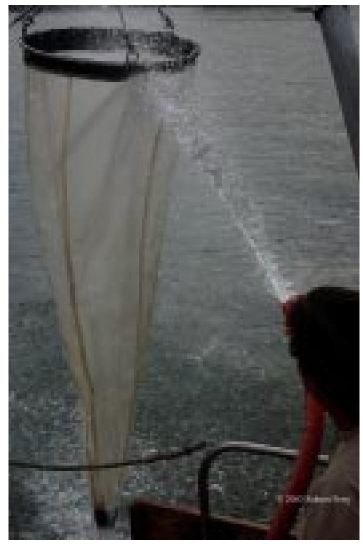
UCLA
Marine Science Center
OceanGLOBE

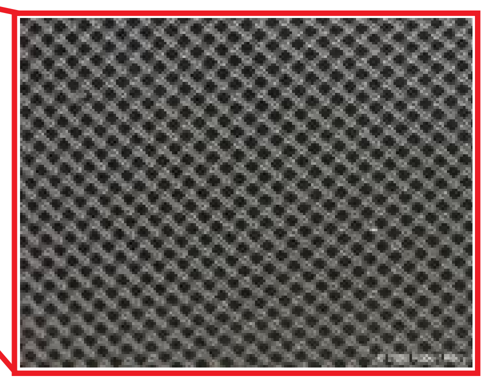
A Guide to the MARINE PLANKTON of **southern California** 3rd Edition

Robert Perry - UCLA OceanGLOBE & Malibu High School

PLANKTON NET COMING UP



RINSE DOWN



MESH OF NET
(magnified)

name____

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species within each taxon are arranged alphabetically

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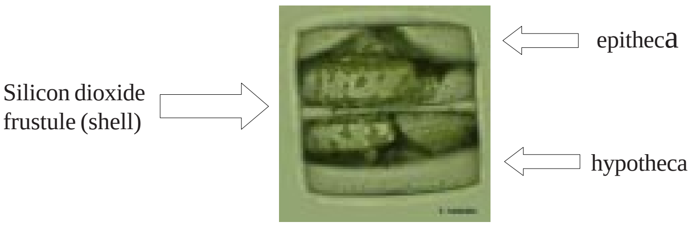
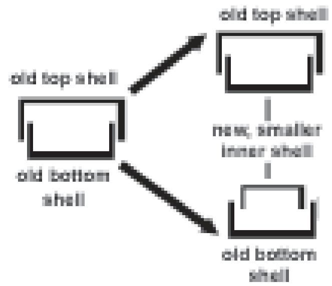
PHYTOPLANKTON

Part 1 - 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. One shell is older (the epitheca) is slightly larger than the other, younger shell (the hypotheca). The smaller fits inside the larger like a “pill box” or Altoid® mint container. When they split apart to reproduce, each section grows a new, smaller and younger match that fits inside to original. Thus half of the new cells are smaller in size.



Coscinodiscus sp. a solitary diatom



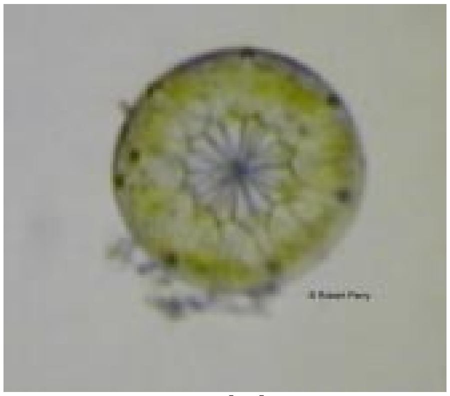
Under the microscope most diatoms will appear green or golden green, and their frustules are as clear as the glass which makes them. When diatoms are exceptionally abundant in the surface water, the ocean will appear very green. Some species like *Coscinodiscus* (above) are solitary, while others like *Chaetoceros* (right) form long chains.

Diatoms are one of the most important groups of producer organisms in the marine ecosystem. They inhabit the illuminated upper 200 meters of most oceans and help form the base of the food chain using photosynthesis to convert solar energy into chemical bond energy. Many diatoms convert the carbohydrates that are produced during photosynthesis into oils. These oils are less dense than the surrounding seawater and, thus, help buoy the diatoms upward into the illuminated photic zone of the ocean. Some diatom chain-forming species prevent sinking through the growth of spiny extensions (the setae or chaetae). During population explosions or “blooms” of these spiny diatoms they may damage the sensitive gills of fish and other animals.


Chaetoceros sp.
form long chains.

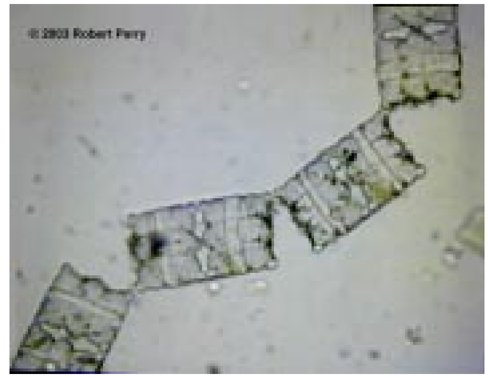
A small handful of diatom species are also toxic to marine animals and humans. Species such as *Pseudo- nitzschia* produce a poisonous chemical known as Domoic Acid (DA). DA is known to cause Amnesic Shellfish Poisoning (ASP) a neurological disorder that affects pelicans, sea lions, and other marine animals including humans. DA builds up inside the tissues of filter-feeding invertebrates such as mussels and clams, which, if eaten during periods of high concentrations of DA, can cause death in humans..


Pseudo-nitzschia australis
produces toxic domoic acid

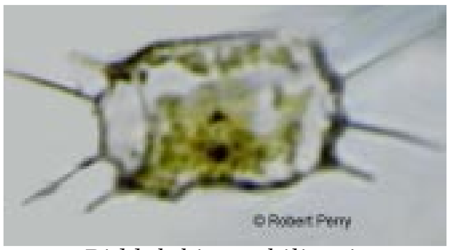


Asteromphalus sp.

