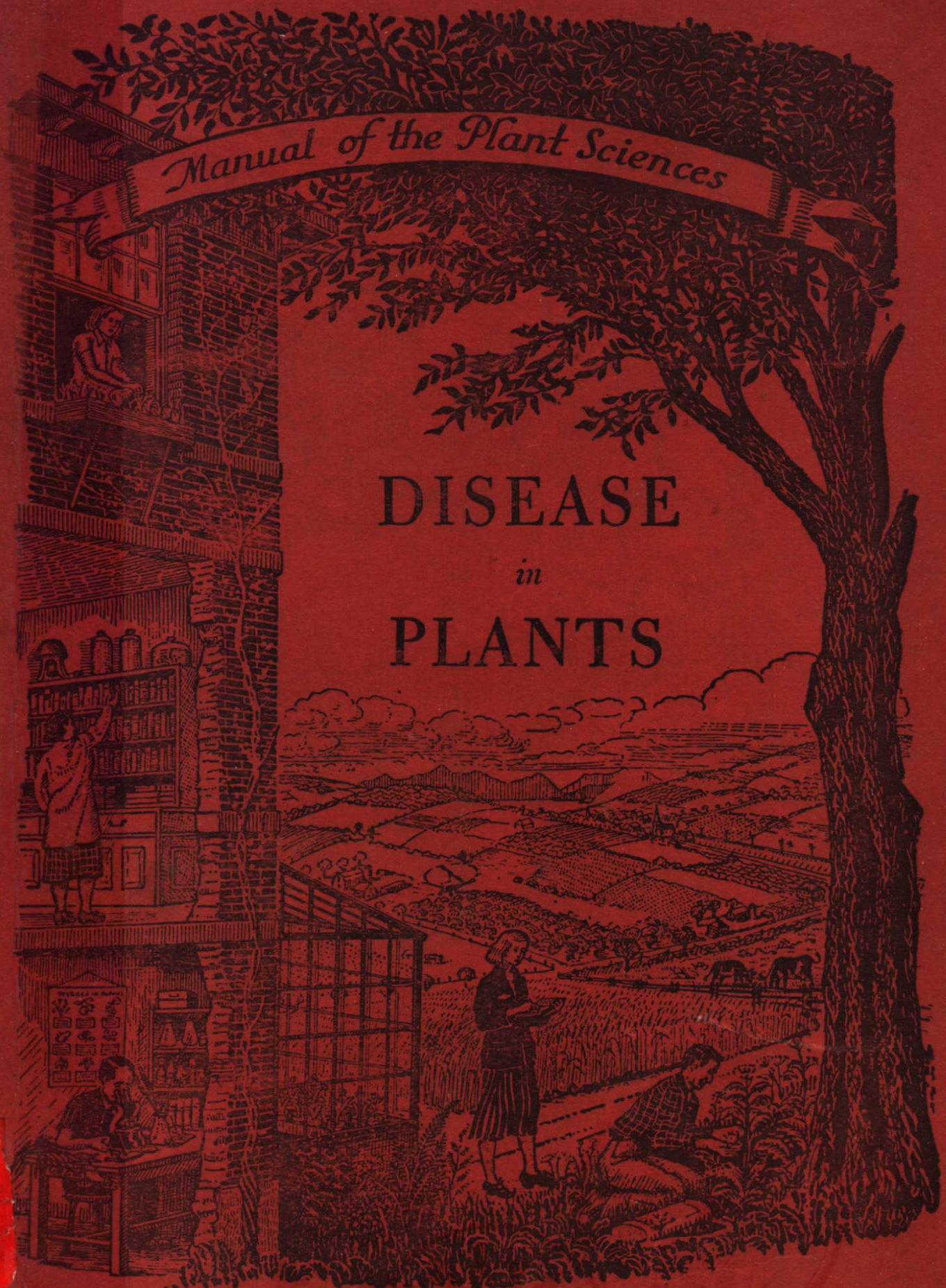
Manual of the Plant Sciences

DISEASE *in* PLANTS



DISEASE

in

PLANTS

An Introduction to Agricultural Phytopathology

by the late NEIL E. STEVENS, Ph.D.
formerly Professor of Botany, University of Illinois

and RUSSELL B. STEVENS, Ph.D.
Associate Professor of Botany, University of Tennessee

1952

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Designed by Frans Verdoorn

FRONTISPIECE FROM *Selecta Fungorum Carpologia* BY L. R. AND C. TULASNE (1861-1865).—The TULASNE brothers, who worked during the middle of the 19th century, are perhaps best remembered for their excellent researches in the life histories of plant pathogenic fungi which were published in several, beautifully illustrated volumes. The mycological emphasis of the TULASNES and their contemporaries on the science of plant pathology, as symbolized in this engraving, is still strongly evident after a full hundred years.

