Pick Your Plankton: Sampling Planktonic Activity

Material adapted from:
New Jersey Marine Science Center Consortium, Education Program Lesson Plans -
http://www.njmsc.org/Education/Lesson_Plans/Plankton.pdf
UCLA Marine Science Center OceanGLOBE lesson plans -
http://www.msc.ucla.edu/oceanglobe/pdf/PlanktonPDFs/PlanktonEntirePackage.pdf

Introduction:
Plankton refers to the aquatic organisms that drift with water currents; either in freshwater environments such as ponds, lakes and rivers or in marine environments such as in the open ocean. There are two broad groups of plankton: phytoplankton (planktonic plant producers) and zooplankton (planktonic animal consumers), each has distinct characteristics to help them survive in an environment where shelter is rare and nutrition is sporadic. In this activity, students will collect their own freshwater plankton sample and investigate different planktonic organisms under a microscope, comparing their collected sample with preserved marine samples.

Objectives:

Students will be able to:
- Classify the various components of plankton
- Collect a plankton sample
- Identify specific organisms within a plankton sample
- Draw inferences about productivity based on their sample

Materials:

Scissors
Glue
Markers/sharpies & flipchart paper
Wire hoops
Nylon Pantyhose
Plastic Jars with Lids
Rubber bands (Materials in **bold** are provided by SMILE)
Duct Tape (optional)
Stapler (optional)
Silicon glue
Seine Twine (mason line)
Keychain rings
Fishing swivels
Fishing weights
Petri dishes
Droppers/pipettes
Microscopes (dissecting microscopes if possible), slides & covers optional
Preserved Marine Plankton
Marine Diatom Microscope Slide
Foraminifera Microscope Slide

Materials provided are enough to support **20** students

Handouts/Transparencies:

Student Worksheet 1
Student Worksheet 2
Student Worksheet 3
Teacher Answer Sheet
Answer Sheet Overhead
Constructing a Plankton Net
Plankton Identification Guide

Part A: Introduction to Plankton and Classification

1. Arrange the students into 4 teams. Have each team cut out one set of plankton pictures from student worksheet 1. Ask each team to organize their set of plankton pictures into two piles: producers and consumers, using the body structure of each planktonic organism as clues. Have volunteers share their team's method for sorting and why this method was chosen.

2. Now ask each student to individually choose one organism out of the picture selection and look at it closely. Assign one side of the room as phytoplankton and the other zooplankton by hanging flipchart paper signs on the walls. Briefly define each plankton type and, using this information, ask the students to move to the side of the room they think their chosen organism belongs to. Once they have made their decision, ask them to compare their organism with those of the other students who have also chosen this group and brainstorm similarities/differences, discussing how they made their group choice.

3. Have the students go back to their team location, returning their picture to the previously sorted pile. Let each team resort their piles if they find that step 2 provided them with information that made them think differently about their initial plankton classifications.

4. Give each team a copy of student worksheet 2. Ask them to cut out each plankton description and, using these descriptions, identify which pictures belong to each description, gluing the pictures to the back of the descriptions as they decide. Once they are finished, project the answer sheet transparency so the students can evaluate their choices within their teams.

5. Next, assign 2 of the teams to the phytoplankton side of the room and the remaining 2 teams to the zooplankton side. Ask them to discuss and summarize key differences between the two types of plankton, writing bullet points on the flipchart paper.

6. Lastly, have the phytoplankton teams write down the advantages of being planktonic in comparison to larger aquatic plants while the zooplankton teams write down advantages of being planktonic in comparison to larger swimming animals and bottom-dwelling life. Discuss their ideas and suggest disadvantages.

Part B: Constructing a Plankton Net

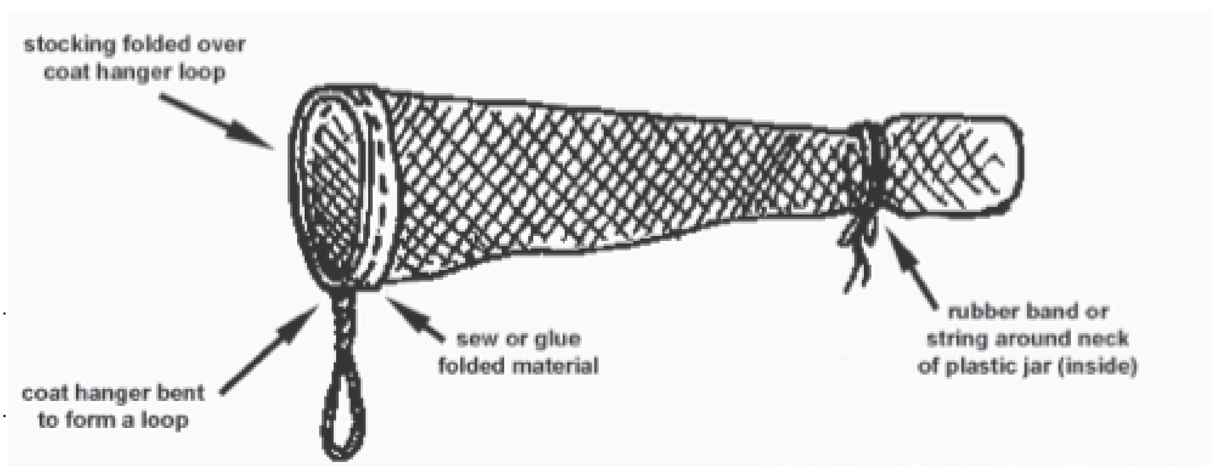
1. Adjust one of the wire hoops to the desired size for opening to the net (approx 10-14" diameter), overlapping the ends. Secure in place with duct tape and/or silicon glue. Alternatively, ends can be secured by wrapping with finer wire or cord.

2. Attach one pantyhose leg by folding the hem of the pantyhose over the top of the wire hoop, starting on the inside of hoop. Using the silicon glue, glue the pantyhose leg to itself 2-4" down from the wire. Staples can also be used to temporarily hold the pantyhose in place while it is glued.

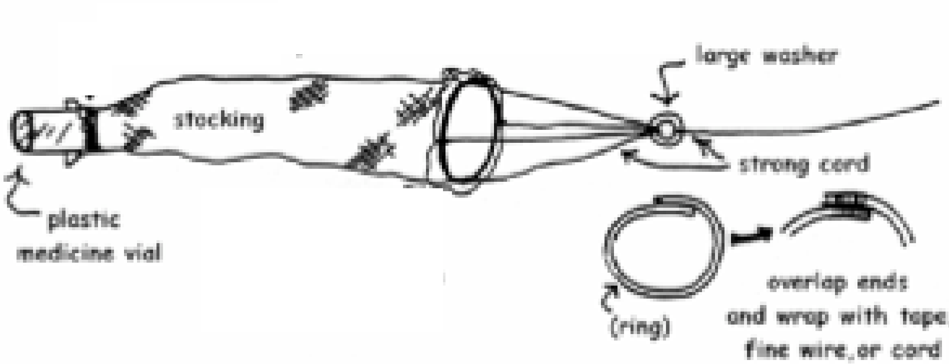
3. Tie a knot at the toe end of the pantyhose. Place an open, pre-rinsed plastic jar inside the pantyhose leg, bottom against the knot. Secure a rubber band around the pantyhose and the top of the jar to hold the jar in place. Save the lid of the jar for sampling later.

4. Tie 3 equal lengths of seine twine onto the wire hoop, carefully threading it through the pantyhose either with a large needle or snipping small holes, so as not to ladder the pantyhose. Silicon glue all the ends in place and the holes through which the cord passes.

5. Tie all three lengths to a fishing swivel, attaching this to a keychain ring (swivel will reduce tangling). Then, tie 2 extra lengths of twine to the keychain, one twice as long as the other. Attach a fishing weight to the short piece; this will anchor the net to the bottom of water body whilst the longer piece will be the towline.



Modified from "Marine Explorations CD-ROM," FOR SEA, 2001. J.Kolb.



