for planning in the preservation of natural plant and animal habitats. I can not share his rather sweeping criticism of the U. S. Forest Service, however. This agency has been committed to a policy of multiple use management for over thirty years—the greatest good to the greatest number in the long run. Its administrators have faithfully tried to follow this policy. It is only natural, then, that the large "roadless areas" and "primitive areas," often containing over a million acres in one block, should be scrutinized for other possible public uses before being set aside. The late Dr. Robert Marshall, the chief advocate of such a classification, was keenly alive to the needs of society as a whole, as well as being a trained plant physiologist. Naturally such large tracts could not be closed to productive use where local industries and communities would thereby suffer hardship. The U. S. Forest Service tries to stabilize communities by insuring a continuous supply of raw material.

Really valuable commercial timberland has, however, been reserved from all cutting and made permanent natural areas by the U. S. Forest Service in a large number of cases, such as the Port Orford cedar reserve and the Tionesta virgin forest in Pennsylvania, to which I took pains to refer in my note in SCIENCE of January 24, which Dr. Van Name does me the favor to quote. This latter area has been carefully zoned to insure adequate undisturbed environments for scientific study. One of the virgin forest areas on the White Mt. National Forest known as the "Bowl," containing 500 acres of magnificent virgin spruce, had so much commercial value that salvage operations were possible after it was destroyed by the hurricane; this many privately owned commercial forests did not have!

While both the U. S. Forest Service and the National Park Service have reserved a very imposing number of natural areas, I fully agree with Dr. Van Name that there are still others equally deserving of attention. In this connection one may even raise the question whether public ownership of this sort is always necessary or best. Some reserves owned by private universities or schools or scientific societies may be even safer from disturbance.

Finally I wish to correct any impression that may have been gained that I would recommend "that the first thing to do is to spend a number of years in an 'inventory' of desirable areas"—while immediate action is needed to save threatened fauna or flora. Certainly not. While unfortunately some surveys of this kind tend to drag on, there is no real reason why an inventory should not be completed in a few months at most if the cooperation of all naturalists were to be enlisted and the country divided into districts. Dr. S. Charles Kendeigh (Vivarium Building, Champaign, Ill.), chairman of the Ecological Society of America Committee for the Study of Plant and Animal Communities, has amassed a large volume already in the course of a survey of areas now reserved or in need of protection. This study could provide a basis for a comprehensive plan for the country to which federal agencies and state planning boards could make substantial and necessary contributions.

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SCIENTIFIC BOOKS

ORIENTATION

The Orientation of Animals, Kineses, Taxes and Compass Reactions. By GOTTFRIED FRAENKEL and DONALD L. GUNN. 352 pp. Oxford University Press. 1940.

THE first part of this volume is intended primarily as a text for undergraduates; the second (pages 136–352) primarily as a handbook for investigators. The aim of the authors is to classify responses already known rather than to elucidate the mechanism involved in the responses.

The classification proposed is a modification of that formulated by Kühn in 1919. The responses are divided into three main categories, designated kineses, taxes and transverse orientations and these are subdivided respectively into ortho- and klino-kinesis; klino-tropo- and telo-taxis; light compass reactions, dorsal and ventral light reactions and ventral earth reactions. Known responses are selected to illustrate the characteristics of each division in the classification, but there is no attempt to classify all the responses which have been described.

Nearly all the categories in the classification appeared long ago under different names, *e.g.*, kineses as changes in rate of response or undirected responses, taxes as directed responses or tropisms, klino-taxis as indirect orientation or orientation by "trial and error," "random movements" or "shock-reactions," tropo- and telo-taxis as direct orientation.

The authors maintain (p. 65) that in the new classification all anthropomorphic implications are eliminated, that the terms used are precisely defined and that it is consequently superior to former classifications which contain such anthropomorphic phrases as "trial and error" (Jennings), and "selection of random movements" (Holmes); and such ill-defined phrases as

"shock-reactions" (Mast). They even contend (p. 9) that if this classification had been formulated earlier, the controversies concerning Loeb's theories would have been to a large extent avoided.