Manual of the Plant Sciences

edited by Frans Verdoorn

Volume I

* * * * *

THE SENIOR AUTHOR *was born in 1887, in Portland, Maine, and spent all of his early life in that state, graduating from Bates College in 1908. From there he went to Yale University, obtaining a Ph.D. in Botany in 1911. After a year of teaching at Kansas State College, he joined the federal Department of Agriculture, an association which lasted some 23 years. During this period he was chiefly concerned with the chestnut blight, with diseases of small fruits and corn, and with the development of the Plant Disease Survey. In 1935 he was made Professor of Botany at the University of Illinois, and served as head of that department for several years prior to his death in 1949, of coronary thrombosis. Dr.* N. E. STEVENS *was president of the Botanical Society of Washington, the American Phytopathological Society, and the Botanical Society of America. In 1930, and again in 1935, he served as an official delegate to the International Botanical Congresses.*

THE JUNIOR AUTHOR *was born in Washington, D.C., in 1915, and graduated from the University of Virginia in 1937. He received the Ph.D. degree in Botany from the University of Wisconsin in 1940, and subsequently taught at Birmingham-Southern College, the University of Louisville, and Alabama Polytechnic Institute. This program was interrupted for four years by service in the Medical Department of the Army during World War II. At present he is Associate Professor of Botany at the University of Tennessee. Dr.* RUSSELL B. STEVENS *worked for a time with the Dutch elm eradication project, and for five summers at the Connecticut Agricultural Experiment Station.*

* * * * *

THE MANUAL OF THE PLANT SCIENCES, a comprehensive, twelve-volume review of the present state, historical development, and future possibilities of the science of botany, will be completed over a period of about five years by the Chronica Botanica Co. under the editorship of FRANS VERDOORN with the assistance of the Editorial Board of CHRONICA BOTANICA.—The authors of each of these concise, readable and stimulating volumes stress the development of the field with which they deal. Basic principles and the relations with other branches of science and human endeavour, in general, are emphasized.—Each volume will consist of about 220-240 pages, with a good number of historical and modern illustrations. The Manual will be concluded with a concise dictionary which will serve at the same time as an index to the entire work.

Plan of the Series:—

PLANT ANATOMY, MORPHOLOGY AND MORPHOGENESIS,
PHYSIOLOGY OF PLANTS,
PLANT BIOCHEMISTRY,
MICROBIOLOGY,
PLANT CYTOLOGY, GENETICS AND BREEDING,
CRYPTOGAMIC BOTANY,
PRINCIPLES OF PLANT TAXONOMY,
PRINCIPLES OF PALEOBOTANY,
PLANT ECOLOGY AND GEOGRAPHY,
INTRODUCTION TO ECONOMIC BOTANY,
DISEASE IN PLANTS,
DICTIONARY OF THE PLANT SCIENCES.

Preface

"Of making many books there is no end . . ."
(Ecclesiastes 12:12).

And that, though the preacher neglected to point it out, is one of the essential characteristics and great advantages of books! Few books indeed go far beyond those on which they are based—many serve as foundation material for other, newer, sometimes better books. So this one complements, does not replace, current excellent texts in plant pathology.

It originated in our attempt to discover a common ground—a least common denominator—for general courses in plant pathology to be given in two different universities. One fact was at once evident. It was not desirable to use the same illustrative material. Tennessee and Illinois are not far distant, but the major crops, the major interests of the students, are different. If this be true of two states which at one point are less than fifty miles apart, how much more evident must it be in states and countries more widely separated. Yet there must be some body of knowledge and a point of view which is common to plant pathology and plant disease problems everywhere. The material here presented is the result of our discussions and studies on this point.