(Nets can be made as part of a team, individually or pre-made before sampling. The materials provided are enough to produce **3 nets**)

NB: Allow 24 hours for glue to dry completely

<u>Part C: Plankton Sampling</u>

1. Divide the students into teams to work with their new nets, making sure every student takes a turn at towing.

2. Collect plankton samples from a nearby aquatic environment such as a pond, lake, stream or river. Scoop the net through the water where the water is calm and in easy reach of the students, such as off a public boat launch ramp. Use the towline to tow the net through the water, whilst the fishing weight allows the net to submerge.

3. Samples can also be collected from moving water, such as streams, rivers or even estuaries, by securely tying the towline on the shore (such as to a bridge or piling), allowing the net to drift through the water. Nets can also be towed behind a small boat if available. Have different teams take samples from different sections of the water body being sampled.

4. Retrieve the samples by having the students reel the net in, detach the collection jar and screw the lid on tightly. Have the students mark their jars with team names, date, time and location of where within the water body the sample was taken.

5. Refrigerate the samples until ready for observation.

<u>Part D: Lab Investigation</u>

1. Set up the microscopes and have clean sides and covers ready if desired.

2. Have the students regroup with their sampling teams and retrieve their samples, placing a few drops of their samples into half a Petri dish or onto a slide.

3. Ask the students to observe their freshwater samples under a microscope, using student worksheet 3 to sketch the plankton they observe. Have the identification guide on hand so students can begin to classify each organism, i.e. diatoms, copepods. If the microscopes being used are not powerful enough to magnify detail needed for identification, skip this step and have the students simply sketch what they see.

4. Now ask the students to repeat the observation process with the preserved marine plankton sample, **NB Eye and glove protection are advised with preserving liquids.**

5. Have the marine diatoms and foraminifera pre-made slides ready for the students to view in addition to observing the preserved sample.

Extensions:

1. Have the students calculate the abundance of each planktonic organism in:
   A The net
   B Per drop under the microscope
   C Per cubic meter of water sampled.

This will require the students to estimate the number of species seen under the microscope. Use http://www.msc.ucla.edu/oceanglobe/pdf/guide_plankton1.pdf as a guide for calculations.

2. Plankton collection can be expanded to a community collection project for investigating local aquatic habitats further. Information ons nearshore community sampling (which can be adapted to suit a freshwater project) and constructing a seine net can be found at:
http://www.njmsc.org/education/Lesson_Plans/NearshoreCommunitySampling.pdf

3. Students can research particular planktonic organisms found further, using the internet/library. Have the students create a team portfolio on a chosen plankton species.

4. Using their new knowledge of plankton, have students design an activity for elementary/middle school class to teach them about plankton in Oregon. Have the students test it out on the rest of the class before taking it to younger schools as a community environmental education project.

Vocabulary:

Autotrophic
An organism that through photo or chemosynthesis produces its own nutrition.
Detritus
Dead and decaying organic material.
Diatoms
A group of phytoplankton that are green and have a shell of silicon. They make the water green in color.
Dinoflagellates
A group of phytoplankton that are reddish-brown and have armored plates of cellulose. They can act like both animals and plants, and can move through the water. Most are bioluminescent and toxic.
Consumer
An organism that gets food from eating other organisms. Also called a heterotroph.
Estuarine
Of or pertaining to estuaries. An estuary is a place where salt water and fresh water meet and mix.
Eutrophication
The process by which a body of water becomes rich in nutrients either naturally or through pollution, and biological productivity is stimulated.
Food chain
All living things depend on each other to live. The food chain is an example of how

some animals may eat other animals or plants to survive. The food chain is a complex balance of life. If one animal's source of food disappears, such as from over fishing or hunting, many other animals in the food chain are impacted.

Heterotrophic
Any organism that is not autotropic: a secondary producer. Utilizes the organic material produced by an autotrophic organism.

Holoplankton
Organisms that spend their entire life as plankton. This group includes krill, copepods, sea snails, slugs, salps, jellyfish and a small number of marine worms.

Larva
A developmental stage of an animal (after hatching from an egg) that appears different than the adult.

Macroplankton
Large plankton; plankton from 2 cm to 20 cm.

Megaplankton
Huge plankton; jellyfish, salps and others with sizes greater than 20 cm.

Meroplankton
Microscopic larval forms of organisms that spend their adult lives as nekton (organisms that swim in the ocean freely) or benthos (organisms that live on the ocean floor). This group includes sea urchins, starfish, sea squirts, most of the sea snails and slugs, crabs, lobsters, octopus, marine worms and most fish.

Microplankton
Plankton from 0.02 mm to 0.2 mm (20 μm to 200 μm) in size.

Nanoplankton
Plankton from 0.002 mm to 0.02 mm (2 μm to 20 μm) in size.

Photosynthesis
The process of plants converting water and carbon dioxide into food using sunlight as energy.

Phytoplankton
Plant plankton. The most important community of primary producers in aquatic systems.

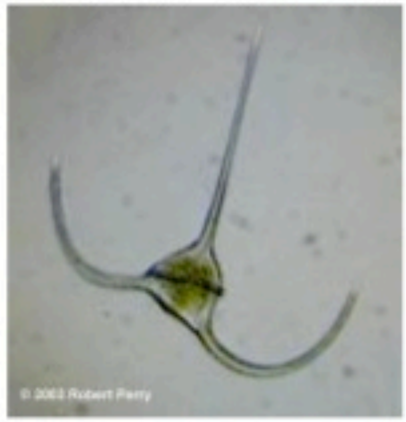
Plankton
Organisms such as jellyfish, seaweeds, and microscopic plants and animals that passively drift or are weak swimmers and are not independent of the currents.

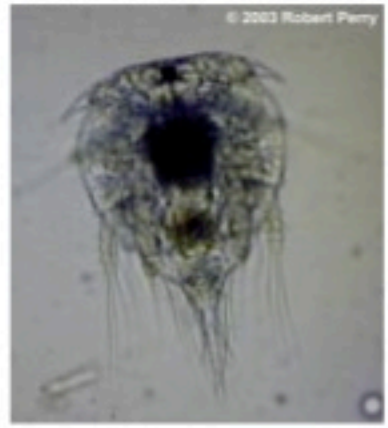
Producer
An organism that makes it own food. Also called an Autotroph.

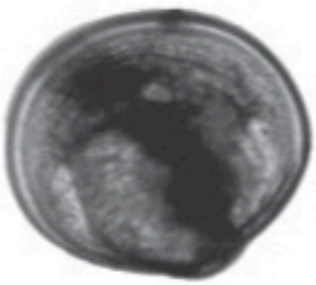
Red tide
A patch of the ocean surface, which has turned reddish-brown by a bloom or population explosion of dinoflagellates through eutrophication.

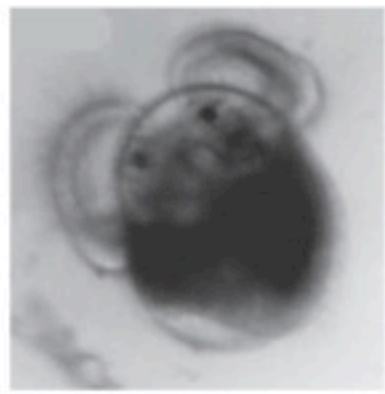
Zooplankton
Animal plankton (primary consumer) that drift in the ocean currents; different types are found at all depths from the surface down to the deepest depths.

