tention of the calcium sulphate method for testing for barium and strontium, which has been abandoned by Fresenius and others, is open to criticism, and the failure to mention de Koninck's excellent potassium cobaltic nitrite test for potassium seems unfortunate in view of the increasing cost of platinum, and of the fact that the test is much more delicate than the one with hydrochloroplatinic acid. Those who have used Gooch's separations of lithium chloride from sodium and potassium chlorides, and of calcium nitrate from strontium nitrate, by means of amyl alcohol, will regret that they receive no mention here.

A striking and valuable feature of the book is the elaborate treatment of the equations of the reactions. In these equations the formulas are frequently rather elaborately developed according to the theory of valency, a practice which at times seems to involve an unnecessary waste of space, on account of the uncertainty of the positions of the atoms in the inorganic compounds.

The part on the acids is unusually full and extensive, including a number of acids that are not usually considered in the text-books. There is a supplement, also, which deals with the rarer metals.

Analytical tables, to which some teachers object, are freely used, but it is stated that in the author's experience these have given the best results.

The translation appears to have been very well done, but a number of errors, particularly in the equations, indicate some lack of care in proof-reading. H. L. W.

The Movements and Reactions of Fresh-water Planarians: A Study in Animal Behaviour. By RAYMOND PEARL, Ph.D. *The Quarterly Journal of Microscopical Science.* Vol. 46, 1903, pp. 509–714.

This paper from the zoological laboratory of the University of Michigan gives a detailed account of a very thorough and careful study of the behavior of planarians. Dr. Pearl states in his introduction that it is his purpose to give such a complete account of his observations that no desired information concerning the work shall be lacking. In America, especially among physiologists, the tendency is to limit papers to the bare statement of results; details of method and observation are omitted. This Dr. Pearl considers an unfortunate tendency; he, therefore, presents a minutely descriptive paper. But even two hundred pages on planarian behavior are not tiresome in this case, for the paper is written with a noteworthy clearness, accuracy and precision of statement. Everywhere it inspires confidence in the reliability of the observations and experiments. The author's painstaking care, resourcefulness and enthusiasm for research are unmistakable. Although Dr. Pearl is evidently responsible for the whole of this study, he gives generous thanks to Professor Herbert S. Jennings for suggestions, criticisms and general helpfulness. Professor Jennings is really the pioneer in the analytic study of animal behavior in this country, and his excellent work on the reactions of unicellular organisms is inspiring many to research along similar lines.

In the paper at hand we find the following chapters: (1) 'A Résumé of the Literature Bearing on the Subject,' (2) 'A Discussion of the Habits and Natural History of Planarians,' (3) 'A Description of the Normal Activities of the Animals,' and (4) 'A Consideration of Their Reactions to Stimuli.' In this chapter the author deals with: (*a*) reactions to mechanical stimuli, (*b*) reactions to food and other chemical stimuli, (*c*) thigmotactic and righting reactions, (*d*) reactions to an electric current, (*e*) reactions to desiccation, and (*f*) reactions to currents of water (rheotaxis).

Throughout the investigation Dr. Pearl's aim has been to analyze all the reactions into their reflex components and to describe the mechanism of each reaction. Briefly stated, the most important results of the investigation are as follows: (1) The normal locomotor movements of planarians are two: *gliding,* by the beating of the cilia on the ventral surface, and *crawling,* due to longitudinal waves of muscular contraction. (2) The animals fa-

tigue quickly and periods of rest alternate with periods of activity, as in more highly organized animals. (3) There is surprising sensitiveness to mechanical stimuli; it is found that even touching the surface of the water near the animal with a needle point causes a visible reaction. (4) Two types of reaction are given to stimuli: the *positive,* which is called forth by weak unilateral stimulation of the head region, serves to take the animal toward the stimulus (important for the obtaining of food); the *negative,* which results from strong stimulation of one side of the anterior region of the body, evidently serves to take the animal away from harmful stimuli. (5) Dr. Pearl calls attention to the fact that *intensity* and *not quality* of stimulation determines which kind of reaction shall be given. In case of all chemicals whose effects were studied it was found that to all solutions above a certain strength the negative reaction was given; to those below, the positive. (6) The reactions to chemicals are practically identical with those to mechanical stimuli. (7) There is no evidence that planarians orient themselves with reference to the lines of diffusing ions of a chemical; instead the reactions are merely repetitions of the positive and negative reactions mentioned. A planarian in the neighborhood of a piece of meat does not turn directly toward the food substance, thus bringing its long axis parallel to the diffusion lines of the substance, but glides along without any evident uniformity of relation to the lines. If it chances to be headed toward the meat when it enters the region of diffusion it obtains the food directly, if not, it continues its forward movement until it is stimulated to give the positive reaction. Thus, the forward gliding followed by the positive reaction may be repeated several times before the organism happens to come in contact with the food substance. (8) The ventral surface of planarians is strongly positively thigmotactic, whereas the dorsal surface is negatively thigmotactic; hence, when turned over so that the dorsal surface is in contact with a solid, the animal immediately rights itself by an extension of the edge of the body which is in contact with the solid. The analysis of the righting reaction given by the author is admirable. (9) The reaction to a constant electric current consists of a turning of the head toward the kathode.