Bacteriastum hyalinum

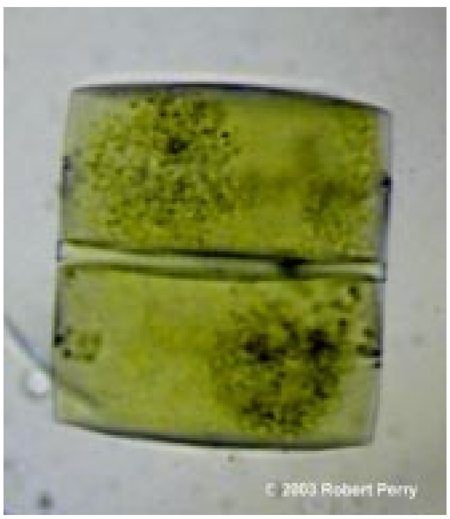


Biddulphia aurita

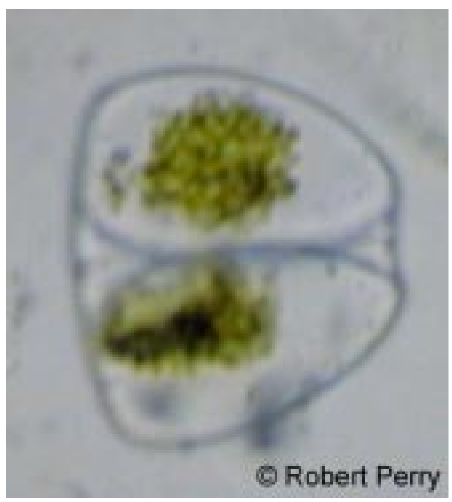


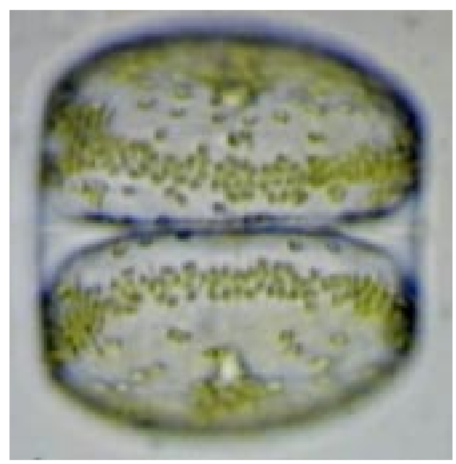
Biddulphia mobiliensis

Coscinodiscus sp. TOP VIEW

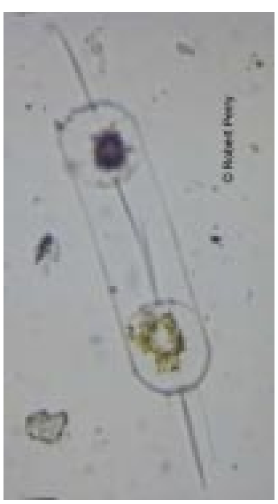


Coscinodiscus sp. SIDE VIEW

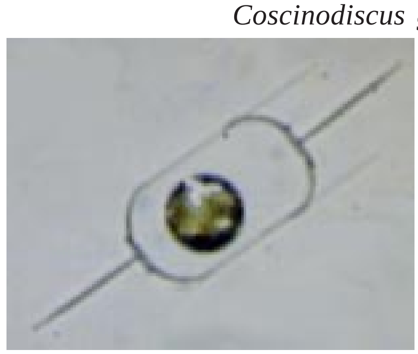




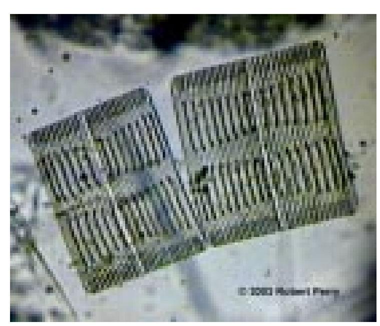
Coscinodiscus granii SIDE VIEW



Ditylum brightwellii

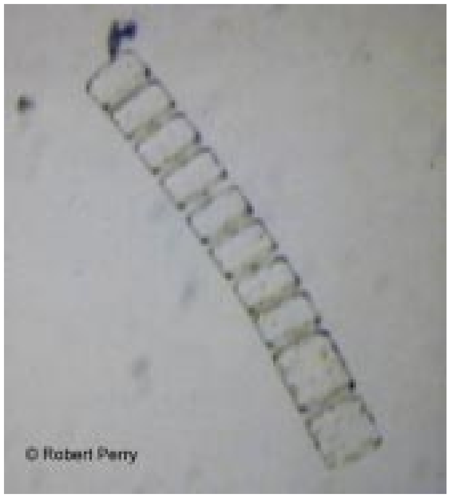


Ditylum sp.

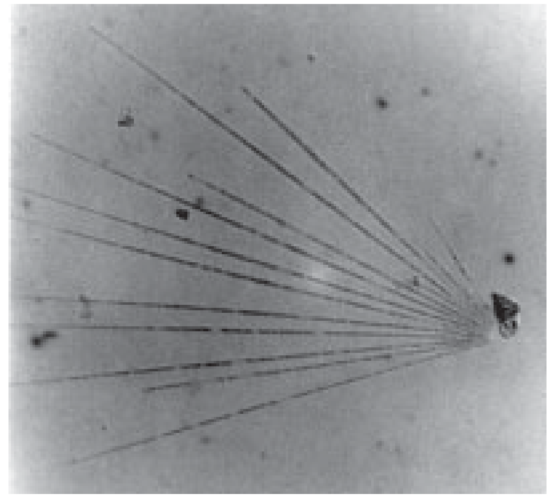


Fragillaria striatula

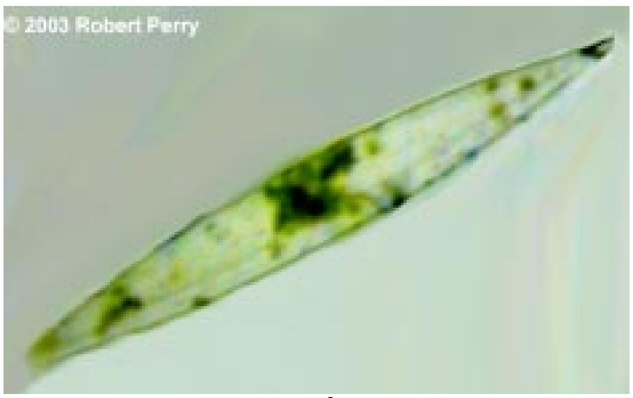
Fragillariopsis sp.



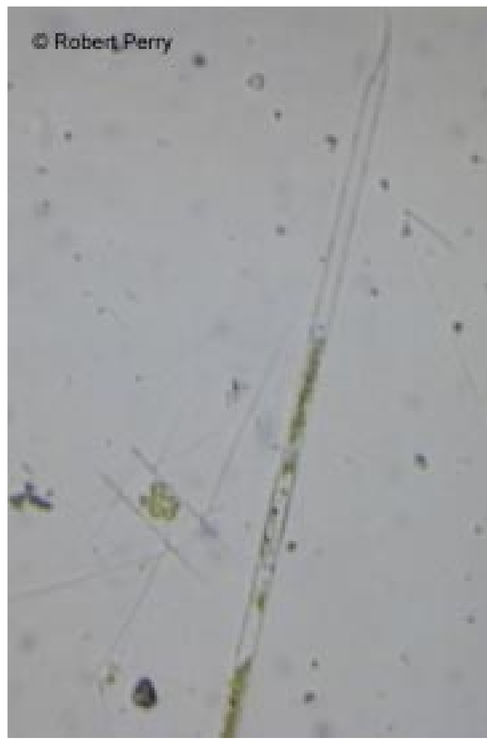
Lauderia annulata

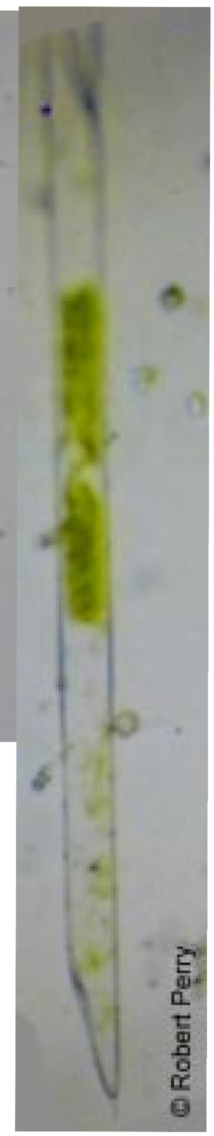


Lioloma pacificum



Navicula sp.