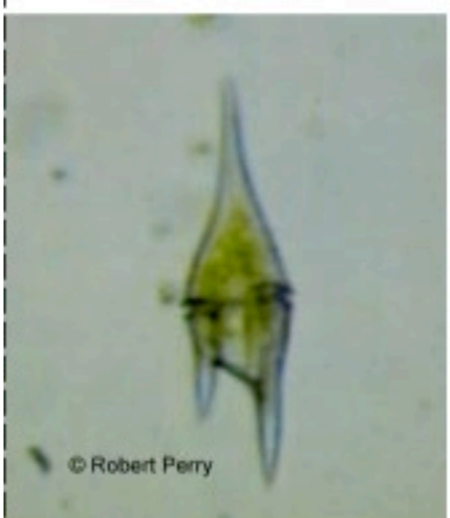
Pick Your Plankton: Student Worksheet 1

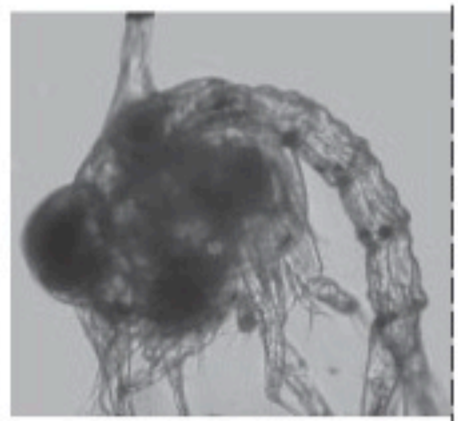


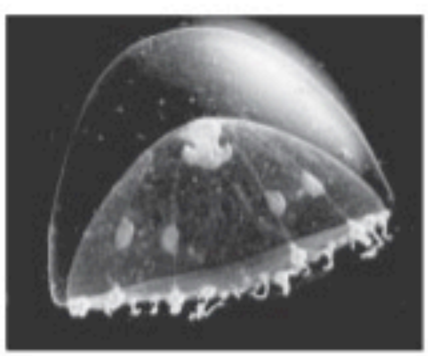


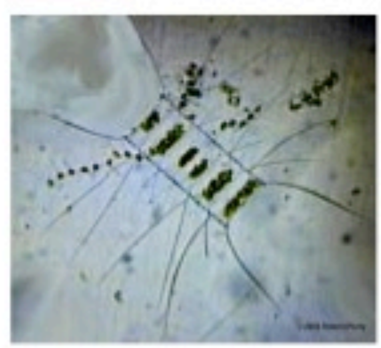




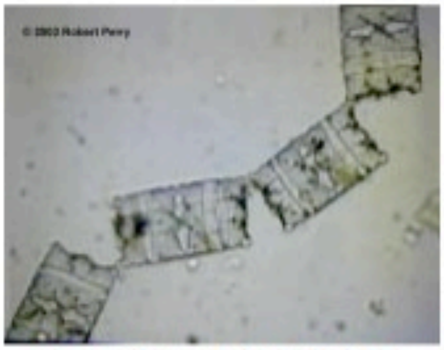




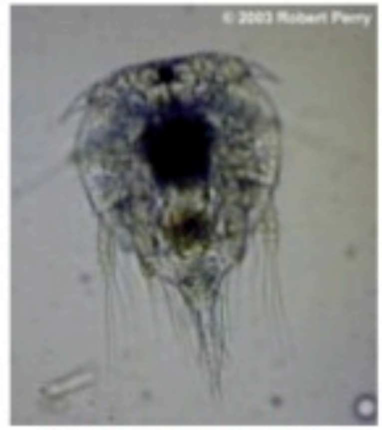


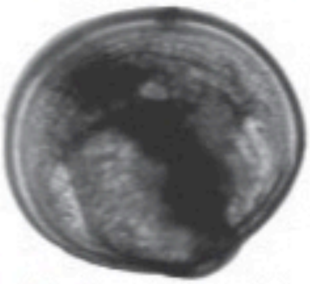


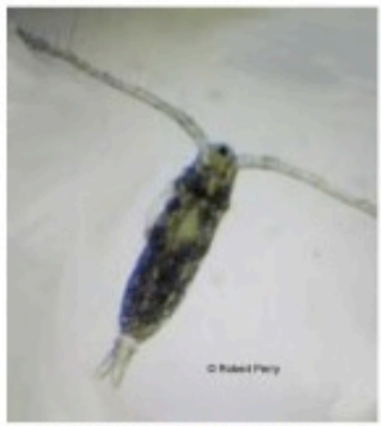
Pick Your Plankton: Teacher Answer Sheet

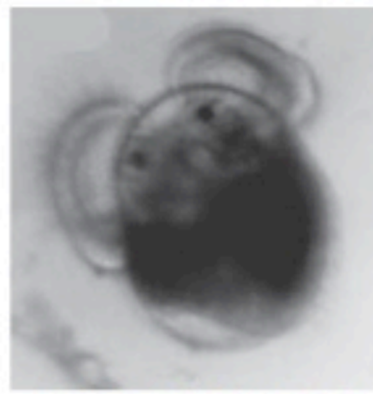

phyto - diatom chain (Biddulphia)


phyto - dinoflagellate (Ceratium)

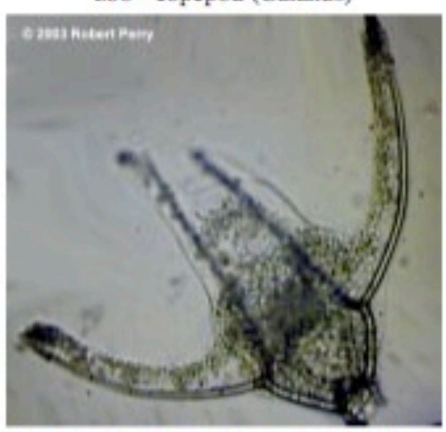

zoo - nauplius larva (barnacle)

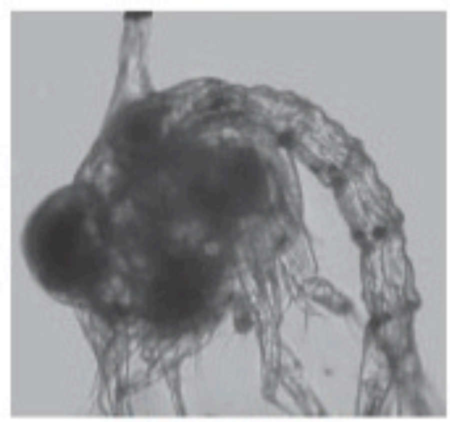

zoo - bivalve veliger larva (clam)

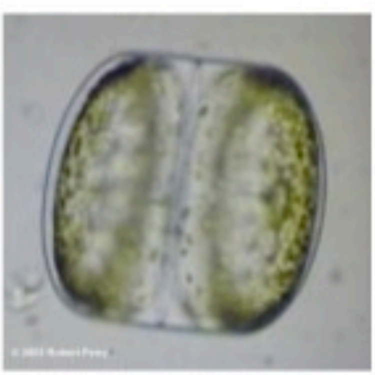

zoo - copepod (Calanus)

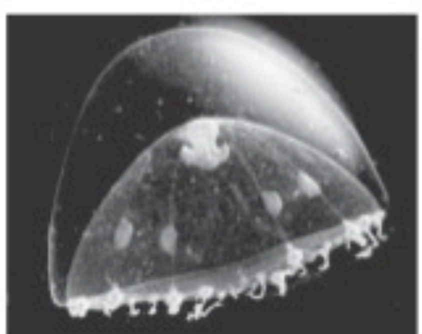

zoo - early veliger larva (snail)

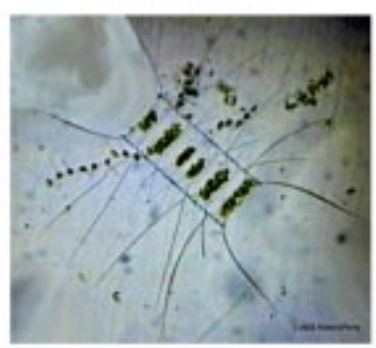
phyto - dinoflagellate (Ceratium)


zoo - echinopluteus larva (sand dollar)


zoo - zoea larva (crab)


phyto - diatom (Coscinodiscus)


zoo - medusa (Phialidium)


phyto - diatom chain (Chaetoceros)

Pick Your Plankton: Student Worksheet 2

DIATOMS

- These phytoplankton are tiny producers shaped like a Petri dish; a top half and a bottom half that fit together
- Along with dinoflagellates, they are one of the most common types of phytoplankton and are often used as environmental indicators
- Some diatoms exist in colonies, forming chains or filaments
- The shell of a diatom is made of silicon, the same chemical from which glass is made
- Their silicon shells do not dissolve easily in water seawater so when diatoms die their tiny shells sink to the bottom of the ocean and pile up.

