THE DEVELOPMENT OF A MOLLUSK.

Scattered all along the Atlantic coast, from Labrador to Florida, is a genus of mollusk known to zoology as *Crepidula* which, despite its abundance, has been so little studied that only comparatively recently has anything definite about its embryology been known. To Prof. E. G. Conklin, of the University of Pennsylvania, we owe the first account of the life history of crepidula. With the results of Prof. Conklin's inquiry before him, Dr. Dahlgren, head of the department of preparation of the American Museum of Natural History, has directed the making of a series of models to illustrate the life history of crepidula, of which models the accompanying illustrations are photographs. The models excellently show those series of active changes which take place in the nuclei of a living cell in the process of division, changes which are designated by the general name karyokinesis. Furthermore they show that many of the organs of the fully-formed animal may be traced back to certain individual cells in the early division stages of the egg. Each of these first-formed cells has its own peculiar shape, size and position, and it invariably gives rise to a particular organ, or part, of the developed animal.

In Fig. 1 we see the undeveloped egg of the crepidula. The two dark spots represent the male and female, or sperm and egg, nuclei which do not fuse before the appearance of what is known as the division spindle. The dark zone represents the animal pole of the egg, or the protoplasmic portion; the lower or more lightly tinted part is the yolk, constituting the vegetal pole of the egg. Two polar bodies are invariably thrown off during the maturation of the egg, which precedes its union with the spermatozoon. Every nucleus contains a substance known as chromatin, which, in the process of division, forms various colored figures, such as disks and threads.

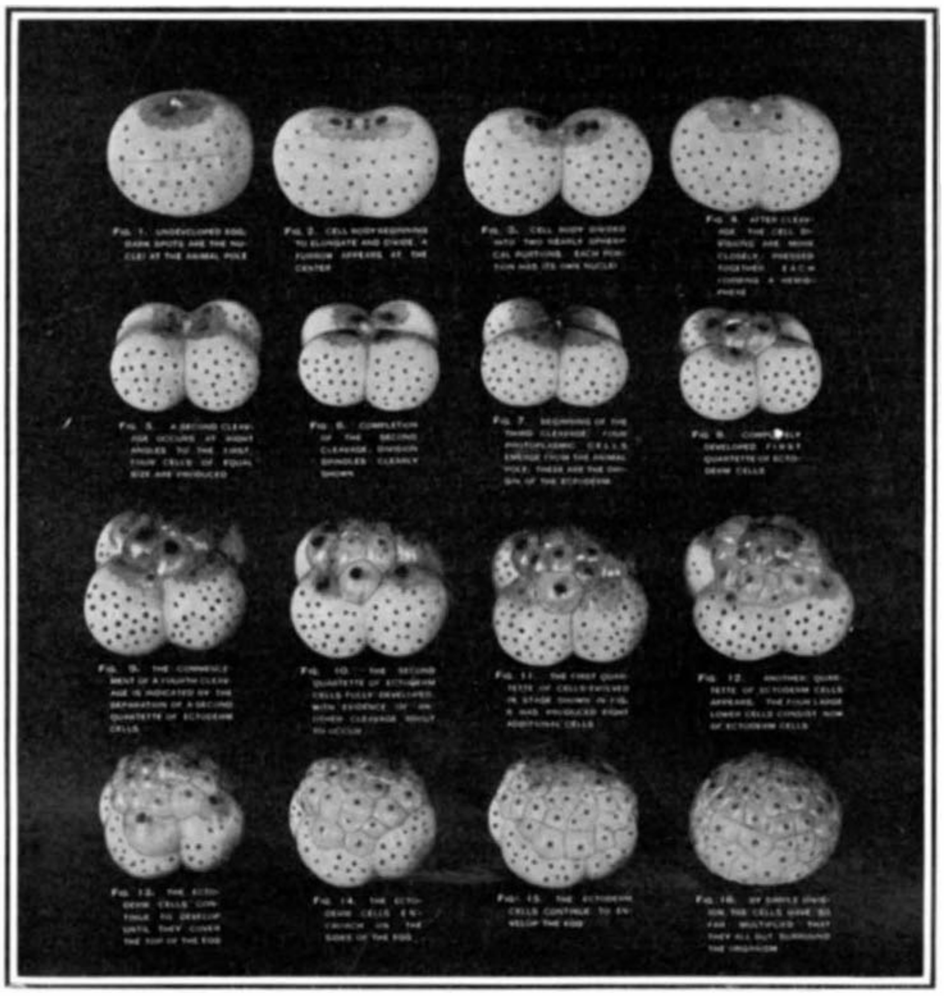
After the chromatin has been distributed equally to the two poles of the division spindle the cell body begins to divide, as shown in Fig. 2. The egg elongates and the entire cell is constricted about the central axis. The cell body then divides into two equal portions, which are at first nearly spherical and touch each other only at a comparatively small surface, as shown in Fig. 3. Each of the halves thus formed has its own nucleus, the two nuclei shown in Fig. 1 having each given up half of its material to form one of the new nuclei. Later the two cells are more closely pressed together and the surface of contact becomes larger, so that each cell forms a hemisphere (Fig. 4). One of these cells forms the anterior half of the future animal, the other the posterior half.

