front of the room.

3. Form the students into small groups gathered around a few desks pushed together. Place a pile of available materials, a gallon jar of water and a sponge in the center of each group.

4. Once an individual has made a plankton model and tested it in their group gallon jar, they can queue up behind the large aquarium at the front of the room.

5. Have pairs of students take turns explaining the adaptations of their plankton and then conduct preliminary heats in the large aquarium. Have two students at a time place their models just below the surface. Have two other students stand ready with stopwatches to record the time each takes to sink to the bottom of the aquarium (25 cm). At the "go" signal (consider using a toy cap pistol for effect) each contestant releases their plankton and the race is on. Have two additional students record the student's name and time on the board.

Sidebar: Starting the race with the plankton just below the surface avoids the problem of surface tension which can keep some models of plankton from sinking.

6. After all students have raced their plankton, select the four students with the slowest times for semi-final sink-offs.

Winners of the two semi-final heats race off for the championship.

7. Have the winners describe the adaptations that led to their plankton's success. Have an awards ceremony and distribute cut-out paper trophies to the slowest racers and participant ribbons to all.

8. Have students make detailed design drawings of their models and label their "adaptations". Display all the plankton "blueprints" on a bulletin board.

9. Tell students that in the next session they will have the opportunity to observe real, live plankton (called brine shrimp) and relate what they have learned about plankton adaptations to the living organism.

Session 3: Observing Live Plankton

Think Pair Share

1. Have the students work in small groups for the first part of this session. Place a clear cup-sized container of brine shrimp in the center of each group.

2. Distribute one sheet of paper and a pencil to each student. Have individuals look closely at the brine shrimp and jot down three questions they have about the brine shrimp.

3. Now with a partner, have students discuss their questions with each other. They can each add new questions to their list based on what their partner wonders about.

4. Have each pair join another pair at their table to make a foursome. Have them compare their questions and choose three of them to share with the class.

5. Distribute three sentence strips and a colored marker to each group. Have the group write their questions on the sentence strips and tape them to a class chart with the words "Questions We Have About Brine Shrimp" written across the top. Lead a class discussion about their questions. Tell them that as questions are answered during this activity, their sentence strips will be moved to the chart labeled "What We Know About Brine Shrimp."

Getting a Closer Look

1. Distribute hand lenses, bug boxes or other magnifier boxes to each student. Distribute petri dishes and droppers to pairs of students.

2. Have the students take a few brine shrimp out of the group container and place it in the petri dish using the dropper. Remind them to not include much water, otherwise the brine shrimp can move around too far and too fast to be seen easily. Have them observe the brine shrimp with this greater magnification and then discuss in their small group what they can now see.

3. Return to the class list of questions and ask if some of the class questions can now be answered. Discuss their ideas and move the questions that have been answered to the "What We Know..." chart.

Sketching the Plankton

1. Distribute a sheet of blank paper and a pencil to each student and tell them they will now have the opportunity to sketch what they see. Describe and demonstrate on the board or chart paper how to make a sketch. Tell students that the sketch should fill their paper and include all the structures they can see.

> *Remind the students that a sketch is just a quick illustration many kids (and adults!) say they can't draw, but feel OK about doing a "just a" sketch.*

2. Ask for student volunteers to work on a class sketch on chart paper posted at the front of the room. Have students take turns adding to this class sketch. Remind them to label the parts of the brine shrimp they add to the illustration.

3. Have each pair of students write down at least three additional questions they now have about brine shrimp. Lead a class discussion and have the students write down the new questions on sentence strips and add them to the class chart. Can any of the previous questions now be answered?

4. Distribute the Brine Shrimp Observations student sheet and have students use it as a guide to add even more details to their drawing.

Information About Brine Shrimp

Brine Shrimp are crustaceans much like crabs and shrimp. They live in salt ponds which contain water much saltier than ocean water. Many of these ponds are made by people so that as the water evaporates, salt crystals are left behind and collected for table salt. The brine shrimp eat phytoplankton in the water and are eaten in turn by birds and water boatmen.

Very salty water has less oxygen than fresh water and so the brine shrimp produce a lot of hemoglobin in their blood to carry oxygen around their bodies. Females are under more stress because they must produce and carry the eggs and so they must produce even more hemoglobin to transport even more oxygen. This causes the females be more red/orange in color than the males. The gills of the brine shrimp are located on each of its 22 legs. The brine shrimp moves its legs continuously to keep the gills oxygenated, to move algae towards its mouth and to keep from sinking.

