as I have mapped it out, is very much more than many of us had when we began. It should fit a man for beginning to give instruction in the smaller colleges or in the minor positions in the universities. It should fit him to lead intelligently the students that come to him in our normal schools. I take it that it is in this direction that we must move if we are to be able to supply from our schools and our universities the men who are to follow us.

You will notice that in all this I have said—"men." I have said so because I have found that when the demand comes, it is mostly for men. I do not know why this is so. We say very pretty things about our women students, and give them good high standings, and say complimentary things about them *as students*; and yet when you yourselves look around for some one to be an instructor, and we write and say—"there is a young woman here who will make a good instructor"—you say: "Our present circumstances are such that we can not employ a woman." Here is one thing that we ought to change. The supply of competent women is much larger than of competent men, and I can assure you from experience in my own department that they make admirable instructors.

I have gone over this problem of the making of botanical teachers in this rapid way in order to stir up thought along many lines. For I hold that it is a serious problem; and that we as teachers of botany owe it to the future that we should prepare in a proper way for the succession of teachers that must follow us.

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## II. THE PRODUCT OF OUR BOTANICAL TEACHING

NOTWITHSTANDING the frequent assertion that teaching of botany is not what it should be, it seems safe to say that there was never a time when there was more good teaching of the subject than we have to-day. That we should have dissatisfaction at a time when so much good teaching is being done, is not at all surprising, inconsistent or undesirable. Botany itself has grown so rapidly, its call for new researches has been so insistent, its place in the applied sciences and in the affairs of men in general, has assumed such prominence and importance, its use as a means of giving a proper education in scientific thought about things that are worth knowing has been so vigorously claimed, that in consequence our attention is directed as never before to the possibilities and errors of botanical teaching.

The teaching is not poorer—we merely know more about it. Present practises are not wholly bad and need not be discontinued, but with the increasing richness and diversity of botanical knowledge, and with better definitions of the purpose of science education, particularly education by means of botanical science, we need to consider our practises anew. If a prominent feature of reform is discontinuance of past vices, a feature of progress is discontinuance of past virtues for better and larger ones.

If the product of our botanical teaching does not meet our ideals, we should look for explanation to some or all of the factors or causes of the very complex situation which confronts us.

1. First, what are our ideals? What do we wish to accomplish through botanical teaching? Do we wish to use the study of botany as a means of developing on the part of the people in general a more dependable method of thinking, better reliance upon native powers of observation, experimentation and interpretation, an attitude that demands evidence before judg-

ment may be given, or do we wish to make knowledge of plant life, its structures, processes, habits and uses, the possession of the people in general in order that they may know more, enjoy more, or may more effectively adapt plant life to their economic uses? Do we wish to prepare students who shall take up research in botany to the end that unsolved problems may have solution? Or have we any definite purpose for botanical education other than that since botany is a field which we have found most interesting we wish to "pass it on" to others?

The ends which we seek certainly should receive the careful attention of all who are engaged in general botanical instruction. Research in botany is not the goal of general botanical education, and botany can not claim a place in the general curriculum of the high school or college if its primary aim is to prepare students for research in botany. On the other hand, research is perhaps the most important by-product of general botanical instruction, since when general courses of instruction are efficient there develop well-grounded students who desire to become investigators in the subject.

The purpose must be more serious than to give passing enjoyment, stimulate curiosity about plants, or to minister, as early botanists sometimes said, to the emotional nature of young ladies. There is great need of development of a rigorous scientific attitude toward plant phenomena. Plants and their products are our constant companions and there are certain fundamental facts and principles that people should know about them. If they learn these facts and principles in a way that develops care in observation, in experiment, and in proper thinking, I believe there is also secured enjoyment of plants and ability to make economic use of them. This central foundation in method and content should be best upon which to build research work. It would seem also that research would find a large number of worthy devotees if general courses of instruction were presented as broadly fundamental to the science, and more significant in practical affairs.

2. A second factor has to do with the quality and preparation of the students who present themselves in our college courses. From an amount of data too limited for final conclusion, it seems that most of the students who elect college courses in botany have had no botany in secondary schools. For some reasons, secondary school courses seldom lead students to take botany in college, or else college requirements prevent their doing so until they have become engrossed with other lines of work. Possibly the difficulty lies in inefficient courses or teaching in secondary schools. These courses have been accused of being too formal, too technical, too closely limited to a special field of botany, not sufficiently full of meaning to young students. Secondary courses in botany have also been accused of being too difficult —an accusation which I think is untrue. It is not, for example, the inherent difficulty of alternation of generations, but lack of any appreciable motive for studying it, which makes it seem difficult. The structure and workings of a steam engine or an automobile are more difficult, but they are "going things"—dynamic—and students solve their mysteries. If an appreciable motive is put into secondary teaching of botany its difficulties are solvable.

