

The Project Oceanography staff would like to thank the following people for their help in creating, editing, and presenting the Squid program materials.

**William Hamner, Ph.D.**

Doctor Hamner is the Director of the SSWIMS program and a Professor at UCLA in Los Angeles. He received a Bachelor of Arts degree in Zoology from Yale University and his Ph.D. in Zoology from the University of California, Los Angeles.

**Peggy Hamner, M.S.**

Peggy is the Project Coordinator for the SSWIMS program and a Staff Research Associate at UCLA in Los Angeles. She received a B. A. degree in Zoology and a Master of Science degree in Marine Ecology, both from the University of California, Davis.

William and Peggy have been a research team since 1972. Their research approach emphasizes the use of SCUBA or research submersibles to study individual animals in their own environment and collect undamaged live animals.

**Stacy Sinclair**

Stacy is a Marine Science Specialist at the UCLA Marine Science Center. She received a M.S. degree in Educational Leadership from Pepperdine University. Stacy taught K-12 education in the Los Angeles Unified School district for eight years. She is certified as a teacher of excellence in the Early Adolescent/Generalist area from the National Board for Professional Teaching Standards.

**Louis Zeidberg**

Louis received a Bachelor of Science degree in Animal Science from U. C. Berkley in 1994. He studied the effects of pollution on stomatopods in Indonesia, and the ability of the Atlantic bottle-nosed dolphin to acquire artificial language. He is currently a doctoral student at UCLA studying squid.

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Marcia Matz: Madrona Middle School

## Unit VII Science Standards with Integrative Marine Science-SSWIMS

### On the cutting edge...

This program is brought to you by SSWIMS, a thematic, interdisciplinary teacher training program based on the California State Science Content Standards. SSWIMS is a program provided by the University of California at Los Angeles in collaboration with Los Angeles County school districts including the Los Angeles Unified School District. This program is funded by a major grant from the National Science Foundation.

## Squid

**Lesson Objectives:** Teachers will provide students access to an integrated physics/biology unit on squid aligned with the National and California State Content Standards.

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### SSWIMS Overview

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The SSWIMS program at the UCLA Marine Science Center is designed to help educators increase their effectiveness by presenting interesting, relevant, content-based materials to students. The SSWIMS program is based on the premise that the science disciplines of physics, chemistry, biology,

mathematics, and earth and space sciences are inter-related. These disciplines can be understood and appreciated more when taught in an integrative standards-based curriculum. This curriculum uses the marine environment as its unifying theme.

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### Squid as an Appropriate Standards Topic

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The materials for the following program have been provided by the SSWIMS staff and participants. This is not a complete set of activities but rather excerpts from a larger unit designed to give educators an idea of what can be accomplished using squid. By using the materials in this packet teachers can provide students access to numerous content standards (national or state).

Through this approach, students learn in a variety of situations, having fun at the same time.



Squid were used in this program for several reasons. First, students know little about squid. Students are excited about

learning that involves living organisms and this allows teachers to cover material more quickly and effectively. Second, animals like squid provide opportunities for teachers to introduce students to various content strands along a common theme. These activities involve students in active discovery

that promotes cooperative learning while meeting the different learning levels of students within a given classroom. Third, squid have become a major food fishery. Understanding the human impact and uses of squid helps students respect the bounty the ocean offers.

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## Standards Alignment

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The power of standards-based instruction is that teachers ask themselves, **before beginning this instruction**, “What can the student produce that demonstrates meeting a standard, and how will that product or performance be assessed?” Teachers plan units by selecting the standard(s), designing a student product or performance, establishing the assessment for that product or performance, sharing the assessment with the students, planning and implementing instruction, assessing and analyzing the results, and using those results to plan further instruction.

The question most teachers ask about standards-based instruction is, “Do we change everything we have been doing, and start over?” The answer in most cases is no. Instead, we focus the delivery of content toward the standards established for a particular grade level because students are responsible for mastering the content **listed for a particular standard at their grade level**. However, concepts supporting a particular standard or set of standards, **can** be introduced, and in

some cases **should** be introduced, at earlier grade levels.

Classroom activities should be designed to address content called for in the standards. These activities should engage the learner and illustrate the relevance of the standard.

The following table illustrates the number of national science content standards that can be met using a minimum of resources. The table shows that the materials contained in this packet represent six of the eight categories and address most of the content areas.