Brine shrimp can live for 2 - 3 months and eggs can be produced when the female is only 3 weeks old. Males have claspers on his head to hold onto the female when he mates with her and fertilizes her eggs within her egg sac. Some of the eggs may hatch while the female is still carrying them and the tiny larvae and brine shrimp can often be seen swimming around amongst the adults.

Brine shrimp eggs are adapted to survive through the time when the salt pond has totally dried up. Dried out eggs will hatch when rain washes the eggs back into the pond. The pond will again become salty as the salt along the water's edge dissolves into the water. Eggs have been known to survive out of water for as long as 13 years. These eggs are sometimes called "sea monkey eggs" and the brine shrimp which hatch out of them "sea monkeys."

An Even Closer Look

1. If you have one or more microscopes available, have the students take turns looking even more closely at the brine shrimp and add more details to their sketches. Ask for volunteers to again add the details to the class sketch.

Sidebar: If you only have 1 - 2 microscopes available, the Brine Shrimp Observations student sheet works well to keep the students occupied while you call a few of them at a time to look through the microscope.

2. Have each group try to answer as many questions from the class generated list as they can. Again lead a class discussion and move the answered questions to the "What we know about brine shrimp" chart.

3. Post the Brine Shrimp poster and give students another chance to look at their brine shrimp after studying the poster. They will probably find structures they might have missed in previous observations. Discuss any new body parts with the class and help them to discover the answers to any questions left on the "Questions About Brine Shrimp" poster.

4. Share some of the facts from the Information About Brine Shrimp that you find interesting or that help to answer some of the students' questions.

Wrap-Up

1. Have students discuss the following question in their small group: Name two ways brine shrimp are similar to other plankton we have seen. In what way are they different? Lead a class discussion about their ideas.

2. Ask if anyone knows where there is a pond nearby that they could walk to. If it is in the neighborhood, ask if anyone would be interested in bringing in some plankton for the class to look at. Do they think freshwater plankton would have the same sort of adaptations that they have been observing with saltwater plankton? Why or why not?

2. Show the key concept and have one or more students read it aloud.

Students discover that plankton have adaptations which help them avoid sinking below the sunlit photic zone.

(Beyond The Activity)

Going Further

Math Extensions

1. Have students graph their sinking times on a frequency histogram on the blackboard (or graph sinking rates in cm/sec)

2. As a class, determine the range (difference between the fastest and slowest) and average sinking time (or rate) for the class. Estimate the time it would take the slowest to sink below the photic zone (25 cm sinking time x 4 = sinking time per meter x 100 = sinking time through photic zone)

Collect Plankton

Construct nylon stocking plankton nets and collect plankton from fresh water ponds or ocean-side piers for microscope observations. Sketch one and describe its flotation adaptations. Can you find both phyto- and zooplankton? (See attached design for a plankton net.)

Library Research

Investigate open ocean food chains. Where does plankton fit in? Who eats plankton directly? (Some whales, pinnipeds, penguins, fish, filter feeding invertebrates like barnacles, clams, sand crabs and many others.)

Field Trips

Visit salt ponds and see brine shrimp in their natural habitat or visit a pond and collect fresh water plankton.

Student Sheet

Brine Shrimp Observations

1. What colors are the brine shrimp? (*Add these colors to your drawing).*

2. Notice how the brine shrimp body is separated into many sections. How many sections are there? *(Show the sections on your drawing)*

3. Brine shrimp use their legs for a number of different purposes. How many legs do brine shrimp have?_________________
Describe two different ways that the legs are used. *(Label the legs and how they are used on your drawing.)*

4.Brine Shrimp use gills for breathing. Where are the gills ? *(Label the gills on your drawing.)*

5. Describe why you think this is a good place to have their gills.

6. Describe two differences between the male and female brine shrimp.

7. Which one (male or female) did you originally sketch?
Make a sketch of the other one showing and labeling the differences between the male and female.

8. What did you think were the two most interesting questions about brine shrimp that the class asked? List the questions, answer them and tell why the questions interested you.

9. Describe the natural habitat of the brine shrimp. What problems do you think they encounter in their everyday life?

10. Describe two reasons why brine shrimp are called plankton.

11. Design an experiment to determine if brine shrimp prefer to be in light or dark. List the materials you would need and describe the first few steps you would take.