Possibly some of the difficulty lies in the fact that the different sciences are incoherent and intermittent in the high schools. In a valuable recent investigation made by an eastern biologist records were collected from 276 high schools. Botany is taught in 225 of them. It is distributed in the

different years of these high schools as follows: first year 76, second year 94, third year 26, fourth year 29. It is evident in so far as these and other statistics go, that something in the way of definiteness is beginning to appear as to the year in which botany is taught. But it is also to be noted that in these schools botany appears in almost every possible relation to the other sciences that are taught, and it is taught by teachers who teach almost every possible combination of subjects in the entire curriculum. The sciences need more of the same sort of consecutiveness that is found in the languages, if we are to develop more worthy scientific value.

Furthermore, from the above-mentioned investigation and others, it appears that the courses in botany vary in nature from systematic botany to a study of the anatomy and cytology which deal with plant evolution. Surely the courses in secondary schools need scientific study, unless it is true that there is no part of the subject and no particular organization that is best for the education of beginners. I believe we have a right to expect that a scientific organization of the science for the secondary schools, in addition to conferring better immediate results upon pupils, will lead more of the students who have done well in science to desire to continue these studies in college. This would be of great advantage, for we need more students who early in life have begun to *think botany* and to think in the scientific method.

The nature of the preparation of our graduate students is also a factor in our product. This varies largely. In at least some of the larger universities comparatively few of the graduates come from the local undergraduate body. They have for the most part had their training in the smaller colleges, and those who come to the university are of two classes—those who are called, and those who are sent. Some of them, through the more general courses of the smaller colleges, got their desire and enthusiasm for botanical investigation, and come to the university to continue that study. They are chiefly those who give us new botanical knowledge. Others, who have not secured suitable positions, come to the university and do graduate work as a means of securing better employment, and good botanists and good teachers sometimes develop from this group. A compelling desire to study botany is the motive most likely to yield results of high order.

3. Another factor in the efficiency of our student product is found in the nature and appropriateness of the courses into which these students go when they come to colleges. Whether research or teaching is the end to be secured, there are needed courses in the general fundamentals of plant life and structures, and in chemistry, physics, physiography and general physiology. Too early specialization is likely to produce a narrow research student, and to render a teacher unable to give to his students the necessary vitality in his introduction to general botany. In our revolt from the special field of systematic botany, botanists went to an extreme of even greater specialization, so that sometimes students in research in morphology are uninformed regarding the relationships of the particular plants with which they work. And so specialized are we at times that teachers in small colleges and secondary teachers who have had our so-called general courses must teach a special field of botany because they know no other. It is quite possible in some cases to go into a secondary-school class in botany and by observation of the nature of the teacher's work, to determine the university in which the teacher was trained. This, of course, is not an argument against research in which we all believe most pro-

foundly, nor against emphasis upon special lines of research in different universities, but is an argument against permitting that special research to dominate courses that presumably are for general education in botany. As Schleiden in 1849 organized the general field of botany as an inductive science, we again need for general students a presentation of the fundamentals of the science as a whole.

There are many other factors that have to do with the efficiency of the product of our botanical teaching. We need more students who in their latter college years have definite purposes in mind—as teaching, research, practise of forestry, agriculture, etc. Possibly our teaching ought to enable them to discover purposes that will absorb them as do other college interests.

More fundamental, however, is the fact that we have been too content to assume without sufficient data, and to dictate regarding the nature of the needs of general instruction in our subject rather than to make the same sort of investigation in the field of teaching that we should make in our botanical investigation. If we can devise methods of making a scientific study of botanical education, we can improve our student-product.

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### III. Methods of Botanical Teaching

As a past master in the art of cooking botanical hares, Dr. Bessey has spent most of his time in elaborating the recipe. To me, however, the problem seems peculiarly one of making sure of getting the hare and then of keeping it long enough to cook it properly. As I see the problem, it seems almost imperative that the hare should be caught in the high school. The chief difficulty in our getting material for turning into young botanists lies at this point. High-school students, and especially the boys, are not attracted to botany; one might say they are not attracted by the kind of botany offered. More than that, and this may be the crux of the whole question, we fail signally to enlighten the parents of the boy as to the real meaning and place of botany. Botany will not attract the attention of the high-school boy unless it meets every-day conditions—unless it puts him in touch with his every-day environment in a way that is sympathetic as well as illuminating. Moreover, it is perhaps of equal importance to bring the public to understand what a fundamental place the knowledge of plants has in every-day life, and how important a part of education it is in consequence.

So far as the high school is concerned, we have the situation entirely in our own hands. Few of us can teach anything but what we have been taught, nor can most of us teach in any way but the one by which we have been taught. If you will look over the high schools of your state you will see that the kind of botany you are teaching is the kind of botany that is being taught in your high schools. It seems to me that few botanists realize this fact. It really means that we are actually teaching high-school botany to our beginners, for this is inevitably the botany that they will carry into the high schools. When we appreciate this fact thoroughly, we shall change our elementary teaching. When we do change it in a way to attract the sympathy of our students, then the problem of catching the hare, or at least of knowing the paths that he will follow, will be solved.

The next most advantageous point for catching botanical hares is upon entrance to college. This last year, in the University of Minnesota, the College of Arts graduated 265 bachelors—most of them maids. There were 195 of the latter and only 70