The book begins with a well-balanced estimate of the relative value of observational and experimental work; it maintains that experiment is the only method by which zoology may be placed upon the same footing with chemistry and physics; it points out the uses and abuses of scientific hypotheses and the necessity of verifying these by experiment; and it concludes that the goal of experimental work is, in the words of Loeb, the control of natural phenomena.

The scope of experimental zoology is so great that it can not be treated as a whole within a volume of ordinary size. The author has therefore omitted from consideration two important fields of study, viz., experimental embryology and the experimental study of regeneration, both of which he has dealt with in other books. The present volume is mainly devoted to those aspects of experimental zoology which have not hitherto received adequate treatment in book form.

The principal topics discussed fall under the following six headings: (1) Experimental Study of Evolution, (2) Experimental Study of Growth, (3) Experimental Studies in Grafting, (4) Experimental Studies of the Influence of the Environment on the Life-cycle, (5) Experimental Studies of the Determination of Sex, (6) Experimental Study of the Secondary Sexual Characters.

Under the first heading are included a large number of topics such as the influence of external conditions in causing changes in the structure of animals, the inherited effects of changes due to environment, the inheritance of acquired characters, experimental hybridizing, the behavior of the germ cells in cross fertilization, inbreeding, the influence of selection, and finally the theory of evolution. These topics are dealt with unequally, the first in particular being very brief, while the last is from its nature rather more speculative than experimental in character. There is everywhere, however, a wealth of reference to works on these topics and many valuable and stimulating suggestions. With the chapters on experimental hybridizing I think it may be said that Morgan first strikes his gait in this book. This subject is treated at much length and in a thorough and admirable manner.

The section of the book on experimental studies on evolution forms rather more than half of the whole work. The remaining sections deal with subjects of a more special character. Under the experimental study of growth, the chapters on the external factors that influence growth, and on growth and regeneration are especially worthy of favorable mention. A single chapter is devoted to experimental studies on grafting, but this chapter is one of the best in the book, and it shows at once the author's intimate and extensive acquaintance with this subject. In the chapters on the experimental studies of the influence of the environment on the life-cycle Morgan has brought together results which are probably less familiar to the average zoologist than are any other topics dealt with in the book. The literature references in these chapters indicate through what a range of publications, many of them relatively inaccessible and but little known, the author has labored in preparing this summary.

The final sections on the determination of sex and on secondary sexual characters deal with some of the most interesting subjects in zoology. The various hypotheses are considered fairly and judicially and the author's own views are set forth in a form which is clear, if not always convincing, and which is sure to stimulate research. And after all this last is perhaps the greatest service which any book can render. In a work which covers so wide a field it is natural that minor faults should occur, but it would be unjust to suppose that it does not also have great merits. Morgan has placed all zoologists under obligation because of this book; it has been received with the highest commendations abroad, and it is a work of which American zoologists may well be proud. EDWIN G. CONKLIN

The Soil-preferences of Certain Alpine and Subalpine Plants. By M. L. FERNALD. Contr. from the Gray Herbarium. Rhodora, September, 1907. 44 pp.

It is refreshing to find, in this study of Fernald, a distinct departure from the hack-

neyed gathering-up of superficial observations on "plant associations," without any mention of the probable, in many cases abundantly obvious, causes of the geographical grouping of plants. Ecological studies, as often made savor strongly of the "gedankenlose Heusammler" habit animadverted upon by Schleiden over half a century ago, and were apparently only temporarily stopped by Darwin's great work. The soil-conditions accompanying the occurrence of certain plant groupings are usually so superficially set forth that nothing but the old classification into hydrophytes, mesophytes and xerophytes is attempted; in conformity with a hypothesis based upon the arbitrary assumption that moisture is the only controlling factor of plant growth. Adding to this hypothesis the factor of soil-texture, and basing thereon the entire work of soil classification, Whitney and the Bureau of Soils of the United States have built up a one-sided theory, which is in flagrant contradiction to facts observable by any one not under the official afflatus of that head center. Some years ago R. M. Harper, in his studies of the plant geography of the southern Coastal Plain, entered upon the right track so far as observations in the field are concerned; but Fernald has added to the field observations a closer discussion of the exact physico-chemical factors which condition plant distribution, such as I have urged for fifty years past.

In defining his investigations as relating to certain "alpine" plants, Fernald really blurs the nature and importance of his work. Alps are usually rocky and have predominantly *sedentary* soils, that is, soils overlying the rocks from which they have been formed by weathering, without having received admixtures of the decomposition-products of other rocks. Such admixtures may, nevertheless, easily occur locally. Moreover, the fact is that the flora of mountains is often largely paludal on account of their "young" geological surface features, and therefore commonly include wet meadows, ponds and lakelets alongside of cliffs and rocky slopes. The frequent washing-down of the decomposition-products of various rocks on the higher slopes to those lower down, has made the word "alpine flora" a designation referring mainly to temperature-conditions. Fernald himself, however, at once recognizes the distribution of the "subalpine" flora to be almost identical with that of a large portion of the lowlands.