DINOFLAGELLATES

- These phytoplankton are tiny producers with the ability to move, although very slowly
- Their name is derived from their tail-like projections called ‘flagella’, which when whipped back and forth allows them to move in a distinctive ‘whirling’ motion
- Theirs shells are made of cellulose, similarly to cardboard or wood
- Along with diatoms, they are one of the most common types of phytoplankton
- Some are reddish-brown in color and are responsible for ‘red tides’ – a phenomenon caused by a sudden bloom of these microscopic organisms
- Many dinoflagellates are also bioluminescent and toxic.

COPEPODS

- These zooplankton are tiny animals related to shrimp, crabs and lobsters – crustaceans
- They are the most abundant animal on Earth, alongside Krill
- They graze on phytoplankton and are hence consumers, often the first trophic level of consumers in aquatic ecosystems, comparable to rabbits or cows in terrestrial ecosystems
- Copepods tend to feed near the surface of the water at night, and then sink to deeper depths during the day to avoid predators
- The sinking of their fecal pellets is an important flux of organic carbon to the deep sea/seafloor
- Copepods are typically 1-2mm long, with a teardrop-shaped body and large antennae
- As with many zooplankton, copepods are also often naturally transparent to camouflage with the water

LARVAE

- These organisms make up a significant portion of the zooplankton group and are the early developmental stages of numerous aquatic animals
- Larval stages are part of a life-cycle that involves metamorphosis, where an organism will have different appearances at different stages of their lives
- Organisms such as fish, crustaceans, insects and amphibians have larval stages, meaning that many creatures (even terrestrial) spend at least part of their life in an aquatic environment
- As many species of organisms have larval stages, different larvae have different features, although some will show characteristics of their future adult form.

Pick Your Plankton: Student Worksheet 3

Step 1: Your freshwater sample

Observe your collected sample closely under a microscope.

Sketch the plankton you see below, adding detail and labeling any key features of the organisms. Using your knowledge of plankton, begin to identify each organism as either phytoplankton or zooplankton, adding this to the labels. Note any organisms that are moving (motile).

Take a look at the samples retrieved by other groups, how do they compare? Does your sample show greater/less abundance of particular planktonic organisms?

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Step 2: The preserved marine sample

Repeat step 1 using the preserved marine sample (caution with preserving liquid). Draw you sketches below.

How does the marine sample compare with the freshwater sample? Are there any planktonic organisms that are present in both? Are there any present in only one? If so, which ones?

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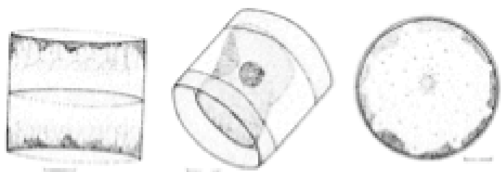
Pick Your Plankton: Plankton Identification Guide

(Taken from Guide to Common Inshore Plankton, UCLA Marine Science Center OceanGLOBE)

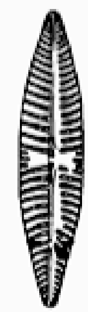
PHYTOPLANKTON

Diatoms

Members of the Protist Phylum Chrysophyta (or Bacillariophycae) are known by the common name "diatoms." The word "Diatom" comes from the Greek *Dia,* = across, and *tom,* = to cut. This refers to the fact that diatoms are enclosed within two glass (SiO_2) shells which split across the middle and separate from each other during reproduction. Under the microscope most diatoms will appear green or golden green, and their glass frustules are as clear as the glass which makes them. When diatoms are exceptionally abundant in the surface water, the ocean will appear very green. Some species like *Coscinodiscus* are solitary, while others like *Chaetoceros* form long chains. These are one of the most important groups of producer organisms in the marine ecosystem. They form the base of the food chain in most ocean waters.



Coscinodiscus spp.
100 - 500 mm
Check the Diatom Guide to determine the exact species you have.

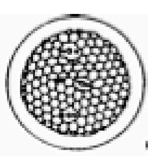


Navicula distans
apical axis = 70 - 130 μm
a "swimming" pennate species

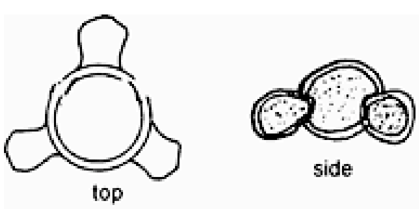
Nitzchia sicula
apical axis = 23 - 121 μm

Proboscia alata
w = 3 - 13μm
l = 150 - 250 μm
for individual cells
length of chains may vary

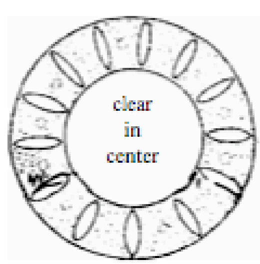
Pleurosigma sp.
apical axis = 200 mm



Minidiscus trioculatus
diam = 2 - 5μm



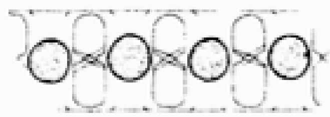
Planktoniella blanda
25 - 55 μm



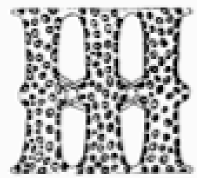
Eucampia zodiacus
cell diam. 8 - 80μm
chains grow in a circle

PHYTOPLANKTON

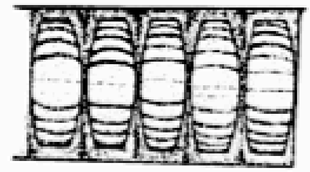
Diatoms (continued)



Odontella mobiliensis
indivi.cell diam. 45 - 200μm
length of chains may vary

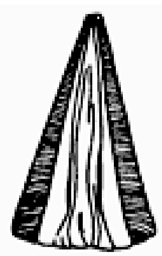


Odontella aurita
indivi.cell diam. 10 - 97μm
length of chains may vary

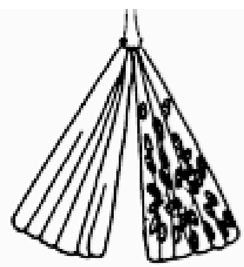


Fragilariopsis oceanica
indivi.cell diam. 10 - 41μm
length of chains may vary

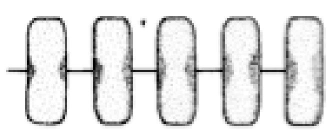
17 *Thalassionema nitzschoides*



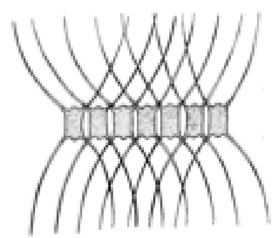
Licmophora longipes
length = 200μm
on gelatinous stalk



Licmophora abbreviata
length = 200μm
on gelatinous stalk

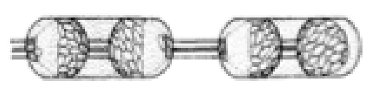


Thalassiosira rotula
indiv. cell diam. 8 - 55 mm



Chaetoceros spp.
a spiny diatom chain
Check Diatom Guide for exact species.

Ditylum brightwelli
indiv. cell diam. 25 - 100 mm

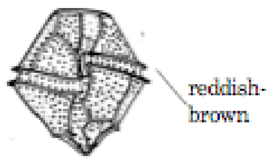


Stephanopyxis palmeriana
indiv. cell diam. 27 - 71 mm

PHYTOPLANKTON

Dinoflagellates

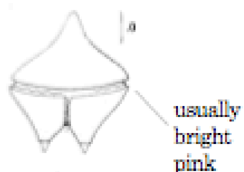
Members of the Protist Phylum Dinoflagellata are very common in coastal plankton samples. They appear clear, reddish-brown, or greenish-brown under the microscope. Many dinoflagellates have red or brown accessory pigments along with chlorophyll to carry out photosynthesis. Hence, when very abundant in the water, the phenomenon is called a "red tide." Dinoflagellates are single celled protists with external armored plates of cellulose. They are motile by means of flagella (usually two), and many species are toxic to animals that may eat them. Most of the bioluminescence we view from boats or along the shore at night is caused when these species are disturbed in the water column.