These activities can also be easily aligned with math standards. For example, the squid race activity allows students to use math in a real life situation, by measuring rates and making comparisons. They use mathematical terminology to express their results and then to inquire into the reasons for their results. The squid recipes also provide real life applications of mathematics. Students can use the information available to calculate meal costs.

Category	Middle School Content Standard	Relevant Activity
Unifying concepts and processes in science	Systems, order, and organization	Use background information to study classification system and how it applies to squid.
	Evidence, models, and explanation	Squid races experiment
	Constancy, change, and measurement	Squid races experiment
	Evolution and equilibrium	
	Form and function	Squid races experiment Gyotaku activity
Science as inquiry	Abilities necessary to do scientific inquiry	Squid races experiment
	Understandings about scientific inquiry	Squid races experiment
Physical science	Properties and changes of properties in matter	
	Motions and forces	Squid races experiment
	Transfer of energy	Squid races experiment
Life science	Structure and function in living systems	Background information Gyotaku activity Squid races experiment
	Reproduction and heredity	Background information
	Regulation and behavior	Background information Squid races experiment
	Populations and ecosystems	Background information
	Diversity and adaptations of organisms	Background information Gyotaku activity Squid races experiment
Science in personal and social perspective	Personal health	Squid recipes
	Populations, resources, and environments	Squid recipes
	Natural hazards	
	Risks and benefits	
History and nature of science	Science as a human endeavor Nature of science History of science	The Squid unit The Squid unit

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## Squid

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written by  
Louis Zeidberg

Squid are a group of **mollusks** that swim in all of the oceans and are eaten by people in many countries. Chinese and Japanese people have dried squid into jerky for centuries; Italian fishermen prepare it fresh and have popularized it as **calamari** in America. We often eat the California market squid, *Loligo opalescens*, batter fried with tartar sauce or lightly fried in oil in a salad. If cooked for more than a minute it gets quite rubbery.



Squid belong to the class Cephalopoda and are related to

**octopuses, cuttle-fish, and nautilus.** Squid are more distant relatives of snails (gastropods), which are also mollusks. The **mantle** of the squid has transformed through evolution from the shell-producing organ of the snail into a cone shaped muscle. This is the part of the squid's body that is sliced into the rings that you eat in a calamari salad. The mantle of a squid surrounds and protects the soft internal organs and regulates water flow through the body. Gentle contractions of the mantle direct oxygen-rich water across the ctenedia (squid gills) for breathing, while hard contractions force water rapidly through the **funnel** or **siphon** to provide thrust. The funnel is directly behind and slightly below the head. It can be maneuvered to jet water in any

direction to push the squid forward, backward, and sideways. Squid also have **fins** that provide lift like the wings of a bird, and occasionally, through hard flapping, can be used for fine scale adjustment of position or slow movements.

Anterior to the mantle is the head. Cephalopods have the largest brains of all of the invertebrates. The brain is dominated by the optic lobe that receives information from the eyes. The eyes of squid are similar to mammalian eyes. Both have a **lens**, **retina**, and **iris**, and the eyes of near-shore species of squid also have a **cornea**. Squid vision is very good in low light, and although they do not see in color, they can see polarized light.



At the bottom of the head is the mouth. Like snails, squid are equipped with a **radula** –a rasping tongue with a conveyor belt of teeth. But the cephalopods have an added feature that no other mollusk has, a **beak**. It looks like the beak of a parrot and is very sharp. The mouth is surrounded by eight **arms** lined with suckers and two **tentacles**. The tentacles shoot out to grab the prey, then the squid moves forward and surrounds the food item with arms that manipulate it to the mouth.

Their skin is lined with **chromatophores**, sacks of pigments (red, yellow, brown, and black) that can be constricted to hide or expanded to show a given color. Groups of these chromatophores create color patterns that are a form of communication among squid.

Squid eat many types of **zooplankton**, mainly copepods, krill, and larval fish. Larger squid eat adult fish and even other cephalopods. They can be cannibals. The jumbo squid, *Dosidicus gigas*, of Mexico and southern California, can reach six feet long and has been filmed eating sharks and harassing divers.

Squid in turn are eaten by sharks, fish, and marine mammals such as seals, sea lions, and dolphins.

