pistillate aments are nearly sessile, oblong, up to 3 cm. long; the bracts are pubescent, marginally ciliate, divided about to the middle into three equal lobes which diverge rather widely, the mature bracts reaching usually about 1 cm. long by 1 cm. wide and the angle formed at the base of the bract by the almost straight sides being practically a right angle; and the nut is narrowly obovate and slightly wider than the wing. In the rather constantly subcordate base of the leaves and in the more widely diverging lobes of the fruiting scales the Ashtabula specimens suggest a tendency towards the *Betula alleghanensis* of Britton, and it is not improbable that more typical specimens of this latter *Betula* might be found in the Ashtabula corner of Ohio.

CARNEGIE MUSEUM,
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SOME MODERN TRENDS IN ECOLOGY

BY NORMAN TAYLOR

When Ernst Haeckel, in 1866, first used the term *ecology*, it is safe to say that he little realized how the word would ultimately be construed to cover a very different set of biological factors from those described by him. Not only has the word *ecology* had a somewhat checkered career, having to stand as the outward and visible sign of many phases of biological activity, but it seems quite likely that a rather large section of that science which deals with organisms in their relation to environment has wrongfully appropriated this much used and sadly misunderstood word.

Let us hastily review the use of it by the chief exponents of what is just now a very important feature of botanical literature. While it has been stated that Haeckel first coined the term, the principles underlying the concept of ecology are very ancient. Without unearthing the more or less apocryphal progenitors of the idea, one distinguished figure of the last century stands out with whom we must reckon. Writing in 1836 Meyen has this to say: "The station (ecology) of plants denotes the relation in which the plants stand to the situation in which they always

grow." This master in the study of plant geography recognizes, but does not specifically define, ecology. The passage quoted above is the epitome of Meyen's idea of ecology, and his treatment of it is mostly physiographic and edaphic. He thinks and writes of plant ecology in terms denoting unmistakably that the relation of plants *en masse* to their environment is, to him, the crux of the question.

Warming, the father of modern plant ecology, delimited the concept thus, in 1895: Ecology "teaches us how plants or plant communities adjust their forms and modes of behavior to actually operating factors, such as the amounts of available water, heat, light, nutriment, and so forth." This landmark in the development of the science is almost exclusively physiographic in its scope, and throughout it is the relation of plants *en masse*, and plant communities, to their environment that is considered fundamental. That these "actually operating factors" must, of course, operate on individuals, in order to have the least effect upon the distribution of collections of plants, was fully recognized by the author.

He did not, however, consider these purely physiologic and morphologic adaptations of individuals as the principal feature of ecology, for his book is mainly a descriptive study of vegetation.

In this country, one of the first to use the term and the first to make a serious contribution to the science, was MacMillan. During 1897, in his Minnesota Botanical Studies, which were wholly physiographic in character, he says: "That branch of biology which concerns itself with the adaptation of organisms to their surroundings, is . . . termed ecology." His Metaspermae of the Minnesota Valley marks the beginning of a voluminous literature of a distinctly ecological trend, notwithstanding the fact that this particular work was phytogeographical, which is quite another thing. That MacMillan, in most of his writings, was an ecological plant geographer and that the distribution of plants *en masse* was the chief interest with him, is the only conclusion that forces itself on his numerous readers.

We have, then, still with us in 1897, the word *ecology*, which, if not actually, had by usage become a symbol of a rather definite idea, almost exclusively physiographic in scope.

Omitting the several hundred papers of varied size and begotten of various concepts of the science, let us quote another figure of prominence in the field. Coulter, in his Plant Structures (1900), defines the field of ecology thus: "It treats of the adjustments of plants *and their organs* to their physical surroundings, and also their relations with one another and with animals, and has sometimes been called 'plant sociology.'" The italics are mine. While this was not the genesis of a new phase of ecology, it was at least one of the first prominent expositions of the indisputable fact that adjustments of plants and plant communities to their environment must, in the last analysis, rest upon the adjustment of the organs of individual plants to external influences. It is merely an elaboration of the fact noted by Warming in 1895, that the distribution of plants must be correlated with the adjustment of the individual plant. That plant communities depend for their existence upon the community of response in the organs of individuals of the society or association, seems so self evident, that it is strange the idea was not very strongly exploited before the passage quoted above was written. We see here one of the first extensions of the concept of *ecology* to cover a new set of activities, a partial transference of the idea from plants to their organs. This addition, while not revolutionary, is significant, and hereafter we find a broader note throughout ecological literature. Some of Coulter's writings have been "ecology" of the old order, although he seems to be one of the first figures of prominence to draw attention to the individualistic and functional phase of the science.