Lingulodinium polyedrum
aka: *Gonyaulax polyedra*
dino: 42-54 µm.

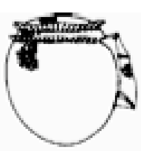
Ceratium fusus
70 µm (top to bottom)
Similar to *Ceratium inflatum* which is larger (1,000+ µm), and captured occasionally by our microplankton nets.

Ceratium inflatum
1000+ µm
Check the size estimate of this species against your microscope field of view. Don't confuse it with a much smaller but similar species *C. fissus*, a nanoplankton.

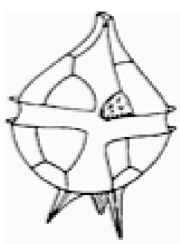


Peridinium sp.
dino: 50 - 100 mm

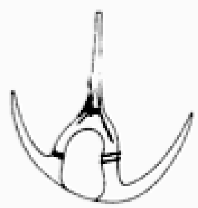
Prorocentrum micans
40 - 50 mm



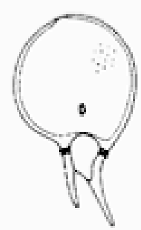
Phalacroma rotundatum
40 µm (top to bottom)
A small toxic dinoflagellate.



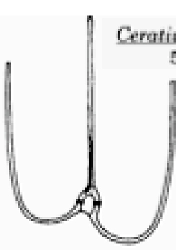
Protoperidinium pellucidum
100 µm



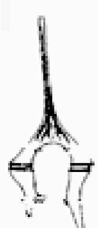
Ceratium tripos
100 µm



Ceratium gravidum
100 µm

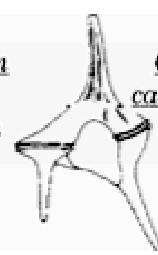


Ceratium trichoceros
500 µm



Ceratium lineatum
100 µm

Ceratium furca
100 µm

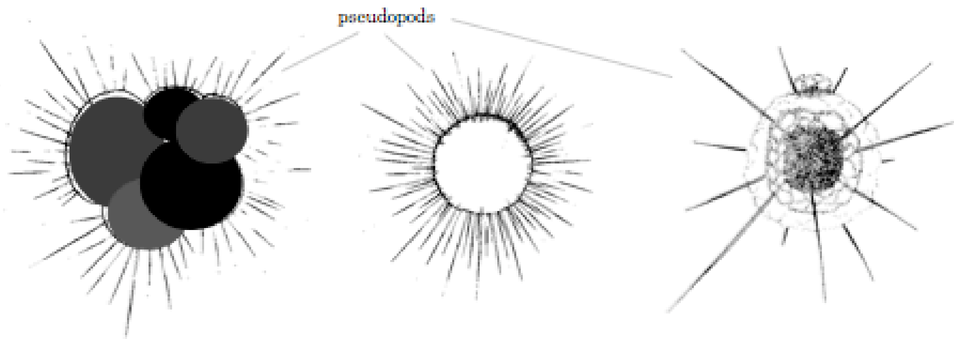


Ceratium candelabrum
100 µm

ZOOPLANKTON

Phylum PROTOZOA

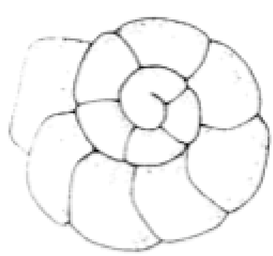
These 1-celled heterotrophic Protists occur frequently in our coastal plankton hauls. Two groups of ameboid protozoans, the Radiolarians, and the Foraminiferans, and one ciliate group, the Tintinnidae, are particularly common. Radiolarians feed themselves by sending body extensions called pseudopods out of tiny holes in their shells. Others use cilia to create feeding currents. When they die, their shells "rain" down and cover vast areas of the seabed many meters thick.



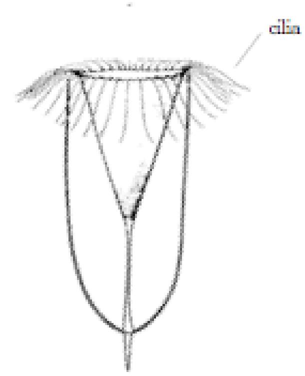
Globigerina bulloides
100 mm

Orbulina universa
50 mm and up

Acanthometron sp.
100 mm



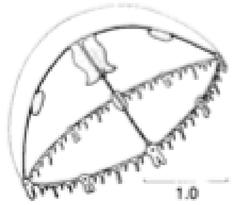
Foraminifera.
125 mm
a small spiral shell with tiny chambers.
(If specimen is larger and has no chambers, see Mollusca: gastropod veliger larvae)



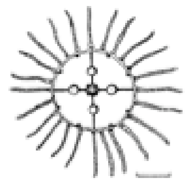
Family Tintinnidae
200 mm

Phylum CNIDARIA

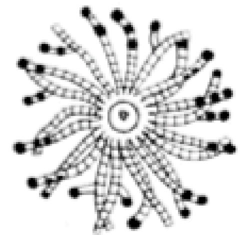
The southern California planktonic Cnidarians (old name: Coelenterates) range in size from large jellyfish such as *Pelagia sp.* (2 meters long), to the microscopic medusa and larvae we capture in our microplankton nets. Medusae represent one stage in the complex life cycle of a hydroid or schyphozoan. All exhibit characteristic radial symmetry, have no organs and have a ring of stinging tentacles surrounding a central mouth. Under the microscope, most cnidarians are colorless.



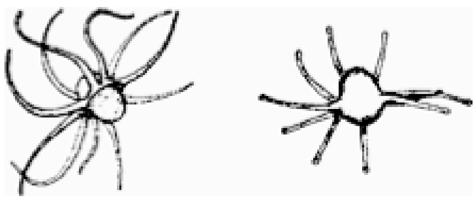
Phialella sp.
3.0 mm



Obelia spp.
1.0 mm
Planktonic medusa stage.



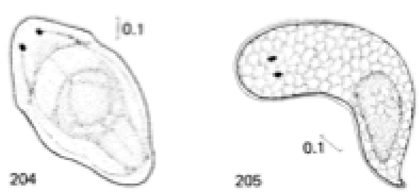
Staurocladia bilateralis



Actinula larvae
500mm
of an Anthomedusa
Hydrozoan. An
asexual budding stage.

Phylum PLATYHELMINTHES

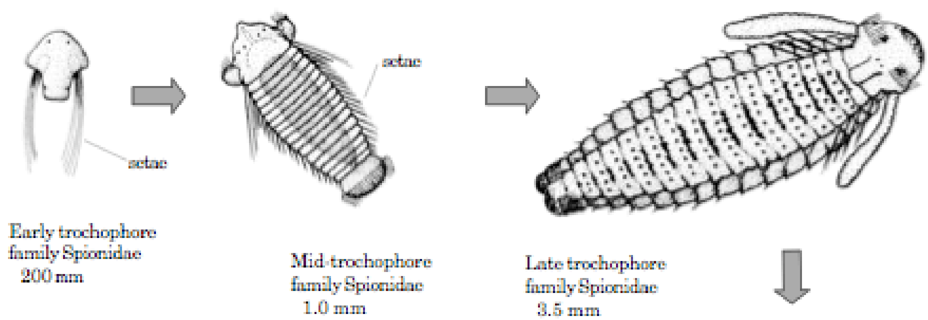
Most of the flatworms in southern California are benthic. The are called "flatworms" because they are compressed dorso-ventrally, like a piece of ribbon. This was the first phylum to exhibit bilateral symmetry and the first phylum to have tissues working together as rudimentary organs. It is only occassionally that we capture one in a plankton net, but it does happen. These animals are very hearty, even after netting, refrigerating, stirring, and dropping onto a slide, they will still be very active under the microscope. The planktonic specimens are usually a dark brown or brownish green in color, and their eyespots will be quite evident on their anterior end.



