

any any method is as good as any other method, and that the results must be good because *we* have done the work. I feel sure that the use of experiment in connection with our methods of teaching, and the measurement of results will go a long way toward changing our present methods and improving upon our present results.

F. E. CLEMENTS

UNIVERSITY OF MINNESOTA

DISCUSSION

Professor John M. Coulter, University of Chicago:

As Dr. Bessey says, some of us began botany a good while ago, when facts were so few that they were pieced out with enthusiasm, and our knowledge of the subject was chiefly enthusiasm; but now the facts have multiplied so enormously that it is a problem how to present them.

I have been in discussions of this kind for a good many more years than I should like to acknowledge. They have all sounded alike to me, but the thing I learn from them is this: that no matter how much thought we give to the technique of teaching botany, or how many devices we suggest as to methods of presenting it, a gratifying group of successful botanists continue to surmount all the obstructions we manage to place in their way. My definition of a successful teacher has long been one who places the fewest obstructions in the way of the student.

It is clear that we must encourage independence and originality in our students if they are to become investigators or only teachers. This attitude is appearing in the teaching of botany, for teachers are becoming more independent, and are thinking more for themselves. No teacher, however successful, has the right to prescribe for others a detailed method of teaching. It is only a stupid teacher who copies some other

teacher. Every one must have his own way, and if the text-book is the only way for him, let him use it; if he can do better without it, let him throw it away.

In brief, the problem is this. We are confronted by all sorts of suggestions as to teaching. Our subject has grown to be so vast and is still growing so rapidly that we know not how to deal with it in detail. There are just two general things that a teacher must keep in mind, and the details can be left to shift for themselves.

In the first place, there must be developed a general perspective of the subject. It is a vast plexus, and each of us in his own individual way must develop for the student some conception of the extent and interrelationships of this plexus we call botany, so that he may leave us with no narrow vision.

In the second place, in addition to the perspective, there must be developed what we call the scientific method, which is a certain attitude of mind. This is absolutely fundamental. There are many ways of doing this and every teacher has his own way of enforcing the training that demands the truth, and knows what it takes to reach the truth.

It is my conviction that any one cultivating this perspective and this scientific attitude of mind, by whatever detail of method they have been reached, is likely to prove successful in any form of botanical activity, whether it be teaching or investigating, with the scientific motive or with the practical motive. The details have become too numerous to include in instruction, but it will always be possible to train a spirit that will be able to master any details.

Professor F. C. Newcombe, University of Michigan:

I will say that I feel considerably cheered up since the last two addresses. No doubt

the rest of you, or some of you, feel the same way. I was beginning, a few minutes ago, to congratulate myself that such instruction as I had received was received twenty-five years ago instead of at the present time, because I know that if it had been received at the present time I could have become nothing but some poor ignoramus.

First of all, I should like to refer to some of the ideas presented here this evening:

Professor Bessey stated that our students in the university are looking here and there without reference to any aim in life, and I wondered whether he had actually looked into the matter of student elections in his university, where elections have been quite free, as they are in the university with which I am connected, or whether he has been seriously investigating this subject. The matter has been looked into in my university, and there it is found that more than 80 per cent. of the students who have perfect freedom in elections have elected with some aim. There is a comparatively small percentage of students who are browsing around without taking any direction.

The second thing that Dr. Bessey says is that he is trying a system of instruction in his university of 20 to 25 hours in botany as preparation for a college or university instructorship. That is the minimum we in Michigan think the average student should have for preparation to teach botany in the high school.

It was said a few minutes ago by Dr. Coulter that it is not a matter of the number of hours the student spends on a subject, but it is the ability which the student develops for doing things, his attitude, his efficiency, his originality, that makes him able to advance. I had some years ago a student who took only one year in botany. She was a teacher, and she had been teach-

ing for some time, and I gave that woman the strongest recommendation of any woman who went out that year. She had only one year, and yet she was ready. It is not how many courses the student has, it is a matter of the student's ability to take new ground, to start in a new direction and develop the subject for himself.

On the side of research, I can not help placing in contrast to the quantity of preparatory work which some of us think we must have from our students before coming to research, that well-trying system in the German universities with which you are all familiar, and which reduces the number of students to a few successful ones by the law of survival of the fittest. You know that, in the German universities, the student takes perhaps on the average not more than one year in elementary botany, and is then allowed to go along for a few weeks, or possibly a semester with a *Vorarbeit*, and is then thrown mostly upon his own resources for investigation. There are many successful botany teachers and investigators who come out of that sort of training. I wouldn't advocate that sort of training in this country; but I think there is danger of our overdoing the matter in endeavoring to give the student something of all kinds of knowledge in botany. If the student is fit for any kind of teaching after he has had proper training in some lines of work he will be able to work out something for himself that he may not have been trained for in the schools.

It was stated here also in one of the addresses that the aim of general education is not for research. I think that statement was made. I would not say that one aim of general botanical education is not for research. What have we been talking about and hearing about in this session of scientific societies in Minneapolis? We have been hearing of the need of the in-

vestigation of plant physiology, of phytopathology, of the study of all things that are related to the welfare of the people of this nation and of the world. Now, if it isn't the university's business to prepare men for research, I should like to know where that business does lie.

