trial arts especially rank among the most permanent, not to say eternal, of all the manifestations of humanity. It is hardly too much to say that only by the extinction of entire peoples are useful arts ever lost (except as superseded by more useful devices); and until well within the period of writing any arts possibly lost by extinction of peoples left little trace.

W J McGEE

SCIENTIFIC BOOKS

Light and the Behavior of Organisms. By S. O. MAST. New York, John Wiley and Sons. 1911.

While the present volume deals primarily with the question of the orientation of organisms the author tells us that it "may be considered a treatise on the behavior of organisms in their reactions to light." The first three chapters constituting Part I. are devoted to the historical setting of the subject and the statement of general problems and view-points. Part II. is concerned with the way in which organisms turn towards or from a source of stimulation. In addition to giving a very good résumé of the observations of others upon orientation this part contains a considerable amount of new material from the author's own researches. These include investigations of orientation in Indian corn, *Nasturtium, Amœba, Euglena* and a few other flagellates, the swarm spores of *Œdogonium, Hydra, Eudendrium* and some worms and insect larvæ. In general this work gives evidence of having been done with care and accuracy and adds materially to our knowledge of the general *modus operandi* of orientation. It is evident now to every one who has followed the work in this subject during the past few years that orientation is accomplished by a great variety of methods in different organisms. There is no such thing as a general scheme of orientation.

Loeb's theory of orientation is the author's favorite object of attack and he recurs to this doctrine and certain other views of Loeb with the persistence of Cato in urging the destruction of Carthage. It is not difficult to adduce cases that do not fall under Loeb's explanation of the way in which animals become oriented, but some of Mast's own investigations seem to afford about as good support as has been furnished for the theory which he so persistently attacks. No clearer case of orientation through the local response of the part directly stimulated could well be imagined than the one afforded by *Amœba,* and the author admits that the "method of orientation is in harmony with much in Verworn's theory and also with the essentials in Loeb's." But he adds that "it does not, however, support the idea connected with these theories, that a constant intensity produces a constant directive stimulation." I am not sure that I understand the pertinency of the criticism, for there is nothing in the theories of either of these writers which implies that the actual stimulating effect of any directive agency is subject to no variation. Both of these writers have adduced several cases which show that such variation occurs, and it is out of the question to suppose that either of them has overlooked the obvious importance of internal changes in determining the way in which an animal responds.

The author's experiments on the larvæ of *Arenicola* are of especial interest in regard to the problem of orientation. There is no reference either in the text or in the bibliography to the previous work of Lillie on the method of orientation in this form, although there is a quotation from a paper by Lillie dealing with certain features of its structure and development. The observations of Lillie are in general confirmed, but Mast has performed several additional experiments which bring out more clearly the fact that orientation is "due to difference of intensity on opposite sides" of the organism. The orienting response is shown to be due to light falling upon the eyes, the other parts of the body being apparently insensitive to this stimulus. When the larva is suddenly illuminated on one side there are no random or trial movements, but the head is bent directly toward the source of light. All the evidence points to the conclusion that orientation is the result of comparatively

simple reflex responses. The question remains open whether the stimulus is produced by the direct action of light on the sensitive surface of the animal or by changes in intensity of the stimulus caused by the lateral movements of the body. The question in this as in many other cases is difficult to decide. Analogy with the method of orientation in *Euglena* leads the author to incline toward the latter alternative, but the experimental data obtained did not enable him to solve the problem. In either case orientation in this form is apparently as automatically regulated an activity as one might expect according to the well-known theory of Loeb.

The problem of whether the rays of light *per se* or variations of light intensity *per se* afford the stimuli which cause orientation is discussed in connection with accounts of experiments on the blow fly, earth-worms and other forms. There is much to be said for the efficiency of both these factors in special cases. There are instances in which the shock of transition from one light intensity to another causes a marked reaction. Light in other cases has a constant stimulating effect apart from any shock of transition. In an organism going towards or away from the light deviations from the direct course produce a change of intensity of light falling on its two sides; that the animal turns directly and automatically into line does not of itself enable one to decide whether it turns because it is more strongly stimulated on the one side than on the other, or whether it turns on account of a change of light intensity. There have been few attacks upon this particular problem and the author does well to bring it into more prominence than it has usually been accorded.

Part III., entitled General Considerations on Reactions to Light, deals chiefly with the various methods of forming groups in regions of certain optimum illumination, reactions which involve no directive effect of light, and the factors which induce changes in the phototactic response. There is no discussion of any theoretical attempt to explain the reversal of phototaxis and the author advances no views of his own.