12. Some people call brine shrimp "Sea Monkeys". Describe why you think that is a good (or bad) name for them or make up one of your own and explain why you think it is the better name.

The Great Plankton Race Home Activities

FAMILY FIELD TRIP TO THE PET STORE

Visit a local pet store and purchase some brine shrimp to observe at home. The aquarium trade feeds brine shrimp to many kinds of fish. Call the aquarium store to find out which day their brine shrimp are delivered. Purchase about an ounce (which will cost about $1.00). The store will put the brine shrimp in a plastic bag, but as soon as you get home, put them in a plastic container (Tupperware works great) with the lid off. Place them in your refrigerator until you are ready to observe them. If you are unable to find live brine shrimp, you might try one of the following suggestions:

- purchase brine shrimp eggs (sometimes called sea monkeys) and grow them out yourself
- purchase Triops and grow them out (Often available in nature or museum stores)
- collect pond water from a neighborhood pond or horse trough or place a jar of water to which you have added hay and other greens on a sunny window sill and watch it turn green over the next few weeks. You won't see brine shrimp here, but you will be able to see fresh water, microscopic plankton which are really cool!

FAMILY FIELD TRIP TO THE POND

Visit your local pond and use a jar to collect a sample of water. Try making a plankton net at home and using it to collect plankton. You can use hand lenses or bug boxes to see the larger plankton swimming around.

PLANKTON RACES

Collect material to make plankton at home with your family and have a race to determine which plankton sinks the most slowly. Have everyone draw a sketch of the plankton they made. Describe to your family why slow sinking is such a good adaptation for plankton to possess. Draw a few sketches of some of the real plankton you saw at school and describe their adaptations to your family.

INTERNET PLANKTON SEARCH

Search for plankton on the internet. What interesting web sites can you find? What two new things did you learn about plankton?

WHAT DOES A JELLYFISH FEEL LIKE?

Cold jello made in a plastic bag feels a lot like an actual jellyfish. Dissolve 1 envelope of unflavored gelatin in 1/4 cup of cold water in a microwavable bowl. Let it stand for 2 minutes them put the mixture in the microwave for 30 seconds. Stir and then let stand again for two minutes. Add 1 1/4 cups cold water and mix thoroughly. Pour the mixture into a plastic sandwich bag and chill.

Background

Dip a clear jar into the sea and examine your sample. At first glance, the contents may seem devoid of life; but, under a microscope, an incredible world teeming with life is revealed. These tiny plants and animals are critically important to the health of the ocean, for they form the base of the food chain. Called *plankton* (from the Greek word for wandering), they drift at the mercy of the currents. Although most plankton are tiny, any organism which can't swim against a current qualifies as plankton; some, like the jelly fish can be quite large. The plants in the plankton are called *phytoplankton* and the animals are called *zooplankton*. Scientists further classify plankton according to their life histories. Organisms which spend their whole lives drifting are called *holoplankton;* those spending only part of their lives as plankton are *meroplankton*. Most meroplankton are larvae of animals which spend their adult lives on the bottom (like mussels) or free swimming (like anchovies).