Squid have one last defense; they can squirt a blast of **ink** when panicked. The ink clouds the water, often in a shape similar to the squid itself. Once the ink is released, all squid in the area jet away. The ink contains chemicals that may be a warning sign to other squids that danger is near. This chemical makes the ink taste tangy, leading to its popularity as a sauce on pasta. I highly recommend calamari over fettuccini with black sauce (the ink).

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## Squid Recipes

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Squid have been used as food for thousands of years. They have been eaten in a wide variety of countries including Denmark, Italy, Spain, China, Japan, and the Philippines. They are even popular in the United States. More people are eating squid today because they are high in protein, low in fat, inexpensive, and can be prepared in a variety of ways. Squid can be sauted, grilled, fried, baked, or even stewed.

We have included a couple of basic squid recipes taken from the *Catching, Cleaning, and Cooking Squid* pamphlet that was written by Mildred Townsend, Christopher Dewees, and Robert Price. The leaflet was partially prepared from information supplied by the National Marine Fisheries Service and National Oceanic and Atmospheric Administration. It is a California Sea Grant Marine Advisory publication.

### Chili Squid

16-oz can stewed tomatoes  
8 oz can chili beans  
basil, oregano, and bay leaves  
8-oz Portuguese sausage, sliced  
onion, sliced  
squid mantles and arms, sliced

Sauté sliced sausage and onions in a hot frying pan. Add tomatoes, chili beans, and herbs. Bring the mixture to a boil. Add the sliced arms and mantles. simmer until the mantle turns white (2 to 3 minutes). Serve hot with rice or crackers.

### Fried Squid

egg, beaten  
1/2 cup milk  
pinch of salt and pepper  
cup of cornmeal  
1/3 cup oil  
squid mantles and arms

Mix egg, milk, salt, and pepper in a mixing bowl. Dip the squid mantles and arms in the mix and roll lightly in cornmeal. Heat oil in a hot frying pan and cook squid for about 2 minutes. Serve hot or cold with rice or crackers.

## Activity: Squid Races!

A "Reactive" Activity  
by  
Bill Tarr  
([wtarr@lausd.k12.ca.us](mailto:wtarr@lausd.k12.ca.us))

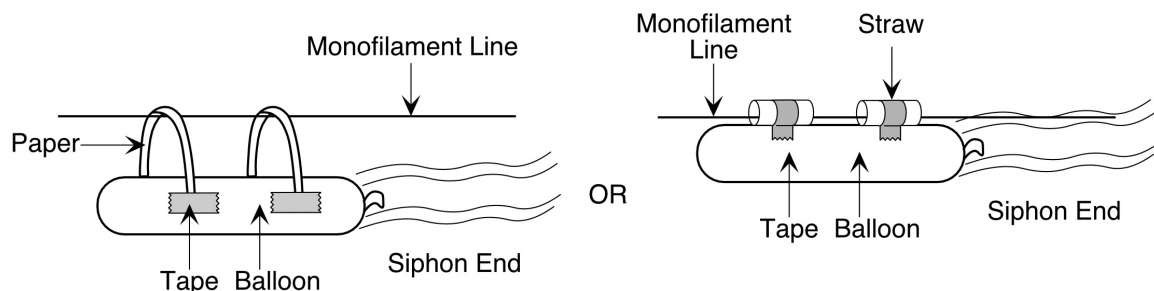
This is a fun activity that illustrates two main ideas. Obviously one of these is squid propulsion, which can be either an introductory or culminating activity when combined with a squid dissection. The second idea is for Physical Science and is a good demonstration of Newton's Third Law of Motion (for every action, there is an equal but opposite reaction). In fact, you could build an entire physics unit on animal locomotion!

### Materials:

- stop watch, measuring tape (optional)

(per group of 2 students)

- Markers to draw on a balloon (It would be wise to try this first.)
- Monofilament fishing line approximately 3 m long
- Two strips of stiff paper approximately 1cm x 1 cm, or a drinking straw
- Tape (Masking tape is cheap and works well.)
- Two chairs (or locations about the room to extend fishing line)
- A small paper clip
- String, crepe paper, streamers, or ribbon
- Pictures or diagrams of squid



### Procedure:

1. One student should inflate the balloon, and while holding the end, twist it and attach the paper clip (Do not tie the balloon!)
2. After observing diagrams of squid, students should try to make the balloon look as much like a squid as possible using the markers, string, ribbon, etc. (You should have some extra balloons at this point to replace squid lost to disaster!) **NOTE: The siphon end must be the neck of the balloon!!**
3. Once the squid are created they are ready for the races! Stretch the line across the room and tie one end to the back of a chair or a wall (Be careful



that the students don't trip or strangle themselves on the line!) Try to keep the line as high as possible, so everyone can see the race.