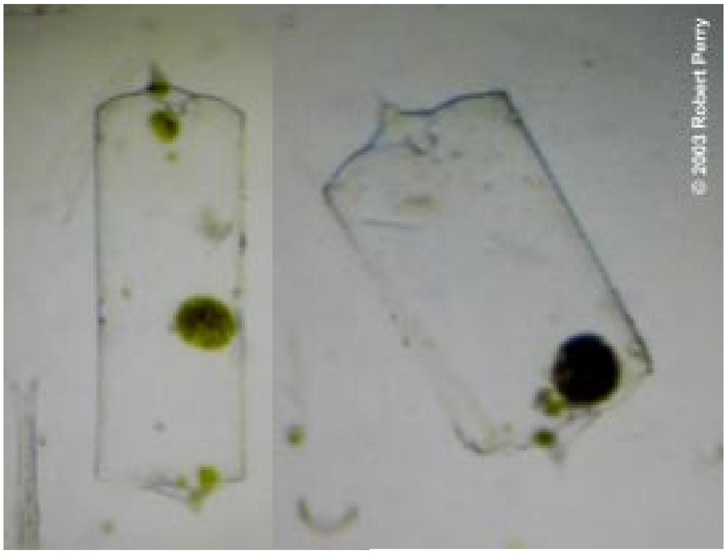




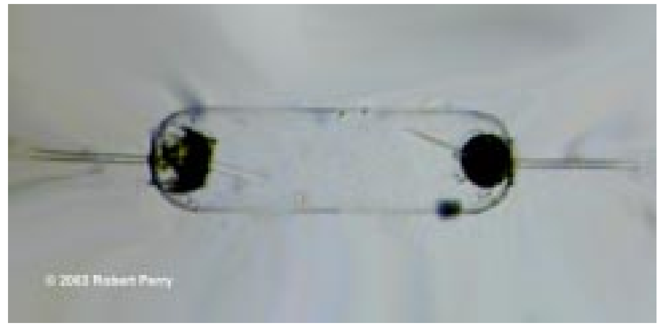
Proboscia alata

Pseudo-Nitzschia australis

Phytoplankton - Diatoms



Rhizosolenia sp.



Stephanopyxis sp.

Thalassionema sp.

Thalassiosira sp.

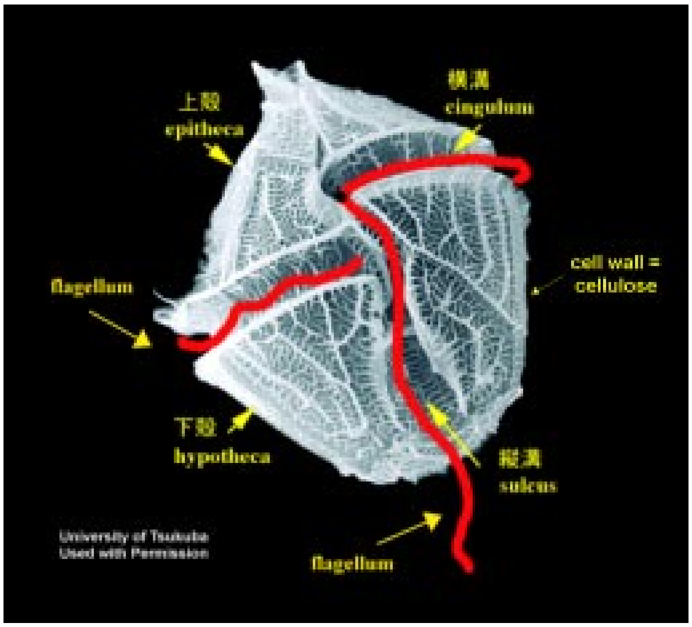
Thalassiosira punctigera

Use the space below to draw and identify any new species of diatoms you may see this year:

PHYTOPLANKTON

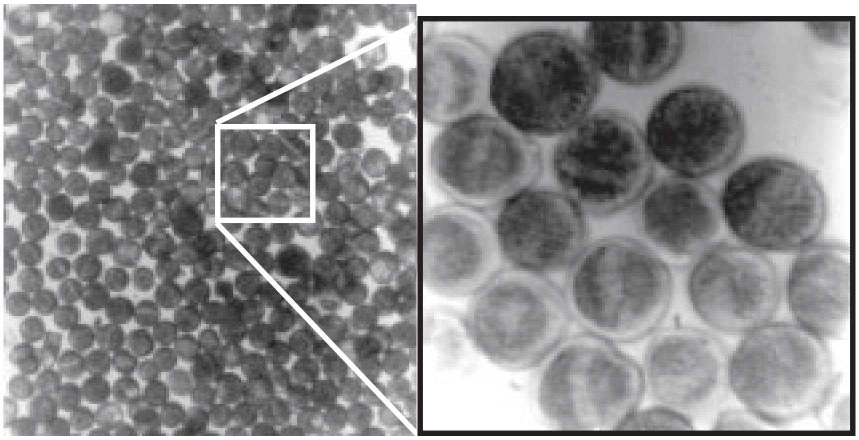
Part 2 - Dinoflagellates

Members of the Protist Phylum Dinoflagellata (aka Dinophyta or Pyrrophyta) are very common in coastal plankton samples. The name comes from the greek word "***Dinos***" which means "to spin," and "**flagellate**" which means to have flagella. Flagella are whip-like "tails" that act like propellers and cause these single celled organisms to rotate through the water. When observed immediately after capture, under a microscope, dinoflagellates move in a wonderful spiral pattern. Large species are caught with a microplankton net, and smaller species require a nanoplankton net.

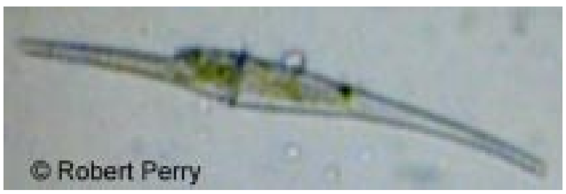


Dinoflagellates appear reddish-brown, or greenish-brown under the microscope. Many dinoflagellates have red or brown accessory pigments along with chlorophyll to carry out photosynthesis. Hence, when very abundant in the water, the phenomenon is called a "red tide." Red tides are localized patches of discolored water from dinoflagellate population explosions. They can become so abundant that they block out all sunlight except for the upper few centimeters of the ocean surface. Consequently the dinoflagellates in the shade become heterotrophic to survive. As heterotrophs, they may rapidly deplete the oxygen content of the surrounding ocean water causing sessile organisms to die. If the red tide includes very spiny species, they can also clog animals' gills or cause abrasions in gill tissue that then becomes susceptible to secondary bacterial infection. These factors combine to give red tides, and the dinoflagellates that cause them, a bad reputation for killing fish and other animals in certain places in the world. Dinoflagellates possess external armored plates of cellulose. These cellulose plates protect the tiny single celled organisms from predators. Often these plates are extended to form long, sharp spines that further protect the cells. Another interesting fact is that most members of this group can produce their own biochemical light. Most of the bioluminescence we view from boats or from breaking waves along the shore at night is caused by dinoflagellates.

