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MODERN BOTANY.[1]

BY CHARLES R. BARNES, PROFESSOR OF BOTANY IN THE UNIVERSITY OF WISCONSIN.

I VENTURE to say that the ideas conjured up by the words "botany" and "botanists" in the minds of those of you whose school days ceased anywhere from fifteen to twenty years ago, or perhaps even at a later date, will be one which is very widely different from the ideas that those words ought to bring up. To most people the word "botany" recalls something which chiefly means the collecting of flowering plants in the spring; pulling flowers to pieces in an endeavor, too often a vain endeavor, to find out a long, hard name for the plant; an endeavor which is often vain unless they have acquired the very useful trick of looking in the index for the common name. The word "botanist" brings to mind a sort of harmless crank who spends most of his time in wandering about fields and woods and poking into swamps and bringing home arms full or boxes full of plants; perchance drying them and preserving them. Yet these two ideas are so extremely foreign to the subject of botany as it is thought of to-day, that I venture to present to you some hints of what modern botany is, and particularly what modern botany is on its economic side. The study that I have indicated as being the common one is the study of a part only of botany; one to be sure which is not without its value; but it is only the most elementary part of the subject. It was very natural that when people began, in the revival of learning, and at the close of the middle ages, to study plants, they should first turn their attention to the plants which were nearest at hand, and to those plants which attracted their attention most readily on account of their size. So we find that the early studies of plants are almost exclusively an attempt to describe and classify; at first simply to describe the plants which one found about him; later to ascertain what the relations of these plants to each other were. From that day until the present this study and classification of the higher plants has been almost the only subject to which any very great attention has been given. In our own country the people who came to it, if they had had any training at all in botany, had been impressed with the importance of the same ideas. They had come to a new country. It was their first duty to make known to those abroad who were studying plants, what the flora of this country was; and, from the year 1750 on, collections of great number and often of considerable value went across the water.

From 1750 to late in the present century little attention was given to any other department of botany; and it is only within the last ten or fifteen years that descriptive botany has had any competitors for favor. In Germany, however, the matter is widely different; it has been a much longer time since systematic botany, the study of plants as far as their classification is concerned, was the only topic which attracted attention. The reason of this is perfectly evident. People exhausted the subject to a certain degree in that country, and they then naturally turned their attention to some other phase of plant study. Germany and France stand far in advance of this country to-day in the investigations which their botanists have pursued, solely because of the longer time during which they have been at work, and the greater amount of time which each investigator is able to give to his own special subject.

But students nowadays are not expected to collect flowers and find out their names and then congratulate themselves that they have studied botany. They are put to work with the microscope to see the very minutest arrangement of the complicated machinery of plants. They are set to work with the pencil to delineate these arrangements; to record their observation in a way which appeals at once to the eye, without the intervention of words; and, in spite of the repeated assertion that they cannot draw, they are told to do the very thing which they cannot do until they have learned how to do it. They are asked to equip themselves with chemical and physical knowledge, in order that they may be able to study this machinery in action; and when they have attained a sufficient knowledge of other sciences, then, and then only, can they expect to unravel some of the mysteries of plant life, in many ways the least mysterious of organic things.

Now, what is the object and purpose of such training as this? First, it is to develop skill of eye, hand, and brain. It is to bring to them something of those qualities to which the essayist of the evening alluded. It is to enable them to see in the material things around them something more than bits of matter. It is to enable them to gain that breadth of comprehension and grasp of intellect which it is desirable that every educated man should attain. I hope, therefore, that the members of this society will use their utmost endeavor to have this sort of vital and vitalizing study commenced in the schools below the college and university; in what we may call the primary schools as contrasted with the secondary ones. Most of the high schools in the State to-day, I am sorry to say, are studying this subject in the same way in which it was studied twenty-five years ago, and they are doing this work partly because they have had no pull from higher schools to lift them to a higher level, and partly because they know no better way.

On its economic side this sort of training has its chief value, and it is that, I take it, in which the members of this society are mainly interested. Let me select a few topics from the very great number at my disposal in order to illustrate to you, if I can, just what the economic bearing of this

[1] An address delivered before the State Agricultural Society of Wisconsin, Feb. 1, 1892; stenographically reported and published by permission of the secretary in advance of the volume of Proceedings for the year.

science is; just what we may expect from it; just what we have a right to demand from it.

Take the single topic of the culture of plants. In how far has that been exhausted? How much do we really know about the reasonableness of our modes of cultivation? How much do we know about the effect of other modes of cultivation than those which have been in vogue for fifty, or one hundred, or hundreds of years? One suggestion in this direction may suffice as an illustration. If any man should sow Indian corn in the same way that he sows wheat, with the expectation of obtaining any crop of grain from it, we should almost consider him an idiot. And yet I wonder whether it is very much less idiotic to sow wheat in the way that we do, with the expectation of attaining the best results possible from this as a grain crop. I do not say that we do not get a crop, often a good crop. A magnificent one, as compared with what we have ever had, has been raised in the past year; but who knows whether the cultivation of wheat in something the same way in which Indian corn is cultivated, that is, by giving it a much greater range for obtaining its nourishment, and better advantages of light and air, would not increase the yield by a very large percentage? Indeed, there have been some experiments, on not a very small scale, which would seem to indicate that there are possibilities in this direction which we have not yet even attempted to ascertain.