4. Now the students may either tape the straw pieces to their "squid" or use paper strips (as per the diagram). Let the students experiment with whole straws or cut pieces (You will find that the length of the straw makes a difference!) and thread them on the line.

Time the races and measure the distance traveled, have students calculate speed and have fun! Perhaps score the "squid" on artistic ability or anatomical correctness as well!

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## Activity: Squid Science Becomes Squid Art

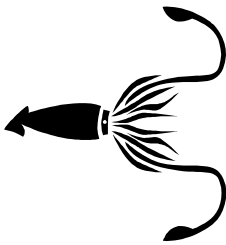
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Prepared by  
Stacy Sinclair  
National Board Certified Teacher  
[Sinclair@ucla.edu](mailto:Sinclair@ucla.edu)

### Squid Gyotaku

#### Background:

*Gyotaku* means "fish rubbing" in Japanese. Fish printing originated in Japan or China in the early 1800's. Plants have been printed in Europe since the 1400's, so this art form is practiced globally. In Japan, *gyotaku* is practiced by sportsmen to preserve accurate records of their catches. In the United States, *gyotaku* has been practiced only since the 1960's when the late Mrs. Janet Canning began to display her prints. Practicing the art of *gyotaku* is a good way to gain appreciation for the beauty and variety of marine organisms. This technique is effective for making prints of fish, shells, rocks, flowers, and other natural objects.



#### California State Science Standards addressed:

##### Kindergarten:

- How to observe and describe similarities and differences in the appearance... of animals
- How to identify major structures of common... animals

##### Grade 1

- How to infer what animals eat from the shapes of their teeth

##### Grade 3

- Examples of diverse life forms in different environments such as oceans...

##### Grade 5

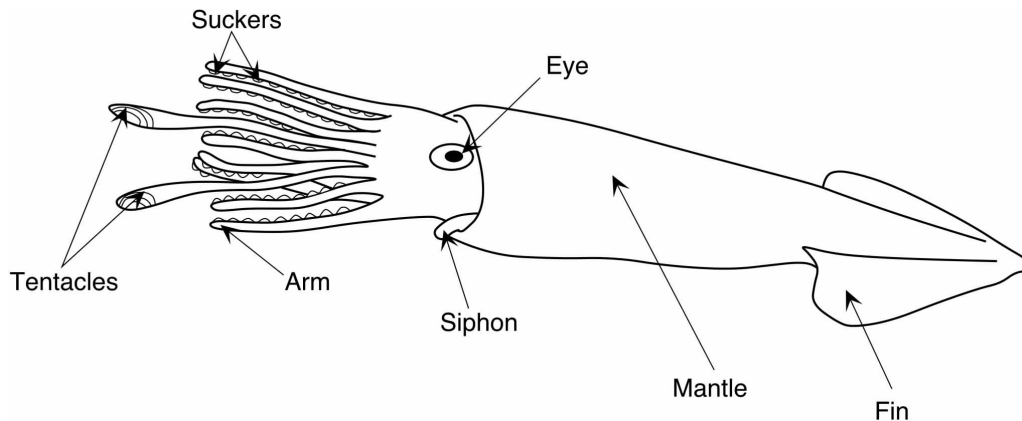
- Animals have structures for respiration, digestion, waste disposal, and transport of materials.

##### Grade 7

- The anatomy and physiology of ... animals illustrate the complementary nature of structure and function

#### Objectives:

- To record and observe the external characteristics of local squid.
- Compare the external characteristics of a sampling of local squid for similarities and differences.
- Compare the external characteristics of squid to other mollusks, and other invertebrates.