As the author says: "All the normal reactions to stimuli are of the nature of reflexes, more or less complex. What the animal will do after a given stimulus, or in a given situation, can be predicted with reasonable certainty. There is, however, some variation in the behaviour, depending on the physiological or tonic condition of the individual at the time of stimulation. Thus a stimulus sufficiently weak to induce the positive reaction in one specimen may cause the negative reaction in another; or at different times the same individual may show different reactions—either the positive or negative—to the same stimulus" (p. 703).

Concerning the psychological position of planaria Dr. Pearl makes some very sane remarks. His study enables him to say that the reactions of this flat-worm are much more complicated than those of the unicellular organisms as described by Professor Jennings. There is, moreover, a certain amount of variability and adjustment to the demands of a situation. The chief function of the planarian brain is the 'preservation of the tonus of the organism,' while the main function of the nervous system as a whole is 'the rapid conduction of impulses.' Dr. Pearl says he does not think we can say whether the worms possess consciousness or not. And he adds: "Any 'objective criterion' of consciousness does not exist." He might well have said that *no such criterion is possible.*

One might with some cause criticise the paper on the ground of undesirable prolixity. The author has everywhere given full descriptions of his methods and results, and in addition he frequently gives diagrams to illustrate the reactions. Sometimes these diagrams are quite unnecessary in view of the simplicity of the reaction and the clearness of the verbal description. There is also unnecessary repetition throughout the paper. The author has gone to the opposite extreme, in his effort to avoid the omission of significant details.

For the work itself we have only praise. It is an important contribution to comparative physiology.

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A Course in Invertebrate Zoology. A Guide to the Dissection and Comparative Study of Invertebrate Animals. By HENRY SHERRING PRATT, Professor of Biology at Haverford College and Instructor in Comparative Anatomy at the Marine Biological Laboratory of the Brooklyn Institute of Arts and Sciences at Cold Spring Harbor, L. I. Boston, Ginn & Co. 1902.

Dr. Pratt's 'Invertebrate Zoology' is strictly a laboratory book, intended to give the student all the information and directions which are needed for the intelligent laboratory study of animals, and nothing more. In this the author has as a rule succeeded admirably. His attempt is to give such practical directions that the student can go on with his work profitably without having an instructor at his elbow. In carrying out this attempt he has not hesitated to give directly such information as is necessary to enable the student to do the work intelligently, and has not attempted to disguise his information under the form of questions—a ruse which has proved so disfiguring to many of the recent laboratory manuals. The absence of pedagogical fads is in fact noticeable and refreshing. The information given is chosen judiciously to accomplish the purpose for which it is intended. There are no figures in the book, as the laboratory work takes largely the form of drawing the careful dissections made, and the author has doubtless experienced the strong tendency of students to imitate the figures of the text. Commendably explicit directions are given for making these drawings.

The plan adopted is to study each one of the larger groups of invertebrates as a whole, several of its representatives being dissected in such a way as to bring out relationships. The first group taken up is the Arthropoda, including study of a wasp, a beetle, a grasshopper, a caterpillar, a centiped, the crayfish or lobster, a crab, a sow-bug, an amphipod, *Caprella,* larval decapods, a copepod, *Daphnia,* and a nauplius larva. Somewhat less extensive studies are undertaken of the Annelida, the flatworms, Bryozoa, Mollusca, Tunicata, Echinodermata, Cnidaria, sponges and Protozoa. While the directions are comparative, the author has tried to make those for each organism complete, so that every teacher may take up the forms in such order as he chooses. Doubtless most teachers would desire to modify the directions in some points to suit their own methods of work; a lack of precision to be noticed in some cases in the directions for the dissection of some of the more difficult systems of organs may thus be remedied. The main body of the book is followed by an outline of animal classification and a glossary of the terms used in the directions.

The book will certainly be found very useful both to teachers of invertebrate zoology and to those attempting without the aid of a teacher to obtain some practical knowledge of the anatomy of invertebrates. While the well prepared teacher can usually work best with laboratory directions which he has himself prepared, even this class will find the book suggestive and helpful.

H. S. JENNINGS.
ANN ARBOR, MICH.,
April 16, 1903.

SOCIETIES AND ACADEMIES.

GEOLOGICAL SOCIETY OF WASHINGTON.

AT the 141st meeting of the society, held in the assembly hall of the Cosmos Club, Wednesday evening, March 25, 1903, three interesting papers were presented.

Under the title 'Statics of a Tidal Glacier,' Mr. G. K. Gilbert said in part:

"An iceberg floats in sea water with about seven eighths of its mass submerged. A glacier entering an arm of the sea with a depth less than seven eighths the thickness of the ice continues to rest on the bottom. In the discussion of the origin of fiords it is generally assumed that such a glacier is partly sustained by the sea water, and that the rock bed is to the same extent relieved of ice pres-