use of aluminum sulphate in quantities sufficient to reduce the alkalinity nearly to the neutral point has resulted in marked improvement in the physical condition of the soil, particularly with respect to its permeability to water. This improvement in condition is certanly not temporary. With some soils that have been under observation for two years it still continues.

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SIREN, A HERBIVOROUS SALAMANDER?

THE correlation of structure and habits is of great philosophical interest, and, if for correlation one read causation, of still greater interest. The study of form apart from function is a noted source of error, and the study of function apart from form, while not so productive of error, is frequently an unnoted waste of time.

These observations apply particularly well to the food preferences of Amphibians, which are in general comparable to the tolerably famous Ophidia of Iceland. In brief, Amphibians have no food preferences. Much careful work, very productive of negative results, has been done on the food of adult Salientia. These animals, as might be expected from their uniform dentition and digestive apparatus, are carnivorous and undiscriminating. What they eat is determined by its size and its propinquity. The food of the same species in different localities differs much more than does the food of different species in the same locality.

Larval Salientia differ considerably from adults in structure of mouth and of intestines, and in correlation with their long, convoluted digestive tract, their horny beaks and fringing rows of keratinous "teeth," they are herbivorous in the same fashion that the adults are carnivorous, and the food of tadpoles of different species is more alike than is the food of larva and adult of the same species.

Larval salamanders apparently do not differ in their food from adults, as is indicated by the similar structure of mouth and intestines in both. Nor do salamanders in general vary much from a uniform structure, or from an undiscriminating and carnivorous diet.

Siren and *Pseudobranchus*, of course, differ notably from the other salamanders in their mouth structures. Teeth are present only on the prevomers, and the dentary and the premaxilla are furnished with horny beaks, strangely reminiscent of those of tadpoles.

I had occasion recently to examine specimens of *Siren lacertina* from Gainesville, Florida. I found their stomachs and intestines packed with filamentous algae. The intestine was noticeably long and convoluted. Comparison with *Amphiuma*, a beast of similar shape and habitat, brought out a great difference in the proportionate lengths of the digestive tract. *Amphiuma* is carnivorous and the stomach of the specimen examined contained fragments of crawfish. The intestine extended almost straight through the body cavity and was of nearly the same length. The algae-crammed intestine of a *Siren* measured 1270 mm from mouth to anus, while the animal itself measured only 480 mm from mouth to anus.

Little has been published on the food of *Siren* from Linnaeus's original supposition that it ate serpents, to Hurter's remark, "Sirens feed on worms and minnows. Most of those in my possession were caught with hook and line baited with worms."[1]

Garman, indeed, says "LeConte found nothing but mud in the stomachs of those he examined."[2] This seems to be the only record of stomach examination, and the "mud" was very probably a black, semi-digested mass of algae.

Barton in his letter to Schneider in 1821 says that he fed his specimens on angleworms, pieces of meat, etc. This and Hurter's remarks may be compared with the well-known habits of tadpoles in aquaria, where they will eat decomposing animal matter, although their ordinary food is diatoms and algae.

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SCIENTIFIC BOOKS

The Domain of Natural Science. The Gifford Lectures delivered in the University of Aberdeen in 1921 and 1922. By E. W. HOBSON. The Macmillan Company, 1923. xvi + 510 pages.

THE purpose of this book is to set forth and maintain by cogent argument the author's theory of the true character of natural science and by means of a strict delineation of this domain of knowledge "to vindicate the perfect freedom of religious and philosophical thought from any fear of destructive interference from the side of natural science, subject to the sole condition that no encroachment is made upon the autonomy of natural science in its own proper domain." In its implications concerning the problem of forming a general philosophy of life and the world these lectures take their place with a body of literature which has recently grown up and which has shown the rise among scientists of a saner attitude towards the place and importance of natural science in the construction of our total view of phenomena and life and character. It affords further evidence of the growing tendency to recognize and emphasize the limitations of natural science as regards certain fundamental problems of thought and philosophy not

[1] Trans. Acad. Sci. St. Louis, XX, 5, p. 67, 1911.
[2] Bull. Illinois State Lab. Nat. Hist., III, p. 385, 1892.

lying strictly within its domain. In recent years this movement has been gaining moment in a remarkable way which could hardly have been predicted ten years ago.

