dence of it in the moon's motion. Reasons may exist for this: but until the mechanism of the action can be made more definite it is hardly worth while to belabor the point.

The hypothesis presents many difficulties. Even if one is disposed to admit provisionally a correlation between the four curves —and this is open to considerable doubt—it is difficult to understand how, under the electron theory of magnetic storms, the motions of moon and planets can be sensibly affected. I am perhaps catching at straws in attempting to relate two such different phenomena with one another, but when we are in the presence of anomalies which show points of resemblance and which lack the property of analysis into strict periodic sequences some latitude may be permissible.

In conclusion, what, it may well be asked, is the future of the lunar theory now that the gravitational effects appear to have been considered in such detail that further numerical work in the theory is not likely to advance our knowledge very materially? What good purpose is to be served by continuous observation of the moon and comparison with the theory? I believe that the answer lies mainly in the investigation of the fluctuations already mentioned. I have not referred to other periodic terms which have been found because the observational evidence for their real existence rests on foundations much less secure. These need to be examined more carefully, and this examination must, I think, depend mainly on future observations rather than on the records of the past. Only by the greatest care in making the observations and in eliminating systematic and other errors from them can these matters be fully elucidated. If this can be achieved and if the new theory and tables serve, as they should, to eliminate all the known effects of gravitation, we shall be in a position to investigate with some confidence the other forces which seem to be at work in the solar system and at which we can now only guess. Assistance should be afforded by observations of the sun and planets, but the moon is nearest to us and is, chiefly on that account, the best instrument for their detection. Doubtless other investigations will arise in the future. But the solution of the known problems is still to be sought, and the laying of the coping stone on the edifice reared through the last two centuries can not be a simple matter. Even our abler successors will hardly exclaim, with Hotspur,

> By heaven, methinks, it were an easy leap
> To pluck bright honor from the pale-faced moon.

They, like us and our predecessors, must go through long and careful investigations to find out the new truths before they have solved our difficulties, and in their turn they will discover new problems to solve for those who follow them:

> "For the fortune of us, that are the moon's men, doth ebb and flow like the sea, being governed, as the sea is, by the moon."

E. W. BROWN

BOTANY IN THE AGRICULTURAL COLLEGE

FIVE years ago, there was, I believe, no college in the United States which required that plant physiology be studied by any student of agriculture. There were a very few colleges in which it was possible for students of agriculture to take as much as one year's work in this subject, but the number of such places was exceedingly limited and remains so. The college of agriculture of the University of the Philippines was founded at that time; and having a free hand in planning its course of study, I provided that every student not only could but must take one full year of plant physiology, and that students taking the course regularly must have this year of physiology before being admitted to the study of agriculture itself.

There were several reasons for taking this rather radical step. Decidedly the strongest of these was the obvious fact that the raising of crops is essentially nothing more or less than applied botany. The botany which is useful in plant industry is not a study of the names of cultivated plants and weeds, and not primarily the cataloguing of plant products and plant diseases, but is the phase of botany which treats of the responses of plants to the conditions under which they grow. This is plant physiology. It is a phase of botany which can not be taught to students who have not some previous general knowledge of plants. It is here taught to students who have had one year of general botany, but who have not yet any chemistry. Some have had physics and some have not. It would be impossible to give to our students the sort of a quasi-cultural subject which is usually presented where plant physiology is taught at all in the United States. But a considerable part of the American course which could not be given to our students would likewise be useless to them. Our course in plant physiology is planned specifically to give students such an understanding of the behavior of plants as should serve as a guide in the treatment of crops.

This course was put in operation here without any advertising; while I felt perfectly sure that the proposition that the best scientific foundation for plant industry is a knowledge of plant physiology, is a sound one, I felt also that the general respect for a widely adopted system would be so strong that a radical experiment of this kind would be sure to receive very little favorable attention until it had been well tested in practise. Five years' experience should be enough to put a plan, which may have looked like an experiment at its first trial, on a different basis. During these five years, the same plan in greater dilution has been applied in some places in the United States. The example of Wisconsin in requiring half a year of plant physiology of students in some agricultural courses may have more weight in commending the subject than does our local experience with a full year. The desirable thing is that the value of the subject be recognized, and it is to be hoped that Wisconsin's example will be followed by other institutions as fast as is in their power.

It has already been stated that our course in physiology is fitted directly to the practical purpose it is to serve. For this purpose, growth receives particularly careful study. The student is drilled in growth measurements until he regards them as a matter of course, rather than as experiments. The number of such measurements required of each student is approximately 3,000. Aside from giving a thorough first-hand idea of the growth of a variety of plants and of different parts of plants under various treatment, this extensive drill has the practical result that the student acquires speed and accuracy in such work, such that if he is afterward called upon to determine how fast the plants in a corn field or coconut or coffee plantation are growing, he goes at it with skill and confidence. I have asked a number of graduates of American agricultural colleges how fast corn should grow at different ages; not one could give anything better than a relative and altogether indefinite answer. Not one of them knew anything about it from personal observation of a single plant. Not one had, so far as he remembered, even been given a figure on the subject; let alone being called upon to fix it in his mind by finding out for himself. Not one had any standard by which he could state that a plant or a field of corn was growing as it should, or doing better or worse. It seems to me that the graduate of an agricultural college should know a good deal more about the behavior of corn than any of these graduates do know. It would amaze our students if they were made to realize that a student could graduate from a famous agricultural college in a state where corn is a leading crop, without ever following through the growth of a single corn plant. Corn has received a careful study of just this kind in the United States, and is, so far as I know, the only American crop which has received a really careful study of this kind.

