Literature

Biology a Science of Experiment

CUVIER classified the sciences into three categories: the sciences of calculation, as pure mathematics, most of astronomy and part of physics; the sciences of experiment, as most of physics and chemistry, and the sciences of observation, as natural history. And in the order as they stand do these different groups of sciences approach exactness and certainty in their claimed facts. The sciences of zoölogy and botany and geology, then, are the least sure as to fact. To make them more certain it is necessary to raise them, if possible, from sciences of mere observation into sciences of experiment and calculation.

About 1880 Carl Semper, the zoölogist of the University of Würzburg, wrote a book called "Animal Life as Affected by the Natural Conditions of Existence" (published in the familiar red-bound International Scientific Series), in which he laid the foundation, or at least pointed the way, to make biology, in part at least, a science of experiment. In 1897 Charles B. Davenport, then instructor in zoölogy in Harvard, now director of the Carnegie Laboratory for Experimental Evolution, gathered together in two volumes under the title "Experimental Morphology" the facts known at that time touching the relation of individual plant and animal reactions to environmental or extrinsic influences. And now comes the latest summary account from Dr. Morgan,* professor of experimental zoölogy in Columbia University, of the status of the study of animals by experiment.

Since Davenport's book several European books have appeared, as Haake's, Maas's and Przibram's, and a journal for the publication of original investigations along this line (*Archiv für Entwicklungs Mechanik*) has been established. Also the general papers of Roux, Hertwig, Herbst, Driesch and other active Continental experimental zoölogists have been published. But most of these books and papers limit their attention to experimental work with the egg and immature stages of animals—that is, to animal development, and Morgan's is really the first satisfactory authoritative account of experimental zoölogy in all its phases. This is at once an evidence of American interest and activity in this modern aspect of biological investigation and a reason for our self-congratulation.

What is experimental zoölogy? The first step in the development of a fertilized frog's egg is a splitting or cleavage quite thru the tiny mass of protoplasm and yolk (altho the halves do not separate, but remain within the egg membranes and apposed). Now this first cleavage occurs in nature regularly parallel to the pull of gravity. Is the direction of this cleavage perhaps determined by gravity? By compelling the egg, which has its yolk and germinal plasm definitely arranged with regard to each other, to lie so that the axis normally parallel to gravity is at right angles to it, and noting the direction of the first cleavage in eggs so placed, it may be determined whether this direction is caused by gravity or by some more intrinsic influence, such as the relative disposition of yolk and plasm. Does this first cleavage which divided the yolk and germ plasm into halves indicate the median plane of the future embryo, or, in other words, is each one of these halves of the egg predetermined to produce a right or left half of the developed frog? By killing or removing by delicate manipulation one or the other of these halves the answer to this question may be found out.

What is fertilization? Is a sperm cell actually necessary to initiate and maintain the development of an egg cell? Loeb's experimentally obtained results in initiating by physico-chemical stimuli the development of unfertilized egg cells of sea-urchins and other animals help toward getting answers to such questions.

And so on. Experiment in biology is the introduction into the zoölogical and botanical laboratories of the familiar

* EXPERIMENTAL ZOÖLOGY. *By T. H. Morgan.* 454 pp. 25 Figs. New York: The Macmillan Company. $2.75.

processes of the physical and chemical laboratories, whereby conditions are known, controlled, measured and modified, and the corresponding results or effects are accurately noted. Such methods have already been applied to determine the influence of external conditions in causing changes in the structure of animals, the effects of hybridization, the factors that influence growth and development, the factors that determine sex and secondary sexual characters, etc.

Professor Morgan's book is the best, indeed the only up-to-the-moment abstract of the results and the various phases of this experimental investigation of the life and make-up of animals. It is not primarily a book for the general reader, but there is no other for him on the same subject. And he can better afford not to understand a few of Professor Morgan's references and yet be able to rely on what he does understand as being true, than to look for a more popular and less reliable account.