We have attempted to include the subject matter of plant pathology in a series of twenty lectures planned, in so far as practicable, as self-contained units. Consideration of specific pathogens, diseases, and control measures is delegated to the laboratory. In serving the needs of majors in Horticulture, Agronomy, Agricultural Education, Agricultural Economics, Dairying; of men who will some day be county agents, Smith-Hughes teachers, commercial demonstration agents, professional plant pathologists, or private farmers, we find no better plan.

It is hoped that a volume which tries to concentrate attention on general principles will prove helpful to the understanding of the science and practice of plant pathology. Specifically planned and prepared for students, it may prove of value to professional plant pathologists and to the general reader.

After long consideration the title "Disease in Plants" was chosen as giving the fairest picture of the material contained in this book. It is not without interest to note that just half a century ago, in 1901, a book bearing the same title was published by H. MARSHALL WARD, regarded by many as the greatest of the early British pathologists, and as having an enormous amount of influence on the development of the science in that country. Like ours, his book deals strictly with the subject indicated, and does not include descriptions of particular diseases. We might almost have lifted much of his introductory material and transferred it to these pages, so closely do his ideas align with ours.

My father's death, in 1949, at a time when much of the manuscript was essentially complete, was both a deterrent and a spur to its completion. It is only with the help and encouragement of others that this has been done. E. M. STODDARD of the Connecticut Agricultural Experiment Station, S. A. DIACHUN of the University of Kentucky, and C. M. STEVENS of the State College of Washington have critically read the manuscript and a large number of their suggestions have been incorporated. It is a pleasant obligation to acknowledge their contribution, and to recognize the assistance given by numerous colleagues through their publications, letters, informal conversations, and generous loan of many illustrations. For a wealth of experience, work, and patience, Dr. FRANS VERDOORN deserves our deepest gratitude.

We have tried, in a limited way, to direct the reader's attention further by use of literature citations, but this is by no means to be regarded as a complete survey of original sources. The usable knowledge available to each of us was compounded of material from many sources, written and oral. This was combined, it is to be hoped, with some original ideas. After a few months or years, it is frequently difficult to distinguish sources. If there appear in this text phrases or sentences which represent direct quotations save for the formality of the quotation marks, it is unplanned, but rather is evidence that someone has said or written so forcefully that not only the idea, but the very form, became fixed in mind. We derive comfort, perhaps justification, in the words of the author-physician, OLIVER W. HOLMES, to be found in his "Medical Essays": "The traveller who would not drink of the Nile until he had tracked it to its parent lakes, would be like to die of thirst; and the medical practitioner who would not use the results of many laborers in other departments without sharing their special toils, would find life far too short and art immeasurably too long."

RUSSELL B. STEVENS,
Knoxville, Tennessee,
September, 1951.

"Disease is from old and nothing about it has changed. It is we who change as we learn to recognize what was formerly imperceptible." (CHARCOT).

"The name of a disease is not, as it is continually regarded, a thing." (ALBUTT).

". . . to perceptive minds, chance and intuition are far more potent than reason and logic." (PARKES).

". . . a new idea is the most quickly acting antigen known to science." (WILFRED TROTTER).

"The use of statistics does not lessen the necessity for using common sense." (BEVERIDGE).

"How to distinguish the promising clues is the very essence of the art of research." (BEVERIDGE).

"If you plant small potatoes, you will reap small potatoes." (FREDERICK THE GREAT).

"Instead of writing thick books or even little libraries on the nature and control of plant diseases, we would do better to assemble basic statistical data, to determine, by estimates, the average losses from diseases, so that we may avoid these losses by foresight." (SCHLEIDEN).

"Disease, dis-ease,—disturbed quiet, uncomfortableness,—means imperfect or abnormal reaction of the living system, and its more or less permanent results." (OLIVER W. HOLMES).

"So dependent are some plant diseases on the influence of the environment that, before such causal agents as fungi were known, the diseases were attributed solely to the environmental conditions . . . If rabbits were invisible microscopic organisms unknown to science, and a break in the fence always resulted in destruction of the plants, a logical conclusion from experience would be that the lettuce was destroyed by the break in the fence." (FAWCETT).

"On July 27 I passed from Cork to Dublin, and the plants bloomed in all the luxuriance of an abundant harvest. Returning on August 3, I beheld with sorrow mere wastes of putrefying vegetation." (FATHER MATHEW).

"The history of all great planting enterprises teaches us that he who undertakes to cultivate any plant continuously in open culture over large areas must run the risk of epidemics." (H. MARSHALL WARD).