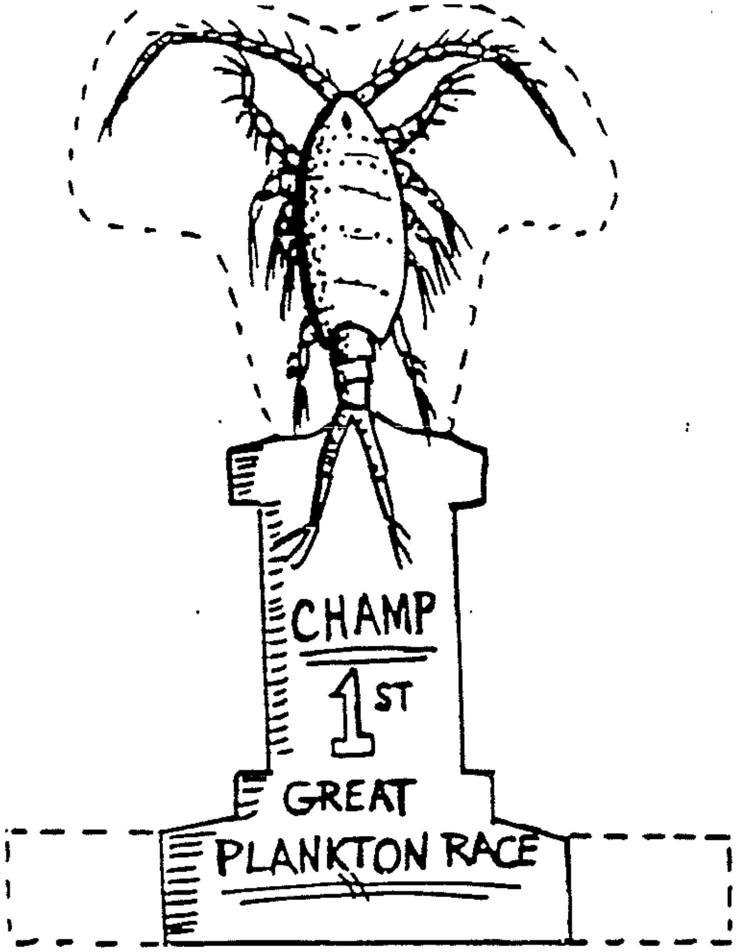
The one-celled plants of the phytoplankton form the pastures of the sea. The vast majority of marine organisms depend on phytoplankton-based food chains. In addition, phytoplankton produce much of our oxygen and are important absorbers of carbon dioxide (responsible for global warming). Diatoms and dinoflagellates are among the most important members of the phytoplankton. Diatoms are housed in beautifully decorated glass skeletons resembling petri dishes. Some diatom species form long chains which may help them float and avoid being eaten. Dinoflagellates share both animal and plant traits. Like plants, most photosynthesize, but some eat other organisms. They can also swim using tiny whip-like flagellae. Some dinoflagellates are bioluminescent and create light when disturbed by waves, boat wakes or predators. Other dinoflagellates produce toxins which they release into the water. During blooms they may become so abundant that the water turns red. These "red tides" can cause fish kills due to poisoning and oxygen depletion. During some months, mussels and other filter-feeding shellfish are unsafe to eat due to concentrated dinoflagellate toxins which cause Paralytic Shellfish Poisoning.

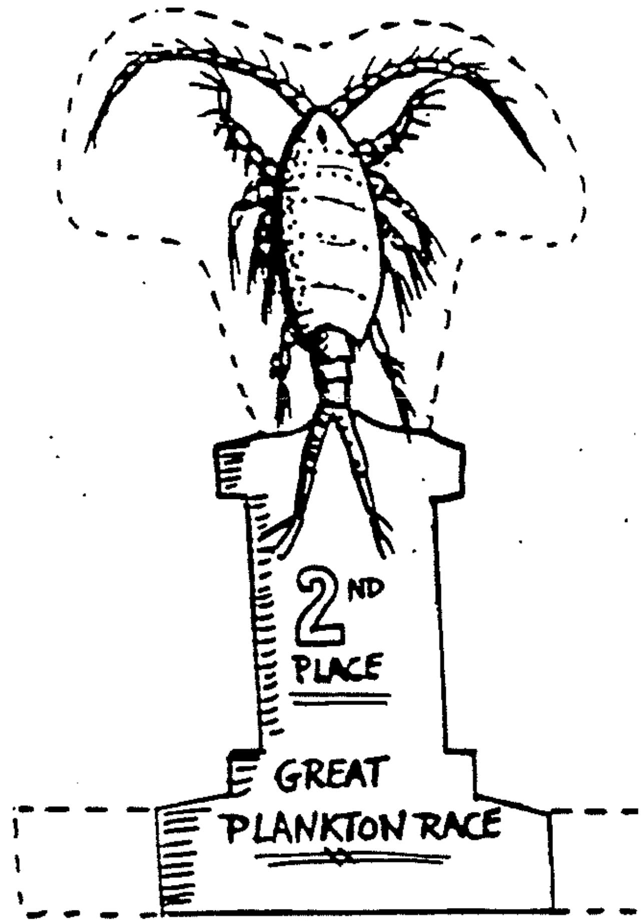
Most major animal groups have representatives in the zooplankton. Arthropods of the class Crustacea are the most numerous zooplankton. Some, like the copepods spend their entire lives in the plankton (holoplankton). Copepods graze on phytoplankton, and, as the most numerous animals on earth, are critically important to the ocean ecosystem. Some crustaceans, like crab larvae, are temporary members of the plankton community, and settle to the bottom to live their adult lives. Shrimp-like krill are among the most popularly known plankton because they are the major food source for some of the great whales. Other common zooplankton groups include the phyla Cnidaria (jelly fishes), Mollusca (larvae of snails, clams, etc., and holoplanktonic pteropods and heteropods), Chaetognatha (arrow worms), Ctenophora (comb jellies), and Chordata (e.g., fish larvae, salps, and larvaceans). With nowhere to hide in the open sea, many plankton species are transparent, and nearly invisible. In addition, many have long spines to help repel predators.

