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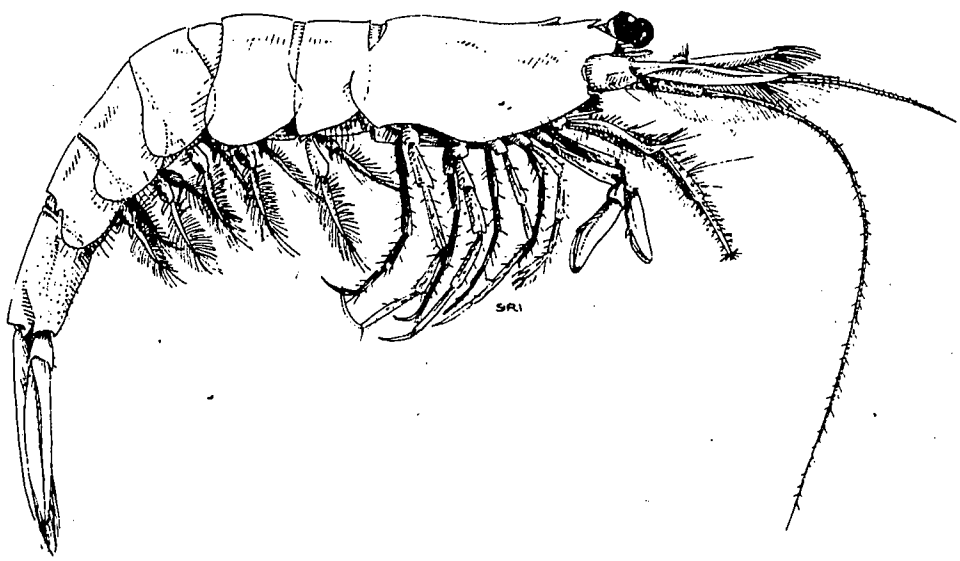
ABSTRACT

Project MER (Marine Ecology Research) is aimed at improving environmental education in the San Francisco Bay Area schools. As part of meeting this goal, it is hoped that students and teachers can see the results of their efforts being put to practical use. This guide is the third of a series produced to help students and teachers gather data concerning the San Francisco Bay-Delta-Estuary Complex and to organize these data to make a contribution to the literature of science and to serve as the groundwork upon which knowledgeable decisions about the environment could be based. Presented in this guide is a key to aid in identifying the more common invertebrate and vertebrate forms found in the Bay area. Physical descriptions are accompanied by illustrations. Related documents are SE 016 645, SE 016 646 and SE 016 648 through SE 016 650. (JP)

PROJECT M E R

MARINE ECOLOGY RESEARCH



HANDBOOK OF TECHNIQUES
and
GUIDES FOR THE STUDY
of the
SAN FRANCISCO BAY-DELTA-ESTUARY COMPLEX

KEY TO THE INVERTEBRATES

PART III

Prepared by

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February 1971

The HANDBOOK OF TECHNIQUES AND GUIDES FOR THE STUDY OF THE SAN FRANCISCO BAY-DELTA-ESTUARY COMPLEX was developed and prepared by the staff of the Contra Costa County Department of Education and teachers in Contra Costa and Alameda counties. It is reproduced through the facilities of the Alameda County Superintendent of Schools Office.

Prepared as a course of study for grades 9-14 in aquatic ecology.

For information concerning Project MER or this publication, write to:

Director, Project MER
Contra Costa County Department of Education
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Pleasant Hill, California 94523

COVER

Crago franciscorum, the Bay Shrimp, was once the most prevalent shrimp in San Francisco Bay. Today, as the result of changes in Bay waters, it is no longer commercially important.

The line drawing of *Crago f.* was prepared by Margaret Lynn Siri, student of Ed Springer, at Kennedy High School.

FOREWORD
Preliminary Edition

The waters of the San Francisco Bay - Delta - Estuary Complex, as with waters of any similar complex which range from those of relative high salinity to low, virtually fresh water, contain organisms which have been able to survive because of their ability to withstand fluctuations in salinity. Most of the keys which are available to help identify specimens tend to be restricted to either coastal highly saline or inland fresh water species. Biologists working in brackish estuarine waters frequently find it difficult to identify species without utilizing a wide assortment of keys.

The purpose of this key is to aid in identifying the more common invertebrate and vertebrate forms found in the San Fransicso Bay - Delta - Estuary Complex. Prepared by Jim Shettler, a great many sources have been used in an attempt to identify the more prevalent organisms. Even as the key was being prepared, many forms not included were being recognized as important in these waters. Such problems are to be expected, and, though frustrating to the author, should be recognized by all using this key. In order to meet the publication deadline, they are not included but will be in the first revision. As the key becomes "field tested" and additional forms identified, it will be revised.

As the users of this key, you can assist in future revisions which will be necessary if the process of monitoring the life forms in these waters is to be simplified and the results of the identifications considered valid. As you identify forms not included, carefully preserve the specimen and note when and where the organism was collected. You are encouraged to prepare the diagrams of organisms you encounter to be included in the future revisions of this key. Your contributions, and those of the many students involved in the monitoring program of Project MER, will result in a key which future students and biologists can use in local ecological studies.

George J. Castellani
Director, Project MER

FOREWORD

Since the limited circulation of the preliminary edition of this key, many individuals have offered assistance to Jim Shettler, and their suggestions are encorporated in this first edition.

In the preparation of a key such as this, much time must be devoted to the laborious but necessary task of reducing and touching up diagrams. This is a tedious job and we are grateful to Dr. Gene Cheung, for the many hours she devoted preparing many of the diagrams for publication.

Special appreciation is extended to Mrs. Wyn-Miller of the Contra Costa Department of Education who is responsible for touching up many of the diagrams in this publication and typing the manuscript.

Margaret Lynn Siri, a senior at John F. Kennedy High School in Richmond, has prepared eight line drawings of common invertebrates. Her drawing of *Crago franciscorum* appears on the cover.

Dr. Cheung, who has a Ph.D. in Zoology and is a graduate of Davis, is very familiar with the local waters and has contributed several short keys and diagrams of several organisms to this publication.

The California Department of Fish and Game has supplied us with copies of out-of-date publications containing drawings of organisms for inclusion in the key for which we are grateful.

KEY TO THE ANIMAL PHYLA

1a.	Animals with backbones - (includes vertebrates) usually fishes.	CHORDATES
1b.	Animals without backbones (invertebrates)	2
2a.	Microscopic animals; the head appears to have two rotating wheels.	ROTIFERA
2b.	Without rotating wheels.	3
3a.	With jointed legs and antennae (crustaceans).	ARTHROPODS
3b.	Without jointed legs.	4
4a.	With shells; as in snails, clams and oysters . . .	11
4b.	Without shells (or worm-like and living in hard tubes).	5
5a.	Animals spongy; many small (pin size) openings evenly dispersed over the surface (sponges)	PORIFERA
5b.	Not as in 5a.	6
6a.	Small animals, body less than 5 mm with a circle of tentacles around the mouth, usually attached to rocks or plants (jellyfish belong to this group)	COELENTERATA
6b.	Not as in 6a	7
7a.	Animals with size and appearance of gooseberries, transparent (the comb jellies).	CTENOPHORA
7b.	Not as in 7a.	8
8a.	Leathery, round, with two openings; attached with short stalks (tunicates).	CHORDATA
8b.	Not as in 8a	9
9a.	Animals shaped like torpedoes with rounded fins (arrow worms)	CHAETOGNATHA
9b.	Animals worm-like (sometimes found in hard tubes) . . .	10
10a.	Body flattened (flatworms)	PLATYHELMINTHES
10b.	Body segmented; many segments with bristles and flattened lateral lobes; some are tube worms (segmented worms).	ANNELIDA
11a.	Body covered with several overlapping shells; attached to rocks or pilings (barnacles).	ARTHROPODA
11b.	Shells coiled or dish-shaped or bivalved (two sides) - (clams, snails, limpets, oysters and mussels).	MOLLUSCA

PORIFERA

(Sponges)

Sponges are a primitive form of life found in our local waters. There is a great variety in the shape and color of sponges which make it difficult to give a general description of their morphology.

The simplist and smallest forms are represented by *Grantia* which inhabit quieter fresh waters. Marine forms are generally found in larger colonies forming irregular balls or look like small trees with larger, thick branches. Close examination with a hand lens will reveal the many openings and pores through which water flows. One often finds forms of sponges which encrust in thin layers on rocks or in shells of mollusks.

Many marine sponges found in our bay have needle or starlike calcium particles within their "skin" referred to as spicules. If a piece of the sponge is immersed in a strong base such as potassium hydroxide, the "flesh" will dissolve and the spicules may be isolated and observed under the microscope. Frequently, biologists prepare spicule preparations to make certain of the identification of the sponges.

PORIFERA

Many sponges exist in the Bay-Delta-Estuary Complex. At the present time, we do not have the necessary diagrams for inclusion.

COELENTERATA
(Coelenterates)

The coelenterates are readily identified by their jelly-like bodies, cup shape and radial symetry. They lack heads and segmentation of the body and tentacles, armed with stinging cells called nematoblasts, are used for trapping smaller organisms and forcing them in the main opening called the mouth.

There are two major forms which predominate in the bay-delta-estuary complex. The smaller forms which appear as a small plant to the naked eye are called *polyps*. These are usually found attached to pilings and rocks.

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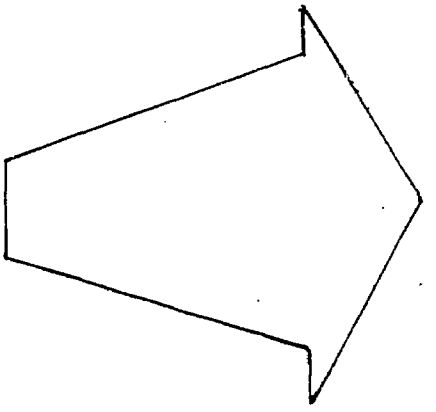

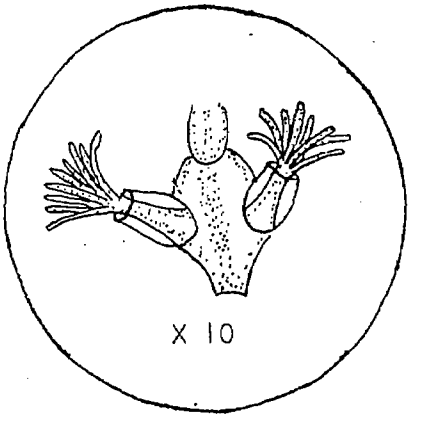

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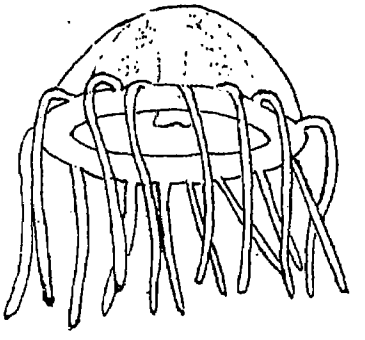
The free-swimming form, commonly referred to as the *medusa* include the jelly fish and have the basic body pattern illustrated below.