Fernald presents (pp. 158 to 164) lists of 258 plants belonging to the territories of New England and Canada, tabulated so as to show their occurrence, either preferably or exclusively, upon rocks considered respectively as potassic,[1] calcareous and magnesian.

These tables show, in three columns, the plants belonging to soils formed from (supposedly) potassic, calcareous and magnesian rocks, and exhibit the very striking contrasts, as well as some coincidences, in the floras inhabiting the three classes of rocks.

Among the most striking of these is the often-observed poverty of the vegetation on soils derived from exclusively or chiefly magnesian rocks, such as serpentine and talc schist; to which may be added dolomite, which, though consisting more than half of lime carbonate, shows everywhere a more or less depauperated flora, especially when compared with adjacent areas of non-magnesian limestones. Fernald shows how, on the north slope of Mt. Albert, a serpentinous plateau in Gaspé county, by the partial admixture of calcareous and potassic rocks an immediate increase of species and a more luxuriant development take place. A very few plants only are known to prefer purely magnesian soils, everywhere. Among these, Fernald mentions specially, *Cerastium arvense,* whose ash contains the unusual proportion of 19.8 per cent. of MgO.

Fernald promises, by analyses of the ashes of a number of these plants (as well as, it is to be hoped, of corresponding soils) to establish definitely the relations between their plant-food requirements and their rock habitats. As regards the soils, it is evidently of high importance that the analyses should be made by such methods as will show their *permanent* character, and not merely the accidental present

[1] Whether the granites, gneisses and mica schists assumed by Fernald as producing soils rich in potash really do so, is somewhat questionable, and should be verified by analysis.

condition; since the distribution of native plants is a matter of secular or millennial, and not merely of existing conditions. The interpretation of these analyses will require no mere routine consideration of percentages, but must be correlated with the physical composition; inasmuch as a light sandy oil requires much less lime to support a calciphile flora than a heavy clay;[2] and the same is more or less true of other ingredients. It should not be forgotten, however, that quite a large number of plants have long ago been shown to be practically indifferent to the absence or presence of lime.

Again, the paludal or peaty nature of the ground or locality requires consideration. The mere *presence* of a certain proportion of lime may be wholly ineffective in bringing about a calciphile flora if humic acids present produce an acid condition of the soil mass. On the other hand, if a calcareous weathering-product is exposed to continuous leaching, as may easily happen on the summits of hills bearing abundant vegetation, the lime carbonate may be almost wholly leached out, and islands of calcifuge plants will then be found in calciphile territory. The calcareous washings, on the contrary, will impregnate the lower ground, which is always more calcareous than the higher slopes; and so a calciphile flora may, and very commonly does, occur where no obvious source of lime exists in the uplands.

Fernald rightly considers the hornblendic rocks as sources of calcareous soils; yet in the Hawaiian islands the black lavas, which weather into spongy iron ores used as soils, are almost fully leached of the lime that forms so large a proportion of both pyroxene and hornblende, by the abundant rains of the tropics; while the almost identical basalts on the Pacific coast produce calcareous soils, with a uniformly calciphile flora, on account of the deficient rainfall.

It is thus obvious that not only the original soil-forming rocks, but also the climatic conditions and the "lay of the land" must be considered in forecasting the plant-geography of any region. The failure to do this and the physiologically erroneous definition of calcareous soils as "soils that effervesce with acids," has brought about the confusion which appears in the works of Schimper, Contejean and others, as to the causes of plant distribution.

Fernald's paper is provided with copious references to sources of information in relation to the occurrence of rocks and plants, as vouchers for his conclusions. On the other hand, his references to cognate work done in Europe as well as in this country, are somewhat scanty, being probably left for the final publication of his results.

His present conclusions are succinctly set forth in the following quotations from p. 170 of the paper:

After comparing the floras of three areas located not far apart and under identical conditions of exposure and precipitation, he says:

