too much weathered to show glacier scratches.

The oscillations of the land surface in the Vermont region are well known to geologists, as are the effects produced upon the surface by which in various ways both highlands and lowlands were modified. One class of these phenomena is found in the ancient water levels which are plainly discernible in many localities.

Geologists are indebted to Professor H. L. Fairchild for his careful study of these levels through New England. So far as Vermont has been studied, Dr. Fairchild's results are given in the Tenth Report of the Vermont Survey.

Of the level plains, terraces and similar features he writes:

> The broad stretches of sand plains on both sides of the Champlain Valley and conspicuous in Vermont are clear evidence of standing water at levels far above Lake Champlain.

Again:

> The terraces, beaches and shore phenomena in the open Champlain Valley were produced by waters confluent with the sea. The summit marine plane lies uplifted to-day about four hundred feet above tide at the south edge of Vermont and about eight hundred feet at the north border of the state.

Most if not all the terraces in the Connecticut Valley which have been explained as due to river flood action are to be accounted for in the same manner as Professor Fairchild has shown in Bulletin, Geol. Society, Vol. 25, pp. 219–242.

The condition of Lake Champlain and the many changes through which this lake has passed from Pre-Cambrian time to the end of the Pleistocene forms an interesting chapter in the physiographic history of Vermont, but the story is far too long to be told at this time.

From what has been shown it will be seen that the present physiography of Vermont has become what it is through the action of a great variety of geological agencies during several periods of past time.

At least eight epochs may be defined. First, in Pre-Cambrian times were formed the hard crystalline rocks found in the interior of the Green Mountains. Second, an unknown interval of erosion and subsidence, during which a large part of the Pre-Cambrian beds were removed. Third, Cambrian deposition when the sandstone, shale and limestone of this time was laid down. Fourth, a relatively short period of erosion when these beds were all carried off except the few remnants now standing. Fifth, deposition of thick beds of limestone and shale in the Ordovician ocean. Sixth, a period of igneous activity and metamorphism during which the schist, quartzite, gneiss and slate and marble were formed. This was the time of the greater uplift of the Green Mountains as now they appear. Seventh, a vast interval from the close of the Ordovician to the beginning of the Pleistocene. Eighth, the Pleistocene glaciation and erosion.

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WHAT KINDS OF BOTANY DOES THE WORLD NEED NOW?[1]

FOR months, even years, after the great war began I felt that the world had suddenly been plunged into darkness, intense and impenetrable, in which one could only grope one's way, unable to determine or to keep one's direction, shocked and grieved that those lights, which were thought to serve as guides before, had so completely gone out. I believe now that this series of figures is wrong; that, instead, the world has had such a light turned upon it that we are dazzled, if not blinded, that its shams have been exposed as the pleasing envelopes of selfishness—mercenary, political and social—that the lights which had guided us before are still burning but that they have become so shaded and dimmed by human goggles that they disappeared in the flood of light which makes war a great revelation of human weakness, human wickedness, human stupidity, and human ideals.

[1] An address delivered at the meeting of the San Francisco Bay Section, Western Society of Naturalists, at Stanford University, on November 30, 1918.

It may be more the function of others to inspect the quaking edifice of civilization, to ascertain and repair its weaknesses; but now is certainly the opportunity, and hence the obligation, of scientific men to review their sciences, to consider the relations of science, be it zoological, botanical or geological, to human life, human needs and human ideals. This review should comprise both the pursuit of science, research if you will, and also the teaching of science.

So far as the teaching of botany is concerned, two such reviews have come to my notice, one English, the other American.[2] No one, so far as I recall, has recently reviewed the pursuit of botanical science in any more public way than in addresses to professional audiences, such as the botanical section of the American Association for the Advancement of Science, and its affiliated societies, and even these reviews are only relatively recent.