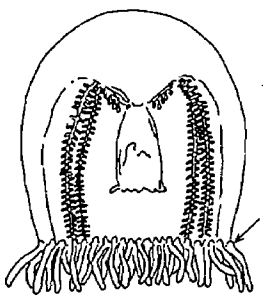


COELENTERATES

KEY TO THE MOST COMMON COELENTERATES OF THE SAN FRANCISCO BAY-DELTA-ESTUARY

Prepared by Gene Cheung, Ph.D.

1a.	Small free-swimming jellyfish, 1/2 to 2 inches in diameter, found floating frequently in bay waters. Definite red spots on tentacles	*Polyorchis*
1b.	Attached coelenterate forms	- 2 -
2a.	Sea anemones, alone or in clusters, commonly on pilings and floats, colors brown, white or greenish	*Metridium*
2b.	Small colonial attached forms	- 3 -
3a.	Feeding heads (hydranths) mostly contained within a thin, transparent, bell-shaped covering; colony form bushy with fine branches	Group of hydroids including: *Gonothyraea* *Obelia* *Campanularia*
3b.	Heads not covered with a thin, transparent cap	- 4 -
4a.	Heads with two circlets of tentacles; colony in large clusters usually on pilings at low tide levels	*Tubularia crocea*
4b.	Heads with a single circlet of tentacles; colony low in form spreading over the surface of attachment	- 5 -
5a.	Stalks with a clear, transparent outer layer or coat (theca) found in fresh or brackish water only	*Cordylophora*
5b.	Stalks without transparent outer coat, found at low tide in marine situations	*Clava spp.*



Polyorchis penicillatus

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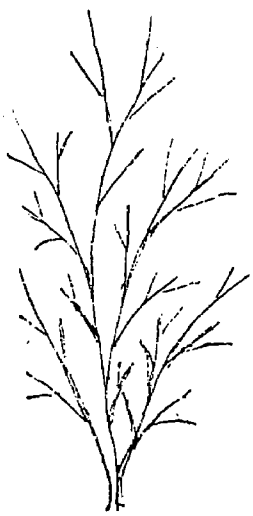

Gonothyraea

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Tubularia crocea

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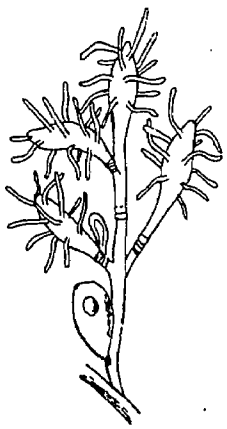

Cordylophora lacustris

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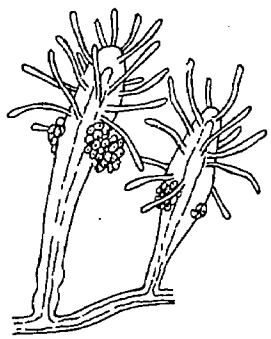

Clava leptostyla

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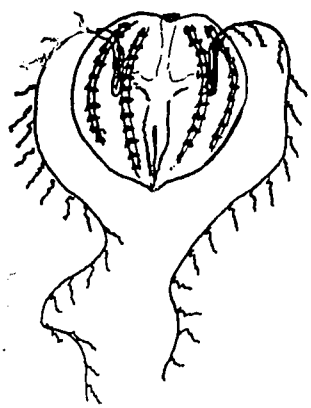
CTENOPHORA
(Comb Jellies)

Swimming ctenophores are easily recognized in a jar of sea water by the iridescent sparkling of the combs (hair structures on the side of the body) and by the eight pairs of paddle-like structures which are used to paddle around. They are easily distinguished from the Medusa Coelenterates in that there are never any tentacles present.



IX

PLATYHELMINTHES
(Flatworms)

The flatworms are frequently found among rocks, plant roots or as parasites of other organisms.

They are simple in internal structure. Externally, they appear flattened and vary considerably in length.

Flatworms are conveniently divided into three classes which reflect basic structural differences and modes of living.

Class: Turbellarians -- These include the free-living forms you will most frequently encounter. *Planaria* are typical fresh water forms. Marine forms are frequently colorful. Unlike *Planaria*, the head is not as clearly defined.

Class: Trematodes -- Commonly called flukes, all members of this class are parasitic. Frequently external parasitic flukes can be found in the gills of fish.

Class: Cestoda -- These are the common tapeworms whose bodies are composed of units called *proglottids*, frequently mistakenly called segments. Strictly parasitic, you may find tapeworms in the gut of fish when you undertake a fish gut analysis to study the feeding habits of various fish.

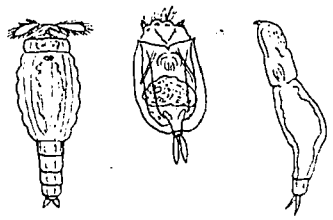
+ + + + + + + + + +

Although free-living flatworms are known to exist in the San Francisco Bay-Delta-Estuary Complex, none have been identified at the present time. As species are identified, they will be included in future editions.

ROTIFERA
(Wheel Animals)

The rotifers represent a group of small invertebrates which range from a few millimeters to microscopic. They may be taken in plankton trawls or observed in a jar of sea water. The most distinctive characteristic of this group is the cilia lined "wheel orgen" at the mouth end of the animal which circulates the water and aids in trapping smaller organisms for food. The posterior end may be attached to a rock or plant.

Typical rotifer forms are illustrated below:



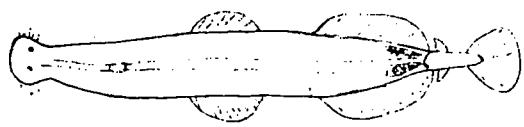
10X

+ + + + + + + + + +

Although free-living rotifers are known to exist in the San Francisco Bay-Delta-Estuary Complex, none have been identified at the present time. As species are identified, they will be included in future editions.

CHAETOGNATHA
(Arrow Worms)

The Chaetognatha are strictly a marine group of organisms. Their bodies are torpedo-shaped and small, 20 to 70 mm long. "Fins" are found on the sides and tail and the head has bristles surrounding the mouth. Unsegmented and transparent, Arrow Worms tend to surface at night but are also found attached to algae or rocks in shallow water.



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MOLLUSCA
(Molluska)

The mollusks are a group of animals which have undergone great diversity in their evolution, as they have adapted to a wide range of habitats.

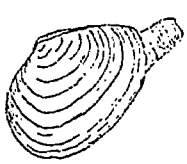
Taxonomists have divided the mollusks into five major classes. Only three classes contain major residents of the Bay-Delta-Estuary complex.+

Class: Scaphopoda (Tooth Shells)

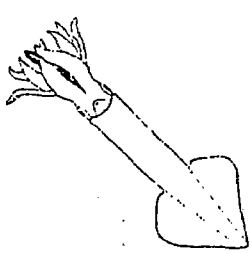
Class: Amphineura (Chitons)

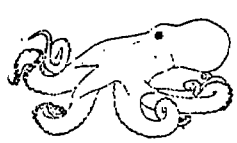
+ Class: Gastropoda (Univalves - Snails, Sea Slugs, Limpets)

+ Class Pelecypoda: (Bivalves - Clams, Mussels, Oysters)



+ Class Cephalopoda: (Squids and Octopi)





MOLLUSCA

CLASS - GASTROPODA (UNIVALVES)

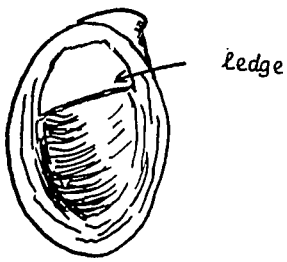
LIMPETS

Crepidula convexa

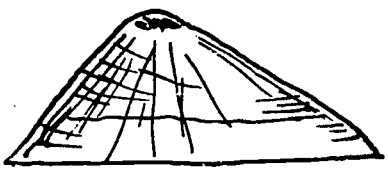
The Gray Slipper Shell. Approximately 20 mm long, it is grayish green with specks of color. The interior of the shell is mottled brown with an attached shelf that is white. They are often found on clams and seaweed.

Acmea pelta

These limpets have a conical shell with no holes in them. The outside pattern is usually varied with radiating bands of checkerboard-like appearance. The interior usually has some bluish coloring and a dark stain at the center.



Crepidula convexa



Acmea pelta

MOLLUSCA

CLASS - GASTROPODA
(UNIVALVES)

SNAILS

Thais lamellosa

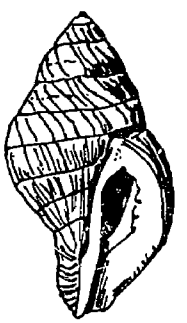
This snail is quite variable in shape; some are almost entirely smooth, and others show the layers which give the snail its name. Shells are usually light brown, sometimes with white bands, and occasionally light lavender or pinkish shells may be found.

Nassarius obsoletus

Up to 20 mm long, this snail is extremely abundant in San Francisco Bay. The top is usually blunt or eroded and the surface is black and the shell markings are difficult to discern.

Littorina scutulata

The shell is small and oval with a fairly smooth surface with rounded whorls and a spire of medium heigth. The shell is dark gray to gray purple with a narrow purple band lining the central inner lip of the opening.