**Materials:**

- Squid - a box of frozen squid costs about \$4 for 30 squid
- Container - for holding squid when not in use
- Paints - water - based if working on paper (and if you want to use the squid later for dissection) or fabric paints for t-shirts
- Brushes - various sizes
- Newsprint or cotton pieces
- Rag or paper towels
- Newspaper
- Modeling clay
- Straight pins
- Pencil - to write person's name on their work
- Trash bags with ties to hold used squid
- Paper or 100% cotton t-shirt (washed)

**Procedures:**

1. Defrost squid by placing in a container of room temperature to warm water.
2. Clean the outside of the squid. Remove any mucus.
3. Wipe down squid with a rag or paper towel so that it is dry.
4. Place squid on a newsprint-covered table. Spread out the squid's tentacles and fins.
5. Use modeling clay and pins as necessary to separate mantle, tentacles, etc. in order to get the desired effect.
6. Brush a thin coat of paint on the squid using a 1/2" to 1" brush. If the paint is too thick, details will not come out on your print. Stroke your squid first from head to tail, leaving the eye unpainted. After you have covered the entire squid with paint, brush again from tail to head. This improves the quality of your print.
7. Place your paper (or cotton t-shirt) over the squid. Press the paper firmly with your finger over the entire painted squid. Be careful not to wrinkle or move the paper excessively. Excessive paper movement can result in "double prints"
8. Rub the entire squid.

9. When you finish rubbing, gently remove the paper. Study your results for mistakes. You can repaint the squid for another print.
10. Use a small brush to paint in the eye
11. With other brushes and paints, you can put the squid in its habitat.
12. Wash off the squid and return it to the holding container.
13. Once the print is dry, you may want to label the external characteristics of the squid.

**Closure:**

- Student's prints can be displayed and compared for similarities and differences.
- Students can compare the squid's structures for eating and locomotion with structures of other animals used for the same purpose.

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## Student Information: Squid

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Squid are interesting animals. They are often seen scooting through the water in search of a **zooplankton** meal. This meal may include **copepods** and **krill**. Squid may look harmless to you, but they can be frightening to their **prey**. Imagine a giant school of squid scooting toward you, their **arms** flailing in the water, each squid propelled forward by a **jet** stream.

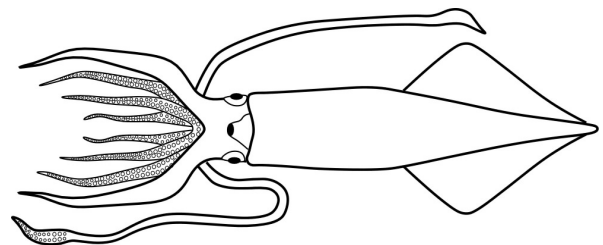
When they are ready to strike, their two **tentacles** shoot forward to grab their prey. The eight arms push the food into the sharp **beak** that tears it into smaller pieces. The food then goes into the **radula**. This tiny conveyor belt with teeth chews the food. It is then swallowed. Lunch is over.

The squid has enemies too and needs to protect itself from being eaten. How does it do this? If the squid cannot escape just by swimming, it may release a cloud of **ink**. The ink clouds the water making it easier to escape.

Squid can also communicate with each other. They do this with tiny sacs of pigments in their skin. These sacs are called **chromatophores**. As the squid changes the size of these sacs, different colors are revealed. The squid can create patterns of color by continuing to change the sac size. They can send messages much like blinking caution lights on the highway.

Scientists find squid and their relatives interesting because they have eyes that are similar to human eyes. Although they cannot see color, they can see very well in low light.

People find squid fascinating to watch and study but they are also good to eat. The Chinese and Japanese have eaten them for centuries as **jerky**. Today we have many recipes that include **calamari**. Perhaps you will eat some soon.



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## Squid Vocabulary

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**Appendage**-a smaller external body part attached to a larger body part

**Aquatic**-having to do with water

**Arms**-a long appendage projecting from the body, similar in use to a human arm;

**Beak**-hard, projecting structure in the mouth of cephalopods that is strong and sharp and used for tearing food

**Calamari**-squid prepared as food

**Cephalopoda**-a class of tentacled, marine mollusks: these "head footed" creatures have their "feet" (arms and tentacles) attached to their head