A glance at the botanical science of various epochs in the past shows the changes in emphasis which teachers have given it, changes in direction which its leaders have encouraged. The well-known statement of Mrs. Lincoln,[3] which never fails to release a smile, if not to arouse a laugh, whenever it is quoted, is but one of many statements of the peculiar fitness or of the importance of botanical study for a part or the whole of the human race. But in spite of these statements the world has little idea of what botany really is or what its devotees are trying to accomplish. Hence, while to name a man a plant pathologist is to connect his name with one of the branches of botanical science, to call him a botanist is to suggest to the mind of the average man something very different from the vigorous and virile person capable of working hard a good many more than eight hours a day and playing at least equally hard besides. Why is this? The explanation seems to be that the various branches of botanical science have themselves forgotten their origin, soon after they became independent, and the rest of the world never knew or cared. What "man in the street" is aware that the present science of bacteriology had its foundations laid and its first story built in botanical laboratories, and that even now bacteriological papers come from the same source? Forestry is botanical science applied to trees and the accompanying vegetation of the forest, and no forester is anything more than an administrator, no matter how much engineering, entomology and geology he may know, unless he is first and foremost a botanist, versed in the anatomy and physiology of the trees which he is to sow, cultivate, protect from damage by disease, animals and fire, and to harvest. Horticulturists, agriculturalists, farmers, are botanists as well as the New Englandish spinster who "analyzes" some of the by-products of a summer vacation. By superior organization, admirable enthusiasm, and freedom from that excess of modesty which has been one of the misfortunes of botanists, every one knows of plant pathologists and of plant pathology. But the plant pathologist can not recognize a diseased plant unless he knows what it looks like when it is well, he can not tell what is wrong about its functions unless he knows the normal ones.

All of these men are applying, consciously or unconsciously, what has been learned through the experience of the race and the deliberate investigations of the few. Whenever the fruits of "pure science" can be used, they become applied science or "practical." But nothing can be applied that is not first found out, and the changing requirements of the world make new demands upon the stores of knowledge acquired by study and by experience. The careful housewife draws out from her stores in attic and closet what she has put away as prospectively but not immediately useful, and thereby she saves unnec-

[2] See a series of contributions in numbers 1–6, *New Phytologist*, 17, 1918, and Davis in Science, N. S., 48, No. 1247, November 22, 1918.

[3] Lincoln, Mrs. Almira H., "Familiar Lectures on Botany," 3d edition, Hartford, 1832, p. 14: "The study of botany seems peculiarly adapted to females; the objects of its investigation are beautiful and delicate; its pursuits, leading to exercise in the open air, are conducive to health and cheerfulness."

essary drain upon the family purse. Thus the accumulations of years come, sooner or later, into use. So it is with science. In these last years of unusual and great stress, the knowledge of woods has brought about the utilization, with the minimum loss of time, of spruce, black walnut and other materials in the manufacture of airplane parts.

No one should be so unimaginative as to wish to check curiosity merely because one may not see now what possible use there may be of the fruits of curiosity. Scientific curiosity should have the heartiest support and encouragement. There should be no neglect of "pure science" merely because the world is hungry; but because the world is hungry, can not we botanists take account of stock and make some estimate of what parts of our field of study are likely to help most to relieve the present need? As a plant physiologist some parts of my subject seem to me to have more immediate prospects of usefulness than others, and to deserve for this reason more study. I can conceive, for example, no reason, scientific or other, for attempting to carry the study of geotropic phenomena any further until the chemist has thrown more light upon the contents and the changes within the cell. But that one should conclude that all study of irritability should stop is absurd. We may, perhaps, well conclude that further study of the directive effects of light may cease for a time, for we know pretty well about the movements, the bendings, of motile and sessile organisms toward or from sources of light: but how much do we actually know about the effects of light upon that chain of processes which ends in the production of fruit and seed? The observations of Delpino, the experiments of Vöchting and Klebs, the experience of agriculturalists and horticulturists in the sunlit arid regions of our western country and in the greenhouse, all point to light as the most effective stimulus to reproduction in plants that we know. Would there be any unworthiness in the student of plant physiology who is interested in the phenomena of irritability choosing to work on the influence of light rather than on the directive influence of gravity?