> Precipitation and exposure are, then, of only minor importance in determining the localized distribution of our alpine plants.
>
> In attempting to account for the peculiarities of plant distribution, much stress has of late been laid upon the degree of fineness or coarseness of soils, and their water content. But to those intimate with the occurrence of our alpine plants these factors, again, seem of secondary importance. For instance, *Cystopteris montana* on Mt. Albert grows in equal abundance on the firm and steep amphibolite cliffs and in the deep, fine and (water-) saturated alluvium of mountain streams. *Selaginella selaginoides*, abundant in the wet, mossy bogs of Bonaventure and Gaspé counties, Quebec, is quite as much at home in the well-drained alpine meadows, or in the crevices of either wet or dry rocks; in the latter situation becoming stiffer and more stocky than in deep shade or moisture. *Zygadenus chloranthus* is apparently indifferent whether it is in the crevices of sunbaked rock, on cold cliffs, in river alluvium or on wet bogs. Similarly, many other members of the flora characteristic of the areas classed as group 2 (calciphile) grow in wet or dry, fine or coarse soils.
>
> The distinctive plants of groups 1 and 3 (potassic and magnesian) likewise show a remarkable indifference to the coarseness or fineness, the dryness or saturation of their supporting soils . . . seem equally at home in crevices of sun-baked or

[2] See "Soils," etc., pp. 494–497, 367 ff.

spray-showered rock, on sandy plains, in well-drained alpine meadows and in saturated sphagnum bogs. . . . we are hardly justified in depending upon these (physical) factors to explain the distribution indicated in the preceding tabulation.

In other words, Fernald's observations show that in accordance with the ancient experience of mankind (although contrary to the officially promulgated doctrine), certain chemical soil-conditions are not only equally as potent as, but sometimes prepotent over, even extreme physical conditions, notably in the case of lime; so that without the accompanying study of chemical soil-composition, mere physical analysis gives no definite clew to soil-values, adaptations and peculiarities. It is to be ardently hoped that the broader method of ecological investigation, as exemplified by Fernald's work, will be more generally applied, and so render such work both theoretically and practically more fruitful than it has been in the past. For what is true of wild plants is of necessity true for cultivated ones also.

E. W. HILGARD

BERKELEY, CALIF.,
Oct. 10, 1907

SOCIETIES AND ACADEMIES

THE OHIO ACADEMY OF SCIENCE

THE seventeenth annual meeting of the academy was held at Miami University, Oxford, O., on November 28, 29 and 30, the president of the society, Mr. Charles Dury, of Cincinnati, presiding. On Thursday evening an informal reception took place in Hepburn Hall, where accommodations for members of the academy were generously provided by the university authorities. The sessions on Friday and Saturday were held in Brice Hall.

The address of the president on "Zoological Reminiscences of the Cincinnati 'Zoo,'" occurred at 1:30 P.M. Friday, while in the evening at 7:30 Professor G. W. Hoke discussed "The Nearer East—A Study in Social Geography." Other papers of interest were those by Professor Bruce Fink on "The Status of American Lichenology," Professor S. R. Williams, "A Peculiar Circulatory Modification of *Necturus maculosus*," E. F. McCampbell, "Report on a New Pathogenic Pirosome" (presented by Professor Herbert Osborn in the absence of the speaker).

The following is the complete program:

"A Study of the Origin and Growth of the Egg in *Syncoryne mirabilis*," by Mary D. Mackenzie.

"A Better Method of Preparing Herbarium Specimens," by W. A. Kellerman.

"Compensatory Growth in *Podarke obscura*," by Sergius Morgulis.

"Note on the Development of the Skull in Clupea," by Edward L. Rice.

"Factors determining Cave Habitation as illustrated by the Cave Isopod and its Nearest Outdoor Ally," by A. M. Banta.

"*Symbiotes duryi* n. sp., a New Endomychid from Ohio," by L. B. Walton.

"Notes on the Early Development of Enteropnuesta," by B. M. Davis.

"The Discomycetes of Oxford and Vicinity," by Freda M. Bachman.

"*Wolffia brasilensis* in Ohio," by Robert F. Griggs.

"The Psychology of Speaking," a Scientific Analysis of the Art of Speaking," by John S. Royer.

"The Flora of Cranberry Island, Buckeye Lake," by W. A. Kellerman.

"Reaction of Amphibian Embryos to Tactile Stimuli," by G. E. Coghill.

"The Epibranchial Placodes of Ameiurus," by F. L. Landacre.

"Periodicity of Spirogyra," by W. F. Copeland.

"The Dispersal and Planting of Seeds by Nature's Methods," by W. L. Lazenby.

"The Male Reproductive Organs of *Cimbex americanus* Leach," by H. H. Severin and H. C. Severin.

"A Peculiar Circulatory Modification in *Necturus maculosus*," by S. R. Williams.

"A Migration of *Anosia plexippus* in Ohio," by Herbert Osborn.

"The Variability of Zygospores in *Spirogyra quadrata* formed by Scalariform and by Lateral Conjugation, and its bearing on the Theory of Amphimixis," by L. B. Walton.

"Some Observations concerning the Effects of Freezing on Insect Larvæ," by J. S. Hine.

"The Status of American Lichenology," by Bruce Fink.

"Stains for Embryonic Skeletons," by E. L. Rice.

"A Note on the Occurrence of *Typhlopsylla octactenus* in Ohio," by Herbert Osborn.