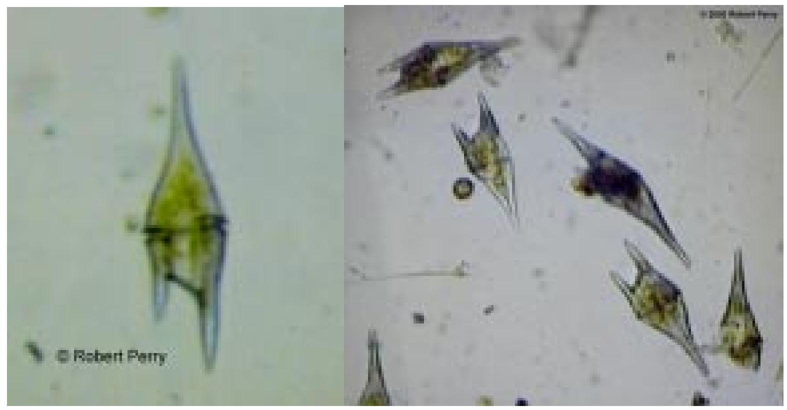
Dinoflagellates are the second most abundant form of autotrophic life in the marine ecosystem. As such. they are at the base of the food chain and provide food for herbivorous zooplankton and sessile benthic suspension feeders. Many dinoflagellate species are also toxic, and some are poisonous to humans. Although it is unlikely that organisms high up on the food chain like humans swallow enough tiny planktonic dinoflagellates directly to pose a threat, their toxins are "biomagnified" through the food chain. Simply put, this means that it takes approximately 10 pounds of dinoflagellates to make one pound of zooplankton or benthic suspension feeder. Every unit of poison found naturally in a dinoflagellate will magnify ten-fold in the next trophic level, a hundred times in the next level and so forth. Species such as *Alexandrium* and *Gymnodinium* are known to cause PSP (Paralytic Shellfish Poisoning) in humans. PSP results when humans eat shellfish such as mussels, clams or oysters that are suspension feeders who have, in turn, been consuming these dinoflagellates. Symptoms of PSP include nausea, dizziness, a tingling numbness, respiratory failure and even death. It is not wise to consume these shellfish during periods of the year when toxic dinoflagellates are blooming.



Alexandrium sp. from a “Red Tide” Nanoplankton sample.
Diameter 42-54 µm



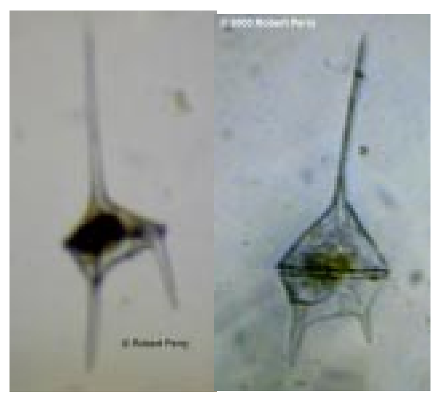
Ceratium fusus
Length 200-540 µm



Ceratium furca

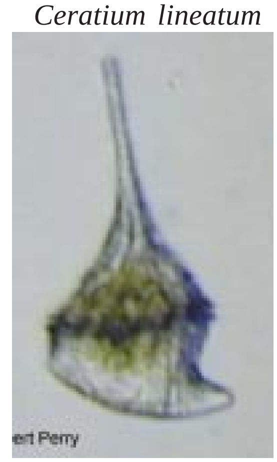
Ceratium gibberum

Ceratium horridum



Ceratium lineatum

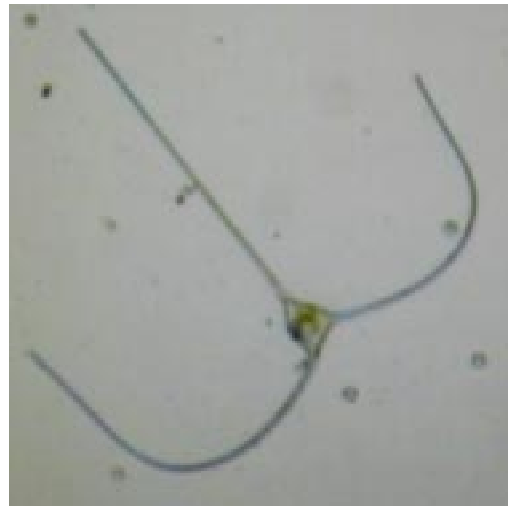
Ceratium inflatum
Length 1000 µm (1 mm)



Ceratium lineatum gamete

Ceratium lunula

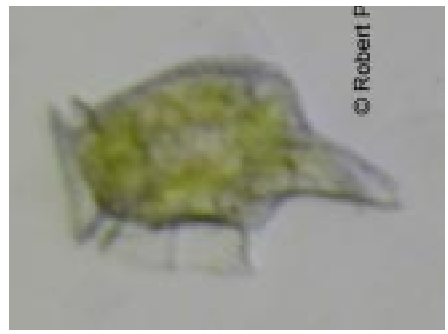
Ceratium platycorne



Ceratium trichoceros

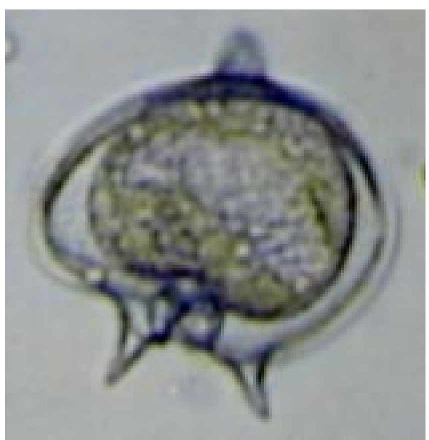
Ceratium macroceros

Ceratium tripos



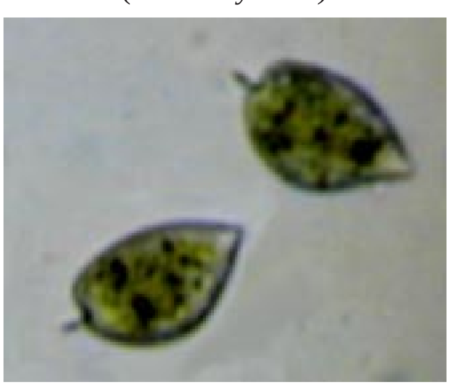
Dinophysis sp.

Lingulodinium polyedra
Diameter 42-54 µm
(aka *Gonyaulax)*

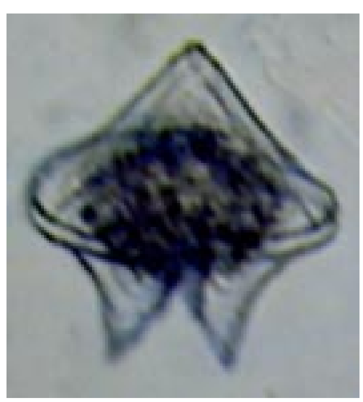


Peridinium sp.
Diam. 50 - 100 mm (often pink)

Pololampas palmipes



Prorocentrum micans 40 - 50 mm



Protoperidinium sp.

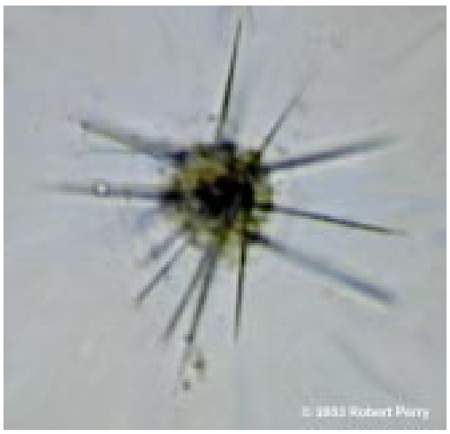
Phytoplankton - Dinoflagellates

ZOOPLANKTON

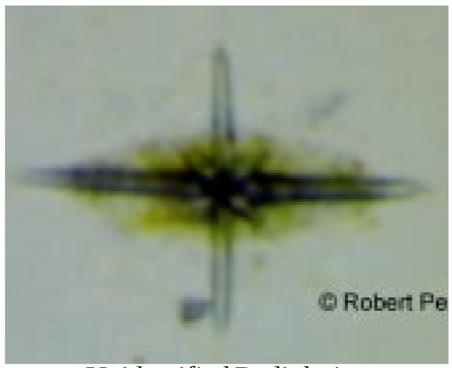
Part 1 - Phylum PROTOZOA

Protozoans are the third, and last, common planktonic group that belongs to the Kingdom Protista. These single celled organisms are different from the other Protists, the Diatoms and Dinoflagellates, because they are heterotrophs and do not contain photosynthetic pigments. Consequently they are mostly without color and appear clear under the microscope. Protozoans occur frequently in our coastal plankton hauls. The phylum Protozoa is often divided into four classes: Ciliates, Flagellates, Amebas and Sporozoa. Many of the Ciliates and Flagellates are extremely small members of the Picoplankton size category. This means we cannot magnify them with sufficient power to identify them, but they are often extremely abundant on our microscope slides zooming and spinning around in the background.