The most important chemical reaction in all nature, from the standpoint of man and other living things at least, is that which results in the combination of carbon dioxide and water into sugar. The botanist has been fond of saying that plants stand between the animal kingdom and starvation; but what has he done about it? I do not ignore the invaluable studies of plant nutrition which have been carried on and are now in progress; but too many of us have given little thought to the problems involved in that reaction of which the botanist is peculiarly the custodian. Need the world have been as hungry to-day as millions of its inhabitants are, if we botanists had reflected as much upon the processes of nutrition in plants as we have, for example, upon the possible or probable course of evolution? Do we realize that, while water can only be moved, it can not be made, food can be made, and made so near to the points of maximum consumption, that the problems of transport can be very greatly reduced, if the kinds of food and the methods of culture are more accurately adjusted to the demand? This is not merely a problem for the economist; it is a problem of first rate importance for the botanist.

My allusion to the doctrine and the studies of evolution must not be misunderstood; for no one acknowledges more frankly the enormous benefits, material as well as intellectual, which have flowed from the emancipation of the race from the bonds which held it for generations, however deplorable the results of a misguided application of one of Darwin's doctrines may have been in the last four years. But whatever the course of evolution may have been, we know that it is possible, because plants are plastic under cultivation, to breed strains which will withstand, for a time at least, conditions and enemies which others can not endure. Acquired characters may or may not be heritable; but conditions may be so modified that, in the new complex, a new and endurable balance is established.

The indirect fruits of the studies of Mendal and De Vries and their followers are profitable to the race, very profitable, though this was not foreseen probably during the years that monk and professor were working in their gardens on problems of apparently purely theoretical interest. In the light of subsequent events it is easy for us to guess that an intelligent visitor might have appraised these experiments as more likely to be useful at some time to the race than some others which we may imagine him to have seen at about the same period. And we can to-day make just such judgments, leading our students, however elementary, to thoughts no less developing, no less elevating, but more suggestive of possible benefit to themselves and their contemporaries, than others which we may select from our repertoire.

In a meeting which has been filled with interesting and enthusiastic descriptions of work done, a "paper" which contains nothing but reflections may seem the more completely out of place if the question which it asks is not answered in definite terms; but I am so averse to anything which may even seem to dictate what intelligent, thoughtful, conscientious students and teachers should do that, even if I had a formula, I should keep it to myself. My purpose will have been served if, in addition to those who have so far discussed with themselves and others the question before us, we all search for an answer which we can effectively put into action. For the college no less than for business, peace will bring the need of reconstruction; and he who fails to take a long, broad and deep view of the subject of his own greatest interest will fail to share his best with the world which supports him.

GEORGE J. PEIRCE

DAVID ERNEST LANTZ

AFTER an illness of only a week, Professor David E. Lantz, assistant biologist in the Bureau of Biological Survey, died of pneumonia at his home in Washington, D. C., on October 7. He was born at Thompsontown, Pa., March 1, 1855, and his early education was received in the public schools and at the State Normal School at Bloomsburg, Pa., where he graduated with the degree of M.S. In 1878 he removed to Kansas where he became widely known in educational and scientific circles. He served as superintendent of schools at Manhattan, professor of mathematics in the State Agricultural College from 1883 to 1857, principal of the Dickinson County High School, and field agent of the Kansas Agricultural Experiment Station.

In 1904 he received an appointment in the Bureau of Biological Survey as assistant biologist, and since that time has been occupied mainly in investigating mammals of economic importance. He was particularly active in collecting and applying information in regard to the domestication and uses of native mammals, and published papers on deer farming, raising rabbits for food, muskrats and skunks for fur, and guinea pigs for use in laboratory work. His work was especially important in relation to food conservation in developing and applying practical methods of destroying animals injurious to agriculture and stock raising. He spent much time in the field demonstrating methods of preventing the depredations of prairie-dogs, pocket gophers, jack rabbits, ground squirrels and field mice. More recently he devoted his attention with a considerable degree of success to the organization of cooperative campaigns to destroy rats.

Professor Lantz was always active in scientific circles. He served as secretary and president of the Kansas Academy of Sciences, of which he was a life member. He was also an honorary life member of the Kansas State Horticultural Society, an associate member of the American Ornithologists' Union, and a member of the Biological Society of Washington.

While in Kansas, he took a lively interest in its fauna, devoting his spare time largely to collecting specimens and compiling information relating to the vertebrates of that state. He acquired a field and museum knowledge of birds and published a revised edition of Snow's "Birds of Kansas." He also prepared a work-