Dredging. Two dredges are shown and one is being dragged along the bottom. The dredge is towed at a rate of about 2 mph. The size of the boat is such that if the dredge fouls, the boat is held and the line does not not break. A winch powered from the motor hauls up the dredge from depths of 5 to 500 ft. Deeper hauls could be made by using a bronze cable instead of rope. The dredge on the stern of the boat is the one most commonly used. Other dredges not shown are used for amphioxus and other small forms, and another type for rocky bottoms.

First Collect the Specimens -- The Marine Lab

By GEORGE E. MACGINITIE

MARINE animal and plant forms are of great interest to the biologist, chiefly for two reasons. Much experimental biological research is carried on with marine material because it is usually easily available, can be easily handled experimentally, and provides large numbers of eggs. This last characteristic permits experiments with large quantities under controlled laboratory conditions, and provides an excellent supply of raw material for embryologists. The second reason for biological study of marine organisms is the desire for knowledge of the natural history of these forms. The ecology, or relationship between these plants and animals and their environment is a field which has drawn the interest of many biologists in the past and today.

However, detailed study, both for experimental purposes and for ecological information, must be conducted in the laboratory. Collection of marine organisms is therefore necessary.

The William G. Kerckhoff Marine Laboratory of the California Institute's Biology Division, located in Corona Del Mar, on the east side of Newport Bay about one-half mile from the entrance, is ideally situated for the study of marine life. The flora and fauna of the region are abundant and encompass a great diversity of forms. Seaweeds grow profusely on the jetties and on the rocky shores toward Laguna Beach. The region supplies all types of marine habitats for animals: rocky shores, rock jetties, mud flats, sandy beaches, the ocean bottom, and the open water of the ocean. Mud flats, rocky shores and sandy beaches are all within walking distance of the Laboratory. It is possible to collect members of all of the major groups of marine animals for experimental purposes. To mention a few, there are ample supplies of sponges, hydroids, jelly fishes, sea anemones, sea pens, flatworms, annelid worms, echiuroid worms, sea urchins, sand dollars, star fishes, mollusks, crabs, lobsters, tunicates, balanoglossus, amphioxus and fishes.

Good boating facilities are a necessary adjunct to the activities carried on at a marine laboratory in order to obtain the material needed for biological research. The Kerckhoff Marine Laboratory is very fortunate in this respect. Newport Harbor is out of the belt of northwest winds which prevail farther north along the California coast, and the channel islands have something of a dampening effect on large ground swells from the open ocean expanse, so that it is possible to engage in towing or dredging operations almost any day of the year.

The Laboratory owns a 26 foot boat, equipped with a 40 hp engine, which is used for making plankton tows and for dredging operations. There is also a skiff that can be used for collecting in the vicinity of the Laboratory within the entrance of the bay. An ample wharf extends from the Laboratory into the bay.

Diatoms and Dinoflagellates, tiny microscopic plants which float on or near the surface of the ocean in great quantities, sometimes tons per acre, furnish food for a great variety of species of animals. The surface waters of the ocean therefore are very rich in living forms. To obtain these, open ended, cone-

The Haul. These specimens were obtained near the harbor's east jetty in from 10 to 20 ft of water. The haul included sea urchins, sea cucumbers, and cushion stars that can be used for experimental embryology. In addition, there is a lobster used for problems in immunology and for protein studies and a moon shell snail used for physiological studies, interesting because it has pink nerves. Dozens of new species have been found near the Laboratory.

shaped nets are towed through the water with the open end toward the boat. Plants and animals are thus strained out and collect in a glass contained securely fastened in the small end of the net. This material is brought to the Laboratory where that to be used for research purposes is separated out.

Perhaps the greater amount of material obtained with the boat is from the ocean bottom. Many types of dredges and collecting mechanisms have been devised for obtaining particular specimens for study. Some animals live in the rough rocky regions and others live upon or burrow within the smooth muddy floor of the ocean. The surface-dwelling forms on the smooth floor of the ocean are easily obtained, but for the burrowing forms, which are very numerous and of many diverse species, some type of dredge must be used which will dig into the ocean floor and bring the animals to the surface where they are caught in a net that either follows behind or is a part of the digging apparatus.

Collectors have found that the best type for obtaining animals from the rocky bottom is a small, heavily-built, three-cornered dredge. This type of dredge scrapes animals or seaweeds from the crevices and is much less likely to foul and become fast in the rocks. Rough animals like certain star fishes and spiny sea urchins may be obtained by entangling them in an old piece of fish net which is dragged over the rocks. When animals are dredged they are placed in a live-tank aboard the boat through which a stream of ocean water is pumped so that the animals remain fresh and suitable for use when they arrive at the Laboratory.