The peculiar karyokinetic markings, shown in Fig. 4 by the four black spots at the upper pole of the egg, indicate that when the cell has reached this stage, another cleavage is about to occur in a plane at right angles to the first. Two fairly independent furrows are produced, appearing near the animal pole and running around until they reach the vegetal pole, forming four blastomeres of approximately equal size. The same elongation of the two cells which characterized the beginning of the process of cleavage, as illustrated in Fig. 2, again takes place. Each nucleus during division breaks into what are known as division spindles, the production of which also marked the first cleavage (Fig. 2). In Fig. 6, the second cleavage is shown complete. This second cleavage lies in the median plane of the future animal and divides its body into right and left portions.

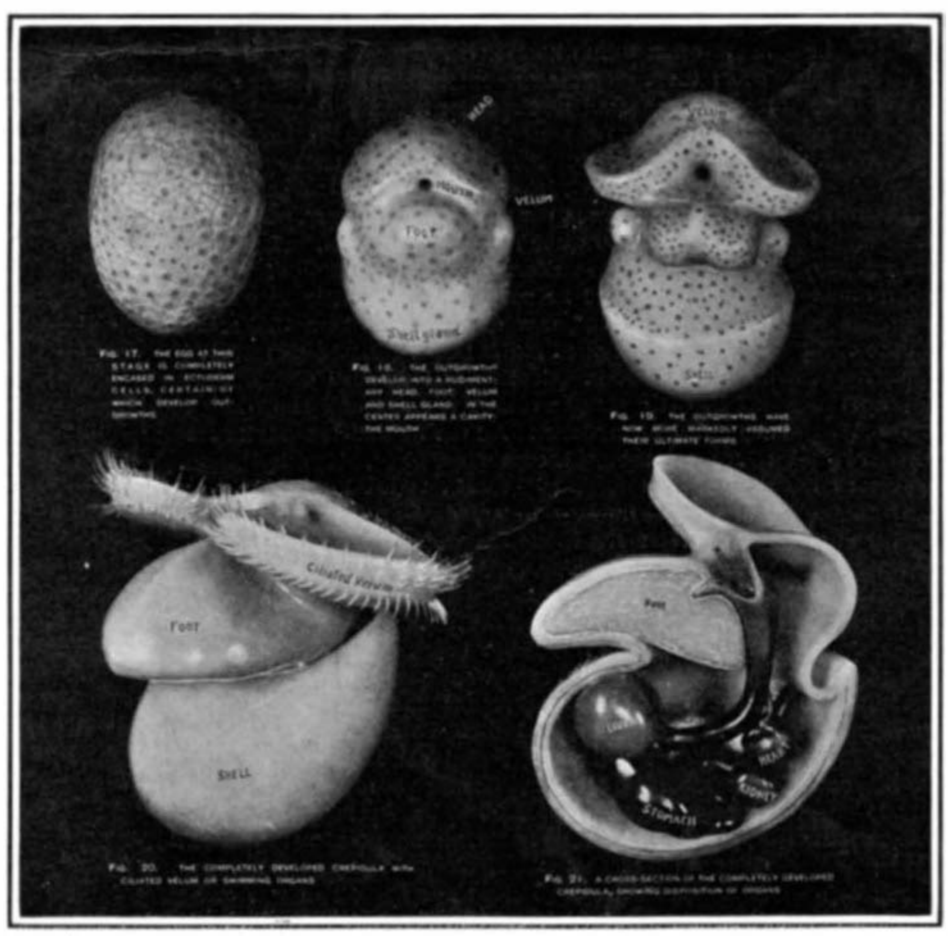
Up to this time, cleavage has been equal. There have been two cleavage planes at right angles to each other; but now another phenomenon takes place. The next cleavage gives rise to four small protoplasmic cells at the animal pole of the egg. These are the first beginnings of the ectoderm, which is subsequently to envelope the whole egg and become the integument of the animal's body (Fig. 9). The head and brain of the future animal come from these four small cells.

