tion may prove it to be untenable; but it is to its credit that, besides tracing to dynamical causes the existing distribution of continent and ocean, it offers an explanation of the difference between the Atlantic and Pacific types of coast, it gives indications of a possible account of those alternations of sea and land which first led to the study of geology, and it suggests an origin for Charles Darwin's unknown force, the operation of which is slow and intermittent, but irresistible.

A. E. H. LOVE

PLANT PATHOLOGY[1]

YOUR secretary has asked me to review as far as possible in ten or fifteen minutes our actual knowledge of plant diseases, the best methods of combating them, the progress that has been made, together with a suggestion or two as to some improvements that may be expected in the future. I have accepted the invitation, knowing fully that I could not in so short a time begin to cover so much ground with a sufficient degree of thoroughness to give an adequate idea even of the most important bearings of pathology on horticulture, but I concluded that the committee must have had in mind that I would use their request as an illustration of the greatest failing, not only in pathological investigation, but in the application of methods recommended for the control of diseases, namely, *too much haste and lack of thoroughness.* These are failings incident to work in a new country under great pressure, where the field is large and the workers few. There has been a good measure of economic justification for the mistakes of the past, and they are teaching us valuable lessons for our guidance in the future. What we need now is to study carefully these successes and failures and determine as accurately as may be possible their causes as a basis for improved practise.

The old conditions are rapidly changing. The new times require more careful and intensive methods.

One-crop farming, too short and unwise crop rotations, improper methods of fertilizing and culture, with destruction of humus and the life and fertility of the soil, careless methods of propagation and seed selection, the use of varieties not adapted to soil and climate, and other limiting conditions are responsible for loss from diseases in a larger degree than is realized. An orange, or plum, or peach, or apple, or any other tree or shrub, whose cambium responds to a few warm days in winter or early spring, is not a safe variety to plant in localities where such warm periods occur. Plants of northern range, accustomed to respond to lower initial heat stimulus, are thus subject to winter injury in more southern latitudes. On the other hand, plants of southern range planted north start later, are less subject to late frosts, but may be injured by early frosts. These cold injuries are often hardly noticeable, but they are sufficient to weaken the plant and open the way for trunk cankers and numerous other parasitic diseases which the trees could otherwise resist.

A soil slightly too acid or alkaline for a particular variety, though not enough to prevent growth, may nevertheless weaken the root system, or, in fact, the whole plant, making it subject to serious disease. So also the moisture or temperature fluctuations of the soil and its aeration may be unfavorable to a particular variety, making it less resistant to disease, if not actually causing a pathological condition in itself. Too little attention has been given to these factors by the farmers and horticulturists as well as by the pathologists.

[1] Paper read at the meeting of the National Council of Horticulture, Jamestown, Va., September 23, 1907.

An important duty in this new century will be to develop a better appreciation and more accurate understanding of the relation of these factors to health and disease. The cropping system of a farm or orchard, the planting of a nursery or a park to be satisfactory and successful in securing healthy growth must be undertaken only after a careful consideration of all these factors involved. Like the architect, the horticulturist and the farmer must have a carefully thought-out plan and as nearly as possible see the end from the beginning.