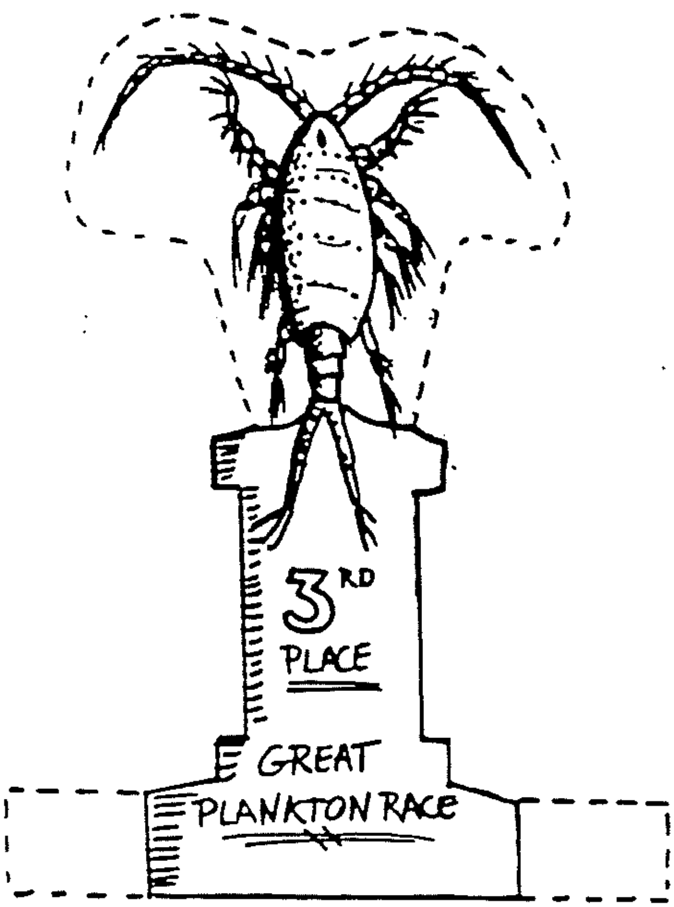
All plankton must avoid sinking. Phytoplankton need sunlight for photosynthesis, so they must stay within the photic zone, usually the top 100 meters. Zooplankton depend on phytoplankton and other zooplankton for food, so they must avoid sinking as well. Plankton avoid that sinking feeling by increasing their surface area and/or decreasing their density. Most plankton are quite small, providing larger surface to volume ratios than larger organisms. Flattened bodies and appendages, spines, and other body projections also slow sinking by adding surface area without increasing density. Some diatoms resist sinking by forming chains. Another way to resist sinking is to store low density substances like oil or fat which increase buoyancy and also serve as food reserves. In addition, water currents caused by convection and upwelling can stir the water and help keep plankton from sinking.