[on storage of citrus] *"Be sure to keep them away from the vicinity where liquor is kept. Examine them every 10 days and remove the spotted ones or they will spread infection to fruits near them."* (HAN YEN-CHIH, 1178).

"It is the advantage of being a statistician that one can make out a case against most interpretations of statistical trends." (MAJOR GREENWOOD).

". . . almost every rational action has to be based upon some sort of forecast of its future results. Rational human beings, therefore, must of necessity be forecasters." (KARL T. COMPTON).

"Nothing emerges more clearly from the history of biological thought than that almost without exception the crucial experiments which have been most loudly hailed at the time they were made, as forever settling the problem under discussion, have been subsequently found to have led to quite erroneous conclusions. It takes months, or even years, of careful observational work to get ready to do a really significant biological experiment." (PEARL).

"The whole of existence is too great a thing to yield its secrets when studied in one aspect only." (DAMPIER).

"When the experiment is concluded the results must again be submitted to scrutiny, so that they may be checked, accepted, or refuted by the supreme inquisitor, observation. Observation is, indeed, the first act in scientific procedure, and it is the last act also." (LORD MOYNIHAN).

"Like glaciation, floods and famine, disease makes man active, versatile and inventive by shattering his complacency, rendering him supremely uncomfortable, developing his foresight and forcing him to assume some responsibility for his own destiny. Pestilence destroys equanimity and teaches that procrastination is death, action is life, and knowledge is salvation. Under its influence, men think, defy superstition, ignore tradition, and try the new." (J. HOWARD BEARD).

DE MORBIS PLANTARUM COGNOSCENDIS ET CURANDIS DISSERTATIO

EX PHÆNOMENIS DEDUCTA

A

P. JOANNE BAPT. ZALLINGER S.J.

PROF. PHYS. PUBL. ET ORDIN.

PROPUGNATUR

CUM POSITIONIBUS

EX

UNIVERSA PHILOSOPHIA

A

FRANCISCO VOGLSANGER

AD S. JOAN. TYROL.

ET A

CAROLO BURGER

PRÆNOB. HELVET. GLARON. NAVEL

PERMISSU SUPERIORUM.

OENIPONTI,

TYPIS JOANNIS THOMÆ NOB. DE TRATTNERN,

CÆS. REG. AUL. TYPOGRAPHI, ET BIBLIOPOLÆ.

MDCCLXXIII.

FATHER ZALLINGER'S *De Morbis Plantarum*, PUBLISHED IN 1773, IS ONE OF THE EARLIEST BOOKS DEVOTED ENTIRELY TO PLANT PATHOLOGY.—In contrast to PLENCK'S later book was the philosophical treatment given by ZALLINGER, in this rare classic, in which he devoted a large part of his efforts to consideration of disease as a phenomenon, and attempted to classify the different sorts of disease, *in modo Linnaeano*, on a symptomatic basis.

I^re. FIGURE.

FIGURE DU TERREIN LABOURÉ A LA CHARRUE.

	1^re. DIVISION. 60 pieds.	2^e. DIVISION. 40 pieds.	3^e. DIVISION. 221. pieds.	4^e. DIVISION. 40 pieds.	5^e. DIVISION. 60 pieds.
A	Bled ſain ſans préparation. — RÉSULTAT. Quelques Épis cariés.	Le même infecté exprès de noir. — RÉSULTAT. Une quantité prodigieuſe d'Épis cariés.	Bled ſain ſans préparation. — RÉSULTAT. Quelques Épis cariés.	Le même infecté de noir & préparé en cet état avec l'eau ſaoulée de nitre, & la chaux en poudre. — RÉSULTAT. Épis cariés, rares.	Bled ſain ſans préparation. — RÉSULTAT. Quelques Épis cariés.
	SENTIER.				
B	Bled originairement infecté de noir, préparé comme celui de la 3^e. diviſion ſuivante. — RÉSULTAT. Épis cariés, rares.	Le même infecté de noir, ſemé en cet état. — RÉSULTAT. Une grande quantité d'Épis cariés.	Le même lavé 1°. dans l'eau commune, 2°. dans l'eau de leſſive ordinaire, 3°. humecté avec trois pintes d'eau de leſſive de potaſſe, 4°. ſaupoudré de chaux. — RÉSULTAT. Épis cariés, rares.	Le même lavé 1°. dans l'eau commune, 2°. dans l'eau de leſſive ordinaire, 3°. humecté avec l'eau ſaoulée de nitre, & ſaupoudré de chaux. — RÉSULTAT. Épis cariés, rares.	Le même préparé comme celui de la 3^e. diviſion. — RÉSULTAT. Épis cariés, rares.