From 1900 until 1905 the number of ecological papers published was enormous and much of it was the descriptive study of vegetation. But mark how the best known exponent of the plant association-idea limits his definition of the science in his Research Methods in Ecology (1905): "The clue to the field of ecology is found in the Greek word οἶκος, home. [It] . . . has been largely the descriptive study of vegetation; physiology has concerned itself with function; but, when carefully analyzed, both are seen to rest upon the same foundation." Notwithstanding the last part of this statement, most of the ecological writing of

Professor Clements has been the descriptive study of vegetation. All but sixty pages of the work just cited are devoted to phases other than the functional side of ecology.

From the time of this work until the present, most of the men engaged in ecological work have laid more emphasis upon the physiographic side of the subject than upon the individual response of plant organs. Transeau, Shreve, Clements, Gleason, R. M. Harper, Spalding, Harshberger, Drude, and Cowles, to mention only a few, have written papers which, in the main, discussed the physiographic features of the science.

It would be unfair to those mentioned above to infer that they have ignored the question of the individual response of plant organs to environmental factors as being the controlling agency in the occurrence of plant communities. But it may be said, with a large measure of truth, that most of them while thoroughly realizing the fundamental nature of this proposition, have seen fit to lay stress rather upon the physiographic problems than upon those of functional and individual adaptations.

In other words, the term *ecology* has grown enormously in significance since the time of 1897. It has so broadened its scope that to-day one of the chief American exponents of the science not only maintains that the physiologic and morphologic response of plant organs are the main features of ecology, but unlike most of his predecessors, he devotes nine tenths of his book to these phases of the subject. Professor Cowles, in the introduction to his new text book,* has this to say, in explaining the change of emphasis: "Plant ecology has a two-fold aspect: the one considers the individual organism and its component parts as related to environment; this, since it overlaps morphology and physiology may be called *morphological and physiological ecology*, or the ecology of plant structure and behavior. The other aspect considers plants *en masse* as related to soil and climate; this, since it overlaps physiography, may be called *physiographic ecology*, or the ecology of vegetation."

Less than ten pages of the present work are devoted to plant

* Coulter, J. M., Barnes, C. R., and Cowles, H. C., A Textbook of Botany for Colleges and Universities, Vol. II, Ecology, pp. i–x + 485–964, figs. 700–1234. American Book Co., N. Y. $2.00. [December, 1911.]

associations and related phases of the subject, and all the rest of the book deals with the morphologic and physiologic home-economy of plant organs and behavior. This, to quote the preface, has been done "to develop certain general conceptions that are felt to be fundamental." It should be stated, however, that the work is not for professional ecologists.

Within the limits of Professor Cowles' restrictions, it would be difficult to imagine a more complete or satisfactory treatment of the underlying foundations of ecology. Roots and rhizomes are first discussed in their relation to absorptive, anchoring and propping functions. Under "root hairs" there is a long discussion of different soil constituents, bog water, salts of various kinds, and so forth, and the effect these have on plants. Soil exhaustion and its relation to deleterious root excretion is also discussed.

In the long chapter on the ecology of leaves, the first part is given over to the discussion of chlorophyll and food manufacture, and later the structure and arrangement of chlorenchyma is presented. "The Relation of Leaves to Light," "Air Chambers and Stomata," "Protection from Excessive Evaporation," "Variations in Leaf-form," "Absorption of Water and Non-gaseous Solutes of Leaves," "Leaves as Organs of Secretion and Excretion," "Leaves as Organs of Accumulation of Water and Food," and "Miscellaneous Leaf Structures and Relations," are all sections of this chapter and will give the reader an idea of the scope of the work.

Lack of space forbids discussion of the subjects presented in this chapter, but it may be questioned by some whether the sparse undergrowth of hemlock forests is mostly a matter of shade (p. 546); for is it not related also to the excessive amount of tannic acid leached from the trunk and branches during rains, and perhaps also in part to toxicity of the decayed leaves of the hemlock?

In the chapter devoted to stems, a large variety of subjects are discussed, such as stems as organs of display, reproductive organs, conductive and mechanical tissue, and the accumulation of food and water in stems. All the features of ecological significance are treated in detail and with a thoroughness that should

set an ideal for all users of the book. On page 708 the statement that "alligator" bark is caused by the division of the bark into blocks of somewhat equidistant transverse and longitudinal furrows may excite some comment. It is quite certain that the peculiar bark feature there described may be characterized by such furrows, but hardly *caused* by them. This touches closely the question of anthropomorphism, which while specifically disavowed by Professor Cowles, is nevertheless a common form of expression throughout the book. Without a skillfully devised and obviously clumsy form of expression, it is almost impossible to write of the ecological factors of plant economy without drifting into a more or less anthropomorphic style.