**Chromatophore**-sac in living organisms that contains pigments used to change color patterns in the skin

**Copepod**-microscopic, aquatic crustacean having an elongated tail

**Cornea**-outer clear coating of the eye

**Crustacean**-a group of animals, including crabs, lobsters, and shrimp, having segmented bodies and a hard outer shell

**Cuttle-fish**-a squid like animal that has 8 arms, 2 tentacles and an internal shell

**Elongate**-having a shape longer than it is wide

**Fin**-a membranous appendage extending from the body of an aquatic animal; used for swimming

**Funnel**-the part of the squid through which water jets to provide rapid directional movement

**Gastropoda**-a class of mollusks having a single coiled shell or no shell at all, with a foot located on the lower surface and eyes and feelers on a distinct head

**Ink**-a dark liquid ejected by cephalopods for protection

**Invertebrate**-an animal without a backbone or spinal column (not a vertebrate)

**Iris**-pigmented part of the eye that regulates the amount of light entering the eye

**Jerky**-meat that has been cut into strips and preserved by drying or smoking

**Jet**-the water that is forcefully ejected through the squid's funnel (siphon)

**Krill**-any of the small shrimp-like crustaceans of the family *Euphausiidae*

**Larval Fish**-newly hatched, early stages of a fish

**Lens**-part of the eye that focuses the light rays to make an image

**Mantle**-soft outer body wall of a mollusk; muscle

**Membrane**-a thin, flexible sheet of material

**Microscopic**-something so small that it can only be seen through a microscope

**Mollusk**- the common name for animals with soft bodies, mantles, and shells in the Phylum Mollusca; clams, mussels, snails, squid, and octopus are mollusks.

**Nautilus**-a cephalopod mollusk found in the Pacific and Indian Oceans having a spiral, pearly-lined shell with a series of air filled chambers that provide buoyancy

**Octopus**-a marine mollusk with a rounded soft body, eight arms but no tentacles, a large distinct head, and a beaklike mouth

**Optic Lobe**-part of the brain responsible for sight

**Pigment**-a substance that produces color in a plant or animal

**Predator**-any animal that catches and eats other animals

**Prey**-any animal that is hunted and caught for food by a predator

**Radula**-a tongue-like organ with rows of teeth found in some mollusks

**Retina**-a light sensitive membrane that lines the inner eyeball and that is connected to the brain through the optic nerve

**Siphon**-interchangeable with funnel

**Tentacle**-a long, flexible, whiplike appendage that may be used in feeding or as a sense organ

**Viscera**-soft internal organs of the body

**Zooplankton**-animals, often microscopic, that drift in the water

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## Media Connections

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### **Tentacles: The Amazing World of Octopus, Squid, and Their Relatives**

Martin, James, Crown Publishers, 1993, 32p. ill.

A lively and scientific introduction to the cephalopods. Enhanced with colorful descriptions, and anecdotes. Splendid photos and drawings. Glossary & index. Gr. 1-7

### **Octopus and Squid**

Hunt, James C., Monterey Bay Aquarium, 1996

A scientific view of the octopus and squid. Includes fishing, courtship and mating, problem-solving characteristics, members of the phylum and family, and fabulous color photos. Species list & index. 64 pages.

### **Adaptations in Mollusks**

American Institute of Biological Sciences, 1967

This film considers modifications that have produced today's great variety of the ancient phylum of a hypothetical primitive mollusk and shows special adaptations in sea and land snails, the carnivorous turban snail, sea slugs, clams, and oysters.

### **Adaptive Radiation: The Mollusks. Biology: Unit 6, Animal Series**

Encyclopedia Britannica, 1961

Defines mollusks and tells how classes are named, with examples of each class, and illustrates how the general form of the mollusks is adapted in various species. Relates how mollusks reproduce and tells of their value to man. Length: 18 minutes

### **Marine Biology Coloring Book** by Thomas M. Niesen, Wynn Kapit (Illustrator)

ISBN: 0064603032

Provides clear drawings of marine organisms including a page of structure and function content aligned to internal and external images. Organisms arranged in taxonomic order.

### **Incredible Suckers**, an Oxford Scientific Films Production in association with Thirteen/WNET and the BBC from Nature Video Library (60 min – Color/nr)

Provides vivid images of the cephalopods – chambered nautilus, cuttlefish, octopus, and squid. Biologist and award-winning filmmaker Mike deGruy has been studying these animals over the last 20 years. He has captured startling footage of cephalopods and their behavior in various environments.



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