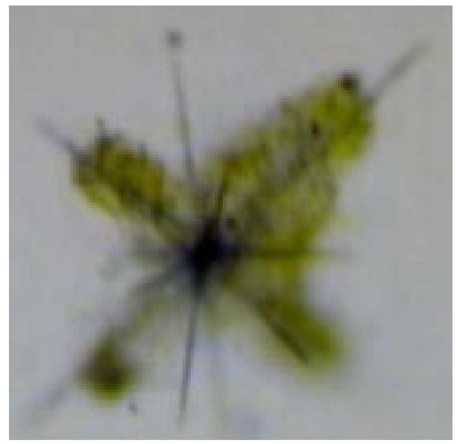
Two groups of ameboid protozoans, the **Radiolarians**, and the **Foraminiferans**, and one ciliate group, the **Tintinnidae**, are particularly common. Radiolarians feed themselves by sending body extensions called pseudopods out of tiny holes in their shells. When they die, their shells "rain" down and cover vast areas of the seabed many meters thick. Tintinnids use cilia to create feeding currents.



Acanthometron sp.



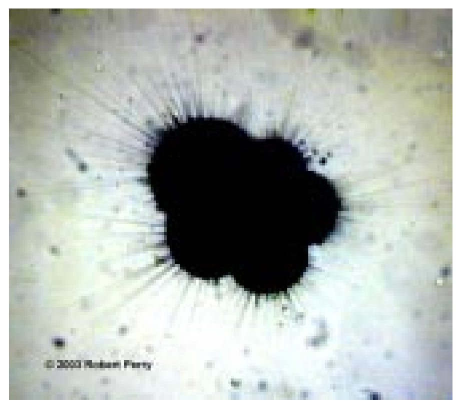
Unidentified Radiolarian



Unidentified Radiolarian

Discorbis sp. (a Foraminiferan)

Unidentified Radiolarians



Globigernia bulloides

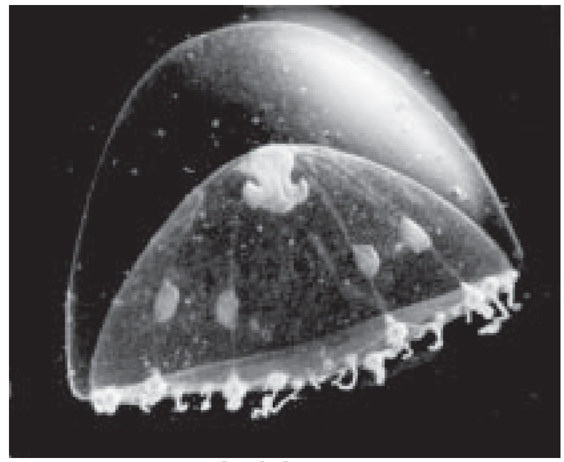
Unidentified
Family Tintinnidae

ZOOPLANKTON

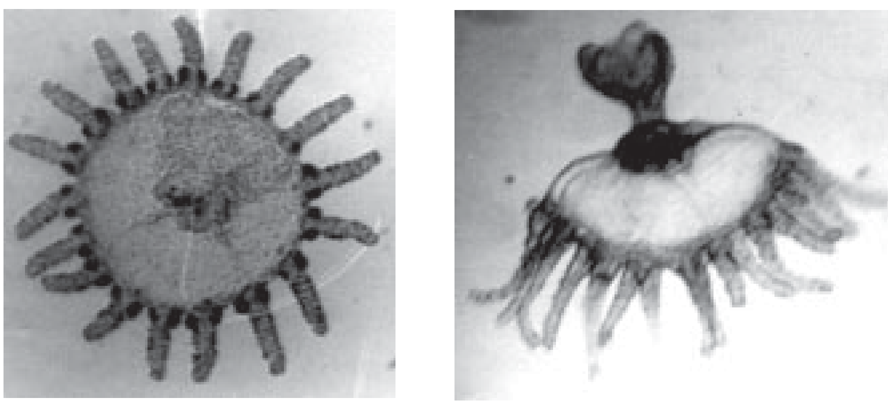
Part 2 - Phylum CNIDARIA

Southern Californias planktonic Cnidarians (also known as Coelenterates) range in size from large jellyfish such as Pelagia sp. (over 2 meters long), to the microscopic medusa and larvae we capture in our mi croplankton nets. Medusae represent one stage in the complex life cycle of a hydroid or jellyfish. All exhibit characteristic radial symmetry, meaning they have a spherical or cylindrical body. They are at the tissue level of organization, not possessing true organs, and have only two kinds of tissues at that. Cnidarians are easy to spot with their ring of stinging tentacles surrounding a central mouth. This stinging capability makes this group mostly carnivorous and is the origin of their phylum name, Cnidaria, Greek for "stinging nettle." Under the microscope, most cnidarians are colorless.

Actinula larva



Phialidium sp



Obelia sp.
a Hydroid medusae
Top View = left
Lateral View = Right
from 1.5 mm - 3 mm

Pelagia sp.
The Purple jelly:
a large planktonic Cnidarian. Most commonly seen washed ashore as beach debris.

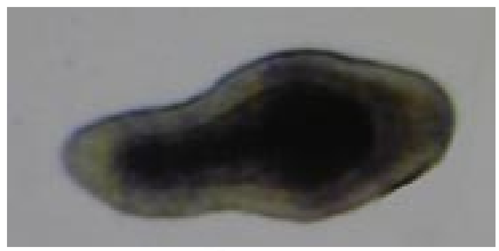
NOT FOUND IN PLANKTON NETS.
(thankfully)

ZOOPLANKTON

Part 3 - Phylum PLATYHELMINTHES

Platyhelminthes in southern California are primarily a benthic phylum. They are called "flatworms" because they are compressed dorso-ventrally, like a piece of ribbon. Some people jokingly call this “life in 2 Dimensions.” Platyhelminthes are thought to be the first phylum to have evolved a true head on one end of the body, and a tail on the opposite end. The evolution of a head means the flatworms were the first creatures on Earth to move head first through their environment. A head and tail also means that their right and left sides are mirror images, which is to say they were the first organisms on Earth to exhibit bilateral symmetry. Flatworms were also the first phylum to have tissues working together as rudimentary organs, but no organ systems exist in this group.