Next after growth in the attention it receives is transpiration. Next in order is direct study of the mineral food of plants, and nitrogen. Transpiration receives more careful study because it is of importance in a number of aspects. Without water in which plants can absorb it, mineral food is as useless in the soil as it is in a warehouse. Mineral food is studied in water culture, in pot culture, and in beds on the farm. In water culture, the work is made as exact as it possibly can be, using chemically pure salts, distilled water, and the most insoluble containers. In the field the work is made as practical as it can be, using ordinary garden crops on ordinary farm soil, with the fertilizers which are regarded as generally available. As a matter of interest, manure, ashes and commercial fertilizers used in this experiment are analyzed on the grounds, and the results of the analysis given to the students. But the experiment is intended and understood to show the students what results they can obtain at home by methods of procedure which are practicable there. Work on such a scale as these fertilizer experiments must be done by groups instead of by individual students, else the course will demand more time than can be found in a single year.

Other phases of plant physiology receive less attention. There are a reasonable number of experiments on photosynthesis. But, important as it is, this phase of plant activity is relatively not subject to direct human control; a thorough familiarity with it is accordingly of much less practical utility. The study of respiration is still briefer. Such subjects as geotropism, and the others sometimes grouped under the head of "Irritability," are treated briefly in lectures, and passed over with an easy experiment or two, not requiring more than a day each in the laboratory.

Practically in the place of this, the student in the American college of agriculture is taught chemistry. Chemistry is of course a necessary part of agricultural education. Our students study it for two years. But the plant physiology and not the chemistry is the basis on which their agriculture rests.

The difference in the scientific foundation makes the instruction in plant industry itself different. Our courses in agronomy are full of plant physiology. In these cases, the special plant physiology of the particular crops has thorough study. Thus, the students of the coconut measure the growth of leaf, root, flowering branch and fruit. The growth of the leaf is the easiest index to the general activity of the tree, and accordingly receives most attention. This work has now been carried on so long, and such a mass of data has been accumulated that it is possible to establish a figure which represents satisfactory activity, and to determine approximately how much this varies with the change in weather from day to day. With this information, the student can go into a coconut plantation and determine with a high measure of probability the average production from the grove two years and a half hence; and he can do this after 24 hours' observation. The estimate he makes is a very much more reliable one than can be made from a three months' study of the present rate of production. We expect to establish standards of this kind for all of our principal crops. But to do so, and get figures which can be relied upon, is no small task. On the coconut we have more than 100,000 single measurements of rate of growth. Standards of this kind are certainly worth having. I do not think it admits of question that the ability to use, and if need be to make them, is a valuable part of a student's education.

The student also measures the absorption of water by the roots of the coconut and its transpiration from the leaves, and the absorption of mineral food by the roots. He learns how much water the plant needs, and how it responds to differences in the water supply. When he gets done, he knows enough about the physiology of the coconut to realize that soil analysis, or even the decidedly more useful analysis of the parts of the plant, will not, by itself, give him any idea of whether or not it is worth while to apply fertilizers. He knows that if his trees are getting less mineral food than they should, it may be impossible to remedy the deficiency by buying fertilizers, and that the difficulty frequently can be remedied, and remedied more cheaply, by the use of water. In short, he understands the behavior and the wants of the plants he is growing, and can accordingly treat them with a degree of intelligence which can not be hoped for from those who have not become familiar with the practical phases of plant physiology.

The object of agricultural education is to produce farmers who will do their work intelligently. Speaking for plant industry alone, the most essential part of such a training is the acquisition on the student's part of the kind of understanding of plants, and particularly of the plants which he will raise, which he can get from the study of their physiology, and in no other way. The name of the study is of course of no importance. If it be chemistry of the kind represented by Adolf Mayer's "Agricultural Chemistry," or physics of the type of Wollny's "Agricultural Physics," the aim is reached. Both of these are plant physiology under other names which do not hurt them. But I do not believe that a student ever came out of an American college of agriculture, trained in physics or chemistry of this kind.

