# The Egg in Kerckhoff

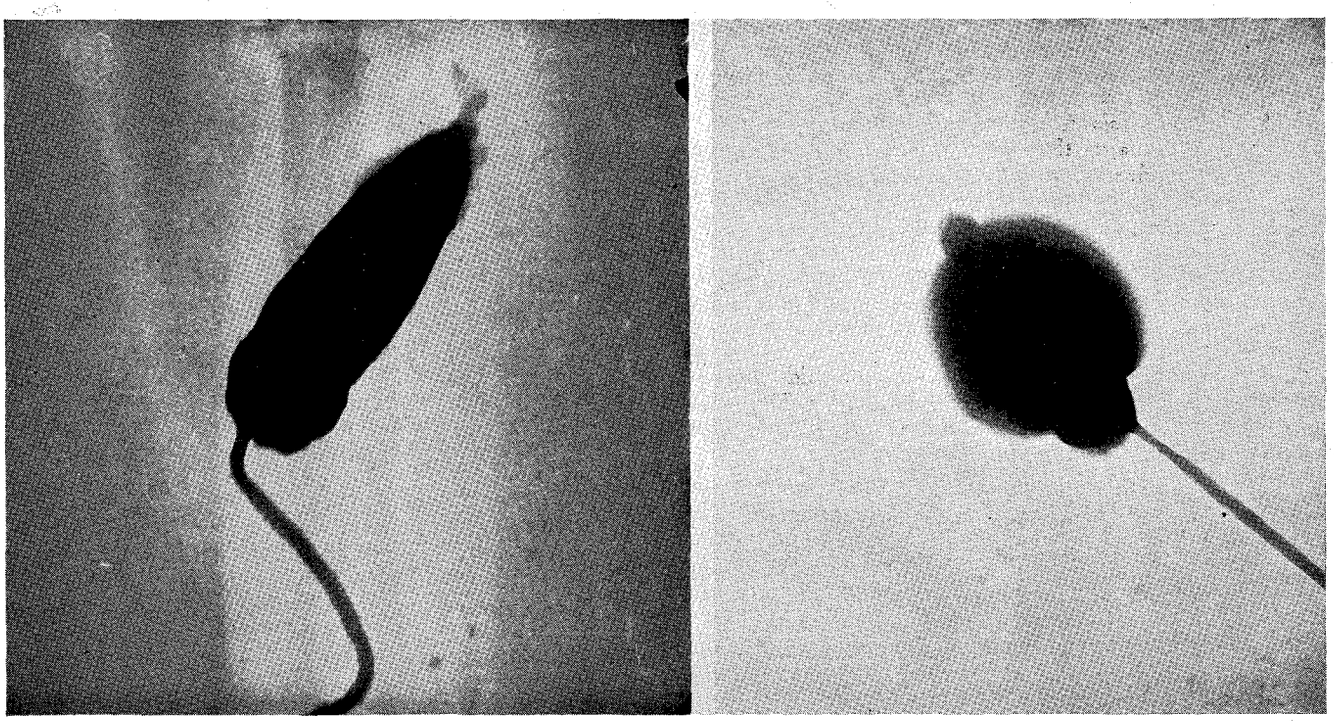
By ALBERT TYLER

RESEARCH in Embryology is directed toward finding the basic causes of the transformations involved in the development of an adult organism from the egg. It is now well established that the main principles and features of development are the same in most multicellular animals; so that discoveries made with eggs and embryos of one kind of animal apply in general to practically all others. This, then, means that the main problems of development may be studied in species that are most suitable for the particular process under investigation, that are most easily handled experimentally, and that provide large numbers of eggs. These characteristics are particularly true of various marine animals. Since the Division of Biology has a Marine Laboratory within a short distance of Pasadena, we are in an especially advantageous position for carrying on such research.

## IMMUNO-EMBRYOLOGY

Various kinds of embryological problems have been investigated by the staff and students at the Marine Laboratory and at the main laboratories in Pasadena. These deal mainly with the early stages of development, and for the most part the research is along the line now known at Chemical Embryology, which seeks to identify the chemical reactions responsible for various embryological processes. At present much of the work is concerned with problems of fertilization, which comprise the all-important initial steps in development. Studies in this field have shown the processes of fertilization to be very largely analogous to those encountered in the field of Immunology, and the investigations have proceeded on that basis. Thus, for example, not only does the engulfment of the sperm by the egg in fertilization resemble the phagocytic processes studied by immunologists, but there are specific substances obtained from eggs and sperm that interact in the manner of antigen and antibody. One kind of substance obtained from sperm is an enzyme that dissolves certain membrane barriers surrounding the egg and this same agent is also found in various pathogenic bacteria, in venoms, etc., where it evidently acts by enabling the toxic material to invade the tissues of an animal. So, it may be seen that studies of fertilization are related to those of infection. To implement this approach, immunological laboratories were set up jointly by the embryologists and Professor Sterling Emerson, who found similar relations of Immunology to his problems in Genetics. These immuno-genetics and immuno-embryological laboratories have been equipped and supported largely by grants from the Rockefeller Foundation.

As part of the students' general biological training, a course in Embryology is included in the undergraduate Biology Curriculum. This course includes some experimental work along with the more standard descriptive studies. Along with this a course in Microscopical Technique and Histology is given by the Department. These subjects serve as preparation for advanced work in Embryology, for the work in related fields such as Genetics and Physiology, and as part of the pre-medical requirements for students pre-

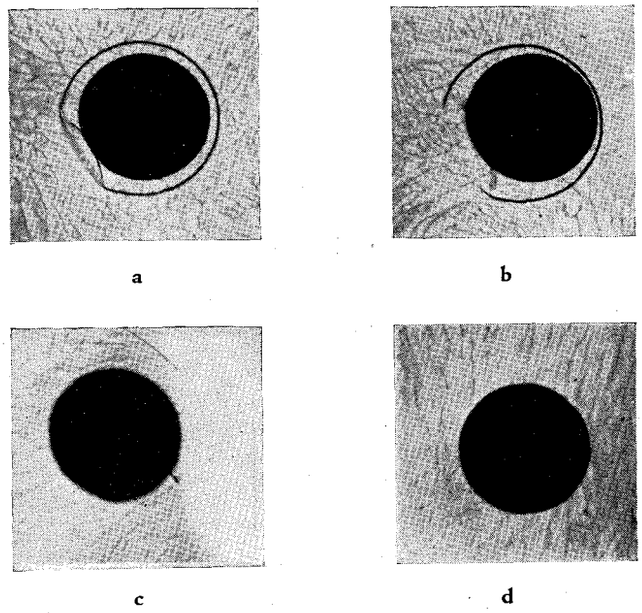


**The head and part of the tail of the spermatozoon of a sea urchin taken with the electron microscope at a magnification of 30,000X. These two pictures illustrate the effect of extracting from the spermatozoon one of the specific substances involved in fertilization. On the left is the normal and on the right the extracted spermatozoon. They show that the active material is evidently derived from the nuclear region of the head, which becomes rounded, swollen, and less dense after extraction, while the acrosome, midpiece, and tail remain relatively unaffected.**

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.