Longueur entiere du Terrein, 38 pieds.

Longueur.....entiere.....du.....Terrein.....421.....pieds.

LAY-OUT OF ONE OF THE CLASSIC EXPERIMENTAL PLOTS USED BY TILLET, NEAR BORDEAUX, DURING THE YEARS 1753-1754, FOR HIS STUDIES OF WHEAT SMUT.—This work is described in the "Continuation" to his *Dissertation sur la cause qui corrompt et noircit les grains de bled dans les épis* (available in an English translation, by H. B. HUMPHREY, in *Phytopathological Classics*, No. 5). TILLET's efforts were among the earliest truly experimental studies of disease in plants.

JOSEPHI JACOBI PLENCK

Consiliarii Caesareo-regii Chirurgiae Doctoris, Chemiae atque I. tantisper Professoris publici, ordinarii in Academia medico-chirurgica Josephina, ejusdemque Academiae Secretarii perpetui, nec non Inspectoris pharmacopoearum militarium atque chirurgi status militaris supremi

PHYSIOLOGIA

ET

PATHOLOGIA PLANTARUM.

Praestat naturas voce doceri.

Seneca.

VIENNAE,

Apud A. Blumauer, 1794.

Die

Exantheme

der Pflanzen

und einige mit diesen verwandte

Krankheiten der Gewächse

pathogenetisch und nosographisch

dargestellt

von

Franz Unger,

der Heilkunde Doctor, Stadt- und Landgerichts-Physicus, der kön. bayerischen botanischen Gesellschaft zu Regensburg, der großherz. weimarischen Societät für die gesammte Mineralogie zu Jena, der k. k. Landwirthschafts-Gesellschaft in Steyermark ordentlichem und correspondirendem Mitgliede.

Mit sieben Kupfertafeln.

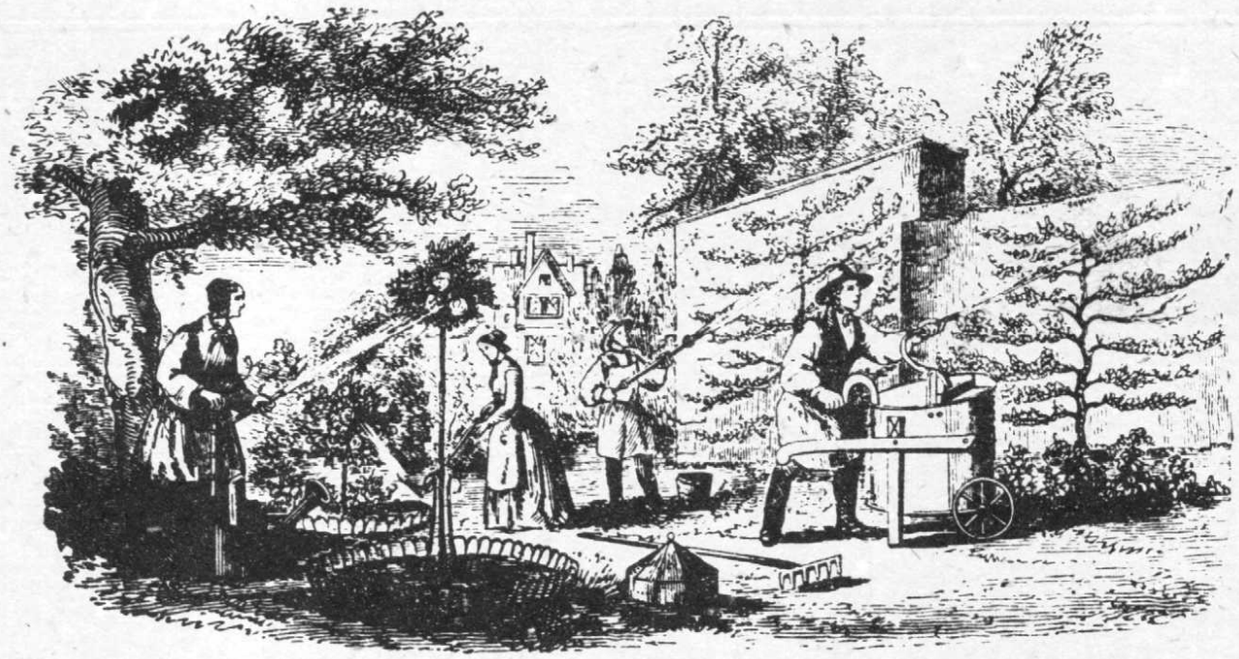
Wien.