Although there has not been time for so much experience on this point, I believe that the advantage in our method of training goes well beyond the preparation for farming. By giving the student a more intelligent understanding of the behavior of his crops, we must give him a more intelligent interest in the problems of the farm. Up to this time, every one of our graduates is still a student or is engaged in agricultural work. Some are farming, some are employed by the Insular Bureau of Agriculture, and some are teaching agriculture. It is of course not to be expected that *all* of our graduates will always stick to the profession. But I am very confident that a larger proportion of them will do so than would if their training had been of the usual American kind. I had a chance two years ago to question a number of students about to graduate in agriculture at one of the foremost colleges in the United States. To the first questions, they all answered alike, that they study agriculture in college for the purpose of learning to farm scientifically; that the scientific basis of agriculture, as they had learned it, was chemistry; and that the chemistry they had been taught was something they would be unable to put into individual practise as farmers. As to whether, if the chance had been given, they could have made better use of plant physiology as a basis of agriculture, some thought they could, and others had not come sufficiently into touch with the subject to have an opinion. They all agreed that their education had failed to give them such an understanding of the problems of plant production, that they would be able, as individual farmers, to tackle its problems competently. In my opinion, the four years' instruction which had been given to them had failed essentially. Conscious inability to wrestle with problems is incompatible with an active interest in them.

The cities of the United States are growing at the expense of the country. It is universally agreed that the movement from country to city is a national calamity. The reason for this movement is not that the city offers greater prospect of material advance, for it does not do so. That life has been more comfortable and easier in the city has had something to do with this movement, but only a very minor part. Those who could live most comfortably on the farm, because of their means, have, on the whole, been most likely to move to the city. The essential cause of migration is that city life is interesting in a way which farm life is not. Neither bodily comfort, nor the certainty of such future success as will answer his needs, will keep the man who has the means to move to the city in a place where his mind is not interested. An agricultural education should of course qualify a man to farm with greater profit because of his education. But if it does not do more than this, if it does not give him a keen, intelligent interest in the problems he will encounter on the farm, it ought still to be counted a failure. To be really successful in their work, the agricultural colleges must send their graduates out so trained that the farm will present the fullest field for the activities of their minds. The successful agricultural college must train its students in such a way that the city, and not the country, is too intolerably dull for a permanent residence. The American college of agriculture does not do this, and the main cause of its failure is that the kind of agricultural problems which are presented, discussed and worked with in its classes, are not the kind which it is practicable for a farmer to work with after he graduates. The graduate is not equipped to find employment for his intellect on the farm.

The theses in all this writing are:

First: the American college course in agriculture is basically wrong. Plant industry as a science must rest on an understanding of plants.

Second: the mistake of not giving this understanding results not merely in the waste of considerable time, and in making poorer farmers than might be produced, but results also in the failure of the college to check. as it should be expected to do, the movement, from the farm to the city, of the country's best blood.

E. B. COPELAND

SANITATION IN VERA CRUZ

THE Vera Cruz correspondent of the *Journal* of the American Medical Association writes that the hot season, which is also the rainy season, begins in Vera Cruz in May or June and lasts until the end of September, and as the season advances the tendency is for the death and morbidity rate for all diseases to increase, due to the heat itself, and the rapid increase in the amount of malaria; yet thanks to the effective work of our sanatoriums, this year is an exception, in that the civil death-rate for July is practically no greater than for June, in which month it was lower than the average. The civil death-rates per thousand of population, per annum, for the months of June and July for the past five years for the city of Vera Cruz are given below; the improvement for July of this year is too great to be accidental or due to anything but improved sanitation.

	June	July
1910	36.86	46.86
1911	38.29	46.86
1912	44.86	49.72
1913	36.86	41.15
1914	32.00	32.58

A comparative statement of the civil deaths from communicable diseases for June and July of this year is as follows:

	June	July
Typhoid fever	1	0
Malaria	8	2
Smallpox	4	1
Dysentery	12	4
Tuberculosis	19	26
Diarrhea and enteritis, under 2 years	19	14
Diarrhea and enteritis, 2 years and over.	28	23

The increase of deaths from tuberculosis is not unusual during the hot weather; the smallpox epidemic is over and there are now no cases in the city; between May 18 and July 31, 66,432 persons were vaccinated; revaccinations are now being made when indicated but general vaccination ceased with the end of July. The principal gain is due to the fall in the death-rates for malarial and intestinal diseases and this improvement is directly due to our preventive measures.

The antimalarial measures which affect the civil population are three: the suppression of mosquito breeding, the use of the army laboratory in establishing the correct diagnosis, and the following up and treatment of all proved carriers of gametes in the blood. Mosquito-breeding has been largely suppressed by the extensive and intricate system of ditches in the environs of the city, totaling about 25 miles in length; miles of vacant lots and hundreds of acres of swamp at the bases of the gigantic sand-dunes behind the city have been drained by the Health Department, and it is now possible to sleep comfortably in almost all parts of the city without the use of mosquito-bars, something heretofore unknown at the height of the rainy season.

Malaria has been made a reportable disease by the Health Department and demonstration of the parasite in the blood is insisted on as far as possible. All houses where proved cases of malaria have occurred have been visited by inspectors trained in mosquito extermination, and secondary cases have been so far practically unknown. As a result of a partial malarial survey of the city, it has been found that the disease is principally localized along the railroad and the railroad yards. Further investigations along this line are now under