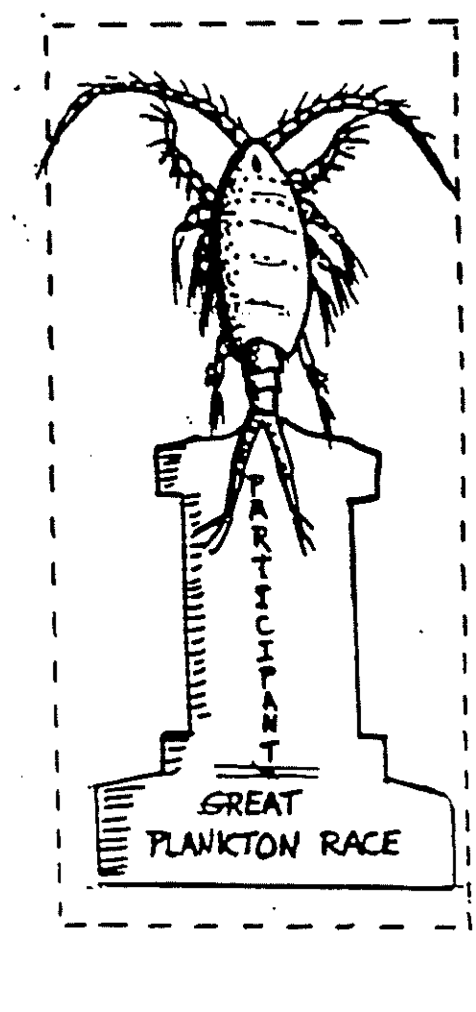
While plankton are too weak to swim against a current, many do swim relatively huge distances *vertically* each day. Great numbers of zooplankton commute up to 1,300 feet toward the surface (at night) and back down each day. That's the equivalent of a person walking 25 miles to and from work each day! There are several possible reasons for this amazing daily vertical migration. Migrating plankton can take advantage of greater densities of food near the surface at night when they can't be as easily seen by predators, then move to deeper, darker waters at sunrise. Plankton can move faster and feed more efficiently in warmer surface waters, then conserve energy in deeper, cooler waters where they move more slowly. Another theory is that, since horizontal current directions vary with depth, plankton can catch rides to other areas by moving vertically.

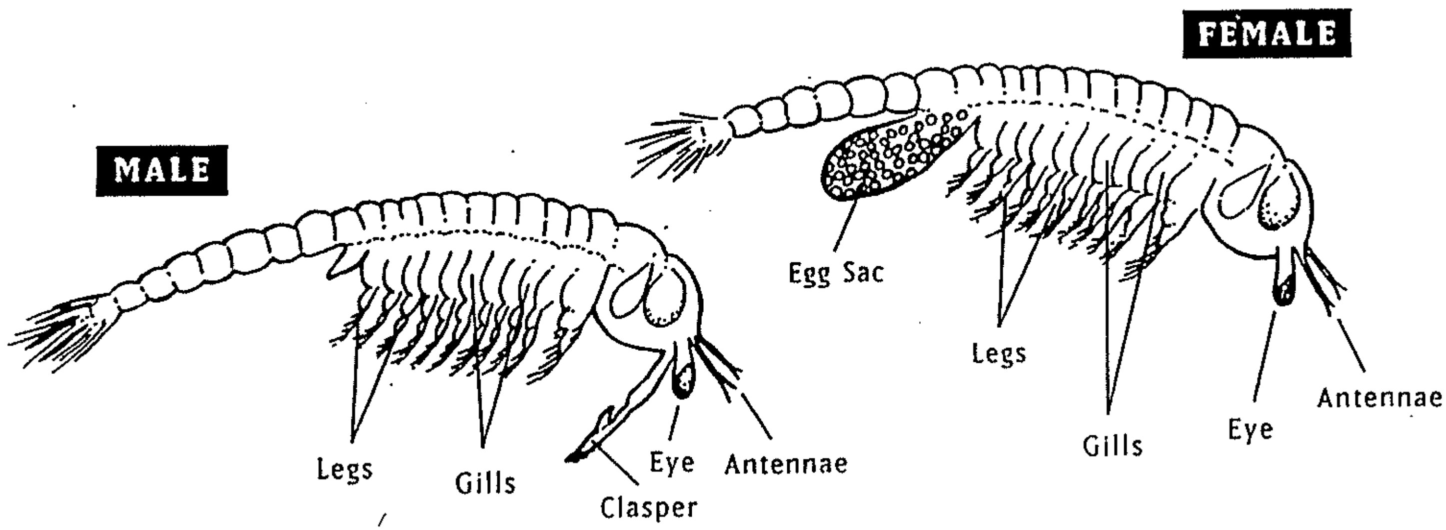
Scientists measure productivity by the amount of phytoplankton produced in an area in a given amount of time. Plankton densities vary greatly for different ocean regions. 90% of the ocean is virtually a biological desert, with relatively few plankton or other marine life. Low densities of plankton in mid-oceanic areas result in extremely clear, deep blue waters. Most of the sea's productivity is in coastal areas above the continental shelf where upwelling and input from rivers provide high nutrient levels. High densities of plankton in these coastal areas result in green waters, and low visibility. As plankton die, nutrients constantly sink to depths below the photic zone, resulting in lower productivity. In upwelling areas, seasonal winds push surface waters offshore creating upwelling of deep nutrient rich waters from below. A ten thousand-fold increase in phytoplankton may occur at this time. 90% of the world's fisheries occur in these rich coastal areas thanks to the high densities of plankton.