You hear a great deal from our own university experiment station about the food of animals; and Professor Henry is constantly experimenting to ascertain just what are the best foods to produce a given result with a given animal. He has endeavored to ascertain something of the effect of different rations upon the bones, upon the muscles, upon the fat of various animals. Why should we not have some experiments carried on in regard to the food of plants? Does anybody know what the effect of a given ration of food for a plant will be? So far as I can recollect, experiments on what we may designate as feeding plants, have been carried on to a very limited extent. We have endeavored to ascertain particularly where plants obtain their nitrogen; and for the last twenty-five years, almost, this question has been one under experiment and under discussion. I suppose that many of you know something of the prolonged experiment which has been carried on at Rothamstead; and perhaps some of you know of the recent experiments of Hellriegel and Wilfarth, and Frank, men who are endeavoring to find out whether plants, when kept in very vigorous condition, can obtain nitrogen from the air, or whether it is absolutely necessary to get it from compounds in the soil. Here is a problem which has been attacked in the way these other questions ought to be attacked, and in the very way in which we may expect a solution of these thousands of other problems in regard to feeding plants. The most recent experiments in regard to this source of nitrogen for plants make it quite possible that when plants are in a very vigorous and thrifty condition they are then able to fix the free nitrogen of the air; and that when they are not at their highest notch of vigor, they are then able to get their supply of nitrogen only from nitrogenous compounds in the soil. On this very point we have some recent experiments that perhaps would interest you; and, bear in mind, I am only mentioning these as illustrative. I am trying to show the necessity for such a preparation in botanical study as will enable the men who are most deeply and profoundly interested in this very study to carry on some of those experiments that it seems so highly desirable to carry on.

Only a few months ago a paper was published by two of the men who have been experimenting longest on this matter of nitrogen assimilation; and they give some hints in regard to the harvesting of those plants which produce large quantities of nitrogenous material that may turn out to be of very great money value. It has been found that the contents of leaves of clover, so far as nitrogen was concerned, was very much greater at the close of the day, or near the close of the day, than it was in the morning or during the forenoon. That is, during the day, especially on bright and sunny days, the plants were able to manufacture large quantities of these materials. Now one of the main things for which our clover crop is grown is the large amount of nitrogenous materials which it contains as compared with other fodders. It is quite plain that if these results are correct, the harvesting of such a crop as this near the close of the day is going to give us a fodder whose money value is decidedly greater than that of one harvested early in the day, before the plant has been able to manufacture these substances; for in the course of the night the large majority of them are utilized for the plant's own growth, and are converted into other forms of material which are less valuable as animal food.

But I cannot dwell upon that topic. Let me give you a hint from another field. Perhaps if I should ask any of you what is the purpose of the shade-trees along the streets of our cities and villages the answer would be quite unanimous that these trees were for shade and beauty; and yet these trees are not used for that purpose. At least nobody, I think, would imagine that that was their use, if he passed along the streets of our own city. He would think that the main purpose of the best elms was to furnish adequate stays for some electric pole or to support the telephone wires which pass through them. He would suppose, if he saw the city force making a street, that the chief purpose of the roots of the trees was to be grubbed out of the way for the first curbstone or sidewalk that the city wished to put along that way. If one saw people trimming their shade-trees, he would think that the main advantage of these was to afford an object lesson as to how badly work could be done, and how much injury could be inflicted upon an unoffending plant, apparently with the intention of affording it early relief from its sufferings by death. Our treatment of shade-trees in the streets of cities and villages is one of the crying shames of this day. Watch the "trimming" of street trees. Ignorant laborers half chop and half break off the limb of a tree, and leave the rough end exposed to wind and weather instead of caring for the wound properly. We seem to think we have no more duties towards that particular tree except to ged rid of a branch that may be a little bit in our way. We do the very thing which will subject that tree to the greatest danger. We offer the very best chance for the attack of parasitic animals and plants on that tree; as though our main purpose was to destroy it, instead of our alleged intent, to trim it in order to maintain and augment its beauty.

This naturally suggests the management of forests. *Management* of forests? We hardly know of such a thing in this country. We do not manage our forests. We simply cut them down, and then are glad that the cutters can move on to some other acre and cut it down in the same way. We have made almost no provision in this country for maintaining our supply of timber. People may say what they please about the inexhaustibility of our forest resources. Those of you who have given the subject any attention know that it is utter folly to say that our forest resources are inexhaustible, or that they are not being exhausted at a most extrava-

gant rate. Now men trained in the knowledge of how plants live and grow and behave have some basis on which they can suggest ways of managing forests which will not only yield all the timber that is needed at the present time, but which will enable these forests to continue to yield such supplies for an indefinite period of years. Forest management is not unknown in other countries. We simply have trained no men in this country to have any idea what forest management means.