It may be truthfully stated that no recent text book has given such a thoroughly satisfactory treatment of saprophytism and symbiosis in so far as these subjects deal with ecological problems, as the one at hand. The principles underlying the functional activity of plants wholly autophytic and those "whose existence depends upon antecedent or coexistent organic forms," must be recognized by those who study the habits and environmental necessities of plants. Furthermore, the practical bearing of the subject is limitless, as the cultivation of crops and of thousands of individual plants can only be successfully accomplished by a thorough understanding of this perplexing relation of one plant upon another, and by the application of these principles to horticultural and agricultural practice. In the section dealing with parasitism there is a discussion of grafting and the influence of stock and scion upon each other. The formation of galls, nitrogen-fixing bacteria, and the mycorhizal problem, together with the nature of lichen symbiosis, are also fully discussed.

More than one hundred pages are given over to reproduction and dispersal, both in the so-called seedless plants and in the Spermatophyta. Among the latter, particular attention is drawn to the modes of pollination by wind and water, and a long discussion of insect pollination deals with this important branch of ecology. This, almost exclusively, deals with the intricate methods of pollination in various types of flowers and by various

types of insects, scarcely at all with the ultimate effects of these operations. This point of view, however, colors the whole tone of the book, as one might expect from the exposition quoted above. It is not the effects upon the distribution of plants that it is aimed to present, so much as the individual response of the organs of plants to external environmental factors. It may be questioned by some, that in view of the distributional phase of ecology which has hitherto appropriated so much attention, it should not have received more notice from the author of the present work. That it has not indicates, at least, a significant trend in modern ecology.

After a short chapter on germination in its relation to ecological problems, Professor Cowles takes up the much discussed and perhaps much overdone question of "Plant Associations." As an antidote for the association-idea run riot, to which we have unfortunately become accustomed, this chapter is the most effective imaginable. Coming as it does from an authoritative American ecologist, it should serve to check those who have written as though the minute description of somewhat similarly constituted vegetation areas, was the end and aim of ecology. One very necessary concomitant of the study of plant associations, Dr. Cowles has probably intentionally omitted, perhaps because the book was intended for undergraduate use. But it seems doubtful if one can intelligently study the associations of plants, without taking into account the ancestral history of the species or genera under consideration. This, of course, involves larger problems of geographical distribution, center and periphery of distributional frequency, climatic factors, and the geological history of the area treated.

In bringing to a close this somewhat brief outline of this work, scholarly in its treatment, broad in its outline and comprehensive in its ideas as to the fundamentals of plant ecology, as the author has by his treatment conceived that science, it is a pleasure to record the fact that it will undoubtedly be a standard book on the subject for years to come. A bibliography and an index complete the usefulness of the work for the student. I have found only a single error of fact, on page 495, where the wholly marine *Zostera* is stated to be a salt marsh plant.

Some there are who will feel that the evolution of the ecology-idea has changed, become more individualistic and narrow, less communistic and "broad." For such the present book will not be "ecology" at all, but a study of the response of plant individuals and their organs to external influences. That such response is the fundamental and penultimate basis of ecology all will agree, but that it is the superstructure and ultimate aim of the science some will doubt. But "ecologists are not agreed even as to fundamental principles and motives, indeed no one, . . . least of all the present speaker, is prepared to define or delimit ecology." Warming did not say this, nor Clements, but Henry Chandler Cowles said it as late as 1904.*

Brooklyn Botanic Garden

PROCEEDINGS OF THE CLUB

February 28, 1912

The meeting of February 28, 1912, was held in the Museum Building of the New York Botanical Garden, 4 P.M., Vice-President Barnhart presiding. Fifteen persons were present.

The minutes of the meetings of January 31 and February 13 were read and approved.

Dr. Marshall A. Howe, Secretary of the Board of Editors, presented the following proposed agreement between the Torrey Botanical Club and Columbia University:

With a view to enlarging the Library resources of the Department of Botany of Columbia University and of the Torrey Botanical Club, the following AGREEMENT BETWEEN THE TORREY BOTANICAL CLUB AND COLUMBIA UNIVERSITY WAS ENTERED INTO.

It is hereby agreed by Columbia University that it will provide for the storage of the publications of the Torrey Botanical Club; and that it will bind, catalogue and make accessible the periodicals received by it in exchange for the publications distributed in the manner below described.

It is also agreed that members of the Torrey Botanical Club

* Science II. **19**: 879. Je 1904.