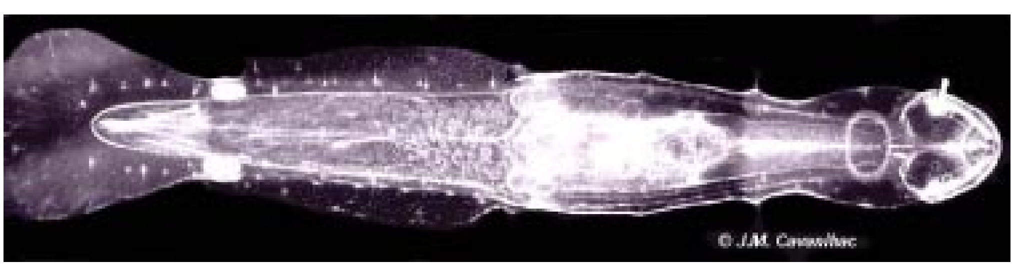
It is only occassionally that we capture a flatworm in a plankton net, but it does happen. These animals are very hearty, even after netting, refrigerating, stirring, and dropping onto a slide, they will still be very active under the microscope. The planktonic specimens are usually a dark brown or brownish green in color, and sometimes their eyespots will be quite evident on their anterior (head) end.



Unidentified Flatworms

Part 4- 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, <u>*Sagitta*</u>, is abundant in our area

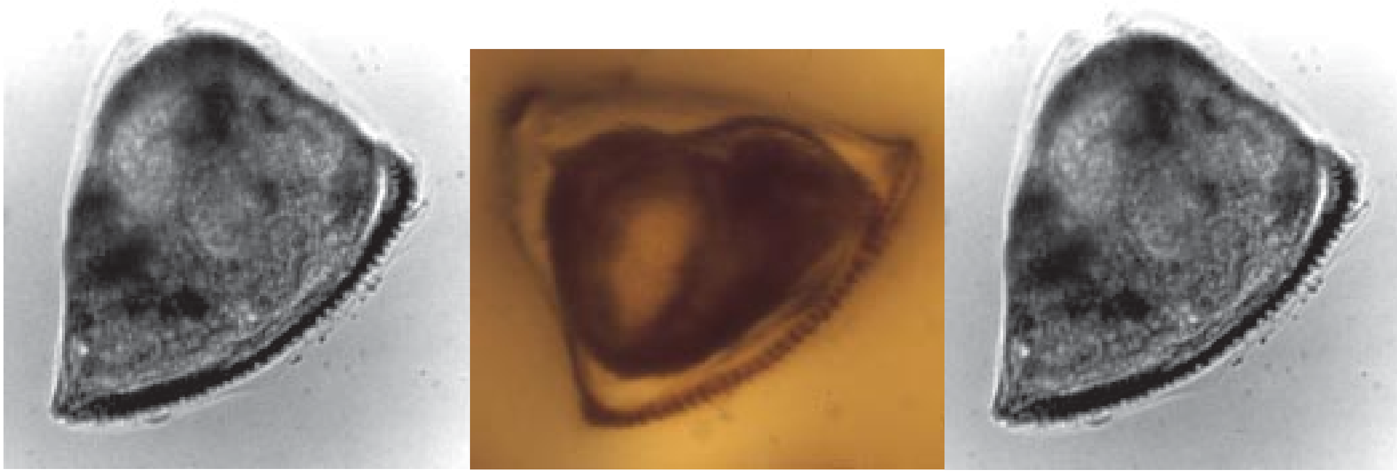


Sagitta sp, an arrow worm. Length approx. 1 cm.
Photo courtesy of BIODIDAC

ZOOPLANKTON

Part 5- Phylum BRYOZOA

Bryozoans are ubiquitous benthic colonial animals that attach and spread over rocks, kelp, shells and man-made marine structures. They are tiny wormlike creatures that live inside boxes and are barely visible to the naked eye. Bryozoans 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. Cyphonautes larvae drift in the currents until ready to settle out to the bottom and take up a sessile benthic existance. Once a larva lands it begins to divide asexually and continues to divide until an entire area is covered by identical clones.



Bryozoan **cyphonautes larvae**

Part 6- Phylum PHORONIDA

The phylum Phoronida is another relatively obscure group of sessile, benthic wormlike animals that the average person on the street never heard of. Phoronids are found attached to submerged pier pilings, boat docks, and other underwater substrates that offer exposure to non-turbulent water flow. The actinotrocha larva is extremely rare in our open coast, nearshore plankton hauls

Actinotrocha larva of a Phoronid.

ZOOPLANKTON

Part 7- Phylum ROTIFERA

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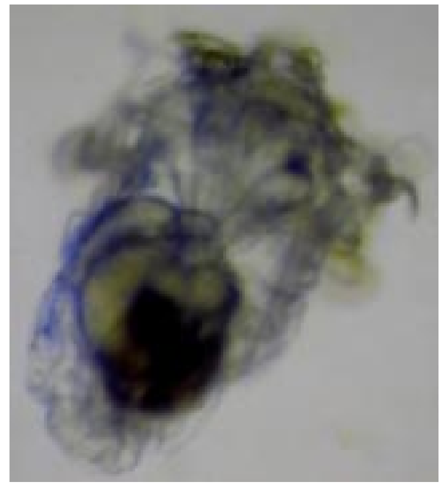
Rotifers are very common planktonic animals in fresh water lakes and streams. Although rare in the ocean, rotifers are unusual animals in many respects. First, rotifers are very small, usually less than 200mm, which, for a complex multicellular animal, brings it to about the size of a typical protozoan. Second, almost all rotifers are females. Males in some families have never been observed. Females lay fertile eggs without the need of a male or fertilization, using a process known as parthenogenesis. One species of planktonic marine rotifer has been recorded along the shore.

Unidentified Rotifers
(left and above)



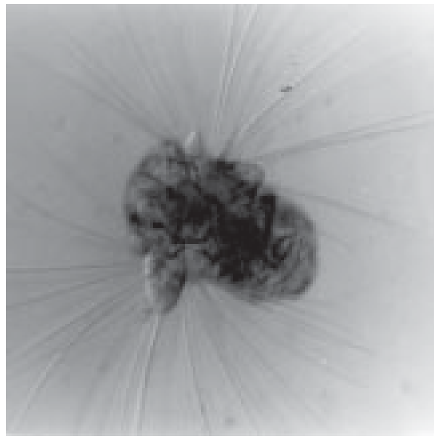
Branchionus plicatitlis

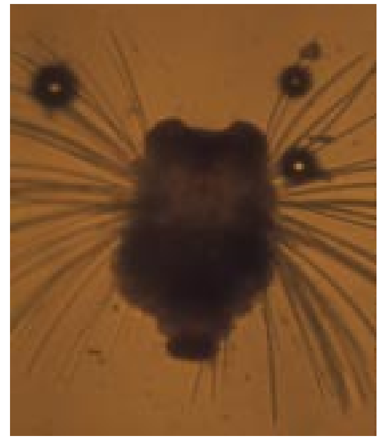
Part 8 - Phylum ANNELIDA, Class POLYCHAETA

Segmented worms are members of the phylum Annelida (latin, *annulus*: segment or ring). These “marine worms” or “bristle worms” are the most abundant worms in our local ocean and therefore the most common type of worm we capture in our coastal plankton hauls. The planktonic Annelids are members of the class Polychaeta (*poly* = many; *chaeta* = hairs or bristles) and are relatives of the other types of Annelids seen on land (earthworms) and in fresh-water (leeches). Anatomically they are distinguished from the other kinds of worms by having a body that is divided into multiple repeating compartments or segments from head to tail. Each segment has small extensions or “legs” (parapodia) on the right and left side, and each parapodium bears numerous stiff bristles (chaeta or setae).