And then we have the immense subject of diseases of plants, and that is a study which seems to have attracted the greatest attention at the present day. The division of vegetable pathology at the Department of Agriculture at Washington is receiving a vast deal more attention than the division of forestry, and yet I doubt very much whether its money value to the people is any greater. The money value of the study of *both* these subjects to the American people, and *particularly to the farmers of the country*, is almost beyond calculation. We hardly realize what this money value is. We are so used to losing a certain percentage of our farm crops by diseases that we really pay no attention to it. If our animals, our flocks and herds, should be decimated as often as the crops are, we should hear such a hue and cry as would bring immediate attention on all hands to it. I suppose there is no one of you, who has given the subject a moment's thought, but will agree with me that the loss from rust on the wheat crop for the present year, stated in the very lowest possible terms, could not fall below one per cent. How much money does that mean on six hundred odd million bushels of wheat? It means several million more than has been laid out in the study of plants in all the centuries. It means a great many hundreds of thousands of dollars more than we shall lay out the next century for the study of plants; and yet we are learning and can learn how not only to check but how absolutely to prevent such diseases as this. I do not say that this particular one can be absolutely checked at the present time, but we know ways in which it can be reduced to a minimum, even at present. The same thing might be said in regard to such diseases as those of the smut in corn and oats. Very careful estimates of certain years have shown us that as much as ten per cent sometimes of an oat crop is damaged by that one disease alone. That might mean a good many millions of dollars on that one crop. So that a study of these plant diseases is by no means either fruitless or valueless.

But you say, "Why not let anybody who is concerned with these matters study them?" Chiefly because it is not possible for any man who does not know something of the life history of the parasite which causes a disease to go about checking or curing it. He may guess at some remedy, and he may, by a lucky guess, hit upon the right remedy. He may think of some process that possibly will turn out the right one, but he is not nearly so apt to think about the right process or to hit upon the right experiment as the man who has been properly trained for this kind of work. That sort of training means *time* to study, and *time* to work, and *money support* while the work is being carried on.

I might dwell at very much greater length on these various topics; but enough has been said, I hope, to give you some idea of what modern botany is and what the modern botanist is. It will at least give you a truer idea than you would have if you considered him *merely* as the man who goes out and gathers some plants, useful as this may be, or the man who tears apart some flowers to find out what the names of the flowers are. Rather, I would have you think of the botanists of the country as those men who are studying means of discovering, checking, and curing the plant diseases; men who are studying how plants grow, and how they may be helped in their growth and not harmed. They are men who are studying what is the rational basis for our modes of culture; and it is to these men the agriculturist must turn, with the hope that their experiments will lead him in the future, as they have in the past, to more rational modes of cultivation, and to better knowledge of the organisms, the very intricate organisms in spite of their simplicity, with which he has constantly to deal.

NOTES ON A DESTRUCTIVE FOREST TREE SCOLYTID.

BY ANDREW D. HOPKINS.

THE family of beetles known as Scolytidæ contains in this country, so far as known, something over 160 species. They are small, cylindrical, brown or black beetles. The largest one of the family, *Dendroctonus terebrans*, is thirty-two hundredths of an inch long, while the smallest, *Cripturgus atomus*, is but four hundredths of an inch long. With a few exceptions, beetles belonging to this family breed in the bark of wood of different forest and fruit trees. Each species usually has a preference for certain kinds of trees. Those feeding on the bark are called bark beetles, while those entering the wood are termed timber beetles. The bark beetles breed in and feed upon the inner bark of trees or logs, and when fully developed emerge through the bark, leaving it pierced with small round holes. The timber beetles enter directly through the bark, making their "pin-hole" tunnels in all directions through the wood; their eggs are deposited in these tunnels, and when the young are fully developed they emerge from the original entrance made by the parent beetle.

It has been claimed that Scolytids never attack healthy, living trees. We acknowledge that as a rule the different species of this family have a preference for unhealthy trees or those which have been broken by storm or felled by the axe, but in this *Dendroctonus frontalis* we certainly have an exception to the rule. From the abundant evidence I have obtained during extended and careful investigation, I am convinced that the death of large and small, vigorous trees of five species of pine and of the black spruce was caused primarily by the attack of this insect; in fact, this species seems to have a preference for the green bark on the living pine and spruce which they invade.

As Entomologist of this Station, I have conducted some investigations regarding the ravages of this beetle, and, since May 2 of this year, have travelled about 340 miles through some of the principal regions of the State, where the pine and spruce are most common. The species of pine observed were the White Pine (*Pinus alba*), the Yellow Pine (*P. echinata*), the Pitch Pine (*P. rigida*), the Table Mountain Pine (*P. pungens*), and the common Scrub Pine (*P. inops*). The Black Spruce (*Picea Mariana*) is also a common and valuable tree on some 500,000 acres of the higher mountains and table-lands of this State.

Trees varying from five inches in diameter to the largest, finest specimens of the five species of pine mentioned, and of the Black Spruce, were found dying in different sections from a cause which it was my duty to investigate. A large number of the dead, dying, and green trees were felled and examined. Every part of the trees from the roots near the surface to the terminal twigs and leaves was carefully