Planktonic platyhelminths.
up to 1.0 mm length

Phylum ANNELIDA
Class Polychaeta

The segmented Annelid worms we capture in our coastal plankton hauls are mostly the larval stages of benthic species, many of which are sedentary tube-dwellers as adults. Polychaetes are characterized by their setae, or bristles, which run along both sides of the body attached to each segment. Very early polychaete trochophore larvae are essentially just a swimming "head." As the worm elongates its body and grows in the plankton, it adds additional segments behind the head in a posterior direction. Trochophores can be seen at various stages of development, early, middle and late. One purely pelagic family, the Phyllodociidae, are occasionally captured especially by Marine Biology students conducting offshore research. Polychaete specimens are typically hearty and remain active even after refrigeration of the sample over night.

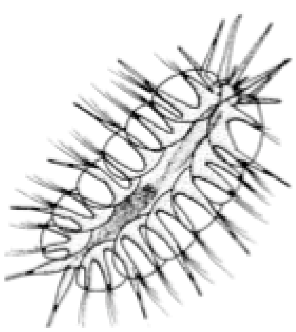


Early trochophore
family Spionidae
200 mm

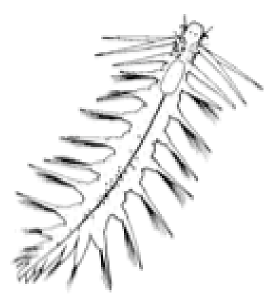
Mid-trochophore
family Spionidae
1.0 mm

Late trochophore
family Spionidae
3.5 mm

Adult
Tube-Dwelling
Benthic
Worm



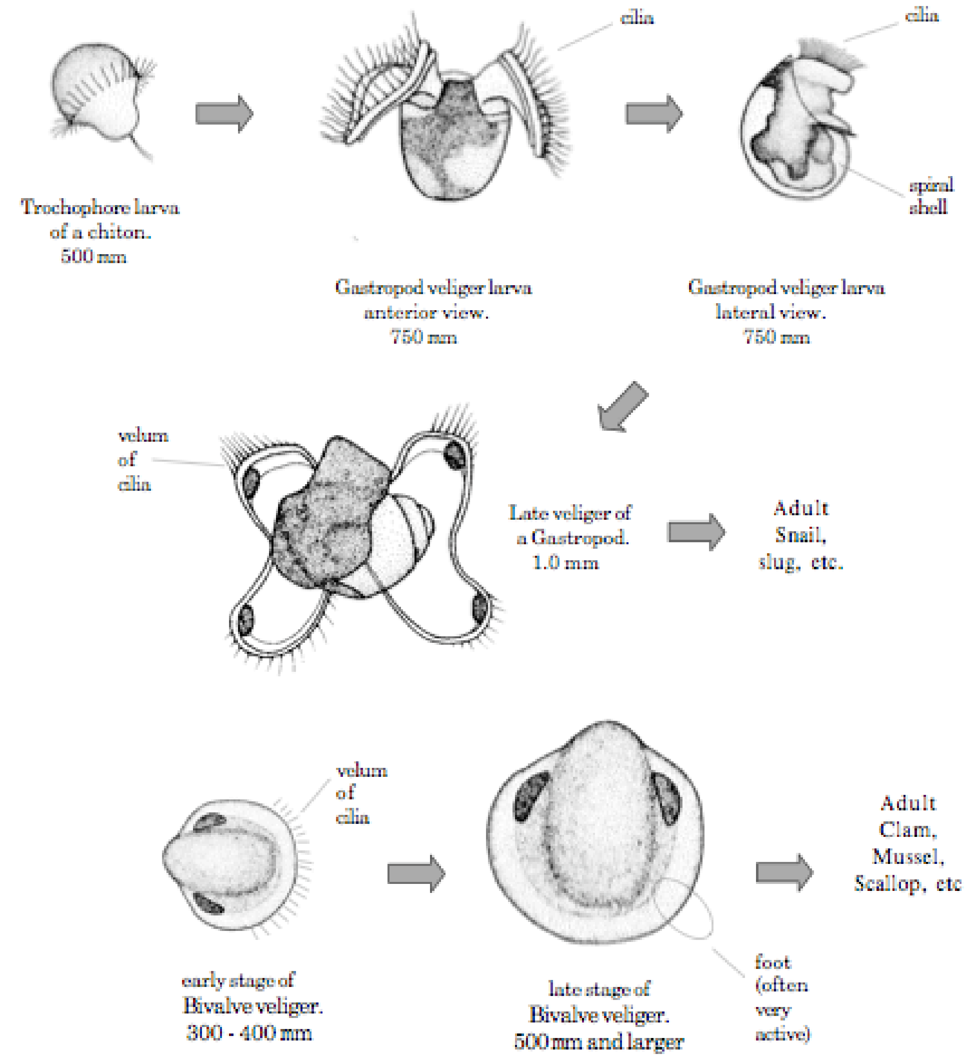
Family Polynoidae
2.5 mm



Family Phyllodociidae
2.5 mm
(a pelagic family)

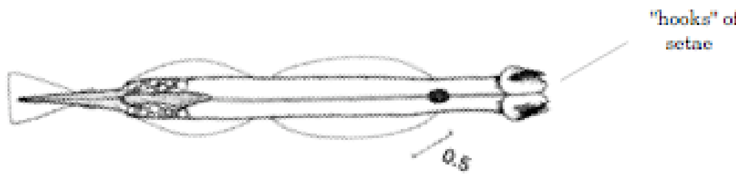
Phylum MOLLUSCA

Mollusks are another very common group captured in coastal plankton hauls. Mollusks undergo at least two stages in the plankton before their final metamorphosis to a benthic life. The first stage of mollusk development is known as the trochophore larva and very similar to the Polychaetes stage of the same name. The second stage is the veliger larva from the latin word *velum*, which means "veil" or "wing." The velum is a large beautiful winged structure bordered by actively beating cilia. Veligers live in the plankton and grow until their shells become too big and heavy to float. They sink as they undergo a final metamorphosis to a benthic adulthood.



Phylum Chaetognatha

Arrow worms are found both in deep hauls and surface coastal hauls. They are very transparent and long. When you find a cylindrical clear object using a compound microscope and a sample from a normal microplankton haul, try moving the slide and looking for the characteristic "hooks" of setae around the head. A low power dissecting microscope is best for these MACROplanktonic, holoplanktonic carnivores. One genus, ***Sagitta***, is abundant in our area

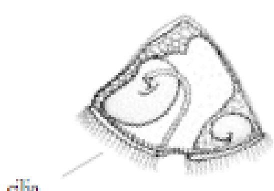


Sagitta spp.
10 mm

YOU CAN SEE THIS SPECIES WITHOUT A MICROSCOPE

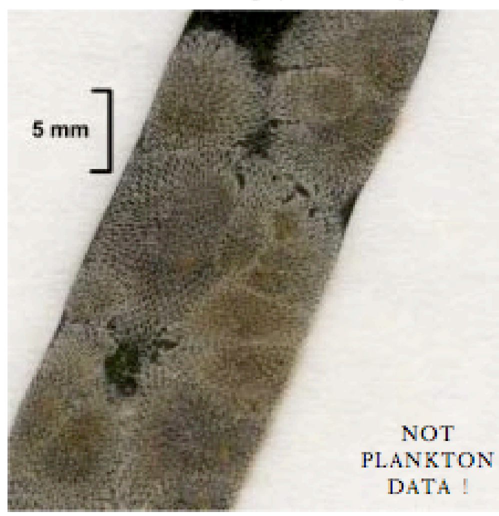
Phylum BRYOZOA

Bryozoans are ubiquitous benthic colonial animals that attach and spread over rocks, kelp, shells and man-made marine structures. They reproduce, develop and distribute themselves geographically using a triangular- shaped cyphonautes larvae. Cyphonautes shells are transparent, double and the open edge is fringed with active cilia. The internal organs are easy to see inside. Nothing looks quite like a cyphonautes larva, and once you see one under the microscope you won't forget it.



planktonic Bryozoan
Cyphonautes larva.
500 - 800 mm

larva grows up and becomes a bottom dweller



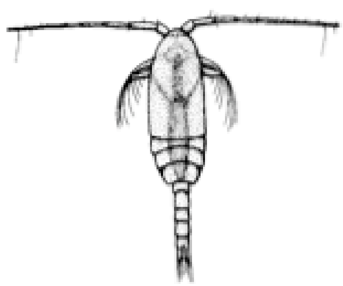
Adult benthic Bryozoan Colony
on a blade of *Zostera* from Zuma Beach.
indiv. zooids = 800 - 1000 mm
common on kelp fronds, rocks, shells, etc.