Thais lamellosa

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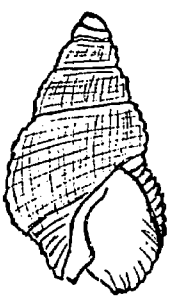


Nassarius obsoletus

2X

Littorina scutalata

2X

MOLLUSCA

CLASS - PELECYPODA
(BIVALVES)

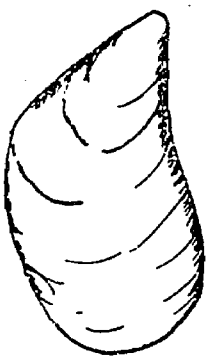
MUSSELS

Mytilus edulis (Bay Mussel)

This Bay Mussel is smooth and purplish black. It is found along bay shores and on pilings usually attached by strong fibrous strings.

Mytilus californianus (Sea Mussel)

Valves elongated, purple in color, covered with a black, glossy periostracum; marked with faint concentric lines. Two muscles. Umbo at extreme end. Meat bright orange. Size up to 8 inches. The Sea Mussles are found attached to rocks, sometimes in great mats, by the byssus. They live between tide lines where they are exposed to the full force of the surf. Distribution generally limited to waters near the Bay entrance.



Mytilus edulis

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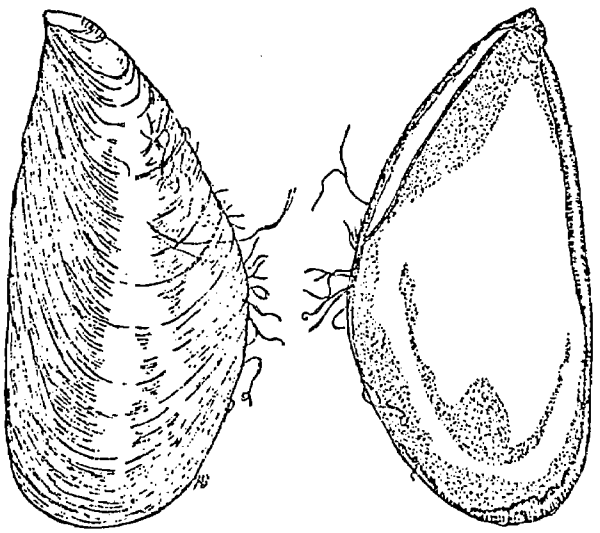

Mytilus californianus

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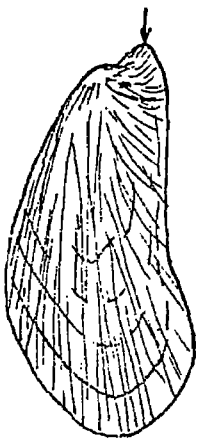
Modiolus demissus (Ribbed Mussel)

Most abundant in the southern part of the Bay, the Ribbed Mussel is brown with prominent radiating ribs, and may grow to a length of nearly five inches. Note that the end of the shell projects beyond the apex (see arrow.)

Modiolus rectus (Horse Mussel)

Umbos near but not at the extreme end. Valves brownish and either bearded or markedly ribbed. The meat is orange or reddish. The Horse Mussles are solitary species, generally found partly buried and anchored securely by the byssus in sandy mud or gravel.



Modiolus demissus
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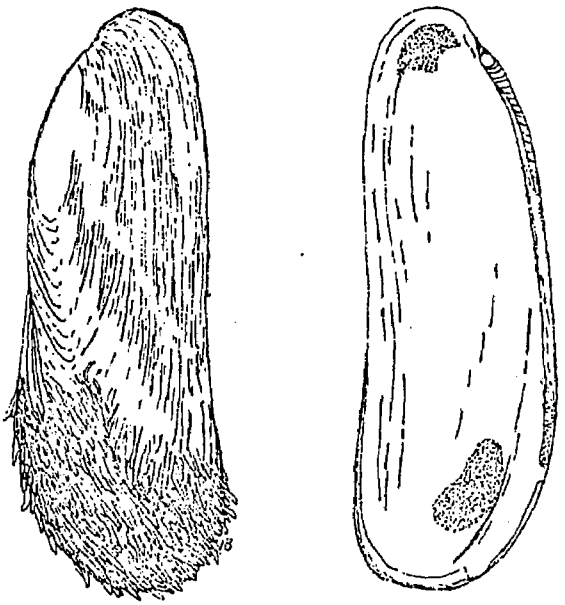


Modiolus rectus
1X

MOLLUSCA

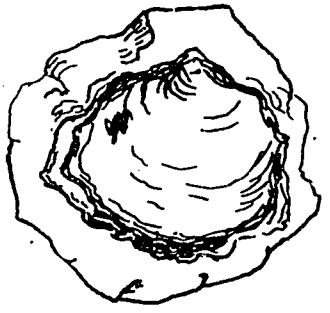
OYSTERS

Ostrea lurida (Native Oyster)

This oyster is found settling on rocks, pilings and the shells of other clams. Valves irregular in shape, circular or elongated, sometimes scalloped at the edges, dark gray or blackish. Under valve (left) cupped, upper flat. Seldom exceeds 2 inches.

Crassostrea virginica (Virginian Oyster)

Shell widens gradually from a narrow pointed beak. Upper valve smallest and flattest with leaf-like scales of shell, lower valve deeply cupped. Exterior of shell a dingy, leaden color. Interior of shell a shiny white with black muscle scar. On our coast length to about six inches. Differs from both other species of oysters by having black muscle scars.



Ostrea lurida

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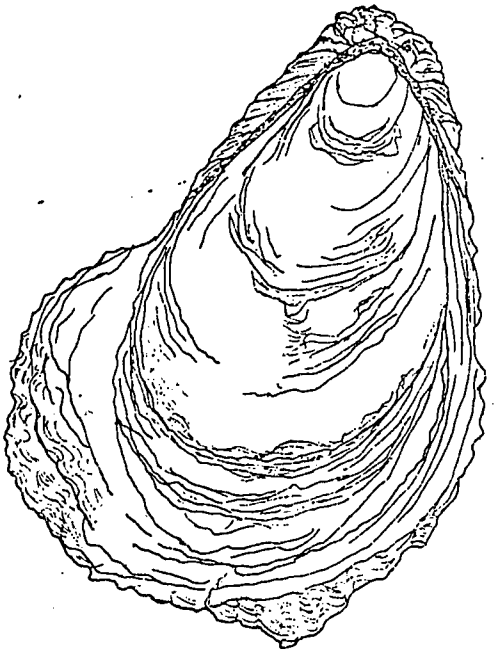

Crassostrea virginica

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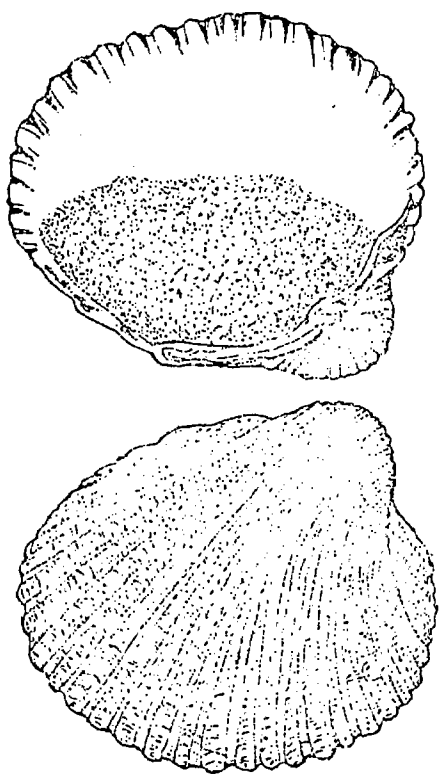
CLAMS

Cardium corbis (Heart Cockle)

Valves strongly arched, symmetrical, with prominent radiating ribs and grooves which interlock at the edges as in the scallop. The siphons are very short. The mantle margins are fused at two points to form siphon openings. This species attains a size of 2-3/4 inches. The Heart Cockle is found on the tide flats in inlets and bays and also on sand and gravel beaches. These cockles live on the surface or just beneath it. They are active diggers but their short siphons do not allow them to burrow to any great depths.

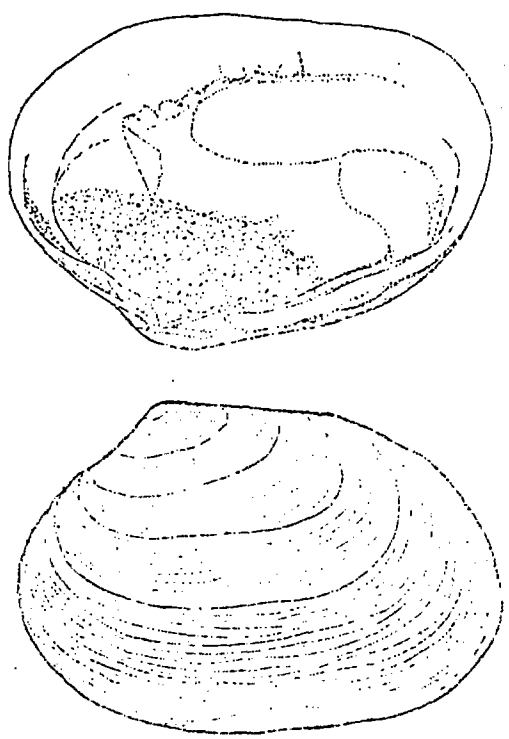
Saxidomus nuttalli (Washington Clam)

Shell oval, outside surface with numerous strongly defined concentric growth lines. Color, outside brownish white; inside white, slightly tinged with purple near the siphonal end. Siphons united, long and retractile. Grows to a length of 9 inches. The Washington Clam lives at a depth of 8 to 10 inches in the mud flats of all bays and inlets from Alaska to San Diego.



Cardium corbis

1X



Saxidomus nuttalli

1/2X

Chione fluctifraga, Chione undatella, Chione succincta (Hard-Shell Cockles)

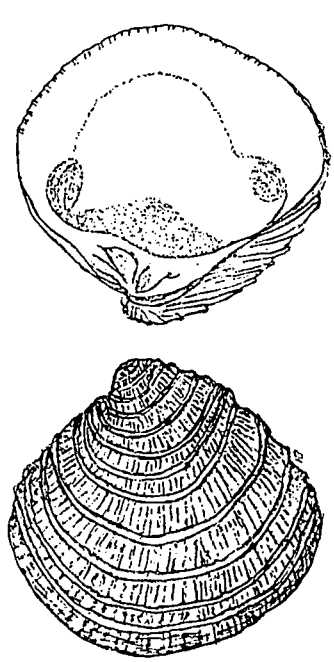
Compact rounded valves with radiating and concentric ridges. Short united siphons. Shells covered by a thin gray periostracum. They reach a size of 2 to 2-1/2 inches. These clams live just under the surface in firm sand or sandy mud in bays and inlets. The siphonal ends of the valves are sometimes visible.