In order to understand properly the bearing of the author's thesis it is necessary to have in mind the exact meaning which he attributes to the term natural science. This term, he says, "is generally restricted to denote the group of those special sciences which concern themselves with the study of what we call physical phenomena, including the cases in which the phenomena are connected with living organisms." And he adds further: "In the somewhat narrow sense in which I shall employ the term, natural science excludes any direct consideration of the mental or psychical facts in living organisms from its purview." He thus restricts the term natural science to the phenomena of the apsychical physical world.

On account of the methods which he employs the conclusions of the scientist are strictly limited to a finite portion of time and a finite portion of space. They can not comprehend at once the whole of reality, or even the totality of phenomena which are capable of investigation. The possibility of natural science depends on "the fact that there is in our percepts, that is, in what we call nature, a considerable degree of regularity in the sequences of phenomena." To what extent this uniformity of nature prevails is a matter for investigation. When science comes to deal with phenomena these are treated not as individuals but as classes; natural science does not include individuality in its domain. Neither are its theories built up in terms of the percepts of phenomena nor even in terms of classes of percepts. Its scheme is a conceptual one. "An essential characteristic of every scientific theory is that it only serves to give a conceptual description of a range of phenomena which is of a limited and circumscribed character, spatially and temporally." No scientific theory is all-embracing in its character. The deterministic schemes which are set up by science are necessarily relative and partial. "The conclusion of the whole matter seems to be that the conception that the whole world of physical phenomena, or that a finite part of that world, is theoretically capable of being represented by a unified deterministic scheme is unproved and unprovable. All that natural science has established is that tracts of phenomena can be found which are sufficiently represented for certain purposes by means of deterministic schemes."

The book opens with an introductory lecture. This is followed by three lectures in which the author sets forth his main thesis concerning the conceptual character of all scientific theory and his subsidiary thesis that natural science does not enable one to conclude to a strictly deterministic scheme for natural phenomena. In the next fourteen lectures he presents the detailed argument for his general position, analyzing this with respect to mathematics, the theory of time and space, theories of matter, dynamics, electrical theory, relativity, general biology, heredity and evolution. In the two concluding lectures he treats of the relation of natural science to general thought and to theism. The volume is a very useful one for all who have to do with such questions as are raised in it.

The view set forth by Hobson "tends to limit and circumscribe the influence which natural science will have upon the wider views of the world with which philosophy and religion concern themselves. If it be admitted that natural science, when reduced to its essential elements, is independent of any opinions which may be held as regards a reality behind phenomena, and if the notions of final causes and of efficiency [in the sense of efficient causation] be regarded as extraneous to it, it would seem to follow that the existence and the special results of natural science can not be employed in any very direct manner for the purpose of throwing light upon the nature of an assumed reality, or of exercising any decisive influence in the contest between rival views as to the nature of reality."

The conclusion is thus reached that natural science can not exercise any controlling influence upon religious and philosophical thought so long as the latter leave natural science free in its own proper domain. If one adjoins to natural science certain appropriate philosophical principles and propositions, then the two together may generate conclusions of wide reach. Some possible cases are examined in the last two lectures. But there is nothing in natural science to put a categorical negative in the way of transcendental conclusions when these are reached along other paths and are sustained by considerations which lie outside the domain of natural science.

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LABORATORY APPARATUS AND METHODS

A NEW RHYTHM APPARATUS

THE instruments which have been used in experimental studies of rhythm and other time processes have, as a rule, been either too restricted in their adjustment and adaptability to varieties of patterns, or else lacking in degree of precision. As there is a wide range of usefulness in various kinds of laboratories for this type of timing device, I will describe the apparatus which has gradually developed in the Iowa psychological laboratory after experimenting with various forms of rhythm apparatus.