The Laboratory is a two-story, cement, Spanish-type building containing four large rooms and several smaller ones. It was purchased in 1929 and soon thereafter equipped with a salt water system, and a road was built so that cars could reach the laboratory grounds. The large laboratories and one of the small laboratories are equipped with aquarium tables and aquaria. Salt water, which is pumped daily at high tide to a 5000 gallon tank on the roof of the Labora-

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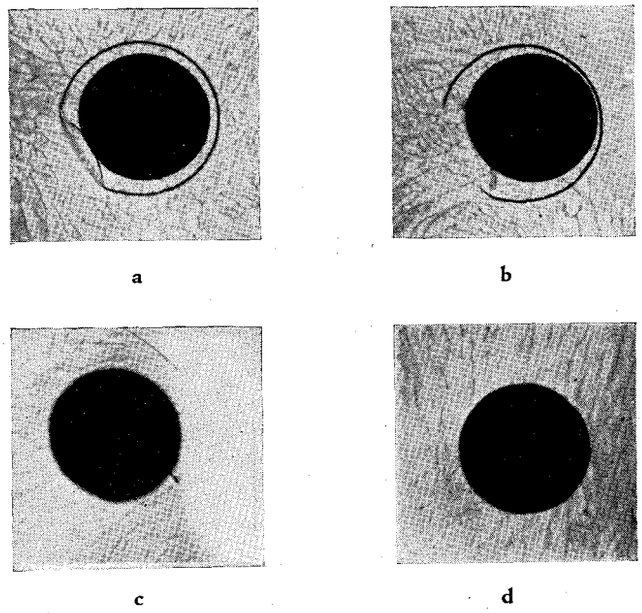
Laboratory Scene. Right foreground: Opening sea urchins to obtain sex products for respiratory experiments. Background: Sorting the dredge haul for unusual specimens, which are sent to specialists all over the world. Left foreground: A typical salt water table with its aquaria. The small aquarium is for photographic work. The larger aquaria and jars contain certain animals which are being kept for feeding problems and growth rate records, and others for solving problems in natural histories and life histories.

paring for Medicine. Graduate students majoring in Embryology pursue advanced courses, seminars, and research in Experimental Embryology along with advanced studies in other departments of the Division of Biology, in Chemistry, or in Physics.

OPPORTUNITIES FOR EMBRYOLOGISTS

There has been a gradually increasing demand for embryologists from various sources apart from the universities. Mention may be made of a few such opportunities for non-academic work. In laboratories engaged in production of vaccines, trained embryologists are often employed in connection with the cultivation of viruses on the membranes of chick embryos. Openings for embryologists may be found in fishery stations, in the fish industry, in laboratories and farms engaged in Animal Husbandry (including artificial insemination and poultry raising), in laboratories and enterprises concerned with Endocrinology (production of, or testing for, hormones), in control work in industries involved in radiation work, and even in the paint industry in connection with such things as development of anti-fouling agents. As in other biological fields, completion of advanced work beyond the bachelors' degree and broad training in Chemistry and Physics as well as in Biology are of advantage to men seeking a career in teaching, research, or industry.



Photomicrographs of an egg of a marine mollusk, the keyhole limpet, showing the dissolution of the egg membrane by means of an enzyme derived from sperm of the same species. Pictures taken at a, 1 minute; b, 1¾ minutes; c, 2½ minutes; and d, 3¼ minutes after addition of the enzyme solution. (From Tyler, 1939).

First Collect the Specimens

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tory, flows by gravity through lead pipes to the aquaria in the laboratories. With the type of installation in use, and its proximity to the entrance of the bay, the salt water system is very efficient, making it easy to culture marine larval forms or maintain adult animals. The temperature of the water in the aquaria in the laboratory is never more than one degree above that of the ocean water.

During 1932, 1933 and 1934 a rather complete survey of the animal population was made, both of the bay animals and the outside ocean fauna. Now when a particular animal is needed for experimental work, a suitable type of dredge is selected and dredging is carried on over the type of bottom that that particular organism inhabits. With few exceptions, however, towing or dredging for a particular animal cannot be done without obtaining a sample of animals of the region. So many new and interesting specimens are still being brought in.

This availability of material means that by towing, or dredging, or collecting on mud flats or rocky shores, living marine material for almost any type of experimental biological research may be supplied. Visiting professors usually come to the Laboratory with a definite problem in view, and so know what organisms they need to carry on their research.

A great deal of work has been done on the respiratory requirements of fertilized eggs and the developing larvae. Another embryological study is based on the fact that most marine animals discharge their sex products directly into the sea water, where fertilization takes place. To prevent waste, nature has provided such animals with an enzyme called fertilizin. When one animal spawns the fertilizin released at the same time causes all other individuals of the same species in the near vicinity to spawn. The determination of the chemical nature and the function of fertilizin has been a problem receiving much attention at the Laboratory.

Many life histories of marine animals are being solved because it is easy to raise larvae in the laboratory. And, because of the ease of simulating natural conditions within the laboratory, much information is being added to our knowledge of the natural history of marine forms.

Marine animals have great powers of regeneration. In some forms, a small piece of an adult will grow into a new animal, in other a new leg grows when one is lost. A star fish that is being used in regeneration experiments grows an entire body from a piece of an arm.

The crustacea of the region furnish material for experimental nerve physiology, and from them a great deal has already been learned about the inhibitory portion of the nervous system. Some of the fishes also afford excellent material for nerve study. The blood of star fishes and of lobsters is being used for studies in immunology, and for protein and amino acid investigations.

Until his death in late 1945, Dr. Thomas Hunt Morgan made use of the Marine Laboratory. where he carried on experiments on the genetics and development of the tunicate **Ciona.** This tunicate is hermaphroditic, that is it is functional both as a male and a female. However, it will not fertilize its own eggs. By treatment with dilute acids or by other means, it is possible to fertilize an individual's eggs with its own sperm. Because of the salt water system, the resulting offspring can be raised to maturity, and thus successive generations from a single parent can be obtained.

The Laboratory is open to biology students of the Institute, members of the Division of Biology, and visiting research workers from other divisions or from other institutions. Undergraduate biologists are required to take a month's work at the Laboratory in the summer following their sophomore year.