Phylum Arthropoda

Class Crustacea

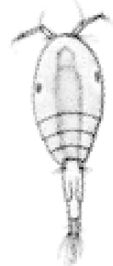
Crustaceans are the most abundant form of animal life in the plankton. There are several important groups that we see frequently, and others that show up only periodically. Every plankton sample contains debris in the form of moulted crustacean exoskeletons (known as exuvia). The most abundant planktonic crustaceans belong to the Order Copepoda, and a typical copepod may undergo ecdysis twelve times in its life. This means there may be as many as twelve times as much copepod debris in our samples as live specimens! Benthic crustaceans also moult and their exoskeletons may also float in the water column. It is common for coastal hauls to pick up barnacle moults and others. Students must begin by learning the difference between a live planktonic crustacean and one of their moults. Live specimens have clear shells and their organs, heart, eyes, blood and other parts can usually be seen inside. Moults are usually broken fragments or pieces of incomplete appendages and are clear, with no color or internal parts visible.

The 3 sub-orders of Copepods:



suborder Calanoidea

Calanoid copepods have a major movable articulation between the 5th and 6th thoracic segment, or posterior to their 5th thoracic legs. They tend to be more oval shaped and often have long or branched antennae.



suborder Cyclopoidea

Cyclopoid copepods have a major movable articulation between the 4th and 5th thoracic segment, or between their 4th and 5th thoracic legs. They tend to be more round shaped and often have shorter or less branched antennae than calanoids.

suborder Harpacticoidea

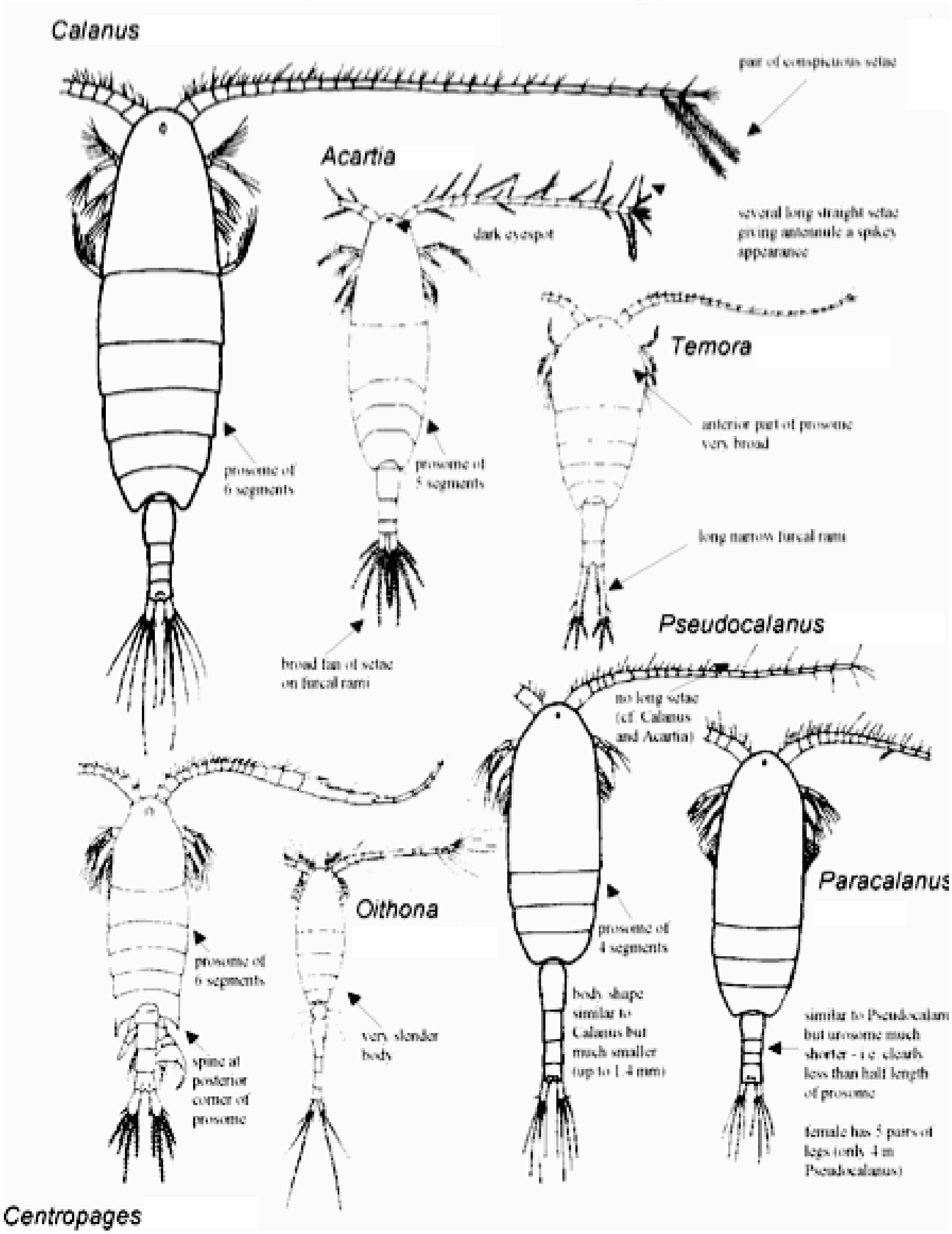
Harpacticoid copepods have a metasome that is about the same width as their urosome. The often have very long setae extending from their caudal rami.

Beginning copepod students may stop here.
Choose one the 3 groups above for your data.
2nd and 3rd year students should proceed to the genus and/or species level of identification. (next pages).

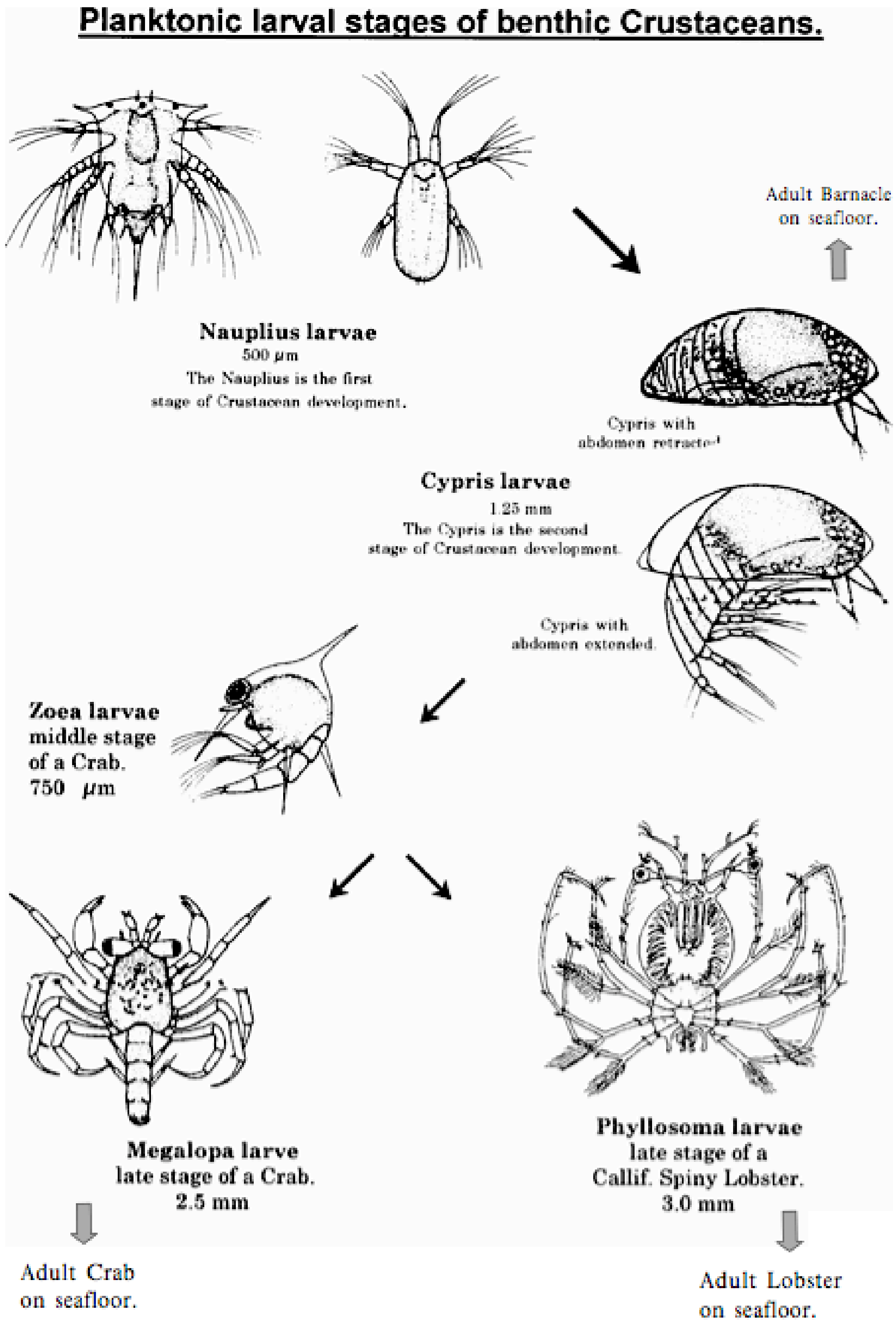
Common genera of copepods from southern California.