It seems to me we have a double duty—we must provide teachers and we must provide investigators. The university's function is just as much for research as for instruction. The staff should be just as much bound to the doing of research as to the giving of instruction, and just as much bound to train the young people under them for research as to train them for teaching. We need both. We need research just as much as instruction.

Now, is it true, as was stated here, that there is no open door to a career in the study of botany? It was said of law, medicine, etc., that there is an open door. But at the present time we can say to the student, there is also an open door in the study of botany. What does it mean when Dr. Bessey says they can not supply the demand? We have all of us felt that same thing. It means that, although the remuneration is not adequate in many directions, still there is the open door toward the earning of one's livelihood at least.

Now, to take up quite a different matter, and that on the main subject that this discussion opened with: that is, the question as to why we do not have more students becoming professional botanists. That's what the meaning is, I think, of the question as it was put. Now, the case is not so bad as has been presented here. If you will pardon me, I will review the relations at our own institution. We have no agricultural college at the university. We have a first-year class of 200 students—I think 194 this year; we have, besides that, in our classes above the freshman year, 175 stu-

dents. Now, that proportion does not seem to me to be bad at all. We have our advanced classes with ten students, fifteen students, one class with thirty-two students, another one, second-year students, or mostly of second-year students, with fifty-five, and to my mind the proportion is not bad and it does not call for any great alarm as to the future. I expect in the future that the proportion of students in the advanced class will tend to increase instead of diminish. I don't see why it should not.

I find the method of encouraging the promising student to go on with the work is justified. We all make mistakes, but nevertheless we can, with ordinary good judgment, read the case right four times out of five, and perhaps more often than that, and I have found that by advising with those who attract attention as capable students, one can usually find several who can be led, without very much persuasion, in the direction of becoming professional botanists. One thought that is on a different matter. I have been considering for two or three years whether, as teachers of high-school teachers, we ought not to change somewhat—I know it is already done in Minnesota—whether some of us ought not to change our methods so that the perspective of the high-school teacher is brought more into relation with his subject matter as it occurs in nature. Of course a great deal can be done by greenhouse study; but after all that does not take altogether the place of field study, and I believe we must draw these teachers to field study so that when they go out to teach botany in the schools they may show their pupils the way by which they can in themselves carry the work further than it is carried in the schools—the high schools and lower grades.

I would like to see a set of statistics from

which I could ascertain how many of the professional botanists—those who have passed out from under our hands within the past ten or fifteen or twenty years, or longer—how many of these were young investigators before they went to the high school. I will venture to guess that I could pick out in this room fifteen or twenty of the men who sit right here whose youth I know something about, who made collections of plants and insects and hammered up rocks to get the fossil shells out of them before they went to the university or came within three or four years of it.

If statistics should bear out my belief, we should find that most scientists are so born and not given their bent by training, and that the few turned by training in the direction of professional science are thus influenced by the teacher who knows how to make the student an investigator at the same time he is pupil.

LEONARD P. KINNICUTT

In the issue of *SCIENCE* of February 17 there appeared a brief notice of the death of Professor L. P. Kinnicutt, director of the department of chemistry in the Worcester Polytechnic Institute.

Leonard Parker Kinnicutt was born in Worcester, May 22, 1854, the son of Francis H. and Elizabeth Waldo (Parker) Kinnicutt. He received his early education in the schools of Worcester, graduating from the high school in 1871. He went at once to the Massachusetts Institute of Technology, where he devoted himself chiefly to the study of chemistry. Following his graduation, in 1875, with the degree of bachelor of science, he spent four years in professional studies in Germany. At Heidelberg he came under the inspiring influence of Bunsen from whom he acquired an appreciation of the value of careful and accurate analysis. Here also under Bunsen's guidance he was initiated into the refinements of gas analysis. This was the period when organic chemistry was developing with tre-

mendous rapidity especially in Germany. Bunsen had passed the zenith of his career and was not in sympathy with the new tendency which was manifesting itself in chemistry. It is not surprising then to find the young Kinnicutt leaving Heidelberg and matriculating at Bonn. Only ten years before, Kekulé had been called to the University of Bonn to take charge of the newly built laboratory, which at that time was the finest in all Germany and after which later laboratories were patterned. Kekulé's was a charming personality. His lectures were a model for simplicity of arrangement and clearness of presentation, and the experimental demonstrations were carried out with such fascinating ease and dexterity that the young Kinnicutt was captivated by the spirit and beauty of organic chemistry and devoted himself diligently to its study.

He was fortunate in being accepted into the private laboratory of the master, where he became associated with Richard Anschütz, the present director of the Chemical Institute at Bonn. In collaboration with Anschütz he published a number of papers, chiefly on phenyl-glyceric acid. This association ripened into a lasting friendship. Returning to the United States in 1879, he spent a year in study with Ira Remsen at the Johns Hopkins University, and then three years at Harvard, where he served as instructor in quantitative analysis and as private assistant to Wolcott Gibbs, at that time Rumford professor of chemistry. In 1882 he received from Harvard the degree of doctor of science and in September of the same year accepted an appointment as instructor of organic chemistry at the Worcester Polytechnic Institute. In the following January he became assistant professor of chemistry; three years later he was made full professor, and since 1892 has been director of the chemical department.

As early as 1885 Professor Kinnicutt began to give attention to the question of sewage disposal and sanitary problems. He became an authority on the sanitation of air, water and gas; on the methods of analysis and on the disposal of wastes. He paid particular atten-