Polychaetes in the plankton are mostly the larval stages of benthic species, many of which are sedentary tube-dwellers as adults. Very early polychaete trochophore larvae are essentially just a swimming "head." As the worm elongates its body and grows, and 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 planton hauls on research vessels. Polychaete specimens are typically hearty and remain active even after refrigeration of the sample over night.

unidentified
planktonic
polychaete





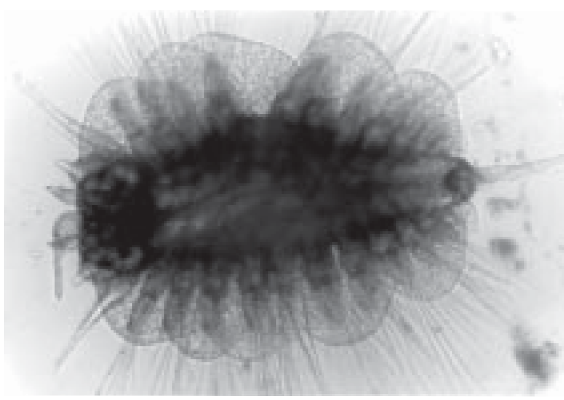
Early trochophore polychaete larvae

Mid trochophore polychaete larvae

Late trochophore polychaete larvae

Late trochophore polychaete larvae

unidentified planktonic polychaete

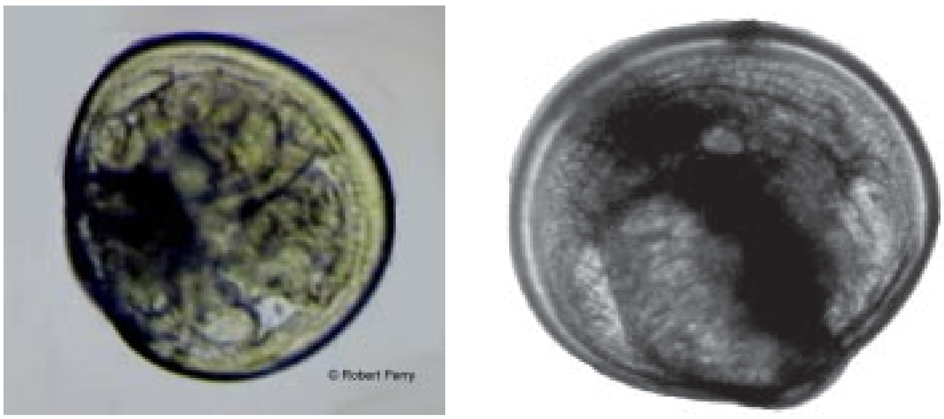


Use the space below to draw and identify any new polychaete species you may see this year:

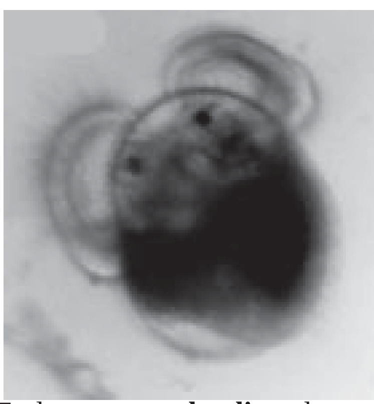
ZOOPLANKTON

Part 9- Phylum MOLLUSCA

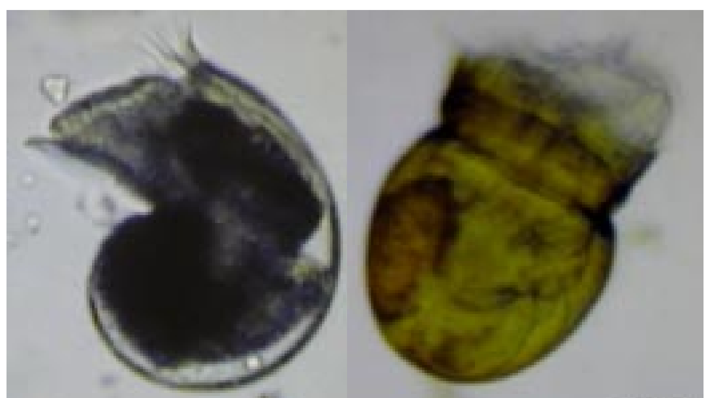
Mollusks are one of the mega-sized phyla in the ocean. The name Mollusca comes from the Greek, *mollis*, which means "soft," and all members of this phylum have soft, muscular bodies that are usually protected by one or more external calcium shells (in adulthood). The shell forms early in life and helps us determine which mollusk class a planktonic larva belongs to. Gastropod larvae have a single, spiral shell and Bivalve larvae have two "clam shaped" shells. 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 is 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.



Bivalve veliger larvae



Early **gastropod veliger** larvae



Mid **gastoropod veliger** larvae
Lateral view=left; Top view = right

Late **gastropod veliger** larvae

ZOOPLANKTON

Part 10- 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 detritus and debris in the form of moulted crustacean exoskeletons (known as **exuvia**). 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.

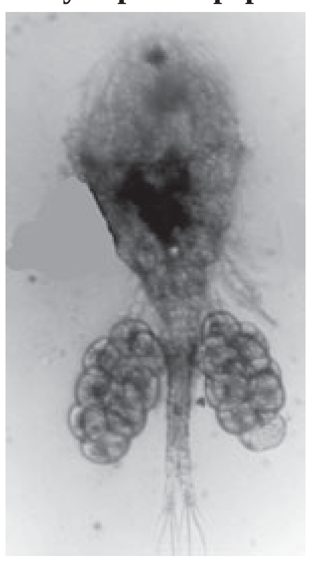
Order COPEPODA

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 twelve times as much copepod debris in our samples as live specimens! We will distinguish between three Sub-Orders of Copepods:
1- 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. **2- 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 **3- 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.

1- Calanoid copepod

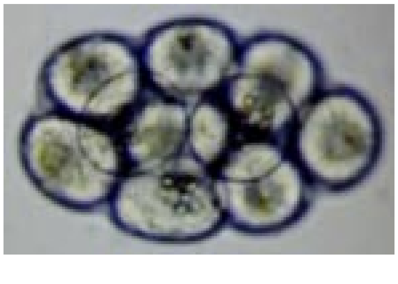
(**Calanoid** means "similar to the copepod genus *Calanus*)

2- Cyclopoid copepod



(**Cyclopoid** means "similar to the copepod genus *Cyclops*)

3- Harpacticoid copepod



Cyclopoid copepod egg sac

CRUSTACEAN LARVAE

Crustaceans begin life as a developing embryo inside an egg which is being carried along with hundreds or thousands of other eggs. Some species, on the other hand, shed their eggs into the current. Many crustaceans show up in our plankton samples in their first stage after hatching from the egg, the **nauplius** stage. There may be several nauplius stages, then a metamorphosis to a second larval stage known as the **cypris** larva. The cypris may develop into a **zoea**, in crabs, for example, or a **phyllosoma**, in the case of the spiny lobster.

On the next page, mysiid shrimp, a big crustacean, are taken in our nets only occassionally. The branchiopod cladocerans *Evadne* and *Podon,* on the other hand, are quite common.