Macoma nasuta, (Bent Nose Clam)

These two clams are similar. Both of them have flattened shells that are chalky and more or less oval in outline. *M. nasuta* (the Bent Nose Clam, see diagram below) can approach 50 mm in length and the ligament (the valve hinge) is slender. The valves are bent to the right (see arrow on diagram.) *M. inconspicua* is smaller (less than 25 mm) and the valve is not bent as in *M. nasuta*. They both frequent bottoms where mud is mixed with sand.

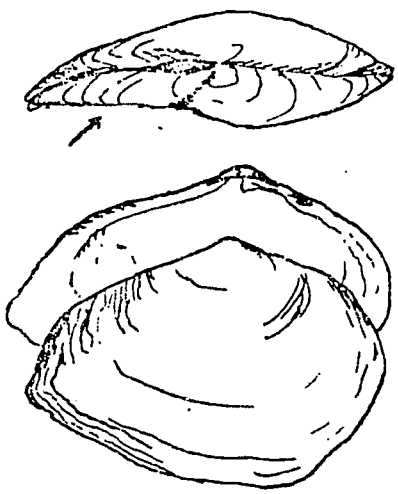
Schizothaerus nuttallii (Gaper)

Valves thin, cannot close completely, curved outward at the end to accommodate the siphons. Siphons large, covered with heavy, dark skin and tipped with two horny plates. Umbos toward anterior end of shell. Grows to 8 inches in length and 4 pounds in weight. The Gaper lives in the mud bottoms of the Bay.



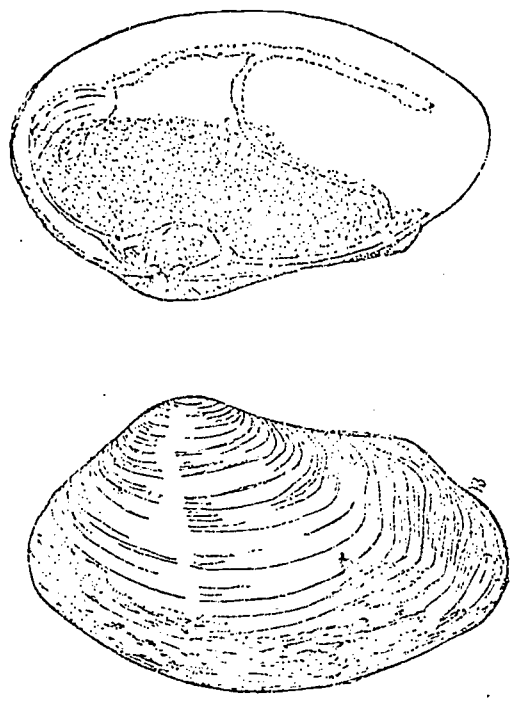
Chione undatella

1X



Macoma nasuta

1X



Schizothaerus nuttallii

1/4X

Mya arenaria (Soft Shell Clam)

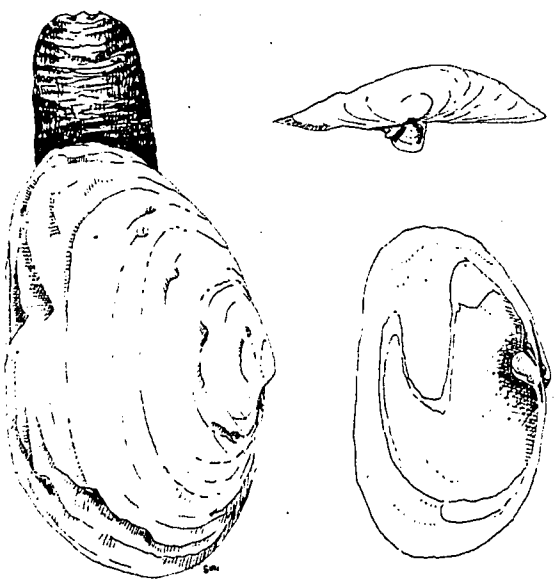
On bay shores, often in mud that is unpleasantly dirty. A dingy gray, fragile-shelled clam with a thick stubby siphon is the Soft Shell Clam. This siphon cannot be retracted completely back within the valves (shells.) It usually lies deeply buried with only its siphon near the surface.

Tagelus californianus (Jackknife or Razor Clam)

Valves 3 to 4 times as long as wide. Strongly arched, almost forming a cylinder. Umbos central, siphons separate and long. Color, white or grayish; dull brownish "skin." Size up to 4 inches. This species lives in a smooth-lined permanent burrow, 15 to 16 inches deep, in quiet bays with a fairly stable bottom.

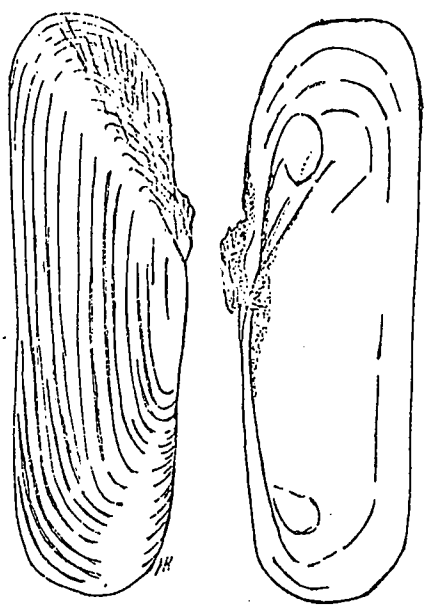
Petricola pholadiformis (Rock Borer)

Approximately 60 mm long, this Rock Borer is often found boring into clay and soft rocks. There are several strong, radiating ribs at the front end, but they are numerous, crowded, and fine throughout the rest of the shell.



Mya arenaria

1X



Tagelus californianus

1/2X

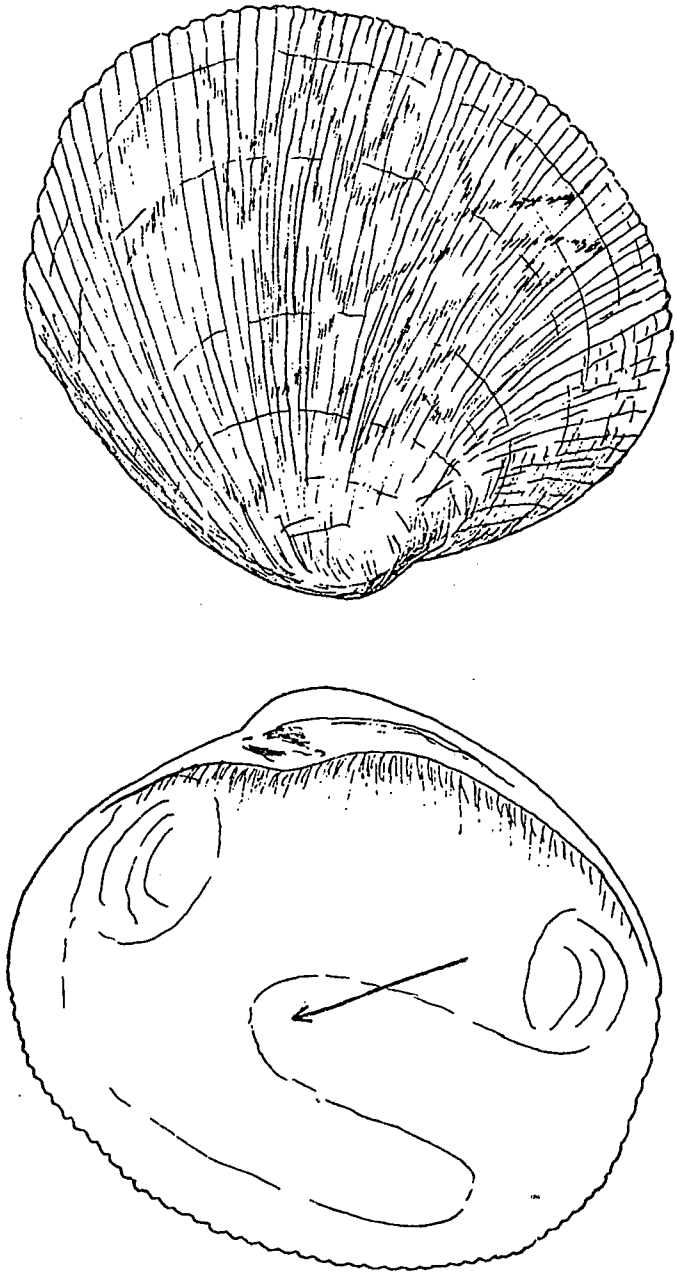
Petricola pholadiformis

1X

MOLLUSCA

Protothaca staminea

The Common Littleneck Clam. It has radiating ribs and less prominent, concentric ridges. The color is highly variable from grayish to a pale brown.



Protothaca staminea

2X

MOLLUSCA

Corbicula fluminea

More than 10 mm long and very thick in cross section. It has very heavy valves (shells) that appear to be covered by a dark colored "skin." They abound in low salinity and fresh waters. Frequently used by fishermen as bait. Shells may be found in unusual locations.

Pisidium spp.

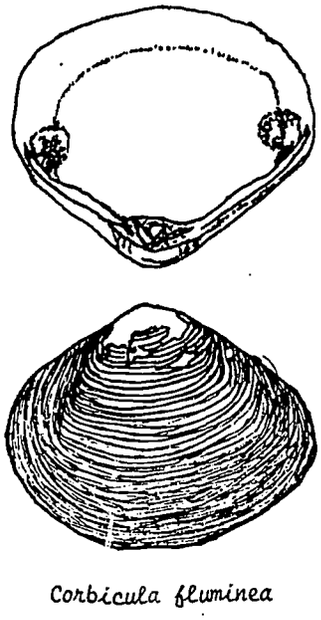
Small clam--less than 20 mm, not common.