Part IV. deals with reactions to light of different wave-lengths. Much work in this field has given inconclusive results on account of failures to obtain pure monochromatic light and on account of not taking into consideration differences in energy of different wave-lengths. While in general the rays toward the violet end of the spectrum are more potent in producing the heliotropic response in both plants and animals, the rule is not without exceptions in both kingdoms. As the writer states, this is probably due to the fact that some chemical processes are accelerated by light of certain wave-length, while other chemical processes are accelerated most by light of a different wave-length. Sometimes monochromatic light is more potent than white light, a fact which suggests that certain rays tend to inhibit or reverse chemical reactions which are caused by rays of a different wave-length. Mast's treatment of the effect of light of different wave-lengths can not fail to be very helpful to all workers in this rather difficult subject.

The final chapter on Theoretical Considerations contains, besides a general summary of results, a renewed attack upon Loeb, a short consideration of the much-refuted vitalism of Driesch, and an exposition of the general position of Jennings to which the author is a very close adherent. After stating that according to Jennings's views the reactions of an organism are fundamentally purposeful and that they depend upon previous activity as well as present external conditions, the author expounds the position of Jennings as follows: "Reactions are defined as changes in the activity of organisms. Such changes may occur under constant external conditions. They are therefore due primarily to internal changes. External factors cause reactions not directly, but indirectly, by altering internal processes (physiological states). Variability in reaction to given external conditions is due to changes in physiological states. If an organism responds to light of a given intensity in a given way now, and to the same intensity in another way later, it is because the physiological state of the organism has changed." Fol-

lowing this with a statement of the principle of association, Mast continues:

> Every step in the development of the theory is supported by numerous experimental facts and all seems to fit with what is known concerning the reactions of organisms. Reactions, according to the theory, are as stated above, primarily due to physiological states. External agents ordinarily produce reactions through the effect they have on these states. By the application of this idea all the different phenomena connected with reactions to light as summarized at the beginning of this chapter can be accounted for.

All this sounds rather naïve as compared with the critical exposition of the preceding part of the volume. It would indeed be comforting to be able to repose with such a spirit of confidence and contentment in a general philosophy of behavior, but it is perhaps pertinent to enquire if the author has not been deceived with the delusive appearance of explanation where no real explanation has been given. It is an obvious truism that external factors cause reactions by altering internal processes; else they would not be reactions at all. It is equally obvious that if changes of behavior occur where external conditions do not vary they must be due to the fact that internal conditions do vary; or, in other words, if the cause of a change is not outside of the organism it must perforce be inside of the organism. Phenomena may thus be "accounted for" on the basis of varying internal states, but as it is admitted that in most cases we are entirely ignorant of what these states are we are about as much enlightened as we are by the celebrated explanation of the sleep-producing effect of opium by attributing it to a dormitive principle.

There is a useful bibliography in which the effort is made to include all the important works on reactions to light in both animals and plants, but several noteworthy contributions are not included. Notwithstanding minor defects, the work of Mast will prove of great value to students of the effect of light on the behavior of organisms, and the author is to be congratulated on having made so substantial a contribution to the subject.

S. J. Holmes

A Laboratory Manual of Physical Geography. By R. S. Tarr and O. D. von Engeln. New York, The Macmillan Company. 1910.

Tarr and von Engeln's "Laboratory Manual of Physical Geography" is the most practical and best organized manual that has yet appeared. Prepared as an exercise and notebook, with detachable leaves, and containing within its covers a large part of the necessary equipment for work, except for topographic maps, minerals and certain simple pieces of physical apparatus, it is a hand-book and guide available for both the expert and inexpert teacher. Although primarily devoted to the study of physical geography, much emphasis is made of life relations and therefore the book not only meets a present condition, but makes possible a development of the phase of geography which is beginning to be emphasized by the better secondary school teachers.

Of the seventy-three exercises in the book, nine are devoted to the earth as a globe, seven to excursions, eight to minerals and rocks, five to map study, twenty-six to the physiography of the lands, two to the ocean, fourteen to the atmosphere and one each to life zones and magnetism.

Thus the special emphasis is good, though it is questionable whether mineral and rock study deserves to remain in physical geography and whether the ocean is not given too little emphasis. The larger life relations to the ocean, apart from the phenomena associated with ocean currents and tides, are so important and fascinating that it seems unreasonable to omit them, while space is given to minerals and to the physical phenomena of condensation. Laboratory work should be devoted to topics that are not capable of being learned more easily and more effectively through demonstration, and certainly condensation can not be included in this class.

The order of treatment under the land forms is original in that types of plains are studied in relation to drainage and not following drainage, and thus a better unity is preserved. Mountains are grouped according to