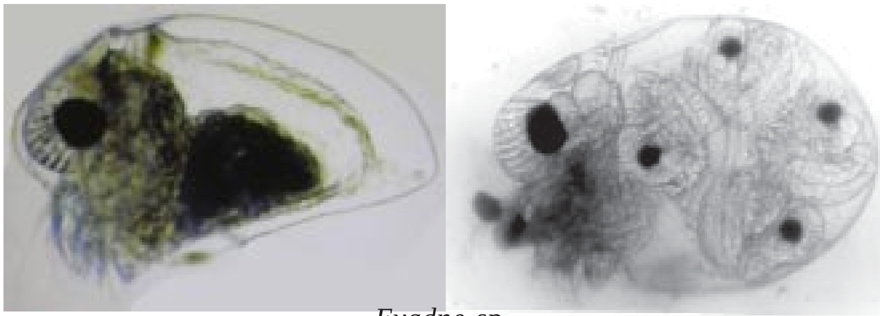
Crustacean **nauplius larvae**

Crustacean **cypris larvae**

Crab zoea larva

Zoea larva of an Anomuran **Crab**

Calif. Spiny Lobster **phyllosoma larva**
(Late June and July Only)



Evadne sp.
Note: specimen on the right is a gravid female

Podon sp.

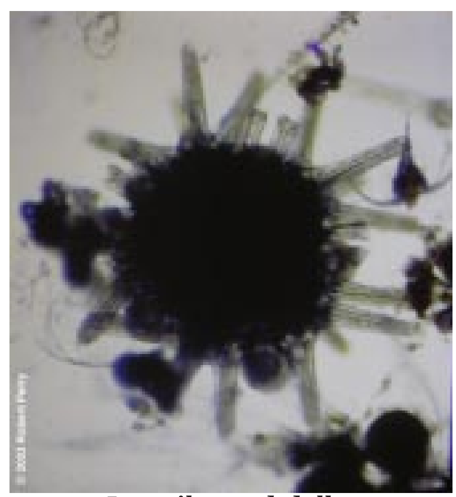
Zoea larva of a shrimp. Length 2 cm

Mysiid shrimp Length 5 - 10 cm

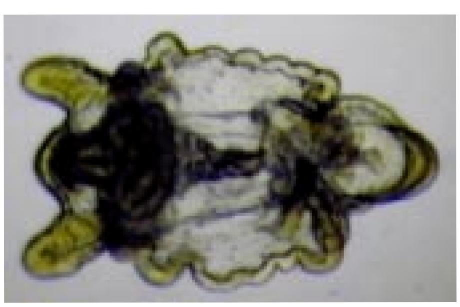
Part 11- Phylum ECHINODERMATA

Echinoderms are entirely benthic animals. They are among the dominant phyla of the abyssal benthos. They are also very abundant on the seafloor in nearshore waters. 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. Because these photographs are taken from samples at Zuma Beach, CA, an exposed sandy beach, we find a lot of sand dollar larvae.

Echinopluteus larvae (of sea urchin and sand dollar)



Juvenile sand dollar
(Dendraster excentricus)



Bipinnaria larva of a sea star

ZOOPLANKTON

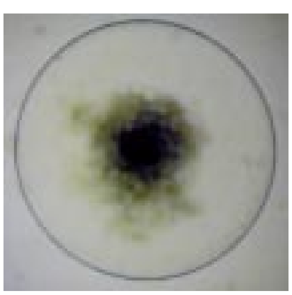
Part 12- Phylum CHORDATA

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 hatch to larvae if they survive. It is common for us to capture fish eggs (technically most are really "embryos," even though they look like eggs from the outside) and fish larvae in our coastal plankton hauls.

In addition certain members of the subphylum Urochordata (like *Fritillaria* and *Oikopleura*) 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) they swim freely away from the mucous home.

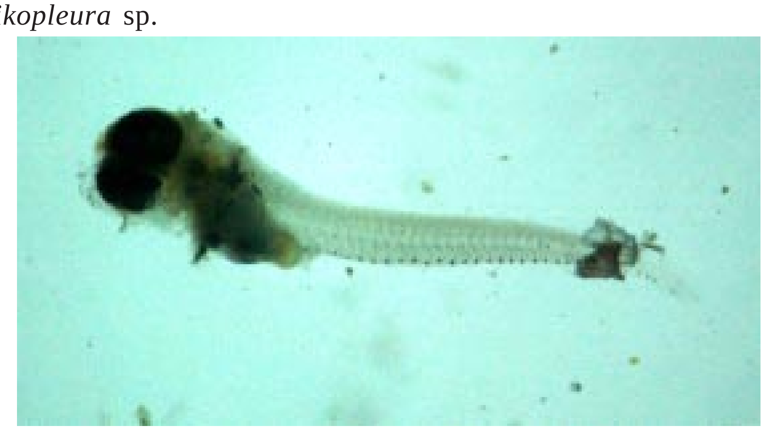
Fritillaria sp.

Oikopleura sp.



Early Fish embryo

Late fish embryo

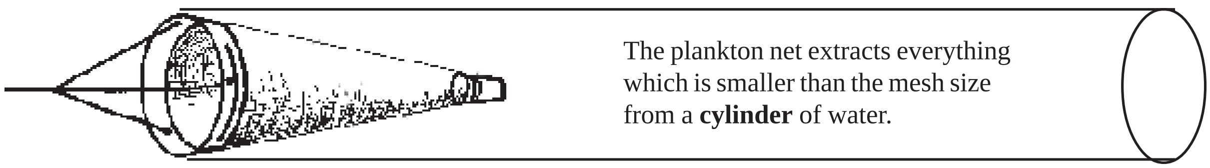


Fish larva

Appendix 1 - Quantifying your plankton data.

THREE STEPS USED FOR CALCULATING THE ABUNDANCE OF EACH PLANKTONIC ORGANISM IN A CUBIC METER (m^3) OF SEAWATER.

Step One:
CALCULATING THE VOLUME OF WATER SAMPLED BY THE NET



To compute the number of cubic meters of seawater that have been sampled by the plankton net, we use the following general formula for the volume of a cylinder:

You must know:

Pi	**=**	**3.1415926536...**
r^2	**=**	**radius of net opening (in m), squared**
L	**=**	**Length (distance net was towed, in m)**

Formula:

$$\text{Volume} = \text{Pi } r^2 L$$

(Volume = cubic meters (m^3) of seawater)

NOTE FOR SAMPLES TAKEN BY BOAT:

When nets are towed behind a vessel, “L” (length of tow in meters) is calculated by knowing the **speed** of the vessel in meters per hour, and the **time** (or duration; the decimal fraction of an hour that the net was fishing). Length is calculated by the formula: **Length of tow = Speed x Time**.

Since most vessels have speed measured in **knots** (nautical miles per hour), you first need to multiply 1,853 meters per nautical mile x Speed in knots to find the speed in meters per hour. If the time (duration) was measured in minutes, you must divide minutes by 60 min/hr to convert the time to hours.

Step Two:
CALCULATING THE AVERAGE NUMBER OF EACH SPECIES PER DROP SAMPLED UNDER THE MICROSCOPE.

You must know: 1- the total number of each species counted (a sum taken from all the drops you analyzed)
2- the total number of drops you analyzed

Calculation: simply divide the number of each species by the total number of drops you analyzed; use two decimal places of accuracy.

Formula: **#/drop** = total number you observed / number of drops analyzed in class

Step Three:
CALCULATING THE NUMBER OF EACH SPECIES IN A CUBIC METER OF SEA-WATER. ($\#/m^3$)

You must know: 1- The **volume** of seawater samples by the net in cubic meters. (You calculated this number in Step One.)
2- The **average number** of each species per drop. (You calculated this in Step Two.)
3- The **total number of drops** in the sample jar. (You multiply the sample volume in mL by 20 drops per mL).

Formula: $\#/m^3 = (\#/drop \times total\ drops) / Volume$

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