Gemma gemma

A small, shiny clam--less than 5 mm, very common in this Bay. The shell is no longer than it is high. It is somewhat triangular in outline. The shell is white with a purple tinge and the margin of the inner edge is finely notched.

Tapes semidecussata (Japanese Littleneck)

Elongate, oval valves ornamented by well defined, radiating ribs and less prominent concentric ridges. Radiating ribs particularly heavy and conspicuous at posterior end. Inside ventral margins of shell smooth. Pallial sinus extending less than halfway to anterior muscle scar. Hinge ligament external, prominent. Color highly variable, mostly yellowish or buff with geometric patterns of wavy brown or black lines and blotches on sides. Attains a length of three inches. Differs from other littlenecks by short pallial sinus, extending less than halfway to anterior muscle scar, and from chiones in the very prominent radiating ribs and rounded pallial sinus. There are many differences of opinion among systematists on the proper genus in which to place this clam. It has been called *Tapes*, *Venerupis*, *Paphia* and *Protothaca*, but seems best fitted to *Tapes*.



Corbicula fluminea

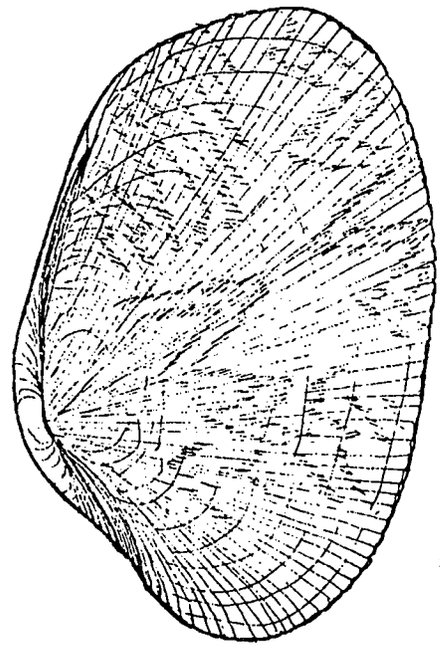
1X

Pisidium spp.

1X

Gemma gemma

4X



Tapes semidecussata

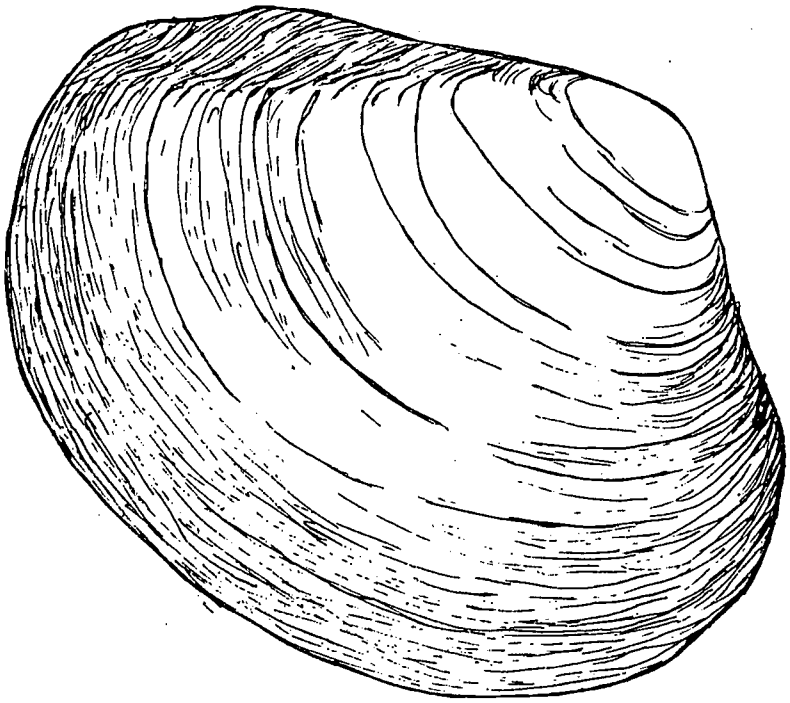
1X

Spisula catilliformis

Valves thin, particularly at the edges except in very old specimens where the ventral margin appears thick and laminated. A dull, yellowish-brown periostracum covering the shell where not eroded. Shell ornamented by a single raised rib radiating from the umbo at the posterior end, and numerous, fine, concentric growth lines. Differs from Hemphill's Dish Clam by having a slightly rounded dorsal slope; from the California Mactra by having a rather smooth outer shell along the posterior margin and from the Gapers by being able to close tightly along all margins.

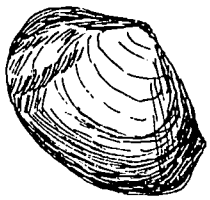
Cryptomya californica

A small (15 to 50 mm) irregular mya-like clam found nestling in rock holes and crannies or burrowing in gravel around worm tubes; it varies much in shape.



Spisula catilliformis

1X



Cryptomya californica

1X

ANNELIDIA
(Annelids or Segmented Worms)

The annelids are clearly recognizable by their ring-like segments of the body. Unlike the common earthworm, an annelid, most marine worms called polychaeta, have body parts which extend out from their long, slender bodies.

The marine polychaeta can be divided into two groups on the basis of their methods of locomotion. They are the Tube Worms, which generally remain in a sand or lime tube which they secrete and the Errant, which are free-swimming.

Tube Polychaeta:	Not very abundant in the bay waters.
Errant Polychaeta:	Many are distinctive by the paired, fleshy lobes called *parapodia* which extend from the segments.

ANNELIDIA

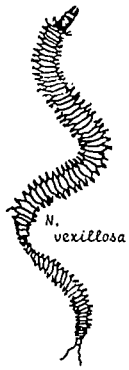
CLASS - POLYCHAETA

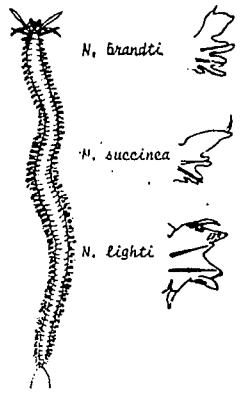
Species identification of the errant polychets is extremely difficult. Field identification of *families* is not too difficult. The following characteristics of several families of polychets and accompanying figures of specimen found in the San Francisco Bay-Delta-Estuary Complex will assist in identification by family.

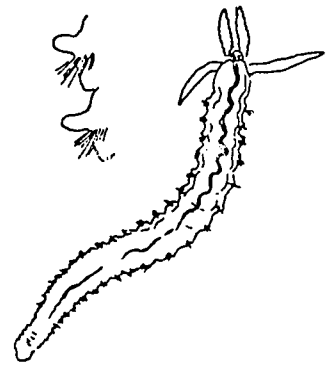
FAMILY NEREIDAE

Worms, four pair of eyes. About the mouth there are four pair of small, fleshy projections called *cirri*. At anterior end is found a flesh projection called the *pharynx*. It is armed with a pair of jaws for catching prey.

Examples:



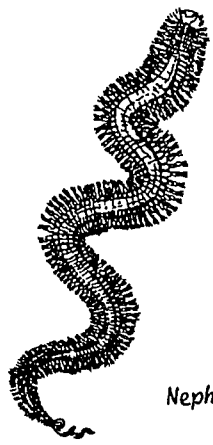




FAMILY NEPHTYIDAE

In the Bay the most common Nephtyidae is *Nephtys caecoides*. The body is not divided into regions. From each segment extends a pair of fleshy lobes (parapods) with rather stiff hair-like structures called *setae*. There are no large projections from the anterior end.

Example:



Nephtys caecoides

ANNELIDIA

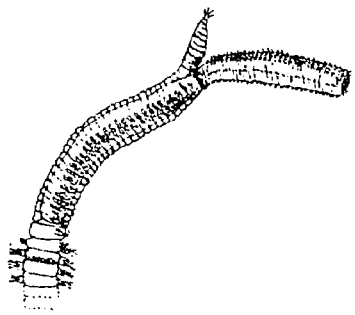
CLASS - POLYCHAETA

FAMILY GLYCERIDAE

Burrowing worms frequenting mud flats. The anterior end (prostamium) is conical. The pharynx is very large, cylindrical, and can be extended by the worm. This modification of the pharynx, called the *proboscis*, is armed with at least four jaws for snaring prey. The body typically is divided into two regions based on modification of appendages.

Example:

Glycinde armigera

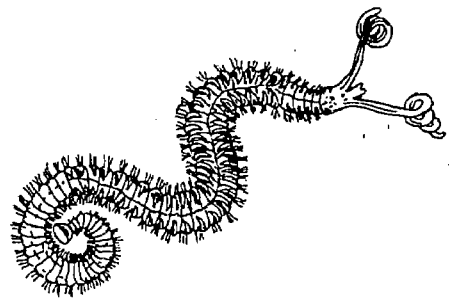


FAMILY SPIONIDAE

The tip of the anterior end has two long tentacle-like structures called *palps* which characterizes this family. The body is not divisible into distinct regions.

Example:

Polydora ligni



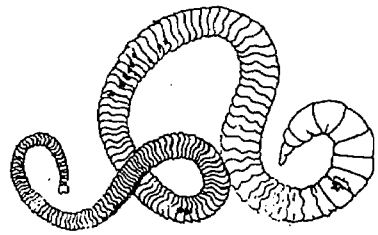
FAMILY CAPITELLIDAE

Superficially resembles an earthworm, but the body is not clearly divisible into regions. The body tapers at both ends.

Capitella capitata

A local form. Is blood red and approaches 125 mm in length.

Capitella capitata



ARTHROPODA
(Arthropods - Jointed-Legged Animals)

The arthropods represent the phylum with the greatest number and variety of organisms. Included in this phylum are the insects, spiders and crustaceans. All the organisms in this group characteristically possess jointed legs, a hard exoskeleton and a segmented body.

Of the several classes of arthropods which exist, the most important in the aquatic environment belong to the CLASS CRUSTACEA. These organisms are characterized as having a head with two pair of *antennae*. The body typically has a hard exoskeleton with a rigid plate over the thorax called the *carapace*. The number of legs vary in the different orders, but typically, they are modified for food getting (claws present), walking, swimming and respiration.

The following diagram, A Division of the Class Crustacea, lists the major SUB-CLASSES and ORDERS which you will find in the San Francisco Bay - Delta - Estuary Complex as you undertake biological sampling.