Gedruckt und im Verlage bey Carl Gerold.

1833.

PLENCK's book, first published in Latin in Vienna, in 1794, and later in German, French and Italian, seems to have been the most widely circulated and influential text in the years succeeding its appearance. It was a brief, practical, succinct work, based on observation, and showed sufficient breadth of view to include injuries due to insects, extremes of weather, and poison gases.

UNGER, in his *Exanthema*, the leading phytopathological text of the Romantic period, still subscribed to the notion that pathogenic organisms were produced by diseased host tissues, *i.e.*, resulted from the disease itself. Aside from this rather natural error, studies of plant diseases, particularly of those caused by fungi, were by this time well advanced, and, according to present standards, increasingly accurate.



These illustrations, taken from *La Belgique Horticole*, are typical of many appearing in the Victorian era, and attest the enormous popularity of disease control by spraying which followed the work of MILLARDET and others in developing Bordeaux mixture. We may well say that, even today, no other control measure is so widely recognized, at least in working with horticultural crops. The gardener in the lower illustration appears to be using an insecticide; with equipment which seems, to say the least, somewhat cumbersome.

PHYTOPATHOLOGY

VOLUME V NUMBER 3

JUNE, 1915

INTERNATIONAL PHYTOPATHOLOGIC COLLABORATION

WORK BEGUN IN EUROPE—WILL IT BE PROSECUTED IN AMERICA?

JAKOB ERIKSSON

THE BEARING OF THE QUESTION

During the last twenty-five years we have seen in Europe an endeavor to bring together the phytopathologists of different countries to a systematic collaboration for combating the diseases of cultivated plants.

This idea is based on the fact, now, as I think, uncontested, that not only the growers but also the men of science are in most cases puzzled as to how to act against the parasites of different kinds, which now and then menace the culture of plants. Why this annoying state of things? The answer to this question is that our impotence against these enemies is due chiefly to serious deficiencies in our knowledge of the nature of the destroyers.

In a few cases only, do we really know the nature of these so well, that we may found on this knowledge an effective control of the diseases. Such is the case with the smuts (Tilletia and Ustilago) on the cereals, parasites that we know well enough to be able somewhat to control.

But in how many other cases is this true?

The common potato disease (*Phytophthora infestans*), known in Europe and in North America since about the year 1845, has been diligently and repeatedly studied on both continents. In spite of all efforts the parasite has spread to all countries where potatoes are cultivated, at last (1904) to Australia. It is true that we have learned that the spraying of the potato field with fungicides is an effective method of restricting the destructive effects of the fungus. Further we profit by the fact that varieties of potatoes differ in their susceptibility to attack by the parasite. But we are not advanced any further. We are yet incapable of preventing an outbreak of the disease or of stopping the spread of it. In spite

This essay, written for the then new American journal *Phytopathology*, under the stress of the first World War, represents ERIKSSON's first appeal, in English, directed toward the theme of international collaboration in plant disease control. As the great Swedish plant pathologist said: "The idea of an international collaboration in order to control the most destructive diseases of cultivated plants was made public for the first time, in Vienna in 1890. Later the same question was presented to international meetings: 1900 in Paris; 1903, 1905 and 1907 in Rome; 1907 in Vienna; 1908 in Montpellier; 1909 and 1910 in Rome; 1912 in Paris; 1913 and 1914 in Rome." Fortunately, such cooperation has indeed developed, to the infinite betterment of the science of phytopathology. While it remains as true today as then that "for . . . more effective means for combating the diseases . . . the only way . . . is continued research and continued experiments, in other words, a strengthening and development of scientific pathological work," there exist few branches of pure or applied biology where the results obtained in one part of the world are of more importance to workers in other regions than in plant pathology.

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