RESISTANCE AND IMMUNITY

Our ideal, of course, is to cultivate plants that can in the largest measure consistent with other requirements fight their own battles. Observation and experience have given us a large amount of information on adaptability to conditions and resistance to disease, which remains to be classified and digested in order to be made generally available. We often neglect to reap the benefits of a destructive drouth, a cold wave, an epidemic of disease, or the failure of a crop, *by neglecting to study and save what is left.* The few straggling plants left do not appeal to the average man. He plows them up or turns in the hogs. But the man familiar with nature's methods sees in these survivors resistant strains and saves the few straggling plants for seed, with the hope that the few survivors may have some peculiarity transmittable to progeny, making them resistant to the factor that caused the general destruction of the crop. In this way originated the wilt-resistant cotton, wilt-resistant cowpeas and flax, and cowpeas and tobacco resistant to nematode or root-knot. Strains of red-clover resistant to anthracnose (a disease which in many sections of the South makes it impossible to grow ordinary non-resistant clover) were also originated in this way. Strains of corn, oats, wheat, rye, clover, alfalfa, sugar beets and other grains, forage plants and vegetables resistant to cold, alkali and drouth have been developed from such selections—in some cases made purposely by subjecting the crop to these conditions, in others in simply taking advantage of what occurred naturally. In some of the older and more thickly populated parts of the world, necessity has forced the saving of the last straw. This is why we find the drouth-resistant durum wheats in the dry regions of Russia and Asia and around the Mediterranean, the alkali and drouth-resistant alfalfas and other forage crops in the same regions, a cold-resistant alfalfa in Siberia and Northern Manchuria, the cold-resistant winter-wheats of Russia, and other crops too numerous to mention. Hundreds of years of culture and selection, forced by poverty and necessity under forbidding conditions of cold and drouth and disease, have made those sections veritable storehouses of good things, but what nature and necessity have not produced for us we can in large measure do for ourselves. We can combine the cold-resisting quality of the trifoliate inedible orange with the fruit qualities of the tender, sweet orange; the disease-resistant quality of the citron with the fruit quality of the edible melons; the rust-resistant quality of the durum wheat with the berry of the blue stem; the cold-resistant quality of the wild crab with the fruit of our finer apples. The possibilities of such composite breeding have scarcely been touched or appreciated. In such work many factors must be taken into account and great care and foresight exercised.

PATHOLOGICAL INVESTIGATION

Coming now to the scientific study of plant diseases, there is almost unlimited room for improvement. Compared with what there is still to discover, our knowledge of most diseases is still meager and

one-sided. The brain of the pathologist is his most important instrument in such investigations. It must be trained to work with precision in all of the various directions and fields involved in such study. This is not now generally the case, and our colleges must be awakened to their duty. To most successfully combat a disease, we should know the causes that contribute to it and as much about the causes as possible. We should understand the pathological reaction of the diseased plant. Only in this way shall we be able to remove the causes or protect the plant against them or assist it to recover.

SPRAYING

In the cases of disease due to attack of parasitic organisms, we are often able to protect our crops by spraying. Spraying, like a coat of mail, is a protection against entrance to the tissues by invading organisms. If there are any holes in the coat of mail or if it is made of poor material or is put on after the arrow has pierced the flesh, it may be of no avail. Much of our spraying has holes in it. The tissues are not properly coated during the periods of attack. Much of the new growth is left unprotected during the critical period. The parasite gets in through these places, and we find too late that hasty, careless spraying is of little value.

Improperly made mixtures, or mixtures made of poor materials, are often of no protection and may be as injurious as the disease. Even good Bordeaux mixture can not safely be used on some plants, like peaches, and in some seasons is slightly injurious to apples.

The apparatus for spraying is, as a rule, poorly constructed, clumsy and in great need of general improvement and adaptation to particular conditions. Demand good machinery and pay for it. It is essential to success. Those who know these things must teach, *by demonstration,* those who know imperfectly or do not know at all. Literature is valuable as an aid to demonstration teaching, but can never take the place of it. Too much dependence on literature is one of our great educational mistakes. Send out fewer bulletins and more men.

Briefly, then, we shall improve on the pathology of the last century if we take time to be careful and thorough; study the causes of failure and profit by the results; demand better-trained minds and improved apparatus, and depend in our teaching more upon men and less upon books.

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SCIENTIFIC BOOKS

The Carboniferous of the Appalachian Basin. By John J. Stevenson, Professor of Geology in New York University. Pp. 595.

This is the title of a volume recently issued by Judd & Detweiler, of Washington, D. C. The volume consists of four papers previously published in the *Bulletin of the Geological Society of America* between 1903 and 1907.

The subjects treated in these several papers in order of publication are: "Lower Carboniferous," a paper of 82 pages, presented before the society, July 1, 1902, and published March 28, 1903; "The Pottsville" is next discussed in a paper of 174 pages, presented before the society, January 1, 1904, and published under date of May 28 of the same year; the "Allegheny" and "Conemaugh" formations were discussed in the third paper of 165 pages, presented before the society, December 29, 1905, and published May 28, 1906, while the concluding paper of 174 pages, including an elaborate index, presented before the society December 29, 1906, and published under date of April 19, 1907, deals with the "Monongahela" and "Dunkard" formations, ending with a chapter on "Geographical Changes during Pennsylvanian" time, and some "Paleontologic Notes" upon the fauna and flora of the Pennsylvanian.