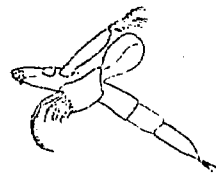
A DIVISION OF THE CLASS CRUSTACEA

CLASS: CRUSTACEA

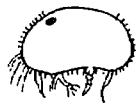
SUBCLASS: BRANCHIOPODA (Branchipods)

ORDER:
- ANOSTRACA (Fairy and Brine Shrimps)
- CLADOCERA (Water Fleas)
- OTHERS

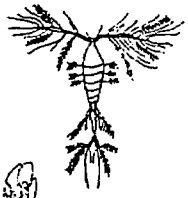




SUBCLASS: OSTRACODS (Mussel or Seed Shrimps)



SUBCLASS: COPEPODS (Copepods)

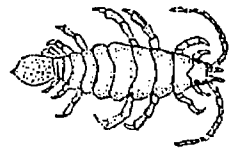



SUBCLASS: CIRRIPEDIA (Barnacles)


SUBCLASS: MALACOSTRACA (Malacostracans)

ORDER:
- MYSIDACEA (Ghost or Opossum Shrimp)

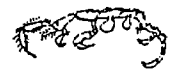
- ISOPODA (Sowbugs)



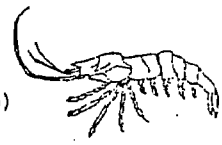
- AMPHIPODA (Scuds, Sand Fleas and Beach Hoppers)
  - HYPERIIDEA (Big-eyed Scuds)

  - GAMARIDS (Scuds)

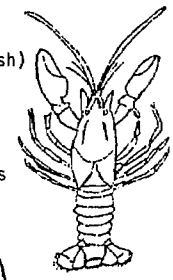
  - CAPRELLIDS (Skeleton Shrimp)



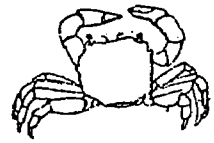
- DECAPODA (Shrimp, Lobsters, Crabs)



  - SUBORDER - NANTANTIA (Shrimp)
  - SUBORDER - REPTANTIA (Lobsters and Crayfish)



  - Several for the many crab types



ARTHROPODA

CLASS - CRUSTACEA

SUBCLASS - BRANCHIOPODA (Branchipods)

ORDER - Cladocera (Water Fleas)

Bosmina longirostris

Planktonic and small (2 to 3 mm), these water fleas have a body that is encased in a semitransparent shell. They use at least one pair of antennaes for swimming. One pair of antennae forms a beak (arrow).

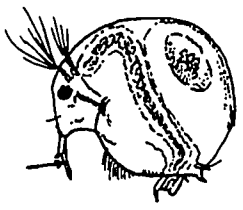
Diaphanosoma brachyurum

Planktonic and small (8 to 1.2 mm), no long spines on head or abdomen.

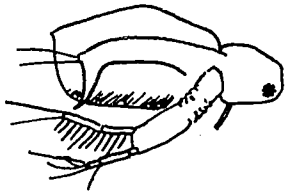
Daphnia pulex

Planktonic and small (2 to 4 mm), very small antenna.

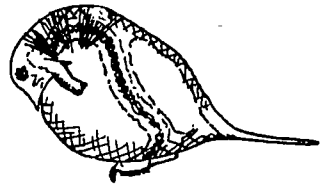
Leptodora kindtii



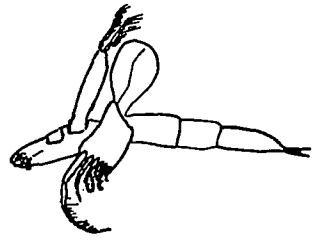
Bosmina longirostris
10X



Diaphanosoma brachyurum
10X



Daphnia pulex
10X



Leptodora kindtii
10X

ARTHROPODA

CLASS - CRUSTACEA

SUBCLASS - COPEPODS (Copepods)

Acartia clausi

Small plankton (less than 1.5 mm) with an elongated body. Four definite segments behind head. (Appendages and antennae not shown in figure.)

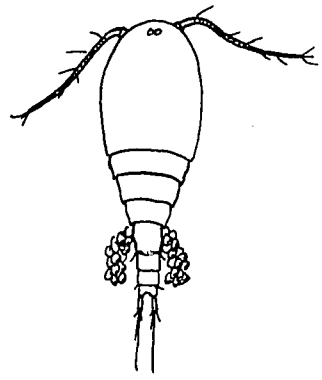
Cyclops vernalis

Generally found in plankton samples. ♀ as illustrated, has egg sacs observed on posterior. Size range from 2 to 4 mm. Most numerous nearer fresh water portion of bay.

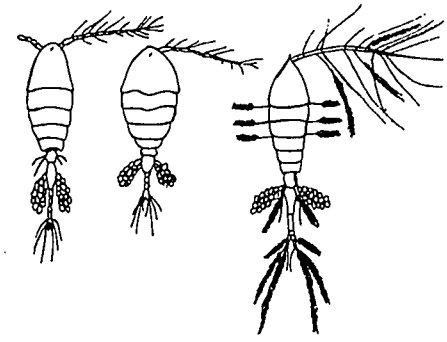
Oithona spp.

The body is very transparent with reddish pigment distributed throughout. Small plankton (less than 1 mm.) Large paired egg sacs on females. Five segments behind head.

Acartia clausi
10X



Cyclops vernalis
10X



Oithona spp.
10X

ARTHROPODA

CLASS - CRUSTACEA

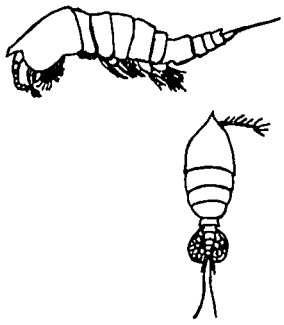
SUBCLASS - COPEPODS (Copepods) (Continued)

Euterpina (sp.)

Small plankton (less than 1 mm.) Tends to be found more to the seaward end of the bay.

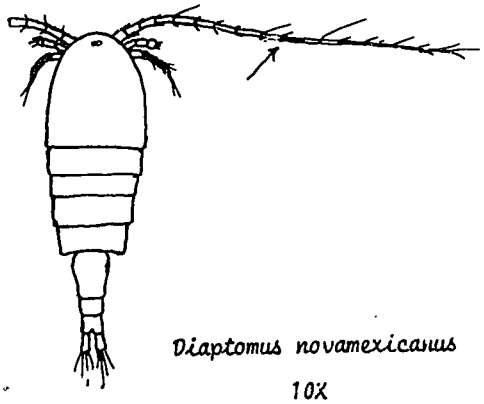
Diaptomus novamexicanus

The first antenna is as long as the body. Small plankton (1 to 3 mm.) Rarely found further west than Suisun Bay, most frequently found near Pittsburg and Antioch.



Euterpina (sp.)

10X



Diaptomus novamexicanus

10X

SUBCLASS - CIRRIPEDIA (Barnacles)

Balanus spp.

These barnacles are usually attached -- *B. crenatus* is usually found under rocks, whereas *B. improvisus* is found in bays or brackish water at river mouths. A larval form of this animal is often found in plankton samples (these are microscopic.)

Balanus spp.

1X

ARTHROPODA

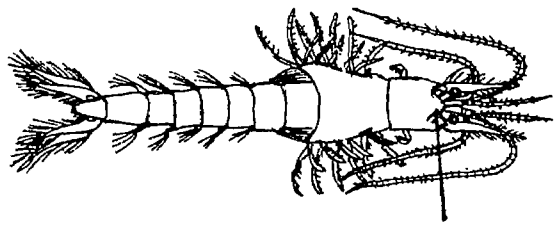
CLASS - CRUSTACEA

SUBCLASS - MALACOSTRACA (Malacostracans)

ORDER - Mysidacea (Ghost or Opossum Shrimp)

Neomysis awatschensis, N. mercedis

These opposum shrimp are relatively large plankton. *N. mercedis* reaches 15 mm and *N. awatschensis* reaches 10 mm. The latter shrimp also has a black pointed rostrum (see arrow.)



Neomysis awatschensis, N. mercedis

5X

ARTHROPODA

CLASS - CRUSTACEA

SUBCLASS - MALACOSTRACA (Malacostracans)

ORDER - Isopoda (Sowbugs)

Idothea (Pentidotea) wosnesenskii

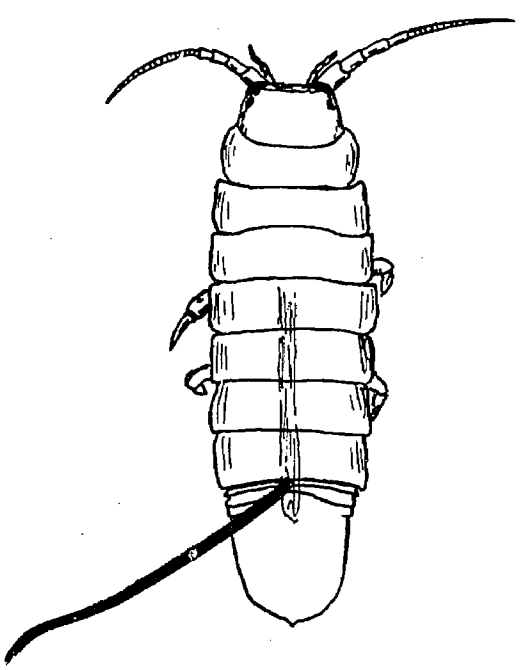
This isopod is found on seaweed primarily and is usually the same color as the seaweed. Approximately 1.2 cm long. All of the feet have claws that hold this animal to the seaweed.

Gnorimosphaeroma oregonensis

This pillbug-like isopod is found commonly on the rocks or shells during a low tide. It is dark with variable patterns on its back. This species has a rounded margin on its uropod (see arrow) which differentiates it from *S. pentodon* below. Both species will roll into a ball just as a pillbug will.