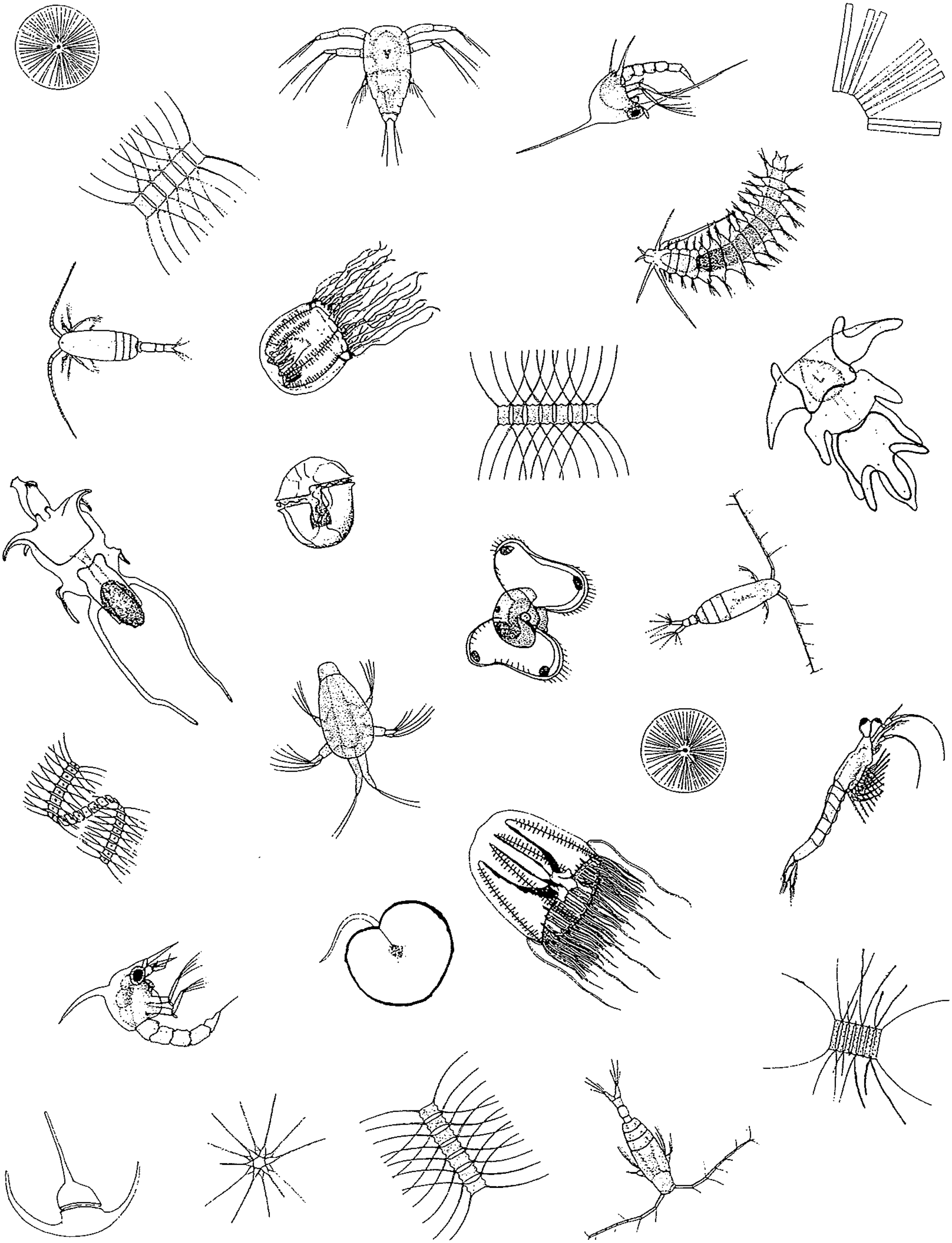

CHAMP
1ST
GREAT
PLANKTON RACE

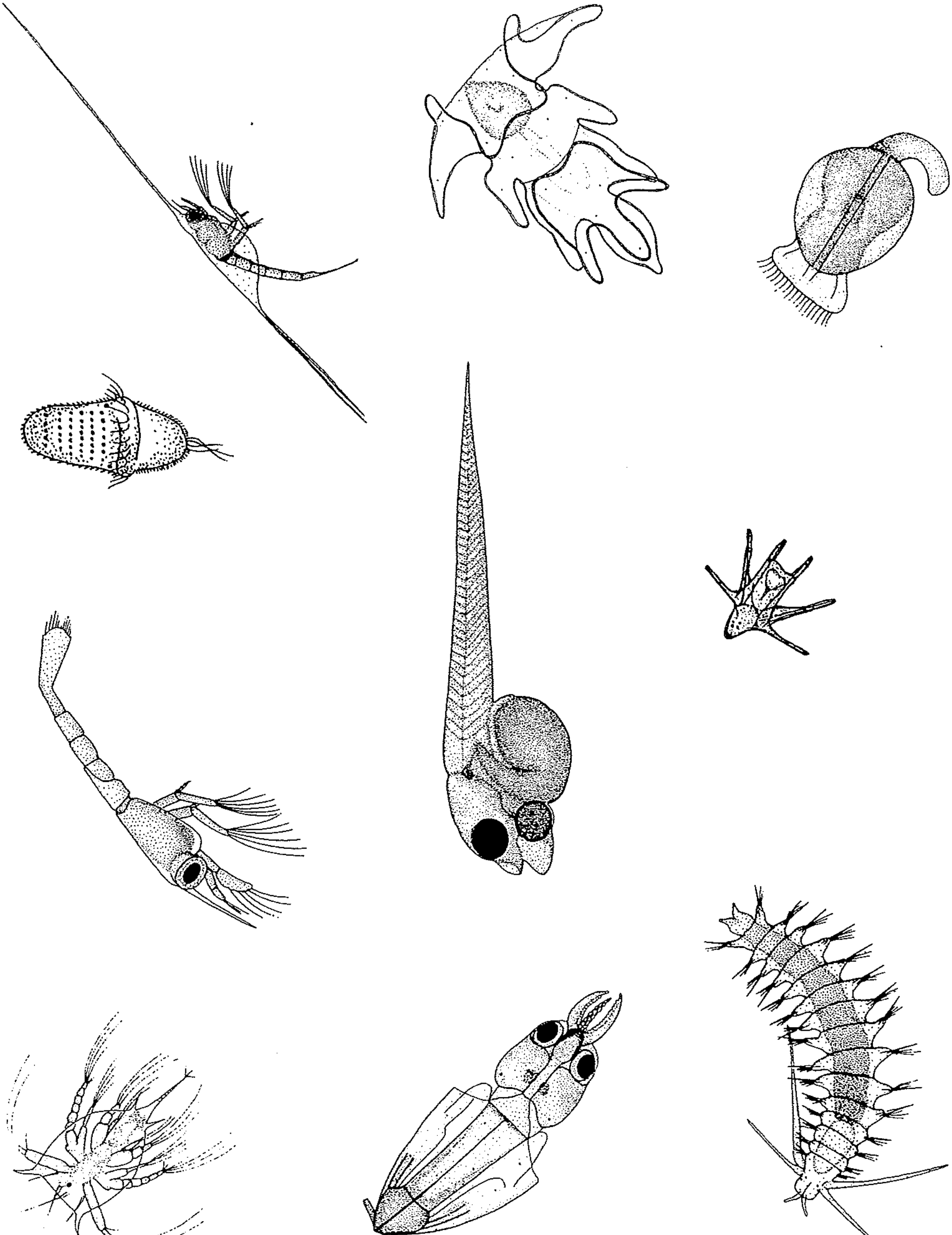

2ND
PLACE
GREAT
PLANKTON RACE


3RD
PLACE
GREAT
PLANKTON RACE


PARTICIPANT
GREAT
PLANKTON RACE


MALE
Legs
Gills
Eye
Antennae
Clasper
FEMALE
Egg Sac
Legs
Gills
Eye
Antennae





BREATH TAKING!

Data Sheet

	Resting		Breath Holding		Diving	
	Heart Rate	Blood Pressure	Heart Rate	Blood Pressure	Heart Rate	Blood Pressure
Diver #1						
Diver #2						
Diver #3						
Diver #4						
Diver #5						
Diver #6						

MARE: Marine Activities, Resources, and Education
Polar Seas Curriculum