In Fig. 9, the beginning of the fourth cleavage is indicated by the separation from the larger cells of another quartette of small ectoderm cells. These develop until they assume the size and shape shown in Fig. 10. As the animal continues to grow by this process of division, the first quartette which was formed in the stage shown in Fig. 8 has been split up into eight cells, so that we now have twelve ectoderm cells in all (Fig. 11). The karyokinetic figures in the larger cells indicate that the separation of a third quartette of ectoderm cells is about to take place. The second and third quartettes give rise to all the ectoderm of the future animal except that over the head. A large cell is now formed at the posterior pole of the egg (Fig. 13) which contains all the substance of the middle layer or mesoderm of the future animal. The four lower large cells, which now, after separation from those of the ectoderm and mesoderm, consist entirely of entoderm cells, are destined to form the internal lining of the future mollusk's digestive organs. Tracing the process of evolution still further we find that in Figs. 13 and 14 the ectoderm cells have increased by simple division until they cover the top of the entire egg. Finally, in the stage represented in Fig. 16, these cells are shown all but surrounding the embryo. Soon they completely surround it, leaving only a very small opening—the mouth (Fig. 17). The embryo now assumes a more decidedly ovoid shape. Certain lines of cells shown in Fig. 17 develop into outgrowths or projections, constituting the more striking features of Fig. 18. These outgrowths are the head at the top and the velum which lies below it; the foot in the center, with the mouth a mere cavity above it; and at the bottom a gland which secretes the shell. In Fig. 19, we find these outgrowths have more pronouncedly developed into the forms they will ultimately assume. The velum assumes almost a mushroom-like appearance. Finally we have the fully developed larva or veliger, shown in Fig. 20. Here we see the velum with its several rows of cilia, which are nothing but swimming organs highly essential to a sessile mollusk, because the animal is dependent upon them for the distribution of the species. In Fig. 21, we have a median section of the completely developed mollusk, each of the parts being properly labeled.

The terms velum and veliger require some explanation. The velum, as its name indicates, is a veil or sail which is a highly characteristic ciliated formation of the molluscan embryo serving as an organ of locomotion in that stage when the embryo is called a veliger. It is usually soon lost, but in some cases it is retained permanently in a modified form.



The First Stages of a Mollusk's Growth.



The Last Stages of a Mollusk's Growth.

THE DEVELOPMENT OF A MOLLUSK.

New Fire-Damp or Gas Indicator.

A new automatic apparatus for indicating the presence of illuminating gas or fire-damp in the atmosphere has been brought out by Messrs. Hauger and Pescheux, of Paris. The apparatus is composed of a very sensitive balance which carries at one end of the beam a tight recipient containing ordinary air, while it is balanced at the other end by a plate having the same surface. Thus the apparatus is at rest when the surrounding air is in the normal condition for respiration. Should the composition of the air change, its density is modified according to the amount of gas which is mixed with it. In this case as the air which the vessel contains is invariable, seeing that the vessel is tight, the balance is destroyed. If the foreign elements are lighter than the air, the vessel goes down, and the reverse is the case where the mixture becomes denser than the air. The balance is arranged so as to plunge a needle into a mercury cup and close an electric circuit. Thus a bell can be rung or other apparatus worked even at a distance, and this can be of great utility for mines. In the case of private apartments the current can be made to operate an automatic device for opening a window, ringing an alarm bell at the same time. As the needle is regulated at will, we can make the apparatus work for any desired degree of the gaseous mixture. In order to neutralize the atmospheric influences of temperature and pressure, the inventors use two compensating devices which are mounted upon the scale beam. One of these is used to correct the pressure variations and consists of an aneroid chamber which acts on a multiplying lever so as to displace a rider along the scale beam, thus keeping the balance constant under varying air pressures. Heat influences are compensated by a composite metal spiral which acts upon a lever and shifts a rider upon the beam in the same way. When once it is accurately calibrated, the instrument is invariable at different temperatures and pressures.

The power generated in a modern steamship in a single voyage across the Atlantic is enough to raise from the Nile and set in place every stone of one of the great pyramids.