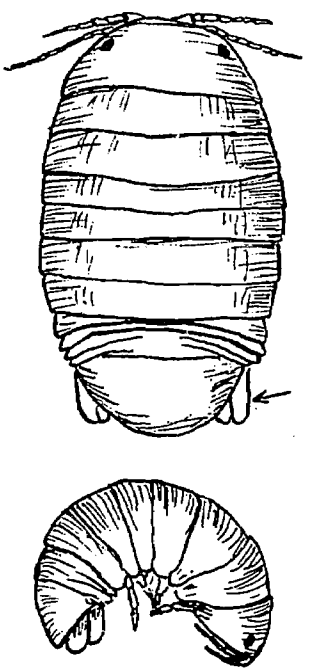
Sphaeroma pentodon

Very similar to *G. oregonensis* shown in drawing. However, this species has uropods (see arrow) that have large teeth on their margins. *S. pentodon* is frequently found burrowing into soft rock and it will roll into a ball when you pick it up.



Idothea (Pentidotea) wosnesenskii

3X



Gnorimosphaeroma oregonensis

5X

ARTHROPODA

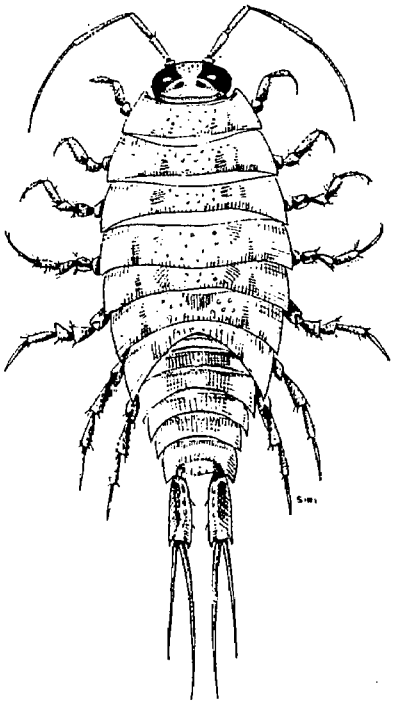
CLASS - CRUSTACEA

SUBCLASS - MALACOSTRACA (Malacostracans)

ORDER - Ispoda (Sowbugs)

Ligia occidentalis

A larger, common isopod frequenting the higher zones in rocky areas. In this species of *Ligia*, the distance between the eyes approximates the size of the eyes and uropods (rear appendages) are much longer than broad.



3X

ARTHROPODA

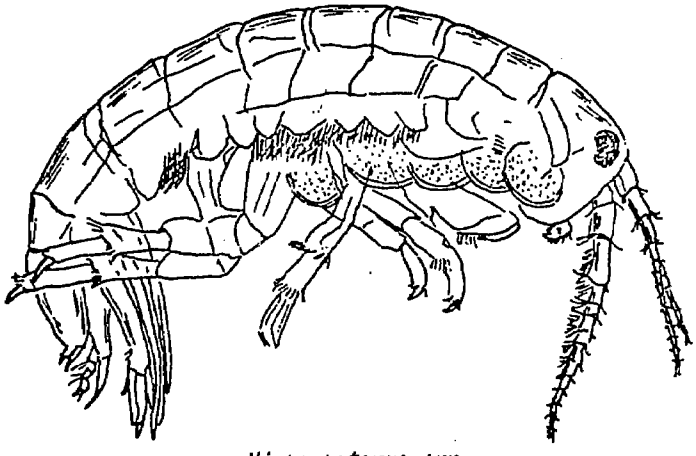
CLASS - CRUSTACEA

SUBCLASS - MALACOSTRACA (Malacostracans)

ORDER - Amphipoda (Scuds, Sand Fleas and Beach Hoppers)

Microprotopus spp.

This "scud" is very common in plankton samples. Approximately 75 mm in length, it is somewhat greenish and swims by moving its legs very rapidly.



Microprotopus spp.

20X

ARTHROPODA

CLASS - CRUSTACEA

SUBCLASS - MALACOSTRACA (Malacostracans)

ORDER - Decapoda (Shrimp, Lobsters, Crabs)

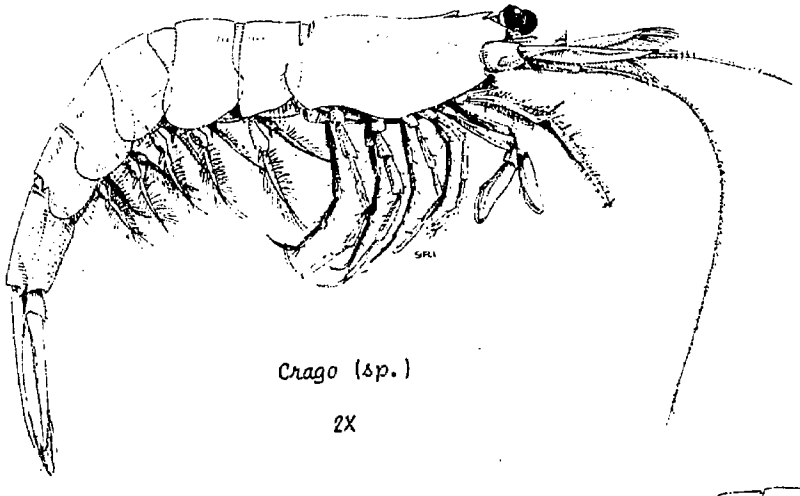
Suborder - Nantantia (Shrimp)

Crago (sp.)

Gray shrimp, 5 to 6 cm long. *Crago franciscorum* is uniform gray. *Crago nigricanda* has a big black spot on the tail, and *Crago nigromaculata* has a black spot on the side of the abdomen.

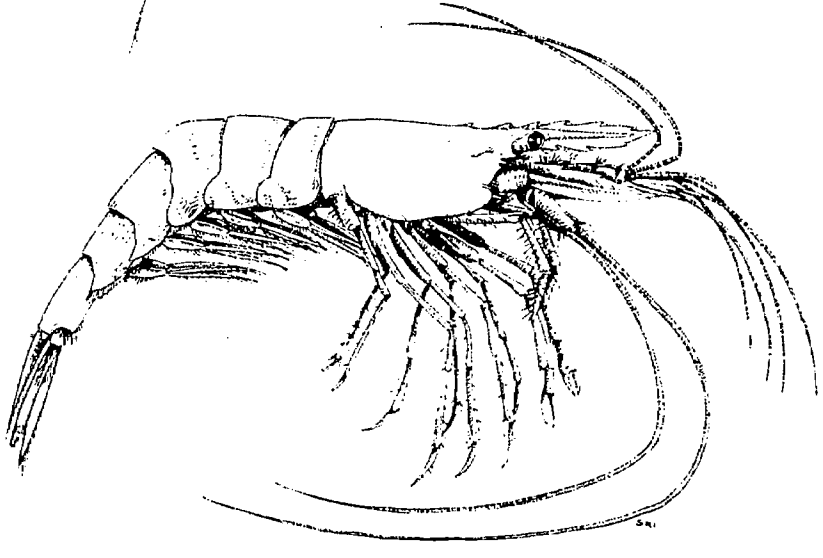
Palaemon macrodactylus

This introduced shrimp is similar to *Crago* but is easily distinguished by its large second walking leg (see arrow.)



Crago (sp.)

2X



Palaemon macrodactylus

2X

ARTHROPODA

CLASS - CRUSTACEA

SUBCLASS - MALACOSTRACA (Malacostracans)

ORDER - Decapoda (Shrimp, Lobsters, Crabs)

Suborder - Remaining suborders

Hemigrapsis oregonensis

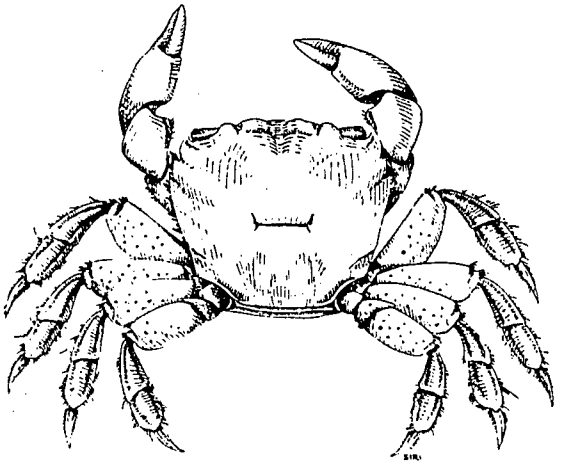
This small crab (to 8 cm across) is found in muddy banks especially under rocks. It is a dull green.

Hemigrapsis nudus

Closely related, but easily distinguished from *H. oregonensis* by the reddish purple spots on its claws and absence of hair on its legs.

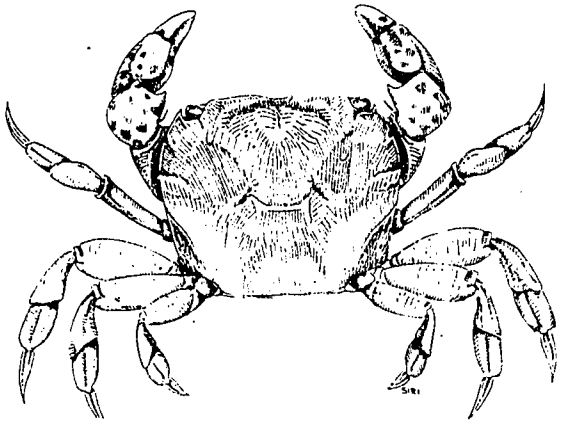
Pachygrapsus crassipes

The Lined Shore Crab is often seen hiding among the rocks. The back is greenish with reddish or purplish stripes and the large claws are reddish on top.