But in spite of their contentions it must be said that they did not well succeed either in avoiding anthropomorphic implications or in precision in defining terms. They say, *e.g.* (pp. 64 and 77), "klino-taxis involves comparison of intensities at successive points in time" and "tropo-taxis simultaneous comparison of intensities on the two sides." How, it may be asked, is an animal to compare intensities at successive points in time without reason and memory? Aren't these phrases fully as heavily loaded with anthropomorphic implications as those which the authors reject?

The authors (p. 134) define "klino-taxis" as "attainment of orientation indirect, by interruption of regularly alternating lateral deviations of part or whole of body, by comparison of intensities of stimulation which are successive in time; examples, fly larvae, *Euglena,* larvae of *Arenicola, Amaroncium.*" It so happens, however, that in none of these animals are the processes involved in orientation in accord with the definition of "klino-taxis" given. Orientation in photo-positive specimens is brought about by a series of responses to shadows cast on the photo-sensitive tissue by opaque structures in the body and rotation on the longitudinal axis, *i.e.,* by a series of shock-reactions. These continue until the organism faces the light, after which rotation no longer produces shadows on the photo-sensitive tissue. There is no indication whatever of "comparison of intensities of stimulation." They say: "photo-taxis means respectively movement straight toward or straight away from the light." Animals, however, rarely, if ever, take a straight course. They say (p. 93): "When the frontal ommatidia alone are stimulated, the bee walks straight forward." But they present no evidence indicating that these ommatidia are actually stimulated. Then, too, light, gravity, etc., are frequently referred to as stimuli in place of stimulating agents.

It is indeed questionable whether the new nomenclature is superior to the old, either in avoidance of anthropomorphic implications or in precision in meaning. Moreover, terms like taxis and tropisms often tend to inhibit investigation; for they encourage placing phenomena in categories as an ultimate aim rather than knowledge concerning the processes involved in the phenomena. Then, too, they readily acquire the status of causal agents. Has not every scientist experienced this? Indeed, it is not difficult to ascribe causality to taxis in the following quotation (p. 298): "Negative photo-taxis takes it [*Litorina*] inward on the floor, negative geo-taxis upwards on the end of the wall, and positive photo-taxis outwards."

The authors are a bit careless in reference to credit for priority; and the accuracy of a considerable number of statements is questionable. For example, the first analysis of photic orientation should be credited to Ray, 1693; in place of De Candolle, 1832 (p. 5); the idea that the enlargement in the flagellum in *Euglena* is photo-sensitive should be credited to Mast, 1911, in place of Tschakhotine, 1936 (p. 70); the fact that blow-fly larvae "give the same response to changes of intensity when the light is all from above . . . and when it is presented as a horizontal beam" should be credited to Mast, 1911, in place of Gunn, unpublished (p. 67); the nature of the response of Hydra in a horizontal beam of light should be credited to Mast, 1911, in place of Haug, 1933 (p. 74); the fact that insects after one eye is covered gradually go more directly toward the light should be credited to Radl, 1903, in place of Minnich, 1919 (p. 93). The authors say that Loeb "uses the term (tropism) in two senses," whereas he uses it in at least four (p. 9). They say Mast calls orientation in fly larvae a shock-reaction, whereas he maintains that the larvae orient by means of a series of shock-reactions (p. 64). They contend (referring to orientation of *Euglena*) that it is not known how "a turn away from the light is responsible for causing the path to curve toward the light," whereas Mast, 1911, has described this in detail (p. 72). They say the larva of *Arenicola* has but one eye, whereas it is well known that it has two (p. 73).

Classification of responses is obviously a difficult and an important problem. The more thought devoted to it, the better. The volume under consideration is at least a worthwhile attempt to contribute to its solution. It will doubtless arouse interest in the study of the nature and the significance of responses as well as in their classification.

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RAMANUJAN

Ramanujan. Twelve lectures on subjects suggested by his life and work. By G. H. HARDY. 236 pp. Cambridge: at the University Press, 1940. New York: The Macmillan Company, 1941. $6.00.

IN 1936, as part of the Harvard Tercentary celebration, the author delivered two lectures on the subject: The Indian Mathematician Ramanujan and his work. The first lecture, much the more biographical of the two, was published in volume 44 of the *American Mathematical Monthly,* and is reprinted in the present book as Lecture I. The original second lecture, which dealt more with Ramanujan's contributions to mathematics, has now been expanded to make the other eleven lectures. Most of this expansion, naturally enough, is the result of having adequate space to tell