(This page for 2nd and 3rd year students.)

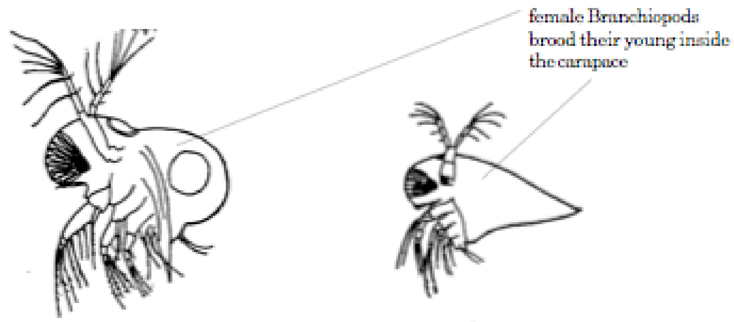
Diagrams modified from the Field Ecology course, Heriot-Watt University. Edinburgh, Scotland.
http://www.bio.hw.ac.uk/marine/modules/crercops.pdf



2nd year copepod students may stop here, at the genus level.
Advanced students: use the technical references for species i.d.


Planktonic larval stages of benthic Crustaceans.
Adult Barnacle on seafloor.
Nauplius larvae
500 μm
The Nauplius is the first stage of Crustacean development.
Cypris with abdomen retracted
Cypris larvae
1.25 mm
The Cypris is the second stage of Crustacean development.
Cypris with abdomen extended.
Zoea larvae middle stage of a Crab. 750 μm
Megalopa larve
late stage of a Crab.
2.5 mm
Phyllosoma larvae
late stage of a
Callif. Spiny Lobster.
3.0 mm
Adult Crab on seafloor.
Adult Lobster on seafloor.

Class Crustacea (concluded here)
Branchiopod Cladocerans:



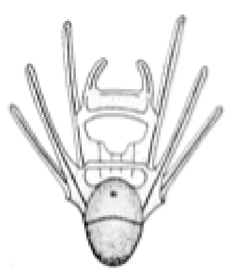
Podon sp.
750 mm

Evadne sp.
750 mm

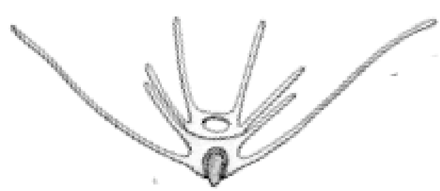
Phylum ECHINODERMATA

Echinoderms are entirely benthic animals. They are among the dominant phyla in the Abyss. In order to reproduce themselves and distribute the species, all five groups of Echinoderms use planktonic larvae. These larvae are very unique and readily identifyable.

Pluteus larvae
(of urchins, sand dollars and brittle stars):



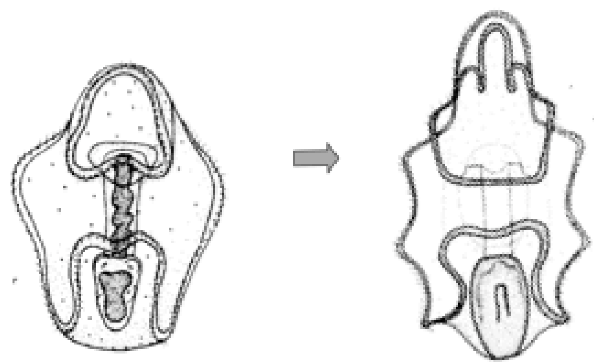
Echinopluteus larva
of an Echinoid.
1.0 mm



Ophiopluteus larva
of an Ophiuroid.
1.25 mm

ECHINODERM LARVAE, cont'd

Asteroid (sea star) larvae:

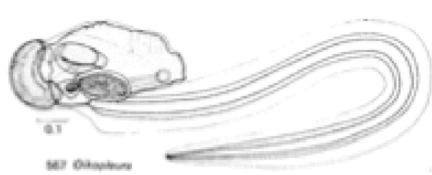


Bipinnaria larva.
(The first stage of
Asteroid development)
1.5 mm

Brachiolaria larva.
(The second stage of
Asteroid development)
1.5 mm

Phylum CHORDATA

The most conspicuous and abundant members of the Phylum Chordata are the modern, boney fishes (subphylum Vertebrata, Class Osteichthyes). Most families of fish cast their eggs into the plankton where they grow to larvae or fry if they survive. It is common for us to capture fish eggs and fish larvae in our coastal plankton hauls. In addition certain members of the subphylum Urochordata are entirely planktonic and only recently have been appreciated for their enormous role in both epipelagic and mesopelagic ecosystems. These Urochordates, the Larvaceans or "salps," secrete a mucous "house" and live inside where they actively pump water and feed on smaller planktonic ife. When disturbed (as by our plankton nets) the swim freely away from the mucous home.

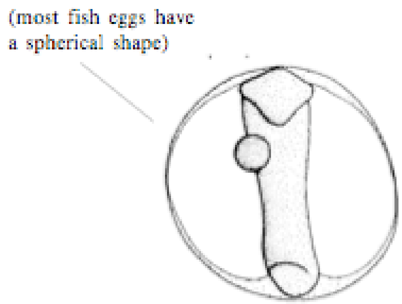


Oikopleura sp.
A Larvacean Urochordate.
2.5 mm

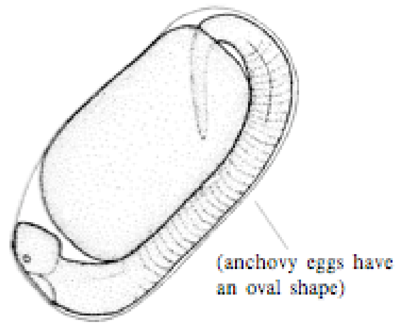
YOU CAN SEE THIS
SPECIES WITHOUT
A MICROSCOPE

CHORDATA, cont'd

Fish eggs and larvae:

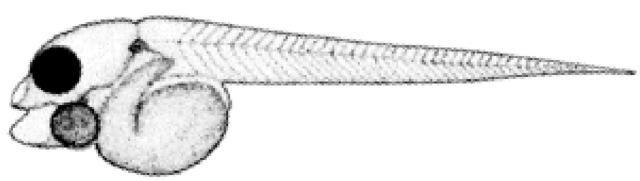


Typical fish "egg."
(species of embryo unknown)
2.0 mm



Embryo of N. Anchovy
Engraulis mordax
2.0 mm

YOU CAN JUST BARELY SEE
THESE STAGES WITHOUT
A MICROSCOPE



Fish larva.
(species unknown)
4.0 mm