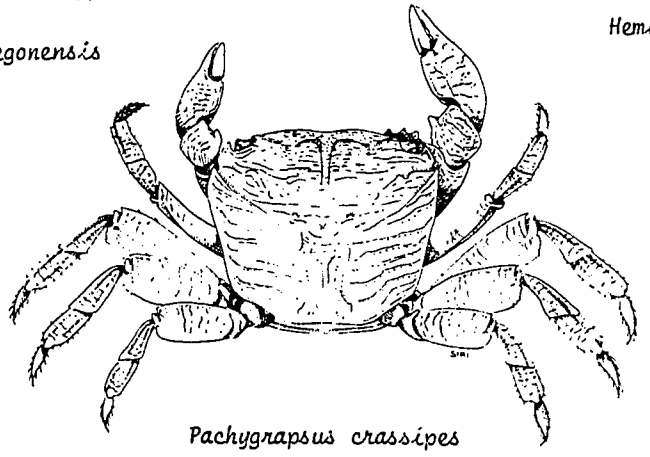
Hemigrapsis oregonensis

1-1/2X



Hemigrapsis nudus

1-1/2X



Pachygrapsus crassipes

1/4X

ARTHROPODA

CLASS - CRUSTACEA

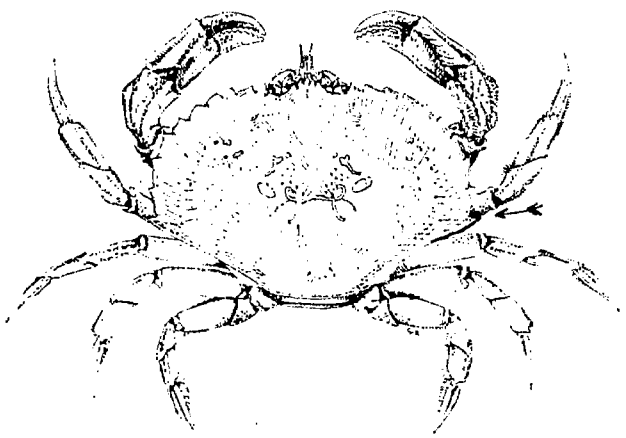
SUBCLASS - MALACOSTRACA (Malacostracans)

ORDER - Decapoda (Shrimp, Lobsters, Crabs)

Suborder - Remaining suborders

Cancer magister

The Dungeness Crab. This crab is reddish but its pinchers are without the darker coloration found on other species. The tenth tooth from the eye (see arrow) is at the widest part of the back (carapace.)



Cancer magister

1/3X

ARTHROPODA

CLASS - CRUSTACEA

SUBCLASS - MALACOSTRACA (Malacostracans)

ORDER - Decapoda (Shrimp, Lobsters, Crabs)

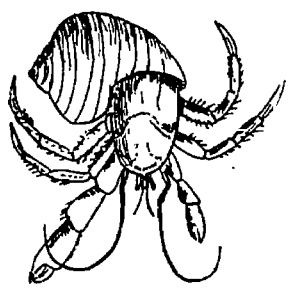
Suborder - Remaining suborders

Pagurus hirsutiusculus

These little hermit crabs can be seen scurrying along the bottom carrying their borrowed snail shell. This particular species has its antennae the same color as its body -- usually black or green.

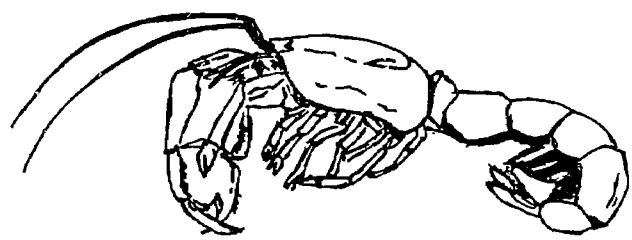
Callianassa californiensis

This is a burrowing, pink "ghost shrimp" whose burrows are raised on low conical hills. It is large (up to 15 cm.)



Pagurus hirsutiusculus

1X



Callianassa californiensis

1X

CHORDATA

The chordates represent the highest evolved group of animals. Among this group are the more primitive forms PROTOCHORDATES, which are relatively few in numbers and strictly aquatic. The major members of this phylum are the VERTEBRATA which include those organisms with backbones. With the exception of some mammals such as whales, seals, (and on occasion man as the result of his technology), the major classes of vertebrates found in the aquatic environment are the fishes. Great numbers and varieties frequent the waters of the San Francisco Bay - Delta - Estuary Complex and are frequently taken in seines when surveying pelagic populations.

There are several methods of dividing the CHORDATES into groups or taxonomic divisions. The diagram on the following page, Major Groups of Chordates Found in the San Francisco Bay - Delta - Estuary Complex, is one method of dividing the chordates and has been adopted for use in this key.

CHORDATES

SUBPHYLUM - UROCHORDATA OR TUNICATES (ASCIDIANS - SEA SQUIRTS OR SEA GRAPES)

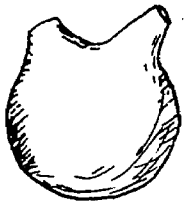
KEY TO THE MOST COMMON TUNICATES OF THE SAN FRANCISCO BAY-DELTA-ESTUARY

Prepared by Gene Cheung, Ph.D.

1a.	Individuals occur singly	- 2 -
1b.	Many individuals in a common matrix	- 3 -
2a.	Body covering (test) is a clear gelatinous mass; body directly attached to substrate	*Ciona*
2b.	Body covering a tough but smooth membrane, gray to greenish, body directly attached	*Molgula*
2c.	Body covering wrinkled into longitudinal folds, often warty looking at top; body elongated and attached by a stalk to substrate; color tan to reddish-brown	*Styela*
3.	Many small individuals (2 to 4 mm) in a stiff gelatinous matrix which may be a low encrusting mat or lobed up from the substrate. Individuals vary in color from gray to black and red-brown to orange. Water intake aperture large, without teeth, lobes, or pointed "tongue" at edge	*Diplosoma*

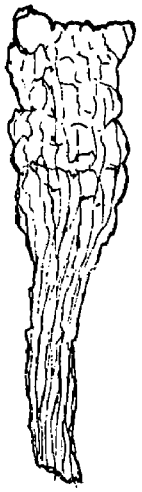
Ciona sp.

1X



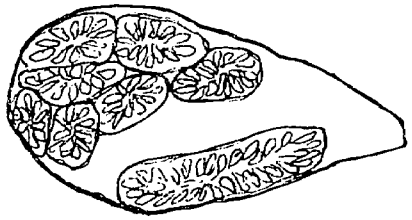
Molgula manhattensis

1X



Styela

1X



Diplosoma

1X

CHECKLIST OF INVERTEBRATES INCLUDED IN THIS KEY

PORIFERA

COELENTERATA

Polyorchis
Metridium
Hydroids including the geni:
Gonothyraea
Obelia
Campanularia

Tubularia crocea
Cordylophora
Clava spp.

CTENOPHORA

PLATYHELMINTHES

ROTIFERA

CHAETOGNATHA

Arrow worms

Chaetognath

MOLLUSCA

Scaphopoda

Amphineura

Gastropoda

Snails

Thais lamellosa
Nasarius obsoletus
Littorina scutalata

Limpets

Crepidula convexa
Acmea pelta

Pelecypoda

Mussels

Mytilus edulis
Mytilus californianus
Modiolus demissus
Modiolus rectus

Oysters

Ostrea lurida
Crassostrea virginica

Clams

Cardium corbis
Saxidomus nuttalli
Chinoe spp. including:
C. fluctifraga
C. undatella
C. succincta

Macoma nasuta, M. inconspicua
Schizothaerus nuttallii
Mya arenaria
Tagelus californianus
Petricola pholadiformis
Corbicula fluminea
Pisidium spp.
Gemma gemma
Tapes semidecussata
Protothaca staminea
Spisula catilliformis
Cryptomya california

ANNELIDIA

Nereidae

Nephtyidae
Nephtys caecoides

Glyceridae
Glycinde armigera
Spionidae
Polydora ligni
Capitellidae
Capitella capitata

Checklist of Invertebrates Included in this Key (Continued)

ARTHROPODA

Branchiopoda

Cladocera (Water Fleas)

Bosmina longirostris
Diaphanosoma brachyrum
Daphnia pulex
Leptodora kindtii

Copepods

Copepods

Acartia clausi
Cyclops vernalis
Oithona spp.
Euterpina (sp.)
Diaptomus novamexicanus

Cirripedia

Barnacles

Balanus spp.

Malacostracans

Mysidacea (Ghost or Opossum Shrimp)

Neomysis awatschensis, N. mercedis

Isopoda (Sowbugs)

Idothea (Pentidotea) wosnesenskii
Gnorimosphaeroma oregonensis
Sphaeroma pentodon

Amphipoda (Scuds, Sand Fleas and Beach Hoppers)

Microprotopus spp.

Decapoda (Shrimp, Lobsters, Crabs)

Nantantia (Shrimp)

Crago (sp.) C. franciscorum, C. nigricanda, C. nigromaculata
Palaemon macrodactylus
Hemigrapsis oregonensis
Hemigrapsis nudus
Pachygrapsus crassipes
Cancer magister
Pagurus hirsutiusculus
Callianassa californiensis

CHORDATES

Tunicates (Sea Squirts or Sea Grapes)

Ciona
Molgula manhattensis
Styela
Diplosoma

BIBLIOGRAPHY

Miner, R. W., *Field Book of Seashore Life*, G. P. Putnam's Sons; New York 1950

Davis, C. C., *The Marine and Fresh Water Plankton*, Michigan State University Press 1955

Newell, G. E. and R. C. Newell, *Marine Plankton*, Hutchinson Educational 1963

Shepherd, W. M., *A Guide to Some Tomales Bay Polychaetes*, University of the Pacific Marine Station 1964

Aplin, J. A., *Biological Survey of San Francisco*, State of California Department of Fish and Game MRO Ref. No. 67-4, 1967

Light, S. F., *Intertidal Invertebrates of the Central California Coast*, University of California Press, Berkeley, Calif., 1954

Hedgpeth, J. W., *Seashore Life*, University of California Press; Berkeley, Calif., 1970

Pennak, R. W., *Fresh-water Invertebrates of the United States*, Ronald Press, New York, 1953

Turner, J. L. and D. W. Kelley, *Ecological Studies of the Sacramento-San Joaquin Delta, Part I Zooplankton, Zoobenthos, etc.*, Department of Fish and Game of California, Fish Bulletin 133, 1966

Ibid, *Ecological Studies of the Sacramento-San Joaquin Delta, Part II Fishes of the Delta*, Department of Fish and Game of California, Fish Bulletin 136, 1966

Needham, J. G. and P. R. Needham, *A Guide to the Study of Fresh-water Biology*, Holden-Day, Inc., San Francisco, 1967

Hartman, O., *Polychaetous Annelids from California*, University of Southern California Press, Los Angeles, 1944

Ibid, *Goniadidae, Glyceridae and Nephtyidas*, University of Southern California Press, Los Angeles, 1950

Byrne, H. M. and et al, *Ecology of the Delta, Part II*, Final Report of the Junior College Workshop in Biology - Northern Section, Diablo Valley College, Pleasant Hill, California, 1964